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Vanasse Hangen Brustlin, Inc.

February 14, 2008

Ref: 65763.00

Mr. Mike Heyl
Southwest Florida Water Management District
7601 U.S. Highway 301 North
Tampa, FL 33637-6759

Re: Un-gauged Springs Discharge

Dear Mike:

This letter report has been prepared to summarize the results of our initial sampling event to document un-gauged springs discharge in the Homosassa, Chassahowitzka and Crystal Rivers. Also provided herein are recommendations for sampling program modification based upon the results of this initial event. A good low tide series for the next sampling event occurs from March 24 – 26 and this is the next proposed sampling event with your concurrence.

The initial sampling event took place from January 8 – 10, with the Homosassa, Crystal and Chassahowitzka Rivers being sampled on consecutive days in that order. Sampling occurred pursuant to the submitted monitoring program, as modified during our meeting on December 13, 2007, and authorized by your December 18, 2007 email. Figures depicting the sampling transects are attached.

The field data from the three day sampling event are provided electronically on the enclosed CD. A total of 107 measurements were made during this event, with a range of 15 to 32 measurements made at the individual transects. Overall, the quality of the field data looks good. Mr. Dann Yobbi of Hydrologic Data Collection, Inc. prepared the measurement summaries and subsequent regression analyses.

It was originally planned that the US Geological Survey (USGS) would collect discharge measurements at their upstream springs gage sites concurrent with our sampling. Unfortunately, USGS was not able to make measurements at their sites. To evaluate potential un-gauged springs discharge between the USGS gage and our sampling transects, the upstream discharge (baseline) was calculated from the data collected at the USGS gage concurrent with our sampling events. The difference in discharge calculated from our bracketed transects on the Crystal and Chassahowitzka Rivers were compared to determine un-gauged discharge for these systems. The difference in discharge from the USGS station and the sampling transect was used to determine un-gauged discharge for the Homosassa River.

Following review of the differences in discharge between our field measurements, Mr. Yobbi concluded that it is uncertain that un-gauged seepage can be determined using these field differences in discharge. Regression equations with high R^2 values were developed comparing the upstream discharge (upper transect and/or USGS gage) with the downstream field measurements with various time offsets (15 to 60 minutes). The regression equations are also provided on the enclosed CD and are graphically depicted in Appendix A.

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A more promising way to estimate seepage may involve using daily discharge at the USGS gages and the regression equations. Mr. Yobbi worked up a 30-day average discharge record using the regression equations with mixed results. Results are promising for the Chassahowitzka River, but questionable for Crystal and Homosassa Rivers. There is a net gain of about 90 cfs between the two downstream sites on the Chassahowitzka River, but more than 1,000 cfs net gain between the two downstream sites on the Crystal River. Crystal River flows appear to be highly influenced by Salt River.

Based upon the results of this initial event, some suggested/recommended changes to the sampling program are provided below.

1. Make a longer (12-13 hours) series of measurements on each river starting and ending near min/max discharge. This would provide a half-tidal cycle of data to add to the regressions.

2. Switch measurement site from the upper Crystal River site (Transect 2) to Salt River. This is important because we need some idea of the flows entering and leaving Crystal River between the USGS gage and the lower discharge site.

3. Make sure that USGS measurements are conducted concurrent with our measurements. The best way to guarantee this may be for Mr. Dann Yobbi to assist Mr. David Fulcher. Alternately, Sid Flannery could make the request directly to USGS.

Extending the data collection to a half tide cycle adds approximately five hours to field sampling for each transect. Sampling per the revised program recommended in Items 1 and 2 above would cost $18,000 per event. The cost for Mr. Yobbi to help USGS as outlined in Item 3 above would cost $5,295. A Purchase Order for the Fiscal Year 2008 budget amount would be needed to have sufficient budget for the existing or proposed sampling program.

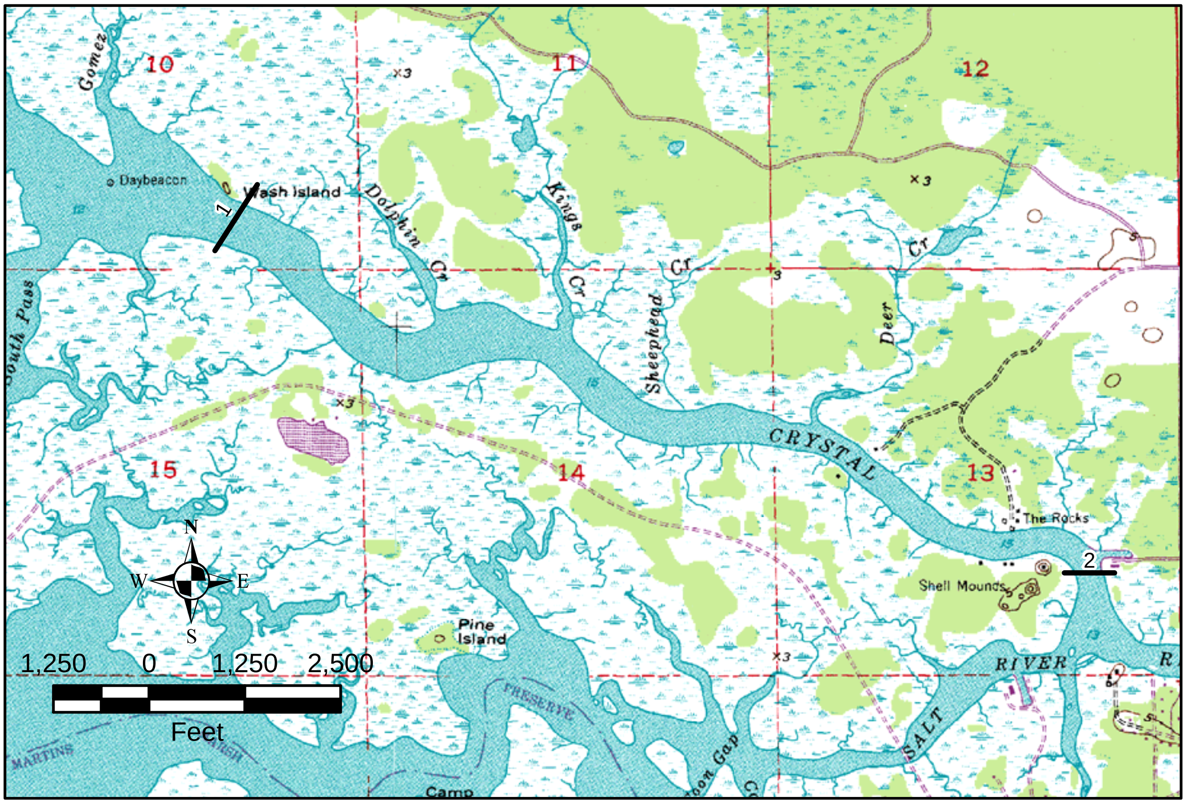
Please feel free to contact Dann Yobbi or me if you have any questions.

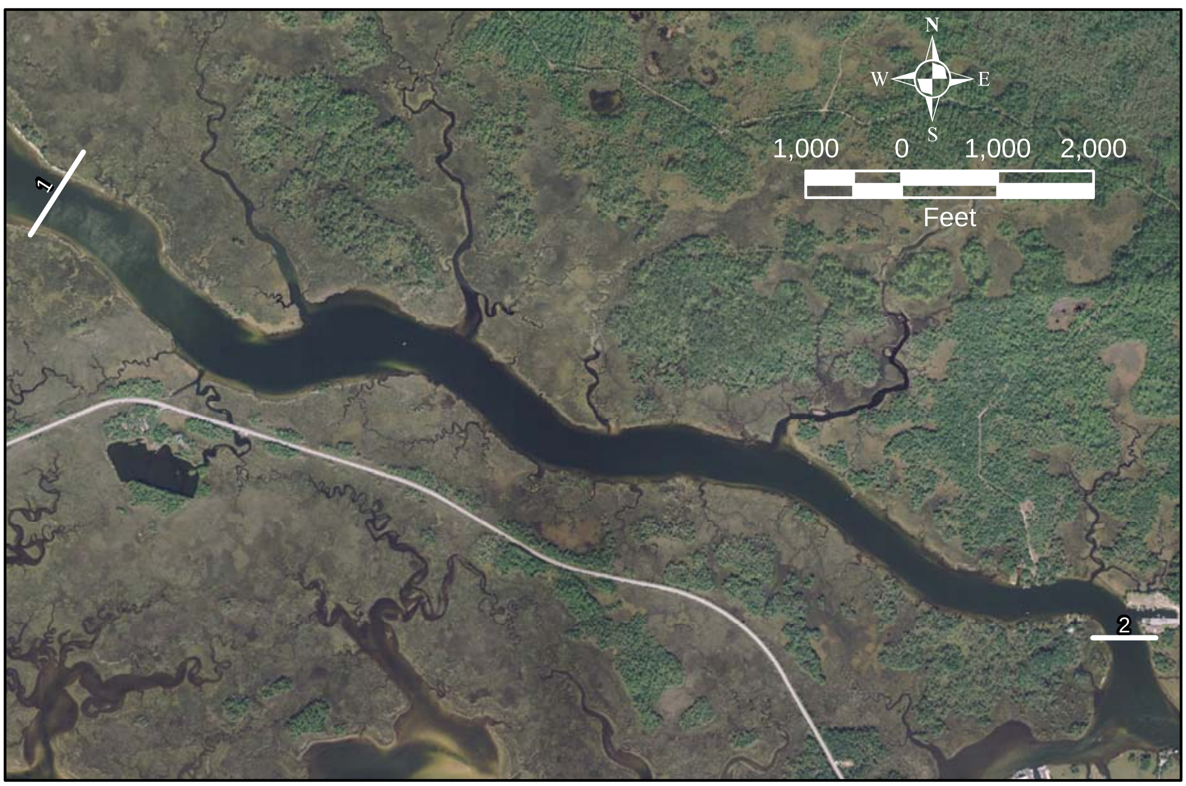
Sincerely,

VANASSE HANGEN BRUSTLIN, INC.

Gary M. Serviss
Principal Scientist

cc: John Coffin, Hydrologic Data Collection, Inc.





