APPENDIX

Southwest Florida Water Management District. 2017. Correspondence and other relevant documents associated with stakeholder input and public outreach concerning development of the proposed minimum flow for the Crystal River/Kings Bay system. Brooksville, Florida.

May 19, 2011

MEMORANDUM

TO: File

FROM: Douglas A. Leeper, Chief Environmental Scientist, Ecologic Evaluation Section, Southwest Florida Water Management District

SUBJECT: Powerpoint slides by Sid Flannery concerning Crystal River/Kings Bay minimum flows

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This memorandum documents a Powerpoint slide presentation that was developed by Sid Flannery, Chief Environmental Scientist with the District. The slides were likely used for a presentation to the Crystal River Management Group (in September 2007). The slides, or a similar set of slides were also used for presentations by Sid Flannery to the Crystal River Rotary Club (in Jun 2007), the Crystal River Waterfront Board (in March or April 2008), the Citrus County Task Force (in May 2008), and the Kings Bay Association (in May 2008).

DAL
Attachment: Powerpoint slides by Sid Flannery concerning minimum flows for Crystal River

Attachment

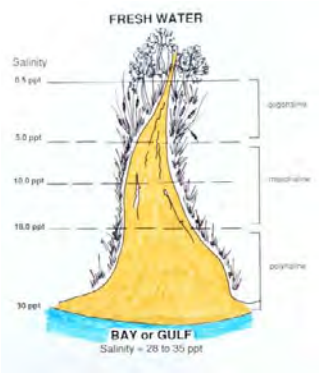
Powerpoint Slides by Sid Flannery Concerning Minimum Flows for Crystal River

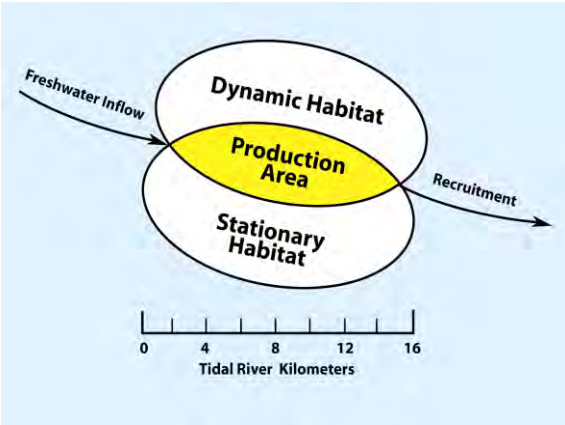
(F.S. 373.042)

Minimum flows are “the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area”

Translated

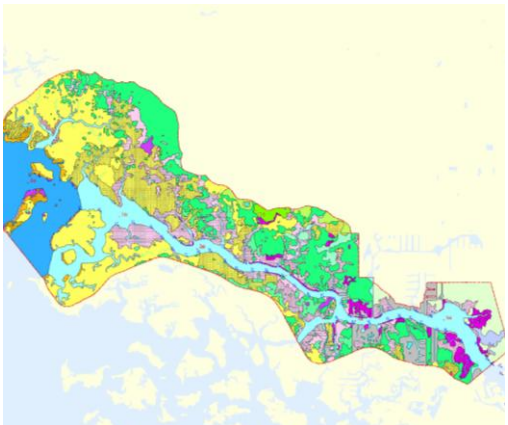
How much water can be removed for water supply without damaging the ecology of a river or its receiving estuary



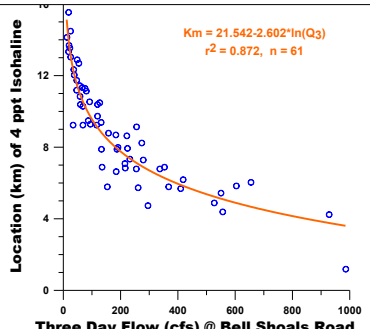


Typical MFL study elements

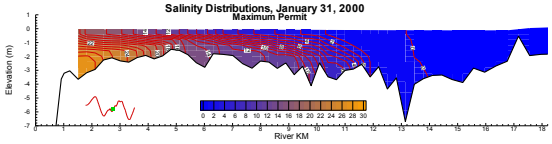
- Structural alterations, previous withdrawals
- Bathymetry
- Salinity
- Shoreline and submerged vegetation
- Benthic invertebrates
- Fish
- Thermal refuge for Manatees
- Water quality



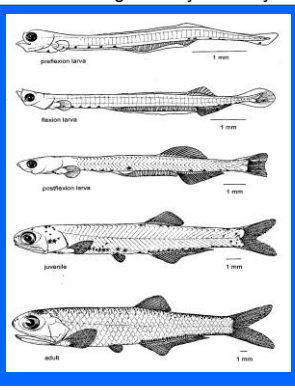
Isohaline locations as function of inflow

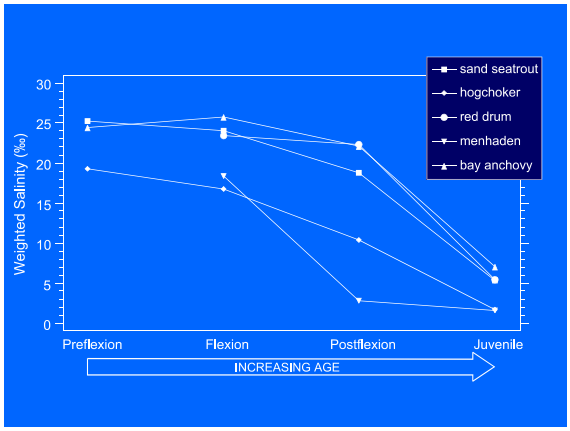


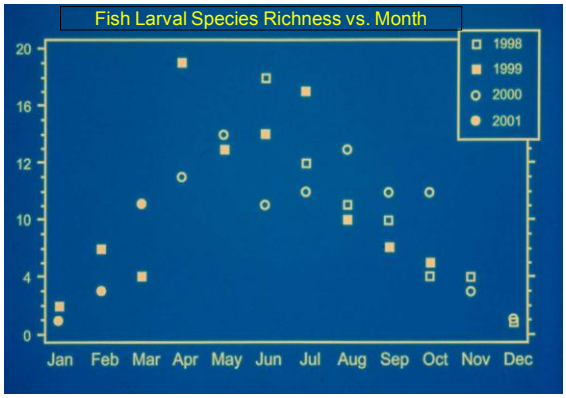
Hydrodynamic model simulations



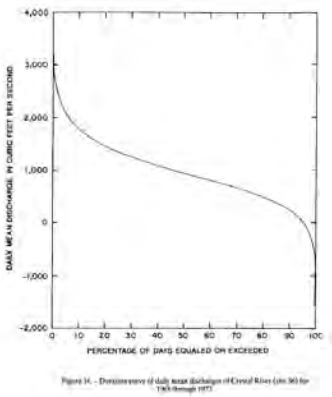
Life stages – bay anchovy

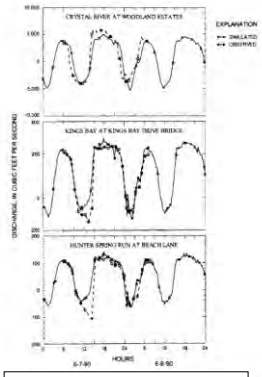






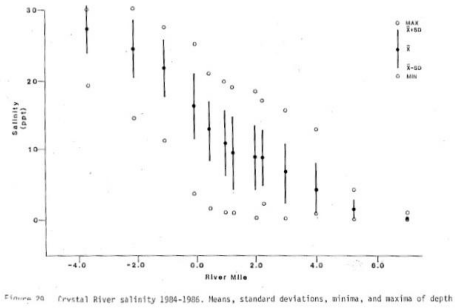


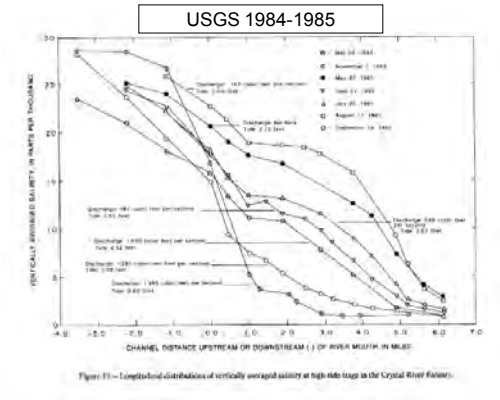




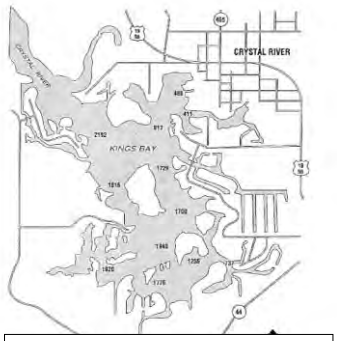
USGS 1990

Mote Marine Lab, 1984-1985

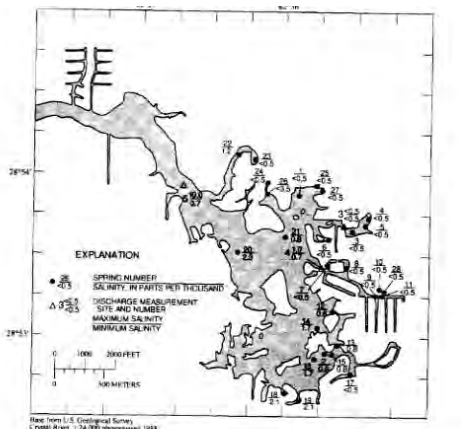




USGS 1984-1985



Specific Conductance SWFWMD 1985



Minimum Flow Rule Process

- Crystal River System scheduled for 2010
- Conduct research 2008-2009
- Draft report for peer review and public, Spring 2010
- Peer review reports to Gov. Board, summer 2010
- District replies to Peer review, public hearing
- Board action

May 20, 2011

MEMORANDUM

TO: File

FROM: Douglas A. Leeper, Chief Environmental Scientist, Ecologic Evaluation Section, Southwest Florida Water Management District

SUBJECT: Presentation on Agency activities and responsibilities for Kings Bay

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This memorandum documents a presentation on agency responsibilities in Kings Bay by Phillip Rhinesmith, a Senior Environmental Scientist with the District, to the Citrus Task Force in March 2008. The meeting agenda and minutes are included as attachments.

DAL

Attachments: A – Agenda for March 2008 Citrus Task Force meeting
B – Minutes from March 2008 Citrus Task Force meeting

Attachment A

Agenda for March 2008 Citrus Task Force meeting

Citrus County Task Force
Meeting Agenda

March 10, 2008
3:00 p.m.

Lecanto Government Building
3600 West Sovereign Path, Room 166
Lecanto, Florida 34461

*****All meetings are open to the public*****

1. Call to Order and Roll Call

2. Pledge of Allegiance

3. Approval of the January 14, 2008 Minutes

4. Crystal River/Kings Bay - Summary of the Various Agencies Responsibilities and Actions – Philip Rhinesmith, Southwest Florida Water Management District (SWFWMD)

5. Lake Rousseau - Summary of the Various Agencies Responsibilities and Actions – Jerry Krummrich, Florida Fish and Wildlife Conservation Commission (FFWCC)

6. Water Resource Education Related Activities
   a. Citrus County – Bernadine Flood
   b. Florida Department of Environmental Protection – Judy Ashton
   c. FFWCC – Jerry Krummrich
   d. SWFWMD – Beth Putnam
   e. LAKEWATCH – Claude Brown

7. Update on the Tsala Apopka Diagnostic Activities – Jerry Krummrich, FFWCC

8. Agenda and Location for Next Meeting

9. Public Input

10. Status Reports (no presentations)
    a. Water Quality Monitoring
    b. Tussock Spoil Site Access
    c. Diagnostic Survey of Sediments and Vegetation in the Tsala Apopka Chain-Of-Lakes

11. Goals, Objectives, Actions, Projects, and Schedules (information only)
    a. Improve Fisheries Habitat
    b. Maintain or Improve Water Quality
    c. Restore Historic Connections
    d. Improve Marsh Habitat
    e. Develop Restoration Plans

12. Adjournment

The District does not discriminate based on disability. Anyone requiring reasonable accommodations under the ADA should call 1-800-423-1476, extension 4226 (Florida only), 628-4226 (Suncom), or 352-796-7211, extension 4226; Fax 352-797-5806 or 663-5806 (Suncom); TDD only 1-800-231-6103 (Florida only).

If you have any questions concerning this meeting, please call 1-800-423-1476 or 352-796-7211, extension 4227. If a party decides to appeal any decision made with respect to any matter considered at a meeting, that party will need a record of the proceedings, and for such purpose that party may need to ensure that a verbatim record of the proceedings is made, which record includes the testimony and evidence upon which they appear is to be based.

Attachment B

Minutes for March 2008 Citrus Task Force meeting

APPROVED

MINUTES OF THE MEETING

Citrus County Task Force
of the
Citrus/Hernando Waterways Restoration Council

March 10, 2008

The Citrus County Task Force met at 3:05 p.m. on March 10, 2008, at the Lecanto Government Building, Lecanto, Florida.

Task Force Members Present	**Technical Advisory Group Members Present**	**SWFWMD Staff Members Present**
Michael Moberley, Chair	Judy Ashton, FDEP	Mark Hammond
Sandra Clodwick, Secretary	Mark Edwards, Citrus Co.	Veronica Craw
Carl Bertoch, Member	Bruce Hasbrouck, FDOT	Jimmy Brooks
Michael Czerwinski, Member	Jerry Krummrich, FFWCC	Beth Putnam
Ken Frink, Member	Sam Lyons, CRBB	
Wayne Sawyer, Member	Philip Rhinesmith, SWFWMD	

Task Force Members Absent	**Technical Advisory Group Members Absent**	**Recording Secretary**
George Miskimen, Member	Colonel Paul L. Grosskruger, USACE	Josie Guillen, SWFWMD
	Bo Rooks, WRBB	

SWFWMD – Southwest Florida Water Management District
FDEP – Florida Department of Environmental Protection
CRBB – Coastal Rivers Basin Board Member
WRBB – Withlacoochee River Basin Board Member
FFWCC – Florida Fish and Wildlife Conservation Commission
FDOT – Florida Department of Transportation
USACE – United States Army Corp of Engineers

A list of others present who signed the attendance roster is filed in the permanent files of the Task Force. The numbers preceding the items listed below correspond with the published agenda.

1. **Call to Order and Roll Call**
   Chair Michael Moberley convened the meeting.

2. **Pledge of Allegiance**
   Chair Moberley led the Pledge of Allegiance.

3. **Approval of Minutes**
   Following consideration, Mr. Carl Bertoch moved, seconded by Ms. Sandra Clodwick to approve the January 14, 2008 meeting minutes.

4. **Crystal River/Kings Bay – Summary of the Various Agencies Responsibilities and Actions**

Mr. Philip Rhinesmith summarized the various agency responsibilities from FDEP, SWFWMD, United States Geological Survey, Citrus County, City of Crystal River, and FFWCC and their actions such as: water quality, sediment, restoration, submerged aquatic vegetation and algae, water management plan, minimum flows and levels, cooperative funding, and wildlife management.

5. **Lake Rousseau - Summary of the Various Agencies Responsibilities and Actions**

Mr. Jerry Krummrich summarized the various agency responsibilities from SWFWMD, LAKEWATCH, Greenways and Trails, FDEP, FFWCC, and Citrus County and their actions such as: water quality, operations and maintenance, watershed management, nuisance aquatic plants and tussocks, fisheries, recreation, navigation, and minimum flows and levels.

6. **Water Resource Education Related Activities**

a. **Citrus County** – Ms. Joan Bradshaw from the Institute of Food and Agricultural Sciences gave a brief presentation on the following: 1) the county extension office, who they are; 2) Florida Yards & Neighborhoods and the benefits; 3) conservation concerns; 4) water related educational programs; 5) watershed efforts; 6) Citrus County Conservation Committees; 7) youth activities.

b. **FDEP** – Ms. Judy Ashton gave a brief presentation on the following: 1) Clean Marina Program; 2) Restoration; 3) Coastal & Aquatic Managed Areas; 4) Parks Department; 5) Stream Ecology/Bioassessment; 6) Internship Program.

c. **FFWCC** – Mr. Jerry Krummrich gave a brief presentation on Water Resource Education Activities specifically related to lakes and specifically to Lake Tsala Apopka and Lake Rousseau. Project W.I.L.D. is a program directed at teachers with information on the Florida ecosystems and the environment. Another program is directed to lakeshore homeowners with information on control of aquatic vegetation and use of herbicides. There are links to other agencies and organizations on the FFWCC's website. These include the FDEP and LAKEWATCH. The LAKEWATCH website is a valuable tool to understanding the importance of water quality, clarity, and other questions frequently asked by users and homeowners. Many of the education opportunities made available by the FFWCC are web-based and easy to use.

d. **SWFWMD** – Ms. Beth Putnam gave a presentation on youth education (mini grants, teacher training, field trip programs, education resources, and outreach), and public education (Florida Friendly Landscaping, watershed education, water C.H.A.M.P., community education grants, cooperative funding, publications, outreach, media messaging, and water conservation).

e. **LAKEWATCH** – Mr. Claude Brown did not attend the meeting.

7. **Update on the Tsala Apopka Diagnostic Activities**

Mr. Allen Martin, FFWCC, stated the Task Force members and the Technical Advisory Group (TAG) recommended a diagnostic study. FFWCC provided $723,731.50, to contract with PB Americas, Inc. Mr. Martin stated the preliminary characterization and

mapping of tussocks is to identify and prioritize future harvesting or scraping projects. The chemical sediment assessment is to prioritize potential hydraulic dredging projects and to determine possible spoil contamination issues. Mr. Martin also stated the hydrographic survey of all 15 lakes determined distribution and total quantity of unconsolidated sediment.

8. **Agenda and Location for Next Meeting**

- Update on MFLs (relationship with Crystal River Rousseau)
- Task Force position regarding Crystal River and Lake Rousseau activities in this year's annual report
- Potential Use of Alternate Dredge Sediments
- Morrison Pool/Sinks

The location of the next meeting will be at the Lecanto Government Building.

9. **Public Input**

- Mr. Bill Garvin, citizen, informed the Task Force members of the trash he picked up during Save Our Water Week. In three hours, 60 empty aluminum beverage cans were collected. The Rainbow River has a "No Disposable" law. Mr. Garvin asked if something similar can be done at the Homosassa and Crystal River.

  Mr. Garvin stated LAKEWATCH is testing the Homosassa River. Mr. Garvin is doing five spots on the Homosassa River and Mr. Ron Miller is doing three spots on Pepper Creek. The University of Florida has been doing fish counts and fish studies. They also did sediment retrieval in the Homosassa River. Mr. Garvin suggested the Task Force members contact them for more input.

- Mr. Charles Coose, citizen, asked for help to restore the SE corner of Hunters Bay by dredging the culvert drainage runoff that has occurred after many years. The culverts are in place and they drain Highway 19, Highway 44, and Highway 495. This is a county-wide problem and the runoff is going into Kings Bay. Mr. Coose has personally paid for soil samples/core borings. Mr. Cooses recommended that 18-24 inches of sediment be removed. Mr. Coose provided the Task Force members with hard copy information and photos.

- Ms. Dee Atkins, citizen, stated that City of Crystal River has an ordinance in place that requires the use of slow release fertilizers. However, until the county and the state adopt the same programs, there is not much they can do.

  Ms. Atkins stated any waterfront property should have public sewer service and any area where it is not feasible for public sewer needs to have high performance septic systems. Runoff comes from the higher parts of the county and it all comes down to Crystal River. This issue needs to be county wide, preferably state wide.

- Mr. John Fusch, citizen, stated essentially we have a dead river. There is nothing growing at the lower end of the Withlacoochee River. Mr. Fusch has photographic evidence from the early 80s showing a lot of grass, manatee feed, and habitat for bass. The herbicide program on Lake Rousseau is suspect. Mr. Fusch has been working with FDEP and was concerned when he learned that FDEP had not done

any monitoring in that part of the river when conducting the herbicide programs. Mr. Fusch stated that FDEP will begin a sonar program which will last for 100 days. Mr. Fusch is asking for help.

- Mr. Al Grubman, TOOFAR, thanked SWFWMD for keeping the water up in Lake Panasoffkee. Mr. Grubman continued to state SWFWMD opened three panels for golf course structures, opened a fourth panel recently, opened the Moccasin Slough panel, the gate to Lake Bradley, and the gate to Lake Consuela.
  Mr. Grubman stated there are two sinkholes in Morrison Pond. Together they account for a loss of 3.5 millions of gallons per day. The data from SWFWMD indicates two sinkholes are involved. The SWFWMD is in the process of analyzing the data. Mr. Grubman requested the Task Force members ask for the sinkholes to be stopped specifically those that do not affect property owners.

  Mr. Grubman asked Task Force member Mr. Carl Bertoch if the TAG meetings fall under the Sunshine Law. Mr. Bertoch's reply was each agency falls under the Sunshine Law. The TAG is not a policy making group.

- Mr. Ron Miller, citizen, Gulf Restoration Network (GRN) is a conservation organization related to the Gulf of Mexico. Their goal is to protect the nature coast of Florida. They are sponsoring overflights of the coastal area for those interested in conservation issues. GRN has offered an airplane flight for the Task Force members on Wednesday, March 19.

- Mr. Norman Hopkins, Amy Remley Foundation, thanked all of the agencies that supplied information which enabled the foundation to build the website. The website has attracted 60,000 hits per year. The next step is to move ahead and focus on the requirements of Citrus County for a public education center. Mr. Hopkins will be talking with SWFWMD and FDEP for the design plan. The intention of the building will be environmentally neutral. It should manufacture its own energy, use its own energy within the building, and the grounds should be environmentally friendly according to the standards provided by SWFWMD. Mr. Hopkins stated the problem is funding and is asking for help.

  Mr. Hopkins stated there are three things affecting Crystal River or are going to affect Crystal River if nothing is done. The first thing is the Primerica Development. There was a measurable impact from the Home Depot development. The second is the Three Sisters project. Mr. Hopkins would like to see this item on the agenda generated from the previous meeting minutes regarding Three Sisters project. On January 15, the responsibility for applying for funds for the Florida Communities Trust (FCT) fell to the City of Crystal River. As a housing development, it will affect the principle source of freshwater for Kings Bay and Crystal River upon which the economy of the region depends. We need to watch that very closely that it proceeds for conservation and not for development. The third is Clemson University, which is due to make a statement at the next Kings Bay working group meeting. They have telegraphed that they will recommend the application of chemicals to control invasive species within the river run. That should be resisted because of the bio-accumulated effects it will have on toxins that are already present in the sediment.

- Mr. Casey Nayfield, citizen, stated that the primary threat to the bay is the development of the Three Sisters property. We must do everything in our means to raise funds in the amount of $2.8 million so the City of Crystal River can match the funds and get the $6.6 million from the FCT grants. If we lose this property, then 90 home sites and approximately 300 condominium units are going to have a dramatic affect on the springs system as well as the bay itself. The plan is that SWFWMD has promised to come in to restore some of this to natural wetlands, which will also increase the filtration in our bay and help out tremendously. Mr. Nayfield stated it is home to the manatees. It is the last spring system that flows pure freshwater year-round in the bay.

- Ms. Mary Cravin, citizen, stated she read in a Polk County newspaper, that there is a huge military training project projected to go in the green swamp area. That will mean filling, paving, etc. The SWFWMD is aware of it and what has been going on so far has met with their approval. Ms. Cravin feels it could affect Citrus County and its waterways.

10. **Status Reports**
No presentations were made. The current Water Quality Monitoring report mailed to the Task Force members in their agenda packet and was also available for the public at the meeting.

11. **Goals, Objectives, Actions, Projects, and Schedules**
No action taken.

12. **Adjournment**
There being no further business or announcements presented before the Task Force, the meeting was adjourned at 5:33 p.m.

May 20, 2011

MEMORANDUM

TO: File

FROM: Douglas A. Leeper, Chief Environmental Scientist, Ecologic Evaluation Section, Southwest Florida Water Management District

SUBJECT: Presentation of minimum flows and levels at the May 2008 Citrus Task Force meeting

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This memorandum documents a presentation on minimum flows and levels made by Sid Flannery, Chief Environmental Scientist with the District, to the Citrus Task Force in May 2008. The meeting agenda and minutes are included as attachments.

DAL

Attachments: A – Agenda for May 2008 Citrus Task Force meeting
B – Minutes from May 2008 Citrus Task Force meeting

Attachment A

Agenda for May 2008 Citrus Task Force meeting

Citrus County Task Force
Meeting Agenda

May 12, 2008
3:00 p.m.

Lecanto Government Building
3600 West Sovereign Path, Room 166
Lecanto, Florida 34461

*******All meetings are open to the public*******

1. Call to Order and Roll Call
2. Pledge of Allegiance
3. Approval of the March 10, 2008 Minutes
4. Pump-out Station on Homosassa River Update – Chair Moberley
5. Website – Chair Moberley
6. Update on Minimum Flows and Levels (relationship with Crystal River/Lake Rousseau) - Sid Flannery - Southwest Florida Water Management District (SWFWMD)
7. Task Force Position Regarding Crystal River and Lake Rousseau Activities in this Year's Annual Report – Chair Moberley
8. Beneficial Use of Dredged Material – Allen Martin, Florida Fish and Wildlife Conservation Commission
9. Morrison Pool/Sinks
10. Sources of Chlorophyll "a" in Kings Bay: Results of a Two-year Study by the University of South Florida - Veronica Craw – SWFWMD
11. Agenda and Location for Next Meeting
12. Public Input
13. Status Reports (no presentations)
    a. Water Quality Monitoring
    b. Tussock Spoil Site Access
    c. Diagnostic Survey of Sediments and Vegetation in the Tsala Apopka Chain-Of-Lakes
14. Goals, Objectives, Actions, Projects, and Schedules (information only)
    a. Improve Fisheries Habitat
    b. Maintain or Improve Water Quality
    c. Restore Historic Connections
    d. Improve Marsh Habitat
    e. Develop Restoration Plans
15. Adjournment

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Attachment B

Minutes for May 2008 Citrus Task Force meeting

APPROVED

MINUTES OF THE MEETING

Citrus County Task Force
of the
Citrus/Hernando Waterways Restoration Council

May 12, 2008

The Citrus County Task Force met at 3:05 p.m. on May 12, 2008, at the Lecanto Government Building, Lecanto, Florida.

Task Force Members Present	**Technical Advisory Group Members Present**	**SWFWMD Staff Members Present**
Michael Moberley, Chair	Judy Ashton, FDEP	Mark Hammond
Sandra Clodwick, Secretary	Mark Edwards, Citrus Co.	Veronica Craw
Carl Bertoch, Member	Bruce Hasbrouck, FDOT	Jimmy Brooks
Michael Czerwinski, Member	Jerry Krummrich, FFWCC	Sid Flannery
Ken Frink, Member	Philip Rhinesmith, SWFWMD	
Wayne Sawyer, Member		

Task Force Members Absent	**Technical Advisory Group Members Absent**	**Recording Secretary**
George Miskimen, Member	Colonel Paul L. Grosskruger, USACE	Josie Guillen, SWFWMD
	Bo Rooks, WRBB	
	Sam Lyons, CRBB	

SWFWMD – Southwest Florida Water Management District
FDEP – Florida Department of Environmental Protection
CRBB – Coastal Rivers Basin Board Member
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FFWCC – Florida Fish and Wildlife Conservation Commission
FDOT – Florida Department of Transportation
USACE – United States Army Corp of Engineers

A list of others present who signed the attendance roster is filed in the permanent files of the Task Force. The numbers preceding the items listed below correspond with the published agenda.

1. **Call to Order and Roll Call**
   Chair Michael Moberley convened the meeting.

2. **Pledge of Allegiance**
   Chair Moberley led the Pledge of Allegiance.

3. **Approval of Minutes**
   Following consideration, Mr. Carl Bertoch moved, seconded by Mr. Wayne Sawyer to approve the March 10, 2008 meeting minutes.

4. **Pump-Out Station on Homosassa River Update**

Chair Moberley addressed the Task Force members (members) regarding the installation of a waste pump-out station on the Homosassa River. Chair Moberley has explored some options the last couple of months and tentatively arranged with McRaes Fishing Resort to have the pump-out station on the Homosassa River. Chair Moberley also spoke to Gary Bartell with Citrus County and Judy Ashton with FDEP. Judy stated FDEP would be able to fund 75 percent of the cost and perhaps Citrus County Board of County Commissioners would fund 25 percent. A quote will need to be done on the system. Chair Moberley spoke to Gary Bartell and Gary Madoff (also with Citrus County), regarding the 25 percent funding and perhaps there may be avenues to explore. Since the county is installing public restrooms at McRaes' and a lift station, the members thought it would be a good idea to also install a pump-out station while this work was being done. McRaes Fishing Resort, FDEP and Citrus County all agree that installing the pump-out station is a good idea. Chair Moberley will follow-up with the county to put this plan into action.

Ms. Judy Ashton with FDEP stated to the members the price for a pump-out station ranges from $1,500 - $30,000. FDEP also funds pump-out vessels up to $50,000. FDEP will fund 75 percent of the cost. The 75 percent includes construction, installation, renovation, purchase of pump-out equipment, holding tanks, pump-out boats, dump stations, educational materials and signs, reimbursement of all sewage lines to connect to the pump-out equipment to the boat slips or to a dock or holding tank as well as sewage lines connecting pump-out equipment to a sewage treatment plant. Equipment installation can include electrical, pipes, and labor.

Chair Moberley stated to the Task Force members with economic times the way they are, the legislative will most likely not appropriate any funding for projects this year. Chair Moberley continued saying to the Task Force members that they need to be creative and to come up with projects that do not cost any money. Chair Moberley will be presenting to the members some no cost ideas later in the meeting.

5. **Website**

Chair Moberley stated that Mr. Jim Hunter had suggested to Chair Moberley to set up a website (a clearing house) to provide information from other agencies and volunteers performing work in Citrus County which can also offer hyperlinks to the other groups/agencies within the county. Chair Moberley is encouraging the idea of the website to the members to education the public. Chair Moberley introduced Mr. Richard Patz to give a brief discussion on the website. Mr. Patz would explore the possibility of having a website, a small grant to fund the website, or donation of funds.

Mr. Patz stated there are a large number of stakeholders in Citrus County related to waterways, navigation, fisheries, etc. Mr. Patz stated that there probably is not a central clearing house that anyone can gain access to and require the necessary information. Mr. Patz stated he would need to study this to determine if the theory has merit. If so, Mr. Patz will inform the members his recommendation as to what the Task Force might consider doing. Mr. Patz stated to the members he has experience writing and getting grants in the area.

Chair Moberley entertained a motion for Mr. Patz explore the option of a website and report back to the members. Mr. Ken Frink moved to accept the motion. Mr. Sawyer seconded the motion. Motion passes unanimously.

6. **Update on Minimum Flows and Levels (relationship with Crystal River/Lake Rousseau)**

Mr. Sid Flannery with SWFWMD gave a presentation explaining what Minimum Flow is and translating how much water can be removed for water supply without damaging the ecology of a river or its receiving estuary? Mr. Flannery included the Minimum Flow rule schedule for the next few years. Mr. Flannery further explained fresh versus estuarine minimum flow studies.

7. **Task Force Position Regarding Crystal River and Lake Rousseau Activities in this Year's Annual Report**

Chair Moberley stated to the members that there is a great need in Citrus County and one of them being Three Sisters. Chair Moberley asked Mr. Dale Jones from FFWCC to discuss the possibility of using the $150,000 the legislative granted to the Task Force towards Three Sisters.

Mr. Jones stated he does not know the exact details of the funds, but will research and get back to the members in about two weeks.

Chair asked the members, "What is our position regarding Crystal River and Lake Rousseau for our annual report?"

Mr. Bertoch asked the Chair what needs to be done about the work on Tsala Apopka? Is it a lack of funds? Chair Moberley responded that the members needed to be creative whether it be education or to have a campaign to gather the public to get permits to clean up a small amount of lake shore. Chair Moberley stated we need to continue to see what the Task Force can do for Tsala Apopka.

Mr. Michael Czerwinski stated part of the Task Force's objective is to take in response from the public and identify potential restoration plans. There are a number of issues for instances Crystal River/Kings Bay which are somewhat unresolved. It has been identified that there are problems with Lyngbya, salinity issues, and Lyngbya dredging.

Ms. Sandra Clodwick stated the Bureau of Invasive Plant Management has been transferred from FDEP to FFWCC, which could possibility be an asset to Lake Rousseau and would like some information on it. Ms. Clodwick would like to see FFWCC give a better balance concerning the invasive plant control.

Chair Moberley is directing the members on projects to be included in the report to the legislature which would require funding and also work on projects that do not require any funding. This way, if the legislature does not grant us funding for the projects, the Task Force is still moving ahead on certain projects.

8. **Beneficial Use of Dredged Material**

Mr. Allen Martin with FFWCC gave a presentation on the potential beneficial use alternatives for dredged sediments from Florida lakes. Mr. Martin stated what the background, goals, showed the study areas of 10 lakes FFWCC is focusing on,

sediment management options, categories of beneficial uses, such as: Engineering, Agricultural, Industrial/Commercial, Environmental Enhancement, and Recreational. Mr. Martin continued by stating the environmental enhancements, sediment characterization, and the characteristics of the lakes.

9. **Morrison Pool/Sinks**

No presentation given since Mr. Sawyer was satisfied with the current status of the Morrison Pool.

10. **Sources of Chlorophyll a in Kings Bay: Results of a Two-year Study by the University of South Florida**

Ms. Veronica Craw from SWFWMD gave a presentation on the nutrients and water quality of Kings Bay. Ms. Craw stated reduced water clarity was identified as a primary management issue in the Kings Bay SWIM Plan. Suspended solids were the primary cause of decreased clarity. The solids were primarily Chlorophyll. Twelve sites distributed throughout Kings Bay were sampled every other month from Oct 2005 – Nov 2007. The identity and bio-volume of chlorophyll sources were determined for each sample. The University of South Florida determined that Phytoplankton was the primary source of Chlorophyll a in Kings Bay and Diatoms were the dominant group of phytoplankton.

11. **Agenda and Location for Next Meeting**

Update on the Pump-out Station on the Homosassa River
Update on the Clearing House Website
Update on the Clemson Study
Update on FFWCC Hardwood Reduction in Flying Eagle
Update on Marion County Swales Ordinance
Update on FFWCC Spoil Site Funding for Three Sisters

The location of the next meeting will be at the Lecanto Government Building.

12. **Public Input**

- Mr. Duane Brooks, citizen, questioned the Three Sisters Springs, “Do we know how much that man wants for those springs? We’ll have to wait and see what he wants for it.”

  Mr. Brooks stated there was an article in the paper about an ex-commissioner regarding the lake system. According to the article the ex-commissioner suggested taking the money from money currently being used to build a desalination plant and put the efforts into cleaning our lakes. It would mean to take 4 feet of sediment out and be replaced by 4 feet of water, which would result in 25 billion gallons of water in the lake system. The ex-commissioner should have done this 10-12 years ago.

  In regards to clean up, it would be easier to install a seawall instead of giving $500 to the Corp of Engineers. It would keep pollutants from going into the lake.

- Mr. Tom Kane, citizen, said the quality in Kings Bay has gone down hill in terms of clarity, diversity and quantity. Mr. Kane proposed to corner off 3-4 different places and see if we can restore that section of the bay. Mr. Kane suggested to

keep plant eaters off of it, provide a nursery area for young marine species, allow the plants to grow, and provide oxygen to clean out some of the areas.

Mr. Czerwinski suggested to Mr. Kane to attend the next Kings Bay Working Group meeting and bring his proposal to them as well.

Discussion Items (not on the agenda) from the Members

Chair Moberley informed the members that Dr. George Miskimen submitted a letter of resignation dated May 15, 2008. Meetings can be held, but until the position is filled, no action can be taken.

Mr. Ken Frink asked the members to review the documents (which was passed out earlier) from Marion County Land Development Code and give copies to the TAG to bring back some suggestions. Mr. Frink stated it is a low cost effort. Mr. Frink suggested copies of the documents be sent to the governing agencies (county, cities) which will be one step towards this effort.

Mr. Czerwinski showed an aerial photo of an area formerly known as Roscow Farms. This area is a 140 acre site with 70 - 300 linear feet of shoreline that is completely dry, as much as 25 acres of restoration. The landowner wants to mow and disk approximately 150 feet of the shoreline while it is still dry. Mr. Czerwinski is looking into getting some funding to get equipment at the site.

13. **Status Reports**

No presentations were made. The current Water Quality Monitoring report was mailed to the Task Force members in their agenda packet and was also available for the public at the meeting.

14. **Goals, Objectives, Actions, Projects, and Schedules**

No action taken.

15. **Adjournment**

There being no further business or announcements presented before the Task Force, the meeting was adjourned at 5:07 p.m.

May 19, 2011

MEMORANDUM

TO: File

FROM: Douglas A. Leeper, Chief Environmental Scientist, Ecologic Evaluation Section, Southwest Florida Water Management District

SUBJECT: Information on minimum flows and levels presentation to the Citrus County Task Force of the Citrus/Hernando Waterways Restoration Council

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This memorandum documents information pertaining to a presentation on minimum flows and levels provided by Doug Leeper, a Chief Environmental Scientist with the District that was made to the Citrus Task Force on August 9, 2010.

DAL

Attachments: A - Agenda for the August 9, 2010 Meeting of the Citrus Task Force
B - Slides prepared by Doug Leeper for an August 9, 2010 presentation to the Citrus Task Force
C – Approved Minutes for the August 9, 2010 Meeting of the Citrus Task Force

Attachment A

Agenda for the August 9, 2010 Meeting of the Citrus Task Force

Citrus County Task Force
Meeting Agenda

August 9, 2010
2:00 p.m.

Lecanto Government Building
3600 West Sovereign Path, Room 166
Lecanto, Florida 34461

*******All meetings are open to the public*******

SWFWMD – Southwest Florida Water Management District	FFWCC – Florida Fish and Wildlife Conservation Commission
FDEP – Florida Department of Environmental Protection	FDOT – Florida Department of Transportation
TAG – Technical Advisory Group	USACOE – United States Army Corp. of Engineers

1. Call to Order and Roll Call
2. Pledge of Allegiance
3. Approval of the June 14, 2010 Minutes
4. Flying Eagle Prescribed Burns – Philip Rhinesmith, SWFWMD
   a. Public Input
5. Oil Spill - Jamie Arleo, FDEP
   a. Public Input
6. Minimum Flows – Doug Leeper, SWFWMD
   a. Public Input
7. Summary of the July TAG Meeting – Allen Martin, FFWCC
   a. Public Input
8. Advertising Notices for Task Force Meetings – Veronica Craw, SWFWMD
   a. Public Input
9. Report to the Legislature – Task Force Members
10. Election of Officers
    a. Chair
    b. Secretary
11. Agenda for Next Meeting – **Tuesday, September 14 and/or Monday, October 11**
12. Public Input
13. Adjournment

The Southwest Florida Water Management District (District) does not discriminate on the basis of disability. This nondiscrimination policy involves every aspect of the District's functions, including access to and participation in the District's programs and activities. Anyone requiring reasonable accommodation as provided for in the Americans with Disabilities Act should contact the District's Human Resources Director, 2379 Broad Street, Brooksville, Florida 34604-6899; 1-352-796-7211 or 1-800-423-1476 (Florida only), extension 4702; TDD (Florida only) 1-800-231-6103; or email to ADACoordinator@swfwmd.state.fl.us.

If you have any questions concerning this meeting, please call 1-352-796-7211 or 1-800-423-1476 (Florida only), extension 4227. If a party decides to appeal any decision made with respect to any matter considered at a meeting, that party will need a record of the proceedings, and for such purpose that party may need to ensure that a verbatim record of the proceedings is made, which record includes the testimony and evidence upon which they appear is to be based.

www.watermatters.org/waterways

Attachment B

Slides prepared by Doug Leeper for an August 9, 2010 presentation to the Citrus Task Force

Minimum Flows and Levels Update

Douglas A. Leeper
Jason L. Hood
Southwest Florida Water Management District

Citrus / Hernando Waterways Restoration Council
Citrus County Task Force
Lecanto, Florida

August 9, 2010

Florida Statutes, Section 373.042

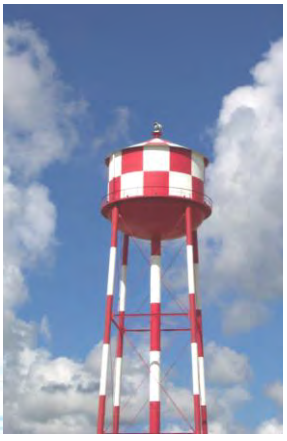
- Minimum Flows and Levels -

The **minimum flow** for a given watercourse shall be the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area.

The **minimum water level** shall be the level of groundwater in an aquifer and the level of surface water at which further withdrawals would be significantly harmful to the water resources of the area.

Regulatory Use of Minimum Flows and Levels

- Water Resource Planning
- Water-Use Permitting
- Environmental Resource Permitting



Minimum Flows and Levels Process

- Priority List and Schedule developed and updated annually
- Methods and flows or levels are developed and peer-reviewed
- Workshops held for public input
- Recovery or prevention strategies developed, as necessary
- Governing Board adopts flows or levels into District rules (Chapter 40D-8, Florida Administrative Code).
- Recovery strategies are included in regional water supply plans in in some case incorporated into District rules (Chapter 40D-80, Florida Administrative Code)

Priority Schedule – Northern Systems

2010
Chassahowitzka River system and springs, Gum Springs group, Homosassa River system and spring, Upper and Middle Withlacoochee River system (Green Swamp), Rainbow Springs

2011
Crystal River system and Kings Bay Spring, Lower Withlacoochee River system, Bonable Lake, Little Bonable Lake, Tiger Lake

2013
Tooke Lake, Whitehurst Pond

Status

Peer-Review Completed
Chassahowitzka River system and springs

Peer-Review Ongoing
Homosassa River system and spring
Upper and Middle Withlacoochee River system (Green Swamp)

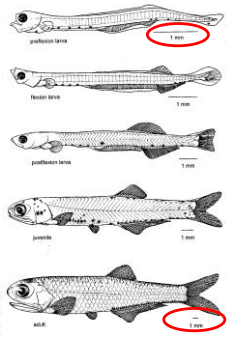
Data Collection Ongoing
Crystal River system and Kings Bay Spring, Lower Withlacoochee River system, Gum Springs group, Rainbow Springs, Bonable Lake, Little Bonable Lake, Tiger Lake, Tooke Lake, Whitehurst Pond

Tidal River Minimum Flows Study Elements

- Withdrawal impacts
- Structural alterations
- Bathymetry
- Shoreline and submersed vegetation
- Benthic invertebrates
- Fish and invertebrate plankton and nekton
- Salinity-based habitats
- Thermal refuge volume for manatees

Plankton and Nekton

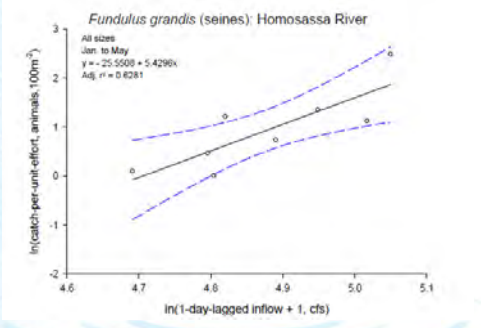
- Bay Anchovy Example-



Source: Peebles et al. (2009)

Plankton and Nekton

- Gulf Killifish Relationship to Flow -



Source: Peebles et al. (2009)

Manatee Thermal Habitat (Refuge)



Recommended Minimum Flows

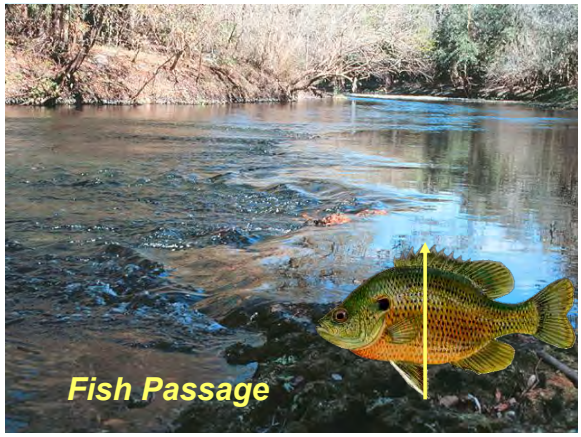
Chassahowitzka River System
An eleven percent reduction in baseline flows past the USGS Chassahowitzka River near Homosassa, FL gage

Homosassa River System
A five percent reduction in baseline flows measured as combined daily mean flow past the USGS Homosassa Springs at Homosassa Springs, FL and Southeast Fork Homosassa Springs at Homosassa Springs, FL gages

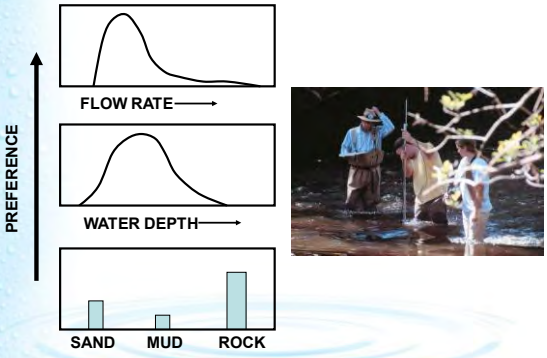
Freshwater River Minimum Flows Study Elements

- Withdrawal impacts
- Structural alterations
- Wetted perimeter (stream bottom)
- Fish passage over shoals
- Instream habitats for fish and invertebrates
- Floodplain vegetation and inundation
- Inundation of woody habitats





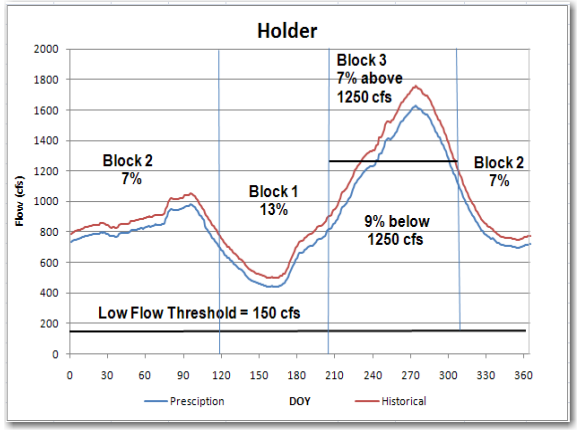
Fish and Invertebrate Habitat Suitability



Recommended Minimum Flows

Upper and Middle Withlacoochee River System (Green Swamp)

Season-specific percent reductions in baseline flows past the USGS Withlacoochee River near Holder, FL, Withlacoochee River at Wysong Dam at Carlson, FL, and Withlacoochee River at Croom, FL gages





Contact Information

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Title: Chief Environmental Scientist

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Phone: 1-800-423-1476 or 352-796-7211
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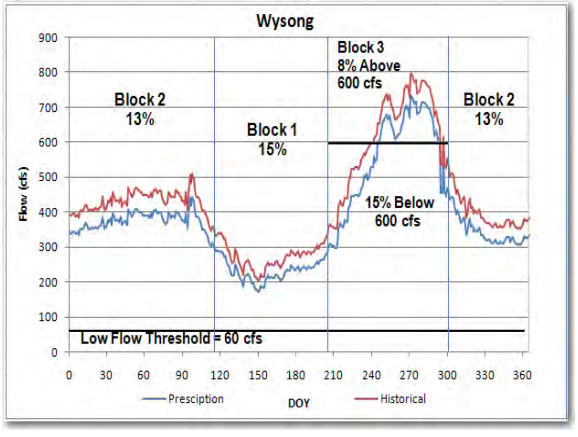
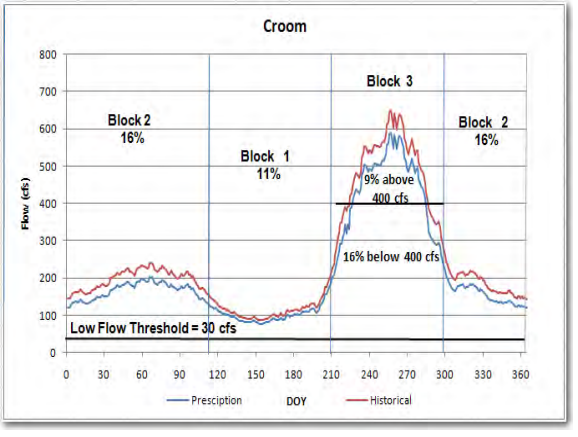
E-Mail: doug.leeper@swfwmd.state.fl.us

Web Site: www.swfwmd.state.fl.us or
watermatters.org

Extra Slides





Attachment C

Approved Minutes for the August 9, 2010 Meeting of the Citrus Task Force

MINUTES OF THE MEETING

Citrus County Task Force
of the
Citrus/Hernando Waterways Restoration Council

August 9, 2010

The Citrus County Task Force met at 2:00 p.m., August 9, 2010 at the Lecanto Government Building, Lecanto, Florida.

Task Force Members Present	**Technical Advisory Group Members Present**	**Recording Secretary**
Carl Bertoch, Member	Katasha Cornwell, FDOT	Josie Guillen, SWFWMD
Michael Czerwinski, Member	Mark Edwards, Citrus Co.	
Eric Latimer, Member	Domenic LetoBarone, FDEP	
Michael Moberley, Chair	Allen Martin, FFWCC	
Wayne Sawyer, Member	Philip Rhinesmith, SWFWMD	

Task Force Members Absent	**Technical Advisory Group Members Absent**
Sandra Clodwick, Secretary	Bill Bachschmidt, WRBB
Ken Frink, Member (Resigned)	Colonel Alfred Pantano, USACOE

SWFWMD – Southwest Florida Water Management District	FFWCC – Florida Fish and Wildlife Conservation Commission
FDEP – Florida Department of Environmental Protection	FDOT – Florida Department of Transportation
CRBB – Coastal Rivers Basin Board Member	USACOE – United States Army Corp of Engineers
WRBB – Withlacoochee River Basin Board Member	TAG – Technical Advisory Group

A list of others present who signed the attendance roster is filed in the permanent files of the Task Force. The numbers preceding the items listed below correspond with the published agenda.

1. **Call to Order and Roll Call**
   Chair Moberley convened the meeting. Ms. Josie Guillen called the roll and noted a quorum was present.

2. **Pledge of Allegiance**
   Chair Moberley led the Pledge of Allegiance.

3. **Approval of Minutes**
   Following consideration, Mr. Carl Bertoch moved, seconded by Mr. Wayne Sawyer to approve the June 14, 2010 meeting minutes. Motion carried unanimously. The motion will need to be reaffirmed at the next scheduled meeting since the task force is not fully constituted due to the resignation of Mr. Ken Frink.

   Other Business/Topics of Discussion not on the Agenda
   Ms. Veronica Craw stated to the members since the task force is not fully constituted, they can take provisional action and reaffirm the action at the next scheduled meeting.

APPROVED

4. **Flying Eagle Prescribed Burns**

Mr. Philip Rhinesmith, SWFWMD, filling in for Mr. Kevin Love, stated no new acreage has been burned since the last update from Mr. Love. Mr. Rhinesmith stated the conditions have not warranted any prescribe burns. Mr. Rhinesmith stated, staff has achieved some upland prescribed fire application at both Potts Preserve and Flying Eagle, but no wetland marsh fires because of the wet conditions.

Public Input

Mr. Al Grubman, TOO FAR, asked Mr. Rhinesmith if the high priority is still the same on Mr. Love's list as in the past.

Mr. Chester Bradshaw, citizen, stated you can put all the fire you want in the lake system, do the dredging of the muck sediment, but the important issue the task force needs to look at is to try and restore the natural water flow through the lake system. Mr. Bradshaw requested the Task Force put their efforts into the things that will make a difference with the lake.

5. **Oil Spill**

Commander David Burns, United States Coast Guard, gave a presentation on Coast Guard's efforts to track the oil from the Deepwater Horizon oil spill. Commander Burns first gave some history on sector lines of demarcation of the Coast Guard Florida Peninsular Command Post-Branch St. Petersburg. Commander Burns reviewed the various agencies responsibilities including Emergency Operations of the various counties for responding to oil spills. Commander Burns showed a graphic depicting a list of governmental agency responders and their responsibilities. Commander Burns next showed a map depicting the topography of the deep Gulf and explained the remote possibility of oil making its way to the shallow water areas along the Nature Coast. Commander Burns next showed several photos and he and Mr. Dominick Letobarone of FDEP described the "Trigger Zones" along the flight paths. The thought was that if oil was detected crossing these zones there would be a response from Command Post - Branch St. Petersburg. FDEP initiated the collection of baseline data from Taylor to Collier counties and have analyzed samples collected from the Gulf. This information is available on several agency websites. Only one sample (tar ball) was found in this area and was not tied to the Deepwater Horizon event. Additionally, Shoreline Cleanup Assessment Techniques (SCAT) were overseen by the FDEP and Coast Guard.

Chair Moberly asked if there were specific methods to clean mangrove and marsh areas. Commander Burns suggested that their efforts are focused on keeping the oil from entering these areas.

Public Input

Mr. Norman Hopkins, representing the Amy Remley Foundation commended the timely baseline sampling by FDEP. Mr. Hopkins wanted to know if there was any danger of oil contamination through the freshwater springs offshore, from water contaminated with oil being forced through fractures into the springs. Commander Burns responded by saying he has no comment on the subject. Dominick Letobarone from FDEP stated that many agencies are participating in a natural resource damage assessment team to look at these types of questions. Mr. Hopkins said there were links on the Amy Remley website to many of the agencies mentioned during the presentation.

APPROVED

6. **Minimum Flows**

Mr. Doug Leeper, SWFWMD, stated that minimum flows and levels (MFLs) have been established for several waterbodies. In Citrus County, MFLs have been established for the Tsala Apopka Chain of Lakes and Fort Cooper Lake. Mr. Leeper stated MFLs will be established for the Chassahowitzka River System, Homosassa River System, Upper and Middle Withlacoochee River Systems. Mr. Leeper stated next year the MFLs will be established for Crystal River/Kings Bay and the Lower Withlacoochee River. Mr. Leeper stated staff applies different procedures depending if the river system is a tidal system or a freshwater system. Mr. Leeper explained the process of the MFLs. A priority list and schedule is developed and updated annually. Methods and flows or levels are developed and peer-reviewed. Mr. Leeper stated workshops are held for public input, recovery or prevention strategies are developed, as necessary. Mr. Leeper stated the SWFWMD Governing Board adopts the flows or levels into the SWFWMD rules, Chapter 40D-8, Florida Administrative Code. Mr. Leeper stated the recovery strategies are included in the regional water supply plans (in some cases it is incorporated into the SWFWMD rules). Mr. Leeper showed the members the priority schedule in the northern systems for 2010-2013. Mr. Leeper stated which systems were completed and ongoing by peer-review, and ongoing data collection.

Public Input

Mr. Grubman, stated when the Withlacoochee Regional Water Supply Authority is looking to take water, their consultant establishes a proxy MFLs. Mr. Grubman addressed Mr. Leeper on how he feels about it and how it relates to what he is doing.

Mr. Norman Hopkins, Amy Remley Foundation, stated he admires what is being done scientifically to assess the MFLs. Mr. Hopkins stated most of the public does not understand what is happening. Mr. Hopkins stated that the public does understand, for an example, when a consultant states they want to move water into a reservoir and it can be taken from those waterbodies with MFLs which are far below the actual levels in the waterbody. Mr. Hopkins stated because the public does not understand, a suggestion would be to have a policy statement either from the task force or from another body to illustrate how the MFLs which have been scientifically evaluated are actually applied in practical issues.

7. **Summary of the July TAG Meeting**

Mr. Allen Martin, FFWCC, stated the reason the TAG met was to discuss the in-lake disposal. Mr. Martin stated FFWCC staff put together some information to come to a conclusion of either getting a permit to do the work or a letter from the USACOE. Mr. Martin stated the scientific evidence shows no reason in-lake disposal cannot or should not be used, but it is agreed that upland storage could be utilized whenever practical. Mr. Martin stated the TAG discussed different methods on how projects can be done. It was determined that FFWCC is not able to pursue a system permit for Tsala Apopka, unless a policy changed. Mr. Martin stated the TAG thought they should look at projects working under the assumption and realization that in-lake is not an option for disposal, but to look for upland disposal options instead.

Public Input

None.

APPROVED

Other Business/Topics of Discussion not on the Agenda

Chair Moberley stated there were emails going back and forward among the members that border violating the Sunshine Law. Chair Moberley is concerned about this and expressed the types of issues that can be violated. Chair Moberley asked the members in the future to be more careful when corresponding via email.

10. **Election of Officers**

The Election of Officers was tabled until the Task Force is fully constituted.

9. **Report to the Legislature**

Chair Moberley asked the members since the legislation has not given us any funds, do we want to submit the same report as last year's? Mr. Bertoch asked what about endorsing a specific request of a project(s) that the various agencies are making? Chair Moberley's concern is since the Task Force is not fully constituted, how will it affect approving the report to the legislature. Ms. Craw stated that the members can take provisional action. Mr. Bertoch suggested adding a statement to the report adopting MFLs to require the water management districts to combine their thought processes.

8. **Advertising Notices for Task Force Meetings**

Ms. Craw clarified to the members the costs of advertising the meetings and changing/adding future meeting dates. Ms. Craw stated the advertising of the meetings does not need to be noticed in the 16 county SWFWMD jurisdiction. The advertising will continue in the Citrus County newspaper to meet the noticing requirements which includes any deviation from the 2011 published meeting dates.

11. **Agenda for Next Meeting**

Report to the Legislature

Other Business/Topics of Discussion not on the Agenda

Mr. Michael Czerwinski stated the 305(B) reports and the 303(D) list are where water quality is being obtained. Mr. Czerwinski showed the members the current phosphorous levels in Florida waters from 1970 – 2005. Mr. Czerwinski stated the draft report was just issued. The report will show what is going on with water quality in Florida, how to control nutrients in the state of Florida, and stormwater controls, etc. Mr. Czerwinski stated the next objective is to move on to the springs, specifically Kings Bay. Mr. Czerwinski suggested designating some restoration projects whether they come from the agencies or from the public. Mr. Czerwinski stated the focus is to get the attention of the legislature or the agencies to express concern on which restoration project to fund.

12. **Public Input**

None.

13. **Adjournment**

There being no further business or announcements presented before the Task Force, the meeting was adjourned at 4:15 p.m.

APPROVED

May 19, 2011

MEMORANDUM

TO: File

FROM: Douglas A. Leeper, Chief Environmental Scientist, Ecologic Evaluation Section, Southwest Florida Water Management District

SUBJECT: Electronic mail correspondence between Brent White and City of Crystal River staff regarding salinity in Kings Bay

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This memorandum documents an e-mail from Brent White, a District Staff Water Conservation Analyst, to staff of the City of Crystal River. The e-mail concerns salinity in Kings Bay.

DAL
Attachment: A - E-Mail from Brent White to City of Crystal River Staff, Dated November 18, 2010
Attachment: B - Attachment to E-Mail from Brent White to City of Crystal River Staff, Dated November 18, 2010

Attachment A

E-Mail from Brent White to City of Crystal River Staff, Dated November 18, 2010

From: Brent M. White
To: Andrew Houston; jgorman@crystalriverfl.org; DBurnell@crystalriverfl.org
Cc: Cara S. Martin; John F. Ferguson; Kenneth R. Herd; Brian Armstrong; Joe P. Quinn; Roberta Starks; Doug Leeper
Subject: Kings Bay Salinity question
Date: Thursday, November 18, 2010 9:29:53 AM
Attachments: J_Ferguson_Kings Bay_11_2010.docx

Morning Andy, Jackie & David,

When the District's Northern Utility Outreach team met with the City of Crystal River last month, you had expressed some concerns to us about the salinity levels in Kings Bay. You asked us if there were any studies or monitoring of salinity levels that we could share. Attached is a white paper write-up describing what has been assessed to date in relation to Kings Bay. If you have any additional questions, please feel free to contact Doug Leeper, Chief Environmental Scientist, at Doug.Leeper@swfwmd.state.fl.us or at 1-800-423-1476, ext. 4272.

Thank you,

Brent White
Brent M. White, Water Conservation Analyst
Conservation and Utility Outreach Section (CPS)
Resource Projects Department (PRJ)
2379 Broad Street
Brooksville, FL 34604-6899
Phone: 1-800-423-1476 (Florida Only)
-or- (352) 796-7211 Ext. 4214
Fax: (352) 797-5806
Cell: (813) 679-1464
E-Mail: Brent.White@watermatters.org

The District now has a page on Facebook. To become a fan, visit
http://www.facebook.com/WaterMatters
You can also follow us on Twitter at http://www.Twitter.com/SWFWMD

Attachment B

Attachment to E-Mail from Brent White to City of Crystal River Staff, Dated November 18, 2010

Email statement from John Ferguson; On October 18, we had a Utility Outreach meeting with the City of Crystal River's administrator and new utility director, Andy Houston and David Burnell. During the meeting, they expressed concern about increasing salinities in Kings Bay. Residents have apparently commented to them about barnacle growth where they hadn't seen it before. They wanted to know what studies or monitoring of salinities is done by the District.

District Monitoring;
From 1991 to present, the District has monitored nutrients, major ions, trace metals and field parameters at multiple springs in Kings Bay on a quarterly frequency, and additional springs on a yearly frequency. Some springs in the Kings Bay Group were irregularly monitored for water quality in the mid-1990's because they are low-discharge springs that have water quality similar to a larger, nearby spring. Other springs were added to the sampling schedule following a spring vent inventory conducted in 2009 for the MFL study of Kings Bay. Spring vents that are currently being sampled by the District are listed in Table 1. Additionally, priority pollutant scans, including volatile organic compounds, pesticides, trace metals and bacteria, are conducted on selected springs every other year. Nitrogen isotope samples are also collected from selected springs every other year alternating with the collection for priority pollutants.

Spring Name	*Monitoring Frequency*	*Tidal*
Tarpon Hole	***Quarterly***	***Yes***
Hunters	***Quarterly***	***Yes***
Catfish	***Quarterly***	***Yes***
Parker Island	***Quarterly***	***Yes***
Magnolia Circle	***Quarterly***	***Yes***
Jurassic	***Quarterly***	***Yes***
Black	***Quarterly***	***Yes***
Three Sister's No. 1	***Quarterly***	***Yes***
Idiot's Delight	***Yearly***	***Yes***
Millers Creek	***Yearly***	***Yes***
House	***Yearly***	***Yes***
Sids	***Yearly***	***Yes***
Golfview	***Yearly***	***Yes***
House	***Yearly***	***Yes***

Table 1. Kings Bay Group; Monitoring Sites, Frequency, & Tidal Influence

The District also began collecting surface water quality samples throughout Kings Bay at 12 locations in 2006 on a bi-monthly frequency, and since October 2010 collects samples at those sites quarterly. Other shorter-term monitoring has also been conducted for minimum flow and level assessments.

The initial objective of the District's springs monitoring efforts was to investigate nutrients, particularly nitrate, in groundwater discharging from springs to Surface Water Improvement and Management (SWIM) Program priority water bodies. In addition to springs in Kings Bay, the District also performs water quality monitoring at springs in the following Groups; Aripeka, Weeki Wachee, Storch, Chassahowitzka, Homosassa, Gulf Hammock, Rainbow, Panasoffkee, Gum Slough, Crystal (Pasco Co.),

Lithia/Buckhorn, and select springs in Pinellas and Sarasota Counties. For tidally influenced springs, every attempt is made to collect water quality samples when tidal stage is the lowest. All samples are collected from within the spring vent via a peristaltic pump to reduce any influence from surface water. These protocols assist with determining contributions of Upper Floridan aquifer (UFA) water quality to spring pools, runs, rivers, and receiving estuarine waters.

Data from the District's Springs Networks have been used in internal reports which investigate the origin of nitrates discharged from springs. Data have also been used by the FDEP and the FGS for reporting on the status and/or trends of nutrients as well as other parameters (such as saline indicators) discharged from springs, and for Total maximum Daily Load assessments. All District data are available from the District's Water Management Information (WMIS) database.

Increasing Salinity;

Many spring vents in Kings Bay are affected by tides and discharge slightly brackish water due to subsurface mixing of fresh and saline groundwater in the coastal margin. Data collected by the District, and results recently released in Florida Geological Society Bulletin 69, show that certain saline indicator parameters (specific conductance and chloride) are trending upward (Figure 1) and spring discharge is trending downward statewide. The District concurs with statements in Bulletin 69 that discharge in many of our coastal springs have been declining, and the declines since the 1960's are predominately related to climatic variation. Available information suggests that the observed trends in spring discharge are largely the result of reduced rainfall, and is possibly coupled with a rise in sea level. A decrease in rainfall results in reduced recharge to the UFA, which is the source of spring discharge and results in lower groundwater levels and reduced pressure. When pressure in the aquifer is reduced, springs discharge less. Increased sea level has a similar effect on spring discharge. The higher the water's surface over a spring vent, the greater the downward pressure that is exerted, further reducing the discharge from the spring. The combination of reduced spring discharge and rising sea level may be the principal cause for higher salinities throughout Kings Bay.

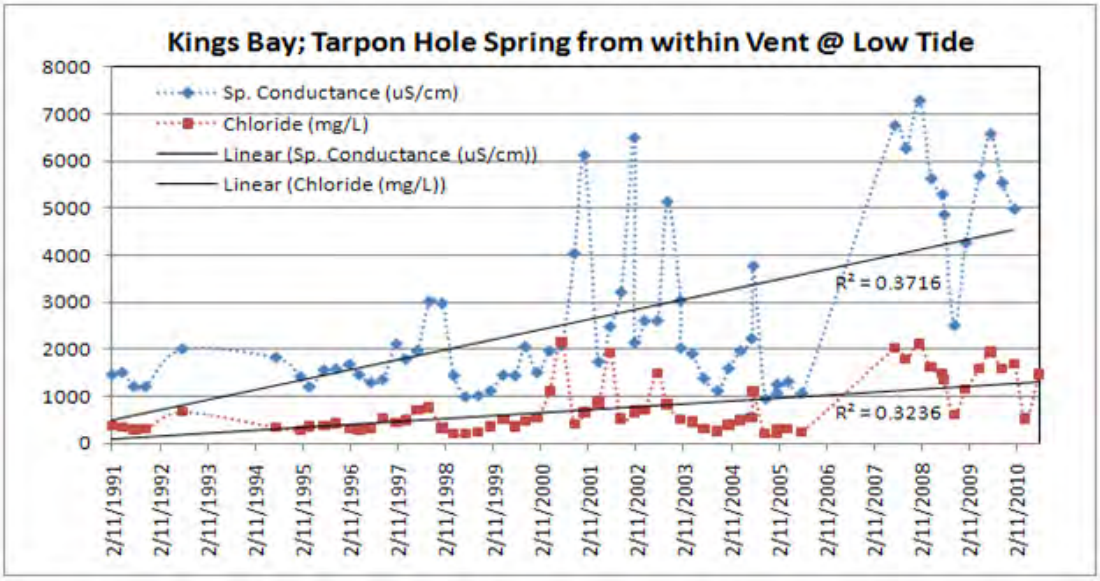

Figure 1. Period of Record Data Results for Saline Indicators in Tarpon Springs – Kings Bay

In Florida only a few locations have long-term rainfall records, which limits the ability to reconstruct drought/flood cycles. However, one of the long-term gages (1900-2010) is located in Brooksville (Chinsengut-Hill. NOAA Station 1046). A convenient technique to assess drought intensity and duration is called a cumulative departure from average (Figure 2). In practice, long-term average annual rainfall is subtracted from each year and these annual differences are accumulated through time. For example, the average annual rainfall at Brooksville from 1931 through 1998 is 55.5 inches/year. In 1931, the annual rainfall was 43.2 inches resulting in a departure from average of negative 12.2 inches. In 1932, the annual rainfall was 45.2 inches, or a departure of negative 10.2 inches. The cumulative departure for these two years is the sum of the annual departure values, or negative 22.4 inches. Figure 2 illustrates the cumulative departure from normal for the Brooksville site for 1931-1998. From 1931 until 1960, there was higher than average rainfall, resulting in the red trend line. After 1960, rainfall totals began to decline resulting in the blue trend line. Both trend lines represent statistically significant trends in cumulative rainfall departure from long-term average values.

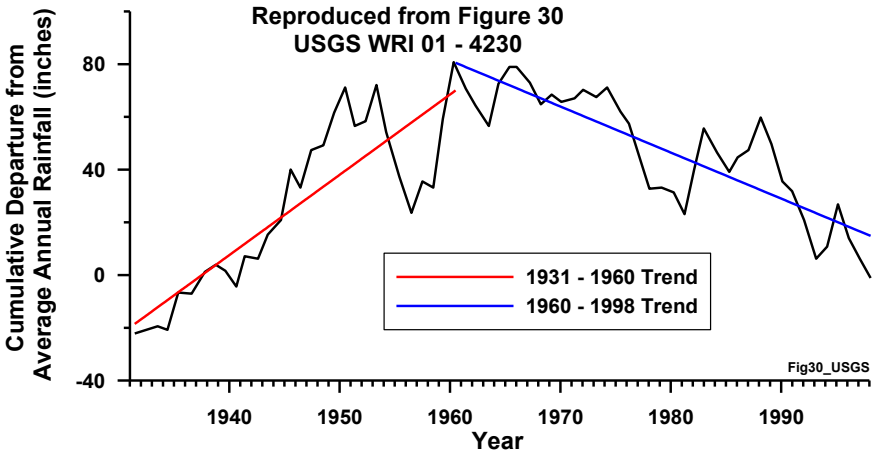

Figure 2. Cumulative annual rainfall departure from average – Brooksville, Florida

In addition to drought conditions, sea level is rising. Figure 3 illustrates rise in sea level at St. Petersburg (upper panel) and at Cedar Key (lower panel) based on information summarized by the National Oceanic and Atmospheric Administration. The rate of rise at Kings Bay has not been measured, but it is reasonable to assume that it will be within the range observed of the bordering stations. Between 1931 and 2010, sea level at Kings Bay has probably risen between 5.7 inches and 7.4 inches.

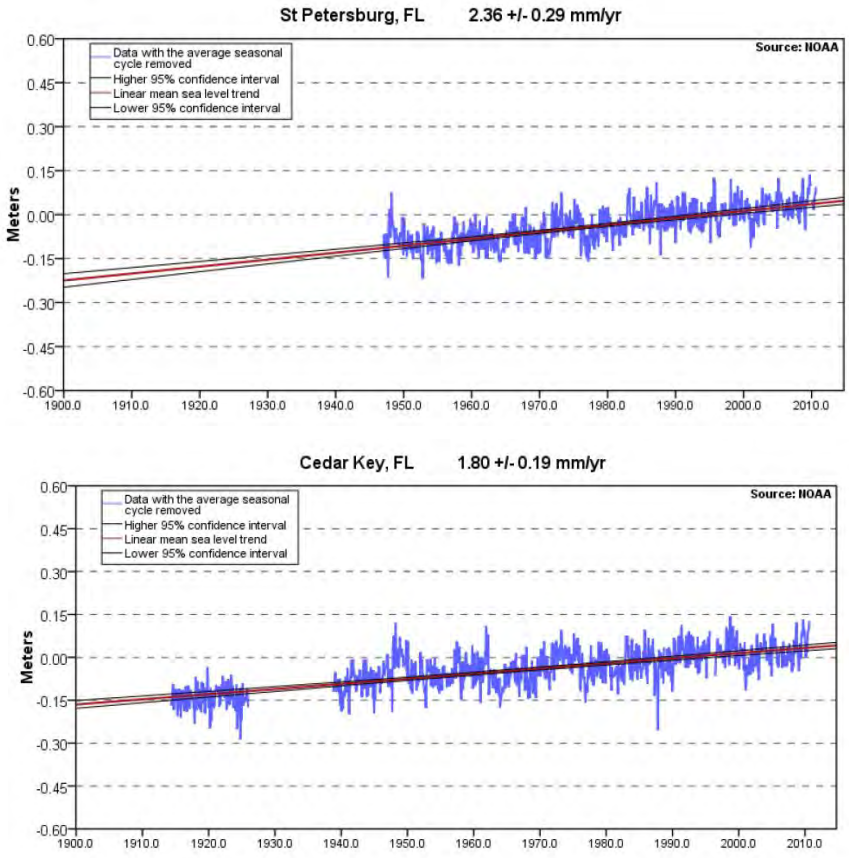

Figure 3. Sea level rise at St. Petersburg and Cedar Key, Florida.

May 19, 2011

MEMORANDUM

TO: File

FROM: Douglas A. Leeper, Chief Environmental Scientist, Ecologic Evaluation Section, Southwest Florida Water Management District

SUBJECT: Powerpoint slides by Marty Kelly concerning minimum flows and levels presented to the Citrus County Utility Infrastructure Advisory Group

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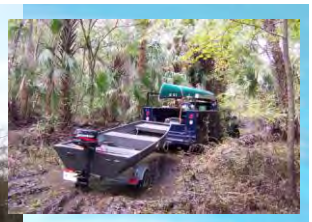
This memorandum documents a Powerpoint slide presentation that was developed by Marty Kelly, Minimum Flows and Levels Program Director for the District. The slides were used for a presentation to the Citrus County Utility Infrastructure Advisory Group in December 2010.

DAL
Attachment: Powerpoint slides by Marty Kelly concerning minimum flows and levels

Attachment

Powerpoint Slides by Marty Kelly Concerning Minimum Flows and Levels





MINIMUM FLOWS AND LEVELS

CITRUS COUNTY
UTILITY INFRASTRUCTURE ADVISORY GROUP
DECEMBER 8, 2010

Southwest Florida Water Management District

Minimum Flows and Levels

Florida Statutes, Section 373.042

The **minimum flow** for a given watercourse shall be the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area.

The **minimum water level** shall be the level of groundwater in an aquifer and the level of surface water at which further withdrawals would be significantly harmful to the water resources of the area.

2010

- **Chassahowitzka River System and Springs** (includes Chass. Main, Chass. #1, Crab Creek, Potter and Ruth and Blind Spring)
- **Homosassa River System and Springs** (includes Halls River Springs, Southeast Fork Homosassa River Springs, Homosassa Main Springs, Hidden River Springs)
- Lower Myakka River System
- Polk County Lakes – Crystal, North Lake Wales
- **Upper and Middle Withlacoochee River System (Green Swamp)**



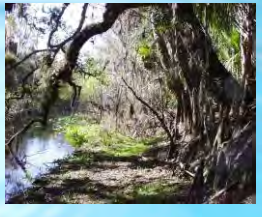
2011

- Brooker Creek
- Hillsborough County Lakes – Carroll, Hooker, Raleigh, Rogers, Starvation, and Wimauma
- **Lower Withlacoochee River System**
- Marion County Lakes - Bonable, Little Bonable, Tiger
- Polk County Lake – Lowery, Hancock
- Upper Peace River "Middle" and "High" Minimum Flows
- **Crystal River System and Kings Bay Spring**
- Pithlachascotee River System
- **Gum Springs Group**
- Little Manatee River
- Manatee River System (Braden River Estuary)
- **Rainbow River and Springs**
- Shell Creek Estuary



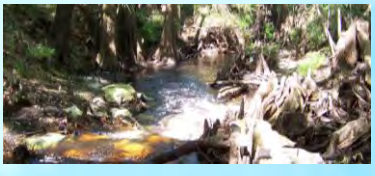
2012

- Charlie Creek
- Horse Creek
- North Prong Alafia River
- South Prong Alafia River
- Hillsborough County Lakes – Kell, Keene, Hanna
- Polk County Lakes – Amoret, Aurora, Bonnet, Easy, Effie, Little Aurora, Josephine



2013

- Prairie Creek
- Shell Creek (freshwater segment)
- Hernando County Lakes - Tooke, Whitehurst
- Highland County Lakes – Damon, Pioneer, Pythias, Viola
- Polk County Lake – Trout



2014

- Cypress Creek
- Bullfrog Creek



2015

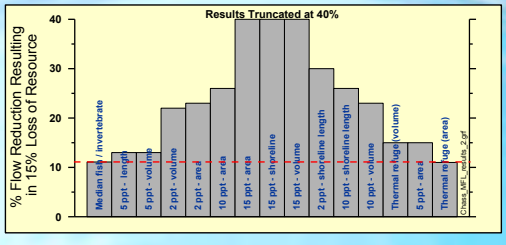
- Lower Peace River – re-evaluation
- Polk County Lake - Eva



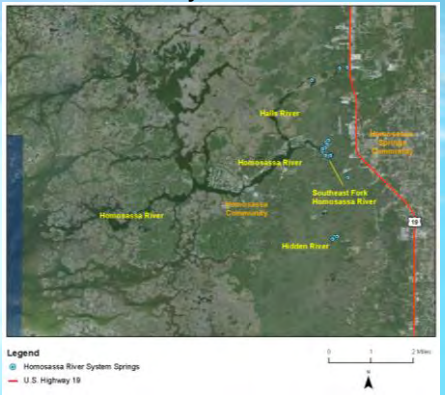
Chassahowitzka River System



Chassahowitzka Recommended MFL – No More than 11% Reduction in Flow



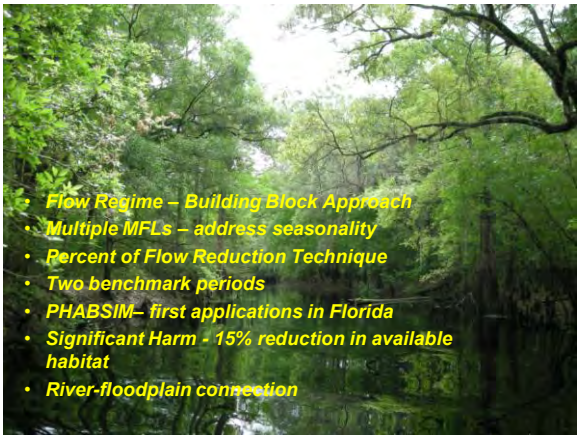
Homosassa River System



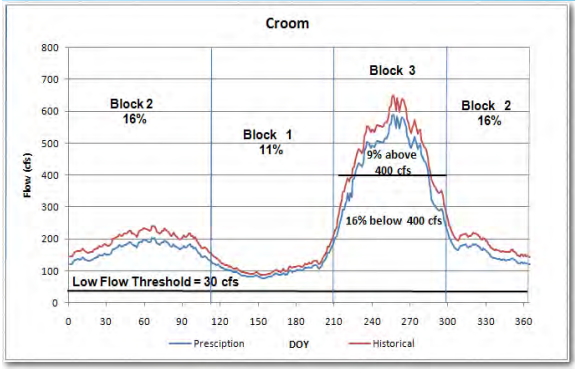
Homosassa River System Recommended Minimum Flows

A five percent reduction in baseline flows measured as combined daily mean flow past the USGS Homosassa Springs at Homosassa Springs, FL and Southeast Fork Homosassa Springs at Homosassa Springs, FL

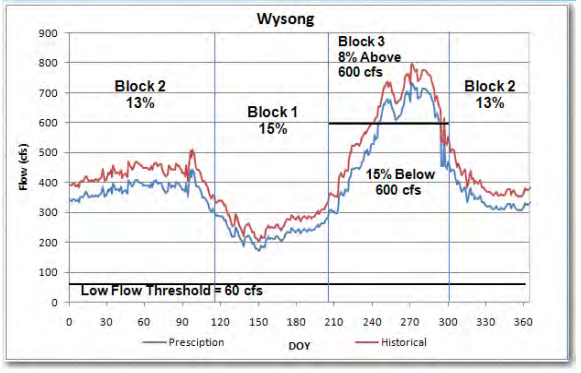




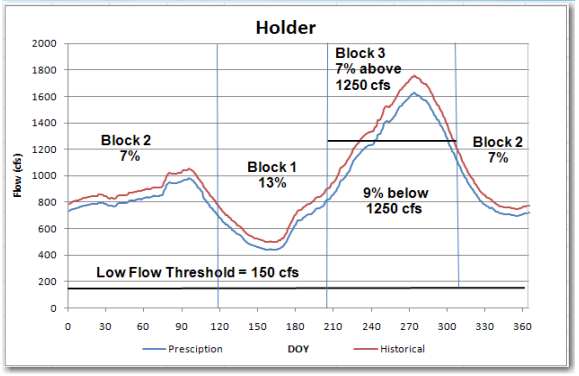
Flow Prescription – Croom and Upstream



Flow Prescription – Croom to Wysong



Flow Prescription – Wysong to Holder

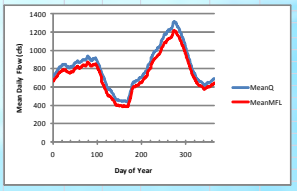




WITHLACOOCHEE AT HOLDER

Period for Calculations				
8/10/1965 to 12/31/2009			B2 Low Trigger %	0.07
LFT	150		B3 Low Trigger %	0.09
Block 1	0.13	B2 Trigger Q	0	
Block 2	0.07	B3 Trigger Q	1250	
Block 3 HF %	0.07			
Max Diversion	10000			

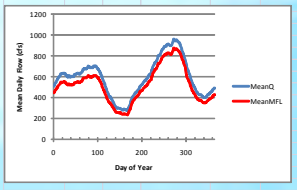
	CFS	MGD		% of Q
Mean Q	817	528.1	Block 1	10.88%
Mean MFL Q	753	486.3	Block 2	6.59%
Mean Available	65	41.7	Block 3	7.90%
% of Mean Q	7.90%	7.90%	%ofXAnnuals	7.80%



WITHLACOOCHEE AT WYSONG

Period for Calculations				
8/10/1965 to 12/31/2009			B2 Low Trigger %	0.13
LFT	60		B3 Low Trigger %	0.15
Block 1	0.15	B2 Trigger Q	0	
Block 2 HF %	0.13	B3 Trigger Q	600	
Block 3 HF %	0.08			
Max Diversion	100000			

	CFS	MGD		% of Q
Mean Q	592	382.6	Block 1	12.70%
Mean MFL Q	523	337.8	Block 2	12.26%
Mean Available	69	44.7	Block 3	11.14%
% of Mean Q	11.70%	11.70%	%ofXAnnuals	11.98%

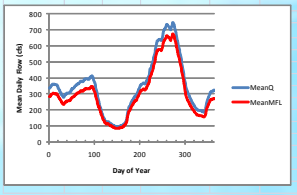


WITHLACOOCHEE AT CROOM

Period for Calculations				
8/10/1965 to 12/31/2009			B2 Low Trigger %	0.16
LFT	30		B3 Low Trigger %	0.16
Block 1	0.11	B2 Trigger Q	0	
Block 2 HF%	0.16	B3 Trigger Q	400	
Block 3 HF %	0.09			
Max Diversion	10000			

Note: substituted 0.01 cfs for flows on days when reported flow was 0 to avoid division by zero errors in the spreadsheet

	CFS	MGD		% of Q
Mean Q	347	224.1	Block 1	8.05%
Mean MFL Q	303	195.8	Block 2	13.74%
Mean Available	44	28.3	Block 3	11.23%
% of Mean Q	12.61%	12.61%	%ofXAnnuals	11.87%



Simple River Water Budget

Discharge = Rainfall – ET

Rainfall = 50 inches
ET = 38 inches
Discharge = 12 inches

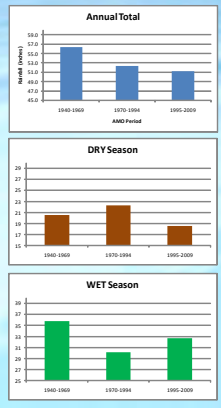
Rainfall = 45 inches
ET = 38 inches
Discharge = 7 inches

Net Result

10% decrease in rainfall

42% decrease in discharge

BIO_AVG



	Annual Total (inches)
1940-1969	56.3
1970-1994	52.4
1995-2009	51.3
POR	54.1

	Dry Season Total (inches)	X% of Annual Totals
1940-1969	20.6	36%
1970-1994	22.3	42%
1995-2009	18.6	36%
POR	20.6	38%

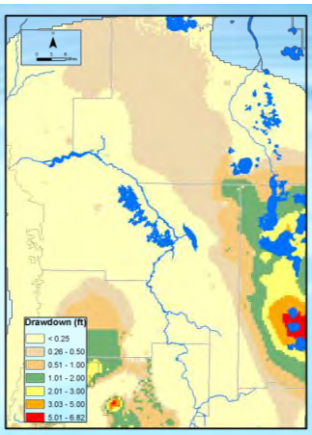
	Wet Season Total (inches)	X% of Annual Totals
1940-1969	35.8	64%
1970-1994	30.1	58%
1995-2009	32.7	64%
POR	33.5	62%

Withdrawal Impacts

- Northern District Model -



Source: Basso (2010)



USGS Gaging Station	No Pumping Baseflow (cfs)	2005 Baseflow (cfs)	Percent Change (%)
Compressco	8.92	8.60	-1.3
Dade City	12.61	12.31	-2.3
Trilby	56.62	55.15	-0.8
Croom	99.36	101.36	2.0
Floral City	95.16	97.43	2.4
Wysong Dam	152.54	155.58	2.0
Holder	235.58	231.13	-1.9



Criteria for Selection of MFL Waterbodies

- "Each water management district shall include all first magnitude springs, and all second magnitude springs within state or federally owned lands purchased for conservation purposes. . ." FS 373.042 (2)





Must Also Consider Structural Alterations

Florida Statutes, Section 373.0421



Culverts, Dams, Ditches, etc.



Roads, Buildings, etc.









What is Significant Harm?

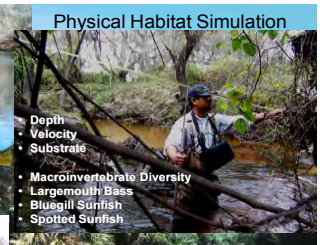
- Not defined by State Law
- Defined or implicit in District standards or thresholds used to establish minimum flows and levels
- Standards or thresholds are specific to water resource type and value

Examples

- Preventing cypress wetland degradation in lake basins
- Preventing more than a 15% decline in habitat availability in river segments
- Preventing or slowing rate of saltwater intrusion into aquifers



Physical Habitat Simulation







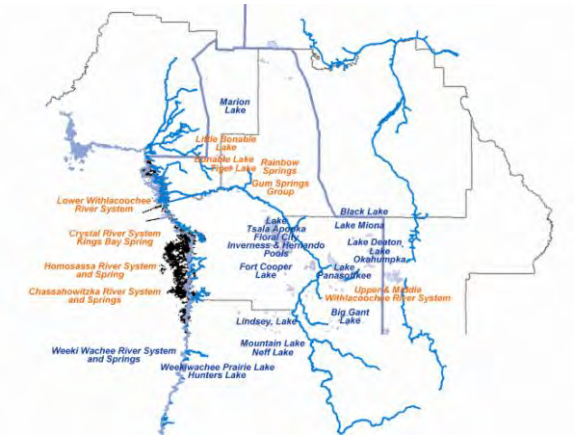
Weeki Wachee MFL Rule adopted 12/16/08

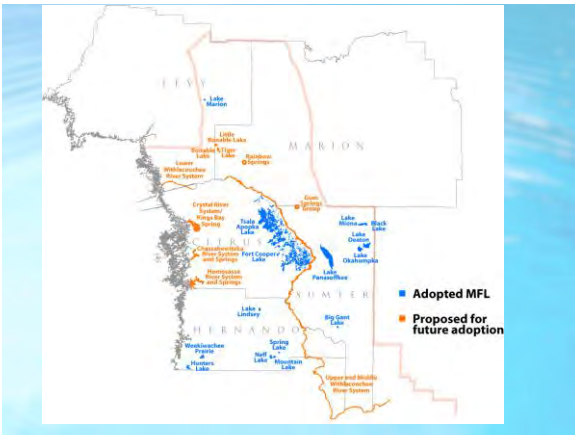
40D-8.041

- *(a) ". . . . For purposes of this rule, the Weeki Wachee System includes the watercourse from the Weeki Wachee Spring to the Gulf of Mexico including Twin Dees Spring, Mud River (including Salt Spring) from Mud Spring to the confluence with the Weeki Wachee River and Jenkins Springs and associated spring run.*
- *(b) The Minimum Flow for the Weeki Wachee River System is intended to preserve 90% of the natural flow of the natural flow of the Weeki Wachee River system. . . ."*



31





May 19, 2011

MEMORANDUM

TO: File

FROM: Douglas A. Leeper, Chief Environmental Scientist, Ecologic Evaluation Section, Southwest Florida Water Management District

SUBJECT: Electronic mail from Gary Williams to Boyd Bilhovde concerning Three Sisters Spring and contact information for Crystal River/Kings Bay minimum flows work

---

This memorandum documents an e-mail from Gary Williams, Senior Environmental Scientist with the District, to Boyd Bilhovde with the Chassahowitzak National Wildlife Refuge. The e-mail concerns contact information for a District staff member working on minimum flows development for the Crystal River/Kings Bay system and a slide presentation for a District project associated with property in the vicinity of Three Sisters Springs.

DAL

Attachments: A - E-Mail from Gary Williams to Boyd Bilhovde, Dated December 10, 2010
B - Powerpoint Slides provided by Gary Williams to Boyd Bilhovde on December 10, 2010

Attachment A

E-Mail from Gary Williams to Boyd Bilhovde, Dated December 10, 2010

From: Gary E. Williams
To: Boyd_Blihovde@fws.gov
Cc: Michael_Lusk@fws.gov; Joyce_Kleen@fws.gov; Doug Leeper
Subject: MFL contact for Kings Bay
Date: Friday, December 10, 2010 8:45:52 AM
Attachments: Kings Bay Working Group - Dec 2010.pptx

Good morning Boyd,
Just wanted to follow up on our conversation yesterday at the Kings Bay Working Group. Doug Leeper, who is copied on this email, is the point of contact for the Kings Bay/Crystal River MFL. You can reach Doug at 352 796-7211 ext. 4272. I have also attached the treatment wetland presentation from yesterday so you can have access to all of the graphics. See you tomorrow morning.

Gary

Gary E. Williams, Ph.D.
Resource Projects Department
Southwest Florida Water Management District
2379 Broad Street
Brooksville, Florida 34604
ph: 352.796.7211 x4286 fax: 352.797.5806
website: www.watermatters.org

Attachment B

Powerpoint Slides provided by Gary Williams to Boyd Bilhovde on December 10, 2010

Three Sisters Treatment Wetland Description and Status

Gary Williams
Southwest Florida Water Management District

Background

- Stormwater discharging into Three Sisters canal receives treatment for floatable debris and large-particle sediment only
- SWFWMD purchased 30% of the Three Sisters property to construct a treatment wetland
- Treatment wetlands can remove nutrients, metals, and particulate matter, among other items
- SWFWMD will pay for the design and construction of the treatment wetland
- Treatment wetland will be managed by the USFWS

Three Sisters site was formerly hardwood swamp



Three Sisters – current land cover



Stormwater inputs



Approximately 135 acres of stormwater runoff will be treated



Potential layout for wetland



Consultant Team

- Wetland Solutions, Inc. will oversee project with assistance from Jones Edmunds and 5M Civil
  - Extensive experience with both treatment wetlands and springs

Wetland Solutions, Inc.

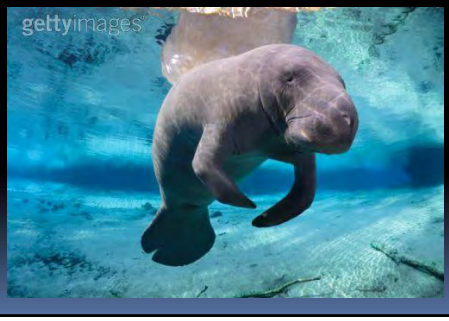
JONES EDMUNDS
ENGINEERS | ARCHITECTS | SCIENTISTS

5M Civil LLC

Wetland Design and Construction Timeline

- Select consultant to design wetland and oversee construction - complete
- Conceptual plan – summer 2011
- Final design - spring 2012
- Begin construction – summer 2012
- Wetland operational – winter 2012 - 2013

Questions?



May 19, 2011

MEMORANDUM

TO: File

FROM: Douglas A. Leeper, Chief Environmental Scientist, Ecologic Evaluation Section, Southwest Florida Water Management District

SUBJECT: Electronic mail correspondence concerning comments from Mr. Ron Miller regarding salinity in Kings Bay

---

This memorandum documents correspondence submitted to the District by Mr. Ron Miller, concerning salinity in Kings Bay.

DAL
Attachment: E-Mail String Associated with E-Mail Submitted to the Distirct by Ron Miller on November 19, 2010

Attachment

E-Mail String Associated with E-Mail Submitted to the Distirct by Ron Miller on November 19, 2010

From: Marty Kelly
To: Doug Leeper
Subject: FW: Kings Bay Salinity question
Date: Thursday, December 30, 2010 9:23:33 AM

Doug,

FYI.
Cara, FYI - Doug is lead on Crystal River/Kings Bay and on Homosassa.
Happy New Year.
Marty
-----Original Message-----
From: Cara S. Martin
Sent: Wednesday, December 29, 2010 2:26 PM
To: Ron Miller
Cc: Marty Kelly; Mike Heyl
Subject: RE: Kings Bay Salinity question
Thank you. Happy New Year to you as well.
Cara

From: Ron Miller [rmille76@tampabay.rr.com]
Sent: Wednesday, December 29, 2010 11:51 AM
To: Cara S. Martin
Subject: Fw: Kings Bay Salinity question
Hi Cara,
Here is more information related to the MFL question. Attached is an interesting article about the decreasing springs flow over the past 50 years. You may also be interested in the string of emails here. They mainly addresse salinity concerns in the Crystal River.
That is all for now.
HAPPY NEW YEAR !!!
Ron

-----Original Message-----
From: Ron Miller
Sent: Friday, November 19, 2010 8:25 PM
To: Jim Bitter ; Priscilla Watkins ; Bill Garvin ; Ron Schultz ; Al Grubman
Subject: Fw: Fwd: FW: Kings Bay Salinity question
Hi Again,
The below message was sent before my note was complete. Please look at the attached report. It supports our position that the Homosassa current flow is not a good representation of historical flow. And I did send our SWFWMD letter to all of these folks.
Ron

From: "Ron Miller" <rmille76@tampabay.rr.com>
Sent: Friday, November 19, 2010 8:19 PM
To: "Al Grubman" <grubman1@gmail.com>; "Ron Schultz" <eda@tampabay.rr.com>;

"Jim Bitter" <jbitter@tampabay.rr.com>; "Bill Garvin"
<wgarvin@tampabay.rr.com>; "Priscilla Watkins" <priswat@tampabay.rr.com>
Subject: Fw: Fwd: FW: Kings Bay Salinity question
> Hi All,
>>
Looks like Kings Bay is worried about salinity too. See report but I did
> fire off our letter to SWFWMD to all these guys.
>>
Ron
>>>
> ----------
> From: "Jim Hunter" <Jim.Hunter@bocc.citrus.fl.us>
> Sent: Friday, November 19, 2010 2:05 PM
> To: "Bob Glancy" <Bob.Glancy@bocc.citrus.fl.us>; "Brad Thorpe"
> <Brad.Thorpe@bocc.citrus.fl.us>; "Ken Frink"
> <Ken.Frink@bocc.citrus.fl.us>;
> "Kevin Smith" <Kevin.Smith@bocc.citrus.fl.us>; "Mark Edwards"
> <Mark.Edwards@bocc.citrus.fl.us>; "Robert Knight"
> <Robert.Knight@bocc.citrus.fl.us>; "Vince Cautero"
> <Vince.Cautero@bocc.citrus.fl.us>; <David_Conrad@doh.state.fl.us>;
> <rmille76@tampabay.rr.com>
> Subject: Fwd: FW: Kings Bay Salinity question
>
>>
>>
>>>>> "Gerry Mulligan" <gmulligan@chronicleonline.com> 11/19/2010 8:47 AM
>>>>> >>>
>> You each might be interested in this report.
>>
>> Gerry
>>
>> _____
>>
>> From: KC Nayfield [mailto:kcmidway@tampabay.rr.com]
>> Sent: Friday, November 19, 2010 7:57 AM
>> To: Gerry Mulligan
>> Subject: Fw: Kings Bay Salinity question
>>
>>
>> FYI
>>
>> KC
>> ----- Original Message -----
>> From: Laura Black <mailto:lblack@crystalriverfl.org>
>> To: Adelaide Pickett <mailto:adelaidepck@aol.com> ; Andrew Freund
>> <mailto:prohunterprofisher@yahoo.com> ; Andrew Houston
>> <mailto:ahouston@crystalriverfl.org> ; bcoleman@sheriffcitrus.org ;
>> Jackie Gorman <mailto:jgorman@crystalriverfl.org> ; James Farley
>> <mailto:jfarley@crystalriverfl.org> ; joree@earthlink.net ;
>> kcmidway@tampabay.rr.com ; csimmons@sheriffcitrus.org ; Michael
>> Czerwinski <mailto:mczerwinski@mgcenvironmental.com> ; Michelle Evans
>> <mailto:mevans@crystalriverfl.org> ; Mike Shier
>> <mailto:mshier62@aol.com> ; jdixon@sheriffcitrus.org ; Thomas Anderson

>> <mailto:thosanderson@hotmail.com>
>> Sent: Thursday, November 18, 2010 2:49 PM
>> Subject: FW: Kings Bay Salinity question
>>
>>
>>
>>
>>
>>
>> From: Andrew Houston
>> Sent: Thursday, November 18, 2010 10:04 AM
>> To: Laura Black
>> Subject: FW: Kings Bay Salinity question
>>
>>
>>
>> Please pass this on to members of the Waterfront Advisory Board
>>
>>
>>
>> From: Brent M. White [mailto:Brent.White@swfwmd.state.fl.us]
>> Sent: Thursday, November 18, 2010 9:30 AM
>> To: Andrew Houston; Jackie Gorman; David Burnell
>> Cc: Cara S. Martin; John F. Ferguson; Kenneth R. Herd; Brian Armstrong;
>> Joe P. Quinn; Roberta Starks; Doug Leeper
>> Subject: Kings Bay Salinity question
>>
>>
>>
>> Morning Andy, Jackie & David,
>>
>>
>>
>> When the District's Northern Utility Outreach team met with the City of
>> Crystal River last month, you had expressed some concerns to us about
>> the salinity levels in Kings Bay. You asked us if there were any
>> studies or monitoring of salinity levels that we could share. Attached
>> is a white paper write-up describing what has been assessed to date in
>> relation to Kings Bay. If you have any additional questions, please
>> feel free to contact Doug Leeper, Chief Environmental Scientist, at
>> Doug.Leeper@swfwmd.state.fl.us or at 1-800-423-1476, ext. 4272.
>>
>>
>>
>> Thank you,
>>
>> Brent White
>>
>>
>>
>> Brent M. White, Water Conservation Analyst
>>
>> Conservation and Utility Outreach Section (CPS)

>>
>> Resource Projects Department (PRJ)
>>
>>
>>
>>
>>
>>
>>
>> 2379 Broad Street
>>
>> Brooksville, FL 34604-6899
>>
>> Phone: 1-800-423-1476 (Florida Only)
>>
>> -or- (352) 796-7211 Ext. 4214
>>
>> Fax: (352) 797-5806
>>
>> Cell: (813) 679-1464
>>
>> E-Mail: Brent.White@watermatters.org
>>
>>
>>
>> The District now has a page on Facebook. To become a fan, visit
>> http://www.facebook.com/WaterMatters
>>
>>
>>
>> You can also follow us on Twitter at http://www.Twitter.com/SWFWMD
>>
>>
>>
>>
>>

May 19, 2011

MEMORANDUM

TO: File

FROM: Douglas A. Leeper, Chief Environmental Scientist, Ecologic Evaluation Section, Southwest Florida Water Management District

SUBJECT: Meeting and correspondence with Chassahowitzka National Wildlife Refuge staff regarding minimum flows development

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This memorandum documents a January 2011 meeting and associated correspondence between staff from the District and the Chassahowitzka National Wildlife Refuge concerning minimum flows development for Springs Coast rivers.

DAL

Attachments: A - E-Mail from Boyd Blihovde, dated December 10, 2010
B - Slides by Doug Leeper used for the January 5, 2011 meeting
C - Slides by Mike Heyl used for the January 5, 2011 meeting
D - E-Mail from Doug Leeper to Joyce Kleen, dated January 14, 2011
E - E-Mail from Doug Leeper to Joyce Kleen, dated February 2, 2011

Attachment A

E-Mail from Boyd Blihovde, dated December 10, 2010

From: Boyd_Blihovde@fws.gov
To: Doug Leeper
Cc: Michael_Lusk@fws.gov
Subject: Fw: MFL contact for Kings Bay
Date: Friday, December 10, 2010 11:45:48 AM

Mr Leeper,

Hey, I am the Assistant Manager at Chassahowitzka NWR Complex (which includes the Crystal River NWR). We are very interested in talking to you about the upcoming establishment of MFLs for Crystal River. As you are aware, this is a critical area for the manatee (a focal species for the Refuge). We would appreciate it if we could schedule a meeting sometime after the Holidays to discuss the MFL process and discuss some of our concerns.

If that is possible, please let me know. Also don't hesitate to call if needed. My cell phone number is 352-302-2301...

Thanks,
boyd blihovde
Deputy Refuge Manager
Chassahowitzka National Wildlife Refuge Complex
1502 SE Kings Bay Drive
Crystal River, FL 34429
(P) 352-563-2088
(F) 352-795-7961

Attachment B

Slides by Doug Leeper used for the January 5, 2011 meeting

Development of Minimum Flows for the Homosassa River, Chassahowitzka River and Crystal River/Kings Bay Systems

Doug Leeper - Mike Heyl - Sid Flannery - Marty Kelly

Southwest Florida Water Management District

Brooksville, Florida

January 5, 2011

Minimum Flows and Levels

- Florida Statutes, Section 373.042 -

The **minimum flow** for a given watercourse shall be the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area.

The **minimum water level** shall be the level of groundwater in an aquifer and the level of surface water at which further withdrawals would be significantly harmful to the water resources of the area.

What is Significant Harm?

- Not defined by state law
- Defined or implicit in District standards or thresholds used to establish minimum flows and levels
- Standards or thresholds are specific to water resource type and value

Examples

- Preventing cypress wetland degradation in lake basins
- Preventing or slowing rate of saltwater intrusion into aquifers
- Preventing more than a 15% decline in habitat availability in river segments

Minimum Flows and Levels Considerations

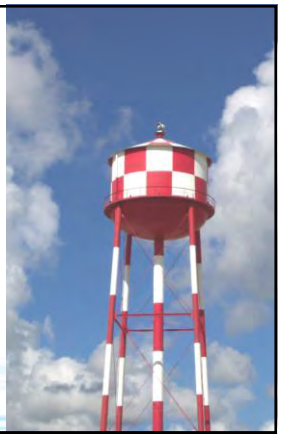
- Florida Administrative Code, Chapter 62-40.473 -

Shall consider natural seasonal fluctuations and environmental values, including:

- Recreation in and on the water
- Fish and wildlife habitats and the passage of fish
- Estuarine resources
- Transfer of detrital material
- Maintenance of freshwater storage and supply
- Aesthetic and scenic attributes
- Filtration and absorption of nutrients and other pollutants
- Sediment loads
- Water quality
- Navigation

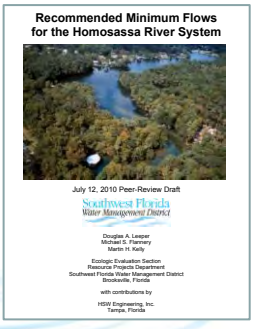
Regulatory Use of Minimum Flows and Levels

- Water-Use Permitting
- Environmental Resource Permitting
- Water Resource Planning



Minimum Flows Reports

Draft minimum flows reports and peer-review reports are posted on the District Web site at: *watermatters.org*



Process for Establishing Minimum Flows and Levels

- Priority List and Schedule developed
- Methods, flows or levels developed and peer-reviewed
- Workshops held for public input
- Recovery or prevention strategies developed, as necessary
- Governing Board adopts minimum flows and levels into Chapter 40D-8, Florida Administrative Code
- Necessary recovery strategies included in Regional Water Supply Plan and in some cases adopted into Chapter 40D-80, Florida Administrative Code

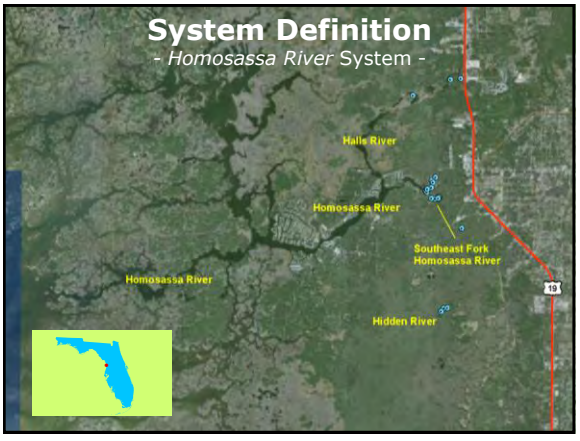
Tidal River Minimum Flows

- Study Elements -

- Defining the system
- Baseline flows and salinity evaluations
- Evaluation of withdrawal impacts on flows
- Evaluation of structural alterations
- Bathymetric mapping
- Shoreline and vegetation mapping
- Benthic invertebrate evaluations
- Planktonic and nektonic fish and invertebrate evaluations
- Salinity-based habitat modeling
- Thermal habitat modeling for manatees

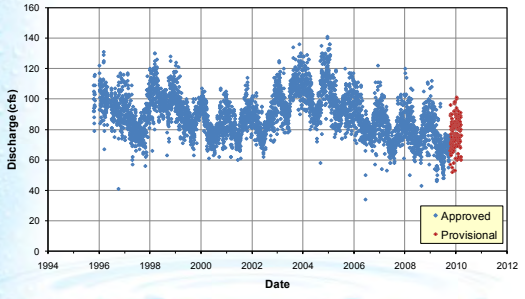
System Definition

- Homosassa River System -



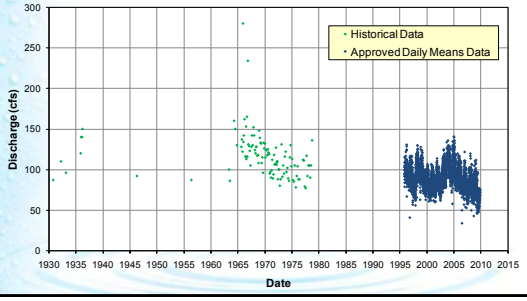
Baseline Flows and Salinity

- Daily Mean Discharge Record for Homosassa Springs -



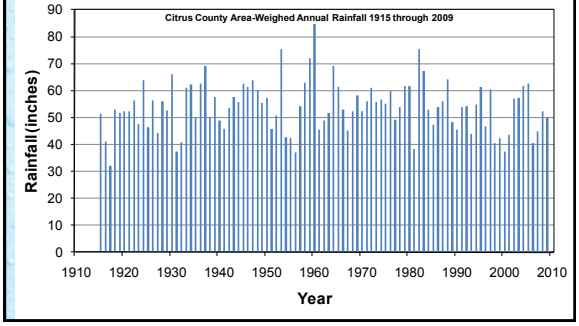
Baseline Flows and Salinity

-Approved Daily Mean Discharge Record and Historical Instantaneous Discharge Record for Homosassa Springs -



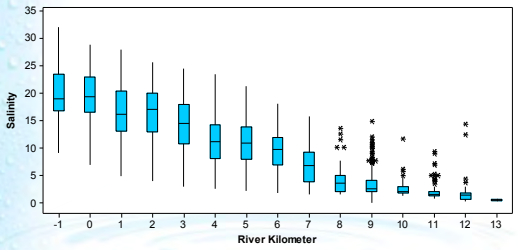
Baseline Flows and Salinity

-Flows are Consistent with Rainfall -



Baseline Flows and Salinity

-Tides, Spring Discharge and Winds Create a Longitudinal Salinity Gradient In the Homosassa River -



Withdrawal Impacts

- Northern District Model -

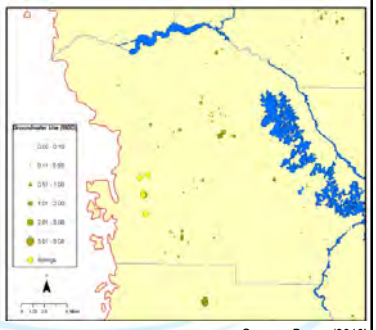


Source: Basso (2010)

Withdrawal Impacts

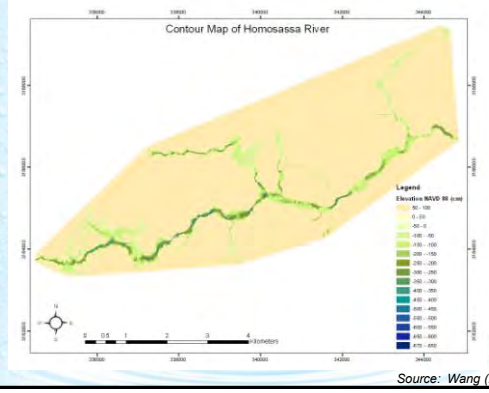
- Northern District Model -

Withdrawals of 438.1 MGD in 2005 were associated with an ~1% reduction in discharge from Homosassa River system springs



Source: Basso (2010)

Bathymetry



Source: Wang (2007)

Shoreline Mapping



Source: PBS&J (2009)

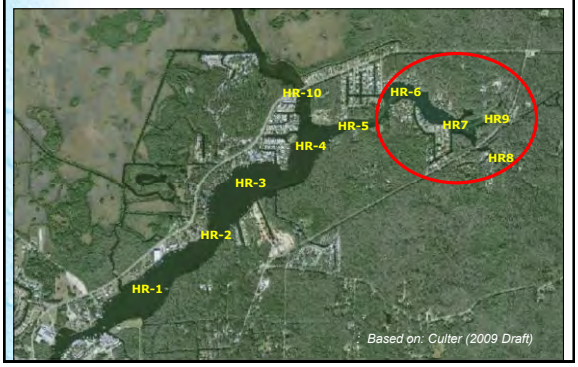
Vegetation Mapping



Source: PBS&J (2009)

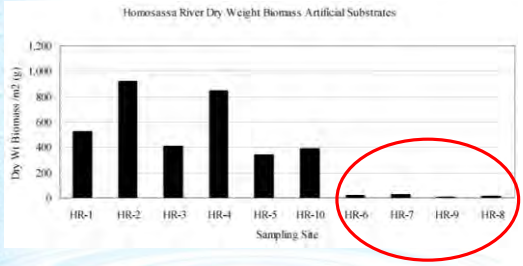
Benthic Invertebrates

- Barnacle Sampling Sites -



Benthic Invertebrates

- Barnacle Biomass by Site -



Source: Cutetr (2009)

Plankton and Nekton

- Gulf Killifish Example -

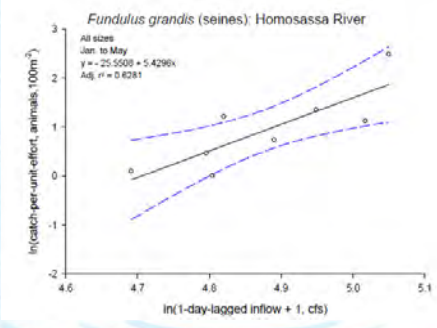


Maximum Length = 145 mm

Image Source: Freshwater Fishes of Texas: A Field Guide by C. Thomas, T.H. Bonner and B.G. Whiteside

Plankton and Nekton

- Gulf Killifish Abundance and Flow -



Source: Peebles et al. (2009)

Plankton and Nekton

- Abundance and Flow Results -

- Flow reductions from <1 to 2.7% associated with 15% reductions in abundances of 20 pseudo-species
- However, model issues suggest caution when interpreting results



Image source: J. Ditty, S. Holt, J. Matthews and T. Minello; NOAA Fisheries Service, Galveston Lab

Salinity-Based Habitat Modeling

- Biologically Relevant Salinity Criteria -



Water volume, bottom area and shoreline length associated with salinities that characterize or affect:



- availability of fish habitat
- availability of invertebrate habitat
- the amount and/or type of shoreline vegetation
- other, undefined system components and processes

Salinity-Based Habitat Modeling

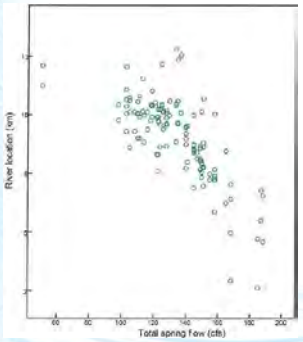
- Hydrodynamic Model -



Source: HSW Engineering, Inc. (2010)

Salinity-Based Habitat Modeling

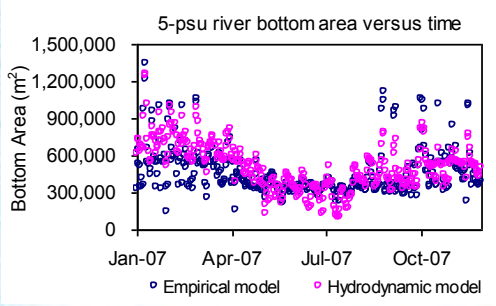
- Regression Models -



Source: HSW Engineering, Inc. (2010)

Salinity-Based Habitat Modeling

- Hydrodynamic and Regression Model Comparison-



Source: HSW Engineering, Inc. (2010)

Salinity-Based Habitat Modeling

- All Results -

Salinity-Based Habitat	Percent-of-Flow Reduction Associated with 15% Reductions in Habitat from Median Baseline Conditions		
	Hydrodynamic Model 2007 Benchmark Period	*Regression Model 2007 Benchmark Period*	*Regression Model 1995-2009 Benchmark Period*
Bottom Area			
Salinity ≤ 2 Based on Bottom Isohaline Location	< 5	NM	NM
Salinity ≤ 2 Based on Water-Column Average Isohaline Location	< 5	NM	NM
Salinity ≤ 3 Based on Bottom Isohaline Location	5 – 10 (8.4)	< 5	< 5
Salinity ≤ 3 Based on Water-Column Average Isohaline Location	5 – 10 (9.1)	< 5	< 5
Salinity ≤ 5 Based on Bottom Isohaline Location	15	> 30	5 – 10 (6.3)
Salinity ≤ 5 Based on Water-Column Average Isohaline Location	10 – 15	20	5 – 10 (7.0)
Salinity ≤ 12 Based on Bottom Isohaline Location	25	20	10
Salinity ≤ 12 Based on Water-Column Average Isohaline Location	25 – 30	30	10 – 15
Water Volume			
Salinity ≤ 2	< 5	NM	NM
Salinity ≤ 3	10	5 – 10 (5.3)	< 5
Salinity ≤ 5	15	20 – 25	5 – 10 (6.9)
Salinity ≤ 12	20 – 25	25	10 – 15
Natural Shoreline Length			
Salinity ≤ 2	NA	NM	NM
Salinity ≤ 3	20 – 25	10 – 15	10 – 15
Salinity ≤ 5	15 – 20	> 30	> 30
Salinity ≤ 12	NA	5	5

Thermal Habitat Modeling for Manatees

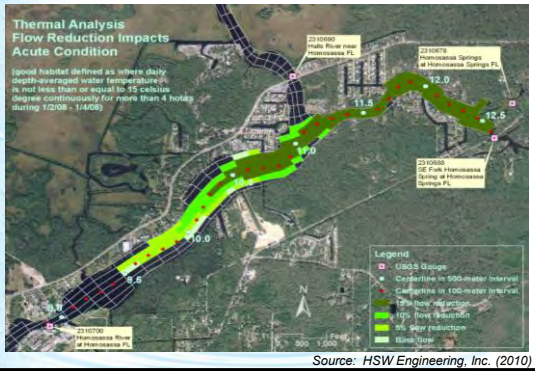
Favorable Habitat

- Water temperature >68°F for duration of critically cold, 3-day period
- Water temperature >59°F for duration of critically cold, 4-hour period
- Water depth >=3.9 feet



Thermal Habitat Modeling for Manatees

- Results Example -



Source: HSW Engineering, Inc. (2010)

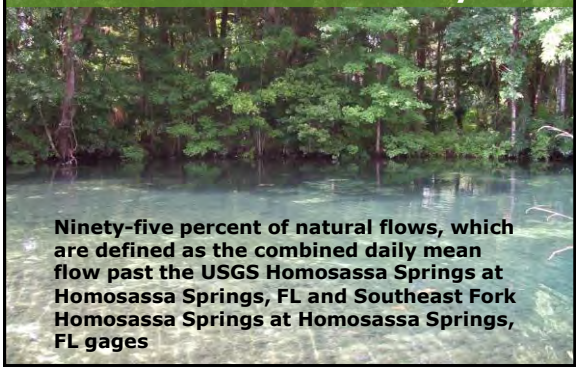
Thermal Habitat Modeling for Manatees

- Results -

- Flow reduction between 5-10% associated with a 15% reduction in favorable refuge habitat during critically cold four-hour period
- Flow reduction between 25-30% associated with a15% reduction in favorable refuge habitat during critically cold three-day period



Recommended Minimum Flows for the Homosassa River System



Ninety-five percent of natural flows, which are defined as the combined daily mean flow past the USGS Homosassa Springs at Homosassa Springs, FL and Southeast Fork Homosassa Springs at Homosassa Springs, FL gages

Crystal River / Kings Bay System

- Schedule -



- **Target date for initial draft report development – May 2011**
- **Target date for presentation of draft report to the District Governing Board – Jul 2011**
- **Target date for completion of peer-review – Oct 2011**
- **Target date for rule adoption – Nov 2011**

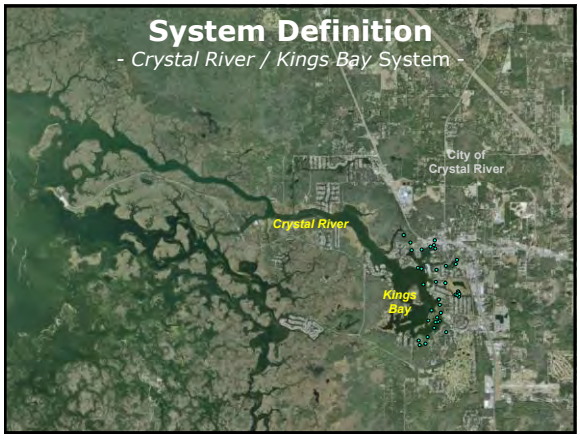
Crystal River / Kings Bay

- Study Elements -

- Defining the system ✓
- Baseline flows and salinity evaluations ***Ongoing***
- Evaluation of withdrawal impacts on flows ***Ongoing***
- Evaluation of structural alterations ✓
- Bathymetric mapping ✓
- Shoreline and vegetation mapping ***Ongoing***
- Benthic invertebrate evaluations ✓
- Planktonic-nektonic fish & invertebrate evaluations ***Ongoing***
- Salinity-based habitat modeling ***Ongoing***
- Thermal habitat modeling for manatees ***Ongoing***

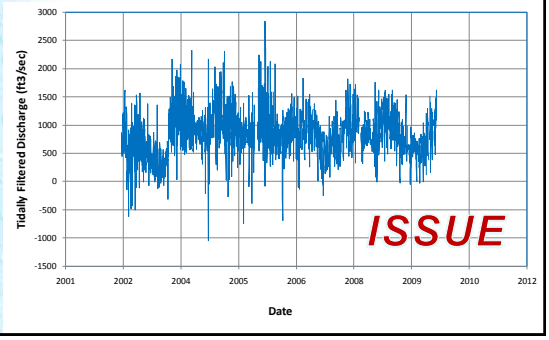
System Definition

- Crystal River / Kings Bay System -

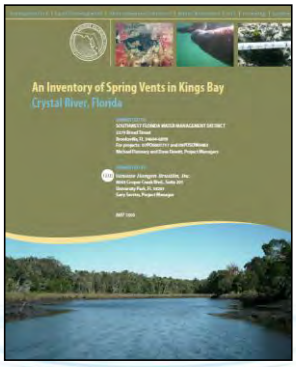


Baseline Flows and Salinity

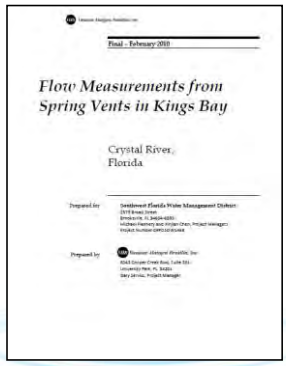
-Approved Daily Mean Discharge Record, USGS Crystal River at Bagley Cove Gage Site -



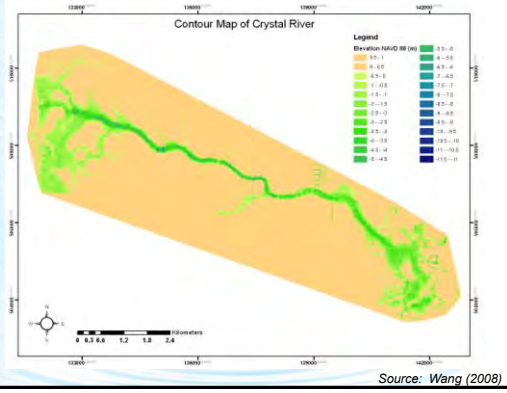
Spring Vent Mapping



Spring Vent Discharge Evaluation

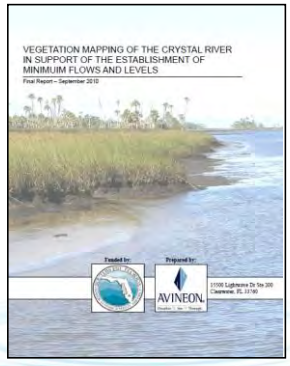


Bathymetry



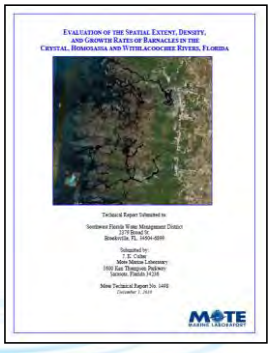
Source: Wang (2008)

Shoreline & Vegetation Mapping



Benthic Invertebrates



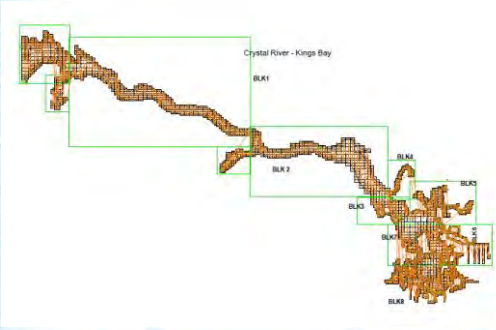


Data Summarization



Salinity-Based Habitat Modeling

- Hydrodynamic Model -



Source: X. Chen, SWFWMD

Contact Information

Name: Douglas A. Leeper

Title: Chief Environmental Scientist

Mail: Southwest Florida Water Mgmt. District
2379 Broad St.
Brooksville, FL 34604-6899

Phone: 1-800-423-1476 or 352-796-7211
Extension 4272

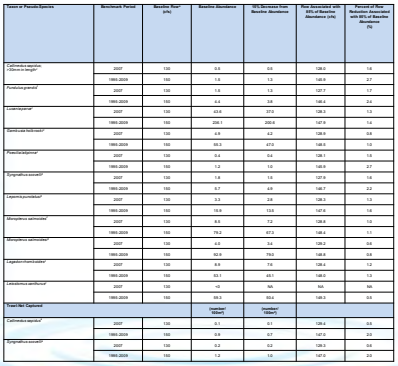
E-Mail: doug.leeper@swfwmd.state.fl.us

Web Site: www.swfwmd.state.fl.us or
watermatters.org

Plankton and Nekton Results

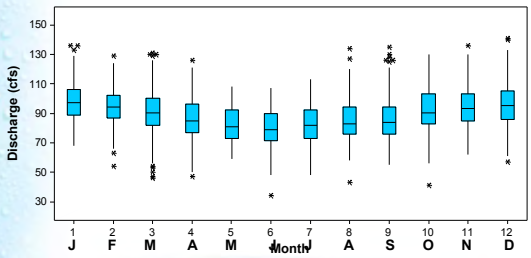
Taxon or Pseudo-Species	Benchmark Period	Baseline Flow* (cfs)	Baseline Abundance (number/ channel or number/ 100m³)	85% of Baseline Abundance (number/ channel or number/ 100m³)	Flow Associated with 85% of Baseline Abundance (cfs)	Percent of Flow Reduction Associated with 85% of Baseline Abundance (%)
Plankton-Net Captured			(number/ channel)	(number/ channel)		
Hargeria rapax[a]	2007	130	67,242	57,155	128.1	1.4
	1995-2009	150	333,722	283,663	147.8	1.4
Lucania parva postflexion larvae[a]	2007	130	1,407	1,196	128.2	1.4
	1995-2009	150	7,457	6,339	147.9	1.4
Ostracods, podocopid[a]	2007	130	31,031	26,376	128.2	1.3
	1995-2009	150	172,563	146,678	148.0	1.3
Acartia tonsa[a]	2007	130	1,294,494	1,100,319	128.6	1.1
	1995-2009	150	11,345,444	9,643,627	148.40	1.1
Eurytemora affinis[a]	2007	130	2,849	2,421	128.9	0.8
	1995-2009	150	49,686	42,233	148.8	0.8
Seine-Net Captured			(number/ 100m³)	(number/ 100m³)		
Palaemonetes intermedius[a]	2007	130	11.4	9.7	127.5	1.9
	1995-2009	150	35.8	30.4	146.9	2.1
Callinectus sapidus; <30 mm in length[a]	2007	130	1.4	1.2	129.1	0.7
	1995-2009	150	16.1	13.7	148.3	1.1

Plankton and Nekton Results (cont.)



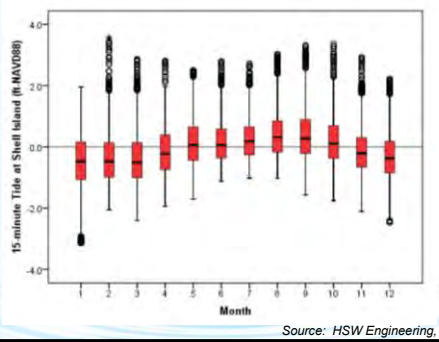
Baseline Flows and Salinity

- Monthly Mean Discharge for Homosassa Springs -



Baseline Flows and Salinity

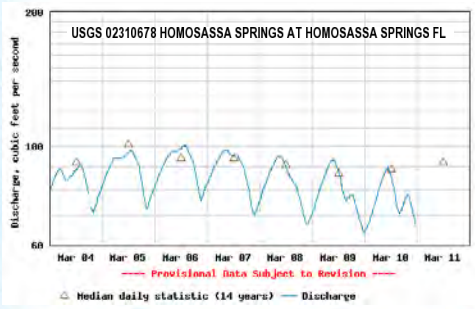
- Seasonal Tide Influences -



Source: HSW Engineering, Inc. (2010)

Baseline Flows and Salinity

- Daily Tidal Cycle Influences -



Source: USGS National Water Interface System Web Interface

Baseline Flows and Salinity

- Flows Summary Table -

Statistic (cfs or N)	Homosassa Springs at Homosassa Springs FL	SE Fork Homosassa Spring at Homosassa Springs FL	Combined Homosassa and SE Fork Springs	Halls River	Homosassa River at Homosassa FL (tidally filtered)	Hidden River near Homosassa FL
Maximum	141	100	240	1,995	2,090	25.0
75th Percentile	98	68	165	200	350	11
Median	88	60	147	108	251	8.0
25th Percentile	79	53	131	28	167	4.6
Minimum	34	23	57	-765	-636	1.3
Mean	89	61	149	129	272	8.0
Standard Deviation	14	11	26	181	183	4.4
Number (N) of daily Records	4,975	3,123	3,102	1,662	1,774	2,063

Attachment C

Slides by Mike Heyl used for the January 5, 2011 meeting

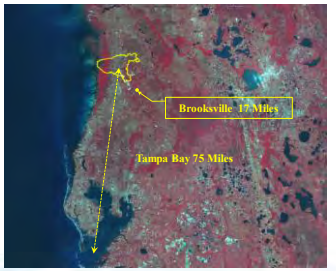
Proposed Minimum Flows and Levels for the Chassahowitzka River System

Mike Heyl
Chief Env. Scientist

Public Meeting
December 16, 2010

Southwest Florida Water Management District

Chassahowitzka River System



USGS Defined Springsheds

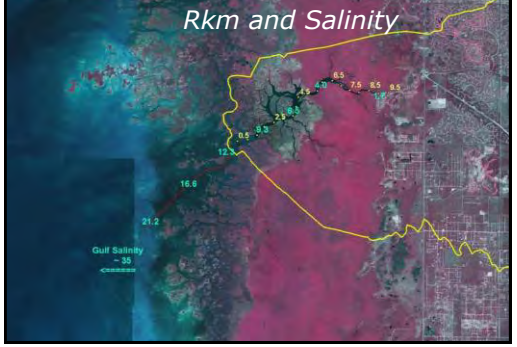


USGS WRIR01-4230

Named Springs in Chassahowitzka System



Rkm and Salinity



Water volume, bottom area and shoreline length associated with salinities that characterize or affect:

- availability of fish habitat
- availability of invertebrate habitat
- the amount and/or type of shoreline vegetation
- other, undefined system components and processes



SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Minimum Flow and Levels (MFL) Rule

Section 373.042 F.S.

'the minimum flow shall be the limit at which further **withdrawals** would be **significantly harmful** to the water resources or ecology of the area.'

- Based on 'best information available'

(See also 62-40.473 FAC.)

Not to be confused with a permit.

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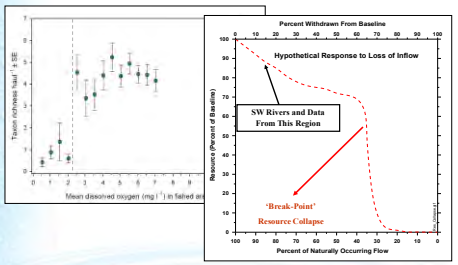
Significantly Harmful ?



Operationally Defined as 15% Loss of Resource or Habitat

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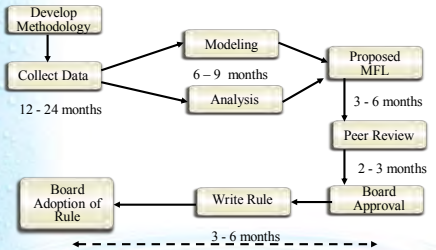
MFL Timeline - Process



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Resources and Habitats Evaluated

Resources and Habitat Evaluated	
Salinity Habitat	**Fish / Invertebrate Abundance**
2 ppt - volume	Bay anchovy, juvenile (*Anchoa mitchilli*)
5 ppt - volume	Tanaid (*Hargeria rapax*)
10 ppt - volume	Midge larvae (dipterans, chironomid larvae)
15 ppt - volume	Pink shrimp (*Farfantepenaeus duorarum*)
2 ppt - area	Gulf killifish (*Fundulus grandis*)
5 ppt - area	Rainwater killifish (*Lucania parva*)
10 ppt - area	Bluefin killifish (*Lucania goodei*)
15 ppt - area	Sailfin Molly (*Poecilia latipinna*)
2 ppt - shoreline length	Spotted sunfish (*Lepomis punctatus*)
5 ppt - shoreline length	Pinfish (*Lagodon rhomboides*)
10 ppt - shoreline length	
15 ppt - shoreline length	
Benthos	**West Indian Manatee**
Diversity	Chronic / Acute thermal refuge (volume)
Abundance	Chronic / Acute thermal refuge (area)
Mollusc	**SAV Density**
Oyster (*Crassostrea virginica*)	American eelgrass (*Vallisneria americana*)
Marshclam (*Polymesoda caroliniana*)	Southern waternymph (*Najas guadulupensis*)
Hooked mussel (*Ischadium recurvum*)	Sago pondweed (*Potamogeten pectinatus*)

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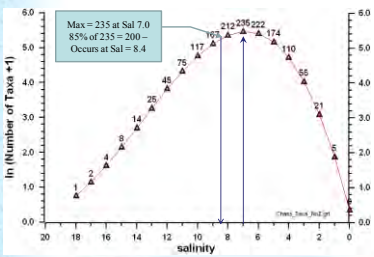
Benthos Diversity Example



At typical flow, salinity 7.0 occurs at Rkm 3.3

At this same location, salinity = 8.4 when flow is reduced 8%

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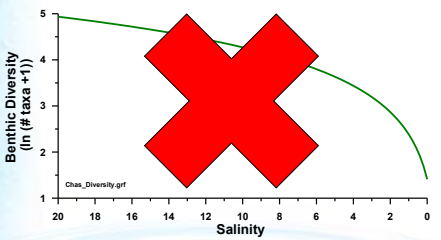
Chassahowitzka Diversity



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Polymesoda carolinia– #/m2 v.s. Salinity (Regional)

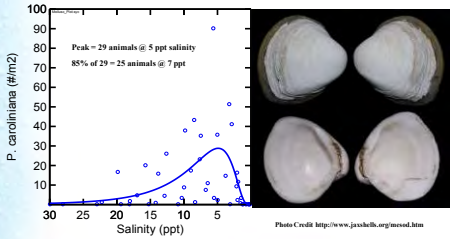

Photo Credit http://www.jaxshells.org/mesod.htm

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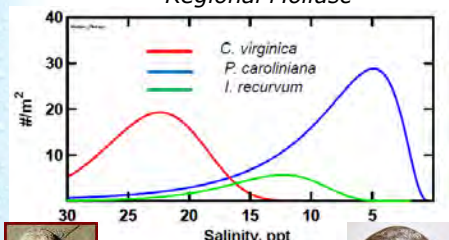
Regional Mollusc





Crassostrea virginica



Ischadium recurvum

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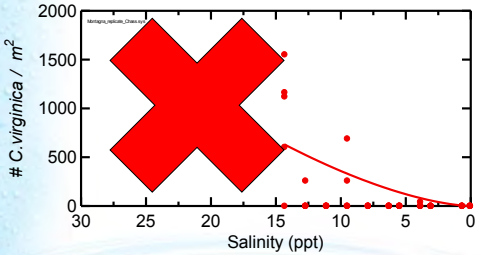
C. Virginica (oysters)



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Criteria for evaluating fish/invertebrates

	Seine or trawl	Tow	Combined
Taxa Collected	46	66	112
Significant relationship to Flow	23	13	36
Number positive linear or mid-flow maximum	13	3	16
Greater than or equal to 10 observations	8	3	11
Variation explained by flow greater than or equal to 30%	8	3	11
Percent of taxa collected	17%	5%	10%

Bay anchovy *(Anchoa mitchilli)*	Fresh to Marine
Tanaid *(Hargeria rapax)*	Marine
Midges (dipterand, chironomid larvae)	Fresh
Pink shrimp *(Farfantepenaeus duorarum)*	Marine
Gulf killifish *(Fundulus grandis)*	Fresh - Brackish
Rainwater killifish *(Lucania parva)*	Fresh to Marine
Bluefin killifish *(Lucania goodei)*	Fresh - Brackish
Sailfin molly *(Poecilia latipinna)*	Fresh to Marine
Spotted sunfish *(Lepomis punctatus)*	Fresh
pinfish *(Lagadon rhomboides)*	Marine

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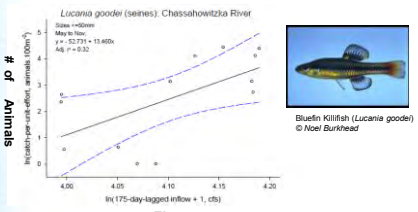
Chassahowitzka Fish



Bluefin Killifish (*Lucania goodei*)
© *Noel Burkhead*

http://www.flmnh.ufl.edu/fishsouthflorida/everglades/marshes/glossary/bluefinkillifish.html

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Plankton and Nekton

- Blue Crab Example -



Source: J. Ditty, S. Holt, J. Matthews and T. Minello
NOAA Fisheries Service, Galveston Lab

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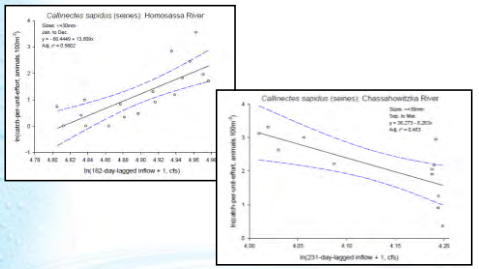
Blue Crab Nekton



Source: Peebles et al. (2009). Greenwood et al. (2008)

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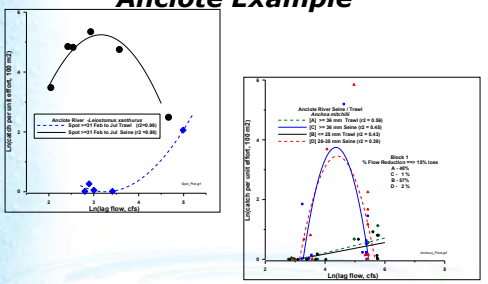
Fish / Invertebrate *Responses*
Anclote Example



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Fish / Invertebrate Responses

Taxa	Type	Season	Flow Reduction (%)		
			As Presented in Peer Draft	All Taxa	As Presented In Final Report
Plankton Net					
Anchoa mitchilli juveniles	Linear	Annual	1.0	1.0	1.0
Hargeria rapax	Linear	Annual	1.9	1.9	1.9
Dipterans, chironomid larvae	Linear	Annual	2.3	2.3	2.3
Seine and Trawl					
Farfantepenaeus duorarum (T)	Quadratic	Annual	15.2	15.2	15.2
Farfantepenaeus duorarum (S)	Quadratic	Annual	17.2	17.2	17.2
Fundulus grandis	Quadratic	Annual		11.9	11.9
Lucania parva	Quadratic	Annual	11.1	11.1	11.1
Lucania goodei	Linear	May-Nov		0.9	
Poecilia latipinna	Quadratic	Annual	13.3	13.3	13.3
Lepomis punctatus	Linear	May-Nov		1.6	
Lagodon rhomboides	Quadratic	Jan-Jun		17.9	
Median for resource			**11.1**	**11.1**	**11.5**

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Thermal Refuge Requirements

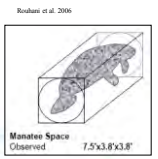
No More than a 15% Loss over Baseline Area and Volume

Chronic Requirements :

- Minimum 3.8 ft Access at High Tide
- Minimum 3.8 ft Depth at Low Tide
- Minimum of 20° C for 3-days

Acute Requirements :

- No more than 4 hours ≤ 15° C



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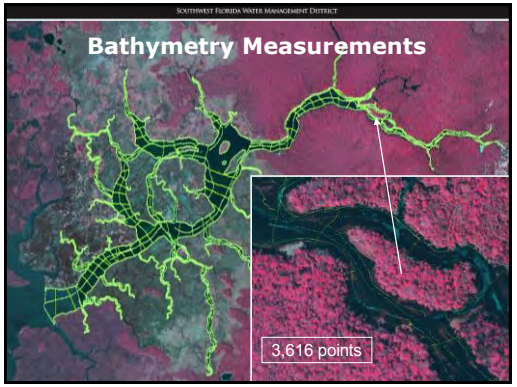

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Thermal Refuge - Chassahowitzka

Chronic Thermal Refuge – No overlapping red areas.

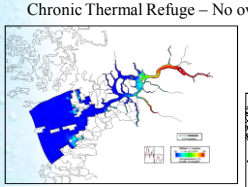


Figure -
Plan view of water temperatures during the critically cold period

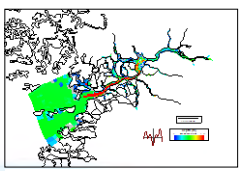
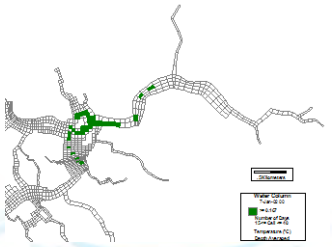


Figure -
Plan view of water depths at low tide during the critically cold period.

Thermal Refuge

Acute Thermal Refuge – 11 % Flow Reduction
Causes 15% reduction in volume.



MFL Summary - 1

Resource	Criteria	Reduction in Baseline Flow
Salinity Habitat		(%)
2 ppt - volume	15% loss in volume	22
5 ppt - volume	15% loss in volume	13
10 ppt - volume	15% loss in volume	23
15 ppt - volume	15% loss in volume	>40
2 ppt - area	15% loss in area	23
5 ppt - area	15% loss in area	15
10 ppt - area	15% loss in area	26
15 ppt - area	15% loss in area	>40
2 ppt - shoreline length	15% loss in length	30
5 ppt - shoreline length	15% loss in length	13
10 ppt - shoreline length	15% loss in length	26
15 ppt - shoreline length	15% loss in length	>40

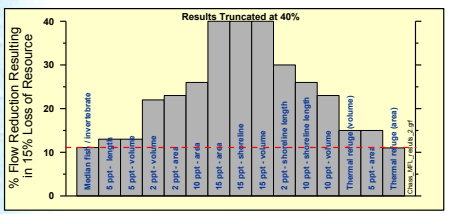
MFL Summary - 2

Resource	Criteria	Reduction in Baseline Flow
Fish / Invertebrate Abundance		
Anchoa mitchilli juveniles (#/channel)	15% loss in abundance	1.0
Hargeria rapax (#/channel)	15% loss in abundance	1.9
Dipterans, chironomid larvae (#/channel)	15% loss in abundance	2.3
Farfantepenaeus duorarum (#/100m^2)	15% loss in abundance	17.2
Farfantepenaeus duorarum (#/100m^2)	15% loss in abundance	15.2
Fundulusgrandis(#/100m^2)	15% loss in abundance	11.9
Lucania parva (#/100m^2)	15% loss in abundance	11.1
Lucania goodei (#/100m^2) Seasonally derived	15% loss in abundance	0.9
Poecilia latipinna (#/100m^2)	15% loss in abundance	13.3
Lepomis punctatus (#/100m^2) Seasonally derived	15% loss in abundance	1.6
Lagodon rhomboids (#/100m^2) Seasonally derived	15% loss in abundance	17.9
	Fish / Invertebrate Median :	**11.5**

MFL Summary - 3

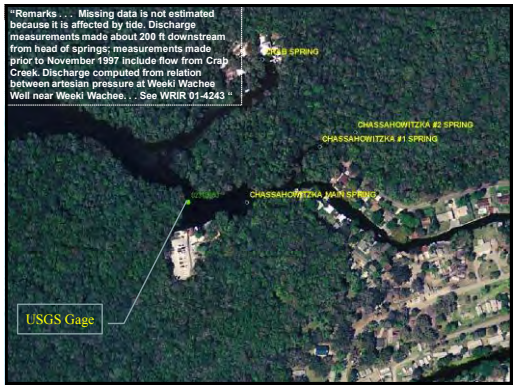
Resource	Criteria	Reduction in Baseline Flow
Benthos		
Diversity - Positive response with salinity not included	15% loss of diversity	
SAV Density		
Vallisneria americana (Not used - see text)	15% loss of peak density	1
Najas guadalupensis (Not used - see text)	15% loss of peak density	2
Potamogeton pectinatus (Not used - see text)	15% loss of peak density	1
Mollusc		
Crassostrea virginica - Optimal salinity outside sample domain - not used.	15% loss of peak abundance	
West Indian Manatee		
Acute thermal refuge (volume)	15% loss in volume	15
Acute thermal refuge (area)	15% loss of area	11

Recommended MFL – No More than 11% Reduction in Flow

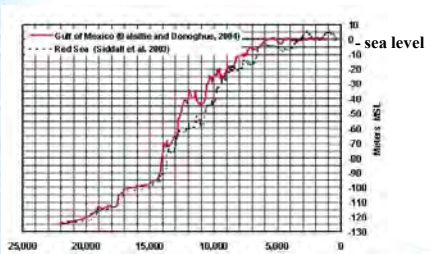




"Remarks . . . Missing data is not estimated because it is affected by tide. Discharge measurements made about 200 ft downstream from head of springs; measurements made prior to November 1997 include flow from Crab Creek. Discharge computed from relation between artesian pressure at Weeki Wachee Well near Weeki Wachee. . . See WRIR 01-4243 "



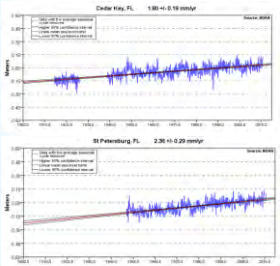
Sea Level Rise – Gulf of Mexico



– sea level

Calendar year, B.P.

Sea Level Rise – Gulf of Mexico



Cedar Key
5.7 " since 1931

St. Petersburg
7.4 " since 1931

Sea Level Rise

Sea-level rise influences coastal ecosystems through several mechanisms

- Increases salinity
- Alters plant community structure & productivity



USGS

V.Burkett, Ph.D. 3/1/2010
Hart Research Institute.
Texas A&M

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Chassahowitka, Florida

Photos: M. Newberger



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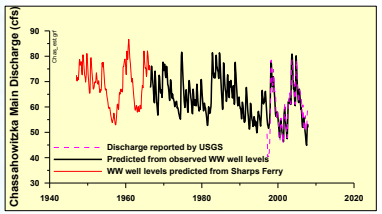

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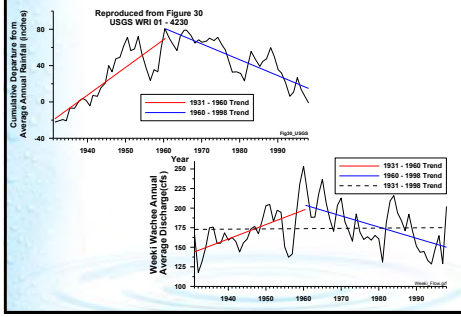
Drought and Discharge



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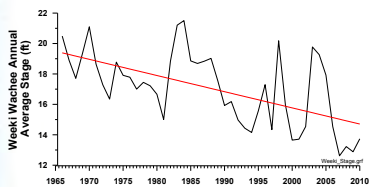
Upper Floridan Aquifer



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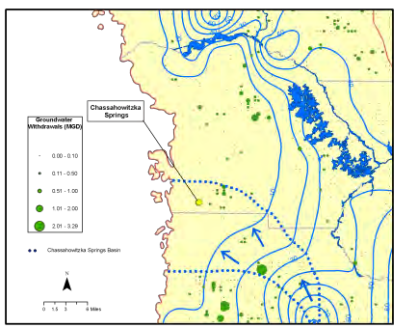

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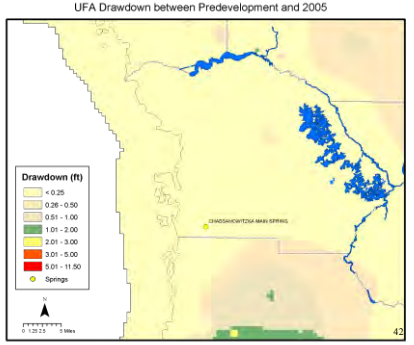
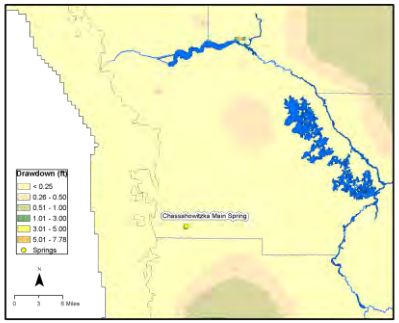


UFA Drawdown between Predevelopment and 2030



43

Northern District Model Results

Simulated Change in Nature Coast Springflow due to 2005 and Projected 2030 Groundwater Use

Spring Name	Predev Flow (cfs)	2005 Flow (cfs)	Percent Change (%)	2030 Flow (cfs)	Percent Change (%)
Weeki Wachee Spring	143.73	137.27	-4.5	132.31	-7.9
Crystal River Group	346.85	343.57	-0.9	339.55	-2.1
Homosassa Spring	71.65	70.98	-0.9	70.12	-2.1
Chassahowitzka Spring	64.14	63.47	-1.0	62.83	-2.0

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Peer Review Panel Summary

The District is to be commended for voluntarily committing to independent scientific peer review of its MFLs determinations. The Scientific Review Panel (the Panel) finds that the District's goals, data, methods and conclusions, as developed and explained in the MFL report, are reasonable and appropriate. The District's multi-species approach is to be applauded because it does not ignore species with variable life history requirements. The District approached this analysis in an appropriately holistic manner; that is, with attention paid to both the ecological requirements of the river system and to the various watershed and springshed segments of the contributing landscape already modified by humans.

Attachment D

E-Mail from Doug Leeper to Joyce Kleen, dated January 14, 2011

From: Doug Leeper
To: Joyce_Kleen@fws.gov
Subject: Updated Mote Barnacle Report
Date: Friday, January 14, 2011 9:04:46 AM
Attachments: Culter 2010 - Evaluation...barnacles in the Crystal, Homosassa and Withlacoochee....pdf

Joyce – after I provided the set of recent reports on the Homosassa and other spring systems, Sid Flannery provided me with an updated copy of the barnacle report by Mote Marine Lab. Please replace any file I've already provided with the attached version of the report. Thanks.

Douglas A. Leeper, Chief Environmental Scientist
Resource Projects Department, Southwest Florida Water Management District
2379 Broad Street, Brooksville, FL 34604-6899
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Fax: 352-754-6885
E-Mail: doug.leeper@watermatters.org
Web Site: watermatters.org

Attachment E

E-Mail from Doug Leeper to Joyce Kleen, dated February 2, 2011

From: Doug Leeper
To: Joyce_Kleen@fws.gov
Cc: Mike Heyl; Marty Kelly
Subject: Follow-Up on Data Discussion from our Jan 5 Meeting
Date: Thursday, February 03, 2011 9:59:50 AM

Hi Joyce:

Mike Heyl checked with me today to see whether we have provided the information that you requested during our Jan 5 meeting in Brooksville. Some scribbles I made on my calendar indicate that I sent you the following reports on the afternoon of the 5th, right after our meeting ended.

- Homosassa, Kings Bay, Withlacoochee barnacle report by Culter (Mote Marine Laboratory)
(I also sent a revised version of the report on Jan 14)
- Kings Bay vent location report by VHB, Inc.
- Kings Bay vent discharge report by VHB, Inc.
Crystal River/Kings Bay benthos report by Water and Air Research, Inc.
- Crystal River/Kings Bay bathymetry report by Wang
- Crystal River/Kings Bay literature review by Frazer and others

Mike recalls that you requested a copy of the slides he and I showed during the meeting and also were interested in discharge data obtained by VHB, Inc. and any vegetation data that we may have for Kings Bay, Crystal River and the Chassahowitzka River System. I think we're covered with regard to the discharge data, as that information is included in the Kings Bay vent discharge report by VHB, but I will send some additional data files anyway. You can look forward to soon receiving a CD (or two – not sure the file will fit on one disc) with the following information.

- Slides that I showed at our meeting on January fifth
- Slides that Mike showed at the meeting
- A 2010 report and associated data on vegetation in Crystal River/Kings Bay that was prepared by Avineon, Inc.
(I think I already sent you the Avineon report and data, but I'm not sure)
- A 2002 report by Clewell and others concerning vegetation in the Crystal River system and several other west-central FL tidal rivers
- A 1997 report and associated data on vegetation in Crystal River/Kings Bay and four other tidal river system that was prepared by the Florida Marine Research Institute
- Reports dated 2005, 2006, 2007 and 2010 and associated data on submersed aquatic vegetation in Kings Bay that were prepared by Frazer, Jacoby and others with the University of Florida
- A 2006 report and associated data on the bathymetry of the Chassahowitzka River system that was prepared by Ping Wang with the University of South Florida
- A 2008 report and associated data on the bathymetry of the Crystal River/Kings Bay system

that was prepared by Ping Wang with the University of South Florida
- A 2009 report and associated data (pictures) on the location of spring vents in Kings Bay that was prepared by Vanesse Hangen Brustlin, Inc.
- A 2010 report and associated data on flows from spring vents in Kings Bay that was prepared by Vanesse Hangen Brustlin, Inc.

Let me know if you have any questions about the files/data once you get the CD(s).
See you sometime soon, I'm sure.
Douglas A. Leeper, Chief Environmental Scientist
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May 19, 2011

MEMORANDUM

TO: File

FROM: Douglas A. Leeper, Chief Environmental Scientist, Ecologic Evaluation Section, Southwest Florida Water Management District

SUBJECT: Electronic mail correspondence concerning questions from Mr. Gary Maidhof regarding manatee monitoring in Kings Bay

---

This memorandum documents correspondence between Dr. Marty Kelly and Mr. Gary Maidhof, concerning manatee monitoring in Kings Bay.

DAL

Attachment: E-Mail Correspondence between Marty Kelly and Gary Maidhoff regarding manatee monitoring in Kings Bay

Attachment

E-Mail Correspondence between Marty Kelly and Gary Maidhoff regarding manatee monitoring in Kings Bay

From: Marty Kelly
To: Gary Maidhof
Cc: Doug Leeper; Mike Heyl
Subject: RE: MFL Analysis Question
Date: Friday, February 11, 2011 4:15:52 PM

Gary,

I'll ask my guys to correct me if I'm wrong, but we are not using the USGS for any manatee work. We are, of course, dependent on their flow monitoring which is partially supported by the District. Our primary work related to manatees involves the development of thermal models in order to predict the impact of potential withdrawals on volume/area of thermal refuge habitat.

Marty

From: Gary Maidhof [Gary.Maidhof@bocc.citrus.fl.us]
Sent: Friday, February 11, 2011 4:08 PM
To: Marty Kelly

Subject: MFL Analysis Question
I have a general question regarding the MFL analysis for the Chassahowitzka, Homosassa and /or the pending CR / King's Bay MFL studies ?

Are you using USGS for any of the analysis regarding manatees ?

Apparently somebody heard they were in-town studying manatees and wanted to know why. I figured it was probably MFL related but wanted to check with you first before I responded.
If you could drop me an e-mail response or feel free to call me at 352-527-5202.

Thanks

May 19, 2011

MEMORANDUM

TO: File

FROM: Douglas A. Leeper, Chief Environmental Scientist, Ecologic Evaluation Section, Southwest Florida Water Management District

SUBJECT: Electronic mail correspondence concerning request from Mr. Matthew Arsenault for bathymetric data for Kings Bay and Crystal River

---

This memorandum documents correspondence between Doug Leeper and Matthew Arsenault regarding Mr. Arsenault's request for bathymetric data for the Kings Bay/Crystal River system.

DAL
Attachment: E-Mail from Doug Leeper to Matthew Arsenault, Dated February 01, 2011

Attachment

E-Mail from Doug Leeper to Matthew Arsenault, Dated February 01, 2011

From: Doug Leeper
To: "matthew.a.arsenault@gmail.com"
Date: Tuesday, February 01, 2011 8:49:19 AM
Attachments: Wang 2008 - Shoreline mapping and bathymetric...Crystal River...WITH MAPS.pdf

Mr. Arsenault:

In response to your recent request to Cori Cuttler, I am providing an Adobe PDF version of a recent report on the bathymetry of the Kings Bay/Crystal River system. Please feel free to contact me if you have any questions concerning the report or the data summarized in the document.

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Web Site: watermatters.org

May 19, 2011

MEMORANDUM

TO: File

FROM: Douglas A. Leeper, Chief Environmental Scientist, Ecologic Evaluation Section, Southwest Florida Water Management District

SUBJECT: Documentation of February 2011 communications with Norman Hopkins regarding minimum flows development for Crystal River/Kings Bay

---

This memorandum documents a February 9, 2011 telephone conversation between Mr. Norman Hopkins and Mr. Doug Leeper, the Southwest Florida Water Management District, concerning development of minimum flows for the Crystal River/Kings Bay system. A log of the conversation and follow-up correspondences are provided as attachments to this memorandum.

DAL

Attachments: A - Phone Log
B - E-Mail from Doug Leeper to Norman Hopkins, dated February 11, 2011
C- Mail from Norman Hopkins to Doug Leeper, dated February 11, 2011
D - E-Mail from Doug Leeper to Norman Hopkins , dated February 11, 2011

Attachment A

Phone Log

Who called: Mr. Norman Hopkins
Staff contact: Doug Leeper, Ecologic Evaluation Section, SWFWMD
Issue: Crystal River/Kings Bay minimum flows
Date: February 9, 2011

Notes:

1. Requested information on published reports examining relationships between rainfall and salinity in Kings Bay and water discharged from springs within the bay.

   Response: sent information via e-mail on February 11, 2011

2. Lives near Black Spring.

3. Has seen specific conductance shift from around ~5,000 uSm/cm @25C to ~12,900 uSm/cm @25C.

4. Notes that surface water flows in the region have been tracked, but groundwater flows have not. Hopkins and Hopkins have written a grey-literature paper on groundwater flow in the area.

5. Requested information regarding the depth of freshwater in the aquifer systems in Citrus County.

   Response: sent information via e-mail on February 11, 2011

6. Contact information.
   e-mail: norman@amyhrf.org
   Phone: 352-795-9517

Attachment B

E-Mail from Doug Leeper to Norman Hopkins, dated February 11, 2011

From: Doug Leeper
To: "norman@amyhrf.org"
Cc: "norman@amyhremleyfoundation.org"
Bcc: Marty Kelly; Ron Basso; Xinjian Chen; Cara S. Martin; Karen Lloyd; Yassert Gonzalez; Roberta Starks; Jay Yingling
Subject: Info Request Regarding Kings Bay/Crystal River System MFLs
Date: Friday, February 11, 2011 2:28:32 PM

Mr. Hopkins:

It was a pleasure to speak with you this past Wednesday regarding development of minimum flows for the Kings Bay/Crystal River system.

With regard your request concerning information on the depth of the freshwater lens underlying Citrus County, I spoke with Ron Basso, a Senior Professional Geologist/Engineer with the District and he suggested that I refer you to one of the many web-based discussions of the Ghyben-Herzberg relation. This relationship or ratio implies that for each foot that the potentiometric surface of an unconfined aquifer is above sea level, there will be 40 feet of freshwater below sea level in the underlying aquifer.

The link below (supplied by Ron) points to a Wikipedia page on Saltwater Intrusion that includes a discussion of the Ghyben-Herzberg relation.

http://en.wikipedia.org/wiki/Saltwater_intrusion

Maps at the links below, which show recent elevations for the potentiometric surface of the Upper Floridan aquifer in west-central Florida can be used with the Gyhben-Herzberg relation to gain an understanding of the approximate thickness of the freshwater lens in Citrus County and nearby areas.

a) Link to a map of the potentiometric surface of the Upper Floridan aquifer, west-central Florida, September 2008, by A.G. Ortiz
http://pubs.usgs.gov/sim/3071/pdf/sim-3071.pdf

b) Link to a map of the potentiometric surface of the Upper Floridan aquifer, west-central Florida, May 2009, by A.G. Ortiz
http://pubs.usgs.gov/sim/3093/pdf/sim-3093.pdf

I'm not currently able to provide you with much information that addresses your question concerning published studies of relationships between rainfall and salinity and Kings Bay and water discharged from springs located in the bay. A 2009 report by Copeland and others (Bulletin No. 69 of the Florida Geological Survey) contains some information on water chemistry of Hunters Spring and Catfish Spring for the period from 1991 through 2003. Data for these and the other springs discussed in the report are also evaluated for the period from 1998 through 2003 (identified as , "Sequence C"

in the report), a period that included an extended drought. Here's a link to Bulletin 69, which is titled, "Regional and Statewide Trends in Florida's Spring and Well Groundwater Quality (1991-2003)":

http://publicfiles.dep.state.fl.us/FGS/FGS_Publications/B/B69MainReport/Bulletin%2069%20Color.pdf

While searching for the link listed above for Bulletin 69, I found two additional links that should be of use to reader of the bulletin. The first link points to a document containing "Errata" for the bulletin that was posted on a Florida Department of Environmental Protection web page. The second link points to a web page of the University of Florida George A. Smathers Library that indicates a revised version of the bulletin is scheduled for publication in the spring of 2011.

http://publicfiles.dep.state.fl.us/FGS/FGS_Publications/B/.../B69Errata.docx
http://ufdc.ufl.edu/UF00095137/00002

With regard to Kings Bay salinity and rainfall, I would also direct your attention to a recent report that was prepared for the District by HydroGeologic, Inc. The 2010 report, titled "Groundwater Flow and Transport Model for the Northern District Water Resources Assessment Project Area, Version 2.0" includes information on predicted saltwater intrusion for scenarios associated with groundwater withdrawal rates that occurred in 2005, groundwater withdrawal rates that may be expected for the year 2025 and for a scenario that represent severe drought conditions. The electronic version of this report is too large to distribute as an attachment to this e-mail, so I've placed a copy of the report on the District's FTP site for you to retrieve. The file, which is named "HydroGeo2010" can be retrieved from the "pub/outgoing" folder on the FTP site by following the directions on the "How to Access our Anonymous FTP Server" page of the District web site at the following link:

http://www.swfwmd.state.fl.us/data/ftp/

Please let me know if you have any problems obtaining the file posted on our FTP site or have additional questions or comments regarding the information outlined in this e-mail. I look forward to continued communications with you regarding development of minimum flows for the Crystal River/Kings Bay system.

Douglas A. Leeper, Chief Environmental Scientist
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Fax: 352-754-6885
E-Mail: doug.leeper@watermatters.org
Web Site: watermatters.org

Attachment C

E-Mail from Norman Hopkins to Doug Leeper, dated February 11, 2011

From: Norman Hopkins
To: Doug Leeper
Subject: Re: Info Request Regarding Kings Bay/Crystal River System MFLs
Date: Friday, February 11, 2011 2:48:16 PM

Thank you Doug for your kind and prompt reply to my request which I shall study with interest. I am familiar with Ghyben- Herzberg which should help.

On 2/11/2011 2:28 PM, Doug Leeper wrote:

(NOTE: remainder of e-mail not presented here)

Attachment D

E-Mail from Doug Leeper to Norman Hopkins , dated February 11, 2011

From: Doug Leeper
To: "norman@amyhrf.org"
Bcc: Ron Basso; Roberta Starks; Xinjian Chen
Subject: Another Water Quality Report
Date: Friday, February 11, 2011 3:03:17 PM

Mr. Hopkins:

Ron Basso pointed out that you may also want to look at the 2005 District report titled, "Coastal Ground-Water Quality Monitoring Network / Water-Use Permit Network Report, Volume V". This document is rather large, so I will put an electronic version of the file named "CGWQMN_Vol5" on our FTP site for you to retrieve.

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Web Site: watermatters.org

May 19, 2011

MEMORANDUM

TO: File

FROM: Douglas A. Leeper, Chief Environmental Scientist, Ecologic Evaluation Section, Southwest Florida Water Management District

SUBJECT: Information on Kings Bay presented to the Citrus County Task Force of the Citrus/Hernando Waterways Restoration Council by Norman Hopkins

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This memorandum documents information pertaining to a presentation on Kings Bay by Norman Hopkins at the March 14, 2011 Citrus Task Force meeting.

DAL

Attachments: A - Agenda for the March 14, 2011 Meeting of the Citrus Task Force
B – Approved Minutes for the March 14, 2011 Meeting of the Citrus Task Force

Attachment A

Agenda for the March 14, 2011 Meeting of the Citrus Task Force

Citrus County Task Force
Meeting Agenda

March 14, 2011
2:00 p.m.

Lecanto Government Building
3600 West Sovereign Path, Room 166
Lecanto, Florida 34461

*******All meetings are open to the public*******

SWFWMD – Southwest Florida Water Management District	FFWCC – Florida Fish and Wildlife Conservation Commission
FDEP – Florida Department of Environmental Protection	FDOT – Florida Department of Transportation
TAG – Technical Advisory Group	USACOE – United States Army Corp. of Engineers

1. Call to Order and Roll Call

2. Pledge of Allegiance

3. Approval of the June 14, 2010, August 9, 2010, October 11, 2010, and January 10, 2011 Minutes

4. Election of Officers
   a. Chair
   b. Secretary

5. Kings Bay – Norman Hopkins, Amy Remley Foundation
   a. Public Input

6. Flying Eagle/Potts Preserve Prescribed Fire Update – Joel DeAngelis, SWFWMD
   a. Public Input

7. Restoration of the Lower Withlacoochee River – Dan Hilliard, WAR
   a. Public Input

8. Public Input – Other Topics

9. Agenda Items for Next Meeting – **Tuesday, May 10, 2011 at Crystal River City Hall**

10. Adjournment

REVISED

The Southwest Florida Water Management District (District) does not discriminate on the basis of disability. This nondiscrimination policy involves every aspect of the District's functions, including access to and participation in the District's programs and activities. Anyone requiring reasonable accommodation as provided for in the Americans with Disabilities Act should contact the District's Human Resources Director, 2379 Broad Street, Brooksville, Florida 34604-6899; 1-352-796-7211 or 1-800-423-1476 (Florida only), extension 4702; TDD (Florida only) 1-800-231-6103; or email to ADACoordinator@swfwmd.state.fl.us.

If you have any questions concerning this meeting, please call 1-352-796-7211 or 1-800-423-1476 (Florida only), extension 4227. If a party decides to appeal any decision made with respect to any matter considered at a meeting, that party will need a record of the proceedings, and for such purpose that party may need to ensure that a verbatim record of the proceedings is made, which record includes the testimony and evidence upon which they appear is to be based.

Attachment B

Approved Minutes for the March 14, 2011 Meeting of the Citrus Task Force

MINUTES OF THE MEETING

Citrus County Task Force
of the
Citrus/Hernando Waterways Restoration Council

March 14, 2011

The Citrus County Task Force met at 2:00 p.m., March 14, 2011 at the Lecanto Government Building, Lecanto, Florida.

Task Force Members Present
Robert Christensen, Member
Sandra Clodwick, Secretary
Michael Czerwinski, Member
Al Grubman, Member
Eric Latimer, Member
Michael Moberley, Chair
Wayne Sawyer, Member

Technical Advisory Group Members Present
Mark Edwards, Citrus Co.
Allen Martin, FFWCC

Recording Secretary
Josie Guillen, SWFWMD

Task Force Members Absent

Technical Advisory Group Members Absent
Judy Ashton, FDEP
Katasha Cornwell, FDOT
Bill Bachschmidt, WRBB
Philip Rhinesmith, SWFWMD
Colonel Alfred Pantano, USACOE

SWFWMD – Southwest Florida Water Management District	FFWCC – Florida Fish and Wildlife Conservation Commission
FDEP – Florida Department of Environmental Protection	FDOT – Florida Department of Transportation
CRBB – Coastal Rivers Basin Board Member	USACOE – United States Army Corp of Engineers
WRBB – Withlacoochee River Basin Board Member	TAG – Technical Advisory Group

A list of others present who signed the attendance roster is filed in the permanent files of the Task Force. The numbers preceding the items listed below correspond with the published agenda.

Audio recording of the meeting is available upon request.

1. **Call to Order and Roll Call**
   Chair Moberley convened the meeting. Ms. Josie Guillen called the roll and noted a quorum was present.

2. **Pledge of Allegiance**
   Chair Moberley led the Pledge of Allegiance.

3. **Approval of the June 14, 2010, August 9, 2010, October 11, 2010, and January 10, 2011 Minutes**
   Now that the Task Force is fully constituted, following consideration, Mr. Al Grubman moved, seconded by Ms. Sandra Clodwick to approve the June 14, 2010, August 9, 2010, October 11, 2010, and January 11, 2010 meeting minutes. Motion carried unanimously.

APPROVED

4. **Election of Officers**

Chair Moberley opened the floor for nominations for Chair. Mr. Wayne Sawyer nominated Mr. Al Grubman. There being no further nominations, Chair Moberley asked for a motion to close the nominations. Mr. Robert Christensen moved the motion and Ms. Clodwick seconded the motion. Motion passed unanimously and declared Mr. Grubman as Chair.

Chair Moberley opened the floor for nominations for Secretary. Mr. Eric Latimer nominated Mr. Michael Czerwinski. Mr. Czerwinski declined. Mr. Sawyer nominated Mr. Michael Moberley. There being no further nominations, Chair Moberley asked for a motion to close the nominations. Mr. Grubman moved the motion and Ms. Clodwick seconded the motion. Motion passed unanimously and declared Mr. Moberley as Secretary.

From this point Chair Grubman took the lead of the meeting.

5. **Kings Bay**

approx. 9 minutes into the meeting

Mr. Norman Hopkins, Amy Remley Foundation, provided information on Kings Bay. Mr. Hopkins presented a map which showed the permeability of the soil over the areas of the Brooksville Ridge, Dunnellon Gap, the Coastal Plain areas, and the west and north boundaries of Citrus County. Mr. Hopkins stated the darker areas show where the water percolates faster. The darkest shades are 10-20 inches per hours, which indicate a more permeable area. Mr. Hopkins stated it is termed as a poorly confined aquifer, which means liquids are readily absorbed. Mr. Hopkins showed another map which represents the relative pressure distribution within the main Floridan aquifer system. Mr. Hopkins stated the wavy lines join parts of equal artesian pressure. The map shows the water flowing into the Kings Bay recharge area from the southeast, from the northeast, and from the north. The saltier water which underlies a freshwater lens of the aquifer is held down by the volume of water which constitutes the freshwater lens. The next map Mr. Hopkins presented showed the depths of the lens. In 1975, the area of Kings Bay had a lens depth of 250-500 feet. Mr. Hopkins stated the Florida Geological Survey advised that the levels have been reduced significantly since that time because of drought and from pumping. Mr. Hopkins stated in the shaded area along the east coast of Florida, there is no potable water. Potable water is defined as having chlorides less than or equal to 250 milligrams per liter and dissolved solids less than or equal to 500 milligrams per liter. The lack of potable water in the shaded section of the east coast according to Mr. Klein was the result of pumping. Mr. Hopkins stated pumping is a significant action which depletes the depths of water constituting the lens. When artesian flows encounter water flowing in fracture or karstic conduits the path of least resistance is adopted by the combined flow - in the direction of the conduit flows conveying groundwater to the spring vents. In the next map, Mr. Hopkins shows the variations of saltiness across parts of Kings Bay. The southwest area indicates higher (saltier) conductance with the lower readings shown to the north. Mr. Hopkins stated drought periods and pumping over the years have reduced aquifer levels and depth of the freshwater lens allowing saltier water to well up from lower levels.

Mr. Hopkins stated the Amy Remley Foundation was asked to give a presentation to the Florida Public Services Commission concerning the area occupied by the proposed nuclear site. Mr. Hopkins noted that it will be helpful if the work that is being done by the foundation to track the flows of water underground were acknowledged and supported by the Task Force. Mr. Hopkins asked that the work that has been done by the

APPROVED

foundation be recognized and given support. He said it will be an important contribution that the Task Force could make to preserve the quality of water in Kings Bay and the health of the environment.

Mr. Hopkins stated the cost of electricity generated by the nuclear plant would be several times the cost paid by consumers today as the plant exceeding $22 billion. Mr. Hopkins stated that it is unsustainable for either Progress Energy or Duke Energy to sustain that level of expenditure. Mr. Hopkins presented an alternative strategy which will be beneficial to the environmental versus having a nuclear plant in that position. Mr. Hopkins asked for the support of the Task Force for the work the foundation has done, will propose to do, and asked to provide a presentation at a future meeting.

Mr. Wayne Sawyer stated there has been a Citrus Port proposal for Citrus County. Mr. Sawyer asked Mr. Hopkins to provide a study of how it will affect the fragility of the environmental waters, tankers, water discharge. Mr. Hopkins stated the County is not proposing to bring tankers into any port. The tankers cannot come closer than approximately 50 miles into the gulf. Mr. Hopkins stated what the County is proposing is a discharge from the tankers into barges.

Mr. Eric Latimer answered Mr. Hopkins question on the amount of groundwater usage; Progress Energy has proposed 1.58 million gallons per day (mgd). Mr. Latimer stated he would be able to provide a staff member from Progress Energy to attend a future Task Force meeting to discuss the Environmental Impact Statements.

Mr. Hopkins stated the figure Mr. Latimer gave is not the troublesome figure. The troublesome figure is the 128 mgd which Progress Energy is proposing to take from the barge canal which will vent 50 mgd into the atmosphere charged with tritium which will fall into the ground and accumulate in groundwater which will affect the groundwater reserves for this area and Levy County. Mr. Hopkins stated that Progress Energy proposes to pump 60 mgd directly to the Crystal River Energy Complex and into the Gulf of Mexico.

Mr. Latimer corrected Mr. Hopkins and stated the water is pumped back into the discharge canal at the Crystal River plant.

Chair Grubman asked Mr. Hopkins to provide the members a hard copy of future presentations.

6. **Flying Eagle/Potts Preserve Prescribed Fire Update**
approx. 1 hour into the meeting

Mr. Joel DeAngelis, SWFWMD, stated last month conditions were great for burning in the main marsh at Flying Eagle. Staff conducted three burns, totaling about 1,300 acres. The burn was predominantly marsh and the hammocks within the marsh and along the edges. The conditions were low humidity, northeast winds, water in the airboat trails to contain fire in the units, and either moist or saturated conditions in the marsh vegetation.

7. **Restoration of the Lower Withlacoochee River**
approx. 1:32 hours into the meeting

Mr. Dan Hilliard, Director of Withlacoochee Area Residents (WAR) gave a presentation on the report entitled "Saving Valuable Resources-Restoration of the Lower Withlacoochee River and Preservation of Coastal Estuarine Resources." The report includes descriptions of water quality, water supply, and natural systems restoration. Mr.

APPROVED

Hilliard explained that the lower Withlacoochee River is an example of a mix of conditions. There is evidence of increasing chlorophyll levels and algae in the lake. Mr. Hilliard noted several extremes in conditions in the first two pages of the report. The lower river system is altered by the creation of the Lake Rousseau impoundment and the lower Withlacoochee River is altered as well.

The State of Florida places the value of the system at $587 billion. The Lake has been identified as a future water supply by the Withlacoochee River Water Supply Authority (WRWSA).

The alterations to the system include widening the channel which has slowed the discharge rate and has resulted in increasing salinity levels up river. The bifurcation of the lower river by the barge canal; the river lost 29 percent of its average annual flows. This coupled with drought and modifications to the lower river have led to the death of many large cypress trees along the lower river. The barge canal impacts have been studied and are the topic of several reports. URS looked at alternatives to address improving flows to the lower river. The Janicki report looked at hydrodynamic models and impacts to benthic communities. The reports agree that there are impacts to the benthic community with reduced flows. The sporadic high flows have been lost in the river because of these modifications. The goal is to preserve what we have left. Additional impacts are pending on the lower river with the Progress Energy Power Plant. The other impact to flows is potentially the WRWSA's withdrawals from 3 surface water points and 3 wellfields. The proposal for restoration includes the installation of a barrier/lock mechanism 6-miles west of the existing Inglis Lock raising the head 1.8 feet. A spillway gate constructed at the east end of the rock dam at the cul-de-sac where the Lyngbya growth is located would restore the hydrologic connection to the lower river.

Ms. Clodwick reiterated her concerns for a solution to this problem and to maintain or improve the health of the lower river and all the waterbodies of Citrus County. Before the Task Force could make a decision on the subject, Ms. Clodwick asked for comments regarding Mr. Hilliard's presentation and the two recommendations made by WAR from Mark Hammond and the Technical Advisory Group.

Mr. Sawyer stated that he wanted time to review the report and have Mark Hammond make suggestions.

Other Business/Topics of Discussion not on the Agenda

Mr. Michael Czerwinski asked the Task Force to have a stakeholders meeting for the restoration of Kings Bay. Chair Grubman stated the May meeting would be an excellent time to discuss Kings Bay seeing as the Task Force and the Kings Bay Working Group will be present. Ms. Clodwick agreed with Chair Grubman's statement. Ms. Clodwick also agreed with Chair Grubman's comment if issues are going to differ from the focus of Kings Bay, then perhaps a stakeholders meeting might be necessary, so the stakeholders can address their concerns.

Public Input

Mr. Hopkins stated he would like to see a focus of the mind and a meaningful presentation at the combined meeting in May.

8. **Agenda Items for Next Meeting**

Kings Bay Restoration

APPROVED

9. **Public Input**
None

10. **Adjournment**
There being no further business or announcements presented before the Task Force, the meeting was adjourned at 4:37 p.m.

APPROVED

May 25, 2011

MEMORANDUM

TO: File

FROM: Douglas A. Leeper, Chief Environmental Scientist, Ecologic Evaluation Section, Southwest Florida Water Management District

SUBJECT: Presentation on the status of minimum flows and levels development to the Citrus County Board of County Commissioners

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This memorandum documents information pertaining to a presentation on minimum flows and level made by Doug Leeper, Chief Environmental Scientist, to the Citrus County Board of County Commissioners at the April 26, 2011 meeting of the Board.

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Attachments:
- A – Excerpted pages from the agenda for the April 26, 2011 Meeting of the Citrus County Board of County Commissioner
- B - Slides used by Doug Leeper at the April 26, 2011 Meeting of the Citrus County Board of County Commissioners
- C – Excerpted pages from a Citrus County Memorandum concerning Minutes for the April 26, 2011 Meeting of the Citrus County Board of County Commissioners

Attachment A

Excerpted pages from the Agenda for the April 26, 2011 Meeting of the Citrus County Board of County Commissioners

BOARD OF COUNTY COMMISSIONERS OF CITRUS COUNTY, FLORIDA
Citrus County Courthouse, Room 100
110 N. Apopka Avenue, Inverness, FL 34450

REVISED AGENDA
April 26, 2011 at 1:00 P.M.

Dennis Damato, District 1, Chairman	Betty Strifler, Clerk of the Circuit Court
Winn Webb, District 5, 1st Vice Chairman	Richard Wm. Wesch, County Attorney
Joe Meek, District 3, 2nd Vice Chairman	Brad Thorpe, County Administrator
John J. (J.J.) Kenney, District 2	Eber E. Brown, Deputy County Administrator
Rebecca Bays, District 4	

MISSION

Citrus County Government will be a value-driven organization dedicated to responsive citizen service by providing quality programs, services and facilities to build a strong community and promote the best quality of life for our citizens.

All persons desiring to address the County Commission will be asked to limit their comments to the specific subject being discussed.

There will be a time limit set for all persons speaking at the public hearings, zone changes, workshops, and "Open To The Public" portion of a meeting. Organizations will be limited to five (5) minutes and individuals to three (3) minutes on either side of the item being discussed.

All members of the public wishing to speak at the "Open To The Public" portion of a meeting will have three (3) minutes per person per day to make their request or presentation. If the request or presentation deals with a matter that requires investigation by County staff, the Chairman will refer it to the County Administrator to follow-up with the person making the request.

Any person who decides to appeal any decision of the Governing Body with respect to any matter considered at this meeting will need a record of the proceedings and for such purpose may need to provide that a verbatim record of proceeding is made which record includes testimony and evidence upon which the appeal is to be based. (Section 286.0105 Florida Statutes)

Any person requiring reasonable accommodation at this meeting because of a disability or physical impairment should contact the County Administrator's Office, Citrus County Courthouse, 110 N. Apopka Avenue, Inverness, FL 34450 (352) 341-6560, TTY (352) 341-6580 at least two days before the meeting.

A. CALL TO ORDER – April 26, 2011, Citrus County Courthouse, 110 North Apopka Avenue, Inverness, Florida

A1. Invocation

A2. Pledge of Allegiance

A3. Roll Call

A4. Recognition of Public Officials

C. PUBLIC HEARINGS - WORKSHOPS - PRESENTATIONS

C1. **1:25 P.M. PROCLAMATION – NATIONAL PUBLIC WORKS WEEK**

a. Approve and authorize the Board to execute a Proclamation declaring May 15 through May 21, 2011 as "Public Works Week" in Citrus County, Florida.

C2. **1:30 P.M. PROCLAMATION – RETURNING VETERAN – LAWERENCE OGLE**

a. Approve and authorize the Board to execute a Proclamation declaring May 7, 2011, as "Lawrence M. Ogle Day" in Citrus County, Florida.

C3. **1:30 P.M. PROCLAMATION – BETTER SPEECH AND HEARING MONTH**

a. Approve and authorize the Board to execute a Proclamation declaring the month of May, 2011, as "Better Speech and Hearing Month" in Citrus County, Florida.

C4. **1:40 P.M. PROCLAMATION – TOASTMASTERS AWARENESS DAY**

a. Approve and authorize the Board to execute a Proclamation declaring April 29, 2011, as "Toastmasters Awareness Day" in Citrus County, Florida.

C5. **1:45 P.M. PRESENTATION – SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT – MFL MINIMUM FLOW AND LEVELS**

a. Presentation and overview by Doug Leeper, Chief Environmentalist with Southwest Florida Water Management District (SWFWMD) regarding the minimum flows and levels in Citrus County, Florida.

Attachment B

Slides used by Doug Leeper at the April 26, 2011 Meeting of the Citrus County Board of County Commissioners

Update on Minimum Flows and Levels in Citrus County

Douglas A. Leeper
Chief Environmental Scientist
Southwest Florida Water Management District

Citrus County Board of County Commissioners Meeting
Inverness, Florida

April 26, 2011

Florida Statutes, Section 373.042

- Minimum Flows and Levels -

The **minimum flow** for a given watercourse shall be the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area.

The **minimum water level** shall be the level of groundwater in an aquifer and the level of surface water at which further withdrawals would be significantly harmful to the water resources of the area.

Withdrawal-Related Significant Harm

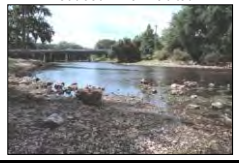
Reduced Basin Connectivity



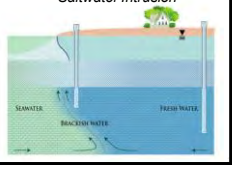
Degraded Wetlands



Reduced River Habitat



Saltwater Intrusion



Regulatory Use of Minimum Flows and Levels

- Water Resource Planning
- Water-Use Permitting
- Environmental Resource Permitting



Process for Establishing Minimum Flows and Levels

- Priority List and Schedule developed and updated annually
- Methods, flows or levels developed and peer-reviewed
- Workshops held for public input
- Recovery or prevention strategies developed, as necessary
- Governing Board adopts minimum flows and levels into Chapter 40D-8, Florida Administrative Code,
- Necessary recovery strategies included in Regional Water Supply Plan and in some cases adopted into Chapter 40D-80, Florida Administrative Code

Minimum Flows and Level Priority List and Schedule – Citrus Co. Water Bodies

Already Adopted

- Ft. Cooper Lake
- Tsala Apopka Lake (Floral City, Inverness and Hernando Pools)



Minimum Flows and Level Priority List and Schedule – Citrus Co. Water Bodies

Scheduled for Adoption

- Chassahowitzka River System and Springs
  (includes Chass. Main, Chass. #1, Crab Creek, Potter, Ruth and Blind Springs)
- Homosassa River System and Springs
  (includes Halls River Springs, Southeast Fork Homosassa River Springs, Homosassa Main Springs, Hidden River Springs)
- Upper and Middle Withlacoochee River System (Green Swamp)



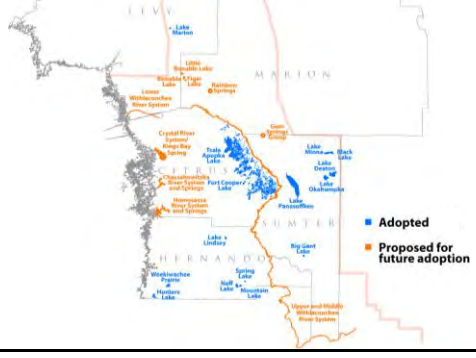
Minimum Flows and Level Priority List and Schedule – Citrus Co. Water Bodies

Scheduled for Adoption

- Crystal River System and Kings Bay Springs
- Lower Withlacoochee River System



Regional Minimum Flows and Levels

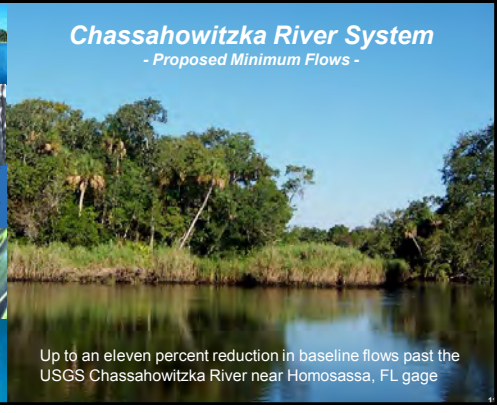


Chassahowitzka River System



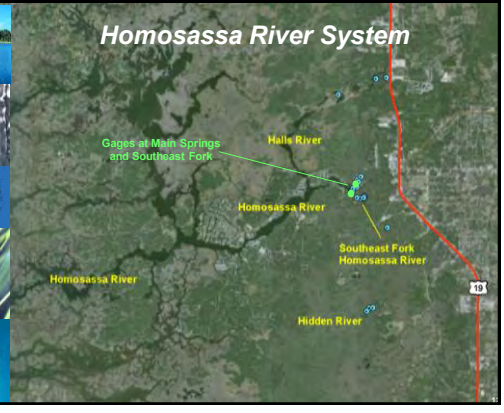
Chassahowitzka River System

- Proposed Minimum Flows -



Up to an eleven percent reduction in baseline flows past the USGS Chassahowitzka River near Homosassa, FL gage

Homosassa River System



Homosassa River System
- Proposed Minimum Flows -

Up to a five percent reduction in baseline flows measured as combined daily mean flow past the USGS Homosassa Springs at Homosassa Springs, FL and Southeast Fork Homosassa Springs at Homosassa Springs, FL gages

Upper and Middle Withlacoochee River System (Green Swamp)



Upper and Middle Withlacoochee River System (Green Swamp)
- Proposed Minimum Flows -

Season-specific allowable percent reductions in baseline flows past the USGS Withlacoochee River near Holder, FL, Withlacoochee River at Wysong Dam at Carlson, FL, and Withlacoochee River at Croom, FL gages

Upper and Middle Withlacoochee River System
- Proposed Minimum Flows -



Questions?

Contact Information

Name: Douglas A. Leeper

Title: Chief Environmental Scientist

Mail: Southwest Florida Water Mgmt. District
2379 Broad St.
Brooksville, FL 34604-6899

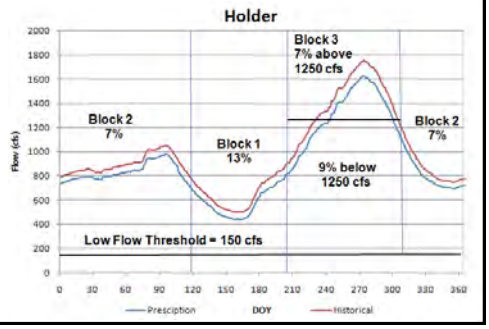
Phone: 1-800-423-1476 or 352-796-7211
Extension 4272

E-Mail: doug.leeper@swfwmd.state.fl.us

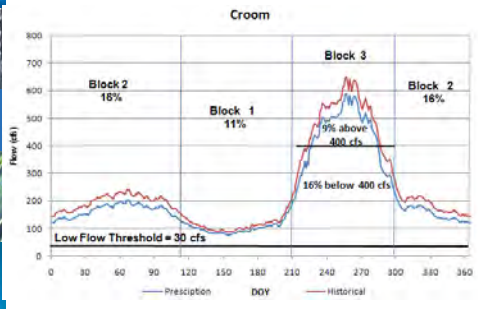
Web Site: www.swfwmd.state.fl.us or
watermatters.org

Extra Slides

Upper and Middle Withlacoochee River System
- Proposed Minimum Flows -



Upper and Middle Withlacoochee River System
- Proposed Minimum Flows -



Attachment C

Excerpted pages from a Citrus County Memorandum concerning Minutes for the April 26, 2011 Meeting of the Citrus County Board of County Commissioners

Item No.:	B1
Date:	5/10/11
Approved for Agenda:	B. Thag

AGENDA MEMORANDUM

THROUGH:	Betty Strifler, Clerk of the Circuit Court
FROM:	Tifani White, Deputy Clerk
SUBJECT:	Minutes of the Board of County Commissioners
AGENDA DATE:	**May 10, 2011**

BRIEF OVERVIEW:

BUDGET IMPACT/FUNDING SOURCE:

Account No.	Account Title	Current Budget	YTD Expenditures	Encumbrances	Available Balance
					$0

RECOMMENDED ACTION:

Approve the minutes of the Regular Meeting held on April 26, 2011.

Attachment: Minutes

Reviewed & Approved by:

County Attorney	
Management & Budget	
Risk Management	
Other	

REGULAR MEETING OF THE BOARD OF COUNTY COMMISSIONERS OF CITRUS COUNTY, FLORIDA - 1:00 P.M.

A. ***CALL TO ORDER - April 26, 2011, Citrus County Courthouse, 110 North Apopka Avenue, Inverness, Florida***

The Chairman called the meeting to order at 1:00 p.m.

A1. Invocation

A2. Pledge of Allegiance

A3. Roll Call

BOARD MEMBERS: First Vice Chairman Winn Webb, Second Vice Chairman Joe Meek, Commissioner Rebecca Bays, and Commissioner John J. (J.J.) Kenney.

STAFF: County Attorney Richard Wm. Wesch, County Administrator Brad Thorpe, Deputy Clerk Tifani White, and Clerk of Courts Finance Director Sarah Koser.

A4. Recognition of Public Officials

Property Appraiser Geoffrey Greene was present.

B. ***CONSENT AGENDA***

Motion by Second Vice Chairman Joe Meek, seconded by Commissioner John J. (J.J.) Kenney, to pull items B9 and B34 for discussion and approve the balance of the Consent Agenda items. Motion carried unanimously.

B1. Approve the minutes of the Regular Meeting held on April 12, 2011.

B2. Approve the county warrants for payroll and accounts payable.

B3. LEFT BLANK INTENTIONALLY

B4. Approve budget transfers for Board of County Commissioners/County Administrator, Board of County Commissioners, Solid Waste, HUD-Section 8, Low Income Home Energy Assistance, Fleet and Transportation Management, Code

Commissioner John J. (J.J.) Kenney, to approve item C1. Motion carried unanimously.

Public Works Director Ken Frink thanked all Public Works staff members for their work.

C2. 1:30 P.M. PROCLAMATION - RETURNING VETERAN - LAWERENCE OGLE

a. Approve and authorize the Board to execute a proclamation declaring May 7, 2011, as "Lawrence M. Ogle Day" in Citrus County, Florida.

Motion by Second Vice Chairman Joe Meek, seconded by Commissioner Rebecca Bays, to approve item C2. Motion carried unanimously.

C3. 1:30 P.M. PROCLAMATION - BETTER SPEECH AND HEARING MONTH

a. Approve and authorize the Board to execute a proclamation declaring the month of May, 2011, as "Better Speech and Hearing Month" in Citrus County, Florida.

Motion by Commissioner John J. (J.J.) Kenney, seconded by Second Vice Chairman Joe Meek, to approve item C3. Motion carried unanimously.

Commissioner Webb noted the many children in the audience were present in support of Sergeant Major Ogle.

C4. 1:40 P.M. PROCLAMATION - TOASTMASTERS AWARENESS DAY

a. Approve and authorize the Board to execute a proclamation declaring April 29, 2011, as "Toastmasters Awareness Day" in Citrus County, Florida.

Motion by Commissioner Rebecca Bays, seconded by Second Vice Chairman Joe Meek, to approve item C4. Motion carried unanimously.

C5. 1:45 P.M. PRESENTATION - SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT - MFL MINIMUM FLOW AND LEVELS

a. Presentation and overview by Doug Leeper, Chief Environmentalist with Southwest Florida Water Management District (SWFWMD) regarding the minimum flows and levels in Citrus County, Florida.

Following the presentation Mr. Leeper responded to questions from the Board. Citizens Al Grubman, Marco Wilson, Ron Miller, Dan Hilliard, Jim Bitter, and Hope Corona commented on some of the points mentioned during the presentation.

C6. 2:15 P.M. PUBLIC HEARING - CR486 LAND EXCHANGE - GLOBAL ASSOCIATES INTERNATIONAL GROUP, INC.

a. Conduct a Public Hearing for the adoption of a resolution of the Board of County Commissioners authorizing a Land Exchange between Citrus County and Global Associates International Group, Inc., in accordance with Section 125.37, Florida Statutes to acquire land necessary to the "CR 486 Phase II Road Improvement Project" and authorize Chairman to execute same.

b. Approve and authorize the Chairman to execute the Property Exchange Agreement.

c. Approve and authorize the Chairman to execute the Billboard Relocation Agreement.

d. Approve and authorize the Chairman to execute a deed to Global Associates International Group, Inc. for part of Lot 4 of an unrecorded subdivision 22000 in Section 24, Township 18S, Range 17E.

e. Authorize staff to close on the property and authorize the Clerk to place acceptance stamp on deed from Global Associates International Group, Inc. and record in the public records of Citrus County, Florida.

Cambell McLean and Kent Hipp, representatives of GrayRobinson gave a PowerPoint presentation.

Motion by Second Vice Chairman Joe Meek, seconded by Commissioner Rebecca Bays, to approve item C6 (Resolution No. 2011-072). Motion carried unanimously.

C7. 2:25 P.M. PRESENTATION - ECONOMIC DEVELOPMENT COUNCIL (EDC) INVESTMENT REQUESTS

May 19, 2011

MEMORANDUM

TO: File

FROM: Douglas A. Leeper, Chief Environmental Scientist, Ecologic Evaluation Section, Southwest Florida Water Management District

SUBJECT: Documentation of April 2011 communications with Norman Hopkins regarding minimum flows development for Crystal River/Kings Bay

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This memorandum documents an April 4, 2011 telephone conversation between Norman Hopkins and Sid Flannery concerning development of minimum flows for the Crystal River/Kings Bay system. An e-mail and attachment sent to Mr. Flannery by Mr. Hopkins was distributed to staff and is documented in attachments to this memorandum.

DAL

Attachments: A - E-Mail from Sid Flannery to staff concerning communications with Norman Hopkins
B – Document provided by Norman Hopkins

Attachment A

E-Mail from Sid Flannery to staff concerning communications with Norman Hopkins

From: Sid Flannery
To: Marty Kelly; Doug Leeper; Ron Basso; Mike Heyl
Cc: Norman Hopkins
Subject: FW: FPSC review 2011 of Docket 080148-EI and the Order issued August 12, 2008
Date: Monday, April 04, 2011 8:25:41 AM
Attachments: FPSCA_RMay2011.pdf

Doug, Marty, Ron, Mike,

At the request of Norman Hopkins of the Amy Remley Foundation in Crystal River, I am forwarding the attached document to you. Mr. Hopkins description of the document is below. I am sending it to Mike as well as it pertains to the proposed power plant that I believe would be near or associated with the Withlacoochee River.

From Norman Hopkins:

Further to our brief chat today, I attach the document referred to. We were asked by FPSC staff to submit such a document illustrating that Levy units 1 and 2 would not provide electricity at a reasonable cost as claimed by the utility and to suggest an environmentally preferable alternative. We have another month before it is due at the FPSC.

I would appreciate it if you would pass it on to the MFL review team.

The Foundation has drafted the document after having been requested by the Florida Public Services Commission to do so. It is being examined by others (environmental, legal and political) who will advise how best to proceed. The document is still a work in progress as we will reflect advice as it is given.

My purpose in passing it on to you is to give a heads up with regard to the MFL work in regard to Crystal River/Kings Bay. Ron Basso referred to the Ghyben- Herzberg Lens in a recent e-mail to me. The Howard Klein document at Figure 4. was obtained from the University of Florida as a TIFF file.

Thank you and kind regards.

Sid
Michael S. (Sid) Flannery
Chief Environmental Scientist
Southwest Florida Water Management District
2379 Broad St.
Brooksville, FL 34604-6899
phone: 352-796-7211, ext. 4277
email: sid.flannery@swfwmd.state.fl.us

Attachment B

Document provided by Norman Hopkins

Research Paper re. FPSC Annual Review of Docket NO. 080148-EI

BACKGROUND

Businesses and people need a reliable, secure, environmentally safe electricity supply at a stable acceptable price. Affordable electricity is a prerequisite to the creation of new jobs in Florida today. The nuclear facility proposed for Levy County just cannot fulfill that essential requirement.
(The illustration Figures referred to are shown in Annex C).

Environmental Issues

The fresh water "lens" of the regional aquifer systems is the sole source of potable water of the region. It is recharged exclusively by rainfall which percolates readily into the underground aquifer systems. [See Figure 1.]

Anthropogenic pollutants percolate down from the land surface into the aquifer systems reducing water quality of the lens. When pumped withdrawals, for domestic, agricultural or industrial uses, combine with the natural discharges via spring vents and exceeds regional rainfall amounts, concentrations of chlorides and dissolved solids well up from deeper aquifer systems and add to the degradation of water quality in the lens, [See Figure 2.]

Increasing saltiness levels of spring discharges over prior years had already induced ecological changes, as marine and exotic species of aquatic vegetation out-competed native fresh water species. Yet just a single isolated year of near average rainfall was sufficient to reduce by half measurements of specific conductance (saltiness) of water being discharged from Kings Bay springs. A recent study by Vanasse Hangen and Brustlin, Inc, showed graphically just how prone are these systems serving Kings Bay to anthropogenic changes from pumping and pollution. [See Figure 3.]

"Potable water" was defined by Howard Klein et. al. in 1975, in MS 42 (revised), as having fewer than 250 mg per liter of chlorides and no more dissolved solids than 500 mg per liter. when depths of the potable water lens were last determined. Klein attributed to pumping activities the lack of potable water lens along the east coast of Florida, at parallels of latitude comparable to those of Citrus and Levy counties. The FGS advise that depths recorded by him at the time will have reduced since then. [See Figure 4.]

Environmental Issues with the proposed Levy nuclear plant

Radionuclides emitted in water vapor by a nuclear plant on the proposed site will come to earth, percolate into and accumulate in the unprotected aquifer systems over the operating life of the plant. Consumption of water and food contaminated with such radio-active elements establishes a clear path over time to create cancers in humans. Unlike the skin on the outside of of the body there is nothing to protect the cells and tissues from the damaging effects of emitted alpha and beta particles once ingested, inhaled or otherwise absorbed. [See Annex A]. The BEIR VII, 2005, report of the National Academy of Sciences indicates that *any* exposure to radiation can have detrimental health effects.

Discharging untreated water into the Gulf of Mexico conveys radionuclides into those waters to contaminate the entire food web nurtured there. Sea grasses absorb nutrients from the biomass in which they are rooted and from the water column. Protected species of manatee regularly ingest aquatic vegetation during their summer forage are at risk of cancer from radioactive elements in water molecules.

Excavation and pressure grouting deep into the aquifer lens to de-water foundations for the reactor pads will compromise the lens and the associated zone of influence.

Energy intensive production processes of the uranium fuel harms the environment by emitting greenhouse gases (GHG) and the banned Chlorofluorocarbons (CFC) which deplete atmospheric ozone.

The incalculable cost burden of raised health costs and depletion of the manatee population over time would impact the eco-tourism element of the local economy supported by the presence of manatees in the wild. (The latter is estimated to exceed $20million a year).

Are these the anthropogenic consequences needed in this region of Florida?

Nuclear Reactors:
During the 1960s, Cold War period, Uranium was the nuclear fuel of choice presumably because of its path to higher power Plutonium weapon systems. and possibly due to issues with durability of materials. The legacy today is weapon proliferation, terrorism threat, used fuel hazard (millions of times more radioactive than before use), groundwater contamination by Tritium and other nuclides, and exposure to catastrophic risks (of limited insurability).

Tritium is the most prevalent of the very many radionuclides emitted by the proposed nuclear reactors, according the designers. Tritium (like any other hydrogen atom) bonds readily with oxygen to form water, creating a pathway to internal cells and tissues of living creatures susceptible to cancer from radiation exposure. Tritiated (radioactive) water remains so for 120 years until decay into Helium. Tritium has a half-life of 12.43 years and is an EPA classified carcinogen of living organisms.

Every day the Levy plant is expected to vent 50+ million gals. of water to the air and discharge 60+ million gals. of water to near shore Gulf of Mexico waters. These events over the life of the plant accumulate radionuclides in both the potable water source in aquifer systems and the near shore biotic systems, hazarding health of humans and health of the protected manatee species valued by the local economy.

It is understood that Thorium nuclear fuel, abandoned after five years successful operation in the United States in favor of Uranium, is in use elsewhere today. Thorium is said to be more plentiful than Uranium, emits no tritium, yields more electrical energy per ton than 200 tons of Uranium or 3,500 tons of Coal, is not a terrorism objective, and fails safe automatically. Reportedly thorium nuclear power is again being addressed in the United States and being pursued in China, but it is not known how long it would take for it to become a preferred source of electrical energy.

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CONSUMER COST of ELECTRICITY

Nuclear Financial Risk:
Cash flow metrics of utility corporations pursuing nuclear options reduce their Credit Ratings by between 25 and 35% (from A to Baa rating) raising loan rates and reducing market demand for the "paper". In 2005, FCG (Federal Credit Guarantees) were introduced to encourage lenders to loan to utilities to meet the then perceived energy needs (at taxpayer expense of default in repaying the loan). Since 2005, EIA reports that that capacity need has reduced by 94GW.

Reliable cost estimates are not available absent any experience of building the Levy reactor type The EIA, Annual Energy Outlook 2011, shows nuclear to be the most expensive option for Florida by far costing $22.5billion spread over ten to fifteen years, during which the overnight costs soar. [See Figure 5.]

Seeking to reduce the unsustainable corporate debt cost burden by passing on in consumer tariffs even before any approval to build is issued, transfers the burden from those who receive benefit from taking such risk to those who do not, By law a public utility supplier is allowed to recover from ratepayers only costs which are *prudently* incurred, meaning avoiding high-risk options when a lower risk option will "get the job done". (Note: Union Electric Company Opinion #279, Docket No.ER84-560, July 20, 1987, Federal Energy Regulatory Commission (FERC), with respect to expenditures on its Callaway nuclear plant).

Wall Street's Jim Hempstead, a Moody's Senior V.P., in the Wall Street Journal on 18 February 2010, observed that, "We think the probability that things will go wrong with these large projects is greater than the probability that things will go right." This and the nuclear industry proclivity to under assess and over-run both cost and time estimates prompted twelve financial analysis firms in the wake of the Fukushima Daiichi experience to down rate nuclear industry corporate prospects.

As insufficient funds accrue to the utility corporation from consumer billings to cover ongoing costs of plant debt the capital is considered "stranded". The utility faces the option to close down and decommission the plant, disposing of all the toxic waste and cleaning up any environmental damage, or sell the loss making facility to a competitor at a price that consumer billings would justify.

No rational business model can sustain a capital costs burden at too high a proportion of product cost. The financial burden for the proposed Levy nuclear facility has been calculated to exceed three quarters (75%) of total costs per kWh(e) exclusive of profit, which is not a viable proposition in face of a competitive alternative. [See Annex B].

The uranium nuclear energy option has become simply too expensive and too risky. Skyrocketing cost of building new nuclear reactors have rendered it unable to compete with falling natural gas prices that could stay low for decades. Moreover, lower cost alternatives that are now more widely available afford utilities much more flexibility in providing energy consistent with their changing demand curve. The decline in demand growth for electricity has negated petitions made years earlier for determination of need,

Public policy cannot supplant the economic reality that nuclear economics are so bad that risk cannot be entertained by the traditional capital markets, Only upon the false premise of taxpayer subsidies (federal loan guarantees or unfunded mandates) or ceding sovereignty to infusion of capital from foreign equipment vendors or their governments, can reactor construction even be kick started. The nuclear industry is demanding state ratepayers subsidize and guarantee to pay the construction costs, even if the reactors are not built or are abandoned to stranded capital.

Neither the federal nor the state government should force tax and rate payers to fund another many-billion dollar stranded capital bailout of an industry that is totally uneconomic and has no chance of standing on its own shareholder and bondholder shoulders (as reported in the local press attributed to a utility corporate spokesperson on 24 February, 2011.).

A BASELOAD and ENVIRONMENTALLY PREFERABLE ALTERNATIVE

DOE recently announced that a photovoltaic system should become a utility scale candidate by 2016. It would however displace needed forested areas. A Thorium nuclear reactor is not on the horizon at this time. Florida could not accommodate an IGCC CCS plant, and any other centralized fossil fuel (hydrocarbon) plant would emit harmful GHGs.

Natural gas (a fossil fuel) is now being piped into the region with the possibility of it being used as lower cost fuel for either central or distributed electricity generation lasting for decades. More efficient use of installed centralized plants could be made adopting Renewable Electrolysis whereby generated electricity is stored, say, as compressed hydrogen gas, and reprocessed using utility scale fuel cells to satisfy peak demands.

However, radically fewer GHG emissions result from using electrochemical fuel cell systems instead hydrocarbon fuel combustion.

Adopting a fuel cell distributed electrical generation strategy would offer several advantageous features:

- generation close to point of use avoids need for costly transmission lines.

- very high energy efficiency with low noise and minimal pollution enables even higher energy efficiencies from fuel cells with CHP applications.

- a variety of fuels can be used from hydrogen to methane gas from waste.

- creative integrated industrial applications save both money and manpower.

- typically, for every 1,000 kWh(e) produced less than one ounce of pollution results as opposed to the twenty five (25) pounds produced from central grid systems.

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Distributed Generation (DG)

DOE aims by 2020, to have one fifth of all new commercial building powered by DG, supplying extremely reliable power for critical commercial, industrial, communication and health care facilities. Every DG application relieves load from centralized generation facilities.

A single state (Connecticut) estimates that conserving resources and curbing emissions presents a 35,000MW energy market with 7,000MW (20%) employing fuel cell systems - principally combined heat and power (CHP) applications.

Today a DG FuelCell Energy Inc. CHP facility comes on stream 12 to 14 months after agreeing project financing at, say, $4,350 per kW and (assuming fuel cost of $6.00 per MMBtu) yielding $0.14 per kWh(e) with the latter reducing by between one and two cents when utilizing CHP. (This compares with more than $11,000 per kW for the Levy proposal extending over eleven more years).

Efficiency Comparisons:

a. Plant Capacity Factor (CF) - Percent achievable of nameplate rating:
   i. Fuel Cells - CF up to 95%,
   ii. a pulverized coal plant (PCP) - CF up to 95%,
   iii. Wind - CF 25 – 35%, Solar - CF 15 – 25%.

b. Plant Energy Efficiency (EE) - Percent energy conversion. :
   i. Fuel Cell (DFC ™) EE 47%, DFC-hybrid EE 55 - 65%,
      DFC/CHP EE 60 -80%.
   ii. Micro-turbine EE 25 – 30%, Small Gas Turbine EE 25-35%,
      Natural Gas Engine EE 30 – 42%,

c. Plant Effective Utilization (EU) - Percent operating at Peak output:
   i. DFC-hybrid EU 93%.
   ii. PCP EU 70.44%,

d. GHG emissions - FC percent emitted of PCP, saving tons per year:
   i. Nitrous oxides 0.06% saving 249 tons
   ii. Sulfurs 0.001% saving 3,500 tons
   iii. Carbon dioxide 45% saving 357,000 tons

Conclusions of the EIA in regard to fuel cell applications in context of DG are reproduced below *(emphasis added)*:

" Distributed generation technologies, particularly fuel cells and PV, have received a great deal of attention from the energy community regarding their potential to save energy, increase the reliability of electricity supply, and decrease the cost of extending the current electrical grid. The tax incentive cases with resulting high penetrations also demonstrate the potential for distributed generation technologies with waste heat recovery to lower total carbon dioxide emissions from combined buildings and utility electricity generation. While the reductions in carbon dioxide emissions are not large enough to make what could be characterized as a major contribution toward stabilizing greenhouse gas emissions, *distributed generation can contribute to that goal by helping to offset projected growth.* Other conclusions are:

- The role of new, emerging technologies (PV, fuel cells, and microturbines) is critical to the projected growth of distributed resources. However, if given similar incentives, more traditional gas-fired technologies would also contribute.
- Technology cost reductions, as assumed in the advanced technology case for PV and fuel cells, *lead to projected increases in total distributed generation in the buildings sector of more than 25 percent compared with the reference case projections by 2020.*
- Net metering implemented in the model has a larger effect on the projections than that for the advanced technology cost case.
- Purchase incentives (including tax credits, lowered installed costs, and net metering) tend to reduce the projected marginal generation efficiency of installed distributed resources. *These incentives increase the applicability of distributed generation by easing the requirements for utilizing waste heat and thus spur penetration into additional applications*.
- The potential for distributed generation to mitigate carbon dioxide emissions depends on two key elements. First is the efficiency of displaced central station generation units: the more efficient the central station units are, the smaller will be the reduction in carbon dioxide emissions as a result of increases in distributed generation. The second is the efficiency of the distributed generation technology: PV makes direct carbon dioxide reductions with no offsets, whereas fuel-based distributed generation technologies create carbon dioxide emissions that depend on total efficiency, which can vary widely.
- "Standalone" estimates of reductions in carbon dioxide emissions derived from analysis of the buildings sector only (i.e., isolated from the electricity supply sector) should be avoided. *Such estimates do not include the impacts of increased distributed generation on the central station generation and can overstate the amount of savings*."

Fuel Cell System examples:
See also Annex D in regard to Renewable Electrolysis (RE) applied to improving operating efficiency of centralized electricity generating facilities.

A FuelCell Energy Inc., DFC™ versatile power plant has three modules -
Fuel Cells (FCM). Mechanical Balance of Plant (MBOP) and,
Electrical Balance of Plant (EBOP).

- the FCM reforms Hydrogen from the source fuel and combines it with air in the fuel cell stack producing electricity, water and heat. (Many Fuel cells are operated in parallel).
- the MBOP provides outside air, preheats and humidifies the source fuel, and extracts heat energy from the the FCM reaction process converting it into a usable form.
- the EBOP inverts and conditions DC electrical power into utility grade AC power, interconnecting with necessary switching and protection functions.

Waste water Treatment (WT): methane fuel produced from the WT plant's anaerobic digester is used in a DFC to generate ultra-clean process power while heat from the fuel cell is used to heat the sludge to help anaerobic digestion. Up to 90% efficiency is achieved from this CHP application. The methane gas qualifies as a renewable fuel for incentive funding. The plant can be designed to automatically blend digester gas with natural gas, allowing continuous operation with different gas yields from the digester.

Gills Onions, California (GOC):- GOC produces 300,000 lbs of onion waste per day which was interred as fertilizer at considerable transportation and labor costs.

In 2009, GOC introduced fuel cell systems in a process to extract juice from the waste, converting it to a bio gas via anaerobic digestion, where fuel cells provide base load ultra clean process power 24/7. Annual verifiable savings amount to $700,000 in electricity costs, plus $450,000 in labor, diesel and insurance from eliminating waste interment (residual fiber from a crushing process is also sold as cattle feed), plus 14,500 tons of carbon dioxide emissions were eliminated.

Investment payback is expected over six years.

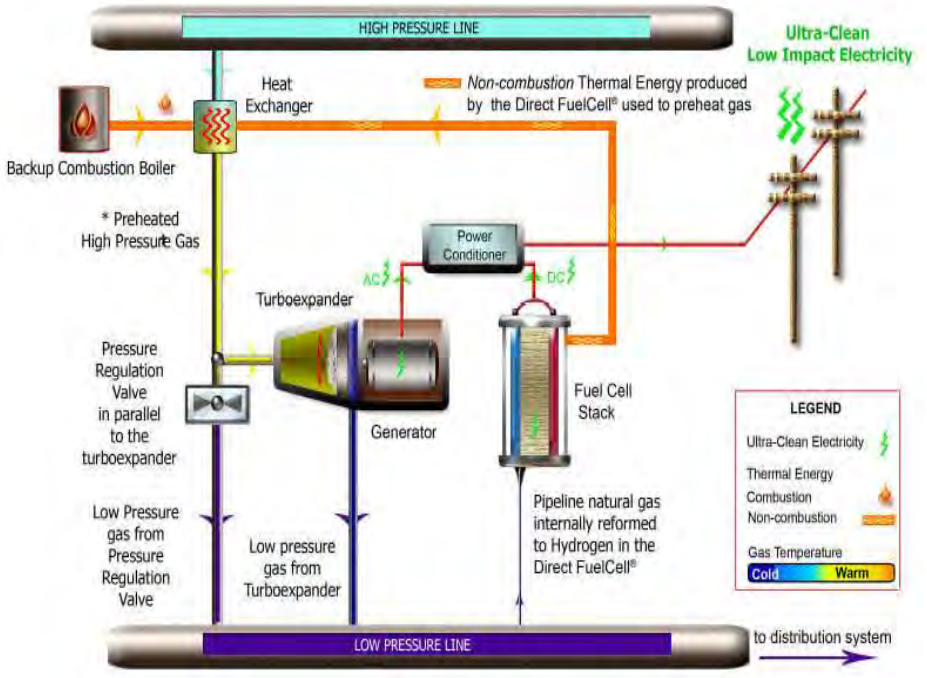
Natural Gas Distribution:- Combining a DFC™ power plant with an unfired gas expansion turbine and a generator enables recovery of energy normally lost in gas distribution pipeline pressure step-down operations to supply both process heat and electricity to the grid, as illustrated below.



FuelCell Energy Inc, DFC- ERG

Direct FuelCell Energy Recovery Generation

Enbridge, Inc. Canada



Annex A

Community Health - Radioactive Water

Background Levels

Rays of energy from outer space entering the earth's atmosphere cause some hydrogen atoms there to adopt a second neutron. This isotope of hydrogen is called tritium. According to the IATA, 1981, tritium has a radioactive half life of 12.43 years. All three isotopes of hydrogen have a single proton in their nucleus. Atoms of protium (ordinary hydrogen) has no neutron in its nucleus and is stable, deuterium has one neutron in its nucleus and is stable. Tritium with two neutrons in its nucleus is unstable and ejects Beta particles (essentially high-energy electrons). Since the number of protons determines chemical bonding, tritium behaves like ordinary hydrogen and replaces it in water molecules producing radioactive water. (Hoffman Tritium Study).

Incorporated in water molecules in precipitation from the atmosphere, tritium ultimately reaches the land or sea surface. From where it readily cycles through the hydro-logic and biologic components of the biosphere, including our ground-water aquifer reservoirs.

There are several sources of tritium in addition to the above. Since the early 1960s, when the atmospheric testing of thermonuclear weapons raised background levels by several orders of magnitude (100 times), Background levels have receded to twice the level preceding the weapons testing period. All nuclear electric power plant reactors emit tritium into water and the atmosphere. Progress Energy and Nuclear Regulatory Commission documents simply refer to the fact that all reactors emit tritium and the EPA monitors levels.

The standard unit of measure, a tritium unit (TU), is a set ratio of tritium atoms to hydrogen atoms in a substance, for example, water. In terms of radioactivity, one TU is equivalent to 3.19 picocuries per liter (Clark and Fritz, 1997). In SI units, one tritium unit is about 0.118 bequerels per liter (Bq/L), where the bequerel is one unit of disintegration per second. Tritium decays naturally over time of about 120 years to become helium.

Tritium is classified by the EPA as a human cancer causing agent. We can take this agent into our bodies by breathing, through the pores in the skin, and by eating or drinking contaminated fluids or food. EPA sets a fairly tight limit on drinking water under the Safe Drinking Water Act, at 740 becquerels per liter. The Beta particles do not normally penetrate the skin.

All living organisms can be harmed by the beta particles emitted from tritium, which can sever chemical bonds and damage cells, affecting DNA structures and subsequent generations. Effects upon microorganisms are probably not known. By extension, so also are consequences upon dependent ecologic systems and species, on which our marine food web and the livelihood of so many depend. The difficulty in constructing a test environment involving Beta radiation has led to a lack of essential documentation.

Scientific Uses

Ratios of tritium to helium in ground water can give an accurate measure of age (and possible source) of that water. Both tritium and helium are relatively inert gases. The method separates helium derived from tritium from helium derived from natural sources. The tritium/helium method is based on the radioactive decay of tritium relative to helium. Apparent age estimates from the tritium/helium method can be extremely accurate (within months) for groundwater containing high tritium concentrations (waters recharged since 1963). Unlike the chlorofluorocarbon dating method, tritium/helium is a valid technique for sites contaminated with organic compounds.

Use of Tritium as an aid to water age assessment — data on natural tritium concentrations in water in the upper part of the Floridian Aquifer were collected from December 1966 to November 1968 to evaluate tritium as a radioactive tracer. Some useful information on recharge characteristics resulted. In very general terms, an appreciable concentration of tritium is an indicator of younger water.

The natural production rate of tritium in the atmosphere is considered constant, but nuclear weapons tests as late as the early 1960's raised the tritium level to many times the normal level. The level declined after the tests but has not returned to normal, estimated by L. L. Thatcher as about 6 TU along the Atlantic Coast (Stringfield, 1966, p. 150).

During the 2-year sampling period in the Floridian Aquifer study area, one or more samples were collected at each of 26 different observation stations. Bimonthly samples were collected and analyzed from ten of the stations, including Rainbow and Silver Springs, Ocala Caverns, and seven wells.

Samples collected irregularly from four wells in the confined part of the aquifer, mostly in the Oklawaha River valley, contained zero to only traces of tritium, indicating complete or nearly complete decay of originally contained tritium. This supports interpretations from other geologic and hydrologic data that the water was old and not subject to direct recharge being in a confined aquifer system. On the other hand, all samples collected east of the river valley in the unconfined part of the aquifer had appreciable concentrations of tritium, thus supporting the belief that much of that area was subject to direct recharge. Each of the samples had more than twice the presumed normal concentration of 6 TU in rainfall, but far below peak concentrations measured in rainfall in Ocala in 1963 after the large thermonuclear tests in late 1962, thus suggesting that the high concentrations in the ground water from 1963 recharge had already passed.

The weighted average tritium concentration for 1963 precipitation in Ocala was 620 TU (Stewart and Galsworthy, 1968, p. 281). Concentrations in ground-water samples collected west of the Oklawaha valley during the 1966-1968 sampling period ranged from 13 to 174 TU while rainfall in Ocala ranged from 20 to 158 TU. The concentration in eleven samples collected at Rainbow Springs averaged about 49 TU with a high of 85 TU in May 1967 and a low of 38 TU in March 1968. Silver Springs water during the same period averaged about 47 TU with a high of 150 TU in May 1967 and a low of 25 TU in July 1967. This compares with a count of only 4.2 TU in Silver Springs water in January 1961 (Stringfield, 1966, p.150). The average concentration in the seven wells sampled bi-monthly during 1966-68 was about 80 TU, and rainfall at Ocala for the same period was about 60 TU.

Ever since the record highs in precipitation in 1963, there has been a general decline in tritium concentration, although seasonal peaks and troughs continue to occur as they would under normal conditions. A similar decline apparently occurs at most groundwater observation stations. A correlation is suggested between many of the concentration curves for the groundwater stations and the curve for precipitation. A lag of a month or two is apparent from the rainfall peaks to the peaks in several of the ground-water curves. Correlation of the curves is very much

complicated by variable recharge characteristics and by differential rates of ground-water movement in the area. Much remains to be done to properly integrate and fully evaluate the tritium data, but in the meantime the tritium data provide a useful tool for recognition of some differences in recharge conditions from one place to another within the study area.

The Proposed Nuclear plan for Levy County

The amount of tritium estimated for the discharges from the two nuclear plants proposed for Levy County is given in Appendix J, to the USNRC DEIS report, NUREG-1941.

A Progress Energy document avers, "Tritium is a byproduct of generating electricity at nuclear power plants. All nuclear plants release tritium into both the water and air. The U.S. Environmental Protection Agency (EPA) regulates the acceptable level of tritium concentrations in groundwater and drinking water".

Other Progress Energy documentation indicates the intention to take between 100 and 130 million gallons of water a day from the Cross Florida Barge Canal. Of that amount 40% (say 50 million gpd) would be emitted to air and 60% (say 60 million gpd), at elevated temperatures, piped alongside the Barge Canal to vent to the Gulf waters using the existing outlet from the Crystal River Energy Complex.

Both sources of discharge carry radioactive tritium. Local precipitation would return tritium to people, soils and groundwater cumulatively every day. Ejection to the Gulf waters would pollute water and offshore sea grass meadows, with unpredictable consequences to plants and wildlife including the protected manatee species which regularly forage there. Citrus and Levy Counties draw domestic drinking water supplies from wells into the unconfined aquifer systems exposed to fallout effluent from the proposed Levy nuclear reactors. Potentiometric flows from the site , and concentration of flows within identified fracture sets would appear to imperil domestic and drinking water supplies from aquifer systems serving populations of both Citrus and Levy County. See also the "Braidwood and Dresden Nuclear Power Plants" as a Foundation News Item (March 2, 2009).

Comments submitted to the Nuclear Regulatory Commission on behalf of the Amy H Remley Foundation arising from the DEIS review meeting on 23 September 2010, are reproduced below.

"Tritium. Before licensing any LNP plant, the public needs to be apprised of how, in what quantities and into which areas harmful radionuclides are to be released and accumulated in groundwater over the operating life of the plant for both gaseous and liquid effluent pathways. Together with the calculated dosages resulting therefrom.

Concern about Tritium is expressed for several reasons:

- It cannot be denied that atmospheric deposits of tritium in water molecules accumulate in groundwater of a poorly confined aquifer system. Fifty or so years ago, measured amounts of tritium in ground water near Ocala had risen to exceed one hundred times normal background levels - due to nuclear events many thousands of miles away on the other side of the planet.
- All nuclear reactors including those proposed for Levy County and that at the CREC throughout their operating life continually release tritium (together with several dozen other radionuclides such as strontium and radio-iodine) (Pages, J-3 and J-7),
- Tritium abides in tritiated water molecules as hydrogen as explained in the USNRC Tritium Backgrounder,
- Tritium is a radioactive isotope of hydrogen and an EPA listed human cancer causing agent, emitting Beta particles until it degrades into helium after about 120 years,
- Furthermore, it is believed that the dosage models used in this DEIS only consider routine radiation releases and fail to account for either accidental releases or tritiated water accumulations in groundwater.
- Moreover calculated dosage limits also assume venting of a routine radiation release from "standard man's" contaminated bodily fluids within a few days,.
- The integrity of blowdown water piping to the CR site through a single wall PVC pipe without leak detection causes concern, especially as it will be subject to regular daily seismic disturbances from mining activities.
- The statistics put forward by Mary Olson at the 23 September 2010 review meeting, indicating levels of human harm from radionuclide emissions and in high level wastes within the regulated standards, were simply staggering and quite unacceptable to civilized society. "

See also the Appendix to this Annex: Letter sent to the Nuclear Regulatory Commission on 3 November, 2010. Text of an email received from the NRC in response is also attached suggesting that little or no action is proposed follows on the next page:

QUOTE

Mr. Hopkins,

Responses to your comments will be provided in Appendix E of the Levy EIS or in the EIS itself if the staff determines that additional technical detail is necessary.

Sincerely,

Douglas Bruner.

-----Original Message-----
From: Norman Hopkins [mailto:norman@amyhrf.org]
Sent: Tuesday, March 01, 2011 10:34 AM
To: Bruner, Douglas
Cc: gregory_hogue@ios.doi.gov; Michael Lusk
Subject: NRC Docket Nos. 52-029 and 52-030

Doug,

I wrote to you on 3 December, 2010, in which I emphasized the concerns I had raised during the DEIS hearings in Crystal River on 23 September, 2010.

In particular, I indicated the need for the community to be informed of expected accumulated Tritium penetration by pathways into groundwater and the Gulf waters.

My reason for writing now is that I note that Scott Flanders' letter to Mr Gregory Hogue of February 14, 2011, did not mention anything about tritium discharges into the Gulf of Mexico affecting the sea grass meadows there and any consequent impact upon the local protected manatee population which feed upon them in the summer months. Moreover, the Enclosure 1 - Crystal River Plant Manatee Protection Plan neither addresses the issue nor considers the increased effluent discharges from the Levy plant.

Would you please confirm that the issues raised at the DEIS meeting and in my letter have been scheduled for attention by the utility company and will be communicated for the information of the community exposed to hazard or otherwise affected in due course.

Thank you. Sincerely, Norman

UNQUOTE

Appendix to Annex A



The Amy H Remley Foundation, Incorporated

Restore the Waters

3 November, 2010

Douglas Bruner Esq
Mail Stop T7-E18
U.S. Regulatory Commission
Washington, DC 20555-0001

Dear Mr Bruner,

Thank you for allowing time for this our additional submission following the review of the draft NUREG-1941 on 23 September, 2010, and our two previous e-mails.

History repeats itself. Decades ago U.S. utilities abandoned over 130 nuclear plant orders because of massive cost overruns and construction delays. The Energy Information Administration reports Progress Energy's rising costs to $22.5billion (a 5.625 times increase) and a five years delay to 2021 and 2023 for Levy nuclear plants 1 and 2 - see, www.eia.doe.gov/cneaf/nuclear/page/nuc_reactors/reactorcom.html.

Significantly, the Florida Public Services Commission in their Order No. PSC-08-0518-FOF-EI, issued on August 12, 2008, approving PEF's petition of need for 2,200 MW base load power by year 2016, also ordered an annual review of long term feasibility and costs. Albeit, the extended recession we suffer and the rising costs and delays have since negated the substance of the petition for determination of need by 2016, which had been adopted by both the NRC and USACE as a bounding target for assessing environmentally preferable alternatives (Section 9.2). The basic premise upon which PEF based their petition has been rendered unsafe and should be re-examined. Figures recited in Section 10, are out of date

However, we point to a systemic fallacy which encourages the taking of excessive business risks at the expense of consumers. Industry lobbying, providing for profit as a given percentage, has ensured that the bigger the cost burden of assumed fiscal risk the bigger the profit guaranteed by legislation - come what may. Utilities may pursue investments in the tens of billions of dollars immune to the consequences of any bad business decisions affecting the bottom line. This creates an unacceptable undisclosed conflict of interest: where shareholders, bondholders and executives benefit at the expense of their customers, running contrary to a reason quoted for the FPSC Order that, " ...*(PEF)* will provide adequate electricity at a reasonable cost".

Note that the Ocala Star Banner, reported the FPSC's recent approval of Progress Energy's request for $163.6 million surcharge on customers to contribute toward repair to its Crystal River nuclear power plant and their proposed new Levy County plant. "The 4-0 FPSC vote will mean an average $5.53 per month cost increase to Progress Energy's more than 1.6 million Florida customers beginning in 2011". *Consumers have no prospect of any return on their investment (call it a tax).*

Note further the computations of Craig A. Severance, in Business Risks and Costs of New Nuclear Power, January, 2009, indicating costs of electricity from a similar installation to the Levy proposal to be $0.30 per kWh (prior to any capital cost raise). This five fold increase over current rates - without the surcharge - is hardly a "reasonable cost" and a likely barrier to PEF in wholesale markets.

Turning now to environmentally preferable alternatives.

We note that systemic inefficiencies exist when there is no way to store electricity generated in times of off peak or lower seasonal demand. Such "losses" of the Crystal River plants in 2008, for example, amounted to more than 800MW(e) (equivalence of a spare plant) - calculated from EIA maintained database information and data submitted by PEF as Final True-up data to the FPSC. Necessary energy storage as compressed hydrogen gas could be provided by an approach called Renewable Electrolysis (RE).

In RE, as previously indicated to you, electrical energy is captured and stored as compressed hydrogen gas (released by electrolysis) which can be re-converted into electricity using fuel cells, to meet up-turns in demand. Thereby allowing the operation of existing facilities at more efficient levels than those needed during periods of lower demand, supplemented by electricity from renewable wind or solar photo voltaic sources to enable real pollution free economies to be made.

Costs of RE systems are measured in millions not billions of dollars. Modular RE systems can be sited near concentrations of electricity users saving both $ and environmental costs of additional transmission lines.

We find the consideration of alternatives to the proposed action demanded by NEPA Section 1023(2)(C) in the draft NUREG-1941 to be utterly inadequate (RE is completely ignored and omitted from the documents).

This RE approach was referred to in our first response to you sent by e-mail attachment on October 18, 2010, and is evaluated in Technical Report NREL/TP-560-46267; September 2009; Levelized cost; centralized hydrogen; distributed hydrogen; hydrogen production; H2A Production Model.

The NRC maxim **Protecting People and the Environment** requires that we reiterate our very serious concern with the siting of any nuclear plant in a region with poorly confined aquifer systems allowing aerial effluent fallout to penetrate into and accumulate in groundwater. This was also represented to you from the podium and by e-mail attachment on October 18, 2010. It is not adequately addressed in the draft NUREG-1941 documents despite some deliberations in Chapter 7 and Appendix J.

We repeat; before licensing any LNP plant, the public needs to be apprised of how, in what quantities and into which areas harmful radionuclides are to be released and accumulated in groundwater over the operating life of the plant for both gaseous and liquid effluent pathways. Together with the calculated dosages resulting therefrom, especially regarding infants fed on mother's milk. (The harm is done to us when beta radiating elements get inside us).

Groundwater accumulates harmful cancer causing agents over the decades of a nuclear plant's life where it remains radioactive for decades more. We drink it. We eat animal and vegetable products after they too assimilate the contamination. Also, the marine food web is poisoned by the toxic waste belched daily into offshore sea grass meadows which nurture our marine food web supplying food that we also eat.

In conclusion, we earnestly recommend that PEF be advocated to adopt plans which take account of the systemic deficiencies revealed, both as to business risks and their adverse impact both financial and health-wise upon their customers, and improve supply side generating efficiencies by embracing the environmentally preferable approach offered by Renewable Electrolysis. In our view continuing to use the excessive business risks as an excuse to surcharge customers must cease.

Sincerely,

[original signed]

(Norman Hopkins, Director)

Annex B

Discussion of the Financial Fallout of the Levy County Nuclear Proposal.
A utility that builds a nuclear power plant may well experience a 25 % to 30% deterioration in cash-flow-related credit metrics, with cash flow from operations as a percentage of debt falling from 25% to the mid teens range. Meaning a fall from an A credit rating to a Baa rating incurring an increased loan interest rate coupled with an inability to sell the downgraded bonds in the credit markets.

Note that federal credit guarantees protect the lender and not the utility corporation nor its shareholders or ratepayers. As a private company the utility is not immune from bankruptcy. Credit ratings of both utilities and their customers suffer.

Central utility corporations supply power from a variety of sources having different price points for grid energy imports. Nevertheless, focusing on the nuclear plant costs, and considering that most households and small businesses carry high interest debt loads and try to pay them down, charging higher rates for electrical energy restricts the ability of consumers to make minimum payments on their debt balances which affect their credit ratings.

Excessive rate increases can result from the utility's attempt to defray construction by charging consumers in advance or charging them excessive rates for kWhs actually delivered from the nuclear facility.

Independent evaluations by the EIA of the economic competitiveness of new nuclear power conclude it to be the most expensive. Whereas utilities campaigning for new nuclear power claim it is the least expensive electricity source. No one has actually built a nuclear facility as that proposed for Levy County and no firm cost experience exists. Typically, an assessment is made of the cost to build a plant at today's (same day build) prices as an "overnight" cost usually expressed as per kilowatt (kW) rated capacity in nominal dollars allowing for different sized plants and for inflating construction costs during the build period. [See Figure 5.]

The EIA, Annual Energy Outlook Reference Case 2011, page 17 (Richard Newell) shows that nuclear is the most expensive plant to build in terms of Overnight costs per kW(e), together with Coal Integrated Gasification (IGCC) with Carbon Capture and Sequestration (CCS), albeit, the latter would not be appropriate in Florida.

Local rates charged for domestic electricity supplies have increased by about two thirds over the past twelve years to more than $0.13 per kWh(e). Calculations modeled upon those of Craig A. Severance CPA, in "Business Risks and Costs of New Nuclear Plants", January, 2009", "Due Diligence on The Economics and Business Risks of New Nuclear Power" delivered on March 4, 2010, to the Global Public Policy Conference in Potsdam, Germany, and using data from the EIA, Energy Outlook 2011, Reference Case and several other sources indicate that electricity costs from the proposed nuclear facility in Levy County would likely exceed $0.33 per kWh (see the attachment to this Annex).

The starting point for the assessment of construction costs is the sum of construction costs at today's prices referred to as "overnight costs". The Power Capital Costs Index (PCCI) published by Cambridge Energy Research Associates tracks “hard costs” of construction of power plant in America and Europe since the year 2000 from which an average yearly cost escalation of such hard costs accounting for about 51% of overnight costs can be derived at 12.76 %. Other costs, accounting for 45% of an “Overnight” cost estimate – e.g. fees, owners’ costs including licensing and legal, and transmission integration, may be less affected by such rapid worldwide cost escalation. The Handy-Whitman “All Steam Plus Nuclear Generation Plant” average of 4.85% per year may be the more appropriate factor. The remaining 4% of “Overnight” Costs is assumed to inflate at the 3% general economy inflation rate. The average weighed escalation factor has been derived at 8.81% per year of the assessed overnight costs.

As both equity and borrowed funds are used to fund the cost of finance during the planning and construction period and both expect to earn returns, an average weighted cost of capital of 14.5% is assumed. Some utilities propose to “lower costs” by charging financing costs to ratepayers during or even prior to construction. However, “early recovery” charges simply force ratepayers to pay extra financing costs to make ends meet instead of raising capital in the markets where costs are reflected in returns available to shareholders, bond holders and executive remuneration.

Several factors affecting construction costs and expected kWh tariffs are taken into account including the history of industry cost over-runs, difficulty in securing firm, reliable cost estimates, escalating construction costs during the years required to approve and build the plant, and cost increases due to construction delays.

Additional risk factors reflect the massive sunk costs to be sustained before any electricity can be generated, giving rise to stranded capital, difficult to quantify decommissioning and clean up costs including restoration of contaminated soils and groundwater, consequent variations to credit ratings of the utility and consumers, and burdens placed upon consumers from advanced recovery of anticipated costs.

Such an assessment of financial risks relating to nuclear power facilities caused six Wall Street Investment Banks in 2007, to withhold finance from any nuclear power venture as being too risky.

There is no place in Florida to sequester carbon dioxide from an IGCC CCS coal fueled plant. Any nuclear plant located in a region having poorly or unconfined aquifer systems will contaminate groundwater with cancer causing tritium. Carbon costs to be levied on coal fueled generation for directly polluting the biosphere and upon nuclear plants for polluting the biosphere with effluents from uranium fuel cycle processes will bear upon their economics. Both involve massive downside risks of sunk capital before a single kW of power is produced - blind to any actual demand curve needs.

Appendix to Annex B

New Nuclear Power "Most Likely" All-in Construction cost -Thousands of nominal dollars

Year	AP 1000 Unit 1 Pct Constr.	AP 1000 Unit 2 Pct Constr	Escalation Factor Constr	Brick&mortar Costs $thousands 2009 dollars	Cumulative Costs $ thousands	Annual Cost of Capital $ thousands	Cumulative Capital Cost Equity + debt $ thousands	Cumulative Total "All-in" costs $ Thousands
2011								
2012	0.4	0.4	1	46	46	3.288	3.288	49.763
2013	3	3	1.08	376	423	29.922	33.210	456.132
2014	2	0	1.17	136	559	39.540	72.750	631.611
2015	3	2	1.26	366	925	65.434	138.184	1063.035
2016	5	1.5	1.36	514	1438	101.768	239.952	1678.351
2017	10	1.5	1.47	982	2420	171.250	411.202	2831.674
2018	36.6	5	1.59	3843	6263	443.113	854.315	7117.334
2019	27	10	1.72	3697	9960	704.684	1558.999	11519.098
2020	10	36.6	1.85	5008	14968	1059.022	2618.020	17586.374
2121	3	27	2	3486	18454	1305.632	3923.652	22377.625
2122	0	10	2.16	1255	19709	1394.411	5318.063	25026.860
2123	0	3	2.34	408	20117	1423.265	6741.327	26857.942
	100	100		5.34	9 <<per kW>> per kWh>>>		3.018	12.012 $0.25

Assumptions:		Comment
Overnight cost per KW	$5,339.00	1
Escalation weighted Average	8.81%	2
Percent debt	55.00%	3
Average capacity Factor	80.00%	4
Construction delays	none	5

Comments:

1,EIA, Annual Energy Outlook Reference Case 2011, page 17(Table 2) – by Richard Newell

2. Uses Cambridge Energy Research Associates press release 21 December 2010 – Index for North America average cost growth trend. showing cost downturn from the recession and a flat 2010.

3. Conservative estimate (lower cost of capital)

4..Uses MIT 2003, Future of Nuclear Power, Overview and Executive Summary - mid point values of two scenarios.

5. Delays would increase costs further.

Total Generation Costs "Most Likely Scenario" - Costs per kWh – in nominal Dollars for first year generation in 2023

Cost Component:	$per kWh
CAPITAL Cost	$0.25
OPERATION and MAINTENANCE w/o FUEL	$0.01
PROPERTY Taxes	$0.02
DECOMMISSIONING and WASTE costs reserve	$0.02
FUEL CYCLE costs	$0.03
TOTAL	$0.33

Cost escalation factor rates	Pct of Constr		Nominal Wghtd Avg
HW 00-07 Avg	4.85%	45.00%	2.18%
PCCI 00-07 AVG	12.76%	51.00%	6.51%
GEN. INFLATION	3.00%	4.00%	0.12%
Weighted Avg. Escalation			8.81%

Assumptions for Weighted Average Cost of Capital

	Net of Corpn Tax	Before Tax Gross	Pct of Funding	Weighting
Equity	15.00%	24.59%	45.00%	11.06%
Interest	6.25%	6.25%	55.00%	3.44%
	Weighted AVG. Cost of Capital =			14.50%

Annex C

Figures

Figure 1.

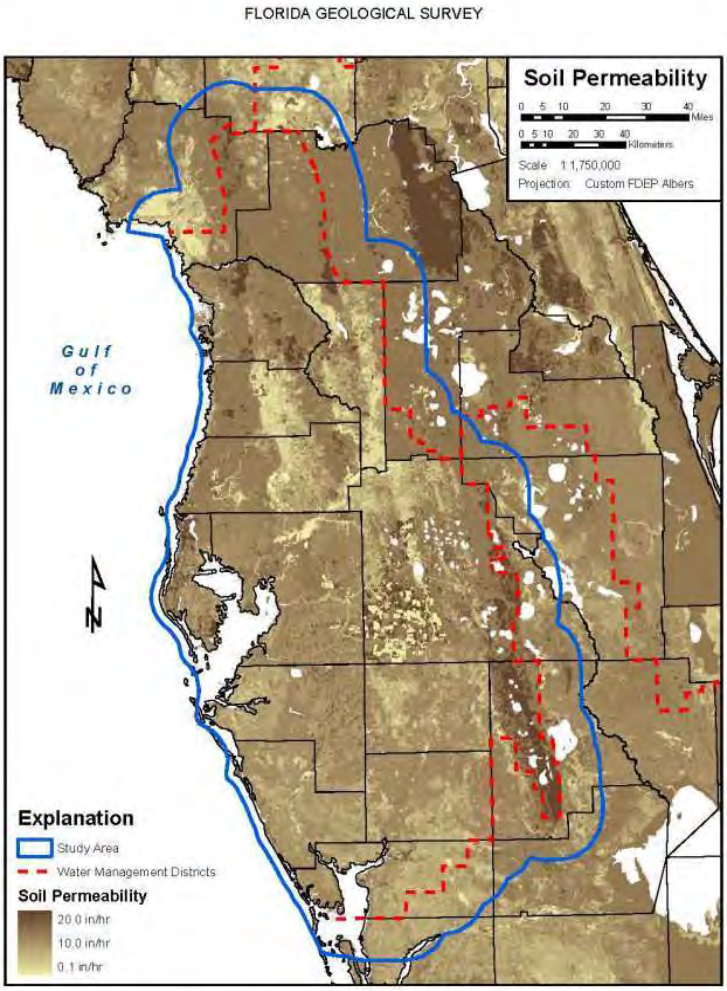


Figure 18. Soil permeability of study area (Arthur et al., in review); (data compiled on per county basis from U.S. Department of Agriculture, Natural Resource Conservation Service, 2002 and the Florida Geographic Data Library [www.fgdl.org]).

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Soil Permeability

Darker areas show where water falling upon the land percolates faster underground to join aquifer systems - 10 to 20 inches per hour.

Scientists term aquifers under Citrus and Levy counties as "poorly" confined - meaning that liquid is readily absorbed over most areas.

Figure 2.

FLORIDA GEOLOGICAL SURVEY

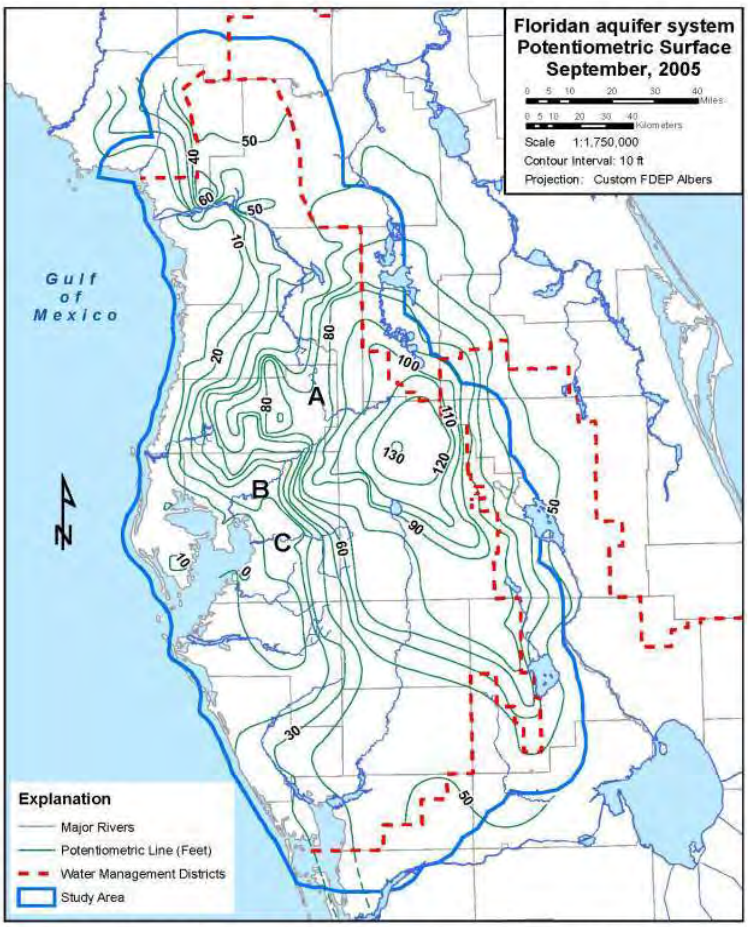

Figure 30. Potentiometric surface of the Floridan aquifer system, September, 2005 (from Ortiz, 2006); A – Withlacoochee River, B – Hillsborough River and C – Alafia River. See Figure 1 for additional river labels.

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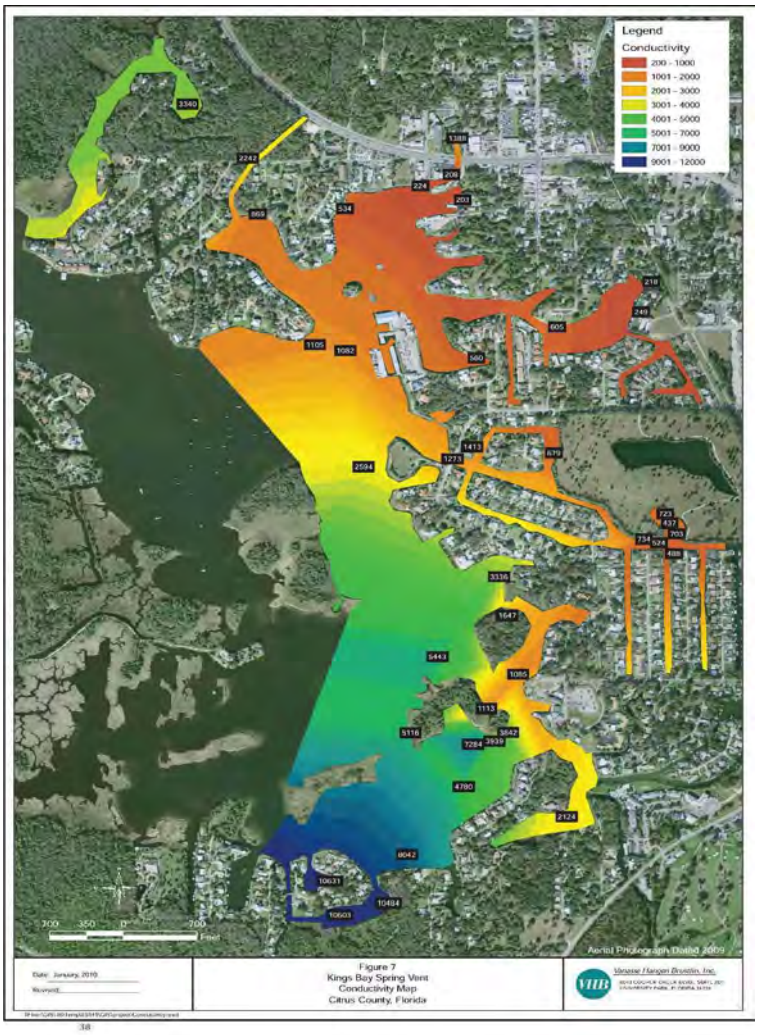
Aquifer systems

This figure represents the relative artesian pressure distribution within the the main - Floridan - aquifer systems. The thin wavy lines join points of equal artesian pressures, similar to a contour joins points of equal land elevation. In general, water tends to flow from areas of higher to lower pressure at right angles to the "contours", entering Citrus County from the SE and NE.

When such flows encounter water flowing in fractures the path of least resistance is adopted by the combined flow.

Saltier more mineralized water is held to greater depths by weight of a "lens" of fresh water above. FGS cautions that lens depths diminished since Klein's work (c.1960/70s).

Figure 3.



Kings Bay Saltiness

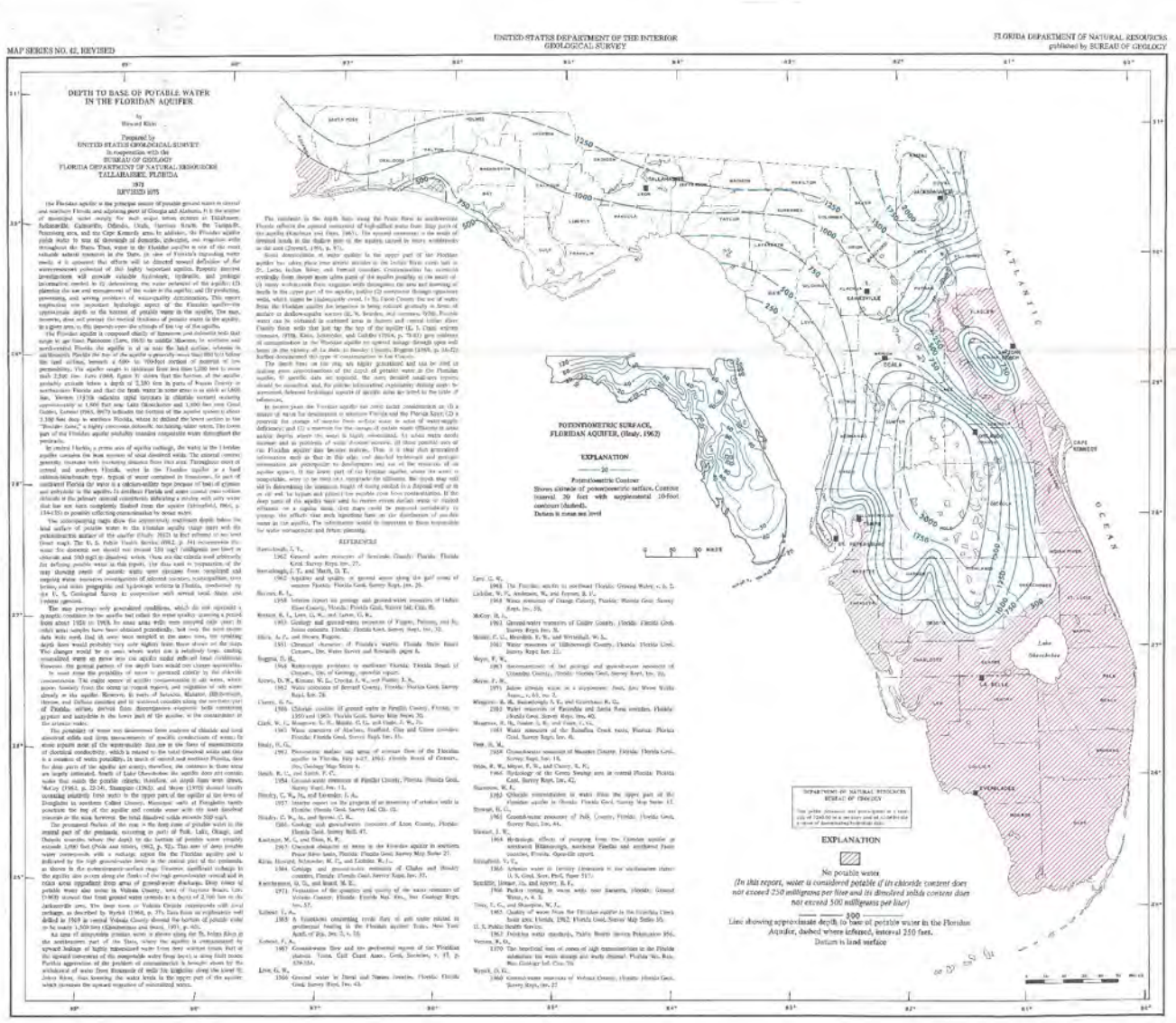
This figure shows the variation of saltiness across parts of Kings Bay. The darker blue in the SW indicates higher (saltier) conductance with the lower readings shown brown to the north.

Conductance measurements recorded from the spring vent discharges, vary with seasonal rainfall amounts.

Drought periods and pumping over the years have reduced aquifer levels and depth of the fresh water "lens". The reduced weight of the lens allows saltier water to well up from deeper down. The increased saltiness from the springs appears not to be due to intrusion of sea water from the Gulf,

The principal underground tributary flows contribute to the phenomenon, particularly where rates of flow reduce over time due to sedimentation within conduit pathways affecting their porosity and permeability.

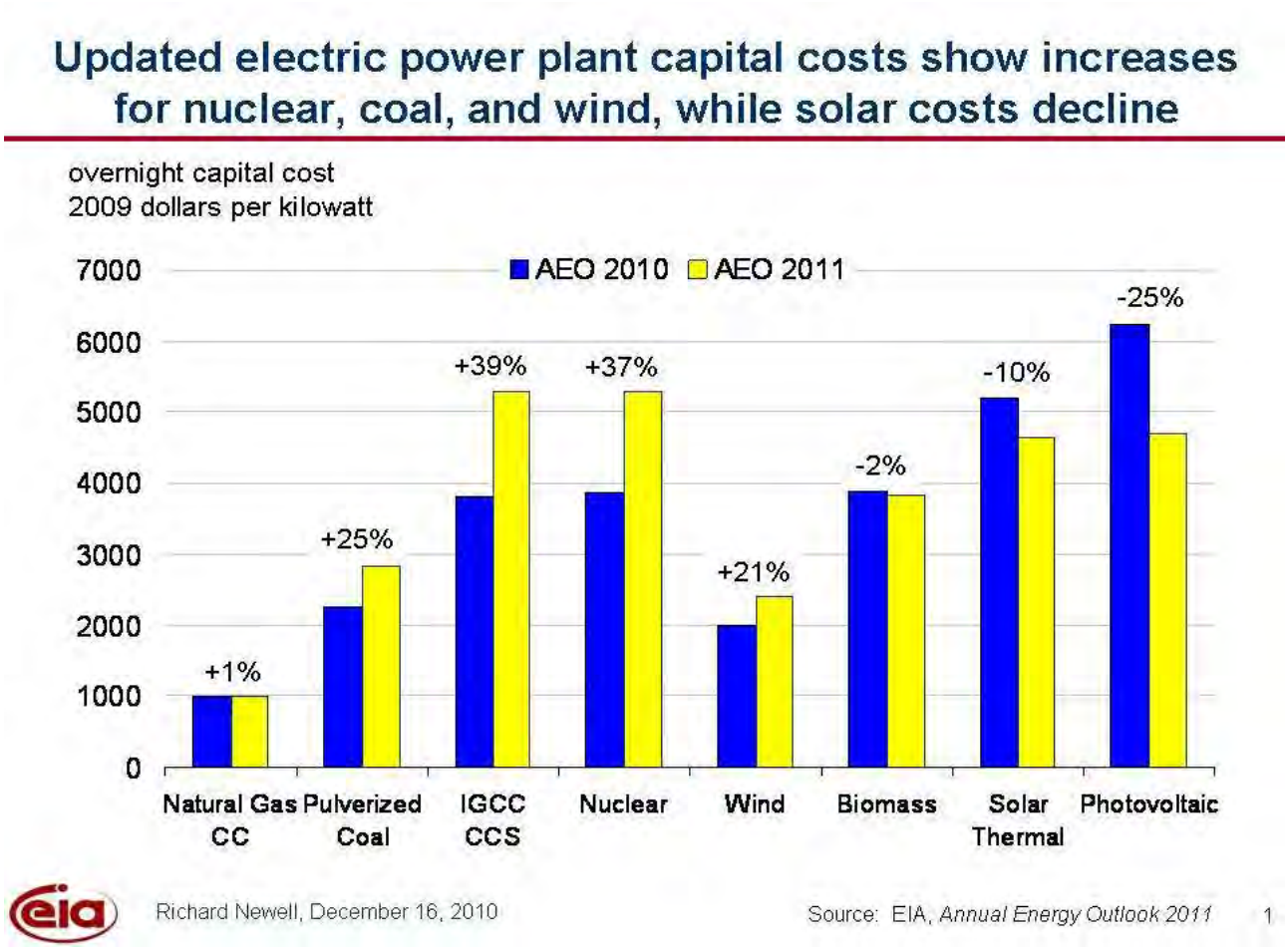
Figure 4.



Depth of potable water MS 42 1971 Rev 1975 by Howard Klein et al.

"Potable water" defined as chlorides less than or equal to 250 mg/L, and dissolved solids less than or equal to 500 mg/L.
Depths of lens given relative to land surface datum in feet.
FGS advise that the levels indicated for 1975 will have diminished by today and new data will not be complete for some time.
Klein attributes loss of potable water along Florida's east coast to pumping activities.

Figure 5.



Overnight Capital Costs expressed per KW of "nameplate" plant capacity.

Annex D

Renewable Electrolysis (RE) - Taken from www.amyhrf.org- Education Section. Significant under-utilized generating capacity is revealed by comparing actual annual kWh(e) output achieved compared with "Summer rate capability" (Peak rate). Systemic supply side inefficiencies exist when there is no way to store electricity generated in times of off peak or lower seasonal demand. These "losses" could be recovered by adopting Renewable Electrolysis (RE).

In RE, electrical energy is captured and stored as compressed hydrogen gas released by electrolysis, which can be re-converted into electricity using fuel cells to meet up-turns in demand as base load. When complemented progressively by new renewable energy sources – wind or solar photo voltaic arrays – RE would enable GHG intensive plants to be phased out. Also modular RE units could be sited near substations serving population centers. Decentralizing capacity in this way would make it more difficult to disrupt supplies by Cyber attacks and create many more manufacturing, installation and maintenance jobs in the process. Recent reports of hacks into the US power grid are thought by some to be preparatory to larger disruptions.

Renewable Electrolysis.
This Foundation is indebted for the co-operation of the DOE - NREL and particularly to Darlene Steward et. al. and NREL/PR-560-47547 from proceedings of the HTAC meeting February 11, 2010. (Note that 1kg H_2 is equivalent energy to 1gal gasoline. The Florida location is not suited to the competitive Pumped Hydro or Compressed Air Energy Storage technologies.)

Note: Some of the manufacturers approached in regard to larger static fuel cells have their business models tuned to using natural gas as their energy source, which is perfectly reasonable in view of the availability of natural gas in the market place. Their process requires natural gas to be reformed into hydrogen and then the hydrogen is the energy source for the fuel cell, as opposed to electrolyzing separation of hydrogen from water. One manufacturer offers a 1MW PEM hydrogen fuel cell at a cost of about $4million.

Hydrogen technologies are reviewed in Technical Report NREL/TP-560-46267, September 2009 by Darlene Steward et al - Click here to read Darlene . Essentially, hydrogen energy electrolysis and storage offers an opportunity to harness supply side generation capacity which is not used in the absence of storage. Efficiencies suffer where plants are forced to ramp down to accommodate both seasonal and daily cyclical reduced demands. When complemented by progressive expansion of clean energy generation by wind or solar PV arrays a transition from GHG intensive fossil fuels to clean technologies can be made.

For example, based upon 2008 data, the scope for supply side increases in efficiencies from the four coal fired plants of the Crystal River Energy Complex (CREC) has a potential for 29.56% or 683 MW(e) equivalent, rising to more than 800 MW(e) including the current nuclear facility. Today's achievable Round Trip energy efficiencies (H_2 hydrolysis through fuel cell) are estimated to be between 40% and 47%. Another significant issue is the ability to site PV arrays with Renewable Electrolysis close to a substation near to a conurbation center, say Orlando or The Villages already connected to the CREC.

RE would facilitate higher supply side efficiencies, at significantly lower costs, in an environmentally preferable manner, and be beneficial instead of harmful to human health than, say, adding nuclear generating capacity. A smoother transition to an altogether cleaner strategy nation-wide could result and create jobs so urgently needed both in manufacture and installation and maintenance.

A Renewable Electrolysis Scenario.

An "Renewable Electrolysis" scenario is described avoiding much of the negative environmental consequences which does not appear to have been addressed in the draft NUREG-1941 DEIS. Time and wealth consumed with PEF LNP proposition could be applied to bring on stream increased power capacity in a radically shorter time scale, for significantly less cost, creating local employment opportunities so urgently needed and avoiding degradation of highly valued natural resources. Earlier elimination of GHG and methyl mercury emissions from earlier closure and decommissioning of the dirty coal-fired units at the CREC would be a landmark achievement for PEF.

An Example

For example, the hydrogen plant postulated below could be accommodated in some seven cubic meters of space. PV arrays could be brought on stream as described below (as similar installations have already been provided elsewhere in Florida), together with hydrogen plant providing for base load supply, both of which could be progressively expanded over time, taking advantage of cost reductions as technologies mature:

- solar energy PV arrays and inverters could be installed on the LNP site to serve prescient increases in demand,
- hydrogen electrolysis and storage plant could create an off-grid local energy reserve. The energy resource for the hydrogen plant could be derived from off-peak grid supplies in times of lower demand enabling more efficient operating schedules of existing plants, complemented by yield from solar energy arrays on site.
- future disabling events to the CREC nuclear facility could be recovered more expediently using the reserve,
- a simple energy arbitrage scenario is postulated for the hydrogen plant consisting of an initial 300 MWh nominal storage capacity that is charged during off-peak hours (18 hours per day on weekdays and all day on weekends) and discharged at a rate of 50 MWh for 6 peak hours on weekdays. Process water would be electrolyzed to produce hydrogen, for storage as compressed hydrogen gas in above ground steel tanks for use in polymer electrolyte membrane (PEM) fuel cells. Some estimated time and cost parameters are suggested (excluding any benefit from possible federal subsidies):

1. acquire land bank for expansion of PV system or wetland s mitigation, say, 5,000 acres @ c. $100million, bringing total acreage to 10,000 acres [say, 1 year],
2. PV indirect costs (engineer, procure,construct) @ $11million [over say, 2.5 years],
3. build initial 10MW (AC) PV array on 60 acres @ $40million direct cost (incl. inverters c. $4million),
4. initial PV total cost $151million - excluding land prepn. [elapsed time, say, 3 years],
5. Hydrogen plant (Electrolyzer, Hydrogen storage, Fuel cells) consisting of, 50 electrolyzer units to yield 52,300 kg/day H_2 (run in of-peak hours only) Process water Cooling system Transformer, Thyristor, Electrolyzer Unit, Lye Tank, Feed Water Demineralizer, Hydrogen Scrubber, Gas Holder, 2 Compressor Units to 30 bar (435 psi), Deoxidizer, Twin Tower Dryer.
6. Estimated net present (2011) cost of H2 plant @ $225million.

Note: Using hydrogen for energy storage provides unique opportunities for later integration between the transportation and power sectors. Producing a small amount of excess hydrogen (five 280-kg tanker-truck loads or 1,400 kg per day) reduces the overall levelized cost of energy for this scenario by about 6% compared with the purely energy arbitrage scenario.

Fuel Cells. A fuel cell is an electrochemical device that combines hydrogen and oxygen to produce electricity, with water and heat as its by-product. As long as fuel is supplied, the fuel cell will continue to generate power. Since the conversion of the fuel to energy takes place via an electrochemical process without combustion (electrolysis), the process is clean, quiet and efficient – two to three times more efficient than fossil fuel burning.

No other energy generation technology offers the combination of benefits that fuel cells do. In addition to low or zero emissions and fuel portability, benefits include high efficiency and reliability, multi-fuel capability, citing flexibility, durability, scalability and ease of maintenance. Fuel cells operate silently, so they reduce noise pollution as well as air pollution and the waste heat from a fuel cell can be used to provide hot water or space heating for a home or business.

There are many uses for fuel cells – all of the major automakers are working to commercialize a fuel cell car. Fuel cells are powering buses, boats, trains, planes, scooters, forklifts, even bicycles. There are fuel cell-powered vending machines, vacuum cleaners and highway road signs. Miniature fuel cells for cellular phones, laptop computers and portable electronics are on their way to market. Hospitals, credit card centers, police stations, and banks are all using fuel cells to provide power to their facilities. Waste water treatment plants and landfills are using fuel cells to convert the methane gas they produce into electricity. Telecommunications companies are installing fuel cells at cell phone, radio and 911 towers.

Hydrogen is potentially the most abundant and inexhaustible energy source available. However it cannot be harvested or mined or pumped from the ground. To isolate it as the energy carrier that it is, one has to break the bonds to other elements to which it is attached in nature. Unlike electricity which does not "keep", whereas, hydrogen can be stored or moved from place to place for use for work as a compressed gas, or as a super chilled liquid or in suspension with metal hydrides. Hydrogen is the basis of all hydrocarbon fuels we depend upon today.

Caveat

Our children are taught that forests breathe in carbon dioxide, use the carbon to make cellulose and wood for trunks and roots, and breathe out oxygen for us to use in our bodies. Some are taught that forests and vegetation folded into the earth eons ago became the source of the fossil fuels we burn today - coal, oil and natural gas - for our comfort, power and transportation needs. Fewer understand that combustion of hydrocarbon fossil fuels releases carbon as carbon dioxide into the biosphere for our eventual harm, and some deny the reality of the consequences of global climate change that is the inevitable result.

Science concludes that we continue to burn hydrocarbons to our universal peril and classes fossil fuels as "dirty" pollutants of our biosphere. Moreover, whether these harmful emissions come from the exhaust pipes of our vehicles or the smoke stacks of industry or electricity power generation plants, carbon dioxide is not the lone pollutant. Methane, is twenty times and nitrous oxide is almost three hundred times more destructive to our biosphere, methyl mercury contaminates the food web and addles our brains, and sulfur oxides are a health hazard as are emitted mineral particulates. Furthermore some fuel, for example Uranium, and Natural Gas obtained by Slick-Water Hydraulic Fracturing of shale deposits, need the application of so much energy in their fuel cycle processing and yield so many pollutant by products that they also should be classified "dirty".

Furthermore, uranium enrichment is hugely productive of harmful CFC gaseous materials and together with mining, conversion, milling and fuel rod fabrication are energy intensive processes emitting carbon dioxide in to the atmosphere.

It is quite unacceptable to trade public health for electrical energy.

An alternative strategy to meet consumer needs is now needed in the absence of a truly efficient and safe alternative centralized electricity generation facility.

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May 19, 2011

MEMORANDUM

TO: File

FROM: Douglas A. Leeper, Chief Environmental Scientist, Ecologic Evaluation Section, Southwest Florida Water Management District

SUBJECT: Questions and comments raised by Mr. Norman Hopkins during a May 13, 2011 telephone conversation regarding minimum flows and levels development for the Crystal River/Kings Bay system

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This memorandum documents a May 13, 2011 telephone conversation between Mr. Norman Hopkins with the Amy H. Remley Foundation and Mr. Doug Leeper, with the Southwest Florida Water Management District, concerning development of minimum flows for the Crystal River/Kings Bay system. Summary information concerning the major points and requests raised by Mr. Hopkins are outlined, along with staff responses and associated actions. Documents relevant to the telephone discussion and information addressed in the memorandum are attached.

Telephone Call Log

Who called: Mr. Norman Hopkins
Staff contact: Doug Leeper, Ecologic Evaluation Section, Resource Projects Department
Issue: Crystal River/Kings Bay minimum flows
Date of call: May 13, 2011

Primary Items Discussed During the Telephone Conversation

1. Mr. Hopkins requested that I forward an original article from Ms. Priscilla Watkins concerning minimum flows development for the Homosassa River system that was recently published in the Voice of the River (the newsletter of the Save the Homosassa River Alliance, Inc.).

   Response/Action: During our phone conversation, I noted that Ms. Watkins article was not sent directly to the District and that the District response to the article that Mr. Hopkins received via e-mail from Mr. Ron Miller was recently distributed to Mr. Jim Bitter and Mr. Al Grubman, respective presidents of the Save the Homosassa River Alliance, Inc. and TOOFAR, Inc. I noted that the response was prepared following publication of Ms. Watkins article in the Voice of the River and in the TOO FAR News, which is a newsletter of TOOFAR, Inc. After our phone discussion, I forwarded an electronic version of the edition of the Voice of the River that contains Ms. Watkins' article to Mr. Hopkins via electronic mail (see Attachment A to this memorandum).

2. Mr. Hopkins requested that I download and review a document posted on the Amy H. Remley Foundation web site. The document, authored by Mr. Hopkins, is titled *Research Paper re. FPSC Annual Review of Docket NO. 080148-EI.*

Response/Action: For discussion purposes, I downloaded the document from the Foundation web during my telephone conversation with Mr. Hopkins, and indicated that I would subsequently review the document. Although I did not exhaustively review the document, I did review the portions that seemed relevant to current District work supporting minimum flows development for Crystal River/Kings Bay and forwarded an electronic version of the document with a few added comments and suggestions to Mr. Hopkins. The marked-up copy of the document forwarded to Mr. Hopkins is attached to this memorandum as Attachment B and was included as an attachment to an e-mail that was sent on May 19, 2001 (see Attachment C). As discussed with Mr. Hopkins, I forwarded the document to other District staff working on the development of minimum flows for the system and will provide him with any additional staff comments that are received.

3. Mr. Hopkins requested that District staff also review another document available from the Foundation web site. The document, authored by Mr. Hopkins and David Hopkins, is titled *Groundwater Flows Affecting Crystal River/Kings Bay - a Case Study.* This document is attached to this memorandum as Attachment D. According to Mr. Hopkins, the genesis for the work outlined in the document came from a SWIM plan for the river/bay system, in which the District indicated there was a need for study of groundwater flow paths contributing to discharge and potential pollutant loading to Kings Bay. Because this identified work was not completed, the Hopkins' undertook an effort to describe groundwater flow paths contributing to spring discharge in the Kings Bay area.

   Mr. Hopkins noted that although a summary of the work outlined in the report was presented to the Coastal Rivers Basin Board prior to completion of the report, he has not presented results from the analyses to any local technical groups. He noted that he has requested, but has not been granted permission to present findings from the project to the Citrus County Task Force and the Citrus County Technical Advisory Group of the Citrus/Hernando Waterways Restoration Council. He further noted that he has recently spoken with Veronica Craw, the District's Environmental Section Manager, regarding presentation of the work to the Coastal Rivers Basin Board and learned that the status of District Basin Boards is currently in flux. Mr. Hopkins also asked whether information from the Hopkins and Hopkins study may be presented to the District Governing Board. He also asked whether staff could comment on the validity of the conclusions outlined in the study document.

   Response/Action: I noted that I would examine the document prepared by Hopkins and Hopkins and would ask other relevant staff working on development of minimum flows for the Crystal River/Kings Bay system to also examine the manuscript. Although I read the document, I was not able to develop any substantive comments to provide to Mr. Hopkins. Any comments that are provided by other District staff will be forwarded or summarized and provided to Mr. Hopkins.

