Progress Energy – NRC Meeting
Levy Nuclear Plant
Geotechnical Review

01-10-08

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Meeting Objectives

- Introduce Levy site and project timeline
- Review foundation conditions at Levy
- Review foundation concepts under consideration

Site Location

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Levy County Nuclear Plant

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Levy Site

Levy County
Marion County
Proposed Levy County Power Plant Site
Inglis, FL
Lake Rousseau
Dunnellon, FL
Withlacoochee River
Barge Canal
Crystal River Power Plant Site
Citrus County
Gulf of Mexico
Crystal River, FL
approx. 5 miles
Levy County
500 kV Switchyard Units 1 & 2
Cooling Towers Unit 2
Unit 2
Cooling Towers Unit 1
Unit 1
Units 1 & 2 Make Up Pumphouse
Barge Slip
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Levy Nuclear Plant Project Schedule

- NRC COL Application July 2008
- Limited Work Authorization (LWA) May 2010
- NRC COL Issued 1st Quarter 2012
- Plant On-line 2016

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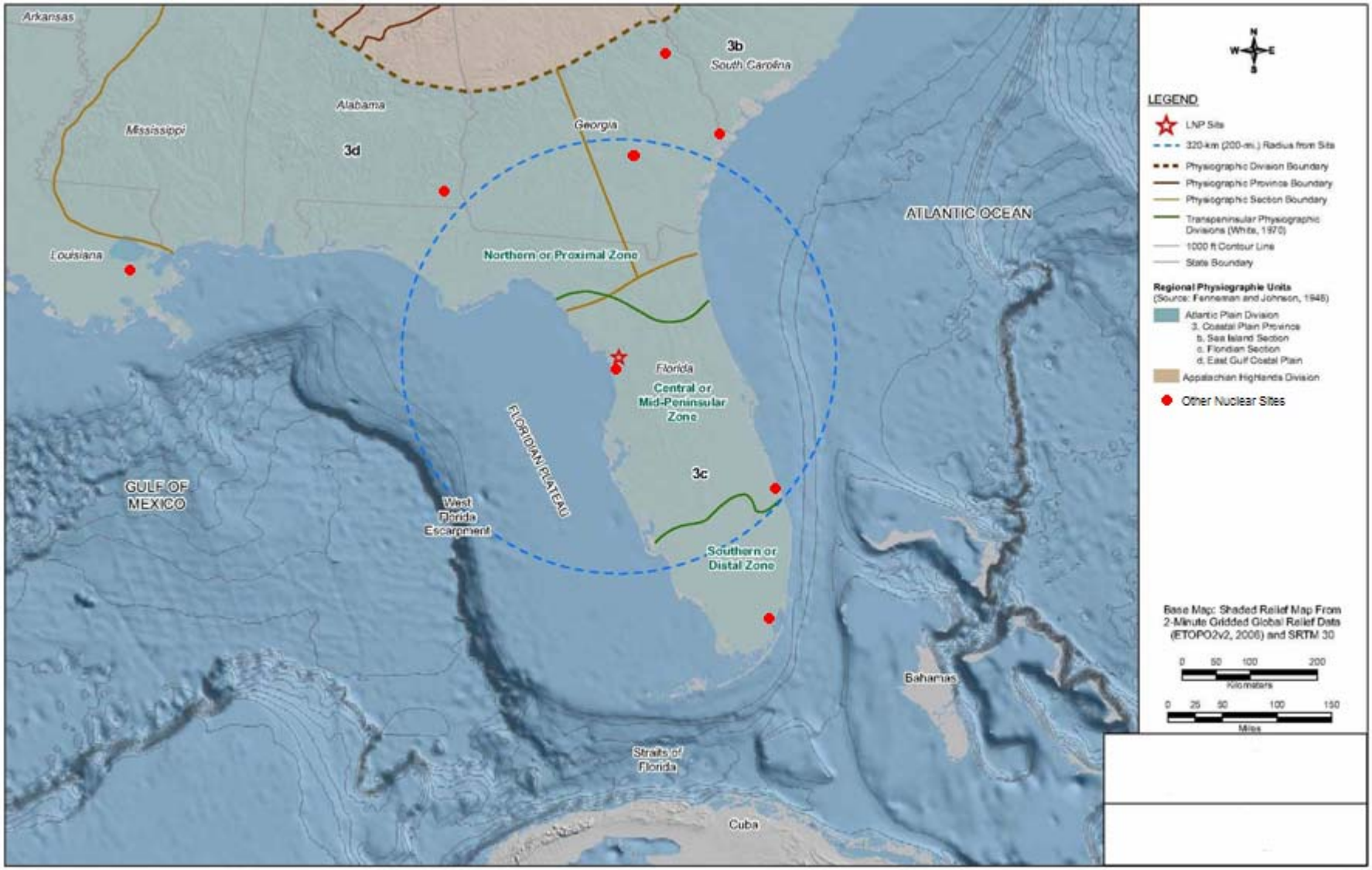
Regional Physiographic Map



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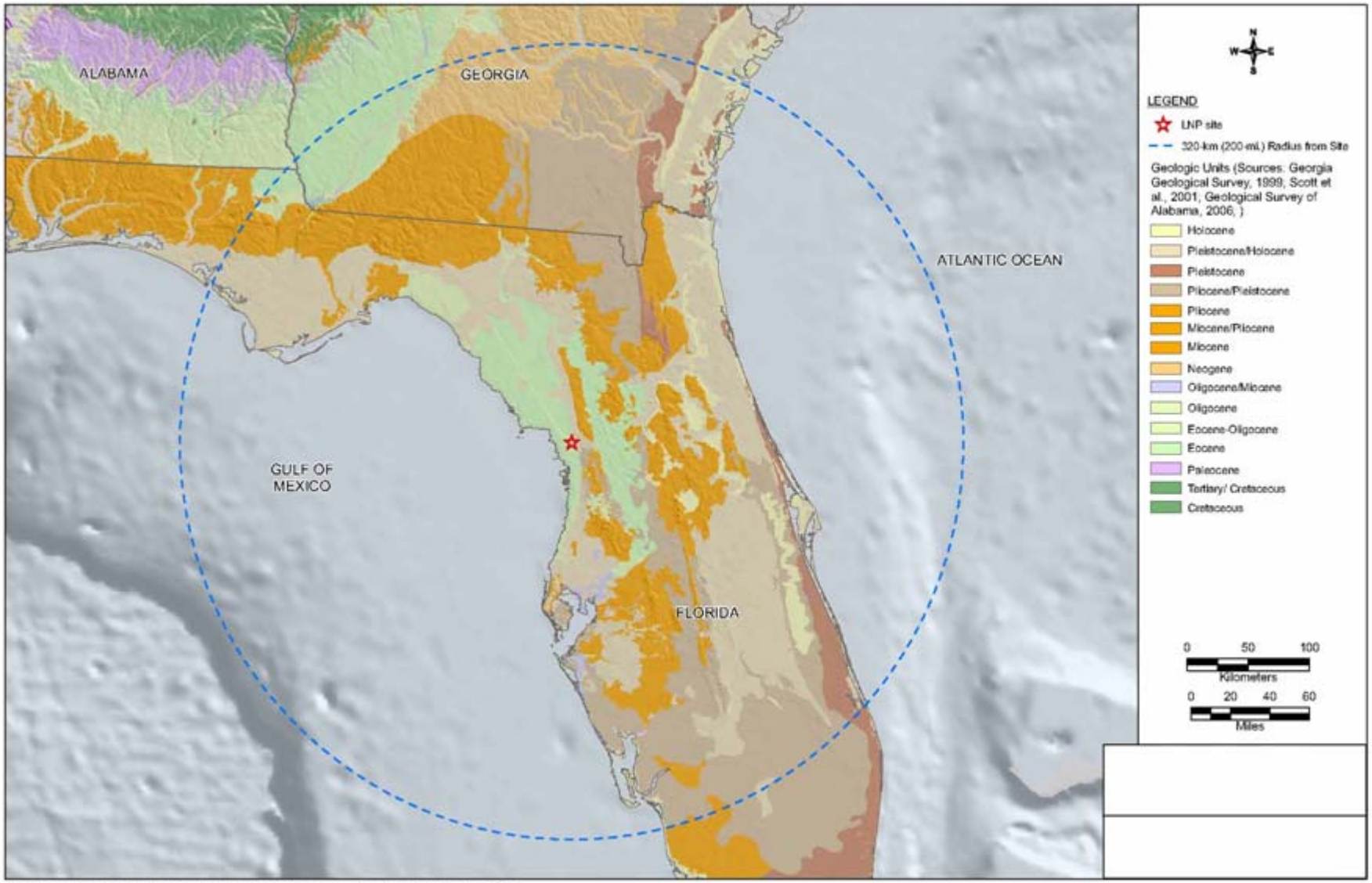
Regional Geology



