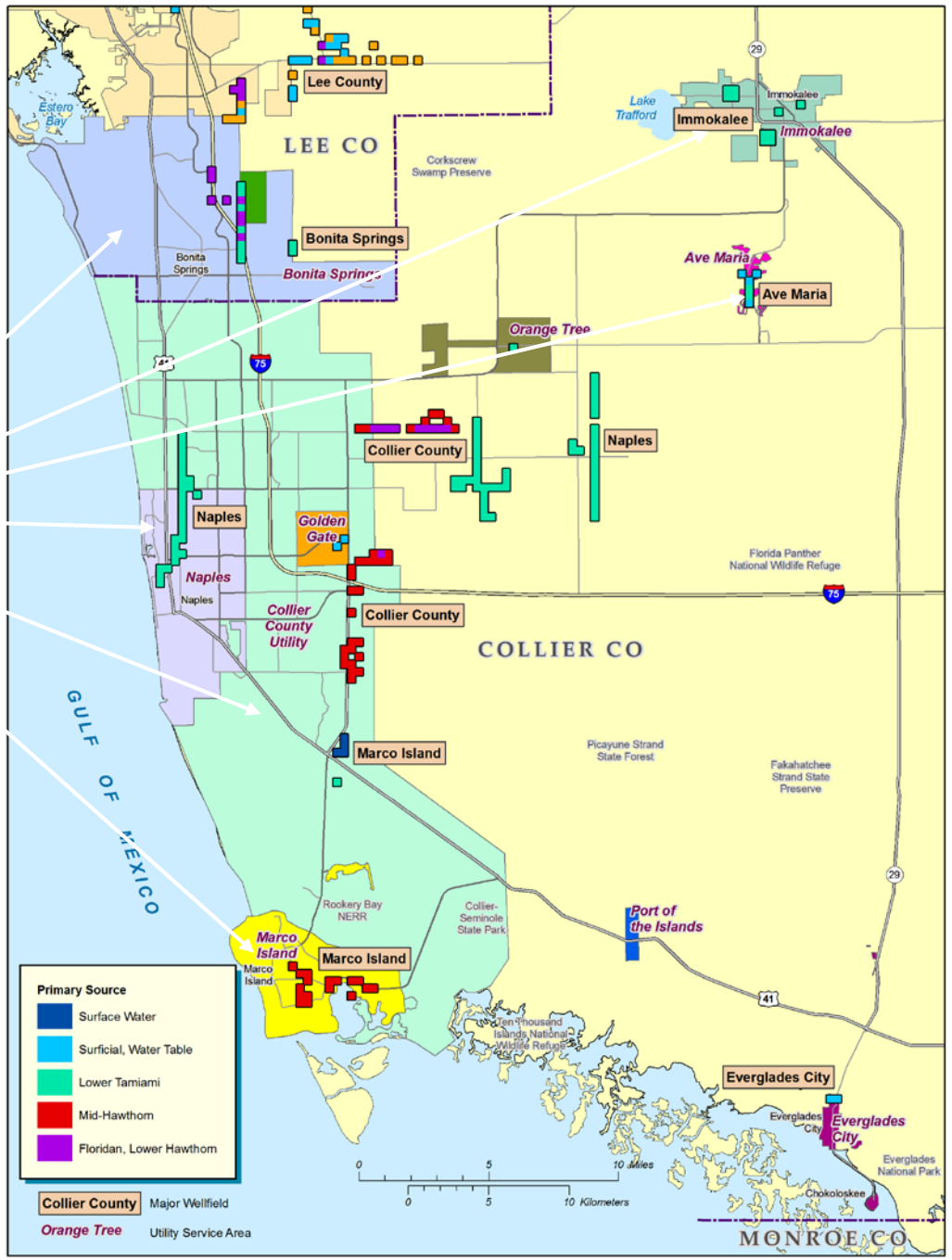
# Saltwater Interface Mapping Update

Peter J. Kwiatkowski, P.G.
Resource Evaluation Section Administrator
Water Supply Bureau, Water Resources Division

**Big Cypress Basin Board Meeting**
**October 24, 2019**

# Why is this Important?

Utility Service Areas



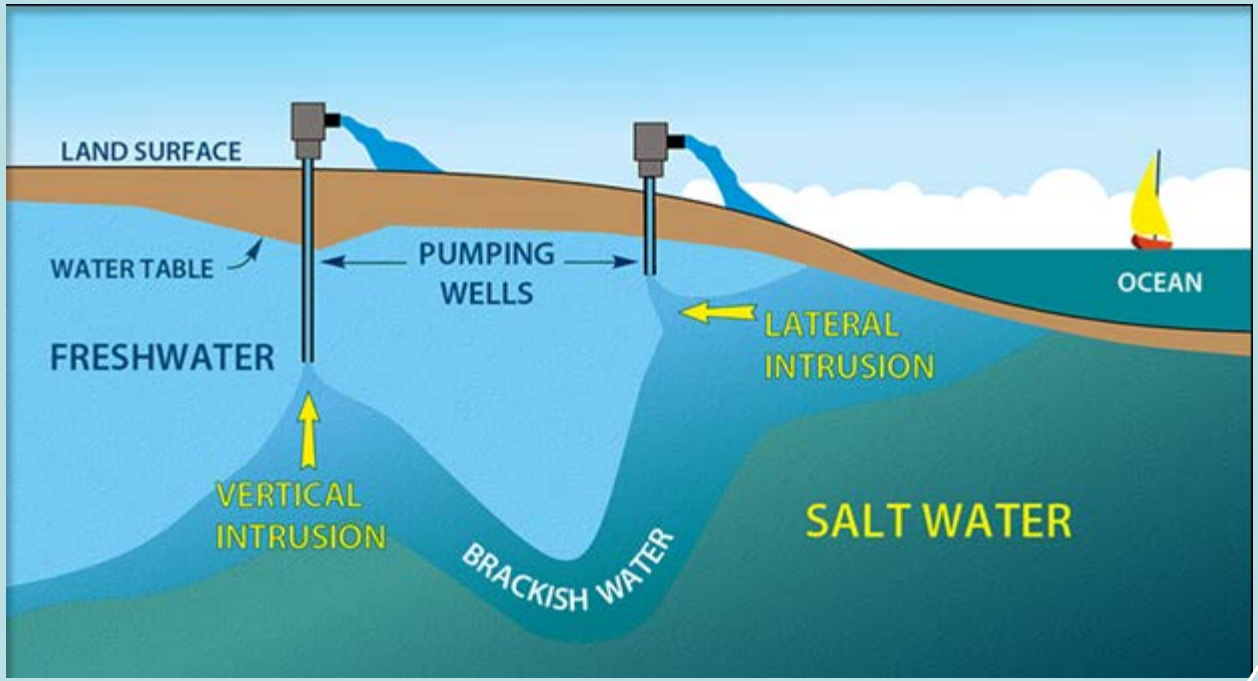

- Wellfields are a major water supply source – protect investment
- Once saltwater enters wells, very difficult – if not impossible -- to reverse
- Very expensive to relocate wellfields and associated infrastructure (pipelines, treatment plants and processes, etc.)
- Other sources of water more expensive to treat (e.g., Floridan aquifer – reverse osmosis)