Date: 11/07/07

Revised:

Figure 1
Proposed Location of Transects for Measurement of Ungaged Ground-water Contributions to the Crystal River
Citrus County, Florida

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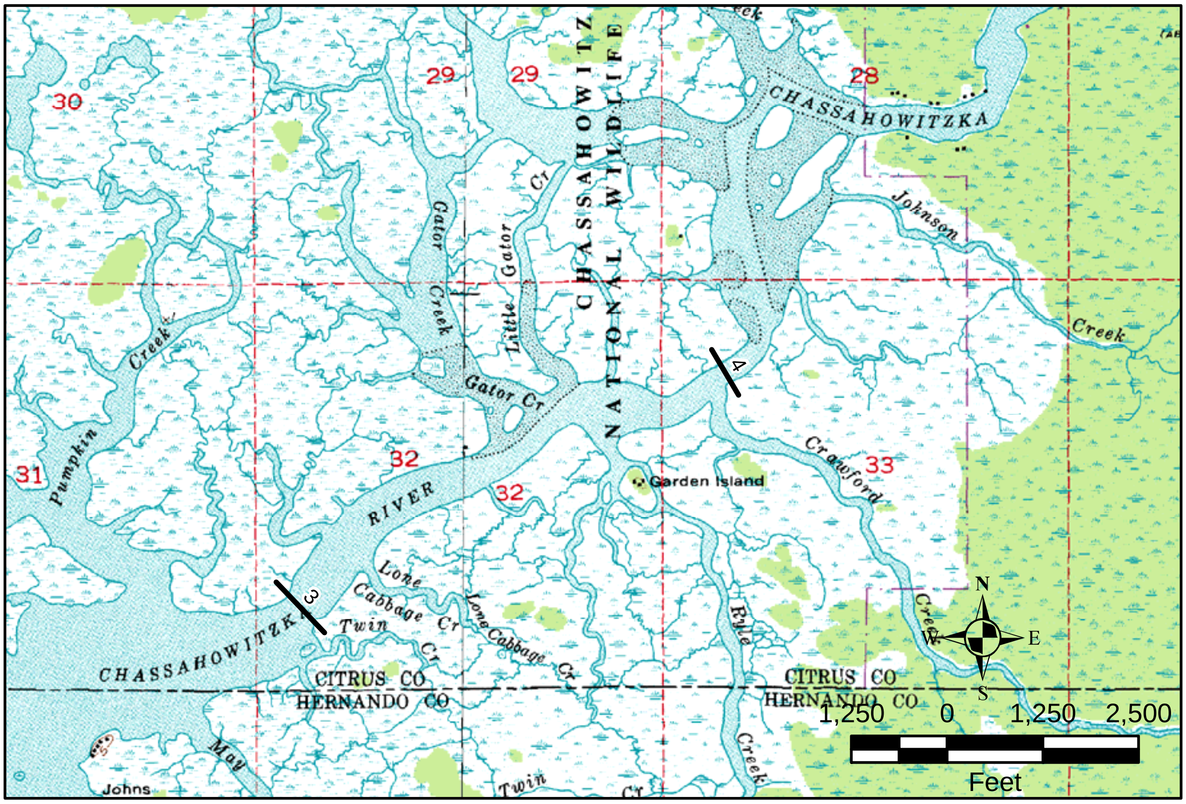

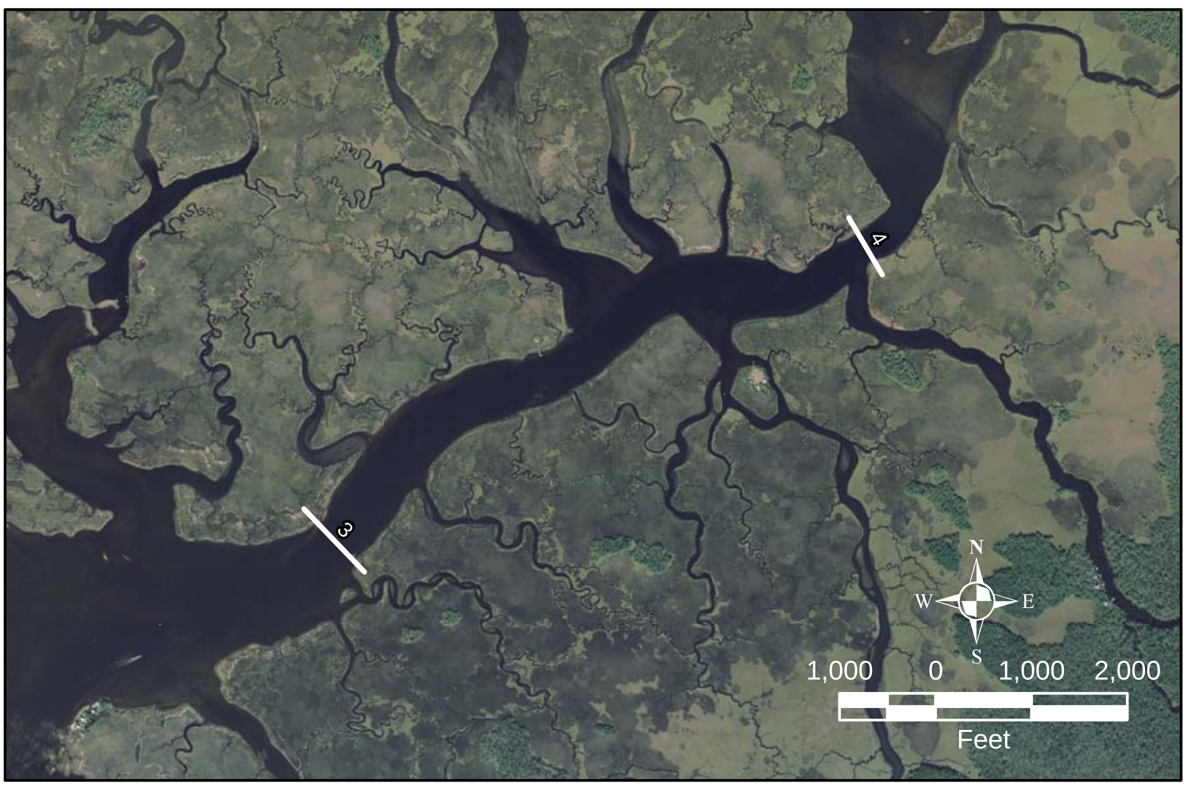

Date: 11/07/07

Revised:

Figure 2
Proposed Location of Transects for Measurement of Ungaged Ground-water Contributions to the Chassahowitzka River
Citrus County, Florida

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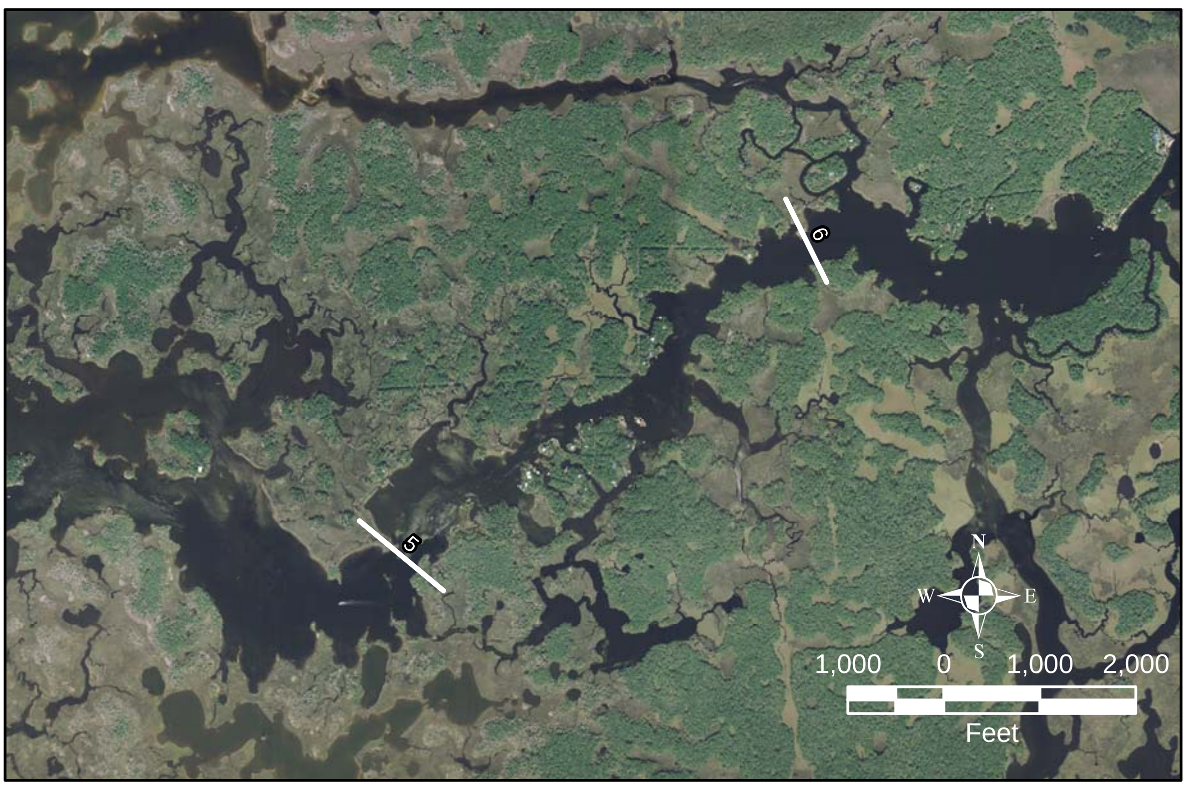

Date: 11/07/07

Revised:

Figure 3
Proposed Location of Transects for Measurement of Ungaged Ground-water Contributions to the Homosassa River
Citrus County, Florida