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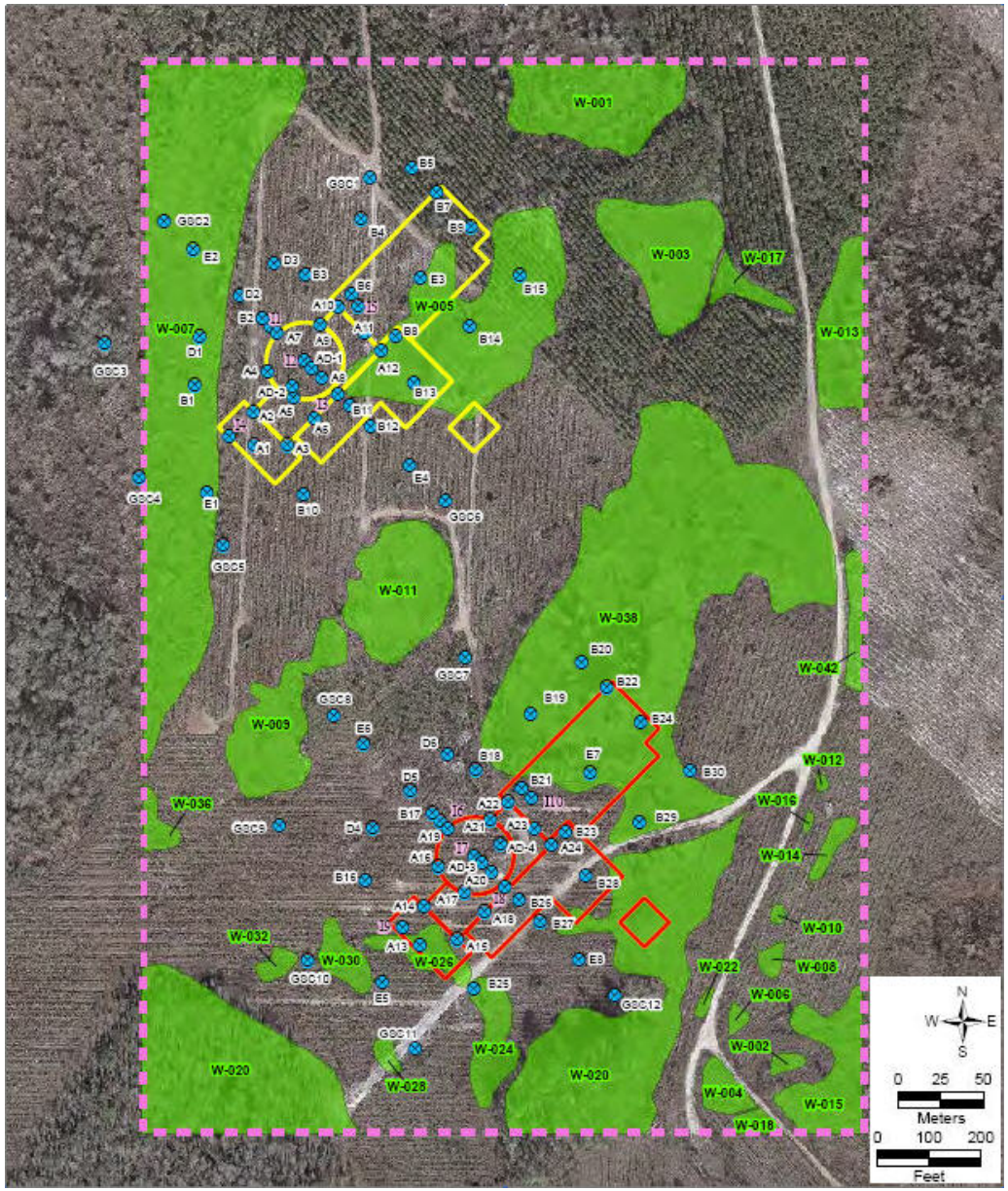
Boring Layout



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Summary of Field Investigations

- Boring Program (SPT & Coring)
  - 51 borings under Safety Related structures
  - 65 additional borings for site characterization/Non-Safety Related structures
  - Depths - 45 feet to 500 feet
- Seismic Geophysical Testing (to 500 ft)
  - Downhole
  - Suspension logging
- Acoustic Televiewer and Caliper Surveys
  - Performed in open mud-rotary holes where P-S logging was performed
- Geophysical Logging
  - Natural gamma, gamma-gamma, neutron-neutron, and induction
- Pressuremeter Testing
- Laboratory Testing Program

North Plant Profile Locations

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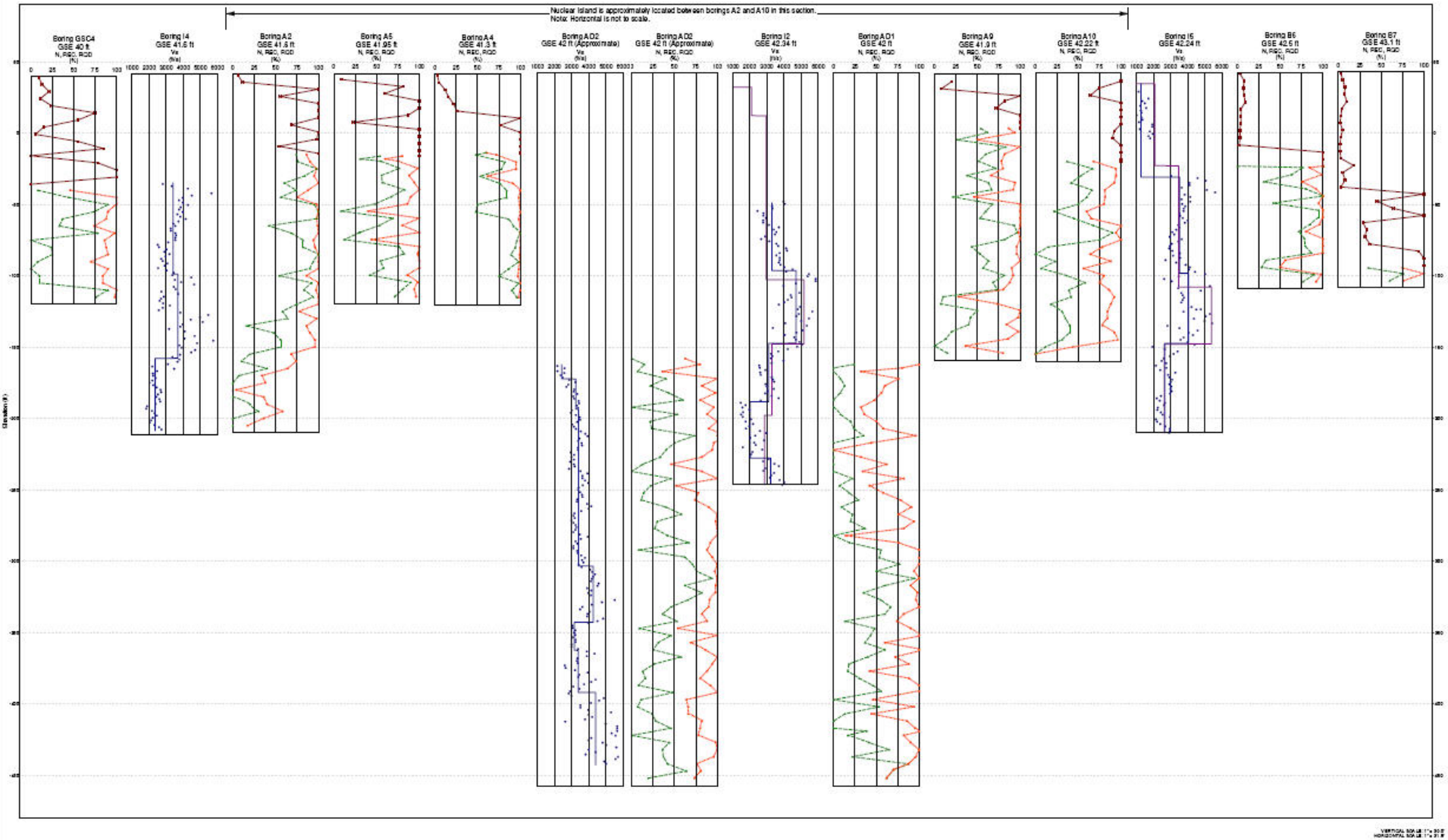
North Plant Preliminary North-South Profile



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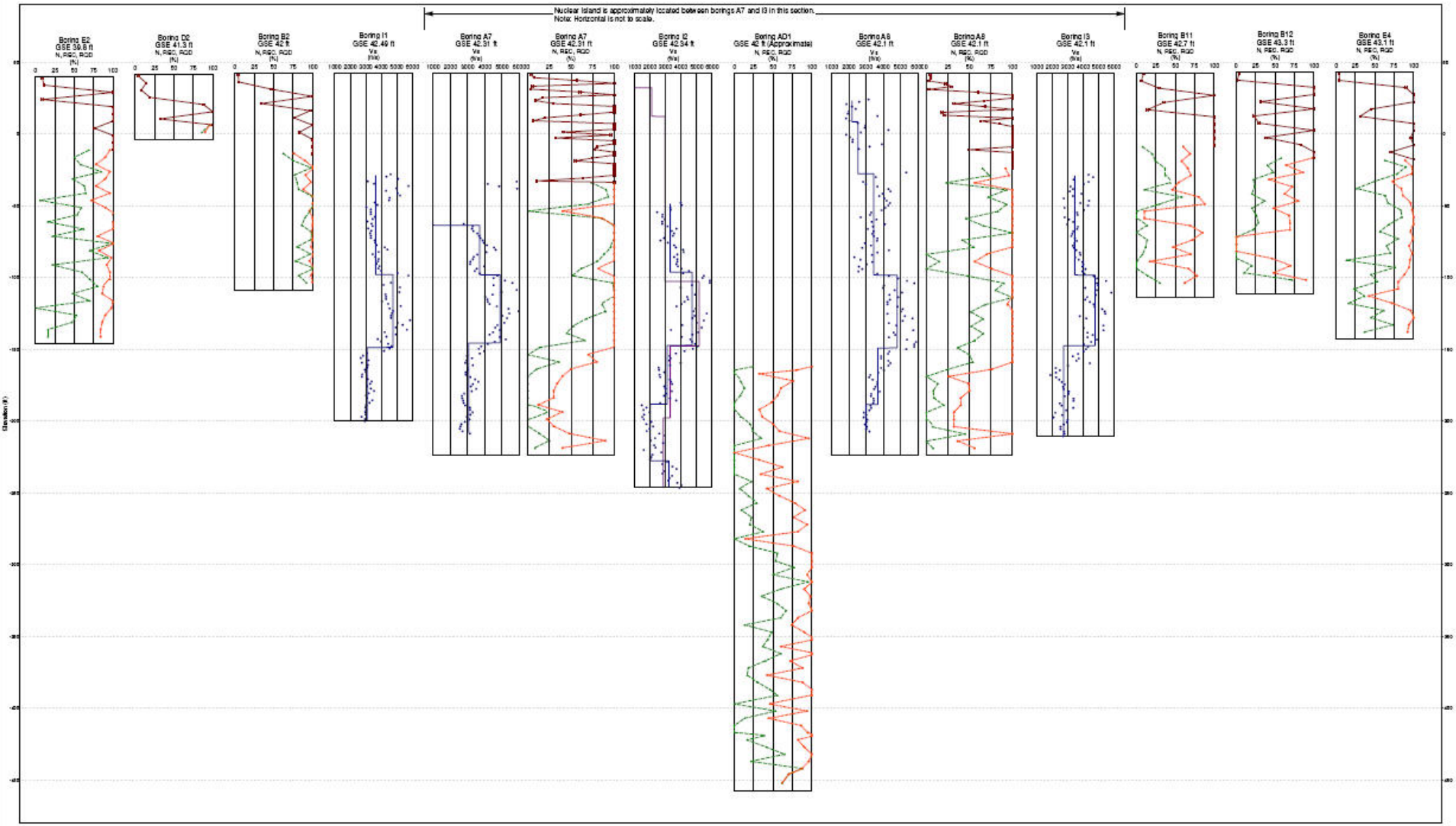
North Plant Preliminary East-West Profile



