US Army Corps of Engineers®
New York District

NEW YORK AND NEW JERSEY HARBOR DEEPENING CHANNEL IMPROVEMENTS NAVIGATION STUDY

DRAFT INTEGRATED FEASIBILITY REPORT & ENVIRONMENTAL ASSESSMENT

APPENDIX B2:

GEOTECHNICAL ANALYSIS

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1. Introduction

New York-New Jersey Harbor consists of numerous bays, rivers, and channels of complex shape that are connected to the Hudson River. Some channels and bays within the New York -New Jersey Harbor will go through widening, deepening, and bend easing to improve navigation efficiencies within the New York and New Jersey Harbor and allow passage of Maersk Triple E Ultra Large Container Vessel Class (Triple E) as design vessel for this study. The Feasibility Study of New York and New Jersey Harbor Deepening Channel Improvement is an evaluation for channel widening, deepening, bend easing, and related improvements throughout the Ports of New York and New Jersey. The study areas include Anchorage, Port Jersey, Kill Van Kull, Arthur Kill, and Newark Bay reaches (Figure 1).

To perform the economical analysis of widening, deepening, and bend easing the channels, a number of factors will need to be considered. These factors include the physical nature of the material to be removed, how much material will be removed, appropriate methods of removal, where to dispose of dredged material, and what effects the project will have on nearby properties. In order to provide proper solutions for these factors, relatively detailed knowledges of the subsurface are required as follows:

- mapping the top of bedrock and delineate where it will occur along the proposed channel improvements so that volumetric calculations can be performed;
- mapping the thickness of contaminated material throughout the port so that volumetric calculations of contaminated material can be performed;
- other mappings such as Top of Pleistocene and sand/gravel to help define the dredgeability and disposal options for the dredged materials in the various reaches;
- defining profiles and cross sections to illustrate the aerial distribution of the various soil and rock types that will be encountered along each reach. Based on the profiles and cross sections, a specific course of action such as blasting or dredging with a specific type of dredge is determined;
- defining the characteristics (soil or rock classification, density, unit weight, compressive strength etc.) of various soil and rock types to be encountered along each reach so that dredgeability analysis and slope stability analysis can be performed;
- determining which dredging equipment that might be best suited for each stratigraphic reach using available computer programs and dredging records;
- analyzing the stability of the channel side slopes; and
- evaluating the potential effects that blasting may have on nearby structures.

Recent economical analysis shows deepening the pathways by 4 feet (to fifty-four feet below mean lower low water (-54’ MLLW)) and by 5 feet (to fifty-five feet below mean lower low water (-55’ MLLW)) have considerable net benefits. Hence, in this study, dredgeability and slope stability analyses for project areas were performed on the basis of both 4 feet and 5 feet deepenings.

2. Geological Information

2.1. Bedrock Lithology and Top Contour Map of Rock

The locations and types of rock which are encountered if the channels are deepened to proposed deepening depths of fifty-four feet below mean lower low water (-54’ MLLW) and fifty-five feet below mean lower low water (-55’ MLLW) are shown in Figure 2. The top contour map of rock can be employed to determine the volume of rock that will require removal. The location, type and volumes of rock can be used for blasting analysis and cost analysis.

Bedrocks in the Kill Van Kull are composed of Serpentinite as metamorphic rocks in the Constable Hook reaches, Sandstone as a sedimentary rock in the Bergen Point reach, Diabase as an igneous rock from Bergen Point to the eastern part of Newark Bay, and Shale as a sedimentary rock with the arkosic sandstone member at Shooters Island. Throughout the Kill Van Kull, previously blasted, fractured, or moderately weathered bedrock underlies the channel.

Bedrocks in the Newark Bay consist of mainly Sandstone with shale member on the west, and mainly Diabase with Sandstone, Serpentinite, and Shale on the east. The Diabase, Sandstone and Shale are members of the Brunswick Formation (Jurassic) of the Newark Basin Physiographic Province.

Bedrocks in the Port Jersey Channel is mainly Schist. The east of the Port Jersey Channel is known to be in thrust-fault contact with Serpentinite associated with the Hartland Formation. Bedrock was not encountered above the projected project depths (-54’ MLLW and –55’ MLLW) in the Anchorage and Port Jersey channels.

Poorly consolidated sandstone and shale of the Atlantic Coastal Plain Physiographic Province (Tertiary-Cretaceous) underlies Ambrose Channel but were not encountered within the depth of El. -75 MLLW.

2.2. Pleistocene Sediments

The bedrock complex is overlain by Pleistocene glacial sediments that range in size from silt and clay to large cobbles and boulders. In most cases glaciation subdued the terrain by leveling the higher peaks and filling the valleys with glacial till (ground moraine). However, in some cases, low relief, elongated hills were formed by debris pushed in front (terminal moraine) or to the sides (lateral moraines) of the advancing glacier. A terminal moraine exists along the south edge of Staten Island up to the Narrows, and then appears again in the Bay Ridge section of Brooklyn. The terminal moraine continues out on Long Island to Nassau County where it splits into two separate terminal moraines that continue out to Montauk Point and Orient Point. The southern terminal moraine is known as the Ronkonkoma and the northern as the Harbor Hill. Adjacent to the Narrows, the Harbor Hill terminal moraine overlies the Ronkonkoma.

Southeast of the terminal moraine are outwash deposits of sand and gravel that extend under Lower New York Bay. These fluvial deposits are the result of ice melt water washing soils out beyond the terminal moraine. Behind the terminal moraine is a ground surface moraine deposit consisting of an unsorted mixture of sand, silt, clay, gravel, cobbles and boulders. These materials were picked up by the advancing ice and dropped as the ice melted. Scattered within this ground moraine are fluvial deposits, such as eskers and kames, which were deposited by concentrated ice melt water that flowed in and under the ice.

As the glacier receded, the terminal moraine became a natural dam that impounded the glacier melt water and formed a number of large lakes. Varved silts and clays were deposited within these lakes. These varved deposits which overlie ground moraines are sometimes as thick as one hundred feet (100'). Sands were deposited on top of the varved silt and clay when the lakes became shallow. Eventually the terminal moraine was breached, and the glacial lakes were drained. Subsequent to the draining of these glacial lakes, outwash plains composed of alluvial sand deposits were formed along the perimeter of the lakebeds.

Figure 3 shows a top contour map of Pleistocene. The map defines where the dense (more difficult to dredge) Pleistocene Sediments will be encountered. It should be noted that Pleistocene sediments are normally red to brown, rarely contain shells and are relatively dense when compared to Holocene (Recent) sediments, which are normally gray to black and frequently contain shells. Although there are significant differences between Pleistocene and Holocene (Recent) sediments it is not always easy to define the top of the Pleistocene. Based on N values and soil descriptions of soil borings, it is anticipated that most of sediments in Anchorage, Port Jersey, Kill Van Kull, and Newark bay reaches will be Pleistocene. Top of Pleistocene contour map can be considered a Paleo-structure or Paleo-geographic map. It is known that the top of the Pleistocene normally occurs at an elevation of approximately 20 feet below mean lower low water (-20' MLLW) along the flats adjacent to channels.

2.3. Sand/Gravel Sediments (Pleistocene-Holocene)

Map of sand and gravel-sized sediments above sixty-feet below mean lower low water (-60' MLLW) is shown on Figure 4. The map can be used to determine where the dredged material will be predominantly sand and gravel, silt and clay or some combination. The map should be used in conjunction with the Top of Pleistocene Map, Isopach Maps, as well as profiles and cross-sections to help define the most suitable contract limits, possible dredge types, and disposal location. All these factors are employed in the cost analysis.

2.4. Holocene (Recent) Sediments

It is known that during the last 20,000 years, sea level has risen as much as three hundred feet (300') and continues to rise at a rate of one to two feet (1'-2') per 100 years. As a result, the project area that was high and dry during the Pleistocene has become a tide-dominated estuary. A blanket of Holocene (Recent) sediments ranging from poorly graded sand, silty sand, slightly organic silt, and occasionally peat has been deposited. The thickness of the Holocene section is a few feet in the flats adjacent to the navigation channels.

The upper portion of the Holocene section often emits a petroleum-like odor and contains man made debris including toxic chemicals and heavy metals. One objective of this study was to estimate the aerial distribution (location and thickness) of the contaminated material so that volumes could be approximated. This was accomplished through the use of isopach (thickness) maps. The thickness of contaminated material above sixty feet below mean lower low water (-60' MLLW) was determined in those borings in which it was detected. The thickness of contaminated interval was estimated in each boring from physical characteristics (moisture content, color, odor, and soil density), scanning methods (UV fluorescence and photo-ionization) and direct testing (total petroleum hydrocarbons). The isopach maps shown in Figure 5 show the location and aerial distribution of contaminated sediments that will require removal and disposal as the channels are deepened. In this study, soft and loose soils were assumed to be an indicative of Holocene deposits, namely, not HARS suitable.

3. Data Review and Analysis Methodology

3.1. Review and Inventory of Existing Subsurface Data

A review of previous Corps of Engineer reports and dredging contracts was conducted to obtain existing subsurface information. Other public agencies and private sources were contacted to determine the availability of additional subsurface data. As few soil testing borings were located within limits of proposed reaches, soil testing borings located outside of limits of proposed Reaches also were considered to obtain existing subsurface information of proposed reaches. The distribution, depth, and quality of the available data was reviewed to determine the need for additional subsurface. It was shown through the review that some of the channels such as Kill Van Kull, and Anchorage would require very little additional data whereas other channels including Newark Bay and Port Jersey would require more additional subsurface data due to lack of existing subsurface data.

3.2. Field Testing and Subsurface Data

Standard Penetration Test (SPT) methods have been applied to collect continuous soil samples throughout the proposed reaches. Representative soil and rock samples were selected for testing from both SPT borings and vibracores to define the geotechnical properties of the soil necessary for slope stability analysis, dredging analysis and blasting analysis and to employ possible low cost and efficient techniques to determine the thickness of the contaminated interval. Geotechnical testing included grain size distribution, moisture content, unit weight, specific gravity, liquid and plastic limits. Multiple undisturbed (Shelby Tube) samples were recovered from each of the major silt and clay layers. Triaxial tests were performed on the undisturbed samples to determine shear strength, cohesion and other factors necessary for slope stability. Rock cores were recovered in those areas where shallow (<65'from MLLW) bedrock was encountered. Cores were described in detail and rock quality designation (RQD) was determined. Point load tests were conducted on representative core samples.

The thickness of the contaminated interval was determined by use of ultra-violet fluorescence, photo ionization, total petroleum hydrocarbons and moisture content.

3.3. Soil Profiles and Cross-Sections

In the subsequent subsections, the individual reaches are described in detail through the use of soil profiles and cross-sections. The profiles were employed to illustrate the aerial extent of the various soil and rock types that will be encountered within reaches. Soils that have similar characteristics (i.e. Silty Sand and Silty Gravel) or that are difficult to differentiate in the field (i.e. Silty Clay or Clayey Silt) were grouped together to define stratigraphic units. Soil color was employed as another factor in determining the stratigraphic units illustrated. Pleistocene sediments are commonly reddish-brown whereas the Holocene sediments are frequently gray, tan or black. Although a stratigraphic unit is, for instance, called Holocene Silt and Clay, it may contain minor sand or gravel sub-units.

Cross sections show the stratigraphy of soil and rock types that are encountered along the middle of reaches. The soil types and their properties such as unit weight, cohesion, and friction angle are very significant factors to be considered in determining side slope stability.

3.4. Dredgeability Analysis

Guides of program DREDGABL developed by WES was used to aid Engineers in determining the suitability of various sediments to dredging. The guides lead engineers to determine if a given sediment type can be dredged and what dredges are most appropriate for the dredging procedure. The guides require the soil type, rock type, fineness (grain size), consistency (i.e., soft, medium, stiff, or hard), and in-situ compactness (i.e., loose, medium, or dense). For compressible sediments (both Organic and Inorganic Clay and Silt), soil type described by using the Unified Soil Classification System (USCS) and soil consistency are needed to perform the dredgeability analysis. For coarser sediments (Sand and Gravel), specific USCS soil type and compactness are needed. Additionally, the guides provide dredgeability information for rock and shale fragments, cemented soils, shells and debris.

Table 1 is a summary of the general dredging characteristics of the overall dredge types. Specific dredges are listed for each reach. Before a final dredge type is selected, coordination with other agencies must be made. Some dredge types are not permitted because of environmental concerns, cost or availability. Final selection of the dredge type to be used lies with the Contractor in coordination with the USACE and other agencies.

Table 1: Summary of Dredge Operating Characteristics

Dredge Type	% Solids in Slurry By Weight	Turbidity	Open Water Operation	Range of Production (cu.yd. /hr.)	Dredging Depth Limits (ft)	Wave Height Limits (ft)	Limiting Currents
Hopper Dredges	10 - 20	High	Yes	500 - 2000	< 80	< 7	7 Knots
Mechanical Dredges	In Situ	Average	Yes	30 - 500	< 100	< 3	3 Knots
Pipeline Dredges	10 - 20	Average	Depends On Type	25 – 10,000	< 14	< 3	3 - 7 Knots

Each reach can be considered either "soft" or "moderate to hard" as a reference to the ease of dredging. Overall, Ambrose, Anchorage, and Port Jersey Channel can be considered "soft" because the sediments are relatively loose sands or soft to very soft silts and clays and should be easily dredged. Channels such as Kill Van Kull, Newark Bay, and Port Jersey can be considered "moderate to hard" either because the sediments are dense to very dense or rock is present; these channels would require additional efforts during dredging including rock blasting. According to previous experiences, rocks with unconfined compressive strengths less than 7,000 psi or RQD values less than 30% is considered dredgeable.

3.5. Slope Stability Analysis

It is necessary to determine the stability of the channel side slopes for the following reasons:

- If there are structures close to the top of the slope and failure occurs, the structural stability of the structure is diminished, and very significant damage may occur.
- If reach side slopes are not stable, then failure will result in significant shoaling. Frequent expensive maintenance including dredging will be required.
- Proper measures to unstable slopes can be taken into consideration. The measures can be simulated to verify their effectiveness.
- After estimating approximate full extents of unstable slopes and determining proper measures to unstable slopes, total cost for stabilization of unstable slopes can be approximated.

Slope stability analysis was performed using the computer program SLOPE/W developed by Geo-Slope International, Ltd. The program requires input including data such as channel slope profiles, stratigraphy, and soil properties. The Spencer's method was used to obtain the lowest factor of safety for the governing cross section of each slope. Circular and non-circular potential failure surfaces were searched with optimization.

Side slopes of each reach in non-rock material were constructed and have been maintained at a 1 (rise) on 3 (run) ratio. These slopes are very similar to those that existed along the natural channel prior to dredging. It is known that these side slopes have been proven to be stable near critical structures for all types of soils within the channel. However, even slopes with 1 on 3 may not be stable especially for soft soils such organic silts, peat, and loose sands. Excessive sloughing of these types of soils may occur causing more frequent maintenance dredging. Hence, while in view of these factors, a side slope of 1 on 3 is considered where possible, resulting unstable slopes should be stabilized by low cost measures. The results of slope stability based on a 1 on 3 side slope is summarized for each channel evaluated.

The existing channel side slopes in rock areas were constructed at a 1 (rise) on 1 (run) ratio. This slope has proven to be stable, especially near structures. The 1 on 1 side slopes were basically formed from the blasting. The explosives in the blast holes break and push the rock upward in a shape of a 45 degree angle cone. These 1 on 1 side slopes in rock are relatively easy for a contractor to dredge after blasting. In view of these factors a side slope of 1 on 1 is recommended where possible in rock areas. In areas where a steeper slope is required, more detailed analysis should be performed. Factors such as the orientation (strike and dip) of fractures and bedding planes should be determined.

4. Dredgeability and Slope Analyses

4.1. Anchorage Channel (AN-1)

4.1.1. Stratification

Anchorage Channel is the primary channel in the Upper Bay. Reach AN-1 is located at the south end of the Anchorage Channel. Soil test borings performed at this reach are displayed in Figure 6. The stratification of Reach AN-1 was determined based on types and consistencies of each material encountered in the soil test borings. The stratification of Reach AN-1 is shown in Figure 11. The profile indicates that the Reach AN-1 is primarily composed of Holocene (Recent) Silt. Based on proposed deepening depths of fifty-four feet below mean lower low water (-54 MLLW) and fifty-five feet below mean lower low water (-55' MLLW), Silt can easily be determined as a material to be removed when the reach are deepened.

4.1.2. Dredgeability

For the purpose of DREDGABL analysis, the Silt in Reach AN-1 was classified as either OL or OH with very soft to soft consistencies and medium to high plasticity. These criteria were determined from a review of the boring logs in the reach. The Silts of Reach AN-1 have excavation characteristics classified as "good" for clamshell dredge, "very good to good" for backhoe dredge, and "very good" for cutter dredge as shown in Table 2.

Table 2: Dredgeability of Materials for Reach AN-1

Material Type	Dredge Type			
	Clamshell	Backhoe	Cutter	Blast
Silt	Good	Very Good to Good	Very Good	NA

When factors such as dredging records, contamination, disposal, and availability of dredging equipment are considered, an environmentally friendly clamshell dredge would appear to be the most suitable equipment to dredge Reach AN-1.

4.1.3. Slope Stability

Soil test boring location RHF98-25 was used to estimate soil strata and soil properties for analyses of slope stability as overall, the boring can provide whole soil stratification which is useful to understand stabilities of slope proposed for four feet and five feet deepenings. The soil properties of soil strata of the boring are shown below:

Table 3: Soil Properties of Soil Strata at Reach AN-1

Boring No.	Material Type	Top Elevation of Stratum (ft)	Representative N-Value (blows/ft) /RQD (%)	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (Deg.)
RHF98-25	Silt	-45.1	0	90	50	0
	Silt	-53.0	0	100	100	0

Using the above soil properties, circular and non-circular potential failure surfaces were searched by optimized grid-radius, entry-exit, and block analyses. As a result of simulations, the lowest safety factors of slope analyses for four feet and five feet deepenings at this reach equals 1.71 and 1.51, respectively; the slope stability criteria with the minimum factor of safety of 1.5 was satisfied. The summary of slope stability analyses at Reach AN-1 is shown in Table 4.

Table 4: Summary of Slope Analyses at Reach AN-1

Boring No.	Factors of Safety of 4' Deepening		Factors of Safety of 5' Deepening	
	Min	**Max**	**Min**	**Max**
RHF98-25	1.711	1.794	1.505	1.567

4.2. Port Jersey Channel (PJ-1)

4.2.1. Stratification

The Port Jersey Channel is located in Bayonne, New Jersey between the Military Ocean Terminal on the south and the Global Marine Terminal and the Northeast Automobile Terminal on the north. Reach PJ-1 is a triangle-shaped reach located at the entry of the Port Jersey Channel from Anchorage Channel. Soil test borings performed at this reach are displayed on Figure 7. The stratification of Reach PJ-1 was determined based on material types and material consistencies of the soil test borings. Reach PJ-1 mainly consists of:

- Holocene (Recent) sediments: soft black, grey, and dark grey Silt (OL or OH) and underlying Silty Clay (CL, OH or MH); and

- Pleistocene age sediments: a dense to very dense, fine to medium grained, red-brown Sand (SP-SM) with lenses of stiff Silt and Clay and occasional Gravel.

The stratification of Reach PJ-1 is shown in Figure 12.

4.2.2. Dredgeability

As the other sediments account for a limited amount of the total volume, Silt (OL or OH) and Silty Clay (CL, OH or MH) were analyzed as a main material to be dredged in Reach PJ-1. Based upon the results from the analysis, the Silt and Silty Clay of Reach PJ-1 have excavation characteristics classified as “good” for clamshell dredge, “very good to good” for backhoe dredge, and “very good” for cutter dredge. The Sand (SP-SM) of Reach PJ-1 is classified as “good to fair” for clamshell dredge, “good” for backhoe dredge, and “very good to good” for cutter dredge as shown in Table 5.

Table 5: Dredgeability of Materials for Reach PJ-1

Material Type	Dredge Type			
	Clamshell	**Backhoe**	**Cutter**	**Blast**
Silt & Silty Clay	Good	Very Good to Good	Very Good	NA
Sand	Good to Fair	Good	Very Good to Good	NA

Consistencies of Silts and Silty Clays were classified as very soft to soft and the consistencies of Sands were classified as being fine to medium grained with medium density. Based upon previous analyses the Recent Silt and Silty Clay sediments can be dredged by all dredges being used for comparison, therefore, only the Sand was used for determining the suitability of the selected dredge types. All dredge types are proved to be suitable for this reach with the cutter dredge having the best results. In view of dredging records, contamination, disposal, and availability of dredging equipment, a clamshell dredge will be suitable to dredge the Reach PJ-1.

4.2.3. Slope Stability

Soil test boring locations ANC98-81 and PJ-4 were used to estimate soil strata and soil properties for analyses of slope stability as overall, the borings can provide whole soil stratification which is useful to understand stabilities of slope proposed for four feet and five feet deepenings. The soil properties of soil strata of the borings are shown in Table 6.

Table 6: Soil Properties of Soil Strata at Reach PJ-1

Boring No.	Material Type	Top Elevation of Stratum (ft)	Representative N-Value (blows/ft) /RQD (%)	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (Deg.)
ANC98-81	Silt	-21.0	0	90	50	0
	Silty Clay	-33.0	0	100	100	0
	Sand	-63.5	70	135	0	42
PJ-4	Silt	-32.0	0	90	50	0
	Silty Clay	-35.0	0	100	100	0
	Sand	-42.0	80	135	0	42
	Schist	-84.0	NA	155	5000	40

Using the above soil properties, circular and non-circular potential failure surfaces were searched by optimized grid-radius, entry-exit, and block analyses. As a result of simulations, the area of boring PJ-4 in the western portion of the Reach PJ-1 resulted in the lowest safety factors of slope analyses for four feet and five feet deepenings as 2.7 and 2.69, respectively. On the other hand, the area of boring ANC98-81 in the eastern portion of the Reach PJ-1 resulted in the lowest safety factors of slope analyses for four feet and five feet deepenings as about 0.70 and 0.69, respectively. The area of boring PJ-4 in the western portion of the Reach PJ-1 satisfies the slope stability criteria with the minimum factor of safety of 1.5; however, the area of boring ANC98-81 in the eastern portion of the Reach PJ-1 fails to meet the minimum factor of safety. The summary of slope stability analyses at Reach PJ-1 is shown in Table 7.

Table 7: Summary of Slope Analyses at Reach PJ-1

Boring No.	Factors of Safety of 4' Deepening		Factors of Safety of 5' Deepening	
	Min	Max	Min	Max
ANC98-81	0.696	0.709	0.690	0.700
PJ-4	2.702	2.706	2.690	2.702

Critical slope failures in the area of boring ANC98-81 occur over the bottom of thick, soft consistency Silty Clay layer. The full extent of the soft Silt and Silty Clay should need to be further investigated to determine a proper type and the scope of application of mitigation measure to stabilize the slopes in the eastern portion of the Reach PJ-1.

4.3. Kill Van Kull Channel (KVK-1)

4.3.1. Stratification

The Kill Van Kull Channel is located north of Staten Island, New York and south of Bayonne, New Jersey. The channel connects Upper New York Harbor with the Arthur Kill Channel and Newark Bay Complex. Reach KVK-1 is a triangle-shaped reach located on the south of entry of Kill Van Kull from Ambrose Channel. Soil test borings performed at this reach are displayed on Figure 8. The stratification of Reach KVK-1 was determined based on material types and material consistencies of the soil test borings. The Reach KVK-1 mainly consists of:

- Holocene (Recent) sediments: soft black, grey, and dark grey Silt (OL or OH) and a layer of dense to loose consistency Sand (SP-SM);

- Pleistocene age sediments: dense to very dense Cobble and Boulder; and

- Serpentinite as a bedrock.

The stratification of Reach KVK-1 is illustrated in Figure 13. Based on proposed deepening depths of fifty-four feet below mean lower low water (-54 MLLW) and fifty-five feet below mean lower low water (-55' MLLW), Holocene (Recent) sediments will mainly be removed when the reach is deepened.

4.3.2. Dredgeability

Based upon the results from the analysis of dredgeability, the Silt of Reach KVK-1 has excavation characteristics classified as "good" for clamshell dredge, "good" for backhoe dredge, and "very good" for cutter dredge. Sand is classified as "very good to fair" for clamshell dredge, "very good to good" for backhoe dredge, and "very good" for cutter dredge. Cobble and Boulder are classified as "poor" for clamshell dredge, "fair to good" for backhoe dredge, and "good" for cutter dredge. Serpentinite rock is encountered below fifty feet below mean lower low water (-50 MLLW) in the western portion of Reach KVK-1. These dredgeabilities of each material are summarized in Table 8.

Table 8: Dredgeability of Materials for Reach KVK-1

Material Type	**Dredge Type**			
	Clamshell	**Backhoe**	**Cutter**	**Blast**
Silt	Good	Good	Very Good	NA
Sand	Very Good to Fair	Very Good to Good	Very Good	NA
Cobble/Boulder	Poor	Fair to Good	Good	NA
Serpentinite	Very Poor	Poor	Poor	Good

Consistencies of Silts were classified as very soft to soft and the consistencies of Sands were classified as density to loose. Consistencies of Cobble and Bounder were classified as dense to very dense and RQD of the Serpentinite rock was estimated as 44%. Based upon previous analyses, the Recent Silt and Sand sediments can be dredged by all dredges. In view of dredging records, contamination, disposal, and availability of dredging equipment, a clamshell dredge will be suitable to dredge the Recent Silt and Sand sediments in the Reach KVK-1. Cobble and Boulder can be dredged by backhoe and cutter dredges. Serpentinite rock encountered below fifty feet below mean lower low water (-50 MLLW) in the western portion of Reach KVK-1 should be dredged to a limited extent to reach the proposed deepening depths. Hence, a heavy cutter dredge will be economical and suitable to dredge the limited extent of Serpentinite rock in the western portion of the Reach KVK-1.

4.3.3. Slope Stability

Soil test boring locations ANC98-31, ANC98-30, and KVK98-1A were used to estimate soil strata and soil properties for analyses of slope stability as overall the borings can provide whole soil stratification which is useful to understand stabilities of slope proposed for four feet and five feet deepenings. The soil properties of soil strata of the borings are shown in Table 9.

Table 9: Soil Properties of Soil Strata at Reach KVK-1

Boring No.	Material Type	Top Elevation of Stratum (ft)	Representative N-Value (blows/ft) /RQD (%)	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (Deg.)
ANC98-31	Silt	-42.0	0	90	50	0
	Sand	-44.0	8	115	0	31
	Silt	-50.0	0	90	50	0
ANC98-30	Silt	-27.0	0	90	50	0
	Sand	-43.0	10	120	0	30
	Silt	-55.0	0	90	50	0
KVK98-1A	Silt	-22.8	0	90	50	0
	Sand	-39.0	4	110	0	28
	Sand	-43.0	18	120	0	32.5
	Serpentinite	-54.0	44%	155	5000	40

Using the above soil properties, circular and non-circular potential failure surfaces were searched by optimized grid-radius, entry-exit, and block analyses. As a result of simulations, the area of boring ANC98-31 in the eastern portion of the Reach KVK-1 resulted in the lowest safety factors of slope analyses for four feet and five feet deepenings as about 0.54 and 0.49, respectively. The area of boring ANC98-30 in the middle of the Reach KVK-1 resulted in the same lowest safety factor of slope analyses for four feet and five feet deepenings as about 1.15. In addition, the area of boring KVK98-1A in the middle portion of the Reach KVK-1 resulted in the same lowest safety factor of slope analyses for four feet and five feet deepenings as about 1.14. Overall, most of the Reach KVK-1 look like not satisfying the slope stability criteria with the minimum factor of safety of 1.5. The summary of slope stability analyses at Reach KVK-1 is shown in Table 10.

Table 10: Summary of Slope Analyses at Reach KVK-1

Boring No.	**Factors of Safety of 4' Deepening**		**Factors of Safety of 5' Deepening**	
	Min	**Max**	**Min**	**Max**
ANC98-31	0.473	0.481	0.488	0.573
ANC98-30	1.148	1.159	1.148	1.159
KVK98-1A	1.144	1.170	1.144	1.170

It is anticipated that critical slope failures in the eastern portion of Reach KVK-1 including boring ANC98-31 will occur as mode of deep-seated slope failure due to very thick, soft consistency top and third layers of silt materials and relatively thin, medium consistency second sand layer. On the other hand, critical slope failures in the eastern and middle portions of Reach KVK-1 including borings ANC98-30, KVK98-1A, and KN-11 will occur as mode of local slope failure due to a relatively thick, medium to firm consistency second layer of sand in the middle of the reach and dense to very dense second layer of boulder/cobble in the eastern portion.

The full extent of the soft consistency silt should need to be further investigated to determine a proper type and the scope of application of mitigation measure to stabilize the slopes in the Reach KVK-1.

4.4. Newark Bay (NWK-1)

4.4.1. Stratification

Newark Bay is located at the north of the junction of the Kill Van Kull and Arthur Kill Channels and extends northward to the New Jersey Turnpike Extension Bridge in Jersey City, New Jersey. Reach NWK-1 is a triangle-shaped strip located and extending from south to north on the eastern side of Newark Bay. Soil test borings performed at this reach are displayed in Figure 9. The proposed deepening depths for the reach are fifty-four feet below mean lower low water (-54 MLLW) and fifty-five feet below mean lower low water (-55’ MLLW). The Reach NWK-1 mainly consists of:

- Holocene (Recent) sediments: soft black, grey, and dark grey Silt (OL or OH);

- Pleistocene age sediments: hard to medium-stiff consistency Clay (CL or CH), very dense to medium consistency Sand (SP), and very dense to medium consistency Gravel (GC-GM); and

- Bedrocks such as Diabase, Diorite, Serpentinite, Shale, and/or Sandstone.

The stratification of Reach NWK-1 is illustrated in Figure 14. Based on the proposed deepening depths of fifty-four feet below mean lower low water (-54 MLLW) and fifty-five feet below mean lower low water (-55’ MLLW), considerable amounts of Holocene (Recent) and Pleistocene sediments will be removed when the reach are deepened.

4.4.2. Dredgeability

Based upon the results from the analysis of dredgeability, the Silt of Reach NWK-1 has excavation characteristics classified as “good” for clamshell dredge, “good” for backhoe dredge, and “very good” for cutter dredge. Clay is classified as “poor” for clamshell dredge, “fair to poor” for backhoe dredge, and “good” for cutter dredge. Sand is classified as “good to fair” for clamshell dredge, “very good to good” for backhoe dredge, and “very good to good” for cutter dredge. Gravel is classified as “poor” for clamshell dredge, “fair to poor” for backhoe dredge, and “good” for cutter dredge. Most of sub-crops of bedrocks including Diabase, Diorite, Serpentinite, Shale, and/or Sandstone are encountered below fifty feet below mean lower low water (-50 MLLW) in the most portions of Reach NWK-1 except for northern portion of the reach; sub-crops of bedrocks in the northern portion of the reach extend close to twenty feet below mean lower low water (-20 MLLW). The dredgeabilities of each material are summarized in the Table 11.

Table 11: Dredgeability of Materials for Reach NWK-1

Material Type	Dredge Type			
	Clamshell	**Backhoe**	**Cutter**	**Blast**
Silt	Good	Good	Very Good	NA
Clay	Poor	Fair to Poor	Good	NA
Sand	Good to Fair	Very Good to Good	Very Good to Good	NA
Gravel	Poor	Fair to Poor	Good	NA
Bedrocks (Diabase, Diorite, Serpentinite, Shale, and/or Sandstone)	Very Poor	Poor	Poor	Good

Consistencies of Silts were classified as very soft to soft and the consistencies of Clays were classified as hard to medium-stiff. Consistencies of Sands and Gravels were classified as very dense to medium, and RQDs of the bedrocks were estimated in the range of 25% to 85%. Based upon previous analyses, the Recent Silt sediments can be dredged by all dredge types. In view of dredging records, contamination, disposal, and availability of dredging equipment, a clamshell dredge will be suitable to dredge the Recent Silt sediments in the Reach NWK-1.

While Sand sediments also can be dredged by all dredges, Clay and Gravel sediments can be dredged only by cutter dredges. As the Sand sediments lies between the Clay and the Gravel sediments and Sand sediments can be dredged by all dredge types, it is efficient to determine a dredge type available for Clay and Gravel sediments. Hence, a cutter dredge will be suitable to dredge the Clay, Sand, and Gravel sediments.

As the most of bedrocks encountered in most portions of the Reach NWK-1 except for the northern portion are located below fifty feet below mean lower low water (-50 MLLW), a heavy cutter dredge will be economical and suitable to remove the limited extent of the bedrocks to reach the proposed deepening depths. However, it is anticipated that the significant amounts of bedrocks encountered in northern portion of the Reach NWK-1 will be in need of blasting to reach the proposed deepening depths. The full extent of the bedrocks in need of blasting in the northern portion should need to be further investigated to estimate more accurate costs and schedules.

4.4.3. Slope Stability

Soil test boring locations PA2-443, PA2-486, NB98-34, and NBN-01-SFI-2 were used to estimate soil strata and soil properties for analyses of slope stability as overall, the borings can provide whole soil stratification which is useful to understand stabilities of slope proposed for four feet and five feet deepenings. The soil properties of soil strata of the borings are shown in Table 12.

Table 12: Soil Properties of Soil Strata at Reach NWK-1

Boring No.	Material Type	Top Elevation of Stratum (ft)	Representative N-Value (blows/ft) /RQD (%)	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (Deg.)
PA2-443	Silt	-11.5	0	90	50	0
	Clay	-41.5	5	110	630	0
	Clay	-45.0	35	130	4375	0
	Clay	-64.0	10	120	1250	0
	Shale	-82.0	NA	155	5000	40
NB98-34	Silt	-15.7	0	90	50	0
	Sand	-24.0	3	105	0	28
	Clay	-29.0	9	115	1125	0
	Decomposed Shale	-44.0	75	135	0	37
	Shale, Serpentinite, Diabase, and Sandstone	-49.0	NA	155	5000	40
NBN01-SFI-2	Silt	-6.4	0	90	50	0
	Sand	-17.5	35	130	0	39.5
	Clay	-21.5	35	130	4375	0
	Sandstone	-37.5	80%	155	5000	40
PA2-486	Silt	-16.5	0	90	50	0
	Clay	-35.0	30	125	3750	0
	Sand	-48.0	55	135	0	41
	Diabase	-58.5	>70%	155	5000	40

Using the above soil properties, circular and non-circular potential failure surfaces were searched by optimized grid-radius, entry-exit, and block analyses. As a result of simulations, the area of boring PA2-443 in the northern end of the Reach NWK-1 resulted in the same lowest safety factor of slope analyses for four feet and five feet deepenings as about 0.62. The area of boring NBN01-SFI-2 in the northern tenth of the Reach NWK-1 resulted in the lowest safety factors of slope analyses for four feet and five feet deepenings as about 1.68 and 1.67, respectively. The area of boring NB98-34 in the middle of the Reach NWK -1 resulted in the same lowest safety factor of slope analyses for four feet and five feet deepenings as about 1.94. The area of boring PA2-486 in the southern portion of the Reach NWK-1 resulted in the same lowest safety factor of slope analyses for four feet and five feet deepenings as about 1.00. Overall, the northern end and southern portion of the Reach NWK-1 look like not satisfying the slope stability criteria with the minimum factor of safety of 1.5, while the middle and northern tenth portions of the Reach NWK-1 meet the slope stability criteria. The summary of slope stability analyses at Reach NWK-1 is in Table 13.

Table 13: Summary of Slope Analyses at Reach NWK-1

Boring No.	**Factors of Safety of 4' Deepening**		**Factors of Safety of 5' Deepening**	
	Min	**Max**	**Min**	**Max**
PA2-443	0.617	0.645	0.617	0.637
NB98-34	1.944	1.953	1.944	1.962
NBN01-SFI-2	1.678	1.745	1.671	1.688
PA2-486	1.002	1.050	1.004	1.050

It is anticipated that critical slope failures in the northern end and southern portion of Reach NWK-1 including borings PA2-443 and PA2-486, respectively, will occur as mode of local slope failure due to thick, very soft consistency top layer of silt materials underlain by a relatively medium-stiff to hard consistency second layer of clay. On the other hand, it is anticipated that slope failures in the northern tenth and middle portions of Reach NWK-1 including borings NBN01-SFI-2 and NB98-34, respectively, would not occur due to a relatively thinner, soft consistency top layer of silt materials underlain by relatively denser sand layer.

The full extent of the very soft consistency silt should need to be further investigated to determine a proper type and the scope of application of mitigation measure to stabilize the slopes in the Reach NWK-1.

4.5. Newark Bay (NWK-2)

4.5.1. Stratification

Reach NWK-2 is located between South Elizabeth Channel and Arthur Kill Channel and on the southwestern side of Newark Bay. Soil test borings performed at this reach are displayed on Figure 10. The proposed deepening depths for the reach are fifty-four feet below mean lower low water (-54 MLLW) and fifty-five feet below mean lower low water (-55' MLLW). The Reach NWK-2 mainly consists of:

- Holocene (Recent) sediments: soft black, grey, and dark grey Silt (OL or OH);

- Pleistocene age sediments: hard to medium-stiff consistency Clay (CL or CH), and very dense to medium consistency Gravel (GC, GM, or GP); and

- Bedrocks such as Sandstone and/or Shale.

The stratification of Reach NWK-2 is shown on Figure 15. Based on proposed deepening depths of fifty-four feet below mean lower low water (-54 MLLW) and fifty-five feet below mean lower low water (-55' MLLW), a majority of Holocene (Recent) and Pleistocene sediments will be removed when the reach are deepened. A significant amount of bedrock also will be removed to reach the design deepening depths.

4.5.2. Dredgeability

Based upon the results from the analysis of dredgeability, the Silt of Reach NWK-2 has excavation characteristics classified as "good" for clamshell dredge, "good" for backhoe dredge, and "very good" for cutter dredge. Clay is classified as "poor" for clamshell dredge, "fair to poor" for backhoe dredge, and "good" for cutter dredge. Gravel is classified as "poor" for clamshell dredge, "good to poor" for backhoe dredge, and "good to fair" for cutter dredge. Most of bedrocks including Sandstone are encountered below forty feet below mean lower low water (-40 MLLW) in the most northern half of Reach NWK-2 except for northern end of Reach NWK-2; bedrocks including Sandstone and/or Shale are encountered close to or below forty feet below mean lower low water (-40 MLLW) in the northern end and southern half of Reach NWK-2. The dredgeability of each material is summarized in the below Table 14.

Table 14: Dredgeability of Materials for Reach NWK-2

Material Type	Dredge Type			
	Clamshell	**Backhoe**	**Cutter**	**Blast**
Silt	Good	Good	Very Good	NA
Clay	Poor	Fair to Poor	Good	NA
Gravel	Poor	Good to Poor	Good to Fair	NA
Bedrock (Sandstone or Shale)	Very Poor	Poor	Poor	Good

Consistencies of Silts were classified as very soft to soft, and the consistencies of Clays were classified as hard to medium-stiff. Consistencies of Gravels were classified as very dense to medium and RQDs of the bedrocks were estimated in the range of 26% to 100%. Based upon previous analyses, the Recent Silt sediments can be dredged by all dredges. In view of dredging records, contamination, disposal, and availability of dredging equipment, a clamshell dredge will be suitable to dredge the Recent Silt sediments in the Reach NWK-2. Cutter dredges will be suitable to dredge Clay and Gravel sediments.