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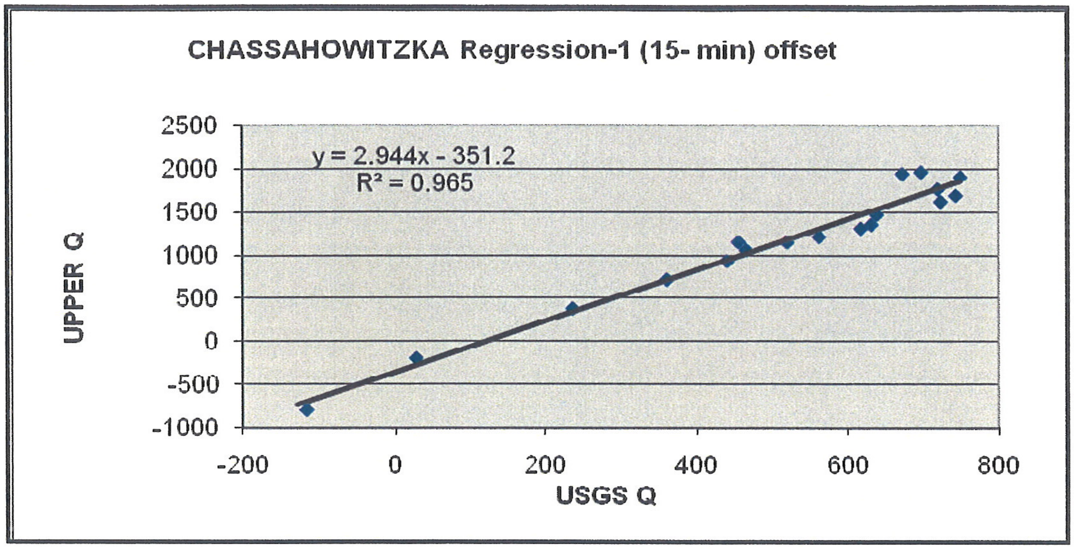
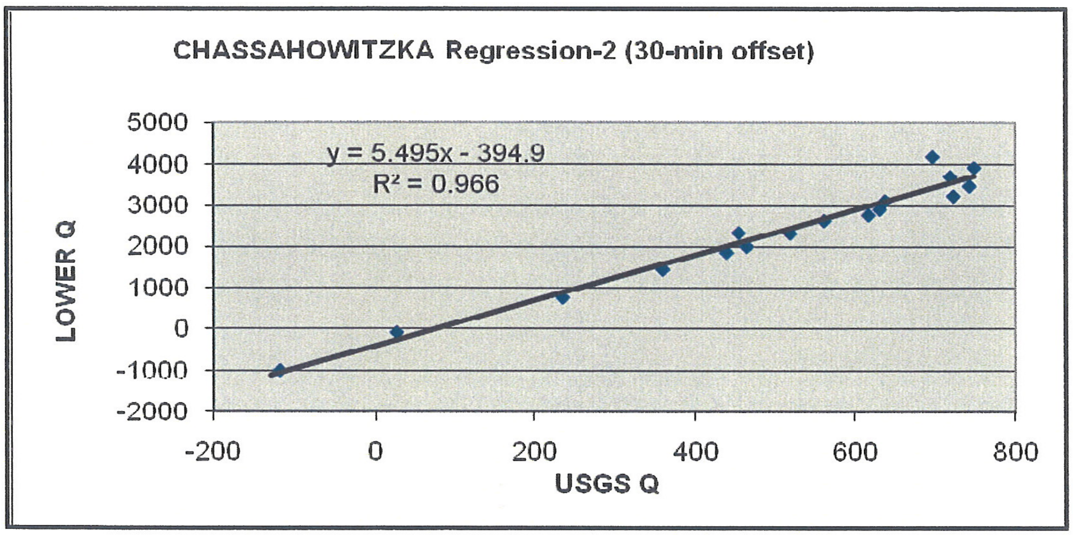
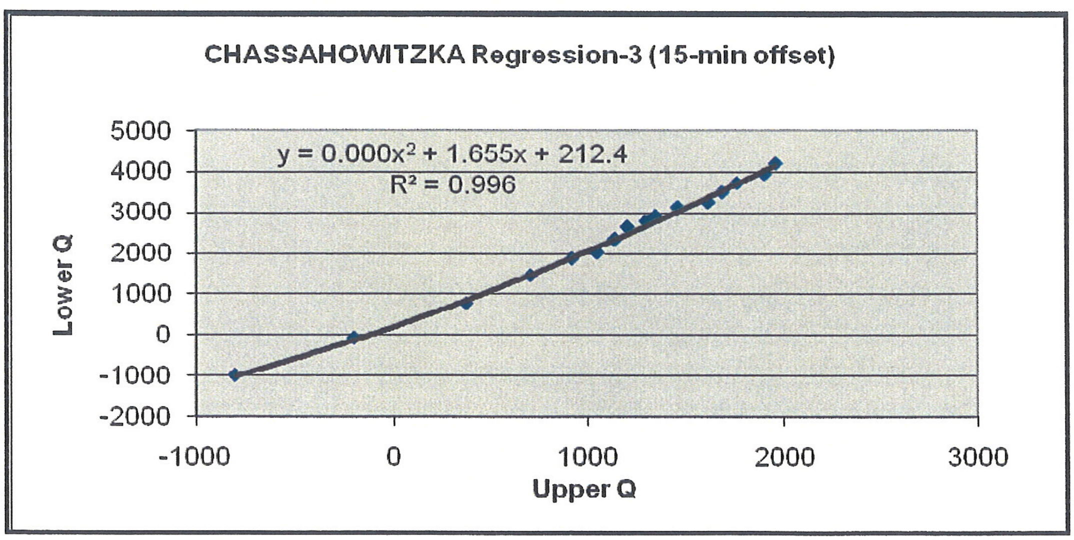
APPENDIX A

REGRESSION EQUATIONS

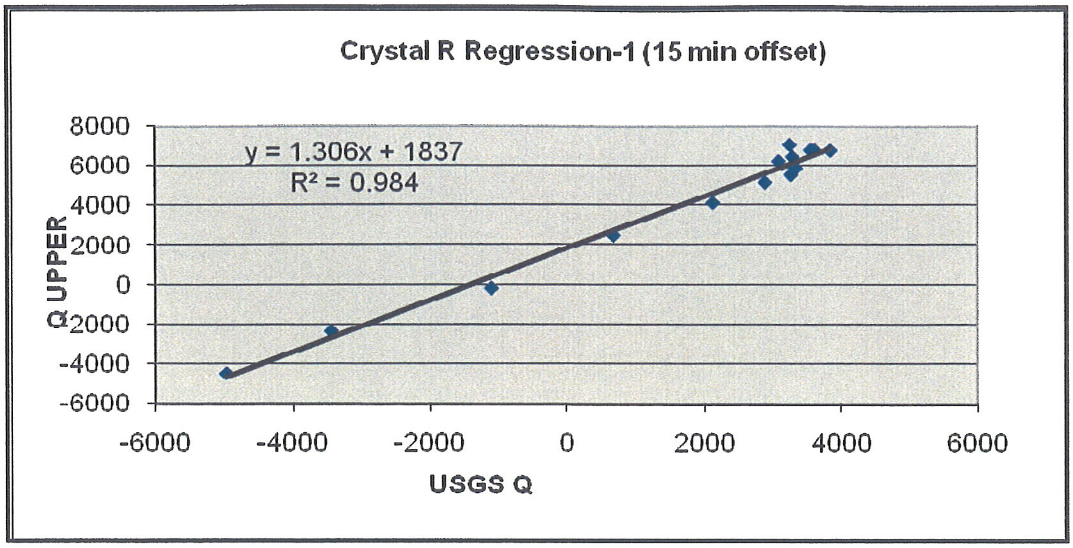
CHASSAHOWITZKA RIVER

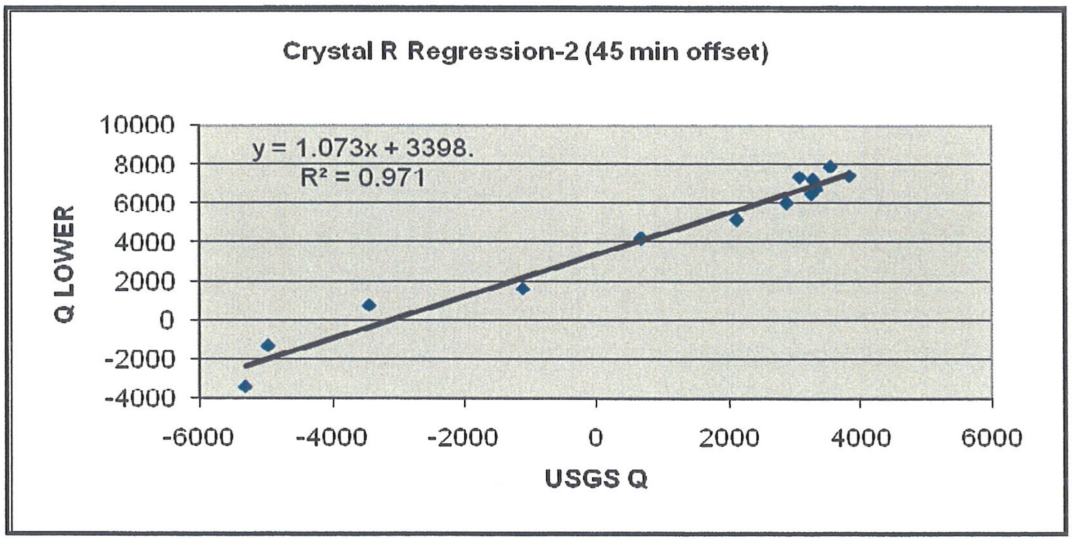


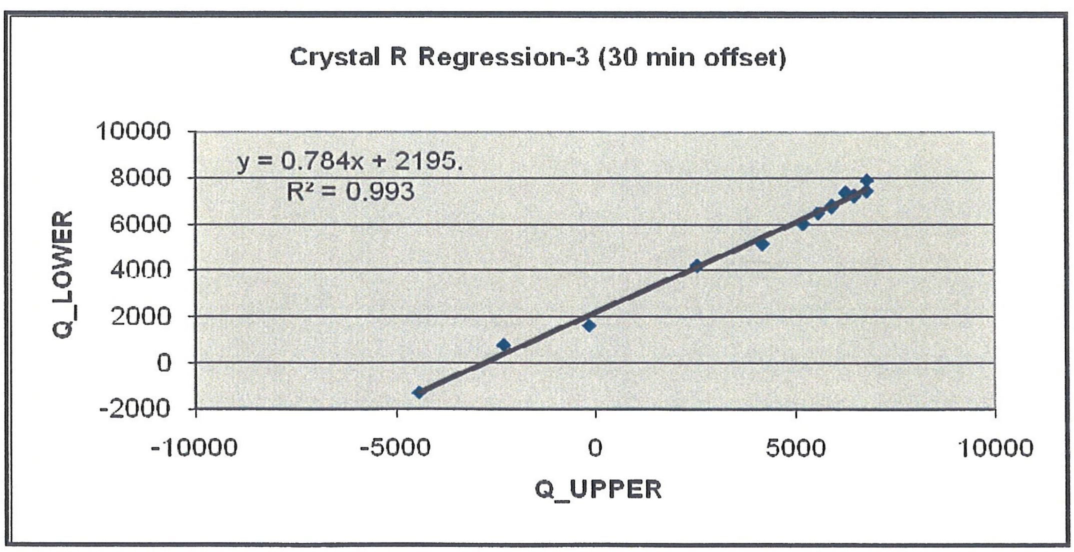




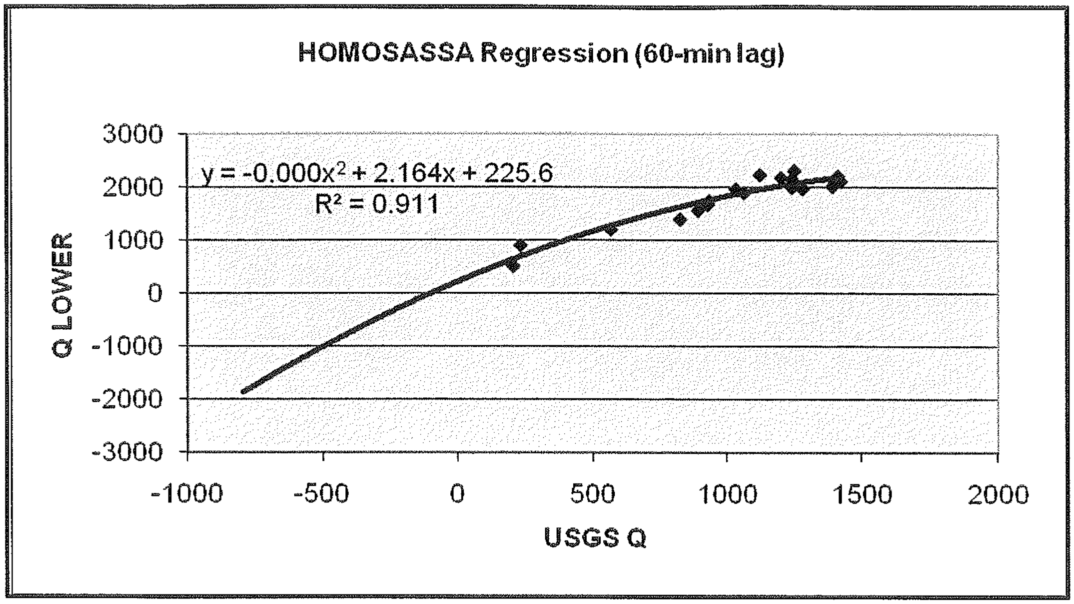
CRYSTAL RIVER







HOMOSASSA RIVER



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Vanasse Hangen Brustlin, Inc.

