BROWARD GROUNDWATER ELEVATION MAPS - PREDICTED CHANGES AND PLANNED UPDATES

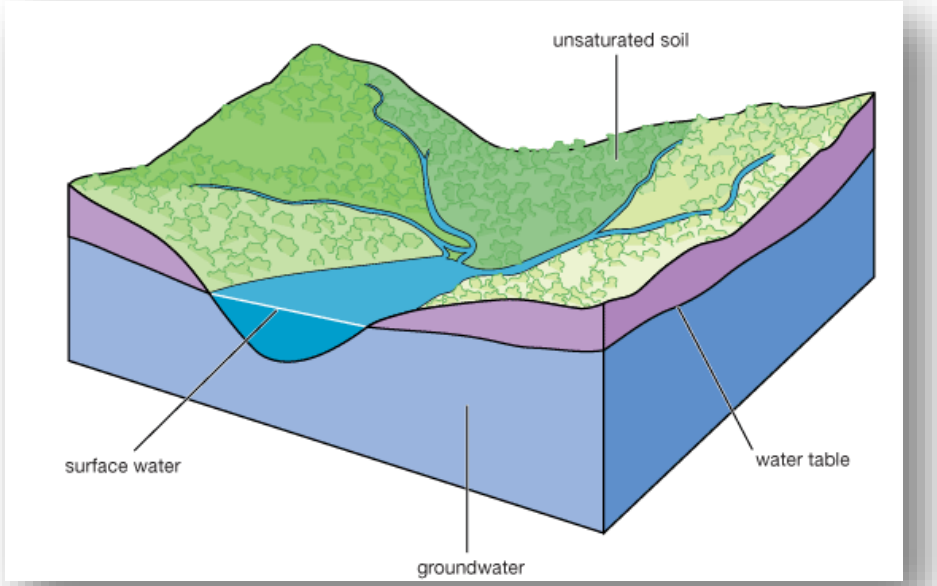
ENVIRONMENTAL PLANNING AND COMMUNITY RESILIENCY DIV.

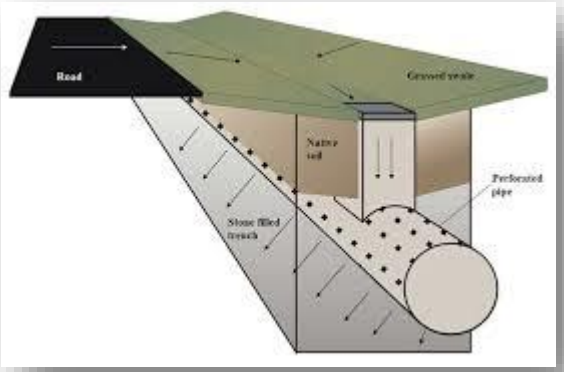
Overview

- Purpose/Application
- Current Maps
- Future Concerns
- Proposed Update Methodology
- Adoption Process
- Design Examples

Application

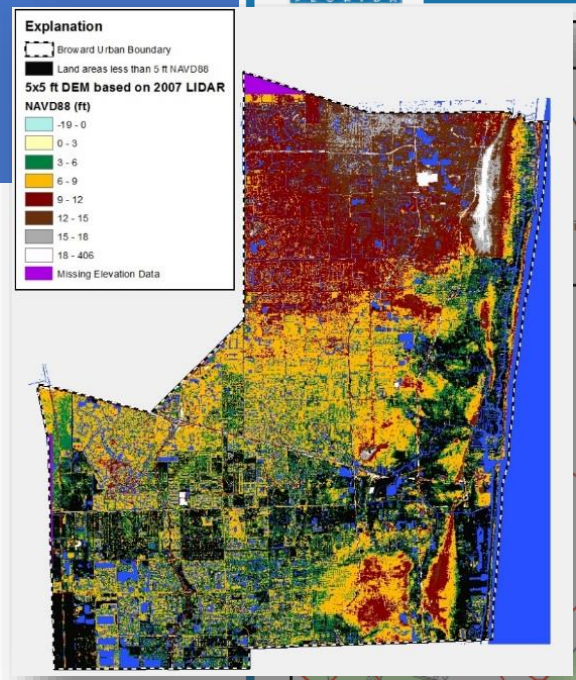
- Provides for proper design of stormwater management systems during permitting process.
- Impacts the need for correctly identifying wet or dry retention areas for proper functioning of system for on-site storage



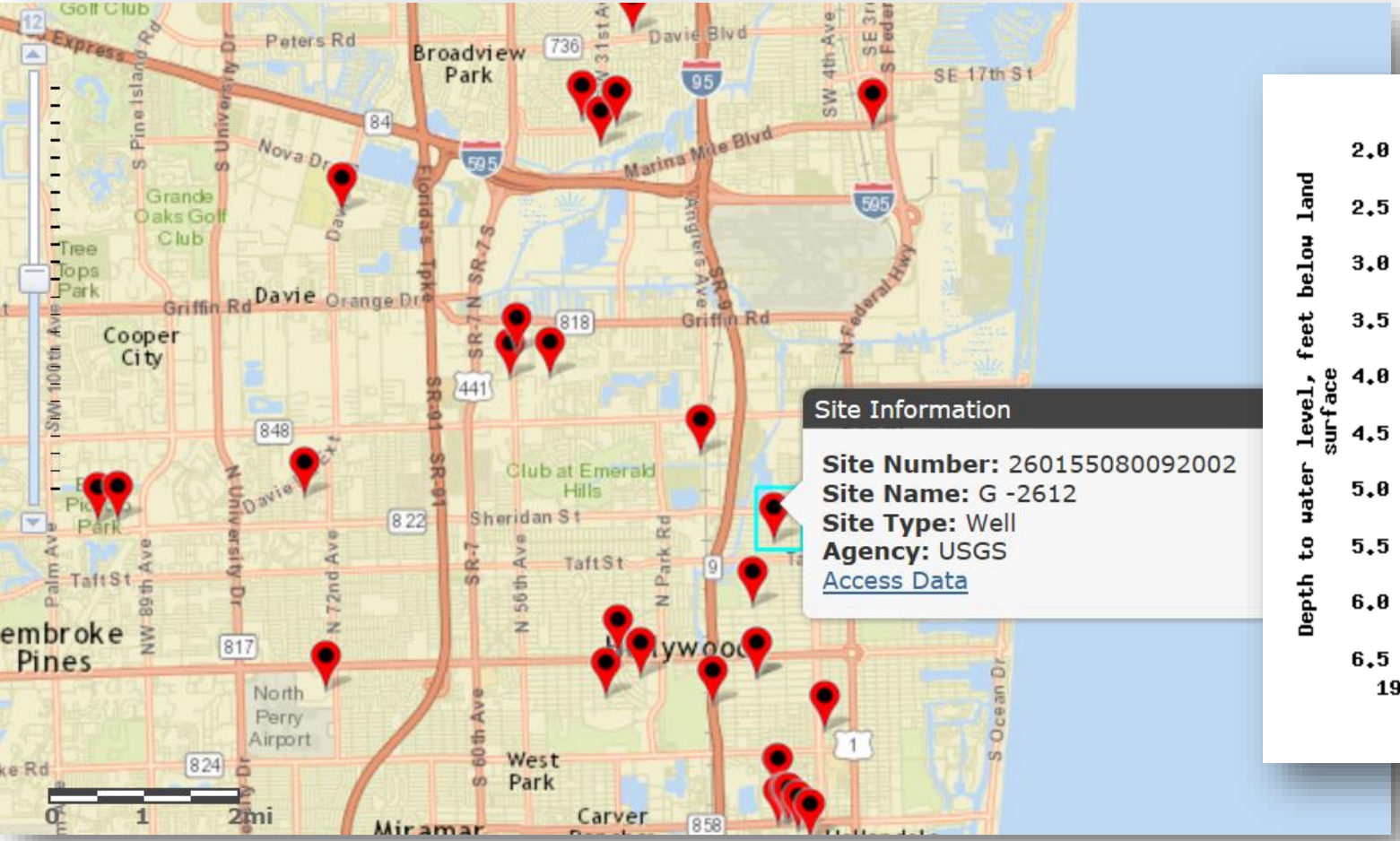


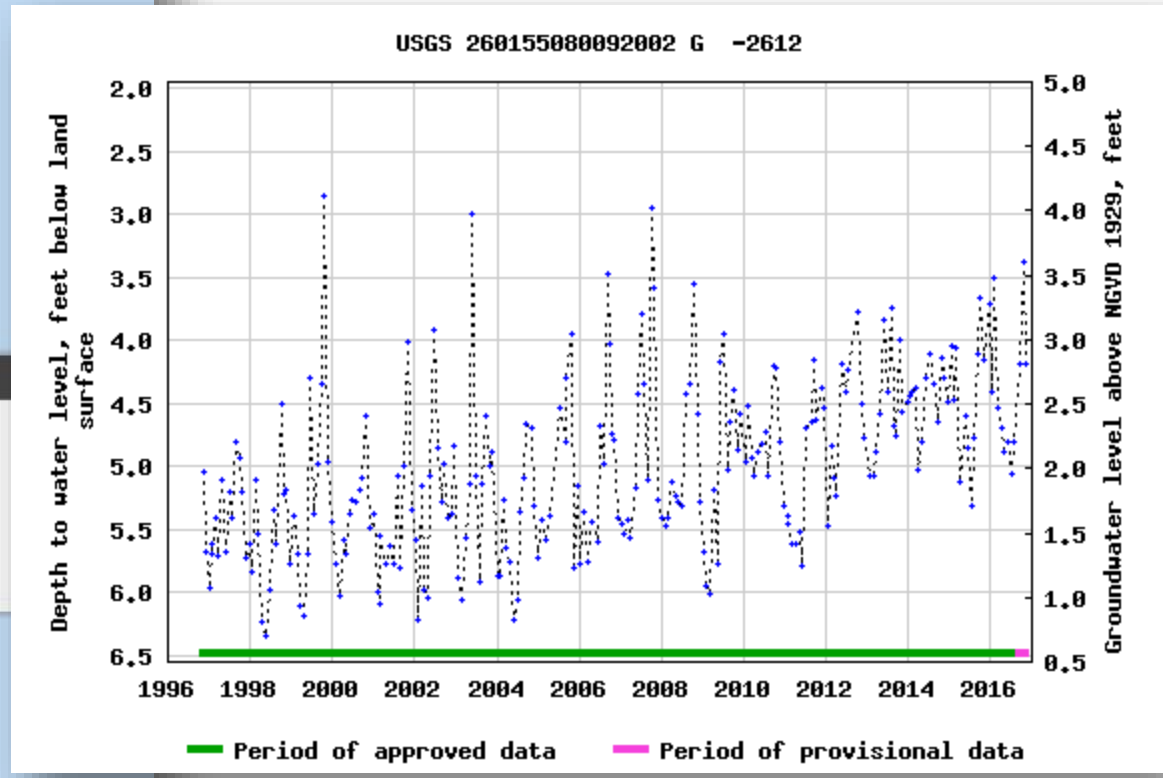
Current Maps

- Adopted in 2000
- Based on groundwater & surface water measurements
- Limited data (e.g., along coast line) requires use of site-specific measurements of GW
- Changes in hydrology have occurred, necessitating update



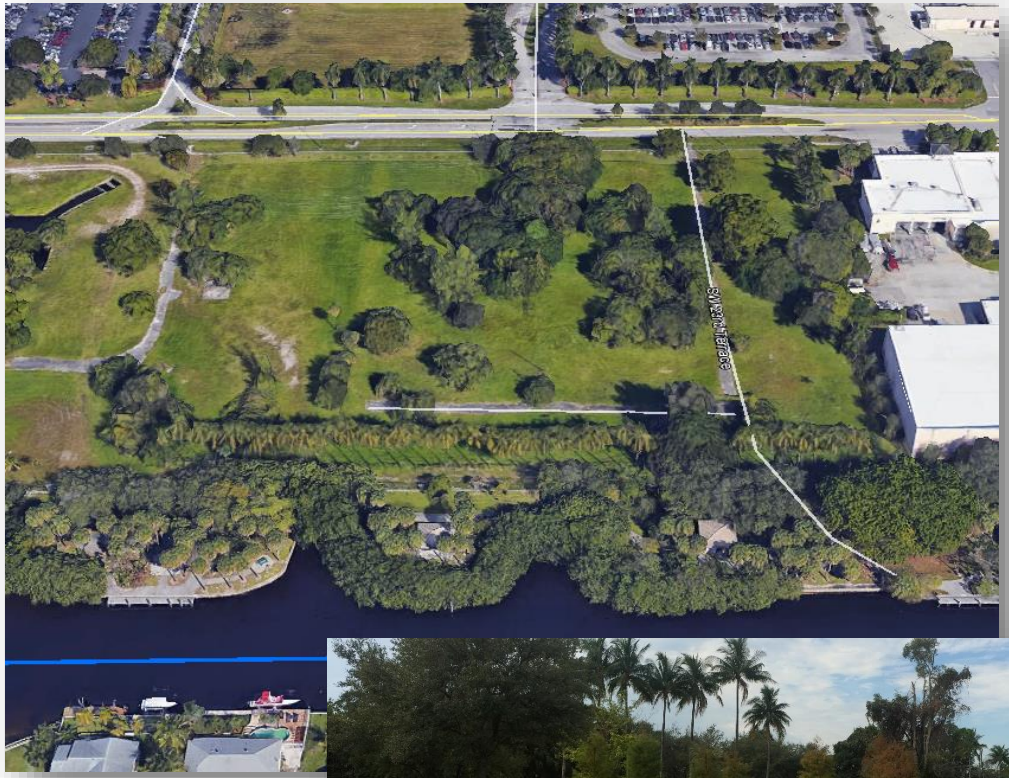
Rising Historic Groundwater Levels





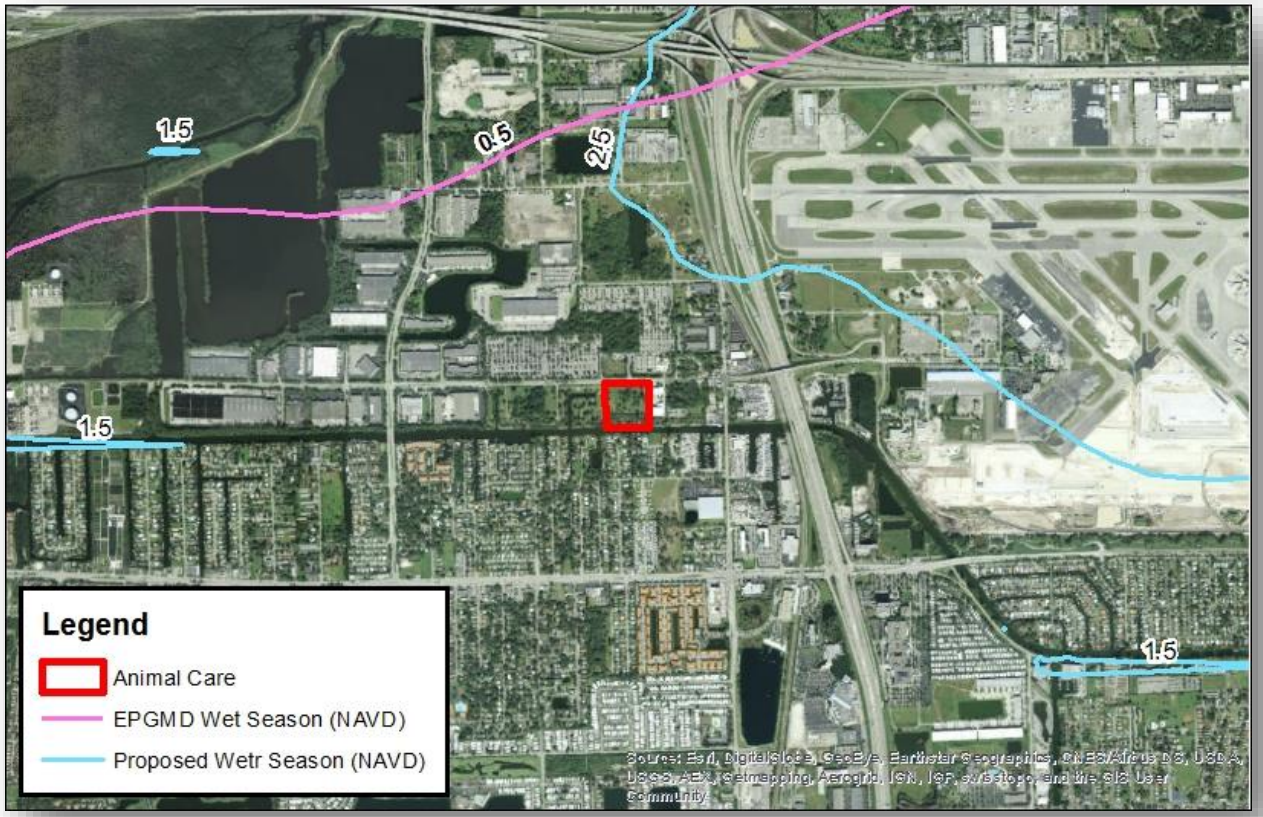
1 ft. rise in some wells over last 20 years

