



# **Saltwater Intrusion and Potential Effects on Water Supply in South Florida**

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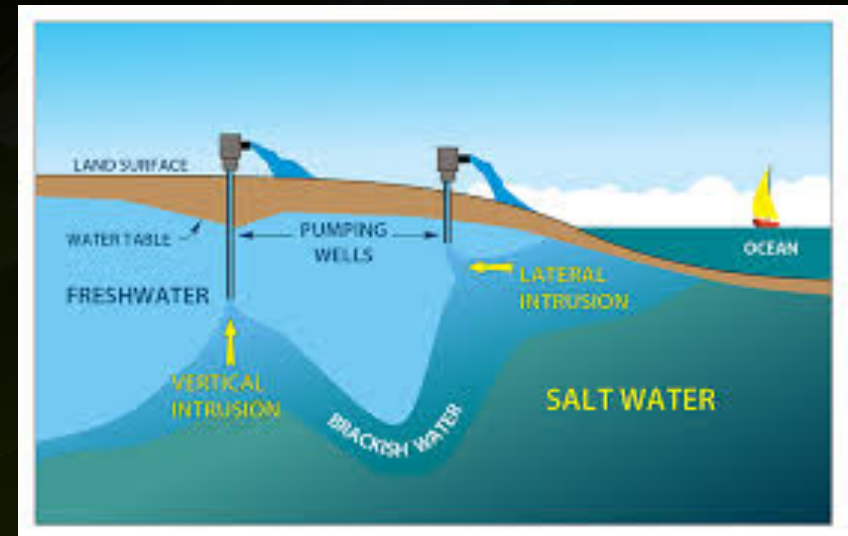
[sfwmd.gov](http://sfwmd.gov)

# Agenda

- **Overview of Saltwater Intrusion and Aquifers**
- **Why Is This Important?**
- **Engineering and Operations**
- **SFWMD Saltwater Interface Mapping Approach**
- **Results – 2009 vs. 2014**
- **Conclusions**
- **What Can We Do?**
- **Next Steps for Mapping Update**

# Common Sources of Saltwater Intrusion

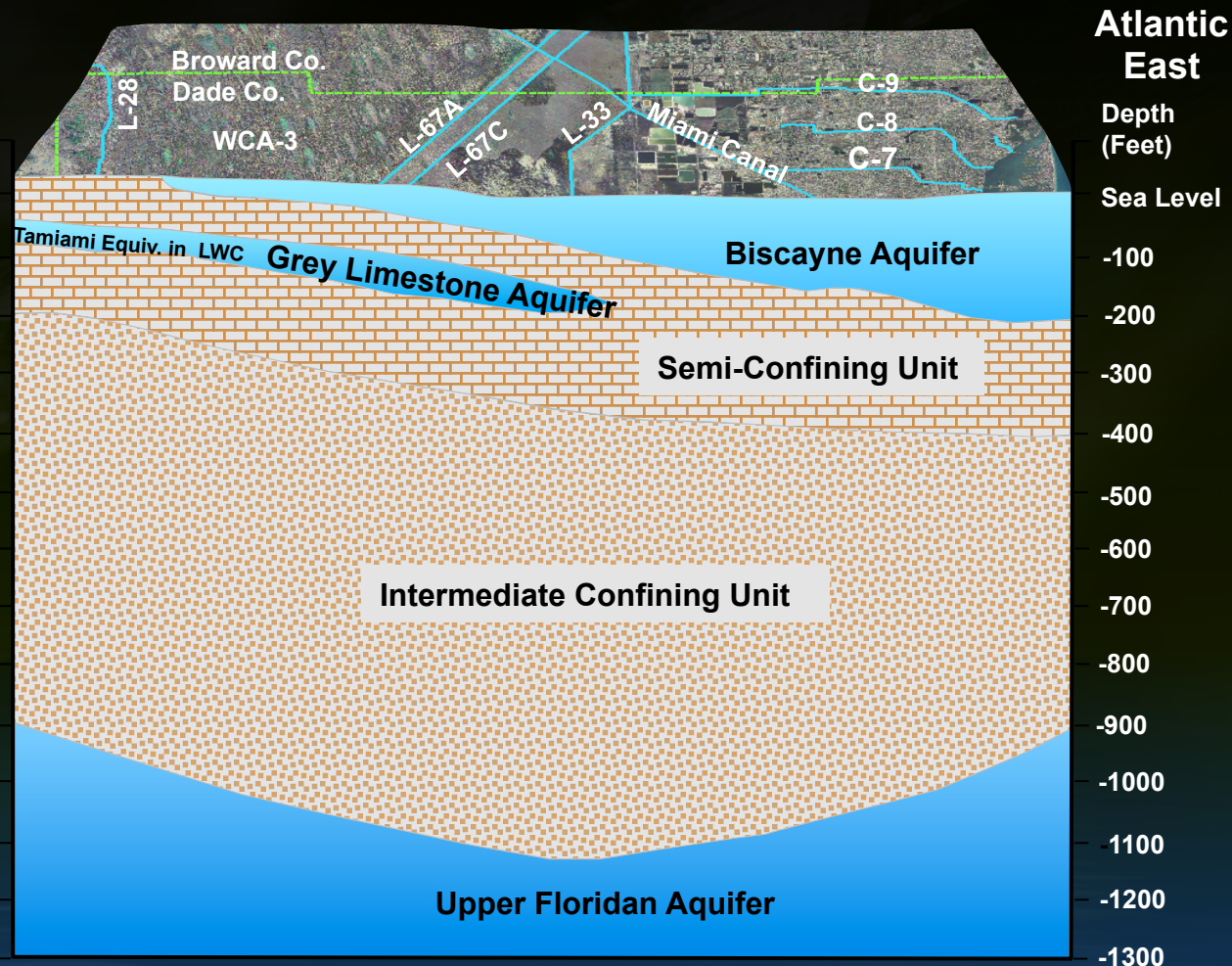
- Lateral intrusion from the coast
- Vertical intrusion (upconing) from saltwater below
- Surface Infiltration -- estuaries, boat basins, saltwater marshes, saltwater canals, etc.
- Ancient (relict) seawater trapped in low permeability aquifers





# Biscayne Aquifer – Our Freshwater Supply Source

- One of the most prolific aquifers in the world
- Calcareous sandstone or limestone with numerous solution cavities
- Thickest along coast, thins westward towards the Everglades
- Recharged by canals and local rainfall