July 15, 2008

Ref: 65763.00

Mr. Sid Flannery
Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34604-6899

Re: Ungaged Springs Discharge
Data Analysis and Summary Letter Report

Dear Sid:

This letter report has been prepared to summarize the results of the March 2008 sampling event and to provide an evaluation of the January and March 2008 sampling events to document ungaged spring discharge in the Crystal and Chassahowitzka Rivers. More specifically, the letter report provides:

- Evaluation of results.
- Regression equations relating discharge at the sampling sites with the U.S. Geological Survey (USGS) computed discharge for the March 2008 sampling event (Appendix A).
- Regression equations relating discharge at the sampling sites with the USGS computed discharge for the combined January and March 2008 sampling events (Appendix B).
- Difference in discharge calculated at the transects (Appendix C).
- Field data collected during the second sampling event (Appendix D).

The second sampling event took place from March 26 – 27, 2008, with the Crystal and Chassahowitzka Rivers being measured on consecutive days in that order. Figures 1 and 2 show the transect sampling sites for the Crystal and Chassahowitzka Rivers, respectively. The upper discharge sampling site for Crystal River (Transect 2) during the January 2008 event was relocated to Salt River (Transect 2A) during the March 2008 event. The lower sampling site for Crystal River (Transect 1) and both transects for the Chassahowitzka River (Transects 3 and 4) were the same for both events.

The U.S. Geological Survey collected discharge measurements concurrently at their upstream during the March 2008 event. The USGS data from their ratings were used to develop the

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regression equations relating 15-minute discharge at the USGS sites and the sampling sites (Appendices A and B).

The field data from the March 2008 sampling event are included in Appendix D and EXCEL files for the regression analysis are provided electronically on the enclosed CD. A total of 148 measurements were made during this event, with a range of 33 to 46 measurements made at the individual transects. The quality of the field data is good, and Dann Yobbi of Hydrologic Data Collection, Inc. prepared the measurement summaries, regression analyses, discharge analyses at sampling sites, and provided an evaluation of results.

Using the 15-minute discharge at the USGS streamflow sites and the regression equations, daily discharge at the sampling sites was calculated for October 1, 2007 through June 17, 2008. Calculated differences in discharge from the USGS sites and the sampling sites (Appendix C) were used to evaluate ungaged discharge in the Crystal and Chassahowitzka Rivers. EXCEL files for the discharge calculations are provided electronically on the enclosed CD

EVALUATION OF RESULTS

Crystal River

Following review of the difference in discharge between the USGS site and sampling sites, it is believed that ungaged seepage below the USGS discharge site cannot be quantified using the field measurements and the regression equations. Discharge at the mouth is about 75 percent greater than discharge at the USGS site and tidal flows and storage in the estuarine marshes and tributary creeks are probable sources of the increase in discharge between the downstream and upstream sites. Field measurements also show that Salt River is a significant and complicated source and outlet of water to the Crystal River as indicated by the nonlinear relation to the discharge at the USGS site (Appendix A). Average daily discharge estimated for the October 2007-June 2008 period at the mouth was 1,640 ft^3/s, 923 ft^3/s at the upstream USGS site, and 737 ft^3/s at Salt River.

The District may wish to consider other techniques to quantify submarine ground-water seepage to the lower section of the Crystal River, such as analytical, chemical, and numerical methods; including seepage meters and pore water profiles to measure flow directly; and/or resistivity mapping and airborne electromagnetic surveys to determine the spatial variation in aquifer-water quality. Seepage and water-quality data could be used to develop a numerical model to simulate ground-water flow and mixing.

Chassahowitzka River

Following review of the difference in discharge between the USGS site and sampling transect sites; it is believed that ungaged seepage estimates below the USGS discharge site can be quantified on a limited basis using the field measurements and the regression equations. Differences in discharge and seepage estimates between the two transect sampling sites is highly dependent on river discharge above the transect sampling sites. At a daily river discharge of 150 ft^3/s, a discharge difference of about -80 ft^3/s is estimated between the sampling sites, increasing to about 90 ft^3/s and 260 ft^3/s at daily river discharges of 200 ft^3/s and 250 ft^3/s, respectively (Appendix C). At higher river discharge (>175 ft^3/s), ungaged seepage and storage are probable sources of the difference in discharge between the sampling sites. Whether the discharge difference at the higher river discharge is primarily from ungaged seepage or primarily from storage is uncertain. At lower river discharge (<175 ft^3/s), tidal flows and storage in the estuarine marshes and creeks are probable sources of the difference in discharge between the downstream and upstream sampling sites and ungaged seepage estimates can not be determined using the field measurements and the regression equations. For the October 2007-June 2008 period, average discharge estimated at the mouth was -678 ft^3/s, -130 ft^3/s at the upstream site, and 14 ft^3/s at the upstream USGS site; indicating upstream movement and storage of water into the estuarine marshes and tributary creeks.

A better approach to quantifying discharge to the lower part of the Chassahowitzka River would be to measure individual spring runs below the USGS discharge site on a quarterly basis and/or to follow a similar approach as suggested above for Crystal River.

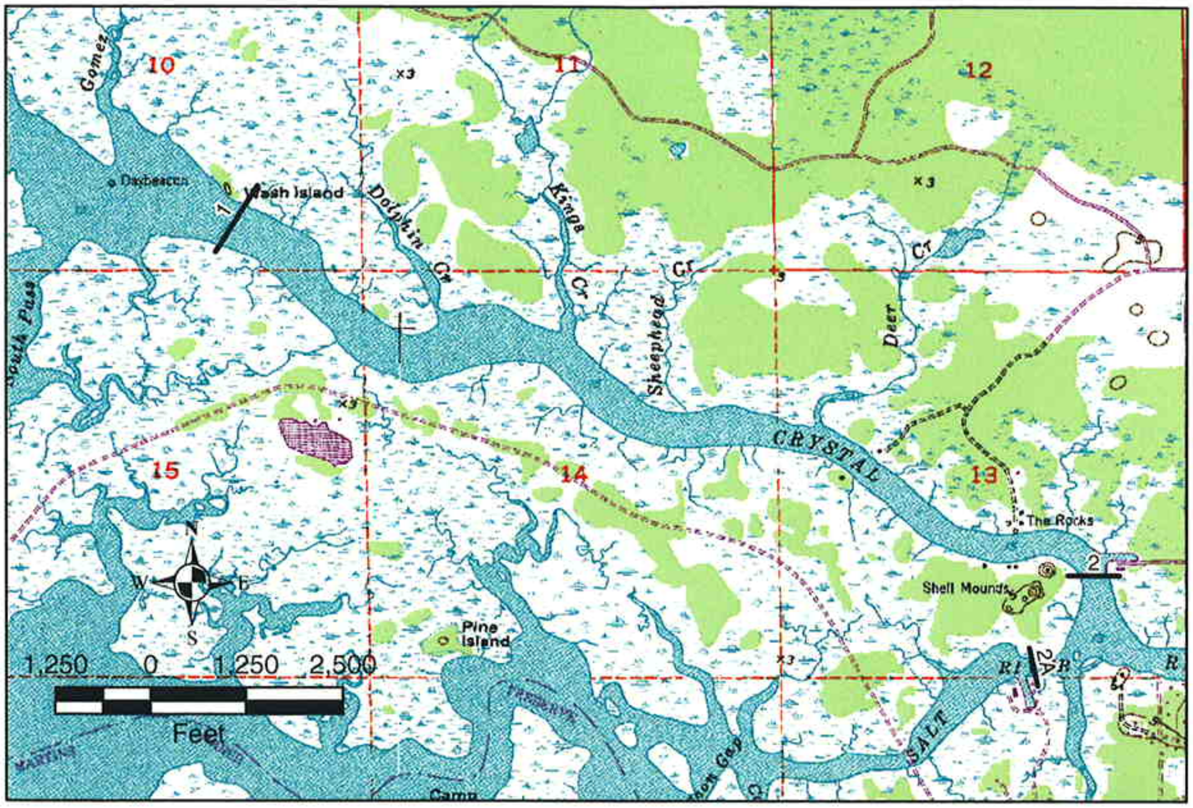
Please feel free to contact Dann Yobbi or me if you have any questions.

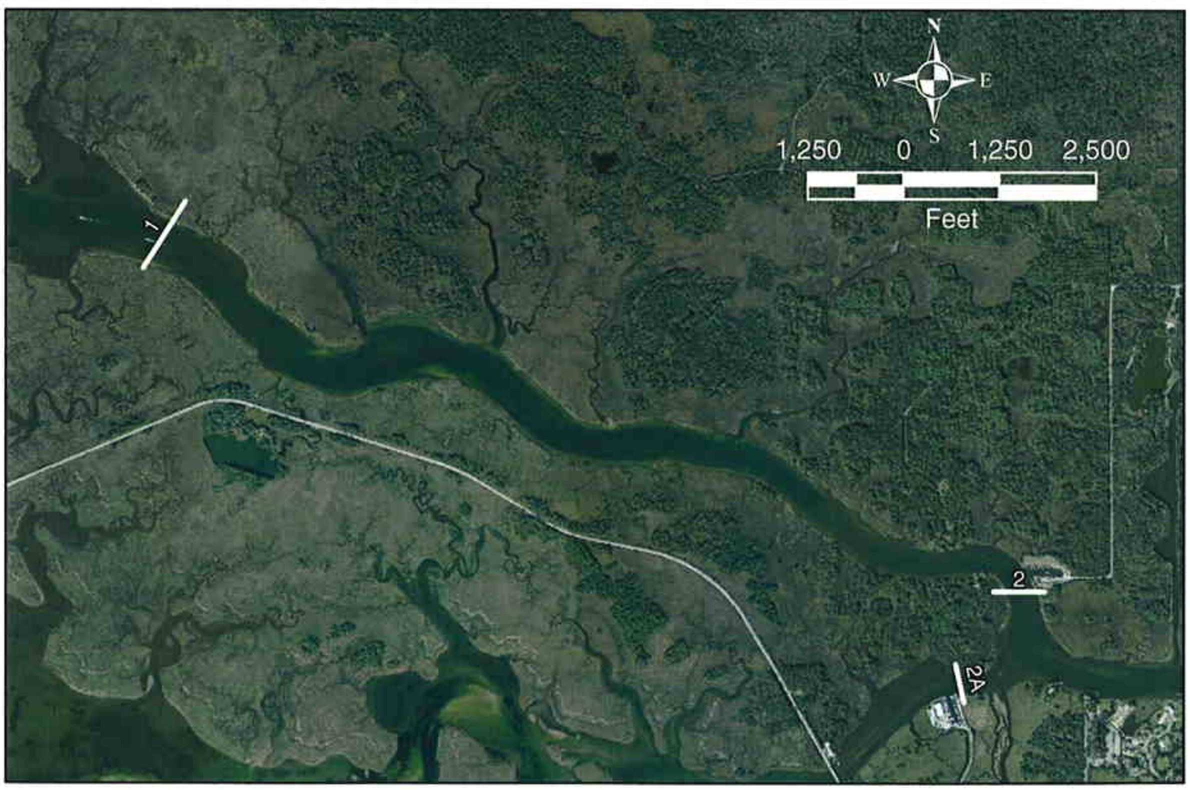
Sincerely,

VANASSE HANGEN BRUSTLIN, INC.