# Presentation Outline

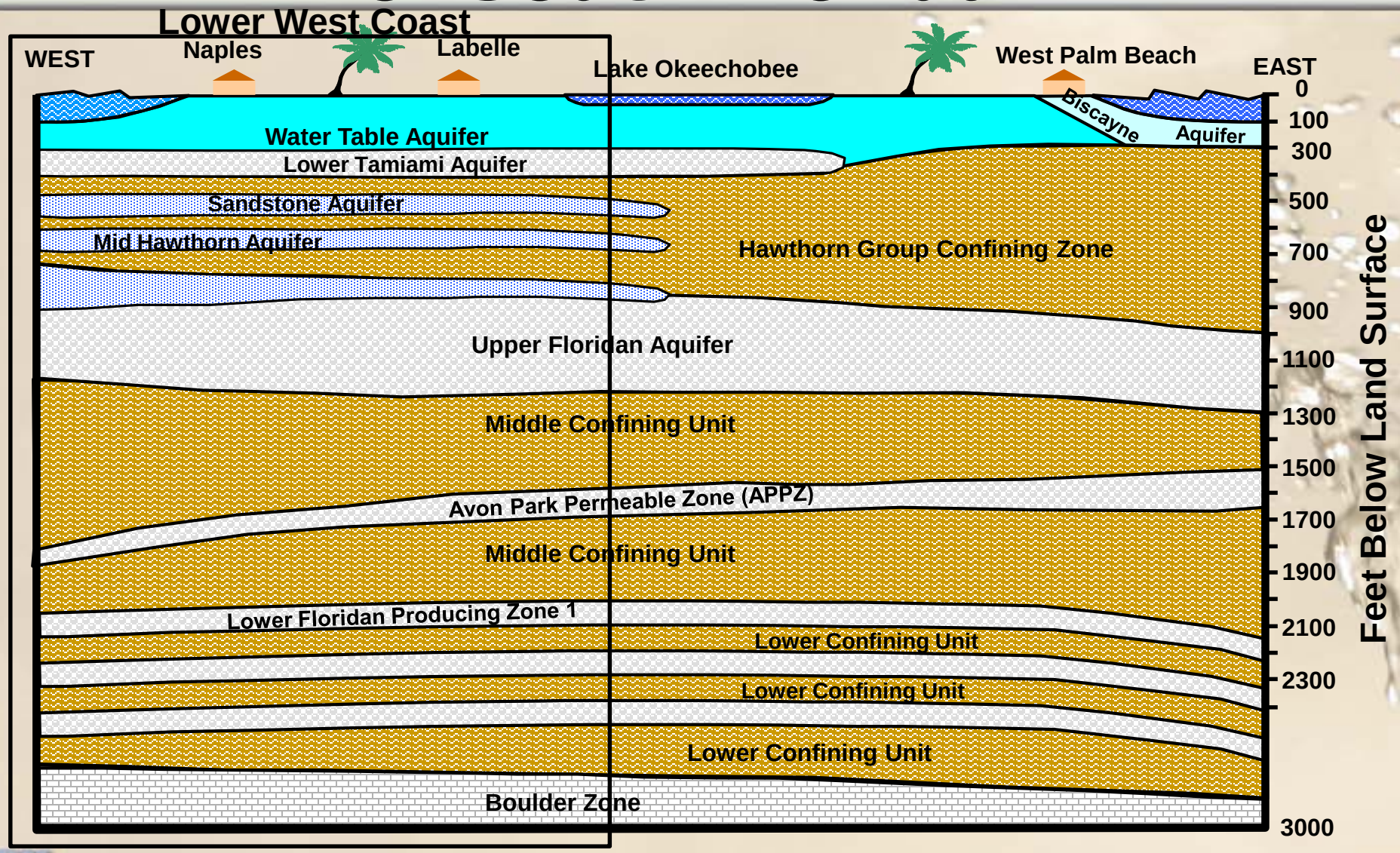
- Importance to wellfields and infrastructure
- Overview of saltwater intrusion and aquifers
- Project approach
- Results – Water Table, Lower Tamiami, Sandstone, Mid-Hawthorn aquifers (2009, 2014, and 2019)
- Conclusions
- Next steps

# Saltwater Intrusion -- Definition and Common Sources

- Saltwater Intrusion – movement of saltwater into aquifers
- Saltwater Interface – mapped position of a line representing saline water with an equal chloride concentration (i.e., 250 milligrams per liter)
- Lateral intrusion from the coast
- Vertical intrusion (upconing) from saltwater below
- Surface Infiltration -- estuaries, boat basins, saltwater marshes, saltwater canals, etc.
- Ancient (relict) seawater trapped in low permeability portions of aquifers

