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
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
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.
CCSM Results - Difference Against Base
Comparison of 1990’s averages to 2060’s averages

May-Oct

Aug-Oct

Jul-Sep
HadCM3 Results - Future Wet Season Averages

Legend

- May-Oct
- Aug-Oct
- Jul-Sep
HadCM3 Results - Difference Against Base

May-Oct

Aug-Oct

Jul-Sep
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 coastal areas
• 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
Final Map

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

\[
L = \frac{\text{FS} \times (\% \text{WQ})(V_{\text{wq}}) + V_{\text{add}}}{K(\text{H}_2 \text{W} + 2\text{H}_2 \text{D}_u - \text{D}_u^2 + 2\text{H}_2 \text{D}_s) + (1.39 \times 10^{-4})\text{W}\text{D}_u}
\]

Conservative Formula

(Required when \( \text{D}_s > \text{D}_u \), a likely condition in a SLR scenario)

\[
L = \frac{\text{FS} \times (\% \text{WQ})(V_{\text{wq}}) + V_{\text{add}}}{K(2\text{H}_2 \text{D}_u - \text{D}_u^2 + 2\text{H}_2 \text{D}_s) + (1.39 \times 10^{-4})\text{W}\text{D}_u}
\]
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
Design Example 1
Surface Water Management

Design Example 1

PARKING LOT ON BOTTOM OF BUILDING
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
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

<table>
<thead>
<tr>
<th>Permitted Conditions</th>
<th>SLR Scenario</th>
<th>SLR Adjusted Design</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WSWT:</strong> 1.5’ NAVD</td>
<td><strong>WSWT:</strong> 3.5’ NAVD</td>
<td><strong>WSRT:</strong> 3.5’ NAVD</td>
</tr>
<tr>
<td><strong>WATER QUALITY VOLUME</strong></td>
<td><strong>WATER QUALITY VOLUME</strong></td>
<td><strong>Increase in Total Construction Costs</strong></td>
</tr>
<tr>
<td>Required: 0.08 acre-feet</td>
<td>Required: 0.08 acre-feet</td>
<td>1.6% Increase in Total Construction Costs</td>
</tr>
<tr>
<td>Provided 0.08 acre-feet By 70 LF exfiltration trench</td>
<td>Provided 0.05 acre-feet By 70 LF exfiltration trench</td>
<td>40 LF additional exfiltration trench</td>
</tr>
<tr>
<td>100-YR, 3-DAY PRE-POST MAX</td>
<td>100-YR, 3-DAY PRE-POST MAX</td>
<td>Added pump to drainage well</td>
</tr>
<tr>
<td>Required: 9.38’ NAVD</td>
<td>Required: 9.38’ NAVD</td>
<td>Provided 9.38’ NAVD By 1 pumped drainage well</td>
</tr>
<tr>
<td>Provided 9.38’ NAVD By 1 gravity drainage well</td>
<td>Provided 9.65’ NAVD By 1 gravity drainage well</td>
<td>Provided 9.38’ NAVD By 1 gravity drainage well</td>
</tr>
</tbody>
</table>

**Costs:**
- **Permitted Conditions:**
  - Provided 0.08 acre-feet By 70 LF exfiltration trench: $15,225*
  - Provided 9.38’ NAVD By 1 gravity drainage well: $72,500**
- **SLR Scenario:**
  - Provided 0.05 acre-feet By 70 LF exfiltration trench: $23,925*
- **SLR Adjusted Design:**
  - Provided 0.08 acre-feet By 110 LF exfiltration trench: $23,925*
  - Provided 9.38’ NAVD By 1 gravity drainage well: $72,500**
  - Provided 9.38’ NAVD By 1 pumped drainage well: $23,925*
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

SLR Scenario: Change to Pumped Well
Surface Water Management
Design Example 2
HABITABLE FLOOR DESIGNED HIGHER
Surface Water Management
Design Example 2

Stem Wall Example

HABITABLE FLOOR DESIGNED HIGHER
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
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

25-YR, 3-DAY CONTAINMENT
Required: 2.55’ NAVD perimeter
Provided
2.75’ NAVD perimeter berm

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 Scenario

WSWT: 2.5’ NAVD
WATER QUALITY VOLUME
Required: 0.05 acre-feet
Provided
0.05 acre-feet
By 85 LF exfiltration trench

25-YR, 3-DAY CONTAINMENT
Required: 3.14’ NAVD perimeter berm
Provided
3.14’ NAVD perimeter berm

SLR Adjusted Design

WSWT: 2.5’ NAVD
WATER QUALITY VOLUME
Required: 0.05 acre-feet
Provided
0.05 acre-feet
By 85 LF exfiltration trench

25-YR, 3-DAY CONTAINMENT
Required: 3.14’ NAVD perimeter berm
Provided
3.14’ NAVD perimeter berm

1.0% Increase in Total Construction Costs

$1,160*
$6,800**
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.