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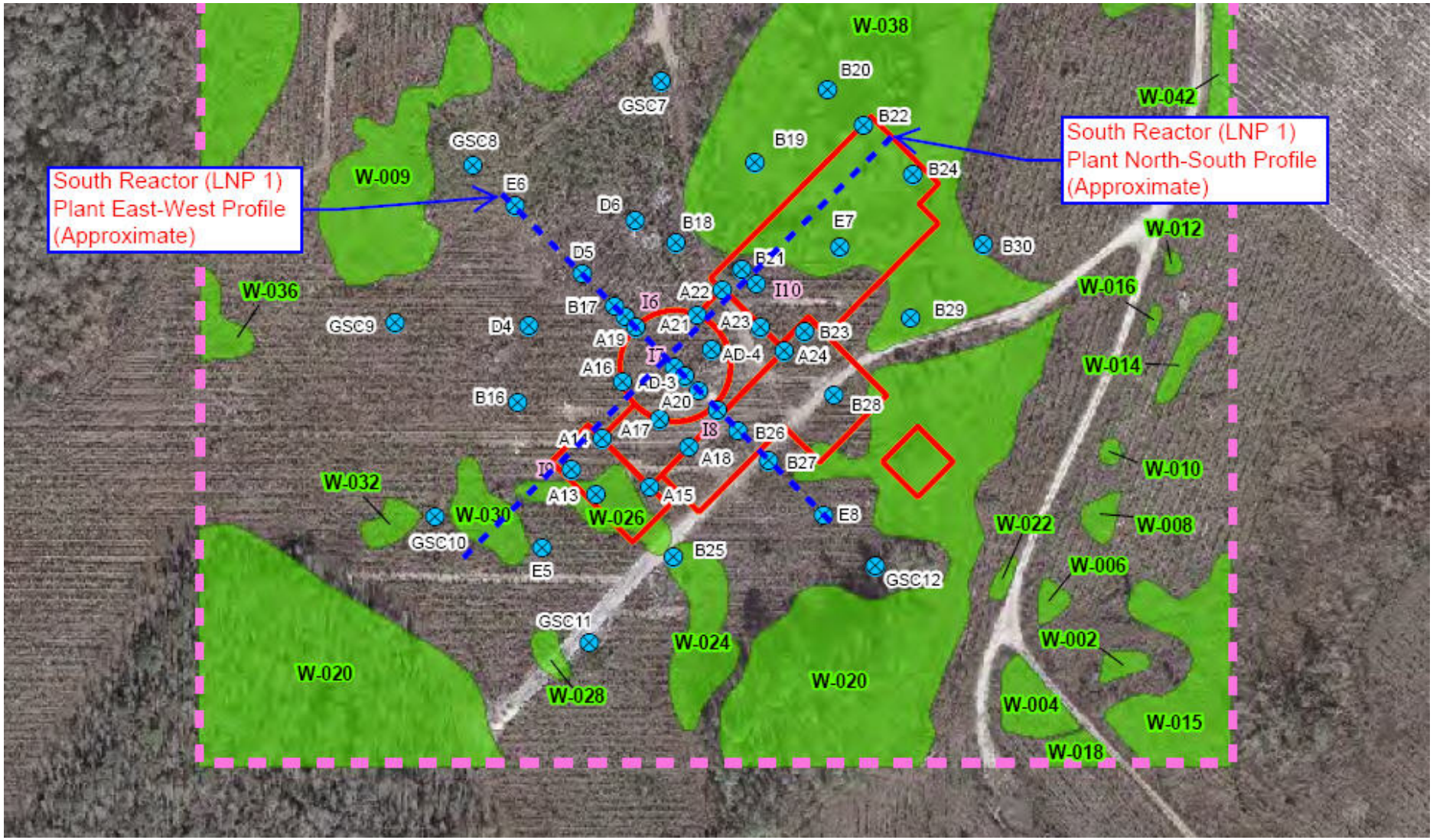
South Plant Profile Locations



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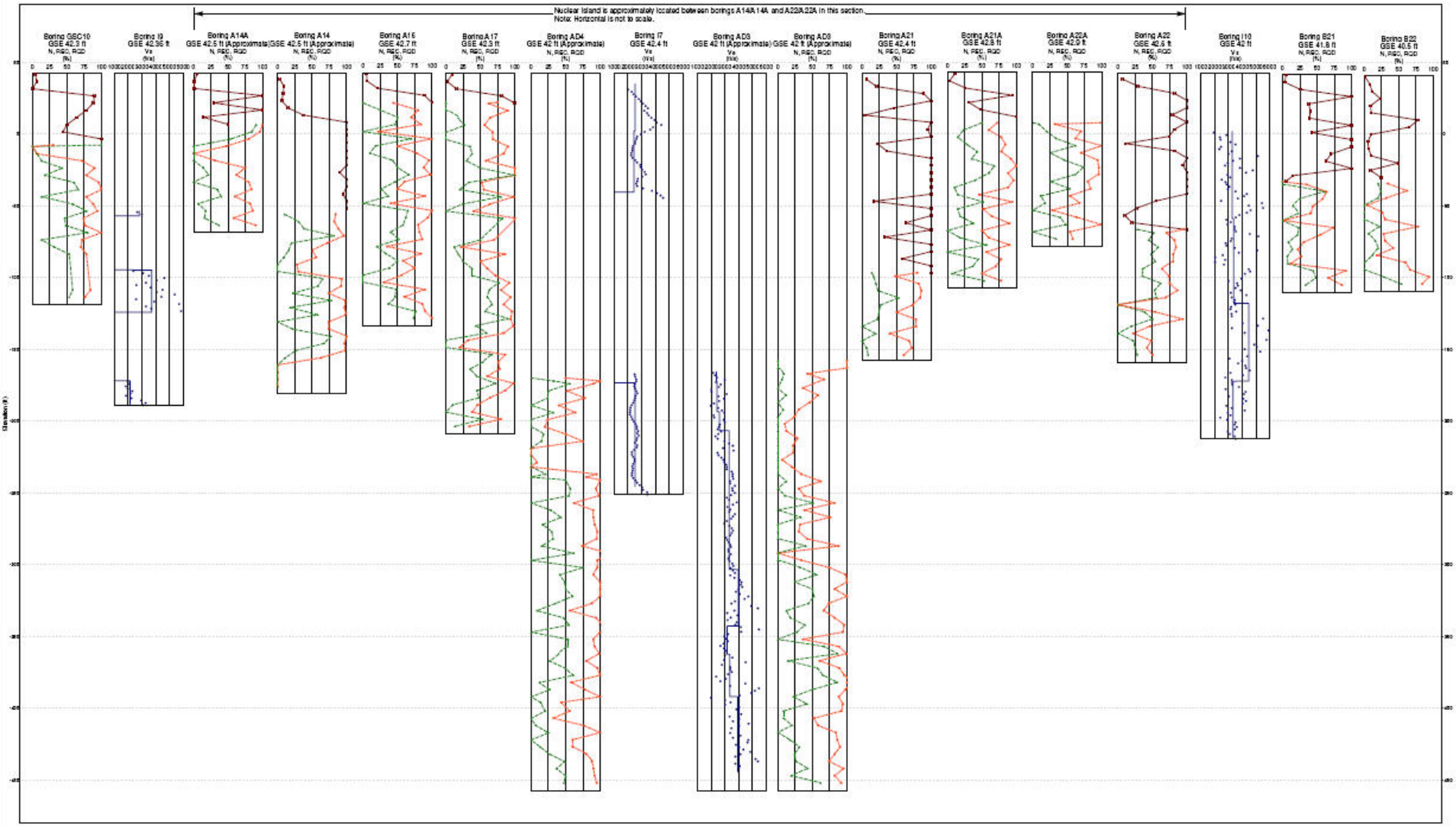
South Plant Preliminary North-South Profile



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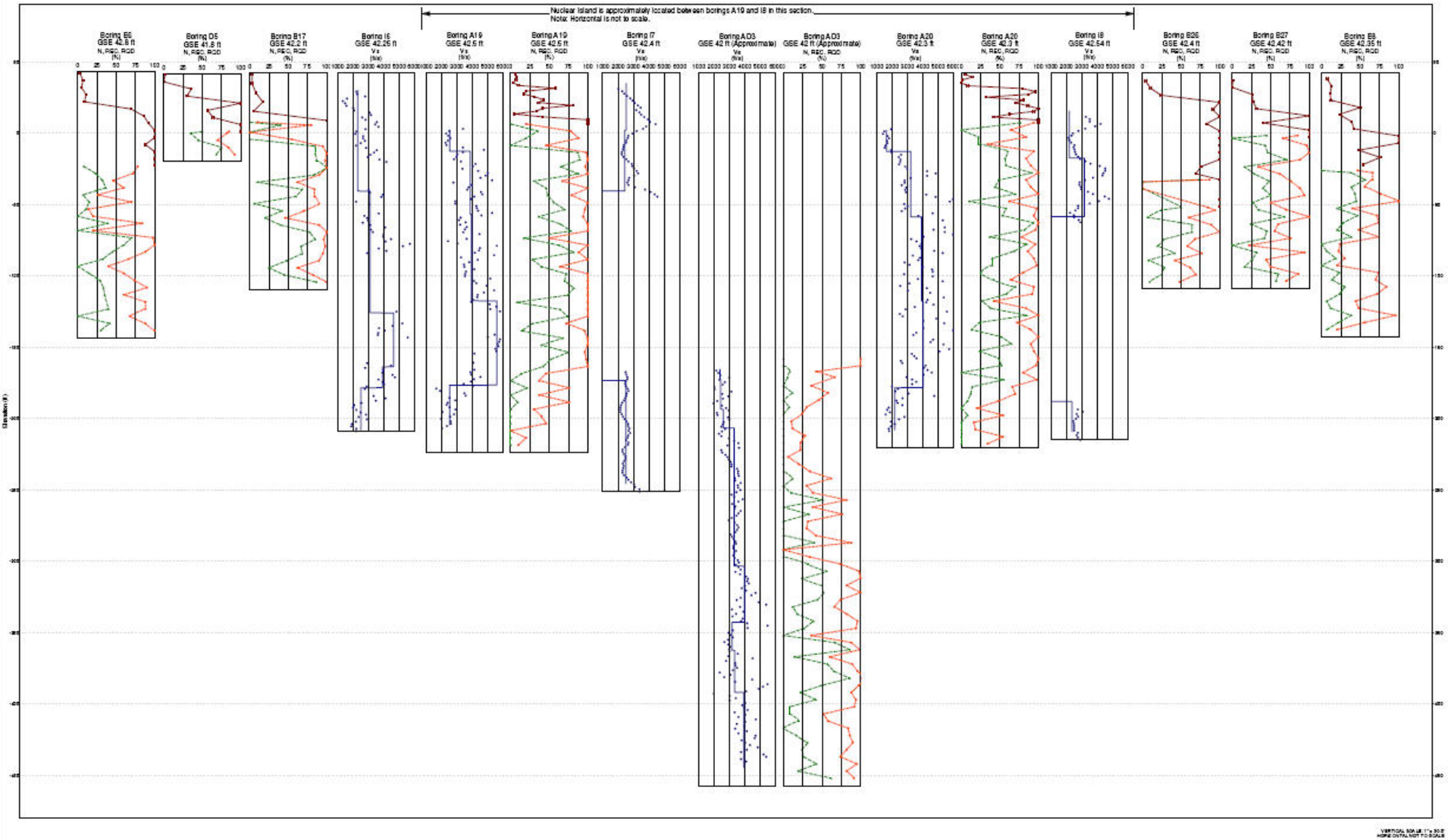
South Plant Preliminary East-West Profile