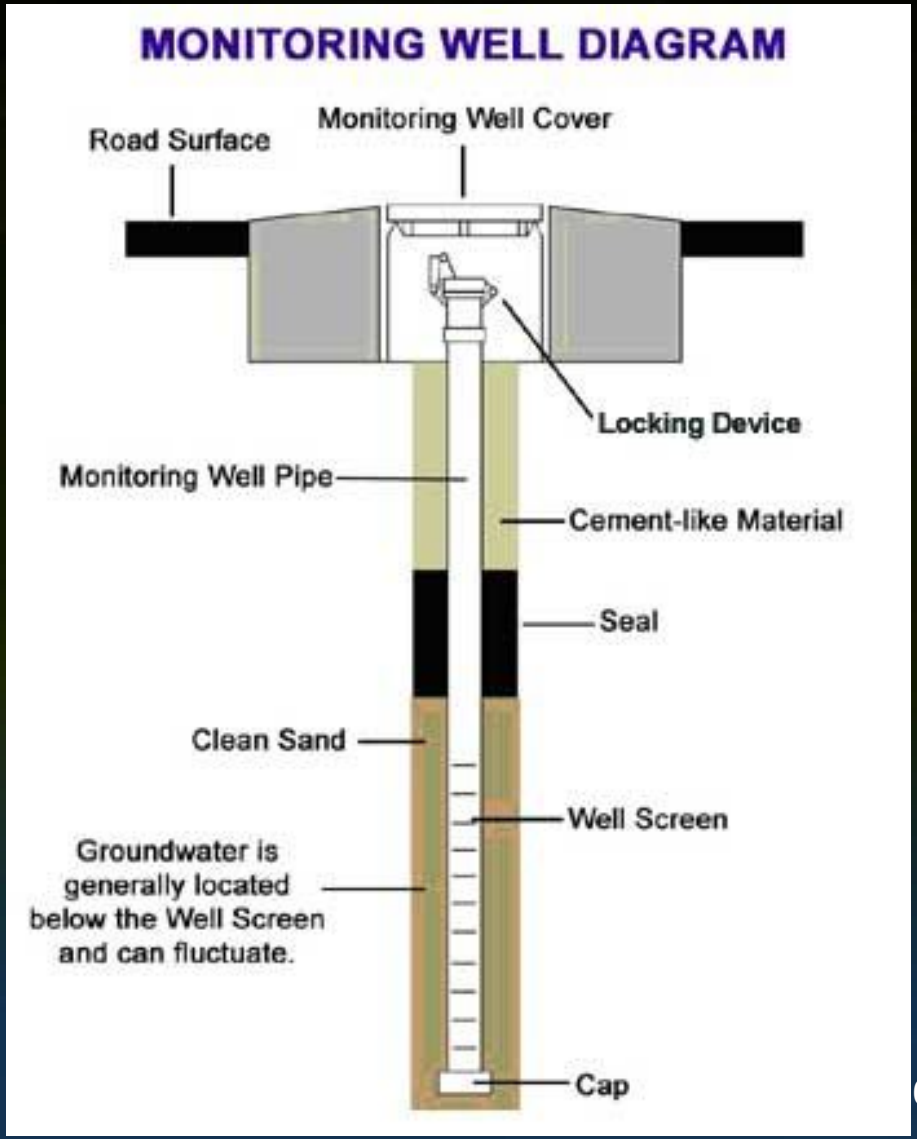


# Generalized Hydrogeology of South Florida



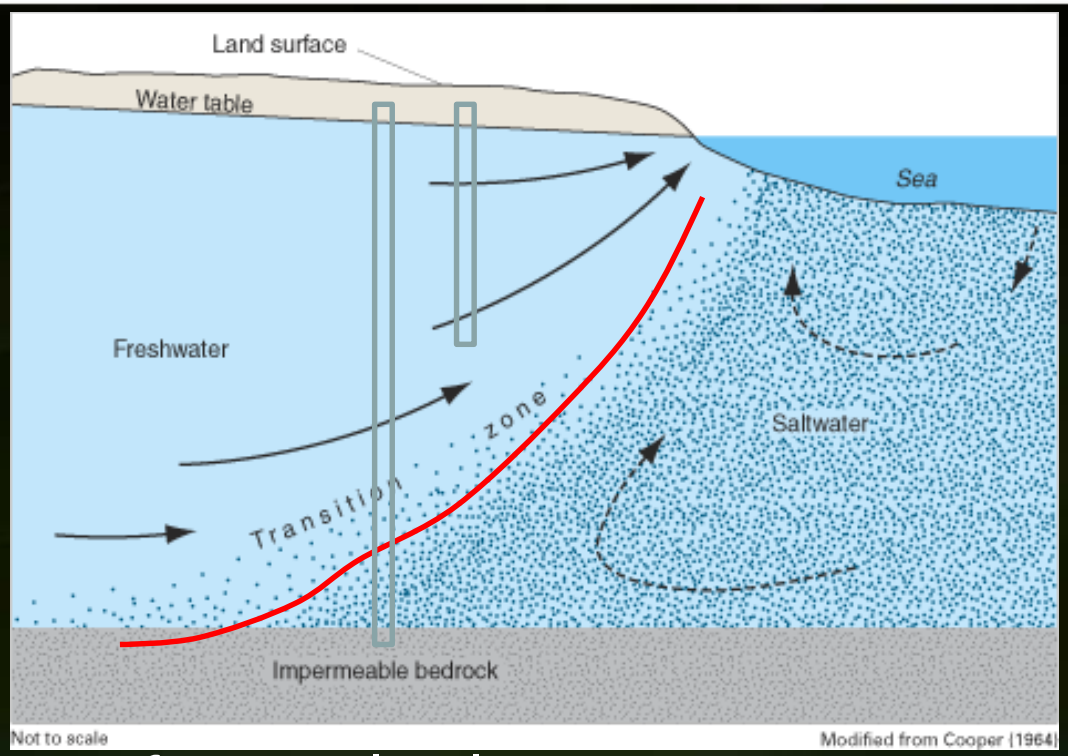
# Saltwater Interface Mapping Project Approach

- Map the 250 milligrams per liter (mg/L) chlorides (isochlor) – corresponding to drinking water standard;
- Compare interface positions (i.e., 2009, 2014, 2019)
- Update maps every 5 years
- Use all available monitor well data (USGS, SFWMD, Counties, Water Use Permittees)
- End of dry season
- Coastal aquifers: Water Table, Lower Tamiami, Sandstone, Mid-Hawthorn
- Note areas of concern, adjust monitoring, and adapt as necessary



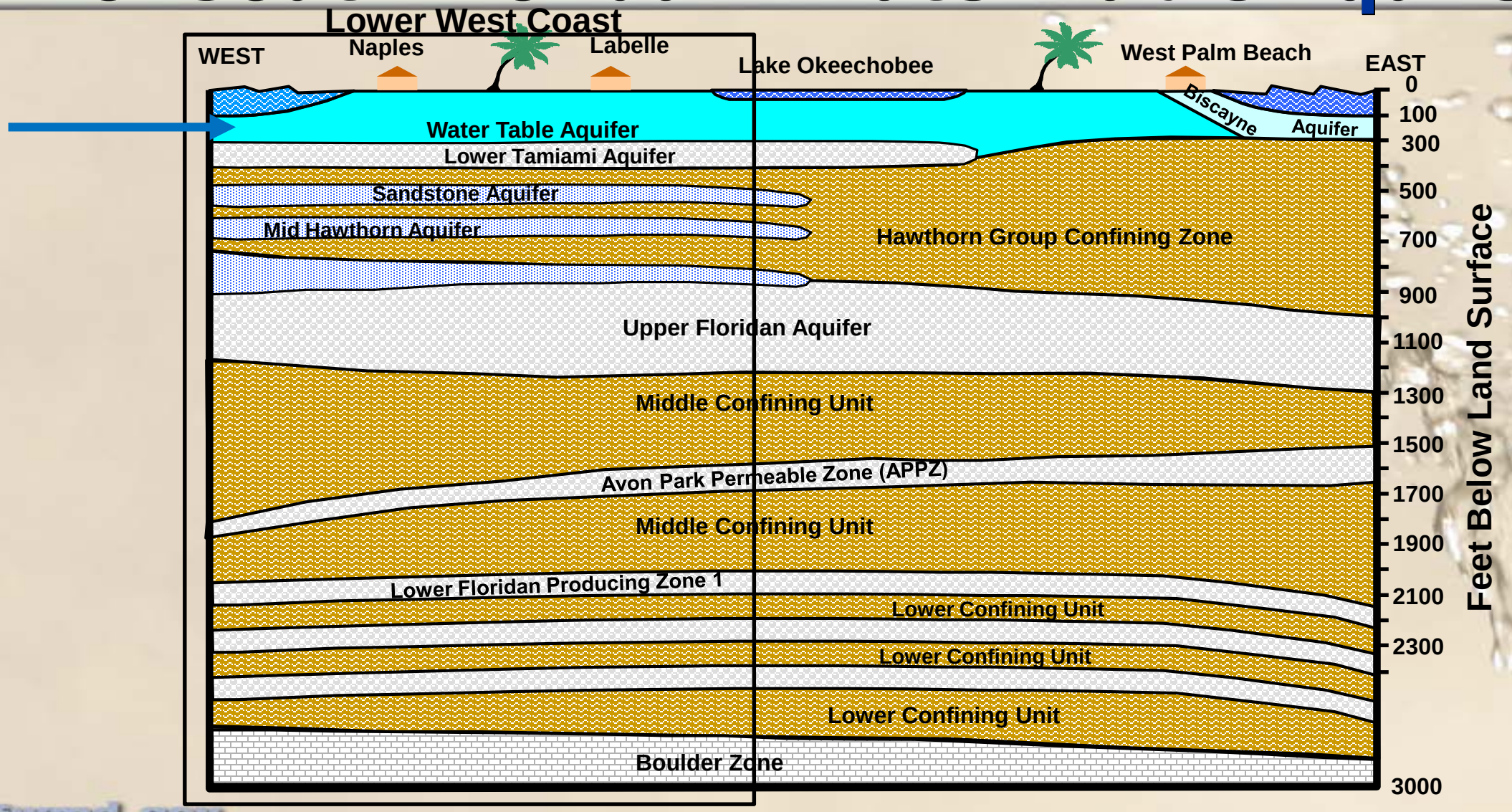
# Mapping Challenges

- Representing a three-dimensional system on a two-dimensional map
- Representing a dynamic interface with fixed-time snapshot
- Representing a diffuse front with a single line