   With regard to Mr. Hopkins request to present information to the Governing Board, I noted during our phone conversation that the District is initiating a public workshop series for discussion of

technical issues related to minimum flows development and reevaluation for spring-dominated river systems of the Springs Coast, and suggested that these workshops may provide opportunities for addressing some of his concerns. Following my phone conversation with Mr. Hopkins, I discussed his request regarding a presentation to the Governing Board with Veronica Craw and Marty Kelly, the District's Minimum Flows and Level Program Director. Both agreed that the planned public workshops on Springs Coast minimum flows and any future workshop(s) that will be held specifically to discuss proposed minimum flows for the Crystal River/Kings Bay system will serve as appropriate forums for discussion of Mr. Hopkins' concerns. This information along with information pertaining to the procedure for addressing the Governing Board at Board meetings was included in an e-mail that was sent to Mr. Hopkins on May 19, 2001 (see Attachment C to this memorandum).

4. A primary concern expressed by Mr. Hopkins is that groundwater withdrawals in the greater Kings Bay area will result in the crossing of a "tipping point" (his terminology) associated with potential loss of the freshwater lens in the groundwater system underlying Citrus County. Mr. Hopkins noted that based on information presented by H. Klein in a 1971 (revised in 1975) United States Geological Survey document titled *Depth to Base of Potable Water in the Floridan Aquifer*, he believes the loss of the freshwater lens has occurred along the east coast of central Florida and questions how close to a "tipping point" we may be with respect to the aquifer system along the Springs Coast (see an e-mail from Mr. Hopkins received on May 19, 2011 for clarification regarding Klein's work – this e-mail is included as Appendix F to this memorandum). Mr. Hopkins also asked whether the District has knowledge concerning the depth of the freshwater lens in the Kings Bay area. He emphasized that analysis of flows and effects of water withdrawals on Kings Bay springs should be "confined to the depth of the freshwater lens, not the entire aquifer system."

   Mr. Hopkins suggests that to protect the freshwater lens in Citrus County and the quality of water in Kings Bay, it is recommended that a "theoretical tipping point plus a margin of fifty percent" be maintained in the fresh groundwater lens. This "theoretical tipping point" may be represented by the mass of freshwater within the aquifer system underlying Citrus County.

   <u>Response/Action</u>: I acknowledged Mr. Hopkins position and indicated that I would share his comments and suggestions with other staff working on development of minimum flows for the Crystal River/Kings Bay system. In an e-mail sent to Mr. Hopkins on February 11, 2011 (see Attachment E) I noted that the Ghyben-Herzberg relationship and available potentiometric surface information could be used to approximate the thickness of the freshwater lens in Citrus County and nearby areas. The Ghyben-Herzberg relationship or ratio implies that for each foot that the potentiometric surface of an unconfined aquifer is above sea level, there will be 40 feet of freshwater below sea level in the underlying aquifer. Recent United States Geological Survey maps of the potentiometric surface in west-central Florida (which Mr. Hopkins was directed to via links in my February 11, 2011 e-mail) indicate that in the vicinity of Kings Bay, freshwater potentially extended from the surface to a depth of 40 feet below sea level in May 2009, and from a depth of 40 to 120

feet below sea level in September 2008. In an e-mail sent to Mr. Hopkins on May 19, 2011, I noted that modeling of the effects of water withdrawals on spring discharge to Kings Bay indicates that recent (circa 2005) withdrawals reduce discharge by approximately one percent. Ron Basso, a Senior Professional Geologist/Engineer with the District notes that the groundwater flow model also predicts approximately 0.1 foot of ground-water level decline due to withdrawals in the coastal area of Citrus County from predevelopment to 2005 conditions.

Ron also notes, that regional saltwater intrusion modeling completed by the consulting firm, HydroGeoLogic, Inc. did not indicate significant changes in Upper Floridan aquifer groundwater salinity over the next 50 years due to withdrawals in the northern part of the District.

Finally, Ron emphasizes that District staff recognizes the concern over increasing salinity in the groundwater system of this area. That is why we have constructed sophisticated computer models of both freshwater and solute transport flow of the area. In addition, the District maintains an expansive coastal water quality monitoring program that continually samples and tests salinity in monitor wells throughout the coast region. This program has been ongoing since the early 1990s.

5. Other comments/questions/views raised or expressed by Mr. Hopkins included the following.

   a. The freshwater lens system is presumably the same for Springs Coast springs, but some areas are "compromised", as indicated by water quality information for some spring vents presented in the 2010 report by Vanesse Hangen Brustilin, Inc., titled, *Flow Measurements from Spring Vents in Kings Bay, Crystal River, Florida*.
   b. The State of Florida has failed to prevent degradation of water quality in Kings Bay between 1970 and current times.
   c. Water quality in the Bay has not been preserved in accordance with laws governing water quality protection.
   d. The quality of water in Kings Bay is important to the ecology and economy of the region and should be protected.
   e. The Foundation is pursuing avenues of input with various state and federal agencies and other governmental offices regarding water quality in Kings Bay, development of a new nuclear-power facility in Levy County, and development of a planned mine (referred to as the Tarmac/Kings Road Mine).
   f. Mr. Hopkins questioned how groundwater flows and other environmental phenomena that may extend beyond the boundaries of the Southwest Florida Water Management District are addressed and modeled.
   g. Models used for consideration of groundwater flows and other environmental phenomena are deficient. They are too simplistic and may not be useful on a local scale.

h. Mr. Hopkins wonders why recent environmental changes, including increased salinities in portions of Kings Bay, expanded distribution of barnacles, increased abundance of *Chaetomorpha* algae, decreased abundance of *Lyngbya* algae, and earlier timing of annual population increases in *Chaetomorpha* algae are occurring. He questioned whether these changes are related to changes in the mass of the freshwater lens underlying Citrus County.
i. There is substantial scientific debate regarding a number of factors that may be relevant to Kings Bay; ranging in scale from the occurrence of gas vacuoles in *Lyngbya* to climate change.

Attachment A - E-Mail to Norman Hopkins from Doug Leeper, dated May 13, 2011
Attachment B - *Research Paper re. FPSC Annual Review of Docket NO. 080148-EI*; obtained from the Amy H. Remley Foundation Web site, with comments added by Doug Leeper
Attachment C - E-Mail to Norman Hopkins from Doug Leeper, dated May 19, 2011
Attachment D - *Groundwater Flows Affecting Crystal River/Kings Bay - a Case Study*; obtained from the Amy H. Remley Foundation Web site
Attachment E - E-Mail to Norman Hopkins from Doug Leeper, dated February 11, 2011
Attachment F - E-Mail from Norman Hopkins to Doug Leeper, dated May 19, 2011

Attachment A

E-Mail to Norman Hopkins from Doug Leeper, dated May 13, 2011

From: Doug Leeper
To: norman@amyhrf.org
Subject: Voice of the River
Date: Friday, May 13, 2011 12:17:41 PM
Attachments: SHRA 2011 - Spring 2011 Newsletter.pdf

Mr. Hopkins:

Per our conversation, I'm forwarding the edition of the *Voice of the River* that contains the article written by Ms. Priscilla Watkins. I obtained the Adobe PDF version of the newsletter from the Save the Homosassa River Alliance web site.

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E-Mail: doug.leeper@watermatters.org
Web Site: watermatters.org

Attachment B

Research Paper re. FPSC Annual Review of Docket NO. 080148-EI; obtained from the Amy H. Remley Foundation Web site, with comments added by Doug Leeper

Obtained from The Amy H. Remley Foundation web site at:
http://www.amyhremleyfoundation.org on May 13, 2011.
Authored by N. Hopkins, per phone communication.

Research Paper re. FPSC Annual Review of Docket NO. 080148-EI

D. Leeper notes - May 2011
Yellow highlighting used for review purposes. Comments added using red text boxes.

EXECUTIVE SUMMARY

The waters administered by the Southwest Florida Water Management District (SWFWMD) are all south of Florida's Hydrologic Divide such that the sole source of recharge to the aquifer and its fresh water lens system is rainfall.

The rainfall for Citrus and Levy Counties, 1915-1996, averaged about 52 inches a year with evapotranspiration directly returning some 42 inches to the atmosphere. Exposed water bodies and impermeable surfaces evaporate water into the atmosphere at much higher rates (up to 64 inches per year) which further reduce volumes available for recharge.

The systems depicted by the FGS Bulletin 68 indicate a unified water source for the spring systems which supply virtually all of the fresh water flowing out of the coastal rivers of the Nature Coast.

Not sure whether this reference to "Means" is for a report or a personal communication.

Environmentally, these Ghyben-Herzberg lens systems are crucial important not only to healthy stream flows and the biotic health of the protected waterways but also to the region's potable water supply. The lens system assures the water supply only so long as its lens' mass remains sufficient to inhibit mixing of non-potable water from lower aquifer systems. Florida Geological Survey (Means) advises that the lens' depths have reduced since last being surveyed by Howard Klein et. al., in 1975 but is not due to be determined again for some time to come.

Klein reported upon areas of the east coastal and southern regions of Florida which had become completely denuded of the potable water lens due to over-pumping. Moreover, the 2010 report to SWFWMD by Vanasse Hengen Brustlin, Inc. graphically illustrates the discharge of non-potable water from spring vents fed from a contaminated lens system co-located with an underground tributary into the southern section of Kings Bay.

Should be Causseaux and Fretwell 1983) - have not read this original report

Periods of drought, returns to the atmosphere, high rates of pumping, and lateral underground infusions from the Gulf of Mexico (Fretwell and Causseaux,1983), seek to reduce the mass and precipitate the mixing. **To preserve the integrity of this vital potable water lens systems an absolute standard would appear to be warranted and rigorously enforced, say, at the theoretical tipping point plus a fifty percent margin.**

Massive excavation and pressure grouting of the lens systems to seal off to a depth of 100 feet in order to de-water the foundation structures for the two nuclear reactors proposed for Levy county will radically disrupt and hazard the region's potable water resource. It will be further exacerbated should the excavation of the Tarmac /Kings Road mine be permitted by the United States Army Corps of Engineers (to a depth of 120 feet over an area of 2,757 acres for one hundred years).

Moreover, fall out from reactor air emissions, of certified carcinogenic radionuclides, onto the region's poorly confined aquifer systems will seriously hazard public health in local communities. Over the life of the plant accumulations in groundwater systems will have exceeded federal drinking water standards many times over.

Hazard will also be created by the proposed discharge of raw waste and similarly irradiated blow down water to the Gulf of Mexico via the utility's Crystal River complex, posing an unacceptable threat to the food web nurtured in the near shore sea grass meadows as well as to the protected species of West Indian Manatee which forage there during summer months.

The proposed Levy County nuclear venture is classified by financial institutions (Wall Street's Jim Hemptead, for example) as inherently too risky for commercial financing. Continuing escalation of capital costs of the nuclear reactors render their debt service charges an excessive component of electricity tariffs per kWh(e) to be recovered from consumers. When total energy efficiency is the measure of reward for performance, the public utility will earn it so long as it is not allowed to be the arbiter of policy.

Harvard Business School's Professor Michael Porter, in 1991, asserted that,

> *" appropriately planned environmental regulations will stimulate technological innovation, leading to reductions in expenses and improvements in quality. As a result, domestic businesses may attain a superior competitive position in the international marketplace, and industrial productivity may improve as well."*

Significant positions attained by enterprises of the State of Connecticut in fuel cell based distributed electrical power generation attest to this truth.

The State of Florida would be better served at lower cost to consumers both for energy security and environmentally by introducing selective distributed power generation applications employing fuel cell and renewable fuel applications which better survive hazardous weather events, yield improved energy efficiencies, while avoiding longer term used fuel hazards of all kinds. A corresponding reduction in need for overly large centralized power generation and expensive distance transmission line losses would be realized.

We must remember as David Suzuki, wrote in "Betraying Nature" of 8 April, 2009, an essay, published in "the Big Picture", 2009, by David Suzuki and Dave Robert Taylor.

> *"One of the hallmarks of science is that experiments must be repeatable. So when performing experiments, we remove all the confounding factors that could influence or confuse the results.* ***But nature doesn't work that way.*** *Nature does not operate in a vacuum. Interconnections among the various parts of the natural world are what actually drive it. When we pull it apart, we lose context, and that can mean everything."*

Like all biotic systems, time itself has conditioned the global fabric of our own existence within the reach of nature's complex of interrelating natural systems. We should not expose vital natural systems like the Ghyben-Herzberg lens systems, which we do not control, to any risk of unintended consequences of any human interference.

BACKGROUND

Businesses and people need a reliable, secure, environmentally safe electricity supply at a stable acceptable price. Affordable electricity is a prerequisite to the creation of new jobs in Florida today. The nuclear facility proposed for Levy County just cannot fulfill that essential requirement.

Admiral Hyman Rickover - On the hazards of nuclear power. Testimony to Congress (28 January 1982); published in Economics of Defense Policy: Hearing before the Joint Economic Committee, Congress of the United States, 97th Cong., 2nd sess., Pt. 1 (1982), testified as follows:

> *"I'll be philosophical. Until about two billion years ago, it was impossible to have any life on earth; that is, there was so much radiation on earth you couldn't have any life — fish or anything. Gradually, about two billion years ago, the amount of radiation on this planet—and probably in the entire system—reduced and made it possible for some form of life to begin... Now when we go back to using nuclear power, we are creating something which nature tried to destroy to make life possible... Every time you produce radiation, you produce something that has a certain half-life, in some cases for billions of years. I think the human race is going to wreck itself, and it is important that we get control of this horrible force and try to eliminate it... I do not believe that nuclear power is worth it if it creates radiation. Then you might ask me why do I have nuclear powered ships. That is a necessary evil. I would sink them all. Have I given you an answer to your question?"*

David Suzuki, wrote in "Betraying Nature" of 8 April, 2009, an essay, published in "the Big Picture", 2009, by David Suzuki and Dave Robert Taylor.

> *"One of the hallmarks of science is that experiments must be repeatable. So when performing experiments, we remove all the confounding factors that could influence or confuse the results. But nature doesn't work that way. Nature does not operate in a vacuum. Interconnections among the various parts of the natural world are what actually drive it. When we pull it apart, we lose context, and that can mean everything."*

Like all biotic systems, time itself has conditioned the global fabric of our own existence within the reach of nature's complex of interrelating natural systems and changing periods of day, night and the seasons. A mathematical modeler, to assist understanding, has first to establish that the system addressed is capable of worthwhile examination as a separate entity and remain representative of the total universe of data and influences that man barely understands. Anything less is merely a "pulling apart" resulting in loss of contextual meaning.

Environmental Issues

Environmental issues both impact and are impacted by people. There is no single ecologic factor that acts alone in any environment.

The fresh water "lens" of the regional aquifer systems is the sole source of potable water of the region. It is recharged exclusively by rainfall which percolates readily into the underground aquifer systems. [See Figure 1.](The illustration Figures are collected in Annex C).

Anthropogenic pollutants percolate down from the land surface into the aquifer systems reducing water quality of the lens. When the lens depth is reduced below a required threshold, for example, when pumped withdrawals, for domestic, agricultural or industrial uses, combine with the natural discharges via spring vents and have exceeded the regional rainfall accumulations, concentrations of chlorides and dissolved solids are allowed to well up from deeper aquifer systems [illegible] the degradation of water quality in the lens, [See Figure 2.]

Compartive data are not presented in VHB, Inc. and are similarly not presented here.

A recent study by Vanasse Hangen and Brustlin, Inc, showed graphically just how prone are these systems serving Kings Bay to anthropogenic changes from pumping and pollution. [See Figure 3.] Increasing saltiness levels of spring discharges over prior years had already induced ecological changes, as marine and exotic species of aquatic vegetation out-competed native fresh water species. Yet just a single isolated year of near average rainfall was sufficient to reduce by half measurements of specific conductance (saltiness) of water being discharged from Kings Bay springs.

When depths of the potable water lens were last determined by Howard Klein et. al. in 1975, in MS 42 (revised), "potable water" was defined as having fewer than 250 mg per liter of chlorides and no more dissolved solids than 500 mg per liter. Klein attributed to pumping activities the lack of potable water lens along the east coast of Florida, at comparable parallels of latitude to those of Citrus and Levy counties. [See Figure 4.] The Florida Geological Survey (FGS) advise that depths recorded by him of this "Ghyben-Herzberg lens" at the time will have reduced since then. Fretwell & Causseaux in their 1982 FGS publications reported their findings of penetration of chloride concentrations originating from the Gulf of Mexico which also were affecting the the extent of the potable water lens.

No supporting citation provided for statements regarding FGS comments on the depths of the G-H lens.

Environmental Issues with the proposed Levy nuclear plant

Over the operating life of the plant radionuclides emitted in water vapor by a nuclear plant on the proposed site will come to earth, percolate into and accumulate in the unprotected aquifer systems. Consumption of water and food products contaminated with such radio-activity establishes a clear path over time to create cancer in humans. Unlike the skin on the outside of of the body there is nothing to protect the cells and tissues from the damaging effects of emitted radioactiveparticles once ingested, inhaled or otherwise absorbed. [See Annex A]. The BEIR VII, 2005, report of the National Academy of Sciences indicates that *any* exposure to radiation can harm human health.

Tritium is the most prevalent of the very many radionuclides emitted by the proposed nuclear reactors, according to their designers. Tritium (like any other hydrogen atom) bonds readily with oxygen to form water, creating a pathway to internal cells and tissues of living creatures susceptible to cancer from radiation exposure. Tritiated (radioactive) water remains so for 120 years until decay into Helium. Tritium has a half-life of 12.43 years and is an EPA classified carcinogen of living organisms. Every day the Levy plant is expected to vent 50-plus million gallons of tritiated water to the air and discharge 60-plus million gallons into near shore Gulf of Mexico waters. These events over the life of the plant accumulate radionuclides in both the regional potable water source and the near shore biotic systems, hazarding health of humans and health of the protected manatee species valued by the local economy. Sea grasses absorb nutrients from the biomass in which they are rooted and from the water column.

The incalculable cost burden of raised health costs, together with depletion of the manatee population over time would likely impact the local economy particularly its eco-tourist element supported by the presence of manatees in the wild. (The latter alone is estimated to exceed $20million a year local economic benefit).

Note also that uranium nuclear facilities are not carbon neutral. Production processes of the uranium fuel rods are energy intensive and harmful to the environment by emitting both greenhouse gases (GHG) and the banned Chlorofluorocarbons (CFC) which deplete atmospheric ozone.

Excavation and pressure grouting deep into the aquifer lens to de-water reactor pad foundations will compromise the lens and the associated zone of influence.

Nuclear Reactors

During the 1960s' Cold War period, uranium was the nuclear fuel of choice presumably because of its path to higher power plutonium weapon systems. and possibly due to issues with durability of materials employed in the reactor vessels. The legacy today is weapon proliferation, terrorism threat, used fuel hazard, groundwater contamination by Tritium and other radionuclides, and exposure to catastrophic risks (of only limited insurance protection).

A thorium nuclear reactor, was abandoned after five years successful operation in the United States in favor of Uranium, Thorium, in use elsewhere today, is said to be more plentiful than Uranium, emits no tritium, yields more electrical energy per single ton than 200 tons of Uranium or 3,500 tons of Coal, is not a terrorism objective, and can be made to fail safe automatically. Reportedly thorium nuclear power is again being addressed in the United States and being pursued in China, but it is not known how long it is expected to be for it to become a preferred source of electrical energy.

Pronouncements from rogue state and terrorism agencies aver their intention to devastate the nation and its allies with releases of radio activity with weaponry or so-called dirty bombs, in spite of the constant endeavor to prevent their access to nuclear material. Possession of a nuclear weapon is seen as a power to be sought by many who possess them and many that desire to have them.

Used uranium fuel rods are several million times more radioactive after irradiation in a reactor than before such use. The existence of hazard and extensive costs to clean up any accidental or deliberate radioactivity release has been amply demonstrated by such cases around the world. There is no safe depository anywhere for such material. Provision for safe storage in the United States is a federal responsibility such that utility corporations are paid millions of dollars for local storage on reactor sites pending a national depository such as the recently abandoned Yucca Mountain project. Reprocessing of used fuel on large scale is apparently not a viable option.

Any release of radiation from a nuclear power plant is classed as a nuclear accident for the purposes of the Price Anderson Act (PAA), 1957. For that reason U.S. loss policies exclude "nuclear accidents". The PAA limits of claim per reactor appear to be inadequate for a major event.

CONSUMERS' COST of ELECTRICITY

Nuclear Financial Risk

Cash flow metrics of utility corporations pursuing nuclear options reduce their Credit Ratings by between 25 and 35% (from A to Baa rating) raising loan rates and reducing market demand for the "paper". In 2005, Federal Credit Guarantees (FCG) were introduced to encourage lenders to loan to utilities to meet the then perceived energy needs (at taxpayer expense of any default in repaying the loan). Since 2005, EIA reports that that capacity need has reduced by 94GW.

Reliable cost estimates are not available absent any experience of building the Levy reactor type. The EIA, Annual Energy Outlook 2011, shows nuclear to be the most expensive option for Florida by far, costing $22.5billion spread over ten to fifteen years, during which the overnight costs are expected soar. [See Figure 5.]

Seeking to reduce the unsustainable corporate debt cost burden by passing on in consumer tariffs even before any federal licensing approval to build is issued, transfers the burden from those who receive benefit from taking such risk (eg PEF shareholders) to those who do not (e.g. PEF ratepayers), By law a public utility supplier is allowed to recover from ratepayers only costs which are *prudently* incurred, meaning avoiding high-risk options when a lower risk option will "get the job done". (Note, for example: Union Electric Company Opinion #279, Docket No.ER84-560, July 20, 1987, Federal Energy Regulatory Commission (FERC), with respect to expenditures on its Callaway nuclear plant).

Wall Street's Jim Hempstead, a Moody's Senior V.P., in the Wall Street Journal on 18 February 2010, observed that, "We think the probability that things will go wrong with these large projects is greater than the probability that things will go right." This and the nuclear industry proclivity to under assess and over-run both cost and time estimates prompted twelve financial analysis firms in the wake of the Fukushima Daiichi experience to down rate nuclear industry corporate prospects.

When consumer billings provide insufficient funds to cover ongoing costs of a utility corporation's plant debt the capital cost is considered "stranded". The utility can either close down and decommission the plant, disposing of toxic waste and restoring or sell the loss making facility to a competitor at a justifiable price.

Public Utility Business Model

No rational business model can sustain a capital costs burden at too high a proportion of product cost. The financial burden for the proposed Levy nuclear facility has been calculated to exceed three quarters (75%) of total costs per kWh(e) exclusive of profit, which is not a viable proposition in face of a competitive alternative. [See Annex B].

The uranium nuclear energy option has become simply too expensive and too risky. Skyrocketing cost of building new nuclear reactors have rendered it unable to compete with falling natural gas prices that could stay low for decades. Moreover, lower cost alternatives that are now more widely available afford utilities much more flexibility in providing energy consistent with their changing demand curves. The decline in demand growth for electricity has negated petitions made years earlier for determination of need,

Public policy cannot supplant the economic reality that nuclear economics are so bad that risk cannot be entertained by the traditional capital markets, Only upon the false premise of taxpayer subsidies (federal loan guarantees or unfunded mandates) or ceding sovereignty to infusion of capital from foreign equipment vendors or their governments, can reactor construction even be kick started. The nuclear industry is demanding state ratepayers subsidize and guarantee to pay the construction costs, even if the reactors are not built or are abandoned to stranded capital.

Neither the federal nor the state government should force tax and rate payers to fund another many-billion dollar stranded capital bailout of an industry that is totally uneconomic and has no chance of standing on its own shareholder and bondholder shoulders (as reported in the local press attributed to a utility corporate spokesperson on 24 February, 2011).

So long as a utility corporation can simply generate electricity and sell it with no heed to how efficiently it is consumed nor account taken of environmental costs there is no incentive for the industry to change the way it behaves. Should the performance measure of distributable profits reflect both supply and demand side energy efficiency an essential change would be stimulated. Emphasis upon distributed as opposed to centralized generation would appear to be a step in the right direction - at least as a focus upon reality.

A BASELOAD and ENVIRONMENTALLY PREFERABLE ALTERNATIVE

DOE recently announced that a photovoltaic system should become a utility scale candidate by 2016. (It would however displace needed forested areas.) A Thorium nuclear reactor is not on the horizon at this time. Florida could not accommodate an IGCC CCS plant, and any other centralized (hydrocarbon) fossil fuel plant would emit harmful GHGs.

Natural gas (a fossil fuel) is now being piped into the region with the possibility of it being used as lower cost fuel for either central or distributed electricity generation lasting for decades. More efficient use of installed centralized plants could be made by adopting Renewable Electrolysis whereby generated electricity is stored, say, as compressed hydrogen gas, and reprocessed using utility scale fuel cells to satisfy peak demands.

However, radically fewer GHG emissions result from using electrochemical fuel cell systems instead hydrocarbon fuel combustion.

Adopting a fuel cell distributed electrical generation strategy would offer several advantageous features:

- generation close to point of use avoids need for costly and power loss inducing transmission lines.

- very high energy efficiency with low noise and minimal pollution enables even higher energy efficiencies from fuel cells with CHP applications.

- a variety of fuels can be used from hydrogen to methane gas from waste.

- creative integrated industrial applications save both money and manpower.

- typically, for every 1,000 kWh(e) produced less than one ounce of pollution results as opposed to the twenty five (25) pounds of pollution produced from central grid systems.

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Distributed Generation (DG)

DOE aims by 2020, to have one fifth of all new commercial building powered by DG, supplying extremely reliable power for critical commercial, industrial, communication and health care facilities. Every DG application relieves load upon centralized generation facilities.

A single state (Connecticut) estimates that conserving resources and curbing emissions presents a 35,000MW energy market with 7,000MW (20%) employing fuel cell systems - principally combined heat and power (CHP) applications.

Today a DG FuelCell Energy Inc. CHP facility comes on stream 12 to 14 months after agreeing project financing at, say, $4,350 per kW and (assuming fuel cost of $6.00 per MMBtu) yielding $0.14 per kWh(e) with the latter reducing by between one and two cents when utilizing CHP. (This compares with more than $11,000 per kW for the Levy proposal extending over eleven more years).

Efficiency Comparisons:

a. Plant Capacity Factor (CF) - Percent achievable of nameplate rating:
   i. Fuel Cells - CF up to 95%,
   ii. a pulverized coal plant (PCP) - CF up to 95%,
   iii. Wind - CF 25 – 35%, Solar - CF 15 – 25%.

b. Plant Energy Efficiency (EE) - Percent energy conversion. :
   i. Fuel Cell (DFC ™) EE 47%, DFC-hybrid EE 55 - 65%,
      DFC/CHP EE 60 -80%.
   ii. Micro-turbine EE 25 – 30%, Small Gas Turbine EE 25-35%,
      Natural Gas Engine EE 30 – 42%,

c. Plant Effective Utilization (EU) - Percent operating at Peak output:
   i. DFC-hybrid EU 93%.
   ii. PCP EU 70.44%,

d. GHG emissions - FC percent emitted of PCP, saving tons per year:
   i. Nitrous oxides 0.06% saving 249 tons
   ii. Sulfurs 0.001% saving 3,500 tons
   iii. Carbon dioxide 45% saving 357,000 tons

Conclusions of the EIA in regard to fuel cell applications in context of DG are reproduced below *(emphasis added)*:

" Distributed generation technologies, particularly fuel cells and PV, have received a great deal of attention from the energy community regarding their potential to save energy, increase the reliability of electricity supply, and decrease the cost of extending the current electrical grid. The tax incentive cases with resulting high penetrations also demonstrate the potential for distributed generation technologies with waste heat recovery to lower total carbon dioxide emissions from combined building sector and utility electricity generation. While the reductions in carbon dioxide emissions are not large enough to make what could be characterized as a major contribution toward stabilizing greenhouse gas emissions, *distributed generation can contribute to that goal by helping to offset projected growth.* Other conclusions are:

- The role of new, emerging technologies (PV, fuel cells, and microturbines) is critical to the projected growth of distributed resources. However, if given similar incentives, more traditional gas-fired technologies would also contribute.
- Technology cost reductions, as assumed in the advanced technology case for PV and fuel cells, *lead to projected increases in total distributed generation in the buildings sector of more than 25 percent compared with the reference case projections by 2020.*
- Net metering implemented in the model has a larger effect on the projections than that for the advanced technology cost case.
- Purchase incentives (including tax credits, lowered installed costs, and net metering) tend to reduce the projected marginal generation efficiency of installed distributed resources. *These incentives increase the applicability of distributed generation by easing the requirements for utilizing waste heat and thus spur penetration into additional applications*.
- The potential for distributed generation to mitigate carbon dioxide emissions depends on two key elements. First is the efficiency of displaced central station generation units: the more efficient the central station units are, the smaller will be the reduction in carbon dioxide emissions as a result of increases in distributed generation. The second is the efficiency of the distributed generation technology: PV makes direct carbon dioxide reductions with no offsets, whereas fuel-based distributed generation technologies create carbon dioxide emissions that depend on total efficiency, which can vary widely.
- "Standalone" estimates of reductions in carbon dioxide emissions derived from analysis of the buildings sector only (i.e., isolated from the electricity supply sector) should be avoided. *Such estimates do not include the impacts of increased distributed generation on the central station generation and can overstate the amount of savings*."

Fuel Cell System examples

See also Annex D in regard to Renewable Electrolysis (RE) applied to improving operating supply side efficiency of centralized electricity generating facilities.

A FuelCell Energy Inc., DFC™ versatile power plant has three modules - Fuel Cells (FCM). Mechanical Balance of Plant (MBOP) and, Electrical Balance of Plant (EBOP).

- the FCM reforms Hydrogen from the source fuel and combines it with air in the fuel cell stack producing electricity, water and heat. (Many Fuel cells are operated in parallel).
- the MBOP provides outside air, preheats and humidifies the source fuel, and extracts heat energy from the the FCM reaction process converting it into a usable form.
- the EBOP inverts and conditions DC electrical power into utility grade AC power, interconnecting with necessary switching and protection functions.

Waste water Treatment (WT): methane fuel produced from the WT plant's anaerobic digester is used in a DFC to generate ultra-clean process power while heat from the fuel cell is used to heat the sludge to help anaerobic digestion. Up to 90% efficiency is achieved from this CHP application. The methane gas qualifies as a renewable fuel for incentive funding. The plant can be designed to automatically blend digester gas with natural gas, allowing continuous operation with different gas yields from the digester.

Gills Onions, California (GOC):- GOC produces 300,000 lbs of onion waste per day which was once interred as fertilizer at considerable transportation and labor costs.

In 2009, GOC introduced fuel cell systems in a process to extract juice from the waste, converting it to a bio gas via anaerobic digestion, where fuel cells provide base load ultra clean process power 24/7. Annual verifiable savings amount to $700,000 in electricity costs, plus $450,000 in labor, diesel and insurance from eliminating waste interment (residual fiber from a crushing process is also sold as cattle feed), plus 14,500 tons of carbon dioxide emissions were eliminated.

Investment payback is expected over six years.

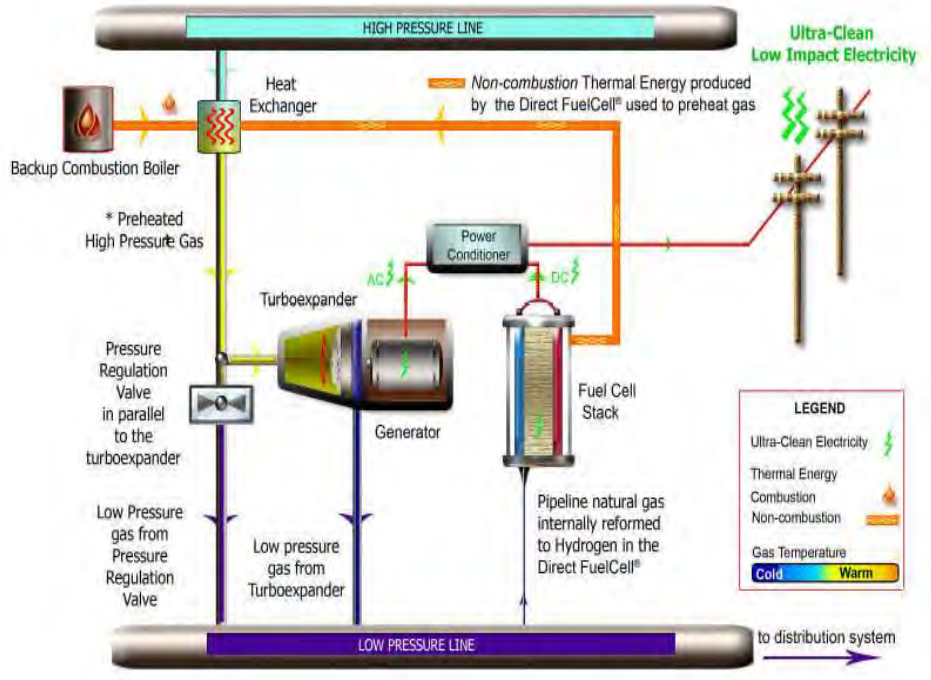
Natural Gas Distribution:- Combining a DFC™ power plant with an unfired gas expansion turbine and a generator enables recovery of energy normally lost in gas distribution pipeline pressure step-down operations to supply both process heat and electricity to the grid, as illustrated below.



FuelCell Energy Inc, DFC- ERG

Direct FuelCell Energy Recovery Generation

Enbridge, Inc. Canada



Home Heating and Power: Micro combined heat and power (m-CHP) delivered in quantity in Japan by Panasonic, together with the very many competing systems exhibited at Hanover Messe, Germany, (April, 2011), emphasize the extent of the world market for these fuel cell applications employing natural gas of various kinds as the fuel source. Systems producing up to 5kW electricity and 12 kW heat are expected to come to market within the forthcoming two to four years.

Annex A

Community Health - Radioactive Water

Background Levels

Rays of energy from outer space entering the earth's atmosphere cause some hydrogen atoms there to adopt a second neutron. This isotope of hydrogen is called tritium. According to the IATA, 1981, tritium has a radioactive half life of 12.43 years. All three isotopes of hydrogen have a single proton in their nucleus. Atoms of protium (ordinary hydrogen) has no neutron in its nucleus and is stable, deuterium has one neutron in its nucleus and is stable. Tritium with two neutrons in its nucleus is unstable and ejects Beta particles (essentially high-energy electrons). Since the number of protons determines chemical bonding, tritium behaves like ordinary hydrogen and replaces it in water molecules producing radioactive water. (Hoffman Tritium Study).

Incorporated in water molecules in precipitation from the atmosphere, tritium ultimately reaches the land or sea surface. From where it readily cycles through the hydro-logic and biologic components of the biosphere, including our ground-water aquifer reservoirs.

There are several sources of tritium in addition to the above. Since the early 1960s, when the atmospheric testing of thermonuclear weapons raised background levels by several orders of magnitude (100 times), Background levels have receded to twice the level preceding the weapons testing period. All nuclear electric power plant reactors emit tritium into water and the atmosphere. Progress Energy and Nuclear Regulatory Commission documents simply refer to the fact that all reactors emit tritium and the EPA monitors levels.

The standard unit of measure, a tritium unit (TU), is a set ratio of tritium atoms to hydrogen atoms in a substance, for example, water. In terms of radioactivity, one TU is equivalent to 3.19 picocuries per liter (Clark and Fritz, 1997). In SI units, one tritium unit is about 0.118 bequerels per liter (Bq/L), where the bequerel is one unit of disintegration per second. Tritium decays naturally over time of about 120 years to become helium.

Tritium is classified by the EPA as a human cancer causing agent. We can take this agent into our bodies by breathing, through the pores in the skin, and by eating or drinking contaminated fluids or food. EPA sets a fairly tight limit on drinking water under the Safe Drinking Water Act, at 740 becquerels per liter. The Beta particles do not normally penetrate the skin.

All living organisms can be harmed by the beta particles emitted from tritium, which can sever chemical bonds and damage cells, affecting DNA structures and subsequent generations. Effects upon microorganisms are probably not known. By extension, so also are consequences upon dependent ecologic systems and species, on which our marine food web and the livelihood of so many depend. The difficulty in constructing a test environment involving Beta radiation has led to a lack of essential documentation.

Scientific Uses

Ratios of tritium to helium in ground water can give an accurate measure of age (and possible source) of that water. Both tritium and helium are relatively inert gases. The method separates helium derived from tritium from helium derived from natural sources. The tritium/helium method is based on the radioactive decay of tritium relative to helium. Apparent age estimates from the tritium/helium method can be extremely accurate (within months) for groundwater containing high tritium concentrations (waters recharged since 1963). Unlike the chlorofluorocarbon dating method, tritium/helium is a valid technique for sites contaminated with organic compounds.

Use of Tritium as an aid to water age assessment — data on natural tritium concentrations in water in the upper part of the Floridian Aquifer were collected from December 1966 to November 1968 to evaluate tritium as a radioactive tracer. Some useful information on recharge characteristics resulted. In very general terms, an appreciable concentration of tritium is an indicator of younger water.

The natural production rate of tritium in the atmosphere is considered constant, but nuclear weapons tests as late as the early 1960's raised the tritium level to many times the normal level. The level declined after the tests but has not returned to normal, estimated by L. L. Thatcher as about 6 TU along the Atlantic Coast (Stringfield, 1966, p. 150).

During the 2-year sampling period in the Floridian Aquifer study area, one or more samples were collected at each of 26 different observation stations. Bimonthly samples were collected and analyzed from ten of the stations, including Rainbow and Silver Springs, Ocala Caverns, and seven wells.

Samples collected irregularly from four wells in the confined part of the aquifer, mostly in the Oklawaha River valley, contained zero to only traces of tritium, indicating complete or nearly complete decay of originally contained tritium. This supports interpretations from other geologic and hydrologic data that the water was old and not subject to direct recharge being in a confined aquifer system. On the other hand, all samples collected east of the river valley in the unconfined part of the aquifer had appreciable concentrations of tritium, thus supporting the belief that much of that area was subject to direct recharge. Each of the samples had more than twice the presumed normal concentration of 6 TU in rainfall, but far below peak concentrations measured in rainfall in Ocala in 1963 after the large thermonuclear tests in late 1962, thus suggesting that the high concentrations in the ground water from 1963 recharge had already passed.

The weighted average tritium concentration for 1963 precipitation in Ocala was 620 TU (Stewart and Galsworthy, 1968, p. 281). Concentrations in ground-water samples collected west of the Oklawaha valley during the 1966-1968 sampling period ranged from 13 to 174 TU while rainfall in Ocala ranged from 20 to 158 TU. The concentration in eleven samples collected at Rainbow Springs averaged about 49 TU with a high of 85 TU in May 1967 and a low of 38 TU in March 1968. Silver Springs water during the same period averaged about 47 TU with a high of 150 TU in May 1967 and a low of 25 TU in July 1967. This compares with a count of only 4.2 TU in Silver Springs water in January 1961 (Stringfield, 1966, p.150). The average concentration in the seven wells sampled bi-monthly during 1966-68 was about 80 TU, and rainfall at Ocala for the same period was about 60 TU.

Ever since the record highs in precipitation in 1963, there has been a general decline in tritium concentration, although seasonal peaks and troughs continue to occur as they would under normal conditions. A similar decline apparently occurs at most groundwater observation stations. A correlation is suggested between many of the concentration curves for the groundwater stations and the curve for precipitation. A lag of a month or two is apparent from the rainfall peaks to the peaks in several of the ground-water curves. Correlation of the curves is very much

complicated by variable recharge characteristics and by differential rates of ground-water movement in the area. Much remains to be done to properly integrate and fully evaluate the tritium data, but in the meantime the tritium data provide a useful tool for recognition of some differences in recharge conditions from one place to another within the study area.

The Proposed Nuclear Plant for Levy County

The amount of tritium estimated for the discharges from the two nuclear plants proposed for Levy County is given in Appendix J, to the USNRC DEIS report, NUREG-1941.

A Progress Energy document avers, "Tritium is a byproduct of generating electricity at nuclear power plants. All nuclear plants release tritium into both the water and air. The U.S. Environmental Protection Agency (EPA) regulates the acceptable level of tritium concentrations in groundwater and drinking water".

Other Progress Energy documentation indicates the intention to take between 100 and 130 million gallons of water a day from the Cross Florida Barge Canal. Of that amount 40% (say 50 million gpd) would be emitted to air and 60% (say 60 million gpd), at elevated temperatures, piped alongside the Barge Canal to vent to the Gulf waters using the existing outlet from the Crystal River Energy Complex.

Both sources of discharge carry radioactive tritium among other nuclides. Local precipitation would return tritium to people, soils and groundwater cumulatively every day. Ejection to the Gulf waters would pollute water and offshore sea grass meadows, with unpredictable consequences to plants and wildlife including the protected manatee species which regularly forage there. Citrus and Levy Counties draw domestic drinking water supplies from wells into the unconfined aquifer systems exposed to fallout effluent from the proposed Levy nuclear reactors. Potentiometric flows from the site , and concentration of flows within identified fracture sets would appear to imperil domestic and drinking water supplies from aquifer systems serving populations of both Citrus and Levy County. See also the "Braidwood and Dresden Nuclear Power Plants" as a Foundation News Item (March 2, 2009).

Comments submitted to the Nuclear Regulatory Commission on behalf of the Amy H Remley Foundation arising from the DEIS review meeting on 23 September

2010, are reproduced below.

"Tritium. Before licensing any LNP plant, the public needs to be apprised of how, in what quantities and into which areas harmful radionuclides are to be released and accumulated in groundwater over the operating life of the plant for both gaseous and liquid effluent pathways. Together with the calculated dosages resulting therefrom.

Concern about Tritium is expressed for several reasons:

- It cannot be denied that atmospheric deposits of tritium in water molecules accumulate in groundwater of a poorly confined aquifer system. Fifty or so years ago, measured amounts of tritium in ground water near Ocala had risen to exceed one hundred times normal background levels - due to nuclear events many thousands of miles away on the other side of the planet.
- All nuclear reactors including those proposed for Levy County and that at the CREC throughout their operating life continually release tritium (together with several dozen other radionuclides such as strontium and radio-iodine) (Pages, J-3 and J-7),
- Tritium abides in tritiated water molecules as hydrogen as explained in the USNRC Tritium Backgrounder,
- Tritium is a radioactive isotope of hydrogen and an EPA listed human cancer causing agent, emitting Beta particles until it degrades into helium after about 120 years,
- Furthermore, it is believed that the dosage models used in this DEIS only consider routine radiation releases and fail to account for either accidental releases or tritiated water accumulations in groundwater.
- Moreover calculated dosage limits also assume venting of a routine radiation release from "standard man's" contaminated bodily fluids within a few days,.
- The integrity of blowdown water piping to the CR site through a single wall PVC pipe without leak detection causes concern, especially as it will be subject to regular daily seismic disturbances from mining activities.
- The statistics put forward by Mary Olson at the 23 September 2010 review meeting, indicating levels of human harm from radionuclide emissions and in high level wastes within the regulated standards, were simply staggering and quite unacceptable to civilized society. "

See also the Appendix to this Annex: Letter sent to the Nuclear Regulatory Commission on 3 November, 2010.

Appendix to Annex A



The Amy H Remley Foundation, Incorporated

Restore the Waters

3 November, 2010

Douglas Bruner Esq
Mail Stop T7-E18
U.S. Regulatory Commission
Washington, DC 20555-0001

Dear Mr Bruner,

Thank you for allowing time for this our additional submission following the review of the draft NUREG-1941 on 23 September, 2010, and our two previous e-mails.

History repeats itself. Decades ago U.S. utilities abandoned over 130 nuclear plant orders because of massive cost overruns and construction delays. The Energy Information Administration reports Progress Energy's rising costs to $22.5billion (a 5.625 times increase) and a five years delay to 2021 and 2023 for Levy nuclear plants 1 and 2 - see, www.eia.doe.gov/cneaf/nuclear/page/nuc_reactors/reactorcom.html.

Significantly, the Florida Public Services Commission in their Order No. PSC-08-0518-FOF-EI, issued on August 12, 2008, approving PEF's petition of need for 2,200 MW base load power by year 2016, also ordered an annual review of long term feasibility and costs. Albeit, the extended recession we suffer and the rising costs and delays have since negated the substance of the petition for determination of need by 2016, which had been adopted by both the NRC and USACE as a bounding target for assessing environmentally preferable alternatives (Section 9.2). The basic premise upon which PEF based their petition has been rendered unsafe and should be re-examined. Figures recited in Section 10, are out of date

However, we point to a systemic fallacy which encourages the taking of excessive business risks at the expense of consumers. Industry lobbying, providing for profit as a given percentage, has ensured that the bigger the cost burden of assumed fiscal risk the bigger the profit guaranteed by legislation - come what may. Utilities may pursue investments in the tens of billions of dollars immune to the consequences of any bad business decisions affecting the bottom line. This creates an unacceptable undisclosed conflict of interest: where shareholders, bondholders and executives benefit at the expense of their customers, running contrary to a reason quoted for the FPSC Order that, " ...*(PEF)* will provide adequate electricity at a reasonable cost".

Note that the Ocala Star Banner, reported the FPSC's recent approval of Progress Energy's request for $163.6 million surcharge on customers to contribute toward repair to its Crystal River nuclear power plant and their proposed new Levy County plant. "The 4-0 FPSC vote will mean an average $5.53 per month cost increase to Progress Energy's more than 1.6 million Florida customers beginning in 2011". *Consumers have no prospect of any return on their investment (call it a tax).*

Note further the computations of Craig A. Severance, in Business Risks and Costs of New Nuclear Power, January, 2009, indicating costs of electricity from a similar installation to the Levy proposal to be $0.30 per kWh (prior to any capital cost raise). This five fold increase over current rates - without the surcharge - is hardly a "reasonable cost" and a likely barrier to PEF in wholesale markets.

Turning now to environmentally preferable alternatives.

We note that systemic inefficiencies exist when there is no way to store electricity generated in times of off peak or lower seasonal demand. Such "losses" of the Crystal River plants in 2008, for example, amounted to more than 800MW(e) (equivalence of a spare plant) - calculated from EIA maintained database information and data submitted by PEF as Final True-up data to the FPSC. Necessary energy storage as compressed hydrogen gas could be provided by an approach called Renewable Electrolysis (RE).

In RE, as previously indicated to you, electrical energy is captured and stored as compressed hydrogen gas (released by electrolysis) which can be re-converted into electricity using fuel cells, to meet up-turns in demand. Thereby allowing the operation of existing facilities at more efficient levels than those needed during periods of lower demand, supplemented by electricity from renewable wind or solar photo voltaic sources to enable real pollution free economies to be made.

Costs of RE systems are measured in millions not billions of dollars. Modular RE systems can be sited near concentrations of electricity users saving both $ and environmental costs of additional transmission lines.

We find the consideration of alternatives to the proposed action demanded by NEPA Section 1023(2)(C) in the draft NUREG-1941 to be utterly inadequate (RE is completely ignored and omitted from the documents).

This RE approach was referred to in our first response to you sent by e-mail attachment on October 18, 2010, and is evaluated in Technical Report NREL/TP-560-46267; September 2009; Levelized cost; centralized hydrogen; distributed hydrogen; hydrogen production; H2A Production Model.

The NRC maxim **Protecting People and the Environment** requires that we reiterate our very serious concern with the siting of any nuclear plant in a region with poorly confined aquifer systems allowing aerial effluent fallout to penetrate into and accumulate in groundwater. This was also represented to you from the podium and by e-mail attachment on October 18, 2010. It is not adequately addressed in the draft NUREG-1941 documents despite some deliberations in Chapter 7 and Appendix J.

We repeat; before licensing any LNP plant, the public needs to be apprised of how, in what quantities and into which areas harmful radionuclides are to be released and accumulated in groundwater over the operating life of the plant for both gaseous and liquid effluent pathways. Together with the calculated dosages resulting therefrom, especially regarding infants fed on mother's milk. (The harm is done to us when beta radiating elements get inside us).

Groundwater accumulates harmful cancer causing agents over the decades of a nuclear plant's life where it remains radioactive for decades more. We drink it. We eat animal and vegetable products after they too assimilate the contamination. Also, the marine food web is poisoned by the toxic waste belched daily into offshore sea grass meadows which nurture our marine food web supplying food that we also eat.

In conclusion, we earnestly recommend that PEF be advocated to adopt plans which take account of the systemic deficiencies revealed, both as to business risks and their adverse impact both financial and health-wise upon their customers, and improve supply side generating efficiencies by embracing the environmentally preferable approach offered by Renewable Electrolysis. In our view continuing to use the excessive business risks as an excuse to surcharge customers must cease.

Sincerely,

[original signed]

(Norman Hopkins, Director)

Annex B

Discussion of the Financial Fallout of the Levy County Nuclear Proposal.
A utility that builds a nuclear power plant may well experience a 25 % to 30% deterioration in cash-flow-related credit metrics, with cash flow from operations as a percentage of debt falling from 25% to the mid teens range. Meaning a fall from an A credit rating to a Baa rating incurring an increased loan interest rate coupled with an inability to sell the downgraded bonds in the credit markets.

Note that federal credit guarantees protect the lender and not the utility corporation nor its shareholders or ratepayers. As a private company the utility is not immune from bankruptcy. Credit ratings of both utilities and their customers suffer.

Central utility corporations supply power from a variety of sources having different price points for grid energy imports. Nevertheless, focusing on the nuclear plant costs, and considering that most households and small businesses carry high interest debt loads and try to pay them down, charging higher rates for electrical energy restricts the ability of consumers to make minimum payments on their debt balances which affect their credit ratings.

Excessive rate increases can result from the utility's attempt to defray construction by charging consumers in advance or charging them excessive rates for kWhs actually delivered from the nuclear facility.

Independent evaluations by the EIA of the economic competitiveness of new nuclear power conclude it to be the most expensive. Whereas utilities campaigning for new nuclear power claim it is the least expensive electricity source. No one has actually built a nuclear facility as that proposed for Levy County and no firm cost experience exists. Typically, an assessment is made of the cost to build a plant at today's (same day build) prices as an "overnight" cost usually expressed as per kilowatt (kW) rated capacity in nominal dollars allowing for different sized plants and for inflating construction costs during the build period. [See Figure 5.]

In Fig. 5, the EIA, Annual Energy Outlook Reference Case 2011, (Richard Newell) shows that nuclear is the most expensive plant to build in terms of Overnight costs per kW(e), together with Coal Integrated Gasification (IGCC) with Carbon Capture and Sequestration (CCS), albeit, the latter would not be appropriate in Florida.

Local rates charged for domestic electricity supplies have increased by about two thirds over the past twelve years to more than $0.13 per kWh(e). Calculations modeled upon those of Craig A. Severance CPA, in "Business Risks and Costs of New Nuclear Plants", January, 2009", "Due Diligence on The Economics and Business Risks of New Nuclear Power" delivered on March 4, 2010, to the Global Public Policy Conference in Potsdam, Germany, and using data from the EIA, Energy Outlook 2011, Reference Case and several other sources indicate that electricity costs from the proposed nuclear facility in Levy County would likely exceed $0.33 per kWh (see the attachment to this Annex).

The starting point for the assessment of construction costs is the sum of construction costs at today's prices referred to as "overnight costs". The Power Capital Costs Index (PCCI) published by Cambridge Energy Research Associates tracks “hard costs” of construction of power plant in America and Europe since the year 2000 from which an average yearly cost escalation of such hard costs accounting for about 51% of overnight costs can be derived at 12.76 %. Other costs, accounting for 45% of an “Overnight” cost estimate – e.g. fees, owners’ costs including licensing and legal, and transmission integration, may be less affected by such rapid worldwide cost escalation. The Handy-Whitman “All Steam Plus Nuclear Generation Plant” average of 4.85% per year may be the more appropriate factor. The remaining 4% of “Overnight” Costs is assumed to inflate at the 3% general economy inflation rate. The average weighted escalation factor has been derived at 8.81% per year of the assessed overnight costs.

As both equity and borrowed funds are used to fund the cost of finance during the planning and construction period and both expect to earn returns, an average weighted cost of capital of 14.5% is assumed. Some utilities propose to “lower costs” by charging financing costs to ratepayers during or even prior to construction. However, “early recovery” charges simply force ratepayers to pay extra financing costs to make ends meet instead of raising capital in the markets where costs are reflected in returns available to shareholders, bond holders and executive remuneration.

Several factors affecting construction costs and expected kWh tariffs are taken into account including the history of industry cost over-runs, difficulty in securing firm, reliable cost estimates, escalating construction costs during the years required to approve and build the plant, and cost increases due to construction delays.

Additional risk factors reflect the massive sunk costs to be sustained before any electricity can be generated, giving rise to a prospect of stranded capital, difficult to quantify decommissioning and clean up costs including restoration of contaminated soils and groundwater, consequent variations to credit ratings of the utility and consumers, and burdens placed upon consumers from advanced recovery of anticipated costs.

Such an assessment of financial risks relating to nuclear power facilities caused six Wall Street Investment Banks in 2007, to withhold finance from any nuclear power venture as being too risky.

There is no place in Florida to sequester carbon dioxide from an IGCC CCS coal fueled plant. Any nuclear plant located in a region having poorly or unconfined aquifer systems will contaminate groundwater with cancer causing tritium. Carbon costs to be levied on coal fueled generation for directly polluting the biosphere and upon nuclear plants for polluting the biosphere with effluents from uranium fuel cycle processes will bear upon their economics. Both involve massive downside risks of sunk capital before a single kW of power is produced - blind to any actual demand curve needs.

Appendix to Annex B

New Nuclear Power "Most Likely" All-in Construction cost -Thousands of nominal dollars

Year	AP 1000 Unit 1 Pct Constr.	AP 1000 Unit 2 Pct Constr	Escalation Factor Constr	Brick&mortar Costs $thousands 2009 dollars	Cumulative Costs $ thousands	Annual Cost of Capital $ thousands	Cumulative Capital Cost Equity + debt $ thousands	Cumulative Total "All-in" costs $ Thousands
2011								
2012	0.4	0.4	1	46	46	3.288	3.288	49.763
2013	3	3	1.08	376	423	29.922	33.210	456.132
2014	2	0	1.17	136	559	39.540	72.750	631.611
2015	3	2	1.26	366	925	65.434	138.184	1063.035
2016	5	1.5	1.36	514	1438	101.768	239.952	1678.351
2017	10	1.5	1.47	982	2420	171.250	411.202	2831.674
2018	36.6	5	1.59	3843	6263	443.113	854.315	7117.334
2019	27	10	1.72	3697	9960	704.684	1558.999	11519.098
2020	10	36.6	1.85	5008	14968	1059.022	2618.020	17586.374
2121	3	27	2	3486	18454	1305.632	3923.652	22377.625
2122	0	10	2.16	1255	19709	1394.411	5318.063	25026.860
2123	0	3	2.34	408	20117	1423.265	6741.327	26857.942
	100	100		5.34	9 <<per kW>> per kWh>>>		3.018	12.012 $0.25

Assumptions:		Comment
Overnight cost per KW	$5,339.00	1
Escalation weighted Average	8.81%	2
Percent debt	55.00%	3
Average capacity Factor	80.00%	4
Construction delays	none	5

Comments:

1,EIA, Annual Energy Outlook Reference Case 2011, page 17(Table 2) – by Richard Newell

2. Uses Cambridge Energy Research Associates press release 21 December 2010 – Index for North America average cost growth trend. showing cost downturn from the recession and a flat 2010.

3. Conservative estimate (lower cost of capital)

4..Uses MIT 2003, Future of Nuclear Power, Overview and Executive Summary - mid point values of two scenarios.

5. Delays would increase costs further.

Total Generation Costs "Most Likely Scenario" - Costs per kWh – in nominal Dollars for first year generation in 2023

Cost Component:	$per kWh
CAPITAL Cost	$0.25
OPERATION and MAINTENANCE w/o FUEL	$0.01
PROPERTY Taxes	$0.02
DECOMMISSIONING and WASTE costs reserve	$0.02
FUEL CYCLE costs	$0.03
TOTAL	$0.33

Cost escalation factor rates	Pct of Constr		Nominal Wghtd Avg
HW 00-07 Avg	4.85%	45.00%	2.18%
PCCI 00-07 AVG	12.76%	51.00%	6.51%
GEN. INFLATION	3.00%	4.00%	0.12%
Weighted Avg. Escalation			8.81%

Assumptions for Weighted Average Cost of Capital

	Net of Corpn Tax	Before Tax Gross	Pct of Funding	Weighting
Equity	15.00%	24.59%	45.00%	11.06%
Interest	6.25%	6.25%	55.00%	3.44%
	Weighted AVG. Cost of Capital =			14.50%

Annex C

Figures

Figure 1, illustrates that rainfall permeates down to join aquifer water underground. It is the sole source of water constituting the Ghyben Herzberg Lens of the regional aquifer systems, originating in consequence of a global complex of climatic, weather and hydrologic systems, Scientists term aquifers under Citrus and Levy counties as "poorly" confined - meaning that liquid is readily absorbed over most areas. Darker areas show where water falling upon the land percolates faster to join aquifer systems - 10 to 20 inches per hour.

Figure 1.

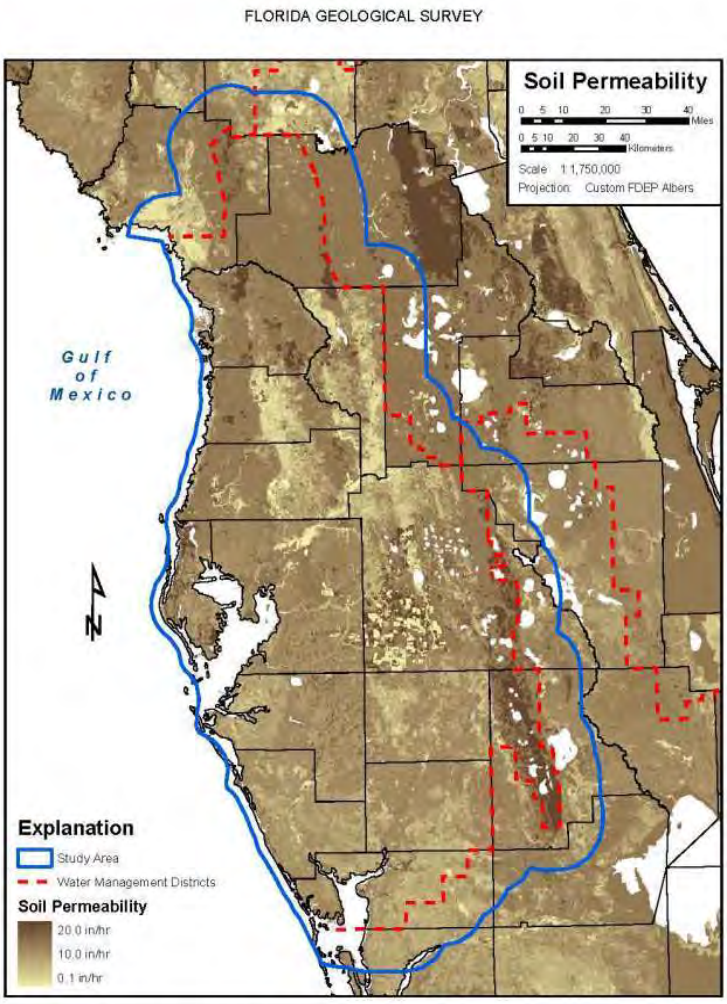


Figure 18. Soil permeability of study area (Arthur et al., in review); (data compiled on per county basis from U.S. Department of Agriculture, Natural Resource Conservation Service, 2002 and the Florida Geographic Data Library [www.fgdl.org]).

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Figure 2, represents the relative artesian pressure distribution within the the main - Floridan - aquifer systems. The thin wavy lines join points of equal artesian pressures, as a contour would join points of equal land elevation. Water tends to flow from areas of higher to lower pressure at right angles to the "contours", to enter Citrus County from the SE and NE. (The flows are further influenced by conduit pathways of karstic features and fracture sets established over geologic time, as the path of least resistance is adopted by the combined flow). In particular the Nature Coast coastal river systems, being fed principally by spring discharges from the aquifer constitute a contiguous sub-system.

Figure 2.

Regional ground-water basin may be sub-divided into several ground-water basins.

FLORIDA GEOLOGICAL SURVEY

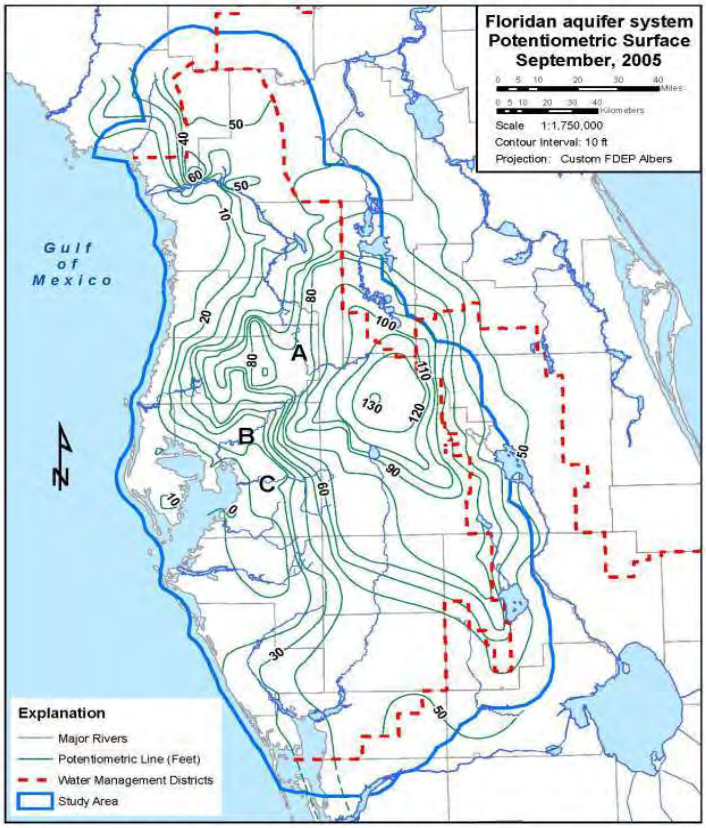

Figure 30. Potentiometric surface of the Floridan aquifer system, September, 2005 (from Ortiz, 2006); A – Withlacoochee River, B – Hillsborough River and C – Alafia River. See Figure 1 for additional river labels.

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Sedimentation within conduit pathways influence porosity and permeability and condition rates of flow within them.

Figure 3, illustrates that periods of rainfall drought or plenty, together with pumping and pollution along underground tributary flows, have consequences upon salinity levels of water delivered from the spring vents. These show how the Lens water quality has been compromised over recent times which in turn has led to ecologic and species change in the surface water body.

Use of word "These" is innapropriate. More importantly, Figure 3 does not show "compromise over recent times".

Figure 3.

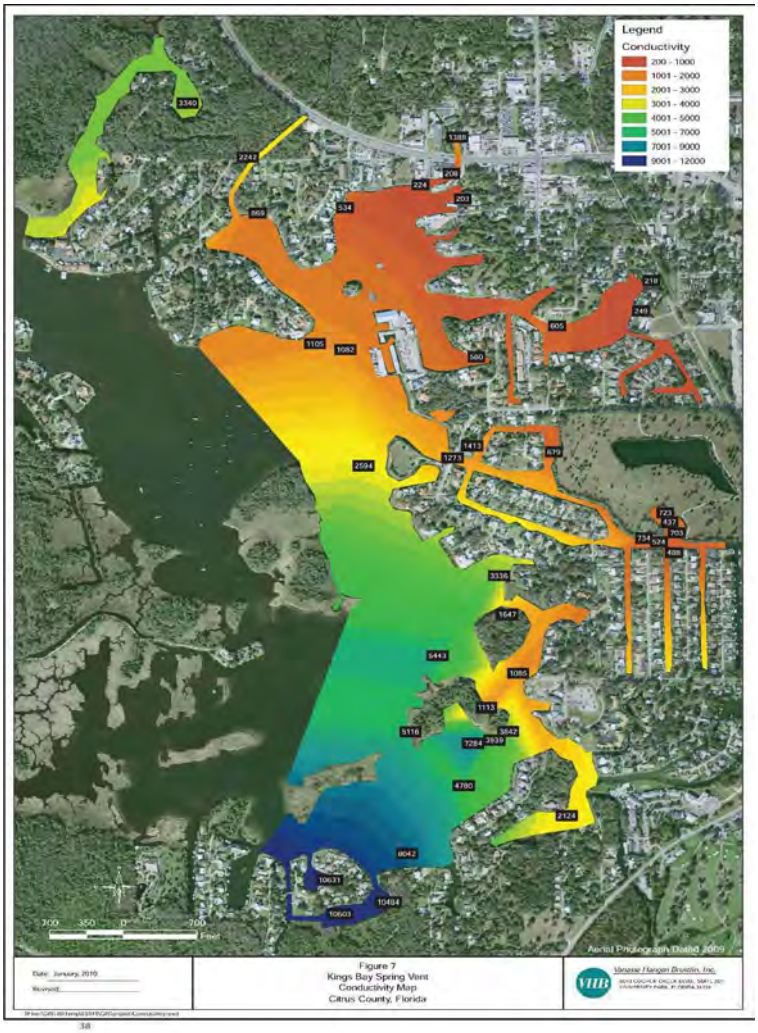


Figure 3

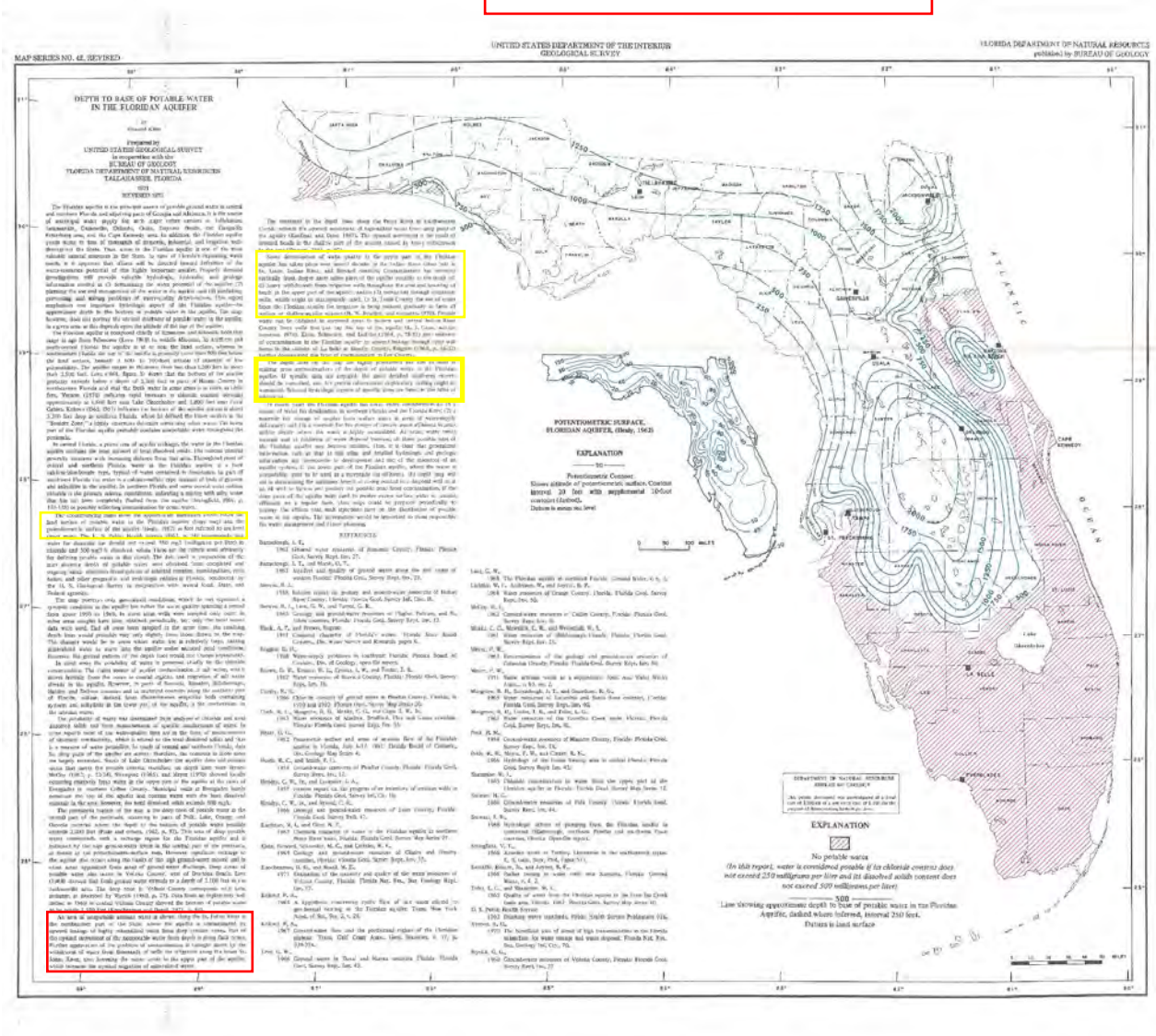
Kings Bay Saltiness

This figure shows the variation of saltiness across parts of Kings Bay. The darker blue in the SW indicates higher (saltier) conductance with the lower readings shown brown to the north. Conductance measurements recorded from the spring vent discharges, vary with seasonal rainfall amounts. The increased saltiness from the springs appears not to be due to intrusion of sea water from the Gulf, The principal underground tributary flows contribute to the phenomenon.

Figure 4, is an historic view of the Florida Ghyben Herzberg Lens system and shows how over-pumping has reduced its depth and mass to allow upwelling of saltier water from lower levels to fatally compromise water quality. Saltier more mineralized water is held to greater depths by weight of a "lens" of fresh water above. FGS cautions that lens depths have diminished since Klein's work (c.1960/70s).

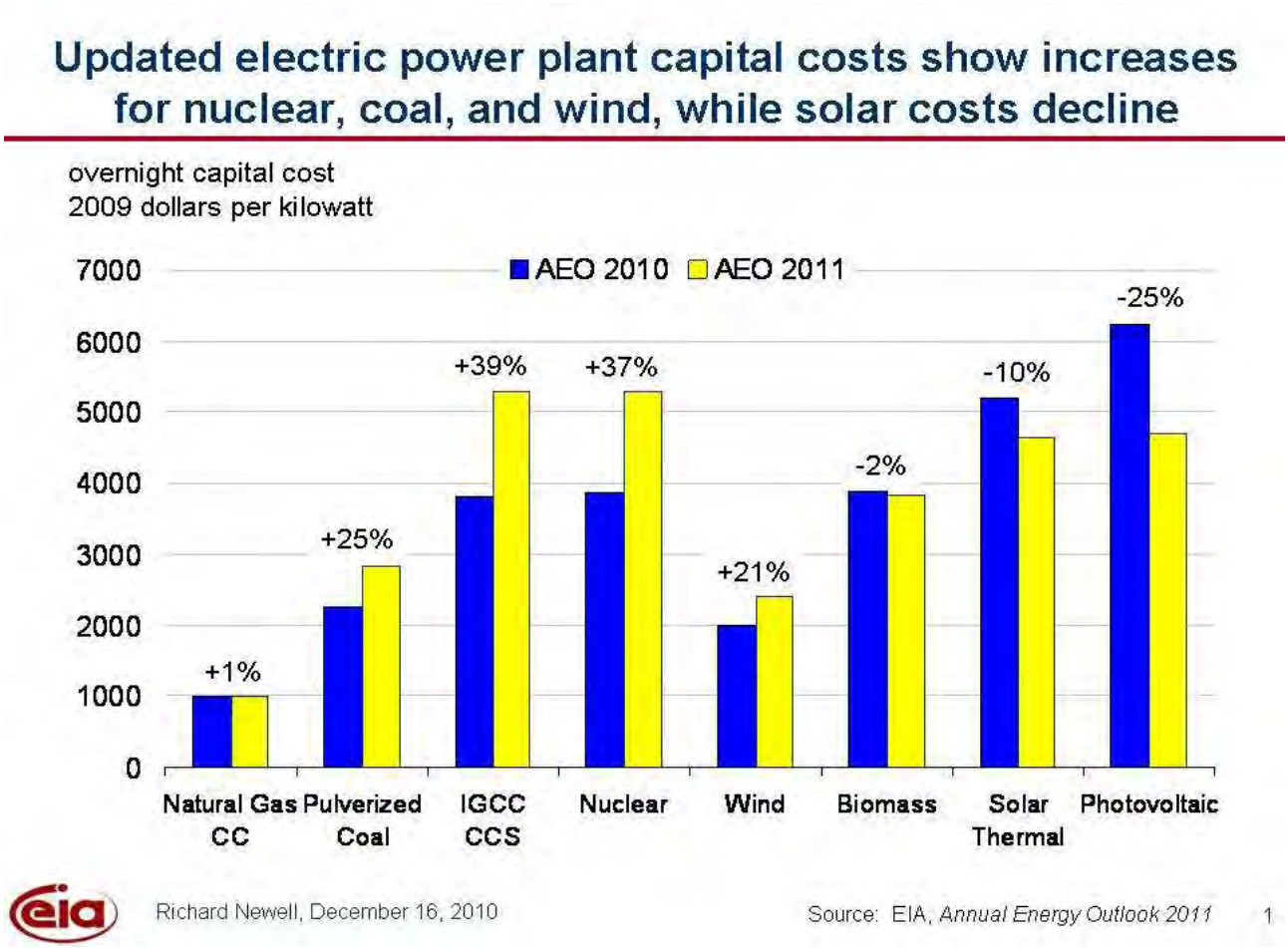
Add citation for the FGS "caution" identified here.

Figure 4.



"Potable water" defined by Howard Klein et al. 1975, as chlorides less than or equal to 250 mg/L, and dissolved solids less than or equal to 500 mg/L. Depths of lens given in feet relative to land surface datum. Klein attributes loss of potable water along Florida's east coast to pumping activities. Drought periods and pumping over the years have reduced aquifer levels and depth of the fresh water "lens". The reduced mass of the lens allows saltier water to well up from deeper down.

Figure 5.



Overnight Capital Costs expressed per KW of "nameplate" plant capacity.

Annex D

Renewable Electrolysis (RE) - Taken from www.amyhrf.org- Education Section. Significant under-utilized generating capacity is revealed by comparing actual annual kWh(e) output achieved compared with "Summer rate capability" (Peak rate). Systemic supply side inefficiencies exist when there is no way to store electricity generated in times of off peak or lower seasonal demand. These "losses" could be recovered by adopting Renewable Electrolysis (RE).

In RE, electrical energy is captured and stored as compressed hydrogen gas released by electrolysis, which can be re-converted into electricity using fuel cells to meet up-turns in demand as base load. When complemented progressively by new renewable energy sources – wind or solar photo voltaic arrays – RE would enable GHG intensive plants to be phased out. Also modular RE units could be sited near substations serving population centers. Decentralizing capacity in this way would make it more difficult to disrupt supplies by Cyber attacks and create many more manufacturing, installation and maintenance jobs in the process. Recent reports of hacks into the US power grid are thought by some to be preparatory to larger disruptions.

Renewable Electrolysis.
This Foundation is indebted for the co-operation of the DOE - NREL and particularly to Darlene Steward et. al. and NREL/PR-560-47547 from proceedings of the HTAC meeting February 11, 2010. (Note that 1kg H_2 is equivalent energy to 1gal gasoline. The Florida location is not suited to the competitive Pumped Hydro or Compressed Air Energy Storage technologies.)

Note: Some of the manufacturers approached in regard to larger static fuel cells have their business models tuned to using natural gas as their energy source, which is perfectly reasonable in view of the availability of natural gas in the market place. Their process requires natural gas to be reformed into hydrogen and then the hydrogen is the energy source for the fuel cell, as opposed to electrolyzing separation of hydrogen from water. One manufacturer offers a 1MW PEM hydrogen fuel cell at a cost of about $4million.

Hydrogen technologies are reviewed in Technical Report NREL/TP-560-46267, September 2009 by Darlene Steward et al - Click here to read Darlene . Essentially, hydrogen energy electrolysis and storage offers an opportunity to harness supply side generation capacity which is not used in the absence of storage. Efficiencies suffer where plants are forced to ramp down to accommodate both seasonal and daily cyclical reduced demands. When complemented by progressive expansion of clean energy generation by wind or solar PV arrays a transition from GHG intensive fossil fuels to clean technologies can be made.

For example, based upon 2008 data, the scope for supply side increases in efficiencies from the four coal fired plants of the Crystal River Energy Complex (CREC) has a potential for 29.56% or 683 MW(e) equivalent, rising to more than 800 MW(e) including the current nuclear facility. Today's achievable Round Trip energy efficiencies (H_2 hydrolysis through fuel cell) are estimated to be between 40% and 47%. Another significant issue is the ability to site PV arrays with Renewable Electrolysis close to a substation near to a conurbation center, say Orlando or The Villages already connected to the CREC.

RE would facilitate higher supply side efficiencies, at significantly lower costs, in an environmentally preferable manner, and be beneficial instead of harmful to human health than, say, adding nuclear generating capacity. A smoother transition to an altogether cleaner strategy nation-wide could result and create jobs so urgently needed both in manufacture and installation and maintenance.

A Renewable Electrolysis Scenario.

An "Renewable Electrolysis" scenario is described avoiding much of the negative environmental consequences which does not appear to have been addressed in the draft NUREG-1941 DEIS. Time and wealth consumed with PEF LNP proposition could be applied to bring on stream increased power capacity in a radically shorter time scale, for significantly less cost, creating local employment opportunities so urgently needed and avoiding degradation of highly valued natural resources. Earlier elimination of GHG and methyl mercury emissions from earlier closure and decommissioning of the dirty coal-fired units at the CREC would be a landmark achievement for PEF.

An Example

For example, the hydrogen plant postulated below could be accommodated in some seven cubic meters of space. PV arrays could be brought on stream as described below (as similar installations have already been provided elsewhere in Florida), together with hydrogen plant providing for base load supply, both of which could be progressively expanded over time, taking advantage of cost reductions as technologies mature:

- solar energy PV arrays and inverters could be installed on the LNP site to serve prescient increases in demand,
- hydrogen electrolysis and storage plant could create an off-grid local energy reserve. The energy resource for the hydrogen plant could be derived from off-peak grid supplies in times of lower demand enabling more efficient operating schedules of existing plants, complemented by yield from solar energy arrays on site.
- future disabling events to the CREC nuclear facility could be recovered more expediently using the reserve,
- a simple energy arbitrage scenario is postulated for the hydrogen plant consisting of an initial 300 MWh nominal storage capacity that is charged during off-peak hours (18 hours per day on weekdays and all day on weekends) and discharged at a rate of 50 MWh for 6 peak hours on weekdays. Process water would be electrolyzed to produce hydrogen, for storage as compressed hydrogen gas in above ground steel tanks for use in polymer electrolyte membrane (PEM) fuel cells. Some estimated time and cost parameters are suggested (excluding any benefit from possible federal subsidies):

1. acquire land bank for expansion of PV system or wetland s mitigation, say, 5,000 acres @ c. $100million, bringing total acreage to 10,000 acres [say, 1 year],
2. PV indirect costs (engineer, procure,construct) @ $11million [over say, 2.5 years],
3. build initial 10MW (AC) PV array on 60 acres @ $40million direct cost (incl. inverters c. $4million),
4. initial PV total cost $151million - excluding land prepn. [elapsed time, say, 3 years],
5. Hydrogen plant (Electrolyzer, Hydrogen storage, Fuel cells) consisting of, 50 electrolyzer units to yield 52,300 kg/day H_2 (run in of-peak hours only) Process water Cooling system Transformer, Thyristor, Electrolyzer Unit, Lye Tank, Feed Water Demineralizer, Hydrogen Scrubber, Gas Holder, 2 Compressor Units to 30 bar (435 psi), Deoxidizer, Twin Tower Dryer.
6. Estimated net present (2011) cost of H2 plant @ $225million.

Note: Using hydrogen for energy storage provides unique opportunities for later integration between the transportation and power sectors. Producing a small amount of excess hydrogen (five 280-kg tanker-truck loads or 1,400 kg per day) reduces the overall levelized cost of energy for this scenario by about 6% compared with the purely energy arbitrage scenario.

Fuel Cells. A fuel cell is an electrochemical device that combines hydrogen and oxygen to produce electricity, with water and heat as its by-product. As long as fuel is supplied, the fuel cell will continue to generate power. Since the conversion of the fuel to energy takes place via an electrochemical process without combustion (electrolysis), the process is clean, quiet and efficient – two to three times more efficient than fossil fuel burning.

No other energy generation technology offers the combination of benefits that fuel cells do. In addition to low or zero emissions and fuel portability, benefits include high efficiency and reliability, multi-fuel capability, citing flexibility, durability, scalability and ease of maintenance. Fuel cells operate silently, so they reduce noise pollution as well as air pollution and the waste heat from a fuel cell can be used to provide hot water or space heating for a home or business.

There are many uses for fuel cells – all of the major automakers are working to commercialize a fuel cell car. Fuel cells are powering buses, boats, trains, planes, scooters, forklifts, even bicycles. There are fuel cell-powered vending machines, vacuum cleaners and highway road signs. Miniature fuel cells for cellular phones, laptop computers and portable electronics are on their way to market. Hospitals, credit card centers, police stations, and banks are all using fuel cells to provide power to their facilities. Waste water treatment plants and landfills are using fuel cells to convert the methane gas they produce into electricity. Telecommunications companies are installing fuel cells at cell phone, radio and 911 towers.

Hydrogen is potentially the most abundant and inexhaustible energy source available. However it cannot be harvested or mined or pumped from the ground. To isolate it as the energy carrier that it is, one has to break the bonds to other elements to which it is attached in nature. Unlike electricity which does not "keep", whereas, hydrogen can be stored or moved from place to place for use for work as a compressed gas, or as a super chilled liquid or in suspension with metal hydrides. Hydrogen is the basis of all hydrocarbon fuels we depend upon today.

Caveat

Our children are taught that forests breathe in carbon dioxide, use the carbon to make cellulose and wood for trunks and roots, and breathe out oxygen for us to use in our bodies. Some are taught that forests and vegetation folded into the earth eons ago became the source of the fossil fuels we burn today - coal, oil and natural gas - for our comfort, power and transportation needs. Fewer understand that combustion of hydrocarbon fossil fuels releases carbon as carbon dioxide into the biosphere for our eventual harm, and some deny the reality of the consequences of global climate change that is the inevitable result.

Science concludes that we continue to burn hydrocarbons to our universal peril and classes fossil fuels as "dirty" pollutants of our biosphere. Moreover, whether these harmful emissions come from the exhaust pipes of our vehicles or the smoke stacks of industry or electricity power generation plants, carbon dioxide is not the lone pollutant. Methane, is twenty times and nitrous oxide is almost three hundred times more destructive to our biosphere, methyl mercury contaminates the food web and addles our brains, and sulfur oxides are a health hazard as are emitted mineral particulates. Furthermore some fuel, for example Uranium, and Natural Gas obtained by Slick-Water Hydraulic Fracturing of shale deposits, need the application of so much energy in their fuel cycle processing and yield so many pollutant by products that they also should be classified "dirty".

Furthermore, uranium enrichment is hugely productive of harmful CFC gaseous materials and together with mining, conversion, milling and fuel rod fabrication are energy intensive processes emitting carbon dioxide in to the atmosphere.

It is quite unacceptable to trade public health for electrical energy.

An alternative strategy to meet consumer needs is now needed in the absence of a truly efficient and safe alternative centralized electricity generation facility.

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Attachment C

E-Mail to Norman Hopkins from Doug Leeper, dated May 19, 2011

From: Doug Leeper
To: norman@amyhrf.org
Bcc: Marty Kelly; Sid Flannery; Mike Heyl; Xinjian Chen; Ron Basso; Mark Barcelo; Cara S. Martin; Karen Lloyd; Jay Yingling; Yassert Gonzalez; Veronica Craw; Gary E. Williams; Chris Zajac
Subject: Follow-Up to Recent Call Concerning Crystal River/Kings Bay MFLs
Date: Thursday, May 19, 2011 3:08:49 PM
Attachments: 1 Hopkins 2011 - FPSCA_RMay2011 - DL_Comments.pdf

Mr. Hopkins:
It was a pleasure to speak with you last Friday regarding the development of minimum flows for the Crystal River/Kings Bay system. I'm writing today to follow-up on number of points that we discussed. I've grouped information/text below using a numbered-list system to facilitate my preparation and your consideration of the content of this e-mail.

1. First, I hope that you received the e-mail I sent on May 13th with the attached edition of the *Voice of the River* that you requested. As you know, the edition of the Save the Homosassa River Alliance newsletter which I forwarded to you includes an article written by Ms. Priscilla Watkins that concerns minimum flows development for the Homosassa River system.

2. Please note that per your request, I read the document titled *Research Paper re. FPSC Annual Review of Docket NO. 080148-EI* which you authored and would like to offer a few comments on the manuscript. The attached file includes an Adobe PDF formatted version of the document with comments added in red text contained in text boxes. Note that I will plan on providing the document to other District staff working on minimum flows for the river/bay system and will forward any comments that are sent my way.

3. Please note that per your request, I also obtained and read the document titled *Groundwater Flows Affecting Crystal River/Kings Bay - a Case Study*, from the Amy H. Remley Foundation web site. Although I'm not able to provide any substantive comments on this document, I will forward it to other staff working on minimum flows development for the Crystal River/Kings Bay system and will provide you with any comments that are received.

4. In response to your request for an opportunity to present findings outlined in the Hopkins and Hopkins document to the District Governing Board, I discussed your request with Veronica Craw, the District's Environmental Section Manager, and with Marty Kelly, the District's Minimum Flows and Level Program Director. Both agreed that the planned public workshops on Springs Coast minimum flows that you and I discussed during our recent phone conversation, and any future workshop(s) that will be held specifically to discuss proposed minimum flows for the Crystal River/Kings Bay system will serve as appropriate forums for discussion of the technical issues that you've raised in the Hopkins and Hopkins document and the other manuscript you asked me to look at. With regard to making a presentation to the District Governing Board, I would direct you to the information provided below in italics, which I obtained from a recent Governing Board agenda. The text below describes how individuals may address Board members during regularly scheduled Governing Board meetings. As I'm sure you are aware, the District Governing Board meets regularly, on a monthly basis, and meeting information, including schedules and meeting site details is posted on the District web site.

If you wish to address the Board concerning any item listed on the agenda or an issue that does not appear on the agenda, please fill out a speaker's card at the reception desk in the lobby and give it to the recording secretary. Your card will be provided to the Chair who will call on you at the appropriate time during the meeting. When addressing the Board, please step to the podium, adjust the microphone for your comfort, and state your name for the record. Comments will be limited to three minutes per speaker. In appropriate circumstances, the Chair may grant exceptions to the three-minute limit.

The Board will accept and consider written comments from any person if those comments are submitted to the District at Southwest Florida Water Management District, 2379 Broad Street, Brooksville, Florida 34604-6899. The comments should identify the number of the item on the agenda and the date of the meeting. Any written comments received after the Board meeting will be retained in the file as a public record.

Please note that the two documents you've authored and which are cited in this e-mail will be retained in the files associated with the work supporting development of minimum flows for the Crystal River/Kings Bay system. I plan to also include all peer-review and public comments in appendices to the draft and final reports that are developed as part of the minimum flows development process. This should substantially enhance interested individual's access to comment/input on the District's work.

5. Based on our discussion, it appears that with respect to minimum flows development, a primary concern of yours is that groundwater withdrawals in the greater Kings Bay area will result in the crossing of a "tipping point" (your terminology) associated with potential loss of the freshwater lens in the groundwater system underlying Citrus County. I gather that based on information presented by H. Klein in a 1971 (revised in 1975) United States Geological Survey document titled *Depth to Base of Potable Water in the Floridan Aquifer*, you believe the loss of the freshwater lens has occurred along the east coast of central Florida, presumable due to water withdrawals, and wonder how close to a "tipping point" we may be with respect to the aquifer system along the Springs Coast. I believe that during our telephone conversation you also asked whether the District has knowledge concerning the depth of the freshwater lens in the Kings Bay area. Also, based on our conversation and consideration of the documents you suggested that I review, I understand that you recommend that a "theoretical tipping point plus a margin of fifty percent" be maintained for protection of the fresh groundwater "lens" in Citrus County and for protection of water quality in Kings Bay.

Please note that by my sharing this e-mail and the documents you have suggested that I review with other District staff, your comments will be considered by all those working on minimum flows development for the Crystal River/Kings Bay system. With regard to your question concerning the mass of freshwater in the aquifer system underlying Citrus County, I would refer you to the information I sent to you in an e-mail dated February 11, 2011. In that e-mail, I noted that the Ghyben-Herzberg relationship and available potentiometric surface information could be used to approximate the thickness of the freshwater lens in Citrus County and nearby areas. The Ghyben-Herzberg relationship or ratio implies that for each foot that the potentiometric surface of an unconfined aquifer is above sea level, there will be 40 feet of freshwater below sea level in the underlying aquifer. The recent United States Geological Survey maps of the potentiometric surface in west-central Florida that I directed you to via links in my February e-mail indicate that in the vicinity of Kings Bay, freshwater potentially extended from the surface to a depth of 40 feet below sea level in May 2009, and from a depth of 40 to 120 feet below sea level in September 2008.

With regard to withdrawal impacts on the aquifer system and spring discharge in Kings Bay, I would note that modeling efforts based on recent (calendar year 2005) water withdrawals indicate that area groundwater use may reduce spring discharge to the bay by approximately one percent. Ron Basso, a

Senior Professional Geologist/Engineer with the District adds that the groundwater flow model used for this area also predicts approximately 0.1 foot of ground-water level decline due to withdrawals in the coastal area of Citrus County from predevelopment to 2005 conditions. Ron further notes that regional saltwater intrusion modeling completed by the consulting firm, HydroGeoLogic, Inc. in 2008 did not indicate significant changes in Upper Floridan aquifer groundwater salinity over the next 50 years due to withdrawals in the northern part of the District. Finally, Ron emphasizes that District staff recognizes the reason for concern over increasing salinity in the groundwater system of the Springs Coast area. This awareness is why we have constructed sophisticated computer models of both freshwater and solute transport flow of the area. In addition, we have supported an expansive coastal water quality monitoring program that includes measurement of salinity in monitor wells throughout the region. This program has been ongoing since the early 1990s.

I hope that you find this information useful and welcome your continued input regarding development of minimum flows for the Crystal River/Kings Bay system.

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Attachment D

Groundwater Flows Affecting Crystal River/Kings Bay - a Case Study; obtained from the Amy H. Remley Foundation Web site

Groundwater Flows Affecting Crystal River/Kings Bay - a Case Study

by
Norman Hopkins and David Hopkins

Executive Summary

After Crystal River/Kings Bay was classified as an Outstanding Florida Water (OFW) and is subject to the State of Florida Antidegradation Policy, requiring water quality standards to be held to levels as at 1st March, 1979**,** water quality has degraded significantly since that time.

Studies over the years have determined that most of the water entering Kings Bay is groundwater which has traveled underground before being discharged from springs into the Bay. Contaminants simply permeate the porous karst terrain into the groundwater as it flows within the Floridan Aquifer System.

Research was undertaken and computing algorithms developed to determine those natural groundwater flow paths most likely to deliver groundwater to the spring vents of the Kings Bay system. Two underground tributary systems of the OFW were identified trending northeast-southwest and southeast-northwest into Kings Bay.

Goals for the protection of the OFW from pollutants delivered via the springs on those paths were deduced and listed according to best management practices recommended by state departments. Protection measures put in place by municipal and county authorities would reduce the quantity of pollutants being discharged from the springs, reinforcing measures advocated by the Southwest Florida Water Management District.

Groundwater Flows - a Case Study
by Norman Hopkins and David Hopkins

Situation

Following a petition of local citizens, the then Florida Department of Environmental Regulation (now FDEP), on October 28, 1982, submitted a report to the Environmental Regulation Commission (ERC) on The Proposed Designation of the Crystal River as an Outstanding Florida Water (OFW).

Subsequently, with effect February 1, 1983, the ERC approved the petition designating Crystal River/Kings Bay an OFW (Chapter 62-302.700(9) FAC). Ambient water quality of the system, against which the state Antidegradation Policy was to be applied, was defined as that existing on March 1, 1979 (Chapter 62-302.700(8) FAC). Nevertheless, water quality studies conducted since that time have shown degradation to have taken place.

Evidence of Degradation



This picture taken on 3 June 2010 by Harley Means of FGS, shows the blue Hunter Spring (upper right) toward the narrows by the park area. The green algae covering the remainder of Hunter Spring Run evidences serious water quality degradation. As of writing this extensive algal bloom, which has the appearance of Diatom or Microcystis had not been specifically identified.

In August, 2006, teams from the University of Florida led by Thomas K. Frazer reported under contract to the Southwest Florida Water Management District on water quality and vegetative evaluations of the coastal rivers of Citrus County, and adjacent Gulf Coast waters. Confirming local anecdotal observations of water quality degradation. the conclusion to the report on the three rivers asserted degradation and that similar results were likely for the Crystal River/ Kings Bay and lower Withlacoochee rivers. Extracts follow:

> The teams reported that, Groundwater nutrient enrichment presents a potentially serious ecological issue for much of central Florida. Because of the occurrence of the large aquifer systems and highly permeable karst geology, there are numerous locations and multiple pathways by which nutrient-enriched ground water can permeate and mix with the surface waters. Springs, for example, provide a direct conduit for nutrient-enriched ground water to move from the aquifer to surface waters. As nutrient-laden ground water enters the surface water system, largely via the springs, there is potential for adverse ecological changes to occur downstream. Increases in stream nutrient concentrations/loads, for example, have been linked to changes in autotrophic community composition, vegetative biomass, and an increase in nuisance species (Wong and Clark 1976; Mace et al. 1984; Wright and McDonnell 1986a, 1986b). Such changes can, in turn, affect shifts in community structure and alter food web dynamics (see Hershey et al. 1988; Peterson et al. 1993). In extreme cases, the ecological health and integrity of a system may be severely compromised as a consequence of increased nutrient inputs.
>
> Concerns over the potential effects of increased nutrient delivery to the rivers was raised nearly a decade earlier when Jones et al. (1997) reported elevated nitrate concentrations within ground water emanating from the springs, and complexes of springs, that feed each of those systems. At that time, however, there were few quantitative data available that would allow scientists or water resource managers to determine whether or not the ecological character of these specific river systems had been or might be affected by an increase in nitrate. Frazer et al. (2001a) subsequently provided the first quantitative assessment of the Homosassa, Chassahowitzka, and Weeki Wachee rivers. (see also Hoyer et al. 2004). However, they also reported significant statistical relationships between nitrate and soluble reactive phosphorus and submersed aquatic vegetation and periphyton growth on macrophytes in both the Homosassa and Chassahowitzka rivers and indicated that additional nutrient inputs to these rivers could lead to changes in the vegetative community. These changes , in combination, were legitimate reasons for concern. Increased nutrient delivery, loss of native macrophytes and increased periphyton loads are symptomatic of eutrophication related phenomena.

It stands to reason with more than 90% of the water in Kings Bay having been discharged from the springs that the contaminants in that water must have accumulated as the water flowed underground before issuing from the springs. The emphasis upon springs as the principal source for the degradation is especially relevant to Crystal River/Kings Bay which is almost entirely fed from springs.

Groundwater Flows

The following is taken from Florida geological Survey Bulletin 66.

> In order to fully understand the water quality of Florida's springs, a rudimentary understanding of the origin and chemistry of Florida's groundwater is needed. Most people are aware that Florida is surrounded on three sides by salt water. Many are unaware however, that salt water also underlies the entire state. The reason for this is that the Florida Platform consists of carbonate rocks that were deposited in a shallow ocean. At the time of deposition of the rocks under the ocean, salt water existed in their intergranular pore spaces. Gradually over geologic time, sea level was lowered relative to its position when the carbonate sediments were deposited. Through compaction and downwarping of sediments on both sides of the Platform, a series of complex fracture patterns developed. The patterns are often reflected at land surface and have actually influenced the pathways of many of Florida's streams.
> As sea level lowered, the central portion of the Florida Platform was exposed to the atmosphere. Over time, rainfall percolated downward and eventually replaced the upper portion of salt water in the carbonates with a fresh water "lens." Today, the "lens" is generally deepest in the central portion of the state and becomes narrower toward Florida's coastline. The lens is over 2,000 feet thick at its maximum (Klein, 1975). It should be understood that the base of the lens is transitional rather than a sharp boundary. Groundwater in the deeper portion of the lens, and along our coasts, is mixed and has relatively high concentrations of saline indicators such as sodium (Na), chloride (Cl), and sulfate (SO4).
> Water discharging from Florida's springs has its ultimate source from rainfall. Much of the rainfall reaching land surface flows overland to surface-water bodies, evaporates or is transpired by plants. However, a portion of the rainfall percolates downward through the sediments where it recharges our aquifers. During its travel downward from land surface to the water table, and while water resides within Florida's aquifer systems, many factors affect the water chemistry.

Residence time is the length of time that water is in contact with a particular portion of an aquifer system (Upchurch, 1992). A long residence time may allow sufficient time for chemical reactions between the water and the aquifer rock. As such, water chemistry reflects the composition of the aquifer rock. Typical residence times range from several days to thousands of years depending on the nature of the flow system (Hanshaw et al., 1965).

A second factor affecting ground-water chemistry is its flow path, which is the length and depth of the path that the groundwater follows as it flows through an aquifer (Upchurch, 1992). In general, shallow, short flow paths, which are characteristic of the SAS *(Surficial Aquifer System)*, result in low residence times for chemical reactions. Consequently, the total dissolved solid (TDS) content is less than in longer flow-path systems. If the flow path is long (on the order of tens of kilometers), such as commonly occurs in the FAS *(Floridan Aquifer system)*, reactions between rock and water become more probable and the TDS content of the water increases as a result of continued rock-water chemical reactions. Because of its residence time and flow path, spring water quality is typically reflective of the interactions of the major rock types of the source aquifer and water within it.

A third factor that is of particular interest is intergranular porosity (pores through which water passes between the individual rock matrix grains). Even though Florida's karst features suggest the existence of large, secondary cavernous pores spaces, most of the pores tend to be small (Upchurch, 1992). Fortunately, whenever the pore throats are very small, they act as filters for microbes, small organic substances, and clay minerals. In general, this results in very clean groundwater that is extremely desirable for both drinking water and recreational purposes. Unfortunately, some contaminants originating from our land use activities are not always removed and contaminate groundwater.

Dr. Robert O. Vernon had written in 1951, published as Florida Geological Survey – Bulletin 33.

A proportion of surface water is continually evaporated and transpired back into the atmosphere, part runs off as streams or collects in basins as ponds or lakes, part permeates under ground to enter voids in rocks to flow downhill eventually to the sea. Water contained in the voids in the rocks is subsurface water and that which completely saturates the rock is groundwater. If the top surface of the groundwater is free to fluctuate upwards and downwards the water is under water-table conditions. If the groundwater surface is overlain by a formation that contains few voids, or poorly connected voids or small enough voids to restrict the flow of water, the water is confined and under artesian conditions.

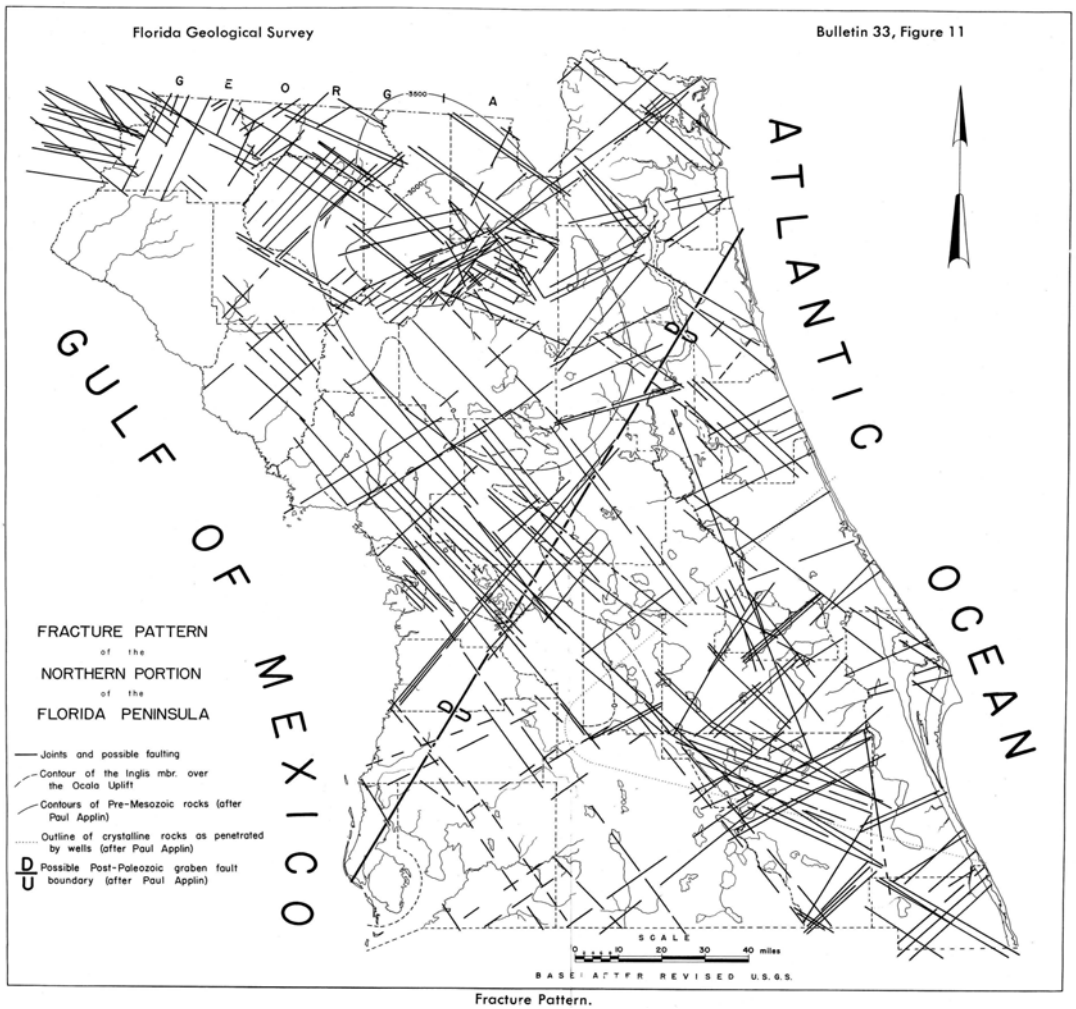
He also wrote, (on page 43): Limestone is as a rule jointed vertically and bedded horizontally and openings along these joints and beds provide easy avenues of travel for water. The ultimate source of all Florida's ground water is from the rain and precipitates from the atmosphere. As the rain water falls through the air it becomes charged with carbon dioxide gas that combines with water to form carbonic acid. On the ground humic acids from rotting vegetation is added. These are the common solvents of limestone. … As it moves through pores and open spaces in the limestone it acts as a slow solvent to increase the size of the openings and to connect them to form a continuous system of channels. As these channels are expanded by solution, cave systems are developed horizontally and one system may lie over another and may be connected by vertical tubes and rooms."

He continues (on page 44), to discuss the formation of sinkholes by cave collapse near the surface and how solution pipes are created by upward artesian pressures to form springs or seeps at the ground surface, which in turn may continue to expand in size over time.

He emphasizes (on page 240): ...since all fresh water in Citrus county is derived directly from atmospheric precipitation falling locally and on adjacent counties, conservation of groundwater resources requires that water consumed does not exceed that which is readily available from streams, lakes and wells and that this usage be small enough to maintain normal storage of waters on the surface and in the ground. Otherwise, lake levels lower, and well and stream flows decrease".

Although the literature describes natural transport of chemicals within the aquifer, the increased urbanization over the years has introduced contaminants from fertilizers and mineral elements from vehicle exhausts into the groundwater flows which contribute to the degradation of water quality.

Prior to Dr Vernon's writing, faulting was not previously recognized in Florida. He mapped fracture patterns from their physiographic expressions shown on mosaics and contact prints of aerial photographic stereo pairs, having verified them with geologic and core hole sections and surface observations. He further verified their positions with reasoning of the geologic movements taking place some millions of years earlier in the Tertiary period when the Florida land mass was given form. (See Bulletin 33, Figure 11, on the next page).



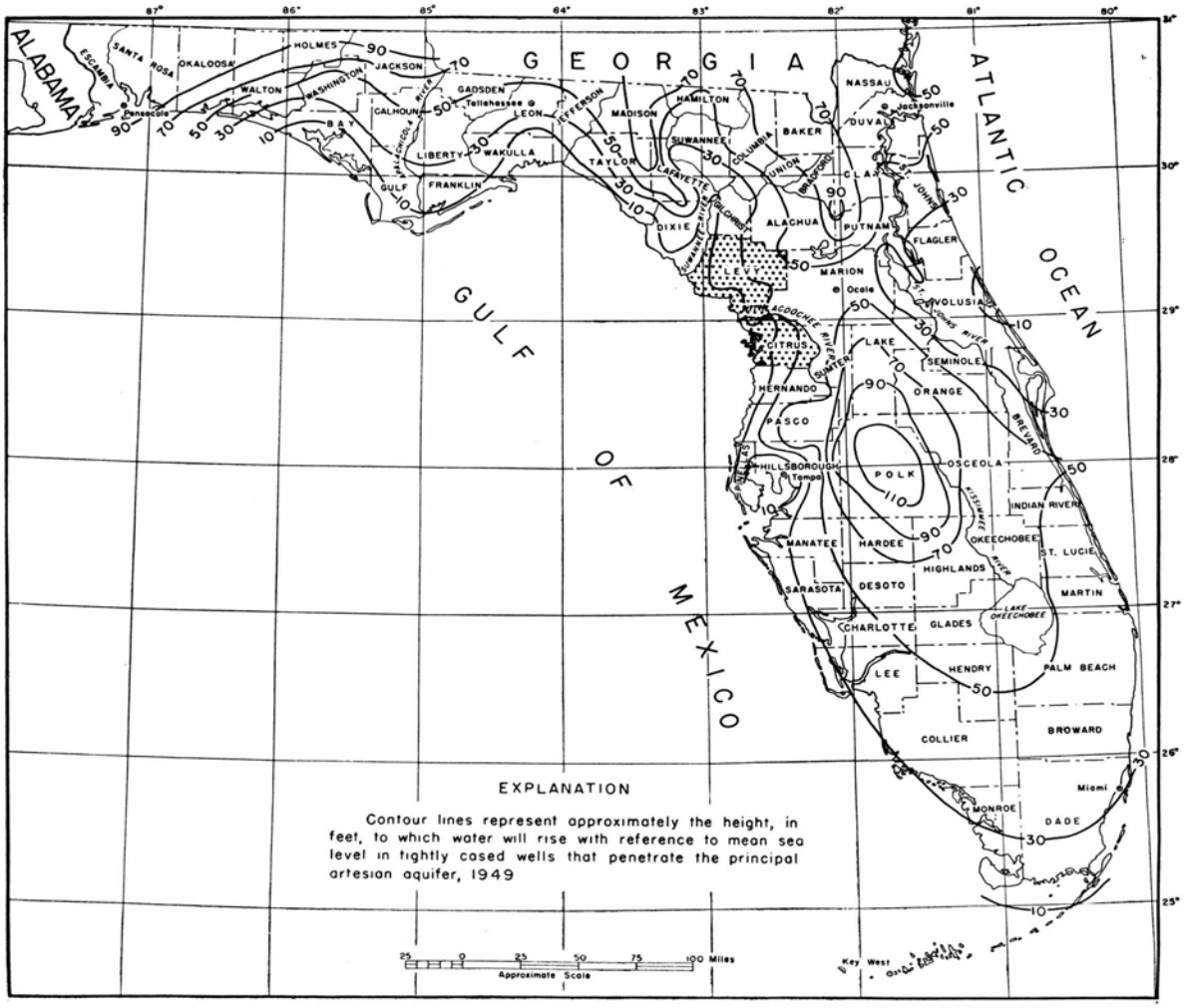
Fracture Pattern.

That fractures existed and conveyed water underground from place to place as been accepted for a long time. How they came into being, whether by tectonic forces or by lower sea levels over geologic time divides geologists today. Vernon, from his extensive down to earth surveys, drew attention to the pattern of fractures evident in Citrus and Levy counties trending generally southeast-northwest. Alongside those trending northeast-southwest intersecting at large angles and irregularly spaced along the flanks of what he termed the Ocala uplift -now termed, Ocala platform.

The identification by this Foundation of the southeast-northwest fracture conduits to the spring vents in the south part of Kings Bay are consistent with Vernon's rationale.

In Bulletin 33, Figure 40, on the next page, Vernon depicts artesian (or, piezometric) water flows of Florida. Data was constructed by measuring water levels in wells penetrating into the aquifer, referring the measurements to sea level and locating the wells on a map of Florida.

The imaginary surface by joining points of equal pressure with smooth lines called contours is known as the piezometric surface. Water is added to the aquifer from rainfall and leaves it as it is pumped out or runs down to the sea. The direction of flow is perpendicular to the contours, from areas where the piezometric surface is higher to areas of lower pressure. Areas where water is being added to the aquifer are referred to as recharge areas, and relatively low contours are referred to as discharge areas where water leaves the aquifer by leakage, springs or wells.



Piezometric Surface of Florida, 1951

Robert O. Vernon, *Geology of Citrus and Levy Counties, Florida* (Tallahassee, FL: The Florida Geological Survey, 1951)

Downloaded from *Maps ETC*, on the web at http://etc.usf.edu/maps [map #f8899]

Note: The existence of Florida's Hydrologic Divide depicted on page 10 of the Water Resources Atlas of Florida, showing a line snaking from Cedar Key to new Smyrna Beach would restrict both surface and groundwater flows towards Citrus County to those flowing southward from the northern part of Putnam County.

Faulkner, writing twenty two years after Vernon in the U.S. GEOLOGICAL SURVEY Resources Investigations Report, I-73, relates that he and others have observed that most caverns and solution channels in the limestone are oriented along near-vertical fractures having trends of fracture systems mapped at the surface. The logical inference is that water moving through the aquifer tends to follow the line of least resistance or greatest permeability, which in this case is along the fractures. In general, the greatest solution of limestone at shallow depths below the water table takes place where the greatest amount of water moves through. Thus cavities are developed as the walls of fractures are dissolved away by recently recharged ground water with a high carbon dioxide (CO_2) content. Faulkner explores the relationship of the fracture and fault system to the subsurface drainage system and emphasizes the importance of lineament indications of the presence of conduits governing direction and routes of groundwater flows. He encourages (p110), use of various remote sensing methods, such as aerial infrared and color photography, should be investigated and utilized where possible to aid in the delineation of certain stratigraphic and structural characteristics of the area, the knowledge of which may help to further define routes of preferential ground-water flow, and thereby aid in preventing pollution of water in the aquifer.

Thus two factors contribute to the routes taken by groundwater flows. First, the general patterns of piezometric flows, and second, the concentration of such flows and modification to their route when they join waters flowing in fracture conduits. Patterns of piezometric flow may vary with season and periods of drought or plenty, as aquifer head levels change opening or closing available channels through the rock. On the other hand, fracture conduits which have existed millions of years do not change their position. They only enlarge with the passage of time so long as acid charged waters flow into them, or accumulate sediments or material particles over time which affect the permeability and rates of flow in the conduits.

In the SJRWMD Special Publication SJ2007-SP4, Fifty-year Retrospective Study of the Ecology of Silver Springs, Florida, Knight (2006), observes:

> "Water quality and biological conditions at the Kings Bay Spring Group, headwaters of the Crystal River in Citrus County, were summarized by the Southwest Florida Water Management District (2005). In their evaluation they reported average nitrate nitrogen concentrations of about 0.165 mg/L in Tarpon Hole and 0.291 mg/L in Hunters Spring. Numerous ecological impairments have been identified in Kings Bay, apparently partially in response to elevated concentrations of nitrogen. These observations include loss of water clarity, increased populations of benthic algae and especially Lyngbya (also see Cowell and Botts 1994), increases in occurrence of unconsolidated sediments, and loss of desirable rooted submerged aquatic plants (particularly Vallisneria). Increasing salinities in Kings Bay may be a result of declining spring flow due to increasing groundwater withdrawals. In turn these increased salinities may have resulted in reduced SAV biomass, triggering a self-reinforcing cycle of increased growth of phytoplanktonic algae, decreased water clarity, and reduced light needed by SAV. Decreased water clarity and increased benthic algal dominance were observed at Silver Springs during the past fifty years. The Kings Bay research offers a possible clue to the effects of declining submerged macrophyte plant communities on these changes."

People and land-use practices are currently the leading cause of water pollution, harmful to humans, wildlife and the environment.

Polluted runoff occurs when rain runs off impervious surfaces such as rooftops, paved streets, highways, and parking lots. As water runs off these surfaces, it can pick up pollution such as: oil, grease, toxic chemicals, bacteria, excess fertilizer nutrients, pesticides, soil, trash, and animal waste. From whence, the water can flow directly, into a local stream, bay, lake, an underground tributary, or waterway. Clearance of trees and shrubs greatly assists this phenomenon. (See page 86 and 87, of Jones(1994). Of course, increasing impervious areas increases evaporation rates (See, Water Resources Atlas of Florida,1998, pages 148 and 149) reducing quantities of rainwater feed to aquifers and conduit flows. Thus depleting water deliveries to connected waterways, exacerbating salt water intrusions and ecologic system change, stimulating more harmful algae growth and degrading their water quality.

In addition, the large impervious surfaces in urban areas increase the quantity of peak flows of runoff, which in turn cause hydrologic impacts such as floods, scoured stream beds, channels, in-stream sedimentation, loss of fish and wildlife habitat and stimulates harmful toxic algal blooms. Sandy or gravelly soils allow rapid infiltration of contaminated stormwater into aquifers used for drinking and domestic water supply.

Untreated stormwater is not safe to drink nor swim in. It can contain toxic metals such as cadmium, molybdenum, arsenic, and lead, organic compounds, bacteria, and viruses. Polluted stormwater is the cause of many beach closures for health reasons.

Diodoto (1999) described:

> In south Florida, linear features (photolinears) are detected and identified based primarily upon indicators such as aligned solution depressions, surface ponds, vegetation, and variations in soil tone (Trainer and Ellison, 1967, Parizek, 1975). Doline (sinkhole) development can be expected to follow orientation of photolinears, as these represent areas of higher permeability and porosity.

Permeability and Porosity

Porosity is the percentage ratio of the volume of void spaces to the total volume of material in a given space. It represents the relative storage capacity of that space. Permeability is a measure of the ease with which fluids will flow though such a space where the voids are interconnected to allow fluid to flow.

Vernon explained the formation of holes in limestone rock formations, which have the capacity to store groundwater and, as the holes (both small and large) are interconnected, to facilitate piezometric flows. Flow rates are conditioned by material occupying the rock voids together with the water, and thus flow rate is a function of porosity and permeability both for groundwater matrix flows and flows in fracture conduits having suitable porosity.

Rock fractures significantly affect rates and direction of groundwater flows, as Faulkner has emphasized. Fractures may be completely void, both small and extremely large spaces, or have accumulations of material in them. Fractures may collect a variety of material into the fracture space as piezometric flows join along the whole length of the fracture, or a number of associated fracture paths. Rates of flow in fracture conduits vary according to porosity, permeability and head pressure within the FAS.

The composition of the material accompanying water in the rock or fracture voids affect ra te of flow through the rock or fracture space. The shapes, sizes, and degree to which granular materials are packed together affect both porosity and permeability properties in rock formations and fractures. In addition, of course, the intrinsic fluid viscosity and pressure also influence the rates of flow.

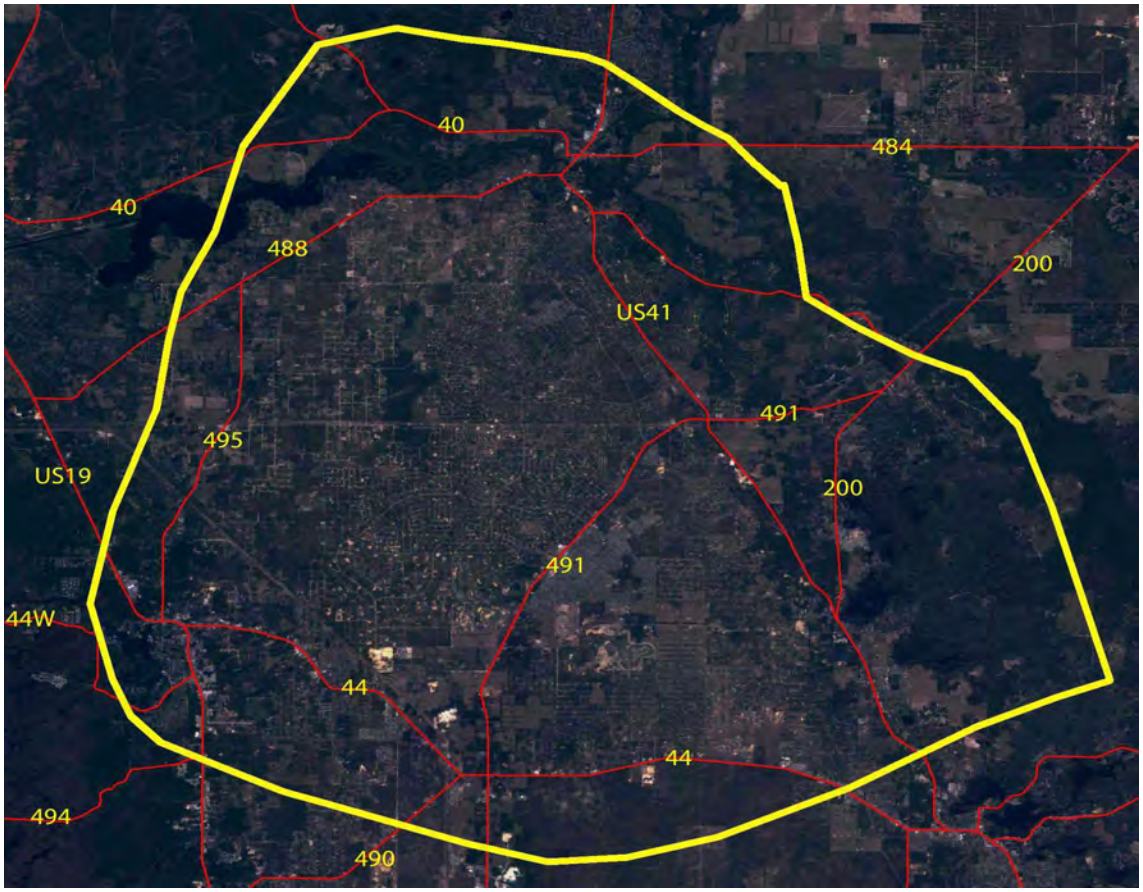
Ground/Surface water balance

Vernon discussed the relationship between groundwater under artesian conditions (Floridan aquifer system) and water under water table conditions (Surficial aquifer system). He and Faulkner also discussed how waters fed from underground flows appear at the surface. Surface waters become streams, rivers, lakes and wetlands which have flow paths controlled by topography rather than the head pressures and conduits. Surface waters are exposed to interaction with the atmosphere and saltwater tides. Lake evaporation rates locally in Citrus County average some four feet per year into the atmosphere (Water Resources Atlas of Florida, page 33). In addition, trees and plants transpire water to the atmosphere at more modest rates.

A Climatic Water Budget can be derived to illustrate the balance at the surface represented in inches by: PRECIPTATION (from the atmosphere) EQUALS (EVAPORATION + TRANSPIRATION – WATER SHORTAGE (historical)) + SURPLUS(moisture) + STORAGE_DELTA (soil water change). Such budget information is used to indicate water deficiency, water surplus, soil water recharge, and soil moisture utilization – that is a measure of the recharge amount of water percolating into the ground minus any amount taken up by plants, used or transpired.

This water balance is a vital component of environmental health, local and global climate and weather, impacting agriculture, livestock, marine and fresh water fisheries, recreation and quality of life. In the Water Resources Atlas of Florida, page 149, and depicted in the Effect of Covered Surfaces on Runoff, man's creation of impervious areas for roads, parking, buildings, clear cutting forests and the like diminish waters naturally fed back into the atmosphere by up to one tenth, reduce ground infiltration by up to three tenths and increase run off by at least four times – gathering a rich supply of pollutants on its way before eventual release into aquifer waters.

RESEARCH



The mapping above shows the groundwater recharge basin, or springshed area of the Kings Bay springs, as over printed in yellow on satellite topographical imagery (with the principal roads shown in red). Data was taken from the FDEP database, courtesy of the Southwest Florida Water Management District. Base data was derived from piezometric (artesian) flow mapping similar to those used by Vernon. Rain falling upon Citrus and surrounding Counties accumulating in this springshed is the principle source of water discharging from springs into Kings Bay. The area is described as poorly confined karst terrain having a high permeability, allowing liquid contaminants to drain directly into the FAS waters and attendant conduit systems.

Searches to locate aerial photographs or derived lineaments with respect to Citrus County in the vicinity of Crystal River/Kings Bay, as used by Vernon or Faulkner, were unfruitful, as were examination of historic archives for Citrus County (in person), and various state and university departments (with help from librarians).

Reports of work undertaken by the US Army Corps of Engineers were discussed with Army Corps project managers, and a GIS department manager. Telephone discussions were held with persons of Florida Geological Survey and United States Geological Survey and with members of Consulting organizations. Most helpful discussions with scientists of the Southwest Water Management District over a period of many months led to reviews of documentation and other material.

Eventually, a photograph of a mylar sheet of lineaments for the whole of Florida was obtained, prepared by The Remote Sensing Section, State Topographic Office, Florida Department of Transportation, in 1973. Several weeks later a 30 x 30 inches (approx) mylar was obtained from a state archive of the same set of photo lineaments containing four registration marks. A mosaic made with sixteen (16) Multispectral images taken by the NASA/GE Earth Resources Technology Satellite from an altitude of 570 miles, between Oct'.72 and Apr.'73, was also obtained having matching registration marks with those on the mylar.

A procedure was devised by the Foundation to orient and register the mosaic and the mylar in order to compute latitude and longitude of selected lineaments. A region encompassing Citrus County and part of Levy County was prepared and checked for accuracy within the constraints of the mylar and verified against the mylar superimposed over the mosaic, both physically mounted and in the computer. (Since that time a source of digitized photographs used to create the mylar has been discovered).

Lineament latitude and longitude data were calculated and entered to a database of Google Earth and there combined with data of sinkhole locations. Lastly, latitude and longitude data of spring vents, as supplied by the Southwest Florida Water Management District, for the chosen and adjacent areas were added.

Kings Bay/Crystal River Tributary Flows

Crystal River/Kings Bay is said to be the largest estuarine water body in the United States having its water sourced almost entirely from springs, and probably also in the world. The groundwater issuing from the springs originates from the Floridan aquifer system flowing under artesian pressure as they are complemented by faster flowing waters in fracture set conduits. It is the flow from fracture sets which contributes to higher the rates of flow from some of the springs in Crystal River/Kings Bay.

The upper image on the next page shows photo lineaments derived from the aerial survey conducted in 1972/3, confirming findings of Vernon (1951), and Faulkner (1973). The paths of the lineaments have been affirmed by computed Latitude and Longitude of lineaments, selected with coincident sinkhole and spring vent locations auto-plotted from official database information. The dark red SE to NW line represents the fracture indicated by Dr Vernon's research (probable joint with parallel fracture sets extending to the SW shown as indicated by Vernon - Bulletin 33,Fig. 11 - as purple lines). The circles show spring positions (those for Crystal River/Kings Bay are shown on the lower image). The blue lines are those lineaments with affirming physical features, as opposed to the white lines with have no known qualifying features. Some offshore spring vents are also shown.

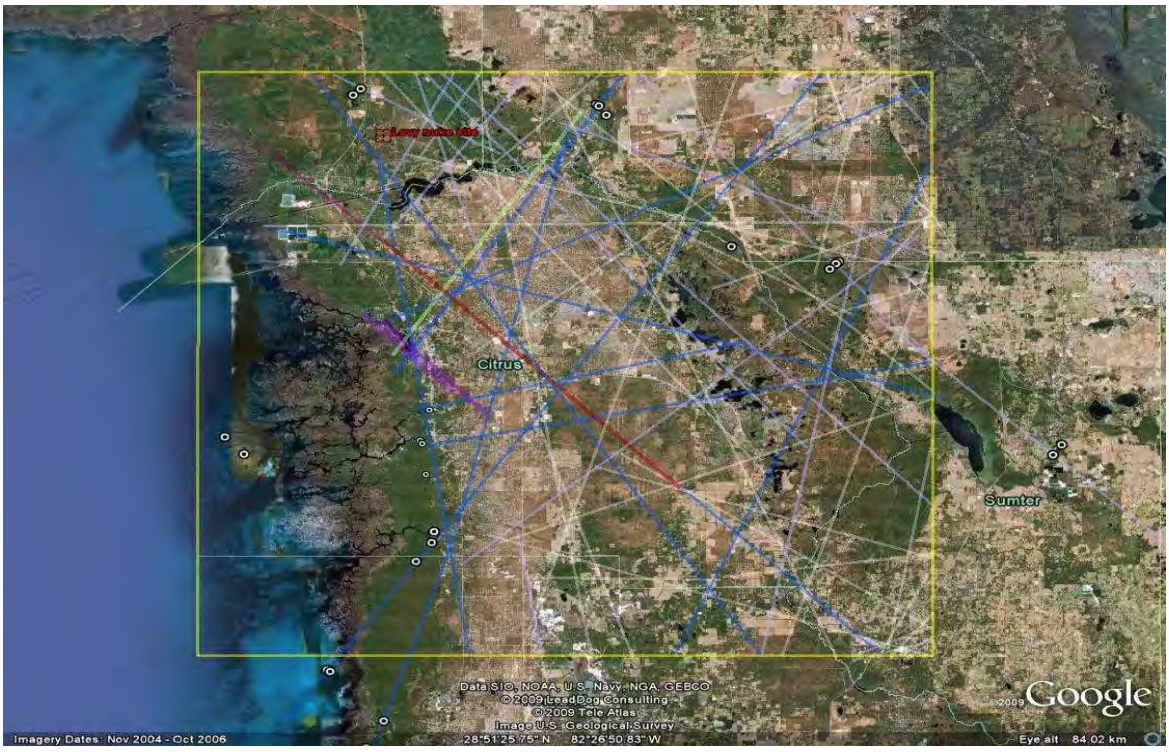
The NE to SW light green and parallel blue line which connects from the Rainbow River area is suggested as a second fresh water tributary path. The light green line passing through two Kings Bay springs and two sink holes (not shown), together with the parallel blue line passing through a number of spring vents in Kings Bay and six sink holes located on it's path, tends to support the second significant tributary path of the river system.

On the lower image on the following page, the SE to NW purple lines (parallel to the Vernon fracture line, shown in dark red in the upper image) encompass a major tributary underground flow, delivered from fractures into Kings Bay from spring vents.

This pattern of lineaments predicates two separate water sources serving the south-west and north-east portions of the bay. In USGS Open File Report 96-230, (1996), Hammett, et al, observe that surface waters do not intermingle between the north-east and south-west portions of the bay. The lineaments (probable conduits) from the north-east appear to intersect those from the south east. Specific conductance readings of spring vents which are lowest in the group laying to the north-east of Kings Bay with values up to 500µS/cm, and highest from those vents to the south-west of the bay with Values up to 12900µS/cm, with graduating values in between according to SWFWMD data. Since the surface waters have no interaction it suggests that mixing could be happening beneath the Bay waters.

Of further interest is the location of cave systems in the Withlacoochee Forest, Citrus Tract, positioned coincident with a photo lineament of the 1972, DOT aerial survey. This suggests that the caves are probably surface representations of a deeper fracture. Although the particular caves are dry today they were probably once expressions of aquifer conduit flow. The direction of the lineament indicates a path into the recharge basin of the King's Bay springs.

Citrus County Lineaments





Crystal River Lineaments

Note that explanation of these two graphics is given on the previous page

When these fractures (suggested by lineaments) were formed, the western shore of the land mass would have extended far into what has become the Gulf of Mexico, say, 50 to 150 miles(USGS FlaSH data). Hence fractures would not stop at US19 but extend westwards, to either deliver fresh water as conduits breached the seabed, or, allow for salt water to be pumped under the sea according to extant tidal or weather surge pressures. The reason lineaments did not show on the mylar could be because areas west of US19 were not surveyed or were too wet to register lineaments in a discharge zone. A black and white 1970s GIS map of the region did not reveal any lineament data nor did a 2008 infrared photograph.

So far, the principal sources of information cited relating to lineaments and fractures, are those of Vernon (1951), Faulkner (1972), and the FDOT (1972/3) aerial survey data.

A further important source of information is that of Gregg W. Jones and Dr. Sam B, Upchurch et. al. (1994), Origin of Nutrients in Ground Water Discharging from Kings Bay Springs. Notwithstanding that the Vernon (1951) report is not cited as a reference, and no mention is made of particular fracture conduit flow paths, nor reference made to vehicle exhaust sources of groundwater pollutants, it is a very thorough analysis of hydrology and geochemistry.

> The discussion of hydro-chemical facies from well samples, on pages 44 through 49 and Figures 18 and 19, of Jones(1994) reveals an east-west connection between the Tsala Apopka lakes region and Kings Bay Springs, as a sub-regional flow system passing under the central area of Citrus County which was not reflected in the aerial survey data.
>
> The note on page 25, of Jones (1994) describes the nature of fractures and photo-linears, according to co-located sinkholes (Littlefield et al. 1984), as "major conduit systems for groundwater flow". Figure 30, on page 81, of Jones(1994) illustrates potentiometric (peizometric) travel times for that groundwater flow corridor (under conduit flow conditions travel times would likely be shorter). However, there is no evidence in the aerial data of a fracture conduit on that path, possibly due to the depth of the overburden of the Brooksville Ridge.
>
> Moreover,. The choice of the 15% porosity factor is seen as a conservative stretch of the Travel Time computation. Especially for the southeast-northwest tributary flow, as predicated on page 80, of their report. Personal data from SWFWMD 2010, reports nitrate concentrations in Kings Bay (0.28 – O.35mgL) markedly lower than those seen in the Rainbow River (1.8 mgL).
>
> Emphasis is also given to degradation of water quality in the protected waterway of Crystal River/Kings Bay on page 66, of Jones(1994), when considering Total Nitrogen, as follows.
>
> > "Since transformations between nitrogen species are rapid and complex, it is often best to consider total nitrogen. Total nitrogen concentrations represent the summation of all of the previously discussed analytes.
> >
> > The distribution of total nitrogen (Figure 25a and b) ties several of the pathways previously discussed together. The high nitrogen concentrations that have resulted from leakage from Lake Tsala Apopka are well represented. The east-west, northeast-southwest, and north-south corridors are also strengthened. These corridors correspond with principal directions of fractures and lineaments and suggest that there is a long-term supply heading for the springs. The high in the western portion of the City of Crystal River is contoured with the springs, suggesting a connection."
>
> Attention is drawn on page 110 (item 14) in Jones(1994) to an increased nitrogen feed into Kings Bay, say, by the year 2014. The Lyngbya growth recently observed in the Three Sisters Springs complex may herald an early arrival of that feed.

The following paragraphs, were suggested by USACE as a good summary on fracture-trace mapping principles by Diodato (1999):

Photolinear analysis is a type of remote sensing analysis wherein investigators map linear features (photolinears) observable on aerial photographs or other remotely-sensed images. The use of photolinears for ground-water well siting was pioneered by Lattman and Parizek (1964). For linear features of geologic origin, lineaments are defined as those photolinear features greater than one mile in length, whereas fracture traces are the same type of feature having a total length of less than one mile. The width of these zones of fracture concentration can vary from a few to tens of meters. In general, longer lineaments tend to have wider surface expressions of the zone of fracture and wider zones of fracture concentration at greater depths. Because the fracture trace is the surface expression of the vertical zone of fracture concentration, Parizek has suggested the "fracture zone trace" might be a more appropriate descriptive term (Parizek and Diodato, 1995).

Zones of fracture concentration in soluble rocks such as carbonates and evaporates can lead to enhanced dissolution of these rocks due to accelerated chemical and physical weathering. In the case of rocks prone to karstification. White (1999) has determined that the development of karst conduits begin when fracture apertures reach about one centimeter.

In south Florida, linear features (photolinears) are detected and identified based primarily upon indicators such as aligned solution depressions, surface ponds, vegetation, and variations in soil tone (Trainer and Ellison, 1967, Parizek, 1975). Doline (sinkhole) development can be expected to follow orientation of photolinears, as these represent areas of higher permeability and porosity.

Legal Issues

According to the Institutes of Justinian, a Roman codification of customary law, Book II.I.1., "By the law of nature these things are common to all mankind – the air, running water, the sea, and consequently the shores of the sea."

The English common law recognized similar principles of ownership, but vested it in the sovereign, held in trust for the use and benefit of the public.

As applied in the United States, this public trust embraced all tidal waters and all navigable waters, and is incorporated in the Florida Constitution (Article X, Section 11), subject to certain exceptions, only when in the public interest, regarding sale and private use. Owners of land abutting a water body, Riparians, share rights with the public and each other. If a body of water is navigable or tidal, riparians share a right with the public and each other to navigate, fish and swim. They also control use of their land to gain access to the water.

However, since 1856, (*Chatfield v. Wilson*, 28 Vt. 49, 54 [1856]), "The secret, changeable and unknowable character of underground water in its operations is so diverse and uncertain that we cannot well subject it to the regulations of the law, nor build upon it a system of rules, as is done in the case of surface streams ".

This arcane and somewhat arbitrary principle has bedeviled relations between land owners wanting to exploit resources in a manner they see as their right, and the environment as it serves the interest and needs of the general public. It has encouraged both legislation and litigation, especially in regard to wetlands conversions, which has cost untold millions of tax dollars and degraded water resources immeasurably.

People and land-use practices are currently the leading cause of water pollution, harmful to humans, wildlife and the environment.

Florida State Law

Florida state law regards wetland as "Isolated" unless connected by surface water flows. There is finite risk of decisions being taken that would result in degrading water quality of protected waters, contrary to law.

Antidegradation Policy

The Florida Antidegradation Policy (Sections 62-302.300 and 62-4.242, F.A.C.) recognizes that pollution that causes or contributes to new violations of water quality standards or to the continuation of existing violations is harmful to the waters of the state. Under this policy, the permitting of new or previously un-permitted existing discharges is prohibited where the discharge is expected to reduce the quality of a receiving water below the classification established for it. Any lowering of water quality caused by a new or expanded discharge to surface waters must be manifestly in the public interest (that is, the benefits of the discharge to public health, safety, and welfare must outweigh any adverse impacts on fish and wildlife or recreation). Further, the permittee must demonstrate that other disposal alternatives (for example, reuse) or pollution prevention are not economically and technologically reasonable alternatives to the surface water discharge.

Florida Law Commentary

Notwithstanding that "Waters" are defined whether or not flowing underground through pores or conduits, (Sections 62-520,200(21) FAC.), the following interpretations have been given by FDEP by e-mail exchange.

1. Classification of a surface water as an Outstanding Florida Water does not extend that classification to adjacent groundwater. Florida law treats surface water and groundwater as two separate things even when groundwater flows directly into a surface water.

2. Wetlands whose only connection to other state waters is via groundwater flow are considered "isolated", as state law does not recognize such connections.

3. The 9th CC of Appeal decision, to the effect in the normal sense of the word that a Tributary flow from a source into a waterway may be underground or on the surface, relates to determining whether or not a wetland is subject to regulation by the U.S. Army Corps of Engineers under the Federal Clean Water Act. It has no bearing upon Florida law.

4. The ERP rules (for SFWMD see rule 40D-4.301) state that in order to receive a permit an applicant must provide reasonable assurance that, among other things, the project will not adversely affect the quality of receiving waters such that the water quality standards set forth in Chapters 62-4, 62-302, 62-520, 62-522 and 62-550, F.A.C., including any antidegradation provisions of paragraphs 62-4.242(1)(a) and (b), subsections 62-4.242(2) and (3), and Rule 62-302.300, F.A.C., and any special standards for Outstanding Florida Waters and Outstanding National Resource Waters set forth in subsections 62-4.242(2) and (3), F.A.C., will be violated. Rules 62-520 and 522 are the groundwater rules.

5. The ERP regulates all wetlands whether they are connected to other state waters or not. In considering whether or not to issue an ERP, consideration would be given to the impact of that activity on groundwater and if that groundwater directly flows to a surface water that is an OFW then consideration would be given to the impact on the OFW.

If we really care about conserving Florida's water resources, when faced with risk of degrading water quality of a protected United States waterway, or diminishing a scarce fresh water resource, as as a condition precedent for issuing any permit to proceed even under Florida state law, the proposed developer should be required to prove conclusively that the venture will not act to the detriment of the public interest.

United States Federal Law

Clean Water Act of 1972 (federal law administered by USACE, supervised by EPA)**.**

Congress intended The Clean Water Act (CWA) to apply to "all waters of the United States". Waters of the United States embraced among other things, tributaries of various waters, adjacent wetlands, and intrastate waters with linkages to interstate commerce.

However, the act has been weakened by two Supreme Court decisions.

1. In 2001, the United States Supreme court in a 5 to 4 decision held in Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers — the SWANCC case - that non-navigable, intrastate waters are not protected by the Clean Water Act.
2. In June, 2006, the United States Supreme court in the case referred to as Rapanos/ Carabell handed down a plurality decision with four justices opining that the jurisdiction of the CWA should only apply to "relatively permanent, standing, or continuously flowing" waters, or wetlands immediately adjacent to such waters. Justice Kennedy voted with the plurality to remand the case to the lower court, but disagreed with the plurality's reasoning and rendered his own explanation. Justice Kennedy's opinion focused on whether the specific wetlands at issue possess a "significant nexus" with navigable waters.

Among numerous court decisions following the SWANCC and Rapanos decisions, the Ninth Circuit Court of Appeal, on August 6, 2007, handed down their decision in the Russian River case. The decision affirmed the wetland significant nexus (JK), and that Tributary flow into a navigable-in-fact United States waterway may be surface or underground (according to normal use of the word "Tributary") and flows could be intermittent (due to seasonal or drought influences). Although this principle is reflected in Florida state law, it is not being vigorously applied.

The Clean Water Restoration Act of 2009, currently in U.S. Congress, would seek to restore longstanding safeguards to all the nation's water resources by replacing the word "navigable" with "waters of the United States" throughout the CWA, to include all "isolated" waters, headwater streams, small rivers, ponds, lakes and wetlands, and remove any doubts introduced by the Supreme Court decisions.

Federal Law Commentary

It would appear that federal law outweighs state law today in regard to isolated waters, when such waters (flowing above or below ground) connect with tributaries of a navigable-in-fact United States waterway, which may include wetlands in "significant nexus". However, it is noted that under the significant nexus test, a party seeking to invoke the court's jurisdiction had to present evidence of a hydrologic connection. Rapanos, 126 S. Ct. at 2250-51 (Kennedy, J., concurring). That connection may suffice in some but not all cases to show "some measure of the significance of that connection for downstream water quality."Id. at 2251.86/

A question is raised as to the meaning of significant nexus. It is conceivable that evidence of hydrologic connection could not be obtained in every case. In a case where a United States navigable-in-fact waterway was protected by law against degradation of water quality, and being supplied with water by a tributary (flowing above or underground), and any pollutant discharge into the tributary sufficient to degrade water quality in the waterway, then the tributary and waterway would be classed as a significant nexus. However, should a wetland be adjacent to the tributary and filter run off into the tributary, would that wetland possess significant nexus with the waterway, and be a connected wetland? [Currently excluded under Florida state law].

It is important to know the course of underground water flows in order to frame decisions which safeguard our precious underground water resources, as they continue to be consumed at higher rates than they are created by rainfall. That said, for purposes of a court proceedings would evidence of a hydrologic connection be necessary in addition to any fracture set analysis or any other reasoning ?

If it were possible to ascertain hydrologic connection by sampling water at say, well A, and sampling water discharged from say, spring vent B, and should the water from both sources have sufficiently similar characteristics, then it could be concluded that the water sources were connected. However, in reality, it is not so simple. A conduit flow occurs when the properties of porosity and permeability of the conduit space are such as to allow fluid to flow in the conduit. (See Porosity and Permeability above).

In view of the different treatments prescribed by state and federal law, and having in mind the principal of Supremacy of Law, it would seem that the only way to achieve harmony would appear to be for the law to be clarified by a binding court decision.

Nevertheless, recognizing that the physical complexities may inhibit the determination of significant nexus in advance of a given industrial or commercial building venture, obligation should rest upon a potential developer to respect the public interest. Faced with risk of degrading water quality of a protected United States waterway, or diminishing a supply of a fresh water scarce resource, the proposed developer should be required to prove that the venture will not act to the detriment of the public interest, as a condition precedent for issuing any permit to proceed.

Recommended Goals for Protection for the OFW

Following advice in the November, 2002, document, "Protecting Florida's Springs – Land Use Strategies and Best Management Practices", and in the 2008 Guidebook of Springs Protection, goals to be achieved should include the following:

1. Restore water quality in Kings Bay to levels prescribed as at 1 March 1979.
2. Verify the revealed tributary flows by peer review.
3. Delineate protection zones for the tributaries and associated spring vents.
4. Establish protection criteria for the delineated zones and their groundwater paths.
5. Define and harness enforcement programs required by the Florida Antidegradation Policy.
6. Define and implement water quality restoration programs for the OFW.
7. Develop a dollar/value function model and a Water Budget for Citrus County to assist in framing public interest decisions affecting the OFW.
8. A key issue for elevating any ERP process to federal level would appear to rest upon determination of linkage between threatened wetlands and the OFW surface water body of Crystal River/Kings Bay by way of the southeast-northwest trending tributary.

Notes

The preemption or supremacy doctrine derives from the Supremacy Clause of the Constitution (Article VI) which states that the "Constitution and the laws of the United States... shall be the supreme law of the land... anything in the constitutions or laws of any State to the contrary notwithstanding." This means that any federal law and even a regulation of a federal agency trumps any conflicting state law. However, the application of this principle is not always easy as many issues arise which are considered implied and not expressly stated in the language of any given rule of law.

Furthermore, Section 307 of the Coastal Zone Management Act, 1972, (CZMA) contains the Federal consistency requirements, which apply to federal activities, development projects, permits and licenses, and support to state and local governments. In the CZMA, Congress created a federal and state partnership for management of coastal resources, codified in the state's coastal management program. The processes established, to ensure compliance with the state's federally approved coastal management program, is called a consistency determination for federal activities and development projects and a consistency certification for federal permits and licenses and federal support to state and local agencies.

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Attachment E

E-Mail to Norman Hopkins from Doug Leeper, dated February 11, 2011

From: Doug Leeper
To: "norman@amyhrf.org"
Cc: "norman@amyhremleyfoundation.org"
Bcc: Marty Kelly; Ron Basso; Xinjian Chen; Cara S. Martin; Karen Lloyd; Yassert Gonzalez; Roberta Starks; Jay Yingling
Subject: Info Request Regarding Kings Bay/Crystal River System MFLs
Date: Friday, February 11, 2011 2:28:32 PM

Mr. Hopkins:

It was a pleasure to speak with you this past Wednesday regarding development of minimum flows for the Kings Bay/Crystal River system.

With regard your request concerning information on the depth of the freshwater lens underlying Citrus County, I spoke with Ron Basso, a Senior Professional Geologist/Engineer with the District and he suggested that I refer you to one of the many web-based discussions of the Ghyben-Herzberg relation. This relationship or ratio implies that for each foot that the potentiometric surface of an unconfined aquifer is above sea level, there will be 40 feet of freshwater below sea level in the underlying aquifer.

The link below (supplied by Ron) points to a Wikipedia page on Saltwater Intrusion that includes a discussion of the Ghyben-Herzbergrelation.

http://en.wikipedia.org/wiki/Saltwater_intrusion

Maps at the links below, which show recent elevations for the potentiometric surface of the Upper Floridan aquifer in west-central Florida can be used with the Gyhben-Herzberg relation to gain an understanding of the approximate thickness of the freshwater lens in Citrus County and nearby areas.

a) Link to a map of the potentiometric surface of the Upper Floridan aquifer, west-central Florida, September 2008, by A.G. Ortiz
http://pubs.usgs.gov/sim/3071/pdf/sim-3071.pdf

b) Link to a map of the potentiometric surface of the Upper Floridan aquifer, west-central Florida, May 2009, by A.G. Ortiz
http://pubs.usgs.gov/sim/3093/pdf/sim-3093.pdf

I'm not currently able to provide you with much information that addresses your question concerning published studies of relationships between rainfall and salinity and Kings Bay and water discharged from springs located in the bay. A 2009 report by Copeland and others (Bulletin No. 69 of the Florida Geological Survey) contains some information on water chemistry of Hunters Spring and Catfish Spring for the period from 1991 through 2003. Data for these and the other springs discussed in the report are also evaluated for the period from 1998 through 2003 (identified as , "Sequence C" in the report), a period that included an extended drought. Here's a link to Bulletin 69, which is titled, "Regional and Statewide Trends in Florida's Spring and Well Groundwater Quality (1991-

2003)":

http://publicfiles.dep.state.fl.us/FGS/FGS_Publications/B/B69MainReport/Bulletin%2069%20Color.pdf

While searching for the link listed above for Bulletin 69, I found two additional links that should be of use to reader of the bulletin. The first link points to a document containing "Errata" for the bulletin that was posted on a Florida Department of Environmental Protection web page. The second link points to a web page of the University of Florida George A. Smathers Library that indicates a revised version of the bulletin is scheduled for publication in the spring of 2011.

http://publicfiles.dep.state.fl.us/FGS/FGS_Publications/B/.../B69Errata.docx

http://ufdc.ufl.edu/UF00095137/00002

With regard to Kings Bay salinity and rainfall, I would also direct your attention to a recent report that was prepared for the District by HydroGeologic, Inc. The 2010 report, titled "Groundwater Flow and Transport Model for the Northern District Water Resources Assessment Project Area, Version 2.0" includes information on predicted saltwater intrusion for scenarios associated with groundwater withdrawal rates that occurred in 2005, groundwater withdrawal rates that may be expected for the year 2025 and for a scenario that represent severe drought conditions. The electronic version of this report is too large to distribute as an attachment to this e-mail, so I've placed a copy of the report on the District's FTP site for you to retrieve. The file, which is named "HydroGeo2010" can be retrieved from the "pub/outgoing" folder on the FTP site by following the directions on the "How to Access our Anonymous FTP Server" page of the District web site at the following link:

http://www.swfwmd.state.fl.us/data/ftp/

Please let me know if you have any problems obtaining the file posted on our FTP site or have additional questions or comments regarding the information outlined in this e-mail. I look forward to continued communications with you regarding development of minimum flows for the Crystal River/Kings Bay system.

Douglas A. Leeper, Chief Environmental Scientist
Resource Projects Department, Southwest Florida Water Management District
2379 Broad Street, Brooksville, FL 34604-6899
Telephone: 1-800-423-1476, ext. 4272 (FL only) or 352-796-7211, ext. 4272
Fax: 352-754-6885
E-Mail: doug.leeper@watermatters.org
Web Site: watermatters.org

Attachment F

E-Mail From Norman Hopkins from Doug Leeper, dated May 19, 2011

From: Norman Hopkins
To: Doug Leeper
Subject: Re: Follow-Up to Recent Call Concerning Crystal River/Kings Bay MFLs
Date: Thursday, May 19, 2011 3:25:13 PM

Thank you for your e-mail which is appreciated. I will review your comments in red to the document just as soon as I am able. Meanwhile in regard to Klein it was he (not me) who asserted that elimination of potable water in his 1975 report was due to pumping.

Kind regards, Norman

On 5/19/2011 3:08 PM, Doug Leeper wrote:

(Note: remainder of e-mail not reproduced here)

May 25, 2011

MEMORANDUM

TO: File

FROM: Douglas A. Leeper, Chief Environmental Scientist, Ecologic Evaluation Section, Southwest Florida Water Management District

SUBJECT: Correspondence between Norman Hopkins and Doug Leeper regarding minimum flows for the Crystal River/Kings Bay system

---

This memorandum documents correspondence between Norman Hopkins and Doug Leeper regarding development of minimum flows for the Crystal River/Kings Bay system. Electronic mails are attached.

DAL

Attachments: A – E-mail from Norman Hopkins to Doug Leeper, dated May 24, 2011
B – E-mail from Doug Leeper to Norman Hopkins, dated May 25, 2011

Attachment A

E-mail from Norman Hopkins to Doug Leeper, dated May 24, 2011

From: Norman Hopkins
To: Doug Leeper
Subject: MFL
Date: Tuesday, May 24, 2011 8:13:20 AM

Doug,

I have read your comments upon the downloaded document from our website and clarify as follows:

- Causseaux and Fretwell reported in two papers in 1983; I have copies and have read them.
- I appreciate Figure 3 is a snapshot. However it requires knowledge of local observations over the years which I will address for you separately. I refer to Figure 3 as locally illustrating one case in point.
- FGS input from their Bulletin 68 was communicated to the CHWRC-Task Force in the presence of TAG members on 14 March, 2011. FGS by their e-mail of 2/25/2011, had qualified the Klein report which had been supplied to us by UF in a sufficiently high resolution which was not available to us from elsewhere.
- Please give citation to your suggestion noted on our Page 27 that "Regional groundwater basin may be sub-divided into several groundwater basins".
- I will address separately my reference to tipping point which applies not only to the fresh water of the lens but to other factors affected by changes in saltiness.
- How sure are you that all withdrawals both current and potential are accurately recorded in the data you use in the models ?
- What are the parameters used in calculating the percentages quoted at the meeting on May 9th and also quoted in your e-mail?
- We have no knowledge of the HydroGeoLogic, Inc., 2008, modeling.
- Please note that I have been a stakeholder to these waters for almost seventeen years and have actively pursued research of science documentation at the District's invitation for more than twelve years and published results to the Foundation website since 2007. I represented a local stakeholder group at an early Stakeholders Conference .
- I note your words: "as appropriate forums for discussion of the technical issues that you've raised "; and, "could be used to approximate the thickness of the freshwater lens in Citrus County and nearby areas"; and, "Ron emphasizes that District staff recognizes the reason for concern over increasing salinity in the groundwater system of the Springs Coast area."

I hope this helps. I assume that I shall be allocated time to present results of our work at the June 8th workshop meeting. Meanwhile I will write again as soon I am able..

Sincerely , Norman Hopkins

Attachment B

E-mail from Doug Leeper to Norman Hopkins, dated May 25, 2011

Note: original e-mail from Norman Hopkins (see Attachment A) deleted from this e-mail

From: Doug Leeper
To: "Norman Hopkins"
Bcc: Marty Kelly; Sid Flannery; Mike Heyl; Xinjian Chen; Ron Basso; Mark Barcelo; Cara S. Martin; Veronica Craw; Gary E. Williams; Chris Zajac; Amy K. Harroun; Darcy A. Brune; Robyn O. Felix
Subject: Response to Requests-Questions-Comments on MFLs
Date: Wednesday, May 25, 2011 8:21:26 AM

Norman:

Seems that my recent e-mail to you has been helpful, based on the points included in your May 24th e-mail. Here are responses, prepared with assistance from Ron Basso, to the requests, questions and some of the comments included in your e-mail.

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Your request: *Please give citation to your suggestion noted on our Page 27 that "Regional groundwater basin may be sub-divided into several groundwater basins".*
Response: My suggestion was based on information presented by Lari. A., Knochenmus and Dann K. Yobbi, in the 2001 United States Geological Survey Water-Resources Investigations Report 01-4230, titled "Hydrology of the Coastal Springs Ground-Water Basin and Adjacent Parts of Pasco, Hernando, and Citrus Counties, Florida".

Your question: *How sure are you that all withdrawals both current and potential are accurately recorded in the data you use in the models ?*
Response: The District has a high level of confidence in the metered and estimated water use values used for evaluating effects of withdrawals on groundwater levels and discharge to springdominated rivers in the Northern District Model domain. Approximately 80 percent of water use is metered in Citrus and Hernando Counties. For water-use permitted wells, which account for 95 percent of water use in our Northern District model, locations are accurate and most locations are recorded using a Global Positioning System (GPS). Well construction information is required to be supplied to the District from the permit holder or the well construction contractor if it is a proposed well. This construction information, well diameter, casing depth, and total depth are the basis to assign the well withdrawal into the appropriate geologic layer in the computer-based flow model. Incidentally, a single well will often withdraw water from multiple layers within the model. Water use is estimated for household domestic and lawn irrigation wells based on county population not served by public supply and an average per capita use rate from public supply water use. This allows us to estimate total water use for domestic self-supply for each county. We then simply divide this total water use by the number of domestic wells in the county to get a water use per well quantity in the model. Water use estimated from domestic wells accounts for five percent of total groundwater withdrawn in the model.

We obviously have less confidence in projected withdrawal rates, but they are based on University of Florida's medium population projections by County, the assumption that groundwater will continue to be the primary water-supply for the region, and that conservation and other demandreducing activities will continue at their current levels. Development of alternative supplies, increased effectiveness of conservation efforts or slower than expected population growth would,

understandably, lead to reduced future demand. Modeling of future withdrawal scenarios is based on the assumption that future water demand will be met through water withdrawals at existing well locations since it is generally unknown where wells will be drilled over the next 20 years. Development of new withdrawal locations within the model domain has, however, also been investigated for proposed wellfields that have been identified in the Withlacoochee Regional Water Supply Authority water supply plan.

Your question: *What are the parameters used in calculating the percentages quoted at the meeting on May 9th and also quoted in your e-mail?*
Response: The predicted approximate one percent flow reduction associated with groundwater withdrawals for calendar year 2005 is based on the difference in simulated springflow between non-pumping and 2005 conditions. In 2005, approximately 438 million gallons per day (mgd) of groundwater withdrawals occurred in the Northern District model domain.

Your comment: *We have no knowledge of the HydroGeoLogic, Inc., 2008, modeling.*
Response: I can appreciate your comment, based on review of the e-mail I sent to you this past February 11th. In that e-mail, I noted that I had posted an electronic version of a 2010 report by HydroGeoLogic, Inc. to our FTP site for your to retrieve. The file was apparently too large to send as an e-mail attachment, hence the need for distribution of the document via FTP. Hopefully you were able to download the 2010 document, which I should note is a follow-up to a 2008 report by HydroGeoLogic, Inc. Their earlier report addresses the initial development and use of the Northern District Model, which was subsequently revised and used for the work outlined in the 2010 report. To ensure that you have access to both the 2008 and 2010 HydroGeoLogic reports, I have posted a new zipped file containing the two documents on the District FTP site. The file is named **HGL_2008_10.ZIP** and is stored in the public-outgoing folder on the FTP site. A direct link to that folder is listed below.

http://ftp.swfwmd.state.fl.us/pub/out/

You should be able to save the file directly from this folder to your computer. If you have trouble retrieving the file, please contact me or direct your browser to the "How to Access our Anonymous FTP Server" page of the District web site at the link below.

http://www.swfwmd.state.fl.us/data/ftp/

Your comment: *I assume that I shall be allocated time to present results of our work at the June8th workshop meeting.*
Response: Our current plan for the first Springs Coast Minimum Flows Public Workshop on June 8th involves identification of the goals for the workshop, a general discussion of the minimum flows and levels process, a status update on minimum flows development for spring-dominated tidal river systems of the Springs Coast, and identification of topics to be addressed at future workshops. We assume that there will be a great deal of input from both invited representatives and others regarding topics to be addressed at future workshops, and do not expect to devote a substantial amount of time to discussion of any single topic or topics.
<><><><><><><><><><><><><><><>

Thanks again for your interest in the development of minimum flows for the Crystal River/Kings Bay system.

Douglas A. Leeper, Chief Environmental Scientist
Resource Projects Department, Southwest Florida Water Management District
2379 Broad Street, Brooksville, FL 34604-6899
Telephone: 1-800-423-1476, ext. 4272 (FL only) or 352-796-7211, ext. 4272
Fax: 352-754-6885
E-Mail: doug.leeper@watermatters.org
Web Site: watermatters.org

From:	Doug Leeper
To:	"ckeller@wetlandsolutionsinc.com"
Cc:	Gary E. Williams; Xinjian Chen; Veronica Craw; Marty Kelly
Subject:	MFLs Hydrologic Data Request for Kings Bay
Date:	Thursday, June 30, 2011 9:53:00 AM

Hi Chris:

I've pulled together a number of files relevant to your recent request for hydrologic data that has been compiled for our ongoing minimum flows and levels work on Kings Bay. The files include 15-minute and daily data from the USGS, a report (and associated data) on spring discharge in Kings Bay that was prepared for the District by Vannesse Hangen Brustlin, Inc., a USGS report by Yobbi and Knochenmus (and a data file that I compiled based on information presented in Yobbi and Knochenmus) and a few files related to *preliminary* estimation of spring discharge into Kings Bay based on District use of a regional groundwater model.

The files have been loaded onto a CD that I will drop in the mail today.

Douglas A. Leeper, Chief Environmental Scientist
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Web Site: watermatters.org

June 27, 2011

MEMORANDUM

TO: File

FROM: Douglas A. Leeper, Chief Environmental Scientist, Ecologic Evaluation Section, Southwest Florida Water Management District

SUBJECT: Documentation of a June 27, 2011 telephone conversation with Norman Hopkins regarding minimum flows development for Crystal River/Kings Bay

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This memorandum documents a June 27, 2011 telephone conversation between Mr. Norman Hopkins, with the Amy. H. Remley Foundation, and Mr. Doug Leeper, with the Southwest Florida Water Management District, concerning development of minimum flows for the Crystal River/Kings Bay system. A log of the conversation is provided below.

Phone Log

Who called: Mr. Norman Hopkins
Staff contact: Doug Leeper, Ecologic Evaluation Section, SWFWMD
Issue: Water Quality Event in Crystal River/Kings Bay
Date: June 27, 2011

Notes/Items Discussed:

1. Mr. Hopkins indicated that Mr. Ron Miller, with the Save the Homosassa River Alliance, had recently forwarded an e-mail to him regarding a fissure in the main Homosassa Springs pool. The e-mail included correspondences between District staff and staff from the Florida Department of Environmental Protection, and was sent to Mr. Miller and others by me on June 24, 2011 as a follow-up to previous correspondence associated with a water-quality event that occurred at Homosassa Springs in March 2011. The March 2011 event included the discharge and suspension of an orange-brown material in the main spring pool and run. Mr. Hopkins noted that a similar event had occurred previously in the Black Springs area of Kings Bay. He noted that the event in Black Springs cove coincided with construction activities at a property near the bay which is located "on the line of fractures sets that feeds Black Springs." He noted that the suspended material discharged from the spring vents was cleared from the water column within about four days, and circulated from Black Springs cove to the east and was deposited near the Kings Bay shoreline. Based on this occurrence, he suggested that the photograph of a potentially new fissure in the Homosassa Springs pool that was provided by Mr. Art Yerian, the Park Manager at Ellie Schiller Homosassa Springs Wildlife State Park, and which was attached to the e-mail that I sent on June 24, was likely not a new fissure, but that the water quality event that occurred in the Homosassa system was probably associated with an anthropogenic or potentially naturally disturbance in the springshed.

2. Mr. Hopkins also noted that during the No-Name storm of 1993, approximately 14 to 18 inches of sediment was deposited in the spring vents in Black Springs cove. This sediment was eliminated from the spring/cove area after about 12 years, through natural spring flow and tidal action. He further noted

that a berm of “shale” near the cove outlet/inlet was trammeled during the recent past as a result of actions by one of his neighbors.

3. Mr. Hopkins noted that the volume of water flowing from springs in Kings Bay during the 1970s, 1980s and 1990s averaged 630 million gallons per day. In contrast, he noted that recent measurements of spring discharge reported in a report by Vanesse Hangen Brustlin, Inc. total about 410 million gallons per day. He noted that comparison of these data “indicates that the flow rate has declined by one third in 15 or 16 years.”

4. Mr. Hopkins noted that in 2003 or 2004 he presented information to the Citrus-Hernando Waterways Restoration Council indicating that eighty percent of the spring vents in the western portion of Kings Bay had been blocked to some degree. He noted that this information was based on personal observations and discussions with other local parties. The blockages were attributable to anthropogenic actions and natural deposition processes occurring during the No-Name storm and Hurricane (or tropical storm) Josephine. Mr. Hopkins noted that he was providing this information to support his assertion that groundwater discharge into Kings Bay has declined. He further suggested that coupled with available water quality information, this information concerning spring vent blockages lends credence to Rick Copeland’s assertion in a circular published by the Florida Geological Survey, that degradation of water quality is correlated with reductions in spring flow.

5. Mr. Hopkins noted that circulation patterns in Kings Bay are quite complex. He described numerous changes in flow patterns and erosion that have occurred in the Black Springs cove area, attributing these changes to storm activities, reduced spring discharge and relocation of a now derelict, floating dock.

6. Mr. Hopkins noted that he had seen a recent article on flow decreased in springs associated with the Suwannee River system, and wondered whether I was aware of the article and accompanying photographs. I noted that I had seen the article, which appeared in the St. Petersburg Times on June 26, 2011.

7. Contact information.
   e-mail: norman@amyhrf.org
   Phone: 352-795-9517

Southwest Florida Water Management District
2379 Broad Street, Brooksville, Florida 34604-6899
(352) 796-7211 or 1-800-423-1476 (FL only)
TDD only 1-800-231-6103 (FL only)
On the Internet at: WaterMatters.org

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MEETING NOTICE

Springs Coast Minimum Flows and Levels Public Workshop Agenda

Wednesday, June 8, 2011
2:00 p.m

Lecanto Government Building
3600 West Sovereign Path, Room 166
Lecanto, Florida 34461

*******All workshops are open to the public*******

SWFWMD – Southwest Florida Water Management District

1. Workshop Initiation and Staff Introductions, Doug Leeper and other Staff (SWFWMD) ***(5 minutes)***

2. Introductory Presentation, Doug Leeper (SWFWMD) ***(15 minutes)***
   a. Purpose and Goals for the Workshop Series
   b. Minimum Flows and Levels Overview
   c. Status of Minimum Flows and Levels Development on the Springs Coast

4. Format for the Workshop Series, Doug Leeper (SWFWMD) and Stakeholder Representatives ***(10 minutes)***

5. Potential Workshop Topics, Doug Leeper (SWFWMD) and Stakeholder Representatives ***(30 minutes)***

6. Public Input ***(3 minutes per individual)***

7. Scheduling of Next Workshop and Identification of Topics ***(5 minutes)***

8. Adjournment

If you have any questions concerning this meeting, please call 1-352-796-7211 or 1-800-423-1476 (Florida only), extension 4272.

Springs Coast Minimum Flows and Levels Public Workshop

Lecanto Government Services Building
3600 West Sovereign Path, Room 166
Lecanto, Florida 34462

June 8, 2011

Workshop Outline

- Purpose and goals for the workshop series
- Minimum flows and levels (MFLs) overview
- Status of MFLs development on the Springs Coast
- Format for the workshop series
- Potential workshop discussion topics
- Public input
- What's next

Purpose and Goals for the Workshop Series



Purpose and Goals

- Discuss existing data and methods that have been used or will be used to establish minimum flows for the Chassahowitzka, Crystal, Homosassa and Weeki Wachee River systems
- Discuss and identify additional data and/or methods that could be used to evaluate or reevaluate minimum flows for the systems
- Support decisions regarding timelines for adoption or reevaluation of minimum flows for the systems

Identified Issues

- Sea level rise
- Discharge measurement and reporting
- Groundwater and withdrawal impacts modeling
- Significant harm
- Modeling of salinity-based habitats
- Modeling of thermal refuges for manatees
- Modeling biological responses to flow changes
- Water quality issues

Minimum Flows and Levels Overview



Florida Statutes, Section 373.042

- Minimum Flows and Levels -

The **minimum flow** for a given watercourse shall be the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area.

The **minimum water level** shall be the level of groundwater in an aquifer and the level of surface water at which further withdrawals would be significantly harmful to the water resources of the area.

Florida Administrative Code, Chapter 62-40.473

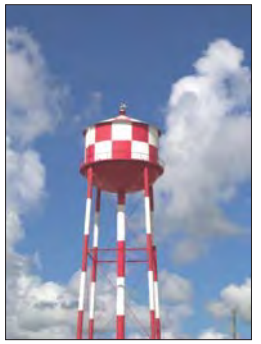
- Minimum Flows and Levels -

...consideration shall be given natural seasonal fluctuations in water flows or levels, nonconsumptive uses, and environmental values associated with coastal, estuarine, riverine, spring, aquatic, and wetland ecology, including:

(a) Recreation in and on the water;
(b) Fish and wildlife habitats and the passage of fish;
(c) Estuarine resources;
(d) Transfer of detrital material;
(e) Maintenance of freshwater storage and supply;
(f) Aesthetic and scenic attributes;
(g) Filtration and absorption of nutrients and other pollutants;
(h) Sediment loads;
(i) Water quality; and
(j) Navigation.

Regulatory Use of Minimum Flows and Levels

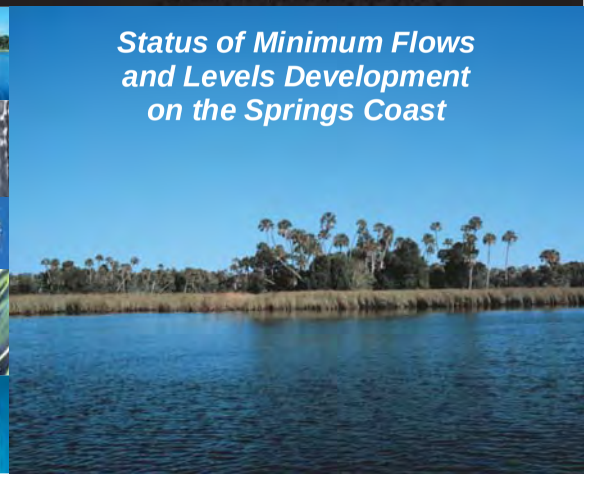
- Water Resource Planning
- Water-Use Permitting
- Environmental Resource Permitting



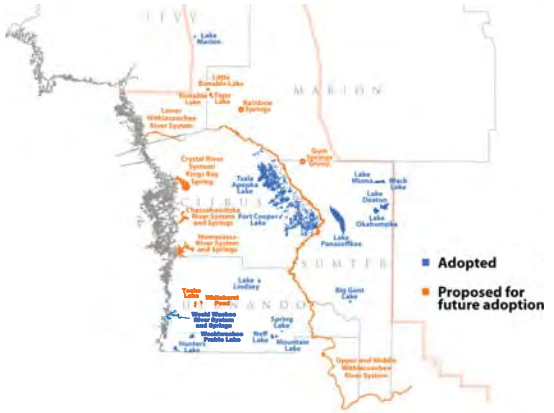
Process for Establishing Minimum Flows and Levels

- Priority List and Schedule developed and updated annually
- Methods, flows or levels developed and peer-reviewed
- Workshops held for public input
- Recovery or prevention strategies developed, as necessary
- Governing Board adopts minimum flows and levels into Chapter 40D-8, Florida Administrative Code
- Necessary recovery strategies included in Regional Water Supply Plan and in some cases adopted into Chapter 40D-80, Florida Administrative Code

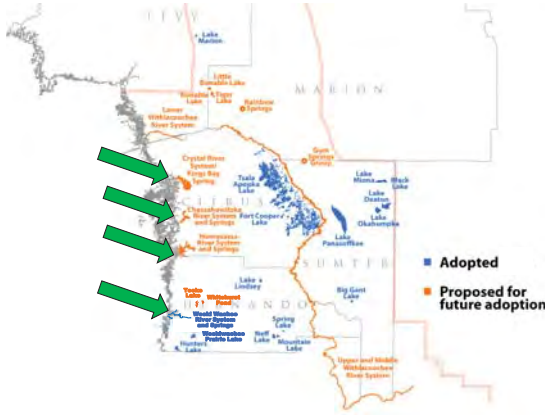
Status of Minimum Flows and Levels Development on the Springs Coast



Regional Minimum Flows and Levels

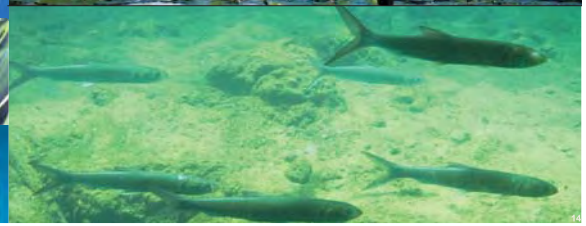


Focus for the Workshop Series



Workshop Format





Typical Workshop Agenda

- Review of previous workshop discussions
- Discussion of specific topics by District staff and stakeholder representatives
- Public input
- Identification of topics to be discussed at subsequent workshops

Potential Timeline

- First workshop – June 2011
- Additional monthly workshops
- Staff evaluation and recommendation(s) based on workshops – Fall/Winter 2011

Information Exchange

- Web site
  - Dedicated workshop web page at: ***www.WaterMatters.org/SpringsCoastMFL*** or ***www.swfwmd.state.fl.us/projects/mfl/springs-coast-mfl.php***
  - Link to the page is listed under "Most Recent Web Sites" on the District's main page at: ***www.WaterMatters.org***
  - Related information posted on the existing minimum flows and levels page at: ***www.swfwmd.state.fl.us/projects/mfl/***
- Electronic mail
  - Doug Leeper's address: ***doug.leeper@watermatters.org***
  - Your address: please provide ***your e-mail address*** for workshop noticing and other correspondence

Potential Workshop Discussion Topics



Identified Topics

- Sea level rise
- Discharge measurement and reporting
- Groundwater and withdrawal impacts modeling
- Significant harm
- Modeling of salinity-based habitats
- Modeling of thermal refuges for manatees
- Modeling biological responses to flow changes
- Water quality issues

Mean Sea Level Trend

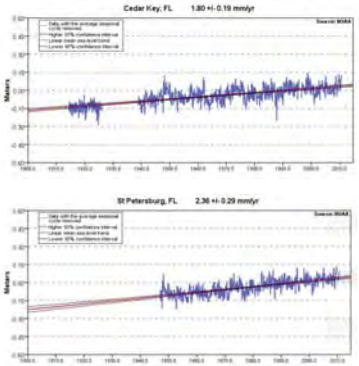
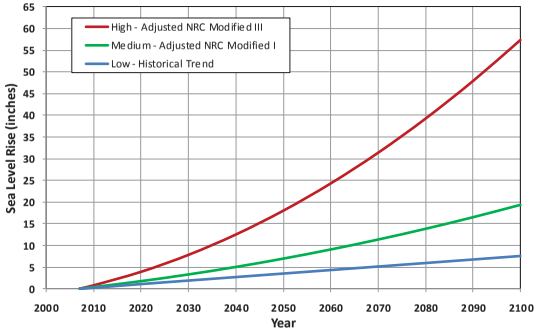


Image source: Mean Sea Level Trends for Stations in Florida page of the National Oceanic and Atmospheric Administration Tides and Currents web site at http://tidesandcurrents.noaa.gov/sltrends/sltrends_states.shtml?region=fl/

Sea Level Rise Projections Relative to 2007 Conditions



Based on U.S. Army Corps of Engineers method outlined in Circular No. 1165-2-211



Stakeholder Representatives Discussion of Potential Workshop Topics



Public Input on Workshop Topics

What's Next

- Next workshop date/location
- Topic(s) to be discussed – *to be determined*
- Information to be posted on the web site
- Workshop agenda and announcement to be distributed by e-mail



Contact Information

Name: Douglas A. Leeper

Title: Chief Environmental Scientist

Mail: Southwest Florida Water Mgmt. District
2379 Broad St.
Brooksville, FL 34604-6899

Phone: 1-800-423-1476 or 352-796-7211
Extension 4272

E-Mail: doug.leeper@watermatters.org

Web Site: watermatters.org or
http://www.swfwmd.state.fl.us/

From:	Helen Spivey
To:	Doug Leeper
Cc:	Pat Rose (office); Katie Tripp
Subject:	Question on salt water intrusion and spring flows
Date:	Wednesday, July 13, 2011 5:07:01 PM

Hi Doug:
Sorry it has taken me awhile to put this question to e-mail, but have been working on what I don't understand to ask you so you all can give me an answer.

In the first place I heard a number of years ago and saw, but do not have the report, that one of the 2 spring vents flowing into the Fishbowl at Homosassa Springs Ellie Schiller State Wildlife Park was pumping salt water.

Secondly, I keep hearing about salt water intruding into Kings Bay, Crystal River, and I know of pilings and boats getting barnacles they have never had before. Some are attributing this to the drought years we have had. Others say it is the sea level rise. Some are saying it is both. And some say if we live like good citizens the sea level rise may halt. And if Mother Nature starts to curb our drought period we will be back to a natural system with the exception of how much freshwater is being mechanically pumped from the ground.

Now I am wondering, if pumping groundwater from cities, counties, agriculture, power plants, etc., could be allowing salt water from the wedge to also come up with the spring flow?

Is the freshwater column that's floating over the salt water wedge being reduced enough by inland groundwater pumping to allow some of the salt water wedge to come up in the springs with the freshwater?

If it is, can and will this be tolerated by Water Management?

Is the spring flow being tested for salt water content? And is any salt water showing up with the freshwater? And if so how much?

I have a definite interest in this because I have been working on a plan to utilize certain plants known to clear nutrients from waters like treated sewerage to experiment with them in Kings Bay. If the water system I want to clear is receiving salt water from the spring flow and people pumping is allowed to increase, (which is still the practice here as development needs more potable water,) then will the vegetation I want to use become ineffective because it is not "that" salt tolerant?

And if the salt water is happening with freshwater spring flow, will the temperature of the springs become colder? And if so how much colder? I am of course looking here at the warm water sanctuaries USFWS sets aside for manatees in the cold winter. Have been trying to get this answered for over 7 years.

Thanks very much for considering these and looking forward to the answers. See

you Monday.

Regards,
Helen Spivey

From: Michael G. Czerwinski
To: Doug Leeper
Subject: Kings Bay / Crystal River
Date: Thursday, August 11, 2011 9:52:51 AM

Doug,
This e mail is a follow-up to our phone conversation. I have been tasked by the city of Crystal River to pull together pertinent reports and summaries that might assist with permitting a pilot restoration project on Kings Bay. In that effort I am familiar with, have in house copies and have reviewed numerous studies, but suspect that this is not a complete listing. Therefore, I am beginning my task by attempting to first pull together an annotated bibliography of studies/reports on Kings Bay or Crystal River. I would then review this listing to determine where I need to supplement our library and obtain additional reports for review. It is anticipated that I will then compile pertinent maps, summarize pertinent reports etc and provide these to permitting agencies during "pre application conferences" and in the future to use within a decision matrix to assist with ranking proposed pilot areas (one or two criteria that would imply, for example good historical water quality or quality data, vegetative mapping, sediment cores etc).

It is my understanding that you have a annotated bibliography and will be sending it to me shortly. Please also include if possible, "in press" or on-going, or unpublished" reports where your MFL teams may be gathering data or producing reports. Thanks I will also touch base with Gary Williams.

Michael G. Czerwinski, P.A.
ENVIRONMENTAL CONSULTANTS MGC
Michael G. Czerwinski, P.G., P.W.S.
Senior Scientist, President
2716 South Lecanto Hwy
Lecanto, Florida 34461
Phone: (352) 249-1012 ext. 301
Toll Free: (877) 249-1012
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From: Marty Kelly
To: Helen Spivey
Cc: Ron Basso; Doug Leeper; Kevin J Grimsley
Subject: RE: Question on salt water intrusion and spring flows
Date: Thursday, July 14, 2011 10:47:23 AM

Helen,

Always a pleasure hearing from you. I think this can be addressed at least in part by Ron Basso's presentation on Monday. In the mean time, we are actually looking into the sea-level rise issue in more detail particularly in Chass and Homosassa; however, since we're building the estuarine model on Crystal River in-house, we will be looking into this also. I will need to follow up on the extent to which salinity is actually being measured coming out of spring vents. Our recorders on the river measure salinity, but this is not the same as measuring it at the spring vents themselves.

I will see you on Monday, and we will get your questions answered as best we can.

Marty

From: Helen Spivey [mailto:manatees2@gmail.com] **On Behalf Of** Helen Spivey
Sent: Wednesday, July 13, 2011 7:46 PM
To: Marty Kelly
Subject: Fw: Question on salt water intrusion and spring flows

Doug knew I was going to ask the tough questions so he left town. LOL He said to send stuff on and you were the one I knew.
Helen

-------Original Message-------

From: Helen Spivey
Date: 7/13/2011 5:07:40 PM
To: Doug.Leeper@swfwmd.state.fl.us
Cc: Pat Rose (office); Katie Tripp
Subject: Question on salt water intrusion and spring flows

Hi Doug:
Sorry it has taken me awhile to put this question to e-mail, but have been working on what I don't understand to ask you so you all can give me an answer.

In the first place I heard a number of years ago and saw, but do not have the report, that one of the 2 spring vents flowing into the Fishbowl at Homosassa Springs Ellie

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Thanks very much for considering these and looking forward to the answers. See you Monday.

Regards,
Helen Spivey

From:	Doug Leeper
To:	"Michael G. Czerwinski"
Cc:	Gary E. Williams; Marty Kelly
Subject:	RE: Kings Bay / Crystal River
Date:	Thursday, August 11, 2011 11:28:56 AM
Attachments:	Frazer et al. 2010 - Compilation..Crystal River...Task 1.pdf Kings-Crystal Doc Listings for MCerwinsksi 11aug2011.pdf

Mike:
Attached are two PDF files per our phone conversation this morning. First is the literature summary on Crystal River by Frazer et al. Second contains listings for Kings Bay/Crystal River documents stored in my data files and listings from the SWFWMD library (search words: Kings Bay, Crystal River).

Hope this helps.

Douglas A. Leeper, Chief Environmental Scientist
Resource Projects Department, Southwest Florida Water Management District
2379 Broad Street, Brooksville, FL 34604-6899
Telephone: 1-800-423-1476, ext. 4272 (FL only) or 352-796-7211, ext. 4272
Fax: 352-754-6885
E-Mail: doug.leeper@watermatters.org
Web Site: watermatters.org

From: Michael G. Czerwinski [mailto:mczerwinski@mgcenvironmental.com]
Sent: Thursday, August 11, 2011 9:42 AM
To: Doug Leeper
Subject: Kings Bay / Crystal River

Doug,
This e mail is a follow-up to our phone conversation. I have been tasked by the city of Crystal River to pull together pertinent reports and summaries that might assist with permitting a pilot restoration project on Kings Bay. In that effort I am familiar with, have in house copies and have reviewed numerous studies, but suspect that this is not a complete listing. Therefore, I am beginning my task by attempting to first pull together an annotated bibliography of studies/reports on Kings Bay or Crystal River. I would then review this listing to determine where I need to supplement our library and obtain additional reports for review. It is anticipated that I will then compile pertinent maps, summarize pertinent reports etc and provide these to permitting agencies during "pre application conferences" and in the future to use within a decision matrix to assist with ranking proposed pilot areas (one or two criteria that would imply, for example good historical water quality or quality data, vegetative mapping, sediment cores etc).

It is my understanding that you have a annotated bibliography and will be sending it to me shortly. Please also include if possible, "in press" or on-going, or unpublished" reports where your MFL teams may be gathering data or producing reports. Thanks I will also touch base with Gary Williams.

Michael G. Czerwinski, P.A.

ENVIRONMENTAL CONSULTANTS *MGC*



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August 8, 2011

MEMORANDUM

TO: File

FROM: Douglas A. Leeper, Chief Environmental Scientist, Ecologic Evaluation Section, Southwest Florida Water Management District

SUBJECT: Documentation of an August 8, 2011 telephone conversation with Norman Hopkins regarding minimum flows development for Crystal River/Kings Bay and the Springs Coast Minimum Flows and Levels Public Workshop series.

This memorandum documents an August 8, 2011 telephone conversation between Mr. Norman Hopkins, with the Amy. H. Remley Foundation, and Mr. Doug Leeper, with the Southwest Florida Water Management District, concerning development of minimum flows for the Crystal River/Kings Bay system and the Springs Coast Minimum Flows and Levels Public Workshop series. A log of the conversation is provided below.

Phone Log

Who called: Mr. Norman Hopkins
Staff contact: Doug Leeper, Ecologic Evaluation Section, Southwest Florida Water Management District
Issues: Minimum flows development for Kings Bay/Crystal River and the Springs Coast Minimum Flows and Levels Public Workshop series
Date: August 8, 2011

Notes/Items Discussed:

1. Mr. Hopkins indicated that he would be interested in making a presentation at the next Springs Coast Minimum Flows and Levels Public Workshop, but noted that it will be difficult to provide a meaningful presentation within a five minute period. Mr. Leeper and Mr. Hopkins discussed presentation scheduling for the workshop and noted that it is expected that short (5 to 10 minute) presentations by stakeholder representatives may be expected to stimulate discussion among the stakeholder representatives panel that may last longer than five minutes.

2. Mr. Hopkins expressed concern that the application of the Northern District Model for minimum flows analyses described by Mr. Ron Basso for during the July 18, 2011 Springs Coast Minimum Flows and Levels Public workshop does not include or account for dissolved nitrogen concentrations. He also noted that it is imperative to attempt to integrate findings from various modeling approaches when developing minimum flows. Mr. Leeper noted that the Northern District Model is a groundwater flow model that may be used to evaluate the effects of water withdrawals on spring/river discharge. He further noted that the District has and may continue to develop and use a variety of additional models to support minimum flows development, and indicated that results from all of these analyses are considered when developing minimum flow recommendations. Modeling approaches used in the past have included use of hydrodynamic models for evaluating salinity, thermal characteristics and

water/particle residence times for riverine systems, use of regression models for evaluating river salinity characteristics and use of regression models for evaluating population level responses of biota to potential flow reductions.

2. Mr. Hopkins noted that a formal process should be developed to ensure minimum flows and levels should somehow be used to inform or guide political decisions concerning land use and development. He further noted that it is imperative that the District better engage the public with regard to minimum flows development and enhancement of behaviors that may be expected to improved area water quality and ensure availability of water resources. Mr. Leeper noted that the ongoing Spring workshop series is one means for enhancing communication between the District and interested parties, including those involved in political decision-making processes.

3. Mr. Hopkins noted that published literature is available which identifies associations between increased nitrogen concentrations and environmental degradation, and strongly requests that evaluation of nitrogenous compounds and their relationship to spring discharge be considered in the development of minimum flow recommendations for Kings Bay. Mr. Leeper indicated that staff will evaluate all appropriate water quality parameters when developing minimum flow recommendations for the Crystal River/Kings Bay system.

4. Mr. Hopkins noted that is important to "strike a balance" or maintain a natural balance between plant and microbial competition for scarce nutrient resources in places like Kings Bay.

5. Contact information.
e-mail: norman@amyhrf.org
Phone: 352-795-9517

From:	Alan Martyn Johnson
To:	Doug Leeper; R Rodriguez
Cc:	J Weaver; Marty Kelly; Dana Bryan; Al Grubman; Ron Miller; Brad Rimbey; Brent Whitley; Norman Hopkins
Subject:	Crystal River Spring Discharge
Date:	Tuesday, September 27, 2011 9:48:02 AM
Attachments:	Crystal River Velocities Doc Sept 27.doc

The September 6 meeting in Lecanto sparked my interest in flows for Crystal River. You may recall my question about the 975 cfs versus the 410 cfs as mentioned in Norman Hopkins presentation.

Such a difference was worth some investigation.

Over the last few days I have been reviewing past and present information.
1977 Rosenau gave 916 cfs for an 11 year period 1964-75
1989 Yobbi & Knochenmus gave 975 cfs for a 13 year period 1965-77
I also reviewed the VHB report from 2010 which measured each individual spring.

I could not find the base data for 916 cfs or the 975 cfs but both referenced measurement 3 miles downstream.

So I started looking at the USGS Gage Site at Bagley Cove 02310747.

The graph of stream velocity for the period of record on the web site 2002 to present quickly revealed a declining trend.

Digging deeper into the daily data shows a distinct trend to significantly lower stream velocities at this site, which I think clearly translates to lower flows.

THE STREAM VELOCITY DECREASES IN LESS THAN 10 YEAR ARE NOT JUST WORRYING THEY ARE ALARMING.

Background
There is no tidally filtered discharge data for this site and daily data going back to late 2002 reports average daily stream velocities.
Stream velocity at this site does not appear to be subject to the same/similar Vi to Vm mathematical equation as is the case for the Homosassa River MacRea's.
A number of velocity measurements at the same Gage Height have been checked and irrespective of the direction of flow the stage area at that gage height came out very close to 5170 sq ft

I took the daily velocity data and averaged them over a month. As far as I can see such averaging is valid to get a month average.

The data is summarized in the attached word document. I have not shown all months as the graph became more difficult to follow.

I have also added the rainfall data for Citrus County so that you can see if you think this may be rainfall driven either annually or from one/two/three months prior to the velocity figures.

May be someone from SWFWMD or USGS would like to comment as to why I should not be alarmed by this data.

To me it is more evidence that the harm to the rivers in this part of Florida has already been done and I reiterate what I said at the September 6 meeting. There should be a moratorium on any further water permits.

I have also been looking at some of the well data resulting from Ron Millers questions, but will save that for another day.

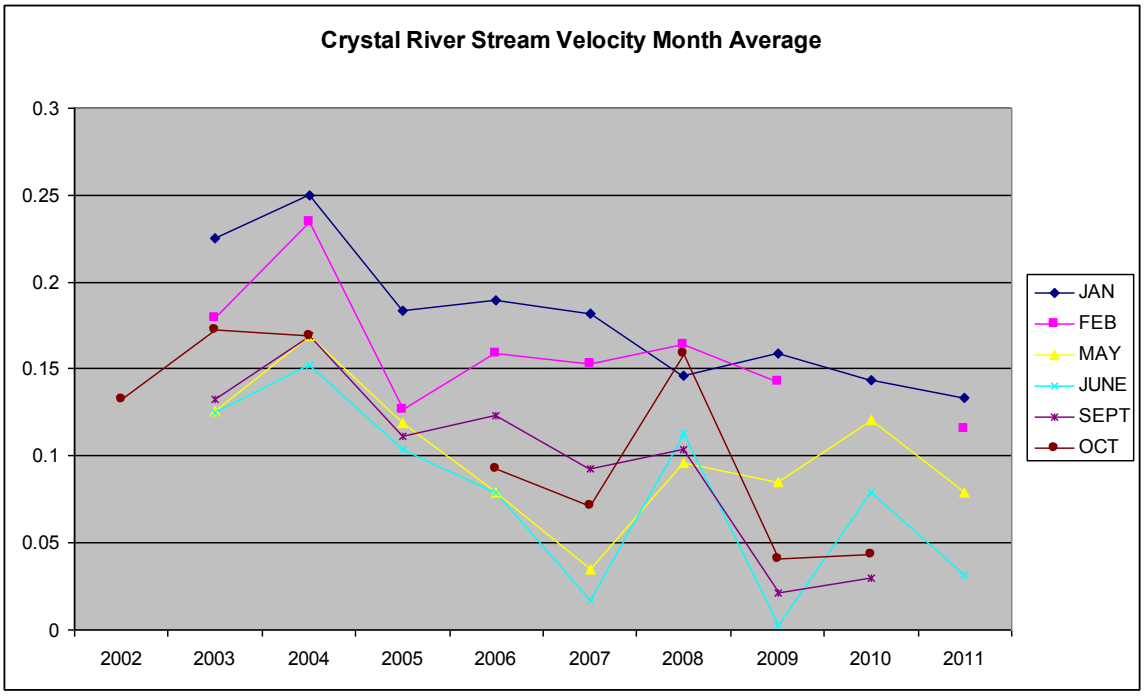
Martyn

P.S. For USGS; Is there some reason the velocity data for 02310747 going back to 2002 remains Provisional?. Only Specific Conductance shows as Approved.

Monthly Averaged Stream Velocity for USGS 02310747 Bagley Cove Crystal River

	JAN	FEB	MAY	JUNE	SEPT	OCT
2002						0.1329
2003	0.2255	0.1793	0.1255	0.1250	0.1323	0.1729
2004	0.2500	0.2341	0.1690	0.1523	0.1689	0.1687
2005	0.1832	0.1264	0.1194	0.1033	0.1110	
2006	0.1897	0.1586	0.0790	0.0790	0.1233	0.0930
2007	0.1821	0.1530	0.0352	0.0167	0.0923	0.0710
2008	0.1459	0.1644	0.0961	0.1127	0.1033	0.1587
2009	0.1590	0.1424	0.0848	0.0023	0.0217	0.0406
2010	0.1439		0.1210	0.0787	0.0293	0.0433
2011	0.1333	0.1157	0.0791	0.0312		

Blank month are where there were too many missing daily data for averaging.



Rainfall data for Citrus County

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
2001	2.73	0.40	7.29	0.12	0.52	6.70	11.10	4.29	9.25
2002	4.00	2.40	2.38	1.18	0.59	10.64	10.32	7.89	3.86
2003	0.17	6.24	5.83	1.80	2.44	19.54	6.09	8.05	3.09
2004	2.56	5.01	1.66	1.86	2.69	9.04	9.63	7.36	17.25
2005	1.08	1.76	6.26	5.79	6.28	9.68	10.20	8.13	2.28
2006	1.28	4.43	0.03	1.17	1.86	6.47	7.58	6.81	5.56
2007	1.68	2.84	1.72	1.85	0.86	5.74	9.14	7.59	5.35
2008	3.74	4.18	4.52	2.33	0.20	8.17	11.06	12.52	1.84
2009	2.17	1.05	1.38	1.27	10.24	7.54	8.96	5.49	5.39
2010	3.87	4.72	9.34	2.01	4.21	4.65	6.04	12.21	3.31

2011	4.19	1.99	7.90	1.34	1.58	5.70	8.58	8.46	
Avg Month	2.50	3.18	4.39	1.88	2.86	8.53	8.97	8.07	5.72

Rainfall for 2008 was higher than 2006 and 2007, but lower than 2005 and 2006. Correlation does not appear to be rainfall alone.

From:	Doug Leeper
To:	"Alan Martyn Johnson"
Cc:	"rrodrigu@usgs.gov"
Bcc:	Richard Kane (rkane@usgs.gov); Kevin Grimsley (kjgrims@usgs.gov); Marty Kelly; Mike Heyl; Ron Basso
Subject:	RE: Crystal River Spring Discharge
Date:	Tuesday, September 27, 2011 10:36:15 AM
Attachments:	02310750 Crystal River near Crystal River FL - Daily Data 30mar2011.xlsx

Hi Martyn:

Thanks for the e-mail regarding discharge in Crystal River. I believe that the "downstream" discharge data that you've identified may be associated with USGS site no. 02310750 (Crystal River near Crystal River FL).

Here's a link to the USGS web page for the site:

http://waterdata.usgs.gov/fl/nwis/dv?referred_module=sw&site_no=02310750

Thinking that you may find it useful, I've attached an Excel file that contains data that I have previously retrieved from this web page.

Regarding your questions about changes in discharge within the river, I can note that our preliminary estimates developed using the Northern District Model suggest that groundwater withdrawal impacts on flows are on the order of about one percent. We can therefore attribute most of the changes in flows to reduced rainfall during recent decades.

Douglas A. Leeper, Chief Environmental Scientist
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E-Mail: doug.leeper@watermatters.org
Web Site: watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Tuesday, September 27, 2011 9:49 AM
To: Doug Leeper; R Rodriguez
Cc: J Weaver; Marty Kelly; Dana Bryan; Al Grubman; Ron Miller; Brad Rimbey; Brent Whitley; Norman Hopkins
Subject: Crystal River Spring Discharge

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Martyn

P.S. For USGS; Is there some reason the velocity data for 02310747 going back to 2002 remains Provisional?. Only Specific Conductance shows as Approved.

From: Ron Basso
To: Alan Martyn Johnson
Cc: Doug Leeper; Mark Barcelo
Subject: FW: Crystal River Spring Discharge
Date: Tuesday, September 27, 2011 12:09:54 PM
Attachments: crystal_riv_flow.pdf
crystal_river_springflow.pptx

Mr. Johnson:

Our preliminary evaluation of groundwater impacts to the Crystal River (Kings Bay) spring complex is consistent with Homosassa Springs with current simulated impact of about one percent. As I mentioned previously during our last public meeting, there is a problem with the previously referenced discharge cited for Crystal River springs of 916 cfs – it is much too high. Our consultants and myself came to this realization during the calibration of the Northern District model when we were trying to match simulated springflow to this number. Hydrogeologic (2008) in their report summarizing the flow calibration for Crystal River springs provides a detailed explanation as to why this number is too high. I've summarized that discussion and supplemented it with additional analysis comparing UFA water levels with the recorded discharge at Bagley Cove which shows some unusual results. The USGS is planning to reevaluate the discharge record at Bagley Cove. In short, the recorded discharge rate for these group of springs is problematic with much too high discharge reported in the past. We feel our estimate of about 450 cfs is about right based on water budget information. I have attached a powerpoint file and PDF summarizing the issues with the Bagley Cover flow record. If you have any additional questions, please feel free to contact me.

Ron Basso, P.G.
Senior Professional Geologist
Hydrologic Evaluation Section
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ph 1-800-423-1476 (in state)
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FAX 352-797-5799

From: Doug Leeper
Sent: Tuesday, September 27, 2011 10:36 AM
To: Alan Martyn Johnson
Cc: rrodrigu@usgs.gov
Subject: RE: Crystal River Spring Discharge

Hi Martyn:

Thanks for the e-mail regarding discharge in Crystal River. I believe that the "downstream" discharge data that you've identified may be associated with USGS site no. 02310750 (Crystal River near Crystal River FL).

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Sent: Tuesday, September 27, 2011 9:49 AM
To: Doug Leeper; R Rodriguez
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From:	Norman Hopkins
To:	Alan Martyn Johnson
Cc:	Doug Leeper; R Rodriguez; J Weaver; Marty Kelly; Dana Bryan; Al Grubman; Ron Miller; Brad Rimbey; Brent Whitley
Subject:	Re: Crystal River Spring Discharge
Date:	Tuesday, September 27, 2011 11:59:47 AM

Martyn, You are clearly being very thorough and we thank you for that, sincerely.
I have tried to base my research on published science documentation and note your quoting from some of the same. I support your conclusions and look forward to the October 4, meeting.
I liked Doug's comment at the last meeting concerning negative MFL values.
When MFL were first postulated in 2000 (I think) I attended presentations by FDEP at which no mention was made of any withdrawals when levels exceeded the MFL. I did not record the name of the lady who read from that statute on September 6. I do recall being alarmed at meetings of the WRWSA when their (ex SWFWMD) consultant first spoke of permitted withdrawals above the MFL. He also spoke of storing withdrawals in surface reservoirs which would accelerate evaporation rates markedly beyond those when leaving the water underground. That "bad joke" has turned seriously sour.
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From: Alan Martyn Johnson
To: Doug Leeper
Cc: R Rodriguez
Subject: RE: Crystal River Spring Discharge
Date: Wednesday, September 28, 2011 8:07:58 AM

Doug,
Thanks for the information. I will take a detailed look at it later.

In a quick look just a few minutes ago I noted that the site reported Mean Daily Discharge 1964 thru 1977. As far as I can see this was done on a 24 hour basis and resulted in numbers that are difficult to understand. Probably someone realized that the 24.84 cycle may make more sense and could not find a way to sort 24.84 hr data for the Bagley Cove Site (that is a very quick thought).

It appears this site 02310750 was further downstream than the current site at Bagley Cove. Will have to look closer at this than just the Location Map on the one web page. Presumably the Bagley Cove site offered some advantages.
As I say I have only just taken a quick look.

Much appreciate the information.

Martyn

From: Doug.Leeper@swfwmd.state.fl.us
To: martynellijay@hotmail.com
CC: rrodrigu@usgs.gov
Date: Tue, 27 Sep 2011 10:36:17 -0400
Subject: RE: Crystal River Spring Discharge

Hi Martyn:

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From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Tuesday, September 27, 2011 9:49 AM
To: Doug Leeper; R Rodriguez
Cc: J Weaver; Marty Kelly; Dana Bryan; Al Grubman; Ron Miller; Brad Rimbey; Brent Whitley; Norman Hopkins
Subject: Crystal River Spring Discharge

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From:	Doug Leeper
To:	"Norman Hopkins"
Cc:	Martyn Johnson (martynellijay@hotmail.com)
Bcc:	Marty Kelly; Paul Williams
Subject:	RE: Crystal River Spring Discharge
Date:	Tuesday, September 27, 2011 1:31:22 PM
Attachments:	Munson et. al 2005 - Determining Minimum Flows and Levels - The Florida Experience.pdf

Norman:

I saw some requests directed toward me in your recent e-mail to Martyn Johnson ---

"Perhaps Doug could cite the original statute together with any modification which speak specifically of withdrawals when levels are above the MFL setting and from where such withdrawals may be taken and how such withdrawals may be calculated with respect to tidally influence systems".

As I began pondering your questions I immediately thought about the presentation on water use permitting that Paul Williams made at the July Springs Coast Minimum Flows and Levels Public Workshop. Perhaps you may find your questions addressed in his slides, which are included in the larger District presentation posted on the workshop web site at:

http://www.swfwmd.state.fl.us/files/database/site_file_sets/1968/SWFWMD_SLIDES_SHOWN_AT_MEETING_-_Springs_Coast_MFLs_Publ_Wrkshp_18jul2011.pdf

In addition, specific references to the portions of the Florida Statutes pertaining to water use permitting may be found in the references or footnotes included in the various District rules associated with the consumptive use of water. Here's a link to our primary water use permitting rules (Chapter 40D-8, Florida Administrative Code):

https://www.flrules.org/gateway/ChapterHome.asp?Chapter=40d-2

As an aside, note that conditions for issuance of permits identified in rule 40D-2.301 refer to the Basis of Review, which is incorporated into the rule by reference. The basis of review includes a section (4.3) which specifies that minimum flows and levels are one criterion used for evaluating requests for issuance of water use permits. Here's a link to the Water Use Permit Information Manual Part B – Basis of Review:

http://www.swfwmd.state.fl.us/files/database/site_file_sets/17/erp_basis_of_review.pdf

Hope this information adequately addresses your concerns. I'm sure that the information gained from reviewing District rules and the portion of the Florida Statutes pertaining to water resources can be easily supplemented by any number of scholarly articles that address consumptive water use in Florida and which are readily available on the internet. I've attached one such article authored by two of my colleagues and myself that provides a brief history of the legal and societal changes that have been associated with the evolution of minimum flows and levels development in our state – hope you enjoy it.

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From: Norman Hopkins [mailto:norman@amyhrf.org]
Sent: Tuesday, September 27, 2011 12:01 PM
To: Alan Martyn Johnson
Cc: Doug Leeper; R Rodriguez; J Weaver; Marty Kelly; Dana Bryan; Al Grubman; Ron Miller; Brad Rimbey; Brent Whitley
Subject: Re: Crystal River Spring Discharge

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From: Alan Martyn Johnson
To: Ron Basso
Cc: Doug Leeper; Mark Barcelo
Subject: RE: Crystal River Spring Discharge
Date: Wednesday, September 28, 2011 8:35:24 AM

Ron,
Thanks for the information. I have taken a quick look at the attachments.

Couple of questions from the first quick look.

- Is Slide 2 tidally adjusted discharge?
- In the write up 4.0 a discharge figure of 796 cfs is mentioned for the time period August 16, 2002 to October 1, 2010. From that same data source is there any trend? The velocity figures I shared certainly show a trend.

- It is interesting that USGS is planning to reevaluate the data. I thought they reviewed the data annually. Do you have any idea what they think is wrong or are they just going to look at how they tidally filter the output?

I did mention to Doug in an e-mail a few minutes ago that at the Site 02310750 USGS reported mean discharge 1964 - 1977. It appears the data was for a 24 hour period and thus was difficult to make sense of. A 24.84 hour analysis would make more sense and possibly be better than the Godin low pass filter used for the Homosassa River data.

Thanks,
Martyn

From: Ron.Basso@swfwmd.state.fl.us
To: martynellijay@hotmail.com
CC: Doug.Leeper@swfwmd.state.fl.us; Mark.Barcelo@swfwmd.state.fl.us
Date: Tue, 27 Sep 2011 12:09:52 -0400
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From:	Alan Martyn Johnson
To:	Doug Leeper
Subject:	RE: Crystal River Spring Discharge
Date:	Wednesday, September 28, 2011 8:39:42 AM

Doug,
Will review these later, but appreciate your taking the time to address Norman's questions.

You again show your great communication and organization skills.

Good Job,
Martyn

From: Doug.Leeper@swfwmd.state.fl.us
To: norman@amyhrf.org
CC: martynellijay@hotmail.com
Date: Tue, 27 Sep 2011 13:31:26 -0400
Subject: RE: Crystal River Spring Discharge

Norman:

I saw some requests directed toward me in your recent e-mail to Martyn Johnson ---

"Perhaps Doug could cite the original statute together with any modification which speak specifically of withdrawals when levels are above the MFL setting and from where such withdrawals may be taken and how such withdrawals may be calculated with respect to tidally influence systems".

As I began pondering your questions I immediately thought about the presentation on water use permitting that Paul Williams made at the July Springs Coast Minimum Flows and Levels Public Workshop. Perhaps you may find your questions addressed in his slides, which are included in the larger District presentation posted on the workshop web site at:

http://www.swfwmd.state.fl.us/files/database/site_file_sets/1968/SWFWMD_SLIDES_SHOWN_AT_MEETING_-_Springs_Coast_MFLs_Publ_Wrkshp_18jul2011.pdf

In addition, specific references to the portions of the Florida Statutes pertaining to water use permitting may be found in the references or footnotes included in the various District rules associated with the consumptive use of water. Here's a link to our primary water use permitting rules (Chapter 40D-8, Florida Administrative Code):

https://www.flrules.org/gateway/ChapterHome.asp?Chapter=40d-2

As an aside, note that conditions for issuance of permits identified in rule 40D-2.301 refer to the Basis of Review, which is incorporated into the rule by reference. The basis of review includes a section (4.3) which specifies that minimum flows and levels are one criterion used for evaluating requests for issuance of water use permits. Here's a link to the Water Use Permit Information Manual Part B – Basis of Review:

http://www.swfwmd.state.fl.us/files/database/site_file_sets/17/erp_basis_of_review.pdf

Hope this information adequately addresses your concerns. I'm sure that the information gained from reviewing District rules and the portion of the Florida Statutes pertaining to water resources can be easily supplemented by any number of scholarly articles that address consumptive water use in Florida and which are readily available on the internet. I've attached one such article authored by two of my colleagues and myself that provides a brief history of the legal and societal changes that have been associated with the

evolution of minimum flows and levels development in our state – hope you enjoy it.

Douglas A. Leeper, Chief Environmental Scientist
Resource Projects Department, Southwest Florida Water Management District
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Telephone: 1-800-423-1476, ext. 4272 (FL only) or 352-796-7211, ext. 4272
Fax: 352-754-6885
E-Mail: doug.leeper@watermatters.org
Web Site: watermatters.org

From: Norman Hopkins [mailto:norman@amyhrf.org]
Sent: Tuesday, September 27, 2011 12:01 PM
To: Alan Martyn Johnson
Cc: Doug Leeper; R Rodriguez; J Weaver; Marty Kelly; Dana Bryan; Al Grubman; Ron Miller; Brad Rimbey; Brent Whitley
Subject: Re: Crystal River Spring Discharge

Martyn, You are clearly being very thorough and we thank you for that, sincerely.
I have tried to base my research on published science documentation and note your quoting from some of the same. I support your conclusions and look forward to the October 4, meeting.
I liked Doug's comment at the last meeting concerning negative MFL values.
When MFL were first postulated in 2000 (I think) I attended presentations by FDEP at which no mention was made of any withdrawals when levels exceeded the MFL. I did not record the name of the lady who read from that statute on September 6. I do recall being alarmed at meetings of the WRWSA when their (ex SWFWMD) consultant first spoke of permitted withdrawals above the MFL. He also spoke of storing withdrawals in surface reservoirs which would accelerate evaporation rates markedly beyond those when leaving the water underground. That "bad joke" has turned seriously sour.
Perhaps Doug could cite the original statute together with any modification which speak specifically of withdrawals when levels are above the MFL setting and from where such withdrawals may be taken and how such withdrawals may be calculated with respect to tidally influence systems.
Norman

On 9/27/2011 9:48 AM, Alan Martyn Johnson wrote:
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From:	Alan Martyn Johnson
To:	Brent Whitley; Doug Leeper
Subject:	RE: Crystal River Spring Discharge
Date:	Wednesday, September 28, 2011 8:46:23 AM

Brent,
I have no idea about any dredging.
Presumably your thought is that if the channel were deepened the stage area (channel cross section) would have been increased and the velocities reduced.
It is a valid thought on the data I shared.

By copy I will pass this on to Doug Leeper who may be best able to direct the question to get an answer.

Martyn

Subject: RE: Crystal River Spring Discharge
Date: Tue, 27 Sep 2011 12:05:18 -0400
From: BrentWhitley@Sierra-Properties.com
To: martynellijay@hotmail.com

Martyn,

I am just curious, but did any dredging of the channel go on at any point around 04-05 when the real decline appears to start. Your information is ALARMING ESPECIALLY IN LIGHT OF THE FACT THAT RAINFALL DECLINE WAS NOT SIGNIFICANT OVER THE NEXT 6 YEARS.

BRENT

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Tuesday, September 27, 2011 9:49 AM
To: Doug Leeper; R Rodriguez
Cc: J Weaver; marty.kelly@swfwmd.state.fl.us; Dana Bryan; Al Grubman; Ron Miller; Brad Rimbey; Brent Whitley; Norman Hopkins
Subject: Crystal River Spring Discharge

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From: Ron Basso
To: Alan Martyn Johnson
Cc: Doug Leeper; Mark Barcelo
Subject: RE: Crystal River Spring Discharge
Date: Wednesday, September 28, 2011 9:01:20 AM

Mr. Johnson:

Slide 2 is the tidally-adjusted discharge from the USGS website for Bagley Cove. While it's difficult to discern a trend over the 8-year period, the flow values do generally decrease over the last couple of years. I haven't discussed the reevaluation of the discharge data with the USGS other than they are aware of these issues and have agreed to reevaluate it.

Ron Basso, P.G.
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From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Wednesday, September 28, 2011 8:36 AM
To: Ron Basso
Cc: Doug Leeper; Mark Barcelo
Subject: RE: Crystal River Spring Discharge

Ron,
Thanks for the information. I have taken a quick look at the attachments.

Couple of questions from the first quick look.

- Is Slide 2 tidally adjusted discharge?
- In the write up 4.0 a discharge figure of 796 cfs is mentioned for the time period August 16, 2002 to October 1, 2010. From that same data source is there any trend? The velocity figures I shared certainly show a trend.

- It is interesting that USGS is planning to reevaluate the data. I thought they reviewed the data annually. Do you have any idea what they think is wrong or are they just going to look at how they tidally filter the output?

I did mention to Doug in an e-mail a few minutes ago that at the Site 02310750 USGS reported mean discharge 1964 - 1977. It appears the data was for a 24 hour period and thus was difficult to make sense of. A 24.84 hour analysis would make more sense and possibly be better than the Godin low pass filter used for the Homosassa River data.

Thanks,
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From: Ron.Basso@swfwmd.state.fl.us
To: martynellijay@hotmail.com
CC: Doug.Leeper@swfwmd.state.fl.us; Mark.Barcelo@swfwmd.state.fl.us
Date: Tue, 27 Sep 2011 12:09:52 -0400
Subject: FW: Crystal River Spring Discharge

Mr. Johnson:

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From: Doug Leeper
Sent: Tuesday, September 27, 2011 10:36 AM
To: Alan Martyn Johnson
Cc: rrodrigu@usgs.gov
Subject: RE: Crystal River Spring Discharge

Hi Martyn:

Thanks for the e-mail regarding discharge in Crystal River. I believe that the "downstream"

discharge data that you've identified may be associated with USGS site no. 02310750 (Crystal River near Crystal River FL).

Here's a link to the USGS web page for the site:

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Thinking that you may find it useful, I've attached an Excel file that contains data that I have previously retrieved from this web page.

Regarding your questions about changes in discharge within the river, I can note that our preliminary estimates developed using the Northern District Model suggest that groundwater withdrawal impacts on flows are on the order of about one percent. We can therefore attribute most of the changes in flows to reduced rainfall during recent decades.

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Web Site: watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Tuesday, September 27, 2011 9:49 AM
To: Doug Leeper; R Rodriguez
Cc: J Weaver; Marty Kelly; Dana Bryan; Al Grubman; Ron Miller; Brad Rimbey; Brent Whitley; Norman Hopkins
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From: Ron Basso
To: Alan Martyn Johnson
Cc: Doug Leeper; Mark Barcelo
Subject: RE: Crystal River Spring Discharge
Date: Wednesday, September 28, 2011 10:27:11 AM

Mr. Johnson:

The Bagley Cove discharge record are daily values. I provided the reasoning for why the numbers are too high for springflow in yesterdays email. The actual flow measurements may be accurate but determining what is actual spring flow versus tidal flow is the more difficult issue. In other words, the measurements probably include both spring flow and tidal flows.

Ron Basso, P.G.
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FAX 352-797-5799

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Wednesday, September 28, 2011 9:21 AM
To: Ron Basso
Cc: Doug Leeper; Mark Barcelo
Subject: RE: Crystal River Spring Discharge

Ron,
Thanks for the quick reply. Are those tidally adjusted figures in slide 2 daily or monthly?

The reason I asked about monthly is that I have been looking at the info Doug sent me on the 'old' site 02310750, the monthly discharges are given for this site and while daily data may be difficult to understand I think over a month the average should be fairly good. Data from USGS web Site in the attached file, or you can go directly to it.

On what basis do you think the numbers are high? I would assume that some form of stream velocity measurement was used, may be not as accurate as todays ACDP, and I am sure that the data was collected with good intent and should not be dismissed without an explanation.

Martyn

From: Ron.Basso@swfwmd.state.fl.us
To: martynellijay@hotmail.com
CC: Doug.Leeper@swfwmd.state.fl.us; Mark.Barcelo@swfwmd.state.fl.us
Date: Wed, 28 Sep 2011 09:01:17 -0400
Subject: RE: Crystal River Spring Discharge

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From: Doug Leeper
To: "Alan Martyn Johnson"
Cc: Ron Basso; Mark Barcelo
Bcc: Marty Kelly; Richard Kane (rkane@usgs.gov); Kevin Grimsley (kjgrims@usgs.gov)
Subject: RE: Crystal River at Bagley Cove Discharge Record
Date: Wednesday, September 28, 2011 11:20:00 AM

Martyn:

In recent conversations I've had with USGS staff, they've indicated that they are currently revising the set of rating curves used to predict discharge at the Bagley Cove gage site. In the meantime, I do not plan on expending much additional energy evaluating the currently reported discharge data, as it will undoubtedly be modified.

Douglas A. Leeper, Chief Environmental Scientist
Resource Projects Department, Southwest Florida Water Management District
2379 Broad Street, Brooksville, FL 34604-6899
Telephone: 1-800-423-1476, ext. 4272 (FL only) or 352-796-7211, ext. 4272
Fax: 352-754-6885
E-Mail: doug.leeper@watermatters.org
Web Site: watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Wednesday, September 28, 2011 8:36 AM
To: Ron Basso
Cc: Doug Leeper; Mark Barcelo
Subject: RE: Crystal River Spring Discharge

Ron,
Thanks for the information. I have taken a quick look at the attachments.

Couple of questions from the first quick look.

- Is Slide 2 tidally adjusted discharge?
- In the write up 4.0 a discharge figure of 796 cfs is mentioned for the time period August 16, 2002 to October 1, 2010. From that same data source is there any trend? The velocity figures I shared certainly show a trend.

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Thanks,
Martyn

NOTE: remainder of e-mail string deleted by Doug Leeper

From: Alan Martyn Johnson
To: Ron Basso
Cc: Doug Leeper; Mark Barcelo; R Rodriguez; J Weaver
Subject: RE: Crystal River Spring Discharge
Date: Thursday, September 29, 2011 8:04:07 AM

Ron,
Thanks for confirming that Slide 2 is tidally corrected daily discharge.

I read the explanation of why the discharge figures from the 70's are high as they do not match the NDM and some recent regression analyses.

I still do not understand how the USGS data was so far off. As I said, I believe USGS collected the data with good intent.

Maybe USGS can offer some explanation of the 916cfs and 975cfs.

N.B. that the velocity figures I shared for 2003 (Site 02310747 Bagley Cove) would indicate discharge of around 800cfs on an annual basis; with January 2003 and 2004 being over 1000cfs.

Last night I started to look at the daily net discharge using the tidal cycles for the first week of August 2011. So far this is showing discharge around 200 cfs; matching the velocity averages I shared.

I have to agree that it is a difficult task to accurately segregate the tidal flows and the spring flows, but surely a mass balance (averaging inflow and outflow) must come close. USGS data can not be that far off.

Thanks,
Martyn

From: Ron.Basso@swfwmd.state.fl.us
To: martynellijay@hotmail.com
CC: Doug.Leeper@swfwmd.state.fl.us; Mark.Barcelo@swfwmd.state.fl.us
Date: Wed, 28 Sep 2011 10:27:02 -0400
Subject: RE: Crystal River Spring Discharge

Mr. Johnson:

The Bagley Cove discharge record are daily values. I provided the reasoning for why the numbers are too high for springflow in yesterdays email. The actual flow measurements may be accurate but determining what is actual spring flow versus tidal flow is the more difficult issue. In other words, the measurements probably include both spring flow and tidal flows.

Ron Basso, P.G.
Senior Professional Geologist
Hydrologic Evaluation Section
Southwest Florida Water Management District
ph 1-800-423-1476 (in state)
ph 352-796-7211, ext. 4291 (outside state)

FAX 352-797-5799

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Wednesday, September 28, 2011 9:21 AM
To: Ron Basso
Cc: Doug Leeper; Mark Barcelo
Subject: RE: Crystal River Spring Discharge

Ron,
Thanks for the quick reply. Are those tidally adjusted figures in slide 2 daily or monthly?

The reason I asked about monthly is that I have been looking at the info Doug sent me on the 'old' site 02310750, the monthly discharges are given for this site and while daily data may be difficult to understand I think over a month the average should be fairly good. Data from USGS web Site in the attached file, or you can go directly to it.

On what basis do you think the numbers are high? I would assume that some form of stream velocity measurement was used, may be not as accurate as todays ACDP, and I am sure that the data was collected with good intent and should not be dismissed without an explanation.

Martyn

From: Ron.Basso@swfwmd.state.fl.us
To: martynellijay@hotmail.com
CC: Doug.Leeper@swfwmd.state.fl.us; Mark.Barcelo@swfwmd.state.fl.us
Date: Wed, 28 Sep 2011 09:01:17 -0400
Subject: RE: Crystal River Spring Discharge

Mr. Johnson:

Slide 2 is the tidally-adjusted discharge from the USGS website for Bagley Cove. While it's difficult to discern a trend over the 8-year period, the flow values do generally decrease over the last couple of years. I haven't discussed the reevaluation of the discharge data with the USGS other than they are aware of these issues and have agreed to reevaluate it.

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From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
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To: Ron Basso
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To: martynellijay@hotmail.com
CC: Doug.Leeper@swfwmd.state.fl.us; Mark.Barcelo@swfwmd.state.fl.us
Date: Tue, 27 Sep 2011 12:09:52 -0400
Subject: FW: Crystal River Spring Discharge

Mr. Johnson:

Our preliminary evaluation of groundwater impacts to the Crystal River (Kings Bay) spring complex is consistent with Homosassa Springs with current simulated impact of about one percent. As I mentioned previously during our last public meeting, there is a problem with the previously referenced discharge cited for Crystal River springs of 916 cfs – it is much too high. Our consultants and myself came to this realization during the calibration of the Northern District model when we were trying to match simulated springflow to this number. Hydrogeologic (2008) in their report summarizing the flow calibration for Crystal River springs provides a detailed explanation as to why this number is too high. I've summarized that discussion and supplemented it with additional analysis comparing UFA water levels with the recorded discharge at Bagley Cove which shows some unusual results. The USGS is planning to reevaluate the discharge record at Bagley Cove. In short, the recorded discharge rate for these group of springs is problematic with much too high discharge reported in the past. We feel our estimate of about 450 cfs is about right based on water budget information. I have attached a powerpoint file and PDF summarizing the issues with the Bagley Cover flow record. If you have any additional questions, please feel free to contact me.

Ron Basso, P.G.
Senior Professional Geologist

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From: Doug Leeper
Sent: Tuesday, September 27, 2011 10:36 AM
To: Alan Martyn Johnson
Cc: rrodrigu@usgs.gov
Subject: RE: Crystal River Spring Discharge

Hi Martyn:

Thanks for the e-mail regarding discharge in Crystal River. I believe that the "downstream" discharge data that you've identified may be associated with USGS site no. 02310750 (Crystal River near Crystal River FL).

Here's a link to the USGS web page for the site:

http://waterdata.usgs.gov/fl/nwis/dv?referred_module=sw&site_no=02310750

Thinking that you may find it useful, I've attached an Excel file that contains data that I have previously retrieved from this web page.

Regarding your questions about changes in discharge within the river, I can note that our preliminary estimates developed using the Northern District Model suggest that groundwater withdrawal impacts on flows are on the order of about one percent. We can therefore attribute most of the changes in flows to reduced rainfall during recent decades.

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Sent: Tuesday, September 27, 2011 9:49 AM
To: Doug Leeper; R Rodriguez
Cc: J Weaver; Marty Kelly; Dana Bryan; Al Grubman; Ron Miller; Brad Rimbey; Brent Whitley; Norman Hopkins
Subject: Crystal River Spring Discharge

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Such a difference was worth some investigation.

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Digging deeper into the daily data shows a distinct trend to significantly lower stream velocities at this site, which I think clearly translates to lower flows.

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Martyn

P.S. For USGS; Is there some reason the velocity data for 02310747 going back to 2002 remains Provisional?. Only Specific Conductance shows as Approved.

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From:	Alan Martyn Johnson
To:	Doug Leeper
Cc:	Ron Basso; Mark Barcelo
Subject:	RE: Crystal River at Bagley Cove Discharge Record
Date:	Thursday, September 29, 2011 8:07:25 AM

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Martyn

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To: martynellijay@hotmail.com
CC: Ron.Basso@swfwmd.state.fl.us; Mark.Barcelo@swfwmd.state.fl.us
Date: Wed, 28 Sep 2011 11:20:51 -0400
Subject: RE: Crystal River at Bagley Cove Discharge Record

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From:	Doug Leeper
To:	"Alan Martyn Johnson"; Brent Whitley (brentwhitley@sierra-properties.com)
Cc:	Richard Kane (rkane@usgs.gov); Kevin Grimsley (kjgrims@usgs.gov)
Bcc:	Marty Kelly; Xinjian Chen; Mike Heyl; Ron Basso
Subject:	RE: Crystal River Spring Discharge
Date:	Thursday, September 29, 2011 8:03:00 AM

Martyn & Brent:

I'm not aware of any specific dredging of Crystal River, with the exception of the landscape changes evident in historical aerial photography of the region. I do know that minor sediment and algal mat removal from portions of Kings Bay was completed in the late 1990s and on a smaller scale sometime within the past few years.

With regard to the channel profile at the Bagley Cove gage site, I expect that major changes in morphology would be picked up when discharge rating curves are reviewed and/or revised.

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From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Wednesday, September 28, 2011 8:47 AM
To: Brent Whitley; Doug Leeper
Subject: RE: Crystal River Spring Discharge

Brent,
I have no idea about any dredging.
Presumably your thought is that if the channel were deepened the stage area (channel cross section) would have been increased and the velocities reduced.
It is a valid thought on the data I shared.

By copy I will pass this on to Doug Leeper who may be best able to direct the question to get an answer.

Martyn

Subject: RE: Crystal River Spring Discharge
Date: Tue, 27 Sep 2011 12:05:18 -0400
From: BrentWhitley@Sierra-Properties.com
To: martynellijay@hotmail.com

Martyn,

I am just curious, but did any dredging of the channel go on at any point around 04-05 when the real decline appears to start. Your information is ALARMING ESPECIALLY IN LIGHT OF THE FACT THAT RAINFALL DECLINE WAS NOT SIGNIFICANT OVER THE NEXT 6 YEARS.

BRENT

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Tuesday, September 27, 2011 9:49 AM
To: Doug Leeper; R Rodriguez
Cc: J Weaver; marty.kelly@swfwmd.state.fl.us; Dana Bryan; Al Grubman; Ron Miller; Brad Rimbey; Brent Whitley; Norman Hopkins
Subject: Crystal River Spring Discharge

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Subject:	RE: Crystal River Spring Discharge
Date:	Thursday, September 29, 2011 8:30:25 AM

Doug,
Thanks for your fast response to the question from Brent.

One would have thought that the regular Field Measurements would have picked up any significant changes to the stage area.

Martyn

From: Doug.Leeper@swfwmd.state.fl.us
To: martynellijay@hotmail.com; brentwhitley@sierra-properties.com
CC: rkane@usgs.gov; kjgrims@usgs.gov
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From: Kevin J Grimsley
To: Alan Martyn Johnson
Cc: Brent Whitley; Doug Leeper; rkane; R Rodriguez
Subject: RE: Crystal River Spring Discharge
Date: Friday, September 30, 2011 11:28:48 AM

Martyn,

We're not aware of any dredging in the area either and our measurements haven't shown any significant changes in the cross-section. The flow in '04 - '05 was higher than normal due to the hurricanes those years, so some decrease from then would be expected.

The discharge data at 02310747 is provisional because we are in the process of revising it. We hope to complete that process and set the data to approved within the next month. The tidal filtered discharge will be available at that time.

****
Kevin Grimsley, P.E.
Supervisory Hydrologist
USGS, Florida Water Science Center
10500 University Center Drive, Suite 215
Tampa, FL 33612
kjgrims@usgs.gov
813-498-5064
****

From: Alan Martyn Johnson <martynellijay@hotmail.com>
To: Doug Leeper <doug.leeper@swfwmd.state.fl.us>, Brent Whitley <brentwhitley@sierra-properties.com>
Cc: rkane <rkane@usgs.gov>, Kevin J Grimsley <kjgrims@usgs.gov>, R Rodriguez <rrodrigu@usgs.gov>, J Weaver <jdweaver@usgs.gov>
Date: 09/29/2011 08:31 AM
Subject: RE: Crystal River Spring Discharge

Doug,
Thanks for your fast response to the question from Brent.

One would have thought that the regular Field Measurements would have picked up any significant changes to the stage area.

Martyn

From: Doug.Leeper@swfwmd.state.fl.us
To: martynellijay@hotmail.com; brentwhitley@sierra-properties.com
CC: rkane@usgs.gov; kjgrims@usgs.gov
Date: Thu, 29 Sep 2011 08:03:36 -0400
Subject: RE: Crystal River Spring Discharge

Martyn & Brent:

I'm not aware of any specific dredging of Crystal River, with the exception of the landscape changes evident in historical aerial photography of the region. I do know that minor sediment and algal mat removal from portions of Kings Bay was completed in the late 1990s and on a smaller scale sometime within the past few years.

With regard to the channel profile at the Bagley Cove gage site, I expect that major changes in morphology would be picked up when discharge rating curves are reviewed and/or revised.

Douglas A. Leeper, Chief Environmental Scientist
Resource Projects Department, Southwest Florida Water Management District
2379 Broad Street, Brooksville, FL 34604-6899
Telephone: 1-800-423-1476, ext. 4272 (FL only) or 352-796-7211, ext. 4272
Fax: 352-754-6885
E-Mail: doug.leeper@watermatters.org
Web Site: watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Wednesday, September 28, 2011 8:47 AM
To: Brent Whitley; Doug Leeper
Subject: RE: Crystal River Spring Discharge

Brent,
I have no idea about any dredging.
Presumably your thought is that if the channel were deepened the stage area (channel cross section) would have been increased and the velocities reduced.
It is a valid thought on the data I shared.

By copy I will pass this on to Doug Leeper who may be best able to direct the question to get an answer.

Martyn

Subject: RE: Crystal River Spring Discharge
Date: Tue, 27 Sep 2011 12:05:18 -0400
From: BrentWhitley@Sierra-Properties.com
To: martynellijay@hotmail.com

Martyn,

I am just curious, but did any dredging of the channel go on at any point around 04-05 when the real decline appears to start. Your information is ALARMING ESPECIALLY IN LIGHT OF THE FACT THAT RAINFALL DECLINE WAS NOT SIGNIFICANT OVER THE NEXT 6 YEARS.

BRENT

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Tuesday, September 27, 2011 9:49 AM
To: Doug Leeper; R Rodriguez
Cc: J Weaver; marty.kelly@swfwmd.state.fl.us; Dana Bryan; Al Grubman; Ron Miller; Brad Rimbey; Brent Whitley; Norman Hopkins
Subject: Crystal River Spring Discharge

The September 6 meeting in Lecanto sparked my interest in flows for Crystal River. You may recall my question about the 975 cfs versus the 410 cfs as mentioned in Norman Hopkins presentation.

Such a difference was worth some investigation.

Over the last few days I have been reviewing past and present information.
1977 Rosenau gave 916 cfs for an 11 year period 1964-75
1989 Yobbi & Knochenmus gave 975 cfs for a 13 year period 1965-77
I also reviewed the VHB report from 2010 which measured each individual spring.

I could not find the base data for 916 cfs or the 975 cfs but both referenced measurement 3 miles downstream.

So I started looking at the USGS Gage Site at Bagley Cove 02310747.

The graph of stream velocity for the period of record on the web site 2002 to present quickly revealed a declining trend.

Digging deeper into the daily data shows a distinct trend to significantly lower stream velocities at this site, which I think clearly translates to lower flows.

THE STREAM VELOCITY DECREASES IN LESS THAN 10 YEAR ARE NOT JUST WORRYING THEY ARE ALARMING.

Background
There is no tidally filtered discharge data for this site and daily data going back to late 2002 reports average daily stream velocities.
Stream velocity at this site does not appear to be subject to the same/similar Vi to Vm mathematical equation as is the case for the Homosassa River MacRea's.
A number of velocity measurements at the same Gage Height have been checked and irrespective of the direction of flow the stage area at that gage height came out very close to 5170 sq ft

I took the daily velocity data and averaged them over a month. As far as I can see such averaging is valid to get a month average.

The data is summarized in the attached word document. I have not shown all months as the graph became more difficult to follow.

I have also added the rainfall data for Citrus County so that you can see if you think this may be rainfall driven either annually or from one/two/three months prior to the velocity figures.

May be someone from SWFWMD or USGS would like to comment as to why I should not be alarmed by this data.

To me it is more evidence that the harm to the rivers in this part of Florida has already been done and I reiterate what I said at the September 6 meeting. There should be a moratorium on any further water permits.

I have also been looking at some of the well data resulting from Ron Millers questions, but will save that for another day.

Martyn

P.S. For USGS; Is there some reason the velocity data for 02310747 going back to 2002 remains Provisional?. Only Specific Conductance shows as Approved.

IMPORTANT NOTICE: All E-mail sent to or from this address are public record and archived. The Southwest Florida Water Management District does not allow use of District equipment and E-mail facilities for non-District business purposes.

From:	Alan Martyn Johnson
To:	Kevin J Grimsley
Cc:	Brent Whitley; Doug Leeper; rkane; R Rodriguez; J Weaver; Ron Basso
Subject:	RE: Crystal River Spring Discharge
Date:	Tuesday, October 04, 2011 8:42:13 AM

Kevin,
Thanks for the response to the questions of dredging and any change in the stage area from the field measurements. This eliminates these potential influences on the velocity measurements.

Regarding the influence of the hurricanes; these events can clearly be seen in the velocity measurements:
Hurricane Francis September 5, 2004 draws water from Crystal River/Kings Bay average stream velocity 0.59 ft/sec and then on September 6 pushes water back in average stream velocity -0.26 ft/sec
Hurricane Ivan September 16, 2004 push water into CR/KB average stream velocity -0.16 ft/sec

Hurricane Arlene June 11, 2005 pushes water into CR/KB average stream velocity -0.11 ft/sec
Hurricane Dennis July 10, 2005 pushes water into CR/KB average stream velocity -0.33 ft/sec
Hurricane Katrina August 26/26 draws water out of CR/KB and then on 27th pushes water back in average stream velocity -0.13 ft/sec.

Possibly the most notable is Hurricane Alberto June 13, 2006 which pushed water into CR/KB average stream velocity -0.42 ft/sec with the highest gage height for the period of record at 16.32 ft.

The other hurricanes are also reflected in the gage heights.

But, at the end of the event what is pushed into Crystal River/Kings Bay flows out: thus, I think, balancing the net effect of the storm.

In reviewing the data I also noted the influence each of these hurricanes had on rainfall. For example September 2004 Francis and Ivan appear to be the most likely cause of higher rainfall and increased levels in the aquifer resulting in higher spring discharges (and some surface run off) than in the previous year, but look at January and February 2004. January and February velocities were not influenced by any weather event that I have so far identified; December 2003 rainfall for Citrus County was low. January 2004 average, February 2004 higher than average. Have even tried looking around those higher velocity days Jan 6/7 and 10/11, and Feb 7/8 and 16/17/18.

Overall the trend for the stream velocities from 2002/3 through present is a decreasing trend and the measurement methods, stage area etc appear to be comparable. Can such a trend not be true with a rework/review of the data/methods?

As a though had been shared comparing Crystal River to Rainbow River I pulled the

discharge data for USGS Site 02313100 Rainbow River 5 miles down stream of the springs; the discharge data also appear to be indicating a downward trend. I have not looked at this in detail, but did per chance note that discharges for the months after those 2004 hurricanes and the rainfall they produced did indicate increased discharge.

Just more food for thought about the possible influence of increased mechanical pumping of the aquifer.

Martyn

To: martynellijay@hotmail.com
CC: brentwhitley@sierra-properties.com; doug.leeper@swfwmd.state.fl.us; rkane@usgs.gov; rrodrigu@usgs.gov
Subject: RE: Crystal River Spring Discharge
From: kjgrims@usgs.gov
Date: Fri, 30 Sep 2011 11:29:49 -0400

Martyn,

We're not aware of any dredging in the area either and our measurements haven't shown any significant changes in the cross-section. The flow in '04 - '05 was higher than normal due to the hurricanes those years, so some decrease from then would be expected.

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Fax: 352-754-6885
E-Mail: doug.leeper@watermatters.org
Web Site: watermatters.org

From:	Norman Hopkins
To:	Doug Leeper
Subject:	Yesterday"s MFL meeting
Date:	Wednesday, September 07, 2011 12:00:30 PM

Thank you for your help with the presentation yesterday, I appreciate it.

I first learned of the MFL program in 2001 from an FDEP speaker. I agree with the lady public input speaker who said that the law in 2000 did not have a component in regard to the setting of withdrawal targets for coast river systems (I did not note her name or affiliation).

I did not read it in the law then nor was it referred to by the FDEP speaker. The first I heard of withdrawal targeting was from an ex-SWFWMD consultant retained by the WRWSA.

For many reasons I have since regarded the current program as a perversion of the law being pursued by honorable individuals as a matter of policy. If I am wrong to see it as I do I would be pleased if you would tell me why.

I appreciate the reasons why the panel was not constituted as a committee and that it allows panelists to exchange views between meetings. I have long thought that insufficient consideration was being given to public knowledge of matters which affect them but you should be congratulated in setting a forum where views can be exchanged. I meant what I said in picking up on Jim Bitter's contribution and suggesting a panel report to accompany your recommendation to the Governing Board. However, I shudder at the prospect of trying to arrive at a concensus in order to do so.

Kind regards, Norman

September 28, 2011

MEMORANDUM

TO: File

FROM: Douglas A. Leeper, Chief Environmental Scientist, Ecologic Evaluation Section, Southwest Florida Water Management District

SUBJECT: Documentation of September 2011 telephone conversation with Norman Hopkins regarding minimum flows development for Crystal River/Kings Bay

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This memorandum documents a September 28, 2011 telephone conversation between Mr. Norman Hopkins and Mr. Doug Leeper, the Southwest Florida Water Management District, concerning development of minimum flows for the Crystal River/Kings Bay system.

Phone Log

Who called: Mr. Norman Hopkins
Staff contact: Doug Leeper, Ecologic Evaluation Section, SWFWMD
Issue: Crystal River/Kings Bay minimum flows
Date: September 9, 2011

Notes:

1. Requested information regarding the next scheduled Springs Coast minimum flows and levels workshop and the upcoming Minimum Flows and Levels Priority List and Schedule meeting.
   Response: information was provided

2. Requested clarification regarding discharge data for the Crystal River system.
   Response: information was discussed, including the planned revision of the discharge record for the United States Geological Survey gage site at Bagley Cove.

3. Requested information on Florida Statutes pertaining to minimum flows and levels.
   Response: information was provided via e-mail (see attachment to this memorandum).

4. Noted that it seems inappropriate to establish minimum flows that allow for flow reductions in Crystal River, given that it is an Outstanding Florida Water and concentrations of some water quality constituents are higher than the ambient conditions associated with the time period when the river received its special waters designation.

   Response: discussed Outstanding Florida Waters and Clean Water Act with respect to environmental resource permitting and effluent discharge permitting. Noted that the issue of increased water quality constituents, such as nitrogen, is a total maximum daily load (TMDL) issue that should be concerned with the source-loading, rather than the establishment of minimum flows. It was agreed that further discussion of this topic over the telephone was not useful, and Mr. Hopkins suggested

that this topic may be discussed at the upcoming stakeholder representatives meeting on Springs Coast minimum flows and levels.

6. Contact information.
   e-mail: norman@amyhrf.org
   Phone: 352-795-9517

DAL
Attachment: E-mail from Doug Leeper to Norman Hopkins, dated September 28, 2011

From:	Doug Leeper
To:	Norman Hopkins (norman@amyhrf.org)
Cc:	Marty Kelly
Subject:	Requested Links to Florida Statutes
Date:	Wednesday, September 28, 2011 2:00:00 PM

Norm:

Per your request, I am providing links to relevant portions of the Florida Statutes that deal with minimum flows and levels and consumptive water use permitting.

Douglas A. Leeper, Chief Environmental Scientist
Resource Projects Department, Southwest Florida Water Management District
2379 Broad Street, Brooksville, FL 34604-6899
Telephone: 1-800-423-1476, ext. 4272 (FL only) or 352-796-7211, ext. 4272
Fax: 352-754-6885
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LINKS TO FLORIDA STATUTES

Florida Statutes, Chapter 373, Water Resources
http://archive.flsenate.gov/statutes/index.cfm?App_mode=Display_Statute&URL=0300-0399/0373/0373ContentsIndex.html&StatuteYear=2011&Title=%2D%3E2011%2D%3EChapter%20373

Part I, Water Resources Plan
http://archive.flsenate.gov/statutes/index.cfm?App_mode=Display_Statute&Search_String=&URL=0300-0399/0373/0373PARTIContentsIndex.html

Section 373.042, um flows and levels.—
http://archive.flsenate.gov/statutes/index.cfm?App_mode=Display_Statute&Search_String=&URL=0300-0399/0373/Sections/0373.042.html

Section 273.0421, Establishment and implementation of minimum flows and levels.—
http://archive.flsenate.gov/statutes/index.cfm?App_mode=Display_Statute&Search_String=&URL=0300-0399/0373/Sections/0373.0421.html

Part II, Permitting of Consumptive Uses of Water
http://archive.flsenate.gov/statutes/index.cfm?App_mode=Display_Statute&Search_String=&URL=0300-0399/0373/0373PARTIIContentsIndex.html

Florida Statues, Chapter 187, State Comprehensive Plan
http://archive.flsenate.gov/statutes/index.cfm?App_mode=Display_Statute&URL=0100-0199/0187/0187ContentsIndex.html&StatuteYear=2011&Title=%2D%3E2011%2D%3EChapter%20187

Section 187.201 State Comprehensive Plan adopted.—

*(see 187.201(7)(b)6**)***
http://archive.flsenate.gov/statutes/index.cfm?App_mode=Display_Statute&Search_String=&URL=0100-0199/0187/Sections/0187.201.html

From: Doug Leeper
To: "taryn.sudol@gmail.com"
Subject: Kings Bay Data Request
Date: Monday, September 26, 2011 3:59:00 PM

Hi Taryn:

It was a pleasure to speak with you today regarding information on Kings Bay. Here's the information you requested.

Below is an excerpt from a United States Geological Survey report that includes descriptive information for Kings Bay, including average water depths.

Hammett, K.M., Goodwin, C.R. and Sanders, G.L. 1996. Tidal-flow, circulation and flushing characteristics of Kings Bay, Citrus County. United States Geological Survey Open-File Report 96-230. Tallahassee, Florida.

"Description of the Study Area

Kings Bay is in Citrus County on the west coast of peninsular Florida. The estuary measures about 1.5 mi north to south and about 0.5 mi east to west and has a surface area of less than 1 mi2. Romie (1990) estimated that the estuary receives direct runoff from an area of about 2.7 mi2. The land around Kings Bay is low and flat, with land-surface elevations averaging about 5 ft above sea level. Saltmarsh covers much of the area between Kings Bay and the Gulf of Mexico. Throughout most of this part of Florida, limestone bedrock is overlain by a thin layer of sandy soil, but, in some areas, the limestone protrudes at land surface. The bottom of Kings Bay is exposed limestone with a multitude of submarine springs and seeps (Yobbi and Knochenmus, 1989). The average depth in Kings Bay is about 8 ft (fig. 2), but the shallow tidal flats in the southwestern part of the bay are sometimes exposed at low tide, and one of the major springs south of Banana Island has a depth of about 65 ft. Along the channel of Crystal River, depths are typically 8 to 12 ft. In the early 1960's, a network of 75-ft-wide canals was dredged along the eastern edge of the bay as part of waterfront residential development (Fox and others, 1988). The depths of the canals are not shown in figure 2, but the average depth is about 6 ft."

The report identified above is available on-line at the District Library web page at the following URL:
http://www15.swfwmd.state.fl.us/LibraryImages/TIDAL%20FLOW%20CIRCUL%20&%20FLUSHING%20CHARACT%20KINGS%20BAY.PDF

Here's some information on discharge measurements at United States Geological Survey sites in Crystal River, which connects Kings Bay to the Gulf of Mexico. I've also provided links to the United States Geological Survey web pages associated with the sites. Note that the Geological Survey is currently reviewing the equations used for estimating discharge at the Bagley Cove site and expects that the reported discharge values will be reduced once the new analyses are implemented. The historical records from the Crystal River near Crystal River site are not being modified.

Current (more recent) Discharge Data
USGS 02310747 Crystal River at Bagley Cover Near Crystal River FL
Approved tidally filtered discharge for period of record = 796.0 cubic feet per second
United States Geological Survey web page:
http://waterdata.usgs.gov/fl/nwis/uv/?site_no=02310747&PARAmeter_cd=00065,00060

Older Discharge Data
USGS 02310750 CRYSTAL RIVER NEAR CRYSTAL RIVER FL
Approved tidally filtered discharge for period of record = 970.6 cubic feet per second
United States Geological Survey web page:
http://waterdata.usgs.gov/fl/nwis/dv?referred_module=sw&site_no=02310750

Let me know if you have any questions about the information I've provided. Also, you should be able to find a number of reports and scientific papers pertaining to Kings Bay on the web.

Douglas A. Leeper, Chief Environmental Scientist
Resource Projects Department, Southwest Florida Water Management District
2379 Broad Street, Brooksville, FL 34604-6899

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Fax: 352-754-6885
E-Mail: doug.leeper@watermatters.org
Web Site: watermatters.org

From: Taryn Sudol
To: Doug Leeper
Subject: Re: Kings Bay Data Request
Date: Tuesday, September 27, 2011 10:37:31 AM

Dear Mr. Leeper,

Thank you. These reports are definitely helpful to my project. I appreciate you taking the time to collect these for me and pointing me in the right direction.

Sincerely,
Taryn Sudol

On Mon, Sep 26, 2011 at 3:59 PM, Doug Leeper <Doug.Leeper@swfwmd.state.fl.us> wrote:
> Hi Taryn:
>
>
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>

From:	Alan Martyn Johnson
To:	Doug Leeper; Norman Hopkins; Ron Miller; Al Grubman; Dana Bryan; Marty Kelly; Brad Rimbey; Ron Basso; Brent Whitley
Cc:	rkane; Kevin J Grimsley
Subject:	Crystal River Mass Balance from Discharge Data Bagley Cove USGS 02310747
Date:	Monday, October 10, 2011 7:45:17 AM
Attachments:	Crystal River Mass Balance First Week Aug.xls Crystal River Springs Summary 2010 study extract.xls

---

For those that may be interested.

In an e-mail over a week ago I did say that despite the fact the data for the Bagley Cove Crystal River may change after review, I would look at the mass balance thru a number of tidal cycles. After looking at the rainfall data to minimize any run-off influence, I chose the first week of August. Below is a summary of the results.

Frankly, I was amazed at how well the process was able to separate the net outflow from such major tidal flow and provide results that appear to follow (but not perfectly) logic e.g. as the tide levels decrease the net outflows increase.

As you will see in the attached Excel file I had some question of how best to make corrections within each cycle for the change in Gage Height from beginning to end of the cycle. I opted to use the Gage Height at the Bagley Cove site and try to relate it to all of Kings Bay (600 acres). You will see in the file that the Gage Height highs/lows at the mouth of Kings Bay 02310742 are about one hour later than Bagley Cove 02310747.

Given there is in the order of 100 million cubic feet of flow in each direction between high and low tides it is remarkable how the mass balance indicate such accuracy/consistency **The order of magnitude of spring discharge 300 cfs must at least be a close approximation**. This derives from a Mean Stream Velocity of about 0.05 ft/second, looking back to 2002-3 spring discharge was in the order of 3 times greater and for some months up to 5 times greater.

Before going thru this I read in detail the VHB February 2010 Report Flow Measurements from Spring Vents in Kings Bay. To give me a better picture of all these measurements I extracted the data into an Excel File for ease of reference. You may find the file interesting, particularly when considering the discharge of good quality (low specific conductance) water from these vents. You will see I sorted the springs by both discharge and specific conductance.

I fully recognize the difficult task of quantifying Kings Bay discharges with good accuracy, but I have to repeat that the mass balance at Bagley Cove was much more definitive than expected. For the instrumentation to be able to provide data that separates a Net Balance reasonably consistently over six cycle period and have it demonstrate good logic to the physical reality is a credit to technology and those who deploy it.

I am always willing to listen to other interpretations of this data and certainly any thoughts about the best way to correct the Net Discharge for changers in Gage Height.

Credit where credit is due.
A lot of effort and expenditure goes into collecting this and similar data; none of the data speaks for itself and there are different ways of looking at it. But, only by exploring it and where necessary modifying collection methods will we be able to understand how to preserve

these OUTSTANDING FLORIDA WATERS.

Commentary
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Just may be we should start questioning assumptions in the NDM despite all the money spent on it.

But, back to Crystal River Mass Balance.

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Third	212	242	13.88	11.43	13.88	11.62	13.98	0.1
Fourth	397	388	13.98	11.44	13.58	11.58	13.95	-0.03
Fifth	345	343	13.95	11.29	13.3	11.62	13.94	-0.01
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Total	277	293	13.74				14.06	0.32

As always comments welcome.

This is all food for thought.

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May be it is time to stop sucking the aquifer.

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Martyn

From:	Norman Hopkins
To:	Alan Martyn Johnson
Cc:	Doug Leeper; Ron Miller; Al Grubman; Dana Bryan; Marty Kelly; Brad Rimbey; Ron Basso; Brent Whitley; rkane; Kevin J Grimsley
Subject:	Re: Crystal River Mass Balance from Discharge Data Bagley Cove USGS 02310747
Date:	Monday, October 10, 2011 8:58:44 AM

Thank you Martyn - great work. I think that you should present this information at the MFL meeting being organized by Brad. Norman

On 10/10/2011 7:46 AM, Alan Martyn Johnson wrote:

> For those that may be interested.
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> In an e-mail over a week ago I did say that despite the fact the data for the Bagley Cove Crystal River may change after review, I would look at the mass balance thru a number of tidal cycles. After looking at the rainfall data to minimize any run-off influence, I chose the first week of August. Below is a summary of the results.
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To:	Norman Hopkins
Cc:	Doug Leeper; Ron Miller; Al Grubman; Dana Bryan; Marty Kelly; Brad Rimbey; Ron Basso; Brent Whitley; rkane; Kevin J Grimsley
Subject:	RE: Crystal River Mass Balance from Discharge Data Bagley Cove USGS 02310747
Date:	Wednesday, October 12, 2011 8:31:41 AM

Norman,
Thanks for the Thank You, appreciated.

As regards presenting this at Brad's meeting I do not think this qualifies as 'verified' use of the discharge data. And USGS are in the middle of the review of data from the Bagley Cove Site 02310747.

This was my way of trying to look at the data in a manner that could make the discharge data more useful. Currently, the discharge data is a mass of numbers; I simply thought that looking at the data using the 24.84 hour cycle (as closely as I could) may be of interest and possibly be more meaningful. The method of filtering the discharge data for Homosassa River 02310700 does not appear to provide results that are useful, at least as far as I can see. Tidal filtering of the discharge dat at 02310700 uses some Godin low pass filtering method on the 15 minute data computed over a full year and then applied to the discharge data.

My analysis of the Bagley Cove discharge was shared as food for though, and shared fairly broadly as it was much better than I expected.

I hope someone picks up on the idea; or can point out where the idea is flawed. The analysis complimented the analysis I did of the stream velocities which I shared some days ago.
Martyn

Date: Mon, 10 Oct 2011 09:00:24 -0400
From: norman@amyhrf.org
To: martynellijay@hotmail.com
CC: doug.leeper@swfwmd.state.fl.us; rmille76@tampabay.rr.com; grubman1@gmail.com; dana.bryan@dep.state.fl.us; marty.kelly@swfwmd.state.fl.us; brimbey3@tampabay.rr.com; ron.basso@swfwmd.state.fl.us; brentwhitley@sierra-properties.com; rkane@usgs.gov; kjgrims@usgs.gov
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From: Doug Leeper
To: "MAD MAX"
Bcc: Marty Kelly; Mike Heyl; Sid Flannery; Gary E. Williams; Veronica Craw
Subject: RE: Chassahowitzka Modeling Report Posted on MFLs Web Site
Date: Tuesday, October 25, 2011 9:02:46 AM

Max –

Thanks for the e-mail. It's always good to hear stakeholders opinions regarding management of our springs.

The modeling we are doing for year 2030 conditions is an attempt to evaluate how future sea level rise will affect salinities in the river/spring systems of the Springs Coast. This information will help the Southwest Florida Water Management District establish the best protective minimum flows for the systems.

Douglas A. Leeper
Chief Environmental Scientist
Resource Projects Department
Southwest Florida Water Management District
2379 Broad Street
Brooksville, Florida 34604-6899
1-800-423-1476, ext. 4272 (FL only)
352-796-7211, ext. 4272
352-754-6885 (Fax)
doug.leeper@watermatters.org

From: MAD MAX [mailto:rhinesmith@webtv.net]
Sent: Tuesday, October 25, 2011 1:50 AM
To: Doug Leeper
Subject: Re: Chassahowitzka Modeling Report Posted on MFLs Web Site

DUDE, What are u yakking about-year 2030? I am More concerned with being allowed to hike into 3 sisters springs for a swim. instead of waiting another damn Year .for permission to walk on our TAXPAYER lands we, incl me, gave donations $$$ to buy. They? are trying to turn it into damn tourist look-don't touch-park like fishbowl Homosassa. 3 sisters should stay wilderness, but then fat folks won't visit it. arrrrgggggghhhh MAX

From: Alan Martyn Johnson
To: Doug Leeper; Kevin J Grimsley
Cc: Norman Hopkins
Subject: FW: Crystal River Spring Discharge
Date: Friday, February 17, 2012 8:46:27 AM

Doug and Kevin,
You may recall this e-mail from Kevin confirming an earlier one from Doug that the Crystal River Bagley Cove data was being reviewed/revised.
Presumably this review/revision has been completed as the P's have changed to A's in the records.

Was anything significant found as a result of the review? And was the data revised, which I interpret as changed?

You may recall I had expressed concern that the data indicated a significant decline in flow thru the past 10 year period.
Is my concern still justified or was the data on which I based my concern inaccurate?

I did note Kevin's point about the hurricanes, Frances and Alberto.

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Subject: RE: Crystal River Spring Discharge
From: kjgrims@usgs.gov
Date: Fri, 30 Sep 2011 11:29:49 -0400

Martyn,

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USGS, Florida Water Science Center
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Tampa, FL 33612
kjgrims@usgs.gov
813-498-5064
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To: Alan Martyn Johnson
Cc: Doug Leeper; Norman Hopkins
Subject: Re: FW: Crystal River Spring Discharge
Date: Friday, February 17, 2012 1:08:11 PM

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The data were revised to eliminate inconsistencies between the 3 or 4 different equations that had been used over that time period. The revised records use a single, consistent equation from October, 2002 to present.

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To: Doug Leeper <doug.leeper@swfwmd.state.fl.us>, Kevin J Grimsley <kjgrims@usgs.gov>
Cc: Norman Hopkins <norman@amyhrf.org>
Date: 02/17/2012 08:47 AM
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To:	Al Grubman; Ron Miller; Norman Hopkins; Brent Whitley; Dan Hillard; Dana Bryan; Doug Leeper; Mike Heyl; Kevin J Grimsley; R Rodriguez
Subject:	Follow up FOIA Equations response
Date:	Thursday, February 16, 2012 8:26:14 AM
Attachments:	Chassahowitzka River Gage 02310663 Verification FOIA Equation.xls

Following up on yesterdays e-mail regarding the equations. Brad made a good point about not looking at data after the date of his request in case there is a change. To that end I have added the data (blue) from October 18, 2011 on the spreadsheet I shared yesterday. I did download the whole 120 days data, but thought that was a little much to share yesterday to make the point.

For Chassahowitzka main spring I had plugged the equation into August 25, 2011 which is what resulted in the original question. The equation matches the calculated discharge on USGS web site.

As promised I have looked at Bagley Cove Crystal River. Even looking at the equation yesterday I had concerns, sure enough it does not match. I even tried using the stream level instead of gage height. The stage area may well be the 1895.9 sq.ft. and the 527.2ft. may be the channel width, but with gage heights typically around 12 ft something is not right in this equation.

Yesterday one of my readers asked if I was now agreeing that the discharge data is correct.

Let me be clear in case my wording yesterday was not. The equations for the three Homosassa sites and Chassahowitzka main spring are the equations USGS uses to calculate the discharge. That does not mean these calculated discharges are TRUE.

Let me first take the SE Fork; the calculated discharge when considered over a tidal cycle indicates much larger changes of level in the roughly 3 acre pool upstream of the gage site than actually occur. My speculation is that the discharge as cfs is much more consistent than the calculated discharge data implies. To support this speculation, I have measured stream velocities many times, using oranges passing under the Fishbowl Bridge . The whole purpose of the velocity meter at this location is to better understand this. I have recently had conversations with manufacturers of acoustic velocity meters in order to better understand why after over 5 months we still await even preliminary data.

Homosassa River Macrae's; I still have major concerns that the squaring of negative velocity reading (0.121382*Ivel*Ivel) in the equation results in a bias in the calculation of inflow versus outflow.

Homosassa Main Springs; in my opinion this is closest to the truth, , but there are still occasions when the field measurements differ by more than 10%.

Chassahowitzka main spring; I have some concern that the large multiplier applied to the stage change, the 905.3087, the factor resulting in negative flow is rather high. Brad Rimbey and myself have been trying to determine the open water area upstream of the gage site to do a similar calculation to what I did for SE Fork. The canals are reasonably easy to estimate, the problem is trying to get a number for the area 'upstream' of Bubba/Seven Sisters Springs. I intend in the next few weeks to get a better handle on whether or not there are any upstream

flows i.e. past Bubba Spring.

Let me be clear, none of this is easy simple science. USGS and SWFWMD are trying to understand these springs, but sometimes it is necessary to step back from the computers, regression analyses and models and ask the folks what they see. Those folks that have seen the Homosassa and Chassahowitzka Rivers deteriorate, they are the test of whether or not the computer simulation is meaningful. My timing of floating oranges may not be as accurate as an acoustic velocity meter, if it is located correctly and the equations used to translate what it sees as stream velocity to cfs are correct, but the oranges have no way to go other than with the flow!!.

Have a great day.

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To: martynellijay@hotmail.com
CC: brentwhitley@sierra-properties.com; doug.leeper@swfwmd.state.fl.us; rkane@usgs.gov; rrodrigu@usgs.gov
Subject: RE: Crystal River Spring Discharge
From: kjgrims@usgs.gov
Date: Fri, 30 Sep 2011 11:29:49 -0400

Martyn,

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Supervisory Hydrologist
USGS, Florida Water Science Center
10500 University Center Drive, Suite 215
Tampa, FL 33612
kjgrims@usgs.gov
813-498-5064

****

From: Alan Martyn Johnson
To: Kevin J Grimsley
Cc: Doug Leeper; Norman Hopkins
Subject: RE: Crystal River Spring Discharge
Date: Saturday, February 18, 2012 7:30:42 AM

Kevin,
Thanks. Appreciate the prompt reply and directing us to the report.

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CC: doug.leeper@swfwmd.state.fl.us; norman@amyhrf.org
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Date: Fri, 17 Feb 2012 13:08:04 -0500

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Cc: Norman Hopkins <norman@amyhrf.org>
Date: 02/17/2012 08:47 AM
Subject: FW: Crystal River Spring Discharge

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****

From: Kevin J Grimsley
To: Alan Martyn Johnson
Cc: Doug Leeper; Norman Hopkins
Subject: Re: Crystal River Spring Discharge
Date: Saturday, February 18, 2012 1:31:43 PM

Martyn,

I disagree, the Godin filter is working exactly as it is intended. I'm not sure of the reasons behind how the water year is defined. It has changed a couple of times in the past, but I think the primary reason is that it matches the federal fiscal calendar.

Thanks, I am enjoying the new position and all of the new challenges it brings.

****

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813-498-5064

****

From: Alan Martyn Johnson
To: Doug Leeper
Cc: Norman Hopkins; Kevin J Grimsley
Subject: RE: Crystal River Spring Discharge
Date: Saturday, February 25, 2012 12:17:14 PM

Doug,
You may recall my e-mail of September 27, 2011 when I expressed concern regarding the apparent decrease in flow from the Crystal River Springs. Kevin Grimsley and you advised me that the data for the Bagley Cove Gage Site 02310747 was being revised. Recently, Kevin shared with us the revised data.

Given the confidence Kevin expressed regarding the tidally filtered discharge data, I have looked at the data using both the month mean and water year mean results. This is data taken directly from the document Kevin directed us to.

As you will see from the table and graphs there is a strong trend over the nine year period. This trend is similar to what I had seen in the 'unrevised' data and described as "Alarming".

I wish I could share Kevin's confidence in this tidally filtered data. I was under the impression that the purpose of tidally filtering was to be able to see the underlying discharge from the springs. When I look at the daily results, example year shown below, it is hard to imagine how the spring flow can change in this manner. May be someone can explain what these numbers mean, if they have time.

For now, I can only conclude the trend looks ALARMING, but with reservation regarding the meaning (validity) of the tidally filtered discharge data.

TIDALLY FILTERED DISCHARGE BAGLEY COVE 02310747

	2002/3	2003/4	2004/5	2005/6	2006/7	2007/8	2008/9	2009/10	2010/11
Oct	551	736	725	433	395	255	680	138	174
Nov	687	869	768	639	516	431	671	326	333
Dec	869	1,030	922	797	506	652	718	536	476
Jan	856	1,002	729	726	682	625	619	572	500
Feb	704	906	506	648	611	649	485	822	433
Mar	603	824	656	496	600	723	351	---	390
Apr	552	779	578	458	399	514	261	---	422
May	506	697	513	325	71.6	386	330	532	350
Jun	530	634	391	278	30.1	443	15.7	306	110
Jul	378	579	376	489	154	391	240	262	308
Aug	437	592	411	514	341	421	125	188	264
Sep	577	704	473	522	405	451	67.5	93.1	311
	2002/3	2003/4	2004/5	2005/6	2006/7	2007/8	2008/9	2009/10	2010/11
Water Y	604	780	586	529	371	485	381	319	337

704 Hurricane Frances Sept 6, 2004
278 Hurricane Alberto June 13, 2006

I have tried to find some logical explanation for the high numbers in December 2003 and January

2004; rainfall does not appear to be the answer.
There is a large gap in the 2010 data, for February(4 days data only) March and April resulting in the lines on the graph being meaningless for that time period.

From the data Kevin directed us to I have chosen 2008/9 as an example, it has the low monthly figure for June 2009 in the above table.

RESIDUAL DISCHARGE, TIDALLY FILTERED, CUBIC FEET PER SECOND WATER YEAR
OCTOBER 2008 TO SEPTEMBER 2009 DAILY MEAN VALUES

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	662	878	989	706	488	584	21	351	---	528	361	233
2	821	877	1,100	369	364	1,070	74	267	---	342	116	233
3	837	1,090	1,030	499	801	868	380	287	---	415	226	128
4	881	986	991	526	1,040	714	258	364	---	380	348	-28
5	838	796	915	294	---	430	5.4	383	---	75	319	-28
6	917	750	835	177	---	409	21	343	---	-124	167	-67
7	844	766	1,100	631	---	439	634	255	---	80	96	-45
8	520	603	744	846	---	375	329	85	---	213	137	36
9	712	879	445	698	407	365	212	255	---	327	322	202
10	831	896	332	237	151	229	113	269	242	347	201	349
11	740	643	38	184	181	247	138	275	199	191	101	241
12	646	404	926	535	523	393	344	384	147	147	94	-193
13	638	161	929	534	449	289	113	211	217	85	287	-11
14	528	-85	548	860	392	374	-122	213	154	249	234	31
15	364	372	586	1,020	679	256	300	301	137	395	153	-320
16	418	1,170	635	1,210	1,020	333	642	353	87	240	-35	-479
17	262	1,060	611	869	726	654	741	535	67	-3.6	129	-250
18	498	1,250	683	488	336	518	348	1,100	14	276	-148	-112
19	1,070	---	690	493	---	499	-80	1,200	-59	398	-416	-121
20	773	---	721	1,220	---	695	-126	472	-82	248	-432	-84
21	697	---	994	983	---	882	258	374	-112	92	-84	92
22	840	---	1,200	603	---	675	582	288	89	139	63	120
23	586	669	644	586	931	176	494	109	219	164	105	182
24	172	480	524	447	561	-55	398	226	25	93	201	209
25	561	673	513	355	383	-234	580	102	-221	128	246	306
26	690	629	573	497	272	-346	365	-67	-496	287	301	401
27	---	529	535	452	141	-476	299	66	-245	380	134	340
28	---	394	583	387	-138	-362	209	117	-63	338	47	239
29	---	179	550	644	---	340	86	227	-213	252	200	243
30	---	388	518	971	---	426	207	565	223	317	211	177
31	1,020	---	771	873	---	127	---	---	---	448	204	---
Mean	680	671	718	619	485	351	261	330	15.7	240	125	67.5
Max	1,070	1,250	1,200	1,220	1,040	1,070	741	1,200	242	528	361	401
Min	172	-85	38	177	-138	-476	-126	-67	-496	-124	-432	-479

In addition to the yellow highlighted days, look at the Min-Max spread for each of the months. I must be missing something about what this data means, hence my reservation.

May be when I get time I will again take a look at the discharge data using the tidal cycle approach.

Martyn

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From:	Doug Leeper
To:	Xinjian Chen; Sid Flannery; Mike Heyl; Gary E. Williams; Ron Basso
Cc:	Kevin Grimsley (kjgrims@usgs.gov); (KHackett@JanickiEnvironmental.com)
Subject:	Update MJohnson Bagley Cove Q Issues
Date:	Monday, February 27, 2012 8:14:39 AM
Attachments:	1357 E-Mail from MJohnson to DLeeper & KGrimsley - FW_ Crystal River Spring Discharge 17feb2012.pdf 1358 E-Mail from KGrimsley to MJohnson - Re_ FW_ Crystal River Spring Discharge 17feb2012.pdf 1359 E-Mail from MJohnson to KGrimsley - RE_ Crystal River Spring Discharge 18feb2012.pdf 1360 E-Mail from KGrimsley to MJohnson - Re_ Crystal River Spring Discharge 18aug2012.pdf 1371 E-Mail from MJohnson - RE_ Crystal River Spring Discharge 25feb2012.pdf

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Greetings:

Attached a set of recent e-mails from/to Martyn Johnson regarding discharge measurement at the USGS Bagley Cove site on Crystal River. Mr. Johnson's most recent e-mail from February 25th is directed to me. Not sure whether I need to respond to anything in this e-mail, but some of my thoughts regarding the points he raised are outlined below. Figured I would pass this information along to keep you updated on Crystal River flows issues and determine whether you have any advice/thoughts regarding Mr. Johnson's comments.

My initial thoughts regarding the main themes in Mr. Johnson's February 25th e-mail:

1. The downward discharge trend identified by Mr. Johnson as "alarming" seems consistent with rainfall pattern.

2. Mr. Johnson's assertion that the "*purpose of tidally filtering was to be able to see the underlying discharge from the springs*" is not quite right, as we discussed at our recent meeting in Brooksville and as described in the text below, from the USGS Water-Data Report 2010 for the Bagley Cove site.

"The residual discharges are not total "freshwater" flow, but are a combination of freshwater flow and water storage caused by higher or lower Gulf of Mexico mean water levels. The residual discharge is used to estimate mean daily discharge values. By convention, the U.S. Geological Survey has established ebb (seaward) flows as positive flow and flood (landward) flows as negative flows."

Given this description of what the residual discharge values for the Bagley Cove site represent, I still believe that the discharge time-series for the site does represent one of our best tools for approximating the long-term combined discharge from the springs in Kings Bay.

3. Finally, the negative flows issue. Although we discussed negative flow values at our recent meeting, I'm not quite sure I can account for their frequency in the Bagley Cove record, other than to note that the reported residual flows account for freshwater flow, upstream storage effects and tide stage.

Douglas A. Leeper
Chief Environmental Scientist
Resource Projects Department
Southwest Florida Water Management District
2379 Broad Street
Brooksville, Florida 34604-6899
1-800-423-1476, ext. 4272 (FL only)
352-796-7211, ext. 4272
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Herald-Tribune

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Saving manatees from the cold, naturally

By Kate Spinner
Published: Friday, February 24, 2012 at 4:27 p.m.

Before settlers ditched and drained Florida, more water bubbled up from beneath the ground to feed rivers and streams or seeped slowly into creeks from soggy wetlands. Warmed by the Earth, that water kept manatees alive during the chilliest days of winter.

But Florida's development upended that natural system. Now the endangered manatees, aquatic cousins to the elephant, rely largely on people's demand for electricity to get them through the winter.

Power plants provide the only source of warmth in many of the state's diminished waterways, attracting manatees by the hundreds during cold snaps. Yet state wildlife regulators say power plants are not manatees' best insurance plan, because they can fail suddenly, may close temporarily or have to be remodeled.

Hundreds of manatees died during the last two years — two of the coldest winters on record — but even more would have perished if even one power plant failed. The need is so critical that Florida Power & Light is spending $250,000 a year to keep water warm for manatees at its Cape Canaveral plant while a new operation is being built there.

Thinking long-term, the Florida Fish and Wildlife Conservation Commission is looking to the state's remaining natural areas — including one in North Port — to provide permanent manatee protection during cold days.

Successfully preserving natural warm areas hinges on limiting the amount of water people take from the spring-fed rivers for drinking water, agriculture, recreation and other uses.

But a separate agency, the Southwest Florida Water Management District, determines how much water can be taken from rivers and streams, through regulations called minimum flows.

Flows in almost every spring in the state are declining, but not quite enough to significantly put manatees in danger now, said Ron Mezich, a biological scientist with the FWC. The pressure on those resources is increasing, however.

"We're in pretty good shape. That's why we're pushing for these minimum flows to get set now rather than later so we don't lose more flow than necessary," Mezich said.

Need for warmth

Manatees require warm water to survive the winter. When water temperatures fall below 68 degrees, the large animals swim inland, finding refuge in spring-fed creeks and rivers where water temperatures are higher.

This year's mild weather made the winter easy for the big mammals. Only nine so far this year have been found dead from cold stress, even after a few days of near freezing weather.

The story was different in 2010 and 2011, when prolonged freezes took an enormous toll. Wildlife rescuers found about 400 dead manatees, with the likelihood that many more died out of sight.

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Those large numbers, for a population of animals estimated at about 5,000, raised questions among FWC staff and manatee advocates about whether there are enough natural warm sites for manatees to gather.

Although hundreds of manatees congregate at power plants to shelter from the cold, a failure of the plant or a reduction in its heat generation could lead to a deadly situation. Manatees also tend to survive better at natural sites, manatee advocates say.

"Certainly manatees are most protected at natural warm water sites and we've seen that in the last few winters," said Katie Tripp, director of science and conservation with Save the Manatee Club. "The cold stress in and around the springs has been lower than it has been around power plant waters because it's natural."

Managing flow

Once the water district sets a minimum flow, it puts a limit on how much water developers, farmers or other industries can take from the river or its surrounding aquifers.

In the Homosassa, Chassahowitzka and Crystal rivers north of Tampa, springs keep 72-degree water constantly flowing. During cold days, hundreds of manatees pack into those rivers, making them among the most important refuges in the state.

To protect them, the water district was originally supposed to set minimum flows for the Crystal River in 2010 and the other two rivers in 2011.

"We're a little bit delayed relative to our original schedule," said Doug Leeper, the water district's chief environmental scientist. He blamed the delay on the complexity of the river systems and the large number of "stakeholders."

Among the most contentious is the Chassahowitzka. The district proposed that the river could handle an 11 percent reduction in flow without significantly harming wildlife, including manatees. Residents protested, appalled at any flow reduction.

The district is not allowed to set a minimum flow that would cause significant harm, a subjective threshold.

Leeper said the district is in talks with residents but any proposed minimum flow has to be approved by the governor-appointed board that manages the water district. Pressure comes from both sides: residents and those who may want to tap the river's water in the future.

"Those pressures don't necessarily influence the scientific basis for minimum flows, but they can come into play when political bodies, such as the governing board, decides not to implement minimum flows," Leeper said.

On the northeast coast of Florida, where Blue Spring also draws hundreds of manatees, pressure from water suppliers near Orlando is threatening flow rules already in place.

"There's some push back to allow more pumping of groundwater in that area," Mezich said.

Flow protections for Blue Spring, set in 2008, came after a lengthy battle, Tripp said. The rules require flows to increase so that the spring can host more manatees in the future.

Improving access

Maintaining water flow is one part of the equation in protecting wintering manatees. Another is improving access to warm water.

Of the 22 small and large natural springs across the state, more than half have barriers that impede manatees, according to a 2006 assessment by the federal Marine Mammal Commission.

North Port's Warm Mineral Spring is one. Known as a refuge for tourists seeking a soothing dip in Florida's only true warm spring, it also could host manatees if they could get there.

The spring seeps into Salt Creek, a shallow and narrow tributary that runs straight through a neighborhood before it empties into the Myakka River.

There are weirs and low tides to navigate, limiting the number of manatees the creek can hold. Still more than 70 manatees at a time have packed the creek during cold weather.

The FWC is researching ways to make the creek more accessible, possibly by dredging parts of it, if water flows from the spring are sufficient.

Salt Creek and Warm Mineral Spring does not attract as many manatees as other refuges, but it is a critical site because it is the only natural warm water area in Southwest Florida.

"It's important," Mezich said. "In the long term it's very important."

March 21, 2012

MEMORANDUM

TO: File

FROM: Douglas A. Leeper, Chief Environmental Scientist, Ecologic Evaluation Section, Southwest Florida Water Management District

SUBJECT: Documentation of March 2012 telephone conversation with Norman Hopkins regarding minimum flows development for Crystal River/Kings Bay

---

This memorandum documents a March 21, 2012 telephone conversation between Mr. Norman Hopkins and Mr. Doug Leeper, the Southwest Florida Water Management District, concerning an e-mail sent by Mr. Martyn Johnson to Doug Leeper, Southwest Florida Water Management District on March 21, 2012.

Phone Log

Who called: Mr. Norman Hopkins
Staff contact: Doug Leeper, Ecologic Evaluation Section, SWFWMD
Issue: Crystal River/Kings Bay flows
Date: March 21, 2012

Notes:

1. Mr. Hopkins noted that Mr. Johnson's e-mail does not identify the issue of the "over-pumping effect of upconing of saltwater at the [freshwater] lens, leading to increased conductivity."

