Tampa Bay Water Section 21 Wellfield Restoration Project:

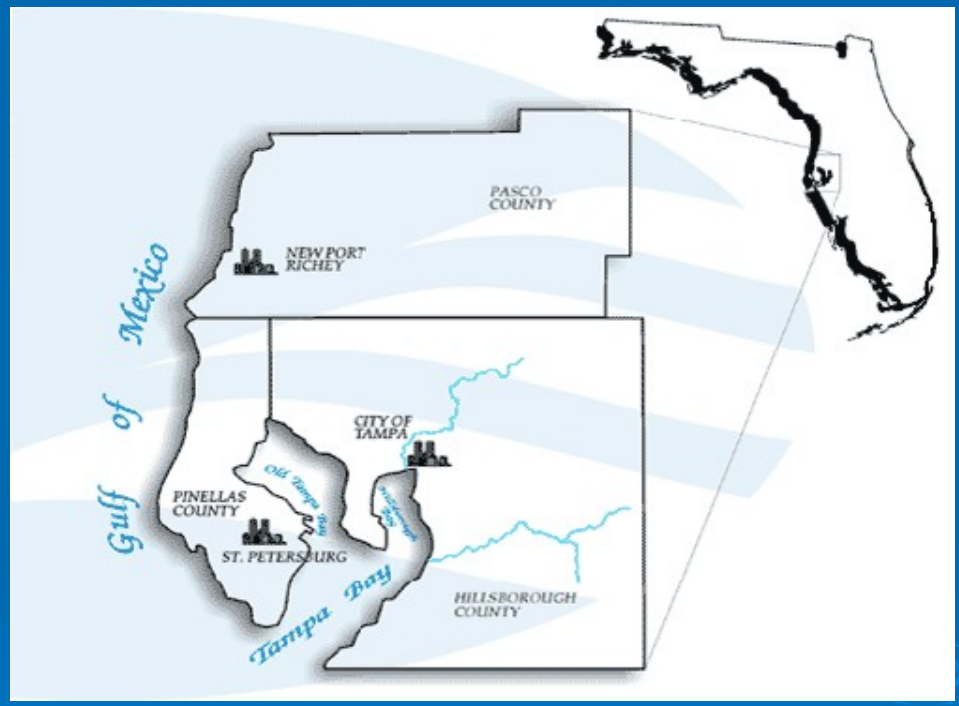
Evaluating Potential Health Risks Associated with Wetland Restoration Using Storm Water and Reclaimed Water

Deborah Daigle, P.G

HDR Engineering, Inc.

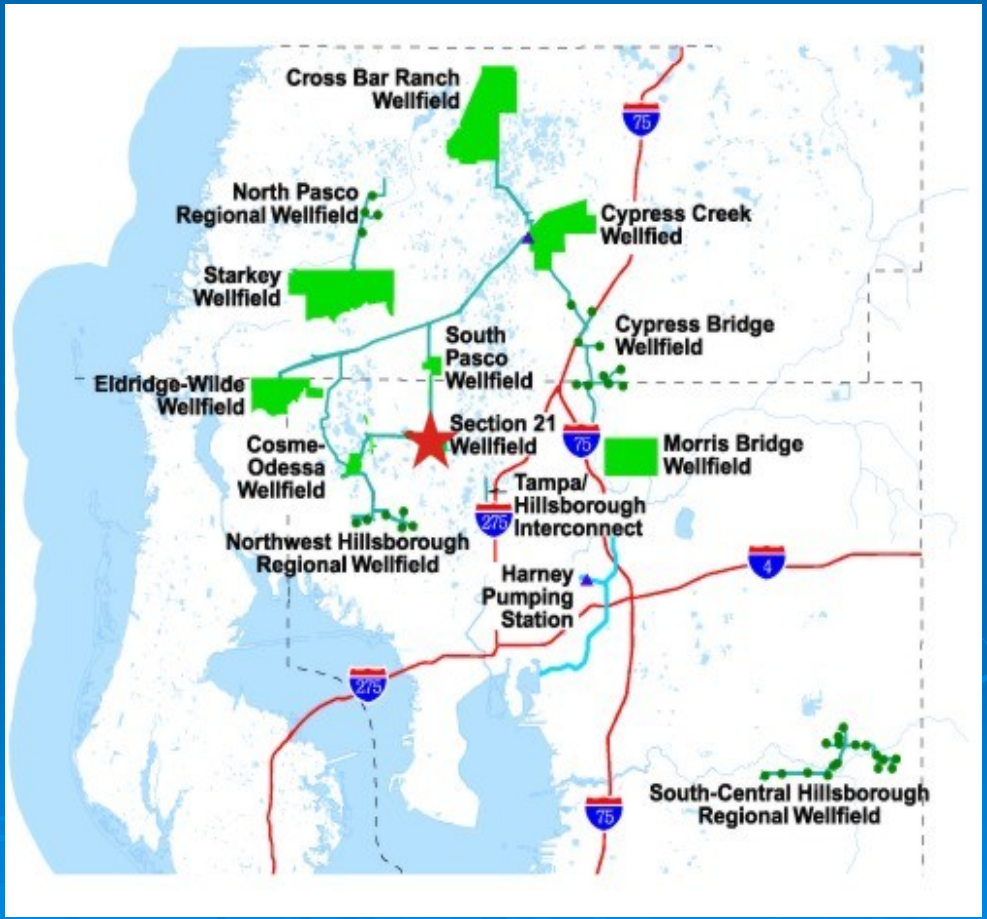
Tampa Bay Water

- Florida's Largest Wholesale Water Supplier
- Created by Interlocal Agreement
- Six Member Govt's



Groundwater Facilities

- 11 Wellfields
- Regulated by SWFWMD
- City of St. Petersburg owns the Section 21 Wellfield
- Property leased to Hillsborough County for use as a public park
- Tampa Bay Water owns 1 acre parcels surrounding the well heads