As the most of sub-crops of bedrocks encountered in northern half of the Reach NWK-2 except for the northern end are located below fifty feet below mean lower low water (-50 MLLW), a heavy cutter dredge will be economical and suitable to remove the limited extent of the bedrocks to reach the proposed deepening depths. However, as the most of sub-crops of bedrocks encountered in northern end and southern half of the Reach NWK-2 are located close to or below forty feet below mean lower low water (-40 MLLW), the significant amounts of bedrocks encountered in northern end and southern half of the Reach NWK-2 will be in need of blasting to reach the proposed deepening depths. The full extent of the bedrocks in need of blasting in the northern end and southern half should need to be further investigated to estimate more accurate costs and schedules.

4.5.3. Slope Stability

Soil test boring locations PA2-479 and B4-84 were used to estimate soil strata and soil properties for analyses of slope stability as overall, the borings can provide whole soil stratification which is useful to understand stabilities of slope proposed for four feet and five feet deepenings. The soil properties of soil strata of the borings are shown in Table 15.

Table 15: Soil Properties of Soil Strata at Reach NWK-2

Boring No.	Material Type	Top Elevation of Stratum (ft)	Representative N-Value (blows/ft) /RQD (%)	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (Deg.)
PA2-479	Silt	-2.5	0	90	50	0
	Clay	-12.0	11	120	1370	0
	Clay	-30.0	41	130	5125	0
	Decomposed Shale	-40.5	180	140	0	37
	Shale and Sandstone	-61.0	>30%	155	5000	40
B4-84	Silt	-6.1	0	90	50	0
	Sand	-24.5	20	120	0	33.5
	Gravel & Sand	-27.5	75	135	0	41
	Sandstone	-43.0	26%	155	5000	40

Using the above soil properties, circular and non-circular potential failure surfaces were analyzed by optimized grid-radius, entry-exit, and block analyses. As a result of simulations, the area of boring PA2-479 in the middle and northern half of the Reach NWK-2 resulted in the same lowest safety factor of slope analyses for four feet and five feet deepenings as about 1.94. The area of boring B4-84 in the southern portion of the Reach NWK-2 resulted in the same lowest safety factor of slope analyses for four feet and five feet deepenings as about 1.00. Overall, the southern portion of the Reach NWK-2 looks like not satisfying the slope stability criteria with the minimum factor of safety of 1.5, while the middle and northern half of the Reach NWK-2 meet the slope stability criteria. The summary of slope stability analyses at Reach NWK-2 is shown in Table 16.

Table 16: Summary of Slope Analyses at Reach NWK-2

Boring No.	Factors of Safety of 4' Deepening		Factors of Safety of 5' Deepening	
	Min	Max	Min	Max
PA2-479	1.944	2.099	1.944	1.948
B4-84	1.002	1.102	1.002	1.039

It is anticipated that critical slope failures in the southern portion of Reach NWK-2 including boring B4-84 will occur as mode of local slope failure due to thick, very soft consistency top layer of silt materials underlain by relatively medium to very dense consistency layers of sand and gravel. On the other hand, it is anticipated that slope failures in the northern and middle portions of Reach NWK-2 including boring PA2-479 would not occur due to a relatively thinner, soft consistency top layer of silt materials underlain by relatively denser clay layers.

The full extent of the very soft consistency silt should need to be further investigated to determine a proper type and the scope of application of mitigation measure to stabilize the slopes in the Reach NWK-2.

Attachment #1

Figures

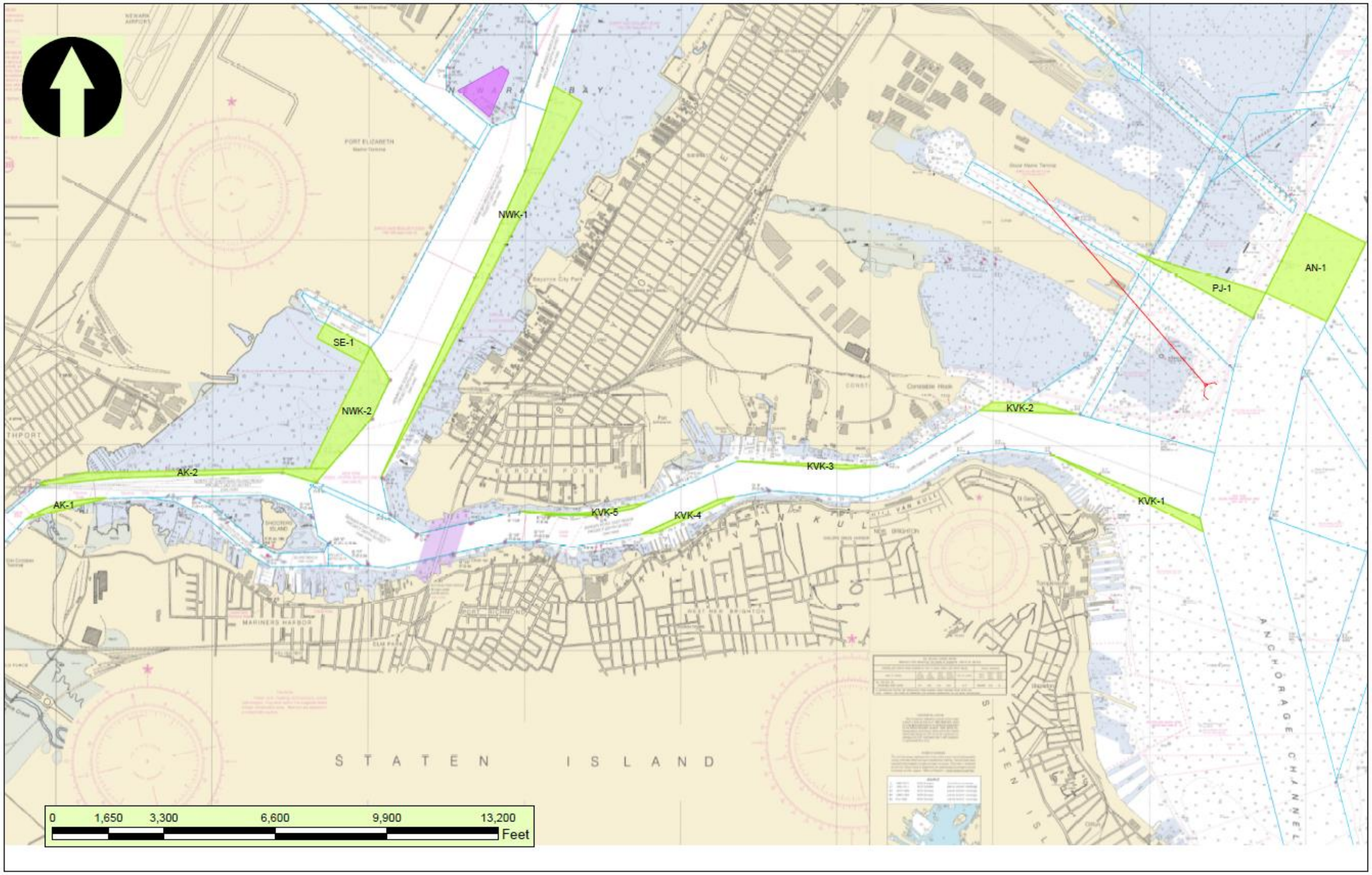

Figure 1: Project Areas for New York and New Jersey Harbor Deepening Channel Improvements