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Summary of Engineering Parameters for Soil and Rock

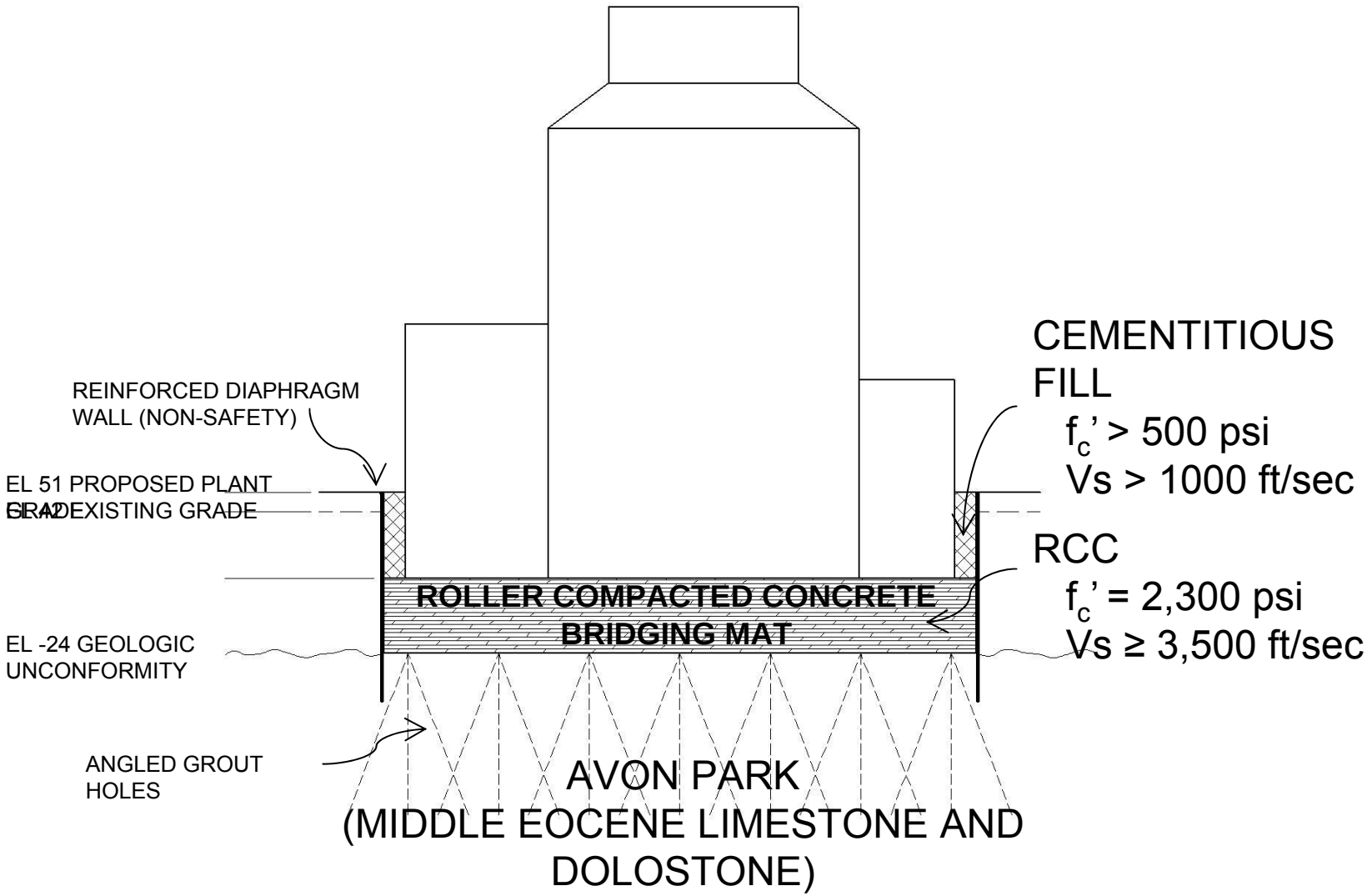
Preliminary Mean Soil/Rock Parameters of North Reactor LNP-2

Layer	Type	Mean Unconfined Compressive Strength (psi)	Typical Shear Wave Velocity (ft/sec)
S-1	Soil	-	2,000
S-2	Soil	-	2,200
S-3	Soil	-	3,000
NAV-1	Rock	2,573	3,500
NAV-2	Rock	3,200	4,800
NAV-3	Rock	1,046	3,000

Preliminary Mean Soil/Rock Parameters of South Reactor LNP-1

Layer	Type	Mean Unconfined Compressive Strength (psi)	Typical Shear Wave Velocity (ft/sec)
S-1	Soil	-	2,000
S-2	Soil	-	2,200
S-3	Soil	-	2,800
SAV-1	Rock	3,978	3,500
SAV-2	Rock	1,046	2,500

LNP Foundation Concept I



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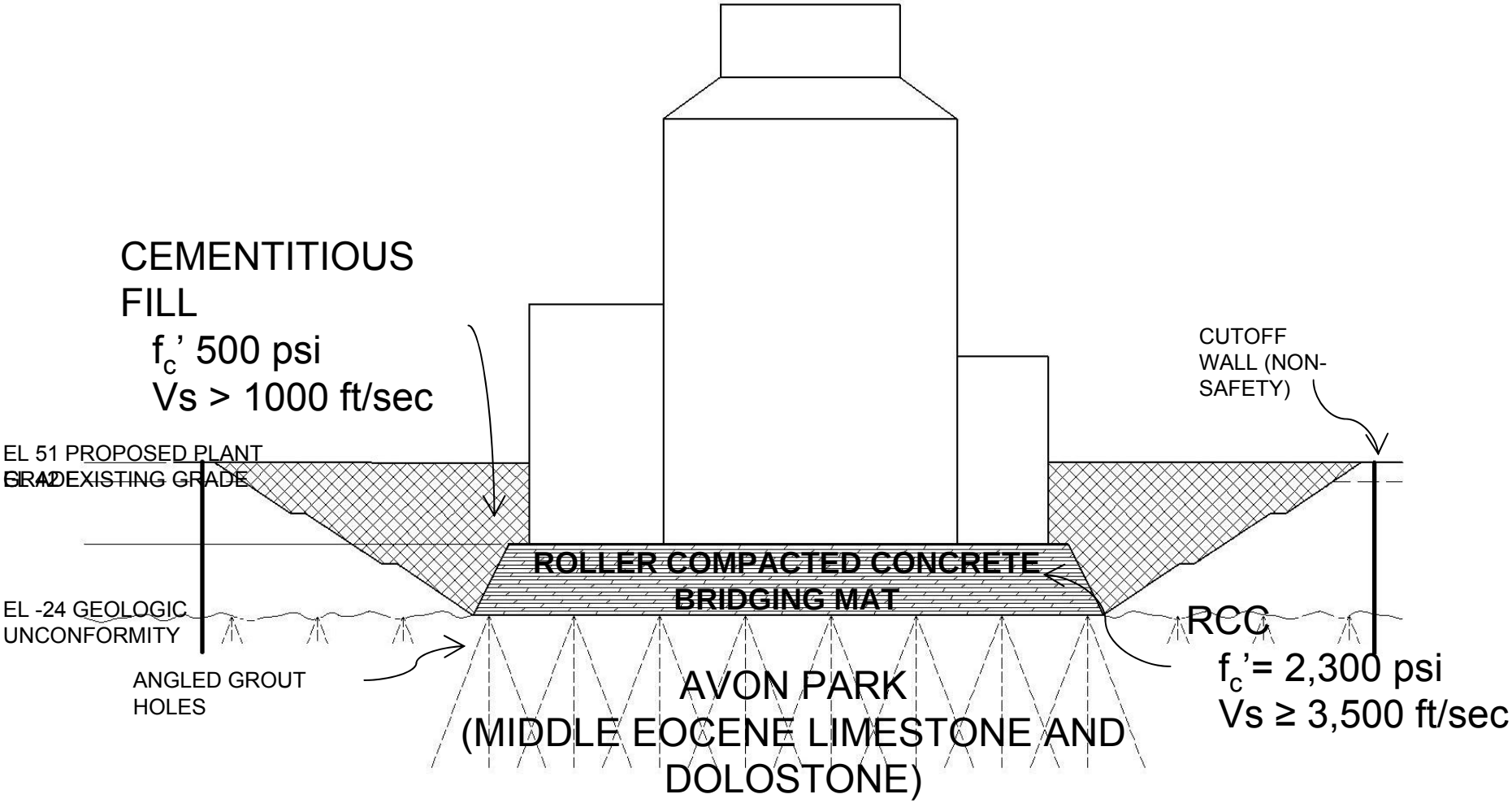
LNP Foundation Concept II



UCS ≈ 1,000-4,000 psi; Vs ≈ 3,000-4,500 ft/sec

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LNP Foundation Concepts – A “Defense in Depth with Multiple Lines” Approach

- Line 1 – AP1000 Basemat
- Line 2 – 35-foot thick RCC Bridging Mat
- Line 3 – 75-foot thick Grouted Zone
- Line 4 – Long-Term Monitoring Program

LNP Foundation Concepts

- RCC Bridging Mat: ~35-ft thick RCC Mat
  - Basic Function
    - Bridge over postulated solution-induced irregularities in the Avon Park that may develop in the future
    - Provide a “bedrock” foundation for the AP1000 Basemat
    - A Safety Related feature
  - Basic Properties
    - $f_c' > 2{,}300$ psi
    - $V_s > 3{,}500$ fps