Gary M. Serviss
Principal Scientist

cc: John Coffin, Hydrologic Data Collection, Inc.





Date: 11/07/07 Revised:	Figure 1 Location of Transects for Measurement of Ungaged Groundwater Contributions to the Crystal River Citrus County, Florida	*Vanasse Hangen Brustlin, Inc.* 8043 Cooper Creek Blvd. Suite 201 University Park, Florida 34201

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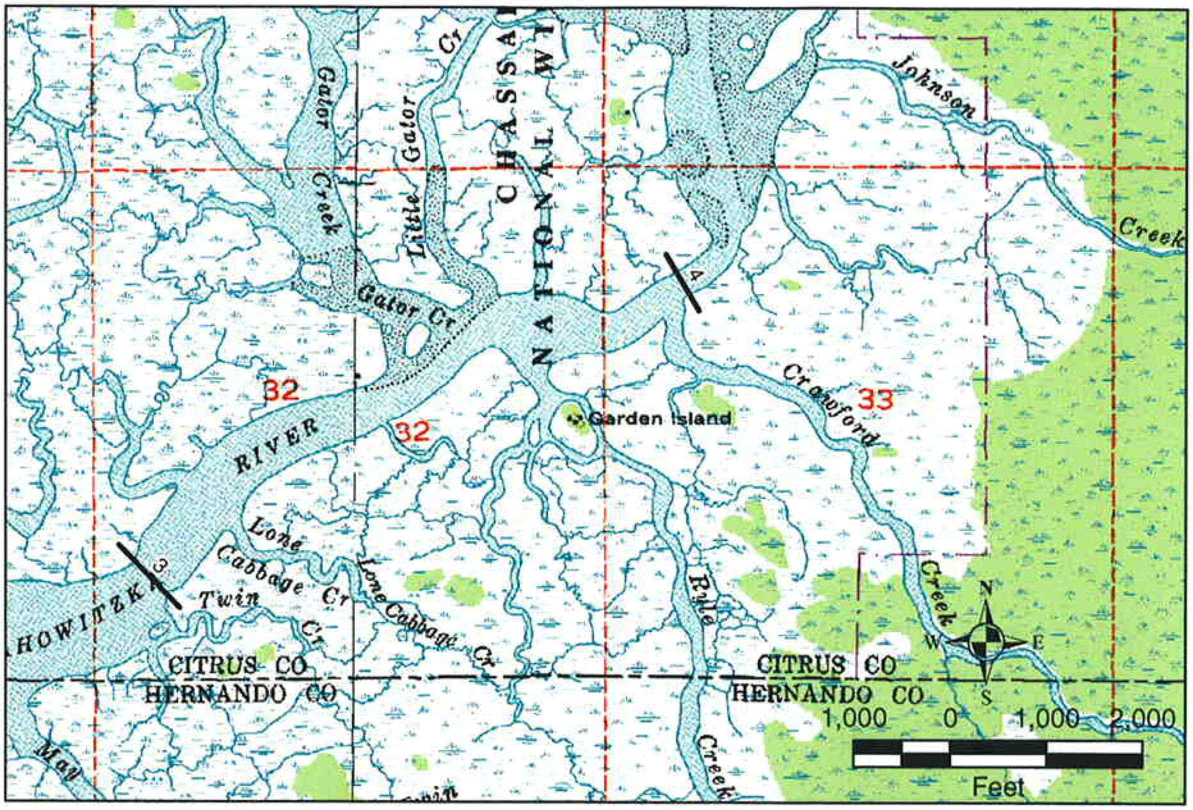

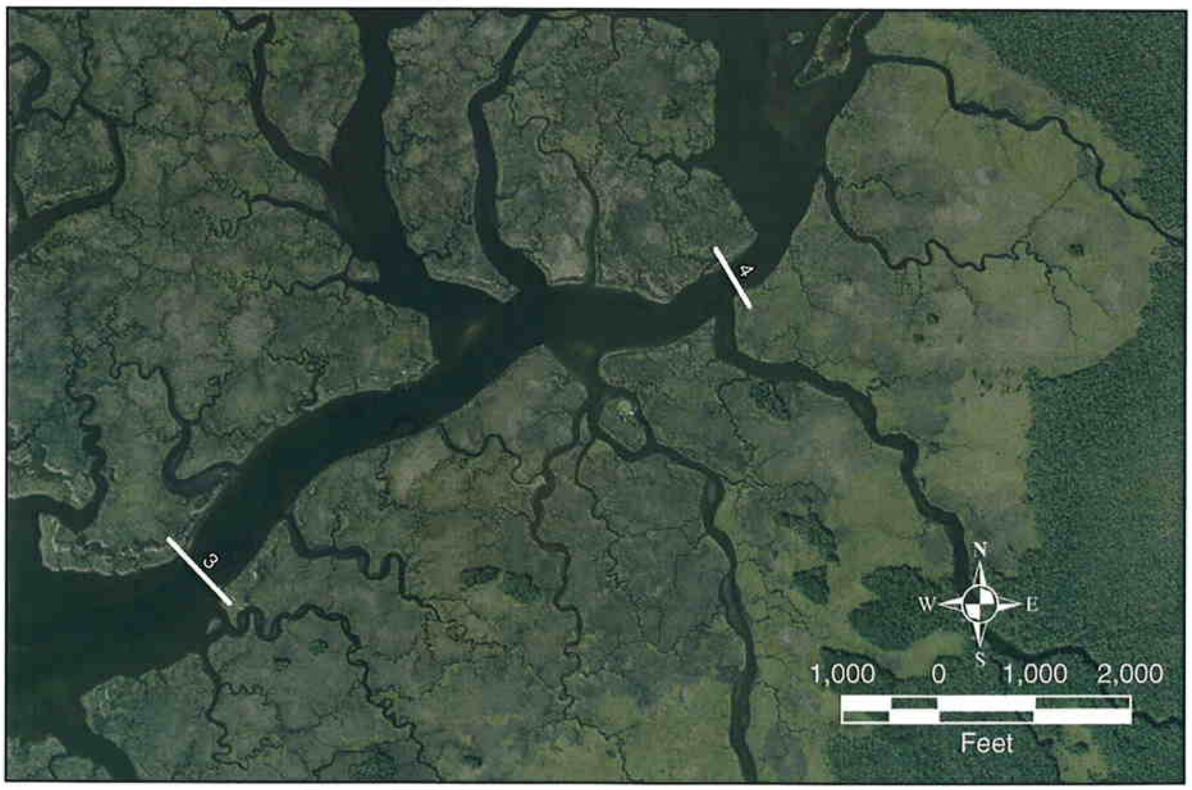

Date: 11/07/07

Revised:

Figure 2
Location of Transects for Measurement of Ungaged Groundwater Contributions to the Chassahowitzka River
Citrus County, Florida

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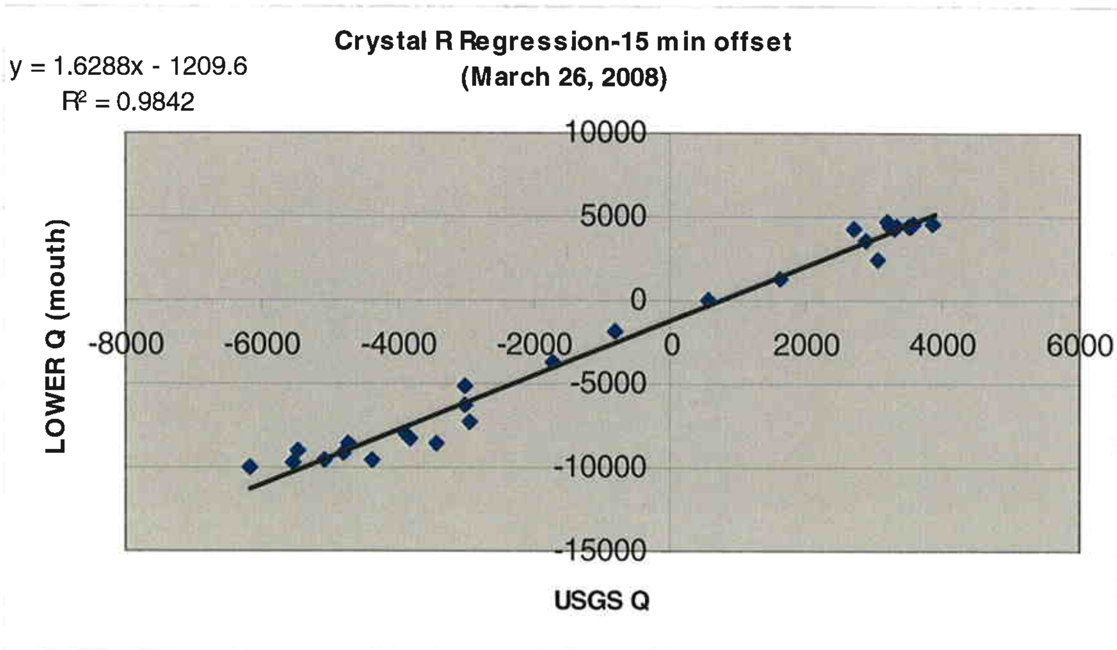
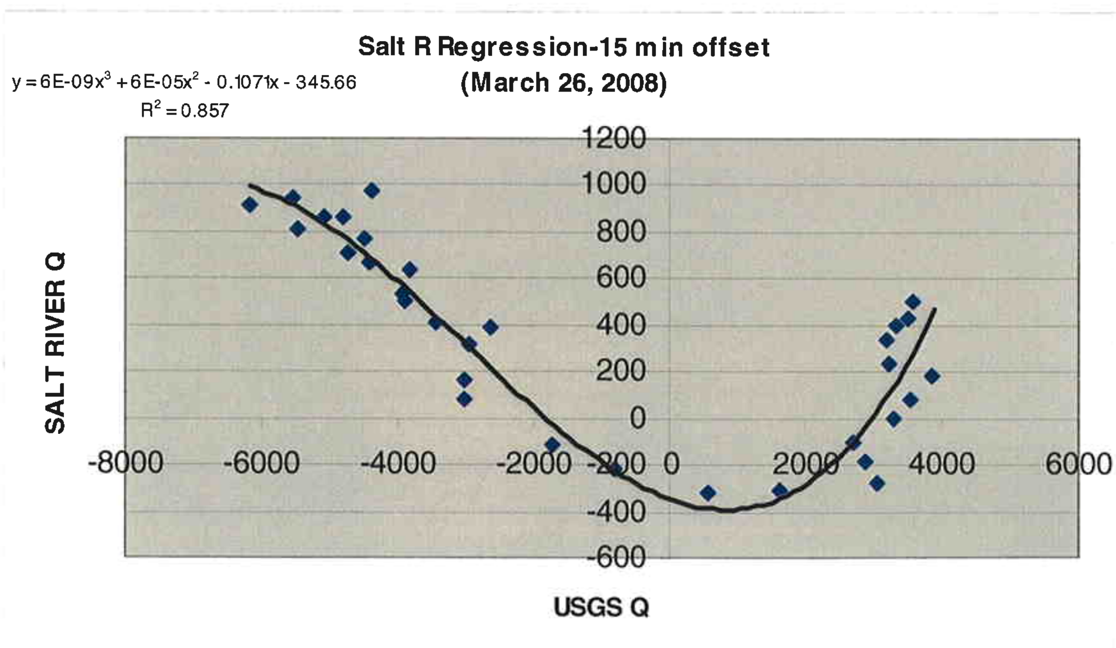
Appendix A