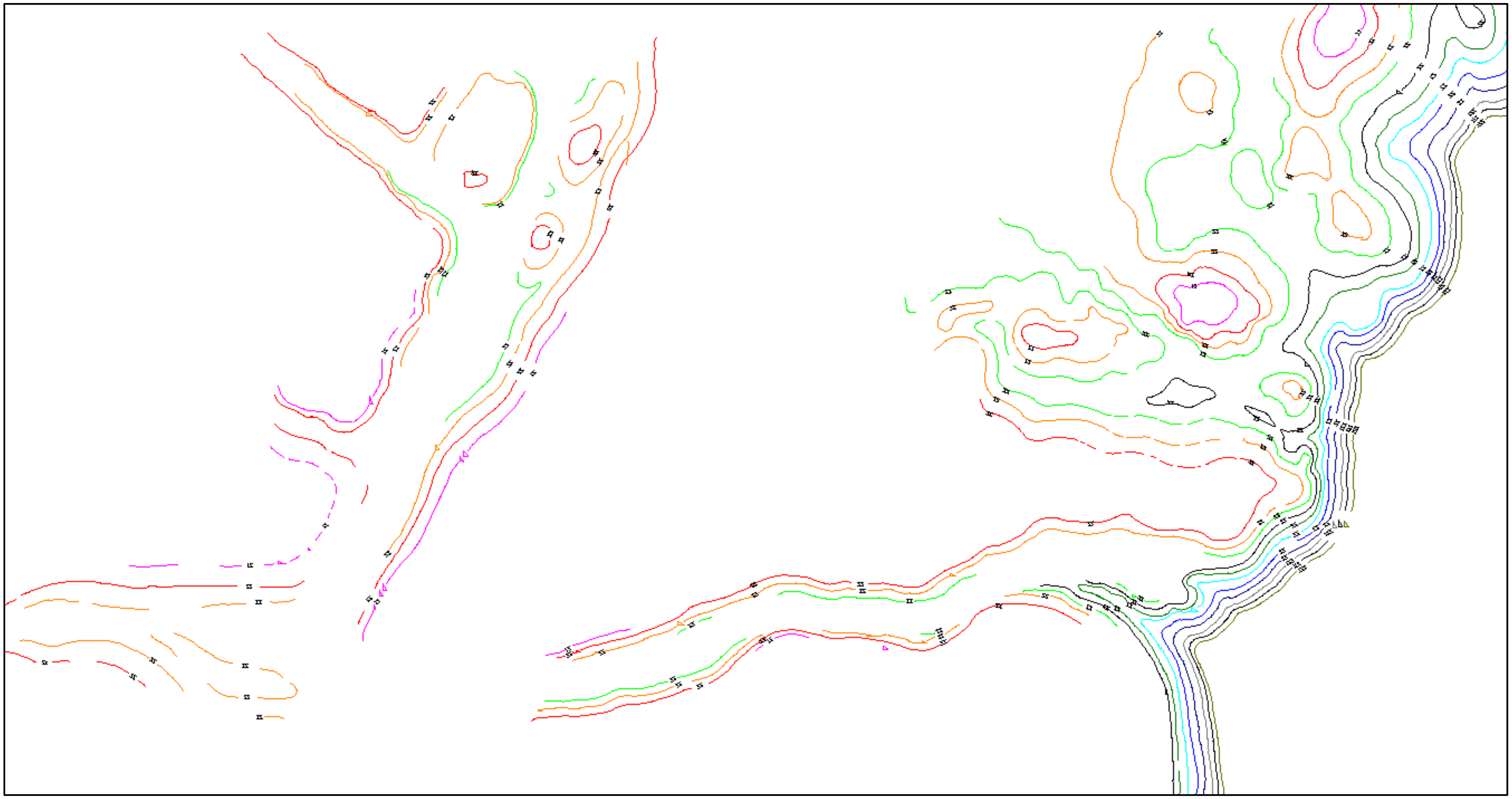

Figure 2: Top Contour Map of Pleistocene of Project Areas

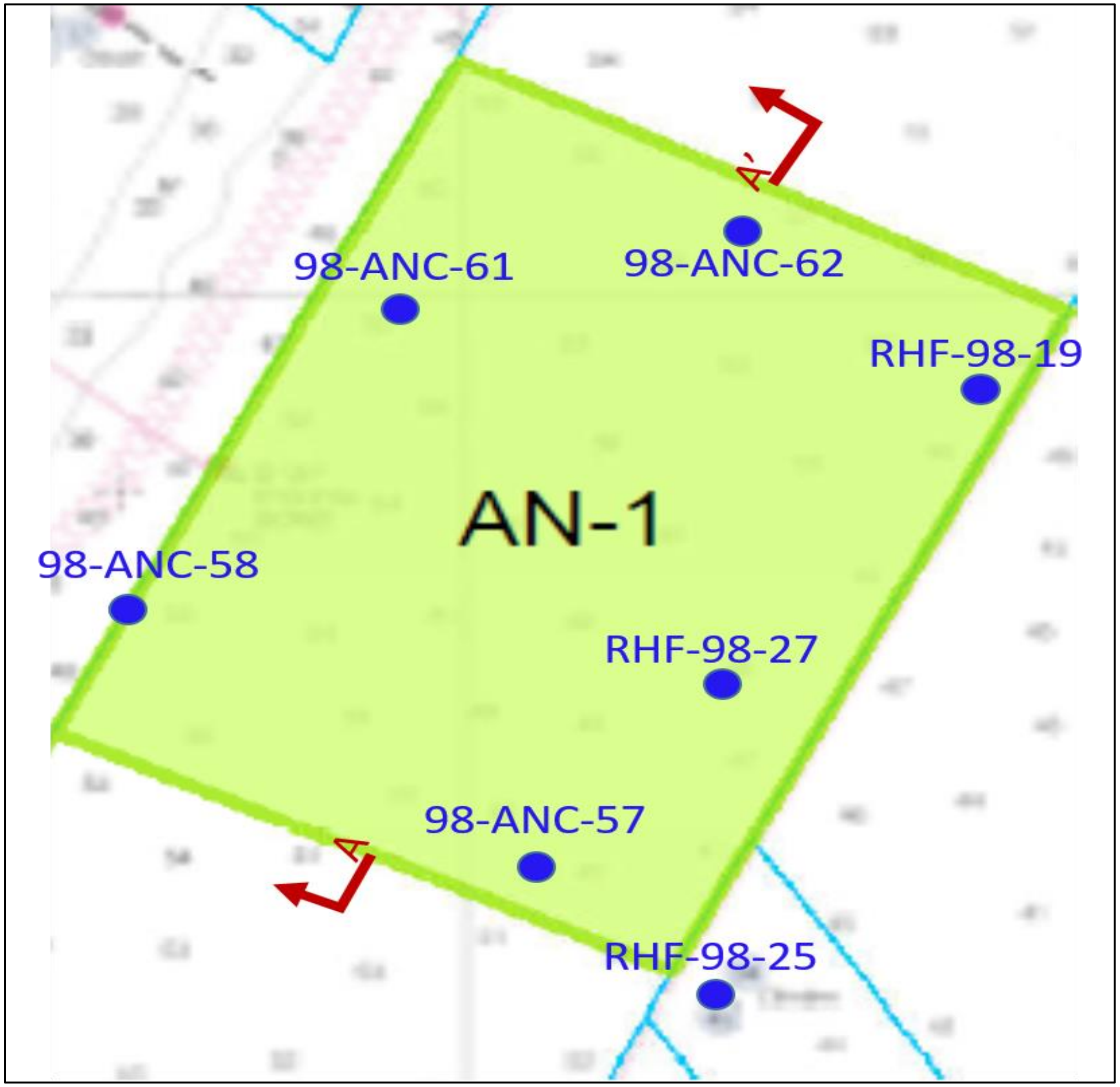

Figure 3: Boring Location Plan of Reach AN-1

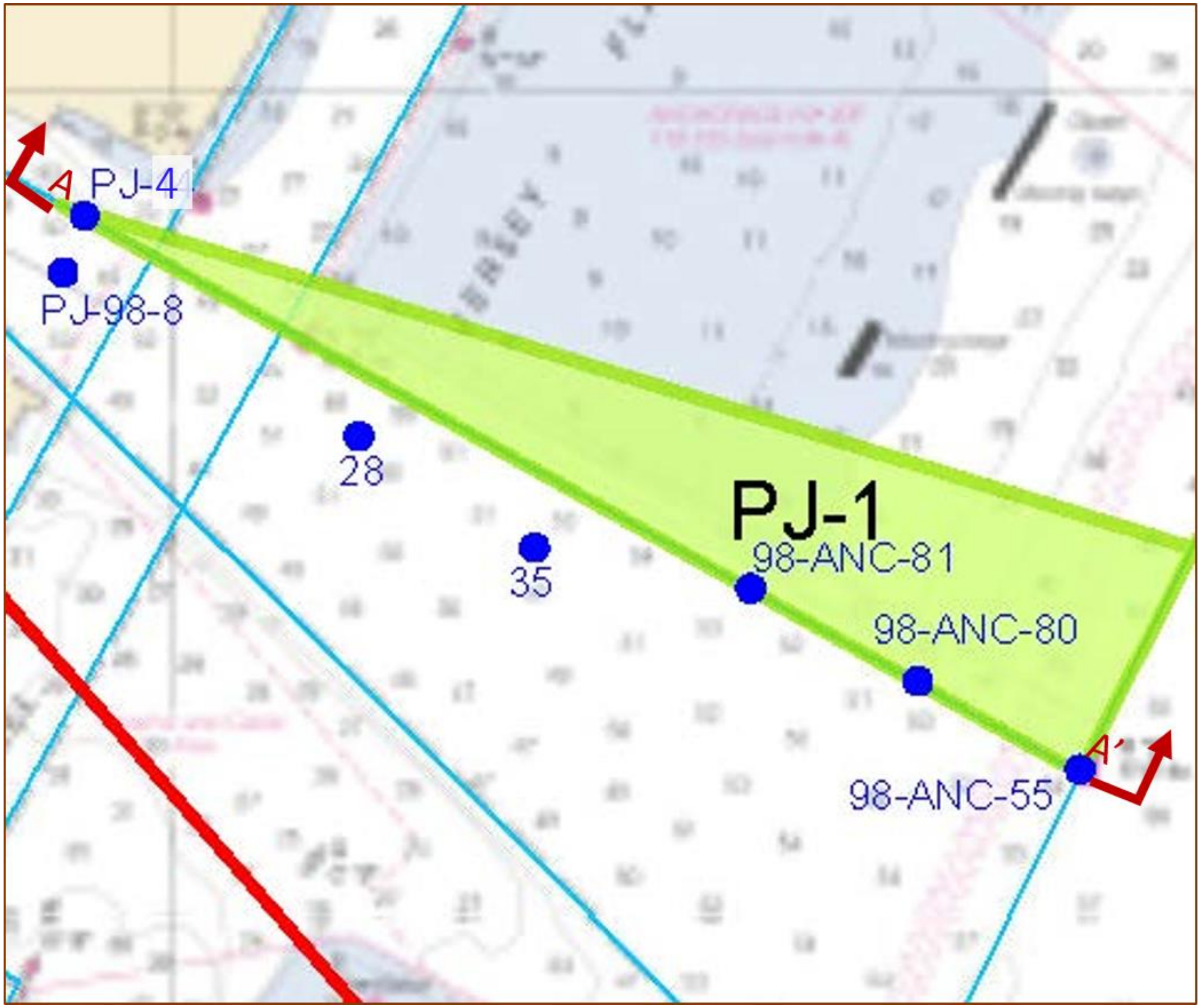

Figure 4: Boring Location Plan of Reach PJ-1

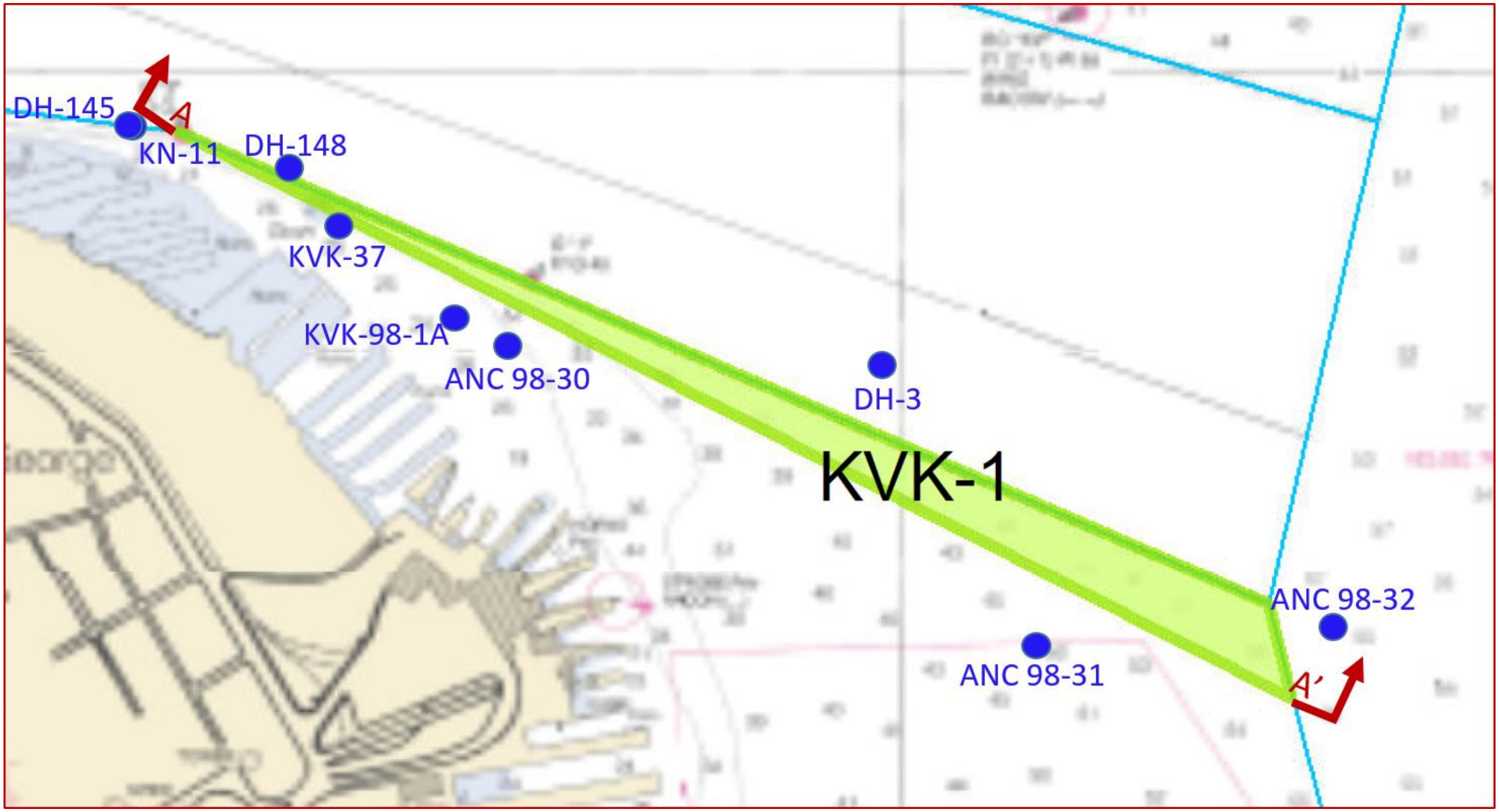

Figure 5: Boring Location Plan of Reach KVK-1

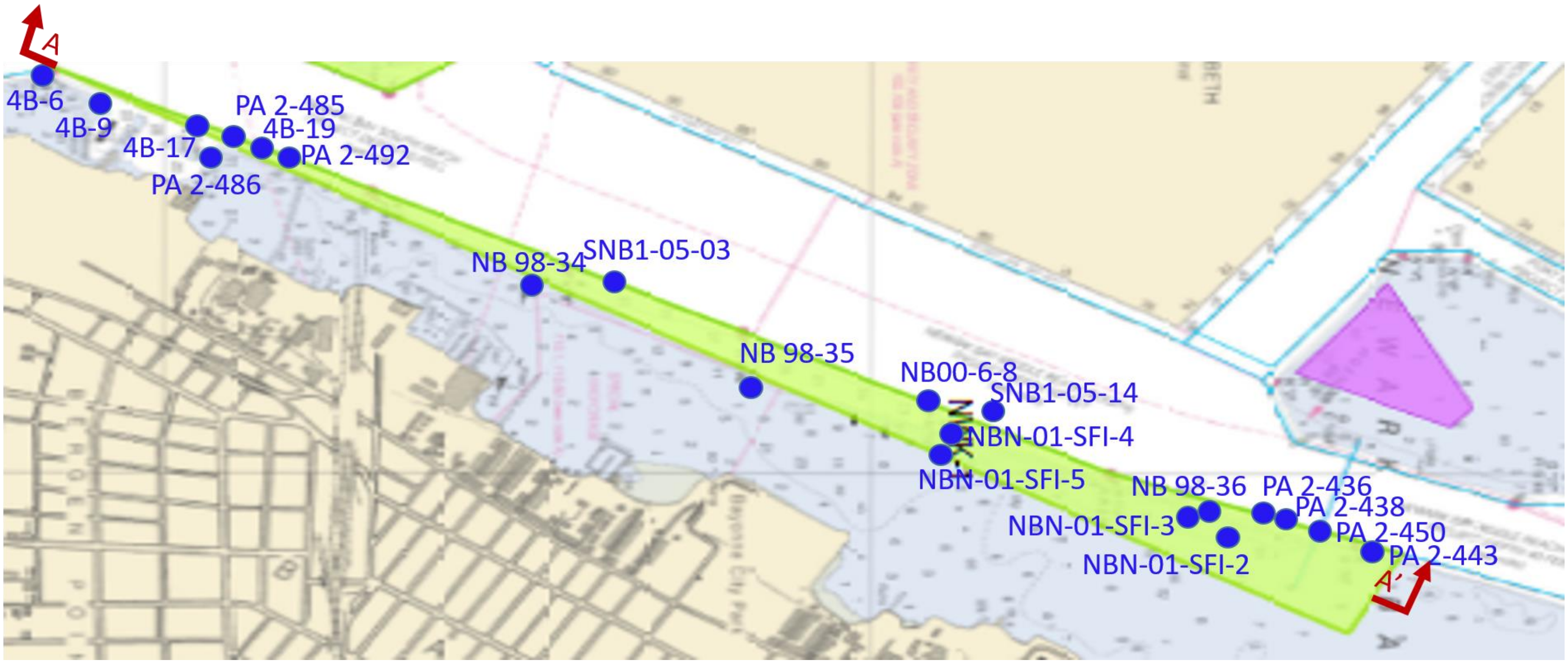

Figure 6: Boring Location Plan of Reach NWK-1

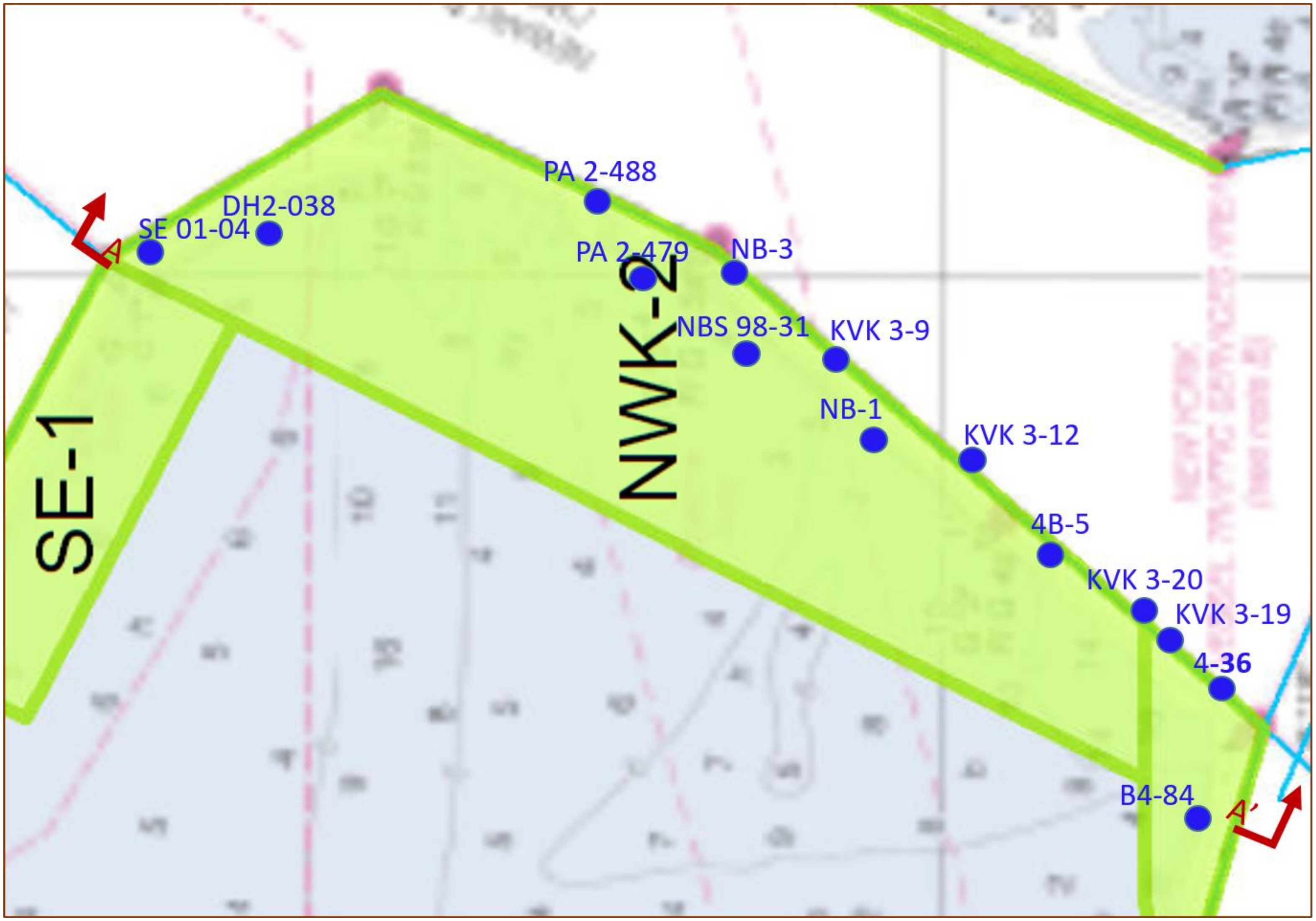

Figure 7: Boring Location Plan of Reach NWK-2

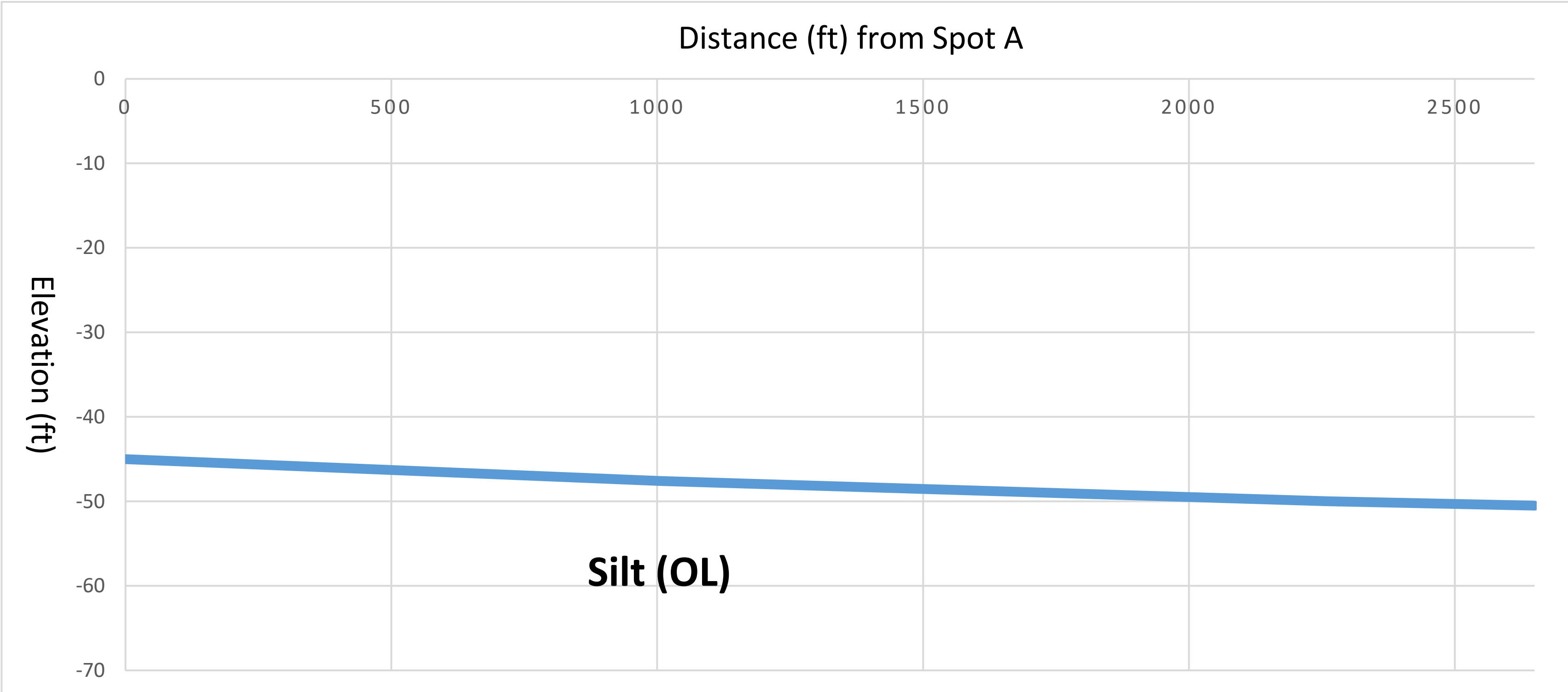

Figure 8: Cross-Section (A-A') of Reach AN-1

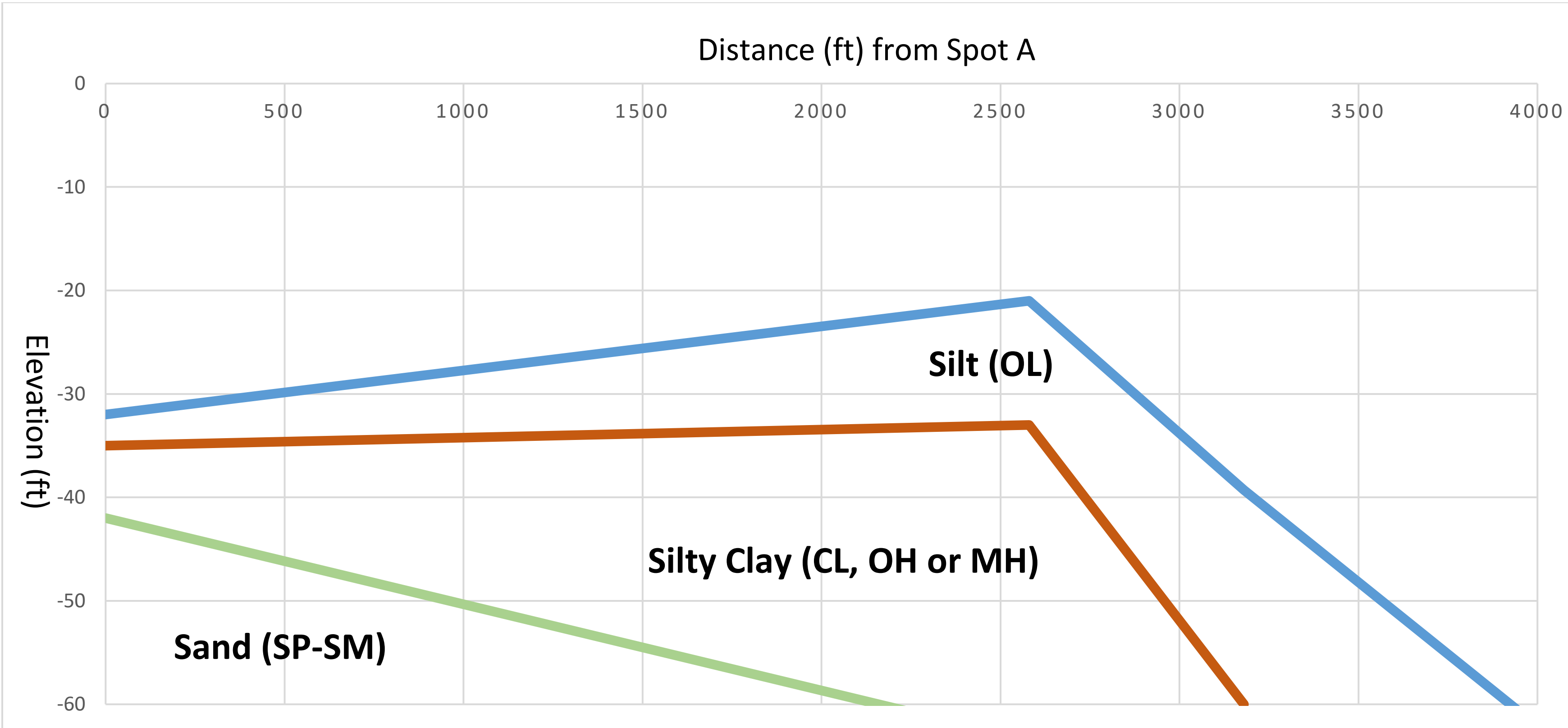

Figure 9: Cross-Section (A-A') of Reach PJ-1

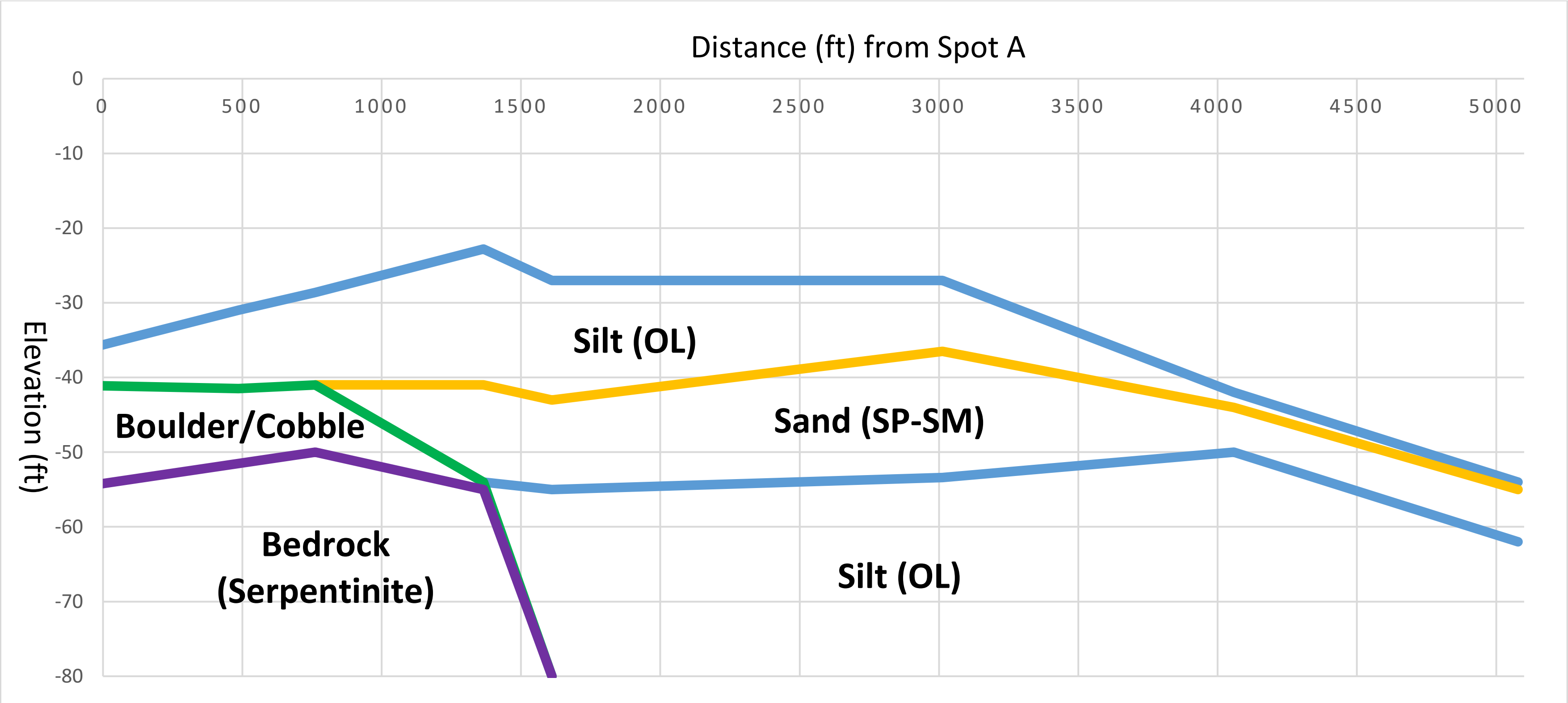

Figure 10: Cross-Section (A-A') of Reach KVK-1

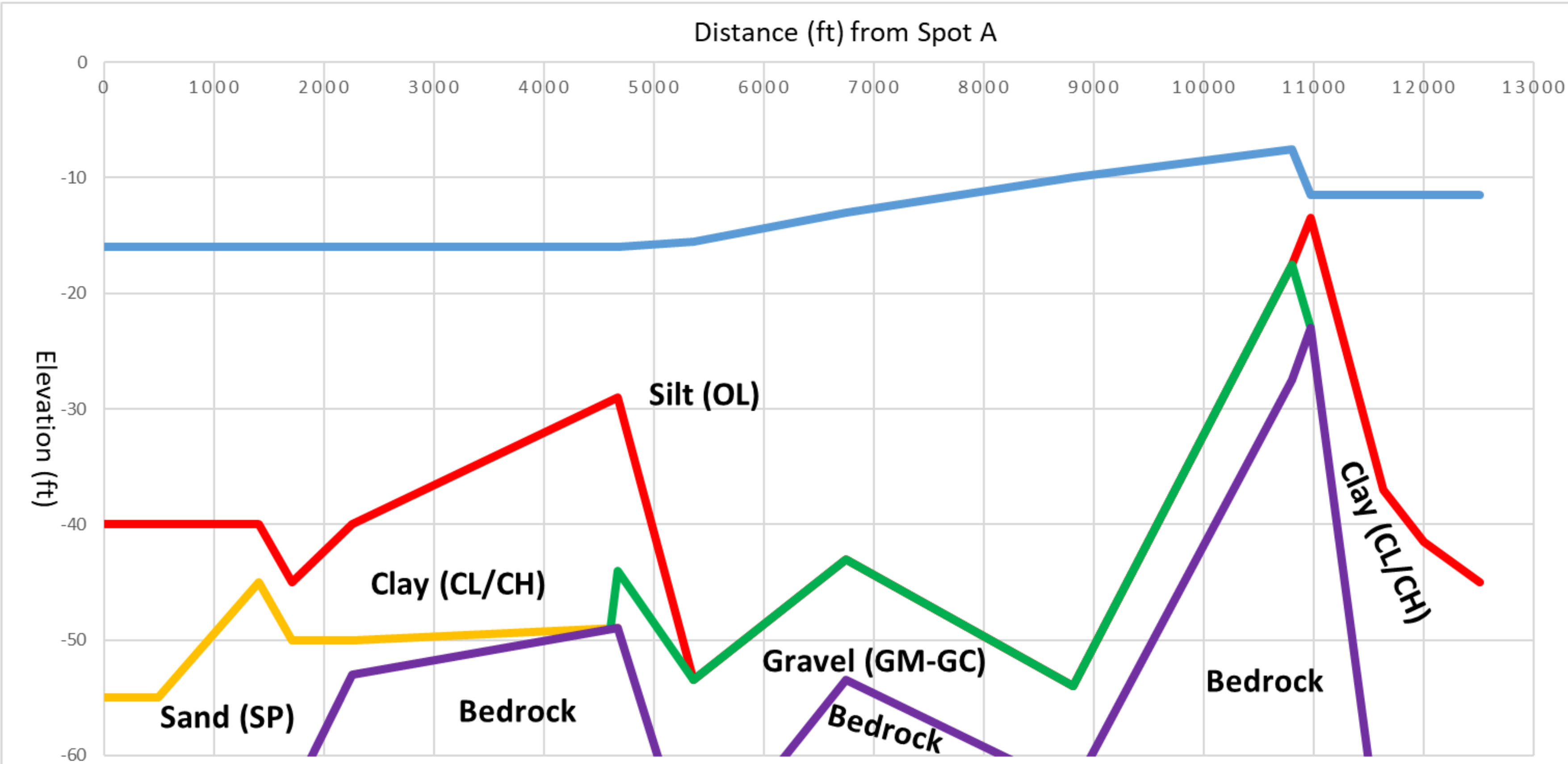

Figure 11: Cross-Section (A-A') of Reach NWK-1

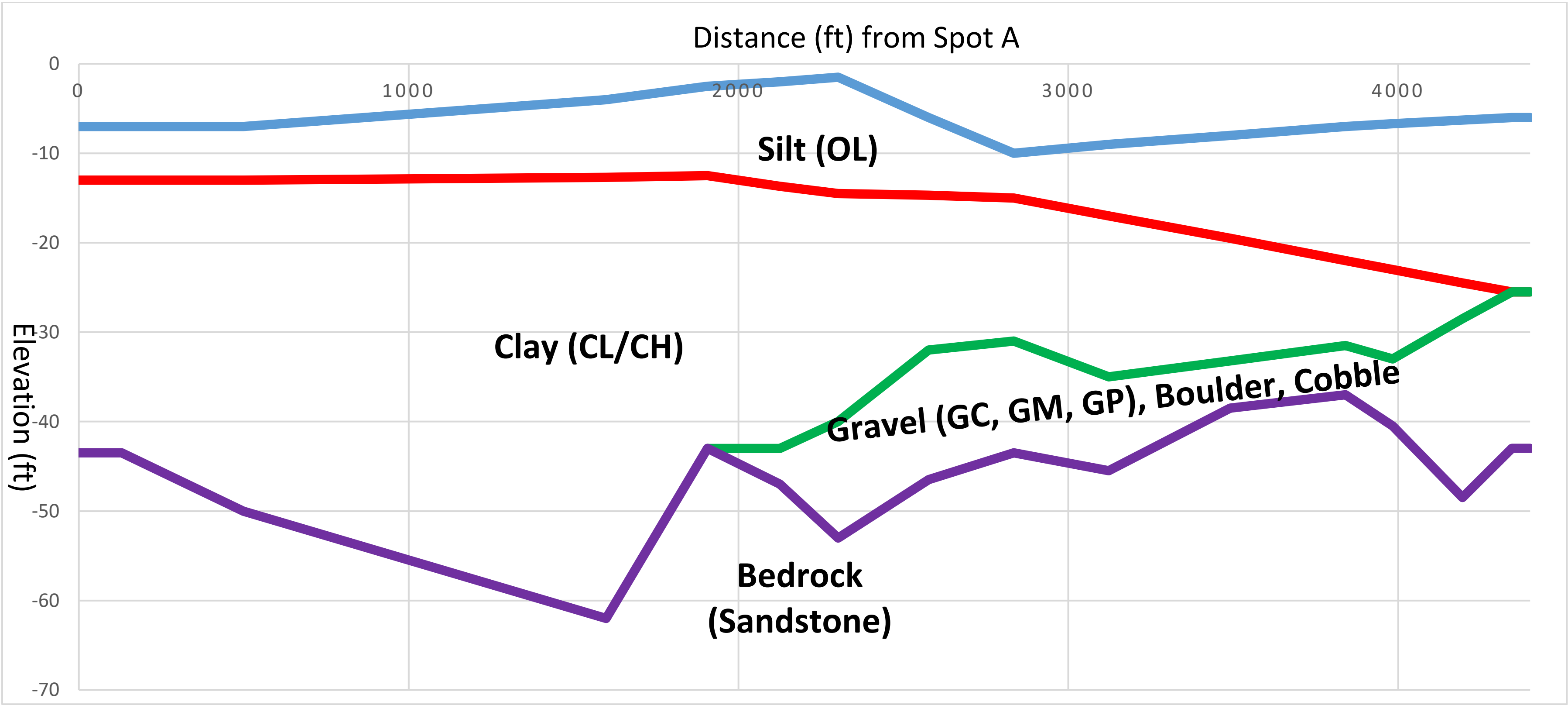

Figure 12: Cross-Section (A-A') of Reach NWK-2

Attachment #2

SPT Boring Logs

ANC 98-57

179977

-49.4

970985

ELEVATION	DEPTH	BLOWS 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
-50			T		Black CLAY, with small shell fragments (OH)	Shell Fragments 0-TD
	1					
	2					
	3					
	4					
-55	5					
	6					
	7					
	8		T			
	9				-59.2	
-60	10				Dark gray CLAY, with small shell fragments (OH)	
	11					
	12		T			
	13					
	14					
-65	15					
	16		T		TD = -66.0'	
	17					
	18					
	19					
	20					
	21					
	22					
	23					
	24					
	25					
	26					
	27					
	28					
	29					
	30					

ANC 98-58

ANC 98-58						180980
-55.9						969943
ELEVATION	DEPTH	BLOWS / 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	1				Black CLAY, with shell fragments (OL)	
	2					
	3					
-60	4				-60.7	
	5				Black CLAY (OL)	
	6					
	7					
	8					
-65	9				-65.7	
	10				Black CLAY (OH)	
	11					
	12		T			
	13					
-70	14					
	15					
	16					
	17					
	18					
	19					
	20					
	21					
	22					
	23					
	24					
	25					
	26					
	27					
	28					
	29					
	30					

ANC 98-61

ANC 98-61	667812
-53.0	617426

ELEVATION	DEPTH	BLOWS 6"	SAMPLE NUMBER
	1	WOR	S1
-55	2	WOR	
	3		S2
	4	WOR	
	5		S3
	6	WOR	S4
-60	7		
	8	WOR	
	9		S5
	10	WOR	
	11		S6
-65	12	WOR	
	13		S7
	14	WOR	
	15		S8
	16	WOR	
-70	17		S9
	18	WOR	
	19		S10
	20	WOR	
	21		S11
-75	22		
	23		
	24		
	25		
	26		
	27		
	28		
	29		
	30		
	31		
	32		
	33		
	34		
	35		
	36		
	37		
	38		
	39		
	40		
	41		
	42		
	43		
	44		
	45		
	46		
	47		
	48		
	49		

CLASSIFICATION OF MATERIALS (Description)	Layer boundary	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
Black, very soft SILT, some fine Sand, trace shell fragments (OL)	-55.0	Trace Shell fragments 0'-TD
Black, very soft, slightly plastic SILT, trace fine Sand, trace shell fragments (OL)	-59.0	
Dark gray to black, very soft, slightly plastic SILT, trace fine Sand, trace shell fragments (OL)	-61.0	
Dark gray, very soft, slightly plastic SILT, trace fine Sand, trace shell fragments (OL)	-67.0	
Gray, very soft, slightly plastic SILT, trace fine Sand, trace shell fragments (OL)		TD = -75.0'

ANC 98-62

667858

-50.0

618436

ELEVATION	DEPTH	BLOWS 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	1	WOR	S1		Dark gray to black, very soft, slightly plastic SILT, trace fine Sand (OL)	
	2	WOR	S2			-52.0
	3					
	4	WOR	S3		Dark gray, very soft, slightly plastic SILT, some fine Sand (OL)	
-55	5					
	6	WOR	S4			
	7					
	8	WOR	S5			
	9					
-60	10	WOR	S6			
	11				-62.0	
	12	WOR	S7		Gray, very soft, slightly plastic SILT, some fine Sand (OL)	
	13					
	14	WOR	S8			
-65	15					
	16	WOR	S9			
	17					
	18	WOR	S10			
	19					
-70	20	WOR	S11			
	21					
	22	WOR	S12			
	23					
	24	WOR	S13			
-75	25				TD -76.0'	
	26					
	27					
	28					
	29					
	30					
	31					
	32					
	33					
	34					
	35					
	36					
	37					
	38					
	39					
	40					
	41					
	42					
	43					
	44					
	45					
	46					
	47					
	48					
	49					

RHF 98-19

RHF 98-19		667332
-49.7		618946

SMPL NOATION	SMPLE	BLOWS 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
-50	1	WOR	1		Black, slightly organic, Clayey SILT, trace fine Sand and Gravel (ML)	Petroleum odor, Shell fragments 0.0'-8.5'
	2					
	3					
	4					
-55	5					
	6					
	7					
	8				-58.2	
	9		2		Gray, Clayey SILt (MH)	
-60	10					
	11					
	12					
	13					
	14					
-65	15					
	16					
	17				TD = -67.1	Pushed last 1.0'
	18					
	19					
	20					
	21					
	22					
	23					
	24					
	25					
	26					
	27					
	28					
	29					
	30					
	31					
	32					
	33					
	34					
	35					
	36					
	37					
	38					
	39					
	40					
	41					
	42					
	43					
	44					
	45					
	46					
	47					
	48					
	49					

RHF 98-25						665395
-45.1						617954
SMPL NOATION	SMPLE	BLOWS 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc. if significant)
	1	WOR	1		Black, slightly organic, Clayey	Slight odor
	2				SILT, little fine Sand (MH)	0.0'-8.0'
	3		2			
	4					
-50	5		3			
	6				-51.1	
	7		4		Very dark gray, slightly	
	8				fossiliferous, fine SAND,	-53.1
	9		5		some Silt and Clay (SM)	
-55	10					Trace of small
	11		6		Dark gray, slightly	shell fragments
	12				fossiliferous, CLAY (CH)	6.0'-20.0'
	13		7			
	14					
-60	15		8			
	16					
	17		9			
	18					
	19		10			
-65	20				TD = -65.1	
	21					
	22					
	23					
	24					
	25					
	26					
	27					
	28					
	29					
	30					
	31					
	32					
	33					
	34					
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	40					
	41					
	42					
	43					
	44					
	45					
	46					
	47					
	48					
	49					

RHF 98-27 | 666401

-47.6 | 618146

SMPL NOATION	SMPL NO	BLOWS 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	1	WOR	1		Black, slighly organic, Clayey SILT, trace Sand (ML)	Organic/petroleum odor 0.0'-6.1'
-50	2					
	3					
	4					
	5				-53.2	
	6		2		Dark gray, Silty SAND (SM)	-53.7
-55	7					
	8				Gray, slightly fossiliferous Clayey SILT, trace Sand (MH)	Trace shell frag. 6.1'-10.6'
	9					
	10		3			
	11					
-60	12					
	13					
	14					
	15		4			
	16					
-65	17					
	18					
	19					
	20					
	21					
-70	22					
	23					
	24				TD = -72.5'	
	25					
	26					
	27					
	28					
	29					
	30					
	31					
	32					
	33					
	34					
	35					
	36					
	37					
	38					
	39					
	40					
	41					
	42					
	43					
	44					
	45					
	46					
	47					
	48					
	49					

PJ-4	612139
-32.0	667760

Depth	Blows
0–1.5	WOH / WOH / WOH
3–4.5	WOH / WOH / WOH
5–6.5	WOH / WOH / WOH
8–9.5	WOH / WOH / WOH
10–11.5	32 / 45 / 77
13–14.5	39 / 42 / 51
16–17.5	48 / 56 / 43
19–20.5	65 / 60 / 72
22–23.5	74 / 85 / 32
25–26.5	58 / 42 / 39
30–31.5	36 / 49 / 50
34–35.5	7 / 22 / 22
39–40.5	16 / 36 / 48
44–45.5	22 / 30 / 76
49–50.5	83 / 77 / 79
52–53	77 / 137
55–56	43 / 70

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc. if significant)
-32.0 to -42.0	0–10	Clay	Black to gray, organic Silty CLAY, trace Sand	tr. Shells
-42.0 to -84.0	10–52	Sand	Brown, medium to coarse SAND, trace Silt, trace Gravel	
			Brown, fine to medium SAND, little Gravel, trace Silt	
			Brown, fine to medium SAND, trace Gravel, trace Silt	
			Brown, medium to coarse SAND, little Gravel, trace Silt	
			Brown, medium to fine SAND, little Silt, trace Gravel	
			Brown, medium to fine SAND, little Gravel, trace Silt	
-84.0 to -88.0	52–56	Schist	BOULDERS and Decomposed Mica SCHIST	
-88.0 to -97.0	56–65	Schist	Mica SCHIST	

Elevation scale: -35, -40, -45, -50, -55, -60, -65, -70, -75, -80, -85, -90, -95, -100; depth scale 1–72.

PJ 98-08

667449

-41.0 | **611990**

ELEVATION	DEPTH	BLOWS 6"	SAMPLE NUMBER	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	1–2	WOR, WOR, WOR, WOR	S-1	Black SILT, very soft, wet, highly plastic. (OL)	
	2–4	7, 6, 6, 5	S-2	Dark gray to brown, Silty SAND, medium density to very dense, moist wet, some fine to coarse Gravel. (SM)	-43.5
-45	4				
	7–9	4, 4, 7, 14	S-3		
-50	9				
	12–14	25, 30, 34, 34	S-4		
-55	14				
	17–19	30, 50, 50, 75	S-5		
-60	19				
	22–24		S-6	Brown SAND, very dense, moist, poorly graded, trace fine Gravel. (SP)	-63.0
-65	24				
-70	29				

Depth scale: 1 through 44

TD = -65.0

ELEV.	USCS	%G	%S	%F	LL	PL	PI	%H20	SG
-53to-55'	SM	16.3	40	43.7				[illegible]	

28 | 666847

-10.0 | 613058

ELEVATION	DEPTH	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
-10.0	0	Black, SILT (OL)	Start: 7/18/89 Finish: 7/18/89
-16.0	6	Gray SILT, trace fine Sand (ML)	-16.0'
-19.0	9	Gray to brown, fine SAND (SP)	-19.0'
-30.0	20	Yellow, medium to coarse SAND (SP)	-30.0'
-37.0	27	Red-brown, fine-medium SAND and coarse GRAVEL (SP-GP)	-37.0'
-44.5	34.5	Red-brown, fine SAND, some Silt (SM)	-44.5'
-66.0	56		TD= -66.0'

SAMPLE NUMBER	BLOWS 6"
S1	WOR, WOR, WOR, WOR
S2	WOR, WOR, WOR, WOR
S3	WOR, WOR, WOR, WOR
	WOR, WOR
S4	WOR, WOR, WOR, WOR
S5	WOR, WOR, WOR, WOR
S6	WOH, WOH, WOH, 1
S7	0, 7, 4, 3
S8	5, 5, 6, 8
S9	5, 4, 6, 7
S10	8, 10, 8, 8
S11	8, 6, 9, 11
S12	8, 8, 10, 9
S13	10, 8, 12, 9, 13, 12, 18, 16
S14	8, 9, 10, 11, 11, 10, 13, 18
S15	5, 5, 7, 7, 9, 9, 7, 14
S16	3, 3, 9, 15, 13, 16, 16, 33
S17	42, 42, 27, 25, 55, 98, 100
S18	5, 7, 12, 15, 17, 20, 22, 22
S19	10, 15, 16, 19, 22, 20, 25, 25
S20	9, 12, 14

35		666526
-11.0'		613647

ELEVATION	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
-11.0' to -15.0'	Black SILT (OL)	Start: 7/20/89 Finish: 7/20/89
-15.0' to -27.0'	Gray, CLAY, trace-little Sand (CL)	
-27.0' to -31.0'	Gray to brown, medium to coarse SAND, some Gravel (SP)	-27.0'
-31.0' to -34.0'	Red-brown, fine-medium SAND, trace Gravel (SP)	-31.0'
-34.0' to -63.0'	Red-brown, CLAY and GRAVEL (CL-GC)	-34.0'
		TD= -63.0'

DEPTH	SAMPLE NUMBER	BLOWS 6"
0–2	S1	WOR, WOR, WOR, WOR
2–4	S2	WOR, WOR, WOR, WOR
4–6	S3	WOR, WOR, WOR, WOR
6–8	S4	WOR, WOR, WOR, WOR
8–10	S5	WOR, WOR, WOR, WOR
10–12	S6	WOR, WOR, WOR, WOR
12–14	S7	WOR, WOR, WOR, WOR
14–16	S8	WOR, 5, 7, 8
16–18	S9	6, 12, 10, 7
18–20	S10	10, 7, 8, 8
20–22	S11	11, 10, 9, 9
22–24	S12	10, 10, 14, 14
24–26	S13	6, 9, 9, 12
26–28	S14	8, 19, 17, 23
28–30	S15	16, 16, 24, 15
30–32	S16	13, 13, 10, 8
32–34	S17	4, 5, 4, 5
34–36	S18	8, 7, 8, 7
36–38	S19	5, 8, 10, 12
38–40	S20	4, 5, 8, 9
40–42	S21	5, 6, 9, 9
42–44	S22	7, 5, 7, 10
44–46	S23	2, 3, 4, 3
46–48	S24	5, 6, 7, 10
48–50	S25	3, 3, 5, 5
50–52	S26	8, 6, 5, 5

ELEVATION scale: -15, -20, -25, -30, -35, -40, -45, -50, -55, -60. DEPTH scale: 1–52.

ANC 98-55 | 665816

-61.0 | 615769

ELEVATION	DEPTH	BLOWS 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc. if significant)
		WOR			Black, very soft, slightly plastic SILT, trace shell fragments (OL) -65.0	Trace Shell Fragments 0-4'
	1					
	2	WOR				
	3					
-65	4	WOR			Dark gray, very soft, slightly plastic SILT (OL)	
	5					
	6	WOR				
	7					
	8	WOR				
-70	9					
	10	WOR			-72.0	
	11				Gray, very soft, slightly plastic SILT (OL)	
	12	WOR				
	13					
-75	14	WOR				
	15				TD = -76.0'	
	16					
	17					
	18					
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	20					
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	49					

ANC 98-80 | 666180

-39.3 | 615112

ELEVATION	DEPTH	BLOWS 6"	SAMPLE NUMBER	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
-40	0–4	WOR	S1, S2	Dark gray Clayey SILT, very soft, medium plasticity, trace shell fragments. (OL)	Shell fragments (0'-12')
	4–8	WOR	S3, S4	Gray to dark gray SILT, very soft, low to medium plasticity, trace shell fragments. (OL)	-43.3 Strong Odor (8'-12')
-45, -50	8–12	WOR	S5, S6	Dark gray Clayey SILT, very soft, medium plasticity, strong odor, trace shell fragments. (OL)	-47.3
	12–14	WOR	S7		-51.3
-55	14–20	WOR	S8, S9, S10	Dark gray SILT, very soft, slightly plastic. (OL) / Gray to dark gray SILT, very soft, low to medium plasticity, trace fine sand. (OL)	-53.3
-60, -65	20–28	WOR	S11, S12, S13, S14	Gray Silty CLAY, very soft, highly plastic, trace shell fragments. (OH)	-59.3 Shell Fragments (20'-32')
-70	28–32	WOR	S15, S16	Gray Clayey SILT, very soft, medium plasticity, trace shell fragments. (OL)	-67.3
-75	32–36	WOR	S17, S18	Gray to light gray SILT, very soft, low to medium plasticity, trace fine sand, trace peat. (OL)	-71.3
					TD = -75.3'

Depth scale: 1–49

DEPTH	USCS	% G	% S	% F	LL	PL	PI	% H2O	SG
0-2	CL/OL		25.3	74.7				101.4	

ANC 98-81

666473

614535

-21.0

ELEVATION	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc. if significant)
-21.0 to -27.0	Dark gray SILT, very soft, slightly plastic, trace shell fragments and fine Gravel (OL)	Trace shell fragments 0-6'
-27.0 to -29.0	Gray SILT, very soft, slightly plastic. (OL)	-29.0
-29.0 to -33.0	Gray SILT, very soft, slightly plastic trace fine Sand, trace shell fragments. (OL)	Trace shell fragments 8'-12'; -33.0
-33.0 to -37.0	Gray Silty CLAY, very soft, medium to high plasticity. (OH)	-37.0
-37.0 to -63.0	Light gray Silty CLAY, very soft, medium to high plasticity trace shell fragments, trace fine Gravel (OH) Trace wood fragments below 32.0' and some wood fragments below 40' Color change to gray	Trace shell fragments 16'-42'
-63.0 to -64.0	Gray to light gray fine Silty SAND, very dense. (SM)	-64.0
-64.0 to -75.0	Light gray fine SAND, dense, poorly graded. (SP)	Large (1/2") wood fragments 44-46'
		TD = -75.0'

DEPTH	BLOWS/6"
0-42	WOR
42-44	60, 65, 100
44-46	28, 33, 63, 85
47-50	30, 36, 32, 35, 30
50	42
50-54	36, 33, 30, 39, 7, 8, 12, 24

DH-145

661754

-37

609338

ELEVATION	DEPTH	BLOWS / 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	1	P, P			Black SILT, some Sand	Petroleum odor
	2	P, P				
-40	3	P, P				
	4	6, 8				-41.0
	5	61, 17			SERPENTINE SAPROLITE	
	6	23, 30				
	7	28, 23				
-45	8	26, 32				TD: -45.0
	9					
	10					
	11					
	12					
-50	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					
	21					
	22					
	23					
	24					
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	47					
	48					
	49					

KN-11

661754

-41.7

609328

ELEVATION	DEPTH	BLOWS / 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
		3 / 7			Black SILT & Sand. (ML-SM)	
	1	4 / 3			Red-brown gravelly, dense glacial TILL. (GM)	-42.7'
	2	3*				
-45.0	3	2*				
	4	2*				
	5	4*				
	6	4*			Decomposed SERPENTINE bedrock.	-47.6'
	7	3*				
-50.0	8	3*				
	9	3*				
	10	3*				
	11	4*			TD = 53.7'	
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					
	21					
	22					
	23					
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	47					
	48					
	49					

DH-148

661588

-38.5

609849

ELEVATION	DEPTH	BLOWS 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
-40	1–3	P, P, P, P, P, P			Black, oily SILT, trace Sand	
	3–8	9, 11			Decomposed SERPENTINITE	-41.5
-45						
						TD: -46.5
-50						

Depth scale: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49

KVK-37

661423

-40.1

610028

ELEVATION	DEPTH	BLOWS / 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
		10 19			Brown, fine SAND, some Silt and Clay, trace to some Gravel (SM)	
	1	43 37				
	2	36 29				
	3	19 22				
	4	23 27				
-45.0	5	42 51				
	6	39 47				
	7	62 54				
	8	49 62				
	9	84 100/5"				
-50.0	10					TD = 50.2'
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					
	21					
	22					
	23					
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	49					

KVK 98-1A

661096

-22.8

610448

ELEVATION	DEPTH	BLOWS 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	1	WOR	S1		Dark gray to black Clayey SILT, trace very fine Sand. (MH)	Moderate - strong Petroleum odor. Trace of Shell fragments.
-25	2	WOR	S2		-25.8	
	3					
	4	WOR	S3		Dark gray to black very fine SAND, some Silt. (SM)	-26.8
	5					
	6	WOR	S4		Dark gray to black Clayey SILT, slightly organic, little very fine Sand. (MH)	Mod Petroleum odor. Trace of Sand Silt and Shell fragments.
-30	7					
	8	WOR	S5			
	9					-31.8
	10	WOR	S6		Dark gray fine to medium SAND, some Silt. (SM)	-32.8 Weak - mod Petroleum odor.
	11					
-35	12	WOR	S7		Dark gray to black Clayey SILT, slightly organic, trace very fine Sand. (MH)	
	13	WOH				-36.3 WOH on last 6"
	14	WOR	S8			
	15				Dark gray fine to medium SAND, little Silt. (SM)	-37.8 Weak sour odor.
	16	2 4				-38.8
-40	17	1 2 2	S9		Dark gray Clayey SILT. (MH)	Trace of Shell Hash. (Marine).
	18				Gray to dark gray fine to medium SAND, micaceous, trace silt. (SP-SM)	
	19–22					
-45	22					
	23	7 12 10 8	S10			Trace of Shell Hash, large, coarse, Sand-sized Mica frags.
	24–26					
-50	27	6 10 8 7	S11			Oyster Shells.
	28–30				-53.8	
	31				Cobbles and Boulders. -54.8	Erratic Drilling
-55	32					Smooth Drilling
	33–40		C1		SERPENTINITE, Dark green with red-brown bands, high angle fractures (60°) with white minerals along fracture faces.	C1 = 57.8' to 62.8' Cut 5' Rec 5' RQD = 44%
-60	37					
-65	42					
	41–49					

DEPTH	USCS	% G	% S	% F	LL	PL	PI	% H2O	SG
	SW/SM	0.8	89.2	10.0					2.78

ANC 98-30

661000

-27.0

610637

Sample Number	Depth (ft)	Blows/6"
S1	0–2	WOR
(Shelby Tube)	2–4	
S2	4–6	WOR
S3	6–8	WOR
S4	8–10	WOR
S5	10–12	WOR
S6	12–14	WOR
S7	14–16	WOR
S8	16–18	15, 18, 22, 18
S9	18–20	1, 4, 5, 5
S10	20–22	3, 4, 5, 7
S11	22–24	6, 9, 15, 15
S12	24–26	10, 9, 8, 7
S13	26–28	6, 4, 1, 6
S14	28–30	1, WOR
S15	30–32	WOR
S16	32–34	WOR
S17	34–36	WOR
S18	36–38	WOR
S19	38–40	WOR
S20	40–42	WOR
S21	42–44	WOR
S22	44–46	WOR
S23	46–48	WOR

CLASSIFICATION OF MATERIALS (Description)	Bottom Elevation	REMARKS (Drilling time, water loss, depth of weathering, etc. if significant)
Dark gray, very soft, slightly plastic SILT, trace fine Sand (OL)	-30.0	Petroleum Odor (0'-2'); Shelby Tube 2'(29') - 4'(31') Recovered 24"
Dark gray, very soft, slightly plastic SILT, some fine Sand, trace shell fragments (OL)	-37.0	Trace Shell Fragments(4'-16')
Dark gray, very soft, slightly plastic SILT, trace fine Sand, trace shell fragments (OL)	-43.0	
Olive gray, moderately dense to dense, fine to medium SAND, trace Silt (SP)	-45.0	High Amount Shell Fragments (16'-22')
Olive gray, soft, fine to medium SAND, trace Silt (SP)	-49.0	
Olive gray, loose to moderately dense, fine to medium SAND, some Silt, trace shell fragments (SM)	-55.0	Trace Shell Fragments(22'-28')
Olive gray, very soft, slightly plastic SILT, trace to little Sand (OL)		Putrid Odor (30'-TD)

TD = -75.0'

DH-3

660880

-36.3

611942

ELEVATION	DEPTH	BLOWS 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
		WOR			Dark gray SAND, little Silt, trace of Gravel (SW)	DR = Drove Rod
	1					
	2					
	3	2				
-40	4	1				
		2				
	5	2				
		DR				
	6					
	7					TD: -43.3
	8					
-45	9					
	10					
	11					
	12					
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	15					
	16					
	17					
	18					
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ANC 98-31

ANC 98-31	**659960**
-42.0	**612497**

SAMPLE NUMBER	BLOWS/6"
S1	WOR
S2	5, 6, 7, 6
S3	2, 3, 1
S4	10, 9, 2, 1
S5	WOR
S6	WOR
S7	WOR
S8	WOR
S9	WOR
S10	WOR
S11	WOR
S12	WOR
S13	WOR
S14	WOR
S15	WOR
S16	WOR
S17	WOR

ELEVATION	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
-44.0	Black, very soft, slightly plastic SILT, trace shell fragments (OL)	Trace Shell Fragments(0'-10')
-48.0	Dark gray, loose to moderately dnse, fine to medium SAND, some Silt, trace shell fragments (SM)	
-52.0	Dark gray, loose, fine to medium SAND, trace shell fragments (SP)	
-58.0	Gray, very soft, moderately plastic, Clayey SILT (OL)	
-64.0	Gray, very soft, slightly plastic SILT, trace to little Sand (OL)	
-66.0	Gray, very soft, highly plastic Silty CLAY (OH)	
-68.0	Gray to dark gray, very loose, fine to coarse SAND, little to some Silt (SM)	
-70.0	Gray, very soft, slightly plastic SILT, trace of wood fragments (OL)	
	Gray, very soft, moderately high to highly plastic, Silty CLAY, trace of wood fragments (OH)	TD = -75.0'

ELEVATION: -45, -50, -55, -60, -65, -70, -75

DEPTH: 1–49

ANC 98-32 | 659929

-54.0 | 613509

ELEVATION	DEPTH	BLOWS 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
-55	1	WOR ↓	S1		No Recovery -56.0	
	2–4	9, 10, 8, 3	S2		Dark gray, loose to moderately dense, fine SAND, some Silt, trace shell fragments (SM) -60.2	Trace Shell Fragments(2'-20')
	4–6	WOR ↓	S3			
-60	6–8	5, 6, 4, 3	S4		Gray to dark gray, loose, fine SAND, trace shell fragments (SP)	
	8–10	WOR ↓	S5			
-65	10–12	1, 1	S6			
	12–14	WOR, 2, 1, 1	S7			
	14–16	WOR, 1, 1, 1	S8			
-70	16–18	3, 1, 1	S9		-72.0	
	18–20	WOR ↓	S10		Gray, very soft, highly plastic, Silty CLAY, trace shell fragments (OL)	
-75	20–21	WOR	S11			TD = -75.0'

Depth scale: 1–49

4B-6 | 660569

-43.2 | 589415

ELEVATION	DEPTH	BLOWS 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
		WOR			Gray SILT (OL)	
-45	1					-45.0
	2	10 12			Red-brown SILT, some Clay, little to some Gravel (CL)	
	3	12 16				
	4	28 30				
	5	34 41				
-50	6	32 38				
	7	41 49				
	8					TD = -51.2
	9					
	10					
-55	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					
	21					
	22					
	23					
	24					
	25					
	26					
	27					
	28					
	29					
	30					
	31					
	32					
	33					
	34					
	35					
	36					
	37					
	38					
	39					
	40					
	41					
	42					
	43					
	44					
	45					
	46					
	47					
	48					
	49					

4B-9		661171
-34.6		589686

ELEVATION	DEPTH	BLOWS 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS	REMARKS
		0			Gray SILT (ML)	
	1	0				
		1				
	2	0				
		1				
	3	1				
		1				
	4	2				-38.6
		4			Red-brown Clayey SILT. little to some Gravel. trace Sand (ML)	
-40	5	4				
		6				
	6	6				
		6				
	7	9				
		13				
	8	17				
		12				
	9	16				
		19				
-45	10	23				
		14				
	11	23				
		29				
	12	71				
		33				
	13	65				
		58				
	14	91				
		35				
-50	15	26				
		67				
	16	70				
		42				
	17	31				
		69				
		26				TD = -52.6
	18					
	19					

4B-17

662279

-39.7

590191

ELEVATION	DEPTH	BLOWS / 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
-40		11			Red-brown CLAY, some Silt, little to some Gravel, trace of fine-medium Sand (SM)	
		10				
	1	14				
		11				
	2	9				
		9				
	3	11				
		12				
	4	20				
		20				
-45	5	20			Red-brown, fine-medium SAND, some Silt, little to some Gravel (SM)	-45.0
		20				
	6	15				
		18				
	7	20				
		20				
	8	40				
		39				
	9	57				
		79			TD = -50'	
-50	10					
	11					
	12					
	13					
	14					
-55	15					
	16					
	17					
	18					
	19					
	20					
	21					
	22					
	23					
	24					
	25					
	26					
	27					
	28					
	29					
	30					
	31					
	32					
	33					
	34					
	35					
	36					
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	40					
	41					
	42					
	43					
	44					
	45					
	46					
	47					
	48					
	49					

PA 2-485

-40.0'

662375

590294

Elevation	Depth	Sample	Classification of Materials	Remarks
-40.0 to -45.0	0–5	S1	Black, organic Silty CLAY	-45.0'
-45.0 to -50.0	5–10	S2	Red-brown, Silty CLAY, little Gravel (CL)	-50.0'
-50.0 to -58.0	10–18	S3, S4	Red-brown, fine SAND, little Silt, little Gravel (SP)	
-58.0 to -63.5	18–23.5	S5	Red-brown, fine SAND and Gravel (SP)	Glacial till -63.5'
-63.5 to -78.5	23.5–38.5	C1, C2, C3	Fractured DIABASE	C1= -63.5' to -68.5' Cut 5.0' Rec 86% 1+ Pieces RQD 10% C2= -68.5' to -73.5' Cut 5.0' Rec 88% 2+ Pieces RQD 34% C3= -73.5' to -78.5' Cut 5.0' Rec 92% 5+ Pieces RQD 85% TD= -78.5'

Drill rate (core run, depth 24–38): 10, 11, 11, 10, 11, 9, 12, 11, 10, 12, 12, 11, 10, 11

* drill rate in minutes per foot

PA 2-492

663258

-35.5

590716

S1	Brown, fine to medium SAND, little Gravel (SP)	
S2	Red-brown, Silty CLAY, some Gravel (CL)	-40.0'
S3		
S4	Red-brown, fine to medium SAND and Gravel (SP)	-50.0'
	Red-brown, decomposed SHALE, little fine to medium Sand	-53.0'
S5		
	Gray and red-brown, SHALE Boulders Sandstone layer at top	-57.0' C1= -57.0' to -62.0' Cut 5.0' Rec 34% 2 Pieces
S6	Red-brown, decomposed Rock, little fine to coarse Sand -67.0'	-62.0'
	Fractured, DIABASE	C2= -67.0' to -72.0' Cut 5.0' Rec 60% 3+ Pieces RQD 25% C3= -72.0' to -79.0' Cut 7.0' Rec 75% 5+ Pieces RQD 44% C4= -79.0' to -85.0' Cut 6.0' Rec 83% 5+ Pieces RQD 61% C5= -85.0' to -90.0' Cut 5.0' Rec 70% 4+ Pieces RQD 25% C6= -90.0' to -100' Cut 10.0' Rec 100% 12+ Pieces RQD 70%
		TD= -100.0'

NB 98-34	665150
-15.7	591781

ELEVATION	DEPTH	BLOWS 6"	SAMPLE NUMBER	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
-15.7 to -23.7	0–8	WOR	S-1, S-2, S-3, S-4	Black SILT and CLAY, very very soft, trace Sand. (MH)	Strong petrol odor
-23.7 to -28.7	8–13	3, 2, 1, 2	S-5	Gray fine SAND, trace Silt, trace Shell fragments. (SP)	-23.7
-28.7 to -43.7	13–28	3, 1, 3, 7 / 2, 4, 4, 5 / 6, 6, 8, 10	S-6, S-7, S-8	Red-brown CLAY, soft to firm, fat, highly plastic, trace Silt. (CH)	-28.7
-43.7 to -48.9	28–33	9, 19, 25, 25 / 50	S-9, S-10	Red brown SILT, fat, little Clay, trace Sand and Gravel. (MH)	-43.7
-48.9 to -64.7	33–49	RB		COBBLES and BOULDERS-SHALE, Serpentinite, Diabase and Sandstone	-48.9 CI=-49.0to-60.7' Cut 11.7' Rec 50% Cobbles and Boulders RB= Roller Bit TD= -64.7'

Elevation scale: -20, -25, -30, -35, -40, -45, -50, -55, -60, -65

Depth scale: 1–49

SNB1-05-03

666132

-48.2'

592035

Sample Number	Blows / 6"
S1A	WOR, WOR
S1B	WOR, WOR, WOR
S2	WOR, WOR, WOR, WOR
S3A	WOR, 2
S3B	42, 57
	1, 100/08
S5	10, 12, 100/.5
S6	23, 23, 24, 35
S7	100/42
S8	42, 100/25
S9	24, 100/25

Elevation	Depth	Classification of Materials (Description)	Remarks
-49'	0.8	Black SILT (OH)	-49'
-49' to -53.5'	0.8–5.3	Red-brown Silty CLAY (CL/ML)	-53.5'
-53.5' to -67.3'	5.3–19.1	Red-brown SILT, SAND, and GRAVEL TILL (GM)	Cobbles and Boulders
			TD = -67.3'

Elevation scale: -50, -55, -60, -65, -70

Depth scale: 1–23

Legend

NB 98-35

667120

-25.3'

592891

ELEVATION	DEPTH	BLOWS 6"	SAMPLE NUMBER	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	1–2	WOR	S1	Black SILT, trace Clay, trace fine Sand (MH)	Slight odor
	2–4	WOR	S2		trace Shell fragments
-30	4–6		S3		
	6–8		S4		
	8–10		S5		
-35	10–12		S6		
	12–14	0, 0, 2, 2	S7	-39.5'	
-40	14–16	0, 2, 2, 2	S8	Dark gray, fine to medium SAND, some Silt, trace fine to coarse Gravel (SM)	Shell fragments
	16–18	3, 3, 6, 11			-43.5'
	18–20	3, 3, 6, 11	S9	Gray, fine to medium SAND, trace fine Gravel, trace Silt (SP)	Shell fragments
-45	20–22	3, 3, 2, 7			-47.5'
	22–24	4, 5, 9, 8	S10	Reddish-brown fine to coarse GRAVEL, some Clay, some fine to medium Sand (GC)	Shell Fragments -49.5'
-50	24–26	8, 9, 8, 11	S13	Reddish brown CLAY, some fine to coarse Gravel, Sand (CL)	Shell Fragments Lean -51.5'
	26–28	4, 9, 21, 50/3	S14	Reddish brown fine to coarse GRAVEL, some Clay (GC)	-53.5'
-55	28–31.5			Gray-green to light green SERPENTINITE, slightly to moderately fractured -57.0'	C1:-53.5-57.0' Cut3.5', Rec2.9% RQD 68.5%
-60	32–36				

SNB1-05-14

669100

-47.7'

593305

Elevation	Depth	Blows / 6"	Sample Number	Classification of Materials (Description)	Remarks
	0–1	WOR, WOR	S1A	Black SILT (OH/OL)	
-50	1–2	WOR, WOR	S1B	Red-brown Silty CLAY (CH/CL)	-49.2'
	2–4	WOR, WOR, WOR, WOR			
	4–5	WOR, WOR	S3A		
	5–6	5, 5	S3B	Red-brown Clayey SILT, GRAVEL, and rounded Rock fragments TILL (GM/GC)	-53.6
-55	6–8	9, 6, 2, 4	S4		
	8–10	4, 4, 8, 12	S5		
-60	11–13	16, 23, 44, 100/.3	S6		
	13–15	21, 22, 48, 31	S7		
	15–16	45, 100/.5	S8	SANDSTONE	TOR = -63.3'
-65	16–17	4			Cut 5.3', Rec 3.8'
	17–18	3			RQD 72%
	18–19	2			FPF 4+,3,4,2,3
	19–20	2			LCS .4,.9,1.65
	20–21	3			
-70					TD = -69.5'
-75					

Depth scale: 1–36; Elevation scale: -50, -55, -60, -65, -70, -75

NBN-01-SFI-3

670672

-7.5'

594251

Elevation	Depth	Blows / 6"	Sample Number
	0–2	WOR, WOR, WOR, WOR	S1
-10	2–4	WOR, WOR, WOR, WOR	S2
	4–6		U T
-15	6–8	WOR, WOR, WOR, WOR	S4
	8–10	WOR, WOR, [illegible], 14	S5
	11–12		U T
-20	12–14	29, 39, 10, 9	S7
	14–16	3, 6, 7, 7	S8
-25	17–19	4, 6, 4, 5	S9
	21–22	4	
-30	22–23	4.5	
	23–24	3.25	
	24–25	4	
	25–26	4	
	26–27	9.25	
-35	27–28	2	
	28–29	10.5	
	29–30	7	
	30–31	3	
	31–32	4	
-40	32	2.5	

Depth scale: 1–35. Elevation scale: -10, -15, -20, -25, -30, -35, -40.