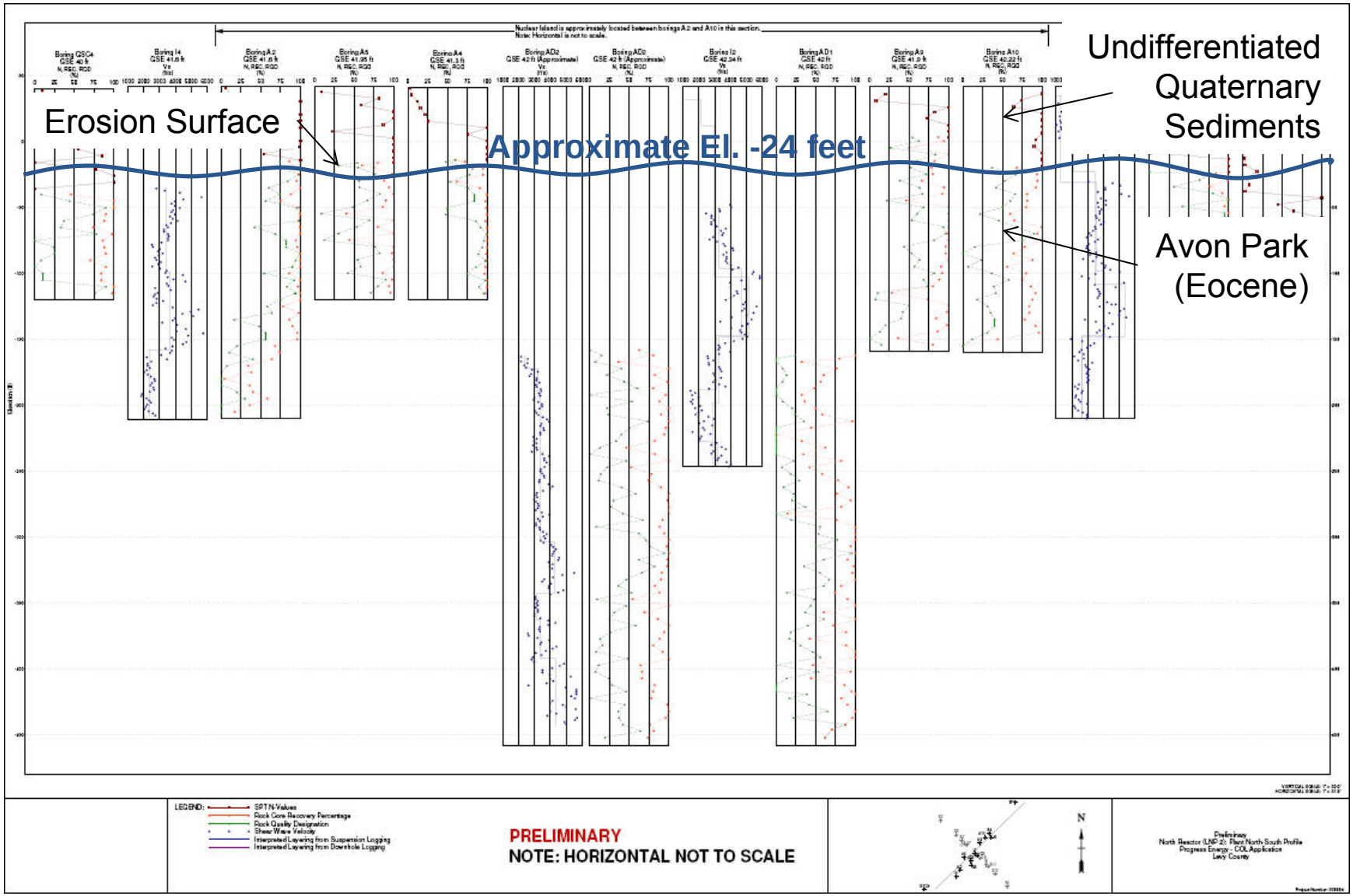
LNP Foundation Concepts

- Approximately 75-foot thick Grouted Zone (upper Avon Park)
  - Basic Functions
    - Provide a “bottom for the bathtub”
    - Prevents future solution activity by inhibiting the flow of water through porous zones and fractures
    - Not a Safety Related feature
  - Basic Properties
    - UCS ≈ 2,500 psi
    - V_s ≈ 3,000-4,500 ft/sec

LNP Foundation Concept

- Mid-Eocene Avon Park is the founding media
  - Basic Function
    - Support the overlying RCC Bridging Mat
    - Location of the FIRS
  - Basic Properties
    - UCS ≈ 2,500 psi
    - V_s ≈ 3,500 ft/sec

Planned Excavation Bottom



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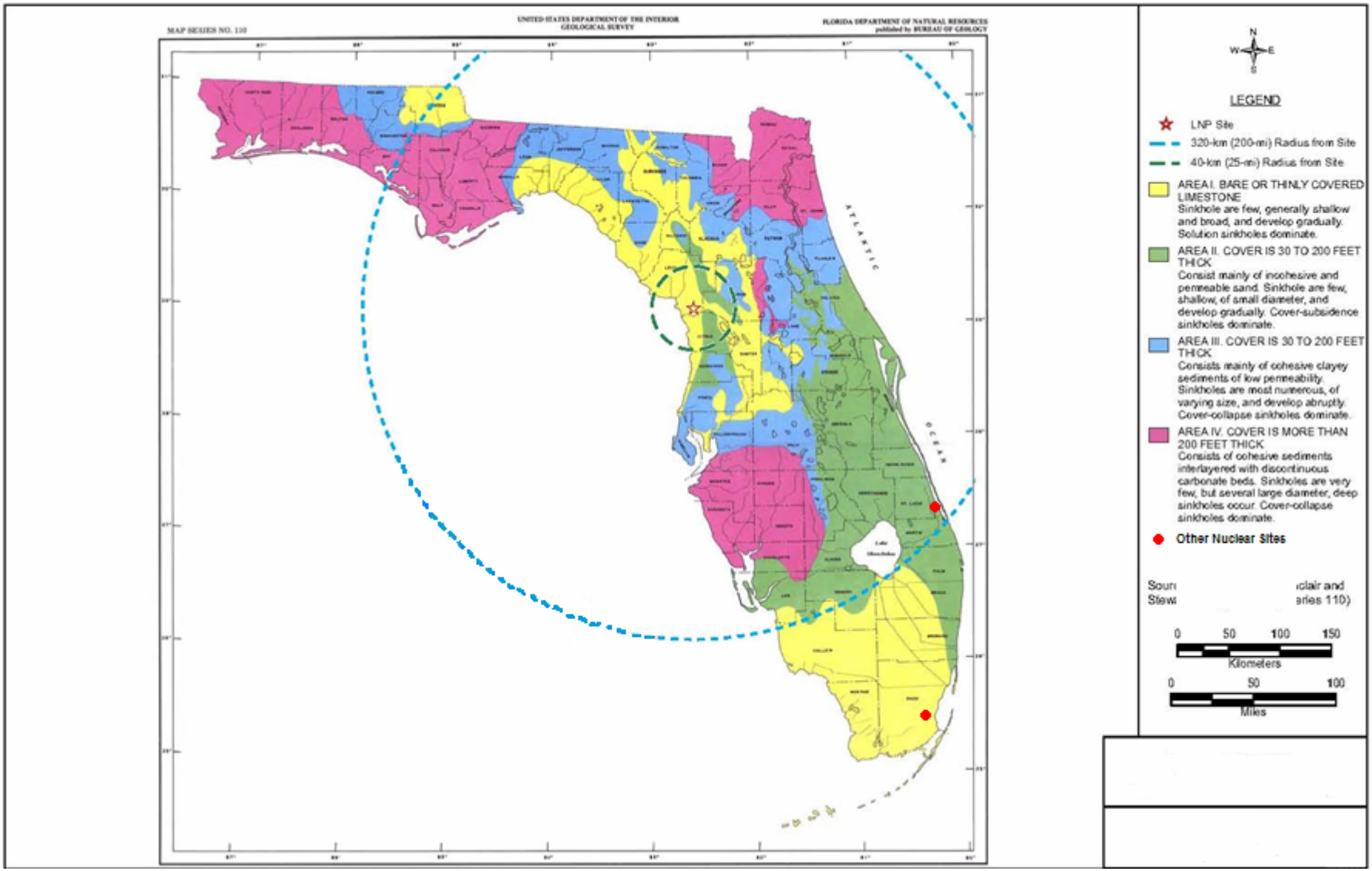
LNP Foundation Media

- …the Avon Park Formation is cream to light brown or tan, poorly indurated to well-indurated, variably fossiliferous, limestone (grainstone, packstone, and wackstone, with rare mudstone)…
- …the uppermost part of the Avon Park Formation…varies between limestone and dolostone…dolostone predominates deeper within the unit…