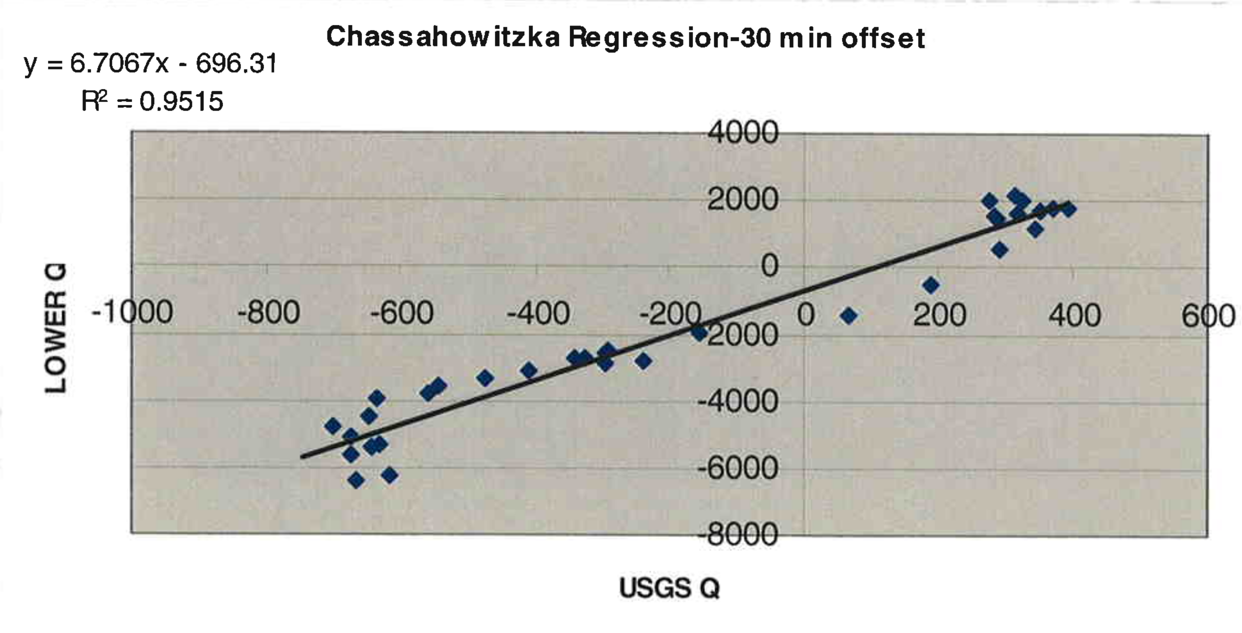
Regression Equations
(March 2008 Sampling Event)