# Why is this Important?

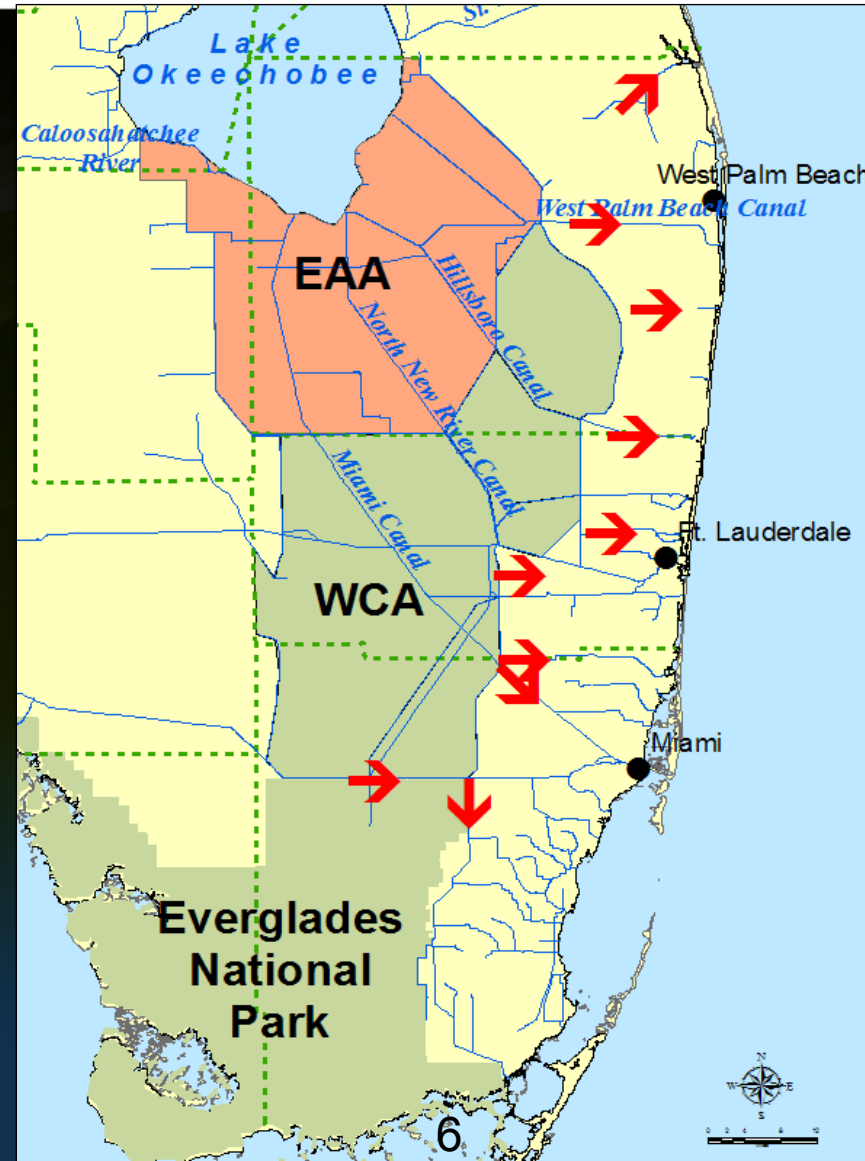


- **Wellfields are a major water supply source – protect investment**
- **Once saltwater enters wells, very difficult – if not impossible -- to reverse**
- **Very expensive to relocate wellfields and associated infrastructure (pipelines, treatment plants and processes, etc.)**
- **Other sources of water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

# Water Deliveries to Lower East Coast Urban Areas

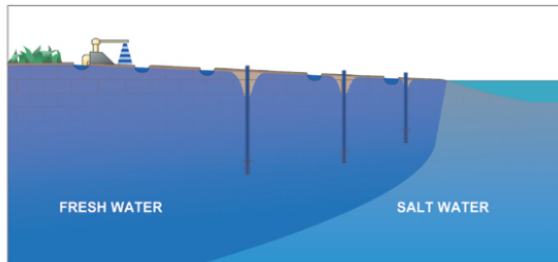
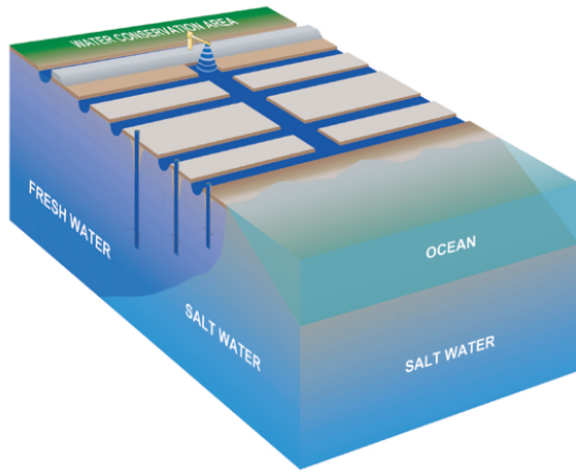
Water deliveries maintain groundwater levels and recharge wellfields

- Lake Okeechobee
- Water Conservation Areas
- SFWMD Canals
- Local/secondary Canals
- Average Delivery Rates (500 to 600 mgd)

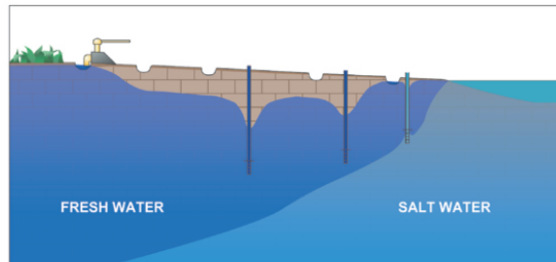
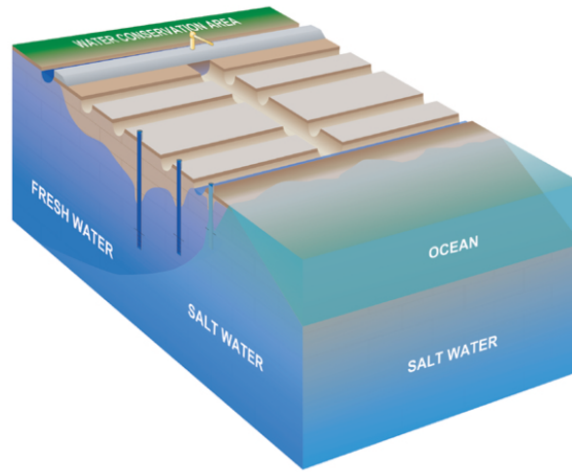