Consequences of Groundwater Pumping

- Impacts to Wetlands and Lakes
- Permit Requirements
  - Pumpage Reductions
  - Lake and Wetland Restoration Program for all Wellfields
- CSES, Phase I and II Mitigation Plans

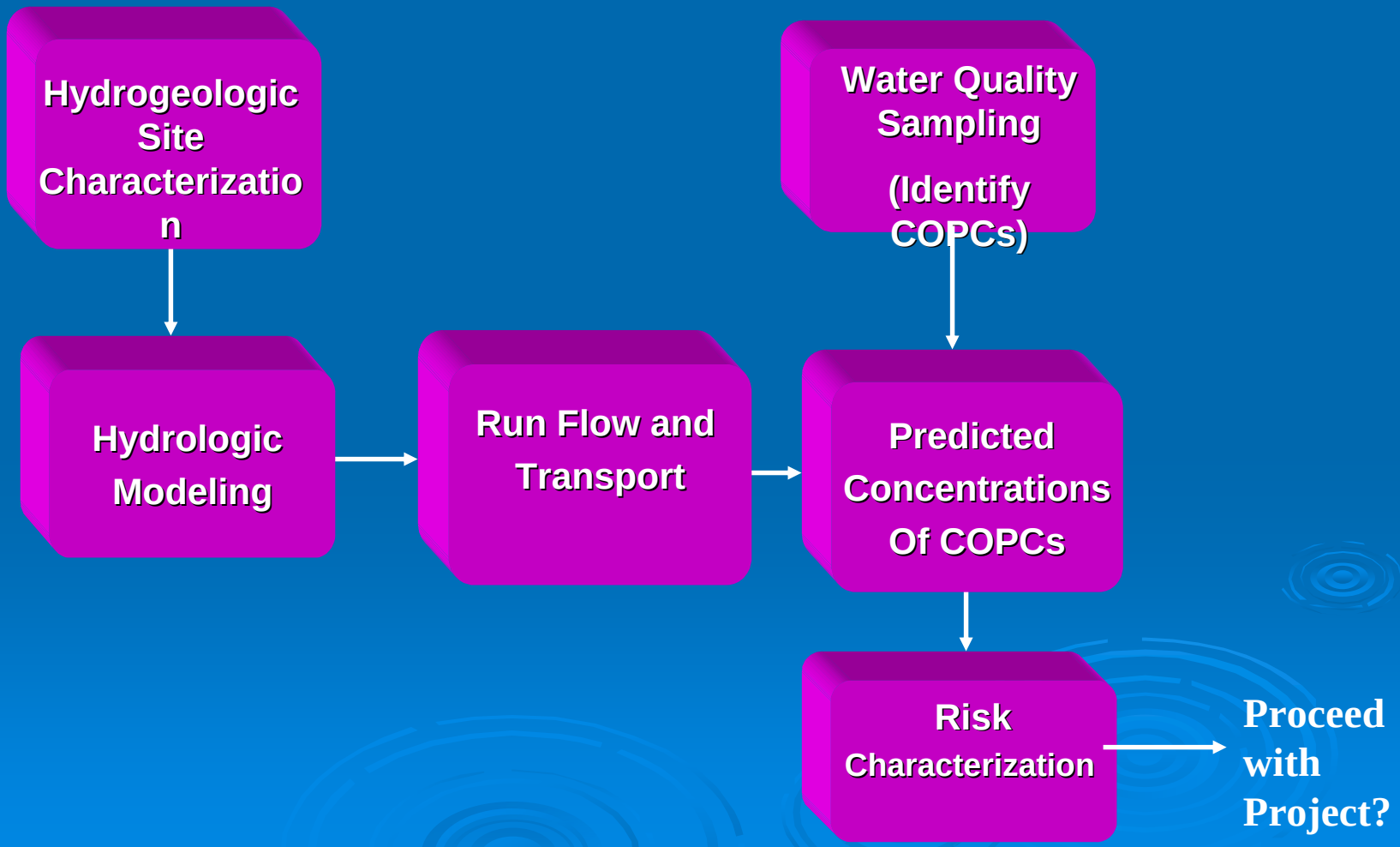
Potential Restoration Source Options

- Groundwater Augmentation
- Reclaimed Water Augmentation
- Drainage Modifications
- Surface/Stormwater Diversion

Section 21 Wellfield Restoration Project

- Divert Storm Water and/or Reclaimed Water to Wetlands on Wellfield.
- Investigate the Potential Public Health Risks
- Develop and Utilize a Scientific Process for Evaluating Potential Impact to Public Health
- **Co-Funded by SWFWMD and EPA**