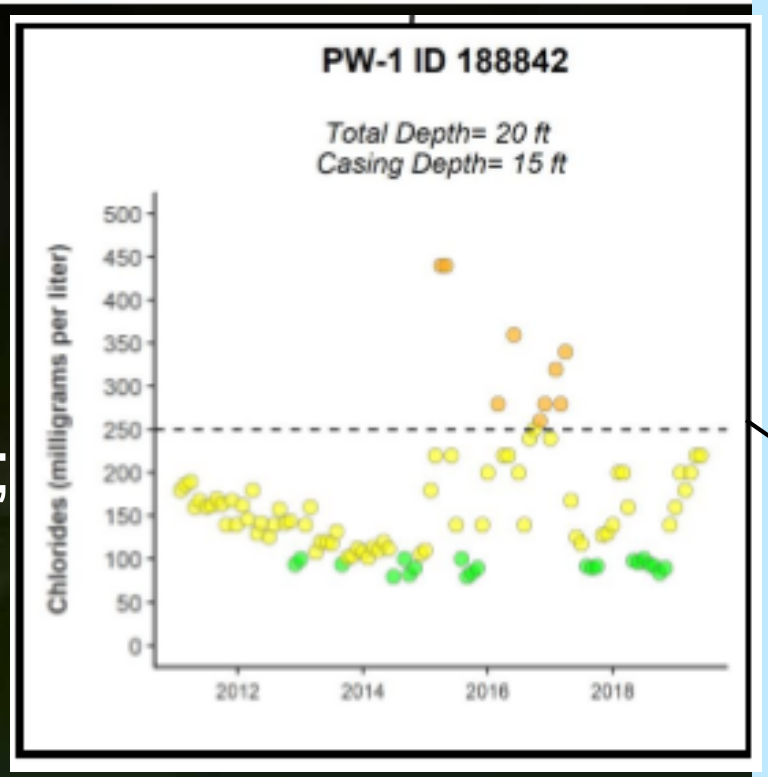

- Mapping from data that may represent one of several saltwater intrusion pathways
- Some wells used in 2009 and 2014 not available in 2019 (e.g., wells abandoned, destroyed, no longer required to be monitored, etc.)

# Generalized Hydrogeology of South Florida – Water Table Aquifer



# Results: Water Table Aquifer

- DRAFT (only minor tweaks anticipated, if any)
- Relatively stable; slight change due to new well data



**Structures**
- Culvert
- Lock
- Pump
- Spillway
- Weir
- Roads

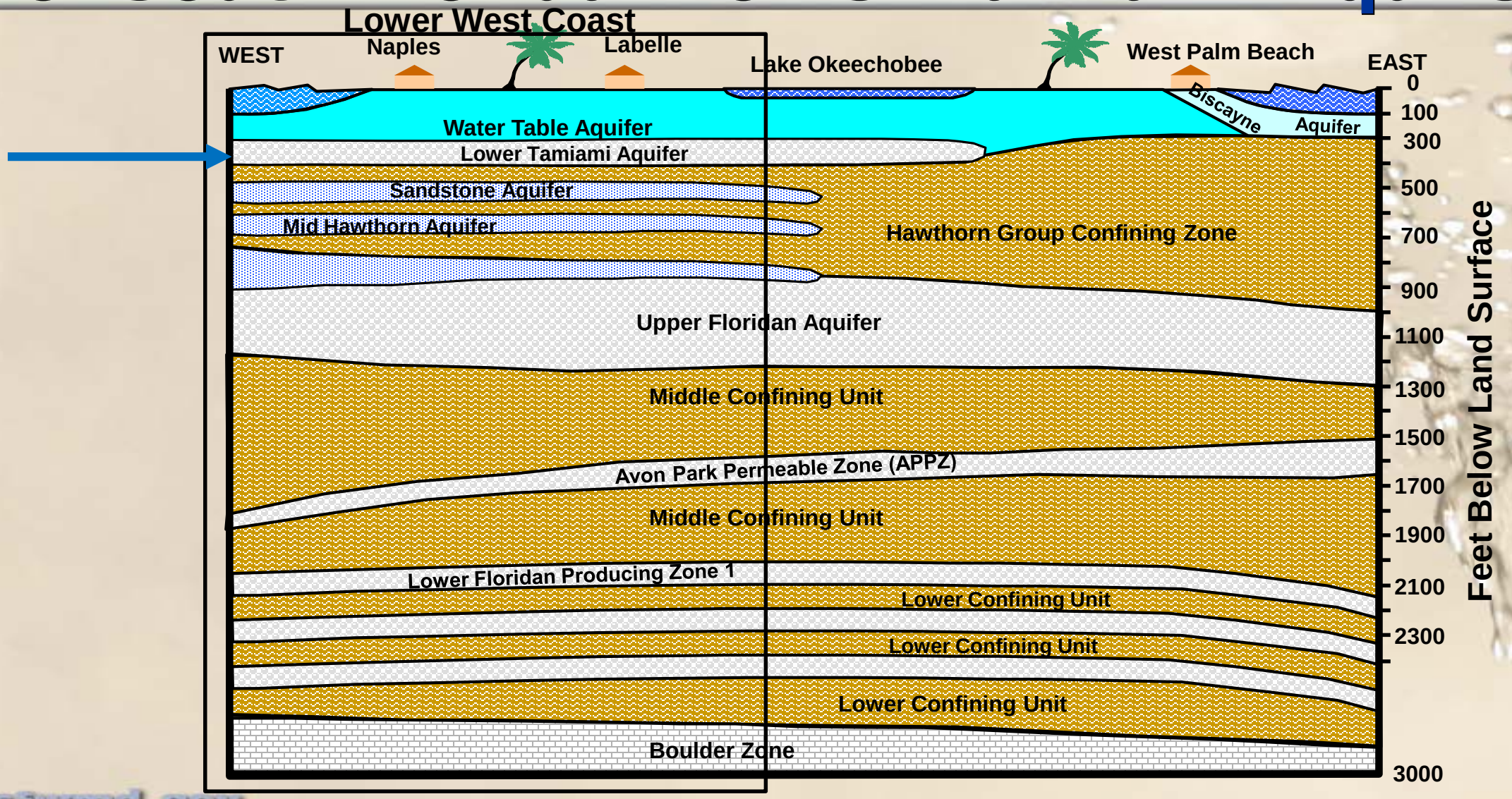
**Chloride Concentration**
- ≤ 100 mg/L
- 101 - 250 mg/L
- 251 - 1,000 mg/L
- > 1,000 mg/L

**Chloride Labels**
- 1 (135) — Map ID (Chloride)

**Saltwater Interface: Estimated 250 mg/L Isochlor**
- 2019
- 2014
- 2009

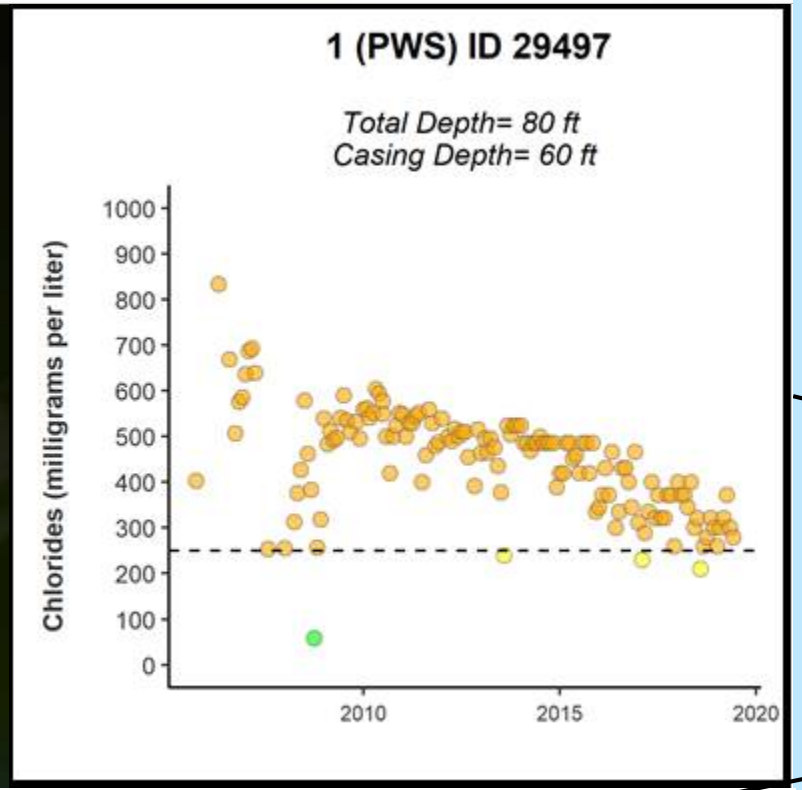
- Wellfields
- Freshwater Bodies
- Saline Water Bodies
- Mangrove & Saltwater Marshes