Solution Activity Risk Map



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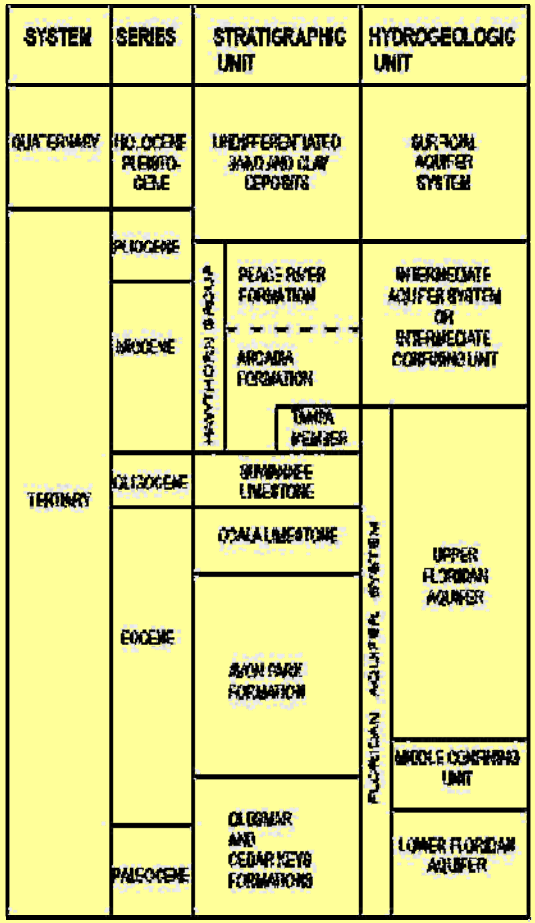
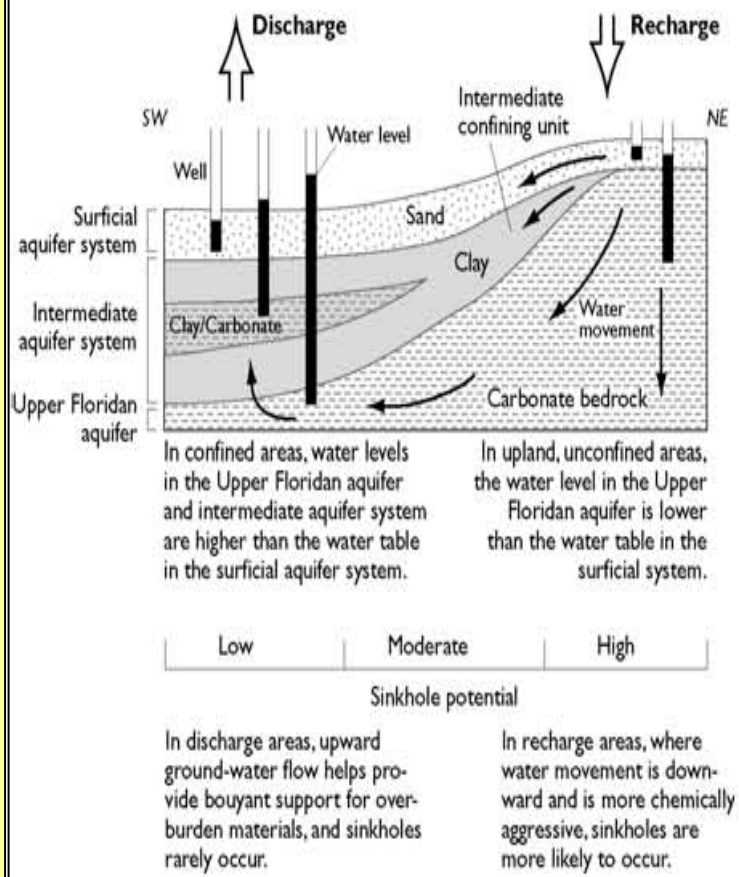
Solution Activity Potential





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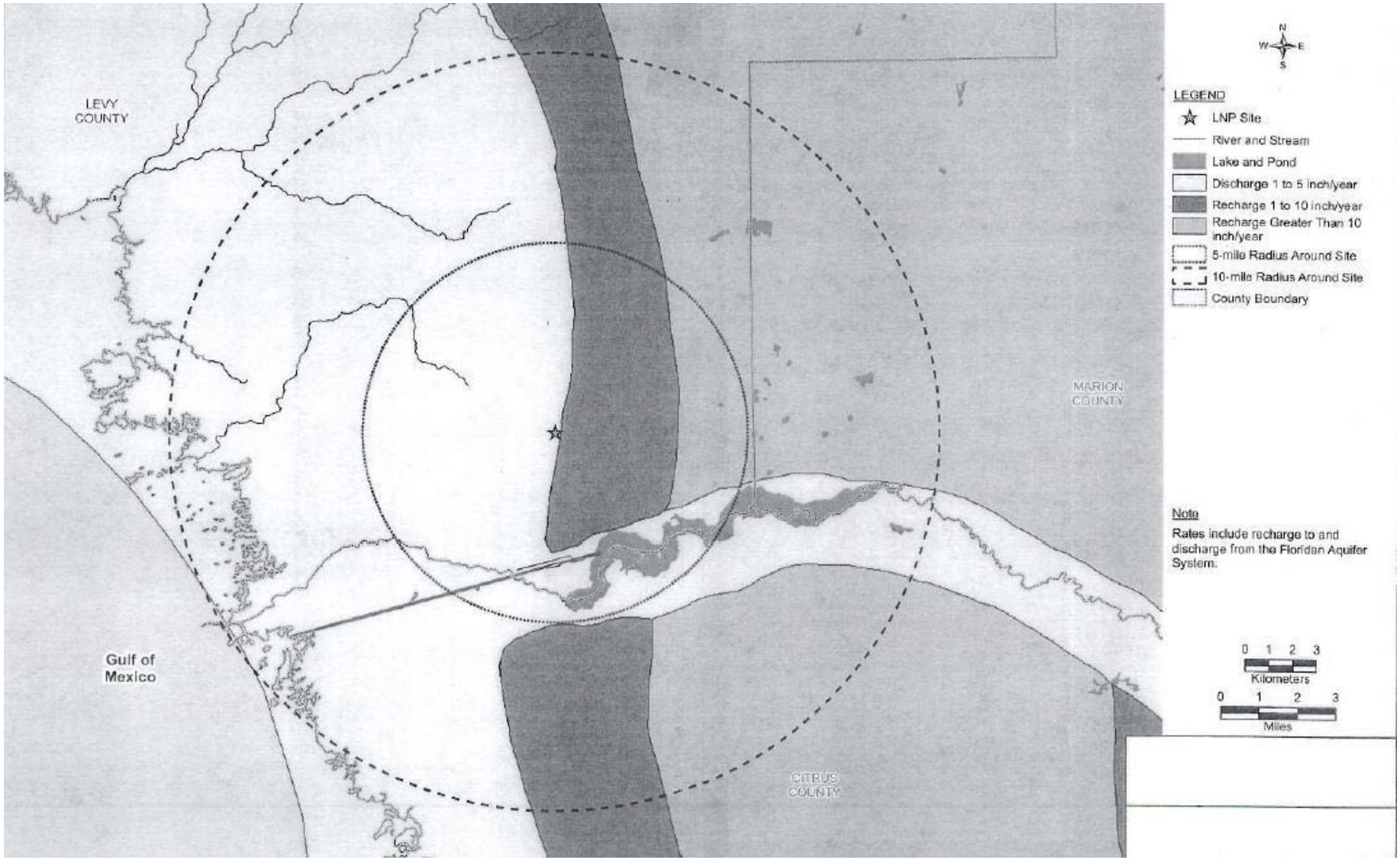
Recharge and Discharge Areas



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Approach – Potential Solution Activity under Grouted Zone (~150 feet below grade)

- Assess probability and volume of potential solution activity
  - Literature Review
  - Site-specific data review
    - Rod drops, drill fluid losses
    - Core recovery, RQD's
    - acoustic televiewer and caliper surveys
- Using Statistics of data, estimate volume, frequency and depths of potential solution activity
- Show that Foundation Concepts will "bridge" over potential solution activity without distress to AP1000 Basemat

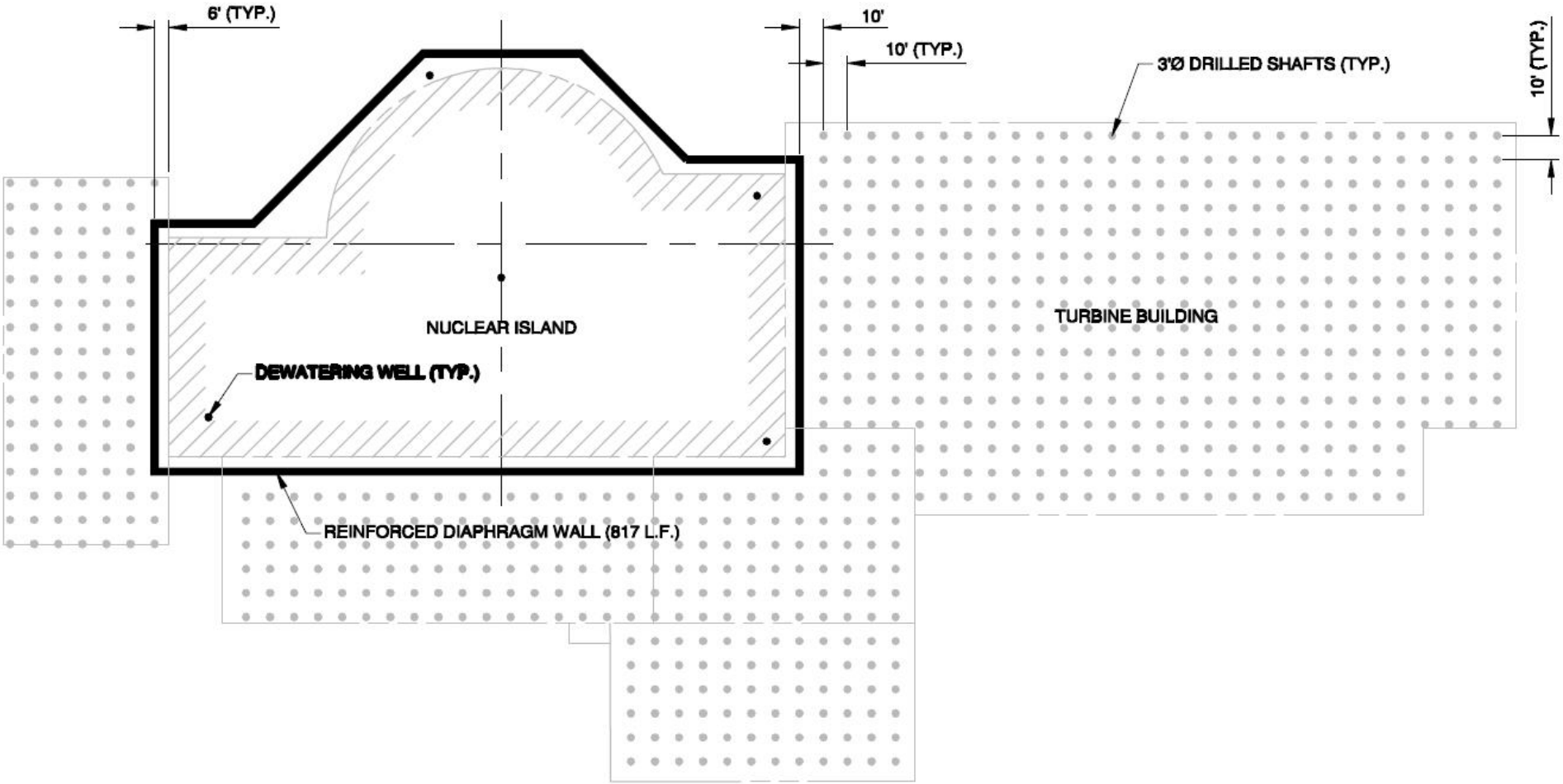
LNP Foundation Concepts

- Long-term Monitoring Program Considerations
  - Rate of Solution Activity
  - Changes in Porosity / Permeability of the Grouted Zone
  - Changes in Groundwater Quality
  - Settlement of the RCC Bridging Mat
  - Settlement of the AP1000 Basemat