Classification of Materials (Description)	Remarks
Black SILT (OH)	
Gray, SILT and SAND (SM)	
Red-brown, Clayey SILT (CL)	
Red-brown, SAND and GRAVEL with trace Silt (GM)	
Gray, SANDSTONE	TOR = -28.5' C1:-28.5' to-35.1' Cut 6.6', Rec 5.8' RQD 70% C2:-35.1' to-35.9' Cut0.8', Rec0.3' RQD 70% C3:-35.9' to-39.5' Cut3.7', Rec3.7' RQD 70%
	TD = -39.5'

NB 98-36

670741

-11.5'

594176

ELEVATION	DEPTH	BLOWS 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0–2	WOR	S1		Gray, medium to coarse SAND, some Silt and Clay, trace fine to coarse Gravel (SM)	-13.5'
	2–4	0, 2, 4, 6	S2		Reddish brown CLAY, trace to little fine to coarse, rounded Gravel (CH)	
	4–6	9, 10, 11, 12	S3			
	6–8	4, 7, 8, 9	S4			
	8–10	4, 10, 13, 10	S5			
	10–12	3, 9, 13, 50/.1	S6		-23.3'	
	12–17		C1		Light-gray, fine to medium grain Hornblende DIORITE, slightly weathered, very hard, moderate to highly fractured w/iron stain and Clay along fractures -28.2'	C1:-23.3'-28.2' Cut4.9',Rec4.9' RQD 43%
	17–19		C2		Black to green, Hornblende SERPENTINITE, medium to coarse grain, hard, moderate to highly weathered, intensely fractured	C2:-28.2'-30.5' Cut2.7',Rec2.7' RQD 42.9% TD=-30.5'

Elevation scale: -15, -20, -25, -30, -35

Depth scale: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39

DEPTH	USCS	% G	% S	% F	LL	PL	PI	$\%H_2O$	SG
8.0-10.0	CL	1.7	17.2	81.1	33	17	16		2.83

NBN-01-SFI-2 | 670866

-6.4' | 594403

ELEVATION	DEPTH	BLOWS 6"	SAMPLE NUMBER	CLASSIFICATION OF MATERIALS (Description)	REMARKS
	0–2	WOR, WOR, WOR, WOR	S1	Black SILT (OH)	
-10	2–4	WOR, WOR, WOR, WOR	S2		
	4–6		UT	Gray, SAND and SILT (SM)	Shelby Tube 2.0
	6–8	WOR, WOR, WOR, WOR	S4		
-15	8–10	WOR, WOR, WOR, WOR	S5		
	10–12	WOR, WOR, 18, 25	S6	Gray, GRAVEL and SAND (SM)	
-20	12–14	23, 17, 17, 20	S7	Brown, SAND (SM)	
	14–16	15, 17, 19, 14	S8		
	16–17		UT	Red-brown, Clayey SILT (CL)	Shelby Tube 1.1'
-25	17–19	10, 10, 18, 17	S10		
	19–21	15, 21, 23, 23	S11		
	21–23	9, 11, 16, 18	S12		
-30	23–25	20, 26, 32, 36	S13		
	25–27	11, 10, 12, 12	S14		
-35	27–29	26, 32, 37, 14	S15	Red-brown, SAND and GRAVEL trace Silt (GM)	
	29–31	2, 10, 14, 17	S16		
-40	31–37	6.5, 4.3, 7, 5.5, 5.3, 4.5	C1	Light-gray, SANDSTONE	TOR = -37.6' C1: -37.6' to -43.2' Cut 6.2', Rec 6.2' RQD 83%
	37–38	5	C2	TD = -44.2'	C2: -43.2' to -44.2' Cut 1', Rec 0.3'
-45	38–40				

PA 2-486

PA 2-486	662291
-16.5'	590468

	Black, organic Silty CLAY	
	Red-brown, Silty CLAY, little Gravel (CL)	-35.0'
-48.0'	Red-brown, SAND, little to some Silt, trace Gravel (SP)	Sample saved in jar only
	Red-brown, Silty CLAY, some Gravel (GC)	-50.0'
	Red-brown, fine SAND, little Gravel (SP)	-55.0' Decomposed Shale
-58.5'	DIABASE	C1= -58.5' to -62.5' Cut 4.0' Rec 85% 3+ Pieces RQD 58%
	Light-gray SANDSTONE	
	DIABASE	C2= -62.5' to -72.5' Cut 10.0' Rec 100% 11+ Pieces RQD 89%
		C3= -72.5' to -77.5' Cut 5.0' Rec 82% 6 Pieces RQD 78%
		C4= -77.5' to -82.5' Cut 5.0' Rec 95% 7+ Pieces RQD 60%
		C5= -82.5' to -90.0' Cut 7.5' Rec 100% 8+ Pieces RQD 65%
	* drill rate in minutes per foot	TD= -90.0'

PA 2-438	671364
-29.5'	594315

ELEVATION	DEPTH	BLOWS 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
-30	1	WOR WOR WOR	S1		Black, Silty CLAY and SAND (SC)	
	2					
	3	WOR WOR WOR	S2			
	4				-34.5'	
	5					
-35	6	WOR WOR WOR	S3		Red-brown, Silty CLAY, little fine Sand (CL)	
	7					
	8					
	9	4 5 9	S4			
	10					
-40	11					
	12	4 6 10	S5			
	13					
.3' →	14					
	15	5 6 5	S6			
	16					
-45	17		U			
	18		T			Shelby Tube
	19					
	20	6 5 8	S8			
	21					
	22		U			
-50	23		T			Shelby Tube
	24				-54.0'	
	25	5 8 8	S 10		Red-brown, Clayey SILT (ML)	
	26					
	27					
-55	28	6 7 8	S 11			
	29				-59.0'	
	30	1 4 5	S 12		Red-brown, Silty CLAY, trace Gravel (CL)	
	31					
	32					
	33					
-60	34				-64.0'	
	35	3 8 12	S 13		Red-brown, Clayey SILT (ML)	
	36					
	37					
	38					
	39					
-65	40	17 11 16	S 14			
	41					
	42					
	43					
	44					
-70	45					
	46	75/0			Seamy, fractured SANDSTONE	C1:-70.5' to-75.5' Cut 5' Rec 50% 4+ pieces
	47					
	48					
	49					
	50					
-75	51					C2:-7.5' to-80.0' Cut 4.5' Rec 66% 4+ pieces
	52					
	53					
	54					
	55					
-80	56					TD =-80.0'
	57					

PA 2-450	672032
-37.5	214838

ELEVATION	DEPTH	BLOWS 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
-37.5 to -85.0	0–47.5				Black to red-brown silty CLAY, trace to some Gravel (CL)	
-85.0 to -90.0	47.5–52.5				Red SHALE	-85.0

ELEVATION: -40, -45, -50, -55, -60, -65, -70, -75, -80, -85, -90, -95

DEPTH: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59

PA 2-443 | 672220

-33.5 | 594590

ELEVATION	DEPTH	BLOWS 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
-35	1	WOR WOR WOR	S1		Black-red brown silty CLAY,	
	2	WOR WOR WOR	S2		little Gravel (CL)	
	3					
	4					
	5	WOR WOR WOR	S3			
-40	6					
	7	WOR WOR 10	S4			
	8					
	9	2 3 2	S5			
	10					
-45	11					
	12	10 12 25	S6			
	13					
	14	13 14 17	S7			
	15					
-50	16					
	17	5 6 9	S8			
	18					
	19					
	20	PH PH PH	9U			
-55	21	10 11 25	S10			
	22					
	23	12 14 21	S11			
	24					
	25					
-60	26	PH PH PH PH	12U			
	27					
	28	8 21 23	S13			
	29					
	30					
-65	31					
	32	1 5 7	S14			
	33					
	34					C1 83 - 85
	35					CUT 2 REC 50%
-70	36	4 4 6	S15			1 PIECE
	37					
	38					
	39					C2 85 - 88
	40					CUT 3 REC 83%
-75	41					6 PIECES
	42	3 3 5	S16			
	43					
	44					C3 88 - 93
	45					CUT 5 REC 20%
-80	46					1 PIECE
	47	10 14 20	S17			
	48					
	49	98*				-83.0
	50				Red SHALE	* 300 LBS HAMMER,
	51					50/0
-85	52					
	53					
	54					
	55					
-90	56					
	57					
	58					
	59					
	60					
	61					

SE 01-04

664834

-37.8

589406

ELEVATION	DEPTH	BLOWS/FT	SAMPLE NUMBER
		WOR	S1
	1	WOR	S1
		WOR	S1
-40	2	WOR	S2
		WOR	S2
	3	WOR	S2
		WOR	S3
	4	WOR	S3
	5	2 / 50	S3
	6	33 / 100	S4
-45	7	2.5	
	8	7.5	
	9	24	
	10	12	
	11	8	
-50	12	7.5	
	13	9	
	14	10	
	15	8.75	
	16	8	
-55	17		
	18		
	19		
	20		
	21		
-60	22		
	23		
	24		

CLASSIFICATION OF MATERIALS (Description)

Black, Silt / Ooze (OL)

-42.8 Red-brown, Sand (~~SM~~) CL

-44.7 Gray, Sandstone

TD= -54.0'

ELEV.	USCS	%G	%S	%F	LL	PL	PI	%H2O	SG
-40.8'	OH		33	67				80	

UC: 7,400psi @ -52.45 to-53.2'

REMARKS

Strong Petrol Odor

Clay layer at top

C1= -44.8' to -48.5'
Cut 3.7' Rec 1.3'
RQD 0%

C2= -48.5' to -54.0'
Cut 5.5' Rec 5.45'
RQD 66%

DH 2-038

664358

-7.0

589491

ELEVATION	DEPTH	BLOWS/FT	SAMPLE NUMBER	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	1	WOH		ORGANIC SILT (OL)	
				-8.50	
	2			ORGANIC SILT, some Sand (OL)	
-10	3				
	4				
	5	WOH			
	6			-13.0	
	6			SAND (SP)	
	7				
-15	8				
	9				
	10	29			
	11				
	12			-19.0	
	12			Clayey SILT (ML)	
-20	13				
	14				
	15	21			
	16				
	17				
-25	18			-25.0	
	18			Silty CLAY (CL)	
	19				
	20	14			
	21				
	22				
-30	23				
	24				
	25	8			
	26				
	27				
-35	28				
	29			-36.0	
	29			SILT and CLAY (CL-ML)	
	30	4			
	31				
	32				
-40	33			-40.5	
	34			GRAVEL and CLAY (CL-ML) GC	
	35	38			
	36				
	37				
-45	38				
	39				
	40	40			
	41			TD = -48'	
	42				
-50	43				
	44				
	45				
	46				
	47				
	48				
	49				

PA 2-488

663083

−45.0'

589528

Elevation	Description	Remarks
−45.0' to −50.0'	Red-brown, CLAY and SILT, trace fine Sand (ML-CL)	−50.0'
−50.0' to −58.0'	Red-brown, Silty CLAY, little Gravel (CL)	−58.0'
−58.0' to −63.0'	Gray, SAND and little to some Silt (SP)	−63.0'
−63.0' to −90.0'	Gray, SANDSTONE	C1= −63.0' to −66.0' Cut 3.0' Rec 75% 2+ Pieces RQD 22% C2= −66.0' to −76.0' Cut 10.0' Rec 88% 6+ Pieces RQD 71% C3= −76.0' to −86.0' Cut 10.0' Rec 100% 5+ Pieces RQD 91% C4= −86.0' to −90.0' Cut 4.0' Rec 97% 6+ Pieces RQD 84% TD= −90.0'

* Drill rate in minutes per foot

PA 2-479	662869
-2.5'	589198

Elevation	Classification	Remarks
-5.0	Red-brown, Silty CLAY, little Gravel (CL)	shell fragments
-10.0	Gray, fine to medium SAND, little SILT (SM)	-7.5' shell fragments
-15.0	Red-brown, Silty CLAY (CL)	-15.0' varved
-20.0	NR No Recovery	-22.0'
-25.0 to -40.0	Red-brown, Silty CLAY, little Gravel (CL)	
-45.0	Decomposed SHALE	
-50.0	Brown fine to medium SAND and Gravel	
-55.0	Red-brown decomposed SHALE, little fine SAND	
-60.0	Black/gray Silty CLAY, decomposed Shale	-61.0' (Refusal)
	Gray SHALE and Sandstone	Boulders & Cobbles -64.0'
-65.0	NR No Recovery	-65.0' (Refusal)
-70.0 to -80.0	Gray SANDSTONE	C1= -65.0' to -69.0 Cut 4.0' Rec 80% 34 Pieces RQD 56% C2= -69.0' to -75.0 Cut 6.0' Rec 100% 34 Pieces RQD 32% C3= -75.0' to -80.0 Cut 5.0' Rec 98% 34 Pieces RQD 82%
-80.0		TD= -80.0'

NB-3	662595
-36.0'	589258

ELEVATION	DEPTH	SAMPLE NUMBER	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc. if significant)
	1–2	S1	Black, organic SILT and fine SAND, little Shell fragments (OL)	
-40	3–7	S2	Brown, SILT, some Gravel, little fine Sand (ML)	-38.5'
-45	8–10	S3	Reddish-brown, GRAVEL, some Silt, little fine Sand (GP)	-43.0'
-50	11–15		Gray, medium to fine grained Quartz SANDSTONE	-47.0' C1= -47.0' to -52.0' Cut 5', Rec 80% RQD = 73%
	16–19		TD= -52.0'	

ELEV.	USCS	%G	%S	%F	LL	PL	PI	%H2O	SG
44-46	GM	65	20	15				10.7	2.58

NBS 98-31 | 662530

-2.4 | 588974

ELEVATION	DEPTH	BLOWS 6"	SAMPLE NUMBER	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc. if significant)
	1–2	WOR, WOR, WOR, WOR, 2	S-1	Black, very soft SILT (ML)	No Recovery
-5	2–7	2, 2	S-2, S-3	Gray, fine to medium SAND, some Clay, trace to little Shell fragments (SC).	-4.40 Trace Shell fragments
-10	7–12	2	S-4	Gray, medium to coarse SAND, (predominantly shell fragments) trace Clay (SP)	-9.40 Sand-sized materials mostly Shell fragments
-15	12–17	8, 7, 10, 14	S-5	Reddish-brown, fine to medium SAND, trace gravel-size quartz pebbles, trace Clay (SP).	-14.4 -15.9
-20	17–20	8, 12, 14, 23	S-6	Red-brown CLAY, soft, plastic, some Silt. (CH)	-19.4 Firm to stiff
	20–22			Red-brown CLAY, some Silt trace gravel-sized rock fragments. (CH)	
-25	22–24	3, 6, 6, 8	S-7		-24.4 Firm
-30	24–32	4, 11, 18, 20	S-8	Red brown CLAY, firm, highly plastic, trace to little Silt trace gravel (CH).	
-35	32–39	22, 33, 44, 46	S-9	Red-brown SILT and CLAY, stiff to hard, medium plasticity, trace Sand and Gravel. (CH-MH)	-34.4 Stiff to hard
-40	37–38	26, 50/	S-10		
	39–43			COBBLES and BOULDERS.	-41.1
-45, -50	43–51			COBBLES of GRANITE, SHALE and CHERT	-45.6 C1=-38.8to-39.9 COBBLES & BOULDERS C2=-39.8to-48.0 COBBLES & BOULDERS
-55	51–53			TAN, Fine-grained SANDSTONE	-53.2 C3=-48.0to-55.8 RQD=75% TD=-55.8'
	54–57				

KVK 3-9

662211

588957

Elevation: -17.6

ELEVATION	DEPTH	CLASSIFICATION OF MATERIALS	REMARKS
-17.6 to -30.6	0–13	Red-brown, Silty CLAY and GRAVEL, trace Sand (CH-GM)	
-30.6 to -32.6	13–15	Red-brown Clayey SILT, trace Sand (ML)	-30.6
-32.6 to -46.6	15–29	Red-brown Clayey SILT and GRAVEL, some Sand (MH-GM)	-32.6
-46.6 to -51.6	29–34	Gray, fractured SANDSTONE.	-46.6 C1 46.6 - 51.6 Cut 5′ Rec 3′
			TD = -51.6

BLOWS 6": 4, 10, 8, 8, 25, 15, 23, 100, 100, 16, 16, 18, 24, 6, 6, 13, 17, 5, 9, 15, 22, 12, 19, 27, 34, 23, 39, 71, 105, 117, 100, 30, 76, 55, 79, 79, 100, 88, 100, 53, 108, 97, 100, 87, 83, 92, 100, 100

Elevation scale: -20, -25, -30, -35, -40, -45, -50

Depth scale: 1–35

Column headings: ELEVATION, DEPTH, BLOWS 6", SAMPLE NUMBER, LEGEND, CLASSIFICATION OF MATERIALS, REMARKS

NB-1

NB-1	662037
-10.0	588710

ELEVATION	DEPTH	BLOWS 6"	SAMPLE NUMBER	CLASSIFICATION OF MATERIALS	REMARKS
	1	WOR	S1	Dark gray, Organic SILT, little fine Sand, some Shell Fragments (OL)	
	2				
	3				
	4			Brown SILT, little fine Sand, trace fine Gravel (ML)	-13.5
-15	5	7			
	6	10 16 27	S2		
	7				
	8				
	9				
-20	10	15		Red-brown, Clayey SILT, little to fine Sand, some Rock Fragments (ML)	-19.0
	11	9 10 13	S3		
	12				
	13				
	14				
-25	15	21			
	16	22 29 23	S4		
	17				
	18				
	19				
-30	20	28			
	21	37 74 100	S5		
	22				
	23				
	24			Red-brown SILTand fine to medium GRAVEL, little Sand (ML)	-33.5
-35	25	75 100	S6		
	26				
	27				
	28				
	29				
-40	30	100	S7		
	31				
	32				
	33				
	34			Green-gray coarse to fine quartz SANDSTONE	-43.5
-45	35				
	36				
	37				
	38				TD = -48.3
	39				
	40				
	41				
	42				
	43				
	44				
	45				
	46				
	47				
	48				
	49				

ELEV.	USCS	% G	% S	% F	LL	PL	PI	% H2O	SG
20.0-22.0	SM	6	82	12				29.7	2.56

KVK 3-12

661750

-21.0

588598

ELEVATION	DEPTH	BLOWS 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS	REMARKS
-21.0 to -35.2	0–14.2	5, 9, 13, 16, 9, 17, 24, 24, 17, 29, 41, 67, 20, 25, 35, 49, 17, 25, 39, 51, 37, 35, 79, 29, 29, 41, 41, 67, 100			Red-brown Silty CLAY and GRAVEL. some Sand. trace BOULDERS (CL)	Glacial till
-35.2 to -38.0	14.2–17.0	105	C1		BOULDERS	-35.2 C1 35.2-38.0' CUT 2.8' REC. 0.8' -38.0
-38.0 to -45.7	17.0–24.7	135, 47*, 35*, 98, 54, 73, 70, 63, 88, 85, 73, 100, 20*			Red-brown Silty CLAY and GRAVEL. some Sand. trace BOULDERS (CL)	* 300 lbs hammer
-45.7 to -50.8	24.7–29.8		C2		Gray, fractured SANDSTONE.	-45.7 C2 45.8-50.8' CUT 5.0' REC. 2.3' TD = -50.8

Elevation scale: -25, -30, -35, -40, -45, -50

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30

4B-5	661479
-38.3	588287

ELEVATION	DEPTH	BLOWS 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS (Description)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
		RB			Rock fragments and GRAVEL (GP)	-38.4
	1					RB = Roller Bit
-40	2				Weathered Sandstone Bedrock	-40.0
	3					
	4				Light green SANDSTONE	
	5					
	6					
-45	7					TD = -45.0
	8					
	9					
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					
	21					
	22					
	23					
	24					
	25					
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	29					
	30					
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	32					
	33					
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	36					
	37					
	38					
	39					
	40					
	41					
	42					
	43					
	44					
	45					
	46					
	47					
	48					
	49					

KVK 3-20

661162

-31.4

588096

ELEVATION	DEPTH	BLOWS 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS	REMARKS
-35 -40	1 2 3 4 5 6 7 8 9 10 11	13 22 9 11 13 17 13 16 45 29 100			Red-brown Clayey SILT. some Gravel. little Sand (ML)	
					SANDSTONE	-36.8 C1 36.8-41.8′ CUT 5.0′ REC. 2.0′ TD = -41.8′

KVK 3-19

661057

-33.0

587986

ELEVATION	DEPTH	BLOWS / 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS	REMARKS
-35	1, 2, 3, 4, 5, 6	1, 4, 13, 33, 108, 55*, 48, 100, 28*, 23*, 68, 103, 28*, 20*			Red-brown Clayey SILT. some Gravel. little Sand (ML)	* 300 lbs hammer
-40	7	100				
	8, 9, 10				SANDSTONE	-40.4 C1 40.4-43.4' Cut 3.0' Rec 3.0' TD = -43.4
	11					

4B-36

660880

-38.3

587812

ELEVATION	DEPTH	BLOWS 6"	SAMPLE NUMBER	LEGEND	CLASSIFICATION OF MATERIALS	REMARKS
-40	1–4	WOR, 90, 100			Red-brown SAND. some COBBLES (SP)	
-45	5–9				SAND and COBBLES	C1 43.3-48.3′ Cut 5.0′ Rec 1.3′
-50	10–14				Light-green SANDSTONE	-48.3 C2 48.3-53.3′ Cut 5.0′ Rec 3.5′
	15–19					TD = -53.3′

B4-84 | 660915

-6.1 | 587373

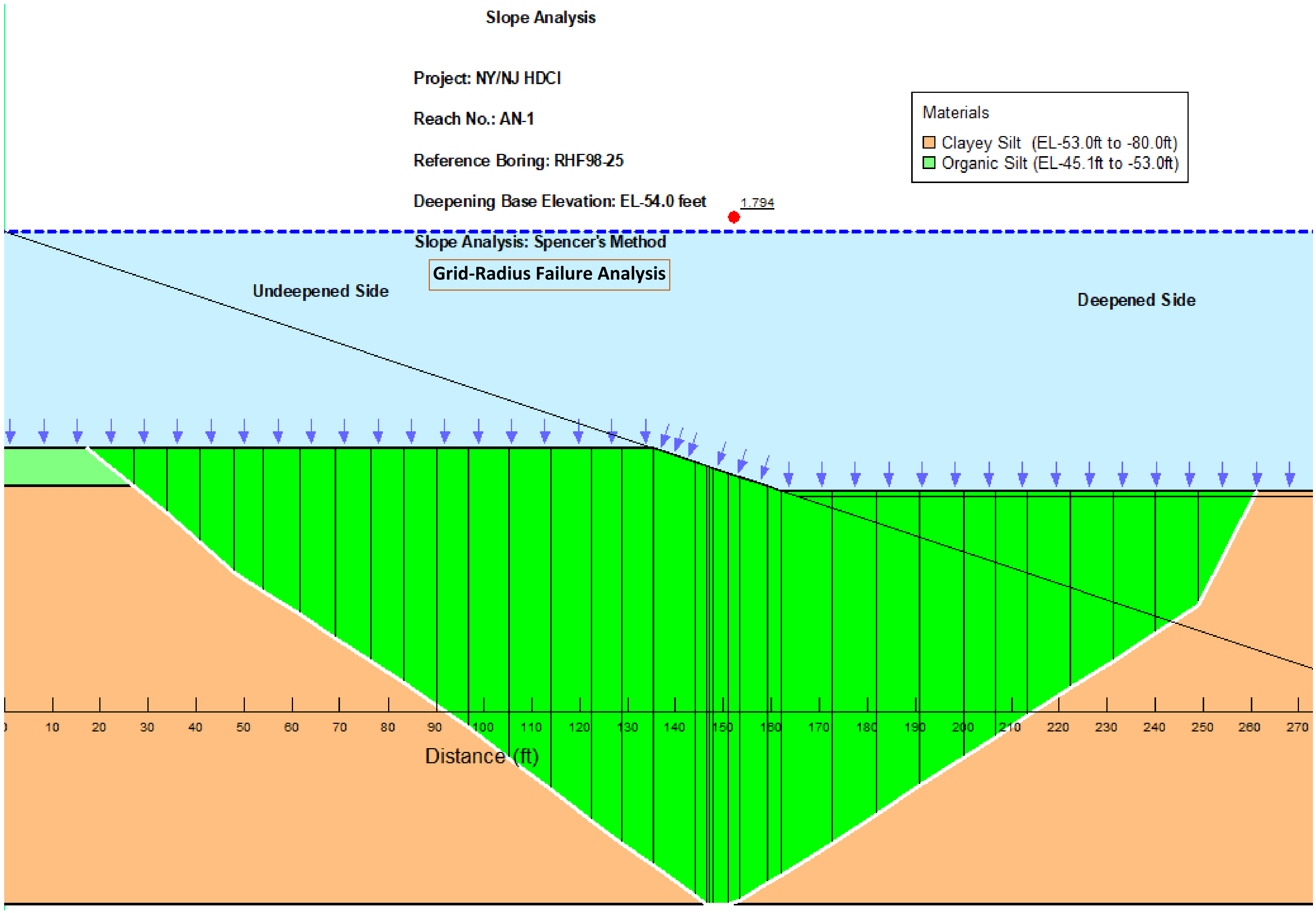
ELEVATION	DEPTH	CLASSIFICATION OF MATERIALS (Description)	REMARKS
	1–10	Black, organic, Silty CLAY trace fine Sand (OH)	
-16.1'	11–14	Gray, organic, Silty CLAY some fine Sand, trace Gravel (OH)	
-20.1' / -21.1'	15–16	Gray, fine to medium SAND some Silt (SM)	
-23.1'	17–19	Gray, organic SILT, some Sand (OL)	
	20–25	Gray-brown, fine to coarse SAND, some Silt, trace Gravel (SM)	
-31.6'	26–37	Red-brown GRAVEL and SAND, trace Silt and Clay (SM-GM)	
-43.1'	38–43	Red-brown, broken SHALE and gray SANDSTONE	C1-43.1' to -48.1' Cut 5', Rec 67% RQD = 26% C2-48.1' to -49.1' Cut 1', Rec 1' RQD = 100%
		TD = -49.1'	

Elevation scale: -10.0, -15.0, -20.0, -25.0, -30.0, -35.0, -40.0, -45.0, -50.0

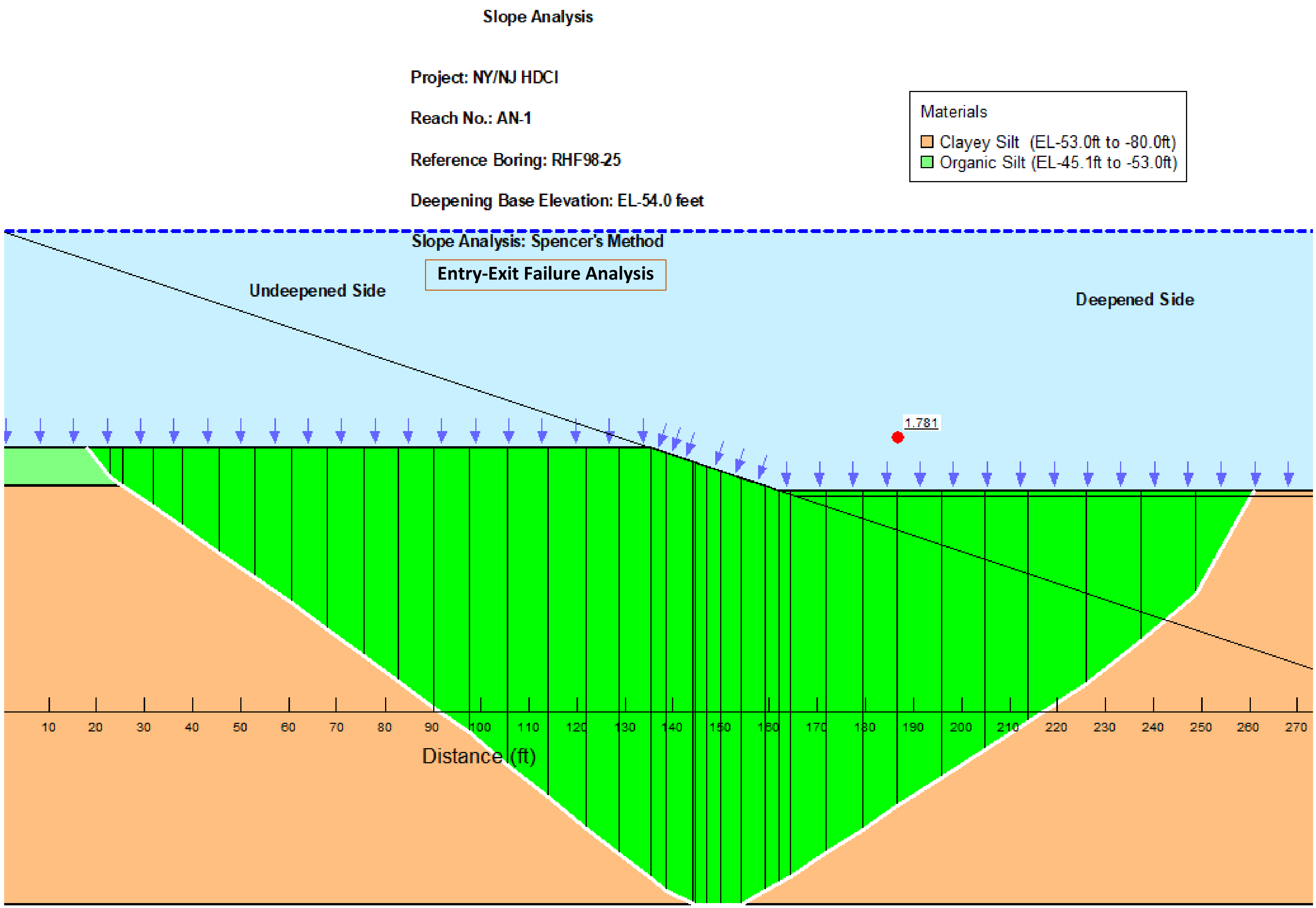
Depth scale: 1–49

Attachment #3
Slope Analyses

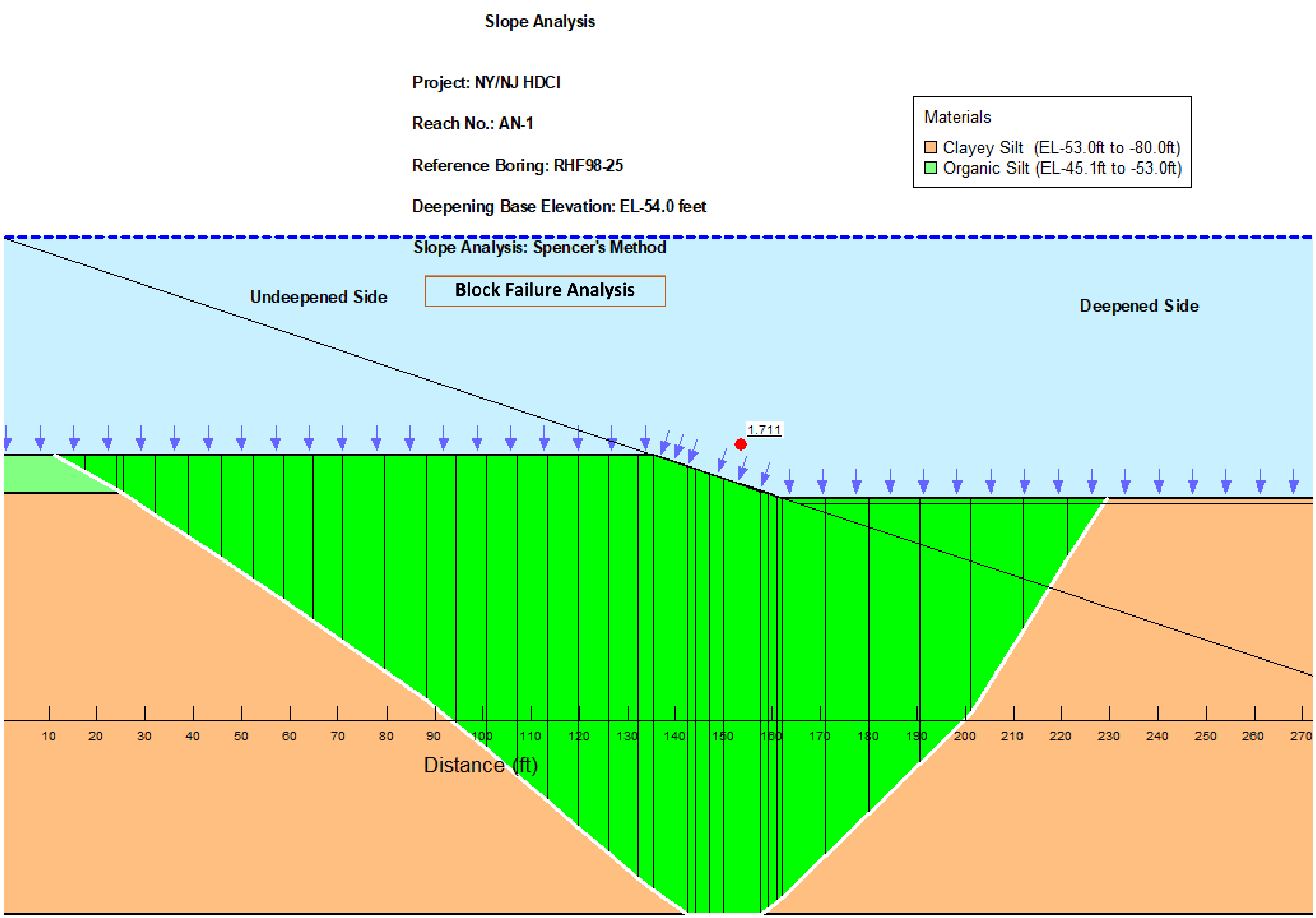
Designed by:	JK	Date:	01 Oct., 2020
Checked by:		Date:	

