FES STORMWATER WORKSHOP 2010

GEOTECHNICAL FACTORS TO CONSIDER IN DESIGNING BMPS

Understanding Florida's New Stormwater Quality Criteria

FLORIDA ENGINEERING SOCIETY

When: Thursday, September 23rd
Where: The Westin Lake Mary, Orlando North
2974 International Parkway
Lake Mary, FL 32746-1409

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PRAGMATISM
FDEP
STORMWATER

Table Of Contents

Presentation

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Home Study

PART 1

Implications of the New Stormwater Rule In Terms of Dry Retention Requirements

New FDEP Stormwater Rule

for Stormwater Treatment

New stormwater regulations will mandate:

- An 85% reduction of post-development nutrient loading, or

- No net increase in post-development nutrient loading compared to predevelopment (natural vegetative community), i.e., Post <= Pre

Calculations based on average annual nutrient loading (N & P), in kilograms per year.

Predevelopment is not the same as existing conditions. Visualize current site with a natural land cover condition, as if no clearing or earthwork had been done.

Stormwater Treatment Performance Standards

	REDEVELOPMENT SITES ≤ 2 ACRES	ALL OTHER ACTIVITIES
NON-OFWs	85% or Post = Pre, whichever is less, Unless feasibility analysis demonstrates lower level is appropriate	85% or Post = Pre, whichever is less
OFW	Post = Pre, Unless feasibility analysis demonstrates lower level is appropriate	Post = Pre
IMPAIRED WATERS	85% or Post = Pre, whichever is less, Unless feasibility analysis demonstrates lower level is appropriate AND Net Improvement for pollutant not meeting water quality standards	85% or Post = Pre, whichever is less, OR, if the water body is an OFW Post = Pre AND In either case net improvement for the pollutant not meeting water quality standards
IMPAIRED WATERS WITH ADOPTED TMDL OR BMAP	85% or Post = Pre, whichever is less, Unless feasibility analysis demonstrates lower level is appropriate AND Net improvement or TMDL/BMAP % reduction, whichever is greater, pollutant not meeting water quality standards	85% or Post = Pre, whichever is less, Or, if the water body is an OFW Post=Pre AND In either case net improvement or TMDL/BMAP % reduction, whichever is greater, for the pollutant not meeting water quality standards

Dry Pond Example, Required Retention Depth

For Type A soils in Central Florida

Development Type	Curve Number	DCIA	Existing SJRWMD Rule, Retention Depth (in)	85% Reduction FDEP Rule, Retention Depth (in)	Post = Pre FDEP Rule, Retention Depth (in)
Low Density Residential	43.8	7.5	1	0.3	1.3
Single Family	48.4	22.8	1	0.5	3.1
Multi-Family	68.1	66.4	1.5	1.2	4+
High Intensity Commercial	66.9	81	1.6	1.4	4+

Notes:

1. Existing SJRWMD calculated for online treatment.
2. Post = Pre calculated using predevelopment Event Mean Concentration, for generic Undeveloped/Rangeland/Forrest.

Dry Pond Example, Required Retention Depth

For Type B soils in Central Florida

Development Type	Curve Number	DCIA	Existing SJRWMD Rule, Retention Depth (in)	85% Reduction FDEP Rule, Retention Depth (in)	Post = Pre FDEP Rule, Retention Depth (in)
Low Density Residential	64	7.5	1	0.7	1.1
Single Family	66.9	22.8	1	0.8	2.4
Multi-Family	79.3	66.4	1.5	1.4	4+
High Intensity Commercial	78.5	81	1.6	1.5	4+

Notes:

1. Existing SJRWMD calculated for online treatment.
2. Post = Pre calculated using predevelopment Event Mean Concentration, for generic Undeveloped/Rangeland/Forrest.

Dry Pond Example, Required Retention Depth

For Type C soils in Central Florida

Development Type	Curve Number	DCIA	Existing SJRWMD Rule, Retention Depth (in)	85% Reduction FDEP Rule, Retention Depth (in)	Post = Pre FDEP Rule, Retention Depth (in)
Low Density Residential	75.9	7.5	1	1.0	1.0
Single Family	77.8	22.8	1	1.1	1.4
Multi-Family	85.9	66.4	1.5	1.5	4+
High Intensity Commercial	85.4	81	1.6	1.6	4+

Notes:

1. Existing SJRWMD calculated for online treatment.
2. Post = Pre calculated using predevelopment Event Mean Concentration, for generic Undeveloped/Rangeland/Forrest.

Dry Pond Example, Required Retention Depth

For Type D soils in Central Florida

Development Type	Curve Number	DCIA	Existing SJRWMD Rule, Retention Depth (in)	85% Reduction FDEP Rule, Retention Depth (in)	Post = Pre FDEP Rule, Retention Depth (in)
Low Density Residential	81.5	7.5	1	1.2	1.0
Single Family	82.9	22.8	1	1.2	1.9
Multi-Family	88.9	66.4	1.5	1.5	3.6
High Intensity Commercial	88.5	81	1.6	1.6	3.4

Notes:

1. Existing SJRWMD calculated for online treatment.
2. Post = Pre calculated using predevelopment Event Mean Concentration, for generic Undeveloped/Rangeland/Forrest.

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PART **2**

Key Geotechnical Highlights And Concerns In Draft Stormwater Quality Rule

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Key Geotechnical Highlights and Concerns

- Underdrain systems may become BMP pariah, making development on shallow water table sites onerous.
- Dry detention has been cast aside as a pariah – need to reconsider bringing it back from exile, maybe as a hybrid underdrain system.
- Requirement for four feet of filter material in a stormwater harvesting system needs to be revisited; advocate a more tempered view of the cyanobacteria concern.
- Mandating that the control elevation for wet detention be no less than SHGWT minus 6 inches will require too much site filling. Recommend a more flexible range of control elevations.

Key Geotechnical Highlights and Concerns (cont'd.)

- Sensitive Karst Areas (SKAs) are not mapped out in current FDEP rule. SKA boundaries should be left to the individual water management district based on their experience (no FAVA maps).
- For wet detention systems, consideration for substantial nitrate removal in managed aquatic systems will be needed, otherwise these much used systems may no longer be viable. Another option is to focus on phosphorus as a surrogate nutrient for removal, instead of applying the same removal efficiencies for both phosphorus and nitrogen (for example, 85% P, 40% N removal).

PART 3

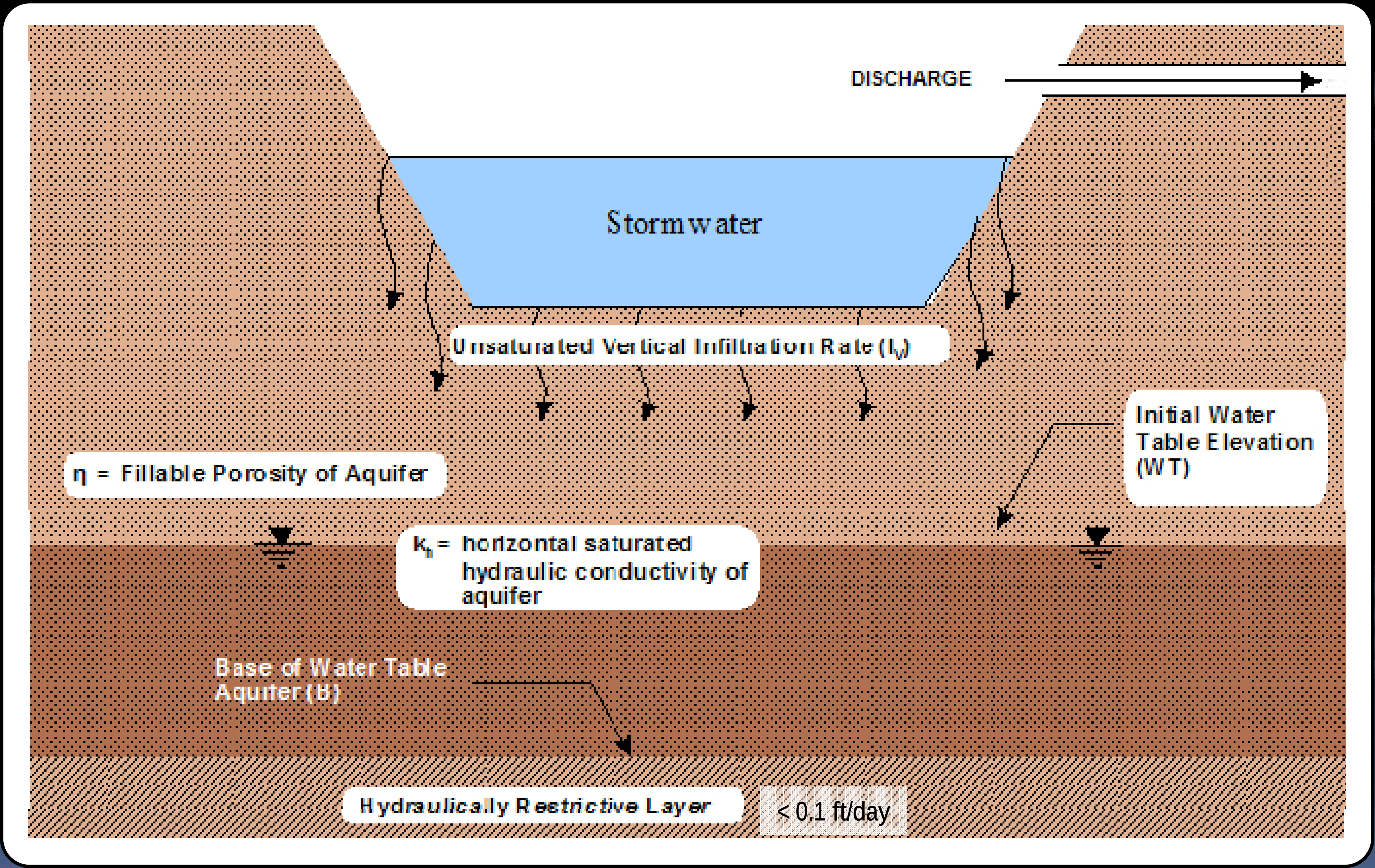
GEOTECHNICAL INVESTIGATION

TO ESTIMATE AQUIFER PARAMETERS

Geotechnical Investigation to Estimate Aquifer Parameters

- Note the word is estimate & not determine.
- Must appreciate the physical meaning of each aquifer parameter.
- Aquifer, in this sense, does not refer to the Floridan aquifer but usually the uppermost sand aquifer into which the pond is excavated.
- This task should be conducted by an experienced geotechnical engineer.
- Two important references:
  - SWFWMD Training Workshop on SHWT (1998 Edition)
  - Section 7.2 of SJRWMD Special Publication SJ93-SP10

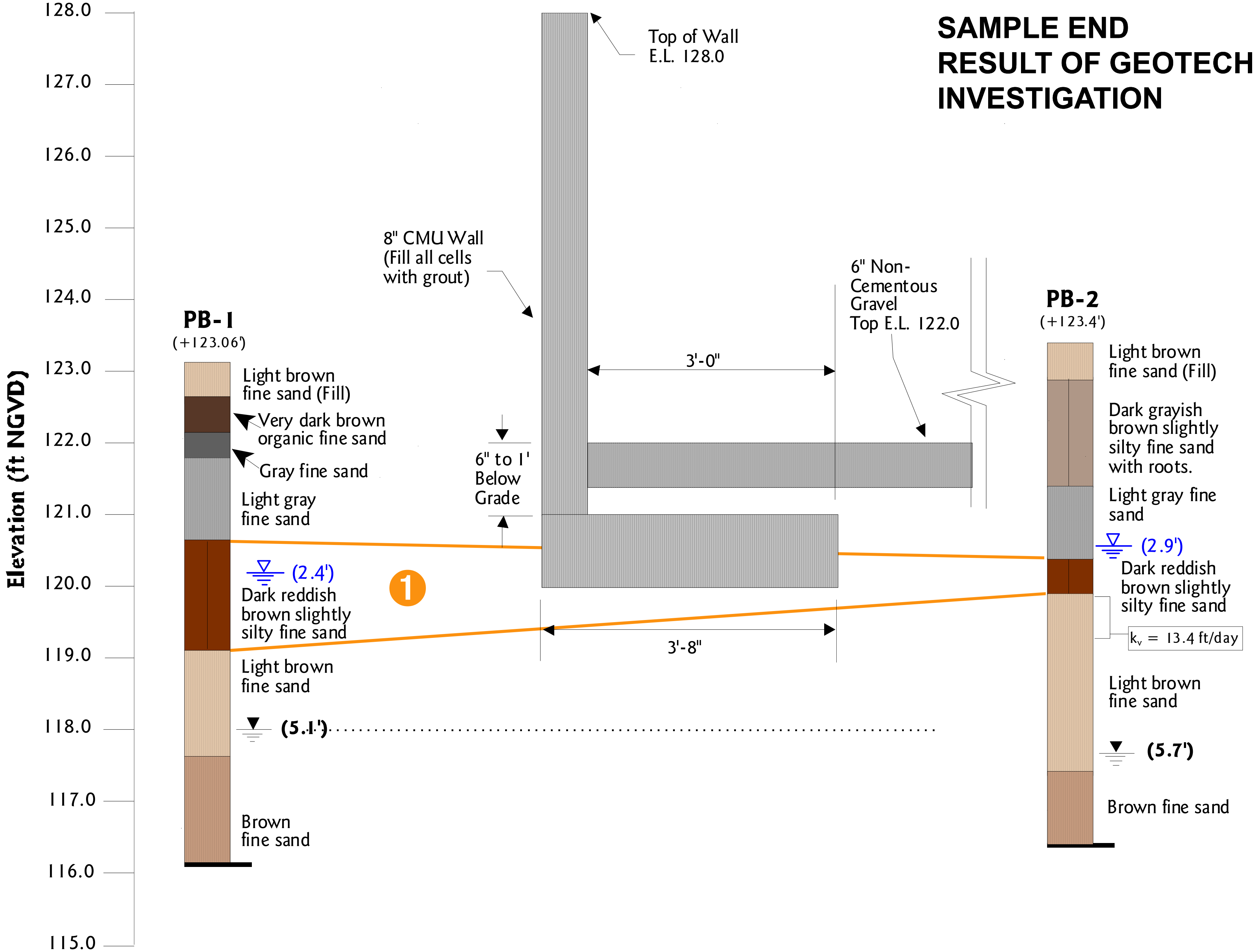
Visualization of the Aquifer Parameters (Parsimony)



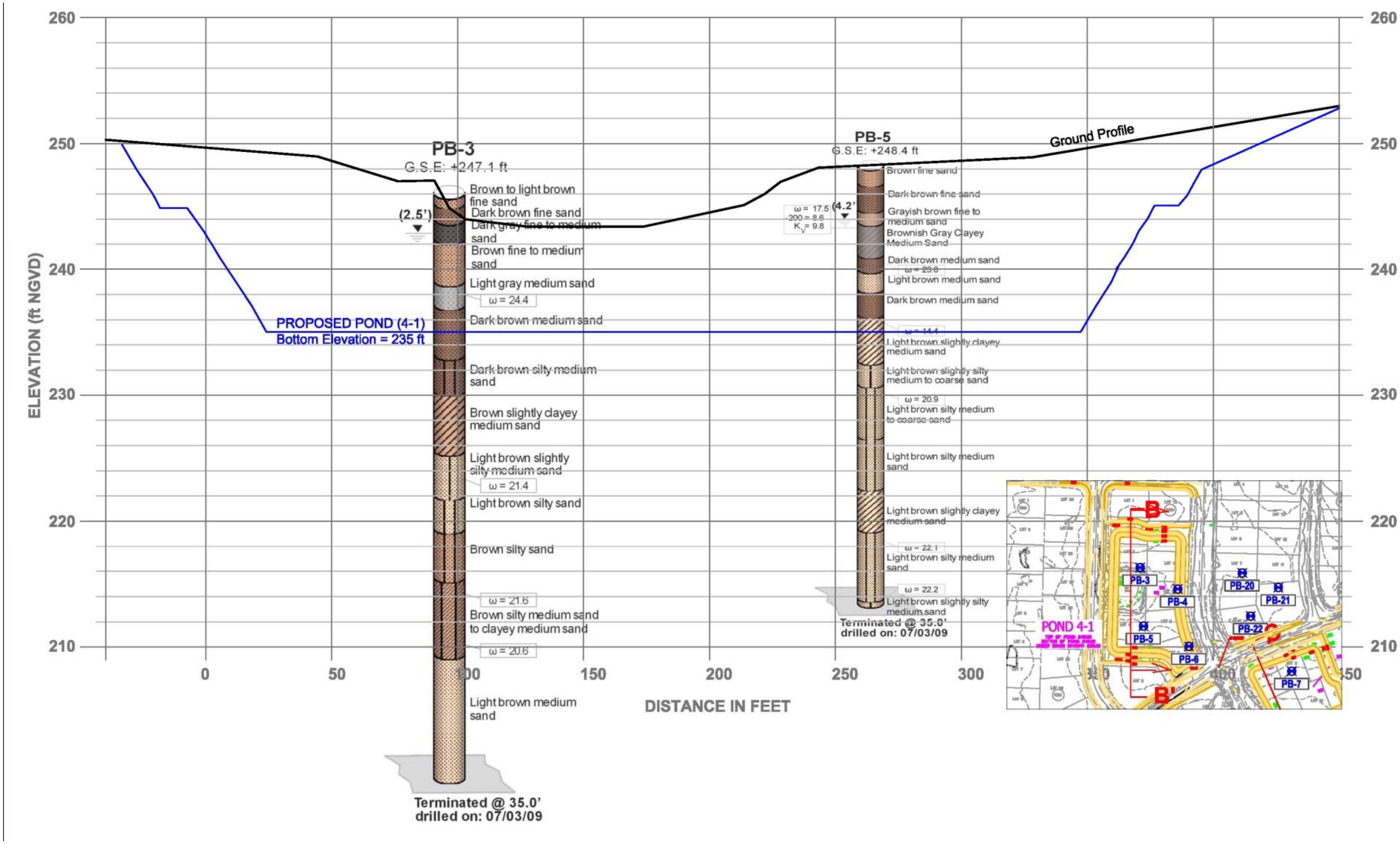
GEOTECHNICAL INVESTIGATION - STORMWATER PONDS

- Objective of the soils report is to provide numerical values for the following aquifer parameters:
  - Seasonal high water table (ft NGVD); use contour map if strongly sloping
  - Seasonal fluctuation of water table (ft) [only for wet pond]
  - Base of effective aquifer (ft NGVD)
  - Weighted horizontal hydraulic conductivity of effective aquifer (ft/day)
  - Fillable porosity
  - Unsaturated vertical infiltration rate (ft/day) [only for dry pond where unsaturated flow is being considered]
- Parameters should be clearly stated in one section or in a table of the soils report. It should not be buried within the verbiage of the report.

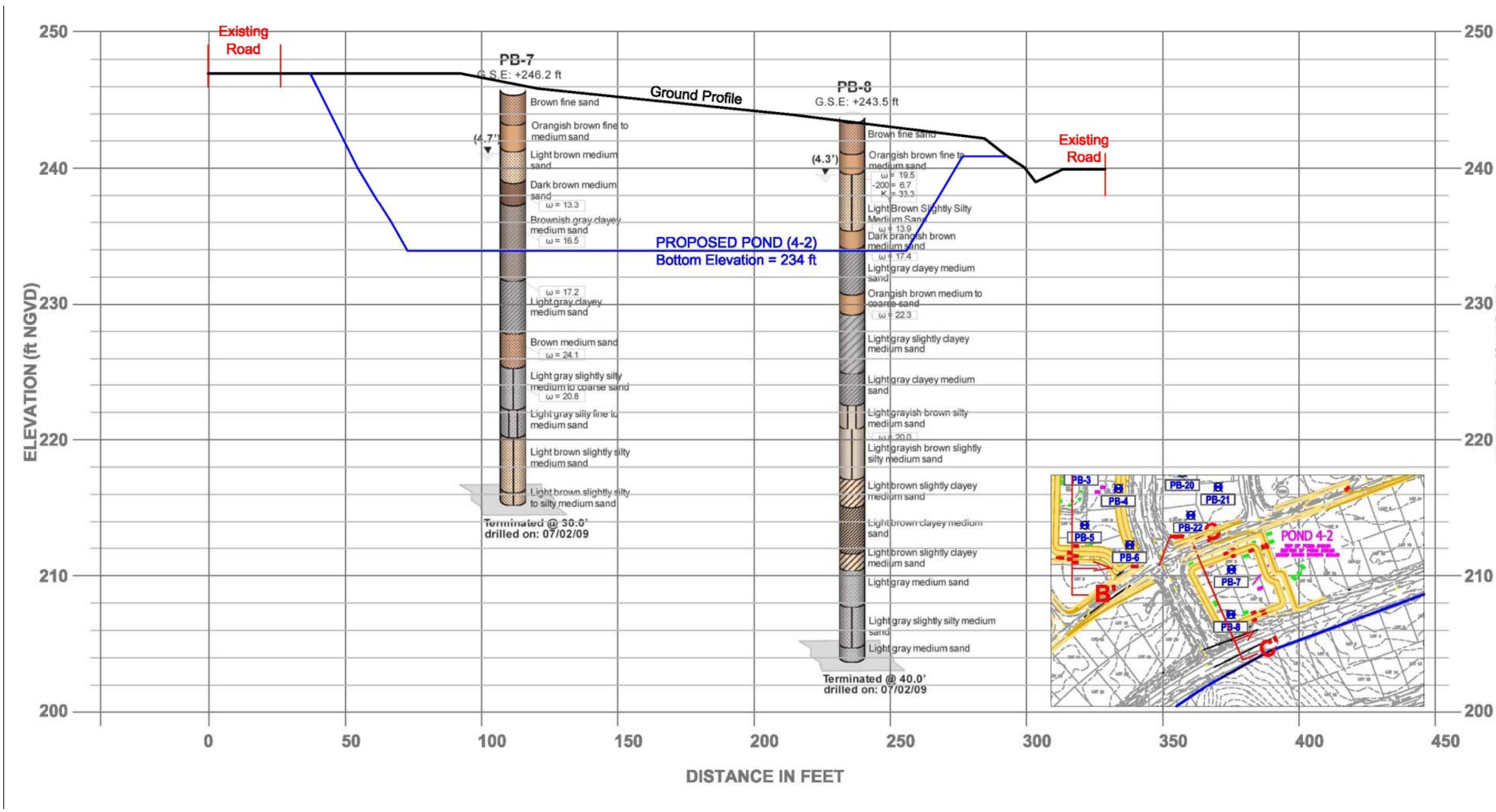
SAMPLE END RESULT OF GEOTECH INVESTIGATION