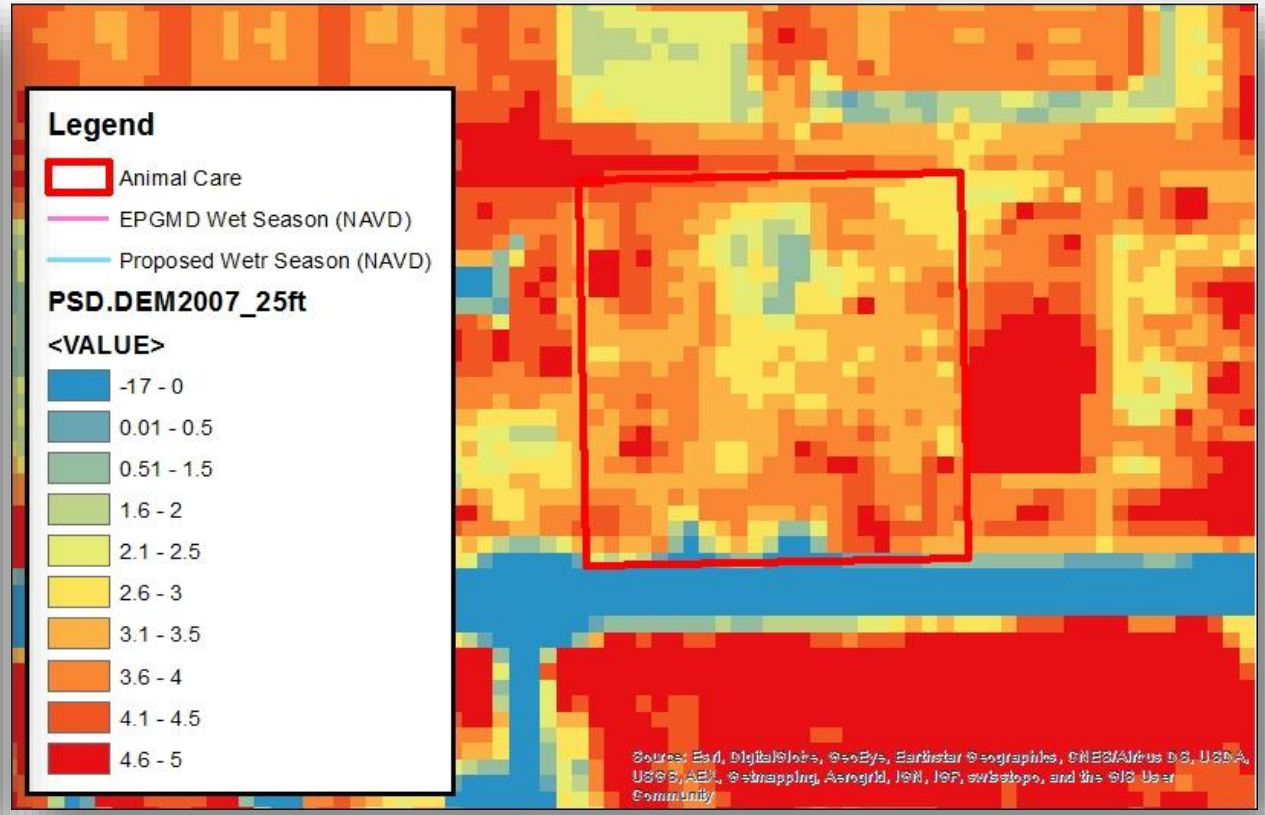
Example- New Broward County Animal Care Facility



New dry retention area ~~functioning~~ as wet retention

New Vs. Old Contours & LiDAR





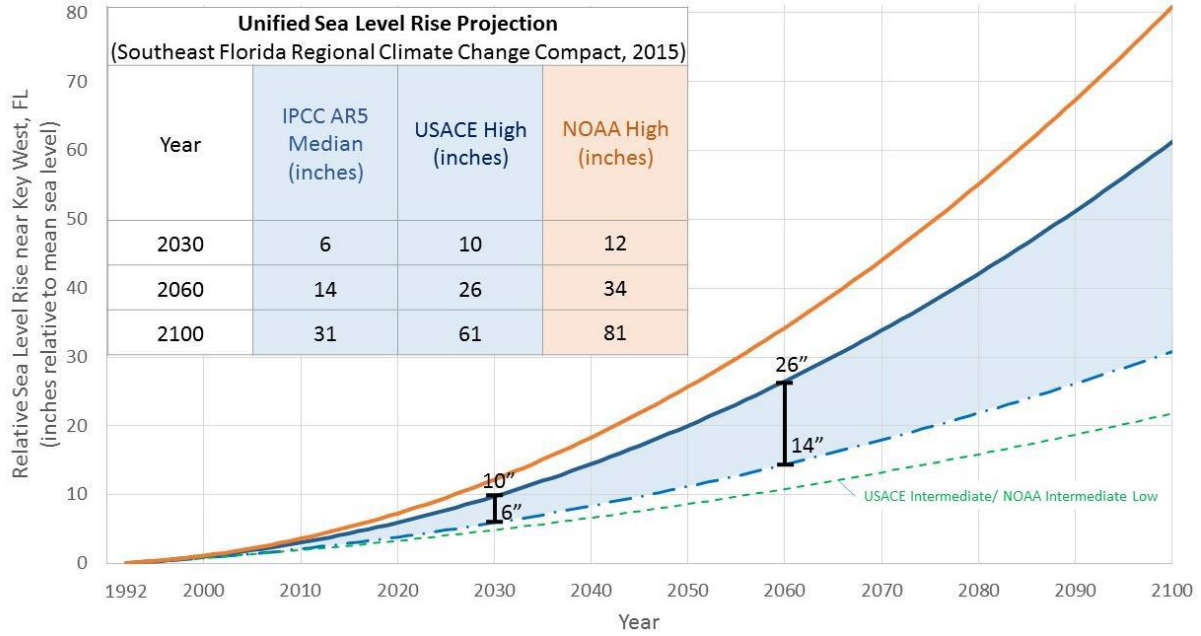
Land was high enough to support dry retention but old GW table estimated water surface shallower than reality.
Resulting in $50,000 in retrofitting on new facility

New Challenge- Future Conditions

- Including:
  - Influence of sea level rise
  - Changes in precipitation
- Requires we address with modernized standards and system design

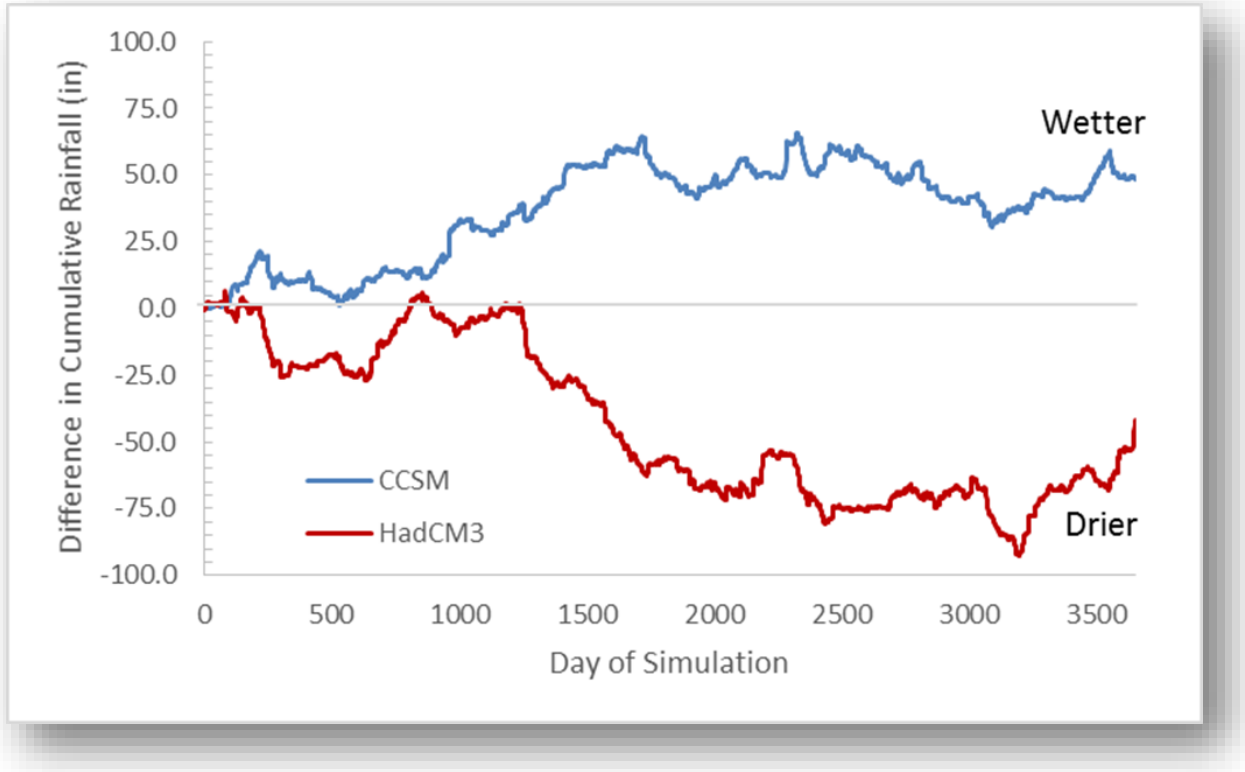
Unified Sea Level Rise Projection
(Southeast Florida Regional Climate Change Compact, 2015)

Year	IPCC AR5 Median (inches)	USACE High (inches)	NOAA High (inches)
2030	6	10	12
2060	14	26	34
2100	31	61	81



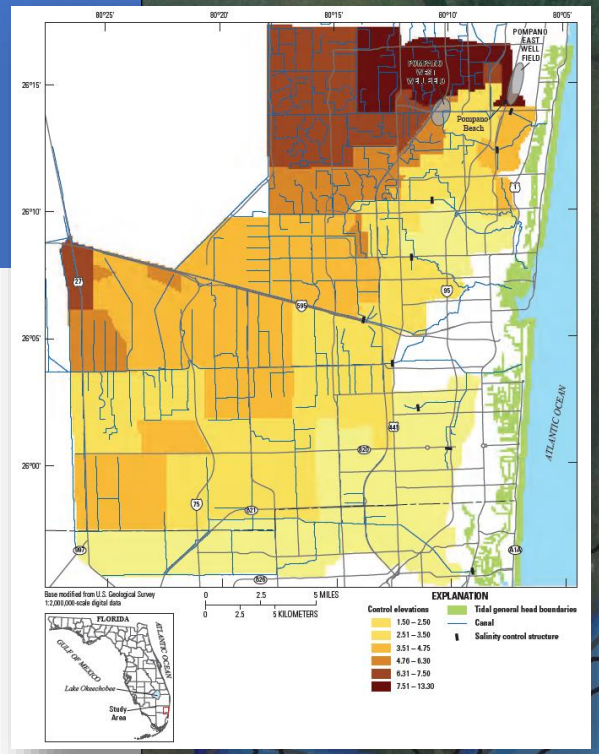
Proposed Update Methodology

- Use of new County Wide Inundation Model
- Future period 2060-2069
- NRC 3 SLR
  - 26.6-33.9 inch increase from 1992 levels
- CCSM climate model
  - 9.1% rainfall increase
- Use of future wet season



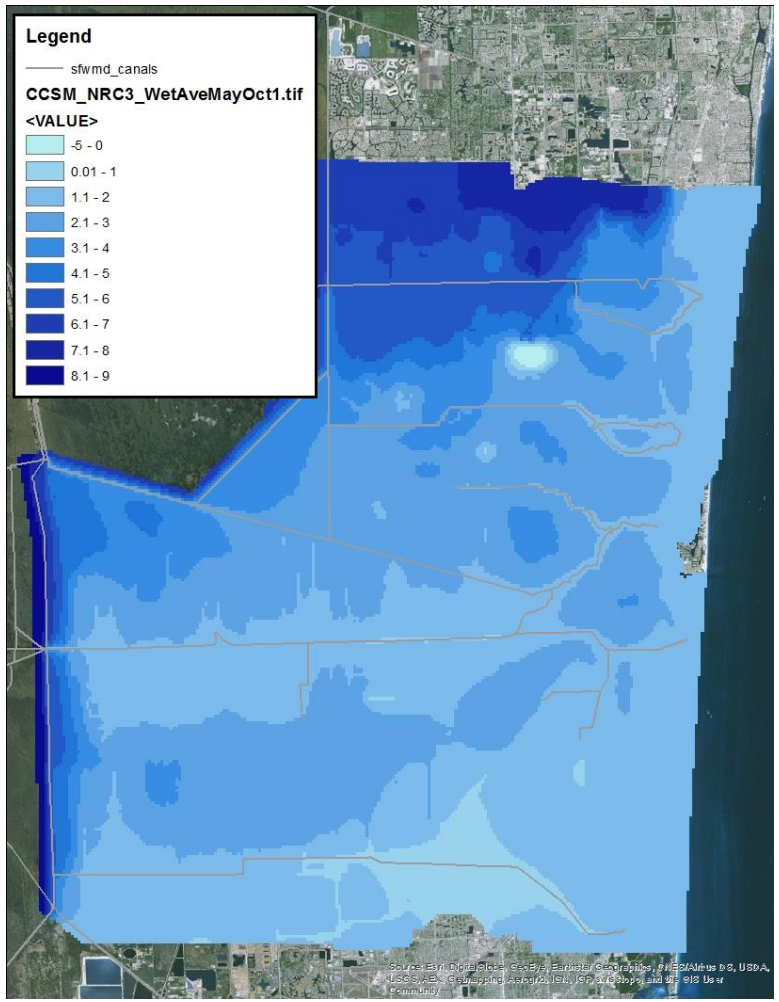
Current Map to Modeled 1990-1999

- Match the overall break points for most contours
- Better define influence of wellfields and certain control elevations
- Agreement with design elevations

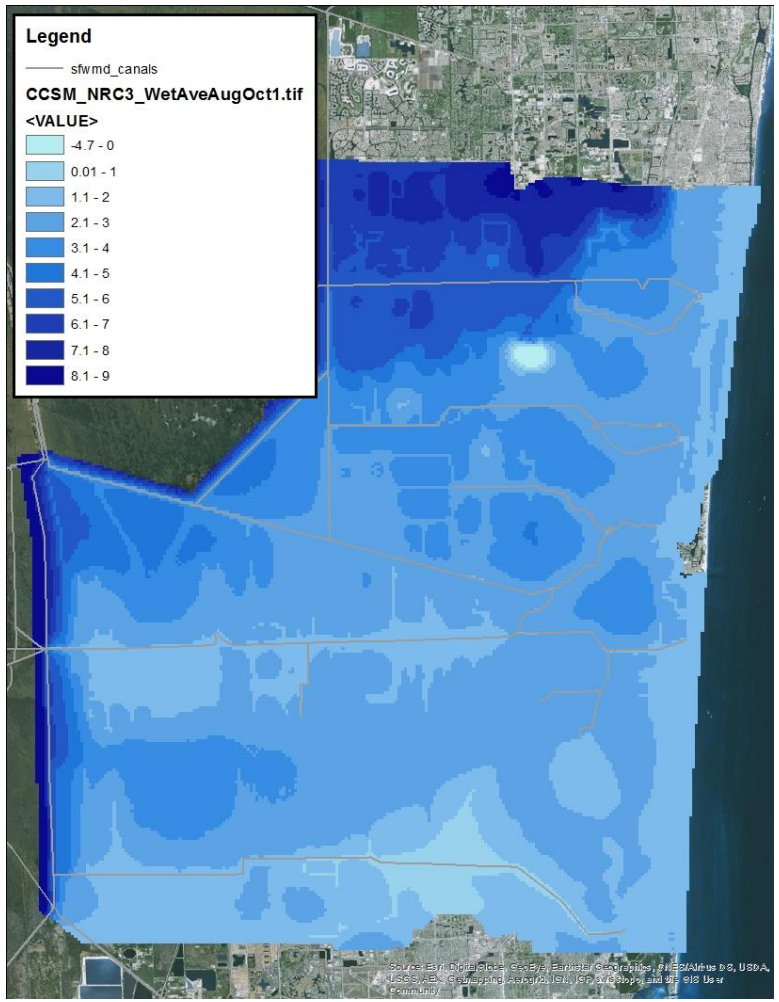


CCSM Results- Future Wet Season Averages

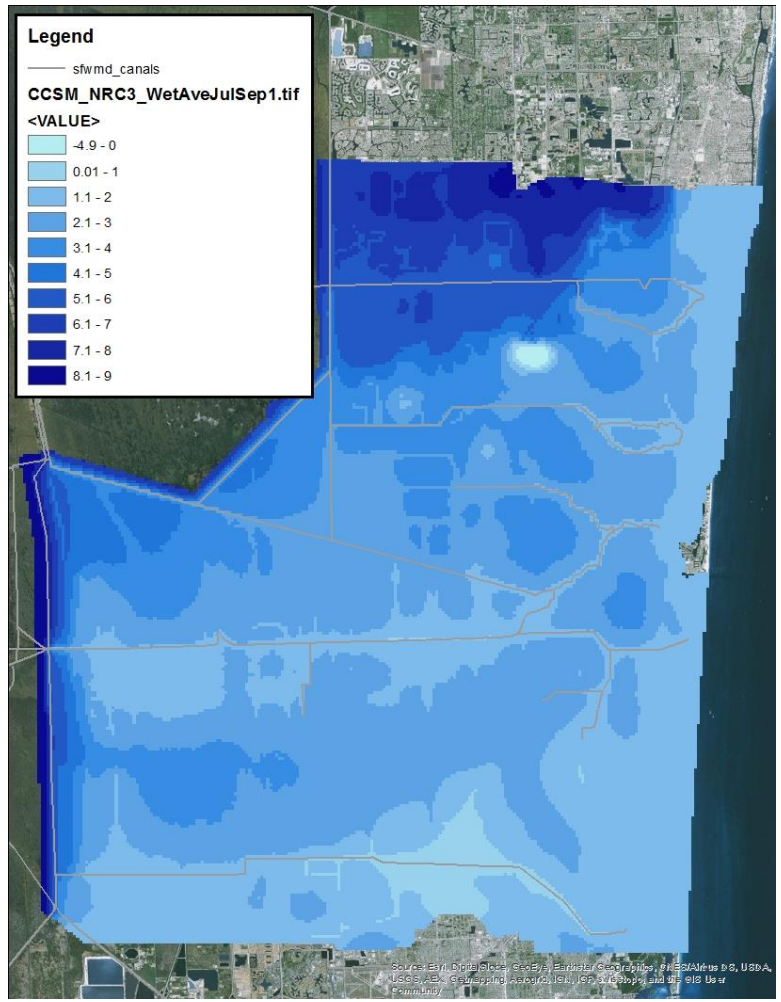
Explored 3 different wet season periods, historical 6 month wet season, historical 3 month peak wet season, and future 3 month peak wet season



May-Oct (selected)