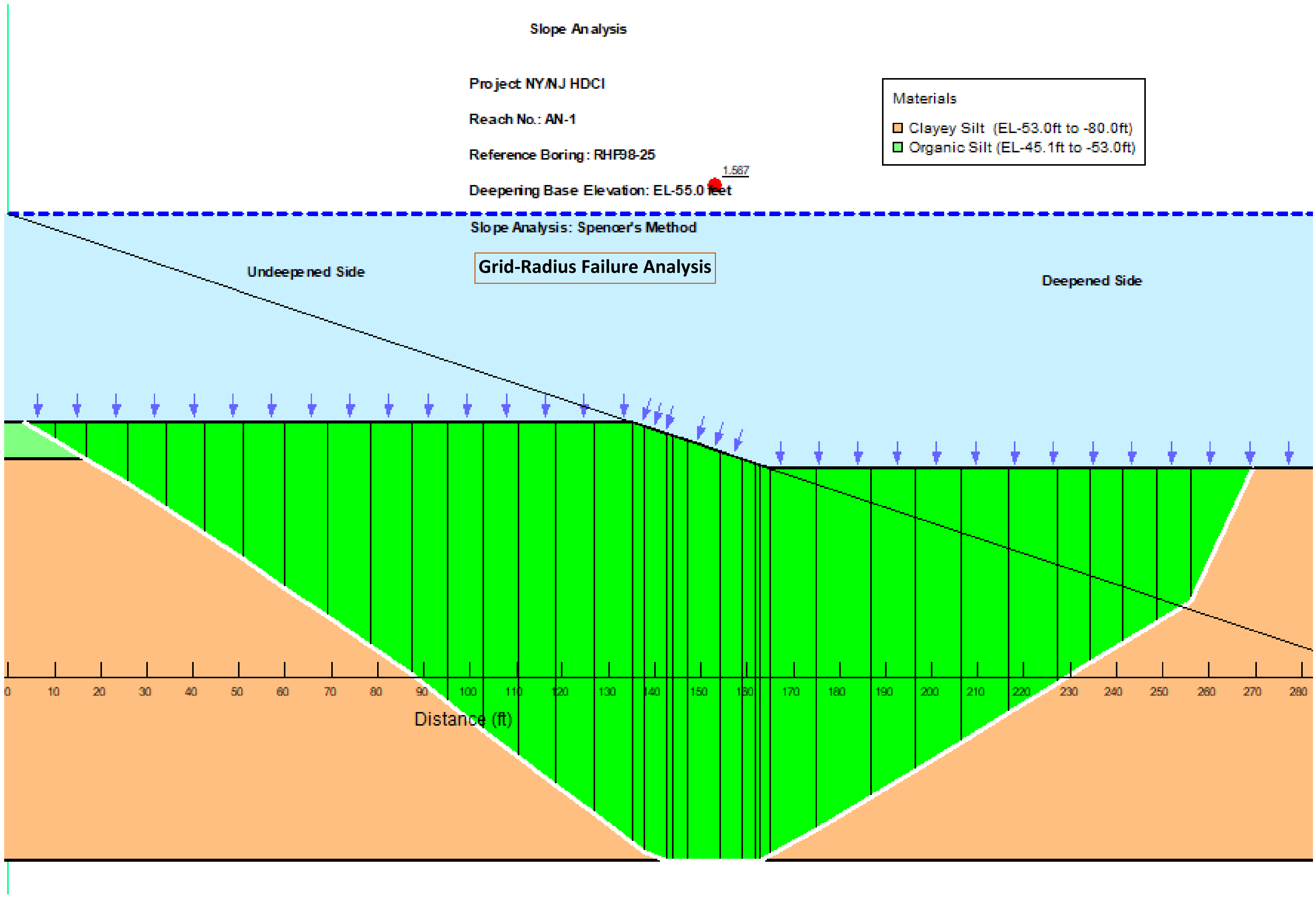


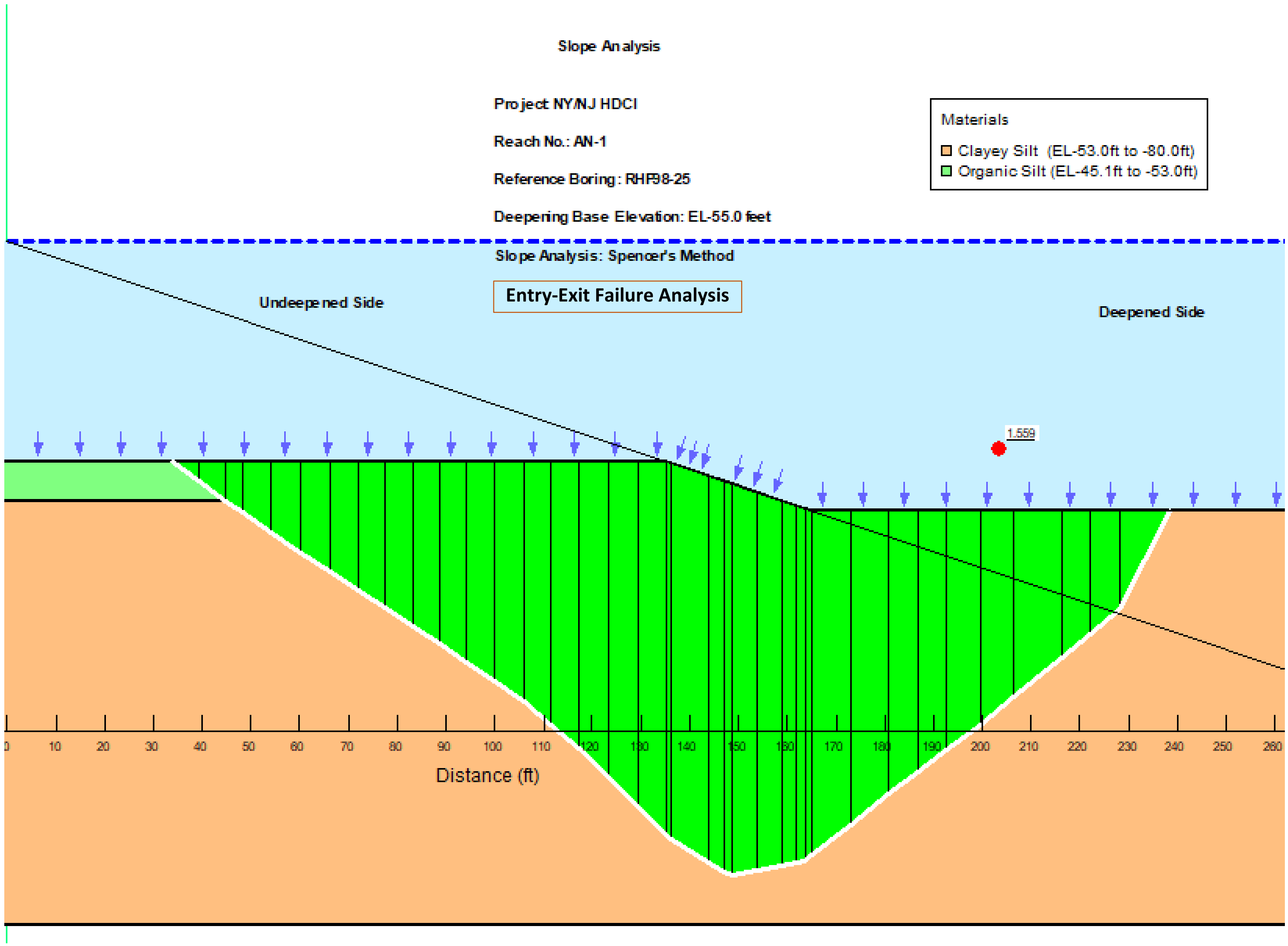
Slope Analysis
Project: NY/NJ HDCI
Reach No.: AN-1
Reference Boring: RHF98-25
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Grid-Radius Failure Analysis
1.794
Materials
Clayey Silt (EL-53.0ft to -80.0ft)
Organic Silt (EL-45.1ft to -53.0ft)
Undeepened Side
Deepened Side
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270
Distance (ft)



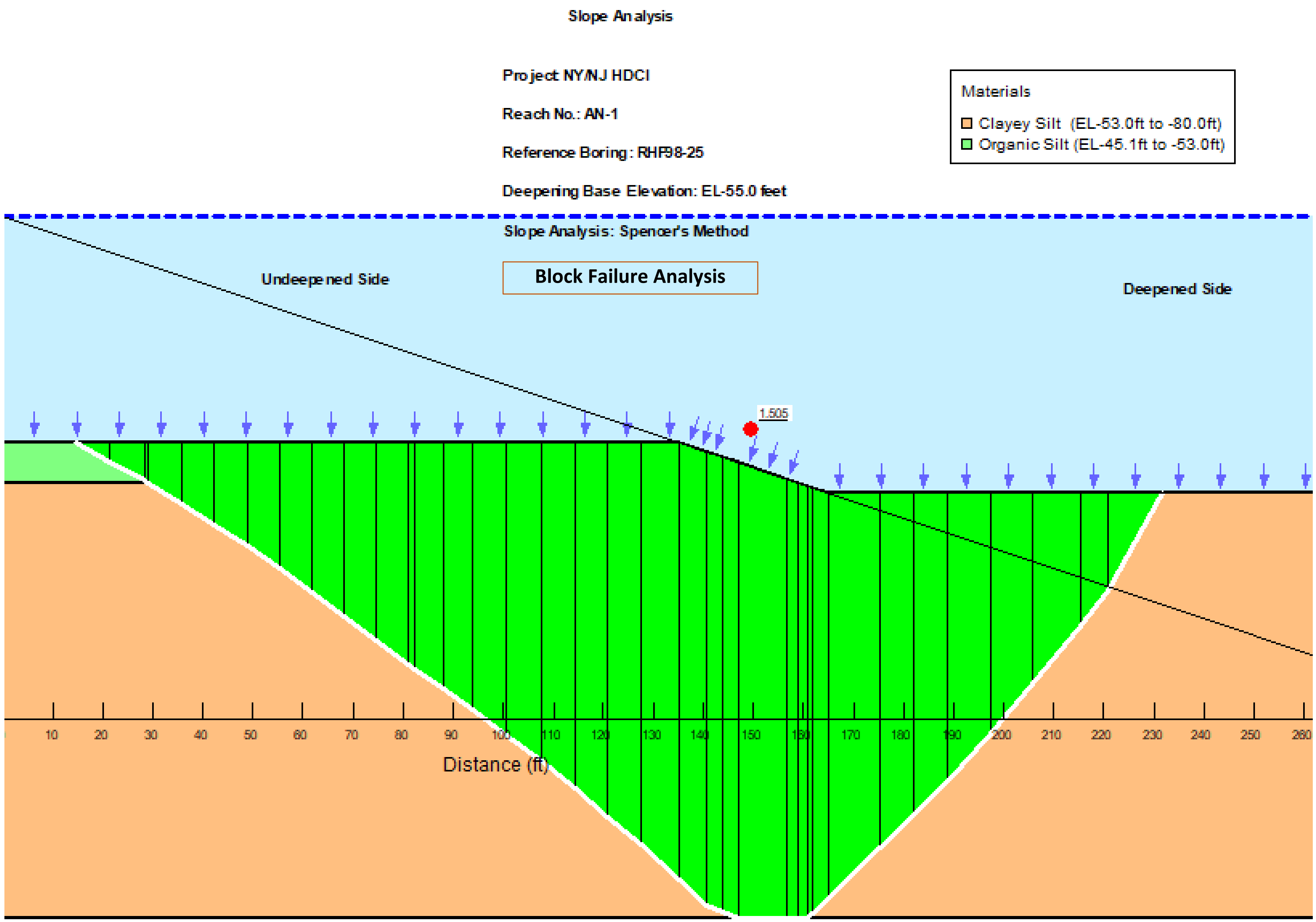
Slope Analysis
Project: NY/NJ HDCI
Reach No.: AN-1
Reference Boring: RHF98-25
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Entry-Exit Failure Analysis
Materials
Clayey Silt (EL-53.0ft to -80.0ft)
Organic Silt (EL-45.1ft to -53.0ft)
Undeepened Side
Deepened Side
1.781
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270
Distance (ft)


Slope Analysis
Project: NY/NJ HDCI
Reach No.: AN-1
Reference Boring: RHF98-25
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Block Failure Analysis
Undeepened Side
Deepened Side
Materials
Clayey Silt (EL-53.0ft to -80.0ft)
Organic Silt (EL-45.1ft to -53.0ft)
1.711
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270
Distance (ft)

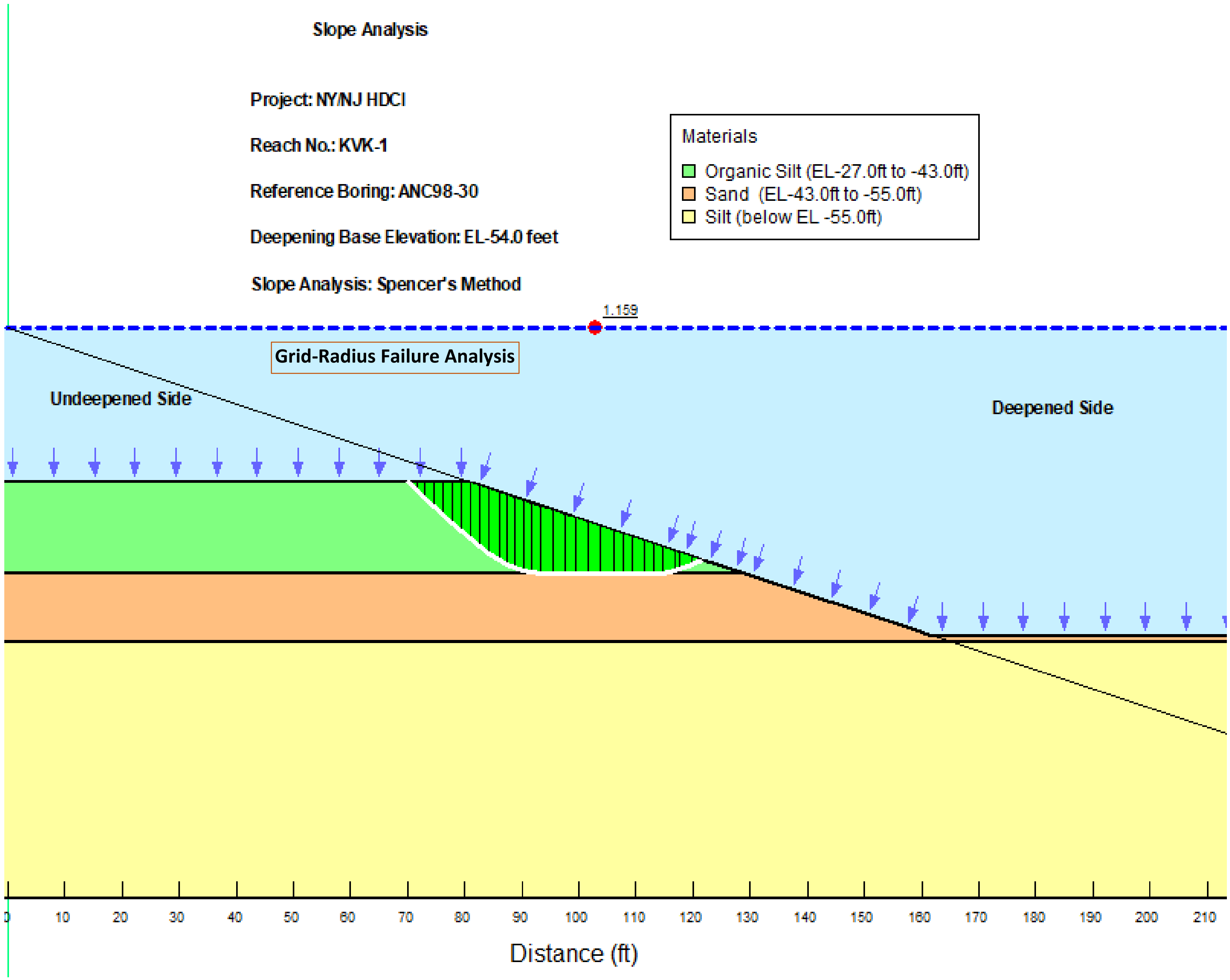

Slope Analysis
Project NY/NJ HDCI
Reach No.: AN-1
Reference Boring: RHF98-25
Deepening Base Elevation: EL-55.0 feet
1.567
Slope Analysis: Spencer's Method
Grid-Radius Failure Analysis
Materials
Clayey Silt (EL-53.0ft to -80.0ft)
Organic Silt (EL-45.1ft to -53.0ft)
Undeepened Side
Deepened Side
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280
Distance (ft)



Slope Analysis
Project NY/NJ HDCI
Reach No.: AN-1
Reference Boring: RHF98-25
Deepening Base Elevation: EL-55.0 feet
Slope Analysis: Spencer's Method
Entry-Exit Failure Analysis
Materials
Clayey Silt (EL-53.0ft to -80.0ft)
Organic Silt (EL-45.1ft to -53.0ft)
Undeepened Side
Deepened Side
1.559
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260
Distance (ft)



Slope Analysis
Project NY/NJ HDCI
Reach No.: AN-1
Reference Boring: RHF98-25
Deepening Base Elevation: EL-55.0 feet
Slope Analysis: Spencer's Method
Block Failure Analysis
Materials
Clayey Silt (EL-53.0ft to -80.0ft)
Organic Silt (EL-45.1ft to -53.0ft)
Undeepened Side
Deepened Side
1.505
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260
Distance (ft)



Slope Analysis
Project: NY/NJ HDCI
Reach No.: KVK-1
Reference Boring: ANC98-30
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Materials
Organic Silt (EL-27.0ft to -43.0ft)
Sand (EL-43.0ft to -55.0ft)
Silt (below EL -55.0ft)
1.159
Grid-Radius Failure Analysis
Undeepened Side
Deepened Side
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
Distance (ft)

Slope Analysis

Project: NY/NJ HDCI

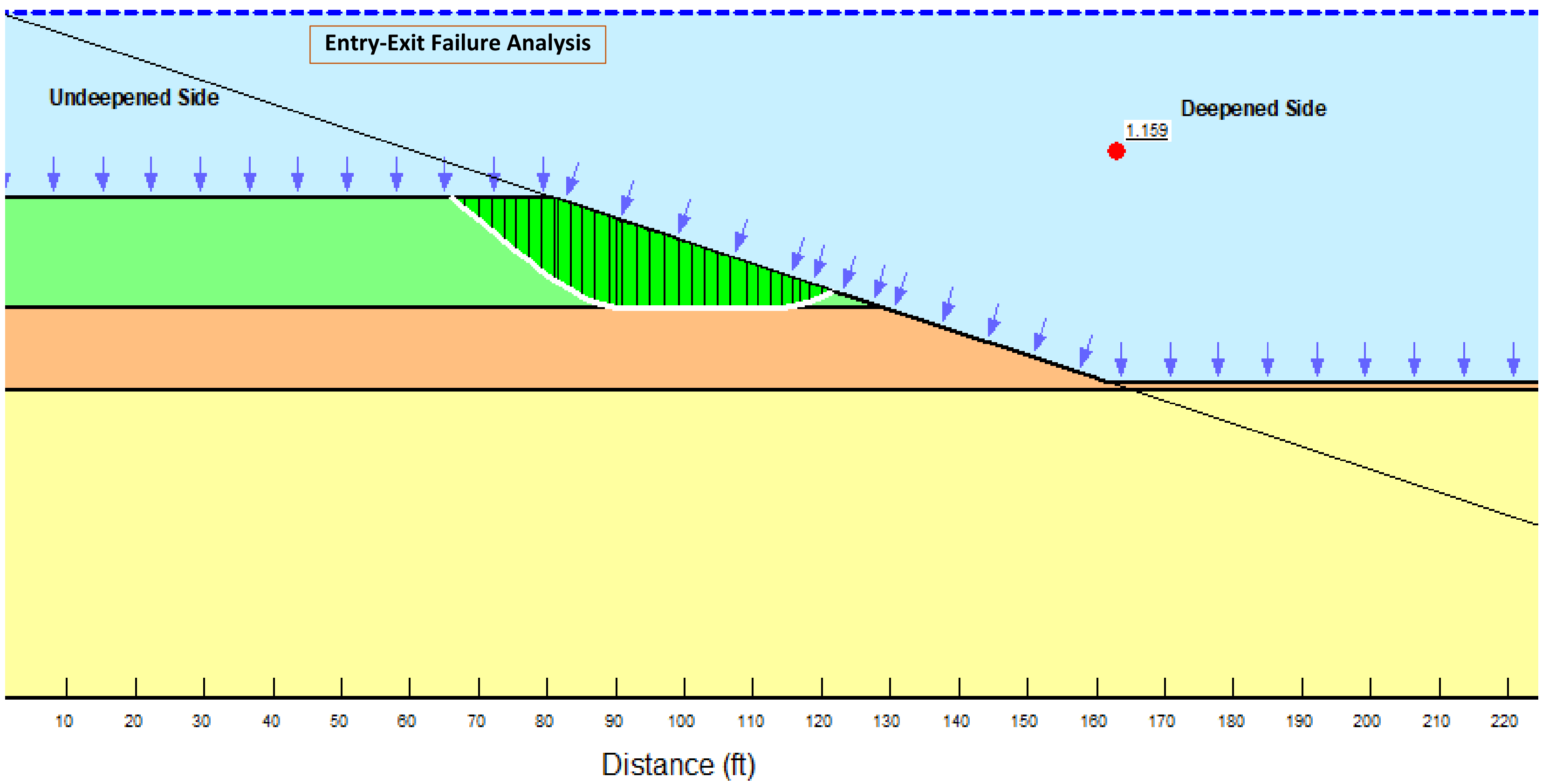
Reach No.: KVK-1

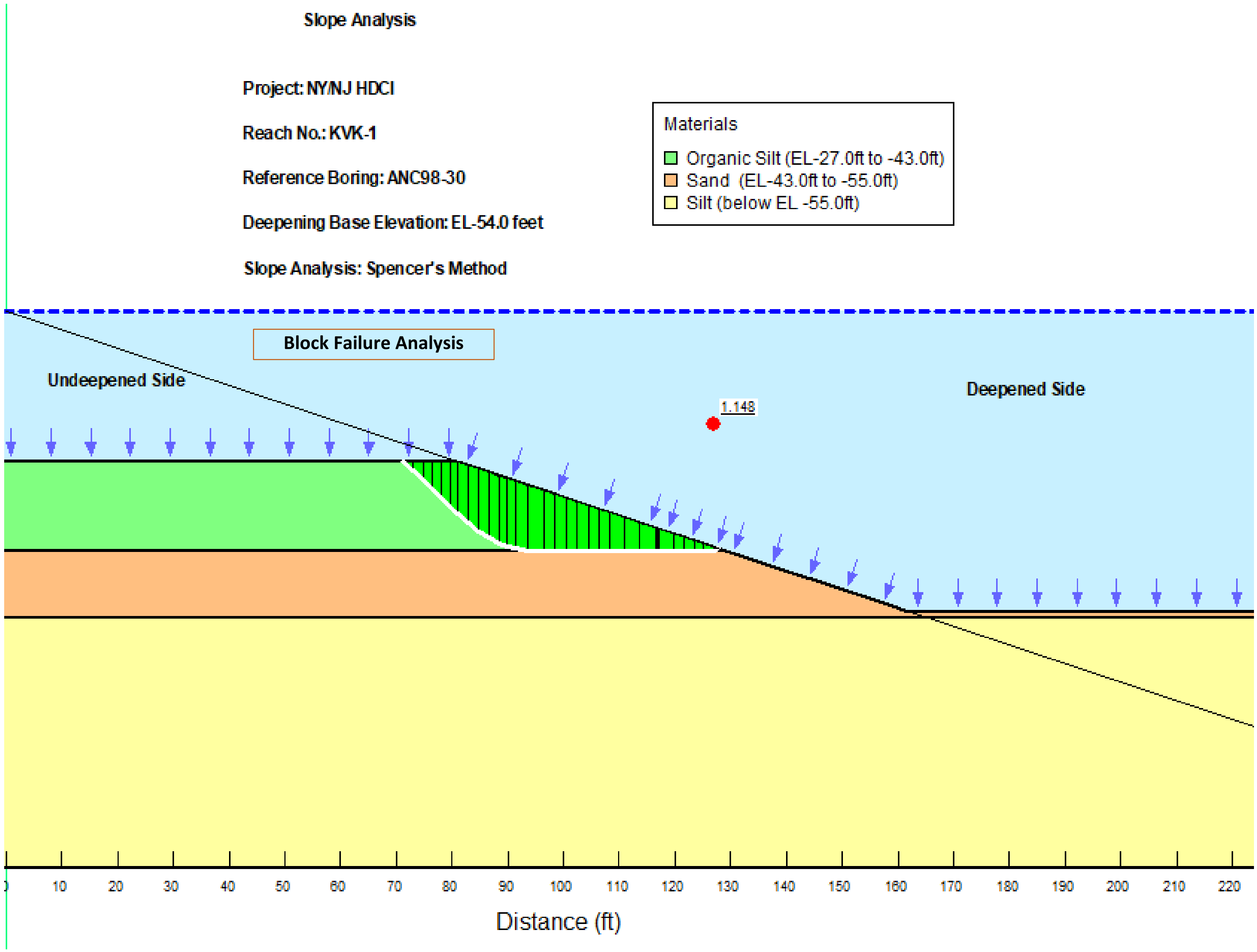
Reference Boring: ANC98-30

Deepening Base Elevation: EL-54.0 feet

Slope Analysis: Spencer's Method

Materials
Organic Silt (EL-27.0ft to -43.0ft)
Sand (EL-43.0ft to -55.0ft)
Silt (below EL -55.0ft)




Slope Analysis
Project: NY/NJ HDCI
Reach No.: KVK-1
Reference Boring: ANC98-30
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Materials
Organic Silt (EL-27.0ft to -43.0ft)
Sand (EL-43.0ft to -55.0ft)
Silt (below EL -55.0ft)
Block Failure Analysis
Undeepened Side
Deepened Side
1.148
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220
Distance (ft)

Slope Analysis

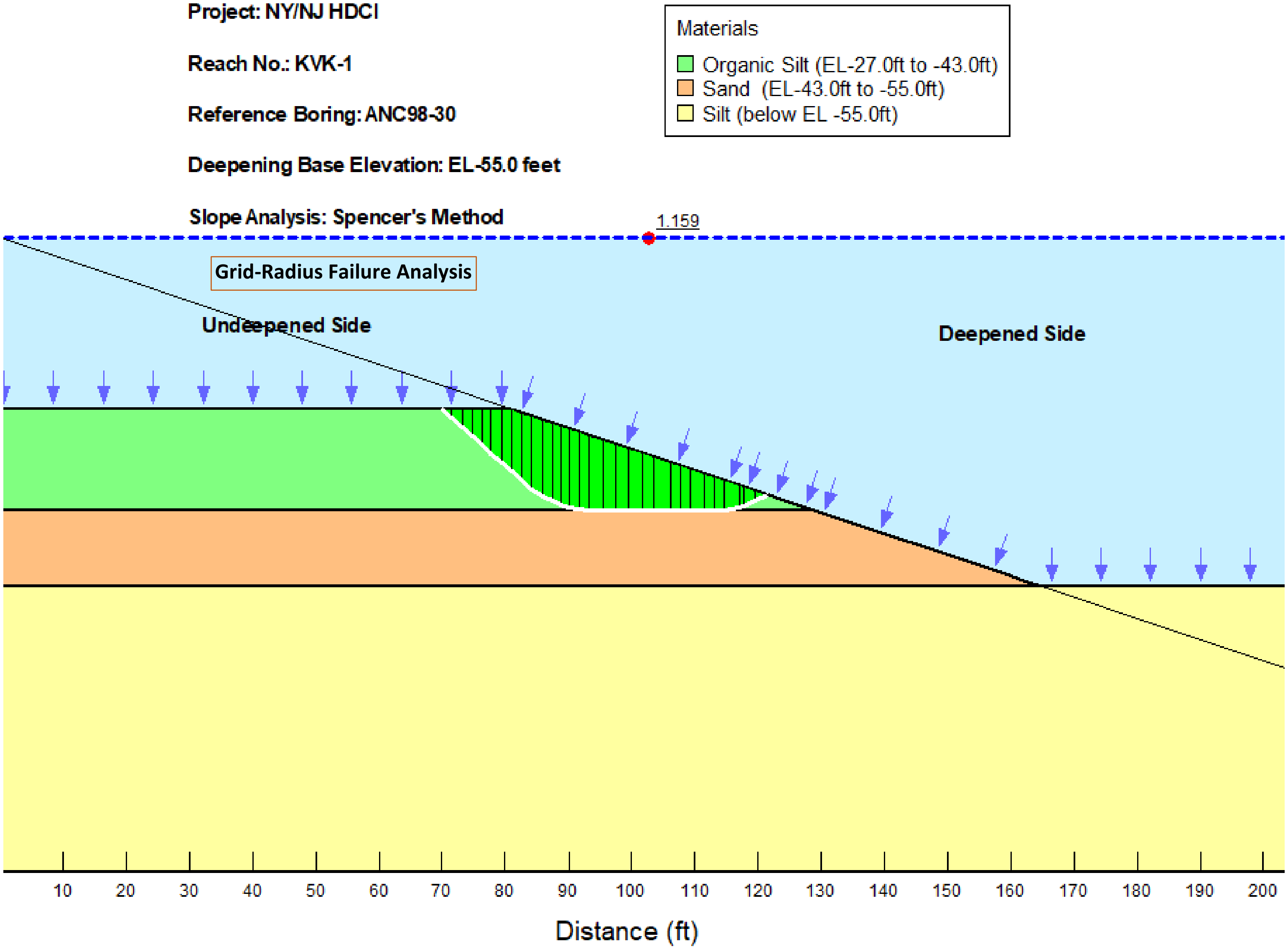
Project: NY/NJ HDCI

Reach No.: KVK-1

Reference Boring: ANC98-30

Deepening Base Elevation: EL-55.0 feet

Slope Analysis: Spencer's Method



Slope Analysis

Project: NY/NJ HDCI

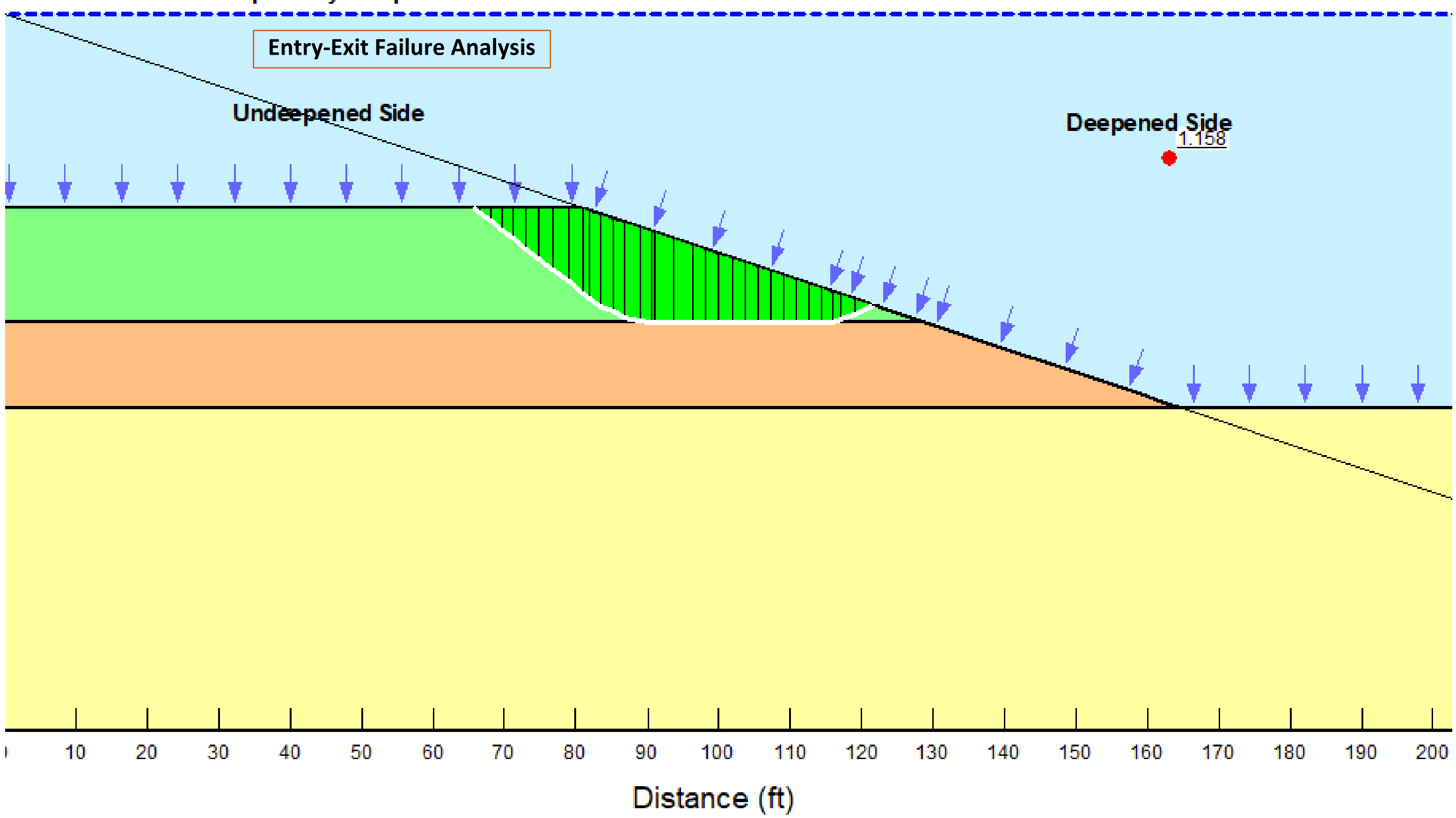
Reach No.: KVK-1

Reference Boring: ANC98-30

Deepening Base Elevation: EL-55.0 feet

Slope Analysis: Spencer's Method

Materials
- Organic Silt (EL-27.0ft to -43.0ft)
- Sand (EL-43.0ft to -55.0ft)
- Silt (below EL -55.0ft)