2. Noted that what Mr. Johnson commented on at the Homosassa River system may be similar to what is occurring at Black Springs in Kings Bay. Mr. Hopkins noted that water from the spring has higher conductivity than seawater in the general area downstream from the spring. Commented that Sugarmill Woods sub-division is a "notorious" overpumping area that may sit on a conduit that supplies water to Kings Bay.

3. Noted that at an upcoming Citrus Task Force Meeting, Connie Bertok from the FDEP in Tallahassee will be speaking on wetland issues.

6. Contact information.
   e-mail: norman@amyhrf.org
   Phone: 352-795-9517

DAL

From:	Gary E. Williams
To:	abiddlecomb1@gmail.com; acwilkie@ufl.edu; Al Grubman; allen.martin@MyFWC.com; Andy Houston (ahouston@crystalriverfl.org); Art Jones; Audrey Durr; Bill Caton; Bob Knight; Boyd Blihovde; Brad Rimbey; Brian Nelson; Cara S. Martin; carol_lippincott@cox.net; cdambrosio@tampabay.rr.com; Charles Kovach; Chris Keller; christine collins (christineswfwmd@yahoo.com); Chuck Jacoby (cajacoby@ufl.edu); chuck_tomberlin@yahoo.com; Dave Dewitt; debbe.hooper@bocc.citrus.fl.us; Debra Burden; deeatkins@tampabay.rr.com; don schmitz; ecasey21@hotmail.com; Eric DeHaven; Gary E. Williams; gary maidhof (gary.maidhof@bocc.citrus.fl.us); guy.means@dep.state.fl.us; info@floridakayakcompany.com; janebau@ufl.edu; Janet Mulligan; janna1@tampabay.rr.com; Jason Evans; Jeff Greenwell; Jeff Schardt; jeff.sowards@dep.state.fl.us; Jennifer Sagan [jsagan@waterandair.com]; jerry.krummrich@fwc.state.fl.us; jonathan.brucker@dep.state.fl.us; joyce_kleen@fws.gov; jpowell@sea2shore.org; jsmith1215@juno.com; kal@ifas.ufl.edu; Katie Tripp (ktripp@savethemanatee.org); kcmidway@tampabay.rr.com; Keith Morin; Kendal Harr (drharr@fvpconsultants.com); kenfrink@bellsouth.net; Kenneth Denson; Kent Smith (kent.smith@myfwc.com); Kevin Kemp ; KMitchell@argentmanagementllc.com; kostelnick@earthlink.net; Kris Kaufman; Larry Walker; manatees@habitats.org; Maria Merrill; Mark Hammond; mark.edwards@bocc.citrus.fl.us; marnold@chronicleonline.com; melissa.charbonneau@dep.state.fl.us; Michael Gudis; michael_lusk@fws.gov; Mike Czerwinski (mczerwinski@mgcenvironmental.com); nhopkin1@tampabay.rr.com; nicholas.robbins@dep.state.fl.us; nicole_adimey@fws.gov; Paula Coble "Paula Coble" "Paula Coble" <pcoble@marine.usf.edu> (pcoble@marine.usf.edu); randy.havens@myfwc.com; Rebecca Bays; RG Schmidt; Richard.Owen@dep.state.fl.us; Rick Hicks, FDEP; rmille76@tampabay.rr.com; Robbie Lovestrand (robert.lovestrand@myfwc.com); Robyn Comney (conmy.robyn@epa.gov); ron.mezich@fwc.state.fl.us; ron@barbaron.com; samhernbch@yahoo.com; Sandra Clodwick (sandra@sandraclodwick.com); shea.armstrong@myfwc.com; skynote@ufl.edu; Steve Kingery (skor1@netzero.net); Steve Shea; susan_butler@usgs.gov; Terri Calleson; Terry Hansen; texasaquatic@aol.com; Tom Frazer (frazer@ufl.edu); tracylynnc@peoplepc.com; Veronica Craw; Virginia Singer; wgarvin@tampabay.rr.com; William Robinson
Cc:	Kevin Grimsley (kjgrims@usgs.gov); Xinjian Chen; Hansen, Terry; Chris Anastasiou; Mike Heyl; Sid Flannery; Doug Leeper
Subject:	Reminder: Kings Bay Working Group meeting on May 3
Date:	Thursday, April 26, 2012 11:26:38 AM
Attachments:	Map to Visitor Center.pdf

Just a quick reminder that there is a Kings Bay Working Group meeting on May 3 from 2 – 4 pm at the visitor center of Crystal River Preserve State Park. Note that the tentative Beemats item on the agenda I previously sent out has been cancelled. See you next week.
Gary

KINGS BAY WORKING GROUP

MEETING AGENDA

MAY 3,

2012

2:00 pm – 4:00 pm MEETING OF THE KINGS BAY WORKING GROUP

Agenda Item #1 WELCOME/INTRODUCTIONS
-Gary Williams and Chris Anastasio, Southwest Florida Water Management District

Agenda Item #2 KINGS BAY TOTAL MAXIMUM DAILY LOAD (TMDL)/BASIN MANAGEMENT ACTION PLAN (BMAP) PROCESS
-Terry Hansen, Florida Department of Environmental Protection

Agenda Item #3	MEASURING DISCHARGE IN CRYSTAL RIVER AT BAGLEY COVE -Kevin Grimsley, United States Geological Survey
Agenda Item #4	MODELING HYDRODYNAMICS IN CRYSTAL RIVER/KINGS BAY -Xinjian Chen, Southwest Florida Water Management District
Agenda Item #5	NEWS FROM OTHER MEMBERS
Agenda Item #6	ADJOURN

Modeling Hydrodynamics in Crystal River/Kings Bay

XinJian Chen, Ph.D., P.E.
Southwest Florida Water Management District

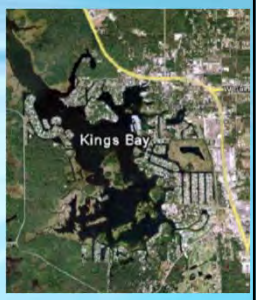
Kings Bay Working Shop
Crystal River State Preserve Visitor Center
Crystal River, FL 34428
May 3, 2012



Outline of the Presentation

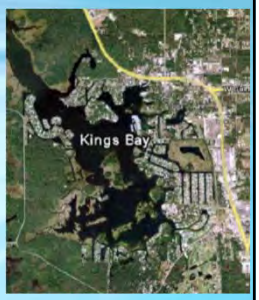
- Background
- UnLESS3D Model
- Data Needed for Model Application
- Model Results
- Spring Flow
- Summary

- Kings Bay is a small embayment (2.43 km^2) with about 72 detectable spring vents and countless hairline fractures.
- Many islands, finger channels, and spring runs – all in comparable length scale with the passage of water in the bay.



Background

- A first magnitude spring system, with spring flows contributing ~ 99% of total freshwater loading to the estuary.
- Spring discharges vary with tides.
- Spring flows have a relatively constant temperature at ~22 - 23 ^0C, making it a large natural refuge site for manatees in cold winters.



Objectives

Purpose:

- Protect existing thermo-characteristics
- Protect existing low salinity habitats
- Improving flushing

MFL Evaluation:

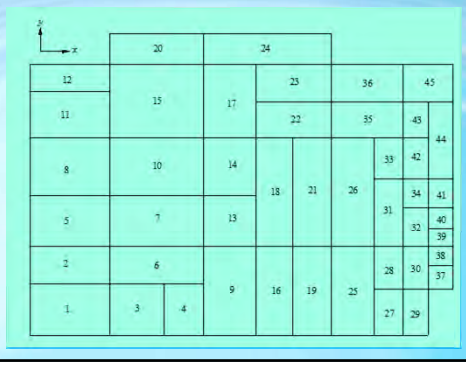
- Data collections
- Analyses of field data
- Modeling hydrodynamics

Major Features of UnLESS3D

1. Solves flux-based finite difference equations – FV model;
2. Uses Z-levels with hybrid grids: regular Cartesian grid cells for inner areas & cut-cells for bottom and boundary areas , allowing automatically tracking of shoreline variations (wetting & drying;)
3. Uses unstructured Cartesian grids, allowing the grid size to be split in both the x- and y-directions simultaneously;
4. Allows grid size to be arbitrarily reduced without any restrictions which are often imposed on other unstructured grid models;
5. Has no internal-external mode splitting;
6. Uses E-L method for convection terms; and
7. Uses a very efficient semi-implicit scheme, the FSC method, which is unconditionally stable with respect to gravity waves, bottom frictions, and vertically eddy viscosity terms.

UnLESS3D Model

Typical UnLESS3D Mesh



3D Governing Equations

Continuity:

$$\frac{\partial u_I}{\partial x_I} = 0 \rightarrow \frac{\partial \eta}{\partial t} = -\frac{\partial}{\partial x_1}\int_{h_0}^{\eta} u_1 d\xi - \frac{\partial}{\partial x_2}\int_{h_0}^{\eta} u_2 d\xi + r$$

Momentum:

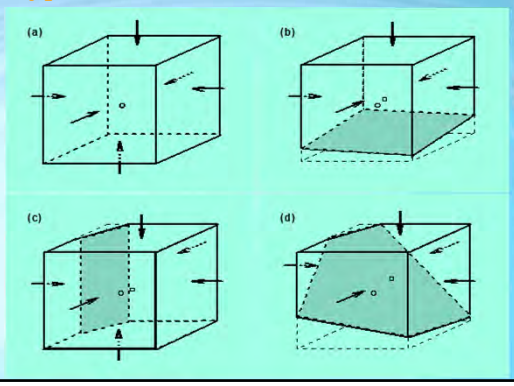
$$\frac{du_I}{dt} = \frac{\partial u_I}{\partial t} + u_m \frac{\partial u_I}{\partial x_m} = -\frac{g}{\rho}\frac{\partial}{\partial x_I}\left(\int_z^{\eta} \rho d\xi\right) + \phi_I + \frac{\partial}{\partial x_m}\left(A\frac{\partial u_I}{\partial x_m}\right)$$

$$\phi_I = (fu_2, -fu_1, -g)$$

Transport:

$$\frac{\partial c}{\partial t} + \frac{\partial u_m c}{\partial x_m} = \frac{\partial}{\partial x_m}\left(B\frac{\partial c}{\partial x_m}\right) + S + R$$

Types of Grid Cells



UnLESS3D-Related Publications - Selected

XinJian Chen. 2003. A free-surface correction method for simulating shallow water flows. *J. Comput. Phys.*, 189: 557-578.

XinJian Chen. 2004. A Cartesian method for fitting the bathymetry and tracking the dynamic position of the shoreline in a three-dimensional, hydrodynamic model. *J. Comput. Phys.*, 42: 233-247.

XinJian Chen. 2009. A Three-Dimensional Unstructured Cartesian Grid Model for Crystal River/Kings Bay in Southwest Florida. *ASCE Proceedings of Estuarine & Coastal Modeling, 11*, 173:186.

XinJian Chen. 2011. A Three-Dimensional Hydrodynamic Model Using Unstructured Cartesian Grids. *Int. J. Numer. Methods Fluids*, 66:885-905, DOI:10.1002/fld.2290.

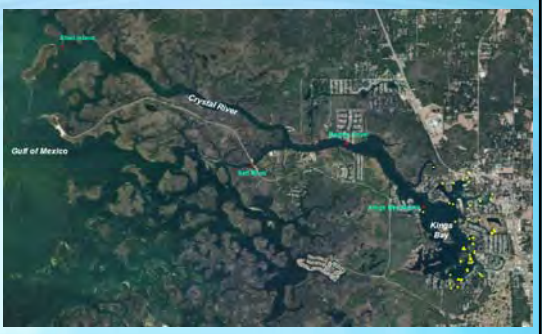
Model Calibration/Verification

Continuous recordings of
- water level,
- current,
- salinity, and
- temperature

inside the simulation domain.

Data Needed for Model Application

Data Locations



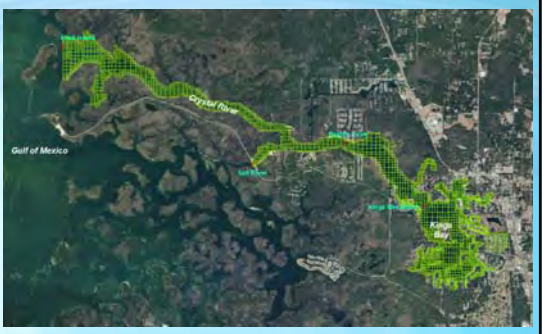
Boundary Conditions

Water levels, salinities and temperatures at open boundaries (the mouth of Crystal River and Salt River),

Spring flows

Wind speed and direction, solar radiation, air temperature, and air humidity

Crystal River / Kings Bay Mesh



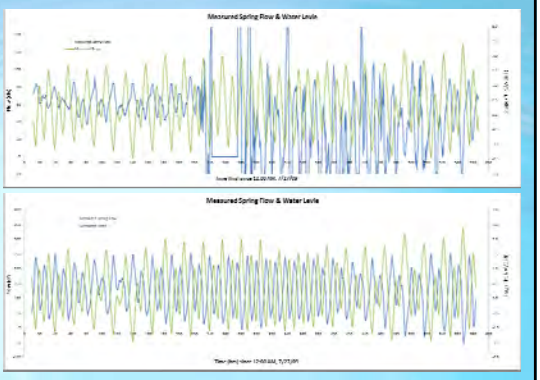
Uncertainties in Spring Flow Data

Based on limited measurements, an earlier USGS study estimated the average total spring discharge during 1965 - 1977 to be about 975 cfs.

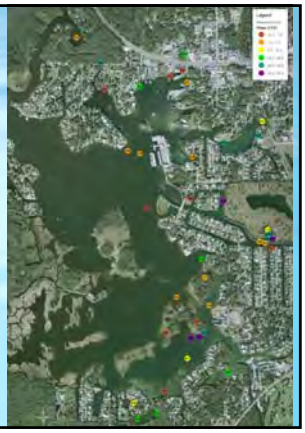
A June 1990 USGS study identified 28 spring vents with a measured total discharge of 735 cfs.

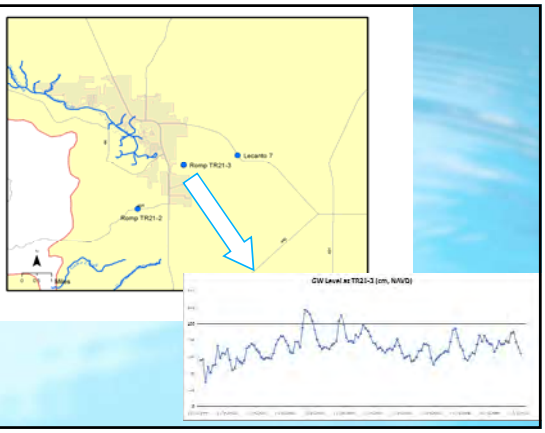
In a 2009 SWFWMD study, 72 spring vents were identified with a measured total discharge of about 490 cfs.

District's GW model suggests that spring discharge closer to the lowest of the above three numbers.

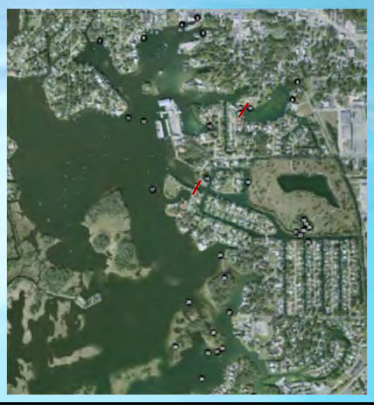


Measured Spring Flows in Fall 2009 – Rates are Averages of Multiple Measurements



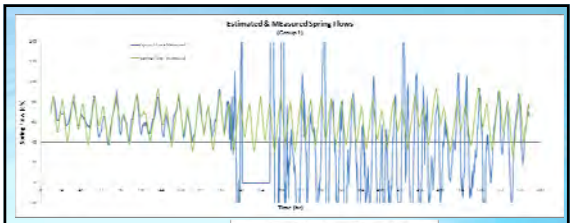


ADCP Data

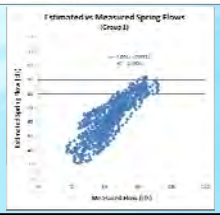


$$Q = Q_0\left[1 + C_1(G - G_0 - \eta) + C_2\frac{\partial \eta}{\partial t}\right]$$

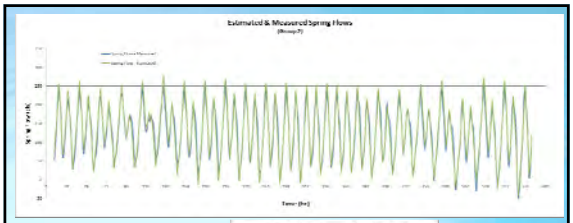
Q = Estimated spring flow
Q_0 = Measured average spring flow
G = Groundwater level
G_0 = Baseline GW level
η = Surface water level
C_1 = Coefficient
C_2 = Coefficient



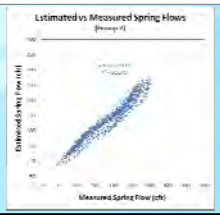
G_0 = 2.48 ft, NAVD88
C_1 = 0.268 ft^{-1}
C_2 = 342.0 sec ft^{-1}



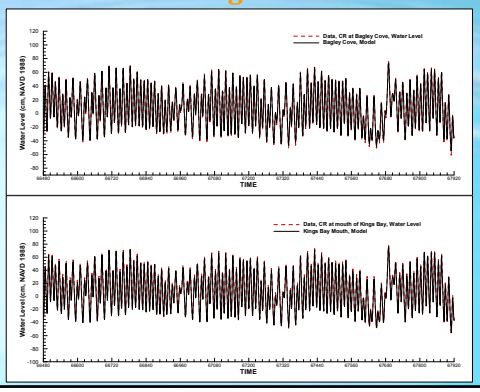
Model Results



G_0 = 2.354 ft, NAVD88
C_1 = 0.502 ft^{-1}
C_2 = 2448.0 sec ft^{-1}



Model Results - Stage



Spring Flow Modeling

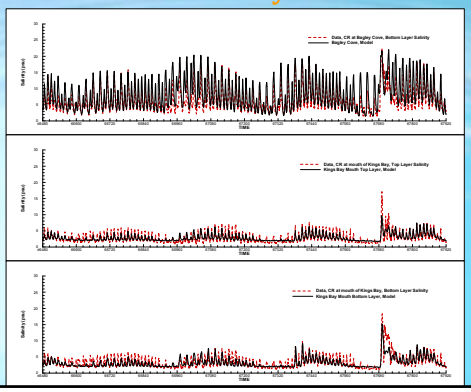
Use Group 1 parameters (G_0, C_1, C_2) for vents north of Group 2 ADCP site

Use Group 2 parameters (G_0, C_1, C_2) for the remaining vents

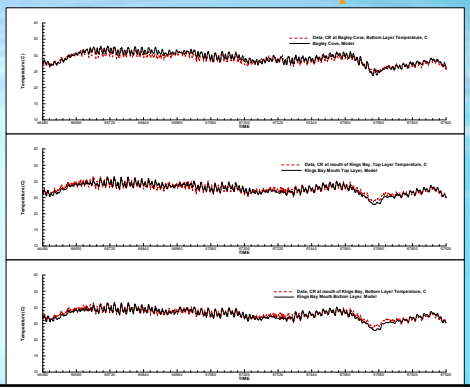
Overall Spring Flow = $\Sigma Q_{vent} + F \times \Sigma Q_r$

- Q_r represents contributions of flows from hairline fractures,
- 40 Q_rs are randomly (both location & rate) distributed in Kings Bay according to a uniform distribution,
- ΣQ_r = 400 cfs, and
- F = 0.1.

Model Results - Salinity

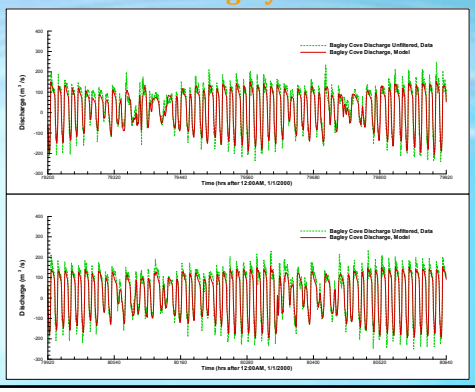


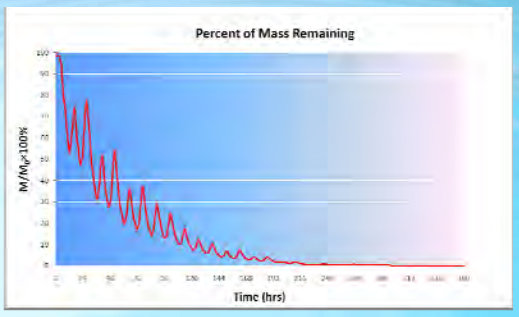
Model Results – Water Temperature



Movies of model results during February 8 – 11, 2009, during which air temperature ranged between 2 and 25.1 °C (35.6 – 77.18 °F)

Model Results – Bagley Cove Flux

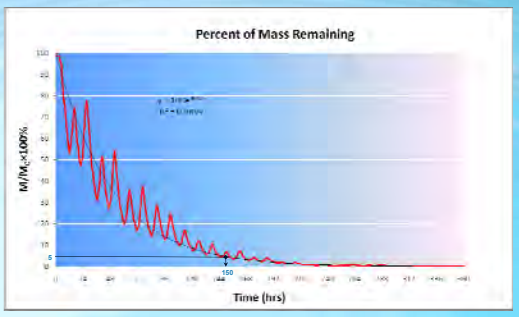


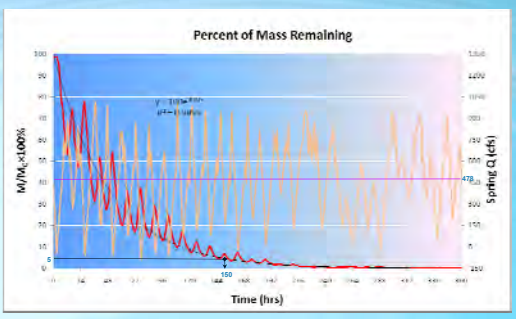


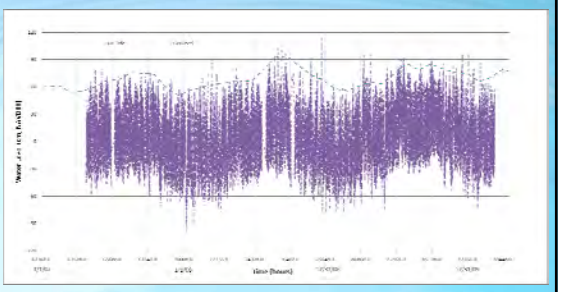
Fitness of the Model - Some Statistics

	Mean Error	Mean Abs. Error	Skill
Bagley Cove Water Level (cm)	1.01	3.21	0.99
Mouth of Kings Bay WL (cm)	0.79	4.51	0.99
Average for Water Level (cm)	0.90	3.86	0.99
Bagley Cove Salinity (psu)	1.15	2.41	0.80
Mouth of Kings Bay Top Layer Sal (psu)	-0.48	0.86	0.76
Mouth of Kings Bay Bottom Layer Sal (psu)	-0.85	1.35	0.70
Average for Salinity (psu)	-0.06	1.54	0.75
Bagley Cove Temperature (°C)	0.15	0.73	0.99
Mouth of Kings Bay Top Layer Temp (°C)	-0.04	0.70	0.98
Mouth of Kings Bay Bottom Layer Temp (°C)	-0.02	0.77	0.98
Average for Temperature (°C)	0.03	0.73	0.98
Bagley Cove Cross-Sectional Flux ($m^3\ sec^{-1}$)	-9.28	29.14	0.97

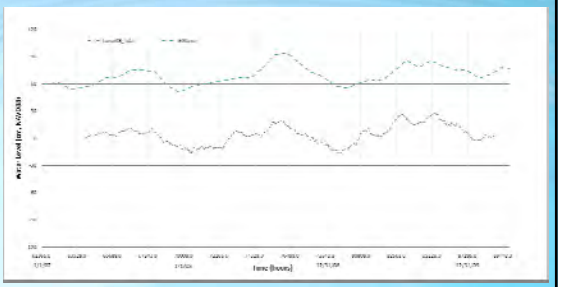
$$Skill = 1 - \frac{\sum (y^M - y^D)^2}{\sum (|y^M - \overline{y^D}| + |y^D - \overline{y^D}|)^2}$$





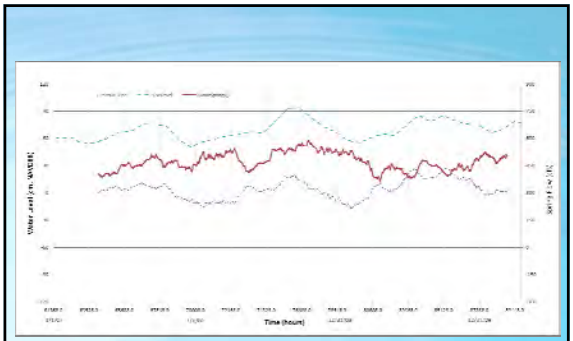


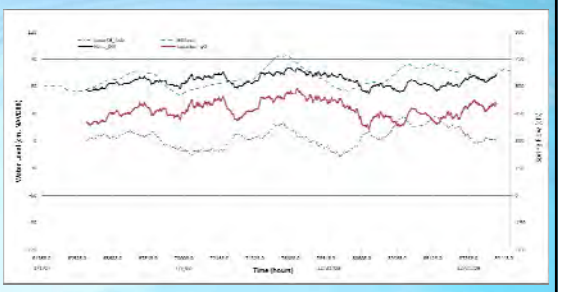
Spring Flow



Certainties in Spring Flow Data

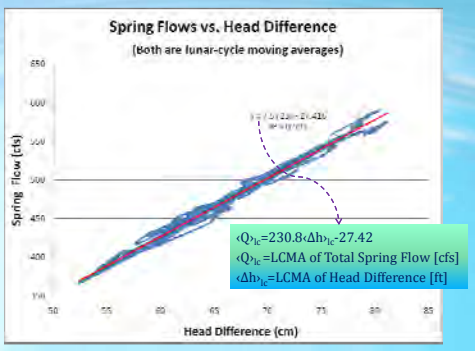
1. Tides affect spring flows;
2. Groundwater level affects spring flow rates;
3. Salinities in spring flows vary with tides & location;
4. Temperatures in spring flows are almost the same both spatially and temporally; and
5. Because of 1 & 2, and difficulties in the field measurement, a reliable method for estimating spring flow is hard to obtained but desirable.





Summary

- For management purpose, total spring flow can be estimated as $\langle Q \rangle_{lc}=230.8\langle \Delta h \rangle_{lc}-27.42$.
- Estuarine residence time depends on the spring discharges. With an average total spring flow of 478 cfs, estuarine residence time for Kings Bay is roughly 150 hours.



Thank You!

Summary

- A 3-D model named UnLESS3D has been developed and applied to Crystal River/ Kings Bay.
- The model application is successful with good matches of simulated results with measured data.
- Based on field data, spring flow from each vent can be estimated with an empirical formula ($Q=Q_0[1+C_1(G-G_0-\eta)+C_2\partial\eta/\partial t]$), which allows UnLESS3D to be successfully calibrated and verified against real-time data of stage, salinity, and temperature.

From:	SWFWMD Daily Media Report
To:	All_Users
Subject:	SWFWMD Daily Media Report
Date:	Friday, June 01, 2012 3:27:56 PM

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
DAILY MEDIA CONTACTS
6/01/2012
As of 3:30 p.m.

Reporter's Name: Ray Reyes
Media Outlet: Tampa Tribune
Reason for Call: Rainfall
Agency's Response: Reporter spoke with several District staff members in response to today's rainfall in the Tampa Bay area. Staff discussed that the rainfall was helpful but the region will need much more as we head into the summer rainy season.

Reporter's Name: Charlie Brennan
Media Outlet: Citrus County Chronicle
Reason for Call: Sea Level Rise
Agency's Response: Editorial editor contacted staff to confirm whether a statement in a recently submitted guest column is accurate. The guest column states that there has been a six-inch rise in Kings Bay and Crystal River over the last 30 years as a result of climate change according to the District. Staff explained that there has been about a 2.4-inch rise over the last 30 years as a result of sea level rise.

Reporter's Name: Mike Wright
Media Outlet: Citrus County Chronicle
Reason for Call: Lake Levels
Agency's Response: Reporter requested and was provided with data by District Operations staff for Lake Rousseau and the Tsala Apopka Chain of Lakes in response to the recent rainfall.

Reporter's Name: Matthew Seeger
Media Outlet: WUSF-FM
Reason for Call: Rainfall
Agency's Response: Reporter conducted a telephone interview with a District staff member in response to today's rainfall in the Tampa Bay area. Staff discussed that the rainfall was helpful but the region will need much more as we head into the summer rainy season.

From: SWFWMD Daily Media Report
To: All_Users
Subject: SWFWMD Daily Media Report
Date: Thursday, August 23, 2012 4:17:43 PM

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
DAILY MEDIA CONTACTS
8/23/2012
As of 4:00 p.m.

Reporter's Name: Mike Reeves
Media Outlet: WXJB-FM
Reason for Call: Rainfall
Agency's Response: Morning show host interviewed a District staff member this morning regarding the recent rainfall, Tropical Storm Isaac and controlled burns.

Reporter's Name: Mac Harris
Media Outlet: Citrus County Chronicle
Reason for Call: Bottled Water Permit
Agency's Response: Editorial board member contacted staff to find out what the basis is for the permitted amount of 76,700 gallons per day for a bottled water permit recently issued in Crystal River. Staff discussed that the amount is based on the permittee's commitment to sell 28 million gallons of water per day to an Ocala bottled water company.

Reporter's Name: Jim Hunter
Media Outlet: Citrus County Chronicle
Reason for Call: Citrus County Task Force
Agency's Response: Reporter contacted staff about a Homosassa River project that will be discussed at the next Citrus County Task Force Meeting. Reporter spoke to the District's Environmental manager who discussed that the District is providing technical assistance to the Homosassa River Alliance for the Mitten Cove Restoration project, which will be presented at the next task force meeting on Sept. 10. The pilot project involves sediment removal and revegetation.

Reporter's Name: Jim Hunter
Media Outlet: Citrus County Chronicle
Reason for Call: FDOT Mitigation
Agency's Response: Reporter contacted staff after hearing that FDOT may be planning to purchase some mitigation credits in Citrus County for an I-75 project. Reporter spoke to the District's Environmental manager who explained that FDOT has removed two I-75 road construction projects from the District's FDOT mitigation plan. Reporter was referred to FDOT for additional information.

Reporter's Name: Jim Hunter
Media Outlet: Citrus County Chronicle
Reason for Call: Kings Bay Park Lagoon Restoration Project
Agency's Response: Reporter contacted staff to get the status of the Kings Bay Park Lagoon Restoration Project. Reporter spoke to the District's Environmental manager who explained that the design and permitting for the cooperatively funded project is currently included in the District's FY2013 tentative budget. Citrus County will need to apply for additional cooperative funding in FY2014 for the construction. The pilot project includes sediment removal and revegation in a small portion of

Kings Bay. Citrus County is the lead on the project.

Reporter's Name: A.B. Sidibe
Media Outlet: Citrus County Chronicle
Reason for Call: Lake Levels
Agency's Response: Reporter contacted staff to set up an interview about lake levels in Citrus County for a story he is working on for Sunday. The District's Hydrologic Data manager is scheduled to speak with the reporter tomorrow morning.

Reporter's Name: Laura Kinsler
Media Outlet: Tampa Tribune
Reason for Call: Governor's Study Committee
Agency's Response: Reporter contacted staff to speak with the District's Utility Services Program chief about being appointed to the Governor's Study Committee on Investor-Owned Water and Wastewater Utility Systems. Staff discussed that the committee will study issues facing small private utilities and come up with recommended solutions. The committee's first meeting is scheduled for Sept. 6 in Tallahassee.

Reporter's Name: Gary Pinnell
Media Outlet: Highlands Today
Reason for Call: Tropical Storm Isaac
Agency's Response: Reporter contacted the District to find out if the District is preparing for Tropical Storm Isaac. Reporter was told that staff is discussing preparations today.

Reporter's Name: A.B. Sidibe
Media Outlet: Citrus County Chronicle
Reason for Call: Unauthorized Construction
Agency's Response: Reporter contacted staff regarding some unauthorized grading and filling activities that occurred in Crystal River, causing a restaurant to flood. Reporter wanted to confirm that the District has visited the site and told the property owner to remove the fill material. Staff is researching.

Reporter's Name: Anna Phillips
Media Outlet: Tampa Bay Times
Reason for Call: Hillsborough River Levels
Agency's Response: Reporter contacted staff to get water levels for the Hillsborough River. The District's Hydrologic Data manager spoke with the reporter this afternoon and provided her with a link to the National Weather Service Southeast River Forecast Center for the current elevation and flood stage of the river.

Chassahowitzka and Homosassa River Systems
PUBLIC MEETING COMMENT CARD

Southwest Florida Water Management District

Your comments will be provided to the Governing Board. Please make sure t clearly print your name and email address or phone number. Thank you for your comments.

Name SHARON KERNER **Date**

Email Address or Phone Number Sharonkerner1@yahoo.com 10/8/2012

We have a significant water abuse problem. We must act to change the proposed consumptive-use rules and change minimum flow levels to ZERO percent! Increasing minimum flow levels will cause "significant harm" and irreparable damage to ALL of our rivers and habitats. Saltwater intrusion is imminent. We ALL must actively participate in cleaning up and protecting our springs, rivers and aquifers. Recharge is wholly dependent on rainfall – it's a fact, as aquifer levels fall, springs flow with less vigor. There is a direct correlation between water quantity and water quality. As quoted by Art Jones, "dilution is the solution to pollution."

I am outraged over a $50.00 water permit issued by SWFWMD to allow between 76,000 and 153,000 gallons of water per DAY be pumped, shipped, bottled and sold by a private bottling company for a 10 year span within Crystal River city limits. Neither Crystal River nor Citrus County will realize 1 cent of revenue from this debacle. AND it water is NOT even metered. Who knows what at means! This was just a BAD decision. Permit requirements must be changed!

Safeguards must be established to curb our wasteful and contaminating water usage. Do away with septic tanks, plant Florida friendly landscapes, install duel-flush toilets, minimize or use slow-release fertilizer, and install rain barrels. Be creative and conscientious stewards of our natural recourses. We ALL must protect the future of our state's water supply and the vitality of our delicate aquatic ecosystems, including our manatees. Support laws and leaders who are committed to the principles of sustaining our precious water! VOTE, NEVER GIVE UP AND BUY AMERICAN!

tity.

SKerner
3885 N Nokomis Pt
CR, FL 34428

S.W.F.W.M.D.
2379 Broad St.
Brooksville, FL

October 4, 2012

MEMORANDUM

TO: File

FROM: Douglas A. Leeper, Chief Environmental Scientist, Ecologic Evaluation Section, Southwest Florida Water Management District

SUBJECT: Documentation of October 4, 2012 telephone conversation with Norman Hopkins regarding minimum flows development for Chassahowitzka/Homosassa/Crystal systems

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This memorandum documents an October 4, 2012 telephone conversation between Mr. Norman Hopkins and Mr. Doug Leeper, the Southwest Florida Water Management District, concerning development of minimum flows for the Chassahowitzka and Homosassa River systems and the planned minimum flows work for the Crystal River/Kings Bay system.

Phone Log

Who called: Mr. Norman Hopkins
e-mail: norman@amyhrf.org
Phone: 352-795-9517
Staff contact: Doug Leeper, Water Resources Bureau, SWFWMD
Issue: Chassahowitzka/Homosassa/Crystal River/Kings Bay minimum flows
Date: October 4, 2012

Notes:
Questions/comments

1. Are you confident that you have established a cause and effect relationship between changes in flows and changes in the environment?
2. If the environmental change that has occurred is associated with a 1% change in flows what effects will 2 or 3% or higher percentage changes have?
3. Change in salinity in the rivers is a function of changes in incursion of Gulf water and changes in salinity of water coming from the springs.
4. Have seen substantial changes in vegetation and fish over the past 15 years at Kings Bay.
5. Ecosystems are too complex to try to make predictions based on a single parameter.
6. Relationships of pollutants and toxics to flows in the rivers have not been well studied and integrated into the minimum flows work.
7. Should implement a hiatus on withdrawals unless it can be determined that a withdrawal will benefit a water resource. This can be accomplished given the economic downturn.
8. The implementation/development of MFLs has been "corrupted" from its original intent.
9. Economy of Springs Coast region will not support funding requirements for future needed recovery projects.
10. Must consider economic effects of setting MFLs.
11. Must consider the effects of pollutants when setting MFLs.

DAL

From: Ron Miller
To: Doug Leeper
Subject: Homosassa WUCA
Date: Wednesday, October 31, 2012 11:25:12 AM

Hi Doug,

Interesting meeting yesterday.

What specifically is a Water Use Caution Area? How and where does it affect water permits?

I think the decision to re-evaluate this in 6 years would demand better water flow measurement for the Homosassa. I will never believe a well in Weeki Watchee helps with an accurate measurement of the Homosassa Flow. After all the NDM showed that the Chazz MFL could be controlled different from the Homosassa.

Best Regards,

Ron

From:	Doug Leeper
To:	"Ron Miller"
Bcc:	Adrienne Vining; Chris Anastasiou; Chris Zajac; Dave Dewitt; Doug Leeper; Ed Call; Eric DeHaven; Gary E. Williams; Jay Yingling; Jerry Mallams; Karen West; Kenneth R. Herd; Laura Donaldson; Lou Kavouras; Mark Barcelo; Mark Hammond; Michael Molligan; Mike Heyl; Robyn O. Felix; Ron Basso; Sid Flannery; Tammy Hinkle; Veronica Craw; Virginia Singer; Xinjian Chen; Yassert Gonzalez
Subject:	RE: MFL Questions
Date:	Tuesday, November 13, 2012 12:08:00 PM

Hi Ron:

Thanks for your recent e-mail. I've reproduced your questions below and provided what I hope you find to be useful responses.

1. At the Governing Board meeting last week someone said that the 3% MFL was the lower than any other MFL except for one case. What was that case and what was the resulting water management action?

The statement at the Governing Board meeting was made in reference to the minimum flows established by the St. Johns River Water Management District for Blue Spring in Volusia County. The rule amendments adopted for this priority water body require a phased increase in five-year average spring flow from the current rate to a rate corresponding to the higher, long-term average flow for the spring. Full implementation of this minimum flow may accordingly be characterized as an allowable 0% flow reduction.

2. What is the status of the Crystal River MFL program? Some folks tell me it has been put on hold.

As part of the annual update of our Minimum Flows and Levels Priority List and Schedule, the District Governing Board recently approved the rescheduling of minimum flows adoption for the Crystal River System and Kings Bay Springs for fiscal year 2014 (our fiscal year 2014 runs from October 1, 2013 through September 30, 2014). The updated priority list and schedule reflecting this and other changes will be submitted to the Department of Environmental Protection by November 15, 2012 for review and approval. Staff continues to work on data collection, compilation and analysis in support of the development of minimum flow recommendations for the river/spring system by the end of fiscal year 2014. For example, we are currently working with a consultant on the collection of additional discharge measurements from several springs in the bay.

3. How do you plan to implement the directive by the Governing Board to set a framework for a WUCA for Hernando & Citrus Counties?

To address development of a framework for the potential designation of Hernando and Citrus counties as a Water Use Caution Area, staff will be compiling information on a variety of factors for the Board's consideration. These factors may include but not be limited to: water levels in lakes, wetlands and groundwater systems; environmental resources including vegetation, fish and wildlife; groundwater quality; adopted minimum flows and levels; current and future land-use; water supply availability; and costs associated with water supply development. Opportunities for stakeholder input to this process may involve the hosting of public meetings, direct

correspondence between stakeholders and staff or Governing Board members and exchange of information via the District web site.

Douglas A. Leeper
Chief Environmental Scientist
Water Resources Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, Florida 34604-6899
1-800-423-1476, ext. 4272 (FL only)
352-796-7211, ext. 4272
352-754-6885 (Fax)
doug.leeper@watermatters.org

From: Ron Miller [mailto:rmille76@tampabay.rr.com]
Sent: Thursday, November 08, 2012 1:32 PM
To: Doug Leeper
Subject: MFL Questions

Hi Doug,

Here are a few questions on the MFL program:

1. At the Governing Board meeting last week someone said that the 3% MFL was the lower than any other MFL except for one case. What was that case and what was the resulting water management action?

2. What is the status of the Crystal River MFL program? Some folks tell me it has been put on hold.

3. How do you plan to implement the directive by the Governing Board to set a framework for a WUCA for Hernando & Citrus Counties?

Best regards,
Ron

From:	Boyd Blihovde
To:	Jerry Mallams; Dave Dewitt; Doug Leeper; Mike Heyl; Catherine Wolden; Gary E. Williams; Ed Call; Jason Hood; Michael Lusk; Amber Breland; Dan Bove; Joyce Kleen; Chris Anastasiou
Subject:	Thanks for a very productive meeting
Date:	Wednesday, January 23, 2013 11:59:12 AM

Dave DeWitt
Doug Leeper
Mike Heyl
Gary Williams
Jason Hood
Ed Call

Thanks to you all for making the trip and helping us understand the SWFWMD and the work you do. I thought the meeting was well worth the time, but above all else I think it will help us meet our agencies objectives in the future (especially when an MFL for Crystal River is coming up)!

I hope the future meetings will be equally productive and that we can do a better job of communicating our concerns as we move forward.

I want to summarize a few key things that were brought up:

- USFWS needs to do a better job of communicating with SWFWMD
- USFWS needs to set up a meeting with Chris Anastasiou on issues involving TSS
- USFWS needs to try to attend/watch a presentation to the Gov. Board on 1.29.2013
- SWFWMD will plan another meeting (technical meeting) sometime in February
- USFWS will start winter surveys of Chass River (details need to be sorted out)
- USFWS/SWFWMD will look into other forms of monitoring that may be helpful on the Chass River (and CR)

Please add anything I've left out. Hope this helps.

Boyd Blihovde
Assistant Refuge Manager
Crystal River NWR Complex
1502 SE Kings Bay Drive
Crystal River, FL 34448
352-563-2088 x205
www.fws.gov/crystalriver

From: Gary E. Williams
To: Veronica Craw; Doug Leeper; Mike Heyl; Sean King
Subject: FW: Lunch before Kings Bay Working Group?
Date: Friday, March 29, 2013 7:12:33 AM

I'm having lunch with USFWS next week before the Kings Bay Working Group meeting. See highlighted text below.
Gary

Gary E. Williams, Ph.D
Springs and Environmental Flows Section
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, Florida 34604
Ph. (352) 796-7211 x4286

From: Lusk, Michael [mailto:michael_lusk@fws.gov]
Sent: Thursday, March 28, 2013 6:02 PM
To: Gary E. Williams
Cc: Blihovde, Boyd; Joyce Kleen Joyce_Kleen Joyce_Kleen@fws.gov (Joyce_Kleen@fws.gov)
Subject: Re: Lunch before Kings Bay Working Group?

Hi Gary,

Sounds good to me. Just let us know what time you will be coming by the office before the meeting.

We need to talk about MFL's as well. Just as a heads-up, any MFL recommended above 0 is going to put us in a very hard spot politically. Just want to give you a heads-up on the politics because it's being affected by the lyngbya removal issue.

Michael Lusk
Refuge Manager
Crystal River NWR Complex
1502 SE Kings Bay Dr
Crystal River, FL 34429
O: (352) 563-2088 ext. 202
E: Michael_Lusk@fws.gov

"We must take change by the hand or rest assuredly, change will take us by the throat." - Winston Churchill

On Thu, Mar 28, 2013 at 7:53 AM, Gary E. Williams <Gary.Williams@swfwmd.state.fl.us> wrote:

Hi All,
A few weeks ago, I had emailed about picking your brains regarding the listening session you had for the Kings Bay rule changes. Would any/all of you be able to get together for lunch next Wednesday? I'll be over for the Kings Bay Working Group meeting that day. Just let me know.
Thanks,
Gary

Gary E. Williams, Ph.D
Springs and Environmental Flows Section
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, Florida 34604
Ph. (352) 796-7211 x4286

From: Barry Billets
To: Sid Flannery; SpringsTeam
Cc: Doug Leeper
Subject: Re: Crystal River benthos report
Date: Monday, August 05, 2013 7:42:30 AM

Sid,

I really appreciate you sending me a copy of the report. It looks like all the pages came through the server. I am preparing a research proposal and am doing a literature search. This document will be helpful. Thanks! -Barry

Barry Billets, M.S.
Biologist
Gulf Archaeology Research Institute

From: Sid Flannery <Sid.Flannery@swfwmd.state.fl.us>
To: "barrybillets@yahoo.com" <barrybillets@yahoo.com>; SpringsTeam <SpringsTeam@swfwmd.state.fl.us>
Cc: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Thursday, August 1, 2013 9:28 AM
Subject: Crystal River benthos report

Barry,

Here is the Crystal River benthos report you were asking about. Please let me know that you have received it.

Sid Flannery
Chief Environmental Scientist
Southwest Florida Water Management District
2379 Broad St.
Brooksville, FL 34604-6899
phone: 352-796-7211, ext. 4277
email: sid.flannery@swfwmd.state.fl.us

RESOURCE MANAGEMENT COMMITTEE

October 25, 2016

Submit and File Report

Proposed Minimum Flow for the Crystal River / Kings Bay System Prior to Independent Scientific Peer Review Update

Purpose
To provide, for information only, the recommended minimum flow for the Crystal River / Kings Bay River System and summarize the methodologies used to develop the recommendation.

Background/History
The Crystal River Springs Group is a first-magnitude springs system consisting of a cluster of 70 springs located in Kings Bay in western Citrus County. Kings Bay is a tidally influenced embayment and is the headwater of Crystal River, which terminates approximately 6 miles west of Kings Bay in the Gulf of Mexico. Because the Crystal River / Kings Bay System is dominated by spring flow, there is little annual variation in flow, and land-use activities in the springshed affect both the quantity and quality of groundwater entering the river.

From November 1969 through October 2015, the long-term average spring flow from the Crystal River Springs Group was 374 cubic feet per second or 201 million gallons per day. Direct measurements of flow taken instantaneously from 70 spring vents and continuously over 25 days from two groups of vents were used to derive a relationship linking spring flow to water level in Kings Bay and groundwater level in a nearby well, which was then used to generate a baseline flow record, with the consideration of a flow decline estimated using version 4 of the Northern District Model (NDM) under 2010 pumping conditions.

Purpose/Approach
The purpose for establishing minimum flows is to identify limits beyond which further withdrawals would be significantly harmful to the water resource or ecology of the area. The District is required by Florida Statutes to adopt the minimum flow for the Crystal River / Kings Bay System by July 1, 2017. Minimum flows were developed for the Crystal River / Kings Bay River using the best information available, as required, and were based on all relevant environmental values identified in the Florida Water Resource Implementation Rule for consideration when setting minimum flows. Hydrodynamic modeling was used to evaluate the effects of potential flow reductions on salinity habitats, water temperature, and water-residence time in the system.

Of the results of the various habitat-based analyses used to develop a minimum flow for the Crystal River / Kings Bay System, the volume of water with salinity less than two practical salinity units was the most sensitive or restrictive to reductions in flow. The recommended minimum flow for the Crystal River / Kings Bay System is 88 percent of the natural flow, i.e., 88 percent of the flow that would exist in the absence of water withdrawal impacts. The District will reevaluate this minimum flow within ten years of its adoption into rule.

The minimum flow recommendation for the Crystal River / Kings Bay System is protective of all relevant environmental values identified for consideration in the Water Resource Implementation Rule when establishing minimum flows and levels. Updated groundwater

modeling (NDM, Version 5) indicates that the existing spring flow is above the minimum flow and the predicted spring flow in 20 years is projected to remain above the minimum flow. Therefore, the proposed minimum flow is being met and a recovery strategy is not required.

The data, methodologies, and models used to develop the recommended minimum flow are summarized in the report "*Recommended Minimum Flow for the Crystal River / Kings Bay System - Peer Review Draft,*" which is provided under separate cover.

Benefits/Costs

The recommended minimum flow was developed to ensure that the environmental values associated with the Crystal River / Kings Bay System are protected from significant harm that could result from additional withdrawals. The adopted minimum flow for this system will support the District's water supply planning, water use permitting, and environmental resource permitting programs.

The next step toward establishing the minimum flow involves peer review of the recommended minimum flow by an independent scientific panel. The panel will conduct their review, with public and stakeholder input, and report to the Governing Board at a future meeting. Following staff consideration of the peer review report and stakeholder input, staff will return to the Board with proposed rule language to establish a minimum flow for the Crystal River / Kings Bay System.

Staff Recommendation:

This item is submitted for the Committee's information, and no action is required.

Presenter: Gabe Herrick, Senior Environmental Scientist, Natural Systems & Restoration

Bureau

MEETING SUMMARY

Southwest Florida Water Management District
Scientific Peer Review Panel Meeting and Field Trip
Proposed Minimum Flows for the Crystal River/Kings Bay System

Sites in Citrus County, Florida and the Southwest Florida Water Management District
Brooksville Headquarters in Brooksville, Florida
November 4, 2016

The Southwest Florida Water Management District (District) organized and facilitated a meeting of the independent scientific peer review panel reviewing a draft District report on proposed minimum flows for the Crystal River/Kings Bay System located in Citrus County. The meeting was held from 8:30 a.m. to 4:00 p.m and included a morning field trip to sites on the bay and an afternoon session at the District Headquarters, located at 2379 Broad Street in Brooksville, Florida. The meeting was advertised in the Florida Administrative Register and on the District's web site. In addition, numerous interested parties and local government staff and officials were notified of the event.

Meeting participants included the Panel Chair, Steve Peene and Panelists, Ken Watson and Adam Munson. District participants included: Doug Leeper, MFLs Program Lead; Gabe Herrick, Senior Environmental Scientist; Ron Basso, Chief Hydrogeologist; Stacey Day, Senior Environmental Scientist; Sky Notestein, Senior Environmental Scientist; Chris Anastasiou, Chief Environmental Scientist; Mark Green, Springs & Environmental Flows Manager, Eric DeHaven, Resource Management Assistant Director; Melissa Gulvin, Government Affairs Program Manager, and Mike Bray, Assistant General Counsel. Dave Burnell, the Crystal River City Manager, participated in the meeting and several stakeholders, including Dan Hilliard with the Florida Springs Institute, Anne Holbrook with the Save the Manatee Club, Martyn Johnson and B.J. Jarvis with the University of Florida Institute of Food and Agricultural Science Citrus County Extension Service joined the meeting remotely using teleconferencing and web-based utilities.

The meeting was initiated in the field at Hunter Spring Park with participant introductions that were followed by District staff presentations that addressed the peer review process, including adherence to Florida's Government in the Sunshine law. Following this initial site visit, meeting participants traveled to Crystal River Archeological State Park and the Roger Batchelor Pier at Fort Island Gulf Beach. Upon return to the District Headquarters in the afternoon, the meeting continued with a second round of introductions followed by District staff presentations concerning panel and stakeholder use of a publicly-noticed web board maintained by the District for exchange of information relevant to the peer review in accordance with Sunshine Law requirements, and the process used for developing minimum flows for the Crystal River/Kings Bay System. The panel then discussed issues they anticipate addressing as part of the review and the format they may use for their final report. The panel requested and the District agreed to schedule an additional panel teleconference for the afternoon of November 15, 2016 to support panel activities. The meeting ended with a public comment period facilitated by District staff.

Questions, comments, requests and issues discussed during the meeting are summarized below under general subject headings. This summary information is followed by the meeting agenda and a scanned sign-in sheet.

Summary of Discussed Questions/Comments/ /Requests/Issues

Scheduling and General Panel Activities

1. The panel discussed a general outline for their report, noting that they expect to develop a collaborative document that efficiently addresses all issues/questions included in the project scope of work.

2. The panel discussed the potential need to develop written questions/comments prior to their next scheduled meeting and this prompted discussion of the need for and utility of an additional panel teleconference. Based on this discussion, the panel requested and the District agreed to facilitate a publicly-noticed panel teleconference to be held on November 15, 2016 from 1:00 to 5:00 p.m.

3. The panel noted that they planned to develop some work products by November 12, 2016, in advance of the requested November 15, 2016 teleconference. In addition, they indicated they planned to develop a draft review report by November 28, 2016.

4. The panel discussed the need to review and comment on aspects of the District's draft report that were not integral to development of the recommended minimum flows. They determined that all information presented in the report was potentially subject to review, although they anticipate focusing on the primary elements associated with the minimum flow recommendations.

Baseline Flows/Discharge Measurement

5. The panel and District staff discussed the spring vent identification and spring vent/group discharge measurement projects that were completed for the District by Vanasse Hangen Brustlin, Inc.

6. The availability of reported discharge and other data, including the information available from the U.S. Geological Survey's National Water Information System: Web Interface, was discussed.

7. Issues associated with measurement/estimation of discharge in the system were discussed and included: 1) methods used for measuring/estimating discharge at current and historical U.S. Geological Survey gage sites; 2) the U.S. Geological Survey's revision of previously reported discharge at their currently active gage at Bagley Cove; 3) reported discharge at a historical U.S. Geological Survey gage located downstream from the Bagley Cove gage site; 4) estimation of springflow to the bay based on water budget analyses; and 5) the District's estimation of submarine groundwater discharge to the system.

8. The panel determined that they planned to directly contact U.S. Geological Survey staff to learn more about available information for the river, including the method(s) used to determine discharge at the current gage site at Bagley Cove.

9. The panel and District staff also discussed information available for other sites in the system that were used to support development of the recommended minimum flows, including the U.S. Geological Survey gage sites at Salt River, Shell Island and at the origin of Crystal River in Kings Bay. Groundwater level measurement sites were also discussed, including the well that was used for the District's estimation of submarine groundwater discharge and the well monitoring network used for assessing saltwater intrusion into area aquifers.

Hydrodynamic Modeling

10. The panel noted that based on the importance of the District-developed hydrodynamic model for development of the proposed minimum flows, they would expend considerable effort on reviewing the model and its application.

11. The Panel Chair, Dr. Peene, and Panelist Ken Watson indicated they planned to contact the model developer, XinJian Chen, a Chief Professional Engineer with the District, to learn more about the modeling effort. To comply with "Sunshine Law" requirements, it was agreed panelists would contact Dr. Chen individually by phone, rather than as a group.

Groundwater Flow Modeling

12. Based on a question from Dr. Watson, Mr. Basso noted that a recharge rate varies from about 15 to 20 inches per year across the springshed depending on rainfall conditions for the simulations conducted with the Northern District Model (NDM) that support the minimum flow analyses.

13. Also in response to a panel question, Mr. Basso noted that available long-term monitoring well data for the Crystal River/Kings Bay area do not exhibit a decrease in Upper Floridan aquifer water levels that is evident in other portions of the northern District. Mr. Basso opined that added recharge associated with historical and ongoing diversion of water from the Withlacoochee River into the Tsala Apopka chain of lakes could possibly account for enhanced recharge within the springshed - which might provide a reason for the lack of a long-term decrease in aquifer water levels in the vicinity of the Crystal River/Kings Bay system. Mr. Basso indicated that that theory would be tested through the application of a more advanced model of the Lake Tsala-Apopka chain of lakes from the USGS – which is expected early next year.

Minimum Flow Criteria Development and Application

14. The panel discussed the salinity and thermal-habitat criteria that were used to support development of the proposes minimum flows.

15. One of the Panelists, Dr. Munson, indicated he planned to spend considerable time assessing the appropriateness of the salinity and thermal-habitat criteria used for the Crystal River/Kings Bay System.

General

16. Ongoing District project/experiments in the vicinity of Hunter Spring and other locations in Kings Bay that addresses repopulation of the bay with American eelgrass were discussed.

17. Ongoing District projects that address stabilization of bay shoreline.

18. Ongoing dredging and *Lyngbya* removal projects that are being implemented by non-District groups to remove surficial sediments and mechanically remove nuisance algae to encourage growth of desirable submersed aquatic vegetation were discussed.

19. The extent of altered shoreline within the bay and historical/recent changes to adjacent upland areas were discussed,

20. The effects of physical disturbance, salinity, flow, shading, and manatee grazing on submersed aquatic vegetation within the bay and river were discussed.

21. The TMDLs established for the system were discussed.

22. The relative abundance and composition of submersed aquatic vegetation at the river's mouth and in nearshore areas were discussed.

23. Potential effects of sea level change on coastal plant assemblages, the freshwater/saltwater interface in coastal aquifers, and how the potential effects in the vicinity of rivers, such as at the Crystal River/Kings Bay system, may differ from those in nearshore areas of west-central Florida that are not proximal to major inflows.

24. The impact of residence times on the overall water quality in the system were discussed along with historic levels of chlorophyll a blooms.

Public Comment

24. Mr. Hilliard noted that a TMDL associated with the concentration of nitrate has been established for the Crystal River/Kings Bay System. He added that residence time and any changes in residence time associated with the recommended minimum flow that could affect nitrogen concentrations within the system should be considered by the peer review panel. Mr. Hilliard also noted that the recommended minimum flows address the Crystal River/Kings Bay System as a whole and that it may be more appropriate to consider development of minimum flows for individual components of the system, e.g., selected individual or groups of springs or spring vents. This alternative approach is based on, in part, substantial differences in the magnitude of discharge and the chemistry of water emanating from individual spring vents or groups of vents.

Meeting Agenda

Southwest Florida Water Management District
2379 Broad Street, Brooksville, Florida 34604-6899
(352) 796-7211 or 1-800-423-1476 (FL only)
WaterMatters.org

An Equal Opportunity Employer

Bartow Office
170 Century Boulevard
Bartow, Florida 33830-7700
(863) 534-1448 or
1-800-492-7862 (FL only)

Sarasota Office
6750 Fruitville Road
Sarasota, Florida 34240-9711
(941) 377-3722 or
1-800-320-3503 (FL only)

Tampa Office
7601 U.S. 301 North (Fort King Highway)
Tampa, Florida 33637-6759
(813) 985-7481 or
1-800-836-0797 (FL only)

MEETING NOTICE

AGENDA

Southwest Florida Water Management District (SWFWMD)
Scientific Peer Review Panel Meeting and Field Trip
Proposed Minimum Flows for the Crystal River/Kings Bay System
Friday, November 4, 2016; 8:30 a.m. to 4:00 p.m.
Field Trip Sites (Crystal River, FL) and District Headquarters (Brooksville, FL)

Crystal River/Kings Bay System Field Trip *(field trip may be cancelled due to inclement weather)*

1. Site 1: Hunter Spring Park (104 NE1st Avenue, Crystal River, FL 234429)
   - Welcome and introductions facilitated by Doug Leeper, MFLs Program Lead, SWFWMD
   - Review of the Sunshine Law by Mike Bray, Assistant General Counsel, SWFWMD
2. Site 2: Crystal River Archeological State Park, 3400 North Museum Point, Crystal River, FL 34428
3. Site 3: Roger Batchelor Pier at Fort Island Gulf Beach (12073 West Fort Island Trail, Crystal River, FL 34428

District Headquarters (2379 Broad Street, Brooksville, FL 34604-6899)

To join the WebEx Meeting, hit Contol+Click on this link: Join WebEx meeting
Meeting number: 735 246 851; Can't join the meeting? Contact support.
Conference call-in number: 1-888-670-3525; Participant passcode: 1372920332#

4. Overview of proposed minimum flows by Gabe Herrick, Senior Environmental Scientist and Ron Basso, Chief Hydrogeologist, SWFWMD
5. Crystal River/Kings Bay System peer review web forum by Doug Leeper
6. Peer review panel discussion facilitated by Steve Peene, Peer Review Panel Chair, with Panelists Ken Watson and Adam Munson
7. Public comment period moderated by Melissa Gulvin, Government Affairs Program Manager, SWFWMD

Participants will be asked to save their comments until the public comment portion of the meeting. If you wish to speak during the public comment period, please fill out a speaker's card and give it to the Moderator (Melissa Gulvin), who will call on you at the appropriate time during the meeting. Comments will be limited to three minutes per speaker. In appropriate circumstances, the Moderator may grant exceptions to the three-minute limit.

For questions or to submit additional public comment on the peer review of the proposed minimum flow for the Crystal River/Kings Bay System, please use the comment card provided during the meeting or contact Doug Leeper by email at doug.leeper@watermatters.org, by telephone at 1-800-423-1476, extension 4272, or by mail at the address listed at the top of this agenda.

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FIELD TRIP + AFTERNOON SESSION – CRYSTAL RIVER/KINGS BAY PEER REVIEW 11/4/2016

PUBLIC WORKSHOP
Sign-In Sheet

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Cc:	Mark A. Green; Jerry Mallams; Chris Anastasiou
Subject:	FW: Florida Springs Institute"s Comments on Recommended Minimum Flow for the Crystal River/Kings Bay System Peer Review Draft
Date:	Thursday, November 10, 2016 11:48:44 AM
Attachments:	2016.11-10 FSI Crystal River_Kings Bay MFL comments FINAL.PDF

For your review:

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Subject: RE: Florida Springs Institute's Comments on Recommended Minimum Flow for the Crystal River/Kings Bay System Peer Review Draft

Thank you Ms. Obara,
Thank you to the Florida Springs Institute for preparing your recommendations on the Crystal River/Kings Bay MFL. I will share this with staff and it will be posted on the WebForum for the peer reviewers to access.

Melissa Gulvin
Government Affairs Program Manager
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Subject: Florida Springs Institute's Comments on Recommended Minimum Flow for the Crystal River/Kings Bay System Peer Review Draft
Importance: High

Good morning Ms. Gulvin,

Please find our comments regarding the recommended minimum flow for the Crystal River/Kings Bay System peer review draft attached for consideration by the SWFWMD. Thank you.

Heather Obara, Esq.
Associate Director, Howard T. Odum Florida Springs Institute
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Please consider the environment before printing this email.

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November 10, 2016

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Government Affairs Program Manager
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Transmitted via email to Melissa.Gulvin@swfwmd.state.fl.us

Subject: Florida Springs Institute Comments on Recommended Minimum Flow for the Crystal River/Kings Bay System Peer Review Draft

Dear Melissa:

The Howard T. Odum Florida Springs Institute is a private, non-profit, scientific and educational organization dedicated to the better understanding and wise management of Florida's artesian springs. The Florida Springs Institute is actively involved in conducting springs baseline assessments and in providing science-based recommendations for springs restoration and protection. In this role, the Florida Springs Institute reviews all draft agency actions related to Florida's springs, including the development and implementation of minimum flows and levels.

As required by Florida statutes, protection of Florida's natural water bodies, including artesian springs, is the responsibility of the state's water management districts (WMDs). This oversight requires that your agency first and foremost protect the public trust by preserving the natural structure and function of water bodies, including the Crystal River/Kings Bay Springs System. The Crystal River/Kings Bay System has several special designations that establish a very high bar for protection. The Crystal River/Kings Bay System is a Florida Class III water body, requiring maintenance of fishable and swimmable conditions and compliance with more than 40 water quality criteria. Crystal River/Kings Bay is an Outstanding Florida Water that is protected from any human activity that will cause degradation of water quality compared to conditions in the 1980s; a Surface Water Improvement and Management (SWIM) water body requiring restoration of impaired water

quality and habitat; an Outstanding Florida Spring; and the site of a U.S. National Wildlife Refuge established for the protection and propagation of the endangered West Indian manatee. These protections represent a public mandate for the Southwest Florida WMD to provide the highest level of protection to the natural ecological health of Crystal River and Kings Bay and the natural artesian springs that nourish those inland waters.

Despite these special designations, the Crystal River/Kings Bay System has experienced significant impairments over the past 40+ years. The Crystal River/Kings Bay System has suffered from wastewater discharges, elevated nitrogen levels in its feeder springs, haphazard and short-sighted aquatic weed and recreational management by state and local agencies, and major reductions in historic spring flows. The Florida Springs Institute recently concluded that historic flow reductions at Crystal River/Kings Bay have averaged 58%[1]. The result of these unfortunate but avoidable stresses is a formerly pristine aquatic ecosystem suffering from increased salinity, elevated nitrogen and phosphorus concentrations, and excessive recreational activities, and that has lost over 90% of its native vegetation, water clarity, and fish populations.

THE CONCLUSION FROM THE ABOVE SUMMARY IS THAT THE CRYSTAL RIVER/KINGS BAY SYSTEM CANNOT TOLERATE AND SHOULD NOT BE SUBJECTED TO ANY ADDITIONAL ANTHROPOGENIC IMPACTS.

The WMD's proposal to allow an additional flow reduction of up to 12% is in direct conflict with the hard facts that the Crystal River/Kings Bay System is already impaired; is not receiving statutory protections as intended by the Florida Legislature; and should be placed in recovery to restore some or all its historic flows. The WMD has an undeniable mandate to reduce groundwater pumping to help reverse the significant harm caused by lowered spring flows.

The Southwest Florida WMD's Northern District Model v.5 has estimated that the Crystal River/Kings Bay System average flow has declined by only 1.5% because of consumptive uses. This result is highly suspect since actual flow data reported by the U.S. Geological Survey and analyzed by the Florida Springs Institute indicate an average historic flow reduction of about 58%. The District's utilization of recent flows as a baseline for this MFL analysis, and disregard for decades of earlier data demonstrating much higher flows, is scientifically dishonest. Use of a water balance based on a current springshed delineation ignores the fact that the springshed feeding the Crystal River/Kings Bay System has declined by more than 60% compared to the 831 mi^2 pre-development springshed area estimated by the Florida Springs Institute.

Validation of the magnitude of the actual historic flow reduction at Crystal River/Kings Bay is provided by the effect of increasing hydraulic residence time on populations of phytoplanktonic algae and declining water clarity. As detailed by the Florida Springs Institute in the Kings Bay Springs Restoration Plan, declines in water clarity are primarily due to increasing populations of suspended algae in the water column. Increasing water residence time in the bay leads to algal blooms because of the time needed to fully realize the effects of exponential algal cell multiplication. Although historic nutrient levels were adequate to fuel phytoplankton blooms, water clarity in Kings Bay was very high as recently as the 1980s and has been declining over

[1] Florida Springs Institute. 2016. Kings Bay/Crystal River Springs Restoration Plan. High Springs, Florida. 127 pp.

the same period that groundwater withdrawals have increased and spring flows have declined. The Florida Springs Institute's conclusion is that the effects of declining spring discharges coupled with reckless aquatic weed management in Kings Bay have been the principal reasons behind the loss of water clarity and the natural submerged aquatic plant populations.

The Florida Springs Institute has concluded that regional groundwater extractions in the Southwest Florida Water Management District must be reduced by about 235 million gallons per day to restore Crystal River/Kings Bay System average flows to 95% of their historic values. This reduction in allowable groundwater pumping is the only strategy that will reduce the observed increases in salt water intrusion and excessive phytoplankton growth in Kings Bay, and allow restoration of native plant and wildlife communities.

In summary, the Florida Springs Institute provides the following recommendations to the Southwest Florida WMD:

- It is critical that the WMD estimate a statistically-based confidence interval around the 1.5% NDM v.5 estimate of groundwater pumping impacts at Crystal River/Kings Bay and exercise an abundance of caution before allowing any additional groundwater extractions that are likely to further affect this water body.
- The WMD should re-evaluate the effects of existing groundwater pumping considering the statistical uncertainty applicable to the NDM, combined with a re-evaluation of the empirical water balance estimates based on the larger springshed area indicated by earlier potentiometric maps of the Floridan Aquifer.
- The WMD should pick the most limiting metric derived during the assessment of significant harm to the protected Crystal River/Kings Bay System water resource and human use analysis, and adopt a minimum flow of no more than an average 5% reduction compared to the pre-1950s baseline flows;
- The WMD should contract with the U.S. Geological Survey or the National Science Academy to estimate a pre-development water balance for the entire WMD and establish a safe groundwater yield that sets a cap on total groundwater pumping in Southwest Florida to limit District-wide spring flow reductions to no more than 5% of pre-development flows; and
- The WMD should fully fund and implement the updated Crystal River/Kings Bay SWIM plan and work with state and local stakeholders to prepare a Crystal River/Kings Bay Springs Basin Management Action Plan to achieve full compliance with the nitrate and phosphorus Total Maximum Daily Loads established by the Florida Department of Environmental Protection.

All available technical evidence supports the findings that the Crystal River/Kings Bay Springs System is:

1. A truly outstanding natural water body with regional and national natural and economic value to human society;
2. Impaired by reduced flows, elevated nitrate concentrations, and excessive recreational pressures; and
3. Will not recover to an acceptably high level of environmental health without a significant reduction in regional groundwater pumping and nitrogen loading, and enhanced management of recreational impacts.

Please deliver the message to your Executive Director and Governing Board that we respectfully request that they establish minimum flow limits or a water reservation for the Crystal River/Kings Bay System that ensure and sustain full recovery of healthy environmental conditions.

If you have any questions concerning this information and recommendations, please call to discuss.

Sincerely,



Robert L. Knight, Ph.D., Director
Howard T. Odum Florida Springs Institute
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Enclosures

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Kings Bay/Crystal River Springs Restoration Plan

Prepared by

The Howard T. Odum

Florida Springs Institute

February 2016

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Kings Bay/Crystal River Springs Restoration Plan

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Acknowledgements

The Howard T. Odum Florida Springs Institute gratefully acknowledges the financial support of the Fish and Wildlife Foundation of Florida, Inc. "Protect Florida Springs" Tag Grant PFS 1415-07 for preparation of this report.

A work that attempts to encompass the entirety of a subject is always reliant on the work of others. This Restoration Action Plan incorporates the work of professionals from virtually every environmental research institution and agency in Florida, including the Southwest Florida Water Management District (SWFWMD), the U.S. Geological Survey (USGS), the U.S. Fish and Wildlife Service (USFWS), the Florida Department of Environmental Protection (FDEP), the Florida Fish and Wildlife Conservation Commission (FWC), the University of Florida (UF), and engineering and environmental consultants.

Key references used to prepare this document include: early reports prepared by the USGS (Yobbi 1989, Yobbi 1992, and Knochedemus and Yobbi 2001); Surface Water Improvement and Management (SWIM) plans prepared by the SWFWMD (1989, 2000, 2005, and 2015); the Total Maximum Daily Load (TMDL) report prepared by FDEP for Kings Bay and springs (Bridger 2014); and various reports prepared by the University of Florida (Jacoby et al. 2007, Frazer et al. 2006, and others).

A debt of gratitude is owed to the non-profit King's Bay Springs Alliance, a citizen's advocacy group, for their long-term support of the Kings Bay and Crystal River springs ecosystems. Sincere thanks are given to Florida nature photographer John Moran, Springs Eternal Project, who captured the outstanding image of a Three Sister Springs manatee reproduced on this report's cover.

Executive Summary

There are more than 70 artesian spring vents feeding groundwater to Kings Bay/Crystal River in Citrus County, Florida. Historically these springs discharged more than 900 cubic feet per second (CFS) or 580 million gallons per day (MGD). Prior to the 1970s, Kings Bay was a fisherman's and scuba diver's paradise. Eelgrass (*Vallisneria americana*) covered the bottom of the bay like a lawn of un-mowed waving grasses. Water clarity was so good that divers and fishermen could see the fish, manatees, and other aquatic wildlife hundreds of feet away.

The decline in water quality in Kings Bay/Crystal River began in the 1960s. As the City of Crystal River grew around Kings Bay, real estate development led to excavation of numerous finger canals, providing dry ground for housing development and boating access for many of the new residents. The city began discharging treated, municipal wastewater with high nutrient concentrations directly to Kings Bay in 1962. Spring flows were noticeably declining by the 1970s.

With dredged finger canals, developed shorelines, and the city's wastewater inputs, increasing nutrient contamination led to proliferation of exotic aquatic weeds, including hydrilla (*Hydrilla verticillata*) and water hyacinths (*Eichhornia crassipes*). While Kings Bay's water remained clear during this period, extreme measures, such as addition of copper herbicides and sulfuric acid, were applied to kill off the plants that were interfering with recreational boating.

By the 1980 and 1990s, the poorly considered plant management measures had freed the bay from hyacinths and hydrilla dominance but had also largely led to the unintentional eradication of the desirable eelgrass. Spring flows continued to decline as Citrus County's and southwest Florida's population grew with increased reliance on groundwater for watering manicured landscapes and for farm irrigation. The result of declining spring flows combined with the loss of much of the native aquatic vegetation in Kings Bay was the proliferation of undesirable planktonic and benthic algae and a marked increase in salinity in the springs and bay. With these physical changes, water clarity in much of Kings Bay declined to less than 20 feet.

Whereas meaningful restoration of Kings Bay/Crystal River may appear to be complex, the causes of the impairment problems are well understood, and corrective actions are feasible to implement. In other words, today's residents and tourists visiting Kings Bay/Crystal River could live to see a restored and vibrant ecosystem. Restoration can only result if everyone involved pulls together to make the relatively easy lifestyle changes that are needed to assure success in restoring Kings Bay/Crystal River.

This report documents the declining flow rates of the Kings Bay/Crystal River springs, literally the lifeblood of this natural aquarium. Present average flows are about 58% lower than historical flows. Some of this reduction (estimated as 13%) results from a long-term decline in regional rainfall. This leaves an anthropogenic flow decline estimated as 45%, or about 265 MGD. To restore spring flows to at least 95% of their historical levels (a level that is not likely to cause appreciable harm to the ecology and human uses of the water body), it will be necessary to reduce regional groundwater pumping by more than 235 MGD. This goal can be accomplished through stricter water-conservation and water-pricing measures.

Water quality in the springs feeding Kings Bay/Crystal River has been declining since the 1970s. Principal water quality issues are related to increasing concentrations of plant-growth

nutrients (nitrogen and phosphorus), increasing salinity, and the resultant loss of water transparency. All of these changes are in direct violation of Florida's water laws. Whereas the Florida Department of Environmental Protection and the Southwest Florida Water Management District have been preparing plans for the past 26 years to deal with this unacceptable contamination, other than the transfer of the city's wastewater discharge to land application (thereby moving the nutrient problems from surface to groundwater), there have been no substantive efforts to improve these water quality problems. The result is that water quality in Kings Bay/Crystal River is continuing to decline. This conclusion is easy to see by examining the springs and Kings Bay water quality trends since the 1970s.

Kings Bay/Crystal River's water quality is closely related to its spring inflows. Restoring spring flows will reduce problems with water clarity and increasing salinity, and make eelgrass restoration possible. These water quality improvements must also be dealt with directly. The use of fertilizers throughout the springshed that feeds these springs needs to be greatly reduced, probably by at least 64% or by about 2.6 million pounds (1,300 tons) per year. This objective can be accomplished by the region's residents and farmers. A price needs to be added to fertilizer sales ("Aquifer Protection Fee") to discourage their excessive use and to help fund education and restoration activities. Present urban and agricultural "best management practices" need to be revised and upgraded to achieve much lower fertilizer use and nutrient releases from animal manures. Finally, many of the 41,000 septic tank disposal systems in the springshed must be hooked up to conventional wastewater treatment facilities with advanced nutrient removal.

Some of the restoration actions described above will require funding. Others will result in considerable savings to the general public. How much is a restored Kings Bay/Crystal River worth? That is a decision Springs Coast residents will need to make. Everyone desires clearer and cleaner water in Kings Bay. Everyone wishes to have access to uncontaminated groundwater for drinking and bathing. It is time to have an honest discussion about the trade-offs with these issues. If the current landowners and commercial interests that rely upon a healthy Kings Bay do not convince their neighbors that Kings Bay/Crystal River restoration and protection are technically and economically feasible, then no one will have the chance to enjoy the former beauty of this priceless natural resource.

Section 1.0 Regional Perspective

1.1 Introduction

For more than a century, Florida has attracted new residents because of the moderate winter climate and natural beauty of the state. This attraction has spurred residential, commercial, and urban development to support the infrastructure necessary to provide for an expanding population. Additionally, agriculture has taken advantage of Florida's moderate climate to produce quantities of food and forage, including row crops, livestock, and dairy goods. This increasing economic development has resulted in inevitable stresses on Florida's natural environment as humans have altered the landscape to suit their needs. While the natural environment of Florida (for example the beaches, estuaries, rivers, and springs) are what attracted many people in the first place to the State, the inevitable "footprint" of those residents and tourists has taken its toll on these natural resources.

The human population of Florida was estimated to exceed 20 million in 2015. Given the area of the state (53,900 square miles or 34.5 million acres) and assuming that these people are evenly distributed throughout the state, the average density of Florida residents is about 370 people per square mile. This density represents a significant increase from about 2.8 million residents in 1950 (51 people per square mile). Population expansion and high-intensity life styles characterized by excessive irrigation, fertilizer use, and recreational activities are ultimately responsible for the observed impairments in Florida's natural environments, including springs. Reversal of the negative trends described in this report can result by a collective acknowledgement of the detrimental consequences of this human footprint and purposeful reduction of behaviors affecting the environment.

1.2 Why Springs are Important

Springs and spring runs are a unique class of freshwater ecosystems. They differ from most fresh water aquatic environments in various appreciable ways. Springs maintain relatively minor variation in flows (hydrostatic) compared to the majority of streams and rivers. They exhibit high water clarity (transparent) unlike most streams and rivers, with optimal light availability for primary productivity; and springs have consistent chemistry (chemostatic) and water temperature (thermostatic) because of groundwater inflows.

This unique combination of physical and chemical properties serves to optimize ecological efficiency and wildlife habitat in Florida's springs and spring runs. Highly stable environmental conditions in springs promote the evolution of complex, adapted plant and animal communities. The efficient use of available light by spring ecosystems translates into high productivity of fish and other wildlife. In addition to the importance of spring runs for the support of highly productive warm-water fisheries, and their support for other fresh water fauna such as turtles, alligators, and water-dependent birds, they are critical for the life history of other large and economically-important migratory wildlife such as striped mullet and West Indian manatees. The wildlife habitat function of springs is well documented (Odum 1957; WSI 2010; Knight 2015).

1.3 Springs Coast Springs Focus Area

North and central Florida is the home of over 1,000 artesian springs. All of these springs are threatened to a lesser or greater extent by human activities within their groundwater contributing areas (Knight 2015). The Howard T. Odum Florida Springs Institute (FSI) has grouped these springs into 15 principal Springs Focus Areas that include one or more major springs and their approximate contributing area. The location and extent of the Springs Coast Focus Area is illustrated in Figure 1.

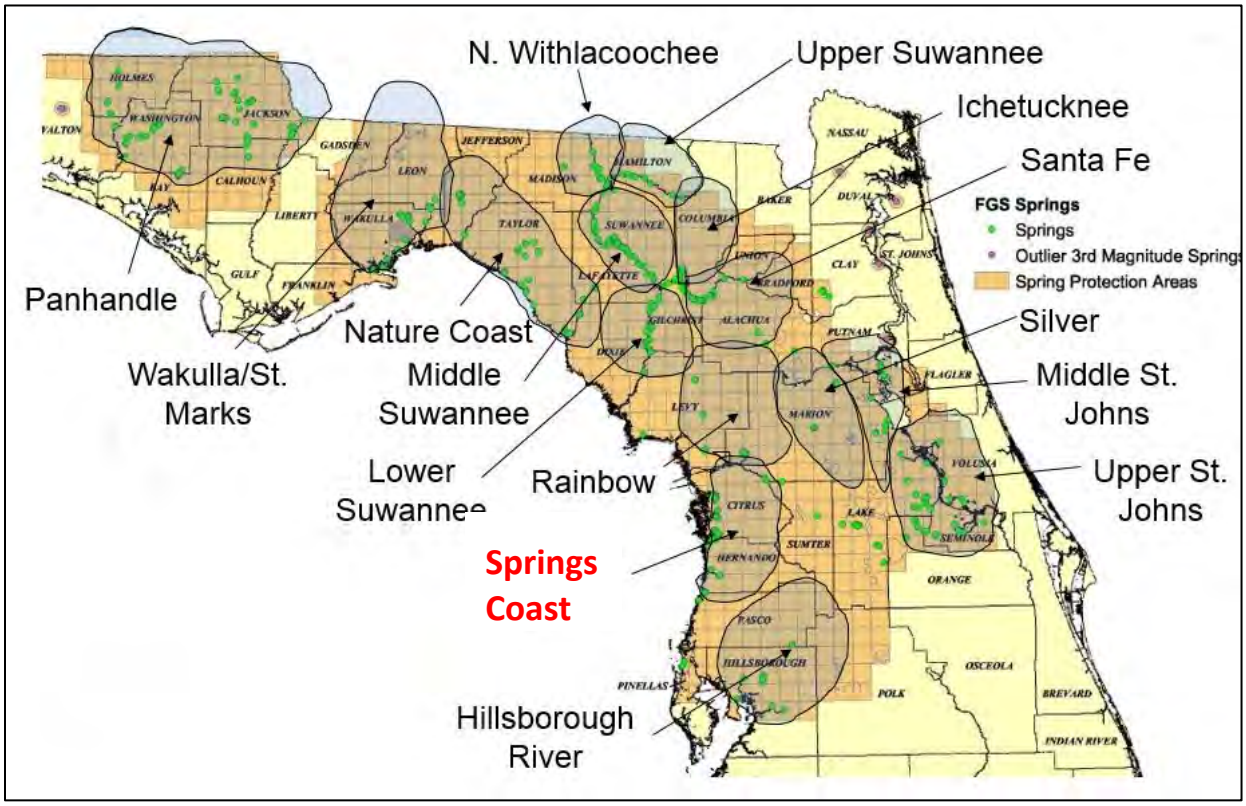


Figure 1. Approximate extent of 15 Florida Springs Restoration Focus Areas delineated by the Florida Springs Institute that are threatened by development pressures. The Springs Coast Springs Focus Area is highlighted in red type (Knight 2015).

The Springs Coast Focus Area includes Citrus, Hernando, and surrounding counties and is located along the west-central coast of peninsular Florida. This coastal area is primarily a zone of groundwater discharge. The Upper Floridan Aquifer is the source of these springs, and discharge is from a regional flow system that encompasses an area of about 3,400 square miles (mi^2) (Yobbi 1992). The Springs Coast Focus Area contains four first magnitude spring groups (springs that discharge more than 100 cubic feet per second [cfs] [64.6 million gallons per day (MGD)]) and many smaller springs. These springs historically discharged an average combined total of about 1,956 cfs (1,264 MGD) of groundwater to coastal rivers, salt marshes, and swamps along the Gulf of Mexico.

The Springs Coast Focus Area is undergoing rapid growth, and groundwater resources are being actively developed for regional and local water supply. Of interest and concern is the quantity of coastal spring water that is being diverted to human uses, increasing contamination of spring flows with nitrate nitrogen (N) and other contaminants, and the environmental effects of flow and water quality reductions to the freshwater and estuarine resources of the area (Yobbi 1989; SWFWMD 2015).

1.4 Description of the Springs Coast Area

The Springs Coast Focus Area primarily includes the coastal drainages of Citrus, Hernando and Pasco Counties and portions of Marion, Sumter, Lake and Polk Counties (Figure 2). This area is bounded on the north and east by the western topographic divide of the Withlacoochee River drainage basin, on the south by a topographic divide near the Hernando-Pasco County line, and on the west by the Gulf of Mexico. Springhill, a census-designated place has a population of nearly 99,000. The largest incorporated municipality in the area is Brooksville with an estimated 2014 population of 7,719.

The Springs Coast basin lies within the coastal lowlands and the central highlands topographic regions (Cooke 1939) and is characterized by a series of karst ridges and marine terraces that parallel the coast. The terraces are low and nearly flat, whereas the ridges are high and undulating. Land altitudes vary from sea level at the Gulf Coast to about 240 feet above sea level near Brooksville. Numerous swamps, lakes, and intermittent ponds occur in the area. The coastline is broad and flat and dotted with many small islands separated by shallows.

The Springs Coast Focus Area is underlain by a thick sequence of honeycombed and fractured limestone and dolomite of Cenozoic geologic age (from 2.6 to 66 million years before present). The carbonate rocks are at or near land surface and covered by unconsolidated, porous sands that range in thickness from less than five feet near the coast to over 100 feet in the Central highlands.

1.5 Climate

The climate in the Springs Coast Focus Area, including Crystal River/Kings Bay, is subtropical and humid. Rainfall occurs in the area as a result of three types of weather systems: frontal, convective, and tropical cyclonic (SWFWMD 2000). Long-term (from 1900 to 2010) daily rainfall was 54.2 inches/year (Figure 3). Over this period, annual rainfall totals varied from a low of 38.3 inches to a maximum of 79.9 inches. The 25th percentile annual rainfall was 48.9 inches and the 75th percentile annual total was 60.4 inches. Over the period-of-record, there has been a declining trend in annual rainfall amounts, starting at about 58 inches/year in 1900 and ending at about 49 inches/year in 2010.

Based on data over a 30-year period (1971–2000), the average summer temperature is 82.1 ^{o}F and the average winter temperature is 58.5 ^{o}F. The overriding climatological influence affecting the area is the Gulf of Mexico (SWFWMD 2000).

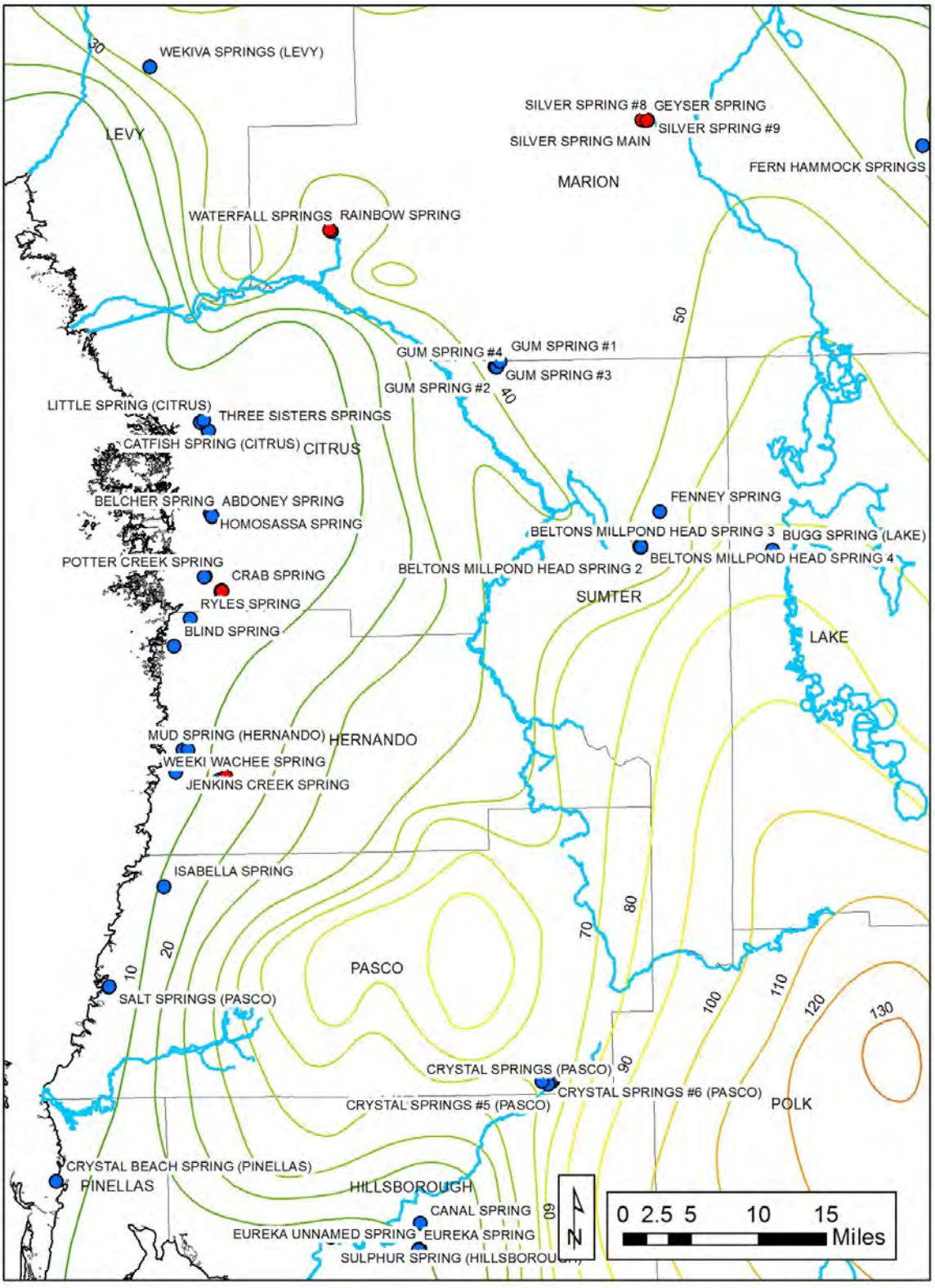


Figure 2. Florida's "Springs Coast", including all or parts of Levy, Marion, Citrus, Hernando, Hillsborough, Sumter, Lake, Pasco, and Polk Counties and four first-magnitude springs groups.

1.6 Physiographic Regions

Four named physiographic regions, including the Coastal Swamps, Gulf Coastal Lowlands, Brooksville Ridge, and Tsala Apopka Plain, are found in the Springs Coast study area (Figure 4). An additional offshore physiographic region is designated as drowned karst. The Coastal Swamps region extends 2 to 5 miles (mi) landward of the Gulf of Mexico with land-surface altitudes less than 10 feet (ft). Wetlands predominate in this region, where saturated, poorly drained, organic soils overlie the carbonate rocks of the Upper Floridan Aquifer. The western part of the Coastal Swamps region contains bayous, salt marshes, and palm-covered islands; the eastern part contains low-lying hardwood hammocks interspersed with small sand ridges.

The Gulf Coastal Lowlands region ranges from sea level to about 100 ft above sea level, and consists of scarps and terraces that create rolling hills capped by aeolian sands. The Pamlico Terrace, an ancient shoreline 25 to 30 ft above the present sea-level stand, parallels the modern shoreline and is the most distinctive topographic feature in this region.

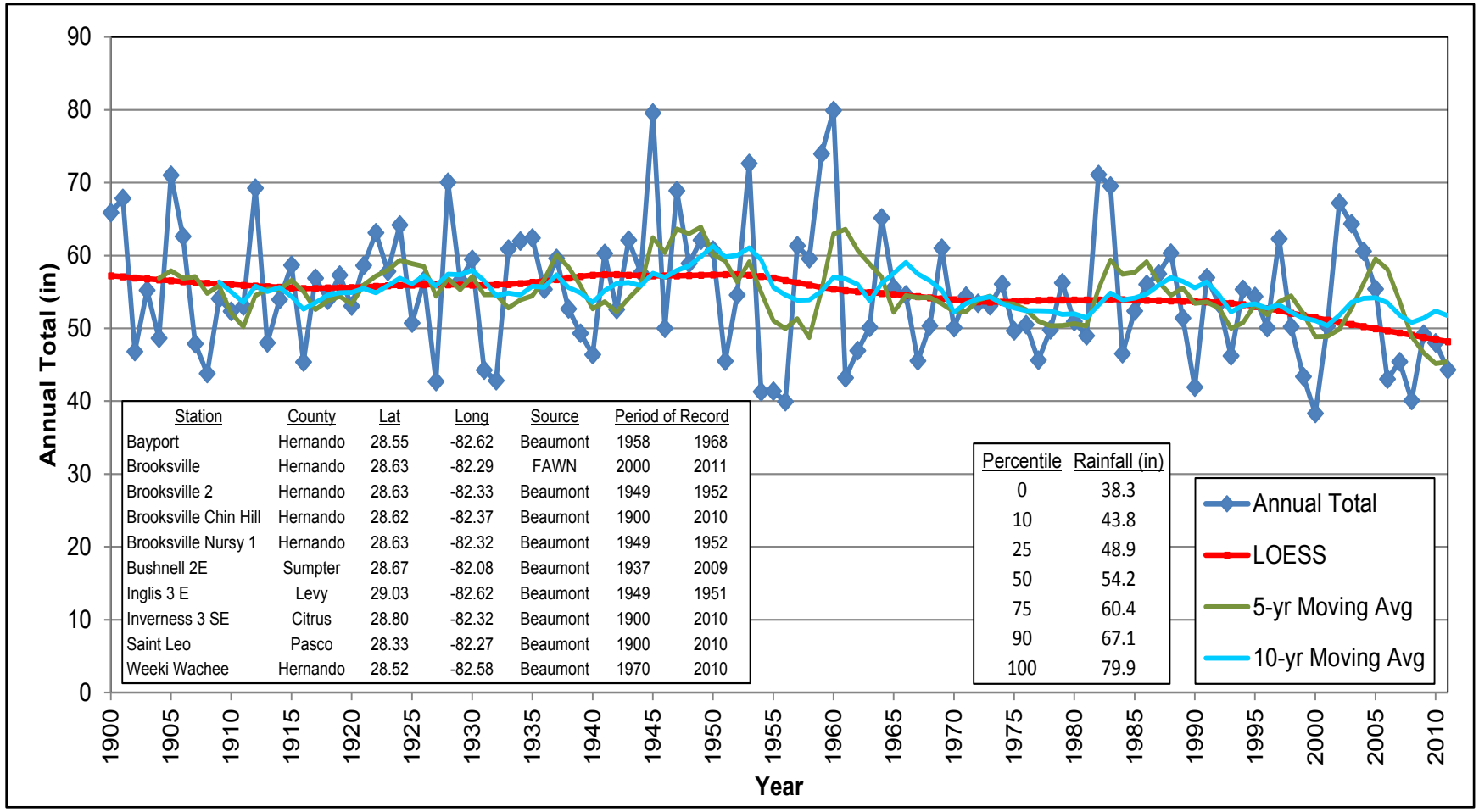
The Brooksville Ridge trends northwest-southeast and has an irregular land surface. The Brooksville Ridge is characterized by rolling hills that consist of remnant marine deposits modified by subaerial erosion, karstification, and wave action. Land-surface altitudes vary more than 100 ft over short distances and range from 70 to 240 ft above sea level.

The Tsala Apopka Plain has land-surface altitudes ranging from 35 to 75 ft above sea level; the plain lies between the Brooksville Ridge to the west and the Withlacoochee River to the east. This region contains interconnected lakes and wetlands that are hydraulically connected to the Withlacoochee River and the Upper Floridan Aquifer. The weakly cemented soils in this region retain rainfall near land surface, where some of the rainfall eventually discharges to the Withlacoochee River.

The drowned karst region extends offshore from the mouths of the rivers to shallow depths (less than 20 ft) in the Gulf of Mexico. The drowned karst region is characterized by flat topography and brackish water rather than saltwater due to dilution by freshwater discharged from springs and seeps.

1.7 Karst

The Springs Coast Focus Area is characterized by numerous sinkholes, internal drainage, and undulating topography typical of karst landscapes. The carbonate rocks of the Upper Floridan Aquifer have been extensively and repeatedly subjected to chemical dissolution and deposition processes in response to sea-level fluctuations. These karst processes are most active near or at the water table (saturated/unsaturated interface) and near or at the saltwater/freshwater interface (mixing zone). The locations of these interfaces are not temporally constant; therefore, multiple horizons of concentrated karst features can be found within the carbonate rocks. The wide fluctuation in sea level stands during the Miocene age (5.3 to 23 million years before present), especially the late Miocene, resulted in an intense period of karst development.



Station	County	Lat	Long	Source	Period of Record	
Bayport	Hernando	28.55	-82.62	Beaumont	1958	1968
Brooksville	Hernando	28.63	-82.29	FAWN	2000	2011
Brooksville 2	Hernando	28.63	-82.33	Beaumont	1949	1952
Brooksville Chin Hill	Hernando	28.62	-82.37	Beaumont	1900	2010
Brooksville Nursy 1	Hernando	28.63	-82.32	Beaumont	1949	1952
Bushnell 2E	Sumpter	28.67	-82.08	Beaumont	1937	2009
Inglis 3 E	Levy	29.03	-82.62	Beaumont	1949	1951
Inverness 3 SE	Citrus	28.80	-82.32	Beaumont	1900	2010
Saint Leo	Pasco	28.33	-82.27	Beaumont	1900	2010
Weeki Wachee	Hernando	28.52	-82.58	Beaumont	1970	2010

Percentile	Rainfall (in)
0	38.3
10	43.8
25	48.9
50	54.2
75	60.4
90	67.1
100	79.9

Figure 3. Average monthly and annual rainfall totals in the Florida Springs Coast Focus Area (1900 - 2010).

The origin of Florida karst is controversial, because of the absence of dolomitization (replacement of calcium by magnesium) and the geometry of karst features, indicating that many of these features formed as rainwater infiltrated through the surficial unsaturated or vadose limestone and near the surface of the saturated limestone or shallow phreatic zone in freshwater caves. Modern groundwater chemistry indicates that shallow groundwater in the recharge area is under-saturated with respect to calcite and dolomite, whereas downgradient from the recharge area, chemical equilibrium is achieved and karstification is inhibited. Therefore, the karst features that are the first-order magnitude springs (groundwater discharge points) developed in a recharge area.

1.8 Hydrogeologic Framework

Rainfall is the source of recharge for the Upper Floridan Aquifer. Recharge occurs as percolation through surficial soil deposits and drainage into sinkholes that breach the surficial aquifer. Surface drainage in the Springs Coast Focus Area is minimal and most regional water movement is through the Upper Floridan Aquifer. The few perennial streams present are supplied almost entirely from spring discharge. A surficial sand aquifer, separate from the Upper Floridan Aquifer, is not present as a continuous unit within the Springs Coast Focus Area. Some perched water-table aquifers of limited extent are present locally in these sands. The surficial deposits, however, are generally too thin or clayey to compose an aquifer utilized for water supply.

The principal rivers that drain the Springs Coast Focus Area are, from north to south, the Crystal, Homosassa, Chassahowitzka, and Weeki Wachee Rivers. Each of these rivers originates from a spring or group of springs that provide almost the entire freshwater flow of the rivers. Numerous other small springs and spring-fed streams dot the coastal fringe of the study area (Figure 5). Names and historical (baseline) discharge rates for springs and spring-fed rivers are listed in Table 1.

The Upper Floridan Aquifer is the source of these springs and rivers, as well as virtually all water used by humans in the area. The aquifer is composed of various geologic units that function as a single hydrologic unit; from top to bottom: the Suwannee and Ocala Limestones and the Avon Park Formation. The top of the aquifer is about 80 ft below land surface in the ridges of the Central Highlands but is at or near land surface near the coast. The base of the Upper Floridan Aquifer in the study area is considered to be at the first occurrence of vertically persistent evaporites, which generally are present about 600 ft below sea level in the lower part of the Avon Park Formation. Saltwater is present in the upper part of the aquifer near the coast and is present at a depth of approximately 100 feet, from 1 to 5 mi inland.

The estimated predevelopment potentiometric surface of the Upper Floridan Aquifer and the groundwater drainage area tributary to the Springs Coast Focus Area are shown in Figure 6. The groundwater drainage area extends 30 to 40 miles beyond the eastern edge of the coastal springs topographic divide to the eastern topographic divide of the Withlacoochee River and encompasses an area of about 3,400 mi^2. Arrows on the map indicate the general direction of flow in the aquifer within the area. Water moves generally northwesterly from the interior of the area toward the Gulf of Mexico and from areas of high potential to areas of low potential perpendicular to the contour lines. The potentiometric-surface map in Figure 6 is a composite of

potentiometric-surface maps made for the area from mid-1970 through 1979. The contours are considered to represent average annual (steady-state) water levels and to have been affected little by development.

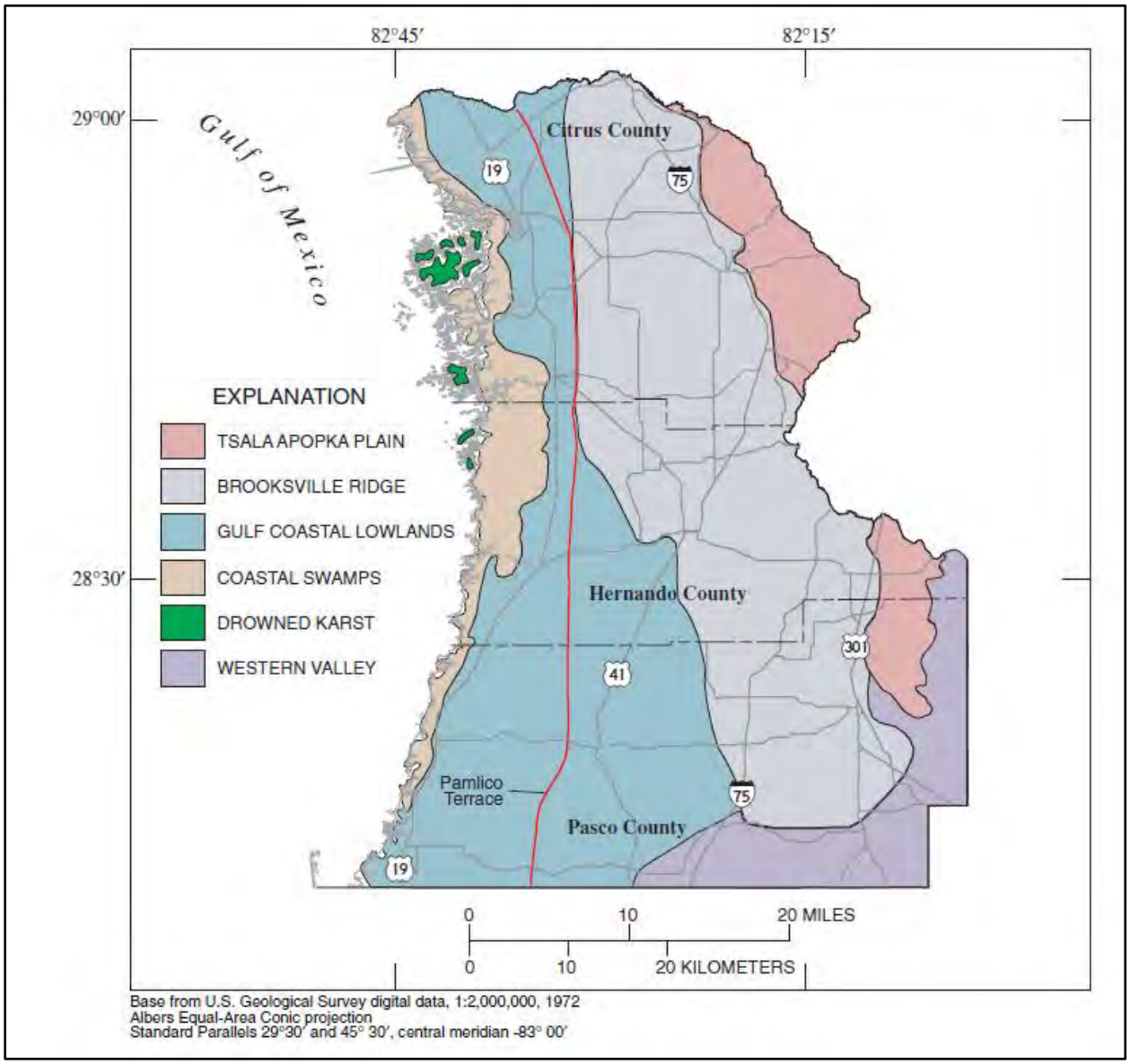


Figure 4. Physiographic regions of the Springs Coast (Knochenmus and Yobbi 2001).

The Coastal Springs Groundwater Basin is bounded by groundwater divides rather than topographic divides because the principal drainage is by way of groundwater flow in the Upper Floridan Aquifer. The Withlacoochee River, which is the only major surface-runoff drainage feature, forms the eastern and northern boundaries of the Springs Coast Focus Area (Figure 5). The river is conceptualized as a hydrologic divide because the gradient along reaches of the river as well as between the Upper Floridan Aquifer and the river is nearly zero. Although the river is in hydrologic contact with both the Upper Floridan Aquifer and an interconnected chain

of lakes, the groundwater gradient is flat so that groundwater exchange across these boundaries is minimal. Other rivers in the basin are coincident with groundwater discharge from the Upper Floridan Aquifer and originate as springs.

1.9 Descriptions of Selected Spring Groups

Enlarged openings in carbonate rocks concentrate groundwater flow, which result in further dissolution of the rocks, creating sinks and springs along with large areas of diffuse seepage. The size of openings and ultimately the type of spring vent formed are related to the cementation of the rocks. Hard zones in limestone can maintain large openings, and linear-fracture or circular-rock-type spring vents are common. Soft zones in limestone generally are filled with unconsolidated sediments, and sand-boil-type spring vents form. Cave divers have determined that the type of spring vent can vary with depth.

Descriptions of selected springs and major surface-water features in the Aripeka, Weeki Wachee, Chassahowitzka, and Homosassa Springs groundwater basins are summarized here and presented in greater detail in a report by the Southwest Florida Water Management District (SWFWMD 1998; Jones et al. 1994). The Kings Bay/Crystal River springs group is described in detail in the next section of this report.

The Aripeka Springs Groundwater Basin contains many small springs (Figure 5) including Aripeka 1, Hammock Creek Head, Boat, Aripeka 2, Gator, Magnolia, and Bobhill Springs. Aripeka 1, Aripeka 2, and Magnolia Springs are sediment-filled, and Boat and Bobhill Springs are circular-rock-type spring vents. The spring runs, except from Bobhill Springs, form the branching pattern of Hammock Creek, which derives flow from a 1-mi^2 basin. The basin is west of U.S. Highway 19 and straddles the Pasco and Hernando County line. Hammock Creek and Bobhill Springs discharge to the Gulf of Mexico (SWFWMD 1998).

The Weeki Wachee Springs Groundwater Basin contains the first-order magnitude spring – Weeki Wachee Springs – and numerous smaller springs, including Little, Salt, and Mud Springs. Located near U.S. Highway 19, the majority of flow in Weeki Wachee River is from Weeki Wachee Springs. The river has a well-defined channel that meanders about 7 mi from the headwaters to the Gulf of Mexico. The spring runs from the smaller springs are tributaries to the Weeki Wachee River. The spring run for Little Springs (also known as Twin Dees) is a 0.2-mi long tributary to the Weeki Wachee River. The spring vent at Weeki Wachee Springs is a 150-ft diameter, circular-rock-type vent extending from the riverbed to a depth of 10 ft below the riverbed. Below this depth, a north-south trending, linear-fracture type vent is present. At a depth of 185 ft below the riverbed, the fracture dimensions are 20 by 3 ft (SWFWMD 1998). Below a depth of 205 ft, a large cavern with passages exiting from both ends of the room conveys water away from Weeki Wachee Springs (SWFWMD 1998). The spring vent at Little Springs is a 4-ft diameter, circular-rock-type vent extending to a depth of about 50 ft; below this depth, the vent angles north for about 1,500 ft (Rosenau et al. 1977).

Caverns and wide conduits connected with Weeki Wachee Springs have been explored to a depth of about 300 ft (SWFWMD 1998). Salt Spring has a 6-ft diameter, circular-rock-type spring vent that extends to a depth of 170 ft. The vent is intersected by multiple horizons of lateral passages below a depth of 60 ft. Mud Spring has a circular-rock-type vent with a 185-ft vertical drop and is located on the west side of a 400 ft spring pool.

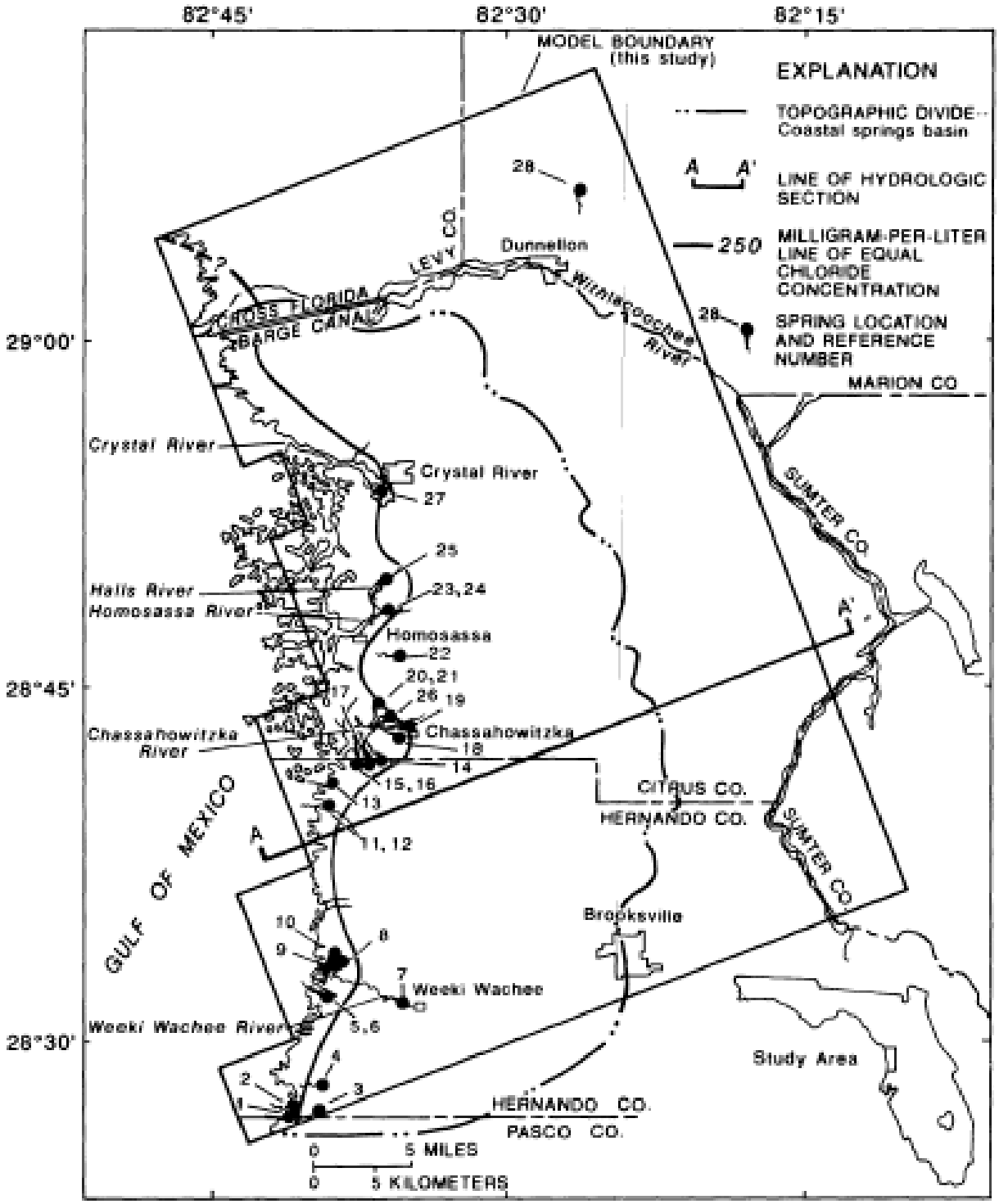


Figure 5. Location of Springs Coast Focus Area springs and position of 250-milligram-per-liter line of equal chloride concentration in the Upper Floridan Aquifer at 100 feet below sea level (Mills and Ryder 1975; Yobbi 1989).

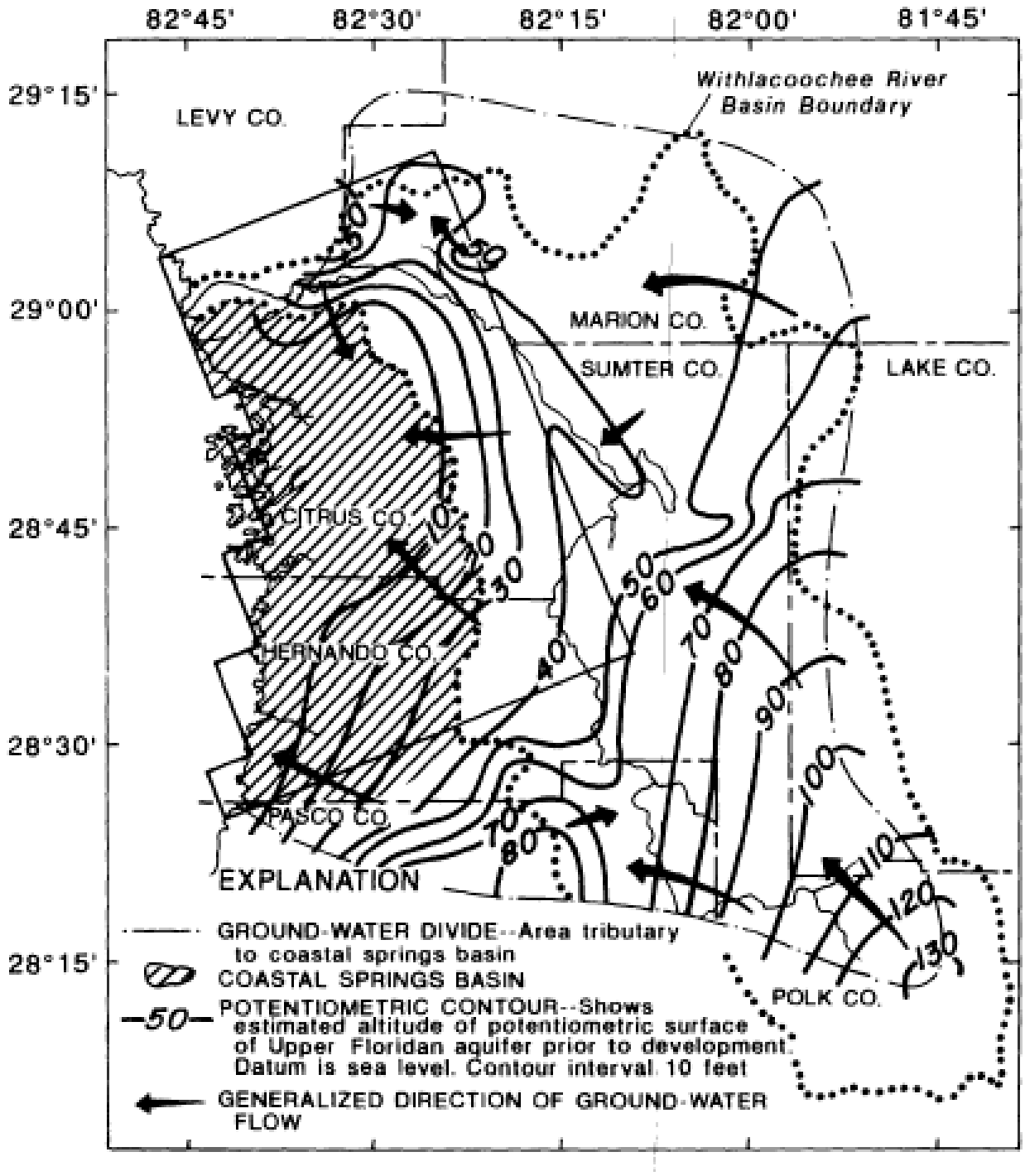


Figure 6. Groundwater drainage area contributing water to the Springs Coast Focus Area and related average potentiometric level of the Upper Floridan Aquifer tributary to the coastal environment pre-development (Yobbi 1989).

Table 1. Hydrologic data for Springs Coast Focus Area springs. These data are roughly equivalent to baseline flows prior to 1975 and have a combined average of 1,956 cfs (1,264 MGD) without Rainbow. Spring numbers refer to locations illustrated on Figure 5 (Yobbi 1989).

Spring No. (fig. 1)	Spring name	Period of record	Number of discharge measurements	Instantaneous discharge (ft^3/s)		Average chloride concentration (mg/L)
				Average	Range	
1	Unnamed spring no. 1	1964-65	6	8.7	5-11.0	391
2	Boat Spring	1962-64	2	3.8	1.5-6.0	17
3	Bobhill Springs	1961-72	6	3.3	2.0-4.4	5
4	Unnamed spring no. 2	1960	1	1	---	5
5	Unnamed spring no. 4	1962	1	10.0	---	1,600
6	Unnamed spring no. 5	1962	1	12.5	---	1,500
7	Weeki Wachee Springs	1917-74	364	176	101-27.5	5
8	Salt Spring	1961-75	11	30.6	24.7-38.9	912
9	Mud Spring	1961-75	6	52.0	0-128	8,000
10	Unnamed spring no. 6	1960	1	[1]5	---	2,700
11	Unnamed spring no. 7	1961	1	[1]50	---	--
12	839-238-7	1961	1	50.3	---	4,600
13	Unnamed spring no. 8	1961	1	[1]10	---	6,400
14	Unnamed spring no. 9	1961-64	3	28.8	20.9-35.4	136
15	Unnamed spring no. 10	1961	1	5	---	4,300
16	Unnamed spring no. 11	1961-64	2	15.6	5-26.2	3,800
17	Unnamed spring no. 12	1961-65	6	28.6	9.1-39.9	2,100
18	Baird Creek Springs	1964-65	5	31.1	11.1-53.1	2,350
19	Chassahowitzka Springs	1930-72	81	139	31.8-197	127
20	Ruth Spring	1961-72	6	8.8	8.0-11.8	460
21	Potter Spring	1961-65	6	6.5	0-22.0	460
22	Hidden River Springs	1964-65	5	26.5	7.0-65.6	1,300
23	Homosassa Springs	1931-74	90	106	80-165	812
24	Southeast Fork Homosassa Springs	1931-74	89	69.1	33-129	54
25	Halls River Springs	1964-66	12	162	95.7-291	1,020
26	Salt Creek Springs	1961	0	--	---	1,900
27	Crystal River Springs	1964-75	-[2]	916	-1,520-4,320	820
28	Rainbow Springs	1899-1974	-[3]	763	487-1,230	3

[1]Estimated.
[2]Daily discharge, tidally affected.
[3]Daily discharge.

The Chassahowitzka River is a shallow, flat, sluggish stream that meanders through about 6 mi of lowland swamps and tidal marshes and discharges to the Gulf of Mexico (Figure 5). More than a dozen springs contribute flow to the Chassahowitzka River; the majority of freshwater flow is from Chassahowitzka Springs, unnamed springs upstream from Chassahowitzka Springs, and Crab Creek Spring. Chassahowitzka Springs is a 50-ft wide, cone-shaped, sediment-filled vent located near the center of the river channel in about 20 ft of water. Several springs, collectively known as the unnamed springs, are found in the 250-ft long natural limestone channel upstream from Chassahowitzka Springs. The combined flow from the unnamed springs and from the man-made canal is measured at the gauging station named the Unnamed Tributary to Chassahowitzka River. The spring vents are circular-rock-type vents (vertical solution pipes) connected by horizontal conduits. The largest spring is Bubba Spring

(Chassahowitzka 1), which consists of two vertical pipes connected by a 15-ft long horizontal conduit. The flow from Bubba Spring emanates from a small opening in the horizontal passage midway between the two vertical pipes. Crab Creek is a short tributary to Chassahowitzka River, and has a hummocky limestone bottom. At least four circular-rock-type vents contribute flow to Crab Creek. The largest spring is Crab Creek Spring, located at the head of Crab Creek; the spring lies in 13 ft of water. The surface expressions of the spring vents at both Baird Creek Head Spring and Ruth Spring are linear fractures that discharge brackish water.

A large spring and numerous smaller springs contribute flow to the Homosassa River, which meanders through about 6 mi of lowland swamps and discharges to the Gulf of Mexico. Springs that contribute the majority of freshwater flow to Homosassa River include Homosassa Springs, springs supplying flow to the Southeast Fork of the Homosassa River, and springs supplying flow to Halls River. Exploration of Homosassa Springs is limited to a depth of about 70 ft, but past surveys indicate the presence of three large circular-rock-type vents within a collapsed-cavern feature. Various springs with both circular-rock- and linear-fracture type vents contribute flow to the Southeast Fork of the Homosassa River (SWFWMD 1998). Flow in the 2.5-mi-long Halls River is derived from many uncharted springs in the wide, shallow, and thickly vegetated river channel. The largest spring supplying flow to Halls River is Halls River Head Spring, a sediment-filled vent without a visible boil located in a 200-ft-wide spring pool. Hidden River is geographically located between the Chassahowitzka and the Homosassa Rivers. Hidden River is not typical for this area because it originates as groundwater discharge from a group of springs, flows overland for about 2 mi, and then disappears underground. The flow in Hidden River probably enters the Homosassa River downstream from the Homosassa River gauge. Two springs that contribute flow to Hidden River are Hidden River Head Spring and Hidden River Spring No. 6. Both of these springs are shallow (about 5 ft deep) with small sediment-filled vents.

Section 2.0 Description of the Kings Bay/Crystal River Springs Group

2.1 General Description

Kings Bay/Crystal River is located in Citrus County (coordinates 28° 53.3' N and -82° 35.9' W) approximately 60 miles north of Tampa, Florida. The bottom of Kings Bay is exposed limestone with a multitude of submarine springs and seeps (Yobbi and Knochenmus 1989). The land around Kings Bay is low and flat, with land-surface elevations averaging about 5 ft above sea level. Saltmarsh covers much of the area between Kings Bay and the Gulf of Mexico. The average depth in Kings Bay is about 8 ft (Figure 7), but the shallow tidal flats in the southwestern part of the bay are sometimes exposed at low tide, and one of the major springs south of Banana Island (Tarpon Spring) has a depth of about 65 ft. Along the channel of Crystal River, depths are typically from 8 to 12 ft. In the early 1960s, a network of 75-ft-wide canals was dredged along the eastern edge of the bay as part of waterfront residential development. The depths of the canals are not shown in Figure 7, but the average depth is about 6 ft.

Kings Bay discharges into Crystal River at the northwest corner of the bay. For the 13-year period from 1965 to 1977, the discharge at gauging station 02310750, near the City of Crystal River and about 2 mi downstream from the mouth of Kings Bay, averaged 975 cfs (630 MGD) (Yobbi and Knochenmus 1989). The main channel of Crystal River measures about 7 miles from the mouth of Kings Bay to the Gulf of Mexico. Kings Bay is tidally influenced because of its close proximity to the gulf. Flow reversals associated with incoming tides are commonplace in the canals and ditches. For typical tidal oscillations, the range in stage in Kings Bay is from 3 to 4 ft from low to high tide. Because there are no major stream inlets to Kings Bay, virtually all of the freshwater inflow into Crystal River is the result of spring discharge.

The first-magnitude spring system that forms the 600-acre Kings Bay embayment is the second largest spring system, as measured by discharge, in the state of Florida (SWFWMD 2005). As a result, collective discharge from the more than 70 known springs located in Kings Bay accounts for approximately 99 percent of the freshwater entering the bay (Hammett et al. 1996).

The Kings Bay/Crystal River watershed supports numerous listed and unlisted wildlife species, including the West Indian manatee (SWFWMD 2005). With a mean annual water temperature range of 66°F to 76°F, Kings Bay forms the largest natural warm-water refuge for the endangered West Indian manatee in Florida (SWFWMD 2011). Accordingly, the unique ecological attributes of Kings Bay/Crystal River were recognized by the state of Florida in 1983 through its designation as an Outstanding Florida Water (OFW). To date, commercial and recreational activities associated with the distinctive habitat and wildlife of Kings Bay has supported the local economy. However, rapid development of the watershed has resulted, coincident with increases in the county's population from approximately 9,268 in 1960 to approximately 141,236 in 2014. This development has increased human-related activities that are affecting water quality and natural systems in Kings Bay (SWFWMD 2005).

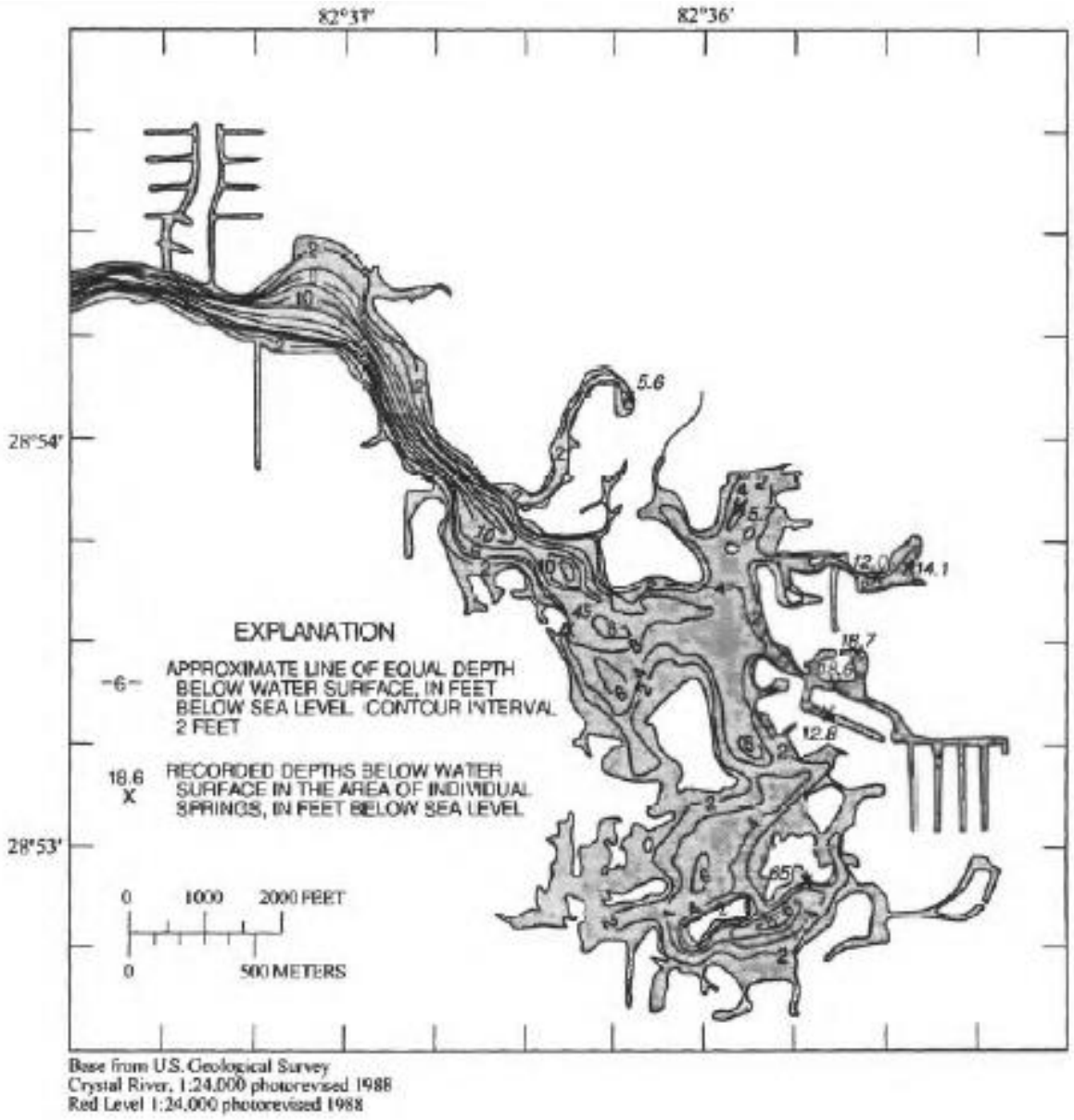


Figure 7. Generalized depth contours for Kings Bay and Crystal River, Citrus County, Florida (Hammett et al. 1996).

2.2 Descriptions of Key Springs

Vanasse Hangen Brustlin (VHB 2009) prepared a detailed inventory of spring vents in Kings Bay/Crystal River (Appendix A). VHB's report noted that many of the springs consisted of more than one vent in close proximity that contributed to the overall discharge of a specific spring. A total of 70 springs were documented. In some areas, particularly in the case of previously unnamed springs, groups of springs in the same geographic area were lumped into "spring complexes" with a single identification number. A total of 41 named and numbered spring complexes were depicted and discussed in the report. A priority list of springs was developed based upon qualitative flow estimates made during the inventory of spring vents.

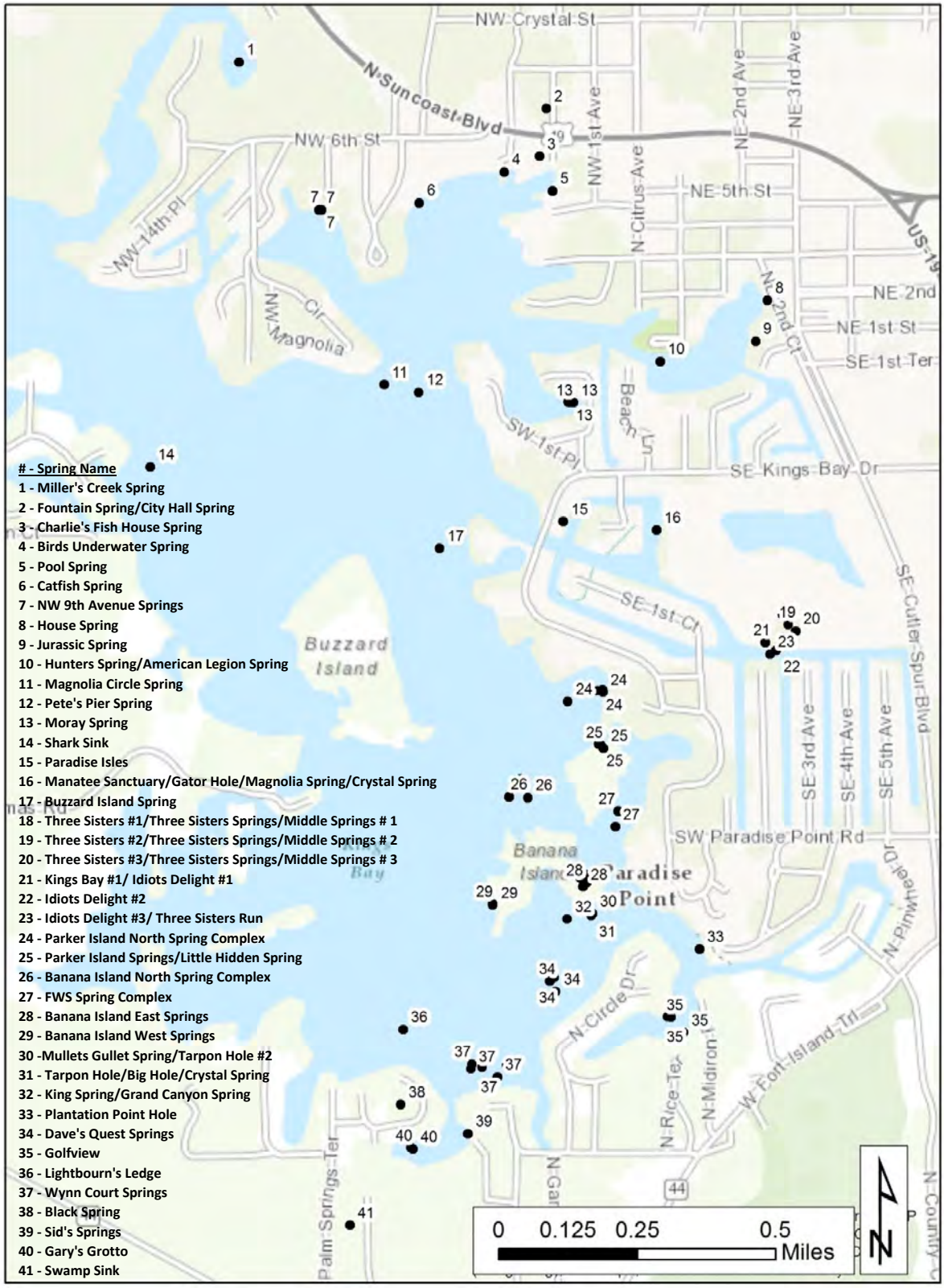


Figure 8. Kings Bay spring vent survey (VHB 2009). Spring numbers refer to spring vent complexes listed in Appendix A.

2.2.1 Hunter Spring

Hunter Spring, also known as American Legion Spring, is located in the northeastern portion of Kings Bay in Hunters Cove (No. 10, Figure 8). The spring is surrounded by a recreational park to the north and a residential area to the east and south. The spring vent is located within a designated swimming area about 40 ft offshore of the park. The spring is tidally affected. The average discharge rate for Hunter Spring measured by a SWFWMD contractor in 2009 (VHB 2010) was 31.02 cfs (20 MGD).

2.2.2 House Spring

House Spring is located at the head of the easternmost end of Hunter Cove (No. 8, Figure 8) within a seawall enclosure used as a swimming area. This multiple vent spring area is approximately 4 ft deep at the center of the swimming enclosure. Numerous other sand boils were also observed within this area. According to VHB (2010), the average discharge rate measured for House Spring was 5.23 cfs (3.4 MGD).

2.2.3 Idiot's Delight Spring

Idiot's Delight Spring is located on the east side of Kings Bay (Nos. 21-23, Figure 8). This spring complex is located within the Paradise Isles and Palm Island subdivision canal system. The spring consists of a group of 3 vertical shafts at least 20 ft in depth, the largest of which is documented to be 5 ft in diameter. The spring lies adjacent to the shoreline and west of the Three Sisters Springs run. Water depths in this area are approximately 4 feet. The spring is tidally influenced. According to VHB (2010), the average discharge rate for Idiot's Delight Spring was 4.84 cfs (3.1 MGD).

2.2.4 Tarpon Spring

Tarpon Spring, also known as Tarpon Hole Spring and King Spring, is located just south of Banana Island in the southern portion of Kings Bay (No. 31, Figure 8). The largest of the 30 springs that make up the headwaters of the Crystal River, Tarpon Spring is a popular scuba-diving location that is easily accessible by boat. This spring vent system is the middle vent of the 3 large vent systems in this area. It consists of multiple holes and fractures. The fractures are generally in a roughly circular formation and appear to represent a large undercut shelf/cavern that collapsed sometime in the past. Water depths measured at the edge of the spring formation were approximately 4 to 5 ft, while depths at the deepest center were approximately 15 to 20 ft. The depth of this vent has been previously reported as 65 feet (Yobbi and Knochenmus 1989). According to VHB (2010), the average discharge rate for Tarpon Spring was 42.83 cfs (28 MGD), but its discharge is influenced by tidal stage.

2.2.5 Black Spring

Black Spring (Citrus) Complex is located near the end of a canal in a residential neighborhood at the southern margin of Kings Bay (No. 38, Figure 8). The spring lies in 4 feet of water and may produce a boil at the surface of the canal. The spring is one of several vents in the area and is tidally affected. According to VHB (2010), the average discharge rate for Black Spring was 5.89 cfs (3.8 MGD).

2.2.6 Three Sisters

Three Sisters is a group of three spring vents located adjacent to and north of Idiot's Delight, within a small cove connected by an artificial channel to the Paradise Isles and Palm Island subdivision canal system (Nos. 18-20, Figure 8). The land area around Three Sisters was previously dominated by forested wetlands that were subsequently bulldozed and filled for residential development. A fringing growth of the original wetland forest still surrounds the Three Sisters Springs Basin. In 2013, the State of Florida in partnership with the U.S. Fish and Wildlife Service (USFWS) and the City of Crystal River purchased the 57-ac area surrounding and including Three Sisters Springs. This area is in the process of restoration and protection with construction of a stormwater treatment wetland, restoration of the shoreline around the springs and the man-made Lake Linda, and construction of a manatee-viewing boardwalk around the springs. VHB (2010) reported a combined flow from the Three Sisters of 78.47 cfs (51 MGD).

2.3 Crystal River/Kings Bay Contributing Area

The estimated historical contributing area for groundwater discharged by the Kings Bay/Crystal River Springs and surface runoff to the bay is shown in Figure 9. The area contributing groundwater to the Kings Bay/Crystal River Springs was historically about 831 mi^2 and included much of Citrus County and portions of Marion, Sumter, Lake, and Levy Counties. The surface watershed feeding Kings Bay/Crystal River (FDEP Water Body Identification Number [WBID] 1341) is shown in Figure 10 and includes about 61 mi^2.

The generalized current springsheds for the Kings Bay Springs Group used by Bridger (2014) and the SWFWMD (2015) for their respective total maximum daily load (TMDL)/basin management plan (BMAP) and SWIM reports are based on much smaller contributing areas. The FDEP concluded that the estimated Kings Bay contributing area encompasses approximately 261 mi^2. This area includes 233 mi^2 in Citrus County and 28 mi^2 in Marion County, Florida. SWFWMD's SWIM project assumes a 320 mi^2 springshed located in Citrus and Marion counties.

2.4 Groundwater Recharge

The Kings Bay/Crystal River Springshed is also essentially the recharge area for the springshed. Groundwater discharging from the Kings Bay/Crystal River springs originates within this recharge area. In the recharge area, rainfall that reaches the land surface infiltrates through the soils and overlying sediments to the Upper Floridan Aquifer. This groundwater subsequently moves downgradient by gravity (from higher to lower potentiometric levels) toward springs and the coast.

Bush and Johnston (1988) estimated recharge for the entire Floridan Aquifer that extends from South Carolina, through the Coastal Plain of Georgia, under all of the Florida peninsula, and into coastal Alabama and Mississippi. A digitized version of their map was used to estimate the typical average recharge to the Floridan Aquifer in the entire SWFWMD, in the five counties surrounding and including Citrus County. Annual average (area weighted) groundwater recharge within the SWFWMD was estimated by Bush and Johnston (1988) to be 4.1 inches/year (Figure 11). Over the estimated 9,780 mi^2 of the entire SWFWMD, this value is equivalent to an average recharge estimate of about 3.18 billion gallons/day (BGD) or 4,915 cfs.

Similar analyses were made for the five-county project area (average 6.95 inches/year or about 2,372 MGD) and for Citrus County alone (average 10.4 inches/year or about 310 MGD).

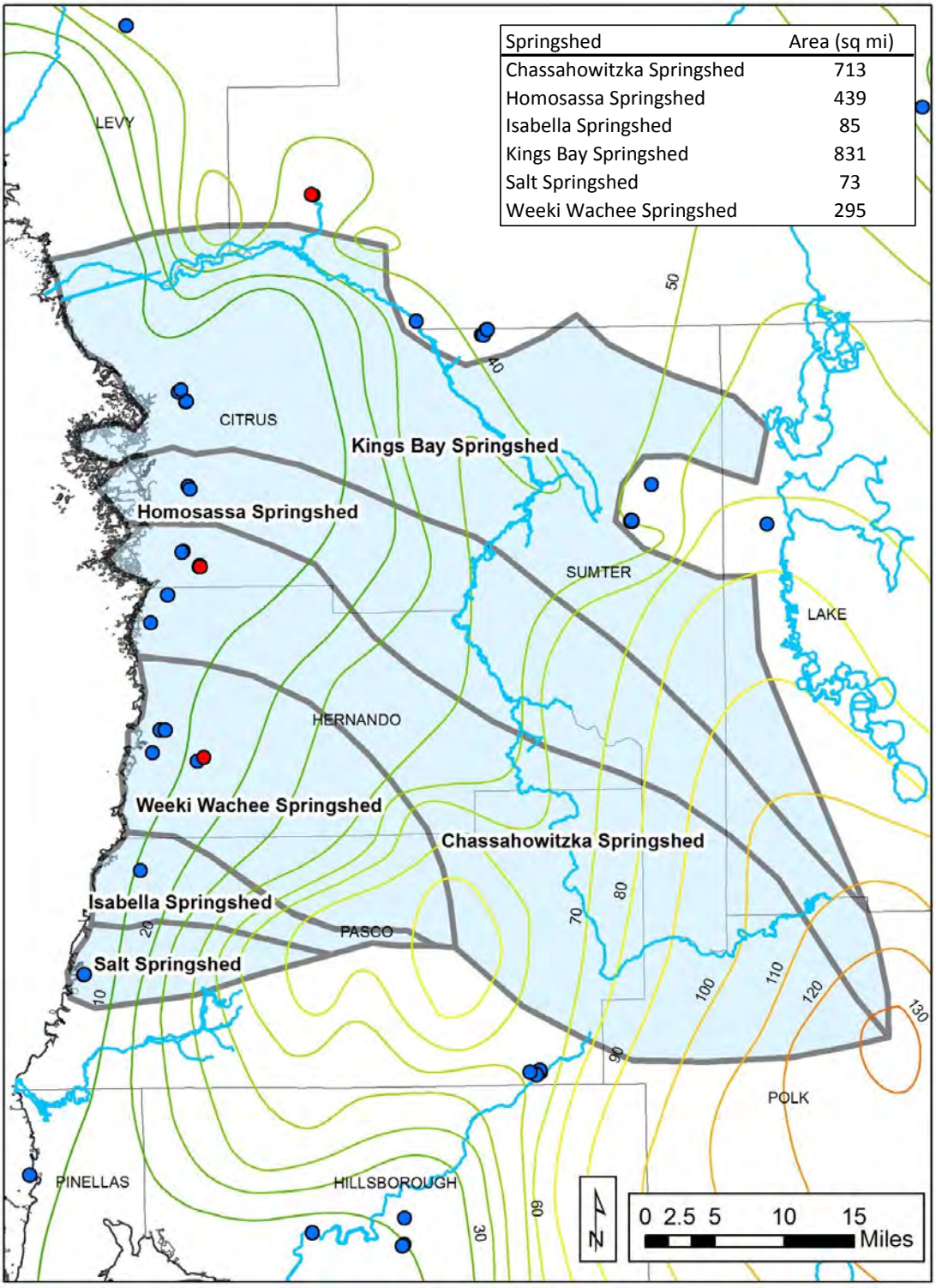


Figure 9. Springs Coast Focus Area estimated redevelopment springsheds (red dots indicate first magnitude springs whereas blue dots are second magnitude springs).

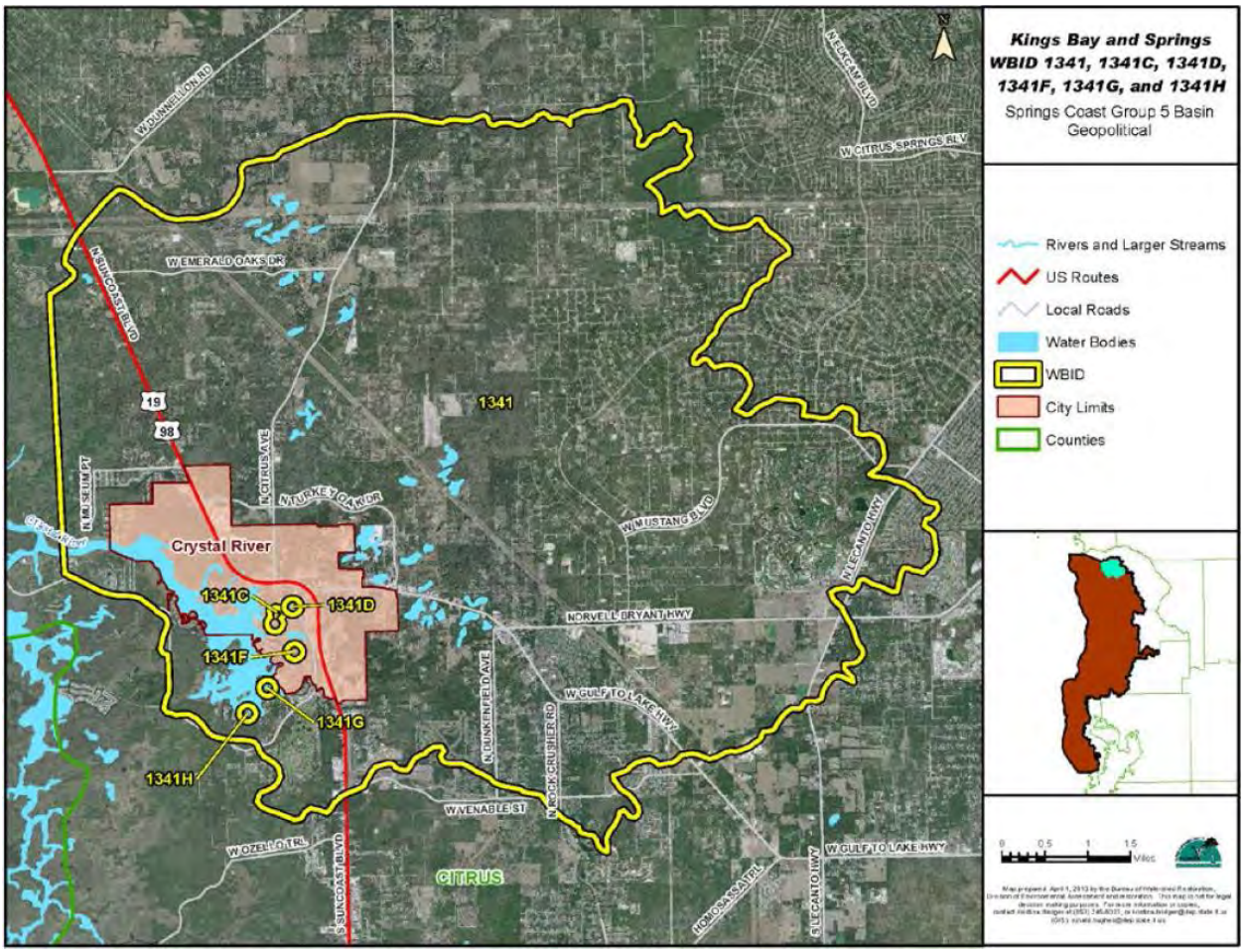


Figure 10. Kings Bay Watershed (WBID 1341, Bridger 2014).

A number of investigators have estimated recharge for the various physiographic regions of Citrus County (SWFWMD 2000). Recharge is low along the coast, where it ranges from negative 9 inches (discharge) to positive 12 inches per year. In the Tsala Apopka area, recharge is low to moderate, ranging from 5 to 21 inches per year and averaging 12 inches. In the Brooksville Ridge area recharge is high, ranging from 14 to 22 inches per year.

Recharge is highest in the Brooksville Ridge because it is a karst terrain with internal drainage to the upper Floridan Aquifer. Sinkholes are abundant, the land surface is generally very well drained, and the water table is relatively deep (greater than 10 ft deep). Surface waters are not abundant, and there are no permanent streams or extensive wetland areas. These factors maximize recharge because infiltration is rapid, surface runoff is not present, and evapotranspiration is minimal. Recharge is lower in the Tsala Apopka area because the potentiometric surface of the Floridan Aquifer is close to land surface in this area (SWFWMD 2000).

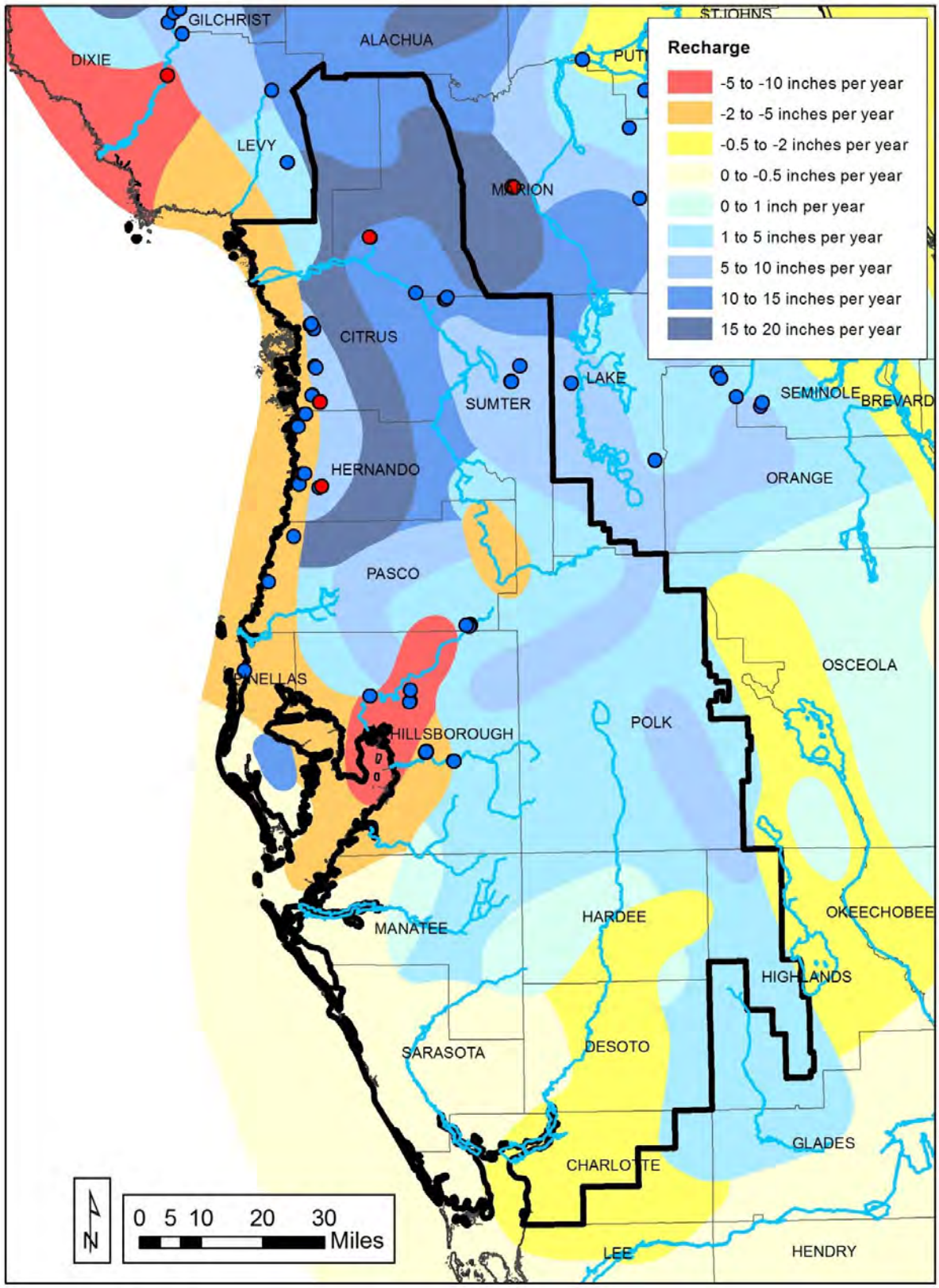


Figure 11. SWFWMD Recharge to the Floridan Aquifer (Bush and Johnston 1988).

2.5 Springshed Land Use

The land uses in the contributing area for Kings Bay were identified using the most recent (2009) SWFWMD land use Geographic Information System (GIS) coverage and were aggregated using the simplified Level 1/Level 2 codes (Figure 12). Table 2 summarizes the land uses and land cover category breakdowns, and Figure 13 shows the principal land uses in the contributing area as mapped by FDEP (Bridger 2014). Urbanized areas are the predominant land use category in the contributing area (45%), followed closely by "forestry/rural open" (26%). Agricultural land uses in the springshed comprise only about 10% of the contributing area. Urbanized areas increased from 95.21 mi^2 in 1989 to 117.56 mi^2 in 2009. Conversely, agricultural areas decreased from 34.95 mi^2 in 1989 to 24.58 mi^2 in 2009. In this same period, forest/rural open areas also decreased from 80.04 in 1989 to 67.46 mi^2 in 2009. Both of these decreases were a result of agricultural and forest/rural open areas converting to urbanized areas.

2.6 Aquifer Vulnerability

All groundwater and aquifer systems are susceptible to some extent to contamination from surface sources of pollution. An aquifer vulnerability assessment provides a data-based method of estimating that susceptibility to groundwater contamination. In 2005, the Florida Geological Survey published the Floridan Aquifer Vulnerability Assessment (FAVA), which assessed the contamination potential of Florida's principal aquifer systems (Arthur et al. 2005). Because of Florida's hydrogeologic setting, all of Florida's groundwater is vulnerable to contamination; however, the FAVA report identifies areas of relatively higher or lower vulnerability based on natural hydrogeology, not anthropogenic (human) factors. Contamination of groundwater can result through pollution of surface waterbodies or by infiltration through soils and sediments overlying aquifer systems. The likelihood of contamination increases in karstic areas (e.g., sinkholes and other features), in areas where the aquifer is unconfined, and in areas with permeable soils, among other factors.

In karstic areas near major springs, groundwater has the potential to flow rapidly and traverse large distances (hundreds to thousands of feet) in a short amount of time (days to weeks). Because groundwater flow is rapid and direct, dispersion, dilution and retardation of contaminants is minimal and springs are vulnerable to contamination. Areas with numerous closed topographic depressions (limited or no drainage), which are strongly correlated to areas with a high density of karstic features, are abundant in Citrus County. Where the Intermediate Aquifer System is thick and low in permeability, it provides some level of protection of the underlying Floridan Aquifer System from contamination, but where it is absent or breached by sinkholes, vulnerability to contamination increases.

The Intermediate Aquifer System is generally absent in the Kings Bay/Crystal River Springshed, and the Floridan Aquifer System is unconfined. With the exception of a relatively small area east of the Tsala-Apopka Lake system, the entire springshed is characterized as being Vulnerable, More Vulnerable, or Most Vulnerable to contamination (Arthur et al. 2005).

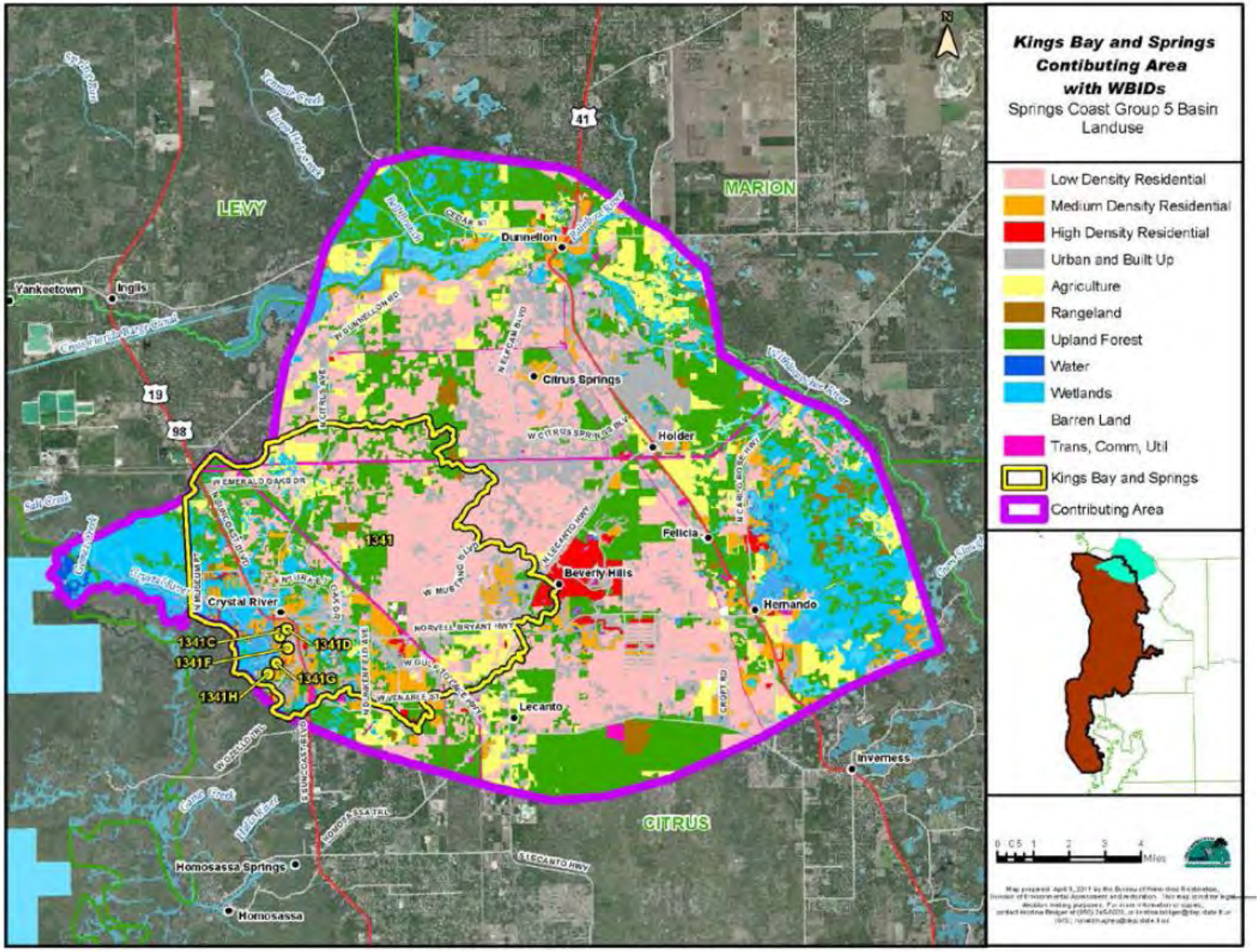


Figure 12. Contributing 2009 land uses in the Kings Bay/Crystal River Springshed (Bridger 2014).

Table 2. Classification of Land Use Categories for the Kings Bay Contributing Area in 2009 (Bridger 2014).

SWFWMD 2009 Land Use	Code	Acres	Mi²	% Contributing Area
Residential Low Density	1100	43,842	68.50	26.24%
Residential Medium Density	1200	8,511	13.30	5.09%
Residential High Density	1300	2,512	3.93	1.50%
Commercial and Services	1400	2,315	3.62	1.39%
Industrial	1500	349	0.55	0.21%
Extractive/Quarries/Mines	1600	344	0.54	0.21%
Institutional	1700	696	1.09	0.42%
Recreational (golf courses, parks, marinas, etc.)	1800	2,403	3.75	1.44%
Open Land	1900	14,265	22.29	8.54%
Agriculture	2000	15,732	24.58	9.42%
Rangeland	3000	1,959	3.06	1.17%
Forest/Rural Open	4000	43,177	67.46	25.84%
Water	5000	5,147	8.04	3.08%
Wetlands	6000	22,808	35.64	13.65%
Barren Land	7000	270	0.42	0.16%
Communication, Transportation, Utilities	8000	2,759	4.31	1.65%
TOTAL	**-**	**167,089**	**261.08**	**100.00%**

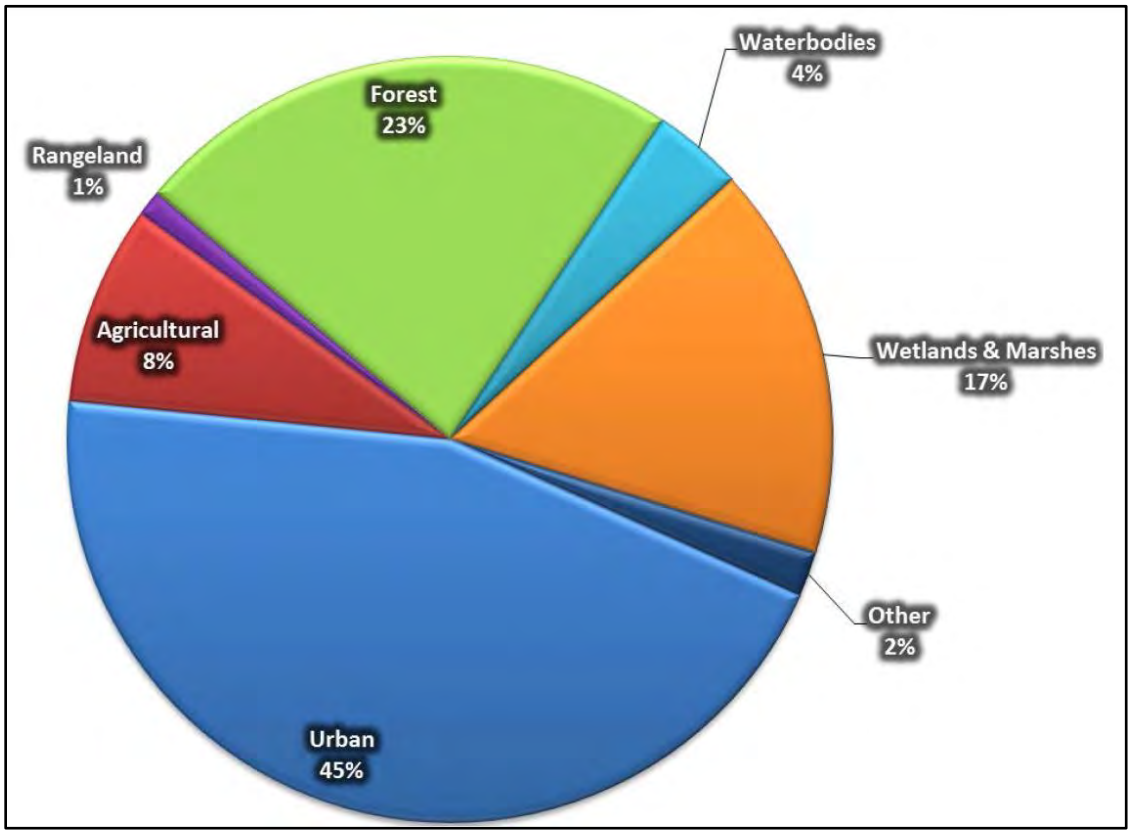


Figure 13. Kings Bay/Crystal River Springshed land uses as percentage of total land use (Bridger 2014).

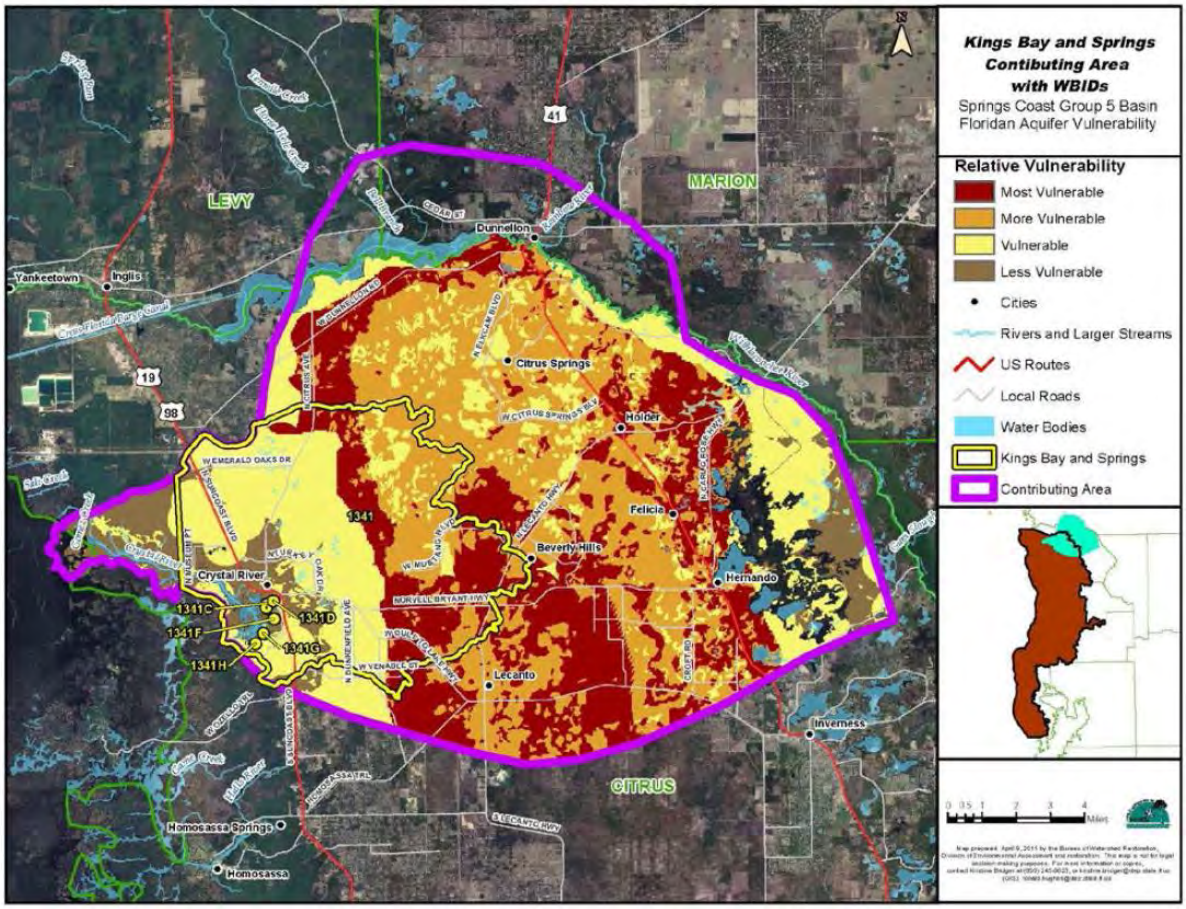


Figure 14. Kings Bay/Crystal River springshed vulnerability (FDEP 2015).

Figure 14 shows the mapped vulnerability of the Floridan Aquifer in the area contributing to Crystal River/Kings Bay springs. The map shows that the Floridan Aquifer in the entire contributing area for Kings Bay is more vulnerable to contamination from surface sources than other areas in the state. The vulnerability of the aquifer in the Kings Bay springshed was also evaluated based on county-specific aquifer and soil data and found that the majority of the springshed is "more vulnerable "or "most vulnerable" to contamination.

2.7 Human Population

Significant changes in the land use of the Kings Bay/Crystal River contributing basin began with European settlement of the area in the mid-1700s. During the 1800s major land uses included agriculture, horse and cattle ranching, and timber harvesting. By the 1900s timber and mining activities were predominant throughout the watershed, with timber and distillation of turpentine directly affecting Kings Bay. Rapid development of the watershed during the latter part of the 1900s resulted in significant increases in urban land use. Analysis of land use and cover codes indicate that acreage utilized for urban activities within the watershed increased by 16,007 acres from 1944 to 1995 (SWFWMD 2000). During this same time period, upland forested

acreage decreased by 16,451 acres. These land use changes within the Crystal River/Kings Bay watershed were coincident with rapid increases in the county's population over a 40-year period. The estimated population of Citrus County increased from approximately 9,268 in 1960 to approximately 141,236 in 2010.

Kings Bay and much of its contributing area are in Citrus County, and the City of Crystal River adjoins the bay. In 2010, the U.S. Census Bureau reported that there were a total of 59,915 households and 78,423 housing units in Citrus County. The population density was 242.8 people per square mile of land area. In 2010, the U.S. Census Bureau reported that the total population within the City of Crystal River's urbanized area was 3,111. During the past five decades, Citrus County and the City of Crystal River were among the fastest growing counties and cities in Florida. A large percentage of this increase has been attributed to retirees moving into the area (SWFWMD 2000). The economy of the Kings Bay region is supported by ecotourism and the population of retired residents. Growth in these areas has led to an associated growth in real estate, construction, wholesale and resale trade, and service sectors of the economy.

Impacts of land use activities on the Crystal River/Kings Bay system are increased if the entire groundwater contributing area, as illustrated in Figure 14 above, is included. The resulting management area for Kings Bay/Crystal River covers approximately 831 mi^2 and extends as far to the southeast as Polk County. Therefore, land use activities throughout a multi-county area have the potential to affect, through direct runoff and groundwater discharge, water quality in Kings Bay, Crystal River and the near shore estuaries of the Gulf of Mexico west of this area.

Appreciable, urbanization of the immediate Kings Bay watershed began in the mid-1900s, prior to the implementation of many stormwater Best Management Practices (BMPs). As a result, water quality in Crystal River/Kings Bay has been, and continues to be, affected by stormwater runoff and nutrient loadings from local septic tanks, agricultural practices, and spring discharge. Additionally, extensive dredge and fill activities (circa 1960) altered much of the Kings Bay and portions of the Crystal River shorelines. Designed to provide residential and commercial boat access to Kings Bay and Crystal River, these activities created numerous sea walls and dead-end canal systems, which have altered the hydraulic regime and historical natural wetlands of Kings Bay.

2.8 Sediments

Dependent on ambient conditions, sediments can have a major effect on water quality by either releasing or binding, nutrients, chemical contaminants and heavy metals. Additionally, resuspension of sediments into the water column can contribute to the impairment of water clarity; affecting recreational activities and growth of submersed aquatic plants. The Coastal Springs Restoration Project was initiated by Citrus County and the City of Crystal River in 1995. After initial delays, the project effected removal of silt and benthic algal mats from Tarpon Hole Spring and Hunters Spring with a cutter-head vacuum system in 1997. Anecdotal reports indicate the springs quickly silted in following completion of the dredging.

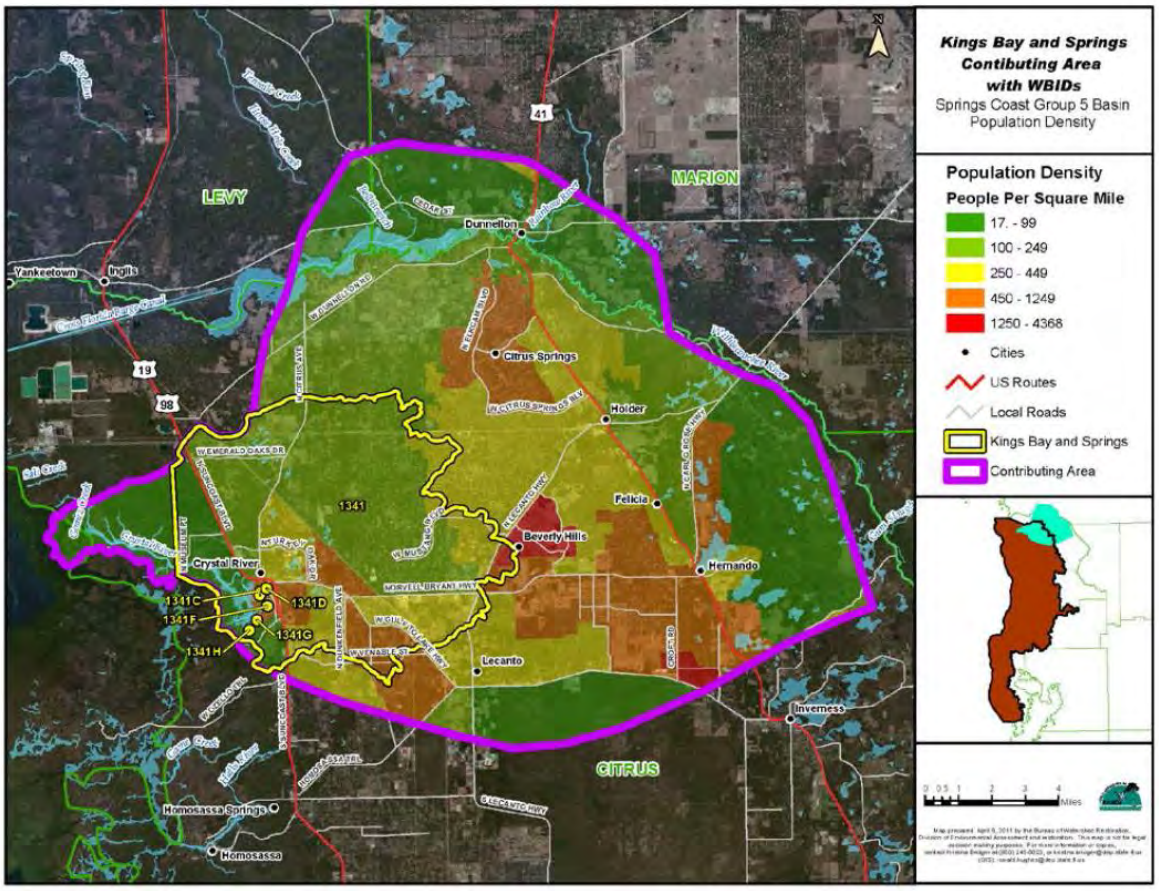


Figure 15. Human population density in the Kings Bay/Crystal River Springshed (Bridger 2014).

In 1993, the Florida Institute of Technology submitted a baseline sediment mapping and analysis for Crystal River/Kings Bay and Lake Panasoffkee to the District (SWFWMD 2000). Characteristics of Kings Bay sediments were reported as follows:

- Shallow thickness (range 0.0 – 3.4 feet);
- Comprised largely of fine grained particles;
- Have low average percent organic matter;
- Contain elevated copper and slightly elevated lead and zinc concentrations;
- Moderate nutrient concentrations (TKN range: 337 – 2,400 mg/kg, TP range: 189 – 474 mg/kg);
- Undetectable concentrations of organochlorine pesticides;
- Past dredging activities have resulted in sediments that are a poor candidate for paleo-ecological (pollen identification) analysis; and
- Sources of sediment organic matter vary within the bay (Figure 23)
    - Western Cedar Cove – *Lyngbya* sp.

- Eastern Cedar Cove – terrestrial
- Northwest Banana Island – aquatic algae
- South Banana Island – terrestrial
- Southern Kings Bay – *Typha* sp. detritus.

Through diffusion and resuspension, enriched sediments can release nutrients into the overlying water column and affect growth of submersed plants and aquatic algae.

2.9 Hydraulics

As a tidally influenced embayment, Kings Bay receives substantial fresh water inflows from spring discharge but is affected daily by tidal fluctuations in the Crystal River. The result is a complex interaction between spring flow exiting the bay and tidal fluctuations of incoming and outgoing tides.

Flushing and circulation characteristics modeled by Hammett et al. (1996) indicated that the open waters of Kings Bay were flushed relatively quickly in the 1990s; mean residence times were reported as follows:

- Low inflow conditions (735 cfs) – 59 hours;
- Typical inflow conditions (975 cfs)– 50 hours; and
- Low inflow with reduced friction (735 cfs, no hydrilla) – 56 hours.

Circulation patterns, identified by the hydrodynamic model, were almost identical between the three simulated hydrologic conditions listed above. Circulation patterns were similar for the Island. The combined spring discharge acts to separate waters north of Buzzard Island from the remainder of the bay.

2.10 Spring Flows

The flow record for Crystal River and for individual springs in Kings Bay is fragmentary. Continuous flow records in the Crystal River are reported by the U.S. Geological Survey (USGS) for the periods from 1965 to 1977 at Station USGS 02310750 and from 2002 to present at Station USGS 02310747. In 1977, Rosenau et al. (1977) reported the combined springs discharge at Kings Bay/Crystal River to be 916 cfs (592 MGD). Yobbi and Knochenmus (1989) reported an average flow in the Crystal River for the period from 1965 to 1977 as 975 cfs (630 MGD). The median flow for this time period was fairly consistent until a questionable rising trend became evident from during 1975-1977 (Figure 16).

VHB (2010) reported 2009 spring flow and *in situ* water quality of spring vents within the Kings Bay portion of Crystal River in Citrus County, Florida (Appendix B). The flow measurements were obtained at spring vents previously identified by VHB in the May 2009 report to the District titled: ***An Inventory of Spring Vents in Kings Bay, Crystal River, Florida***. VHB (2009) noted that many of the springs consisted of more than one vent in very close proximity which contributed to the overall discharge of that spring vent.

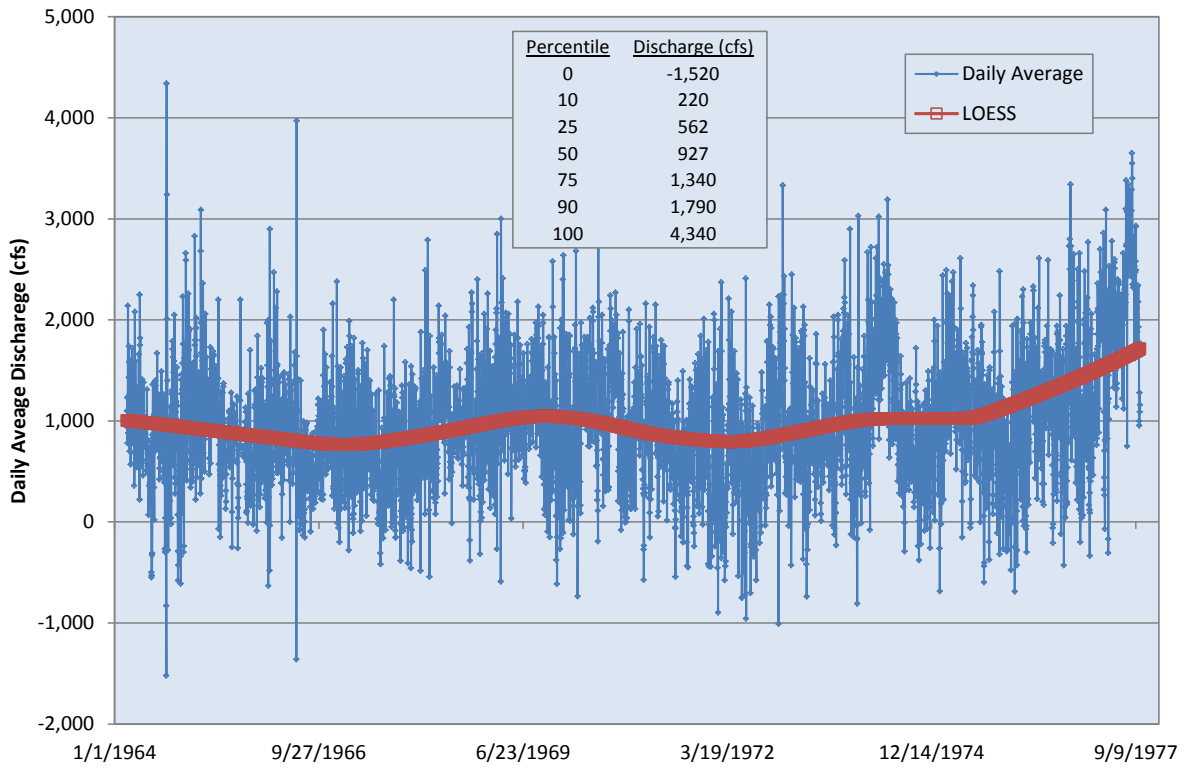


Figure 16. Crystal River discharge measured at USGS 02310750. The red line is a locally-weighted, moving average (LOESS) fit to the data. The increasing trend in flows beginning in 1975 resulted during a period of declining regional rainfall and appears to be an anomaly.

The spring vents identified by VHB (2009) are the principal source of fresh water supplied to Kings Bay/Crystal River. On average, about 99% of flow in the Crystal River is contributed by springs, and 1% is derived from stormwater runoff from the small surface watershed estimated as 2.7 mi^2 (Romie 1990; Hammett et al. 1996).

Spechler and Schiffen (1995) reported that Kings Bay/Crystal River spring flow was 877 cfs (567 MGD). Hammett et al. (1996) reported a measured flow in the Crystal River of 735 cfs (475 MGD) during June 1990, a period with below normal rainfall. These authors indicate that the 1990 flow is about 25% less than the historic flow reported by Yobbi and Knochenmus (1989). SWFWMD (2001) concluded that this observed reduction in spring flow "…is similar to other springs in the region and may be attributable to decreased rainfall and/or increased ground-water withdrawals in recharge areas near the springs".

Average flow in Crystal River for the more recent period (2002 – 2015) was 451 cfs (292 MGD) with relatively constant flows from 2002 to 2004 and with a declining trend between 2005 and 2010 (Figure 17). Average Crystal River flows in 2004 were 762 cfs (492 MGD), about 325 cfs (210 MGD) in 2010, and reached an all-time low annual average of 271 cfs (175 MGD) in 2012. The most recent ten-year average flow was reported as 389 cfs (251 MGD).

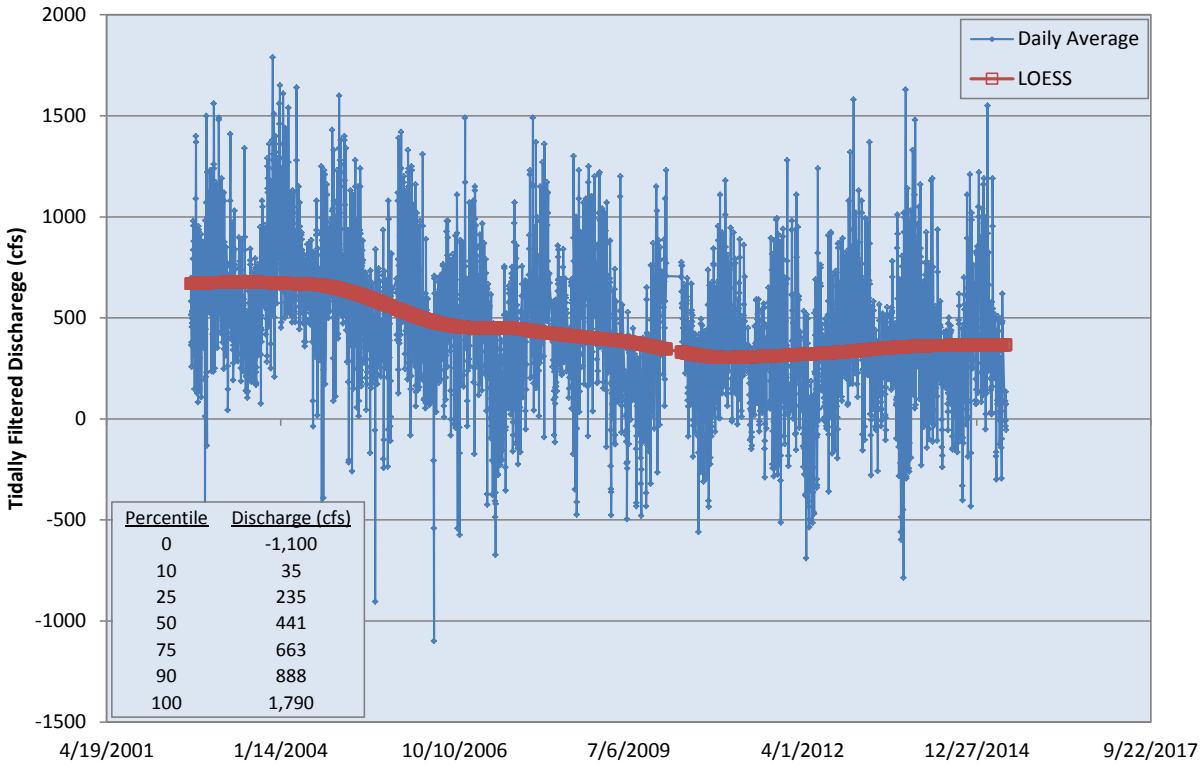


Figure 17. Daily Crystal River flows (cfs) at USGS Station 02310747 from 2002 through 2015.

VHB (2010) reported synoptic spring flow data for the Kings Bay/Crystal River springs for July to October 2009 of 465 cfs (300 MGD). This value is similar to recent flows measured at the downstream USGS gauge in the Crystal River, providing additional evidence that springs flows dominate the water supply to the Crystal River.

The available flow and other data indicate that declining flow rates have been measured for the Kings Bay/Crystal River spring complex since at least the 1990s. The overall estimated flow reduction that can be estimated from these data based on a 1970s baseline (916 cfs, 592 MGD) and the most recent decade of data (389 cfs, 251 MGD) was about 527 cfs (340 MGD), an average reduction of 58% from the earliest recorded baseline.

2.11 Water Quality

2.11.1 Ground Water

Romie (1990) identified four major sources of nutrient loading to Kings Bay; spring discharge, sewage treatment effluent, septic tank leachate and stormwater runoff. Proportionate loadings from each source were estimated and it was determined that spring discharge contributed approximately 94% of total nitrogen (TN) and 84% of total phosphorus (TP) entering the bay. Average TN and TP concentrations from nine springs sampled during the project were 0.35 and 0.04 mg/L, respectively.

The SWFWMD's Ambient Water Quality Monitoring Program analyzed groundwater samples collected from 103 wells located within the identified Kings Bay recharge area in 1991. These data were combined with water chemistry information collected from significant springs in the Kings Bay springs complex to characterize the local groundwater quality. Results of the two-year study were as follows (Jones et al. 1994):

- Approximately 335 and 38 tons of N and P, respectively, are discharged from the Kings Bay springs annually.
- Approximately 205 of the 335 tons, or 61%, of N discharged annually are in the form of nitrate.
- Although spring and groundwater data were not sufficient to indicate any trend in nitrate concentrations, the average concentration reported was 0.2 mg/l (1991 – 1992), which is approximately 20 times greater than the generally accepted background level of 0.01 mg/l (uncontaminated waters of the Floridan Aquifer). However, it is unknown whether historical nitrate concentrations in discharge from the Kings Bay springs complex were ever equivalent to 0.01 mg/l.
- The spring's groundwater sources originate from a drainage basin approximately bounded by the Withlacoochee River and a groundwater flow-line divergence in south-central Citrus County.
- Groundwater in the Crystal River/Kings Bay recharge area has most likely entered the Floridan Aquifer within the last 50 years.
- Small, localized loadings of development-related N (turf fertilizers and septic tank discharges) associated with the eastern portion of the City of Crystal River drainage basin most likely comprise the majority of the low levels of N in spring discharge.
- Additional natural and anthropogenic N loadings are anticipated to affect groundwater discharges into Kings Bay in the near future. These sources of N-enriched groundwater are traveling towards Kings Bay from the east-central and north-central portions of the recharge area and will affect the bay dependent upon travel time through the Floridan Aquifer.

The SWFWMD continued to collect quarterly water chemistry data from Tarpon Hole and Hunters Spring from 1991 to 2004. Mean concentration for this more recent time period at Tarpon Hole were: TN - 0.29 mg/L, nitrate N - 0.165 mg/L, and TP – 0.04 mg/L; and at Hunters Springs: TN – 0.51 mg/L, nitrate N – 0.291, and TP – 0.03 mg/L.

Specific conductance was observed to increase in Tarpon Hole since 1991 (range 1231 – 3299 µS/cm) for Tarpon Hole discharge, indicating greater salinities in spring discharges since 1991.

2.11.2 Surface Water

2.11.2.1 General

Of the reports that include surface water quality information for Kings Bay, the Springs of Florida (Rosenau et al. 1977) possibly contains the oldest data recorded for the system. Data collected from a surface sample over Tarpon Hole spring in the 1970s indicated a nitrate concentration of 0.06 mg/l and a specific conductivity of 555 µS/cm.

2.11.2.2 Salinity

Yobbi and Knochenmus (1989) compiled data relevant to river discharge, high-tide stage, and salinity to characterize salinity distributions within Crystal River. Of interest, this study concluded that increased groundwater withdrawals could reduce spring flow and generate an upstream movement of vertically averaged salinities (through tidal fluctuations) in Crystal River and Kings Bay.

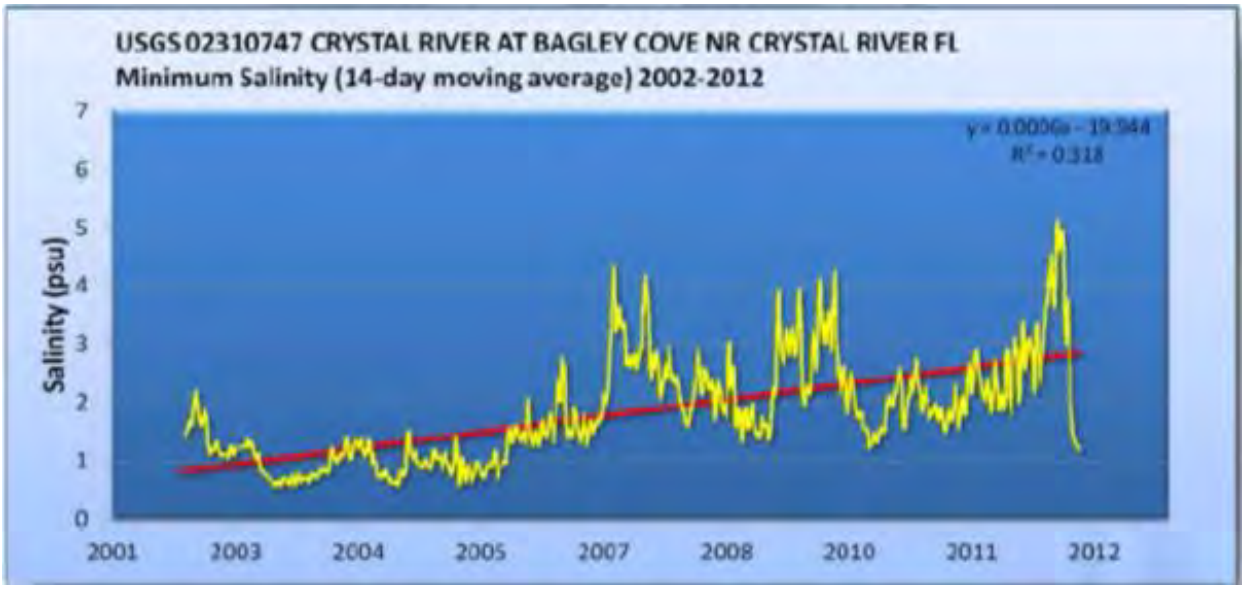


Figure 18. Salinity reported as practical salinity units (psu) over Time at Bagley Cove. Minimum salinity over the past ten years has been steadily increasing at the gauge on Crystal River at Bagley Cove, just downstream of the mouth of Kings Bay. Maximum salinity has also increased slightly but not as much as minimum salinity indicating that the bay is getting less fresh (SWFWMD 2015).

Salinity concentrations of approximately two to three practical salinity units (psu) have been suggested by the University of Florida to reduce total plant biomass in Kings Bay (Hoyer et al. 2001). Average salinities in Kings Bay might be elevated to these levels by tidal surges during storm events, landward movement of the coastal transition zone or alterations in the bay's salinity regime through reduced fresh water inflow.

Frazer et al. (2001) reported bottom salinities in Kings Bay ranging from a minimum of 0.74 psu to a maximum of 15.36 psu, with a mean salinity of 2.1 psu for the one-year study period (2000). Frazer et al. (2001) suggested that long-term increases in average salinity, adequate to significantly reduce total plant biomass, might have occurred since 1989.

Salinity concentrations affect which submersed plant species succeed in Kings Bay and can reduce total plant biomass when the plant community is dominated by freshwater species. At this time, mean salinities in the bay are approximately 2 psu (SWFWMD 2000).

VHB (2010) reported that spring conductivity varied spatially within Kings Bay from a low of 203 µS/cm to a high of 12,096 µS/cm, with an average of 2,045 µS/cm. Figure 19 presents the average conductivity data for each numbered spring and group cross-section in Kings Bay. The data are sparse, and so the interpolation of the contours should be viewed more on a qualitative

basis to discern the general trends. The Kings Bay spring conductivities increase from very low levels in the northeast to brackish conductivities in the southwest.

2.11.2.3 Nutrients

Nitrogen

Nitrogen is found in various forms (usually in the form of nitrate, nitrite, and ammonium) and is ubiquitous in the environment. Relatively low N concentrations cause a significant shift in the balance of spring ecological communities, leading to the degradation of biological systems because of the overgrowth of algae and sometimes aquatic plants (Harrington et al. 2010).

Nitrate is a mobile and conservative form of N that is the dominant form of the TN in spring discharges. Historically, nitrate N was only a minor constituent of spring water, and typical nitrate concentrations in Florida springs were lower than 0.05 milligrams per liter (mg/L) until the early 1970s. In recent years, elevated concentrations of nitrate N (above 0.05 mg/L have been found in many springs (WSI 2009).

In water, TN is made up of both inorganic and organic fractions. Inorganic N components include ammonium, nitrate, and nitrite. In Kings Bay, based on the long-term annual average data (2004 – 2012) from multiple stations, nitrate constitutes 36% of the TN (Bridger 2014). Therefore, the remaining N content (organic N and ammonium) in the bay is approximately 64%. Various sources of organic N are present within the bay, including stormwater runoff, microbial cycling, and aquatic vegetation nutrient cycling.

For Kings Bay, the TN and nitrate N data from water-quality sampling stations for the entire period of record (1974 – 2012) were analyzed by FDEP to detect temporal trends. The statistical test revealed an increasing temporal trend in the bay for nitrate N from 1980 to 2012 and a decreasing temporal trend in the bay for TN from 1974 through 2012 (Bridger 2014). This declining trend for TN is likely related to the cessation in wastewater discharges from the City of Crystal River to Kings Bay in 1992. The increasing trend in annual nitrate N concentrations for Hunter Spring and Tarpon Hole Spring are shown in Figures 20 and 21, respectively.

Phosphorus

Phosphorus (P) is naturally abundant in the geologic material underlying much of Florida and is often present in high concentrations in both surface water and ground water. Total P includes both orthophosphate (ortho P) and organic forms of P.

In Kings Bay, based on the long-term annual average from multiple stations (2004–12), ortho P constitutes 41% of the TP (Bridger 2014). Therefore, the organic P content in the bay is approximately 59%. According to Bridger (2014), there are various sources of organic P within the bay, including tidal mixing with adjacent wetlands, stormwater runoff, sediment recycling within bay sediments, and aquatic vegetation nutrient cycling. For Kings Bay, TP and ortho P data from water quality sampling stations for the period of record (1974 – 2012) were analyzed to detect temporal trends. The statistical test revealed a slight increasing temporal trend in the bay for TP and a slight decreasing temporal trend in the bay for ortho P (Bridger 2014). Figure 22 shows the annual TP and ortho P concentrations in the bay for the period of record.

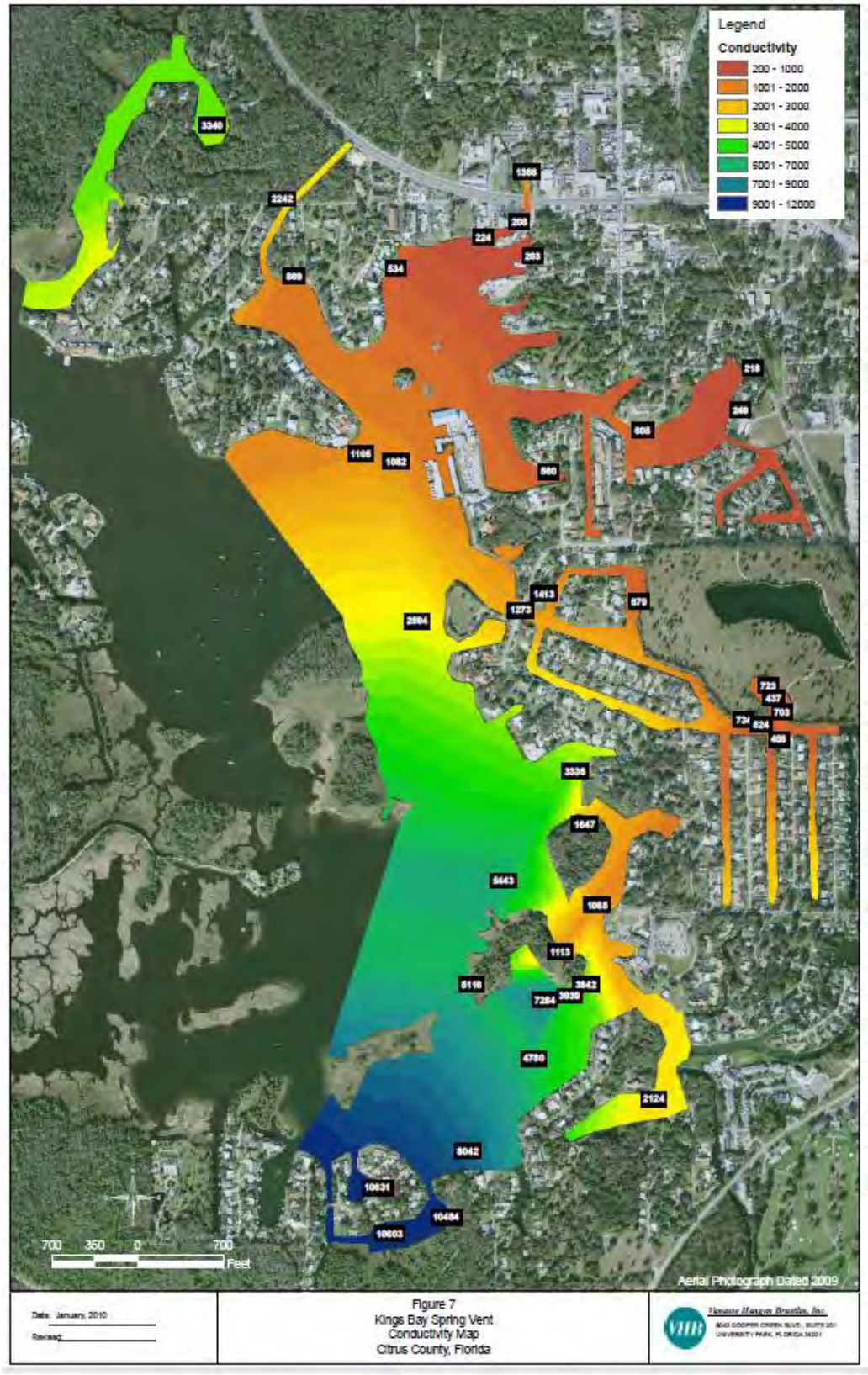


Figure 19. Specific conductance isopleths at Kings Bay measured in October 2009 (VHB 2010).

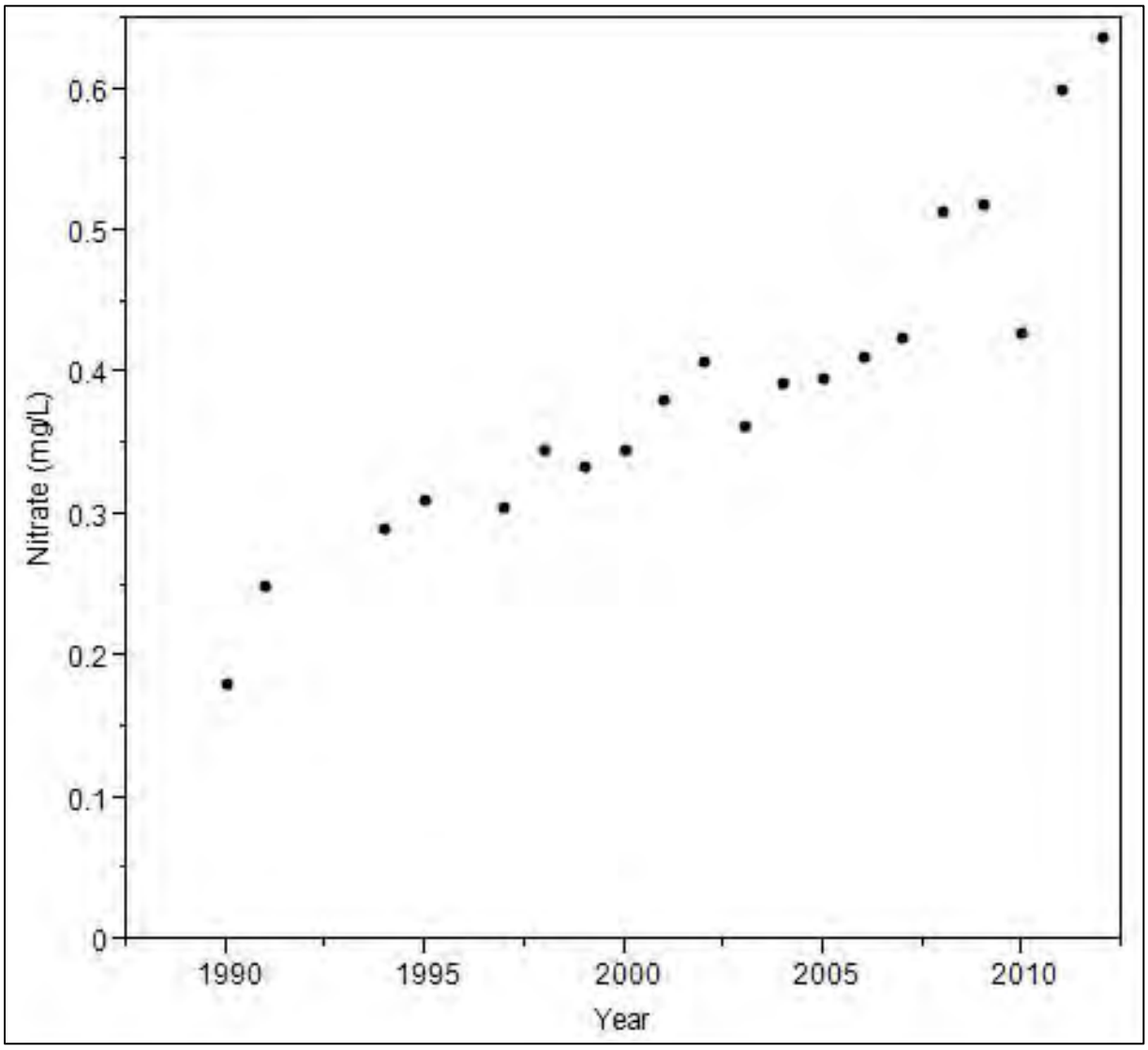


Figure 20. Annual average nitrate N concentrations in Hunter Spring for the period-of-record (Bridger 2014).

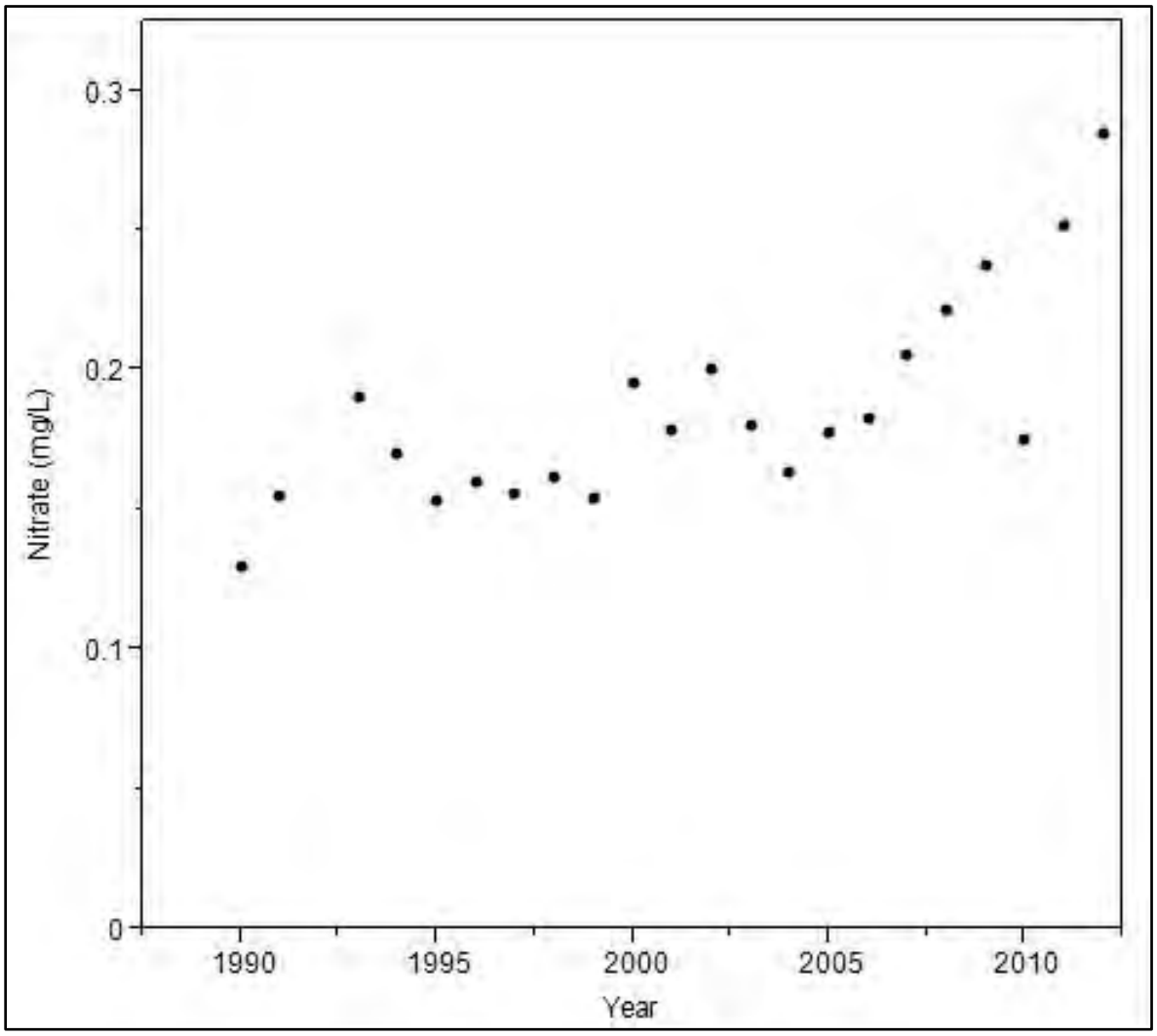


Figure 21. Annual average nitrate N in Tarpon Spring over the period-of-record (Bridger 2014).

The most common form of P in geologic material is ortho P because it is relatively insoluble in alkaline, carbonate-rich aquifers (SWFWMD 1998). If ortho P is present in spring discharge, local groundwater inputs from nearby sources are often indicated. Most of the P in the spring vent samples is in the form of ortho P based on a long-term annual average data (Bridger 2014). The organic P content is low in spring discharge. Ortho P data from several Kings Bay springs were analyzed to detect temporal trends. Based on the statistical tests, no temporal trends were detected for orthophosphate in Hunter Spring, House Spring, Black Spring, Idiot's Delight Spring, and Tarpon Hole Spring (Bridger 2014). The ortho P data range for Hunter Spring, House Spring, Idiot's Delight Spring, Tarpon Hole Spring, and Black Spring has not significantly differed from 1989 to 2012.

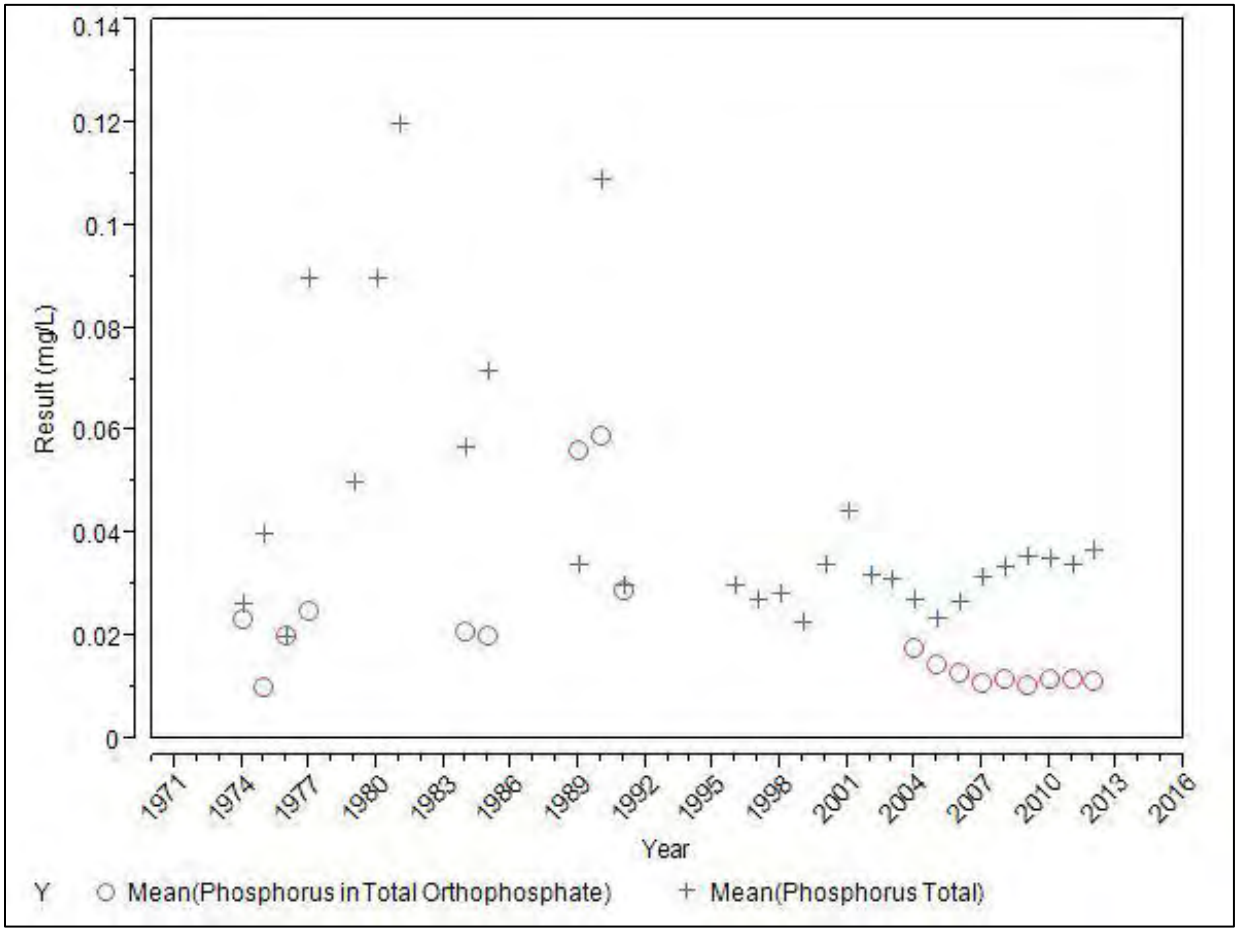


Figure 22. Ortho P and total P temporal trends in Kings Bay (Bridger 2014).

2.11.2.4 Water Clarity

Water clarity reduction has long been a primary water quality issue in Crystal River/Kings Bay (SWFWMD 1989, 2000, 2015). Water clarity is inversely related to chlorophyll (an indicator of planktonic algae) and total suspended solids in the bay. There is evidence that high amounts of aquatic vegetation in the past were associated with high water clarity in the bay (Hoyer et al. 1997). Since 2006, average bay-wide water clarity (as measured by horizontal Secchi disk) ranged from 8 to 14 feet of visibility (Figure 23, SWFWMD 2015). Water clarity varies in Kings Bay by both time and location. Temporal variation in clarity occurs to a small degree on a daily basis, as the best water clarity is observed in early morning before wind and recreation has suspended phytoplankton and organic sediments. Long-term variation has been observed during seasonal and prolonged drought periods when spring discharge and bay flushing is reduced. Spatial variation in water clarity occurs throughout the bay, primarily due to proximity to large spring vents where greater water flushing occurs.

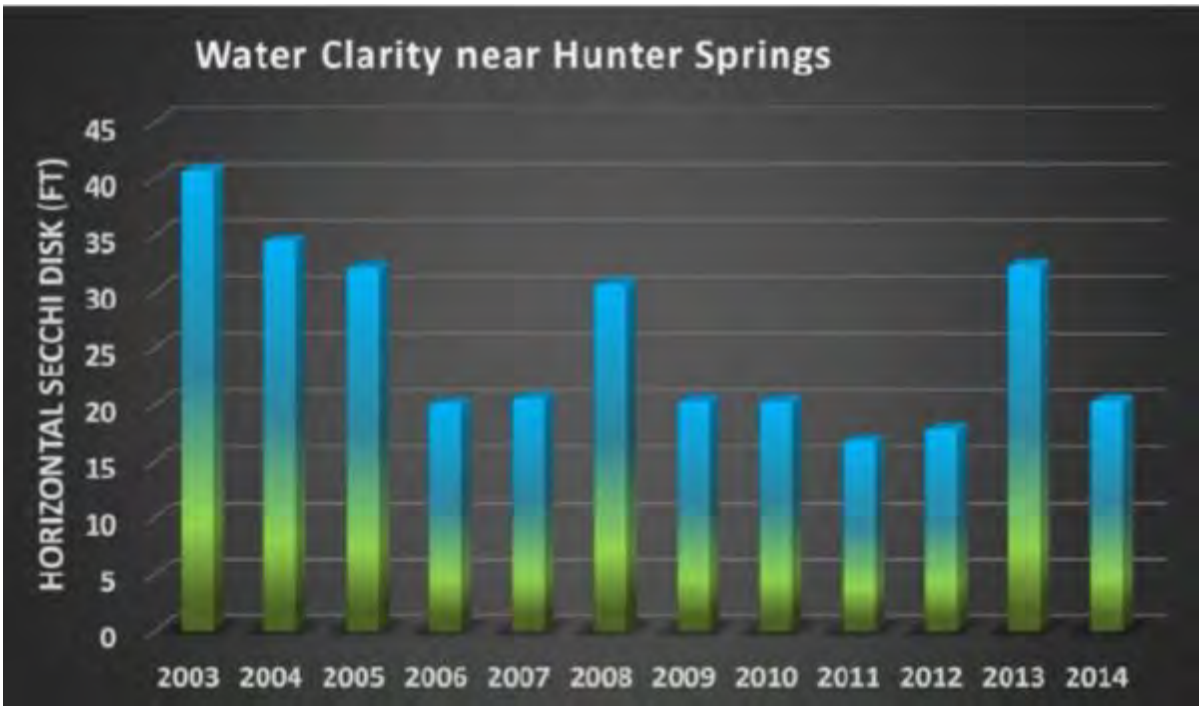


Figure 23. Water Clarity near Hunter Springs. Water clarity, as measured by a Horizontal Secchi Disk, over time at station KBN2, 1,200 feet from Hunter Springs and 500 feet from Jurassic Spring. Clarity is affected by many factors including the amount of chlorophyll and suspended sediment in the water column, tide, and spring discharge (SWFWMD 2015).

Recreational activities in Kings Bay related to diving, snorkeling and manatee viewing contribute substantially to the local economy. These activities depend a great deal upon unimpaired water clarity. Clear water has historically been a significant characteristic of the bay; however, declines in water clarity have occurred since the 1980s. Quantitative estimates of the reduction in water clarity since this time period are not available since use of the horizontal Secchi disk to assess water clarity in Kings Bay was not initiated until 2002.

At one time, researchers from the SWFWMD and the University of Florida suspected that resuspension of the fine sediments and silts in Kings Bay may have been contributing to the declines noted in water clarity. In 2001, the University of Florida analyzed areas in Kings Bay where sediments were most susceptible to wind-driven disturbance (Bachmann et al. 2001). This analysis modeled the contribution of sediment resuspension to declining water clarity. It was concluded that resuspension of bottom sediments by wind-driven waves was not the primary factor reducing water clarity in the bay.

In 1995, the University of Florida analyzed data collected by the LAKEWATCH volunteer monitoring program (from August 1992 to August 1995) (Bishop and Canfield 1995). Data included in the report indicated that visibility in the bay appeared to be associated primarily with algal cells in the water column. It was originally proposed that the bay's canal systems were a significant source of phytoplankton that would flush in the bay during increased flows and decrease visibility within Kings Bay. However, analysis of the LAKEWATCH data by Hoyer et al. (1997) determined that phytoplankton abundance in the canals was not

significantly different than in the open waters of the bay; dismissing the canals as the primary source of clarity-reducing phytoplankton. The Hoyer et al. (1997) study did document an inverse relation between the abundance of aquatic plants and chlorophyll concentrations in Kings Bay. As increases in phytoplankton standing crop typically reduce water clarity and phytoplankton standing crop rises during periods of low aquatic plant abundance, it was suggested that there is a direct link between aquatic plant abundance and water clarity in the bay.

2.12 Biota

2.12.1 Aquatic Vegetation

Submersed aquatic plant communities support wildlife species, stabilize sediments and remove contaminants from the water column. These functions highlight the importance of healthy aquatic plant communities in a water body such as Kings Bay and its springs.

Historical anecdotal evidence suggests that extensive eelgrass (*Vallisneria americana*) beds once dominated the vegetative community of Kings Bay. With the advent of development in the surrounding watershed (circa 1940), invasive and exotic plant species were introduced to Kings Bay. The initial exotic plant species impacting the bay's native aquatic plant communities was water hyacinth (*Eichhornia crassipes*), a floating plant that can substantially reduce the light available to plants at the bottom of the water column. Anecdotally, water hyacinth once covered large portions of the bay (Evans et al. 2007) and presumably led to a decline in native submerged aquatic vegetation (SAV).

The introduction of nuisance species such as hydrilla (*Hydrilla verticillata*) circa 1960 and Eurasian Water Milfoil (*Myriophyllum spicatum*) also circa 1960, and a rapid expansion of the native filamentous algae in the genus lyngbya (*Lyngbya* spp.) circa 1980, adversely altered the composition of SAV in Kings Bay. Hydrilla rapidly expanded throughout the bay, and efforts to control the species included sulfuric acid applications (Phillippy 1966), herbicide treatments, and mechanical harvesting. Copper-based herbicides for control of nuisance algae were eliminated after elevated levels of copper were found in the tissues of dead manatees in the region (Packard and Puckett 1983). Extensive mats of *Lyngbya* sp. became common in the bay, overlaying and shading rooted aquatic plants.

Currently hyacinth, hydrilla, and milfoil have declined so significantly they are no longer considered threats to native SAV in the bay; however, *Lyngbya* and other filamentous algae species, such as the green alga *Chaetomorpha*, remain prevalent and may inhibit native SAV from recolonizing Kings Bay. Poorly considered and executed historic plant management techniques likely exacerbated the loss of eelgrass beds and inadvertently led to their replacement of eelgrass by a dominant cover of filamentous benthic algae. An increase in the density of microscopic, phytoplanktonic algae throughout the water column has also accompanied the decline in coverage by the native eelgrass. This increase in phytoplankton has reduced water clarity and further limited the growth of rooted SAV such as eelgrass.

Numerous studies funded by SWFWMD and largely conducted by the University of Florida have documented the shift from native, rooted SAV to dominance by phytoplankton and benthic filamentous algae. For example, in 2001, the University of Florida monitored water clarity, water chemistry, and aquatic macrophyte abundance in Kings Bay to characterize the

relationship between aquatic vegetation and water clarity (Hoyer et al. 2001). Historical LAKEWATCH data were used to augment data collected for the study. Results supported the substantive effects of aquatic plant abundance on water clarity in Kings Bay; primarily through the inverse relationship between abundance of rooted plants and algae suspended in the water column. Ten species of submersed aquatic plants and algae were identified as part of the study, of which the four predominant species were milfoil, hydrilla, filamentous algae, and eelgrass. Based on a summary of historic data, the biomass of submerged vegetation in Kings Bay has decreased markedly and remained relatively low since the early 1990s (Figure 24).

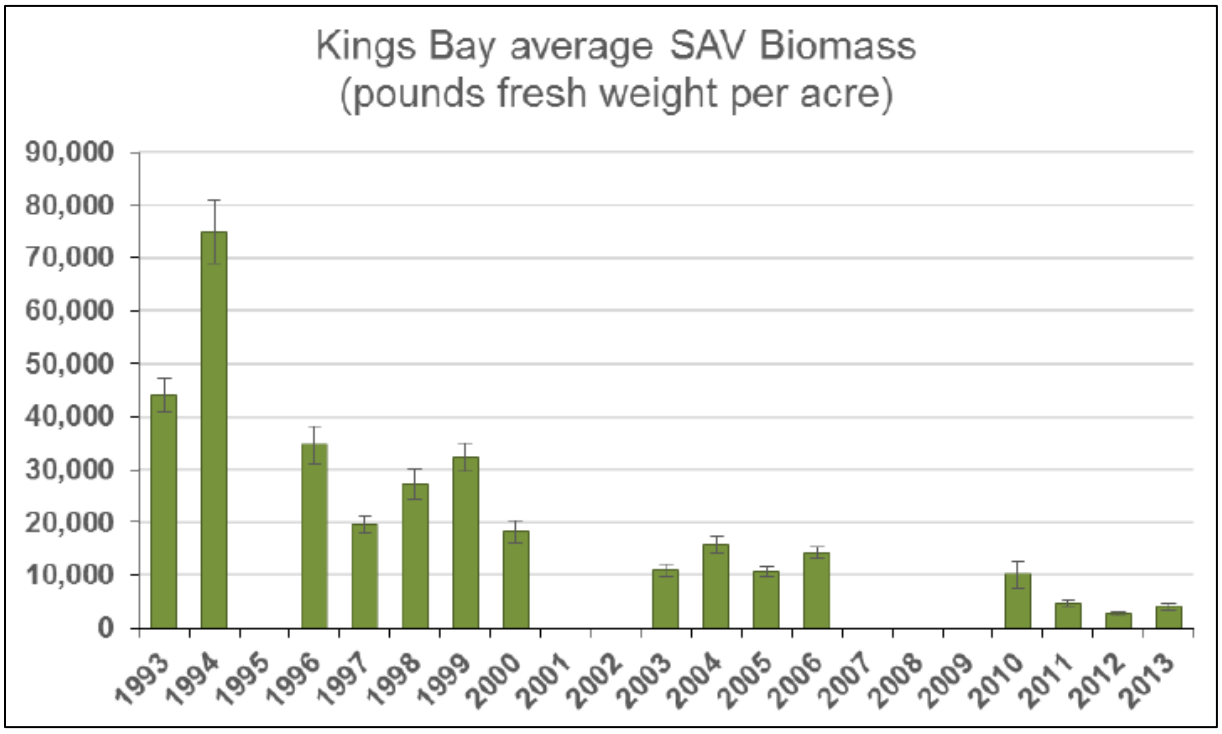


Figure 24. Kings Bay Average SAV Biomass (SWFWMD 2015).

The Kings Bay ecosystem has experienced considerable changes to fish and wildlife habitats, particularly over the past seventy years. It is believed that the bay was once filled with native SAV which helped maintain water clarity and provided abundant habitat for aquatic wildlife. Native SAV has declined substantially due to the combined effects of invasive species (including algae), aquatic plant management measures, salinity increases, muck accumulation, and sedimentation. Shoreline development has also been extensive and has replaced much of the natural shoreline and adjacent wetlands surrounding the bay, which filtered the water and provided habitat.

In the early 1900s, much of the bottom of Kings Bay would have been populated with SAV, which provided ample habitat and food for many commercially- and economically-important fish species and other wildlife. In this shallow waterbody, rooted aquatic plants also reduced wave action, stabilized sediments, and assimilated nutrients that would otherwise have promoted the growth of algae; functions that help maintain water clarity.

Submerged aquatic plants have been sampled at 71 stations in Kings Bay since October 2004 to October 2013 (Table 3). Ten types of vegetation were recorded: i.e., filamentous algae, coontail (*Ceratophyllum demersum*), muskgrass (a macroscopic algae *Chara* sp.), hydrilla, milfoil, southern naiad (*Najas guadalupensis*), pondweed (*Potamogeton pectinatus* and *P. pusillus*), eelgrass, and horned pondweed (*Zannichellia palustris*). Widgeongrass (*Ruppia maritima*) was not found, although it was present in samples from 2004–2006.

The application of consistent methods means that these data and the resulting maps can be compared to data and maps from sampling in 2004, 2005, 2006, 2011, and 2012 (Jacoby et al. 2014). Mean percentage covers ± SE calculated across samples taken during all October sampling periods were 77.4 ± 3.7% for all SAV, 42.3 ± 2.6% for filamentous algae, 8.1 ± 1.0% for southern naiad, 6.1 ± 0.7% for Eurasian milfoil, and 6.9 ± 1.2% for eelgrass. In 2004–2006, coontail, chara, hydrilla, and pondweed also covered an overall average of at least 1% of the bottom during October sampling periods.

In October 2010, biomass for all SAV combined ranged from 0 to over 1,000 g dry weight (DW) per square meter (m^2), with an overall mean ± SE of 106.1 ± 26.9 g DW m^2. Overall mean biomass ± SE for the four taxa covering at least 1% of the bottom on average were 73.2 ± 25.2 g DW m^2 for filamentous algae, 14.0 ± 5.3 g DW m^2 for naiad, 11.3 ± 2.8 g DW m^2 for milfoil, and 1.8 ± 0.6 g DW m^2 for eelgrass. Mean biomass ± SE calculated across all samples taken in October 2004, 2005 and 2006 was 133.5 ± 11.1 g DW m^2 for all SAV, 104.3 ± 10.6 g DW m^2 for filamentous algae, 5.6 ± 1.0 g DW m^2 for naiad, 4.3 ± 0.5 g DW m^2 for milfoil, and 7.7 ± 1.6 g DW m^2 for eelgrass.

Table 3. Average percent cover by SAV species/type for Kings Bay (data from Jacoby et al. 2014).

Species	2004	2005	2006	2011	2012	2013
Ceratophyllum demersum	1.0	0.7	0.6	0.7	0.8	0.0
Chara sp.	2.1	1.4	2.8	2.0	1.8	1.1
Filamentous algae	42.0	39.1	42.5	21.4	16.7	16.9
Hydrilla verticillata	6.7	5.5	5.8	0.5	0.3	0.5
Myriophyllum spicatum	10.0	3.8	8.1	7.3	3.6	2.0
Najas guadalupensis	3.9	11.2	11.6	11.7	7.1	4.9
Potamogeton pectinatus	0.6	0.0	0.5	1.7	0.5	0.2
Potamogeton pusillus	5.1	5.4	5.7	1.7	1.0	0.5
Ruppia maritima	0.2	0.8	1.1	0.0	0.0	0.0
Vallisneria americana	4.4	3.7	3.5	2.6	1.0	1.7
Zannichellia palustris	0.0	3.5	4.4	3.1	2.3	2.0
Exotic / Filamentous algae	**58.7**	**48.4**	**56.5**	**29.2**	**20.6**	**19.3**
Native	**17.2**	**26.7**	**30.0**	**23.4**	**14.5**	**10.4**

Analysis of recent historical SAV data indicate that vegetation in Kings Bay is continuing to change and that the coverage of desirable SAV species such as eelgrass is continuing to decline. Widgeongrass, although present at low cover, has not been recorded since 2006. On average, combined SAV, filamentous algae and eelgrass covered from two to three times as much area in the month of October during 2004, 2005, and 2006 than in October 2010. In addition, the overall mean biomass of both combined SAV and eelgrass were 2.2 and 4.3 times higher in the earlier samples.

Both the University of Florida (Hauxwell et al. 2003) and the SWFWMD concluded a pilot study in 2001 investigating the potential of removing *Lyngbya* mats from five sites in Kings Bay and revegetating with eelgrass. In each instance, newly planted eelgrass was quickly consumed by manatees, regardless of size or density of the installed plants. Hauxwell et al. (2003) found that excluding manatees from newly planted eelgrass beds increased survivability. However, abundance of the protected plants was then reduced through competition with other species, primarily Eurasian milfoil. Moreover, allowing the eelgrass plants to establish, for an approximate 5-month period, did not increase survivability once protective fencing was removed. Results of both studies indicate that extensive restoration of eelgrass, through replanting activities, is not currently feasible in Kings Bay.

2.12.2 Phytoplanktonic Algae

Phytoplanktonic algae are small photosynthesizing organisms that occur in the water column in sunlit areas. The production of chlorophyll by these organisms can turn the water column green and impede light penetration. Phytoplankton can block sunlight from reaching aquatic life at the bottom and absorb the light so that there is less reaching the benthic zone. While the production of chlorophyll is naturally occurring, elevated levels can have adverse effects on designated beneficial uses and cause impairment. Planktonic algae populations and their chlorophyll production vary greatly with depth because the algae must stay within the top portion of the waterbody where sunlight is available to photosynthesize and stay alive. Elevated chlorophyll levels, which occur in association with elevated nutrients, have contributed to an ecological imbalance in Kings Bay, particularly in the Hunter Spring area. Some algae produce toxins, which during an algal bloom can become harmful at high concentrations. The reduction of nutrients (N and P) in the water column may have the beneficial effects of reducing chlorophyll concentrations as well as the biomass of filamentous algal mats.

Chlorophyll concentrations, a proxy for phytoplankton abundance, are highly variable throughout the Kings Bay but in general have increased over the period of record from 2003-2012. Chlorophyll correlates with total P in the bay (Figure 26). There is no apparent relationship between chlorophyll and total N in the bay (SWFWMD 2015).

The primary driver of chlorophyll in the bay is likely hydraulic (water) residence time, the amount of time for water to move through the bay. Longer residence times allow increased phytoplankton growth and cell multiplication prior to being flushed out of the bay. The net result is higher water column chlorophyll levels and lower water clarity in the bay. Residence time is not easily measured, but specific conductivity can be used as a surrogate for residence time, since higher conductivity in the bay may indicate reduced spring flows and that less flushing is occurring. The correlation between chlorophyll and conductivity in the bay suggests that residence time is driving increases in chlorophyll and phytoplankton density, although P concentrations and other factors may also be important (Figure 27).

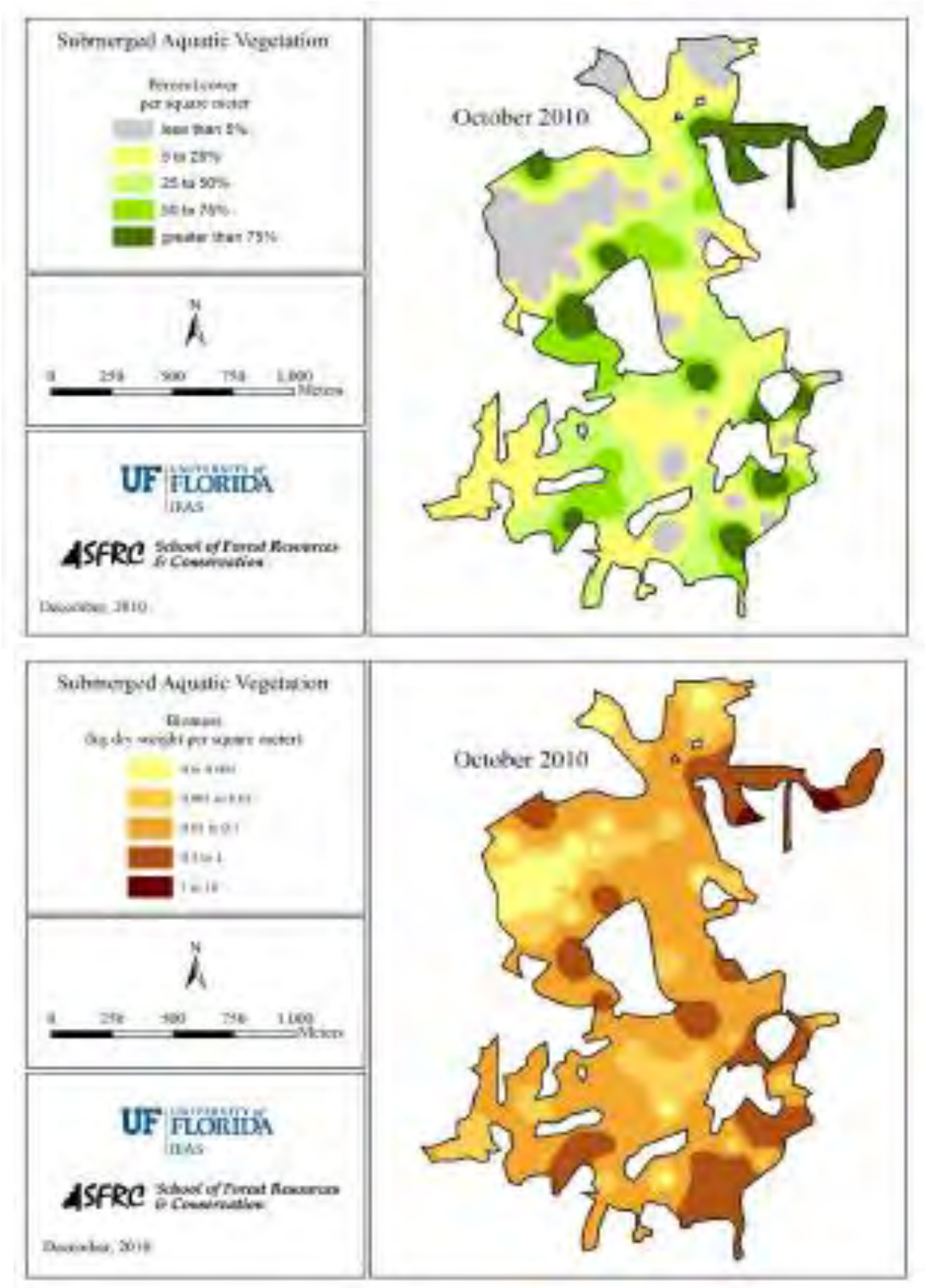


Figure 25. Maps of interpolated percent cover of Kings Bay SAV and biomass (Jacoby et al. 2010).

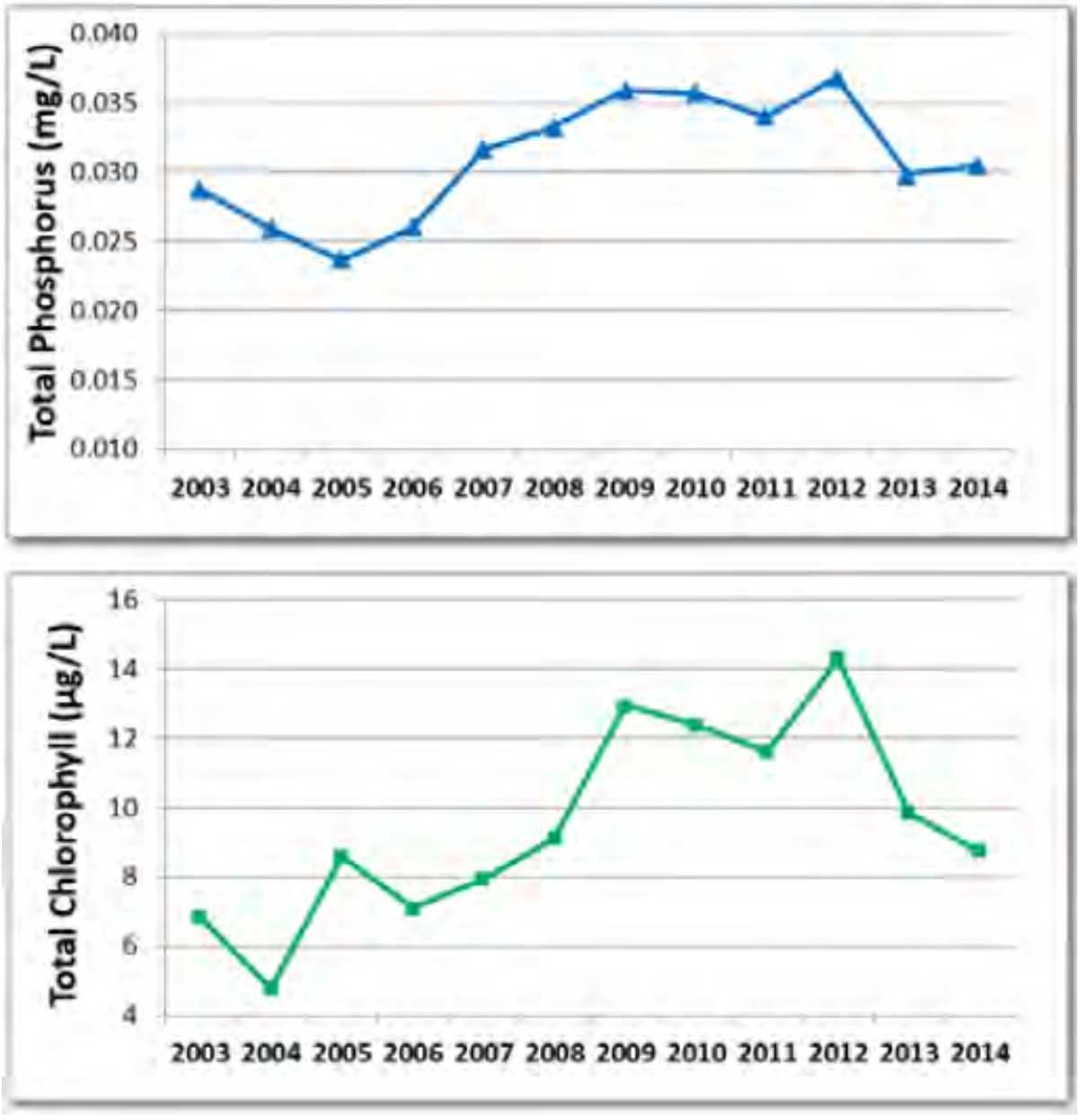


Figure 26. Annual average total P and total chlorophyll concentrations in Kings Bay. Data collected quarterly from 12 stations (SWFWMD 2015).

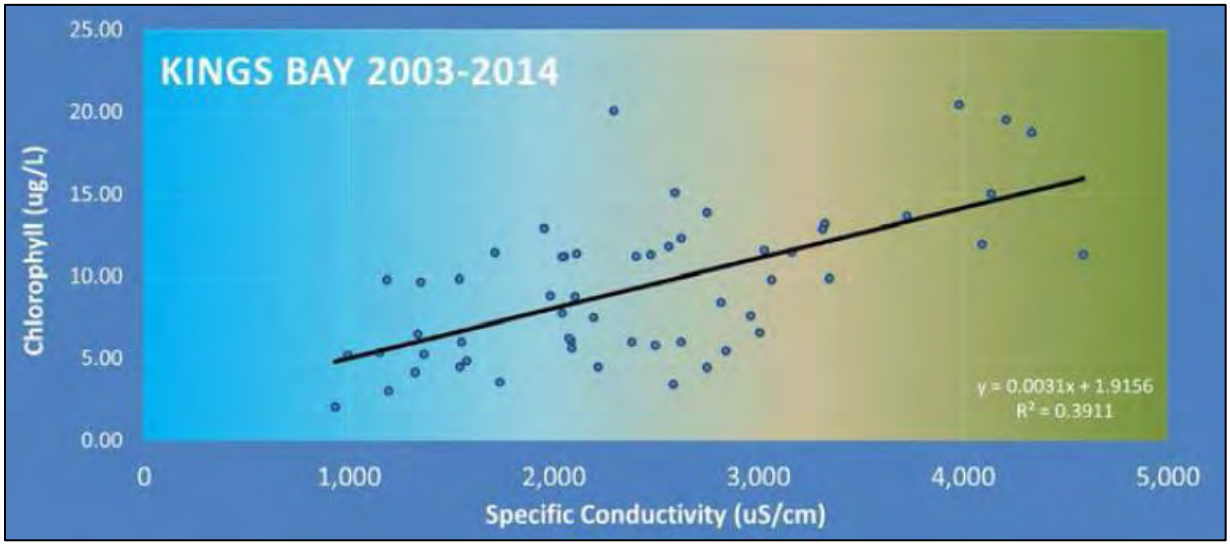


Figure 27. Chlorophyll versus specific conductivity in Kings Bay (SWFWMD 2015).

2.12.3 Wildlife

Crystal River discharges to the Gulf of Mexico near the middle of a region of the state commonly referred to as the Springs Coast. The Springs Coast spans an area from the Waccasassa River for the northern boundary and the Pithlachascootee River for the southern boundary (Wolfe et al. 1990). This region is characterized by numerous rivers and creeks that combine with diffuse groundwater discharge to create an extensive estuarine ecosystem along the gulf. The relatively shallow gulf waters allow extensive seagrass meadows where adequate sediments are present, while areas of exposed karst geology tend to be dominated by calcareous macroalgae. Coastal habitats also include oyster bars, mangroves, salt marshes, and moving inland, hydric hammocks.

Baseline terrestrial wildlife data from the watershed of Kings Bay/Crystal River were collected in 1990 by the Florida Game and Fresh Water Fish Commission (Joiner et al. 1992). The majority of the sampling was conducted in the St. Martin's Marsh Aquatic Preserve, southwest of Kings Bay, but one sampling site was located north of Crystal River on the William's Tract. Five major habitat types were identified in the watershed: tidal marsh, hydric hammock, flatwoods, spring-run stream, and depression marsh. The exact sampling procedures used are described in detail in the FFWCC report (Joiner et al. 1992).

Twenty-one species of amphibians, 47 species of reptiles, 191 species of birds, and 22 species of mammals were documented from the Kings Bay/Crystal River watershed. These numbers included the following state or federally listed species: gopher frog (*Rana capito*), American alligator (*Alligator mississippiensis*), eastern indigo snake (*Drymarchon corais*), Florida pine snake (*Pituophis melanoleucus*), river cooter (*Pseudemys concinna*), gopher tortoise (*Gopherus polyphemus*), American oystercatcher (*Haematopus palliatus*), least tern (*Sterna antillarum*), little blue heron (*Egretta caerulea*), reddish egret (*Egretta rufescens*), snowy egret (*Egretta thula*), tricolored heron (*Egretta tricolor*), wood stork (*Mycteria americana*), bald eagle (*Haliaeetus leucocephalus*), swallow-tailed kite (*Elanoides forficatus*), peregrine falcon (*Falco peregrinus*),

American kestrel (*Falco sparverius*), sandhill crane (*Grus canadensis*), Florida scrub jay (*Aphelocoma coerulescens*), seaside sparrow (*Ammodramus maritimus*), marsh wren (*Cistothorus palustris*), brown pelican (*Pelecanus occidentalis*), red-cockaded woodpecker (*Picoides borealis*), burrowing owl (*Athene cunicularia*), and Florida mouse (*Podomys floridanus*).

The aquatic invertebrates of Crystal River/Kings Bay have been investigated in several reports. Mote Marine Laboratory characterized the occurrence of barnacles (*Balanus subalbidus*) in Kings Bay (Cutler 2010). The widespread presence of barnacles in Kings Bay was attributed to elevated salinities due to sea level rise and reduced spring discharge. The relationship of physical characteristics, particularly salinity, and the spatial distribution of benthic macroinvertebrates was investigated by Evans et al. (2010). In that 2010 study, live oysters were observed from the river mouth upstream to where mean water column salinity was approximately 4 parts per thousand. The amphipods *Apocorophium louisianum* and *Cerapus benthophilus*, and the bivalve mollusc, *Cyrenoida floridana*, were the numerically dominant organisms and these three species made up 67.5% of the total number of organisms collected (Evans et al. 2010). The number and diversity of taxa declined longitudinally from the river mouth upstream to approximately mid-river and then increased in Kings Bay. Evans et al. (2010) concluded that a long-term decline in freshwater inputs and resultant elevated salinity concentrations might lead to an increase in number of taxa, an increase in number of salt-tolerant taxa, and perhaps a decrease in chironomids, freshwater oligochaetes, *Gammarus* sp., freshwater gastropods (e.g., *Pyrgophorus platyrachis, Littoridinops* sp.), and other taxa characteristic of the oligohaline and freshwater zones of the Kings Bay/Crystal River system.

The fish community of Kings Bay is being characterized by Florida Fish and Wildlife Conservation Commission (FWC) biologists as part of a multi-year survey of first magnitude springs systems in the SWFWMD (Simcox et al. 2015). The FWC is conducting a series of fish sampling events to document fish abundance, diversity, richness, and fish species composition in portions of Kings Bay. To date, a total of 34 fish species have been collected from Kings Bay, including both freshwater and saltwater species (Table 4). Common freshwater species included largemouth bass (*Micropterus salmoides*), bluegill sunfish (*Lepomis macrochirus*), and inland silversides (*Menidia beryllina*). Common saltwater species included mojarra (*Eucinostomus* sp.), striped mullet (*Mugil cephalus*), and pinfish (*Lagodon rhomboids*). As with other coastal spring systems, marine species utilize Kings Bay year-round, and especially during the winter as a thermal refuge. Sampling during the winter season observed that 90% of the fish were of saltwater or estuarine species, while in the summer only 64% of the sampled fish were saltwater or estuarine in origin.

In 1994, the USFWS analyzed mercury levels in tissues of largemouth bass caught in the Crystal River National Wildlife Refuge (Brim et al. 1994). Results of the study indicated that levels of mercury found in the fish tissues were insufficient to kill the largemouth bass. However, through bioaccumulation, the recorded concentrations of mercury were above levels believed to harm predatory birds feeding upon the bass.

Table 4. Fish species collected from Kings Bay/Crystal River (Simcox et al. 2015; SWFWMD 2015).

Common Name	Scientific Name	Common Name	Scientific Name
Atlantic needlefish	*Strongylura marina*	stingray	*Dasyatis spp.*
bay anchovy	*Anchoa mitchilli*	striped mullet	*mugil cephalus*
black drum	*Pogonias cromis*	white mullet	*mugil curema*
clown goby	*Microgobius gulosus*	American eel	*Anguilla rostrata*
common snook	*Centropomus undecimalis*	hogchoker	*Trinectes maculatus*
Crevalle jack	*Caranx hippos*	mullet spp.	*Mugil spp.*
gray snapper	*Lutijanus griseus*	red drum	*Sciaenops ocellatus*
hardhead catfish	*Ariopsis felis*	bluegill	*Lepomis macrochirus*
ladyfish	*Elops saurus*	bowfin	*Amia calva*
menhaden spp.	*Brevoortia spp.*	eastern mosquitofish	*Gambusia holbrooki*
mojarra spp.	*Eucinostomus sp.*	Florida gar	*Lepisosteus platyrhincus*
naked goby	*Gobiosoma bosci*	inland silverside	*Menidia beryllina*
pinfish	*Lagodon rhomboides*	largemouth bass	*Micropterus salmoides*
sheepshead	*Archosargus probatocephalus*	rainwater killifish	*Lucania parva*
sheepshead minnow	*cyprinodon variegatus*	redear sunfish	*Lepomis microlophus*
silver perch	*Bairdiella chrysoura*	Seminole killifish	*Fundulus seminolis*
spotted seatrout	*Cynoscion nebulosus*	spotted sunfish	*Lepomis punctatus*

The Florida manatee (*Trichechus manatus latirostris*), a subspecies of the West Indian manatee (*Trichechus manatus*), is native to Florida. These herbivorous mammals reach an average adult size of 10 feet long and approximately 1,000 pounds. As migratory animals, their summer range can extend widely along the Atlantic and Gulf coasts, while in the winter, populations become concentrated in Florida. Manatees are sensitive to cold temperatures and are susceptible to hypothermia in water temperatures below 68 °F. As a result, Kings Bay (and other springs with coastal connections) provides critical warm water habitat, with individual manatees often returning to the same wintering areas year after year. Based on long-term observations by USGS and the USFWS biologists, 90% of the manatees utilizing Kings Bay during cold weather events are associated with King, Three Sisters, Gator Hole, and Hunter springs (Provancha et al. 2012).

To address the need for providing critical habitat, the USFWS Crystal River National Wildlife Refuge was established in 1983 specifically for manatee protection. The Refuge comprises nearly 180 acres in and around Kings Bay and includes seven winter (Nov. 15 – Mar. 31) manatee sanctuaries in Kings Bay totaling approximately 40 acres.

The manatee population utilizing Kings Bay has been increasing, especially since 2009 (Figure 28, Kleen and Breland 2014). As a historical comparison, during the winter of 1997 - 1998, the Kings Bay record count was 284 (USFWS 1998). The current record Kings Bay manatee count of 708 animals was set on February 20, 2015.

Manatees feed on aquatic vegetation from seagrass meadows and coastal rivers and are reported to consume about 10% of their body weight daily (Worthy and Worthy 2014). Within Kings Bay, it has become a repeated annual observation that manatees will graze the submerged aquatic vegetation down to bare sediments during the winter (Provancha et al.

2012). It is likely that the cumulative impact of manatee feeding on SAV has increased over time as the number of manatees utilizing Kings Bay has increased. The impact of manatee grazing on the survival of transplanted SAV in Kings Bay has been evaluated and the findings suggested that some protective measures are necessary to prevent over grazing (Hauxwell et al. 2004). Although Kings Bay SAV can re-grow during the spring/summer if the plant roots remain and grazing pressures are reduced, other environmental pressures exist as well. Freshwater SAV survival and growth has been repeatedly observed to decline following marine salt water intrusion during hurricanes and tropical storm events (Frazer et al. 2006). In addition, competition for space and light by invasive SAV species (e.g., hydrilla or lyngbya) has the potential to reduce the abundance of desirable SAV (SWFWMD 2015).

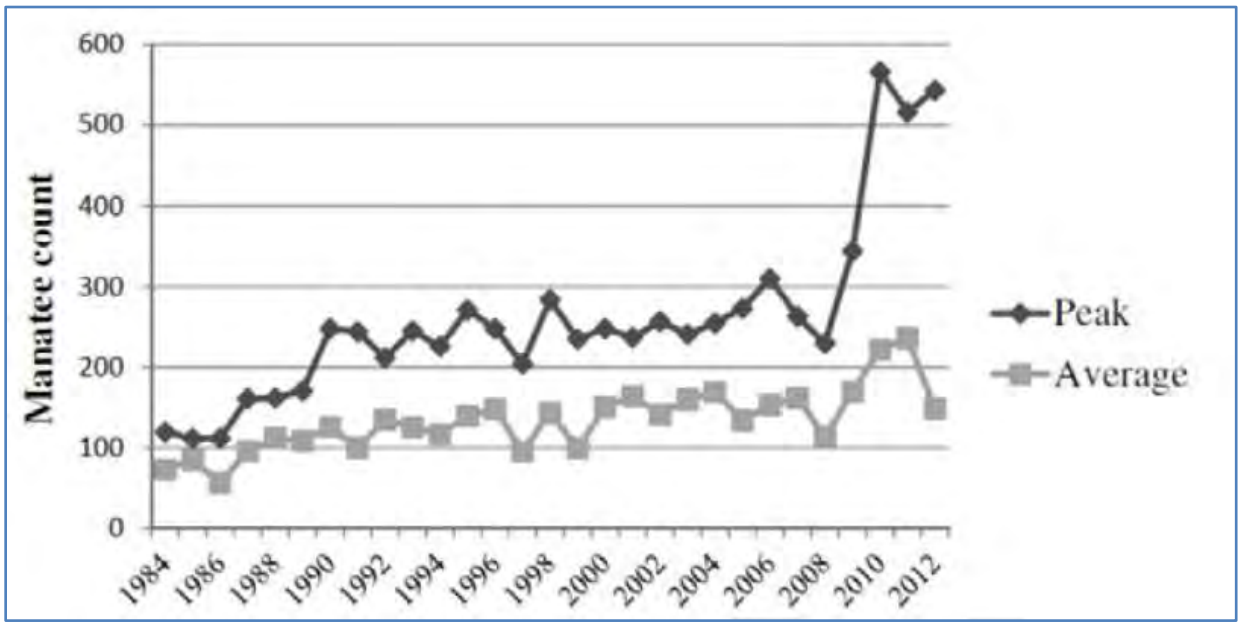


Figure 28. Peak and average manatee winter counts in Kings Bay from 1983 through 2012 (Kleen and Breland 2014).

Upon the discovery of elevated copper in the tissues of dead manatees in the 1980s, a study was initiated by the USFWS to assess contaminant concentrations in Kings Bay sediments (Facemire 1991). Copper from herbicides applied to control hydrilla in the 1970s had accumulated in the sediments and it was suggested that the copper was being bio-transported through submersed plants to the grazing manatees. Although sediment concentrations were elevated at all sites sampled during the study, it was not conclusive that transport of copper by submersed plants was sufficient to reach levels lethal to the bay's manatees.

2.12.4 Humans

The diversity of Florida's wildlife attracts tourists and creates jobs. Ecotourism is a major reason that tourists visit the City of Crystal River and surrounding communities, and these areas are economically dependent on ecotourism. The loss of habitats such as swamps, marshes, and estuaries can have both economic and quality-of-life implications for the community. Since recreational activities occur on and in the water, water quality is the most important aspect of

ecotourism in these areas (City of Crystal River 2004). A visible component of the Kings Bay/Crystal River watershed, wildlife enhance the local economy by supporting commercial and recreational fishing, diving and snorkeling activities and manatee viewing tours. Accordingly, research projects and protective measures implemented in Kings Bay to date by federal and state wildlife agencies have focused largely on fish and the West Indian manatee.

Since approximately 1983, Citrus County has conducted bacteriological tests on the waters of Hunters Spring Park for the City of Crystal River. On occasion, levels of coliform bacteria are high enough to close the park's beach to swimming. It is unclear if bacteriological data from other areas in Kings Bay exist.

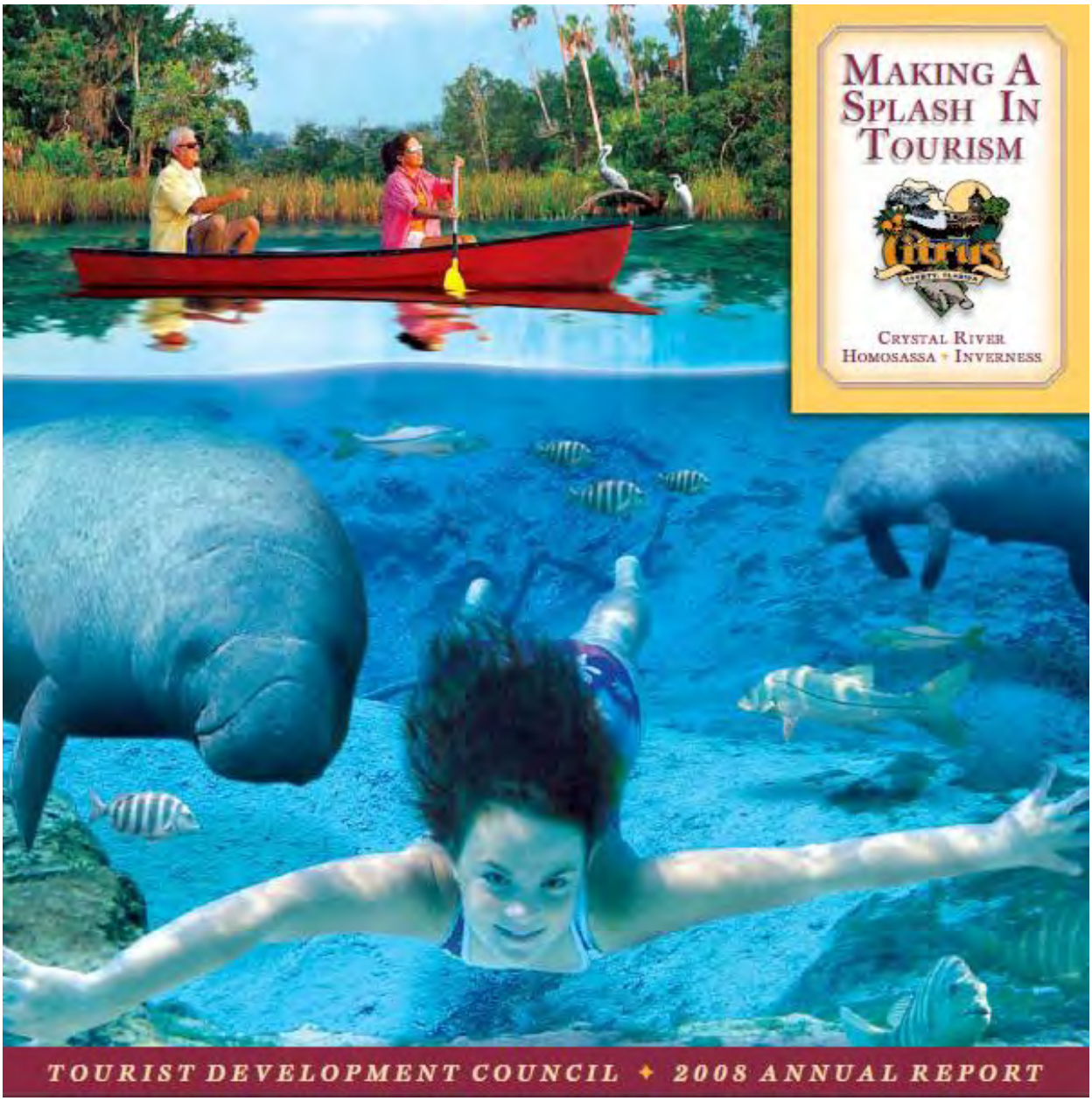


Figure 29. Manatee viewing and paddle sports are among the leading recreational opportunities attracting visitors to Citrus County, Florida.

Section 3.0 Kings Bay/Crystal River Springs System Impairments and Threats

3.1 Groundwater Quantity Reductions

3.1.1 Groundwater Use Permits

In 2010, there were a total of 22,799 groundwater consumptive use permits (CUPs) active in the SWFWMD (Figure 30). These permits authorize an average groundwater extraction of 2.8 billion gallons/day (BGD).

The majority of these permits are for groundwater pumping with average daily uses greater than 0.1 MGD. Smaller groundwater withdrawals (< than 100,000 gallons per day, classified as domestic self-supply) are allowed without permit and number in the hundreds of thousands.

Numbers of groundwater permits in the counties in and around Kings Bay/Crystal River are summarized in Table 5. These permits allocate a total average removal of 205 MGD. It is critical to understand that all fresh groundwater extracted in these counties and in the entire SWFWMD would otherwise contribute to spring and diffuse groundwater discharges to coastal streams and estuaries. Since the karstic limestones of the Floridan Aquifer are interconnected throughout the SWFWMD and neighboring water management districts, spring flows at Kings Bay/Crystal River are reduced by regional groundwater use.

3.1.2 Estimated Groundwater Use

Groundwater is the sole source of permitted water supply within the northern half of the SWFWMD. While some groundwater uses are measured and reported, many are not monitored. For this reason, it is necessary for the water management districts to estimate total groundwater use. The USGS also estimates all water uses in Florida once every five years (Marella 2014). These water use estimates have been made since 1965.

Table 6 and Figure 31 summarize the USGS groundwater use estimates by decade for the entire SWFWMD, for the five counties surrounding and including Citrus County for the period of record from 1965-2010. Total estimated groundwater extraction in the SWFWMD has increased by 140% between the 1960s and 2010s, from 401 to 965 MGD. Estimated groundwater uses in the 2010s were: public supply – 32%, agriculture – 46%, commercial/industrial/mining – 7%, domestic self-supply – 7%, and recreational – 5.6%.

3.1.3 Net Consumption

Gross groundwater extraction may overestimate impacts to spring flows. The difference between total groundwater extracted and the amount of used water returned to the aquifer is termed "net consumption". The USGS has estimated a range of net consumption percentages for differing water uses. These fractions are summarized in Table 7 and are only rough estimates, considering the actual variety of detailed water uses and their differences in resulting evapotranspiration, infiltration, and runoff fractions.

Table 7 estimates that the net consumptive use of water in the counties that contribute to Kings Bay/Crystal River spring flows has increased from about 8 MGD (12 cfs) in the 1960s to about 28 MGD (43 cfs) in the most recent decade. During this period-of-record the estimated net consumption of groundwater has increased during every decade.

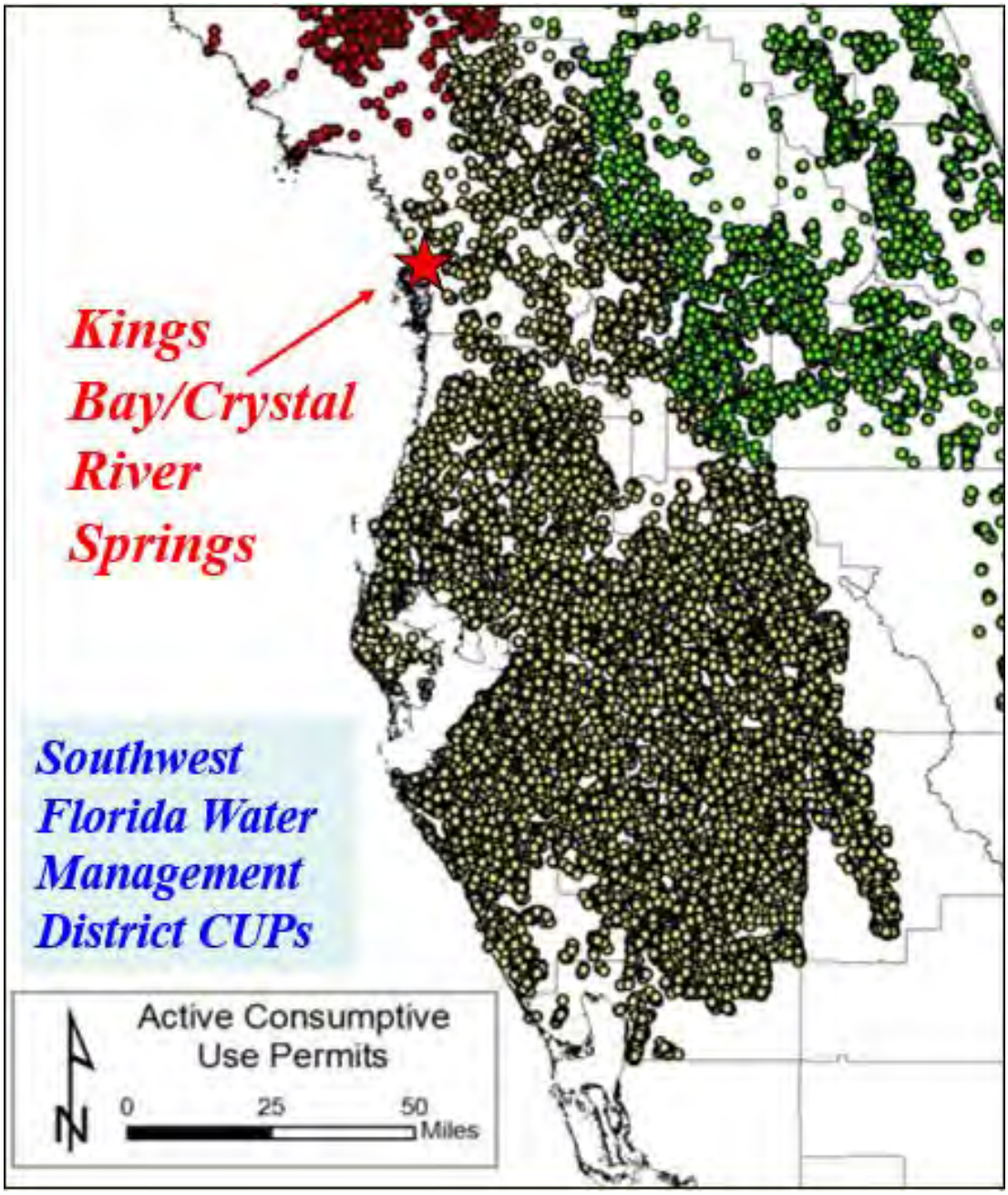


Figure 30. In 2010 there were a total of 22,799 consumptive use permits in the SWFWMD (indicated by yellow dots), authorizing a total daily groundwater extraction of about 2.8 billion gallons. Additional groundwater use permits in the Suwannee River Water management District (red dots) and in the St. Johns River Water Management District (green dots) also exert a regional influence on aquifer levels and spring flows in the Springs Coast Focus Area (FSI, unpublished).

Table 5. Number of groundwater permits in the counties in and around Kings Bay/Crystal River (2010).

COUNTY	PERMITTED ANNUAL AVG WITHDRAWAL (MGD)	WELLS (#)
CITRUS	52.7	421
LAKE	2.07	41
LEVY	26.3	318
MARION	38.1	745
SUMTER	86.2	837
TOTAL	205	2,362

Table 6. Estimated average decadal fresh groundwater withdrawals within the SWFWMD.

District	Withdrawals (MGD)					
	1960	1970	1980	1990	2000	2010
SWFWMD	401	1,007	1,156	1,302	1,321	965
Agricultural	81.9	425.5	540.2	630.1	683.1	447.8
Comm, Ind, Mining	285.8	359.7	279.8	277.9	117.5	63.8
Domestic	4.9	56.2	58.3	67.6	52.7	68.1
Power Generation	0.1	0.8	2.9	2.9	6.8	17.6
Public Supply	28.3	165.4	274.9	323.9	408.9	313.1
Recreational	---	---	---	---	52.0	54.8

Source: U.S. Geological Survey (http://fl.water.usgs.gov/)

Scientific Investigation Report 2014-5088, Open-File Report 94-521

1960 estimated using county withdrawal data

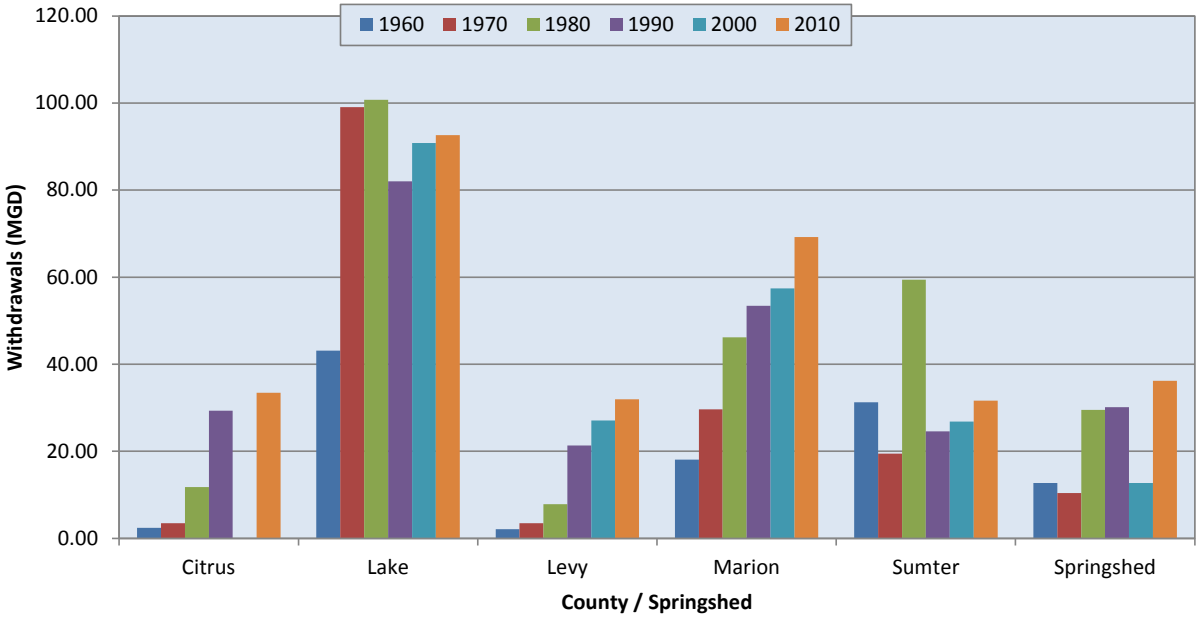


Figure 31. Average decadal fresh groundwater withdrawals for the Kings Bay/Crystal River Springshed and surrounding counties.

Table 7. Summary of estimated net consumption (total use minus amount returned to the groundwater) by water use category. The highest estimated net consumptive uses are for agricultural irrigation and "recreational" (golf courses).

Use Type	Percent Consumed[1]
Public Supply	28%
Domestic	28%
Commercial, Industrial, Mining	20%
Agricultural	68%
Recreational	77%
Power Generation	8%

[1]Average values from USGS (Marella 1988, 1992, 1999, 2004, and 2009)

3.1.4 Groundwater Modeling

3.1.4.1 USGS (Yobbi 1989)

A digital ground-water flow model was developed by Yobbi (1989) to approximate steady-state, predevelopment flow conditions in the Upper Floridan Aquifer of coastal west-central Florida. The aquifer is the major source of public water supply and natural spring flow in the area. The aquifer was simulated as a one-layer system with constant vertical recharge and discharge rates. A head-dependent drain function was used to simulate spring flow.

Model calibration consisted of adjustments of aquifer transmissivities and recharge-discharge rates until the average absolute error per grid block was less than 3 feet and computed spring discharge was within 10 percent of measured or estimated discharges. Calibration

transmissivities ranged from 8,640 feet squared per day in the northern part of the area to nearly 13,000,000 feet squared per day near large springs. Calibration inflows were about 2,700 cfs (1,744 MGD). Of this, about 2,567 cfs (1,658 MGD) discharges as natural spring flow and 137 cfs (only 5% or 88.5 MGD) discharges as upward leakage along the coast. A sensitivity analysis indicated that the model was most sensitive to changes in transmissivity and least sensitive to changes in upward leakage.

The model was used to demonstrate aquifer response to large man-made groundwater pumping stresses. Withdrawing a total of 116 cfs (75 MGD) from five regional pumping centers resulted in potentiometric-surface drawdowns ranging from 0.1 foot to 1.7 feet. Drawdowns of 1 foot or more occurred in 13 of the 298 active nodes; drawdowns of less than 0.2 foot occurred along the coast. Total spring flow decreased about 5 percent, and the impact on individual springs varied from 0.1 percent at Rainbow Springs to 8.0 percent at the spring group comprised of Homosassa Springs, southeast fork of Homosassa Springs, and Halls River.

A "worst-case" situation also was tested where 62 cfs (40 MGD) was pumped individually, one at a time, at each of the 16 spring nodes. Results of the simulation showed a significant effect on the flow of springs. Of the 13 spring groups simulated, 6 contributed at least 50 percent of their flow to pumpage. All small springs south of the Chassahowitzka River ceased flowing and Weeki Wachee Springs contributed 25 percent of its flow to pumpage (Yobbi 1989).

3.1.4.2 SWFWMD Groundwater Flow Model (SWFWMD 2015)

The coastal springs in Pasco, Hernando, and Citrus Counties, Florida consist of four first magnitude spring groups and numerous smaller springs, which are points of substantial groundwater discharge from the Upper Floridan Aquifer. Spring flow is proportional to the water level in the aquifer and is affected primarily by the magnitude and timing of rainfall. Groundwater levels in 206 Upper Floridan Aquifer wells and surface water stage, flow, and specific conductance of water from springs at 10 gauging stations were measured to define the hydrologic variability (temporally and spatially) in the Coastal Springs Ground-Water Basin and adjacent parts of Pasco, Hernando, and Citrus Counties. Rainfall at 46 stations and groundwater withdrawals for three counties were used to calculate water budgets, to evaluate long-term changes in hydrologic conditions, and to evaluate relations among the hydrologic components.