# Regional Water Deliveries

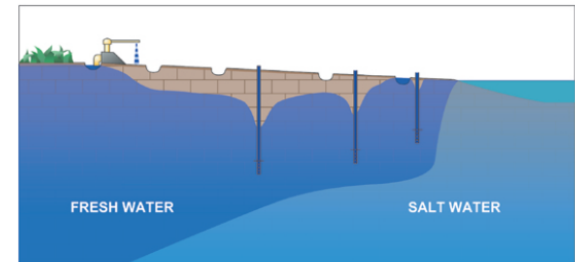
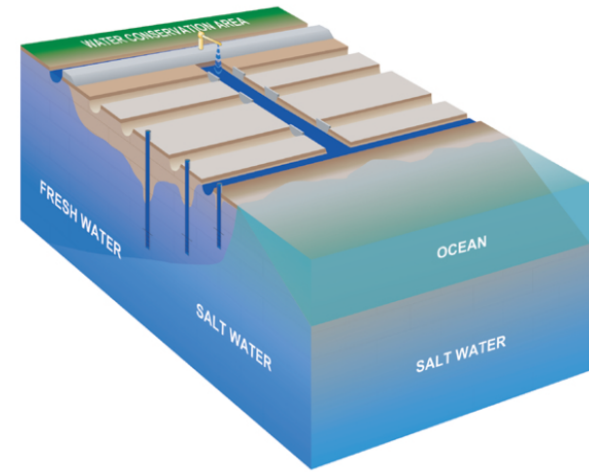
## NORMAL WATER DELIVERY



## NO WATER DELIVERY



## STRATEGIC WATER DELIVERY





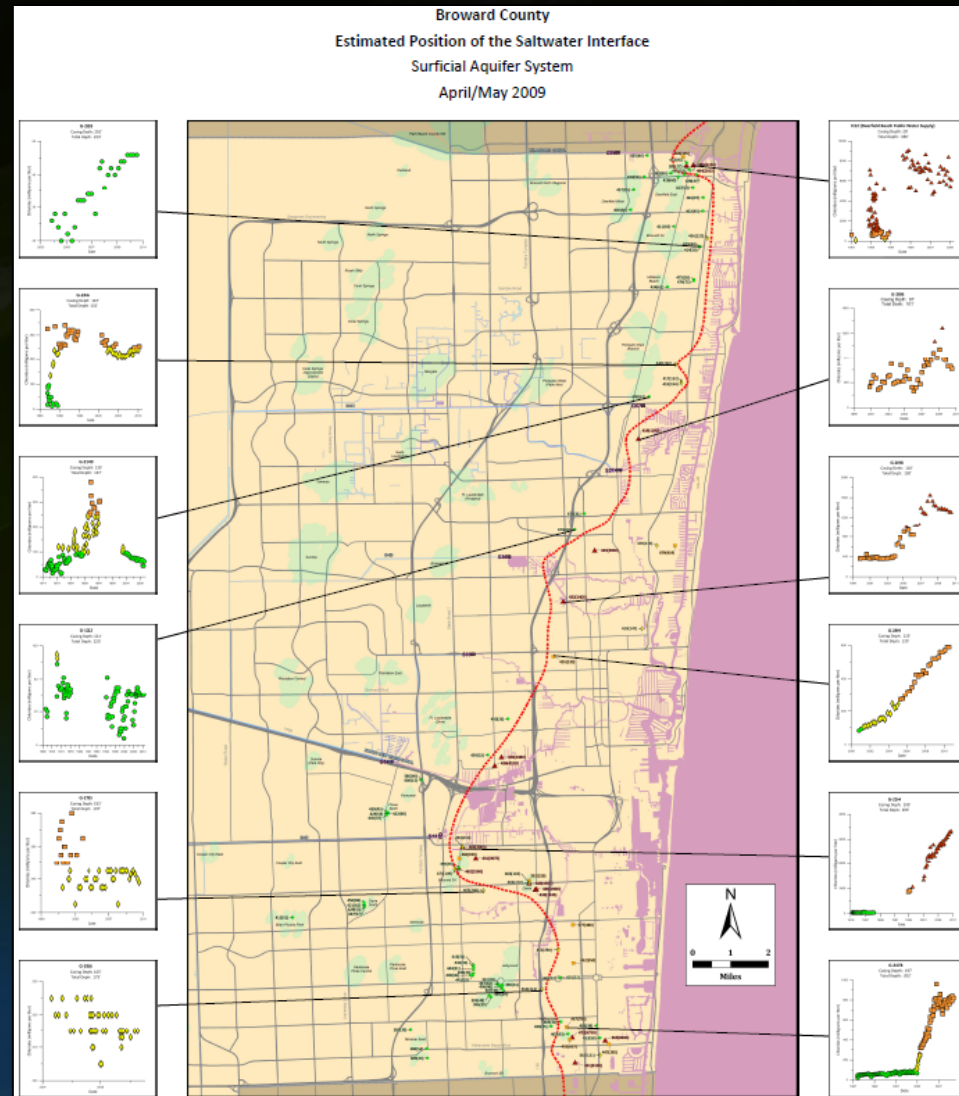
# What factors affect the position of the salt water interface?

- ▶ **Surface Water Control Structures**
  - ▶ Maintain canal stages to prevent inland saltwater movement
  - ▶ Help maintain groundwater levels to minimize inland movement of saltwater in aquifer
- ▶ **Public Water Supply Wellfields**
  - ▶ Well Locations
  - ▶ Well Depths
  - ▶ Pumping Rates
  - ▶ Proximity to Saltwater
  - ▶ Proximity to Canals (Recharge)