Section 21 Risk Assessment Process

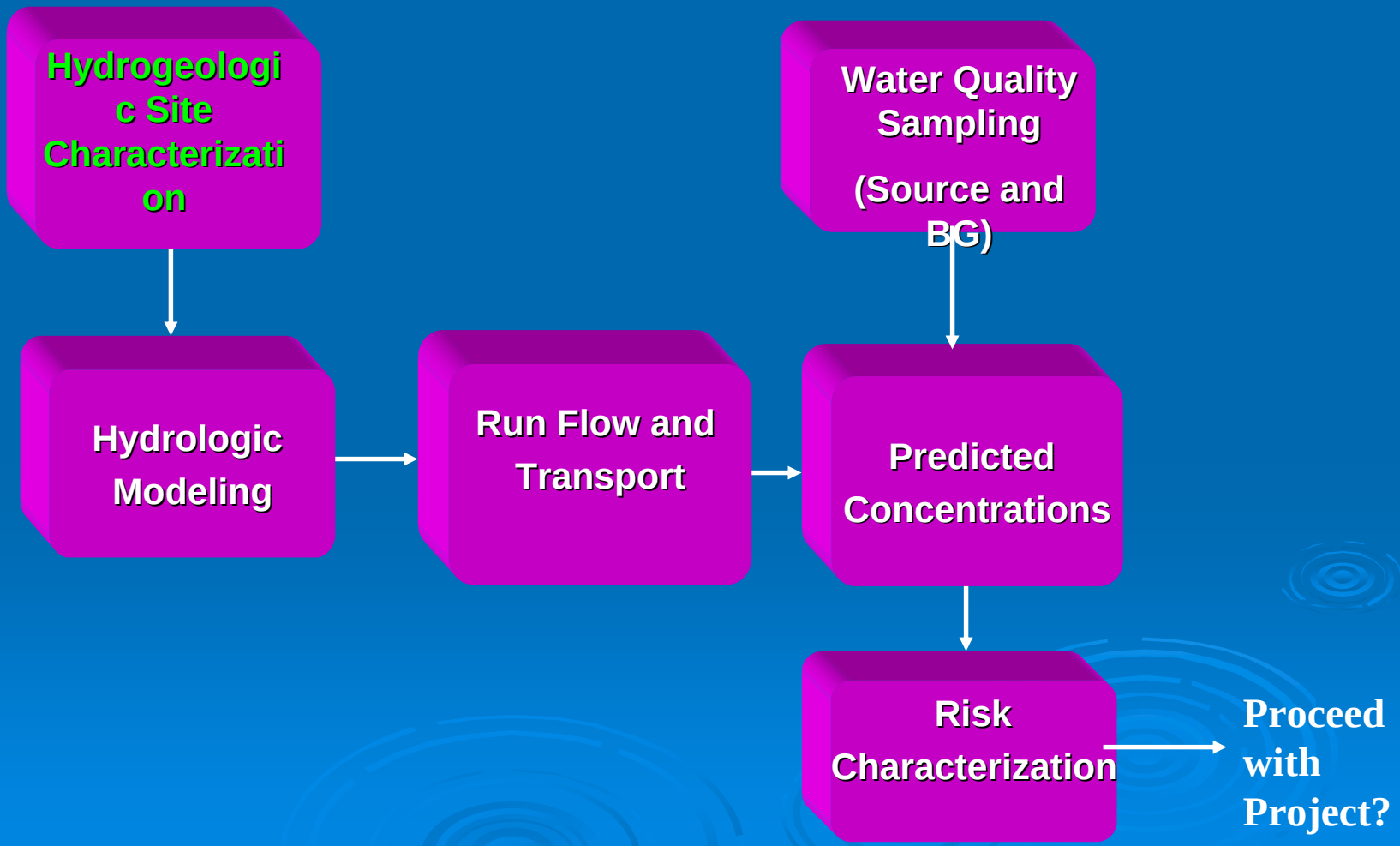


Site Map

Active Production Well

Restoration Site

Section 21 Risk Assessment Process

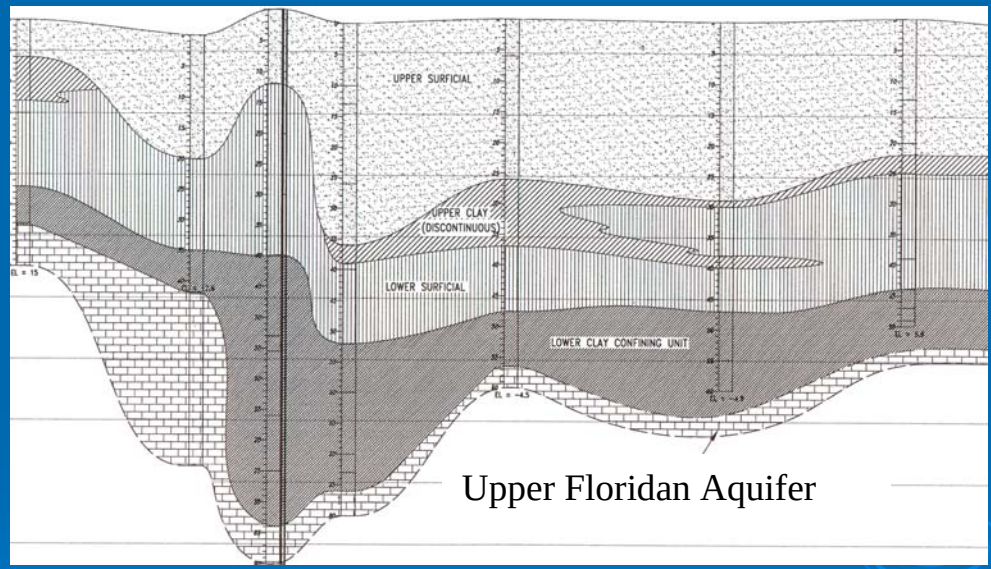


Hydrogeologic Site Characterization

- Required for Model Input
- Ground Penetrating Radar
- 29 Soil Borings
- Laboratory Testing-Soils
- 24 Monitoring Wells
- Aquifer Performance Tests
- Tracer Tests

Site Hydrogeology

- Shallow Water Table Aquifer
- Confining Layer of Variable Thickness
- Floridan Aquifer Source of Drinking Water
- High Occurrence of GPR Anomalies