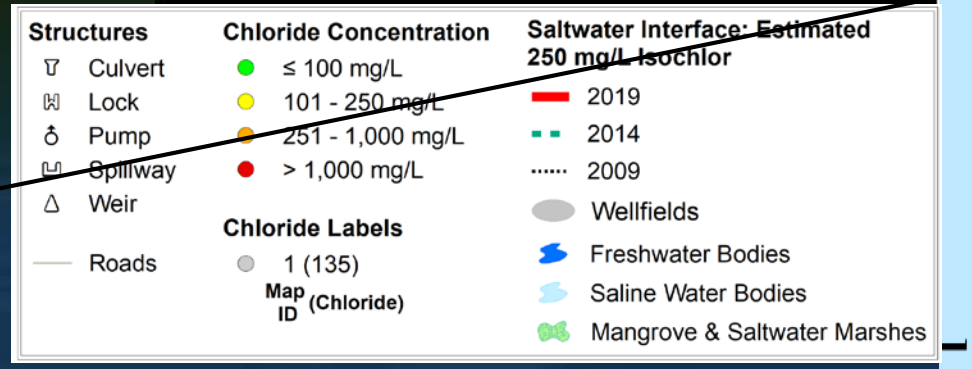
# Generalized Hydrogeology of South Florida- Lower Tamiami Aquifer

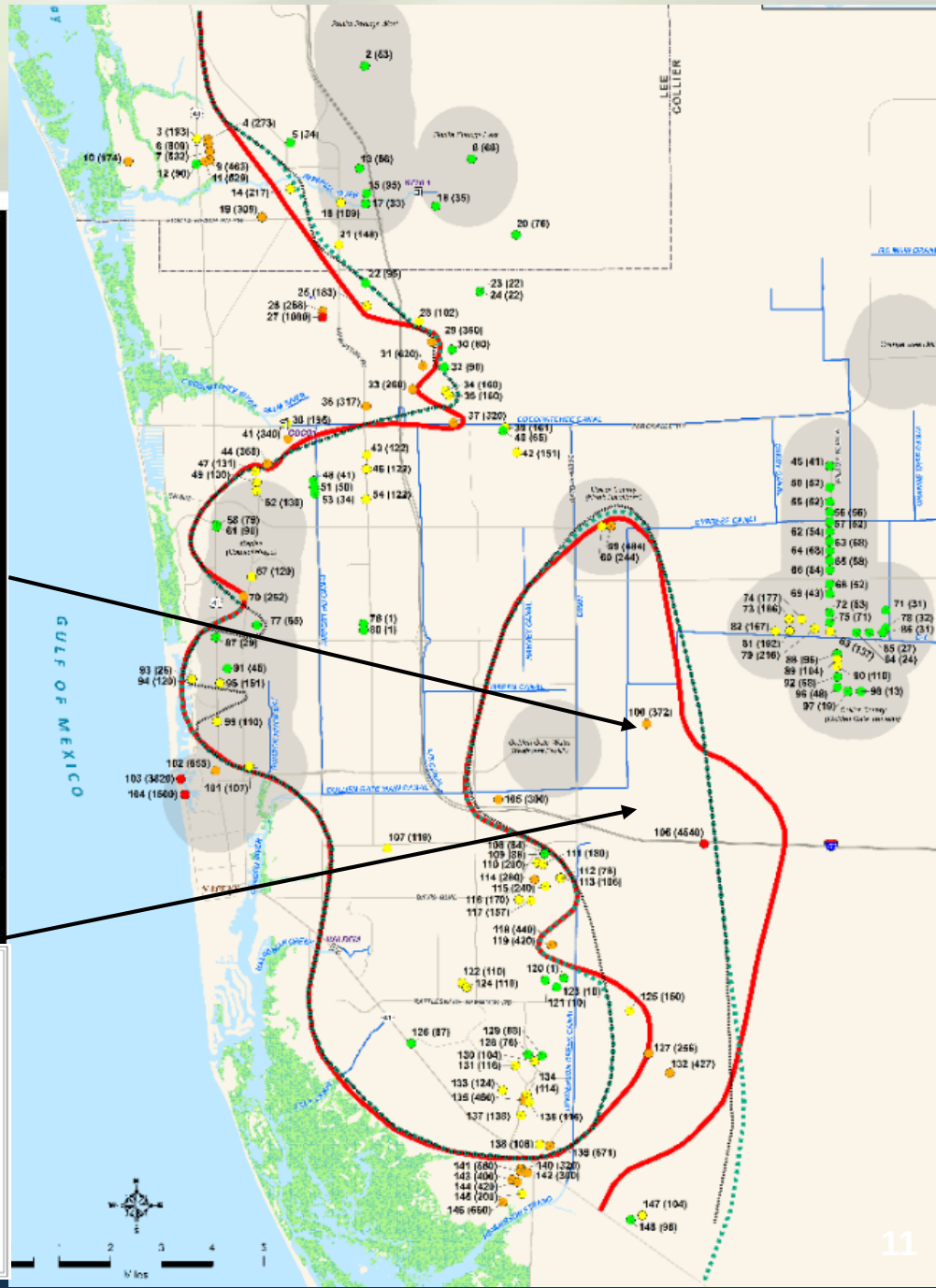


# Results: Lower Tamiami Aquifer

- Relatively stable near Naples Coastal Ridge wellfield
- Interface retreated in Bonita Springs and northern Collier County
- Movement in southern Collier County
- Relict (ancient) seawater