Based on computer flow modeling and water budget results from the SWFWMD, the cumulative impact of groundwater withdrawals on Kings Bay spring flow was predicted to result in a relatively small impact on spring flow (about 2% of long-term average) compared to rainfall changes. The SWFWMD maintains that groundwater withdrawals are low in magnitude and dispersed within the Kings Bay springshed. In 2012, the SWFWMD estimates that groundwater withdrawals in the springshed were equivalent to 1.1 inches per year. Using an average recharge rate of 20 inches per year, they made up just 5.5 percent of recharge in the basin. If 50 to 60 percent of water withdrawn is returned to the aquifer in the springshed through septic tank leakage, wastewater treatment facilities, and irrigation, then consumptively-used quantities would account for a little over 2.5 percent of average recharge.

The SWFWMD maintained a metered and estimated water use database from 1992 through 2012. In the Kings Bay springshed, SWFWMD concluded that groundwater withdrawals declined since reaching their peak of 18.1 MGD in 2006. In 2012, groundwater withdrawals

based on estimated and metered use were 16.2 MGD. Since the year 2000, groundwater use within the springshed has grown at a relatively small rate of 0.23 MGD per year. Public supply, domestic self-supply, and recreation (e.g. golf courses) account for the majority of groundwater use in the Kings Bay springshed, with lesser amounts used for industry and agriculture.

SWFWMD (2015) states that: "While groundwater withdrawals currently have minimal impact on Kings Bay spring flow, the expected increase in demand for water over the coming decades is being addressed through the development of Minimum Flows and Levels (MFLs) and Regional Water Supply Plans. Both the SWFWMD and the Withlacoochee Regional Water Supply Authority (WRWSA) periodically publish water supply plans to address current and future demands on water resources. Kings Bay lies within the Northern Planning Region where the 2005-2030 increase in demand is projected to be 90.4 million gallons per day".

The SWFWMD's claim that existing pumping rates have only reduced flow at the Kings Bay/Crystal River springs by 2 to 2.5% is contradicted by other lines of evidence presented below. Also, the USGS model described above indicated that pumping and spring flow reductions are close to 1:1.

The major discrepancy between model output and actual spring flow data is an indication that the model used by the water management district to issue Consumptive Use Permits is seriously flawed. The SWFWMD's conclusion that any part of the future demand for water can be met with Floridan Aquifer groundwater, will inevitably lead to further spring flow reductions along Florida's "Springs Coast".

The SWFWMD is required by law to establish MFLs for priority surface watercourses (e.g. streams and rivers) and aquifer systems within its boundaries (Section 373.042, F.S.). Given their status as a spring system of "first magnitude" (>100 cfs [>64.6 MGD]), the Kings Bay/Crystal River springs are on that priority list. As defined by statute, "the minimum flow for a given watercourse shall be the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area." In scheduling the development and adoption of MFLs, state law further directs the SWFWMD to prioritize all first-magnitude springs and second-magnitude springs within state or federally owned lands purchased for conservation purposes. MFLs serve as a protective metric for making permitting and planning decisions regarding water withdrawals, either surface or groundwater. If it is determined that water levels or flows in a waterbody are either below or projected to fall below the applicable MFLs during the next 20 years as a result of water withdrawals, then a recovery or prevention strategy must be developed and implemented as part of a regional water supply plan. The MFL for Crystal River/Kings Bay is scheduled to be adopted in 2017 (SWFWMD 2015).

3.1.5 Inter-Basin Groundwater Transfers

Springsheds are defined based on potentiometric surfaces in the Floridan Aquifer. As groundwater levels change, springshed boundaries can move, sometimes over large distances measured in miles. In some cases large withdrawals, or significant changes in rainfall and evapotranspiration have even resulted in springshed boundaries shifting between adjacent water management districts. An example of a very significant springshed boundary shift has occurred between the SWFWMD and the St. Johns River Water Management District (SJRWMD) with an increase in the groundwater contributing area feeding Rainbow Springs and a decline in the Silver Springs springshed (Knight 2015).

Knight and Clarke (2014) provided an estimated water balance for the Florida springs that receive groundwater inflows from the Floridan Aquifer. The estimated overall spring water balance indicates that total average recharge to the Floridan Aquifer pre-development was about 13.9 billion gallons per day (BGD); resulting in an estimated total spring discharge of about 12.3 BGD with an estimated 11.2 BGD discharging through North Florida's springs (Bush and Johnson 1988; Knight and Clarke 2014). Based on available flow data current average springflow in Florida's 1,000+ springs during the most recent decade (2000-2009) was estimated as 7.2 BGD, for an estimated 36% average combined springflow reduction (Knight and Clarke 2014).

In the SWFWMD, the estimated total pre-development springflow estimated by Bush and Johnston (1988) was about 2,070 MGD. By 2010, the estimated average springflow decline in the SWFWMD's 238 documented springs as a direct result of human groundwater use was about 18% or 379 MGD (Knight and Clarke 2014). Considering that the 2010 estimated pumping rate in the SWFWMD reported by Marella (2014) was 965 MGD, this discrepancy indicates that the Floridan Aquifer within the boundaries of the SWFWMD is receiving on average as much as 586 MGD of groundwater from adjacent water management districts, including the SJRWMD and the Suwannee River Water Management District.

3.1.6 Spring Flow Reductions

Groundwater pumping in Southwest Florida started well before the 1960s (Bush and Johnston 1988) with documented saltwater intrusion occurring in Tampa and St. Petersburg by the 1920s and 1930s. By the 1960s, water utilities in Hillsborough County alone were pumping between 55 and 60 MGD from the Floridan Aquifer. Since groundwater pumping was already resulting in some declines in regional aquifer levels, springs all along the Springs Coast had already experienced some unquantified level of anthropogenic flow reductions prior to the 1960s. It is considered probable that true baseline or pre-development spring flows at Kings Bay/Crystal River were greater than the flows reported for the 1960s and 1970s.

The earliest average flow "baseline" for the Kings Bay/Crystal River springs reported in the literature was between 916 and 975 cfs (592 and 630 MGD) in the 1960s and 1970s. The last few years of flow records from that period appear anomalous and were not accompanied by increased rainfall. For this restoration plan, a conservative estimate of the average spring flow for this "baseline" period from 1964 through 1973 is 916 cfs (592 MGD).

Spring flows in Kings Bay/Crystal River have been variable but generally decreasing over the period of record. As documented above, spring flows were estimated between 735 and 877 cfs (475 to 567 MGD) by the early 1990s. The average Crystal River flow for the 12 years from 2002 to 2014 was 451 cfs (292 MGD). The combined flow of all of the Kings Bay/Crystal River springs was reported as 465 cfs (300 MGD) in 2009. Based on Crystal River flows measured over the most recent decade of data (2005 to 2014), the average flows have declined to about 389 cfs (251 MGD) for an estimated period-of-record decline of 527 cfs (340 MGD) or 58% of the "baseline" flow.

3.1.7 Estimated Water Balance

As described earlier in this report, rainfall data over the entire 110-year period of record indicate a slight declining trend in annual rainfall totals starting in the 1950s. Moving average (LOESS) rainfall totals peaked at about 57 inches/year in the 1950s and declined to about 48

inches/year by 2010, an estimated decline of about 16%. These rainfall data trends can be used to estimate the proportion of the observed 58% overall spring flow reduction that is due to changing rainfall patterns vs. increased groundwater pumping rates. A simple water budget approach is utilized to make this evaluation.

A water budget is an inventory of inflows, outflows, and storage for a water system. The system of interest in this report is the Floridan Aquifer under the entire Kings Bay/Crystal River contributing area estimated to be about 831 mi^2. Water budgets for the Kings Bay/Crystal River springs were estimated for two periods:

- 1964 to 1973, assumed to be early enough to represent a period of relatively less water supply development (less than 30% of recent water use estimates in Figure 31), and
- 2005 to 2014, assumed to be typical of current conditions.

Estimation of empirical water budgets for the Kings Bay/Crystal River springs earlier than the 1964 to 1973 decade is impractical due to insufficient input data.

Principal water inputs to the Kings Bay/Crystal River springs water budget include:

- Rainfall and used water recharge in the springshed.

Principal water outflows that were considered in the water budget included:

- Groundwater pumping within the springshed, and
- Spring discharges to Kings Bay/Crystal River.

For the purpose of this water budget analysis, total recharge of rainfall and evapotranspiration (ET) are assumed to be linear functions of annual total rainfall. These assumptions are order-of-magnitude and approximate until more precise hydrologic data are available.

For this analysis, it is assumed that there is little to no runoff in the springshed. This assumption is reasonable considering the vulnerable to highly vulnerable nature of the springshed (poorly to unconfined aquifer). It is also assumed that all groundwater extracted in the springshed was considered to be consumed and not recycled to the Floridan Aquifer. This assumption is reasonable since the majority of water use was for urban and agricultural irrigation is consumed through evapotranspiration or incorporation in the crop. It is also assumed that there is no change in the delineation of the springshed for the baseline and recent periods. This assumption was considered reasonable based on mapping from historic and recent potentiometric maps of the springshed.

For the 1960s to 1970s "baseline" period, recharge of rainfall resulting in springflow at Kings Bay/Crystal River is estimated as 15.0 inches/year (compared to 12.8 inches/year as estimated for the springshed by Bush and Johnston 1988). Based on a baseline annual rainfall of about 54 inches, this indicates ET during the baseline period was about 39 inches.

For the recent period (2005-2014), springflow had declined by about 58%, indicating a reduced net recharge rate of about 6.3 inches/year. Assuming a linear function between average rainfall and recharge, the recent average recharge would be assumed to be 13.0 inches/year based only on the reduced ten-year average rainfall of about 47 inches/year. This leaves an estimated ET of about 34 inches/year and an estimated reduction of net recharge and resulting springflow of 13.0 – 6.3 = 6.7 inches/year due to groundwater pumping alone. This is equivalent to an

estimated net groundwater consumption rate of about 410 cfs (265 MGD) affecting the Kings Bay/Crystal River spring flows during the most recent decade.

This water budget analysis concludes that regional net groundwater extractions may be resulting in a loss of up to 45% of the observed 58% overall flow reduction in the Kings Bay/Crystal River springs, while rainfall declines make up the remaining 13% of observed spring flow declines, during the most recent decade. These observed flow declines cannot be explained by the estimated groundwater pumping in the springshed alone. Rather, they likely represent a regional decline in aquifer levels resulting from pumping an average of more than one billion gallons of groundwater each day in the SWFWMD over the past 40+ years and by excessive groundwater withdrawals in adjacent water management districts.

Based on the observed increasingly impaired water clarity and rising salinity levels in Kings Bay, this estimated reduction in spring flows appears to be more realistic than the SWFWMD's model estimate of about 2% decline in spring flows due to groundwater withdrawals (SWFWMD 2015). More accurate estimates of spring flow declines due to groundwater pumping will ultimately come from improved climatological data, empirical water budget analysis, and improved groundwater flow models that better account for conduit flows in the Floridan Aquifer.

3.2 Nutrient Sources, Loads, and TMDLs

3.2.1 General

Many of Florida's 1,000+ artesian springs are polluted by excess nitrate N (Knight 2015). For example, Figure 32 provides a summary of median nitrate concentrations in 57 major springs. Typical background nitrate concentrations in the Floridan Aquifer and the springs it feeds are less than 0.05 mg/L. More than 70% of the state's springs now have nitrate concentrations above the 0.35 mg/L regulatory limit. A smaller but significant number of springs have nitrate levels above 1 mg/L, three times the water quality standard and more than 20 times the natural baseline concentration. Some of Florida's larger springs even have nitrate concentrations in the range from 5 to 10 mg/L (Knight 2015).

Elevated spring nitrate levels are a result of the widespread pollution of the Floridan Aquifer due to human activities at the land surface (Figure 33). When excessive N loads are applied to the land surface in areas where the aquifer is poorly confined or unconfined, a fraction of that N leaches downward into the groundwater. The major anthropogenic sources of this excess N include fertilizers and human and animal wastewaters (Knight 2015).

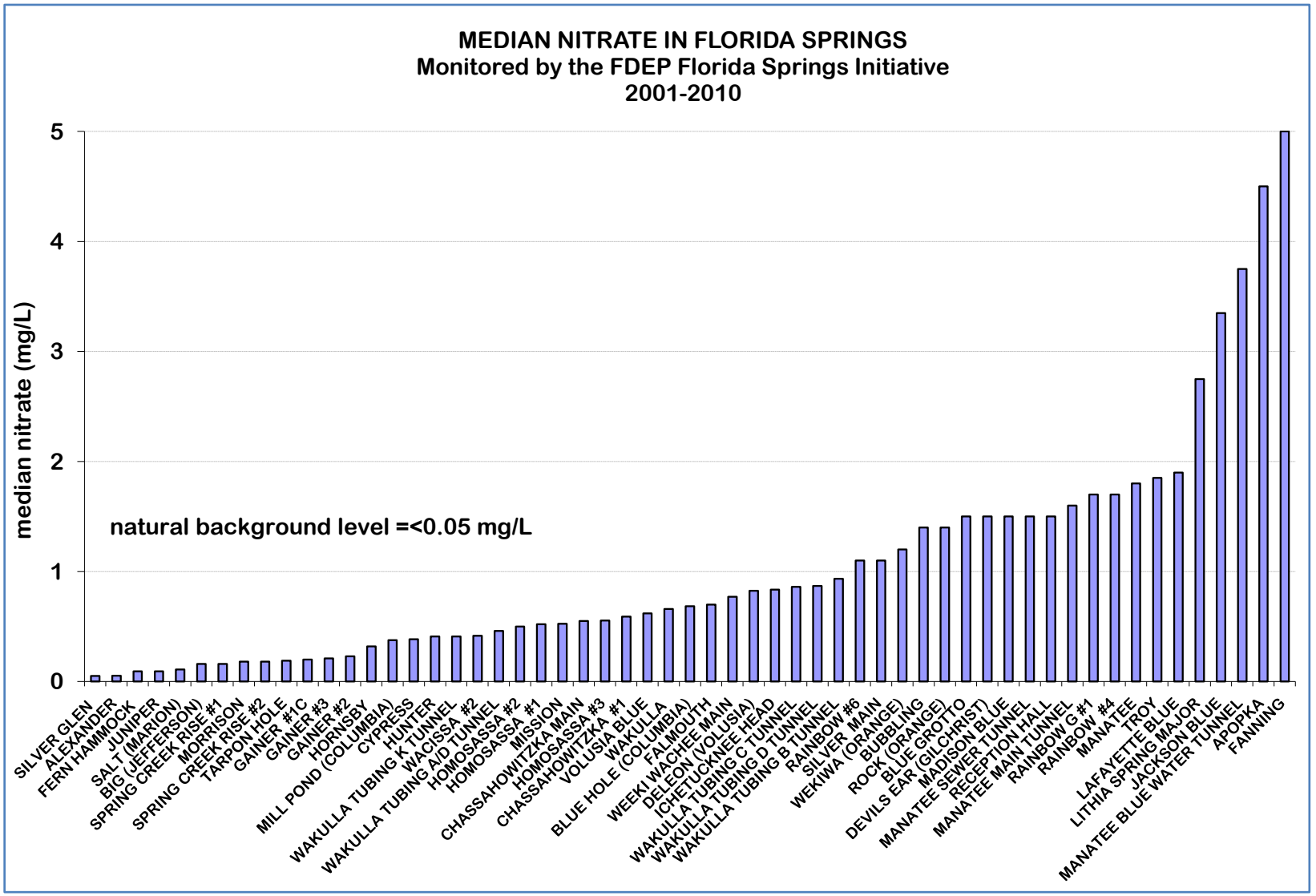


Figure 32. Median nitrate N concentrations measured in Florida springs, 2001-2010 (data from FDEP's Florida Springs Initiative).

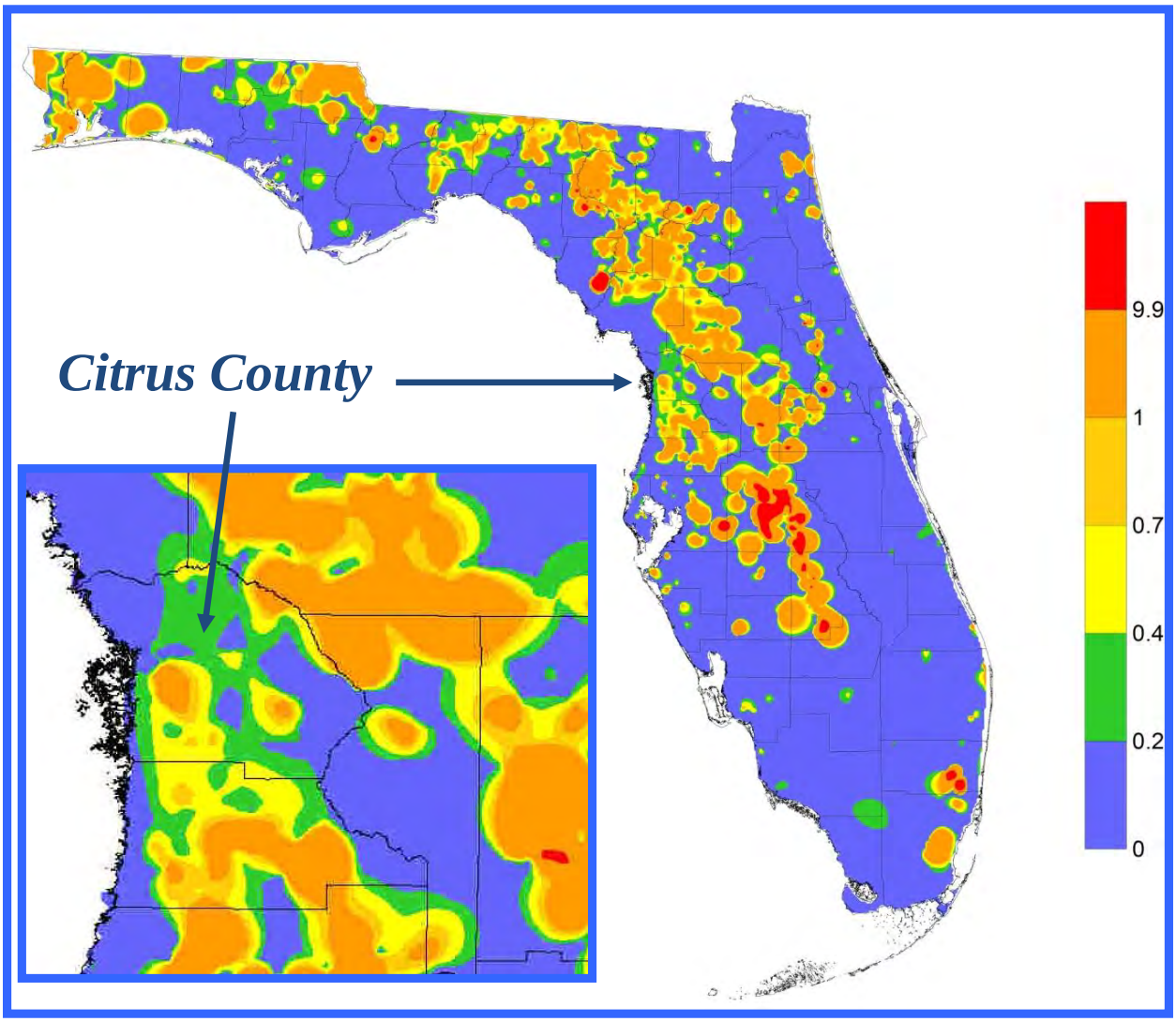


Figure 33. Map of Florida groundwater nitrate N concentrations (mg/L) with inset of the Kings Bay/Crystal River springs contributing area (prepared by the Florida Springs Institute with data from 2000 to 2004).

3.2.2 Kings Bay/Crystal River Springs Nutrient Pollution and TMDLs

Nutrient concentrations in the major springs feeding Kings Bay continue to rise (Figure 34). Observation of these trends has led to ongoing water quality sampling efforts, triggered a TMDL for N and P, and development of a BMAP for nutrient reduction. This work has led to detailed evaluations of the sources and magnitudes of polluting activities and can potentially lead to water quality restoration.

Concerns over effluent discharge into Kings Bay from the City of Crystal River Sewage Treatment Plant (STP) led to an evaluation of water quality in the receiving Crystal River Canal System (Nearhoof 1989). Water quality samples were collected three to four times daily, over a

two-day period, at fourteen stations within the canal system. Concentrations for total Kjeldahl N, nitrite + nitrate, total P and chlorophyll a were reported as follows:

- TKN: 0.03 – 3.64 (mg/l)
- NO_2 + NO_3: 0.0 – 8.2 (mg/l)
- TP: 0.04 – 3.97 (mg/l)
- Chl a: 1.0 – 50.1 (µg/l)

It was concluded that nutrients discharged by the STP were not fully assimilated in the Crystal River Canal System and were consequently negatively affecting water quality in Kings Bay.

As part of the SWFWMD's study to quantify contributions of the four main nutrient loading sources (springs discharge, sewage treatment effluent, septic tank leachate and stormwater runoff) into Kings Bay, Romie (1990) established and sampled approximately 12 ambient surface water quality stations throughout the bay. Estimated contributions of TN and TP from the four main nutrient loading sources were:

- Total N
    - Springs Discharge 94%
    - Sewage Treatment Effluent 3%
    - Septic Tank Leachate 2%
    - Stormwater Runoff 1%
- Total P
    - Springs Discharge 84%
    - Sewage Treatment Effluent 13%
    - Septic Tank Leachate 2%
    - Stormwater Runoff 1%

Average TN and TP concentrations for the 12 surface water stations were 0.387 and 0.04 mg/l, respectively.

Anderson et al. (1991) subsequently utilized Romie's data set in 1991 to evaluate the nutrient loading potential of various wastewater sources in Kings Bay. This evaluation estimated annual nutrient loads into Kings Bay from septic tank systems and wastewater treatment facilities combined were 22,000 kg/y of TN and 6,400 kg/y of TP in 1991.

In March 1992, the City of Crystal River ceased discharging effluent from the City of Crystal River Sewage Treatment Plant into Kings Bay. LAKEWATCH volunteers measured water clarity and water quality parameters monthly from 1992 to 1994 at 21 stations. However, during the last year of the study (June 1994 to June 1995) the number of stations sampled by the volunteers was reduced from 21 to 10 stations.

Conclusions of the report were as follows:

- TN and TP concentrations in Cedar Cove declined significantly following the removal of wastewater discharge.

  - Prior to Removal: Total N – 620 µg/l; Total P - 105 µg/l
  - After Removal: Total N – 220 µg/l; Total P – 27 µg/l
- TN and TP concentrations in southern Kings Bay were not affected.
  - Prior to Removal: Total N – 300 µg/l; Total P - 24 µg/l
  - After Removal: Total N – 260 µg/l; Total P – 28 µg/l
- Short-term increases in TN and TP concentrations were noted after the "Storm of the Century" that occurred in March 1993. However, an increase in chlorophyll concentrations, related to the short-term increases in nutrients, was not evident following the storm.
- No significant differences in TN, TP and chlorophyll concentrations were seen between high and low tides in Kings Bay.

To assess the impact of nutrient loads from canal systems on water clarity in Kings Bay, Hoyer et al. (1997) analyzed nutrient concentrations from several canals and open water stations located in southeastern Kings Bay. The University of Florida analyzed LAKEWATCH (1993-1997) data in conjunction with data collected for the study from 19 sites located in southeastern Kings Bay (1996-1997) to compare nutrient concentrations between canal and open water sites. Results indicated that TN and TP concentrations in the canals were not significantly different from the open water sites and were therefore unlikely to impact water clarity through increasing algal populations in the bay. The University noted positive but statistically weak relationships between chlorophyll and nutrient concentrations, in the open water sites in Kings Bay.

From 1995 to present, LAKEWATCH volunteers have continued to collect samples from four open water and two canal sites within Kings Bay. Data collected by the LAKEWATCH volunteer monitoring program (1992-2002) indicate that mean TN and mean TP concentrations for surface water sites are 0.241 and 0.026 mg/l, respectively. A small decrease in the mean annual TN and TP concentrations for surface water sites in Kings Bay has been noted in the past ten years. Mean annual concentrations of chlorophyll a have significantly increased during the same time period.

While a potentially weak relationship between nutrients and chlorophyll exists in Kings Bay, discharge of nutrients from the bay into Crystal River remains a concern. During an assessment of the physical, chemical and vegetative characteristics of rivers in the Springs Coast area, Frazer et al. (2001) determined that the majority of the nutrients leaving Kings Bay were not assimilated in Crystal River and were instead exported to the nearshore estuaries in the Gulf of Mexico. Nutrients entering the estuaries have the potential to increase phytoplankton production, including the severity of red tide events, and negatively impact existing sea grass meadows and fisheries.

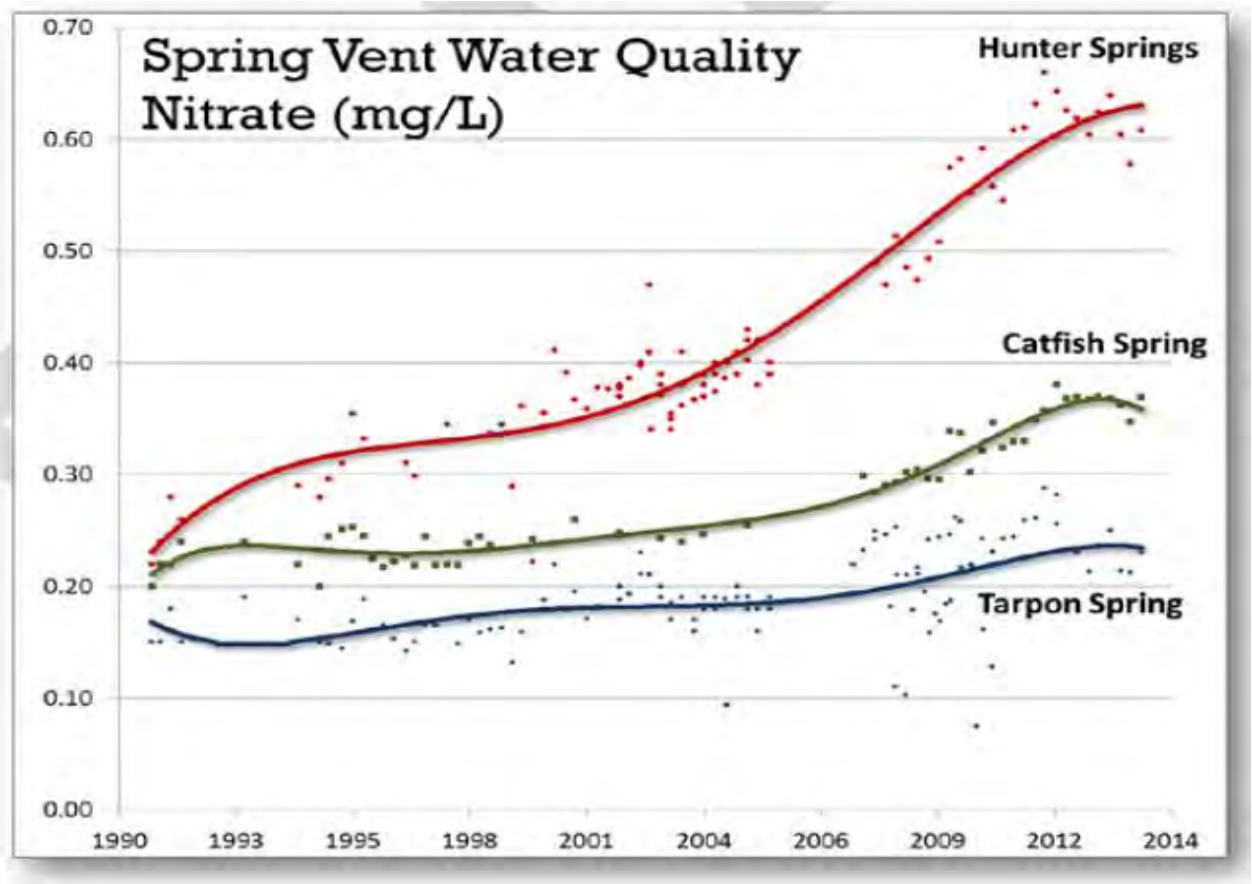


Figure 34. Nitrate N concentration trends in selected springs in Kings Bay. Nitrate increases in spring discharge have primarily occurred in the Hunters Cove area in northeastern Kings Bay, relative to springs in the central and southern portions of the bay (SWFWMD 2015).

To date, many activities to reduce and monitor nutrients in Kings Bay have been implemented. Most notably, discharge of effluent into the bay from the City of Crystal River Sewage Treatment Plant was diverted to a spray-field approximately 5 miles north of Kings Bay in 1992. While a notable improvement, the spray-field is in close proximity to the bay and may continue to affect nutrient loads through ground water infiltration. Additionally, the City has implemented several stormwater treatment projects and successfully transferred a substantial number of residences from onsite disposal systems to municipal wastewater treatment.

In 2012, the FDEP adopted six segments of Crystal River/Kings Bay, Kings Bay, Hunter Spring, House Spring, Idiot's Delight Spring, Tarpon Spring, and Black Spring, on the Verified List of impaired waters for the Springs Coast Basin as required by Section 303(d) of the Clean Water Act (Figure 35). The FDEP used a methodology (per Rule 62-303, F.A.C.) for listing nutrient impaired surface waters based on documentation that supports the determination of an imbalance of flora and fauna in certain areas in Kings Bay. Due to elevated nutrient concentrations (N and P), along with corresponding evidence of algal mats, a TMDL was established in 2014 that set the allowable level of nutrient loading for these segments to meet their applicable water quality criterion for nutrients (Bridger 2014).

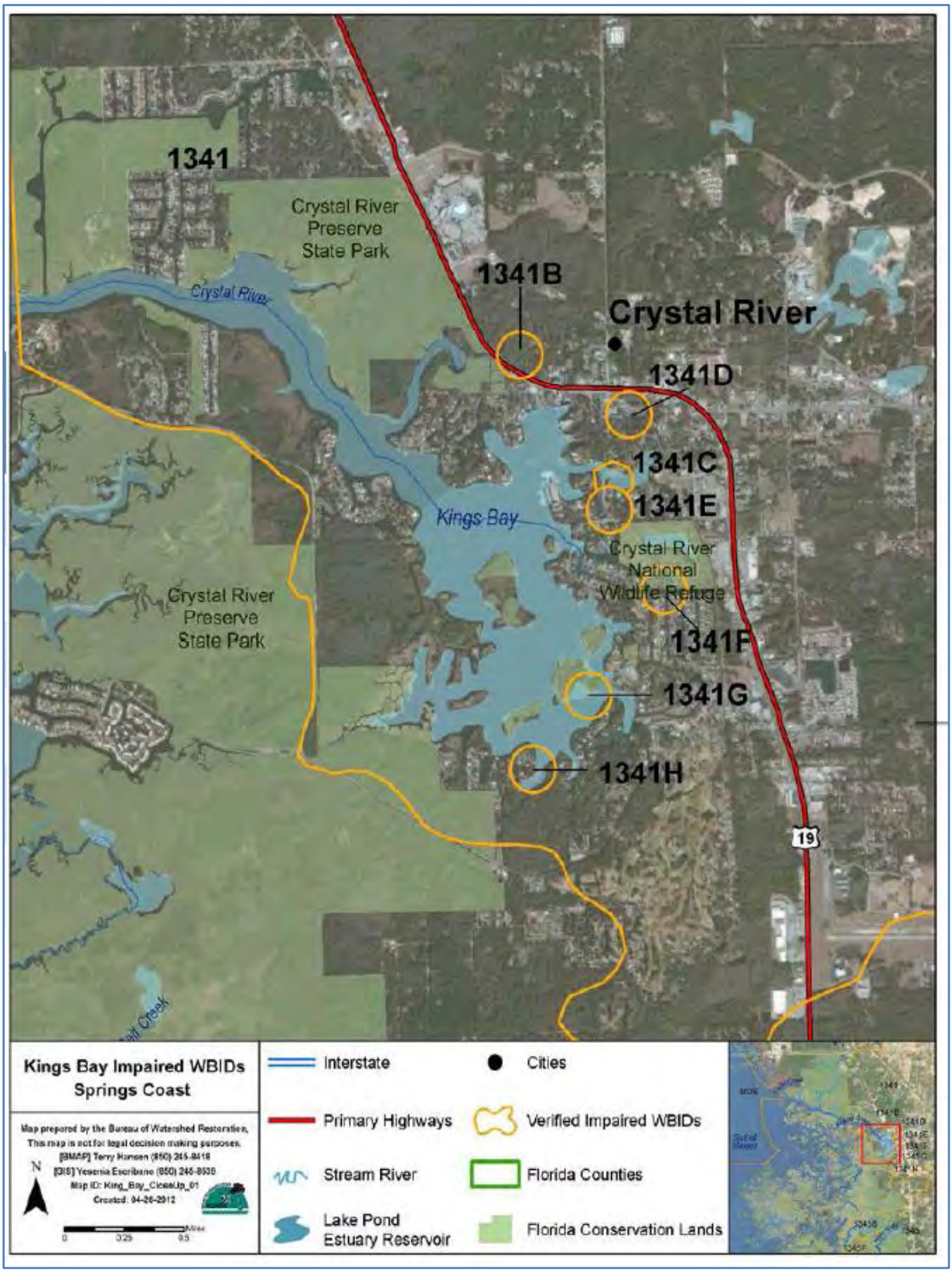


Figure 35. Kings Bay/Crystal River impaired water bodies (FDEP 2015).

As part of the TMDL, the FDEP attributed the excessive algal growth to both N and P enrichment. The FDEP used various lines of evidence such as laboratory studies, biological surveys, and periphyton-nutrient relationships to establish the TMDL water quality targets. These targets account for the long residence time (low-flushing rate) conditions in Kings Bay. For the five listed springs, the annual average nitrate and orthophosphate concentration targets are 0.23 mg/L and 0.028 mg/L, respectively. Since nitrate and orthophosphate are not the dominant forms of these nutrients in Kings Bay, water quality targets were expressed as total nutrient concentrations for this segment. For Kings Bay, the annual average total N and P concentration targets are 0.28 mg/L and 0.032 mg/L, respectively.

The TMDLs will require reductions in nitrate/total N concentrations ranging from 21 to 64 percent. The TMDLs will require reductions in orthophosphate/total P concentrations ranging from 0 to 14 percent. Specific nutrient load reduction goals for N and P were placed on each of the impaired water bodies: Kings Bay – N 22%, P 14%; Hunter Spring – N 64%; House Springs – N 53%; Idiot's Delight – N 26%, P 7%; Tarpon Hole – N 21%, P 10%; and Black Spring – N 26%.

3.2.3 Chemical and Isotopic Tracers to Evaluate N Sources

On two occasions, in 2011 and 2013, a team of samplers from the FDEP's Ground Water Management Section collected water quality samples from springs in the Kings Bay Springs Group for chemical analysis to assess the sources of nitrate. The focus of this investigation was to use chemical and isotopic tracers to evaluate the contribution of nitrate from domestic wastewater sources (Bridger 2014).

Twelve of the springs in the Kings Bay Springs Group were sampled, and eleven of these provided useful information. These springs were selected because they were known to contain significant levels of nitrate and were closest to potential nitrate sources. The samples were analyzed for nutrients, several organic chemicals used as tracers for domestic wastewater, and stable isotopes used to differentiate between inorganic and organic sources of nitrate.

The analytical parameters included nitrate; orthophosphate, galaxolide, tonalide, sucralose, and isotopes of N and oxygen ($\delta^{15}N$ and $\delta^{18}O$ in nitrate). Galaxolide, tonalide, and sucralose have been used in many studies as tracers of domestic wastewater influence in receiving surface waters. In addition, the analysis of $\delta^{15}N$ and $\delta^{18}O$ in nitrate are used to provide information about the nitrate sources and the relative amount of denitrification (the biological breakdown of nitrate in the environment) to which the sample has been subjected. Table 8 summarizes the results of this sampling effort. Nitrate concentrations in the spring samples ranged from 0.06 to 0.65 mg/L.

Sucralose is an artificial sweetener and has been found to be a very resilient tracer of domestic wastewater influence on receiving waters. The positive detection or presumed presence of sucralose was found by the laboratory in six of the springs. Detections of sucralose are indicative of domestic wastewater sources such as wastewater application sites or septic tanks.

The springs with quantifiable concentrations of sucralose also had the highest nitrate concentrations (Hunter Spring and Jurassic Spring). The sucralose concentrations in Hunter Spring and Jurassic Spring were 0.12 and 0.081 µg/L, respectively. Bridger (2014) identified potential nearby sucralose sources, including domestic wastewater application sites and septic tanks.

The isotope results for all but one of these springs can be used for data interpretation. The sample at Magnolia Circle Spring was not taken from the spring vent and included dilution from the bay, which significantly decreases the confidence in the isotope results. Over the years, researchers have associated isotopic ratios in ground water with a variety of sources. From those data, general δ15N ranges have been assigned for the types of sources. The three main N source categories are inorganic (from fertilizer), organic (from animal waste or domestic wastewater), and soil (which includes N from any source that is assimilated by the soil and accumulated in soil organic matter). FDEP does not consider soil N to be a significant factor affecting these springs because most of the soils in the contributing area are low in organic content and would not tend to contain N (Bridger 2014).

Table 8. Water quality results from October 2011 sampling of selected Kings Bay Group springs (Bridger 2014).

Spring	Date	NO2NO3 (mg/L)	Galaxolide (µg/L)	Tonalide (µg/L)	Sucralose (µg/L)	δ15N (‰)	δ18O (‰)
Catfish	10/26/11	0.30	0.0036 U	0.012 U	0.0075 TN	5.38	3.39
Catfish	2/27/13	0.15	-	-	0.010U	7.32	5.66
House	10/25/11	0.50	0.0037 U	0.0012 U	0.026 I	6.19	4.95
House	1/9/13	0.49	-	-	0.010U	5.45	3.44
Hunter	10/25/11	0.65	0.0035 U	0.0012 U	0.12	7.61	5.76
Hunter	1/9/13	0.54	NS	NS	0.041I	7.61	5.76
Idiot's Delight	10/26/11	0.20	0.0036 U	0.0012 U	0.010 U	5.62	4.42
Idiot's Delight	1/9/13	0.22	-	-	-	4.42	3.45
Jurassic	10/25/11	0.54	0.0037 U	0.0012 U	0.081	7.11	5.22
Jurassic	2/27/13	0.54	NS	NS	0.023I	5.59	1.86
Little Hidden	10/25/11	0.20	0.0035 U	0.0012 U	0.0099 U	6.19	5.04
Magnolia Circle	10/25/11	0.06*	0.0036 U	0.0012 U	0.018 I	9.11 S	8.81 S
Manatee Sanctuary	10/26/11	0.14	0.0037 U	0.0012 U	0.012 IN	6.21	5.40
Parker Island	10/26/11	0.21	0.037 U	0.0012 U	0.0098 U	5.27	2.81
Tarpon	10/26/11	0.27	0.0037 U	0.0012 U	0.010 U	5.37	4.48
King	1/9/13	0.21	NS	NS	0.010U	6.41	4.38
Three Sisters #1	10/26/11	0.20	0.0038 U	0.0013 U	0.010 U	5.37	5.35
Black Spring	2/27/13	0.30	NS	NS	0.010U	5.96	4.47

Notes:
µg/L = Micrograms per liter
U - Material was analyzed but not detected. The reported value is the method detection limit for the sample analyzed.
Q - Sample held beyond normal holding time.
I - The reported value is between the laboratory method detection limit and the laboratory practical quantitation limit.
N - Presumed evidence of presence of material.
T - Value reported is less than the criterion of detection.
S - Value suspect because of low NO2NO3 concentration.
NS - Not sampled.
- = Empty cell/no data
* Not representative of spring vent based on historical results.

Figure 36 shows the plotted δ15N and 18ONO3 values for the spring samples compared with the general ranges for inorganic and organic sources. Most of the springs fall between the

inorganic and organic source categories, which could be due to a mixture of inorganic and organic nitrate sources, isotope enrichment caused by denitrification, or a combination of the two. Samples from Hunter, Catfish, and Jurassic Springs had ratios closest to the domestic wastewater/animal waste category, consistent with the detections of sucralose.

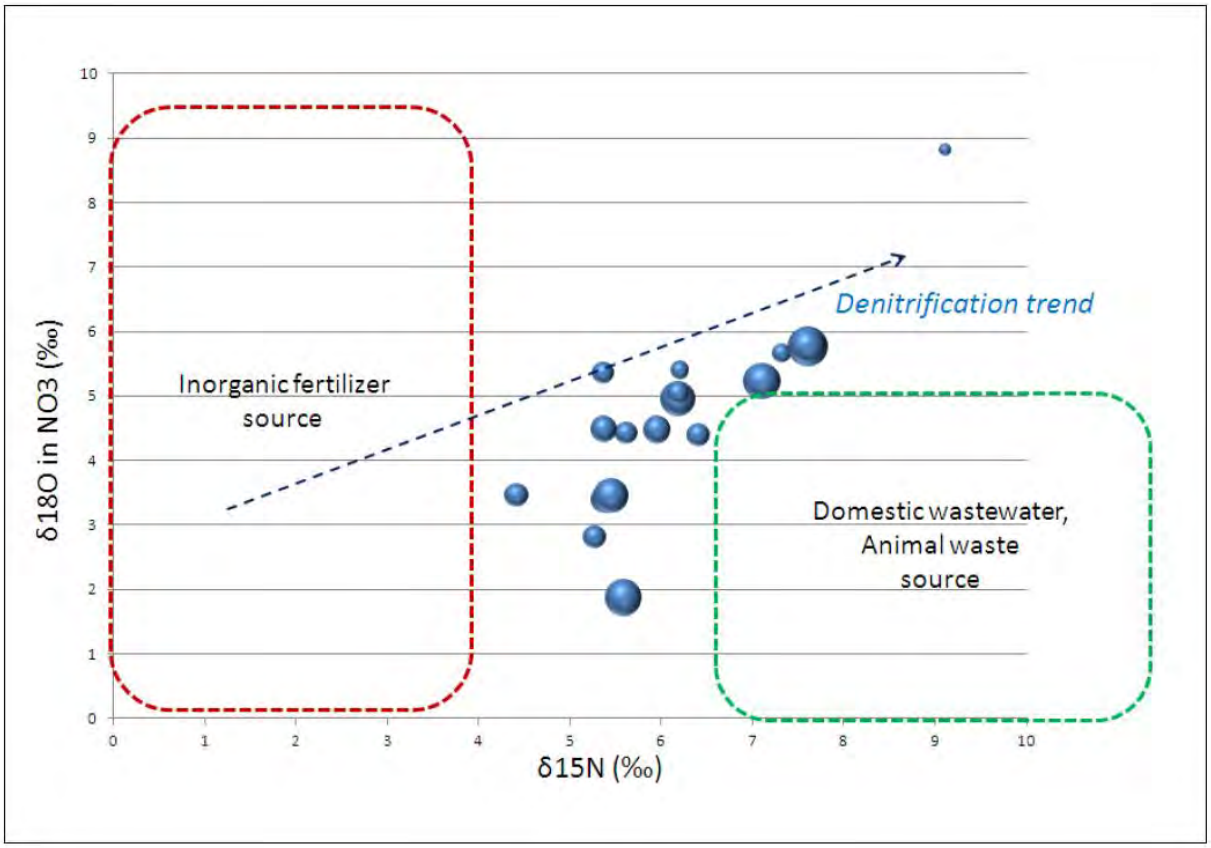


Figure 36. Distribution of δ15n and δ18ono3 Ratios in Kings Bay Group Spring samples and approximate nitrate source ranges. Symbol size is proportionate to nitrate concentration (Bridger 2014).

3.2.4 Land Use Activities Contributing N to Groundwater

3.2.4.1 Nitrogen Source Inventory

FDEP developed a draft N Source Inventory Loading Tool (NSILT) to identify major sources of N for Crystal River/Kings Bay and to estimate their loads to groundwater in the Basin Management Action Plan area (see Table 9 and Figure 37 from Katz et al. 2014). The NSILT is a geographic information system and spreadsheet-based tool that provides estimates of the relative contribution of N from major sources, while taking into consideration the processes affecting the various forms of N as they move from the land surface through soil and geologic strata into the groundwater. As a planning tool, the NSILT can identify areas where N load reduction efforts could be directed.

The draft NSILT identified septic tanks as the primary source of N loading to groundwater within the Crystal River/Kings Bay BMAP area (about 475,000 pounds per year or 51% of the

total N load to the springs). Urban and golf course fertilizers were also a substantial source (about 222,000 pounds per year or 24% combined). The other sources identified were agriculture (fertilizer and livestock, about 15%), atmospheric deposition (8.5%), and wastewater treatment facilities (2.1%). The resulting estimates of N loading to groundwater take into account environmental processes that attenuate N and the rate of recharge to groundwater using information from published studies. To account for recharge rates to the aquifer, non-attenuated N inputs in high recharge areas (>12 in/yr) are multiplied by a weighting factor of 0.9, while N inputs are multiplied by a weighting factor of 0.5 for medium recharge areas (4 to 12 in/yr). The draft NSILT findings estimate an annual load of N of 932,562 pounds (446 tons/year) to groundwater and springs in the Crystal River/Kings Bay BMAP area (Katz et al. 2014; Bridger 2014).

Phosphorus, specifically in the biologically available form orthophosphate, is also a nutrient of concern although P enrichment is minimal in comparison to N. P can reach the waters of Kings Bay/Crystal River from surface runoff from the watershed or from groundwater moving through areas with phosphatic deposits in the overlying geologic formation (Harrington et al. 2010). P enrichment is uncommon in Florida springs because P is typically retained in the limestone matrix of the aquifer (Heffernan et al. 2010). Measured orthophosphate concentrations from springs in Kings Bay do not show an increasing trend over time; however, there have been increases in total P in the bay (Bridger 2014) suggesting that there are local P sources such as stormwater runoff.

Table 9. N Source Inventory Loading Tool (NSILT) draft results for the Kings Bay/Crystal River Impaired Waters (Katz et al. 2014).

Nitrogen Source	Number Units	N load (lbs/yr)		N load (tons/yr)	
		Land Surface	Ground Water	Land Surface	Ground Water
Atmosphere	256 mi2	938,620	79,541	469.31	39.77
Muncipal WW	2.376 MGD	33,144	19,405	16.57	9.70
On-Site Systems	41,504 units	913,133	474,788	456.57	237.39
Golf Course	2,173 ac	366,685	50,219	183.34	25.11
Urban Fertilizer	59,212 ac	985,138	171,776	492.57	85.89
Agric. Fertilizer	1,561 ac	420,441	106,041	210.22	53.02
Livestock	4,827 units	419,406	30,793	209.70	15.40
Total		4,076,567	932,562	2,038	466

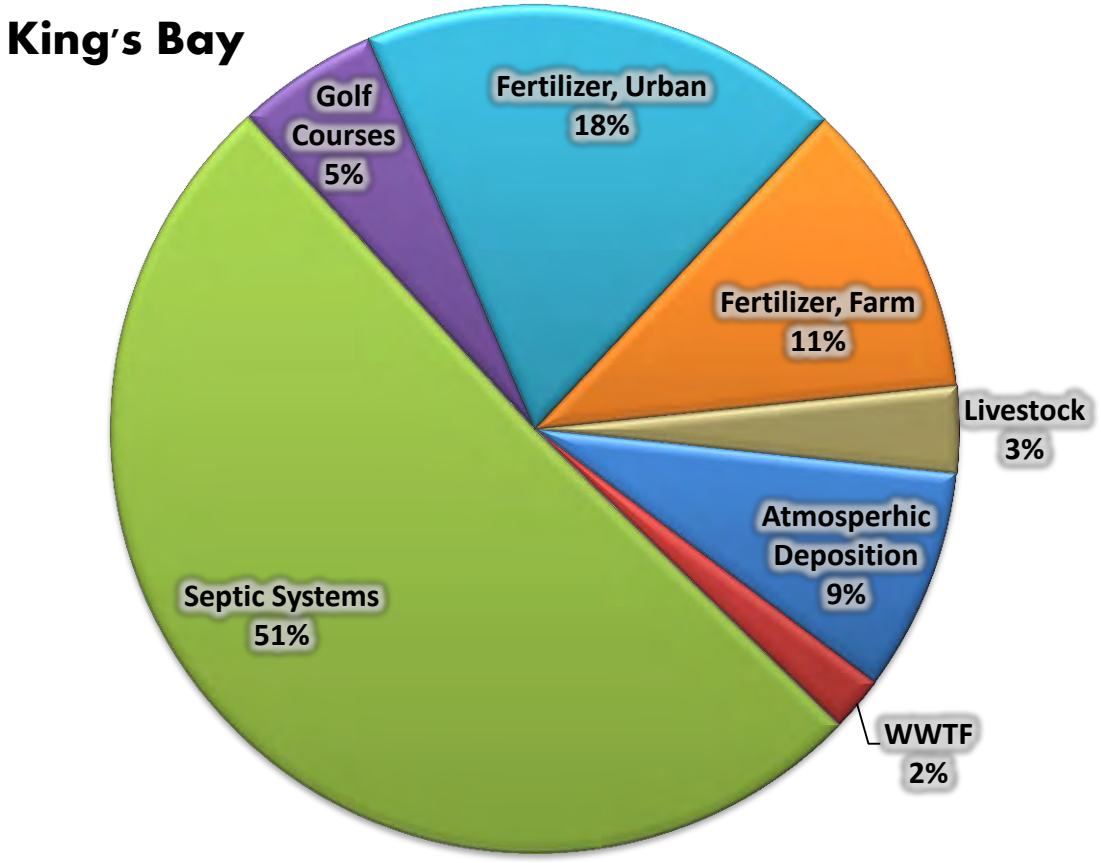


Figure 37. Relative N inputs to groundwater in the Crystal River/Kings Bay BMAP area by source category (Bridger 2014).

3.2.4.2 Agriculture

This category includes point and nonpoint sources of pollutants from pasturelands, row crops, field crops, animal feeding operations and silviculture. Agriculture is one of the leading sources of nutrient impairment to rivers and streams in Florida. In the Kings Bay/Crystal River BMAP area, agriculture accounts for about 18% of the area (130 mi^2).

Fertilizers, manure and other waste products from current agricultural practices are believed to be sources of nitrate contamination to the river and groundwater (i.e., springs) through surface runoff and groundwater seepage. Differences in nitrate loads from springs are controlled by factors such as differences in the magnitude of spring discharges, the size and land use in spring basins, and hydrologic characteristics such as differences in water levels between the river and the aquifer, and the water-transmitting properties of the aquifer.

The nutrient TMDL for Kings Bay/Crystal River and springs indicates that agricultural land uses (crops and livestock) account for about 15% of the nitrate load to the TMDL water bodies. This is equivalent to an annual N load to the land surface of 840,000 pounds/year (420 tons/year) and about 137,000 pounds/year (68 tons/year) to the Floridan Aquifer and springs.

3.2.4.3 Fertilizer

Inorganic fertilizer is a contributing source of nitrate in the impaired Kings Bay and springs. Fertilizer application to both urban and agricultural areas occurs within the Kings Bay contributing area, but in the areas closest to the springs most land use is urban. Within the FDEP-delineated contributing area, a total of 86 of 118 mi^2 of urban areas are residential, and 24.5 mi^2 consist of agricultural lands. Katz et al. 2014 estimated a total fertilizer N load to the land surface in the Kings Bay/Crystal River contributing area of about 1.4 million pounds/year (703 tons/year) and with an estimated 278,000 pounds/year (139 tons/year) reaching the groundwater feeding the springs and wells. Roughly 70% of this fertilizer N is contributed by urban land uses.

3.2.4.4 Livestock

FDEP estimated the potential N loading in Citrus County from livestock by using the U.S. Department of Agriculture (USDA) 2007 Agricultural Census data on the Citrus County livestock population (Table 10). The American Society of Agricultural Engineers (ASAE) (2005) provided estimates of N generated by animal waste. The actual livestock counts in the Kings Bay contributing area are not known. Livestock manure N loads to the land surface were estimated by Katz and Eller (2015) as 419,400 pounds/year (210 tons/year). The fraction of this N reaching the aquifer was estimated as 7% of the total applied or about 30,800 pounds/year (15.4 tons/year).

Table 10. Estimated annual livestock N inputs in Citrus County based on 2007 animal population data (Katz et al. 2014).

[1] USDA 2007
[2] ASAE 2005

Animals	Citrus County Head Count[1]	lbs-N/head/day[2]	lbs-N/head/yr	lbs-N/yr	tons-N/yr
Cattle	6,916	0.44	160.6	1,110,710	555
Chickens (layers)	1,230	0.0035	1.3	1,599	1
Horses/Ponies	1,044	0.2	73.0	76,212	38
Hogs and Pigs	667	0.91	332.2	221,544	111

3.2.4.5 Golf Courses

FDEP identified ten golf courses in the Kings Bay/Crystal River contributing groundwater basin (Bridger 2014). Nine of these courses are active and have a combined surface area of 2,173 acres. Typical N loading from golf courses in north-central Florida has been estimated as 234 pounds N/ac/yr. Based on the assumption that about 72% of the golf course areas are fertilized, the total estimated N load to the land surface is about 367,000 pounds/year (183 tons/year), and the load reaching the aquifer is about 50,000 pounds/year (25 tons/year).

3.2.4.6 Wastewater

The term "wastewater" is used to describe domestic and industrial wastewater discharges to surface water or ground water. Bridger (2014) found that there are no National Pollutant Discharge Elimination System (NPDES) permitted wastewater facilities in the Kings Bay contributing area that directly discharge to the impaired surface waters addressed in the Kings

Bay/Crystal River springs TMDL. All of the existing wastewater application sites in the contributing area discharge to ground water via sprayfields, rapid infiltration basins, drainfields, or percolation ponds. There are 24 permitted domestic wastewater treatment facilities in the contributing area with a combined wastewater load of about 2.4 MGD. Of the permitted domestic wastewater facilities, 6 have design capacities greater than 0.1 MGD (Table 11). The largest facility is the City of Crystal River wastewater treatment plant, which currently uses a sprayfield for effluent disposal. Current plans indicate that this discharge will be eliminated by diversion of the discharge to the nearby Duke Energy Crystal River Power Plant to be used as cooling water. The estimated N load to the land surface from these facilities is about 33,100 pounds/year (16.6 tons/year) and 19,400 pounds/year (9.7 tons/year) to the groundwater.

Table 11. Permitted domestic WWTFs with design capacities greater than 0.1 MGD in the Kings Bay Contributing Area (Bridger 2014).

Facility ID Number	Facility Name	Design Capacity (MGD)
FLA011877	Citrus Springs WWTF	0.2
FLA126594	Dunnellon City Of	0.25
FLA011844	Brentwood Regional WWTF	0.5
FLA011845	Meadowcrest WWTF	0.5
FLA011869	Beverly Hills WWTF	0.575
FLA011848	City of Crystal River WWTF	1.5

3.2.4.7 On-Site Treatment and Disposal Systems (Septic Tanks)

Onsite sewage treatment and disposal systems (OSTDS), also known as septic tank systems, are used for the disposal of domestic wastes at homes that are not on central sewer. The effluent from a well-functioning OSTDS is generally higher in TN concentration than secondarily treated wastewater from a sewage treatment plant (Bridger 2014). On average, the TN concentration in the effluent from a typical septic tank is 57.7 mg/L (Hazen and Sawyer 2009). In a low-density residential setting, N loadings by OSTDS may not be significant, but under a higher density setting, one could expect a potential TN input of up to 129 pounds per acre per year (lb/acre/yr) by conventional septic tanks (Harrington et al. 2010). The risk of contamination from an OSTDS is greater for unconfined (water table) aquifers than for confined aquifers because the former usually are nearer to the land surface and lack an overlying confining layer to impede the movement of contaminants.

FDEP estimated that there are 41,504 OSTDS systems in the Kings Bay/Crystal River Springshed (Figure 38). On average, these septic systems serve about 2.23 persons each. The estimated N load per person entering these septic tanks is about 9.92 pounds/person/year for a total estimated N load in the springshed of about 913,000 pounds/year (457 tons N/year). FDEP concluded that about 52% of this N load reaches the top of the Floridan Aquifer (about 475,000 pounds/year [237 tons/year]) and ultimately discharges at the Kings Bay/Crystal River springs (Bridger 2014).

3.2.5 Nutrient Summary

The Kings Bay/Crystal River springs discharge significant loads of N and P, two plant-growth macronutrients that can stimulate excessive algal growth in receiving waters. N concentrations in spring flows are elevated above numeric N standards in Florida law. P concentrations in these springs are generally not elevated above background levels. While P is moderately correlated with phytoplankton chlorophyll levels in Kings Bay, it is not a problem in the springs that are the focus of this restoration plan.

Nitrate N concentrations in the Kings Bay/Crystal River springs are from 4 to 12 times higher than natural background levels. These high nitrate concentrations are strongly implicated in the undesirable proliferation of benthic algae in Kings Bay. FDEP has concluded in their nutrient TMDL that N concentrations in the springs in Kings Bay need to be reduced from 21 to 64% compared to existing concentrations (Bridger 2014). For the purpose of this restoration plan, the N reduction goal for the entire groundwater contributing area is 64% or roughly 597,000 pounds/year (298 tons/year). Based on an assumed N assimilation rate of about 77% between surface N loads and N loads reaching the Floridan Aquifer (Bridger 2014), the surface N load needs to be reduced from about 4.1 million pounds/year (2,040 tons/year) to about 1.5 million pounds/year (734 tons/year), for a total N reduction of about 2.6 million pounds/year (1,305 tons/year).

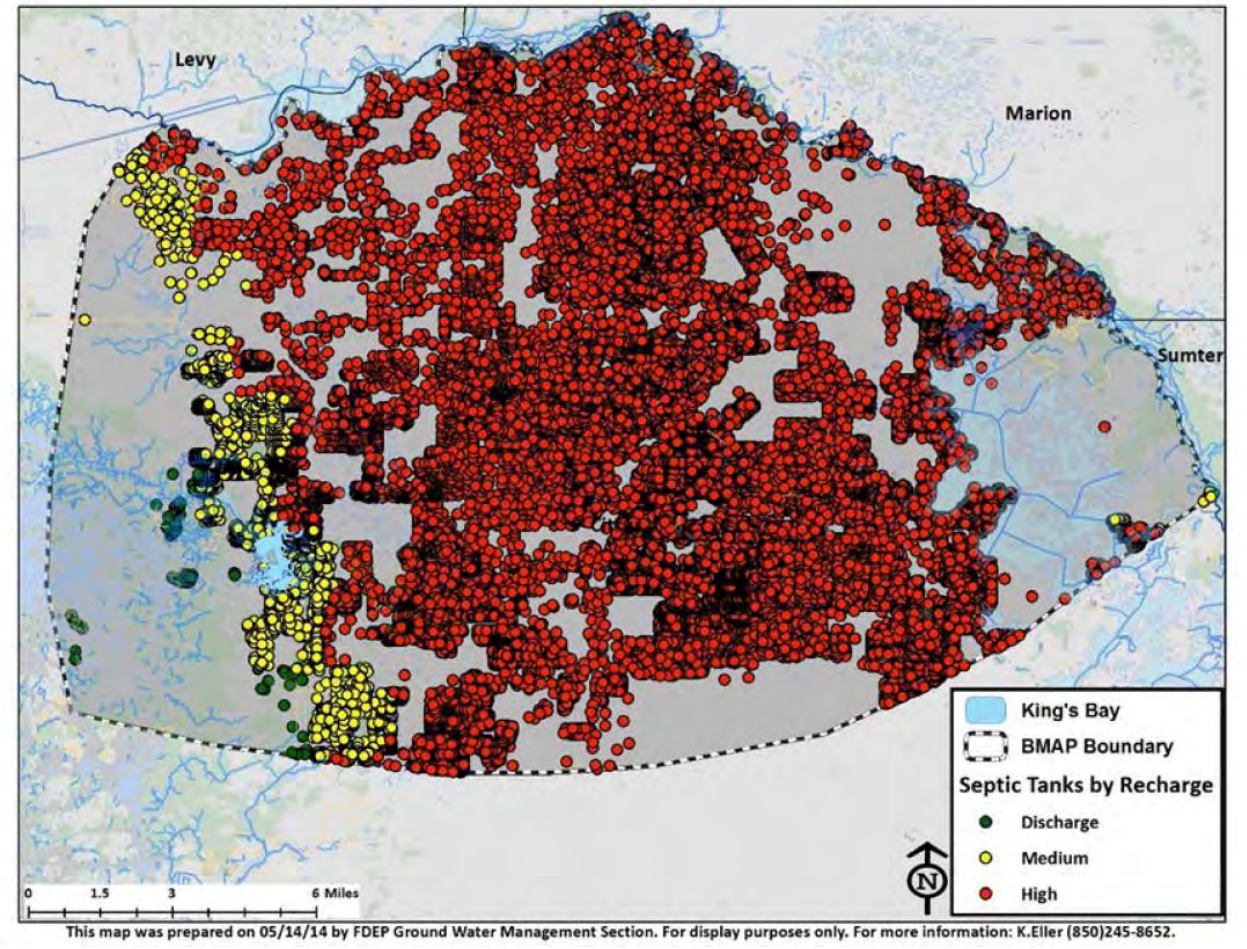


Figure 38. On-Site treatment and disposal systems (septic systems) in the Kings Bay/Crystal River Springshed (FDEP 2015).

3.3 Saltwater Intrusion

The relation of saltwater to freshwater in coastal aquifers in contact with the sea has been recognized for many years. Under hydrodynamic equilibrium, saltwater underlies freshwater in a wedge that decreases in thickness landward. Theoretically, for every foot of freshwater head above sea level measured at the saltwater-freshwater interface, the interface is depressed 40 ft below sea level (Hubbert 1940). A sharp interface between freshwater and saltwater does not exist in coastal aquifers because of tidal fluctuations or water-level fluctuations caused by changes in recharge or pumpage with time. Instead, a dynamic equilibrium has been established that causes freshwater and saltwater to mix and form a transition zone between freshwater and saltwater (Yobbi 1992). In the transition zone, the saltwater is not static but flows in a perpetual cycle from the sea floor into the zone of transition and back to the sea floor (Cooper et al. 1964).

The coastal-springs area is a small but important segment of a larger ground-water flow system. Yobbi (1992) reported that the chemical quality and flow rate of the Kings Bay/Crystal River springs depend on head in the Upper Floridan Aquifer. He concluded that continued

development of groundwater resources within the coastal-springs groundwater basin will modify flow and chemical characteristics of the springs and downstream estuaries and that long-term monitoring at selected springs is needed to assess the long-term effects of human activities. Diagrams showing how movement of the saltwater-freshwater interface could cause variations in specific conductance of water discharging from springs are presented in Figure 39. At times of high water levels in the aquifer, the interface is at its greatest depth, and discharge from the springs tends to be freshest. At times of low water levels, the depth to the interface is at its shallowest level. Under these conditions, saltwater in the aquifer mixes with freshwater flowing upward toward the spring openings, causing increased specific conductance in the spring discharge (Yobbi 1992).

In general, the chloride-concentration and geophysical data indicate an interface that is parallel to the coast with significant landward reentrants at major springs and gulfward extensions of the interface between springs. The presence of the springs has lowered hydraulic heads, permitting higher chloride concentrations at shallower depths. High salt content of many brackish springs indicates that gulf water has intruded through interconnected solution conduits gulfward of the springs (Yobbi 1992).

Salinity increases are an issue in Crystal River/Kings Bay that have already led to significant changes in the ecosystem and will likely become more of a pressing concern in the future (SWFWMD 2015). Reduction in spring flow and sea-level rise are the major contributors to increased salinity in the bay. Researchers at the National Oceanic and Atmospheric Administration have been monitoring sea-level rise along the Springs Coast and estimate a rise of seven inches over the past hundred years (0.07 in/yr). The Gulf of Mexico has always exerted some influence on Kings Bay but it appears that spring flow reductions and salinity pulses have become more frequent in recent years. For example, minimum salinity in Crystal River has tripled over the past ten years meaning the bay is becoming less fresh. Minimum salinity in the upper reaches of Crystal River are 2-3 parts per thousand (ppt), an ecologically important threshold that serves as the dividing line between a freshwater and a marine system. Currently, average bay-wide salinity is around 2-3 ppt. Fifty years ago, salinity was likely less than 1 ppt. Despite the increase in salinity in the surface waters and increases in chloride concentration in some of the bay's more brackish springs, the salt-water interface (the zone between fresher and saltier groundwater) has remained in the same relative location over the past twenty years (SWFWMD 2015).

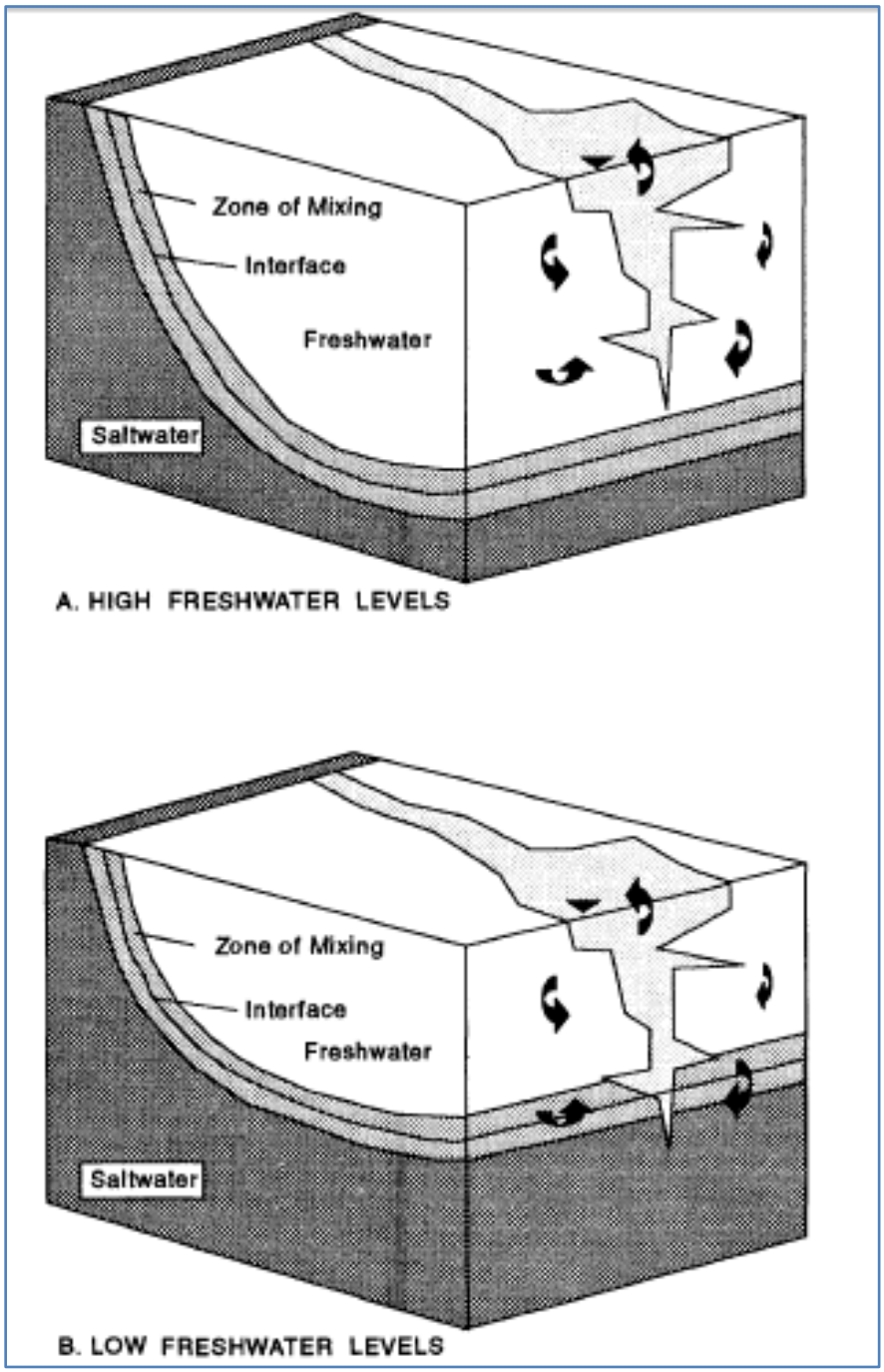


Figure 39. Movement of freshwater-saltwater interface with aquifer levels at a spring vent from (Mann and Cherry 1969 modified by Yobbi 1992).

3.4 Water Clarity

Recreational activities in Kings Bay related to diving, snorkeling and manatee viewing rely substantially on unimpaired water clarity. Substantial declines in the bay's water clarity since the 1970s – 1980s have been repeatedly reported by the local community (SWFWMD 2005). Factors known, or suspected, to affect water clarity in Kings Bay include concentrations of

chlorophyll (a proxy measure of phytoplanktonic algae abundance), reduced flushing due to lower spring discharge, and resuspension of dead algal material and sediments from the bay bottom or from rooted aquatic plants. Resuspension of particulate materials can be exacerbated by boat traffic, manatee grazing and recreational activities related to diving and snorkeling. Additionally, periods of reduced rooted aquatic plant coverage have been linked by the University of Florida to periods of degraded water clarity. Therefore, improving water clarity and re-establishing the native SAV plant cover will need to go hand-in-hand.

Water clarity in Kings Bay has been reported as between 8 and 14 feet while measured clarity near Hunter Springs has generally been less than 25 feet for the past decade. Other springs measured throughout the state typically have more than 100 feet of visibility (up to 300 feet) in the area of the spring boil. Crystal River was named based on its historic high water clarity. Existing poor water clarity conditions in Kings Bay/Crystal River system are directly responsible for reduced aesthetics as well as an ecological imbalance.

3.5 Loss of Native Aquatic Vegetation

Based on historic anecdotal information, submerged, rooted aquatic plants such as eelgrass dominated Kings Bay. These native plants provided habitat and food for the many and diverse wildlife species that formerly inhabited Kings Bay. In this shallow water body, rooted aquatic plants also acted to reduce wave action and assimilate nutrients that would otherwise promote growth of nuisance algal species; functions that help maintain water clarity.

Loss of SAV and their replacement by benthic filamentous algae and phytoplankton as the base of the aquatic food chain is the principal ecological impairment at the Kings Bay/Crystal River system. The succession from a clear-water, shallow embayment, dominated by eelgrass, to a replacement of the eelgrass by hydrilla and water hyacinths, to a phytoplankton-dominated, brackish water estuary with little to no SAV can be explained by a series of unfortunate, human management errors. Based on the data presented in this restoration plan, the string of hapless decisions that led to today's tragic ecological collapse in Kings Bay include:

1. The discharge of poorly-treated municipal wastewater effluent directly into the bay;
2. The canalization of most of the eastern and southern borders of Kings Bay and their subsequent urban development;
3. Introduction of hydrilla and water hyacinth and their explosive growth due to the elevated nutrient levels resulting from urban development;
4. Drastic exotic plant control methods that decimated the remaining native SAV;
5. Increasing nutrient discharges to the bay from urban and agricultural sources even after the wastewater disposal site was relocated to a sprayfield in the springshed;
6. Exploding urban development of the springshed with excessive groundwater consumption and tens of thousands of septic tanks and fertilized landscapes;
7. Declining spring flow rates that in turn increased water residence time in the bay, leading to increased growth of planktonic algae and loss of water clarity;

8. Continuing attempts to control benthic filamentous algae by scraping and dredging, in the process increasing turbidity, reducing water clarity, and damaging remaining native SAV.

Establishing a favorable submersed plant assemblage in Kings Bay remains the stated primary objective for the SWFWMD because such an assemblage should improve water clarity and wildlife habitat. Achievement of this objective will require a shared vision for the future optimal health of Kings Bay and a collaborative approach to achieving that vision. It will also be necessary to undo most of the management mistakes itemized above.

3.6 Manatee Carrying Capacity

The Crystal River/Kings Bay watershed supports numerous listed and unlisted wildlife species including; 21 species of amphibians, 191 species of birds, 22 species of mammals and 47 species of reptiles. Foremost among these species is the endangered West Indian manatee. In 1983, the United States Fish and Wildlife Service established the Crystal River National Wildlife Refuge to protect manatees utilizing Kings Bay for foraging and refuge from the cold waters of the Gulf of Mexico. During the winter, manatees in Florida congregate near spring vents which discharge water at a fairly consistent temperature of 72 °F. These overwintering manatee congregations risk greater exposure to boats and intensify grazing pressure on submerged rooted aquatic plants in Kings Bay. Therefore, management strategies must balance responsibilities to protect manatees with activities designed to protect and enhance existing stands of rooted aquatic plants, for the benefit of other wildlife species and improved water clarity.

Manatees were relatively rare in Kings Bay/Crystal River in the 1970s. Manatee populations in the bay/river system and feeder springs have been increasing since that time, with an average of about 100 animals observed in the mid-1980s to over 200 as the average number in 2015. The maximum manatee count in Kings Bay/Crystal River has increased even more rapidly, from about 150 in the 1980s to over 700 individuals in 2015. It is not known what historic Florida manatee populations were prior to modern development, but it has been recorded that manatees were hunted for meat by both the Seminoles and by European colonists. It is likely that manatee populations were kept in check, below their optimum carrying capacity, throughout the long human prehistory of Florida.

Like all wild animals, manatees are dependent on their environment for food and shelter. There is little doubt that the more than 1,000 artesian springs in North and Central Florida, when pristine, provided considerably more habitat for manatees than what is currently provided. Florida's manatee experts and their enthusiastic private and public support groups have been successful at increasing the state's total manatee population estimated at about 1,000 individuals in the mid-1980s to more than 5,000 in 2014-15. Habitat limitation is becoming a greater and greater challenge for continuing expansion of Florida's manatee population.

The optimal manatee carrying capacity of Kings Bay/Crystal River may or may not already be exceeded. Applying today's very best science to quantifying an appropriate population of manatees that could be supported by a restored Kings Bay/Crystal River ecosystem is a high priority.

3.7 Development and Recreational Impairments

Excessive utilization of public lands, including aquatic systems such as springs, rivers, lakes, and estuaries, is a non-trivial source of ecological impact and impairment. People literally can love the public "commons" to death. Kings Bay/Crystal River and associated springs are no exception.

The principal human impacts that can be observed at Kings Bay/Crystal River include:

- Shoreline development, including removal of native emergent plants and hardening with rip rap and seawalls;
- Power boating with resulting air and water pollution from exhausts, scarring of shallow plant communities, and manatee disturbance/injury;
- Aggressive manatee watching and touching;
- Sport and commercial fishing; and
- Wading in shallow areas.

While all of these activities alone or in moderation are reasonable and beneficial, they can all become seriously detrimental when carried to excess.

Section 4.0 Kings Bay/Crystal River Springs Restoration Goals and Recommendations

4.1 Visioning the Future for Kings Bay/Crystal River Springs

Garald G. "Jerry" Parker, Sr. (1905–2000) was a hydrologist and is known as the "Father of Florida groundwater hydrology." Jerry Parker also named Florida's principal artesian aquifer, the Floridan Aquifer. In 1940, Parker began his career as a hydrogeologist when he made a cross-country trip to help save the water supply of Miami, Florida from saltwater intrusion. Parker developed protective measures to save existing well fields, and also from 1940 to 1947 identified and named the Biscayne Aquifer and defined the geologic structure of southern Florida. Parker was also a mentor to Marjory Stoneman Douglas providing technical information about the hydrology of the Everglades for her 1947 book, The Everglades: River of Grass. In 1969, Jerry Parker served as the first hydrologist and senior scientist for the Southwest Florida Water Management District, where he continued to work until 1975. Afterwards, he worked as a consultant, in Florida and also internationally, into the 1990s.

Jerry Parker first visited Kings Bay and Crystal River in the fall of 1945. In 1982, he published observations he made in 1945, in what may be the earliest description of the Three Sisters Springs system (previously referred to as the Middle Spring) by a professional geologist (Parker 1982):

> "In their natural state there was no recognizable outlet channel draining the Three Sisters Springs - they were landlocked. The shores and surrounding land were thickly vegetated, and access was on foot by way of a winding footpath about 0.3 miles long, westerly from US 19. The general appearance of the area was that of a pristine wooded wetland with bordering growths of taller trees surrounding the lakes, their luxuriant foliage almost forming a leafy canopy over the springs. A rude plank raft was tied to a shoreline tree and a rope for swinging out into the water hung from an overhanging branch.
>
> "While at the springs I swam and dived to determine if these springs were fed by submerged sinkholes or were fed instead by more-or-less diffuse flow from the underlying solution-riddled Ocala Limestone. We found only a clean, white, sandy floor with no limestone pedestal, and water was bubbling up through the sandy floors almost everywhere. Eel grass was common on the spring floors and hydrophytic plants fringed the shores (pages 1-2)."

In September 1982, Parker returned to Three Sisters Springs. By that time, an artificial channel had been cut connecting Three Sisters to a dredged channel and ultimately opening the springs to boat traffic from Kings Bay. Based on that 1982 visit, Parker made the following observations (Parker 1982):

> "The setting of the site has been drastically changed since I saw it first. The once wooded wetlands have been bulldozed over, dredging has been done in at least one of the

springs, and dredged limestone and white sand spread over wide surrounding areas. Only a fringe of big trees still surround the springs.

"The area of the open water of the springs is much enlarged over what it was in 1945, and the banks have not only receded, they are still receding. Trees and bushes have been sawed or chopped down, cuts have been made to allow boats to be dragged ashore, and the general erosion of the banks is indicative of boat waves and propeller wash.

"Paper, beer and pop cans, hot-dog wrappers, sweet corn husks, and other trash are not only strewed on the land about the springs but are also present in the springs. Apparently scallops and other clams are principal items of picnicking as their shells are littered over the bottom of the springs. Eel grass is still present in parts of the springs and it is obvious from its "lawn-mowed" appearance in some places that manatees have been grazing there.

"But the clean white sand is now largely covered with a layer of slimy muck from the erosion of the banks and decaying vegetation. The presence of algae blooms in parts of the shoreline area indicates that eutrophication is setting in.

"All in all, the springs give mute evidence of human violation of this formerly pristine area. The springs are being destroyed by vandals among picnickers and pleasure boaters. This is yet another of nature's beauty spots that is being totally destroyed and all because of people who do not try to enjoy a place of natural beauty without destroying it (pages 5-7)."

Jerry Parker, Sr., devoted his career to learning about Florida's drinking water aquifers and educating people about their wise management. In a recorded interview with his son in 1989, he is quoted as saying: "Water is life; without water, we have nothing. Without water, we die." Jerry Parker, Sr., died in 2000 and, unfortunately, did not live to see Three Sisters Springs purchased by the state of Florida and some of the land around it restored to productive wetlands. But through his memoirs about Three Sisters Springs, their beauty and complexity, and their wanton destruction by the activities of humans, Parker left a testimony concerning what we were given as a free gift needing stewardship and what the future of a restored Three Sisters Springs and Kings Bay/Crystal River may become again.

Parker's description of Kings Bay/Crystal River of the 1940s presents one possible image or future scenario for what it might become again. Achievement of this best-case scenario will depend on providing adequate and clean groundwater to more than 70 springs so they can once again nourish a crystal-clear and productive bay/river. The alternative to this vision is continuing on today's course of declining spring flows, rising nutrient levels, increasing salt water intrusion; and the inevitable blooms of phytoplanktonic algae, loss of water clarity, degraded aesthetics, and diminished wildlife habitat in these coastal spring, river, and estuarine ecosystems.

In their draft Surface Water Improvement and Management (SWIM) plan, the SWFWMD (2015) has assembled a list of "quantifiable objectives" for assessing progress towards restoration of Kings Bay/Crystal River (Table 12). As indicated by the analyses presented in this independent restoration plan, SWFWMD's quantifiable goals may set too low a bar for desired improvements at Kings Bay/Crystal River. Based on the Florida Springs Institute's assessment of the facts surrounding impairments in this spring-fed system, the actions proposed by the

SWFWMD in their previous and current SWIM plans will not be sufficient to achieve the stated objectives.

Table 12. SWFWMD SWIM Quantifiable objectives for Kings Bay/Crystal River restoration.

Water Quality	Target
Water clarity - bay wide	>20 feet
Water clarity - springs areas	>60 feet
Total nitrogen concentrations in the bay	<0.28 mg/L[1]
Total phosphorus concentration in the bay	<0.032 mg/L[1]
Chlorophyll concentrations in the bay	<2.0 µg/L
Water Quantity	
Minimum flows for the River and bay system	TDB in 2017[2]
Natural Systems	
Coverage of desirable submerged aquatic vegetation in the bay	>65%
Coverage of invasive aquatic vegetation in the bay (including filamentous algae)	<10%
Percent of shoreline in natural condition around the bay (including living shorelines)	>50%
1 Bridger 2014 - Nutrient TMDL for Kings Bay (WBID 1341), Hunter Spring (WBID 1341C), House spring (WBID 1341D), Idiot's Delight Spring (WBID 1341F), Tarpon Spring (WBID 1341G), and Black Spring (WBID 1341H)	
2 SWFWMD 2015 Minimum Flows and Levels Priority List and Schedule	

State agencies, including FDEP, SWFWMD, and FDACS are tasked with enforcing Florida's environmental laws and protecting the intrinsic natural values of ecosystems such as springs. However, Florida's state government is subject to conflicting special interests and a political system that too often favors private, for-profit special interests over the interests of the general public. For these reasons, state agencies that have the responsibility to restore and protect environmental treasures like the Kings Bay/Crystal River springs do not wish to take decisive and effective actions to assure timely springs recovery. A lack of will power on the part of the state's environmental agencies is nothing new. Kings Bay/Crystal River and springs have been declining in health on their watch for the past 50 years.

The information included in this document leads to recommended actions that need to occur to reclaim a reasonable fraction of the former environmental health of the Kings Bay/Crystal River springs. Based on this technical review of the known facts and a broad understanding of springs ecology and management, the Florida Springs Institute recommends the following alternatives to the SWFWMD's quantifiable objectives for a restored Kings Bay/Crystal River Springs ecosystem:

- Reduce regional groundwater extractions affecting Kings Bay/Crystal River springs by about 235 MGD) within the next ten years to restore average spring flows to 95 percent of their historic average levels and to reduce salt water intrusion and excessive phytoplankton growth;
- Reduce N loads to the springshed from fertilizer and human/animal wastewater disposal by at least 64 percent within the next ten years to achieve the springs TMDL

nitrate numeric standard of 0.28 mg/L and to discourage continuing proliferation of benthic filamentous algae;

- Begin immediately to replant and restore eelgrass dominance (>90% cover) to provide an adequate supply of desirable forage for West Indian manatees;
- Within one year, conduct an in-depth analysis of the optimal carrying capacity for manatees in Kings Bay/Crystal River;
- Measure and widely report the restoration of water clarity with an ultimate goal in the springs of >100 feet and in the bay of >40 feet; and
- Regulate boat traffic with idle speed only in the entire Kings Bay and exclude all power boating within one hundred feet of the springs.

4.2 Key Stakeholders

This section briefly lists the key stakeholder groups that will need to come together as partners to support the recommendations outlined in this report.

Private Landowners

There are tens of thousands of private landowners who will be affected by any comprehensive restoration of the Kings Bay/Crystal River springs because the majority of the springshed is in private ownership. Based on our current understanding of the actions that will need to be taken to achieve the desired spring restoration goals, many of these private landowners will be affected by water and fertilizer use restrictions, and possibly increased fees for wastewater management - either through local utility rate increases or by possible upgrades to on-site sewage disposal systems.

Federal, State, and Local Governments

Key public stakeholders identified during this restoration planning effort include:

- United States Government
    - U.S. Congress
    - U.S. Environmental Protection Agency
    - U.S. Forest Service
    - U.S. Geological Survey
    - U.S. Fish and Wildlife Service
    - U.S. Department of Agriculture
    - Natural Resource Conservation Service
- Florida Government
    - Florida Legislature, Governor, and Cabinet
    - Department of Environmental Protection

  - Southwest Florida Water Management District
  - Department of Forestry
  - Florida Fish and Wildlife Conservation Commission
  - Department of Economic Opportunity
  - Department of Agriculture & Consumer Services
- Counties
  - Citrus County, Florida
  - Levy County, Florida
  - Marion County, Florida
  - Sumter County, Florida
  - Hernando County, Florida
  - Pasco County, Florida
- Incorporated Areas
  - Crystal River, Florida
  - Inverness, Florida
  - Other incorporated areas

Non-Governmental Organizations

- Kings Bay Springs Alliance
- Save the Manatee Club
- Save Crystal River
- One Rake at a Time
- Florida Defenders of the Environment
- 1000 Friends of Florida
- Florida Audubon
- Sierra Club
- Howard T. Odum Florida Springs Institute

Agricultural and Forestry Operations

Industrial, Commercial, and Development Operations

4.3 Developing a Restoration Roadmap

A holistic restoration roadmap for the Kings Bay/Crystal River springs must include the following components:

- Restoration Plan (this report)
  - Summary of Existing Conditions
  - Impairments that can be restored
  - Specific Goals and Schedule for Restoration
  - Practical Steps Needed to Achieve Those Goals
  - Responsible Parties
- Implementation Plan (future report)
  - A Timeline for Implementing the Restoration Plan
  - Approximate Costs and Funding Sources
  - Monitoring of Progress with Continuing Adaptive Management in Response to Measured improvements

The SWFWMD is currently updating their Kings Bay/Crystal River SWIM Plan (SWFWMD 2015). FDEP is currently preparing a BMAP for the Kings Bay springs complex. Those documents, if cleansed of political and special interest caveats and enhanced by a real commitment to restore the resource, have the potential to contribute to an effective implementation plan for the Kings Bay/Crystal River system.

4.4 Specific Goals for Restoration and Practical Steps to Achieve Those Goals

4.4.1 Water Quantity Restoration

The preliminary water quantity restoration goal for the Kings Bay/Crystal River springs is to restore at least half of the estimated clear groundwater inflow that has been lost. This goal will require a reduction in average groundwater pumping to achieve at least 95% of historic spring flows or a reduction of regional groundwater extractions of more than 365 cfs (235 MGD) throughout the Springs Coast Restoration Focus Area. This reduction in groundwater pumping should be based on a springshed-wide assessment of groundwater use priorities.

Reductions in groundwater pumping need to be prioritized based on their regional economic importance and can be made through a combination of the following proactive measures:

- Increased water use efficiency;
- Increased water conservation; and
- Increased reliance on alternative rain water and surface water supplies to reduce reliance on groundwater uses as much as possible.

Until a detailed economic evaluation is conducted, it is reasonable to assume that all existing groundwater users in the Kings Bay/Crystal River Springshed need to reduce their

groundwater use. The SWFWMD must take the lead by increasing public awareness of the root causes of springs impairment (over pumping of groundwater) and cutting back on existing non-essential permitted uses. A good first step will be to place a fee (Aquifer Protection Fee) on all permitted groundwater uses. This fee would have immediate benefits by reducing existing groundwater uses and would generate public revenue to implement restoration activities.

Public and domestic self-supplies could reasonably achieve their water use reduction goal by reducing or totally eliminating landscape and lawn irrigation with groundwater. If rainfall could be stored locally in ponds, cisterns, or rain barrels, then these outside water use activities could be permitted and continued where necessary.

Agricultural production in North Florida has relatively recently developed a dependency on crop irrigation using groundwater. This use cannot be sustained at current rates if restoring spring flows and river health is a priority. The logical first step is to stop issuance of any new groundwater use permits for crop irrigation in the Kings Bay/Crystal River Springshed. The next step is to revise existing agricultural permits to restrict water uses to the most necessary and efficient cropping methods and to meter all uses. Local and regional groundwater pumping will need to be reduced to restore adequate flows in the Kings Bay/Crystal River springs.

Conversion of a large percentage of crops being grown on over-drained, highly vulnerable lands, to non-irrigated crops such as long-leaf pine plantations or, in some cases, unimproved pasture will be necessary to attain the ultimate water quantity restoration goal. Springs protection zones should be developed based on the aquifer vulnerability maps reproduced in this report. No new high-intensity agricultural operations should be permitted on vulnerable lands unless they can rely totally on rainfall and surface water storage. Subsidies and tax incentives may need to be developed to lessen the impact of these types of restrictions on existing agricultural producers located in vulnerable areas. Conservation easements that convert row crop agriculture to long leaf pine forest should be funded with money from Florida's Land and Water Amendment.

Other significant water uses in the springshed, including commercial/industrial and recreational, will also need to reduce their reliance on groundwater supplies.

4.4.2 Water Quality Restoration

The preliminary target for average nitrate N concentrations in the Kings Bay/Crystal River springs is 0.23 mg/L as determined by FDEP in their nutrient TMDL (Bridger 2014). This goal will require an estimated 64% reduction in all N loads to the vulnerable portions of the springshed. Katz et al. (2014) estimated that there is approximately 139 tons/year of total N introduced into the Floridan Aquifer in the springshed in the form of N fertilizer. Other important N sources include septic systems with a N load estimate of 237 tons/year. Rainfall contributes on average about 40 tons/year of N to the aquifer in the springshed area. Including lesser sources such as wastewater disposal, golf courses, and domesticated animals, the total combined load of N to the Floridan Aquifer and springs is about 466 tons/year.

Based on the average estimated natural attenuation of N sources of 77%, the total N load to the land surface in the springshed is estimated as 2,038 tons/year. To achieve the desired 64% N load reduction to the aquifer, it will be necessary to reduce these surface N loads to less than 733 tons/year or by 1,305 tons/year.

The N load in municipal wastewaters and in septic tank effluents can be practically reduced by more than 70% through upgrades using advanced N removal methods. However, since the N load to the aquifer contributed by rainfall is not readily controllable, fertilizer uses will also need to be reduced in the vulnerable portions of the springshed by more than 64% or about 450 tons of fertilizer N per year to meet FDEP's TMDL goal of 0.23 mg/L.

The first step in this reduction should be placing a significant fee on the sale of all N-containing fertilizers in the springshed. This Aquifer Protection Fee will have the double benefit of reducing fertilizer use and raising money needed for land acquisition and wastewater treatment upgrades.

The second step should be strict limits of urban and rural fertilizer use to meet the target reductions in no more than 10 years. In combination with a large reduction in landscape and agricultural irrigation, fertilizer use will decline proportionally. An acceptable solution might be to phase in cuts to all N fertilizer use in the springshed at about 50 percent reduction in the first five years, followed by a second phased reduction of an additional 50 percent over the next five years, and consideration of one additional phased reduction if found to be necessary based on the measured nitrate N levels in the Kings Bay/Crystal River springs. A phased program to reduce fertilizer use would allow greater flexibility for businesses and private homeowners to develop less polluting cropping and landscaping strategies.

Nutrient loads originating from livestock will also need to be reduced by at least 64% to achieve the TMDL nitrate limit for the Kings Bay/Crystal River springs. One way to accomplish this goal is to eliminate all pasture fertilization and then to limit the density of grazing animals to what can be supported by unimproved pasture. A second alternative is to collect all animal manure and to recycle it as an alternative to using inorganic N fertilizers. Ultimately, the number of large grazing animals in the springshed will need to be reduced significantly to achieve the nitrate TMDL goal.

Human wastewater N loads in the springshed can be reduced by implementing advanced N removal for all central wastewater plants and by providing centralized collection and wastewater treatment for all high-density septic tank areas. A detailed analysis evaluating and comparing N removal measures using technologies such as constructed wetlands, biological nutrient removal processes, and N-removal on-site septic systems should be prepared as part of the Kings Bay BMAP process.

In summary, the anticipated Kings Bay BMAP must provide realistic but stringent N reduction measures, regardless of whether or not they adversely affect agriculture or urban land use practices. Costs for these upgrades are likely to be significant and should in turn be compared to costs to reduce other N inputs to the aquifer from fertilizers and animal/human wastes. The nitrate contamination at the Kings Bay/Crystal River springs will not be solved unless all options are on the table and evaluated for cost effectiveness ($ per pound of N that is prevented from reaching the aquifer).

4.4.3 Invasive Vegetation

Proliferation of benthic filamentous algae and planktonic algae throughout Kings Bay/Crystal River and springs has led FDEP to adopt a nutrient TMDL for the river and springs. In addition to the increasing prevalence of filamentous algae, hydrilla has been introduced in some springs and is common throughout the river. A system-wide approach should be taken to manage

exotic and invasive vegetation that includes education and coordinated efforts of interested groups to maximize the effective and environmentally-sound solutions.

4.4.4 Holistic Ecological Restoration

The effects of reduced flows, increasing concentrations of nitrate N, invasions by exotic plant and animal species, and increasing recreational uses are resulting in visible long-term changes to the natural flora and fauna of the Kings Bay/Crystal River springs. Ecological restoration will require a holistic approach to dealing with all sources of impairment simultaneously, rather than a piecemeal approach of divided responsibilities by an array of state and local agencies.

4.5 Education Initiatives

Ongoing public education about the threats facing the long-term health of the Kings Bay/Crystal River and springs will be essential for achieving ultimate restoration. This Restoration Plan provides a preliminary roadmap to fully accomplish restoration goals. However, getting this information out to the public and to the State officials and legislators who are most concerned with springs' protection is an important part of this educational process. This will require public presentations, public meetings, newspaper and TV reporting, rallies at key springs, and many partnerships. The Kings Bay Springs Alliance, Inc. and Save Crystal River, Inc., both non-governmental organization, will learn how to work together and provide leadership to implement this restoration plan. Technical support will be provided by the Howard T. Odum Florida Springs Institute and other springs advocacy and educational organizations throughout North Florida.

4.6 Regulatory Assistance

FDEP is currently developing a BMAP to achieve the TMDL nitrate N goals for Kings Bay/Crystal River and springs (Bridger 2014). The SWFWMD has prepared several drafts of the Kings Bay/Crystal River SWIM plan (SWFWMD 2015). Active participation by these two state agencies will be crucial to improve and implement the BMAP expeditiously to reverse the increasing nitrate levels and declining flows. This Restoration Plan can serve as the "People's BMAP" if the FDEP and SWFWMD plans do not provide an efficient and timely plan to achieve success with restoration and protection of this spring system.

The SWFWMD is planning to finalize Minimum Flows and Levels (MFLs) for the Kings Bay/Crystal River and springs by 2017. MFLs for first magnitude spring groups have been required by Florida law since 1973. After 44 years, it is time to finish this MFL process. Evidence presented in this report indicates that due to a combination of groundwater pumping and declining rainfall, flows in these springs are already well below historic levels (58% or 340 MGD). The SWFWMD has not met its responsibility to develop and enforce protective MFLs for the Kings Bay/Crystal River springs. This situation is unacceptable and must be corrected expeditiously.

The Florida Department of Agriculture and Community Services (FDACS) is the state agency responsible for regulating agricultural practices in Florida. A paradigm shift is necessary at FDACS and in the development of agricultural Best Management Practices (BMPs). For example, existing BMPs are developed to maximize economic yield while minimizing environmental pollution. This focus on maximizing profits cannot result in adequate springs'

protection. Agricultural BMPs must be re-designed to first achieve necessary environmental protections and secondly to provide reasonable economic returns. An effort to develop "Advanced BMPs" should result in zoning restrictions on certain intensive agricultural activities like those found for high-intensity urban development. In areas of high groundwater vulnerability, the only agricultural crop that is consistently capable of maintaining an average groundwater nitrate concentration of less than 0.35 mg/L is probably long leaf pine. Until a better "Advanced BMP" becomes available, an unfertilized, non-irrigated forestry crop should be mandated by FDACS for the most vulnerable karst areas of the state.

4.7 Closing Statement

Implementation of the recommendations listed above will require significant will-power and changes to "business as usual." Eventual restoration and long-term protection of the Kings Bay/Crystal River springs will require a shift from focusing on short-term needs of individuals and businesses, and taking a longer view for conservation and protection of clean and abundant groundwater for the public as a whole. A healthy and sustainable future is dependent on reversing the spring impairments caused by the current focus on short-term gratification.

Groundwater is one of the most important natural resources in Florida. Currently, the groundwater that feeds the Kings Bay/Crystal River springs is neither clean nor abundant. As evidenced so clearly by the deteriorating water quality and declining spring flows at Kings Bay and Crystal River, North Florida's groundwater resources are on a declining trajectory. Fortunately, as long as it rains, groundwater is a renewable resource. Hope for the future health of Kings Bay and Crystal River and for Florida's springs in general is in the hands of people who have learned to appreciate and value these shared natural resources.

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Appendix A. Inventory of Spring Vents in Kings Bay Crystal River, Florida (VHB 2009)

A.1 Introduction

Vanasse Hangen Brustlin, Inc. (VHB) completed a field inventory and documentation of spring vents within the Kings Bay portion of Crystal River in Citrus County, Florida (VHB 2009). The field inventory was conducted over the period of October 14th – 16th and 27th – 29th 2008, and January 26th – 27th 2009, for a total of eight field days. The following previous reports were used to help locate the Kings Bay spring systems:

- Hammett, K.M., C.R. Goodwin, and G.L. Sanders. 1996. Tidal-Flow, Circulation, and Flushing Characteristics of Kings Bay, Citrus County, Florida. U.S. Geological Survey Open File Report 96-230. Tallahassee, Florida.
- Rosenau, J.C., G.L. Faulkner, C.W. Hendry, Jr., and R.W. Hull. 1977. Springs of Florida (revised): Florida Bureau of Geology Bulletin 31. 461 p.
- Scott, T.M., G.H. Means, R.P. Meegan, R.C. Means, S.B. Upchurch, R.E. Copeland, J. Jones, T. Roberts, and A. Willet. 2004. Springs of Florida (Revised): Florida Bureau of Geology Bulletin No. 66. 658 p.

VHB also included information on spring vent locations and names provided by District staff (Dave Dewitt) during the field surveys.

A.2 Methods

The survey method consisted of navigation by boat to the approximate locations of previously documented spring vents summarized in the above described letter report. Upon arrival at a previously documented spring location, efforts were made to detect the spring's presence, including visual observation of spring "boils" from the boat, and surveys along the surface and bay bottom via snorkel and SCUBA equipped divers. In addition to the previously documented springs, other potential spring vents detected by spring signs (i.e., boils) were also investigated.

When a spring vent location was field confirmed, its location was recorded in latitude and longitude coordinates via a GPS equipped arc pad. In addition, the vents depth, dimensions and orientation/configuration were noted. Digital photographs were taken of the vent mouth, when possible, along with occasional surface images.

The survey revealed that many of the springs consist of more than one vent in very close proximity. Multiple discharge locations were often observed in a relatively small area that jointly contributed to the overall discharge for that "spring". A single set of GPS coordinates was obtained to mark these vent clusters and each vent cluster was considered a single spring for the purposes of this study.

A.3 Springs Descriptions

A total of 70 springs were documented, and their coordinates are provided in Table A-1. This is substantially more than reported in the cross-reference table which noted a potential of 42 springs.

In some areas, there are springs that are so close together that they could not be depicted separately on Figure A-1 for mapping purposes. A single location was used on Figure A-1 to depict the location of these springs, but the individual GPS coordinates of each spring are provided in Table A-1. Combining close proximity springs for mapping purposes resulting in the depiction of 52 locations for the 70 springs.

Finally, especially in the case of previously unnamed springs, groups of springs in the same geographic area of Kings Bay were lumped into a single site designation. These "spring complexes" were given the same site name and site number in Table A-1 and the same site number on Figure A-1. The grouping into spring complexes resulted in a total of 41 named and numbered springs/spring complexes as listed in Table A-1 and depicted on Figure A-1.

The spring vents varied greatly in flow magnitude from 1st order magnitude vents to 3rd order or less. Many of these vents were previously identified in the earlier reports identified above. However, several of the vents were not identified in these reports. When possible, these vents were identified or labeled consistent with their historic designations. In some instances, names have been provided (in italics) for previously unnamed springs of suitable size.

Provided below are physical descriptions of the vents/vent complexes surveyed during the field events. Information relative to approximate flow and depth are based upon the conditions at the time of the survey. Most of the surveys took place from mid to low tides, so the approximate flows were likely on the high side and the depths on the low side. The descriptions are presented in a general north to south order based upon the vents geographic locations. The number in parentheses at the end of the spring name corresponds to the spring numbers on Figure A-1 and Table A-1.

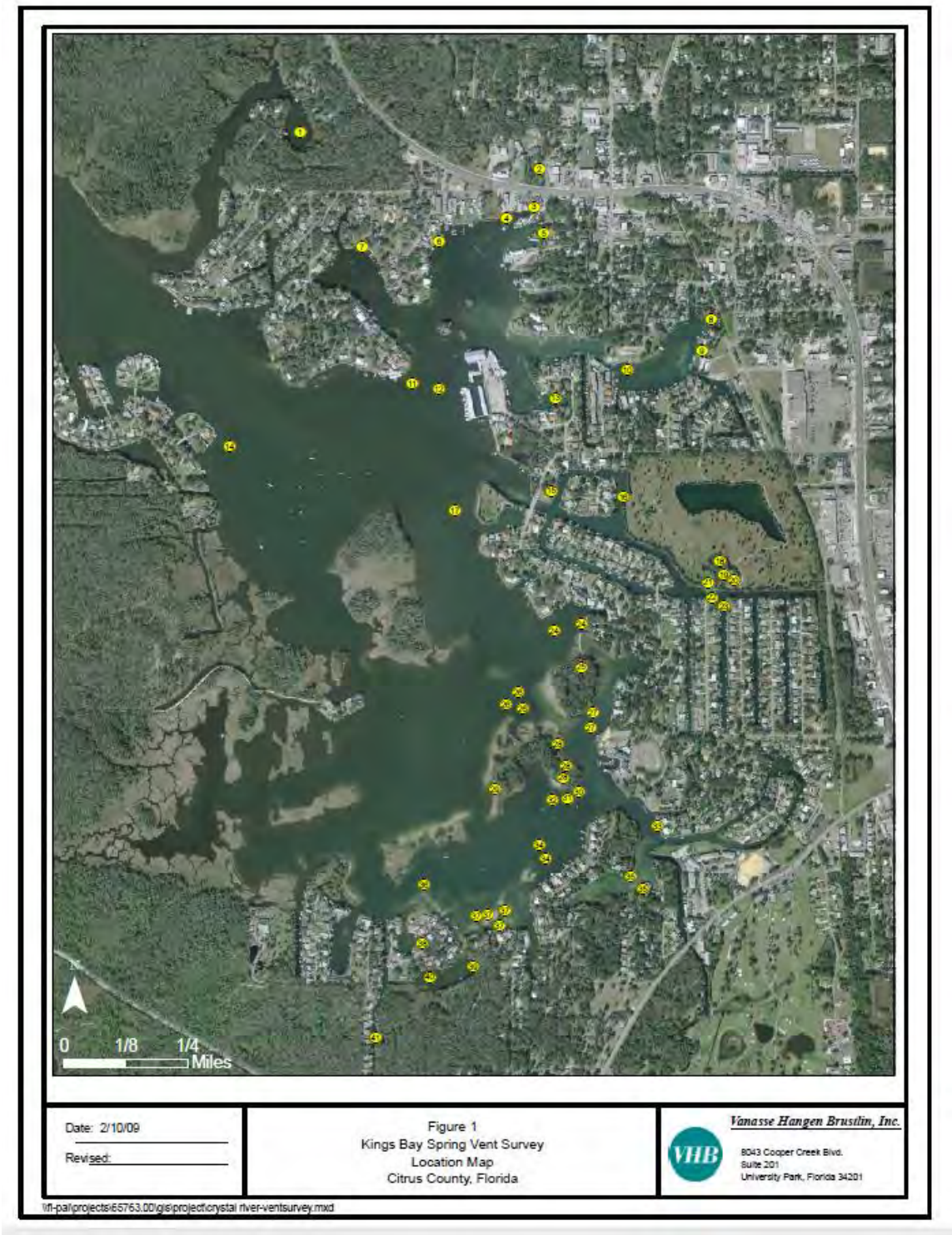


Figure A-1. Kings Bay spring vent survey (VHB 2009). Spring numbers refer to detailed springs list in Table A-1.

Table A-1. Documented Kings Bay Spring Vents (VHB 2009).

ID number	Name	Latitude	longitude

ID number	Name	Latitude	longitude
1	Hammett 23/Miller's Creek Spring	28° 54'05.10"N	82° 36'12.49"W
2	Fountain Spring/City Hall Spring	28° 54'01.29"N	82° 35'43.60"W
3	Charlie's Fish House Spring	28° 53'57.32"N	82° 35'44.23"W
4	Hammett 25/Birds Underwater Spring	28° 53'56.05" N	82° 35'47.56"W
5	Hammett 27/Pool Spring	28° 53'54.48" N	82° 35'43.02"W
6	Hammett 1/Catfish Spring	28° 53'53.50"N	82° 35'55.54"W
7	Hammett 26/NW 9th Avenue Springs	28° 53'52.93"N	82° 36'04.75"W
7	Hammett 26/NW 9th Avenue Springs	28° 53'52.93"N	82° 36'04.96"W
7	Hammett 26/NW 9th Avenue Springs	28° 53'52.91"N	82° 36'04.97"W
8	Hammett 4/House Spring	28° 53'45.44"N	82° 35'22.84"W
9	Hammett 5/Jurassic Spring	28° 53'42.08"N	82° 35'23.93"W
10	Hammett 3/Hunters Spring/American Legion Spring	28° 53'40.41"N	82° 35'32.91"W
11	Hammett 21/Magnolia Circle Spring	28° 53'38.49"N	82° 35'58.84"W
12	Pete's Pier Spring	28° 53'37.85"N	82° 35'55.60"W
13	Hammett 6/Moray Springs	28° 53'37.03"N	82° 35'41.57"W
13	Hammett 6/Moray Springs	28° 53'37.01"N	82° 35'41.40"W
13	Hammett 6/Moray Springs	28° 53'36.99"N	82° 35'41.09"W
14	Hammett 20/Shark Sink	28° 53'31.69"N	82° 36'20.86"W
15	Hammett 7/Paradise Isles	28° 53'27.18"N	82° 35'42.02"W
16	Hammett 8/Manatee Sanctuary/Gator Hole/Magnolia Spring/Crystal Spring	28° 53'26.50"N	82° 35'33.27"W
17	Buzzard Island Spring	28° 53'24.97"N	82° 35'53.64"W
18	Hammett 10/Three Sisters #1/Three Sisters Springs/Middle Springs # 1	28° 53'19.46"N	82° 35'21.37"W
19	Hammett 28/Three Sisters #2/Three Sisters Springs/Middle Springs # 2	28° 53'18.70"N	82° 35'20.87"W
20	Hammett 28/Three Sisters #3/Three Sisters Springs/Middle Springs # 3	28° 53'18.14"N	82° 35'20.16"W
21	Hammett 9/ Kings Bay #1/ Idiots Delight #1	28° 53'17.22"N	82° 35'23.03"W
22	Hammett 11 /Idiots Delight #2	28° 53'16.55"N	82° 35'22.04"W
23	Hammett 11A/Idiots Delight #3/ Three Sisters Run	28° 53'16.24"N	82° 35'22.55"W

ID number	Name	Latitude	longitude
24	Parker Island North Spring Complex	28° 53'13.30"N	82° 35'38.33"W
24	Parker Island North Spring Complex	28° 53'13.23"N	82° 35'38.51"W
24	Parker Island North Spring Complex	28° 53'13.21"N	82° 35'38.76"W
24	Parker Island North Spring Complex	28° 53'13.10"N	82° 35'38.30"W
24	Parker Island North Spring Complex	28° 53'12.33"N	82° 35'41.58"W
25	Hammett 12/Parker Island Springs/Little Hidden Spring	28° 53'08.84"N	82° 35'38.69"W
25	Hammett 12/Parker Island Springs/Little Hidden Spring	28° 53'08.74"N	82° 35'38.47"W
25	Hammett 12/Parker Island Springs/Little Hidden Spring	28° 53'08.48"N	82° 35'38.26"W
26	Banana Island North Spring Complex	28° 53'05.92"N	82° 35'46.10"W
26	Banana Island North Spring Complex	28° 53'05.46"N	82° 35'46.09"W
26	Banana Island North Spring Complex	28° 53'04.48"N	82° 35'47.12"W
26	Banana Island North Spring Complex	28° 53'04.40"N	82° 35'45.35"W
27	Hammett 13/FWS Spring Complex	28° 53'03.29"N	82° 35'36.87"W
27	Hammett 13/FWS Spring Complex	28° 53'01.98"N	82° 35'37.11"W
28	Banana Island East Springs	28° 52'58.18"N	82° 35'40.51"W
28	Banana Island East Springs	28° 52'58.09"N	82° 35'39.95"W
28	Banana Island East Springs	28° 52'57.85"N	82° 35'40.45"W
28	Banana Island East Springs	28° 52'57.65"N	82° 35'40.27"W
28	Banana Island East Springs	28° 52'57.38"N	82° 35'39.76"W
28	Banana Island East Springs	28° 52'57.03"N	82° 35'40.16"W
29	Banana Island West Springs	28° 52'55.63"N	82° 35'48.63"W
29	Banana Island West Springs	28° 52'55.53"N	82° 35'48.62"W
30	Hammett 15/Mullets Gullet Spring/Tarpon Hole #2	28° 52'54.82"N	82° 35'39.29"W
31	Hammett 2/Tarpon Hole/Big Hole/Crystal Spring	28° 52'54.68"N	82° 35'39.37"W
32	Hammett 16/King	28° 52'54.37”N	82° 35'41.64"W

ID number	Name	Latitude	longitude
	Spring/Grand Canyon Spring		
33	Plantation Point Hole	28° 52'51.89"N	82° 35'29.22"W
34	Dave's Quest Springs	28° 52'49.54"N	82° 35'42.92"W
34	Dave's Quest Springs	28° 52'49.24"N	82° 35'43.29"W
34	Dave's Quest Springs	28° 52'48.41"N	82° 35'42.71"W
35	Hammett 17/Golfview	28° 52'46.32"N	82° 35'32.19"W
35	Hammett 17/Golfview	28° 52'46.26"N	82° 35'31.90"W
35	Hammett 17/Golfview	28° 52'45.02"N	82° 35'30.70"W
36	Lightbourn's Ledge	28° 52'45.26"N	82° 35'57.09"W
37	Wynn Court Springs	28° 52'42.41"N	82° 35'50.60"W
37	Wynn Court Springs	28° 52'42.31"N	82° 35'47.33"W
37	Wynn Court Springs	28° 52'42.18"N	82° 35'49.62"W
37	Wynn Court Springs	28° 52'42.00"N	82° 35'50.68"W
37	Wynn Court Springs	28° 52'41.34"N	82° 35'48.20"W
38	Hammett 18/Black Spring	28° 52'39.08" N	82° 35'57.28"W
39	Hammett 19/Sid's Springs	28° 52'36.66"N	82° 35'50.99"W
40	Gary's Grotto	28° 52'35.51"N	82° 35'56.35"W
40	Gary's Grotto	28° 52'35.38"N	82° 35'56.18"W
41	Swamp Sink	28° 52'29.10"N	82° 36'02.06"W

Hammett 23/Miller's Creek Spring (1). This spring is located at the head of Miller's Creek at coordinates 28°54'05.10"N, 82°36'12.49"W and consists of a two vents within a large fracture in the bottom. Dimensions of these vents were approximately 1.2 feet x 1.0 feet, and 2.4 feet x 0.75 feet, respectively. Water depths at the edge of the fracture were approximately 10.0 feet, while the deeper center of the vents was approximately 28 feet. Discharge volumes were low.

Fountain Spring/City Hall Spring/Little Spring/Independence Spring (2). This spring is located adjacent to the City of Crystal River City Hall at 28°54'01.29"N, 82°35'43.60"W. The center of this spring is within a walled and lined pond that is roughly circular in shape, with an approximate diameter of 85 feet and an estimated depth of five to six feet deep. As access into the pond is restricted, a physical description of the spring vent mouth was not made. Spring flow was moderate. This walled pond discharges on its western side to an approximately 15-foot-wide, vertical-sided ditch, which flows south under U.S. HWY 19 and into Kings Bay.

Charlie's Fish House Spring (3). This spring is located immediately adjacent to the parking lot seawall of Charlie's Fish House restaurant at 28°53'57.32"N, 82°35'44.23"W, which is at the very northeastern corner of Kings Bay. This very small spring vent is estimated at approximately 0.5 feet in diameter and had a low flow. Water depths ranged from exposed at low tide, to approximately two feet deep at high tide. This spring was not identified on any of the previous studies.

Hammett 25/Birds Underwater Spring (4). This spring is located adjacent to Birds Underwater Tours dive shop at 28°53'56.05"N, 82°35'47.56"W under a covered dock slip and consists of two very small spring vents estimated at approximately 0.5 to 0.75 feet in diameter. Water depths are estimated to range from approximately 1.0 feet at low tide to 3 feet at high tide. Discharge volumes associated with this spring were minimal.

Hammett 27/Pool Spring (5). This spring is enclosed within a walled off swimming area associated with the Kings Bay Lodge resort, creating a spring fed swimming pool. This spring is located at 28°53'54.48"N, 82°35'43.02"W and consists of multiple small spring vents. One vent is located within the "pool" itself and has approximate dimensions of 3.0 feet x 0.5 feet. Three other vents are located outside of the main pool area but discharge into the pool through a small flow-way under the pool stairs. Measurements could not be made on these vents due to lack of access. Collectively pool spring discharges into Kings Bay through a small square orifice. Water depths within the pool were estimated at 3 feet deep, and the discharge was minimal.

Hammett 1/Catfish Spring (6). This spring is located near the Best Western Crystal River Resort and adjacent to a residential single family dock at 28°53'53.50"N, 82°35'55.54"W. It consists of one main spring vent opening with approximate dimensions of four feet by eight feet, and numerous other associated smaller cracks and vents ranging from 0.5 feet x 0.5 feet to 1.0 feet x 1.0 feet. This spring has numerous pieces of lumber and tree limbs within its opening, and the water depth was approximately 15 feet. Discharge was estimated to be moderate to high.

Hammett 26/NW 9th Avenue Springs (7). This spring complex is located at the head of the western most embayment of the northern portion of Kings Bay at 28°53'52.93"N, 82°36'04.96"W. It is approximately 8 feet off of the sea-walled edge and consists of three small vents with approximate dimensions of 1.0 feet x 0.8 feet, 0.3 feet x 0.4 feet, and 0.9 feet x 0.8 feet. Water depths were approximately 3.5 feet to 4.0 feet deep, with depths inside the spring vents ranging from 4.0 feet to 4.8 feet. Discharge volumes were estimated to be low to minimal. It appears unlikely that these small springs represent those measured by Hammett due to their small size and location to the east of the canal indicated in the Hammett report. The location of Hammett 26 near the mouth of the canal would seem to indicate that this was a cross-section location for flow measurement.

Hammett 4/House Spring (8). This spring is located at the head of the eastern most embayment of the northern portion of Kings Bay at 28°53'45.44"N, 82°35'22.84"W within a sea–walled enclosure. This enclosure is obviously intended to be used as a swimming area, complete with a pool slide and ladder, for a single family residence. This multiple vent spring area is approximately four feet deep at the center of the "pool"/swimming enclosure. Approximate dimensions of the larger vents within this spring complex include a 2.4 x 2.3 foot vent, a 0.2 x 0.5 foot vent, and a 1.0 x 0.5 foot vent. Numerous other "sand boils" were also observed within this area. Discharge volumes were estimated to be low to moderate.

Hammett 5/Jurassic Spring (9). This spring is located approximately 360 feet south of House Spring, within the eastern embayment off of the northern portion of Kings Bay at 28°53'42.08"N, 82°35'23.93"W. Like House Spring, Jurassic Spring has been partially sea-walled with a few boat docks installed as well. This spring consists of two larger vent mouths, one measuring approximately 16 feet long and with varying widths of between 3.5 and 4.2 feet, and the second vent mouth measuring approximately 4.9 feet long x 0.9 feet wide. Within the larger vent mouth, the flow was determined to exit from three primary points, the first measured at 0.9 x 1.8 feet, the second measured at 0.3 x 0.3 feet, and the third measured at 2.1 x 4.0 feet. Approximate depths to bottom within the spring area ranged between 13 and 15 feet. Discharge volumes within this spring complex were estimated to be moderate to high.

Hammett 3/Hunters Spring/American Legion Spring (10). This spring is located approximately 800 feet west of Jurassic Spring within the eastern embayment off of the northern portion of

Kings Bay at 28°53'40.41"N, 82°35'32.91"W. It is immediately offshore of Hunters Spring Park and consists of five individual spring vents clustered within an approximate 10-foot diameter circle and at approximately 15 feet deep. Approximate dimensions of the vent mouths include two approximately round vents of 2.0 and 1.5 feet diameters, respectively, an oblong vent of 4.0 feet x 1.1 feet, an oblong vent with a length of 5.0 feet and widths of 1.5 to 2.5 feet, and a kidney bean shaped vent approximately 4.0 feet long by 1.5 feet wide at one end of the "bean" and 2.0 feet wide at the other end of the "bean" (and connected by a narrower area). Discharge volumes within this spring complex were estimated to be moderate to high.

Hammett 21/Magnolia Circle Spring (11). This spring is located near the eastern tip of the Magnolia Shores subdivision/residential area at 28°53'38.49"N, 82°35'58.84"W. It consists of a single vent that is shaped somewhat like a kidney, and has approximate dimensions of 3.1 feet x 2.0 feet and an approximate depth of 5 feet. Most of the flow was determined to be coming from the left hand lobe of the vent, which has dimensions of 2.0 feet x 0.5 feet. The right hand lobe has approximate dimensions of 1.6 feet x 0.5 feet. Discharge volumes from this spring were estimated to be high.

Pete's Pier Spring (12). This spring complex is located in the northern half of Kings Bay at 28°53'37.85"N, 82°35'55.60"W. It is approximately 400 to 450 feet west of the Pete's Pier boat ramp, at an approximate 6 foot depth, and consists of two vents aligned in an approximately north/south direction. The northern of the two vents is approximately 0.75 feet x 1.1 feet, while the southern of the two vents is approximately 0.1 feet x 1.6 feet. This vent system is believed to be part of a larger fracture line in the bay bottom in this area, and more vents, though unobserved during the field event, are thought to be probable. Discharge volumes from this spring complex were estimated to be moderate.

Hammett 6/Moray Springs (13). This spring complex is located at the head of the moderately sized cove behind Pete's Pier Marina in the northern portion of Kings Bay. It is surrounded by homes, sea-walls and larger boat docks associated with the Agua Vista subdivision. Multiple spring vent clusters with coordinates of 28°53'37.03"N, 82°35'41.57"W; 28°53'37.01"N, 82°35'41.4"W; and 28°53'36.99"N, 82°35'41.09"W are present within this complex. Some of the larger vent dimensions within each of these clusters measured approximately 2.0 x 1.5 feet, 2.0 x 0.8 feet, 0.8 x 0.9 feet, 0.8 x 0.8 feet, and 0.5 x 0.9 feet. Numerous other smaller and ill-defined vents were also observed. Discharge volumes were estimated to be low to moderate.

Hammett 20/Shark Sink (14). This feature is located on the extreme western edge of Kings Bay, just south of the discharge point into the Crystal River at 28°53'31.69"N, 82°36'20.86"W. This feature is approximately 30 to 40 feet deep and consists of a limestone bottom covered in a thick layer of silt and fine sediment. No spring flow was observed at this feature. However, this result must be viewed with caution at this time as visibility was so poor that minor spring flow could be undetected.

Hammett 7/Paradise Isles (15). This spring is located approximately opposite 1218 SE Kings Bay Drive within a sea walled cove associated with a canal lot in the Paradise Isles subdivision at 28°53'27.18"N, 82°35'42.02"W. This spring complex consists of approximately 12 vents mouths/fractures, most of which are very small. Dimensions of the larger vents include an approximately 0.5-foot diameter circular vent, an oblong 1.0 x 0.5 foot vent, and a large fracture vent approximately 5.0 feet x 0.5 feet in size. Water depths within this area are approximately 10 to 12 feet deep. Discharge volumes were estimated to be low.

Hammett 8/Manatee Sanctuary/Gator Hole/Magnolia Spring/Crystal Spring (16). This spring, also associated with the Paradise Isles subdivision canal system, is approximately 720 east of the Hammett 7 spring complex at 28°53'26.50"N, 82°35'33.27"W. This complex of approximately 13 vents is aligned along an approximately 60-foot-long fracture that is sinusoidal in shape within the greater "bowl" shape of the spring formation. Depths of this fracture range from approximately 15 feet deep at the shallow end of the fracture to approximately 25 feet deep at the deepest areas of the fracture. Individual vent sizes along the fracture ranged between approximately 1.2 feet x 1.0 feet up to approximately 5.0 feet x 2.0 feet. Discharge volumes were estimated to be high.

Buzzard Island Spring (17). This spring is located east of the northern tip of Buzzard Island at 28°53'24.97"N, 82°35'53.64"W. This spring appears to have been evaluated by Rosenau. It consists of a single vent that is oval in shape with dimensions of 1.7 feet x 0.8 feet and an approximate depth from the surface of 8 feet. Discharge volumes were estimated to be moderate.

Hammett 10/Three Sisters # 1/Three Sisters Springs/Middle Springs # 1 (18). This spring is part of a larger complex that consists of three spring "bowls" aligned upon an approximate northwest-southeast axis and with an approximate total length of 250 feet. Each bowl of this spring complex contained spring vents, and for purposes of this survey only, the center coordinates of each bowl were recorded. The northwestern bowl of this trio is centered at 28°53'19.46"N, 82°35'21.37"W, and contains approximately twelve circular vents with dimensions ranging between 1.0 feet and 0.5 feet. Water depths were estimated at 8 to 10 feet deep and discharge volumes were low to moderate.

Hammett 28/Three Sisters # 2/Three Sisters Springs/Middle Springs # 2 (19). The middle bowl of the trio is centered at 28°53'18.70"N, 82°35'20.87"W and contains what is effectively (due to debris, including tree limbs and vegetation within the spring) a very large kidney shaped vent approximately 20 feet long by 5 feet wide. Water depths within this bowl were approximately 20 feet deep and discharge volumes were high.

Hammett 28/Three Sisters # 3/Three Sisters Springs/Middle Springs # 3 (20). The southeastern bowl of the trio is centered at 28°53'18.14"N, 82°35'20.16"W and contains approximately six vents with dimensions ranging between 2.1 feet x 2.1 feet to 0.4 feet x 0.4 feet. Water depths were estimated at approximately 15 to 20 feet deep and discharge volumes were high.

Hammett 9/Kings Bay #1/Idiots Delight #1 (21). This spring complex is located within the Paradise Isles and Palm Island subdivision canal system approximately 1400 feet southeast of the Hammett 8 spring complex. These vents are located at 28°53'17.22"N, 82°35'23.03"W and consist of two vents, one with approximate dimensions of 3.0 feet x 2.8 feet, the other with dimensions of 0.5 x 0.3 feet, both of which are located immediately adjacent to the shoreline and west of Three Sisters Springs run. Water depths in this area were approximately 4 feet deep and discharge volumes were moderate.

Hammett 11/ Idiots Delight #2 (22). The vents in this complex are southeast of Hammett 9 and are located at 28°53'16.55"N, 82°35'22.04"W. The vent complex consists of six vents with dimensions ranging from 3.5 feet x 1.5 feet to 0.4 feet x 0.3 feet. These vents are approximately 6.0 feet deep, and discharge volumes were moderate.

Hammett 11A/ Idiots Delight #3/Three Sisters Run (23). Another spring, herein identified as Hammett 11A, is located south of Hammett 9 and Hammett 11 within the center of the dredged canal at 28°53'16.24"N, 82°35'22.55"W. This spring consists of a single vent with approximate dimensions of 2.0 feet x 1.9 feet. The water depth was approximately 9.5 feet deep and discharge volume was moderate.

Parker Island North Spring Complex (24). This spring complex consists of approximately 5 to 8 vents in water depths ranging between 5 and 12 feet of water scattered over a moderately sized area. This spring complex appears to have been evaluated by Rosenau. Coordinates of these vents include the following locations: 28°53'13.30"N, 82°35'38.33"W; 28°53'13.23"N, 82°35'38.51"W; 28°53'13.21"N, 82°35'38.76"W; 28°53'13.10"N, 82°35'38.3"W; and 28°53'12.33"N, 82°35'41.58"W. All vents were irregular in shape, this due to fractured limestone along the bottom in this area, and vent sizes ranged from 1.0 feet x 0.25 feet to 3.0 feet x 4.0 feet. Discharge volumes were low to moderate.

Hammett 12/Parker Island Springs/Little Hidden Spring (25). This three vent spring complex is located within the interior of Parker Island, and the spring bowl edges are exposed at low tide. Coordinates of these three vents include the following locations: 28°53'08.84"N, 82°35'38.69"W; 28°53'08.74"N, 82°35'38.47"W; and 28°53'08.48"N, 82°35'38.26"W. Vent sizes ranged between approximately 4.0 feet x 1.5 feet to approximately 0.4 feet in diameter. Discharge volumes were low to moderate.

Banana Island North Spring Complex (26). This complex of somewhat widely separated springs is located on the north side of Banana Island and consists of at least four separate spring vent areas, some with multiple vents. Some of these springs appear to have been evaluated by Rosenau, and one may correspond with Hammett 14. Coordinates of these vents include the following locations: 28°53'05.92"N, 82°35'46.10"W; 28°53'05.46"N, 82°35'46.09"W; 28°53'04.48"N, 82°35'47.12"W; and 28°53'04.40"N, 82°35'45.35"W. The vent dimensions ranged from a 15 foot x 4 foot crack/fracture line in the bottom, to a 2.5 foot x 0.25 foot crack/fracture line. Water depths ranged from approximately 2.0 feet at the shallowest vent to approximately 12 feet deep at the deepest vent. Discharge volumes were estimated to range from low to moderate, depending on the vent.

Hammett 13/FWS Spring Complex (27). This spring system consists of two main spring vents located at coordinates 28°53'03.29"N, 82°35'36.87"W and 28°53'01.98"N, 82°35'37.11"W. These vents consisted of fractures in the limestone along the bottom, and ranged in size from 6.0 x 0.5 feet to 2.3 feet x 1.5 feet. Water depths were approximately 10 feet and discharge volumes were estimated to be moderate to high.

Banana Island East Springs (28). This multiple vent spring complex consisted of six main vent areas observed on the east end of Banana Island. Coordinates for these areas include: 28°52'58.18"N, 82°35'40.51"W; 28°52'58.09"N, 82°35'39.95"W; 28°52'57.85"N, 82°35'40.45"W, 28°52'57.65"N, 82°35'40.27"W; 28°52'57.38"N, 82°35'39.76"W; and 28°52'57.03"N, 82°35'40.16"W. These spring vents were all located on or near the waters edge at the time of the field event and consisted of very small vents in the mud bottom. Water depths ranged from exposed to approximately 1 foot, and discharge volumes were estimated to be low.

Banana Island West Springs (29). This multiple vent spring complex consisted of three main boils observed on the west end of Banana Island primarily located at coordinates 28°52'55.63"N,

82°35'48.63"W and 28°52'55.53"N, 82°35'48.62"W. One of these springs may have been evaluated by Rosenau. One boil consisted of an approximately 12-foot-long fracture with approximately 3 vents along its length. These vents ranged in length between 1.0 feet and 0.5 feet and were all approximately 0.25 feet wide. This fracture line was approximately 4 feet deep, and discharge volumes were low. The second, and volume-wise greater spring, was found to be encircled by cement blocks and exiting into Kings Bay via a 0.75 foot x 0.5 foot hole. This spring vent was approximately 2.0 feet deep, and discharge volumes were moderate. A third boil was observed at the water's edge and consisted of numerous small vents with approximately 0.15 to 0.25 foot diameters. The discharge volume from these vents was low.

Hammett 15/Mullets Gullet Spring/Tarpon Hole #2 (30). This spring system is the eastern-most vent of a large three vent systems in this area and is located at coordinates 28°52'54.82"N, 82°35'39.29"W. It consists of multiple large undercut type fractures in the bottom through which the spring is discharging. These cracks were measured at 15 feet x 4 feet wide, 14 feet long x 2 feet wide, and 9 feet x 2 feet wide and were roughly orientated in a circular formation. Water depths at the edge of the circular fracture formation were approximately 4 to 5 feet deep and approximately 15 feet deep in the center. Discharge volume was high.

Hammett 2/Tarpon Hole/Big Hole/Crystal Spring (31). This spring vent system is the middle vent of the three large vent systems in this area and is located at coordinates 28°52'54.68"N, 82°35'39.37"W. It consists of multiple fractures and holes in the bottom through which flow was detected. The fractures can generally be described to be trending in a roughly circular formation and appear to represent a large undercut shelf/cavern which collapsed sometime in the past. Approximate dimensions of the cracks/fractures in the limestone ranged from 7.0 feet by varying widths up to 2.5 feet, 10 feet x 0.9 feet, 7 feet x 0.4 to 2.0 feet, and 5.0 feet x 2.0 feet. In addition, the small holes in the bottom can be described as irregular in shape, and all with similar dimensions of approximately 1.5 x 1.0 feet. Water depths at the edge of the spring formation were approximately 4 to 5 feet, while depths at the deepest center were approximately 10 to 15 feet. Discharge volumes at this spring system were high.

Hammett 16/King Spring/Grand Canyon Spring (32). This spring vent system is located south of Banana Island at coordinates 28°52'54.37"N, 82°35'41.64"W and is the western-most spring boil of the three large vent systems in this area. Three spring vents are found in this spring with dimensions ranging from 20 feet long x 8 feet wide to two vents with similar dimensions of approximately 3.0 feet x 1.5 feet. Water depths at the vent mouths were approximately 28 feet, and discharge volumes were moderate.

Plantation Point Hole (33). This historic spring vent is located just off of a seawall to the northeast of the Plantation Inn property at coordinates 28°52'51.89"N, 82°35'29.22"W. A knowledgeable individual informed District staff that it used to flow (David DeWitt, personal communication). The edges of the former vent are approximately 5 feet deep (from the surface) and slope to approximately 10 feet at the bottom. No flow was observed at this former spring.

Dave's Quest Springs (34). This three vent spring complex is located approximately 200 feet south-southwest of King Spring at coordinates 28°52'49.54"N, 82°35'42.92"W, 28°52'49.24"N, 82°35'43.29"W, and 28°52'48.41"N, 82°35'42.71"W. At least one of these springs appears to have been evaluated by Rosenau. The spring vents consist of both fractures and solution holes in the shallow limestone shelf in this area. Dimensions of these fractures ranged from 6 feet long x 0.5

feet wide to 4 feet long x 2 feet wide. Depths at the edges of the fractures ranged from 6 feet to 8 feet, and discharge volumes were moderate.

Hammett 17/Golfview (35). This multiple vent spring complex is located north of the Golfview subdivision. It consists of two closely spaced vents at coordinates 28°52'46.32"N, 82°35'32.19"W, and 28°52'46.26"N, 82°35'31.9"W, with dimensions of 3.0 feet x 1.5 feet and 1.5 feet x 1.5 feet, respectively, located within the middle of the channel area at an approximate 5 foot depth. Discharge volumes at these vents were low. In addition, a third multiple spring vent complex, located approximately 150 to 200 feet away to the southeast, was noted near the edge of the channel at 28°52'45.02"N, 82°35'30.7"W. This third vent complex consisted of approximately 10 spring vents within the deep algae covered bottom, with dimensions ranging from 2.0 feet x 1.8 feet to 0.3 feet x 0.3 feet. Discharge volumes at this third vent complex were low to moderate. A follow up visit was made to the third vent complex approximately 3 months later, and it was noted that the dimensions and number of spring vents had changed, and there was now only one large vent with approximate dimensions of 5 feet x 4 feet and strong flow.

Lightbourn's Ledge (36). This limestone feature is located at 28°52'45.26"N, 82°35'57.09"W and consists of an undercut ledge approximately 8 to 10 feet deep. No spring flow was observed at this feature, though it appears that flow was likely at some point in the past based upon the ledges morphologic features. This spring appears to have been evaluated by Rosenau.

Wynn Court Springs (37). These vents consist of several small to moderately large fractures in the limestone shelf. At least one of these springs appears to have been evaluated by Rosenau. Coordinates for these various vent locations include: 28°52'42.41"N, 82°35'50.60"W; 28°52'42.31"N, 82°35'47.33"W; 28°52'42.18"N, 82°35'49.62"W; 28°52'42.00"N, 82°35'50.68"W; and 28°52'41.34"N, 82°35'48.20"W. Dimensions of these fractures ranged between 6 feet long x 0.2 feet wide, to 3 feet long x 0.25 feet wide. Water depths at the edges of these fractures were all about 1 foot deep, and discharge volumes were low.

Hammett 18/Black Spring (38). This spring complex consists of multiple fractures within the limestone bottom. It is located at coordinates 28°52'39.08"N, 82°35'57.28"W. Dimensions of these fractures ranged between 15 feet long x 0.5 feet wide and 6 feet long x 0.5 feet wide. Water depths were 3 to 5 feet deep and discharge volumes were moderate.

Hammett 19/Sid's Springs (39). This multiple vent spring complex consists of two larger adjacent bowl areas, each populated by several spring vents. It is located at coordinates 28°52'36.66"N, 82°35'50.99"W. Approximately 14 individual vents are located within this complex, with dimensions ranging between 6.0 feet x 3.0 feet to 1.5 feet x 1.5 feet. Water depths at the edge of the spring bowls were approximately 1.0 feet, and water depths of approximately 12 to 15 feet deep were observed within the deeper centers. Discharge volumes were moderate to high.

Gary's Grotto (40). This spring complex consists of fractures within the shallow limestone bottom. It is located approximately 400 feet west southwest of Hammett 19 at coordinates 28°52'35.51"N, 82°35'56.35"W and 28°52'35.38"N, 82°35'56.18"W. Dimensions of these fractures ranged between 15 to 6 feet long x 2 to 1 foot wide. Water depths ranged from 0.5 feet to 10 feet below the surface and discharge volumes were moderate.

Swamp Sink (41). The southern-most site visited is a circular feature located off a canal. This area is surrounded by swamp and appears to have been at least partially bermed. The area is

uniformly five feet deep. No vents were located, but stratified water appears to indicate diffuse flow. An adjacent resident indicated that the area no longer flows. There is a karst feature at the east end of Hook Island within the southwest portion of Kings Bay. This feature is an apparent historical location of a spring. Discharge was not observed at this location during several investigations by District staff during 2007 and 2008 (David DeWitt, personal communication). This feature is located at 28°52'52.77"N, 82°36'15.00"W but has not been depicted on Figure A-1.

Three springs designated by Hammett as 22, 24 and 26 could not be located. They are theorized to have been discharge measurement cross-section locations. Apparent spring discharge was observed at 24 (and subsequently further down the canal at 26), but the source of the discharge was quite a distance upstream.

Appendix B. Kings Bay/Crystal River Springs Flow and Water Quality Assessment (VHB 2010)

B.1 Introduction

Vanasse Hangen Brustlin, Inc. (VHB 2010) completed flow and in situ water quality measurements of spring vents within the Kings Bay portion of Crystal River in Citrus County, Florida. The purpose of this project is to quantify spring discharge from submerged spring vents for use in a hydrodynamic model of Kings Bay. The model is being developed by the Southwest Florida Water Management District (District) in its efforts to establish a Minimum Flow for Kings Bay. The discharge from spring vents within Kings Bay and in its watershed are the primary sources of baseflow to the system. The flow measurements are considered the best data for model construction and, as such, the emphasis was placed on measuring those springs which contribute the most flow. The flow measurements were obtained at spring vents previously identified by VHB in the May 2009 report to the District titled An Inventory of Spring Vents in Kings Bay, Crystal River, Florida. This report noted that many of the springs consisted of more than one vent in very close proximity which contributed to the overall discharge of that "spring". A total of 70 springs were documented. In some areas, particularly in the case of previously unnamed springs, groups of springs in the same geographic area were lumped into "spring complexes" with a single identification number. A total of 41 named and numbered spring complexes were depicted and discussed in the report. A priority list of springs was developed based upon qualitative flow estimates made during the inventory of spring vents.

B.2 Methods

Starting with the 41 named and numbered spring complexes identified in the inventory report, a few sites were deleted since no flow was observed during the inventory study. Two measurement sites were also added to capture known inflow sites for springs discharge not located within Kings Bay proper, but within the watershed contributing to the baseflow. The Hammett 24 site (H24), a ditch which discharges spring flow into the northern portion of Kings Bay, was identified in a U.S. Geological Survey Open File Report (Hammett et al. 1996). The second site is slightly downstream of Fountain Spring (2) and includes the discharge from this spring as well as flow from upstream springs (this flow measurement location continues to be referred to as Fountain Spring although the majority of discharge originates upstream). Figure B-1 depicts the location of the spring vents and discharge locations measured during this study.

Flow measurements were made using a variety of methods and meters to most accurately capture the discharge for a specific vent or vent complex. The measurement of submerged spring vent discharge was complicated by the nature, complexity and depth of the vents/vent complexes as well as the tidal nature of Kings Bay. The specific method used to determine discharge for each vent/vent complex was selected based upon its ability to provide the most accurate data for the calculation of discharge. In some cases, more than one measurement technique was used to strengthen the confidence of the measurement.

All velocity measurements were made using acoustic doppler profiler (ADP) type meters. These meters can be divided into single cell and multi-cell categories. The single cell meter (SonTek FlowTracker) was generally used in depths of four feet or less, and the two multi-cell ADPs (SonTek RiverCat and SonTek Shallow Water) were generally used in depths over four feet. The acoustic meters can be positioned such that they are capable of recording velocities in the horizontal or vertical.

A few sites have open channel flow conditions. In these instances, the standard USGS mid-section method for the measurement of discharge in an open channel was employed using the appropriate acoustic meter. This type of measurement is referred to as an instantaneous cross-section measurement. Those springs discharging through a shallow ditch (Hammett 24 and Fountain Spring (2)) or a shallow natural spring run (Parker Island Springs (25)) were measured with the standard USGS method and a single cell ADP. The multi-cell ADP was used to measure discharge in deeper areas, including the natural spring run from Black Spring (38) and the narrow cross-section at House Spring (8). The Three Sisters spring run (3S) was measured using both the single cell and multi-cell acoustic meters.

In two locations, discharge measurements of cross-sections were made to provide additional information about upstream springs. A discharge measurement was made using the multicell ADP at a narrow location in Miller Creek, below the Miller Creek Spring (1). A similar measurement was made using the multi-cell ADP at the northerly channel from the embayment containing Sid's Springs (39) and Gary's Grotto (40). The single cell ADP was used to make the discharge measurement in the western canal from the embayment containing Sid's Springs and Gary's Grotto.

In two locations, there are several springs that discharge through a single canal. Group 1 (G1) consists of House Spring (8), Jurassic Spring (9), and Hunters Spring (10), and Group 2 consists of Paradise Isles (15), Manatee Sanctuary (16), Three Sisters Springs (18, 19, and 20), Kings Bay #1 (21), Idiots Delight #2 (22), and Idiots Delight #3 (23).

These areas are subject to tidal flow influences and were monitored over several successive diurnal tide cycles using a multi-cell ADP recording and logging point velocity data over time at 15-minute intervals. The Group 1 multi-cell ADP was placed approximately 25' from the southern seawall in the deepest point of a narrow cross-section previously monitored by USGS. The Group 2 multi-cell ADP was placed under the roadway bridge in a deep central location. Both SW devices were bolted onto a concrete slab to prevent movement and were oriented in the direction of the strongest flow.

Instantaneous discharge measurements were conducted periodically at these sites under different tidal conditions using the multi-cell ADP. The measurements were used to develop velocity ratings using the recorded point velocity data at the time of the discharge measurement versus the mean measured velocity for the discharge measurements. The velocity rating was used in conjunction with surveyed cross-sectional areas of the measured section to compute discharge. The discharge measurements took place under varied tidal conditions (i.e., spring and neap tides), and the cross-sections dimensions were surveyed to provide an accurate area determination. These types of measurements are referred to as diurnal cross-section measurements.

Finally, velocity measurements were made at vent openings and are referred to as vent measurements. Two pieces of information, area and velocity, are required to accurately determine discharge. After determining the vent shape and taking the appropriate measurements required to determine its area, the area was computed using common geometric formulas. The single cell ADP was placed within the vents to measure flow for the shallow vents which were easily accessible. This method was used for Pool Spring (5) where it was placed within the outflow window, NW 9th Avenue Springs (7), Parker Island Springs (25), Banana Island East Springs (28), Banana Island West Springs (29), Golfview (35) – one small spring vent, and for the Wynn Court Springs (37).

The remaining velocity measurements at vent openings were performed using a multicell ADP velocity meter mounted to a board and pipe assembly to allow the device to measure horizontally. In locations with multiple vents within a few feet of each other, the ADP measurement was made across the broader "bowl" of these vents. This measurement entailed a SCUBA diver measuring the vent opening and then placing the ADP device appropriately near the vent. A blanking distance of approximately 0.5 feet was used to account for the devices measurement restrictions. The multi-cell ADP recorded velocity in up to five evenly spaced "bins" based upon distance from the unit. A series of six measurements were made 10 seconds apart at each location. Velocity measurements were taken continuously for 60 seconds at each vent, and the average mean velocity was used for computation of discharge.

Measurements of velocity were taken in multiple locations for larger vents with diffuse flow to develop an average velocity for that vent. The emphasis of this effort was based upon the finalized priority list which stressed the higher flow vents and more than one measurement of these vent were made as time allowed. In some cases, vent measurements were done to supplement the other measurement methods discussed above. Table B-1 provides a summary of the type(s) of flow measurements made for each named and numbered spring. Two additional small spring vents were located and measured (beyond those mapped during the inventory) in close proximity to existing sites. One of the springs was located approximately 50 feet southwest of the original Buzzard Island Spring (17) and was included as a part of this spring. Another spring (called Paul's Paradise) was located in close proximity to the FWS Spring Complex (27), and its information was summarized as part of this complex.

Specific conductance and temperature were measured and recorded, along with time, concurrent with each flow measurement. A multi-parameter water quality sonde was calibrated daily and used to obtain the specific conductance and temperature readings.

The sampling schedule was based upon tide stage as estimated from tide charts of Kings Bay. The actual tide stage was determined using the time of the measurement and measured stage at the USGS gauge at the mouth of Kings Bay (Site 02310742 – Crystal River at Mouth of Kings Bay FL). The times of all measurements, water quality data collection, and tide stage were converted to Eastern Standard Time (EST) for consistency.

B.3 Results

The field measurements were conducted over the period of July 27th – 31st, August 17th – 20th, September 21st – 25th, and October 5th – 8th, 2009, for a total of eighteen field days. The July and August monitoring efforts focused on the diurnal cross-section monitoring of Groups 1 and 2. Measurements were also performed at the individual springs which comprise Groups 1 and 2

during these monitoring weeks. The September and October monitoring period involved measuring the remaining springs not included in Groups 1 and 2, including multiple measurements at some of the larger springs during different tide stages. When possible, measurements were conducted near low tide, especially at spring vents identified as having low flow.

The project scope called for diurnal cross-section monitoring over two successive diurnal tides during varied tide conditions (i.e., spring and neap tides). The July monitoring occurred during neap tides with the August monitoring capturing the spring tides. The ADP velocity meters continued to be deployed between the two field measurement periods which serve to provide a much larger set of data.

The ADP was deployed at both Groups 1 and 2 on July 27, 2009 and retrieved on August 20th. There is a data gap from August 6 – 7 at Group 1, and the data becomes very erratic from August 5 to 18, which appears to be the result of algae blanketing the ADP velocity meter.

A total of 42 instantaneous discharge measurements were made using the ADP at the Group 1 site. These measurements and the surveyed cross-sectional area allowed the development of stage vs. area and point velocity vs. mean velocity ratings for use in computing discharge. The regression analysis of the velocity rating developed for the Group 1 site had an R^2 value of 0.85. The growth of bottom algae probably affected the quality of the discharge record at this site. The ratings were used to compute the 15-minute values of discharge. The computed discharges are the result of data and measurements collected over only a 24-day period and are considered fairly accurate for that period. A reference mark was set at the time the area cross-sections were run for Group 1 and could be used to tie in elevation, if desired.

A total of 36 instantaneous discharge measurements were made using the ADP at the Group 2 site. Similar to Group 2, these measurements and the surveyed cross-sectional area allowed the development of stage vs. area and point velocity vs. mean velocity ratings for use in computing discharge. The regression analysis of the velocity rating developed for the Group 2 site had an R^2 value of 0.94. The ratings were used to compute the 15-minute values of discharge. The computed discharges are the result of data and measurements collected over only a 24-day period and are considered fairly accurate for that period. A reference mark was set also at the time the area cross-sections were run and could be used to tie in elevation, if desired.

Instantaneous cross-section and vent measurements were obtained throughout the four weeks of field monitoring. During the July and August neap and spring tide monitoring for Groups 1 and 2, the individual springs comprising these groups were measured as a cross check of the downstream results. Measurements at the remaining springs were conducted during the September and October monitoring periods.

B.3.1 Field Measurements

In situ water quality monitoring took place in conjunction with the discharge measurements. Discharge was usually measured for the vents in each grouping prior to the measurement of temperature and conductivity. A SCUBA diver placed the water quality sonde in the opening of each vent or at the measured cross-section. In a few locations, water quality data were recorded at different locations in the water column to contrast it with the observed water quality in the vents. The results of the water quality monitoring are provided in Table B-1.

Table B-1. Discharge and water quality from documented Kings Bay Spring Vents (VHB 2010).

# - Spring Name	Flows (cfs)	Temp. (°C)	Sp.Cond. (umho/cm)
1 - Hammett 23/Miller's Creek Spring	2.54	22.93	3340
2 - Fountain Spring/City Hall Spring	12.52	24.52	1388
3 - Charlie's Fish House Spring	0.02	23.26	208
4 - Hammett 25/Birds Underwater Spring	0.09	23.26	224
5 - Hammett 27/Pool Spring	2.25	23.37	203
6 - Hammett 1/Catfish Spring	11.45	23.33	534
7 - Hammett 26/NW 9th Avenue Springs	0.26	23.22	869
8 - Hammett 4/House Spring	5.23	23.32	218
9 - Hammett 5/Jurassic Spring	23.96	23.31	249
10 - Hammett 3/Hunters Spring/American Legion Spring	31.02	23.32	605
11 - Hammett 21/Magnolia Circle Spring	1.94	23.34	1105
12 - Pete's Pier Spring	0.37	23.42	1082
13 - Hammett 6/Moray Spring	0.33	23.49	560
14 - Hammett 20/Shark Sink	--	--	--
15 - Hammett 7/Paradise Isles	0.88	23.48	1413
16 - Hammett 8/Manatee Sanctuary/Gator Hole/Magnolia Spring/Crystal Spring	50.03	23.49	679
17 - Buzzard Island Spring	0.2	24.08	2594
18 - Hammett 10/Three Sisters #1/Three Sisters Springs/Middle Springs # 1	7.39	23.42	723
19 - Hammett 28/Three Sisters #2/Three Sisters Springs/Middle Springs # 2	25.83	23.43	437
20 - Hammett 28/Three Sisters #3/Three Sisters Springs/Middle Springs # 3	45.25	23.38	703
21 - Hammett 9/ Kings Bay #1/ Idiots Delight #1	4.84	23.4	734
22 - Hammett 11 /Idiots Delight #2	3.46	23.4	524
23 - Hammett 11A/Idiots Delight #3/ Three Sisters Run	0.75	23.4	488
24 - Parker Island North Spring Complex	1.22	24.01	3336
25 - Hammett 12/Parker Island Springs/Little Hidden Spring	1.74	23.3	1647
26 - Banana Island North Spring Complex	3.83	23.2	5443
27 - Hammett 13/FWS Spring Complex	2.37	23.38	1085
28 - Banana Island East Springs	0.34	23.32	1113
29 - Banana Island West Springs	0.14	23.24	5116
30 -Hammett 15/Mullets Gullet Spring/Tarpon Hole #2	28.91	23.29	3842
31 - Hammett 2/Tarpon Hole/Big Hole/Crystal Spring	42.83	23.28	3939
32 - Hammett 16/King Spring/Grand Canyon Spring	53.91	23.3	7284
33 - Plantation Point Hole	--	--	--
34 - Dave's Quest Springs	1.03	23.27	4780
35 - Hammett 17/Golfview	19.71	23.3	2124
36 - Lightbourn's Ledge	--	--	--
37 - Hammett 19/Wynn Court Springs	0.05	23.43	8042
38 - Hammett 18/Black Spring	5.89	23.58	10631
39 - Hammett 19/Sid's Springs	11.25	23.21	10484
40 - Gary's Grotto	14.85	23.88	10603
41 - Swamp Sink	--	--	--

Table B-1 summarizes the site location, combined discharge, temperature (°C), and specific conductance (µS/cm). The Event Average Temperature or Conductivity represents the average of the measured parameter for all vents measured at that spring on that date. The Overall

Average Temperature and Conductivity has been calculated for those springs with more than one set of water quality measurements. The Total Discharge represents the sum of the measured discharge for all vents measured at that spring on that date (the Vent Average is summed with other individual vent measurements). Average Discharge has been calculated for those springs with more than one set of measurements.

The average total discharge for each numbered spring, Hammett 24, and the Three Sisters Spring run are graphically depicted on Figure B-1. The discharges have been classified in six categories and color coded for ease of review. When reviewing the measured discharge, it is important to remember that the instantaneous cross-section measurements at H24, 2, 38, 39, 40, and to a lesser extent 25, include surface water discharge from upstream sources and tidal input. It appears that the Three Sisters Spring Run maintains positive flow, so all measured discharge would be from the springs.

Site 24 is comprised of a number of scattered vents with conductivity readings ranging from 2,359 to 5,000 µS/cm. The highest conductivity was observed at a low volume vent ("c"). A measurement of the conductivity in the vicinity of this vent was also observed to be 5,000 µS/cm. This may indicate that surface water flows into these low flow vents at high tide stages and discharges at low tide stages, as mentioned by District staff (personal communication, David DeWitt). A measurement of the ambient conductivity was also made at Black Spring (38) where the overall average conductivity within the vents was the highest of all sites at 10,631 µS/cm. However, for Black Spring, the ambient conductivity was substantially lower at 5,503 when compared to the average vent conductivity that day of 12,080. For Black Spring, it does not appear that surface water enters the vents at high tide, and these vents are a source of brackish water (6.9 salinity) to Kings Bay.

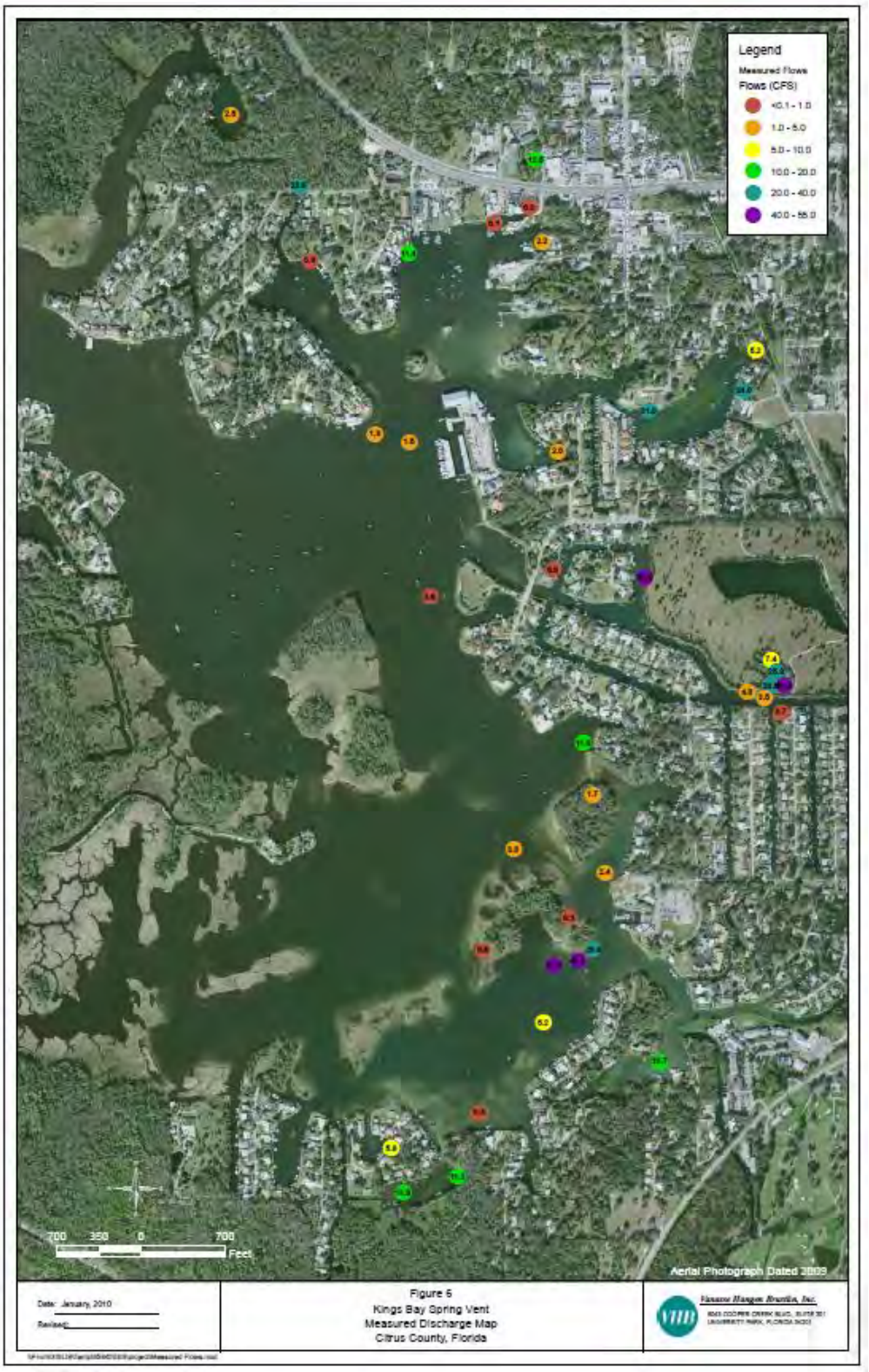


Figure B-1. Kings Bay Spring Vent measured discharge (VHB 2010).

Conducting multiple discharge measurements using different methodologies, as well as the diurnal cross-sections, revealed occasional inconsistencies in the measured discharge. This was most apparent at Three Sisters Springs where the sum of the individual vents measurements exceeded the discharge measured within the spring run. As discussed earlier, multiple vents located within the same "bowl" were measured as a unit – usually with multiple measurements at different angles. These bowls were usually encompassed a sizable sectional area (the Middle Spring (19) measured 10.5 x 8.5, and a bowl at the southern spring (20) measured 12.0 x 9.0). The field measurements would have scanned over the larger springs in the bowl and likely captured the higher velocities, which, when multiplied by the large area, would have indicated large flow volumes. As a result, it is likely that the estimated discharge from Springs 19 and 20 overestimate the actual discharge. The discharge recorded in the Three Sisters Springs Run is believed to better represent the discharge from these three springs because of the accuracy of the cross-section measurements. A similar "bowl" area involves Spring 24 (measurement SV240924a).

In some cases, the calculated discharge seems high compared to the impression of the field sampling personnel. Again, these instances relate to those vents with large cross-sectional areas – usually long vents. Multiple measurements in different locations were taken at some of these vents to determine the averages, and these discharge calculations are not questioned. However, the discharge calculated at some large vents associated with Manatee Sanctuary Spring (16), and to a lesser extent at Gary's Grotto (40), may overestimate the discharge.

Conversely, not all of the vents at each spring could be measured. So although the largest vents and those deemed to have the strongest flow were measured, not all discharge was measured and the total flow from those springs would be slightly greater. This is particularly true at Springs 13 (Moray), 15 (Paradise Isles), 16 (Manatee Sanctuary), 22 (Idiots Delight #2) and, to a lesser extent, 23 (Idiots Delight #3).

The precision of the measurement methods likely differed. Wading cross-section measurements with the single cell ADP and vent measurements where the single cell ADP was inserted into the throat of the vent represent the most accurate velocity measurement because of the exactness of placement. Multi-cell ADP vent measurements of small springs were also relatively precise along with the multi-cell ADP instantaneous cross-section measurements in narrower areas. The accuracy of the discharge measurements was likely lower when the multi-cell ADP was used on large vents and the long deep cross-sections.

B.4 Hydrodynamics of Kings Bay

Kings Bay is an estuary on the gulf coast of peninsular Florida with a surface area of less than one square mile. It is a unique estuarine system with no significant inflowing rivers or streams. As much as 99 percent of the freshwater entering the bay originates from multiple spring vents at the bottom of the estuary.

The circulation and flushing characteristics of Kings Bay were evaluated by applying SIMSYS2D, a two-dimensional numerical model. Field data were used to calibrate and verify the model. Lagrangian particle simulations were used to determine the circulation characteristics for three hydrologic conditions: low inflow, typical inflow, and low inflow with reduced friction from aquatic vegetation. Spring discharge transported the particles from Kings Bay through Crystal River and out of the model domain. Tidal effects added an oscillatory

component to the particle paths. The mean particle residence time was 59 hours for low inflow conditions, 50 hours for typical inflow conditions, and 56 hours for low inflow with reduced friction; therefore, particle residence time is affected more by spring discharge than by bottom friction.

Circulation patterns were virtually identical for the three simulated hydrologic conditions. Simulated particles introduced in the southern part of Kings Bay traveled along the eastern side of Buzzard Island before entering Crystal River and exiting the model domain.

The flushing characteristics of Kings Bay for the three hydrodynamic conditions were determined by simulating the injection of conservative dye constituents. The average concentration of dye initially injected in Kings Bay decreased asymptotically because of spring discharge, and the tide caused some oscillation in the average dye concentration. Ninety-five percent of the injected dye exited Kings Bay and Crystal River within 94 hours for low inflow, 71 hours for typical inflow, and 94 hours for low inflow with reduced bottom friction. Simulation results indicate that all of the open waters of Kings Bay are flushed by the spring discharge. Reduced bottom friction has little effect on flushing (Hammett et al. 1996).

Appendix C. Regulatory Programs for Protection of the Kings Bay/Crystal River Ecosystem

C.1 Introduction

Like most of Florida's artesian springs, the Kings Bay/Crystal River springs are protected through existing federal, state, and local ordinances and designations that are intended to limit or totally prevent ecological impairment. These laws and policies are aimed, directly or indirectly, at protecting the springshed and the springs that nourish the Crystal River and the nearshore estuarine waters of the Gulf of Mexico. With each passing year, additional protections are being considered and, in some cases, implemented. However, as documented by the environmental information collected for this report, piecemeal enforcement of existing regulations has not been successful at halting the continuing decline in the environmental health of the Kings Bay/Crystal River springs or the Floridan Aquifer they depend on for nourishment. Examination of existing policies and elimination of their inadequacies and/or lax enforcement of existing laws is necessary to reverse the ongoing decline of Florida's springs. A brief summary of these regulations is provided below.

C.2 Federal and State Water Quality Regulations

C.2.1 Designated Uses and Water Quality Standards

In Kings Bay/Crystal River, the Florida Department of Environmental Protection (FDEP) is responsible for water quality regulation. In Florida, Kings Bay, Crystal River, and the feeder springs are Class III waterbodies, which are designated for recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife. Tidal creeks and coastal waters in the adjacent Gulf of Mexico are designated as Class II waterbodies for shellfish propagation or harvesting (FDEP 2003). The Crystal River is also designated as an Outstanding Florida Water by the FDEP (Florida Administrative Code Rule 62-302.700), which is a waterbody designated worthy of special protection because of its natural attributes. In general, FDEP cannot legally issue permits for direct discharges that would lower existing water quality or indirect discharges that would significantly degrade a nearby waterway designated as an OFW (FDEP 2012a). Kings Bay/Crystal River is also listed as a Surface Water Improvement and Management (SWIM) water body, requiring corrective action by the SWFWMD.

FDEP administers Florida's water quality standards for surface water quality, including designated uses, numeric and narrative water quality criteria intended to protect those uses, and antidegradation policies that define the procedures to be followed when evaluating activities that may impact water quality. Florida surface water quality standards and criteria are described in Chapter 62-302 of the Florida Administrative Code (FAC). In 1998, the EPA issued a strategy requesting each state to develop a plan for adopting numeric nutrient water quality criteria, in addition to already established numeric criteria for other parameters (e.g., dissolved oxygen, pH, temperature, bacteria, metals, pesticides, and other organic chemicals). Florida has adopted statewide numeric N and P criteria for river/streams and lakes/reservoirs, as well as

site-specific P criteria for wetlands and N and P criteria for estuaries (F.A.C. Rules 62-302.531 and 62-302.532) (EPA 2013). FDEP is in the process of developing numeric nutrient criteria for the Crystal River Estuary (FDEP 2013a). In addition to numeric criteria, there are also narrative criteria such as the prohibition of discharging toxic materials in toxic amounts.

Under §303(d) of the Clean Water Act, states are required to compile a list of impaired waters and submit that list to EPA for approval. Impaired waters are those which do not meet applicable state water quality standards, i.e., do not support their designated use(s). The list of impaired waters is also required by the Florida Watershed Restoration Act (FWRA; Subsection 403.067[4] Florida Statutes [F.S.]). These waters are then scheduled for development of a TMDL, which provides a pollutant reduction goal that can be implemented to restore the designated use of the water. Federal regulations require that states consider all existing and readily available information when compiling a §303(d) list. EPA considers the formal listing process under the Endangered Species Act to be readily available information, and the loss of use of a waterbody by a listed aquatic species due to degradation of water quality and/or aquatic habitat to be evidence of impairment. Consequently, such waters must be included on state §303(d) lists and addressed by TMDLs designed to restore conditions suitable for the endangered species.

States have responsibility for the development of TMDLs, which are subject to EPA approval. Sections 403.067(6) and (7) of the Florida Statutes state that FDEP may develop a basin management action plan (BMAP) that addresses the watersheds and basins that contribute to a TMDL waterbody. The purpose of the BMAP is to implement load reductions to achieve TMDLs, including specific projects, monitoring approaches and best management practices (BMPs) (FDEP 2012b). BMPs were cited by the FWRA of 1999 as the best way to reduce pollution to Florida's waters. BMP Manuals contain a combination of practices designed to reduce loading from particular activities, such as nutrient management, pesticide usage and water management. As required by Section 403.067(7)(b)2(g) of Florida law, agricultural producers in basins with TMDLs must implement a BMP plan or conduct water quality monitoring to prove discharges meet state water quality standards. The FWRA also requires that when BMPs are adopted, FDEP must verify their effectiveness in achieving pollutant reductions (Migliaccio and Boman 2013).

C.2.2 The SWIM Act & SWIM Priority Water Bodies

In recognition of the need to place additional emphasis on the restoration, protection and management of the surface water resources of Florida, the Florida Legislature, through the Surface Water Improvement and Management (SWIM) Act of 1987, directed the state's water management districts to "design and implement plans and programs for the improvement and management of surface water" (Section 373.451, Florida Statutes). The SWIM legislation requires the water management districts to protect the ecological, aesthetic, recreational, and economic value of the state's surface water bodies, keeping in mind that water quality degradation is frequently caused by point and non-point source pollution, and that degraded water quality can cause both direct and indirect losses of habitats.

Under the Act, water management districts identify water bodies for inclusion into the program based on their regional significance and their need for protection and/or restoration. This process is carried out in cooperation with the Florida Department of Environmental Protection (FDEP), the Florida Fish and Wildlife Conservation Commission (FFWCC), the Florida

Department of Agriculture and Consumer Services (FDACS) and local governments. Crystal River/Kings Bay was named a SWIM priority water body in 1989.

In accordance with the SWIM Act, once a water body is selected, a SWIM Plan must be adopted by the water management district's governing board and approved by the FDEP. Before the SWIM Plan can be adopted, it must undergo a review process involving the required state agencies. The purpose of this updated Crystal River/Kings Bay SWIM Plan is to set forth a course of action by identifying the quantity, scope, and required effort of projects appropriate for the system, while considering the levels of funding. In 1989, the SWFWMD adopted the Crystal River/Kings Bay as a SWIM water body and developed the first Crystal River/Kings Bay SWIM Plan. The 1989 SWIM plan identified a variety of projects that included studies and data collection efforts. These projects were diagnostic in nature with a focus on obtaining an initial understanding of the system. As projects were completed and the SWFWMD staff's understanding of the system increased, SWIM plans were periodically updated. The Crystal River/Kings Bay plan was updated in 2000 to evaluate management issues and to determine which areas to focus management strategies in the future. As each SWIM plan was updated, management issues shifted from the area immediately surrounding the River and Bay in the watershed to more regional issues within the springshed. A 2015 SWM update is currently in preparation by SWFWMD.

C.2.3 Antidegradation Policy

Florida's Antidegradation Policy is contained in Chapter 62-4, F.A.C., "Permits," and Chapter 62-302, F.A.C., "Surface Water Quality Standards" allows for protection of water quality above the minimum required for a classification. FDEP states that excessive nutrients (total nitrogen and total phosphorus) constitute one of the most severe water quality problems facing the State. It is FDEP's stated policy to limit the introduction of man-induced nutrients into waters of the State. Particular consideration is to be given to the protection from further nutrient enrichment of waters which are presently high in nutrient concentrations or sensitive to further nutrient concentrations and sensitive to further nutrient loadings. Also, particular consideration is given to the protection from nutrient enrichment of those waters containing very low nutrient concentrations: less than 0.3 milligrams per liter total nitrogen or less than 0.04 milligrams per liter total phosphorus.

Florida's policy is to afford the highest protection to Outstanding Florida Waters (OFW). No degradation of water quality, other than that allowed in Rule 62-4.242(2) and (3), F.A.C., is to be permitted in OFWs, notwithstanding any other state rules that allow water quality lowering. No FDEP permit or water quality certification can be issued for any proposed activity or discharge within an OFW, or which significantly degrades, either alone or in combination with other stationary installations, any OFWs.

C.2.4 NPDES

As authorized by the Clean Water Act, the NPDES permit program regulates point sources that discharge pollutants into waters of the United States. NPDES permits are required for operation and sometimes construction associated with domestic or industrial wastewater facilities or activities (e.g., wastewater treatment facilities, mines, etc.). In Florida, the EPA has delegated administration of the NPDES permit program to FDEP.

C.2.5 Groundwater Regulations

Groundwater is protected by laws at both the federal and state levels. The U.S. Environmental Protection Agency (EPA) is responsible for groundwater protection through the Safe Drinking Water Act, which requires maximum contaminant level standards for drinking water. The Safe Drinking Water Act established the Underground Injection Control, Wellhead Protection, and Source Water Protection Programs, which are administered by FDEP (Aquifer Protection Program) in Florida. The Resource Conservation and Recovery Act (RCRA) regulates disposal of solid and hazardous wastes and established a national program for the regulation of underground storage tanks. The Comprehensive Environmental Resource Compensation and Liability Act (CERCLA) set up a "superfund" and authorized the federal government to clean up chemical spills or hazardous substance sites that threaten the environment. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) authorizes EPA to control the availability of potentially harmful pesticides. The Toxic Substances Control Act (TSCA) authorizes EPA to control toxic chemicals that could pose a threat to the public and contaminate groundwater. The Surface Mining Control and Reclamation Act (SMCRA) regulates mining activities, some of which can negatively impact groundwater.

In addition to the Aquifer Protection Program, FDEP has a Ground Water Management Program that is responsible for evaluating and addressing groundwater resources that adversely affect surface water quality as part of Florida's Watershed Restoration Program. This program conducts groundwater – surface water interaction assessments, restoration of springs and implementation of best management practices for agrichemical effects on water quality.

In Florida, rules pertaining to groundwater quality include Groundwater Classes, Standards and Exemptions, Wellhead Protection and Underground Injection Control.

C.2.6 Impaired Waters, TMDLs and BMAPs

C.2.6.1 Florida Impaired Waters and TMDLs

In order to meet Clean Water Act and FWRA requirements, watersheds within the state, as defined by FDEP, have been allocated into five groups based on geography. Each group undergoes a cycle of five phases on a rotating schedule. Phases 1 and 2 entail preliminary water quality assessments and strategic monitoring to verify detected impairments. Phase 3 addresses the development and adoption of TMDLs for waters verified as impaired in Phase 2. In Phases 4 and 5, a BMAP is developed and implemented in order to achieve the TMDL. Each phase is scheduled to take about a year (FDEP 2003).

Under the FWRA, the TMDL allocation adopted by rule may be an "initial" allocation among point and non-point sources, with a "detailed" allocation to specific point sources and categories of nonpoint sources established through a BMAP. This type of qualitative approach has previously been deemed to be inappropriate for groundwater-fed springs (e.g., the Santa Fe River BMAP) due to the complicated hydrogeologic nature of the watershed, which would require the quantification of denitrification across many separate areas. As a result, the BMAP may be implemented via an iterative phased process, where management actions will be focused in geographically defined areas and/or on specific types of agricultural commodities. Monitoring data collected as a part of the Phase 1 monitoring plan will be entered into STORET and used to refine the implementation of Phase 2 nutrient reduction best management practices (BMPs). Phase 1 is anticipated to focus on working with watershed stakeholders to develop

urban and agricultural BMPs for restoration focus areas (RFAs), the development of county springshed protection ordinances, and the determination of nitrate isotope species in groundwater, which will be used in monitoring (FDEP 2012b).

C.2.6.2 Basin Management Action Plan (BMAP)

FDEP's method of achieving the TMDLs for impaired water bodies such as the Kings Bay/Crystal River is development and implementation of a Basin Management Action Plan (BMAP). A BMAP is a restoration plan developed by FDEP and basin stakeholders that formalizes the activities that will are necessary to reduce the pollutant loads and achieve the TMDL. Stakeholders in these BMAPs include the SWFWMD, local governments, agriculture and other businesses, and interested local citizens and environmental groups. The Florida Department of Agriculture and Consumer Services (FDACS) also has an important role in the implementation of restoration activities. The BMAP for the Kings Bay/Crystal River system is currently in preparation (SWFWMD 2015).

C.2.6.3 Florida Wastewater Management Permits

The FDEP NPDES program regulates point source discharges to waters of Florida. Under the program, point source discharges are distinguished as either stormwater or wastewater and separate permitting apparatuses are established to regulate each. In the case of stormwater, the FDEP NPDES Stormwater Program issues NPDES permits for stormwater discharges associated with construction activity, industrial (multi-sector) activity, and Municipal Separate Storm Sewer Systems (MS4). For wastewater, FDEP further categorizes NPDES facilities as domestic or industrial and maintains a list of facilities in its Wastewater Facility Regulation database.

Domestic wastewater includes sanitary wastewater or sewage from dwellings, business buildings, and institutions. All other types of wastewater, such as runoff or leachate from industrial or commercial storage, handling or processing, are considered industrial (FDEP 2003). Permitted wastewater discharges occur at relatively stable rates, particularly municipal discharges, whereas permitted stormwater discharges can be highly variable, depending on precipitation.

C.3 Water Law/Water Rights

C.3.1 State Water Law Overview

Water is regulated under the Florida Water Resources Act of 1972 (Chapter: 40B-4 F.A.C). The act established a regional water management system by setting up five water management districts drawn on hydrologic boundaries that have the power to levy taxes to fund their mission (373.069). The water management districts are governed by a board appointed by the Governor and confirmed by the State Legislature (373.073). The board directs water resources policy for their district; hence policy between the districts varies (Christaldi 1996). The act also specifies that FDEP create a state water use plan which includes policies related to water supply, water quality, flood protection, and regional supply plans.

C.3.1.1 Public Trust Doctrine

Lands under navigable waters in the State of Florida are held in trust for the people. This follows the English common law doctrine in which the sovereign held title to the beds of

navigable and tidal waters as a trustee for the benefit of the people (Baumann 2013). Upon admission to the Union in 1845, the state of Florida gained title to the beds of navigable lakes, streams, and tidal waters. The public trust doctrine was codified in the 1968 Constitution and the government's power to sell these lands was limited (Florida Constitution Article X Section 11). The Trustees of the Internal Improvement Trust Fund, composed of the governor and cabinet, have authority over title to all submerged lands (Florida Statutes 253.12). Submerged lands include the beds of tidal waters below the line of mean high water, and of non-tidal navigable waters below the ordinary high water line (OHWL). OHWL and mean high water line (MHWL) are not defined by Florida statutes; however the Florida Supreme Court has established criteria for determinations of OHWL (Kaiser 2012). Determining OHWL requires site-specific analysis of water's effects on the landscape, as evidenced by physical indicators such as soil, vegetation, and geomorphology. MHWL is determined by averaging the high tides over a full lunar cycle.

A letter of consent or a sovereignty submerged land easement is required for the following "public or private management activities, which include permanent preemption by structures or exclusion of the general public, associated with protection of threatened, endangered and special concern species, rookeries, artificial or natural reefs, parks, preserves, historical sites, scientific study activities, or habitat restoration or enhancement areas" (F.S. Chapter 18-21). Application for use of sovereignty submerged lands is made at either the FDEP District Office or Suwannee River Water Management District. The FDEP Submerged Lands Section then prepares the submerged land leases and easements, which can include term renewals, modifications and assignment to new upland owners (FDEP 2013b).

C.3.1.2 Riparian Water Rights

Technically, "riparian" refers to rivers and streams, while "littoral" refers to lakes, but the term "riparian rights" includes lakes, streams, and rivers. Thus, the only way to obtain riparian rights is to purchase riparian property. In Florida, a riparian landowner owns to the OHWL on navigable waters and the state owns the land water-ward of the OHWL. As summarized by Baumann (2013): A riparian landowner has the following general and specific rights included with riparian rights. General rights are those shared by the public (navigation, commerce, fishing, bathing, and boating). Special rights are that of the upland owner adjacent to the water body and include right of access from the water to the riparian land, a right to wharf out to navigability, the right to take title to the property by accretion and reliction, and the right to an unobstructed view over the adjoining waters (Section 253.141, Fla. Stat.).

C.3.1.3 Navigable Waters

Kings Bay and Crystal River are classified as navigable water under the Florida Constitution and Statutes. As such, the water bottom (below mean high water), is owned by the State of Florida. Upper reaches of the Suwannee that are non-tidally influenced that are declared "navigable," entitle state ownership of the streambed only to the OHWL. Therefore, unlike some other southern states, when a freshwater stream is navigable, the state owns the streambed from bank to bank: the sand bars and stream banks below OHWL are state-owned property.

C.3.1.4 Navigable Servitude

Streams which have been declared to be navigable are open to the public. Even if one part of the streambed in a navigable stream is owned by the state and the remainder is private property, a person has a right to be anywhere on that stream, provided that person remains afloat and does not wade onto the privately-owned portion of the streambed without the landowner's permission.

C.3.2 Water Withdrawals

The SWFWMD regulates all water uses within its boundaries pursuant to the provisions of Chapter 373, F.S. and consistent with Chapter 62-40, F.A.C. A water use permit (minor water use permit by rule, general water use permit, or individual water use permit) is required prior to the withdrawal or diversion of water for any water use except those expressly exempted by law or District rule. Individual residential water wells, exempted for the permit process, are required to be permitted during installation, tested for contamination, and permitted for abandonment. Reporting requirements and withdrawal capacities for each permit type are outlined below and in Chapter 40B-2 F.A.C.

C.3.2.1 Minor Water Use Permit

The following categories of water use are regulated through minor water use permits:

- Water used for agriculture, commercial, potable water supply, augmentation and other uses provided the average daily use is less than 100,000 gallons per day and the maximum daily use is less than 250,000 gallons per day, water is being drawn through a single pipe/well casing no larger than four inches, water is not transported across District boundaries, and water conservation practices shall be implemented.
- Water used for landscape irrigation provided the average daily use is less than 100,000 gallons per day and the maximum daily use are less than 250,000 gallons per day, and water is being drawn through a single pipe/well casing no larger than four inches or a utility. Permittee also has to follow rules pertaining to irrigation volume output and timing of irrigation.
- Water used for hydrostatic testing provided the permittee provides written notice to the SWFWMD at least ten business days prior to each test, the water is not transported across District boundaries, and the permittee allows SWFWMD personnel access to monitor the test.

C.3.2.2 General Water Use Permit

A general water use permit is required for all withdrawals or diversions which are less than ten million gallons per day maximum and less than two million gallons per day average daily rate of withdrawal.

C.3.2.3 Individual Water Use Permit

An individual water use permit is required for all withdrawals exceeding general water use permit daily rates.

C.3.2.4 Obtaining a Water Use Permit

A permit applicant must meet three conditions in order to receive a consumptive use permit as per F.S. Section 373.223. The use must be a reasonable-beneficial use, which is defined as "the use of water in such quantity as is necessary for economic and efficient utilization for a purpose and in a manner which is both reasonable and consistent with the public interest". Second, the use must not cause harm to other users. Finally, the use must be consistent with the public interest (FLA. STAT. § 373.223(1)(1995)). The Florida Water Resources Act of 1972 (Chapter: 40B-4 F.A.C.) specifies that FDEP create a state water use plan which includes policies related to water supply, water quality, flood protection, and regional supply plans (Christaldi 1996). The SRWMD is required by Chapter 373, Florida Statutes, to assess water supplies every five years to determine if natural systems will be able to maintain a healthy condition and supply demands for water (SRWMD 2013a).

Exemptions from the water permitting process include domestic uses as defined in Section 373.019(6), F.S., water used strictly for firefighting, withdrawals made for dewatering activities for a total period not to exceed 180 consecutive days, withdrawal from artificial retention structures for the purpose of structure repair, and groundwater remediation authorized by the Florida Department of Environmental Protection.

C.4 Minimum Flows and Levels (MFLs) and Permitting

Florida law (Chapter 373.042, Florida Statutes) requires the state water management districts or the Department of Environmental Protection to establish minimum flows and levels (MFLs) for aquifers, surface watercourses, and other surface water bodies to identify the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area. Rivers, streams, estuaries and springs require minimum flows, while minimum levels are developed for lakes, wetlands and aquifers. Minimum flows and levels are adopted into Southwest Florida Water Management District (District) rules (Chapter 40D-8, Florida Administrative Code) and used in the District's water use permitting program to ensure that withdrawals do not cause significant harm to water resources or the environment.

Minimum Flows and Levels means "the minimum flow for a watercourse or the minimum water level for groundwater in an aquifer or the minimum water level for a surface water body that is the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area". These levels have not yet been established by the SWFWMD for Kings Bay/Crystal River springs. Minor, general, and individual water use permitting for groundwater withdrawal can be granted or denied based on the potential effect to complying with the MFLs.

The statute (Chapter 373.042(1), F.S.) also provides guidance for establishing MFLs using the "best information available", considering "seasonal variations" and "protection of non-consumptive uses." MFLs are intended to protect non-consumptive uses of water which includes the water necessary for navigation and recreation, and for fish and wildlife habitat and other natural resources (Chapter 62-40, Florida Administrative Code (F.A.C.)). The State Water Resources Implementation Rule provides additional policy guidance (Chapter 62-40.473, F.A.C.), indicating that "consideration shall be given to the protection of water resources, natural seasonal fluctuations in water flows or levels, and environmental values associated with coastal, estuarine, aquatic, and wetlands ecology. . . ".

These environmental values may include:

- Recreation in and on the water;
- Fish and wildlife habitats and the passage of fish;
- Estuarine resources;
- Transfer of detrital material;
- Maintenance of freshwater storage and supply;
- Aesthetic and scenic attributes;
- Filtration and absorption of nutrients and other pollutants;
- Sediment loads;
- Water quality; and
- Navigation.

The scientific analysis completed for establishing the MFL is subject to a peer review process. Before the SWFWMD Governing Board adopts the MFL in the District rules (40D-8, F.A.C.), a four- to six-month process must be followed that involves public workshops, review by the Florida Department of Environmental Protection, and publication in the Florida Administrative Weekly ensues.

Public and private water supply is currently the largest water use category permitted in the SWFWMD. Further permitting for development can also be affected as these permits allow a certain amount of groundwater to be withdrawn. Increased withdrawal may affect one of the ten values that the MFL was established to protect and compromise the interests of those values (e.g., recreation, fish passage, and water quality).

Previously, approved permits in one WMD could affect an adjoining WMD as many of the district boundaries are rivers. In an effort to avoid duplicative effort and reduce costs, the Florida Legislature passed Senate Bill 244 in June 2013 amending several Florida Statutes in Chapter 373 (Water Resources) to better manage cross boundary MFLs between adjoining WMDs and facilitate more effective regional water supply planning.

Minimum Flows and Levels for Crystal River/Kings Bay is scheduled for adoption in late 2017 (SWFWMD 2015).

C.5 Aspects of Florida Water Law That May Negatively Affect Springs

The Florida Water Resources Act of 1972 (Chapter 373, Florida Statutes [F.S.]) regulates water within the state and established a regional water management system of five water management districts. These water management districts are governed by a Governor appointed board. The board directs water resources policy for their district; hence policy between the districts varies (Christaldi 1996). Chapter 373.042, F.S directs the district Governing Board to establish MFLs for all surface watercourses and groundwater in an aquifer in the area. MFLs are intended to protect non-consumptive uses of water which includes the water necessary for navigation and recreation, and for fish and wildlife habitat and other natural

resources (Chapter 62-40, F.A.C.). Water uses cannot be permitted that causes any MFL to be violated.

However, many spring MFLs have not yet been developed. As MFLs are created for lakes, rivers, and streams in this area, coordination between adjacent water management districts is essential. The Florida Legislature passed Senate Bill 244 in June 2013 amending several Florida Statutes in Chapter 373 (Water Resources) to better manage cross boundary MFLs between adjoining WMDs (SRWMD 2013b; Florida Senate 2013) and facilitate more effective regional water supply planning.

A permit applicant must meet three conditions in order to receive a consumptive use permit as per F.S. Section 373.223: 1) the proposed use is a reasonable beneficial use, 2) the use will not interfere with existing legal users of water, and 3) the proposed use is consistent with the public interest. Ensuring that the Kings Bay/Crystal River springs have adequate water resources is in the public interest. However, neither the legislature nor the water management districts have clearly outlined the "public interest" test and how it should be applied with respect to permitting decisions (Angelo et al. 2008). This uncertainty can present problems for permit issuing authorities, especially when an application is found to not meet the public interest test.

MFLs are established to protect water resources from "significant harm", but "significant harm" is not defined in the statutes. Angelo et al. (2008) proposes that "significant harm" should be measured in terms of context as well as intensity because "if harm to estuarine resources occurs in a national park that was created for the purpose of restoring and maintaining those resources unimpaired for future generations, then a lesser degree of harm should be considered 'significant' than if the same degree of harm was caused to an area with a lesser protected area classification". The fact that "significant harm" is not defined in the statutes, interpretation is left in the hands of the water management districts.

Water use permits will continue to be issued while MFLs are in development through 2017. "Affected" parties can dispute approval of a water use permit application which may adversely affect refuge water use. An affected party has the right to a formal administrative hearing pursuant to Section 120.569 and 120.57(1), Florida Statutes, where there is a dispute between the District and the party regarding an issue of material fact. A petition for formal hearing must comply with the requirements set forth in Rule 28- 106.201, F.A.C.

MEETING SUMMARY

Southwest Florida Water Management District
Scientific Peer Review Panel WebEx Meeting and Teleconference
Proposed Minimum Flows for the Crystal River/Kings Bay System

Southwest Florida Water Management District Brooksville Headquarters
November 15, 2016

The Southwest Florida Water Management District (District) organized and facilitated a meeting of the independent scientific peer review panel reviewing a draft District report on proposed minimum flows for the Crystal River/Kings Bay system in Citrus County. The meeting was conducted from 1:00 to approximately 3:30 p.m. as a teleconference with links to a web-based utility for sharing presentation materials, and was facilitated from the District Headquarters at 2379 Broad Street in Brooksville, Florida. The meeting was advertised in the Florida Administrative Register and on the District's web site. In addition, numerous interested parties and local government staff and officials were notified of the meeting.

Meeting participants included the Panel Chair, Steve Peene and Panelists, Adam Munson and Ken Watson. District participants included: Doug Leeper, MFLs Program Lead; XinJian Chen, Chief Professional Engineer; Ron Basso, Chief Hydrogeologist; Gabe Herrick, Senior Environmental Scientist; Sean King, Professional Engineer; Kym Holzwart, Senior Environmental Scientist; Mark Green, Springs & Environmental Flows Manager, and Eric DeHaven, Resource Management Assistant Director. Martyn Johnson, an interested stakeholder, also participated in the meeting.

The meeting was initiated with participant introductions. The remainder of the meeting included discussion of: U.S. Geological Survey flow measurements at Bagley Cove; flow calculations made by the District; hydrodynamic model calibration and application; Panel questions and comments concerning the minimum flows report sections; and project scheduling and assignments. The meeting also included public comment. Issues, comments, questions and requests discussed during the meeting are summarized below and are followed by the meeting agenda and a scanned sign-in sheet.

Summary of Discussed Issues/Comments/Questions/Requests

Agenda Item 2 – Discuss U.S. Geological Survey flow measurements at Bagley Cover

- Dr. Peene noted that he had recently contacted Kevin Grimsley, the Data Chief with the U.S. Geological Survey (USGS) Florida Water Science Center in Tampa to discuss discharge measurement in Crystal River. He provided a summary of his interaction with Mr. Grimsley, noting that prior to 2002 discharge measurements made in the river system were made with equipment that may not have adequately accounted for tidal flows. He added that since 2002, the USGS has deployed ADCP equipment for implementation of an index-velocity approach for estimating discharge in the river at the Bagley Cove gage site, and in 2011 they revised previously reported discharge values for the site based on use of a refined velocity rating curve. Dr. Peene also noted that the USGS has recently installed new ADCP equipment for measuring velocities at the Bagley Cove site and expect to use data collected with the new equipment to develop an improved velocity-rating curve for future discharge reporting. Finally, Dr. Peene noted that Mr. Grimsley indicated that reported discharge at the Bagley Cove site can be

considered a good estimate of "net outflow" in the river/bay system when reported values are composited over long-term periods, perhaps on the order of three months; adding that the net outflow could consist of spring discharge and net surface water flow.

- Mr. Basso stated that the long-term average flow from Bagley Cover since 2002 is now about 450 cfs. He added that the "old" data prior to the 2011 data revisions were 200-300 cfs higher.

- Dr. Chen discussed some recently completed analyses in which he compared discharge in Crystal River reported by the USGS at the Bagley Cove site, modeled discharge at the site derived with the hydrodynamic model he has created for the Crystal River/Kings Bay system, and modeled submarine discharge to Kings Bay. Dr. Chen noted that he still has issues with the USGS Bagley Cove reported discharge by the USGS as it shows a high degree of variability going from below zero to near 800 cfs from 2007 through 2009.Dr. Chen identified analyses he had done using the updated USGS data where he had taken the flow and performed 3-month running averages on the flow data and compared it to his calculations of flow. He identified that the USGS data had significant variation in relation to his calculations. He provided the plot of this analysis. Dr. Peene asked if he could get the raw data that Dr. Chen used for this analysis. Dr. Chen said he would provide this.

<u>Agenda Item 3 – SWFWMD flow calculation</u>

- Dr. Peene noted that he had recently discussed the District's development of submarine discharge estimates with Dr. Chen. He provided a summary of the approach for meeting participants and indicated that he agreed with the equations developed by Dr. Chen for the discharge estimates.

- Issues associated with the estimation of discharge, including sources of uncertainty and comparison of submarine discharge estimates with discharge reported by the USGS at the Bagley Cove gage site, were discussed.

- Given that an interested stakeholder, Mr. Martyn Johnson had previously submitted comments on discharge measurement and estimation to the District, the Panel and District staff agreed to allow Mr. Johnson to participate in the Panel discussion of agenda item 3, rather than requiring that his input be limited to only the public comment portion of the meeting.

  Several topics were addressed during the ensuing discussion, including: the extent/quantity of the measured spring/spring vent discharge data sets; temporal differences in measured discharge values; expectations for flow variability based on potentiometric surface changes and recharge area/rates; and the relative contributions of runoff and spring discharge to flow in the system.

<u>Agenda Item 4 – Hydrodynamic model calibration and application</u>

- Dr. Peene noted that he had recently discussed development, calibration and application of the Crystal River/Kings Bay system hydrodynamic model with its creator, with Dr. Chen.

- Dr. Peene suggested that interpretation of the modeling information presented in the District's report could be enhanced through use of consistent and readily understandable units for figures, tables and report text.

- Dr. Peene asked about gaps in presented model simulation results and Dr. Chen noted that the gaps corresponded to periods when model input data (e.g., tide stage) were temporarily unavailable.

- Dr. Peene noted that calibration statistics for the model seem reasonable, based on comparable models he has evaluated.

- Dr. Peene identified that reductions in flow may create a net increase in the downstream boundary condition in the model. This is presently not in the model. Dr. Chen and Dr. Peene agreed that a sensitivity analysis based on varying downstream boundary salinity conditions could be useful for model characterization. Dr. Chen noted that he did not, however, expect that varying downstream boundary salinities would have much effect on predicted changes in upstream salinity-habitats.

- The Panel discussed other modeling issues such as: the number of model layers; whether rainfall and surface water runoff were included in the model; how salinities were assigned to model cell and translated to shoreline, bottom and water column habitat values; whether the model includes differing or varying salinities for water flowing from differing vents; and that the District should consider presenting the temperature model calibration for the critical winter "manatee season".

- Dr. Watson indicated that he'd like to see some comparisons of computed submarine groundwater discharge with rainfall. Mr. Basso offered that staff can make that comparison and provide the peer review panel supplemental information. Staff will examine the long-term and event-based changes in groundwater discharge with rainfall.

<u>Agenda Item 5 – Discuss report chapters 1, 2, 3, 4 and report appendices</u>

- Dr. Peene suggested that the Panel should consider making an assessment of the quality of the reported discharge data for the USGS Bagley Cove site.

- Dr. Watson indicated he had prepared some suggestions for clarifying the text and planned to include those in the Panel's report.

- Dr. Munson asked whether the salinity-based analyses for shorelines was based on total shoreline length or vegetated shoreline length and Mr. Leeper noted that it was based on the total length of shoreline habitat.

- Dr. Watson asked how predicted salinity-based habitat volumes, lengths and areas were characterized and compared for various simulations. Dr. Chen noted that average responses were used for comparisons between baseline and reduced flow conditions.

- Dr. Peene commented on the presentation of relationships between flow and nitrogen concentrations in the water quality section of the District's report and wondered whether similar analyses had been conducted to examine potential relationships between residence time and chlorophyll concentrations.

- Dr. Munson noted the presentation of comparisons between baseline conditions and reduced flow conditions could be enhanced through reporting of absolute changes (e.g., differences in volumes, area, shoreline lengths, etc.) in addition to the percentage change values that are included in the draft minimum flows report.

- Dr. Peene noted that it may be useful to also graphically represent changes in salinity-based habitats between baseline and reduced flow scenarios as was done for the presentation of potential changes in thermally-favorable habitat.

- Dr. Watson indicated that it would be helpful to more directly describe recent and projected changes in sea level in the vicinity of the river/bay system.

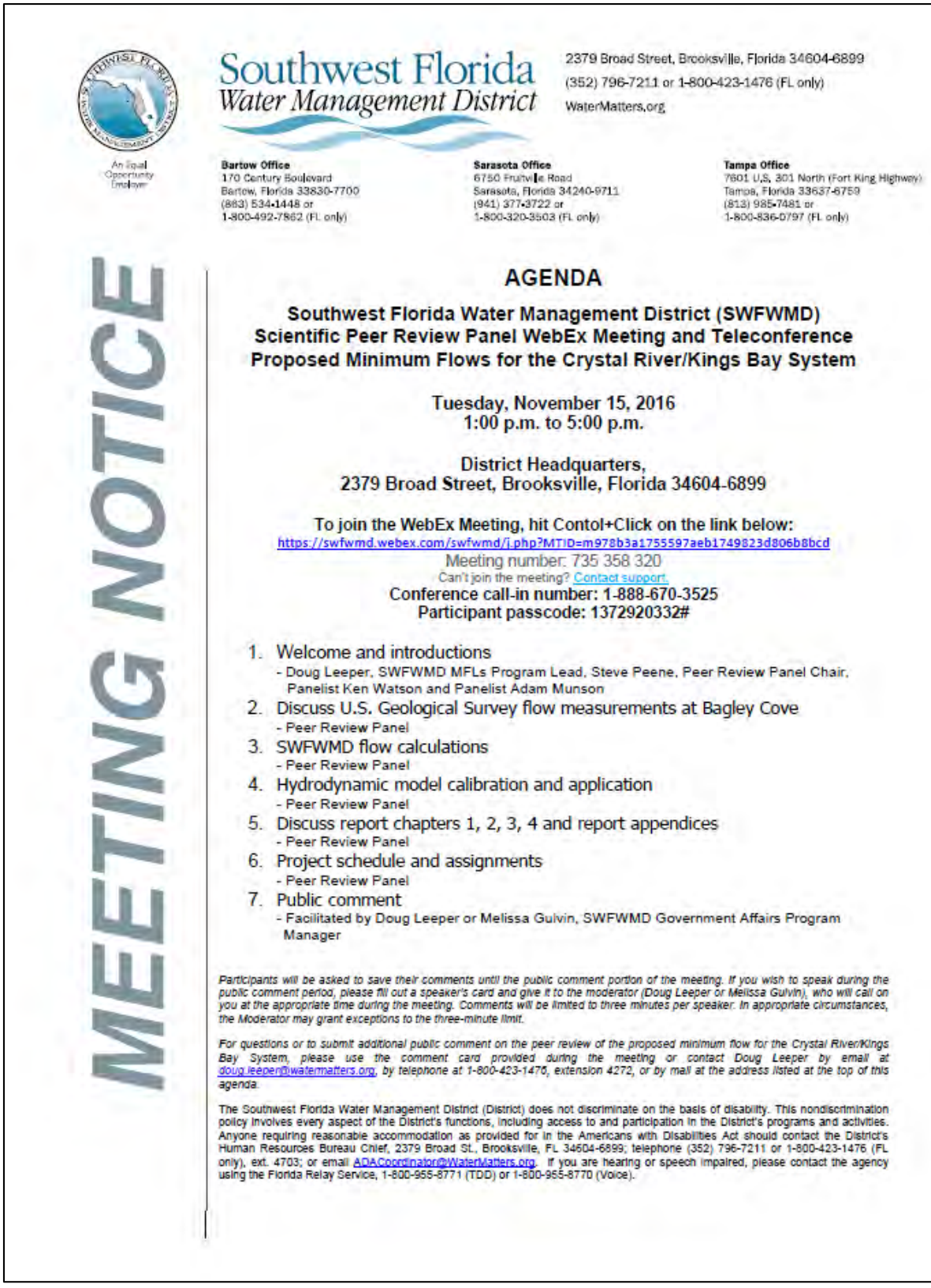
Agenda Item 6 – Project schedule and assignments

- The Panel discussed scheduling and other issues including:
    - An 11/18/2016 target for developing and posting (on the review WebForum) initial written comments and discussion points
    - Plans to discuss these initial submittals at the scheduled 11/21/2016 Panel teleconference
    - Dr. Peene's plans to use the Panel submittals to develop a first draft of the Panel's report in advance of the scheduled 12/5/2016 Panel teleconference
    - Plans to discuss the first draft at the 12/5/ 2016 teleconference
    - Planned submission of the Panel's report to the District by 12/12/2016
    - Understanding that all panelists would consider the entire report, with Dr. Peene, Dr. Watson and Dr. Munson, also respectively focusing on the hydrodynamic modeling, flow measurement/estimation and ecological aspects of the District's report

Agenda Item 7 – Public comment

- Mr. Johnson indicated that he wonders how flows will be measured in the Crystal River/Kings Bay System in the future and how the proposed minimum flow will be implemented, including how it will be determined whether the minimum flow is being met.

Meeting Agenda



Southwest Florida Water Management District

2379 Broad Street, Brooksville, Florida 34604-6899
(352) 796-7211 or 1-800-423-1476 (FL only)
WaterMatters.org

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1-800-320-3503 (FL only)

Tampa Office
7601 U.S. 301 North (Fort King Highway)
Tampa, Florida 33637-6759
(813) 985-7481 or
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MEETING NOTICE

AGENDA

Southwest Florida Water Management District (SWFWMD)
Scientific Peer Review Panel WebEx Meeting and Teleconference
Proposed Minimum Flows for the Crystal River/Kings Bay System

Tuesday, November 15, 2016
1:00 p.m. to 5:00 p.m.

District Headquarters,
2379 Broad Street, Brooksville, Florida 34604-6899

To join the WebEx Meeting, hit Contol+Click on the link below:
https://swfwmd.webex.com/swfwmd/j.php?MTID=m978b3a1755597aeb1749823d806b8bcd
Meeting number: 735 358 320
Can't join the meeting? Contact support.
Conference call-in number: 1-888-670-3525
Participant passcode: 1372920332#

1. Welcome and introductions
   - Doug Leeper, SWFWMD MFLs Program Lead, Steve Peene, Peer Review Panel Chair, Panelist Ken Watson and Panelist Adam Munson
2. Discuss U.S. Geological Survey flow measurements at Bagley Cove
   - Peer Review Panel
3. SWFWMD flow calculations
   - Peer Review Panel
4. Hydrodynamic model calibration and application
   - Peer Review Panel
5. Discuss report chapters 1, 2, 3, 4 and report appendices
   - Peer Review Panel
6. Project schedule and assignments
   - Peer Review Panel
7. Public comment
   - Facilitated by Doug Leeper or Melissa Gulvin, SWFWMD Government Affairs Program Manager

Participants will be asked to save their comments until the public comment portion of the meeting. If you wish to speak during the public comment period, please fill out a speaker's card and give it to the moderator (Doug Leeper or Melissa Gulvin), who will call on you at the appropriate time during the meeting. Comments will be limited to three minutes per speaker. In appropriate circumstances, the Moderator may grant exceptions to the three-minute limit.

For questions or to submit additional public comment on the peer review of the proposed minimum flow for the Crystal River/Kings Bay System, please use the comment card provided during the meeting or contact Doug Leeper by email at doug.leeper@watermatters.org, by telephone at 1-800-423-1476, extension 4272, or by mail at the address listed at the top of this agenda.

The Southwest Florida Water Management District (District) does not discriminate on the basis of disability. This nondiscrimination policy involves every aspect of the District's functions, including access to and participation in the District's programs and activities. Anyone requiring reasonable accommodation as provided for in the Americans with Disabilities Act should contact the District's Human Resources Bureau Chief, 2379 Broad St., Brooksville, FL 34604-6899; telephone (352) 796-7211 or 1-800-423-1476 (FL only), ext. 4703; or email ADACoordinator@WaterMatters.org. If you are hearing or speech impaired, please contact the agency using the Florida Relay Service, 1-800-955-8771 (TDD) or 1-800-955-8770 (Voice).

CRYSTAL RIVER / KINGS BAY MFLs PEER REVIEW PANEL MEETING 11/15/2016

PUBLIC WORKSHOP
Sign-In Sheet

Southwest Florida Water Management District
WATERMATTERS.ORG • 1-800-423-1476

Name	Address/City/ZIP	Phone	Email Address
A.M. JOHNSON.	43815 Blue Water Point HOMOSASSA FL 34448	404-731-6187	martyne11jay@hotmail.com.

MEETING SUMMARY

Southwest Florida Water Management District
Scientific Peer Review Panel WebEx Meeting and Teleconference
Proposed Minimum Flows for the Crystal River/Kings Bay System

Southwest Florida Water Management District Brooksville Headquarters
November 21, 2016

The Southwest Florida Water Management District (District) organized and facilitated a meeting of the independent scientific peer review panel reviewing a draft District report on proposed minimum flows for the Crystal River/Kings Bay system in Citrus County. The meeting was conducted from 1:00 to approximately 3:30 p.m. as a teleconference with links to a web-based utility for sharing presentation materials, and was facilitated from the District Headquarters at 2379 Broad Street in Brooksville, Florida. The meeting was advertised in the Florida Administrative Register and on the District's web site. In addition, numerous interested parties and local government staff and officials were notified of the meeting.

Meeting participants included the Panel Chair, Steve Peene and Panelists, Adam Munson and Ken Watson. District participants included: Doug Leeper, MFLs Program Lead; XinJian Chen, Chief Professional Engineer; Ron Basso, Chief Hydrogeologist; Gabe Herrick, Senior Environmental Scientist; Sky Notestein, Senior Environmental Scientist; and Jackie Sampson, Intern with the Springs & Environmental Flows Section. A representative of the Florida Fish and Wildlife Conservation Commission also participated in the meeting.

The meeting was initiated with participant introductions. The remainder of the meeting included discussion of: comments by Peer Review panelists, MFLs review guidelines; Panel recommendations and suggestions for future District efforts, and finalization of the Panel's report outline and structure. The meeting also included public comment. Issues, comments, questions and requests discussed during the meeting are summarized below and are followed by the meeting agenda.

Summary of Discussed Issues/Comments/Questions/Requests

Agenda Item 2 – Review of comments by Peer Review Panelists

Dr. Watson's comments

- Dr. Watson reviewed the history of reported discharge at U.S. Geological Survey (USGS) gage sites.
- Dr. Peene clarified that the USGS Bagley Cove gage has recently been outfitted with new equipment for measuring velocities, but the USGS has not begun to report results based on data collected with the new instrumentation. Dr. Peene mentioned that the new equipment can look at a larger portion of the cross section than the existing equipment does, which measures velocities over a portion of the cross-section.
- Dr. Watson inquired as to whether USGS has agreed that current, revised discharge measurements for the Bagley Cove site are biased high, and guessed the answer is "no".

- Dr. Peene added that the projection of discharge used for regional groundwater modeling with the Northern District Model) is closer to USGS at Bagley Cove reported discharge than the submarine groundwater discharge value used for Dr. Chen's hydrodynamic modeling of the Crystal River/Kings Bay System.
- It was noted that the three month running average of discharge from the USGS Bagley cove data exhibits variation that is unexpected.
- Dr. Watson recalled similar situation in "noisy" discharge data for the Homosassa River.
- Dr. Watson suggested revised phrasing regarding the manatee thermal habitat discussion in the minimum flows report. He suggested that the District consider noting that a 15% change in thermally-favorable habitat is not an appropriate criterion for the Crystal River/Kings Bay System given the abundance of habitat within the system.
- Dr. Munson commented that stakeholders will be very interested in manatee analysis.
- Dr. Watson noted that regarding measured flow at G1 and G2 ADCP locations, the District's report should be more explicit about identifying the percentage of total flow to the system that was measured at the two sites.
- Dr. Watson asked whether calculation of bottom area for the hydrodynamic modeling analyses was based on the bottom layer of model. Dr. Chen answered yes.
- Dr. Peene suggested the explanation of how salinity habitat is calculated should be enhanced within the report.
- Dr. Watson commented that he "loved the brevity of the report", but agreed that additional text should be included to describe the salinity habitats in the methods and results sections, with emphasis on the ecological importance of the habitats.
- Dr. Watson commented on his appreciation for Dr. Chen's recent visualization of salinity habitats.
- Dr. Watson asked if it would be useful to have an analysis of the probability of "die-off" events associated with changes in salinity habitats.
- Dr. Munson suggested that scouring and salinity changes may cause die-offs of selected plant, algal or other species and there is no "magic" salinity value that will preserve the ecologic integrity of the system.
- Dr. Watson asked if there are any organisms that prefer the 0-2ppt habitat that would be impacted by short-term exposure to higher (e.g., 10 ppt) salinities.
- Dr. Munson said he usually refers to the 3.5 ppt threshold published by Hoyer et al. (2004)* as critical to submersed aquatic vegetation.

  **Hoyer, M.V., Frazer, T.K., Notestein, S.K. and Canfield, D.E. 2004. Vegetative characteristics of three low-lying Florida coastal rivers in relation to flow, light, salinity and nutrients. Hydrobiologia 528: 31-43*
- Dr. Peene commented on the ambiguities associated with defining an "event", including the type of event and what constitutes an event, when developing minimum flows. For example, he noted that picking a surge-associated value or event would be difficult.
- Dr. Watson suggested that it might be worth commenting on past changes in sea level.
- The USGS Bagley Cove flow issue was reintroduced to the discussion; Dr. Peene stated he would like to put the issue "to bed."
- Dr. Watson commented his gut feeling is that we are not going to resolve the USGS Bagley cove issue regarding discrepancy in reported flow with the estimate of submarine groundwater discharge used in Dr. Chen's hydrodynamic model.
- Mr. Basso commented the 90-day average for the USGS flow record exhibits a degree of variability that is relatively high for a baseflow dominated system.
- Dr. Watson inquired about salinity measurements at spring vents.
- Dr. Chen stated that Vanasse Hangen Brustlin, Inc. gathered that data.
- Dr. Peene cautioned using model output as verification of model input.
- Mr. Basso commented that these are not large differences in measured and computed flows (about 20% difference in flow from a collection of more than 70 springs).

- Mr. Leeper stated that the District looked at relative impact when developing the minimum flow recommendations, thus relative decreases in flow associated with any particular analysis or flow record could apply to any measured or simulated flow record.
- Dr. Watson suggested that at some point in the future it would be useful to look into the potential discrepancy between reported USGS flow at Bagley Cove and the estimated submarine groundwater discharge used by the District for the minimum flow analyses.
- Mr. Basso stated that short term calibration of the District's discharge calculation model can be bolstered by continued monitoring in the future.
- Mr. Leeper clarified that we do not consider the USGS reported discharge as unreliable, but that it is simply not appropriate for use in the hydrodynamic modeling that served as the primary basis for the District minimum flow recommendations.
- Dr. Chen added that he tried using the USGS Bagley Cove discharge data in the District's hydrodynamic model but found that it was not appropriate. He added that the mean submarine groundwater discharge value of 374 cfs discussed during the meeting is based on hind-casted values for the period from 1969 to 2015, while the mean flow of 447 cfs reported at Bagley Cove is based on discharge values reported by the USGS for the period from 2002 to 2015. Dr. Peene stated that it would be useful to compare mean discharge values from the two sources for the same period of record. Dr. Chen also emphasized that the 374 cfs submarine groundwater discharge value is not model output; rather it is based on discharge estimates derived with an empirical formula based on measured data.
- Dr. Peene stated that for estimating submarine groundwater discharge, coefficients were determined for scaling-up the flows measured at sites G1 and G2, adding that flows at these two sites account for ~ 40-50% of the total submarine groundwater discharge to the system.
    - Dr. Chen noted the approach the District used is the best that can be done with available data, adding that there are many uncertainties. For example, he noted that the mean 374 cfs submarine groundwater discharge estimate may be plus or minus 50 cfs, adding that the 374 cfs value is based on a lunar average, has uncertainty, and is derived using values based on hind-casted tides and groundwater levels. Dr. Chen stated that the USGS data is not unreliable, but that it is not appropriated for use in the District's hydrodynamic model; he added that he tried using the USGS filtered and unfiltered data for model development/simulations, and found it would not work.

Dr. Munson's comments

- Dr. Munson stated he is comfortable with the 15% change criterion used for the recommended minimum flow.
- Dr. Munson expressed concern that there is no distinction between hardened shoreline and vegetated shoreline, nor of any other ecotones, for the shoreline-based salinity analyses presented in the District's report. He indicated that hardened seawall may be less important than vegetated and natural shoreline. Dr. Munson also noted there are sessile organisms within the system that will not be able to readily respond to shifting salinity habitats, and wondered how "static-habitat" for these organisms would potentially be affected by changes in flow.
- Mr. Leeper agreed that distinguishing between hardened and total shoreline is valuable when establishing minimum flows, but indicated that this may not have been considered for the Crystal River/Kings Bay System due to lack of data, and added that hardened shoreline is habitat for organisms.

- Dr. Munson indicated there may some confusion regarding the status of Lyngbya in the river/bay system, noting that the minimum flows report indicates Lyngbya proliferation is a problem, while District staff indicated during the Panel's field trip that it is a minor issue.
- Dr. Munson commented that the link between residence time and chlorophyll should be explored in future analysis, and it should be noted in the report that available data do not exist to make this link.
- Dr. Peene urged caution regarding presentation of percent exceedances for chlorophyll concentrations, noting that exceedance values for chlorophyll concentrations should be calculated using rule-specific criteria that are, he thinks, based on annual means.
- Dr. Herrick noted that chlorophyll exceedance values reported in table 3-7 in the minimum flows report are based on individual samples, rather than the rule-based water-quality exceedance criteria, and that staff would review how this information is presented in the minimum flows report. He added that this data was collected for a variety of purposes and that future sampling and analysis may be better directed towards analyses supporting minimum flow development.
- Dr. Watson suggested that the detail of water quality analysis presented in the report may give it an importance it does not merit, given that water quality (other than salinity) is not used to set the minimum flow for the system.
- Dr. Munson stated that residence time is important and should be discussed.
- Dr. Peene stated that the linkage between residence time and chlorophyll is missing from the report, adding that if this linkage is not understood this should be stated in report.
- Dr. Munson stated that it would be useful to see values for shoreline length, volume and bottom area.
- Dr. Peene suggested absolute values of salinity based habitats be presented in tabular format next to relative changes associated with flow reductions.

Dr. Peene's comments

- Dr. Peene stated he thinks the hydrodynamic model is properly calibrated and he has no concerns about inaccuracy of model predictions.
- Dr. Peene expressed concern over periods of "no data" that are presented in some modeling results, noting that they should be excluded from presentation of calibration results. Dr. Chen identified that these periods were part of the model calibration statistics and agreed to eliminate them from the analyses.
- Dr. Peene inquired if table 2-1 in the minimum flow report includes diffuse flows. Dr. Chen answered in the affirmative.

Agenda Item 3 – MFLs review guidelines discussion

- Dr. Watson suggested total values of habitat (i.e., shoreline length, volume and area) be discussed and presented in the minimum flows report when presenting relative changes in habitats.
- Dr. Peene noted that he understood that the USGS Bagley Cove data were not utilized for the minimum flow analyses.
    - Mr. Leeper stated the District did consider the Bagley Cove data by trying to develop regression models with the data for predicting salinities (isohaline locations) and abundances/distributions of selected organisms. He added that these modeling attempts were not successful.

    - Dr. Chen noted that he had considered the Bagley Cove discharge data for development and application of the Crystal River/Kings Bay hydrodynamic model, but found that it did not work.
- Dr. Peene stated that more clarity was needed in discussing limitations of Bagley cove data for the minimum flow analyses.
- Dr. Peene noted that hydrodynamic model assumptions are not always clearly stated in the report.

Agenda Item 4 – Recommendations and future efforts

- The panel decided to compose a list of issues with guidelines and suggested solutions. Each panelist will do this.

Agenda Item 5 – Finalize report outline and structure

- The Panel reviewed and agreed to continue to use their draft report outline.
- The panel agreed to develop a draft report by 11/30/2016.

Agenda Item 6 – Public comment

- No public comment was provided.

Meeting Agenda

Southwest Florida Water Management District
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MEETING NOTICE

AGENDA

Southwest Florida Water Management District (SWFWMD)
Scientific Peer Review Panel WebEx Meeting and Teleconference
Proposed Minimum Flows for the Crystal River/Kings Bay System

Monday, November 21, 2016
1:00 p.m. to 4:00 p.m.

District Headquarters,
2379 Broad Street, Brooksville, Florida 34604-6899

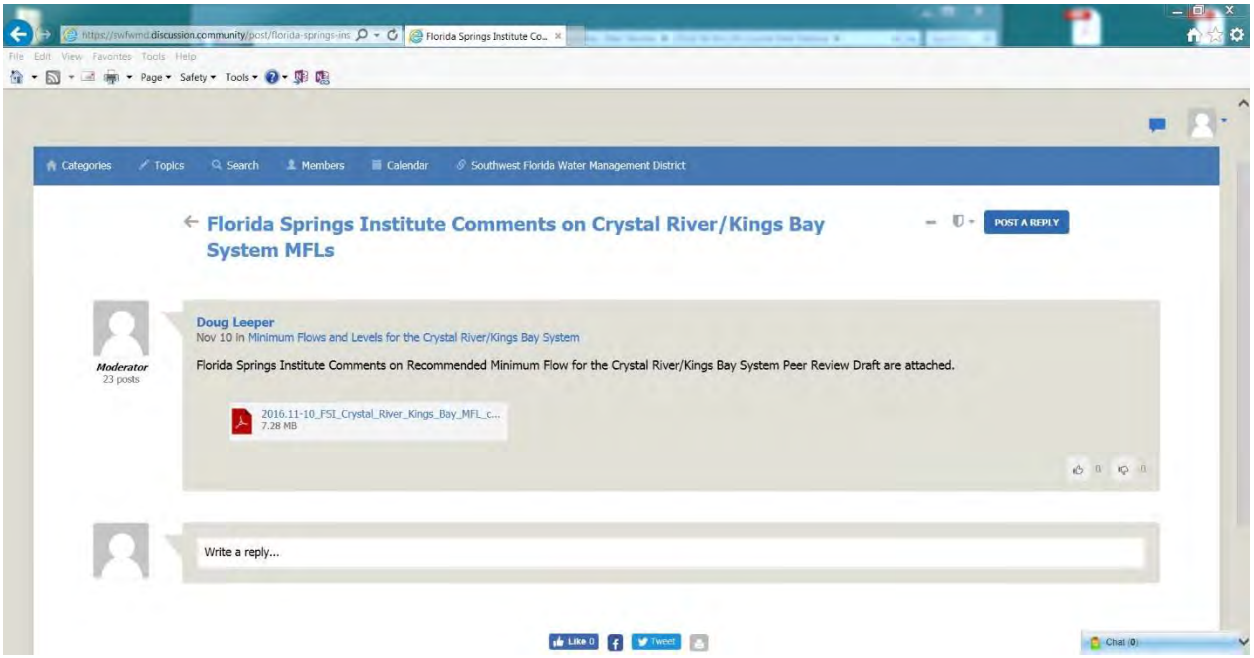
To join the WebEx Meeting, hit Contol+Click on the link below:
Join WebEx meeting
Meeting number: 733 380 623
Can't join the meeting? Contact support.
Conference call-in number: 1-888-670-3525
Participant passcode: 1372920332#

1. Welcome and introductions
   - Doug Leeper, SWFWMD MFLs Program Lead, Steve Peene, Peer Review Panel Chair, Panelist Ken Watson and Panelist Adam Munson
2. Review of comments by Peer Review Panelists
   - Peer Review Panel
3. MFLs review guidelines discussion
   - Peer Review Panel
4. Recommendations and future efforts
   - Peer Review Panel
5. Finalize report outline and structure
   - Peer Review Panel
6. Public comment
   - Facilitated by Doug Leeper

Participants will be asked to save their comments until the public comment portion of the meeting. If you wish to speak during the public comment period, please fill out a speaker's card and give it to the moderator (Doug Leeper), who will call on you at the appropriate time during the meeting. Comments will be limited to three minutes per speaker. In appropriate circumstances, the Moderator may grant exceptions to the three-minute limit.

For questions or to submit additional public comment on the peer review of the proposed minimum flow for the Crystal River/Kings Bay System, please use the comment card provided during the meeting or contact Doug Leeper by email at doug.leeper@watermatters.org, by telephone at 1-800-423-1476, extension 4272, or by mail at the address listed at the top of this agenda.

The Southwest Florida Water Management District (District) does not discriminate on the basis of disability. This nondiscrimination policy involves every aspect of the District's functions, including access to and participation in the District's programs and activities. Anyone requiring reasonable accommodation as provided for in the Americans with Disabilities Act should contact the District's Human Resources Bureau Chief, 2379 Broad St., Brooksville, FL 34604-6899; telephone (352) 796-7211 or 1-800-423-1476 (FL only), ext. 4703; or email ADACoordinator@WaterMatters.org. If you are hearing or speech impaired, please contact the agency using the Florida Relay Service, 1-800-955-8771 (TDD) or 1-800-955-8770 (Voice).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Southwest Florida Water Management District
Florida Springs Institute Comments on Crystal River/Kings Bay System MFLs
POST A REPLY
Doug Leeper
Nov 10 in Minimum Flows and Levels for the Crystal River/Kings Bay System
Moderator
23 posts
Florida Springs Institute Comments on Recommended Minimum Flow for the Crystal River/Kings Bay System Peer Review Draft are attached.
2016.11-10_FSI_Crystal_River_Kings_Bay_MFL_c...
7.28 MB
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From:	hobara@floridaspringsinstitute.org
To:	Melissa Gulvin
Cc:	Cara S. Martin; Dan Hilliard; Heather Obara; Doug Leeper
Subject:	Florida Springs Council"s Comments on Recommended Minimum Flow for the Crystal River/Kings Bay System Peer Review Draft
Date:	Wednesday, November 30, 2016 12:41:54 PM
Attachments:	2016.11-30 FINAL FSC Comments re Kings Bay_Crystal River DRAFT MFL.pdf
Importance:	High

Good morning Ms. Gulvin,

Please find the Florida Springs Council's comments regarding the recommended minimum flow for the Crystal River/Kings Bay System peer review draft attached for consideration by the SWFWMD. Thank you.

Heather Obara, Esq.
Treasurer-Secretary, Florida Springs Council
hobara@floridaspringsinstitute.org
Office: (386) 454-2427
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Katie Tripp, PhD
Save the Manatee Club

November 30, 2016

Melissa Gulvin
Government Affairs Program Manager
Southwest Florida Water Management District
2379 Broad Street
Brooksville, Florida 34604-6899

Transmitted via email to Melissa.Gulvin@swfwmd.state.fl.us.

Subject: Florida Springs Council Comments to Kings Bay/Crystal River Minimum Flow and Level (MFL) Draft

Dear Ms. Gulvin:

Executive Summary

The Florida Springs Council, Inc. (FSC) is providing the following comments for the purposes of constructive criticism and to facilitate improved understanding by the public and the Southwest Florida Water Management District (District) Governing Board. In addition, it is the intent of the FSC to improve the final rule for the benefit of the citizens of the state of Florida.

The format of these comments mirrors the draft structure and will refer to specific chapters and sections throughout.

Chapter 1

Section 1.3.3 Environmental Values

	Considered	Value Addressed
(a) Recreation in and on the water;	Yes	No
(b) Fish and wildlife habitats and the passage of fish;	Yes	Yes
(c) Estuarine resources;	Yes	No
(d) Transfer of Detrital material;	N/A	N/A
(e) Maintenance of freshwater storage supply;	Yes	Uncertain
(f) Aesthetic and scenic attributes;	Yes	Uncertain
(g) Filtration and absorption of nutrients and other pollutants;	Yes	No
(h) Sediment loads	Yes	N/A
(i) Water quality; and	Yes	No

(j) Navigation	Yes	Uncertain (relevance of eval. factors)

Red highlights in the last column are points of disagreement or uncertainty in reference to Table 1-7. Discussion follows:

Section 1.3.4 Significant Harm

The District has inappropriately relied on an arbitrary 15% loss of resources as a threshold of significant harm in the development of MFLs. Used once in the peer review process to set the upper Peace River MFL, it has become the accepted standard throughout the District, without a case-by-case peer reviewed justification. Recently this 15% metric has been casually disregarded as a matter of convenience in support of large-scale reductions of flow in support of the District's interest in water supply. The standard is either defensible or it is not, and it serves no credible purpose when it is altered for the sake of expeditious rule development or in service of other agendas. This is critically important when it is offered in support of long-range planning and protection of the resources. Variable standards cannot be viewed by the District's constituents with credibility. The 15% significant harm standard should either undergo the rulemaking process with opportunity for public notice and comment and scientific peer review, or MFLs should be set exclusively on a case-by-case basis with a view toward conserving essential ecological resources.

Because of the unique resources of the Kings Bay system/Crystal River, namely the presence of critical manatee habitat, it is worth examining whether this 15% derivation is indeed an acceptable measure for significant harm. If the 15% standard is already deemed flexible, as discussed above, then in setting the KB/CR MFL it would behoove the Department to adopt a more conservative threshold from the outset, even prior to explicitly linking flow reductions to decreased critical resources. Particularly given the uncertain effects posed by climate change, the District should apply a precautionary approach to standard setting to ensure the long-term viability of the system.

Section 1.4.1 Hydrologic Setting

Figure 1-1 of the draft recommendations is misleading in that it is presented as the "water shed". It does not represent the contributing area of the spring basin, which more properly defines the system under review. Properly defining this area is critically important in understanding the complexity of the system, which contains more than 70 spring vents with discharges of contrasting chemistry, temperature, and flow. *See* FDEP documents related to TMDL Rule and BMAP development or Figure 1.5.

The graphic below, extracted from the adopted TMDL Rule, reveals the disparity between the "water shed" (yellow border) and contributing area (purple border). The represented differences are significant, and use of "watershed" detracts from credibility of the draft.

March 2016 FDEP NSILT Basin Map

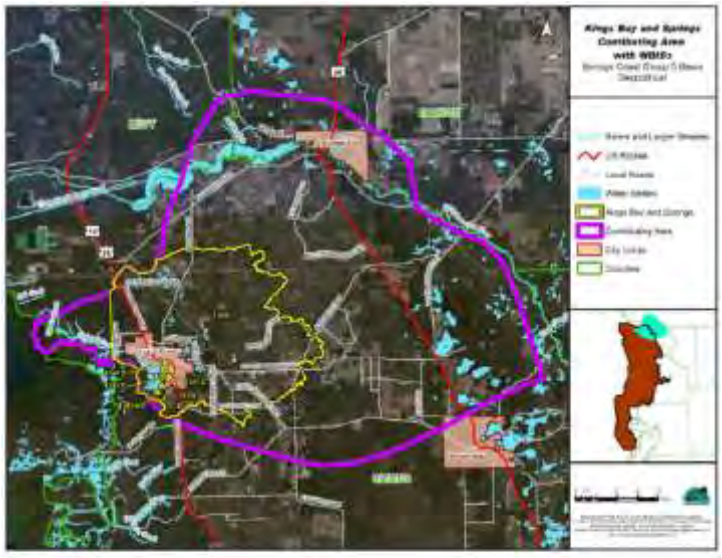

Figure 1.5. Estimated Contributing Area for the Following Verified Impaired WBIDs: Kings Bay (WBID 1341), Hunter Spring (WBID 1341C), House Spring (WBID 1341D), Idiot's Delight Spring (WBID 1341F), Tarpon Spring (WBID 1341G), and Black Spring (WBID 1341H)

It also seems that it might be worthwhile for the District to specifically request a peer review analysis of the data underlying Figure 1-3, delineation of springshed potentiometric surfaces and transmissivity. Because this graphic reflects data published in 2006 (and likely gathered earlier), groundtruthing assessments at UFA performance test sites would be valuable to evaluating the regional consistency of the aquifer in light of increases in groundwater withdrawals over the intervening decade.

Section 1.4.4 Groundwater Levels and Withdrawals

It is not clear that ROMP TR21-2 is properly located to provide reliable reference for the Kings Bay Basin due to proximity to the basin boundary, nor is it clear that the well is actually within the basin. See Figure 1-12 in comparison to Figure 1-3. FSC suggests the ROMP locations be mapped with basin boundaries included.

Reference to ground water pumping "within a 5 mile radius of the springs" is irrelevant as to source and volume. Estimates or metered withdrawals for the basin are inappropriate if for no other reason than that there has been a lack of significant development within the 5-mile radius of the springs within the last 15 years. Development in the mid- and eastern portions of the basin has been more robust in the same time frame.

Citrus County's population is concentrated in the coastal and northern portion of the jurisdiction, with a majority share found in the Kings Bay basin contributing area. Information from the FDEP NSILT/TMDL documents and supported by the county's *"CITRUS COUNTY 10-YEAR WATER SUPPLY FACILITIES*

WORK PLAN - 2013" (attached) suggests clearly that approximately 58% of the population, or 96,065 residents, occupy the basin's contributing area. This suggests a level of groundwater withdrawal significantly higher than that presented in the draft recommendation.

Type	Volume
Potable water	14.40 MGD
Non-potable water; all uses	5.48 MGD
Total	19.88 MGD

It is understood that a large portion of the resource is returned to the aquifer as recharge, but a significant discrepancy exists between the numbers above and the volume presented in the draft. The 2.6 mgd/5-mile radius reference below is irrelevant and misleading:

"Groundwater withdrawals have declined in the Crystal River Spring Group springshed since reaching their peak of 18.1 mgd in 2006. In 2014, groundwater withdrawals based on estimated and metered use were 15.3 mgd. Since 2005, groundwater use has essentially remained flat with a slightly negative change rate of -0.02 mgd per year. The quantity of groundwater withdrawn within a five-mile radius of the springs is relatively small and was 2.6 mgd in 2014." (CRKB MFL Draft; pp. 17)

The Draft MFL also states that the District maintains a database of metered and estimated water usage from 1992-2014. FSC requests that the Draft MFL cite to where that data is publicly available, given that in other water management meetings that FSC members have been involved in, the District has given the impression that water usage can only be generally estimated and is not metered for agricultural users.

Figure 1-15

The relevance and accuracy of this figure is unclear. In addition to the concerns stated above, the Northern Planning Area encompasses far more than the Kings Bay Basin. Specificity in relation to the Basin is strongly recommended.

Section 1.4.5 Groundwater Level Trend

Due to the previously mentioned variability of water chemistry and quality identified in the myriad of vents in the Kings Bay system, it is reasonable to conclude that the overall system acts in unity within the bay, yet it in fact illustrates sub-basin dynamics. The use of a single well as reference to characterize trends within the sub-basins is highly suspect. Evidence to this point is found in the Kings Bay/Crystal River TMDL Rule (http://www.dep.state.fl.us/water/tmdl/docs/tmdls/final/gp5/KingsBay-1341-nutr-tmdl.pdf) and within the draft itself. *See* Section 1.6.1.1 of the draft and Table 1-6. It is not the concentration that is significant, it is the variability presented which requires finer resolution of the proposed rule. In the short term, this analysis is not immediately significant, but the long term success of the rule makes a focused examination of sub-basin dynamics extremely important during the first 10-year review cycle.

Section 1.4.6 Predicted Change in Spring Flow

Predictions based on a macro view of the Crystal River Group, Manatee Spring, and House Spring are data set limited, and will not provide the micro level view necessary for long-term assurance of the rule's success. Without determination of the sources of various spring discharges in the larger system, WUP review cannot reasonably be expected to achieve stipulated objectives. In short, it is perfectly reasonable to anticipate adverse reductions of flow in select springs if well siting is not adequately regulated. The District does not possess a database that can, at present, satisfactorily address this issue.

Table 1-2 Predicted Flow Changes

The segment "Model Groundwater Withdrawals" is confusing. FSC requests clarification regarding what purpose this data is expected to serve. In a similar vein, more information is needed regarding how the NDM evaluated 2035 estimates: what values of recharge were used, where alternative water supply and conservation and reuse factors were evaluated, and the likely impacts of climate change and possible changes in the potentiometric surface of the UFA. Recharge estimates can also not be assumed to remain constant with increasing regional development and land use changes.

Section 1.4.7.1 Vegetation

Historical perspective of aquatic vegetation is described herein and in the District's adopted SWIM Plan. Threats to SAV communities due to algal proliferation fueled by nutrient pollution are recognized. Another issue pertinent to this system, and recognized in the system TMDL, and by the District, is residence time of discharged spring flows in the system. The Draft MFL discusses the impact of nutrients, but fails to include a discussion of residence time and the interrelations among flow, nutrients, residence time, and increased algal proliferation. Edits to that effect should be included in the draft.

Section 1.4.8 Human Use

The popularity of the system as an attraction and economic driver is acknowledged, and 14-year old data for economic contribution are presented in the form of $17.13 million direct input to the local economy. In fact, more recent information suggests clearly that Kings Bay and two additional spring systems (Homosassa and Chassahowitzka), in concert, generate nearly $200 million per annum to the Citrus County economy.

This section should include an analysis of projected trends as well as historical land use changes. It is important to address how anticipated regional development will further contribute to nitrate pollution as well as groundwater withdrawals in the area, and the likely impacts associated with those changes.

Figure 1-18

This graphic clearly depicts the reason Figure 1-1 is inappropriate. Changing regional land use patterns alter hydrology and impact delineating of watershed and contributing area boundaries.

Development and groundwater withdrawals in the region overall may also result in some springflows declining and rerouting groundwater discharges to other vents. These complicated changes should be studied relative to past land use changes and modeled future predictions in order to fully assess human use and impacts on the system.

Section 1.5 Measured Criteria Linked to Significant Harm

Salinity Habitats and Thermal Refuge for manatees are the two metrics examined in development of the draft. This narrow focus is insufficient.

Moreover, in setting flow criteria based on preserving manatee thermal refuge, the standard for Kings Bay and Crystal River should be to preserve 100% of anticipated manatee refuge, as at Blue Spring, because the two systems are of comparable importance to wintering manatee populations.

This section should include a more detailed discussion of manatee thermal refuge needs in the Kings Bay/Crystal River system and how that system compares to other Gulf and Atlantic coast springsheds that have used manatee thermal refuge as criteria linked to significant harm. The Draft MFL should also include information discussing the relationship among vegetation, salinity, flow, and availability of thermal refuge, as these factors are interdependent within the KB/CR system. Please also see further discussion of the analysis presented in section 1.5.2.

This seems to be the best location for the District to make its case for relying primarily upon these two criteria. Given the algae and nitrate problems in the system, water quality parameters may be more or as important to analyze in evaluating significant harm. It is particularly important for the District to clarify the interrelationship among salinity, flow, SAV health, and algal proliferation if it plans to rely on salinity as a primary criteria for assessing significant harm. Salinity harms SAV, but may also reduce the incidence of certain types of algae (or spawn growth of other algal species), and algal growth likewise impacts SAV; there has been no assessment of the net impacts on the system from these possibly conflicting trends, whereas a sustained strong flow would both reduce impacts from salinity and flush the system of algal buildup, thereby enabling the growth of natural and historical SAV communities. It may therefore make more sense for the District to consider setting the MFL relative to SAV, or else to use salinity and algae coverage or nitrate criteria combined to assess significant harm.

Section 1.5.1.2 Effects of Salinity

The fragile nature of the Kings Bay system is suggested by text within the draft:

"Burghart and Peebles (2011) found that zooplankton, ichthyoplankton, and hyperbenthos communities in spring-fed estuaries of the Florida gulf coast experience more abrupt changes with salinity than in surface-fed estuaries."

This implies a perspective limited to the bay, but there is no evidence reviewed in the draft regarding potential impacts in the near shore estuarine regions (coastal) of the system wherein salinity is a significant component of biological productivity.

This section is incomplete. It acknowledges salinity as a driver of decreased SAV, but should take the additional step of linking (here, as well as elsewhere in the document) salinity increases that damage SAV with system flow reductions. This is a general criticism of the document in that, in evaluating different parameters and criteria, the document neglects to tie the analysis back to the matter at hand – spring flows in the KB/CR system.

The Draft MFL should also assess the affects of salinity on algal growth and species composition to determine how such factors may exacerbate or mitigate SAV reductions.

Section 1.5.2 Manatee Thermal Refuge

Manatee thermal refuge habitat needs should be assessed in concert with an acknowledgement that increasing development and boat traffic in the area. The District should also consult with the federal U.S. Fish and Wildlife Service Crystal River National Wildlife Refuge staff for consistency and conservatism in evaluating thermal refuge needs.

As the Draft MFL notes, the warm water refuge at Kings Bay/Crystal River is anticipated to increase in importance as regional power plants and their artificial warm water discharges are taken offline. The Draft should carry that thought process forward and include discussion of the fact that any thermal refuge analysis must include consideration of increased numbers of manatees using the springs as winter habitat, both the local population grows and as manatees currently using artificial sources are relocated to natural warm water habitats, such as Kings Bay/Crystal River.

Section 1.6.1.1 Water Quality Standards

Please reference prior comments in this document's analysis of Section 1.4.5, in addition to the following considerations:

Table 1-6 illustrates that existing nitrogen concentrations currently exceed TMDL targets for all listed WBIDs. These water quality exceedances indicate that nitrogen is the limiting nutrient fueling algae proliferation in some of the KB/CR waterways. Again, this analysis requires a discussion of residence time, as low flow and algal buildup both create a positive feedback loop resulting in more algae.

Section 1.6.1.2 Are Water Quality Standards Being Met?

Harmful algal growth resulting from nutrient exceedance in this system is exacerbated by prolonged residence time. A 12% reduction in flow will confound recovery actions significantly, in direct conflict with objectives of the District's adopted SWIM Plan. Furthermore, adoption of the staff recommendations will conflict sharply with the state's adopted TMDL rule, which is largely based on the impact of prolonged residence time.

Section 1.6.1.4 Effect of Flow on Water Quality

"We conducted an analysis to correlate rate of discharge from spring vents with water quality of that discharge."

While this study would be valuable in informing the MFL development process, this section fails to meaningfully discuss the results. FSC requests citation and access to the study's methodology and results. This study and its results would be particularly helpful in evaluating whether additional measurable criteria linked to significant harm, such as nitrate concentrations or algal coverage, should be included in section 1.5.

Section 1.6.1.5 Management Plans

It would be of great value to citizen stakeholders, and likely to peer reviewers and regulators themselves, to outline the interrelationships among these various management schemes. It is essential for the success of the SWIM, TMDL, and BMAP processes that future management decisions such as MFL determinations be consistent with and promote the aims of prior management plans. A bird's eye level analysis here of how these different rules and tools interact and support each other would ensure cohesion across different water management categories, plans, and levels.

Section 1.6.2 Sea Level Rise

FSC requests that the District summarize the USACE recommendations it used concerning potential sea level change for evaluating coastal projects to assess the need for specific minimum flow prevention strategies for the KB/CR system over the 20-year planning horizon. If the District is anticipating or relying on aquifer levels rising due to pressure from rising sea levels, that modeling and analysis needs to be made available for public review, considering that the MFL process will essentially cement underlying assumptions and grant water withdrawals on the basis of those assumptions for at least the 10-year period prior to the MFL's next anticipated review.

More substantially, this section should be revised to be titled "Sea Level Rise and Climate Change." The Draft document acknowledges in Section 2.7 that no other effects of climate change were modeled or discussed for the purposes of developing the MFL, despite the fact that drought conditions may persist, reducing spring flows, or that increased frequency and intensity of tropical weather systems may exacerbate saltwater intrusion and a decline in the SAV community, to name only a few possible factors. A full analysis of these factors' likely and potential impacts over the course of the planning period should at least be given some consideration. These impacts have the potential to significantly alter the watershed hydrology even over the short-term, and the very uncertainty involved should obviate the importance of a precautionary and conservative approach in setting the MFL.

Section 1.6.3 Estuary Residence Time

"We include residence time as an output of our modeling effort and consider substantial increases to residence time as potentially harmful, and therefore as evidence in favor of reevaluation."

Prolonged residence time is an important driving factor in nutrient accumulation and algae growth according to the state's TMDL Rule. It is a factor that should be seriously evaluated in context of Section(s) 1.1.3 and 1.1.4 of this draft. If an 11% increase of residence occurs as envisioned in Section 4.6.2, the draft must be demonstrated to not violate the objective of significant harm or

disrupt the basis of the TMDL Rule. Arguably the TMDL rule in and of itself is basis for no further reduction of flows in the Kings Bay spring system.

Section 1.7.1 Recreation in and on the Water

*"**Surveys of residents revealed that they are interested in water clarity and reductions in algal blooms, both of which are identified in the District's SWIM plan**, and which will be addressed, in part, through minimum flow development and implementation by maintaining salinity habitats supportive of native plant establishment and persistence (Evans et al. 2007; SWFWMD 2015)."*

The surveyed residents are the District's constituents and primary source of tax revenue that funds District operations. The SWIM Plan was developed with participation of multiple stakeholders, to include ordinary citizens. They recall with clarity the many events so well presented in the FDEP TMDL document as Figure 2-3; page 18. Given their concerns, therefore, it would be helpful for the District to calculate an estimated timeframe for the time it takes an influx of nutrients in the system to vent discharge, and from discharge to algal blooms, as a function of residence time.



Hunters Cove; WBID 1341C - June 2010; Photo by Harley Means; FDEP

A discussion of water-based recreation should also include an assessment of the intensity of recreational resource use and its direct and indirect impacts **on** water quality as well as noting the importance **to** recreation of improved water quality.

Section 1.7.3 Estuarine Resources

"Estuaries are defined by the confluence of freshwater with marine waters (Day 1989; McLusky and Elliott 2004). As such, estuarine waters exhibit a range of salinities that limit the distribution and abundance of organisms. Our focus on salinity-based habitats will have wide-ranging protective effects on estuarine resources within the Crystal River/Kings Bay system. "

There is no apparent evaluation of impacts on estuarine resources external to and supported by the Kings Bay system. The coastal estuarine resources of Citrus County are a magnificent economic driver and should be defended with dedicated vigilance.

Section 1.7.6 Aesthetic and Scenic Attributes

"Residents and users of Kings Bay and Crystal River are concerned with water clarity and preventing / reducing algal blooms (Evans et al. 2007; SWFWMD 2015). In addition, the tourism industry depends upon manatee thermal refuge during cold months. Both of these concerns are addressed in our analysis of salinity habitats and volume of warm water, which should have wide-ranging effects on maintaining natural aesthetic and scenic attributes, as well as manatee habitat."

It is not clear that estimated increases in residence time will promote a linear response, or that the proposed rule will address and support SWIM Plan goals related to water clarity and algal blooms.

Section 1.7.8 Sediment Loads

"*Submarine groundwater discharge into Kings Bay is free of sediment. A natural community of submerged aquatic vegetation functions to uptake nutrients and prevent re-suspension of sediments and associated nutrients by wave action (Hoyer et al. 2001; Barko and James 2012). Therefore, focusing on preservation of low-salinity habitats and flows associated with their persistence should have strong, positive impacts on sediment loads and their effects throughout the system."*

The last sentence is speculative and conflicts with the first sentence.

Section 1.7.9 Water Quality

"We analyze several water quality parameters and attempt to relate them to freshwater inflow to the system. The two criteria we consider for setting the minimum flow are salinity and temperature, which have both been used as criteria for setting minimum flows for estuarine systems. We also present results and analysis of nutrients and dissolved oxygen concentrations. Furthermore, we model residence time as a function of spring flow to the system."

FSC applauds and supports the above analysis, and requests that the draft rule include supporting data in this section.

Section 1.7.10 Navigation

"Navigation has been impeded in the past by invasive vegetation (Evans et al. 2007). We expect setting minimum flows to protect salinity-based habitats will provide for more effective restoration of native vegetation (See Section 1.5.1.1). Water levels in the system are largely dependent upon tide and not on freshwater inflow."

By this rationale, obstruction by invasive vegetation would best be addressed by elevated salinity levels. Maximum restoration of native vegetation would be facilitated properly by reversion to baseline or flows without elevated nutrients.

Chapter 2

Section 2.1 Groundwater Levels and Discharge Measurement

How did the District account for possible seasonal variation in its ADCP measurements? The 25 days from July 27-August 20, 2009, seem unlikely to be indicative of year-round precipitation and weather patterns, which might have a measurable impact on the surface water levels and tidal variation that the study was designed to measure.

Section 2.2 Predicting Freshwater Inflow

The close proximity of ROMP TR21-3 may be a convenient reference for correlating flows to potentiometric elevations, but its low elevation suggests it to have only general validity relevant only to those discharge points within its domain. The basin is far more expansive and in some cases terrain elevations in the eastern domain exceed 120'. Potentiometric elevations to the east exceed 40' NGVD and the region is rife with a variety of conduits in the karst environment.

Section 2.5 Manatee Thermal Refuge

It is noted that thermal refuge parameters were defined per the space requirements developed for Blue Spring and the Chassahowitzka River and are designated requirements for individual manatees. The needs are presented here absent an analysis of the results of the study of available space. This section would do well to include a discussion of the impacts of the greater recreation in the KB/CR area relative to the Chassahowitzka and Blue Spring to determine possible additional space that may be needed for manatees to avoid motorboats and human harassment.

Section 2.7 Sea Level Rise

See discussion from 1.6.2, above, requesting a restatement of the USACE recommendations utilized in the MFL draft process and discussing the need to evaluate the broader impacts of climate change to predict additional impacts that may undermine baseline flow assumptions.

Chapter 3

Section 3.1 Modeled Salinity Habitats

It is not discussed why the District has selected a threshold of 85% of baseline conditions, unless this is a result of the 15% significant harm threshold discussed in Chapter 1 that is also meant to be evaluated on a case-by-case basis per the measurable criteria for significant harm. If such is the case, we are confused as to whether the 15% is arbitrary **or** is a result of analyzing a salinity threshold at which significant harm occurs. Please clarify this important point. If it is arbitrary, we argue for a more conservative and protective threshold. If it is based on the salinity threshold, we request an explanation of why 85% was selected as the point at which significant harm occurs.

Section 3.2 Modeled Manatee Thermal Refuge

It is again unclear, but becoming more likely, that the 85% target is a product of an arbitrary assumption of 15% decline in resource availability as denoting significant harm. This target is wholly inappropriate for manatees, which are a federally listed species, and for which permitted water withdrawals that cause any harm would constitute illegal "take" as defined under the federal Endangered Species Act. Any deleterious impact on the species therefore qualifies as significant harm.

Section 3.3 Modeled Sea Level Rise

Further explanation is requested to resolve confusion in this section. It is unclear, but it seems as though it is suggested here that habitat reductions that are a result of sea level rise are quantified differently or set apart from water withdrawal reductions. Anticipated sea level rise reductions should be accounted for in setting minimum flows and levels now so that consumptive use permits are not issued in the near term which may in the longer term result in reductions below the MFL as a result of sea level rise or other climate change impacts.

Chapter 4

Section 4.1 Crystal River Spring Group Discharge

Could the District please ask peer reviewers to weigh in specifically with respect to historical discharge estimates? It is confusing that the Draft MFL concludes a mean discharge of 374 cfs despite historical studies finding mean discharges ranging from 447 cfs to 735 cfs to as high as 971 cfs, while even acknowledging that "previous estimates lack the full spatial comprehensiveness" of the District's study. Given the expanded spatial comprehensiveness associated with the 70 vents the District identified, one would expect the District's discharge estimate to be even greater than historical values, at least in the absence of the marked influence of substantial climactic changes and groundwater withdrawals. An accurate estimate of historical discharges is important to determining whether "significant harm" has already occurred that would require mitigation efforts; the Draft MFL seems to assume current levels are an acceptable baseline and that there have not already been substantial declines in ecological resources in the KB/CR system. The District's conclusion here is counterintuitive at best.

Section 4.3 Modeled Manatee Thermal Refuge

This section makes the assertion that there is sufficient warm water, even with reductions, to provide thermal refuge for every manatee in the world, confusingly (and misleadingly) citing Table 3-2. This claim does not account for climate change and other damaging environmental factors, including development, that encroach upon KB/CR refugia suitability, and does not consider the physical imposition and reduction of suitable space associated with motorized water recreation activities.

Section 4.4.2 Nitrogen, Phosphorus, and Salinity

This section needs redress. Several contradictory statements are juxtaposed together within this analysis and clarification from the District or from peer reviewers is requested. The Draft MFL states on multiple occasions that the results of its system-wide analysis contradict, are even "opposite" to the results derived in the system's TMDL process. Rather than seeking to resolve these paradoxical differences in findings, the District simply concludes that the lack of a trend means that nitrate levels have not increased. Absence of evidence is not evidence of absence. Moreover, this conclusion conflicts with findings in the BMAP process which indicate excessive N loading into the system that is estimated to be substantially higher than that which is currently reflected in discharges. Common sense (and evidence contained in BMAP documents) suggests that there is a lag time in N inputs to groundwater and the discharge to the spring. Moreover, if N has not increased in the system since 1984, the District should offer an alternative theory for the recent proliferation of nuisance algae in the system.

The assertion that nutrient levels are outside the scope of the MFL process is likewise questionable, because flushing and residence time, as has been noted throughout these comments, are important factors in nitrogen uptake and re-suspension and algal growth.

Section 4.6 Supplemental Analyses

"Sea level rise and residence time were considered as supplemental to minimum flow development. This means they were not considered as measured criteria for establishing significant harm to environmental values, as was the case for salinity and manatee thermal refuge. However, once we identified the most sensitive criterion for establishing a proposed minimum flow, we determined the potential effects of implementation of the proposed minimum flow on residence time and as part of an analysis of sea level rise. Because a 15 percent decrease in the 2 ppt water volume was associated with a 12 percent reduction in flow, we investigated how that 12 percent reduction in flow will affect estuary residence time as well as salinity-based habitats and manatee thermal refuge under projected sea level rise conditions."

The failure to rely on all available components of evaluation does disservice to the draft and discredits its conclusions and recommendations. It is perfectly clear that nutrient loads, coupled with prolonged residence time in the system are, in tandem, the primary culprits of the system's inclusion on the FDEP 303(d) List of Impaired Waters. While we have little control over sea level rise, we do have the ability to influence residence time. The anticipated median of increase (residence time) within the draft resulting from a 12% reduction of flow is 11%. There is no analysis of the nature of impacts this may promote. We note that during the drought in the early part of this decade that algal blooms proliferated in Kings Bay and the sole variable at play was increased residence time that resulted from diminished flow.

Section 4.6.2 Modeled Residence Time

"Changes in residence time can contribute to increased frequency and severity of algal blooms within the estuaries (Valiela et al. 1997; Burghart and Peebles 2011 [included as appendix]; Wan et al. 2013), although the direct and indirect relationships between residence time and algal populations in the Crystal River/Kings Bay system are not known."

The statement above presents as contradictory and clarification is needed. The contribution of increased residence time is recognized to correlate with algal bloom severity, yet this factor is apparently dismissed due to the parameters of direct or indirect causal relationship, which are not established. District staff has asserted a clear correlation between residence time and algal blooms in public presentations and discussion. Prolonged residence time is the primary factor in the FDEP determination to set TMDL goals significantly below the standard .35 mg/l threshold for nitrate/nitrite pollution.

Failure to fully analyze this factor substantially detracts from the credibility of the draft.

Findings:

The Florida Springs Council, Inc. cannot support the draft recommendations for the following reasons:

1) The Kings Bay/Crystal River system is designated as impaired waters by FDEP for excessive nutrient loads. The state has developed and adopted a TMDL Rule with goals of reducing nutrient loads to levels significantly lower (0.23 mg/l N) than statewide adopted standards (0.35 mg/l N). The basis for these findings is predicated on residence time, a factor largely ignored by draft recommendations.

2) The basis for draft recommendations (2 ppt salinity) is irrelevant to findings in the TMDL rule, and in fact conflicts with the objectives of that rule.

3) The recommendations for 12% reduction are based on an essentially arbitrary 15% significant harm threshold and yet form the basis for future water use permitting, actions that may be irrevocable, or at best problematic, at a later date. The draft recommendations are not supported by review of forecasted demand increases or geographical scope of analysis. Should the Governing Board adopt the recommendations, it will be far more difficult to reverse the harm at a later date than to base authorization for higher levels of withdrawal on then current data sets. <u>The proposed rule is subject to recurrent review for such reasons and such review provides for well-founded modification based on then-current information.</u>

4) A strong argument can be made that staff recommendations for the Kings Bay/Crystal River Spring System should support a recovery strategy rather than one of additional degradation.

5) Staff recommendations are made independently of ongoing efforts by FDEP, which have resulted in a TMDL rule and development of a Basin Management Action Plan. This lack of synergy results in conflict within state agency policies, and is counterproductive to state responsibilities to protect the health, safety, and welfare of the citizens.

Recommendations:

- That staff consider the preceding comments and modify recommendations in the draft accordingly.

- That staff give consideration to recommending a recovery strategy for the system which is complimentary with ongoing FDEP rule/plan development.

Respectfully submitted,



Dan Hilliard, President
Florida Springs Council, Inc.

Enclosure

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CITRUS COUNTY
10-YEAR WATER SUPPLY FACILITIES
WORK PLAN

Prepared For:

FLORIDA DEPARTMENT OF ECONOMIC OPPORTUNITY

Prepared By:

CITRUS COUNTY
GEOGRAPHIC RESOURCES AND
COMMUNITY PLANNING DIVISION

February 26, 2013

Citrus County 10-Year Water Supply Facilities Work Plan

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Citrus County 10-Year Water Supply Facilities Work Plan

I. INTRODUCTION

The purpose of the Citrus County 10-Year Water Supply Facilities Work Plan (Work Plan) is to identify and plan for the water supply sources and facilities needed to serve existing and new population within the local government's jurisdiction. Chapter 163, Part II, F.S., requires local governments to prepare and adopt Work Plans into their comprehensive plans within 18 months after the pertinent water management district approves a regional water supply plan or its update for a region including the local government in question. The Regional Water Supply Plan (RWSP) was approved by the Southwest Florida Water Management District (SWFWMD) on July, 2011. Therefore, the deadline for local governments within the regional water supply planning area to amend their comprehensive plans to adopt a Work Plan is January 26, 2013.

According to state guidelines, the Work Plan and the comprehensive plan amendment must address the development of traditional and alternative water supplies, bulk sales agreements, conservation programs, and reuse programs that are necessary to serve existing and new development for at least a 10-year planning period.

A. Statutory History

The Florida Legislature enacted bills in the 2002, 2004, and 2005 sessions to address the state's water supply needs. These bills, especially Senate Bills 360 and 444 (2005 legislative session), significantly changed Chapter 163 and 373 Florida Statutes (F.S.) by strengthening the statutory links between the regional water supply plans prepared by the water management districts and the comprehensive plans prepared by local governments. In addition, these bills established the basis for improving coordination between the local land use planning and water supply planning efforts.

II. BACKGROUND INFORMATION

A. Overview

Citrus County is located on the coast of west-central Florida with a total area of 773 square miles, which includes about 100 square miles of inland surface-water area consisting largely of the Tsala Apopka Chain of Lakes. The County shares land boundaries with the counties of Levy, Marion, Sumter, and Hernando. The County is bounded on the north and east by the Withlacoochee River and on the west by the Gulf of Mexico.

Citrus County is still mostly rural in nature with a significant amount of conservation area and limited commercial and industrial areas. The County has been undergoing a transformation from a rural to suburban setting. The County is populated with concentrations surrounding the Cities of Inverness and Crystal

River, as well as the unincorporated areas of Beverly Hills, Floral City, Hernando, and Homosassa. Most of the development since 1999 has occurred in and around areas already designated for single family residential. This has led to portions of the County being designated as an urbanized area according to the 2010 Census where the Homosassa Springs-Beverly Hills-Citrus Springs, FL urbanized area has a population of 80,962. The Crystal River and Sugarmill Woods communities have been identified as Urban Clusters according to the 2010 Census with populations of 4,388 and 8,816, respectively.

III. DATA AND ANALYSIS

A. Population Information

The countywide population projections provided by Bureau of Economic Research (BEBR) do not account for seasonal populations. This information is important to consider when planning for water supplies, as it helps identify where growth is occurring and determine the peak demands on public facilities and services. The University of Florida Shimberg Center for Affordable Housing provides population projections at the municipal level, from which the population residing in unincorporated areas can be derived as the remainder of the total BEBR population. In 2010, only 7.31% of the total population of Citrus County resided in the Cities of Inverness and Crystal River. The Shimberg Center projects the unincorporated areas to grow at a faster rate than the municipal centers of Inverness and Crystal River, so that by year 2030, the municipal population will only account for 5.59% of the County's population.

Seasonal population is an important factor for Florida communities. While Citrus County is not considered a major tourist area as compared to other areas of the state, there are people that spend the winter months in the County. A significant amount of Citrus' seasonal population is comprised of retirees.

Table 1 provides population projections for the County through 2025. These population projections are for the Cities of Inverness and Crystal River, and the unincorporated areas of the County, including an estimated seasonal population. Total population is represented in Table 1 as opposed to the population served by utility agencies as shown in Table 2. Population served is less than total population for several of the service areas.

For the purposes of this Work Plan, the unincorporated seasonal population was estimated as a proportion of the total population.

B. Current and Future Geographic Areas Served

Figure 1 depicts current and potential future boundaries of County owned utilities and other public or private water providers.

TABLE 1
CITRUS COUNTY POPULATION PROJECTIONS
2010 - 2025

Jurisdiction	2010 Base	2015	2020	2025
City of Inverness[1]	7,210	7,385	7,550	7,675
City of Crystal River[1]	3,108	2,993	2,836	2,682
Unincorporated Citrus County[2]	141,236	150,876	162,402	173,602
Total County Seasonal[*]	14,406	15,995	17,864	19,790
TOTAL	**165,960**	**177,249**	**190,652**	**203,749**

Sources:
[1] University of Florida Shimberg Center for Affordable Housing,
[2] BEBR mid-range population projection as reported in the Florida Statistical Abstract 2011, Table 1.41
*Seasonal projections by Geographic Resources and Community Planning Division using U.S. Census Bureau American Fact Finder
Prepared by: Citrus County Geographic Resources and Community Planning Division, 2012

C. Population and Potable Water Demand Projections by Each Local Government or Utility

Table 2 shows the population and potable water demand projections for the potable water service areas and future service areas within Citrus County. The Comprehensive Plan has a list of Community Water Systems which are small utilities associated with trailer parks, condominiums, and other small communities in Citrus County contained in Appendix E.

D. Water Supply Facilities

Citrus County is presently served by six regional potable water supply facilities (see Figure 1). Citrus County Utilities Division operates and maintains the largest of these supply facilities. The remaining regional facilities are owned, operated, and maintained by private and semi-public utilities. These include Floral City Water Association, Homosassa Special Water District, and Rolling Oaks Utilities. In addition, the Cities of Crystal River and Inverness operate regional facilities

Citrus County 10-Year Water Supply Facilities Work Plan

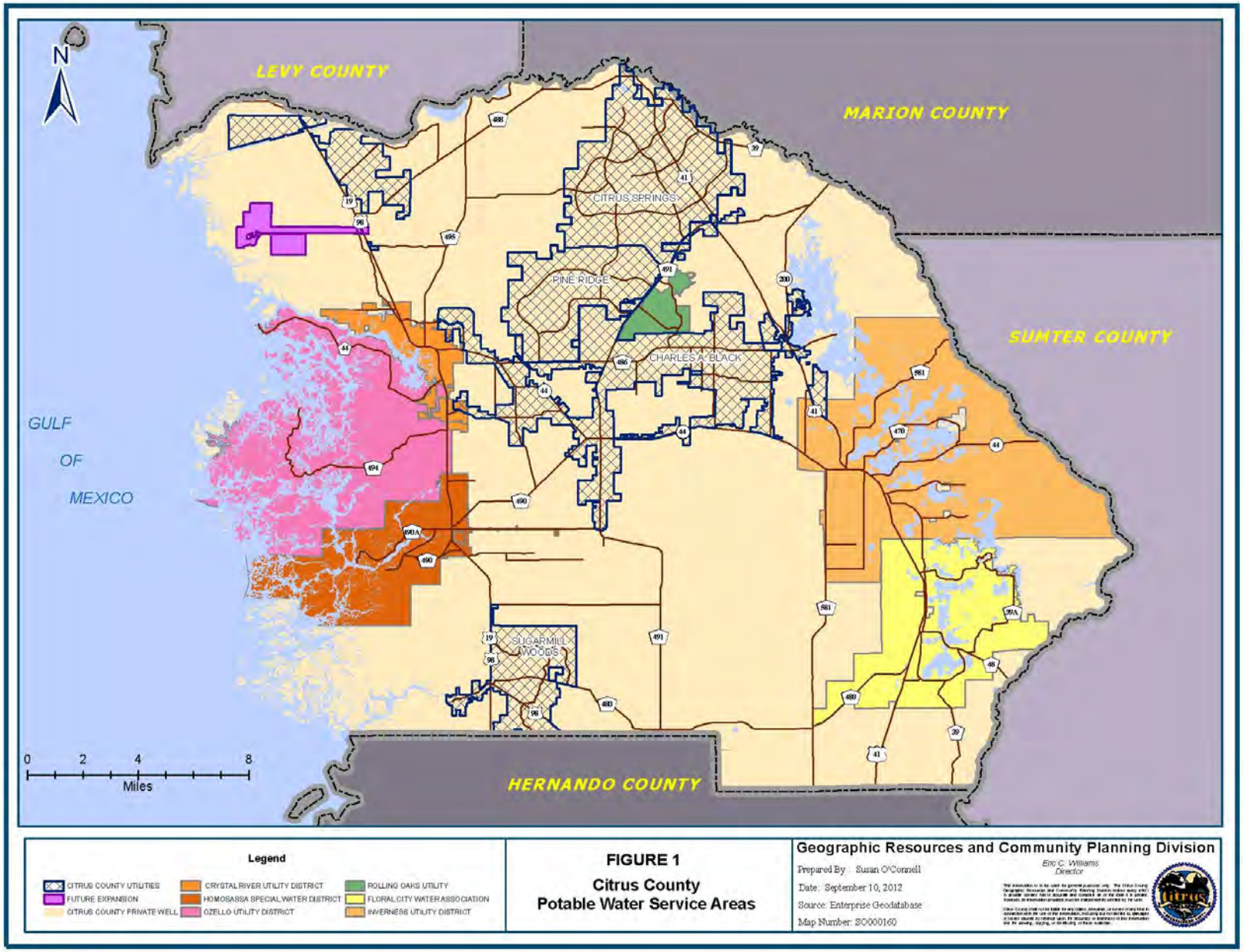


TABLE 2
POPULATION AND POTABLE WATER DEMAND PROJECTIONS
2010 - 2025

Utility Name	2010	2015	2020	2025
Citrus County Utilities				
County Population Served	92,593	101,489	112,026	122,488
Demand (MGD)	18.241	19.993	22.069	24.130
Total Utility Service Area Pop.	92,593	101,490	112,026	122,488
Demand (MGD)	18.241	19.993	22.069	24.130
City of Inverness				
County Population Served	209	209	209	210
Demand (MGD)	0.034	0.034	0.035	0.035
Total Utility Service Area Pop.	8,266	8,473	8,716	8,958
Demand (MGD)	1.364	1.398	1.438	1.478
City of Crystal River				
County Population Served	30	32	34	36
Demand (MGD)	0.005	0.006	0.006	0.006
Total Utility Service Area Pop.	5,213	5,298	5,396	5,493
Demand (MGD)	0.923	0.938	0.955	0.972
Floral City Water Association				
County Population Served	7,374	7,532	7,715	7,898
Demand (MGD)	0.413	0.422	0.432	0.442
Total Utility Service Area Pop.	7,374	7,532	7,715	7,898
Demand (MGD)	0.413	0.422	0.432	0.442
Homosassa Special Water District				
County Population Served	6,301	6,859	7,499	8,137
Demand (MGD)	0.819	0.892	0.975	1.058
Total Utility Service Area Pop.	6,301	6,859	7,499	8,137
Demand (MGD)	0.819	0.892	0.975	1.058
Rolling Oaks Utilities, Inc.				
County Population Served	9,635	9,762	9,911	10,044
Demand (MGD)	1.715	1.738	1.764	1.788
Total Utility Service Area Pop.	9,635	9,762	9,911	10,044
Demand (MGD)	1.715	1.738	1.764	1.788
Small Utilities (Community Water Systems)				
County Population Served	6,438	6,782	7,179	7,573
Demand (MGD)	1.140	1.200	1.271	1.340
Total Utility Service Area Pop.	6,438	6,782	7,179	7,573
Demand (MGD)	1.140	1.200	1.271	1.340
Domestic Self Supply				
Population Served	20,385	21,388	22,564	23,743
Demand (MGD)	2.548	2.673	2.820	2.968
Totals				
Total County Population Served	143,815	154,930	168,049	181,074
Total Demand (County)	25.052	27.099	29.518	31.919
Total Demand (Utilities)	24.751	26.722	29.050	31.360

Source: SWFWMD 2010 Regional Water Supply Plan Community Sheets
Prepared by: Citrus County Geographic Resources and Community Planning Division, 2012

Citrus County 10-Year Water Supply Facilities Work Plan

1. Citrus County Utility System

a) The Charles A. Black - No. 1 Water Plant (CAB-No.1), formerly known as Hampton Hills plant is the major Citrus County potable water supply facility within the WRWSA system development plan. The current facility is served by five wells and has a permitted well pumping (withdrawal) capacity of 6.48 mgd peak month and a storage capacity of eight million gallons. Other regional and package water systems have linked or are projected to link to the CCUD system. The former Celina Hills, Hilltop, and Meadowcrest water systems have linked to the Hampton Hills system, as well as, the Ozello Water Association and the City of Crystal River via the Meadowcrest link. The entire facility was rededicated as the Charles A. Black facility in honor of Mr. Black's long service with SWFWMD. The predominant land uses served by the facility are single family residential with some commercial.

b) The Charles A. Black - No. 2 Water Plant (formerly Meadowcrest) facility service area has been incorporated within the Charles A. Black service area. Initially, the Meadowcrest Water Plant served the Meadowcrest and surrounding areas and portions of the City of Crystal River. The current facility is served by two wells with a permitted pumping capacity of 2.16 mgd peak month and has a storage capacity of one million gallons.

   The predominant land use served by the facility is single-family residential. Office, light industrial, and low density multifamily residential land uses are also served by the system.

   The facility is not planned for any additional capacity in the future. The Charles A. Black facility is projected to serve all future portions of the Meadowcrest service area.

c) The Citrus Springs and Pine Ridge Utilities facilities have been acquired by Citrus County and are currently operated by the Citrus County Utility Division. The area currently serviced by this utility includes the Citrus Springs and Pine Ridge developments in the northern half of the County, which is predominantly single family residential.

   Much of the system's infrastructure in Citrus Springs has not been installed and added capacity is anticipated to accommodate projected growth.

   The condition of these facilities is considered satisfactory. The only treatment to the raw water required is chlorination. These facilities are located along the Brooksville Ridge, which contains one of the best potable water sources in the state.

d) The Sugarmill Woods Utility system was acquired by Citrus County and is currently operated by the Citrus County Utility Division. The area currently serviced by this utility includes the Sugarmill Woods and Chassahowitzka developments in the southern portion of the County.

The predominant land use served by the facility is single family residential although some commercial and multifamily developments also are served.

e) The Ozello Water Association purchases water from Citrus County Utilities. The source is the Charles A. Black Facility.

Approximately 28 percent of the connections serve general commercial and strip commercial land uses while the remaining connections serve single family residential development.

The Ozello Water Association serves approximately 450 commercial establishments.

f) The combined Citrus County Utility system will have a projected 2025 demand of 24.13 mgd as identified in Table 2. The permits for Charles A Black, Citrus Springs-Pine Ridge, Sugarmill Woods, and the Ozello Water Association expire in 2022, 2015, 2019, and 2021, respectively. Citrus County also holds permits for a number of smaller systems which have varying permit expiration dates. Citrus County is working to interconnect these smaller systems and transfer the demand to the larger systems that it operates. In order to meet demand the permits for each of the facilities will need to be renewed in sufficient time to meet demand.

2. Crystal River Utility System

The City of Crystal River has about 30 residents in the southern portion of the city that receive potable water from Citrus County Utilities. In this area of the County/City the potable water utility provider is Ozello Water Association. The Ozello Water Assn. purchases water from CCUD and provides water to City residents. The City of Crystal River bills the City residents for their potable water use.

The projected 2025 demand for the Crystal River residents on CCUD systems is 0.972 mgd. In order to meet demand the permits for each of the CCUD facilities will need to be renewed in sufficient time to meet demand. See description above in section f.

3. Inverness Utility System

The City of Inverness' primary source of water for potable, agricultural, and industrial use is groundwater from the Floridan Aquifer. Presently, 100

percent of water used for these purposes is withdrawn from the Floridan Aquifer.

There is one public water supply system within the City which consists of two wells and three storage tanks. The plan design capacity is 2.7 mgd of which the current maximum daily demand is 1.548 mgd. Expansion of the existing water facility will be needed when the projected potable water demand reaches 80 percent of the design capacity of the existing water plant. There is one major private facility serving Inverness Village Condo Association within the City and numerous private residential wells located mainly in the western portion of the City.

The City currently operates at a maximum of 2.239 mgd and anticipates the current and future water supply needs will be met under the current consumptive use permit. The City is working with SWFWMD to drill a third well to replace the second well, and have drilled two monitoring wells to monitor aquifer levels. A fourth well is included in the 2011-2012 master water use plan to be used in conjunction with a new plant.

The City of Inverness is projected to have a 2025 demand of 1.478 mgd. Their permit will expire in 2021. In order to meet demand the utility will need to implement conservation measures along with renewing the permit within the planning period.

4. Floral City Water Association

The Floral City Water Association service may be extended south and west of the area shown, along CR-480, as development occurs in this area.

Approximately 96 percent of the land uses served by the water system are single family residential developments. Approximately four percent of the connections serve general commercial land uses.

The Association expanded the facilities in 1985, and may have to expand again in future years to accommodate projected growth within the service area, particularly along the CR-480 corridor.

There are several concerns associated with the general condition of this facility that warrant discussion. This facility produces water that is high in iron and hydrogen sulfide content. The treatment of the water includes sand filters to reduce the iron content. Also, an aeration process takes out the small amount of hydrogen sulfide, as well as, reduces the iron content.

This system also has a circulation problem with dead end lines due to the lakes within the service area. Because of the dead end lines, there have been resident complaints about stale water. The Water Association is required to blow off the stagnant water periodically.

In 1984, the facility was extensively modified to improve functionality. Because of this, and the expansion of the facility in 1985, the facility is now in satisfactory condition.

Recently, a new facility has been approved along the CR-480 corridor. The proposed facility is made up of two wells, a treatment facility, and storage tank.

The Floral City Water Association is projected to have a 2025 demand of 0.442 mgd. Their permit will expire in 2018. In order to meet demand the utility will need to implement conservation measures along with renewing the permit within the planning period.

5. Homosassa Special Water District

The Homosassa Special Water District service area is not projected to expand greatly. Expansion may occur along the US-19 corridor, as needed for commercial development, and adjacent to the north-western most service area as needed for residential development.

Approximately 92 percent of the connections serve single family residencal and eight percent of the connections serve general and strip commercial land uses, principally along the US-19 corridor.

This facility is planned for additional capacity. Since this is one of the oldest systems in the unincorporated County, there is an ongoing program to replace the old galvanized metal piping with polyvinyl chloride (PVC) piping.

The facility expanded by developing a new well field site with a one million gallon storage tank on site.

Recently the HSWD, with assistance from the Florida Rural Water Association and FDEP, produced a wellhead protection plan. This plan identifies three levels of protection based on hydrogeology, well construction, and pumpage.

The Homosassa Special Water District is projected to have a 2025 demand of 1.058 mgd. Their permit will expire in 2022. In order to meet demand the

utility will need to implement conservation measures along with renewing the permit within the planning period.

6. Rolling Oaks Utilities

The service area, as shown, is not expected to change although extensive infilling is to occur.

The predominant land use served by the Rolling Oaks Utilities potable water system is single family residential. However, future phases of the Beverly Hills Development, which is served by Rolling Oaks Utilities, include multifamily land uses. This facility has had a history of pressure problems associated with it due to the amount of irrigation and domestic use during the summer months. The facility's past expansions include a new well and an additional storage tank. Should the facility need additional expansion the service area contains areas set aside for utility use.

It is anticipated that County water facilities will be servicing the area west of CR-491 across from the Beverly Hills community and expansion of the Rolling Oaks Utilities system to this area is not expected. This, however, should not preclude the establishment of additional wells needed within the service area to serve the Beverly Hills community.

Rolling Oaks Utilities is projected to have a 2025 demand of 1.788 mgd. Their permit will expire in 2018. In order to meet demand the utility will need to implement conservation measures along with renewing the permit within the planning period.

7. Small Private Water Utilities

The sporadic nature of development in Citrus County has resulted in a large number of privately-owned community water systems. In most instances, the entity operating a potable water system is an investor owned utility company or homeowners' association. In the remaining cases, the entity is an owner of a recreational vehicle park or manufactured home park.

The general geographic locations and the population served for the 54 community water systems are represented in Figure 2.

The predominant land uses served by the water systems are single and multifamily residential. Other land uses are general commercial, public/semipublic buildings, and RV Parks.

8. Self Supply

A significant number of individual water users within unincorporated areas of the County are self supplied through domestic wells.

E. Potable Water Level of Service Standard

The level of service standard is established as 150 gpd/p. The basis for the standard is in accordance with the permits for the Citrus County Utility regional systems (Charles A. Black No. 1, Charles A. Black No. 2, Citrus Springs and Pine Ridge, and Sugarmill Woods) which are operated by the Citrus County Department of Water Resources.