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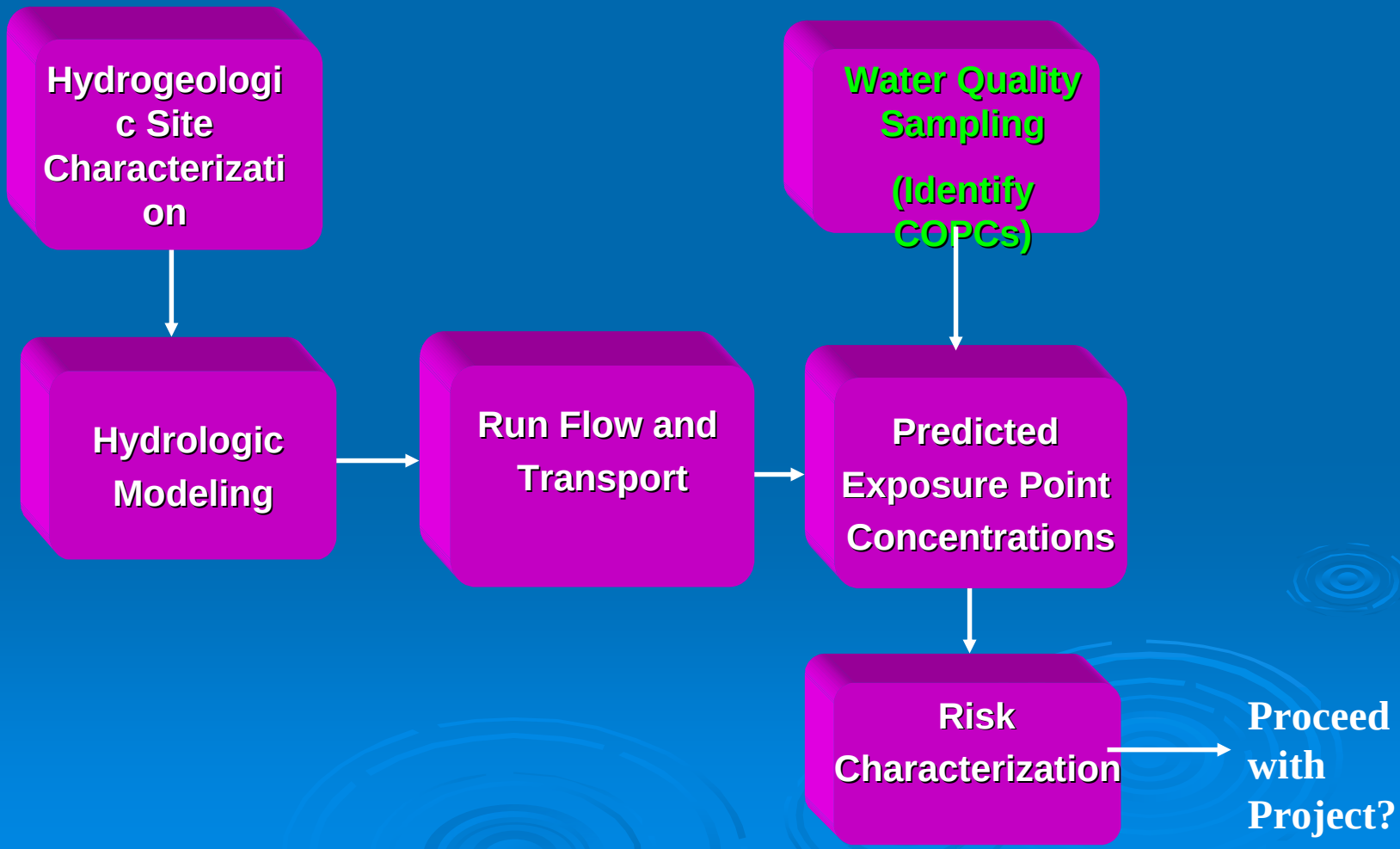


Background and Source Water Characterization

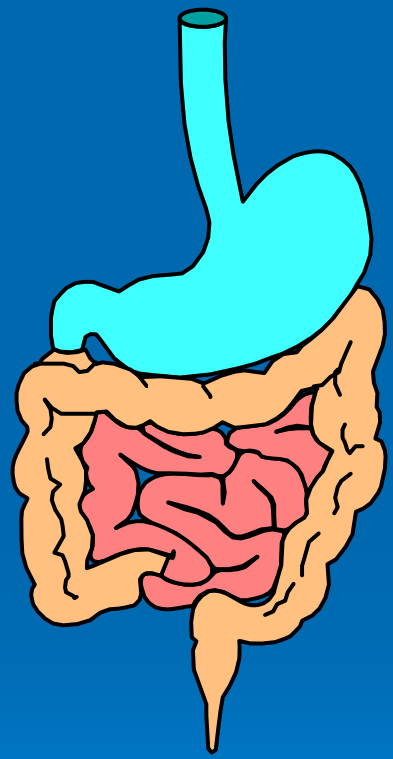
- Sampling for Chemical and Microbial Constituents
  - Production Wells
  - Lakes
  - Wetland
  - Interceptor Canal
  - Reclaimed Water
    - (DMAWWTP)

Water Quality Sampling

- Chemical and Indicator Parameters
  - Field Parameters
  - Primary and Secondary Drinking Water Parameters (62-550 FAC)
  - Disinfection By-Products
  - Nutrients