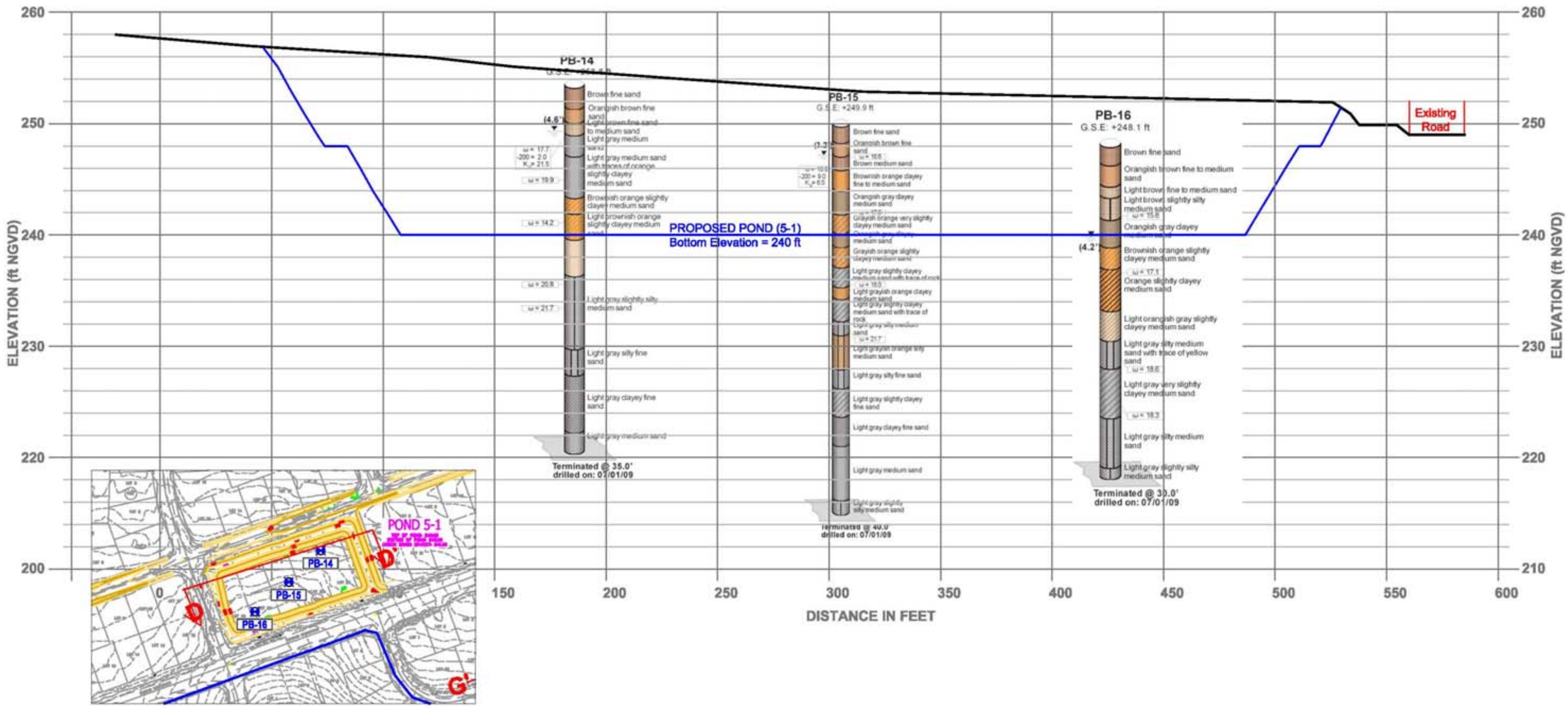
SAMPLE END RESULT OF GEOTECH INVESTIGATION



SAMPLE END RESULT OF GEOTECH INVESTIGATION



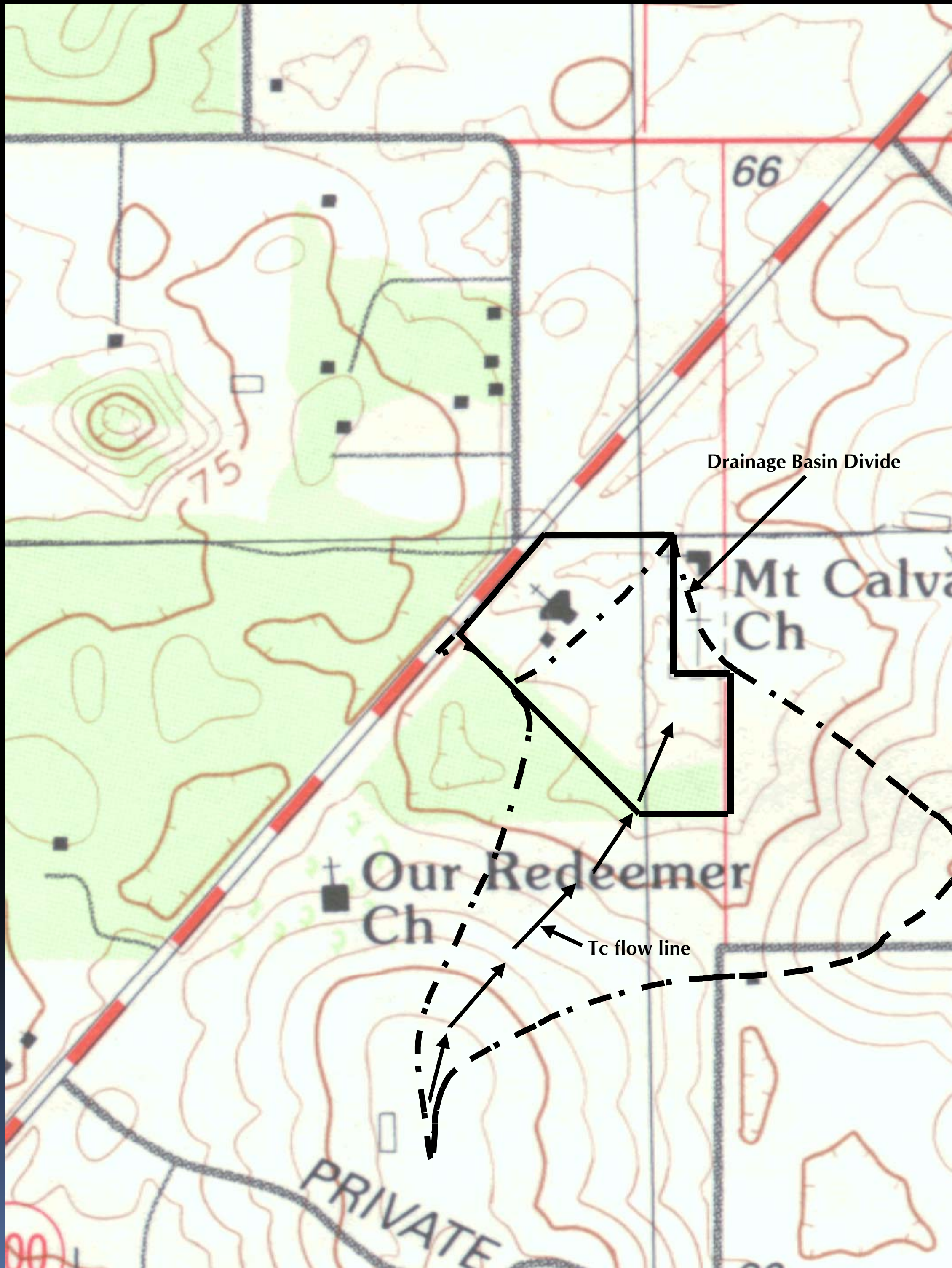
SAMPLE END RESULT OF GEOTECH INVESTIGATION

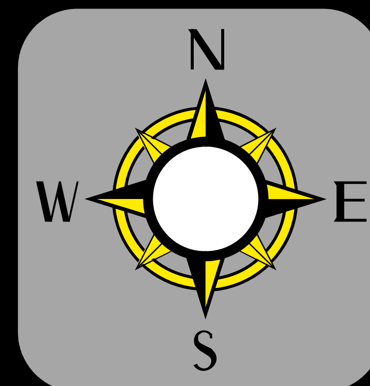


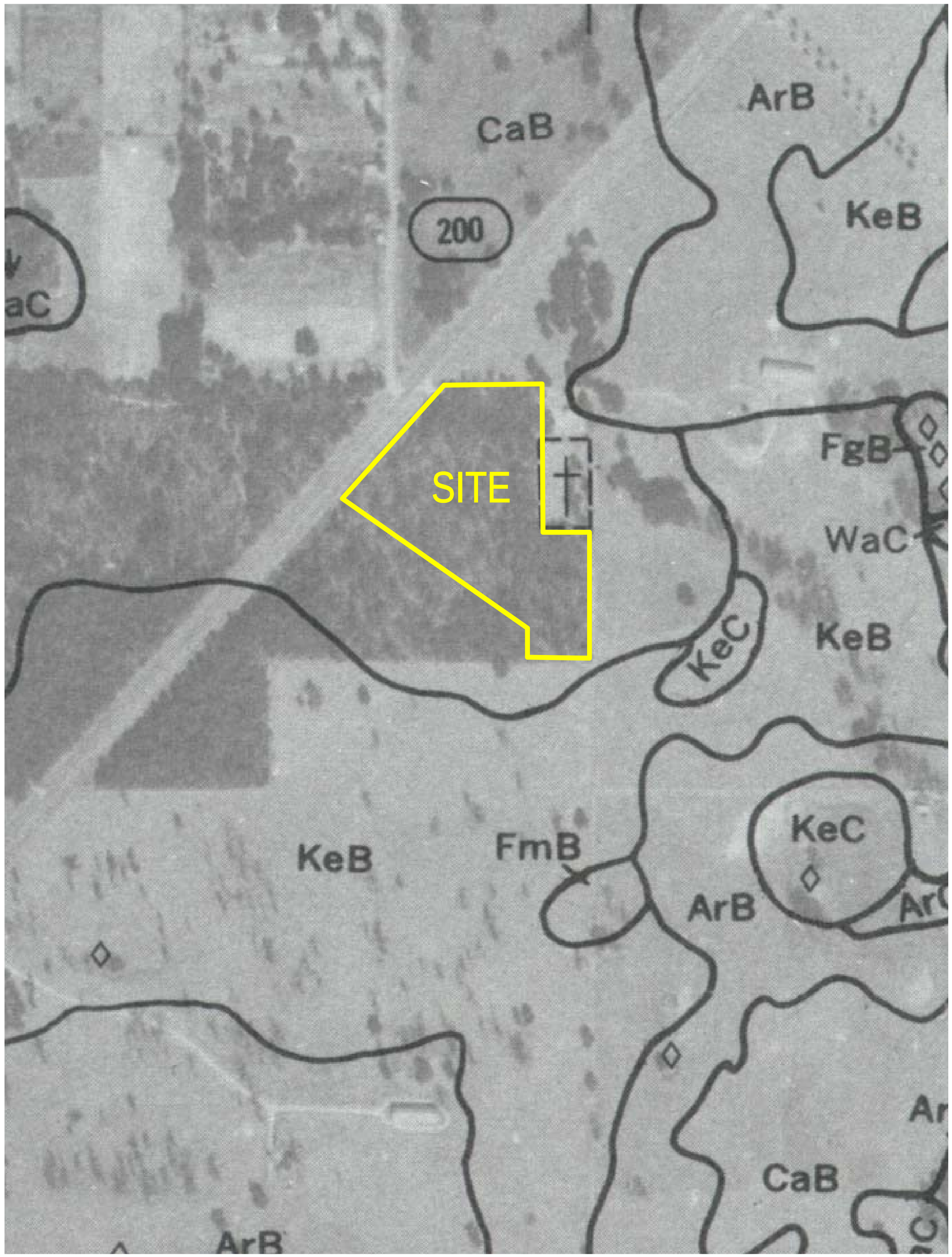
GEOTECHNICAL INVESTIGATION - STORMWATER PONDS

- Review of published data to include:
  - USGS quad map (look at lay of the land and any closed depressions, and contributing drainage basins; good practice to field verify drainage basin divides).
  - NRCS soils map. NRCS data is now available on the internet.
  - Aerial photos, including historical aerial photos in some instances
  - Sub regional map of potentiometric surface of Florida aquifer and compare to land surface elevation or water table elevation
- Map data to include:
  - Location of pond within development
  - Location of adjacent water bodies and wetlands and their water elevations

REVIEW USGS QUADRANGLE MAP







REVIEW NRCS SOILS MAP

Legend:

CaB - Candler sand
0 to 5 % slopes

Table 3: Key NRCS Characterization Data for Arredondo Sand [ArB (0-5% slopes)]

This is a nearly level to sloping, well drained soil that occurs as both large and small areas in the upland. The water table is at a depth of more than 72 inches.		
Hydrologic Soil Group (HSG)		A
REPRESENTATIVE SOIL PROFILE		
Depth	Soil Color & Texture	Permeability
0 - 7 in	dark grayish brown sand	12 to 40 ft/day
7 - 18 in	mixed yellowish brown and dark yellowish brown sand	
18 - 46 in	yellowish brown sand	
46 - 65 in	strong brown sand	
65 - 70 in	strong brown loamy sand	4 to 12 ft/day
70 - 90 in	strong brown fine sandy loam	

Minimum Requirements for Geotech Report

- Site-specific geotechnical data to include:
  - Location of borings within or adjacent to pond. The geotechnical engineer should select the number of pond borings based on the size of the pond. For guidance on the number of borings, refer to page 162 of SJ93-SP10.
  - Soil profiles with stabilized water table measurements at time of drilling
  - Results of hydraulic conductivity tests (if performed). Report should also state type of hydraulic conductivity test performed and reference the location and depth of the test
  - Explicit recommendations for each aquifer parameter

Estimating Aquifer Parameters

- Aquifer thickness: Refer to Section 7.2.1 of SJRWMD SJ93-SP10 for the recommended type and number of soil borings. Also refer to this section for how the soil profile should be interpreted.

- Fillable porosity: Refer to Section 7.2.4 of SJRWMD SJ93-SP10 for recommendations on how to estimate fillable porosity. Rules of thumb: 30% for HSG "A", 25% for HSG "B" & "C", and 20% for HSG "D".

- Weighted horizontal hydraulic conductivity: Refer to Section 7.2.3 of SJRWMD SJ93-SP10 for recommended test procedures and how the weighted average should be computed.

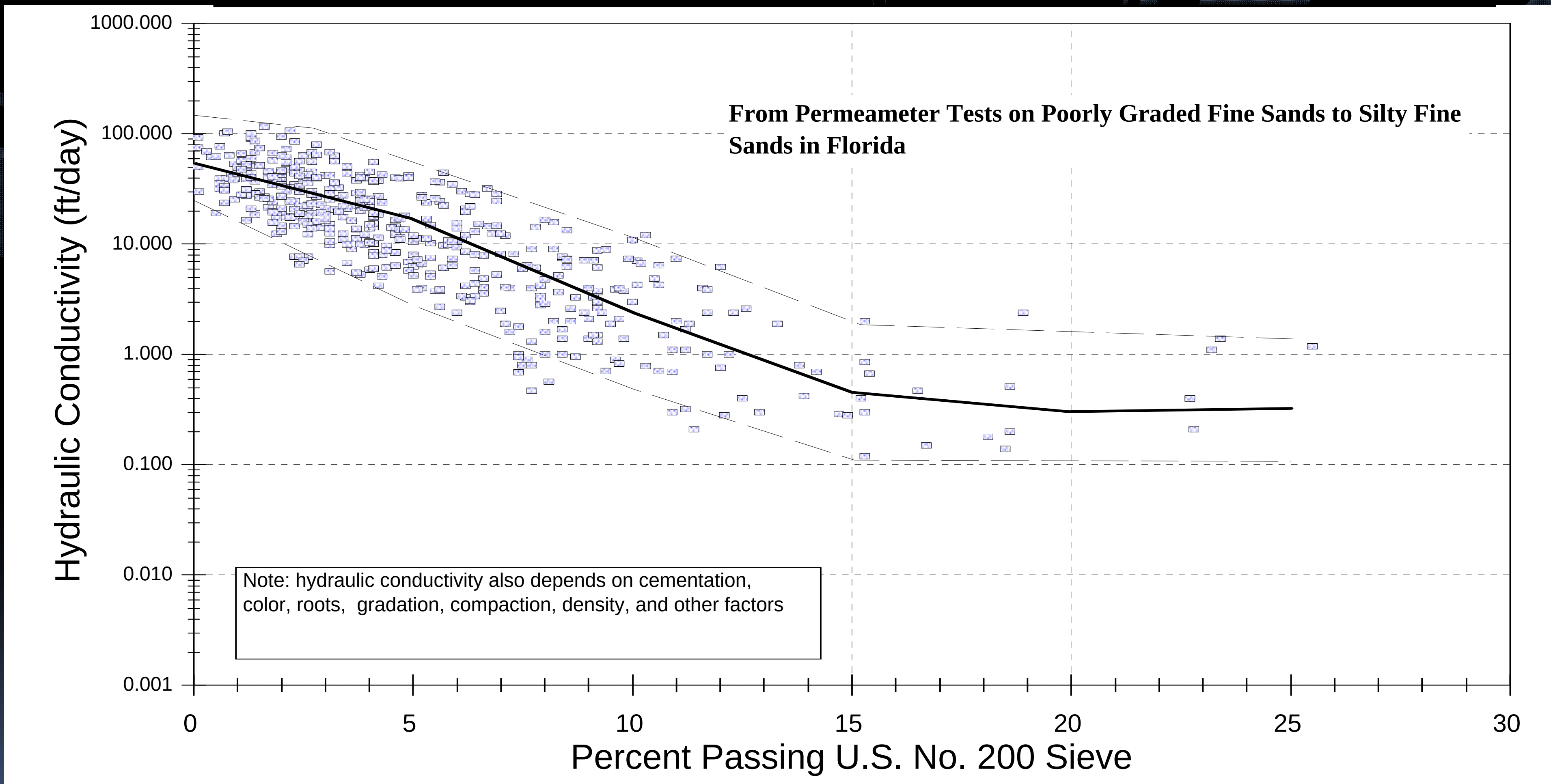
- Unsaturated vertical infiltration rate: use Double Ring Infiltrometer test (described later). Apply minimum safety factor of 2 to measured rate.

Estimating Aquifer Parameters (Continued)

- Seasonal high water table: Refer to Section 7.2.2 of SJRWMD SJ93-SP10 for the recommended procedure.

- Seasonal fluctuation of the water table: typically 3 to 4 ft in the pine flatwood soils and 6 ft or more in the sand ridge soils.

Typical Correlation Between Fines Fraction & Hydraulic Conductivity for Florida Fine Sands



PART 4

GEOTECHNICAL ENGINEERING PITFALLS

IN STORMWATER POND DESIGN

TOPICS

1. Dry Ponds and Mis-Estimated Seasonal High Water Table
2. Dry Bottom Ponds Excavated into Clayey Soils
3. Pond Berm Failures & Flooding Consequences
4. Flooding of Land Locked Lakes
5. Land-Locked Basins Affected by Floridan Aquifer
6. Seepage Through Pond Berms
7. Side Slope Failures Due to Storm-Induced Wave Action
8. Drought
9. Failure of Clay Liner in Regional Stormwater Pond

TOPICS

10. Sinkhole Drying up Lake in Seminole County
11. Sinkholes in Stormwater Pond
12. Clayey Pond Bottom causing Muddy Appearance in Wet Pond
13. Pond NWL and Pavement Grade Separation Problem
14. Pond NWL Stabilizing Lower than Expected due to Perched Water Table
15. Pond NWL Stabilizing Lower than Expected Value
16. Slow Recovery of Water Level in Lakes after Completion of Dewatering
17. Siltation of Pond Bottom During Construction

TOPIC # 1

DRY PONDS AND MIS-ESTIMATED SEASONAL HIGH WATER TABLE

Dry Ponds and Mis-Estimated Seasonal High Water Table – Arbor Ridge

Actual Seasonal High Water Table = +75 ft Pond Bottom - +65 ft
Seasonal High Water Table Assumed by engineer = +63 ft

Dry Ponds and Mis-Estimated Seasonal High Water Table – Arbor Ridge

Actual Seasonal High Water Table = +75 ft   Pond Bottom - +65 ft
Seasonal High Water Table Assumed by engineer = +63 ft

Dry Ponds and Mis-Estimated Seasonal High Water Table – Arbor Ridge

Actual Seasonal High Water Table = +75 ft   Pond Bottom - +65 ft
Seasonal High Water Table Assumed by engineer = +63 ft

TOPIC # 2

Dry Bottom Ponds Excavated into Clayey Soils

Wekiva Run – Pond 1

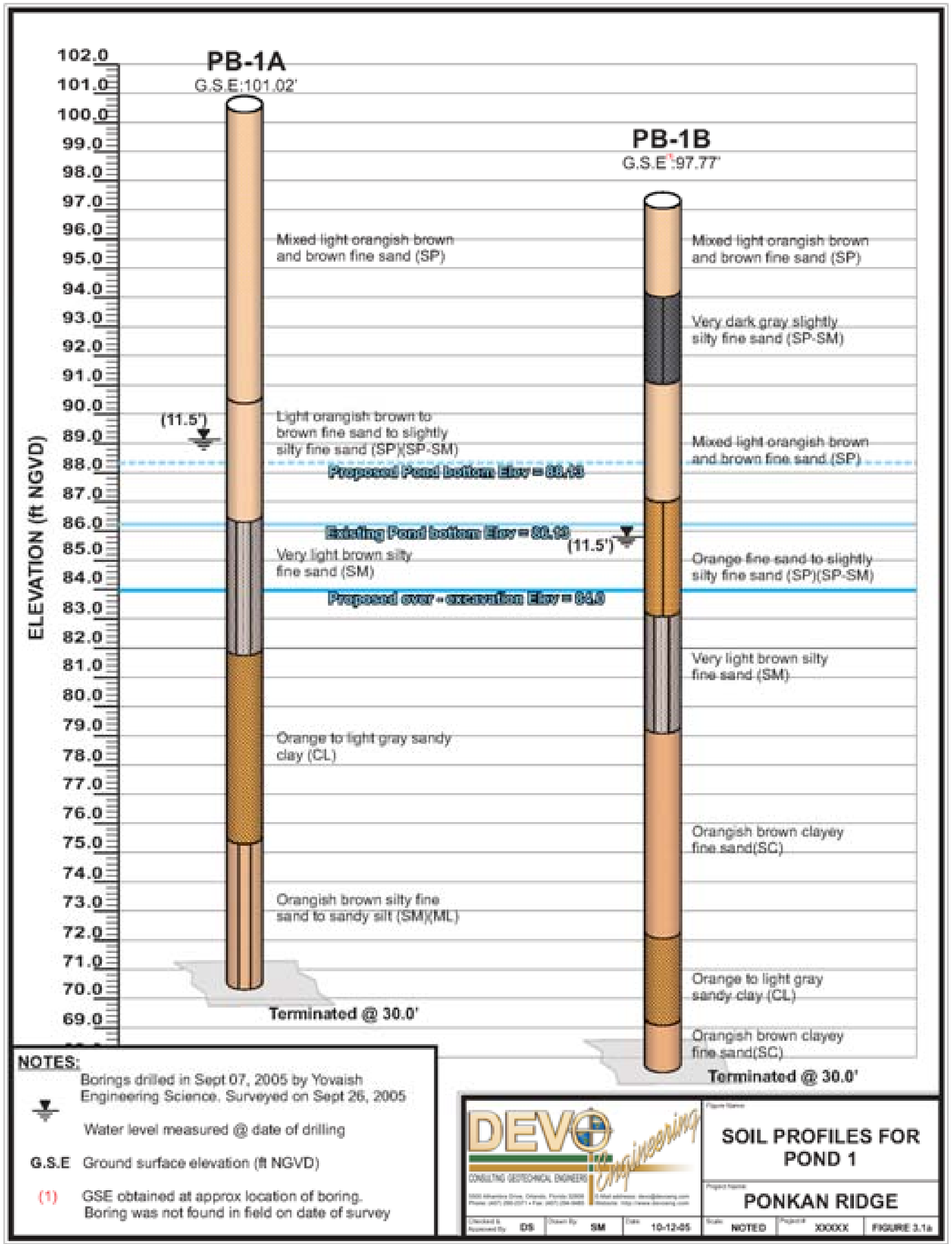


Photo date: 2005

Wekiva Run – Pond 2

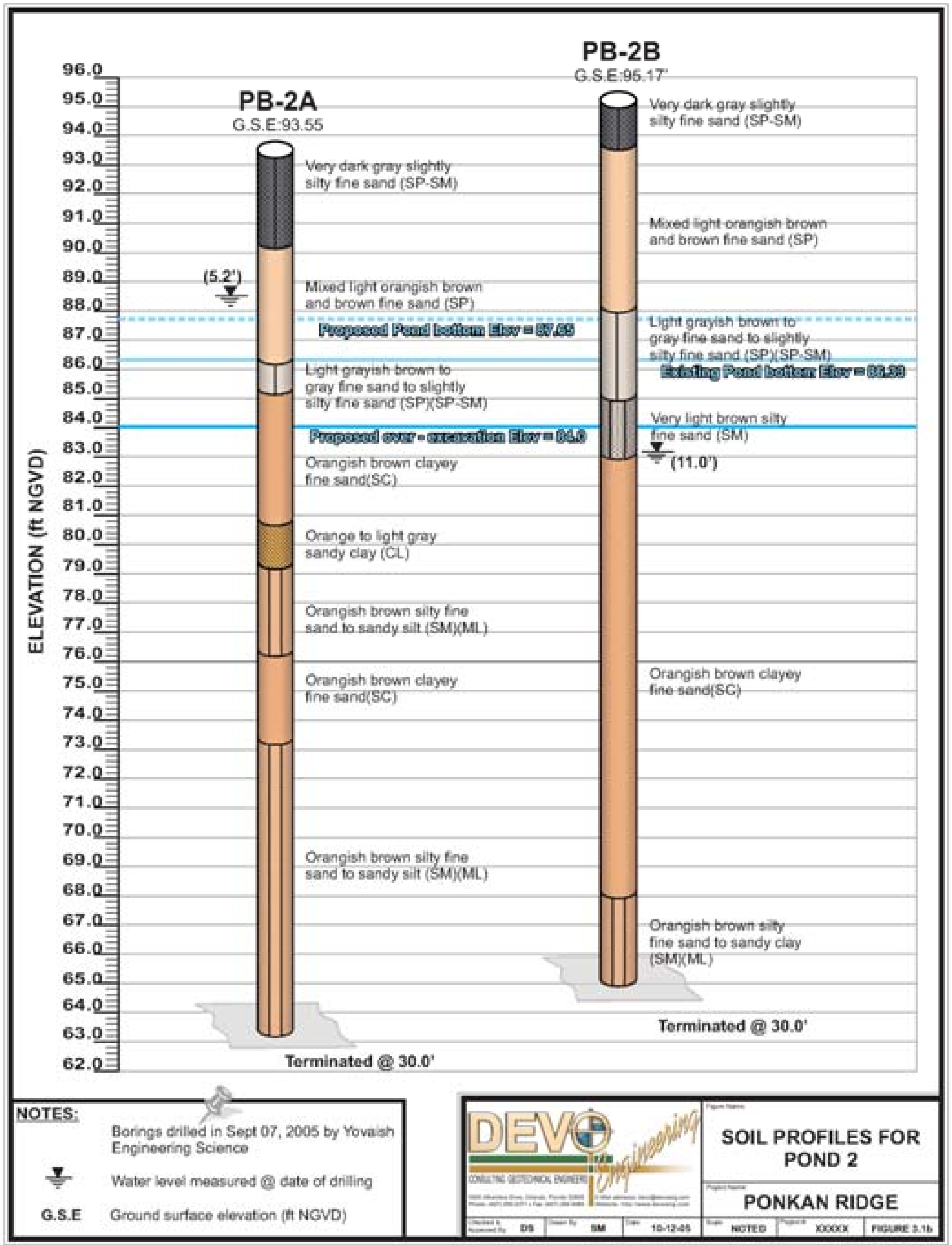


Photo date: 2005

Wekiva Run – Pond 3

Photo date: 2005

TOPIC # 3

Pond Berm Failures & Flooding Consequences

Pond Berms Failures (Tropical Storm Fay)