Aug-Oct

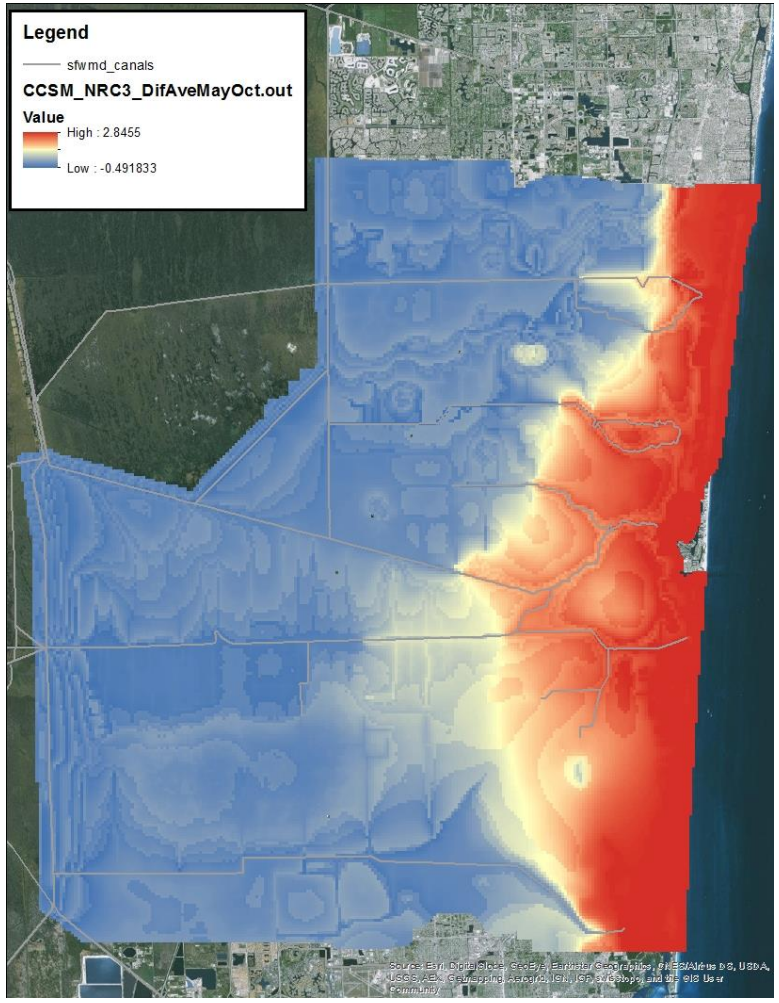


Jul-Sep

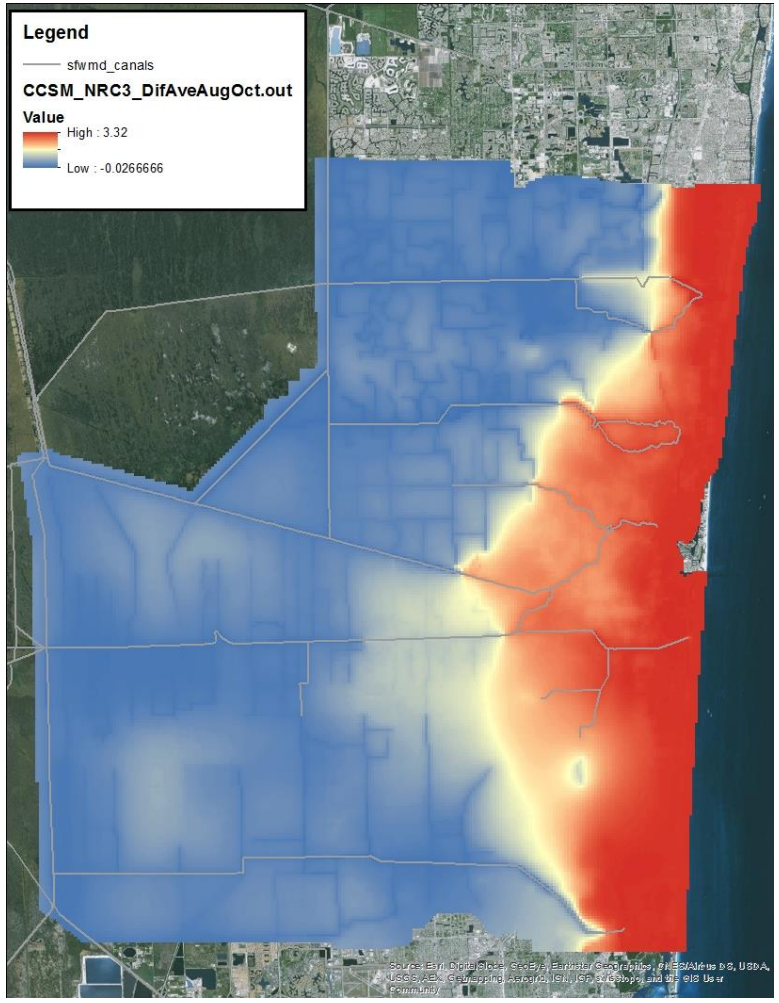
CCSM Results- Difference Against Base

Comparison of 1990's averages to 2060's averages

May-Oct



Aug-Oct



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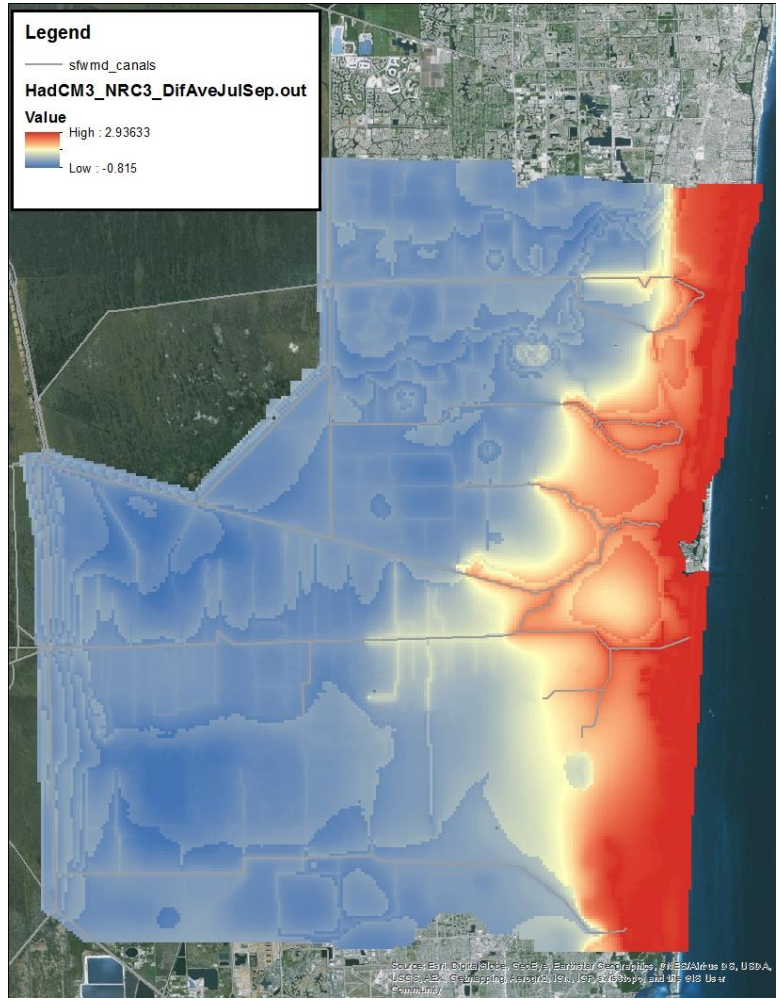
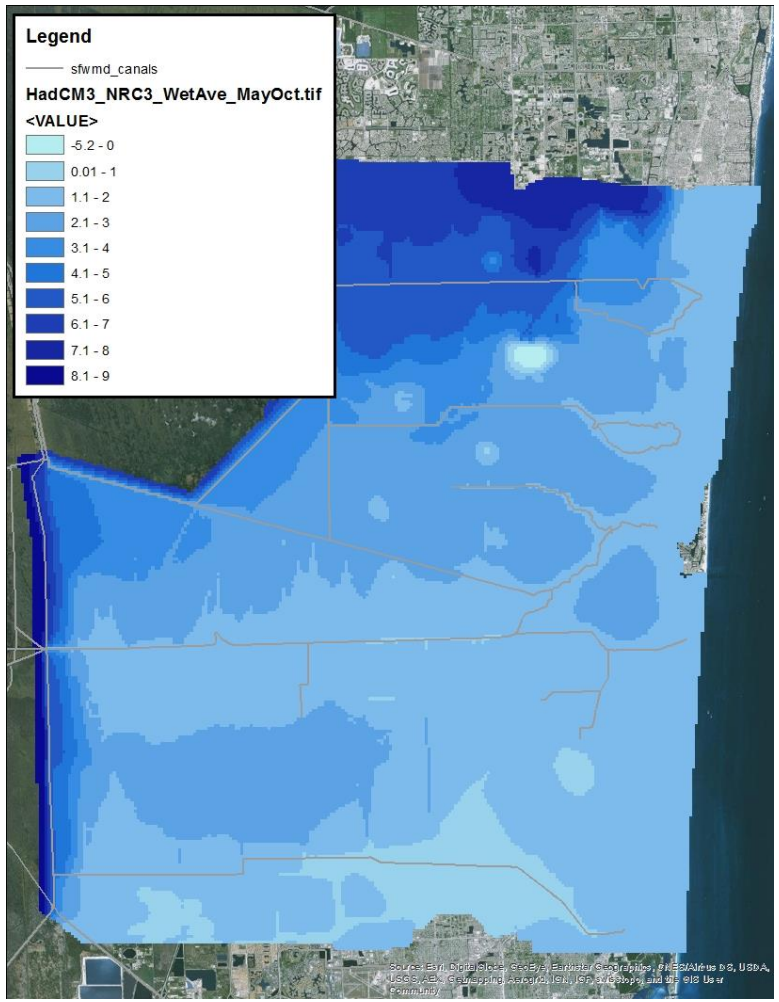
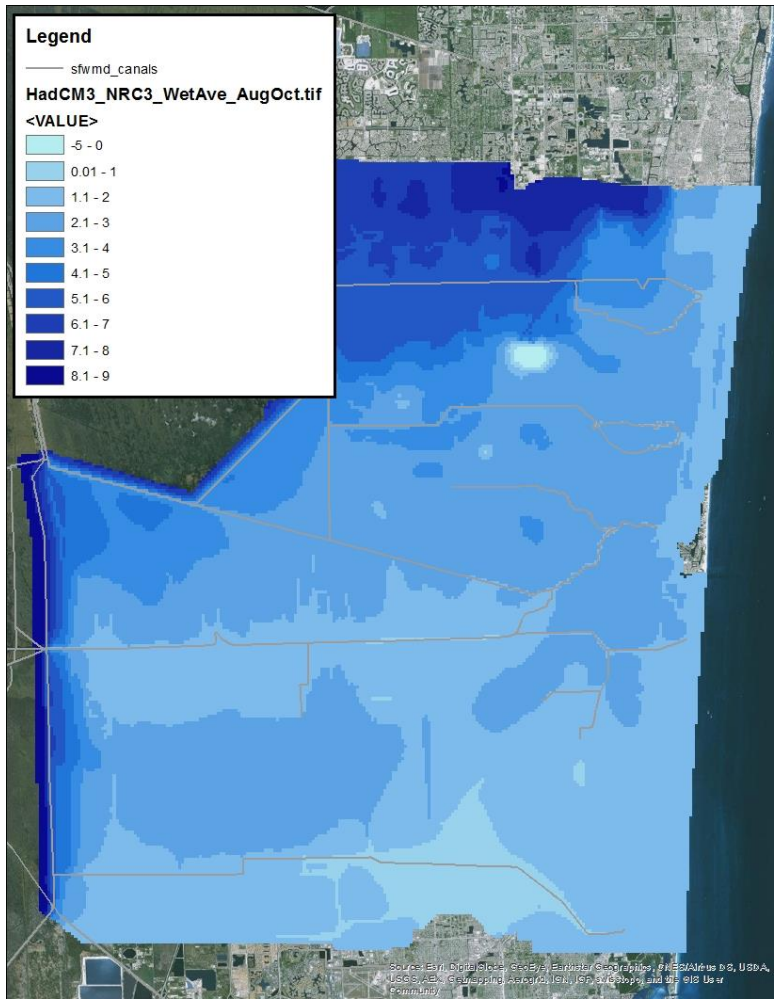


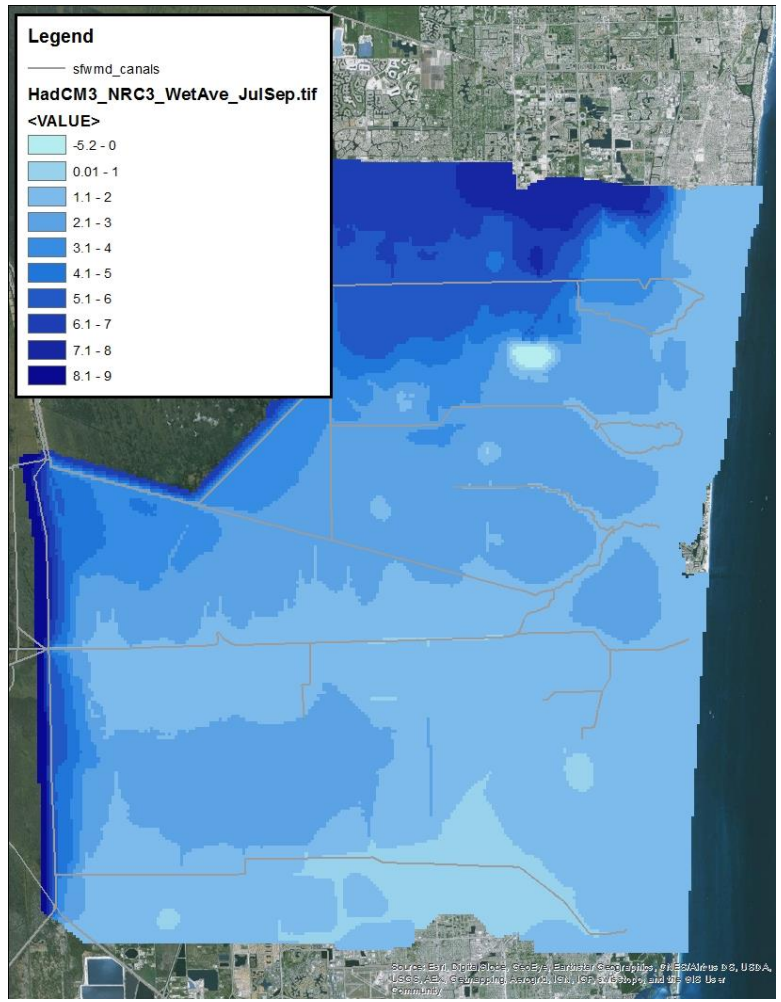
HadCM3 Results- Future Wet Season Averages



May-Oct



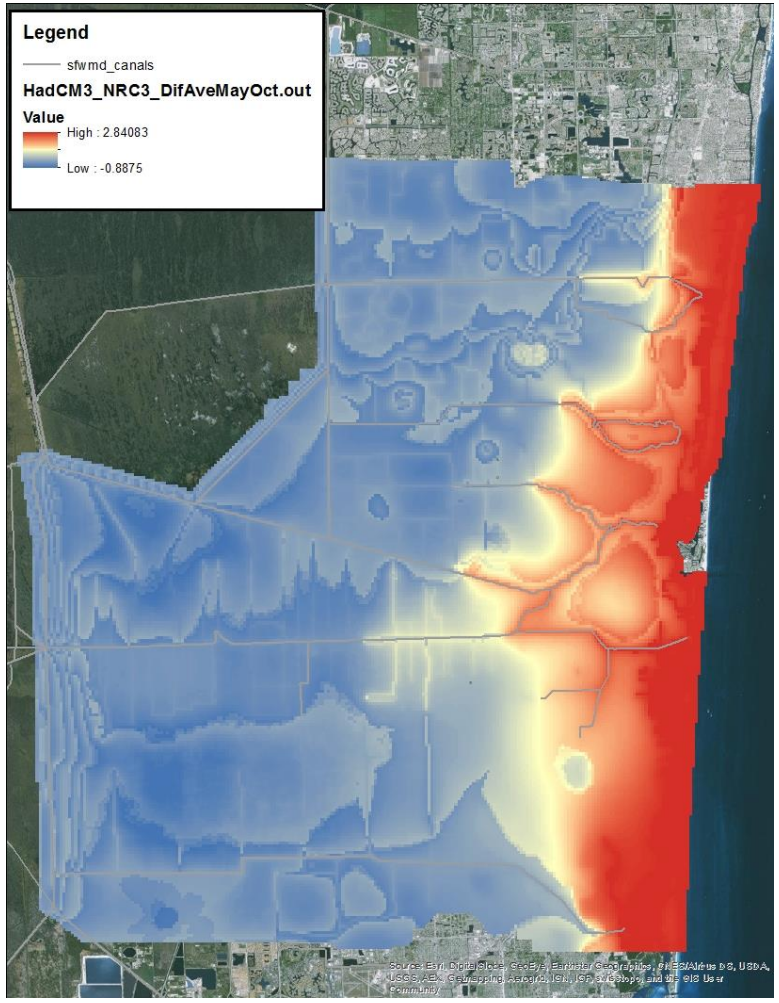
Aug-Oct



Jul-Sep

HadCM3 Results- Difference Against Base

May-Oct



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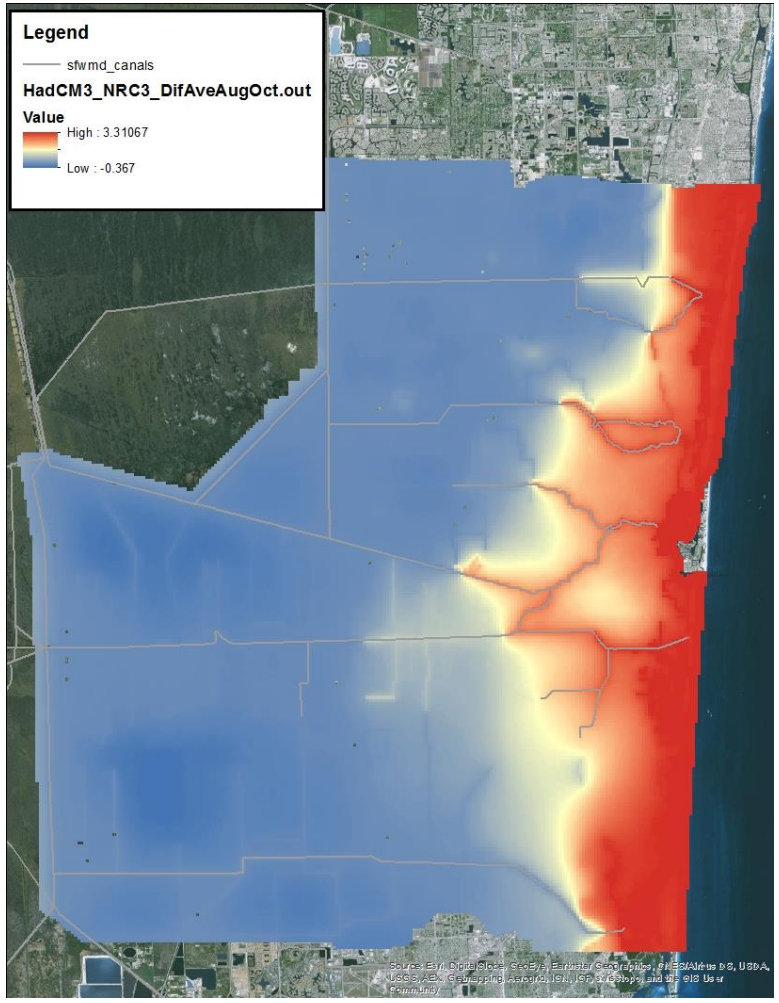