Slope Analysis

Project: NY/NJ HDCI

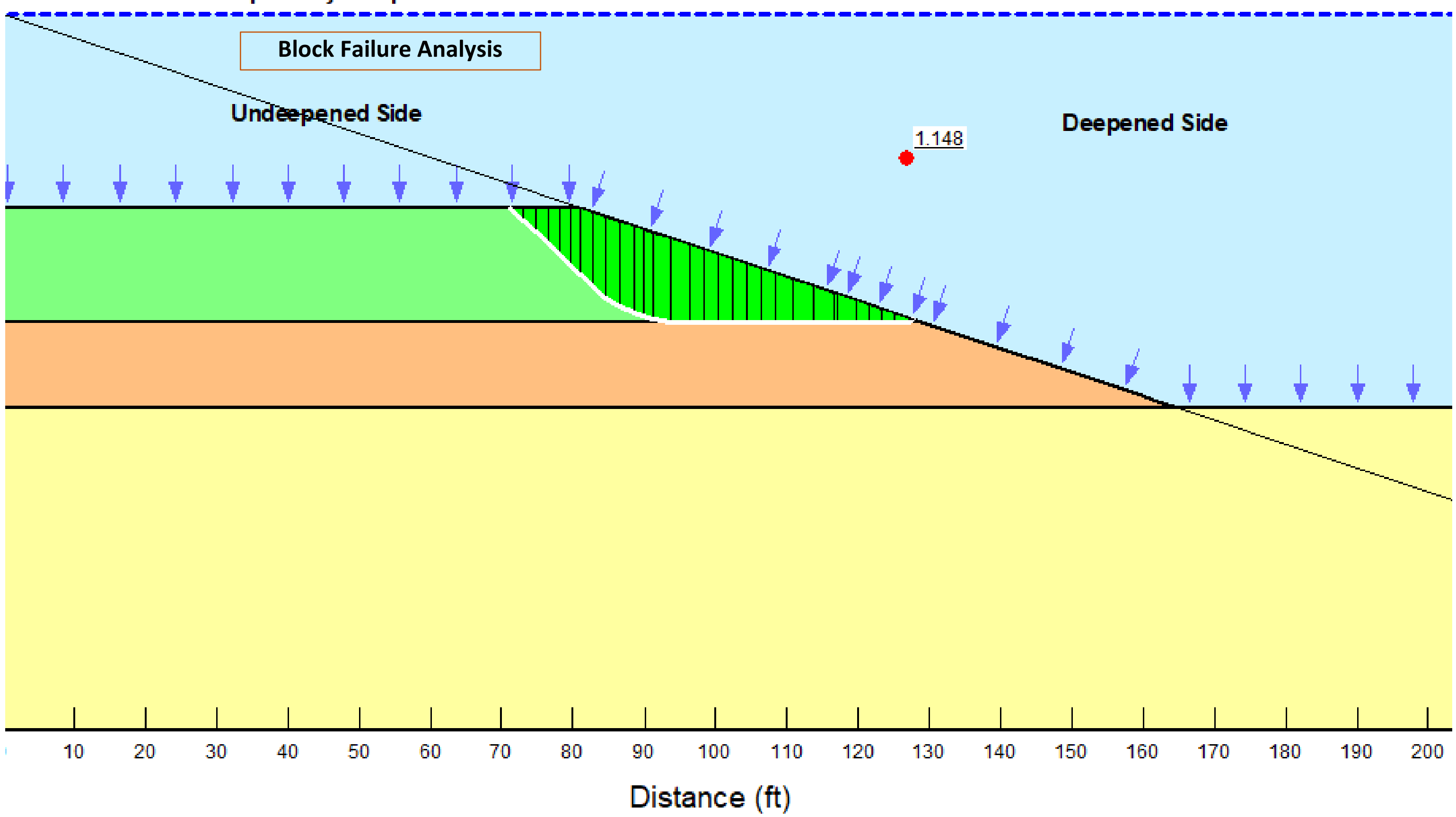
Reach No.: KVK-1

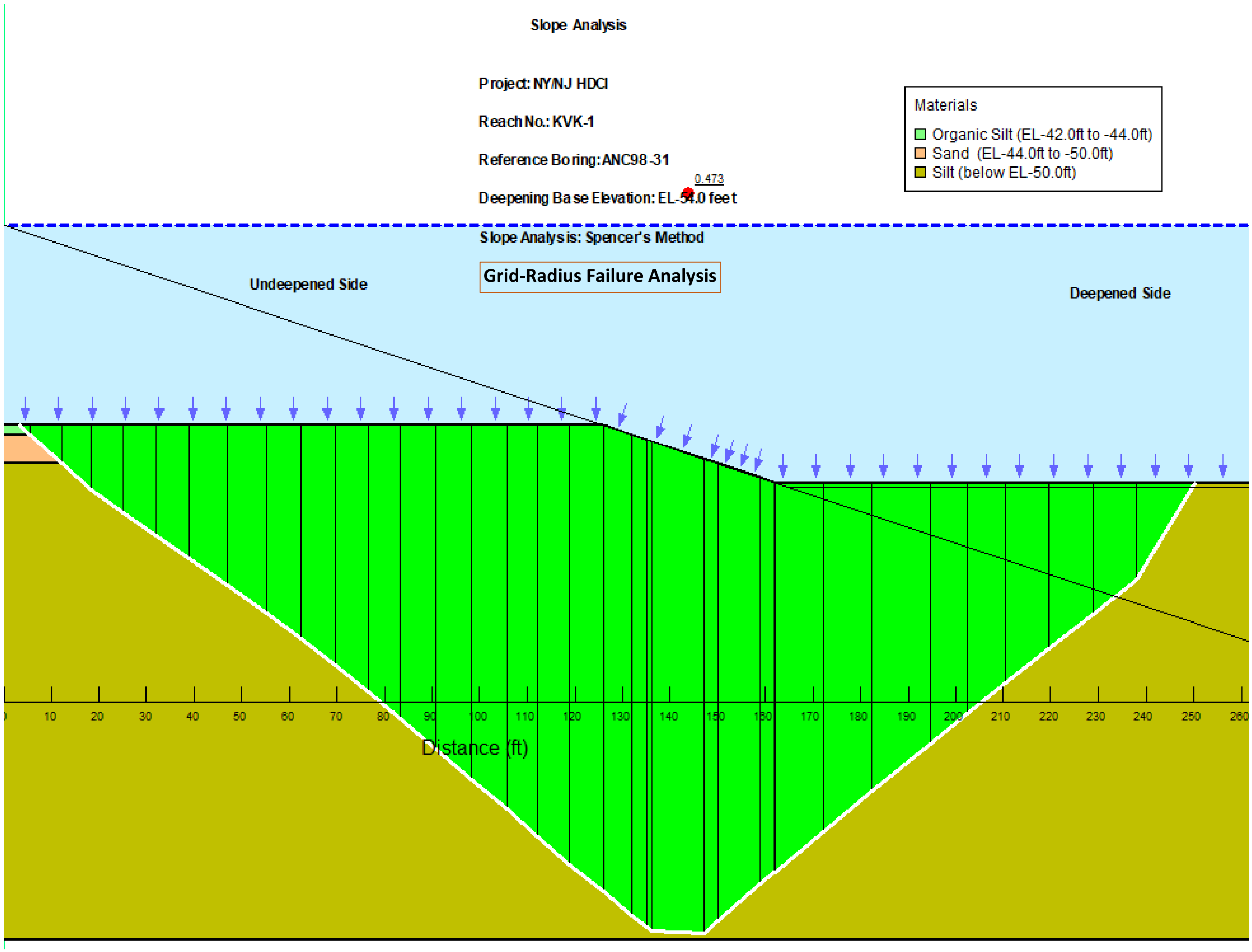
Reference Boring: ANC98-30

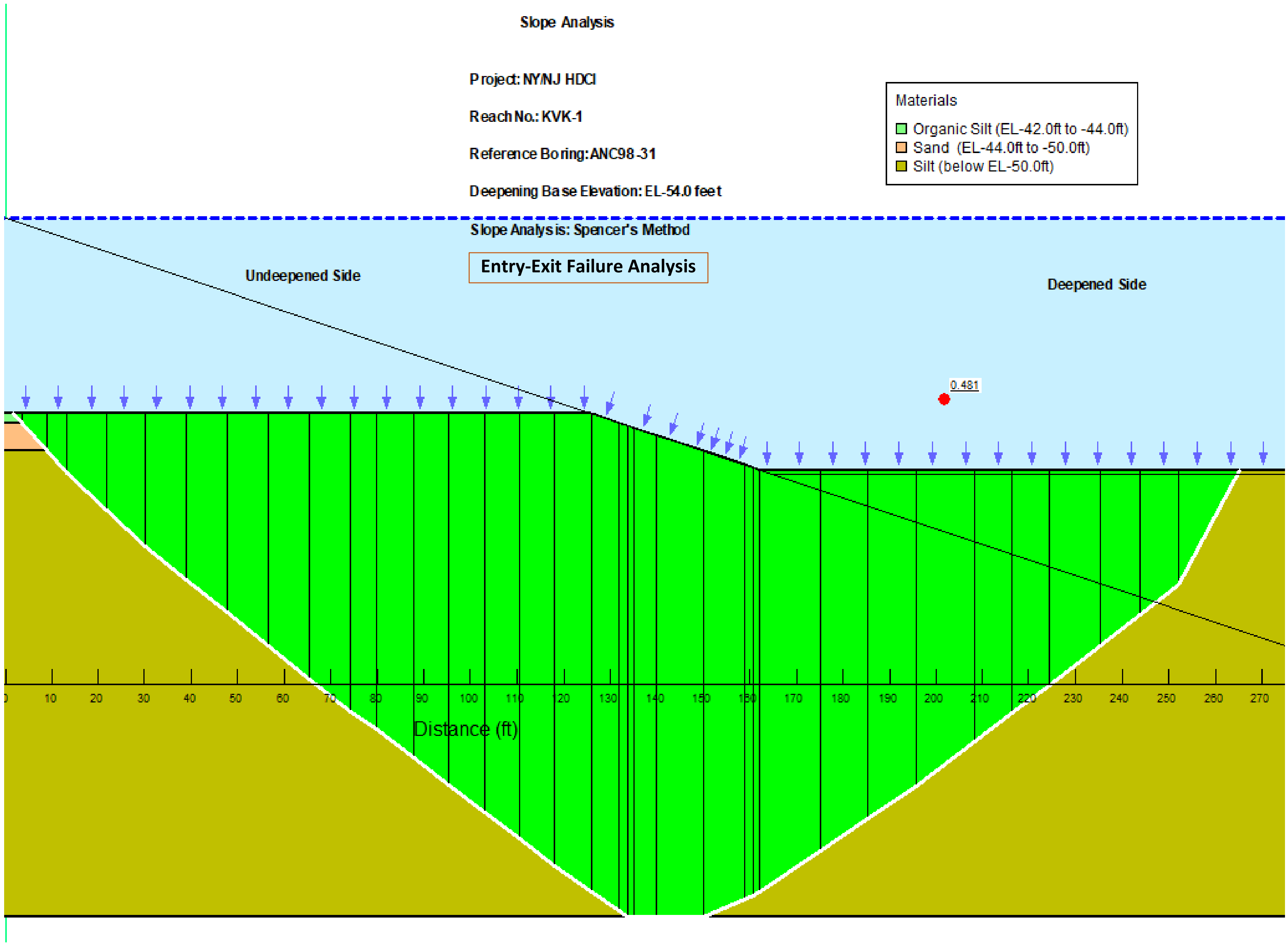
Deepening Base Elevation: EL-55.0 feet

Slope Analysis: Spencer's Method

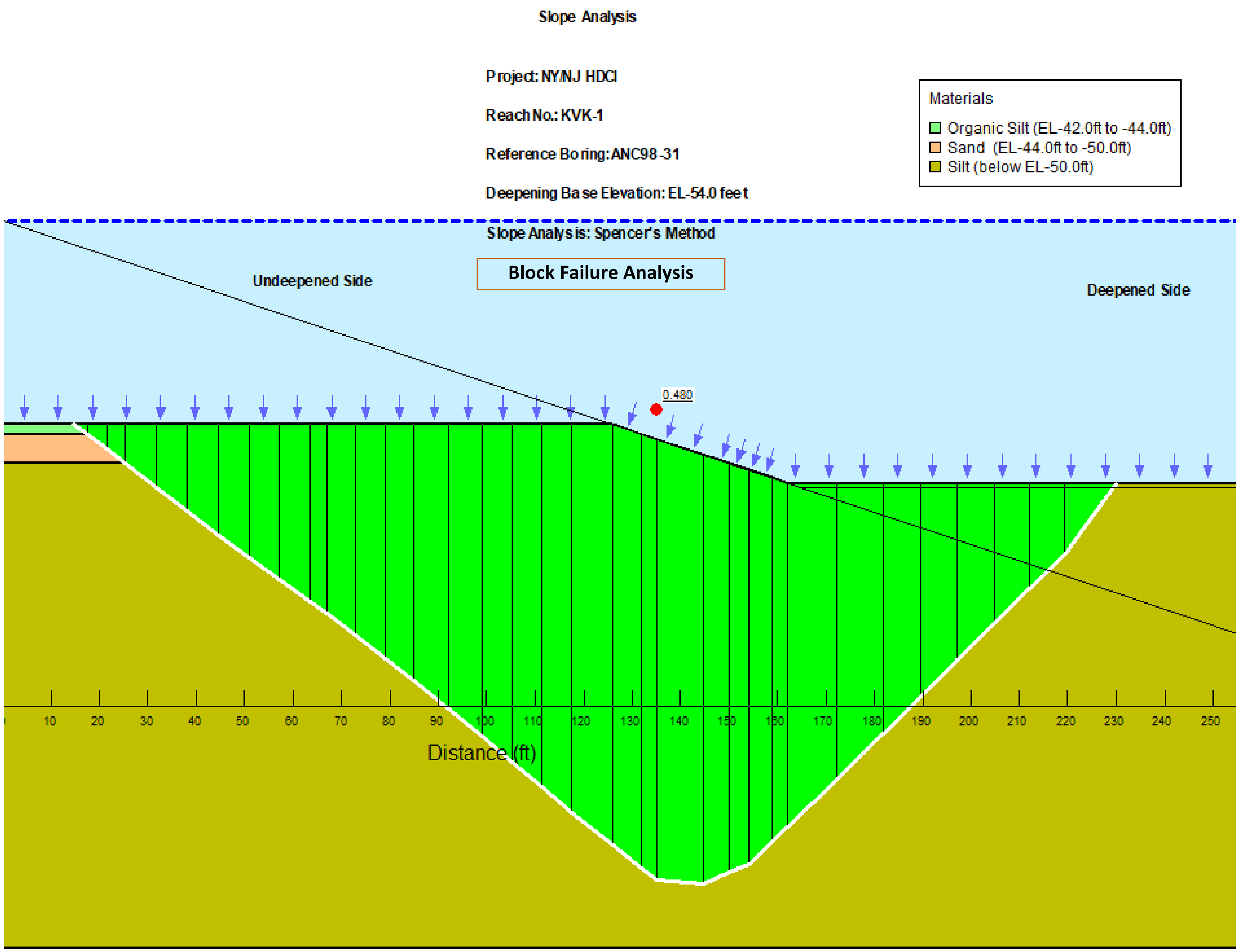
Materials
- Organic Silt (EL-27.0ft to -43.0ft)
- Sand (EL-43.0ft to -55.0ft)
- Silt (below EL -55.0ft)



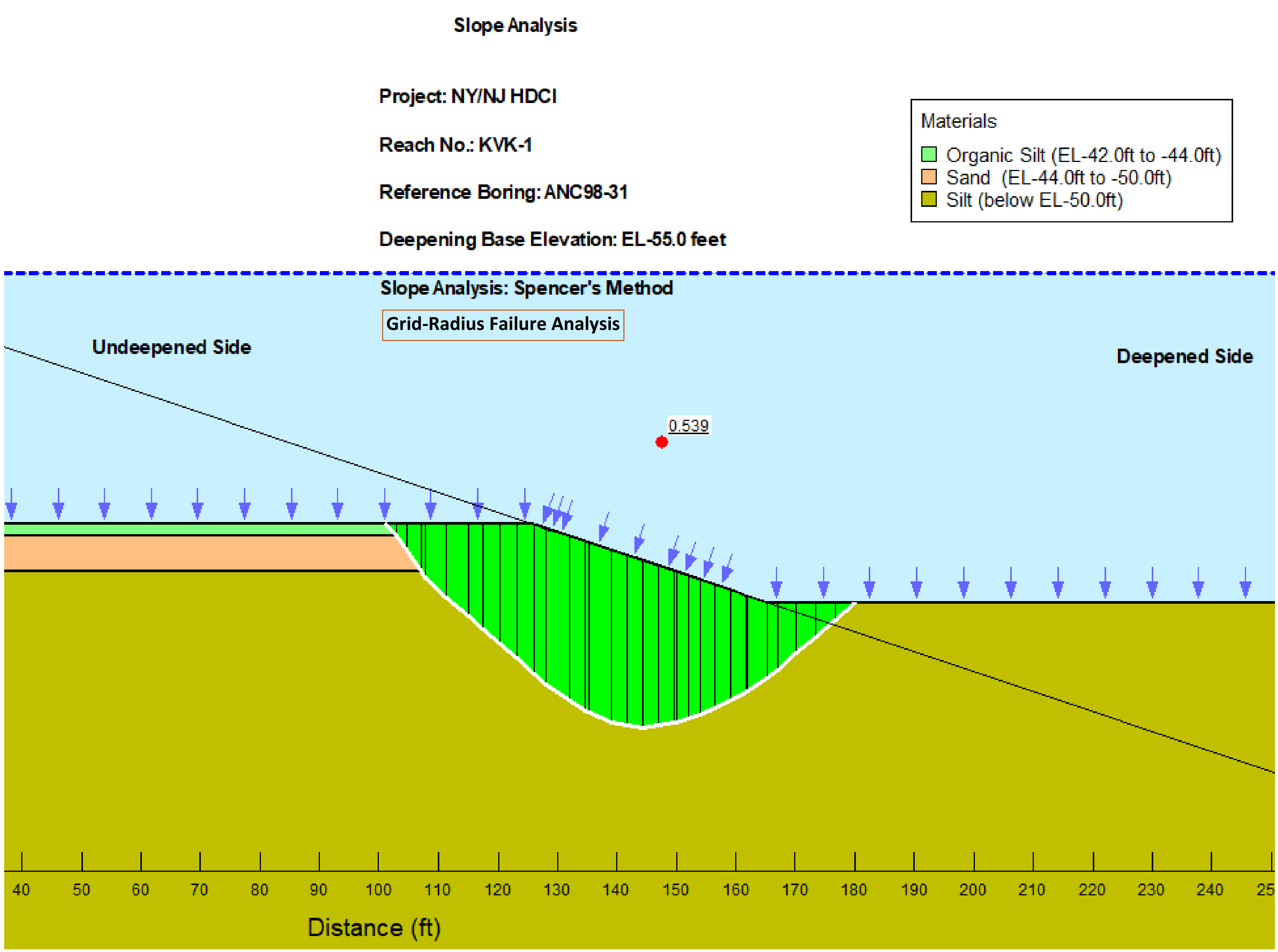

Slope Analysis
Project: NY/NJ HDCI
Reach No.: KVK-1
Reference Boring: ANC98-31
Deepening Base Elevation: EL-54.0 feet
0.473
Slope Analysis: Spencer's Method
Grid-Radius Failure Analysis
Materials
Organic Silt (EL-42.0ft to -44.0ft)
Sand (EL-44.0ft to -50.0ft)
Silt (below EL-50.0ft)
Undeepened Side
Deepened Side
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
Distance (ft)

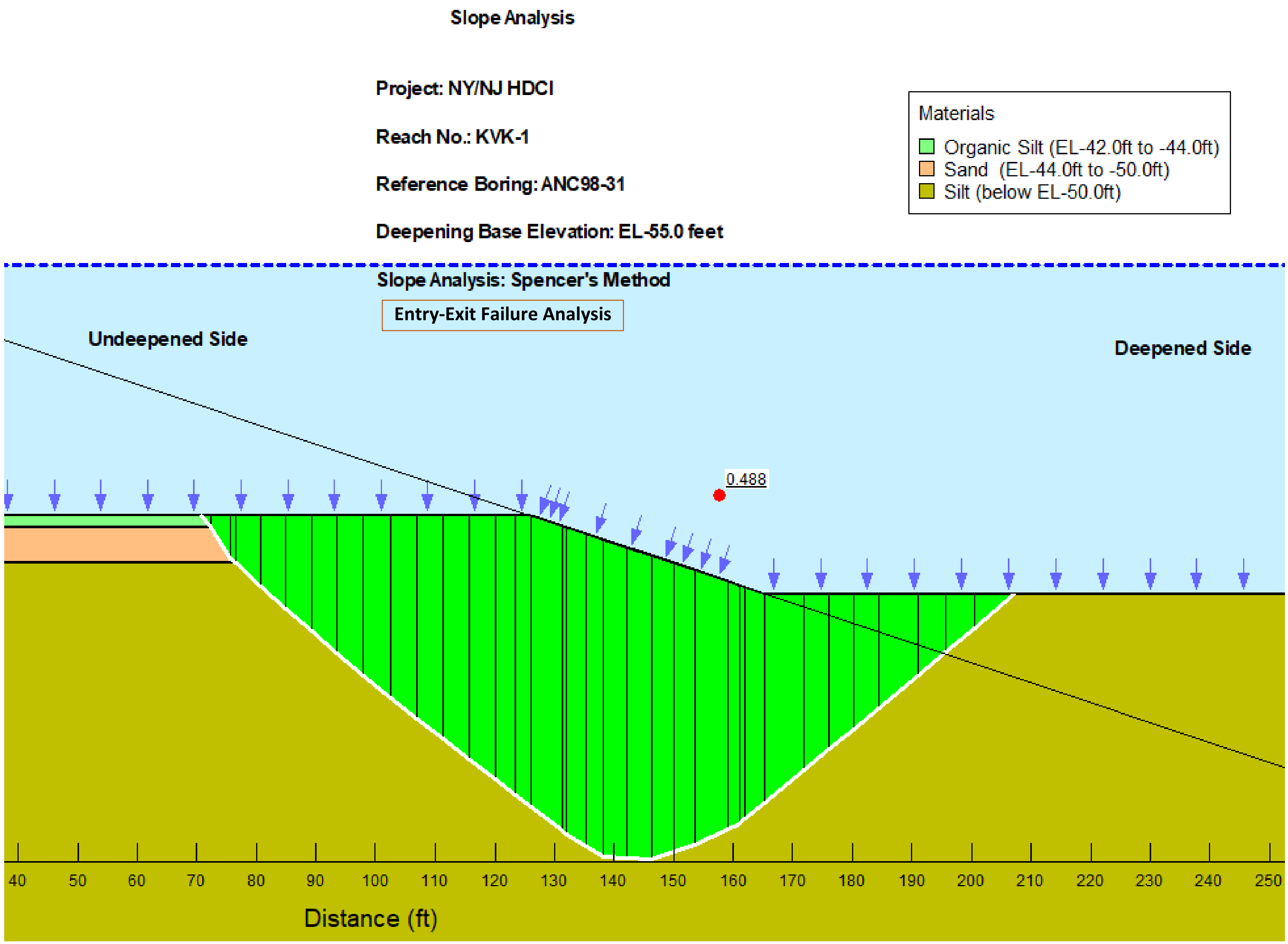


Slope Analysis
Project: NY/NJ HDCI
Reach No.: KVK-1
Reference Boring: ANC98-31
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Entry-Exit Failure Analysis
Materials
Organic Silt (EL-42.0ft to -44.0ft)
Sand (EL-44.0ft to -50.0ft)
Silt (below EL-50.0ft)
Undeepened Side
Deepened Side
0.481
Distance (ft)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270



Slope Analysis
Project: NY/NJ HDCI
Reach No.: KVK-1
Reference Boring: ANC98-31
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Block Failure Analysis
Materials
Organic Silt (EL-42.0ft to -44.0ft)
Sand (EL-44.0ft to -50.0ft)
Silt (below EL-50.0ft)
Undeepened Side
Deepened Side
0.480
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250
Distance (ft)


Slope Analysis
Project: NY/NJ HDCI
Reach No.: KVK-1
Reference Boring: ANC98-31
Deepening Base Elevation: EL-55.0 feet
Materials
Organic Silt (EL-42.0ft to -44.0ft)
Sand (EL-44.0ft to -50.0ft)
Silt (below EL-50.0ft)
Slope Analysis: Spencer's Method
Grid-Radius Failure Analysis
Undeepened Side
Deepened Side
0.539
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
25
Distance (ft)



Slope Analysis
Project: NY/NJ HDCI
Reach No.: KVK-1
Reference Boring: ANC98-31
Deepening Base Elevation: EL-55.0 feet
Slope Analysis: Spencer's Method
Entry-Exit Failure Analysis
Materials
Organic Silt (EL-42.0ft to -44.0ft)
Sand (EL-44.0ft to -50.0ft)
Silt (below EL-50.0ft)
Undeepened Side
Deepened Side
0.488
40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250
Distance (ft)

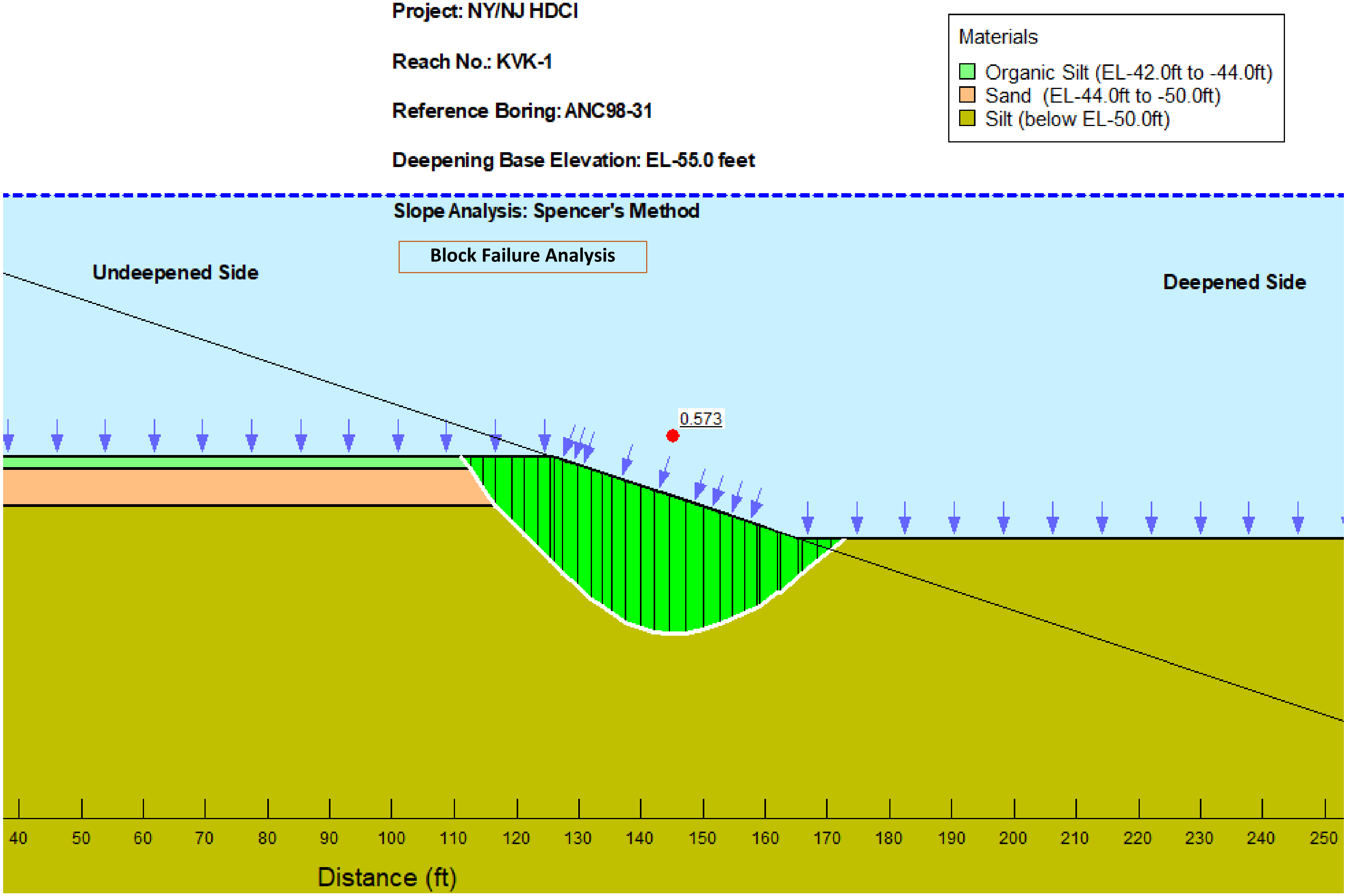
Slope Analysis

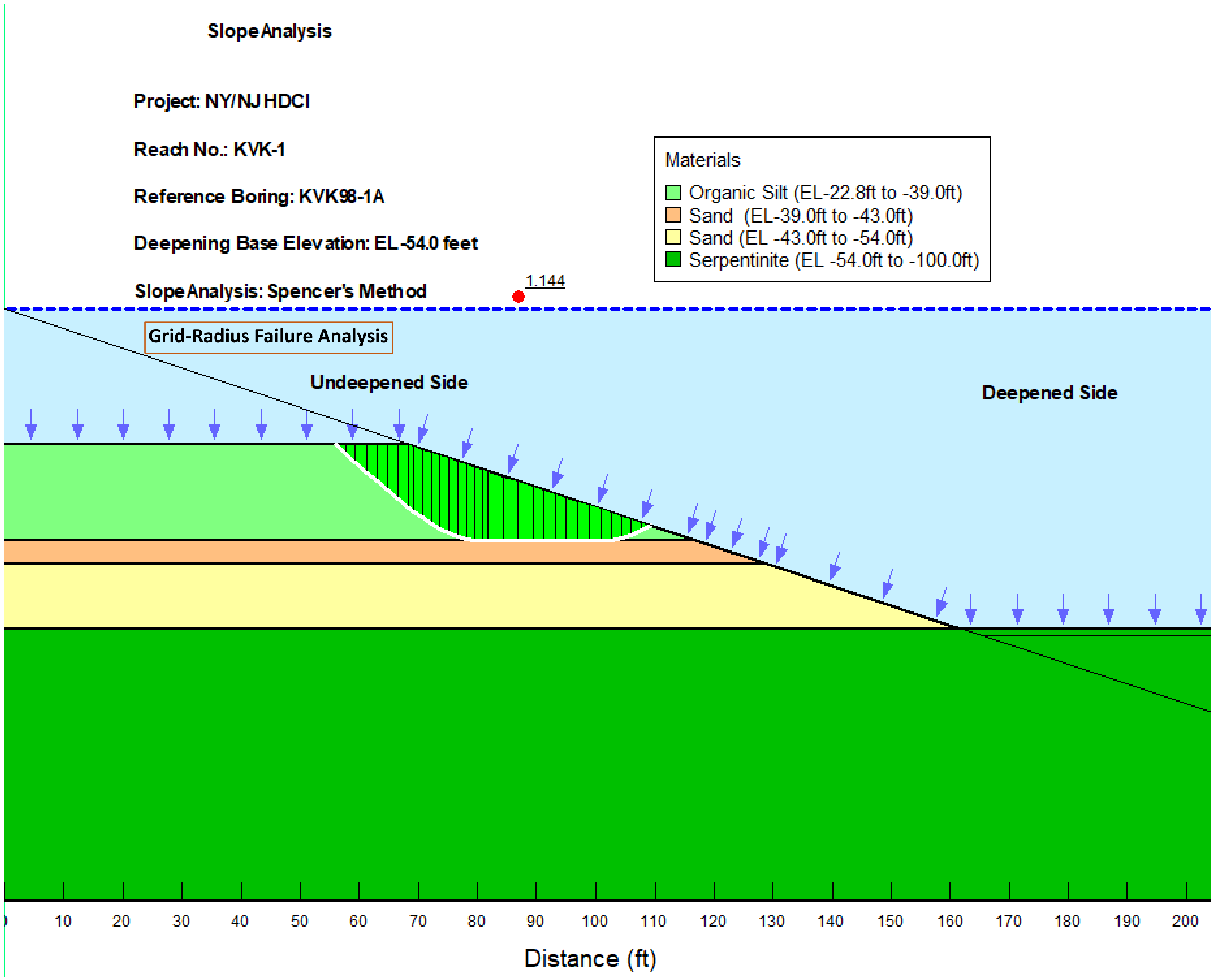
Project: NY/NJ HDCI

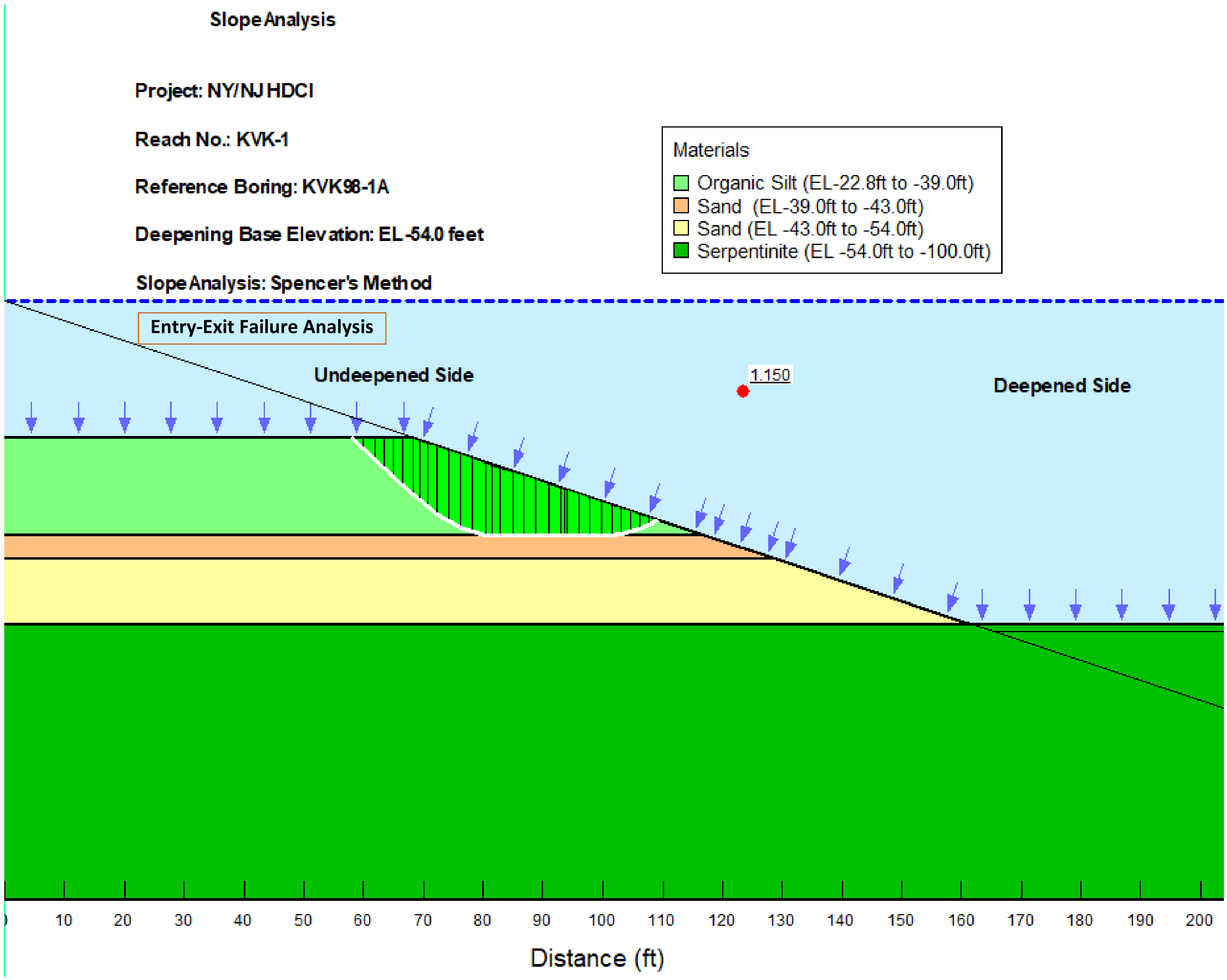
Reach No.: KVK-1

Reference Boring: ANC98-31

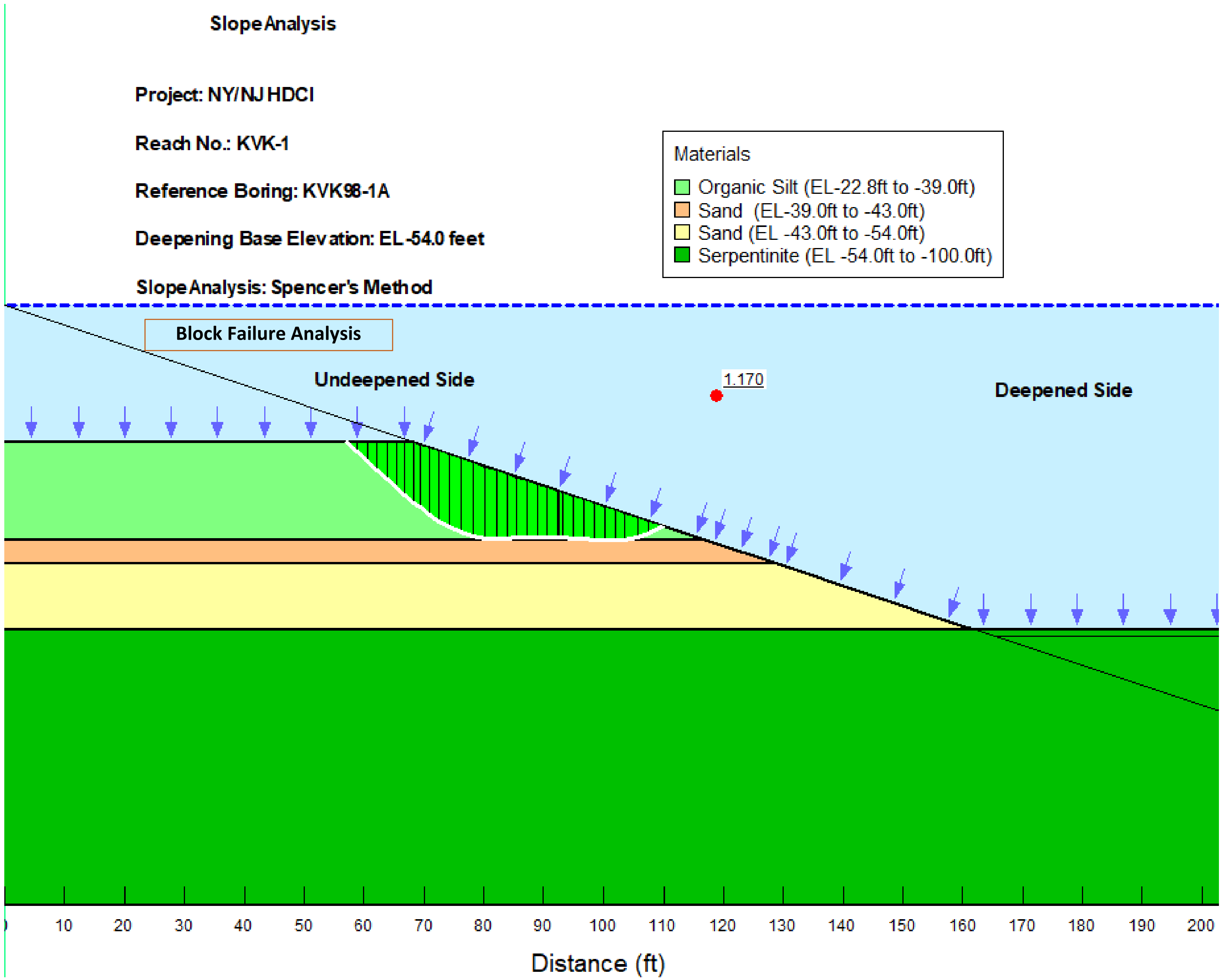
Deepening Base Elevation: EL-55.0 feet

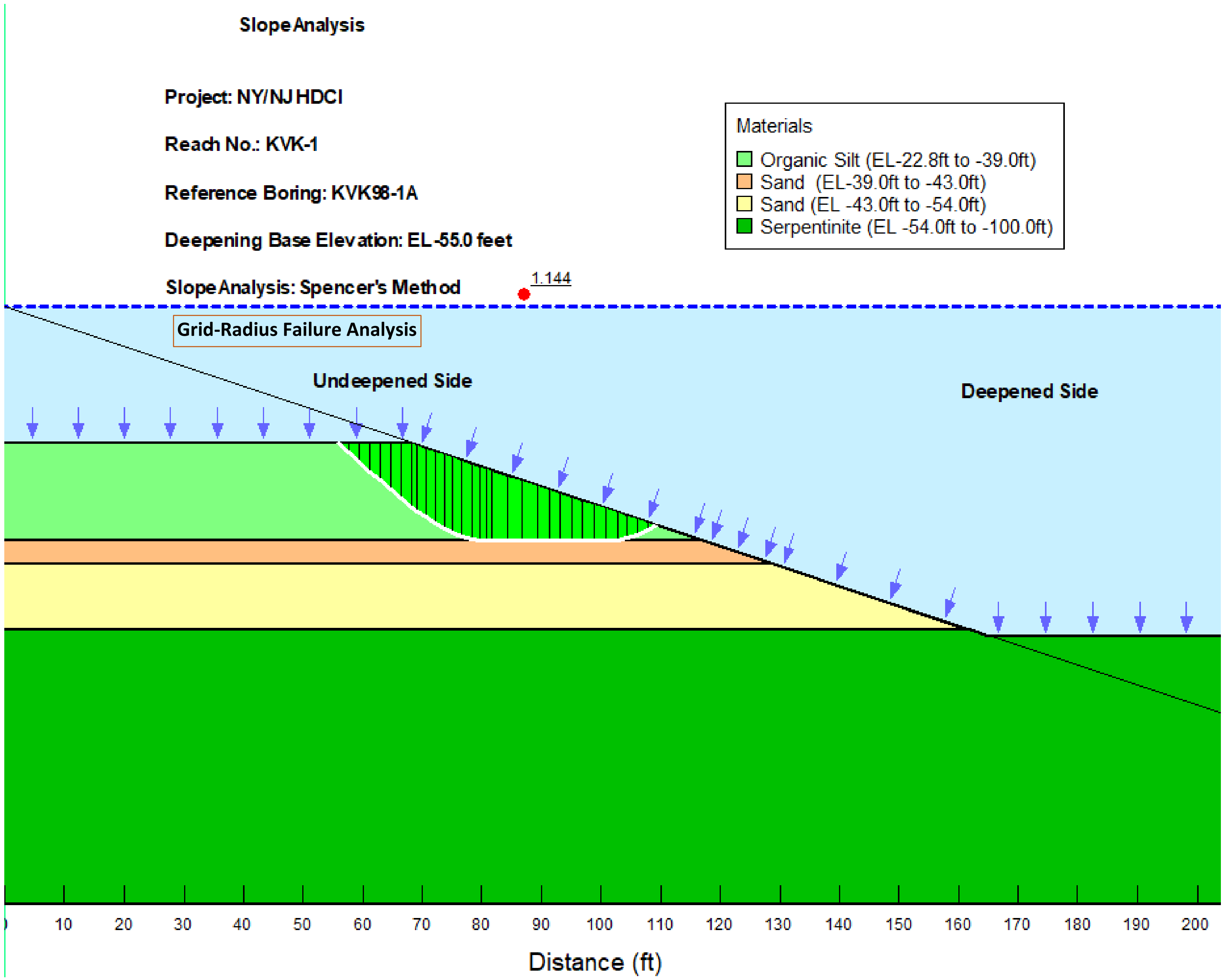



Slope Analysis
Project: NY/NJ HDCI
Reach No.: KVK-1
Reference Boring: KVK98-1A
Deepening Base Elevation: EL -54.0 feet
Slope Analysis: Spencer's Method
1.144
Materials
Organic Silt (EL-22.8ft to -39.0ft)
Sand (EL-39.0ft to -43.0ft)
Sand (EL -43.0ft to -54.0ft)
Serpentinite (EL -54.0ft to -100.0ft)
Grid-Radius Failure Analysis
Undeepened Side
Deepened Side
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Distance (ft)