Water Quality Sampling

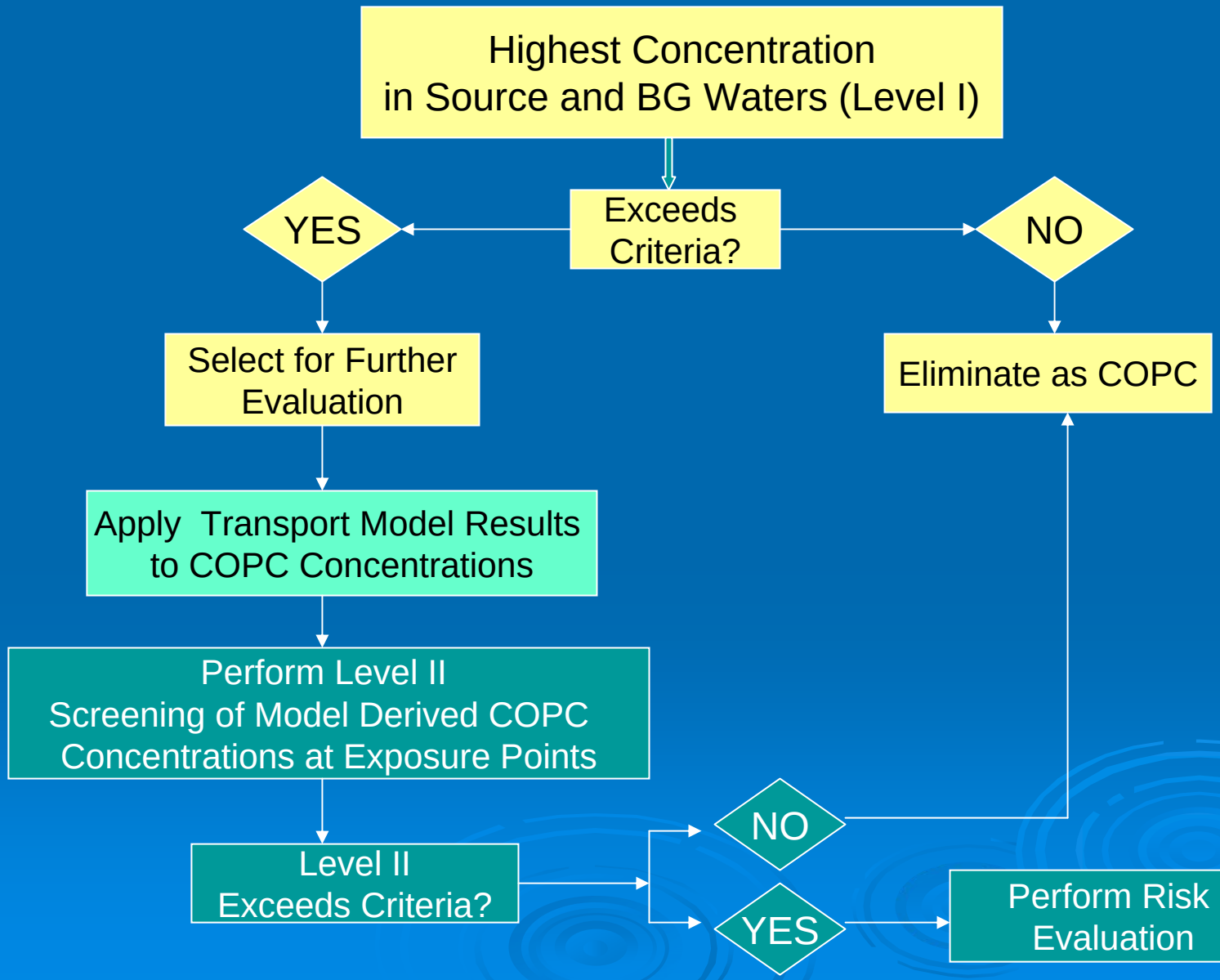
- Microbiological Parameters
  - Human Enteroviruses
  - *Protozoan Parasites*
    - *Cryptosporidium*
    - *Giardia*



Risk Assessment Process

- Chemical Parameters – US EPA Risk Assessment Guidance for Superfund
  - Screening Process to Identify Constituents of Potential Concern (COPCs) to Human Health
- Microbiological Parameters– Quantitative Microbial Risk Assessment (QMRA)

Identify Chemical Constituents of Potential Concern (COPCs): Screening Process



Identify Constituents of Potential Concern (COPCs): Level I Screening Process

- Parameters that do not comply with the following Florida Administrative Codes:
  - 62-550 – Drinking Water MCLs, and
  - 62-777 Groundwater Cleanup Target Levels.
  - 62-302 – Class III Fresh Surface Water Quality Criteria
  - Federal (if no State guidance)

Level I Screening Process

- Parameters that are significantly different (statistically) for the restoration source waters when compared to the background waters