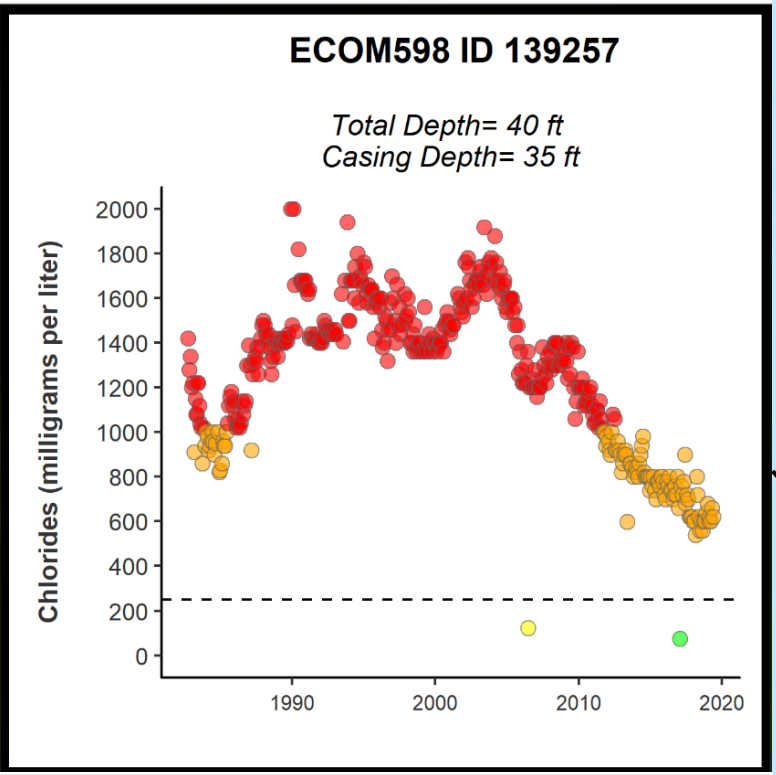


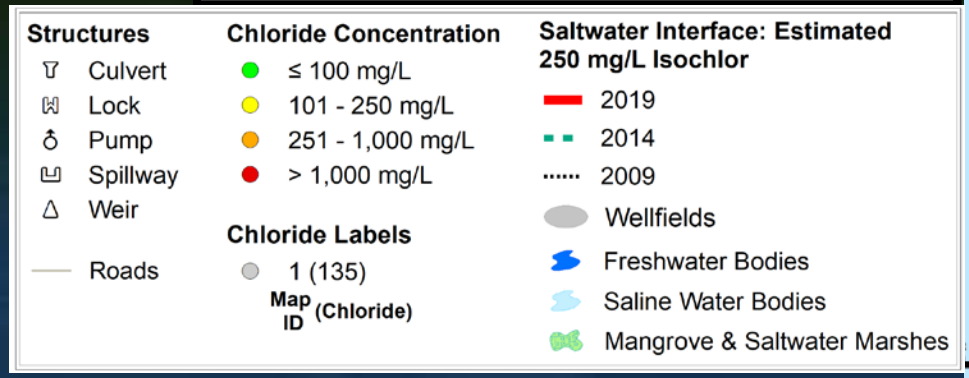



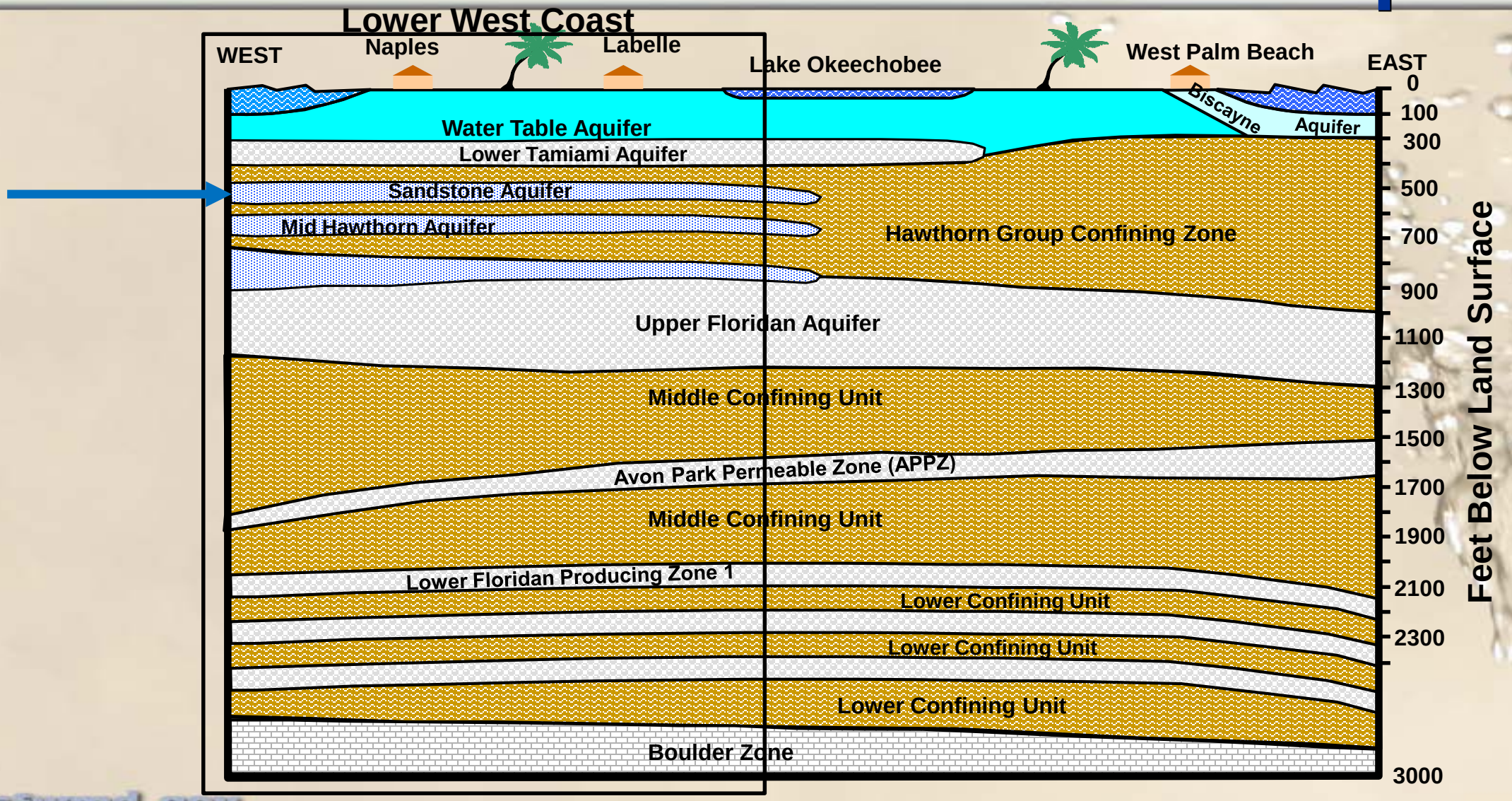
# Results: Lower Tamiami Aquifer (cont'd)

- Eagle Creek Country Club Monitor Well
- Sea-level rise?



# Generalized Hydrogeology of South Florida – Sandstone Aquifer



# Results: Sandstone Aquifer

- Relatively stable interface
- Investigating new lobe near Lehigh Acres
- New data point, new withdrawal, or both?