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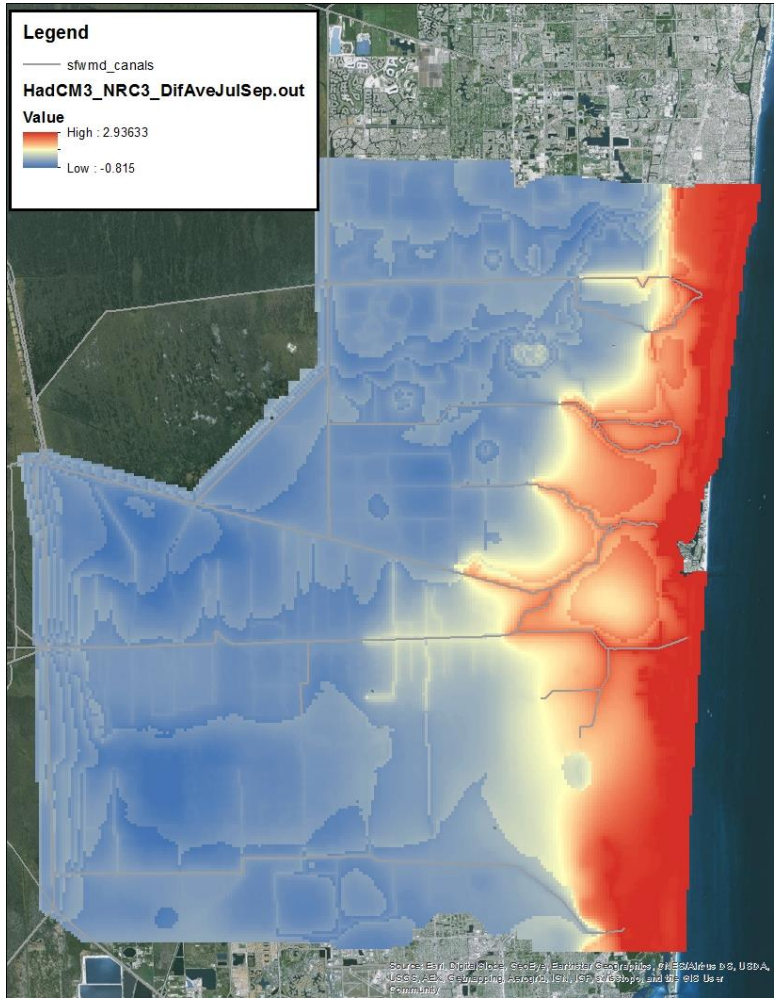
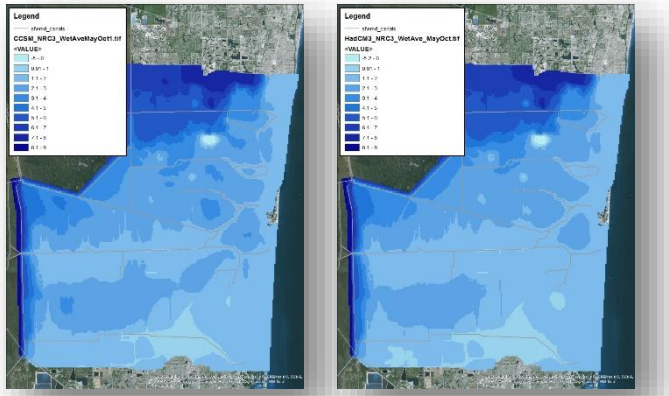
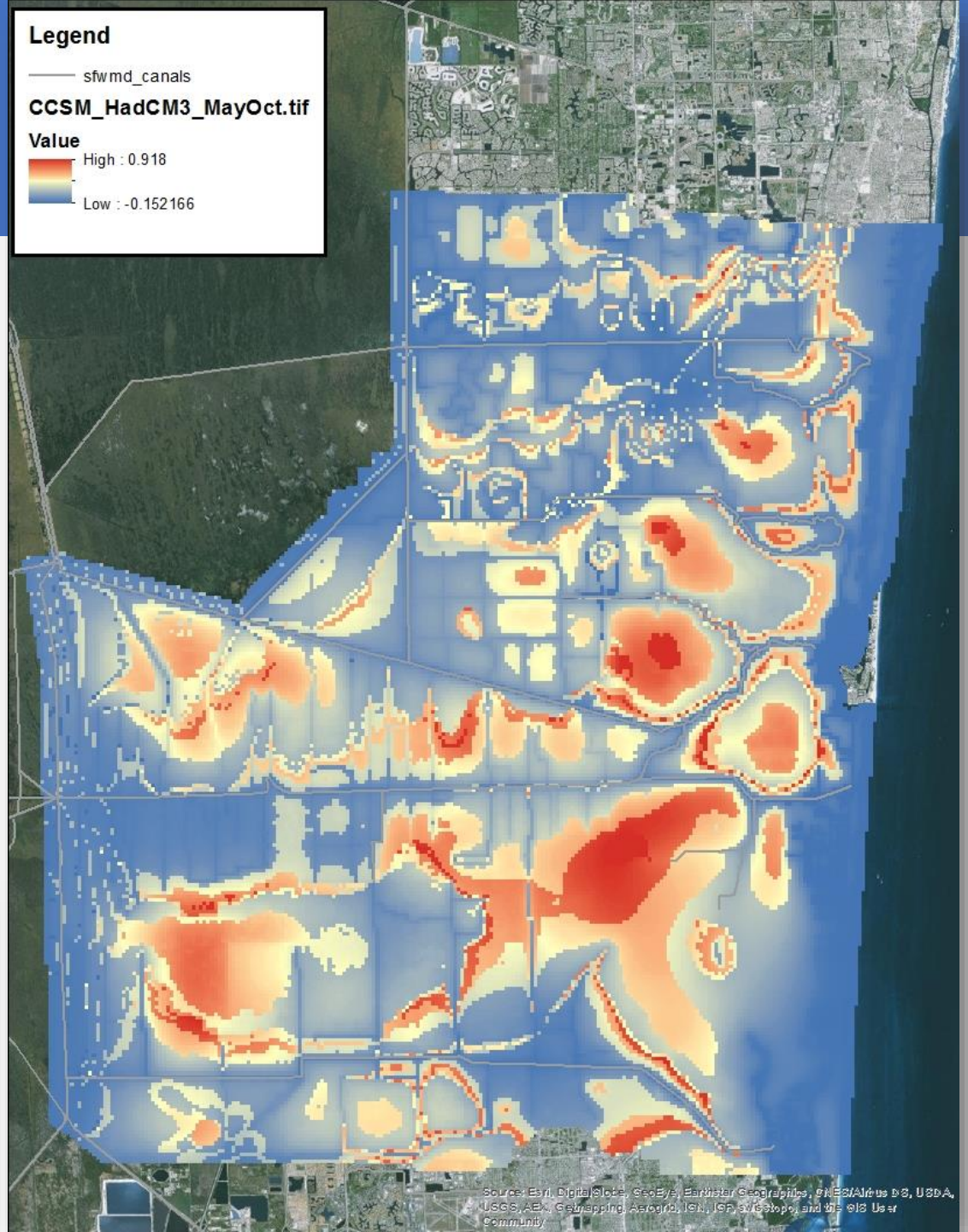


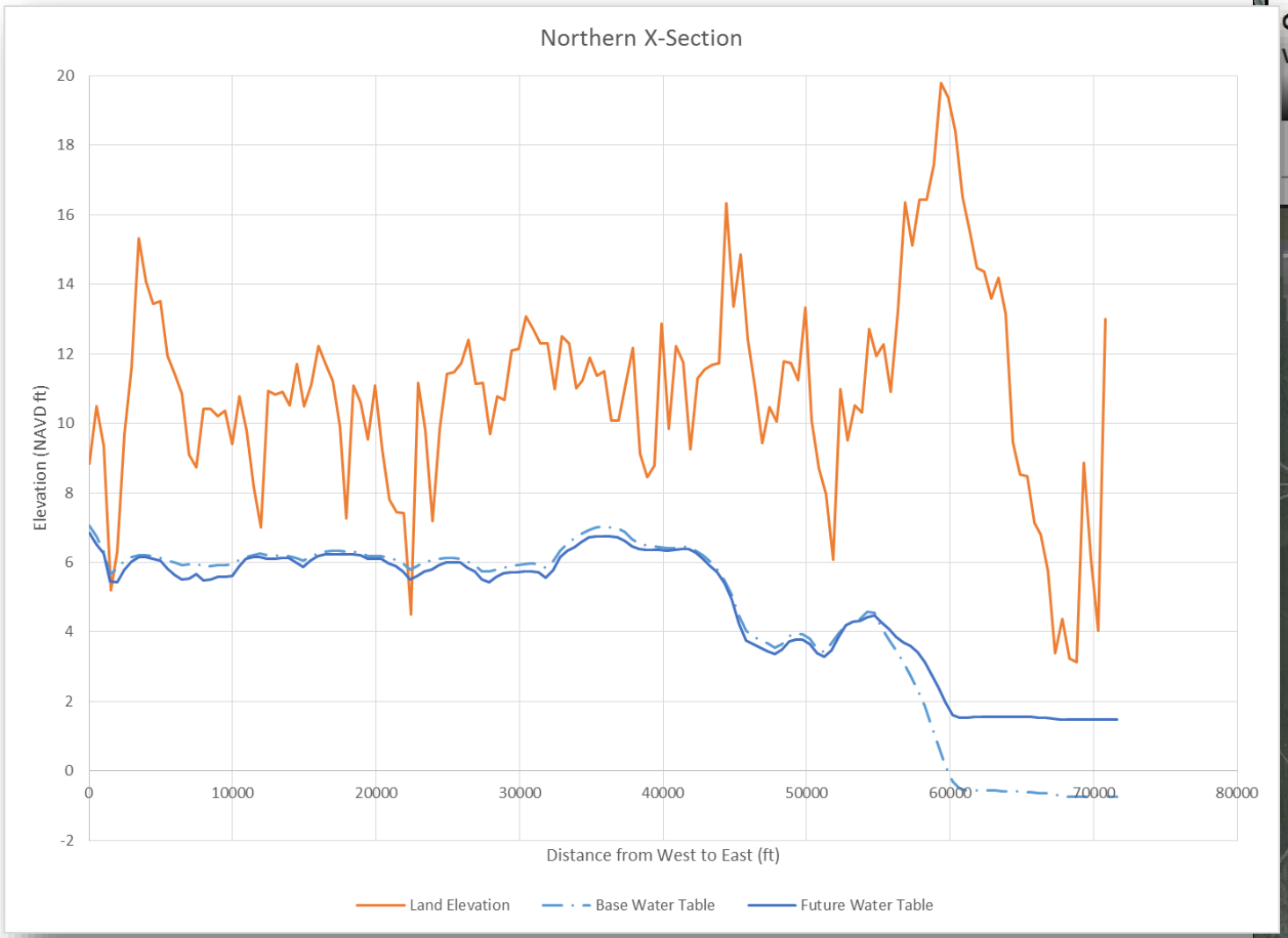
CCSM Vs. HadCM3

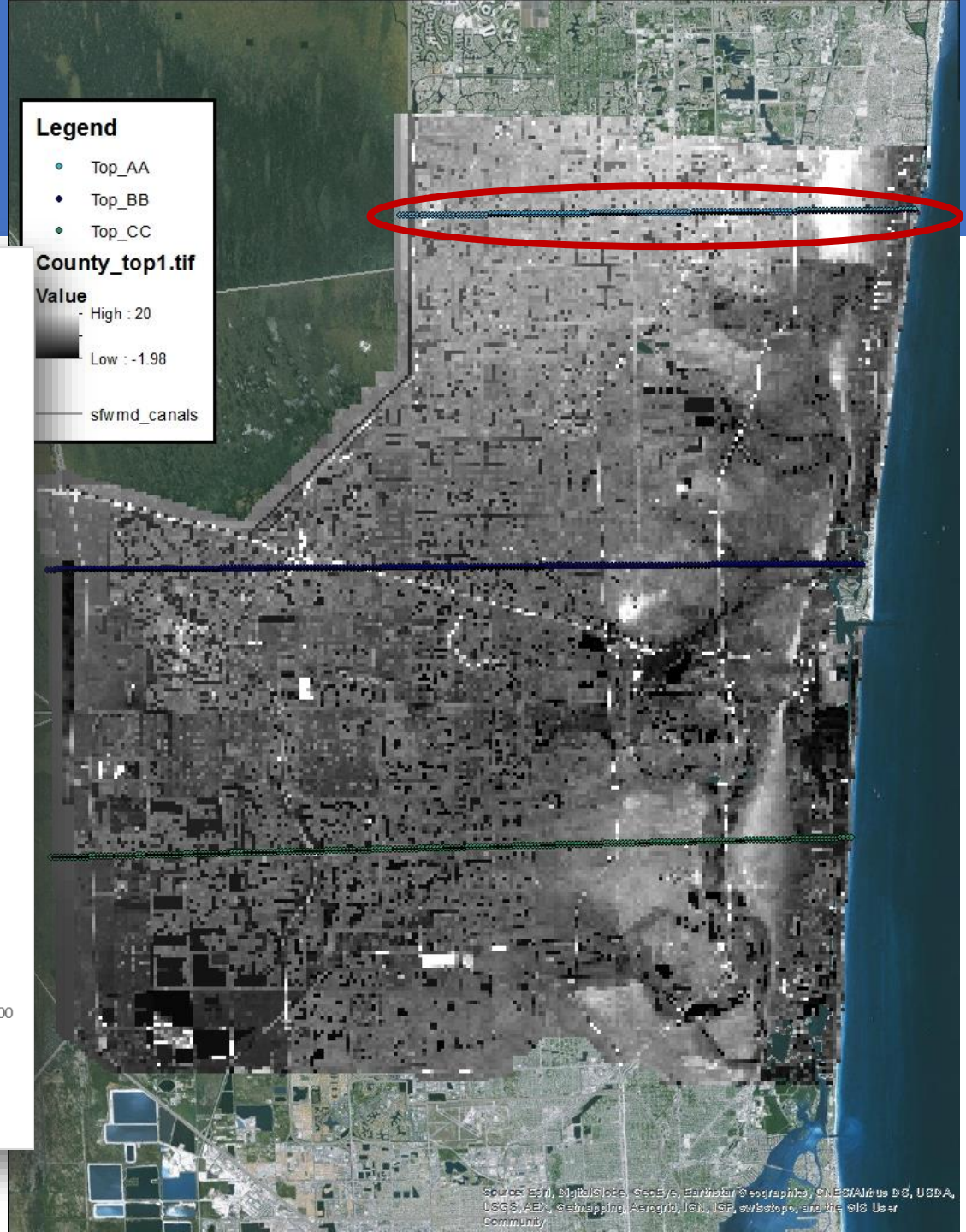
- Same NRC 3 Sea level increases
- Different precipitation models
  - CCSM: 53.4 in/yr to 58.2 in/yr = +9.1%
  - HadCM3: 54.9 in/yr to 50.7 in/yr = -7.6%
- Max difference of 0.918 ft in certain areas