Miller Road Pond Outfall

Photo 1 of 4

Glen Club Drive Pond Berm Failure

Photo 2 of 4

Grande Ville Apartments

Photo 3 of 4

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Saxon Trace Apartments

Photo 4 of 4

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TOPIC # 4

Flooding of Land Locked Lakes

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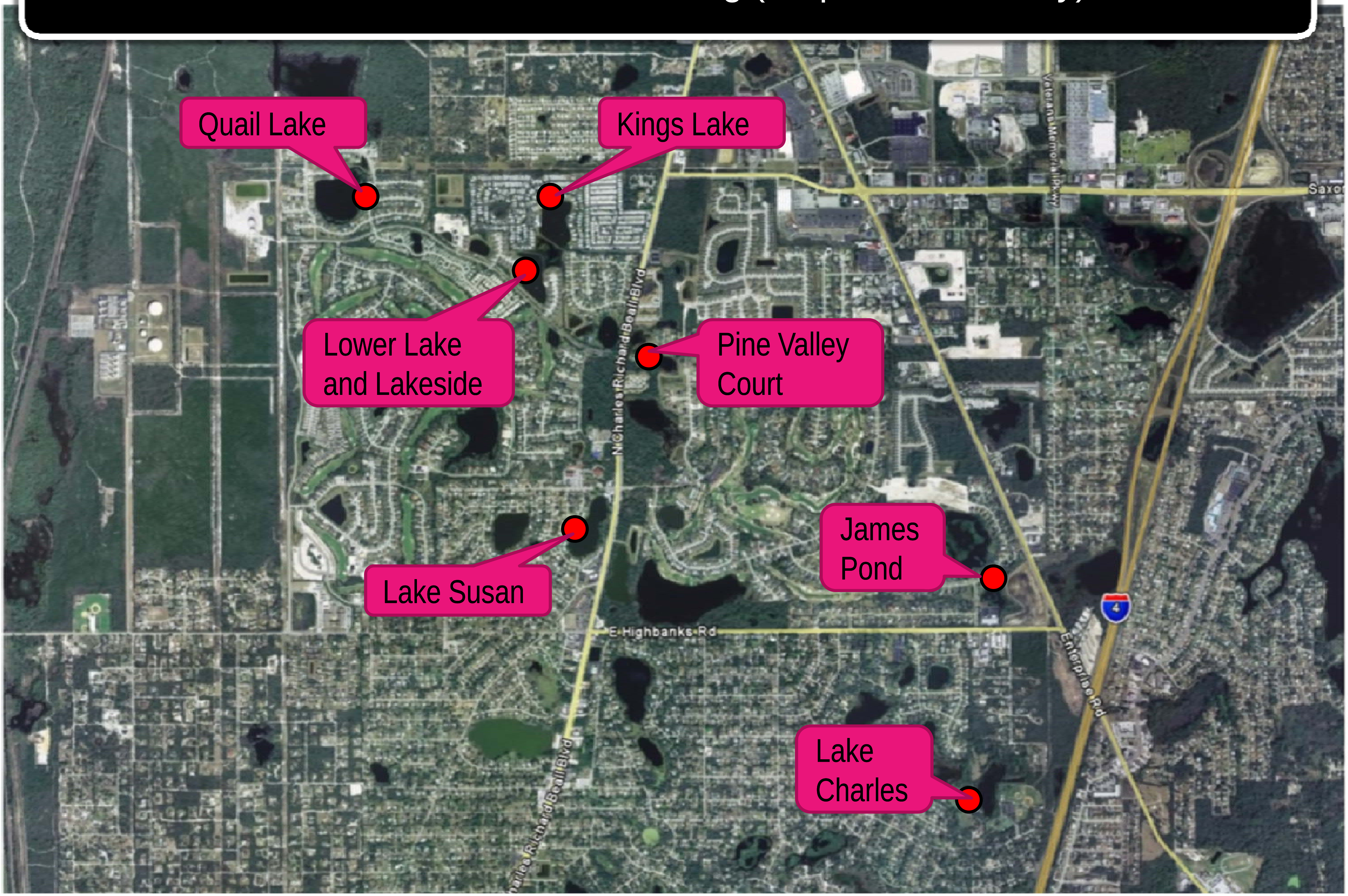
Residential Structure Flooding (Tropical Storm Fay)



DGCC Lower Lake and Lakeside (40 structures flooded)

Photo 1 of 6

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Kings Lake (16 structures flooded)

Photo 2 of 6

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Lake Susan (12 structures flooded)

Photo 3 of 6

James Pond (9 structures flooded)

Photo 4 of 6

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Pine Valley Court (6 structures flooded)

Photo 5 of 6

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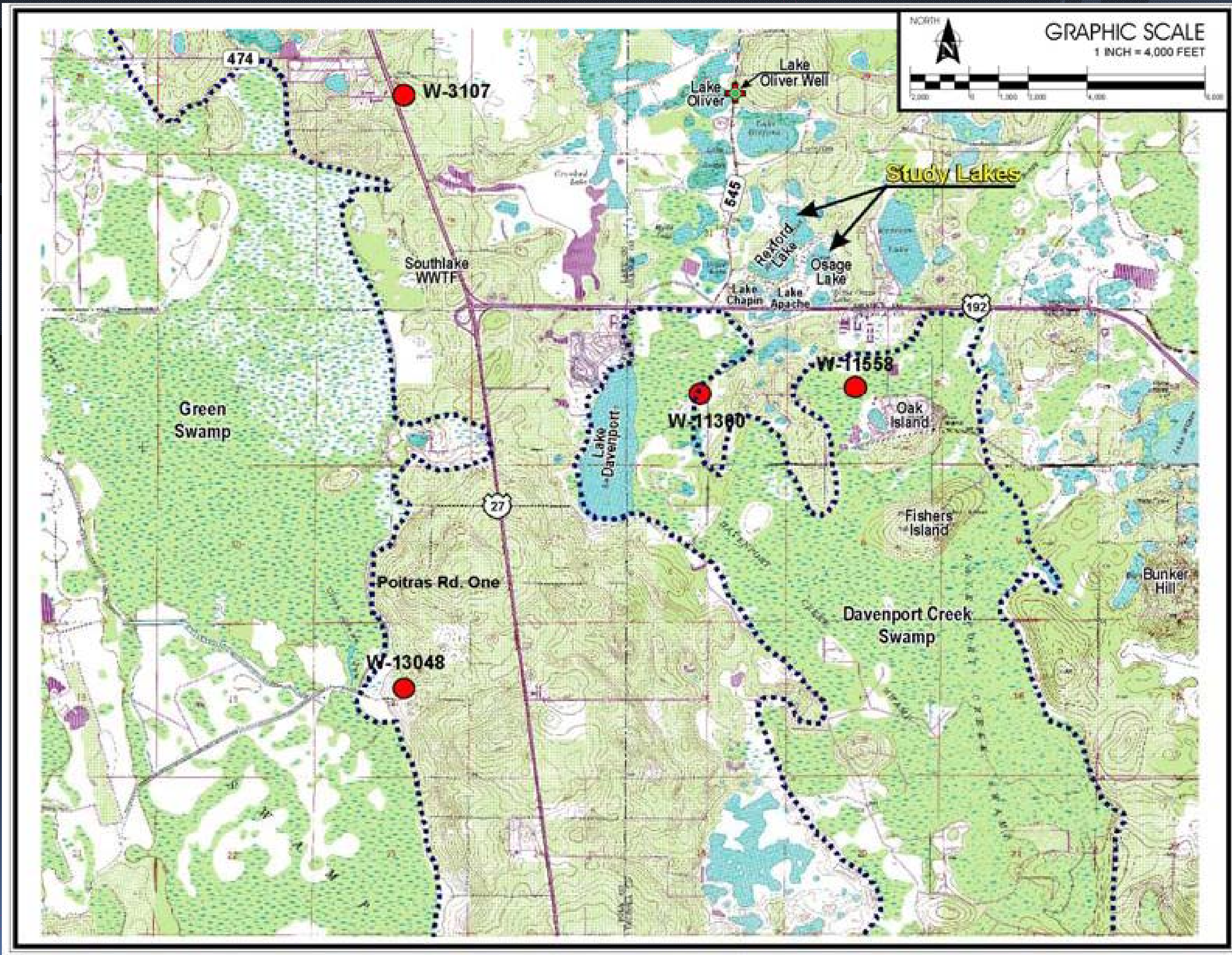
Lake Charles (1 structure flooded)