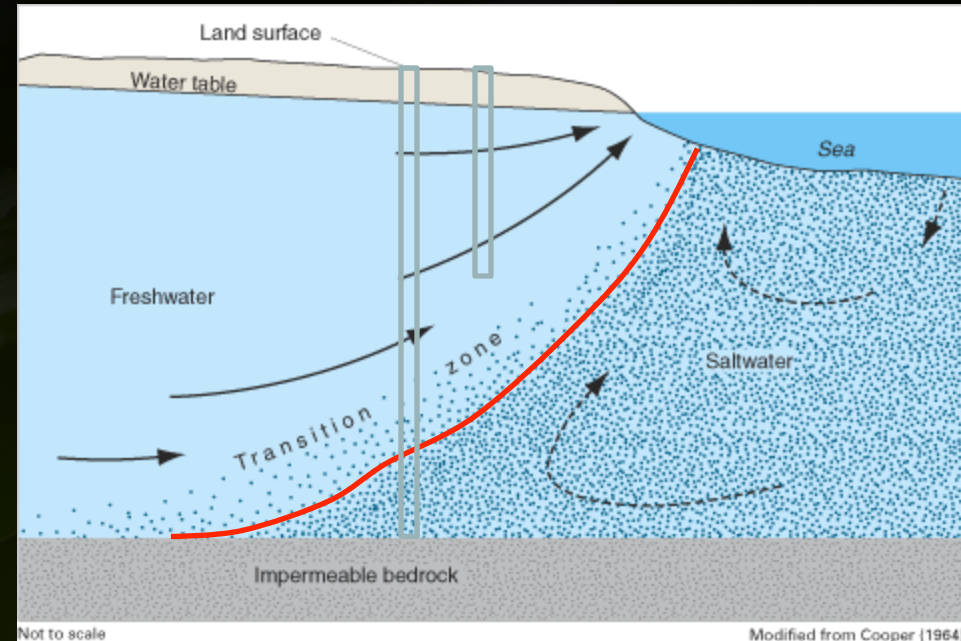
# SFWMD Saltwater Interface Mapping Project

- Strategy -- Compare maps (2009, 2014), note areas of concern, and adjust monitoring accordingly
- Update Maps Every 3 to 5 Years
- Use all available data (USGS, SFWMD, Counties, Water Use Permittees)
- Furthest Inland Extent – Dry Season
- 250 mg/L isochlor
- Graphs (Chlorides vs. time)



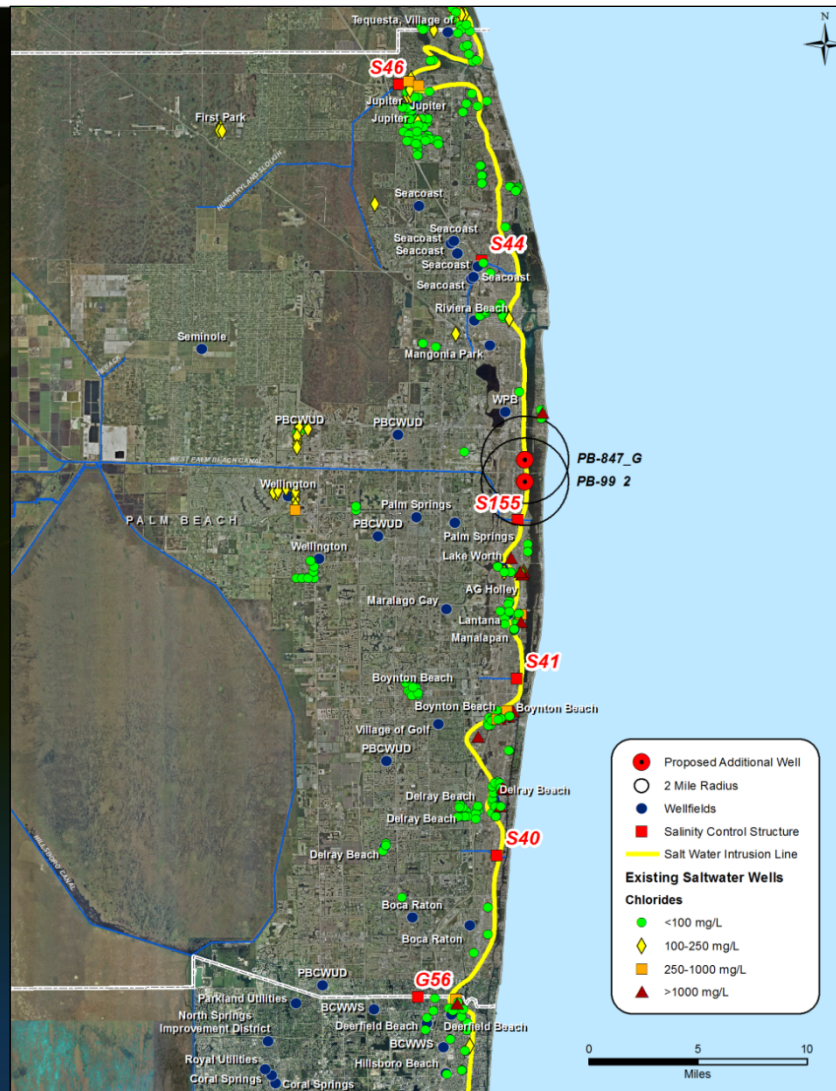
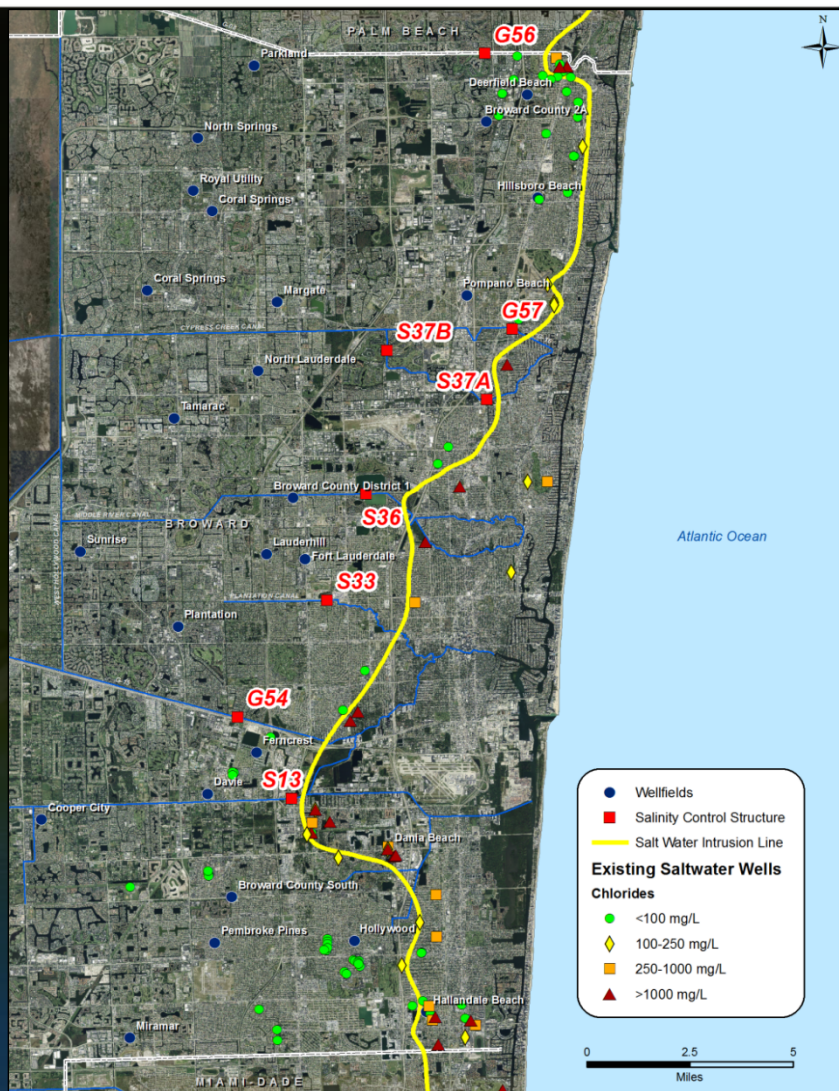
# Mapping Challenges