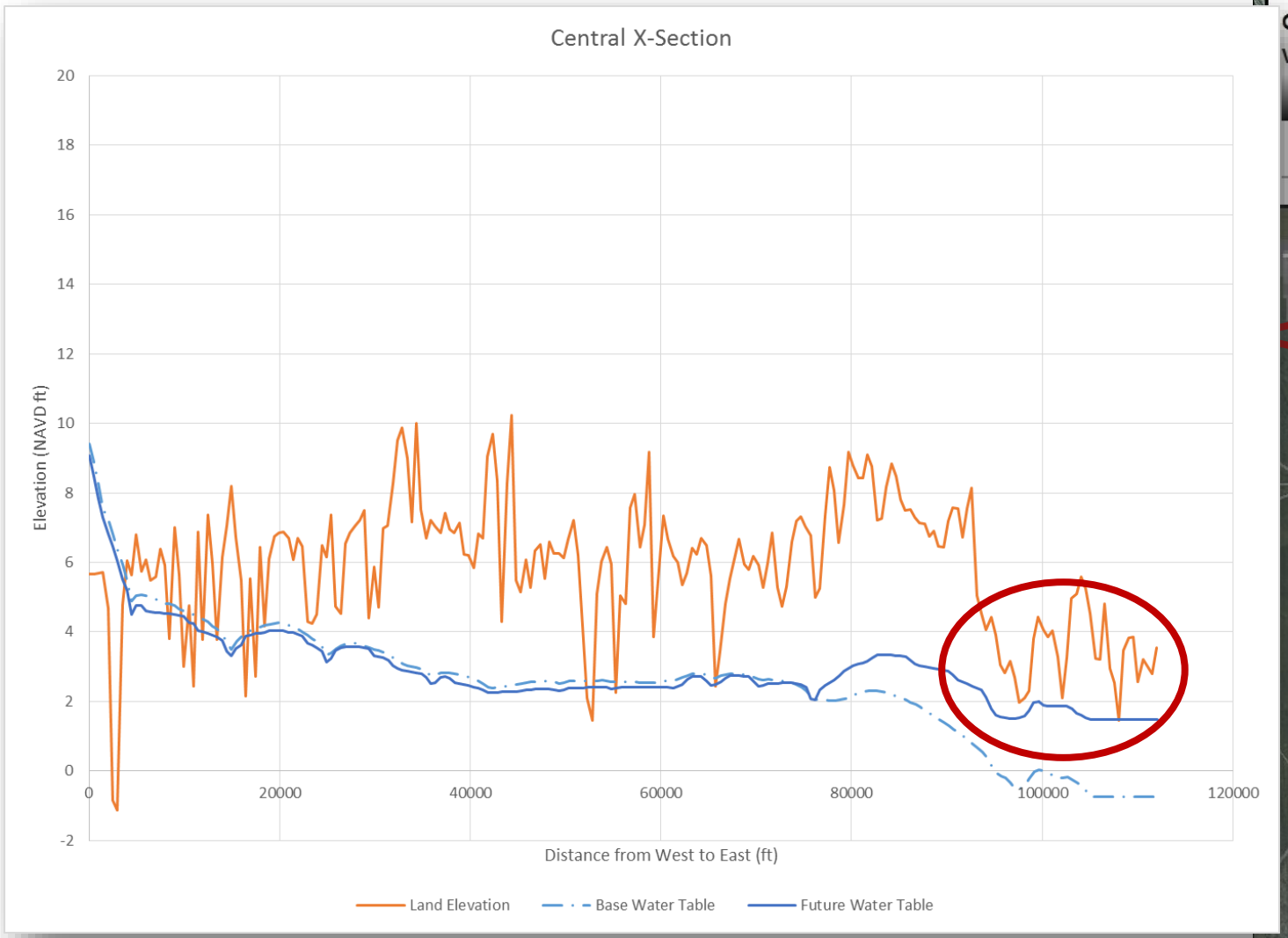
Northern Cross-Sectional Interpretation

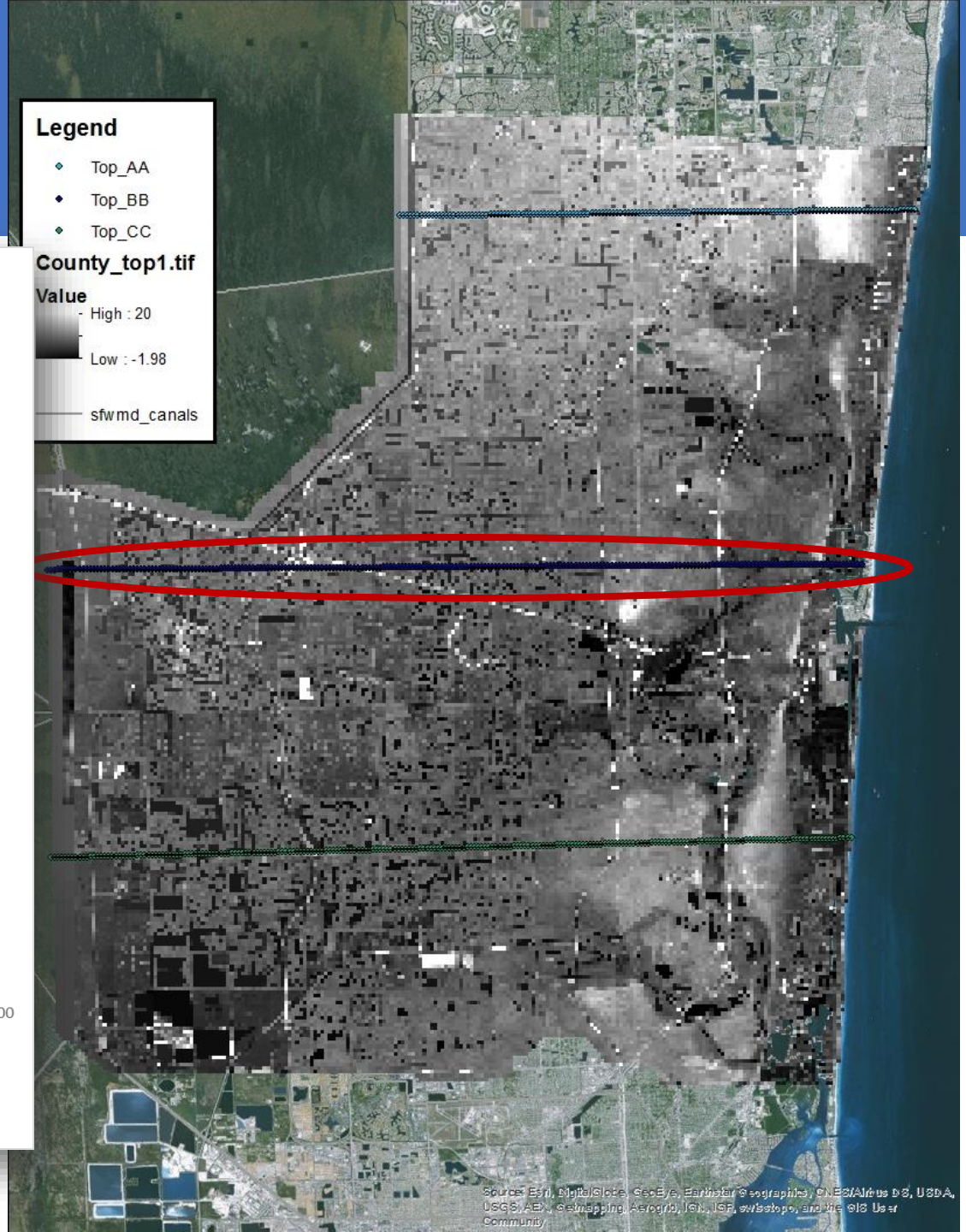




Reasonable storage even with climate change

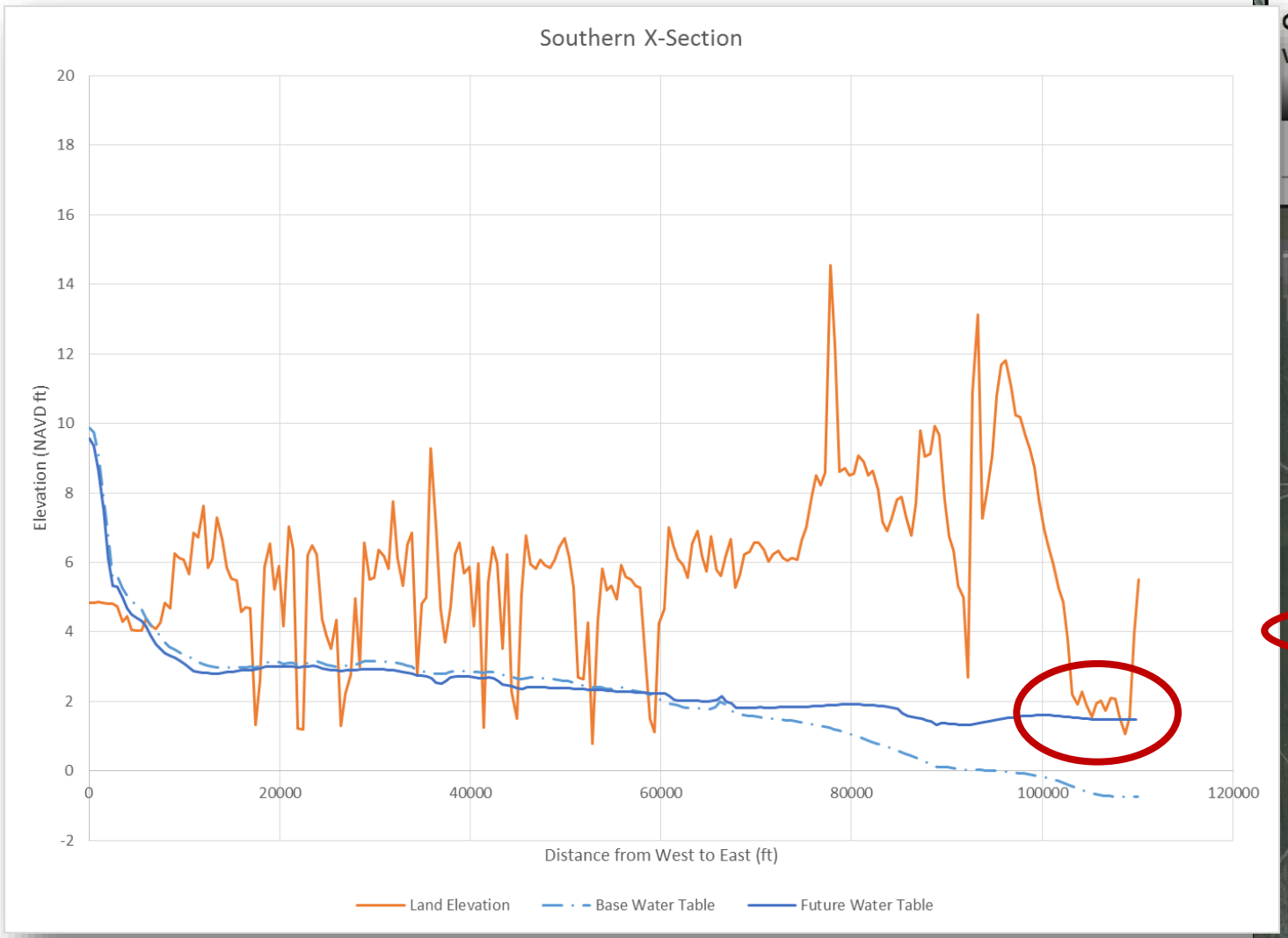
Central Cross-Sectional Interpretation

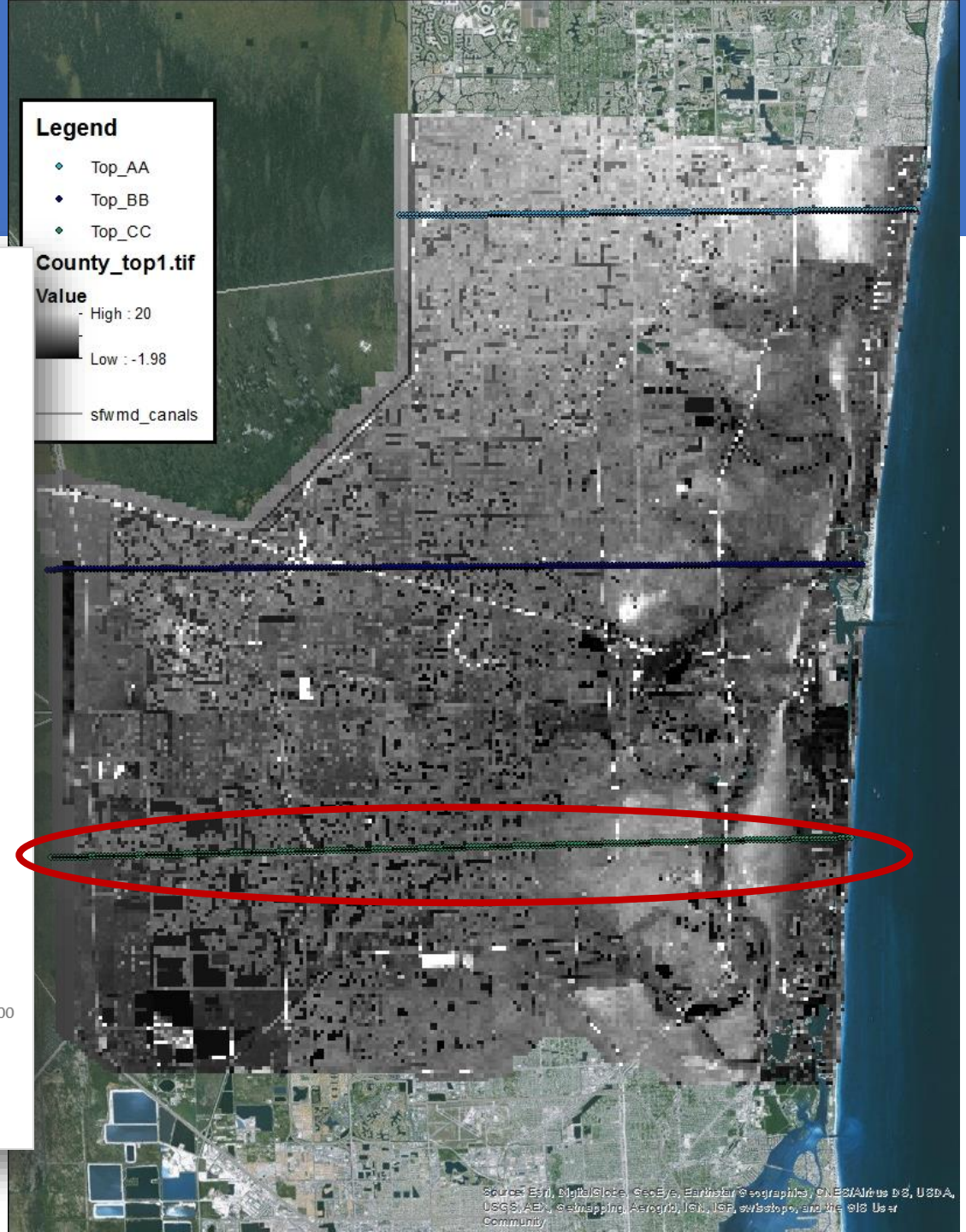




Minimal coastal storage with climate change

Southern Cross-Sectional Interpretation

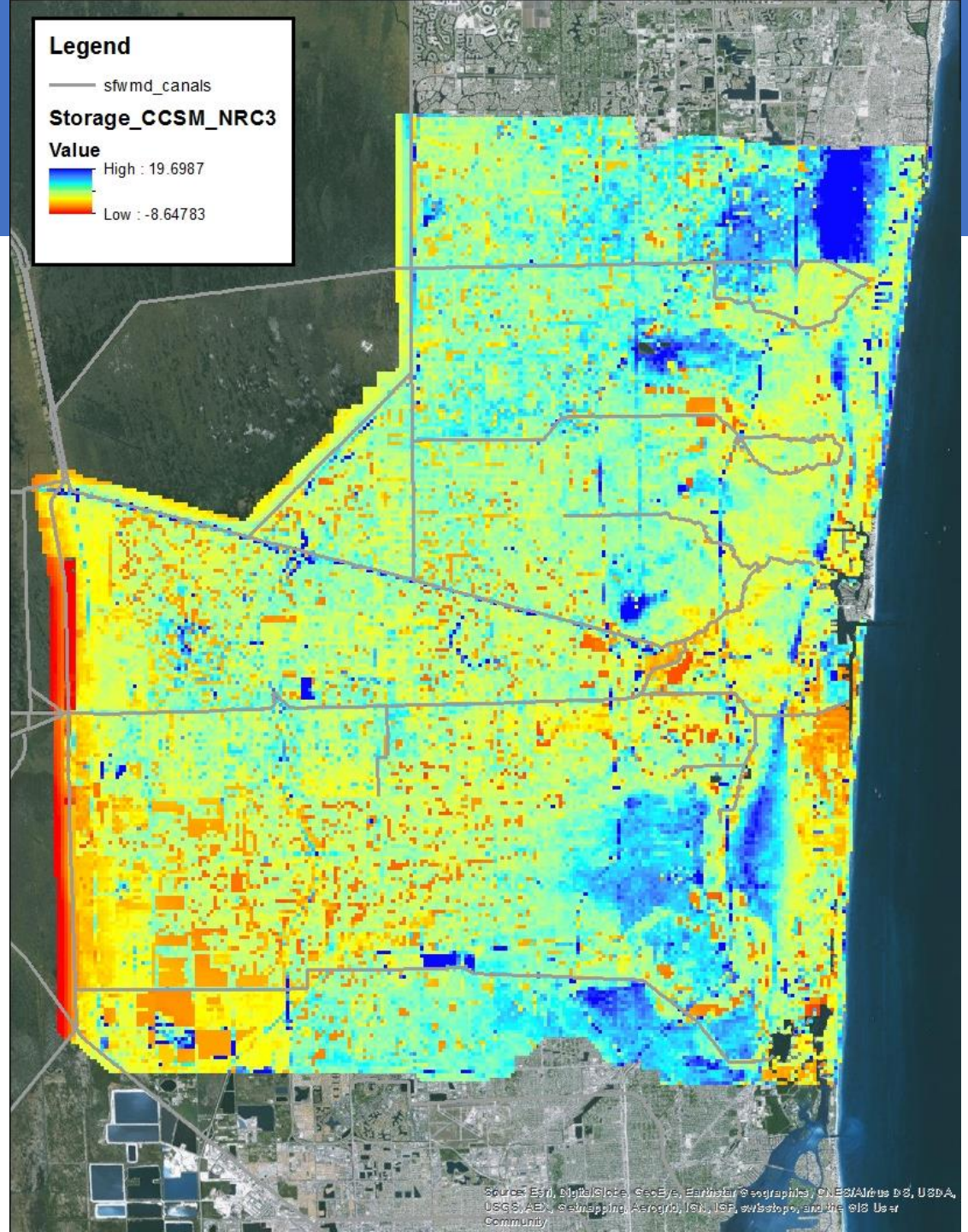




Minimal coastal storage with climate change

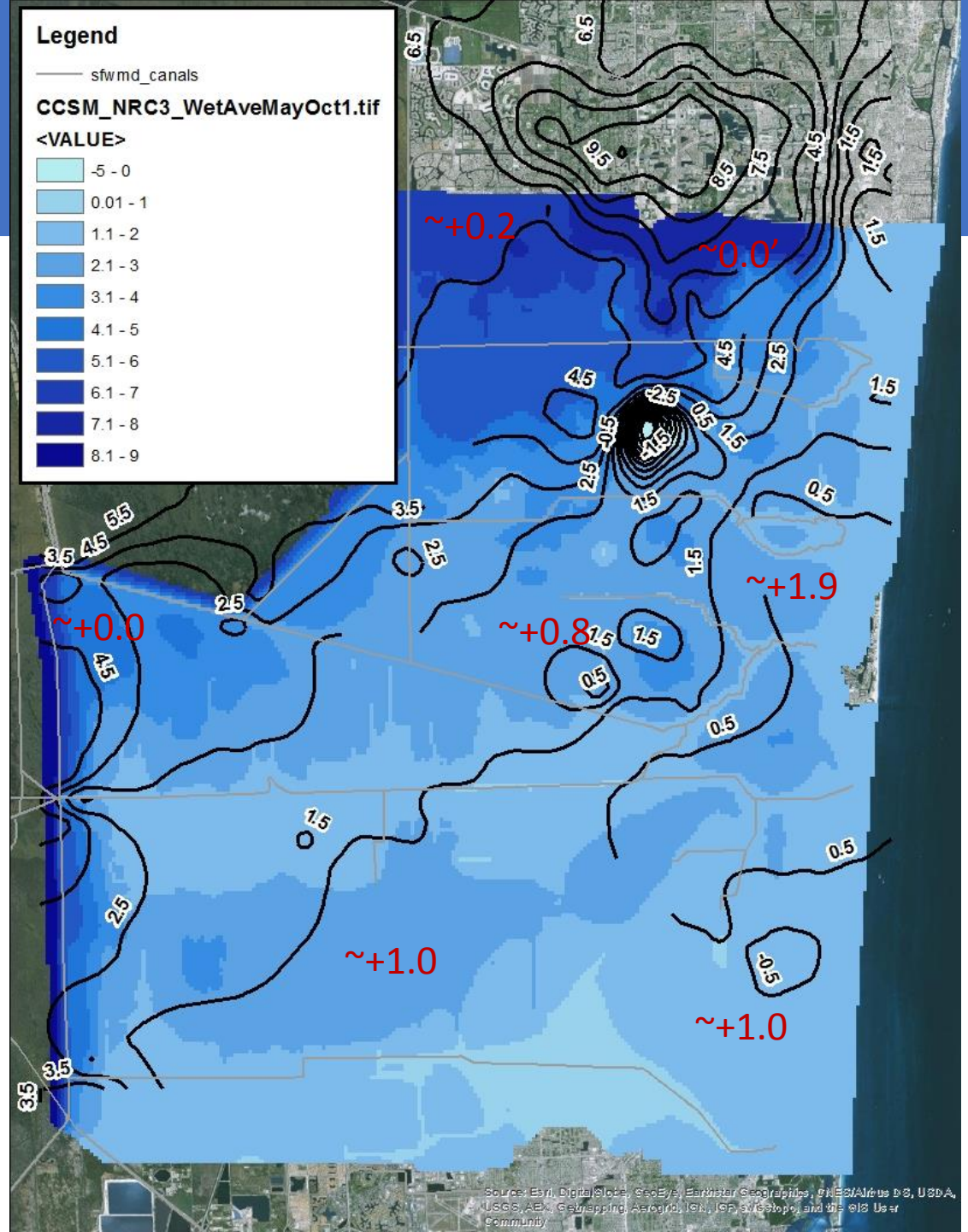
Storage

- Red shows water or no storage
- Blue indicates most storage potential
- Portions of coastal areas lose storage and western area with previously low storage may be effected by reduced ability to drain to costal areas



Proposed Map Vs. Current Map

- Similar to Modeled Base case
  - Minor changes in Western Broward
  - More significant increases in tidally influenced Eastern Broward



Adoption Process

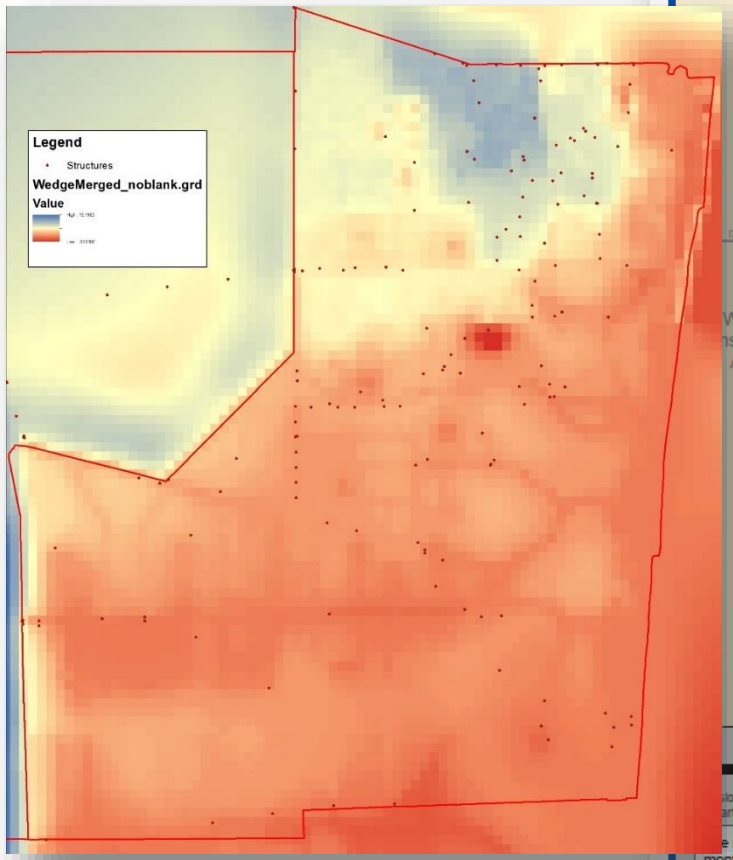
- Approval by Broward County Water Advisory Board and TAC
- Broader stakeholder outreach
- Motion to Direct County Attorney to draft item
- Final revision of Map
- Public Meeting/Stakeholder Meetings
- LUPA/Planning Council Review
- Motion to Set Public Hearing
- Public Hearing/Commission Approval

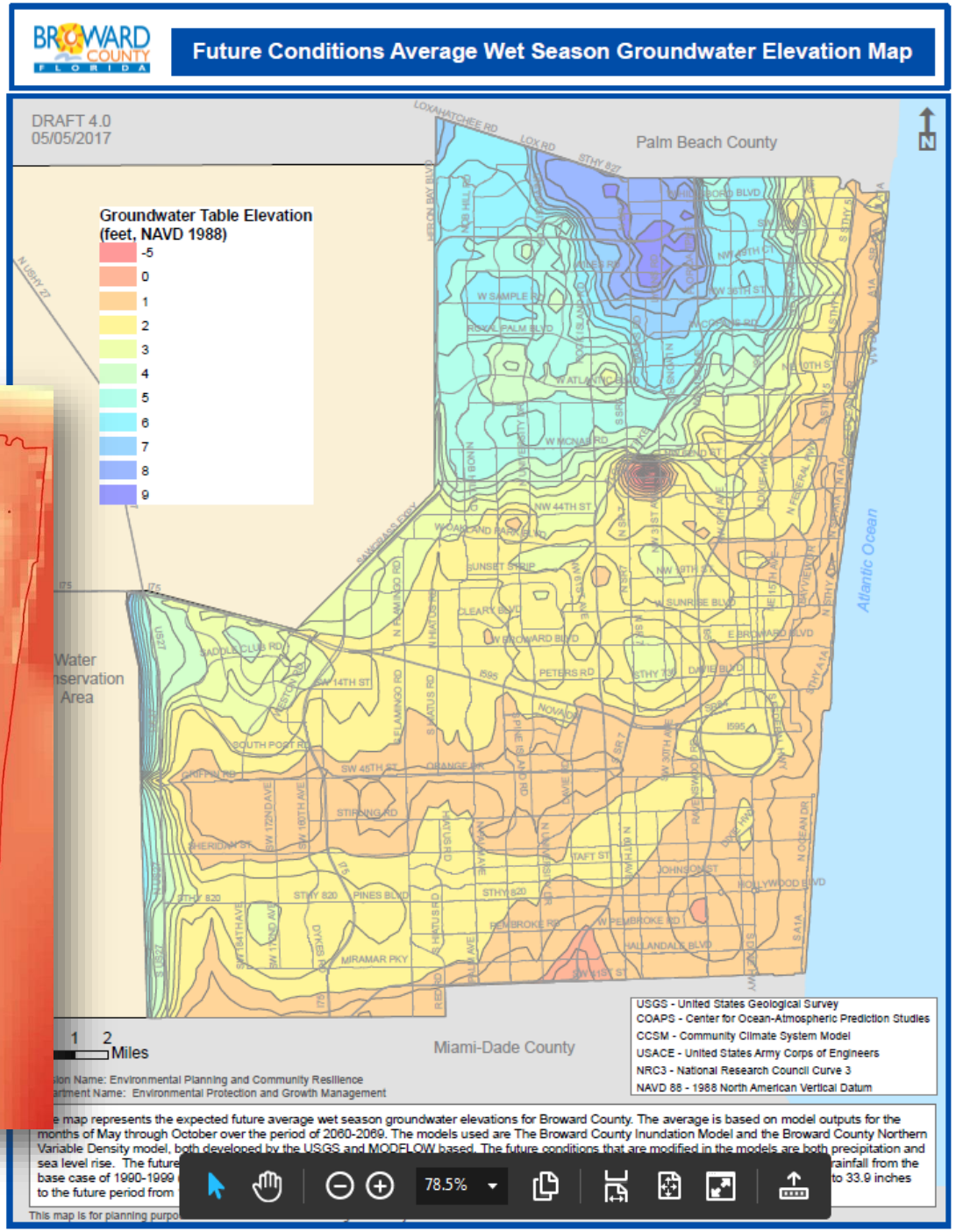