Level I Screening to Identify COPCs

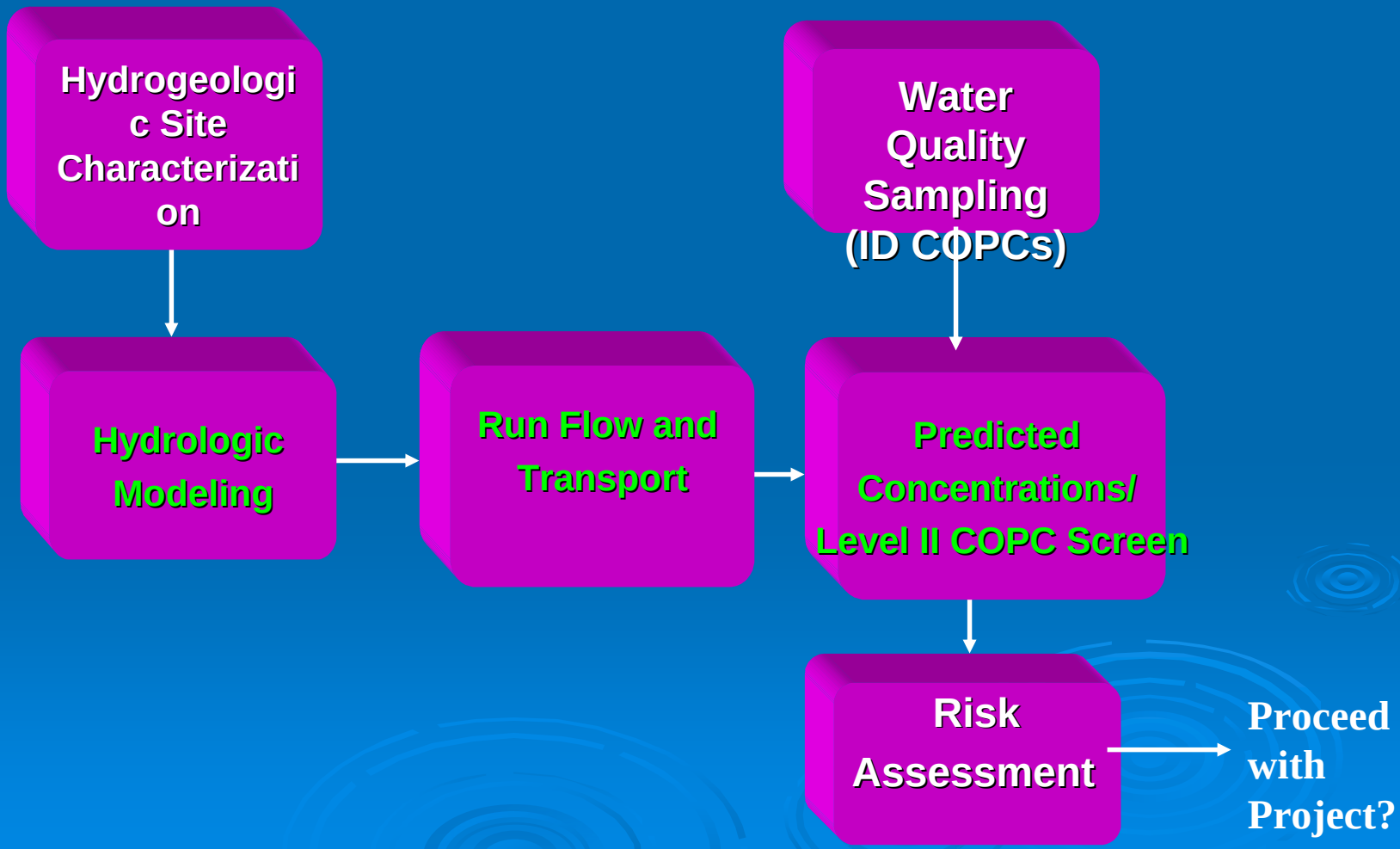
- Dale Mabry AWWTP

Doesn't meet FAC	Statistically Different from Background	Health Risk
Conductivity TDS Odor TTHM Chloroform Bromodichloromethane Dibromochloromethane	Conductivity TDS TTHM Chloroform Bromodichloromethane Dibromochloromethane	Chloroform Bromodichloromethane Dibromochloromethane

- Interceptor Canal

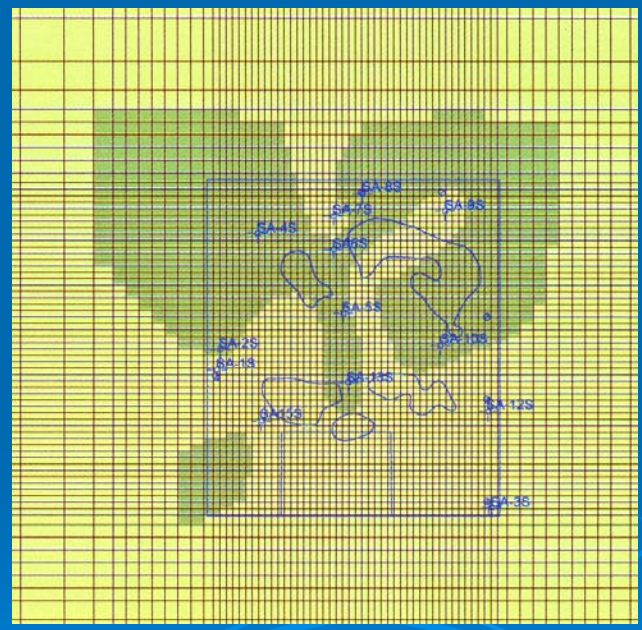
Doesn't meet FAC	Statistically Different from Background	Health Risk
DO Odor Color	Color	None

Risk Assessment Process



Hydrologic Modeling

- Steady-State and Transient Flow and Transport Models
  - MODFLOW
  - MT3D
- Simulate Restoration
  - Source Water Migration Paths and Travel Time to Production Wells
  - COPC Concentration at Production Wells and Lakes/Wetlands