- Representing a three-dimensional feature on a two dimensional map
- Representing a dynamic interface with fixed-time snapshots
- 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 not available in 2014 (e.g., wells abandoned, no longer required to be monitored, etc.)



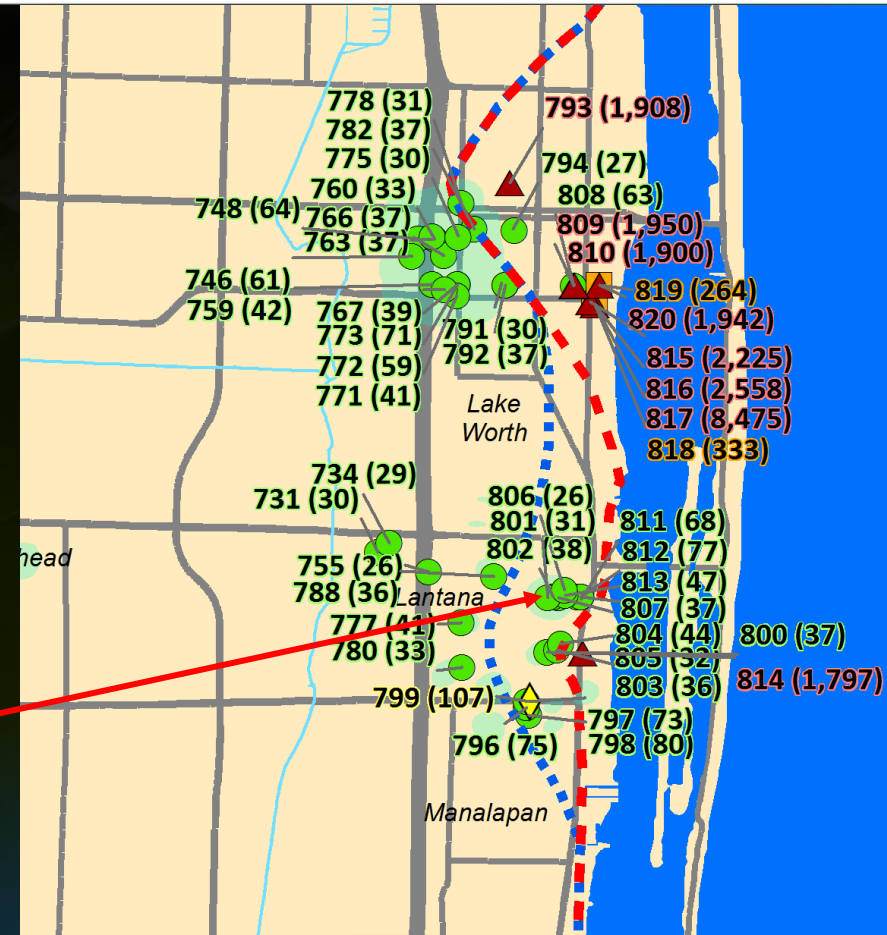
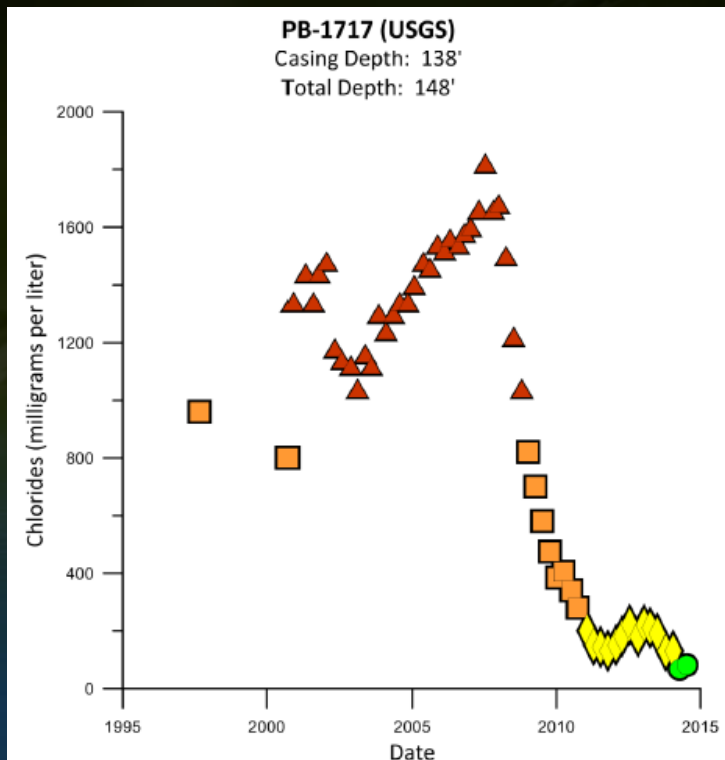


# Baseline Mapping (Broward and Palm Beach counties)



# Lantana/Lake Worth Area – 2009 vs. 2014

- Saltwater interface retreated towards the coast
- Reduced withdrawals from coastal wells