*At each step comments may be made and updates would have to occur to lead to final product that would be more likely adopted by Commission

- Addition of future condition map series
- Current plate used is WM 2.1 (average wet season water levels) as noted in the antecedent conditions criteria
- EPGMD Regulations adopted by Ord.

Final Map

- Map of CCSM 6 month (May-Oct)
  - 2060-2069 average GW conditions
- NRC 3 SLR projection
- CCSM climate model





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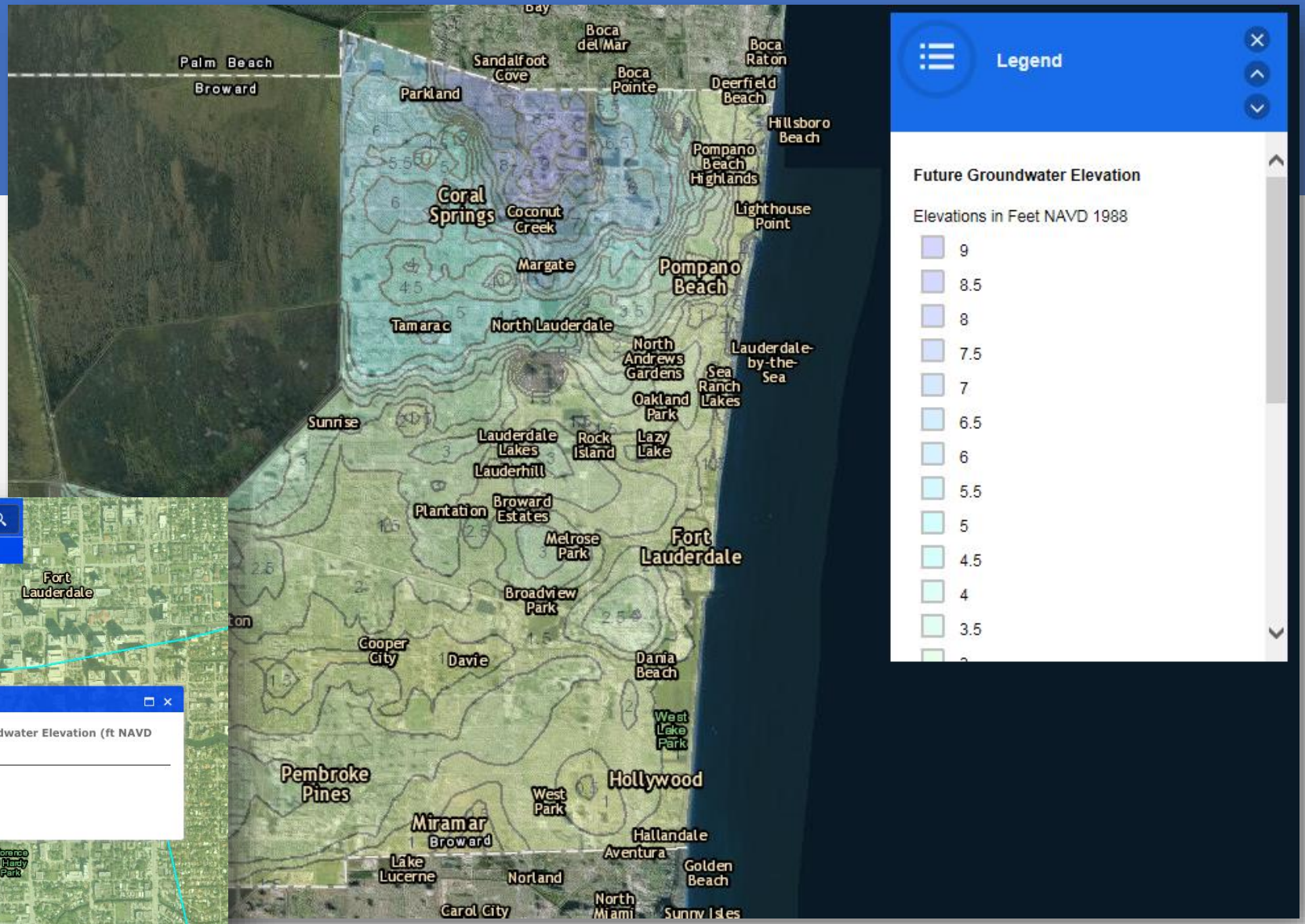
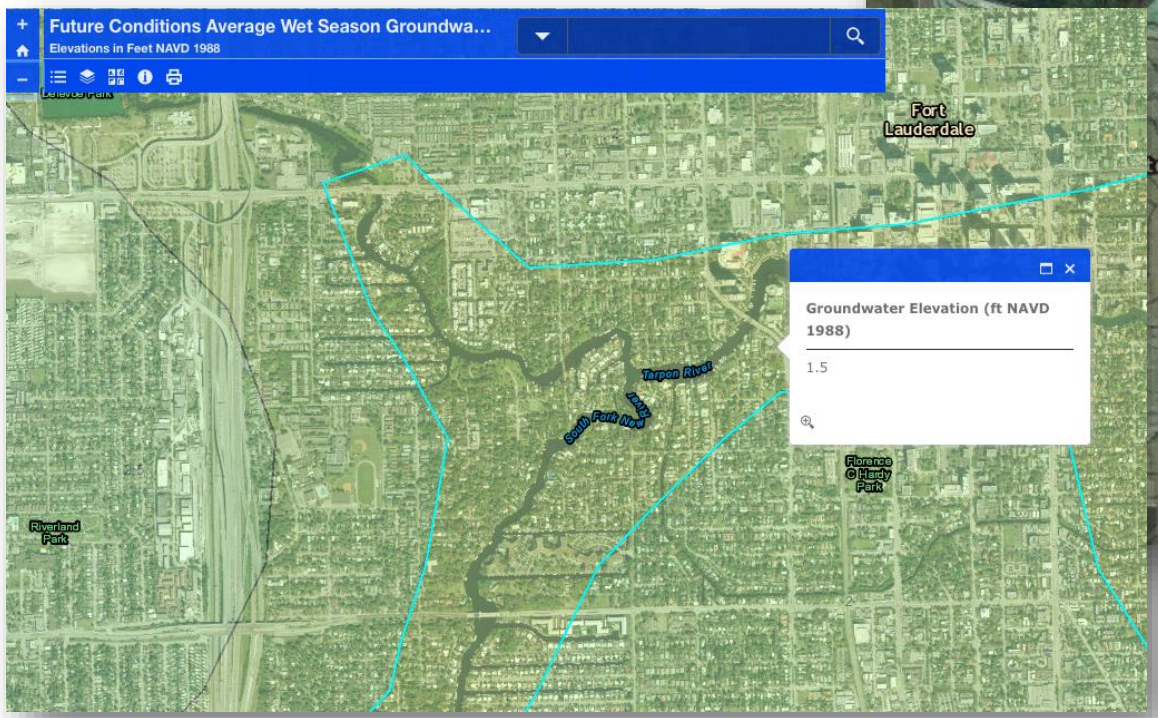




What can we do today?

FLUX ZONE CONCEPT

What do we have to include to meet today's criteria?

Today's Calculations - water quality (exfiltration trench) and quantity (drainage wells)

What is the life expectancy of the project?

Assumptions for probable conditions over the life cycle of the project

- Pragmatic – direct application of SLR projections (i.e. assume water table rises 2 feet)
- Precise – use tools currently under development (SLR future conditions surface and ground water modeling)

What do we have to change to meet expected conditions over the life of the project?

Tomorrow's Calculations - water quality (exfiltration trench) and quantity (drainage wells)

- Pragmatic – designed for maximum practical time period; or
- Resilient – designed for probable conditions at predetermined end of project life.