Other Planned Activities

- Test Pads
  - RCC Placement/Properties
  - Flowable Fill Placement/Properties
- Field Testing
  - Grout Program
- Analyses
  - Assessment of Potential Deep Solution Activity
  - Soil-Structure Interaction

Concept I - Plan



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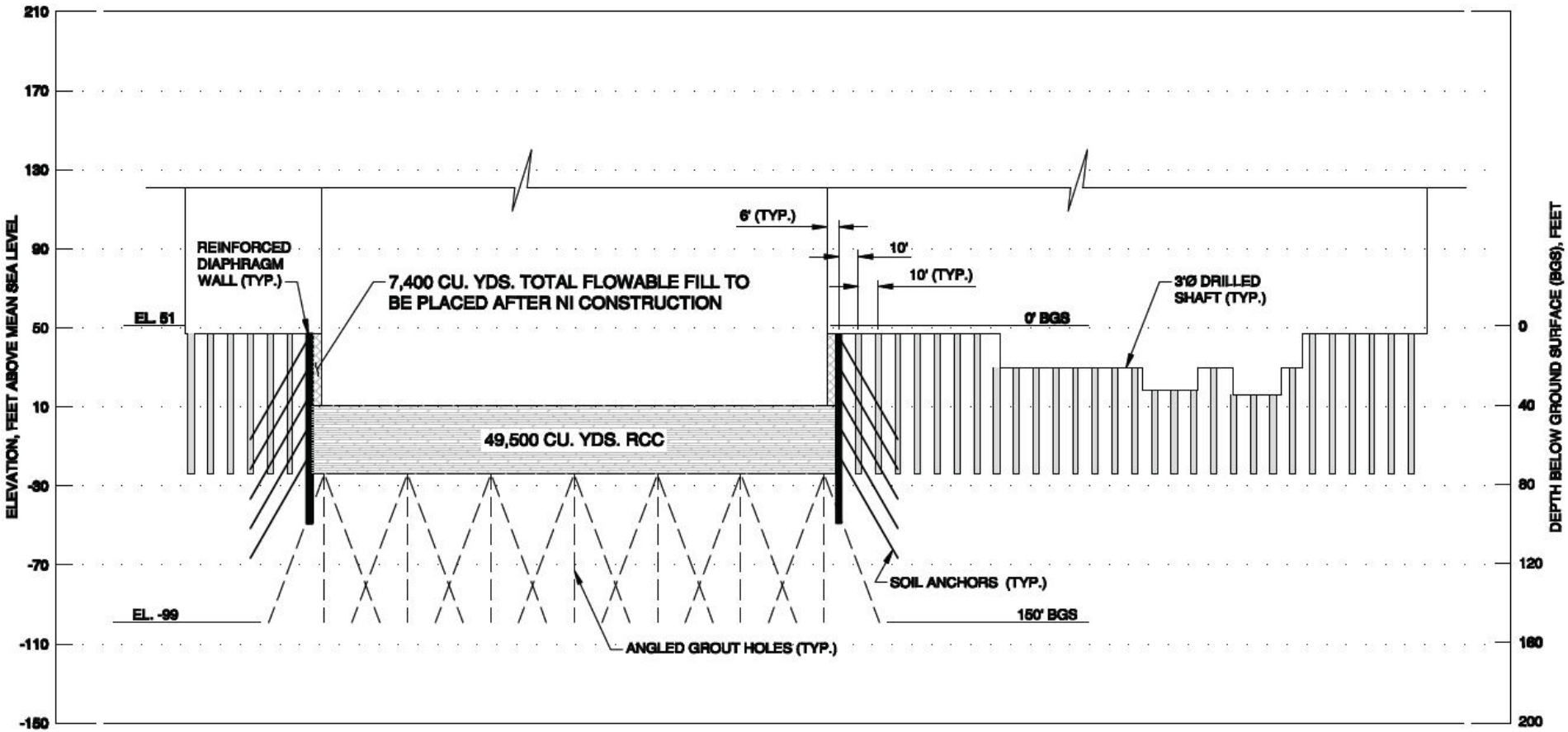
Concept I - Section



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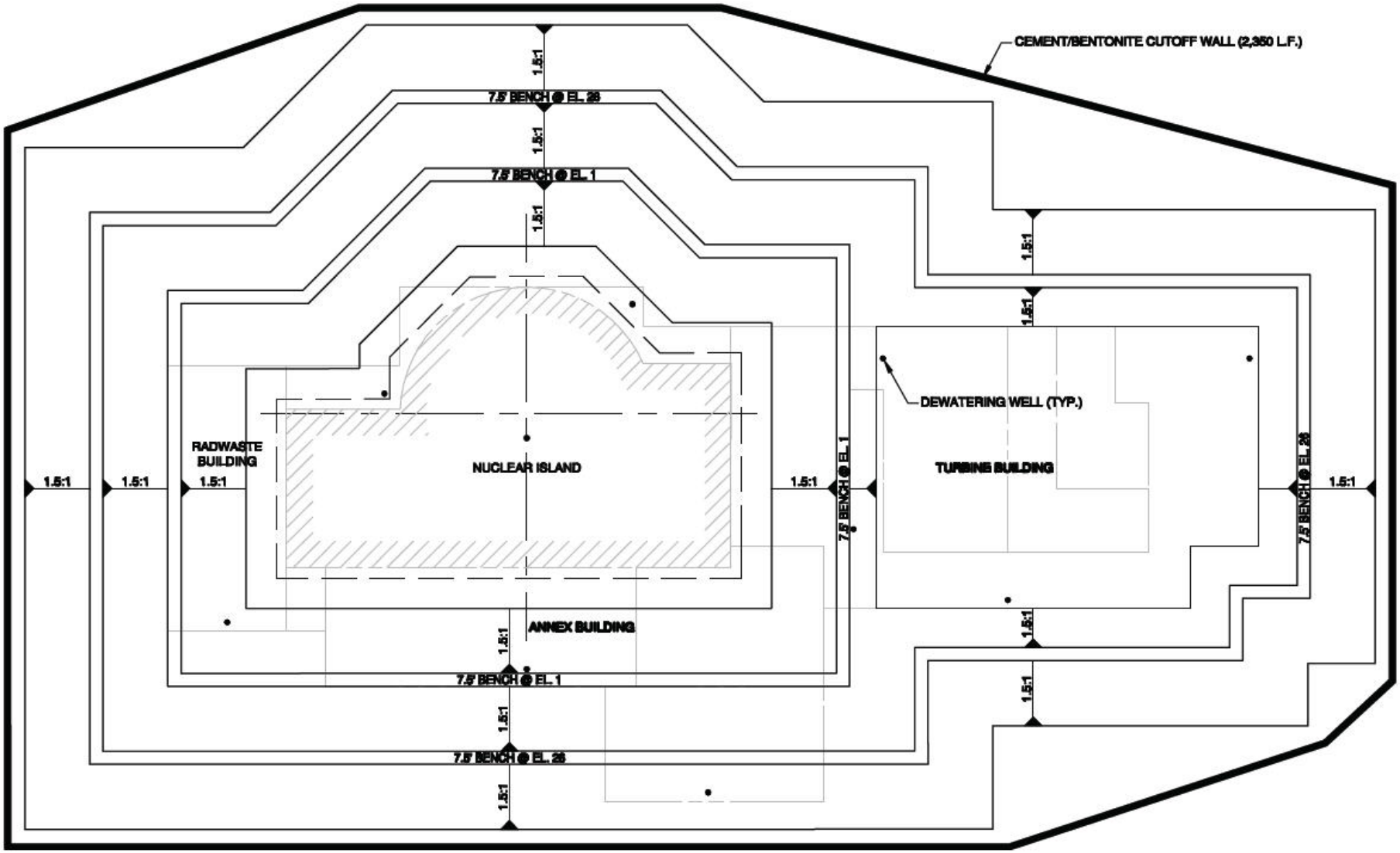
Concept II - Plan



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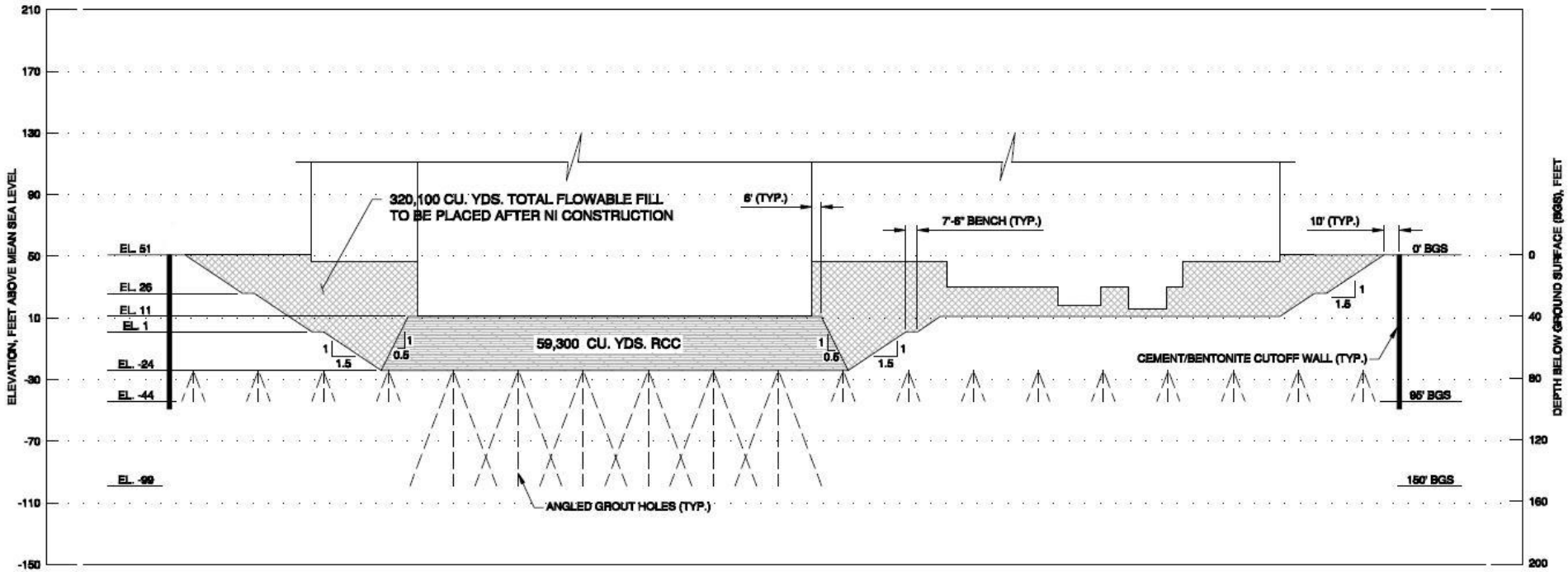
Concept II - Section