<b>Structures</b>	<b>PWS<sup>†</sup> Chlorides</b>	<b>Non-PWS<sup>†</sup> Chlorides</b>	<b>Wellfields in the Water Table Aquifer</b>
○ Culvert	● ≤100 mg/L	○ ≤100 mg/L	● Wellfields in Other Aquifers
□ Lock	◇ 101 - 250 mg/L	◇ 101 - 250 mg/L	■ Saline Water Bodies
⊕ Pump	■ 251 - 1,000 mg/L	■ 251 - 1,000 mg/L	■ Freshwater Bodies
⊗ Spillway	▲ >1,000 mg/L	▲ >1,000 mg/L	■ Mangrove and Saltwater Marsh
▽ Weir			— Roads
	<b>Wells</b>		
	▲ 433 (3900)		
	Map Number (chloride)		

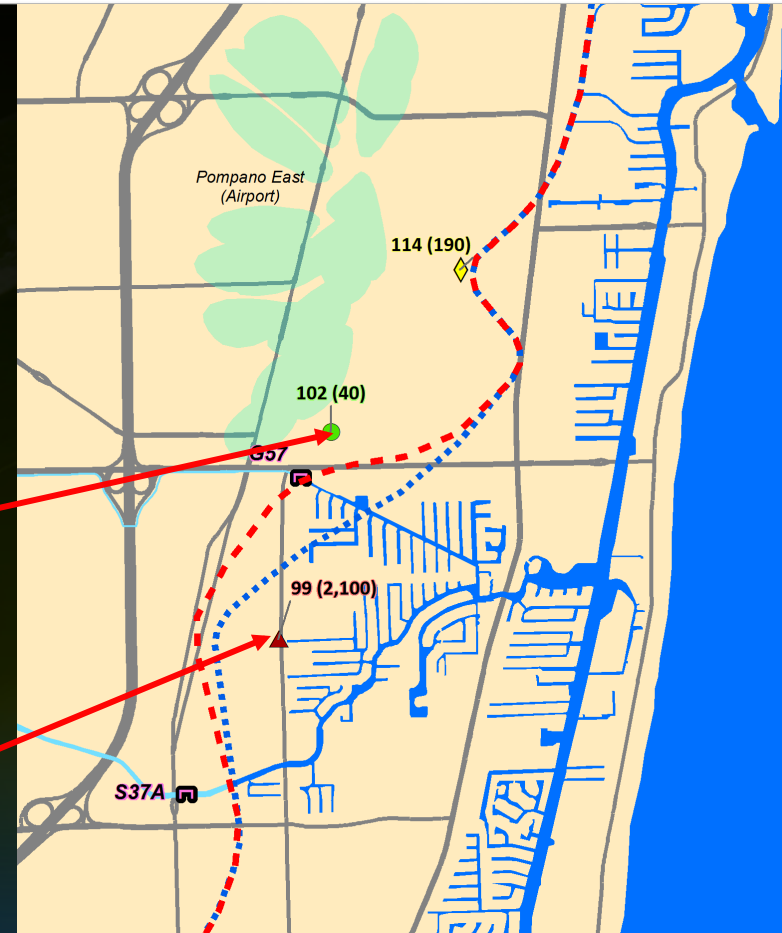
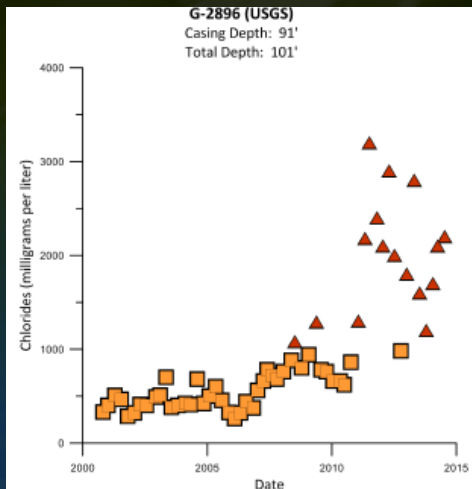
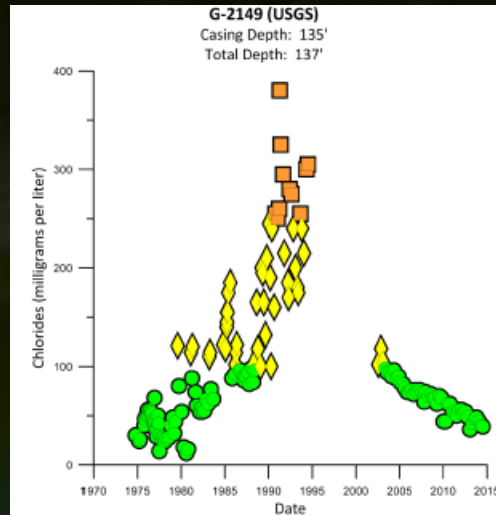
† PWS = Public Water Supply

●●● Estimated 250 mg/L isochlor, 2009 (updated)  
- - - Estimated 250 mg/L isochlor, 2014



# Pompano Beach/Fort Lauderdale Area, 2009 vs. 2014

- Seaward and landward interface movement observed – wellfield pumpage, saltwater canals and water control structures are major influences