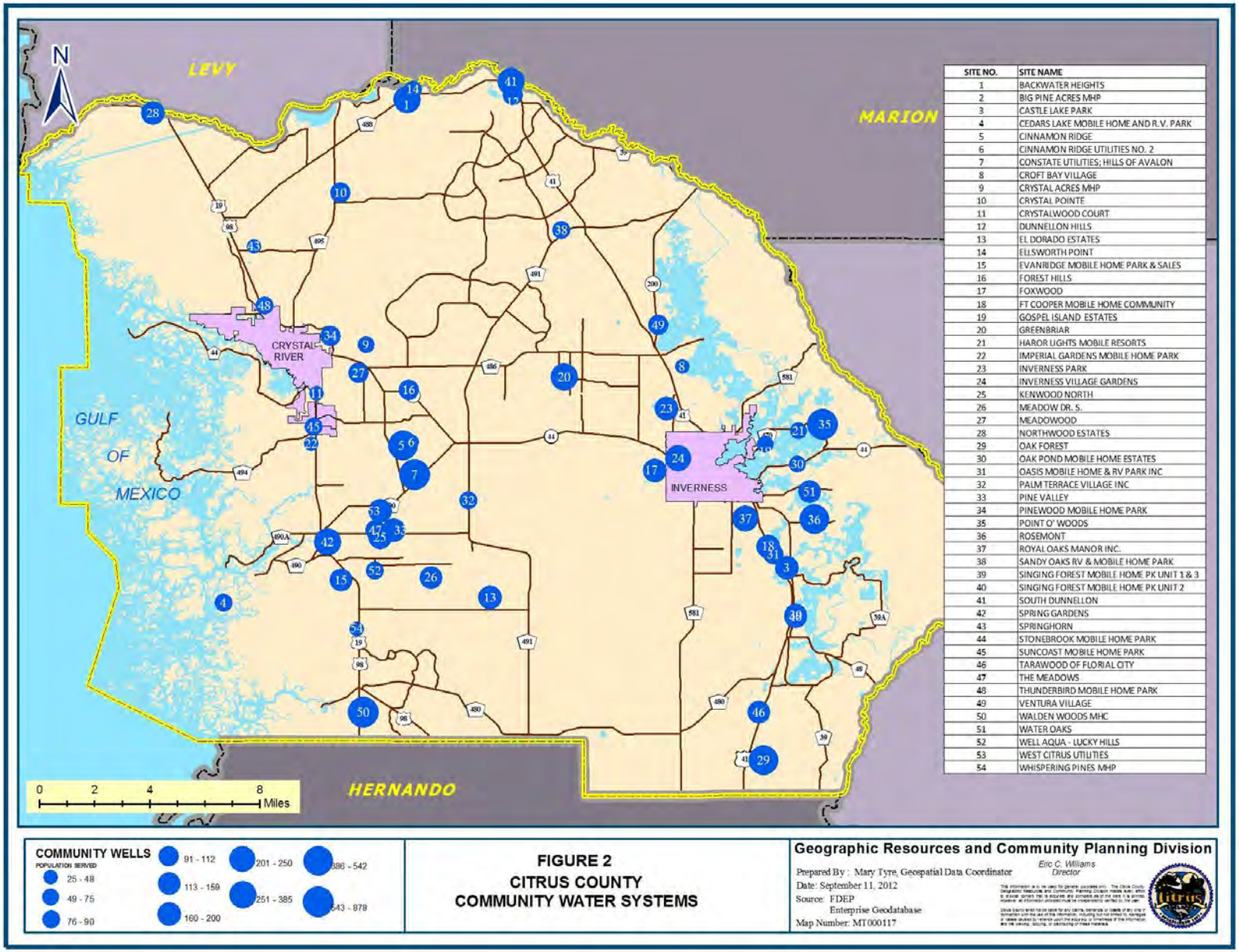
F. Future Water Supply Demands

By 2025, the water system service area is projected to have a functional population of 181,074 resulting in an annual average daily demand of 31.919 mgd. The Withlacoochee River, located along Citrus County's East and North border, has the potential to provide for an additional 93 mgd of water supply, should the need arise. Another factor contributing to the amount of future water supply demand is the projected increase in availability and utilization of reclaimed water. In 2005, Citrus County had a potable water offset (65% utilization) of 0.02 mgd from reclaimed water. This offset from reclaimed water is projected to be as high as 5.36 mgd with 75 percent utilization in the planning period. There is also a potential for seawater desalination as a future source of potable water. A large-scale desalination facility able to produce up to 15 mgd is possible if co-located with Duke Energy's Crystal River power station near the Gulf of Mexico. By reducing the demand on potable water through conservation, better utilization of reclaimed water for non-potable water demands, and possible use of desalination, Citrus County plans to meet any future demands for potable water.

G. Non-Potable Water Supply Demand

Non-potable water is a broad category that includes water for agricultural, commercial, recreational, and aesthetic uses. Agricultural water supply is used to irrigate crops as well as other miscellaneous uses associated with agricultural commodity production. Irrigated crops include citrus, row crops, grasses, nurseries, and pasture. The miscellaneous supply demands include aquaculture, dairy, poultry, and swine. Agriculture water supply demands are expected to remain at or below the current demand levels through the 10 year projected planning period. A change in the methodology used to permit water use in mining operations could help mitigate the projected increase to the projected demand in water.

Citrus County 10-Year Water Supply Facilities Work Plan



SITE NO.	SITE NAME
1	BACKWATER HEIGHTS
2	BIG PINE ACRES MHP
3	CASTLE LAKE PARK
4	CEDARS LAKE MOBILE HOME AND R.V. PARK
5	CINNAMON RIDGE
6	CINNAMON RIDGE UTILITIES NO. 2
7	CONSTATE UTILITIES; HILLS OF AVALON
8	CROFT BAY VILLAGE
9	CRYSTAL ACRES MHP
10	CRYSTAL POINTE
11	CRYSTALWOOD COURT
12	DUNNELLON HILLS
13	EL DORADO ESTATES
14	ELLSWORTH POINT
15	EVANRIDGE MOBILE HOME PARK & SALES
16	FOREST HILLS
17	FOXWOOD
18	FT COOPER MOBILE HOME COMMUNITY
19	GOSPEL ISLAND ESTATES
20	GREENBRIAR
21	HAROR LIGHTS MOBILE RESORTS
22	IMPERIAL GARDENS MOBILE HOME PARK
23	INVERNESS PARK
24	INVERNESS VILLAGE GARDENS
25	KENWOOD NORTH
26	MEADOW DR. S.
27	MEADOWOOD
28	NORTHWOOD ESTATES
29	OAK FOREST
30	OAK POND MOBILE HOME ESTATES
31	OASIS MOBILE HOME & RV PARK INC
32	PALM TERRACE VILLAGE INC
33	PINE VALLEY
34	PINEWOOD MOBILE HOME PARK
35	POINT O' WOODS
36	ROSEMONT
37	ROYAL OAKS MANOR INC.
38	SANDY OAKS RV & MOBILE HOME PARK
39	SINGING FOREST MOBILE HOME PK UNIT 1 & 3
40	SINGING FOREST MOBILE HOME PK UNIT 2
41	SOUTH DUNNELLON
42	SPRING GARDENS
43	SPRINGHORN
44	STONEBROOK MOBILE HOME PARK
45	SUNCOAST MOBILE HOME PARK
46	TARAWOOD OF FLORIAL CTY
47	THE MEADOWS
48	THUNDERBIRD MOBILE HOME PARK
49	VENTURA VILLAGE
50	WALDEN WOODS MHC
51	WATER OAKS
52	WELL AQUA - LUCKY HILLS
53	WEST CITRUS UTILITIES
54	WHISPERING PINES MHP

Commercial potable and non-potable water supply is used in various types of commercial and industrial uses including manufacturing, food processing, mining, dewatering, and power generation. Water used for power generation is primarily used for cooling or other purposes associated with the generation of electricity. Commercial water supply demands are expected to increase in Citrus County through the 10 year projected planning period.

Some alternative sources of non-potable water for agricultural and commercial use are rainwater harvesting and reclaimed water. Rainwater harvesting could offset the amount of water used by collecting surface water runoff and then pumping the collected runoff to be utilized. The use of reclaimed water is dependent on the location of the reclaimed water facilities in relation to sites that could benefit from it.

TABLE 3
CITRUS COUNTY NON-POTABLE WATER DEMAND PROJECTIONS , MGD
2005 – 2025

Water Use Category	Planning Period					Total Increase	
	2005 Base	2005-2010	2010-2015	2015-2020	2020-2025	MGD	%
Public Supply	22.0	5.5	2.9	2.5	2.4	13.3	70.4
Agriculture	0.45	-	-	-	-	0.0	0.0
I/C, M/D, PG	1.7	1.1	0.1	0.1	0.1	1.4	82.4
Rec/Aesthetic	5.4	0.8	0.7	0.6	0.6	2.7	50.0
Incremental Increase	n/a	7.4	3.7	3.2	3.1	17.4	n/a
Cumulative Increase	29.5	36.9	40.6	43.8	46.9	17.4	59.0

Source: SWFWMD 2010 Regional Water Supply Plan
Prepared by: Citrus County Geographic Resources and Community Planning Division, 2012

H. Conservation and Reuse

1. Citrus County Department of Water Resources has enacted a Water Conservation Plan as part of their water use permits. The Water Conservation Plan includes measures to reduce demand on both the supply side and demand side.

   The following water conservation measures are identified in the conservation plan:

   - Informative Customer Billing
   - Leak Detection Program
   - Meter Replacement Program
   - Customer Leak Notification

- Water Conservation Rate Structure
- Toilet and High Efficiency Washer Rebate Program
- Free Indoor Retrofit Kits
- Irrigation System Audits
- Water Restriction Enforcement
- Bill Inserts
- Florida Friendly Landscape Program

As a result of these measures the Citrus County Utilities Division has conserved approximately 10.545 million gallons of water. These water conservation measures will have a substantial impact on the amount of water available for future needs. Table 4 shows the quantified amount of water that is saved by some of these programs and projects what those savings will be through to 2025.

Current State law provides limited protection against exporting local water resources outside the region to out of County water consumers. The damage that can occur is clearly exemplified by the loss of wetlands and lakes within Pasco County since development of regional wellfields by Tampa Bay Water (TBW), formerly known as the West Coast Regional Water Supply Authority (WCRWSA), to serve the highly developed areas within the Tampa Bay Region.

TABLE 4
QUANTIFIED WATER CONSERVATION
SAVINGS PROJECTED THROUGH 2025

Conservation Measure	2012 Water Savings (gallons)[1]	Projected Savings (million gallons)*
Ultra Low Flush Toilet Rebate	2,866,710	37.26
Rain Sensor Device Rebate	876,000	11.38
Bathroom Faucet Aerator	626,778	8.14
Irrigation Audit w/ Rain Sensor Device Installation	2,226,500	28.94
Total	**6,595,988**	**85.72**

Source:
[1] Citrus County Department of Water Resources conservation projections, 2012
* Projected savings by Geographic Resources and Community Planning Division, 2012
Prepared by: Citrus County Geographic Resources and Community Planning Division, 2012

Seawater desalination at the Duke Energy power plant and expansion of existing wastewater treatment facilities and collection systems to increase reuse within the county are all viable options for increasing the amount of reclaimed water available, lessening the need for potable water. The wastewater treatment plant expansions include Beverly Hills/Rolling Oaks, Brentwood, Meadowcrest, Sugarmill Woods, Citrus Springs, and Crystal River. Citrus County has applied for Cooperative Funding through the SWFWMD to expand its waste water lines to ± 75 homes in the environmentally sensitive Homosassa River area.

Recreational and aesthetic water supply is used for golf courses, parks, medians, landscaping, and other large green areas. Golf courses historically have a high demand for irrigation. Growth in golf courses is projected for Citrus County, which in turn increases the demand for water supply. Landscaping and aesthetic water supply demand has increased along with the population of the County. As the population is projected to increase, aesthetic water supply demand is also projected to increase. These water supply demands increase for recreational and aesthetic use can be significantly reduced with extensive development of reclaimed water sources.

Citrus County produces reuse water at the Meadowcrest WWTP, which is sent to the Black Diamond Golf Course. Projections for 2013 estimate that 140 million gallons per year could be used for golf course irrigation.

A reclaimed water line is proposed to be installed at the Sugarmill Woods WWTP in 2015. Sugarmill Woods WWTP currently produces just under 500, 000 gallons of waste water per day that could potentially be used to irrigate nearby golf courses.

2. City of Inverness has adopted a Water Conservation Plan which was developed by the City Public Works Department. Conservation measures include a water conservation rate structure, customer billing and meter reading procedures, water loss detection, and Land Development Code standards regarding landscaping and irrigation.

3. City of Crystal River's primary conservation policy is the use of a water conservation rate structure which charges a higher rate with higher consumption by the resident. The City also makes use of educational pamphlets available to customers in the Utility Billing department as well as in the form of billing inserts and notations on customer statements. Additionally, the City's water utility contractor conducts meter audits and repairs and calibration of large meters, spot checking residential meters, and making repairs, replacements and new installations as necessary. Finally, partnering with the Southwest Florida Water Management District, the city administers a leak detection program.

4. Floral City Water Association does not have its own conservation plan policies and instead "refer" its residents to the County's Water Conservation Plan – April 2012.

5. Homosassa Special Water District has had a water conservation rate structure as part of its conservation efforts since 1995 and is part of its SWFWMD permit. Additionally, the utility makes use of informative customer billing, a leak detection program, a meter reading program, and customer leak notification.

6. Rolling Oaks Utilities has several conservation policies in place, many of which duplicate the County policies. They include leak detection, customer leak notification (after no response from homeowner their water is shut off), meter replacement (300 per year), signs throughout the community warning residents to look out for leaks and broken sprinkler heads, and a weekly publication also comes out that discusses water issues and conservation.

I. Interlocal Agreements

In accordance with previous studies and proposals, the County and the City of Inverness have entered into an Interlocal Agreement to protect the health, safety, and welfare of its citizenry and discourage the proliferation of package plants in environmentally sensitive areas and promote compact orderly growth. The Agreement allows the City to provide water service to a specified area of unincorporated Citrus County within the Inverness area (refer to Figure 5-8 in the Sanitary Sewer Sub-element). Additional agreements with other regional utility operators may be considered at a future date.

J. Capital Improvement Projects

In 2006, the county acquired a number of potable water systems from the Florida Governmental Utility Authority (FGUA). The acquired systems have been integrated in to the county potable water systems. The Capital Improvement Element of the Comprehensive Plan lists the water treatment plants with the current capacity at each plant and the average flows. Table 5 outlines the planned improvements over the next five years. The county has enough capacity to meet planned growth beyond the five-year planning horizon. The projects listed in Table 5 consist mainly of water main extension and upgrades at water treatment plants in accordance with F.A.C. regulations.
Efforts to expand the potable water system are being concentrated in the Central Ridge Area and Planned Service Area of the county. This is where the county is planning for future growth. Many homes in the environmentally sensitive areas

have been connected to central potable water systems over the years. Many of these projects were funded predominantly through grants. A significant number of homes in these environmentally sensitive areas shall remain on private wells. Homes in the less dense areas of the county will continued to be served by private wells. The current planned service area within the county is limited in scope. Some of the environmentally sensitive areas are served by the City of Crystal River and the City of Inverness.

The County will continue to maintain the level of service standard within the planned service area beyond 2025. Potable water capacity is available to address additional growth within the planned service area via the Charles A. Black 1 and 2 facilities.

TABLE 5
CITRUS COUNTY WATER SUPPLY
FACILITIES CAPITAL IMPROVEMENTS 2012-2016

Project Description and Location	Cost
Citrus Springs Topeka Line Extensions	1,400,000
Misc. Renewal & Replacement*	5,938,900
O&M Hardware & Systems Imp – Telemetry*	2,663,000
Fire Hydrants	770,000
Water General Infill Projects	2,000,000
Dawson Street (12" Water Line) Phase 1	450,000
S.R. 44 from Curlew Pl. to Meadowcrest Blvd.	400,000
Golden Terrace Misc. Improvements	-
Oak Forest Misc. Improvements*	-
Foxwood Water Interconnect	-
West Side Fire Flow Improvements	-
Steven Street from Hartford to Croft	475,000
Emergency Generators*	270,000
C.R. 491 & C.R. 486 Connection On Pinecone	540,000
S.R. 44 from Enterprise to Crystal Oaks	670,000
Rock Crusher (C.R. 490) Water Main Extension	1,235,000
Automatic Meter Reading Project	5,000,000
NW Quadrant Water Extensions	4,000,000
TOTAL	**$25,811,900**

*Project costs also include wastewater systems as outlined in Sanitary Sewer Subelement
Source: Citrus County Capital Improvement Plan, 2012-2016
Prepared by: Citrus County Geographic Resources and Community Planning Division, 2012

IV. GOALS, OBJECTIVES, AND POLICIES

GOAL 1: To provide a reliable, efficient and cost-effective water supply system which delivers the adequate quantity and quality of water to satisfy domestic, industrial, commercial, and agricultural purposes without compromising the sustainability of the County's water resources.

Objective 1.1: To appropriately plan for the County's Water Facilities to address current and future demands.

Policy 1.1.1: The County shall identify, evaluate, and select the most cost-effective means of ensuring an adequate water supply including surface water supply, reuse of treated wastewater, demand reduction, conservation, and peak saving through system integration.

Policy 1.1.2: Ensure that the County's Water Facilities are planned in a consistent manner with the County's Comprehensive Plan, especially with the Future Land Use Element and other infrastructure elements.

Policy 1.1.3: Ensure that the County's Water Facilities are planned with the actions defined within the Regional Water Supply Plan prepared by the South West Florida Water Management District (SWFWMD).

Objective 1.2: To ensure that the Potable Water System has adequate facilities maintenance and capacity to satisfy the existing and projected demand.

Policy 1.2.1: Continue to provide regular inspection and preventative maintenance for all the water facilities as required.

Policy 1.2.2: The water treatment facilities within the County shall supply water which meets all applicable federal, State, regional, and local standards.

Policy 1.2.3: The County shall develop and maintain a rehabilitation and replacement program directed at the older portions of the County's existing utility systems.

Policy 1.2.4: The County will continue to monitor current and future developments and will determine required improvements to accommodate these developments.

Policy 1.2.5: Provide treated water to the water distribution system at adequate volume with sufficient pressure to satisfy the demands for potable water.

Citrus County 10-Year Water Supply Facilities Work Plan

Objective 1.3: To assure that adequate Levels of Service are provided by water facilities within their Water Service Area for existing and future populations through the year 2025.

Policy 1.3.1: The Level of Service standards of 150 gpd/p has been established for the County and shall be used in determining the availability of facility capacity and demand created by new development.

Policy 1.3.2: Potable Water Concurrency shall be met at time of development order approval.

Objective 1.4: To expand and improve the efficiency of the County's water conservation and demand reduction programs in order to reduce per capita consumption of potable water.

Policy 1.4.1: The County shall continue its program to research, develop and promote efficient, economically feasible and environmentally sensitive water use and conservation techniques and promote implementation.

Policy 1.4.2: The County shall continue to reduce potable water consumption through water conservation rates, operational measures, rebate programs, landscape and irrigation efficiency programs, educational initiatives, research and evaluation, and re-use alternatives.

Policy 1.4.3: The County shall encourage the use of non-potable water, when potable water is not required, in order to reduce the unnecessary use of potable water.

Objective 1.5: To maintain equitable and financially sound fees and rate structures to support fiscal and capital programs necessary to sustain and develop adequate potable water system facilities.

Policy 1.5.1: The potable water fees, rates, and charges shall be based on sound economic and engineering practices.

Policy 1.5.2: The fees, rates, and charges shall cover system operating costs, programmed projects in the CIP, and estimated funds for emergency repairs.

Policy 1.5.3: Charges for potable water system usage shall reflect all operation costs consistent with the amount of water demand by each system consumer.

Policy 1.5.4: Explore local, state and federal grants to help finance water programs.

Policy 1.5.5: To annually monitor whether the costs of acquiring, interconnecting, and upgrading the facilities to current standards will be offset by the existing and projected rate base of the utility.

Objective 1.6: To prioritize and schedule major water facilities improvements as a component of the capital improvement program.

Policy 1.6.1: The County shall implement the Five-Year Capital Improvement Program (CIP) which shall be updated annually and amended as appropriate.

Objective 1.7: To coordinate and cooperate with all Federal, State, and local agencies to insure safe and sufficient water supply to be provided at a cost-effective rate.

Policy 1.7.1: Coordinate with other County departments on planning capital improvements projects in order to reduce costs and promote efficient use of resources.

Policy 1.7.2: The County shall continue to participate and assist the Withlacoochee Regional Water Supply Authority, the Southwest Florida Water Management District, the United States Environmental Protection Agency in developing innovative techniques to augment existing water supplies to provide for future demands.

Policy 1.7.3: The County shall ensure that their 10-year Water Supply Facilities Work Plan is updated within 18 months of the Southwest Florida Water Management District updating their plan.

5.0 APPENDIX

Water Conservation Plan

April – 2012

Citrus County
Department of Water Resources

INTRODUCTION

Water is the backbone of Citrus County. We use it for recreation. Tourism is dependant on it. Citrus County's unique habitats and wildlife cannot live without it. Thus, it is imperative the county maintain a high quality and quantity of water to ensure its future prosperity.

Situated on the gulf coast, Citrus County abounds with water resources. Seven major rivers flow through Citrus County, including Crystal River, Homosassa River, Hall's River, Chassahowitzka River, Withlacoochee River, St. Martins River and Salt River. In addition, there are over thirty square miles of lakes throughout the county. The abundance of these natural resources and their recreational opportunities are surely high among the reasons that citizens and tourists alike flock to Citrus County. This may also account for the county's population growing nearly twenty percent within the last ten years to 139,747 citizens[1]. Although growth has slowed with the recent economic downturn, demands on the quality and availability of our water resources make planning essential to meeting our future water needs.

Citrus County is fortunate to have access to groundwater from the Floridan aquifer, one of the world's most productive aquifers[2]. One hundred percent of the water used in homes and businesses in Citrus County comes from the Floridan aquifer, regardless if it is received via a private well or public utility. Groundwater supplies, as well as Citrus County's lakes and rivers, are highly dependent on rainfall for replenishment.



The Floridan aquifer system is one of the most productive aquifers in the world. This aquifer system underlies an area of about 100,000 square miles, and it provides water for several large cities, including Savannah and Brunswick in Georgia and Jacksonville, Tallahassee, Orlando, and St. Petersburg in Florida.

Relatively modest in size, Citrus County is not alone in drawing from the Floridan aquifer. Many cities, counties, and utilities in Florida depend on this aquifer or surface waters derived from its source. The Floridan Aquifer can be as deep as 500 to 1000 feet in some areas, and in other areas near the land surface[3]. Unfortunately for Citrus County, the latter is the case. With the aquifer close to the surface in Citrus County, the underground water supply is

[1] www.census.gov
[2] en.wikipedia.org/wiki/Floridan_Aquifer
[3] http://proceedings.esri.com/library/userconf/proc95/to100/p088.html

more susceptible to contamination. Saltwater intrusion has already plagued our southern neighboring counties. On March 10, 2012, Citrus County entered into its second Phase III extreme water shortage order since 2009.

In an effort to protect the county's water supply, Citrus County Water Resources practices water conservation, also known as demand management. Demand Management promotes long-term reduction and efficiency of water use. Some reductions can be realized through increasing-block rate structures, others through reduced irrigation watering allowances and issuance of fines for violating water restrictions[4]. Citrus County is considering increasing its water rates for customers that use greater than 50,000 gallons of water per month. In some communities, five percent of the customers are using more than 25% percent of the water.

There are many options available to demand management programs. Although the level of effectiveness each action imparts can be debated, successful demand reduction to any degree allows Citrus County Water Resources to accommodate a larger population with lesser or equal water supply. Reducing demand on existing water supplies is the less costly option when compared to developing any new water source.

As stipulated by Southwest Florida Water Management District, Citrus County is charged with reducing water use to 150 gallons per person per day by 2019. To achieve this goal, Citrus County's Water Conservation program will include a variety of educational, financial and regulatory initiatives to encourage its customers to reduce their consumption and adopt a year-round conservation ethic.

Citrus County's Water Conservation Plan covers all Water Use Permits associated with the County's Department of Water Resources. This plan will receive annual updates as progress and changes occur within the service area.

WATER & WASTEWATER SYSTEM OVERVIEW



Like the county's population, the Department of Water Resources has grown by over 165% within the last ten years. This growth is largely the result of acquiring the former Florida Governmental Utility Authority Systems located throughout the county. CCU now serves over 22,000 accounts, which equates to approximately 47,000 citizens, or 35% of Citrus County residents that receive CCU's potable water, wastewater treatment, or both. The utility supplies water to an additional 2,150 accounts through bulk water agreements with the Ozello Water Association and Forest Hills. In

[4] IWRA, *Water International*, Volume 27, Number 1, March 2002, pg 100, http://webworld.unesco.org/Water/wwap/pccp/cd/pdf/educational_tools/course_modules/reference_documents/water/waterasaneconomicgood.pdf

addition, agreements have been made with the City of Crystal River and Beverly Hills/Rolling Oaks Utilities to supply potable water in an emergency situation.

Citrus County Utilities continues to expand its service, giving priority to fragile environmental areas along its west coast, such as Chassahowitzka and Homosassa. These expansions allowed CCU to serve an additional 1,700 households, and consequently the removal of septic tanks that can potentially degrade coastal waters. Furthermore, CCU has targeted removal of small, inefficient and outdated package wastewater treatment plants, especially those in coastal regions.

CCU operates 23 water production facilities capable of pumping up to 32 million gallons per day and nine wastewater treatment facilities capable of treating more than two million gallons per day. Citrus County Utilities is an enterprise fund financed through user fees. It operates under strict state and federal mandates. Each facility regularly undergoes rigorous testing to ensure that specific permit conditions are met.

CAPITAL IMPROVEMENT PLAN



The County is aggressively implementing its capital improvement program through three master initiatives: water, wastewater, and reuse water. Among its water initiatives, the Utilities Division is extending water mains where practical to interconnect systems for greater reliability and reduced costs.

The wastewater treatment initiative expanded the Meadowcrest plant from a capacity of a half million gallons per day to two million gallons per day. This provides sufficient capacity to handle another eight years of growth and expansion in the central part of the County. Concurrent with the expansion of the Meadowcrest plant, the utility upgraded its facility to produce treated high-quality wastewater that can be used as reclaimed water for irrigation.



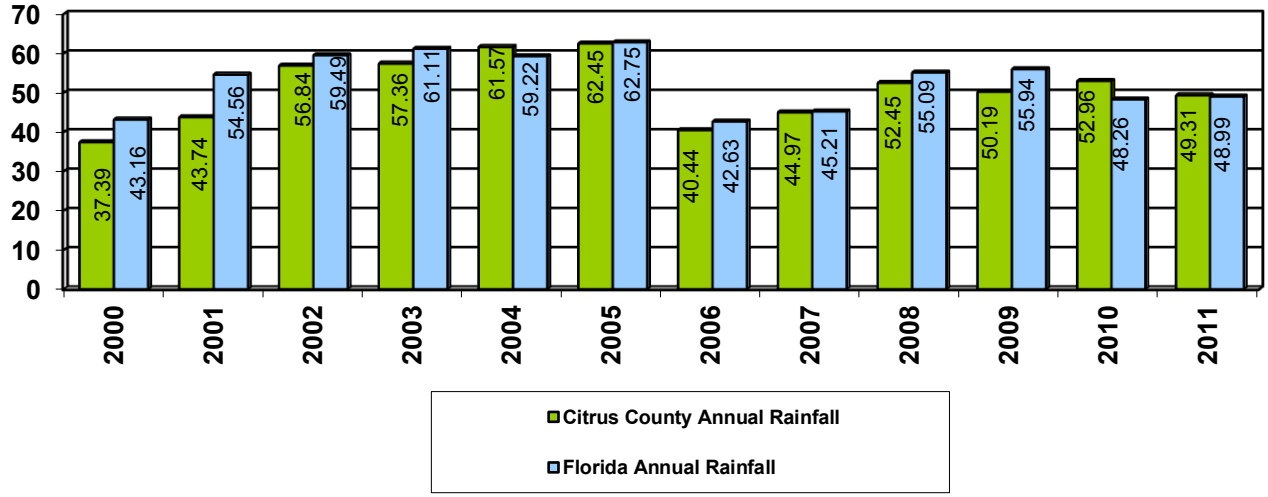
As of July 2011, Citrus County's Meadowcrest facility began sending approximately two hundred and fifty thousand gallons of reclaimed water per day to a pond at Black Diamond Ranch in Lecanto for irrigation. In early 2012, CCU completed an extension of this reclaimed water line to a second receiving pond. Together, these two ponds can receive up to 1.2 million gallons per day.

Point-O-Woods Waste Water Treatment Facility currently sends one hundred percent of its reclaimed water to the nearby golf course for irrigation. Combined, these two reclaimed water sites can reduce ground water withdraws by over 400 million gallons per year.

Within the next ten years, Citrus County Utilities intends to similarly upgrade its wastewater treatment facility in Sugarmill Woods to produce public access reclaimed water for nearby golf courses. Ultimately, due to the use of reclaimed water for golf course irrigation, the three plants could reduce groundwater withdrawals by up to 1/2 billion gallons per year at current flow rates.

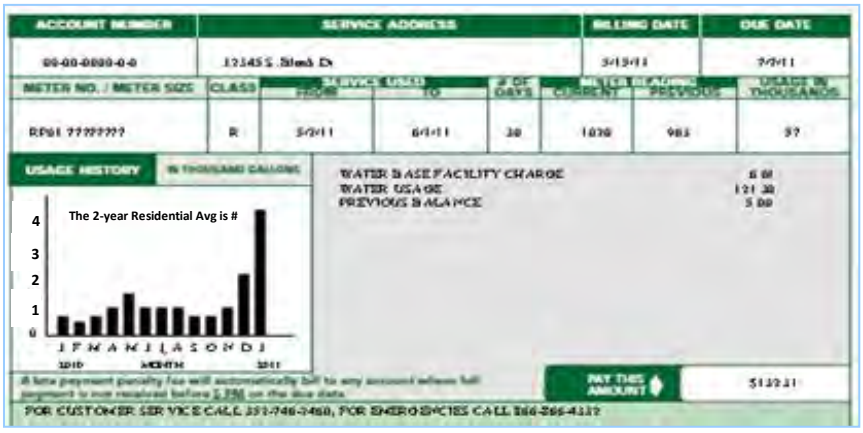
WEATHER AND RAINFALL

Comparison of Citrus and Statewide Rainfall in Inches



http://www.sercc.com/climateinfo_files/monthly/Florida_prcp.html http://www.swfwmd.state.fl.us/data/wmdbweb/rainfall_data_summaries.php

INFORMATIVE CUSTOMER BILLING



Citrus County currently bills for service monthly, per Municode Section 102-134, Billing. The county's current utility bill details a Usage History Bar Chart to enable customers to visually track their usage over a one-year period and quickly identify any irregular use. As of January 1, 2012, per SWFWMD's informative billing requirements, Citrus County added information to customer bills that indicates the average single-family residential water use calculated over the most recent two-year period. This information is included on the monthly bills, which provides customers with an ongoing comparison of their monthly usage versus other residential customers.

ACCOUNTED FOR & UNACCOUNTED FOR WATER LOSSES



Citrus County Utilities Division is devoted to reliably auditing its water supply and keeping system water losses to a minimum.

When unaccounted for water losses reach ten percent, mandatory preventative measures are triggered by the Southwest Water Management District. Citrus County's unaccounted for water level was estimated at 6.7 percent in 2007—well below the threshold. Yet, with the inheritance of antiquated systems from the Florida Governmental Utility Authority in 2007, maintaining acceptable levels of unaccounted for water loss is, and will continue to be, an ongoing challenge.

Distributing potable water to its customers accounts for the vast majority of CCU's water use. However, water is also used throughout the production and treatment process, such as flushing lines to maintain water quality. Meters installed on all water treatment plant lube lines track these operations. Water is also used to ensure public safety. For example, the fire department conducts fire hydrant testing and uses water to extinguish fires. Tracking of these activities are documented and calculated as best as possible. Unfortunately, some water loss sources are more difficult to account for, such as line breaks, pipe leaks, illegal water connections, and under-registering and stuck meters. Referred to as unaccounted for water loss when undetected, these deficits are challenging to locate and calculate.



Citrus County Department of Water Resources regularly conducts water audits of its systems to quantify volumes of real and apparent water losses, assess the financial impact of those losses versus the cost of corrective measures, and make recommendations to further improve CCU water system's efficiency. In August 2011, the CCU team set out to inspect over 4,800 water meter boxes, all production wells and main water line valves in the Sugarmill Woods Water system. Working in conjunction with SWFWMD and the Florida Rural Water Association, the group was armed with electronic listening devises, steel probes and state-of-the-art equipment to locate hidden leaks in the water system. Together they found and CCU repaired over 125 leaks estimated to account for twenty-seven million gallons of water, and reducing the Sugarmill Woods system's unaccounted for water loss from twelve percent to six percent.

Citrus County Utilities is planning water system inspection in Citrus Springs/Pine Ridge during the summer of 2012. The utility's goal is to continue this effort throughout its systems, completing a minimum of ten percent each year.

METER REPLACEMENT PROGRAM

Citrus County Utilities has two meter replacement programs. The first is a utility-wide initiative that began in the Sugarmill Water Treatment plant service area. In this region, meters are being upgraded from a traditional meter to Advanced Metering Infrastructure (AMI) compatible meters. As of January 2012, CCU successfully replaced over 900 meters in this community. Sugarmill Woods is only a starting point for this meter replacement program. The county's goal is to upgrade all meters in Citrus County's service area, ultimately completing the transition to AMI compatible meters within the next five years.



The AMI compatible meter change-out initiative began in April 2011. The first meters of focus are 5/8" meters that have registered over one-million gallons flowed. Meters typically measure accurate water usage up to ten years or one million gallons. After which time, meters often slow and begin to measure inaccurate water flows.

The second meter replacement program is primarily work order initiated. Work orders are created for a variety of reasons. Among the reasons they are created are: customer complaints, meter reader observations or billing that indicates two consecutive months of zero reads. Regardless the reason, a field accuracy test is typically conducted on the meter in question. If the test results produce any unusual results, the meter is replaced.

CUSTOMER LEAK NOTIFICATION



Citrus County Utilities' customer meters are read on a monthly basis. Regular readings offer an opportunity to identify leaks quickly. Therefore, a process was established to identify customer-side leaks.

Prompted by an unusually high meter reading, the first step is to reread and verify that the meter reader's data was entered correctly. Once the data has been confirmed as correct, a representative contacts the customer by telephone to ask if they have made recent changes that could cause increased water usage. It is common to see a jump in water usage when a citizen installs a new lawn or plants, fills a pool, or even experiences a line break. However, if the customer indicates no cause for increased usage, they are encouraged to check for leaks and offered instructions as to how to do it.

Once the customer performs their own leak check and finds no reason for the increased water use, they can call the utility for further assistance. Citrus County Utilities then sends a technician to the customer's site to check the meter area, ask additional questions and help determine the source of the increased water usage. If the irrigation system is the likely culprit, staff offers the customer a self-help sprinkler checkup guide. As previously mentioned, Citrus County Utility's goal is to convert its meters to an AMI system. The upgraded system offers an enhanced customer leak and high-use notification program.

WATER CONSERVATION MEASURES

Below are Citrus County's proposed water conservation measures, their scheduled implementation dates, estimated costs and anticipated water savings for each measure.

Summary of the quantifiable water conservation measures, costs and savings.

CCU BMP	Sector	Cost/ Measure	Savings Rate (gallons per day)	Number of Measures 2012	2013	2014	2015	2016	Estimated 2012 cost of measure	Estimated gallons saved 2012
High-Efficiency Clothes Washer Rebate [1]	SF	$100	16.3	75	75	75	75	75	$7,500	446,213
Ultra Low Flush (ULF) Toilet Rebate [2]	SF	$100	23.8	350	350	350	350	350	$35,000	3,040,450
Soil Moisture Sensor Rebate[3]	SF	$100	200	20	20	20	20	20	$2,000	1,460,000
Rain Sensor Device Rebate[4]	SF	$50	100	20	20	20	20	20	$1,000	730,000
Showerhead Exchange[5]	SF	$5.50 (per kit)	5.3	200	200	200	200	200	$1,100	386,900
Bathroom Faucet[5] Aerator	SF		8.1	200	200	200	200	200		591,300
Kitchen Faucet[5] Aerator	SF		2.7	200	200	200	200	200		197,100
Assisted Living Facility Showerhead Exchange[5]	NR	$5.50 (per kit)	5.3	285	200	0	0	0	$1,568	551,333
Assisted Living Facility Bathroom Faucet[5] Aerator	NR		8.1	350	200	0	0	0	$1,925	1,034,775
Assisted Living Facility Kitchen Faucet[5] Aerator	NR		2.7	285	85	0	0	0	$1,568	280,868
*Irrigation Audit w/ Rain Sensor Device Installation[4]	SF	$385	100	65	-	65	-	-	$25,000	2,372,500

1 – Martin, J. & Heaney, J. (2008) BMP 3: High Efficiency Clothes Washer Rebates, Conserve Florida Water Clearinghouse. Retrieved on April 5, 2011 from http://www.conservefloridawater.org/. Estimating 1.04 loads per day & 15.7 gallons per load for the SF sector, savings are 16.3 gallons per account per day.

2- Mayer, P. (2007) Significant Indoor Water Efficiency is Possible, Aquacraft Water Engineering & Management. Retrieved on April 5, 2011 from http://www.aquacraft.com/sites/default/files/pub/Mayer-%282007%29-Significant-Indoor-Water-Conservation-Is-Possible.pdf.

3 – Dukes, M. & Haley, M.B. (2009) Evaluation of Soil Moisture-Based On-Demand Irrigation Controllers, Phase II. Southwest Florida Water Management District. Retrieved on April 5, 2011 from http://www.swfwmd.state.fl.us/files/database/site_file_sets/13/SMS_Phase_II_Final_Report_12-17-09.pdf.

4 - Ayres Associates (2000). Development of Water Conservation Options for Non-Agricultural Water Users. Southwest Florida Water Management District. Retrieved on June 6, 2011 from http://www15.swfwmd.state.fl.us/LibraryImages/DEVELOPMENT%20OF%20WATER%20CONSERVATION%20OPTIONS%20FOR%20NON-AGRICULTURA.PDF

5 – Cooperative Funding Initiative: FY2012 – Water Conservation, Table A1. Acceptable Data for Estimating Conservation Savings. (2008) Southwest Florida Water Management District. Retrieved on June 6, 2011 from http://www.swfwmd.state.fl.us/files/database/site_files/WaterConservationFY2012[1].pdf

* Regional Residential Irrigation Audit and Education Pilot Program through SWFWMD Cooperative Funding & WRWSA

WATER CONSERVATION RATE STRUCTURE

A conservation rate structure is one means of reducing consumer water use. The tiered increasing block rate structure escalates water costs with increased water use. In general, customer water use decreases when costs rise, therefore changing consumer behavior as it relates to water conservation.

Citrus County Utilities' conservation rate structure applies to its three largest water systems, Sugarmill Woods, Citrus Springs/Pine Ridge and Charles A. Black. A complete copy of the utility rates, which details base rates per meter size, as well as conservation rates, is sent to customers once per year during the months of October and November. The conservation portion of these utility rates is detailed below. Citrus County's current water-conservation-orientated inverted-block rate structure was adopted via Resolution No. 2011-175. As previously mentioned, Citrus County is considering increasing the rate over 50,000 gallons per month water users.for customers that use greater than 50,000 gallons of water per month.

	Sugarmill Woods	Citrus Springs/ Pine Ridge	Charles A. Black
Conservation Rates	Per Thousand Gallons		
0 to 10,000 gallons	$1.19	$1.44	$1.22
10,001 to 20,000 gallons	$1.58	$1.89	$1.54
20,001 to 30,000 gallons	$1.88	$2.27	$1.84
30,001 to 50,000 gallons	$2.50	$3.02	$2.45
0ver 50,000 gallons	$3.74	$4.51	$3.67

YOUTH EDUCATION & OUTREACH

Each year Citrus County Water Resources conducts educational programs throughout its community to encourage water conservation behavior and provide updates on water restriction guidelines. Although these measures can not be quantified, they work to instill a water conservation ethic in our communities' youth. In 2011, the Florida Yards and Neighborhoods team connected with 1730 summer camp children, 176 home-schooled children, 2,144 elementary school science fair students, and 694 primary school students at the Florida-Friendly Learning Landscape in Lecanto to discuss such topics as:



- Florida-Friendly Yards
- Stormwater runoff
- Sinkhole formation
- Water conservation
- Non-point source pollution
- Plant growth requirements
- The hydrologic cycle
- Soil particles and their impact on the travel of water and pollutants through the soil
- The Floridan aquifer
- How to use the water flow bag to test indoor fixtures' efficiency

ADULT EDUCATION & OUTREACH

Website



Citrus County Water Resources maintains a website geared toward educating its citizens about best water conservation practices. Posted are pertinent articles such as, Tips for Saving Water Inside, Tips for Saving Water Outside, How to Fix a Leak and links to other informational sites, like Southwest Florida Water Management District's "Watch the Weather, Wait to Water" campaign. In addition, the site is used to promote seasonal campaigns such as the county's own *Call Before You Install* program and annual rebate incentives program.

Mailed Conservation Literature

Throughout the year, Citrus County Utilities includes conservation material in its utilities bills. Its successful rebate program application is sent via this method, which often receives seven to eight hundred applications. Likewise, conservation tips are disbursed at optimal periods throughout the year to encourage customers to make seasonal changes and checks both inside the home and out. Southwest Florida Water Management District messages are disbursed via utility bill mailings, as well.

Landscape Demonstration Project



Citrus County Water Resources and Citrus County Florida Yards and Neighborhoods joined with the Cypress Village Property Owners Association and SWFWMD to create a model Florida-Friendly Landscape demonstration garden near the main entrance of Sugarmill Woods in Homosassa, Florida. Created in 2010, the garden provides an educational opportunity for residents to see the beauty of native plants that conserve water and thrive in our local climate. Citrus County is planning to upgrade this educational garden in phases over the next four years beginning in 2012.

Community Workshops

Regular workshops are conducted with homeowner associations to relay pertinent water conservation information. Two workshops held in April and July of 2011 for homeowners of the Sugarmill Woods community reached over 200 residents. The April workshop was a compilation of information and representatives, including homeowner associations that discussed Florida-Friendly deed restrictions, local landscapers with Florida-Friendly plants, Citrus County Extension agents discussing outdoor conservation and best management practices, Water Resources informing on indoor water conservation and more. The July workshop primarily focused on allowable watering restrictions for newly planted lawns and plant material, as well as

fertilizer best management practices. The next workshop is scheduled for April 11, 2012 in the Sugarmill Woods Community.

High Volume User List



The Citrus County Department of Water Resources has taken measures to reach its high-volume water use customers. The list is frequently the focus of pilot water conservation projects and studies. In 2011, Citrus County, among other local governments, joined a pilot program being conducted by Withlacoochee Regional Water Supply Authority and Southwest Florida Water Management District. This promising water-saving initiative will target a total of sixty-two irrigation systems from CCU's high users list in the southwest portion of Citrus County. Participants receive a free evaluation of their irrigation system and installation of a rain sensor where one is not functioning or present. The first evaluation was conducted in October of 2011. To date, twenty-eight evaluations have been completed.

The County also pulled from its list of over 30,000 gallons per month water users to participate in a 2011-2012 focus group project through Southwest Florida Water Management District. The program separately target two communities, Sugarmill Woods and Citrus Springs/Pine Ridge. The goal of the focus groups was to determine existing water conservation knowledge, and determine barriers to creating water conservation behavior changes. Both high and low users from each area will be queried.

The results for the first twenty-six irrigation evaluations indicate the majority of customers could make minor modifications to realize water savings. See table below.

Observation	Percentages of Evaluations
Had Dysfunctional Rain Sensor	95%
Should Reduce Runtimes	69%
Recommended Capping of Sprinkler Heads	100%
Had Sprinkler Head(s) Too Low or Blocked	90%
Had Sprinkler Head(s) that Cover Turf and Shrubs	92%
Had Broken or Leaking Sprinkler Heads	90%
Had Sprinkler Heads that Over Spray (driveways, roads, etc.)	100%
Would benefit from Installing Low Volume Irrigation	100%
One Irrigation Application was Recommended	100%

OUTDOOR WATER CONSERVATION MEASURES



IRRIGATION SOURCES OTHER THAN RECLAIMED WATER

One source that efficiently waters small gardens and flower beds here in Citrus County is rain barrels. Rain barrels are most effective when used to supplement natural rainfall. Prior to 2012, the Florida Yards and Neighborhoods team partnered with Citrus County Water Resources to offer Rain Barrel Workshops to its citizens. As of March 2012, 534 rain barrels were distributed through nearly thirty workshops. The majority of the rain barrels distributed are capable of storing about fifty-five gallons of water each. Assuming each homeowner filled and used the contents of their rain barrel once each month, these rain barrels are saving over 320,000 gallons of water each year. Florida Yards and Neighborhoods continues to offer several Rain Barrel Workshops throughout the year.

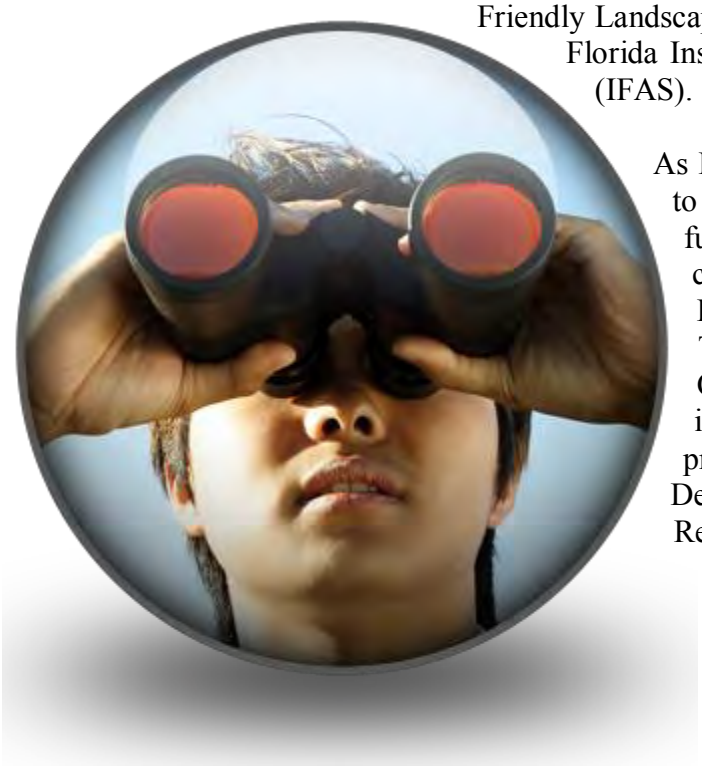
FLORIDA-FRIENDLY LANDSCAPE PRINCIPLES

Citrus County Water Resources has worked closely with the Florida Yards & Neighborhoods (FYN) program throughout the years. In October 2011, the team united with Citrus County Water Resources' conservation group. Citrus County Water Resources will supplement funding of the Florida Yards & Neighborhoods Program at $66,762 annually. FYN is geared toward promoting Florida-Friendly Landscaping™ Practices. Having like goals, the joining of our teams is certain to be a successful and beneficial merging.



Implementing Florida-Friendly practices consistent with Section 373.185 of the Florida Statutes is important to Citrus County. Leading its citizens by example, Citrus County created Administrative Regulation (AR) 12.10-1, which was adopted in 1999. Recently updated, this Administrative Regulation titled, Florida-Friendly Landscaping™ Green Industry Best Management Practices (FFL/GI-BMP) Educational Program, establishes guidelines for managing existing and future turf and landscapes at all Citrus County facilities, requires staff and contractors of Citrus County be certified in FFL/GI-BMP, offers public educational opportunities, and provides demonstration landscapes at various county facilities. As incentive, AR 12.10-1 also offers local businesses and consumers public recognition for adhering to the Florida-Friendly Landscaping™ Green Industry Best Management Practices.

Citrus County has taken additional measures by adopting Municode, Sec. 102-138, titled Meters, which states that, "All vegetative plantings must strictly adhere to the guidelines for "Florida-



Friendly Landscaping" as promulgated by the University of Florida Institute for Food and Agricultural Sciences (IFAS).

As Florida-Friendly Landscaping is important to water conservation, Citrus County has further addressed these principles via its current Land Development Code, Chapter Four, Section 4300, titled Landscaping, Tree Preservation and Open Space. Citrus County will continue to recognize the importance of Florida-Friendly Landscape principles within its proposed Land Development Code under Open Space and Resource Protection, which states that installation of all plant materials shall conform to Florida-Friendly Landscaping Standards. In addition, this section provides a list of recommended vegetation for use in landscaping and directs readers to the following resources for further details:

a. Southwest Florida Water Management District, Plant Guide.

b. Florida-Friendly Landscaping with Florida Native Plants –University of Florida Extension Service, www.floridayards.org.

c. Other assorted publications available at the Citrus County Agricultural Extension office and Citrus County Water Resources office.

Looking toward the future, the Conservation Element of Citrus County's Comprehensive Plan seeks to advance Florida-Friendly landscape principles throughout its communities. This is demonstrated within the Conservation Element's *Goals, Objectives and Policies*, *GOAL #3*, which states, "Citrus County shall preserve, protect, and restore its natural resources for the health, safety, and welfare of its citizens." The *Water Conservation* portion of this goal declares the *Objective*, "The County shall continue measures to conserve fresh water resources as defined by F.A.C." In doing so, two policies would be a focus. The first is Policy 3.6.1, stating "The County shall adopt water conservation regulations providing recognition and/or incentives for xeric landscaping, reuse of grey and treated wastewaters, and public information. The second policy is 3.6.2, stating "The County shall adopt a water conservation ordinance and plan, which supports the SWFWMD water conservation rule and addresses local concerns."

CITRUS COUNTY DEED RESTRICTIONS

Citrus County assists home owner associations in updating their deed restrictions to include Florida-Friendly Landscaping principles. Citrus County Development Services actively works with developers, and Extension Services and Water Resources to educate homeowners and encourage Florida-Friendly water efficient landscaping. Even with the Florida-Friendly



Landscape updates to community deed restrictions, some well established subdivisions still struggle with its residents embracing the concepts. These communities are part of Citrus County's on-going focus to reduce water usage amounts through education and regular workshops with the Home Owners' Association members and residents. CCU works closely with associations to encourage planting Florida-Friendly water efficient landscaping when updating or reestablishing failed lawns and landscapes. This is one of the primary education focuses that it will continue to expand and emphasize over the next five years.

Citrus County's water conservation program will continue to spotlight the areas of highest usage, as well as individual customers that use over 30,000 gallons per month. Additionally, the utility will focus its attention on areas that use on average over 150 gallons per day per person. Such high usage is likely attributed to poor understanding of lawn watering needs or outdated deed restrictions. Education is a key component in changing poor water-use behaviors.

Percentage of Turfgrass



Large irrigated lawns are among the highest sources of water use. Therefore, limiting or ensuring that communities do not require unreasonable amounts of turfgrass within homeowners' lawns is important. Addressing this issue is Citrus County's Land Development Code (LDC), Chapter Five, Compliance Procedures for Residential Planned Developments. The LDC states that landscaping, design and maintenance shall follow the principles of Florida-Friendly landscaping and the Florida Yards and Neighborhoods Program to reduce water use and fertilizer runoff. Planted turf grass and landscaping on residential lots shall be limited to a maximum of 50% of the upland portion of the lot. Turf grasses and landscape vegetation shall be common to the area and drought tolerant.

The Conservation Element of Citrus County's Comprehensive Plan further expresses the county's objective to reduce developments' requirements for large irrigated lawn areas. Here, Policy 3.18.4 elaborates on the already established LDC requirements by stating that the following landscaping BMPs shall be instituted within new and revised planned developments to reduce nutrient loading:

- ✓ Planted turf grass and landscaping on residential lots shall be limited to a maximum of 50% of the upland portion of the deeded lot
- ✓ Turf grasses and landscape vegetation common to the area shall be used.
- ✓ Landscape vegetation shall be drought tolerant; and
- ✓ All development shall require best management practices as dictated by the principles and practices of the Florida Yards and Neighborhood Program.

Type of Turfgrass Requirement

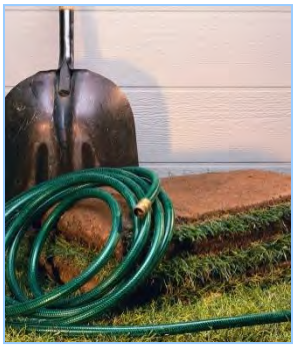


As water conservation awareness has evolved, so has the knowledge of grass watering requirements. Today, it is generally understood that certain turf grasses have greater watering needs than others. With this in mind, the General Landscape Requirements of Citrus County's LDC stipulates that grass species shall be drought tolerant types that are normally grown for lawns within the county and vicinity. To help inform citizens of the types of grasses that require less water, and those that can withstand Florida's frequent periods of drought, Citrus County is initiating a "Call Before You Install" education program. Among other goals, the program intends to help citizens make wiser turf grass choices.

Additionally, the Florida Yards and Neighborhoods team disburses information through its office and offer educational programs on turf grasses that typically thrive in the region, as well as alternatives to grass installation. Citrus County's Water Conservation Specialists also regularly distribute low water use turf grass information to citizens while patrolling for irrigation violations, through email and via phone calls.

Lawns Maintaining Color Requirement

As previously mentioned, Citrus County has made progress in getting local deed restrictions updated to incorporate Florida-Friendly design principles and do away with habits and practices that lead to the wasteful use of water.



Resodding During Droughts

Citrus County will continue to work with its Home Owner Associations to increase water conservation education and change the behaviors and deed restrictions that require home owners to maintain an aesthetically pleasing landscape during periods of drought, which in turn uses water wastefully.

RAIN SENSING AND GROUND MOISTURE DEVICES

Citrus County offers an annual rebate for rain sensors and SMART technology. In 2011, nearly twenty rebates were issued to citizens adding, replacing or upgrading existing devices for their irrigations systems.

Citrus County addresses the need for irrigation systems to have properly functioning rain shut-off devices through its Municode, Sec. 102-138, which states that, "... If irrigation is to be accomplished by an automatic irrigation system, such system shall at all times have an operating rain sensing device or ground moisture detector." Citrus County is in the process of reviewing and updating Section 66, Code of Ordinances, to enforce this requirement.

WATER RESTRICTION ENFORCEMENT



Citrus County government continuously enforces mandatory water use restrictions for all properties within the unincorporated county. In 2010, a full-time Water Conservation Specialist was hired with the primary duty to enforce water restrictions. In late 2011, two additional employees were hired for enforcement responsibilities. The team now includes one supervisor, one administrative support personnel and three enforcement officers. Patrol coverage is performed seven days a week, twenty-four hours a day by working flexible schedules to provide varied coverage.

Citrus County observes SWFWMD water restrictions. As of March 10, 2012, the county moved to one-day-per-week watering restrictions under the Modified Phase III Water Shortage Order. Aggressive enforcement of these restrictions is necessary not only to comply with SWFWMD requirements, but to also to reduce water use to permitted levels. Nearly twelve hundred warnings and citations were issued between January 2010 and March 2012.

IRRIGATION SYSTEM EVALUATIONS

Water Resources contracted seven irrigation system evaluations in 2010 for homes that registered high water usage. In 2011, a pilot Irrigation Evaluation program began to evaluate sixty-two irrigation systems within the Coastal Basin area.

MICRO-IRRIGATION IN PLANT BEDS

Citrus County Water Resources in conjunction with the Florida Yards and Neighborhoods program encourages the use of micro-irrigation on planting beds and other non-turf areas to minimize irrigated acreage. The Citrus County Extension Services Division has made available ―A Guide to Micro-Irrigation" CD that covers the basics of micro-irrigation. The CDs are available to customers that participate in one of the many educational programs held by the Extension Services and Citrus County Water Resources. Additionally, the guide is promoted within the booklet, ―A Guide for Citrus County Newcomers and Natives."

INDOOR WATER CONSERVATION

REBATE INCENTIVE PROGRAM



Low Flow Toilet Rebates

In 2011, as part of its annul Water Smart Rebate Program, Citrus County issued two hundred and twenty rebates to customers that upgraded their existing inefficient toilets to Low-or Ultra-Low-Flow toilets. These modest updates to customer homes could account for one and three quarter million gallons saved each year. The toilet rebate program has grown from $19,000 in rebates issued in 2008 to $50,000 in rebates issued in 2011.

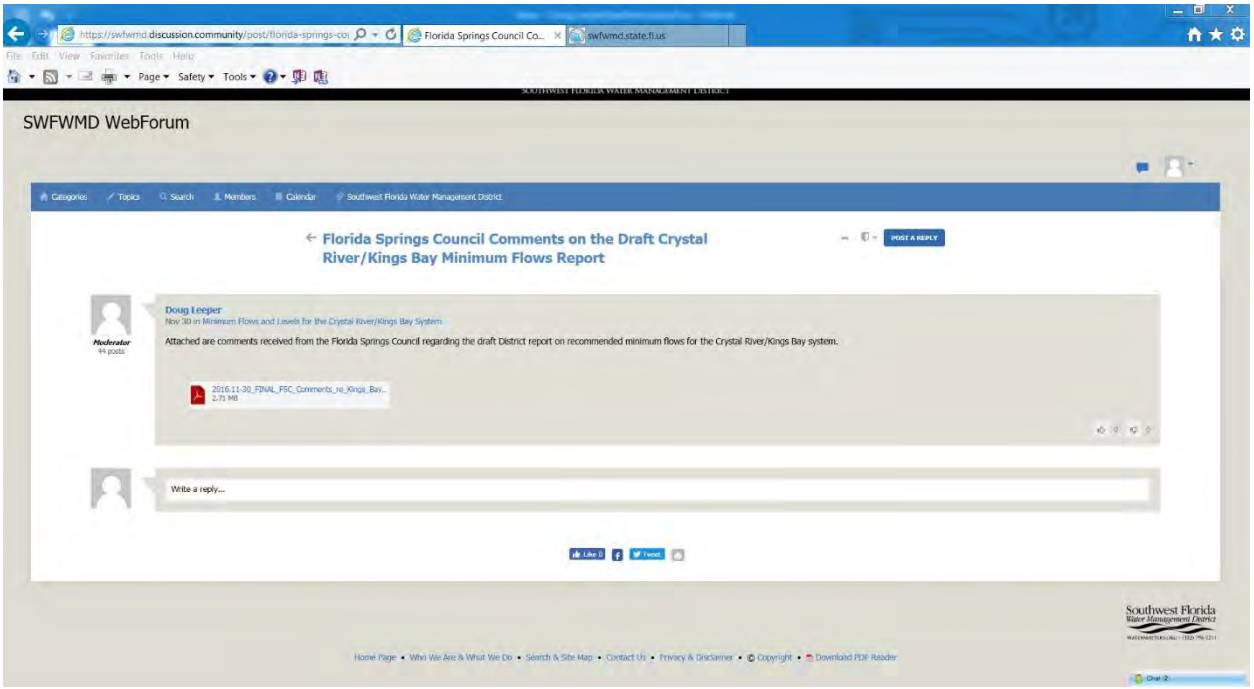
Indoor Plumbing Retrofit Kits

Citrus County's 2012 water conservation goal includes disbursing two hundred indoor plumbing retrofit kits to its residential customers. These kits include one kitchen faucet aerator, two bathroom faucet aerators, a low-flow shower head and toilet leak detection tablets. If accomplished, these water saving measures combined could save as much as one and a quarter million gallons of potable water annually.

As part of a joint effort with Florida Yards and Neighborhoods, Citrus County Water Resources has also disbursed indoor conservation kits to assisted living facilities within is service area. As of March 2012, approximately 300 kits have been installed. An additional 200 kits will be disbursed to facilities throughout the year. Installing these water saving devices within the assisted living facilities is estimated to save nearly 2,000,000 gallons in 2012.

High-Efficiency Clothes Washer Rebates

In 2011, as part of its annul Water Smart Rebate Program, Citrus County Water Resources issued one hundred and eighty-three rebates to customers that replaced their older clothes washers with qualifying high-efficiency clothes washers, which is projected to save nearly a half million gallons of potable water annually.


https://swfwmd.discussion.community/post/florida-springs-co
Florida Springs Council Co...
swfwmd.state.fl.us
File Edit View Favorites Tools Help
Page Safety Tools
SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
SWFWMD WebForum
Categories Topics Search Members Calendar Southwest Florida Water Management District
Florida Springs Council Comments on the Draft Crystal River/Kings Bay Minimum Flows Report
POST A REPLY
Doug Leeper
Nov 30 in Minimum Flows and Levels for the Crystal River/Kings Bay System
Moderator
44 posts
Attached are comments received from the Florida Springs Council regarding the draft District report on recommended minimum flows for the Crystal River/Kings Bay system.
2016.11.30_FINAL_FSC_Comments_re_Kings_Bay...
2.71 MB
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MEETING SUMMARY

Southwest Florida Water Management District
Scientific Peer Review Panel WebEx Meeting and Teleconference
Proposed Minimum Flows for the Crystal River/Kings Bay System

Southwest Florida Water Management District Brooksville Headquarters
December 5, 2016

The Southwest Florida Water Management District (District) organized and facilitated a meeting of the independent scientific peer review panel reviewing a draft District report on proposed minimum flows for the Crystal River/Kings Bay system in Citrus County. The meeting was conducted from 12:00 to approximately 2:15 p.m. as a teleconference with links to a web-based utility for sharing presentation materials, and was facilitated from the District Headquarters at 2379 Broad Street in Brooksville, Florida. The meeting was advertised in the Florida Administrative Register and on the District's web site. In addition, numerous interested parties and local government staff and officials were notified of the meeting.

Meeting participants included the Panel Chair, Steve Peene and Panelists, Adam Munson and Ken Watson. District participants included: Doug Leeper, MFLs Program Lead; XinJian Chen, Chief Professional Engineer; Ron Basso, Chief Hydrogeologist; Gabe Herrick, Senior Environmental Scientist; Eric DeHaven, Resource Management Assistant Director; Sky Notestein, Senior Environmental Scientist; and Jackie Sampson, Intern with the Springs & Environmental Flows Section. Anne Holbrook with the Save the Manatee Club, Yesinia Escribano, with the Florida Department of Agriculture and Consumer Services, and Martyn Johnson, also participated in the meeting.

The meeting was initiated with participant introductions. The remainder of the meeting included discussion of: measured /modeled flows; additional Panelist question/comments; MFLs criteria responses used in the District analyses; and development of the Panel's peer review report. The meeting also included public comment. Issues, comments, questions and requests discussed during the meeting are summarized below and are followed by the meeting agenda.

Summary of Discussed Issues/Comments/Questions/Requests

Agenda Item 2 – Final discussion of measured/modeled flows

- Dr. Peene initiated the discussion by noting that he had conducted some summary analysis of U.S. Geological Survey flow records for the Bagley Cove site and had determined that similar to previous analyses completed by Dr. Chen, the flows are comparable to the submarine groundwater discharge estimates for Kings Bay derived by the District and used for development of the recommended minimum flows. He added that the District's use of the estimated submarine groundwater discharge is reasonable for the modeling analyses that were completed for the minimum flow analyses.
- Dr. Watson noted that he had also compared the U.S. Geological Survey data with the District's submarine groundwater discharge estimates and found a difference of about 7% between the two data sets.

- Dr. Munson noted that the development of minimum flows requires acceptance of some level of uncertainty with regard to hydrologic and other data, and he finds the variability evident in the discharge records used for the District analyses to be acceptable.
- All three panelists noted that the historic discharge values on the order of 900 cfs that were collected at a site downstream from the current Bagley Cove gage site are not supportable and appropriately not used for the District's minimum flow analyses.
    - Mr. Basso added to this discussion that the ~900 cfs historic flow value was an average for the 13-year period from 1964-1977, and the record actually includes much higher reported flows.
    - Mr. DeHaven noted that the District would appreciate the Panel's inclusion of comments regarding the historic flow record in their final report.

Agenda Item 3 – Panelist's additional questions/comments since the last meeting

- Dr. Peene noted that he had not yet incorporated Dr. Watson's most recent comments (that had previously been posted to the peer review web board) into the draft Panel summary document.
    - Dr. Watson noted that his recent comments were relatively minor.
- Dr. Munson noted that he had no additional major comments.

Agenda Item 4 – Discussion of MFLs criteria responses

- For this discussion item, Panelists summarized initial written comments which they had previously posted to the peer review web board.
- Dr. Watson asked how the District anticipated structuring the minimum flow rule and how it would be evaluated.
    - Mr. Leeper noted that the rule language would likely express the minimum flow as a percentage of the natural flow, with the natural flow defined as the flow that would exist in the absence of withdrawals. He added that differences between long-term spring flows simulated with the Northern District Model for scenarios that include defined withdrawal quantities and for a non-pumping scenario would serve as the primary information for assessing whether the minimum flow is being met and would be met under future withdrawal conditions. He added that that additional information including withdrawal rates, rainfall, groundwater levels, water budgets, and measured discharge data would also likely be used to support minimum flow status assessments.
- Dr. Watson noted that data collection efforts supporting development of the minimum flows seemed adequate.
- Dr. Watson suggested that inclusion of double mass curves in the minimum flows report which illustrate relationships between various hydrologic parameters (e.g., rainfall, measured discharge, submarine groundwater discharge) could be useful.
- Dr. Watson noted that the 15% change criterion used by the District for minimum flow development is a useful presumptive approach, although it could be superseded or discounted in cases where site-specific information can more readily be used. As an example, he cited the District finding that the preservation of 85% of the thermally-favorable habitat for manatees in Kings Bay was not an especially relevant criterion for setting minimum flows for the river/bay system.

- Dr. Watson noted that the District could consider including additional information concerning data/modeling uncertainties in the body of the minimum flows report. He acknowledged that some of this information is included in the report appendices.
- Dr. Munson noted that the approach used for development of the proposed minimum flows for the Crystal River/Kings Bay system is reasonable and consistent with approaches used for previously develop minimum flows. He added that the recommended minimum flow for the river/bay system is also reasonable.
- Dr. Munson noted that the data collection supporting development of the minimum flows seemed reasonable and adequate.
- Dr. Munson identified some potential uncertainty regarding the status of Lyngbya in the bay, noting that the during the review panel field trip, District staff indicated that over-abundance of this alga is not a current management concern for the system. He wondered about the source of information that would support this position and noted that if it exists, it should be described in the minimum flows report.
- Dr. Munson noted that he does not take exception to the use of 15% criteria for minimum flows development. However, he added that he continues to recommend that the District consider evaluating non-hardened, i.e., relatively natural shorelines as part of their assessment of percentage changes in salinity-based habitat in responses to flow reductions.
- Dr. Peene noted that although changes in residence time would not be expected to affect nutrient concentrations within water discharged from spring vents, it may be expected to affect environmental factors in the bay and/or river. He added that although the District report acknowledges the potential importance of residence time on water quality and other factors within the river/bay, the linkages between residence time and these factors are not fully identified or used as criteria to support minimum flow development. He added that he would like to see the report revised to further address the availability of existing information that could be used to investigate any linkages between residence time and environmental factors. Finally, he wondered how the identification of a TMDL for the system could factor into the development of a minimum flow.
    - In response to this discussion, Mr. Basso and Mr. Leeper provided a brief summary of water quality and minimum flow concerns that arose during the relatively recent development of minimum flows for two Outstanding Florida Spring systems, the Chassahowitzka and the Homosassa systems. They noted that as part of the process, the Florida Department of Environmental Protection received a challenge which alleged that the development and planned implementation of the minimum flows for the systems were not consistent with the Clean Water Act. Mr. Leeper briefly summarized the outcome of the challenge review/findings, noting that the proposed minimum flows were found to be consistent with the Florida Water Resources Implementation Rule and that the state programs administered by authority of that rule were consistent with the Clean Water Act.
- Dr. Peene noted that the report could be improved with an enhanced characterization of data and modeling uncertainties.
- Dr. Peene noted that further investigation of relationships between measured discharge at Bagley Cove, estimated submarine discharge and other hydrologic factors may be useful and should be pursued at some time in the future.
- Dr. Peene noted that the calibration of the hydrodynamic model used to support development of the minimum flows is reasonable and “within the bounds of the state-of-the art” for this type of modeling.

- Dr. Chen provided an overview of a sensitivity analysis he had recently completed at the suggestion of the Panel. The analysis involved varying salinity at the downstream boundary of the hydrodynamic model as a function of discharge to determine potential effects of the varying salinity on the changes in salinity-based habitats which were integral to the minimum flow analyses. His results, which were previously posted to the peer review web board, indicated minimal effects would be associated with the varying boundary condition.

Agenda Item 5 – Discussion of draft report

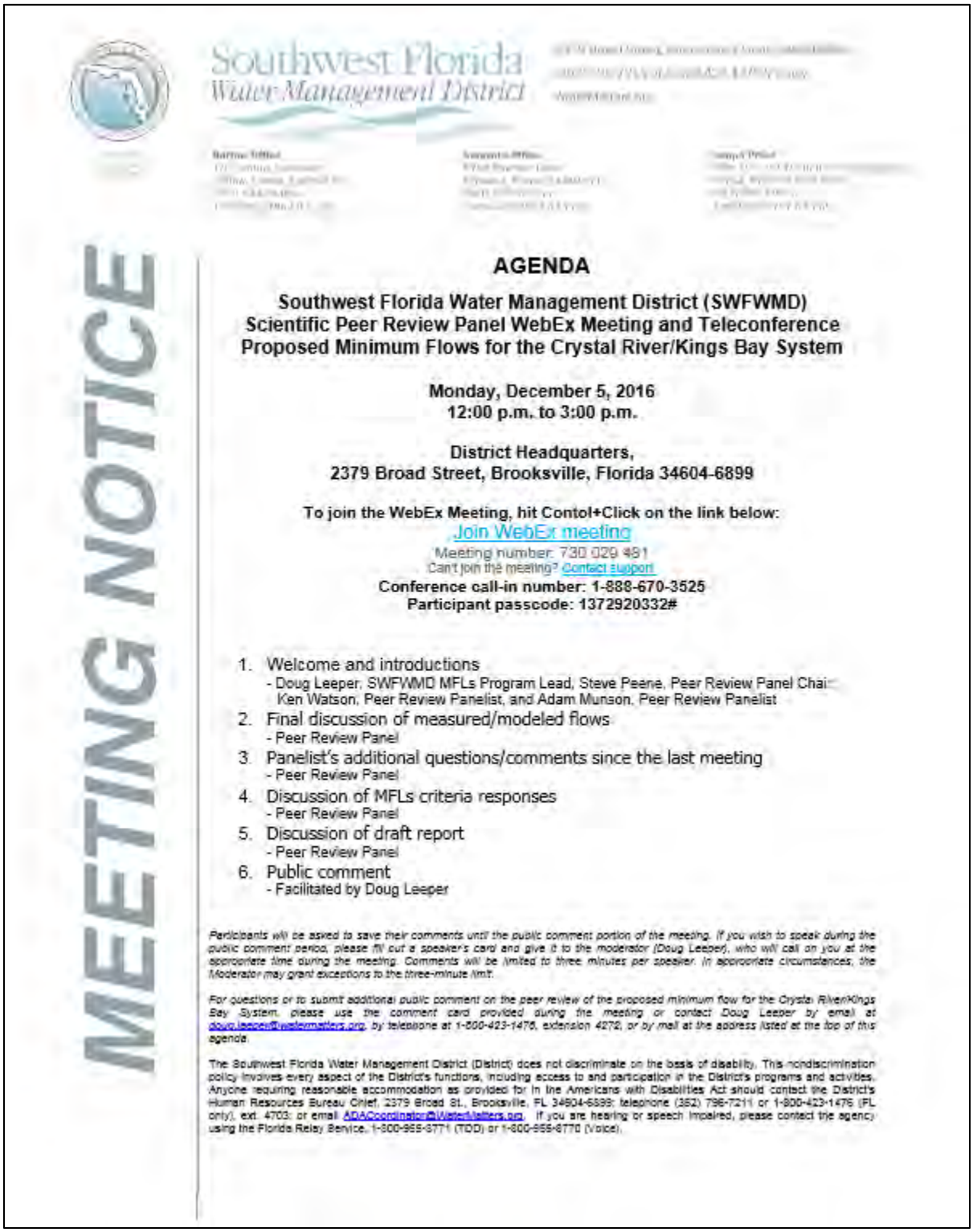
- As part of the discussion of their draft report, the Panel indicated:
    - They anticipated few changes to the introductory section.
    - They anticipated including some comments on historical and recent measurement of discharge made by the U.S. Geological Survey and the estimation of submarine groundwater discharge made by the District.
    - They anticipated recommending that absolute values as well as relative percentage values be presented for salinity habitat modeling results.
    - They anticipated recommending the consideration of hardened and natural shorelines for assessment of flow-related changes in salinity-based habitats.
    - They expected to continue to use a tabular format to summarize specific comments and recommended corrective actions.

- For completion of their final report the Panel agreed to:
    - Post initial edits to the draft report by Wednesday, December 7th.
    - Distribute emails to serve as alerts for web board postings to support timely review of all posts and completion of the Panel's final report by Monday, December 12th.

Agenda Item 6 – Public comment

- Mr. Johnson identified several issues of concern, noting:
    - That measurement or estimation of discharge in the Crystal River/Kings Bay system is difficult.
    - The U.S. Geological Survey's methods for tidally filtering measured discharge values at the Bagley Cove gage site are based on a tidal-cycle or period that may not be appropriate.
    - That discharge values included in figure 2-4 within the District's minimum flows report and a similar figure in a paper published in the Journal of Marine Science by Dr. Chen do not seem to be supported by any measured data, adding that the extent of variation in discharge values (e.g., from about 0 to ~260 cfs) seems unrealistic.
- Additional input by Mr. Johnson appeared to have been limited by technical difficulties. While other meeting participants continued to be able to communicate with District staff and the Peer Review Panelists via the activated conference call utility, the connection with Mr. Johnson was intermittently non-functional and eventually fully non-functional.

Meeting Agenda



Southwest Florida Water Management District

MEETING NOTICE

AGENDA

Southwest Florida Water Management District (SWFWMD)
Scientific Peer Review Panel WebEx Meeting and Teleconference
Proposed Minimum Flows for the Crystal River/Kings Bay System

Monday, December 5, 2016
12:00 p.m. to 3:00 p.m.

District Headquarters,
2379 Broad Street, Brooksville, Florida 34604-6899

To join the WebEx Meeting, hit Contol+Click on the link below:
Join WebEx meeting
Meeting number: 730 029 481
Can't join the meeting? Contact support
Conference call-in number: 1-888-670-3525
Participant passcode: 1372920332#

1. Welcome and introductions
   - Doug Leeper, SWFWMD MFLs Program Lead, Steve Peene, Peer Review Panel Chair, Ken Watson, Peer Review Panelist, and Adam Munson, Peer Review Panelist
2. Final discussion of measured/modeled flows
   - Peer Review Panel
3. Panelist's additional questions/comments since the last meeting
   - Peer Review Panel
4. Discussion of MFLs criteria responses
   - Peer Review Panel
5. Discussion of draft report
   - Peer Review Panel
6. Public comment
   - Facilitated by Doug Leeper

Participants will be asked to save their comments until the public comment portion of the meeting. If you wish to speak during the public comment period, please fill out a speaker's card and give it to the moderator (Doug Leeper), who will call on you at the appropriate time during the meeting. Comments will be limited to three minutes per speaker. In appropriate circumstances, the Moderator may grant exceptions to the three-minute limit.

For questions or to submit additional public comment on the peer review of the proposed minimum flow for the Crystal River/Kings Bay System, please use the comment card provided during the meeting or contact Doug Leeper by email at doug.leeper@swfwmdmfls.org, by telephone at 1-800-423-1476, extension 4272, or by mail at the address listed at the top of this agenda.

The Southwest Florida Water Management District (District) does not discriminate on the basis of disability. This nondiscrimination policy involves every aspect of the District's functions, including access to and participation in the District's programs and activities. Anyone requiring reasonable accommodation as provided for in the Americans with Disabilities Act should contact the District's Human Resources Bureau Chief, 2379 Broad St., Brooksville, FL 34604-6899; telephone (352) 796-7211 or 1-800-423-1476 (FL only), ext. 4703; or email ADACoordinator@WaterMatters.org. If you are hearing or speech impaired, please contact the agency using the Florida Relay Service, 1-800-955-8771 (TDD) or 1-800-955-8770 (Voice).

From: Doug Leeper
To: "hobara@floridaspringsinstitute.org"
Cc: FootPrintsPRR; Shellie Ferreira-Lee; Mark A. Green; Jennette Seachrist; Eric DeHaven
Subject: RE: SWFWMD Public Records Request - Heather Obara - Total FY Budgets for only Springs MFLs from 2013-...
Date: Tuesday, December 13, 2016 4:47:00 PM
Attachments: Rainbow_Crystal MFLs Contracts-POs-TWAs 2016-12-08 Rev 2016-12-13.pdf
image002.png

Ms. Obara:

The table below was prepared by District staff in response to your recent inquiry concerning total fiscal year budgets for spring minimum flows and levels (MFLs) for the period from 2013 through 2017. Information on budgeted and expended funds is summarized for projects within the District's Minimum Flows and Levels Program that are associated specifically with spring MFLs and those within the program that include efforts associated with spring MFLs and MFLs for other priority water bodies. Unfortunately, for the group of "programmatic" projects that address both spring and non-spring MFLs, we do not have funding allocations/expenses parsed by spring-related and non-spring-associated efforts. For both the spring-specific and programmatic projects, budgeted/expended funds include operating expenses, contractual dollars and staff salaries/benefits.

Project Code	Project Name	FY2013 Budgetd ($)	FY2013 Expended ($)	FY2014 Budgetd ($)	FY2014 Expended ($)	FY2015 Budgetd ($)	FY2015 Expended ($)	FY2016 Budgetd ($)	FY2016 Expended ($)	FY2017 Budgetd ($)	Comments
B208	MFL Estb - Rainbow River Freshwater System	5,891	52,720	47,181	83,554	53,085	39,482	99,449	92,792	64,031	Spring MFLs
B209	MFL Estb - Chassahowitzka River & Springs System	0	10,237	0	9,885	9,154	10,612	6,412	4,189	5,858	Spring MFLs
B273	MFL Tech Sp - Strmflw Rdc-Measure Effects of MFL	17,195	84,188	1,337	40,958	0	0	0	0	0	Spring MFLs
B807	MFL Estb - Crystal River/Kings Bay Estuary System	56,516	15,241	75,117	29,024	80,377	13,789	73,686	114,192	136,678	Spring MFLs
B808	MFL Estb - Gum Springs Group Freshwater System	19,837	3,997	581	8,399	0	10,593	2,472	24,347	0	Spring MFLs
B811	MFL Estb - Silver River MFL Assistance to SJRWMD	7,111	1,818	2,658	2,460	4,582	0	0	573	0	Spring MFLs
B817	MFL Re-Eval - Springs Systems	33,509	55,342	65,202	16,923	81,824	79,377	58,083	32,408	152,535	Spring MFLs
B822	MFL Re-Eval - Homosassa Rvr & Spgs Sys	0	0	0	0	0	3,356	120,061	6,753	85,807	Spring MFLs
B823	MFL Re-Eval - Chassahowitzka Rvr & Sprgs System	0	0	0	0	0	0	125,610	8,292	84,125	Spring MFLs
P248	MFL Tech Sp - Freshwater Systems	126,659	180,220	139,136	112,931	169,277	189,644	151,738	138,943	144,138	Programatic-Includes Spring and Other MFLs
P255	MFL Tech Sp - Hydrologic Analysis	88,879	42,941	114,381	23,705	93,201	62,027	93,939	46,902	59,440	Programatic-Includes Spring and Other MFLs
P263	MFL Tech Sp - Compliance	0	18,174	54,753	25,703	50,421	20,489	53,260	6,999	33,688	Programatic-Includes Spring and Other MFLs
P274	MFL Estb - Peer Review & Technical Advisory Cnslt	176,542	-10	153,273	2,524	182,390	4,909	182,472	39,331	187,343	Programatic-Includes Spring and Other MFLs
P686	MFL Tech Sp - Estuarine Systems	165,207	219,353	124,893	191,215	357,468	159,323	202,984	67,376	173,215	Programatic-Includes Spring and Other MFLs
P862	MFL Tech Sp - INTB Model Maintenance	0	0	50,000	0	54,128	32,991	67,645	53,176	75,749	Programatic-Includes Spring and Other MFLs
P863	MFL Estb - Priority List & Schedule Annual Update	0	0	0	0	0	0	0	3,298	5,232	Programatic-Includes Spring and Other MFLs
P876	MFL Tech Sp - Northern District Wrap	56,421	219,764	22,895	180,619	22,352	40,385	21,241	54,309	37,840	Programatic-Includes Spring and Other MFLs
P876A	AMFL Tech Sp - Northern District Wrap - Acq	0	0	0	0	0	0	0	867	0	Programatic-Includes Spring and Other MFLs
P883	MFL Tech Sp - NTB Phase II Investigation	154,611	136,849	97,257	57,927	103,181	80,156	94,212	71,119	97,051	Programatic-Includes Spring and Other MFLs
P883A	MFL Tech Sp - NTB Phase II Investigation - Acq	0	0	0	0	0	0	0	3,806	0	Programatic-Includes Spring and Other MFLs
Total ($)		**908,378**	**1,040,834**	**948,664**	**785,827**	**1,261,440**	**747,133**	**1,353,264**	**769,672**	**1,342,730**	

Funds budgeted/expended for the expert testimonial and non-testimonial and related consulting services for the Silver and Rainbow springs MFLs that were identified in the District's response to your previous request for a listing of all contractors/costs for the District's Rainbow and Crystal River/Kings Bay MFLs projects are not included in the table above. Funds for these services are associated with project Z040, which is administered by the District's Office of General Counsel and is not included in the MFLs Program budget. As indicated in staff's response to your previous inquiry, funds allocated to six Z040 project agreements developed for services related to the Silver/Rainbow springs MFLs total $195, 687.50.

Note that I have attached a PDF file to this email. This file is a replacement for the summary list of contractors for the Rainbow River and Crystal Springs minimum flows that was previously provided by the District. The updated file includes corrected contract numbers (in the third column) for the last three entries (rows) in the summary table.

Thanks for your inquiry. Please let me know if you have any questions regarding the information I've sent.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: FootPrintsPRR
Sent: Friday, December 09, 2016 12:56 PM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: SWFWMD Public Records Request - Heather Obara - Total FY Budgets for only Springs MFLs from 2013-...

When replying, type your text above this line.

Notification of Issue Registration

Workspace: Public Records Request
Issue: Heather Obara - Total FY Budgets for only Springs MFLs from 2013-2017
Issue Number: 21538

Priority: Medium **Status:** Under 7 days old
Date: 12/09/2016 **Time:** 12:55:42
Created By: Shellie Ferreira-Lee

Description:
Entered on 12/09/2016 at 12:55:41 PM EST (GMT-0500) by Shellie Ferreira-Lee:
Email will be forwarded to the PRR ticket.

Current Assignees: Shellie Ferreira-Lee

CC(s): (this edit only) doug.leeper@swfwmd.state.fl.us

Issue Information:

Internal Request: Off

Contact Information:

Last Name: Obara **First Name:** Heather
Email Address: hobara@floridaspringsinstitute.org **Phone:** (386) 454-2427

From:	Doug Leeper
To:	Eric DeHaven; Melissa Gulvin
Cc:	Kym Holzwart; Ron Basso; Jerry Mallams; Mark A. Green; Gabe I. Herrick
Subject:	FW: SWFWMD Public Records Request - Heather Obara - Public Records Request - Rainbow and Kings Bay MF...
Date:	Tuesday, November 08, 2016 11:18:00 AM

From: Jeanette Lopez
Sent: Tuesday, November 08, 2016 10:18 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Mark A. Green <Mark.Green@swfwmd.state.fl.us>
Subject: FW: SWFWMD Public Records Request - Heather Obara - Public Records Request - Rainbow and Kings Bay MF...

From: FootPrintsPRR
Sent: Tuesday, November 08, 2016 9:48 AM
To: Jeanette Lopez <Jeanette.Lopez@swfwmd.state.fl.us>
Subject: SWFWMD Public Records Request - Heather Obara - Public Records Request - Rainbow and Kings Bay MF...

When replying, type your text above this line.

Notification of Issue Change
The following changes have been made to this Issue: *canRead:agentRoles, Changed Title, Changed Issue data or Contact data, Appended a Description, Added Assignees : Shellie Ferreira-Lee Valerie Jordan, Escalated: Set Start Date & Status, Changed Status to Under 7 days old from NewRequest, Escalated: Send Acknowledgement Email, Escalation email sent: hobara@floridaspringsinstitute.org, Escalation email sent: footprints.pm@watermatters.org, canRead:allRoles.*
Workspace: Public Records Request
Issue: Heather Obara - Public Records Request - Rainbow and Kings Bay MFL - List of Contractors, Cost, Summary of Work
Issue Number: 21222

Priority:	Medium	**Status:**	Under 7 days old
Date:	11/08/2016	**Time:**	09:48:22
Creation Date:	11/07/2016	**Creation Time:**	15:44:07
Created By:	webmaster@watermatters.org		

Description:
Entered on 11/08/2016 at 9:48:21 AM EST (GMT-0500) by Valerie Jordan:
Thank you for reviewing the following public records request and being able to provide the items listed. Please forward that information to Shellie Ferreira-Lee and copy me, Valerie Jordan, in order for us to collect all the information and provide to the requester. Keep track of the the amount of time involved in order for us to figure in that cost for this request.

Entered on 11/07/2016 at 3:44:07 PM EST (GMT-0500) by webmaster@watermatters.org:
Please provide a complete list of the contractors and the cost of their contracts for both the Rainbow and Kings Bay Minimum Flow and Level (MFL) studies. A brief summary of work contracted
and/or completed through October 2016 will be sufficient. Please include all relevant contracts for
consultants, universities, peer reviewers, and others. Also, please send the District's total fiscal year budgeted amounts for MFLs during the past five years.

Permit Type = WCP
Permit Number =
County of Permit =
Project Name =
Permit Address =
Issuing Permit Office =

Info Needed =

Other/Comments =

Current Assignees: Document Services, Shellie Ferreira-Lee, Valerie Jordan

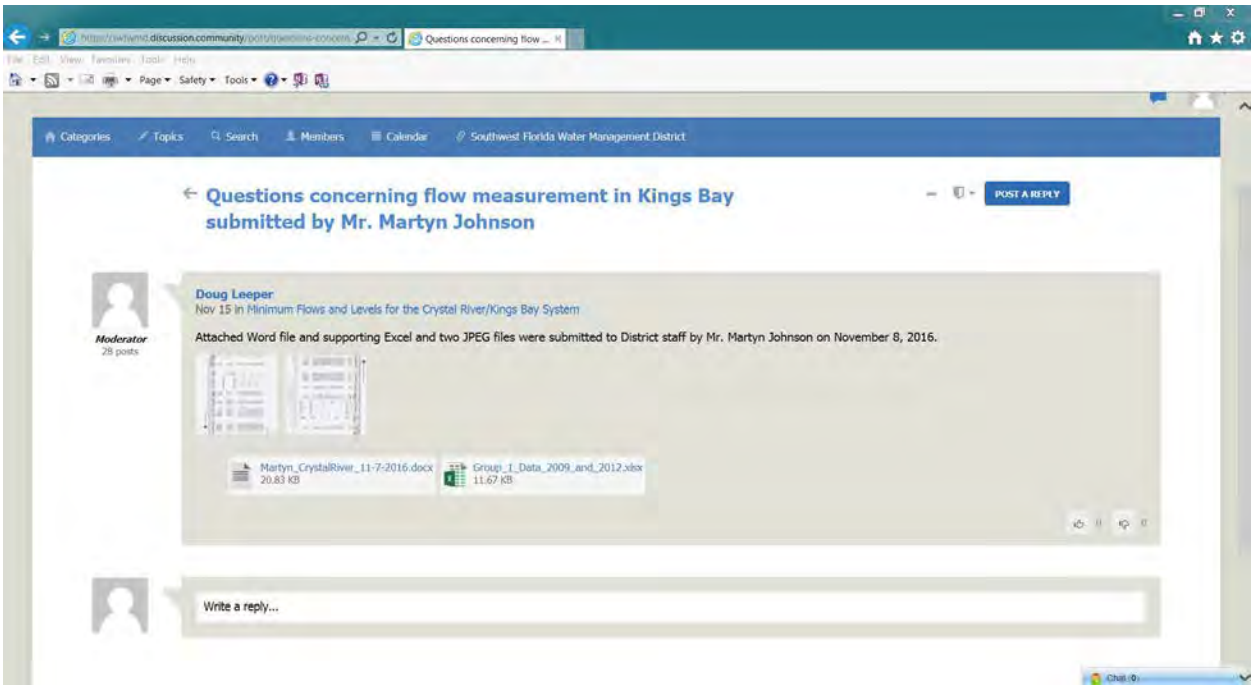
CC(s): (this edit only) doug.leeper@swfwmd.state.fl.us, Mark.Green@swfwmd.state.fl.us, Kym.Holzwart@swfwmd.state.fl.us, Jeanette.Lopez@swfwmd.state.fl.us

Issue Information:

Internal Request: Off

Contact Information:

Last Name:	Obara	**First Name:**	Heather
Company:	Howard T. Odum Florida Springs Institute	**Email Address:**	hobara@floridaspringsinstitute.org
Phone:	386-454-2427	**Street Address:**	23695 W US Hwy 27
City:	High Springs	**Zip/Postal Code:**	32643


Categories
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Southwest Florida Water Management District
Questions concerning flow measurement in Kings Bay submitted by Mr. Martyn Johnson
POST A REPLY
Doug Leeper
Nov 15 in Minimum Flows and Levels for the Crystal River/Kings Bay System
Moderator
28 posts
Attached Word file and supporting Excel and two JPEG files were submitted to District staff by Mr. Martyn Johnson on November 8, 2016.
Martyn_CrystalRiver_11-7-2016.docx
20.83 KB
Group_1_Data_2009_and_2012.xlsx
11.67 KB
Write a reply...

From M. Johnson

Word File possibly easier to read than an e-mail CRYSTAL RIVER/KINGS BAY MFL

11-7-2016

It is possible my last lengthy e-mail was too much at once. So let me focus on one aspect THE FIELD MEASUREMENTS DATA USED AS THE BASIS, the VHB data FIELD MEASUREMENTS in 2009 and 2012 focusing on the field measurements for Group 1 Springs.

Just as a reminder from the Draft Report Page 41

"Mean spring flow from field measurements of all 70 vents was used as the long-term mean spring flow (q_0) (Equation 1). Flow from individual vents within the bay was modeled using Equation 1 with parameters C_1 and C_2 from the nearest spring group (G1 or G2), with q_0 as measured in the field, and with ΔG as a linear function of distance from G1 or G2 to account for variation in potentiometric surface among vents.
Flows estimated using Equation (1) are able to account for 72% and 94% of the variation in measured flow in the two groups (G1 and G2) of springs (Figure 2-4).

Question 1

Is q_0 the mean of all 70 vents and if so what is this?
Or is q_0 the mean field measurement for each individual spring vent. In the purple highlight it states flow from individual vents 'was' modeled.

An explanation is needed; the model has to start from some hard facts/measurements. The only place I see reference of hard data is the VHB field measurements. AND 70 APPEARS TO ORIGINATE FROM SOME VENT SITES HAVING MULTIPLE VENTS eg. SV10 HAS 4 VENTS.

Question 2

The green highlighted words introduce ΔG: it is not immediately apparent what the distance between G1 and G2 (which appears to relate to Group 1 and Group 2) has to do with spring flow from vents such as Millers Creek SV1 or Garrys Grotto SV40……. notwithstanding G in the blocked explanation of Equation 1, page 41 states " ***G* represents the groundwater level in ROMP TR21-3."**

An explanation is needed; and if this is a variation in potentiometric surface among vents where is there any evidence/measurement of this other than the potential difference in time that high and low tide occur at each of the vents, which I doubt is of any significance.

Question 3

Figure 2-4 for Group 1 has taken the field data in Figure 4 VHB 2010 and somehow translated Discharge cfs to Spring Flow- Measured (the red dotted line). I have not so far found an explanation of how this was done. The range of Discharge run from 150 cfs to -40 cfs and the Spring Flows run from 40 cfs to 90 cfs. There is a large area 'upstream' of the cross-section and as mentioned in my last e-mail this is of the order of 13 acres which fills and emptied each tidal period. Taking the average from Figure 2-4 as around 70 cfs Spring Flow, this does not appear to match the measured spring flows at vents 8, 9, and 10 which comprise Group 1 . And the measured spring flows do not appear to support the range of

flows for each tidal cycle. Most of the spring flows are fairly tight grouped particularly when considering accuracy limitations mentioned in the VHB report.

An explanation is needed; as somehow the logic which must prevail is missing.

Now let me focus on the field measurements VHB 2010 and 2012. These two sets of data form the basis for the Draft Report, and are the only **actual** spring flow measurements considered. As such there must be a clear understanding of what was measured and how the data supports the mathematical relationships with USGS stage measurements at Gage Site 02310742 and Well Level ROMP TR21-3 285234082341901. I will focus on the Group 1 which consists of Spring Vents 8 House Spring, 9 Jurassic Spring 10 Hunters Spring; noteworthy is that Hunter and House are both assigned 5 cfs in NDM 5 with the qualification * Estimated, no observed spring discharge available..
Attached are scans of the pages from 2009 which I have marked with some notes and should help in understanding of my comments. I have also attached an xls sheet where the measurements are set side by side for possible easier comparison. It also shows stage from the USGS gage at the mouth of Kings Bay at the time closest to VHB measurements.

- Flow from SV8 House Spring is measured by cross-section in a spring run. Four measurements in 2009 show reasonable consistency averaging 5.23 cfs and the two for 2012 averaging 3.85 cfs. The data appears to be good showing reasonable consistency.
  The 2009 relationship with stage at 02310742 is not good, but this must recognize level in ROMP TR21-3 is not known by measurement on the respective days. The 2012 data is consistent with the hypothesis relating to stage, again recognizing the level in ROMP TR21-3 is not known.

  NOTE: There are other springs that were measured in spring runs, thesemay not be influenced by tidal change to the same extent…***possibly not all springs can be treated as equal***.

- Flow from SV9 Jurassic Spring is a vent measurement. There are sixteen measurements in 2009 however the last one in the time series for each date is lower and added to the average of the other three measurements; there is no explanation of this; an explanation is warranted. Averages are consistent averaging 23.96 cfs.
  For 2012 there are four measurements, the second measurement on each day is much lower than the first; same explanation needed. Average flow using summing of the high and low flow for each day is 12.42 cfs. Roughly half the 2009 flow. No relationship to stage is evident, no well level ROMP TR21-3 is available.

- Flow from SV10 is a vent/vents measurement. There appear to be four vents each measured in very short timeframe, 7 minutes or less. In 2009 data the four measurements on each day are summed giving an overall average of 31.02 cfs. For 2012 there are eight measurements four each on two days flows on 10/11/2012 total 37.7 cfs and for 11/08/2012 lower at 13.16 cfs. No relationship to stage is evident in 2009 as all flows are reasonably close and stage is significantly lower on 8/17/2009. Stage in 2012 is lower on both days than in 2009, but no data for ROMP TR21-3.

- USGS output available on the waterdata.usgs.gov for ROMP TR21-3 is from 1979-06-21 initially on a two monthly basis and since 1993 twice yearly.
  In the Draft Report page 39
  " Groundwater levels used for estimating discharge were measured at ROMP TR21-3""
  And in Dr.Chen's October 2016 pdf page 214
  "The ADCP measurements was conducted during a 25-day period in summer 2009, during which both surface water level data in Kings Bay and groundwater level data at a nearby well were available. The GW well station is called ROMP TR21-3…"

  These words appear to imply that actual well levels were available/measured at the time of the VHB work. However, it appears that not only was Well Level for ROMP TR21-3 hindcast from Lecanto 7 well no 285254082323001, but may have been interpolated from the field measurements. 2009-05-20 measurement was **1.83 feet NAVD29 and 2009-09-22 the measurement was 3.37 feet NAVD 29.** Please confirm if SWFWMD have other Well Level data from USGS or if levels were interpolated between Field Measurements for 2009 and where the data is for the 2012 study period, Is it possible ROMP TR21-3 was hindcast back to May 1966 and forward cast to 2012.

  Without the measurements to verify the validity of the hypothesized connection between the data, the Draft Report has a questionable credibility.

  Note: Lecanto 7 is also by Field Measurements with the last reported 2011.

There are many other points of concern, but most importantly how will MFL be measured and or monitored ? I do not think the concept of the MFL legislation anticipated Simulated Minimum Flow.
While I am skeptical of the mathematical models which are based on very limited actual data, I fully agree with the words on Appendix pdf page 198

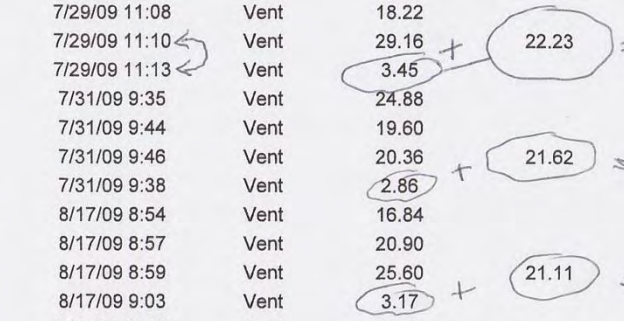
Quote
In order to protect this ecologically valuable springs/estuarine system, a regulatory minimum spring water flow rate needs to be determined and established.
End Quote
May I add the caveat, 'these need to be measurable'.

Martyn

PS for interest. What conditions and when gave the max and min modeled spring discharge of 960 cfs and -112 cfs for the period Nov 1969 to October 2015 Appendix pdf page 326 .

Table 2. (cont.) Summary of Instantaneous Cross-section and Vents Measurements at Springs in Kings Bay, Crystal River, Florida

Site	Measurement No.	Date and Time	Measurement Type	Measured Discharge	Vent Average	Total Discharge	USGS Stage Data EST Time	USGS Stage Data Corrected Stage (MSL)
7	SV07100809	10/8/09 11:18	Vent	0.57			1115	-0.9
7	SV07100809a	10/8/09 11:23	Vent	0.21			1130	-1.01
7	SV07100809b	10/8/09 11:29	Vent	0.01			1130	-1.01
					Average Discharge	0.79		
8	SV08072909	7/29/09 11:49	X-Section	3.34		3.34	1145	0.07
8	SV08073109	7/31/09 9:01	X-Section	5.99		5.99	900	1.12
8	SV08081709	8/17/09 9:23	X-Section	4.20		4.20	915	0.51
8	SV08081809	8/18/09 12:38	X-Section	7.40		7.40	1230	1.32
					Average Discharge	5.23		
9	SV09072909	7/29/09 11:07	Vent	19.30			1100	0.36
9	SV09072909a	7/29/09 11:08	Vent	18.22			1115	0.27
9	SV09072909b	7/29/09 11:10	Vent	29.16			1115	0.27
9	SV09072909c	7/29/09 11:13	Vent	3.45		25.68	1115	0.27
9	SV09073109	7/31/09 9:35	Vent	24.88			930	1.18
9	SV09073109a	7/31/09 9:44	Vent	19.60			945	1.17
9	SV09073109b	7/31/09 9:46	Vent	20.36			945	1.17
9	SV09073109c	7/31/09 9:38	Vent	2.86		24.47	945	1.17
9	SV09081709	8/17/09 8:54	Vent	16.84			900	0.41
9	SV09081709a	8/17/09 8:57	Vent	20.90			900	0.41
9	SV09081709b	8/17/09 8:59	Vent	25.60			900	0.41
9	SV09081709c	8/17/09 9:03	Vent	3.17		24.28	900	0.41
9	SV09081909	8/19/09 12:28	Vent	15.41			1230	0.99
9	SV09081909a	8/19/09 12:30	Vent	21.04			1230	0.99



True Average
5.23 cfs

Table 2. (cont.) Summary of Instantaneous Cross-section and Vents Measurements at Springs in Kings Bay, Crystal River, Florida

Site	Measurement No.	Date and Time	Measurement Type	Measured Discharge	Vent Average	Total Discharge	USGS Stage Data EST Time	USGS Stage Data Corrected Stage (MSL)
9	SV09081909b	8/19/09 12:32	Vent	19.84	18.76		1230	0.99
9	SV09081909c	8/19/09 12:34	Vent	2.65		21.41	1230	0.99
					Average Discharge	23.96		
10	SV10072909	7/29/09 9:55	Vent	3.65			1000	0.74
10	SV10072909a	7/29/09 9:57	Vent	3.19			1000	0.74
10	SV10072909b	7/29/09 10:00	Vent	14.30			1000	0.74
10	SV10072909c	7/29/09 10:02	Vent	8.73		29.87	1000	0.74
10	SV10073109	7/31/09 10:16	Vent	3.89			1015	1.12
10	SV10073109a	7/31/09 10:18	Vent	3.94			1015	1.12
10	SV10073109b	7/31/09 10:19	Vent	14.93			1015	1.12
10	SV10073109c	7/31/09 10:20	Vent	5.25		28.00	1015	1.12
10	SV10081709	8/17/09 8:19	Vent	4.58			815	0.12
10	SV10081709a	8/17/09 8:21	Vent	5.08			815	0.12
10	SV10081709b	8/17/09 8:23	Vent	12.36			830	0.21
10	SV10081709c	8/17/09 8:25	Vent	11.25		33.26	830	0.21
10	SV10081909	8/19/09 11:52	Vent	5.11			1145	0.53
10	SV10081909a	8/19/09 11:54	Vent	3.23			1200	0.67
10	SV10081909b	8/19/09 11:56	Vent	19.46			1200	0.67
10	SV10081909c	8/19/09 11:59	Vent	5.13		32.93	1200	0.67
					Average Discharge	31.02		
11	SV11092109	9/21/09 8:03	Vent	1.56			800	0.4
11	SV11092109a	9/21/09 8:05	Vent	1.89	1.73	1.73	800	0.4
11	SV11100509	10/5/09 9:31	Vent	2.16		2.16	930	-0.8
					Average Discharge	1.94		

Average 9 23.96

Average 10 SV 31.02 if 4 distinct Vents Hammett 3 Hunter American Legion Shown on page 6

Add

Add.

Add.

→ Hammett 3 I thought was the numbering given by Hammett in 1996 or earlier but Draft Report only mentions Hammett in connection with Bagley Cove.

2012 Data

RED DATA IS CALCULATED DATA NOT IN VHB REPORT

Yellow highlighted data is the figure added to the average of the 3 other measurements

	Springflow cfs fromVBH		Stage 2310742O USGS
SV10121022 Hunters Spring 10/22/12 1504 EST 10.675	10.675		-0.71
SV10121022b Hunters Spring 10/22/12 1511 EST 2.962	2.962		
SV10121022c Hunters Spring 10/22/12 1516 EST 22.352	22.352		
SV10121022d Hunters Spring 10/22/12 1519 EST 1.714	1.714		
Day Total		37.70	
SV1020121108 Hunters Spring 11/08/12 1245 EST 3.99	3.99		0.041
SV1020121108a Hunters Spring 11/08/12 1248 EST 1.50	1.5		
SV1020121108b Hunters Spring 11/08/12 1251 EST 5.49	5.49		
SV1020121108c Hunters Spring 11/08/12 1253 EST 2.18	2.18		
Day Total		13.16	
Overall Average		25.43	
SV09121024 Jurassic Springs 10/24/12 1101 EST 11.516	11.516		1.1
SV09121024c Jurassic Springs 10/24/12 1106 EST 0.728	0.728		
Day Average		12.244	
SV0920121108 Jurassic Springs 11/08/12 1159 EST 11.80	11.8		0.41
SV0920121108c Jurassic Springs 11/08/12 1209 EST 0.79	0.79		
Day Average		12.59	
Overall Average		12.417	
	2.07		0.93
SV08121030 House Spring 10/30/12 0911 EST 5.620	5.62		0.05
		3.845	

2009 Data

	Springflow cfs fromVBH			Stage 2310742O
10 SV10072909 7/29/09 9:55 Vent 3.65	3.65			1.55
10 SV10072909a 7/29/09 9:57 Vent 3.19	3.19			
10 SV10072909b 7/29/09 10:00 Vent 14.30	14.3			
10 SV10072909c 7/29/09 10:02 Vent 8.73 29.87	8.73		29.87	
10 SV10073109 7/31/09 10:16 Vent 3.89	3.89			1.63
10 SV10073109a 7/31/09 10:18 Vent 3.94	3.94			
10 SV10073109b 7/31/09 10:19 Vent 14.93	14.93			
10 SV10073109c 7/31/09 10:20 Vent 5.25 28.00	5.25		28	
10 SV10081709 8/17/09 8:19 Vent 4.58	4.58			0.27
10 SV10081709a 8/17/09 8:21 Vent 5.08	5.08			
10 SV10081709b 8/17/09 8:23 Vent 12.36	12.36			
10 SV10081709c 8/17/09 8:25 Vent 11.25 33.26	11.25		33.26	
10 SV10081909 8/19/09 11:52 Vent 5.11	5.11			missing
10 SV10081909a 8/19/09 11:54 Vent 3.23	3.23			
10 SV10081909b 8/19/09 11:56 Vent 19.46	19.46			
10 SV10081909c 8/19/09 11:59 Vent 5.13 32.93	5.13		32.93	
Average Discharge 31.02			31.02	
9 SV09072909 7/29/09 11:07 Vent 19.30 1100 0.36	19.3			1.09
9 SV09072909a 7/29/09 11:08 Vent 18.22 1115 0.27	18.22			
9 SV09072909b 7/29/09 11:10 Vent 29.16 22.23 1115 0.27	29.61	22.23		
9 SV09072909c 7/29/09 11:13 Vent 3.45 25.68 1115 0.27	3.45	25.68		
9 SV09073109 7/31/09 9:35 Vent 24.88 930 1.18	24.88			1.52
9 SV09073109a 7/31/09 9:44 Vent 19.60 945 1.17	19.6			
9 SV09073109b 7/31/09 9:46 Vent 20.36 21.62 945 1.17	20.36	21.62		
9 SV09073109c 7/31/09 9:38 Vent 2.86 24.47 945 1.17	2.86	24.47		
9 SV09081709 8/17/09 8:54 Vent 16.84 900 0.41	16.84			0.47
9 SV09081709a 8/17/09 8:57 Vent 20.90 900 0.41	20.9			
9 SV09081709b 8/17/09 8:59 Vent 25.60 21.11 900 0.41	25.6	21.11		
9 SV09081709c 8/17/09 9:03 Vent 3.17 24.28 900 0.41	3.17	24.28		
9 SV09081909 8/19/09 12:28 Vent 15.41 1230 0.99	15.41			missing
9 SV09081909a 8/19/09 12:30 Vent 21.04 1230 0.99	21.04			
9 SV09081909b 8/19/09 12:32 Vent 19.84 18.76 1230 0.99	19.84	18.76		
9 SV09081909c 8/19/09 12:34 Vent 2.65 21.41 1230 0.99	2.65	21.41		
Average Discharge 23.96 over all dates			23.96	
8 SV08072909 7/29/09 11:49 X-Section 3.34 3.34 1145 0.07	3.34			0.91
8 SV08073109 7/31/09 9:01 X-Section 5.99 5.99 900 1.12	5.99			1.23
8 SV08081709 8/17/09 9:23 X-Section 4.20 4.20 915 0.51	4.2			0.77
8 SV08081809 8/18/09 12:38 X-Section 7.40 7.40 1230 1.32	7.4			1.79
Average Discharge 5.23			5.23	

From:	Xinjian Chen
To:	Doug Leeper
Cc:	Gabe I. Herrick; Ron Basso; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ross Morton
Subject:	RE: Crystal River Kings Bay Draft MFL Report
Date:	Monday, November 14, 2016 3:40:06 PM
Attachments:	XJC"s Response to Martyn CrystalRiver 11-7-2016.docx

Attached is my response to Mr. Johnson's comments on spring flow estimate. Please revise as needed. Thanks!

XinJian

From: Doug Leeper
Sent: Thursday, November 10, 2016 4:45 PM
To: Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>
Cc: Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Mark A. Green <Mark.Green@swfwmd.state.fl.us>; Jennette Seachrist <Jennette.Seachrist@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Ross Morton <Ross.Morton@swfwmd.state.fl.us>
Subject: FW: Crystal River Kings Bay Draft MFL Report

XinJian:

Assuming we will be responding to inquiries regarding the Crystal MFLs that are submitted by Mr. Martyn Johnson, it would be helpful if you could make an initial attempt at the questions he has included in four attached files.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Ron Basso
Sent: Thursday, November 10, 2016 4:29 PM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: FW: Crystal River Kings Bay Draft MFL Report

Here's Mr. Johnson's latest. See attached word doc.

From: Ross Morton
Sent: Wednesday, November 09, 2016 10:12 AM

To: Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>
Cc: Earl C. Rich <Earl.Rich@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>
Subject: FW: Crystal River Kings Bay Draft MFL Report

FYI – I do not discern a public record request unless Earl indicates otherwise, so a response is not required.

Possible response:

"Your comments and the attachments you provided in the email are appreciated and noted by the District. I will make sure these comments are included with any other comments received by the District on this topic and as a result of the meeting referenced below."

Ross T. Morton, P.W.S., CO-OP®, F.S.C.C.M.
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About The Ombudsman: http://www.swfwmd.state.fl.us/about/staff/ombudsman.php

---

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Tuesday, November 08, 2016 7:32 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>
Subject: Crystal River Kings Bay Draft MFL Report

May be my previous comments and questions were too broad to get answers, so let me focus on the VHB measurements and particularly Group 1.
I have put my comments/questions in a word file as this may be easier than a long e-mail.
The other attachments may help in understanding my points.

Martyn

From: Melissa Gulvin
Sent: Tuesday, November 08, 2016 12:35 PM
To: 'martynellijay@hotmail.com' <martynellijay@hotmail.com>
Subject: Re: WebEx information for Friday's Peer Review Panel Meeting for the proposed Crystal River/Kings Bay MFL

Hi Mr. Johnson,

I'm sorry you weren't able to hear the meeting. There were four other people listening

remotely who were able to hear all the way until the meeting concluded, so I'm not sure what was going on. The meeting was not recorded, but meeting notes were taken and will be available later this week. The meeting notes will be posted on the WebForm. The WebForum is the one location where the peer reviewers can communicate back and forth throughout the process. It's also where the public can post comments they want the peer reviewers to see, or you can send them to District staff and we will post for you. This is the link to the WebForum: https://swfwmd.discussion.community/categories. You'll need to register, which can be found on the top right corner of the webpage. The PowerPoint slides from Friday's meeting are already posted. The meeting notes will be posted this week.

The peer review panel chose to add another meeting date, which will be next Tuesday, Nov. 15 at 1 p.m. Staff plan to discuss your comments at this meeting.

The peer review panel will be joining remotely, but we do have a room reserved at the District for staff and any interested stakeholders. If you want to give participating remotely another try, the information to do so is below. These meetings are posted on the District's calendar. If there's ever a change to the teleconference or WebEx information, which I don't foresee, the updates will be on the agenda posted on the District's calendar.

Join the teleconference: All you have to do is dial the number on your phone and then enter the participant passcode followed by the # key.

Dial: 1-888-670-3525

Participant passcode: 1372920332#

Join the WebEx meeting:

https://swfwmd.webex.com/swfwmd/j.php?MTID=m978b3a1755597aeb1749823d806b8bcd

Meeting number: 735 358 320

Can't join the meeting? Contact support here: https://swfwmd.webex.com/swfwmd/mc

I apologize again for the difficulties you experienced trying to participate on Friday. Please let me know if I can be of further assistance.

Melissa Gulvin
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Southwest Florida Water Management District
279 Broad Street, Brooksville, FL 34604
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(352) 206-4047 cell
Melissa.Gulvin@WaterMatters.org

Please find *XJC's response*

Word File possibly easier to read than an e-mail CRYSTAL RIVER/KINGS BAY MFL

11-7-2016

It is possible my last lengthy e-mail was too much at once. So let me focus on one aspect THE FIELD MEASUREMENTS DATA USED AS THE BASIS, the VHB data FIELD MEASUREMENTS in 2009 and 2012 focusing on the field measurements for Group 1 Springs.

Just as a reminder from the Draft Report Page 41

"Mean spring flow from field measurements of all 70 vents was used as the long-term mean spring flow (q_0) (Equation 1). Flow from individual vents within the bay was modeled using Equation 1 with parameters C_1 and C_2 from the nearest spring group (G1 or G2), with q_0 as measured in the field, and with ΔG as a linear function of distance from G1 or G2 to account for variation in potentiometric surface among vents.
Flows estimated using Equation (1) are able to account for 72% and 94% of the variation in measured flow in the two groups (G1 and G2) of springs (Figure 2-4).

Question 1
Is q_0 the mean of all 70 vents and if so what is this?

No, it is not the mean of all 70 vent.

Or is q_0 the mean field measurement for each individual spring vent. In the purple highlight it states flow from individual vents 'was' modeled.

Yes, it is the mean field measurement for each individual spring vent or a group of vents within a model grid. Yes, it was modelled using Equation (1).

An explanation is needed; the model has to start from some hard facts/measurements. The only place I see reference of hard data is the VHB field measurements. AND 70 APPEARS TO ORIGINATE FROM SOME VENT SITES HAVING MULTIPLE VENTS eg. SV10 HAS 4 VENTS.

Equation (1) and its coefficients (C_1, C_2, and ΔG) were obtained from the 2009 field measurements by VHB. Also, q_0 was from the VHB measurements.

Yes, some springs have multiple vents.

Question 2
The green highlighted words introduce ΔG: it is not immediately apparent what the distance between G1 and G2 (which appears to relate to Group 1 and Group 2) has to do with spring flow from vents such as Millers Creek SV1 or Garrys Grotto SV40……. notwithstanding G in the blocked explanation of Equation 1, page 41 states " ***G* represents the groundwater level in ROMP TR21-3."**

An explanation is needed; and if this is a variation in potentiometric surface among vents where is there any evidence/measurement of this other than the potential difference in time that high and low tide occur at each of the vents, which I doubt is of any significance.

Water movement in the spring vent is mainly driven by pressure gradient in the vertical direction. Pressure in flowing the water consists of hydrostatic pressure and non-hydrostatic pressure. Non-hydrostatic pressure (or dynamic pressure) is related to the acceleration of water particles and its vertical gradient is represented with the time derivative term in Equation (1). Hydrostatic pressure is caused by the water head. In other words, the hydrostatic portion of the pressure gradient is caused by the head difference between groundwater and surface water levels at the site.

Although we have surface water level data in Kings Bay (or modeled surface water level at each grid), we don't have groundwater level data in Kings Bay or at each grid. The ROMP TR21-3 well is the closest groundwater site for Kings Bay. Considering the fact that groundwater level (or potentiometric surface) meets see level somewhere in the proximity of the approximate location of the coastline, the potentiometric surface slopes downward from inland area to coastal area. Because the ROMP TR21-3 well is farther inland than Kings Bays, potentiometric surface in Kings Bay would be lower than that at ROMP TR21-3. Furthermore, potentiometric surfaces for Group 1 springs and Group 2 springs could be slightly different. The symbol ΔG represents the decline of potentiometric surface at the spring vent in comparison with that at ROMP TR21-3. Slightly different ΔG values obtained from measured data for G1 and G2 springs are most likely caused by the downward sloping of the potentiometric surface as it approaches the coastline.

The simplest way to account for the spatial variation of the potentiometric surface is to assume that it linearly declines toward the approximate location of the coastline. We simply assume that the decline of the potentiometric surface is proportional to the distance from ROMP TR21-3. With this assumption, one can then roughly estimate ΔG values for all springs known the distances of these springs from the ROMP TR21-3 well.

Question 3

Figure 2-4 for Group 1 has taken the field data in Figure 4 VHB 2010 and somehow translated Discharge cfs to Spring Flow- Measured (the red dotted line). I have not so far found an explanation of how this was done. The range of Discharge run from 150 cfs to -40 cfs and the Spring Flows run from 40 cfs to 90 cfs. There is a large area 'upstream' of the cross-section and as mentioned in my last e-mail this is of the order of 13 acres which fills and emptied each tidal period. Taking the average from Figure 2-4 as around 70 cfs Spring Flow, this does not appear to match the measured spring flows at vents 8, 9, and 10 which comprise Group 1 . And the measured spring flows do not appear to support the range of flows for each tidal cycle. Most of the spring flows are fairly tight grouped particularly when considering accuracy limitations mentioned in the VHB report.

An explanation is needed; as somehow the logic which must prevail is missing.

It is true that there is certain area upstream of the cross section of G1 (and G2) that makes up a tidal prism. Figure 4 in the 2010 VHB report shows discharge at this cross section, which also include the tidal flux through it. Taking away this tidal flux (prism) from discharge resulted in the net spring flow through the G1 cross section, which was plotted with the red dashed line in Figure 2-4. Please see the following report for details on how the tidal flux is estimated:

XinJian Chen, 2014. On the Estimation of Submarine Groundwater Discharge to Kings Bay, Technical Report, Southwest Florida Water Management District, 7601 Highway 301 North, Tampa, Fla. 33637.

The average of spring flow through the G1 cross-section was 63.06 cfs during the 9-day period between 7/27/2009 and 8/4/2009, while the total of average flows for Springs 8, 9, and 10 was 60.21 cfs from the vent flow measurements on 7/29/2009, 7/31/2009, 8/17/2009, and 8/19/2009. The discrepancy is 4.5%, which should be considered as very small, especially when the following uncertainties are involved in these data:

1. *There could be errors associated with vent measurement, ADCP measurement, and rating curve development.*
2. *Sample sizes differ by more than 2 orders of magnitude. While the cross-sectional flow was recorded with a frequency of four times an hour, the vent measurements were conducted only 4 times in the 2009 VHB measurement. As such, the former had a sample size of more than 800, while the later has a sample size of 4.*
3. *As can be seen from the above text, the time period for the cross-sectional discharge measurement was 7/27/2009 – 8/4/2009. Although the first two vent measurement fell within this time period, the second two did not.*
4. *There could be some diffuse flux that was recorded in the cross-sectional discharge measurement.*
5. *There could be errors associated with the tidal prism estimate.*

Now let me focus on the field measurements VHB 2010 and 2012. These two sets of data form the basis for the Draft Report, and are the only **actual** spring flow measurements considered. As such there must be a clear understanding of what was measured and how the data supports the mathematical relationships with USGS stage measurements at Gage Site 02310742 and Well Level ROMP TR21-3 285234082341901. I will focus on the Group 1 which consists of Spring Vents 8 House Spring, 9 Jurassic Spring 10 Hunters Spring; noteworthy is that Hunter and House are both assigned 5 cfs in NDM 5 with the qualification * Estimated, no observed spring discharge available..
Attached are scans of the pages from 2009 which I have marked with some notes and should help in understanding of my comments. I have also attached an xls sheet where the measurements are set side by side for possible easier comparison. It also shows stage from the USGS gage at the mouth of Kings Bay at the time closest to VHB measurements.

- Flow from SV8 House Spring is measured by cross-section in a spring run. Four measurements in 2009 show reasonable consistency averaging 5.23 cfs and the two for 2012 averaging 3.85 cfs.

The data appears to be good showing reasonable consistency.
The 2009 relationship with stage at 02310742 is not good, but this must recognize level in ROMP TR21-3 is not known by measurement on the respective days. The 2012 data is consistent with the hypothesis relating to stage, again recognizing the level in ROMP TR21-3 is not known.

NOTE: There are other springs that were measured in spring runs, thesemay not be influenced by tidal change to the same extent…***possibly not all springs can be treated as equal***.

- Flow from SV9 Jurassic Spring is a vent measurement. There are sixteen measurements in 2009 however the last one in the time series for each date is lower and added to the average of the other three measurements; there is no explanation of this; an explanation is warranted. Averages are consistent averaging 23.96 cfs.
  For 2012 there are four measurements, the second measurement on each day is much lower than the first; same explanation needed. Average flow using summing of the high and low flow for each day is 12.42 cfs. Roughly half the 2009 flow. No relationship to stage is evident, no well level ROMP TR21-3 is available.

- Flow from SV10 is a vent/vents measurement. There appear to be four vents each measured in very short timeframe, 7 minutes or less. In 2009 data the four measurements on each day are summed giving an overall average of 31.02 cfs. For 2012 there are eight measurements four each on two days flows on 10/11/2012 total 37.7 cfs and for 11/08/2012 lower at 13.16 cfs. No relationship to stage is evident in 2009 as all flows are reasonably close and stage is significantly lower on 8/17/2009. Stage in 2012 is lower on both days than in 2009, but no data for ROMP TR21-3.

  From measured flow through the G1 cross-section shown in Figure 2-4, it is clear that the temporal variability from Springs #8, #9, and #10 is significant. Strong tidal signals can be seen in both the Group 1 and Group 2 springs. As such, the instantaneous vent measurements, each conducted within a short period of time, are expected to vary in a large range and not to be consistent each time.

- USGS output available on the waterdata.usgs.gov for ROMP TR21-3 is from 1979-06-21 initially on a two monthly basis and since 1993 twice yearly.
  In the Draft Report page 39
  " Groundwater levels used for estimating discharge were measured at ROMP TR21-3""
  And in Dr.Chen's October 2016 pdf page 214
  "The ADCP measurements was conducted during a 25-day period in summer 2009, during which both surface water level data in Kings Bay and groundwater level data at a nearby well were

available. The GW well station is called ROMP TR21-3…"

These words appear to imply that actual well levels were available/measured at the time of the VHB work. However, it appears that not only was Well Level for ROMP TR21-3 hindcast from Lecanto 7 well no 285254082323001, but may have been interpolated from the field measurements. 2009-05-20 measurement was **1.83 feet NAVD29 and 2009-09-22 the measurement was 3.37 feet NAVD 29.** Please confirm if SWFWMD have other Well Level data from USGS or if levels were interpolated between Field Measurements for 2009 and where the data is for the 2012 study period, Is it possible ROMP TR21-3 was hindcast back to May 1966 and forward cast to 2012.

Measured surface water level and groundwater level data are available during 2009 and 2012 VHB field study periods. These data are also available for the model scenario run period during October 6, 2006 through October 13, 2015. No hindcasting of ROMP TR21-3 data was necessary during the 9-year model simulation period.

Without the measurements to verify the validity of the hypothesized connection between the data, the Draft Report has a questionable credibility.

Note: Lecanto 7 is also by Field Measurements with the last reported 2011.

There are many other points of concern, but most importantly how will MFL be measured and or monitored ? I do not think the concept of the MFL legislation anticipated Simulated Minimum Flow.
While I am skeptical of the mathematical models which are based on very limited actual data, I fully agree with the words on Appendix pdf page 198

Quote
In order to protect this ecologically valuable springs/estuarine system, a regulatory minimum spring water flow rate needs to be determined and established.
End Quote
May I add the caveat, 'these need to be measurable'.

Martyn

PS for interest. What conditions and when gave the max and min modeled spring discharge of 960 cfs and -112 cfs for the period Nov 1969 to October 2015 Appendix pdf page 326 .

From:	Melissa Gulvin
To:	Ron Basso; Doug Leeper; Ross Morton; Xinjian Chen; Earl C. Rich
Subject:	FW: Today"s MFL peer review meeting
Date:	Tuesday, November 15, 2016 10:23:42 AM

My response to Mr. Johnson:

From: Melissa Gulvin
Sent: Tuesday, November 15, 2016 10:23 AM
To: Martin Johnson <martynellijay@hotmail.com>
Subject: Today's MFL peer review meeting

Good morning Mr. Johnson,

Today's meeting is in room 112 here at the District. Come in through the lobby and the receptionist will direct you to the room. Staff plans to address comments from your email on Nov. 8 at today's meeting during the public comment period. I'm sorry I won't be here to meet you this afternoon. I'll be in Citrus County for another meeting.

Thank you for the additional comments on the Rainbow River MFL below.

Melissa Gulvin
Government Affairs Program Manager
Southwest Florida Water Management District
2379 Broad Street, Brooksville, FL 34604
(352) 796-7211, ext. 4419
(352) 206-4047 cell
Melissa.Gulvin@WaterMatters.org

From: Alan Martyn Johnson <martynellijay@hotmail.com>
Date: November 14, 2016 at 8:40:06 AM EST
To: Doug Leeper <doug.leeper@swfwmd.state.fl.us>, Ron Basso <ron.basso@swfwmd.state.fl.us>, Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>
Subject: Rainbow River Review 1

Doug, Ron and Melissa,

Last week I received answers to some of my questions from USGS regarding the Rainbow River MFL so I have pulled together some of my comments.

For ease of reading I have put my comments in a word file for you to consider.

I have major concerns regarding the work by ECT. Who was responsible for reviewing the work done by ECT or was it just accepted without question?

I am still waiting for USGS to provide the discharge equations for the two gage sites on Rainbow River. These may address some of the other concerns I have regarding flows.

In addition I have comments regarding the analysis of water quality data, fish data and floodplain habitat which I will address later.

Regarding Crystal River Kings Bay Review tomorrow, what is the room location at the Brooksville Office, I hope to be able to attend in person.

Martyn

From:	Shellie Ferreira-Lee
To:	Doug Leeper
Subject:	FW: Issue=21222 - Heather Obara - Public Records Request - Rainbow and Kings Bay MFL - List of Contractors, Cost, Summary of Work
Date:	Friday, December 09, 2016 9:02:13 AM
Attachments:	Rainbow_Crystal MFLs Contracts-POs-TWAs 2016-12-08.docx

---

Good morning Doug:

I am forwarding the email sent to Ms. Obara providing the information requested for your records.

Thank you!

Shellie A. Ferreira-Lee
Records Management Specialist
(352) 796-7211, ext. 4053
shellie.ferreira@watermatters.org

From: Shellie Ferreira-Lee
Sent: Friday, December 09, 2016 9:01 AM
To: 'hobara@floridaspringsinstitute.org' <hobara@floridaspringsinstitute.org>
Cc: FootPrintsPRR <FootPrints.PRR@swfwmd.state.fl.us>
Subject: Issue=21222 - Heather Obara - Public Records Request - Rainbow and Kings Bay MFL - List of Contractors, Cost, Summary of Work

Dear Ms. Obara:

I am contacting you regarding your public records request (Issue No 21222) for "a complete list of the contractors and the cost of their contracts for both the Rainbow and Kings Bay Minimum Flow and Level (MFL) studies. A brief summary of work contracted and/or completed through October 2016 will be sufficient. Please include all relevant contracts for consultants, universities, peer reviewers, and others. Also, please send the District's total fiscal year budgeted amounts for MFLs during the past five years." I have attached the responsive information to your request. This public records request will now be closed.

Thank you for requesting information from the Southwest Florida Water Management District. Please do not hesitate to contact me if you have any questions.

Shellie A. Ferreira-Lee
Records Management Specialist
(352) 796-7211, ext. 4053
shellie.ferreira@watermatters.org

List of Contractors (Agreements/Purchase Orders/Task Work Assignments) and Costs for Projects Associated with Development of Minimum Flows for the Rainbow River and Crystal River/Kings Bay Systems

Prepared: December 8, 2016; Revised December 12, 2016

System	District Unit Code	Contract/Purchase Order/Task Work Assignment Number	Contractor	Cost	Project Description
Rainbow	B208	05PO0001661-2	University of Tampa (Jim Gore)	$25,000	Macroinvertebrate and fish assessments of the Rainbow River System
Rainbow	B208	05PO0001661-3	University of South Florida (Jim Gore)	$15,000	Macroinvertebrate and fish assessments of the Rainbow River System
Rainbow	B208	05PCSOW163	University of South Florida (Jim Gore)	$35,000	PHABSIM model development for the Rainbow River System
Rainbow	B208	05PC0001648-1	PBS&J	$40,500	Characterization of relationships between elevation, soils, and vegetation communities of the Rainbow River floodplain
Rainbow	B208	14PW0000042	University of South Florida (Ping Wang)	$24,203.00	Shoreline mapping and bathymetric survey for the Rainbow River
Rainbow	P248	15TW000033	Environmental Consulting & Technology, Inc.	$69,992.55	Development of updated HEC-RAS model for Rainbow River System
Rainbow	B208	16PO0000305	University of Tampa (Jim Gore)	$9,500.00	PHABSIM model updates for Rainbow River System
Rainbow	P248	08PO0000368	HSW Engineering, Inc.	$101,191.20	Evaluate water resources and human use values (WRVs) Phase II (Rainbow River)
Rainbow	P274	16PO0000819	University of Florida (Matthew Cohen)	$9,900.00	Peer review of proposed minimum flow for the Rainbow River System (Panelist 3)
Rainbow	P274	16PO0000820	Dann Kenneth Yobbi	$9,900.00	Peer review of proposed minimum flow for the Rainbow River System (Panel Chair)
Rainbow	P274	16PO0000821	Lee Wilson & Associates	$9,900.00	Peer review of proposed minimum flow for the Rainbow River System (Panelist 2)
Crystal	P274	16TW0000363	Applied Technology and Management, Inc.	$15,769.95	Crystal River MFLs peer review Panelist 1 (Chair) (P274)
Crystal	P274	16TW0000364	HSW Engineering, Inc.	$13,128.08	Crystal River MFLs peer review Panelist 2 (P274)

System	District Unit Code	Contract/Purchase Order/Task Work Assignment Number	Contractor	Cost	Project Description
Crystal	P274	16TW0000411	Jones, Edmunds & Associates, Inc.	$13,975.43	Crystal River MFLs peer review Panelist 3 (P274)
Crystal/other	B807/B258	09POSOW1199	Mote Marine Laboratory	$22,196.00	Evaluation of the spatial extent and relative density of barnacles in the Crystal, Homosassa and Withlacoochee rivers, Florida
Crystal	B807	07POSOW0827	University of South Florida	$38,926.00	Shoreline mapping and bathymetric survey for the Crystal River and King's Bay System
Crystal	B807	09POSOW1364	Water & Air Research, Inc.	$82,800.00	Sampling and analysis of oyster distributions and benthic macroinvertebrate populations in Crystal River
Crystal	B807	09POSOW1892	University of Florida Program in Fisheries and Aquatic Sciences	$131,900.00	Compilation and synthesis of existing Data to support MFLs development, and characterization of submersed aquatic vegetation in Kings Bay
Crystal	B807	09POSOW1890	Avineon, Inc.	$75,250.00	Vegetation mapping of the Crystal River
Crystal/other	B807	11POSOW1097	Janicki Environmental, Inc.	$21,900.00	Development of salinity and isohaline regressions for Crystal River and Brooker Creek
Crystal	B807	08C00000074	University of South Florida Board of Trustees	$309,763.00	Investigation of freshwater inflow effects on fish and invertebrate use of the Crystal River estuary
Crystal/other	P274	15PO0000717	Dann Kenneth Yobbi	$10,000.00	Comparison of methods used to compute spring flow of the Chassahowitzka and Southeast Fork of the Homosassa Springs complexes, and review of flow hindcasting method for Kings Bay
Crystal/other	P274	14PWO000039	Dann Kenneth Yobbi	$3,200.00	Review of flow record modeling for Crystal River/Kings Bay
Crystal	B807	09POSOW1468	Vannasse Hangen Brustlin, Inc.	$103,600	Spring Flow Evaluation in Kings Bay, Crystal River, Florida
Crystal	B817/ P686	12POWSOW1054	Vannasse Hangen Brustlin, Inc.	$119,970.00	Additional Kings Bay spring flow measurements
Crystal	B807/ B209/ B222	07PO0001717 09POSOW0483	Vannasse Hangen Brustlin, Inc.	$100,577.00	Inventory of spring vents in Kings Bay

System	District Unit Code	Contract/Purchase Order/Task Work Assignment Number	Contractor	Cost	Project Description
Crystal/ other	P686	12POSOW1080	Florida Fish and Wildlife Conservation Commission	$43,860.00	Assessment of relationships of fish and invertebrate populations with static and dynamic habitats in estuarine systems
Rainbow/ other	Z040	15C00000064-3	Mark T. Stewart	$35,000.00	Expert testimonial and non-testimonial and related consulting services; peer review of Northern District Model, Version 5
Rainbow/ other	P255	16P0000150	St. Johns River Water Management District (SJRWMD)	$37,402.36	Recalibration of the Norther District Model (P255), i.e., development of the Northern District Model, Version 5, in conjunction with the SJRWMD (50% cost-share by each district)
Rainbow/ other	Z040	15C00000076-1	AquaSciTech Consulting, PLCC	$25,000.00	Expert testimonial and non-testimonial and related consulting services
Rainbow/ other	Z040	15C00000074-1	Atkins North America, Inc.	$25,000.00	Expert testimonial and non-testimonial and related consulting services
Rainbow/ other	Z040	15C00000075-1	Brian G. Ormiston	$25,000.00	Expert testimonial and non-testimonial and related consulting services
Rainbow/ other	Z040	15C00000063-2	Progressive Water Resources LLC	$50,000.00	Expert testimonial and non-testimonial and related consulting services
Rainbow/ other	Z040	15C00000065-4	SDII Global Corporation	$35,687.50	Expert testimonial and non-testimonial and related consulting services

The Gainesville Sun.com

Posted December 1, 2016 at 2:00 am

Robert Knight: Make Crystal River clear again



Photos by John Moran

North Florida's nature photographer laureate, John Moran, said it best when he paraphrased author Mark Twain: "The mightiest river in Florida is the River of Denial that flows through Tallahassee."

Under tight control from the state's capital, the Southwest Florida Water Management District is telling us that the springs that feed Kings Bay and Crystal River on Florida's Nature Coast in Citrus County have more flow than they need to be healthy. But I ask you: "When was the last time those springs looked healthy to you?"

When I first boated and swam at Tarpon Hole in 1977, the water was crystal clear. The bottom of the spring was visible in 65 feet of water. When the Florida Springs Institute completed the Kings Bay Phytoremediation Demonstration Project last year, we were lucky to see the bottom in areas with only six feet of water.

Not only is water clarity in Kings Bay almost entirely gone, so are the eelgrass and other native plants that historically covered the bottom of the bay. Those plants were the natural salad bar that supported large populations of game fish and manatees that provide the foundation for the region's tourism economy.

The Kings Bay aquatic ecosystem is not healthy. In fact, it is just one of many severely impaired water bodies in coastal Florida. Nutrients and salinity are on the rise and water clarity is in free fall. The plant community is now dominated by algae, both free-floating planktonic and filamentous benthic species that cover the sediments. The noxious blue green alga, Lyngbya, regrows almost as fast as the Rotary Club can rake and haul it out of the bay.

Repeated efforts to dredge the benthic algae and to re-plant eelgrass at great public cost have failed due to rising salinity in the groundwater coming from the springs, as well as from Gulf of Mexico storms. The Southwest Florida Water Management District has spent millions to fix Kings Bay's problems, yet the bay continues to degrade despite a plethora of additional plans and studies.

The latest insult to those who treasure Crystal River's springs is the district's draft plan to establish minimum flows. The 1972 Florida Water Resources Act required the adoption of minimum flows for the 70-plus springs feeding Kings Bay.

After 44 years of injurious delay and inaction, the water management district has somehow concluded that an additional 12 percent decline in flows at Kings Bay/Crystal River will not cause "significant harm." This claim, brought to you at great expense by district staff and paid consultants, rings as true as recent promises by presidential candidates. Political science is the art of coercing real scientists to defend decisions being made in Tallahassee.

The U.S. Geological Survey, the most respected hydrological agency in the world, reported that the average natural historic flows of the Kings Bay/Crystal River springs system were between 916 and 975 cubic feet per second (between 592 and 630 million gallons per day). More recent measurements document that the average spring flow during the past decade has plummeted to 389 cubic feet per second (251 million gallons per day), a greater than 58 percent decline.

This well-documented flow decline at the Kings Bay/Crystal River springs is validated by the concurrent reduction in water clarity caused by free-floating, planktonic algae. These microscopic plants have more time to multiply in a stagnant water environment resulting from drastically reduced flows, and their growth is fueled by rising spring nutrients and saltwater intrusion.

The principal underlying cause of the observed flow decline, saltwater intrusion and elevated nutrient concentrations at Kings Bay/Crystal River is excessive urban and agricultural development. The only way to reverse the algae problems and restore water clarity in Kings Bay is to dial back groundwater pumping and fertilizer use throughout the Southwest Florida Water Management District.

The Crystal River springs are silent. You must be their voice if you want to see them and the entire Kings Bay ecosystem restored to health. Let the district's Governing Board know that you do not support the proposed minimum flow for Kings Bay/Crystal River and that you adamantly oppose their decision to further reduce spring flows.

Tell the Governing Board members that you want Crystal River clear again, starting with a district-wide reduction of permitted groundwater pumping.

Remember Mark Twain's other famous words: "Whiskey is for drinking, water is for fighting over!"

— Robert Knight is director of the Howard T. Odum Florida Springs Institute. To learn more about restoring the Kings Bay/Crystal River Springs System, visit the institute's website at www.floridaspringsinstitute.org and visit the North Florida Springs Environmental Center in High Springs.

Taking action on springs



GARY KUNK/Special to the Chronicle

This aerial photo shows Hunters Spring outside the swim area.

Many coming together to improve quality of county's springs

Re: Bob Knight column, which ran in the Citrus County Chronicle, Gainesville Sun and Tampa Bay Times.

As Dr Knight's article in last Sunday's Chronicle alluded, we have an impending water supply crisis which we need to address as individuals and through the legislature. As everyone is aware, there are many other states that also have the same impending problems.

Florida has recognized the problem, and has started to collect the basic scientific data needed to efficiently address the problem. The leading agencies in this effort include The Southwest Florida Water Management District (SWFWMD,) the Florida Department of Environmental Protection (FDEP) and the United States Geological Survey (USGS.)

The general public impression is we have an abundance of water here in Florida, which is a public asset. Unfortunately, due to climate fluctuations, rising population and increased water needs for agriculture, the demand created by county and ing a water balance.

Reading Dr Knight's article would give you the impression the legislature and agencies have done little to solve the problem, when in fact much has been done. First and foremost, the agencies, funded by your tax dollars, collect the basic scientific data to make informed decisions. Furthermore, they have identified and prioritized the various drivers and potential solutions which impact not only the springs flow but water quality.



Bob Mercer
GUEST COLUMN

DETRIMENTS TO SPRING FLOW

So what impacts spring flow? Certainly our increased need for water is one of the factors, but more importantly, our weather patterns are ultimately responsible for aquifer and spring recharge. One expert in climatology reported we are just coming off a 30-year dry cycle and are beginning to start a 30-year wet cycle. Obviously, in drought conditions, the spring flow will be reduced compared to when we have historic high levels of rain. One of the positive

Knight column about springs contained errors

Re: Dec. 4 guest column by Bob Knight titled "Crystal not clear."

As the leading scientific agency in the region charged with managing the water resources for west-central Florida, it is my professional obligation to point out some fatal flaws in the arguments posed by Bob Knight in the Dec. 4 guest column: "Crystal not clear."



Chris J. Anastasiou
GUEST COLUMN

While Knight correctly points out some of the issues facing King's Bay, he fails to disclose all of the facts, instead using inaccurate statements that call into question the professionalism and ethics of some of the finest scientists I have ever had the honor to work with.

For example, he paints an overly simplistic

Complex problem needs unity of purpose

THE ISSUE:
Criticizing partners.

OUR OPINION:
Work together to resolve pollution woes.

Part of the problem in cleaning up troubled waterways like King's Bay and Crystal River is interested parties always like to think their ideas are the best.

Such is the case in last Sunday's Chronicle when Dr. Robert Knight wrote a guest column urging local residents to do something to protect our spring-fed bay.

Dr. Knight was urging residents to stand opposed to the Southwest Florida Water Management District's minimum flow recommendations for the Citrus County waterways.

On one hand, Dr. Knight is correct. The volume of water that flows into the bay and river has been reduced and that is a huge problem. Further reducing water flow is a very bad idea.

But in the same column the respected scientist shrugged off the many other efforts going on in our community to revitalize the springs. Notably, he chided the water management district for working with the Save Crystal River organization to clean up the existing mess we have on the bottom of King's Bay.

The cleanup efforts have just begun by SCR and the results are already positive. Thousands of pounds of muck have been removed and spring vents that have been closed for decades have been reopened. Native grasses have been replanted.

We call that progress.

The problem with the difficult environmental problems facing Crystal River is that we have had decades of talk and reports and almost no real action.

Finally, Art Jones and his One Rake at a Time organization came along and started slowly pulling muck from the bay by hand.

The Save Crystal River group then organized and they have used high-energy activism and strong political connections to really get things moving. They used communication skills and volunteer citizen leadership to convince state and local politicians to start funding a clean up of the river. Millions of dollars have been spent on vacuuming the bottom of the bay and early results are good.

At the same time the water management district caught the enthusiasm and started funding storm water retention projects that treats rain water before it runs into the bay.

Millions more have been spent on expanding sewer systems and pulling old septic tanks out of service — thus reducing another source of pollution.

A major stormwater project has just been completed at Three Sisters Springs by the water management district.

More recently the county commission passed a fertilizer ordinance that will restrict the use of fast-release products — a major cause of pollution.

The city of Crystal River joined with the water management district and Duke Energy to divert treated effluent from the city sewerage plant up to the Crystal River energy site. This project has saved millions of gallons of fresh water that was being used in the energy company's cooling towers.

Natural disasters such as Hurricane Hermine — which flooded all the local fresh water bays and rivers with salt water — can make the task more complicated, but they can not discourage those willing to fight the good fight.

The Save Crystal River enthusiasm has been felt by all levels of government and folks are joining together to clean up our springs, rivers and bays.

Increasing the flow of water in the springs will certainly help solve the problem and flush the bay. But criticizing other members of "the team" who are working to resolve this complex problem hurts the entire effort. That's why three decades of scientific reports sit gathering dust and have had no impact on actually dealing with the problem.

The complete solution involves removing septic tanks, reducing fertilizer use, replanting native grasses, improving the spring flow, reducing water consumption, filtering storm water runoff, reusing discharge water from sewerage plants, vacuuming up the muck on the river and bay bottoms and many other compatible efforts.

Save Crystal River has won public support because they are actually getting something done other than just talk about the problem and write reports.

Let's stop wasting time criticizing the efforts of others who have the same ultimate goal and get to work actually solving the problem.

Citrus County Chronicle
Crystal River
Daily 25,740
December 12, 2016

Springs in peril | Dec. 5, Bob Knight column

We, too, care about Kings Bay

As a chief scientist for the leading scientific agency in the region charged with managing the water resources for west-central Florida, I have a professional obligation to point out some flaws in the arguments posed in this column.

While the author correctly points out some of the issues facing Kings Bay, he paints an overly simplistic picture blaming over-pumping and nitrate pollution as the root of all the issues it faces, and efforts to improve the bay as a waste of time. I have had the privilege to work closely with many dedicated individuals and groups who call Crystal River home, and we are committed to restoring the aquatic habitat of Kings Bay.

Regarding the establishment of a Minimum Flow and Level limit (MFL), the water management district voluntarily subjects all technical data, methodologies, models and scientific assumptions used to support development of the proposed minimum flows to independent scientific peer review. The district also invites the public to make comments and methodically addresses every one of those comments.

The MFL is an essential tool to protect Kings Bay for future generations. The district welcomes and encourages objective and fact-based dialogue, which does not stop once the MFL is adopted. Science is an evolutionary process and so is the MFL. But it takes a community to work together to make positive change happen. And guess what? Through the efforts of community-based programs like the district's Springs Coast Steering Committee, One Rake at a Time, the Manatee Ecotourism Association (META), Save Crystal River, and many others, the district and its partners are doing just that.

Chris J. Anastasiou, PhD, *Tampa*

The writer is chief scientist, Natural Systems & Restoration, for the Southwest Florida Water Management District.

Powered by The Gainesville Sun
Gainesville.com

Chris J. Anastasiou: District committed to restoring Crystal River

Tuesday
Posted at 2:00 AM
Updated at 9:05 AM

By Chris J. Anastasiou Special to The Sun

As the leading scientific agency in west-central Florida charged with managing the water resources for the region, it is my professional obligation to point out some fatal flaws in the arguments posed by Robert Knight in his Dec. 1 column, "Make Crystal River clear again."

While Knight correctly points out some of the issues facing Kings Bay, he fails to disclose all of the facts, instead using inaccurate statements that call into question the professionalism and ethics of some of the finest scientists with whom I have ever had the honor to work.

For example, he paints an overly simplistic picture blaming over-pumping and nitrate pollution as the root of all the issues facing Kings Bay, and efforts to improve the bay a waste of time. I have had the privilege to work closely with many dedicated individuals and groups who call Crystal River home, and we are committed to restoring the aquatic habitat of Kings Bay.

Knight insinuates that establishment of a Minimum Flow and Level limit (MFL) is conducted behind closed doors. This couldn't be farther from the truth.

The Southwest Florida Water Management District voluntarily subjects all technical data, methodologies, models and scientific assumptions used to support development of the proposed minimum flows to independent scientific peer review. The district also invites the public to make comments and methodically addresses every one of those comments.

It is important to remember the MFL is an essential tool to protect Kings Bay for future generations. The district welcomes and encourages objective and fact-based dialogue, which does not stop once the MFL is adopted.

Science is an evolutionary process and so is the MFL. But it takes a community to work together to make positive change happen. And guess what? Through the efforts of community-based programs like the district's Springs Coast Steering Committee, One Rake at a Time, the Manatee Ecotourism Association, Save Crystal River and many others, the district and its partners are doing just that.

- Chris J. Anastasiou is chief scientist, natural systems and restoration, for the Southwest Florida Water Management District.

Tampa Bay Times
WINNER OF 12 PULITZER PRIZES

Column: Progress in protecting our water resources

By Bob Mercer, special to the Times

Monday, December 12, 2016 3:56pm

*Editor's note: Bob Mercer, vice president of the board of directors of Save Crystal River, a nonprofit dedicated the preservation of natural resources, responds to "Springs in p*eril," the Dec. 5 column by Bob Knight, director of the Howard T. Odum Florida Springs Institute.

Bob Knight got one thing right: We have an impending water supply crisis we need to address. But he suggests the Florida Legislature and agencies have done little to solve the problem. This is simply not the case. In addition to data collection, agencies have identified and prioritized issues and potential solutions that impact spring flow and water quality.

We agree water demand is a factor. But weather patterns are ultimately responsible for aquifer and spring recharge. In dry cycles, spring flow is decreased. In wet cycles, it's increased. But weather patterns are changing and we need to manage to accommodate them.

In attributing reduced flows strictly to demand, Knight ignores the latest U.S. Geological Survey thinking that includes consideration of tidal effects. Sinkholes are another factor. For example, we know that a sinkhole 20 years ago may have caused a drop in the flow of King Springs. Save Crystal River Inc. has removed many cubic feet of material out of spring vents. In fact, we opened up some 70 small spring vents in the process.

Another common cause of spring flow reduction is the high water table. It is relatively easy to dig into the water table, diverting water from underground into the excavation. Recently, a contractor for the Florida Department of Transportation was doing routine maintenance to a retention pond when he hit the water table filling the retention pond with what was previously underground flow.

Agencies have data. And we've used it. For example:

• Crystal River eliminated a spray field and now pipes reclaimed water to provide 710,000 gallons per day of cooling and cleaning water to Duke Energy.

• Hundreds of septic systems and several antiquated package plants near Kings Bay and Crystal River have been removed. This wastewater will be part of a central sewer system, adding to the quantity of reclaimed water available for use. This protects the environment and reduces demand for potable water.

• The Three Sisters Wetland Treatment System will remove an estimated 423 pounds of nitrogen per year from Kings Bay.

• The Southwest Florida Water Management District has completed a Surface Water Improvement and Management, or SWIM, plan that provides a list of projects to address water quality, water quantity and natural system improvements.

• The Florida Department of Environmental Protection has completed a Basin Management Action Plan that indicated management actions necessary to improve Kings Bay water quality.

• Save Crystal River has spearheaded a sediment removal and replanting project that is being done in cooperation with Swiftmud. It will have a major long-term effect on water clarity and quality by removing over 30 years of detritus from the bottom. We've seen oxygen levels increase along with many species of fish and other organisms.

• Citrus County's recent adoption of more stringent fertilizer use was one of the recommendations in the SWIM plan. And several of our golf courses now use reclaimed water, which reduces the need for potable water irrigation and fertilizer impacts to our waters.

• Many members of the Citrus County Agricultural Alliance are establishing best management practices.

We have a road map and we are implementing it as funding becomes available.

One more thing. Salinity also affects sea grass health. This year, Hurricane Hermine drove the salinity in the Hunter Springs up for about 24 hours. This killed invasive hydrilla and water hyacinth. Our sea grass planting pilot study and Swiftmud's three test plots were also affected. But our genetically modified "Rockstar" sea grass is very resilient and coming back. We've learned from this and have modified our planting to include Salty Dog eelgrass, which is even more salt tolerant.

The fact is, the project has been successful, although we are still learning and will continue to learn. The Legislature and DEP have provided funding for the past year and are expected to provide funding for the upcoming projects. The Kings Bay Restoration Project is recognized statewide as a model for public/private partnerships, which includes the city, Citrus County, Swiftmud and DEP. We hope to be as successful as the Tampa Bay Estuary program has been.

Column: Progress in protecting our water resources 12/12/16
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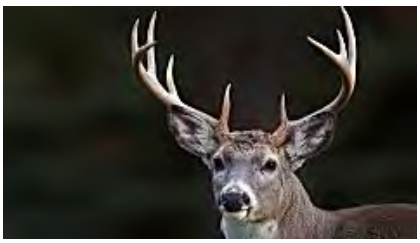

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HowStuffWorks - Adventure



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Wide Open Spaces



Is There a Limit to How Much Fish You Should Be Eating?
The Healthy Fish



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Salt Strong



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Fox News



Five Fantastic Family Hikes in the NC Smokies
North Carolina Smokies

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From: Sean King
To: Doug Leeper; Gabe I. Herrick; Kym Holzwart; Mark A. Green; Sky Notestein; Stacey B. Day; Yonas Ghile; Chris Anastasiou; Xinjian Chen; Barbara Nordheim-Shelt; Danielle Rogers; Jackie M. Sampson
Subject: FW: Springs Vent - December 2016
Date: Thursday, December 01, 2016 3:34:32 PM

FYI, in case you aren't on this listserv.

Sean

From: Florida Springs Institute [mailto:mredon=floridaspringsinstitute.org@mail129.atl61.mcsv.net] **On Behalf Of** Florida Springs Institute
Sent: Thursday, December 01, 2016 10:15 AM
To: Sean King <Sean.King@swfwmd.state.fl.us>
Subject: Springs Vent - December 2016

Monthly update from the Florida Springs Institute

View this email in your browser

Monthly Springs Vent

December 2016

Significant Harm at Crystal River

by Dr. Robert Knight

North Florida's nature photographer laureate, John Moran, said it best when he paraphrased author Mark Twain: ***"The mightiest river in Florida is the River of Denial that flows through Tallahassee."*** Under tight control from the State's capital, the Southwest Florida Water Management District is telling us that the springs that feed Kings Bay and Crystal River on Florida's Nature Coast in Citrus County have more flow than they need to be healthy. But I ask

you: ***"When was the last time those springs looked healthy to you?"***

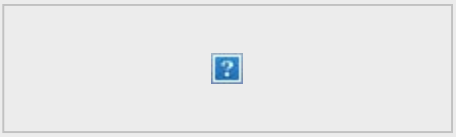
When I first boated and swam at Tarpon Hole in 1977, the water was crystal clear. The bottom of the spring was visible in 65 feet of water. When the Florida Springs Institute completed the Kings Bay Phytoremediation Demonstration Project last year, we were lucky to see the bottom in areas with only six feet of water.

Not only is water clarity in Kings Bay almost entirely gone, so are the eelgrass and other native plants that historically covered the bottom of the bay. Those plants were the natural salad bar that supported large populations of game fish and manatees which are foundational for the region's tourism economy. [Read more...]



Tis the Season to be Tacky?

Florida Springs Institute will be hosting our first Tacky Sweater Fundraiser December 13th from 6-8 pm at Fluid Lounge in Town of Tioga (Gainesville/ Newberry, Florida). Much like our successful summer fundraiser at Fluid, a $10 admission provides you one specialty cocktail (Moscow Mule, Bramble,or an Old Fashioned), and **100% of the $10 admission goes to FSI**! We hope to see you there, but either way please help us spread the word by sharing our event on Facebook. (Tacky sweaters optional but encouraged.)



Did you know you can help save our springs while doing your holiday shopping?

If you haven't already, please consider making your purchases through Amazon Smile. This free service is both fast and easy to set up, and gives 0.5% of your total purchase to FSI. You can find us on Amazon Smile as the Howard T Odum Florida Springs Institute. Thank you for your support!

Join us next week for Springs Academy

Join us at the North Florida Springs Environmental Center (99 NW 1st Avenue, High Springs, FL) Tuesday, December 6th at 12 p.m. for our Springs Academy session with Dr. Robert Knight. This month's session is on Springs Chemistry.

Thanks to Richie Denmark of Project Baseline, you can now view the first Springs Academy session, a springs overview, on YouTube.

New SpringsWatch to launch in 2017

FSI will launch a Rainbow Springs SpringsWatch group in 2017. More information will be available early next year. To learn more about FSI's SpringsWatch Program and how you can volunteer, click here.

Fundraiser Recap

Thanks to everyone who helped make our 2016 fundraiser a success! Our annual fundraiser is our largest fundraiser of the year and in 2016, we beat our previous totals by raising $5,500 after expenses.

Many members of the springs community attended the event along with several new

Florida Springs Interactive Map available online

Over the past year, Florida Springs Institute staff and volunteers have worked to compile a comprehensive Google Earth map of Florida springs with photos, descriptions, and available water quality data. The Florida Springs Interactive Map will continue to undergo regular updates/revisions and be made available to the public. It is available for viewing on our website under "Current Projects."

The Howard T. Odum Florida Springs Institute is a 501c3 non-profit funded entirely by grants and private donations.

springs supporters! Attendees were treated to a delicious catered meal by Celebrations Catering and a wonderful music performance by Whitey Markle and the Swamprooters, all while surrounded by the beautiful backdrop of Kanapaha Botanical Gardens.

FSI staff at our fundraiser

Panel Discussion at the Alachua County Library

On November 5th, Dr. Knight and Jenny Adler participated in a panel discussion on "The Art and Science of Springs Conservation". During the event Dr. Knight discussed his book, *Silenced Springs: Moving from Tragedy to Hope*. Over thirty people attended the discussion.

Looking for a good read this holiday season? Pick up a signed copy on *Silenced Springs* and meet Dr. Knight on December 8th at the Holiday Open House & Local Author Book Signing hosted

by the Matheson History Museum. The event begins at 6 p.m.

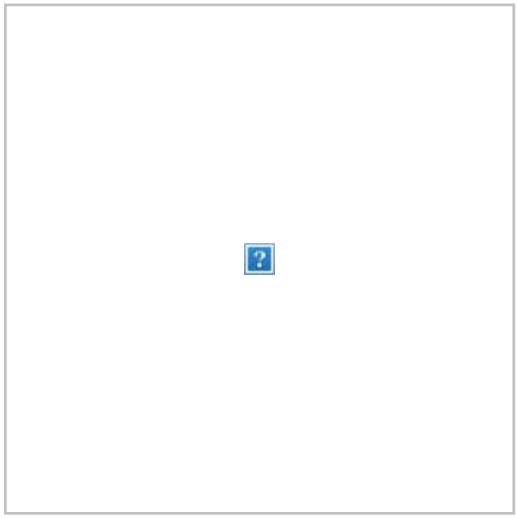
Year End Donations

Please consider making a year end donation to support our efforts to protect and restore our majestic springs for current and future generations.

Give the Gift of FSI

A membership or donation in a loved ones name makes the perfect holiday gift for the springs enthusiasts/environmentalists in your life!

>> Click Here to Donate <<



Facebook Instagram Twitter YouTube Website

The Howard T. Odum Florida Springs Institute is a 501c3 non-profit.
EIN 46-1663401

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MRedon@FloridaSpringsInstitute.org

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Significant Harm at Crystal River

North Florida's nature photographer laureate, John Moran, said it best when he paraphrased author Mark Twain: *"The mightiest river in Florida is the River of Denial that flows through Tallahassee."* Under tight control from the State's capital, the Southwest Florida Water Management District is telling us that the springs that feed Kings Bay and Crystal River on Florida's Nature Coast in Citrus County have more flow than they need to be healthy. But I ask you: *"When was the last time those springs looked healthy to you?"*

When I first boated and swam at Tarpon Hole in 1977, the water was crystal clear. The bottom of the spring was visible in 65 feet of water. When the Florida Springs Institute completed the Kings Bay Phytoremediation Demonstration Project last year, we were lucky to see the bottom in areas with only six feet of water.

Not only is water clarity in Kings Bay almost entirely gone, so are the eelgrass and other native plants that historically covered the bottom of the bay. Those plants were the natural salad bar that supported large populations of game fish and manatees which are foundational for the region's tourism economy.

The Kings Bay aquatic ecosystem is not healthy. In fact, it is just one of many severely impaired water bodies in coastal Florida. Nutrients and salinity are on the rise and water clarity is in free fall. The plant community is now dominated by algae, both free-floating planktonic and filamentous benthic species that cover the sediments. The noxious blue green alga, *Lyngbya*, regrows almost as fast as the Rotary Club can rake and haul it out of the bay.

Repeated efforts to dredge the benthic algae and to re-plant eelgrass at great public cost have failed due to rising salinity in the groundwater coming from the springs, as well as from Gulf storms. The Southwest Florida Water Management District has spent millions to fix Kings Bay's problems, yet the bay continues to degrade despite a plethora of additional plans and studies.

The latest insult to those who treasure Crystal River's springs is the District's draft plan to establish minimum flows. The 1972 Florida Water Resources Act required the adoption of minimum flows for the 70+ springs feeding Kings Bay. After 44 years of injurious delay and inaction, the Water Management District has somehow concluded that an additional 12% decline in flows at Kings Bay/Crystal River will not cause "significant harm". This claim, brought to you at great expense by District staff and paid consultants, rings as true

as recent promises by presidential candidates. Political science is the art of coercing real scientists to defend decisions being made in Tallahassee.

The U.S. Geological Survey, the most respected hydrological agency in the world, reported that the average natural historic flows of the Kings Bay/Crystal River springs system were between 916 and 975 cubic feet per second (between 592 and 630 million gallons per day). More recent measurements document that the average spring flow during the past decade has plummeted to 389 cubic feet per second (251 million gallons per day), a greater than 58% decline.

This well-documented flow decline at the Kings Bay/Crystal River springs is validated by the concurrent reduction in water clarity caused by free-floating, planktonic algae. These microscopic plants have more time to multiply in a stagnant water environment resulting from drastically-reduced flows, and their growth is fueled by rising spring nutrients and saltwater intrusion.

The principal underlying cause of the observed flow decline, saltwater intrusion, and elevated nutrient concentrations at Kings Bay/Crystal River is excessive urban and agricultural development. The only way to reverse the algae problems and restore water clarity in Kings Bay is to dial back groundwater pumping and fertilizer use throughout the Southwest Florida Water Management District.

The Crystal River springs are silent. You must be their voice if you want to see them and the entire Kings Bay ecosystem restored to health. Let the District's Governing Board know that you do not support the proposed minimum flow for Kings Bay/Crystal River and that you adamantly oppose their decision to further reduce spring flows.

Tell the Governing Board members that you want Crystal River clear again, starting with a District-wide reduction of permitted groundwater pumping.

Remember Mark Twain's other famous words: *"Whiskey is for drinking, water is for fighting over!"*

Dr. Bob Knight is Director of the Howard T. Odum Florida Springs Institute. To learn more about restoring the Kings Bay/Crystal River Springs System, visit the Institute's website at www.floridaspringsinstitute.org and visit the North Florida Springs Environmental Center in High Springs.

From:	FootPrintsPRR
To:	Doug Leeper
Subject:	SWFWMD Public Records Request - Heather Obara - Total FY Budgets for only Springs MFLs from 2013-...
Date:	Friday, December 09, 2016 12:55:58 PM

When replying, type your text above this line.

Notification of Issue Registration

Workspace: Public Records Request
Issue: Heather Obara - Total FY Budgets for only Springs MFLs from 2013-2017
Issue Number: 21538

Priority: Medium **Status:** Under 7 days old
Date: 12/09/2016 **Time:** 12:55:42
Created By: Shellie Ferreira-Lee

Description:
Entered on 12/09/2016 at 12:55:41 PM EST (GMT-0500) by Shellie Ferreira-Lee:
Email will be forwarded to the PRR ticket.

Current Assignees: Shellie Ferreira-Lee

CC(s): (this edit only) doug.leeper@swfwmd.state.fl.us

Issue Information:

Internal Request: Off

Contact Information:

Last Name: Obara **First Name:** Heather
Email Address: hobara@floridaspringsinstitute.org **Phone:** (386) 454-2427

From: Doug Leeper
To: "hobara@floridaspringsinstitute.org"
Cc: FootPrintsPRR; Shellie Ferreira-Lee; Mark A. Green; Jennette Seachrist; Eric DeHaven
Subject: RE: SWFWMD Public Records Request - Heather Obara - Total FY Budgets for only Springs MFLs from 2013-...
Date: Tuesday, December 13, 2016 4:47:00 PM
Attachments: Rainbow_Crystal MFLs Contracts-POs-TWAs 2016-12-08 Rev 2016-12-13.pdf
image002.png

Ms. Obara:

The table below was prepared by District staff in response to your recent inquiry concerning total fiscal year budgets for spring minimum flows and levels (MFLs) for the period from 2013 through 2017. Information on budgeted and expended funds is summarized for projects within the District's Minimum Flows and Levels Program that are associated specifically with spring MFLs and those within the program that include efforts associated with spring MFLs and MFLs for other priority water bodies. Unfortunately, for the group of "programmatic" projects that address both spring and non-spring MFLs, we do not have funding allocations/expenses parsed by spring-related and non-spring-associated efforts. For both the spring-specific and programmatic projects, budgeted/expended funds include operating expenses, contractual dollars and staff salaries/benefits.

Project Code	Project Name	FY2013 Budgetd ($)	FY2013 Expended ($)	FY2014 Budgetd ($)	FY2014 Expended ($)	FY2015 Budgetd ($)	FY2015 Expended ($)	FY2016 Budgetd ($)	FY2016 Expended ($)	FY2017 Budgetd ($)	Comments
B208	MFL Estb - Rainbow River Freshwater System	5,891	52,720	47,181	83,554	53,085	39,482	99,449	92,792	64,031	Spring MFLs
B209	MFL Estb - Chassahowitzka River & Springs System	0	10,237	0	9,885	9,154	10,612	6,412	4,189	5,858	Spring MFLs
B273	MFL Tech Sp - Strmflw Rdc-Measure Effects of MFL	17,195	84,188	1,337	40,958	0	0	0	0	0	Spring MFLs
B807	MFL Estb - Crystal River/Kings Bay Estuary System	56,516	15,241	75,117	29,024	80,377	13,789	73,686	114,192	136,678	Spring MFLs
B808	MFL Estb - Gum Springs Group Freshwater System	19,837	3,997	581	8,399	0	10,593	2,472	24,347	0	Spring MFLs
B811	MFL Estb - Silver River MFL Assistance to SJRWMD	7,111	1,818	2,658	2,460	4,582	0	0	573	0	Spring MFLs
B817	MFL Re-Eval - Springs Systems	33,509	55,342	65,202	16,923	81,824	79,377	58,083	32,408	152,535	Spring MFLs
B822	MFL Re-Eval - Homosassa Rvr & Spgs Sys	0	0	0	0	0	3,356	120,061	6,753	85,807	Spring MFLs
B823	MFL Re-Eval - Chassahowitzka Rvr & Sprgs System	0	0	0	0	0	0	125,610	8,292	84,125	Spring MFLs
P248	MFL Tech Sp - Freshwater Systems	126,659	180,220	139,136	112,931	169,277	189,644	151,738	138,943	144,138	Programatic-Includes Spring and Other MFLs
P255	MFL Tech Sp - Hydrologic Analysis	88,879	42,941	114,381	23,705	93,201	62,027	93,939	46,902	59,440	Programatic-Includes Spring and Other MFLs
P263	MFL Tech Sp - Compliance	0	18,174	54,753	25,703	50,421	20,489	53,260	6,999	33,688	Programatic-Includes Spring and Other MFLs
P274	MFL Estb - Peer Review & Technical Advisory Cnslt	176,542	-10	153,273	2,524	182,390	4,909	182,472	39,331	187,343	Programatic-Includes Spring and Other MFLs
P686	MFL Tech Sp - Estuarine Systems	165,207	219,353	124,893	191,215	357,468	159,323	202,984	67,376	173,215	Programatic-Includes Spring and Other MFLs
P862	MFL Tech Sp - INTB Model Maintenance	0	0	50,000	0	54,128	32,991	67,645	53,176	75,749	Programatic-Includes Spring and Other MFLs
P863	MFL Estb - Priority List & Schedule Annual Update	0	0	0	0	0	0	0	3,298	5,232	Programatic-Includes Spring and Other MFLs
P876	MFL Tech Sp - Northern District Wrap	56,421	219,764	22,895	180,619	22,352	40,385	21,241	54,309	37,840	Programatic-Includes Spring and Other MFLs
P876A	AMFL Tech Sp - Northern District Wrap - Acq	0	0	0	0	0	0	0	867	0	Programatic-Includes Spring and Other MFLs
P883	MFL Tech Sp - NTB Phase II Investigation	154,611	136,849	97,257	57,927	103,181	80,156	94,212	71,119	97,051	Programatic-Includes Spring and Other MFLs
P883A	MFL Tech Sp - NTB Phase II Investigation - Acq	0	0	0	0	0	0	0	3,806	0	Programatic-Includes Spring and Other MFLs
Total ($)		**908,378**	**1,040,834**	**948,664**	**785,827**	**1,261,440**	**747,133**	**1,353,264**	**769,672**	**1,342,730**	

Funds budgeted/expended for the expert testimonial and non-testimonial and related consulting services for the Silver and Rainbow springs MFLs that were identified in the District's response to your previous request for a listing of all contractors/costs for the District's Rainbow and Crystal River/Kings Bay MFLs projects are not included in the table above. Funds for these services are associated with project Z040, which is administered by the District's Office of General Counsel and is not included in the MFLs Program budget. As indicated in staff's response to your previous inquiry, funds allocated to six Z040 project agreements developed for services related to the Silver/Rainbow springs MFLs total $195, 687.50.

Note that I have attached a PDF file to this email. This file is a replacement for the summary list of contractors for the Rainbow River and Crystal Springs minimum flows that was previously provided by the District. The updated file includes corrected contract numbers (in the third column) for the last three entries (rows) in the summary table.

Thanks for your inquiry. Please let me know if you have any questions regarding the information I've sent.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: FootPrintsPRR
Sent: Friday, December 09, 2016 12:56 PM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: SWFWMD Public Records Request - Heather Obara - Total FY Budgets for only Springs MFLs from 2013-...

When replying, type your text above this line.

Notification of Issue Registration

Workspace: Public Records Request
Issue: Heather Obara - Total FY Budgets for only Springs MFLs from 2013-2017
Issue Number: 21538

Priority: Medium **Status:** Under 7 days old
Date: 12/09/2016 **Time:** 12:55:42
Created By: Shellie Ferreira-Lee

Description:
Entered on 12/09/2016 at 12:55:41 PM EST (GMT-0500) by Shellie Ferreira-Lee:
Email will be forwarded to the PRR ticket.

Current Assignees: Shellie Ferreira-Lee

CC(s): (this edit only) doug.leeper@swfwmd.state.fl.us

Issue Information:

Internal Request: Off

Contact Information:

Last Name: Obara **First Name:** Heather
Email Address: hobara@floridaspringsinstitute.org **Phone:** (386) 454-2427

List of Contractors (Agreements/Purchase Orders/Task Work Assignments) and Costs for Projects Associated with Development of Minimum Flows for the Rainbow River and Crystal River/Kings Bay Systems

Prepared: December 8, 2016; Revised December 12, 2016

System	District Unit Code	Contract/Purchase Order/Task Work Assignment Number	Contractor	Cost	Project Description
Rainbow	B208	05PO0001661-2	University of Tampa (Jim Gore)	$25,000	Macroinvertebrate and fish assessments of the Rainbow River System
Rainbow	B208	05PO0001661-3	University of South Florida (Jim Gore)	$15,000	Macroinvertebrate and fish assessments of the Rainbow River System
Rainbow	B208	05PCSOW163	University of South Florida (Jim Gore)	$35,000	PHABSIM model development for the Rainbow River System
Rainbow	B208	05PC0001648-1	PBS&J	$40,500	Characterization of relationships between elevation, soils, and vegetation communities of the Rainbow River floodplain
Rainbow	B208	14PW0000042	University of South Florida (Ping Wang)	$24,203.00	Shoreline mapping and bathymetric survey for the Rainbow River
Rainbow	P248	15TW000033	Environmental Consulting & Technology, Inc.	$69,992.55	Development of updated HEC-RAS model for Rainbow River System
Rainbow	B208	16PO0000305	University of Tampa (Jim Gore)	$9,500.00	PHABSIM model updates for Rainbow River System
Rainbow	P248	08PO0000368	HSW Engineering, Inc.	$101,191.20	Evaluate water resources and human use values (WRVs) Phase II (Rainbow River)
Rainbow	P274	16PO0000819	University of Florida (Matthew Cohen)	$9,900.00	Peer review of proposed minimum flow for the Rainbow River System (Panelist 3)
Rainbow	P274	16PO0000820	Dann Kenneth Yobbi	$9,900.00	Peer review of proposed minimum flow for the Rainbow River System (Panel Chair)
Rainbow	P274	16PO0000821	Lee Wilson & Associates	$9,900.00	Peer review of proposed minimum flow for the Rainbow River System (Panelist 2)
Crystal	P274	16TW0000363	Applied Technology and Management, Inc.	$15,769.95	Crystal River MFLs peer review Panelist 1 (Chair) (P274)
Crystal	P274	16TW0000364	HSW Engineering, Inc.	$13,128.08	Crystal River MFLs peer review Panelist 2 (P274)

System	District Unit Code	Contract/Purchase Order/Task Work Assignment Number	Contractor	Cost	Project Description
Crystal	P274	16TW0000411	Jones, Edmunds & Associates, Inc.	$13,975.43	Crystal River MFLs peer review Panelist 3 (P274)
Crystal/other	B807/B258	09POSOW1199	Mote Marine Laboratory	$22,196.00	Evaluation of the spatial extent and relative density of barnacles in the Crystal, Homosassa and Withlacoochee rivers, Florida
Crystal	B807	07POSOW0827	University of South Florida	$38,926.00	Shoreline mapping and bathymetric survey for the Crystal River and King's Bay System
Crystal	B807	09POSOW1364	Water & Air Research, Inc.	$82,800.00	Sampling and analysis of oyster distributions and benthic macroinvertebrate populations in Crystal River
Crystal	B807	09POSOW1892	University of Florida Program in Fisheries and Aquatic Sciences	$131,900.00	Compilation and synthesis of existing Data to support MFLs development, and characterization of submersed aquatic vegetation in Kings Bay
Crystal	B807	09POSOW1890	Avineon, Inc.	$75,250.00	Vegetation mapping of the Crystal River
Crystal/other	B807	11POSOW1097	Janicki Environmental, Inc.	$21,900.00	Development of salinity and isohaline regressions for Crystal River and Brooker Creek
Crystal	B807	08C00000074	University of South Florida Board of Trustees	$309,763.00	Investigation of freshwater inflow effects on fish and invertebrate use of the Crystal River estuary
Crystal/other	P274	15PO0000717	Dann Kenneth Yobbi	$10,000.00	Comparison of methods used to compute spring flow of the Chassahowitzka and Southeast Fork of the Homosassa Springs complexes, and review of flow hindcasting method for Kings Bay
Crystal/other	P274	14PWO000039	Dann Kenneth Yobbi	$3,200.00	Review of flow record modeling for Crystal River/Kings Bay
Crystal	B807	09POSOW1468	Vannasse Hangen Brustlin, Inc.	$103,600	Spring Flow Evaluation in Kings Bay, Crystal River, Florida
Crystal	B817/ P686	12POWSOW1054	Vannasse Hangen Brustlin, Inc.	$119,970.00	Additional Kings Bay spring flow measurements
Crystal	B807/ B209/ B222	07PO0001717 09POSOW0483	Vannasse Hangen Brustlin, Inc.	$100,577.00	Inventory of spring vents in Kings Bay

System	District Unit Code	Contract/Purchase Order/Task Work Assignment Number	Contractor	Cost	Project Description
Crystal/ other	P686	12POSOW1080	Florida Fish and Wildlife Conservation Commission	$43,860.00	Assessment of relationships of fish and invertebrate populations with static and dynamic habitats in estuarine systems
Rainbow/ other	Z040	15C00000064-3	Mark T. Stewart	$35,000.00	Expert testimonial and non-testimonial and related consulting services; peer review of Northern District Model, Version 5
Rainbow/ other	P255	16P0000150	St. Johns River Water Management District (SJRWMD)	$37,402.36	Recalibration of the Norther District Model (P255), i.e., development of the Northern District Model, Version 5, in conjunction with the SJRWMD (50% cost-share by each district)
Rainbow/ other	Z040	15C00000076-1	AquaSciTech Consulting, PLCC	$25,000.00	Expert testimonial and non-testimonial and related consulting services
Rainbow/ other	Z040	15C00000074-1	Atkins North America, Inc.	$25,000.00	Expert testimonial and non-testimonial and related consulting services
Rainbow/ other	Z040	15C00000075-1	Brian G. Ormiston	$25,000.00	Expert testimonial and non-testimonial and related consulting services
Rainbow/ other	Z040	15C00000063-2	Progressive Water Resources LLC	$50,000.00	Expert testimonial and non-testimonial and related consulting services
Rainbow/ other	Z040	15C00000065-4	SDII Global Corporation	$35,687.50	Expert testimonial and non-testimonial and related consulting services

From:	FootPrintsPRR
To:	Doug Leeper
Subject:	SWFWMD Public Records Request - Heather Obara - Total FY Budgets for only Springs MFLs from 2013-...
Date:	Tuesday, December 13, 2016 4:50:18 PM
Attachments:	image002_20161213164848.png Rainbow_Crystal MFLs Contracts-POs-TWAs 2016-12-08 Rev 2016-12-13.pdf

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When replying, type your text above this line.

Notification of Issue Change
The following changes have been made to this Issue: *canRead:agentRoles, Appended a Description, Incoming mail: From: doug.leeper@swfwmd.state.fl.us; To: hobara@floridaspringsinstitute.org; Cc: FootPrints.PRR@swfwmd.state.fl.us, Shellie.Ferreira@swfwmd.state.fl.us, Mark.Green@swfwmd.state.fl.us, Jennette.Seachrist@swfwmd.state.fl.us, Eric.Dehaven@swfwmd.state.fl.us, Added Attachment, Escalated: Notify Assignee of Incoming Email, Escalation email sent: shellie.ferreira@swfwmd.state.fl.us, canRead:allRoles.*

Workspace: Public Records Request
Issue: Heather Obara - Total FY Budgets for only Springs MFLs from 2013-2017
Issue Number: 21538

Priority:	Medium	**Status:**	Under 7 days old
Date:	12/13/2016	**Time:**	16:48:49
Creation Date:	12/09/2016	**Creation Time:**	12:55:41
Created By:	Shellie Ferreira-Lee		

Description:
Entered on 12/13/2016 at 4:48:49 PM EST (GMT-0500) by doug.leeper@swfwmd.state.fl.us:
Ms. Obara:

The table below was prepared by District staff in response to your recent inquiry concerning total fiscal year budgets for spring minimum flows and levels (MFLs) for the period from 2013 through 2017. Information on budgeted and expended funds is summarized for projects within the District's Minimum Flows and Levels Program that are associated specifically with spring MFLs and those within the program that include efforts associated with spring MFLs and MFLs for other priority water bodies. Unfortunately, for the group of “programmatic” projects that address both spring and non-spring MFLs, we do not have funding allocations/expenses parsed by spring-related and non-spring-associated efforts. For both the spring-specific and programmatic projects, budgeted/expended funds include operating expenses, contractual dollars and staff salaries/benefits.

[cid:image002.png@01D25560.A49ED620]

Funds budgeted/expended for the expert testimonial and non-testimonial and related consulting services for the Silver and Rainbow springs MFLs that were identified in the District's response to your previous request for a listing of all contractors/costs for the District's Rainbow and Crystal River/Kings Bay MFLs projects are not included in the table above. Funds for these services are associated with project Z040, which is administered by the District's Office of General Counsel and is not included in the MFLs Program budget. As indicated in staff's response to your previous inquiry, funds allocated to six Z040 project agreements developed for services related to the Silver/Rainbow springs MFLs total $195, 687.50.

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Thanks for your inquiry. Please let me know if you have any questions regarding the information I've sent.

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Natural Systems and Restoration Bureau
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Entered on 12/09/2016 at 12:57:22 PM EST (GMT-0500) by Shellie Ferreira-Lee:
Shellie A. Ferreira-Lee
Records Management Specialist
(352) 796-7211, ext. 4053
shellie.ferreira@watermatters.org

From: Eric DeHaven
Sent: Friday, December 09, 2016 11:19 AM
To: Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Shellie Ferreira-Lee <Shellie.Ferreira@swfwmd.state.fl.us>
Cc: Jennette Seachrist <Jennette.Seachrist@swfwmd.state.fl.us>; Mark A. Green <Mark.Green@swfwmd.state.fl.us>
Subject: FW: Draft report and meeting agenda for the Crystal River/Kings Bay MFL

FYI - Shellie, this should be a records request and Doug will have to work on it.

Eric DeHaven, P.G., Assistant Director
Resource Management Division
Southwest Florida Water Management District
7601 HWY 301 N
Tampa, FL 33637
(813) 985-7481 X2118

From: hobara@floridaspringsinstitute.org<mailto:hobara@floridaspringsinstitute.org> [mailto:hobara@floridaspringsinstitute.org]
Sent: Friday, December 09, 2016 9:13 AM
To: Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us<mailto:Eric.Dehaven@swfwmd.state.fl.us>>
Cc: Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us<mailto:Melissa.Gulvin@swfwmd.state.fl.us>>; Bob Knight <bknight@floridaspringsinstitute.org<mailto:bknight@floridaspringsinstitute.org>>; Dan Hilliard <2buntings@comcast.net<mailto:2buntings@comcast.net>>
Subject: RE: Draft report and meeting agenda for the Crystal River/Kings Bay MFL

Good morning Eric and Melissa,

Could you provide the total FY budgets for only springs MFLs from 2013-2017? Thank you!

Heather Obara, Esq.

Associate Director, Howard T. Odum Florida Springs Institute
hobara@floridaspringsinstitute.org<mailto:hobara@floridaspringsinstitute.org>
Office: (386) 454-2427
Fax: (386) 454-9369
Website<http://www.floridaspringsinstitute.org/>
Facebook<https://www.facebook.com/pages/Howard-T-Odum-Florida-Springs-Institute/203045473038817> Twitter<https://twitter.com/FLSpringsInst>

Please consider the environment before printing this email.

From: hobara@floridaspringsinstitute.org<mailto:hobara@floridaspringsinstitute.org> [mailto:hobara@floridaspringsinstitute.org]
Sent: Tuesday, November 22, 2016 9:07 AM
To: 'Eric DeHaven' <Eric.Dehaven@swfwmd.state.fl.us<mailto:Eric.Dehaven@swfwmd.state.fl.us>>
Cc: 'Melissa Gulvin' <Melissa.Gulvin@swfwmd.state.fl.us<mailto:Melissa.Gulvin@swfwmd.state.fl.us>>; Bob Knight <bknight@floridaspringsinstitute.org<mailto:bknight@floridaspringsinstitute.org>>; Dan Hilliard <2buntings@comcast.net<mailto:2buntings@comcast.net>>; Heather Obara <hobara@floridaspringsinstitute.org<mailto:hobara@floridaspringsinstitute.org>>
Subject: RE: Draft report and meeting agenda for the Crystal River/Kings Bay MFL

Good morning Eric,

Could you provide the total FY budgets for only springs MFLs from 2013-2017? Thank you!

Heather Obara, Esq.
Associate Director, Howard T. Odum Florida Springs Institute
hobara@floridaspringsinstitute.org<mailto:hobara@floridaspringsinstitute.org>
Office: (386) 454-2427
Fax: (386) 454-9369
Website<http://www.floridaspringsinstitute.org/>
Facebook<https://www.facebook.com/pages/Howard-T-Odum-Florida-Springs-Institute/203045473038817> Twitter<https://twitter.com/FLSpringsInst>

Please consider the environment before printing this email.

From: hobara@floridaspringsinstitute.org<mailto:hobara@floridaspringsinstitute.org> [mailto:hobara@floridaspringsinstitute.org]
Sent: Monday, November 21, 2016 1:08 PM
To: 'Eric DeHaven' <Eric.Dehaven@swfwmd.state.fl.us<mailto:Eric.Dehaven@swfwmd.state.fl.us>>
Cc: 'Melissa Gulvin' <Melissa.Gulvin@swfwmd.state.fl.us<mailto:Melissa.Gulvin@swfwmd.state.fl.us>>
Subject: RE: Draft report and meeting agenda for the Crystal River/Kings Bay MFL

Thank you Eric,

I appreciate you sending me this info. Have a wonderful Thanksgiving holiday!

Heather Obara, Esq.
Associate Director, Howard T. Odum Florida Springs Institute
hobara@floridaspringsinstitute.org<mailto:hobara@floridaspringsinstitute.org>
Office: (386) 454-2427
Fax: (386) 454-9369
Website<http://www.floridaspringsinstitute.org/>
Facebook<https://www.facebook.com/pages/Howard-T-Odum-Florida-Springs-

Institute/203045473038817> Twitter<https://twitter.com/FLSpringsInst>

Please consider the environment before printing this email.

From: Eric DeHaven [mailto:Eric.Dehaven@swfwmd.state.fl.us]
Sent: Monday, November 21, 2016 8:21 AM
To: hobara@floridaspringsinstitute.org<mailto:hobara@floridaspringsinstitute.org>
Cc: Melissa Gulvin
<Melissa.Gulvin@swfwmd.state.fl.us<mailto:Melissa.Gulvin@swfwmd.state.fl.us>>
Subject: RE: Draft report and meeting agenda for the Crystal River/Kings Bay MFL

Hello Heather, those totals are for all MFL's.

Eric DeHaven, P.G., Assistant Director
Resource Management Division
Southwest Florida Water Management District
7601 HWY 301 N
Tampa, FL 33637
(813) 985-7481 X2118

---------- Forwarded message ----------
From: "hobara@floridaspringsinstitute.org<mailto:hobara@floridaspringsinstitute.org>"
<hobara@floridaspringsinstitute.org<mailto:hobara@floridaspringsinstitute.org>>
Date: Fri, Nov 18, 2016 at 5:10 PM -0500
Subject: RE: Draft report and meeting agenda for the Crystal River/Kings Bay MFL
To: "Melissa Gulvin"
<Melissa.Gulvin@swfwmd.state.fl.us<mailto:Melissa.Gulvin@swfwmd.state.fl.us>>
Cc: "'Burt Eno'" <burteno@bellsouth.net<mailto:burteno@bellsouth.net>>,
"2buntings@comcast.net<mailto:2buntings@comcast.net>"
<2buntings@comcast.net<mailto:2buntings@comcast.net>>, "'Bob Knight'"
<bknight@floridaspringsinstitute.org<mailto:bknight@floridaspringsinstitute.org>>,
"Heather Obara"
<hobara@floridaspringsinstitute.org<mailto:hobara@floridaspringsinstitute.org>>
Good evening Melissa,

I was wondering if you might be able to provide clarification on the budget amounts below. Are these totals for all MFLs or springs MFLs only? Thank you and have a wonderful weekend!

Heather Obara, Esq.
Associate Director, Howard T. Odum Florida Springs Institute
hobara@floridaspringsinstitute.org<mailto:hobara@floridaspringsinstitute.org>
Office: (386) 454-2427
Fax: (386) 454-9369
Website<http://www.floridaspringsinstitute.org/>
Facebook<https://www.facebook.com/pages/Howard-T-Odum-Florida-Springs-Institute/203045473038817> Twitter<https://twitter.com/FLSpringsInst>

Please consider the environment before printing this email.

From: Melissa Gulvin [mailto:Melissa.Gulvin@swfwmd.state.fl.us]
Sent: Tuesday, November 8, 2016 12:45 PM
To: hobara@floridaspringsinstitute.org<mailto:hobara@floridaspringsinstitute.org>
Cc: Burt Eno <burteno@bellsouth.net<mailto:burteno@bellsouth.net>>;
2buntings@comcast.net<mailto:2buntings@comcast.net>; 'Bob Knight'
<bknight@floridaspringsinstitute.org<mailto:bknight@floridaspringsinstitute.org>>
Subject: RE: Draft report and meeting agenda for the Crystal River/Kings Bay MFL

Hi Heather,

Thanks for submitting the request. In the interim of the request being submitted, I was given the information requested for the District's total fiscal year budgeted amounts for the past five years and wanted to go ahead and provide it:

MFL Total Budget
FY2013 - $2,052,212
FY2014 - $2,079,841
FY2015 - $2,022,346
FY2016 - $2,200,531
FY2017 - $2,091,529

Melissa Gulvin
Government Affairs Program Manager
Southwest Florida Water Management District
2379 Broad Street, Brooksville, FL 34604
(352) 796-7211, ext. 4419
(352) 206-4047 cell
Melissa.Gulvin@WaterMatters.org<mailto:Melissa.Gulvin@WaterMatters.org>

From: hobara@floridaspringsinstitute.org<mailto:hobara@floridaspringsinstitute.org>
[mailto:hobara@floridaspringsinstitute.org]
Sent: Monday, November 07, 2016 3:38 PM
To: Melissa Gulvin
<Melissa.Gulvin@swfwmd.state.fl.us<mailto:Melissa.Gulvin@swfwmd.state.fl.us>>
Cc: Burt Eno <burteno@bellsouth.net<mailto:burteno@bellsouth.net>>;
2buntings@comcast.net<mailto:2buntings@comcast.net>; 'Bob Knight'
<bknight@floridaspringsinstitute.org<mailto:bknight@floridaspringsinstitute.org>>
Subject: RE: Draft report and meeting agenda for the Crystal River/Kings Bay MFL

Good afternoon Melissa,

I will be happy to submit the request on behalf of the Florida Springs Institute.

Heather Obara, Esq.
Associate Director, Howard T. Odum Florida Springs Institute
hobara@floridaspringsinstitute.org<mailto:hobara@floridaspringsinstitute.org>
Office: (386) 454-2427
Fax: (386) 454-9369
Website<http://www.floridaspringsinstitute.org/>
Facebook<https://www.facebook.com/pages/Howard-T-Odum-Florida-Springs-Institute/203045473038817> Twitter<https://twitter.com/FLSpringsInst>

Please consider the environment before printing this email.

From: Melissa Gulvin [mailto:Melissa.Gulvin@swfwmd.state.fl.us]
Sent: Monday, November 7, 2016 3:35 PM
To: hobara@floridaspringsinstitute.org<mailto:hobara@floridaspringsinstitute.org>
Cc: burteno@bellsouth.net<mailto:burteno@bellsouth.net>;
2buntings@comcast.net<mailto:2buntings@comcast.net>; 'Bob Knight'
<bknight@floridaspringsinstitute.org<mailto:bknight@floridaspringsinstitute.org>>
Subject: RE: Draft report and meeting agenda for the Crystal River/Kings Bay MFL

Hello again Heather,

After speaking with staff, we'd like to ask for a public records request to be submitted. The form is found on the top right of this webpage: https://www.swfwmd.state.fl.us/contact/. Thank you.

Melissa Gulvin
Government Affairs Program Manager
Southwest Florida Water Management District
2379 Broad Street, Brooksville, FL 34604
(352) 796-7211, ext. 4419
(352) 206-4047 cell
Melissa.Gulvin@WaterMatters.org<mailto:Melissa.Gulvin@WaterMatters.org>

From: hobara@floridaspringsinstitute.org<mailto:hobara@floridaspringsinstitute.org> [mailto:hobara@floridaspringsinstitute.org]
Sent: Monday, November 07, 2016 1:56 PM
To: Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us<mailto:Melissa.Gulvin@swfwmd.state.fl.us>>
Cc: burteno@bellsouth.net<mailto:burteno@bellsouth.net>; 2buntings@comcast.net<mailto:2buntings@comcast.net>; 'Bob Knight' <bknight@floridaspringsinstitute.org<mailto:bknight@floridaspringsinstitute.org>>
Subject: RE: Draft report and meeting agenda for the Crystal River/Kings Bay MFL

Thank you Melissa,

We look forward to hearing from you soon.

Heather Obara, Esq.
Associate Director, Howard T. Odum Florida Springs Institute
hobara@floridaspringsinstitute.org<mailto:hobara@floridaspringsinstitute.org>
Office: (386) 454-2427
Fax: (386) 454-9369
Website<http://www.floridaspringsinstitute.org/>
Facebook<https://www.facebook.com/pages/Howard-T-Odum-Florida-Springs-Institute/203045473038817> Twitter<https://twitter.com/FLSpringsInst>

Please consider the environment before printing this email.

From: Melissa Gulvin [mailto:Melissa.Gulvin@swfwmd.state.fl.us]
Sent: Monday, November 7, 2016 12:43 PM
To: hobara@floridaspringsinstitute.org<mailto:hobara@floridaspringsinstitute.org>
Cc: burteno@bellsouth.net<mailto:burteno@bellsouth.net>; 2buntings@comcast.net<mailto:2buntings@comcast.net>; Bob Knight <bknight@floridaspringsinstitute.org<mailto:bknight@floridaspringsinstitute.org>>
Subject: RE: Draft report and meeting agenda for the Crystal River/Kings Bay MFL

Hi Heather,

I'm not sure what happened in the land of emails, but this is the first I've seen Dr. Knight's email below. I've looked through my inbox, filed and deleted emails, which are kept archived in Outlook, and cannot find this email. I will gather the information from our staff for him.

Melissa Gulvin
Government Affairs Program Manager
Southwest Florida Water Management District
2379 Broad Street, Brooksville, FL 34604
(352) 796-7211, ext. 4419

(352) 206-4047 cell
Melissa.Gulvin@WaterMatters.org<mailto:Melissa.Gulvin@WaterMatters.org>

From: hobara@floridaspringsinstitute.org<mailto:hobara@floridaspringsinstitute.org> [mailto:hobara@floridaspringsinstitute.org]
Sent: Monday, November 07, 2016 12:28 PM
To: Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us<mailto:Melissa.Gulvin@swfwmd.state.fl.us>>
Cc: burteno@bellsouth.net<mailto:burteno@bellsouth.net>; 2buntings@comcast.net<mailto:2buntings@comcast.net>; hobara@floridaspringsinstitute.org<mailto:hobara@floridaspringsinstitute.org>; Bob Knight <bknight@floridaspringsinstitute.org<mailto:bknight@floridaspringsinstitute.org>>
Subject: FW: Draft report and meeting agenda for the Crystal River/Kings Bay MFL

Good afternoon Melissa,

Have you had a chance to respond to Dr. Knight's below request? If a more formal public records request is needed to obtain the requested information, I would be happy to do so on behalf of the Florida Springs Institute.

Please let us know if you can provide the requested info or if a formal public records request should be made. I look forward to hearing from you.

Heather Obara, Esq.
Associate Director, Howard T. Odum Florida Springs Institute
hobara@floridaspringsinstitute.org<mailto:hobara@floridaspringsinstitute.org>
Office: (386) 454-2427
Fax: (386) 454-9369
Website<http://www.floridaspringsinstitute.org/>
Facebook<https://www.facebook.com/pages/Howard-T-Odum-Florida-Springs-Institute/203045473038817> Twitter<https://twitter.com/FLSpringsInst>

Please consider the environment before printing this email.

From: Bob Knight [mailto:bknight@floridaspringsinstitute.org]
Sent: Friday, October 28, 2016 9:32 PM
To: 'Melissa Gulvin' <Melissa.Gulvin@swfwmd.state.fl.us<mailto:Melissa.Gulvin@swfwmd.state.fl.us>>
Cc: 'Burt Eno' <burteno@bellsouth.net<mailto:burteno@bellsouth.net>>; 'Dan' <2buntings@comcast.net<mailto:2buntings@comcast.net>>; hobara@floridaspringsinstitute.org<mailto:hobara@floridaspringsinstitute.org>
Subject: RE: Draft report and meeting agenda for the Crystal River/Kings Bay MFL

Melissa

Thank you for sharing these reports for the Crystal River/Kings Bay MFL development.

Please provide a complete list of the contractors and the cost of their contracts for both the Rainbow and Kings Bay MFL studies. A brief summary of work contracted and/or completed through October 2016 will be sufficient. Please include all relevant contracts, for consultants, universities, peer reviewers, and others. Also, please send the District's total fiscal year budgeted amounts for MFLs during the past five years.

Thank you.

Bob

Robert L. Knight, Ph.D.
Howard T. Odum Florida Springs Institute
99 NW First Street
High Springs, Florida
www.Floridaspringsinstitute.org<http://www.Floridaspringsinstitute.org>
386-462-1003

From: Melissa Gulvin [mailto:Melissa.Gulvin@swfwmd.state.fl.us]
Sent: Friday, October 28, 2016 2:08 PM
Subject: Draft report and meeting agenda for the Crystal River/Kings Bay MFL

Hello,

The draft report for the Crystal River/Kings Bay MFL is now available online. Please click here to view the report<https://www.swfwmd.state.fl.us/files/database/calendar/CRKB_MFL_DRAFT_2016-10-18.pdf>, and click here to view the appendix<https://www.swfwmd.state.fl.us/files/database/calendar/CRKB_MFL_Draft-apps.pdf>.

I also wanted to share the attached agenda of the initial peer review meeting, which will be held Friday, Nov. 4. Below is the tentative schedule for the MFL to be adopted before July 1, 2017. I will continue to inform you of the process and details of the public meetings.

As always, please feel free to contact me if you would like to schedule a meeting with the District's technical staff to answer any questions you may have.

Have a wonderful weekend.

Melissa Gulvin
Government Affairs Program Manager
Southwest Florida Water Management District
2379 Broad Street, Brooksville, FL 34604
(352) 796-7211, ext. 4419
(352) 206-4047 cell
Melissa.Gulvin@WaterMatters.org<mailto:Melissa.Gulvin@WaterMatters.org>

Oct. 25 District's Governing Board was informed the peer review is being initiated via an information item
Peer review meetings:
Nov. 4: Initial meeting of the peer reviewers; 8 a.m. - noon (various sites on Crystal River/Kings Bay) and 1-4 p.m. (District Headquarters in Brooksville)
Nov. 21: 1-4 p.m. - WebEx/teleconference or in-person at the District Headquarters
Dec. 5: noon-3 p.m. - WebEx/teleconference or in-person at the District Headquarters
Dec. 12: Peer review report due
Feb. - March: Meetings with interested stakeholders will be scheduled
March: Governing Board will be informed of the peer review results through an information item
March: Public workshop (date TBD)
May: Governing Board presentation and request to approve the staff recommendation
June: Rule-making process
July 1: All MFLs must be adopted by July 1, 2017

Entered on 12/09/2016 at 12:55:41 PM EST (GMT-0500) by Shellie Ferreira-Lee:
Email will be forwarded to the PRR ticket.

Current Assignees: Shellie Ferreira-Lee

CC(s): (this edit only) doug.leeper@swfwmd.state.fl.us

Issue Information:

Internal Request: Off

Contact Information:

Last Name: Obara **First Name:**Heather
Email Address:hobara@floridaspringsinstitute.org **Phone:** (386) 454-2427

Attachments: image002_20161213164848.png Rainbow_Crystal MFLs Contracts-POs-TWAs 2016-12-08 Rev 2016-12-13.pdf

From: hobara@floridaspringsinstitute.org
To: Doug Leeper
Subject: RE: SWFWMD Public Records Request - Heather Obara - Total FY Budgets for only Springs MFLs from 2013-...
Date: Wednesday, December 14, 2016 2:03:52 PM
Attachments: image001.png

Thank you Mr. Leeper,

I will pass this along to our President for his review and let you know if we have any questions. I hope you have a wonderful holiday season!

Heather Obara, Esq.
Treasurer-Secretary, Florida Springs Council
hobara@floridaspringsinstitute.org
Office: (386) 454-2427
Fax: (386) 454-9369

Please consider the environment before printing this email.

From: Doug Leeper [mailto:Doug.Leeper@swfwmd.state.fl.us]
Sent: Tuesday, December 13, 2016 4:48 PM
To: hobara@floridaspringsinstitute.org
Cc: FootPrintsPRR <FootPrints.PRR@swfwmd.state.fl.us>; Shellie Ferreira-Lee <Shellie.Ferreira@swfwmd.state.fl.us>; Mark A. Green <Mark.Green@swfwmd.state.fl.us>; Jennette Seachrist <Jennette.Seachrist@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>
Subject: RE: SWFWMD Public Records Request - Heather Obara - Total FY Budgets for only Springs MFLs from 2013-...

Ms. Obara:

The table below was prepared by District staff in response to your recent inquiry concerning total fiscal year budgets for spring minimum flows and levels (MFLs) for the period from 2013 through 2017. Information on budgeted and expended funds is summarized for projects within the District's Minimum Flows and Levels Program that are associated specifically with spring MFLs and those within the program that include efforts associated with spring MFLs and MFLs for other priority water bodies. Unfortunately, for the group of "programmatic" projects that address both spring and non-spring MFLs, we do not have funding allocations/expenses parsed by spring-related and non-spring-associated efforts. For both the spring-specific and programmatic projects, budgeted/expended funds include operating expenses, contractual dollars and staff salaries/benefits.

Project Code	Project Name	FY2013 Budgetd ($)	FY2013 Expended ($)	FY2014 Budgetd ($)	FY2014 Expended ($)	FY2015 Budgetd ($)	FY2015 Expended ($)	FY2016 Budgetd ($)	FY2016 Expended ($)	FY2017 Budgetd ($)	Comments
B208	MFL Estb - Rainbow River Freshwater System	5,891	52,720	47,181	83,554	53,085	39,482	99,449	92,792	64,031	Spring MFLs
B209	MFL Estb - Chassahowitzka River & Springs System	0	10,237	0	9,885	9,154	10,612	6,412	4,189	5,858	Spring MFLs
B273	MFL Tech Sp - Strmflw Rdc-Measure Effects of MFL	17,195	84,188	1,337	40,958	0	0	0	0	0	Spring MFLs
B807	MFL Estb - Crystal River/Kings Bay Estuary System	56,516	15,241	75,117	29,024	80,377	13,789	73,686	114,192	136,678	Spring MFLs
B808	MFL Estb - Gum Springs Group Freshwater System	19,837	3,997	581	8,399	0	10,593	2,472	24,347	0	Spring MFLs
B811	MFL Estb - Silver River MFL Assistance to SJRWMD	7,111	1,818	2,658	2,460	4,582	0	0	573	0	Spring MFLs
B817	MFL Re-Eval - Springs Systems	33,509	55,342	65,202	16,923	81,824	79,377	58,083	32,408	152,535	Spring MFLs
B822	MFL Re-Eval - Homosassa Rvr & Spgs Sys	0	0	0	0	0	3,356	120,061	6,753	85,807	Spring MFLs
B823	MFL Re-Eval - Chassahowitzka Rvr & Sprgs System	0	0	0	0	0	0	125,610	8,292	84,125	Spring MFLs
P248	MFL Tech Sp - Freshwater Systems	126,659	180,220	139,136	112,931	169,277	189,644	151,738	138,943	144,138	Programatic-Includes Spring and Other MFLs
P255	MFL Tech Sp - Hydrologic Analysis	88,879	42,941	114,381	23,705	93,201	62,027	93,939	46,902	59,440	Programatic-Includes Spring and Other MFLs
P263	MFL Tech Sp - Compliance	0	18,174	54,753	25,703	50,421	20,489	53,260	6,999	33,688	Programatic-Includes Spring and Other MFLs
P274	MFL Estb - Peer Review & Technical Advisory Cnslt	176,542	-10	153,273	2,524	182,390	4,909	182,472	39,331	187,343	Programatic-Includes Spring and Other MFLs
P686	MFL Tech Sp - Estuarine Systems	165,207	219,353	124,893	191,215	367,468	159,323	202,984	67,376	173,215	Programatic-Includes Spring and Other MFLs
P862	MFL Tech Sp - INTB Model Maintenance	0	0	50,000	0	54,128	32,991	67,645	53,176	75,749	Programatic-Includes Spring and Other MFLs
P863	MFL Estb - Priority List & Schedule Annual Update	0	0	0	0	0	0	0	3,298	5,232	Programatic-Includes Spring and Other MFLs
P876	MFL Tech Sp - Northern District Wrap	56,421	219,764	22,895	180,619	22,352	40,385	21,241	54,309	37,840	Programatic-Includes Spring and Other MFLs
P876A	AMFL Tech Sp - Northern District Wrap - Acq	0	0	0	0	0	0	0	867	0	Programatic-Includes Spring and Other MFLs
P883	MFL Tech Sp - NTB Phase II Investigation	154,611	136,849	97,257	57,927	103,181	80,156	94,212	71,119	97,051	Programatic-Includes Spring and Other MFLs
P883A	MFL Tech Sp - NTB Phase II Investigation - Acq	0	0	0	0	0	0	0	3,806	0	Programatic-Includes Spring and Other MFLs
Total ($)		908,378	1,040,834	948,664	785,827	1,261,440	747,133	1,353,264	769,672	1,342,730	

Funds budgeted/expended for the expert testimonial and non-testimonial and related consulting services for the Silver and Rainbow springs MFLs that were identified in the District's response to your previous request for a listing of all contractors/costs for the District's Rainbow and Crystal River/Kings Bay MFLs projects are not included in the table above. Funds for these services are associated with project Z040, which is administered by the District's Office of General Counsel and is not included in the MFLs Program budget. As indicated in staff's response to your previous inquiry, funds allocated to six Z040 project agreements developed for services related to the Silver/Rainbow springs MFLs total $195, 687.50.

Note that I have attached a PDF file to this email. This file is a replacement for the summary list of contractors for the Rainbow River and Crystal Springs minimum flows that was previously provided by the District. The updated file includes corrected contract numbers (in the third column) for the last three entries (rows) in the summary table.

Thanks for your inquiry. Please let me know if you have any questions regarding the information I've sent.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: FootPrintsPRR
Sent: Friday, December 09, 2016 12:56 PM

To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: SWFWMD Public Records Request - Heather Obara - Total FY Budgets for only Springs MFLs from 2013-...

When replying, type your text above this line.

Notification of Issue Registration

Workspace: Public Records Request
Issue: Heather Obara - Total FY Budgets for only Springs MFLs from 2013-2017
Issue Number: 21538

Priority: Medium **Status:** Under 7 days old
Date: 12/09/2016 **Time:** 12:55:42
Created By: Shellie Ferreira-Lee

Description:
Entered on 12/09/2016 at 12:55:41 PM EST (GMT-0500) by Shellie Ferreira-Lee:
Email will be forwarded to the PRR ticket.

Current Assignees: Shellie Ferreira-Lee

CC(s): (this edit only) doug.leeper@swfwmd.state.fl.us

Issue Information:

Internal Request: Off

Contact Information:

Last Name: Obara **First Name:** Heather
Email Address: hobara@floridaspringsinstitute.org **Phone:** (386) 454-2427

King's Bay: The future is not so clear



Dan Hilliard
GUEST COLUMN

OK, my wife was right. I took a look at the peer panel draft for the King's Bay/Crystal River Minimum Flows and Levels (MFL) recommendations recently published by the Southwest Florida Water Management District and had a tech seizure. My first attempt at this was a flourish of techno-babble, but after highest level counseling it was obvious that I needed to come back down to Earth.

I admire those who have pitched in to clean up King's Bay for the last several years. It has been inspiring, a profound commitment if ever there were, and one we should all support. Citrus County is unique on this planet in that it has three first magnitude springs on the coast. They are a prime driver in our local economy and an aesthetic treasure only appreciated after first-hand inspection. It matters not whether you are from Tallahassee, Tokyo, Toronto, or Thuringia.

Kudos to you folks that are working tirelessly to protect these treasures!

The King's Bay spring system discharges hundreds of millions of gallons of water daily, yet because of the bay's large expanse, the flow takes a lengthy time to exit the system into coastal waters. In concert with nutrient pollution in the spring water, this leisurely stroll to the Gulf of Mexico promotes algae blooms, sometimes of profound nature. In scientific terminology this is described as residence time, or the span of time it takes from spring vent discharge to exit from King's Bay.

In the aforementioned draft MFL rule recommendations staff presented a variety of data, and some assumptions which supported their conclusions about the system. With an objective of preventing "significant harm," or 15 percent loss of habitat, it was recommended that a 12 percent flow reduction of the historic average discharge was acceptable.

Current estimates are that ground water withdrawals amount to approximately 15.3 million gallons/day (mgd) in the springshed. Although there is debate on this point, the measured average discharge of all springs in the system is presented as 447 cubic feet per second (cfs), or 289 mgd. Staff estimated that residence time in the bay is variable, ranging from approximately 7 to 15.5 days. The average is about 11 days.

The draft is currently being reviewed by an independent peer panel to critique the staff findings and recommendations to the Governing Board.

The recommended authorization for 12 percent reduction of flow will provide for future diversion of approximately 53.6 cfs or 34.68 mgd. This will increase residence time to an average of 12.5 days. It seems like a small sacrifice until one examines the range of times that make the average. What's a day and a half, hey? Depending on seasonal variations of tides and spring flows the residence times might increase as little as 5.7 percent or as much as 30.9 percent. That would be eight to 16 days, depending on those variables.

District staff cited four scientific papers which examined the effect of residence time influence of algal blooms. A brief quote states; "Changes in residence time can contribute to increased frequency and severity of algal blooms within the estuaries." OK, we sort of already figured that out.

Another quote presents as perfectly logical: "In an analysis of zooplankton in spring-fed and surface-fed estuaries in the District, Burghart and Peebles (2011) recommend that residence time be managed to limit phytoplankton blooms."

But wait, there's a staff punch line: "Sea level rise and residence time were considered as supplemental to minimum flow development. This means they were not considered as measured criteria for establishing significant harm to environmental values, as was the case for salinity and manatee thermal refuge."

So, we are going to plan on allowing a significant increase of residence time so we see what happens? If you followed the bouncing ball with this perhaps you share my epiphany. I did not know that ignoring science was the foundation of sound science and recommendations to the Governing Board. Nevertheless, I am easily amused.

It appears there are green storm clouds approaching from the southwest. I wish the city of Crystal River and Citrus County the very best of luck.

Dan Hilliard is president of the Withlacoochee Aquatic Restoration, which was organized in 1984 in response to quality of life threats posed by activities that have a high potential to degrade groundwater and surface water quality.

Citrus County Chronicle
Crystal River
Daily 29,000
December 18, 2016

From:	Doug Leeper
To:	"martynellijay@hotmail.com"
Cc:	Xinjian Chen; Gabe I. Herrick
Bcc:	Ron Basso; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ross Morton; Melissa Gulvin
Subject:	Recent inquiries on MFLs
Date:	Friday, December 16, 2016 4:00:00 PM
Attachments:	Responses to MJohnson 2016-12-16.pdf Group 1 GH Vel Disch and Hydrograph.xls

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Martyn:

Thanks for your recent emails and contributions to the Crystal River peer review process. The attached PDF file includes your emails and associated attachments with imbedded responses from District staff. Also attached is an Excel file that contains discharge data that you requested.

Note that the PDF file includes information pertaining to a file containing water quality data that you requested that is too large to send be email (and has been posted to the District FTP site for you to retrieve) as well as links to a U.S. Geological web site where real-time data that you asked about can be obtained.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

Subject: Emails from Mr. Martyn Johnson with imbedded responses from Southwest Florida Water Management District staff highlighted in blue and grey, with grey highlighting denoting responses to public record requests

Prepared by: XinJian Chen, Gabe Herrick and Doug Leeper
Natural Systems & Restoration Bureau
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
Brooksville, Florida 34605

Date: December 16, 2016

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Monday, December 12, 2016 11:27 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>
Cc: Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>; Ross.Morton@swfwmd.stste.fl.us
Subject: Kings Bay Crystal River Salinity

I am still hoping for an explanation of how the spring discharge from Group 2 springs shown in Figure 2-4 can regularly vary from 0 cfs to 250-270 cfs in 6 hours; there is not a shred of evidence to support this.

Staff Response: This kind of variability of the spring flow discharge is caused by tides. The spring discharge shown in Fig. 2-4 of the District's draft minimum flow report was obtained by separating tidal discharge from measured discharge data collected at the G2 cross section based on the principle of mass balance. There could be some small errors associated with the discharge measurement and the measurement of the upstream water surface area; nevertheless, the discharge variation in the order of 250 cfs for Group 2 springs during these particular days should not be a surprise unless there exist significant errors in the measurements or the mass balance principle.

SALINITY Kings Bay Crystal River

I have a number of questions and comments regarding salinity in the Crystal River Kings Bay MFL Report.

1. **Baseline Flow/Discharge re Salinity**
   Salinity is presented as the factor most appropriate for the MFL recommendation of a 12% reduction in flow from the baseline condition which limits harm (loss of 15% volume/area) to the < 2ppt salinity habitat. These numbers are easily found in the report, but exactly how many CFS the baseline discharge is, appears to be missing or

difficult to find. Is baseline the 201 million gallons per day (310 cfs) in the Executive Summary or some other figure. **What is the baseline cfs?**

Staff Response: Baseline discharge varies with time and thus is not a constant value.

Salinity habitats (defined as < 2ppt) in Kings Bay are those areas where SAV is more healthy/prevalent, but the report gives no indication of where the < 2ppt areas are. In response to Review panel request a visual has been posted on the WebForum (copy attached).
The first visual Baseline is an average over 9 years**.**
Do I assume correctly this is output from the model,
What is:
a) the baseline flow in cfs,

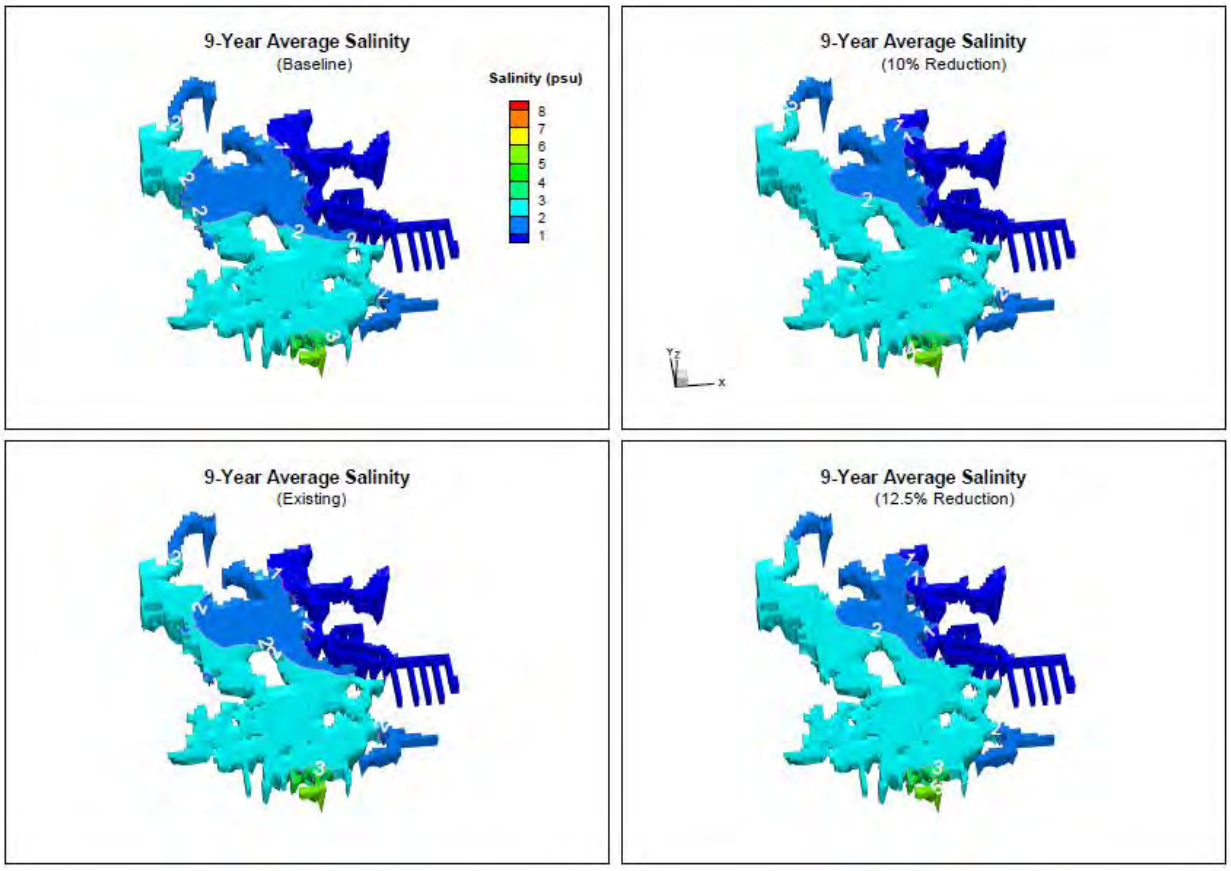
Staff Response: Again, baseline discharge is not a constant; it varies with time.

b) exactly what salinity is averaged over 9 years

Staff Response: Simulated salinity values at each grid cell during the 9-year simulation period were averaged.

c) which 9 years are presented?

Staff Response: The 9-year period is from 10/6/2006 to 10/13/2015.



Is this average daily data if the inflow of spring discharge is fixed and the other model inputs from the USGS Gage Sites are as measured by USGS over 9 years.

Staff Response: No, inflow of spring discharge is not fixed.

It is puzzling how the 3 psu area to the south of Buzzard Island appears to be 'held back' by the 2 psu area from shore to shore north of Buzzard Island.

Staff Response: This could occur because the southern spring vents could be saltier than 3 psu.

What is existing as shown for the bottom left image? Is this baseline without withdrawals and if so where are groundwater withdrawals a model input; not shown in Table 2-2, page 46 but conceptualized in Figure 2-6 page 45.

Staff Response: The "existing" for the bottom left image is the actual condition during the 9-year period. It is not the baseline without withdrawals. Groundwater withdrawal impacts on discharge are predicted as a percent of flow by the Northern District Model (NDM) as shown in Table 1-2 of the draft minimum flow report. Impacted flow is then

converted to baseline flow by dividing by 0.98, which is a conservative estimate, i.e., it likely overestimates impacts and thus overestimates baseline relative to impacted flows. In the conceptual model shown in Figure 2-6 of the draft report, the effect of groundwater withdrawals through groundwater level to spring discharge (3 boxes and two arrows) is estimated by the NDM as a percent impact. That percent impact is then used to adjust spring discharge as estimated by groundwater level and Kings Bay gage height. The conceptualization in Figure 2-6 is a simple visualization that does not capture this level of detailed explanation.

2. **Increased flow Feb 1991 to April 2010**
   In the Section 3.5 Water Quality, Figure 3-4 presents discharge data for 91 dates February 1991 to April 2010 during the time water quality measurements were made. These are interpreted (blue line) to indicate discharge increase from approx 220 cfs to 350 cfs. The origin of this data is not included.
   What is the origin of this data and does the model also show an increasing 'trend' over these years?

   Staff Response: The origin of the discharge data is the topic of section 2.2 "Predicting Freshwater Inflow" within the draft minimum flows report. The origin of Water Quality data is explained in section 2.6 "Water Quality" of the report.

   The district estimates spring discharge (submarine groundwater discharge or SGD) for the system based on an empirical formula. The running average SGD is calculated in equation 10 on page 21 of Chen (2014). Instantaneous SGD for each vent is shown in Equation 1 of the draft minimum flow report on page 41. The discharge plotted on the y-axis in Figure 3-4 within the report is obtained as described in section 2.2 and in Chen (2014) as cited. The dates plotted on the x-axis of Figure 3-4 are those dates on which water quality samples were taken within the database described in Table 2-4 of section 2.6. There is an increasing trend you can see in Figure 3-4 for our estimate of SGD for these dates.

3. **Increased salinity in the 13 zones**
   The report references water quality data from 13 zones representing 535 sampling stations and 9104 entries and concludes "salinity increased in Zones 1 and 3 thru 11 and remained stable in Zones 2, 12 and 13." The stability for Zones 12 and 13 is not surprising as these are off shore.
   I would have thought this data set is important to understanding salinity in Kings Bay, but no mention is made regarding the increases either as percentages or actual values. So far I have been unable to find this data set in SWFWMD's vast data base. I have asked Ron/Doug if they could let me know how to find it.
   What does this data show and how is the increase explained if flow increased over 50% as noted in 2 above.

Staff Response: The data shows trends as described in Table 3-8 within the draft minimum flow report. To reiterate: Mann-Kendall tests showed significant increases in zones 1 and 3-11, no decreases, and no significant trends in zones 2, 12, and 13. The data showing an increase in discharge plotted in Figure 3-4 of the draft minimum flow report is based on daily submarine groundwater discharge on 91 dates for which water quality data was taken. Salinity at any given time and location will be affected by tide stage, offshore wind, and discharge, all of which vary over multiple time scales. Figure 3-4 shows a correlation between discharge and time on water quality sampling dates that had to be removed to remove confounding in the correlations between nitrate and flow and between nitrate and time as shown in Figure 3-5.

It is unlikely that a meaningful trend between daily discharge and instantaneous salinity measurement can be identified. Thus, it is not surprising that instantaneous measurements of salinity showed an increasing trend in 10 zones over 91 dates while a locally weighted regression (LOWESS) shows an increasing trend in discharge over those same dates. This is why a hydrodynamic model is needed to predict salinity at any given place and time throughout the system. Salinity cannot be accurately predicted through regression against current daily discharge when there are so many other factors that will affect salinity aside from daily average discharge on the date of salinity measurement.

4. **Modeling Salinity**

On page 44 of the report it states

Quote

Instantaneous spring discharge for each vent was measured under various tidal conditions. Salinity measurements were taken at the same time (VHB 2010 [included as appendix]). Thus, we are able to model spatially explicit spring flow with corresponding salinity values to accurately predict effects of spring flow on salinity habitats. Discharge was modeled at every spring site using parameters in Equation 1 corresponding to the nearest group (G1 or G2).

End Quote

So it appears the primary driver of the inflow of salinity is the VHB data albeit with the measured discharge being modified by Equation 1.

Note for clarification: Equation 1 for G1 and G2 have different C1 and C2 values. The C values i.e C1G1, C2G1 or C1G2, C2G2 are applied to an individual spring based on the proximity to G1 and G2 X-section.

While I see the other model inputs in Table 2-2 such as data from the USGS Site at Mouth of Kings Bay (salinity gage ht and temp) and meteorological data etc, it appears the volume of tidal inflow to Kings Bay is determined by the gage height and area in Kings Bay.

For each tidal cycle (average change of 2.5 feet gage ht) change over 6 hours) 65 million cubic feet or about 3000 cfs of water ranging in salinity 2000 to 6,000+ specific conductance (1.3 to 3.6 ppt) move in/out of Kings Bay. No data in the report identifies how this large volume of water is distributed in the bay. There is mention of 'tracers' on

page 50, but this modeled with no field data of tracers either chemical or physical to support or verify this modeling. There is mention of bottom roughness page 44. I**t would be interesting to see a visual from the model of the areas both top and bottom salinity at high tide and low tide, as this is really what is of interest. 9 year average is both difficult to comprehend and practically of questionable usefulness.**

Staff Response: During the flood tide, water moves into an estuary, and this "new" water is mainly located in the downstream portion of the estuary and pushes "old" water to the upstream portion of the estuary. During the ebb tide, this process reverses. The local physical shape of the estuary, wind actions, hydrologic loadings, the salinity and temperature distributions, as well as turbulent mixing affect the water movement and thus modify the distribution of the large volume of water you mentioned. The study of this kind of water volume distribution in Kings Bay is an interesting academic exercise but not necessary for our minimum flow evaluation.

The report is aimed at determining how much more water can be withdrawn from the aquifer causing reduction in spring discharge that limits harm to Kings Bay to 15% (starting point not quantified in most cases). Frequently the report attempts to justify the establishment of (percent only) MFL by commentary (summarized in Table 1-7) as protection and promotion. Some of these are more completely;

--In Section 1.7.3……..Our focus on salinity-based habitats will have wide-ranging protective effects on estuarine resources within the Crystal River/Kings Bay system.

--In Section 1.7.5…….By setting the minimum flows for the Crystal River/Kings Bay system at the *minimum* level necessary to prevent *significant* harm, we balance the need to conservatively protect the resources and ecology of the region with the need for fresh water supply.
The question here is what is the starting point; many long term residents recall times when the water was clear and algae blooms infrequent.

Staff Response: The starting point is baseline flow as estimated using the Northern District Model version 5. Minimum flows are not set with the goal to restore a system to any former state, but to set the limit at which further withdrawals would be significantly harmful (Section 373.042, Florida Statutes). Water clarity and algal blooms are affected by many factors and there have been many impacts to the system over the years. The District is currently involved in many cooperative, ongoing projects to improve water clarity and the ecology of the area.

--In 1.7.6……..Residents and users of Kings Bay and Crystal River are concerned with water clarity and preventing / reducing algal blooms (Evans et al. 2007; SWFWMD 2015). In addition, the tourism industry depends upon manatee thermal refuge during cold months. Both of these concerns are addressed in our analysis of salinity habitats and volume of warm water, which should have wide-ranging effects on maintaining natural aesthetic and

scenic attributes, as well as manatee habitat.

--In 1.7.7…….Managing salinity habitats through minimum flow implementation is expected to have far-reaching positive effects on beneficial aquatic vegetation and their associated filtration and absorption of nutrients and other pollutants.

Amazing how allowing destruction of 15% of something has so many beneficial effects. THIS IS NOT CANCER TREATMENT.

Martyn

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Monday, December 12, 2016 7:53 AM
To: Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: Salinity Kings Bay Crystal River

Doug and Ron,
In the MFL report mention is made of data from 13 Zones. Can you point me to where this data can be seen?

Staff Response: Please see Figure 2-8 and Table 2-5 within the draft minimum flows report for information on zone locations. Also, please note that we are providing you with the full Microsoft Access database which contains the water quality data used in the report. Unfortunately, the database file is too large to send by email, so we have posted it to the District FTP site for you to retrieve. The file, named *CRKB_Combined.accdb*, is storied in the "outgoing" folder on the FTP site.

Here's a link to the "outgoing" folder:
ftp://ftp.swfwmd.state.fl.us/pub/outgoing/

If the link above does not work, please follow the directions for accessing information from the "How to Access Our Anonymous FTP Server" page of the District web site at the link below.
https://www.swfwmd.state.fl.us/data/ftp/

Reference is made to Frazer Kings Bay Salinity Project 2001; where is this UF project reported? I can't find it in the SWFWMD library or on line.

Staff Response: This work is referenced in Table 2.4 within the draft minimum flows report and is cited in the literature cited section (Chapter 5) as follows.

Frazer, T. K., Mark V. Hoyer, S. K. Notestein, J. A. Hale, and D. E. Canfield Jr. 2001. Physical, chemical and vegetative characteristics of five Gulf coast rivers. Final Report. Southwest Florida

Water Management District, Brooksville, Florida.

This report and its associated appendices are available from the District library web site at the following URLs:
http://www15.swfwmd.state.fl.us/LibraryImages/04623.pdf
http://www15.swfwmd.state.fl.us/LibraryImages/04624.pdf

Thanks,
Martyn

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Friday, December 09, 2016 8:47 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>
Cc: Brad Rimbey <bwr.crrc@tampabay.rr.com>; ktripp@savethemanatee.org
Subject: Thermal Refuge for manatee Kings Bay

Doug, Ron, Dr. Chen and Melissa,
As you know I have very serious concerns about the credibility of the CrystalRK MFL Report. I am still hoping for an explanation of my concerns regarding spring discharge Group 2 springs going from 0 cfs to 250-270cfs in each tidal cycle (approx 6 hours) as presented in Figure 2-4. (Shared with Doug by e-mail Dec 6)

For now I would like to focus on Thermal refuge for manatee.

The Crystal River Kings Bay MFL Report states:
Page 53
Quote
The UnLESS3D model was able to predict volume and area of water in different temperature fractions throughout the bay. During the coldest 72 hours of the time period modeled, 85% of baseline flow is required to preserve 85% of the volume of water >20°C and deeper than 3.8 ft (Table-3-2, Figure 3-2). During time period with the smallest overall volume of thermal refuge from acute cold stress the volume of refuge was less sensitive to reductions in flow than at other times, however this is the most critical time period corresponding to the unusually cold winter of 2009 - 2010 (Table 3-3, Figure 3-3). At their smallest values, the total volume and area of water warm enough for manatee thermal refuge is sufficient to allow for several hundred thousand manatees.
End Quote
And Page 63
Quote
Although a reduction to 91% of baseline discharge will result in a 15% decrease in acute thermal refuge volume, there will still be enough warm water present for every manatee in the world ten times over (refer to Table 3-2). Thus, we do not find it appropriate to set minimum flows for the Crystal River/Kings Bay system based on manatee thermal refuge, as there appears to be more than enough to sustain the population given present rates of growth. This position is consistent with a report submitted to the U.S. Fish and Wildlife Service, which concluded that warm water is far more abundant than required to support Florida manatee populations, and that manatee protection should focus on forage as the factor limiting population size (Provancha et al. 2012).
End Quote

I**t is unclear where the input data for temperature in this model is obtained from. Could you confirm the source of temperature input data? Is it the temperatures as measured in the VHB reports for each spring, average from VHB or some other source.**

Staff Response: At the downstream boundaries, measured temperature data were used as model input. For spring flows, temperature is assumed to be nearly constant. The measured temperature in July – October 2009 by VHB was about 23.4°C for all spring vents. The model used this temperature for the entire 9-year scenario simulation period, with a small adjustment to allow spring flow during winter months to be slightly colder. At the free surface, heat flux was calculated using measured data for wind, solar radiation, air temperature, and air humidity.

So far I have not found any field studies/data which can be used to verify the output of the model. Does anyone know of any field studies of temperature during winter months.
Katie, Do you know of any field studies/data or even thermal imaging?

Staff Response: The model was calibrated and verified against measured temperature data collected by the U.S. Geologic Survey at Bagley Cove and the Mouth of Kings Bay with a time interval of 15-minutes.

Table 3-3 presents the volume and area of thermal refuge.
What baseline flow is used in modelling these volume and area figures.?

Staff Response: As noted in responses provided above, baseline flow varies with time and is not represented by a single value. It was calculated internally within the model based on the groundwater level in the ROMP TR21-3 well and the water level in Kings Bay.

Martyn
P.S. I have not yet been able to find Provancha 2012 in total, but some abstracts focus attention on available forage for Crystal River.

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Tuesday, December 06, 2016 12:28 PM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: Fw: Crystal River

Doug,
As I recall there was discussion yesterday by the panelist about how USGS filter the discharge data Bagley Cove. This e-mail from Kevin throws some light on the matter, but not the details of how.

Ken Watson in one of his postings recalled similar issues for Homosassa; he was right, it was mainly the Halls River discharge and the end result was the discharge from Halls River was not

included. Kevin told me the filter they used with Halls River (which frankly did not give meaningful results, hence not used) I think it was Godin tidal filter, but I can't find it to confirm.

Martyn

From: Kevin Grimsley <kjgrims@usgs.gov>
Sent: Monday, October 31, 2016 9:56 PM
To: Alan Martyn Johnson
Subject: Re: Crystal River

Martyn,

The King's Bay gage was destroyed (again) and we are looking for an alternate location that isn't so susceptible to damage. Filtered discharge for our gages isn't computed in real-time. We manually update it periodically so you'll see more data at Bagley cove soon.

****
Kevin Grimsley, P.E.
Hydrologic Data Chief, Tampa
USGS Caribbean-Florida Water Science Center
4446 Pet Lane, Suite 108
Lutz, FL 33559
kjgrims@usgs.gov
813-498-5064
****

On Oct 31, 2016, at 9:16 AM, Alan Martyn Johnson <martynellijay@hotmail.com> wrote:

Kevin,
Just started reading Crystal River MFL and decided to look at the latest data from the Gage Sites. I note 02310742 (mouth Kings Bay) stopped operating May 19 and 02310747 (Bagley Cove) stopped daily Tidally filtered discharge June 9.
Any reason you can share?
Thanks,
Martyn

Staff Response: Thanks for the emails and information regarding discharge measurement at the U.S. Geological Survey's Bagley Cove gage site.

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Tuesday, December 06, 2016 12:02 PM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: Peer Review Meeting Dec 5

Doug,
Sorry about the poor connection yesterday, I hung up hoping to get a better connection, when I tried reconnecting got only music after the pass code took. I did send a chat message, not sure if you got that, but I said I would send my input by e-mail. Comments are in the attached Word document.

I will leave it to you to share with SWFWMD persons or place it on the WebForum so the Peer Review Panelists can see where I was heading. At this stage I do not want to be seen as torpedoing the process you have in place so I will not post to the WebForum directly.

I know you work hard to keep the process moving forward, but unless these matters are fully resolved it may be better to explain to the management and/or Board there are some credibility issues with the model which need to be addressed.

Martyn

Staff Response: Thanks for the email and contributing to the peer review process. We did not notice your "chat" message delivered through the WebEx utility, and apologize for that. Your submitted comments will be reviewed by staff and incorporated into the project data set along with all other stakeholder input.

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Saturday, December 03, 2016 8:59 AM
To: jewilson@usgs.gov; Kevin J Grimsley <kjgrims@usgs.gov>
Cc: Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>
Subject: Fw: USGS FOIA 2017-00006 - Response

Janis,
Thank you to yourself and Kevin for making this information available.

I am sharing this with SWFWMD which I trust is in order with the FOIA protocol. Apparantly SWFWMD do not have this specific information although they sponsor the Gage Site and I think it an important factor for their consultant to have in formulating MFL for the Rainbow River.

Martyn Johnson

From: jewilson@usgs.gov <jewilson@usgs.gov> on behalf of Freedom of Information Act, GS-D-EI_ <foia@usgs.gov>
Sent: Friday, December 2, 2016 1:28 PM
To: Alan Martyn Johnson
Cc: GS-GIO Freedom of Information Act
Subject: USGS FOIA 2017-00006 - Response

Dear Mr. Johnson,

I am attaching our final response to USGS FOIA 2017-00006, along with three tables related to the equations you requested. Thank you for your patience while we processed your request. Please let me know if you have any questions.

Sincerely,

Janis Wilson
U.S. Geological Survey
Department of the Interior
Denver Federal Center
Box 25046
Mail Stop 406
Denver, CO 80225-0046
(303) 236-1476 (office)
(303) 236-1451 (fax)
foia@usgs.gov

Staff Response: Thanks for the email and associated attachments regarding discharge measurement at the U.S. Geological Survey's Rainbow River near Dunnellon gage site.

United States Department of the Interior

U. S. GEOLOGICAL SURVEY
BOX 25046 MS 406
Denver Federal Center
Denver, Colorado 80225

Transmitted via Electronic Mail: (martynellijay@hotmail.com)

December 2, 2016

U.S. Geological Survey FOIA #USGS-2017-00006

Dear Mr. Johnson,

This letter is the final response pursuant to your Freedom of Information Act (FOIA) request dated October 3, 2016, and received by the USGS FOIA office on October 10, 2016. The USGS assigned it control number **USGS 2017-00006**. Please cite this number in any future communications with the USGS regarding your request. The USGS acknowledged receipt of your request on October 11, 2016.

You requested the following information:

> **Discharge calculation equations for USGS Gage Sites 02313100 and 02313098 on the Rainbow River, FL.**

USGS Responsive Information

Station 02313098 – Two computation methods have been used at this station:

- The discharge data began on 10/1/2013 and used a direct relationship between discharge measurements at the gage and water level data from 290514082270701, Rainbow Springs Well. This rating does not use an equation, so the lookup table, "02313098.well_rating", is attached. This rating was stopped on 9/30/2015.
- An index-velocity rating was recently finalized and is being used for discharge from 10/1/2015 and forward. The stage-area rating for that method is attached. (See "02313098.area".) The velocity rating equation is:
    - Mean channel velocity = 0.4575 * index velocity + 0.198

Station 02313100 – The discharge at this station is calculated using a direct relationship between discharge measurements at the gage and water level data from 290514082270701, Rainbow Springs Well. This rating does not use an equation, so the lookup table, "02313100.well_rating", is attached. This rating has been in effect since 3/9/2010.

You were classified as an "Other" category requester; however, since we did not comply with any of the FOIA's statutory time limits, we cannot assess search fees associated with your request. See *43 C.F.R. § 2.37(f)(1)*. Therefore, there is no billable fee for the processing of this request.

The 2007 FOIA amendments created the Office of Government Information Services (OGIS) to offer mediation services to resolve disputes between FOIA requesters and Federal agencies as a non-exclusive alternative to litigation. Using OGIS services does not affect your right to pursue litigation. You may contact OGIS in any of the following ways:

Office of Government Information Services
National Archives and Records Administration
8601 Adelphi Road – OGIS
College Park, MD 20740-6001
Email: ogis@nara.gov
Web: https://ogis.archives.gov
Telephone: (202) 741-5770
Fax: (202) 741-5769
Toll-free: 1-877-684-6448

Please note that using OGIS services does not affect the timing of filing an appeal with the Department's FOIA/Privacy Act Appeals Officer.

You also may seek dispute resolution services from our FOIA Public Liaison, Mr. Brian May, by phone at (443) 498-5521; by fax at (443) 498-5510; by email at foia@usgs.gov; or, by mail at U.S. Geological Survey, FOIA Public Liaison, 5522 Research Park Drive, Baltimore, MD 21228.

If you have any questions concerning your request or our response, please contact me either by electronic mail jewilson@usgs.gov or by phone (303) 236-1476. Thank you for your interest in the USGS.

Sincerely,

Janis Wilson
U.S. Geological Survey
Government Information Specialist

Attachments:
1. Text Document, "02313098.well_rating", 6 KB
2. Text Document, "02313098.area", 4KB
3. Text Document, "02313100.well_rating", 6 KB

U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCE

STATION NUMBER 02313098 RAINBOW RIVER NEAR DUNNELLON, FL SOURCE AGENCY USGS
LATITUDE 29.07130556 LONGITUDE -82.42661111
Date Processed: 11/29/2016 10:43:40 EST By kjgrims
Rating for Area (ft^2)
RATING ID: 2.0 TYPE: Velocity-Discharge EXPANSION: STATUS: Approved

EXPANDED RATING TABLE

Stage (ft)	Area (ft^2)										DIFF IN Q PER
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	.1 UNITS
2.00	221.7	222.7	223.8	224.9	226.0	227.1	228.2	229.3	230.4	231.5	10.900
2.10	232.6	233.7	234.8	235.9	237.0	238.1	239.2	240.3	241.4	242.5	11.000
2.20	243.6	244.7	245.8	246.9	248.0	249.1	250.2	251.3	252.4	253.5	11.000
2.30	254.6	255.7	256.8	257.9	259.0	260.1	261.2	262.3	263.4	264.5	11.000
2.40	265.6	266.7	267.8	268.9	270.0	271.1	272.2	273.3	274.4	275.5	11.000
2.50	276.6	277.8	279.1	280.3	281.5	282.7	283.9	285.1	286.3	287.6	12.200
2.60	288.8	290.0	291.2	292.4	293.6	294.9	296.1	297.3	298.5	299.7	12.100
2.70	300.9	302.1	303.4	304.6	305.8	307.0	308.2	309.4	310.6	311.9	12.200
2.80	313.1	314.3	315.5	316.7	317.9	319.1	320.4	321.6	322.8	324.0	12.100
2.90	325.2	326.4	327.7	328.9	330.1	331.3	332.5	333.7	334.9	336.2	12.200
3.00	337.4	338.6	339.9	341.1	342.4	343.6	344.9	346.1	347.4	348.6	12.500
3.10	349.9	351.1	352.4	353.6	354.9	356.1	357.4	358.6	359.8	361.1	12.400
3.20	362.3	363.6	364.8	366.1	367.3	368.6	369.8	371.1	372.3	373.6	12.500
3.30	374.8	376.1	377.3	378.6	379.8	381.1	382.3	383.6	384.8	386.1	12.500
3.40	387.3	388.6	389.8	391.1	392.3	393.6	394.8	396.1	397.3	398.6	12.500

3.50	399.8	401.1	402.4	403.7	404.9	406.2	407.5	408.8	410.1	411.4	12.900
3.60	412.7	413.9	415.2	416.5	417.8	419.1	420.4	421.6	422.9	424.2	12.800
3.70	425.5	426.8	428.1	429.4	430.6	431.9	433.2	434.5	435.8	437.1	12.800
3.80	438.3	439.6	440.9	442.2	443.5	444.8	446.1	447.3	448.6	449.9	12.900
3.90	451.2	452.5	453.8	455.0	456.3	457.6	458.9	460.2	461.5	462.8	12.800
4.00	464.0	465.4	466.7	468.0	469.4	470.7	472.1	473.4	474.7	476.1	13.400
4.10	477.4	478.7	480.1	481.4	482.7	484.1	485.4	486.7	488.1	489.4	13.300
4.20	490.7	492.1	493.4	494.7	496.1	497.4	498.8	500.1	501.4	502.8	13.400
4.30	504.1	505.4	506.8	508.1	509.4	510.8	512.1	513.4	514.8	516.1	13.300
4.40	517.4	518.8	520.1	521.4	522.8	524.1	525.5	526.8	528.1	529.5	13.400
4.50	530.8	532.2	533.6	535.0	536.4	537.8	539.2	540.6	542.0	543.4	14.000
4.60	544.8	546.2	547.6	549.0	550.4	551.8	553.2	554.6	556.0	557.4	14.000
4.70	558.8	560.2	561.7	563.1	564.5	565.9	567.3	568.7	570.1	571.5	14.100
4.80	572.9	574.3	575.7	577.1	578.5	579.9	581.3	582.7	584.1	585.5	14.000
4.90	586.9	588.3	589.7	591.1	592.5	593.9	595.3	596.7	598.1	599.5	14.000
5.00	600.9	602.4	603.8	605.3	606.7	608.2	609.6	611.1	612.6	614.0	14.600
5.10	615.5	616.9	618.4	619.8	621.3	622.7	624.2	625.6	627.1	628.5	14.500
5.20	630.0	631.4	632.9	634.3	635.8	637.3	638.7	640.2	641.6	643.1	14.500
5.30	644.5	646.0	647.4	648.9	650.3	651.8	653.2	654.7	656.1	657.6	14.600
5.40	659.1	660.5	662.0	663.4	664.9	666.3	667.8	669.2	670.7	672.1	14.500
5.50	673.6	675.1	676.6	678.0	679.5	681.0	682.5	684.0	685.5	687.0	14.800
5.60	688.4	689.9	691.4	692.9	694.4	695.9	697.4	698.9	700.3	701.8	14.900
5.70	703.3	704.8	706.3	707.8	709.3	710.7	712.2	713.7	715.2	716.7	14.900
5.80	718.2	719.7	721.2	722.6	724.1	725.6	727.1	728.6	730.1	731.6	14.800
5.90	733.0	734.5	736.0	737.5	739.0	740.5	742.0	743.5	744.9	746.4	14.900

U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCE

STATION NUMBER 02313098 RAINBOW RIVER NEAR DUNNELLON, FL SOURCE AGENCY USGS
LATITUDE 29.07130556 LONGITUDE -82.42661111
Date Processed: 11/29/2016 10:43:40 EST By kjgrims
Rating for Area (ft^2)
RATING ID: 2.0 TYPE: Velocity-Discharge EXPANSION: STATUS: Approved

EXPANDED RATING TABLE

Stage (ft)	Area (ft^2)										DIFF IN Q PER
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	.1 UNITS
6.00	747.9	749.4	750.9	752.5	754.0	755.5	757.0	758.5	760.1	761.6	15.200
6.10	763.1	764.6	766.1	767.6	769.2	770.7	772.2	773.7	775.2	776.7	15.200
6.20	778.3	779.8	781.3	782.8	784.3	785.9	787.4	788.9	790.4	791.9	15.100
6.30	793.4	795.0	796.5	798.0	799.5	801.0	802.6	804.1	805.6	807.1	15.200
6.40	808.6	810.1	811.7	813.2	814.7	816.2	817.7	819.2	820.8	822.3	15.200
6.50	823.8	825.3	826.9	828.4	830.0	831.5	833.1	834.6	836.2	837.7	15.500
6.60	839.3	840.8	842.4	843.9	845.5	847.0	848.6	850.1	851.7	853.2	15.500
6.70	854.8	856.3	857.9	859.4	861.0	862.5	864.1	865.6	867.2	868.7	15.500
6.80	870.3	871.8	873.4	874.9	876.5	878.0	879.6	881.1	882.7	884.2	15.500
6.90	885.8	887.3	888.9	890.4	892.0	893.5	895.1	896.6	898.2	899.7	15.500
7.00	901.3	902.8	904.4	906.0	907.6	909.2	910.7	912.3	913.9	915.5	15.800
7.10	917.1	918.6	920.2	921.8	923.4	925.0	926.6	928.1	929.7	931.3	15.800
7.20	932.9	934.5	936.0	937.6	939.2	940.8	942.4	944.0	945.5	947.1	15.800
7.30	948.7	950.3	951.9	953.4	955.0	956.6	958.2	959.8	961.3	962.9	15.800
7.40	964.5										

ID	Starting Date
2.0	10/01/2015 00:00:00 EDT

U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCE

STATION NUMBER 02313098 RAINBOW RIVER NEAR DUNNELLON, FL SOURCE AGENCY USGS
LATITUDE 29.07130556 LONGITUDE -82.42661111
Date Processed: 11/29/2016 10:12:48 EST By kjgrims
Rating for Discharge (ft3/s)
RATING ID: 1.0 TYPE: Stage-Discharge EXPANSION: STATUS: Approved

EXPANDED RATING TABLE

Stage (ft)	Discharge (ft3/s)										DIFF IN Q PER
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	.1 UNITS
30.60	482.1	483.9	485.8	487.6	489.4	491.2	493.0	494.8	496.6	498.5	18.200
30.70	500.3	502.1	503.9	505.7	507.5	509.3	511.1	513.0	514.8	516.6	18.100
30.80	518.4	520.2	522.0	523.8	525.7	527.5	529.3	531.1	532.9	534.7	18.100
30.90	536.5	538.3	540.2	542.0	543.8	545.6	547.4	549.2	551.0	552.9	18.200
31.00	554.7	556.5	558.3	560.1	561.9	563.7	565.6	567.4	569.2	571.0	18.100
31.10	572.8	574.6	576.4	578.2	580.1	581.9	583.7	585.5	587.3	589.1	18.100
31.20	590.9	592.8	594.6	596.4	598.2	600.0	601.8	603.6	605.4	607.3	18.200
31.30	609.1	610.9	612.7	614.5	616.3	618.1	620.0	621.8	623.6	625.4	18.100
31.40	627.2	629.0	630.8	632.6	634.5	636.3	638.1	639.9	641.7	643.5	18.100
31.50	645.3	647.2	649.0	650.8	652.6	654.4	656.2	658.0	659.9	661.7	18.200
31.60	663.5	665.3	667.1	668.9	670.7	672.5	674.4	676.2	678.0	679.8	18.100
31.70	681.6	683.4	685.2	687.1	688.9	690.7	692.5	694.3	696.1	697.9	18.100
31.80	699.7	701.6	703.4	705.2	707.0	708.8	710.6	712.4	714.3	716.1	18.200
31.90	717.9	719.7	721.5	723.3	725.1	727.0	728.8	730.6	732.4	734.2	18.100

32.00	736.0	737.8	739.6	741.5	743.3	745.1	746.9	748.7	750.5	752.3	18.200
32.10	754.2	756.0	757.8	759.6	761.4	763.2	765.0	766.8	768.7	770.5	18.100
32.20	772.3	774.1	775.9	777.7	779.5	781.4	783.2	785.0	786.8	788.6	18.100
32.30	790.4	792.2	794.0	795.9	797.7	799.5	801.3	803.1	804.9	806.7	18.200
32.40	808.6	810.4	812.2	814.0	815.8	817.6	819.4	821.3	823.1	824.9	18.100
32.50	826.7	828.5	830.3	832.1	833.9	835.8	837.6	839.4	841.2	843.0	18.100
32.60	844.8	846.6	848.5	850.3	852.1	853.9	855.7	857.5	859.3	861.1	18.200
32.70	863.0	864.8	866.6	868.4	870.2	872.0	873.8	875.7	877.5	879.3	18.100
32.80	881.1	882.9	884.7	886.5	888.4	890.2	892.0	893.8	895.6	897.4	18.100
32.90	899.2	901.0	902.9	904.7	906.5	908.3	910.1	911.9	913.7	915.6	18.200
33.00	917.4	919.2	921.0	922.8	924.6	926.4	928.2	930.1	931.9	933.7	18.100
33.10	935.5	937.3	939.1	940.9	942.8	944.6	946.4	948.2	950.0	951.8	18.100
33.20	953.6	955.4	957.3	959.1	960.9	962.7	964.5	966.3	968.1	970.0	18.200
33.30	971.8	973.6	975.4	977.2	979.0	980.8	982.7	984.5	986.3	988.1	18.100
33.40	989.9	991.7	993.5	995.3	997.2	999.0	1001				

ID	Starting Date	Ending Date
1.0	10/01/2013 00:00:00 EDT	09/30/2015 23:59:59 EDT

W RIVER AT DUNNELLON, FL SOURCE AGENCY USGS
LATITUDE 29.04942056 LONGITUDE -82.44759948
Date Processed: 11/29/2016 10:27:50 EST By kjgrims
Rating for Discharge (ft3/s)
RATING ID: 4.0 TYPE: Stage-Discharge EXPANSION: STATUS: Approved

EXPANDED RATING TABLE

Stage (ft)	Discharge (ft3/s)										DIFF IN Q PER
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	.1 UNITS
29.40				381.3	382.5	383.8	385.1	386.3	387.6	388.8	12.571
29.50	390.1	391.3	392.6	393.8	395.1	396.4	397.6	398.9	400.1	401.4	12.500
29.60	402.6	403.9	405.1	406.4	407.6	408.9	410.2	411.4	412.7	413.9	12.600
29.70	415.2	416.4	417.7	418.9	420.2	421.5	422.7	424.0	425.2	426.5	12.500
29.80	427.7	429.0	430.2	431.5	432.8	434.0	435.3	436.5	437.8	439.0	12.600
29.90	440.3	441.5	442.8	444.0	445.3	446.6	447.9	449.2	450.5	451.8	12.800
30.00	453.1	454.4	455.7	457.0	458.3	459.6	460.8	462.1	463.4	464.7	12.900
30.10	466.0	467.3	468.6	469.9	471.2	472.5	473.8	475.1	476.4	477.7	13.000
30.20	479.0	480.3	481.6	482.9	484.2	485.5	486.8	488.1	489.4	490.7	13.000
30.30	492.0	493.3	494.6	495.9	497.2	498.5	499.8	501.1	502.4	503.7	13.000
30.40	505.0	506.3	507.6	508.9	510.2	511.5	512.8	514.1	515.4	516.7	13.000
30.50	518.0	519.3	520.6	521.9	523.2	524.5	525.8	527.1	528.4	529.7	13.000
30.60	531.0	532.3	533.6	534.9	536.2	537.5	538.8	540.1	541.4	542.7	13.000
30.70	544.0	545.3	546.6	547.9	549.2	550.5	551.8	553.1	554.4	555.7	13.000
30.80	557.0	558.3	559.6	560.9	562.2	563.5	564.8	566.1	567.4	568.7	13.000
30.90	570.0	571.3	572.6	573.9	575.2	576.5	577.8	579.1	580.4	581.7	13.000
31.00	583.0	584.3	585.6	586.9	588.2	589.5	590.7	592.0	593.3	594.6	12.900

31.10	595.9	597.2	598.5	599.8	601.1	602.4	603.7	605.0	606.3	607.6	13.000
31.20	608.9	610.2	611.5	612.8	614.1	615.4	616.7	618.0	619.3	620.6	13.000
31.30	621.9	623.2	624.5	625.8	627.1	628.4	629.7	631.0	632.3	633.6	13.000
31.40	634.9	636.2	637.5	638.8	640.1	641.4	642.7	644.0	645.3	646.6	13.000
31.50	647.9	649.2	650.5	651.8	653.1	654.4	655.7	657.0	658.3	659.6	13.000
31.60	660.9	662.2	663.5	664.8	666.1	667.4	668.7	670.0	671.3	672.6	13.000
31.70	673.9	675.2	676.5	677.8	679.1	680.4	681.7	683.0	684.3	685.6	13.000
31.80	686.9	688.2	689.5	690.8	692.1	693.4	694.7	696.0	697.3	698.6	13.000
31.90	699.9	701.2	702.5	703.8	705.1	706.4	707.7	709.0	710.3	711.6	13.000
32.00	712.9	714.2	715.5	716.8	718.1	719.4	720.7	721.9	723.2	724.5	12.900
32.10	725.8	727.1	728.4	729.7	731.0	732.3	733.6	734.9	736.2	737.5	13.000
32.20	738.8	740.1	741.4	742.7	744.0	745.3	746.6	747.9	749.2	750.5	13.000
32.30	751.8	753.1	754.4	755.7	757.0	758.3	759.6	760.9	762.2	763.5	13.000
32.40	764.8	766.1	767.4	768.7	770.0	771.3	772.6	773.9	775.2	776.5	13.000
32.50	777.8	779.1	780.4	781.7	783.0	784.3	785.6	786.9	788.2	789.5	13.000
32.60	790.8	792.1	793.4	794.7	796.0	797.3	798.6	799.9	801.2	802.5	13.000
32.70	803.8	805.1	806.4	807.7	809.0	810.3	811.6	812.9	814.2	815.5	13.000
32.80	816.8	818.1	819.4	820.7	822.0	823.3	824.6	825.9	827.2	828.5	13.000
32.90	829.8	831.1	832.4	833.7	835.0	836.3	837.6	838.9	840.2	841.5	13.000
33.00	842.8	844.1	845.4	846.7	848.0	849.3	850.6	851.9	853.1	854.4	12.900
33.10	855.7	857.0	858.3	859.6	860.9	862.2	863.5	864.8	866.1	867.4	13.000
33.20	868.7	870.0	871.3	872.6	873.9	875.2	876.5	877.8	879.1	880.4	13.000
33.30	881.7	883.0	884.3	885.6	886.9	888.2	889.5	890.8	892.1	893.4	13.000

U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCE

STATION NUMBER 02313100 RAINBOW RIVER AT DUNNELLON, FL SOURCE AGENCY USGS
LATITUDE 29.04942056 LONGITUDE -82.44759948
Date Processed: 11/29/2016 10:27:50 EST By kjgrims
Rating for Discharge (ft3/s)
RATING ID: 4.0 TYPE: Stage-Discharge EXPANSION: STATUS: Approved

EXPANDED RATING TABLE

Stage (ft)	Discharge (ft3/s)										DIFF IN Q PER
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	.1 UNITS
33.40	894.7	896.0	897.3	898.6	899.9	901.2	902.5	903.8	905.1	906.4	13.000
33.50	907.7	909.0	910.3	911.6	912.9	914.2	915.5	916.8	918.1	919.4	13.000
33.60	920.7	922.0	923.3	924.6	925.9	927.2	928.5	929.8	931.1	932.4	13.000
33.70	933.7	935.0	936.3	937.6	938.9	940.2	941.5	942.8	944.1	945.4	13.000
33.80	946.7	948.0	949.3	950.6	951.9	953.2	954.5	955.8	957.1	958.4	13.000
33.90	959.7	961.0	962.3	963.6	964.9	966.2	967.5	968.8	970.1	971.4	13.000
34.00	972.7	974.0	975.3	976.6	977.9	979.2	980.5	981.8	983.1	984.3	12.900
34.10	985.6	986.9	988.2	989.5	990.8	992.1	993.4	994.7	996.0	997.3	13.000
34.20	998.6	999.9	1001	1003	1004	1005	1006	1008	1009	1010	13.400
34.30	1012	1013	1014	1016	1017	1018	1019	1021	1022	1023	13.000
34.40	1025	1026	1027	1029	1030	1031	1032	1034	1035		

ID	Starting Date
4.0	03/09/2010 00:00:00 EST

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Wednesday, November 30, 2016 9:39 AM
To: Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>
Subject: Kings Bay Crystal River Draft Report

I will preface my questions and comments by again recognizing Measuring Spring Discharge into Kings Bay is no simple task.

I have continued to review the data and reports relevant to the Crystal River Kings Bay Draft MFL Report. Unfortunately the more I dig into this my concerns about the validity of what is presented increase.

I will again try to keep this set of questions and comments relatively brief:

- From Dr. Chen's paper Estimation of....2014
  " *A successful model calibration/verification against real-time data measured in Crystal River/Kings Bay during a 2.84-year period from 24 April 2007 to 23 February 2010 confirms that this empirical formula for estimating real-time spring flows out of the numerous vents in Kings Bay is reasonable.*"
  WHERE IS THIS REAL TIME DATA?

  Staff Response: These real-time data can be downloaded from the U.S. Geological Survey's National Water Information System: Web Interface at USGS website [hit control+click to use this link]. If this link does not work, you may try pointing your browser to the following URL: https://waterdata.usgs.gov/fl/nwis/current/?type=flow.

- A clear understanding of the data produced by VHB is essential to link the data with the hypothesized relationship of discharge to well level ROMP TR21-3 and tidal stage. I note VHB are using Mean Sea Level in connection with individual vent and Group measurements in 2009. I assume this was to give relevance to "

  "...*including multiple measurements at some of*

  the larger springs during different tide stages. When possible, measurements were conducted near low tide, especially at spring vents identified as having low flow."
  These levels differ from the USGS Gage measurements of stage and no gage ht is provided with the 2012 discharge data. I have added these (USGS figures) for my own reference and still can not find data to support the relationship of discharge to stage at the Mouth of Kings Bay.
  .

- Most concerning use of MSL is in the presentation of the 15 minute monitoring of discharge thru X Sections G1 and G2. Considering Group 1 for July 27 thru August 4 (which is the easier graph to read in VHB 2009) and Chen 2014 Figure 3 and in the Draft Report Figure 2-4 although no stage data is included... the springs flows are highest at low tide...IF THIS IS TRUE around low tide there should be a positive flow roughly equal to that high springs discharge.
  IS IT POSSIBLE VHB discharge data is off set by the positive discharge velocity being multiplied by a negative area of X-Section due to reference to MSL.
  THE RAW DATA NEEDS TO BE EXAMINED MORE CLOSELY. **I will be happy to look over the raw data for Group 1 July 27 thru August 8 if the XLS file can be shared.**

  Staff Response: We are pleased to provide you with the VHB data in an Excel file named *Group 1 GH Vel Disch and Hydrograph.xls*.

- If discharge for Group 2 springs does range from 0 to 250 cfs as shown in Figure 2-4 of the draft report. In addition to the absence of data to support this, I speculate this would be visually observable at some of these springs as the high discharge is at low tide.

- Relationship between well and stage. I have previously asked for examples of where this relationship is supported by real time data. The wording in Chen 2014 "*For example, a spring vent named H24 in the north portion of Kings Bay was measured on two different days. One was on 23 September 2009 and the other was on 7 October 2009. The first measurement of the discharge was 8.35 cfs, but the second flow measurement was 49.5 cfs, almost six times of the previous measurement*" does not substantiate this beyond question because H24 is measured in a tidal channel. Considering the stage data at the times these two measurements were made does indicate falling tide, resulting in emptying of the pool upstream of the measuring location is a factor which appears not to have been considered. Furthermore in the 2012 VHB monitoring of Spring 32 (a single vent spring) thru a tidal cycle on two different dates does not confirm a clear relationship of lower discharge at higher stage.

- Just for consideration. If SWFWMD are so confident in the discharge which Dr. Chen had published in the Journal of Marine Science Jan 2014 and now used as the basis for all 2016 Draft Report, why was the data in NDM 5 not updated in the most recent version Sept 2016. And equally interesting the graphs and comments in JMS paper appear to have been modified for purposes of the Draft Report. Possibly Dan Yobbi's memo November 2014 was sufficient to throw some light onto the validity negative flow into the spring vents. And the different analysis of the 2009 Group 1 and 2 data...surely the same method can be used for the two sets of data...not some hit and miss approach.

Again, I am willing to take a look at the Group 1 data for 2009 if you can share the raw data files with velocity and x-Section area. I think a total flux thru the x section approach may (as I did for Bagley Cove) may be a more logical approach, which can be used for G1 and G2 alike.

Staff Response: Please see our response to your public records request above.

Martyn

INPUT FROM MARTYN JOHNSON TO PEER REVIEW MEETING DEC 5 2016

It was unfortunate that the telephone connection yesterday was poor. When I tried calling back the system would not connect me. I did send a chat message saying I would send my comments by e-mail. It would have been so much better to discuss these.

Summary
The credibility of the Draft MFL Report for Kings Bay Crystal River is impacted by major aspects of the model calculation which are both intuitively and factually flawed. Discharge figures calculated and presented in Figure 2-4 are not supported by actual measurements by VHB or any other entity.

Let me start out by copying an e-mail.

E-Mail NO REPLY TO DATE
To; Melissa Gulvin, Doug Leeper Ron Basso, And ZinJain Chen on 11/30/2016
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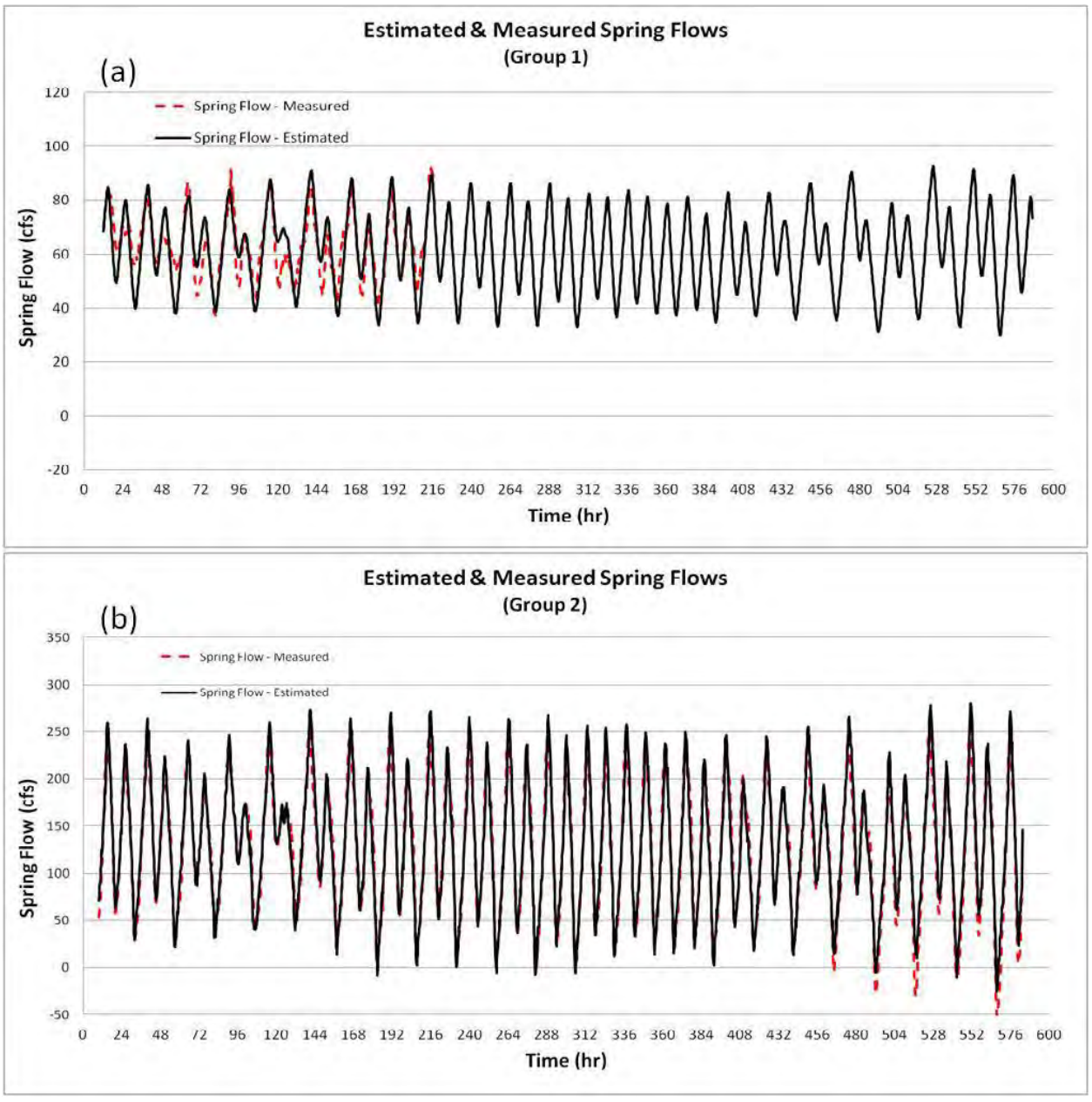
Martyn
E-Mail End



The point I was making regarding Figure 2-4 is that spring flow for the 8 springs in Group 2 shows changes from 0 to 250-270 cfs in the 6 hour tidal cycle on a number of days. (Note:On some days negative flows are shown; a point mentioned in the text of the original paper.) There is not a shred of evidence supporting this large change. Dr. Chen claimed there is no data on discharges from individual springs over a tidal cycle; however he fails to see the discharge measurements for the individual springs in the 2009 study period do have MSL data, which tends to show consistent discharge not major changes. While the 2012 discharge measurements do not show the corresponding stage data, the time of measurement can be cross-referenced to USGS Gage Mouth of Kings Bay for individual springs. Additionally, an effort was made in 2012 VHB work specifically collect discharge from three springs over a tidal cycle, shown in Table 2 of the Technical Memorandum. I have written in the corresponding

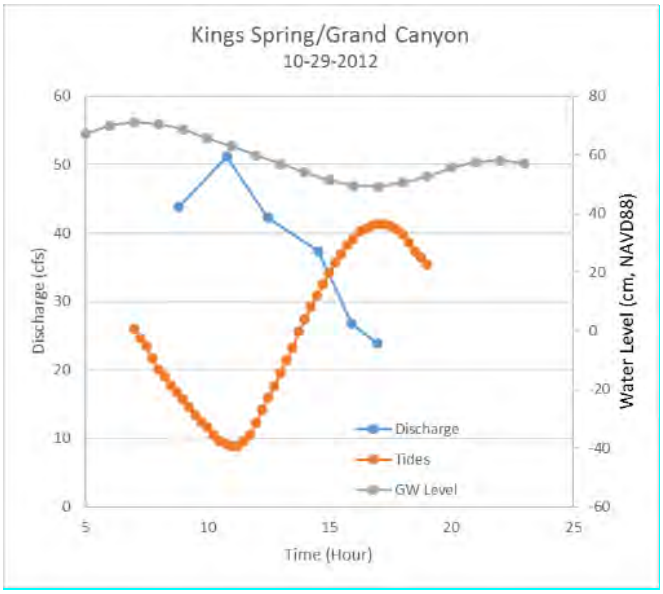
USGS Gage Height for the time of the measurement. Spring 32 does not support changes of the magnitude calculated and shown in Figure 2-4. Note: the model treats all springs close to G2 the same, so Spring 32 is modeled the same as G2, CORRECT?

Staff Response: Yes, Spring 32 is modeled in the same way as that for G2 springs, with the same C_1 and C_2 parameters. However, the ΔG (sometimes also called G_0) parameter is a linear function of the distance to the ROMP TR21-3 well.

In Fig. 2-4 within the draft minimum flows report, the total discharge from the Group 2 springs changed from 0 to 250 – 270 cfs only during spring tides. During neap tides, it changed with a smaller magnitude.

We are pleased that you brought up the 2012 VHB diurnal measurement, especially Spring 32, which was also called Kings Spring/Grand Canyon in the VHB report. In late 2011 and early 2012, a plan was made to measure hourly discharges in three spring vents over two 24-hour periods (the mouth of Crystal River has mixed semidiurnal tidal cycle with two high and two low tides of different sizes every lunar day) to examine effects of tides on spring flow in Kings Bay. Unfortunately, a budgetary restriction at the time limited the duration of the diurnal measurements to only about 8 - 10 hours with some consecutive measurements being separated by more than an hour. Although the 2012 VHB report identified these data as diurnal measurements, they are not truly diurnal data that we were hoping for, because these data didn't give us the entire picture of discharge variation during a tidal cycle, which should be larger than what the 2012 data show. Yet, measured vent flow data at Spring 32 during the two 2010 field trips still gave us some indication of the magnitude of tidal effects on discharge from this spring vent. For example, on October 29, 2012, measured spring flow at Spring 32 changed from 51.19 cfs at 10:48 AM to 23.85 cfs at 16:59 PM, or a decline of 27.34 cfs over 6 hours 11 minutes (see figure below and Table 2 of the 2012 VHB report.) As the trend was still downwards at 16:59 PM, it is expected that the minimum value of spring discharge could be lower than 23.85 cfs on that day.

Although the figure shown below does not give us a whole picture of the spring flow variation during the tidal cycle on October 29, 2012 at Spring 32, it does show that the variability of spring flow during a tidal cycle can be significant, as the flow decline during the 6 hours 11 minutes was about 73% of the mean discharge measured on the day, which was 37.54 cfs. As such, the so-called "diurnal" measurements at Spring 32 in 2012 indeed suggested that the kind of change of magnitude shown in Figure 2-4 is possible. At the minimum, these data did not provide any evidence showing that the kind of change of magnitude presented in Fig 2-4 is not possible.



I also include tides at the mouth of Kings Bay and groundwater level in the ROMP TR21-3 well on 10-29-2012 in the figure above for you to see correlations among these three variables.

While the 0 to 250 cfs for Group 2 emphasize the point, the changes for Group 1 Figure 2-4 of 35 to 90 cfs are similarly not supported by measurements made by VHB or any other entity.

Table 2. Diurnal vent measurement summaries for October 29, 2012 and November 6, 2012.