Photo 6 of 6

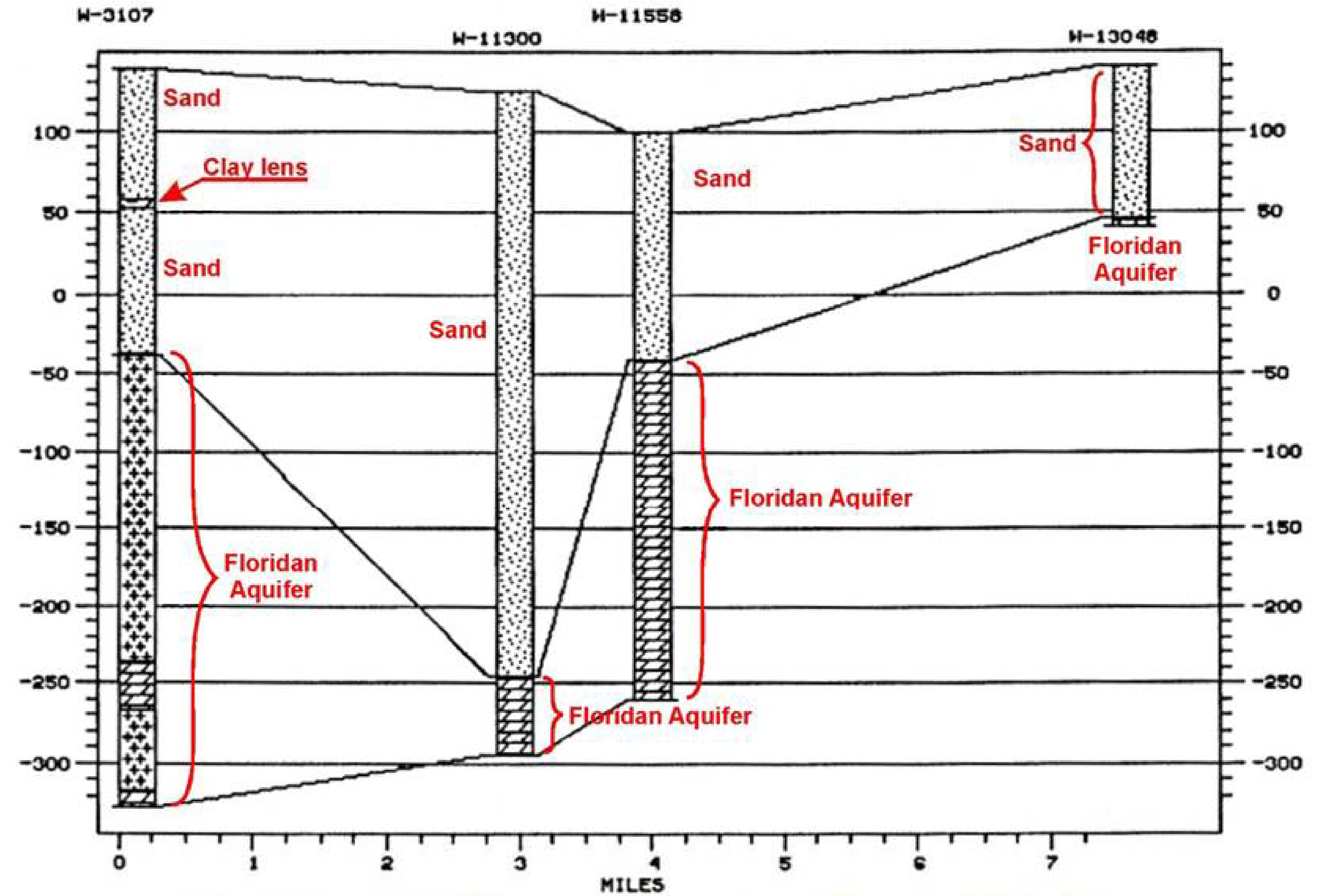
TOPIC # 5

Land-Locked Basins Affected by Floridan Aquifer

Lake Rexford and Lake Osage – Well Locations

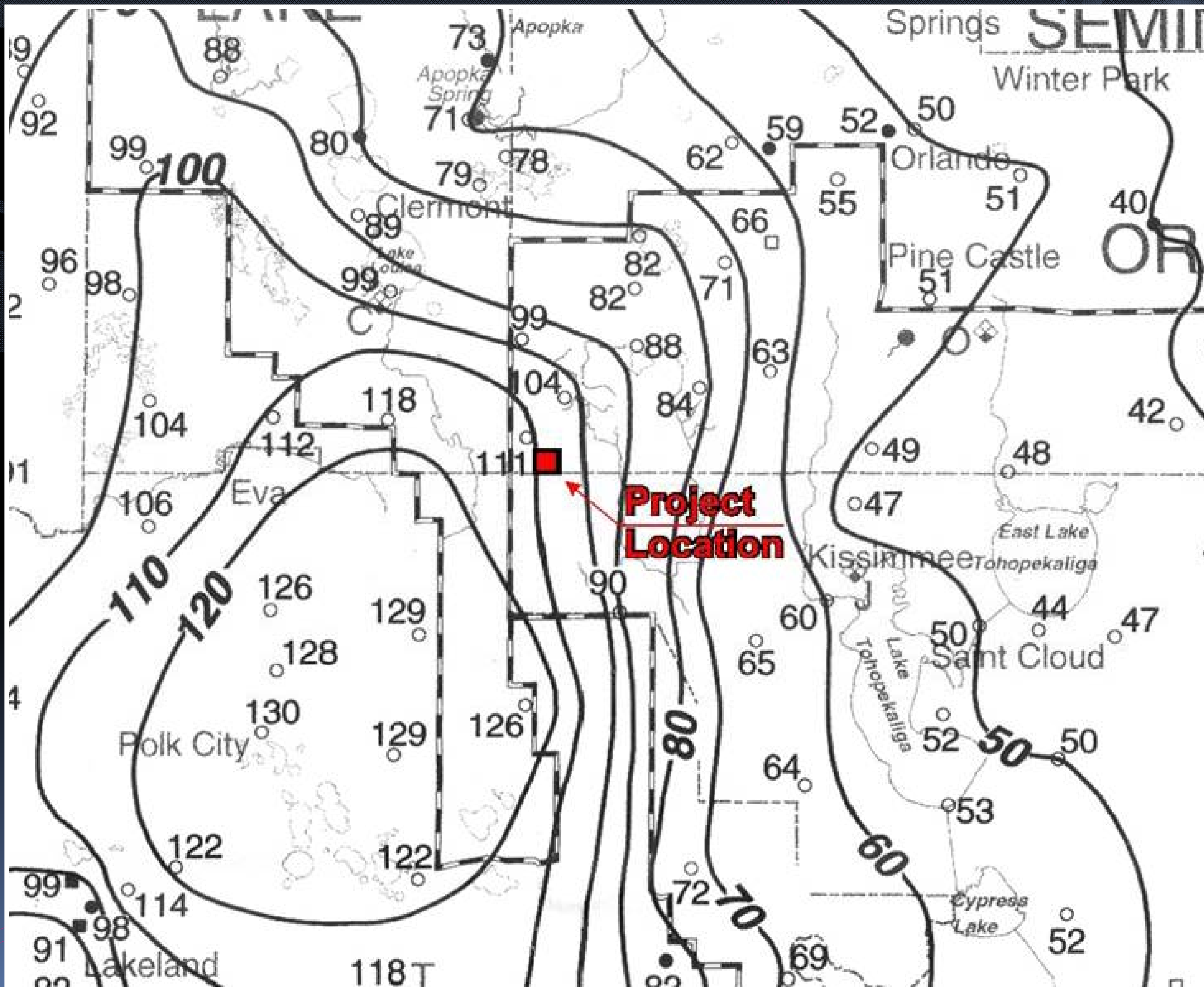


Lake Rexford and Lake Osage -Lithostratigraphy



Lithostratigraphy in SW corner of Orange County based on FGS well logs

Lake Rexford and Lake Osage Potentiometric Surface Contours



Lake Rexford and Lake Osage

Photo date: 2003

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Lake Rexford and Lake Osage

Photo date: 2003

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Lake Rexford and Lake Osage

Photo date: 2003

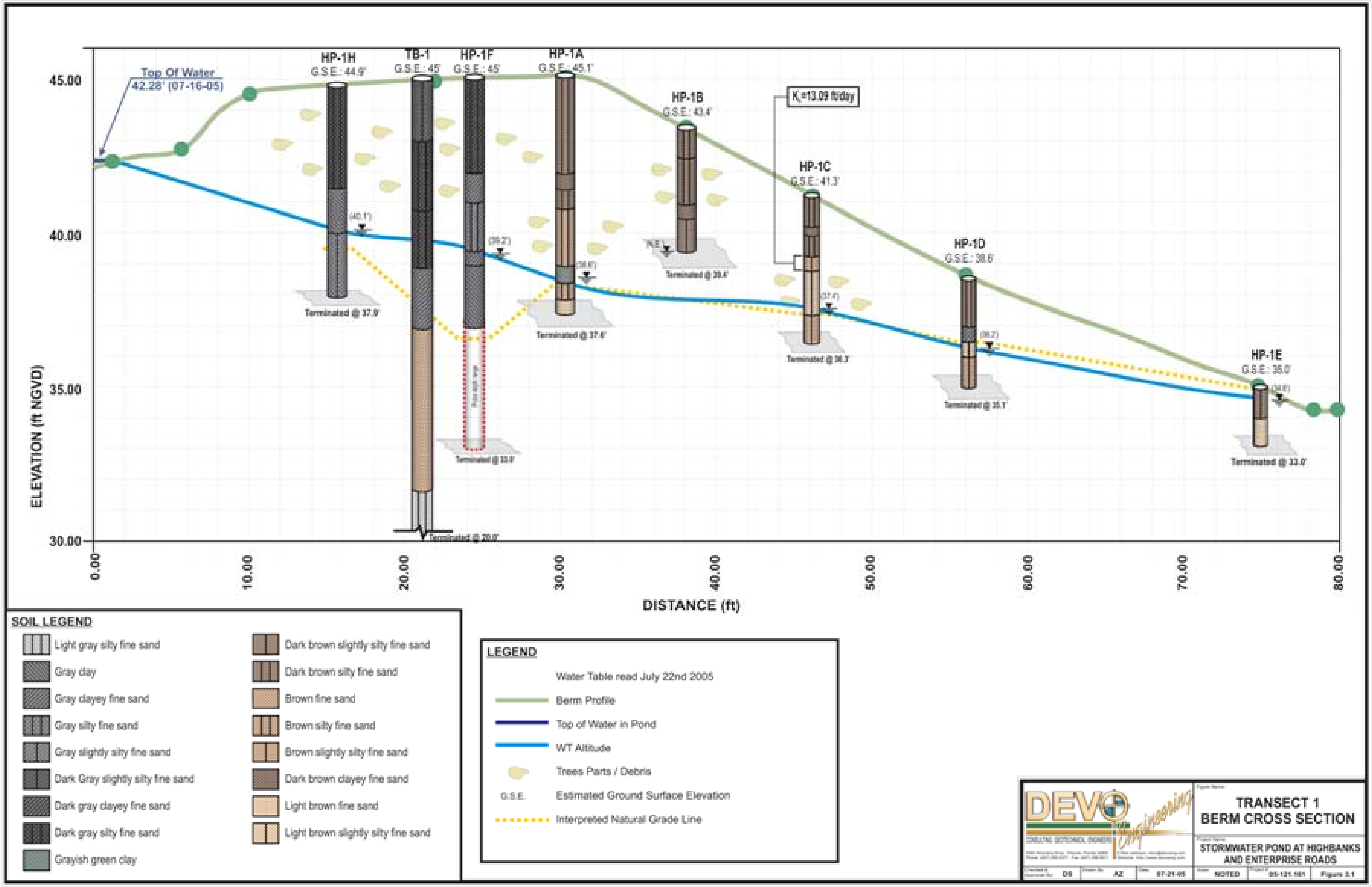
TOPIC # 6

Seepage Through Pond Berms

FDOT Saxon Pond

Photo date: 2003

Highbanks and Enterprise Pond



Downeast Lane

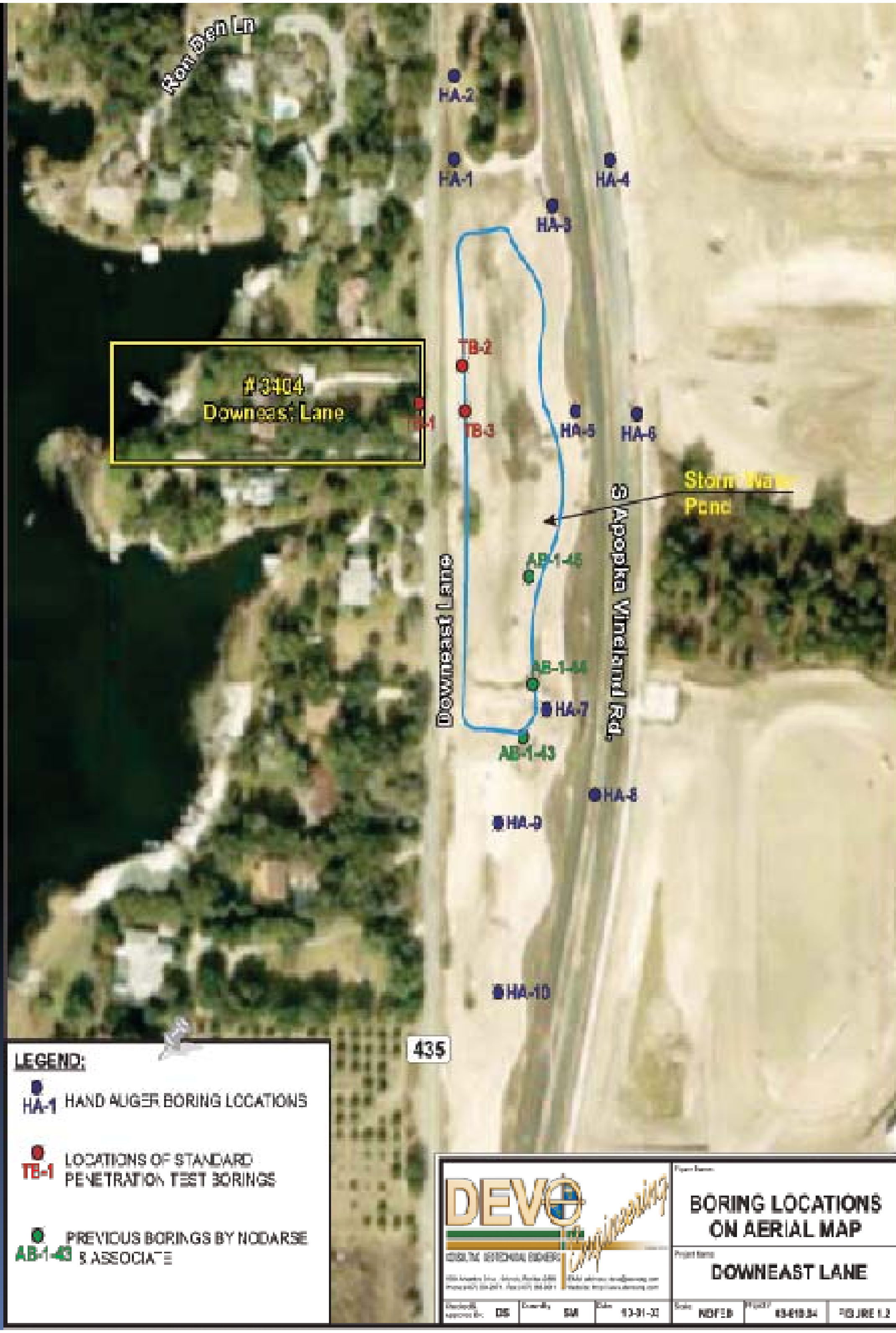
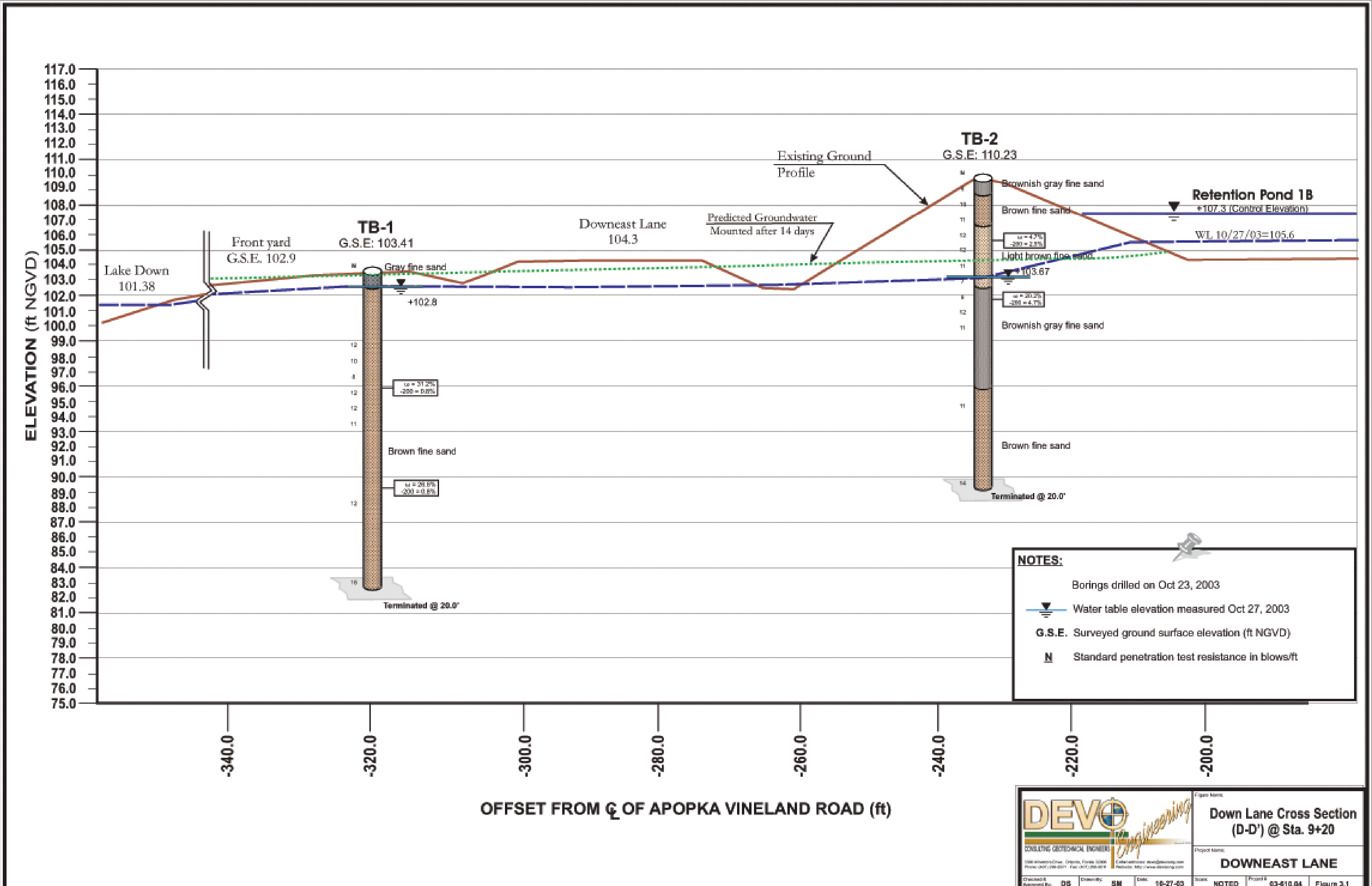


Photo date: 2004

Downeast Lane



Downeast Lane

Photo date: 2004

Downeast Lane

Photo date: 2004

The Overlook at Lake Louisa

Photo date: 2004

The Overlook at Lake Louisa

Photo date: 2004

TOPIC # 7

Side Slope Failures Due to Storm-Induced Wave Action

CR 561 Clermont

Photo date: 2004 (Hurricane Jeanne)

CR 561 Clermont

Photo date: 2004 (Hurricane Jeanne)

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TOPIC # 8

Drought

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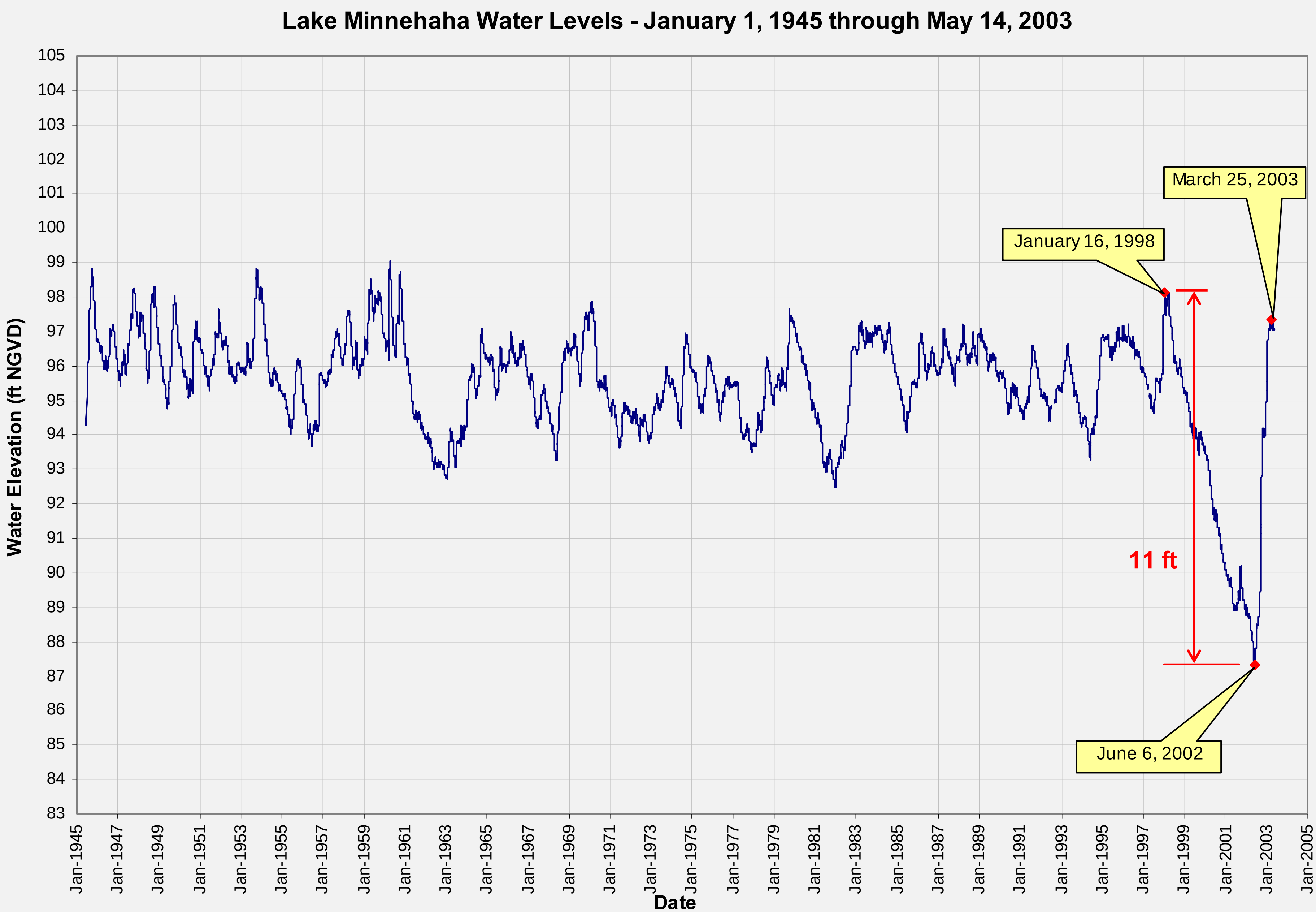
Clermont Chain of Lakes – Lake Minnehaha



Clermont Chain of Lakes – CR 565A Bridge

Navigability and Recreation

Clermont Chain of Lakes – Lake Minneola

Aesthetics and Property Value

Clermont Chain of Lakes – CR 561

Pavement Distress Due To Buried Peat

TOPIC # 9

Failure of Clay Liner in Regional Stormwater Pond

Failure of clay liner in wet pond - FSU Regional Stormwater Pond

Sinkhole 1

Failure of clay liner in wet pond - FSU Regional Stormwater Pond

Sinkhole 1

Failure of clay liner in wet pond - FSU Regional Stormwater Pond

RSF Sinkholes

Sinkhole 1

Failure of clay liner in wet pond - FSU Regional Stormwater Pond

RSF Sinkholes

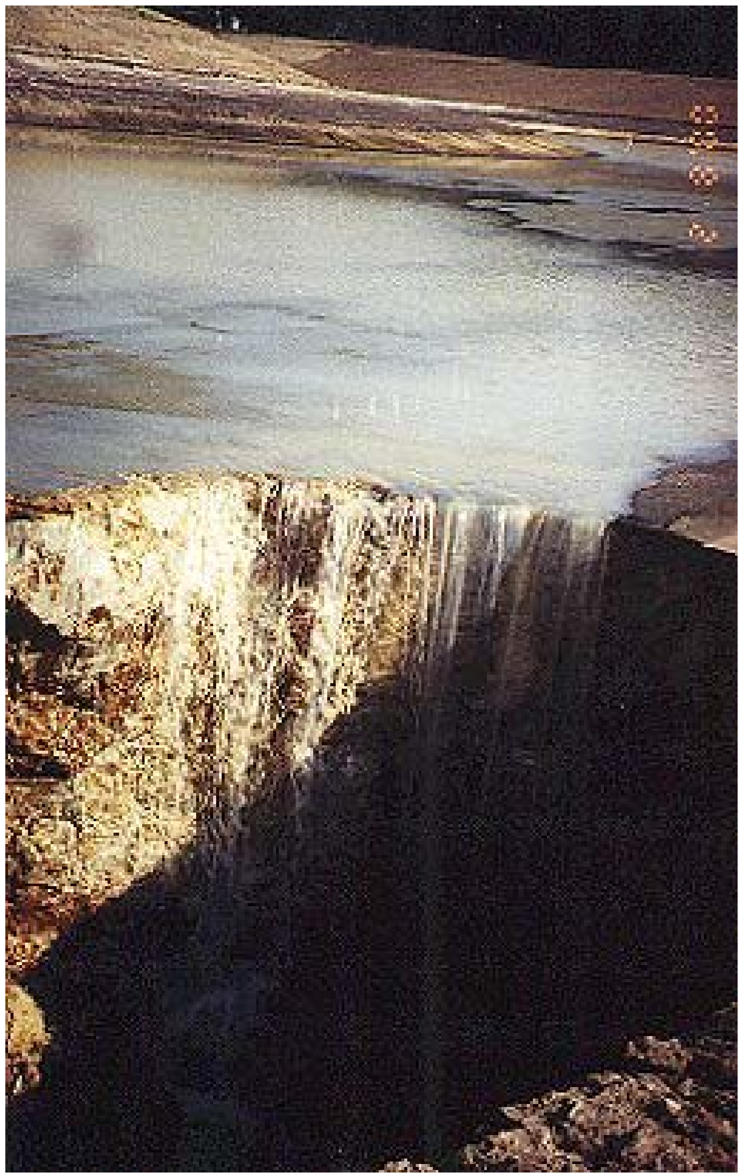
Sinkhole 1

Failure of clay liner in wet pond - FSU Regional Stormwater Pond

RSF Sinkholes

Sinkhole 1

Failure of clay liner in wet pond - FSU Regional Stormwater Pond



Sinkhole 2

TOPIC # 10

Sinkhole Drying up Lake in Seminole County

Sinkholes in lakes - Grace Lake in Seminole County

Lake Levels Just Under Peak Stage - August 26, 2003

Sinkholes in lakes - Grace Lake in Seminole County

Receded Lake - Nov 29, 2003

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Sinkholes in lakes - Grace Lake in Seminole County

Sinkhole Nov 30, 2003

TOPIC # 11

Sinkholes in Stormwater Pond

Sinkholes in ponds - Spring Vista Drive in Debary

South Pond

Sinkholes in ponds - Spring Vista Drive in Debary

North Pond

TOPIC # 12

Clayey Pond Bottom causing Muddy Appearance in Wet Pond

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Clayey pond bottom causing Muddy Appearance in Wet Ponds - Tesoro

Client complains about muddy water appearance in regional stormwater pond

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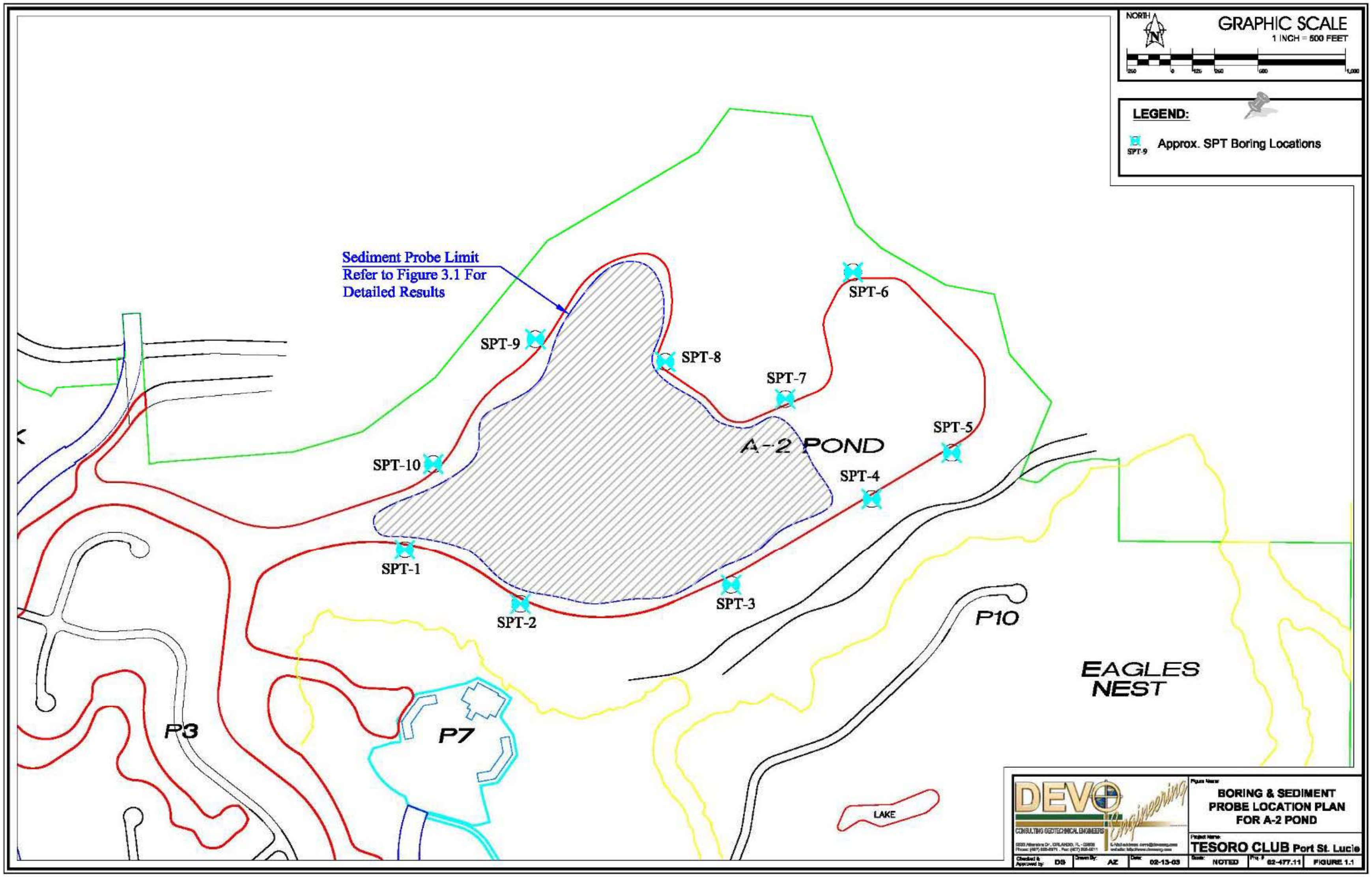
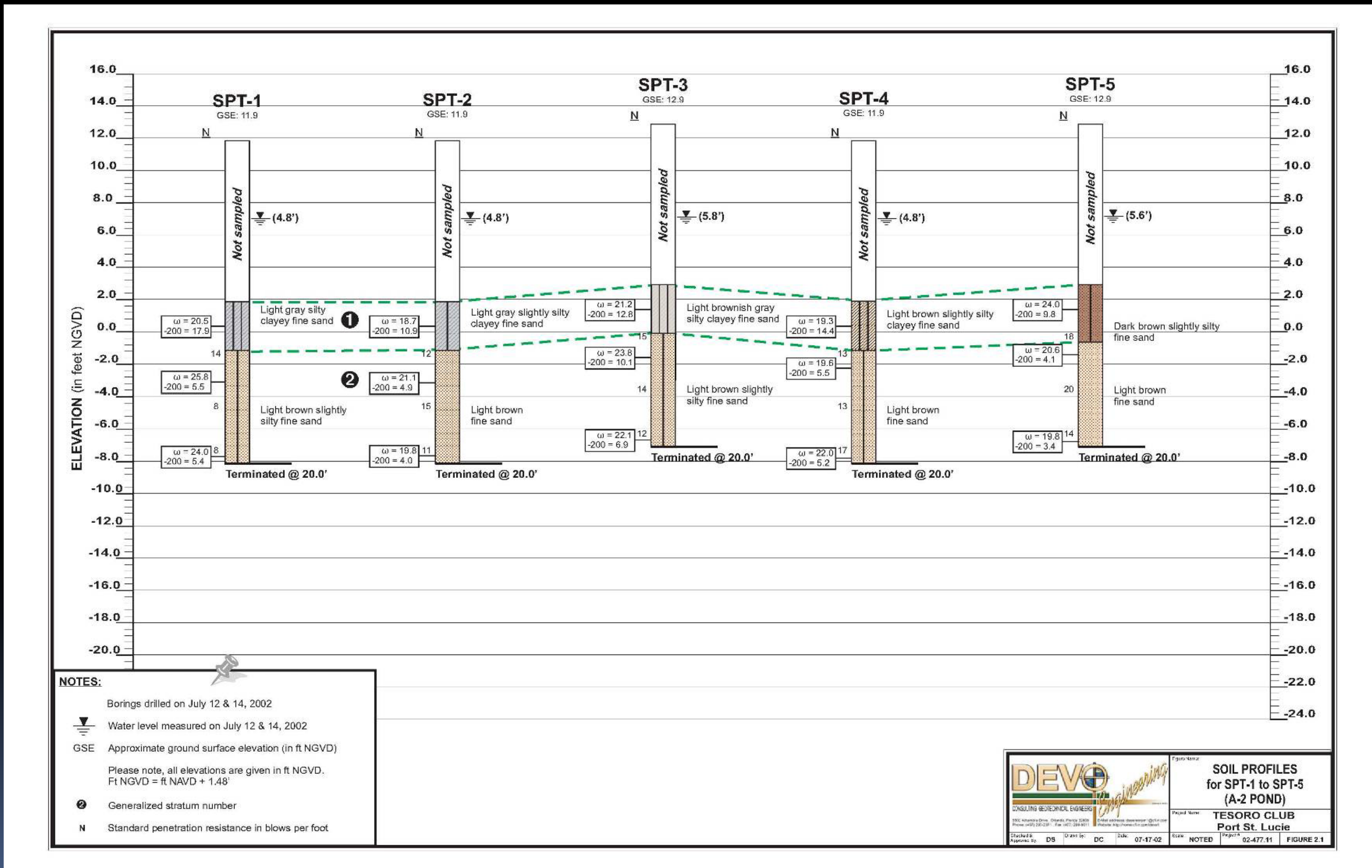
Clayey pond bottom causing Muddy Appearance in Wet Ponds - Tesoro