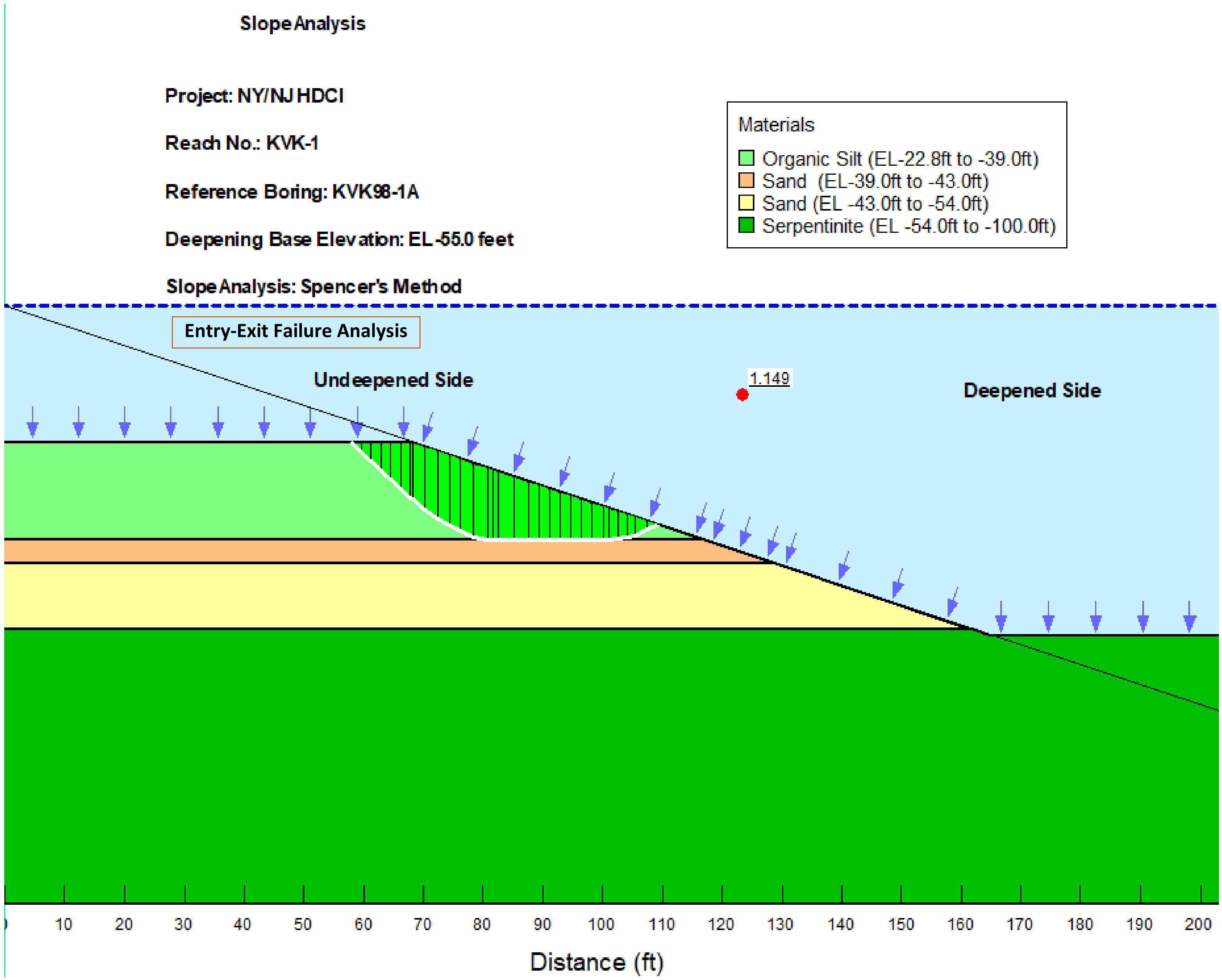


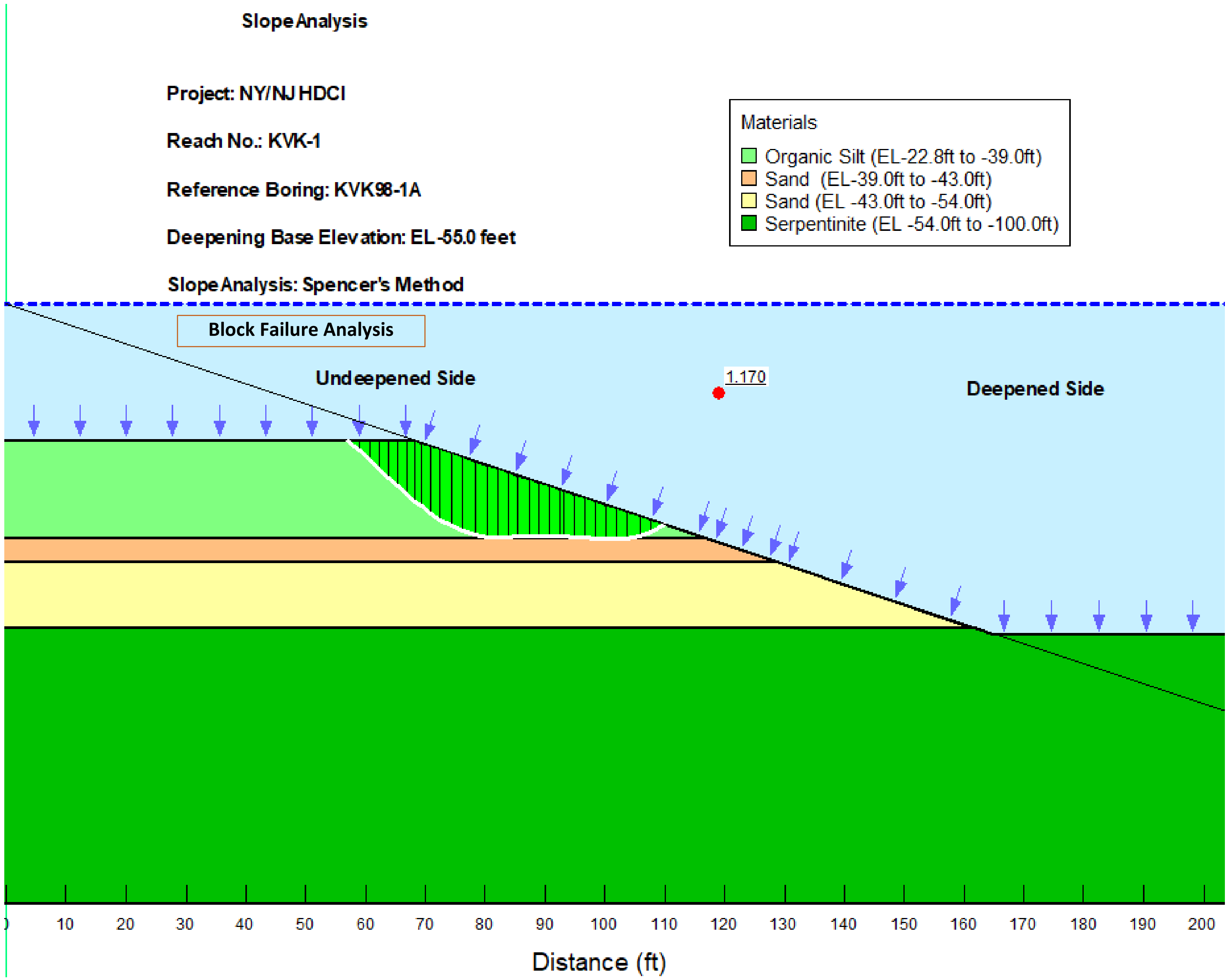
Slope Analysis
Project: NY/NJ HDCI
Reach No.: KVK-1
Reference Boring: KVK98-1A
Deepening Base Elevation: EL -54.0 feet
Slope Analysis: Spencer's Method
Materials
Organic Silt (EL-22.8ft to -39.0ft)
Sand (EL-39.0ft to -43.0ft)
Sand (EL -43.0ft to -54.0ft)
Serpentinite (EL -54.0ft to -100.0ft)
Entry-Exit Failure Analysis
Undeepened Side
1.150
Deepened Side
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
Distance (ft)

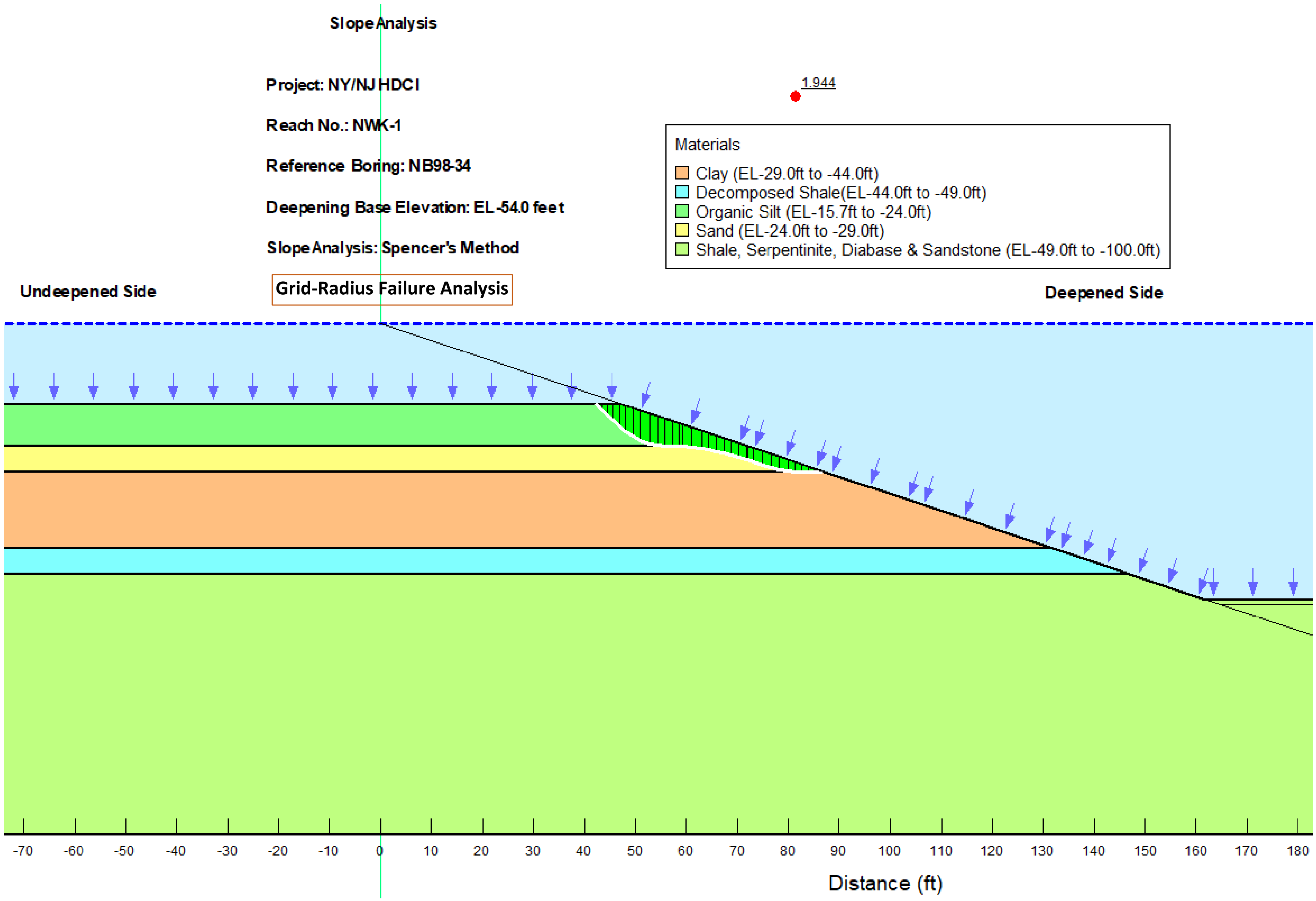

Slope Analysis
Project: NY/NJ HDCI
Reach No.: KVK-1
Reference Boring: KVK98-1A
Deepening Base Elevation: EL -54.0 feet
Slope Analysis: Spencer's Method
Materials
Organic Silt (EL-22.8ft to -39.0ft)
Sand (EL-39.0ft to -43.0ft)
Sand (EL -43.0ft to -54.0ft)
Serpentinite (EL -54.0ft to -100.0ft)
Block Failure Analysis
Undeepened Side
1.170
Deepened Side
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
Distance (ft)



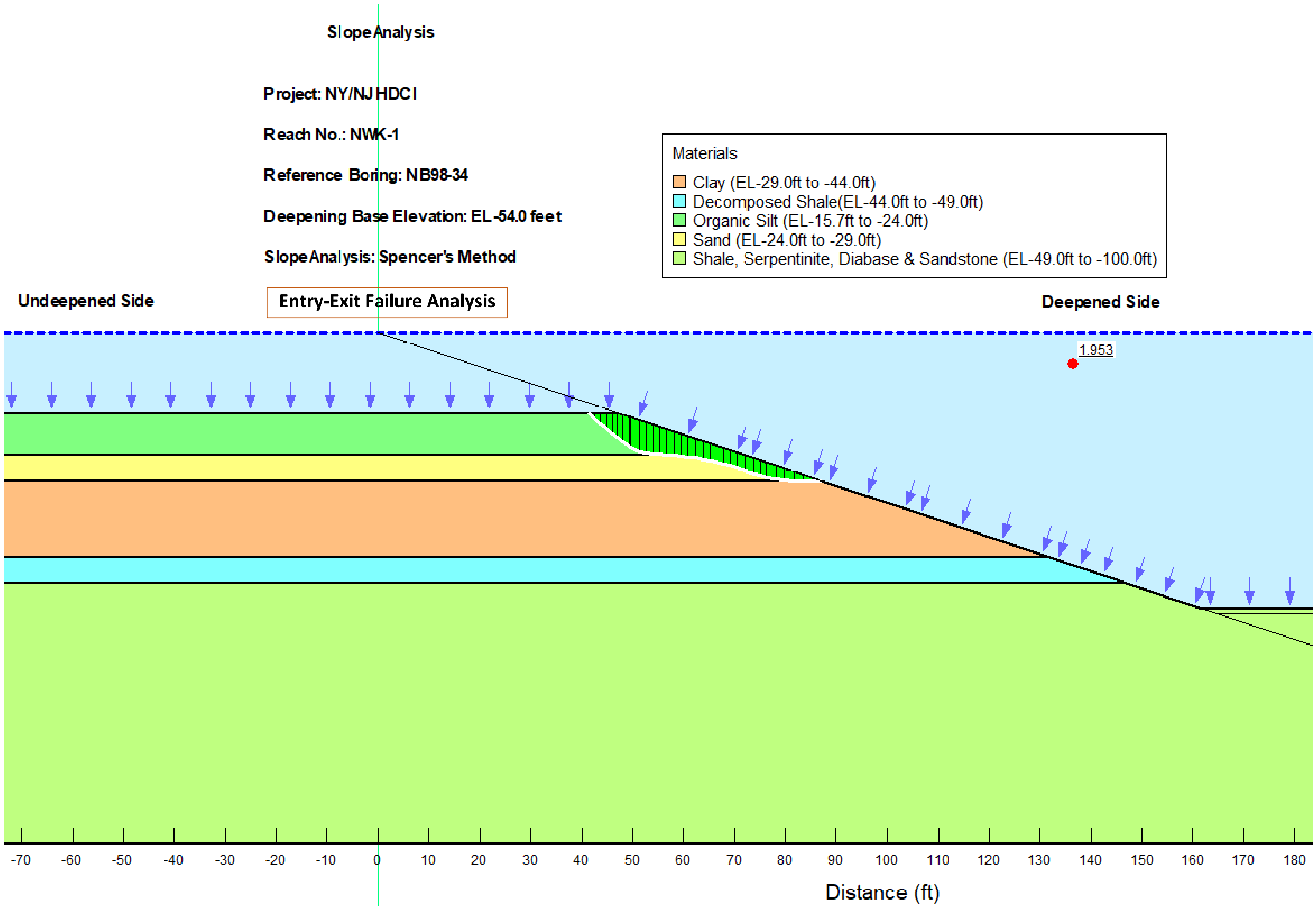
Slope Analysis
Project: NY/NJ HDCI
Reach No.: KVK-1
Reference Boring: KVK98-1A
Deepening Base Elevation: EL-55.0 feet
Slope Analysis: Spencer's Method
1.144
Grid-Radius Failure Analysis
Materials
Organic Silt (EL-22.8ft to -39.0ft)
Sand (EL-39.0ft to -43.0ft)
Sand (EL -43.0ft to -54.0ft)
Serpentinite (EL -54.0ft to -100.0ft)
Undeepened Side
Deepened Side
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Distance (ft)


Slope Analysis
Project: NY/NJ HDCI
Reach No.: KVK-1
Reference Boring: KVK98-1A
Deepening Base Elevation: EL -55.0 feet
Slope Analysis: Spencer's Method
Materials
Organic Silt (EL-22.8ft to -39.0ft)
Sand (EL-39.0ft to -43.0ft)
Sand (EL -43.0ft to -54.0ft)
Serpentinite (EL -54.0ft to -100.0ft)
Entry-Exit Failure Analysis
Undeepened Side
1.149
Deepened Side
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Distance (ft)

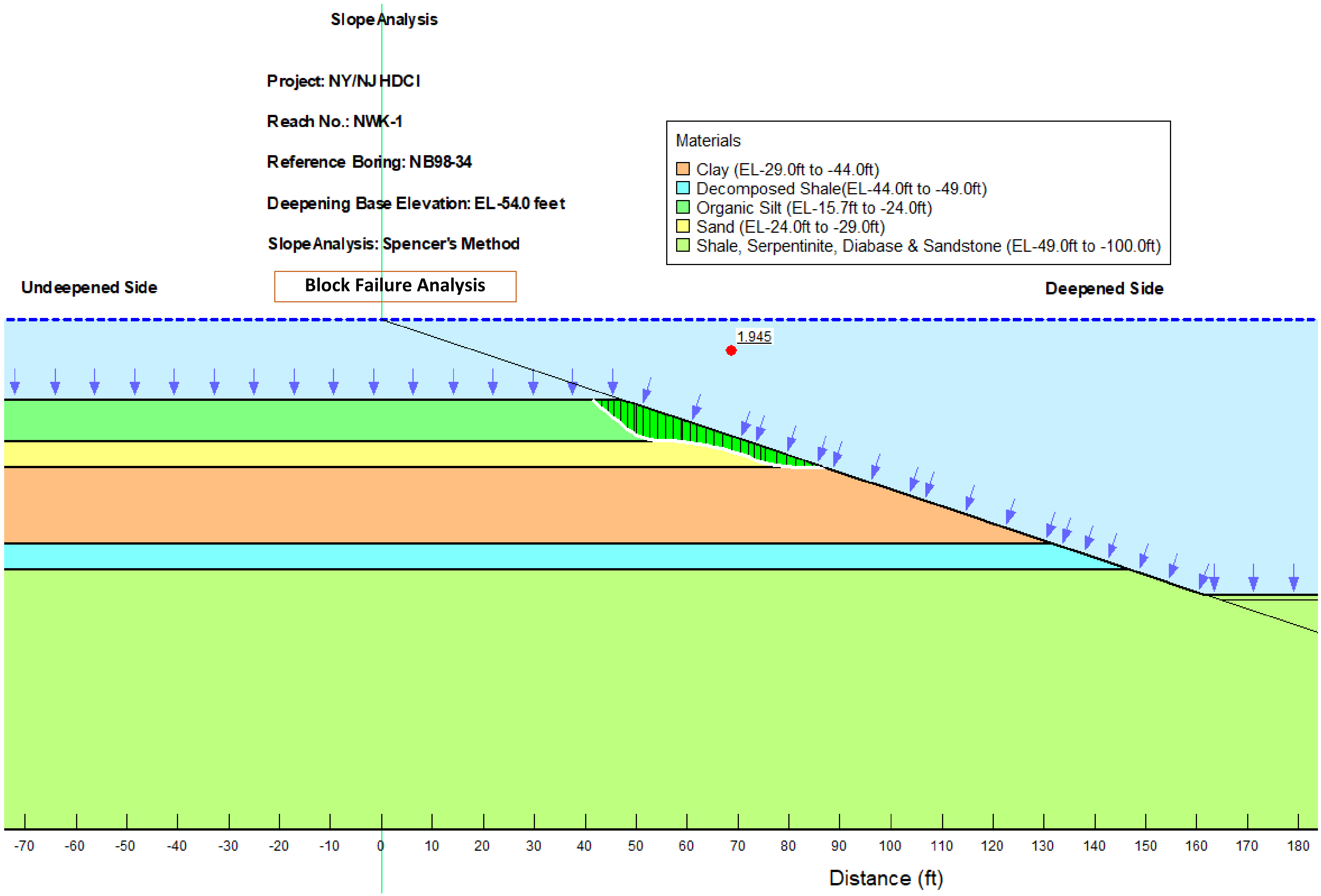

Slope Analysis
Project: NY/NJ HDCI
Reach No.: KVK-1
Reference Boring: KVK98-1A
Deepening Base Elevation: EL -55.0 feet
Slope Analysis: Spencer's Method
Materials
Organic Silt (EL-22.8ft to -39.0ft)
Sand (EL-39.0ft to -43.0ft)
Sand (EL -43.0ft to -54.0ft)
Serpentinite (EL -54.0ft to -100.0ft)
Block Failure Analysis
Undeepened Side
1.170
Deepened Side
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
Distance (ft)



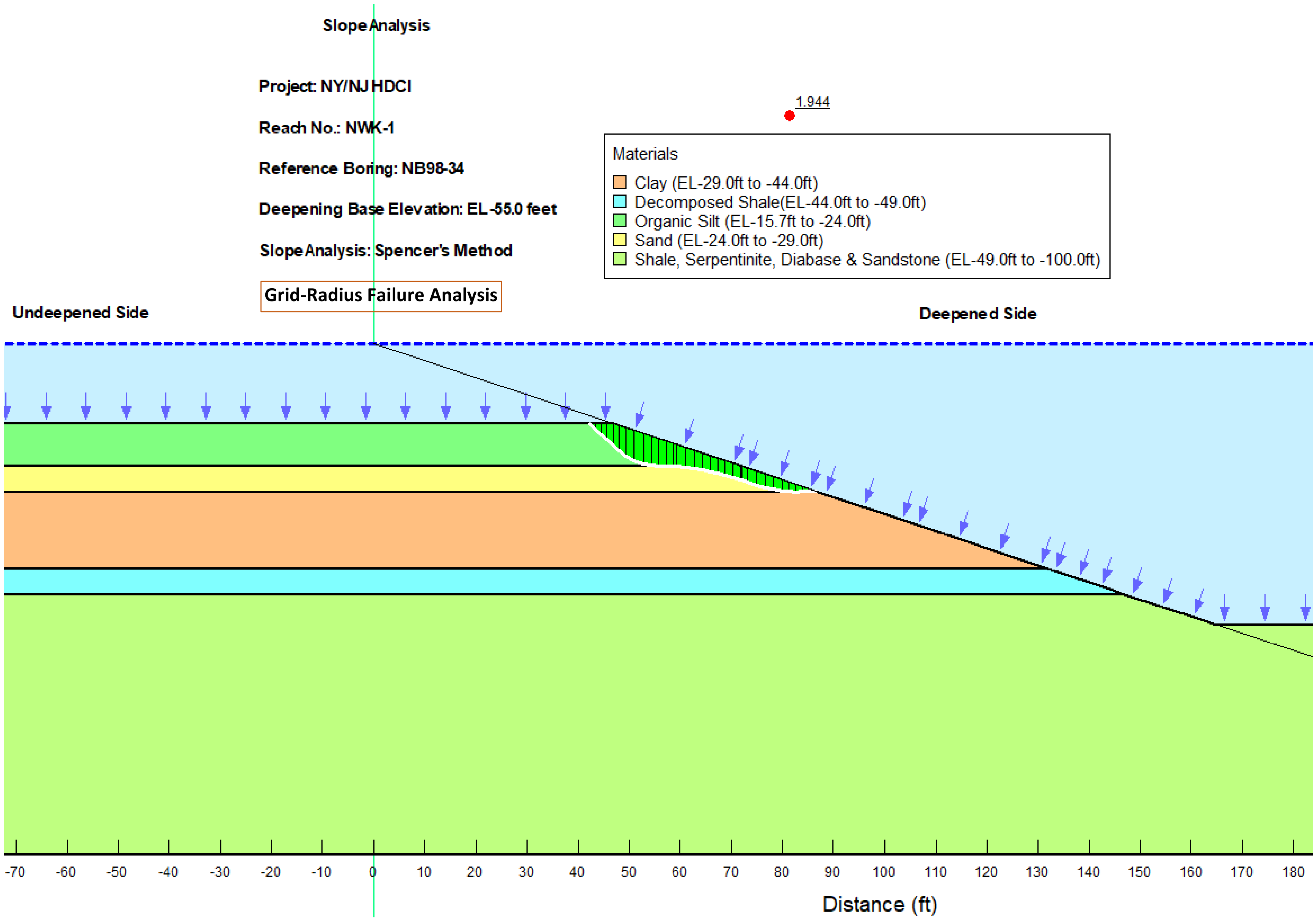
Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-1
Reference Boring: NB98-34
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Grid-Radius Failure Analysis
1.944
Materials
Clay (EL-29.0ft to -44.0ft)
Decomposed Shale(EL-44.0ft to -49.0ft)
Organic Silt (EL-15.7ft to -24.0ft)
Sand (EL-24.0ft to -29.0ft)
Shale, Serpentinite, Diabase & Sandstone (EL-49.0ft to -100.0ft)
Undeepened Side
Deepened Side
-70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
Distance (ft)

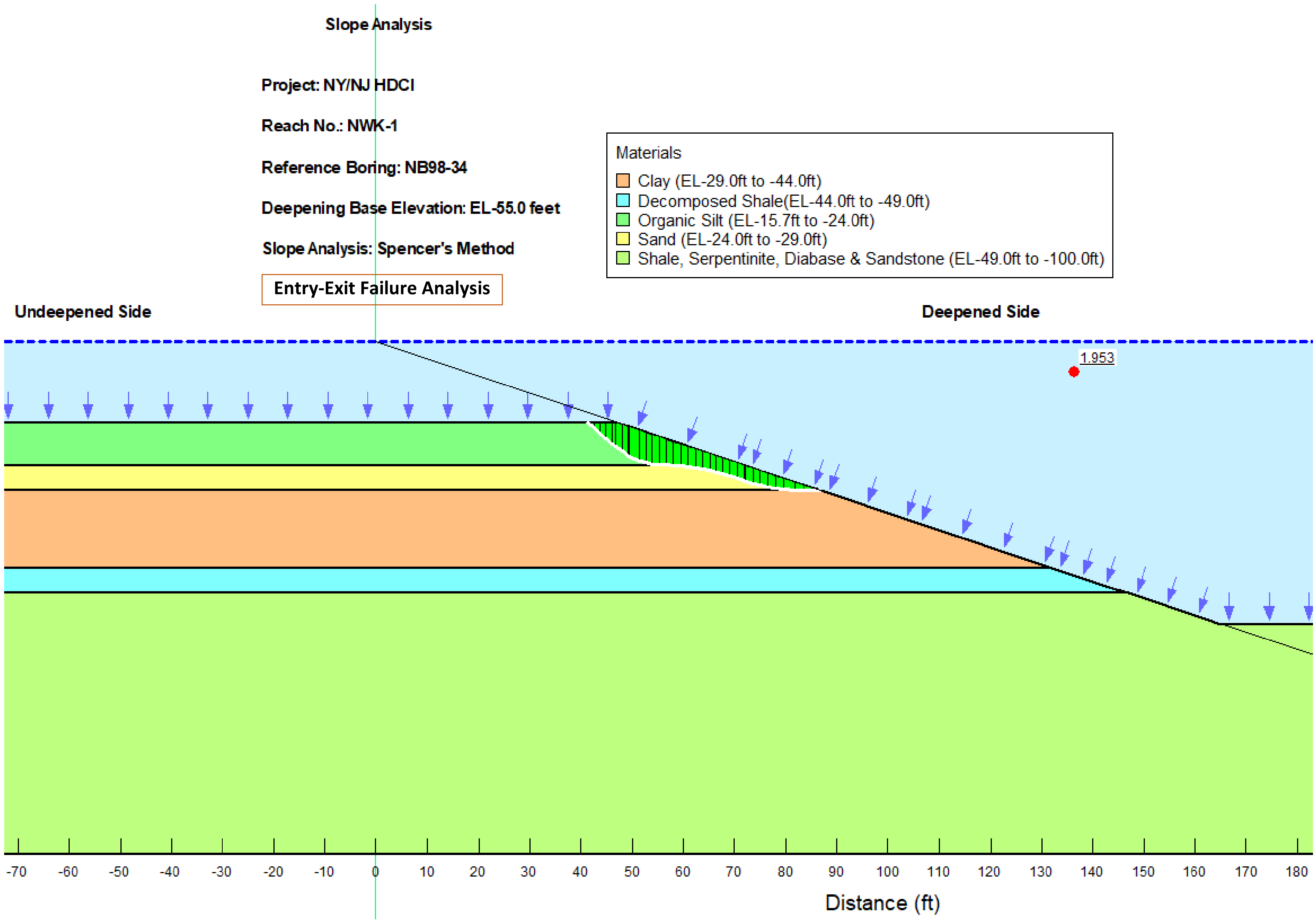


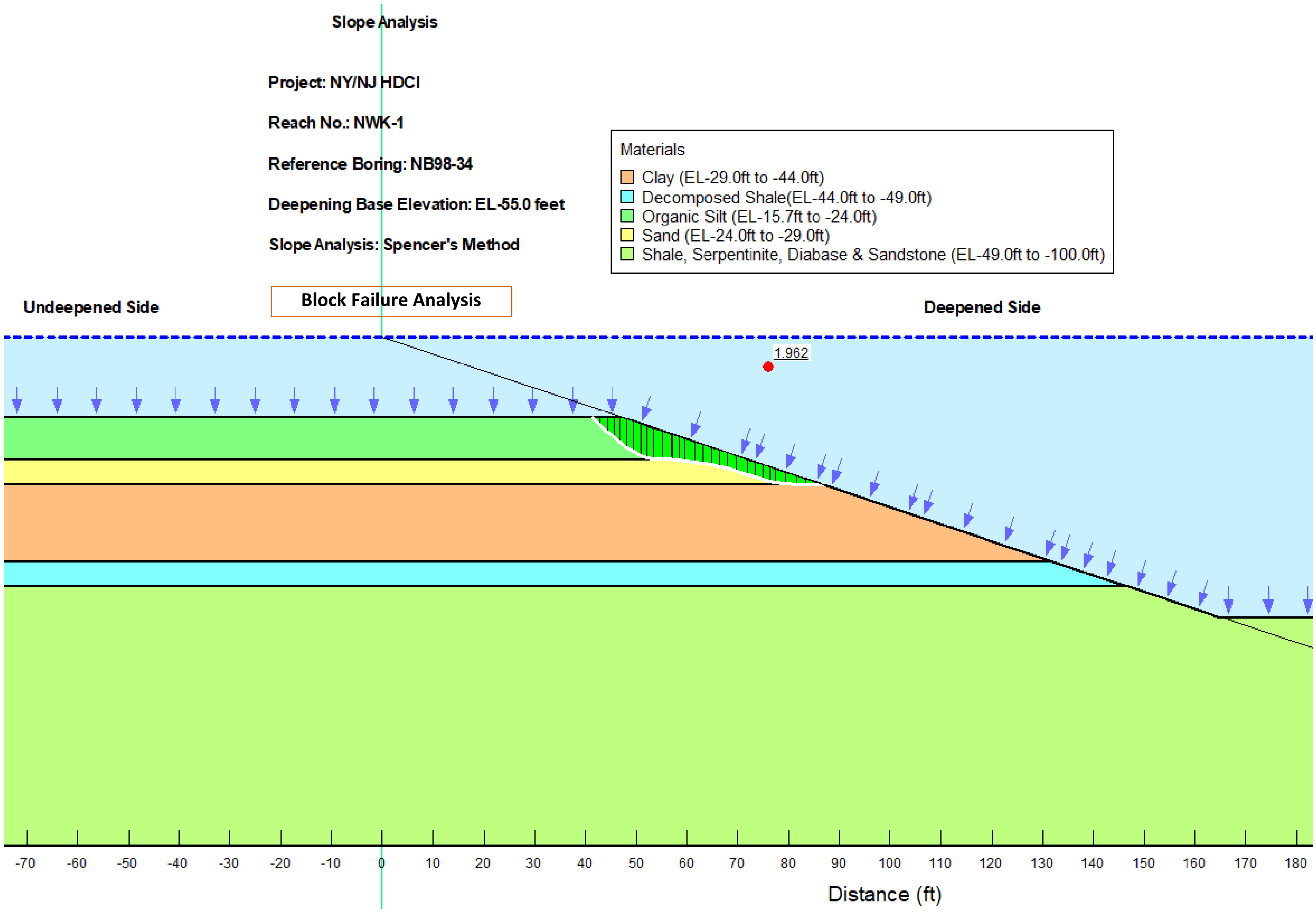
Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-1
Reference Boring: NB98-34
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Materials
Clay (EL-29.0ft to -44.0ft)
Decomposed Shale(EL-44.0ft to -49.0ft)
Organic Silt (EL-15.7ft to -24.0ft)
Sand (EL-24.0ft to -29.0ft)
Shale, Serpentinite, Diabase & Sandstone (EL-49.0ft to -100.0ft)
Undeepened Side
Entry-Exit Failure Analysis
Deepened Side
1.953
-70
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
Distance (ft)



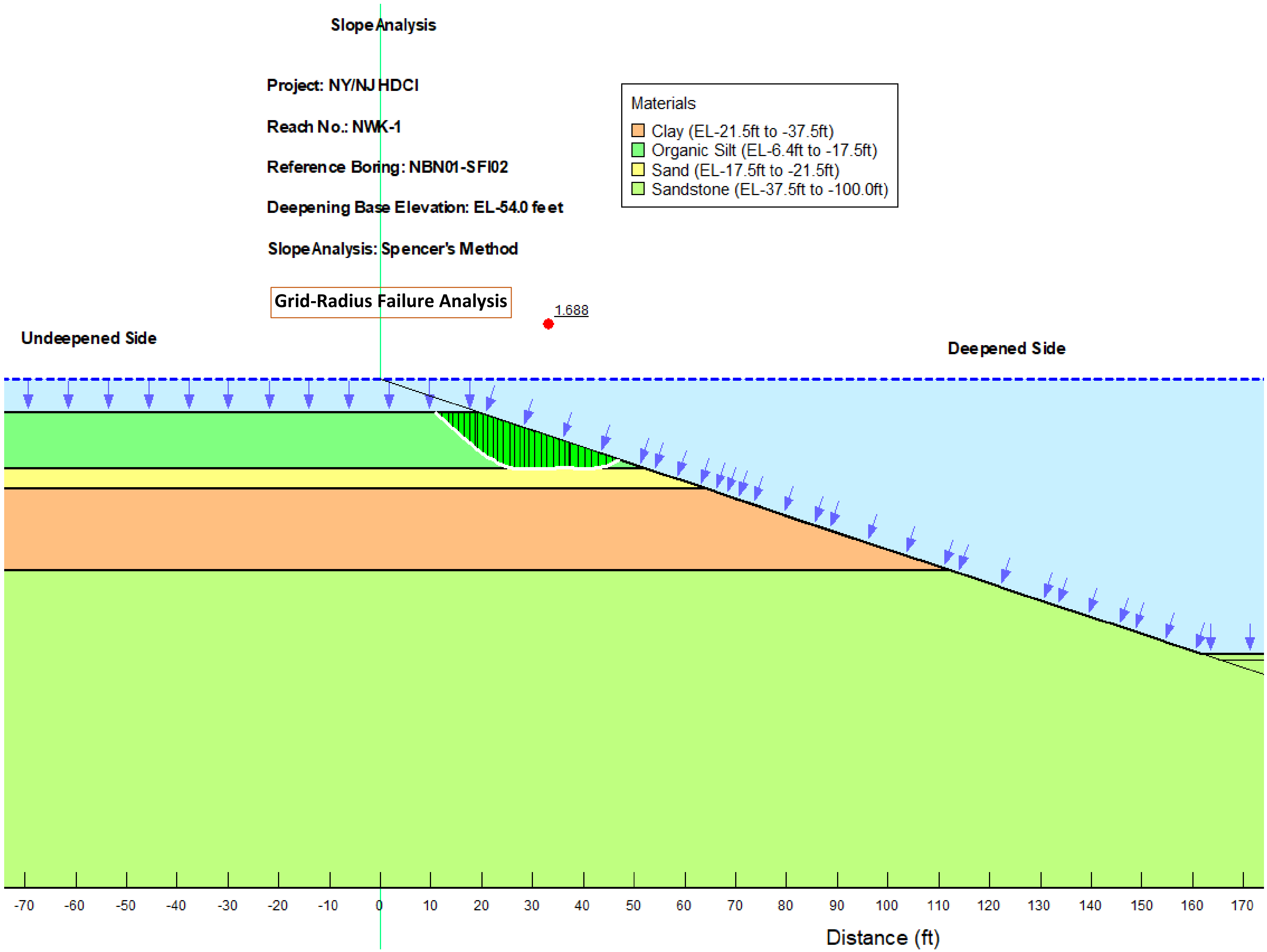
Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-1
Reference Boring: NB98-34
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Block Failure Analysis
Undeepened Side
Deepened Side
Materials
Clay (EL-29.0ft to -44.0ft)
Decomposed Shale(EL-44.0ft to -49.0ft)
Organic Silt (EL-15.7ft to -24.0ft)
Sand (EL-24.0ft to -29.0ft)
Shale, Serpentinite, Diabase & Sandstone (EL-49.0ft to -100.0ft)
1.945
-70
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
Distance (ft)


Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-1
Reference Boring: NB98-34
Deepening Base Elevation: EL-55.0 feet
Slope Analysis: Spencer's Method
Grid-Radius Failure Analysis
1.944
Materials
Clay (EL-29.0ft to -44.0ft)
Decomposed Shale(EL-44.0ft to -49.0ft)
Organic Silt (EL-15.7ft to -24.0ft)
Sand (EL-24.0ft to -29.0ft)
Shale, Serpentinite, Diabase & Sandstone (EL-49.0ft to -100.0ft)
Undeepened Side
Deepened Side
-70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
Distance (ft)

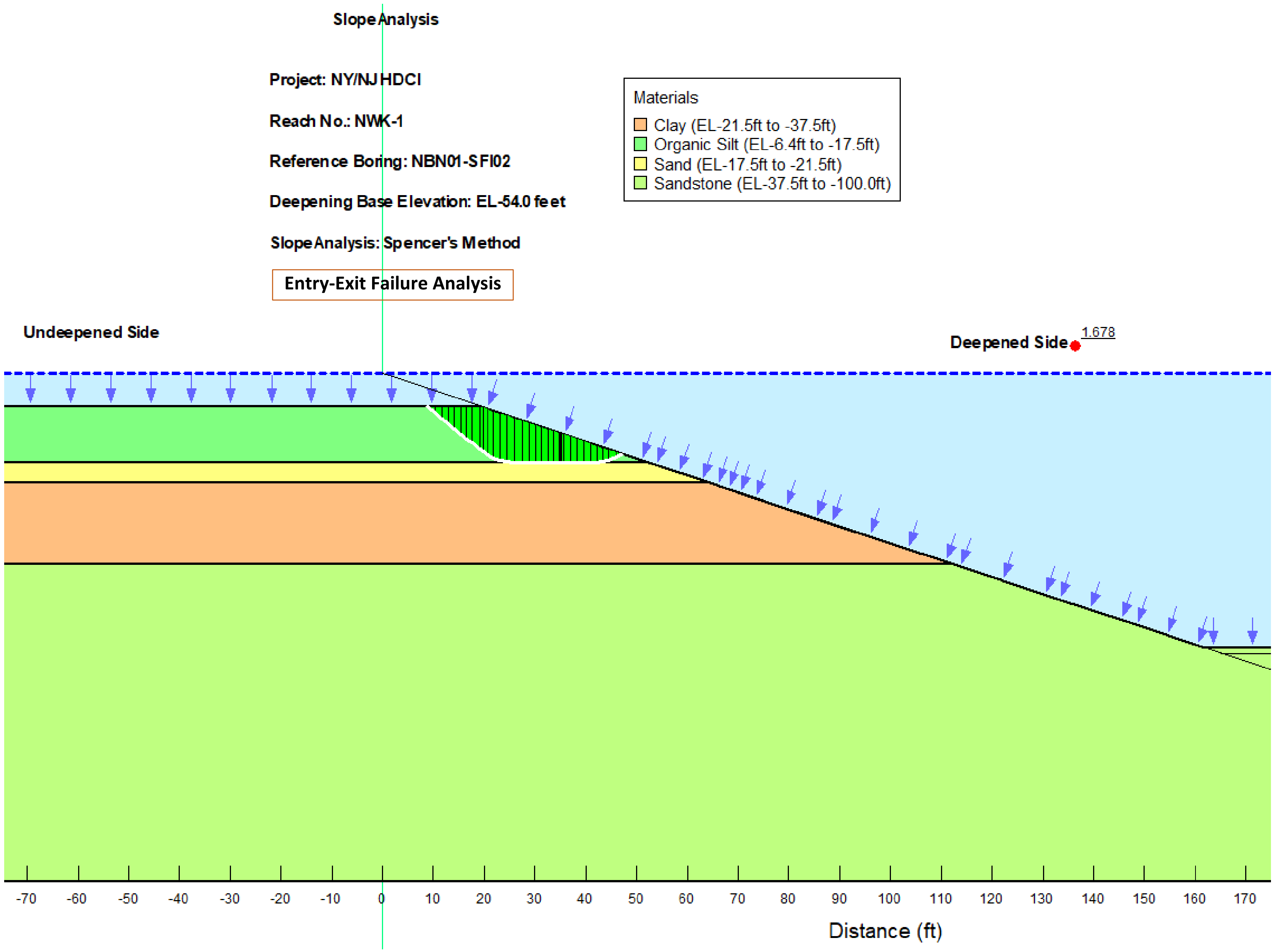

Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-1
Reference Boring: NB98-34
Deepening Base Elevation: EL-55.0 feet
Slope Analysis: Spencer's Method
Entry-Exit Failure Analysis
Materials
Clay (EL-29.0ft to -44.0ft)
Decomposed Shale(EL-44.0ft to -49.0ft)
Organic Silt (EL-15.7ft to -24.0ft)
Sand (EL-24.0ft to -29.0ft)
Shale, Serpentinite, Diabase & Sandstone (EL-49.0ft to -100.0ft)
Undeepened Side
Deepened Side
1.953
-70
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
Distance (ft)