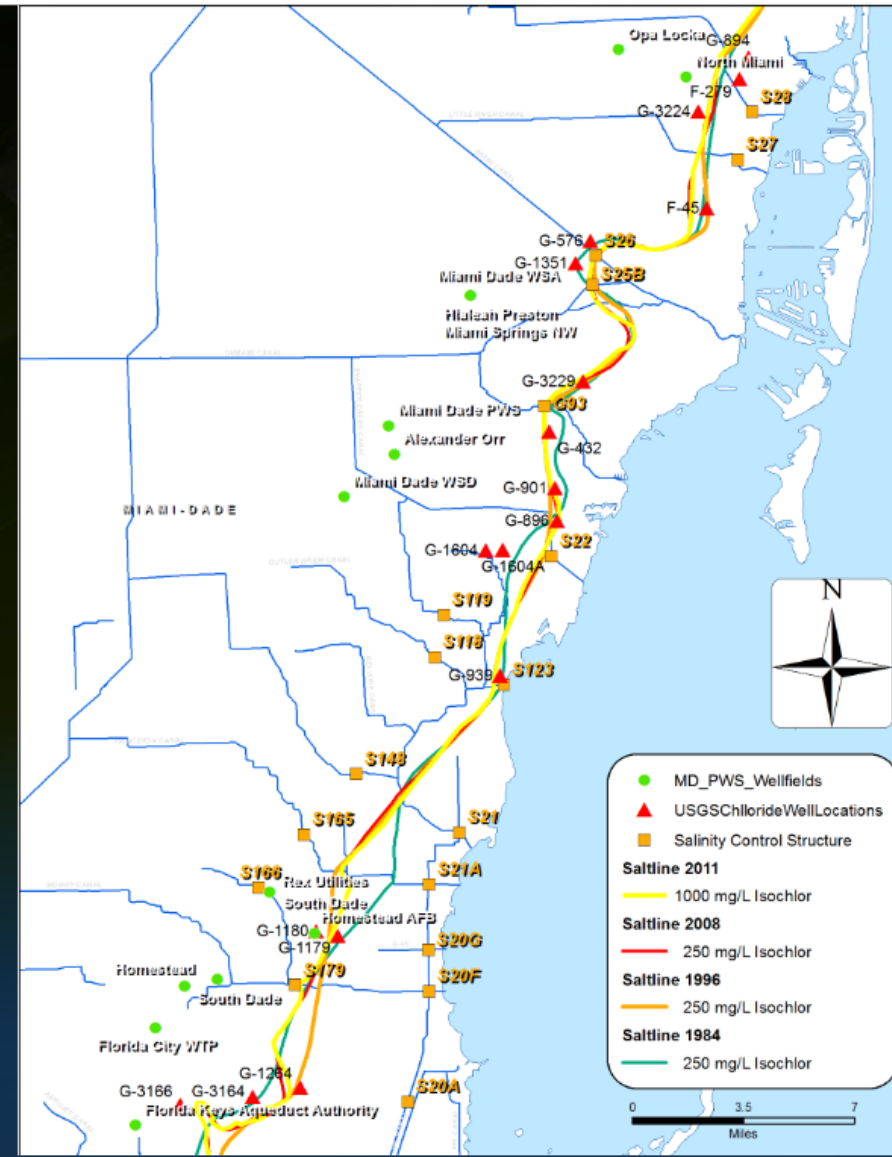


<b>Structures</b> ◊ Culvert □ Lock ⚙ Pump ⚡ Spillway ▽ Weir	<b>PWS† Chlorides</b> ● ≤100 mg/L ◊ 101 - 250 mg/L ◻ 251 - 1,000 mg/L ▲ >1,000 mg/L	<b>Non-PWS† Chlorides</b> ○ ≤100 mg/L ◇ 101 - 250 mg/L □ 251 - 1,000 mg/L ▲ >1,000 mg/L	● Wellfields in the Water Table Aquifer ○ Wellfields in Other Aquifers ■ Saline Water Bodies □ Freshwater Bodies ■ Mangrove and Saltwater Marsh — Roads
	<b>Wells</b> ▲ 433 (3900) Map Number (chloride)	† PWS = Public Water Supply ..... Estimated 250 mg/L isochlor, 2009 (updated) - - - Estimated 250 mg/L isochlor, 2014	



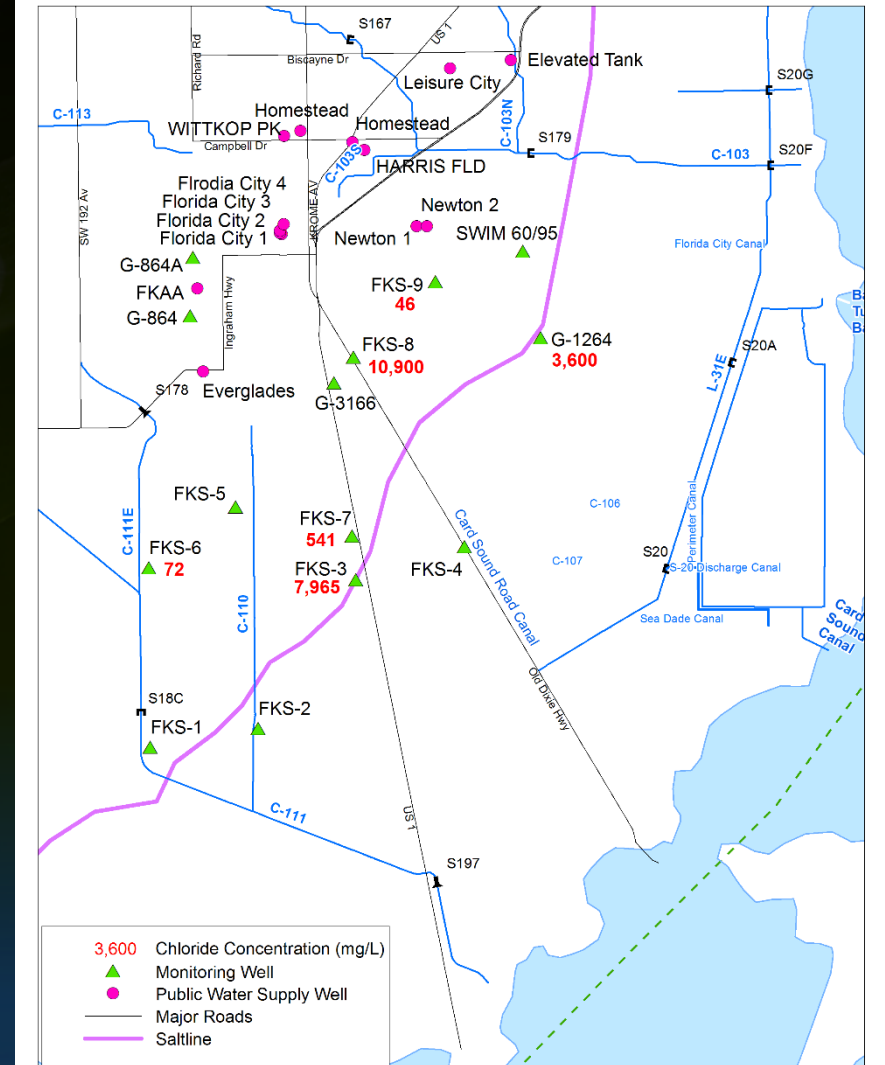
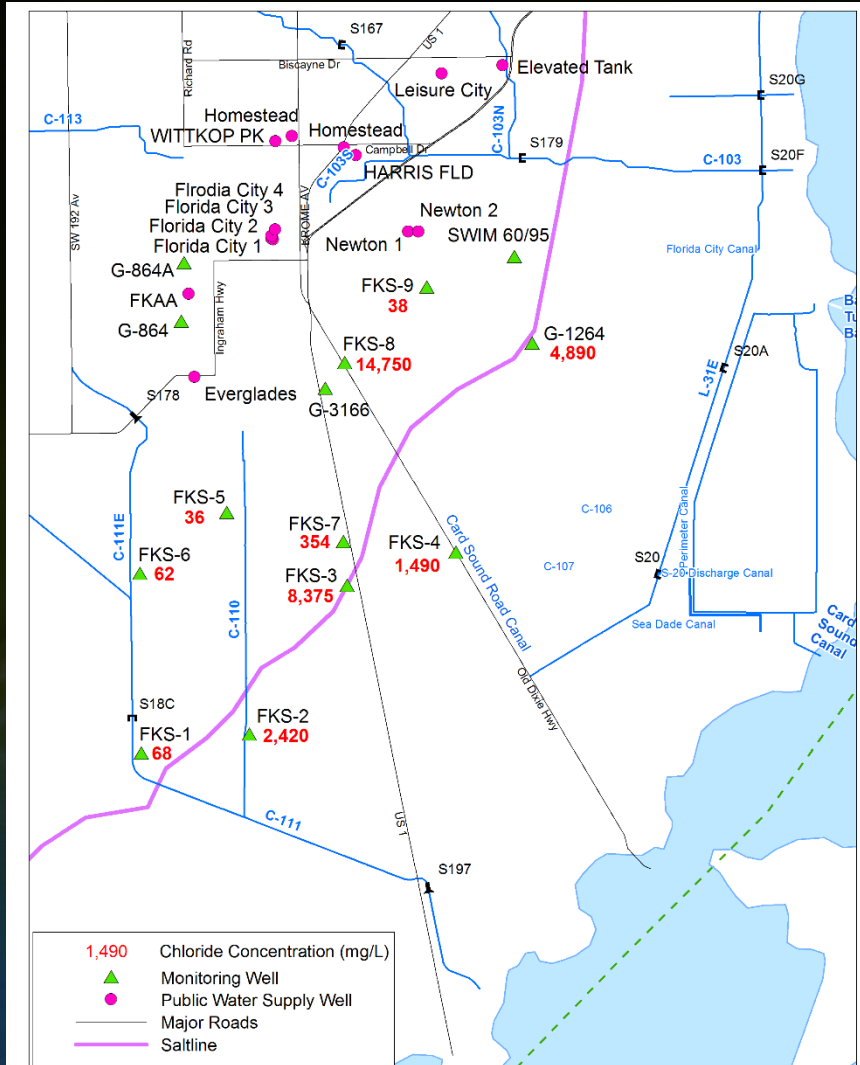
# Estimated Position of Saltwater Interface, Miami-Dade County – 1984 to 2011