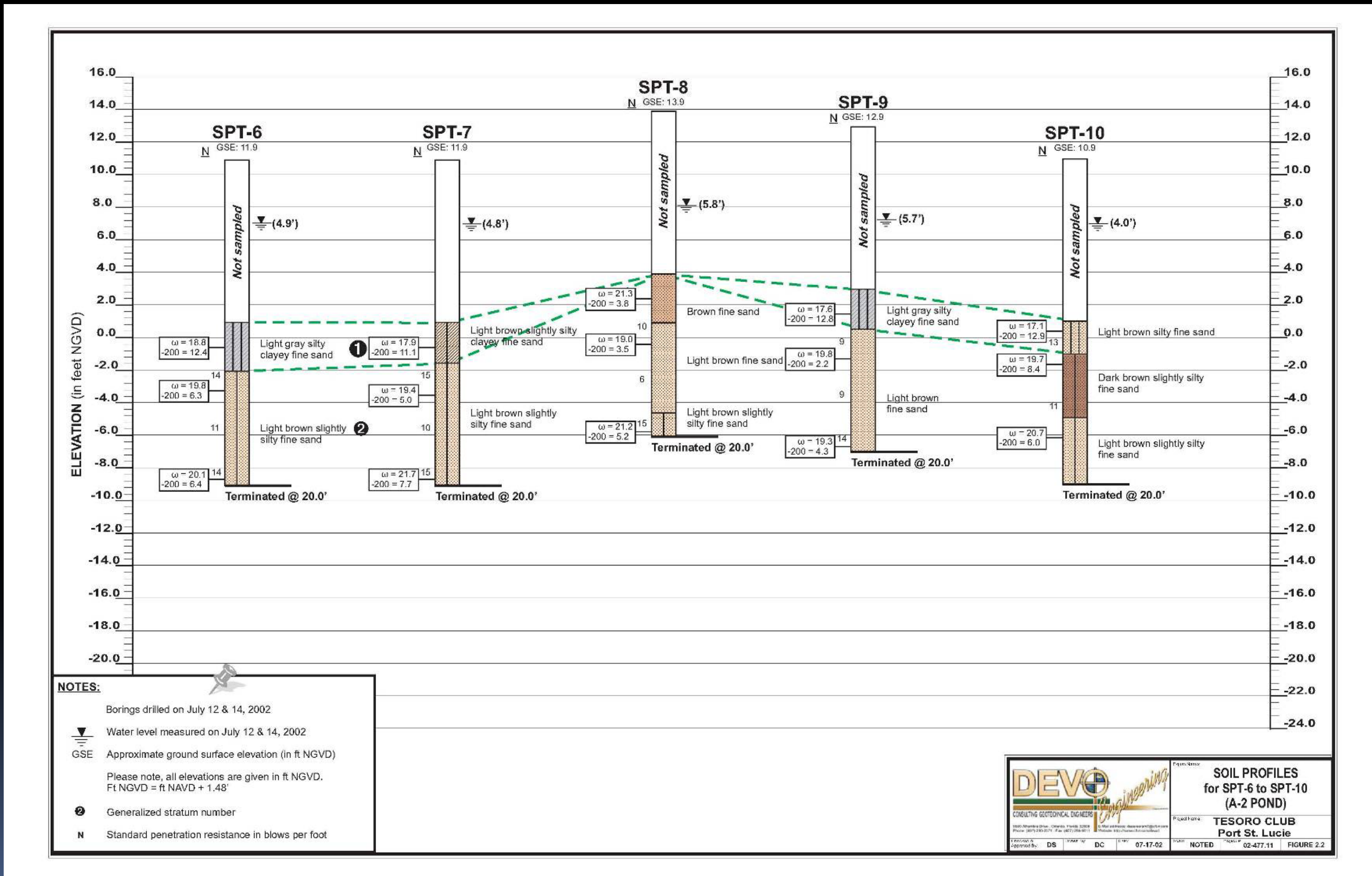
Test Location Plan

Clayey pond bottom causing Muddy Appearance in Wet Ponds - Tesoro



Pond bottom elevation intersects clayey sand (STRATUM 1)

Clayey pond bottom causing Muddy Appearance in Wet Ponds - Tesoro



Pond bottom elevation intersects clayey sand layer (STRATUM 1)

TOPIC # 13

Pond NWL and Pavement Grade Separation Problem

Pond NWL and Pavement Grade Separation - Waterford Chase

Pond NWL and Pavement Grade Separation - Waterford Chase

Pond NWL and Pavement Grade Separation - Waterford Chase

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TOPIC # 14

Pond NWL Stabilizing Lower than Expected due to Perched Water Table

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Pond NWL Below Expected Due to Perched - Becker Commons

BECKER COMMONS- True Water Table

TOPIC # 15

Pond NWL Stabilizing Lower than Expected Value

Pond NWL Stabilizing Below Expected Level - Westlake

WESTLAKE-Resulting Cascading Outfall to Pond

Pond NWL Stabilizing Below Expected Level - Westlake

TOPIC # 16

Slow Recovery of Water Level in Lakes after Completion of Dewatering

Slow Recovery of Lake - New Subdivision in Kissimmee

Slow Recovery of Lake - New Subdivision in Kissimmee

Slow Recovery of Lake - New Subdivision in Kissimmee

Slow Recovery of Lake - New Subdivision in Kissimmee

Slow Recovery of Lake - New Subdivision in Kissimmee

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TOPIC # 17

Siltation of Underdrained Pond Bottom During Construction

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Siltation of Pond Bottom During Construction – Arbor Ridge

Standing water in pond after installation of underdrains

PART 5

GEOTECHNICAL CONSTRUCTION CONSIDERATIONS

FOR STORMWATER MANAGEMENT SYSTEMS

ALTHOUGH EVERYTHING LOOKS GOOD ON PAPER

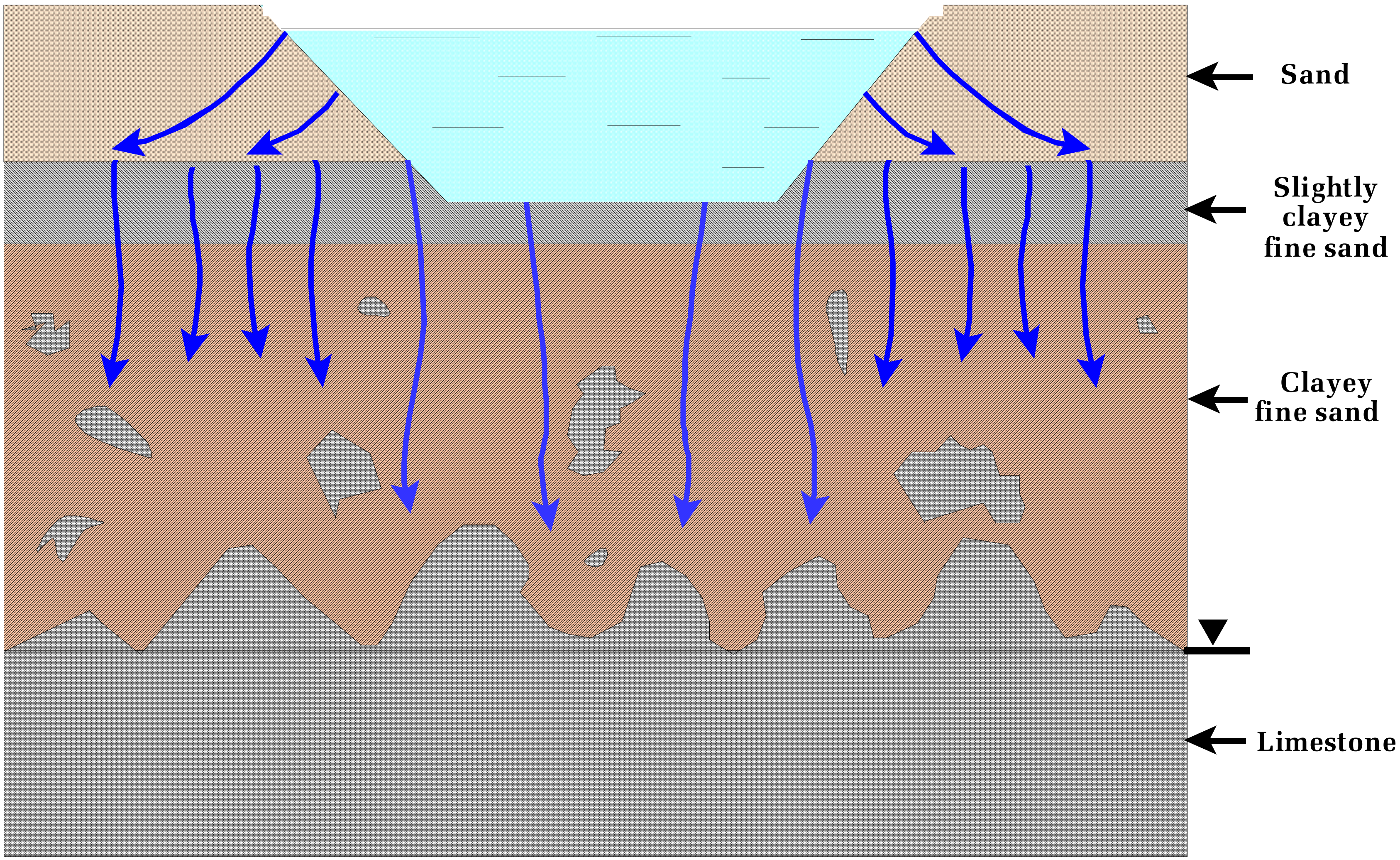
(i.e., thorough geotech & appropriate analysis)

YOU MAY <u>STILL</u> SOMETIMES RUN INTO <u>PROBLEMS</u> IN THE *FIELD*...

THESE ARE SOME OF THE FIELD PROBLEMS

- Remolding & reduction in permeability of naturally leaky clayey soils due to grading and traction of construction equipment
- Siltation of pond bottom mainly during construction (due to lack of erosion & sediment control)
- Rapid clogging of sand filtration systems due to "algae", especially near wetlands
- Settlement of exfiltration trenches on loose sands after initial loading with runoff volume of water
- Over-excavations for under-drained or dry-bottom ponds not carried out per design intent
- Sinkholes form due to concentration of runoff
- Shallow rock in certain parts of the state
- Construction dewatering

Dry Retention In Leaky Aquifer With Deep Water Table Excavation Extends into Clayey Sand



MAINTAINING LEAKINESS OF POND BOTTOM EXCAVATED IN CLAYEY SAND

Where exposed by the pond excavation, the clayey sand unit should be overexcavated by 1 ft, the overexcavated surface heavily scarified, and then backfilled with clean sand excavated from the upper soil profile.

Prior to backfilling with sand, the surface should be inspected by the engineer to ensure heavy equipment track & wheel loads have not sealed the naturally occurring fractures and channels.

As an added safety measure, at least two (2) double ring infiltrometer tests should be performed to ensure the vertical infiltration rate has not been reduced below an acceptable level.

POND BOTTOM SILTATION

- This problem is usually at its worst during construction before the streets are paved and the bare ground is sodded. High sediment load enters the pond reducing percolation through bottom & sides.

- SJRWMD recommends that the pond bottom remain 1 ft higher than the design grade until construction is complete. As a last step, the pond bottom should be excavated to its finish grade and then sodded. This ensures the sediment is removed prior to the pond being put in service.

SETTLEMENT OF LOOSE SAND SUBGRADE UNDER EXFILTRATION TRENCHES

- Loose sands may settle (consolidate) due to the hydraulic stresses resulting from the rapid concentration of stormwater runoff in exfiltration trenches.

- Very loose soil conditions can occur in nature or can be created by the placement of sand backfill without compaction. Settlement of this type usually occurs after the trench receives its first significant quantity of rainfall runoff.

- While this type of settlement may not be a cause for concern where the exfiltration trench is located within a landscape area, it can lead to distress when the trench underlies a structure such as a pavement.

HOW TO AVOID SETTLEMENT OF LOOSE SAND SUBGRADE UNDER EXFILTRATION TRENCHES

- To avoid settlement, it is recommended that, prior to final grading of the cover, the trench be flooded continuously for a minimum period of 8 to 10 hours. Water for flooding may be obtained from a nearby fire-hydrant, well, lake, or potable water connection.
- This flooding should simulate worst case rainfall runoff conditions and mitigate future generalized or localized subsidence.
- Settlement of the chambers and the gravel backfill in the trench should be monitored during the flooding and for about a week thereafter, before final grading is performed.

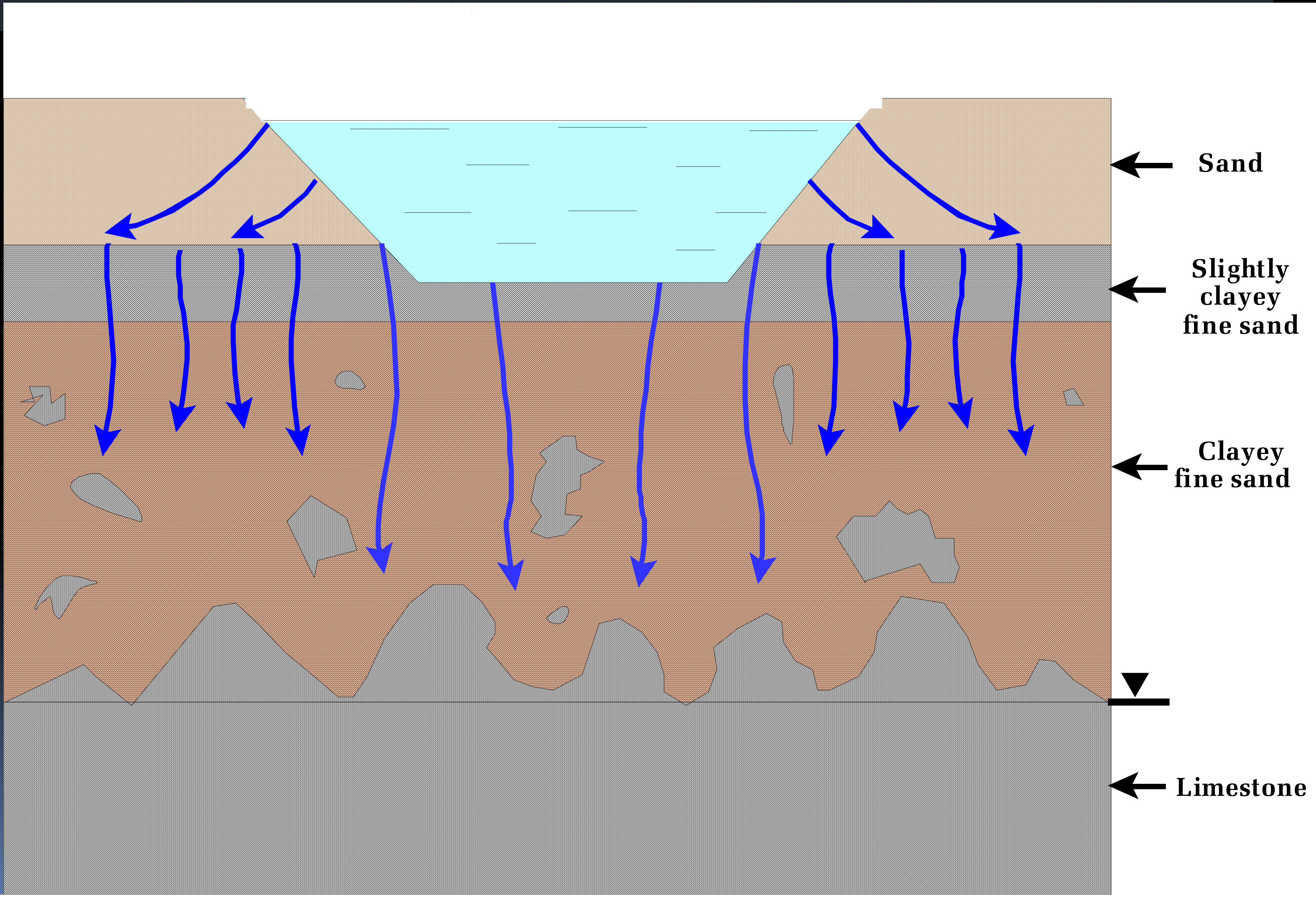
CONSTRUCTION DEWATERING ISSUES

- May need a permit
- Watch out for artesian conditions with uncontrollable vertical upwelling of ground water
- Deep permeable sands may yield very high dewatering quantities. Need to come up with a plan to manage the ground water discharge.
- Dehydration impacts to adjacent wetlands can be a controlling factor.

PART 6

Geotechnical Field Testing in Leaky Aquifers, An Alternate Approach

"Out of the Box" Field Testing For Leaky Sites



“Out of the Box” Field Testing For Leaky Sites

Estimating Vertical Infiltration in Leaky Hydrogeologic Environments

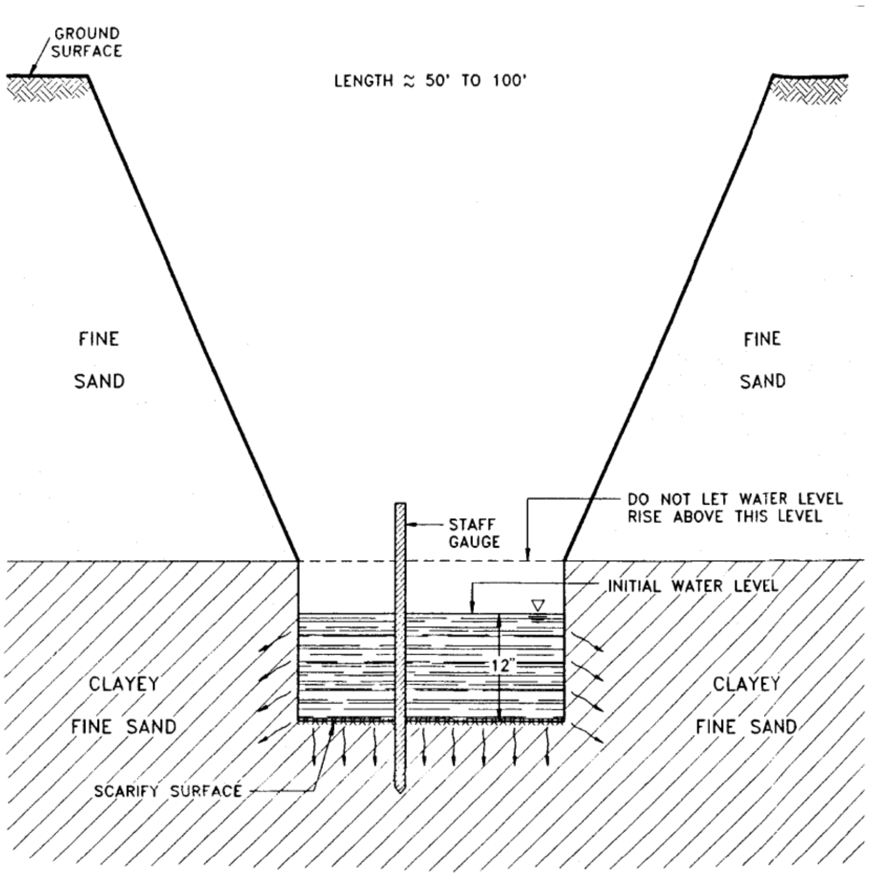
The following test procedure represents an unconventional method for measuring the vertical leakage in settings where percolation occurs through a leaky semi-confining layer (fissured clay matrix) to the underlying aquifer. This situation is very common in Marion County, for example.

Although these sites might have a significant percolative capacity, conventional testing methods, such as laboratory permeability testing or borehole testing, often/usually will not adequately measure percolation rates.

This test procedure was conducted for a large sprayfield in Columbia County (for Lake City), in an area for which vertical leakage accounts for a significant portion of percolative capacity.

Regulators should bear in mind that type of test is expensive.

“Out of the Box” Field Testing For Leaky Sites



TYPICAL CROSS-SECTION OF TRENCH PERCOLATION TEST TO ESTIMATE VERTICAL LEAKANCE

SCALE: 1" = 1'

PROCEDURE

- Stake the approximate centerline of trench in general accordance with location plan. Ensure that centerline of a trench generally follows a contour so that the excavated base of the trench will be fairly flat.
- Excavate trench using backhoe. Minimum trench width is 2.5 feet. Exercise caution not to mix the excavated sand with any clayey soils. Since the sand will be reused to backfill the trench.
- Depth of trench excavation to be monitored by geotech engineer's representative to determine when clayey sand stratum has been encountered.
- Excavate trench about 1.5 feet below top of clayey fine sand stratum.

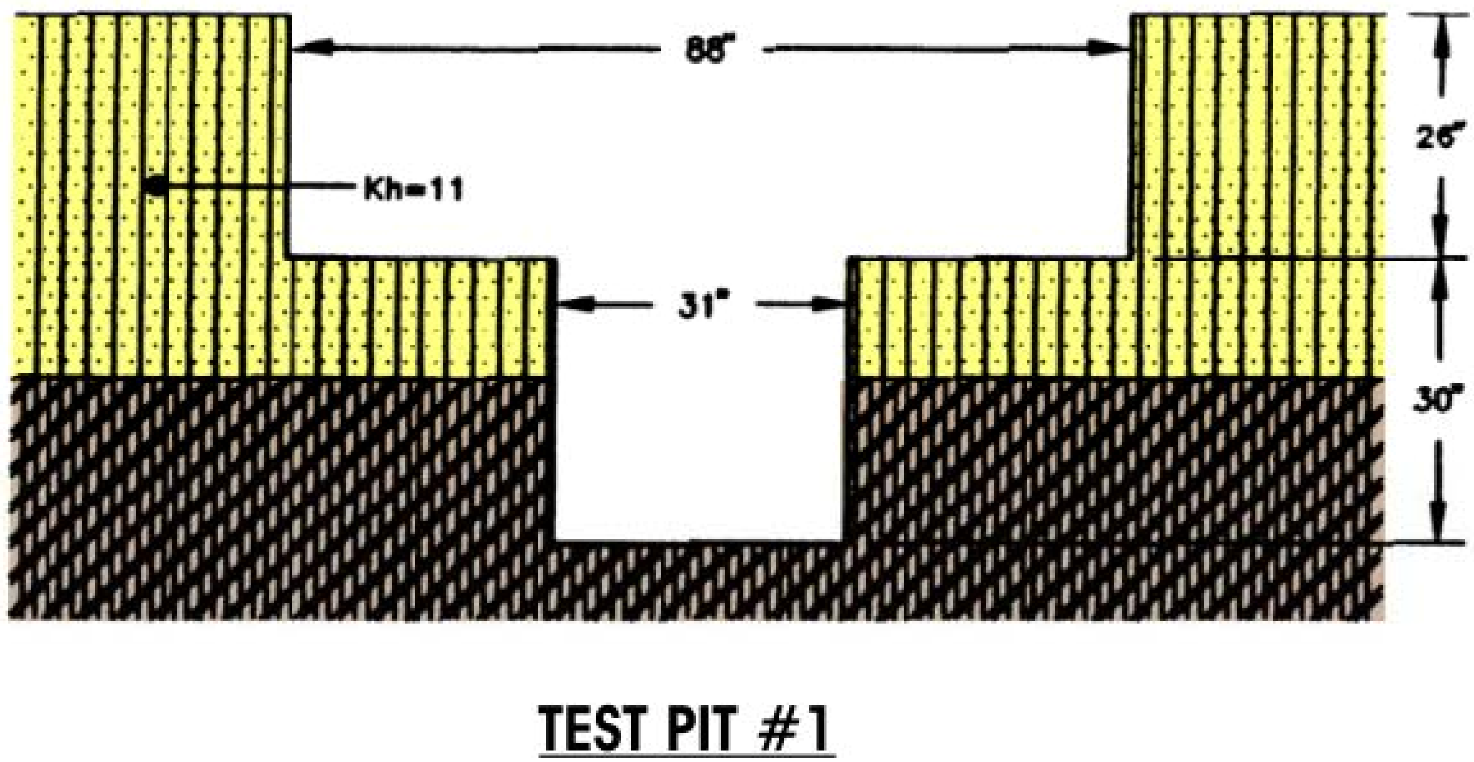
PROCEDURE (cont'd.)