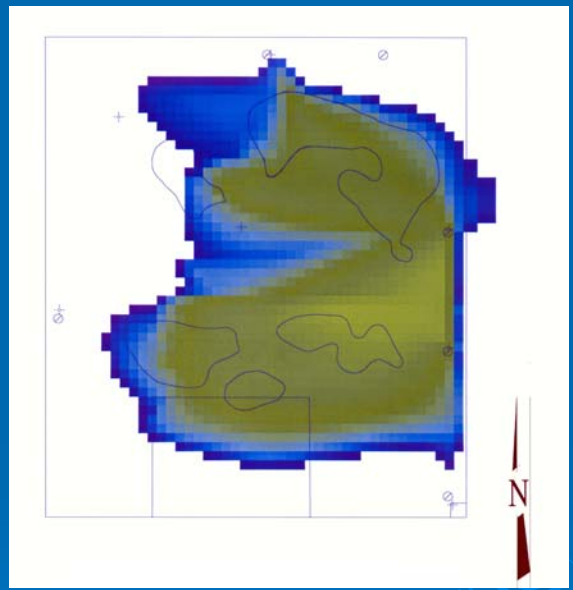


Hydrologic Modeling

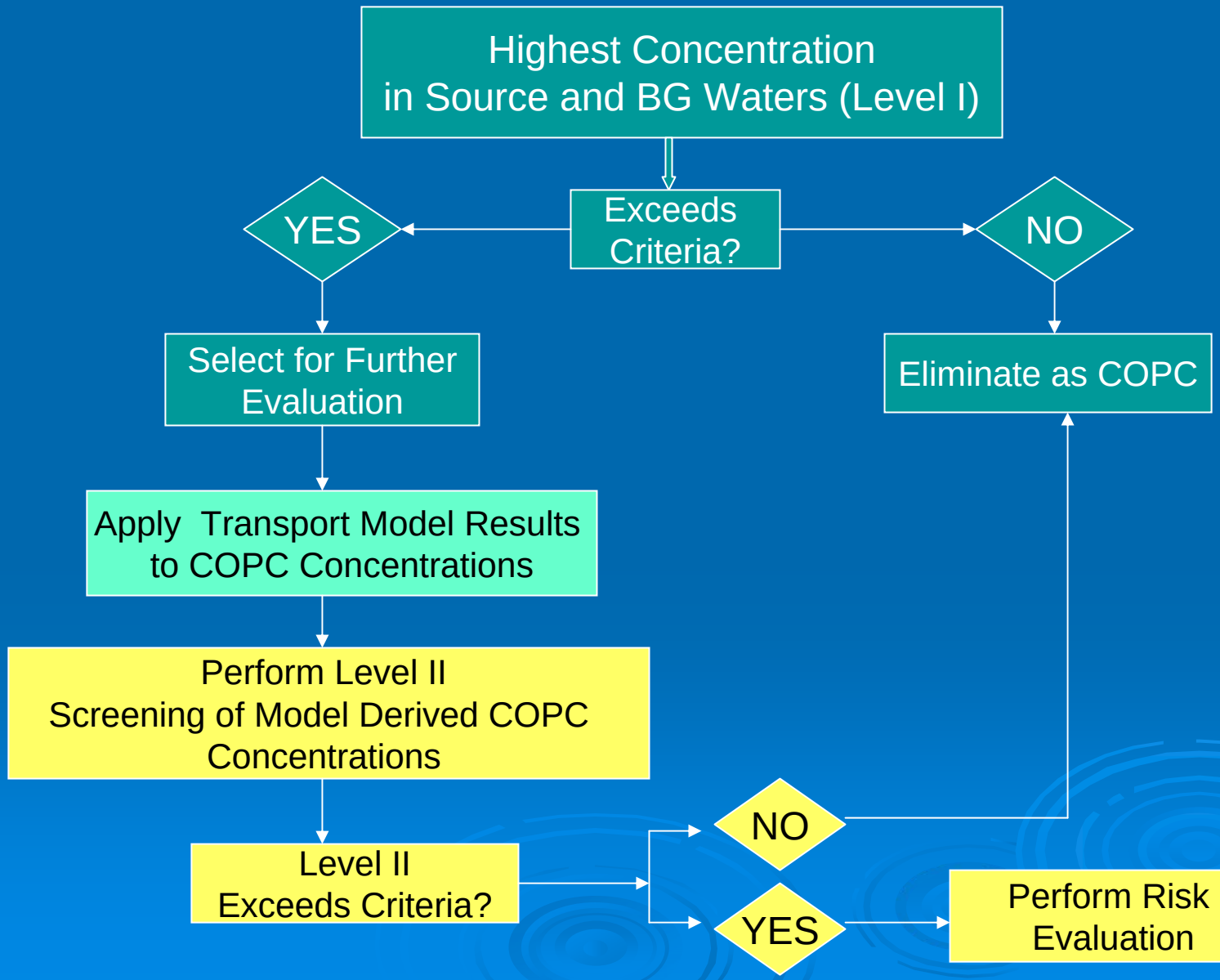
- Starting Concentration of 1000 in Transport Model
- Transient Model Period of 20 Years

Model Results

- First Arrival to First Production Well: ~ 3 Months
- Transport Model
  - Peak Concentration at Production Wells: 0.3% to 5% of Source Water Concentration
  - Lakes: 26% to 98%
  - Wetlands: 5% to 56%



Identify Chemical Constituents of Potential Concern (COPCs): Screening Process



Level II Identification of COPCs

- Calculated concentrations of constituents (identified in Level I) at the each Production well, Lake, and wetland as predicted from site – specific flow and transport modeling.

- Model derived concentrations are compared to State Maximum Contaminant Levels and/or EPA Region 9 Preliminary Remediation Goals (PRGs) –Tap water, EPA WQ Criteria for Human Health Clean Water Act or SDWA requirements