Site	Site Name	Date	Time	Discharge (cfs)	
SV32121029	King Spring/Grand Canyon Spring "Manatee sign"	10/29/12	850 EST	43.86	-0.31
SV32121029b	King Spring/Grand Canyon Spring "Manatee sign"	10/29/12	1048 EST	51.19	-1.02
SV32121029d	King Spring/Grand Canyon Spring "Manatee sign"	10/29/12	1229 EST	42.26	-1.23
SV32121029f	King Spring/Grand Canyon Spring "Manatee sign"	10/29/12	1433 EST	37.35	-0.19
SV32121029i	King Spring/Grand Canyon Spring "Manatee sign"	10/29/12	1555 EST	26.75	0.65
SV32121029k	King Spring/Grand Canyon Spring "Manatee sign"	10/29/12	1659 EST	23.85	1.03
SV3220121106	King Spring/Grand Canyon Spring "Manatee sign"	11/06/12	0808 EST	29.41	1.93
SV3220121106b	King Spring/Grand Canyon Spring "Manatee sign"	11/06/12	0922 EST	32.68	1.55
SV3220121106d	King Spring/Grand Canyon Spring "Manatee sign"	11/06/12	1036 EST	32.35	1.05
SV3220121106f	King Spring/Grand Canyon Spring "Manatee sign"	11/06/12	1148 EST	39.63	0.50
SV3220121106j	King Spring/Grand Canyon Spring "Manatee sign"	11/06/12	1406 EST	43.83	-0.31
SV3220121106l	King Spring/Grand Canyon Spring "Manatee sign"	11/06/12	1542 EST	39.47	-0.06
SV3220121106o	King Spring/Grand Canyon Spring "Manatee sign"	11/06/12	1703 EST	37.46	0.53
SV35121029	Golfview	10/29/12	0659 EST	2.67	0.44
SV35121029a	Golfview	10/29/12	0942 EST	3.53	-0.69
SV35121029c	Golfview	10/29/12	1114 EST	5.53	-1.16
SV35121029d	Golfview	10/29/12	1336 EST	2.42	-0.75
SV35121029e	Golfview	10/29/12	1457 EST	1.68	0.13
SV35121029f	Golfview	10/29/12	1615 EST	2.26	0.76
SV3520121106	Golfview	11/06/12	0716 EST	1.82	1.93
SV3520121106a	Golfview	11/06/12	0830 EST	2.98	1.82
SV3520121106b	Golfview	11/06/12	0945 EST	3.10	1.35
SV3520121106c	Golfview	11/06/12	1058 EST	1.74	0.83
SV3520121106d	Golfview	11/06/12	1213 EST	2.44	0.32
SV3520121106e	Golfview	11/06/12	1457 EST	2.44	-0.44
SV3520121106f	Golfview	11/06/12	1604 EST	5.10	0.05
SV3520121106g	Golfview	11/06/12	1615 EST	3.66	0.20
SV39121029	Sid's Spring	10/29/12	0735 EST	1.87	.24
SV39121029a	Sid's Spring	10/29/12	0746 EST	5.39	.13
SV39121029b	Sid's Spring	10/29/12	1018 EST	2.45	-0.85
SV39121029c	Sid's Spring	10/29/12	1020 EST	4.97	-0.85
SV39121029d	Sid's Spring	10/29/12	1159 EST	2.01	-1.29
SV39121029e	Sid's Spring	10/29/12	1201 EST	4.33	-1.29
SV39121029f	Sid's Spring	10/29/12	1402 EST	2.22	-0.47
SV39121029g	Sid's Spring	10/29/12	1405 EST	1.78	-0.47
SV39121029h	Sid's Spring	10/29/12	1525 EST	2.16	-0.39
SV39121029i	Sid's Spring	10/29/12	1527 EST	2.61	-0.39
SV39121029j	Sid's Spring	10/29/12	1638 EST	1.62	0.86
SV39121029k	Sid's Spring	10/29/12	1640 EST	1.93	0.96
SV3920121106	Sid's Spring	11/06/12	0739 EST	1.97	1.96
SV3920121106a	Sid's Spring	11/06/12	0741 EST	2.22	1.96
SV3920121106b	Sid's Spring	11/06/12	0857 EST	2.37	1.68
SV3920121106c	Sid's Spring	11/06/12	0859 EST	2.12	1.68
SV3920121106d	Sid's Spring	11/06/12	1010 EST	2.04	1.14
SV3920121106e	Sid's Spring	11/06/12	1012 EST	3.52	1.14
SV3920121106f	Sid's Spring	11/06/12	1124 EST	2.92	0.63
SV3920121106g	Sid's Spring	11/06/12	1126 EST	2.03	0.63
SV3920121106h	Sid's Spring	11/06/12	1339 EST	2.95	-0.30
SV3920121106i	Sid's Spring	11/06/12	1341 EST	2.09	-0.30

As telephone connection was lost yesterday I was about to move on to point out the Group 1 and Group 2 discharge measurements use MSL which is different to the USGS NAVD88 by about 0.25 to 0.3 feet as best I can read the graphs. Is it possible this makes a difference to the area

which is used to calculate discharge ('look up table' I think is the term for area at different gage heights).

Additionally:

- is the timing of high tide and low tide different, at the springs vents, than at the USGS 02310742 Mouth of Kings Bay (Bagley Cove USGS 02310747 to Mouth of KingsBay USGS 02310742 is about 15 minutes difference between high tide time, and between USGS 02310742 and the spring vents there is a large pool that fills and empties). I speculate there is a difference in time and the tidal stage change may also be different at the spring vents (dampened by the Large Kings Bay 'pool'..

The VHB individual springs measurements, if anything, show essentially consistent discharge thru the tidal cycle, particularly when accuracy is considered. The closest I can find showing a slight correlation of discharge and stage, is SV 20 in the VHB 2009 report pages 17 and 18:
For 7/28/2009
First 3 measurements are averaged, note variation 40 to 30 cfs in 4 minutes. Then the next 3 measurements, which appear to be 3 smaller vents, are added giving
46.72 cfs MSL -0.2 to –0.3

For 7/30/2009
First 3 measurements are averaged, note tighter grouping. Then the next 3 measurements areadded giving
37.38 cfs MSL higher 1.1

For 8/17/2009
4 measurements added giving (assume multiple measurements at the main vent were not taken or discounted for some reason
45.00 cfs MSL 1.37

For 8/19/2009
First 3 measurements averaged, note variation 53.7 to 32.2 cfs 1 minute apart. Then the next 3 measurements added giving
51.91 cfs MSL -0.97

This does have some indication of a relationship between MSL and discharge, hinging mainly on one measurement of 53.7 cfs, supported to some extent by the discharge from the last vent in each set, BUT THE VARIATION IS 45 cfs to 51 cfs OR ABOUT 13%. Bear in mind the variation in discharge measurements a few minutes apart as an indication of accuracy. Look at SV 20 measurements October 23 and November 12 VHB 2012, either the vent almost dried up or the SOP's failed to monitor the correct vent/vents or report correctly.

Agreed the data is limited, but there is not a shred of evidence supporting the discharge

variations show in Figure2-4.

These points, particularly the magnitude of spring flow change in a tidal cycle (high to low or vice versa) as emphasized by the 0 cfs to 270 cfs with no supporting evidence destroys the credibility of the discharge calculations. The discharge calculations are the basis for the model which supports the entire report.

Lastly on this point, it is inconceivable that the methodology of analyzing the movement of water through the x-section for Group1 and Group 2 are different. Whether it is 3 springs and 613111 sq. ft. of pool or 8 springs and 1,785544 sq. ft. of pool this should not make a difference to the methodology as all the springs in the Group must be considered to respond equally. There is certainly nowhere near enough data to say how differently each spring discharge changes thru a tidal cycle. However, I do agree with Dr. Chen's explanation at the meeting I attended in person, that small spring discharge will have different characteristics than large spring discharges. I would consider this dynamic resistance to flow, but I doubt this is very significant.

Adding to the discussion of Bagley Cove USGS discharge data
USGS Discharge data is the best ongoing data set, however it suffers from:

- The magnitude differences of tidal inflow/outflow relative to the springs discharge flow
- The turbulence at the gage site particularly at the time the direction of flow changes.
- The tidal cycle is 24.84 hours and most daily data is presented on a 24 hour basis, and does not account for the volume lost or gained upstream in Kings Bay due to stage change in the 24 hour.

The second bullet point can be seen best by viewing recent days when the field measurements are taken as the time intervals for discharge calculation are set to one minute intervals not 15 minutes. Whether different instrumentation or multiple velocity meters can overcome the turbulence issue I doubt in the short term. Just after USGS implemented the new rating curve in I did look at total flux over three time periods of about a 10 days but starting and finishing with gage heights almost the same at the point of a directional change. This gave positive discharge on all sets run, but totals were not closely grouped. I am sure given the computing skills of others this could be achieved more quickly than my slow manual assessment. I also saw the turbulence by tossing a handful of red/white painted corks in at the gage site on two occasions at direction change time…sorry about the pollution, but worse have been thrown in. The turbulence was amazing to watch. The discharge methods used by Hammett (think it was 1996) when they had five boats with velocity meters anchored across the river (think it was slightly different point in river to current gage site). This measurement was possibly the best thought out approach; unfortunately it has not been repeated. USGS Field Measurements are helpful in identifying the accuracy of calculated discharge highlighting the major issue of accuracy at time of flow direction change.

For consideration when thinking about the 24.84 hour tidal cycle, assume Kings Bay is 600 acres (no doubt the shoreline mapping can get more accurate) but for a 0.1 ft difference in gage height beginning to end of the 24.84 hours (high tide to high tide) represents an average of 30 cfs flow; 1.0 feet which often occurs is 300 cfs average. To repeat my earlier comment I doubt the entire Kings Bay pool has the same tidal change as Bagley Cove…would be interesting to see any available data.

I trust my comments are helpful. Now is a better time to consider them as opposed to when the report is final.

U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCE

STATION NUMBER 02313098 RAINBOW RIVER NEAR DUNNELLON, FL SOURCE AGENCY USGS

LATITUDE 29.07130556 LONGITUDE -82.42661111

Date Processed: 11/29/2016 10:43:40 EST By kjgrims

Rating for Area (ft^2)

RATING ID: 2.0 TYPE: Velocity-Discharge EXPANSION: STATUS: Approved

EXPANDED RATING TABLE

Stage (ft)	Area (ft^2)										DIFF IN Q PER
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	.1 UNITS
2.00	221.7	222.7	223.8	224.9	226.0	227.1	228.2	229.3	230.4	231.5	10.900
2.10	232.6	233.7	234.8	235.9	237.0	238.1	239.2	240.3	241.4	242.5	11.000
2.20	243.6	244.7	245.8	246.9	248.0	249.1	250.2	251.3	252.4	253.5	11.000
2.30	254.6	255.7	256.8	257.9	259.0	260.1	261.2	262.3	263.4	264.5	11.000
2.40	265.6	266.7	267.8	268.9	270.0	271.1	272.2	273.3	274.4	275.5	11.000
2.50	276.6	277.8	279.1	280.3	281.5	282.7	283.9	285.1	286.3	287.6	12.200
2.60	288.8	290.0	291.2	292.4	293.6	294.9	296.1	297.3	298.5	299.7	12.100
2.70	300.9	302.1	303.4	304.6	305.8	307.0	308.2	309.4	310.6	311.9	12.200
2.80	313.1	314.3	315.5	316.7	317.9	319.1	320.4	321.6	322.8	324.0	12.100
2.90	325.2	326.4	327.7	328.9	330.1	331.3	332.5	333.7	334.9	336.2	12.200
3.00	337.4	338.6	339.9	341.1	342.4	343.6	344.9	346.1	347.4	348.6	12.500
3.10	349.9	351.1	352.4	353.6	354.9	356.1	357.4	358.6	359.8	361.1	12.400
3.20	362.3	363.6	364.8	366.1	367.3	368.6	369.8	371.1	372.3	373.6	12.500
3.30	374.8	376.1	377.3	378.6	379.8	381.1	382.3	383.6	384.8	386.1	12.500
3.40	387.3	388.6	389.8	391.1	392.3	393.6	394.8	396.1	397.3	398.6	12.500
3.50	399.8	401.1	402.4	403.7	404.9	406.2	407.5	408.8	410.1	411.4	

12.900
3.60 412.7 413.9 415.2 416.5 417.8 419.1 420.4 421.6 422.9 424.2
12.800
3.70 425.5 426.8 428.1 429.4 430.6 431.9 433.2 434.5 435.8 437.1
12.800
3.80 438.3 439.6 440.9 442.2 443.5 444.8 446.1 447.3 448.6 449.9
12.900
3.90 451.2 452.5 453.8 455.0 456.3 457.6 458.9 460.2 461.5 462.8
12.800

4.00 464.0 465.4 466.7 468.0 469.4 470.7 472.1 473.4 474.7 476.1
13.400
4.10 477.4 478.7 480.1 481.4 482.7 484.1 485.4 486.7 488.1 489.4
13.300
4.20 490.7 492.1 493.4 494.7 496.1 497.4 498.8 500.1 501.4 502.8
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4.30 504.1 505.4 506.8 508.1 509.4 510.8 512.1 513.4 514.8 516.1
13.300
4.40 517.4 518.8 520.1 521.4 522.8 524.1 525.5 526.8 528.1 529.5
13.400

4.50 530.8 532.2 533.6 535.0 536.4 537.8 539.2 540.6 542.0 543.4
14.000
4.60 544.8 546.2 547.6 549.0 550.4 551.8 553.2 554.6 556.0 557.4
14.000
4.70 558.8 560.2 561.7 563.1 564.5 565.9 567.3 568.7 570.1 571.5
14.100
4.80 572.9 574.3 575.7 577.1 578.5 579.9 581.3 582.7 584.1 585.5
14.000
4.90 586.9 588.3 589.7 591.1 592.5 593.9 595.3 596.7 598.1 599.5
14.000

5.00 600.9 602.4 603.8 605.3 606.7 608.2 609.6 611.1 612.6 614.0
14.600
5.10 615.5 616.9 618.4 619.8 621.3 622.7 624.2 625.6 627.1 628.5
14.500
5.20 630.0 631.4 632.9 634.3 635.8 637.3 638.7 640.2 641.6 643.1
14.500
5.30 644.5 646.0 647.4 648.9 650.3 651.8 653.2 654.7 656.1 657.6
14.600
5.40 659.1 660.5 662.0 663.4 664.9 666.3 667.8 669.2 670.7 672.1
14.500

5.50 673.6 675.1 676.6 678.0 679.5 681.0 682.5 684.0 685.5 687.0
14.800
5.60 688.4 689.9 691.4 692.9 694.4 695.9 697.4 698.9 700.3 701.8
14.900
5.70 703.3 704.8 706.3 707.8 709.3 710.7 712.2 713.7 715.2 716.7
14.900
5.80 718.2 719.7 721.2 722.6 724.1 725.6 727.1 728.6 730.1 731.6
14.800
5.90 733.0 734.5 736.0 737.5 739.0 740.5 742.0 743.5 744.9 746.4
14.900

U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCE

STATION NUMBER 02313098 RAINBOW RIVER NEAR DUNNELLON, FL SOURCE AGENCY USGS

LATITUDE 29.07130556 LONGITUDE -82.42661111

Date Processed: 11/29/2016 10:43:40 EST By kjgrims

Rating for Area (ft^2)

RATING ID: 2.0 TYPE: Velocity-Discharge EXPANSION: STATUS: Approved

EXPANDED RATING TABLE

Stage (ft)	Area (ft^2)						DIFF IN Q PER				
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	.1
UNITS											
6.00	747.9	749.4	750.9	752.5	754.0	755.5	757.0	758.5	760.1	761.6	
15.200											
6.10	763.1	764.6	766.1	767.6	769.2	770.7	772.2	773.7	775.2	776.7	
15.200											
6.20	778.3	779.8	781.3	782.8	784.3	785.9	787.4	788.9	790.4	791.9	
15.100											
6.30	793.4	795.0	796.5	798.0	799.5	801.0	802.6	804.1	805.6	807.1	
15.200											
6.40	808.6	810.1	811.7	813.2	814.7	816.2	817.7	819.2	820.8	822.3	
15.200											
6.50	823.8	825.3	826.9	828.4	830.0	831.5	833.1	834.6	836.2	837.7	
15.500											
6.60	839.3	840.8	842.4	843.9	845.5	847.0	848.6	850.1	851.7	853.2	
15.500											
6.70	854.8	856.3	857.9	859.4	861.0	862.5	864.1	865.6	867.2	868.7	
15.500											
6.80	870.3	871.8	873.4	874.9	876.5	878.0	879.6	881.1	882.7	884.2	
15.500											
6.90	885.8	887.3	888.9	890.4	892.0	893.5	895.1	896.6	898.2	899.7	
15.500											
7.00	901.3	902.8	904.4	906.0	907.6	909.2	910.7	912.3	913.9	915.5	
15.800											
7.10	917.1	918.6	920.2	921.8	923.4	925.0	926.6	928.1	929.7	931.3	
15.800											
7.20	932.9	934.5	936.0	937.6	939.2	940.8	942.4	944.0	945.5	947.1	
15.800											
7.30	948.7	950.3	951.9	953.4	955.0	956.6	958.2	959.8	961.3	962.9	
15.800											
7.40	964.5										

ID Starting Date

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2.0 10/01/2015 00:00:00 EDT

U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCE

STATION NUMBER 02313098 RAINBOW RIVER NEAR DUNNELLON, FL SOURCE AGENCY USGS

LATITUDE 29.07130556 LONGITUDE -82.42661111

Date Processed: 11/29/2016 10:12:48 EST By kjgrims

Rating for Discharge (ft3/s)

RATING ID: 1.0 TYPE: Stage-Discharge EXPANSION: STATUS: Approved

EXPANDED RATING TABLE

Stage (ft)	Discharge (ft3/s)									DIFF IN Q PER
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	.1 UNITS
30.60	482.1	483.9	485.8	487.6	489.4	491.2	493.0	494.8	496.6	498.5	18.200
30.70	500.3	502.1	503.9	505.7	507.5	509.3	511.1	513.0	514.8	516.6	18.100
30.80	518.4	520.2	522.0	523.8	525.7	527.5	529.3	531.1	532.9	534.7	18.100
30.90	536.5	538.3	540.2	542.0	543.8	545.6	547.4	549.2	551.0	552.9	18.200
31.00	554.7	556.5	558.3	560.1	561.9	563.7	565.6	567.4	569.2	571.0	18.100
31.10	572.8	574.6	576.4	578.2	580.1	581.9	583.7	585.5	587.3	589.1	18.100
31.20	590.9	592.8	594.6	596.4	598.2	600.0	601.8	603.6	605.4	607.3	18.200
31.30	609.1	610.9	612.7	614.5	616.3	618.1	620.0	621.8	623.6	625.4	18.100
31.40	627.2	629.0	630.8	632.6	634.5	636.3	638.1	639.9	641.7	643.5	18.100
31.50	645.3	647.2	649.0	650.8	652.6	654.4	656.2	658.0	659.9	661.7	18.200
31.60	663.5	665.3	667.1	668.9	670.7	672.5	674.4	676.2	678.0	679.8	18.100
31.70	681.6	683.4	685.2	687.1	688.9	690.7	692.5	694.3	696.1	697.9	18.100
31.80	699.7	701.6	703.4	705.2	707.0	708.8	710.6	712.4	714.3	716.1	18.200
31.90	717.9	719.7	721.5	723.3	725.1	727.0	728.8	730.6	732.4	734.2	18.100
32.00	736.0	737.8	739.6	741.5	743.3	745.1	746.9	748.7	750.5	752.3	18.200
32.10	754.2	756.0	757.8	759.6	761.4	763.2	765.0	766.8	768.7	770.5	

18.100										
32.20	772.3	774.1	775.9	777.7	779.5	781.4	783.2	785.0	786.8	788.6
18.100										
32.30	790.4	792.2	794.0	795.9	797.7	799.5	801.3	803.1	804.9	806.7
18.200										
32.40	808.6	810.4	812.2	814.0	815.8	817.6	819.4	821.3	823.1	824.9
18.100										
32.50	826.7	828.5	830.3	832.1	833.9	835.8	837.6	839.4	841.2	843.0
18.100										
32.60	844.8	846.6	848.5	850.3	852.1	853.9	855.7	857.5	859.3	861.1
18.200										
32.70	863.0	864.8	866.6	868.4	870.2	872.0	873.8	875.7	877.5	879.3
18.100										
32.80	881.1	882.9	884.7	886.5	888.4	890.2	892.0	893.8	895.6	897.4
18.100										
32.90	899.2	901.0	902.9	904.7	906.5	908.3	910.1	911.9	913.7	915.6
18.200										
33.00	917.4	919.2	921.0	922.8	924.6	926.4	928.2	930.1	931.9	933.7
18.100										
33.10	935.5	937.3	939.1	940.9	942.8	944.6	946.4	948.2	950.0	951.8
18.100										
33.20	953.6	955.4	957.3	959.1	960.9	962.7	964.5	966.3	968.1	970.0
18.200										
33.30	971.8	973.6	975.4	977.2	979.0	980.8	982.7	984.5	986.3	988.1
18.100										
33.40	989.9	991.7	993.5	995.3	997.2	999.0	1001			

ID	Starting Date	Ending Date
1.0	10/01/2013 00:00:00 EDT	09/30/2015 23:59:59 EDT

U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCE

STATION NUMBER 02313100 RAINBOW RIVER AT DUNNELLON, FL SOURCE AGENCY USGS

LATITUDE 29.04942056 LONGITUDE -82.44759948

Date Processed: 11/29/2016 10:27:50 EST By kjgrims

Rating for Discharge (ft3/s)

RATING ID: 4.0 TYPE: Stage-Discharge EXPANSION: STATUS: Approved

EXPANDED RATING TABLE

Stage (ft)	Discharge (ft3/s)									DIFF IN Q PER
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	.1 UNITS
29.40			381.3	382.5	383.8	385.1	386.3	387.6	388.8	12.571	
29.50	390.1	391.3	392.6	393.8	395.1	396.4	397.6	398.9	400.1	401.4	12.500
29.60	402.6	403.9	405.1	406.4	407.6	408.9	410.2	411.4	412.7	413.9	12.600
29.70	415.2	416.4	417.7	418.9	420.2	421.5	422.7	424.0	425.2	426.5	12.500
29.80	427.7	429.0	430.2	431.5	432.8	434.0	435.3	436.5	437.8	439.0	12.600
29.90	440.3	441.5	442.8	444.0	445.3	446.6	447.9	449.2	450.5	451.8	12.800
30.00	453.1	454.4	455.7	457.0	458.3	459.6	460.8	462.1	463.4	464.7	12.900
30.10	466.0	467.3	468.6	469.9	471.2	472.5	473.8	475.1	476.4	477.7	13.000
30.20	479.0	480.3	481.6	482.9	484.2	485.5	486.8	488.1	489.4	490.7	13.000
30.30	492.0	493.3	494.6	495.9	497.2	498.5	499.8	501.1	502.4	503.7	13.000
30.40	505.0	506.3	507.6	508.9	510.2	511.5	512.8	514.1	515.4	516.7	13.000
30.50	518.0	519.3	520.6	521.9	523.2	524.5	525.8	527.1	528.4	529.7	13.000
30.60	531.0	532.3	533.6	534.9	536.2	537.5	538.8	540.1	541.4	542.7	13.000
30.70	544.0	545.3	546.6	547.9	549.2	550.5	551.8	553.1	554.4	555.7	13.000
30.80	557.0	558.3	559.6	560.9	562.2	563.5	564.8	566.1	567.4	568.7	13.000
30.90	570.0	571.3	572.6	573.9	575.2	576.5	577.8	579.1	580.4	581.7	13.000

31.00	583.0	584.3	585.6	586.9	588.2	589.5	590.7	592.0	593.3	594.6
12.900										
31.10	595.9	597.2	598.5	599.8	601.1	602.4	603.7	605.0	606.3	607.6
13.000										
31.20	608.9	610.2	611.5	612.8	614.1	615.4	616.7	618.0	619.3	620.6
13.000										
31.30	621.9	623.2	624.5	625.8	627.1	628.4	629.7	631.0	632.3	633.6
13.000										
31.40	634.9	636.2	637.5	638.8	640.1	641.4	642.7	644.0	645.3	646.6
13.000										
31.50	647.9	649.2	650.5	651.8	653.1	654.4	655.7	657.0	658.3	659.6
13.000										
31.60	660.9	662.2	663.5	664.8	666.1	667.4	668.7	670.0	671.3	672.6
13.000										
31.70	673.9	675.2	676.5	677.8	679.1	680.4	681.7	683.0	684.3	685.6
13.000										
31.80	686.9	688.2	689.5	690.8	692.1	693.4	694.7	696.0	697.3	698.6
13.000										
31.90	699.9	701.2	702.5	703.8	705.1	706.4	707.7	709.0	710.3	711.6
13.000										
32.00	712.9	714.2	715.5	716.8	718.1	719.4	720.7	721.9	723.2	724.5
12.900										
32.10	725.8	727.1	728.4	729.7	731.0	732.3	733.6	734.9	736.2	737.5
13.000										
32.20	738.8	740.1	741.4	742.7	744.0	745.3	746.6	747.9	749.2	750.5
13.000										
32.30	751.8	753.1	754.4	755.7	757.0	758.3	759.6	760.9	762.2	763.5
13.000										
32.40	764.8	766.1	767.4	768.7	770.0	771.3	772.6	773.9	775.2	776.5
13.000										
32.50	777.8	779.1	780.4	781.7	783.0	784.3	785.6	786.9	788.2	789.5
13.000										
32.60	790.8	792.1	793.4	794.7	796.0	797.3	798.6	799.9	801.2	802.5
13.000										
32.70	803.8	805.1	806.4	807.7	809.0	810.3	811.6	812.9	814.2	815.5
13.000										
32.80	816.8	818.1	819.4	820.7	822.0	823.3	824.6	825.9	827.2	828.5
13.000										
32.90	829.8	831.1	832.4	833.7	835.0	836.3	837.6	838.9	840.2	841.5
13.000										
33.00	842.8	844.1	845.4	846.7	848.0	849.3	850.6	851.9	853.1	854.4
12.900										
33.10	855.7	857.0	858.3	859.6	860.9	862.2	863.5	864.8	866.1	867.4
13.000										
33.20	868.7	870.0	871.3	872.6	873.9	875.2	876.5	877.8	879.1	880.4
13.000										
33.30	881.7	883.0	884.3	885.6	886.9	888.2	889.5	890.8	892.1	893.4
13.000										

U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCE

STATION NUMBER 02313100 RAINBOW RIVER AT DUNNELLON, FL SOURCE AGENCY USGS

LATITUDE 29.04942056 LONGITUDE -82.44759948

Date Processed: 11/29/2016 10:27:50 EST By kjgrims

Rating for Discharge (ft3/s)

RATING ID: 4.0 TYPE: Stage-Discharge EXPANSION: STATUS: Approved

EXPANDED RATING TABLE

Stage (ft)	Discharge (ft3/s)										DIFF IN Q PER
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	.1 UNITS
33.40	894.7	896.0	897.3	898.6	899.9	901.2	902.5	903.8	905.1	906.4	13.000
33.50	907.7	909.0	910.3	911.6	912.9	914.2	915.5	916.8	918.1	919.4	13.000
33.60	920.7	922.0	923.3	924.6	925.9	927.2	928.5	929.8	931.1	932.4	13.000
33.70	933.7	935.0	936.3	937.6	938.9	940.2	941.5	942.8	944.1	945.4	13.000
33.80	946.7	948.0	949.3	950.6	951.9	953.2	954.5	955.8	957.1	958.4	13.000
33.90	959.7	961.0	962.3	963.6	964.9	966.2	967.5	968.8	970.1	971.4	13.000
34.00	972.7	974.0	975.3	976.6	977.9	979.2	980.5	981.8	983.1	984.3	12.900
34.10	985.6	986.9	988.2	989.5	990.8	992.1	993.4	994.7	996.0	997.3	13.000
34.20	998.6	999.9	1001	1003	1004	1005	1006	1008	1009	1010	13.400
34.30	1012	1013	1014	1016	1017	1018	1019	1021	1022	1023	13.000
34.40	1025	1026	1027	1029	1030	1031	1032	1034	1035		

ID	Starting Date
4.0	03/09/2010 00:00:00 EST

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Friday, December 09, 2016 8:47 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>
Cc: Brad Rimbey <bwr.crrc@tampabay.rr.com>; ktripp@savethemanatee.org
Subject: Thermal Refuge for manatee Kings Bay

Doug, Ron, Dr. Chen and Melissa,
As you know I have very serious concerns about the credibility of the CrystalRK MFL Report. I am still hoping for an explanation of my concerns regarding spring discharge Group 2 springs going from 0 cfs to 250-270cfs in each tidal cycle (approx 6 hours) as presented in Figure 2-4. (Shared with Doug by e-mail Dec 6)

For now I would like to focus on Thermal refuge for manatee.

The Crystal River Kings Bay MFL Report states:
Page 53
Quote
The UnLESS3D model was able to predict volume and area of water in different temperature fractions throughout the bay. During the coldest 72 hours of the time period modeled, 85% of baseline flow is required to preserve 85% of the volume of water >20°C and deeper than 3.8 ft (Table-3-2, Figure 3-2). During time period with the smallest overall volume of thermal refuge from acute cold stress the volume of refuge was less sensitive to reductions in flow than at other times, however this is the most critical time period corresponding to the unusually cold winter of 2009 - 2010 (Table 3-3, Figure 3-3). At their smallest values, the total volume and area of water warm enough for manatee thermal refuge is sufficient to allow for several hundred thousand manatees.
End Quote
And Page 63
Quote
Although a reduction to 91% of baseline discharge will result in a 15% decrease in acute thermal refuge volume, there will still be enough warm water present for every manatee in the world ten times over (refer to Table 3-2). Thus, we do not find it appropriate to set minimum flows for the Crystal River/Kings Bay system based on manatee thermal refuge, as there appears to be more than enough to sustain the population given present rates of growth. This position is consistent with a report submitted to the U.S. Fish and Wildlife Service, which concluded that warm water is far more abundant than required to support Florida manatee populations, and that manatee protection should focus on forage as the factor limiting population size (Provancha et al. 2012).
End Quote

It is unclear where the input data for temperature in this model is obtained from. Could you confirm the source of temperature input data? Is it the temperatures as measured in the VHB reports for each spring, average from VHB or some other source.

So far I have not found any field studies/data which can be used to verify the output of the model. Does anyone know of any field studies of temperature during winter months.
Katie, Do you know of any field studies/data or even thermal imaging?

Table 3-3 presents the volume and area of thermal refuge.
What baseline flow is used in modelling these volume and area figures.?

Martyn
P.S. I have not yet been able to find Provancha 2012 in total, but some abstracts focus attention on available forage for Crystal River.

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Tuesday, December 06, 2016 12:28 PM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: Fw: Crystal River

Doug,
As I recall there was discussion yesterday by the panelist about how USGS filter the discharge data Bagley Cove. This e-mail from Kevin throws some light on the matter, but not the details of how.

Ken Watson in one of his postings recalled similar issues for Homosassa; he was right, it was mainly the Halls River discharge and the end result was the discharge from Halls River was not included. Kevin told me the filter they used with Halls River (which frankly did not give meaningful results, hence not used) I think it was Godin tidal filter, but I can't find it to confirm.

Martyn

From: Kevin Grimsley <kjgrims@usgs.gov>
Sent: Monday, October 31, 2016 9:56 PM
To: Alan Martyn Johnson
Subject: Re: Crystal River

Martyn,

The King's Bay gage was destroyed (again) and we are looking for an alternate location that isn't so susceptible to damage. Filtered discharge for our gages isn't computed in real-time. We manually update it periodically so you'll see more data at Bagley cove soon.

****
Kevin Grimsley, P.E.
Hydrologic Data Chief, Tampa
USGS Caribbean-Florida Water Science Center
4446 Pet Lane, Suite 108
Lutz, FL 33559
kjgrims@usgs.gov
813-498-5064
****

On Oct 31, 2016, at 9:16 AM, Alan Martyn Johnson <martynellijay@hotmail.com> wrote:

Kevin,
Just started reading Crystal River MFL and decided to look at the latest data from the Gage Sites. I note 02310742 (mouth Kings Bay) stopped operating May 19 and 02310747 (Bagley Cove) stopped daily Tidally filtered discharge June 9.
Any reason you can share?
Thanks,
Martyn

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Tuesday, December 06, 2016 12:02 PM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: Peer Review Meeting Dec 5

Doug,
Sorry about the poor connection yesterday, I hung up hoping to get a better connection, when I tried reconnecting got only music after the pass code took. I did send a chat message, not sure if you got that, but I said I would send my input by e-mail. Comments are in the attached Word document.

I will leave it to you to share with SWFWMD persons or place it on the WebForum so the Peer Review Panelists can see where I was heading. At this stage I do not want to be seen as torpedoing the process you have in place so I will not post to the WebForum directly.

I know you work hard to keep the process moving forward, but unless these matters are fully resolved it may be better to explain to the management and/or Board there are some credibility issues with the model which need to be addressed.

Martyn

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Saturday, December 03, 2016 8:59 AM
To: jewilson@usgs.gov; Kevin J Grimsley <kjgrims@usgs.gov>
Cc: Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>
Subject: Fw: USGS FOIA 2017-00006 - Response

Janis,
Thank you to yourself and Kevin for making this information available.

I am sharing this with SWFWMD which I trust is in order with the FOIA protocol. Apparantly SWFWMD do not have this specific information although they sponsor the Gage Site and I think it an important factor for their consultant to have in formulating MFL for the Rainbow River.

Martyn Johnson

From: jewilson@usgs.gov <jewilson@usgs.gov> on behalf of Freedom of Information Act, GS-D-EI_ <foia@usgs.gov>
Sent: Friday, December 2, 2016 1:28 PM
To: Alan Martyn Johnson
Cc: GS-GIO Freedom of Information Act
Subject: USGS FOIA 2017-00006 - Response

Dear Mr. Johnson,

I am attaching our final response to USGS FOIA 2017-00006, along with three tables related to the equations you requested. Thank you for your patience while we processed your request. Please let me know if you have any questions.

Sincerely,

Janis Wilson
U.S. Geological Survey
Department of the Interior
Denver Federal Center
Box 25046
Mail Stop 406
Denver, CO 80225-0046
(303) 236-1476 (office)
(303) 236-1451 (fax)
foia@usgs.gov

INPUT FROM MARTYN JOHNSON TO PEER REVIEW MEETING DEC 5 2016

It was unfortunate that the telephone connection yesterday was poor. When I tried calling back the system would not connect me. I did send a chat message saying I would send my comments by e-mail. It would have been so much better to discuss these.

Summary
The credibility of the Draft MFL Report for Kings Bay Crystal River is impacted by major aspects of the model calculation which are both intuitively and factually flawed. Discharge figures calculated and presented in Figure 2-4 are not supported by actual measurements by VHB or any other entity.

Let me start out by copying an e-mail.

E-Mail NO REPLY TO DATE

To; Melissa Gulvin, Doug Leeper Ron Basso, And ZinJain Chen on 11/30/2016

I will preface my questions and comments by again recognizing Measuring Spring Discharge into Kings Bay is no simple task.

I have continued to review the data and reports relevant to the Crystal River Kings Bay Draft MFL Report. Unfortunately the more I dig into this my concerns about the validity of what is presented increase.

I will again try to keep this set of questions and comments relatively brief:

- From Dr. Chen's paper Estimation of....2014
  " *A successful model calibration/verification against real-time data measured in Crystal River/Kings Bay during a 2.84-year period from 24 April 2007 to 23 February 2010 confirms that this empirical formula for estimating real-time spring flows out of the numerous vents in Kings Bay is reasonable.*"
  WHERE IS THIS REAL TIME DATA?

- A clear understanding of the data produced by VHB is essential to link the data with the hypothesized relationship of discharge to well level ROMP TR21-3 and tidal stage. I note VHB are using Mean Sea Level in connection with individual vent and Group measurements in 2009. I assume this was to give relevance to "

  "*...including multiple measurements at some of*

  the larger springs during different tide stages. When possible, measurements were conducted near low tide, especially at spring vents identified as having low flow."
  These levels differ from the USGS Gage measurements of stage and no gage ht is provided with the 2012 discharge data. I have added these (USGS figures) for my own reference and still can not find data to

support the relationship of discharge to stage at the Mouth of Kings Bay.

.

- Most concerning use of MSL is in the presentation of the 15 minute monitoring of discharge thru X Sections G1 and G2. Considering Group 1 for July 27 thru August 4 (which is the easier graph to read in VHB 2009) and Chen 2014 Figure 3 and in the Draft Report Figure 2-4 although no stage data is included... the springs flows are highest at low tide...IF THIS IS TRUE around low tide there should be a positive flow roughly equal to that high springs discharge.
  IS IT POSSIBLE VHB discharge data is off set by the positive discharge velocity being multiplied by a negative area of X-Section in some parts due to reference to MSL time to stage at the USGS being reference NAVD88.
  THE RAW DATA NEEDS TO BE EXAMINED MORE CLOSELY. **I will be happy to look over the raw data for Group 1 July 27 thru August 8 if the XLS file can be shared.**

- If discharge for Group 2 springs does range from 0 to 250 cfs as shown in Figure 2-4 of the draft report the absence of data to support this is missing, I speculate this would be visually observable at some of these springs as the high discharge is at low tide.

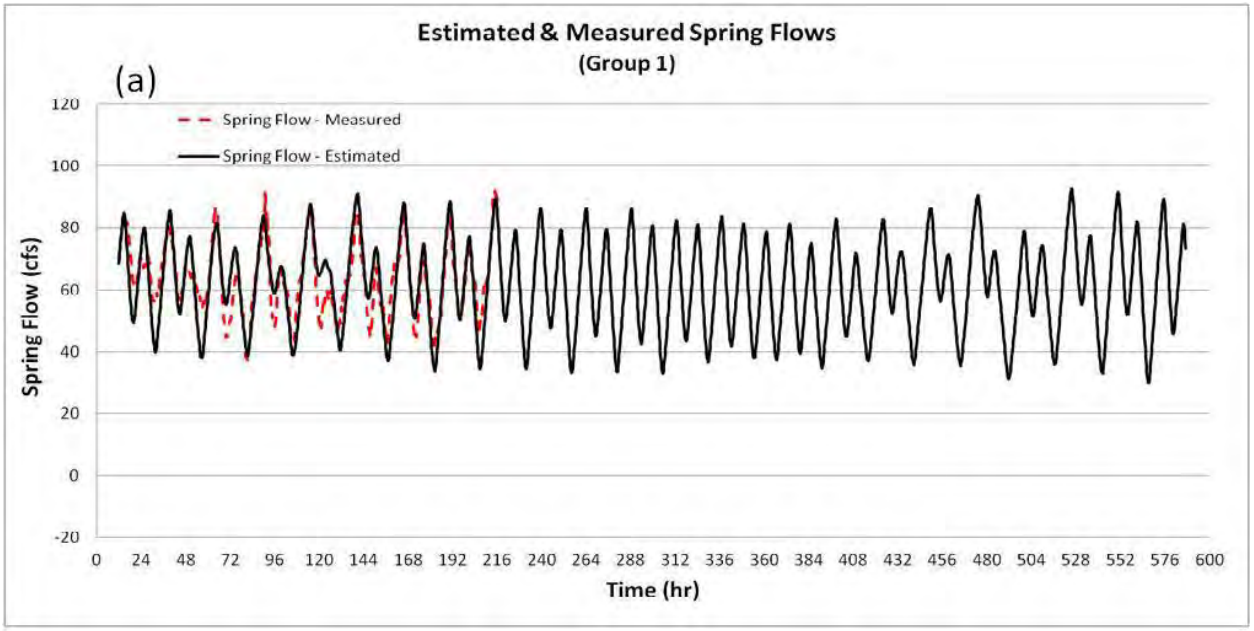
- Relationship between well and stage . I have previously asked for examples of where this relationship is supported by real time data. The wording in Chen 2014 "*For example, a spring vent named H24 in the north portion of Kings Bay was measured on two different days. One was on 23 September 2009 and the other was on 7 October 2009. The first measurement of the discharge was 8.35 cfs, but the second flow measurement was 49.5 cfs, almost six times of the previous measurement*" does not substantiate this beyond question because H24 is measured in a tidal channel. Considering the stage data at the times these two measurements were made does indicate falling tide, resulting in emptying of the pool upstream of the measuring location is a factor which appears not to have been considered. Furthermore in the 2012 VHB monitoring of Spring 32 (a single vent spring) thru a tidal cycle on two different dates does not confirm a clear relationship of lower discharge at higher stage.

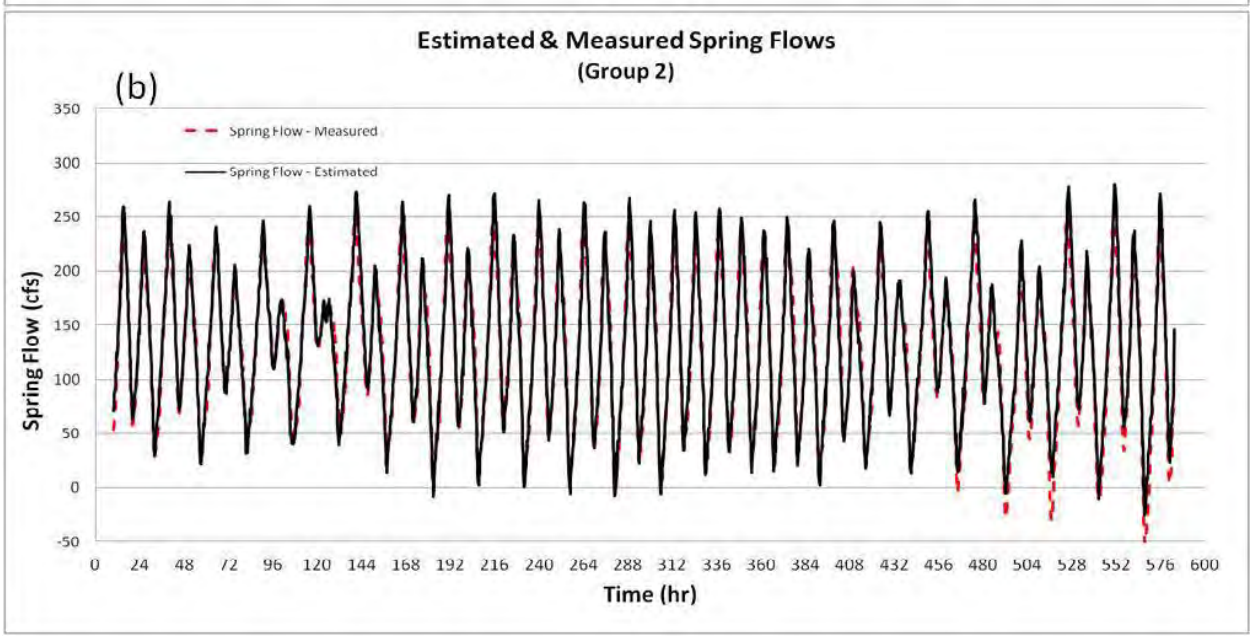
- Just for consideration. If SWFWMD are so confident in the discharge which Dr. Chen had published in the Journal of Marine Science Jan 2014 and now used as the basis for all 2016 Draft Report, why was the data in NDM 5 not updated in the most recent version Sept 2016. And equally interesting the graphs and comments in JMS paper appear to have been modified for purposes of the Draft Report. Possibly Dan Yobbi's memo November 2014 was sufficient to throw some light onto the validity negative flow into the spring vents.. And the different analysis of the 2009 Group 1 and 2 data...surely the same method can be used for the two sets of data...not some hit and miss approach.

Again, I am willing to take a look at the Group 1 data for 2009 if you can share the raw data files with velocity and x-Section area. I think a total flux thru the x section approach may (as I did for Bagley Cove) may be a more logical approach, which can be used for G1 and G2 alike.

Martyn

E-Mail End





The point I was making regarding Figure 2-4 is that spring flow for the 8 springs in Group 2 shows changes from 0 to 250-270 cfs in the 6 hour tidal cycle on a number of days. (Note:On some days negative flows are shown; a point mentioned in the text of the original paper.) There is not a shred of evidence supporting this large change. Dr. Chen claimed there is no data on discharges from individual springs over a tidal cycle; however he fails to see the discharge measurements for the individual springs in the 2009 study period do have MSL data, which tends to show consistent discharge not major changes. While the 2012 discharge measurements do not show the corresponding stage data, the time of measurement can be cross-referenced to USGS Gage Mouth of Kings Bay for individual springs. Additionally, an effort was made in 2012 VHB work specifically collect discharge from three springs over a tidal cycle, shown in Table 2 of the Technical Memorandum. I have written in the corresponding USGS Gage Height for the time of the measurement. Spring 32 does not support changes of the magnitude calculated and shown in Figure 2-4. Note: the model treats all springs close to G2 the same, so Spring 32 is modeled the same as G2, CORRECT?

While the 0 to 250 cfs for Group 2 emphasize the point, the changes for Group 1 Figure 2-4 of 35 to 90 cfs are similarly not supported by measurements made by VHB or any other entity.

Table 2. Diurnal vent measurement summaries for October 29, 2012 and November 6, 2012.

Site	Site Name	Date	Time	Discharge (cfs)	
SV32121029	King Spring/Grand Canyon Spring "Manatee sign"	10/29/12	850 EST	43.86	-0.31
SV32121029b	King Spring/Grand Canyon Spring "Manatee sign"	10/29/12	1048 EST	51.19	-1.02
SV32121029d	King Spring/Grand Canyon Spring "Manatee sign"	10/29/12	1229 EST	42.26	-1.23
SV32121029f	King Spring/Grand Canyon Spring "Manatee sign"	10/29/12	1433 EST	37.35	-0.19
SV32121029i	King Spring/Grand Canyon Spring "Manatee sign"	10/29/12	1555 EST	26.75	0.65
SV32121029k	King Spring/Grand Canyon Spring "Manatee sign"	10/29/12	1659 EST	23.85	1.03
SV3220121106	King Spring/Grand Canyon Spring "Manatee sign"	11/06/12	0808 EST	29.41	1.93
SV3220121106b	King Spring/Grand Canyon Spring "Manatee sign"	11/06/12	0922 EST	32.68	1.55
SV3220121106d	King Spring/Grand Canyon Spring "Manatee sign"	11/06/12	1036 EST	32.35	1.05
SV3220121106f	King Spring/Grand Canyon Spring "Manatee sign"	11/06/12	1148 EST	39.63	0.50
SV3220121106j	King Spring/Grand Canyon Spring "Manatee sign"	11/06/12	1406 EST	43.83	-0.31
SV3220121106l	King Spring/Grand Canyon Spring "Manatee sign"	11/06/12	1542 EST	39.47	-0.06
SV3220121106o	King Spring/Grand Canyon Spring "Manatee sign"	11/06/12	1703 EST	37.46	0.53
SV35121029	Golfview	10/29/12	0659 EST	2.67	0.44
SV35121029a	Golfview	10/29/12	0942 EST	3.53	-0.69
SV35121029c	Golfview	10/29/12	1114 EST	5.53	-1.16
SV35121029d	Golfview	10/29/12	1336 EST	2.42	-0.75
SV35121029e	Golfview	10/29/12	1457 EST	1.68	0.13
SV35121029f	Golfview	10/29/12	1615 EST	2.26	0.76
SV3520121106	Golfview	11/06/12	0716 EST	1.82	1.93
SV3520121106a	Golfview	11/06/12	0830 EST	2.98	1.82
SV3520121106b	Golfview	11/06/12	0945 EST	3.10	1.35
SV3520121106c	Golfview	11/06/12	1058 EST	1.74	0.83
SV3520121106d	Golfview	11/06/12	1213 EST	2.44	0.32
SV3520121106e	Golfview	11/06/12	1457 EST	2.44	-0.44
SV3520121106f	Golfview	11/06/12	1604 EST	5.10	0.05
SV3520121106g	Golfview	11/06/12	1615 EST	3.66	0.20
SV39121029	Sid's Spring	10/29/12	0735 EST	1.87	.24
SV39121029a	Sid's Spring	10/29/12	0746 EST	5.39	.13
SV39121029b	Sid's Spring	10/29/12	1018 EST	2.45	-0.85
SV39121029c	Sid's Spring	10/29/12	1020 EST	4.97	-0.85
SV39121029d	Sid's Spring	10/29/12	1159 EST	2.01	-1.29
SV39121029e	Sid's Spring	10/29/12	1201 EST	4.33	-1.29
SV39121029f	Sid's Spring	10/29/12	1402 EST	2.22	-0.47
SV39121029g	Sid's Spring	10/29/12	1405 EST	1.78	-0.47
SV39121029h	Sid's Spring	10/29/12	1525 EST	2.16	-0.39
SV39121029i	Sid's Spring	10/29/12	1527 EST	2.61	-0.39
SV39121029j	Sid's Spring	10/29/12	1638 EST	1.62	0.86
SV39121029k	Sid's Spring	10/29/12	1640 EST	1.93	0.96
SV3920121106	Sid's Spring	11/06/12	0739 EST	1.97	1.96
SV3920121106a	Sid's Spring	11/06/12	0741 EST	2.22	1.96
SV3920121106b	Sid's Spring	11/06/12	0857 EST	2.37	1.68
SV3920121106c	Sid's Spring	11/06/12	0859 EST	2.12	1.68
SV3920121106d	Sid's Spring	11/06/12	1010 EST	2.04	1.14
SV3920121106e	Sid's Spring	11/06/12	1012 EST	3.52	1.14
SV3920121106f	Sid's Spring	11/06/12	1124 EST	2.92	0.63
SV3920121106g	Sid's Spring	11/06/12	1126 EST	2.03	0.63
SV3920121106h	Sid's Spring	11/06/12	1339 EST	2.95	-0.30
SV3920121106i	Sid's Spring	11/06/12	1341 EST	2.09	-0.30

As telephone connection was lost yesterday I was about to move on to point out the Group 1 and Group 2 discharge measurements use MSL which is different to the USGS NAVD88 by about 0.25 to 0.3 feet as best I can read the graphs. Is it possible this makes a difference to the area which is used to calculate discharge ('look up table' I think is the term for area at different gage heights).

Additionally:

- is the timing of high tide and low tide different, at the springs vents, than at the USGS 02310742 Mouth of Kings Bay (Bagley Cove USGS 02310747 to Mouth of KingsBay USGS 02310742 is about 15 minutes difference between high tide time, and between USGS 02310742 and the spring vents there is a large pool that fills and empties). I speculate there is a difference in time and the tidal stage change may also be different at the spring vents (dampened by the Large Kings Bay 'pool'..

The VHB individual springs measurements, if anything, show essentially consistent discharge thru the tidal cycle, particularly when accuracy is considered. The closest I can find showing a slight correlation of discharge and stage, is SV 20 in the VHB 2009 report pages 17 and 18:
For 7/28/2009
First 3 measurements are averaged, note variation 40 to 30 cfs in 4 minutes. Then the next 3 measurements, which appear to be 3 smaller vents, are added giving
46.72 cfs MSL -0.2 to –0.3

For 7/30/2009
First 3 measurements are averaged, note tighter grouping. Then the next 3 measurements areadded giving
37.38 cfs MSL higher 1.1

For 8/17/2009
4 measurements added giving (assume multiple measurements at the main vent were not taken or discounted for some reason
45.00 cfs MSL 1.37

For 8/19/2009
First 3 measurements averaged, note variation 53.7 to 32.2 cfs 1 minute apart. Then the next 3 measurements added giving
51.91 cfs MSL -0.97

This does have some indication of a relationship between MSL and discharge, hinging mainly on one measurement of 53.7 cfs, supported to some extent by the discharge from the last vent in each set, BUT THE VARIATION IS 45 cfs to 51 cfs OR ABOUT 13%. Bear in mind the variation in discharge measurements a few minutes apart as an indication of accuracy. Look at SV 20 measurements October 23 and November 12 VHB 2012, either the vent almost dried up or the SOP's failed to monitor the correct vent/vents or report correctly.

Agreed the data is limited, but there is not a shred of evidence supporting the discharge variations show in Figure2-4.

These points, particularly the magnitude of spring flow change in a tidal cycle (high to low or vice versa) as emphasized by the 0 cfs to 270 cfs with no supporting evidence destroys the credibility of the discharge calculations. The discharge calculations are the basis for the model which supports the entire report.

Lastly on this point, it is inconceivable that the methodology of analyzing the movement of water through the x-section for Group1 and Group 2 are different. Whether it is 3 springs and 613111 sq. ft. of pool or 8 springs and 1,785544 sq. ft. of pool this should not make a difference to the methodology as all the springs in the Group must be considered to respond equally. There is certainly nowhere near enough data to say how differently each spring discharge changes thru a tidal cycle. However, I do agree with Dr. Chen's explanation at the meeting I attended in person, that small spring discharge will have different characteristics than large spring discharges. I would consider this dynamic resistance to flow, but I doubt this is very significant.

Adding to the discussion of Bagley Cove USGS discharge data

USGS Discharge data is the best ongoing data set, however it suffers from:

- The magnitude differences of tidal inflow/outflow relative to the springs discharge flow
- The turbulence at the gage site particularly at the time the direction of flow changes.
- The tidal cycle is 24.84 hours and most daily data is presented on a 24 hour basis, and does not account for the volume lost or gained upstream in Kings Bay due to stage change in the 24 hour.

The second bullet point can be seen best by viewing recent days when the field measurements are taken as the time intervals for discharge calculation are set to one minute intervals not 15 minutes. Whether different instrumentation or multiple velocity meters can overcome the turbulence issue I doubt in the short term. Just after USGS implemented the new rating curve in I did look at total flux over three time periods of about a 10 days but starting and finishing with gage heights almost the same at the point of a directional change. This gave positive discharge on all sets run, but totals were not closely grouped. I am sure given the computing skills of others this could be achieved more quickly than my slow manual assessment. I also saw the turbulence by tossing a handful of red/white painted corks in at the gage site on two occasions at direction change time…sorry about the pollution, but worse have been thrown in. The turbulence was amazing to watch. The discharge methods used by Hammett (think it was 1996) when they had five boats with velocity meters anchored across the river (think it was slightly different point in river to current gage site). This measurement was possibly the best thought out approach; unfortunately it has not been repeated. USGS Field Measurements are helpful in identifying the

accuracy of calculated discharge highlighting the major issue of accuracy at time of flow direction change.

For consideration when thinking about the 24.84 hour tidal cycle, assume Kings Bay is 600 acres (no doubt the shoreline mapping can get more accurate) but for a 0.1 ft difference in gage height beginning to end of the 24.84 hours (high tide to high tide) represents an average of 30 cfs flow; 1.0 feet which often occurs is 300 cfs average. To repeat my earlier comment I doubt the entire Kings Bay pool has the same tidal change as Bagley Cove…would be interesting to see any available data.

I trust my comments are helpful. Now is a better time to consider them as opposed to when the report is final.

From:	Doug Leeper
To:	"martynellijay@hotmail.com"
Cc:	Xinjian Chen; Gabe I. Herrick
Bcc:	Ron Basso; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ross Morton; Melissa Gulvin
Subject:	Recent inquiries on MFLs
Date:	Friday, December 16, 2016 4:00:00 PM
Attachments:	Responses to MJohnson 2016-12-16.pdf Group 1 GH Vel Disch and Hydrograph.xls

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Martyn:

Thanks for your recent emails and contributions to the Crystal River peer review process. The attached PDF file includes your emails and associated attachments with imbedded responses from District staff. Also attached is an Excel file that contains discharge data that you requested.

Note that the PDF file includes information pertaining to a file containing water quality data that you requested that is too large to send be email (and has been posted to the District FTP site for you to retrieve) as well as links to a U.S. Geological web site where real-time data that you asked about can be obtained.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Doug Leeper
To: Kristine Papin Morris (Kristine.P.Morris@dep.state.fl.us)
Cc: Mark A. Green; Jennette Seachrist; Eric DeHaven; Mike R. Bray; Cathy Kenney
Subject: Rainbow-Crystal status update
Date: Tuesday, December 20, 2016 1:10:00 PM

Hi Kristine:

Following-up on our call, I checked the FAC/FAR web site and noted that we have not yet published a Notice of Development of Rulemaking for the proposed Rainbow and Crystal river MFLs.

However, as we discussed, we have completed peer review for both systems. The peer review panel reports were completed in November 2016 (Rainbow) and December 2016 (Crystal). Staff responses to the peer review panel reports are scheduled to be presented to the District Governing Board in January 2017 (Rainbow) and March 2017 (Crystal).

Doug Leeper
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352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Sid Flannery
To: Doug Leeper
Date: Thursday, December 22, 2016 9:29:05 AM

Hello Doug,

I have a few editorial comments about the draft Crystal River / Kings Bay report. When should I get them to you by? I can send them next week (Dec 26- 30). Is that okay?

I also asked Yonas to forward to you some aerial photos and and email that was sent to him by Dave Blewett of FFWCC.

Merry Christmas! I hope you are on AL today and many others.

Sid

From:	Doug Leeper
To:	"Sid Flannery"
Cc:	Gabe I. Herrick
Subject:	RE:
Date:	Friday, December 23, 2016 7:40:00 AM

Sid – Don't feel rushed regarding submission of your comments on the Crystal MFLs. We are currently scheduled to provide a response to peer review to the Board in March 2017, host a public workshop in March (or possiblyFeb) and present a final report to the Board in May 2017.

Happy holidays!

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
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1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Sid Flannery [mailto:sidflannery22@gmail.com]
Sent: Thursday, December 22, 2016 9:29 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject:

Hello Doug,

I have a few editorial comments about the draft Crystal River / Kings Bay report. When should I get them to you by? I can send them next week (Dec 26- 30). Is that okay?

I also asked Yonas to forward to you some aerial photos and and email that was sent to him by Dave Blewett of FFWCC.

Merry Christmas! I hope you are on AL today and many others.

Sid

From:	Doug Leeper
To:	"martynellijay@hotmail.com"
Cc:	Xinjian Chen; Gabe I. Herrick; Ron Basso
Bcc:	Mark A. Green; Jennette Seachrist; Eric DeHaven; Melissa Gulvin; Ross Morton
Subject:	Recent inquiries on Crystal MFLs
Date:	Monday, January 09, 2017 3:02:00 PM
Attachments:	Responses to MJohnson-Crystal 2017-01-09.pdf

Martyn:

Thanks for your recent emails concerning development of minimum flows for the Crystal River/Kings Bay system. The attached file includes several of your emails and associated email strings with imbedded responses from District staff.

We are currently reviewing your recent emails and comments on the minimum flows proposed for the Rainbow River system and hope to soon send a relevant response.

Doug Leeper
MFLs Program Lead
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Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

Subject: Emails from Mr. Martyn Johnson concerning proposed minimum flows for the Crystal River/Kings Bay system

Prepared by: XinJian Chen, Gabe Herrick, Ron Basso and Doug Leeper
Natural Systems and Restoration Bureau and Water Resources Bureau
Southwest Florida Water Management District
Brooksville, Florida 34605

Date: January 9, 2017

Emails from Mr. Martyn Johnson concerning proposed minimum flows for the Crystal River/Kings Bay system are reproduced in this document along with imbedded responses from Southwest Florida Water Management District staff. District responses to Mr. Johnson's emails and notations identifying "email strings" associated with the emails are highlighted in blue.

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Monday, December 19, 2016 9:39 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Ross Morton <Ross.Morton@swfwmd.state.fl.us>; Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>
Subject: Re: Recent inquiries on MFLs

Doug,
Thanks for the responses. I have quickly looked over these this morning and will have a more detailed review in the next day or two.

My first reaction is there is still no 'evidence' to support the zero to 250cfs change in discharge from Group 2 springs as presented in Figure 2-4.

Regarding Figure 3-4 the report does not make it clear that these flows are computed by the model and not the result of actual measurements. I thought these rather strange as the discharge ranges from 100 cfs to about 650 cfs. Do I assume correctly that these modeled flows are average per day (the day salinity measurements were taken).

Staff Response: Yes, the modeled flows are daily averages.

As regards salinity habitats in Kings Bay and my asking where the large amount of inflow goes, I for one, do not see this as an "academic exercise". The model grid Figure 2-7 shows the model going out to Shell Island so presumably it should be capable of predicting where the high salinity areas are during a 24.84-hour tidal cycle.

I will look closer and send more detailed comments, but I remain very concerned that again SWFWMD does not have a logical fact supported explanation of the discharge from the Group 2 springs varying from zero to 250 cfs. Frankly, I am not "surprised" there is no logical fact

supported explanation because Figure 2-4 data is not correct. Anyone who has enjoyed watching the springs intuitively knows this is not reality. Sorry, I will keep open mind for an explanation, but the whole model output lacks credibility with this as a basis.

Martyn

Martyn

Martyn

Email string included in Mr. Johnson's email

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Friday, December 16, 2016 4:00 PM
To: martynellijay@hotmail.com
Cc: Xinjian Chen; Gabe I. Herrick
Subject: Recent inquiries on MFLs

Martyn:

Thanks for your recent emails and contributions to the Crystal River peer review process. The attached PDF file includes your emails and associated attachments with imbedded responses from District staff. Also attached is an Excel file that contains discharge data that you requested.

Note that the PDF file includes information pertaining to a file containing water quality data that you requested that is too large to send be email (and has been posted to the District FTP site for you to retrieve) as well as links to a U.S. Geological web site where real-time data that you asked about can be obtained.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
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352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Wednesday, December 21, 2016 8:47 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>
Cc: Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>; Ross Morton <Ross.Morton@swfwmd.state.fl.us>
Subject: Crystal River/Kings Bay Response to MJohnson

As the Christmas Season approaches I will cover some more key points from my review of the response sent by Doug last Friday and leave more details for 2017. For those who may not have time right now to read on, let me wish you all a Very Merry Christmas and Best Wishes for 2017.

XLS file Group 1

In my initial analysis of the data I highlighted each high and low tide, then looked at the discharge measured during those periods where the stage changes are small. Some may recall my comment that at low tide the flow thru X-section will be spring discharge (no tidal/stage assignable flow). The data discharges at these times are remarkably consistent, typically 60-65cfs. I then looked at the discharges measure at high tide, again those periods when there is no tidal/stage assignable flow, the disharges are remarkably consistent and in the same range. This gives strong indication that the differences in spring discharge for Group 1 does not change as presented in Figure 2-4 (40 to 80+cfs from high to low tide). I then looked at the inflows and outflows during each tidal cycle thru the 15 minute intervals; while I have only had time to look at the first few cycles the net flow each interval match well with net flow needed to account for the change in stage given constant spring discharge. The stage information used by VBH is from the USGS Gage Site (corrected to MSL for some reason), from the discharge data the high and low tides at the X-Section are about 15 minutes later than at the USGS Gage Site at the mouth of Kings Bay 02310742.

This is strong evidence the spring discharge from the vents in Group 1 do not vary significantly with tide, which is also supported by the VBH measurements at these individual vents.

Baseline, NDM and Thermal refuge

So baseline varies with time! How is this tracked?….baseline varies with spring flow is implied in the wording of the mfl rules in the FAC for Weeki Wachee, Homosassa and Chass.

The response references Table 1-2. In a previous e-mail I did question the similar table in the Rainbow River MFL Report saying there appeared to be an error; then for the Crystal River Report I commented the 'penny had dropped' and I understood the error. Thought someone would have figured by now the 479.1 mgd is 890 cfs, if it were correct for Crystal River the withdrawals are twice the discharge. **This is an error**.

BUT, of more concern is the difference in the same table of pumping v non pumping of 5.16 and 6.92 cfs, which is 3.33 and 4.47 mgd. If I read this correctly this says the NDM 'thinks/predicts/programmed' withdrawals are in the range of 2%. However, Figure 1-14 (only 4 pages earlier) presents groundwater withdrawals from estimated (private unmetered) and metered usage in the Crystal River Springshed as 15 mgd, or over twice as much. **This appears to be inconsistent, what am I missing?**

Staff Response: The baseline flow condition for any MFLs system is the flow or stage in the absence of groundwater withdrawals. Groundwater withdrawal impacts to the Crystal River/King's Bay system are predicted by the NDM 5 regional groundwater flow model and a water budget of the springshed based on recent pumping history.

The groundwater flow model predicts a little over one percent of flow is reduced by current groundwater withdrawals. There is not a one-to-one relationship between groundwater withdrawn in the springshed and flow changes at the King's Bay springs. When water is withdrawn from the Upper Floridan aquifer in the springshed (or the much larger regional groundwater basin) it can come from changes in storage (water level decline), leakage from the overlying surficial aquifer, lakes and wetlands, reductions in evapotranspiration (ET), runoff, and diffuse groundwater seepage to the coast, and seepage to lakes and rivers. In the water budget used in the MFLs approach, we conservatively estimate a high groundwater impact by assuming every gallon of consumptive-used groundwater in the springshed results in a gallon decline in springflow. The U.S. Geological Survey has estimated, on average, that 45% of water withdrawn in the state is consumptively-used. Based on the results of the conservative water budget and NDM 5, staff estimated current groundwater impacts to the Crystal River/Kings Bay system springflow of one to two percent.

Thermal refuge for manatee is shown in Table 3-3 of the MFL Report as finite areas and volumes for various percentage reductions in baseline flow**. What is this baseline discharge cfs associated with these finite areas and volumes?** Is it the non pumping figure from Table 1=2 which is 448.99 cfs, it appears not. It appears to be the discharge as predicted by the model for the coldest 72 hour period shown in Figure 3-2 (coldest 72 hours starting at 8:00 am 1/10/2010) divided by 0.98. Presumably the spring discharge is averaged over the 72 hour period so this baseline is the spring discharge divided by 0.98. Once you focus in on the modeled spring flow for these 3 days, think about this as regards the average withdrawals 15 mgd shown in Figure 1-14. **Maybe the focus needs to be on Maximum Withdrawals (a finite number) non minimum flows relative to an ever changing baseline.**

Staff Response: Table 3-3 in the MFLs report shows minima of 4-hour moving averages of >15 ^{o}C water volume and surface area during the acute condition. Baseline flow during the 4-hour period varied between about 41 cfs to about 511 cfs.

Staff Response Yes Spring 32
Regarding budget restrictions I am pleased someone is attempting to control expenditure of taxpayer money. However, I do not see the main objectives of the 2012 contract with VHB in the data returned (only the contract can show this). Most of the work is a repeat of individual spring vent measurements and the G1 and G2 X-Section flow. The later appears not used in any analysis such as: do the C1 and C2 determined by 'trial and error' for 2009 fit the 2012 flows. Why Springs 32, 35 and 39 were chosen for monitoring is unclear (was there an attempt to justify the idea of reverse flow into the vents, just a small may be) but the data is what we have so what does it indicate.
The discharge measurements on 9/21/2009 were:
13:37 51.55 cfs
13:41 62.65 cfs
13:43 47.52 cfs
These were made at the time of a rising tide (13:30 gh -0.71 and 13:45 gh -0.57 per USGS, VBH indicate rising tide expressed as MSL). So how is this data interpreted? At best it is indicative of

accuracy; with a 20% increase followed by 25% decrease within 6 minutes.
Discharge measurements on 10/29/2012 (gh from USGS) were:
08:50 43.86 cfs @ gh -0.31
10:48 51.19 cfs @ gh -1.02
12:29 42.46 cfs @ gh -1.23
14:33 37.35 cfs @ gh -0.19
15:55 26.75 cfs @ gh 0.65
16:59 23.85 cfs @ gh 1.03
So the high figure you reference of 51.19 cfs is the next to lowest stage. The next measurement 42.46 cfs at a lower gh is 20% lower (gh change of -0.2 feet if the hypothesis holds it should have been higher). The next measurement 37.35 cfs is 21% lower for an increase in gh of over a foot, this is directionally in line with the hypothesis but with less change than other measurements suggest . Agreed there is some trend indication in this very limited data but it is not consistent.

So lets look at the discharge on 11/06/2012:
08:08 29.41 cfs @ gh 1.93
09:22 32.68 cfs @ gh 1.55
10:36 32.35 cfs @ gh 1.05
11:48 39.63 cfs @ gh 0.50
14:06 43.83 cfs @ gh -0.31
15:42 39.47 cfs@ gh -0.06
17:03 37.46 cfs @ gh 0.53
The highest discharge 43.83 cfs is at the lowest gh and the lowest discharge29.41 cfs is at the highest gage height. The difference for 2 feet difference in gh is 25%; given the implied accuracy question this is slim evidence.

These data may indicate a slight trend but are nowhere near the magnitude we are seeking to explain the discharge figures in Figure 2-4, which was **THE VERY POINT MADE IN MY INUT FOLLOWING THE DEC 5 MEETING** and yes I did share the gage height figure handwritten onto the sheet.
What is most noteworthy about these two sets of data is the ***AVERAGE of 10/29/2912 is 37.5 cfs and 11/06/2012 is 36.4 cfs…possibly more evidence that spring discharge is little influenced by tide*** *(note the average gh for 10/29 is -0.18 and for 11/06 is 0.74).* ***Coincidence? may be, may be not.***

Looking at the discharges for Spring 35 does not help confirm even a slight trend. The discharge for Spring 39 is most helpful in that it has discharge taken 2 to 3 minutes apart which often show wide variation indicative of previous mention of accuracy which is most likely more of an issue at low discharge.
Most concerning about Springs 35 and 39 is the Average discharge in 2009 data was 19.71 cfs SV35 and 11.25 cfs SV 39 which are considerably higher the 2012 measurements.

To coin Dan Yobbi's phrase used in his December 15, 2014 memo (in the appendices), this not

”convincing field evidence”. Dan’s memo makes interesting reading and clearly states the use of VHB data collected over a short period of time is not a long term average.
I COMPLETELY AGREE, and will add once again measuring spring discharge into Kings Bay is not an easy task.

Staff Response: At the time when the 2012 contract with VHB, Inc. was executed, the District had already developed an empirical formula for estimating submarine groundwater discharge (SGD) to Kings Bay and a hydrodynamic model that used this SGD formula. Because of the limited time period of the 2009 flow measurements at G1 and G2 made previously by VHB, Inc., it was necessary to collect more flow data at G1 and G2 to validate the empirical formula and the formula coefficients. That was the main purpose of the 2012 contract with VHB, Inc. Springs 32, 35, and 39 were chosen for assessment because they are not part of G1 or G2 springs, and we were interested in determining whether they experience tidal influence similar to that of the G1 and G2 springs.

As noted in Chen’s 2014 report, “On the estimation of Submarine Groundwater Discharge to Kings Bay”, there is a phase shift of about 160 – 165 degrees between SGD and tides. Therefore, the lowest water level does not correspond to the highest spring flow. Another factor that needs to be considered is the groundwater level, which also exhibits significant tidal signals.

I wish you all a Merry Christmas,
Martyn

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Tuesday, January 03, 2017 7:42 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>; Ross Morton <Ross.Morton@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>
Subject: Saragassa Canal 02310740

Over the Christmastime I made a trip to observe the springs in Crystal River Group 2 and spoke to some property owners. Interesting comments, but this is anecdotal evidence and does not rank with computer models.

BUT

I did find a relatively new USGS Gage Station 02310740 While this does not currently report discharge some of other parameters reported since June 2016 do show some interesting information. Notably the regular inflow of water of 4000-6000 specific conductance, which indicated water of this nature is frequently close in Kings Bay to this X-Section. The relation with the lunar tidal cycle is readily apparent in the data.

Appears the Review Panel on the Field Visit were not made aware of this development.

It will be interesting to see the discharge data over the next year.
Martyn

Staff Response: The U.S. Geological Survey Saragassa Canal at Crystal River FL (No. 02319740) gage site was recently installed as a cooperative effort with the District. Data collection at this site was initiated in mid-2016 is expected to eventually yield useful discharge information.

Email string included in Mr. Johnson's email
From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Tuesday, January 03, 2017 7:18 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Ross Morton <Ross.Morton@swfwmd.state.fl.us>; Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>
Subject: Fw: Rainbow River Review

RAINBOW RIVER MFL REMINDER
The concerns I raised in my November 14 e-mail regarding the inaccuracies in the discharge data used to develop the Rainbow River Model have so far not been addressed or brought to the attention of the Review Panel. This is disappointing.

I also forwarded the USGS 'look up tables' which further support the concern I raised about additional spring water discharge below the newer USGS Gage Site 02313098. This information also appears to make the idea of backwater effects on the long term gage site discharge data invalid or rarely significant.

The Review Panels Report includes some very telling comments (which I essentially agree with):
Quote
The Panel finds the 2000 flow anomaly a potentially interesting harbinger of change. The springshed is clearly yielding less flow than expected since 2000. Based on the double mass analysis it appears that current flows are substantially below the MFL and there is nothing in the report that assures recovery to the MFL. The Panel understands that the cause is unknown, while groundwater models suggest that local pumping is not the cause, the Panel has major concerns that the flow anomaly must be considered a "departure from natural flow". Resolving the origin of the anomaly is critical to defensibly conclude that the Rainbow River System is, in fact, not impaired and in need of a recovery plan. The Panel appreciates that MFL reports are living documents, updates and improvements should clearly describe knowledge gaps, and that remedying these gaps are a District priority.
End Quote
And
In the absence of key supporting data, the District should consider capping withdrawals at current levels (or with a minimal allowable increase) until the nutrient issues are effectively addressed. In particular, consideration should be given to allow no reduction in flow unless there is a corresponding decrease in loading so that there is no net increase in projected nitrate concentrations. If this cannot be done, the District needs to be explicit as to the water-quality implications of the proposed MFL.
End Quote

No doubt the Board (as well as myself) will be interested to hear Staff's Response to these concerns raised by the panel.

Martyn

Email string included in Mr. Johnson's email
From: Alan Martyn Johnson <martynellijay@hotmail.com>
Sent: Monday, November 14, 2016 8:40 AM
To: Doug Leeper; Ron Basso; Melissa Gulvin
Subject: Rainbow River Review 1

Doug, Ron and Melissa,
Last week I received answers to some of my questions from USGS regarding the Rainbow River MFL so I have pulled together some of my comments.
For ease of reading I have put my comments in a word file for you to consider.
I have major concerns regarding the work by ECT. Who was responsible for reviewing the work done by ECT or was it just accepted without question?

I am still waiting for USGS to provide the discharge equations for the two gage sites on Rainbow River. These may address some of the other concerns I have regarding flows.
In addition I have comments regarding the analysis of water quality data, fish data and floodplain habitat which I will address later.

Regarding Crystal River Kings Bay Review tomorrow, what is the room location at the Brooksville Office, I hope to be able to attend in person.

Martyn

From:	Doug Leeper
To:	"martynellijay@hotmail.com"
Bcc:	Gabe I. Herrick; Xinjian Chen; Ron Basso; Mark A. Green; Jennette Seachrist; Eric DeHaven; Melissa Gulvin; Ross Morton
Subject:	Jan 11 email on the Crystal MFLs
Date:	Wednesday, January 18, 2017 9:09:00 AM
Attachments:	Response to MJohnson-Crystal 2017-01-18.pdf Group 2 GH Vel Disch and Hydrograph.xls Group 1 Discharges and Plot 2013 WY.xlsx Group 2 Discharges and Plot 2013 WY.xlsx Model Output of SGD for Baseline.xlsx

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Martyn:

Thanks for your January 11, 2017 email concerning development of minimum flows for the Crystal River/Kings Bay system. The attached PDF file include your email with imbedded responses from District staff. Also attached are three Excel files that include data you requested as discussed in the PDF file.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

Subject: Emails from Mr. Martyn Johnson concerning proposed minimum flows for the Crystal River/Kings Bay system

Prepared by: XinJian Chen, Gabe Herrick and Doug Leeper
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
Brooksville, Florida 34605

Date: January 18, 2017

A January 11, 2017 email string from Mr. Martyn Johnson concerning proposed minimum flows for the Crystal River/Kings Bay system is reproduced in this document along with imbedded responses from Southwest Florida Water Management District staff. District responses to Mr. Johnson's inquiries are highlighted in grey.

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Wednesday, January 11, 2017 8:02 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Ross Morton <Ross.Morton@swfwmd.state.fl.us>; Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>
Cc: Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>
Subject: Re: Recent inquiries on Crystal MFLs

Doug,
Thanks for organizing the responses. I have some comments again highlighted in yellow to help keep the record a little easier to follow.

Information request.
Can you share the xls files for the VHB monitoring at X-Sections G2 2009 and X-Sections G1 and G2 for 2012?

Staff Response: The requested information is included in three Excel files (named *Group 2 GH Vel Disch and Hydrograph*, *Group 1 Discharges and Plot 2013 WY*, and *Group 2 Discharges and Plot 2013 WY*, respectively) that will be provided in electronic format in conjunction with this response document.

I will be happy to review the xls data from the 2009 monitoring of Group 2 and confirm if it can show the spring discharges as I have done with Group 1 which look logical and show consistency. The data from monitoring G1 and G2 in 2012 contained in the memo from VHB does not show the gage hts. GH may be in the xls files, but if necessary I could match the times with the USGS record. Best I can tell from visual assessment of the graphs the discharge in 2012 monitoring period was higher this is consistent/supported by other information such as gage heights in some key monitoring wells plus analysis of the Bagley Cove discharge at that

time using the tidal cycle times (24.84 hours or practically as close as the 15 minute data allows).

Note also my request for the 72 hour discharge data associated with thermal refuge, in my comments below.

Staff Response: Thanks for this reminder. We have responded to the request below.

I appreciate that I am asking for a lot of information which takes time to compile. If you need me to make a formal public records request I will happily do this, but hope this is sufficient.
Thanks,
Martyn

Comments on responses sent by Doug Leeper Jan 9, 2017, yellow highlight.

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com] **Sent:** Monday, December 19, 2016 9:39 AM **To:** Doug Leeper <Doug.Leeper@swfwmd.state.fl.us> **Cc:** Ross Morton <Ross.Morton@swfwmd.state.fl.us>; Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us> **Subject:** Re: Recent inquiries on MFLs

Doug,
Thanks for the responses. I have quickly looked over these this morning and will have a more detailed review in the next day or two.
My first reaction is there is still no 'evidence' to support the zero to 250cfs change in discharge from Group 2 springs as presented in Figure 2-4. Regarding Figure 3-4 the report does not make it clear that these flows are computed by the model and not the result of actual measurements. I thought these rather strange as the discharge ranges from 100 cfs to about 650 cfs. Do I assume correctly that these modeled flows are average per day (the day salinity measurements were taken).
Staff Response: Yes, the modeled flows are daily averages.
Martyn's Comments
Thanks. 100 to 650 is hard to comprehend all those changes over the time frame. At least these extremes averages at 375 cfs almost the same as the long term discharge 374 cfs yeild by the model.

As regards salinity habitats in Kings Bay and my asking where the large amount of inflow goes, I for one, do not see this as an "academic exercise". The model grid Figure 2-7 shows the model going out to Shell Island so presumably it should be capable of predicting where the high salinity areas are during a 24.84-hour tidal cycle.
Martyn's Additional Comment
How can the model predict temperature/Thermal Refuge throughout the bay but not salinity? Sorry, but this does not make sense to me.

Staff Response: The hydrodynamic model developed for the minimum flow analyses can be used to predict water temperature and salinity throughout the bay/river system.

I will look closer and send more detailed comments, but I remain very concerned that again SWFWMD does not have a logical fact supported explanation of the discharge from the Group 2 springs varying from zero to 250 cfs. Frankly, I am not "surprised" there is no logical fact 2

supported explanation because Figure 2-4 data is not correct. Anyone who has enjoyed watching the springs intuitively knows this is not reality. Sorry, I will keep open mind for an explanation, but the whole model output lacks credibility with this as a basis.
Martyn
Martyn
Martyn
Email string included in Mr. Johnson's email
From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us> **Sent:** Friday, December 16, 2016 4:00 PM **To:** martynellijay@hotmail.com **Cc:** Xinjian Chen; Gabe I. Herrick **Subject:** Recent inquiries on MFLs
Martyn:
Thanks for your recent emails and contributions to the Crystal River peer review process. The attached PDF file includes your emails and associated attachments with imbedded responses from District staff. Also attached is an Excel file that contains discharge data that you requested.
Note that the PDF file includes information pertaining to a file containing water quality data that you requested that is too large to send be email (and has been posted to the District FTP site for you to retrieve) as well as links to a U.S. Geological web site where real-time data that you asked about can be obtained.
Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org
From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com] **Sent:** Wednesday, December 21, 2016 8:47 AM **To:** Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us> **Cc:** Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>; Ross Morton <Ross.Morton@swfwmd.state.fl.us> **Subject:** Crystal River/Kings Bay Response to MJohnson 3

As the Christmas Season approaches I will cover some more key points from my review of the response sent by Doug last Friday and leave more details for 2017. For those who may not have time right now to read on, let me wish you all a Very Merry Christmas and Best Wishes for 2017. XLS file Group 1 In my initial analysis of the data I highlighted each high and low tide, then looked at the discharge measured during those periods where the stage changes are small. Some may recall my comment that at low tide the flow thru X-section will be spring discharge (no tidal/stage assignable flow). The data discharges at these times are remarkably consistent, typically 60-65cfs. I then looked at the discharges measure at high tide, again those periods when there is no tidal/stage assignable flow, the disharges are remarkably consistent and in the same range. This gives strong indication that the differences in spring discharge for Group 1 does not change as presented in

Figure 2-4 (40 to 80+cfs from high to low tide). I then looked at the inflows and outflows during each tidal cycle thru the 15 minute intervals; while I have only had time to look at the first few cycles the net flow each interval match well with net flow needed to account for the change in stage given constant spring discharge. The stage information used by VBH is from the USGS Gage Site (corrected to MSL for some reason), from the discharge data the high and low tides at the X-Section are about 15 minutes later than at the USGS Gage Site at the mouth of Kings Bay 02310742. This is strong evidence the spring discharge from the vents in Group 1 do not vary significantly with tide, which is also supported by the VBH measurements at these individual vents.
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Staff Response: The baseline flow condition for any MFLs system is the flow or stage in the absence of groundwater withdrawals. Groundwater withdrawal impacts to the Crystal River/King's Bay system are predicted by the NDM 5 regional groundwater flow model and a water budget of the springshed based on recent pumping history.

The groundwater flow model predicts a little over one percent of flow is reduced by current groundwater withdrawals. There is not a one-to-one relationship between groundwater withdrawn in the springshed and flow changes at the King's Bay springs. When water is withdrawn from the Upper Floridan aquifer in the springshed (or the much larger regional groundwater basin) it can come from changes in storage (water level decline), leakage from the overlying surficial aquifer, lakes and wetlands, reductions in evapotranspiration (ET), runoff, and diffuse groundwater seepage to the coast, and seepage to lakes and rivers. In the water budget used in the MFLs approach, we conservatively estimate a high groundwater impact by assuming every gallon of consumptive-used groundwater in the springshed results in a gallon decline in springflow. The U.S. Geological Survey has estimated, on average, that 45% of water withdrawn in the state is consumptively-used. Based on the results of the conservative water budget and NDM 5, staff estimated current groundwater impacts to the Crystal River/Kings Bay system springflow of one to two percent.
Martyn's Comments
The main objective of the NDM is to estimate the effects of groundwater withdrawals on water flows in the area and very specifically spring discharge. The Model, as I understand is built to take into account some of the factors you mention…if not it is of less value than I previously gave it credit for.
Note
Specifically expressed in Versions prior to Version 5 there is a statement pointing out the model is more appropriate for regional rather than local hydrological conditions.

I recall a discussion at one of the public meetings on Chass or Homosassa MFL which identified a reduction in the estimated 'private well' and metered 'public supply' withdrawals of 50-60% (best I recall) in the construction of the model to account for water going back to the aquifer as recharge (septic tanks/sewer systems). The discussion (best I recall) mentioned no similar accounting for commercially meter withdrawals such as golf courses and agricultural as higher percent is 'lost' (recycled) due to high rates of evapotranspiration. And it was pointed out withdrawals that make it to the ground can take years to get back to the levels from which the water came. I agree a perfect one for one is not realistic, but over two to one is the point I was making. After all the aim of the model is to help with Regional Water Supply Planning so the one for one concept (given the adjustments mentioned above) is practical.
Furthermore, please note for springs discharging into Kings Bay the "Observed Flows", model inputs, have remained the same in all versions. These figures are notably higher than the long term discharge of 374 cfs in the MFL Report for the District Model.

Staff Response: Staff notes that a report on the Northern District Model (NDM) version 5.0 and a peer review report for the model are available from the SWFWMD WebForum. The reports were posted to the peer review category for the minimum flows and levels for the Rainbow River System. Links to the model report and peer review report are provided below.

SWFWMD WebForum >
Minimum Flows and Levels for the Rainbow River System >
Final NDM Version 5.0 Report >
https://swfwmd.discussion.community/file?id=3088247

SWFWMD WebForum >
Minimum Flows and Levels for the Rainbow River System >
Peer Review of the NDB Versions (sic) 5 and Predictive Simulations >
https://swfwmd.discussion.community/file?id=3100231

Thermal refuge for manatee is shown in Table 3-3 of the MFL Report as finite areas and volumes for various percentage reductions in baseline flow**. What is this baseline discharge cfs associated with these finite areas and volumes?** Is it the non pumping figure from Table 1=2 which is 448.99 cfs, it appears not. It appears to be the discharge as predicted by the model for the coldest 72 hour period shown in Figure 3-2 (coldest 72 hours starting at 8:00 am 1/10/2010) divided by 0.98. Presumably the spring discharge is averaged over the 72 hour period so this baseline is the spring discharge divided by 0.98. Once you focus in on the modeled spring flow for these 3 days, think about this as regards the average withdrawals 15 mgd shown in Figure 1-14. **Maybe the focus needs to be on Maximum Withdrawals (a finite number) non minimum flows relative to an ever changing baseline.**
Staff Response: Table 3-3 in the MFLs report shows minima of 4-hour moving averages of >15 $_{o}$C water volume and surface area during the acute condition. Baseline flow during the 4-hour period varied between about 41 cfs to about 511 cfs.
Martyn's Comment
Unfortunately, it is not clear if the 41 cfs to about 511 cfs is during a 4 hour period or thru the entire 72 hour period. I suspect the latter is more likely. As I suggested Monday it would be helpful to see the spring discharge for the 72 hour period. Please share if possible.

Staff Response: The requested discharge information is included in an Excel file named *Model output of SGD for baseline* that will be provided in electronic format in conjunction with this response document. The 72-hour period with the coldest moving average water temperature in the Crystal River/Kings Bay System is from 8:00 a.m. on 1/10/2010 through 8:00 a.m. on 1/13/2010. This period corresponds to hours 87896.0 to 87968.0 in the Excel file.

Staff Response Yes Spring 32 Regarding budget restrictions I am pleased someone is attempting to control expenditure of taxpayer money. However, I do not see the main objectives of the 2012 contract with VHB in the data returned (only the contract can show this). Most of the work is a repeat of individual spring vent measurements and the G1 and G2 X-Section flow. The later appears not used in any analysis such as: do the C1 and C2 determined by 'trial and error' for 2009 fit the 2012 flows. Why Springs 32, 35 and 39 were chosen for monitoring is unclear (was there an attempt to justify the idea of reverse flow into the vents, just a small may be) but the data is what we have so what does it indicate. The discharge measurements on 9/21/2009 were: 13:37 51.55 cfs 13:41 62.65 cfs 13:43 47.52 cfs These were made at the time of a rising tide (13:30 gh -0.71 and 13:45 gh -0.57 per USGS, VBH indicate rising tide expressed as MSL). So how is this data interpreted? At best it is indicative of accuracy; with a 20% increase followed by 25% decrease within 6 minutes. Discharge measurements on 10/29/2012 (gh from USGS) were: 08:50 43.86 cfs @ gh -0.31 10:48 51.19 cfs @ gh -1.02 12:29 42.46 cfs @ gh -1.23 14:33 37.35 cfs @ gh -0.19 15:55 26.75 cfs @ gh 0.65 16:59 23.85 cfs @ gh 1.03 So the high figure you reference of 51.19 cfs is the next to lowest stage. The next measurement 42.46 cfs at a lower gh is 20% lower (gh change of -0.2 feet if the hypothesis holds it should have been higher). The next measurement 37.35 cfs is 21% lower for an increase in gh of over a foot, this is directionally in line with the hypothesis but with less change than other measurements suggest . Agreed there is some trend indication in this very limited data but it is not consistent. So lets look at the discharge on 11/06/2012: 08:08 29.41 cfs @ gh 1.93 09:22 32.68 cfs @ gh 1.55 10:36 32.35 cfs @ gh 1.05 11:48 39.63 cfs @ gh 0.50 14:06 43.83 cfs @ gh -0.31 15:42 39.47 cfs@ gh -0.06 17:03 37.46 cfs @ gh 0.53 The highest discharge 43.83 cfs is at the lowest gh and the lowest discharge29.41 cfs is at the highest gage height. The difference for 2 feet difference in gh is 25%; given the implied accuracy question this is slim evidence.
These data may indicate a slight trend but are nowhere near the magnitude we are seeking to explain the discharge figures in Figure 2-4, which was **THE VERY POINT MADE IN MY INUT FOLLOWING THE DEC 5 MEETING** and yes I did share the gage height figure handwritten onto the sheet. What is most noteworthy about these two sets of data is the ***AVERAGE of 10/29/2912 is 37.5 cfs and 11/06/2012 is 36.4 cfs…possibly more evidence that spring discharge is little influenced by tide*** *(note the average gh for 10/29 is -0.18 and for 11/06 is 0.74).* ***Coincidence? may be, may be not.*** Looking at the discharges for Spring 35 does not help confirm even a slight trend. The discharge for Spring 39 is most helpful in that it has discharge taken 2 to 3 minutes apart which often show wide variation indicative of previous mention of accuracy which is most likely more of an issue at low discharge. Most concerning about Springs 35 and 39 is the Average discharge in 2009 data was 19.71 cfs SV35 and 11.25 cfs SV 39 which are considerably higher the 2012 measurements. To coin Dan Yobbi's phrase used in his December 15, 2014 memo (in the appendices), this not 6

”convincing field evidence”. Dan’s memo makes interesting reading and clearly states the use of VHB data collected over a short period of time is not a long term average. I COMPLETELY AGREE, and will add once again measuring spring discharge into Kings Bay is not an easy task.

Staff Response: At the time when the 2012 contract with VHB, Inc. was executed, the District had already developed an empirical formula for estimating submarine groundwater discharge (SGD) to Kings Bay and a hydrodynamic model that used this SGD formula. Because of the limited time period of the 2009 flow measurements at G1 and G2 made previously by VHB, Inc., it was necessary to collect more flow data at G1 and G2 to validate the empirical formula and the formula coefficients. That was the main purpose of the 2012 contract with VHB, Inc. Springs 32, 35, and 39 were chosen for assessment because they are not part of G1 or G2 springs, and we were interested in determining whether they experience tidal influence similar to that of the G1 and G2 springs. As noted in Chen’s 2014 report, “On the estimation of Submarine Groundwater Discharge to Kings Bay”, there is a phase shift of about 160 – 165 degrees between SGD and tides. Therefore, the lowest water level does not correspond to the highest spring flow. Another factor that needs to be considered is the groundwater level, which also exhibits significant tidal signals.

Martyn’s Comments

If the main purpose was validation it is difficult to understand why this was not mentioned in the 2014 documents or the MFL Report. By visual assessment of the graphic data in the memo from VHB regarding the 2012 work, there is slim indication the discharges were higher than in 2009. This is supported by higher water levels in some of the major monitoring wells in the area and analysis of Bagley Cove discharge: not Romp TR21-3, which is so close to the coast it is tidally influenced.

I recall the ‘shift’ mentioned in Chen 2014 final, not mentioned in the article in JMS. I find it hard to accept the explanation of ‘reverse flow’ into the vents be it physical or some pressure wave. In a recent e-mail I mentioned the discharge data in the Group 1 xls file indicated a later high tide at the X-Section by about 15 minutes and asked if there were other gage sites that may help identify this. The data available so far from Saragassa Canal 02310740 confirm this, and further show the gage ht at high tide to be higher. I had previously identified a difference in the high tide stage ht at Mouth of Kings Bay vs Bagley Cove.

As the gage at Mouth of Kings Bay has been inoperative since late May, I recently made a direct comparison with Bagley Cove and Saragassa Canal: this frequently shows the new gage site to be 0.13 to 0.17 feet higher at high tide. These two factors logically account for the ‘shift’ which Chen 2014 final attributed to…see if I can find the quote quick.

“*From field data, it was found that there is a phase shift of about 160 – 165 degrees between spring discharge and tides, which is a little different from previous studies that reported a 180- degree phase difference between tides and SGD. This discrepancy indicates that spring discharge is not only controlled by the head difference between ground water and the water surface elevation in Kings Bay, but also affected by the propagation of the tidal waves through the spring vents and into the aquifer. The effect of the tidal propagation into the aquifer through the vents can be taken into account by including the time derivative of surface water elevation, and the final form of the empirical formula for SGD to the system is a linear combination of the time derivative of the surface water elevation and the head difference between groundwater level and water surface elevation in the bay.*

Regarding the tidal signature at Romp TR21-3, again I have noted this in an e-mail and identified the high level to lag the high at the Mouth of Kings Bay by about 45 minutes.

I wish you all a Merry Christmas,
Martyn

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com] **Sent:** Tuesday, January 03, 2017 7:42 AM **To:** Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>; Ross Morton <Ross.Morton@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>
Subject: Saragassa Canal 02310740
Over the Christmastime I made a trip to observe the springs in Crystal River Group 2 and spoke to some property owners. Interesting comments, but this is anecdotal evidence and does not rank with computer models.
BUT
I did find a relatively new USGS Gage Station 02310740 While this does not currently report discharge some of other parameters reported since June 2016 do show some interesting information. Notably the regular inflow of water of 4000-6000 specific conductance, which indicated water of this nature is frequently close in Kings Bay to this X-Section. The relation with the lunar tidal cycle is readily apparent in the data. Appears the Review Panel on the Field Visit were not made aware of this development. 7

It will be interesting to see the discharge data over the next year.
Martyn
Staff Response: The U.S. Geological Survey Saragassa Canal at Crystal River FL (No. 02319740) gage site was recently installed as a cooperative effort with the District. Data collection at this site was initiated in mid-2016 is expected to eventually yield useful discharge information.
Martyn's Comment
Fully agree and thanks to who initiated this request and got funding. Once we sort out how to interpret the discharge data it will be very valuable in tracking changes in the discharge to Kings Bay. Probably one of the best decisions for Kings Bay in years. THE GREAT DISAPPOINTMENT IS THERE IS NO NITRATE?NITRITE MONITOR. GIVEN THE SWIM PROGRAM IMPORTANCE I WOULD HOPE THIS AN EASY ADDITION.

Staff Response: Monitoring of water quality at several spring vents contributing to the flow past the Saragassa Canal gage site is ongoing as part of the District's Quarterly Spring Monitoring Network.

Email string included in Mr. Johnson's email
From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com] **Sent:** Tuesday, January 03, 2017 7:18 AM **To:** Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Ross Morton <Ross.Morton@swfwmd.state.fl.us>; Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us> **Subject:** Fw: Rainbow River Review
RAINBOW RIVER MFL REMINDER
The concerns I raised in my November 14 e-mail regarding the inaccuracies in the discharge data used to develop the Rainbow River Model have so far not been addressed or brought to the attention of the Review Panel. This is disappointing.
I also forwarded the USGS 'look up tables' which further support the concern I raised about additional spring water discharge below the newer USGS Gage Site 02313098. This information also appears to make the idea of backwater effects on the long term gage site discharge data invalid or rarely significant.

The Review Panels Report includes some very telling comments (which I essentially agree with):
Quote
The Panel finds the 2000 flow anomaly a potentially interesting harbinger of change. The springshed is clearly yielding less flow than expected since 2000. Based on the double mass analysis it appears that current flows are substantially below the MFL and there is nothing in the report that assures recovery to the MFL. The Panel understands that the cause is unknown, while groundwater models suggest that local pumping is not the cause, the Panel has major concerns that the flow anomaly must be considered a "departure from natural flow". Resolving the origin of the anomaly is critical to defensibly conclude that the Rainbow River System is, in fact, not impaired and in need of a recovery plan. The Panel appreciates that MFL reports are living documents, updates and improvements should clearly describe knowledge gaps, and that remedying these gaps are a District priority.
End Quote
And
In the absence of key supporting data, the District should consider capping withdrawals at current levels (or with a minimal allowable increase) until the nutrient issues are effectively addressed. In particular, consideration should be given to allow no reduction in flow unless there is a corresponding decrease in loading so that there is no net increase in projected nitrate concentrations. If this cannot be done, the District needs to be explicit as to the water-quality implications of the proposed MFL.
End Quote 8

No doubt the Board (as well as myself) will be interested to hear Staff's Response to these concerns raised by the panel.
Martyn

Email string included in Mr. Johnson's email

From: Alan Martyn Johnson <martynellijay@hotmail.com> **Sent:** Monday, November 14, 2016 8:40 AM
To: Doug Leeper; Ron Basso; Melissa Gulvin **Subject:** Rainbow River Review 1
Doug, Ron and Melissa,
Last week I received answers to some of my questions from USGS regarding the Rainbow River MFL so I have pulled together some of my comments.
For ease of reading I have put my comments in a word file for you to consider.
I have major concerns regarding the work by ECT. Who was responsible for reviewing the work done by ECT or was it just accepted without question?
I am still waiting for USGS to provide the discharge equations for the two gage sites on Rainbow River. These may address some of the other concerns I have regarding flows.
In addition I have comments regarding the analysis of water quality data, fish data and floodplain habitat which I will address later.
Regarding Crystal River Kings Bay Review tomorrow, what is the room location at the Brooksville Office, I hope to be able to attend in person.

Martyn

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Monday, January 9, 2017 3:02 PM
To: martynellijay@hotmail.com
Cc: Xinjian Chen; Gabe I. Herrick; Ron Basso
Subject: Recent inquiries on Crystal MFLs

Martyn:

Thanks for your recent emails concerning development of minimum flows for the Crystal River/Kings Bay system. The attached file includes several of your emails and associated email strings with imbedded responses from District staff.

We are currently reviewing your recent emails and comments on the minimum flows proposed for the Rainbow River system and hope to soon send a relevant response.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Monday, January 09, 2017 8:46 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Ross Morton <Ross.Morton@swfwmd.state.fl.us>; Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>
Subject: Staff Responses Thermal Refuge December

The weekends cold weather make today an appropriate time to look at Thermal Refuge for manatee and the responses sent in the December 16 e-mail attachment from Doug. I have highlighted my comments yellow to help identify them easily.

To save time the relevant questions/responses are:

December 9 e-mail Subject Thermal Refuge for manatee Kings Bay

The Crystal River Kings Bay MFL Report states:
Page 53
Quote *The UnLESS3D model was able to predict volume and area of water in different temperature fractions throughout the bay. During the coldest 72 hours of the time period modeled, 85% of baseline flow is required to preserve 85% of the volume of water >20°C and deeper than 3.8 ft (Table-3-2, Figure 3-2). During time period with the smallest overall volume of thermal refuge from acute cold stress the volume of refuge was less sensitive to reductions in flow than at other times, however this is the most critical time period corresponding to the unusually cold winter of 2009 - 2010 (Table 3-3, Figure 3-3). At their smallest values, the total volume and area of water warm enough for manatee thermal refuge is sufficient to allow for several hundred thousand manatees.*
End Quote
And Page 63
Quote

Although a reduction to 91% of baseline discharge will result in a 15% decrease in acute thermal refuge volume, there will still be enough warm water present for every manatee in the world ten times over (refer to Table 3-2). Thus, we do not find it appropriate to set minimum flows for the Crystal River/Kings Bay system based on manatee thermal refuge, as there appears to be more than enough to sustain the population given present rates of growth. This position is consistent with a report submitted to the U.S. Fish and Wildlife Service, which concluded that warm water is far more abundant than required to support Florida manatee populations, and that manatee protection should focus on forage as the factor limiting population size (Provancha et al. 2012). End Quote

It is unclear where the input data for temperature in this model is obtained from. Could you confirm the source of temperature input data? Is it the temperatures as measured in the VHB reports for each spring, average from VHB or some other source.

Staff Response: At the downstream boundaries, measured temperature data were used as model input. For spring flows, temperature is assumed to be nearly constant. The measured temperature in July – October 2009 by VHB was about 23.4^{o}C for all spring vents. The model used this temperature for the entire 9-year scenario simulation period, with a small adjustment to allow spring flow during winter months to be slightly colder. At the free surface, heat flux was calculated using measured data for wind, solar radiation, air temperature, and air humidity.

Martyn's Comment
Thanks for the answer. So the temperature input for spring water was 23.4^{o}C for the entire 9 year period with some undefined slightly lower temperature during winter months. This means the temperature of spring discharge was slightly less than the 23.4^{o}C during the defined 72 hours coldest period modeled starting 8:00 am Jan 10, 2010.
From the Response below the temperatures at USGS gate Stations Bagley Cove and Mouth of Kings Bay were also used as model INPUTS (along with the wind, solar radiation, air temperature and air humidity). This leaves the other critical inputs:

- Spring discharge for that defined 72 hour timeframe, which is modeled spring water discharge, and
- Inflow/outflow of river water, which presumably is obtained from a derivative of gage height changes at the Mouth of Kings Bay as you consider Bagley Cove discharge data 'unreliable', and
- Area/ depth profile of Kings Bay

So the model was used to 'predict' the area and volume of water at different temperature fractions throughout the bay (See purple quote above).
NOW AS SPRING DISCHARGE CHANGES THE AREA AND VOLUME OF THE TEMPERATURE FRACTIONS THROUGHOUT THE BAY VARIES SO THE FINITE VOLUME AND AREA IN TABLE 3-3 ARE PRESUMABLY AVERAGES DURING THIS DEFINED 72 HOUR PERIOD (THIS PRESUMPTION IS FROM FIGURE 3-2 WHICH STATES AVERAGE). SIMILARLY THE SPRING DISCHARGE MUST BE THE AVERAGE**……..SO WHAT IS THE SPRING DISCHARGE?** BY IMPLICATION THIS FIGURE IS THE EXISTING (MODELED) DISCHARGE FOR THE PERIOD. IS THIS NOT THE BASELINE FOR TABLE 3-3?
No doubt you can show the spring discharge for each for each 30 minute interval during the

defined 72 hour period, but the average is fine; would be interesting to see the 30 minute discharges if you have time.

Staff Response: As noted in a response above, the requested discharge information is included in an Excel file named *Model output of SGD for baseline* that will be provided in electronic format in conjunction with this response document. The 72-hour period with the coldest moving average water temperature in the Crystal River/Kings Bay System is from 8:00 am on 1/10/2010 through 8:00 a.m. on 1/13/2010. This period corresponds to hours 87896.0 to 87968.0 in the Excel file.

So far I have not found any field studies/data which can be used to verify the output of the model. Does anyone know of any field studies of temperature during winter months.

Katie, Do you know of any field studies/data or even thermal imaging?

Staff Response: The model was calibrated and verified against measured temperature data collected by the U.S. Geologic Survey at Bagley Cove and the Mouth of Kings Bay with a time interval of 15-minutes.

Martyn's Comment
It is not clear how the same data (measured temperature at the USGS Gage Stations) can be used for both calibration and verification. Surely verification must be by comparison to an independent data set i.e. non input data.

Staff Response: The model calibration and verification periods were different as noted in section 4 of the hydrodynamic model report includes as an appendix to the draft minimum flow report.

Table 3-3 presents the volume and area of thermal refuge. **What baseline flow is used in modelling these volume and area figures.?**

Staff Response: As noted in responses provided above, baseline flow varies with time and is not represented by a single value. It was calculated internally within the model based on the groundwater level in the ROMP TR21-3 well and the water level in Kings Bay.

Martyn's Comment
Table 3-3 is very specific about a defined 72 hour timeframe. The spring discharge calculated by the model (based on Equation 1) are used in the model to 'predict' these finite area and volume figures which are AVERAGED over this very specific time. So the modeled spring discharge is specific to this defined timeframe and you can express it as baseline, existing or however you choose but it is specific to that timeframe. So must be the spring discharge.

I will address baseline and the NDM at another time.

Martyn

P.S. I have not yet been able to find Provancha 2012 in total, but some abstracts focus attention on available forage for Crystal River.

Those are my specific comments on the Staff Responses regarding thermal refuge for manatee, but let me point out the MFL Report focuses on water greater than 15°C leaving the more important, water greater than 20°C, unanswered. Water with temperature higher than 20°C is what the manatee need to survive…the real 'manatee refuge'. May be it is political expedience that drives presentation of these larger areas and volumes and associating them the world manatee population. What happens after 4 hours? Just a thought!

Staff Response: The minimum flow analyses included assessments of flow-related changes in "chronic" and "acute" thermally favorable habitats for manatees, with chronic habitat associated with water greater than 20°C during 72-hour periods and acute habitat associated with water greater than 15°C for 4-hour periods. Based on hydrodynamic modeling results we found that area and volume of acute habitat was more sensitive to changes in flow than the area and volume of chronic habitat as indicated in Table 3-2 within the draft minimum flows report.

Martyn

From:	Doug Leeper
To:	"martynellijay@hotmail.com"
Bcc:	Gabe I. Herrick; Xinjian Chen; Ron Basso; Jennette Seachrist; Eric DeHaven; Melissa Gulvin; Ross Morton; Mark A. Green
Subject:	RE: Jan 11 email on the Crystal MFLs
Date:	Wednesday, January 18, 2017 9:13:00 AM

Marty – A correction…four attached Excel files sent with my previous email.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Doug Leeper
Sent: Wednesday, January 18, 2017 9:09 AM
To: 'martynellijay@hotmail.com' <martynellijay@hotmail.com>
Subject: Jan 11 email on the Crystal MFLs

Martyn:

Thanks for your January 11, 2017 email concerning development of minimum flows for the Crystal River/Kings Bay system. The attached PDF file include your email with imbedded responses from District staff. Also attached are three Excel files that include data you requested as discussed in the PDF file.

Doug Leeper
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doug.leeper@watermatters.org

From:	Ross Morton
To:	Doug Leeper
Subject:	FW: Jan 11 email on the Crystal MFLs
Date:	Wednesday, January 18, 2017 11:56:12 AM

Ross T. Morton, P.W.S., CO-OP®, F.S.C.C.M.
2379 Broad Street
Brooksville, FL 34604-6899
Mobile/Office Phone (352)796-7211, (863)534-1448, (813)985-7481, & (941)377-3722
Ext. 6500
Email: ross.morton@watermatters.org
About The Ombudsman: http://www.swfwmd.state.fl.us/about/staff/ombudsman.php

---

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Wednesday, January 18, 2017 9:17 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: Re: Jan 11 email on the Crystal MFLs

Doug,
No problem.
Thanks,
Martyn

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Wednesday, January 18, 2017 9:13:22 AM
To: martynellijay@hotmail.com
Subject: RE: Jan 11 email on the Crystal MFLs

Marty – A correction…four attached Excel files sent with my previous email.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
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doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Wednesday, January 18, 2017 6:43 PM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: Fw: Jan 11 email on the Crystal MFLs

Doug,
Think I have figured out part of the problem; there were two time periods for the G1 monitoring in 2012. Somehow the files covering each of these must be cross-referenced.
Martyn

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Wednesday, January 18, 2017 6:28 PM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: Re: Jan 11 email on the Crystal MFLs

Doug,
I should not have used the term 'No problem' because Murphy was watching!!
Three of the files will open, one will not.
The file for Group 1 (must be 2012) will not open message is:
""Could not be opened due to unsupported features
-Charts or objects with external references (links to other workbooks)""
May be this xl message will help locate and combine the needed link.
FYI The Group 2 2012 has Date, Time, Datum adjusted GH and Discharge i.e. much abbreviated from the 2009, but I think it will work for me.
Martyn

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Wednesday, January 18, 2017 9:09 AM
To: martynellijay@hotmail.com
Subject: Jan 11 email on the Crystal MFLs

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From:	Doug Leeper
To:	"martynellijay@hotmail.com"
Bcc:	Xinjian Chen; Gabe I. Herrick; Ron Basso; Ross Morton; Melissa Gulvin; Mark A. Green; Jennette Seachrist; Eric DeHaven
Subject:	Inquiry - Group 1 Discharges and Plot 2013WY
Date:	Thursday, January 19, 2017 3:30:00 PM
Attachments:	Group 1 Discharges and Plot 2013 WY.xlsx Group 1 Discharges and Plot 2013 WY.pdf

---

Martyn:

The file **Group 1 Discharges and Plot 2013 WY** file opens for me. I'm resending the original Excel file and a PDF version as well.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
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doug.leeper@watermatters.org

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FYI The Group 2 2012 has Date, Time, Datum adjusted GH and Discharge i.e. much abbreviated from the 2009, but I think it will work for me.

Martyn

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Sent: Wednesday, January 18, 2017 9:09 AM
To: martynellijay@hotmail.com
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352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Doug Leeper
To: "martynellijay@hotmail.com"
Bcc: Gabe I. Herrick; Xinjian Chen; Ron Basso; Ross Morton; Melissa Gulvin; Mark A. Green; Jennette Seachrist; Eric DeHaven
Subject: Inquiry-Crystal River KB 13 Zones
Date: Thursday, January 19, 2017 3:44:00 PM

Martyn:

In response to your January 17, 2016 email on the proposed minimum flow for the Crystal River/Kings Bay System I reposted the water quality database file (**CRKB_Combine.accdb**) to the "outgoing" folder of the District FTP site.

Here's a link to the "outgoing" folder:
ftp://ftp.swfwmd.state.fl.us/pub/outgoing/

If the link above does not work, please follow the directions for accessing information from the "How to Access Our Anonymous FTP Server" page of the District web site at the link below.
https://www.swfwmd.state.fl.us/data/ftp/

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Tuesday, January 17, 2017 9:57 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: Crystal River KB 13 Zones

Doug,
Data for 13 Zones
December 16 you provided me with a link to the data.
CRKB_Combined.accdb, in the "outgoing" folde: ftp://ftp.swfwmd.state.fl.us/pub/outgoing/
I downloaded the large folder and decided to focus attention on salinity (easy to measure and not seasonal), so I Saved the section which appeared to contain the Zones and Salinity data.
I did not have time to look any further (family visiting from England more interesting!!) until this last weekend. The data is 2000 to 2005 the majority of which is Zone 3 with some for Zone 1.

Appears I saved the wrong part of the folder, although I did not see anything other than this, regarding Salinity/Zones The accdb file is no longer in the outgoing folder.
Would appreciate if you could have someone repost it; and possibly provide help navigating to salinity.
When making the request I assumed someone had extracted/analyzed the data as it is mentioned in the report.
Thanks and sorry for the inconvenience.

This data is far less important than the VHB xls files for G2 2009 and G1 and G2 for 2012.

Doug,
I have some appreciation of the workload you all must be under to meet concurrent deadlines for a number of MFLs, but the credibility of the models, very specifically the Kings Bay one is critical. 'Uncertainty' is raised a number of times in the CRKB Peer Review Report. My concern with the District model goes much further than 'uncertainty';, however, I am still open to the, so far elusive, shred of logical factual evidence needed to gain credibility. The comment 'should not be a surprise' just does not make the grade.

Thanks for the work you do in organizing responses to my questions and comments.

Martyn

From:	Ross Morton
To:	Doug Leeper; Ron Basso; Xinjian Chen; Gabe I. Herrick; Melissa Gulvin; Chris Anastasiou; Kurt Fritsch
Subject:	Why are Kings Bay Springs different? Monday 9:30 am January 23 coffee, donuts, cookies
Date:	Thursday, January 19, 2017 9:45:05 AM

FYI – If you have any question give me a call. A public record request was not discerned, so any response is at your discretion. I would suggest to coordinate any response through Doug.

Ross T. Morton, P.W.S., CO-OP®, F.S.C.C.M.
2379 Broad Street
Brooksville, FL 34604-6899
Mobile/Office Phone (352)796-7211, (863)534-1448, (813)985-7481, & (941)377-3722
Ext. 6500
Email: ross.morton@watermatters.org
About The Ombudsman: http://www.swfwmd.state.fl.us/about/staff/ombudsman.php

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Thursday, January 19, 2017 8:22 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Ross Morton <Ross.Morton@swfwmd.state.fl.us>; Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>; Mike Heyl <mike.heyl@swfwmd.state.fl.us>; Sky Notestein <Sky.Notestein@swfwmd.state.fl.us>; Chris Anastasiou <Chris.Anastasiou@swfwmd.state.fl.us>
Subject: Why are Kings Bay Springs different? Monday 9:30 am January 23 coffee, donuts, cookies

My e-mails are often long and detailed, in the weeds you may say.

Today and thru the weekend I would encourage you individually to forget about the devil in the detail and to cogitate the following:

What makes Kings Bay Springs so unique that discharges change in some springs two fold from high tide to low tide and other springs more like a hundred fold?
Other springs in the area such as Chassahowitzka and Homosassa do not exhibit changes anyway near this magnitude.

I believe that many ideas and answers come from coffee machine conversations. Consequentially, I hope to discuss your thoughts and ideas from your weekend cogitations by planning to be in the Brooksville Office Cafeteria about 9:30 am Monday January 23. I will be there from 9:00-10:00 with donuts and cookies (I assume the caferteria is open for coffee at that time) and will pay for coffee.

Martyn

The following points may be helpful to frame your thoughts and the discussion. If you are not available you can return your thoughts/ideas by e-mail.

1. Do I agree the discharges vary as per the District Model. Yes or No.

2. I think Kings Bay Springs are different to other springs in the area because….

3. I think there is some tidally related variation in Kings Bay springs discharge which is:
   a) a little less,
   b) about half or,
   c) much less,
   than the District Model predicts.

4. I have had doubts about the changes such as 0 cfs to 250 cfs for G2 springs, but consider model data the best available. Yes or No.

From: Doug Leeper
To: "martynellijay@hotmail.com"
Cc: Gabe I. Herrick; Ron Basso; Xinjian Chen; Melissa Gulvin; Ross Morton; Kurt Fritsch; Sky Notestein; Chris Anastasiou
Subject: Response to meeting invitation for Jan 23
Date: Friday, January 20, 2017 3:56:00 PM

Martyn:

I can meet with you in the District cafeteria prior to 10:00 am on Monday, January 23rd. Please note that I have another meeting scheduled for Monday morning from 10:00 to 11:30 am, so I would have to wrap-up our meeting by about 9:55 am. Please note also that XinJian Chen is on vacation through the early part of February and will therefore not be available to discuss any issues you may have. That's unfortunate as it seems to me that many of your questions are associated with modeling concerns. I also know for sure that Chris Anastasiou cannot participate as he has jury duty on Monday. In addition, Mike Heyl definitely won't be available – he has retired from the District.

Assuming you still plan on traveling to Brooksville, let me know whether you still plan to arrive at 9:00 am. I'll forward any response from you to those copied on your original email (with the exception of Mike Heyl) so they can determine whether they can participate in the planned meeting.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Thursday, January 19, 2017 8:22 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Ross Morton <Ross.Morton@swfwmd.state.fl.us>; Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>; Mike Heyl <mike.heyl@swfwmd.state.fl.us>; Sky Notestein <Sky.Notestein@swfwmd.state.fl.us>; Chris Anastasiou <Chris.Anastasiou@swfwmd.state.fl.us>
Subject: Why are Kings Bay Springs different? Monday 9:30 am January 23 coffee, donuts, cookies

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Martyn
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2. I think Kings Bay Springs are different to other springs in the area because….

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   b) about half or,
   c) much less,
   than the District Model predicts.

4. I have had doubts about the changes such as 0 cfs to 250 cfs for G2 springs, but consider model data the best available. Yes or No.

Group 2 2012 Data Questionable

11/4/2012 4:00	2.44	186.02
11/4/2012 4:15	2.55	80.21
11/4/2012 4:30	2.64	-30.36
11/4/2012 4:45	2.72	-58.36
11/4/2012 5:00	2.79	-77.16
11/4/2012 5:15	2.83	-77.44
11/4/2012 5:30	2.86	-99.86
11/4/2012 5:45	2.84	-93.97
11/4/2012 6:00	2.79	-101.21
11/4/2012 6:15	2.71	-101.72
11/4/2012 6:30	2.61	-84.85
11/4/2012 6:45	2.52	-89.33
11/4/2012 7:00	2.42	-90.71
11/4/2012 7:15	2.32	-85.70
11/4/2012 7:30	2.22	-70.35
11/4/2012 7:45	2.12	-53.10
11/4/2012 8:00	2.03	-47.62
11/4/2012 8:15	1.93	-46.67
11/4/2012 8:30	1.83	-18.30
11/4/2012 8:45	1.73	14.37
11/4/2012 9:00	1.62	58.87
11/4/2012 9:15	1.51	126.71
11/4/2012 9:30	1.41	177.98
11/4/2012 9:45	1.30	211.75
11/4/2012 10:00	1.19	246.30
11/4/2012 10:15	1.08	252.90
11/4/2012 10:30	0.97	240.89
11/4/2012 10:45	0.86	248.64
11/4/2012 11:00	0.74	257.36
11/4/2012 11:15	0.64	263.24
11/4/2012 11:30	0.54	259.90
11/4/2012 11:45	0.45	282.04
11/4/2012 12:00	0.35	307.66
11/4/2012 12:15	0.26	300.64
11/4/2012 12:30	0.17	307.48
11/4/2012 12:45	0.11	300.89
11/4/2012 13:00	0.04	317.77
11/4/2012 13:15	-0.02	319.01
11/4/2012 13:30	-0.02	315.39

negative flow after high tide. 3hours.

10/30/2012 1:45	2.55	258.81
10/30/2012 2:00	2.61	166.61
10/30/2012 2:15	2.65	68.69
10/30/2012 2:30	2.68	-20.11
10/30/2012 2:45	2.70	-48.28
10/30/2012 3:00	2.70	-54.02
10/30/2012 3:15	2.66	-62.62
10/30/2012 3:30	2.62	-63.73
10/30/2012 3:45	2.57	-76.82
10/30/2012 4:00	2.47	-89.97
10/30/2012 4:15	2.40	-87.46
10/30/2012 4:30	2.32	-86.48
10/30/2012 4:45	2.25	-75.10
10/30/2012 5:00	2.15	-66.38
10/30/2012 5:15	2.10	-52.79
10/30/2012 5:30	2.02	-47.68
10/30/2012 5:45	1.93	-35.21
10/30/2012 6:00	1.84	-38.32
10/30/2012 6:15	1.74	-8.81
10/30/2012 6:30	1.64	3.17
10/30/2012 6:45	1.54	38.55
10/30/2012 7:00	1.43	66.22
10/30/2012 7:15	1.33	110.57
10/30/2012 7:30	1.22	157.64
10/30/2012 7:45	1.11	207.94
10/30/2012 8:00	1.00	227.04
10/30/2012 8:15	0.89	251.47
10/30/2012 8:30	0.78	254.41
10/30/2012 8:45	0.68	251.68
10/30/2012 9:00	0.58	257.64
10/30/2012 9:15	0.49	263.42
10/30/2012 9:30	0.41	271.50
10/30/2012 9:45	0.34	278.03
10/30/2012 10:00	0.28	298.19
10/30/2012 10:15	0.25	297.26
10/30/2012 10:30	0.24	287.40
10/30/2012 10:45	0.28	296.05
10/30/2012 11:00	0.37	293.08
10/30/2012 11:15	0.49	290.26
10/30/2012 11:30	0.63	259.02
10/30/2012 11:45	0.77	259.72

negative flow after high tide 3 hours.

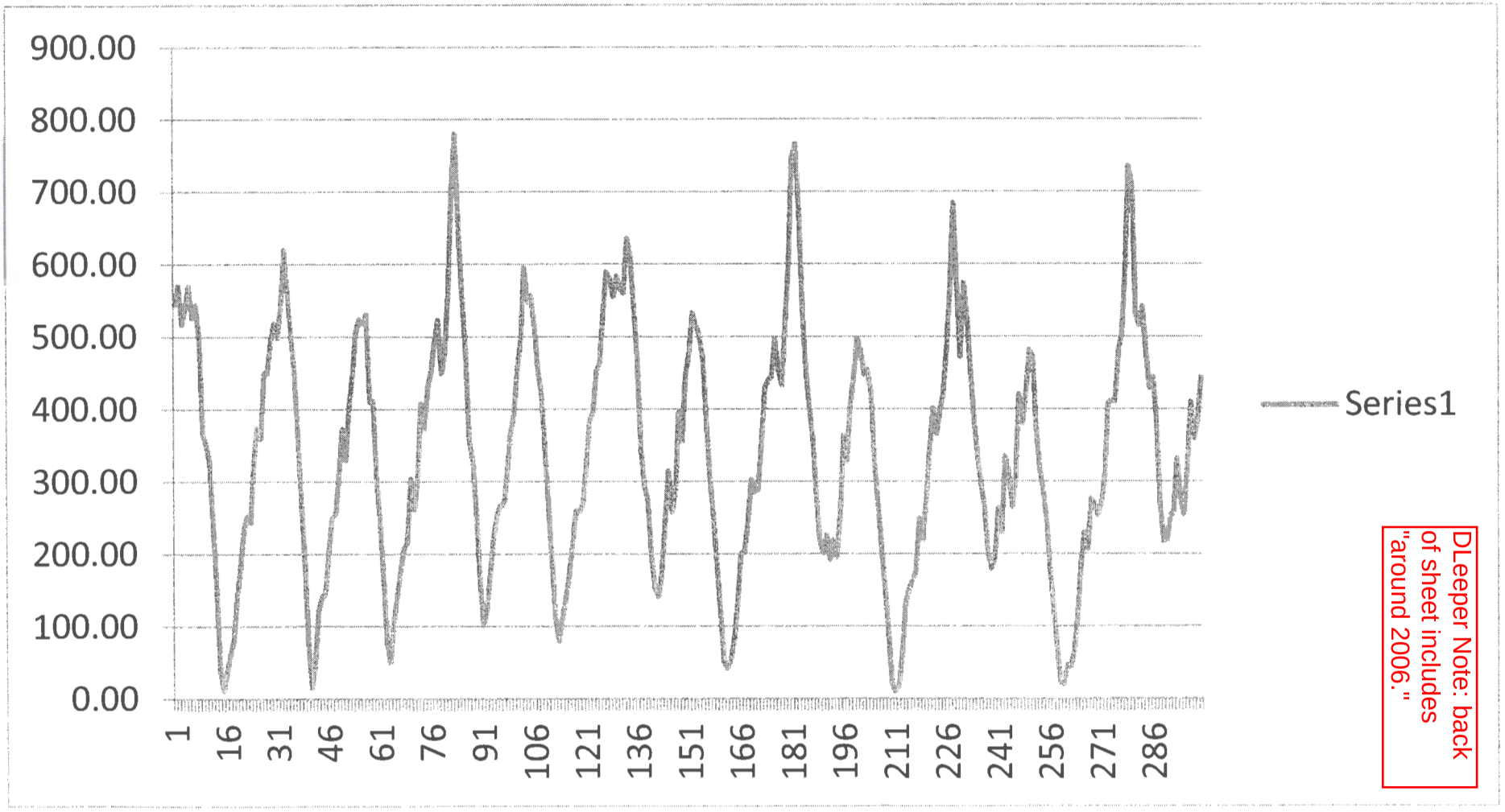
10/28/2012 23:45	1.69	339.65
10/29/2012 0:00	1.78	342.70
10/29/2012 0:15	1.88	332.27
10/29/2012 0:30	1.96	302.86
10/29/2012 0:45	2.04	275.56
10/29/2012 1:00	2.11	206.76
10/29/2012 1:15	2.18	111.73
10/29/2012 1:30	2.24	19.09
10/29/2012 1:45	2.29	-27.55
10/29/2012 2:00	2.34	-31.36
10/29/2012 2:15	2.36	-33.38
10/29/2012 2:30	2.36	-47.77
10/29/2012 2:45	2.34	-55.99
10/29/2012 3:00	2.31	-63.64
10/29/2012 3:15	2.22	-69.96
10/29/2012 3:30	2.15	-62.91
10/29/2012 3:45	2.08	-63.92
10/29/2012 4:00	1.99	-60.72
10/29/2012 4:15	1.91	-37.94
10/29/2012 4:30	1.83	-45.43
10/29/2012 4:45	1.75	-37.12
10/29/2012 5:00	1.66	-43.78
10/29/2012 5:15	1.57	-29.37
10/29/2012 5:30	1.49	-15.99
10/29/2012 5:45	1.38	-6.95
10/29/2012 6:00	1.28	17.00
10/29/2012 6:15	1.18	32.35
10/29/2012 6:30	1.07	59.90
10/29/2012 6:45	0.96	94.80
10/29/2012 7:00	0.86	143.35
10/29/2012 7:15	0.74	179.28
10/29/2012 7:30	0.65	190.00
10/29/2012 7:45	0.54	227.49
10/29/2012 8:00	0.44	228.04
10/29/2012 8:15	0.34	237.47
10/29/2012 8:30	0.27	241.19
10/29/2012 8:45	0.17	221.44
10/29/2012 9:00	0.09	256.14
10/29/2012 9:15	0.00	253.47
10/29/2012 9:30	-0.08	273.08
10/29/2012 9:45	-0.17	274.17
10/29/2012 10:00	-0.24	277.77
10/29/2012 10:15	-0.31	292.42
10/29/2012 10:30	-0.37	278.84

negative flow after high tide.
for over 2 hours+

10/26/2012 19:00	0.02	324.50
10/26/2012 19:15	-0.04	322.16
10/26/2012 19:30	-0.10	327.86
10/26/2012 19:45	-0.13	312.57
10/26/2012 20:00	-0.14	339.60
10/26/2012 20:15	-0.12	316.13
10/26/2012 20:30	-0.06	320.17
10/26/2012 20:45	0.04	330.45
10/26/2012 21:00	0.16	320.26
10/26/2012 21:15	0.28	324.29
10/26/2012 21:30	0.40	323.81
10/26/2012 21:45	0.53	321.22
10/26/2012 22:00	0.67	311.61
10/26/2012 22:15	0.81	290.16
10/26/2012 22:30	0.94	253.08
10/26/2012 22:45	1.07	194.85
10/26/2012 23:00	1.20	119.86
10/26/2012 23:15	1.31	60.51
10/26/2012 23:30	1.43	24.39
10/26/2012 23:45	1.53	2.53
10/27/2012 0:00	1.62	-26.73
10/27/2012 0:15	1.71	4.12
10/27/2012 0:30	1.79	5.34
10/27/2012 0:45	1.85	52.58

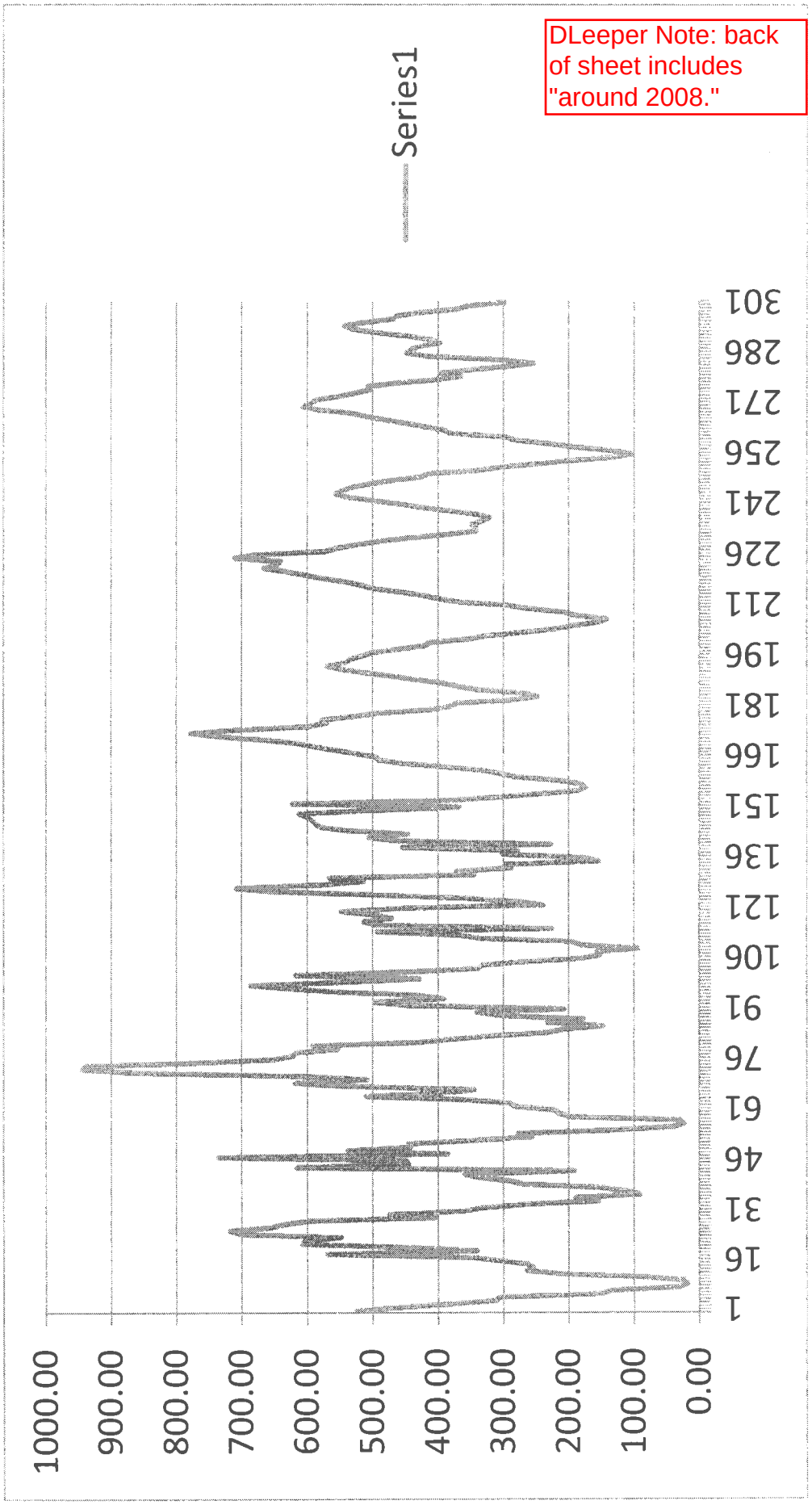
large positive flow after low tide.

1st 150 hours. (week)



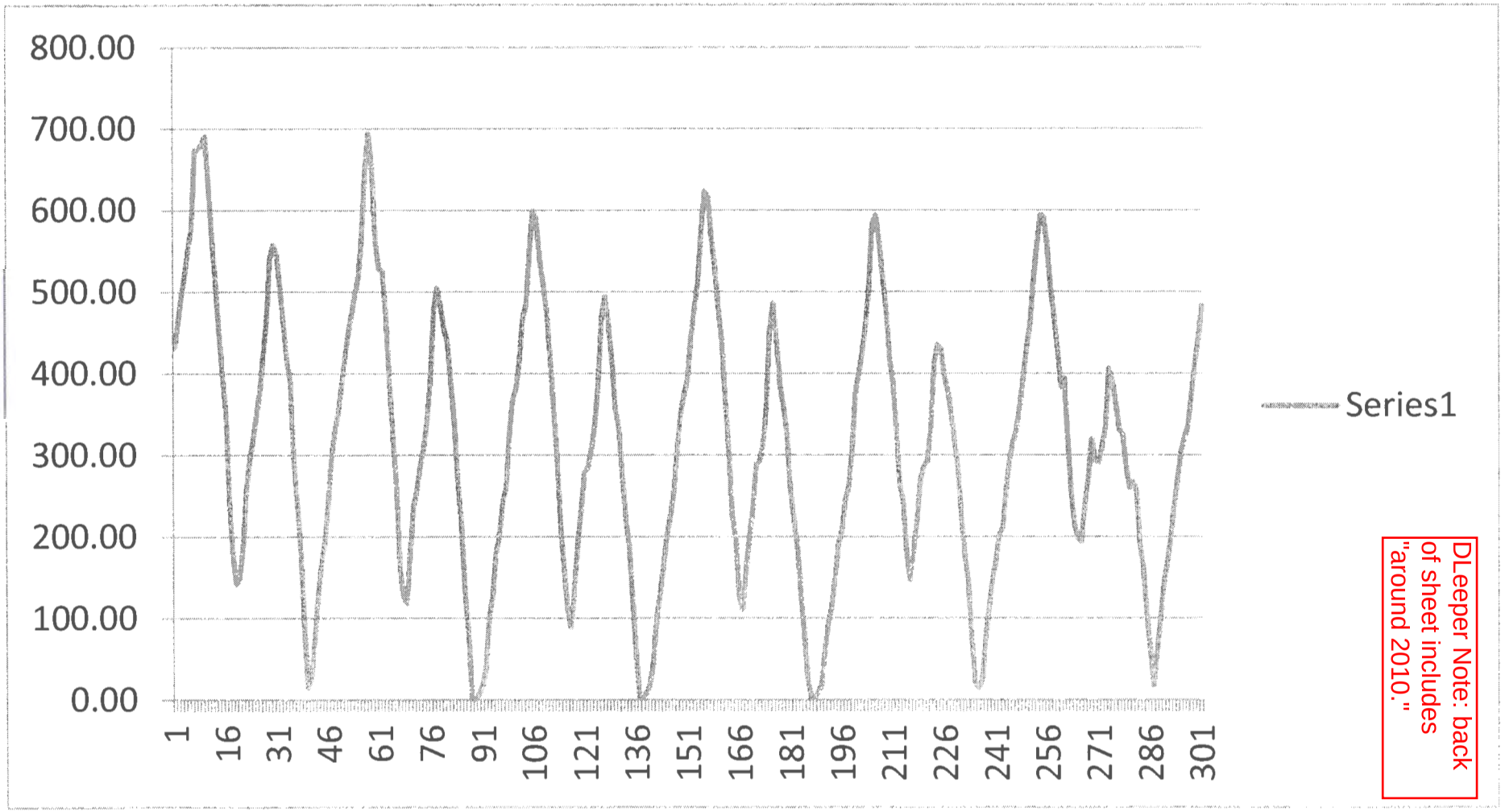
DLeeper Note: back of sheet includes "around 2006."

2nd 150 hours. (week)



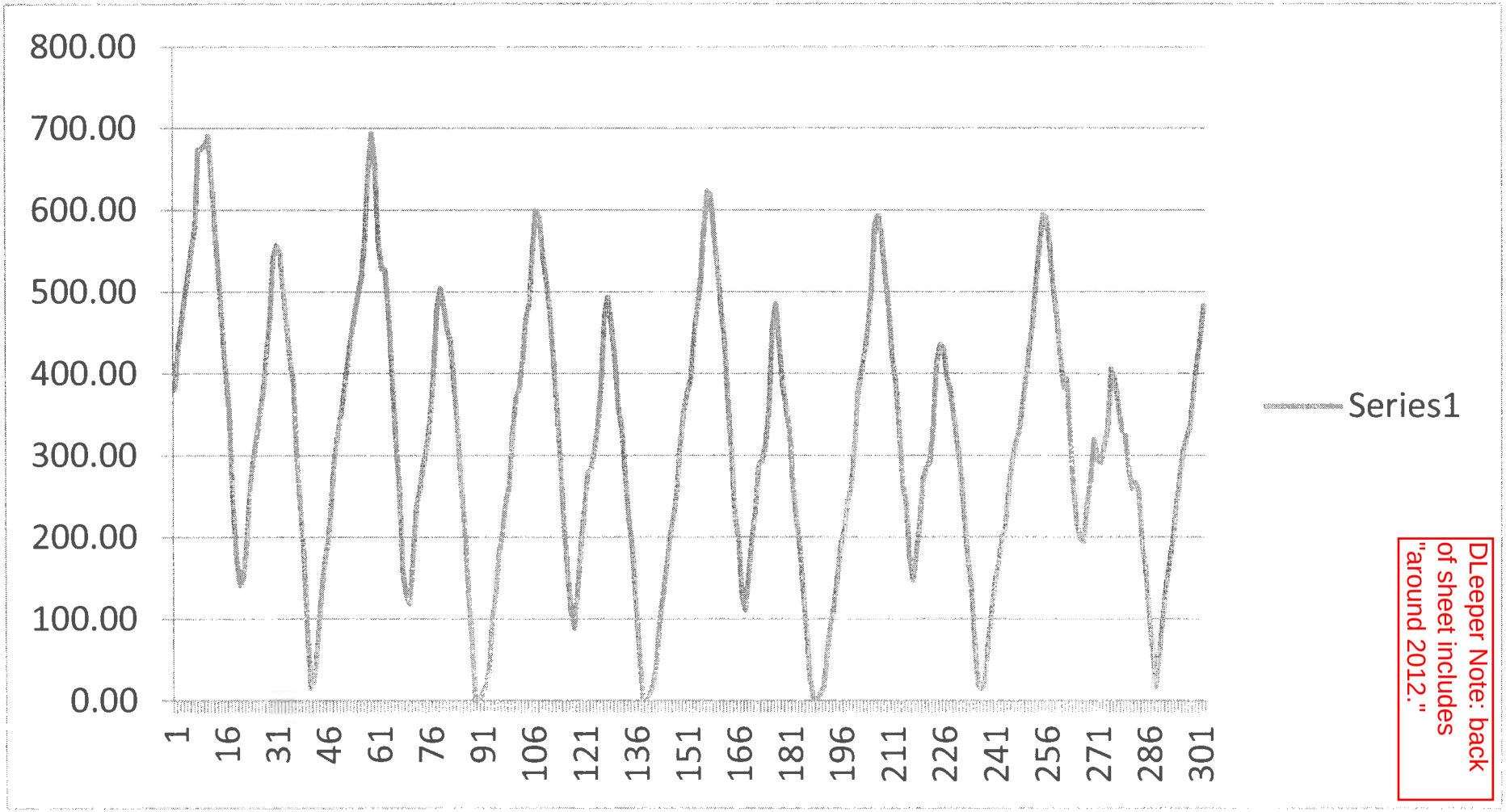
DLeeper Note: back of sheet includes "around 2008."

3rd 150 hours.



DLeeper Note: back of sheet includes "around 2010."

4th 150 hours.



Same day

Calculated Report cfs.

						CFS						
326	10/4/2016 16:32	EDT	Yes	RJD	USGS	111	3.14	104	1		-7.5	0.01
325	10/4/2016 16:16	EDT	Yes	RJD	USGS	112	3.13	104	1		-17	-0.01
324	10/4/2016 15:48	EDT	Yes	RJD	USGS	115	3.18	103	1		-20.1	-0.01
323	10/4/2016 15:32	EDT	Yes	RJD	USGS	110	3.22	102	1		-21.4	-0.02
322	10/4/2016 15:13	EDT	Yes	RJD	USGS	107	3.26	101	1		-14.4	-0.01
321	10/4/2016 14:54	EDT	Yes	RJD	USGS	112	3.3	101	1		-6.7	-0.03
320	10/4/2016 14:33	EDT	Yes	RJD	USGS	103	3.34	100	1		-14.9	-0.01
319	10/4/2016 14:12	EDT	Yes	RJD	USGS	110	3.39	99	1		-19.7	-0.03
318	10/4/2016 13:49	EDT	Yes	RJD	USGS	108	3.44	98	1		-24.5	-0.03
317	10/4/2016 13:31	EDT	Yes	RJD	USGS	108	3.48	97	1		-21.2	-0.02
316	10/4/2016 13:14	EDT	Yes	RJD	USGS	104	3.52	96	1		-23.5	-0.02
315	10/4/2016 12:55	EDT	Yes	RJD	USGS	102	3.55	95	1		-20.9	-0.02
314	10/4/2016 12:22	EDT	Yes	RJD	USGS	104	3.61	94	1		-23	-0.01
313	10/4/2016 12:04	EDT	Yes	RJD	USGS	105	3.65	93	1		-21.1	-0.02
312	10/4/2016 11:45	EDT	Yes	RJD	USGS	99.8	3.68	94	1		-25.5	-0.01
311	10/4/2016 11:26	EDT	Yes	RJD	USGS	101	3.71	92	1		-25.7	-0.02
310	10/4/2016 11:08	EDT	Yes	RJD	USGS	101	3.74	91	1		-21.7	-0.01
309	10/4/2016 10:49	EDT	Yes	RJD	USGS	96.9	3.77	91	1		-23.1	-0.02
308	10/4/2016 10:30	EDT	Yes	RJD	USGS	97.8	3.81	90	1		-15.7	-0.01
307	10/4/2016 10:05	EDT	Yes	RJD	USGS	98.6	3.84	89	1		-2.4	-0.02
306	10/4/2016 9:43	EDT	Yes	RJD	USGS	98.3	3.87	89	1		-16.7	-0.01
305	10/4/2016 9:18	EDT	Yes	RJD	USGS	97.5	3.89	88	1		-4.4	-0.01
304	10/4/2016 8:57	EDT	Yes	RJD	USGS	96.8	3.92	88	1		30.8	0

USGS Field Manager.

Field cfs.

?

Homosassa Springs.

From: Alan Martyn Johnson
To: g.serviss@vhb.com
Cc: Doug Leeper
Subject: Kings Bay Group 2 2012
Date: Monday, January 23, 2017 4:55:33 PM
Attachments: Group 2 Discharges and Plot 2013 WY.xlsx

Gary,

Thanks for calling me back regarding the Group 2 discharge data. As I explained, I do not want to short cut the lines of communication to have you send me any data that must go thru SWFWMD.

My only request is to help confirm if the discharge data Doug sent me is the original data; I see a number of areas that appear to be potential errors such as negative flows after high tides such as 10/29 @ 02:15 to point you to one.

I have marked the file with highlight to quickly identify high and low tides.

As I pointed out my only request is for you to confirm if this is the original data (discharge and time); please note the comment at the top of the GH column which I presume is not VHB but must be directly related.

If this request is out of order I will fully understand, my only intent is to save Doug time in working backwards thru his/their files unnecessarily.

Thanks for sharing your thoughts about a means of monitoring one major vent for velocity (and hence discharge over a full 24 plus hour period.

Martyn

From:	Alan Martyn Johnson
To:	Doug Leeper; Ron Basso; Gabe I. Herrick
Cc:	Xinjian Chen; Melissa Gulvin; Chris Anastasiou; Ross Morton; Kurt Fritsch
Subject:	Jan 23 Coffee Conversation Kings Bay
Date:	Tuesday, January 24, 2017 9:05:03 AM
Attachments:	Group 1 2009 as reported Discharge and GH colums G, I, K, M added by mj.xlsx Group 1 Basics.pptx

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Firstly I would like to thank Doug, Ron and Gabe for taking the time to meet with me yesterday. We had an interesting discussion in which all three indicated they were in agreement with the variations in discharge from Kings Bay Springs. As for the differences to other springs in the area the following were mentioned:
<!--[if !supportLineBreakNewLine]-->
<!--[endif]-->

- Greater tidal change. This is true and is best exampled at the Homosassa main springs where there is no significant 'pool' to fill/empty before the gage station. Tidal change of about 1 ft versus 2 ft in Kings Bay are typical. The main reason for the difference is the restriction to flow at Homosassa (MacRae's or The Shed…worth a visit if you have not been…as is the Freezer). End result Homosassa Main Springs is typically vary +-10% cfs with an associated an increase in salinity as tide falls most likely a result sea water ingress into the karst system feeding one of the three vents.
  <!--[if !supportLineBreakNewLine]-->
  <!--[endif]-->
- 'Morphology of Kings Bay'. The Kings Bay Springs discharge directly into a large bay and there are more spring vents. While this is true, the most comprehensive field measurements at individual springs to date do not provide evidence of the magnitude of discharge change presented in the MFL Report.
  <!--[if !supportLineBreakNewLine]-->
  <!--[endif]-->
- Lag time. It is not clear what difference this makes, but it was mentioned. What is happening at the vents is happening when it happens and all the interplaying forces have had their effect. The discharge from the vents is what it is. There certainly is a lag time from high tide at the Mouth of Kings Bay and the location of the springs. A similar situation 'lag time' (time for water to flow) is clearly evident between Gage Stations Shell Island, Bagley Cove, Mouth of Kings Bay.

We briefly reviewed discharge data from all springs over the 9 year period (I had graphs of one week periods) showing discharges varying from typically 100 cfs to 500 cfs thru a tidal cycle and often 100 cfs to 700 cfs and some occasions dropping to zero. We briefly discussed the general idea of proving this by my thought of taking one major vent and monitoring the velocity and hence discharge over at least 24 hour (a full tidal cycle 28.84 hours). I suggested this could be done reasonably quickly and a reasonable cost. A lot is riding on this District Model. I also pointed out very briefly that there is no trend in the discharge which is typical

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Thanks again to Doug, Ron and Gabe. Doug the Group 1 2012 xls file opened OK from my gig stick Thanks. Hope you got your jacket from reception.

Martyn
<!--[if !supportLineBreakNewLine]-->
<!--[endif]-->

From: Doug Leeper
To: Gabe I. Herrick; Ron Basso; Xinjian Chen
Subject: FW: Kings Bay Group 2 2012
Date: Tuesday, January 24, 2017 3:03:00 PM
Attachments: Group 2 Discharges and Plot 2013 WY.xlsx

FYI – Have a call in to Gary Serviss at VHB to see what's up.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Monday, January 23, 2017 4:55 PM
To: g.serviss@vhb.com
Cc: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: Kings Bay Group 2 2012

Gary,
Thanks for calling me back regarding the Group 2 discharge data. As I explained, I do not want to short cut the lines of communication to have you send me any data that must go thru SWFWMD.
My only request is to help confirm if the discharge data Doug sent me is the original data; I see a number of areas that appear to be potential errors such as negative flows after high tides such as 10/29 @ 02:15 to point you to one.

I have marked the file with highlight to quickly identify high and low tides.

As I pointed out my only request is for you to confirm if this is the original data (discharge and time); please note the comment at the top of the GH column which I presume is not VHB but must be directly related.

If this request is out of order I will fully understand, my only intent is to save Doug time in working backwards thru his/their files unnecessarily.

Thanks for sharing your thoughts about a means of monitoring one major vent for velocity (and hence discharge over a full 24 plus hour period.

Martyn

From:	Doug Leeper
To:	"martynellijay@hotmail.com"
Cc:	Xinjian Chen; Ron Basso; Gabe I. Herrick; Melissa Gulvin; Chris Anastasiou; Ross Morton; Kurt Fritsch
Bcc:	Mark A. Green; Jennette Seachrist; Eric DeHaven
Subject:	RE: Jan 23 Coffee Conversation Kings Bay
Date:	Friday, February 10, 2017 7:53:00 AM
Attachments:	Group 2 GH Vel Disch 2012-10-22 to 2012-11-08 With Meas Work Rev 2017-01-30.xlsx image008.png image009.png image010.png image011.png image012.png image013.png image014.png

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Martyn:

I'm following-up on the inquiries/requests included in your January 24, 2017 email to District staff concerning groundwater discharge and modeling for the Crystal River/Kings Bay System. Please see our responses in italics with gray highlighting imbedded in your original email below.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Tuesday, January 24, 2017 9:05 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>
Cc: Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Chris Anastasiou <Chris.Anastasiou@swfwmd.state.fl.us>; Ross Morton <Ross.Morton@swfwmd.state.fl.us>; Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>
Subject: Jan 23 Coffee Conversation Kings Bay

Firstly I would like to thank Doug, Ron and Gabe for taking the time to meet with me yesterday. We had an interesting discussion in which all three indicated they were in agreement with the variations in discharge from Kings Bay Springs. As for the differences to other springs in the area the following were mentioned:

- Greater tidal change. This is true and is best exampled at the Homosassa main springs where there is no significant 'pool' to fill/empty before the gage station. Tidal change of about 1 ft versus 2 ft in Kings Bay are typical. The main reason for the difference is the restriction to flow at Homosassa (MacRae's or The Shed…worth a visit if you have not been…as is the Freezer). End result Homosassa Main Springs is typically vary +-10% cfs with an associated an increase in salinity as tide falls most likely a result sea water ingress into the karst system feeding one of the three vents.
- 'Morphology of Kings Bay'. The Kings Bay Springs discharge directly into a large bay and there are more spring vents. While this is true, the most comprehensive field measurements at individual springs to date do not provide evidence of the magnitude of discharge change presented in the MFL Report.
- Lag time. It is not clear what difference this makes, but it was mentioned. What is happening at the vents is happening when it happens and all the interplaying forces have had their effect. The discharge from the vents is what it is. There certainly is a lag time from high tide at the Mouth of Kings Bay and the location of the springs. A similar situation 'lag time' (time for water to flow) is clearly evident between Gage Stations Shell Island, Bagley Cove, Mouth of Kings Bay.

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Data from Group 1 and 2 Vanasse Hangen Brustlin (VHB) study was discussed in general. All agreed to have some difficulty getting into all the calculus and differential equations involved in Dr Chen's modeling. I tried to explain this is not necessary to analyze the VHB Group 1 and Group 2 data. It is simply a matter of looking at the water movement into and out of a large tank (the pool) of water 'upstream' of the X-Sections.
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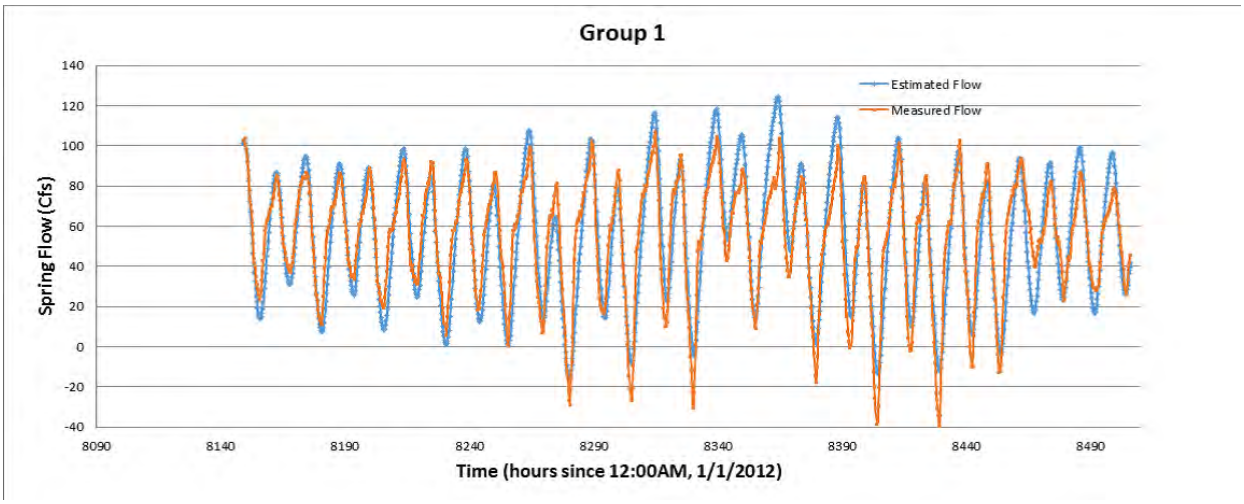
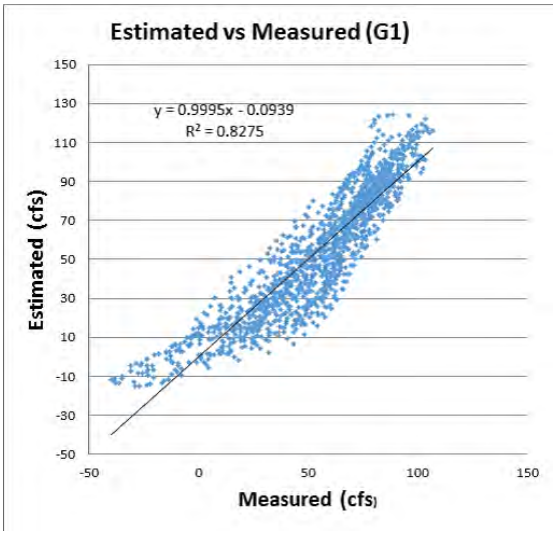
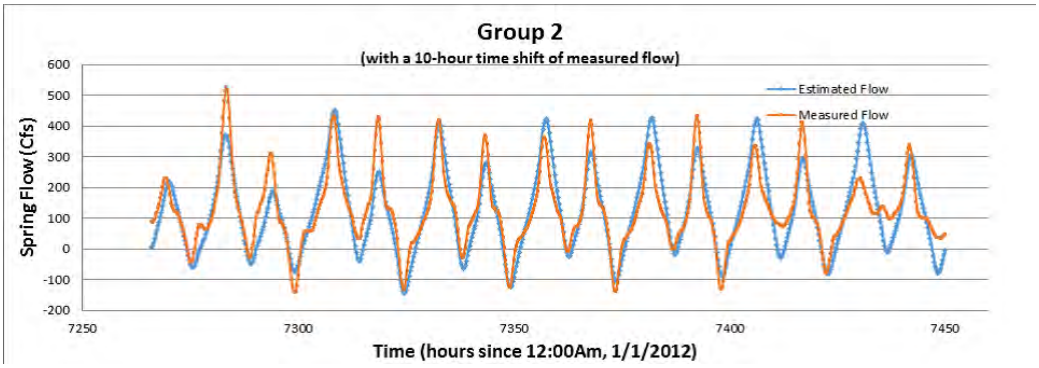
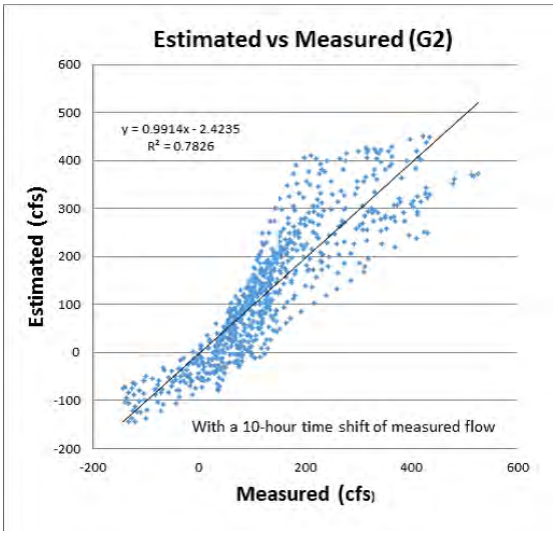
Staff response (2/10/2017): *At the time when the District used the 2012 data to validate the empirical formula for SGD in Kings Bay, we noticed that there was a time shift between recorded time measured flow at G2 and recorded water stage. We contacted VHB about this problem, but VHB was not able to find any information in their field log books which would suggest such a time shift at that time. Even so, District staff still believed that the time shift was real and VHB might have accidently overlooked the issue. As such, District staff made an effort to identify the time shift and it was found that the time shift was about 10 hours consistently during a time frame between 6:00 PM, 10/299/2012 and 12:00 PM, 11/6/2012 but varied for other times. As a result, we decided to only use measured data during this time frame at G2, along with measured data at G1 in 2012, for verification of the empirical formula of the SGD in Kings. The following figures were generated in early 2013 during our analysis and show comparisons of measured flows out of Groups 1 and 2 springs with estimated spring flows.*





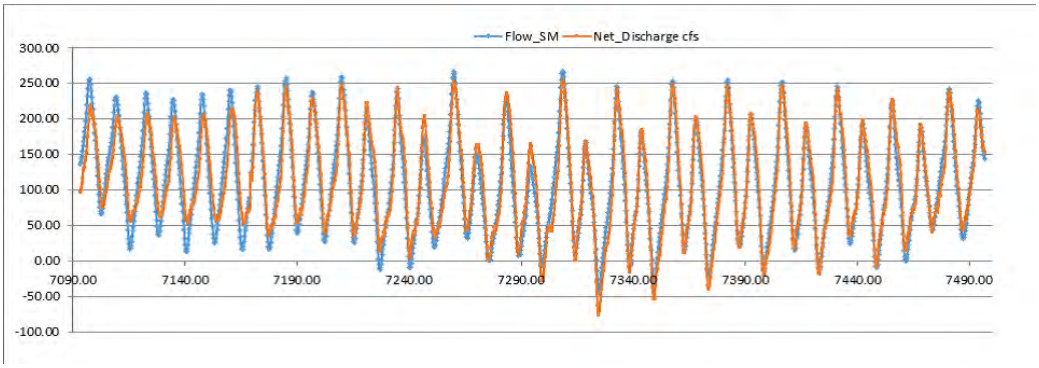


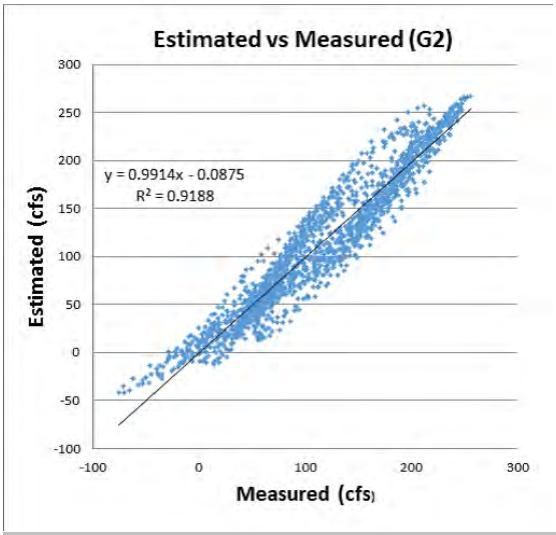


As can be seen from the above figures, we obtained R-squared values of 0.83 and 0.78 for G1 and G2, respectively. These R-squared values were considered satisfactory.

We recently contacted VHB, Inc. again to discuss the Group 2 discharge data from 2012 and learned that the information they originally provided included calculation errors. I have attached the updated Group 2 data file that we received from VHB which includes both the corrected and original discharge values. *The positive and negative flow records in the corrected data set seem more reasonably associated with tide stage. In other words, the time shift issue should have been resolved in the corrected data.*

Note that the original Group 2 discharge data from 2012 was not used for development of the submarine groundwater discharge estimation model or the Crystal River/Kings Bay hydrodynamic model. Rather the data were used as part of a check of the models. We have repeated these model checks using the corrected Group 2 data and the following two figures show the comparison of measured flow and estimated flow using the empirical SGD formula.





As can be seen from the above two figures, the corrected flow data at G2 match estimated SGD much better with a higher R-squared value of 0.92.

As I am skeptical that anyone took the time to look at the data so I am attaching:

- two diagrams to help you get the concept and
- my analysis of the Group 1 data 2009.

As you look at this note I have omitted analyses around the high tide and low tide. This is because the gage heights are timed for the Mouth of Kings Bay and there is about a 15 minute 'lag time' to true high tide at the X-Section. I have looked at shifting the data to correct this lag and do get better agreement at these times, but at this stage I have deleted my calculation, at these times, to avoid the cursory, Oh well look at. As you review this please bear in mind accuracy. 0.01 ft gage height difference in this pool is about 7 cfs.; if you move on to Group 2 the same difference relates to almost 20 cfs. Velocity measurements are recorded to the second decimal place which is then translated to discharge by the stage area rating curve/chart, another accuracy concern. But hopefully these all cancel out in the overall picture.

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Finally, if you want to get bold try forcing the relationship by substituting the calculated spring discharges with ones that vary 40 cfs to 90 cfs thru a tide change such as are determined and presented in the MFL Report. For now I will refrain for sharing this which shows major overage or shortfalls in the pool. Further evidence of how I arrive at my conclusion that the model is based on erroneous hypothesis and is wrong.

Staff response: *Thanks for providing the Excel and Powerpoint files concerning Group 1 discharge estimation for our consideration. Your two PowerPoint slides illustrate the basic principle of mass balance, which can be summarized by the following partial differential equation for both the flood and ebb tides.*

$$q_g = q_m + A\frac{\partial \eta}{\partial t}$$

This equation was used to get the net spring flow in our data analysis. Details about the above equation can be found in a District report that we understand you have reviewed (Chen, 2014, On the Estimation of Submarine Groundwater Discharge to Kings Bay).

Thanks again to Doug, Ron and Gabe. Doug the Group 1 2012 xls file opened OK from my gig stick Thanks. Hope you got your jacket from reception.

Martyn

From:	Ron Basso
To:	Alan Martyn Johnson
Cc:	Doug Leeper; Gabe I. Herrick; Dave Dewitt
Subject:	FW: Jan 23 Coffee Conversation Kings Bay
Date:	Tuesday, January 24, 2017 3:36:04 PM
Attachments:	Tarpon hole hydrolab-2002.ppt Black Spring and Tarpon Hole Spring Winter 2007-08 YSI data.ppt

Mr. Johnson:

Attached is some salinity, tidal, and temperature data for Black Spring in Kings Bay. While we don't have direct flow measurements, the salinity and temperature data provides a good surrogate for the flow. If temperature in the vent falls back to ambient bay temperatures, then that's a pretty good conclusion that flows approach zero or perhaps even marine water going back into the vent during high tide. Just thought I'd share some of this data with you.

Ron Basso, P.G.
Chief Hydrogeologist
Water Resources Bureau
Southwest Florida Water Management District
Ph 800-423-1479 (Florida only)
352-796-7211, ext. 4291

From: Dave Dewitt
Sent: Tuesday, January 24, 2017 2:00 PM
To: Ron Basso <Ron.Basso@swfwmd.state.fl.us>
Subject: RE: Jan 23 Coffee Conversation Kings Bay

Yeah it's all based on water quality, the winter temperature shifts from the relatively constant, warm groundwater discharge of 23 C to the colder bay water. The summer 2008 sonde data has a similar relationship, except with warmer bay water incursions, up until the heavy rainfall from TS Fay produced the driving head for more constant discharge. So temp is key in the observations, but conductance/salinity also shows the reversal from saltier groundwater discharge to fresher bay water siphoning.

David J. DeWitt, P.G.
Chief Professional Geologist
Data Collection Bureau
Southwest Florida Water Management District
2379 Broad St., Brooksville, FL 34604-6899
352/796-7211 ext. 4512

From: Ron Basso
Sent: Tuesday, January 24, 2017 1:27 PM

To: Dave Dewitt <Dave.Dewitt@swfwmd.state.fl.us>
Subject: RE: Jan 23 Coffee Conversation Kings Bay

Dave:

I don't see flow on any of these graphs – is there a surrogate for flow?

From: Dave Dewitt
Sent: Tuesday, January 24, 2017 12:55 PM
To: Ron Basso <Ron.Basso@swfwmd.state.fl.us>
Subject: RE: Jan 23 Coffee Conversation Kings Bay

Ron, attached graphs from YSI sonde field experiments conducted in Winter 2007-2008, the flow reversals were specific to Black Spring, and not any of the other springs on the bay. We also placed a sonde in Tarpon Hole spring to observe the effects of tidal "lag" on groundwater quality in the spring vent. Also attached is an earlier attempt to observe the lag between tidal stage and spring vent salinity at Tarpon Hole spring.

David J. DeWitt, P.G.
Chief Professional Geologist
Data Collection Bureau
Southwest Florida Water Management District
2379 Broad St., Brooksville, FL 34604-6899
352/796-7211 ext. 4512

From: Ron Basso
Sent: Tuesday, January 24, 2017 9:59 AM
To: Dave Dewitt <Dave.Dewitt@swfwmd.state.fl.us>
Subject: FW: Jan 23 Coffee Conversation Kings Bay

Dave:

Didn't you have some data from an offshore spring that shows a reversal in flow with tide?

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Tuesday, January 24, 2017 9:05 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>
Cc: Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Chris Anastasiou <Chris.Anastasiou@swfwmd.state.fl.us>; Ross Morton <Ross.Morton@swfwmd.state.fl.us>; Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>
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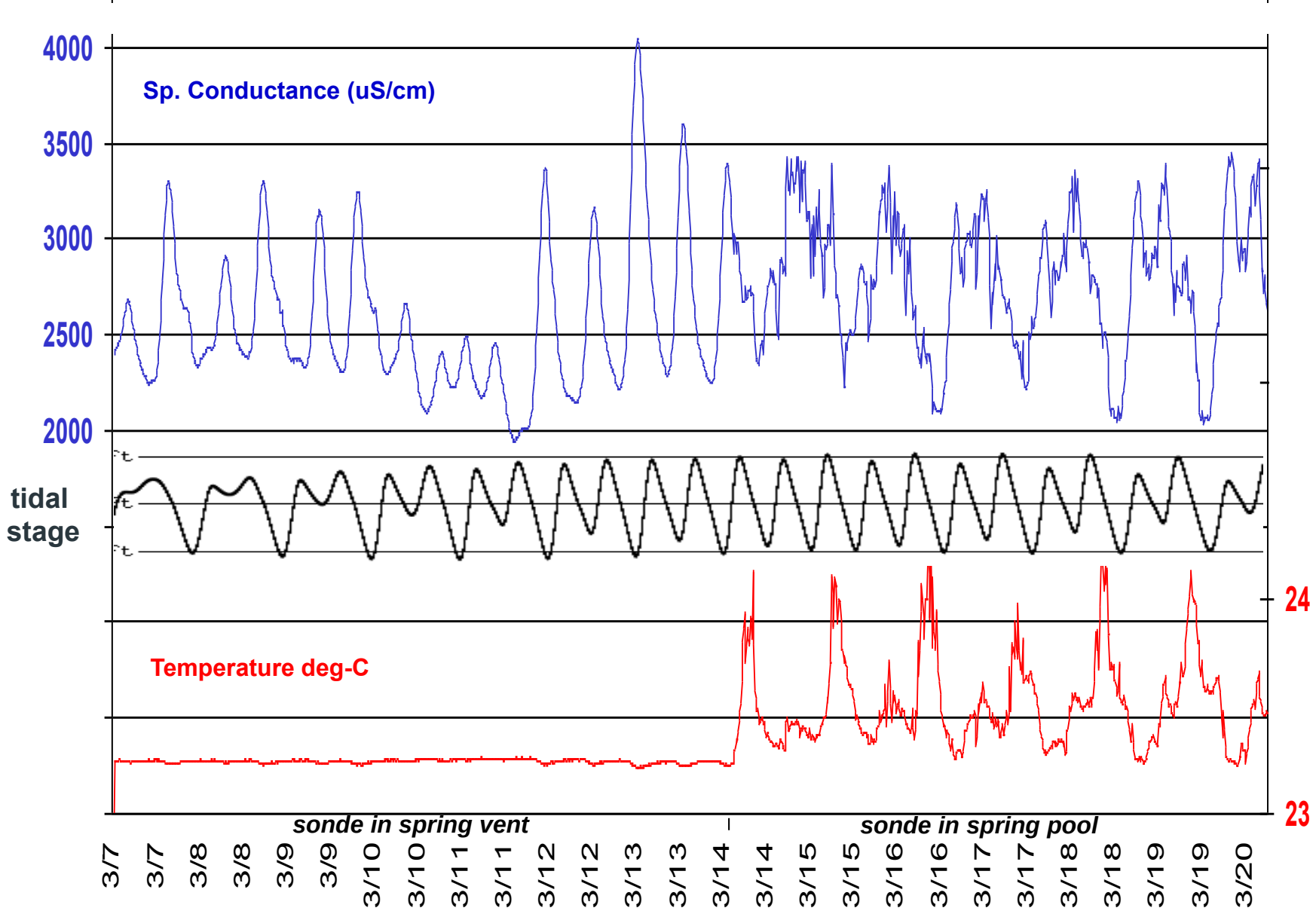
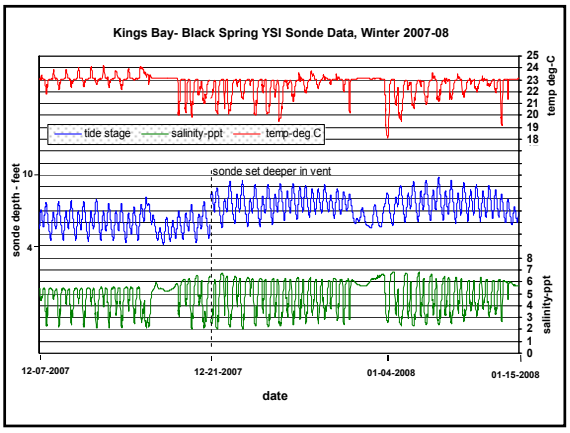
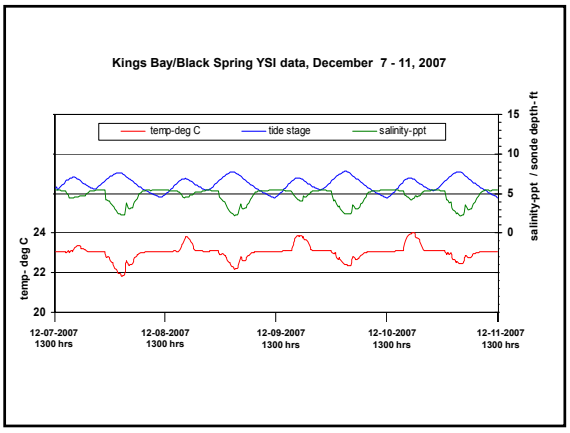


Relation between tidal stage and discharge water quality at Tarpon Hole Spring collected with a Hydrolabs data sonde in March, 2002.


Kings Bay- Black Spring YSI Sonde Data, Winter 2007-08
tide stage
salinity-ppt
temp-deg C
sonde set deeper in vent
sonde depth - feet
temp deg-C
salinity-ppt
12-07-2007
12-21-2007
01-04-2008
01-15-2008
date


Kings Bay/Black Spring YSI data, December 7 - 11, 2007
temp-deg C
tide stage
salinity-ppt
temp- deg C
salinity-ppt / sonde depth- ft
12-07-2007 1300 hrs
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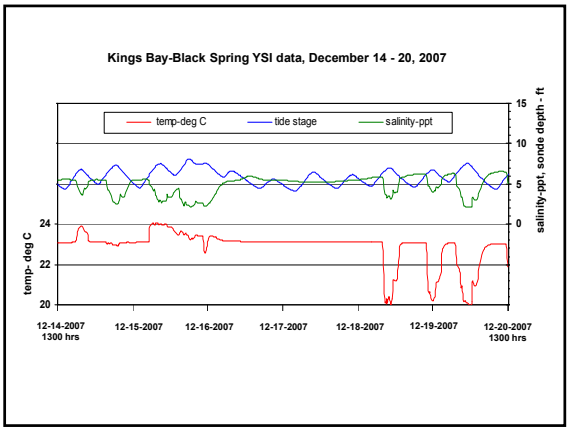
12-10-2007 1300 hrs
12-11-2007 1300 hrs


Kings Bay-Black Spring YSI data, December 14 - 20, 2007
temp-deg C
tide stage
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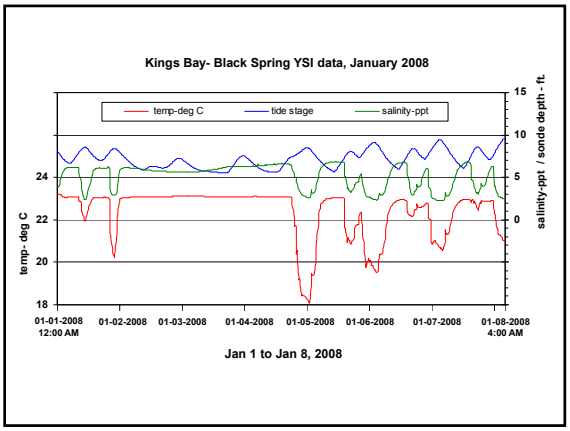
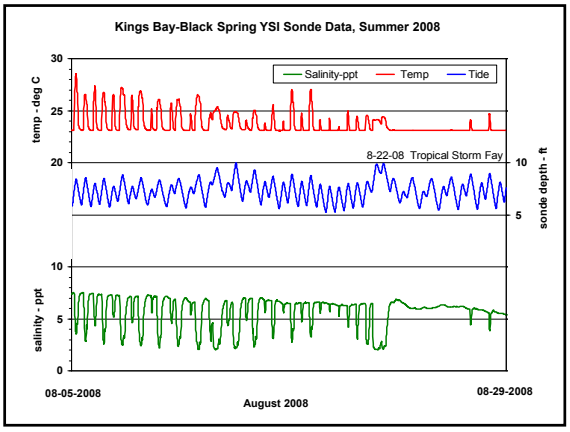
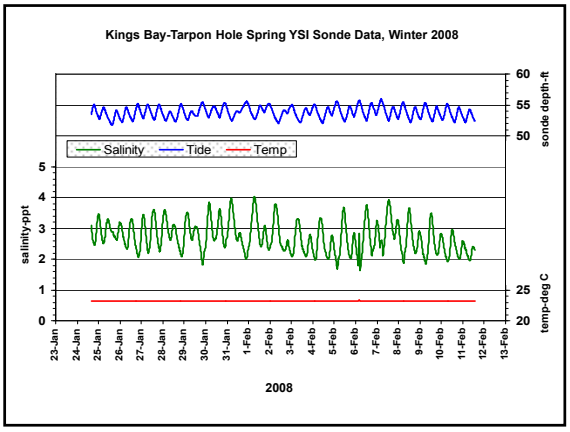
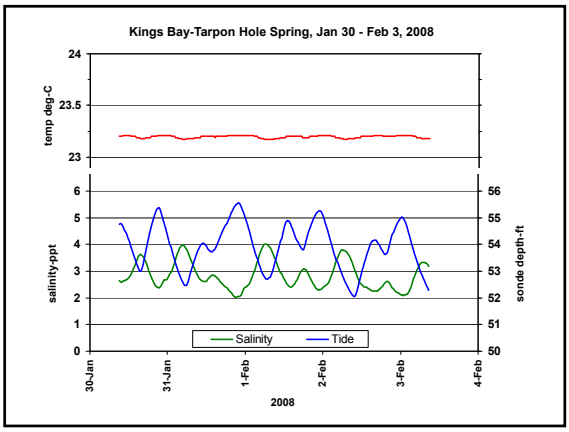
temp- deg C
salinity-ppt, sonde depth - ft
12-14-2007 1300 hrs
12-15-2007
12-16-2007
12-17-2007
12-18-2007
12-19-2007
12-20-2007 1300 hrs


Kings Bay- Black Spring YSI data, January 2008
temp-deg C
tide stage
salinity-ppt
temp- deg C
salinity-ppt / sonde depth - ft.
01-01-2008 12:00 AM
01-02-2008
01-03-2008
01-04-2008
01-05-2008
01-06-2008
01-07-2008
01-08-2008 4:00 AM
Jan 1 to Jan 8, 2008


Kings Bay-Black Spring YSI Sonde Data, Summer 2008
Salinity-ppt
Temp
Tide
8-22-08 Tropical Storm Fay
temp - deg C
salinity - ppt
sonde depth - ft
08-05-2008
08-29-2008
August 2008


Kings Bay-Tarpon Hole Spring YSI Sonde Data, Winter 2008
Salinity
Tide
Temp
salinity-ppt
sonde depth-ft
temp-deg C
2008


Kings Bay-Tarpon Hole Spring, Jan 30 - Feb 3, 2008
temp deg-C
24
23.5
23
salinity-ppt
sonde depth-ft
6
5
4
3
2
1
0
56
55
54
53
52
51
50
Salinity
Tide
30-Jan
31-Jan
1-Feb
2-Feb
3-Feb
4-Feb
2008

From: Alan Martyn Johnson
To: Ron Basso
Cc: Doug Leeper; Gabe I. Herrick; Dave Dewitt
Subject: Re: Jan 23 Coffee Conversation Kings Bay
Date: Wednesday, January 25, 2017 8:23:19 AM

Ron,
Thanks for taking the time to find and share the attachments.
Unfortunately, Tarpon Spring is not easy to pinpoint. The name appears in studies in both Spring 30 and 31 which according to VHB Inventory have 4 vents and 8 vents respectively.

Black Spring is better defined and somehow it rang a small bell in my mind…so I took a quick look at the VHB reports and found:
"The multicell ADP was used to measure discharge in
deeper areas, including the natural spring run from Black Spring (38) and"

And more likely the 'bell' was vague memory of this:

"Site 24 is comprised of a number of scattered vents with conductivity readings rangingfrom 2,359 to 5,000 *u*mhos/cm. The highest conductivity was observed at a low volume vent ("c"). A measurement of the conductivity in the vicinity of this vent was also observed to be 5,000 *u*mhos/cm. This may indicate that surface water flows into these low flow vents at high tide stages and discharges at low tide stages as mentioned by District staff (personal communication, David DeWitt). A measurement of the ambient conductivity was also made at Black Spring (38) where the overall average conductivity within the vents was the highest of all sites at 10,631 *u*mhos/cm. However, for Black Spring the ambient conductivity was substantially lower at 5,503 when compared to the average vent conductivity that day of 12,080. For Black Spring it does not appear that surface water enters the vents at high tide and these vents are a source of brackish water (6.9 salinity) to Kings Bay."

So you do not have to look up the specific info

	Date/Time	Temp	mS/cm	ppt
38 SV38092309 1	9/23/09 9:51	23.89	9183	5.14
38 Spring 38 Ambient	10/5/09 13:29 Surface	26.02	5503	2.96
38 SV38100509a 1	10/5/09 13:09	23.29	12072	6.91
38 SV38100509b 2	10/5/09 13:11	23.25	12096	6.92
38 SV38100509c 3	10/5/09 13:12	23.25	12071	6.91

Black Spring is a low discharge spring the VHB 2009 measurement is 2.88 cfs combined discharge from the three vents. The X-section discharge appears to include tidal movement of water into/out of the 1+ acre cove (I did quickly cross reference USGS GH at Mouth of Kings Bay but for now will leave the details). With an average GH change of say 2 feet the spring discharge accounts for less than half the tidal volume of water movement in or out of the cove in a 6 hour tidal cycle.
I could go into detail about similar concerns about the X-Section flows for springs 39 and 40 which also discharge thru a narrow X-section. Both 39 and 40 data include X-Section discharge on 9/22/2009 Spring 39 at 12:45 hour 9.24 cfs and Spring 40 at 13:22 hour 7.30 cfs. Is this double entry book keeping two ways? Averaging X-section discharge with the addition of instantaneous discharge at each of the vents (both springs) and double entry of

the X-section discharge of the both springs. Accountant needed? Sorry this is very detailed but I did ask in general about fully understanding VHB data months ago.

More interesting…….

A quick look at the map in VHB and Google Earth sparked my interest.

How did these neat coves/spring runs form? Certainly the canals on the south and east side of Black Spring the 'now island' are man-made. But would it be wild speculation that these were once a major springs that washed out this coves? Could it be that over time the erosion by the spring water caused a collapse and thus restricted the fresh spring water flow; so that now there is sea water ingress into the karst structure. It appears very plausible that this group of springs are all part of the same karst channels network.
I have never been to see this specific location, looks from Google Earth to be a nice spot, so I may take a trip out there today and try to find a long term resident/owner to hear about changes they may have seen in their lifetime.
Thanks, will let you know if I find anything of additional interest.
Martyn
<!--[if !supportLineBreakNewLine]-->
<!--[endif]-->

From: Ron Basso <Ron.Basso@swfwmd.state.fl.us>
Sent: Tuesday, January 24, 2017 3:35 PM
To: Alan Martyn Johnson
Cc: Doug Leeper; Gabe I. Herrick; Dave Dewitt
Subject: FW: Jan 23 Coffee Conversation Kings Bay

Mr. Johnson:

Attached is some salinity, tidal, and temperature data for Black Spring in Kings Bay. While we don't have direct flow measurements, the salinity and temperature data provides a good surrogate for the flow. If temperature in the vent falls back to ambient bay temperatures, then that's a pretty good conclusion that flows approach zero or perhaps even marine water going back into the vent during high tide. Just thought I'd share some of this data with you.

Ron Basso, P.G.
Chief Hydrogeologist
Water Resources Bureau
Southwest Florida Water Management District
Ph 800-423-1479 (Florida only)

352-796-7211, ext. 4291

From: Dave Dewitt
Sent: Tuesday, January 24, 2017 2:00 PM
To: Ron Basso <Ron.Basso@swfwmd.state.fl.us>
Subject: RE: Jan 23 Coffee Conversation Kings Bay

Yeah it's all based on water quality, the winter temperature shifts from the relatively constant, warm groundwater discharge of 23 C to the colder bay water. The summer 2008 sonde data has a similar relationship, except with warmer bay water incursions, up until the heavy rainfall from TS Fay produced the driving head for more constant discharge. So temp is key in the observations, but conductance/salinity also shows the reversal from saltier groundwater discharge to fresher bay water siphoning.

David J. DeWitt, P.G.
Chief Professional Geologist
Data Collection Bureau
Southwest Florida Water Management District
2379 Broad St., Brooksville, FL 34604-6899
352/796-7211 ext. 4512

From: Ron Basso
Sent: Tuesday, January 24, 2017 1:27 PM
To: Dave Dewitt <Dave.Dewitt@swfwmd.state.fl.us>
Subject: RE: Jan 23 Coffee Conversation Kings Bay

Dave:

I don't see flow on any of these graphs – is there a surrogate for flow?

From: Dave Dewitt
Sent: Tuesday, January 24, 2017 12:55 PM
To: Ron Basso <Ron.Basso@swfwmd.state.fl.us>
Subject: RE: Jan 23 Coffee Conversation Kings Bay

Ron, attached graphs from YSI sonde field experiments conducted in Winter 2007-2008, the flow reversals were specific to Black Spring, and not any of the other springs on the bay. We also placed a sonde in Tarpon Hole spring to observe the effects of tidal "lag" on groundwater quality in the spring vent. Also attached is an earlier attempt to observe the lag between tidal stage and spring vent salinity at Tarpon Hole spring.

David J. DeWitt, P.G.
Chief Professional Geologist
Data Collection Bureau

Southwest Florida Water Management District
2379 Broad St., Brooksville, FL 34604-6899
352/796-7211 ext. 4512

From: Ron Basso
Sent: Tuesday, January 24, 2017 9:59 AM
To: Dave Dewitt <Dave.Dewitt@swfwmd.state.fl.us>
Subject: FW: Jan 23 Coffee Conversation Kings Bay

Dave:

Didn't you have some data from an offshore spring that shows a reversal in flow with tide?

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Tuesday, January 24, 2017 9:05 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>
Cc: Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Chris Anastasiou <Chris.Anastasiou@swfwmd.state.fl.us>; Ross Morton <Ross.Morton@swfwmd.state.fl.us>; Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>
Subject: Jan 23 Coffee Conversation Kings Bay

Firstly I would like to thank Doug, Ron and Gabe for taking the time to meet with me yesterday. We had an interesting discussion in which all three indicated they were in agreement with the variations in discharge from Kings Bay Springs. As for the differences to other springs in the area the following were mentioned:

- Greater tidal change. This is true and is best exampled at the Homosassa main springs where there is no significant 'pool' to fill/empty before the gage station. Tidal change of about 1 ft versus 2 ft in Kings Bay are typical. The main reason for the difference is the restriction to flow at Homosassa (MacRae's or The Shed…worth a visit if you have not been…as is the Freezer). End result Homosassa Main Springs is typically vary +-10% cfs with an associated an increase in salinity as tide falls most likely a result sea water ingress into the karst system feeding one of the three vents.
- 'Morphology of Kings Bay'. The Kings Bay Springs discharge directly into a large bay and there are more spring vents. While this is true, the most comprehensive field measurements at individual springs to date do not provide evidence of the magnitude of discharge change presented in the MFL Report.
- Lag time. It is not clear what difference this makes, but it was mentioned. What is happening at the vents is happening when it happens and all the interplaying forces have had their effect. The discharge from the vents is what it is. There certainly is a lag time from high tide at the Mouth of Kings Bay and the location of the springs. A similar situation 'lag time' (time for water to flow) is clearly evident between Gage Stations

Shell Island, Bagley Cove, Mouth of Kings Bay.

We briefly reviewed discharge data from all springs over the 9 year period (I had graphs of one week periods) showing discharges varying from typically 100 cfs to 500 cfs thru a tidal cycle and often 100 cfs to 700 cfs and some occasions dropping to zero. We briefly discussed the general idea of proving this by my thought of taking one major vent and monitoring the velocity and hence discharge over at least 24 hour (a full tidal cycle 28.84 hours). I suggested this could be done reasonably quickly and a reasonable cost. A lot is riding on this District Model. I also pointed out very briefly that there is no trend in the discharge which is typical with all other springs due to seasonal rainfall and or a long term rainfall trend.

Why is this? Well I suggested it was due to one set of field measurement data VHB (over a few weeks at most) being the ""long term spring discharge"".

Data from Group 1 and 2 Vanasse Hangen Brustlin (VHB) study was discussed in general. All agreed to have some difficulty getting into all the calculus and differential equations involved in Dr Chen's modeling. I tried to explain this is not necessary to analyze the VHB Group 1 and Group 2 data. It is simply a matter of looking at the water movement into and out of a large tank (the pool) of water 'upstream' of the X-Sections.

This is not rocket science;

--- spring discharge flows into the pool

---water flows out thru the X-section or in thru the X-section

---the resulting increase or decrease of that water in the pool is the difference in Gage Height

As Gage Height and flow into or out of the pool are know from the VHB monitoring, spring discharge every 15 minutes can be easily calculated.

All three agreed they had access to the xls files and I encouraged them to take a look at it.

I also pointed out some very questionable data in the Group 2 2012 file that was shared with me, most notably negative flow thru the X-Section after high tide, in some cases for hours. This data could not have been used to verify the hit and miss determination of the C values for Group 2 as reported. Somehow the data set may have been corrupted, possibly when gage height was modified to "Gage Height at SWFWMD Datum at new staff gage".

As I am skeptical that anyone took the time to look at the data so I am attaching:

- two diagrams to help you get the concept and
- my analysis of the Group 1 data 2009.

As you look at this note I have omitted analyses around the high tide and low tide. This is because the gage heights are timed for the Mouth of Kings Bay and there is about a 15 minute 'lag time' to true high tide at the X-Section. I have looked at shifting the data to correct this lag and do get better agreement at these times, but at this stage I have deleted my calculation, at these times, to avoid the cursory, Oh well look at. As you review this please bear in mind accuracy. 0.01 ft gage height difference in this pool is about 7 cfs.; if you move on to Group 2 the same difference relates to almost 20 cfs. Velocity measurements are recorded to the second decimal place which is then translated to discharge by the stage area rating curve/chart, another accuracy concern. But hopefully these all cancel out in the overall

picture.
I have highlighted some discharge data which are possibly the result of weed or other debris caught on the velocity unit or turbulence such as passing boats.
Finally, if you want to get bold try forcing the relationship by substituting the calculated spring discharges with ones that vary 40 cfs to 90 cfs thru a tide change such as are determined and presented in the MFL Report. For now I will refrain for sharing this which shows major overage or shortfalls in the pool. Further evidence of how I arrive at my conclusion that the model is based on erroneous hypothesis and is wrong.

Thanks again to Doug, Ron and Gabe. Doug the Group 1 2012 xls file opened OK from my gig stick Thanks. Hope you got your jacket from reception.

Martyn

From: Alan Martyn Johnson
To: Ron Basso; Doug Leeper; Gabe I. Herrick; Dave Dewitt
Subject: BLACK SPRING
Date: Friday, January 27, 2017 8:42:11 AM

Doug,
Please see the P.S. at the end. Thanks.

All
I checked out Black Spring.
Wednesday late afternoon a brief visit, very nice location and the view across Kings Bay with orange in the sky was gorgeous. I spoke to a resident who has lived there since 2003. He told me the main spring is 'in the corner' if I wanted to see it. As best he could judge it had stayed much the same as long as he knew. During his first few years there a small spring just off his 'boat dock' which created a small boil, but is now undetectable unless you get in the water and feel around for cooler water during the summer months. He commented this spring was at its strongest after a series of hurricanes/tropical storms shortly after he purchased the property. I assume this must have been late 2004.

I revisited yesterday morning…the house (closest to 'the corner') showed no sign of anyone home, so I took the liberty of walking onto the property to view the head spring. I had been there only a couple of minutes when I heard "Can I help you". To my surprise I was on Norman Hopkins property. We soon recognized each other and he did not need to 'shoot' me!! Doug and Ron likely remember Norman, but for those who do not know; Norman was very active in issues regarding Kings Bay with the Amy Remley Foundation.

Norman explained the history of over 20 years living next to the spring; the fish that spawn in the cove, the manatee that give birth at the spring, the manatee that take thermal refuge right at the spring vents (speculation it may be the same family) etc etc. Asked about spring discharge Norman said it varies some but not much; the easily detected boils from the vents yesterday was much the same as any other time. Norman says there are twelve vents of various sizes and no way was there ever reverse flow. Let me add you would be hard pressed to find a more observant witness than Norman.
I asked if he knew where VBH had the X-Section. He did not know, but had seen and spoken to SWFWMD personnel collecting water samples. Despite asking if they would share the results he has never received any.

In my e-mail the other day I had assumed the X section was at the 'entrance' to the cove where a line of bare rock/sand can be seen on Google Earth imagery; a similar strip of bare rock/sand strip can be seen where the adjacent springs discharge to the main bay. It is possible the X-Section for Black Spring could be much closer to the springs...VHB do not show coordinates for the X-section. And I can say the multiple boils seen yesterday could be more

than 3 cfs.

Bottom line; I will take Norman's observation about the possibility of reverse flow...precis to...no way. VHB concluded no evidence in there brief study.

I did not mention it the other day, but I do not understand the sonde depth shown on the graphs. First slide blue line is referenced as tide stage which appears to change as the sonde is set deeper in the vent. And given there are many vents, minor point, but which vent was the sonde in?
In fairness I can ask in which three vents did VHB take their readings on 10/5/2009. One of the vents is a long, possibly over 8 feet, and narrow, say 6 to 9 inches as viewed. Others are much smaller, say 6 inches diameter.

All adds to the difficulty of determining the spring discharges into Kings Bay, a point we all agree on.

Martyn
P.S.
Doug,
A quick pointer to results from water sampling at Black Spring if you have time. Why...simply kindness.

You may have noticed Norman is no longer active. He is a full time care giver to his wife and is not very stable on his legs. He was insistent on walking the property with me and enjoyed the conversation.
Are water analyse results for Black Spring in the huge file I downloaded from outgoing the other day. I would like to share these with him just as a matter of kindness. He appeared very lonely.
Thanks

From: Doug Leeper
To: Alan Martyn Johnson
Subject: Re: BLACK SPRING
Date: Saturday, January 28, 2017 7:06:13 AM

Thanks for the update on Norman. I've wondered why I haven't heard from him in awhile. Glad to hear he is still around. I think I've sent him information on Black Spring in the past. Will try to find time to look for relevant data next week.

Doug Leeper

From: Alan Martyn Johnson <martynellijay@hotmail.com>
Sent: Friday, January 27, 2017 8:42 AM
To: Ron Basso; Doug Leeper; Gabe I. Herrick; Dave Dewitt
Subject: BLACK SPRING

Doug,
Please see the P.S. at the end. Thanks.

All
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Wednesday late afternoon a brief visit, very nice location and the view across Kings Bay with orange in the sky was gorgeous. I spoke to a resident who has lived there since 2003. He told me the main spring is 'in the corner' if I wanted to see it. As best he could judge it had stayed much the same as long as he knew. During his first few years there a small spring just off his 'boat dock' which created a small boil, but is now undetectable unless you get in the water and feel around for cooler water during the summer months. He commented this spring was at its strongest after a series of hurricanes/tropical storms shortly after he purchased the property. I assume this must have been late 2004.

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Thanks

From:	Doug Leeper
To:	"norman@amyhrf.org"
Cc:	"martynellijay@hotmail.com"; Ron Basso; Gabe I. Herrick; Dave Dewitt
Bcc:	Mark A. Green; Eric DeHaven; Melissa Gulvin
Subject:	Black Spring WQ data
Date:	Friday, February 03, 2017 3:46:00 PM
Attachments:	Black Spring WMIS WQ Data Dwnld 2017-02-02.xlsx

Hello Norman:

Martyn Johnson let me know that you and he spoke last week out at Kings Bay and that you were interested in available water quality data for Black Spring. Have to stay it was good to hear that you are still in the area.

Anyway, I downloaded the available water quality data for the spring from the District Water Management Information System today and included the information in the attached Excel file.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Alan Martyn Johnson
To: Doug Leeper; norman@amyhrf.org
Cc: Ron Basso; Gabe I. Herrick; Dave Dewitt
Subject: Re: Black Spring WQ data
Date: Saturday, February 04, 2017 9:29:06 AM

Doug,
Many thanks for taking the time to share this with Norman. I know Norman will be pleased to see the results of the sampling visits by SWFWMD personnel over many years. The amount of data collected, at this and many other springs, and the organization of it is a tribute to all involved.

As you may expect I could not help have a look!!!

What strikes me about Black Spring is the change in nature of the water over the period 1991 to present. This is most easily seen in the specific conductance and how it has increased (round numbers 4000 in 90's, 6-7000 in 2000-2005, and 10,000+ since 2005). Sodium and potassium levels appear to support/confirm this is increased sea water ingress. I recall there is a relationship of relative sodium and potassium that help further indicate the ingress of sea water, but do not recall it from memory. Strikes me that is a very significant change.

Appreciate you taking the time, thanks.
Martyn

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Friday, February 3, 2017 3:46 PM
To: norman@amyhrf.org
Cc: martynellijay@hotmail.com; Ron Basso; Gabe I. Herrick; Dave Dewitt
Subject: Black Spring WQ data

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2379 Broad Street
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doug.leeper@watermatters.org

From:	Doug Leeper
To:	"martynellijay@hotmail.com"
Cc:	Ron Basso; Gabe I. Herrick; Dave Dewitt
Bcc:	Gary Serviss (gserviss@vhb.com); Xinjian Chen; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ross Morton; Melissa Gulvin
Subject:	RE: BLACK SPRING
Date:	Friday, February 10, 2017 8:03:00 AM

Martyn:

I'm following-up on the inquiries/requests included in your January 27, 2017 email to District staff concerning Black Spring. Please see our responses in italics with gray highlighting imbedded in your original email below.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Friday, January 27, 2017 8:42 AM
To: Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>; Dave Dewitt <Dave.Dewitt@swfwmd.state.fl.us>
Subject: BLACK SPRING

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Norman explained the history of over 20 years living next to the spring; the fish that spawn in the cove, the manatee that give birth at the spring, the manatee that take thermal refuge right at the spring vents (speculation it may be the same family) etc etc. Asked about spring discharge Norman said it varies some but not much; the easily detected boils from the vents yesterday was much the same as any other time. Norman says there are twelve vents of various sizes and no way was there ever reverse flow. Let me add you would be hard pressed to find a more observant witness than Norman.

I asked if he knew where VBH had the X-Section. He did not know, but had seen and spoken to SWFWMD personnel collecting water samples. Despite asking if they would share the results he has never received any.

In my e-mail the other day I had assumed the X section was at the 'entrance' to the cove where a line of bare rock/sand can be seen on Google Earth imagery; a similar strip of bare rock/sand strip can be seen where the adjacent springs discharge to the main bay. It is possible the X-Section for Black Spring could be much closer to the springs...VHB do not show coordinates for the X-section. And I can say the multiple boils seen yesterday could be more than 3 cfs.

Staff response (2/10/2017): *The following information was provided by VHB, Inc.*

- *Both the 9/23/09 and 10/05/09 measurements were made with the RiverCat acoustic doppler current profiler (ADCP) because the cross-section was too deep to conduct a wading measurement. Both measurements were also made fairly close to the spring vents. The 9/23/09 notes state that the measurements were made "at the mouth of the spring area" and was 8.44 cfs. The 10/05/09 notes state the measurement was made "about 20' from the spring vents" and was 6.36 cfs.*

Bottom line; I will take Norman's observation about the possibility of reverse flow...precis to...no way. VHB concluded no evidence in there brief study.

I did not mention it the other day, but I do not understand the sonde depth shown on the graphs. First slide blue line is referenced as tide stage which appears to change as the sonde is set deeper in the vent. And given there are many vents, minor point, but which vent was the sonde in?

Staff response (2/10/2017): *The tide stage data shown in blue in the previously provided figures for Black Spring and Tarpon Hole represent depth of the sensor below the water surface. These data are associated with the "sonde depth – ft" axis labels/values. At Black Spring, the District's sonde was placed in the large vent.*

In fairness I can ask in which three vents did VHB take their readings on 10/5/2009. One of the vents is a long, possibly over 8 feet, and narrow, say 6 to 9 inches as viewed. Others are much smaller, say 6 inches diameter.

Staff response (2/10/2017): *The following information was provided by VHB, Inc.*

- *Three vents were measured on 10/05/09. Vent 1 (SV38100509a) measured 2.2' by 1.0'; Vent 2 (SV38100509b) measured 1.2' by 1.1'; and Vent 3 (SV38100509c) measured 7.2' by 0.7'. When a subset of vents was measured, VHB tried to select the largest and/or strongest flowing vents to capture the highest flows.*
- *VHB also collected water quality data collected concurrent with the discharge measurements. On 9/23/09 the water quality data were collected within Vent 1 (SV38100509a). Water quality data were obtained from all three vents on 10/05/09. When placing the sonde in the vents the emphasis was on obtaining representative results from the springs discharge and reducing or eliminating the influence of the surrounding surface waters. This typically entailed inserting the sonde a foot or more into the throat of the vent, as needed to obtain accurate spring water quality data.*

All adds to the difficulty of determining the spring discharges into Kings Bay, a point we all agree on.

Martyn

P.S.

Doug,

A quick pointer to results from water sampling at Black Spring if you have time. Why...simply kindness.

You may have noticed Norman is no longer active. He is a full time care giver to his wife and is not very stable on his legs. He was insistent on walking the property with me and enjoyed the conversation.

Are water analyse results for Black Spring in the huge file I downloaded from outgoing the other day. I would like to share these with him just as a matter of kindness. He appeared very lonely.

Thanks

Staff response (2/10/2017): *Water quality data for Black Springs were included in an email to Norman Hopkins (and copied to you) on 2/3/2017.*

From:	Melissa Gulvin
To:	Mark Hammond; Eric DeHaven; Doug Leeper; Ron Basso; Gabe I. Herrick; Xinjian Chen
Cc:	Ross Morton
Subject:	Email from Martyn Johnson to Richard Owen RE: guest editorial in the Chronicle
Date:	Monday, January 30, 2017 12:13:32 PM

From: richardowen@wrwsa.org [mailto:richardowen@wrwsa.org]
Sent: Monday, January 30, 2017 10:43 AM
To: Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>
Subject: [FWD: Your article in Chronicle]

FYI

Richard S. Owen, AICP
Executive Director
Withlacoochee Regional Water Supply Authority
richardowen@wrwsa.org
www.wrwsa.org
Mobile: 352-293-5955

> -------- Original Message --------
> Subject: Your article in Chronicle
> From: Alan Martyn Johnson <martynellijay@hotmail.com>
> Date: Mon, January 30, 2017 9:18 am
> To: "richardowen@wrwsa.org" <richardowen@wrwsa.org>
>
> Richard,
> I read your article in the Chronicle and must say it is very well written; as are many fairy tales.
>
> Although pointing out how important MFL's are, conceptually, to managing water withdrawals from springsheds the reality is a lot different.
>
> I encourage you to read the MFLs for Homosassa and Chassahowitzka in the Florida Administrative Code. These MFLs refer to water withdrawals downstream of the USGS gages referenced i.e. river water. There are no such withdrawals. Homosassa and Chassahowitzka MFLs in no way place any controls, limits or restrictions on water withdrawn from the numerous wells sucking water from the aquifer. Or the issue of new well permits.
>
> I can only hope when the MFL for Kings Bay is written and filed in the FAC it will have some meaning as regards water pumped out of the springshed. The Homosassa and Chassahowitzka MFLs are meaningless in this regard.
>
> Your article makes no mention of FDEP listing Kings Bay on the Impaired Waters List (as well as other springs in the area).

We all want to protect and preserve these Outstanding Florida Waters, but the MFLs, so far, do not help in this cause.

As regards Kings Bay I trust you have or will read the draft report. Let me draw your attention to Figure 2-4, modeling of spring water discharge into Kings Bay from the Group 2 springs. The graphs indicate discharge changing from 0 cfs at high tide to 270 cfs at low tide. This hypothesis is then expanded to all the springs. Ask yourself how is it possible that this unusual phenomenon has not been seen by any of the learned people who have studied these springs in the past.
You can make up your own mind.
The Peer Review Panel indicated there is uncertainty in the modeling, I have gone further to say in my opinion this model is wrong.

Logic and truth will prevail despite nicely written articles.

May be I need to write a letter to the Editor.

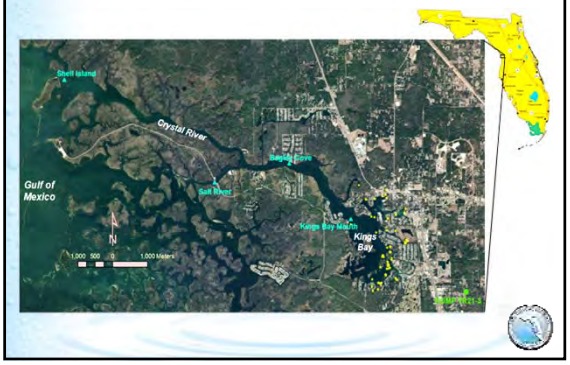
Martyn

Minimum Flow for Crystal River/Kings Bay

Gabe Herrick, PhD
Senior Environmental Scientist

Ron Basso, P.G.
Chief Hydrogeologist

Withlacoochee Regional Water Supply Authority Meeting
January 18, 2017



§ 373.042, Fla. Stat.

"The minimum flow for a given watercourse shall be the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area."

18 Peer Reviews of 15% Change

- "Reasonable"
- "Appropriate"
- "Innovative"
- "Rational and pragmatic"
- "Protective"
- "Prudent"
- ~~Perfect~~

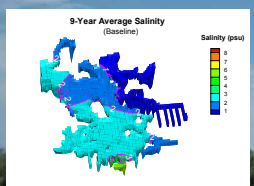


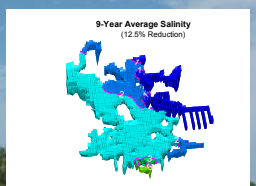
Accurate Prediction

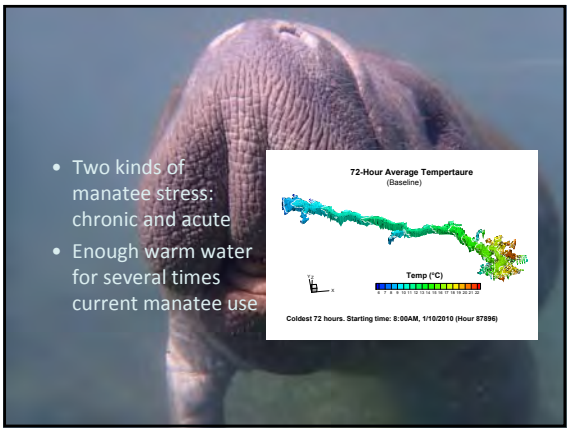
- Water Level: 98%
- Salinity: 75%
- Temperature: 90%



Chen, XinJian. 2012. Simulating hydrodynamics in a spring-fed estuary using a three-dimensional unstructured Cartesian grid model. *Estuarine, Coastal and Shelf Science* 115: 246–259.







Measuring Springflow is Challenging

- USGS Bagley Cove gage flow from 2002 through 2015 averages 447 cfs and is tidally-influenced
- Water budget: 20 in/yr of recharge in the springshed yields a springflow of 455 cfs
- 900+ cfs from the 1960-70s includes marine water and springwater; would require 40 in/yr of recharge in springshed (not realistic)
- Peer review panel believes spring flow varies between 300 and 450 cfs – and not much different in the 1960s based on little change in Floridan aquifer water levels over the last 50 years

NDM 5 - Withdrawal Impact

Year	Non-pumping flow (cfs)	Pumping Flow (cfs)	Impact(cfs)	Impact(%)
2010	449.0	442.1	6.9	-1.5
2014	449.0	443.8	5.2	-1.1
2035	449.0	438.1	10.8	-2.4
2035 w/ Conserv & Reuse	449.0	439.4	9.6	-2.1

Minimum flow recommendation

- 12 percent-of-flow
- Based on low-salinity (2 ppt) habitat
- No recovery or prevention needed BECAUSE
  - 1.5% current impacts
  - 2.5% anticipated 2035

Questions

Southwest Florida Water Management District

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Groundwater Impacts

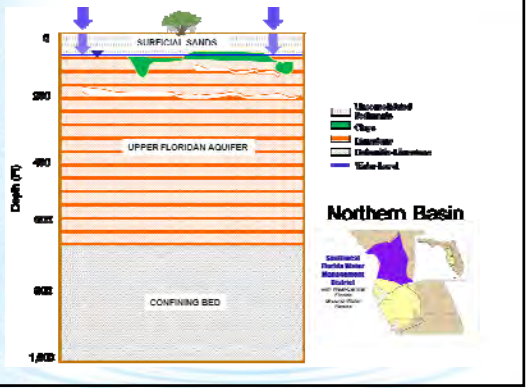
Impact of Groundwater Withdrawals on Proposed Minimum Flows for Crystal River (Kings Bay Springs)



WRWSA Board Meeting
January 18, 2017

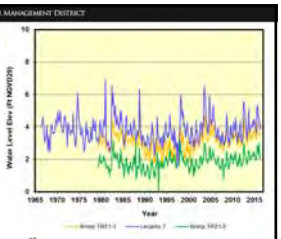
Ron Basso, P.G.
Chief Hydrogeologist

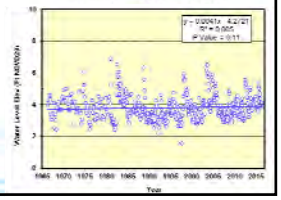
SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT



SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT



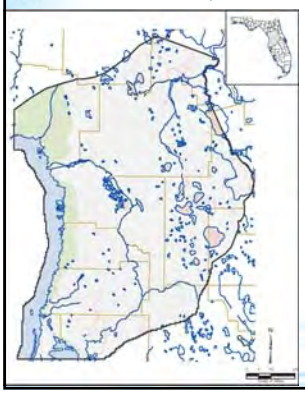




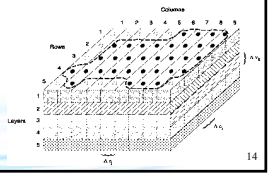
No long-term trend in UFA Water levels

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Northern District Model, Ver. 5



- Layer 1 – Surficial Aquifer
- Layer 2 – Intermediate Confining Unit (Hawthorn)
- Layer 3 – Upper Floridan Aquifer (Suwanee)
- Layer 4 – Upper Floridan Aquifer (Ocala)
- Layer 5 – Upper Floridan Aquifer (Upper Avon Park)
- Layer 6 – Middle Confining Unit
- Layer 7 – Lower Floridan Aquifer (Lower Avon Park/Oldsmar)

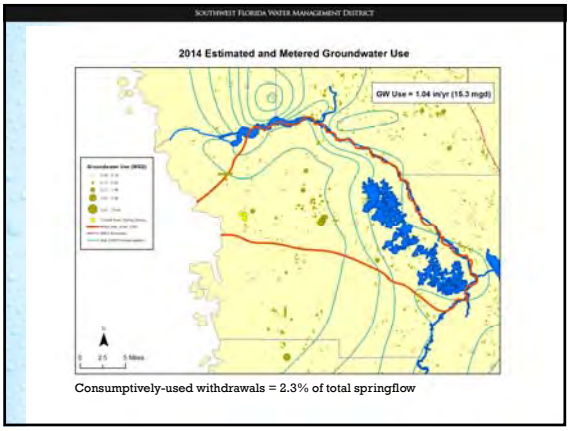


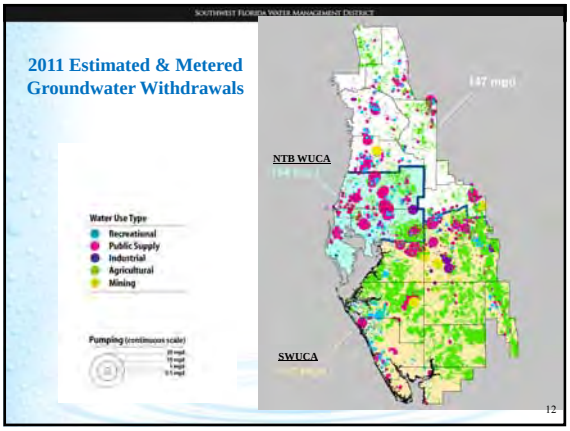
14

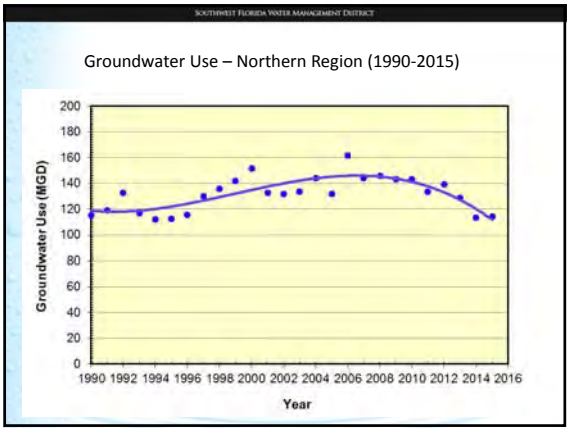
SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

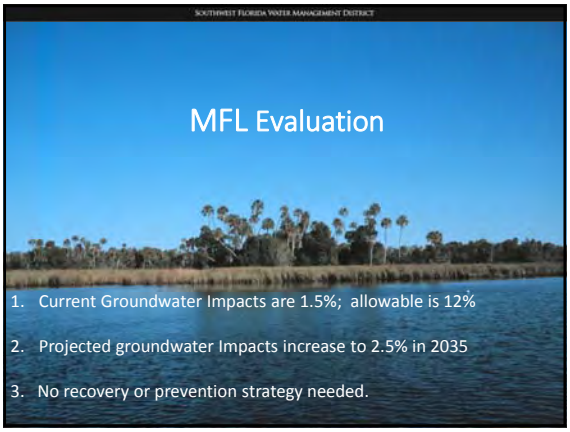
NDM 5 - Withdrawal Impact

Year	Non-pumping flow (cfs)	Pumping Flow (cfs)	Impact(cfs)	Impact(%)
2010	449.0	442.1	6.9	-1.5
2014	449.0	443.8	5.2	-1.1
2035	449.0	438.1	10.8	-2.4
2035 w/ Conserv & Reuse	449.0	439.4	9.6	-2.1


SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
2014 Estimated and Metered Groundwater Use
GW Use = 1.04 in/yr (15.3 mgd)
Consumptively-used withdrawals = 2.3% of total springflow


SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
2011 Estimated & Metered Groundwater Withdrawals
147 mgd
NTB WUCA
SWUCA
Water Use Type
Recreational
Public Supply
Industrial
Agricultural
Mining
Pumping (continuous scale)
12


SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
Groundwater Use – Northern Region (1990-2015)
Groundwater Use (MGD)
200
180
160
140
120
100
80
60
40
20
0
1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016
Year


SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
MFL Evaluation
1. Current Groundwater Impacts are 1.5%; allowable is 12%
2. Projected groundwater Impacts increase to 2.5% in 2035
3. No recovery or prevention strategy needed.

Water district best suited to set minimum flows, levels

The Withlacoochee River Regional Water Supply Authority (WRWSA) is a multi-county water supply planning and development organization. It is comprised of Citrus, Hernando, Marion and Sumter counties and the municipalities within these counties. The WRWSA is statutorily authorized with "developing, recovering, storing, and supplying water for county or municipal purposes in such a manner as will give priority to reducing adverse environmental effects of excessive or improper withdrawals of water from concentrated areas" (373.713(1), Florida Statutes).



Richard S. Owen

GUEST COLUMN

Minimum flows and levels (MFLs) are important to the WRWSA, its member governments and other regulated water users in the region because they help to define the availability of ground and surface water for consumptive use. They are one of the tools used by the water management districts in managing and protecting water and related natural resources.

The MFL ultimately adopted by the SWFWMD for Crystal River/King's Bay will limit the amount of ground water that can be withdrawn in the springshed. As ground water, the least expensive and most widely used source of water in the WRWSA region and in Florida, becomes more limited, more expensive alternative water supplies, such as surface water or water from the lower Floridan aquifer, will need to be developed to meet growing water needs. It is therefore critically important the water management districts utilize the best available information and scientific expertise in establishing MFLs.

We believe the SWFWMD is best equipped to establish these MFLs, specifically including the proposed MFLs for Crystal River/King's Bay. The district has created an establishment process that uses the best available science; subjects the proposals to peer review by independent scientists; makes proposals available to stakeholders, including the public, local, state and federal agencies/governments for review and comment, and allows multiple opportunities for the public and other stakeholders to give input prior to a decision being made by the district governing board.

We all want to preserve, protect and where necessary restore our water and related natural resources of the region. The springs coast is blessed with an abundance of water-related natural resources and those in the public organizations charged with serving the citizenry of the area are all keenly interested in ensuring the long-term integrity of these resources. We want to ensure the decisions made by the water management districts are fact-based, use the best available data and scientific analytical tools, and are conducted in an open, inclusive decision-making process.

We believe the SWFWMD is exemplary in following these principles as it implements its statutory responsibility to set MFLs, including those for Crystal River/King's Bay.

The district's proposed MFLs for Crystal River/King's Bay protects 88 percent of the natural flow, allowing for up to a 12 percent flow reduction due to water withdrawals. Current impacts of groundwater withdrawals are estimated to reduce spring flow by only 1 percent to 2 percent. The proposed minimum flow is, therefore, being met and is also projected to be met for the next 20 years and beyond based on water demand projections. The proposed minimum flow also preserves enough warm water during cold months for several times the current number of manatees that use King's Bay as a warm water refuge.

Efforts to protect and restore Crystal River/King's Bay must continue to focus on the real culprits of the negative changes that have been observed. These include nitrate contamination of our ground and surface waters, and physical alterations to our water and related natural systems.

Other contributing factors that we have less of an ability to control within our region, such as climate change, sea level rise and changes in long-term rainfall patterns, must be and are included in the analysis and an adaptive management approach must be taken.

The WRWSA incorporates the district's latest science, including its adopted MFLs, into our long-range water supply planning and decision making. We help to implement water conservation activities among our members, to help ensure water use is as efficient as possible and to help put off the costs of developing new water supplies to meet growing demands.

Richard S. Owen is the executive director for the Withlacoochee Regional Water Supply Authority.

Citrus County Chronicle
Crystal River
Daily 29,000
January 29, 2017

From:	Alan Martyn Johnson
To:	Doug Leeper; Ron Basso; Gabe I. Herrick
Cc:	Xinjian Chen; Melissa Gulvin; Ross Morton; Kurt Fritsch
Subject:	Kings Bay Crystal River Springs Discharge
Date:	Wednesday, February 08, 2017 8:30:23 AM

All seems to have gone quiet since my January 24 e-mail.

Are you all still convinced the spring discharges vary as exampled by the graphs I shared of random weekly discharge from the xls data set Doug sent me 1/18/2017 Model Output SGD which covered 593000-138350 hours?

Or, are you still trying to understand the logic I presented regarding the VHB 2009 data Group 1 and the pool upstream of the VHB X-Section.

May be someone got bold and considered the spring discharges for Group 1 as presented in Figure 2-4 of the draft report. Maybe there are questions regarding the missing or excess water in that pool when considering Figure 2-4 spring discharge. If you have not been bold, listed below are the first few high and low tide discharges from Figure 2-4 starting with the low tide 7/27/2009 @14:27 (VHB Study data).

Do you want to look at this, or just wait for me to share it with you and show how illogical Figure 2-4 is.

Possibly you would like to share my thoughts with the peer review panel and see if my approach helps clarify some of the "uncertainty" they repeatedly had so much concern about in their final report.

Martyn

Best I can read Figure 2-4 and correlate with VHB
85 cfs at low tide 7/27/2009 @ 14:27
next high tide 50 cfs
80 cfs low
40 cfs high
85 cfs low
50 cfs high
75 cfs low
40 cfs high
80 cfs low

From:	Doug Leeper
To:	"Alan Martyn Johnson"
Cc:	Xinjian Chen; Melissa Gulvin; Ross Morton; Kurt Fritsch; Ron Basso; Gabe I. Herrick
Bcc:	Mark A. Green; Jennette Seachrist; Eric DeHaven
Subject:	RE: Kings Bay Crystal River Springs Discharge
Date:	Friday, February 17, 2017 4:34:00 PM

Martyn – I believe staff addressed the issues included in your February 8th email below in the email I sent to you on February 10th.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Wednesday, February 08, 2017 8:30 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>
Cc: Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Ross Morton <Ross.Morton@swfwmd.state.fl.us>; Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>
Subject: Kings Bay Crystal River Springs Discharge

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next high tide 50 cfs

80 cfs low

40 cfs high

85 cfs low

50 cfs high

75 cfs low

40 cfs high

80 cfs low

From: Alan Martyn Johnson
To: Doug Leeper
Subject: VHB xls Group 2 data 2012
Date: Wednesday, February 08, 2017 8:35:03 AM

Doug,
Have you made any progress to determine if the file you shared is accurate or somehow is corrupted; see my Jan 23 e-mail..

Thanks,
Martyn

From:	Doug Leeper
To:	"Alan Martyn Johnson"
Subject:	RE: VHB xls Group 2 data 2012
Date:	Friday, February 10, 2017 8:02:00 AM

Martyn: I believe I've responded to your inquiry below in the email I sent earlier this morning.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Wednesday, February 08, 2017 8:35 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: VHB xls Group 2 data 2012

Doug,

Have you made any progress to determine if the file you shared is accurate or somehow is corrupted; see my Jan 23 e-mail..

Thanks,

Martyn

From: Alan Martyn Johnson
To: Doug Leeper
Subject: Re: VHB xls Group 2 data 2012
Date: Saturday, February 11, 2017 8:47:58 AM

Doug,
You did share the staff response. I will respond momentarily.

Martyn

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Friday, February 10, 2017 8:02 AM
To: Alan Martyn Johnson
Subject: RE: VHB xls Group 2 data 2012

Martyn: I believe I've responded to your inquiry below in the email I sent earlier this morning.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
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Subject: VHB xls Group 2 data 2012

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Thanks,
Martyn

From: Alan Martyn Johnson
To: Doug Leeper
Cc: Xinjian Chen; Ron Basso; Gabe I. Herrick; Melissa Gulvin; Chris Anastasiou; Ross Morton; Kurt Fritsch
Subject: Re: Jan 23 Coffee Conversation Kings Bay
Date: Saturday, February 11, 2017 9:03:46 AM
Attachments: image008.png
image009.png
image010.png
image011.png
image012.png
image013.png
image014.png

Doug,
I have just spent sometime trying to understand the Staff Response. The answer should come from VBH not staff trying to make sense of corrupted/inaccurate data. The data set is either good or bad, usable or not...this is akin to changing data for Rainbow modelling. The graphs in the 2012 report from VHB do not look unusual, essentially displaying a similar pattern to 2009 for G2. Presumably they used the collected data to generate the graph which leaves the question of how the data set you shared became shifted/corrupted. Look at the name of the author of the file you shared and ask who's payroll this person is on; that may give a clue to the origin of the shift/corruption.

Given some of the data was used to validate, can this be shared? I do not see any use of the 2012 data to validate the 2009 results presented in the report.

Martyn
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From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Friday, February 10, 2017 7:53 AM
To: martynellijay@hotmail.com
Cc: Xinjian Chen; Ron Basso; Gabe I. Herrick; Melissa Gulvin; Chris Anastasiou; Ross Morton; Kurt Fritsch
Subject: RE: Jan 23 Coffee Conversation Kings Bay

Martyn:

I'm following-up on the inquiries/requests included in your January 24, 2017 email to District staff concerning groundwater discharge and modeling for the Crystal River/Kings Bay System. Please see our responses in italics with gray highlighting imbedded in your original email below.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
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Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
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To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>
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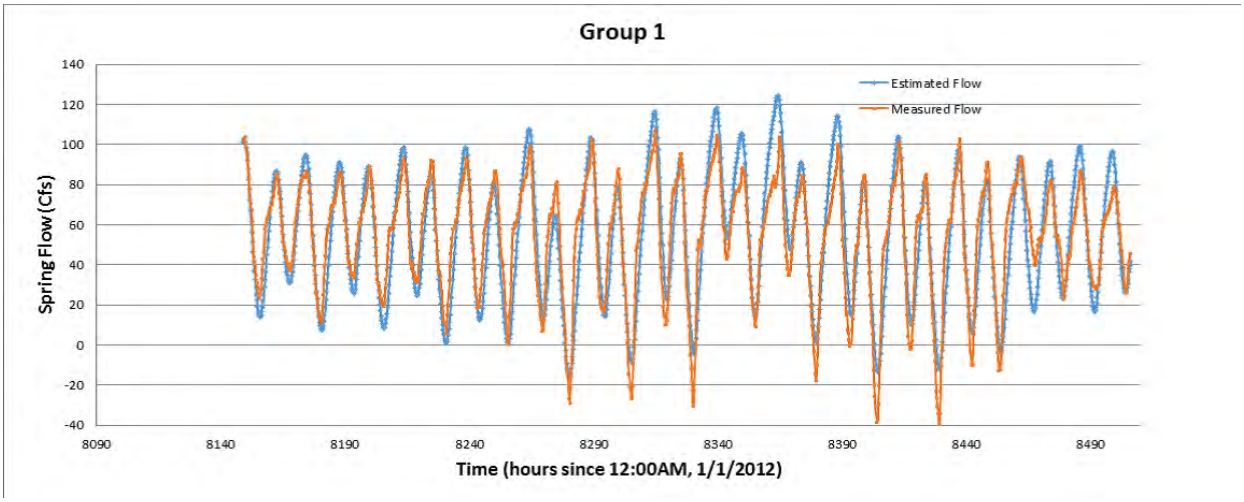

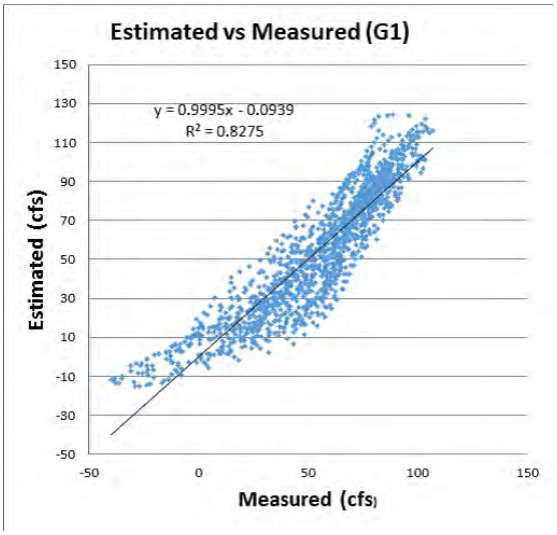

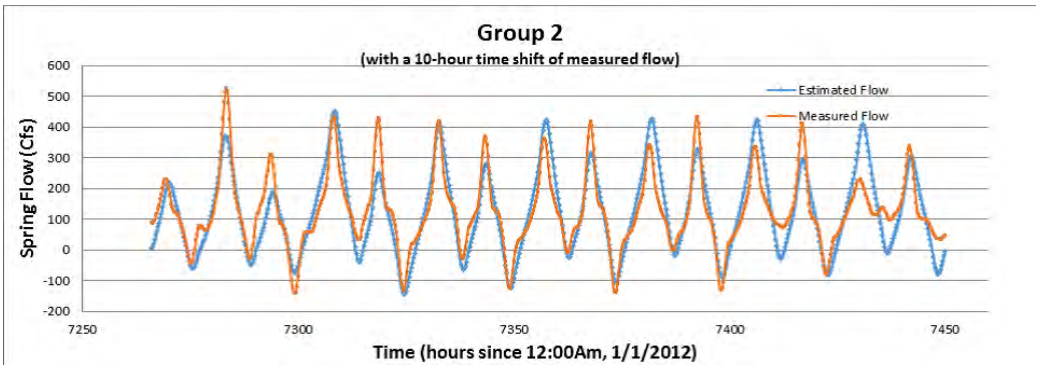

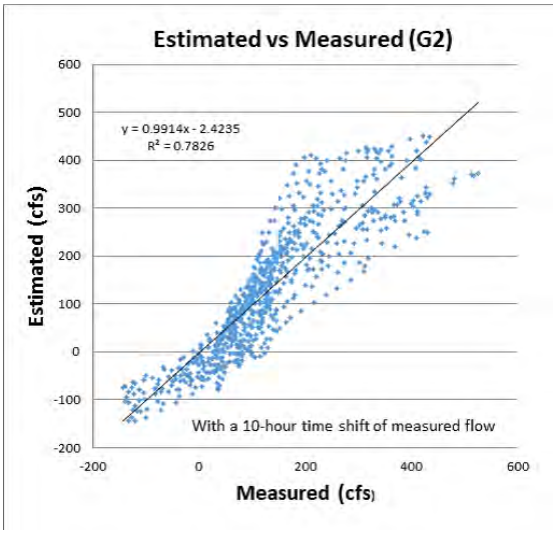

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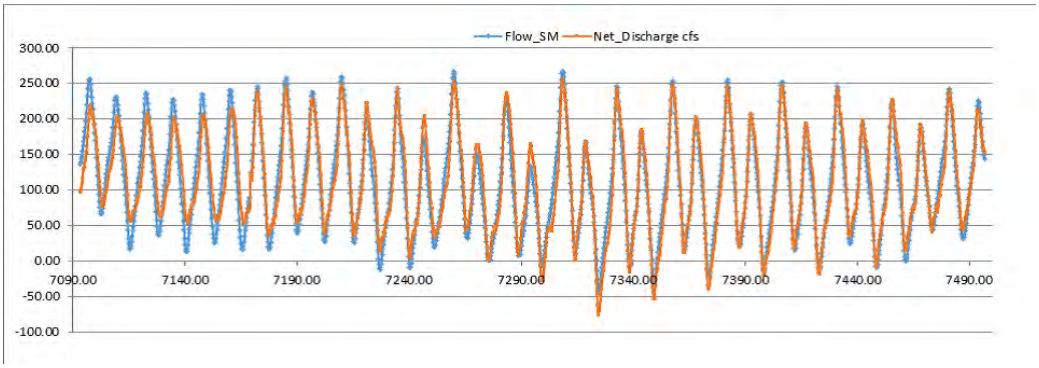

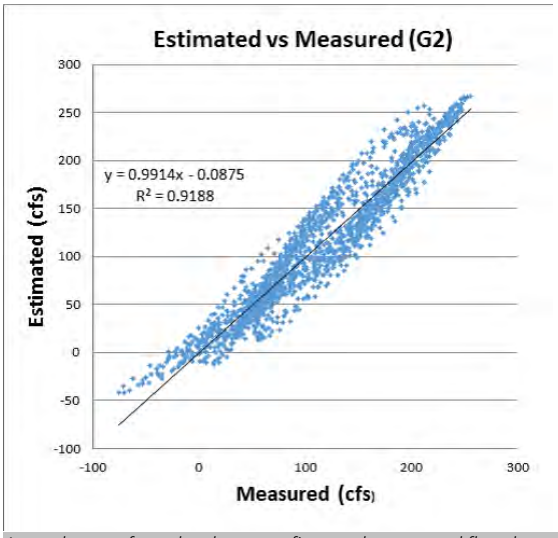

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This equation was used to get the net spring flow in our data analysis. Details about the above equation can be found in a District report that we understand you have reviewed (Chen, 2014, On the Estimation of Submarine Groundwater Discharge to Kings Bay).

Thanks again to Doug, Ron and Gabe. Doug the Group 1 2012 xls file opened OK from my gig stick Thanks. Hope you got your jacket from reception.

Martyn

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To:	"Alan Martyn Johnson"
Cc:	Xinjian Chen; Ron Basso; Gabe I. Herrick; Melissa Gulvin; Chris Anastasiou; Ross Morton; Kurt Fritsch
Bcc:	Mark A. Green; Jennette Seachrist; Eric DeHaven
Subject:	RE: Jan 23 Coffee Conversation Kings Bay
Date:	Friday, February 17, 2017 4:43:00 PM
Attachments:	image001.png image002.png image003.png image004.png image005.png image006.png image007.png

---

Martyn – I shared the revised Group 2 discharge data from VHB, Inc. with you on February 10th. These data were used to develop the last two figures included in the email to you and represent our recent use of the revised data for comparison with model-predicted flows.

Doug Leeper
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Subject: Re: Jan 23 Coffee Conversation Kings Bay

Doug,

I have just spent sometime trying to understand the Staff Response. The answer should come from VBH not staff trying to make sense of corrupted/inaccurate data. The data set is either good or bad, usable or not...this is akin to changing data for Rainbow modelling. The graphs in the 2012 report from VHB do not look unusual, essentially displaying a similar pattern to 2009 for G2. Presumably they used the collected data to generate the graph which leaves the question of how the data set you shared became shifted/corrupted. Look at the name of the author of the file you shared and ask who's payroll this person is on; that may give a clue to the origin of the shift/corruption.

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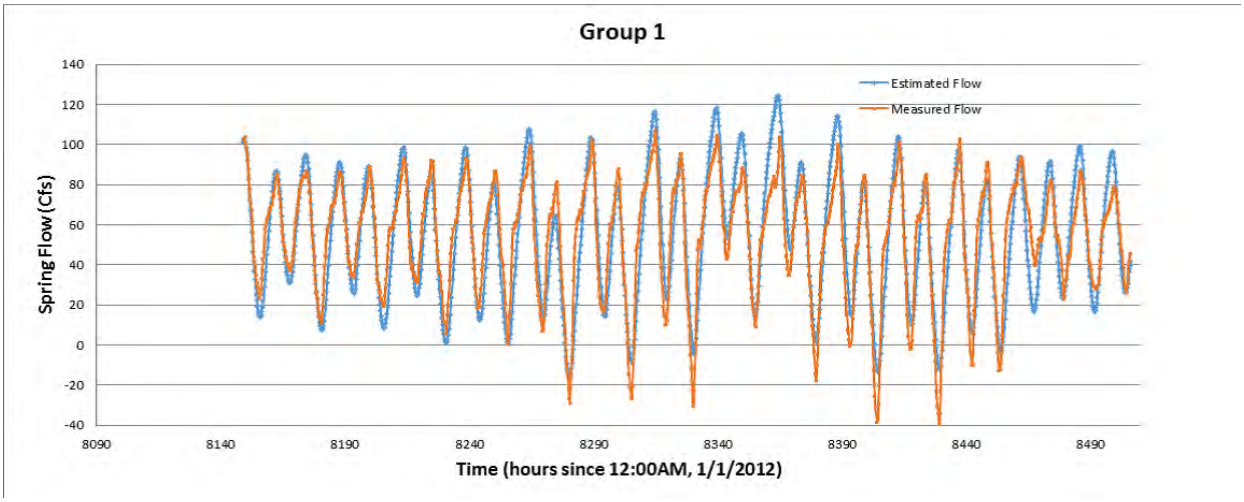

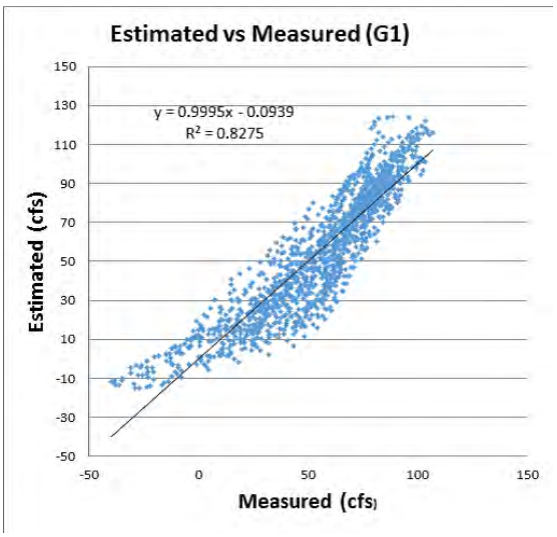

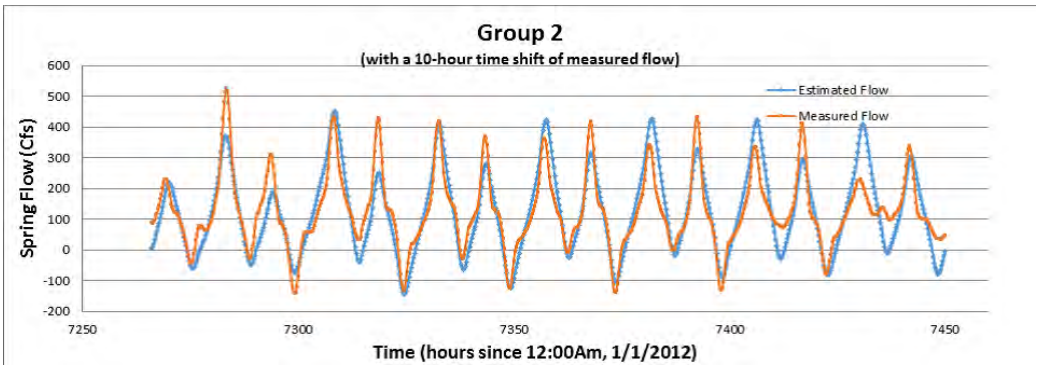

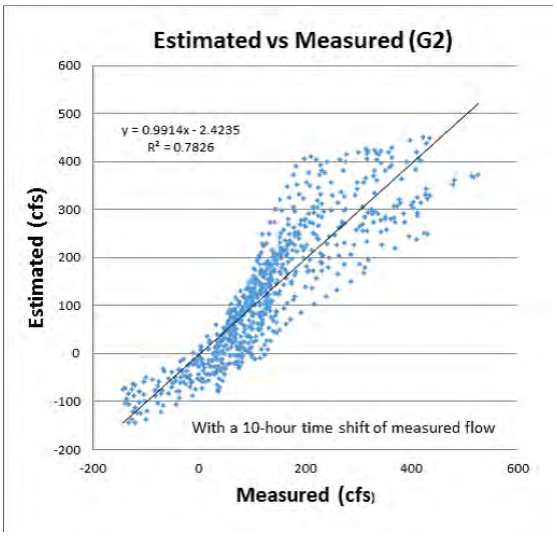

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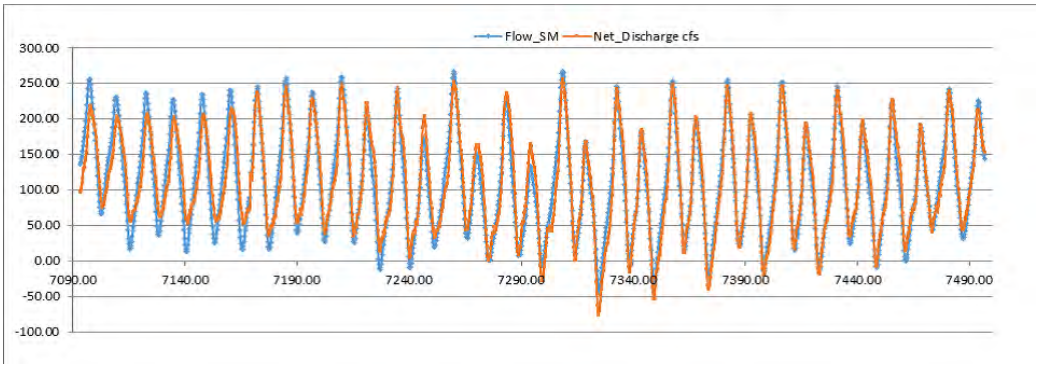

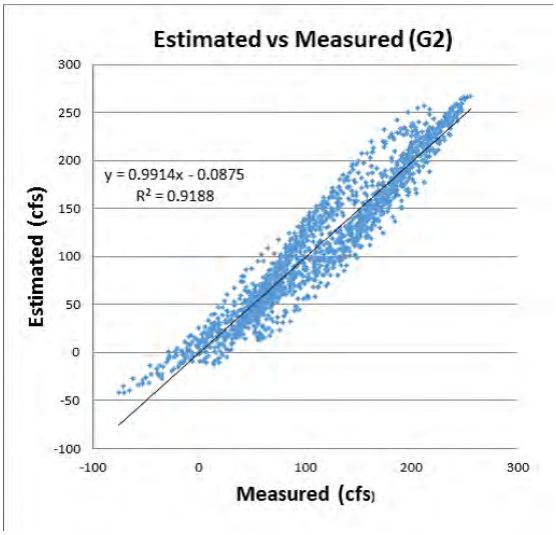

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To: Doug Leeper
Cc: Ron Basso; Gabe I. Herrick; Dave Dewitt
Subject: Re: BLACK SPRING
Date: Saturday, February 11, 2017 9:58:01 AM

Doug,
The staff responses are a case of 'wood and trees'. Bottom line remains; no evidence of reverse flow at Black Springs.

I will share some photographs I took if I get a chance, as I am surprised about the comment about water being too deep.
Martyn

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Subject: BLACK SPRING

Doug,

Please see the P.S. at the end. Thanks.

All

I checked out Black Spring.

Wednesday late afternoon a brief visit, very nice location and the view across Kings Bay with orange in the sky was gorgeous. I spoke to a resident who has lived there since 2003. He told me the main spring is 'in the corner' if I wanted to see it. As best he could judge it had stayed much the same as long as he knew. During his first few years there a small spring just off his 'boat dock' which created a small boil, but is now undetectable unless you get in the water and feel around for cooler water during the summer months. He commented this spring was at its strongest after a series of hurricanes/tropical storms shortly after he purchased the property. I assume this must have been late 2004.

I revisited yesterday morning…the house (closest to 'the corner') showed no sign of anyone home, so I took the liberty of walking onto the property to view the head spring. I had been there only a couple of minutes when I heard "Can I help you". To my surprise I was on Norman Hopkins property. We soon recognized each other and he did not need to 'shoot' me!! Doug and Ron likely remember Norman, but for those who do not know; Norman was very active in issues regarding Kings Bay with the Amy Remley Foundation.

Norman explained the history of over 20 years living next to the spring; the fish that spawn in the cove, the manatee that give birth at the spring, the manatee that take thermal refuge right at the spring vents (speculation it may be the same family) etc etc. Asked about spring discharge Norman said it varies some but not much; the easily detected boils from the vents yesterday was much the same as any other time. Norman says there are twelve vents of various sizes and no way was there ever reverse flow. Let me add you would be hard pressed to find a more observant witness than Norman.

I asked if he knew where VBH had the X-Section. He did not know, but had seen and spoken to SWFWMD personnel collecting water samples. Despite asking if they would share the results he has never received any.

In my e-mail the other day I had assumed the X section was at the 'entrance' to the cove where a line of bare rock/sand can be seen on Google Earth imagery; a similar strip of bare rock/sand strip can be seen where the adjacent springs discharge to the main bay. It is possible the X-Section for Black Spring could be much closer to the springs...VHB do not show coordinates for the X-section. And I can say the multiple boils seen yesterday could be more than 3 cfs.

Staff response (2/10/2017): *The following information was provided by VHB, Inc.*

- *Both the 9/23/09 and 10/05/09 measurements were made with the RiverCat acoustic doppler current profiler (ADCP) because the cross-section was too deep to conduct a wading measurement. Both measurements were also made fairly close to the spring vents. The 9/23/09 notes state that the measurements were made "at the mouth of the spring area" and was 8.44 cfs. The 10/05/09 notes state the measurement was made "about 20' from the spring vents" and was 6.36 cfs.*

Bottom line; I will take Norman's observation about the possibility of reverse flow...precis to...no way. VHB concluded no evidence in there brief study.

I did not mention it the other day, but I do not understand the sonde depth shown on the graphs. First slide blue line is referenced as tide stage which appears to change as the sonde is set deeper in the vent. And given there are many vents, minor point, but which vent was the sonde in?

Staff response (2/10/2017): *The tide stage data shown in blue in the previously provided figures for Black Spring and Tarpon Hole represent depth of the sensor below the water surface. These data are associated with the "sonde depth – ft" axis labels/values. At Black Spring, the District's sonde was placed in the large vent.*

In fairness I can ask in which three vents did VHB take their readings on 10/5/2009. One of the vents is a long, possibly over 8 feet, and narrow, say 6 to 9 inches as viewed. Others are much smaller, say 6 inches diameter.

Staff response (2/10/2017): *The following information was provided by VHB, Inc.*

- *Three vents were measured on 10/05/09. Vent 1 (SV38100509a) measured 2.2' by 1.0'; Vent 2 (SV38100509b) measured 1.2' by 1.1'; and Vent 3 (SV38100509c) measured 7.2' by 0.7'. When a subset of vents was measured, VHB tried to select the largest and/or strongest flowing vents to capture the highest flows.*
- *VHB also collected water quality data collected concurrent with the discharge measurements. On 9/23/09 the water quality data were collected within Vent 1 (SV38100509a). Water quality data were obtained from all three vents on 10/05/09. When placing the sonde in the vents the emphasis was on obtaining representative results from the springs discharge and reducing or eliminating the influence of the surrounding surface waters. This typically entailed inserting the sonde a foot or more into the throat of the vent, as needed to obtain accurate spring water quality data.*

All adds to the difficulty of determining the spring discharges into Kings Bay, a point we all agree on.

Martyn

P.S.

Doug,

A quick pointer to results from water sampling at Black Spring if you have time. Why...simply kindness.

You may have noticed Norman is no longer active. He is a full time care giver to his wife and is not very stable on his legs. He was insistent on walking the property with me and enjoyed the conversation.

Are water analyse results for Black Spring in the huge file I downloaded from outgoing the other

day. I would like to share these with him just as a matter of kindness. He appeared very lonely.

Thanks

Staff response (2/10/2017): *Water quality data for Black Springs were included in an email to Norman Hopkins (and copied to you) on 2/3/2017.*

From: Susanna Martinez Tarokh
To: All_Users
Subject: SWFWMD Daily Media Report
Date: Wednesday, March 15, 2017 3:42:34 PM

SWFWMD DAILY MEDIA CONTACTS
3/15/2017
As of 4:00 p.m.

Media Outlet: Citrus County Chronicle
Reason for Call: Editorial Board Visit
Agency's Response: District initiated visit to the Citrus County Chronicle Editorial Board. PIO, Northern Government Affairs Program Manager and Resource Management Director met for an hour to review information about the District's proposed Minimum Flow and Level for the Rainbow River System. This comes after the paper's editorial ran last week titled, *Ulterior Motive: Flow reductions an awful thing to do to rivers.*

Reporter's Name: Kathy Prucnell
Media Outlet: The Islander
Reason for Call: Long Bar Pointe
Agency's Response: Reporter following up on this project with specific questions- ERP Permit Bureau Chief provided responses. **1.) Is it true, the District will allow these ag exemptions using "best management practices" any time it's zoned agriculture? And if so, what are these best practices?** Ag exemptions for excavation of farm ponds are authorized based on several factors, including use of best management practices, agricultural zoning, and ongoing agricultural activities. The Permittee submitted a revised plan for the lake excavation that is no longer based on qualifying as a farm pond. The revised plan includes the same pond footprint, but includes deeper excavation than the 15' allowed by the farm pond exemption. The revised plan also includes details related to clearing, placement of fill, haul roads and dewatering associated with the lake excavation. **2) The spoil material, would that include land clearing or only the soil dug for ponds?** The ongoing activities, including spoil material and land clearing, are all related to the lake excavation. **3.) Has there been any additional permits/exemptions granted? Have any of the previous permits under review been granted? If so, what and when?** A Petition for Formal Approval of wetland limits (42040157.009) was approved on 12-28-16 and a Phase 1 permit extension (43040157.011) was issued on 1-31-17. A challenge to that approval was received in January and referred to DOAH.

Reporter's Name: Michael Salerno
Media Outlet: Villages Daily Sun
Reason for Call: Dam safety
Agency's Response: Reporter emailed series of questions regarding the District's flood control structures and dam safety to PIO – working with structure operations manager and field operations manager, sent responses back to reporter via email.

Susanna Martinez Tarokh
Public Information Officer
Southwest Florida Water Management District

OFFICE 813-985-7481 ext. 2008
CELL 813-781-9817
watermatters.org/newsroom

Flow reductions an awful thing to do to rivers

For those who love the Rainbow River, it's an assault on the environment

For the Southwest Florida Water Management District, it's a statutory requirement.

Somewhere in the middle is a good thing that, it's widely agreed, is being done for the wrong reasons. That "thing" is the establishing minimum flows and levels for the Rainbow River — and rivers all around Florida.

In Citrus County, minimum flows and levels (MFLs) were set for the Chassahowitzka and Homosassa rivers a few years ago. The Crystal River and King's Bay are next up.

But of immediate concern is the water district's recommendation that a reduced flow of up to 5 percent be instituted for the Rainbow River, in southern Marion County. The premise is: Limiting the flow reduction to 5 percent would cap habitat damage and destruction to 15 percent.

That is, absolutely, an assault on the environment.

The flipside is, this will be the first time the MFL will have been established for the river, so moving forward with scientific data beats blindly wading into the future. The same holds true for setting MFLs for water bodies throughout the state. It's the governor and state lawmakers who mandated the establishment of MFLs. Water districts are just following marching orders.

THE ISSUE:
Minimum flows and levels for the Rainbow River.

OUR OPINION:
Zero reduction is best.

The hushed reality is that the move to allow decreased water flow is directly plugged into increased water withdrawals. Big development and heavy-use agricultural interests come into conflict with protecting the rivers and the life they support. The seemingly noble cause of setting MFLs to ensure the future health of rivers has morphed into condoned degradation. There's a pro-growth political climate that's coming at the expense — in this case — of one of the most beautiful rivers in Florida.

Why not rule that a zero percent reduction in water flow is best and, instead, increase investment in water conservation measures and alternative sources to fuel thirsty development and ag interests? Because that comes at a much higher price.

On March 28 the Southwest Florida Water Management District governing board will meet in Brooksville and take up the issue of the 5 percent MFL reduction for the Rainbow River. The Department of Environmental Protection lists the Rainbow River as one of 41 Florida "Outstanding Florida Waters" of 1,700 rivers, lakes, lake chains, estuarine areas and the Florida Keys. Approving the devastation of up to 15 percent of the river's habitat is simply an assault on Mother Nature.

Citrus County Chronicle
Crystal River
Daily 25,740
March 10, 2017

From:	Alan Martyn Johnson
To:	Doug Leeper
Cc:	Ron Basso; Melissa Gulvin; Xinjian Chen; Gabe I. Herrick
Subject:	Pulsing Springs Of Kings Bay
Date:	Monday, March 06, 2017 8:30:50 AM
Attachments:	bold Group 1 2009 chen spring discharge linear between graph hi-lo.xlsx

Doug,
I am directing this to you as you have coordinated Staff Responses in the past, but it is equally addressed to all cc's.

As discussed/promised attached is my xls file with Dr. Chen's spring discharges for Group 1 springs re Figure 2-4 in the Draft Report. As you will see there is a shortfall or excess water in the pool upstream of the X-section i.e. the stage per VHB/USGS data is not maintained using Dr. Chen's spring discharges. These excess or shartfalls are in bold red and black.
For clarity let me add:

- The Dr. Chen spring discharge is the best I could read the Figure 2-4 these are bold with light blue background.
- The discharges between the hi/low are by linear interpolation for each change high to low.
- The VHB data did not account for the difference in high tide time. You will recall in my spreadsheet determining the spring discharge I left blank those areas around the tide change times. I had done the same with this spreadsheet and you are welcome to do the same to account for the roughly 15 minutes later high tide at the X-section cf Mouth of Kings Bay.

Dr. Chen's calculations are wrong. The idea that Group 1 springs discharge vary as presented in Figure 2-4 is simply not true.

What makes the whole picture more ridiculous is to suggest all other springs in Kings Bay vary depending on their relative location to Group 1 X-section, Group 2 X-section and Romp TR21-3.

Yes my words are blunt, but it appears a 2x4 is needed to get to the truth. May I suggest again you share my comments with Dr. Penne and Dr. Watson. I trust I do not have to request a personal meeting to discuss their uncertainties about spring discharge from the ''pulsing springs of Kings Bay".

I think I have know Doug and Ron long enough that they know I will welcome any rational argument showing I am wrong.

BACKGROUND

I first raised the concern about the wide variations in Kings Bay springs discharge November 7,

2016. I comment how the logic was missing from the discharges presented in Figure 2-4 of the Draft MFL report. Since then we have exchange a number of e-mails, for example November 30, 2016 when I commented, the more I dig into this the more my concern increases.

January 23, 2017 Doug, Ron Basso and Gabe Herrick met with me to discuss the matter in person. While none claimed the ability to discuss the math behind Dr, Chen's assessment, all agreed with the discharges varying as Dr. Chen has calculated. I shared a number of graphs of weekly discharges from the file of Dr. Chen's work on discharge from all Kings Bay Springs (Model Output of SGD for baseline, shared with me January 18). I asked 'Do you really believe these springs have discharge that varies like this?…this is hard to believe'. Following the meeting on January 24, 2017 I shared with you my xls file with my analysis of the VHB Group 1 data and diagrams of the associated mass balance. My analysis indicated Spring discharge did not vary significantly thru the tidal cycle.

Staff response was my diagrams correctly represented the mass balance, but did not comment regarding my xls file findings.

I suggested 'you' get bold and plug Dr.Chen's discharge number into the file to verify they make sense. On February 8, 2017 I gave the discharges from Figure 2-4 graph for the first few tidal cycles. I also suggested you consider sharing my thoughts/analysis with the Peer Review Panel. The Peer Review panel repeatedly expressed uncertainty in their final report.

As example Quote from Comment 46

The equations that are utilized to define all the flows into the system have some basic error associated with them as well as certain levels of uncertainty. For example, in Figure 2-4 looking at plot (a), it is clear that for the period when measured flows were available, there are errors in the estimated flow that would indicate that the model under-predicts the overall net flow out. This error is then carried through an additional level of uncertainty as the equations and coefficients are extrapolated out to other vents in the system. Based on these known errors and uncertainty, it would be important to developed additional ways to verify the total flows. This could be done using the Bagley data, if this data is demonstrated to be useful for this. Still working on the evaluation of the Bagley data.

End Quote

From the same Comment in the Recommendation Quote.

Also, some more definitive discussion of the degree of variation in the direct vent measurements and how they were used to carry the calculations forward is needed.

End Quote

Martyn

From:	Doug Leeper
To:	"Alan Martyn Johnson"
Cc:	Xinjian Chen; Gabe I. Herrick; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ron Basso; Melissa Gulvin
Subject:	RE: Pulsing Springs Of Kings Bay
Date:	Thursday, March 09, 2017 8:26:00 AM
Attachments:	bold Group 1 2009-gh.xlsx Reply to MJohnson 2017-03-09.pdf image001.png image002.png image003.png

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Martyn:

Thanks for the email and attached Excel file concerning spring discharge to Kings Bay that you sent on Monday, March 6, 2017. We note that your email claims “there is a shortfall or excess water in the pool upstream of the X-section” and from this you conclude that “Dr. Chen’s calculations are wrong”. The District is committed to supporting its claims based on evidence. District Staff have developed an empirical formula for estimating submarine groundwater discharge (SGD). District confidence in this formula is proportional to the weight of evidence which supports it.

The District formula can predict surface water levels with 74% accuracy for Group 1 springs and with 94% accuracy for Group 2 springs (R^2 values). These methods have been published in peer reviewed scientific journals by Dr. Chen, and separately peer-reviewed in the minimum flow report. This predictive capacity represents the best information available. There is no better predictive tool for estimating water levels in the Crystal River/Kings Bay system.

The strength of the District formula for SGD comes from its ability to explain the data. Your spreadsheet includes data which you claim demonstrates a shortfall of the SGD formula for predicting flux across a cross section in Kings Bay. Your spreadsheet shows the change in volume over a 15-minute interval for water upstream of the G1 cross section as predicted by G1 discharge and SGD (eq. 1) in column L. This change in volume over time may be referred to as “15-minute flux”. You estimate SGD from a figure, which you acknowledge carries with it a degree of uncertainty. The 15-minute flux predicted by gage height is shown in column M. You subtract M from L to arrive at what you call the “Eccess[sic] Shortfall in pool” shown in column O. From the values in this column O, you conclude the District method for estimating discharge is incorrect.

How does 15-minute flux as estimated from discharges at G1 and SGD compare with 15-minute flux as estimated from gage height? A plot of these fluxes is shown below in Figure 1 (this figure and other figures discussed in this email were developed using information included in the attached Excel file named “bold Group 1 2009-gh which was developed using the file you sent on March 6th; note that a PDF of this email is also attached). The 15-minute flux predicted by discharges at G1 and SGD [labeled Discharges (col L)] clearly mirrors the 15-minute flux predicted by gage height [labeled Gage Height (col M)]. The difference between these two lines is shown as Shortfall (col O). Note the similarity in 15-minute flux as estimated from these two sources. Also please note the time difference between values in col L and col M, which introduces additional errors in col O if the difference between col L and col M is taken simply by subtracting col M from col L in the same row. The time difference between col L and col M can be clearly seen in Figure 1.

The similarity in lines of Figure 1 can be quantified using linear regression. A linear regression of 15-

minute flux from discharges (col L) as a predictor 15-minute flux from gage height (col M) has an R^2 value of 0.9376 (Figure 2 below). This means that the SGD and G1 discharge capture over 93% of the variation in the flux estimated from gage height. Recall there is some uncertainty associated with discrepancy between times of measurement, in measurement of gage height, in discharge at G1, and in estimating SGD from eyeballing values from a plot. Thus, this remaining 6-7% error is not entirely attributable to error in estimation of SGD.

Your analysis is limited to producing a list of differences between two methods for estimating 15-minute flux. These differences (col O) are on the order of 10^4 ft^3/15min. You claim these values are so large as to warrant calling the District "wrong". How large are these values compared to the overall volume of the pool upstream from G1? If we assume an average depth of 3 ft at MSL (a likely underestimate), we can estimate the relative shortfall as a fraction of the overall volume of the bay (Figure 3 below). You can see that these "large" differences are less than 4% of the total volume of the upstream pool (assuming 3ft average depth at MSL).

You have expressed incredulity in the degree of variation in SGD predicted by District formula. However, the District formula SGD has lower variation than any other method for estimating spring discharge to this system. Compare District-formula SGD with discharge reported at USGS 02310747 Crystal River at Bagley Cove near Crystal River, FL (Figure 4 below). The District SGD shows a record of spring flow with much less variability than the discharges reported at Bagley Cove. As such, the District formula for estimating SGD addresses the problem of minimizing fluctuation in estimated spring flow, is based on the mass-balance principle, and has been repeatedly verified against field data.

Analysis of the data you presented in your spreadsheet shows that the District formula does quite well at predicting water levels and fluxes in this system. Although your calculations could make the "Eccess Shortfall in pool" in col O larger in magnitude than it should be, we think the information you've provided support the empirical formula.

We would add that the District empirical formula was obtained through data fitting of spring flow data, which were calculated from measured discharge data at G1 and G2 based on the mass-balance principle. Data fitting is simply a process of finding the best mathematical expression linking a dependable variable with one or more independent variables through minimizing the overall mismatch between measured data and model-predicted results. Just because there are errors between model results and data (in this case, between col L and col M) does not mean that the model is wrong. As mentioned above, errors are minimized but not eliminated in data fitting.

In closing, please note that we will continue to apportion our confidence in the formula for SGD based on the strength of evidence regarding its power to explain observations.

Figure 1. 15-minute flux estimates over a two-day period

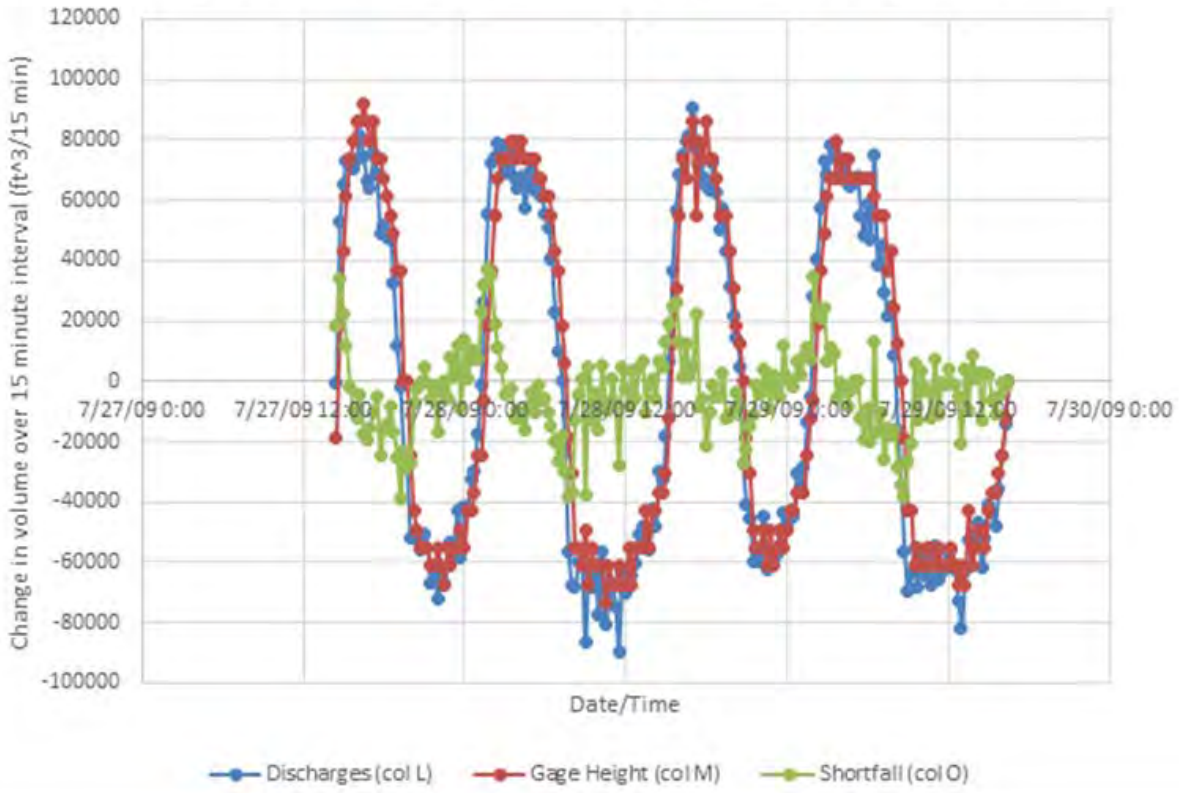
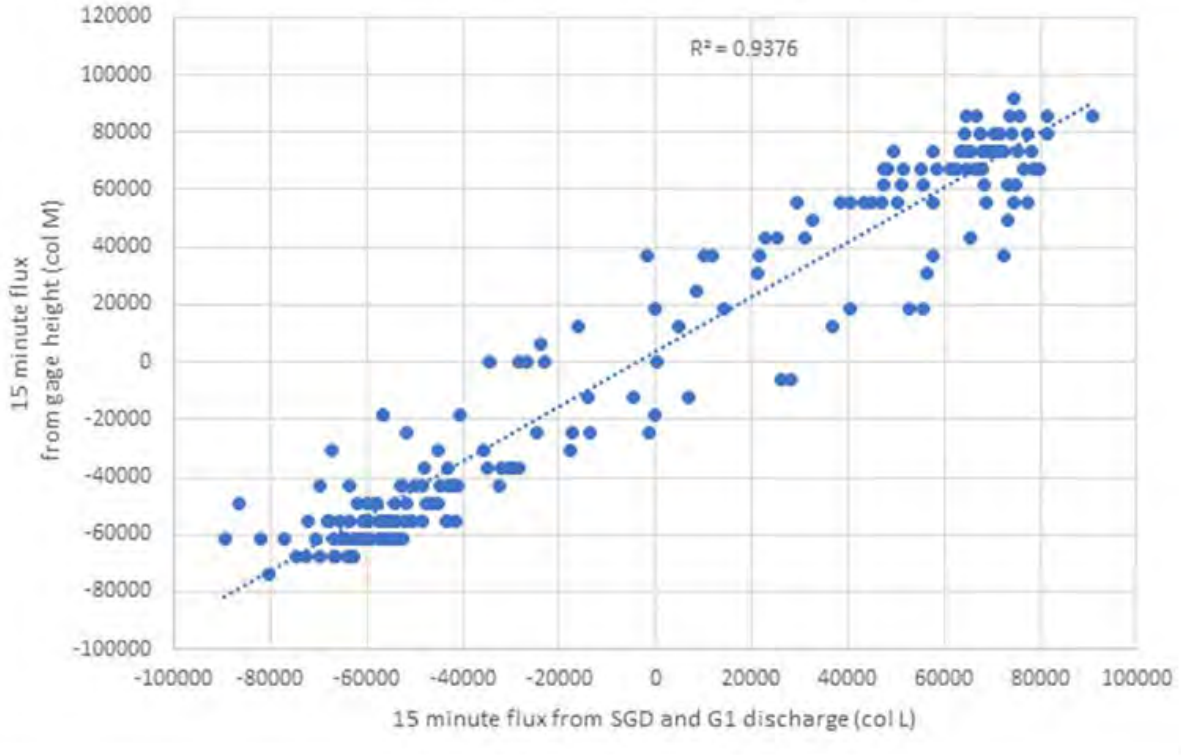
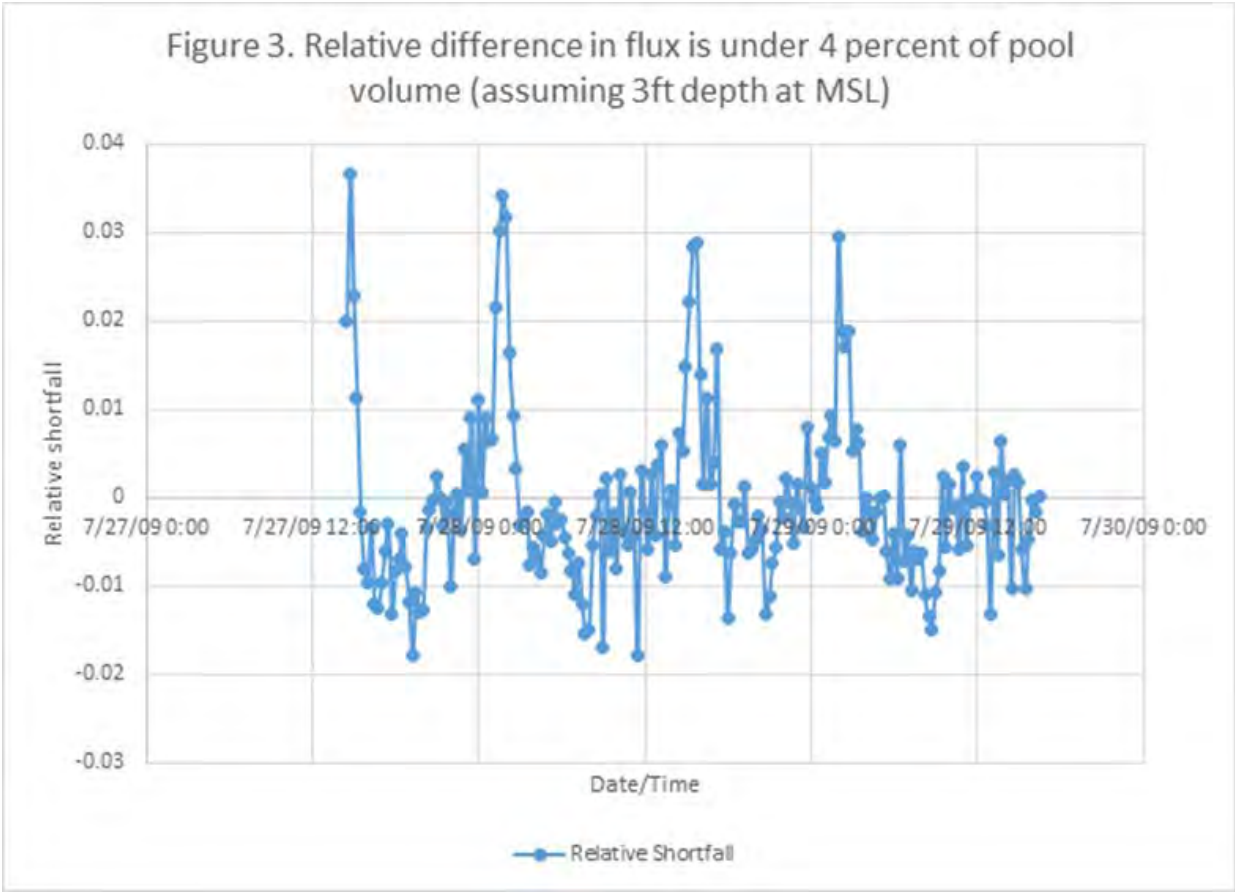


Figure 2. District formula SGD produces estimates of 15-minute flux that are condordant with gage height estimates.





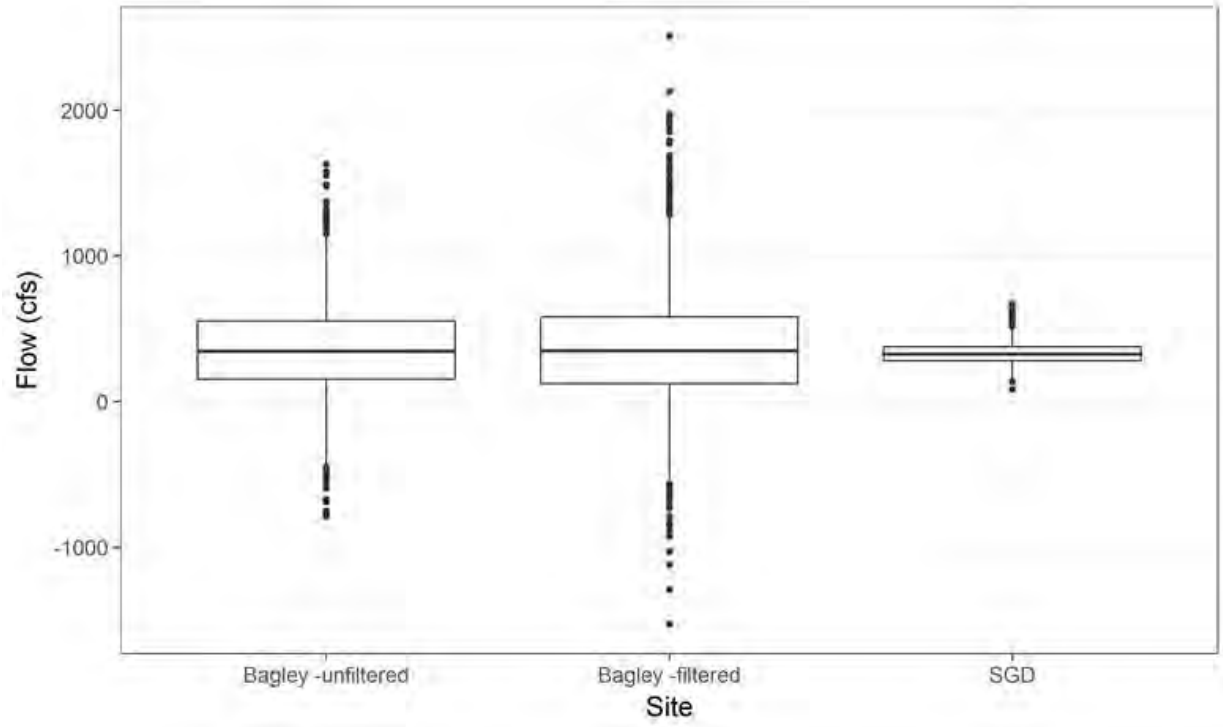


Figure 4. District formula submarine groundwater discharge (SGD) compared with discharges reported at Bagley Cove over the hydrodynamic model period of record. Variation predicted by District SGD is much lower than predicted by reported discharges. Boxplot made with daily mean discharge. Note USGS gage reports frequent negative daily values, even when tidally-

filtered. Dark center line is median, upper and lower box edges are 75th and 25th exceedance percentiles. Whiskers extend to 1.5 IQR. Outliers show as dots beyond whiskers.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Monday, March 06, 2017 8:31 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>
Subject: Pulsing Springs Of Kings Bay

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In closing, please note that we will continue to apportion our confidence in the formula for SGD based on the strength of evidence regarding its power to explain observations.