- Scarify base of trench in any clayey soil to promote infiltration and open up any surface which may have been sealed by the backhoe bucket during excavation.
- Set staff gauge in trench. Use more than one staff gauge if necessary. Staff gauge graduations shall be at least at 1 inch intervals.
- Fill trench with water from water tanker until it stages approximately 1 foot above the base of the trench. Exercise caution to ensure water does not stage above the top of the clayey fine sand stratum such that some of it percolates laterally through the upper mantle of more permeable sand. Also, while an attempt shall be made to fill the trench rapidly, do not fill so rapidly that sloughing and erosion results.

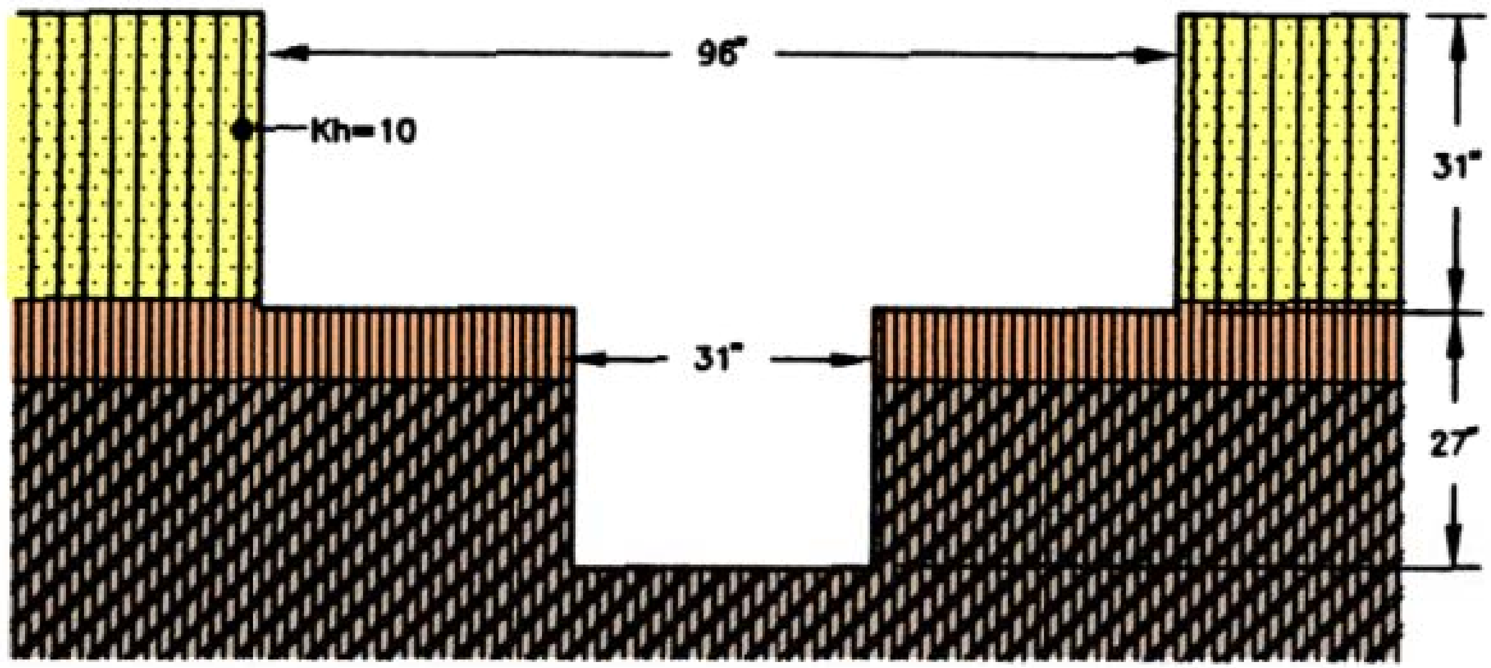
PROCEDURE (cont'd.)

- Approximate quantities of water required to fill the trench are as follows: 50 ft (1000 gal), 75 ft (1500 gal), 100 ft (2000 gal)
- Monitor the rate of fall of the water level in the trench. The frequency of readings shall be such that the time required for each inch of percolation can be measured. This may vary from trench to trench depending on the leakance. Note any rainfall during the test. If possible also record average temperature for each day from a nearby weather station.
- Repeat the hydraulic loading as described above at least once for each test trench. However, if the recovery of the water level is negligible to very slow (less than 1 inch per week). There is no need to repeat the test.
- Upon completion of the test, backfill the trench with sand only. Discard the excavated clayey soil to a stockpile for subsequent disposal during construction. The trench backfill material shall not be compacted.

Test Pit 1: measured rate = 37 in/wk = 0.44 ft/day

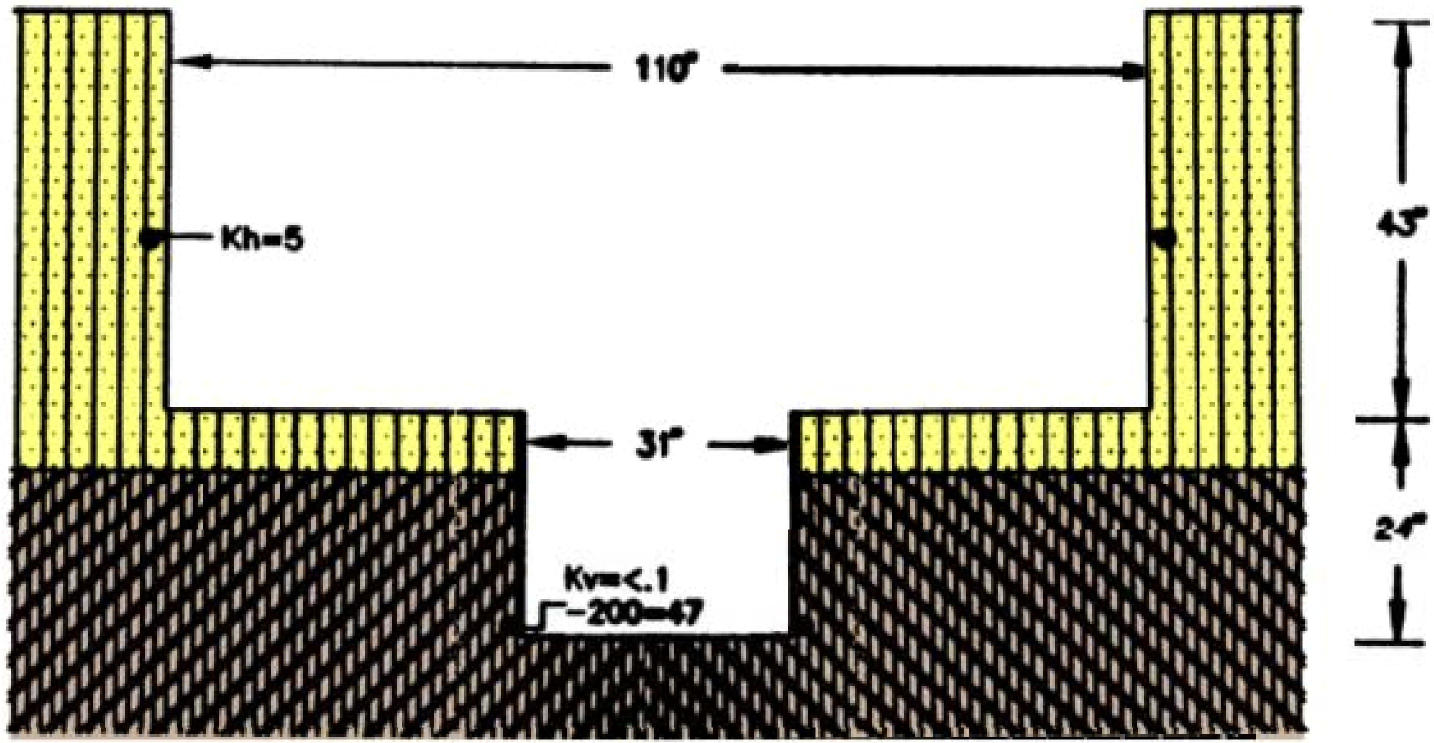


Test Pit 3: measured rate = 19 in/wk = 0.23 ft/day



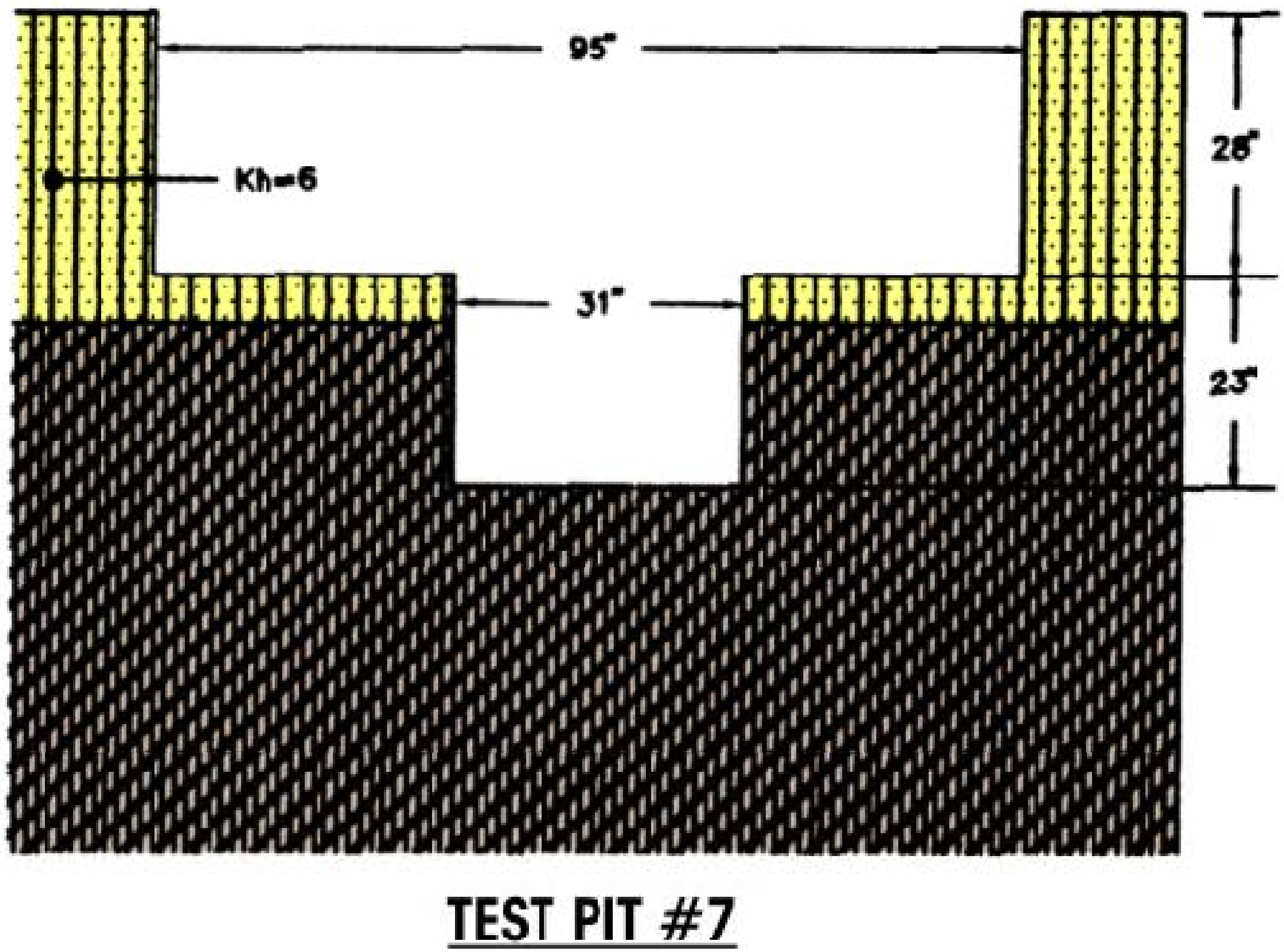
TEST PIT #3

Test Pit 5: measured rate = 140 in/wk = 1.67 ft/day



TEST PIT #5

Test Pit 7: measured rate = 32 in/wk = 0.38 ft/day



PART 7

Relevant Excerpts from March 2010 Draft Applicants Handbook

Reference:

MARCH 2010 DRAFT
DEPARTMENT OF ENVIRONMENTAL PROTECTION
AND WATER MANAGEMENT DISTRICTS

ENVIRONMENTAL RESOURCE PERMIT
STORMWATER QUALITY APPLICANT'S HANDBOOK

DESIGN REQUIREMENTS FOR
STORMWATER TREATMENT SYSTEMS IN FLORIDA

TOPIC # 1

Methodologies, Recovery Analysis, And Soil Testing For Retention Systems

SECTION 21

FDEP DRAFT APPLICANTS HANDBOOK, MARCH 2010

Section 21. Methodologies, Recovery Analysis, And Soil Testing For Retention Systems

For successful designs of retention BMPs, both the unsaturated and saturated infiltration must be accounted for and incorporated into the analysis.

Unless the normal Seasonal High Ground Water Table (SHGWT) is greater than or equal to 2 feet below the bottom of the BMP system, unsaturated vertical flow prior to saturated horizontal mounding shall be conservatively ignored in the recovery analyses. This is not an unrealistic assumption since the height of the capillary fringe in fine sands is on the order of six (6) inches, and a partially mounded water table condition may be remnant from a previous storm event.

Section 21. Methodologies, Recovery Analysis, And Soil Testing For Retention Systems

Computer-based ground water flow models are routinely used by practicing engineers and hydrogeologists to predict the time for percolation of the Required Treatment Volume (RTV)... The computer models require input values of the retention BMP dimensions, retained stormwater runoff volume (the RTV) and the following set of aquifer parameters:

- Thickness or elevation of base of mobilized (or effective) aquifer
- Weighted horizontal saturated hydraulic conductivity of mobilized aquifer
- Vertical unsaturated infiltration rate
- Fillable porosity of mobilized aquifer
- Ambient water table elevation which, for design purposes, is usually the normal Seasonal High Ground Water Table (SHGWT)

Section 21. Methodologies, Recovery Analysis, And Soil Testing For Retention Systems

Determination of Aquifer Thickness

Standard Penetration Test (SPT) borings are recommended for definition of the aquifer thickness, especially where the ground water table is deep.

Manual "bucket" auger borings (when supplemented with classification testing) can also be used to define the thickness of the uppermost aquifer (i.e., the depth to the confining unit), especially for small retention ponds and swales.

The confining unit is a hydraulically restrictive layer (i.e., a clay layer, hardpan, etc.). For many recovery / mounding simulations, the confining unit can be considered as a restrictive layer that has a saturated hydraulic conductivity an order of magnitude (10 times) less that the soil strata (sands) above.

Section 21. Methodologies, Recovery Analysis, And Soil Testing For Retention Systems

Estimated Normal Seasonal High Ground water Table (SHGWT)

In estimating the normal SHGWT, the contemporaneous measurements of the water table are adjusted upward or downward taking into consideration numerous factors, including:

- Antecedent rainfall.
- Soils on the project site.
- Examination of the soil profile, including redoximorphic features, SPT "N" values, depth to "hardpan" or other impermeable horizons, etc.
- Consistency of water levels with adjacent surface water bodies and knowledge of typical hydraulic gradients (water table slopes).
- Vegetative indicators.
- Effects of existing and future development, including drainage ditches, modification of land cover, subsurface drains, irrigation, septic tank drainfields, etc.
- Hydrogeologic setting, including the potentiometric surface of Floridian aquifer and degree of connection between the water table aquifer and the Floridian aquifer.
- Soil morphological features.

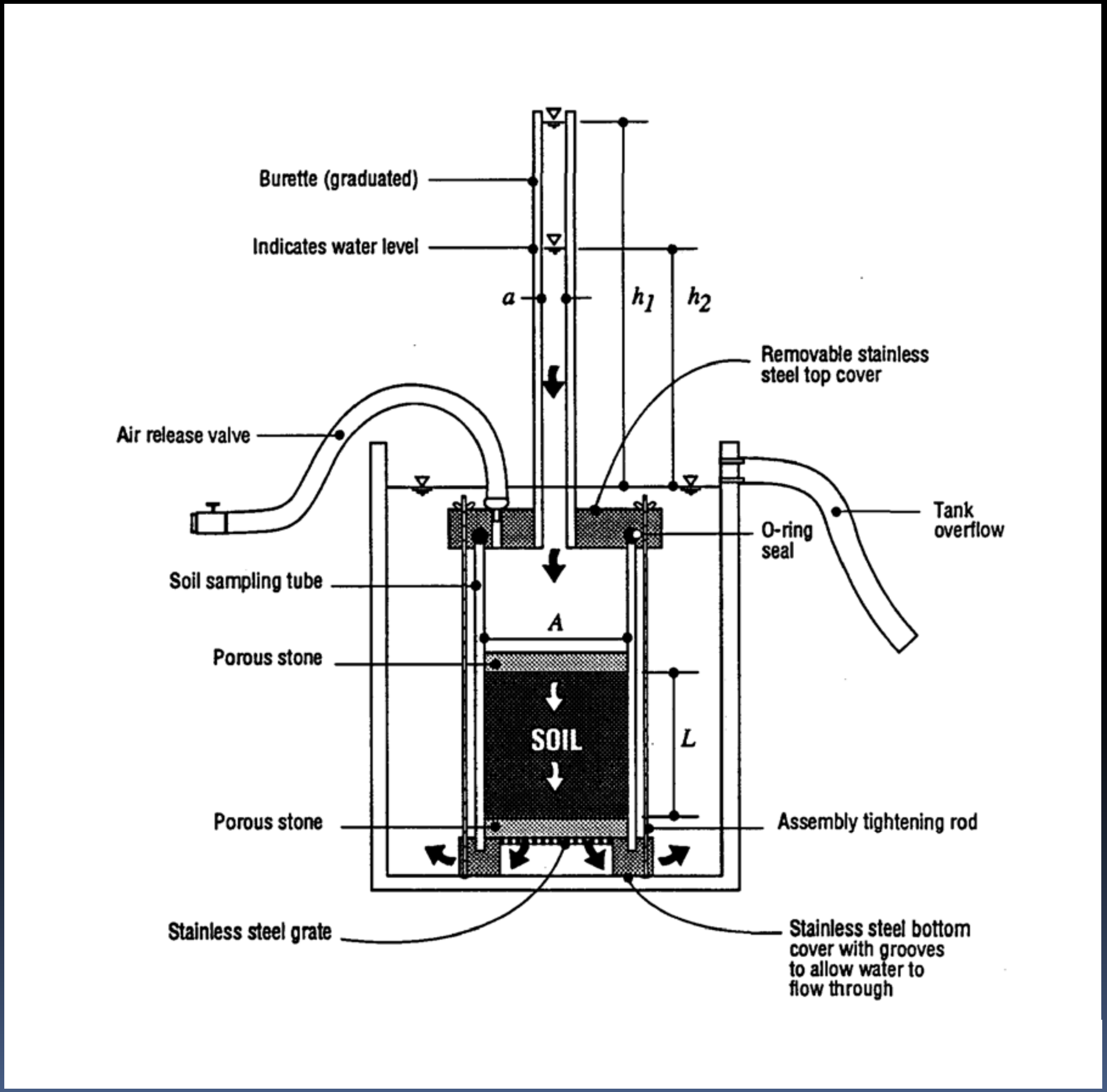
Section 21. Methodologies, Recovery Analysis, And Soil Testing For Retention Systems

Estimation of Horizontal Hydraulic Conductivity of Aquifer (cont'd.)

Hydraulic conductivity tests are required for retention BMPs, which may include the following:

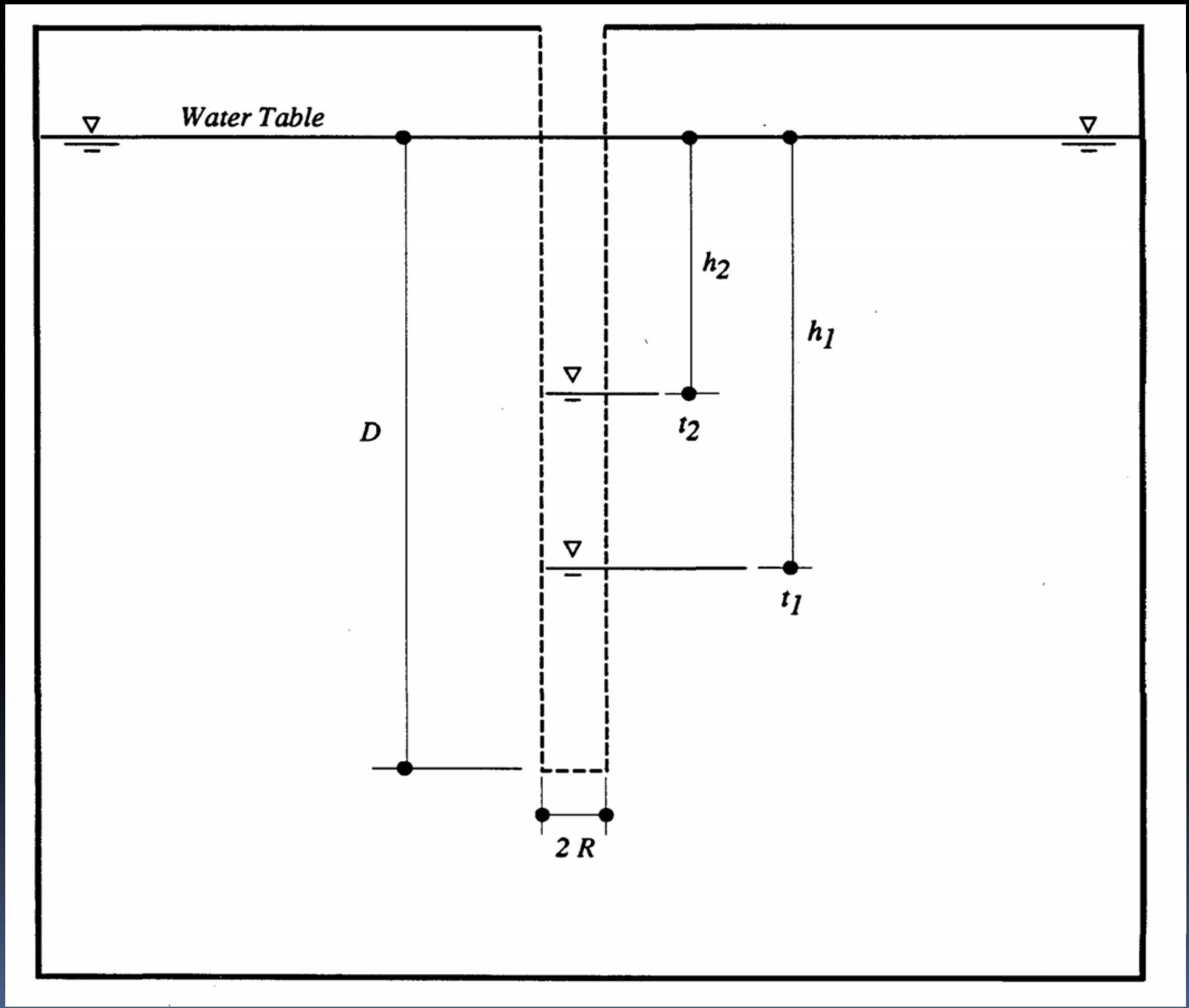
- Laboratory hydraulic conductivity test on an undisturbed sample (constant or falling head)
- Uncased or fully screened auger hole
- Cased hole with uncased or screened extension with the base of the extension at least one (1) foot above the confining layer
- Pump test, when accuracy is important and hydrostratigraphy is conducive to such a test method.
- Slug Test(s)