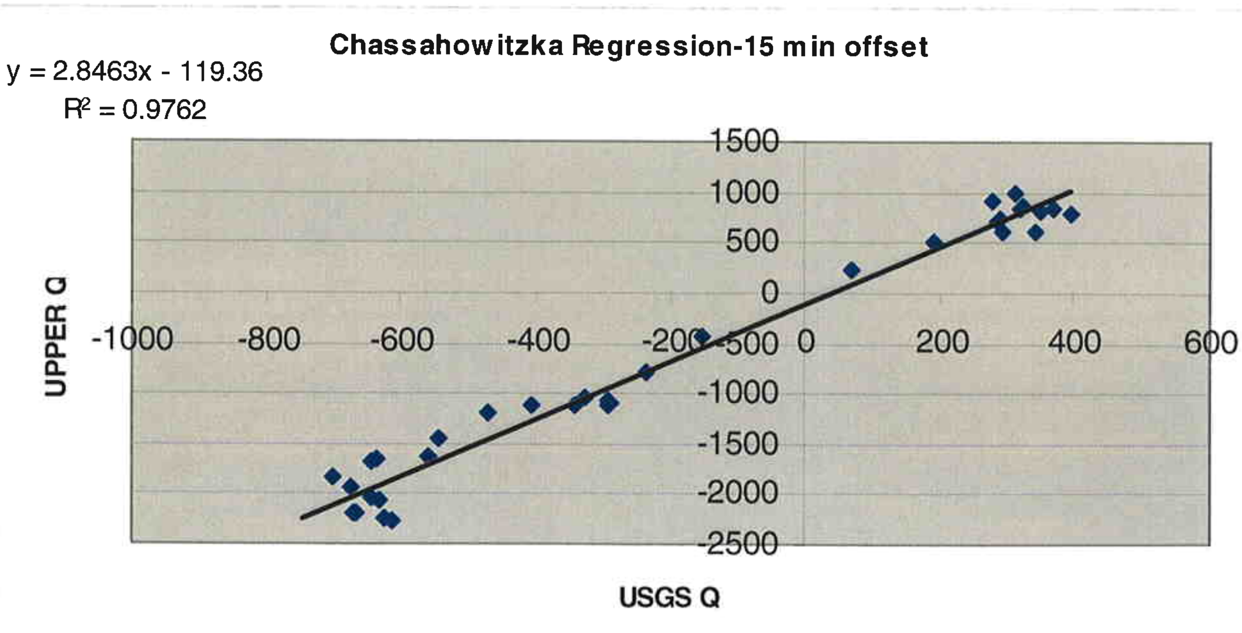
Crystal River
March 26, 2008



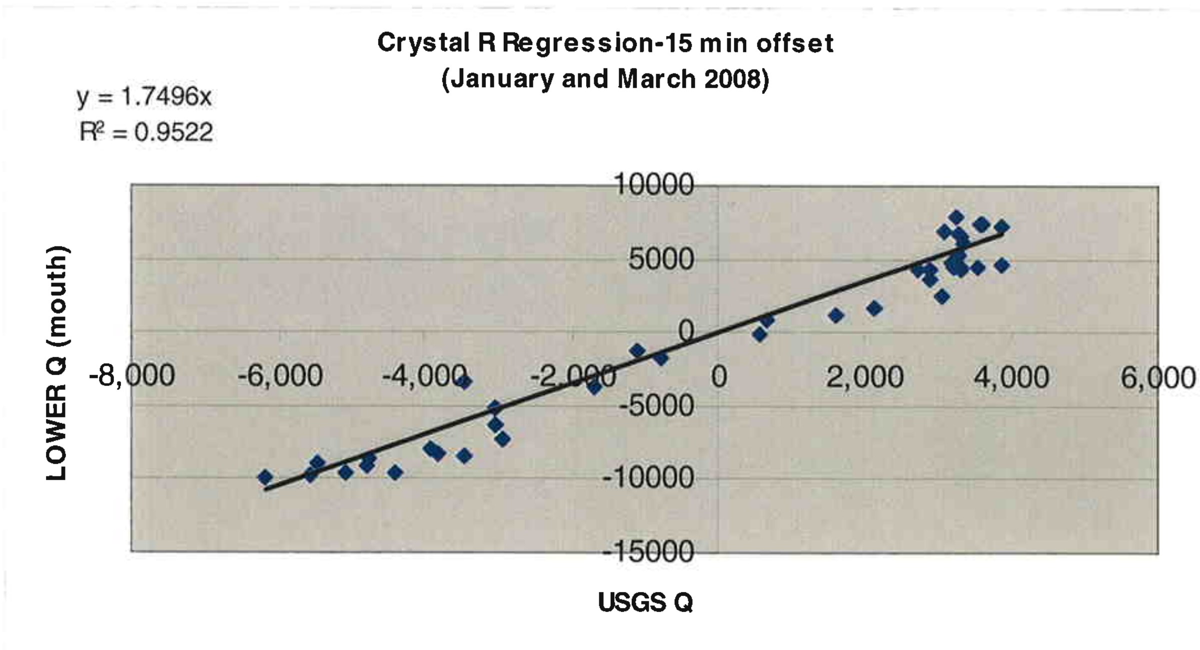


Chassahowitzka River
March 27, 2008

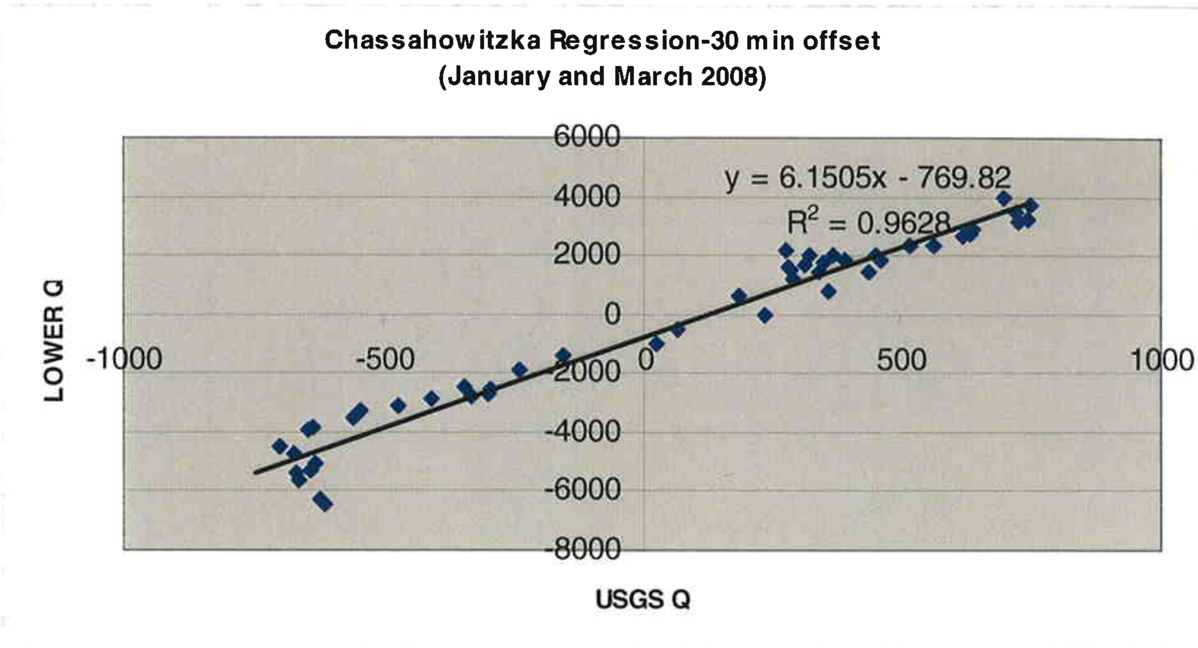


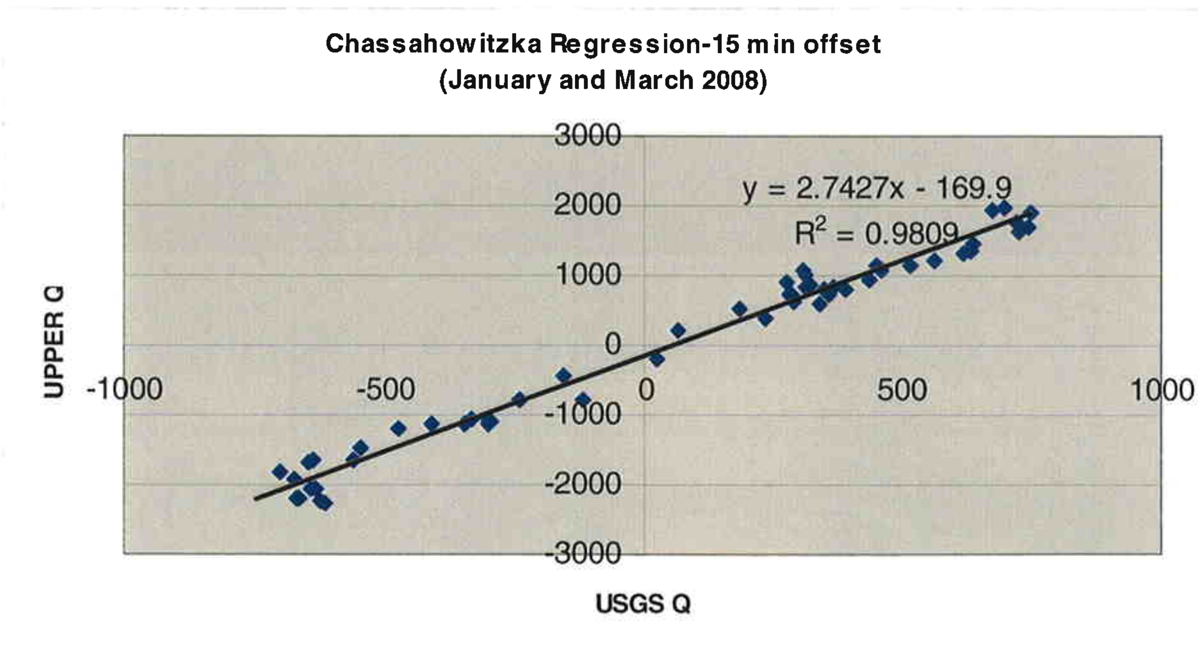


Crystal River



Chassahowitzka River

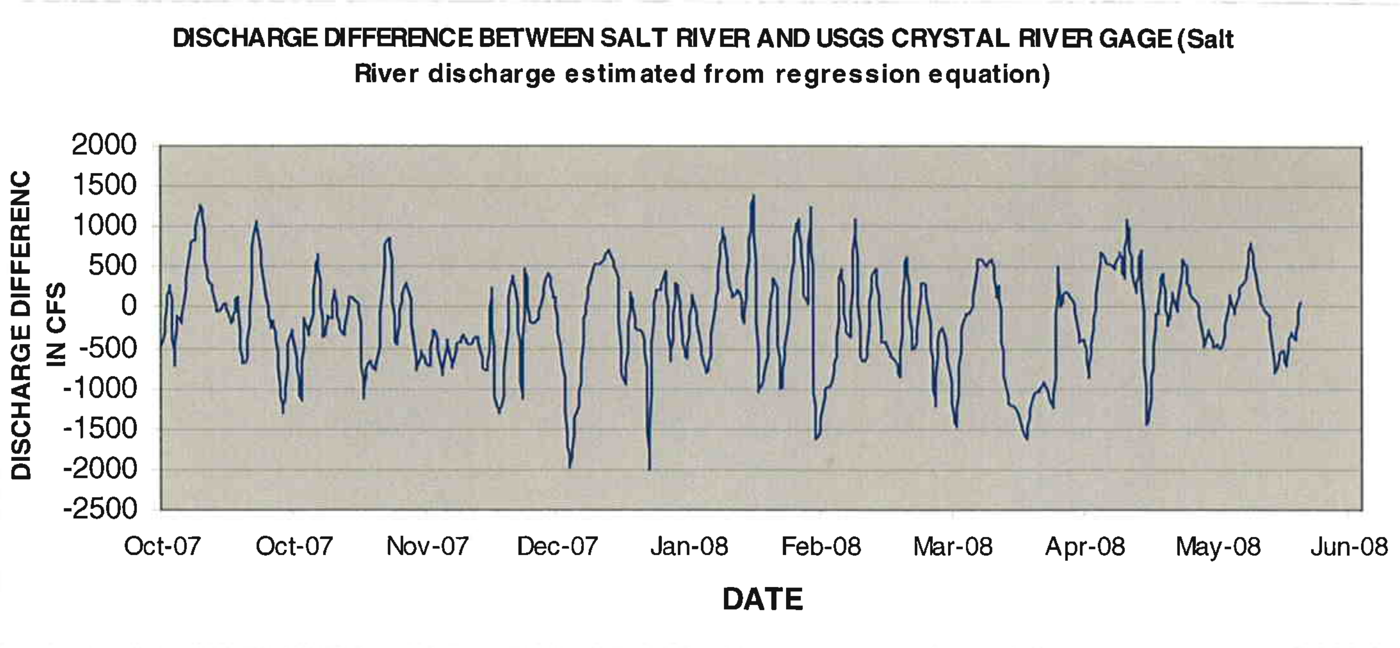


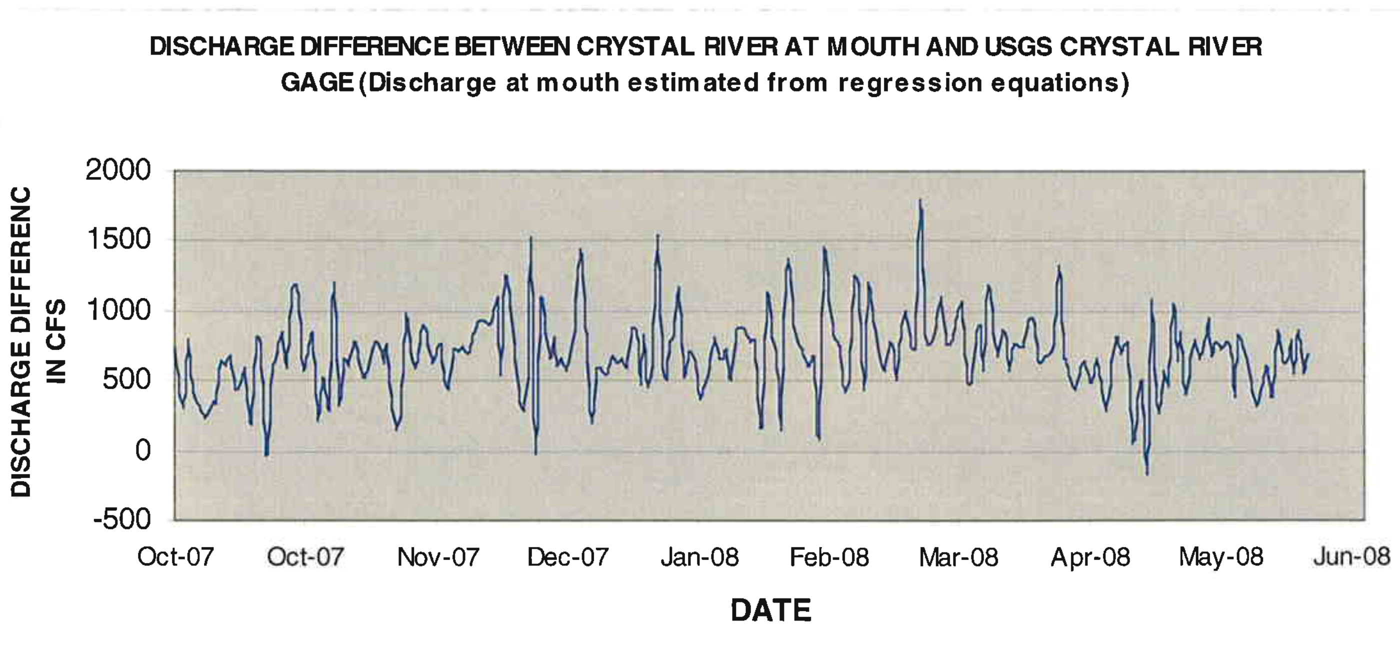


Appendix C

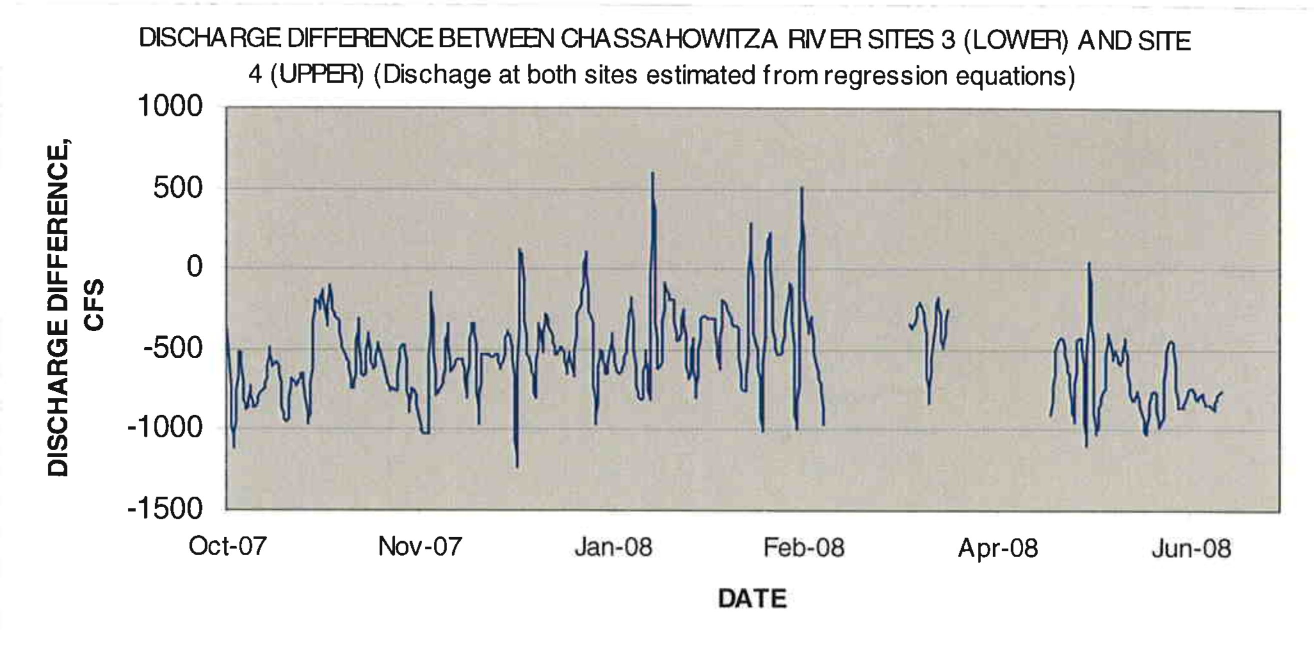
Discharge Difference

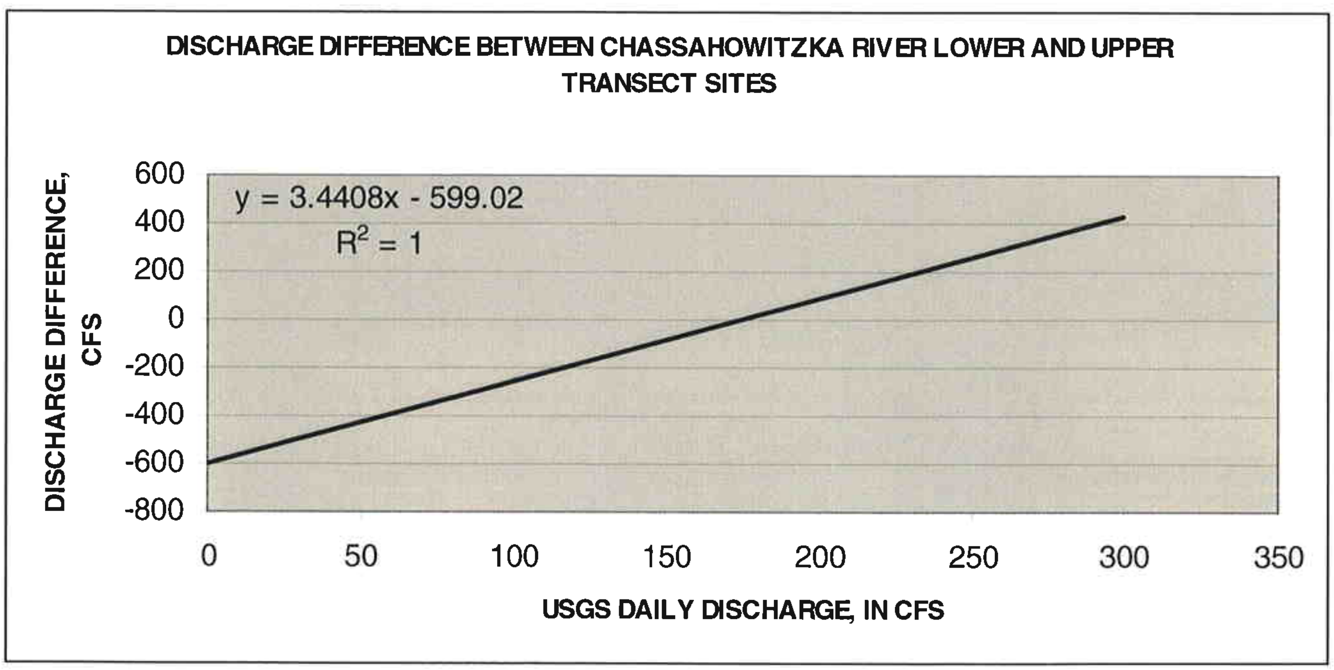
Crystal River





Chassahowitzka River





Appendix D

Field Data-March 2008

Crystal River at Transect 1
Downstream of Channel Marker 1
March 26, 2008

Start Time	End Time	Discharge	Area	Mean Vel
828	836	4572	5776	0.79
837	847	4466	5981	0.75
855	905	4491	5696	0.79
906	916	4787	6066	0.79
925	935	4372	5548	0.79
936	946	4607	5528	0.83
955	1006	4421	5540	0.8
1006	1015	4291	5510	0.78
1018	1029	4266	5722	0.75
1030	1040	4238	5487	0.77
1044	1057	3219	5447	0.59
1100	1111	2133	5725	0.37
1114	1126	809	5744	0.14
1127	1139	-308	5631	-0.05
1145	1153	-2285	5846	-0.39
1154	1205	-3633	6015	-0.6
1207	1214	-4699	5929	-0.79
1217	1224	-5648	6206	-0.91
1247	1255	-7763	6484	-1.2
1255	1300	-9043	6502	-1.39
1302	1307	-7780	6373	-1.22
1308	1315	-7832	6651	-1.18
1316	1322	-8057	6323	-1.27
1324	1331	-8161	6810	-1.2
1335	1342	-8473	6338	-1.34
1401	1409	-9095	6564	-1.39
1417	1424	-10373	7185	-1.44
1431	1437	-9512	6929	-1.37
1438	1444	-9658	6845	-1.41
1504	1510	-8922	6733	-1.33
1511	1517	-9665	7069	-1.37
1519	1525	-9221	6962	-1.32
1526	1532	-9566	7127	-1.34

Salt River at Transect 2A
(About 50 ft above Marina and 500 Downstream of Crystal River Main Channel)
March 26, 2008

Start Time	End Time	Discharge	Area	Mean Vel
741	743	502	917	0.55
750	752	490	888	0.55
755	801	433	921	0.47
809	815	397	871	0.46
821	828	386	896	0.43
837	842	256	855	0.3
855	901	191	836	0.23
911	917	84.9	824	0.1
925	930	15.4	831	0.02
940	947	-93.4	788	-0.12
956	1001	-176	780	-0.23
1012	1015	-275	766	-0.36
1042	1045	-335	772	-0.43
1054	1100	-237	735	-0.32
1110	1113	-178	755	-0.24
1124	1130	64.5	781	0.08
1141	1145	143	762	0.19
1154	1203	301	791	0.38
1211	1215	395	821	0.48
1224	1228	470	882	0.53
1243	1247	637	894	0.71
1258	1301	696	919	0.76
1312	1316	803	922	0.87
1325	1329	906	932	0.97
1342	1345	940	959	0.98
1357	1400	986	1030	0.96
1413	1417	865	1061	0.82
1426	1429	881	1136	0.78
1438	1441	804	1146	0.7
1454	1459	705	1122	0.63
1507	1510	590	1159	0.51
1524	1530	425	1165	0.37
1542	1545	209	1210	0.17

Chassahowitzka River at Transect 3