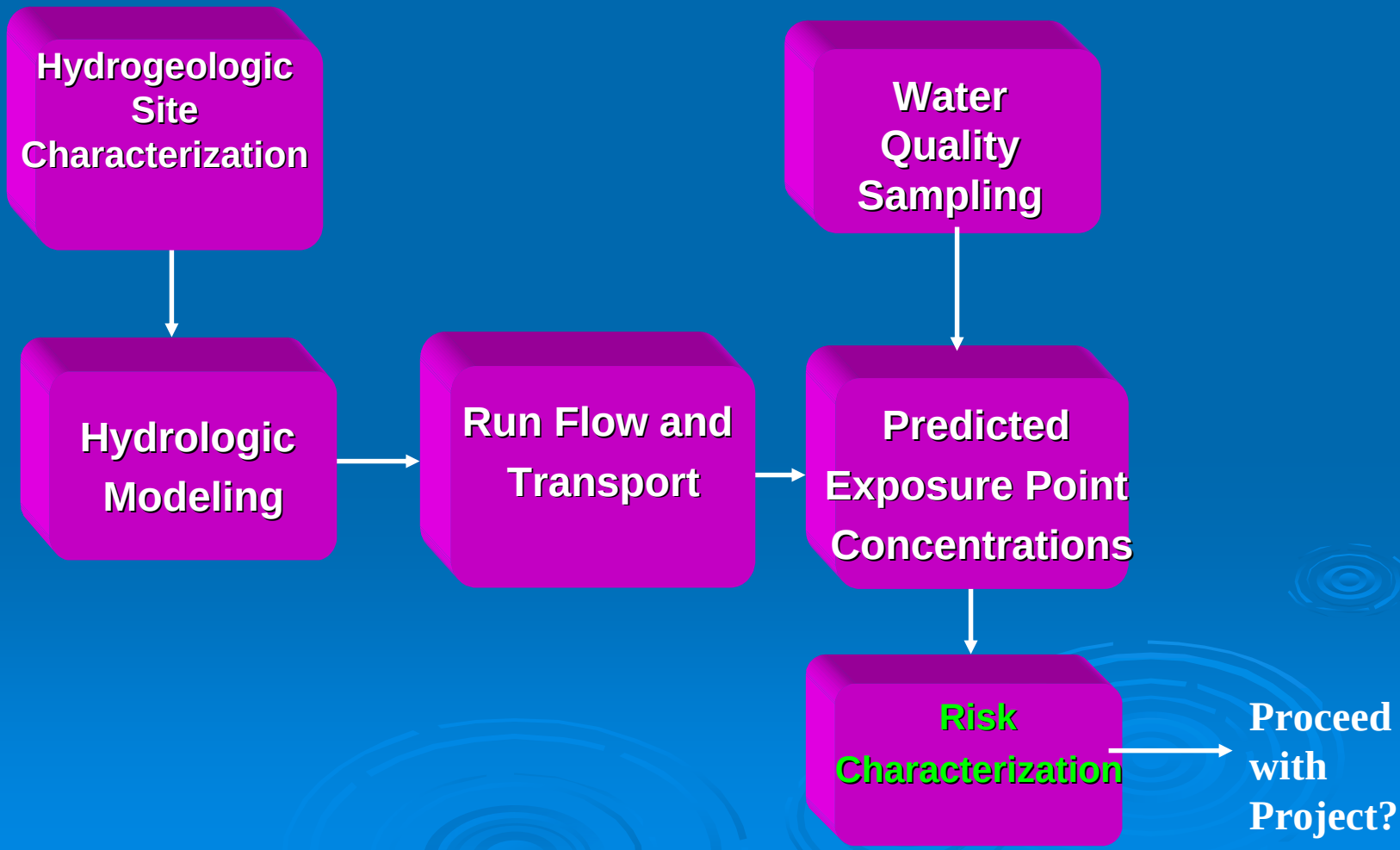
Level II Identification of COPCs

DMAWWTP

- Bromodichloromethane
- Dibromochloromethane

- Exceed Criteria for Wetlands and Lakes

Risk Assessment Tasks



Identify Potentially Exposed Populations (Receptors)

- How will Humans be Exposed?
- Based on Land Use, Activities on the Park, Groundwater Use
  - Resident
  - Park Visitor
  - Worker
  - Trespasser
- Means to which Receptors Exposed

Exposure Pathways and Receptors

Exposure Medium	Exposure Point	Potential Receptor	Age	Exposure Route	On-Site/Off-Site	Selected for Further Analysis
Potable Water	Well	Resident	Adult and Child	Ingestion Dermal Inhalation	Off	No
Incidental Contact	Well	Worker	Adult	Dermal Inhalation	On	Yes
Incidental Contact	Lakes/Wetlands	Worker	Adult	Dermal Inhalation	On	Yes
Swimming	Lakes	Trespasser or Visitor	Adult and Child	Ingestion Dermal Inhalation	On	Yes

Chemical Risk Assessment Results

- Performed Risk Calculations for Selected Exposure Pathways and Receptors for COPCs
- No Human Health Risk Associated with a Chemical Exposure

Microbial Risk Assessment

Quantitative Microbial Risk Assessment (QMRA) Approach*

QMRA Step	Approach
Selection of pathogens	*Cryptosporidium*, *Giardia*, and enteric viruses
Determination of pathogen profile	Maximum and average values from monthly samples over 24 month period
Estimate of pathogen survival	First order die-off as function of time and temperature
Determination of exposure pathways	Ingestion, contact and non-contact recreation
Estimate of pathogen dose-response in humans	Exponential (protozoa), beta-Poisson (virus) models derived from human infectivity studies
Characterization of risk from pathogens	Independent action, based on single and multiple exposures

*Developed by Dr Joan Rose, others

Assumptions Made to Calculate Microbial Risks

- 100% recovery of pathogens by the analytical methods
- 100% viability of the pathogens detected by the analytical methods
- No retardation of pathogens due to transport in aquifer

Assumptions Made to Calculate Microbial Risks

- Inactivation of pathogens by treatment was not considered in the risk calculation
- Variations in water temperature were not considered. Risk calculations were based on a yearly average surface water and aquifer temperature of 26°C

Microbiological Water Quality Results

- Wetland
  - *Cryptosporidium* detected in 1 of 22 samples
- Lake Jackson
  - *Cryptosporidium* in 2 of 24 Samples
- Interceptor Canal
  - *Cryptosporidium* in 1 of 24 Samples
  - *Giardia* in 1 of 24 Samples
- DMAWWTP
  - *Giardia* in 22 of 24 Samples
  - *Cryptosporidium* in 20 of 24 Samples
  - Enteroviruses in 2 of 24 Samples

Exposure Pathway

Pathway	Exposure	Frequency
Ingestion	2 liter/day	365 days/year
Contact Recreational	100 mL/visit	45 days/year
Non-Contact Recreational	1 mL/visit	45 days/year

QMRA

- Ingestion, Contact, and Non-Contact Recreation Risk Calculated for both Existing and Restored Condition
- Compared to Determine Increase or Decrease

QMRA Conclusions - Ingestion

- Interceptor Canal – Compared to Existing Condition
  - Similar yearly risk for *Giardia*
  - Reduced yearly risk for *Cryptosporidium*

- DMAWWTP effluent – Compared to Existing Condition
  - Increases yearly risk for *Giardia*
  - Similar *yearly* risk for *Cryptosporidium*

- The yearly viral risk is negligible for the existing and restored condition no matter which source water is used for restoration.

QMRA Conclusions – Contact and Non-contact Recreational Activities

- Interceptor Canal – Compared to existing condition
  - Similar recreational risk with respect to *Cryptosporidium* and enterovirus
  - Increased recreational risk from *Giardia*-controlled through restricted access.

DMAWWTP effluent - **Compared to existing condition**

- Increased recreational risk for *Cryptosporidium*, *Giardia* and enterovirus– controlled through restricted access

Conclusions

- No significant risks with respect to chemical constituents.
- Use of reclaimed water/storm/surface water presents a comparable or decreasing risk profile for *ingestion* as compared to the background risk with respect to microbiological constituents.
- Use of reclaimed water/storm/surface water presents varying risk profiles for *recreational activities* as compared to the background risk with respect to microbiological constituents.