Section 21. Methodologies, Recovery Analysis, And Soil Testing For Retention Systems



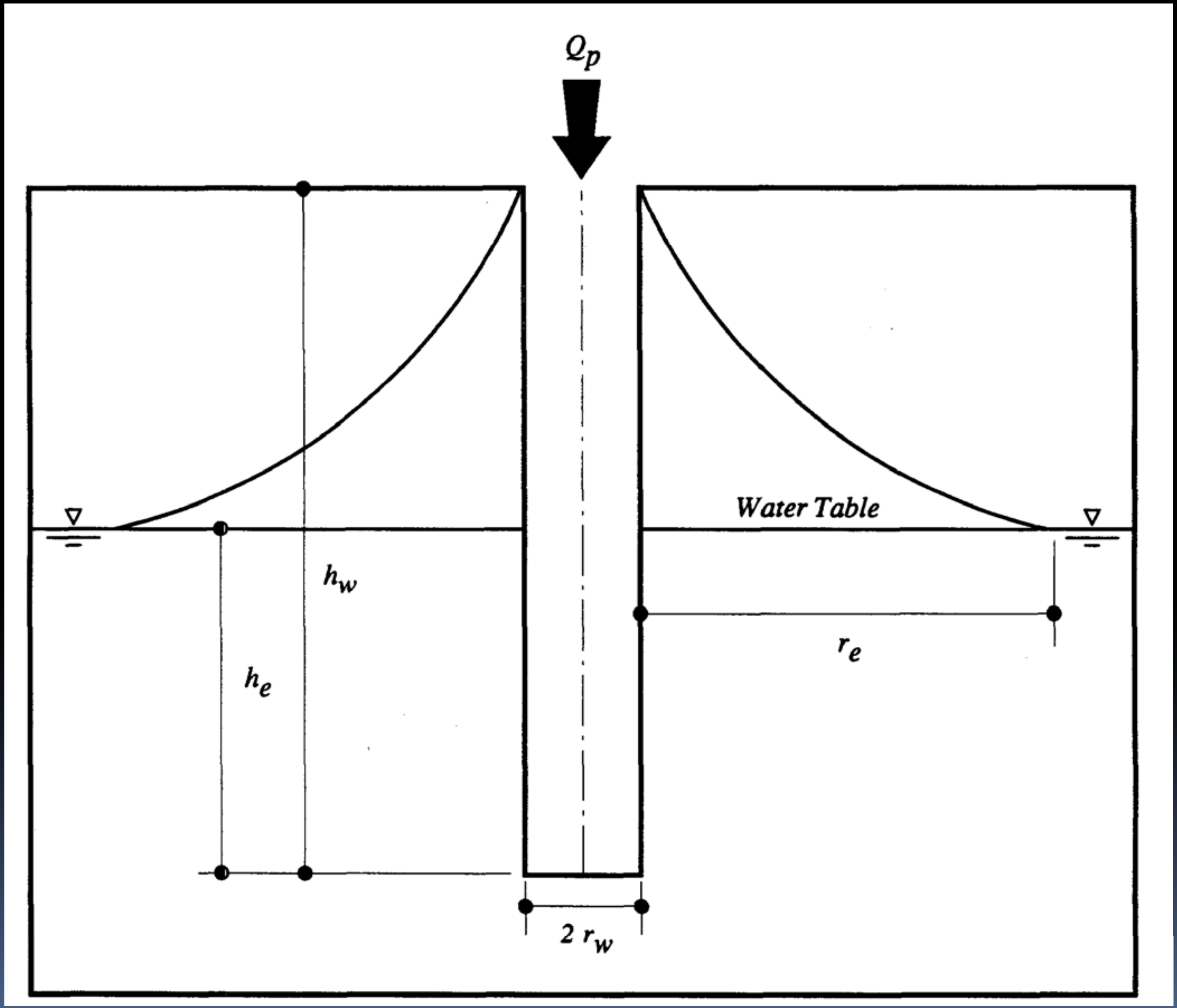
Laboratory Hydraulic Conductivity Test

Section 21. Methodologies, Recovery Analysis, And Soil Testing For Retention Systems



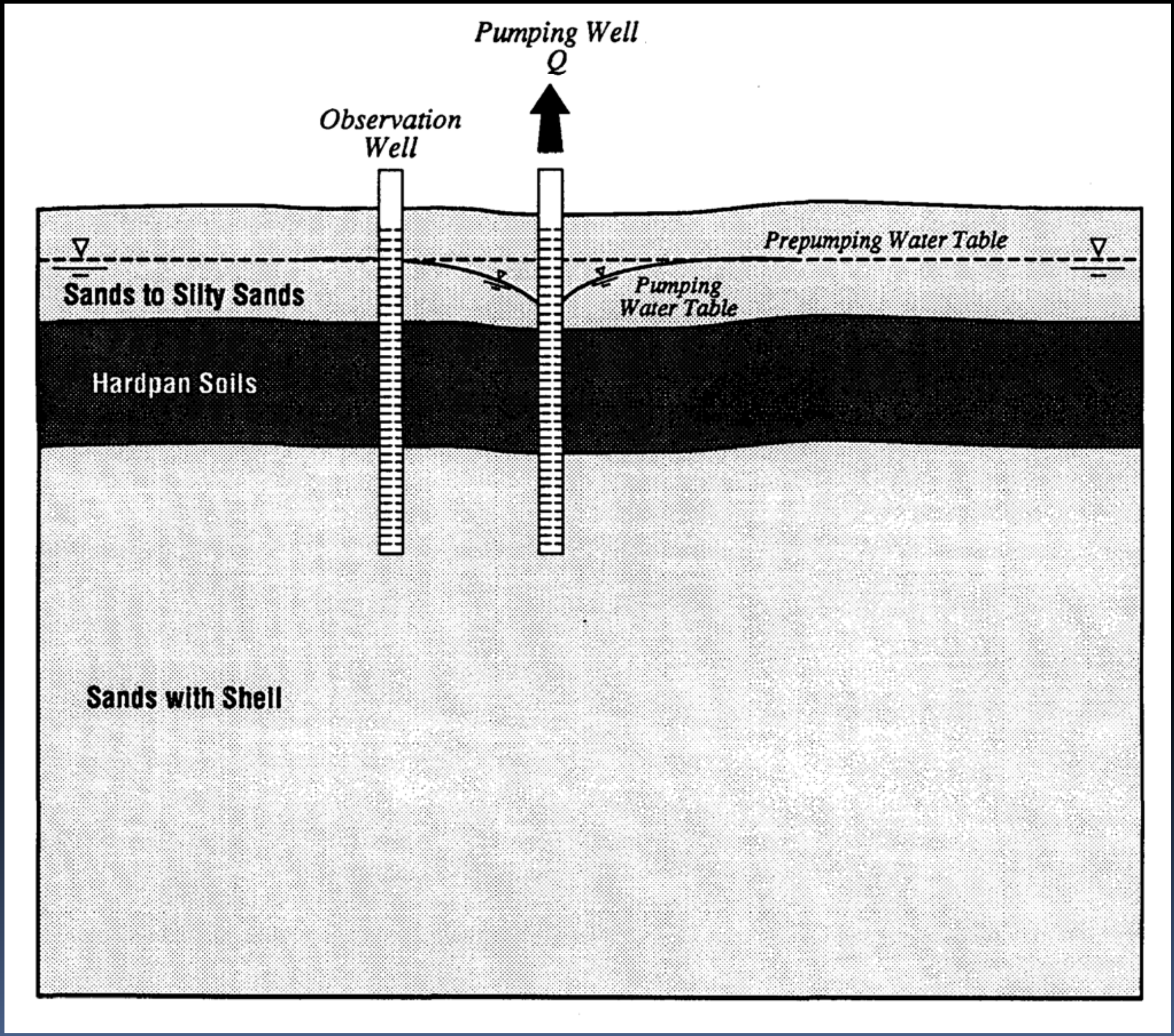
Uncased or Fully Screened Auger Hole, Falling Head

Section 21. Methodologies, Recovery Analysis, And Soil Testing For Retention Systems



Uncased or Fully Screened Auger Hole, Constant Head

Section 21. Methodologies, Recovery Analysis, And Soil Testing For Retention Systems



Pump Test

Section 21. Methodologies, Recovery Analysis, And Soil Testing For Retention Systems

Estimation of Horizontal Hydraulic Conductivity of Aquifer (cont'd.)

For design purposes of all retention BMPs, a saturated hydraulic conductivity value over forty (40) feet per day will not be allowed for fine-grained sands, and sixty (60) feet per day for medium-grained sands.

Restrictions on the use of double ring infiltrometer tests

The double-ring infiltrometer field test is used for estimating in-situ infiltration rates. If used, these tests must be conducted at the depth of the proposed pond bottom, and shall only be used obtain the initial "unsaturated" hydraulic conductivity.

Section 21. Methodologies, Recovery Analysis, And Soil Testing For Retention Systems

Estimation of Fillable Porosity

The fillable porosity of the poorly graded fine sand aquifers in Florida are in a narrow range (20 to 30%).

The higher values of fillable porosity will apply to the well- to excessively-drained, hydrologic group "A" fine sands, which are generally deep, contain less than 5% by weight passing the U.S. No. 200 (0.074 mm) sieve, and have a natural moisture content of less than 5%.

No specific field or laboratory testing requirement is recommended, unless there is a reason to obtain a more precise estimate of fillable porosity.

Section 21. Methodologies, Recovery Analysis, And Soil Testing For Retention Systems

Estimation of Fillable Porosity (cont'd.)

No specific field or laboratory testing requirement is recommended, unless there is a reason to obtain a more precise estimate of fillable porosity. In such a case, it is recommended that the following equation be used to compute the fillable porosity:

$$\text{Fillable porosity} = (0.9\,N) - (\,w\,\gamma_d / \gamma_w\,)$$

Where
- N = total porosity
- W = natural moisture content (as a fraction)
- γ_d = dry unit weight of soil
- γ_w = unit weight of water

Section 21. Methodologies, Recovery Analysis, And Soil Testing For Retention Systems

Factor of Safety

A safety factor of two (2.0) must be used in the recovery analysis of the RTV. Two possible ways to apply this safety factor are:

(a) Reducing the design saturated hydraulic conductivity rates by half; or

(b) Designing for the required RTV drawdown to occur within half of the required drawdown time.

Section 21. Methodologies, Recovery Analysis, And Soil Testing For Retention Systems

Factor of Safety (cont'd.)

The safety factor of two (2.0) is based on the high probability of:

- Soil compaction during clearing and grubbing operations,
- Improper construction techniques that result in additional soil compaction under the retention BMP,
- Inadequate long term maintenance of the retention BMP, and
- Geologic variations and uncertainties in obtaining the soil test parameters for the recovery / mounding analysis (noted in subsequent sections below). These variations and uncertainties are especially suspect for larger retention BMPs.

Requirements For Soil Testing

Information related to soils must include the following:

- Soils test results shall be included as part of a supporting soils/geotechnical report of a project's ERP application. This report must be certified by the appropriate Florida registered professional.
- For all soil borings that are used to estimate the depth to the Seasonal High Ground Water Table (SHGWT), the soil colors shall be denoted by both their English common name and their corresponding Munsell color notation (i.e., light yellowish brown – 10YR 6/4).

Requirements For Soil Testing (cont'd.)

- Soil test locations shall be located on the construction drawings, or as an option, the permit review drawings that are submitted as part of the ERP application to the Agency. The horizontal locations of the soil borings/tests shall be placed on the appropriate plan sheet(s), and vertical locations of the soil borings/tests shall be placed on the appropriate retention BMP cross-section(s). The designation number of each test on the plan or cross-section sheets shall correspond to the same test number in the supporting soils/geotechnical report (i.e., SPT #1, Auger boring #2, hydraulic conductivity test #3, etc.).
- The vertical datum of the soil tests results shall be converted to the same datum of the plan sheets and retention BMP cross-sections.

Minimum Number of Borings

At a minimum, the following number of tests will be required for each proposed BMP unless the specific BMP design criteria do not require soil testing:

Soil Borings:

- One (1) for each BMP, drilled to at least ten (10) feet below the bottom of the proposed BMP system
- For BMPs larger than 0.25 acre, retention systems within Sensitive Karst Areas, complex hydrogeology, appreciable topographic relief under the retention BMP, or areas that been filled or otherwise disturbed to change the site's soil characteristics such as in certain urban areas or reclaimed mined lands:

Minimum Number of Borings

The greater of the following two criteria

- One (1) for each BMP, drilled to at least ten (10) feet below the bottom of the proposed BMP system
- For BMPs larger than 0.25 acre, retention systems within Sensitive Karst Areas, complex hydrogeology, appreciable topographic relief under the retention BMP, or areas that been filled or otherwise disturbed to change the site's soil characteristics such as in certain urban areas or reclaimed mined lands:

$$B = 1 + (2\,A)^{1/2} + L\,/\,(2\,\pi\,W)$$

Where B = number of required borings under each retention BMP
A = average area in acres (measured at control elevation)
L = length of the BMP in feet
W = width of the BMP, in feet
π = PI, approximately 3.14

Minimum Number of Borings (cont'd).

For swales, a minimum of one boring shall be taken for each 500 linear feet or for each soil type that the swale will be built on.

For the recovery / mounding analysis, SPT borings should be continuously sampled at least two (2.0) feet into the top of the hydraulically restrictive layer. If a restrictive layer is not encountered, the boring shall be extended to at least ten (10) feet below the bottom of the pond / system. As a minimum, the depth of the exploratory borings should extend to the base elevation of the aquifer assumed in analysis, unless nearby deeper borings or well logs are available.

Minimum Number of Borings, Example

For pond L / W = 2

Area (acres)	Number of Borings
0.5	2
1	3
2	3
3	4
4	4
5	4

Minimum Number of Required Saturated Hydraulic Conductivity Tests

The greater of the following two criteria:

- One (1) for each BMP, taken no shallower than the proposed bottom of the BMP system, or deeper if determined by the design professional to be needed for the particular site conditions.
- For BMPs larger than 0.25 acre, retention systems within Sensitive Karst Areas, complex hydrogeology, appreciable topographic relief under the retention BMP, or urbanized (or reclaimed mining) areas that have undergone previous soil disturbance:

$$P = 1 + B / 4$$

Where P = number of saturated hydraulic conductivity tests for each retention BMP

B = number of required borings

Minimum number of required Saturated Hydraulic Conductivity Tests (cont'd.)

For wet detention, stormwater harvesting, or underdrain BMPs that have the potential for impacting adjacent wetlands or potable water supply wells, the hydraulic conductivity tests will be required between the location of the BMP and the adjacent wetlands or well.

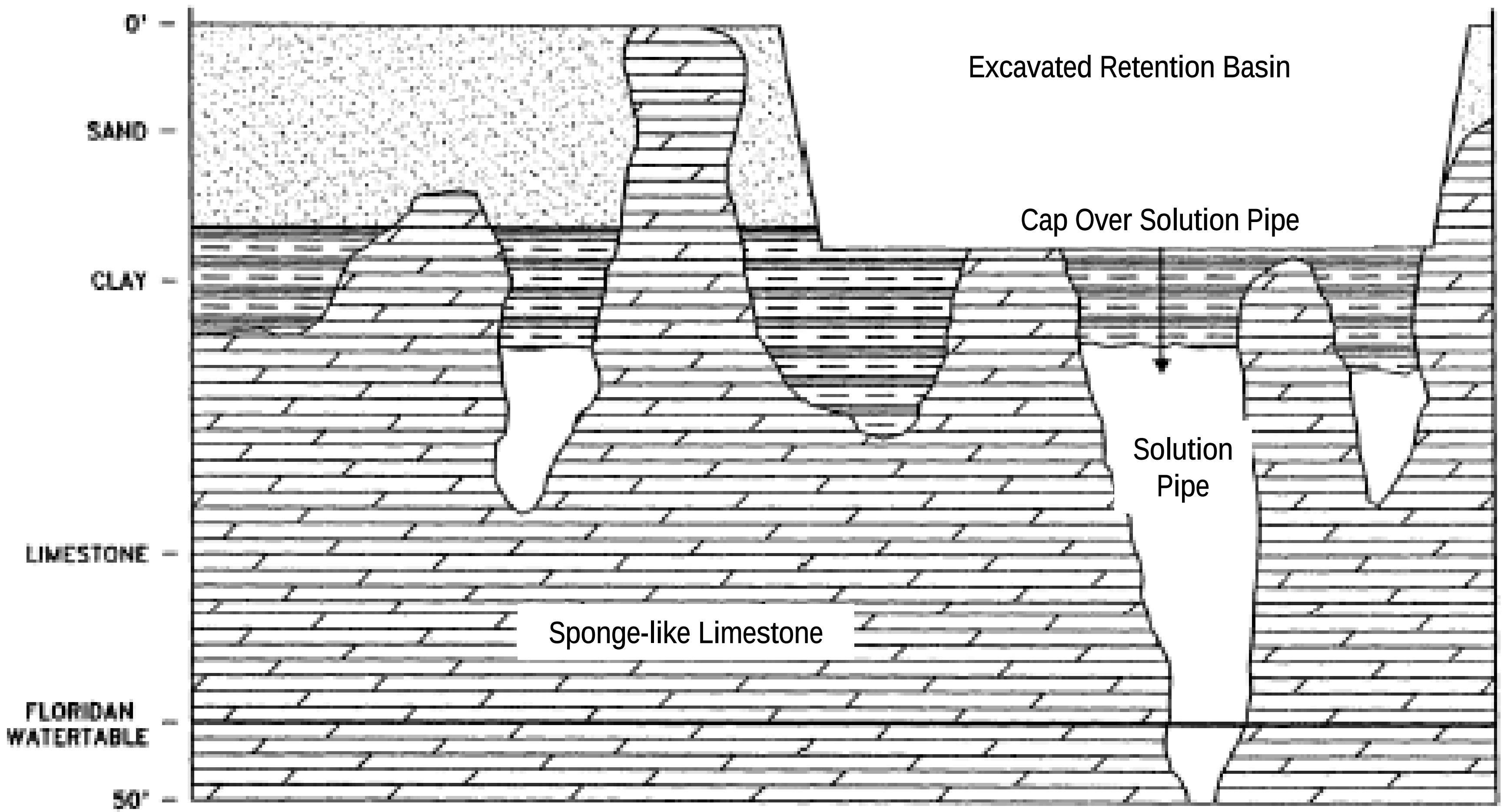
TOPIC # 2

Special Basin Criteria: Sensitive Karst Areas

SECTION 30

FDEP DRAFT APPLICANTS HANDBOOK, MARCH 2010

Section 30. Special Basin Criteria: Sensitive Karst Areas



Section 30. Special Basin Criteria: Sensitive Karst Areas

Solution pipe sinkholes and other types of sinkholes may open in the bottom of stormwater retention basins. The capping plug or sediment fill may be reduced by excavation of the basin. Stormwater in the basin may increase the hydraulic head on the remaining material in the pipe throat. Both of these factors can wash material down the solution pipe. Solution pipes act as natural drainage wells and can drain stormwater basins.

The irregular weathering of the limestone surface in the SKAs contributes to uncertainty and errors in predicting the depth from land surface to limestone. This potential for error must be considered for site investigations when evaluating site borings, and load-specific geological analyses must be included to base site designs.

Additional Design Criteria for Sensitive Karst Areas Section 30.3 .1

Stormwater treatment systems shall be designed and constructed to prevent direct discharge of untreated stormwater into the Floridan Aquifer System.

They also shall be designed and constructed in a manner that avoids breaching an aquitard and such that construction excavation will not allow direct mixing of untreated water between surface waters and the Floridan Aquifer System.

The system shall also be designed to prevent the formation of solution pipes or other types of karst features in the SKAs.

Test borings located within the footprint of a proposed stormwater treatment system must be plugged in a manner to prevent mixing of surface and ground waters.

Additional Design Criteria for Sensitive Karst Areas Section 30.3 .1 (cont'd.)

Stormwater treatment systems constructed within Sensitive Karst Areas shall meet the design criteria set forth earlier in this Handbook and also be designed to meet the following requirements:

- A minimum of three feet of unconsolidated soil material between the surface of the limestone bedrock and the complete extent of the bottom and sides of the stormwater basin. This provision is presumed to provide reasonable assurance of adequate treatment of stormwater before it enters the Floridan Aquifer System. As an alternative, an impermeable, permanent and suitable protective liner shall be placed in bottom.
- Stormwater storage areas and basin depths shall not exceed 10 feet (shallower depths are encouraged) and shall have a horizontal bottom (no deep spots) to reduce the potential for sinkhole formation caused by a large hydraulic head.

Additional Design Criteria for Sensitive Karst Areas Section 30.3 .1 (cont'd.)

- Fully vegetated basin side slopes and bottom (if not a wet pond) planted with turf grass or other appropriate vegetation suitable for growing in the conditions in which it is planted.
- Depending on the potential for contamination to the Floridan Aquifer more stringent requirements may apply.

Additional Design Criteria for Sensitive Karst Areas Section 30.3 .2

Applicants who believe that their proposed system is not within the influence of a karst feature, notwithstanding that it is within the SKAs designated by the Water Management District, and therefore wish to design their system other than as provided in **Section 30.3.1 of this Handbook**, shall furnish the Agency with alternative reasonable assurances that the proposed system complies with Section 30.3.1 of this Handbook. Such reasonable assurance shall consist of:

a. A geotechnical analysis consisting of existing soil, geologic, and lithologic data of the project area that demonstrates the presence of an aquitard consisting of at least 20 feet of unconsolidated low permeability material [clay (particle size less than 0.002mm) content >10%] below the pond bottom that will not be breached by the proposed design and construction; or

b. The presence of a minimum of 100 ft. of unconsolidated material from the bottom of the pond and the top of the limestone as demonstrated by core borings within the proposed pond area; or

Additional Design Criteria for Sensitive Karst Areas Section 30.3 .2 (cont'd.)

c. A geotechnical study, analysis and system design that demonstrates that the existing soil, geologic, and lithologic data of the project area are suitable for stormwater treatment system not designed to the special requirements for Sensitive Karst Areas.

Additional Design Criteria for Sensitive Karst Areas Section 30.3.3

In addition to sites identified by the Water Management District as karst sensitive, the Agency shall require compliance with the criteria in Section 30.3.2 of this Handbook when available data and information indicate that a substantial likelihood exists that a proposed stormwater management system on a site has the potential to be located within the influence of a karst feature based on methodologies generally accepted by registered professionals, and has the potential to adversely affect the Floridan Aquifer System.

Additional Design Criteria for Sensitive Karst Areas Section 30.3.6

- If limestone bedrock is encountered during construction of the stormwater treatment system, the Agency shall be notified within 48 hours and all construction in the affected area shall cease.
- The Permittee shall notify the Agency of any sinkhole development within the stormwater treatment system within 48 hours of discovery and must submit a sinkhole evaluation and repair plan that provides reasonable assurance that the breach will be permanently corrected, prepared by a registered professional, as soon as practical, but no later than 30 days after sinkhole discovery, to the Agency for review and approval.
- The stormwater treatment system will be inspected monthly by the Permittee to determine if any sinkholes have opened in the stormwater system. An annual inspection and certification from the appropriate registered professional stating that the stormwater treatment system is functioning consistent with all permit conditions shall be submitted to the Agency. If the system is not operating as permitted, the registered professional shall submit a restoration plan for approval by the Agency.