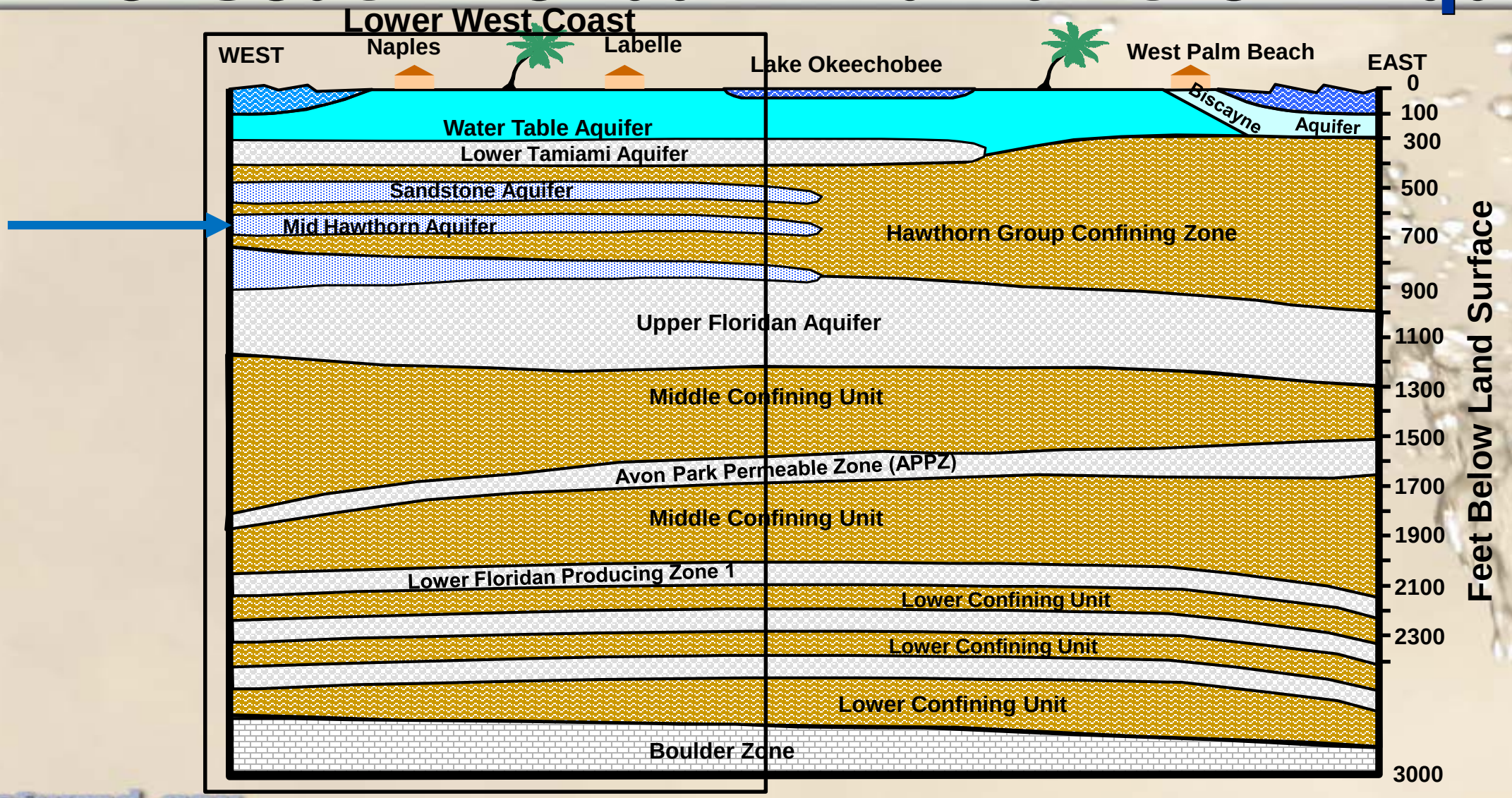
**Structures**
- Culvert
- Lock
- Pump
- Spillway
- Weir
- Roads

**Chloride Concentration**
- ≤ 100 mg/L
- 101 - 250 mg/L
- 251 - 1,000 mg/L
- > 1,000 mg/L

**Chloride Labels**
- 1 (135)
  Map ID (Chloride)

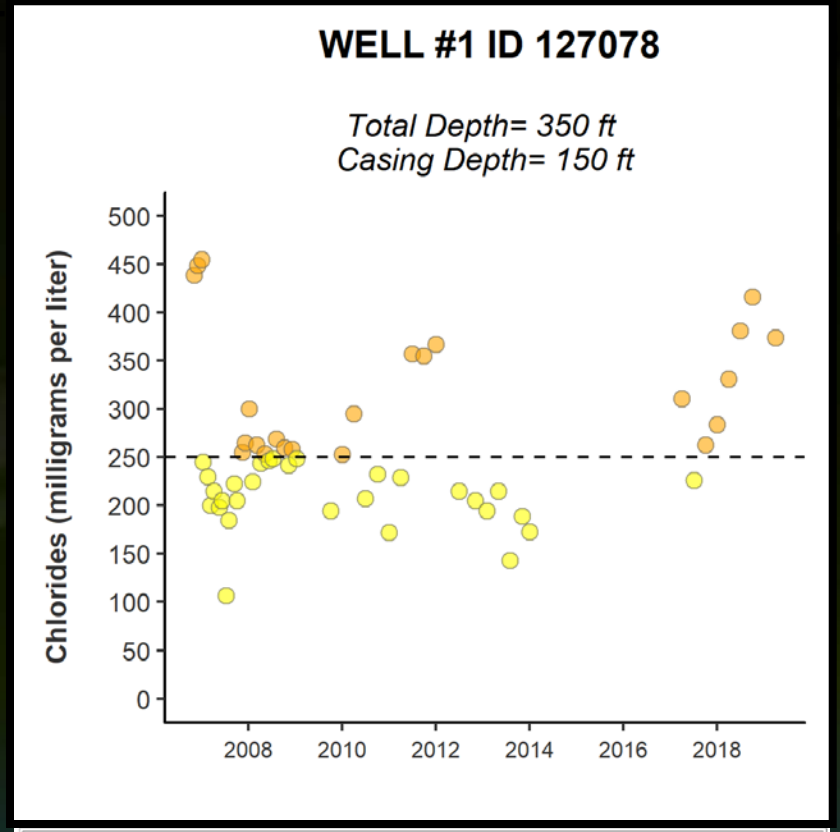
**Saltwater Interface: Estimated 250 mg/L Isochlor**
- 2019
- 2014
- 2009
- Wellfields
- Freshwater Bodies
- Saline Water Bodies
- Mangrove & Saltwater Marshes

# Generalized Hydrogeology of South Florida – Mid Hawthorn Aquifer



# Results: Mid Hawthorn Aquifer

- Slight retreat of interface
- Investigating new lobe near Fort Myers
- New data point, new withdrawal, or both?