- Miami- Dade County contracts directly with USGS to conduct its saltwater intrusion monitoring
- Composite interface positions displayed based on data from several USGS publications (1984, 1996, 2008, and 2011)
- 250 vs. 1,000 mg/L chlorides
- Furthest inland movement west of FPL Turkey Point Cooling Canal System (hypersaline plume) in southern Miami-Dade county



# Before and After, 2009 Water Shortage

May 4, 2009 June 8, 2009



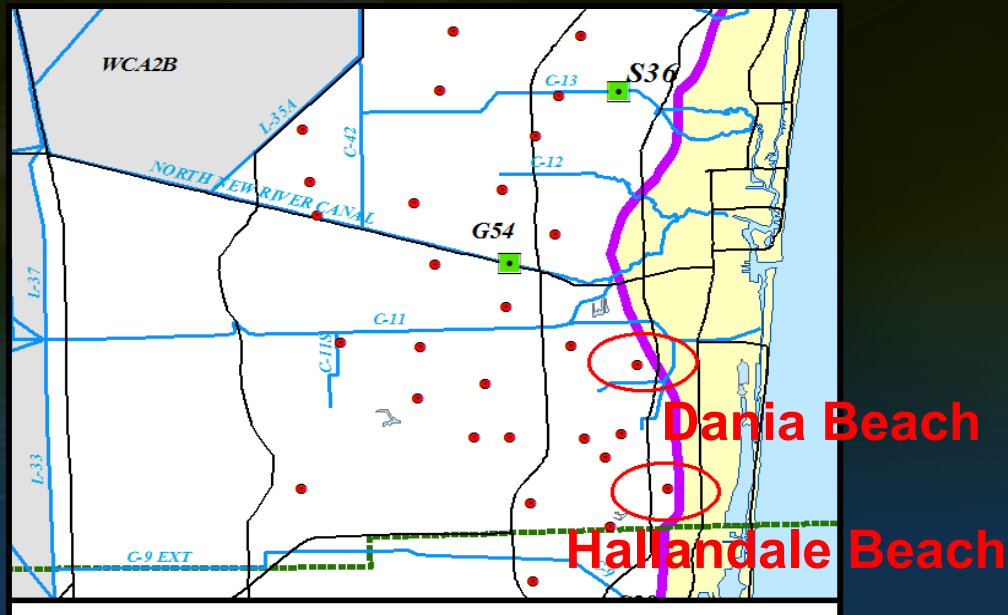
# What Can We Do?

- **Water conservation**
- **Reduce pumpage in coastal wellfields**
- **Prioritize withdrawals from western wellfields, provided they do not cause adverse effects on natural systems**
- **Increase groundwater recharge (canals, reclaimed water, etc.) to maintain and improve freshwater heads to counteract saltwater**
- **Use alternative water supplies (e.g., Floridan aquifer, reuse for irrigation, surface water storage [e.g., C-51 Reservoir], etc.) to reduce reliance on coastal wellfields**



# Utilities at Risk Dania Beach, Hallandale Beach

**Utilities at Risk -- Wellfields near saltwater interface but no western wellfields or Alternative Water Supply**



# Conclusions

- **Regional perspective – No major changes in saltwater interface position from 2009 to 2014**
- **Interface is dynamic – some inland and seaward movement observed**
- **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 to protect water supplies**

# Next Steps for Mapping Update

- **Continue coordination with other Water Management Districts and the Department of Environmental Protection**
- **Work with local governments and permittees to:**
  - **Identify wells from 2009 -- not available in 2014 – and secure their use for 2019 maps**
  - **Identify other existing or new wells to increase mapping accuracy for future maps**
  - **Evaluate need for increased monitoring**
- **Explore funding opportunities to further investigate saltwater intrusion in coastal areas of concern**



# Questions and Discussion



# FPL Turkey Point Power Plant