(About One-Half Mile Downstream of Dog Island)
March 27, 2008

Start Time	End Time	Discharge	Area	Mean Vel
812	820	2159	3822	0.56
820	841	2022	3899	0.52
841	851	2023	3936	0.51
851	903	1806	3856	0.47
905	916	1827	3618	0.51
916	930	1665	3398	0.49
932	942	1710	3538	0.48
945	1003	1544	3389	0.46
1003	1016	1564	3754	0.42
1031	1041	1060	3449	0.31
1041	1053	493	3657	0.13
1053	1107	-492	3408	-0.14
1108	1122	-1418	3329	-0.43
1123	1129	-1922	3398	-0.57
1130	1141	-1926	3322	-0.58
1141	1149	-2784	3596	-0.77
1150	1158	-2323	3206	-0.72
1159	1205	-2856	3443	-0.83
1206	1214	-2492	3617	-0.69
1214	1221	-2553	3475	-0.73
1222	1228	-2376	3683	-0.65
1240	1247	-2719	3605	-0.75
1247	1255	-2762	3738	-0.74
1318	1325	-3145	3814	-0.82
1327	1334	-3303	3583	-0.92
1339	1346	-3495	3887	-0.9
1346	1353	-3634	3944	-0.92
1354	1400	-3836	4066	-0.94
1400	1408	-3775	3802	-0.99
1410	1417	-3948	3879	-1.02
1418	1425	-4021	4178	-0.96
1446	1453	-5000	4083	-1.22
1454	1500	-5036	4089	-1.23
1501	1507	-5176	4178	-1.24
1507	1513	-5033	4199	-1.2
1516	1522	-5513	4325	-1.27
1522	1528	-5286	4182	-1.26
1538	1542	-5569	4453	-1.25
1543	1549	-5606	4116	-1.36
1550	1556	-5955	4271	-1.39
1556	1602	-6394	4314	-1.48

Chassahowitzka River at Transect 3
About One-Half Mile Downstream of Dog Island
March 27, 2008

Start Time	End Time	Discharge	Area	Mean Vel
1603	1608	-6604	4258	-1.55
1609	1614	-6124	4283	-1.43
1614	1618	-6296	4337	-1.45
1619	1623	-6009	4386	-1.37
1624	1628	-6389	4432	-1.44

Chassahowitzka River at Transect 4
(About One-Half Mile Upstream of House on Left Bank)
March 27, 2008

Start Time	End Time	Discharge	Area	Mean Vel
744	748	1064	2184	0.49
752	802	1012	2089	0.48
807	811	941	2204	0.43
820	830	882	1991	0.44
840	843	836	2071	0.4
856	906	791	2073	0.38
915	919	807	2147	0.38
923	933	862	2167	0.4
940	944	722	2135	0.34
952	1002	761	2165	0.35
1014	1019	591	2092	0.28
1023	1031	632	2017	0.31
1043	1049	501	2059	0.24
1056	1102	267	2100	0.13
1110	1115	-370	2085	-0.18
1124	1129	-711	2134	-0.33
1138	1144	-1021	2115	-0.48
1152	1156	-1145	2175	-0.53
1210	1217	-1098	2181	-0.5
1225	1228	-1131	2268	-0.5
1240	1249	-1086	2358	-0.46
1255	1300	-1107	2305	-0.48
1314	1322	-1219	2444	-0.5
1325	1330	-1428	2384	-0.6
1340	1347	-1639	2493	-0.66
1356	1304	-1651	2377	-0.69
1413	1421	-1702	2563	-0.66
1421	1427	-1794	2515	-0.71
1440	1447	-1900	2554	-0.74
1454	1459	-2090	2563	-0.82
1509	1515	-2010	2710	-0.74
1523	1529	-2208	2688	-0.82
1541	1547	-2185	2830	-0.77
1556	1601	-2282	2777	-0.82
1614	1621	-2235	2845	-0.79
1623	1628	-2197	2774	-0.79