**Structures**
- Culvert
- Lock
- Pump
- Spillway
- Weir
- Roads

**Chloride Concentration**
- ≤ 100 mg/L
- 101 - 250 mg/L
- 251 - 1,000 mg/L
- > 1,000 mg/L

**Chloride Labels**
- 1 (135) — Map ID (Chloride)

**Saltwater Interface: Estimated 250 mg/L Isochlor**
- 2019
- 2014
- 2009

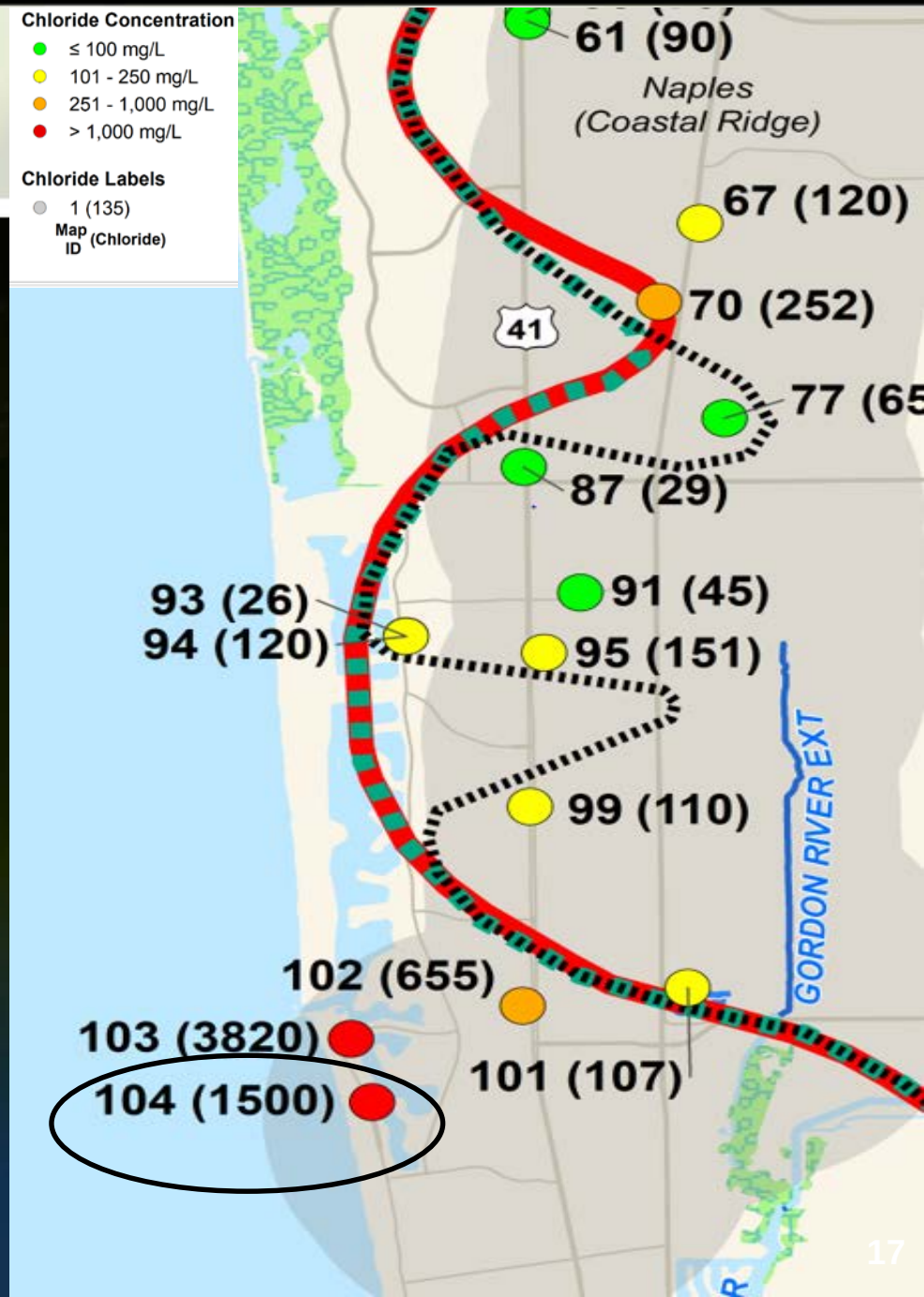
- Wellfields
- Freshwater Bodies
- Saline Water Bodies
- Mangrove & Saltwater Marshes

# Saltwater Intrusion – Then and Now

- C-525 (Map Number 104); Screened Interval 63 to 83 feet below land surface [ft bls]), Lower Tamiami aquifer

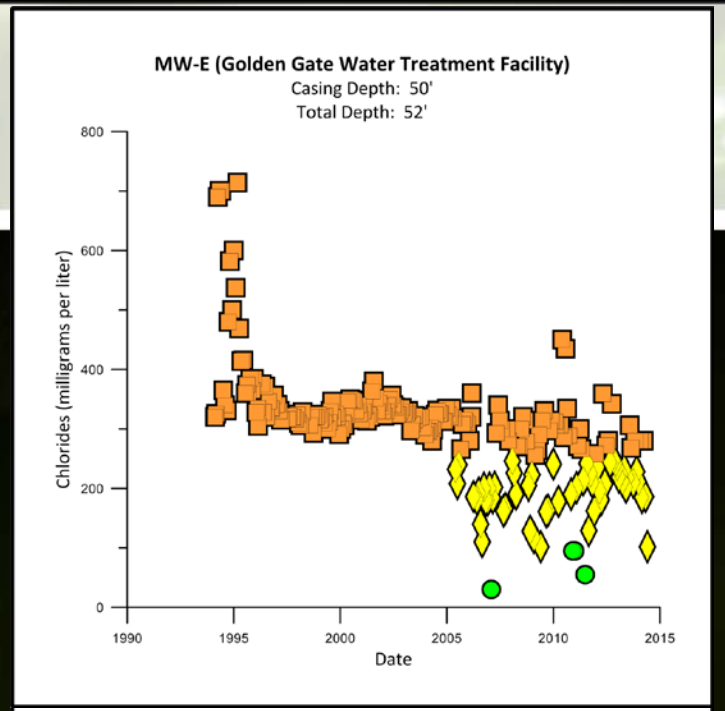
- Chloride Concentrations:
  - 1986 (140 milligrams per liter [mg/L])
  - 2009 (1,120 mg/L)
  - 2014 (1,400 mg/L)
  - 2019 (1,500 mg/L)

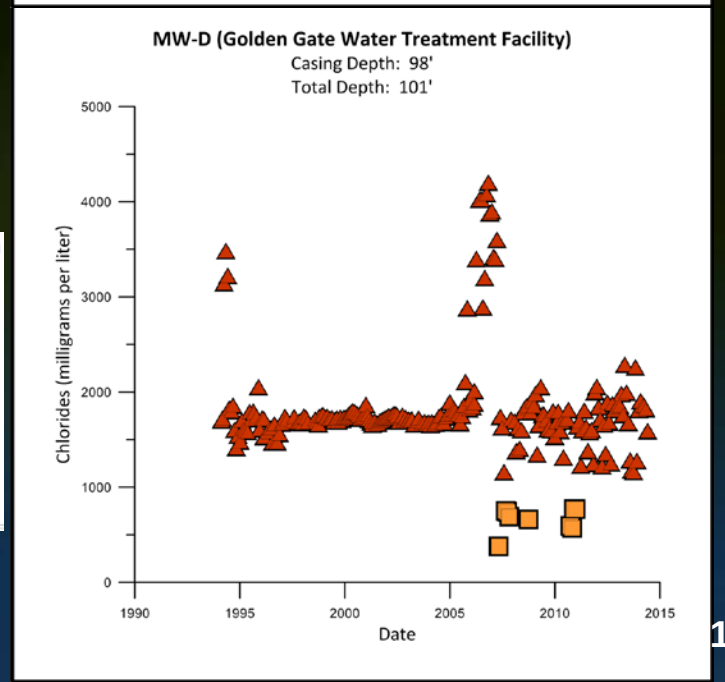
- Possible Explanation -- City of Naples:
  - shifts pumpage to inland wellfields during dry season
  - Increased use of reclaimed water reduces groundwater withdrawals and raises water levels

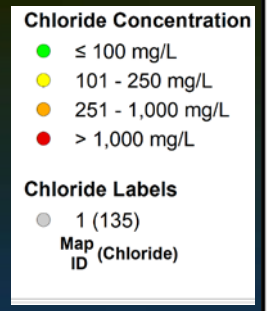


# Upconing of saltwater from below….

- Golden Gate Water Treatment Facility
- Monitor Wells – Lower Tamiami aquifer
- E (50 to 52 ft bls; Chloride = 189 mg/L)
- D (98 to 101 ft bls; Chloride = 1,755 mg/L)
- Demonstrates importance of monitoring (horizontal and vertical) and wellfield management to prevent upconing
- ft bls = feet below land surface
- mg/L = milligrams per liter



# Conclusions

- Water Table Aquifer – Relatively stable; some change due to new well data
- Lower Tamiami Aquifer – Interface retreated in northern Lee and southern Collier counties; advanced in southern Collier County
- Interface is dynamic – advanced and retreated, depending on rainfall, wellfield pumpage, reclaimed water use, sea-level rise (?), etc.
- Saltwater intrusion is occurring, emphasizing the importance of continued monitoring (laterally and vertically) and wellfield management
- Additional, localized monitoring may be required at select wellfields by permittees to protect water supplies

# Next Steps

- Finalize maps
- Work with local governments, permittees, and others to:
  - Identify other existing wells to increase mapping accuracy for future maps
  - Identify funding to facilitate well replacement as needed
  - Evaluate need and identify funding for new wells (critical data gaps or areas of concern)

# SFWMD Staff Acknowledgements

Jonathan Shaw, P.G.,
Principal Hydrogeologist

Alexandra Hoffart,
Geospatial Scientist II

Manuel Zamorano,
Senior Scientist

# Questions and Discussion