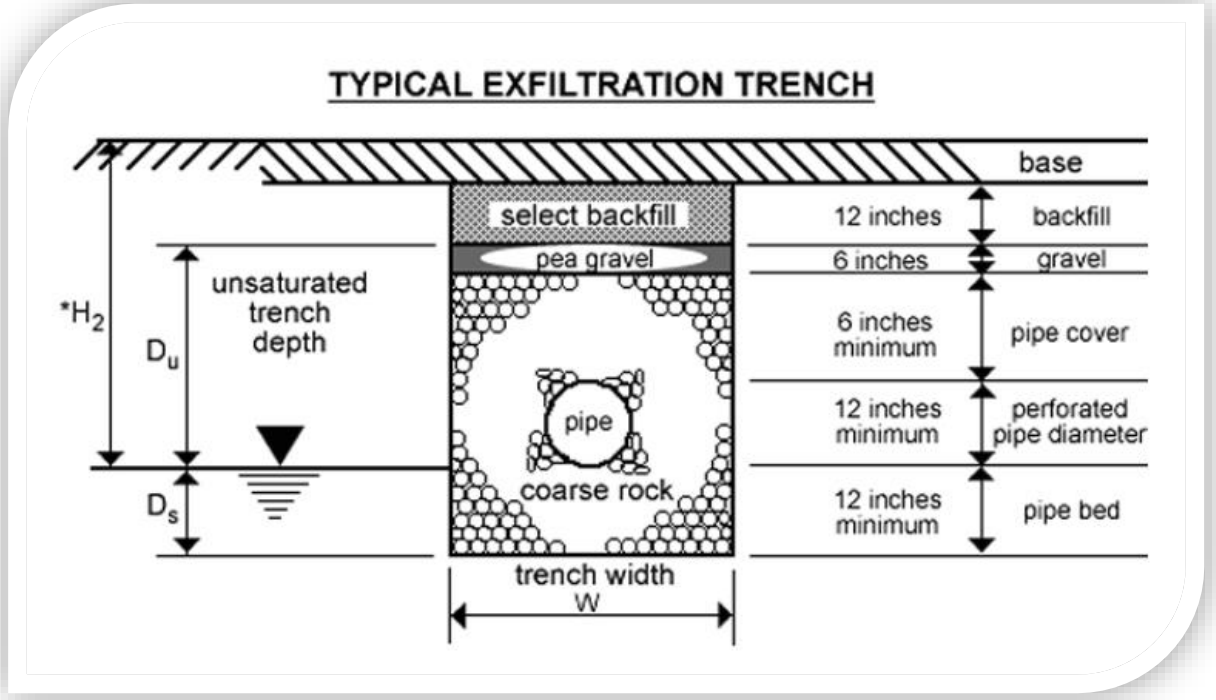
Exfiltration Trench

Regular Formula

$$L = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K(H_2W + 2H_2D_u - D_u^2 + 2H_2D_s) + (1.39 \times 10^{-4})WD_u}$$

Conservative Formula
(Required when Ds > Du, a likely condition in a SLR scenario)

$$L = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K(2\,H_2D_u - D_u{}^2 + 2\,H_2D_s) + (1.39 \times 10^{-4})WD_u}$$



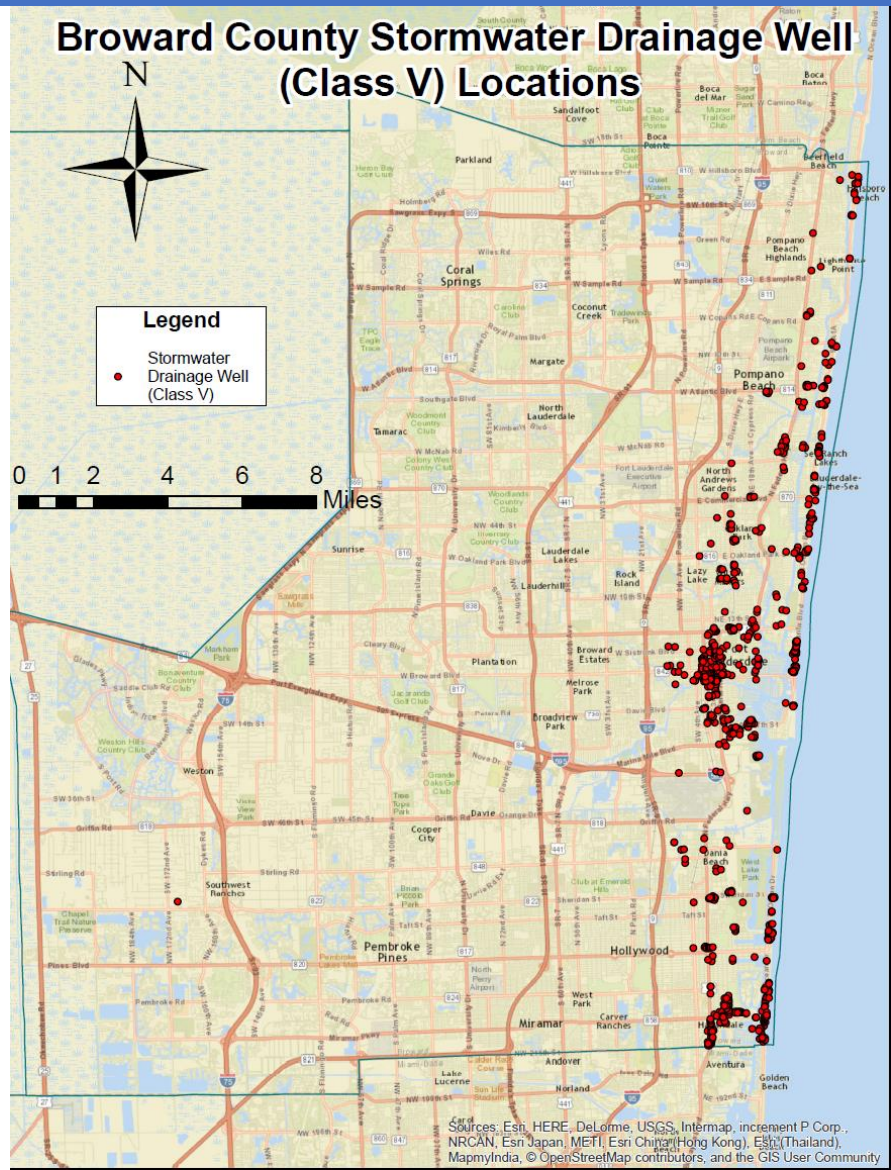
Drainage Wells

Underground Injection Control (UIC)

- Protects Florida's underground sources of drinking water (USDW)
- USDW = aquifer with a total dissolved solids concentration of less than 10,000 milligrams per liter.

>13,000 Class V wells in Florida

- Class V Group 6 = drainage wells
  - ≈ 680 in Broward
  - Typically allowed east of US1 (exceeds 10,000 mg/L TDS)
  - Discharge capacity ranges from <100 up to 1000 GPM/ft-head
  - Typical conservative estimate: 250 GPM/ft-head



Surface Water Management

Design Example 1

Surface Water Management

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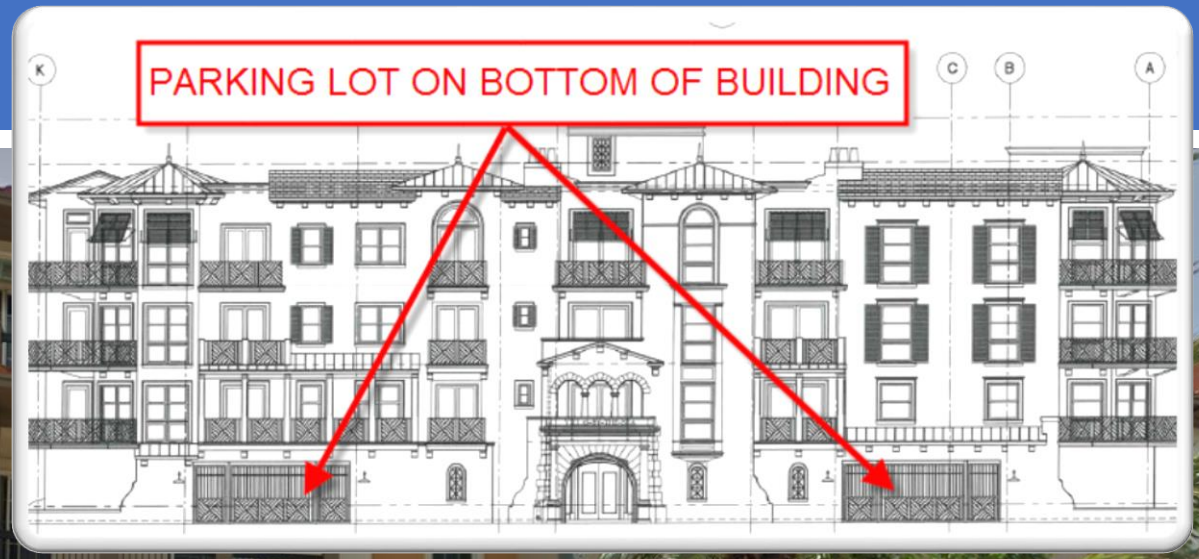


Surface Water Management
Design Example 1

Permitted Conditions

WSWT: **1.5' NAVD**

WATER QUALITY VOLUME

Required: 0.08 acre-feet

Provided
0.08 acre-feet
By 70 LF exfiltration trench

100-YR, 3-DAY PRE-POST MAX

Required: 9.38' NAVD

Provided
9.38' NAVD
By 1 gravity drainage well

SLR Scenario

WSWT: **3.5' NAVD**

WATER QUALITY VOLUME

Required: 0.08 acre-feet

Provided
0.05 acre-feet
By 70 LF exfiltration trench

100-YR, 3-DAY PRE-POST MAX

Required: 9.38' NAVD

Provided
9.65' NAVD
By 1 gravity drainage well

Surface Water Management
Design Example 1

SLR impacts to drainage system

Exfiltration trench lost 37.5% of capacity

- reduced pressure head
- reduced unsaturated depth
- reduced void space
- changes required use of conservative formula

Drainage well lost 34% of discharge capacity

- reduced pressure head on well
- at 342 GPM/foot head
  - Peak discharge reduced from 2011 GPM (4.48 CFS) to 1327 GPM (1.52 CFS)

Surface Water Management
Design Example 1

Permitted Conditions

WSWT: **1.5' NAVD**

WATER QUALITY VOLUME

Required: 0.08 acre-feet

Provided
0.08 acre-feet
By 70 LF exfiltration trench

$15,225*

100-YR, 3-DAY PRE-POST MAX

Required: 9.38' NAVD

Provided
9.38' NAVD
By 1 gravity drainage well

$72,500**

SLR Scenario

WSWT: **3.5' NAVD**

WATER QUALITY VOLUME

Required: 0.08 acre-feet

Provided
0.05 acre-feet
By 70 LF exfiltration trench

100-YR, 3-DAY PRE-POST MAX

Required: 9.38' NAVD

Provided
9.65' NAVD
By 1 gravity drainage well

SLR Adjusted Design

1.6%
Increase in Total Construction Costs

Provided
0.08 acre-feet
By 110 LF exfiltration trench

$23,925*

40 LF additional exfiltration trench

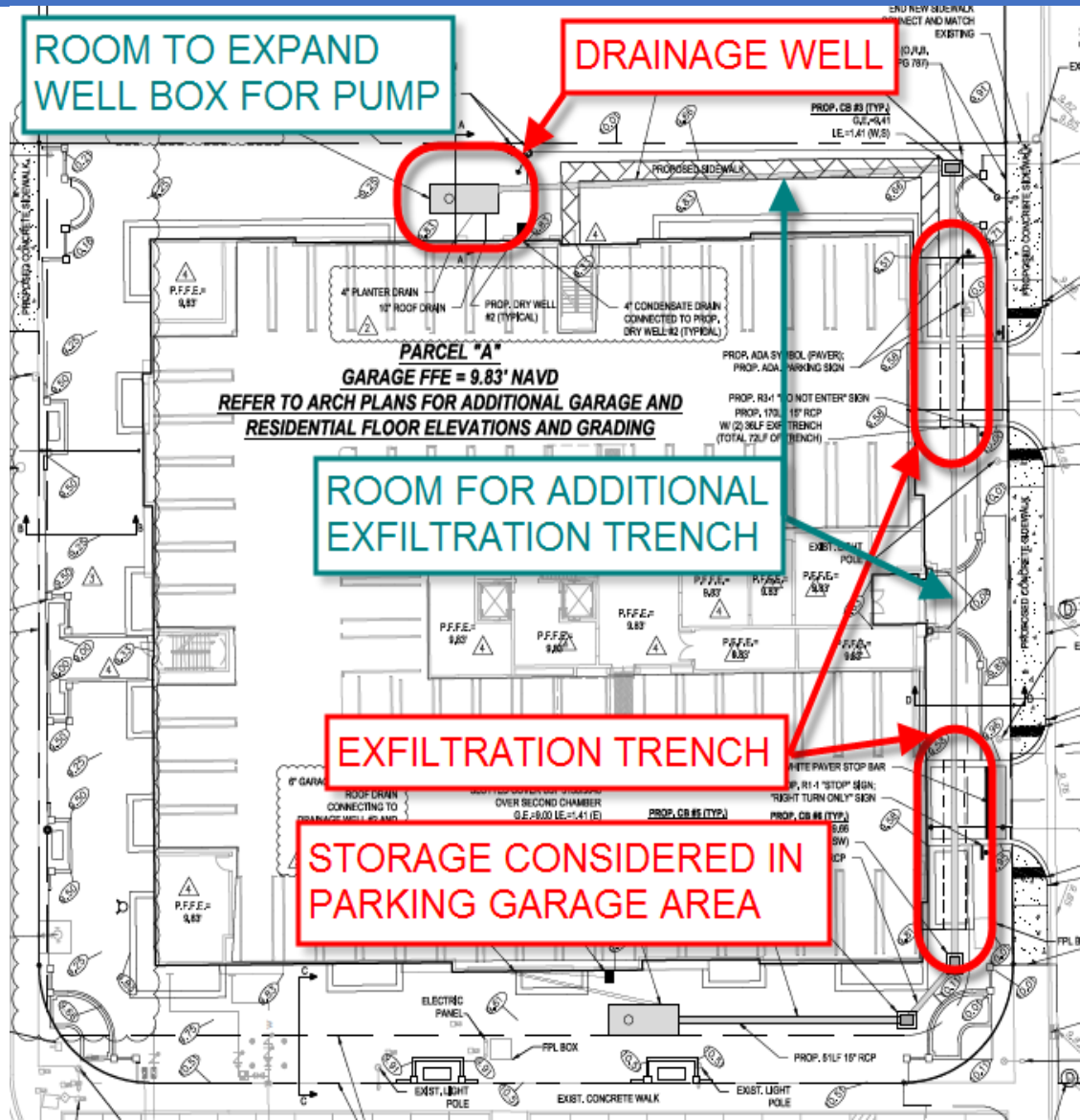
Provided
9.38' NAVD
By 1 pumped drainage well

Added pump to drainage well

Surface Water Management
Design Example 1

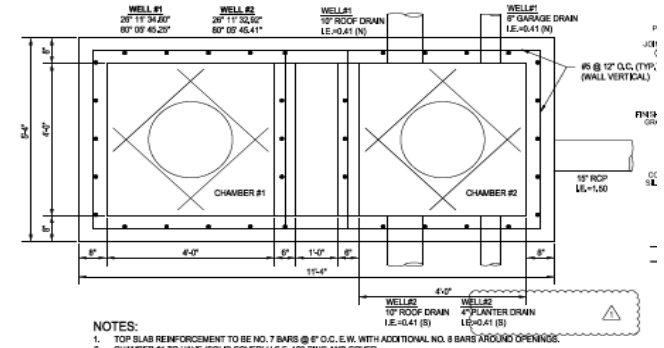
Changes

1. 40 LF additional exfiltration trench
   - Add now or retrofit
2. Pump on drainage well
   - Add now or retrofit

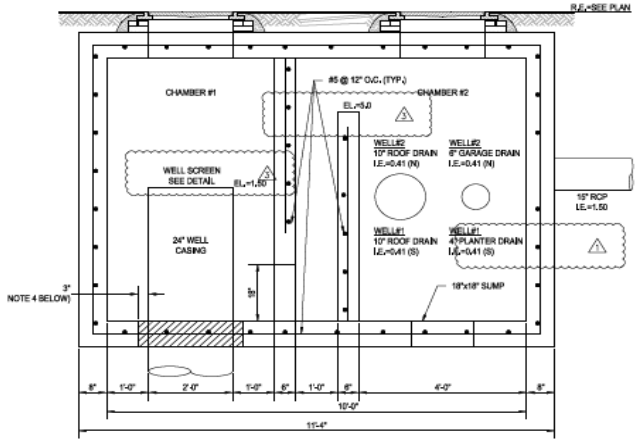


Surface Water Management
Design Example 1

Permitted Condition: Gravity Well



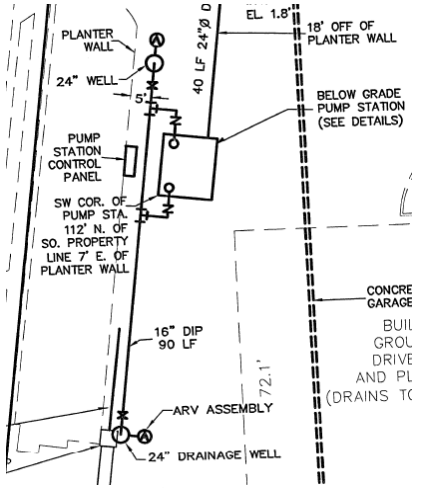
NOTES:
1. TOP SLAB REINFORCEMENT TO BE NO. 7 BARS @ 6" O.C. E.W. WITH ADDITIONAL NO. 8 BARS AROUND OPENINGS.
2. CHAMBER #1 TO HAVE (SOLID COVER) U.S.F. 150 RING AND COVER.
   CHAMBER #2 TO HAVE (SLOTTED COVER) U.S.F. 3130 RING AND 5640 GRATE (OR VALLEY GUTTER/CURB INLET GRATE).
3. SLAB OPENINGS SIZES WITHIN EACH CHAMBER SHALL BE AS REQUIRED BASED UPON INSTALLATION OF FRAME AND GRATE OR RING AND COVER.