TOPIC # 3

Control Elevation for Wet Detention Ponds

SECTION 13

FDEP DRAFT APPLICANTS HANDBOOK, MARCH 2010

Section 13.4(e) Control Elevation for Wet Ponds

The control elevation is the "normal" water level for the pond. The control elevation shall be established as the higher elevation of either the normal wet season tailwater elevation or the SHGWT minus six inches, unless this creates adverse impacts to wetlands at or above the control water table elevation.

However, variation of site conditions throughout the state may allow deviation from this requirement. Accordingly, an applicant may request the Agency to approve another control elevation based upon evaluation of the proposed elevation (see evaluation criteria on next slide).

The Agency will approve an alternative control elevation and its effects on the factors above based on a demonstration by the applicant, using plans, test results, calculations or other information, that the alternative design is appropriate for the specific site conditions and will meet the above considerations.

Evaluation Criteria for Specifying Alternate Wet Pond Control Elevation

- Maintaining existing water table elevations in existing wellfield cones of depression;
- Maintaining water table elevations needed to preserve environmental values at the project site and prevent the waste of freshwater;
- Maintaining minimum flows or levels of surface waters established pursuant to Section 373.042, F.S.
- Assuring that water table elevations will not be lowered such that the existing rights of others will not be adversely affected;
- Preserving ground water recharge characteristics of the project site;
- Maintaining ground water levels needed to protect wetlands and other surface waters;
- Creating adverse impacts on surrounding land and project control elevations and water tables;
- Creating conflicts with water use permitting requirements or water use restrictions;

TOPIC # 4

Underdrain System Design Criteria

SECTION 17
FDEP DRAFT APPLICANTS HANDBOOK, MARCH 2010

Section 17. Underdrain Filtration System Design Criteria

The effectiveness of underdrained ponds for providing nutrient removal in stormwater runoff is currently not well documented. Studies are currently under way in order to develop data to better quantify the removal efficiency of underdrained ponds. Therefore, underdrained ponds should be considered as an "interim BMP". Their inclusion as a BMP in the final FDEP stormwater rule is subject to continuing research.

Section 17. Underdrain Filtration System Design Criteria (cont'd.)

Section 17.3(e). Underdrain Media

Underdrain systems assist in volume recovery where the native soil has a good capacity for percolation, but where high water table conditions generally prevent the infiltration of the treatment volume through the soil profile. To provide proper treatment of the runoff, at least 12 inches of adsorption media is required between the bottom of the basin storing the treatment volume and the outside of the underdrain pipes (and gravel envelope as applicable). The media must provide adsorption for phosphorus and an environment suitable for anoxic conditions that will foster the denitrification process.

Section 17. Underdrain Filtration System Design Criteria (cont'd.)

To remove both total nitrogen and total phosphorus, all of the following adsorption media criteria shall be met:

- Greater than 15% but less than 30% of the particles passing the #200 sieve.
- At least 12 inches in thickness.
- Water holding capacity is at least 35%, and as measured by porosity.
- Permeability is greater than 0.03 inches per hour but less than 0.25 inch per hour. If the filter is being used to remove phosphorus only, the permeability rate can be increased up to a maximum of three inches (3") per hour.
- Organic content is no more than 5% by volume.
- pH is between 6.5 and 8.0.
- Sorption capacity exceeds 0.005 mg OP/mg media.

Example of Underdrain Filtration Medium

Reference: Waneilista & Chang (2008), Alternative Stormwater Sorption Media for the Control of Nutrients

Composition: sandy loam material, limestone, tire crumb and sawdust

Hydraulic Residence Time: 5 hrs

Hydraulic Conductivity: 2.8 ft/day

Life Expectancy: Approximately 2 years (based on nitrate removal)

Note: This study considered physical removal of nutrients, not microbiological removal. Research is currently under way to measure the treatment efficiencies of existing underdrained pond systems in natural soils.

TOPIC # 5
Underground Retention Systems

SECTIONS 6, 7 & 8

FDEP DRAFT APPLICANTS HANDBOOK, MARCH 2010

Underground Retention Systems

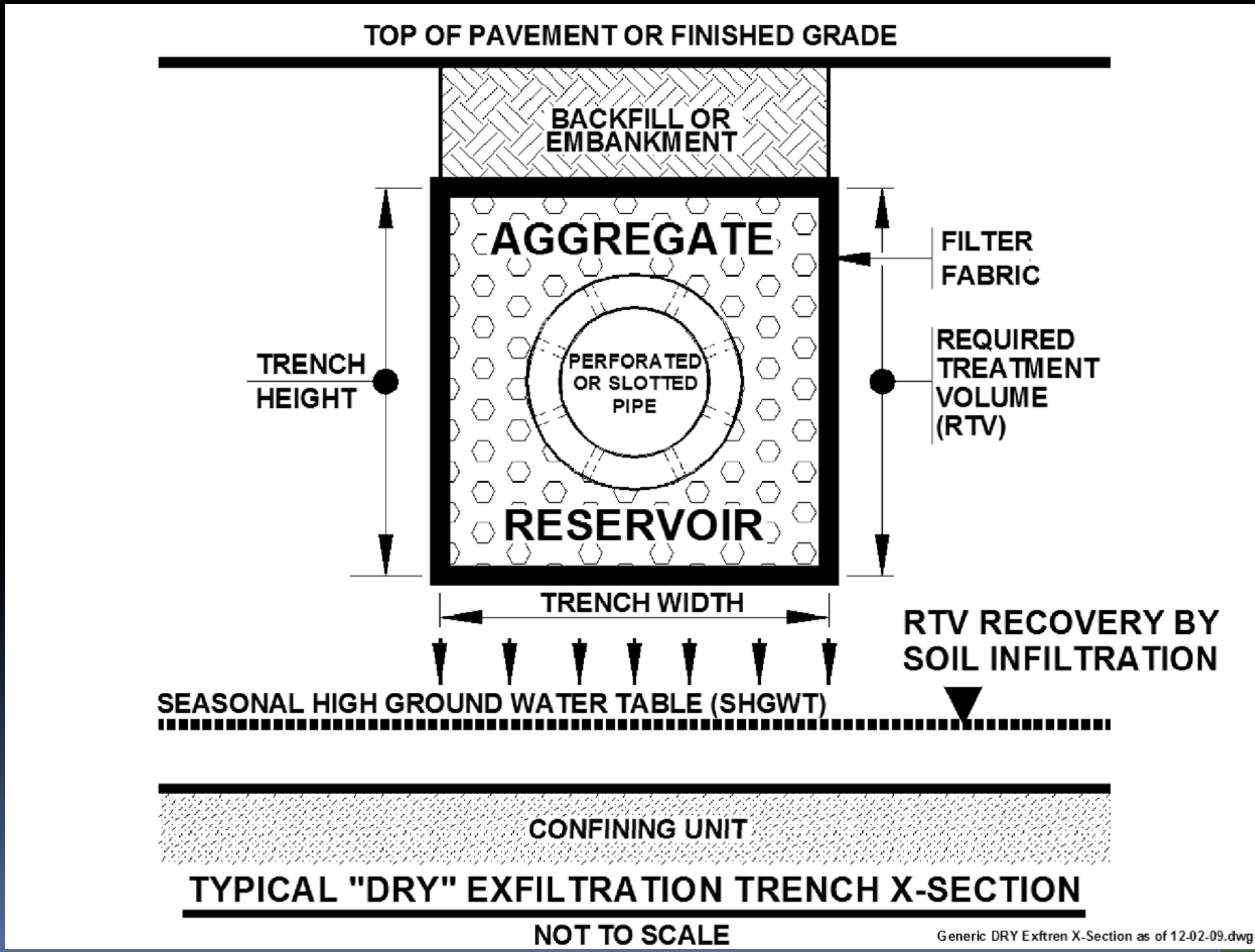
Fore this discussion, underground retention systems include the following:

- Exfiltration Trenches
- Underground Storage & Retention
- Underground Vaults

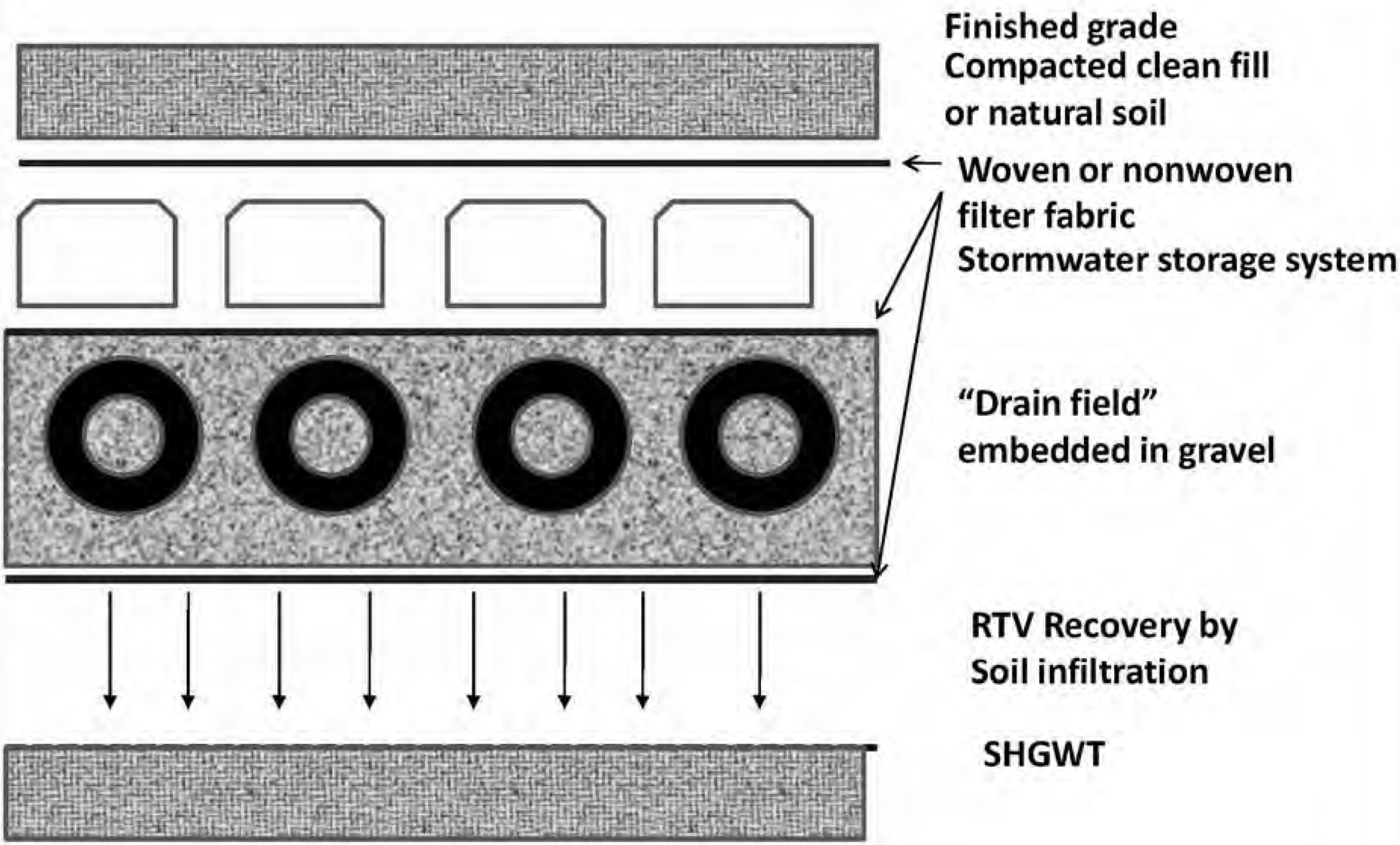
These systems share some common design benefits/drawbacks, construction and maintenance issues, etc.

There are also significant differences between them.
Consult FDEP Stormwater Handbook for details of each system.

Exfiltration Trenches

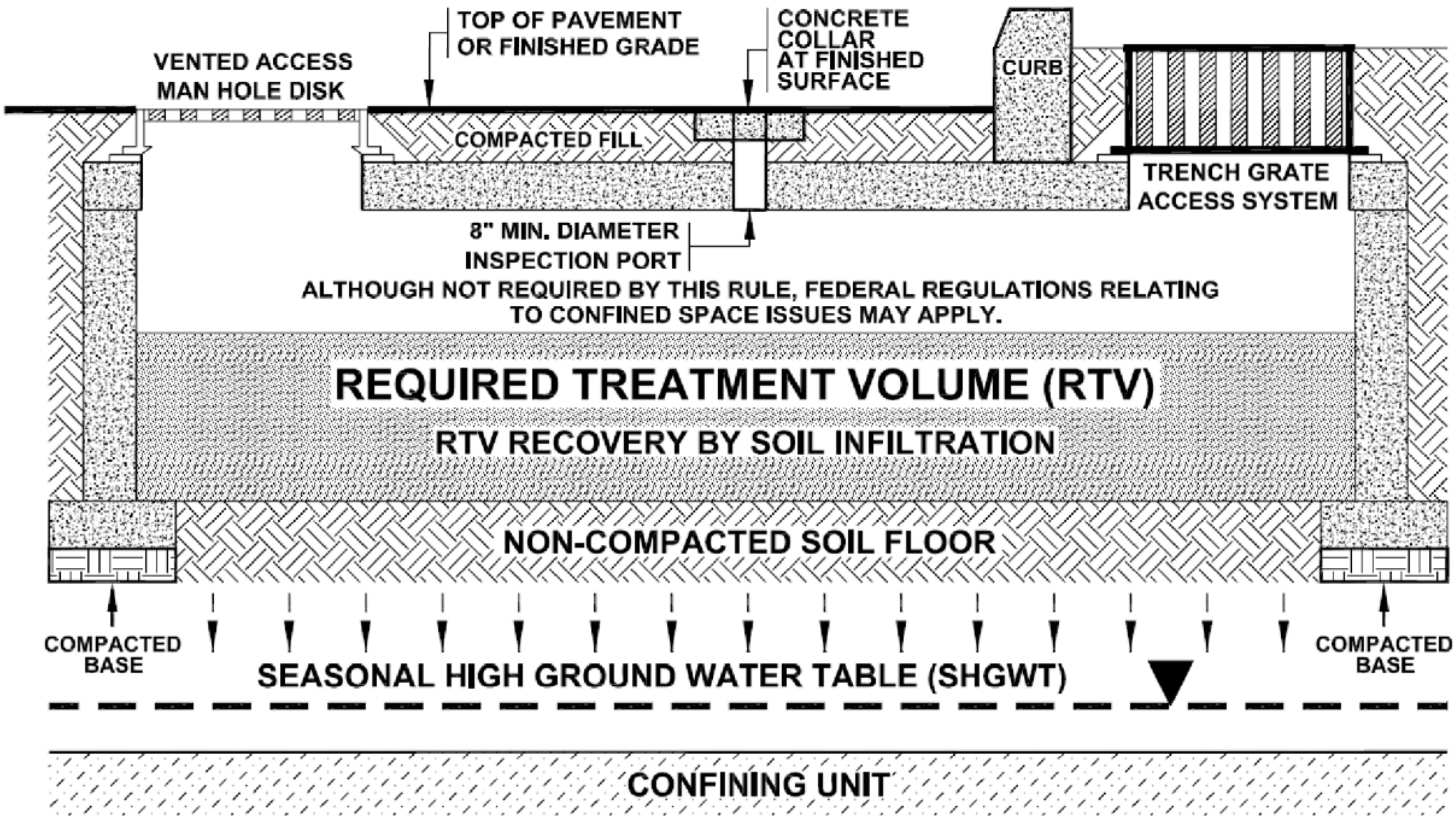


Underground Retention & Storage



Generic Underground Retention System X-Section
Not to scale

Underground Vaults



NOTES:

1. THIS IS A "GENERIC" CONCEPT SKETCH. THERE ARE SEVERAL COMMERCIAL MANUFACTURES OF UNDERGROUND VAULT / CHAMBER SYSTEMS THAT ARE ACCESSIBLE VIA THE INTERNET.
2. A SINGLE ACCESS MANHOLE IS PROHIBITED, AS IT WILL DISCOURAGE MAINTENANCE ACTIVITIES, AND INCREASE THE SAFETY RISK TO MAINTENANCE PERSONNEL.
3. DUE TO HIGH FAILURE RATES (AND THE INCREASED PROBABILITY OF OF INADEQUATE MAINTENANCE AND REHABILITATION EFFORTS), UNDER DRAIN DETENTION / RECOVERY SYSTEMS WILL NOT BE ALLOWED WITHIN AN AN UNDERGROUND RETENTION VAULT / CHAMBER SYSTEM.

GENERIC UNDERGROUND RETENTION VAULTS / CHAMBERS

NOT TO SCALE

GENERIC UNDERGROUND RETENTION VAULT - CHAMBERS - AS OF 01-30-10.DWG

Advantages and Disadvantages

Advantages

- These systems are sometimes used where land values are high, and the owner/applicant desires to minimize the potential loss of usable land with other types of retention Best Management Practices (BMPs).

Disadvantages

- Sediment accumulation and clogging by fines can reduce long term effectiveness.
- High maintenance. Regular inspection and cleaning required.
- Total replacement (especially for exfiltration trenches) may be the only means of restoring the treatment capacity and recovery system which no longer perform adequately over time.
- Periodic replacement of exfiltration trenches should be considered routine operational maintenance.

Underground Retention Systems

<u>Recovery Criteria</u>

These BMPs must:

- Have the capacity to retain the required treatment volume without a discharge and without considering soil storage.
- Recover the required treatment volume of stormwater within 72 hours, with a safety factor of two.
- The seasonal high ground water table shall be at least two feet beneath the bottom of the BMP (see note below).

<u>Note</u>

Exception for Miami-Dade County. In Miami-Dade County exfiltration trenches are not typically designed to be completely above the SHGWT as is the case in the rest of the state. These systems are termed "wet" exfiltration trenches.

Underground Retention Systems

Aggregate Requirements (where applicable)

- Sustainable void spaces must be used in computing the storage volume in the aggregate reservoir. These aggregate void space values shall be the greater of the following:
  - 35% of aggregate volume; or
  - 80% of the measured testing lab values for the selected aggregate(s), if obtained and certified by a Florida licensed geotechnical professional.
- The material used in the aggregate reservoir shall be washed to assure that no more than five percent (5%) of the materials passing a #200 sieve.

Underground Retention Systems

Construction Considerations

Excavation shall be done in such a way as to minimize soil compaction of the bottom of the system.

During construction, every effort should be made to limit the parent soil and debris from entering the trench

- During construction, erosion and sediment controls shall be used to minimize the amount of soil, especially the amount of fines, and debris entering the system.
- During construction, inlet pipes shall be temporarily plugged, to prevent soil and debris from entering the system.
- The underground retention system should not be placed into operation until the contributing drainage area is stabilized and the pretreatment sumps are constructed.

TOPIC # 6

Stormwater Harvesting Design Criteria

SECTION 15

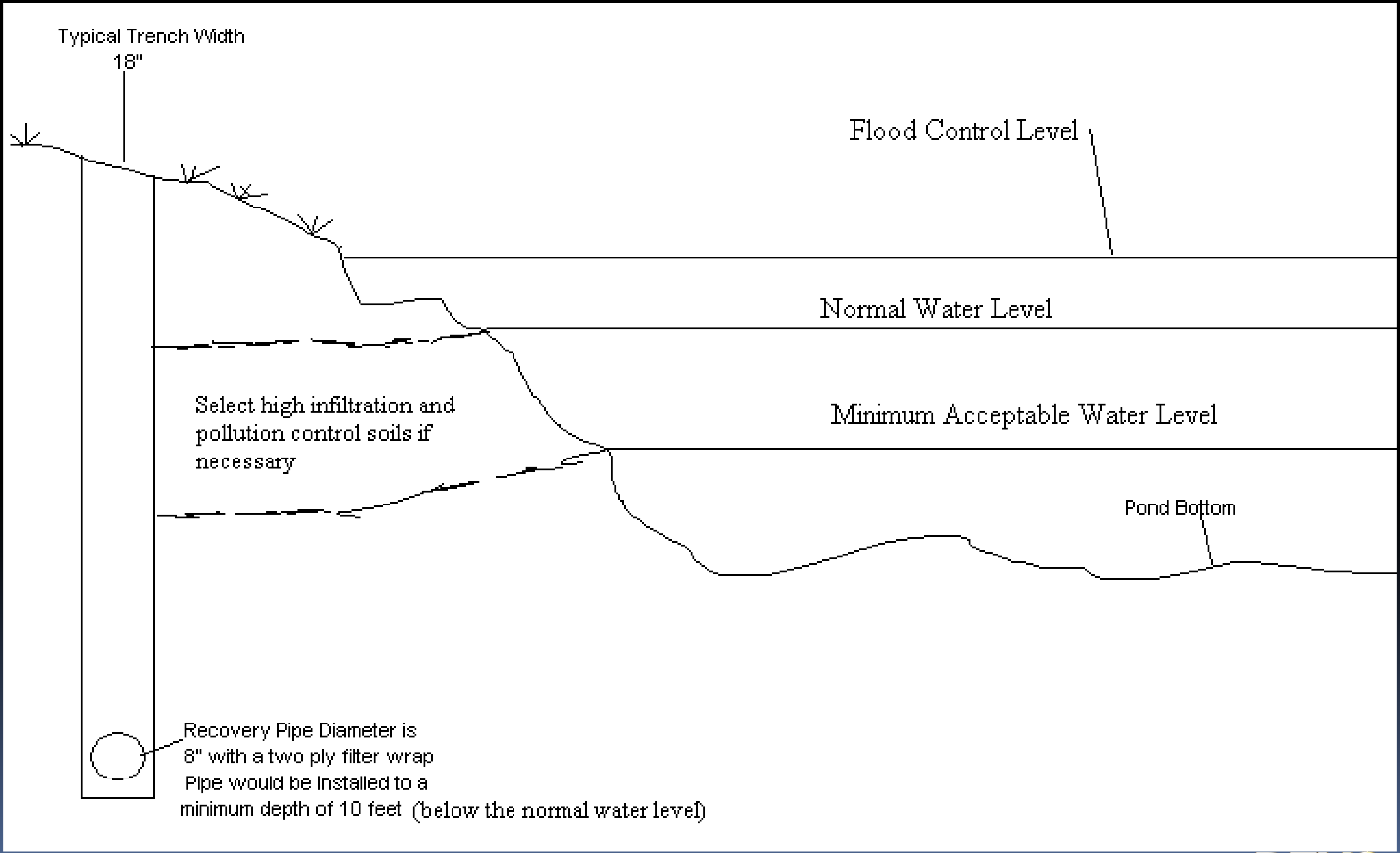
FDEP DRAFT APPLICANTS HANDBOOK, MARCH 2010

Section 15. Stormwater Harvesting Design Criteria

There are many potential uses for treated stormwater. The most common is for irrigation. Others include vehicle washing, cooling tower make-up, rehydration of wetlands, downstream flow augmentation, fire fighting, agricultural

Treated harvested stormwater that is used for irrigation is withdrawn from the stormwater treatment system in a manner that minimizes turbidity, bacteria, pathogens and algal toxins. This can be done by filtering the stormwater to be harvested through a minimum of four (4) feet of native soils or clean sands. This can be accomplished by withdrawing water through a horizontal well configuration located directly adjacent or under the stormwater harvesting pond or by the use of a mechanical sand or disc filter.

Section 15. Stormwater Harvesting Design Criteria (cont'd.)



Section 15. Stormwater Harvesting Design Criteria (cont'd.)

Recommended Application Rates

For typical landscape irrigation, an average irrigation application rate of 0.7 in/week (35 in/yr) is recommended.

The designer shall consult a landscape irrigation specialist for the design of the irrigation system and the recommended irrigation rates.