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LNP Foundation Construction Sequence

- Stage 1
  - Construct Groundwater Cutoff for the “walls of the bathtub”
  - Conduct Grouting Program to form the “bottom of the bathtub”
  - Install the Shallow wells to “drain the bathtub”
  - Install the Deep wells to relieve the uplift pressure

Cutoff Wall Construction

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Secant Pile Cutoff Wall Construction

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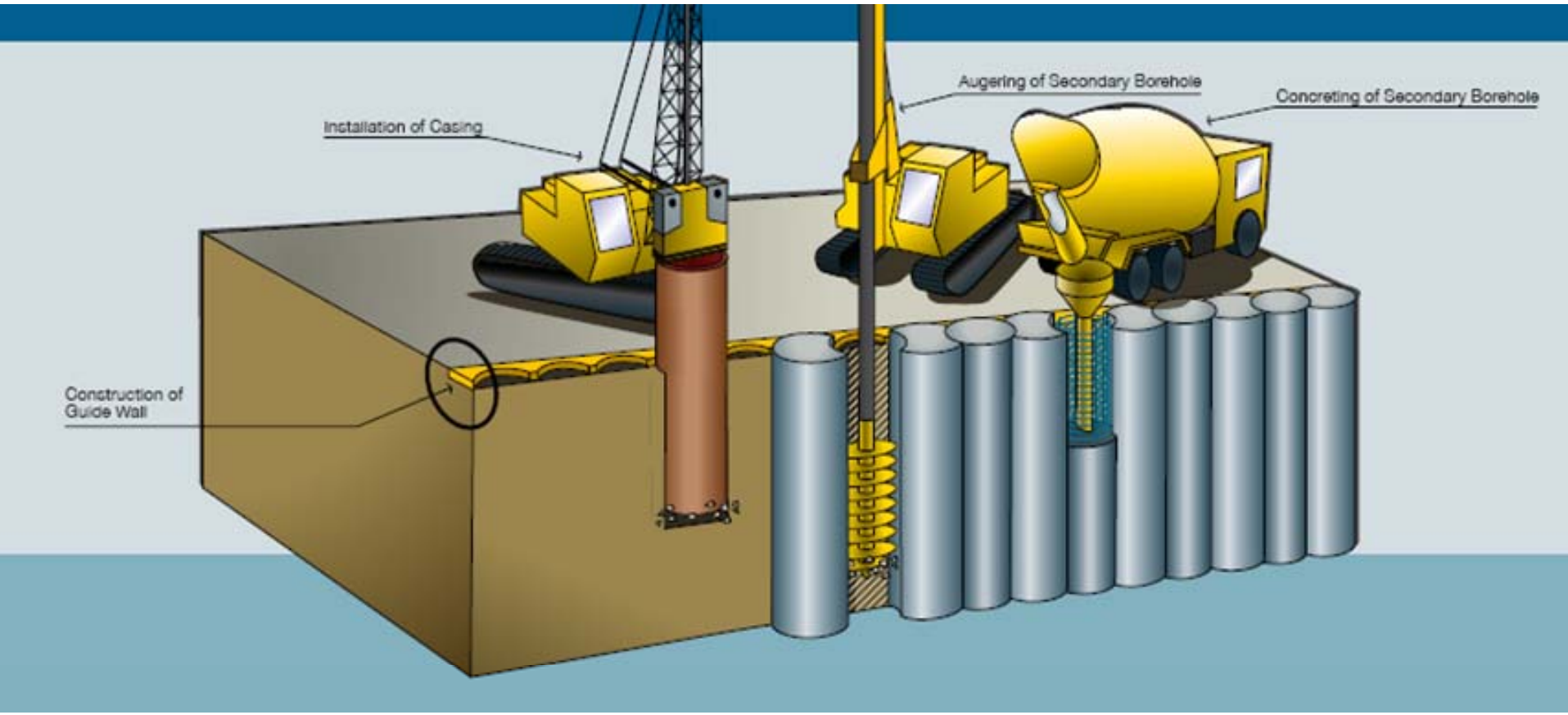
Cutoff Wall Sequence for Secant Piles



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Grouting Program

- Step A
  - Drill & Grout with Low Mobility Grout (LMG)
    - Depth 75 ft (approximate)
    - Spacing 8 ft (subject to confirmation)
    - Concentric Pattern starting on perimeter and working inward toward center
    - Computerized monitoring of pressures and takes

Grouting Program (Cont'd)

- Step B
  - Drill & Grout with High Mobility Grout (HMG)
  - Depth 75 ft (approximate)
  - Split spacing with LMG Holes
  - Computerized monitoring of pressures and takes

LNP Foundation Construction Sequence

- Stage 2
  - Excavate the soil in the “bathtub” down to the Avon Park
  - Prepare the top of the Avon Park
    - Remove soil pockets and soil-filled fractures & replace with dental concrete
    - Clean & remove surface to receive RCC

LNP Foundation Construction Sequence

- Stage 3
  - Construct the RCC Bridging Mat
- Stage 4
  - Install the Waterproofing on the RCC Bridging Mat
  - Construct the Upper half of mudmat to protect the membrane
  - Construct the AP1000 Basemat
  - Backfill as Required

What is RCC?
(Stage 3)

- RCC = Roller Compacted Concrete
- Developed in the 1970s
- Placed with Earth-Moving Equipment
- Strength Same as Conventional Concrete
  - Same Basic Ingredients (increased fly ash)
  - Extensive Pre-Construction Testing
  - Lower Heat of Hydration
- Suitable for Site Conditions at LNP

Example RCC Projects

- Saluda Dam (SCE&G) [ASCE OPAL Award, 2006]
- Taum Sauk Dam (AmerenUE)
- Olivenhain Dam (SDCWA)
- San Vicente Dam Raise (SDCWA)
- Bear Creek Dam (TVA)
- Bellefonte NPP (TVA)

RCC Placement by Truck

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RCC Placement by Conveyor

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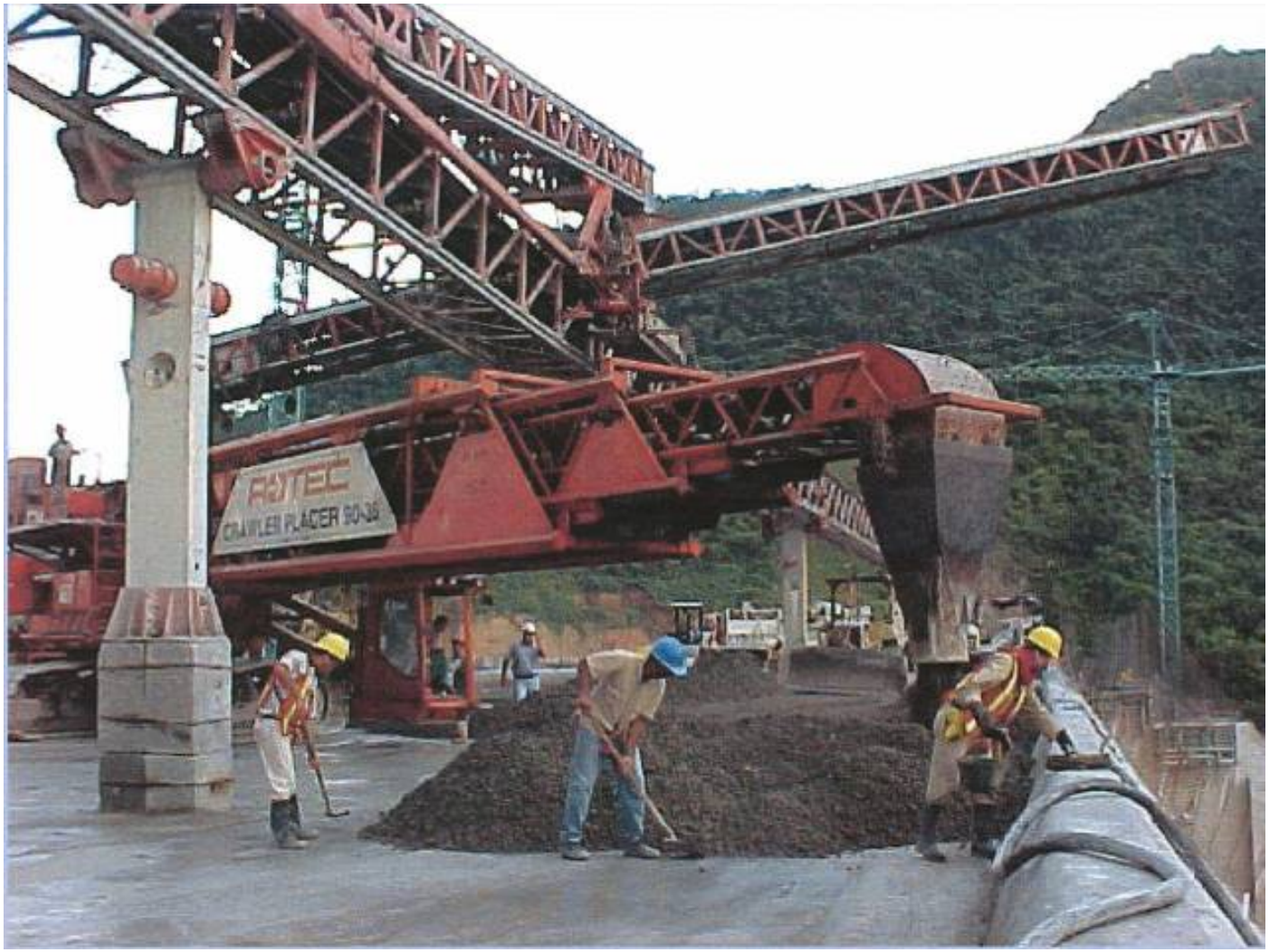
RCC Placement by Conveyor



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RCC Placement by Conveyor

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Spreading RCC with Dozer

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Compacting RCC

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Typical RCC Test Pad

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Typical RCC Sample Cutting

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Typical RCC Sample from Test Pad

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Summary Comments