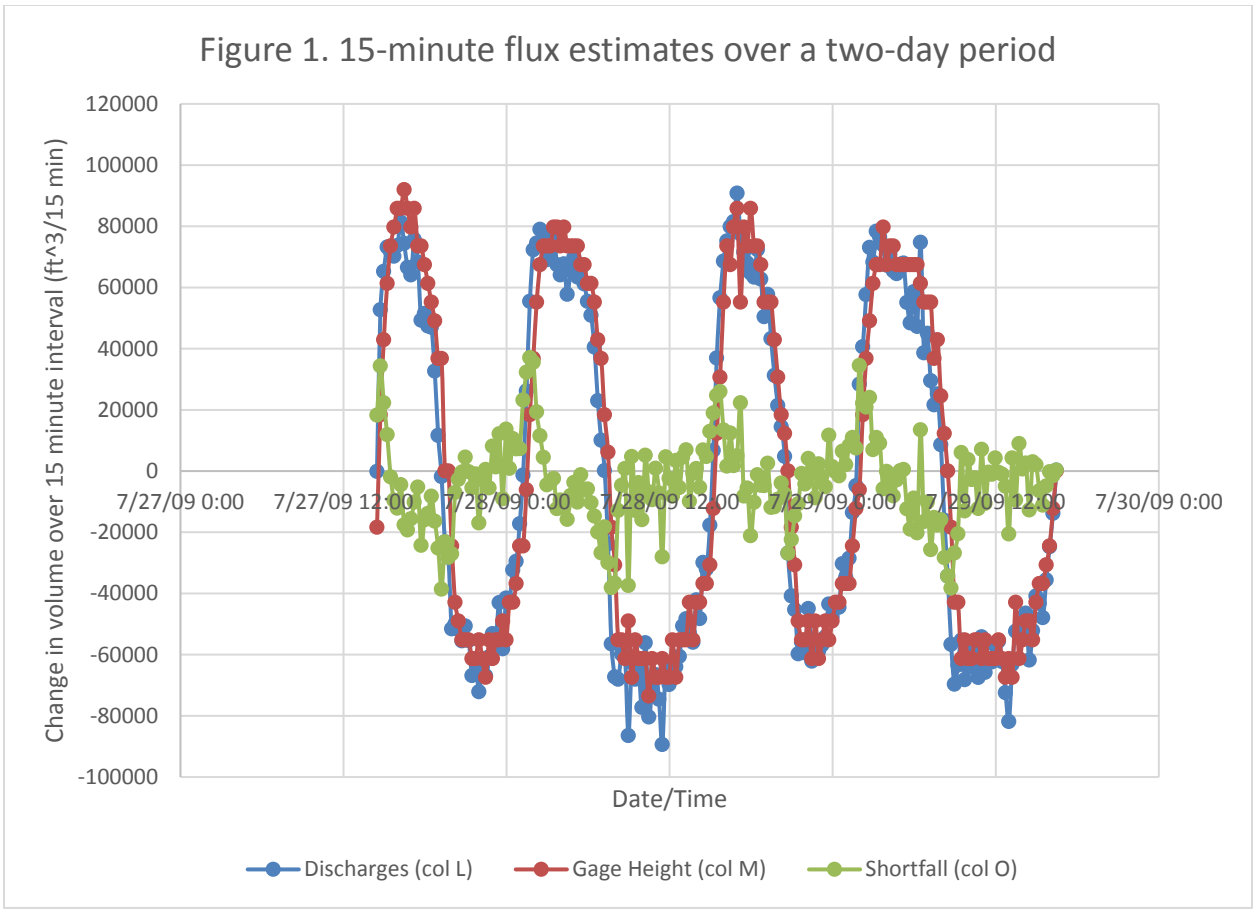
Figure 1. 15-minute flux estimates over a two-day period
Change in volume over 15 minute interval (ft^3/15 min)
120000
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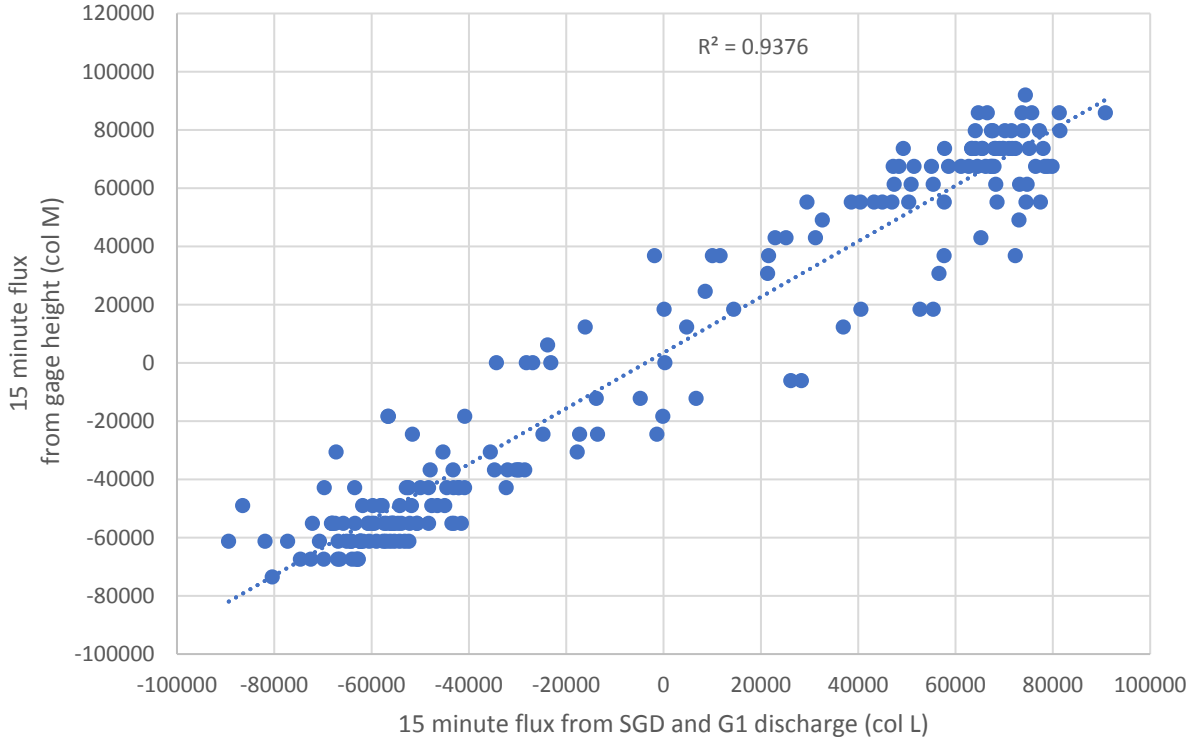
80000
60000
40000
20000
0
-20000
-40000
-60000
-80000
-100000
7/27/09 0:00
7/27/09 12:00
7/28/09 0:00
7/28/09 12:00
7/29/09 0:00
7/29/09 12:00
7/30/09 0:00
Date/Time
Discharges (col L)
Gage Height (col M)
Shortfall (col O)

Figure 2. District formula SGD produces estimates of 15-minute flux that are condordant with gage height estimates.



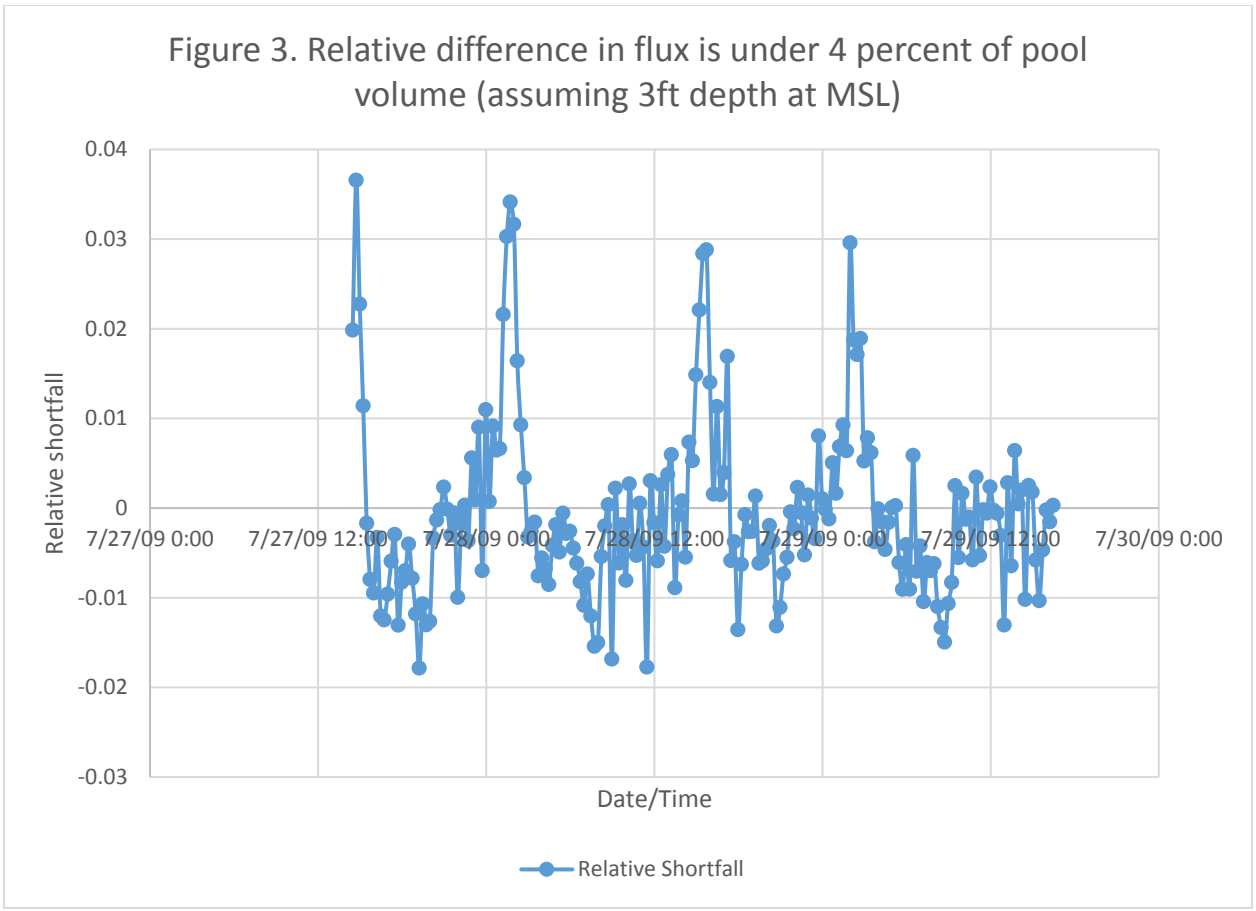


Figure 3. Relative difference in flux is under 4 percent of pool volume (assuming 3ft depth at MSL)
0.04
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
Relative shortfall
7/27/09 0:00
7/27/09 12:00
7/28/09 0:00
7/28/09 12:00
7/29/09 0:00
7/29/09 12:00
7/30/09 0:00
Date/Time
Relative Shortfall

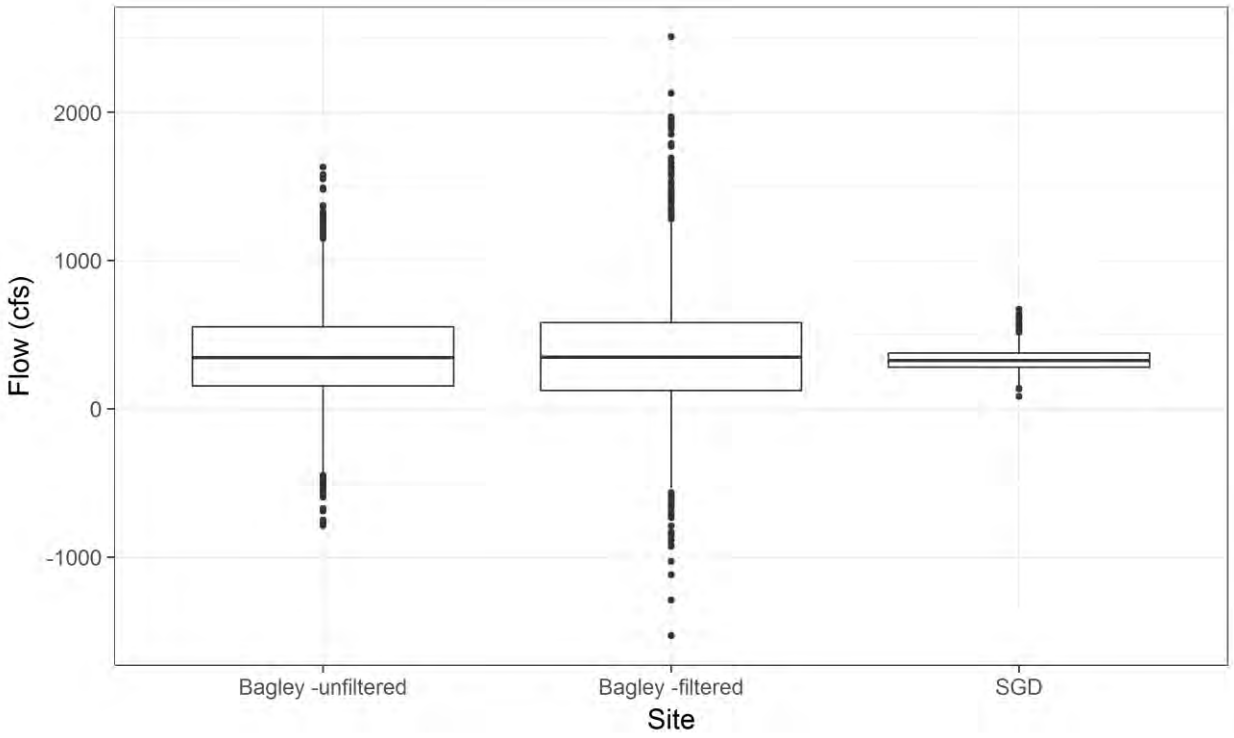


Figure 4. District formula submarine groundwater discharge (SGD) compared with discharges reported at Bagley Cove over the hydrodynamic model period of record. Variation predicted by District SGD is much lower than predicted by reported discharges. Boxplot made with daily mean discharge. Note USGS gage reports frequent negative daily values, even when tidally-filtered. Dark center line is median, upper and lower box edges are 75th and 25th exceedance percentiles. Whiskers extend to 1.5 IQR. Outliers show as dots beyond whiskers.

From:	Alan Martyn Johnson
To:	Doug Leeper
Cc:	Xinjian Chen; Gabe I. Herrick; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ron Basso; Melissa Gulvin; Kurt Fritsch
Subject:	Re: Pulsing Springs Of Kings Bay
Date:	Monday, March 13, 2017 7:37:06 AM
Attachments:	image001.png image002.png image003.png

My e-mail and attachment were a follow up to my e-mail of January 24 where I shared the mass balance, and diagrammatic basis for the mass balance, of the VHB 2009 Group 1 data. The results show the combined Group 1 springs discharge to be almost constant thru the tidal cycles. This makes sense of the VHB data, all parameters are in balance, and is logical given what is generally known about spring discharges. Additionally, the data from measurements at individual springs in Kings Bay in the VHB reports 2009 and 2012, show no evidence of spring discharges varying in the manner shown in the graphic presentation Figure 2-4 in the draft report i.e. pulsing. Repeat no evidence.

In my January 24 e-mail I challenged SWFWMD to 'be bold' and plug the spring discharges from Figure 2-4 into the mass balance and see for yourselves the results. As you did not do that I did it for you. Yes I had to estimate the discharges from the graph (I think you have to admit they are reasonably close), but you are very welcome to change these to the calculated 15 minute discharges used to generate the graph.

In your response no mention is made of the 'uncertainty' expressed by the Peer Review Panel. I would also draw attention to the concerns expressed by Dan Yobbi in his memos December 2014 and September 2015 (in the Appendix of the Draft MFL Report).

For completeness I believe there are two formulas the District has developed for springs discharge based on the location of each individual spring.

The writers of this response appear not to realize the 15 minute shortfalls or excess are cumulative thru each respective tidal cycles.

As for the total volume in the pool....well...what can I say....interesting!

As for regression analysis...what can I say...amazing!

As for Bagley Cove data, this is not related to the mass balance Group 1, but you are welcome to look back at my previous comments particularly about the 24.84 hour tidal cycle shared last year.

Let us get back to the subject, the pulsing springs of Kings Bay.
How about sharing my mass balance January 24 e-mail and the recent one showing how out of balance the spring discharges in Figure 2-4 are, with Dr. Peene and Dr. Watson to see if this

helps them understand the uncertainty they have expressed in the Peer Review Report. Dan Yobbi as well if you want.
<!--[if !supportLineBreakNewLine]-->
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For those who have not seen how the total discharge for all springs discharge varies (pulse) according to Districts two formula, I have attached a graph of a typical week of discharges. This is similar to the ones shared with Doug, Ron and Gabe when we met January 23 and is from the District Model output. Variations during some cycles from less than 50cfs to 700 cfs from high to low tide. Really?

Kings Bay springs do not pulse to such magnitude. I have suggested before and I will repeat it. Take one of the major springs, your choice, and position a velocity meter in the vent and monitor it for a few days. We can quickly prove who is right by in field measurement. I am confident my mass balance (January 24) indicating almost constant discharge from the springs will prevail.

Martyn

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Thursday, March 9, 2017 8:26 AM
To: Alan Martyn Johnson
Cc: Xinjian Chen; Gabe I. Herrick; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ron Basso; Melissa Gulvin
Subject: RE: Pulsing Springs Of Kings Bay

Martyn:

Thanks for the email and attached Excel file concerning spring discharge to Kings Bay that you sent on Monday, March 6, 2017. We note that your email claims “there is a shortfall or excess water in the pool upstream of the X-section” and from this you conclude that “Dr. Chen’s calculations are wrong”. The District is committed to supporting its claims based on evidence. District Staff have developed an empirical formula for estimating submarine groundwater discharge (SGD). District confidence in this formula is proportional to the weight of evidence which supports it.

The District formula can predict surface water levels with 74% accuracy for Group 1 springs and with 94% accuracy for Group 2 springs (R^2 values). These methods have been published in peer reviewed scientific journals by Dr. Chen, and separately peer-reviewed in the minimum flow report. This predictive capacity represents the best information available. There is no better predictive tool for estimating water levels in the Crystal River/Kings Bay system.

The strength of the District formula for SGD comes from its ability to explain the data. Your

spreadsheet includes data which you claim demonstrates a shortfall of the SGD formula for predicting flux across a cross section in Kings Bay. Your spreadsheet shows the change in volume over a 15-minute interval for water upstream of the G1 cross section as predicted by G1 discharge and SGD (eq. 1) in column L. This change in volume over time may be referred to as "15-minute flux". You estimate SGD from a figure, which you acknowledge carries with it a degree of uncertainty. The 15-minute flux predicted by gage height is shown in column M. You subtract M from L to arrive at what you call the "Eccess[sic] Shortfall in pool" shown in column O. From the values in this column O, you conclude the District method for estimating discharge is incorrect.

How does 15-minute flux as estimated from discharges at G1 and SGD compare with 15-minute flux as estimated from gage height? A plot of these fluxes is shown below in Figure 1 (this figure and other figures discussed in this email were developed using information included in the attached Excel file named "bold Group 1 2009-gh which was developed using the file you sent on March 6th; note that a PDF of this email is also attached). The 15-minute flux predicted by discharges at G1 and SGD [labeled Discharges (col L)] clearly mirrors the 15-minute flux predicted by gage height [labeled Gage Height (col M)]. The difference between these two lines is shown as Shortfall (col O). Note the similarity in 15-minute flux as estimated from these two sources. Also please note the time difference between values in col L and col M, which introduces additional errors in col O if the difference between col L and col M is taken simply by subtracting col M from col L in the same row. The time difference between col L and col M can be clearly seen in Figure 1.

The similarity in lines of Figure 1 can be quantified using linear regression. A linear regression of 15-minute flux from discharges (col L) as a predictor 15-minute flux from gage height (col M) has an R^2 value of 0.9376 (Figure 2 below). This means that the SGD and G1 discharge capture over 93% of the variation in the flux estimated from gage height. Recall there is some uncertainty associated with discrepancy between times of measurement, in measurement of gage height, in discharge at G1, and in estimating SGD from eyeballing values from a plot. Thus, this remaining 6-7% error is not entirely attributable to error in estimation of SGD.

Your analysis is limited to producing a list of differences between two methods for estimating 15-minute flux. These differences (col O) are on the order of 10^4 ft^3/15min. You claim these values are so large as to warrant calling the District "wrong". How large are these values compared to the overall volume of the pool upstream from G1? If we assume an average depth of 3 ft at MSL (a likely underestimate), we can estimate the relative shortfall as a fraction of the overall volume of the bay (Figure 3 below). You can see that these "large" differences are less than 4% of the total volume of the upstream pool (assuming 3ft average depth at MSL).

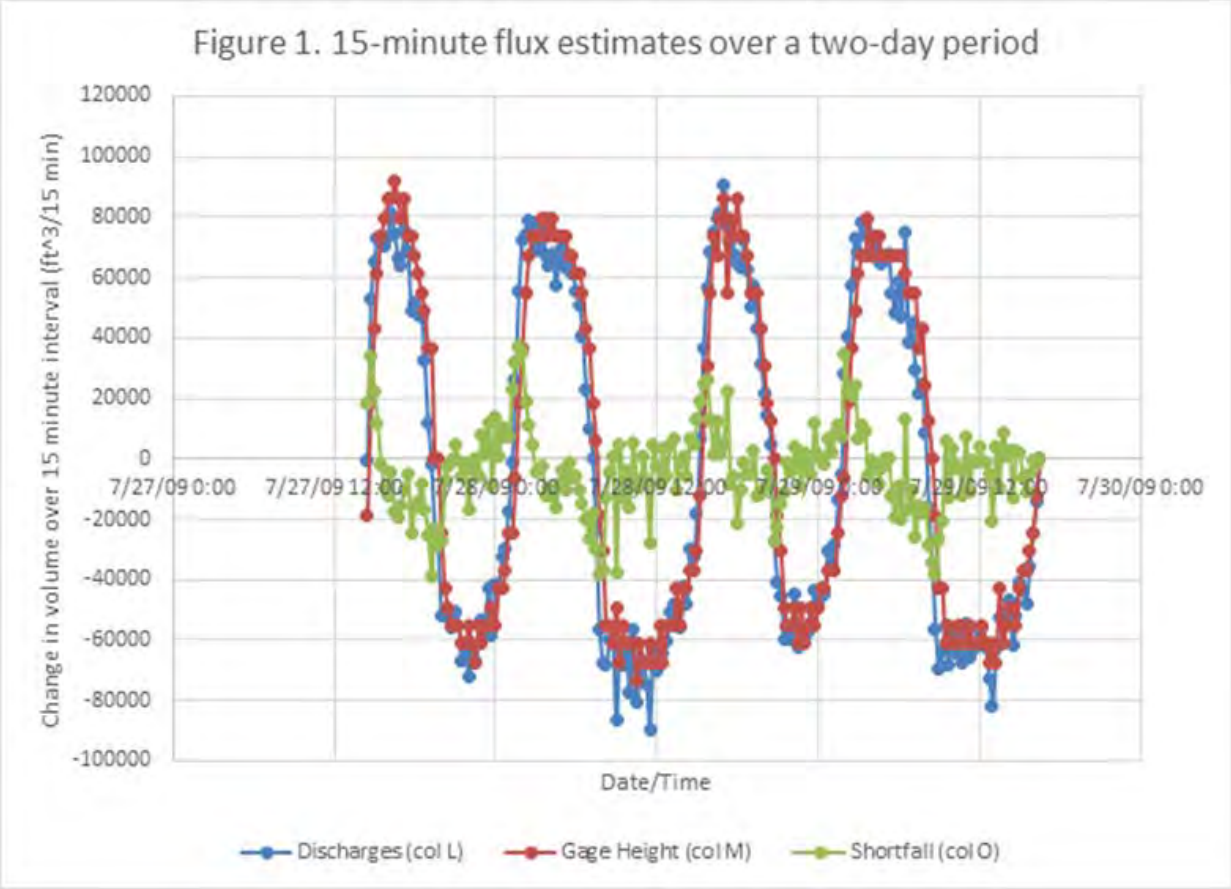
You have expressed incredulity in the degree of variation in SGD predicted by District formula. However, the District formula SGD has lower variation than any other method for estimating spring discharge to this system. Compare District-formula SGD with discharge reported at USGS 02310747 Crystal River at Bagley Cove near Crystal River, FL (Figure 4 below). The District SGD shows a record of spring flow with much less variability than the discharges reported at Bagley Cove. As such, the District formula for estimating SGD addresses the problem of minimizing fluctuation in estimated spring flow, is based on the mass-balance principle, and has been repeatedly verified against field data.

Analysis of the data you presented in your spreadsheet shows that the District formula does quite well

at predicting water levels and fluxes in this system. Although your calculations could make the "Eccess Shortfall in pool" in col O larger in magnitude than it should be, we think the information you've provided support the empirical formula.

We would add that the District empirical formula was obtained through data fitting of spring flow data, which were calculated from measured discharge data at G1 and G2 based on the mass-balance principle. Data fitting is simply a process of finding the best mathematical expression linking a dependable variable with one or more independent variables through minimizing the overall mismatch between measured data and model-predicted results. Just because there are errors between model results and data (in this case, between col L and col M) does not mean that the model is wrong. As mentioned above, errors are minimized but not eliminated in data fitting.

In closing, please note that we will continue to apportion our confidence in the formula for SGD based on the strength of evidence regarding its power to explain observations.



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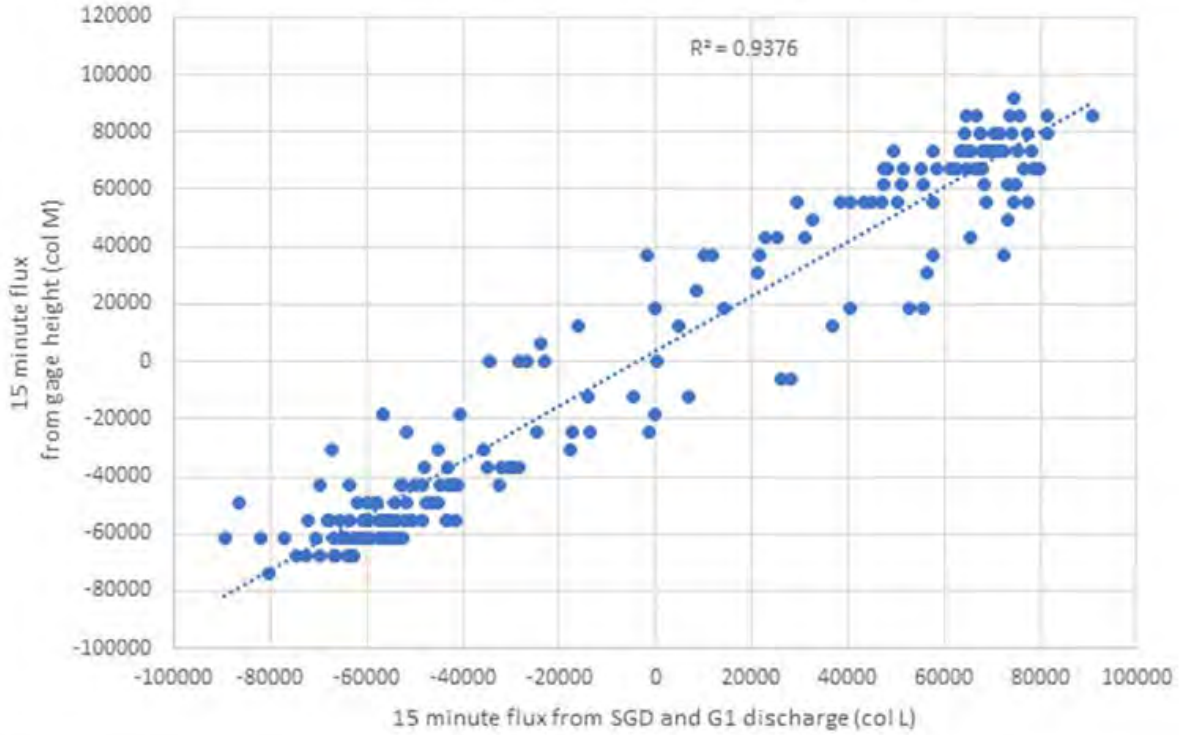
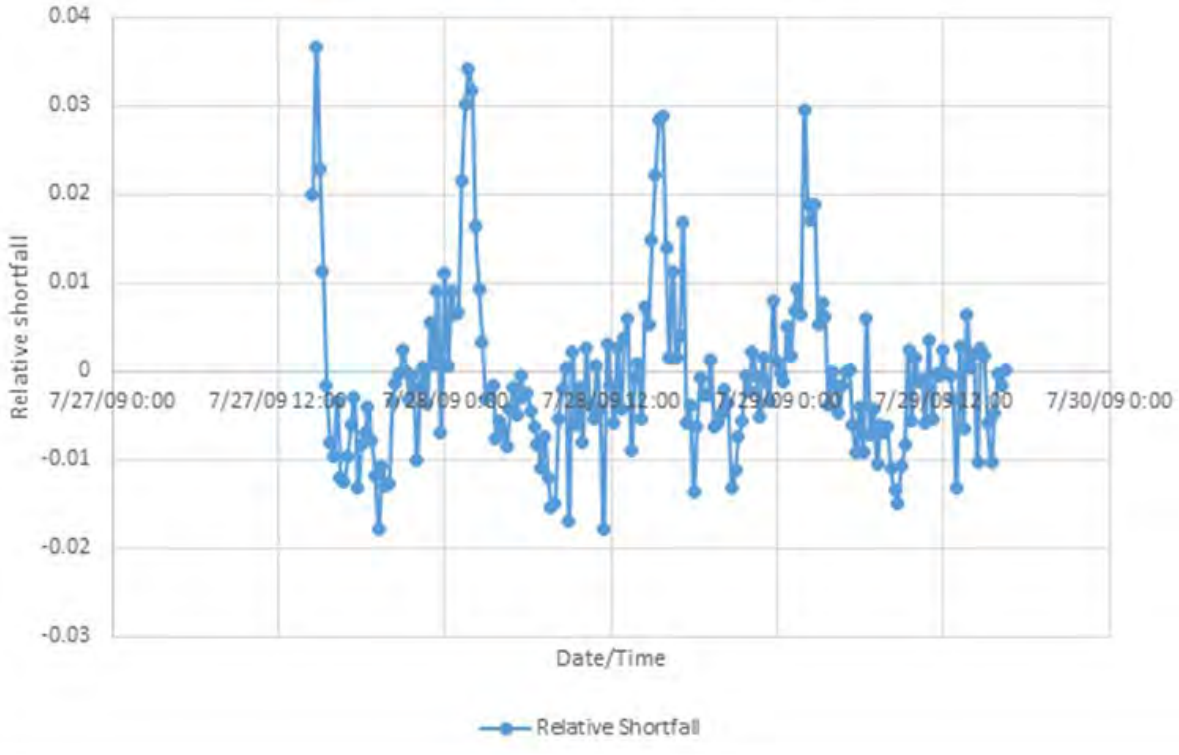
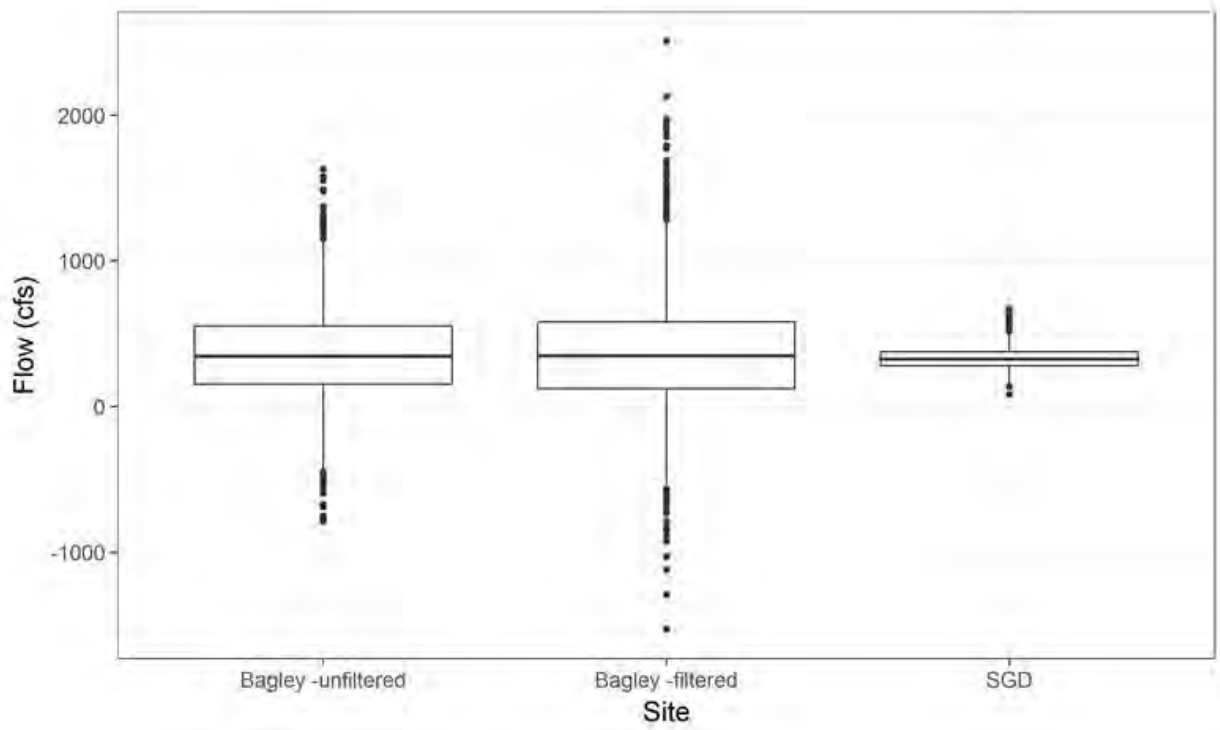


Figure 3. Relative difference in flux is under 4 percent of pool volume (assuming 3ft depth at MSL)





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Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Monday, March 06, 2017 8:31 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>
Subject: Pulsing Springs Of Kings Bay

Doug,

I am directing this to you as you have coordinated Staff Responses in the past, but it is equally addressed to all cc's.

As discussed/promised attached is my xls file with Dr. Chen's spring discharges for Group 1 springs re Figure 2-4 in the Draft Report. As you will see there is a shortfall or excess water in the pool upstream of the X-section i.e. the stage per VHB/USGS data is not maintained using Dr. Chen's spring discharges. These excess or shartfalls are in bold red and black.
For clarity let me add:

- The Dr. Chen spring discharge is the best I could read the Figure 2-4 these are bold with light blue background.
- The discharges between the hi/low are by linear interpolation for each change high to low.
- The VHB data did not account for the difference in high tide time. You will recall in my spreadsheet determining the spring discharge I left blank those areas around the tide change times. I had done the same with this spreadsheet and you are welcome to do the same to account for the roughly 15 minutes later high tide at the X-section cf Mouth of Kings Bay.

Dr. Chen's calculations are wrong. The idea that Group 1 springs discharge vary as presented in Figure 2-4 is simply not true.

What makes the whole picture more ridiculous is to suggest all other springs in Kings Bay vary depending on their relative location to Group 1 X-section, Group 2 X-section and Romp TR21-3.

Yes my words are blunt, but it appears a 2x4 is needed to get to the truth. May I suggest again you share my comments with Dr. Penne and Dr. Watson. I trust I do not have to request a personal meeting to discuss their uncertainties about spring discharge from the ''pulsing springs of Kings Bay".

I think I have know Doug and Ron long enough that they know I will welcome any rational argument showing I am wrong.

BACKGROUND

I first raised the concern about the wide variations in Kings Bay springs discharge November 7, 2016. I comment how the logic was missing from the discharges presented in Figure 2-4 of the Draft MFL report. Since then we have exchange a number of e-mails, for example November 30, 2016 when I commented, the more I dig into this the more my concern increases.
January 23, 2017 Doug, Ron Basso and Gabe Herrick met with me to discuss the matter in person. While none claimed the ability to discuss the math behind Dr, Chen's assessment, all agreed with the discharges varying as Dr. Chen has calculated. I shared a number of graphs of weekly discharges from the file of Dr. Chen's work on discharge from all Kings Bay Springs (Model Output of SGD for baseline, shared with me January 18). I asked 'Do you really believe these springs have discharge that varies like this?…this is hard to believe'. Following the

meeting on January 24, 2017 I shared with you my xls file with my analysis of the VHB Group 1 data and diagrams of the associated mass balance. My analysis indicated Spring discharge did not vary significantly thru the tidal cycle.

Staff response was my diagrams correctly represented the mass balance, but did not comment regarding my xls file findings.

I suggested 'you' get bold and plug Dr.Chen's discharge number into the file to verify they make sense. On February 8, 2017 I gave the discharges from Figure 2-4 graph for the first few tidal cycles. I also suggested you consider sharing my thoughts/analysis with the Peer Review Panel. The Peer Review panel repeatedly expressed uncertainty in their final report.

As example Quote from Comment 46

The equations that are utilized to define all the flows into the system have some basic error associated with them as well as certain levels of uncertainty. For example, in Figure 2-4 looking at plot (a), it is clear that for the period when measured flows were available, there are errors in the estimated flow that would indicate that the model under-predicts the overall net flow out. This error is then carried through an additional level of uncertainty as the equations and coefficients are extrapolated out to other vents in the system. Based on these known errors and uncertainty, it would be important to developed additional ways to verify the total flows. This could be done using the Bagley data, if this data is demonstrated to be useful for this. Still working on the evaluation of the Bagley data.

End Quote

From the same Comment in the Recommendation Quote.

Also, some more definitive discussion of the degree of variation in the direct vent measurements and how they were used to carry the calculations forward is needed.

End Quote

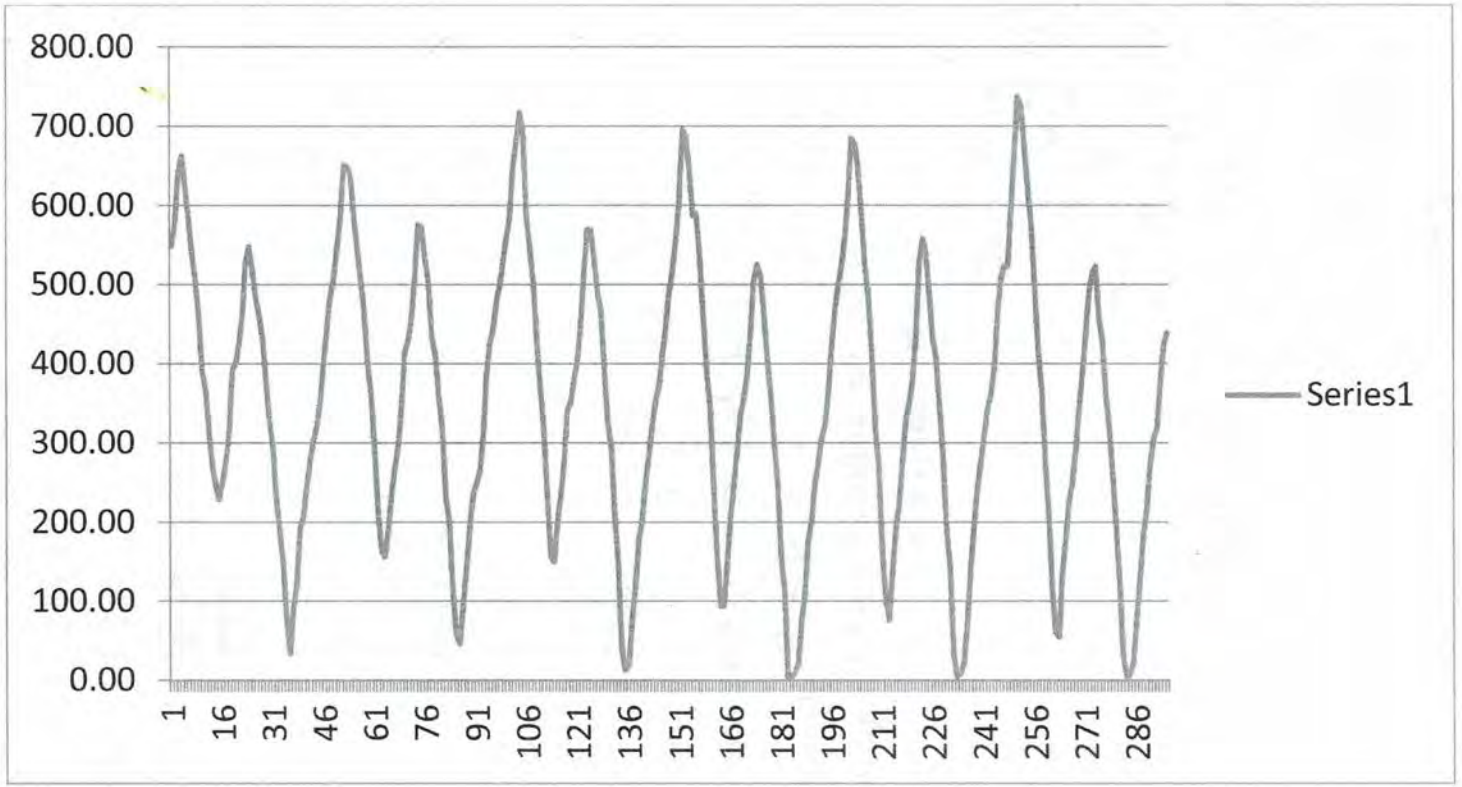
Martyn

From:	Alan Martyn Johnson
To:	Doug Leeper
Cc:	Xinjian Chen; Gabe I. Herrick; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ron Basso; Melissa Gulvin; Kurt Fritsch
Subject:	Re: Pulsing Springs Of Kings Bay
Date:	Monday, March 13, 2017 7:44:53 AM

The attachment dropped as I sent, at least from what I see.

So just to be sure here it is.

Martyn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Series1

From:	Doug Leeper
To:	"Alan Martyn Johnson"
Cc:	Xinjian Chen; Gabe I. Herrick; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ron Basso; Melissa Gulvin; Kurt Fritsch; Mike R. Bray
Subject:	RE: Pulsing Springs Of Kings Bay
Date:	Friday, March 24, 2017 2:07:00 PM
Attachments:	image001.png image002.png image003.png

Martyn:

Thanks for your March 13th email concerning discharge from springs within Kings Bay springs. I've imbedded some "staff responses" highlighted in blue in your original email below.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
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Subject: Re: Pulsing Springs Of Kings Bay

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Figure 2-4 into the mass balance and see for yourselves the results. As you did not do that I did it for you. Yes I had to estimate the discharges from the graph (I think you have to admit they are reasonably close), but you are very welcome to change these to the calculated 15 minute discharges used to generate the graph.

In your response no mention is made of the 'uncertainty' expressed by the Peer Review Panel. I would also draw attention to the concerns expressed by Dan Yobbi in his memos December 2014 and September 2015 (in the Appendix of the Draft MFL Report).

Staff response (3/24/2017): *The District response to peer review panel findings concerning the proposed minimum flow for the Crystal River/Kings Bay System is being provided to the District Governing Board as part of the March 28th Board meeting agenda. The response, which is included in the Board packet as agenda item number 33 in the document at the link below, includes information relevant to panel comments concerning uncertainties in flow estimation. Staff plans to expand the discussion of this uncertainty in the revised version of the minimum flow report.*

http://www.swfwmd.state.fl.us/calendar/notebooks/govboard_03-28-17_notebook_2772.pdf

For completeness I believe there are two formulas the District has developed for springs discharge based on the location of each individual spring.

The writers of this response appear not to realize the 15 minute shortfalls or excess are cumulative thru each respective tidal cycles.

As for the total volume in the pool....well...what can I say....interesting!

As for regression analysis...what can I say...amazing!

As for Bagley Cove data, this is not related to the mass balance Group 1, but you are welcome to look back at my previous comments particularly about the 24.84 hour tidal cycle shared last year.

Let us get back to the subject, the pulsing springs of Kings Bay.

How about sharing my mass balance January 24 e-mail and the recent one showing how out of balance the spring discharges in Figure 2-4 are, with Dr. Peene and Dr. Watson to see if this helps them understand the uncertainty they have expressed in the Peer Review Report. Dan Yobbi as well if you want.

Staff response (3/24/2017): *We understand that you have contacted Dr. Peene and Dr. Watson in a March 23rd email and offered to provide your January 24th email to them directly.*

For those who have not seen how the total discharge for all springs discharge varies (pulse) according to Districts two formula, I have attached a graph of a typical week of discharges. This is similar to the ones shared with Doug, Ron and Gabe when we met January 23 and is from the District Model output. Variations during some cycles from less than 50cfs to 700 cfs from high to low tide. Really?

Kings Bay springs do not pulse to such magnitude. I have suggested before and I will repeat it. Take one of the major springs, your choice, and position a velocity meter in the vent and monitor it for a few days. We can quickly prove who is right by in field measurement. I am confident my mass balance (January 24) indicating almost constant discharge from the springs will prevail.

Staff response (3/24/2017): *As indicated in the draft minimum flow report, staff plan to recommend that the Board approve a scheduled reevaluation of the minimum flow for the Crystal River/Kings Bay system within ten years of the legislatively-mandated July 2017 adoption date. We are committed to the acquisition of additional data, including measured flows, that will support the planned reevaluation effort.*

Martyn

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Thursday, March 9, 2017 8:26 AM
To: Alan Martyn Johnson
Cc: Xinjian Chen; Gabe I. Herrick; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ron Basso; Melissa Gulvin
Subject: RE: Pulsing Springs Of Kings Bay

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We would add that the District empirical formula was obtained through data fitting of spring flow data, which were calculated from measured discharge data at G1 and G2 based on the mass-balance principle. Data fitting is simply a process of finding the best mathematical expression linking a dependable variable with one or more independent variables through minimizing the overall mismatch between measured data and model-predicted results. Just because there are errors between model results and data (in this case, between col L and col M) does not mean that the model is wrong. As mentioned above, errors are minimized but not eliminated in data fitting.

In closing, please note that we will continue to apportion our confidence in the formula for SGD based on the strength of evidence regarding its power to explain observations.

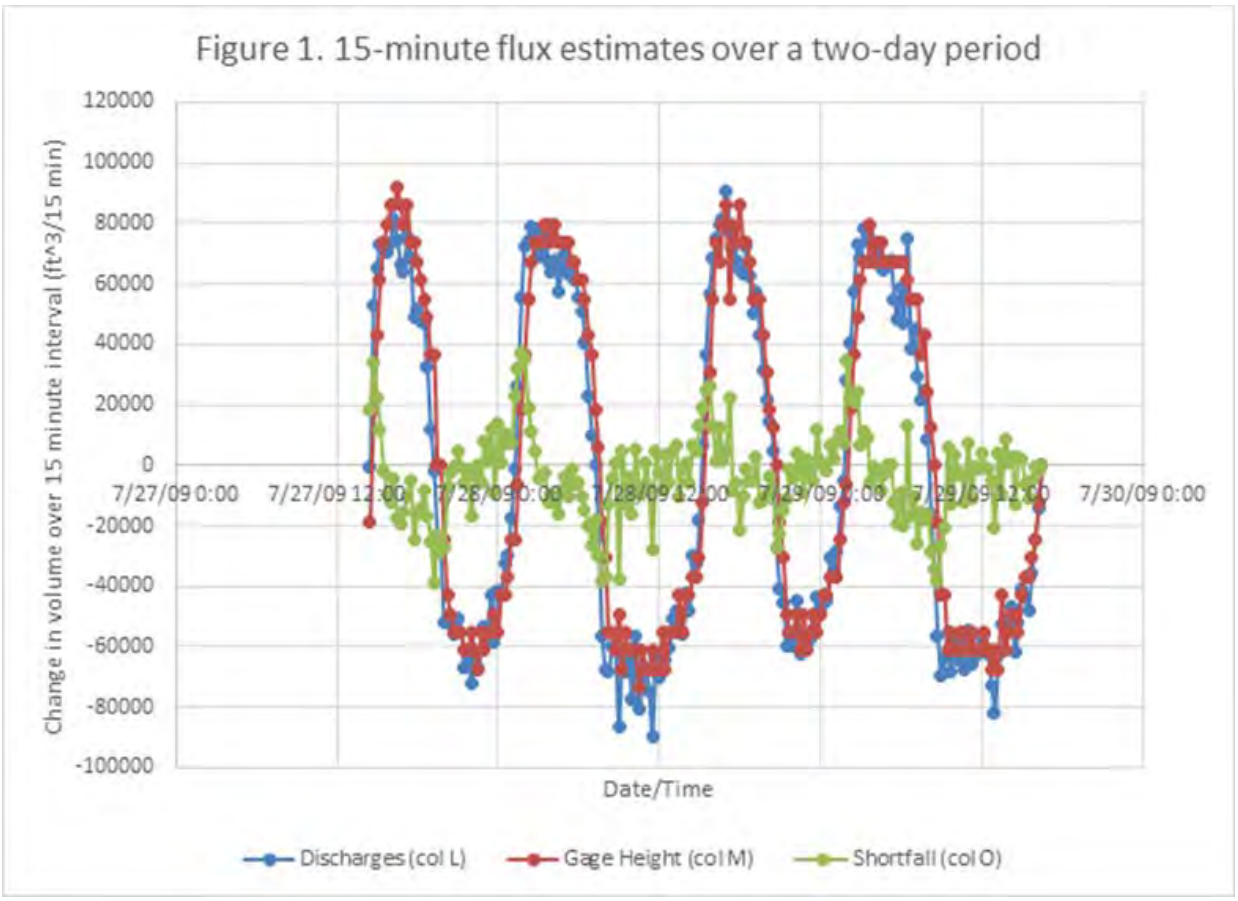


Figure 1. 15-minute flux estimates over a two-day period
Change in volume over 15 minute interval (ft^3/15 min)
120000
100000
80000
60000
40000
20000
0
-20000
-40000
-60000
-80000
-100000
7/27/09 0:00
7/27/09 12:00
7/28/09 0:00
7/28/09 12:00
7/29/09 0:00
7/29/09 12:00
7/30/09 0:00
Date/Time
Discharges (col L)
Gage Height (col M)
Shortfall (col O)

Figure 2. District formula SGD produces estimates of 15-minute flux that are condordant with gage height estimates.

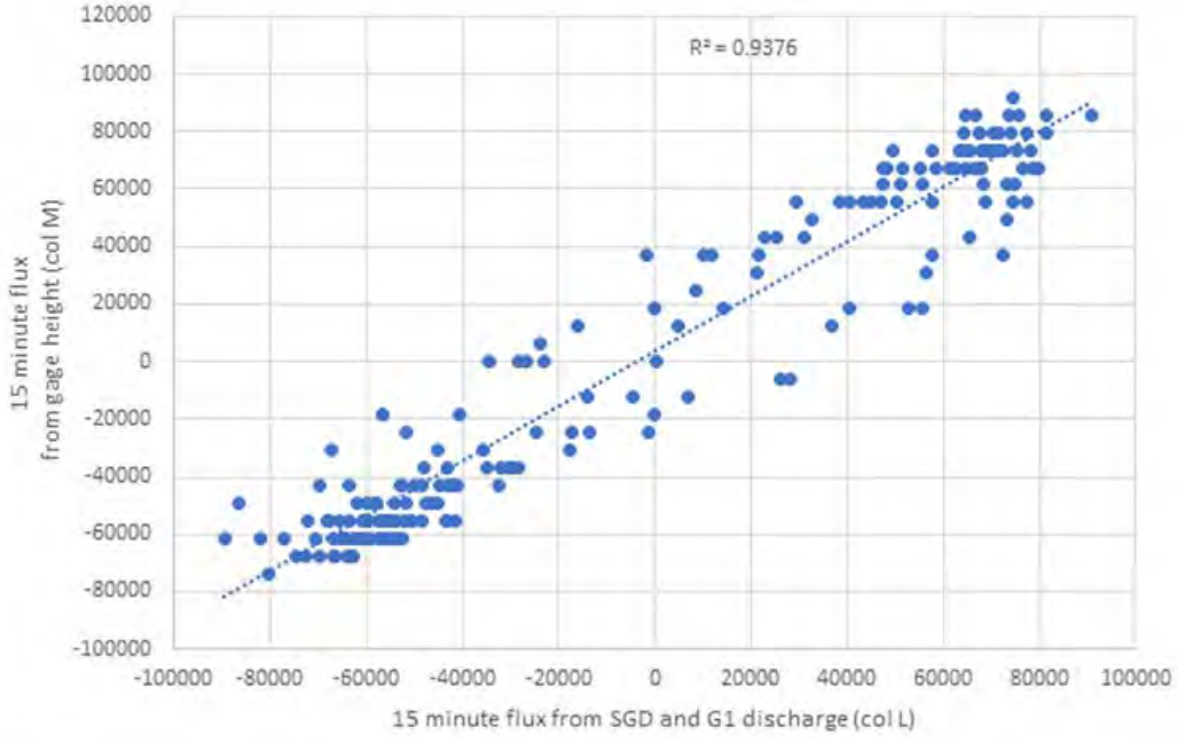
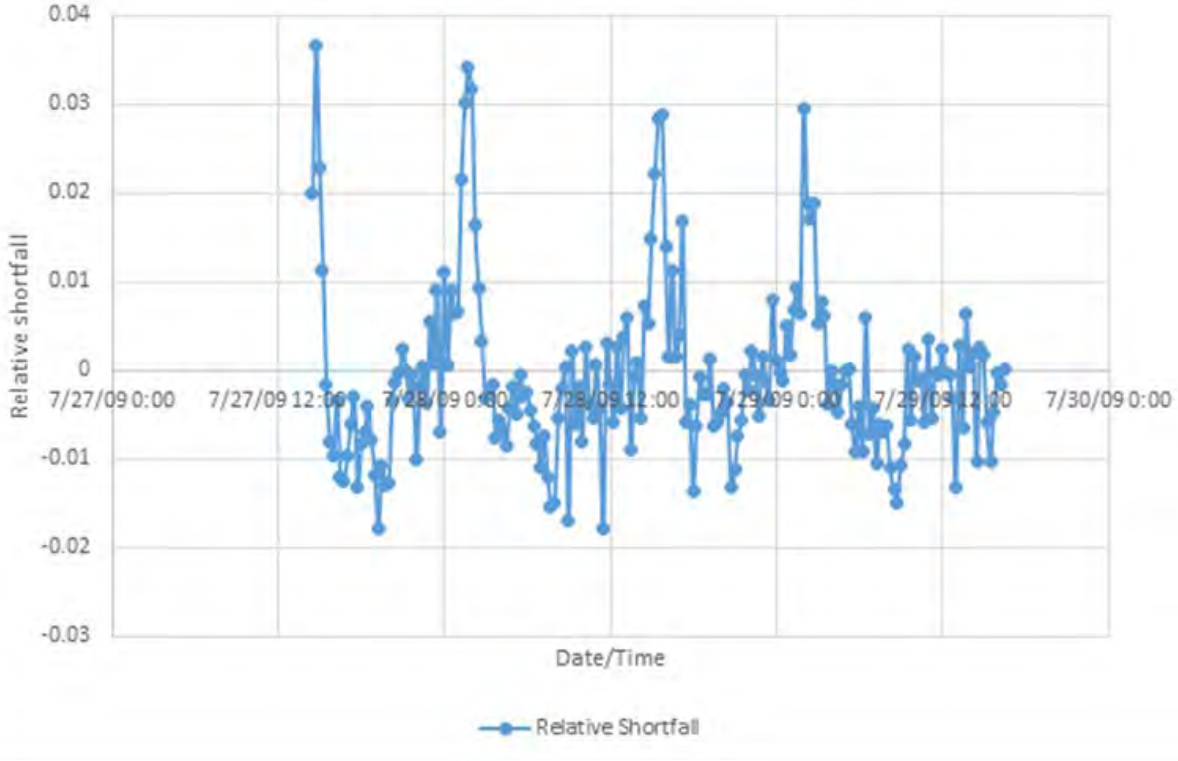


Figure 3. Relative difference in flux is under 4 percent of pool volume (assuming 3ft depth at MSL)



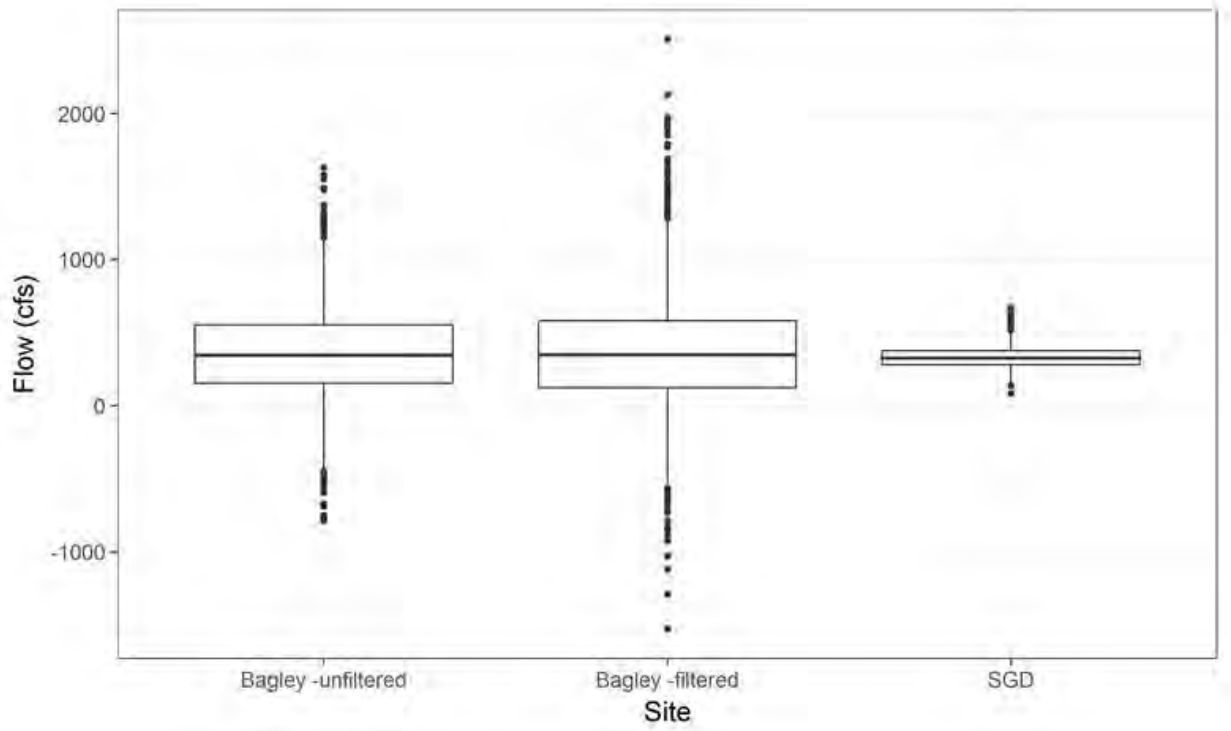


Figure 4. District formula submarine groundwater discharge (SGD) compared with discharges reported at Bagley Cove over the hydrodynamic model period of record. Variation predicted by District SGD is much lower than predicted by reported discharges. Boxplot made with daily mean discharge. Note USGS gage reports frequent negative daily values, even when tidally-filtered. Dark center line is median, upper and lower box edges are 75th and 25th exceedance percentiles. Whiskers extend to 1.5 IQR. Outliers show as dots beyond whiskers.

Doug Leeper

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352-796-7211, ext. 4272

doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Monday, March 06, 2017 8:31 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>
Subject: Pulsing Springs Of Kings Bay

Doug,

I am directing this to you as you have coordinated Staff Responses in the past, but it is equally addressed to all cc's.

As discussed/promised attached is my xls file with Dr. Chen's spring discharges for Group 1 springs re Figure 2-4 in the Draft Report. As you will see there is a shortfall or excess water in the pool upstream of the X-section i.e. the stage per VHB/USGS data is not maintained using Dr. Chen's spring discharges. These excess or shartfalls are in bold red and black.
For clarity let me add:

- The Dr. Chen spring discharge is the best I could read the Figure 2-4 these are bold with light blue background.
- The discharges between the hi/low are by linear interpolation for each change high to low.
- The VHB data did not account for the difference in high tide time. You will recall in my spreadsheet determining the spring discharge I left blank those areas around the tide change times. I had done the same with this spreadsheet and you are welcome to do the same to account for the roughly 15 minutes later high tide at the X-section cf Mouth of Kings Bay.

Dr. Chen's calculations are wrong. The idea that Group 1 springs discharge vary as presented in Figure 2-4 is simply not true.

What makes the whole picture more ridiculous is to suggest all other springs in Kings Bay vary depending on their relative location to Group 1 X-section, Group 2 X-section and Romp TR21-3.

Yes my words are blunt, but it appears a 2x4 is needed to get to the truth. May I suggest again you share my comments with Dr. Penne and Dr. Watson. I trust I do not have to request a personal meeting to discuss their uncertainties about spring discharge from the ''pulsing springs of Kings Bay".

I think I have know Doug and Ron long enough that they know I will welcome any rational argument showing I am wrong.

BACKGROUND

I first raised the concern about the wide variations in Kings Bay springs discharge November 7, 2016. I comment how the logic was missing from the discharges presented in Figure 2-4 of the Draft MFL report. Since then we have exchange a number of e-mails, for example November 30, 2016 when I commented, the more I dig into this the more my concern increases.

January 23, 2017 Doug, Ron Basso and Gabe Herrick met with me to discuss the matter in person. While none claimed the ability to discuss the math behind Dr, Chen's assessment, all agreed with the discharges varying as Dr. Chen has calculated. I shared a number of graphs of weekly discharges from the file of Dr. Chen's work on discharge from all Kings Bay Springs (Model Output of SGD for baseline, shared with me January 18). I asked 'Do you really believe these springs have discharge that varies like this?…this is hard to believe'. Following the meeting on January 24, 2017 I shared with you my xls file with my analysis of the VHB Group 1 data and diagrams of the associated mass balance. My analysis indicated Spring discharge did not vary significantly thru the tidal cycle.
Staff response was my diagrams correctly represented the mass balance, but did not comment regarding my xls file findings.

I suggested 'you' get bold and plug Dr.Chen's discharge number into the file to verify they make sense. On February 8, 2017 I gave the discharges from Figure 2-4 graph for the first few tidal cycles. I also suggested you consider sharing my thoughts/analysis with the Peer Review Panel. The Peer Review panel repeatedly expressed uncertainty in their final report.

As example Quote from Comment 46

The equations that are utilized to define all the flows into the system have some basic error associated with them as well as certain levels of uncertainty. For example, in Figure 2-4 looking at plot (a), it is clear that for the period when measured flows were available, there are errors in the estimated flow that would indicate that the model under-predicts the overall net flow out. This error is then carried through an additional level of uncertainty as the equations and coefficients are extrapolated out to other vents in the system. Based on these known errors and uncertainty, it would be important to developed additional ways to verify the total flows. This could be done using the Bagley data, if this data is demonstrated to be useful for this. Still working on the evaluation of the Bagley data.

End Quote

From the same Comment in the Recommendation Quote.

Also, some more definitive discussion of the degree of variation in the direct vent measurements and how they were used to carry the calculations forward is needed.

End Quote

Martyn

From:	Alan Martyn Johnson
To:	speene@appliedtm.com; kwatson@hsweng.com
Cc:	Doug Leeper
Subject:	Pulsing Springs of Kings Bay
Date:	Thursday, March 23, 2017 8:26:07 AM

Dr.Peene and Dr. Watson,
The attachment to this e-mail is a plot of a typical week of discharge from all springs in Kings Bay. The discharge is from an xls file by SWFWMD and is typical of many weeks of discharge: similar plots were shared with Doug Leeper, Ron Basso and Gabe Herrick at a meeting in January. My intent on sharing this scan is to reinforce this is nothing new and is certainly not worthy of glorified presentation…variations from 50 to 700 cfs is not realistic..

I do not believe the springs in Kings Bay exhibit variations of this magnitude from high tide to low tide. In addition there is not a shred evidence to support such variations. Kings Bay springs do not pulse.

So why am I sharing this with you?

I have analyzed, by mass balance, the data from the VHB work done in 2009 and find the data indicates an essentially constant spring discharge throughout the tidal cycles. I shared my mass balance of Group 1 2009 with SWFWMD thru Doug Leeper on January 24. I chose Group 1 only to keep the concept on track. At that same time I also challenged SWFWMD to be bold and plug the spring discharge presented in Figure 2-4 for Group 1 into a mass balance and see if it make sense. They did not, so I did it for them and it shows shortfalls or extra water in the pool up stream of the X-Section i.e. Figure 2-4 discharge is not validated by mass balance.

I have requested Doug to share my mass balance with you to see if this makes sense and addresses the uncertainty mentioned repeatedly in your review. As far as I can ascertain he has not.
If you are interested I will share the information with you directly, or if you prefer to keep the established lines of communication you can request this from Doug.

Kings Bay Springs do not pulse.

Dr. Watson,
For complete disclosure; I have questions regarding the Rainbow River modeling with respect to severe backwater effect (evidence for the conclusion not forthcoming), and the river profile (about 100 cfs additional flow downstream of new USGS station). Your involvement in development of the Rainbow River HEC-RAS model appears to be minimal but is mentioned; hence my disclosure.

Martyn
P.S. You may recall I sat in, at Brooksville, on a conference call Peer Review meeting last year and asked SWFWMD about Figure 2-4. I also tried to have input on a later conference call but due to poor phone connection hung up and was not able to reconnect.

From:	Alan Martyn Johnson
To:	Doug Leeper
Cc:	Xinjian Chen; Gabe I. Herrick; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ron Basso; Melissa Gulvin; Kurt Fritsch; Mike R. Bray; speene@appliedtm.com; kwatson@hsweng.com
Subject:	Re: Pulsing Springs Of Kings Bay
Date:	Monday, March 27, 2017 8:12:10 AM
Attachments:	image001.png image002.png image003.png

Doug,
Thank you for relaying the staff responses.

Regarding the Staff Responses to the Peer Review Panels Report which are presented in the Governing Board Meeting Note book; it is disappointing and inaccurate for the staff response to repeatedly mention negative daily and monthly discharge measured at the Bagley Cove USGS site.

I would have thought by now staff would understand the daily data based on a 24 hour day is bound to have negative values as the tidal cycle is 24.84 hours. If not they need to read the comment/note on the USGS site for 02310747. Further to state there are monthly negative discharges is inaccurate and steps further than in the MFL Report in attempting to discredit USGS.
The only negative monthly discharges in the USGS Data arise if INCOMPLETE DATA IS SELECTED FOR MONTHLY STATISTICS. These months are June 2009, May 2012, August 2015 and August 2016. For these months there are multiple days when data is not available eg both August 2015 and 2016 there are over 20 days when data was not available, for the 2009 and 2012 months it is 8 and 9 days.

I would further note the Bagley Cove data shows a distinct decrease in 'springs discharge' since the start of data collection at this site and reflects seasonal variations. Seasonal variations are normal phenomena....which the Districts modeled discharges do not reflect.

May be the decrease 'spring discharge' in the Bagley Cove data is viewed as an anomaly as is the Rainbow River decrease. I am of the opinion this is not an anomaly but the truth.

I will elaborate on my points with specific quotes and data as time permits.

As regards my e-mail to Dr. Peene and Dr. Watson I have not heard from them to date. Please note I asked if they would be interested, nothing more.

Sooner or later District is going to have some serious explaining to do regarding the Pulsing Springs of Kings Bay...the 'geological water hammer' of flows changing from 700 cfs to 50 cfs from low tide to high tide may sound the alarm.

Martyn

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Friday, March 24, 2017 2:07 PM
To: Alan Martyn Johnson
Cc: Xinjian Chen; Gabe I. Herrick; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ron Basso; Melissa Gulvin; Kurt Fritsch; Mike R. Bray
Subject: RE: Pulsing Springs Of Kings Bay

Martyn:

Thanks for your March 13th email concerning discharge from springs within Kings Bay springs. I've imbedded some "staff responses" highlighted in blue in your original email below.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Monday, March 13, 2017 7:37 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>; Mark A. Green <Mark.Green@swfwmd.state.fl.us>; Jennette Seachrist <Jennette.Seachrist@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>
Subject: Re: Pulsing Springs Of Kings Bay

My e-mail and attachment were a follow up to my e-mail of January 24 where I shared the mass balance, and diagrammatic basis for the mass balance, of the VHB 2009 Group 1 data. The results show the combined Group 1 springs discharge to be almost constant thru the tidal cycles. This makes sense of the VHB data, all parameters are in balance, and is logical given what is generally known about spring discharges. Additionally, the data from measurements at individual springs in Kings Bay in the VHB reports 2009 and 2012, show no evidence of spring discharges varying in the manner shown in the graphic presentation Figure 2-4 in the draft report i.e. pulsing. Repeat no evidence.

In my January 24 e-mail I challenged SWFWMD to 'be bold' and plug the spring discharges from Figure 2-4 into the mass balance and see for yourselves the results. As you did not do that I did it for you. Yes I had to estimate the discharges from the graph (I think you have to admit they are reasonably close), but you are very welcome to change these to the calculated 15 minute discharges used to generate the graph.

In your response no mention is made of the 'uncertainty' expressed by the Peer Review Panel. I would also draw attention to the concerns expressed by Dan Yobbi in his memos December 2014 and September 2015 (in the Appendix of the Draft MFL Report).

Staff response (3/24/2017): *The District response to peer review panel findings concerning the proposed minimum flow for the Crystal River/Kings Bay System is being provided to the District Governing Board as part of the March 28th Board meeting agenda. The response, which is included in the Board packet as agenda item number 33 in the document at the link below, includes information relevant to panel comments concerning uncertainties in flow estimation. Staff plans to expand the discussion of this uncertainty in the revised version of the minimum flow report.*

http://www.swfwmd.state.fl.us/calendar/notebooks/govboard_03-28-17_notebook_2772.pdf

For completeness I believe there are two formulas the District has developed for springs discharge based on the location of each individual spring.

The writers of this response appear not to realize the 15 minute shortfalls or excess are cumulative thru each respective tidal cycles.

As for the total volume in the pool....well...what can I say....interesting!

As for regression analysis...what can I say...amazing!

As for Bagley Cove data, this is not related to the mass balance Group 1, but you are welcome to look back at my previous comments particularly about the 24.84 hour tidal cycle shared last year.

Let us get back to the subject, the pulsing springs of Kings Bay.
How about sharing my mass balance January 24 e-mail and the recent one showing how out of balance the spring discharges in Figure 2-4 are, with Dr. Peene and Dr. Watson to see if this helps them understand the uncertainty they have expressed in the Peer Review Report. Dan Yobbi as well if you want.

Staff response (3/24/2017): *We understand that you have contacted Dr. Peene and Dr. Watson in a March 23rd email and offered to provide your January 24th email to them directly.*

For those who have not seen how the total discharge for all springs discharge varies (pulse) according to Districts two formula, I have attached a graph of a typical week of discharges. This is similar to the ones shared with Doug, Ron and Gabe when we met January 23 and is from the District Model output. Variations during some cycles from less than 50cfs to 700 cfs from high to low tide. Really?

Kings Bay springs do not pulse to such magnitude. I have suggested before and I will repeat it. Take one of the major springs, your choice, and position a velocity meter in the vent and monitor it for a few days. We can quickly prove who is right by in field measurement. I am confident my mass balance (January 24) indicating almost constant discharge from the springs will prevail.

Staff response (3/24/2017): *As indicated in the draft minimum flow report, staff plan to recommend that the Board approve a scheduled reevaluation of the minimum flow for the Crystal River/Kings Bay system within ten years of the legislatively-mandated July 2017 adoption date. We are committed to the acquisition of additional data, including measured flows, that will support the planned reevaluation effort.*

Martyn

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Thursday, March 9, 2017 8:26 AM
To: Alan Martyn Johnson
Cc: Xinjian Chen; Gabe I. Herrick; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ron Basso; Melissa Gulvin
Subject: RE: Pulsing Springs Of Kings Bay

Martyn:

Thanks for the email and attached Excel file concerning spring discharge to Kings Bay that you sent on Monday, March 6, 2017. We note that your email claims "there is a shortfall or excess water in the pool upstream of the X-section" and from this you conclude that "Dr. Chen's calculations are wrong". The District is committed to supporting its claims based on evidence. District Staff have developed an empirical formula for estimating submarine groundwater discharge (SGD). District confidence in this formula is proportional to the weight of evidence which supports it.

The District formula can predict surface water levels with 74% accuracy for Group 1 springs and with 94% accuracy for Group 2 springs (R^2 values). These methods have been published in peer reviewed scientific journals by Dr. Chen, and separately peer-reviewed in the minimum flow report. This predictive capacity represents the best information available. There is no better predictive tool for estimating water levels in the Crystal River/Kings Bay system.

The strength of the District formula for SGD comes from its ability to explain the data. Your spreadsheet includes data which you claim demonstrates a shortfall of the SGD formula for predicting

flux across a cross section in Kings Bay. Your spreadsheet shows the change in volume over a 15-minute interval for water upstream of the G1 cross section as predicted by G1 discharge and SGD (eq. 1) in column L. This change in volume over time may be referred to as "15-minute flux". You estimate SGD from a figure, which you acknowledge carries with it a degree of uncertainty. The 15-minute flux predicted by gage height is shown in column M. You subtract M from L to arrive at what you call the "Eccess[sic] Shortfall in pool" shown in column O. From the values in this column O, you conclude the District method for estimating discharge is incorrect.

How does 15-minute flux as estimated from discharges at G1 and SGD compare with 15-minute flux as estimated from gage height? A plot of these fluxes is shown below in Figure 1 (this figure and other figures discussed in this email were developed using information included in the attached Excel file named "bold Group 1 2009-gh which was developed using the file you sent on March 6th; note that a PDF of this email is also attached). The 15-minute flux predicted by discharges at G1 and SGD [labeled Discharges (col L)] clearly mirrors the 15-minute flux predicted by gage height [labeled Gage Height (col M)]. The difference between these two lines is shown as Shortfall (col O). Note the similarity in 15-minute flux as estimated from these two sources. Also please note the time difference between values in col L and col M, which introduces additional errors in col O if the difference between col L and col M is taken simply by subtracting col M from col L in the same row. The time difference between col L and col M can be clearly seen in Figure 1.

The similarity in lines of Figure 1 can be quantified using linear regression. A linear regression of 15-minute flux from discharges (col L) as a predictor 15-minute flux from gage height (col M) has an R^2 value of 0.9376 (Figure 2 below). This means that the SGD and G1 discharge capture over 93% of the variation in the flux estimated from gage height. Recall there is some uncertainty associated with discrepancy between times of measurement, in measurement of gage height, in discharge at G1, and in estimating SGD from eyeballing values from a plot. Thus, this remaining 6-7% error is not entirely attributable to error in estimation of SGD.

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You have expressed incredulity in the degree of variation in SGD predicted by District formula. However, the District formula SGD has lower variation than any other method for estimating spring discharge to this system. Compare District-formula SGD with discharge reported at USGS 02310747 Crystal River at Bagley Cove near Crystal River, FL (Figure 4 below). The District SGD shows a record of spring flow with much less variability than the discharges reported at Bagley Cove. As such, the District formula for estimating SGD addresses the problem of minimizing fluctuation in estimated spring flow, is based on the mass-balance principle, and has been repeatedly verified against field data.

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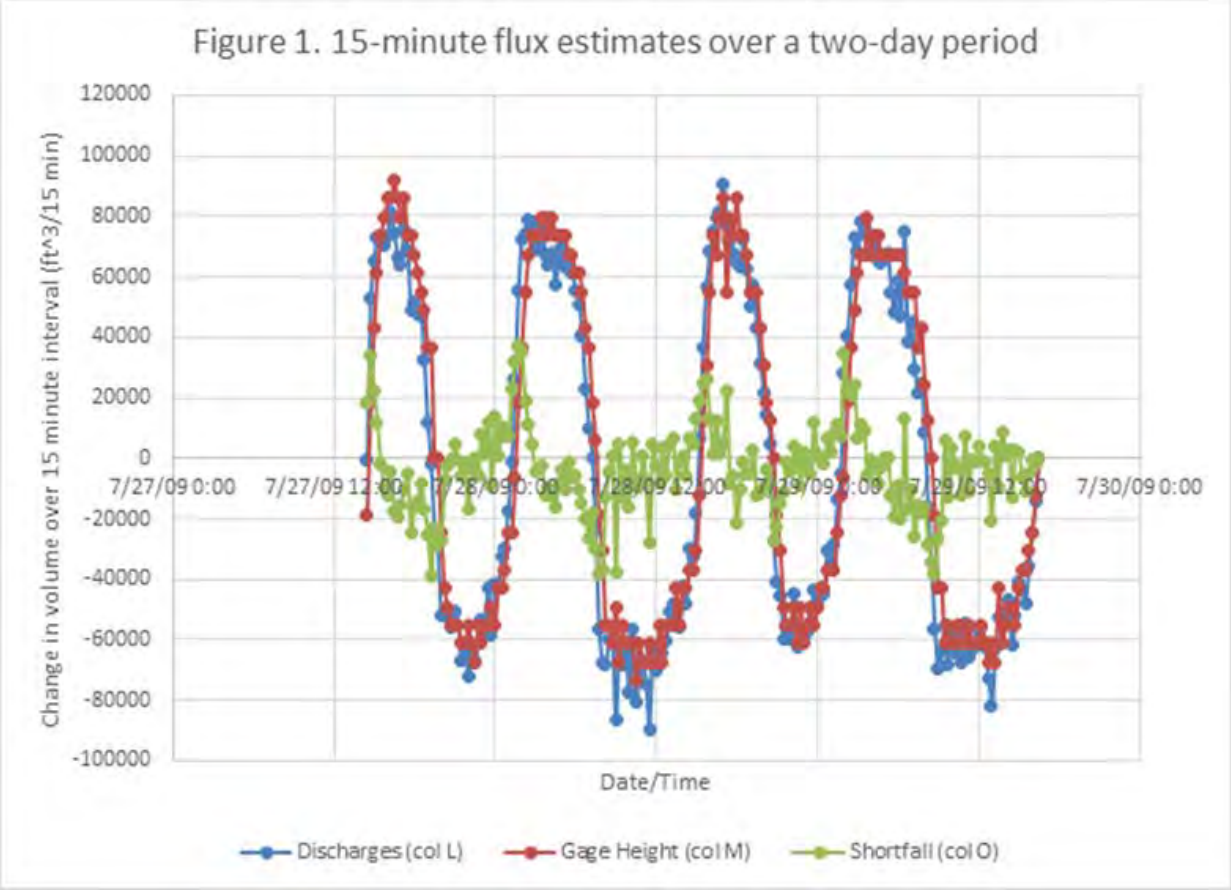
In closing, please note that we will continue to apportion our confidence in the formula for SGD based on the strength of evidence regarding its power to explain observations.



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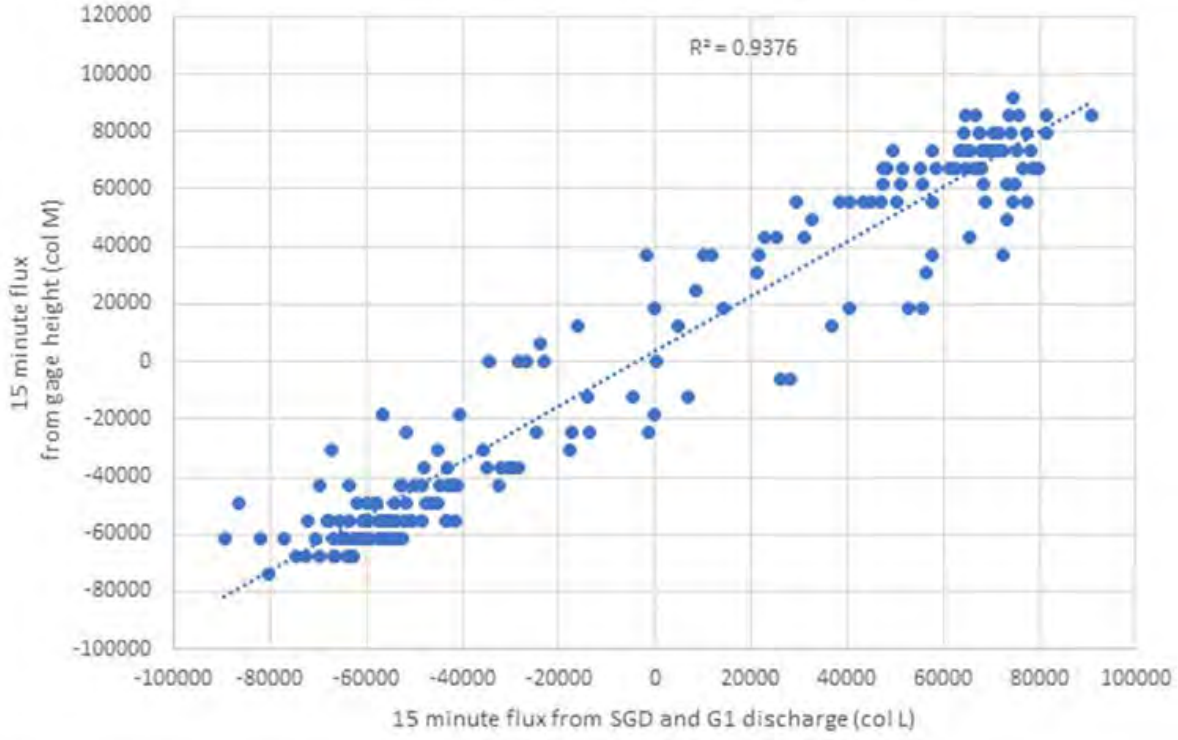

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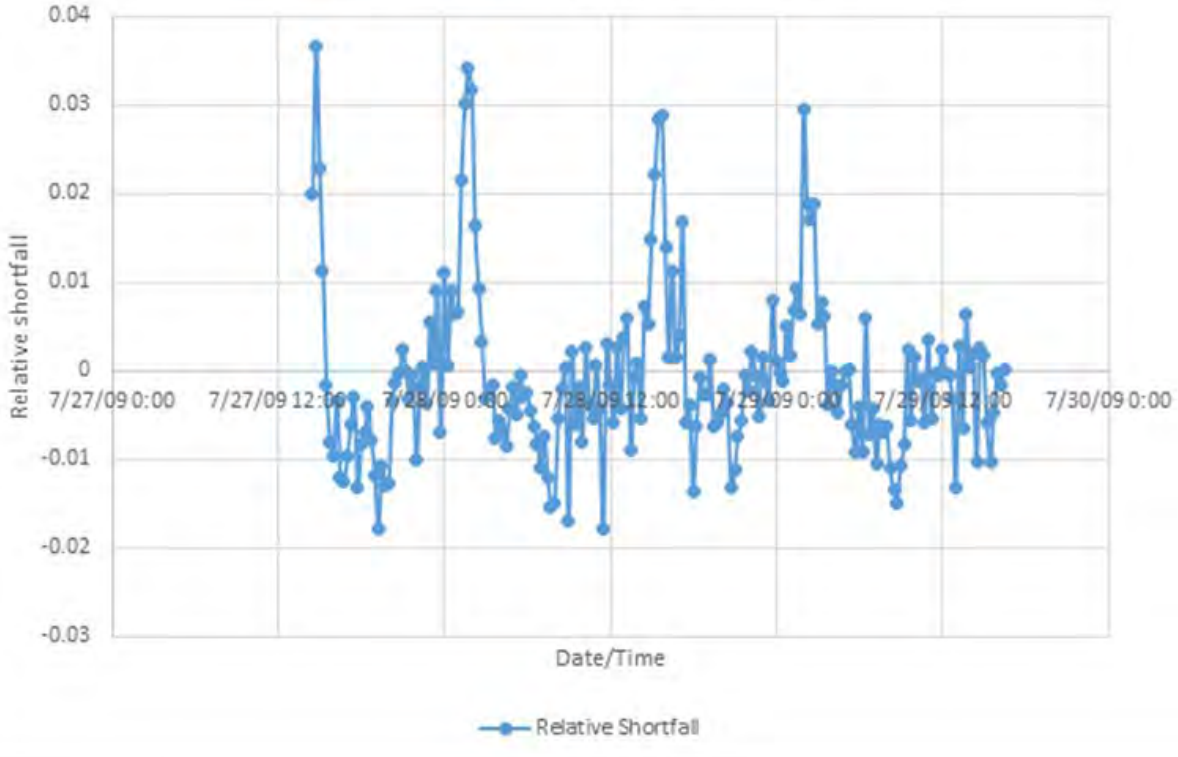

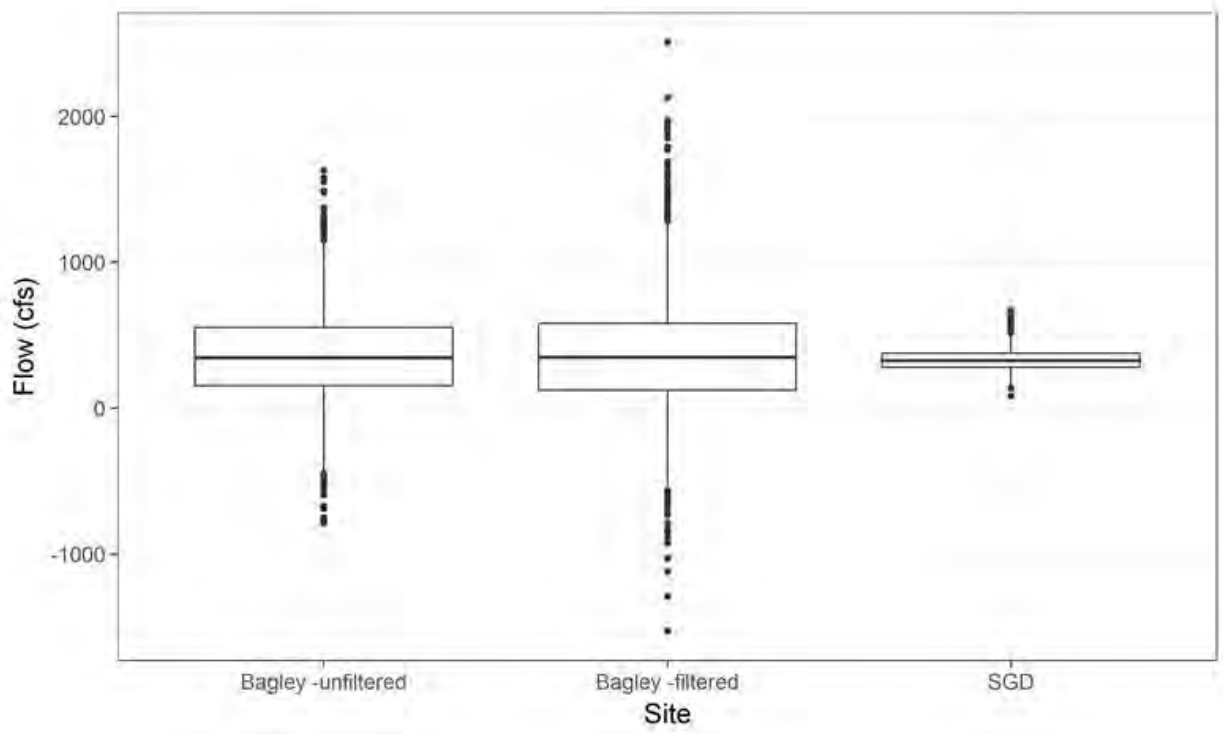

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To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
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Dr. Chen's calculations are wrong. The idea that Group 1 springs discharge vary as presented in Figure 2-4 is simply not true.

What makes the whole picture more ridiculous is to suggest all other springs in Kings Bay vary depending on their relative location to Group 1 X-section, Group 2 X-section and Romp TR21-3.

Yes my words are blunt, but it appears a 2x4 is needed to get to the truth. May I suggest again you share my comments with Dr. Penne and Dr. Watson. I trust I do not have to request a personal meeting to discuss their uncertainties about spring discharge from the ''pulsing springs of Kings Bay".

I think I have know Doug and Ron long enough that they know I will welcome any rational argument showing I am wrong.

BACKGROUND

I first raised the concern about the wide variations in Kings Bay springs discharge November 7, 2016. I comment how the logic was missing from the discharges presented in Figure 2-4 of the Draft MFL report. Since then we have exchange a number of e-mails, for example November 30, 2016 when I commented, the more I dig into this the more my concern increases.
January 23, 2017 Doug, Ron Basso and Gabe Herrick met with me to discuss the matter in person. While none claimed the ability to discuss the math behind Dr, Chen's assessment, all agreed with the discharges varying as Dr. Chen has calculated. I shared a number of graphs of weekly discharges from the file of Dr. Chen's work on discharge from all Kings Bay Springs (Model Output of SGD for baseline, shared with me January 18). I asked 'Do you really believe these springs have discharge that varies like this?…this is hard to believe'. Following the meeting on January 24, 2017 I shared with you my xls file with my analysis of the VHB Group 1

data and diagrams of the associated mass balance. My analysis indicated Spring discharge did not vary significantly thru the tidal cycle.

Staff response was my diagrams correctly represented the mass balance, but did not comment regarding my xls file findings.

I suggested 'you' get bold and plug Dr.Chen's discharge number into the file to verify they make sense. On February 8, 2017 I gave the discharges from Figure 2-4 graph for the first few tidal cycles. I also suggested you consider sharing my thoughts/analysis with the Peer Review Panel. The Peer Review panel repeatedly expressed uncertainty in their final report.

As example Quote from Comment 46

The equations that are utilized to define all the flows into the system have some basic error associated with them as well as certain levels of uncertainty. For example, in Figure 2-4 looking at plot (a), it is clear that for the period when measured flows were available, there are errors in the estimated flow that would indicate that the model under-predicts the overall net flow out. This error is then carried through an additional level of uncertainty as the equations and coefficients are extrapolated out to other vents in the system. Based on these known errors and uncertainty, it would be important to developed additional ways to verify the total flows. This could be done using the Bagley data, if this data is demonstrated to be useful for this. Still working on the evaluation of the Bagley data.

End Quote

From the same Comment in the Recommendation Quote.

Also, some more definitive discussion of the degree of variation in the direct vent measurements and how they were used to carry the calculations forward is needed.

End Quote

Martyn

RESOURCE MANAGEMENT COMMITTEE

March 28, 2017

Submit and File Report

Report from the Scientific Peer Review for the Recommended Minimum Flow for the Crystal River/Kings Bay System and Staff Responses

Purpose

To present the report documenting the findings of the voluntary independent scientific peer review of the "Recommended Minimum Flow for the Crystal River/Kings Bay System -Draft Report for Peer Review" report (B807) and provide staff response to the peer review.

Background/History

Staff completed a draft report recommending the minimum flow (MFL) for the Crystal River/Kings Bay System that was submitted to the Governing Board at its October 2016 meeting. The report was then submitted to an independent scientific peer review panel (Panel) for voluntary review. The Panel was composed of three scientists who have extensive experience in hydrology, ecology, and freshwater inflow relationships of estuarine systems. The Panel's charge was to review the validity of the technical approach used by the District to determine if the proposed minimum flow is supported by data, procedures, and analyses used for its development.

All Panel meetings were advertised in the Florida Administrative Register and on the District's web site; in addition, numerous interested parties and local government staff and officials were notified of the meetings. Meetings of the Panel were held on November 4th, 15th, 21st, and December 5th. The November 4th meeting included a field trip to the Crystal River/Kings Bay System and a face-to-face discussion at the District's Brooksville Office; the other meetings were teleconferences with web-based information sharing capabilities that were facilitated from the Brooksville Office. District staff, and stakeholders participated in all Panel meetings. A publicly-accessible WebForum that was also noticed in the Florida Administrative Register was set up by the District for Panel communication in accordance with Florida's Government-in-the-Sunshine Law.

The Crystal River/Kings Bay System in western Citrus County includes the river, Kings Bay and the Crystal River Springs group, which is a cluster of 70 springs within the bay. Collectively, this first magnitude springs group is classified as an Outstanding Florida Spring. Kings Bay is a tidally influenced embayment and is the headwater of Crystal River, which terminates approximately 6 miles west of the bay in the Gulf of Mexico. The Crystal River / Kings Bay System is an Outstanding Florida Water and a SWIM priority water body.

Purpose/Approach

The District received the Panel's report on December 12, 2016. Overall, the Panel "supports the conclusions presented within the MFL report and the use of the salinity habitat as the primary metric" for the minimum flow analyses. The Panel notes that: "with implementation of some of the edits/recommendation made within [their] report, there are no fatal flaws within the MFL report"; that "[t]he report documents a comprehensive and complex analysis that was concise and well done"; "the report is reasonable and the analysis presented is consistent with other MFL efforts within the District"; "the MFL conclusions are supported by the analyses presented";

and “supported by best available data.”

The Panel identified three key comments or recommendations for improving the minimum flow report, supporting documentation and analyses. These points are summarized below along with staff responses (all Panel comments and staff responses are included in the attached document).

1) The Panel suggests a more thorough discussion of historical discharge records for the system, and an explanation of the District rationale for the method used to estimate submarine groundwater discharge (SGD) or springflow to the system. Specifically, they note: “[t]*he calculation and validation of the historical and present flows from the spring vents remain an issue for this system. The District has determined that the Bagley Cove data, collected by USGS, is not reliable. The SGD methodology developed by the District also has a level of uncertainty, and ancillary calculations of long-term flow using alternate methodologies do not fully support either the USGS or District calculations. The District needs to do a better job of identifying the uncertainty in both methods of flow determination and the limitations this creates.”*

Staff Response:

Staff have analyzed USGS-reported Bagley Cove discharge data and compared it with SGD estimated by the District with an empirical formula. As noted in the draft minimum flow report, the hydrodynamic model used for developing recommended minimum flows for the system was tested using reported Bagley Cove discharge as an estimate of total SGD to the system. Results from these simulations showed poor agreement between model-predicted and measured salinities. This is because reported discharge for the Bagley Cove gage includes signals from wind action, storm surges, storage in Kings Bay, and interactions of these and other factors. These influences can be seen in the frequent negative daily and monthly mean discharge values reported for the Bagley Cove site. Negative monthly discharge is clearly not indicative of spring flow into this system.

Given that the Bagley Cove discharge record yields poor predictive capacity when used as input to the hydrodynamic model and includes negative daily and monthly means throughout the period of record, staff believe the empirical-formula-derived SGD represents the best information available for estimating spring discharge to the system. Staff will emphasize this point in a revised version of the minimum flow report and will characterize the reported Bagley Cove discharge record as less suitable than the estimated SGD record for our minimum flow analyses, rather than “unreliable.” Staff notes that error in the hydrodynamic model output is quantified within the draft minimum flow report, and this information and additional text within the report will be amended to fortify discussion of discharge-related issues identified by the Panel.

2) The Panel indicates that salinity-based shoreline habitat assessment should distinguish between altered and natural shoreline. Specifically, they recommend the District “*consider the difference between sloped and sediment and vegetated shoreline and hardened vertical shoreline (i.e., seawall). The District should assess (for all habitats) if this type of parsing makes sense and would strengthen the MFL conclusions.”*

Staff Response:

District staff agree, and plan to collect information for analyses of salinity-based shoreline habitat changes that distinguish between vegetative, altered, and natural shoreline. These analyses may be completed for consideration in the minimum flow adoption process scheduled for completion by July 1, 2017 in accordance with Section 373.042(2)(a) of the Florida Statutes, or may be incorporated into the planned reevaluation of the minimum flow that is established for the system.

3) The Panel found some issues with the hydrodynamic model boundary conditions and presentation of model calibration information. Specifically, the Panel states: "*[w]hile the hydrodynamic model was deemed sufficient for use in determining the changes in salinity and temperature habitat as of [sic] function of SGD, there were some issues identified within the review that should be resolved before final submission of the MFL report and supporting documentation*."

Staff Response:

District staff agree with the Panels' comments regarding the hydrodynamic modeling used for the analyses, and are working to implement recommended changes. With regard to boundary conditions, newly-run model scenarios indicate that a minor increase in salinity at the downstream boundary due to reduced flow has minimal, non-significant effects on model predictions used for the minimum flow analyses. This information will be included in the updated minimum flow report as will Panel suggested improvements concerning presentation of model calibration statistics and documentation of model-tuning or parameterization associated with seepage estimates.

Staff will incorporate appropriate Panel suggestions into a revised version of the District report on the recommended minimum flow for the Crystal River/Kings Bay System. The revised report will include the Panel's report, staff responses the Panel's review, and input on the proposed minimum flow from all other stakeholders." In accordance with Section 373.042(6)(b), of the Florida Statutes, the Governing Board shall give significant weight to the findings of the Panel when establishing a minimum flow or level.

Following a public workshop to be held in April to obtain additional stakeholder input on the recommended minimum flow, staff will return to the Board in May with proposed rule language necessary to establish the minimum flow for the Crystal River/Kings Bay System.

Staff Recommendation:

This item is submitted for the Committee's information, and no action is required.

Presenter: Gabe Herrick, Senior Environmental Scientist, Natural Systems & Restoration

District Response to the Crystal River/Kings Bay MFLs Peer Review

February 21, 2017

Gabriel Herrick, XinJian Chen, Ron Basso and Doug Leeper
Southwest Florida Water Management District
Brooksville, Florida

Attachment: Response to Review of Crystal MFL 02-22-17_dal_approved (2964 : Report from the Scientific Peer Review for the Recommended

The Southwest Florida Water Management District (District) does not discriminate on the basis of disability. This nondiscrimination policy involves every aspect of the District's functions, including access to and participation in the District's programs and activities. Anyone requiring reasonable accommodation as provided for in the Americans with Disabilities Act should contact the District's Human Resources Bureau Chief, 2379 Broad St., Brooksville, FL 34604-6899; telephone (352) 796-7211 or 1-800-423-1476 (FL only), ext. 4703; or email ADACoordinator@WaterMatters.org. If you are hearing or speech impaired, please contact the agency using the Florida Relay Service, 1-800-955-8771 (TDD) or 1-800-955-8770 (Voice).

Attachment: Response to Review of Crystal MFL 02-22-17_dal_approved (2964 : Report from the Scientific Peer Review for the Recommended

MINIMUM FLOW PEER REVIEW PROCESS

In October, November, and December 2016, the Southwest Florida Water Management District convened a panel for the independent, scientific peer review of minimum flows proposed for the Crystal River/Kings Bay system. The peer review panel, i.e., the Panel, consisted of a Chairperson, Steve Peene with Applied Technology & Management Inc., Panelist Ken Watson, with HSW Engineering Inc., and Panelist Adam Munson, a sub-contractor with Jones, Edmunds & Associates, Inc.

To support the Panel's review, District staff provided initial verbal and written responses to numerous Panel inquiries concerning the proposed minimum flows and their development. Most of these responses were incorporated into summary tables included as appendices to the Panel's final report titled, "Crystal River/Kings Bay Minimum Flow and Level Peer Review", that was submitted to the District on December 12, 2016. In some instances, the summary tables included in the Panel's final report contain Panelist references to staff's initial responses.

The Panel's final report has been posted on the District web site, made available upon request to interested parties, and will be provided to members of the District Governing Board. As directed by Section 373.042 of the Florida Statutes, the Governing Board is to give significant weight to the peer review Panel's final report when establishing minimum flows for the river system.

Staff has reviewed the Panel's final report and developed this document to summarize staff responses to Panel comments. The Panel's final report is reproduced here and amended with staff responses that are highlighted in blue. These responses are provided as replies to previously unanswered Panelist questions or comments and to describe activities that have been or will be undertaken in response to the Panelist's review and input. Yellow highlighting is used judiciously in this document to emphasize key points included in the Panel's final report and identify text from the Panel's report that is relevant to specific District responses. This District response document will be made available to all interested parties, including the District Governing Board.

Attachment: Response to Review of Crystal MFL 02-22-17_dal_approved (2964 : Report from the Scientific Peer Review for the Recommended

CRYSTAL RIVER/KINGS BAY
MINIMUM FLOW AND LEVEL
PEER REVIEW

TWA NOS: 16TW0000363, 16TW0000364, AND 16TW0000411

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
2379 BROAD STREET
BROOKSVILLE, FLORIDA 34604

DECEMBER 2016

Attachment: Response to Review of Crystal MFL 02-22-17_dal_approved (2964 : Report from the Scientific Peer Review for the Recommended

Attachments

Attachment A MFL Review Guidelines

Attachment: Response to Review of Crystal MFL 02-22-17_dal_approved (2964 : Report from the Scientific Peer Review for the Recommended

EXECUTIVE SUMMARY OF PEER REVIEW

The Southwest Florida Water Management District (District) contracted with an independent panel of experts to provide a technical peer review of the proposed Minimum Flows and Levels (MFL) for the Crystal River/Kings Bay Springs system. The Kings Bay/Crystal River system is located in Citrus County on Florida's Springs Coast. The system consists of Kings Bay, an approximately 600-acre estuarine embayment fed by more than 70 spring vents that discharge fresh to slightly saline water. From Kings Bay, the system flows out approximately 6 miles to the Gulf of Mexico through Crystal River. The system is tidally influenced throughout its extent.

Two critical components of the MFL analyses are: a hydrodynamic model developed by the District used to evaluate the changes in salinity and temperature under varied inflow conditions; and a methodology to calculate the submarine groundwater discharge (SGD) to the system. The SGD calculations constitute the long-term flows utilized as the basis for the MFL development. The U.S. Geological Survey (USGS) flow measurements on the system at Bagley Cove were deemed unreliable by the District.

The proposed MFL for the Kings Bay Crystal River system is based primarily on having less than a 15 percent change in salinity habitat (volume, shoreline length, and bottom area), with the key metric being a 15 percent change in the volume of water under 2 parts-per-thousand (ppt) salinity. Other metrics directly assessed included the volume of thermal manatee habitat, residence time, and some components of water quality. The flow reduction defined for the MFL was determined to be protective of these other components.

Overall, the Peer Review Panel supports the conclusions presented within the MFL report and the use of the salinity habitat as the primary metric. A key component of the MFL analyses, the hydrodynamic model, was generally found to be sufficiently developed and calibrated for use in evaluating the changes in the temperature and salinity as a function of SGD. Additionally, the methodology utilized for the calculating the SGD, while containing some degree of uncertainty and potential errors, represents the best available information for use in estimating the present and historical flows from the spring vents.

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The Peer Review Panel did identify key comments/recommendations to improve the MFL report, supporting documentation, and associated analyses. The full document provides detailed comments and recommendations including grammatical edits. A summary of some of the key recommendations are listed below;

- The calculation and validation of the historical and present flows from the spring vents remain an issue for this system. The District has determined that the Bagley Cove data, collected by USGS, is not reliable. The SGD methodology developed by the District also has a level of uncertainty, and ancillary calculations of long-term flow using alternate methodologies do not fully support either the USGS or District calculations. The District needs to do a better job of identifying the uncertainty in both methods of flow determination and the limitations this creates.

Staff Response: Staff have analyzed USGS-reported Bagley Cove data and compared it with SGD estimated by the District with an empirical formula. As described in Chen (2014), the hydrodynamic model used for our minimum flow analyses was tested using reported Bagley Cove discharge as total SGD to the system. The results of this modeling effort showed poor agreement between model-predicted and measured salinities. This is because reported discharge for the Bagley Cove gage includes signals from wind action, storm surges, storages in Kings Bay, and interactions of these and other factors. These influences can be seen in the frequent negative daily and monthly mean values reported for the Bagley Cove site. Negative monthly discharge is clearly not indicative of spring flow into this system.

Given that Bagley Cove discharge record yields poor predictive capacity when used as input to the hydrodynamic model and includes negative daily and monthly means throughout the 2002 to 2016 period of record, the empirical-formula-derived SGD represents the best information available for estimating spring discharge to this system. Staff will emphasize this point in a revised version of the minimum flow report and will characterize the reported Bagley Cove discharge record as less suitable than the estimated SGD record for our minimum flow analyses, rather than “unreliable.” Staff notes that error in hydrodynamic model output is quantified on page 41 of the draft minimum flow report, where skill parameter and R^2 values are given for agreement between simulated output and measured data during the verification period of April 2007 to February 2010. Staff will expand upon discussion of these issues in the revised minimum flow report. We will also emphasize that

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reevaluation efforts will focus on new data collection sites and approaches for better estimation of spring flow.

- The salinity habitat change analyses relied upon a system-wide assessment of change. The District should consider if any habitats aggregated into the volume, area and length categories should be further parsed. One recommendation is to consider the difference between sloped and sediment and vegetated shoreline and hardened vertical shoreline (i.e., seawall). The District should assess (for all habitats) if this type of parsing makes sense and would strengthen the MFL conclusions.

Staff Response: District staff agree, and are developing data for analysis of shoreline salinity based habitat changes that can be used to distinguish between vegetative, altered, and natural shoreline. This analyses may be completed for consideration in the minimum flow adoption process scheduled for completion by July 1, 2017 in accordance with Section 373.042(2)(a) of the Florida Statutes, or may be incorporated into the planned reevaluation of the minimum flow that is established for the system

- While the hydrodynamic model was deemed sufficient for use in determining the changes in salinity and temperature habitat as of function of SGD, there were some issues identified within the review that should be resolved before final submission of the MFL report and supporting documentation. Some specific issues include: evaluation of the sensitivity of the offshore boundary to changes in flows (initial results of this have been provided to the Peer Review Panel); removal of periods of the model runs from the calibration statistics where boundary data are not available; and more complete documentation of the volume of additional flow added into the model to account for seepage and as a tuning parameter for the model calibration.

Staff Response: District staff agree, and are working to address and implement the Panel's recommended changes and comments. Regarding boundary conditions, newly-run model scenarios indicate that a minor increase in salinity at the downstream boundary due to reduced flow has minimal, non-significant effects on model predictions used for the minimum flow analyses. This information will be included in the updated minimum flow report as will Panel suggested improvements concerning presentation of model calibration statistics and documentation of model-tuning or parameterization associated with seepage estimates.

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A component of the Peer Review Panel scope of work was to provide an assessment of the MFL report and supporting documentation against specific listed criteria. These are outlined in Section 3 of the report. The findings of the Peer Review Panel are that, with the implementation of some of the edits/recommendations made within this report, there are no fatal flaws within the MFL report and supporting documentation relative to the specified criteria.

Staff Response: We are pleased that the Panel found “no fatal flaws”, indicating that the issues, comments, questions and concerns they identified may be addressed by the District to improve the minimum flows report, but are not considered necessary. As appropriate and indicated in this summary response document, suggested edits and other recommendations made by the Panel will be incorporated into future drafts of the minimum flows report. In addition, Panel recommendations will guide future assessments associated with the reevaluation of minimum flows that are expected to be adopted for the system in 2017.

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1.0 INTRODUCTION

1.1 BACKGROUND AND SYSTEM DESCRIPTION

The Southwest Florida Water Management District (District) contracted with an independent panel of experts to provide a technical peer review of the proposed Minimum Flows and Levels (MFL) for the Crystal River/Kings Bay Springs system. The peer review panel includes:

- Dr. Steven Peene (panel chair)
- Dr. Ken Watson
- Dr. Adam Munson

The Kings Bay/Crystal River system is located in Citrus County on Florida's Springs Coast. The system consists of Kings Bay, an approximately 600-acre estuarine embayment fed by more than 70 spring vents that discharge fresh to slightly saline water. From Kings Bay, the system flows out approximately 6 miles to the Gulf of Mexico through Crystal River. Figure 1-1, taken from the MFL Report (SWFWMD, 2016), shows the layout of Kings Bay and Crystal River along with the locations of the numerous spring vents to the system. Based upon historic studies, the District has identified that the spring vents provide more than 99 percent of the freshwater entering the system in Kings Bay. Crystal River connects to the Gulf of Mexico at two locations: near Shell Island and through the Salt River (Figure 1-1).

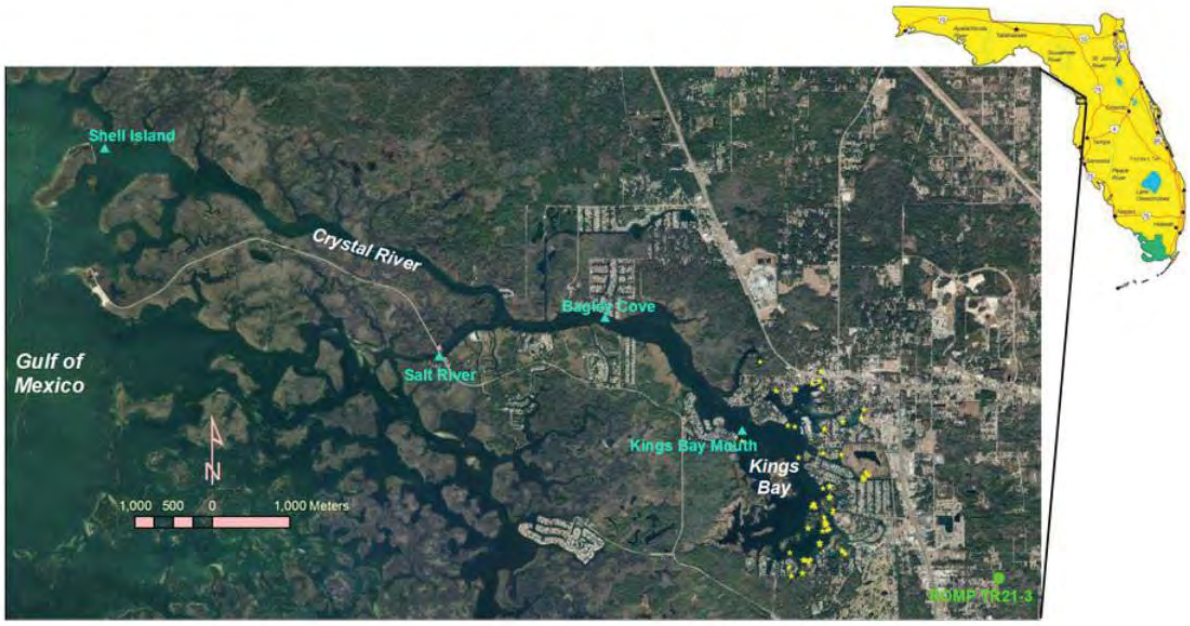

Figure 1-1. Location and Layout of Crystal River/Kings Bay System (SWFWMD, 2016)

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The discharge from the spring vents derives from groundwater within the system's springshed. The Crystal River/Kings Bay springshed spans approximately 310 square miles in northern Citrus County (Figure 1-2).

Flow measurements within the system have consisted of long-term monitoring at Bagley Cove (see Figure 1-1) by the U.S. Geologic Survey (USGS) and more recent data the District collected on direct flows from the spring vents. USGS flow measurement techniques have been modified throughout their period of record and, as identified by discussions with USGS staff, changes are ongoing. Additional data collection has included water level and salinity measurements at Shell Island, Salt River, Bagley Cove, and the Kings Bay Mouth, along with groundwater levels at three wells located near Kings Bay (Figure 1-1).

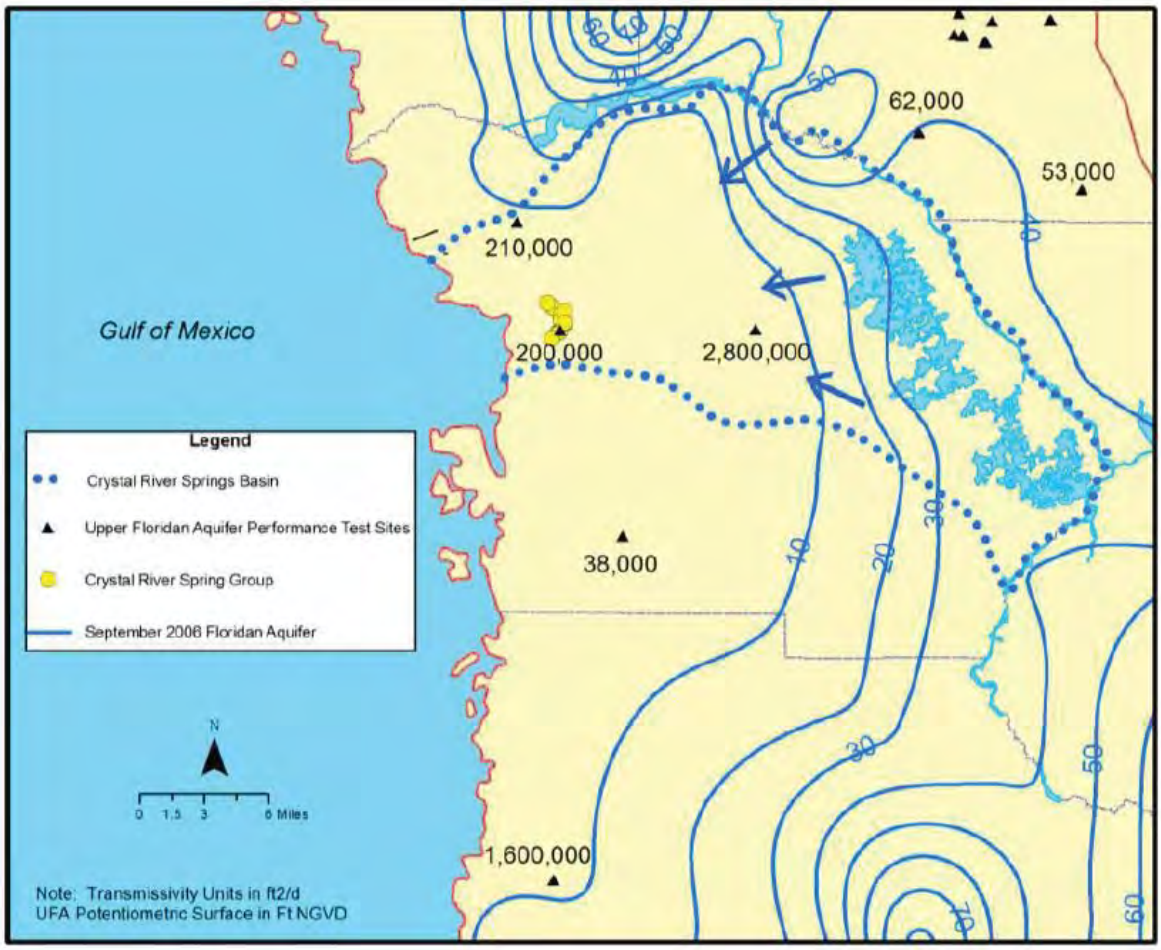

Figure 1-2. Extent of the Crystal River/Kings Bay Springshed (SWFWMD, 2016)

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The accurate determination of the long-term total flow record is a critical component of the MFL development and is discussed in detail in the MFL report and supporting documentation. Discussions center on the use of the data from the USGS station at Bagley Cove (raw and tidally filtered) versus empirically derived direct flows from the spring vents based upon direct vent measurements and water levels in Crystal River and a nearby monitoring well.

A key component of the MFL development was a hydrodynamic model of the system that was utilized to assess the impacts of flow reductions from the spring vents on salinity and thermal habitat. The development, calibration, and application of the hydrodynamic model is discussed in detail in the MFL report and supporting documentation. The assessment of the development, calibration and application of the hydrodynamic model is a primary focus of the peer review.

The Florida Department of Environmental Protection (FDEP) has designated the Crystal River/Kings Bay system as a Class III surface water body, an Outstanding Florida Water (OFW), and a Surface Water Improvement and Management (SWIM) Priority Water Body. The Crystal River Springs group is also classified as an Outstanding Florida Spring. Key environmental resources in the area that were specifically targeted for protection in this MFL include submerged aquatic vegetation (SAV) as well as manatee thermal habitat. The MFL also examined water quality conditions in the system and the impacts of flow reductions on residence times.

The final MFL presented within the report was based on allowance of a 15 percent reduction in the volume of salinity habitat for the most sensitive salinity isohaline [2 parts per thousand (ppt)] using the hydrodynamic model. Based on the 15 percent habitat reduction, an allowable flow reduction of 12 percent was identified. Current water withdrawals are at or less than 2 percent of the baseline flow condition. Based on the comparison of the current withdrawals with the allowable, the MFL document concluded that no recovery strategy was needed.

1.2 REGULATORY BASIS FOR MFL AND PEER REVIEW

Florida Statutes (F.S.) mandate that the District must establish MFLs for state surface waters and aquifers within its boundaries for the purpose of protecting the water resources

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and the ecology of the area from "significant harm." Section 373.042, F.S., provides that the minimum flow for a given watercourse is the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area and the minimum water level is the level of groundwater in an aquifer and the level of surface water at which further withdrawals would be significantly harmful to the water resources or ecology of the area.

Section 373.042, F.S., also provides that MFLs shall be calculated using the best information available, that the Governing Board shall consider and may provide for non-consumptive uses in the establishment of MFLs and, when appropriate, MFLs may be calculated to reflect seasonal variation. The law also requires that when establishing MFLs, changes and structural alterations to watersheds, surface waters, and aquifers shall also be considered (Section 373.0421, F.S.). The State Water Resource Implementation Rules (Chapter 62-40, Florida Administrative Code) includes additional guidance for establishing MFLs, providing that "…consideration shall be given to the protection of water resources, natural seasonal fluctuations in water flows or levels, and environmental values associated with coastal, estuarine, aquatic, and wetlands ecology, including:

a) Recreation, in and on the water;
b) Fish and wildlife habitats and the passage of fish;
c) Estuarine resources;
d) Transfer of detrital material;
e) Maintenance of freshwater storage and supply;
f) Aesthetic and scenic attributes;
g) Filtration and absorption of nutrients and other pollutants;
h) Sediment loads;
i) Water quality; and
j) Navigation."

Section 373.042, F.S., also addresses independent scientific peer review of MFLs, specifying the review of all scientific or technical data, methodologies, and models, including all scientific and technical assumptions employed in each model, used to establish a minimum flow or minimum water level. In addition, the law requires that FDEP or the District Governing Board shall give significant weight to the final peer review panel report when establishing MFLs.

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1.3 DOCUMENTS AND DATA UTILIZED IN THE PEER REVIEW

The following documents and data were provided to the panel members to be utilized in the peer review.

- Recommended Minimum Flow for the Crystal River/Kings Bay System – Draft Report for Peer Review (SWFWMD, 2016a)
- Chapter 6 – Appendices: Recommended Minimum Flow for the Crystal River/Kings Bay System – Draft Report for Peer Review (SWFWMD, 2016b)
- Estimate of Submarine Groundwater Discharge to Crystal River/Kings Bay in Florida with the Help of a Hydrodynamic Model (Chen, 2014)
- On the Estimation of Submarine Groundwater Discharge to Kings Bay (Chen, 2014)
- SWFWMD Presentation – King's Bay – Simulated Spring Flow History
- Northern District Groundwater Flow Model, Version 5.0 (SWFWMD, 2016c)
- Peer Review of the Northern District Model Version 5 and Predictive Simulations, October 10, 2016, Final Report (SWFWMD, 2016d)
- Comparison of Bagley Cove Qs (graphs developed by Dr. Chen of SWFWMD)
- Excel data files from Dr. Chen of Bagley Cove, Salt River, Kings Bay Mouth, and Shell Island measured flows, levels, temperature and conductivity.

1.4 PEER REVIEW PANEL SCOPE AND APPROACH

The Peer Review Panel was scoped to complete the following tasks as part of the MFL Peer Review:

- Review draft of the Crystal River/Kings Bay MFL Report along with available supporting documentation and data
- Participate in Public Meetings including:
    - Kickoff Meeting and Site Visit (November 4, 2016)
    - Web-Meetings (November 15,16, and 21, and December 5, 2016)
- Post written review comments and collaborate with other panelists to develop a single peer review panel report
- Review and provide support in development of meeting agendas and meeting summaries

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Following the process outlined in the scope above, the following sections present the results, comments, and recommendations of the Peer Review Panel.

Section 2 of this report utilizes a tabular template (completed by each of the three peer reviewers) to meet the District's peer review requirements. The tabular comments are presented for each section of the MFL report, as well as key supporting documentation within the appendices. Narrative comments on various key aspects of the MFL report and supporting documentation, precedes the tabularized comments. The tabularized comments include the specific comment, whether the comment has significant impact on the conclusions of the MFL, and recommendations on how to address the comment.

Section 3 presents tabularized results of the panel member's comments concerning the District's peer review assessment criteria, which are outlined in Attachment A of this report. These criteria were specific scoped sub-tasks outlined by the District for the panel members to address.

Section 4 presents referenced literature.

2.0 REVIEW OF MFL REPORT, APPENDICES, AND EXTERNAL REPORTS

The following sections provide detailed review and comments on the MFL report and supporting documentation provided by the District for use by the Peer Review Panel. Section 2.1 presents the review of the MFL Report. Section 2.2 presents the review of the appendices and supporting documentation. A narrative review is provided relative to key aspects of the MFL development as identified by the review panel. Following the narrative comments, tables are provided for each Chapter of the report and for the supporting documentation with detailed comments, identifying if the comment is significant (i.e., impacts the MFL determination), and proposed action items to address the comments.

2.1 MFL REPORT

Specific components of the MFL report and supporting documentation were identified by the peer review panel as critical in the MFL development. These were identified for specific review and discussion. These included;

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- Determination of the Submarine Groundwater Discharge
- Development, Calibration and Application of the Hydrodynamic Model

The following presents the reviewers discussion of these items. Following the narrative discussion, tables are provided with detailed comments from each of the reviewers along with the significance of the comment and recommendations for resolution.

Determination of Submarine Groundwater Discharge

Discharge measurements at USGS gage 02310750 Crystal River Near Crystal River FL (1964 to 1977) were determined to be unreliable and were not used in the MFL study. Average flow during that period was estimated to be 971 cfs. A new gage was activated in 2002 (USGS gage 02310747 Crystal River at Bagley Cove) and tidally adjusted average flow between 2002 and 2015 was calculated to be 447 cfs. This value is the result of adjustments made to the rating curves in 2011. The District concluded for the MFL that the Bagley Cove record, including the most recent adjustments, was unreliable for this MFL work. Discussions with USGS personnel identified that USGS has recently installed new instrumentation at Bagley Cove to obtain more complete data at the cross-section. In the future, a revised rating curve will be developed using the new data and new flow projections can be evaluated.

The District estimated an average flow of 374 cfs for the period of 1969 to 2015 using direct field flow measurements at select spring vents and at two channels which contain the input from multiple spring vents. The channel measurements were taken during July-August 2009. At this same time, water level measurements were collected at the mouth of Crystal river and in groundwater wells adjacent to Kings Bay. The District developed relationships between the water level measurements at the mouth, the water level in the wells and the measured flow at the channels. The relationships developed reflected approximately 60 percent of the flow coming into the system. The relationships were then extrapolated to the other vents to calculate the remaining 40 percent of flow. The flows were then checked using the hydrodynamic model to assure salinity predictions were reasonable and from those simulations a remaining approximately 10% additional flow was added to the system to account for seepage.

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Staff Response: For clarification, the formula to predict submarine groundwater discharge relied on data from the mouth of Kings Bay at United States Geological Survey (USGS) gage #02310742. The Panel's report incorrectly notes that these data were collected at the "mouth of Crystal river" rather than the mouth of Kings Bay.

Based on the above, the MFL flow record and various metrics for developing the MFL are based on empirically derived results without verification against a complete gaged flow record, and the independent drivers are tidal stage, water temperature, and salinity; groundwater elevation at a tidally influenced well; and salinity assigned to spring flow.

The USGS results were defined as unreliable in the MFL document, but discussions with USGS personnel identified that USGS does not believe the data, following the 2011 corrections, and if averaged over a sufficient period, are unreliable. Additionally, the predictions from the Northern District Groundwater Model are closer to the long-term average from the USGS gage (450 cfs versus 447 cfs). Also, the USGS flow at Bagley Cove for the model time period (2006 to 2015) was about 354 cfs and the District estimated springs discharge was 332 cfs, or about a 6% less but reasonably similar.

Staff Response: In the original minimum flows report, the District stated that discharge estimates based on data collected at the USGS Bagley Cove gage (#02310747) are not reliable estimates of groundwater discharge for use in minimum flow analyses. Future drafts will clarify that the discharge reported for this gage is not objectively 'unreliable', as it is not the intent of the District to criticize the discharge reported by the USGS. However, we found reported discharge from this gage was inappropriate as an estimate of submarine groundwater discharge for our minimum flow analyses for two reasons: 1) Long-term negative values exist in reported daily and monthly averages, 2) discharge, when used as an input to the hydrodynamic model in a trial run, produced inferior model-verification results relative to those derived from model runs involving discharge estimates from the District-generated formula for estimating submarine groundwater discharge. The District was therefore able to make better predictions using the alternative estimates of submarine groundwater discharge described in the minimum flow report.

Looking at how the differences impact the MFL development, if the MFL results are used to estimate available water (i.e., 12% of say 374 cfs), then the result is conservative compared

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to using the USGS estimated flow. However, if the MFL result is viewed as a flow (i.e., 88% of 374 cfs), then it is not conservative.

Staff Response: The recommended minimum flow is expressed as percent-of-flow, not as a specific flow value, and is thus conservative, as indicated in the first scenario described above by the Panel.

As there is a level of uncertainty with both the USGS gaged flow and the SWFWMD empirically derived flow, the MFL must note the uncertainty in both, recognize that the impact evaluation is a relative one, i.e., based on percent reductions, and identify that future efforts must be focused on verifying what the total flow into the system is.

Staff Response: Staff will further clarify the uncertainty in reported discharge at the Bagley Cove gage and estimated submarine groundwater discharge derived using the District empirical formula.

Hydrodynamic Model Development, Calibration and Application

A 3-dimensional hydrodynamic model was applied to the Crystal River/King's Bay system to simulate time dependent water levels, currents, salinity and temperature throughout the system. The model utilized is called UnLESS3D. This is an unstructured Cartesian grid model. Within the MFL Report Appendices a report entitled "An Evaluation of Effects of Flow Reduction on Salinity and Thermal Habitats and Transport Time Scales in Crystal River/Kings Bay" was provided. The report included write ups on the UnLESS3D model equations, the physical characteristics of the Crystal River/Kings Bay system and the available field data, the hydrodynamic model calibration and verification, the model scenarios for the flow reduction, and simulations based upon the sea level rise.

The hydrodynamic model boundary inputs include; tides, temperature and salinity at two boundaries (Salt River at the bridge and at the mouth of Crystal River where it meets the Gulf of Mexico); groundwater discharge, temperature and salinity at multiple vent locations along the eastern and southern ends of Kings Bay; and atmospheric forcing at the water surface. The data for the tidal boundaries came from measured data at the two locations. The groundwater discharge came from empirically derived submarine groundwater discharge (SGD) (see previous discussion) and the temperatures and salinities associated

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with these inflows came from available measured data. As the modeled groundwater discharge includes inputs of water surface elevation at the mouth, this value is a dynamic parameter that is calculated for each model time step using the model equations. The atmospheric inputs came from measurements at a nearby meteorologic station.

The model was calibrated to data collected at two interior stations. The first station is at Bagley Cove. The Bagley Cove station is approximately two-thirds of the way up Crystal River between the mouth at the gulf and the entrance to Kings Bay. At the Bagley Cove station, continuous water level, salinity, discharge, and temperature data were available for the calibration. The salinity and temperature data at this station were from the bottom. The second station was located at the mouth of Kings Bay. This station had continuous water level, salinity and temperature data. The salinity and temperature data were at the bottom and surface. The total simulation period was a 34-month period (1037 days), from April 24, 2007 to February 23, 2010. The model was calibrated against real-time data of water level, salinity and temperature for a 150-day period during December 28, 2007 – May 26, 2008 after a spin-up run for 25 days. It was then verified for the remaining days before and after the 150-day calibration period.

Comparisons of the modeled and measured data are presented in the report along with statistics including the R^2 (correlation coefficient), the mean error, the mean absolute error, and the skill assessment. The following bullets discuss the evaluation of the calibration.

- Water Level: The graphical comparisons as well as the various statistical analyses are within acceptable ranges of error for the water level. Generally, the statistics show better than normal results.
- Salinity: The statistical analyses show that the calculated statistics of the errors are within acceptable ranges. The graphical plots show that the model generally captures the temporal and spatial changes in salinity in the system, indicating that the behavior of the salinity under varying tidal and flow conditions is reasonable.
- Temperature: The statistical analyses show that the calculated statistics of the errors are within acceptable ranges and generally better than usual. The graphical plots show that the model generally captures the temporal and spatial changes in temperature in the system, indicating that the behavior of the temperature under varying tidal and flow conditions is reasonable. One comment is that the model

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results presented in the report should focus on the critical winter period so that the reader can see how the model performs graphically during this time.

Staff Response: Staff will include graphical presentation of these results in the revised minimum flow report.

- Cross-Sectional Flux: The comparisons of the simulated and measured cross-sectional flux shows that the model consistently under predicts the maximum flows passing at Bagley Cove. These maximums as seen in the data are generally short lived. Similar statistical analyses performed on the other data should be performed on the discharge data.

Examination of some of the results in the appendices identified that there are periods of time where the model boundary conditions were not available. During these periods the model was simply run through the two points (start and end of missing data) and used linear interpolation between as it ran. While most likely this is not causing significant issues with the model predictions outside of these periods and some period after, this is highly unusual and it is recommended that these periods be filled in as best as possible with reasonable forcing data, or these periods be taken out of the calibration/verification periods.

The hydrodynamic model was applied from October 6, 2006 through October 13, 2015 for the scenario analyses. This is a 9-year period where measured data were available for the forcing functions. The flow reductions were then applied through this period. One issue identified is that the boundary conditions at the mouth of Crystal River and at Salt River Bridge are not altered under the flow reductions. Examination of the salinity time series at these locations does show that they are influenced by the freshwater flow coming out of the system, i.e., they are close enough to shore to be impacted by the flows. A sensitivity analysis should be performed to determine the degree to which these boundaries are expected to increase in salinity overall as a result of the flow reductions. If the differences are significant, the model scenarios should be re-run with the increased downstream boundary salinities.

The hydrodynamic model has been applied to determine the change in volume, bottom area, and shoreline length associated with different salinity ranges, when modeled flows are

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reduced. The criteria applied is a 15% reduction in the volume, area, or shoreline length of any one of the modeled salinity ranges. While it would be preferable to link changes in flow directly to changes in ecology, the difficulty of measuring or expressing this causality is well established and the use of habitat as a more easily measured proxy is reasonable. However, it is desirable to delineate habitat when reasonable since not all habitat offers equal ecologic benefit. This is consistent with the district historical mapping of wetland communities and substrate mapping used in riverine systems in conjunction with HEC-RAS and PHABSIM models. The challenges of the estuarine systems are different and the District has documented the difficulty with identify some community-specific thresholds in its discussion of SAV. However, the District should consider if any habitats aggregated into the volume, area and length categories should be further parsed. One recommendation is to consider the difference between sloped and sediment and vegetated shoreline and hardened vertical shoreline (i.e., seawall). While this may not alter the recommended MFL on Crystal River, it is suggested that, in other applications, there might exist unique or critical habitats that decline over 15% if they are aggregated into the broader categories of volume length and area.

The following tables present detailed comments by chapter and appendices and supporting documentation.

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Table 2-1. Review of Executive Summary

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				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
1	SP	Paragraph 5	No – Because the data seem to not exist but could potentially be considered during re-evaluation.	The report states "These models allowed evaluation of salinity-based habitats, manatee thermal refuge, and residence time as potential indicators of significant harm. Each of these three factors are related to the 10 environmental values put forth in the State Water Resource Implementation Rule. Particular importance was placed on the effect of salinity on promoting submerged aquatic vegetation and reducing algal blooms to promote water clarity.". While the salinity intrusion and the thermal refuge were evaluated fully relative to the MFL development, the residence time and any potential impacts on the system water quality and algal blooms were not fully evaluated in relation to the MFL. This section should be reworded to reflect this.	At this time, based on discussions with District staff, it appears that data are not available to fully quantify the relationship between decreased residence time and specific water quality parameters impacted by residence time (i.e., Chl a). Based on this, the recommendation is that the District acknowledge in the MFL report that a full evaluation of the potential impacts on water quality are not feasible at this time and recommend that future work focus on attempting to quantify the impacts through additional data collection. Staff Response: Future drafts of the minimum flow report will acknowledge that water quality analysis for various parameters, including nutrient and chlorophyll a concentrations are not currently suitable for use in the development of criteria for setting the

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					minimum flow, and will recommend that future work focus on data collection and analysis of water quality parameters. Water quality analyses performed for the recommended minimum flow were inconclusive with respect to relationships between chlorophyll a and flow. Similarly, there are no data analyses showing clear quantitative links between residence time and chlorophyll (algal blooms) in this system. However, the analysis in Table 3.5 shows that residence time will increase by 11% with a 12% decrease from baseline flow, which indicates that it is less sensitive than salinity. Previous analyses did not support direct linkage between discharge and chlorophyll a. However, there are known links between salinity and chlorophyll a in many lotic systems which support using salinity as a criterion for MFL development or assessment. Staff are continuing to

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					assess water quality linkages to flow into and within the system and expect to complete a more thorough assessment of potential flow-related water quality as part of the planned minimum flow reevaluation.
2	SP	Paragraph 6	No	The report states "In addition to model outputs, we also investigated water quality measurements related to the recent Total Maximum Daily Loads established by the Florida Department of Environmental Protection. Our analysis found no consistent relationship between spring flow and water quality measurements for nitrogen, phosphorus, or dissolved oxygen. As such, these water quality measures were not considered as criteria for setting the minimum flow for this system." Chl a and/or other nuisance macro-algal species were not assessed and these are key parameters that may be impacted by the residence time changes.	See resolution recommended for Comment 1. Staff Response: See our response for Comment 1.

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				This will be outlined in more detailed comments in the specific chapters.	
3	KW	Executive Summary Page v	No	The sufficiency of manatee thermal habit as expressed may be arguable.	Reconsider how thermal habitat is evaluated. Staff Response: As discussed in Sections 3.2 and 4.3 of the draft minimum flow report, thermally-favorable habitat sufficient for the known population of manatees would exist in the Crystal River/Kings Bay system at even the highest flow reduction scenario (i.e., a 30% flow reduction) that we modeled. Given this finding, we believe that it is accurate to indicate that habitat sufficient for meeting manatee thermal requirements during cold periods should be available if the minimum flow requirement that natural flow not be reduced by more than 12% is met.
4	KW	Executive Summary Page v	No	Define the baseline time period.	Explicitly define. Staff Response: The baseline period is from October 6, 2006 to October 13,

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					2015. It is mentioned on Page 31 of the hydrodynamic model report (one of the appendixes). We add that in the referenced use of "baseline" in the executive summary of the draft minimum flow report is included to describe natural flow, i.e., flows expected in the absence of withdrawals, associated with the proposed minimum flow, that are associated with proposed minimum flow.

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5	SP	Page 13, first paragraph	No	In the first sentence after the parenthesis, need to bring line back up.	Correct in report. Staff Response: This formatting error will be corrected in future drafts of the report.
6	SP	Page 14, Section 1.4.3, first paragraph	No	The text states "Starting in August 2002, tide-corrected flows have been continuously recorded in the river by the USGS at the Crystal River at Bagley Cove near Crystal River, FL gage #02310747". A more accurate description of the measured flows would be that USGS utilized their Index Velocity Method to calculate flows and reference the USGS publication on index velocity. Additionally, it may be appropriate to further elaborate on the potential errors in the previous flow measurements (prior to 2002).	Reword. Staff Response: Section 1.4.3 will be revised in future draft reports to indicate the U.S. Geological Survey estimates discharge at the Bagley Cove site using an index velocity approach and a reference to the most recent USGS Water Data Report for the site will be included. Staff notes that the second paragraph of Section 1.4.3 addresses potential errors associated with historic discharge estimates made at the downstream "Near Crystal River" site, citing the Yobbi (2014) report which include additional information on the potential errors and is included as an appendix to the minimum flow report.

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7	SP	Page 15, Section 1.4.3, 3rd paragraph	No	The document states “Based on the information described here, we concluded that discharge estimates based on the historic flow record for the Crystal River near Crystal River gage (#02310750), and the currently reported flows at the Crystal River at Bagley Cove gage #02310747 include a mixture of groundwater, stormwater runoff, and marine water, and are not reliable estimates of groundwater discharge from the Crystal River spring group for use in minimum flow analyses.” This is an overstatement on the issues with the USGS data. There is uncertainty with both the USGS and SWFWMD data. There is also evidence showing at times where each appears to agree with other analyses. The report should not discount the USGS data outright, but should acknowledge the uncertainty in both, state why, at this time, the SWFWMD data were used, and identify the need for more comprehensive verification of the actual flow.	Reword. Staff Response: The referenced sentence from Section 1.4.3 of the minimum flows report will be revised to note that staff do not consider the discharge reported by the U.S. Geological Survey “unreliable.” We will instead note that when used as input to the hydrodynamic model, these data yielded poorer model-verification results relative to those from model runs involving discharge values derived with the District-generated formula for estimating submarine groundwater discharge (SGD). The section text will also be revised to note that the SGD estimates, which are described in Sections 2-1 and 2-2, were used in the modeling described in Section 2-3. Additional text will also be included to highlight the ongoing methodological advancements concerning discharge measurement at the Bagley Cove gage site (i.e., the installation of new equipment for measuring channel velocities) and the recent and ongoing installation of two new sites for measuring flows in the bay, at the Saragassa Canal and Hunters Cove.
8	SP	Page 19, Figure 1-13	No	Need to identify the time scale (averaging) of these data, i.e., is this a plot of the annual averages or some type of running average. Given the tidal	Reword graph figure, title, or identify in text.

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				signal identified in the later measurements, I assume these plots must be some form of averaged data.	Staff Response: The graphic caption will be reworded to indicate that these are monthly-averaged water levels.
9	SP	Page 25, Section 1.4.7.2, second to last paragraph	No	The text states "although 566 animals were observed in Kings Bay on a the extremely cold day of January 13, 2010 (Kleen 2014)." Grammatical fix.	Delete the "a." Staff Response: This has been fixed in the draft report.
10	SP	Page 32, Table 1-6	No	The table lists the water quality criteria for the system. While mentioned in the paragraphs above, the chl *a* criteria are not listed in the table. Also, the table needs to include the applicable criteria for Crystal River (1341I) including the Chl *a* criteria. Additionally, some of these criteria have time scales (i.e., annual mean, annual geometric mean) associated with them that need to be properly identified.	Include the appropriate time scales in the criteria table. Staff Response: The criteria table will be modified as suggested.

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11	SP	Page 35, Table 1-7	No	For the Recreation in and on the Water in the table, only protection of salinity habitats is identified. As manatee are a part of the recreational value of the system, manatee thermal refuge should be listed here also.	Reword. Staff Response: Table 1-7 in the report has been modified accordingly.
12	SP	Page 35, Table 1-7	No	Salinity habitats are identified for navigation. As this is a tidal system and water levels are dominated by tides rather than freshwater inflow, is this Use applicable to this system relative to freshwater withdrawal.	Potentially reword. Staff Response: Hydrilla beds were a hindrance to navigation in the past. Hydrilla are sensitive to salinity. This is explained in Section 1.7.10.
13	SP	Page 35, Section 1.7.1, first paragraph	No	As in the previous comment on Table 1-7, as manatee are part of recreation (as identified in the paragraph) the thermal analyses apply here.	Reword. Staff Response: District staff agree and will make appropriate changes to the report.
14	SP	Page 36, Section 1.7.4	No	After the second sentence, there appears to be text "*However, managing*." That should be deleted.	Delete text. Staff Response: This text has been deleted.

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15	SP	Page 36, Section 1.7.6	No	The text states "Residents and users of Kings Bay and Crystal River are concerned with water clarity and preventing / reducing algal blooms (Evans et al. 2007; SWFWMD 2015)." The text indicates that these issues are dealt with in the MFL through the salinity and thermal analyses. The analyses performed in this MFL do not directly address the issue of impacts of flow reduction on algal blooms. The model is used to evaluate the impacts of flow reduction on residence time, but no analyses are performed to relate flow and Chl *a*. Based upon conversations during the public meeting on this topic, it was identified that data at present are limited for this analysis, but efforts are underway to collect more. The text here may need to be modified to reflect this.	Reword, see suggestions in Comment 1. Staff Response (also see our response to Comment 1): Past analyses did not support direct link between discharge and chl a. However, there are known links between salinity and chlorophyll a in many systems which support using salinity as a criterion for MFL development or assessment. Further analyses addressing this issue will be completed as part of the planned minimum flow reevaluation.
16	SP	Page 37, Section 1.7.9	No	The previous comment on the evaluation of Chl *a* should also be addressed in this section.	Reword. See recommendations in Comment 1.

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					Staff Response: See our response to Comment 1.
17	KW	Page 3, Section 1.3.2	No	Consider adding definitions for tidally filtered flow and spring/neap tides; throughout report change tide-corrected to tidally filtered.	Define terms. Staff Response: Definition for tidally filtered flow added. All instances of "tide-corrected" changed to "tidally filtered".
18	KW	Page 2, Section 1.3.1	No	Can harm to WRVs be measured or are we measuring criteria linked to harm – e.g., change in salinity?	Reword. Staff Response: Wording changed from "measure harm to environmental values" to "measure criteria linked to environmental values"
19	KW	Page 3, Section 1.3.2 and Page 66, Section 4.5	No	Consider adding an explanation of how an allowable flow reduction expressed as a percent flow reduction would be applied to the SGD "flow regime" per item #8 in Section 1.3.2 may be helpful.	Explain further. Staff Response: Explanation added to section 1.3.2.

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					The definition of "flow regime" was modified to include an explanation of how a percent of flow reduction preserves the flow regime.
20	KW	Page 3, Section 1.3.2	No	Do historical flows occur in the absence of withdrawal impacts? Historical flows would seem to include impacts.	Reword. Staff Response: Staff notes that in addition to the definition of "long-term" referenced in Section 1.3.2, Rule 40D-8.021 also defines "historic" as a "long-term period when there are no measurable impacts due to withdrawals and Structural Alterations are similar to current conditions." This information will be included in the definition for "baseline" included in the revised report.
21	KW	Page 5, Section 1.4	No	Maps of land surface topography within CR/KB watershed/springshed and KB bathymetry may be useful.	Consider adding graphic. Staff Response: A map of bathymetry will be included with brief description.

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22	KW	Page 11, Section 1.4.1 Figure 1-5	No	Callout(s) for CR/KB may be helpful.	Add to figure. Staff Response: Comment noted by District Staff.
23	KW	Pages 12 13, Section 1.4.2	No	As a companion to Figures 1-6 and 1-7, a cumulative deviation plot might be helpful to show persistence. Annual rainfall volumes on Figure 1-6 would be useful. The Y-axis of Figure 1-7 is the departure from long-term average rainfall.	Consider adding graphic. Staff Response: Staff can add a cumulative departure graph to the report and will update the y-axis title on Figure 1-7.
24	KW	Page 14, Section 1.4.3	No	Are tide corrected flows recorded or calculated? Suggest changing tide corrected to tidally filtered.	Reword. Staff Response: Staff agrees that the term "tidally-filtered" is preferable to "tide-corrected" and will revise the report accordingly.
25	KW	Page 15, Section 1.4.3	Maybe	The two gages include runoff as part of flow measurement. The measured flows are stated to not be reliable estimates of groundwater discharge from the springs group. Is runoff otherwise included in the hydrodynamic model? How well do average tidally filtered flows (or unfiltered	Consider additional analysis now or in the future. Staff Response: Runoff contributes <1% of the total hydrologic loading to the system and was not included in the hydrodynamic model. It is,

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				over longer time periods) at Bagley Cove correlate with rainfall, perhaps based on weekly, monthly, or annual averages? This may be another way of evaluating tidally filtered flow records.	however, possible that measured Bagley Cove flow is somewhat correlated with seasonal or annual average rainfall. Although these correlations are expected to be weak, we will examine these potential relationships.
26	KW	Page 15, Section 1.4.3	Maybe	Has the USGS weighed in on the assertion that current gaged tidally filtered flow (and unfiltered flow) is unreliable? It would be useful to see the index-velocity ratings for the Bagley Cove station and open-channel sites G1 and G2.	Provide ratings. Staff Response: As mentioned by Dr. Peene, the USGS recognizes that there are issues with their flow measurement at Bagley Cove. They plan to further improve their flow measurement at Bagley Cove, including replacing the current ADCP with a new one. The District does not have the referenced index-velocity ratings but can obtain them from the USGS.
27	KW	Page 21, Section 1.4.4.1	No	How were "observed" CR Spring Group flows determined? The definition of mean error (enclosed by parentheses) is missing a "divided by…" term.	Reword. Staff Response: The values were estimated from a water budget of the

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				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
					springshed. This information is contained within the NDM version 4 calibration report by HydoGeologic, Inc.
28	KW	Page 23, Section 1.4.6	No	The top paragraph is a little confusing – Crystal River group versus Crystal River Spring Group discussion. It may be useful to add a column in Table 1-2 for the withdrawals located within the CR/KB springshed.	Reword. Staff Response: Staff will modify the report to clarify the presentation of flow changes predicted with the NDM 5 model. The model withdrawals are those over the entire 10,000 square mile domain of the NDM in Table 1-2.
29	KW	Page 24, Section 1.4.7	No	Is Crystal River an impounded estuary or just the Kings Bay portion?	Explain. Staff Response: The term "impounded estuary" has been removed in favor of a clearer description of the system.
30	KW	Page 29, Section 1.5.1.1	No	Do the references regarding SAV salinity tolerance differentiate between bottom salinity and water-column average salinity?	Explain.

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					Staff Response: There are multiple references cited in this section. Some of which experimentally manipulated salinity in mesocosm experiments, some describe storm events, and others compared sites with varying salinity habitats. Our analysis included water column salinity and bottom salinity. District staff stand by the interpretation that salinity is an important driver of SAV distribution and abundance in Kings Bay.
31	KW	Page 34, Section 1.6.2	No	It may be useful to discuss the mean sea level trend NOAA has documented for one of the tide stations (e.g., Cedar Key) and impact on model and hindcasting.	Explain. Staff Response: Hindcasting was done with measured water level data that was historically affected by sea level. The mean sea level trend at Cedar Key is 1.97 millimeters/year with a 95% confidence interval of +/- 0.18 mm/yr based on monthly mean sea level data from 1914 to 2015 which is equivalent to a change of

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					0.65 feet in 100 years. Staff can add this information to this section and mention that hindcasted water levels in the bay based on historical water levels elsewhere will have been affected by past changes in sea level.
32	KW	Page 35, Section 1.7, Table 1.7, and Page 37, Section 1.7,	No	Clarify in the table that the factor evaluated for Sediment Load is the stability of bottom sediment. It is not clear (in table and text) how protection of native SAV is applicable to Navigation.	Clarify. Staff Response: Clarified in the table and text.
33	KW	Page 37, Section 1.7.8	No	Consider re-phrasing "positive impacts".	Reword. Staff Response: Rephrased.
34	AM	Page 4	No	The District does a good job providing some of the history and buttressing the 15% reduction criterion.	No action needed. Staff Response: District staff appreciate this feedback.
35	AM	Page 4	No	The District states "it is preferable when possible, to explicitly link reductions in flow to critical resources; this is the	Reword.

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				approach we used with our 15% resource reduction standard" Would it be more correct to say the District protects habitat than resource?	Staff Response: Ecologically, a "resource" is a broad term than may include habitat in addition to other substances such as food or nutrients. The 15% criterion could potentially be applied to any resource linked to flow.
36	AM	Page 24	Likely not	The District lists several habitats that are less mobile than others (i.e., Oysters Beds, Hydric Hammocks, and Mangroves). However, the report is not clear concerning the location of these habitats or that salinity changes that occur at their current location. If the goal is to protect these habitats in place, further discussion might be warranted.	Provide further discussion either explaining why it is not an issue or that while this is generally true, data for Crystal river do not exist to assess these habitat specifically. Staff Response: We plan to add analysis of vegetated shoreline to changes in shoreline salinity to address this problem. Shoreline vegetation is the only well-mapped data we could use to identify changes in habitat for sessile species.
37	AM	Page 24	No	Suggest referring to one plant by one name. *Vallisneria Americana* for	Word consistently.

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				example is listed as both Eelgrass and native wild celery.	Staff Response: We will simply not use a common name in the revised report.
38	AM	Page 24	No	The last sentence on the page is confusing and I only bring it up because it is contrary to a verbal statement during the field trip that Lynbya is declining.	In light of our conversations, this is not likely to change the outcome of the current MFL recommendation, but it Is related to the recreational value and to residence time, which has the potential of connecting flow to water quality. If there is evidence that Lynbya is diminishing in the bay, it should be documented in the report. Staff Response: Lyngyba is sensitive to salinity, and recent pulses in salinity due to storm surge from Hurricane Hermine had caused a recent die back in Lyngbya within the bay. This recent die back was mentioned during the peer review panel site visit. However, Lyngbya and other filamentous algae

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					continue to be an ongoing issue in the bay.
39	AM	Page 28	No	Makes the case that it is important to manage shoreline habitat for emergent and shoreline species. This is true but the model contains significant hardened shore length (such as the sea walls in the finger canals near the three sisters), which possibly, because of their location within the bay, will not likely experience significant changes in what are likely to be low salinity conditions due to a reduction in flow. This may add to the shoreline length at low salinities and buffer the percent reduction calculated. It would be useful to run the model and isolate the cells that border naturally vegetated shoreline.	Dr. Chen has provided model output suggesting this issue not likely to change the MFL. However, where the District has the data to delineate markedly different habitats, it should consider disaggregation of the volume, area and length categories to provide more specific habitat protection. For example, as mentioned here, vertical hardened shoreline might be too different a habitat from vegetated shoreline to aggregate the two. Further, the District should review its available data and determine if further disaggregation is appropriate or feasible. Staff Response: The District is working on disaggregating shoreline length into different shoreline types.

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					More data collection is needed to identify shoreline types along the finger channels associated with the bay.
40	AM	Page 32	No – Because the data seem to not exist but could potentially be considered during re-evaluation.	Question…. A significant water quality concern in the past at Crystal River was water clarity and thus in part chlorophyll. There is also a 4.4 microgram per liter target for chlorophyll-a in the river and 5.7 for Kings Bay. On Page 34 it is noted that Burghart and Peebles (2011) recommended that residence time be managed to limit phytoplankton blooms. Finally, the author's note that chlorophyll-a is potentially related to residence time and that substantial increases in residence time is potentially harmful. It is partially addressed in section 2.8 and table 2-6 and again in 3.4 and table 3-5 but perhaps a more full discussion of why it is not a factor in the MFL.	Buttress the current discussion. Staff Response (also see our response to Comment 1): Water quality analyses performed for draft minimum flow report were inconclusive with respect to chlorophyll a relationships to flow. However, staff are looking closely at water quality linkages to flow and expect to complete an enhanced water quality assessment as part of the planned minimum flow reevaluation.
41	AM	Page 32	No – Because the data seem	A recommendation for future work might be to understand how the increases in	See earlier recommendation, Comment 1.

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			to not exist but could potentially be considered during re-evaluation.	ERT potentially correlate with environmental values (specifically Chl-a).	Staff Response: See our response to Comment 40.
42	AM	Page 35, Table 1-7	No	Aesthetic and scenic – Would include protection of natural shoreline vegetation.	Reword. Staff Response: Staff will add this to the report.

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43	SP	Section 2.2	Maybe	The equations that are utilized to define all the flows into the system have some basic error associated with them as well as certain levels of uncertainty. For example, in Figure 2-4 looking at plot (a), it is clear that for the period when measured flows were available, there are errors in the estimated flow that would indicate that the model under-predicts the overall net flow out. This error is then carried through an additional level of uncertainty as the equations and coefficients are extrapolated out to other vents in the system. Based on these known errors and uncertainty, it would be important to developed additional ways to verify the total flows. This could be done using the Bagley data, if this data is demonstrated to be useful for this. Still working on the evaluation of the Bagley data. The equations are utilized to hindcast flows so some additional verification (beyond the model predictions of salinity) of the modeled flows would be beneficial.	The report needs to be more definitive in outlining the uncertainty associated with the SGD calculations and the errors in the various steps and how those might impact the calculated flows. The Figure 2-4a differences are a good example. The graph clearly shows there are errors between the predicted and measured flows at this cross-section. Simple visual inspection indicates that this error would tend to make the calculations under-predict the long-term net flow out. This relationship is then potentially extrapolated to other vents and this error carries over. Also, some more definitive discussion of the degree of variation in the direct vent measurements and how they were used to carry the calculations forward is needed. Again, highlighting how the errors might impact the ultimate flow calculation.

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					Staff Response: Just like any data collection and data fitting processes, there are errors associated with every step of these process we used to estimate SGD. Inevitably, there are some uncertainties in the SGD estimates used in the hydrodynamic model, which, combined with errors from other sources, eventually contribute to the uncertainties of the model results. A factor parameter is built in the hydrodynamic model that can be tuned to control the diffuse flux and allow the SGD uncertainties to be limited to a certain degree. Model calibrations using different values for this factor parameter suggested that the SGD uncertainty should be of the order of 20 cfs or less. As shown in the hydrodynamic model report (one of the appendixes), the final errors of simulated water levels, salinities, and temperatures are in ranges that are acceptable.

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44	SP	Section 2.2	Maybe	The groundwater model predictions of flow from the springs group is on the order of 440 cfs under present conditions. The hindcast flows show averages more around 350 cfs. This further supports the need for verification of the total flow.	See previous recommendations on dealing with uncertainty in the flow measurements, i.e., Comment 43 Staff Response: The estimated SGD average was 355 cfs for the period 1/1/2002 through 10/13/2015. It was 332 cfs for the 9-year simulation period (10/6/2006 through 10/13/2015), and 374 cfs for the period between 11/5/1969 and 10/13/2015. Dr. Ken Watson calculated the average of USGS Bagley Cove flow to be 432 cfs and 354 cfs for the period of record (1/1/2002 through 11/15/2016) and for the 9-year model simulation period, respectively. Interestingly, the USGS Bagley Cove average was only about 7% greater than the estimated SGD average during the 9-year simulation period.

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45	SP	Page 44, Section 2.3, Paragraph 2	No	The text identifies that the model statistics indicate that the model agrees well with measured data based on R2 values and other statistical analyses. I am in agreement with the statement that the statistics are reasonable given the type of data (continuous) being compared to for salinity and temperature.	No action required.
46	SP	Section 2.3, Paragraph 3	No	Based upon the materials in the appendix on the model, along with conversations with District Staff, there was around 10% of the flow that was utilized as a tuning parameter, i.e., to represent the unmeasured flows coming in through diffuse flow and flow from hairline fractures. Not sure if that was included in the flows presented in Table 2-1.	Clarify. Staff Response: Yes, the unmeasured flow quantity is included in Table 2-1. This portion of SGD contribution is 20 cfs or less, or about 6% of total SGD (please see our response to Comment 41). Correction: the 7.4% contribution on Page 24 of the hydrodynamic model report (one of the appendixes) is a mistake and should be changed to 6%.
47	SP	Section 2.3	Maybe	The salinity boundary conditions utilized for the scenario runs assume that there	Some results of sensitivity tests were provided by Dr. Chen showing that

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				will be no change in the salinity conditions at the locations of the boundaries from the reductions in flows. Need to test the validity of that assumption by doing some sensitivity tests on changes in that area based on flow reductions.	this issue would not have a significant impact on the MFL conclusions. Document the sensitivity tests in the report and/or the appendices. Staff Response: New model runs were conducted and it is estimated that the increase of salinity at the mouth of Crystal River is in the range of 0.05 psu (for a 2.5% flow reduction) to 0.77 psu (for a 30% flow reduction.) New scenario runs were conducted and results were analyzed. It was found that the minor increase of salinity at the downstream boundary due to reduced flow has only insignificant effects on the final results.
48	SP	Section 2.6	No	The section discusses analyses of water quality data through trend analyses as well as correlation of flow with water quality data. The methods identify that flows weren't available unless a hindcasting were done. As this was done ultimately for the MFL report, I	Clarify and address the issue of the availability of Chl a data for analyses. Staff Response: The district has chlorophyll a data and is conducting an ongoing analysis of this data with respect to flow. At the time of peer-

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				assume the water quality analyses were done before the hindcasting so they were not available. Additionally, the methods do not discuss analyses of Chl a data which are assumed to be part of the long-term monitoring. If these data were not available, the text should state that.	review draft development, there were no conclusive results of this analysis. Staff recommend further data collection and analysis for trends between Chl a and other water quality and quantity variables.
49	SP	Section 2.8	No	The method used for the residence time calculations were based on dye releases at specific times and tide conditions. The number of periods appear sufficient to characterize the residence times using dye. Another potential method would be to examine water age. This would allow the use of the complete simulation to examine the change in the overall water age in the same way salinity or temperature were evaluated, i.e., over the full simulation cycle.	Consider using the water age method, but if not feasible, the existing method is sufficient. In a re-evaluation, where more data are available for evaluation of the impacts of residence time on Chl a, consider using water age. Staff Response: The District will consider this recommendation as part of the planned minimum flow reevaluation.
50	KW	Page 40, Section 2.2	No	Reference to the third term (i.e., partial derivative) in Equation 1 relating to pressure is contrary to Equation 1 caption note and Chen (2014) report that	Clarify. Staff Response: The caption for Equation 1 will be revised. We note, that in the caption, long-term is roughly the time scale within which the

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				describe the term as relating to tidal flux. Define "long term".	2009 flow measurement was conducted.
51	KW	Page 41, Section 2.2	No	Would N be needed if the groundwater elevation at the "G" well were not influenced by tide? I.e., a true background well. Or is the term needed because of the short time frames being analyzed with the model?	Clarify. Staff Response: It is not clear what N the reviewer was referring to.
52	KW	Page 41, Section 2.2	No	Clarify that the flows from two subsets of springs, G1 with 3 springs and G2 with 8 springs, were evaluated to determine C1 and C2 for each group. Clarify that Figure 2-4 represents the flows from just 11 of the 70 springs and that Figure 2-5 represents the combined flow from all 70 springs.	Clarify. Staff Response: Yes, Fig. 2-4 represents 11 of 70 springs.
53	KW	Page 43, Section 2.2, Figure 2-5	No	The daily average line in the graph is missing,	Modify. Staff Response: This line is plotted with red color but is overlaid by other lines for most of the depicted time. The figure caption will be modified to note this plotting artifact.
54	KW	Page 43, Section 2.3	No	Is the vertical coordinate system a fixed z-grid or sigma grid? it is useful to know	Clarify.

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				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
				when interpreting water-quality and AVF point velocity data collected using a fixed-position monitoring device.	Staff Response: It is a z-coordinate model.
55	KW	Page 44, Section 2.3	No	Is the diffuse flow about 10% or so? Runoff? Direct rainfall?	Clarify. Staff Response: Diffuse flow should be less than about 6%. Runoff and direct rainfall should not be greater than 1% of the total hydrologic loading to the estuary.
56	KW	Page 44, Section 2.3	No	It may be useful to mention spin up period for establishing a numerically balanced initial condition?	Clarify. Staff Response: For the 9-year simulation, the spin-up period is 26 days, from 10/6/2016 to 10/31/2016. It is mentioned on Page 33 of the hydrodynamic model report.
57	KW	Page 46, Section 2.3, Table 2.2	No	Is rainfall included as a meteorological input?	Clarify. Staff Response: No, it is not included as a meteorological input.
58	KW	Page 47, Section 2.4	No	A volume exceedance curve may be helpful.	Consider adding. Staff Response: Staff will consider adding a volume exceedance curve as

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					part of the planned minimum flow reevaluation.
59	KW	Page 47, Section 2.5	No	For what time period were instantaneous measurements of water temperature evaluated?	Clarify. Staff Response: Predicted, not measure instantaneous water temperatures were used to identify time periods during the model simulation period (October 6, 2006 through October 13, s005) with the smallest water volume and area available as refuge from chronic thermal stress.
60	KW	Page 47, Section 2.4	No	"averaged across time" how much time? Daily, POR?	Clarify. Staff Response: Averaged over the entire 9-year simulation period, excluding the first 26 days (spin-up period).
61	KW	Page 47, Section 2.4	No	How was shoreline length calculated?	Clarify. Staff Response: Shoreline was calculated based on bottom elevations at the four corners of a model grid and

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					the simulated water surface elevation. This is more thoroughly explained in Figure 2 on page 10 of the hydrodynamic model report (Chen 2016)
62	KW	Page 48, Section 2.6, second paragraph	No	It is not clear how many water quality samples are associated with concurrent measurements of both groundwater level and sea level versus the number of samples associated with measured values for GW level or sea level.	Clarify. Staff Response: Eighty-four percent of the matching discharge values were calculated values and sixteen percent were interpolated.
63	KW	Page 50, Section 2.7	No	It may be useful to compare the ACOE tide projections with the mean sea level change which has occurred over the past 9 and/or 46 years at the Cedar Key tide station.	Consider adding. Staff Response: The "low" projection by the USACOE is a linear continuation of the long term historical trend, which for Cedar Key is 1.97 mm/yr. The ACOE methods cited in the minimum flow report provide more detail about the sea level rise projections used for our analyses.

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64	KW	Page 51, Section 2.8, Table 2.6	No	Explain the tide terminology (i.e., spring, neap, average) and whether neap and spring are winter-time lows or summer-time highs; explain the spring discharge percentiles (i.e., exceedance or non-exceedance).	Clarify. Staff Response: Spring tides are tides during new or full moon, while neap tides refer tides when the sun and moon are at right angles to each other. Average tides are those between spring and neap tides. The spring discharge percentiles presented in Table 2-6 are percent non-exceedance values. We will consider including footnotes to Table 2-6 to enhance understanding of the tabular information.
65	AM	General	No	No current concerns except the note about residence time above (Comment 39).	No action required.

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Table 2-4. Review of Chapter 3 – Results

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
66	SP	Section 3.4, Table 3-5	Maybe	Table 3-5 shows that there are some relatively significant changes in residence time associated with the flow reductions. As such, the impact of these residence times on water quality (specifically algal blooms) could be important. This needs to be identified in the report and if data are insufficient to do this type of analyses, that needs to be stated.	See recommendations in previous comments. Staff Response: There is no data analysis showing a clear quantitative link between residence time and chlorophyll (algal blooms) in this system. However, the analysis in Table 3.5 shows that residence time will increase by 11% with a 12% decrease from baseline flow, which makes it less sensitive than salinity.
67	SP	Section 3.5	No	The analyses of the data do show that Chl a values are above the criteria a significant portion of the time. One issue is that the analyses should examine the Chl a against the time scale of the criteria, i.e., annual average time frame. If the data still show the system in violation, then the residence time becomes even more important.	If the criteria are going to be used in analyses, and presented in the report, they need to be used properly, accounting for the value and how the data should be compared to the value, i.e., time averaging, etc. Staff Response: The water quality analysis presented in the report is representative of an ongoing

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Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
					investigation of water quality data in the system. Staff will present an updated analysis as part of the planned minimum flow reevaluation, and will consider presenting annual average chlorophyll a concentrations along with relevant water quality standards.
68	SP	Section 3.5	Maybe	Analyses of correlations of nutrients and flow were presented, but no analyses of flow versus Chl a were presented.	See previous recommendations in dealing with evaluation of Chl a data. Staff Response: Analysis of Chlorophyll a vs. daily discharge did not reveal any significant trends that were consistent across the system. This analysis will be included as an appendix to the revised minimum flow report.
69	KW	Page 52, Section 3.1	No	Is the volume calculation across all layers? Or bottom layers for SAV for example or bottom area for benthic. Or does it matter? Well mixed?	Clarify. Staff Response: Yes, the volume calculation is across all model layers.

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				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
					The bottom area calculation used bottom-layer salinity. The model does not assume salinity to be well-mixed.
70	KW	Page 52, Section 3.1	No	Is bottom area in Table 3-1 associated with salinity in the bottom layer of the model?	Clarify. Staff Response: Yes.
71	KW	Page 52, Section 3.1	No	Confirm that the < 2 ppt includes the freshwater portions <0.5 ppt.	Confirm. Staff Response: Yes, it includes < 0.5 psu.
72	KW	Page 52, Section 3.1, Table 3.1	No	The values listed for <2 ppt appear to be inconsistent with values for preceding and succeeding salinities, although I can see how it is possible.	Confirm. Staff Response: The effect of flow reduction on salinity habitats is not necessarily monotonic. Table 3-1 shows that salinity habitats in the range of 1 – 2 psu are most sensitive to the flow reduction. We do not think there are any consistency issues associated with the information presented in the table.

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Table 2-4. Review of Chapter 3 – Results

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
73	KW	Page 52, Section 3.1	No	Is average volume most appropriate? What about the change in the occurrences of high salinity, short term events - like the acute thermal refuge analysis?	Consider addressing. Staff Response: Staff considers use of central-tendency salinities (e.g., mean values) the most appropriate approach for identifying minimum flows.
74	KW	Page 53, Section 3.2 and elsewhere	No	The statements regarding the sufficiency of manatee thermal refuge for much larger populations may be overreaching; same for the two right-most columns that list manatee capacity in Table 3-3 on Page 54. As a reality check, do we think there would be no impact to manatee use of system if flows were reduced to levels such that the thermal refuge volume just exceeded the manatee space requirements? What about habitat volume reduced to twice the volume estimated to be needed? I agree that it would be difficult to make this metric a driver given the overall volume of suitable habitat. It seems that the assumption of a 15 % reduction in habitat causing significant	Consider rewording. Staff Response: We understand the recommended approach for documenting that change in manatee thermal refuge habitat is not a limiting factor for the existing manatee population and should therefore not be considered for minimum flow development. However, we think it is worthwhile to assess potential flow-related changes in thermal refuge as part of the minimum flow development process. We also note that the methods used for assessing manatee habitat needs in the Crystal River/Kings Bay System are consistent with other springs MFLs that have been established, peer reviewed and considered by state and

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Table 2-4. Review of Chapter 3 – Results

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
				harm is not appropriate in the case of manatee thermal refuge. Perhaps calculate the amount (as a percent) of habitat reduction needed to impact the known manatee population, and then state that manatee habitat is therefore not a limiting metric.	federal agency staff associated with manatee management.
75	KW	Page 53, Section 3.2, Figure 3.2, caption	No	The maps illustrate the spatial distribution of warm water, not volumes.	Reword. Staff Response: We note that these maps are three dimensional, with x, y, and z axes, and thus show volume, and are therefore labeled correctly. We do acknowledge, however, that a lack of scales presented for the axes limits the represented volumes to dimensionless values.
76	KW	Page 55, Section 3.3	No	Should the flow reduction be 12% not 9%; clarify that "habitat" is represented by volume of salinity <2 ppt as opposed to bottom area salinity <2 ppt.	Clarify. Staff Response: Text referring to a 9% reduction in flow refers to information that was included in a previous version of Table 3-4 but not included in the version of the table in the draft

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Table 2-4. Review of Chapter 3 – Results

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
					report. This error will be corrected in the revised minimum flow report, and text in Section 3.3 will be revised to indicate the modeled habitat changes discussed are based on water column volumes.
77	KW	Page 55, Section 3.3	No	The model input data for the 9-year simulation period reflect a sea level rise of about 0.06 feet, hence the baseline period includes some habitat loss attributable to sea level rise. This is not substantial but it may be useful to mention/discuss the sea level rise that occurred during the model and historic period.	Consider new language. Staff Response: Sea level rise is ongoing. Impacts to baseline flows are assessed as a percent-of-flow using a regional groundwater model. It is true that model input includes water level in Kings Bay which has increased due to sea level rise. These sea level rises would have impacted baseline flows as well, so the percent-of-flow method we used for assessing flow-related changes in salinity habitat accounts for this.
78	KW	Page 55, Section 3.4	No	Would looking at percentile flows be appropriate for salinity as well?	Consider adding.

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Table 2-4. Review of Chapter 3 – Results

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
					Staff Response: We could have assessed flow-related salinity habitat changes based on flow percentiles. However, we believe comparison of mean responses provides a reasonable approach for identifying the appropriate minimum flow.
79	KW	Page 56, Section 3.4, Table 3-5	No	Define the SGD percentiles as exceedances or non-exceedances.	Define. Staff Response: It is defined as non-exceedance. We will consider including footnotes to Table 2-6 to enhance understanding of the tabular information and also addressing this issue with revisions to the text included in Section 3.4
80	KW	Page 58, Section 3.5.2	No	Define "spring flow" and how it was determined (i.e., measured or calculated).	Define. Staff Response: In this section, spring flow used in the discussion is the daily average of the entire SGD entering Kings Bay. We will insert a parenthetic

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Table 2-4. Review of Chapter 3 – Results

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
					definition for springflow in the topic sentence of the paragraph preceding Table 3-8.
81	KW	Page 58, Section 3.5.2	No	Rephrase "over the time period" to "over the course of 91 dates…" similar to Figure 3-4 caption.	Reword. Staff Response: This will be rephrased for consistency.
82	AM	Page 52, Table 3-1	No	Table 3-1 is the linkage between the model and the ecology. As mentioned in the meeting, the District should consider including absolute volume, area, and length, and not just percent. How much habitat is being preserved and how much is being lost?	Dr. Chen has already provided the Panel these numbers. Recommend including them in the report. Staff Response: These values will be added to the revised minimum flow report.
83	AM	General	No	It would be interesting to understand the uncertainty in the model as it applies to length, area, and volume, though this information is not necessary for the purposes of using the model to recommend an MFL.	None – Just a note.

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Table 2-4. Review of Chapter 3 – Results

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
84	AM	General	No	The discussion of Manatee habitat is thorough enough to make compelling argument that Manatee habitat will not be limiting even if other habitat assumptions were used.	The manatee discussion is sometimes distracting from the factors that directly limit the MFL. However, manatees are also an important factor to many CR/KB stakeholders. Recommend considering if the manatee information should be compiled as a single appendix or left in the report. Staff Response: Many stakeholders are concerned about the manatee population of the southeastern United States. Manatee habitat is one of the primary factors we assess in setting minimum flows for spring systems that are accessible from coastal waters . Therefore, we find it appropriate to include discussion of potential flow-related changes in manatee habitat in the MFL report.

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Table 2-5. Review of Chapter 4 – Discussion: Using Results to Set Minimum Flow

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
85	SP	Section 4.1, Paragraph 1, third sentence	No	There is an extra "the" in the sentence.	Delete text. Staff Response: This typographic error will be corrected in future drafts.
86	SP	Section 4.1	No	The estimated long-term flow for the 46-year period based on the hindcast flow projection from the modeled equations is 374 cfs. Based on the Bagley Cove site the median flow from 2002 to 2015 is 437 cfs. The output from the groundwater flow model for the present conditions is around 440 cfs. The text states "The cross-sectional flux through Bagley Cove is a combination of tidal fluxes, spring flows entering Kings Bay during the preceding 6 – 20 days, stormwater runoff, wind action, and nonlinear interactions among factors affecting circulation and transport processes in the estuary. Furthermore, these previous estimates of discharge do not match the water budget for the springshed, which is able to account for	Reword. Staff Response (also see our response to Comments 6, 26, 43 and 44): We will modify the discussion in the report to indicate that estimated submarine groundwater discharge is within 6 percent of the long-term average of the Bagley Cove flow measured by the USGS from 2006-2015.

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Table 2-5. Review of Chapter 4 – Discussion: Using Results to Set Minimum Flow

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
				455 cfs of spring flow from the Crystal River Springs group given 20 inches of recharge per year." While this statement is true for the previously uncorrected Bagley Cove data, it is not accurate relative to the corrected data, which in the text above it is stated that the median flow is 437 cfs, which does agree with the recharge rates. It is important to note that the methodology utilized to develop the modeled flow equations (index velocity measurements at G1 and G2) was the same as that utilized to measure the flows at the Bagley Station. The uncertainty in both measurements needs to be outlined in the report and the USGS gage flow not fully dismissed.	
87	SP	Section 4.4	No	Reiterate the comment that the analyses do not address the potential for changes in water quality (specifically Chl a) due to changes in residence time. If data are insufficient for this analysis at this time, which was identified through conversations with District personnel,	See previous recommendations on dealing with impact of residence time on Chl a. Staff Response: As stated in several of our responses above, there is no data or analysis linking residence time to Chl a concentration in the Crystal

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Table 2-5. Review of Chapter 4 – Discussion: Using Results to Set Minimum Flow

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
				then this should be stated within the report and identified for future evaluation.	River/Kings Bay System. This will be noted in the revised minimum flow report and identified for future evaluation.
88	KW	Page 62, Section 4.2	No	Resolve the possible inconsistency in Table 3-1 noted previously and revise text if necessary.	Check. Staff Response: As note in our response to Comment 72 above, we do not think there is any inconsistency in Table 3-1.
89	KW	Page 64, Section 4.3	No	It may be helpful to list the allowable flow reductions determined for the Homosassa (3%) and Weeki Wachee (10%).	Add reference. Staff Response: The MFLs for Homosassa and Weeki Wachee will be added to the first chapter of the report.
90	KW	Page 65, Section 4.4.2, paragraph beginning with "None of the vents…."	No	Clarify what "effect of date was removed" means.	Clarify. Staff Response: This is in reference to the residual analysis detailed in Figures 3-4 and 3-5. These figures will be cited in the noted sentence.

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Table 2-5. Review of Chapter 4 – Discussion: Using Results to Set Minimum Flow

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
91	KW	Page 66, Section 4.5	No	The thermal refuge "is" (not "seems to be") more conservative regardless of the hypothetical manatee populations that might be supported.	Clarify. Staff Response: Habitat suitable for use as thermal refuge is more sensitive to flow-related change than the 2 ppt salinity-based habitat discusses in Section 4.5. However, the actual volume of useable thermal refuge required by the number of manatee visiting Kings Bay will be unimpacted by flow reductions of up to 40%. Staff will revise the report to further clarify this issue.
92	KW	Page 69, Section 5.7	No	Clarify that groundwater pumping impacts are from regional pumping.	Clarify. Staff Response: Table 1-2 has been modified to provide clarity to this issue.

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Table 2-5. Review of Appendices and External Reports

Comment No.	Peer Reviewer	Figure, Table, or Page and Paragraph Number	Does Comment Directly and Materially Affect Conclusions of Report? (Yes/No)	To be completed by Reviewer(s)	
				A. Reviewer's Specific Comments	B. Reviewer's Specific Recommended Corrective Action
93	KW	VHB (2010)	No	Report Appendixes A and B are missing. It would be useful to see the index-velocity ratings developed for open-channel locations G1 and G2.	Consider adding the ratings. Staff Response: Appendixes A and B to the VHB, Inc. report were delivered as MS Excel files, which can be provided upon request. The index-velocity ratings developed for G1 and G2 were not required as a delivery in the contract, but VHB, Inc. followed the same USGS procedure in developing these index-velocity ratings.
94	KW	Chen (2014) Pages 12 – 14 and Figures 4 and 5	No	Confirm if the graphics illustrate the total open-channel flow measured at locations G1 and G2 (i.e., spring flow plus the tidal flux component).	Confirm. Staff Response: The referenced figures depict net spring flow (measured flows minus tidal fluxes).

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3.0 SUMMARY OF FINDINGS AND MFL REVIEW GUIDELINES RESPONSE

A component of the Peer Review Panel scope of work was to provide an assessment of the MFL report and supporting documentation against specific listed criteria. The following items outline those specific criteria.

1. Determine whether the conclusions in the Crystal River/Kings Bay springs system MFLs report are supported by the analyses presented.
2. Supporting Data and Information: Review the relevant data, and information that support the conclusions made in the report to determine whether:
    a. The data and information used were properly collected;
    b. Reasonable quality assurance assessments were performed on the data and information;
    c. Exclusion of available data from analyses was justified; and
    d. The data used were the best information available.
3. Technical Assumptions: Review the technical assumptions inherent to the analysis used in the Crystal River/Kings Bay springs system MFLs report to determine whether:
    a. The assumptions are clearly stated, reasonable and consistent with the best information available;
    b. The assumptions were eliminated to the extent possible, based on available information; and
    c. Other analyses that would require fewer assumptions but provide comparable or better results are available.
4. Procedures and Analyses: Review the procedures and analyses used in the Crystal River/Kings Bay system MFLs report to determine whether:
    a. The procedures and analyses were appropriate and reasonable, based on the best information available;
    b. The procedures and analyses incorporate all necessary factors;
    c. The procedures and analyses were correctly applied;
    d. The procedures and analyses are repeatable; and
    e. Conclusions based on the procedures and analyses are supported by the data.

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5. If a proposed method used in the Crystal River/Kings Bay Springs system MFLs report is not scientifically reasonable, the CONSULTANT shall:
    a. List and describe scientific deficiencies and, if possible, evaluate the error associated with the deficiencies;
    b. Determine if the identified deficiencies can be remedied.
    c. If the identified deficiencies can be remedied, then describe the necessary remedies and an estimate of time and effort required to develop and implement each remedy.
    d. If the identified deficiencies cannot be remedied, then, if possible, identify one or more alternative methods that are scientifically reasonable. If an alternative method is identified, provide a qualitative assessment of the relative strengths and weaknesses of the alternative method(s) and the effort required to collect data necessary for implementation of the alternative methods.
6. If a given method or analyses used in the Crystal River/Kings Bay Springs system MFLs report is scientifically reasonable, but an alternative method is preferable, the CONSULTANT shall:
    a. List and describe the alternative scientifically reasonable method(s), and include a qualitative assessment of the effort required to collect data necessary for implementation of the alternative method(s).

Table 3-1 presents the detailed assessments by each of the Peer Review Panelists for each of the criteria. The findings of the Peer Review Panel are that, with the implementation of some of the edits/recommendations made within this report, there are no fatal flaws within the MFL report and supporting documentation relative to the specified criteria.

Attachment: Response to Review of Crystal MFL 02-22-17_dal_approved (2964 : Report from the Scientific Peer Review for the Recommended

Table 3-1. Responses to SWFWMD's Peer Review Assessment Requirements

Task	Subtask	Sub-Subtask	Reviewer's Specific Comments SP = Steven Peene, KW = Ken Watson, AB = Adam Munson
Determine whether the conclusions in the Crystal River/Kings Bay Springs system MFLs report are supported by the analyses presented.			KW: The report documents a comprehensive and complex analysis that was concise and well done. Although conclusions are supported by analyses, an explanation of how an allowable flow reduction expressed as a percent flow reduction would be applied to the SGD "flow regime" per item #8 in Section 1.3.2 is not provided and may be helpful. Staff Response: See our response to Comment 19 in Table 2-2. AM: Overall the report is reasonable and the analysis presented is consistent with other MFL efforts within the District. At times the repost is inclusive of information which is ancillary to the MFL determination and that information could be shifted to the appendix and play a less prominent role in the report. Staff Response: During Panel meetings, the possibility of moving some water quality analyses to appendices was discussed. However, this conflicts with Panel advice to discuss chlorophyll a and residence time more thoroughly within the report. SP: Overall the MFL conclusions are supported by the analyses presented. One area in the report that need to be clarified is the present uncertainty in both available flow measurements (USGS and SWFWMD) and this needs to be reworded in the report along with recommendations for verification in future work. Another area is to recognize the potential impacts to water quality (specifically Chl a and residence time) and that at present the data are not available to quantify. Staff Response: See our responses to Comments 7 and 43 regarding discharge uncertainty and Comment 1 regarding residence time and chlorophyll.

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Table 3-1. Responses to SWFWMD's Peer Review Assessment Requirements			
Task	**Subtask**	**Sub-Subtask**	**Reviewer's Specific Comments** **SP = Steven Peene, KW = Ken Watson, AB = Adam Munson**
	2. Supporting Data and Information: Review the relevant data, and information that support the conclusions made in the report to determine whether:	a. The data and information used were properly collected;	KW: Much of the data used were collected by entities with established field SOPs and are presumed to have been properly collected. AM: A majority of the data have been collected by agencies other than SWFWMD or in the pursuit of other studies. However, all data seems to be collected by entities with trained samplers and SOPs and while, likely not error free, are likely to represent the best available data. SP: The data collected by the SWFWMD for this project appears to have been collected properly. Also the data from outside groups appears to have been collected properly based on existing protocols. Issues with the data are primarily related to limitations in collection methodology and processing.
		b. Reasonable quality assurance assessments were performed on the data and information;	KW: It may be helpful to prepare double-mass curves to characterize associations between rainfall, SGD, and river discharge reported by the USGS. Staff Response: Please see our response to Comment 25 within Table 2-2. SP: Saw no issues with the quality assurance on the data collected. More explanation (especially on the direct flow and vent measurements) of the uncertainty associated with the data should be provided.

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Task	**Subtask**	**Sub-Subtask**	**Reviewer's Specific Comments** **SP = Steven Peene, KW = Ken Watson, AB = Adam Munson**
		c. Exclusion of available data from analyses was justified; and	KW: The data for the reported discharge for the Crystal River gage (#02310750) and for the USGS gage at Bagley Cove (#02310747) were determined to be unreliable estimates of groundwater discharge. Both gages record a mixture of groundwater, storm water runoff, and marine water. Tidal filtering is used in an attempt to exclude the marine water flux and, to the extent runoff is important, a means of accounting for runoff is needed. We take no exception to excluding the gage #2310705 data. However, we think the gage #02310747 data may be useable to help verify the groundwater discharge with either appropriate tide filtering or as an estimate of long term total freshwater discharge (i.e., groundwater discharge and surface water runoff). Staff Response: Tidally-filtered discharge reported at USGS gage #02310747 shows negative daily and monthly average values, which the District takes as sufficient evidence to exclude these data as estimates of freshwater discharge. Further, hydrodynamic modeling using this gage data was done, and showed inferior results see Chen (2014) as cited in MFL report. Note the USGS gage #02310750 (Crystal River near Crystal River with a period of record from 3/1/1964 to 9/30/1977) is incorrectly identified as #02310705 in the comment above. SP: There is clearly uncertainty in both sets of the data for the SGD (USGS and SWFWMD). Complete exclusion or dismissal of this data does not seem warranted. This would not alter how the analyses were performed, as it is recognized that the SWFWMD data works better in the analyses, but the report should identify the potential uncertainty in both and not just completely dismiss the USGS data. Staff Response: See responses pertaining to USGS data in Comments 6, 7, 26, and 86.

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Table 3-1. Responses to SWFWMD's Peer Review Assessment Requirements			
Task	**Subtask**	**Sub-Subtask**	**Reviewer's Specific Comments** **SP = Steven Peene, KW = Ken Watson, AB = Adam Munson**
		d. The data used were the best information available.	KW: In Section 1.4.4 it would be helpful to mention whether groundwater level data are available for locations in the springshed that are more distant from the CR/KB system and tidal influences. Bagley Cove gage data may be usable in some form. Staff Response: Groundwater level data are shown for Lecanto 7, Romp 21-2 and Romp 21-3, see Figures 1-12 and 1-13. Use of Bagley Cove data has been discussed in several of our responses above and will be further explained in revised MFL report. AM: Vegetation: The District provides some significant information from historic SAV studies. Because of the importance of SAV it is appropriate to include it in the report since this is presumably some of the habitat protected by the change in area and volume analysis. While SAV information is documented, the historic concern of filamentous algae could be more thoroughly addressed in the report or the appendix. Especially, if it is less of a concern than in the past as indicated during a field trip. Staff Response: See response to Comment 38. SP: The data used in the hydrodynamic modeling, and the calculation of the flows was the best available with the caveat of the comments on the USGS in earlier sub-tasks.

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Table 3-1. Responses to SWFWMD's Peer Review Assessment Requirements

Task	Subtask	Sub-Subtask	Reviewer's Specific Comments SP = Steven Peene, KW = Ken Watson, AB = Adam Munson
	3. Technical Assumptions: Review the technical assumptions inherent to the analysis used in the Crystal River/Kings Bay springs system MFLs report to determine whether:	a. The assumptions are clearly stated, reasonable and consistent with the best information available;	KW: The definition of baseline and historical flows occurring" in the absence of withdrawal impacts" (i.e., Section 1.3.2) should be qualified. The baseline period of time should be clearly stated in the text. Staff Response: The flow definitions given in Section 1.3.2 are general definitions applying to all systems. This section is not meant to serve as a detailed description of methods. Groundwater impacts relative to baseline are shown in Table 1-2, where the baseline flow is reported for the year 2010 and 2014. Similarly, the baseline period used for assessment of flow-related changes in salinity and thermal-based habitats using the hydrodynamic model is discussed in Section 2.3 of the report. We plan to revise this discussion to more clearly identify the baseline period for the hydrodynamic modeling efforts and also note the baseline period in relevant sections of the results presented in Chapter 3. AM: The largest assumption is the 15% loss of habitat criteria as a harm threshold. This criterion has been discussed for well over a decade and it has continuously been determined to be reasonable and consistent with other environmental flow standards. SP: The assumptions are generally clearly stated and other than the complete exclusion of the USGS data are consistent with the best available information. The sensitivity associated with the offshore boundary for the hydrodynamic scenarios needs to be addressed to complete the analyses. Staff Response: As noted in our response to Comments 6, 7 and 47 above, USGS data for the Bagley Cove gage site and hydrodynamic boundary conditions will be discussed in more detail in future drafts.

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Table 3-1. Responses to SWFWMD's Peer Review Assessment Requirements

Task	Subtask	Sub-Subtask	Reviewer's Specific Comments SP = Steven Peene, KW = Ken Watson, AB = Adam Munson
		b. The assumptions were eliminated to the extent possible, based on available information; and	KW: The assumption that 15% habitat reduction causing significant harm could be explicitly eliminated for manatee thermal refuge. Staff Response: Please see our responses above to Comments 3, 74, 84, and 91 regarding manatee thermal refuge. SP: No unjustified assumption eliminations were identified
		c. Other analyses that would require fewer assumptions but provide comparable or better results are available.	SP: No alternate analyses that would require fewer assumptions were identified through this review.
	4. Procedures and Analyses: Review the procedures and analyses used in the Crystal River/Kings Bay system MFLs report to determine whether:	a. The procedures and analyses were appropriate and reasonable, based on the best information available;	KW: The thermal analysis for manatee could be simplified and presented differently. Based on the space requirements of manatee, the known manatee population, and the available thermal refuge, the default 15% allowable reduction in habitat does not appear to be appropriate – i.e., a much greater reduction in habitat would be needed to cause significant harm and therefore a much greater reduction in flow would be allowable. This a relevant concept because it points out that scenario specific information should be used when available and that default values (i.e., 15 % reduction in habitat) should only be used in the absence of better information. In my view, the report correctly deduces that manatee thermal refuge is not a limiting metric for an MFL. Staff Response: Please see our responses above to Comments 3, 74, 84, and 91 regarding manatee thermal refuge. SP: The salinity habitat volume change determination was based upon the best available information. The exclusion of the manatee thermal habitat was based upon the best available information.

Table 3-1. Responses to SWFWMD's Peer Review Assessment Requirements

Task	Subtask	Sub-Subtask	Reviewer's Specific Comments SP = Steven Peene, KW = Ken Watson, AB = Adam Munson
		b. The procedures and analyses incorporate all necessary factors;	KW: It is unclear whether direct rainfall on the CR/KB system is an input variable in the hydrodynamic model (see Section 2.3). Staff Response: See our response to Comment 57 in Table 2-3 above. AM: As discussed during the third meeting natural shorelines should be delineated from hardened shoreline or that case should be made that they may appropriately substitute for one another as the location of isohalines shift. Staff Response: See our response to Comment 39 in Table 2-2 above.
		c. The procedures and analyses were correctly applied;	KW: Discuss procedure for estimating relative change in shoreline habitat. Staff Response: See our response to Comment 39 in Table 2-2 above.
		d. Limitations and imprecisions in the information were reasonably handled;	KW: Insufficient information is provided from the SGD regression analysis to evaluate the reasonableness of the SGD hindcasted for a 46-year period. It may be helpful to include plots of residuals vs. predictions and observed vs. predicted values. Staff Response. Model skill assessment results discussed in Section 2.2 are the best estimate of the reasonableness of SGD for use in this system. SP: The limitations in the flow calculations were not sufficiently identified in relation to the USGS flow measurements. Staff Response: See our responses to Comments 6, 7, 26, and 86 pertaining to USGS data.

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Table 3-1. Responses to SWFWMD's Peer Review Assessment Requirements			
Task	**Subtask**	**Sub-Subtask**	**Reviewer's Specific Comments** **SP = Steven Peene, KW = Ken Watson, AB = Adam Munson**
		e. The procedures and analyses are repeatable; and	SP: The procedures and analyses seem repeatable for all aspects. Further clarification of key analyses could be provided within the report and these are outlined in the detailed comments.
		f. Conclusions based on the procedures and analyses are supported by the data.	KW: Conclusions are supported by best available data and repeatable procedures and analyses. The relative flow reductions determined for a salinity regime <2 ppt (i.e., Table 3-1) appear inconsistent (although possible) with those for the <1 and <3 ppt regimes and should be checked. Staff Response: See response to Comment 72 regarding inconsistency in salinity response. SP: The conclusions relative to salinity habitat and manatee thermal habitat are supported by the analyses and the data. Conclusions on the lack of impact upon water quality in the system are not supported by the data because the key aspects, Chl a versus residence time changes is not presented. Staff Response: See response to Comment 1 regarding residence time and chlorophyll.

Attachment: Response to Review of Crystal MFL 02-22-17_dal_approved (2964 : Report from the

Table 3-1. Responses to SWFWMD's Peer Review Assessment Requirements

Task	Subtask	Sub-Subtask	Reviewer's Specific Comments SP = Steven Peene, KW = Ken Watson, AB = Adam Munson
5. If a proposed method used in the Crystal River/Kings Bay Springs system MFLs report is not scientifically reasonable, the CONSULTANT shall:	a. List and describe scientific deficiencies and, if possible, evaluate the error associated with the deficiencies; b. Determine if the identified deficiencies can be remedied. c. If the identified deficiencies can be remedied, then describe the necessary remedies and an estimate of time and effort required to develop and implement each remedy. d. If the identified deficiencies cannot be remedied, then, if possible, identify one or more alternative methods that are scientifically reasonable. If an alternative method is identified, provide a qualitative assessment of the relative strengths and weaknesses of the alternative method(s) and the effort required to collect data necessary for implementation of the alternative methods.		KW: Methods are scientifically reasonable. AM: While some methods seem debatable all methods incorporate uncertainty and the ones use by the district are reasonable. SP: The final verification of the total flow remains a deficiency, but at present there is no better data to be utilized. This should be identified as a future need for this system. SP: Another are identified as having some deficiency is the evaluation of the impacts to water quality. The deficiency is in the establishment of the relationship between flow reduction, residence times, and the water quality parameters (Chl a for example) that would be impacted by longer residence times. At present based upon discussions with District personnel, the data to support this analysis is not available. Within the report the District needs to first determine that there are not data that weren't used which might allow this analysis to be completed at this time. If not, then identify this as potential future work. Staff Response: See response to Comment 1 regarding residence time and chlorophyll.

Attachment: Response to Review of Crystal MFL 02-22-17_dal_approved (2964 : Report from the

Table 3-1. Responses to SWFWMD's Peer Review Assessment Requirements			
Task	**Subtask**	**Sub-Subtask**	**Reviewer's Specific Comments** **SP = Steven Peene, KW = Ken Watson, AB = Adam Munson**
6. If a given method or analyses used in the Crystal River/Kings Bay Springs system MFLs report is scientifically reasonable, but an alternative method is preferable, the CONSULTANT shall:	a. List and describe the alternative scientifically reasonable method(s), and include a qualitative assessment of the effort required to collect data necessary for implementation of the alternative method(s).		KW: Percent change in habitat is appropriate for this system. By selecting the most conservative salinity regime, other salinity regimes are protected. SP: No preferred alternate method with the available data has been identified through this review.

Attachment: Response to Review of Crystal MFL 02-22-17_dal_approved (2964 : Report from the

Attachment A

MFL Review Guidelines

Attachment: Response to Review of Crystal MFL 02-22-17_dal_approved (2964 : Report from the Scientific Peer Review for the Recommended

MFL Review Guidelines

1. Determine whether the conclusions in the Crystal River/Kings Bay Springs system MFLs report are supported by the analyses presented.
2. Supporting Data and Information: Review the relevant data, and information that support the conclusions made in the report to determine whether:
    a. The data and information used were properly collected;
    b. Reasonable quality assurance assessments were performed on the data and information;
    c. Exclusion of available data from analyses was justified; and
    d. The data used were the best information available.
3. Technical Assumptions: Review the technical assumptions inherent to the analysis used in the Crystal River/Kings Bay springs system MFLs report to determine whether:
    a. The assumptions are clearly stated, reasonable and consistent with the best information available;
    b. The assumptions were eliminated to the extent possible, based on available information; and
    c. Other analyses that would require fewer assumptions but provide comparable or better results are available.
4. Procedures and Analyses: Review the procedures and analyses used in the Crystal River/Kings Bay system MFLs report to determine whether:
    a. The procedures and analyses were appropriate and reasonable, based on the best information available;
    b. The procedures and analyses incorporate all necessary factors;
    c. The procedures and analyses were correctly applied;
    d. Limitations and imprecisions in the information were reasonably handled;
    e. The procedures and analyses are repeatable; and
    f. Conclusions based on the procedures and analyses are supported by the data.
5. If a proposed method used in the Crystal River/Kings Bay Springs system MFLs report is not scientifically reasonable, the CONSULTANT shall:
    a. List and describe scientific deficiencies and, if possible, evaluate the error associated with the deficiencies;
    b. Determine if the identified deficiencies can be remedied.

Attachment: Response to Review of Crystal MFL 02-22-17_dal_approved (2964 : Report from the Scientific Peer Review for the Recommended

c. If the identified deficiencies can be remedied, then describe the necessary remedies and an estimate of time and effort required to develop and implement each remedy.

d. If the identified deficiencies cannot be remedied, then, if possible, identify one or more alternative methods that are scientifically reasonable. If an alternative method is identified, provide a qualitative assessment of the relative strengths and weaknesses of the alternative method(s) and the effort required to collect data necessary for implementation of the alternative methods.

6. If a given method or analyses used in the Crystal River/Kings Bay Springs system MFLs report is scientifically reasonable, but an alternative method is preferable, the CONSULTANT shall:

   a. List and describe the alternative scientifically reasonable method(s), and include a qualitative assessment of the effort required to collect data necessary for implementation of the alternative method(s).

Attachment: Response to Review of Crystal MFL 02-22-17_dal_approved (2964 : Report from the Scientific Peer Review for the Recommended

From:	Doug Leeper
To:	"Alan Martyn Johnson"
Cc:	Xinjian Chen; Gabe I. Herrick; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ron Basso; Melissa Gulvin; Kurt Fritsch; Mike R. Bray; "speene@appliedtm.com"; "kwatson@hsweng.com"
Bcc:	Mark A. Green
Subject:	RE: Pulsing Springs Of Kings Bay
Date:	Thursday, March 30, 2017 5:39:00 PM
Attachments:	image001.png image002.png image003.png

Martyn:

Was good to speak with you earlier today regarding the Rainbow minimum flow rule.

Responses to your March 27th comments on flow in the Crystal River/Kings Bay System are imbedded in your email below.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Monday, March 27, 2017 8:12 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>; Mark A. Green <Mark.Green@swfwmd.state.fl.us>; Jennette Seachrist <Jennette.Seachrist@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>; Mike R. Bray <Mike.Bray@swfwmd.state.fl.us>; speene@appliedtm.com; kwatson@hsweng.com
Subject: Re: Pulsing Springs Of Kings Bay

Doug,

Thank you for relaying the staff responses.

Regarding the Staff Responses to the Peer Review Panels Report which are presented in the Governing Board Meeting Note book; it is disappointing and inaccurate for the staff response to repeatedly mention negative daily and monthly discharge measured at the Bagley Cove USGS site.

Staff response (3/30/2017): *Approved, tidally-filtered discharge data reported for the Bagley Cove site shows negative daily and monthly mean values. The district mentions these negative values to indicate that this record is not suitable for use as an estimate of spring discharge to the system for hydrodynamic modeling purposes.*

I would have thought by now staff would understand the daily data based on a 24 hour day is bound to have negative values as the tidal cycle is 24.84 hours. If not they need to read the comment/note on the USGS site for 02310747.

Staff response (3/30/2017): *Tidally-filtered discharge is reported after low-pass filtering to remove effects of mismatch in lunar and solar day lengths. Nonetheless, tidally-filtered, approved discharge regularly has negative values. The comments to the gage also note that "The residual discharges are not total "freshwater" flow, but are a combination of freshwater flow and water storage caused by higher or lower Gulf of Mexico mean water levels." This is further indication that the discharge reported at this gage is not intended for use as an estimate of freshwater discharge into Kings Bay.*

Further to state there are monthly negative discharges is inaccurate and steps further than in the MFL Report in attempting to discredit USGS.

Staff response (3/30/2017): *The District has made no attempts to, nor has any interest in discrediting the USGS. Reported negative monthly averages for approved, tidally-filtered discharge from the Bagley Cove gage are a matter of fact. The District has stated that discharge reported at this gage is not a suitable estimate of spring flow into Kings Bay. This is consistent with the USGS remarks which clearly state that "residual discharges are not total 'freshwater' flow". Here, the USGS is referring to "tidally-filtered" discharge as "residual". The District interprets this to mean that discharge reported at this gage is not suited for use as an estimate of spring discharge to the system.*

The only negative monthly discharges in the USGS Data arise if INCOMPLETE DATA IS SELECTED FOR MONTHLY STATISTICS. These months are June 2009, May 2012, August 2015 and August 2016. For these months there are multiple days when data is not available eg both August 2015 and 2016 there are over 20 days when data was not available, for the 2009 and 2012 months it is 8 and 9 days.

Staff response (3/30/2017): *This missing data is further evidence that discharge reported at this gage is not suitable for use in driving a hydrodynamic model which requires frequent, continuous estimates of spring discharge on short time scales.*

I would further note the Bagley Cove data shows a distinct decrease in 'springs discharge' since the start of data collection at this site and reflects seasonal variations. Seasonal variations are normal phenomena....which the Districts modeled discharges do not reflect.

Staff response (3/30/2017): For all of the reasons above, the Bagley Cove data does not reflect 'springs discharge' as noted in the REMARKS for the Bagley Cove gage. District empirical-formula discharge is based on groundwater levels and surface water levels, and thus reflects seasonal variations in those levels.

May be the decrease 'spring discharge' in the Bagley Cove data is viewed as an anomaly as is the Rainbow River decrease. I am of the opinion this is not an anomaly but the truth.

I will elaborate on my points with specific quotes and data as time permits.

As regards my e-mail to Dr. Peene and Dr. Watson I have not heard from them to date. Please note I asked if they would be interested, nothing more.

Sooner or later District is going to have some serious explaining to do regarding the Pulsing Springs of Kings Bay...the 'geological water hammer' of flows changing from 700 cfs to 50 cfs from low tide to high tide may sound the alarm.

Martyn

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Friday, March 24, 2017 2:07 PM
To: Alan Martyn Johnson
Cc: Xinjian Chen; Gabe I. Herrick; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ron Basso; Melissa Gulvin; Kurt Fritsch; Mike R. Bray
Subject: RE: Pulsing Springs Of Kings Bay

Martyn:

Thanks for your March 13th email concerning discharge from springs within Kings Bay springs. I've imbedded some "staff responses" highlighted in blue in your original email below.

Doug Leeper

MFLs Program Lead

Natural Systems and Restoration Bureau

Southwest Florida Water Management District

2379 Broad Street

Brooksville, FL 34609

1-800-423-1476, ext. 4272

352-796-7211, ext. 4272

doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Monday, March 13, 2017 7:37 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>; Mark A. Green <Mark.Green@swfwmd.state.fl.us>; Jennette Seachrist <Jennette.Seachrist@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>
Subject: Re: Pulsing Springs Of Kings Bay

My e-mail and attachment were a follow up to my e-mail of January 24 where I shared the mass balance, and diagrammatic basis for the mass balance, of the VHB 2009 Group 1 data. The results show the combined Group 1 springs discharge to be almost constant thru the tidal cycles. This makes sense of the VHB data, all parameters are in balance, and is logical given what is generally known about spring discharges. Additionally, the data from measurements at individual springs in Kings Bay in the VHB reports 2009 and 2012, show no evidence of spring discharges varying in the manner shown in the graphic presentation Figure 2-4 in the draft report i.e. pulsing. Repeat no evidence.

In my January 24 e-mail I challenged SWFWMD to 'be bold' and plug the spring discharges from Figure 2-4 into the mass balance and see for yourselves the results. As you did not do that I did it for you. Yes I had to estimate the discharges from the graph (I think you have to admit they are reasonably close), but you are very welcome to change these to the calculated 15 minute discharges used to generate the graph.

In your response no mention is made of the 'uncertainty' expressed by the Peer Review Panel. I would also draw attention to the concerns expressed by Dan Yobbi in his memos December 2014 and September 2015 (in the Appendix of the Draft MFL Report).

Staff response (3/24/2017): *The District response to peer review panel findings concerning the proposed minimum flow for the Crystal River/Kings Bay System is being provided to the District Governing Board as part of the March 28th Board meeting agenda. The response, which is included in the Board packet as agenda item number 33 in the document at the link below, includes information relevant to panel comments concerning uncertainties in flow estimation. Staff plans to expand the discussion of this uncertainty in the revised version of the minimum flow report.*

http://www.swfwmd.state.fl.us/calendar/notebooks/govboard_03-28-17_notebook_2772.pdf

For completeness I believe there are two formulas the District has developed for springs discharge based on the location of each individual spring.

The writers of this response appear not to realize the 15 minute shortfalls or excess are

cumulative thru each respective tidal cycles.

As for the total volume in the pool....well...what can I say....interesting!

As for regression analysis...what can I say...amazing!

As for Bagley Cove data, this is not related to the mass balance Group 1, but you are welcome to look back at my previous comments particularly about the 24.84 hour tidal cycle shared last year.

Let us get back to the subject, the pulsing springs of Kings Bay.

How about sharing my mass balance January 24 e-mail and the recent one showing how out of balance the spring discharges in Figure 2-4 are, with Dr. Peene and Dr. Watson to see if this helps them understand the uncertainty they have expressed in the Peer Review Report. Dan Yobbi as well if you want.

Staff response (3/24/2017): *We understand that you have contacted Dr. Peene and Dr. Watson in a March 23rd email and offered to provide your January 24th email to them directly.*

For those who have not seen how the total discharge for all springs discharge varies (pulse) according to Districts two formula, I have attached a graph of a typical week of discharges. This is similar to the ones shared with Doug, Ron and Gabe when we met January 23 and is from the District Model output. Variations during some cycles from less than 50cfs to 700 cfs from high to low tide. Really?

Kings Bay springs do not pulse to such magnitude. I have suggested before and I will repeat it. Take one of the major springs, your choice, and position a velocity meter in the vent and monitor it for a few days. We can quickly prove who is right by in field measurement. I am confident my mass balance (January 24) indicating almost constant discharge from the springs will prevail.

Staff response (3/24/2017): *As indicated in the draft minimum flow report, staff plan to recommend that the Board approve a scheduled reevaluation of the minimum flow for the Crystal River/Kings Bay system within ten years of the legislatively-mandated July 2017 adoption date. We are committed to the acquisition of additional data, including measured flows, that will support the planned reevaluation effort.*

Martyn

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Thursday, March 9, 2017 8:26 AM
To: Alan Martyn Johnson
Cc: Xinjian Chen; Gabe I. Herrick; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ron Basso; Melissa Gulvin

Subject: RE: Pulsing Springs Of Kings Bay

Martyn:

Thanks for the email and attached Excel file concerning spring discharge to Kings Bay that you sent on Monday, March 6, 2017. We note that your email claims "there is a shortfall or excess water in the pool upstream of the X-section" and from this you conclude that "Dr. Chen's calculations are wrong". The District is committed to supporting its claims based on evidence. District Staff have developed an empirical formula for estimating submarine groundwater discharge (SGD). District confidence in this formula is proportional to the weight of evidence which supports it.

The District formula can predict surface water levels with 74% accuracy for Group 1 springs and with 94% accuracy for Group 2 springs (R^2 values). These methods have been published in peer reviewed scientific journals by Dr. Chen, and separately peer-reviewed in the minimum flow report. This predictive capacity represents the best information available. There is no better predictive tool for estimating water levels in the Crystal River/Kings Bay system.

The strength of the District formula for SGD comes from its ability to explain the data. Your spreadsheet includes data which you claim demonstrates a shortfall of the SGD formula for predicting flux across a cross section in Kings Bay. Your spreadsheet shows the change in volume over a 15-minute interval for water upstream of the G1 cross section as predicted by G1 discharge and SGD (eq. 1) in column L. This change in volume over time may be referred to as "15-minute flux". You estimate SGD from a figure, which you acknowledge carries with it a degree of uncertainty. The 15-minute flux predicted by gage height is shown in column M. You subtract M from L to arrive at what you call the "Eccess[sic] Shortfall in pool" shown in column O. From the values in this column O, you conclude the District method for estimating discharge is incorrect.

How does 15-minute flux as estimated from discharges at G1 and SGD compare with 15-minute flux as estimated from gage height? A plot of these fluxes is shown below in Figure 1 (this figure and other figures discussed in this email were developed using information included in the attached Excel file named "bold Group 1 2009-gh which was developed using the file you sent on March 6th; note that a PDF of this email is also attached). The 15-minute flux predicted by discharges at G1 and SGD [labeled Discharges (col L)] clearly mirrors the 15-minute flux predicted by gage height [labeled Gage Height (col M)]. The difference between these two lines is shown as Shortfall (col O). Note the similarity in 15-minute flux as estimated from these two sources. Also please note the time difference between values in col L and col M, which introduces additional errors in col O if the difference between col L and col M is taken simply by subtracting col M from col L in the same row. The time difference between col L and col M can be clearly seen in Figure 1.

The similarity in lines of Figure 1 can be quantified using linear regression. A linear regression of 15-minute flux from discharges (col L) as a predictor 15-minute flux from gage height (col M) has an R^2 value of 0.9376 (Figure 2 below). This means that the SGD and G1 discharge capture over 93% of the variation in the flux estimated from gage height. Recall there is some uncertainty associated with discrepancy between times of measurement, in measurement of gage height, in discharge at G1, and in estimating SGD from eyeballing values from a plot. Thus, this remaining 6-7% error is not entirely attributable to error in estimation of SGD.

Your analysis is limited to producing a list of differences between two methods for estimating 15-minute flux. These differences (col O) are on the order of 10^4 ft^3/15min. You claim these values are so large as to warrant calling the District "wrong". How large are these values compared to the overall volume of the pool upstream from G1? If we assume an average depth of 3 ft at MSL (a likely underestimate), we can estimate the relative shortfall as a fraction of the overall volume of the bay (Figure 3 below). You can see that these "large" differences are less than 4% of the total volume of the upstream pool (assuming 3ft average depth at MSL).

You have expressed incredulity in the degree of variation in SGD predicted by District formula. However, the District formula SGD has lower variation than any other method for estimating spring discharge to this system. Compare District-formula SGD with discharge reported at USGS 02310747 Crystal River at Bagley Cove near Crystal River, FL (Figure 4 below). The District SGD shows a record of spring flow with much less variability than the discharges reported at Bagley Cove. As such, the District formula for estimating SGD addresses the problem of minimizing fluctuation in estimated spring flow, is based on the mass-balance principle, and has been repeatedly verified against field data.

Analysis of the data you presented in your spreadsheet shows that the District formula does quite well at predicting water levels and fluxes in this system. Although your calculations could make the "Eccess Shortfall in pool" in col O larger in magnitude than it should be, we think the information you've provided support the empirical formula.

We would add that the District empirical formula was obtained through data fitting of spring flow data, which were calculated from measured discharge data at G1 and G2 based on the mass-balance principle. Data fitting is simply a process of finding the best mathematical expression linking a dependable variable with one or more independent variables through minimizing the overall mismatch between measured data and model-predicted results. Just because there are errors between model results and data (in this case, between col L and col M) does not mean that the model is wrong. As mentioned above, errors are minimized but not eliminated in data fitting.

In closing, please note that we will continue to apportion our confidence in the formula for SGD based on the strength of evidence regarding its power to explain observations.

Figure 1. 15-minute flux estimates over a two-day period

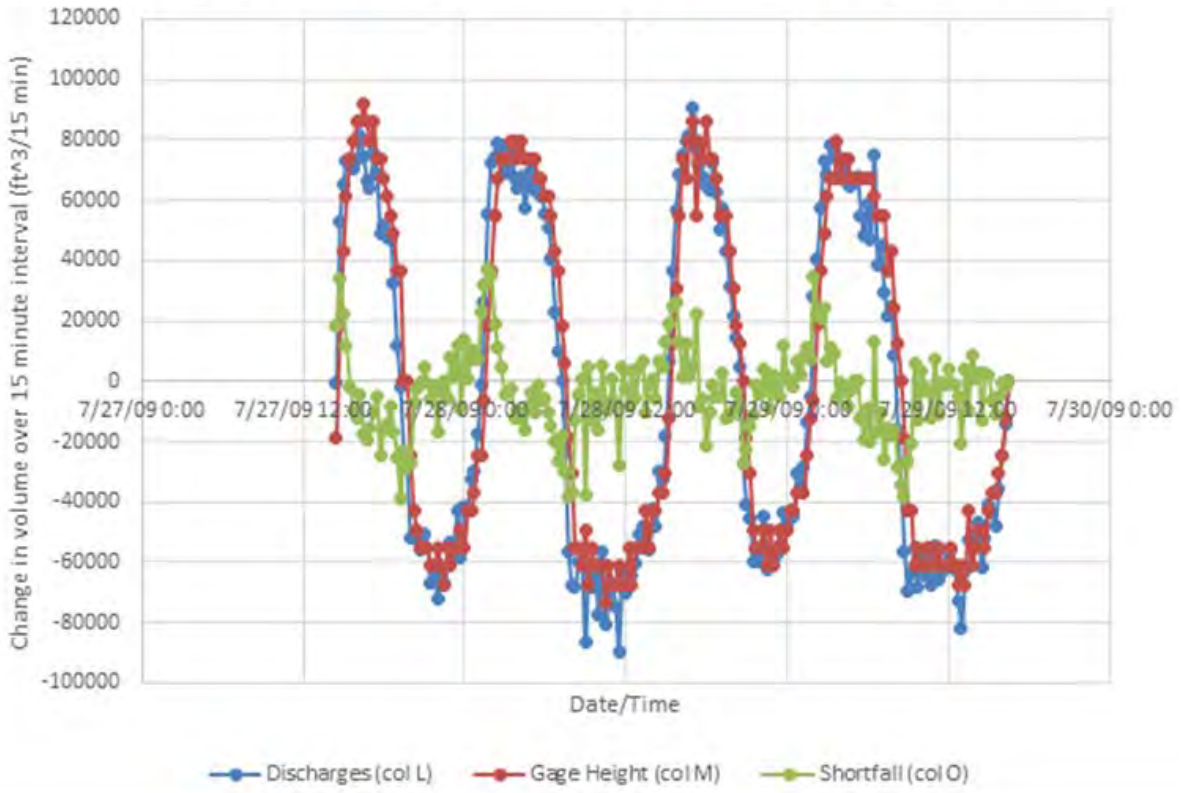
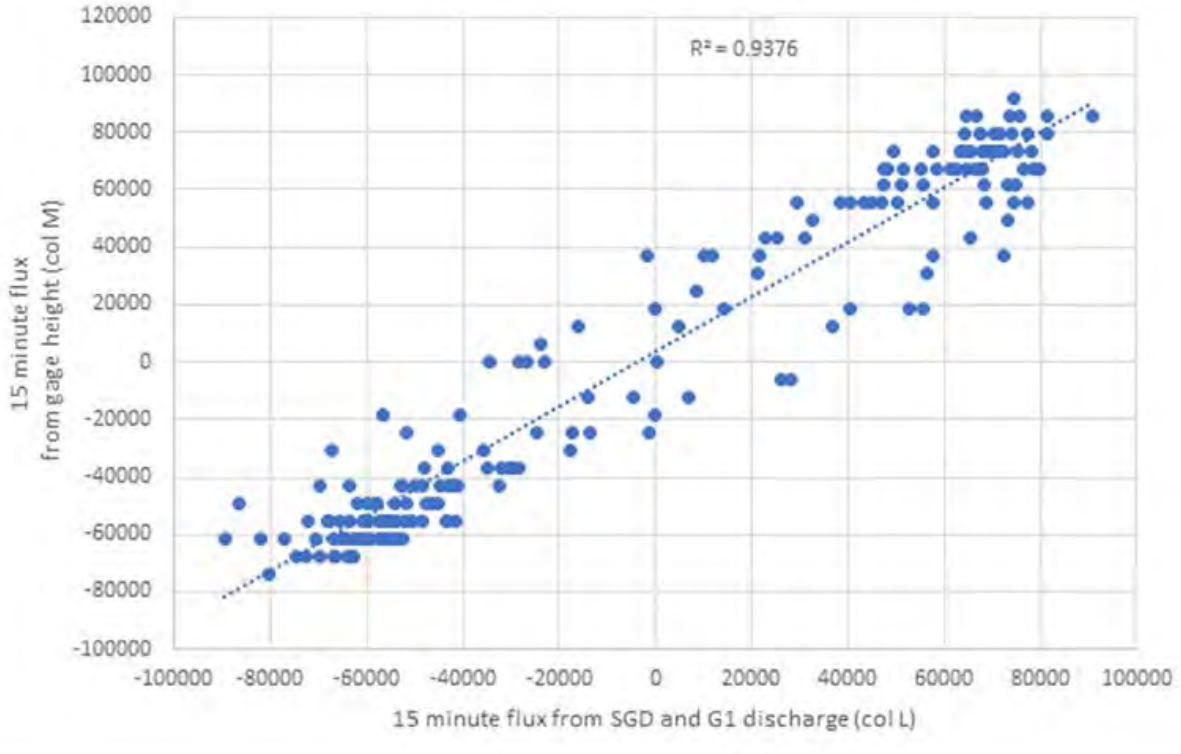
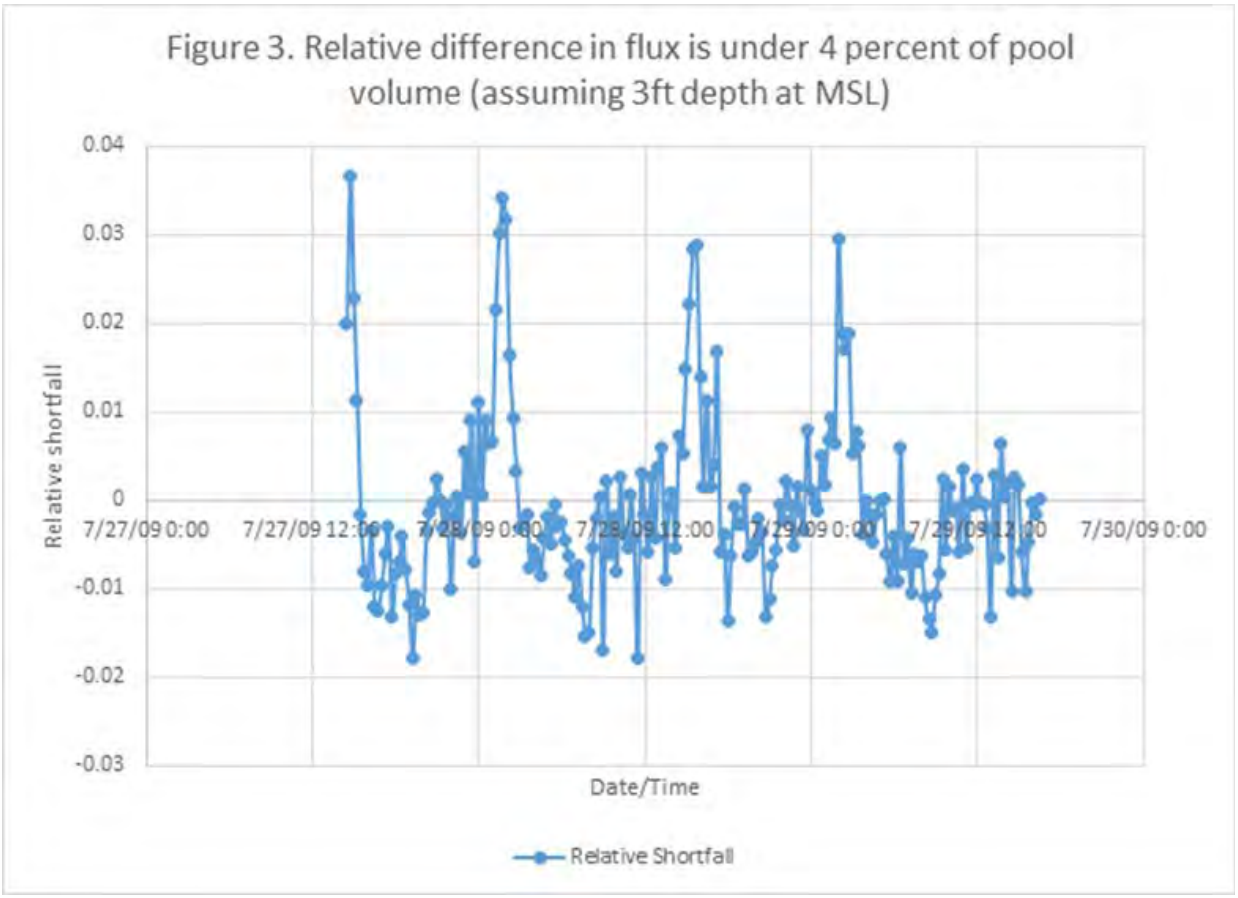


Figure 2. District formula SGD produces estimates of 15-minute flux that are condordant with gage height estimates.





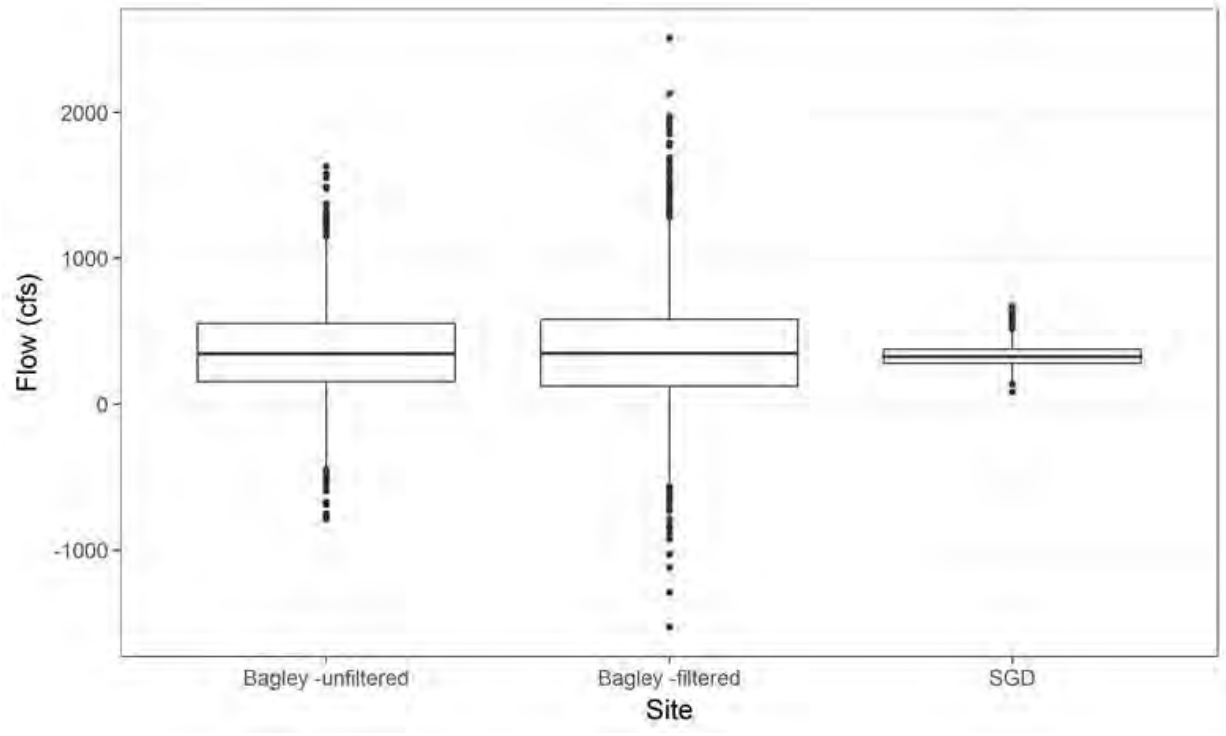


Figure 4. District formula submarine groundwater discharge (SGD) compared with discharges

reported at Bagley Cove over the hydrodynamic model period of record. Variation predicted by District SGD is much lower than predicted by reported discharges. Boxplot made with daily mean discharge. Note USGS gage reports frequent negative daily values, even when tidally-filtered. Dark center line is median, upper and lower box edges are 75th and 25th exceedance percentiles. Whiskers extend to 1.5 IQR. Outliers show as dots beyond whiskers.

Doug Leeper

MFLs Program Lead

Natural Systems and Restoration Bureau

Southwest Florida Water Management District

2379 Broad Street

Brooksville, FL 34609

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doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Monday, March 06, 2017 8:31 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>
Subject: Pulsing Springs Of Kings Bay

Doug,

I am directing this to you as you have coordinated Staff Responses in the past, but it is equally addressed to all cc's.

As discussed/promised attached is my xls file with Dr. Chen's spring discharges for Group 1 springs re Figure 2-4 in the Draft Report. As you will see there is a shortfall or excess water in the pool upstream of the X-section i.e. the stage per VHB/USGS data is not maintained using Dr. Chen's spring discharges. These excess or shartfalls are in bold red and black.

For clarity let me add:

- The Dr. Chen spring discharge is the best I could read the Figure 2-4 these are bold with light blue background.
- The discharges between the hi/low are by linear interpolation for each change high to low.
- The VHB data did not account for the difference in high tide time. You will recall in my spreadsheet determining the spring discharge I left blank those areas around the tide change times. I had done the same with this spreadsheet and you are welcome to do the same to account for the roughly 15 minutes later high tide at the X-section cf Mouth of Kings Bay.

Dr. Chen's calculations are wrong. The idea that Group 1 springs discharge vary as presented in Figure 2-4 is simply not true.

What makes the whole picture more ridiculous is to suggest all other springs in Kings Bay vary depending on their relative location to Group 1 X-section, Group 2 X-section and Romp TR21-3.

Yes my words are blunt, but it appears a 2x4 is needed to get to the truth. May I suggest again you share my comments with Dr. Penne and Dr. Watson. I trust I do not have to request a personal meeting to discuss their uncertainties about spring discharge from the ''pulsing springs of Kings Bay".

I think I have know Doug and Ron long enough that they know I will welcome any rational argument showing I am wrong.

BACKGROUND

I first raised the concern about the wide variations in Kings Bay springs discharge November 7, 2016. I comment how the logic was missing from the discharges presented in Figure 2-4 of the Draft MFL report. Since then we have exchange a number of e-mails, for example November 30, 2016 when I commented, the more I dig into this the more my concern increases.

January 23, 2017 Doug, Ron Basso and Gabe Herrick met with me to discuss the matter in person. While none claimed the ability to discuss the math behind Dr, Chen's assessment, all agreed with the discharges varying as Dr. Chen has calculated. I shared a number of graphs of weekly discharges from the file of Dr. Chen's work on discharge from all Kings Bay Springs (Model Output of SGD for baseline, shared with me January 18). I asked 'Do you really believe these springs have discharge that varies like this?…this is hard to believe'. Following the meeting on January 24, 2017 I shared with you my xls file with my analysis of the VHB Group 1 data and diagrams of the associated mass balance. My analysis indicated Spring discharge did

not vary significantly thru the tidal cycle.
Staff response was my diagrams correctly represented the mass balance, but did not comment regarding my xls file findings.

I suggested 'you' get bold and plug Dr.Chen's discharge number into the file to verify they make sense. On February 8, 2017 I gave the discharges from Figure 2-4 graph for the first few tidal cycles. I also suggested you consider sharing my thoughts/analysis with the Peer Review Panel. The Peer Review panel repeatedly expressed uncertainty in their final report.

As example Quote from Comment 46

The equations that are utilized to define all the flows into the system have some basic error associated with them as well as certain levels of uncertainty. For example, in Figure 2-4 looking at plot (a), it is clear that for the period when measured flows were available, there are errors in the estimated flow that would indicate that the model under-predicts the overall net flow out. This error is then carried through an additional level of uncertainty as the equations and coefficients are extrapolated out to other vents in the system. Based on these known errors and uncertainty, it would be important to developed additional ways to verify the total flows. This could be done using the Bagley data, if this data is demonstrated to be useful for this. Still working on the evaluation of the Bagley data.

End Quote

From the same Comment in the Recommendation Quote.

Also, some more definitive discussion of the degree of variation in the direct vent measurements and how they were used to carry the calculations forward is needed.

End Quote

Martyn

From:	Alan Martyn Johnson
To:	Doug Leeper
Cc:	Xinjian Chen; Gabe I. Herrick; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ron Basso; Melissa Gulvin; Kurt Fritsch; Mike R. Bray; speene@appliedtm.com; kwatson@hsweng.com
Subject:	Re: Pulsing Springs Of Kings Bay
Date:	Friday, March 31, 2017 8:25:04 AM
Attachments:	image001.png image002.png image003.png

Doug,
It was good that we spoke yesterday regarding the rule language for Rainbow.

While I do not have much time this morning I would like to confirm our agreement that the flow as measured at the USGS gage on Rainbow referenced in the rule, is the natural flow minus the withdrawals. We agree the natural flow varies primarily with rainfall and the withdrawals do not. Hence my comment in a recent e-mail the withdrawals are not simply a percent of the flow measured at the gage.
I think we agreed on the generalized idea, when rainfall is lower pumping most likely increases rather than decreases.

Regarding our conversation re WS Farms I did briefly speak to a lady in Permitting; she thought the reason for no pumpage data in that permit file is because the average 84300 gpd is lower than the 100000 gpd when a meter is required and the draw pipe diameter is also below 'meter required'. She thought peak pumpage (428200 gpd for this permit) is not a metering criteria
She was very helpful and very professional and did say she was not an 'authority' on such details and referred me to another person...unfortunately it went to voicemail. I will follow up as time permits.

You commented the withdrawals are dynamic with new wells being installed and old ones being closed down. I agree but the vast majority are in regular use, so I see no reason for a comprehensive list of the withdrawals in the springshed being maintained (agreed for Rainbow it will require co-operation with SJRWMD). Withdrawals in the rule need to be actual withdrawals in the springshed (given the normal estimations used for water use reporting) not some modeled data.

Regarding the comments on the pulsing springs of Kings Bay, I will respond in detail as time permits, but for now let me ask;
Why does USGS take the time to produce the data? and
No doubt there is data that staff who write these responses have on the seasonal variation of ROMP TR21-3 showing how it reflects the rainfall variations.
Martyn
P.S.
Staff writers also need to note USGS have resumed reporting at the newer gage site in Rainbow River. The data confirms my position the river flow profile used in the model is incorrect. Just

remember who contacted USGS last year about the data they were reporting. USGS were very appreciative of my observations. Staff just kept on plowing.

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Thursday, March 30, 2017 5:40 PM
To: Alan Martyn Johnson
Cc: Xinjian Chen; Gabe I. Herrick; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ron Basso; Melissa Gulvin; Kurt Fritsch; Mike R. Bray; speene@appliedtm.com; kwatson@hsweng.com
Subject: RE: Pulsing Springs Of Kings Bay

Martyn:

Was good to speak with you earlier today regarding the Rainbow minimum flow rule.

Responses to your March 27th comments on flow in the Crystal River/Kings Bay System are imbedded in your email below.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Monday, March 27, 2017 8:12 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>; Mark A. Green <Mark.Green@swfwmd.state.fl.us>; Jennette Seachrist <Jennette.Seachrist@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>; Mike R. Bray <Mike.Bray@swfwmd.state.fl.us>; speene@appliedtm.com; kwatson@hsweng.com
Subject: Re: Pulsing Springs Of Kings Bay

Doug,
Thank you for relaying the staff responses.
Regarding the Staff Responses to the Peer Review Panels Report which are presented in the Governing Board Meeting Note book; it is disappointing and inaccurate for the staff response to repeatedly mention negative daily and monthly discharge measured at the Bagley Cove USGS

site.

Staff response (3/30/2017): *Approved, tidally-filtered discharge data reported for the Bagley Cove site shows negative daily and monthly mean values. The district mentions these negative values to indicate that this record is not suitable for use as an estimate of spring discharge to the system for hydrodynamic modeling purposes.*

I would have thought by now staff would understand the daily data based on a 24 hour day is bound to have negative values as the tidal cycle is 24.84 hours. If not they need to read the comment/note on the USGS site for 02310747.

Staff response (3/30/2017): *Tidally-filtered discharge is reported after low-pass filtering to remove effects of mismatch in lunar and solar day lengths. Nonetheless, tidally-filtered, approved discharge regularly has negative values. The comments to the gage also note that "The residual discharges are not total "freshwater" flow, but are a combination of freshwater flow and water storage caused by higher or lower Gulf of Mexico mean water levels." This is further indication that the discharge reported at this gage is not intended for use as an estimate of freshwater discharge into Kings Bay.*

Further to state there are monthly negative discharges is inaccurate and steps further than in the MFL Report in attempting to discredit USGS.

Staff response (3/30/2017): *The District has made no attempts to, nor has any interest in discrediting the USGS. Reported negative monthly averages for approved, tidally-filtered discharge from the Bagley Cove gage are a matter of fact. The District has stated that discharge reported at this gage is not a suitable estimate of spring flow into Kings Bay. This is consistent with the USGS remarks which clearly state that "residual discharges are not total 'freshwater' flow". Here, the USGS is referring to "tidally-filtered" discharge as "residual". The District interprets this to mean that discharge reported at this gage is not suited for use as an estimate of spring discharge to the system.*

The only negative monthly discharges in the USGS Data arise if INCOMPLETE DATA IS SELECTED FOR MONTHLY STATISTICS. These months are June 2009, May 2012, August 2015 and August 2016. For these months there are multiple days when data is not available eg both August 2015 and 2016 there are over 20 days when data was not available, for the 2009 and 2012 months it is 8 and 9 days.

Staff response (3/30/2017): *This missing data is further evidence that discharge reported at this gage is not suitable for use in driving a hydrodynamic model which requires frequent, continuous estimates of spring discharge on short time scales.*

I would further note the Bagley Cove data shows a distinct decrease in 'springs discharge' since the start of data collection at this site and reflects seasonal variations. Seasonal variations are normal phenomena....which the Districts modeled discharges do not reflect.

Staff response (3/30/2017): For all of the reasons above, the Bagley Cove data does not reflect 'springs discharge' as noted in the REMARKS for the Bagley Cove gage. District empirical-formula discharge is based on groundwater levels and surface water levels, and thus reflects seasonal variations in those levels.

May be the decrease 'spring discharge' in the Bagley Cove data is viewed as an anomaly as is the Rainbow River decrease. I am of the opinion this is not an anomaly but the truth.
I will elaborate on my points with specific quotes and data as time permits.
As regards my e-mail to Dr. Peene and Dr. Watson I have not heard from them to date. Please note I asked if they would be interested, nothing more.

Sooner or later District is going to have some serious explaining to do regarding the Pulsing Springs of Kings Bay...the 'geological water hammer' of flows changing from 700 cfs to 50 cfs from low tide to high tide may sound the alarm.
Martyn

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Friday, March 24, 2017 2:07 PM
To: Alan Martyn Johnson
Cc: Xinjian Chen; Gabe I. Herrick; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ron Basso; Melissa Gulvin; Kurt Fritsch; Mike R. Bray
Subject: RE: Pulsing Springs Of Kings Bay
Martyn:
Thanks for your March 13th email concerning discharge from springs within Kings Bay springs. I've imbedded some "staff responses" highlighted in blue in your original email below.
Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Monday, March 13, 2017 7:37 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>; Mark A. Green <Mark.Green@swfwmd.state.fl.us>; Jennette Seachrist <Jennette.Seachrist@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>
Subject: Re: Pulsing Springs Of Kings Bay
My e-mail and attachment were a follow up to my e-mail of January 24 where I shared the mass

balance, and diagrammatic basis for the mass balance, of the VHB 2009 Group 1 data. The results show the combined Group 1 springs discharge to be almost constant thru the tidal cycles. This makes sense of the VHB data, all parameters are in balance, and is logical given what is generally known about spring discharges. Additionally, the data from measurements at individual springs in Kings Bay in the VHB reports 2009 and 2012, show no evidence of spring discharges varying in the manner shown in the graphic presentation Figure 2-4 in the draft report i.e. pulsing. Repeat no evidence.

In my January 24 e-mail I challenged SWFWMD to 'be bold' and plug the spring discharges from Figure 2-4 into the mass balance and see for yourselves the results. As you did not do that I did it for you. Yes I had to estimate the discharges from the graph (I think you have to admit they are reasonably close), but you are very welcome to change these to the calculated 15 minute discharges used to generate the graph.

In your response no mention is made of the 'uncertainty' expressed by the Peer Review Panel. I would also draw attention to the concerns expressed by Dan Yobbi in his memos December 2014 and September 2015 (in the Appendix of the Draft MFL Report).

Staff response (3/24/2017): *The District response to peer review panel findings concerning the proposed minimum flow for the Crystal River/Kings Bay System is being provided to the District Governing Board as part of the March 28th Board meeting agenda. The response, which is included in the Board packet as agenda item number 33 in the document at the link below, includes information relevant to panel comments concerning uncertainties in flow estimation. Staff plans to expand the discussion of this uncertainty in the revised version of the minimum flow report.*
http://www.swfwmd.state.fl.us/calendar/notebooks/govboard_03-28-17_notebook_2772.pdf

For completeness I believe there are two formulas the District has developed for springs discharge based on the location of each individual spring.

The writers of this response appear not to realize the 15 minute shortfalls or excess are cumulative thru each respective tidal cycles.

As for the total volume in the pool....well...what can I say....interesting!

As for regression analysis...what can I say...amazing!

As for Bagley Cove data, this is not related to the mass balance Group 1, but you are welcome to look back at my previous comments particularly about the 24.84 hour tidal cycle shared last year.

Let us get back to the subject, the pulsing springs of Kings Bay.

How about sharing my mass balance January 24 e-mail and the recent one showing how out of balance the spring discharges in Figure 2-4 are, with Dr. Peene and Dr. Watson to see if this helps them understand the uncertainty they have expressed in the Peer Review Report. Dan Yobbi as well if you want.

Staff response (3/24/2017): *We understand that you have contacted Dr. Peene and Dr. Watson in a March 23rd email and offered to provide your January 24th email to them directly.*

For those who have not seen how the total discharge for all springs discharge varies (pulse)

according to Districts two formula, I have attached a graph of a typical week of discharges. This is similar to the ones shared with Doug, Ron and Gabe when we met January 23 and is from the District Model output. Variations during some cycles from less than 50cfs to 700 cfs from high to low tide. Really?

Kings Bay springs do not pulse to such magnitude. I have suggested before and I will repeat it. Take one of the major springs, your choice, and position a velocity meter in the vent and monitor it for a few days. We can quickly prove who is right by in field measurement. I am confident my mass balance (January 24) indicating almost constant discharge from the springs will prevail.

Staff response (3/24/2017): *As indicated in the draft minimum flow report, staff plan to recommend that the Board approve a scheduled reevaluation of the minimum flow for the Crystal River/Kings Bay system within ten years of the legislatively-mandated July 2017 adoption date. We are committed to the acquisition of additional data, including measured flows, that will support the planned reevaluation effort.*

Martyn

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Thursday, March 9, 2017 8:26 AM
To: Alan Martyn Johnson
Cc: Xinjian Chen; Gabe I. Herrick; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ron Basso; Melissa Gulvin
Subject: RE: Pulsing Springs Of Kings Bay

Martyn:

Thanks for the email and attached Excel file concerning spring discharge to Kings Bay that you sent on Monday, March 6, 2017. We note that your email claims "there is a shortfall or excess water in the pool upstream of the X-section" and from this you conclude that "Dr. Chen's calculations are wrong". The District is committed to supporting its claims based on evidence. District Staff have developed an empirical formula for estimating submarine groundwater discharge (SGD). District confidence in this formula is proportional to the weight of evidence which supports it.

The District formula can predict surface water levels with 74% accuracy for Group 1 springs and with 94% accuracy for Group 2 springs (R^2 values). These methods have been published in peer reviewed scientific journals by Dr. Chen, and separately peer-reviewed in the minimum flow report. This predictive capacity represents the best information available. There is no better predictive tool for estimating water levels in the Crystal River/Kings Bay system.

The strength of the District formula for SGD comes from its ability to explain the data. Your spreadsheet includes data which you claim demonstrates a shortfall of the SGD formula for predicting flux across a cross section in Kings Bay. Your spreadsheet shows the change in volume over a 15-minute interval for water upstream of the G1 cross section as predicted by G1 discharge and SGD (eq. 1) in column L. This change in volume over time may be referred to as "15-minute flux". You estimate SGD from a figure, which you acknowledge carries with it a degree of uncertainty. The 15-minute flux predicted by gage height is shown in column M. You subtract M from L to arrive at what you call the "Eccess[sic] Shortfall in pool" shown in column O. From the values in this column O, you conclude the District method for estimating discharge is incorrect.

How does 15-minute flux as estimated from discharges at G1 and SGD compare with 15-minute flux as

estimated from gage height? A plot of these fluxes is shown below in Figure 1 (this figure and other figures discussed in this email were developed using information included in the attached Excel file named "bold Group 1 2009-gh which was developed using the file you sent on March 6th; note that a PDF of this email is also attached). The 15-minute flux predicted by discharges at G1 and SGD [labeled Discharges (col L)] clearly mirrors the 15-minute flux predicted by gage height [labeled Gage Height (col M)]. The difference between these two lines is shown as Shortfall (col O). Note the similarity in 15-minute flux as estimated from these two sources. Also please note the time difference between values in col L and col M, which introduces additional errors in col O if the difference between col L and col M is taken simply by subtracting col M from col L in the same row. The time difference between col L and col M can be clearly seen in Figure 1.

The similarity in lines of Figure 1 can be quantified using linear regression. A linear regression of 15-minute flux from discharges (col L) as a predictor 15-minute flux from gage height (col M) has an R^2 value of 0.9376 (Figure 2 below). This means that the SGD and G1 discharge capture over 93% of the variation in the flux estimated from gage height. Recall there is some uncertainty associated with discrepancy between times of measurement, in measurement of gage height, in discharge at G1, and in estimating SGD from eyeballing values from a plot. Thus, this remaining 6-7% error is not entirely attributable to error in estimation of SGD.

Your analysis is limited to producing a list of differences between two methods for estimating 15-minute flux. These differences (col O) are on the order of 10^4 ft^3/15min. You claim these values are so large as to warrant calling the District "wrong". How large are these values compared to the overall volume of the pool upstream from G1? If we assume an average depth of 3 ft at MSL (a likely underestimate), we can estimate the relative shortfall as a fraction of the overall volume of the bay (Figure 3 below). You can see that these "large" differences are less than 4% of the total volume of the upstream pool (assuming 3ft average depth at MSL).

You have expressed incredulity in the degree of variation in SGD predicted by District formula. However, the District formula SGD has lower variation than any other method for estimating spring discharge to this system. Compare District-formula SGD with discharge reported at USGS 02310747 Crystal River at Bagley Cove near Crystal River, FL (Figure 4 below). The District SGD shows a record of spring flow with much less variability than the discharges reported at Bagley Cove. As such, the District formula for estimating SGD addresses the problem of minimizing fluctuation in estimated spring flow, is based on the mass-balance principle, and has been repeatedly verified against field data.

Analysis of the data you presented in your spreadsheet shows that the District formula does quite well at predicting water levels and fluxes in this system. Although your calculations could make the "Eccess Shortfall in pool" in col O larger in magnitude than it should be, we think the information you've provided support the empirical formula.

We would add that the District empirical formula was obtained through data fitting of spring flow data, which were calculated from measured discharge data at G1 and G2 based on the mass-balance principle. Data fitting is simply a process of finding the best mathematical expression linking a dependable variable with one or more independent variables through minimizing the overall mismatch between measured data and model-predicted results. Just because there are errors between model results and data (in this case, between col L and col M) does not mean that the model is wrong. As mentioned above, errors are minimized but not eliminated in data fitting.

In closing, please note that we will continue to apportion our confidence in the formula for SGD based on the strength of evidence regarding its power to explain observations.

Figure 1. 15-minute flux estimates over a two-day period

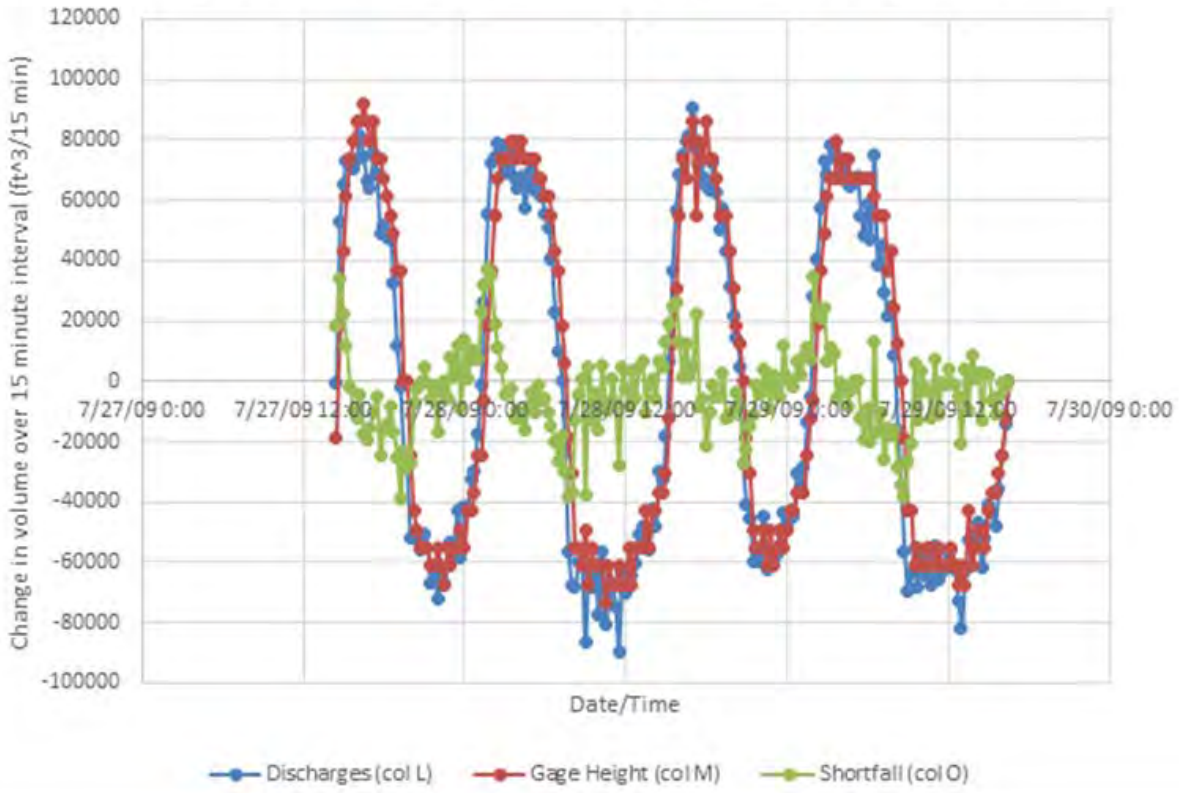
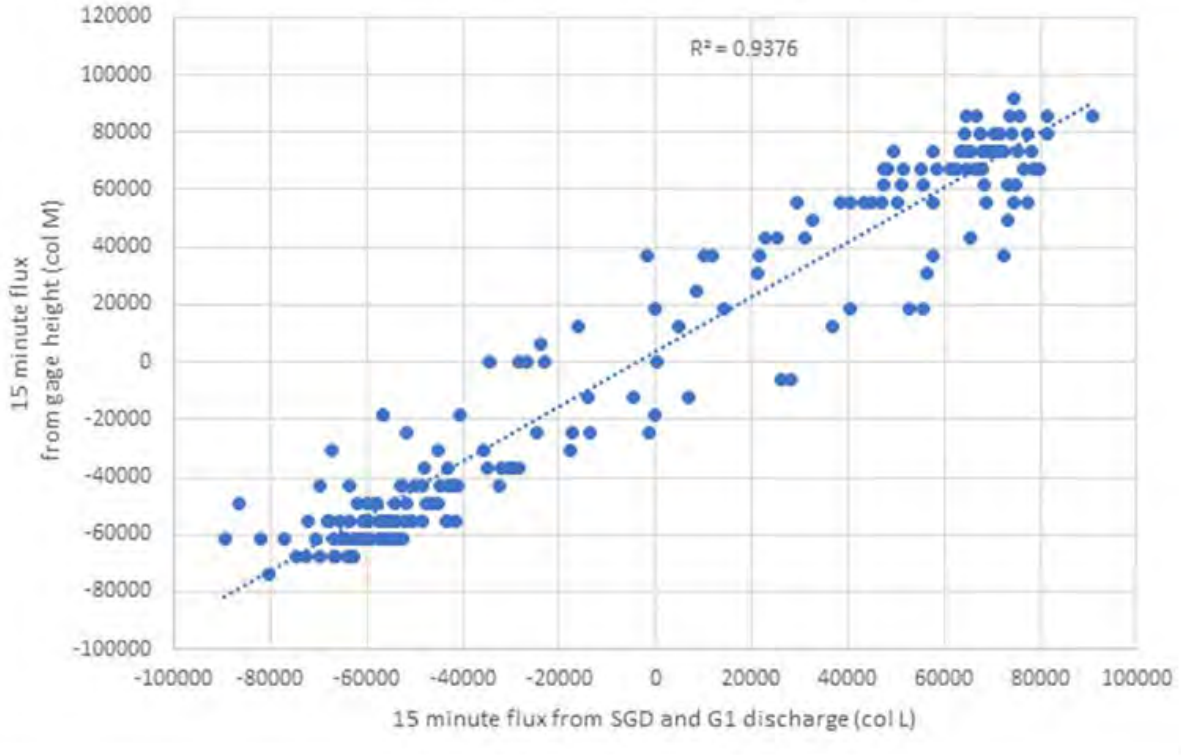
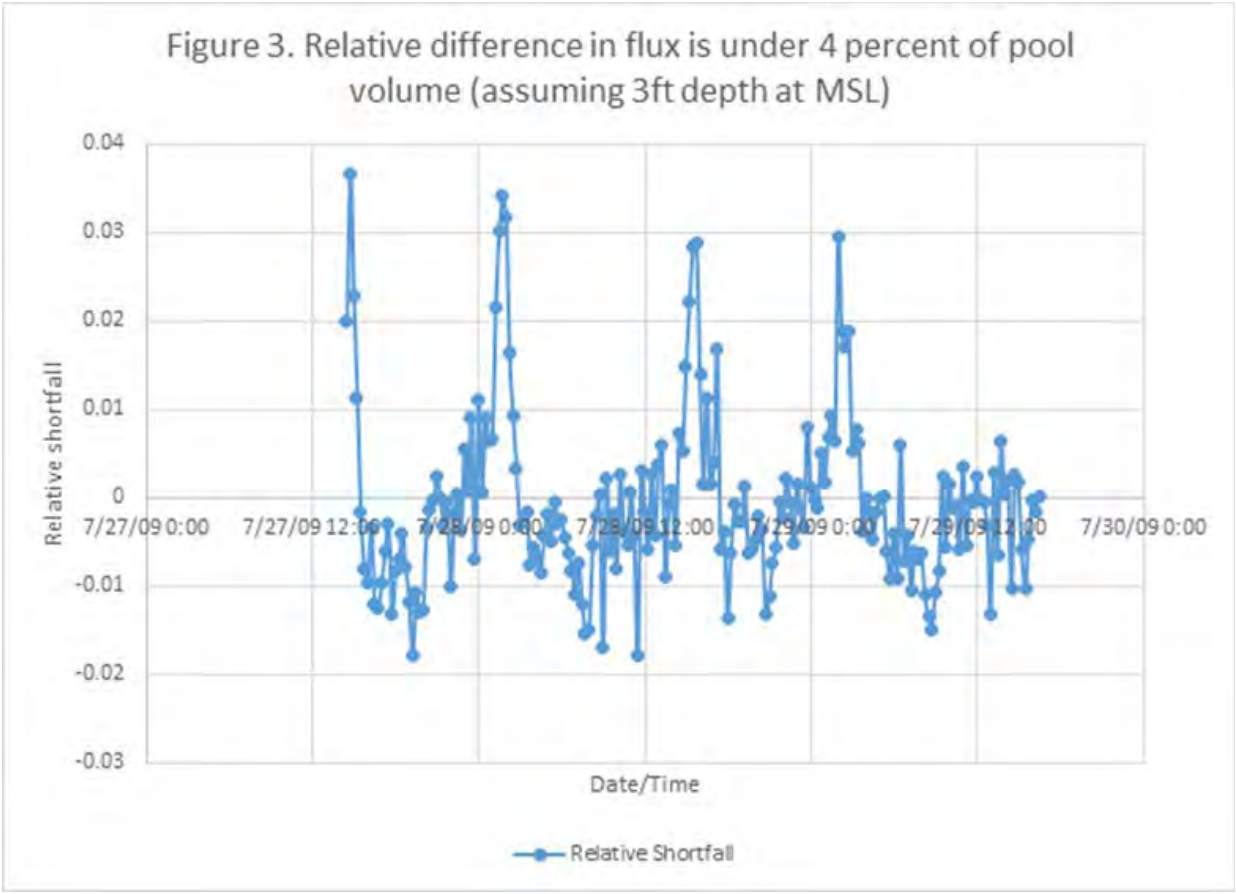


Figure 2. District formula SGD produces estimates of 15-minute flux that are condordant with gage height estimates.





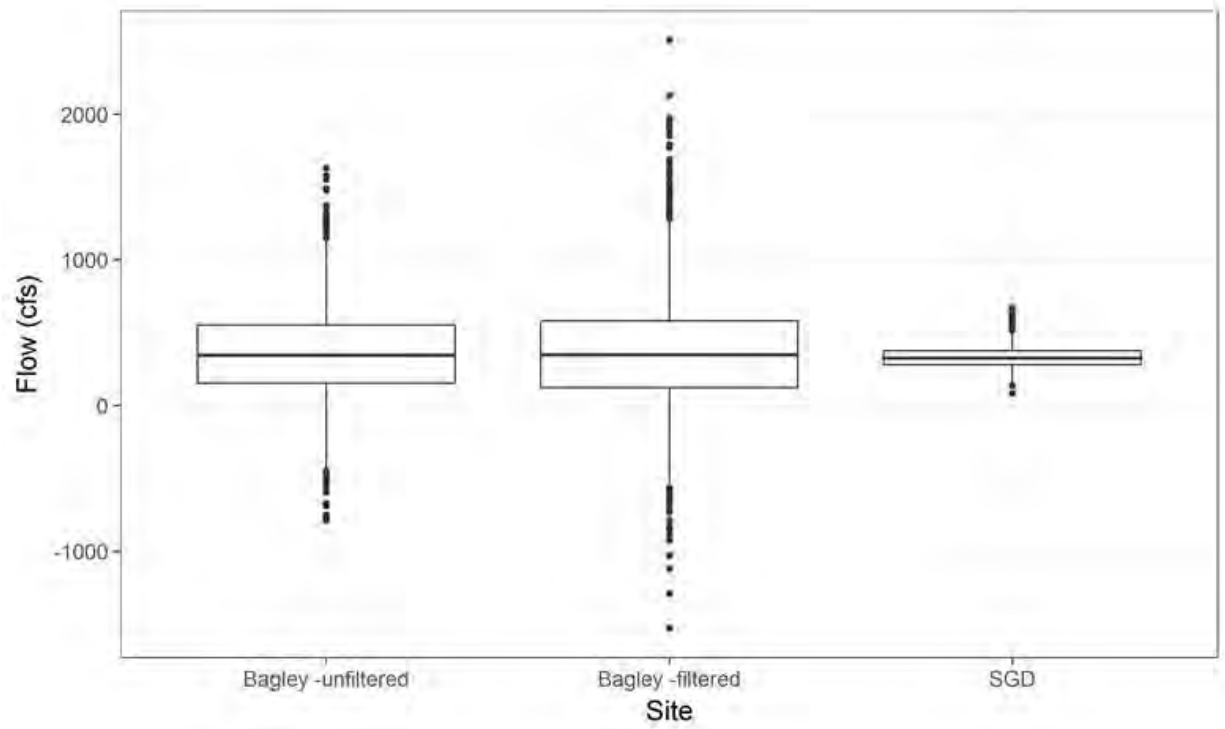


Figure 4. District formula submarine groundwater discharge (SGD) compared with discharges reported at Bagley Cove over the hydrodynamic model period of record. Variation predicted by District SGD is much lower than predicted by reported discharges. Boxplot made with daily

mean discharge. Note USGS gage reports frequent negative daily values, even when tidally-filtered. Dark center line is median, upper and lower box edges are 75th and 25th exceedance percentiles. Whiskers extend to 1.5 IQR. Outliers show as dots beyond whiskers.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
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Brooksville, FL 34609
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352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Monday, March 06, 2017 8:31 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>
Subject: Pulsing Springs Of Kings Bay

Doug,
I am directing this to you as you have coordinated Staff Responses in the past, but it is equally addressed to all cc's.

As discussed/promised attached is my xls file with Dr. Chen's spring discharges for Group 1 springs re Figure 2-4 in the Draft Report. As you will see there is a shortfall or excess water in the pool upstream of the X-section i.e. the stage per VHB/USGS data is not maintained using Dr. Chen's spring discharges. These excess or shartfalls are in bold red and black.
For clarity let me add:

- The Dr. Chen spring discharge is the best I could read the Figure 2-4 these are bold with light blue background.
- The discharges between the hi/low are by linear interpolation for each change high to low.
- The VHB data did not account for the difference in high tide time. You will recall in my spreadsheet determining the spring discharge I left blank those areas around the tide change times. I had done the same with this spreadsheet and you are welcome to do the same to account for the roughly 15 minutes later high tide at the X-section cf Mouth of Kings Bay.

Dr. Chen's calculations are wrong. The idea that Group 1 springs discharge vary as presented in Figure 2-4 is simply not true.

What makes the whole picture more ridiculous is to suggest all other springs in Kings Bay vary depending on their relative location to Group 1 X-section, Group 2 X-section and Romp TR21-3.

Yes my words are blunt, but it appears a 2x4 is needed to get to the truth. May I suggest again you share my comments with Dr. Penne and Dr. Watson. I trust I do not have to request a personal meeting to discuss their uncertainties about spring discharge from the ''pulsing springs of Kings Bay".

I think I have know Doug and Ron long enough that they know I will welcome any rational argument showing I am wrong.

BACKGROUND

I first raised the concern about the wide variations in Kings Bay springs discharge November 7, 2016. I comment how the logic was missing from the discharges presented in Figure 2-4 of the Draft MFL report. Since then we have exchange a number of e-mails, for example November 30, 2016 when I commented, the more I dig into this the more my concern increases.
January 23, 2017 Doug, Ron Basso and Gabe Herrick met with me to discuss the matter in person. While none claimed the ability to discuss the math behind Dr, Chen's assessment, all agreed with the discharges varying as Dr. Chen has calculated. I shared a number of graphs of weekly discharges from the file of Dr. Chen's work on discharge from all Kings Bay Springs (Model Output of SGD for baseline, shared with me January 18). I asked 'Do you really believe these springs have discharge that varies like this?…this is hard to believe'. Following the meeting on January 24, 2017 I shared with you my xls file with my analysis of the VHB Group 1 data and diagrams of the associated mass balance. My analysis indicated Spring discharge did not vary significantly thru the tidal cycle.
Staff response was my diagrams correctly represented the mass balance, but did not comment regarding my xls file findings.
I suggested 'you' get bold and plug Dr.Chen's discharge number into the file to verify they make sense. On February 8, 2017 I gave the discharges from Figure 2-4 graph for the first few tidal cycles. I also suggested you consider sharing my thoughts/analysis with the Peer Review Panel. The Peer Review panel repeatedly expressed uncertainty in their final report.
As example Quote from Comment 46
The equations that are utilized to define all the flows into the system have some basic error associated with them as well as certain levels of uncertainty. For example, in Figure 2-4 looking at plot (a), it is clear that for the period when measured flows were available, there are errors in the estimated flow that would indicate that the model under-predicts the overall net flow out. This error is then carried through an additional level of uncertainty as the equations and coefficients are extrapolated out to other vents in the system. Based on these known errors and uncertainty, it would be important to developed additional ways to verify the total flows. This could be done using the Bagley data, if this data is demonstrated to be useful for this. Still working on the evaluation of the Bagley data.
End Quote
From the same Comment in the Recommendation Quote.
Also, some more definitive discussion of the degree of variation in the direct vent measurements and how they were used to carry the calculations forward is needed.
End Quote

Martyn

From:	Doug Leeper
To:	"martynellijay@hotmail.com"
Cc:	Xinjian Chen; Gabe I. Herrick; Ron Basso; Kym Holzwart
Bcc:	Mark A. Green; Jennette Seachrist; Eric DeHaven; Ross Morton; Mike R. Bray
Subject:	RE: Pulsing Springs Of Kings Bay
Date:	Friday, April 14, 2017 4:10:00 PM
Attachments:	image005.png image006.png image007.png

Martyn: Thanks for your March 31st email. See staff responses imbedded in the body of your email below.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
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From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Friday, March 31, 2017 8:25 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>; Mark A. Green <Mark.Green@swfwmd.state.fl.us>; Jennette Seachrist <Jennette.Seachrist@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>; Mike R. Bray <Mike.Bray@swfwmd.state.fl.us>; speene@appliedtm.com; kwatson@hsweng.com
Subject: Re: Pulsing Springs Of Kings Bay

Doug,

It was good that we spoke yesterday regarding the rule language for Rainbow.

While I do not have much time this morning I would like to confirm our agreement that the flow as measured at the USGS gage on Rainbow referenced in the rule, is the natural flow minus the withdrawals. We agree the natural flow varies primarily with rainfall and the withdrawals do not. Hence my comment in a recent e-mail the withdrawals are not simply a percent of the flow measured at the gage.

I think we agreed on the generalized idea, when rainfall is lower pumping most likely increases rather than decreases.

Staff response (4/14/2017): *I think I agree with what you've written above, although I would clarify that withdrawals can vary with rainfall on a seasonal basis and for shorter-term periods.*

Regarding our conversation re WS Farms I did briefly speak to a lady in Permitting; she thought the reason for no pumpage data in that permit file is because the average 84300 gpd is lower than the 100000 gpd when a meter is required and the draw pipe diameter is also below 'meter required'. She thought peak pumpage (428200 gpd for this permit) is not a metering criteria **She was very helpful and very professional and did say she was not an 'authority' on such details and referred me to another person...unfortunately it went to voicemail. I will follow up as time permits.**

You commented the withdrawals are dynamic with new wells being installed and old ones being closed down. I agree but the vast majority are in regular use, so I see no reason for a comprehensive list of the withdrawals in the springshed being maintained (agreed for Rainbow it will require co-operation with SJRWMD). Withdrawals in the rule need to be actual withdrawals in the springshed (given the normal estimations used for water use reporting) not some modeled data.

Regarding the comments on the pulsing springs of Kings Bay, I will respond in detail as time permits, but for now let me ask;

Why does USGS take the time to produce the data?

Staff response (4/14/2017): *In cooperation with the District, the USGS monitors flow and other parameters at the Bagley Cove site to develop data that can be used for scientific and environmental management purposes. Discharge reported at the Bagley Cove gage measures "a combination of flow and water storage caused by higher or lower Gulf of Mexico mean water levels." This is useful information. However, it is "not total 'freshwater' flow". These are not mutually exclusive statements. Furthermore, gage height, salinity, and temperature at the Bagley Cove gage were used to verify hydrodynamic model results. Note: quotes here taken from remarks in the water-year summary for the gage available on the USGS web site.*

and

No doubt there is data that staff who write these responses have on the seasonal variation of ROMP TR21-3 showing how it reflects the rainfall variations.

Staff response (4/14/2017): *Your April 5th email to me and Ron Basso indicates you have investigated relationships between rainfall and water levels in the ROMP TR-21 well.*

Martyn

P.S.

Staff writers also need to note USGS have resumed reporting at the newer gage site in Rainbow River. The data confirms my position the river flow profile used in the model is incorrect. Just

remember who contacted USGS last year about the data they were reporting. USGS were very appreciative of my observations. Staff just kept on plowing.

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Thursday, March 30, 2017 5:40 PM
To: Alan Martyn Johnson
Cc: Xinjian Chen; Gabe I. Herrick; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ron Basso; Melissa Gulvin; Kurt Fritsch; Mike R. Bray; speene@appliedtm.com; kwatson@hsweng.com
Subject: RE: Pulsing Springs Of Kings Bay

Martyn:

Was good to speak with you earlier today regarding the Rainbow minimum flow rule.

Responses to your March 27th comments on flow in the Crystal River/Kings Bay System are imbedded in your email below.

Doug Leeper

MFLs Program Lead

Natural Systems and Restoration Bureau

Southwest Florida Water Management District

2379 Broad Street

Brooksville, FL 34609

1-800-423-1476, ext. 4272

352-796-7211, ext. 4272

doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Monday, March 27, 2017 8:12 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>; Mark A. Green <Mark.Green@swfwmd.state.fl.us>; Jennette Seachrist <Jennette.Seachrist@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>; Mike R. Bray <Mike.Bray@swfwmd.state.fl.us>; speene@appliedtm.com; kwatson@hsweng.com
Subject: Re: Pulsing Springs Of Kings Bay

Doug,

Thank you for relaying the staff responses.

Regarding the Staff Responses to the Peer Review Panels Report which are presented in the Governing Board Meeting Note book; it is disappointing and inaccurate for the staff response to repeatedly mention negative daily and monthly discharge measured at the Bagley Cove USGS site.

Staff response (3/30/2017): *Approved, tidally-filtered discharge data reported for the Bagley Cove site shows negative daily and monthly mean values. The district mentions these negative values to indicate that this record is not suitable for use as an estimate of spring discharge to the system for hydrodynamic modeling purposes.*

I would have thought by now staff would understand the daily data based on a 24 hour day is bound to have negative values as the tidal cycle is 24.84 hours. If not they need to read the comment/note on the USGS site for 02310747.

Staff response (3/30/2017): *Tidally-filtered discharge is reported after low-pass filtering to remove effects of mismatch in lunar and solar day lengths. Nonetheless, tidally-filtered, approved discharge regularly has negative values. The comments to the gage also note that "The residual discharges are not total "freshwater" flow, but are a combination of freshwater flow and water storage caused by higher or lower Gulf of Mexico mean water levels." This is further indication that the discharge reported at this gage is not intended for use as an estimate of freshwater discharge into Kings Bay.*

Further to state there are monthly negative discharges is inaccurate and steps further than in the MFL Report in attempting to discredit USGS.

Staff response (3/30/2017): *The District has made no attempts to, nor has any interest in discrediting the USGS. Reported negative monthly averages for approved, tidally-filtered discharge from the Bagley Cove gage are a matter of fact. The District has stated that discharge reported at this gage is not a suitable estimate of spring flow into Kings Bay. This is consistent with the USGS remarks which clearly state that "residual discharges are not total 'freshwater' flow". Here, the USGS is referring to "tidally-filtered" discharge as "residual". The District interprets this to mean that discharge reported at this gage is not suited for use as an estimate of spring discharge to the system.*

The only negative monthly discharges in the USGS Data arise if INCOMPLETE DATA IS SELECTED FOR MONTHLY STATISTICS. These months are June 2009, May 2012, August 2015 and August 2016. For these months there are multiple days when data is not available eg both August 2015 and 2016 there are over 20 days when data was not available, for the 2009 and 2012 months it is 8 and 9 days.

Staff response (3/30/2017): *This missing data is further evidence that discharge reported at this gage is not suitable for use in driving a hydrodynamic model which requires frequent, continuous estimates of spring discharge on short time scales.*

I would further note the Bagley Cove data shows a distinct decrease in 'springs discharge' since the start of data collection at this site and reflects seasonal variations. Seasonal variations are normal phenomena....which the Districts modeled discharges do not reflect.

Staff response (3/30/2017): For all of the reasons above, the Bagley Cove data does not reflect 'springs discharge' as noted in the REMARKS for the Bagley Cove gage. District empirical-formula discharge is based on groundwater levels and surface water levels, and thus reflects seasonal variations in those levels.

May be the decrease 'spring discharge' in the Bagley Cove data is viewed as an anomaly as is the Rainbow River decrease. I am of the opinion this is not an anomaly but the truth.

I will elaborate on my points with specific quotes and data as time permits.

As regards my e-mail to Dr. Peene and Dr. Watson I have not heard from them to date. Please note I asked if they would be interested, nothing more.

Sooner or later District is going to have some serious explaining to do regarding the Pulsing Springs of Kings Bay...the 'geological water hammer' of flows changing from 700 cfs to 50 cfs from low tide to high tide may sound the alarm.

Martyn

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Friday, March 24, 2017 2:07 PM
To: Alan Martyn Johnson
Cc: Xinjian Chen; Gabe I. Herrick; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ron Basso; Melissa Gulvin; Kurt Fritsch; Mike R. Bray
Subject: RE: Pulsing Springs Of Kings Bay

Martyn:

Thanks for your March 13th email concerning discharge from springs within Kings Bay springs. I've imbedded some "staff responses" highlighted in blue in your original email below.

Doug Leeper

MFLs Program Lead

Natural Systems and Restoration Bureau

Southwest Florida Water Management District

2379 Broad Street

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doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Monday, March 13, 2017 7:37 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>; Mark A. Green <Mark.Green@swfwmd.state.fl.us>; Jennette Seachrist <Jennette.Seachrist@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>
Subject: Re: Pulsing Springs Of Kings Bay

My e-mail and attachment were a follow up to my e-mail of January 24 where I shared the mass balance, and diagrammatic basis for the mass balance, of the VHB 2009 Group 1 data. The results show the combined Group 1 springs discharge to be almost constant thru the tidal cycles. This makes sense of the VHB data, all parameters are in balance, and is logical given what is generally known about spring discharges. Additionally, the data from measurements at individual springs in Kings Bay in the VHB reports 2009 and 2012, show no evidence of spring discharges varying in the manner shown in the graphic presentation Figure 2-4 in the draft report i.e. pulsing. Repeat no evidence.

In my January 24 e-mail I challenged SWFWMD to 'be bold' and plug the spring discharges from Figure 2-4 into the mass balance and see for yourselves the results. As you did not do that I did it for you. Yes I had to estimate the discharges from the graph (I think you have to admit they are reasonably close), but you are very welcome to change these to the calculated 15 minute discharges used to generate the graph.

In your response no mention is made of the 'uncertainty' expressed by the Peer Review Panel. I would also draw attention to the concerns expressed by Dan Yobbi in his memos December 2014 and September 2015 (in the Appendix of the Draft MFL Report).

Staff response (3/24/2017): *The District response to peer review panel findings concerning the proposed minimum flow for the Crystal River/Kings Bay System is being provided to the District Governing Board as part of the March 28th Board meeting agenda. The response, which is included in the Board packet as agenda item number 33 in the document at the link below, includes information*

relevant to panel comments concerning uncertainties in flow estimation. Staff plans to expand the discussion of this uncertainty in the revised version of the minimum flow report.

http://www.swfwmd.state.fl.us/calendar/notebooks/govboard_03-28-17_notebook_2772.pdf

For completeness I believe there are two formulas the District has developed for springs discharge based on the location of each individual spring.

The writers of this response appear not to realize the 15 minute shortfalls or excess are cumulative thru each respective tidal cycles.

As for the total volume in the pool....well...what can I say....interesting!

As for regression analysis...what can I say...amazing!

As for Bagley Cove data, this is not related to the mass balance Group 1, but you are welcome to look back at my previous comments particularly about the 24.84 hour tidal cycle shared last year.

Let us get back to the subject, the pulsing springs of Kings Bay.

How about sharing my mass balance January 24 e-mail and the recent one showing how out of balance the spring discharges in Figure 2-4 are, with Dr. Peene and Dr. Watson to see if this helps them understand the uncertainty they have expressed in the Peer Review Report. Dan Yobbi as well if you want.

Staff response (3/24/2017): *We understand that you have contacted Dr. Peene and Dr. Watson in a March 23rd email and offered to provide your January 24th email to them directly.*

For those who have not seen how the total discharge for all springs discharge varies (pulse) according to Districts two formula, I have attached a graph of a typical week of discharges. This is similar to the ones shared with Doug, Ron and Gabe when we met January 23 and is from the District Model output. Variations during some cycles from less than 50cfs to 700 cfs from high to low tide. Really?

Kings Bay springs do not pulse to such magnitude. I have suggested before and I will repeat it. Take one of the major springs, your choice, and position a velocity meter in the vent and monitor it for a few days. We can quickly prove who is right by in field measurement. I am confident my mass balance (January 24) indicating almost constant discharge from the springs will prevail.

Staff response (3/24/2017): *As indicated in the draft minimum flow report, staff plan to recommend that the Board approve a scheduled reevaluation of the minimum flow for the Crystal River/Kings Bay system within ten years of the legislatively-mandated July 2017 adoption date. We are committed to the acquisition of additional data, including measured flows, that will support the planned reevaluation*

effort.

Martyn

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Thursday, March 9, 2017 8:26 AM
To: Alan Martyn Johnson
Cc: Xinjian Chen; Gabe I. Herrick; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ron Basso; Melissa Gulvin
Subject: RE: Pulsing Springs Of Kings Bay

Martyn:

Thanks for the email and attached Excel file concerning spring discharge to Kings Bay that you sent on Monday, March 6, 2017. We note that your email claims "there is a shortfall or excess water in the pool upstream of the X-section" and from this you conclude that "Dr. Chen's calculations are wrong". The District is committed to supporting its claims based on evidence. District Staff have developed an empirical formula for estimating submarine groundwater discharge (SGD). District confidence in this formula is proportional to the weight of evidence which supports it.

The District formula can predict surface water levels with 74% accuracy for Group 1 springs and with 94% accuracy for Group 2 springs (R^2 values). These methods have been published in peer reviewed scientific journals by Dr. Chen, and separately peer-reviewed in the minimum flow report. This predictive capacity represents the best information available. There is no better predictive tool for estimating water levels in the Crystal River/Kings Bay system.