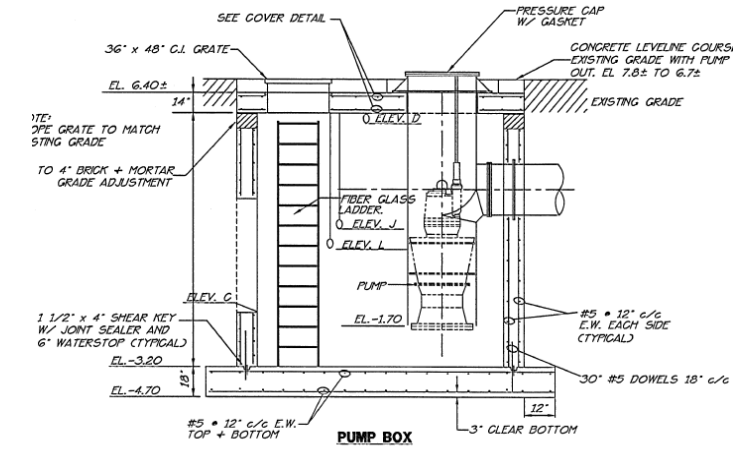


NOTES:
1. SEE PLANS FOR RIM ELEVATIONS AND ROOF DRAIN INVERT ELEVATION.
2. CHAMBER #1 TO HAVE (SOLID COVER) U.S.F. 150 RING AND COVER.
   CHAMBER #2 TO HAVE (SLOTTED COVER) U.S.F. 3130 RING AND 5640 GRATE (OR VALLEY GUTTER/CURB INLET GRATE).
3. CONCRETE=4000 PSI @ 28 DAYS
4. HOLES FOR PIPING SHALL BE 6" LARGER THAN PIPE O.D. AND SHALL BE CAST AT TIME OF FABRICATION.
5. WATER TABLE ELEVATION = 1.41 N.A.V.D.
6. PROVIDE 4 ADDITIONAL (DIAGONAL) TYPE "D" REINFORCEMENT AROUND PIPE OPENING.
4. DESIGN • WELL #1 • 110 GPM/FT. WELL#2 • 232 GPM/FT

PROPOSED DRAINAGE WELL #1/2
SCALE: 1/2" = 1'-0"

SLR Scenario: Change to Pumped Well



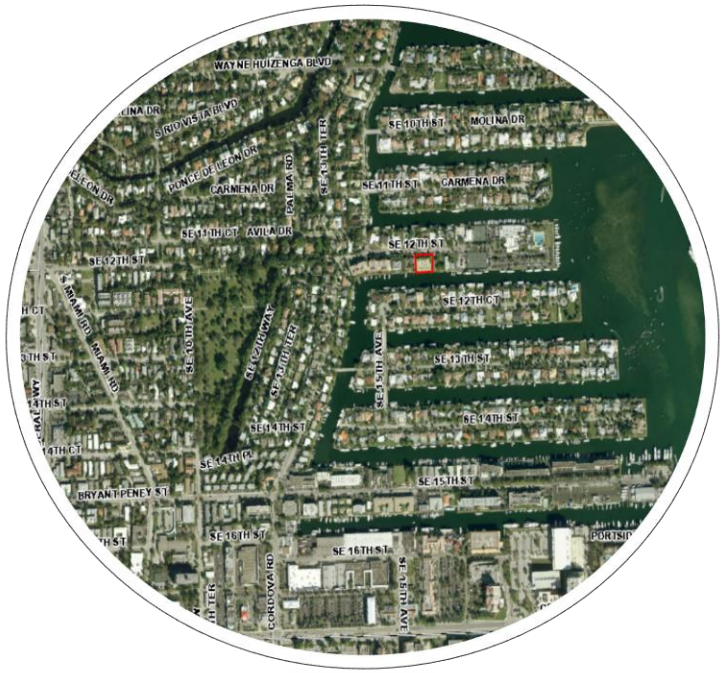


PUMP STATION ELEVATION
SCALE 1"=4'

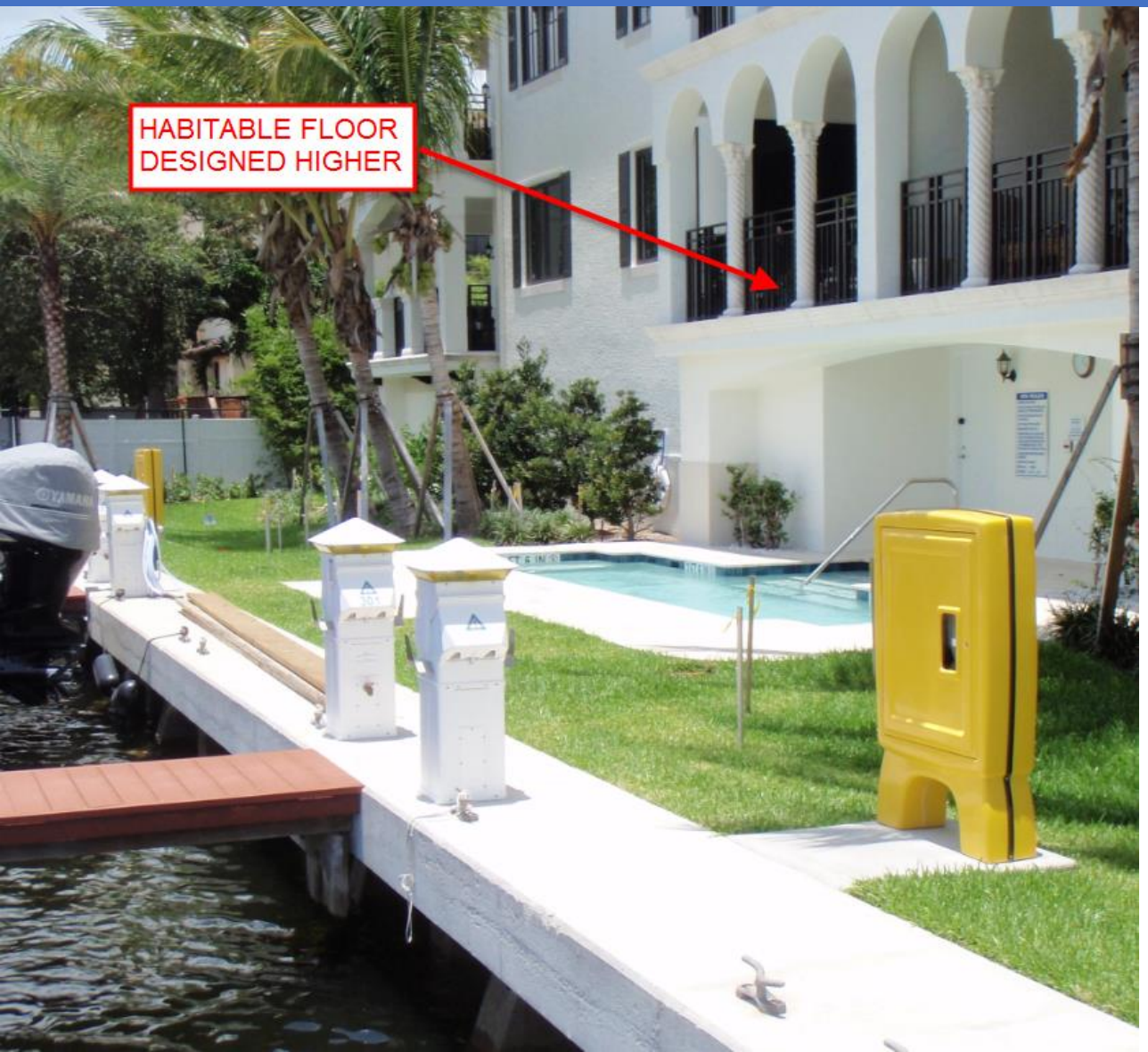
Surface Water Management

Design Example 2

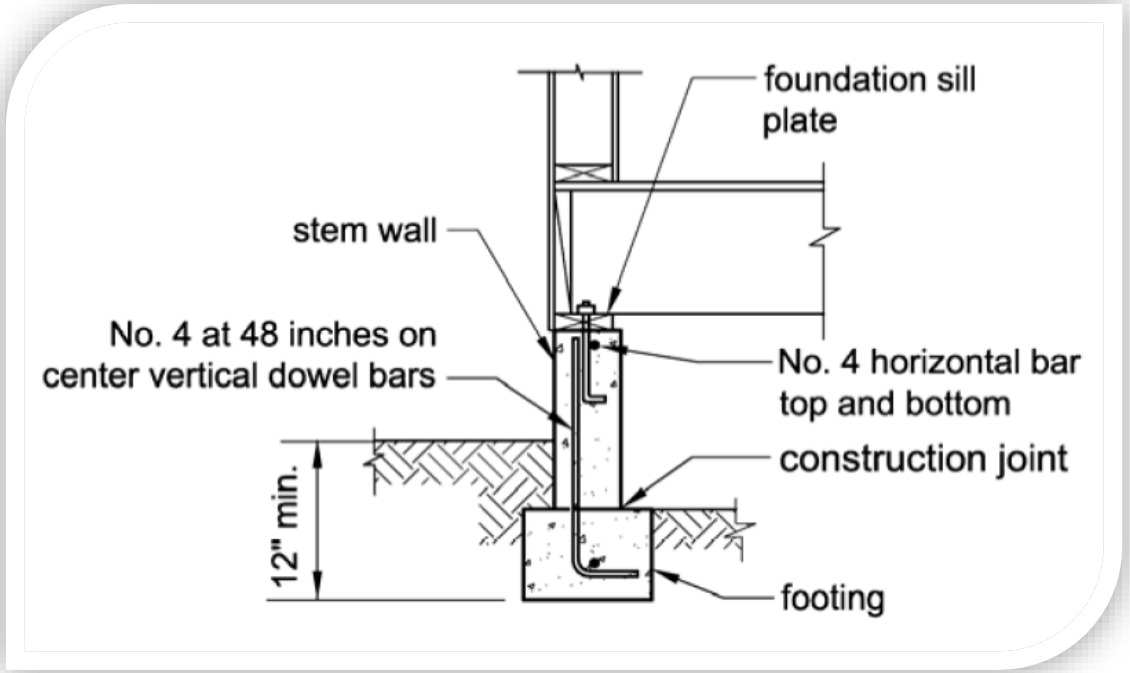
Surface Water Management
Design Example 2



Surface Water Management
Design Example 2



Stem Wall Example



Surface Water Management
Design Example 2

Permitted Conditions

WSWT: **0.5' NAVD**

WATER QUALITY VOLUME

Required: 0.05 acre-feet

Provided
0.05 acre-feet
By 871 ft^2 dry retention

25-YR, 3-DAY CONTAINMENT

Required: 2.55' NAVD perimeter

Provided
2.75' NAVD perimeter berm

SLR Scenario

WSWT: **2.5' NAVD**

WATER QUALITY VOLUME

Required: 0.05 acre-feet

Provided
0 acre-feet
By inundated dry retention

25-YR, 3-DAY CONTAINMENT

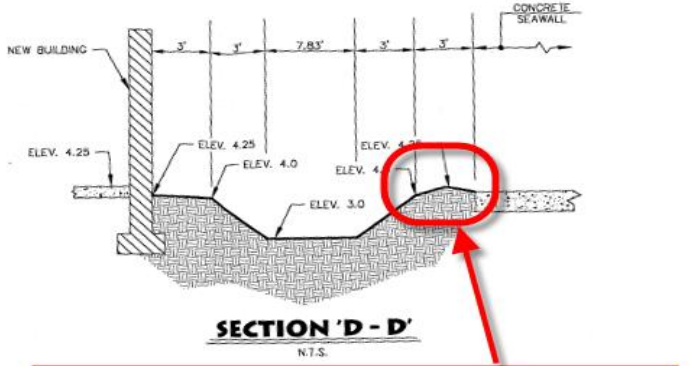
Required: 3.82' NAVD perimeter

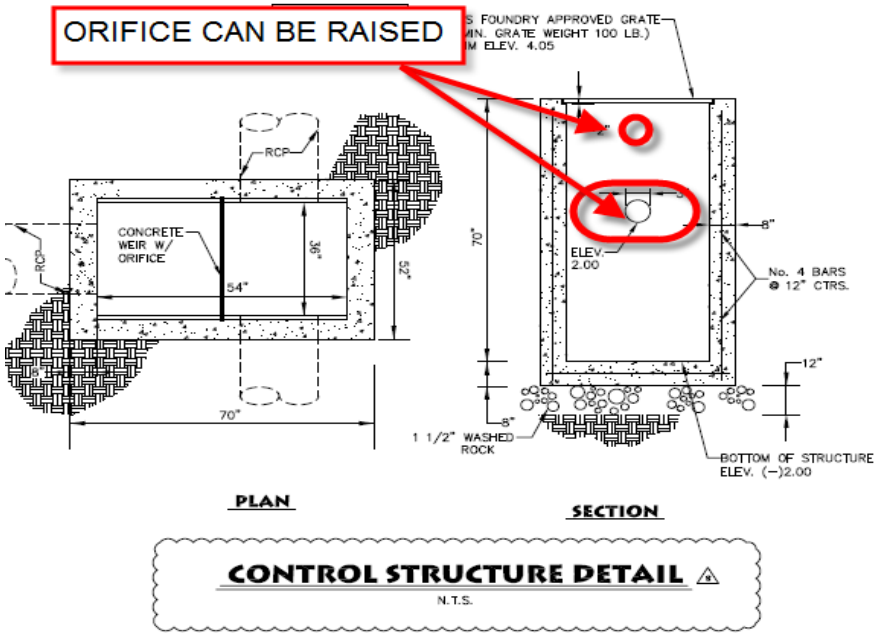
Provided
Overtopped perimeter berm

Surface Water Management
Design Example 2

SLR impacts to drainage system

- Dry retention area completely inundated (elevations to the right are in NGVD)
- All soil storage capacity lost
- Perimeter berm no longer contains 25-yr, 3-day
- Offsite discharge though orifice becomes negligible due to submergence by higher tail water





Surface Water Management
Design Example 2

Permitted Conditions

WSWT: **0.5' NAVD**

WATER QUALITY VOLUME

Required: 0.05 acre-feet

Provided
0.05 acre-feet
By 871 ft² dry retention

$1,160*

25-YR, 3-DAY CONTAINMENT

Required: 2.55' NAVD perimeter

Provided
2.75' NAVD perimeter berm

$6,800**

SLR Scenario

WSWT: **2.5' NAVD**

WATER QUALITY VOLUME

Required: 0.05 acre-feet

Provided
0 acre-feet
By inundated dry retention

25-YR, 3-DAY CONTAINMENT

Required: 3.14' NAVD perimeter berm

Provided
Overtopped perimeter berm

SLR Adjusted Design

1.0%
Increase in Total Construction Costs

Provided
0.05 acre-feet
By 85 LF exfiltration trench

85 LF exfiltration trench

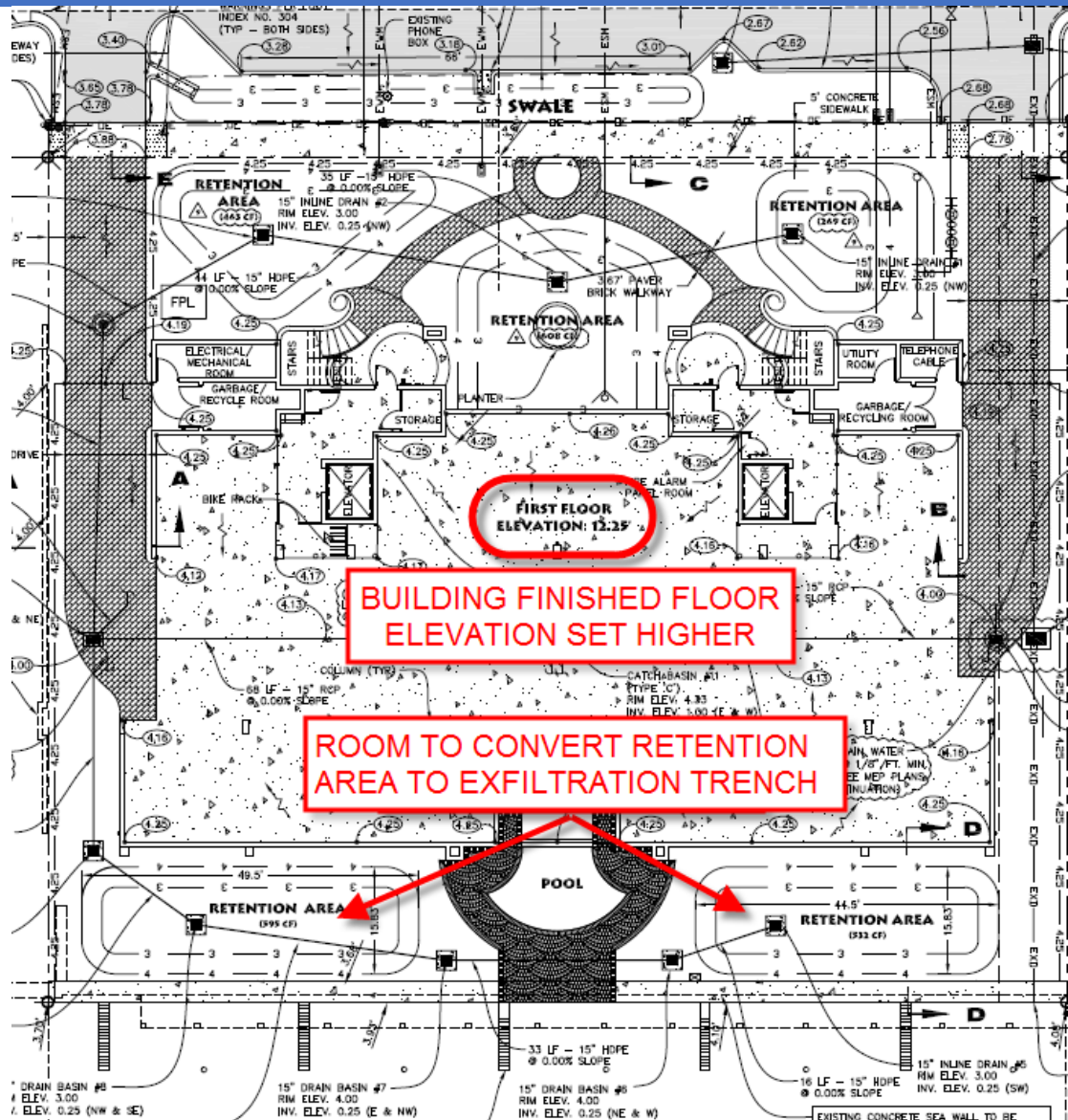
Provided
3.14' NAVD perimeter berm

Raise berm (5in) and orifice (2ft)

Surface Water Management
Design Example 2

Changes

1. Portions of the retention area converted to 85 LF exfiltration trench.
2. Raise orifice 2 feet to match the higher water table
3. Raise the perimeter berm 5 inches to bring the 25-yr, 3-day into compliance.



Questions?