The strength of the District formula for SGD comes from its ability to explain the data. Your spreadsheet includes data which you claim demonstrates a shortfall of the SGD formula for predicting flux across a cross section in Kings Bay. Your spreadsheet shows the change in volume over a 15-minute interval for water upstream of the G1 cross section as predicted by G1 discharge and SGD (eq. 1) in column L. This change in volume over time may be referred to as "15-minute flux". You estimate SGD from a figure, which you acknowledge carries with it a degree of uncertainty. The 15-minute flux predicted by gage height is shown in column M. You subtract M from L to arrive at what you call the "Eccess[sic] Shortfall in pool" shown in column O. From the values in this column O, you conclude the District method for estimating discharge is incorrect.

How does 15-minute flux as estimated from discharges at G1 and SGD compare with 15-minute flux as estimated from gage height? A plot of these fluxes is shown below in Figure 1 (this figure and other figures discussed in this email were developed using information included in the attached Excel file named "bold Group 1 2009-gh which was developed using the file you sent on March 6th; note that a PDF of this email is also attached). The 15-minute flux predicted by discharges at G1 and SGD [labeled Discharges (col L)] clearly mirrors the 15-minute flux predicted by gage height [labeled Gage Height (col M)]. The difference between these two lines is shown as Shortfall (col O). Note the similarity in 15-minute flux as estimated from these two sources. Also please note the time difference between values in col L and col M, which introduces additional errors in col O if the difference between col L and col M is taken simply by subtracting col M from col L in the same row. The time difference

between col L and col M can be clearly seen in Figure 1.

The similarity in lines of Figure 1 can be quantified using linear regression. A linear regression of 15-minute flux from discharges (col L) as a predictor 15-minute flux from gage height (col M) has an R^2 value of 0.9376 (Figure 2 below). This means that the SGD and G1 discharge capture over 93% of the variation in the flux estimated from gage height. Recall there is some uncertainty associated with discrepancy between times of measurement, in measurement of gage height, in discharge at G1, and in estimating SGD from eyeballing values from a plot. Thus, this remaining 6-7% error is not entirely attributable to error in estimation of SGD.

Your analysis is limited to producing a list of differences between two methods for estimating 15-minute flux. These differences (col O) are on the order of 10^4 ft^3/15min. You claim these values are so large as to warrant calling the District "wrong". How large are these values compared to the overall volume of the pool upstream from G1? If we assume an average depth of 3 ft at MSL (a likely underestimate), we can estimate the relative shortfall as a fraction of the overall volume of the bay (Figure 3 below). You can see that these "large" differences are less than 4% of the total volume of the upstream pool (assuming 3ft average depth at MSL).

You have expressed incredulity in the degree of variation in SGD predicted by District formula. However, the District formula SGD has lower variation than any other method for estimating spring discharge to this system. Compare District-formula SGD with discharge reported at USGS 02310747 Crystal River at Bagley Cove near Crystal River, FL (Figure 4 below). The District SGD shows a record of spring flow with much less variability than the discharges reported at Bagley Cove. As such, the District formula for estimating SGD addresses the problem of minimizing fluctuation in estimated spring flow, is based on the mass-balance principle, and has been repeatedly verified against field data.

Analysis of the data you presented in your spreadsheet shows that the District formula does quite well at predicting water levels and fluxes in this system. Although your calculations could make the "Eccess Shortfall in pool" in col O larger in magnitude than it should be, we think the information you've provided support the empirical formula.

We would add that the District empirical formula was obtained through data fitting of spring flow data, which were calculated from measured discharge data at G1 and G2 based on the mass-balance principle. Data fitting is simply a process of finding the best mathematical expression linking a dependable variable with one or more independent variables through minimizing the overall mismatch between measured data and model-predicted results. Just because there are errors between model results and data (in this case, between col L and col M) does not mean that the model is wrong. As mentioned above, errors are minimized but not eliminated in data fitting.

In closing, please note that we will continue to apportion our confidence in the formula for SGD based on the strength of evidence regarding its power to explain observations.

Figure 1. 15-minute flux estimates over a two-day period

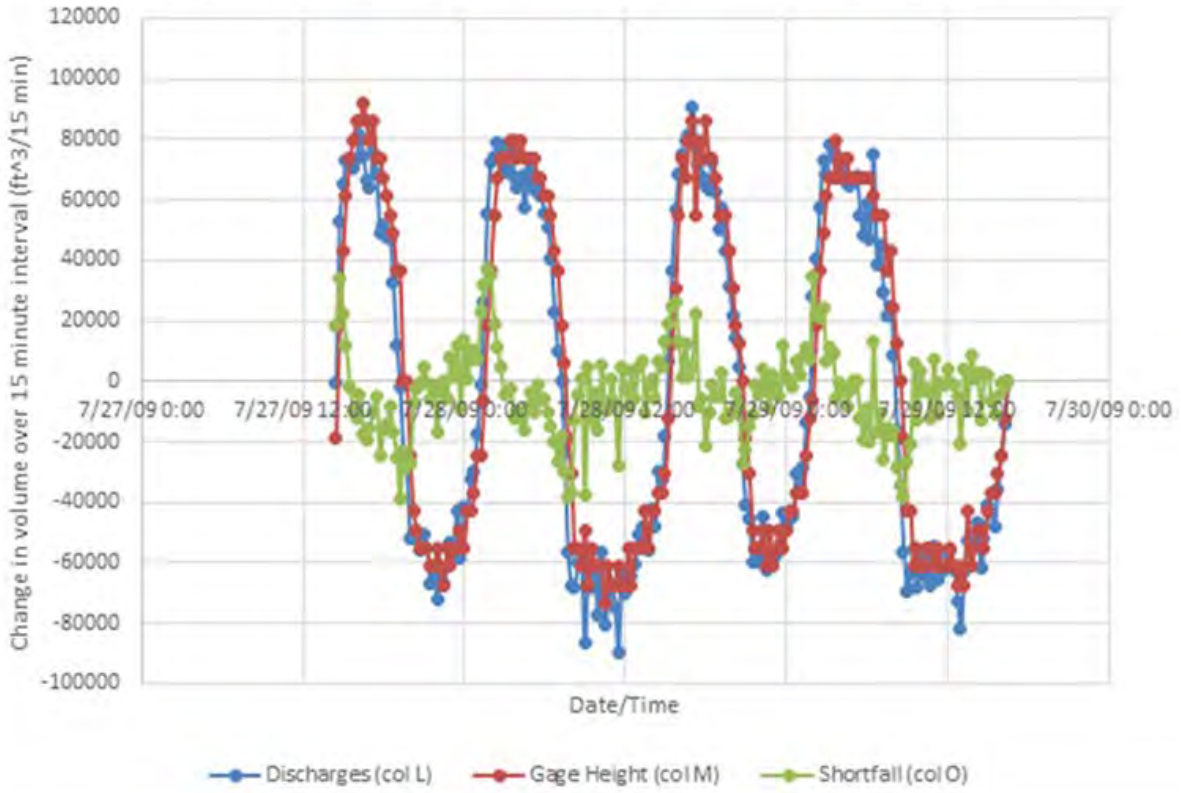


Figure 2. District formula SGD produces estimates of 15-minute flux that are condordant with gage height estimates.

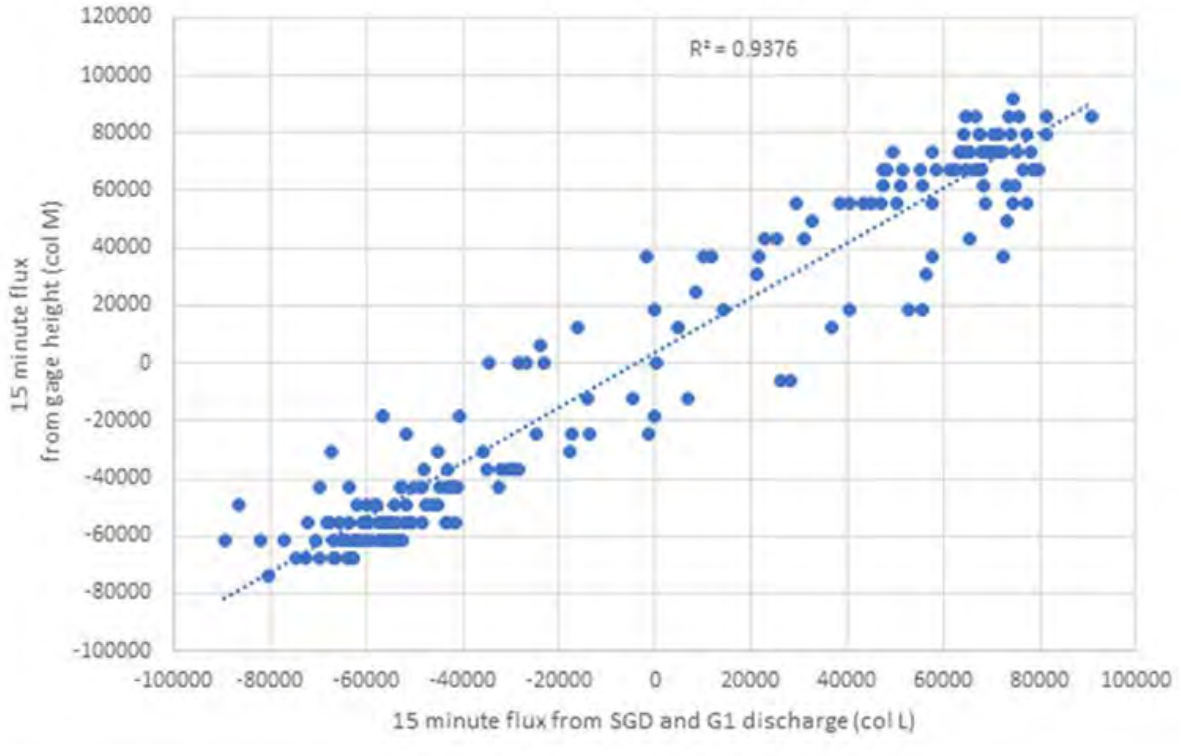
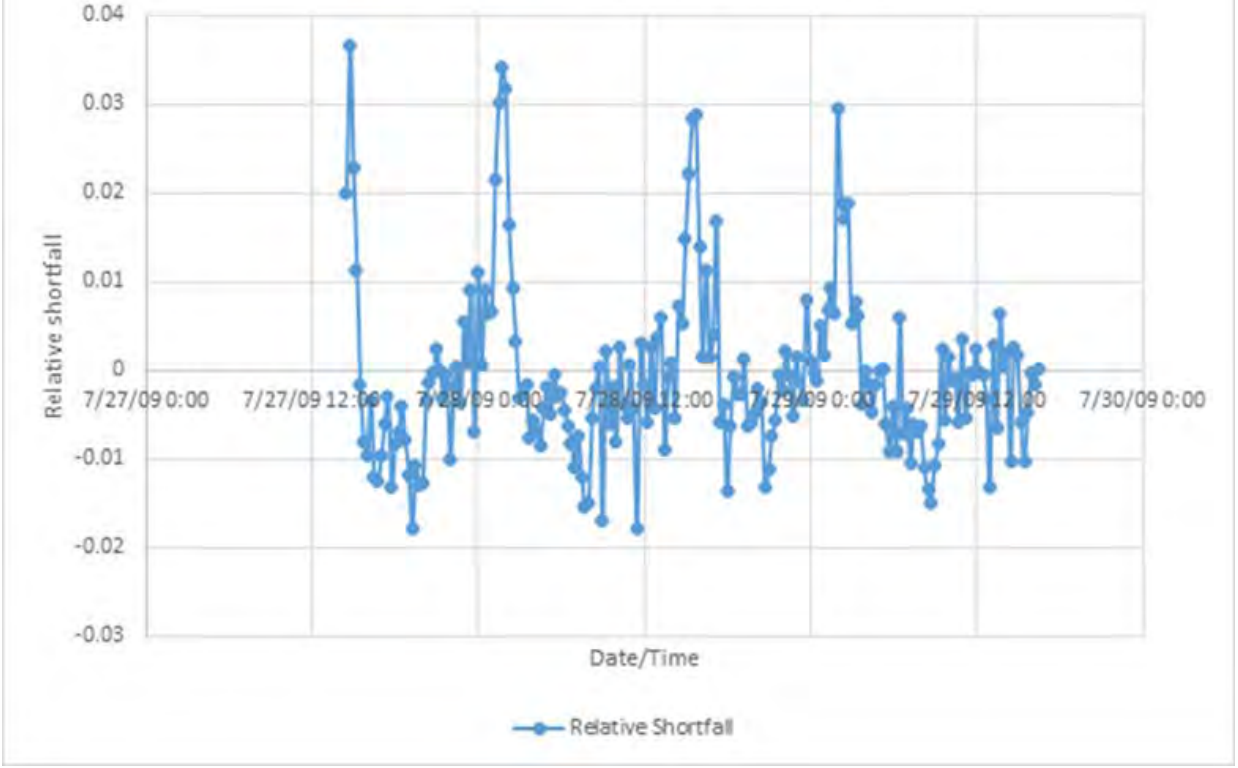


Figure 3. Relative difference in flux is under 4 percent of pool volume (assuming 3ft depth at MSL)



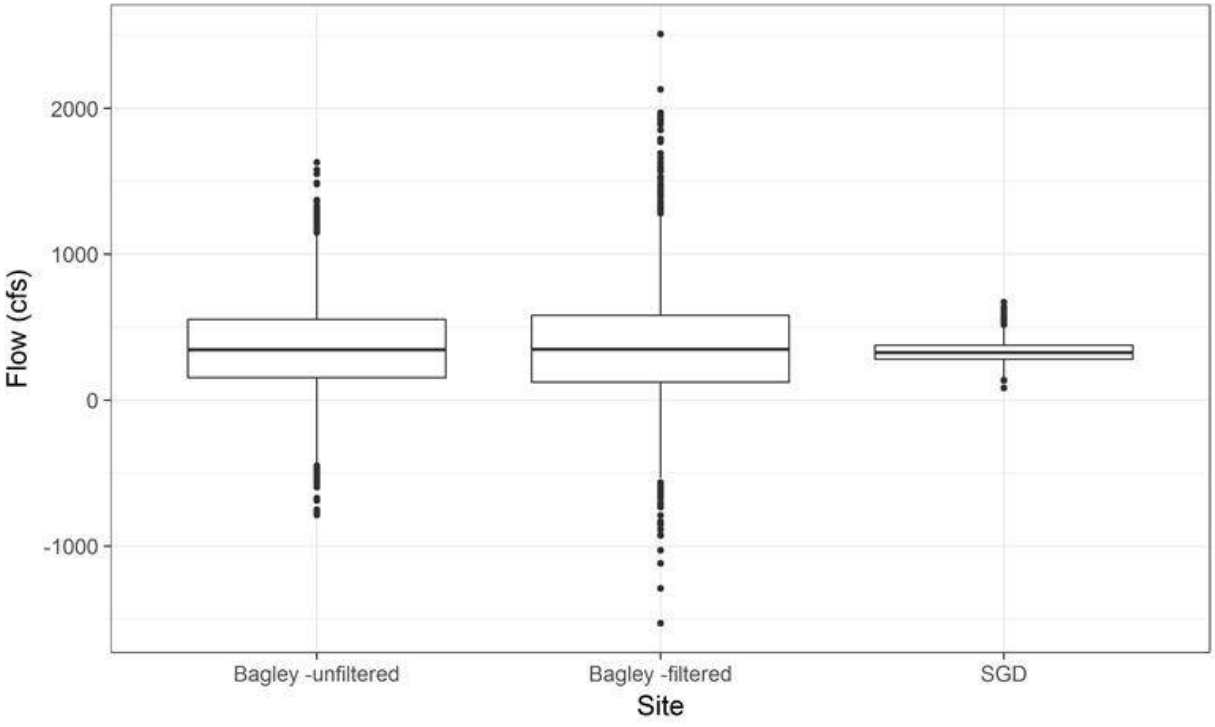


Figure 4. District formula submarine groundwater discharge (SGD) compared with discharges reported at Bagley Cove over the hydrodynamic model period of record. Variation predicted by District SGD is much lower than predicted by reported discharges. Boxplot made with daily mean discharge. Note USGS gage reports frequent negative daily values, even when tidally-filtered. Dark center line is median, upper and lower box edges are 75th and 25th exceedance percentiles. Whiskers extend to 1.5 IQR. Outliers show as dots beyond whiskers.

Doug Leeper

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From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Monday, March 06, 2017 8:31 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>
Subject: Pulsing Springs Of Kings Bay

Doug,

I am directing this to you as you have coordinated Staff Responses in the past, but it is equally addressed to all cc's.

As discussed/promised attached is my xls file with Dr. Chen's spring discharges for Group 1 springs re Figure 2-4 in the Draft Report. As you will see there is a shortfall or excess water in the pool upstream of the X-section i.e. the stage per VHB/USGS data is not maintained using Dr.

Chen's spring discharges. These excess or shartfalls are in bold red and black.
For clarity let me add:

- The Dr. Chen spring discharge is the best I could read the Figure 2-4 these are bold with light blue background.
- The discharges between the hi/low are by linear interpolation for each change high to low.
- The VHB data did not account for the difference in high tide time. You will recall in my spreadsheet determining the spring discharge I left blank those areas around the tide change times. I had done the same with this spreadsheet and you are welcome to do the same to account for the roughly 15 minutes later high tide at the X-section cf Mouth of Kings Bay.

Dr. Chen's calculations are wrong. The idea that Group 1 springs discharge vary as presented in Figure 2-4 is simply not true.

What makes the whole picture more ridiculous is to suggest all other springs in Kings Bay vary depending on their relative location to Group 1 X-section, Group 2 X-section and Romp TR21-3.

Yes my words are blunt, but it appears a 2x4 is needed to get to the truth. May I suggest again you share my comments with Dr. Penne and Dr. Watson. I trust I do not have to request a personal meeting to discuss their uncertainties about spring discharge from the ''pulsing springs of Kings Bay".

I think I have know Doug and Ron long enough that they know I will welcome any rational argument showing I am wrong.

BACKGROUND

I first raised the concern about the wide variations in Kings Bay springs discharge November 7, 2016. I comment how the logic was missing from the discharges presented in Figure 2-4 of the Draft MFL report. Since then we have exchange a number of e-mails, for example November 30, 2016 when I commented, the more I dig into this the more my concern increases.

January 23, 2017 Doug, Ron Basso and Gabe Herrick met with me to discuss the matter in person. While none claimed the ability to discuss the math behind Dr, Chen's assessment, all agreed with the discharges varying as Dr. Chen has calculated. I shared a number of graphs of weekly discharges from the file of Dr. Chen's work on discharge from all Kings Bay Springs (Model Output of SGD for baseline, shared with me January 18). I asked 'Do you really believe these springs have discharge that varies like this?…this is hard to believe'. Following the meeting on January 24, 2017 I shared with you my xls file with my analysis of the VHB Group 1

data and diagrams of the associated mass balance. My analysis indicated Spring discharge did not vary significantly thru the tidal cycle.
Staff response was my diagrams correctly represented the mass balance, but did not comment regarding my xls file findings.

I suggested 'you' get bold and plug Dr.Chen's discharge number into the file to verify they make sense. On February 8, 2017 I gave the discharges from Figure 2-4 graph for the first few tidal cycles. I also suggested you consider sharing my thoughts/analysis with the Peer Review Panel. The Peer Review panel repeatedly expressed uncertainty in their final report.

As example Quote from Comment 46

The equations that are utilized to define all the flows into the system have some basic error associated with them as well as certain levels of uncertainty. For example, in Figure 2-4 looking at plot (a), it is clear that for the period when measured flows were available, there are errors in the estimated flow that would indicate that the model under-predicts the overall net flow out. This error is then carried through an additional level of uncertainty as the equations and coefficients are extrapolated out to other vents in the system. Based on these known errors and uncertainty, it would be important to developed additional ways to verify the total flows. This could be done using the Bagley data, if this data is demonstrated to be useful for this. Still working on the evaluation of the Bagley data.

End Quote

From the same Comment in the Recommendation Quote.

Also, some more definitive discussion of the degree of variation in the direct vent measurements and how they were used to carry the calculations forward is needed.

End Quote

Martyn

From: Alan Martyn Johnson
To: Doug Leeper
Subject: Percent flow approach
Date: Friday, March 31, 2017 10:59:11 AM

Briefly as using a kind persons computer.

The comment about percent flow in staff response to KBCR peer review is Comment 19 and as best I recall is Package Page 147. Hope I remember that correctly. I think it said explanation would be in the 'revised' report.

At least one example of how MFL would be reached/passed will help, then rule wording can be written to be clear, plain and complete.

Martyn

From:	Doug Leeper
To:	"martynellijay@hotmail.com"
Bcc:	Gabe I. Herrick; Xinjian Chen; Ron Basso; Mark A. Green; Jennette Seachrist; Eric DeHaven; Melissa Gulvin; Mike R. Bray; Ross Morton
Subject:	RE: Percent flow approach
Date:	Friday, April 07, 2017 3:58:00 PM

Martyn:

Thanks for your March 31st email.

As noted in the District staff response to the Crystal River/Kings Bay peer review panel's final report that was provided to the Governing Board last week, our response to reviewer comment 19 indicates that additional text has been developed for Section 1.3.2 in the revised minimum flow report to address the panel suggestions regarding "how an allowable flow reduction expressed as a percent flow reduction would be applied to the SGD "flow regime…"

Specifically, the definition of "flow regime" has been modified to include an explanation of how a percent of flow reduction preserves the flow regime. Here is the current language associated with our proposed changes to the definition in the revised report. As that document is a draft work in progress, please note the text below may change.

x. A flow regime is a hydrologic regime characterized by the quantity, timing and variation of flows in a river. Rule 62-40.473, F.A.C., dictates that "minimum flows and levels should be expressed as multiple flows or levels defining a minimum hydrologic regime, to the extent practical and necessary to establish the limit beyond which further withdrawals would be significantly harmful" in Section 373.042(1), F.S. The emphasis on a flow regime, rather than a single minimum flow value, reflects the natural variation present in flowing water systems (Poff et al. 1997). Expressing a minimum flow as an allowable percentage of a flow addresses the intent of protecting the flow regime as allowable flow changes are proportionally-scaled to the magnitude of flow.

Hopefully it is clear from this revised language, from other portions of the minimum flow report, and from some of our previous correspondence and discussions that allowable percent of flow reductions associated with minimum flows are determined from baseline, i.e., natural flow records or conditions. An MFL would be "reached" or "passed" when withdrawal-associated flow reductions equal or exceed those associated with the minimum flow. Minimum flow status assessments rely heavily on hydrologic models and can be supported by evaluation of other types of information, such as rainfall data, flow data, water level data, geological information (e.g., sinkhole occurrence) and withdrawal rate information.

Doug Leeper
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352-796-7211, ext. 4272

doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Friday, March 31, 2017 10:59 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: Percent flow approach

Briefly as using a kind persons computer.

The comment about percent flow in staff response to KBCR peer review is Comment 19 and as best I recall is Package Page 147. Hope I remember that correctly. I think it said explanation would be in the 'revised' report.

At least one example of how MFL would be reached/passed will help, then rule wording can be written to be clear, plain and complete.

Martyn

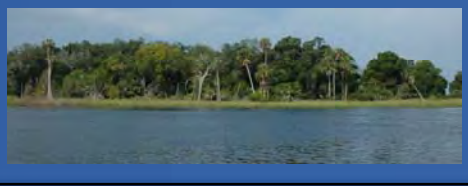
Southwest Florida Water Management District

Proposed Minimum Flow for the Crystal River/Kings Bay System

Southwest Florida Water Management District

Why Establish a Minimum Flow?

- Required by state law for priority springs, streams, and rivers [Section 373.042(1), F.S.]
- Per SB552, Minimum flow for Crystal River/Kings Bay System must be adopted by July 1



2

Southwest Florida Water Management District

What is a Minimum Flow?

- Limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area
- Established to protect flowing systems from damage caused by ground and surface water withdrawals
- Protects from significant harm





3

Southwest Florida Water Management District

Environmental Values Protected When Developing Minimum Flows

- Recreation in and on the water
- Fish and wildlife habitats and the passage of fish
- Estuarine resources
- Transfer of detrital material
- Maintenance of freshwater storage and supply
- Aesthetic and scenic attributes
- Filtration and absorption of nutrients and other pollutants
- Sediment loads
- Water quality
- Navigation

4

Southwest Florida Water Management District

Defining Significant Harm

Significant harm threshold:

- Defined as more than a 15% decrease in available habitat or resource
- Protects 85% of available habitat or resource
- Developed at suggestion of independent scientists
- Supported by 18 panels of independent scientists reviewing proposed minimum flows for other flowing systems
- Method used in minimum flows adopted for 3 other Outstanding Florida Waters
- Well supported in the literature

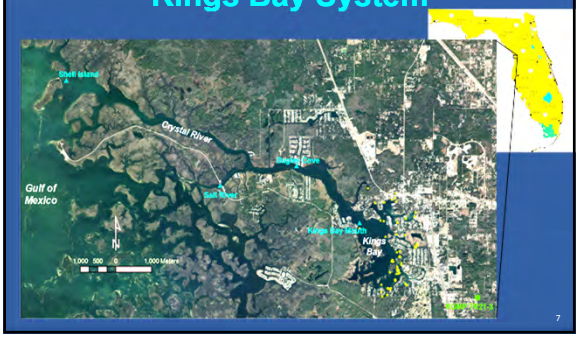
5

Southwest Florida Water Management District

MFL's Program

- *Established 207 MFL's*
  - 19 river segments
  - 16 spring systems
  - 128 lakes
  - 41 wetlands
  - 3 aquifer systems

Location of the Crystal River / Kings Bay System



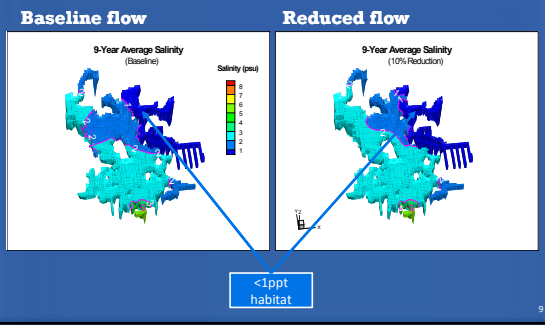
7

Results: Allowable Percent-of-Flow Reductions for Salinity Based Habitats

- Evaluated change in water volume, bottom area and shoreline length
  - At 1, 2, 3, 5, 10, 15 ppt
- 15% loss of the 0.5 ppt shoreline habitat occurs with a 11% reduction in flow
  - This was the most sensitive salinity-based habitat

8

Salinity-based habitat reductions



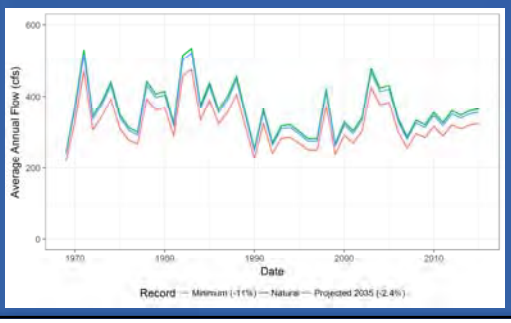
9

Recommended Minimum Flow for the Crystal River / Kings Bay System

- Recommended minimum flow is 89% of the baseline (i.e., natural) flow or an allowable 11% reduction
  - Based on most sensitive criterion: shoreline ≤ 0.5 ppt
- Minimum low-flow or high-flow thresholds not needed
- No need for recovery or specific prevention strategies
- Re-evaluate in 10 years

10

Minimum and projected flows compared with natural variation



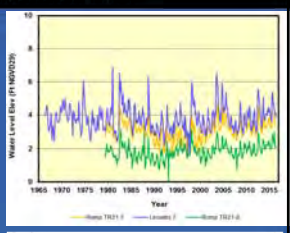
11

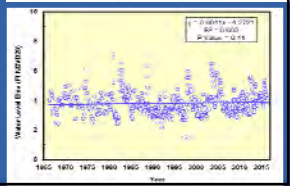
Measuring Springflow is Challenging

- **USGS Bagley Cove gage flow from 2002 through 2015 averages 447 cfs and is tidally-influenced**
- **Water budget: 20 in/yr of recharge in the springshed yields a springflow of 455 cfs**
- **900+ cfs from the 1960-70s includes marine water and springwater; would require 40 in/yr of recharge in springshed (not realistic)**
- **Peer review panel believes spring flow varies between 300 and 450 cfs – and not much different in the 1960s based on little change in Floridan aquifer water levels over the last 50 years**

12





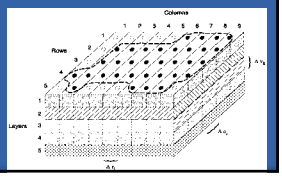


No long-term trend in UFA Water levels

Northern District Model (Version 5.0)



- Based on geologic data from 50 sites and matching 300 well water levels
- Peer Reviewed by Outside Experts
  "NDM, Version 5.0, is the best numerical groundwater flow model currently available for assessing the effects of withdrawals in the central (Florida) springs region."
- Model developed cooperatively with SJRWMD, Marion County, and WRWSA



Crystal River/Kings Bay Spring Flow Change from Groundwater Withdrawals

Year	Flow Reduction (cfs)	Flow Reduction (%)
2010	6.9	-1.5
2014	5.2	-1.1
2035	10.8	-2.4
2035 w/ Conserv & Reuse	9.6	-2.1

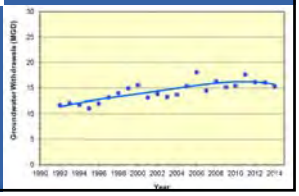
Note: Groundwater withdrawal impact based on Northern District Model Version 5

15

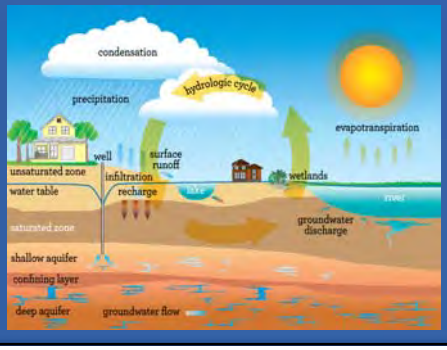


Kings Bay Springshed Groundwater Withdrawals
(Consumptively-used withdrawals = 2.3% of total springflow)

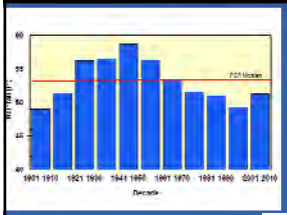
Kings Bay Springshed Groundwater Use History



Water Cycle



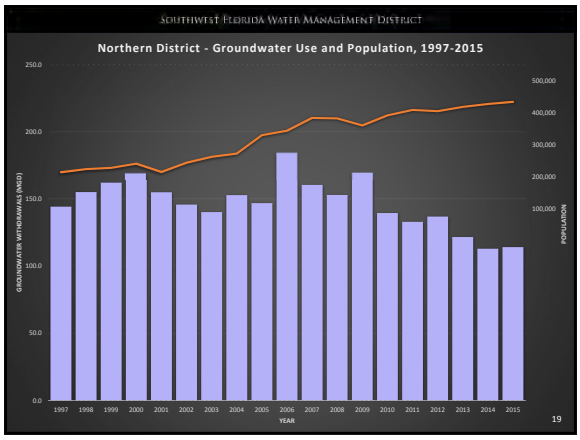
17

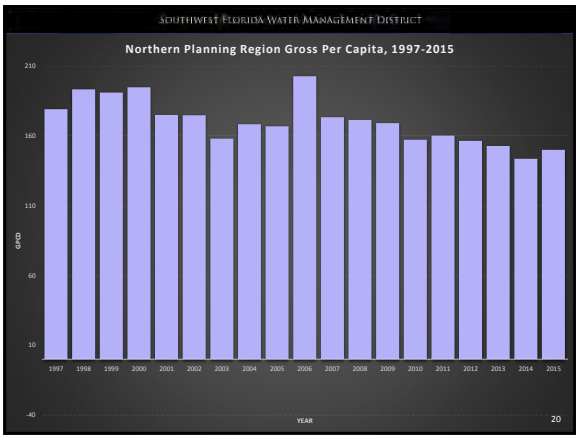


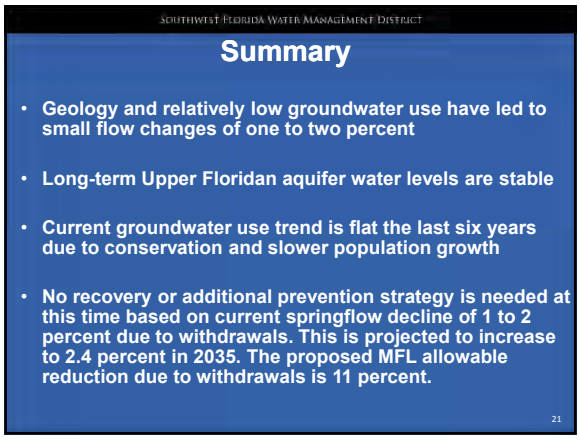
Long-term rainfall trends (1900-2010)

Annual departure in rainfall based on radar rainfall in springshed (1995-2015)




Southwest Florida Water Management District
Northern District - Groundwater Use and Population, 1997-2015
GROUNDWATER WITHDRAWALS (MGD)
POPULATION
YEAR
19


Southwest Florida Water Management District
Northern Planning Region Gross Per Capita, 1997-2015
GPCD
YEAR
20


Southwest Florida Water Management District
Summary
• Geology and relatively low groundwater use have led to small flow changes of one to two percent
• Long-term Upper Floridan aquifer water levels are stable
• Current groundwater use trend is flat the last six years due to conservation and slower population growth
• No recovery or additional prevention strategy is needed at this time based on current springflow decline of 1 to 2 percent due to withdrawals. This is projected to increase to 2.4 percent in 2035. The proposed MFL allowable reduction due to withdrawals is 11 percent.
21

Go with the flow or no?



MATTHEW BECK/Chronicle file

King's Bay in Crystal River is a popular destination for water activities. The Southwest Florida Water Management District (SWFWMD) will soon recommend a reduction of 11 percent of the current flow. The public will have an opportunity to give SWFWMD their views on the subject at a workshop set for 5 p.m. Thursday, April 27, at Crystal River Middle School.

Public invited to workshop on setting minimum flow levels for King's Bay

Michael D. Bates
Staff writer

The water district is working toward adopting minimum flow levels for the Crystal River/King's Bay system.

The Southwest Florida Water Management District is recommending a reduction of 11 percent of the current flow.

The public will have the opportunity to speak to issue at a SWFWMD-sponsored workshop set for 5 p.m. Thursday, April 27 at Crystal River Middle School, 344 NE Crystal St.

A minimum flow or level (MFL) is the limit at which further water withdrawals will cause significant harm to the water resources and the environment. The district said they are designed to protect streams and rivers from impacts associated with ground and surface water withdrawals.

If approved, it would allow the drawdown of up to 11 percent of the Crystal River/King's Bay system for well withdrawals. The district believes that is the maximum amount of drawdown that can occur before more than 15 percent of the habitat is damaged or destroyed.

- **WHAT:** Public workshop on King's Bay MFLs.
- **WHEN:** 5 p.m. Thursday, April 27.
- **WHERE:** Crystal River Middle School, 344 NE Crystal St.

Mark Hammond, director of the SWFWMD's Resource Management Division, told the Chronicle Editorial Board Wednesday it is basing the 11 percent figure on the best available scientific data.

"(An MLF) is just one of those things that protects our water systems," Hammond said.

The district had considered establishing a 12 percent flow level but revised it after receiving new data. If adopted, the district will re-evaluate it in 10 years. It can always revise it upward or downward at any time if new information is obtained.

The Florida Department of Environmental Protection has included the Crystal River/King's Bay system in its list of impaired waterways and in need of restoration.

Contact Chronicle reporter Michael D. Bates at 352-563-5660 or mbates@chronicleonline.com.

Citrus County Chronicle
Crystal River
Daily 25,740
April 20, 2017

From: Melissa Gulvin
To: Martin Johnson
Cc: Doug Leeper
Subject: Update on the proposed minimum flow for the Crystal River/Kings Bay system
Date: Tuesday, April 04, 2017 2:04:38 PM
Attachments: CRKB MFL Public Meeting Agenda.pdf

Hi Mr. Johnson,

I know you are closely following the proposed minimum flow for the Crystal River/Kings Bay system, so I wanted to give you a brief update. This might all be old news to you though!

1) The final draft of the Peer Review Report has been completed and is available electronically. In its report, the peer review panel supports the proposed minimum flow, which protects 88 percent of the natural flow.
2) The public meeting has been scheduled for Thursday, April 27 at 5 p.m. at the Crystal River Middle School auditorium. Agenda attached.
3) The presentation to the District's Governing Board will be at their board meeting on May 23.

Melissa Gulvin
Government Affairs Program Manager
Southwest Florida Water Management District
2379 Broad Street, Brooksville, FL 34604
(352) 796-7211, ext. 4419
(352) 206-4047 cell
Melissa.Gulvin@WaterMatters.org

From:	Alan Martyn Johnson
To:	Melissa Gulvin
Cc:	Doug Leeper
Subject:	Re: Update on the proposed minimum flow for the Crystal River/Kings Bay system
Date:	Wednesday, April 05, 2017 8:33:10 AM

Melissa,
Thanks for sharing. I was aware of the dates although when I heard about the meeting at the school it needed to be confirmed with someone (school board I think).
Martyn

From: Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>
Sent: Tuesday, April 4, 2017 2:04 PM
To: Martin Johnson
Cc: Doug Leeper
Subject: Update on the proposed minimum flow for the Crystal River/Kings Bay system

Hi Mr. Johnson,
I know you are closely following the proposed minimum flow for the Crystal River/Kings Bay system, so I wanted to give you a brief update. This might all be old news to you though!

1) The final draft of the Peer Review Report has been completed and is available electronically. In its report, the peer review panel supports the proposed minimum flow, which protects 88 percent of the natural flow.
2) The public meeting has been scheduled for Thursday, April 27 at 5 p.m. at the Crystal River Middle School auditorium. Agenda attached.
3) The presentation to the District's Governing Board will be at their board meeting on May 23.

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(352) 206-4047 cell
Melissa.Gulvin@WaterMatters.org

From:	Margit Crowell
To:	Alan Martyn Johnson
Cc:	Ron Basso; Doug Leeper; Ross Morton
Subject:	RE: Aggregate data question
Date:	Thursday, April 06, 2017 8:28:34 AM

You're very welcome.
If you have any other questions or need additional data, please let us know.

Regards,

Margit

Margit L. Crowell, M.S., M.Ed., GISP
Chief Scientific Data Analyst
Hydrologic Data Section
Data Collection Bureau
2379 Broad St, Brooksville, FL 34604
T: 352-796-7211, x4310 or 800-423-1476 (Florida only) | F: 352-797-5824 | E: Margit.Crowell@WaterMatters.org

---

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Wednesday, April 05, 2017 6:53 PM
To: Margit Crowell <Margit.Crowell@swfwmd.state.fl.us>
Cc: Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Subject: Re: Aggregate data question

Margit,

Thanks for the information.

As I have a busy few days ahead, so I have just taken a very quick look.

The data appears to confirm my thought about how the high figure reporting (being the high in 24 hour versus the high in the tidal 24.84 hours) sometimes influences the reported figures.

Some of the more unusual figures (larger differences from one day to the next) as shared with Ron in my initial e-mail will require time next week.

Just wanted to acknowledge your response and say Thanks.

Martyn

From: Margit Crowell <Margit.Crowell@swfwmd.state.fl.us>
Sent: Wednesday, April 5, 2017 9:44 AM
To: Alan Martyn Johnson
Subject: RE: Aggregate data question

Hello – The hourly water-level values are attached here in an Excel spreadsheet.

The file is sorted by site ID, then date/time of reading. I included all available raw data for both sites.

The water-quality data are only available as discrete values (no continuous/hourly data), so you already have all of those that are available from the external WMIS portal.

If you have any questions or need anything else, please do not hesitate to contact me.

Regards,

Margit

Margit L. Crowell, M.S., M.Ed., GISP
Chief Scientific Data Analyst
Hydrologic Data Section
Data Collection Bureau
2379 Broad St, Brooksville, FL 34604
T: 352-796-7211, x4310 or 800-423-1476 (Florida only) | F: 352-797-5824 | E: Margit.Crowell@WaterMatters.org

---

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Wednesday, April 05, 2017 9:17 AM
To: Margit Crowell <Margit.Crowell@swfwmd.state.fl.us>
Subject: Re: Aggregate data question

Margit,

Thanks for the information. I had forgotten about the second well and looked at the chloride levels a few minutes ago, and was amazed at what I saw. From 1987 thru 2015 the chloride levels have steadily increased from about 70 mg/l to about 120 mg/l. The results are very telling about the changes in Kings Bay, particularly as the chloride monitoring well has a depth of 240-250 feet and it is presumably at this depth the chloride sampling is done (think it was 46 samples over that time 1987 to 2015, but my screen must have timed out at that point).

Thank you for reminding me about this second well.

The well monitoring water level differ from each of the wells and again differ on the shallower well from the figures on the day tab to the aggregate tab.

Possibly these numbers from the last few days will help clarify my point.

	Chloride well	Level monitoring day tab	Level mon'g aggregate tab
4/4	2.38	2.04	2.01
4/3	2.44	2.04	2.39
4/2	2.17	1.99	2.51
4/1	2.29	2.05	2.42

If possible can you share the hourly figures from say the last month which will help me understand how recording the highest level seen in the 24 hours each day works. I suspect part of this is due to:

- the 24.84 hour tidal cycle; which may influence data when looking at highest level in a calendar days (24 hour)
- the reaction time for the hydraulics to get 240 feet down (although I would have thought this occurs in a fairly short timeframe

Martyn

From: Margit Crowell <Margit.Crowell@swfwmd.state.fl.us>
Sent: Tuesday, April 4, 2017 8:27 AM
To: Alan Martyn Johnson

Subject: RE: Aggregate data question

Hello – There are two active wells at that location, both under the name of ROMP TR 21-3:

ROMP TR 21-3 SURF AQ MONITOR

ROMP TR 21-3 AVPK PZ CHLORIDE MONITOR

We collect hourly water levels (top of the hour) at both. The hourly reading is an instantaneous reading from the sensor at that time.

The daily aggregate value, for groundwater sites, is the maximum value of the hourly readings.

I hope this helps you out – Please do not hesitate to let me know if you have any other questions.

Regards,

Margit

Margit L. Crowell, M.S., M.Ed., GISP
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Hydrologic Data Section
Data Collection Bureau
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T: 352-796-7211, x4310 or 800-423-1476 (Florida only) | F: 352-797-5824 | E: Margit.Crowell@WaterMatters.org

---

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Tuesday, April 04, 2017 7:54 AM
To: Margit Crowell <Margit.Crowell@swfwmd.state.fl.us>
Subject: Re: Aggregate data question

Margit,

Thanks for your e-mail.

I was specifically asking about ROMP TR21-3, so I guess the question more specifically is;

At what times each day is data collected from ROMP TR21-3?

Thanks,

Martyn

From: Margit Crowell <Margit.Crowell@swfwmd.state.fl.us>
Sent: Monday, April 3, 2017 1:49 PM
To: martynellijay@hotmail.com
Subject: Aggregate data question

Hello – I received your inquiry about the aggregate water-level values from WMIS from Ron Basso – I'll be glad to assist you.

The aggregate values are determined from any sub-daily (hourly or 15-minute) data that may be available for a particular site. Only those sites with recorders on them would have sub-daily data.

The recorder values are aggregated to a daily value as follows:

Groundwater sites: Daily maximum water level

Surface-water sites: Daily average water level

This is the same convention that the USGS follows.

If you have any other questions, please do not hesitate to contact me.

Regards,

Margit

Margit L. Crowell, M.S., M.Ed., GISP
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T: 352-796-7211, x4310 or 800-423-1476 (Florida only) | F: 352-797-5824 | E: Margit.Crowell@WaterMatters.org

From: Alan Martyn Johnson
To: Doug Leeper
Subject: Re: Percent flow approach
Date: Wednesday, April 12, 2017 8:53:09 AM

Doug,
My first e-mail after a relaxing week is, to say the least, difficult to comprehend in any practical sense.
Frankly, I get the impression staff are struggling to get their hands away from language that makes complete sense for a surface water fed river.

For a surface river an upstream measurement at station **A** is the natural flow. Then withdrawals from the river by municipality **B**, by farmer **C**, by subdivision community **D** reduce the flow. If the MFL is 10% of natural flow the maximum **B + C + D** can draw from the river is:

- **A** equals 750 cfs today the maximum **B + C + D** can draw before the MFL is reached is 75 cfs
- If last month the flow at **A** on the 12 th was 500 cfs the maximum **B + C + D** could draw was 50 cfs,
- Similarly next month on a day when the flow at **A** is 800 cfs the maximum **B + C + D** can draw is 80 cfs, but if they are only drawing 50 cfs the percent of natural flow withdrawn is 6.25 %.

Simple easy straight forward, the withdrawals are metered or measured by another measuring station.

No need to consider, for the MFL compliance, how much rainfall there was or any model to figure the withdrawals, no NDM (a regional model, not suited to use for individual rivers, springs) needs to be used/abused.

With all the 'factors/estimates' you include in the explanation it will be interesting to see how these are handled in the Rule Language.

Martyn
P.S. I assume this wording, which is work in progress, has been discussed/agreed by a number of District Staff.
Not clear if the multitude of factors/estimates you include are what Rule 62-40.473, F.A.C. is intended to convey as other resource protection tools, particularly as District have used the MFL as a percent of natural flow (albeit there is no agreed method to measure natural flow...other than what remains after poorly defined groundwater withdrawals).

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Friday, April 7, 2017 3:58 PM
To: martynellijay@hotmail.com
Subject: RE: Percent flow approach

Martyn:

Thanks for your March 31st email.

As noted in the District staff response to the Crystal River/Kings Bay peer review panel's final report that was provided to the Governing Board last week, our response to reviewer comment 19 indicates that additional text has been developed for Section 1.3.2 in the revised minimum flow report to address the panel suggestions regarding "how an allowable flow reduction expressed as a percent flow reduction would be applied to the SGD "flow regime…"

Specifically, the definition of "flow regime" has been modified to include an explanation of how a percent of flow reduction preserves the flow regime. Here is the current language associated with our proposed changes to the definition in the revised report. As that document is a draft work in progress, please note the text below may change.

x. A flow regime is a hydrologic regime characterized by the quantity, timing and variation of flows in a river. Rule 62-40.473, F.A.C., dictates that "minimum flows and levels should be expressed as multiple flows or levels defining a minimum hydrologic regime, to the extent practical and necessary to establish the limit beyond which further withdrawals would be significantly harmful" in Section 373.042(1), F.S. The emphasis on a flow regime, rather than a single minimum flow value, reflects the natural variation present in flowing water systems (Poff et al. 1997). Expressing a minimum flow as an allowable percentage of a flow addresses the intent of protecting the flow regime as allowable flow changes are proportionally-scaled to the magnitude of flow.

Hopefully it is clear from this revised language, from other portions of the minimum flow report, and from some of our previous correspondence and discussions that allowable percent of flow reductions associated with minimum flows are determined from baseline, i.e., natural flow records or conditions. An MFL would be "reached" or "passed" when withdrawal-associated flow reductions equal or exceed those associated with the minimum flow. Minimum flow status assessments rely heavily on hydrologic models and can be supported by evaluation of other types of information, such as rainfall data, flow data, water level data, geological information (e.g., sinkhole occurrence) and withdrawal rate information.

Doug Leeper
MFLs Program Lead
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doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Friday, March 31, 2017 10:59 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>

Subject: Percent flow approach

Briefly as using a kind persons computer.

The comment about percent flow in staff response to KBCR peer review is Comment 19 and as best I recall is Package Page 147. Hope I remember that correctly. I think it said explanation would be in the 'revised' report.

At least one example of how MFL would be reached/passed will help, then rule wording can be written to be clear, plain and complete.

Martyn

From: Alan Martyn Johnson
To: Doug Leeper
Cc: Xinjian Chen
Subject: Kings Bay Districts Empirical Equation
Date: Wednesday, April 12, 2017 9:06:05 AM

Doug/Dr. Chen,
As you may have seen last week I was digging into ROMP TR21-3. Can you confirm which gage ht you are using in the Districts Empirical Equation. Is it the deep well (chloride monitoring) or the shallow well (surface water monitoring)?

There is not a lot of difference, but after a rain the surface water monitoring well reacts faster and the chloride well has a slightly different tidal signature.

Thanks,
Martyn

From:	Doug Leeper
To:	"Alan Martyn Johnson"
Cc:	Xinjian Chen
Bcc:	Gabe I. Herrick; Ron Basso; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ross Morton
Subject:	RE: Kings Bay Districts Empirical Equation
Date:	Friday, April 14, 2017 2:25:00 PM

Martyn:

We used the deep, groundwater level for the Upper Floridan Aquifer (Avon Park) at ROMP TR21-3.

Doug Leeper
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doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Wednesday, April 12, 2017 9:06 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>
Subject: Kings Bay Districts Empirical Equation

Doug/Dr. Chen,

As you may have seen last week I was digging into ROMP TR21-3. Can you confirm which gage ht you are using in the Districts Empirical Equation. Is it the deep well (chloride monitoring) or the shallow well (surface water monitoring)?

There is not a lot of difference, but after a rain the surface water monitoring well reacts faster and the chloride well has a slightly different tidal signature.

Thanks,

Martyn

From: Alan Martyn Johnson
To: Doug Leeper
Cc: Xinjian Chen
Subject: Spring Groundwater Discharge into Kings Bay
Date: Thursday, April 13, 2017 8:09:49 AM

Doug/Xinjian,
Are you keeping a current record of the spring discharge into Kings Bay?

If so can you share the total discharges for the last month or two weeks in the format you previously used i.e. hourly.

Thanks,
Martyn

From:	FootPrintsPRR
To:	Doug Leeper
Subject:	SWFWMD Public Records Request - Martyn Johnson - Data - Spring Discharge into Kings Bay Public Re...
Date:	Thursday, April 13, 2017 9:05:55 AM

When replying, type your text above this line.

Notification of Issue Registration

Workspace: Public Records Request
Issue: Martyn Johnson - Data - Spring Discharge into Kings Bay Public Records Request
Issue Number: 22926

Priority: Medium **Status:** Under 7 days old
Date: 04/13/2017 **Time:** 09:05:12
Created By: Shellie Ferreira-Lee

Description:
Entered on 04/13/2017 at 9:05:12 AM EDT (GMT-0400) by Shellie Ferreira-Lee:

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Thursday, April 13, 2017 8:10 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>
Subject: Spring Groundwater Discharge into Kings Bay

Doug/Xinjian,
Are you keeping a current record of the spring discharge into Kings Bay?

If so can you share the total discharges for the last month or two weeks in the format you previously used i.e. hourly.

Thanks,

Martyn

Current Assignees: Document Services, Carol Daleo, Earl Rich, Peggy Meinhardt, Shellie Ferreira-Lee, Valerie Jordan

CC(s): (this edit only) doug.leeper@swfwmd.state.fl.us

Issue Information:

Internal Request: Off

Contact Information:

Last Name: Johnson **First Name:** Martyn
Email Address: martynellijay@hotmail.com

From:	Doug Leeper
To:	"Alan Martyn Johnson"
Cc:	Xinjian Chen
Bcc:	Ross Morton; Chris Anastasiou; Mark A. Green; Gabe I. Herrick; Ron Basso; Kevin Grimsley (kjgrims@usgs.gov)
Subject:	RE: Spring Groundwater Discharge into Kings Bay
Date:	Friday, April 14, 2017 2:56:00 PM

Martyn:

The District is not maintaining current estimates of spring discharge into Kings Bay. The USGS station at the mouth of Kings Bay that has been used in combination with water level data from the ROMP TR21-3 well for estimating discharge is off-line.

The station was damaged (again) by an errant boater last year and we are working with the USGS to install a new data collection station at the mouth of the bay.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
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352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Thursday, April 13, 2017 8:10 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>
Subject: Spring Groundwater Discharge into Kings Bay

Doug/Xinjian,

Are you keeping a current record of the spring discharge into Kings Bay?

If so can you share the total discharges for the last month or two weeks in the format you previously used i.e. hourly.

Thanks,

Martyn

From: Doug Leeper
To: Shellie Ferreira-Lee
Cc: Ross Morton
Subject: FW: Spring Groundwater Discharge into Kings Bay
Date: Friday, April 14, 2017 2:58:00 PM

Shellie – Per our discussion, I responded (see below) to Mr. Johnson's public records request using his original email.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
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doug.leeper@watermatters.org

From: Doug Leeper
Sent: Friday, April 14, 2017 2:56 PM
To: 'Alan Martyn Johnson' <martynellijay@hotmail.com>
Cc: Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>
Subject: RE: Spring Groundwater Discharge into Kings Bay

Martyn:

The District is not maintaining current estimates of spring discharge into Kings Bay. The USGS station at the mouth of Kings Bay that has been used in combination with water level data from the ROMP TR21-3 well for estimating discharge is off-line.

The station was damaged (again) by an errant boater last year and we are working with the USGS to install a new data collection station at the mouth of the bay.

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Thanks,

Martyn

From: Alan Martyn Johnson
To: Doug Leeper
Cc: Xinjian Chen
Subject: Re: Kings Bay Districts Empirical Equation
Date: Monday, April 17, 2017 7:36:31 AM

Doug and Xinjian,
Thanks for the confirmation.
That will help me further examine the discharge record Doug shared with me.
There are some parts of the record that do not make sense to me (even if I accept the fact that you get average flow from the vent measurements in the VHB studies).

Martyn

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Friday, April 14, 2017 2:25 PM
To: Alan Martyn Johnson
Cc: Xinjian Chen
Subject: RE: Kings Bay Districts Empirical Equation

Martyn:

We used the deep, groundwater level for the Upper Floridan Aquifer (Avon Park) at ROMP TR21-3.

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doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Wednesday, April 12, 2017 9:06 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>
Subject: Kings Bay Districts Empirical Equation

Doug/Dr. Chen,
As you may have seen last week I was digging into ROMP TR21-3. Can you confirm which gage ht you are using in the Districts Empirical Equation. Is it the deep well (chloride monitoring) or

the shallow well (surface water monitoring)?
There is not a lot of difference, but after a rain the surface water monitoring well reacts faster and the chloride well has a slightly different tidal signature.
Thanks,
Martyn

From: Alan Martyn Johnson
To: Doug Leeper
Cc: Xinjian Chen
Subject: Re: Spring Groundwater Discharge into Kings Bay
Date: Monday, April 17, 2017 7:32:04 AM

Doug and Xinjian,
I thought that was the case, no discharge data since mid October 2015 as far as I see). USGS Gage destroyed May 19/20, 2016.

Maybe we will soon start getting some discharge data from Saragassa Canal 02310740 and Hunters Cove 02310743. There are already gage height readings which make some interesting comparisons to ROMP TR21-3 possible.

So what spring discharge measurements (after withdrawals) will be in the MFL?

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Martyn

From:	Doug Leeper
To:	"martynellijay@hotmail.com"
Cc:	Xinjian Chen
Bcc:	Gabe I. Herrick; Ron Basso; Chris Anastasiou; Mark A. Green; Jennette Seachrist; Mike R. Bray
Subject:	RE: Spring Groundwater Discharge into Kings Bay
Date:	Friday, April 21, 2017 5:40:00 PM

Martyn:

The proposed rule language for the Crystal River/Kings Bay system is expected to address natural flow at the UGSS Bagley Cove gage or as measured at any other point in the system.

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Thanks,

Martyn

From: Alan Martyn Johnson
To: Doug Leeper
Cc: Xinjian Chen
Subject: Re: Spring Groundwater Discharge into Kings Bay
Date: Saturday, April 22, 2017 7:55:48 AM

Doug,
Thanks for the heads up, but I really do not know what to say above that...I am speechless!

I trust you had a great weekend (not in the office until Monday).

Martyn

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Friday, April 21, 2017 5:40 PM
To: martynellijay@hotmail.com
Cc: Xinjian Chen
Subject: RE: Spring Groundwater Discharge into Kings Bay

Martyn:

The proposed rule language for the Crystal River/Kings Bay system is expected to address natural flow at the UGSS Bagley Cove gage or as measured at any other point in the system.

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Thanks,
Martyn

Presented to Save Crystal River on 4/12/2017

Proposed Minimum Flow for the Crystal River Kings Bay System

Presented by SWFWMD Staff:

- Melissa Gulvin (Government Affairs Program Manager)
- Gabe Herrick, Ph.D. (Senior Environmental Scientist)
- Doug Leeper (MFLs Program Lead)

What is a Minimum Flow?

- Limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area
- Established to protect flowing systems from significant harm caused by ground and surface water withdrawals
- Often referred to as “MFL”

Why Establish a Minimum Flow?

- Required by state law for priority springs, streams and rivers [Section 373.042(2), F.S.]
- Minimum flows for all Outstanding Florida Springs must be adopted by July 1, 2017 [SB552]

MFL Process

- The District has set more than 200 MFLs
- The best information (data) available is used
- Independent scientific peer review panel evaluates the work of District scientists
- Very transparent process
- The general public and other governments/agencies review and comment

MFL Process Continued: Timeline for Crystal River/Kings Bay System MFL

Time Frame	Activities
2007 – Ongoing	Data collection and analyses specific to MFL
November – December 2016	Peer review panel meets and provides evaluation of the peer review draft report
December 2016 – March 2017	District Governing Board shown the peer review feedback and staff’s response; Staff preparing the draft report and posting online
April 27, 2017	Public meeting to seek public input
May 23, 2017	Presentation to Governing Board and request for adoption of the proposed minimum flow
June 2017	Rule-making process
July 1, 2017	MFL must be adopted as required in Section 373.042(2), F.S.

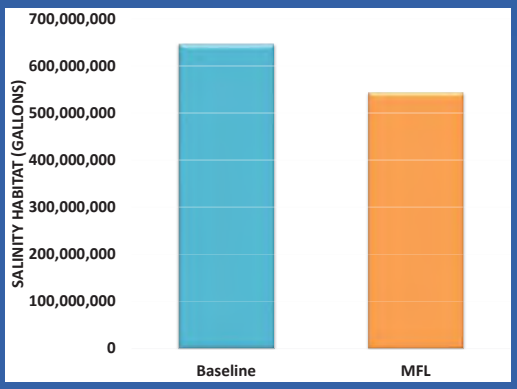
Environmental Values Protected When Developing Minimum Flows

- Recreation in and on the water
- Fish and wildlife habitats and the passage of fish
- Estuarine resources
- Transfer of detrital material
- Maintenance of freshwater storage and supply
- Aesthetic and scenic attributes
- Filtration and absorption of nutrients and other pollutants
- Sediment loads
- Water quality
- Navigation

Proposed Minimum Flow

- Most sensitive environmental value for Crystal River/ Kings Bay System is low-salinity habitat
- Greater than **12 percent** reduction in average flow is significantly harmful to low-salinity habitats
- Proposed minimum flow protects **88 percent** of natural flow

Gallons of Low-Salinity Habitat Available

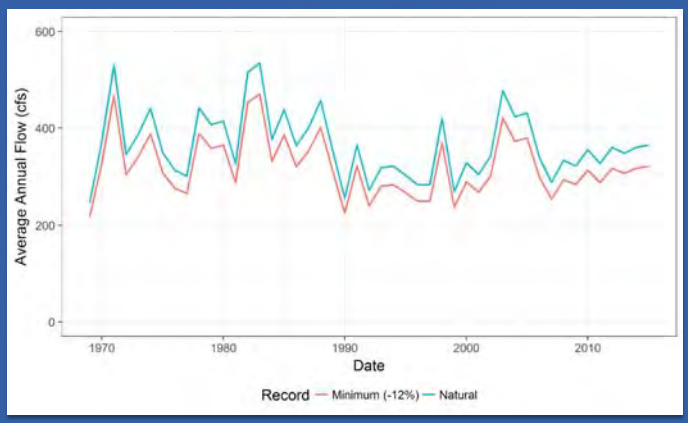


Water Quality

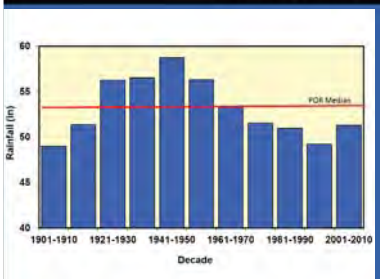
- No strong relationships between water quality and flow
- District is committed to continue additional evaluations between flow and water quality

Springs Coast Steering Committee

Minimum Flow is a Percentage



Minimum flow is a percentage of natural flow, not an average or median flow.



Rainfall Trends

Long-term rainfall trends From 1900-2010

Departure from average annual rainfall 1995-2015

Purple = above average Red = below average

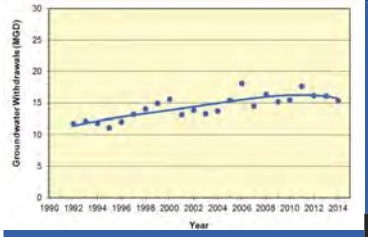


Groundwater Withdrawal

- Current impacts from groundwater withdrawal reduce flow by 1-1.5 percent
- Projected 2035 impacts reduce flow by 2-2.5 percent

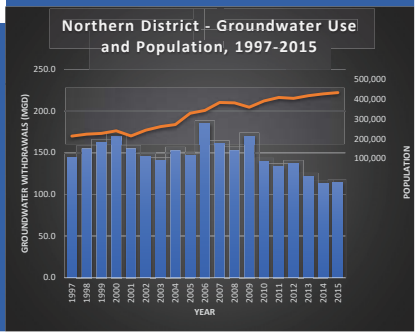
Year	Natural flow	Groundwater withdrawal	Percent reduction from withdrawal
2010	449 cfs	6.9 cfs	-1.5 %
2014	449	5.2	-1.1
2035 projection	449	10.8	-2.4
2035 with conservation and reuse	449	9.6	-2.1

Water Use Trends



Kings Bay Springshed Groundwater Use History

Northern District Groundwater Use and Population

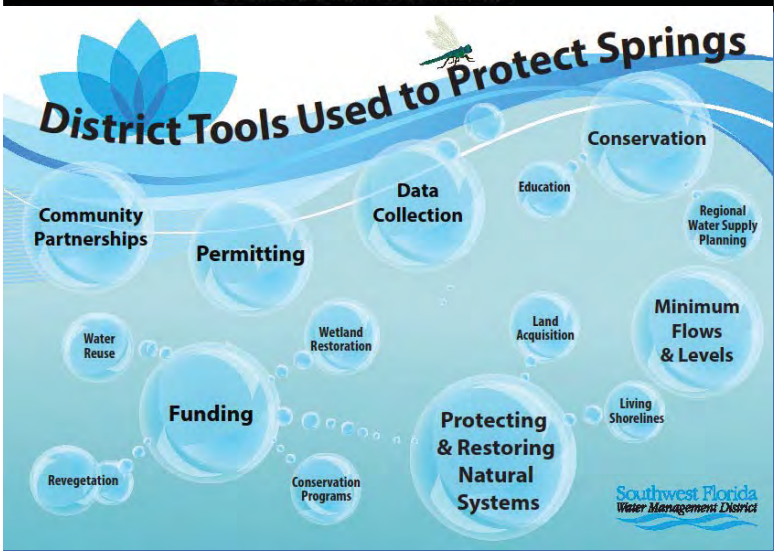


In Summary

- Proposed minimum flow protects 88 percent of the natural flow
- 2035 projections show less than 2.5 percent reduction in natural flow
- No MFL recovery or prevention strategy is needed or projected to be needed

Minimum Flow Status Assessments

- Recommend minimum flow re-evaluation in 10 years
- Conduct annual status assessments and five-year assessments for regional planning
- Continue ongoing monitoring of water quality, flows, groundwater conditions, and rainfall



Additional Slides

Defining Significant Harm

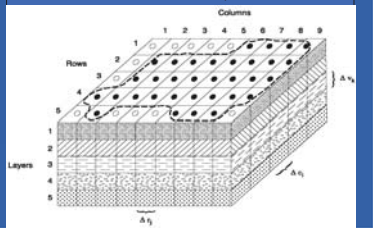
Percent of Flow – Percentage that flow can be reduced without reducing the availability of habitats or resources by more than 15 percent

- Approach is well supported in literature and used internationally
- Developed at suggestion of independent scientists and supported by 17 panels of independent scientists for use in similar systems
- Used in minimum flows adopted for the Homosassa, Chassahowitzka and Weeki Wachee Rivers

Northern District Model (Version 5.0)

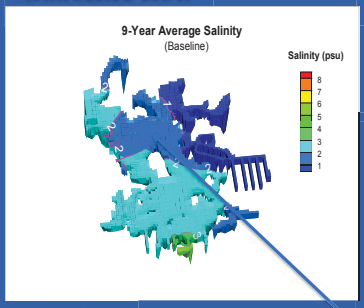


- Layer 1 – Surficial Aquifer
- Layer 2 – Intermediate Confining Unit (Hawthorn)
- Layer 3 – Upper Floridan Aquifer (Suwanee)
- Layer 4 – Upper Floridan Aquifer (Ocala)
- Layer 5 – Upper Floridan Aquifer (Upper Avon Park)
- Layer 6 – Middle Confining Unit
- Layer 7 – Lower Floridan Aquifer (Lower Avon Park/Oldsmar)

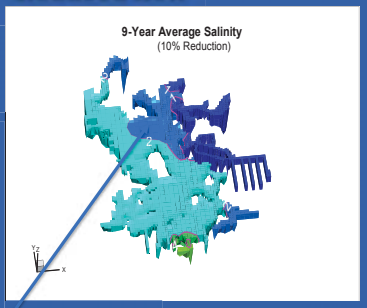


Salinity-based habitat reductions

Baseline flow



Reduced flow

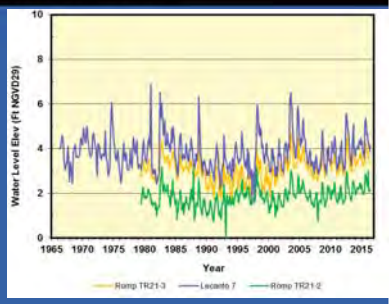


<2ppt habitat

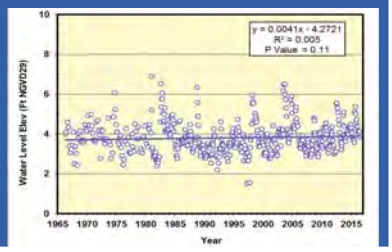
Measuring Springflow is Challenging

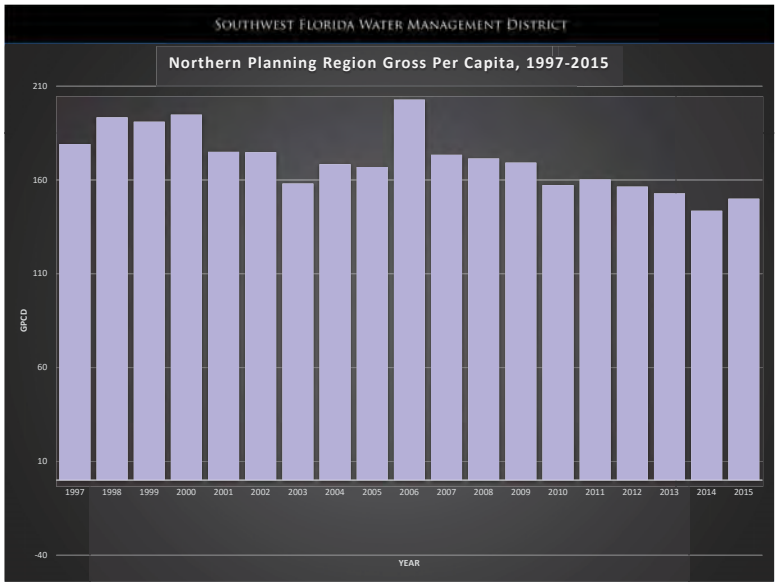
- USGS Bagley Cove gage flow from 2002 through 2015 averages 447 cfs and is tidally-influenced
- Water budget: 20 in/yr of recharge in the springshed yields a springflow of 455 cfs
- 900+ cfs from the 1960-70s includes marine water and springwater; would require 40 in/yr of recharge in springshed (not realistic)
- Peer review panel believes spring flow varies between 300 and 450 cfs – and not much different in the 1960s based on little change in Floridan aquifer water levels over the last 50 years





No long-term trend in UFA Water levels





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Managing fish and wildlife resources for their long-term well-being and the benefit of people.

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MyFWC.com

April 21, 2017

Doug Leeper
MFL Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
doug.leeper@watermatters.org

RE: Crystal River/Kings Bay System Recommended Minimum Flow and Level Report, Citrus County, FL

Dear Mr. Leeper:

Florida Fish and Wildlife Conservation Commission (FWC) staff has reviewed the above-referenced report, appendices, and the Crystal River/Kings Bay system minimum flow and level (MFL) peer review report. We provide the following comments and recommendations as technical assistance during your review of the draft MFL under Chapter 373, Florida Statutes, and in accordance with FWC's authorities under Chapter 379, Florida Statutes.

Project Description

The MFL Report explains the process for setting the proposed minimum flows for the Crystal River/Kings Bay system. The Crystal River/Kings Bay system consists of a group of 70 springs that discharge approximately 201 million gallons per day into the 600 acre Kings Bay. Water from Kings Bay flows into the Crystal River, which flows for approximately six miles before meeting the Gulf of Mexico. This close proximity to the Gulf results in a system that is heavily influenced by marine tides and salt water intrusion. Discharge from spring vents is affected by groundwater levels within the aquifer and by surface water level in the bay above each vent. Rising groundwater levels increase discharge, while rising surface water levels decrease discharge. Since the spring vents occur in an unconfined region of the aquifer, groundwater levels are directly influenced by rainfall and consumptive water use. As such, discharge from the springs varies seasonally in correspondence with rainfall patterns for west-peninsular Florida, and on tidal cycles with the Gulf of Mexico.

Spring discharge and its effect on water salinity, temperature, and residence time within the system were modeled by the Southwest Florida Water Management District (SWFWMD) staff. The models allowed evaluation of salinity-based habitats and manatee thermal refugia as the most sensitive potential indicators of significant harm as described by the SWFWMD. Residence time and several water quality parameters (nitrogen, phosphorus, and dissolved oxygen) were also evaluated through the models but were considered inconclusive in setting the minimum flow values. The volume of water under 2 parts-per-thousand (ppt) salinity was determined to be the criterion upon which the minimum flow would be based since other parameters would be protected using this criterion.

Based on this 2 ppt threshold, the SWFWMD concluded that the Crystal River/Kings Bay system could withstand a 12% reduction in flow from the baseline condition. It was estimated that establishing the MFL at this 2 ppt threshold may reduce the salinity-sensitive habitat in the system that can persist at this level by 15%. The SWFWMD also proposed that the development of a recovery strategy or specific prevention strategies for recovering flows or preventing flows from falling below the proposed minimum flow are not currently necessary based upon potential groundwater withdrawals in the 20-year planning horizon. SWFWMD staff indicates the need to continue monitoring flows in the system and complete periodic status assessments to ensure that the established minimum flow continues to be met. A final recommendation is to reevaluate the MFL for the system within the next ten years.

Comments and Recommendations

FWC staff supports the protection of habitats within the Crystal River/Kings Bay system using the 2 ppt threshold as an effective method for protecting a diverse array of species and preventing significant impacts to the Crystal River/Kings Bay system and coastal estuary. Based on this proposed MFL, FWC staff are focused on potential impacts to submerged aquatic vegetation, the Florida manatee, and potential impacts sea-level rise may have on both.

Submerged aquatic vegetation (SAV) has many positive impacts on the Crystal River/Kings Bay system, and management of low salinity habitats to encourage the growth and expansion of beneficial freshwater vegetation is especially important. Sustainable native freshwater vegetation will in turn have positive effects on water quality throughout the system and provide foraging habitat for manatees that may use the system as a thermal refuge. FWC staff will continue to work with Florida Department of Environmental Protection (FDEP) and the SWFWMD toward improving SAV habitat within the Crystal River/Kings Bay system.

Modeling results demonstrate that manatee thermal refugia, even at the proposed MFL, is not a factor limiting population size in the Crystal River/Kings Bay system. However, federal and state manatee plans both support conserving and restoring natural warm water refuges to provide optimal warm water habitat for manatees. Artesian springs that provide natural warm water habitat for manatees will become even more important for the continued recovery of the Florida manatee in the future, and the Crystal River/Kings Bay system is the most important natural warm water habitat for manatees in Florida. FWC offers continued technical assistance and funding in working with FDEP and the SWFWMD toward improving manatee habitat in the Crystal River/Kings Bay system.

Additionally, sea level rise is predicted to impact the Crystal River/Kings Bay system, altering the sensitivity of the system to reductions in spring flow. As noted above, SWFWMD modeling results indicate that a 12 percent reduction in flow under current sea level conditions corresponds to a 15 percent decrease in the volume of 2-ppt salinity habitat, and the amount of habitat loss increases to between 18 percent to 28 percent depending on the degree of sea level rise predicted over the next 20 years. FWC supports the SWFWMD's suggested need for on-going monitoring of the system and regular

reevaluation of MFLs to determine the severity of the potential impacts of sea level rise on the system.

Finally, FWC staff would like to note that FWC Fishery Independent Monitoring (FIM) data were also provided to the SWFWMD staff for consideration in the development of the MFL for this system. While the data were not as sensitive as the selected parameters above, we recommend future monitoring and modeling consider this information as part of any reevaluation. FWC staff continues to be available to provide technical assistance to the SWFWMD staff in analysis of the freshwater and marine species data with appropriate flow considerations.

We appreciate the opportunity to provide input on the above-referenced MFL draft report. If you need further assistance, please do not hesitate to contact Jane Chabre either by phone at (850) 410-5367 or at FWCConservationPlanningServices@MyFWC.com. If you have specific technical questions regarding the content of this letter, please contact Ted Hoehn at ted.hoehn@MyFWC.com or at (850) 488-8792.

Sincerely,

Tom Champeau

Tom Champeau, Director
Division of Freshwater Fisheries Management

tc/th
ENV 1-12-2
Crystal River Kings Bay MFL_32719_042117

cc: Shannon Wright, FWC-NE Regional Director
Kristine P. Morris, DEP, Kristine.P.Morris@dep.state.fl.us

Minimum Flow Workshop for Florida's Crystal River Springs

The Fishing Wire

April 24, 2017

[District to Hold Workshop on Minimum Flow for Crystal River/Kings Bay in Citrus County]

The Southwest Florida Water Management District (District) invites the public to a workshop on Thursday, April 27 at 5 p.m. at Crystal River Middle School, located at 344 N.E. Crystal Street in Crystal River. The purpose of the workshop is to allow for public comment on the proposed minimum flow for the Crystal River/Kings Bay system in Citrus County.

The Florida Legislature requires the District to set minimum flows and levels for priority water bodies within the District. A minimum flow or level is the limit at which further water withdrawals will cause significant harm to the water resources and/or environment. Minimum flows are a protection measure established to protect streams and rivers from impacts associated with groundwater and surface water withdrawals. They serve as guidelines for the District's permitting programs and for development of alternative water resource projects.

The District has been developing a minimum flow for Crystal River/Kings Bay system for many years. The District's experienced scientists use numerous tools to collect, develop and analysis data before proposing a minimum flow. Their work is then evaluated by an independent peer review panel. During the workshop, District staff will review the technical basis for the proposed minimum flow for Crystal River/Kings Bay.

The workshop will also provide an opportunity for local government, citizens, and others to comment on the proposed minimum flow for the system. Through this open and transparent process, information gathered at the workshop will be summarized and made available to the District's Governing Board. District staff anticipates presenting the proposed minimum flow for Crystal River/Kings Bay at the May Governing Board meeting, where the Governing Board may choose to recommend adoption of the minimum flow into District rules. Governing Board meetings are open to the public, and brief oral comments are permitted on meeting agenda items.

Draft reports summarizing the proposed minimum flow are available for review and are posted on the District's website at WaterMatters.org. For more information regarding the proposed minimum flow, please contact Gabe Herrick, a Senior Environmental Scientist with the District's Springs & Environmental Flows Section at 1-800-423-1476, ext. 4275.

Written comments regarding the minimum flows are also welcome. They can be submitted via mail or email to Gabe Herrick, at 2379 Broad Street, Brooksville, FL 34604-6899 or gabe.herrick@watermatters.org

From: Alan Martyn Johnson
To: Doug Leeper; Ron Basso
Subject: ROMP TR21-3
Date: Wednesday, April 05, 2017 7:14:29 PM

Please note the increase chloride level since 1987 for the deep chloride monitoring well ROMP TR21-3. From my limited knowledge this appears to be fairly significant as the sampling is from the Avon Park formation in an area close to the coast. Is this indicative of salt water intrusion? Would appreciate your thoughts particularly as there are presumably other chloride monitoring wells.

I have also been looking at the monthly data ROMP TR21-3 (extracted myself) to see if there is any seasonal signature, as in wetter/drier months. I do not see a seasonal signature, or a wetter drier year correlation. May be the use of this well data as a flow predictor is not so good after all. Remember also Dan Yobbi commented about how the use of 2 months VHB measurements was hardly ""long term"".

Still no hard evidence to support the "Pulsing Springs of Kings Bay".

Martyn

From:	Alan Martyn Johnson
To:	Doug Leeper
Cc:	Xinjian Chen; Gabe I. Herrick; Ron Basso; Kym Holzwart; Eric DeHaven
Subject:	Re: Pulsing Springs Of Kings Bay
Date:	Monday, April 17, 2017 8:38:45 AM
Attachments:	image005.png image006.png image007.png

Doug,
Did you not get Good Friday as a holiday?
That is true dedication, which I respect.

Re the later turquoise staff comments, you shared these with me before March 30. I responded briefly, but left further response for a later date, so let me take the time warranted by the turquoise comments to respond further:
They are the same in-the-box thinking and generally indicate a concerted effort to promote the District's empirical equation and resulting flow modelling for which there is no factual evidence to support the 'pulsing'. Is disappointing the writer continued to say there are negative monthly data Bagley Cove when these are only in months when incomplete data are used...**THAT IS THE FACT.**

The final response
Staff response (3/30/2017): For all of the reasons above, the **Bagley Cove data does not reflect 'springs discharge'** as noted in the REMARKS for the Bagley Cove gage. District empirical-formula discharge is based on groundwater levels and surface water levels, and thus reflects seasonal variations in those levels.
clearly shows the writers thought process. Guess there is so much equity in the pulsing springs hypothesis it is hard to consider it could be/is flawed.

Let me address the orange comments.

Re your comment on rainfall and withdrawals.
The general idea was when rainfall is lower withdrawals are likely higher (crop irrigation and grass beautification) as I stated, without the examples. The actaul withdrawals are hard to monitor given the many wells with permits up to 100,000 gpd which do not require metering (Note I have not followed up on that understanding per previous e-mail). Some AG permits have peak four times that (no meter). Municipal withdrawals I would think can be monitored/analysed in more detail and show the differences at weekends versus week days and wet versus dry seasons...may be recreational uses, golf courses, can be monitored season to season. The point is there are some significant differences between reality and the models, and **enforceable rules can't rely on models**. The judge and jury want the truth, the facts.

Bagley Cove

I think both Bagley Cove USGS Stations were/are intended to get information on the water discharged from Kings Bay Springs,. Prior efforts were infrequent 'one time' data collection over a few days or less. Some of infrequent measurements went to great lengths to get accurate data, such as the one where five boats with flow measuring equipment were moored across the river (was that Rosenau...not going to look it up right now). Those measurements should not be dismissed, but viewed in the context of accuracy in this difficult task. Since the USGS/SWFWMD started continuous monitoring (original and present sites), the dedicated guys/gals from USGS do not go out to make regular Field Measurement to calibrate the flow measuring equipment simply to provide data to verify computer modelling.....they have been doing that long before the modelling was even dreamed of. If it were only gage height, temperature and salinity data the equipment needed is much easier and less expensive to install and maintain than flow measuring equipment. Just look at all the other site where gage height, salinity and temperature are collected.

Frankly, I believe the USGS data is closer to the truth regarding discharge of Kings Bay Springs than the empirical equation discharge which is used as input to the model. BECAUSE, there is no hard evidence to support the variations in spring discharges the empirical equation generates.

Let us all understand measuring of spring discharge into Kings bay as regards cfs is no easy task. The VHB work was a great start in the right direction, as are the two new sites 02310740 and 02310743. Unfortunately, in my opinion, the District (remembering our coffee conversation) appear to be unable to understand how the empirical equation generates the very unusual results of spring discharges which pulse so markedly. Given all the divers, scientists, fishermen,nature lovers, spring watchers etc they have all missed observing this unusual spring discharge phenomena. I do not think so. If there were springs pulsing to the magnitude the empirical equation hypothesis presents it would have been a well recognized phenomena for years.

Regarding ROMP TR21-3.

I have been reviewing the data Margit sent me along with the gage height at Mouth of Kings Bay (particularly at the time of the VHB studies) and focusing a fair amount of time on major changes seen in the ROMP data (see my e-mail to Ron April 3). Just amazing how quickly the level changes sometimes, and hard to believe this is representative of the driving forces for spring dischage from the aquifer. The well(s) act more like a rain gages reacting rapidly to heavy rainfalls which in turn results in calculated spring discharges reacting quickly. Just take a look.

Hurricane Isaac provides an outstanding example.

Hour 110918 500cfs

Hour 110926 950cfs

Hour 110942 500cfs

Sorry to use nice round numbers, but accuracy to the second decimal is simply not true. I know

some staff member is going to say this is an unusual situation, maybe blaming the instrumentation not the computer or hypothesized equation.
I have lots of other examples particularly around the times of the VHB studies and will share them in due course.

Have a good one,
Martyn

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Friday, April 14, 2017 4:10 PM
To: martynellijay@hotmail.com
Cc: Xinjian Chen; Gabe I. Herrick; Ron Basso; Kym Holzwart
Subject: RE: Pulsing Springs Of Kings Bay

Martyn: Thanks for your March 31st email. See staff responses imbedded in the body of your email below.

Doug Leeper
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Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Friday, March 31, 2017 8:25 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>; Mark A. Green <Mark.Green@swfwmd.state.fl.us>; Jennette Seachrist <Jennette.Seachrist@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>; Mike R. Bray <Mike.Bray@swfwmd.state.fl.us>; speene@appliedtm.com; kwatson@hsweng.com
Subject: Re: Pulsing Springs Of Kings Bay

Doug,
It was good that we spoke yesterday regarding the rule language for Rainbow.
While I do not have much time this morning I would like to confirm our agreement that the flow as measured at the USGS gage on Rainbow referenced in the rule, is the natural flow minus the

withdrawals. We agree the natural flow varies primarily with rainfall and the withdrawals do not. Hence my comment in a recent e-mail the withdrawals are not simply a percent of the flow measured at the gage.

I think we agreed on the generalized idea, when rainfall is lower pumping most likely increases rather than decreases.

Staff response (4/14/2017): *I think I agree with what you've written above, although I would clarify that withdrawals can vary with rainfall on a seasonal basis and for shorter-term periods.*

Regarding our conversation re WS Farms I did briefly speak to a lady in Permitting; she thought the reason for no pumpage data in that permit file is because the average 84300 gpd is lower than the 100000 gpd when a meter is required and the draw pipe diameter is also below 'meter required'. She thought peak pumpage (428200 gpd for this permit) is not a metering criteria

She was very helpful and very professional and did say she was not an 'authority' on such details and referred me to another person...unfortunately it went to voicemail. I will follow up as time permits.

You commented the withdrawals are dynamic with new wells being installed and old ones being closed down. I agree but the vast majority are in regular use, so I see no reason for a comprehensive list of the withdrawals in the springshed being maintained (agreed for Rainbow it will require co-operation with SJRWMD). Withdrawals in the rule need to be actual withdrawals in the springshed (given the normal estimations used for water use reporting) not some modeled data.

Regarding the comments on the pulsing springs of Kings Bay, I will respond in detail as time permits, but for now let me ask;

Why does USGS take the time to produce the data?

Staff response (4/14/2017): *In cooperation with the District, the USGS monitors flow and other parameters at the Bagley Cove site to develop data that can be used for scientific and environmental management purposes. Discharge reported at the Bagley Cove gage measures "a combination of flow and water storage caused by higher or lower Gulf of Mexico mean water levels." This is useful information. However, it is "not total 'freshwater' flow". These are not mutually exclusive statements. Furthermore, gage height, salinity, and temperature at the Bagley Cove gage were used to verify hydrodynamic model results. Note: quotes here taken from remarks in the water-year summary for the gage available on the USGS web site.*

and

No doubt there is data that staff who write these responses have on the seasonal variation of ROMP TR21-3 showing how it reflects the rainfall variations.

Staff response (4/14/2017): *Your April 5th email to me and Ron Basso indicates you have investigated relationships between rainfall and water levels in the ROMP TR-21 well.*

Martyn

P.S.

Staff writers also need to note USGS have resumed reporting at the newer gage site in Rainbow River. The data confirms my position the river flow profile used in the model is incorrect. Just remember who contacted USGS last year about the data they were reporting. USGS were very appreciative of my observations. Staff just kept on plowing.

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Thursday, March 30, 2017 5:40 PM
To: Alan Martyn Johnson
Cc: Xinjian Chen; Gabe I. Herrick; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ron Basso; Melissa Gulvin; Kurt Fritsch; Mike R. Bray; speene@appliedtm.com; kwatson@hsweng.com
Subject: RE: Pulsing Springs Of Kings Bay

Martyn:
Was good to speak with you earlier today regarding the Rainbow minimum flow rule.
Responses to your March 27th comments on flow in the Crystal River/Kings Bay System are imbedded in your email below.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
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2379 Broad Street
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1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Monday, March 27, 2017 8:12 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>; Mark A. Green <Mark.Green@swfwmd.state.fl.us>; Jennette Seachrist <Jennette.Seachrist@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>; Mike R. Bray <Mike.Bray@swfwmd.state.fl.us>; speene@appliedtm.com; kwatson@hsweng.com
Subject: Re: Pulsing Springs Of Kings Bay

Doug,
Thank you for relaying the staff responses.
Regarding the Staff Responses to the Peer Review Panels Report which are presented in the Governing Board Meeting Note book; it is disappointing and inaccurate for the staff response to repeatedly mention negative daily and monthly discharge measured at the Bagley Cove USGS site.

Staff response (3/30/2017): *Approved, tidally-filtered discharge data reported for the Bagley Cove site shows negative daily and monthly mean values. The district mentions these negative values to indicate that this record is not suitable for use as an estimate of spring discharge to the system for hydrodynamic modeling purposes.*

I would have thought by now staff would understand the daily data based on a 24 hour day is bound to have negative values as the tidal cycle is 24.84 hours. If not they need to read the comment/note on the USGS site for 02310747.

Staff response (3/30/2017): *Tidally-filtered discharge is reported after low-pass filtering to remove effects of mismatch in lunar and solar day lengths. Nonetheless, tidally-filtered, approved discharge regularly has negative values. The comments to the gage also note that "The residual discharges are not total "freshwater" flow, but are a combination of freshwater flow and water storage caused by higher or lower Gulf of Mexico mean water levels." This is further indication that the discharge reported at this gage is not intended for use as an estimate of freshwater discharge into Kings Bay.*

Further to state there are monthly negative discharges is inaccurate and steps further than in the MFL Report in attempting to discredit USGS.

Staff response (3/30/2017): *The District has made no attempts to, nor has any interest in discrediting the USGS. Reported negative monthly averages for approved, tidally-filtered discharge from the Bagley Cove gage are a matter of fact. The District has stated that discharge reported at this gage is not a suitable estimate of spring flow into Kings Bay. This is consistent with the USGS remarks which clearly state that "residual discharges are not total 'freshwater' flow". Here, the USGS is referring to "tidally-filtered" discharge as "residual". The District interprets this to mean that discharge reported at this gage is not suited for use as an estimate of spring discharge to the system.*

The only negative monthly discharges in the USGS Data arise if INCOMPLETE DATA IS SELECTED FOR MONTHLY STATISTICS. These months are June 2009, May 2012, August 2015 and August 2016. For these months there are multiple days when data is not available eg both August 2015 and 2016 there are over 20 days when data was not available, for the 2009 and 2012 months it is 8 and 9 days.

Staff response (3/30/2017): *This missing data is further evidence that discharge reported at this gage is not suitable for use in driving a hydrodynamic model which requires frequent, continuous estimates of spring discharge on short time scales.*

I would further note the Bagley Cove data shows a distinct decrease in 'springs discharge' since the start of data collection at this site and reflects seasonal variations. Seasonal variations are normal phenomena....which the Districts modeled discharges do not reflect.

Staff response (3/30/2017): For all of the reasons above, the Bagley Cove data does not reflect 'springs discharge' as noted in the REMARKS for the Bagley Cove gage. District empirical-formula discharge is based on groundwater levels and surface water levels, and thus reflects seasonal variations in those levels.

May be the decrease 'spring discharge' in the Bagley Cove data is viewed as an anomaly as is the Rainbow River decrease. I am of the opinion this is not an anomaly but the truth.

I will elaborate on my points with specific quotes and data as time permits.

As regards my e-mail to Dr. Peene and Dr. Watson I have not heard from them to date. Please note I asked if they would be interested, nothing more.

Sooner or later District is going to have some serious explaining to do regarding the Pulsing Springs of Kings Bay...the 'geological water hammer' of flows changing from 700 cfs to 50 cfs

from low tide to high tide may sound the alarm.
Martyn

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Friday, March 24, 2017 2:07 PM
To: Alan Martyn Johnson
Cc: Xinjian Chen; Gabe I. Herrick; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ron Basso; Melissa Gulvin; Kurt Fritsch; Mike R. Bray
Subject: RE: Pulsing Springs Of Kings Bay

Martyn:

Thanks for your March 13th email concerning discharge from springs within Kings Bay springs. I've imbedded some "staff responses" highlighted in blue in your original email below.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
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1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
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From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Monday, March 13, 2017 7:37 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>; Mark A. Green <Mark.Green@swfwmd.state.fl.us>; Jennette Seachrist <Jennette.Seachrist@swfwmd.state.fl.us>; Eric DeHaven <Eric.Dehaven@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Kurt Fritsch <Kurt.Fritsch@swfwmd.state.fl.us>
Subject: Re: Pulsing Springs Of Kings Bay

My e-mail and attachment were a follow up to my e-mail of January 24 where I shared the mass balance, and diagrammatic basis for the mass balance, of the VHB 2009 Group 1 data. The results show the combined Group 1 springs discharge to be almost constant thru the tidal cycles. This makes sense of the VHB data, all parameters are in balance, and is logical given what is generally known about spring discharges. Additionally, the data from measurements at individual springs in Kings Bay in the VHB reports 2009 and 2012, show no evidence of spring discharges varying in the manner shown in the graphic presentation Figure 2-4 in the draft report i.e. pulsing. Repeat no evidence.

In my January 24 e-mail I challenged SWFWMD to 'be bold' and plug the spring discharges from Figure 2-4 into the mass balance and see for yourselves the results. As you did not do that I did it for you. Yes I had to estimate the discharges from the graph (I think you have to admit they are reasonably close), but you are very welcome to change these to the calculated 15 minute discharges used to generate the graph.

In your response no mention is made of the 'uncertainty' expressed by the Peer Review Panel. I

would also draw attention to the concerns expressed by Dan Yobbi in his memos December 2014 and September 2015 (in the Appendix of the Draft MFL Report).

Staff response (3/24/2017): *The District response to peer review panel findings concerning the proposed minimum flow for the Crystal River/Kings Bay System is being provided to the District Governing Board as part of the March 28th Board meeting agenda. The response, which is included in the Board packet as agenda item number 33 in the document at the link below, includes information relevant to panel comments concerning uncertainties in flow estimation. Staff plans to expand the discussion of this uncertainty in the revised version of the minimum flow report.*
http://www.swfwmd.state.fl.us/calendar/notebooks/govboard_03-28-17_notebook_2772.pdf

For completeness I believe there are two formulas the District has developed for springs discharge based on the location of each individual spring.
The writers of this response appear not to realize the 15 minute shortfalls or excess are cumulative thru each respective tidal cycles.
As for the total volume in the pool....well...what can I say....interesting!
As for regression analysis...what can I say...amazing!
As for Bagley Cove data, this is not related to the mass balance Group 1, but you are welcome to look back at my previous comments particularly about the 24.84 hour tidal cycle shared last year.

Let us get back to the subject, the pulsing springs of Kings Bay.
How about sharing my mass balance January 24 e-mail and the recent one showing how out of balance the spring discharges in Figure 2-4 are, with Dr. Peene and Dr. Watson to see if this helps them understand the uncertainty they have expressed in the Peer Review Report. Dan Yobbi as well if you want.

Staff response (3/24/2017): *We understand that you have contacted Dr. Peene and Dr. Watson in a March 23rd email and offered to provide your January 24th email to them directly.*

For those who have not seen how the total discharge for all springs discharge varies (pulse) according to Districts two formula, I have attached a graph of a typical week of discharges. This is similar to the ones shared with Doug, Ron and Gabe when we met January 23 and is from the District Model output. Variations during some cycles from less than 50cfs to 700 cfs from high to low tide. Really?

Kings Bay springs do not pulse to such magnitude. I have suggested before and I will repeat it. Take one of the major springs, your choice, and position a velocity meter in the vent and monitor it for a few days. We can quickly prove who is right by in field measurement. I am confident my mass balance (January 24) indicating almost constant discharge from the springs will prevail.

Staff response (3/24/2017): *As indicated in the draft minimum flow report, staff plan to recommend that the Board approve a scheduled reevaluation of the minimum flow for the Crystal River/Kings Bay system within ten years of the legislatively-mandated July 2017 adoption date. We are committed to the acquisition of additional data, including measured flows, that will support the planned reevaluation*

effort.
Martyn

From: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Sent: Thursday, March 9, 2017 8:26 AM
To: Alan Martyn Johnson
Cc: Xinjian Chen; Gabe I. Herrick; Mark A. Green; Jennette Seachrist; Eric DeHaven; Ron Basso; Melissa Gulvin
Subject: RE: Pulsing Springs Of Kings Bay

Martyn:

Thanks for the email and attached Excel file concerning spring discharge to Kings Bay that you sent on Monday, March 6, 2017. We note that your email claims "there is a shortfall or excess water in the pool upstream of the X-section" and from this you conclude that "Dr. Chen's calculations are wrong". The District is committed to supporting its claims based on evidence. District Staff have developed an empirical formula for estimating submarine groundwater discharge (SGD). District confidence in this formula is proportional to the weight of evidence which supports it.

The District formula can predict surface water levels with 74% accuracy for Group 1 springs and with 94% accuracy for Group 2 springs (R^2 values). These methods have been published in peer reviewed scientific journals by Dr. Chen, and separately peer-reviewed in the minimum flow report. This predictive capacity represents the best information available. There is no better predictive tool for estimating water levels in the Crystal River/Kings Bay system.

The strength of the District formula for SGD comes from its ability to explain the data. Your spreadsheet includes data which you claim demonstrates a shortfall of the SGD formula for predicting flux across a cross section in Kings Bay. Your spreadsheet shows the change in volume over a 15-minute interval for water upstream of the G1 cross section as predicted by G1 discharge and SGD (eq. 1) in column L. This change in volume over time may be referred to as "15-minute flux". You estimate SGD from a figure, which you acknowledge carries with it a degree of uncertainty. The 15-minute flux predicted by gage height is shown in column M. You subtract M from L to arrive at what you call the "Eccess[sic] Shortfall in pool" shown in column O. From the values in this column O, you conclude the District method for estimating discharge is incorrect.

How does 15-minute flux as estimated from discharges at G1 and SGD compare with 15-minute flux as estimated from gage height? A plot of these fluxes is shown below in Figure 1 (this figure and other figures discussed in this email were developed using information included in the attached Excel file named "bold Group 1 2009-gh which was developed using the file you sent on March 6th; note that a PDF of this email is also attached). The 15-minute flux predicted by discharges at G1 and SGD [labeled Discharges (col L)] clearly mirrors the 15-minute flux predicted by gage height [labeled Gage Height (col M)]. The difference between these two lines is shown as Shortfall (col O). Note the similarity in 15-minute flux as estimated from these two sources. Also please note the time difference between values in col L and col M, which introduces additional errors in col O if the difference between col L and col M is taken simply by subtracting col M from col L in the same row. The time difference between col L and col M can be clearly seen in Figure 1.

The similarity in lines of Figure 1 can be quantified using linear regression. A linear regression of 15-minute flux from discharges (col L) as a predictor 15-minute flux from gage height (col M) has an R^2 value of 0.9376 (Figure 2 below). This means that the SGD and G1 discharge capture over 93% of the variation in the flux estimated from gage height. Recall there is some uncertainty associated with

discrepancy between times of measurement, in measurement of gage height, in discharge at G1, and in estimating SGD from eyeballing values from a plot. Thus, this remaining 6-7% error is not entirely attributable to error in estimation of SGD.

Your analysis is limited to producing a list of differences between two methods for estimating 15-minute flux. These differences (col O) are on the order of 10^4 ft^3/15min. You claim these values are so large as to warrant calling the District "wrong". How large are these values compared to the overall volume of the pool upstream from G1? If we assume an average depth of 3 ft at MSL (a likely underestimate), we can estimate the relative shortfall as a fraction of the overall volume of the bay (Figure 3 below). You can see that these "large" differences are less than 4% of the total volume of the upstream pool (assuming 3ft average depth at MSL).

You have expressed incredulity in the degree of variation in SGD predicted by District formula. However, the District formula SGD has lower variation than any other method for estimating spring discharge to this system. Compare District-formula SGD with discharge reported at USGS 02310747 Crystal River at Bagley Cove near Crystal River, FL (Figure 4 below). The District SGD shows a record of spring flow with much less variability than the discharges reported at Bagley Cove. As such, the District formula for estimating SGD addresses the problem of minimizing fluctuation in estimated spring flow, is based on the mass-balance principle, and has been repeatedly verified against field data.

Analysis of the data you presented in your spreadsheet shows that the District formula does quite well at predicting water levels and fluxes in this system. Although your calculations could make the "Eccess Shortfall in pool" in col O larger in magnitude than it should be, we think the information you've provided support the empirical formula.

We would add that the District empirical formula was obtained through data fitting of spring flow data, which were calculated from measured discharge data at G1 and G2 based on the mass-balance principle. Data fitting is simply a process of finding the best mathematical expression linking a dependable variable with one or more independent variables through minimizing the overall mismatch between measured data and model-predicted results. Just because there are errors between model results and data (in this case, between col L and col M) does not mean that the model is wrong. As mentioned above, errors are minimized but not eliminated in data fitting.

In closing, please note that we will continue to apportion our confidence in the formula for SGD based on the strength of evidence regarding its power to explain observations.

Figure 1. 15-minute flux estimates over a two-day period

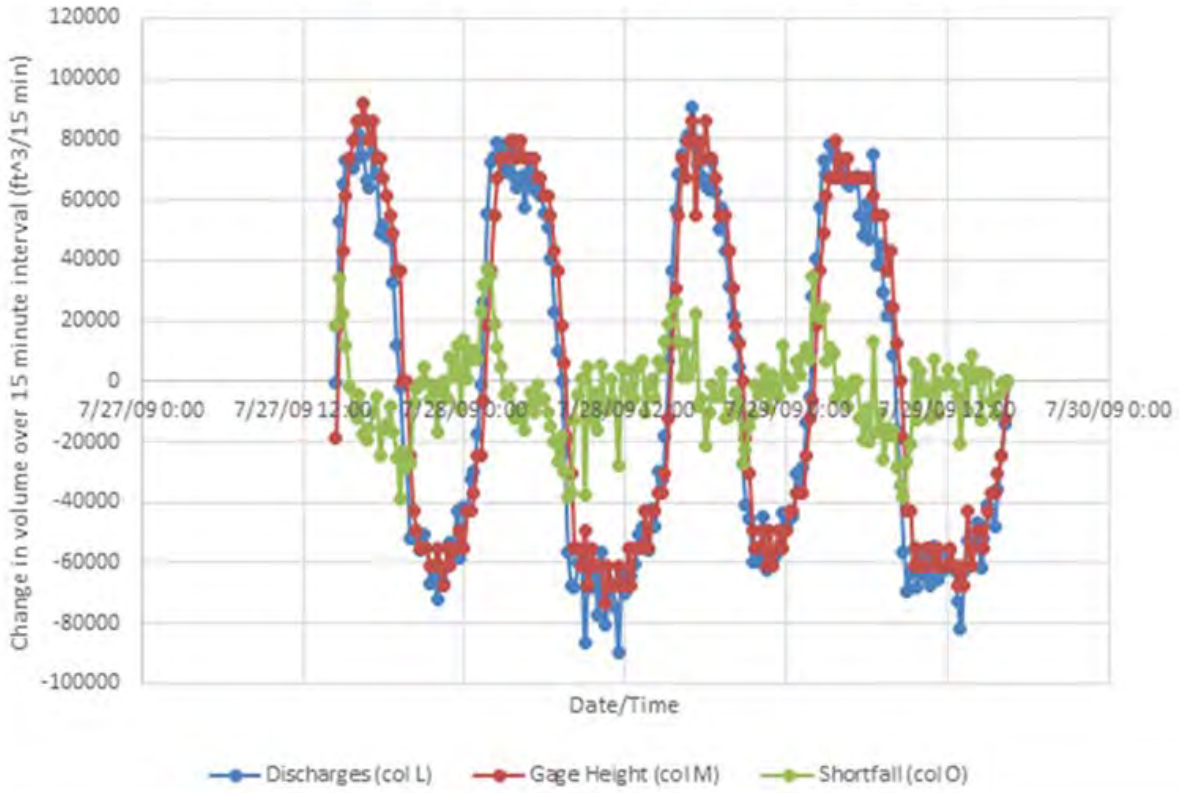
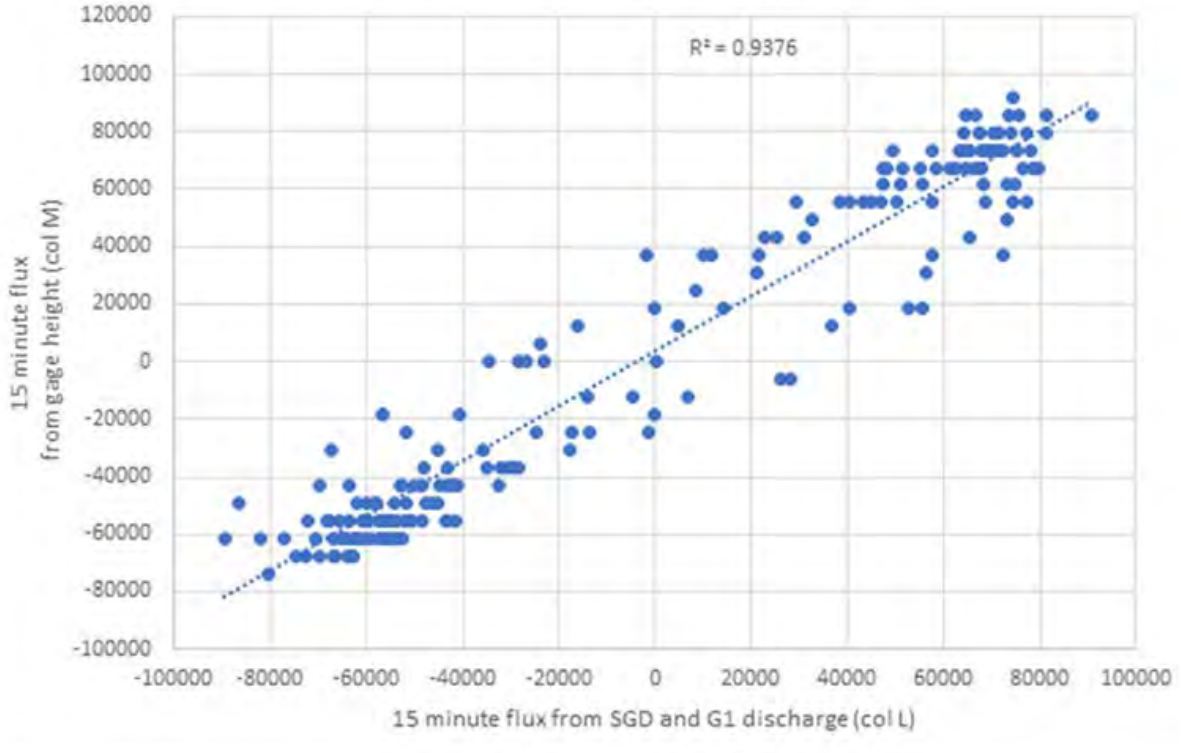
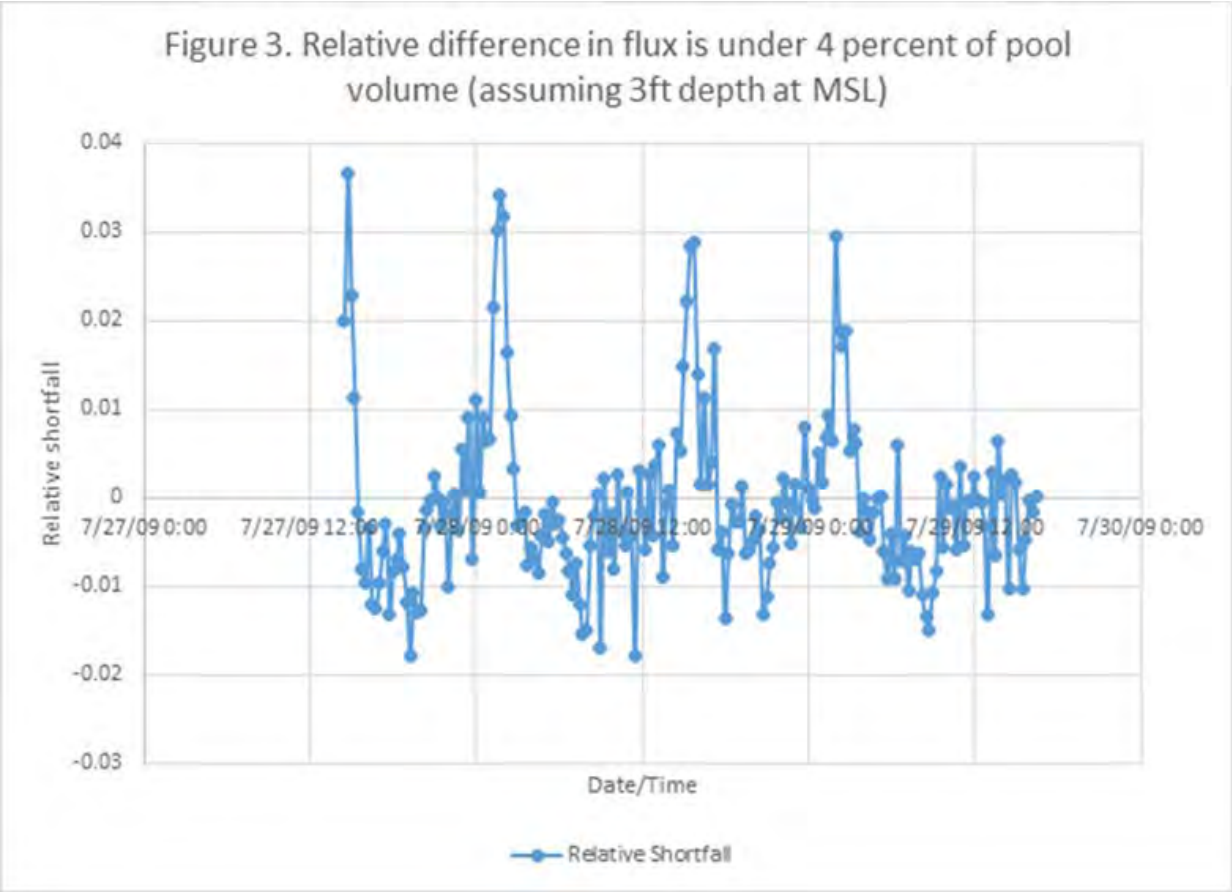


Figure 2. District formula SGD produces estimates of 15-minute flux that are condordant with gage height estimates.





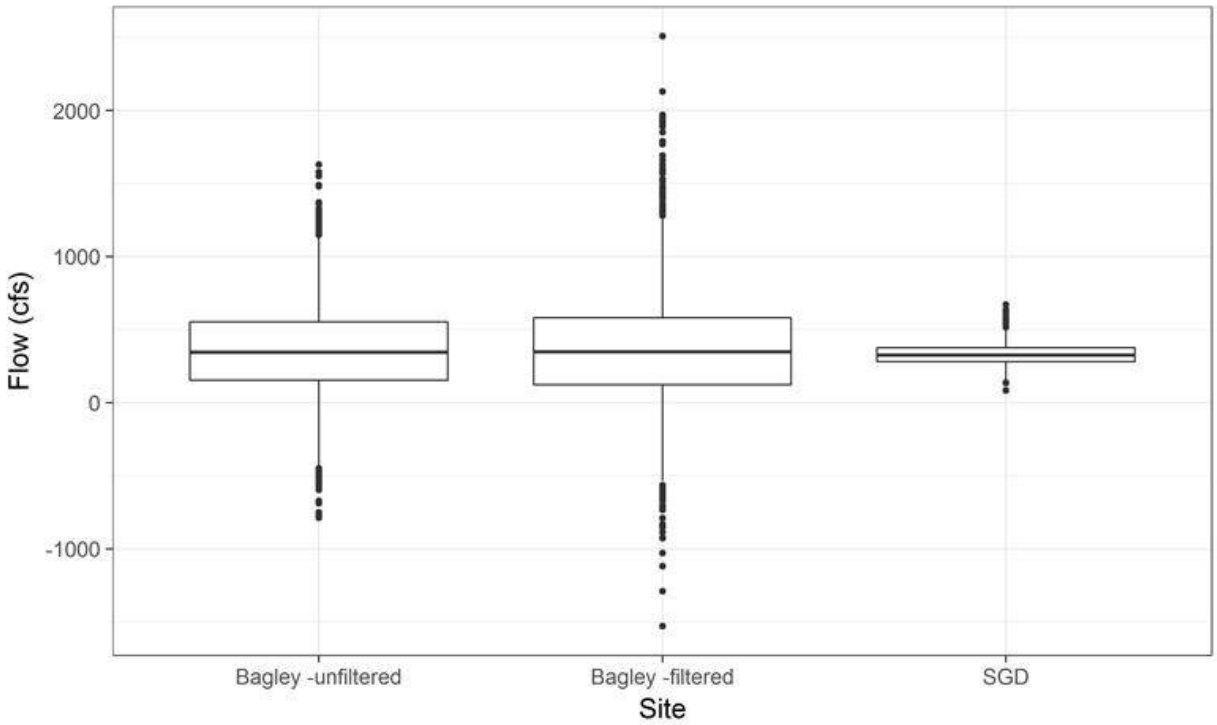


Figure 4. District formula submarine groundwater discharge (SGD) compared with discharges reported at Bagley Cove over the hydrodynamic model period of record. Variation predicted by District SGD is much lower than predicted by reported discharges. Boxplot made with daily

mean discharge. Note USGS gage reports frequent negative daily values, even when tidally-filtered. Dark center line is median, upper and lower box edges are 75th and 25th exceedance percentiles. Whiskers extend to 1.5 IQR. Outliers show as dots beyond whiskers.

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From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Monday, March 06, 2017 8:31 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>
Cc: Ron Basso <Ron.Basso@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>; Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>
Subject: Pulsing Springs Of Kings Bay

Doug,
I am directing this to you as you have coordinated Staff Responses in the past, but it is equally addressed to all cc's.

As discussed/promised attached is my xls file with Dr. Chen's spring discharges for Group 1 springs re Figure 2-4 in the Draft Report. As you will see there is a shortfall or excess water in the pool upstream of the X-section i.e. the stage per VHB/USGS data is not maintained using Dr. Chen's spring discharges. These excess or shartfalls are in bold red and black.
For clarity let me add:

- The Dr. Chen spring discharge is the best I could read the Figure 2-4 these are bold with light blue background.
- The discharges between the hi/low are by linear interpolation for each change high to low.
- The VHB data did not account for the difference in high tide time. You will recall in my spreadsheet determining the spring discharge I left blank those areas around the tide change times. I had done the same with this spreadsheet and you are welcome to do the same to account for the roughly 15 minutes later high tide at the X-section cf Mouth of Kings Bay.

Dr. Chen's calculations are wrong. The idea that Group 1 springs discharge vary as presented in Figure 2-4 is simply not true.

What makes the whole picture more ridiculous is to suggest all other springs in Kings Bay vary depending on their relative location to Group 1 X-section, Group 2 X-section and Romp TR21-3.

Yes my words are blunt, but it appears a 2x4 is needed to get to the truth. May I suggest again you share my comments with Dr. Penne and Dr. Watson. I trust I do not have to request a personal meeting to discuss their uncertainties about spring discharge from the ''pulsing springs of Kings Bay".

I think I have know Doug and Ron long enough that they know I will welcome any rational argument showing I am wrong.

BACKGROUND

I first raised the concern about the wide variations in Kings Bay springs discharge November 7, 2016. I comment how the logic was missing from the discharges presented in Figure 2-4 of the Draft MFL report. Since then we have exchange a number of e-mails, for example November 30, 2016 when I commented, the more I dig into this the more my concern increases.
January 23, 2017 Doug, Ron Basso and Gabe Herrick met with me to discuss the matter in person. While none claimed the ability to discuss the math behind Dr, Chen's assessment, all agreed with the discharges varying as Dr. Chen has calculated. I shared a number of graphs of weekly discharges from the file of Dr. Chen's work on discharge from all Kings Bay Springs (Model Output of SGD for baseline, shared with me January 18). I asked 'Do you really believe these springs have discharge that varies like this?…this is hard to believe'. Following the meeting on January 24, 2017 I shared with you my xls file with my analysis of the VHB Group 1 data and diagrams of the associated mass balance. My analysis indicated Spring discharge did not vary significantly thru the tidal cycle.
Staff response was my diagrams correctly represented the mass balance, but did not comment regarding my xls file findings.
I suggested 'you' get bold and plug Dr.Chen's discharge number into the file to verify they make sense. On February 8, 2017 I gave the discharges from Figure 2-4 graph for the first few tidal cycles. I also suggested you consider sharing my thoughts/analysis with the Peer Review Panel. The Peer Review panel repeatedly expressed uncertainty in their final report.
As example Quote from Comment 46
The equations that are utilized to define all the flows into the system have some basic error associated with them as well as certain levels of uncertainty. For example, in Figure 2-4 looking at plot (a), it is clear that for the period when measured flows were available, there are errors in the estimated flow that would indicate that the model under-predicts the overall net flow out. This error is then carried through an additional level of uncertainty as the equations and coefficients are extrapolated out to other vents in the system. Based on these known errors and uncertainty, it would be important to developed additional ways to verify the total flows. This could be done using the Bagley data, if this data is demonstrated to be useful for this. Still working on the evaluation of the Bagley data.
End Quote
From the same Comment in the Recommendation Quote.
Also, some more definitive discussion of the degree of variation in the direct vent measurements and how they were used to carry the calculations forward is needed.
End Quote

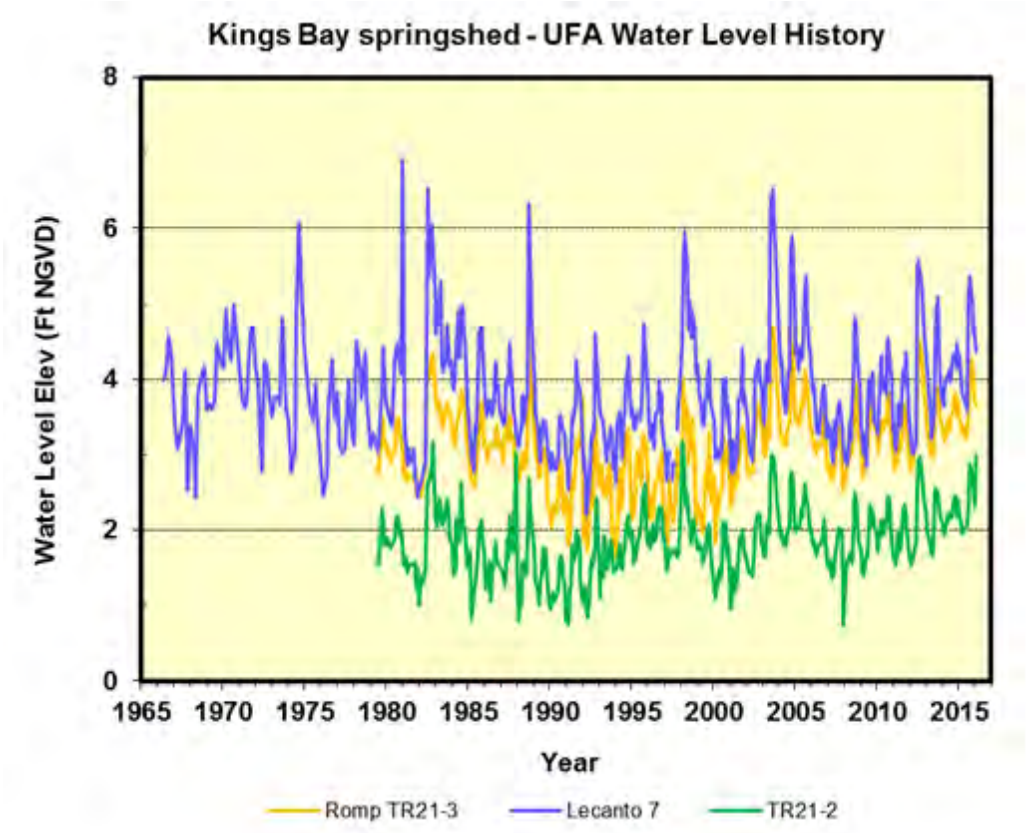
Martyn

From: Ron Basso
To: Alan Martyn Johnson
Cc: Gabe I. Herrick; Xinjian Chen; Doug Leeper
Subject: RE: ROMP TR21-3
Date: Monday, April 24, 2017 11:21:50 AM
Attachments: image002.png

Martyn:

The increasing trend in chloride at this site is evidence of increasing salinity at this monitor well in the deeper portion of the UFA. I would term it a localized change since the majority of monitor wells in our springs region coastal network do not show a statistically significant change. It is not unusual to see localized changes in water quality within our coastal region – this would include wells with upward and downward trends. In fact, the nearby TR21-2 monitor well shows a statistically significant downward trend in chloride. Increases in salinity in our coastal region can occur from rising sea level, reduced UFA recharge due to low rainfall, localized pumping, or storm surge inundation. Both Chassahowitzka main spring and Homosassa No. 1 spring show chloride concentrations increasing during dry periods and then decreasing during wet periods. Both of these springs do not show a statistically significant increase in chloride concentration since the early-1990s when measurements began.

The question of the TR21-3 well water levels being indicative of rainfall changes is illustrated by the comparison below of TR21-3 with TR21-2 and Lecanto 7 monthly water levels. Visual inspection shows that all three monitor well water levels are fluctuating in a similar manner. They all reflect lower water levels during drought periods during the early-1990s, 1999-2000, and 2006-2007 and higher water levels during wet periods during the 1997-98 El Nino and 2004 hurricane periods.



Ron Basso, P.G.
Chief Hydrogeologist/Acting Manager
Resource Evaluation Section
Water Resources Bureau
Southwest Florida Water Management District
Ph 800-423-1479 (Florida only)
352-796-7211, ext. 4291

From: Doug Leeper
Sent: Thursday, April 06, 2017 3:38 PM
To: Ron Basso <Ron.Basso@swfwmd.state.fl.us>
Cc: Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>
Subject: FW: ROMP TR21-3

Ron – Can you help address this one? I know you prepared well chloride slides for the Chass and Homo ordeal. Not sure if you have newer slides or a report to send with a simple answer to his question: "Is this indicative of salt water intrusion?"

Doug Leeper
MFLs Program Lead

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From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Wednesday, April 05, 2017 7:14 PM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>
Subject: ROMP TR21-3

Please note the increase chloride level since 1987 for the deep chloride monitoring well ROMP TR21-3. From my limited knowledge this appears to be fairly significant as the sampling is from the Avon Park formation in an area close to the coast. Is this indicative of salt water intrusion? Would appreciate your thoughts particularly as there are presumably other chloride monitoring wells.

I have also been looking at the monthly data ROMP TR21-3 (extracted myself) to see if there is any seasonal signature, as in wetter/drier months. I do not see a seasonal signature, or a wetter drier year correlation. May be the use of this well data as a flow predictor is not so good after all. Remember also Dan Yobbi commented about how the use of 2 months VHB measurements was hardly ""long term"".

Still no hard evidence to support the "Pulsing Springs of Kings Bay".

Martyn

From: Melissa Gulvin
To: Ron Basso; Gabe I. Herrick; Doug Leeper
Subject: CR/KB MFL City Council slides
Date: Wednesday, March 22, 2017 1:24:55 PM
Attachments: CRKB MFL City Council Final.pptx

As an FYI, attached is the PowerPoint presentation Eric and I used Monday with two of the Crystal River city council members.

Melissa Gulvin
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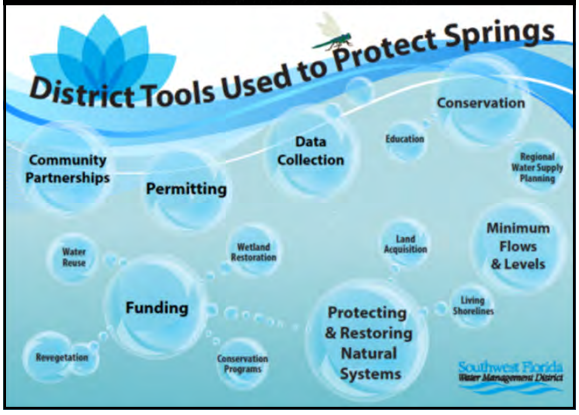

What is a Minimum Flow?

- Limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area
- Established to protect flowing systems from damage caused by ground and surface water withdrawals
- Protects from significant harm

Why Establish a Minimum Flow?

- Required by state law for priority springs, streams and rivers [Section 373.042(1), F.S.]
- Minimum flows for all Outstanding Florida Springs must be adopted by July 1, 2017 [SB552]

MFL Process

- The District has set more than 200 MFLs
- The best information (data) available is used
- Independent scientific peer review panel evaluates the work of District scientists
- Very transparent process
- The general public and other governments/agencies review and comment

MFL Process Continued: Timeline for Crystal River/Kings Bay System MFL

Time Frame	Activities
2007 – Ongoing	Data collection and analyses specific to MFL
November – December 2016	Peer review panel meets and provides evaluation of the peer review draft report
December 2016 – March 2017	District Governing Board shown the peer review feedback and staff's response; Staff preparing the draft report and posting online
April, 2017	Public meeting to seek public input
May 23, 2017	Presentation to Governing Board and request for adoption of the proposed minimum flow
June 2017	Rule-making process
July 1, 2017	MFL must be adopted as required by SB552 passed by the State legislature in 2016

Environmental Values Protected When Developing Minimum Flows

- Recreation in and on the water
- Fish and wildlife habitats and the passage of fish
- Estuarine resources
- Transfer of detrital material
- Maintenance of freshwater storage and supply
- Aesthetic and scenic attributes
- Filtration and absorption of nutrients and other pollutants
- Sediment loads
- Water quality
- Navigation

Southwest Florida Water Management District

Proposed Minimum Flow

- Most sensitive environmental value for Crystal River/ Kings Bay System is low-salinity habitat
  - Adequate inflow of fresh water is essential to maintain this estuarine ecosystem.
- Greater than **12 percent** reduction in average flow is significantly harmful to low-salinity habitats
- Proposed minimum flow protects **88 percent** of natural flow

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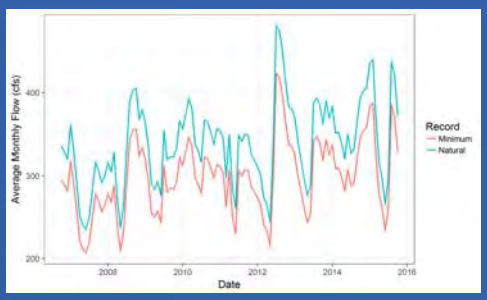
Minimum Flow is a Percentage



Minimum flow is a percentage of natural flow, not an average or median flow.

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Groundwater Withdrawal

- Current impacts from groundwater withdrawal reduce flow by 1-1.5 percent
- Projected 2035 impacts reduce flow by 2-2.5 percent

Year	Natural flow	Groundwater withdrawal	Percent reduction from withdrawal
2010	449 cfs	6.9 cfs	-1.5 %
2014	449	5.2	-1.1
2035 projection	449	10.8	-2.4
2035 with conservation and reuse	449	9.6	-2.1

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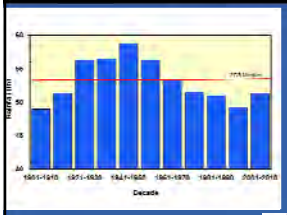


Long-term rainfall trends From 1900-2010

Departure from average annual rainfall 1995-2015

Purple = above average Red = below average

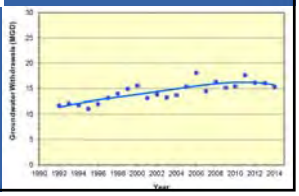


Southwest Florida Water Management District



Kings Bay Springshed Groundwater Withdrawals

Kings Bay Springshed Groundwater Use History



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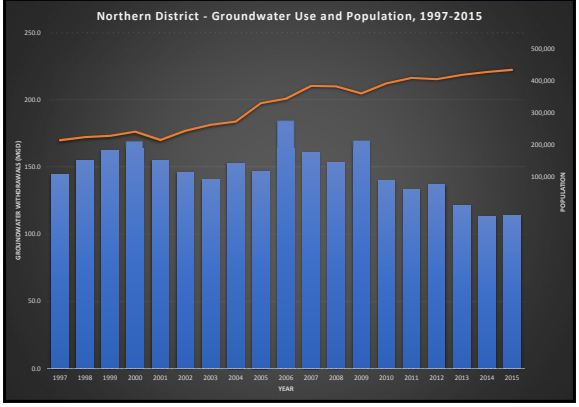
Water Supply Planning

- Regional Water Supply Plan updated every five years
- Public supply water use stable and declining even while the population has increased — how?
  - o Increased water conservation
  - o Expanded water reuse
  - o Declining per capita water use



In Summary

- Proposed minimum flow protects 88 percent of the natural flow
- 2035 projections show less than 2.5 percent reduction in natural flow
- No MFL recovery or prevention strategy is needed or projected to be needed

Minimum Flow Status Assessments

- Recommend minimum flow re-evaluation in 10 years
- Conduct annual status assessments and five-year assessments for regional planning
- Continue ongoing monitoring of water quality, flows, groundwater conditions, and rainfall

Back up slides

Defining Significant Harm

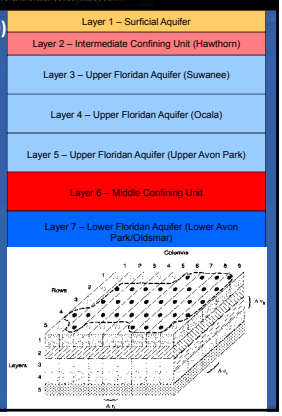
Percent of Flow – Percentage that flow can be reduced without reducing the availability of habitats or resources by more than 15 percent

- Approach is well supported in literature and used internationally
- Developed at suggestion of independent scientists and supported by 17 panels of independent scientists for use in similar systems
- Used in minimum flows adopted for the Homosassa, Chassahowitzka and Weeki Wachee Rivers

6

Northern District Model (Version 5.0)





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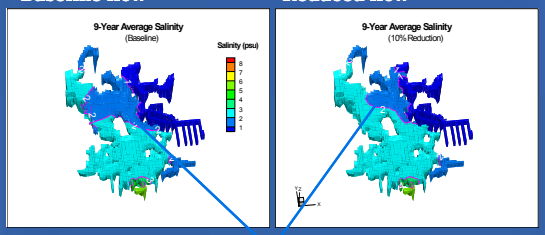
Salinity-based habitat reductions

Baseline flow | **Reduced flow**



<2ppt habitat

Southwest Florida Water Management District

Measuring Springflow is Challenging

- USGS Bagley Cove gage flow from 2002 through 2015 averages 447 cfs and is tidally-influenced
- Water budget: 20 in/yr of recharge in the springshed yields a springflow of 455 cfs
- 900+ cfs from the 1960-70s includes marine water and springwater; would require 40 in/yr of recharge in springshed (not realistic)
- Peer review panel believes spring flow varies between 300 and 450 cfs – and not much different in the 1960s based on little change in Floridan aquifer water levels over the last 50 years

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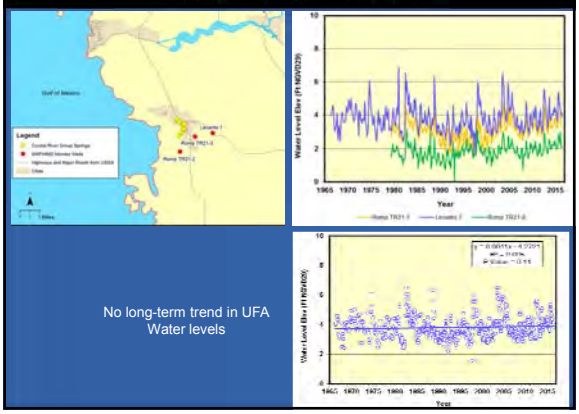

No long-term trend in UFA Water levels

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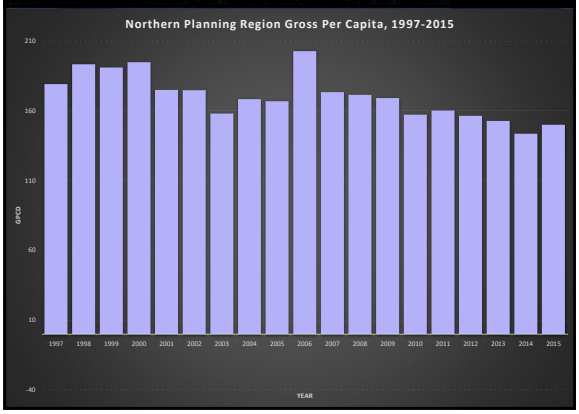

MEETING SUMMARY

Southwest Florida Water Management District
Proposed Minimum Flow for the Crystal River/Kings Bay System Public Workshop

Crystal River Middle School Auditorium
Crystal River, Florida
Thursday, April 27, 2017

The Southwest Florida Water Management District (District) hosted a public workshop on the proposed minimum flow for the Crystal River/Kings Bay System in Citrus County. The workshop started at 5 p.m. at the Crystal River Middle School Auditorium (344 Northeast Crystal Street, Crystal River, Florida). The meeting was advertised in the Florida Administrative Register, local newspapers and on the District's website. In addition, numerous interested parties and local government staff and officials were notified of the meeting and a press release was made available to the regional media.

District representatives in attendance were: Dr. Chris Anastasiou, Chief Environmental Scientist; Ron Basso, Chief Hydrogeologist; Terri Behling, External Affairs Manager; Xinjian Chen, Chief Professional Engineer; Eric DeHaven, Resource Management Assistant Director; Melissa Gulvin, Government Affairs Program Manager; Dr. Gabe Herrick, Senior Environmental Scientist; Mary Margaret Hull, Lead Communications Coordinator; Doug Leeper, MFLs Program Lead; Sky Notestein, Senior Environmental Scientist; Jennette Seachrist, Natural Systems and Restoration Bureau Chief; and Kevin Wills, Senior Economist.

Approximately 31 stakeholders attended the public workshop. The first 45 minutes of the workshop consisted of an open house which provided an opportunity for the public to view numerous informational posters and talk one-on-one with the various District staff present. At 5:45 p.m., a PowerPoint presentation was given by District staff to inform participants about many topics associated with the proposed minimum flow. Topics discussed included: the legal requirements for establishing minimum flows and levels, the District’s Minimum Flows and Levels Program, methods used by the District to establish minimum flows, results of various minimum flow development methods for the Crystal River/Kings Bay System, the proposed minimum flow for the system, regional and local hydrogeology, rainfall and water-use trends, current and projected withdrawal effects on flow in the river system, and the absence of a need for a minimum flow recovery or specific prevention strategy for the system.

Workshop participants were made aware of the various opportunities available for the public to comment on the proposed minimum flow, including: providing oral or written comment during the workshop (a comment card was available for written comments, as were speaker cards used for participants to orally express their comments) or providing written comments to District staff via email or mail following the public workshop. A summary of comments and questions discussed during the workshop is provided below. Attachments to this meeting summary include: the workshop agenda, a printed copy of the PowerPoint presentation used by District staff, sign-in sheets, written comment cards, and request to speak cards, as well as a document submitted during the workshop by a workshop attendee.

Workshop Participant Oral Comments:

1. **Art Jones** – coordinates *Lyngbya* cleanups in Kings Bay; problem with residency time in the Bay; using common sense we want as much water flow coming out of the Bay as possible; *Lyngbya* is horrible algae and we have to go in and rake it out; legacy nutrients in the bay are an issue; instead of 11% reduction and reevaluate in 10 years, maybe start at 2-3% reduction, at most, and then reevaluate; we love the Bay; we are planting eel grass; 11 percent seems out of balance compared to the other MFLs

2. **Janet Barrow** – agrees with previous speaker; lives 20 miles from "here" on ranch with a dry spring; acknowledged we are in drought and dealing with dropped water table; neighbor/friend has salt water in his well

3. **Donald Clark** – used to be dive instructor; Crystal River/Kings Bay used to be a major dive location but most local shops go to Rainbow River now; Rainbow has problems with nitrates, but has better, clearer water because it has better flow; you can't reduce flow because the quality will get worse; you [the District] are supposed to regulate for the public good, but you are regulating the public; you say we should trust you, but you put out a bottled water permit without notifying anyone or local government; they give water to anyone who asks for it; believes the District needs to issue water use permits that will allow a 10% change in flows and that is why the minimum flow was set at an allowable 11% flow reduction; citing saltwater intrusion issues at Cedar Key, emergency rule for the Silver River minimum flow, and the proposed minimum flow for the Crystal River/Kings Bay System, it seems someone is lying

4. **Anne Harvey Holbrook** – representing Save the Manatee Club – manatee habitat is not just about water volume but also water quality; flow and water quality are greatly linked; this sets policy for next ten years; takes long time to set policy and even longer if there are challenges; recommends using a more cautionary approach

5. **Maxine Connor** – moved to Homosassa six years ago and regularly visits Crystal River; has seen decline in water quality of the rivers and springs; you can't see if a manatee is coming because of the poor water quality; participated in BMAP [Basin Management Action Plan] meeting; know you are working to clean up the pollution and know you have budgeted money for clean-up; wonders how can you meet goals in the BMAP if population grows and more pollution is added; if you allow this much withdraw – pollution is greater; agrees with member of the Sierra Club who said they would support an allowable 0-2 percent flow reduction; we need to conserve more

6. **Dr. Burt Eno** – representing Rainbow River Conservation – we have been victimized with recent Rainbow River MFL [minimum flow and level]; we can see the difference; we don't need to model, we see it firsthand; statute says you need to set a minimum flow; you are not setting a minimum flow, you are setting a permitted extraction from the river; you are still taking 5% from Rainbow River and 11% from Kings Bay; violating the intent of the statute itself; acting or reacting to a dictate by the Governor and that we need to have 1,000 people added to Florida per day and need water for them

7. **Jim Tatum** – representing Our Santa Fe River Inc. – from Ft. White; set MFL with no further flow reduction; current river/spring flows are reduced relative to fifty years ago; also have a water quality problem; maybe we [the District] should examine our mission and goals again; should consider restoration; how can you begin to restore the river if

you take more flow; if your goal and mission is not to restore the River, what is it?; noted that water management districts of the state are issuing permits that violate MFLs and impact existing users; urges that no further withdrawals be taken from the Crystal River

8. **Steve Kingery** – enjoyed chatting with staff; conditions in Kings Bay do not follow modeling results and information provided in the charts [posters/slides used for the meeting]; asked whether anyone knows what the best flow rate is for *Vallisneria*; we have no faith going forward in accomplishing the goals we have; number of which water level gets so high flow stops; you said we recognize our model for sea level rise is incomplete; we can guess who benefits from the MFLs; can you tell us who benefits if you are wrong?

9. **Bob Knight** – representing Florida Springs Institute – remembers when Crystal River was clear; noted water clarity is currently about 6 feet; noticed salinity has tripled in last 30 years; notes historic levels and flows are well documented at over 900 cubic feet per second (cfs); notes that current springflow rates represent more than a 50% loss in flow as reported in a recent Florida Springs Institute report that is not referenced in the District's MFL report; we developed the report for you to consider when setting the MFL and you don't even cite our report in your proposal, although it may be buried in the appendices – this is scientifically dishonest; over half of the flow is gone; you have chosen to ignore the historic data; as discussed by the peer review panel that reviewed the proposed minimum flow, the USGS didn't agree with you throwing out the historic data; this is blatant scientific dishonesty; recharge estimates developed by the District are total nonsense; the springshed is 800 square miles not the 300 square miles as reported by the District; flow and algae and flow in Bay is related; we have algae now that we didn't have in the 70s; salt water intrusion is moving inland because of groundwater pumping; this system clearly needs a recovery plan; this is not public input it is a total sham; stop hiding behind a flawed model; asked District staff member Ron Basso about Kissengen Spring; Ron replied that the spring ceased continuous flow in 1950 due to groundwater withdrawals associated with unregulated phosphate mining activity; asked what will happen when the next spring stops flowing; for perspective, should consider what happened with MFLs development in the northern Tampa Bay area where there was substantial public concern

10. **Dan Hilliard** – representing Kings Bay Springs Alliance – if we had clean water, we could pump it without impact, I would be ok with it; but you don't address residence time in your presentation; it needs to be considered; until you have a better handle on residence time take a cautionary view on this; believes Mark Hammond when he said we can adjust it *(the MFL)* up or down; however, if you find out 10 years down the road and you've permitted the quantities, you are stuck; cautionary measured progress on this; you don't have projected demand for 11% flows for planning period; thinks the allowable 11% flow reduction will have substantial effects under low flow conditions

11. **Brad Rimbey**, P.E. – very involved with MFLs for the Chassahowitzka and Homosassa; the staff recommendation for the Chassahowitzka MFL was revised by the Board based in part on the large number of stakeholders that attended the Board meeting where the MFL was discussed – hope this happens for the Crystal River/Kings Bay MFL also; flow is an important issue here; native vegetation disappears with lower flows; algae is smothering vegetation; wonders why flow and water quality relationships were not used to set the minimum flows for the Rainbow and Crystal River/Kings Bay systems; based on the current 1-2% withdrawal impacts on flow and the proposed minimum flow that

would allow an 11% flow reduction, it seems unlikely that anyone in this room will be around when withdrawals ultimately lead to an 11% flow reduction; hope the press gets a call out to this community and they need to show up in numbers to get this changed

12. **Martyn Johnson** – summarized calculations showing one week's flow coming out of Kings Bay from Crystal River springs; said District likes to use number of hours from Y2K for each ½ hour they provide a flow; 60,000 hours – this chart shows you one week of flow at high tide, we have 100 cfs; goes from 100 cfs to 700 cfs – quite a change that happens through the week; the model requires inputs like stage level – at 80,000 hours it goes to 0 flow; 0-600 cfs, this is the sort of data that is used to build the model – it is wrong; one other fact – you don't have a single piece of evidence; do you not think that some of the nature lovers haven't seen the springs change from almost no flow to 800 cfs – wonder if Disney should get involved; what is baseline?

Workshop Participant Written Comments: There were two written comments submitted at the workshop. Those comment cards can be found as an attachment.

Southwest Florida Water Management District

2379 Broad Street, Brooksville, Florida 34604-6899
(352) 796-7211 or 1-800-423-1476 (FL only)
WaterMatters.org

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MEETING NOTICE

AGENDA

Southwest Florida Water Management District
Proposed Minimum Flow for the Crystal River/Kings Bay System
Public Workshop

Thursday, April 27, 2017
5:00 p.m.

Crystal River Middle School Auditorium
344 N.E. Crystal Street, Crystal River, Florida 34428

5:00 p.m. Public Information Open House

5:45 p.m. Presentations begin, followed by public comments

1. Welcome, Introductions, and Background Information
   - Melissa Gulvin, Government Affairs Program Manager, SWFWMD[1]

2. Proposed Minimum Flow for the Crystal River/Kings Bay System
   - Gabe Herrick, PhD, Senior Environmental Scientist, SWFWMD[1]

3. Evaluation of Hydrologic Changes to the Crystal River/Kings Bay System
   - Ron Basso, P.G., Chief Hydrogeologist, SWFWMD[1]

4. Public Comment Period, Facilitated by
   - Melissa Gulvin, Government Affairs Program Manager, SWFWMD[1]

For questions regarding the meeting or the proposed minimum flow for the Crystal River/Kings Bay system, please contact Gabe Herrick by email at gabe.herrick@watermatters.org, by telephone at 1-800-423-1476, extension 4275, or by mail at the address listed at the top of this agenda.

If you wish to speak during the public comment period, please fill out a speaker's card and give it to the moderator (Melissa Gulvin), who will call on you at the appropriate time during the meeting. Comments will typically be limited to three minutes per speaker. In appropriate circumstances, the moderator may grant exceptions to the three-minute limit.

[1]*SWFWMD = Southwest Florida Water Management District*

Agenda

5:00 p.m. **Public Information Open House**

5:45 p.m. **Presentations followed by public comment**

Welcome, Melissa Gulvin, Government Affairs Program Manager

Proposed Minimum Flow for the Crystal River/Kings Bay System
Gabe Herrick, PhD, Senior Environmental Scientist

Groundwater Withdrawal Impacts to Kings Bay Springs
Ron Basso, P.G., Chief Hydrogeologist

Public Comment Period, Facilitated by Melissa Gulvin

Submitting Comments

Verbal comments:

- Fill out a blue card to speak. Blue cards are available on the back table.
- All speakers will be limited to three minutes.

Written comments:

- Please use the white cards — also available on the back table.
- Pick up the handout with directions to submit comments after tonight's meeting.

Timeline

Time Frame	Activities
2007 – Ongoing	Data collection and analyses specific to MFL
November – December 2016	Peer review panel meets and provides evaluation of the peer review draft report
December 2016 – March 2017	District Governing Board shown the peer review feedback and staff's response; Staff preparing the draft report and posting online
April 27, 2017	Public meeting to seek public input
May 23, 2017	Presentation to Governing Board and request for adoption of the proposed minimum flow
June 2017	Rule-making process
July 1, 2017	MFL must be adopted as required in Section 373.042(2), F.S.

Establishing a Minimum Flow



Presented by:
Gabe Herrick, Ph.D.
Senior Environmental Scientist

Why Establish a Minimum Flow?

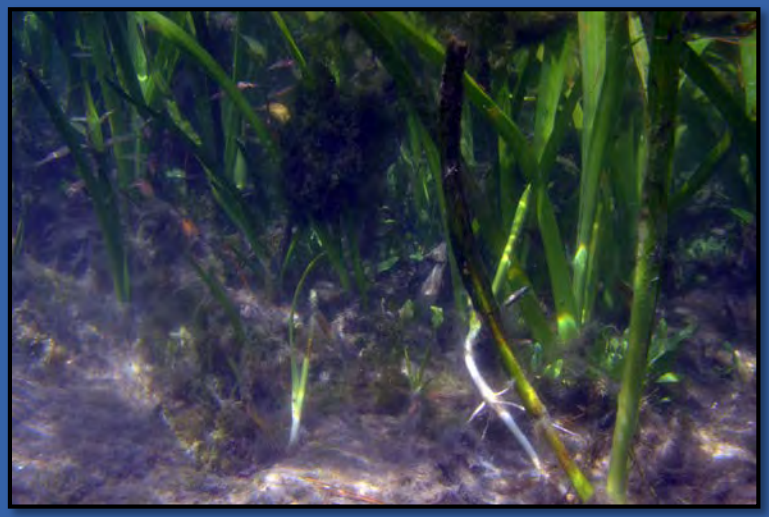
- Required by state law for priority springs, streams, and rivers [Section 373.042(1), F.S.]
- Per SB552, Minimum flow for Crystal River/Kings Bay System must be adopted by July 1



What is a Minimum Flow?

- "Limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area"
- Protective tool used for water use permitting and water supply planning





Environmental Values Evaluated

- Recreation in and on the water
- Fish and wildlife habitats and the passage of fish
- Estuarine resources
- Transfer of detrital material
- Maintenance of freshwater storage and supply
- Aesthetic and scenic attributes
- Filtration and absorption of nutrients and other pollutants
- Sediment loads
- Water quality
- Navigation

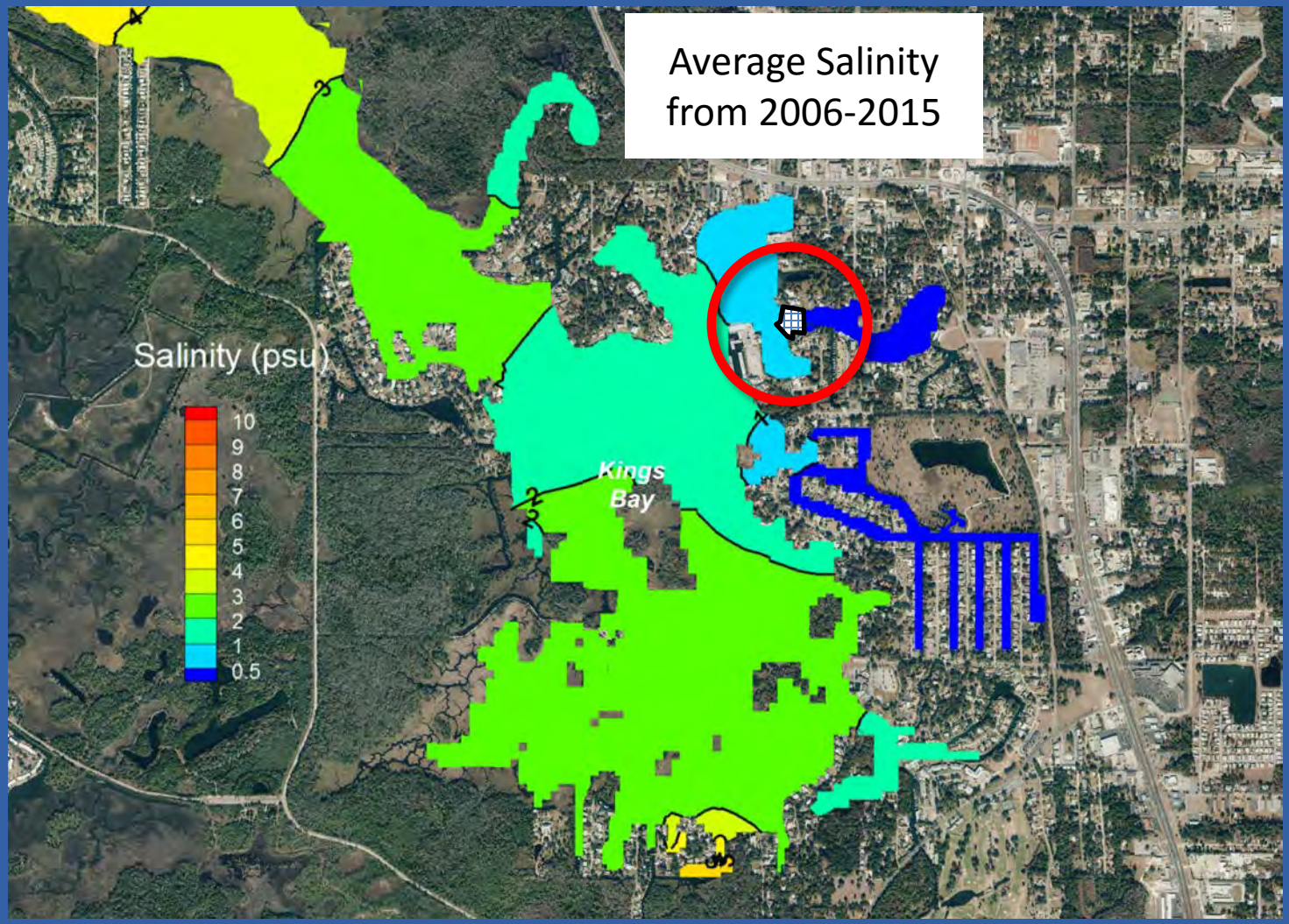
Salinity and Temperature

- Linked to environmental values
- Measurable effects of flow on salinity and temperature
- Salinity has far-reaching ecological importance
- Warm water provides critical habitat for manatee

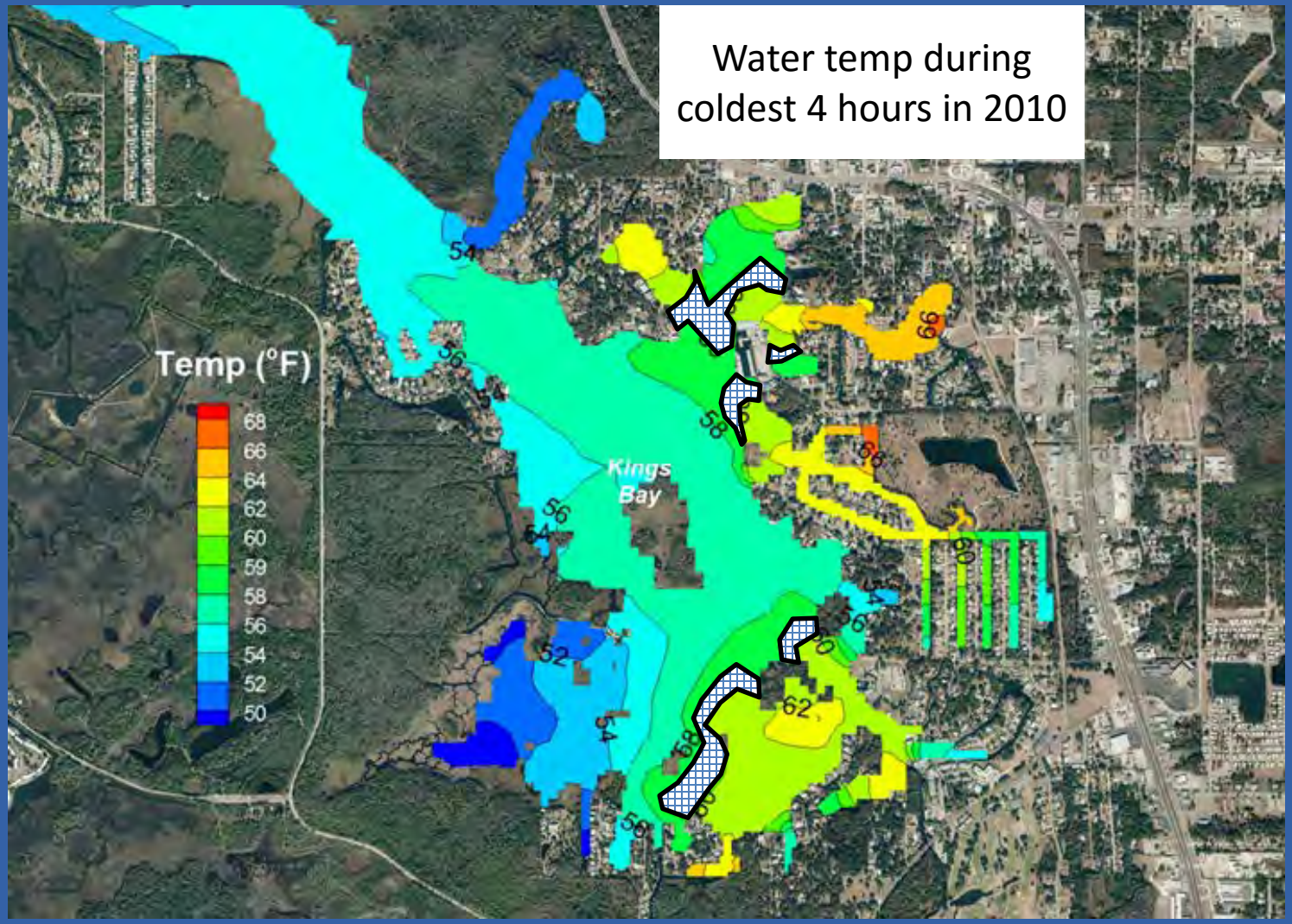
Location of Data Collection Sites



Low-Salinity Shoreline Habitat



Warm Water Refuge (59° F)



Water Quality

- Water quality in Kings Bay is complex
- Water quality driven by:
  - Presence of submerged aquatic vegetation (SAV) habitat, tides, winds, rainfall, sea level change, and pulsed storm events
  - Little to no impact from current groundwater withdrawals
- Explore water quality and flow during reevaluation

Recommended Minimum Flow for the Crystal River / Kings Bay System

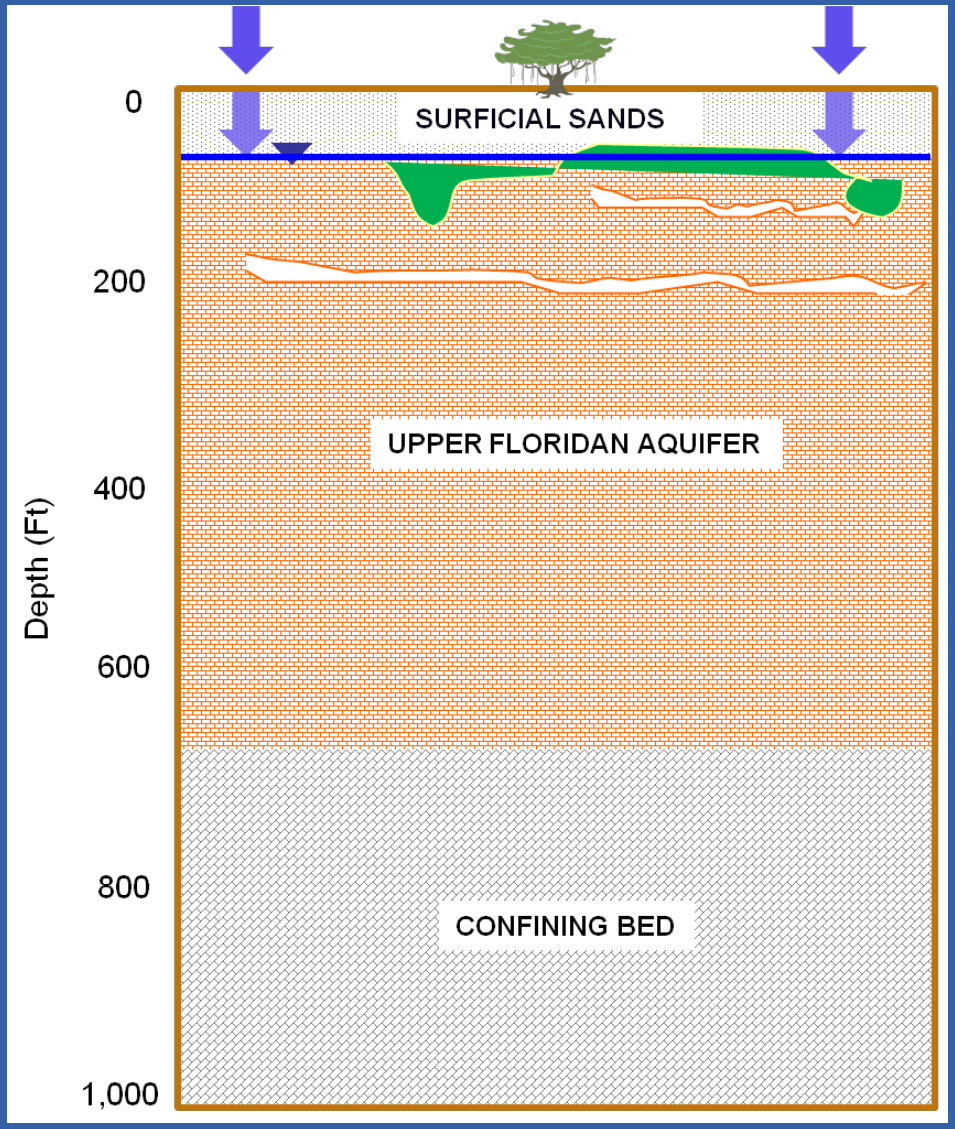
- Recommended minimum flow is 89% of the baseline (i.e., natural) flow or an allowable 11% reduction based on most sensitive criterion: shoreline ≤ 0.5 ppt salinity
- Manatee thermal habitat evaluated but found to be insensitive to flow changes



Groundwater Withdrawal Impacts to Kings Bay Springs

Presented by:
By Ron Basso, P.G., Chief Hydrogeologist

20 inches/year – Highest Recharge in the State

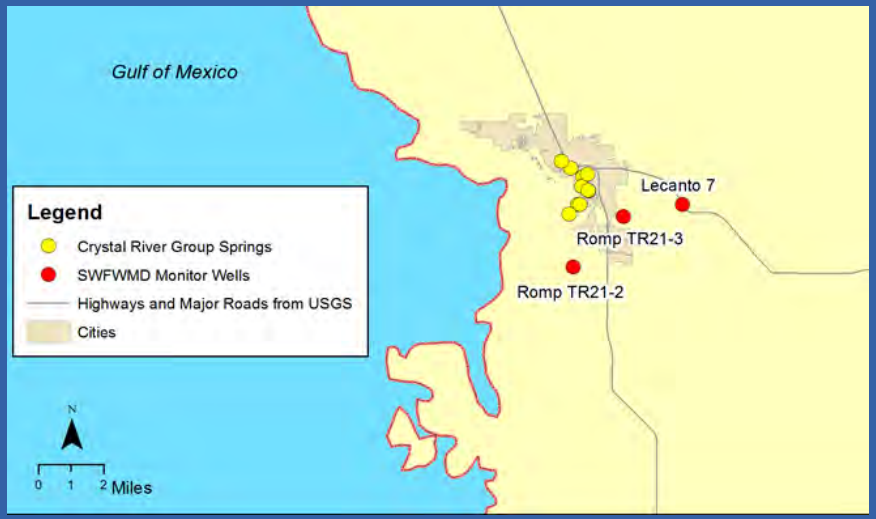


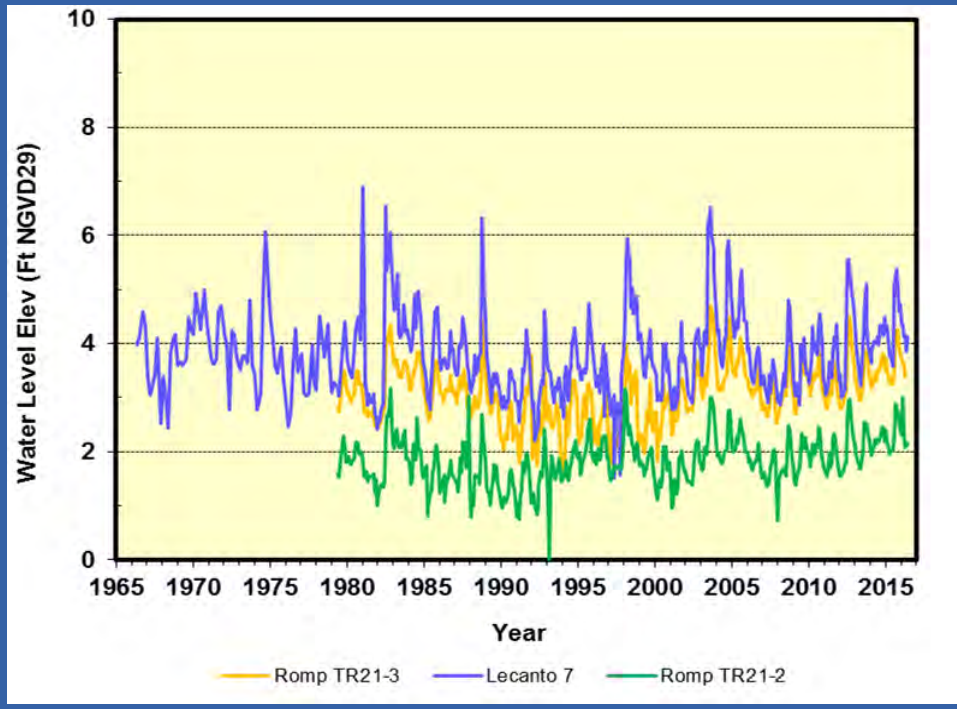
Unconsolidated Sediments
Clays
Limestone
Dolomitic-Limestone
Water-Level

Springflow in Kings Bay

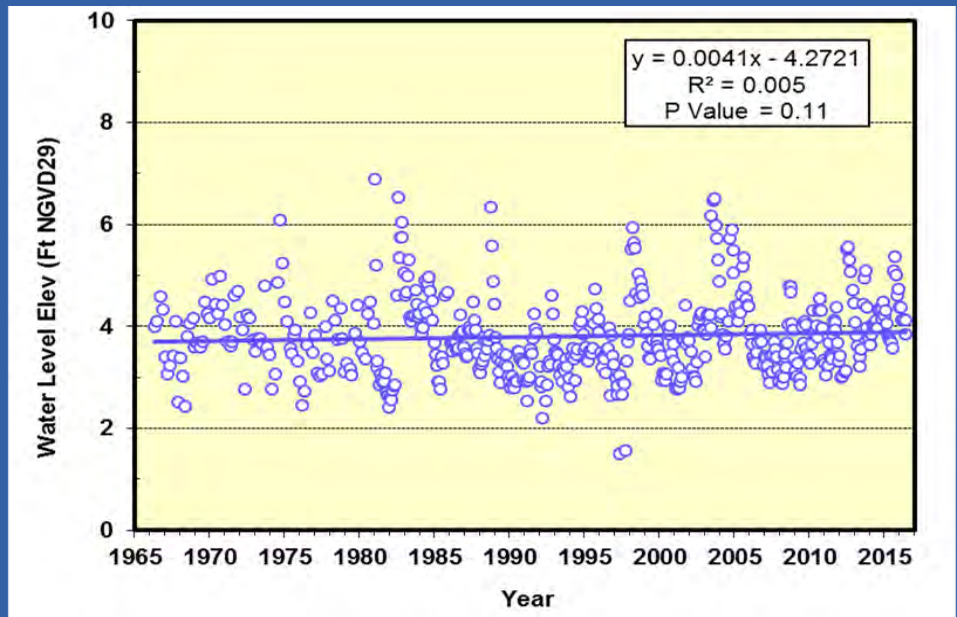
- USGS Bagley Cove gage flow from 2002 through 2015 averages 447 cfs and is tidally-influenced
- Water budget: 20 in/yr of recharge in the springshed yields a springflow of 455 cfs
- 900+ cfs from the 1960-70s includes marine water and was poorly measured; would require 40 in/yr of recharge in springshed (not realistic)
- Peer review panel believes spring flow varies between 300 and 450 cfs – and not much different in the 1960s based on little change in Floridan aquifer water levels over the last 50 years

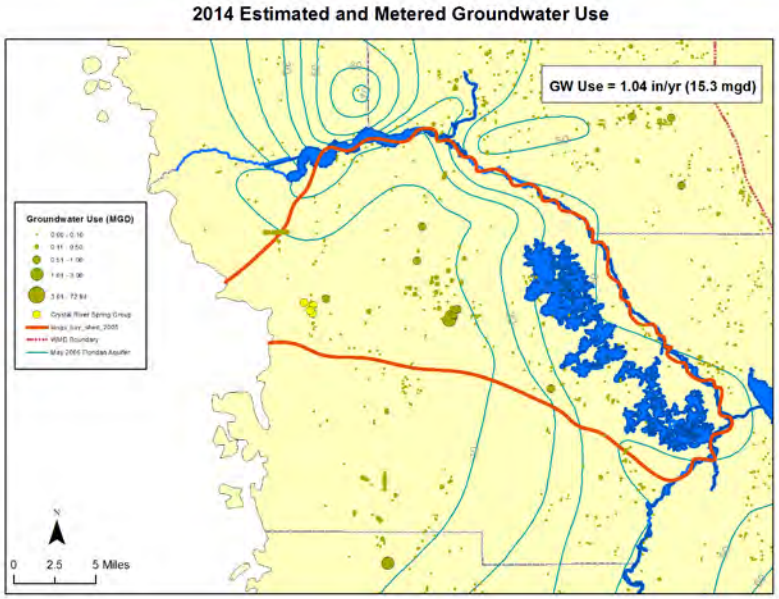
Water level monitor wells near Kings Bay ⇩





No long-term trend in Upper Floridan aquifer water levels ⇨



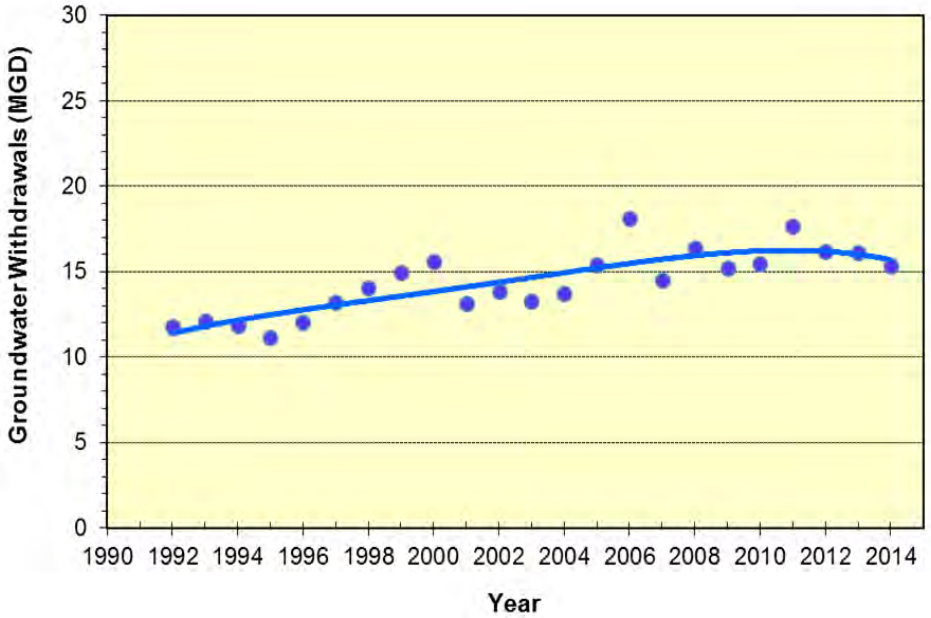


Kings Bay Springshed

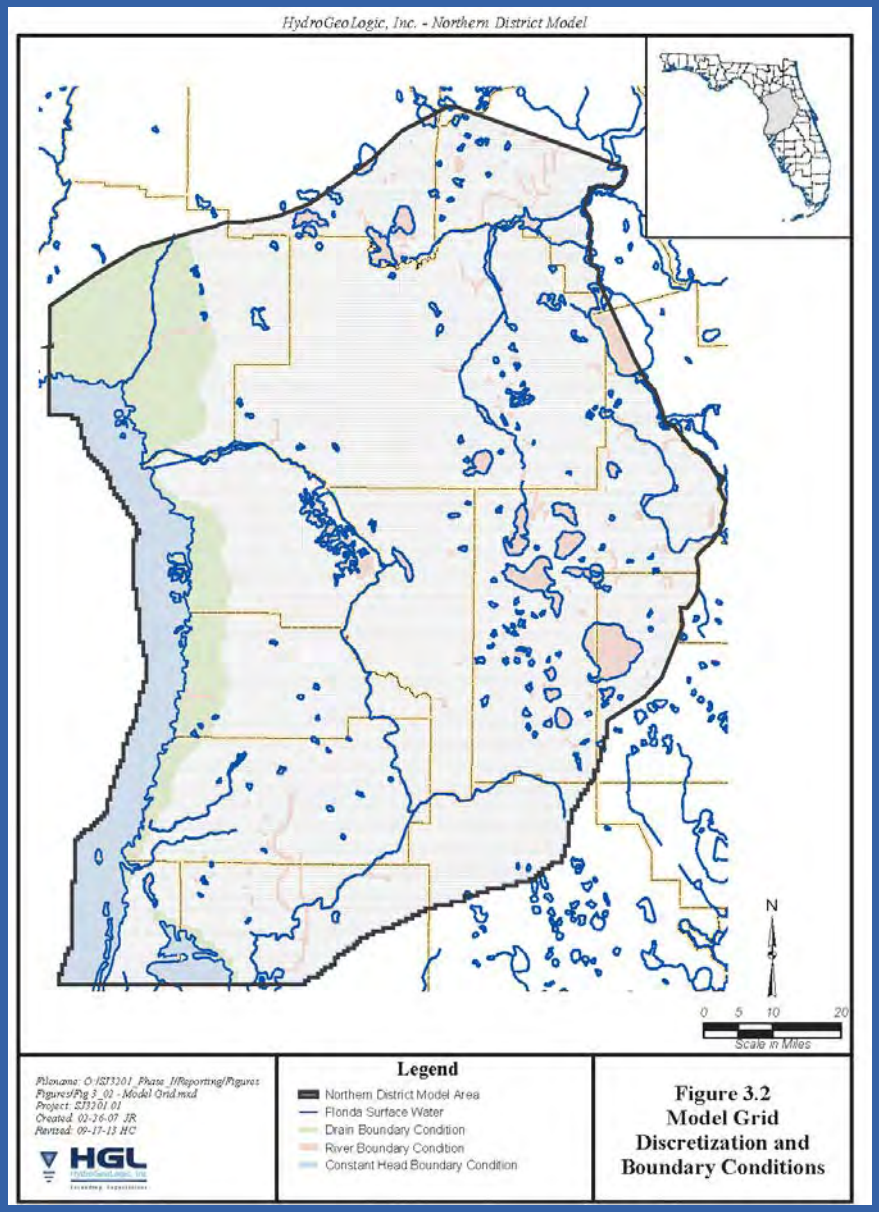
⇦ Groundwater Withdrawals

(Consumptively-used withdrawals = 2.3% of total spring flow)

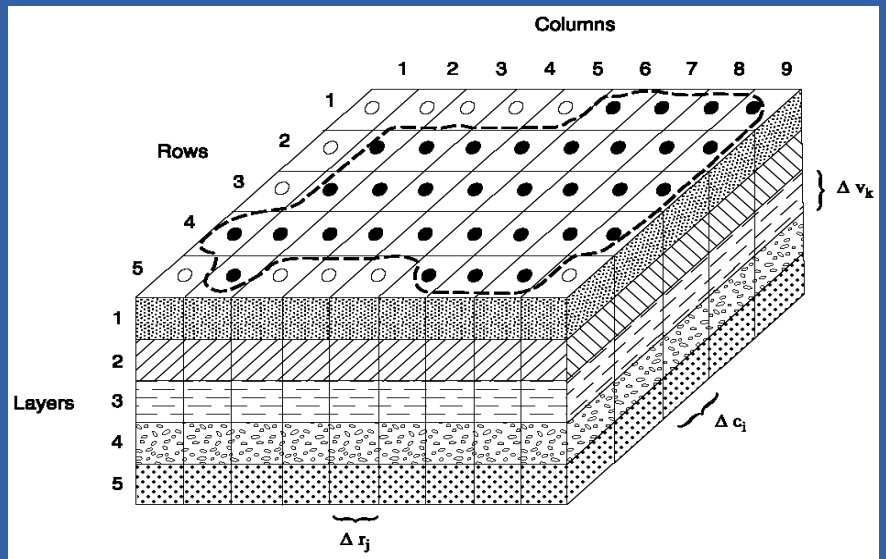
Groundwater Use History ⇨



Northern District Model (Version 5.0)



- Based on geologic data from 50 sites and matching 300 well water levels
- Peer Reviewed by Outside Experts
  "NDM, Version 5.0, is the best numerical groundwater flow model currently available for assessing the effects of withdrawals in the central (Florida) springs region."
- Model developed cooperatively with SJRWMD, Marion County, and WRWSA



Crystal River/Kings Bay Spring Flow Change from Groundwater Withdrawals

Year	Flow Reduction (cfs)	Flow Reduction (%)
2010	6.9	-1.5
2014	5.2	-1.1
2035	10.8	-2.4
2035 w/ Conserv & Reuse	9.6	-2.1

Note: Groundwater withdrawal impact based on Northern District Model Version 5

Groundwater Summary

- Geology and relatively low groundwater use have led to small flow changes of one to two percent
- Long-term Upper Floridan aquifer water levels are stable
- Current groundwater use trend is flat the last six years due to conservation and slower population growth
- No recovery or additional prevention strategy is needed at this time based on current springflow decline of 1 to 2 percent due to withdrawals. This is projected to increase to 2.4 percent in 2035. The proposed MFL allowable reduction due to withdrawals is 11 percent.

Recommended Minimum Flow

- 89% of the baseline (natural) flow or an allowable 11% reduction
  - Based on most sensitive criterion:

    shoreline ≤ 0.5 ppt

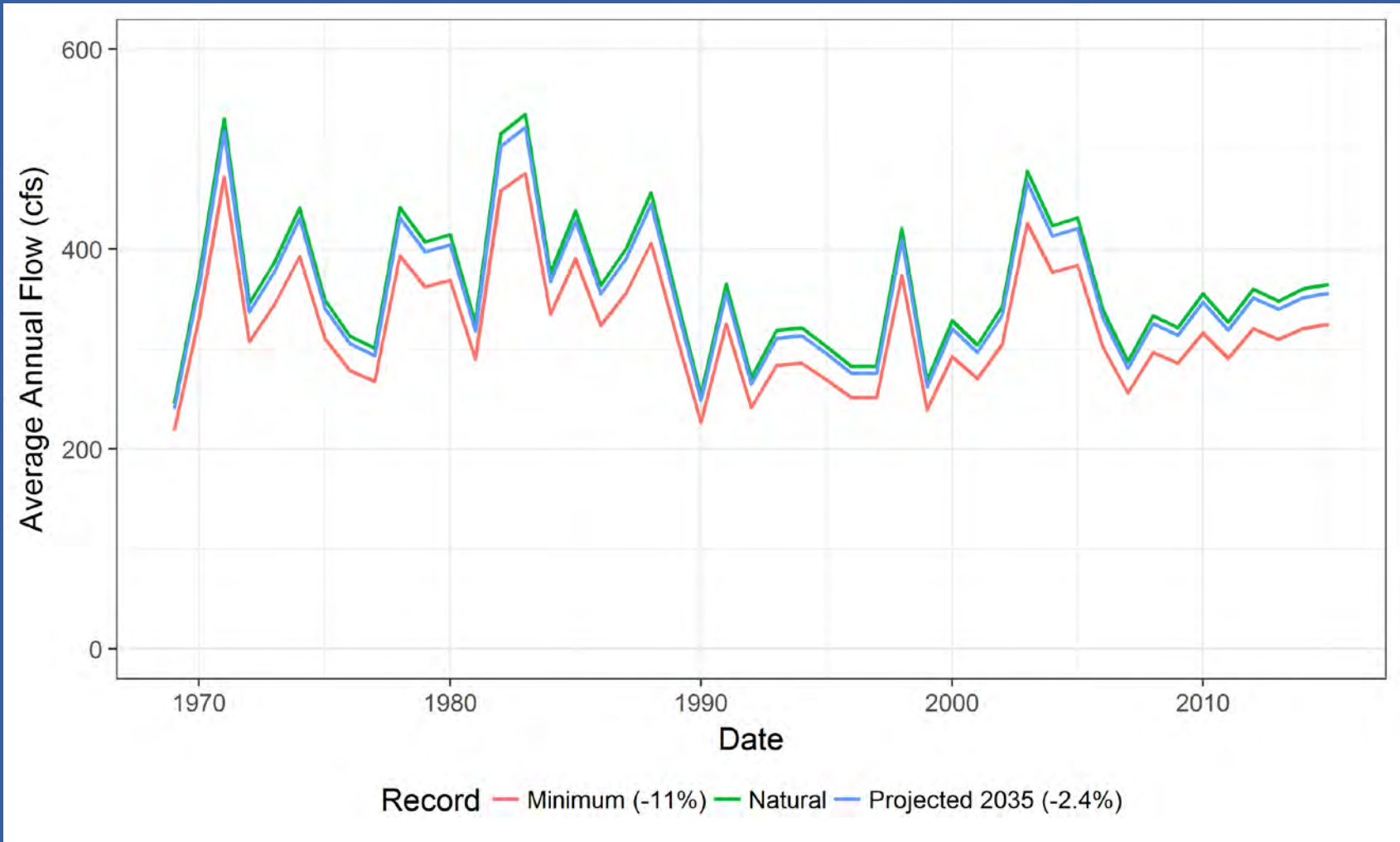
- No need for recovery or specific prevention strategies from groundwater use

- Re-evaluate in 10 years

- Full draft report available at:

  WaterMatters.org/Projects/MFL/MFL_Reports.php

Comparison of Natural Springflow (green) with Projected Decline in 2035 (blue) and the Proposed Minimum Allowable Flow (red)



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PUBLIC MEETING
Sign-In Sheet

Southwest Florida
Water Management District
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Name	Address/City/ZIP	Phone	Email Address
Jim Tatum	914 SW Riverland Ct Ft White 33038	386-454-1966	jim@jimtatum.net
Steve Ringers	Crystal River		steve.crbb@gmail.com
Bob Madeiros	Dunnellon, 34433		bob.madeiros@gmail.com
BURT ENO	DUNNELLON 34432		burteno@bellsouth.net
Donald Clark	9099 S. Great Oaks Dr Floral City Fl. 34431		donziz@embarqmail.com
Ed CALL	123 US 19, Crystal River FL	352-422-2570	—
ROGER DOBRONYI	601 N. WHEELER AVE		SANDYCLAWS@EMBARQMAIL.COM
Margaret Stewart	12112 Fountainbrook Blvd Orlando 32825		mstewart@barry.edu
Roger Smith	123 NW Hwy 19 CRYSTAL RIVER FL, 34429	(352) 586-4788	

PUBLIC MEETING
Sign-In Sheet

Southwest Florida Water Management District
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Name	Address/City/ZIP	Phone	Email Address
Yesenia Escribano	Tallahassee	850-617-1732	yesenia.escribano@freshfromflorida.com
FRANK + PAT KAPOCSI	(9530 West River Holly Path Homosassa 34448)	863-944-8405	FAPKAP@AOL.com
CHERYL PHILLIPS	2218 N. WATERSEDGE DR CRYSTAL RIVER, FL 34429	352-563-0500	cherylphillips@tampabay.rr.com
Sherry Shoemaker	5560 W Nobis Circle Homosassa 34448	(352) 628-4265	bopaw1@gmail.com
A.B. Sidis	Citrus County Chronicle		
Abby Madeiros	6924 W Redmond Ct Dunnellon FL	(727) 460-6754	abby45@gmail.com
Brad Rinbey	10028 S Riviera Pt	813-417-9453	
Art Jones	560 NW 14th Place Crystal River, FL 34428		MrAWJones@ad.com
Anne Harvey Holbrook	aholbrook@savethemanatee.org	863-639-5003	

PUBLIC MEETING
Sign-In Sheet

Southwest Florida Water Management District
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Name	Address/City/ZIP	Phone	Email Address
DAN HILLIARD	34461	527-0023	on record
Ilia Balcom	299 1st Ave. North, St. Pete	813-362-5123	ilia.balcome duke-energy.com
Martyn Johnson.	4381 S. Blue Water Pt. Homosassa.	404-731-6187	martynellijay@hotmail.com.
TOM COTTERILL	6083 W. FRANTORS CT CR	586-7140	—
Janet Barrow			
Maxine Connor	93 Brewallia Ct Homosassa FL 34446	352-503-2166	maxineconnor@gmail.com

PUBLIC MEETING
Sign-In Sheet

Southwest Florida Water Management District
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Name	Address/City/ZIP	Phone	Email Address
Brett Cunningham	730 NE Waldo Rd/Gainesville/32641	352-871-7048	bcunningham@jonesedmunds.com
Theresa Waldron	PO B438 Lecanto FL 34460		
Brian & Robyn Coleman	Citrus BOCC	341 6560	Brian.Coleman@citrusbocc.com
Molly Daly			

Southwest Florida
Water Management District

Agenda Item No. _____

Request to Speak

(Please Print)

Name: Art Jones Date: 4-27-17

Address: 560 NW 14th Place Crystal River

Are you a Lobbyist Registered with the District: Yes___ No___

Representing: Self _____ or Business/Organization: One Rake at a Time

Issue to be address (as printed on agenda):

MFL's

Your position on issue: Favor___Oppose___Other 2 to 3?

To assure that all participants have an opportunity to speak, comments will be limited to three minutes per speaker. When appropriate, exceptions to the three-minute limit may be granted by the Chair. If several individuals wish to speak on the same issue/topic, the designation of one spokesperson is recommended.

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Southwest Florida Water Management District

Agenda Item No. _____

Request to Speak

(Please Print)

Name: Donald Clark Date: 4-27-17

Address: 4099 S. Great Oaks Dr, Floral City Fl. 34436

Are you a Lobbyist Registered with the District: Yes___ No ✓

Representing: Self ✓ or Business/Organization: _____

Issue to be address (as printed on agenda):

re crystal river MSL

Your position on issue: Favor___ Oppose ✓ Other_____

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Southwest Florida Water Management District

Agenda Item No. _____

Request to Speak

(Please Print)

Name: Anne Harvey Holbrook Date: 4/27

Address: _____

Are you a Lobbyist Registered with the District: Yes___ No X

Representing: Self _____ or Business/Organization: Save the Manatee Club

Issue to be address (as printed on agenda):

MFLs

Your position on issue: Favor___ Oppose✓ Other_____

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Southwest Florida Water Management District

Agenda Item No. _____

Request to Speak

(Please Print)

Name: Maxine Connor Date: 4/26/17

Address: 9 Browallia Ct Homosassa FL 34446

Are you a Lobbyist Registered with the District: Yes___ No ✓

Representing: Self ✓ or Business/Organization: _____

Issue to be address (as printed on agenda):

MFL Crystal River / Kings Bay

Your position on issue: Favor___ Oppose ✓ Other ✓

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Southwest Florida Water Management District

Agenda Item No. _____

Request to Speak

(Please Print)

Name: DR. BURT ENO Date: _____

Address: 9220 S.W. 193 CIR. DUNNELLON, FL 34432

Are you a Lobbyist Registered with the District: Yes___ No X

Representing: Self _____ or Business/Organization: RRC

Issue to be address (as printed on agenda):

KINGS BAY MFL

Your position on issue: Favor___Oppose X Other_____

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02.00-100 (10/12)

Southwest Florida
Water Management District

Agenda Item No. _____

Request to Speak

(Please Print)

Name: Jim Tatum Date: 4-27-17

Address: 9145W Riverlane ct Fort White 32038

Are you a Lobbyist Registered with the District: Yes___ No ✓

Representing: Self _____ or Business/Organization: Our Santa Fe River, Inc

Issue to be address (as printed on agenda):

MFLs

Your position on issue: Favor___ Oppose ✓ Other_____

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Southwest Florida
Water Management District

Agenda Item No. /_____

Request to Speak

(Please Print)

Name: Steve Kingery Date: 4/27/17

Address: Crystal River

Are you a Lobbyist Registered with the District: Yes___ No X

Representing: Self ✓ or Business/Organization: _____

Issue to be address (as printed on agenda):

CR MFL

Your position on issue: Favor___Oppose___Other ✓

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02.00-100 (10/12)

Southwest Florida
Water Management District

Agenda Item No. _____

Request to Speak

(Please Print)

Name: Bob Knight Date: _____

Address: _____

Are you a Lobbyist Registered with the District: Yes___ No ~

Representing: Self _____ or Business/Organization: FSI

Issue to be address (as printed on agenda):

KB/CR MFLs

Your position on issue: Favor___Oppose___Other_____

To assure that all participants have an opportunity to speak, comments will be limited to three minutes per speaker. When appropriate, exceptions to the three-minute limit may be granted by the Chair. If several individuals wish to speak on the same issue/topic, the designation of one spokesperson is recommended.

The Southwest Florida Water Management District does not discriminate on the basis of any individual's disability status. This non-discrimination policy involves every aspect of the District's functions, including access to and participation in the District's programs and activities. Anyone requiring reasonable accommodation as provided for in the Americans with Disabilities Act should contact the District's Human Resources Bureau Chief, telephone 352-796-7211, ext. 4702, or 1-800-423-1476 (FL only), ext. 4702; TDD (FL only) 1-800-231-6103; or FAX 352-754-6874.

Southwest Florida Water Management District

Agenda Item No. _____

Request to Speak

(Please Print)

Name: DAN HICKLAND Date: 4-27-17

Address: 1629 N. CROOKED BRANCH DR LECANTO 34461

Are you a Lobbyist Registered with the District: Yes___ No X

Representing: Self _____ or Business/Organization: Kings Bay Springs ALLIANCE

Issue to be address (as printed on agenda):

KBCR MFL DRAFT

Your position on issue: Favor___Oppose___Other YES

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Southwest Florida Water Management District

Agenda Item No. 1

Request to Speak

(Please Print)

Name: Brad Rimbey Date: 4-27-17

Address: 10028 S. Riviera Pt. Homosassa

Are you a Lobbyist Registered with the District: Yes___ No X

Representing: Self ✓ or Business/Organization: _____

Issue to be address (as printed on agenda):
CRKB MFL Workshop

Your position on issue: Favor___ Oppose X Other_____

To assure that all participants have an opportunity to speak, comments will be limited to three minutes per speaker. When appropriate, exceptions to the three-minute limit may be granted by the Chair. If several individuals wish to speak on the same issue/topic, the designation of one spokesperson is recommended.

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Southwest Florida
Water Management District

Agenda Item No. _____

Request to Speak

(Please Print)

Name: Marilyn Johnson Date: _____

Address: 4381 S. Blue Water Pl.

Are you a Lobbyist Registered with the District: Yes___ No✓

Representing: Self ✓ or Business/Organization: _____

Issue to be address (as printed on agenda):
Modeled flow.

Your position on issue: Favor___ Oppose___ Other_____

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Southwest Florida
Water Management District

Agenda Item No. _____

Request to Speak

(Please Print)

Name: Janet Barrow Date: 4/27/2017

Address: P.O. Box 370 Dunnellon

Are you a Lobbyist Registered with the District: Yes___ No Y

Representing: Self Y or Business/Organization: _____

Issue to be address (as printed on agenda):
Kings Bay Springs/Crystal River MFL

Your position on issue: Favor___Oppose___Other Oppose increased withdrawals

To assure that all participants have an opportunity to speak, comments will be limited to three minutes per speaker. When appropriate, exceptions to the three-minute limit may be granted by the Chair. If several individuals wish to speak on the same issue/topic, the designation of one spokesperson is recommended.

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02.00-100 (10/12)

Crystal River/Kings Bay Proposed Minimum Flow Public Workshop Comment Card — April 27, 2017

Please clearly print your name, address, email address and phone number so we can follow up with you, as needed. Thank you for your comments.

Name: Abby Madeiros Phone: (727) 460-6759

Mailing Address: 6924 W. Redmond Court City/Zip: 34433

Email Address:

Do you like the format of this public workshop? (Yes) No Not sure

Did you find the information you learned at the workshop educational? (Yes) No Not sure

You do meet scientists!

Questions and/or Comments:

- There is no mention of possible fracking in our area. Is there a plan to model its affect on our aquifer & springs?
- Are the plans to switch from septic to treatment/reclamation?
- Can the state work to incentivise reclaiming water so that we all win?

Privacy Statement

Principal Purposes: *Information on this card is used to organize and conduct this meeting as well as for the information follow-up.*

Routine Uses: *This information is a public record and may be disclosed to anyone requesting a copy for any purpose pursuant to the Florida Public Records Act, Chapter 119, Florida Statutes. Under Florida law, email addresses are public records. If you do not want your email address released in response to a public records request, do not send electronic mail to this entity. Instead, contact this office by phone or in writing.*

For more information, call the Southwest Florida Water Management District at 1-800-423-1476 (Florida only) or (352) 796-7211.

Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34604-6899

Southwest Florida
Water Management District
WATERMATTERS.ORG · 1-800-423-1476

Crystal River/Kings Bay Proposed Minimum Flow Public Workshop
Comment Card — April 27, 2017

Please clearly print your name, address, email address and phone number so we can follow up with you, as needed. Thank you for your comments.

Name: Sherry Shoemaker Phone: (352) 628-4265

Mailing Address: 5560 W Nobis Circle City/Zip: Homosassa FL 34448

Email Address: bopaw1@gmail.com

Do you like the format of this public workshop? Yes No Not sure

Did you find the information you learned at the workshop educational? Yes No Not sure

Questions and/or Comments:

I would like to see the flow increased not decreased - I have seen a huge decline in the bay since I moved ~~here~~ in 1979. Common sense tells me that decreasing the flow would only make it worse - at the most a decrease of 2-3% (not 11%) in a water that is already impaired & in need of restoration according to the FL environmental protection agency.

Privacy Statement

Principal Purposes: *Information on this card is used to organize and conduct this meeting as well as for the information follow-up.*

Routine Uses: *This information is a public record and may be disclosed to anyone requesting a copy for any purpose pursuant to the Florida Public Records Act, Chapter 119, Florida Statutes. Under Florida law, email addresses are public records. If you do not want your email address released in response to a public records request, do not send electronic mail to this entity. Instead, contact this office by phone or in writing.*

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Brooksville, FL 34604-6899

Southwest Florida
Water Management District
WATERMATTERS.ORG · 1-800-423-1476

This document was provided as a handout by Mr. Martyn Johnson at the public meeting.

60000 to 100000 hrs as graph

600000 hrs

60000.00	415.63
60000.50	403.78
60001.00	368.81
60001.50	306.07
60002.00	310.79
60002.50	294.95
60003.00	146.75
60003.50	98.71
60004.00	171.74
60004.50	247.65
60005.00	239.30
60005.50	334.08
60006.00	310.34
60006.50	374.78
60007.00	399.23
60007.50	401.53
60008.00	361.80
60008.50	387.97
60009.00	449.41
60009.50	476.34
60010.00	494.04
60010.50	526.46
60011.00	588.10
60011.50	602.30
60012.00	599.75
60012.50	531.53
60013.00	700.80
60013.50	465.77
60014.00	492.49
60014.50	436.46
60015.00	359.25
60015.50	259.83
60016.00	195.78
60016.50	151.25
60017.00	83.08
60017.50	93.01
60018.00	89.63
60018.50	198.68
60019.00	222.89
60019.50	205.79
60020.00	303.07
60020.50	303.22
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60021.50	411.44
60022.00	459.97
60022.50	461.54
60023.00	437.46
60023.50	414.55
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60025.00	284.42
60025.50	252.37
60026.00	189.42
60026.50	111.78
60027.00	56.55
60027.50	23.60
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60028.50	94.79
60029.00	150.59
60029.50	128.54
60030.00	185.78
60030.50	301.91
60031.00	245.17
60031.50	285.37
60032.00	337.56
60032.50	355.99
60033.00	401.74
60033.50	445.67
60034.00	496.62
60034.50	554.54
60035.00	528.18
60035.50	543.08
60036.00	600.67
60036.50	568.41
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60037.50	454.85
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60038.50	471.23
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60039.50	353.99
60040.00	313.69
60040.50	223.02
60041.00	199.29
60041.50	125.68
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60042.50	23.66
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60044.00	146.72
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60046.00	361.78
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60057.50	296.34
60058.00	321.05
60058.50	376.62
60059.00	416.78
60059.50	463.40
60060.00	540.96
60060.50	588.01
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60061.50	502.27
60062.00	453.62
60062.50	415.78
60063.00	394.92
60063.50	364.07
60064.00	280.65
60064.50	217.21
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60066.00	51.55
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60069.50	196.03
60070.00	213.12
60070.50	261.43
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60071.50	279.29
60072.00	229.48
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60080.50	182.93
60081.00	237.59
60081.50	270.13
60082.00	267.01
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60083.00	404.63
60083.50	359.04
60084.00	453.02
60084.50	434.30
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60087.50	498.43
60088.00	455.60
60088.50	370.36
60089.00	338.13
60089.50	296.59
60090.00	251.37
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60092.50	251.92
60093.00	295.70
60093.50	315.52
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60094.50	313.36
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60095.50	445.34
60096.00	340.46
60096.50	318.02
60097.00	278.69
60097.50	243.62
60098.00	222.38
60098.50	182.72
60099.00	129.78
60099.50	85.87
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60101.50	16.53
60102.00	35.32
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60103.00	120.66
60103.50	143.51
60104.00	190.86
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60105.00	215.23
60105.50	240.78
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60118.00	372.09
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60119.00	382.78
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60120.50	487.41
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60122.00	438.03
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60128.00	219.97
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60158.00	396.59
60158.50	438.59
60159.00	525.50
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60164.00	258.36
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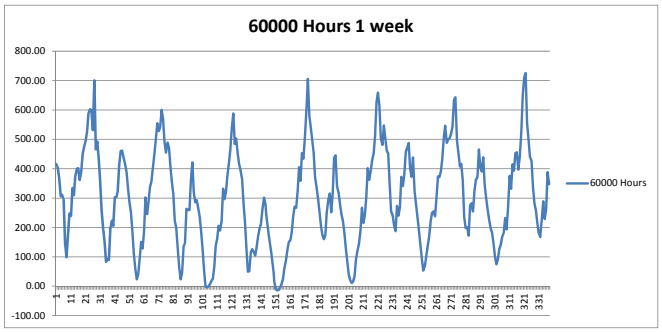

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70002.50	-48.98
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70003.50	-47.91
70004.00	-45.11
70004.50	-41.16
70005.00	-35.20
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70006.00	-21.85
70006.50	-16.17
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70015.00	-49.52
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70016.00	-49.52
70016.50	-47.08
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70017.50	-32.82
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70018.50	-17.07
70019.00	-11.55
70019.50	-5.57
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70023.00	110.05
70023.50	-9.94
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70024.50	-26.03
70025.00	-35.64
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70026.00	-49.52
70026.50	-49.52
70027.00	-49.52
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70028.50	-49.26
70029.00	-43.88
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70030.00	-31.02
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70031.00	-17.50
70031.50	-10.98
70032.00	-5.43
70032.50	-3.93
70033.00	-8.43
70033.50	-12.53
70034.00	-18.40
70034.50	-25.63
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70064.00	-49.52
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70065.00	-49.52
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70066.00	-41.32
70066.50	-32.89
70067.00	-26.77
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70069.50	3.48
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70080.00	-22.64
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70081.00	-10.86
70081.50	-5.85
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70083.00	-10.47
70083.50	-16.16
70084.00	-22.88
70084.50	-30.12
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70085.50	-46.76
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70089.00	-49.52
70089.50	-49.52
70090.00	-47.41
70090.50	-44.16
70091.00	-37.25
70091.50	-31.32
70092.00	-26.50
70092.50	-21.35
70093.00	-16.72
70093.50	-13.19
70094.00	-10.51
70094.50	-10.53
70095.00	-14.08
70095.50	-19.11
70096.00	-25.17
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70097.00	-41.28
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70099.50	-49.52
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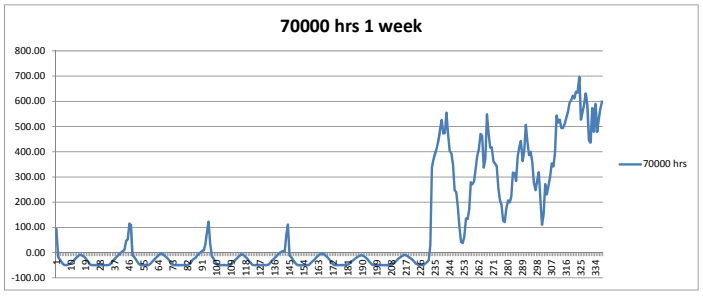

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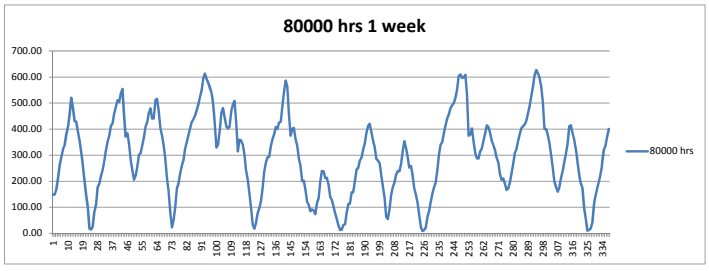

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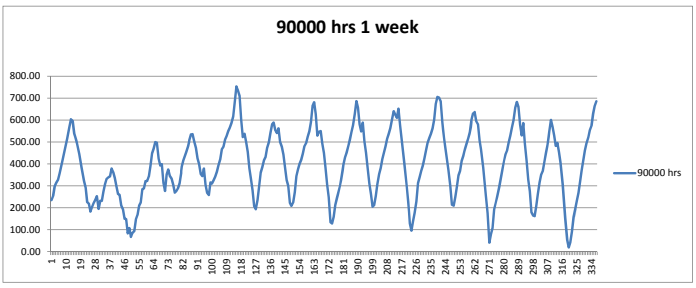

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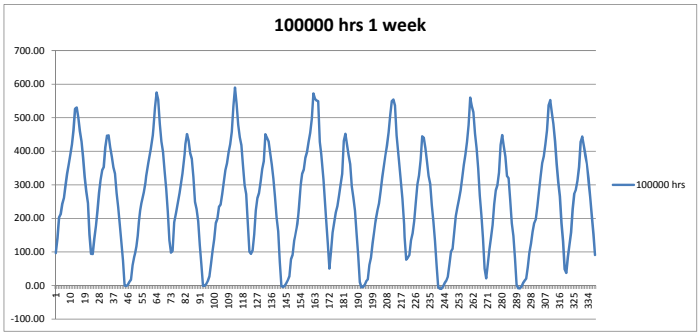

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WEEK IN REVIEW

PHOTO OF THE WEEK



MATTHEW BECK/Chronicle

David Hunsberger fishes from the dock at Wallace Brooks Park in Inverness on Thursday afternoon as a small sailboat drifts across Lake Henderson. Hunsberger was trying his hand at catching largemouth bass.

GOOD NEWS OF THE WEEK

Recently, Lecanto Primary School students got a hands-on lesson in making the Earth a better place to live as they collected trash during the **third annual Jay Stager Memorial One Bag at a Time** event — using canvas bags. "The idea is to do what all of Europe does, which is get rid of the plastic bags by using a cloth bag," said Kings Bay Rotary President Glenn Parker.

HOT TOPIC OF THE WEEK

Students standing — or not standing — for the Pledge of Allegiance

From the county school board members to Chronicle Facebook friends, folks in Citrus County had strong opinions about the state requirement that permits students, with written request from a parent, to sit during the Pledge without placing their hand on their heart.

NEWSMAKER OF THE WEEK

Chet Cole, former executive director of the Key Training Center



Chet Cole loved the people he served, the developmentally disabled, and his love for them inspired the entire community to embrace them as well. He was a role model of what it means to serve "the least of these" and to give them dignity.

The success of the Key Center is because early on, Cole knew that the Key could not depend on government funding and instead developed businesses, including thrift stores and a television station, to raise funds.

Two memorial services for Chet Cole are scheduled this coming week: 5 p.m. Thursday, May 4, at the Chet Cole Life Enrichment Center on the Key Center campus in Lecanto; and, 5 p.m. Friday, May 5, at Seven Rivers Presbyterian Church in Lecanto.

MONDAY

The community was shocked and saddened to learn of the death of **Chet Cole**, the long-time executive director of the Key Training Center, on Sunday, a couple of days after he had suffered a stroke. Cole, 72, was the heart, soul and face of the Key Center for 46 years.

TUESDAY

Sandy Balfour, the former Citrus County School Board member and administrator of the Academy of Environmental Science, was reprimanded for inappropriately grabbing a student by the shoulder last year. Although she is no longer administrator, she is still a teacher in the district. Superintendent of Schools **Sandra "Sam" Himmel** said she stopped short of suspending or firing Balfour because the incident occurred more than a year ago and Balfour is no longer at that job.

Also Tuesday: Crystal River Middle School teacher **Frank Laga** has a knack for inspiring students in the **Advancement Via Determination (AVID) program**; so much so that a number of them return to the school after graduation to work as AVID tutors. The AVID program helps students with average test scores develop problem-solving and organizational skills. When the students discover they're not stupid, that they just learn differently, they blossom.



WEDNESDAY

What can you do with a frisky little dog who likes to run — and doesn't understand that it can't run into traffic? That was the problem **Tom and Debbie Rogers** had with their dog, Brandy. After much trial and error, Tom invented the Amazing **Dog Stopper**, a weighted device hooked onto the dog's collar that slows down a running dog's gait. The device is now for sale on Amazon.com.

Also Wednesday: On Tuesday, Citrus County commissioners agreed to offer the city of Inverness $200,000 annually over five years toward sharing the cost of Whispering Pines Park.

THURSDAY



Last year, 333 vehicle crashes in Citrus County were caused by **distracted driving**, which is anything from texting or talking on a cell phone to reading, putting on makeup, eating or any number of things that people do while driving that take their attention off the road. According to the sheriff's office, the problem is getting worse, not better.

Also Thursday: People with a diagnosed mental illness can find friends, acceptance, support and purpose — even job training — at the **LightHouse**, a program of The Centers.

FRIDAY

The Greenhouse Farmers Market produce stand on U.S. 19 in Homosassa is temporarily closed. Why? As the sign at the stand reads: "due to county harassment." Stand owner, Gary Bartell Jr., says the county is harassing him because his "Welcome to Homosassa" sign that was painted by local artists, is illegal. If found in non-compliance at a code compliance hearing on May 17, Bartell faces fines of up to $1,000 a day until the matter is rectified.

Also Friday: **Southwest Florida Water Management District (SWFWMD)** recommends an 11 percent flow reduction in King's Bay in Crystal River. Water managers met with concerned residents and officials Thursday to discuss minimum-flow levels in the bay, which is utilized heavily by recreational and commercial boaters.

> **The condition of the fields over there is, shall I say, less than desirable. It doesn't have to be first class, but it has to be decent.**
>
> — COUNTY COMMISSIONER JEFF KINNARD, ABOUT THE BALL FIELDS AT WHISPERING PINES PARK IN INVERNESS



Water managers met with concerned residents and officials Thursday to discuss minimum-flow levels in King's Bay in Crystal River. The bay is utilized heavily by recreational and commercial boaters.

MATTHEW BECK/ Chronicle



Gary Bartell Jr. temporarily closed his Greenhouse Farmers Market on U.S. 19 after the county threatened him with fines for code violations. The county said the "Welcome to Homosassa" sign, which Bartell said was painted by local artists, is illegal.

MIKE WRIGHT/Chronicle

— compiled by Nancy Kennedy

Citrus County Chronicle
Crystal River
Daily 29,000
April 30, 2017

From: Sky Notestein
To: Kym Holzwart; Doug Leeper
Subject: FW: You Can Help Save Florida"s Springs!
Date: Tuesday, April 25, 2017 3:02:02 PM

FYI

From: Florida Springs Council [mailto:floridaspringscouncil=gmail.com@mail128.suw14.mcdlv.net] **On Behalf Of** Florida Springs Council
Sent: Tuesday, April 25, 2017 10:01 AM
To: Sky Notestein <Sky.Notestein@swfwmd.state.fl.us>
Subject: You Can Help Save Florida's Springs!

View this email in your browser

Dear Sky,

Florida's springs are one of our state's most beloved natural treasures. Residents and visitors alike have been drawn for decades to the clear waters of our springs and delighted in spring-centered shows, glass bottom boat rides, tubing, kayaking, swimming, and wildlife watching. Manatees, alligators, river otters, Florida Gar, Belted Kingfishers, a variety of turtles, and other wildlife all rely on the vital habitat springs provide.

Unfortunately, pollution in our springs is rising and the flow of fresh water to our springs is declining – threatening the sustainability of springs and our ability to enjoy them.

At a time when we need to invest in restoring our springs, Florida's water management districts are instead authorizing further harm. "Minimum Flow and Levels" (MFLs) for the Rainbow River Springs System and the Silver Springs system have recently been adopted that will allow additional water to be withdrawn from the aquifer that feeds these systems, ensuring these already suffering springs will continue to decline.

We need your help! Please click the buttons below to ask the chairmen and executive directors of the St. Johns River Water Management District and the Southwest Florida Water Management District to reconsider their MFLs for the Silver Springs system and the Rainbow Springs system, respectively. Then click the button to request Governor Scott encourage the districts to revise the MFLs in order to provide the spring systems more protection.

For more information and talking points to use in your communications with the water management districts and Governor Scott please click here.

Email the St. Johns River Water Management District

Email the Southwest Florida Water Management District

Email Governor Scott

Water management districts propose to institutionalize the harm that has been done to our springs rather than try to restore water flow to historic levels. **If you think springs deserve better, write the chairman and the executive director of both water management districts and Governor Scott immediately to let them know!**

Thank you so much for your help!

Sincerely,

Florida Springs Council

Florida Conservation Coalition

Support FSC

The Florida Springs Council is a 501(c)3 nonprofit organization working to ensure the restoration, preservation and protection for future generations of Florida's springs and the Floridan aquifer that sustains those springs and provides our drinking water.

Please consider making a donation to support springs protection.

Click here to donate

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The Florida Springs Council, Inc. is a a 501c3 non-profit.
EIN 81-2889063

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Pull over to let traffic pass

This morning, Thursday, April 20, I followed a land-clearing tractor from Citrus Springs to Pine Ridge on Elkcam Boulevard. There were about 10 vehicles bunched up behind this tractor. Our speed was about 15 mph. I grew up in farm country and when we had to relocate a tractor, we always pulled over and let the traffic pass. This is called courtesy. Look it up.



Don't you have other interests?

In today's paper on Sound Off — today is Thursday (April 20) — I'm calling to ask that guy that writes in all the time for "Arrest tax could be a goldmine." I wish he would get on some other topic to hit on because there is no rhyme or reason for that tax to be instated. First of all, half of the people that are arrested are arrested for nonsensical things. And I'm going to tell you, I was arrested at one time for (being) accused of mooning my neighbor when I'm bending over gardening, OK? So, not all people arrested are arrested because they did something wrong. And half of the time, how can they pay a tax when they don't have the money to do it? They can't even get a job because they're a felon. Let that guy hit on something else already. I do hope that this is published so that he would do something else with his time other than worrying about an arrest tax.

Thank you for your assistance

I would like to reference a good deed on Wednesday — that would be yesterday (April 19). My dog and I would like to say thank you to all the customers and employees at the RaceTrac on (U.S.) 19 who helped me open my car after it locked while I was pumping gas. My dog was extremely pleased about it. ... Anyway, thanks again for all the help.

'Minimum flows' are just double talk

When the Southwest Florida Water Management District talks about setting minimum flows or talks about drawing down the water flow, what this often means is that they're allowing a bottling plant to come in and take water from the aquifer and sell it and bottle water.

Citrus County Chronicle
Crystal River
Daily 25,740
April 27, 2017

Water officials: Spring flow stable



MATTHEW BECK/Chronicle

Water managers met with concerned residents and officials Thursday to discuss minimum-flow levels in King's Bay in Crystal River. The bay is utilized heavily by recreational and commercial boaters.

Water management district recommends flow reduction of 11 percent

A. B Sidibe
Staff writer

The water district's recommended Minimum Flows and Levels (MFLs) for Crystal River/King's Bay are not going down very well with stakeholders and residents, but officials with the agency are insisting there is no need for alarm — spring flow, especially in the northern Floridan Aquifer, remains stable.

And even peering 20 years into the future, Crystal River/King's Bay flow percentages will probably naturally be something in the 2 to 3 percent range, according to Ron Basso, the chief hydrogeologist with the Southwest Florida Water Management District.

At Crystal River/King's Bay, the Southwest Florida Water Management District (SWFWMD) is recommending a reduction of 11 percent of the current flow. If approved, it would allow the drawdown of up to 11 percent of the river/bay system for underground and surface water withdrawals. The district believes that is the maximum amount of drawdown that can occur before more than 15 percent of the habitat suffers what is recognized as significant harm.

Thursday evening at Crystal River Middle School, stakeholders, residents and district officials presented their arguments before about three dozen people, including County Commissioners Jeff Kinnard and Brian Coleman.

"The bottom line is there is more than enough warm water quality in the springs region for manatees and for the foreseeable future," said Gabe Herrick, of SWFWMD, after unveiling the results of the district's decades-old collection of data.

Herrick said baseline salinity-based habitat reductions in the most sensitive portions of the bay — the urban shoreline — have shown in reports a 9-year average of 0.5 parts per thousand (PPT).

Herrick and Basso said based on their peer-reviewed data that Crystal River/King's Bay can handle up to an 11 percent reduction without suffering significant harm and should not need recovery or specific preventive strategies.

Basso added that the bay's spring

See WATER/Page A11

WATER

Continued from Page A1

flows have generally been between 300 to 450 cubic feet per second (cfs) for the past 50 years.

"Withdrawals account for less than 2 percent of water use in this area for the last 8 or 9 years," Basso said. "Even in 20 years, groundwater withdrawals are going to be low."

Basso also pointed out that currently two-thirds of drinking water is derived from the Floridan Aquifer.

However, Dr. Bob Knight, the president of the Florida Springs Institute, took issue with the agency's science and modeling to arrive at such withdrawal levels.

Knight said his institute published a comprehensive study of the area springs and waterways, but was not cited in any of the agency's scientific reports.

"This is what you call peer review ... I call it scientific dishonesty," he said.

He said the reality is that King's Bay has been in steady decline of habitat from the 1960s, when spring flow stood at 900 cfs. Knight added that salinity in the bay has tripled in the past 30 years.

"We all know flow, clarity and quality are intimately connected," he said.

Art Jones, director of the One Rake at a Time project, which works to rid the bay of noxious algae, said district officials should look at the issue of nutrient residency time in the bay in their recommendation.

Jones also urged officials to recommend a 2 or 3 percent withdrawal rate and revisit the issue at the state-mandated 10-year review time.

Don Clark of Floral City said officials can't fix the bay while decreasing flow. Clark accused officials of lying to residents about the plan.

The agency in 2012 did the same thing for the Chassahowitzka and Homosassa rivers and must



STEVE LASKO/For the Chronicle

Art Jones, of the One Rake at a Time project, speaks Thursday night to Southwest Florida Water Management District representatives during a minimum-flow workshop at Crystal River Middle School.

complete the same process for Crystal River and King's Bay by this summer. The Rainbow River's flow and level was set at 5 percent of its current flow level in March.

The district had considered establishing a 12 percent flow level but revised it after receiving new data. If adopted, the district will re-evaluate it in 10 years. It can always revise it upward or downward at any time if new data supports a change. The Florida Department of Environmental Protection has designated the Crystal River/King's Bay system as an impaired waterway and in need of restoration. King's Bay is also an Outstanding Florida Waterway.

According to district officials, the state Legislature requires it to set minimum flows and levels for priority water bodies such as Crystal River/King's Bay. A minimum flow or level is the limit at which further water withdrawals will cause significant harm to the water resources and/or environment. Minimum flows are a protection measure established to protect streams and rivers from impacts associated with groundwater and surface water withdrawals and they are designed to serve as guidelines for the district's permitting programs and for development of alternative water resource projects.

Officials said they have been developing a minimum flow for Crystal River/King's Bay system for many years. The water district's scientists use numerous tools to collect, develop and analyze data before proposing a minimum flow. Their work is then evaluated by an independent peer review panel.

District staff will make a presentation/recommendation to the governing board during a May meeting. The governing board then may choose to recommend adoption of the minimum flow. Brief public comments will also be permitted at that meeting.

Draft reports summarizing the proposed minimum flow are available for review and are posted on the district's website at WaterMatters.org. For more information regarding the proposed minimum flow, please contact Gabe Herrick, a senior environmental scientist with the district's Springs & Environmental Flows Section at 1-800-423-1476, ext. 4275.

Written comments may be submitted via mail or email to Gabe Herrick, at 2379 Broad Street, Brooksville, FL 34604-6899 or gabeherrick@watermatters.org.

Citrus County Chronicle
Crystal River
Daily 25,740
April 28, 2017

From: Alan Martyn Johnson
To: Ron Basso
Cc: Gabe I. Herrick; Xinjian Chen; Doug Leeper
Subject: Re: ROMP TR21-3
Date: Tuesday, April 25, 2017 5:10:02 PM
Attachments: image002.png

Ron,
The chloride trend looks like a stead increase to me. I will take a look at these other wells which are close to the coast...as of right now cI do not know of others where a comparison can be made. Think the Homosassa one stopped operation and the one close to Chass may have also, But that is from memory.

Rainfall ROMP TR21-3
Sorry but that graph is over such a long period it can not show the point I was making. You need to look at some of those days where there are significant changes from one day to the next in the day data (remember the high is the value reported). I listed a few in my first e-mail on this subject, it was only when I got the hourly data the reason for these changes could be seen. Unfortunately, at this time I do not have official day by day rainfalls for Crystal River, even year to date 2017, but back editions of newspapers weather forecast do lend some evidence to my thought.

I have also been looking at ROMP TR21-3 and how it relates to the new gage station at Saragass Canal; ROMP trails the tidal cycle data by between one and two hours. As ROMP data is only reported hourly, I am sure someone can run a regression analysis can home in close than I have so far.
I do not see in any of the equations accounting for this lag when considering ROMP TR21-3 in the Empirical Equation. As you may recall in the mass balance I shared I did point out that "if" the data were shifted by 15 minutes to account for the high/low tide time difference between the Mouth of Kings Bay and the G1 and G2 x-sections the mass balance looked even better at these times and was more in line with the majority of the tidal cycle.....no pulsing springs.

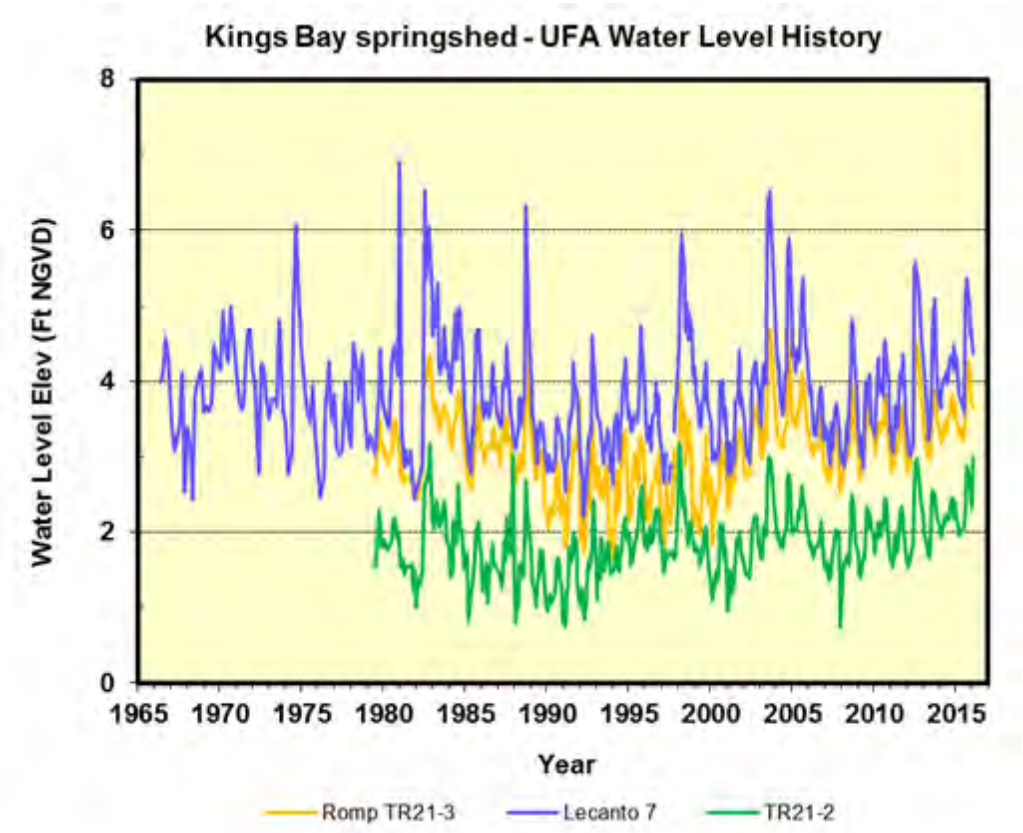
Martyn

From: Ron Basso <Ron.Basso@swfwmd.state.fl.us>
Sent: Monday, April 24, 2017 11:21 AM
To: Alan Martyn Johnson
Cc: Gabe I. Herrick; Xinjian Chen; Doug Leeper
Subject: RE: ROMP TR21-3

Martyn:

The increasing trend in chloride at this site is evidence of increasing salinity at this monitor well in the deeper portion of the UFA. I would term it a localized change since the majority of monitor wells in our springs region coastal network do not show a statistically significant change. It is not unusual to see localized changes in water quality within our coastal region – this would include wells with upward and downward trends. In fact, the nearby TR21-2 monitor well shows a statistically significant downward trend in chloride. Increases in salinity in our coastal region can occur from rising sea level, reduced UFA recharge due to low rainfall, localized pumping, or storm surge inundation. Both Chassahowitzka main spring and Homosassa No. 1 spring show chloride concentrations increasing during dry periods and then decreasing during wet periods. Both of these springs do not show a statistically significant increase in chloride concentration since the early-1990s when measurements began.

The question of the TR21-3 well water levels being indicative of rainfall changes is illustrated by the comparison below of TR21-3 with TR21-2 and Lecanto 7 monthly water levels. Visual inspection shows that all three monitor well water levels are fluctuating in a similar manner. They all reflect lower water levels during drought periods during the early-1990s, 1999-2000, and 2006-2007 and higher water levels during wet periods during the 1997-98 El Nino and 2004 hurricane periods.



Ron Basso, P.G.
Chief Hydrogeologist/Acting Manager
Resource Evaluation Section

Water Resources Bureau
Southwest Florida Water Management District
Ph 800-423-1479 (Florida only)
352-796-7211, ext. 4291

From: Doug Leeper
Sent: Thursday, April 06, 2017 3:38 PM
To: Ron Basso <Ron.Basso@swfwmd.state.fl.us>
Cc: Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>; Xinjian Chen <Xinjian.Chen@swfwmd.state.fl.us>
Subject: FW: ROMP TR21-3

Ron – Can you help address this one? I know you prepared well chloride slides for the Chass and Homo ordeal. Not sure if you have newer slides or a report to send with a simple answer to his question: "Is this indicative of salt water intrusion?"

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Alan Martyn Johnson [mailto:martynellijay@hotmail.com]
Sent: Wednesday, April 05, 2017 7:14 PM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Ron Basso <Ron.Basso@swfwmd.state.fl.us>
Subject: ROMP TR21-3

Please note the increase chloride level since 1987 for the deep chloride monitoring well ROMP TR21-3. From my limited knowledge this appears to be fairly significant as the sampling is from the Avon Park formation in an area close to the coast. Is this indicative of salt water intrusion? Would appreciate your thoughts particularly as there are presumably other chloride monitoring wells.

I have also been looking at the monthly data ROMP TR21-3 (extracted myself) to see if there is any seasonal signature, as in wetter/drier months. I do not see a seasonal signature, or a wetter drier year correlation. May be the use of this well data as a flow predictor is not so good after all. Remember also Dan Yobbi commented about how the use of 2 months VHB measurements was hardly ""long term"".

Still no hard evidence to support the "Pulsing Springs of Kings Bay".

Martyn

From:	Alan Martyn Johnson
To:	Mark Hammond
Cc:	Doug Leeper; Ron Basso; Gabe I. Herrick; Eric DeHaven; Sky Notestein; Chris Anastasiou; Melissa Gulvin; Jennette Seachrist; Xinjian Chen; Bob Knight; Burt Eno; Brad Rimbey; Dan Hillard; AB Sidibe; Ross Morton
Subject:	Pulsing Springs of Kings Bay
Date:	Friday, April 28, 2017 8:10:32 AM
Attachments:	60000 to 100000 hrs as graph.xlsx

Attached is the Excel file I used yesterday to draw attention to how the modeled combined discharges from all springs in Kings Bay vary thru the tidal cycles.
The half hourly data is a direct copy from Dr. Chen's file Model Output of SGD for Baseline(3); it is SWFWMD's data.
At time intervals 60000, 70000, 80000, 90000 and 100000 hours I took one week of data and presented it as a graph.
The magnitude of discharge from high tide (the low points) to low tide (the high points) is typically 6 to 10 fold. SWFWMD do not have any hard evidence to support such large changes.
The best data available is in the reports by Vanasse Hangen Brustlin Inc. which document the measurements at the spring vents taken in 2009 and 2012, none of that data supports such large variations of spring discharge. This information is most easily accessed in the MFL Section of SWFWMD web site (CrystalB_MFL-apps.pdf).
SWFWMD scientists need to take a careful look at this data which forms the basis of the modeling of conditions in Kings Bay, and ask themselves:

- Is this reality?
- Why has this phenomena not been noticed before?
- Where is there any evidence to support this?

I have suggested a solution;
By placing a velocity meter at one of the major spring vents the velocity of the discharge can be monitored, in as little as 24 hours this will provide solid evidence of how discharge from the spring varies.

Just imagine if I were to present such evidence at the May Governing Board Meeting, or soon thereafter.

Martyn

60000 to 100000 hrs as graph

600000 hrs

60000.00	415.63
60000.50	403.78
60001.00	368.81
60001.50	306.07
60002.00	310.79
60002.50	294.95
60003.00	146.75
60003.50	98.71
60004.00	171.74
60004.50	247.65
60005.00	239.30
60005.50	334.08
60006.00	310.34
60006.50	374.78
60007.00	399.23
60007.50	401.53
60008.00	361.80
60008.50	387.97
60009.00	449.41
60009.50	476.34
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60010.50	526.46
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60011.50	602.30
60012.00	599.75
60012.50	531.53
60013.00	700.80
60013.50	465.77
60014.00	492.49
60014.50	436.46
60015.00	359.25
60015.50	259.83
60016.00	195.78
60016.50	151.25
60017.00	83.08
60017.50	93.01
60018.00	89.63
60018.50	198.68
60019.00	222.89
60019.50	205.79
60020.00	303.07
60020.50	303.22
60021.00	323.50
60021.50	411.44
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60027.50	23.60
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60028.50	94.79
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60029.50	128.54
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60030.50	301.91
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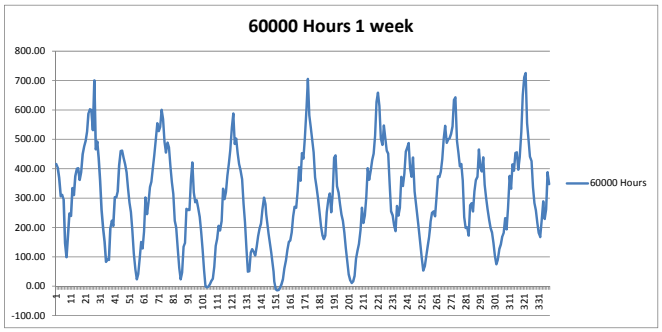

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70003.50	-47.91
70004.00	-45.11
70004.50	-41.16
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70006.50	-16.17
70007.00	-10.55
70007.50	-8.37
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70008.50	-16.17
70009.00	-22.48
70009.50	-30.66
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70011.50	-49.52
70012.00	-49.52
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70028.00	-49.52
70028.50	-49.26
70029.00	-43.88
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70030.00	-31.02
70030.50	-23.26
70031.00	-17.50
70031.50	-10.98
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70035.50	-44.26
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70072.50	-17.62
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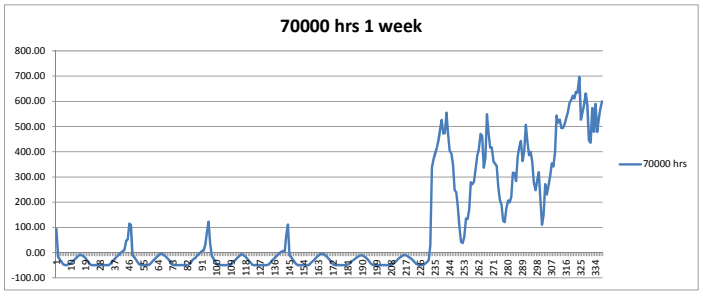

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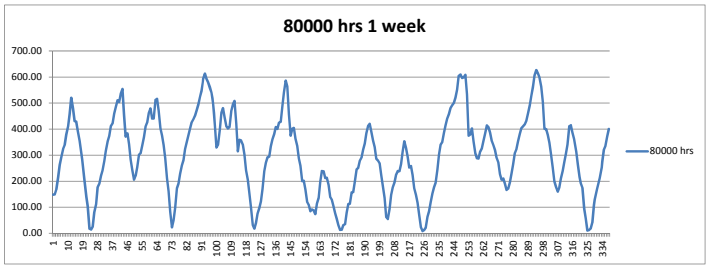

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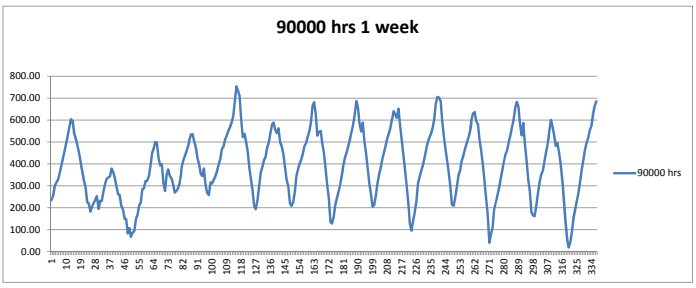

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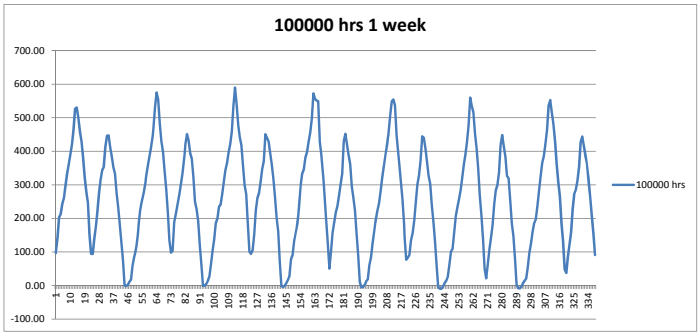

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From: Chris Zajac
To: Danielle Rogers
Cc: Melissa Gulvin; Gabe I. Herrick; Doug Leeper
Subject: Kings Bay MFL Report Request
Date: Tuesday, May 02, 2017 2:00:35 PM

Danielle,

I received a call from Art Jones in Crystal River today. He's requesting 12 hard copies of the draft MFL report and is willing to pick them up in the Brooksville Office if the District will print them for him. I'm not sure who would be the best person to respond to his request but I thought I'd start with you. He did mention that he'd like to meet with Gabe to discuss. His number is (727) 642-7659 and his email address is Mrawjones@aol.com.

Chris Zajac
FARMS Program Manager
7601 US Hwy 301
Tampa, FL 33637
(813) 985-7481 ext. 4413
(352) 586-3776 cell
Chris.Zajac@swfwmd.state.fl.us

From: Art Jones [mailto:MrAWJones@aol.com]
Sent: Tuesday, May 09, 2017 8:22 PM
To: Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>; Mark Hammond <Mark.Hammond@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Kelly Rice <Kelly.Rice@swfwmd.state.fl.us>
Cc: mrawjones <mrawjones@aol.com>; Brad Rimbey <bwr.crrc@tampabay.rr.com>; Dan <2buntings@comcast.net>; Gerry Mulligan <gmulligan@chronicleonline.com>; A. B. Sidibe <asidibe@chronicleonline.com>; marnold@chronicleonline.com

Subject: MFL Kings Bay

Dear Gabe,

Multiple effects are examined during the MFL process. Salinity, Manatee thermal refuge, human use impacts, and human induced impacts. By reading studies in the appendices, it is concluded that SWFWMD examined the effects of human induced impacts and human use impacts.

I am requesting the calculated water withdrawal percentages associated with these effects. Based on page 28 and a previous MFL used as criteria -refer to citation on pg. 28-29, a look at the numbers would be approximately 3% allowable water withdrawal, before significant harm is done using your criteria.

Also please send me water quality data on the 3 wells sited as your examples of stable spring flow. Calcium, alkalinity, mg. Etc.

And, on what basis do you calculate a 1 to 2% water withdrawal as the amount effecting spring flow? Based on data from the field, I calculate much higher numbers. Using per capital water consumption currently in Citrus county based on a pop. Of 141,058 I find domestic use much higher at 24MGD and that does not count snowbirds, commercial and visitors. Adding in Golf courses using the national avg of 312,000gpd, times our 15 golf courses I get another 4.68MGD. Now look at agriculture with an avg. of 2.35acreft/year and I get another 10.24MGD. Avg water used for lawn watering that looses approx 50% to evaporation based on the avg 1,000sq/ft lawn using 620 gallons every time watered I get another 13.92MGD based on 78,423housing units in Citrus Co. and half of those with lawn sprinklers twice/week. Again, very conservative as many irrigated lawns are much bigger and irrigated more often.

This totals a very conservative estimate of ground water pumped at bare minimum of over 52.84 MGD here in Citrus county. Using the Kings bay spring basin as the largest percent 75% of citrus county water consumption I still get 39.63MGD. This compares to the MFL report numbers of only 15MGD.

No matter how hard I try I can not get the numbers in the MFL report dated May 1, 2017 to add up.

Please add this as part of my comments on the MFL report also.

Thank you , Art Jones

Sent from my iPad

From:	Gabe I. Herrick
To:	Art Jones
Cc:	Doug Leeper; Ron Basso; Mark Hammond; Jennette Seachrist; Eric DeHaven; Mike R. Bray; Shellie Ferreira-Lee; Susanna Martinez Tarokh; Melissa Gulvin
Subject:	RE: MFL Kings Bay
Date:	Wednesday, May 10, 2017 2:31:22 PM

Dear Art,

Thank you for your email. Staff responses are embedded in the body of your email below.

Best,

Gabe Herrick, PhD
Senior Environmental Scientist
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34604
352-796-7211 ext. 4275

-----Original Message-----
From: Art Jones [mailto:MrAWJones@aol.com]
Sent: Tuesday, May 09, 2017 8:22 PM
To: Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>; Mark Hammond <Mark.Hammond@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Kelly Rice <Kelly.Rice@swfwmd.state.fl.us>
Cc: mrawjones <mrawjones@aol.com>; Brad Rimbey <bwr.crrc@tampabay.rr.com>; Dan <2buntings@comcast.net>; Gerry Mulligan <gmulligan@chronicleonline.com>; A. B. Sidibe <asidibe@chronicleonline.com>; marnold@chronicleonline.com
Subject: MFL Kings Bay

Dear Gabe,

Multiple effects are examined during the MFL process. Salinity, Manatee thermal refuge, human use impacts, and human induced impacts. By reading studies in the appendices, it is concluded that SWFWMD examined the effects of human induced impacts and human use impacts.

I am requesting the calculated water withdrawal percentages associated with these effects. Based on page 28 and a previous MFL used as criteria -refer to citation on pg. 28-29, a look at the numbers would be approximately 3% allowable water withdrawal, before significant harm is done using your criteria.

District Response:
It is not clear to staff how your 3% allowable impact was determined. The recommended minimum flow for the Crystal River/Kings Bay System was determined based on consideration of changes in salinity, manatee thermal refuge, and other factors. Ultimately, the minimum flow was based on an allowable 11% flow reduction associated with acceptable changes in salinity-based habitats. Impacts associated with human uses, including land-use changes, withdrawals, etc., are integrated into our water withdrawal impact assessment. All groundwater withdrawals associated with those land uses described in pages 28-29 of the MFL report are included in the groundwater flow model used to assess springflow impacts.

Also please send me water quality data on the 3 wells sited as your examples of stable spring flow. Calcium, alkalinity, mg. Etc.

District Response:
Staff is assuming you are requesting water quality data for monitor wells TR21-2, TR21-3, and Lecanto 7 shown in the MFL report in Figure 1-14. These data will be provided under a public records request. There may be a fee

associated with this request. Our staff will contact you with the cost estimate and obtain your approval prior to completing this request.

And, on what basis do you calculate a 1 to 2% water withdrawal as the amount effecting spring flow? Based on data from the field, I calculate much higher numbers. Using per capital water consumption currently in Citrus county based on a pop. Of 141,058 I find domestic use much higher at 24MGD and that does not count snowbirds, commercial and visitors. Adding in Golf courses using the national avg of 312,000gpd, times our 15 golf courses I get another 4.68MGD. Now look at agriculture with an avg. of 2.35acreft/year and I get another 10.24MGD. Avg water used for lawn watering that looses approx 50% to evaporation based on the avg 1,000sq/ft lawn using 620 gallons every time watered I get another 13.92MGD based on 78,423housing units in Citrus Co. and half of those with lawn sprinklers twice/week. Again, very conservative as many irrigated lawns are much bigger and irrigated more often.

This totals a very conservative estimate of ground water pumped at bare minimum of over 52.84 MGD here in Citrus county. Using the Kings bay spring basin as the largest percent 75% of citrus county water consumption I still get 39.63MGD. This compares to the MFL report numbers of only 15MGD.

District Response:
Current impacts to springflow in Kings Bay were largely determined using the NDM version 5 groundwater flow model as discussed in the MFL report. We examined the impacts during two different pumping periods, 2010 and 2014. Withdrawal impacts to springflow varied from 1.5% in 2010 to 1.1% in 2014. Groundwater withdrawals in our six northern counties declined by about 20% from 2010 to 2014 so the predicted impact is slightly smaller in 2014. On the withdrawal side, the District maintains a metered and estimated water use database from 1992-2014 that includes withdrawals from water use permitted wells and estimates of domestic self-supply use. Our most recent estimate of current county-wide water use in Citrus County in 2015 was 26.4 mgd. This includes water use permitted use and estimates of domestic self-supply. Approximately 80% of groundwater withdrawn is metered.

No matter how hard I try I can not get the numbers in the MFL report dated May 1, 2017 to add up.

Please add this as part of my comments on the MFL report also.

District Response:
Your email along with District staff’s response will be included with all other stakeholder input within the MFL report appendices.

Thank you , Art Jones

Sent from my iPad

From: Gabe I. Herrick
To: Doug Leeper; Eric DeHaven; Melissa Gulvin; Ron Basso
Subject: FW: Kings Bay MFL
Date: Monday, May 15, 2017 9:37:21 AM

See email from Art Jones below.

Gabe Herrick, PhD
Senior Environmental Scientist
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34604
352-796-7211 ext. 4275

-----Original Message-----
From: Art Jones [mailto:MrAWJones@aol.com]
Sent: Friday, May 12, 2017 3:46 PM
To: Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>; Melissa Gulvin <Melissa.Gulvin@swfwmd.state.fl.us>; Mark Hammond <Mark.Hammond@swfwmd.state.fl.us>
Cc: mrawjones <mrawjones@aol.com>
Subject: Kings Bay MFL

Dear Gabe,

Thank you for your last response. To clarify the request for the water withdrawl percentages associated with human-induced and/or human-use effects.

We agree human-induced and human-use effects can be included in 2 ways. One way includes them in the assessment, and the other way includes them as the focus for the model run. We are referring to the human-use and human-induced effects as the focus of the model run. We are requesting the water withdrawl percentages associated with the human-use and/or human-induced effects. Similar to SRWMD's use of these effects in establishing the MFL for the Wacissa and Aucilla Rivers. Refer to the SRWMD MFL for Wacissa and Aucilla River. This particular MFL has been included because it involves a bay and the system is tidally influenced similar to Kings Bay and Crystal River.

In particular we are interested in the following model runs and water withdrawl percentages...
The human-use model runs that examine recreation in an on the water, requiring a specific water depth.
The human-induced model runs that alter the fish passage and fish and wildlife habitat based on water levels.
The model run that examines human-induced impacts to the vegetation community and the shoreline vegetative buffer. Various effects at different water levels.

The studies presented in the appendices indicate SWFWMD examined these effects and performed the model runs. However, these effects and corresponding data was not included in the final report. Only the salinity and thermal refuge was included in the final report.

Thank you very much, Art Jones

Sent from my iPad

From: Gabe I. Herrick
To: Doug Leeper; Ron Basso; Melissa Gulvin
Subject: FW: Minimum Flow for Crystal River
Date: Tuesday, May 16, 2017 8:44:22 AM

Gabe Herrick, PhD
Senior Environmental Scientist
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34604
352-796-7211 ext. 4275

From: bobm6522@gmail.com [mailto:bobm6522@gmail.com]
Sent: Monday, May 15, 2017 6:41 PM
To: Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>
Subject: Minimum Flow for Crystal River

My apologies for the late date of this email. We just found out today that this comment period ends this evening.

Citrus County Audubon opposes increasing the minimum flow for the Crystal River another 11%.

Audubon is a conservation organization who uses the health of our birds to calculate the health of our environment.

Citrus County Audubon has observed birds in this region for decades.

We have noticed the reduced numbers birds in this area. We have witnessed the water quality diminishing from crystal clear to cloudy. We have observed the sea grass being overcome by the unhealthy Lyngbya algae.

We have seen the sable palm trees lose their tops because of salt-water intrusion.

We believe Kings Bay and the Crystal River are severely impaired and reducing the flow another 11% will do more harm than good for our waterways.

We understand that the Southwest Florida Water Management District has used science to determine the minimum flows for the Crystal River/Kings Bay system. We are not scientists, so it is a little disconcerting that other, equally qualified scientist, using the same and additional facts, come to a different conclusion.

Audubon's 130 members believe that if the Water District is correct, waiting a year or so will not harm the river. If the Water District is wrong, the additional drawdown might well be the tipping point and have our Kings Bay, and Crystal River might never recover or cost millions more to bring it back.

Crystal River Audubon Society opposes increasing the minimum flow for the Crystal River another 11%.

Thank you

Bob Messersmith
President
CCAS

Sent from Windows Mail

From:	Doug Leeper
To:	"bobm6522@gmail.com"
Cc:	Gabe I. Herrick; Xinjian Chen; Ron Basso; Jennette Seachrist; Eric DeHaven
Subject:	Re: Minimum Flow for Crystal River
Date:	Tuesday, May 16, 2017 1:49:00 PM

Mr. Messersmith:

Thanks for your comments from the Crystal River Audubon Society on the proposed minimum flow for the Crystal River/Kings Bay System. Your comments will be evaluated by staff and made available to District Governing Board members prior to the Board's May 23 meeting at which the Board will consider moving forward with rulemaking associated with the proposed minimum flow.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: bobm6522@gmail.com [mailto:bobm6522@gmail.com]
Sent: Monday, May 15, 2017 6:41 PM
To: Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>
Subject: Minimum Flow for Crystal River

My apologies for the late date of this email. We just found out today that this comment period ends this evening.

Citrus County Audubon opposes increasing the minimum flow for the Crystal River another 11%.

Audubon is a conservation organization who uses the health of our birds to calculate the health of our environment.

Citrus County Audubon has observed birds in this region for decades.

We have noticed the reduced numbers birds in this area. We have witnessed the water quality diminishing from crystal clear to cloudy. We have observed the sea grass being overcome by the unhealthy Lyngbya algae.

We have seen the sable palm trees lose their tops because of salt-water intrusion.

We believe Kings Bay and the Crystal River are severely impaired and reducing the flow another 11% will do more harm than good for our waterways.

We understand that the Southwest Florida Water Management District has used science to determine the minimum flows for the Crystal River/Kings Bay system. We are not scientists, so it is a little disconcerting that other, equally qualified scientist, using the same and additional facts, come to a different conclusion.

Audubon's 130 members believe that if the Water District is correct, waiting a year or so will not harm the river. If the Water District is wrong, the additional drawdown might well be the tipping point and have our Kings Bay, and Crystal River might never recover or cost millions more to bring it back.

Crystal River Audubon Society opposes increasing the minimum flow for the Crystal River another 11%.

Thank you

Bob Messersmith
President
CCAS

Sent from Windows Mail

From: Sid Flannery
To: Doug Leeper; Barbara Nordheim-Shelt
Subject: Crystal River and Morris Bridge Sink
Date: Thursday, May 11, 2017 8:43:24 AM

Hello Doug and Barbara,

How is it going? Busy I expect, but well I hope (easy for me to be say). I first have a question for Doug, then one for Barbara.

Doug - When do you expect to finalize the Crystal River minimum flows report? I read it once and have only a few editorial comments. Most significantly, even if the report does not analyze or use the data, I think it should mention and reference the fish study that USF and FFWCC did on the river and Kings Bay for the District.

Barbara - When does the District plan to develop the scope of work for the next TWA for the sampling of Morris Bridge Sink and the surrounding wetlands. In keeping with our previous correspondence, I would like to give you comments for that. For example, vertical profiles of meter readings in Morris Bridge Sink need to be taken. The first report had some interesting findings, but the absence of vertical profile readings was apparent.

I know retirees should be smug about plans, but I am going to the state where Doug got his graduate degree for a short, fun trip starting tomorrow through Tuesday. So, if nothing is very timely, next week is fine for any response. I can reply sooner, but will be tying from a phone.

Have a good weekend,

Sid

From:	Doug Leeper
To:	"Sid Flannery"
Cc:	Barbara Nordheim-Shelt; Gabe I. Herrick; Xinjian Chen; Ron Basso; Jennette Seachrist; Eric DeHaven
Subject:	RE: Crystal River and Morris Bridge Sink
Date:	Thursday, May 11, 2017 9:06:00 AM

Hey Sid –

Burghart and Peebles (2011) and MacDonald et al. (2011) are cited in section 1.7.2 of the report (see excerpt below) and included the report appendices.

1.7.2 Fish and Wildlife Habitats and the Passage of fish
Salinity-based habitats and manatee thermal refuge are measurable critical resources that are directly linked to fish and wildlife in the Crystal River/Kings Bay system (see Section 1.5). Several surveys funded by the district found diverse communities of fish and invertebrates in the system (Evans et al. 2010 [included as appendix], Burghart and Peebles 2011 [included as appendix], MacDonald et al. 2011 [included as appendix]). Maintaining salinity-based habitats and thermal refuge for manatees will address habitat concerns associated with these fish and wildlife resources. Because the bay and river are tidally influenced, system water levels are driven by tides, not by freshwater inflow. Thus, the passage of fish is not expected to be affected by implementation of minimum flows.

The report posted on-line is our current, final draft (hoping that no major changes will be required). We will be amending the report appendices to include stakeholder input received through May 15th. The upcoming May 23rd Board presentation will include requests for approval of rulemaking and authorization for staff to make any necessary clarifying edits to the report. Latter will let us fix typos, formatting issues, and make minor editorial changes.

Hope your headed to northern Georgia or the coast; the coastal plain away from the coast is not so exciting (although there are some nice blackwater rivers there) – enjoy.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Sid Flannery [mailto:sidflannery22@gmail.com]
Sent: Thursday, May 11, 2017 8:43 AM
To: Doug Leeper <Doug.Leeper@swfwmd.state.fl.us>; Barbara Nordheim-Shelt <Barbara.Nordheim-Shelt@swfwmd.state.fl.us>
Subject: Crystal River and Morris Bridge Sink

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Have a good weekend,

Sid

Board of County Commissioners
Executive Office

110 N. Apopka Ave., New Courthouse, Inverness, Florida 34450
(352) 341-6560 • Toll Free From Citrus Springs/Dunnellon • (352) 489-2120
Fax (352) 341-6584 • Website: www.bocc.citrus.fl.us

Our Vision
"We are a user-friendly and common sense organization dedicated to responsive citizen services."

May 11, 2017

Brian Armstrong, Executive Director
Southwest Florida Water Management District
2379 Broad Street
Brooksville FL 34604-6899

Dear Mr. Armstrong,

We appreciate the staff presentation that was given to the Commissioners and the citizens of Citrus County on Tuesday, May 9. The Citrus County Board of County Commissioners has reviewed the Recommended Minimum Flow for the Crystal River/Kings Bay System and offers comments as provided in this letter.

The report recommends a revised minimum flow of 89 percent of the baseline, natural flow. We understand that the data and studies that have been done in support of this report show that no significant harm will occur with this allowed spring flow reduction. However, in this case we believe the report conclusions are inconsistent with the actual changes in the water quantity of spring flow for the Crystal River/ Kings Bay System.

Clearly, there has been significant degradation in the condition of Crystal River/Kings Bay in the recent past. While the degree to which this damage is caused by spring flow can be argued, it is our opinion that erring on the side of caution when setting the MFL would be prudent. Once all of the factors contributing to the degradation of the Crystal River/Kings Bay system are known and effective restoration efforts have been demonstrated, we believe the issue could be revisited. We feel based on the current conditions, that preserving as much of the natural flow as possible is the reasonable approach.

As a governing body we understand the Legal requirements to implement the Minimum Flow for the spring, we recommend you do implement a minimum flow. However, we

Scott Carnahan Chairman, Commissioner, District 4 - Ronald Kitchen Jr., 1st Vice Chairman, Commissioner, District 2 – Jeff Kinnard, 2nd Vice Chairman, Commissioner, District 1 – Brian Coleman Commissioner, District 5
Jimmie T. Smith, Commissioner, District 3

suggest based on the apparent differences in the scientific data and the reality of the historic spring flow, we suggest you implement a much more conservative number than 11%.

Sincerely,



Scott Carnahan,
Chairman, Citrus County Board of County Commissioners

cc: Board of County Commissioners
Randy Oliver, County Administrator
Jeff Rogers, Assistant County Administrator/Public Works Director
Ken Cheek, Water Resources Director

Smith: I'm 'expert witness' on agritourism law

MIKE WRIGHT
Staff writer

Commissioner Jimmie T. Smith went to bat Tuesday for an Inverness ranch owner and other farmers who want to supplement their income by hosting weddings and other ceremonies.



Jimmie T. Smith said county is wrong about state law.

But Smith's hope to secure buy-in from other commissioners came up empty, other than to say they support business.

Commissioners, other than Smith, shied away from trying to interpret the meaning of "ceremony" included in a 2016 state law as a definition of agritourism.

The county has a pending code compliance case against Williams LTC Inc., owner of 640-acre Lakeside Ranch, which advertises its site for weddings.

Some neighbors have complained about noise from receptions, and the county cited Williams for conducting event and resort activities in a zoning classification that doesn't allow those.

Williams has threatened to sue over the matter. He sent an email on Monday to County Attorney Denise Dymond Lyn outlining his lawsuit plans if the county doesn't either drop the case or postpone it until July.

A hearing officer is scheduled to hear the case on May 17.

Smith, who was a member of the state Legislature and voted for the bill, said the intent was to include weddings as "ceremonies." He said he considers himself an "expert witness" on the law's meaning and, in an email last week to Lyn, said the county is violating state law by moving against a legislative analysis of the bill that said weddings are included in the ceremony definition.

Smith said the bigger issue for the Williams property is noise and parking, and he suggested the county zero in on those areas.

Commissioner Jeff Kinnard said he wouldn't want to tweak county ordinances to address an isolated incident.

"I'd be very careful wading into that water," he said.

Commissioner Brian Coleman said he didn't think the county should define the ambiguity of a state law.

While the Williams case was never specifically named, commissioners heard from two residents of the adjacent Lakeside Country Club community who cited noise issues.

"I do question how loud bands and speakers fit into the definition of a ranch," Leslie Smith said. "All I'm asking for as a property owner is my peace and quiet back."

Commissioner Ron Kitchen Jr. said code issues do not involve the county commission.

"We are to stay out of this kind of thing," he said.

Commissioners ended the discussion without a vote.

Board backs posting for economic director job

Commissioners unanimously approved a suggestion by Kinnard to post the position of economic development director and, rather than seat a county economic development council, rely on an existing business alliance.

Kinnard said the county needs a director to attend numerous state and national events to begin promoting Citrus County.

"We have got to have a top gun," Kinnard said. "I want somebody on their game out there to attend these events."

Kinnard suggested a budget of $200,000 to $250,000, which includes the salary and all costs. Revenue will come from the county's business license tax.

The director will report directly to County Administrator Randy Oliver.

Board hopes to sink MFL recommendations

County commissioners had nothing good to say about the Southwest Florida Water Management District's proposed minimum flows and levels for the Crystal River and King's Bay that would allow a reduction of up to 11 percent.

Commissioners said a reduction of even less than that would cause significant damage. They said saltwater intrusion is already creeping closer toward the bay.

Water management district scientists say 11 percent is the level before substantial damage to plants and wildlife occurs. Commissioners say the damage is happening now.

Commissioners agreed to send a letter to the water district opposing the 11 percent reduction, while also not recommending a specific amount.

The water management district board will decide the issue May 23.

Board backs plan for spay/neuter cats

Commissioners unanimously agreed with a suggestion by Carnahan to create an ordinance calling for mandatory spay or neuter of cats.

Cats adopted from the shelter are already spayed or neutered. The ordinance, if passed, would require residents to spay or neuter their cats.

Commissioners OK new water line in Citrus Hills

Commissioners unanimously approved extending a water line to a Citrus Hills street to serve residents, including one whose well is dry.

At the same time, commissioners decided to keep intact, for now, mandatory hookups for homeowners served by the line.

The water line is for West Britain Street. A survey of the homeowners showed 11 in favor and three against, Utilities Director Ken Cheek said.

In another water-related issue, commissioners decided not to initiate once-a-week water restrictions despite current drought conditions.

Cheek said Sugarmill Woods and Citrus Hills customers of the county's water system are using significantly more water than a year ago — despite rate changes that increased bills for many people.

"Drought trumps rates when it comes to usage," Cheek said.

Most of the usage, Oliver said, occurs in the middle of the night — indicating it's for irrigation.

Contact Chronicle reporter Mike Wright at 352-563-3228 or mwright@chronicleonline.com.

Citrus County Chronicle
Crystal River
Daily 25,740
May 10, 2017

Meeting set to address concerns with MFLs

Special to the Chronicle

There will be a public meeting about the proposed miniumn flows and levels (MFLs) for King's Bay/Crystal River at 9 a.m. Monday, May 15, at the Citrus County Chamber/Tourism Development Council Visitor Center, 915 N Suncoast Blvd. (U.S. 19), Crystal River. Art Jones, founder of the nonprofit One Rake at a Time Inc., will lead the meeting.

A 94-page MFL recommendation report produced by the Southwest Florida Water Manatement District was issued on May 1 and recommends up to an 11 percent reduction of spring flow for Crystal River/King's Bay, according to Jones, who said he has read the full report. This would allow the agency to issue groundwater withdraw permits that could pump an additional 23.7 million gallons per day out of new wells drilled anywhere in the King's Bay spring basin, Jones said.

The King's Bay springs basin includes most of Citrus county, including Inverness and the Lakes Region, parts of Levy, Marion, Sumter and Lake counties. Large wells could be drilled that could help meet the demands of the regional supply of water for growing developments like The Villages in Sumter County, Jones contends. The developers of The Villages have purchased over 200,000 acres on the west side of Interstate 75 that abuts Citrus County and is in the King's Bay spring basin, according to Jones.

Jones believes that additional pumping of ground water could lead to an increase in sinkholes.

King's Bay has already suffered significant harm from reduced flows that effect water quality by increasing the residence time that water circulates in the the bay before flowing out the Crystal River to the Gulf of Mexico. Less water, longer residence time equals more Lyngbya algae, reduced clarity and less sunlight able to penetrate down to the eelgrass restoration areas, Jones said.

There will be a follow-up meeting on Monday, May 22, at 9 a.m. at the chamber for people planning on attending the meeting on Tuesday, May 23, at 9 a.m. at the Brooksville headquarters of the Southwest Florida Water Management District, when the board of directors will vote on the MFL recommendation to reduce flows by up to 11 percent.

For more information, contact Art Jones at 727-642-7659 or email MrAWJones@aol.com.

Citrus County Chronicle
Crystal River
Daily 25,740
May 12, 2017

From: Susanna Martinez Tarokh
To: All_Users
Subject: SWFWMD Daily Media Report
Date: Friday, May 12, 2017 2:50:56 PM

SWFWMD DAILY MEDIA CONTACTS
5/12/2017
As of 3:00 p.m.

Media Outlet: Citrus County Chronicle
Reason for Call: Springs/MFL
Agency's Response: District initiated email sent to newspaper editor and beat reporter correcting a factual inaccuracy in an article titled "Special to the Chronicle"– the article incorrectly states the following: ***The King's Bay springs basin includes most of Citrus county, including Inverness and the Lakes Region, parts of Levy, Marion, Sumter and Lake counties.*** *Large wells could be drilled that could help meet the demands of the regional supply of water for growing developments like The Villages in Sumter County, Jones contends. The developers of The Villages have purchased over 200,000 acres on the west side of Interstate 75 that abuts Citrus County and is in the King's Bay spring basin, according to Jones.* The bolded portion above is stated as factual and not attributed to Art Jones. According to our scientists, this statement is false. The eastern boundary of the Kings Bay springshed or basin is the Withlacoochee River.

Susanna Martinez Tarokh
Public Information Officer
Southwest Florida Water Management District
OFFICE 813-985-7481 ext. 2008
CELL 813-781-9817
watermatters.org/newsroom

Clarification

A story on Page A3 of Friday's edition, "Meeting set tp address concerns with MFLs," warrants clarification. A sentence that reads, "The King's Bay springs basin includes most of Citrus County, including Inverness and the Lakes Region, parts of Levy, Marion, Sumter and Lake counties," should have been attributed to One Rake at a Time organization founder Art Jones. In addition, according to the Southwest Florida Water Management District, that information is false. The eastern boundary of the King's Bay springshed, or basin, is the Withlacoochee River, according to the water district.

Readers can alert the Citrus County Chronicle to any errors in news articles by emailing newsdesk@chronicleonline.com or by calling 352-563-5660.

Citrus County Chronicle
Crystal River
Daily 25,740
May 13, 2017

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FLORAL CITY | HOMOSASSA | INVERNESS

Citrus County Tourism Development Council

c/o Visitors & Convention Bureau
915 N. Suncoast Blvd
Crystal River, Florida 34429
Phone: 352-794-5506 Fax: 352-794-5507

Commissioner
Ronald E. Kitchen
Chairman

Michael Mancke
Plantation on Crystal River
Vice Chairman

Gene McGee
Interest in Tourism

Councilmember Jacquie Hepfer
City of Inverness

Councilmember Michael Gudis
City of Crystal River

Dr. Paresh Desai
Port Hotel & Marina

Karlene Feliciano
Interest in Tourism

Michael Shoemaker
Natures Resort

Daryl Seaton
Best Western Crystal River Resort

May 12, 2017

Brian Armstrong, Executive Director
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34604-6899

Dear Mr. Armstrong,

The Citrus County Tourism Development Council is the leading voice for the Tourism Industry in Citrus County with members representing the hospitality, eco-tourism and other local industries as well as local governments. The Council oversees the staff and operations of the Citrus County Visitors and Convention Bureau which brands itself Discover Crystal River Florida.

Tourism, particularly ecotourism, is an essential and defining industry in our economy. We welcome more than 400,000 people annually with an economic impact on our communities of $200 million. The tourism sector employs over 4,000 people--13% of the county's workforce.

Crystal River/Kings Bay is a crucial asset to our tourism economy with the majority of our hotels, eco-tourism companies and restaurants located on or near its shores. Every day, hundreds of water craft launch from our shores to experience the wonder of this Outstanding Florida Waterway and, particularly, its many manatees. Put simply: as goes the health of Crystal River/Kings Bay, so goes the health of our local economy.

For this reason, the recommendations of the Southwest Florida Water Management District (SWFWMD) regarding Minimum Flows and Levels (MFLs) in Crystal River/Kings Bay are of critical concern to us. The outcome of a revised minimum flow of 89% of the baseline, we believe, could have long lasting repercussions for the health of our industry and the future of our communities.

The District's proposed Minimum Flows and Levels (MFLs) are designed to protect Kings Bay/Crystal River from "withdrawals that would cause significant harm". Based on the experience of residents, guides and hoteliers who have watched the steady demise of this once pristine "Crystal River" eco-system over the past fifty years, it is our contention that significant harm to this ecosystem has already occurred.

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Citrus County
Tourism Development Council

c/o Visitors & Convention Bureau
915 N. Suncoast Blvd
Crystal River, Florida 34429
Phone: 352-794-5506 Fax: 352-794-5507

Saltwater incursions and other factors have shuffled the deck on plants living in Crystal River/Kings Bay with devastating effect on water clarity.

Flows in Kings Bay are already drastically diminished from historical levels. Between 1964 and 1975, measured flows for the Crystal River/Kings Bay springs averaged 592 million gallons per day (mgd) according to Yobbi and Knochenmus--USGS 88-4116. Currently, the Southwest Florida Water Management District's streamflow for Crystal River/Kings Bay is listed as 220mgd. That's a precipitous drop of 63%. Based on this figure, the final draft would allow for a further drop to 196mgd, only one-third of the 1965-75 level. Though flow measurements then and now may be debatable, it nonetheless reveals an unmistakable and alarming trend.

A flow reduction of 11% is expected to result in the further loss of 15% of freshwater shoreline in Crystal River/Kings Bay (pg, vii). We find such a loss to be clearly unacceptable in light of the historic loss of flow and the level of damage already done.

Further, the District's Final Draft openly admits that *"a full determination of the potential impacts of changes to flow on water quality"* is unknown at this time since *"water quality measures other than salinity and temperature were not available for use as criteria for setting the minimum flow."* This suggests that the current scientific analysis suffers from an incomplete data set including *"quantification of potential relationships between flow reductions and water quality parameters – particularly chlorophyll and other parameters tied to water clarity."* (pg, vi)

These admissions within the report are red flags of warning to our industry partners and the residents of this County. If this admittedly incomplete study is wrong, we will pay the price. The fact that SWFWMD admits that it does not know everything that it needs to know suggests a cautious approach is necessary when plotting the future health of an already significantly damaged ecosystem.

As the report suggests, this problem will only be made more difficult as rising sea levels force more salt water into Crystal River/Kings Bay in the years ahead. This will make it exponentially harder to re-establish native aquatic plants within the Kings Bay ecosystem creating further opportunities for the unsightly dominance of invasive species such as lyngbya algae, or worse, a near complete type conversion from freshwater to saltwater plants. On the eve of this historic and literal "sea change" one wonders why we would be discussing reducing flows at all?

Again the final draft honestly states what SWFWMD does not know: *"Although, there is a possibility that rising sea levels will cause coastal groundwater levels to rise, we did not include any effects of sea level rise on groundwater levels. Similarly, we did not attempt to model potential sea level rise effects on water quality of spring discharge."* (pg, 55)

SWFWMD has accomplished great things in the studies leading up to this draft. The level of measurable scientific data included in the final draft provides and evermore intricate

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Citrus County
Tourism Development Council

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Crystal River, Florida 34429
Phone: 352-794-5506 Fax: 352-794-5507

understanding of how this system works. This is truly impressive and gratefully received. But always in the background of such momentous decisions is the question: "What don't we know? What in our understanding is still incomplete?"

That's why we urge caution in allowing a reduction of flows into Crystal River/Kings Bay as significant as 11% (89% MFL). The report projects a rise in human-based use over the next twenty years will be in the range of 3%. So, why is there a need for the 11% allowance? We think the lower figure (3%) is the responsible one and strongly urge a reconsideration of the MFL levels to something much closer to 97% of the baseline.

Respectfully,

Ronald Kitchen, Jr.
Chairman, Citrus County Tourism and Development Council

cc: Board of County Commissioners
Randy Oliver, County Administrator
Jeff Rogers, Assistant County Administrator/Public Works Director
Ken Cheek, Water Resources Director

City of Crystal River

123 Northwest Highway 19
Crystal River, Florida 34428
Telephone: (352) 795-4216
Facsimile: (352) 795-6351

May 10, 2017

Doug Leeper
Minimum Flows and Levels Program Lead,
Springs & Environmental Flows Section
2379 Broad Street
Brooksville, FL 34604-6899

Email: Doug.Leeper@watermatters.org

Re: MFL for Kings Bay

Dear Doug Leeper:

The City of Crystal River supports the setting of minimum flows and levels for the Kings Bay aquifer and appreciates efforts made by Southwest Florida Water Management District to set a limit. Kings Bay and the Crystal River are critical for ecological and economic reasons to our local community now and in the future.

The City has been working with the Florida Department of Environmental Protection, SWFWMD, Citrus County and other organizations, such as Save Crystal River and Duke Energy, to improve water quality and reduce water withdrawal for some time. Incremental improvements have been made to reduce water withdrawal along with the move toward elimination of septic tanks and groundwater treatment systems in an attempt to mitigate small areas within the Kings Bay aquifer that are already stressed by environmental and physical changes.

City Council requested a letter be sent requesting SWFWMD set a more conservative minimum flow and level. It seems reasonable that the limit be set to accommodate demand for a twenty year horizon so that additional data can be accumulated for the planned ten year review. The aquifer modeling done in the past was not as good as todays; in turn ten to twenty years from now, it should be more accurate. Please consider limiting a conservative approach to aquifer withdrawal.

To further that point, today with the lack of rain, the aquifer is seeing reduced flow and some wells within the aquifer have been running dry. This is indicative of how rainfall trends can drastically affect flows at the spring heads in Kings Bay. This in conjunction with sea rise can also greatly affect the ecosystems within Kings Bay and the Crystal River. City Council believes that a lower limit would be safer limit for the citizens and tourists presently utilizing the Kings Bay aquifer.

Thank you in advance for your consideration on this matter.

Sincerely,



David Burnell
City Manager, Crystal River

Jim Farley, Mayor
Pat Fitzpatrick, Vice Mayor
Mike Gudis, Council Member
Robert Holmes, Council Member
Ken Brown, Council Member
Randy Oliver, Citrus County Administrator
Melissa Gulvin, SWFWMD Program Manager

From:	Gabe I. Herrick
To:	Don Clark
Cc:	Xinjian Chen; Ron Basso; Doug Leeper; Melissa Gulvin; Jennette Seachrist; Eric DeHaven; Mike R. Bray
Subject:	RE: comments for district meeting concerning crystal river mfl
Date:	Tuesday, May 02, 2017 11:38:43 AM

Mr. Clark,

Thank you for participating in the recent public meeting on the proposed minimum flow for the Crystal River/Kings Bay System, and for providing written comment in your May 1 email. Your comments will be evaluated by staff and made available to District Governing Board members prior to the Board's May 23 meeting at which the Board will consider moving forward with rulemaking associated with the proposed minimum flow.

Gabe Herrick, PhD
Senior Environmental Scientist
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34604
352-796-7211 ext. 4275

From: Don Clark [mailto:butchclark212@gmail.com]
Sent: Monday, May 01, 2017 8:17 AM
To: Gabe I. Herrick <Gabe.Herrick@swfwmd.state.fl.us>
Subject: comments for district meeting concerning crystal river mfl

i was at your meeting on the 27th. Attendence there was low, but seemingly unanimously against your plans to allow an 11% drop in mfl. Be assured that if this large number is actually adopted heavy opposition will arise. any further reduction in flow there will make the good work being done by your own scientists there, and the citizen volunteers led by art jones, useless. citrus county's way of life and and our economy are intrinsically tied to king's bay, and our rivers, and we will fight to preserve them. It is time to examine how we look at our waters and development. each large water extraction has a cost to our outstanding waters, our way of life, and our tourism. kings bay for instance used to be a true scuba destination, but not now. florida already is the 3rd most populous state. We don't really need more people here. Citrus county has low income, what we need is good paying jobs, which attract young workers who will appreciate our wonderful outdoor lifestyle. So we need to be careful to preserve our rivers and prioritize permits to those who meet our local needs. But your charts show you regard the northern district as a large water resource to support more unprioritized growth. well other counties have beaches, city life, resorts, we have beautiful water and forests, and we aim to keep them. don't forget we took you to court and caused the local sources first policy to be executed, and the author of amendment 1 lives here

From:	Ross Morton
To:	Melissa Gulvin; Doug Leeper; Ron Basso
Cc:	Mark Hammond
Subject:	FW: water flow kings bay / crystal river
Date:	Monday, May 15, 2017 9:55:24 AM

FYI

Ross T. Morton, P.W.S., CO-OP®, F.S.C.C.M.
2379 Broad Street
Brooksville, FL 34604-6899
Mobile/Office Phone (352)796-7211, (863)534-1448, (813)985-7481, & (941)377-3722
Ext. 6500
Email: ross.morton@watermatters.org
About The Ombudsman: http://www.swfwmd.state.fl.us/about/staff/ombudsman.php

From: Ross Morton
Sent: Monday, May 15, 2017 9:55 AM
To: 'Roger Horn' <rhforfreedom@yahoo.com>
Subject: RE: water flow kings bay / crystal river

I will pass your comments along to the "appropriate" people.

Ross T. Morton, P.W.S., CO-OP®, F.S.C.C.M.
2379 Broad Street
Brooksville, FL 34604-6899
Mobile/Office Phone (352)796-7211, (863)534-1448, (813)985-7481, & (941)377-3722
Ext. 6500
Email: ross.morton@watermatters.org
About The Ombudsman: http://www.swfwmd.state.fl.us/about/staff/ombudsman.php

From: Roger Horn [mailto:rhforfreedom@yahoo.com]
Sent: Sunday, May 14, 2017 9:20 AM
To: Ross Morton <Ross.Morton@swfwmd.state.fl.us>
Subject: water flow kings bay / crystal river

Dear Mr. Morton:

Please pass on my strongest objection to the recent minimum flow levels for our river. I have lived on and around Crystal River since 1975. It has always been on the forefront to try to protect and clean up the river. It is in the worst shape I have ever seen it. The recent vacuuming and grass planting seems to show some promise. The dead material chocking out he bottom is a health concern to anybody in it. I and my friends are adamantly against causing additional problems by reducing minimum flows. One of the problems is the muck not being washed out to the gulf and salt water intrusion. I know there are all the studies. All my life I've seen the study's conducted, all someone has to do is live here for 30 or 40 years to see the comparison. Please make our feelings heard to the appropriate people.
Thanks Roger Horn

From:	Doug Leeper
To:	"rhforfreedom@yahoo.com"
Cc:	Gabe I. Herrick; Xinjian Chen; Ron Basso; Jennette Seachrist; Eric DeHaven
Subject:	Re: water flow kings bay / crystal river
Date:	Tuesday, May 16, 2017 1:55:00 PM

Mr. Horn:

Thanks for your comments on the proposed minimum flow for the Crystal River/Kings Bay System. Your comments will be evaluated by staff and made available to District Governing Board members prior to the Board's May 23 meeting at which the Board will consider moving forward with rulemaking associated with the proposed minimum flow.

Doug Leeper
MFLs Program Lead
Natural Systems and Restoration Bureau
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34609
1-800-423-1476, ext. 4272
352-796-7211, ext. 4272
doug.leeper@watermatters.org

From: Ross Morton
To: Melissa Gulvin; Doug Leeper; Ron Basso
Cc: Mark Hammond
Subject: FW: water flow kings bay / crystal river
Date: Monday, May 15, 2017 9:55:24 AM

FYI

Ross T. Morton, P.W.S., CO-OP®, F.S.C.C.M.
2379 Broad Street
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Mobile/Office Phone (352)796-7211, (863)534-1448, (813)985-7481, & (941)377-3722
Ext. 6500
Email: ross.morton@watermatters.org
About The Ombudsman: http://www.swfwmd.state.fl.us/about/staff/ombudsman.php

From: Ross Morton
Sent: Monday, May 15, 2017 9:55 AM
To: 'Roger Horn' <rhforfreedom@yahoo.com>
Subject: RE: water flow kings bay / crystal river

I will pass your comments along to the "appropriate" people.

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Brooksville, FL 34604-6899

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Ext. 6500
Email: ross.morton@watermatters.org
About The Ombudsman: http://www.swfwmd.state.fl.us/about/staff/ombudsman.php

From: Roger Horn [mailto:rhforfreedom@yahoo.com]
Sent: Sunday, May 14, 2017 9:20 AM
To: Ross Morton <Ross.Morton@swfwmd.state.fl.us>
Subject: water flow kings bay / crystal river

Dear Mr. Morton:

Please pass on my strongest objection to the recent minimum flow levels for our river. I have lived on and around Crystal River since 1975. It has always been on the forefront to try to protect and clean up the river. It is in the worst shape I have ever seen it. The recent vacuuming and grass planting seems to show some promise. The dead material chocking out he bottom is a health concern to anybody in it. I and my friends are adamantly against causing additional problems by reducing minimum flows. One of the problems is the muck not being washed out to the gulf and salt water intrusion. I know there are all the studies. All my life I've seen the study's conducted, all someone has to do is live here for 30 or 40 years to see the comparison. Please make our feelings heard to the appropriate people.
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