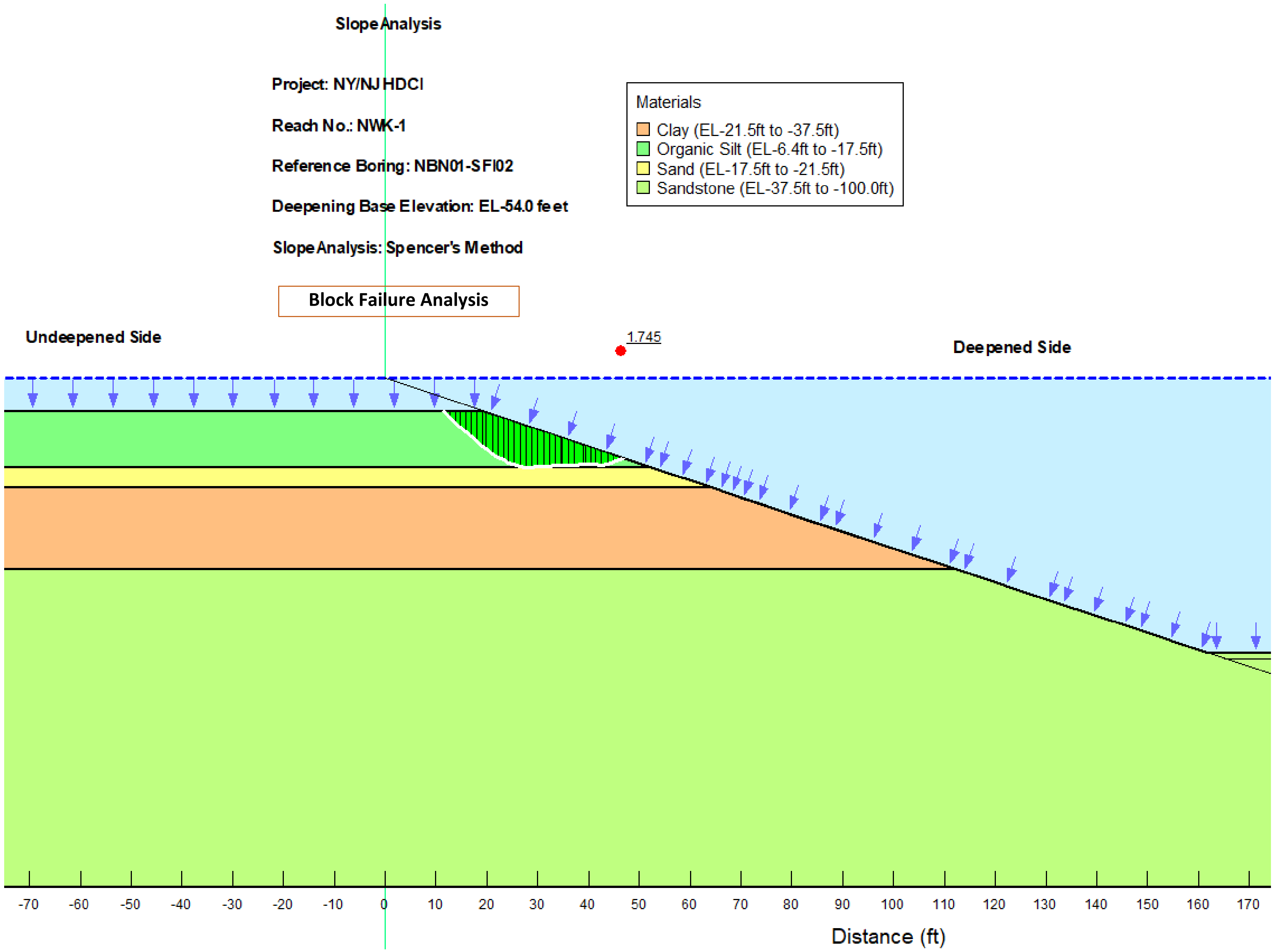


Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-1
Reference Boring: NB98-34
Deepening Base Elevation: EL-55.0 feet
Slope Analysis: Spencer's Method
Materials
Clay (EL-29.0ft to -44.0ft)
Decomposed Shale(EL-44.0ft to -49.0ft)
Organic Silt (EL-15.7ft to -24.0ft)
Sand (EL-24.0ft to -29.0ft)
Shale, Serpentinite, Diabase & Sandstone (EL-49.0ft to -100.0ft)
Block Failure Analysis
Undeepened Side
Deepened Side
1.962
-70
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
Distance (ft)

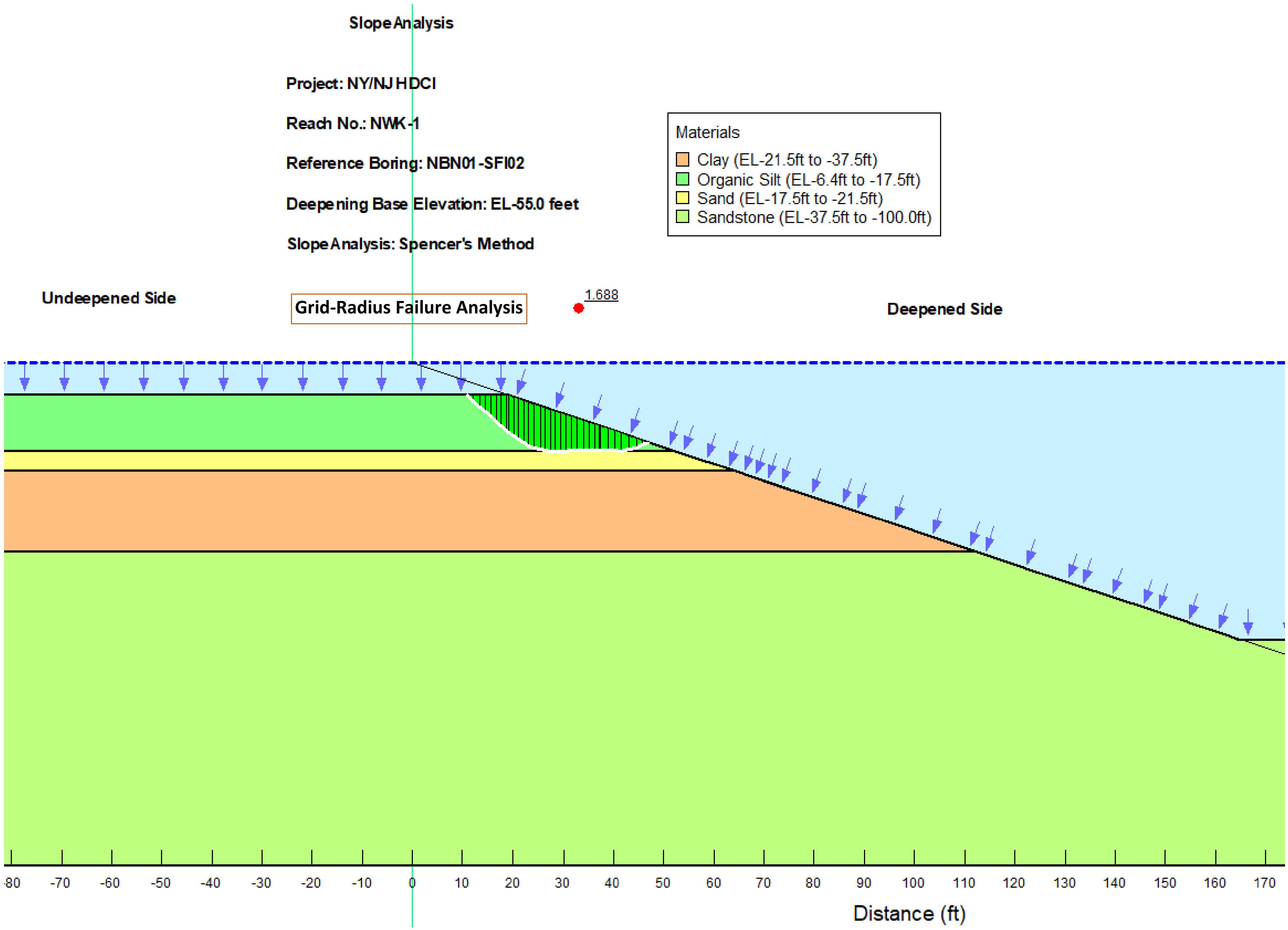


Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-1
Reference Boring: NBN01-SFI02
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Grid-Radius Failure Analysis
1.688
Materials
Clay (EL-21.5ft to -37.5ft)
Organic Silt (EL-6.4ft to -17.5ft)
Sand (EL-17.5ft to -21.5ft)
Sandstone (EL-37.5ft to -100.0ft)
Undeepened Side
Deepened Side
-70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170
Distance (ft)

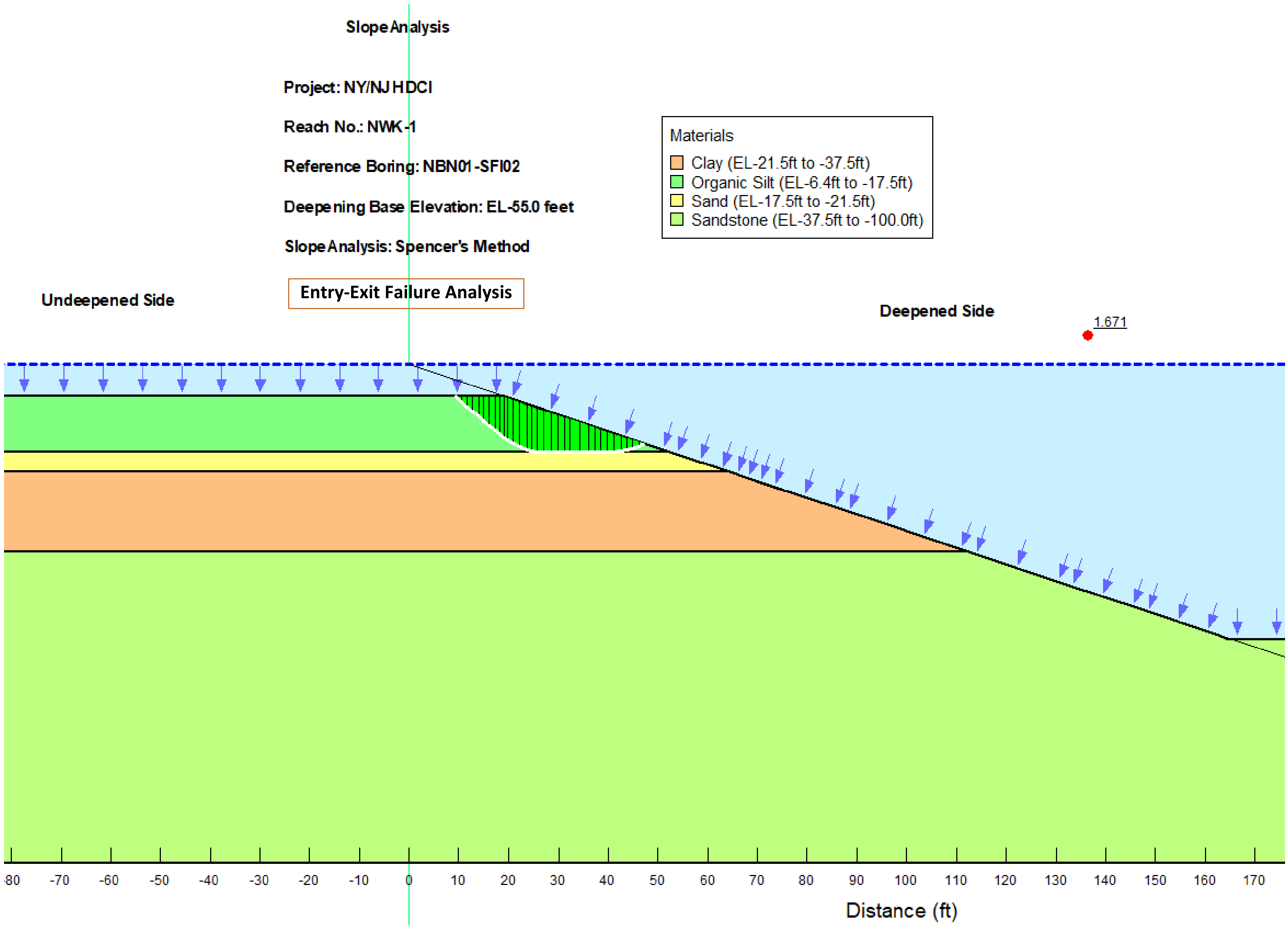

Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-1
Reference Boring: NBN01-SFI02
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Entry-Exit Failure Analysis
Materials
Clay (EL-21.5ft to -37.5ft)
Organic Silt (EL-6.4ft to -17.5ft)
Sand (EL-17.5ft to -21.5ft)
Sandstone (EL-37.5ft to -100.0ft)
Undeepened Side
Deepened Side
1.678
-70
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
Distance (ft)



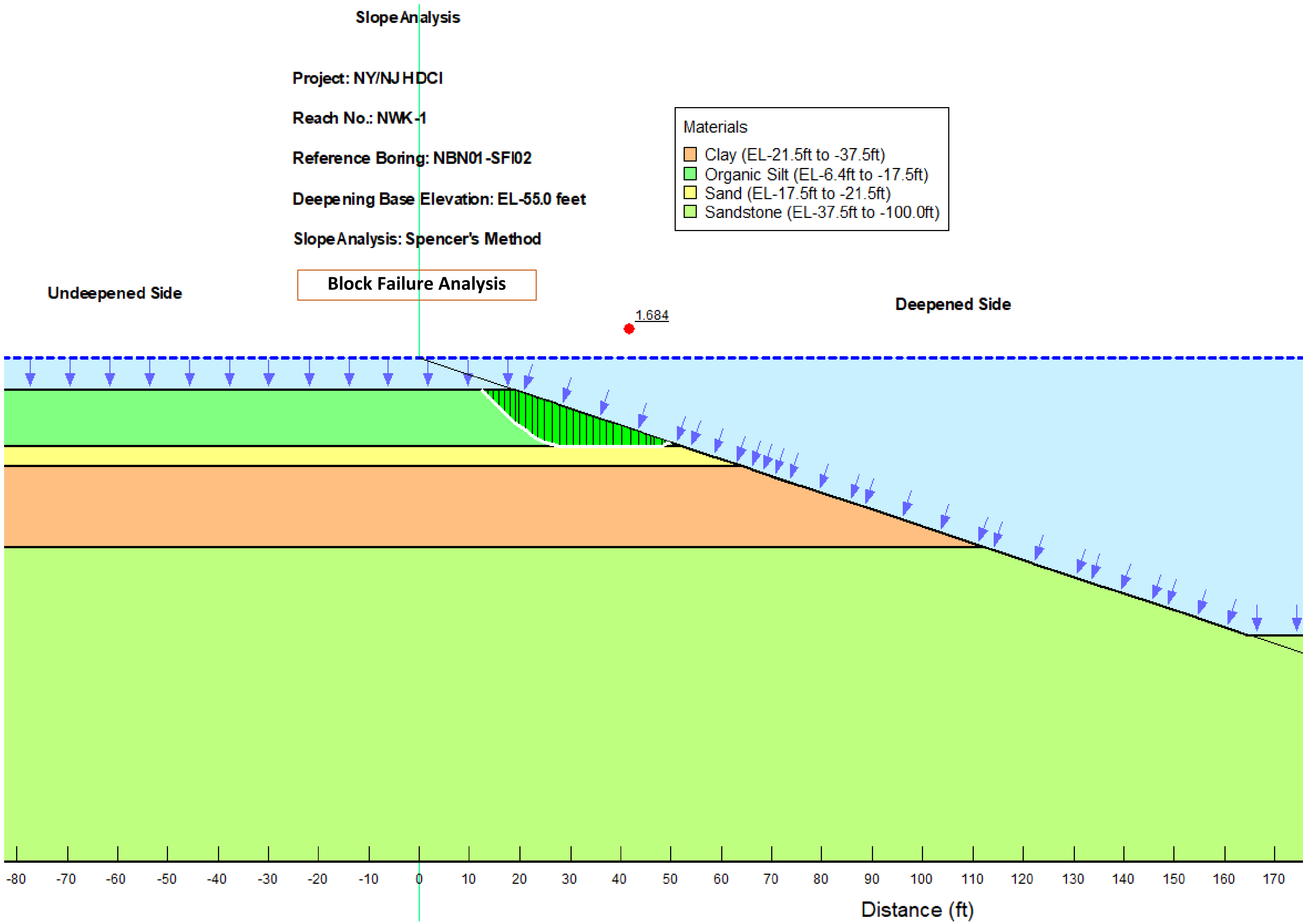
Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-1
Reference Boring: NBN01-SFI02
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Block Failure Analysis
Materials
Clay (EL-21.5ft to -37.5ft)
Organic Silt (EL-6.4ft to -17.5ft)
Sand (EL-17.5ft to -21.5ft)
Sandstone (EL-37.5ft to -100.0ft)
Undeepened Side
1.745
Deepened Side
-70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170
Distance (ft)

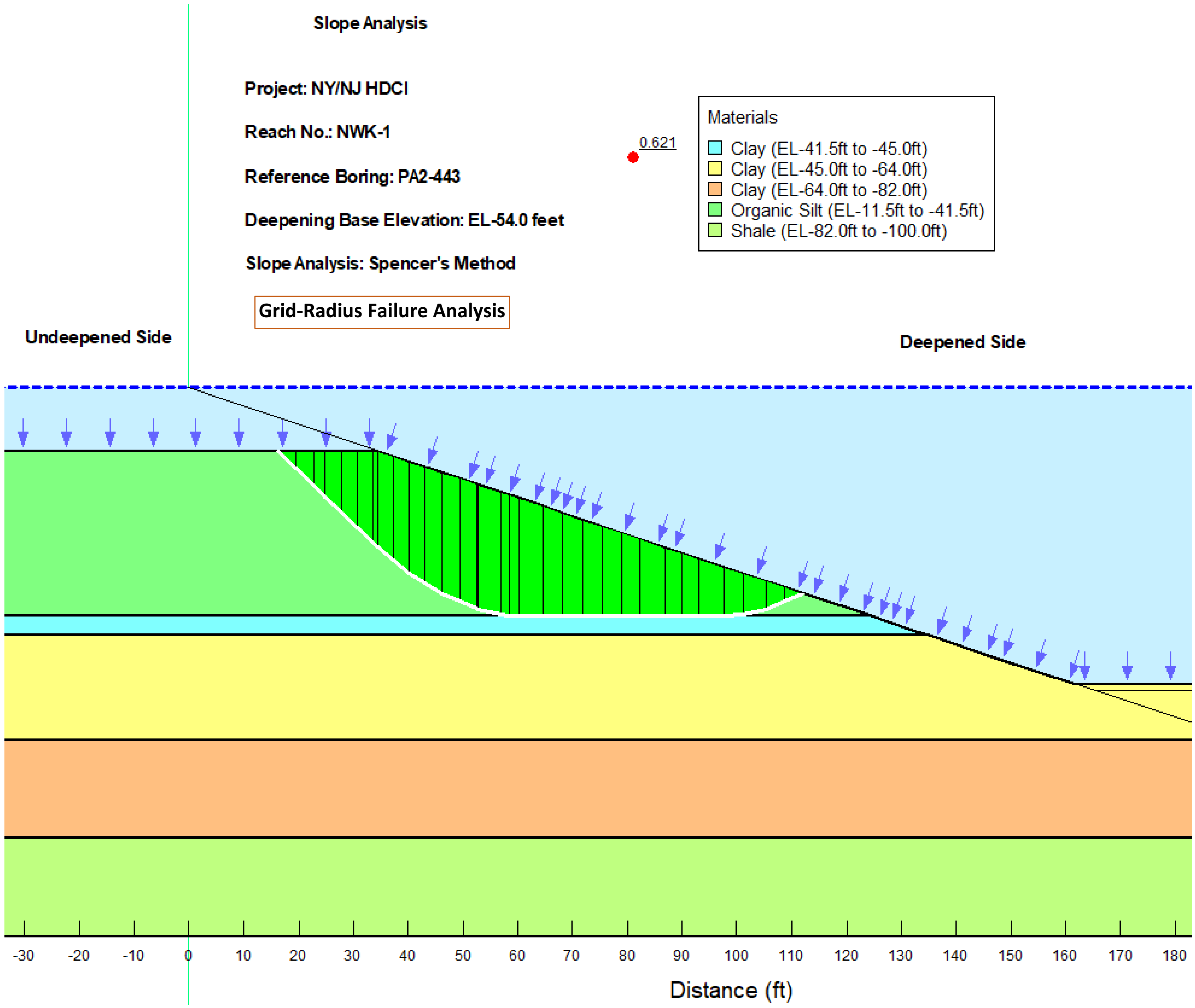


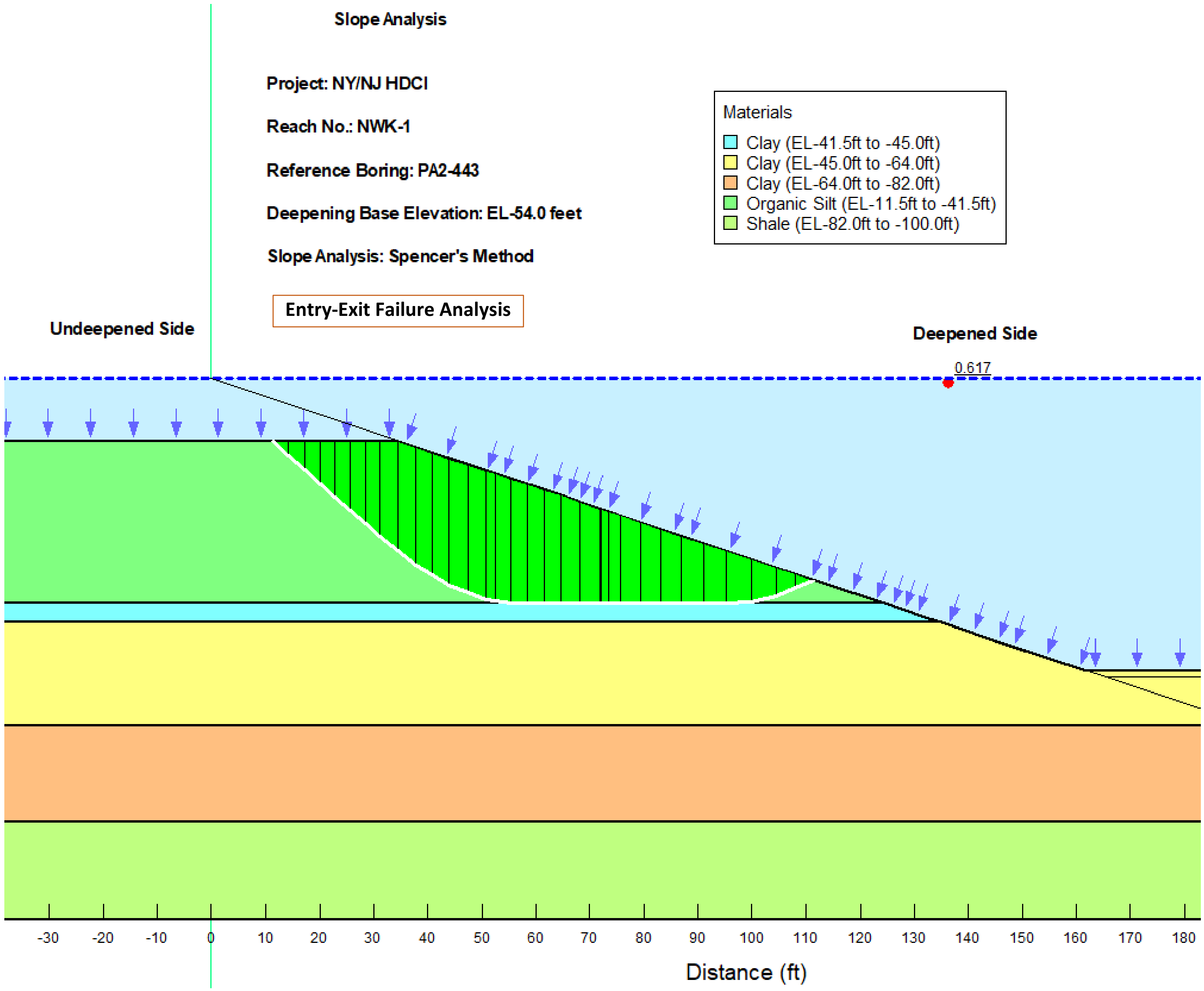
Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-1
Reference Boring: NBN01-SFI02
Deepening Base Elevation: EL-55.0 feet
Slope Analysis: Spencer's Method
Materials
Clay (EL-21.5ft to -37.5ft)
Organic Silt (EL-6.4ft to -17.5ft)
Sand (EL-17.5ft to -21.5ft)
Sandstone (EL-37.5ft to -100.0ft)
Undeepened Side
Grid-Radius Failure Analysis
1.688
Deepened Side
-80
-70
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
Distance (ft)

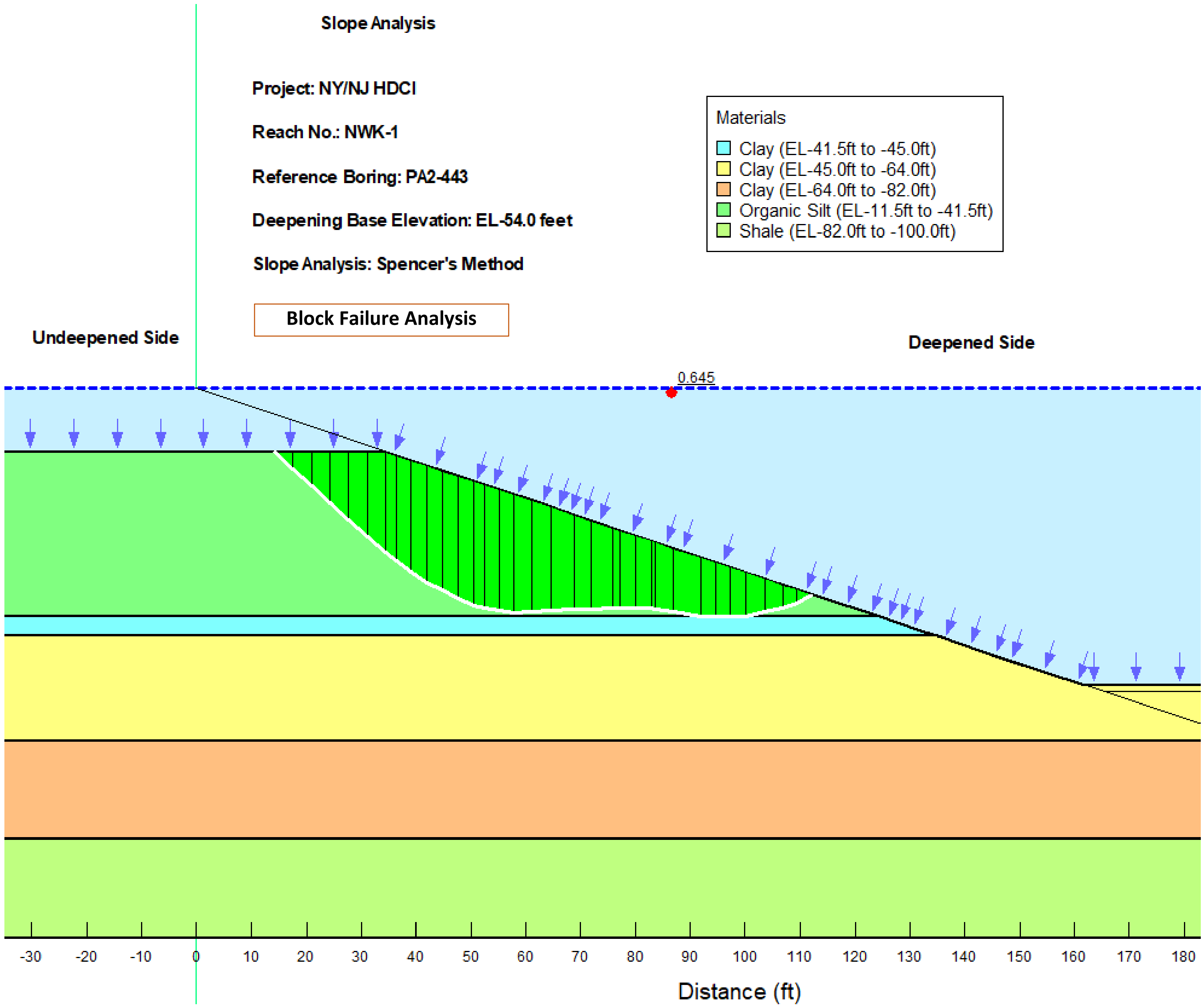


Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-1
Reference Boring: NBN01-SFI02
Deepening Base Elevation: EL-55.0 feet
Slope Analysis: Spencer's Method
Entry-Exit Failure Analysis
Materials
Clay (EL-21.5ft to -37.5ft)
Organic Silt (EL-6.4ft to -17.5ft)
Sand (EL-17.5ft to -21.5ft)
Sandstone (EL-37.5ft to -100.0ft)
Undeepened Side
Deepened Side
1.671
-80
-70
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
Distance (ft)

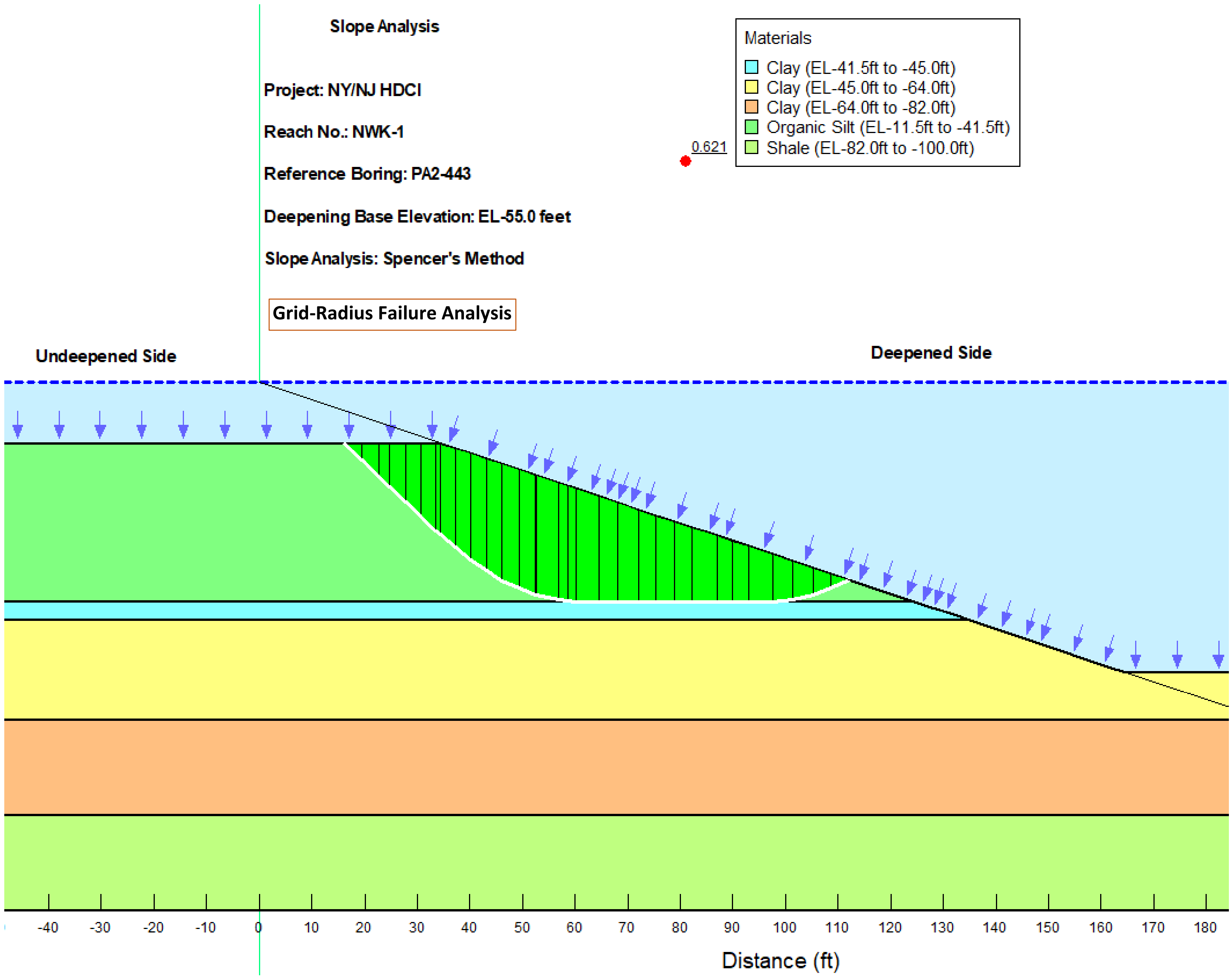

Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-1
Reference Boring: NBN01-SFI02
Deepening Base Elevation: EL-55.0 feet
Slope Analysis: Spencer's Method
Block Failure Analysis
Materials
Clay (EL-21.5ft to -37.5ft)
Organic Silt (EL-6.4ft to -17.5ft)
Sand (EL-17.5ft to -21.5ft)
Sandstone (EL-37.5ft to -100.0ft)
Undeepened Side
Deepened Side
1.684
-80
-70
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
Distance (ft)

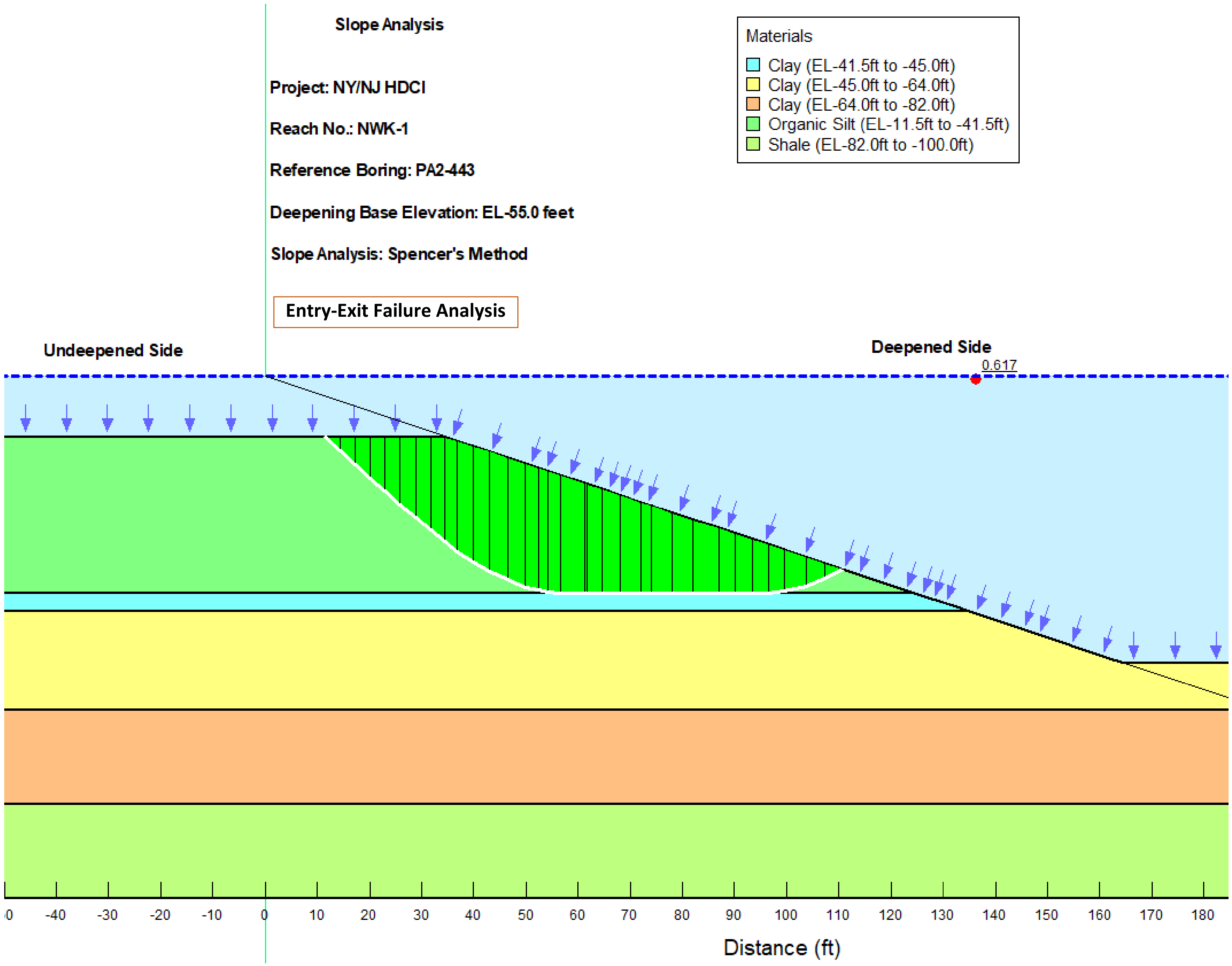

Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-1
Reference Boring: PA2-443
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Grid-Radius Failure Analysis
0.621
Materials
Clay (EL-41.5ft to -45.0ft)
Clay (EL-45.0ft to -64.0ft)
Clay (EL-64.0ft to -82.0ft)
Organic Silt (EL-11.5ft to -41.5ft)
Shale (EL-82.0ft to -100.0ft)
Undeepened Side
Deepened Side
-30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
Distance (ft)


Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-1
Reference Boring: PA2-443
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Entry-Exit Failure Analysis
Materials
Clay (EL-41.5ft to -45.0ft)
Clay (EL-45.0ft to -64.0ft)
Clay (EL-64.0ft to -82.0ft)
Organic Silt (EL-11.5ft to -41.5ft)
Shale (EL-82.0ft to -100.0ft)
Undeepened Side
Deepened Side
0.617
-30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
Distance (ft)

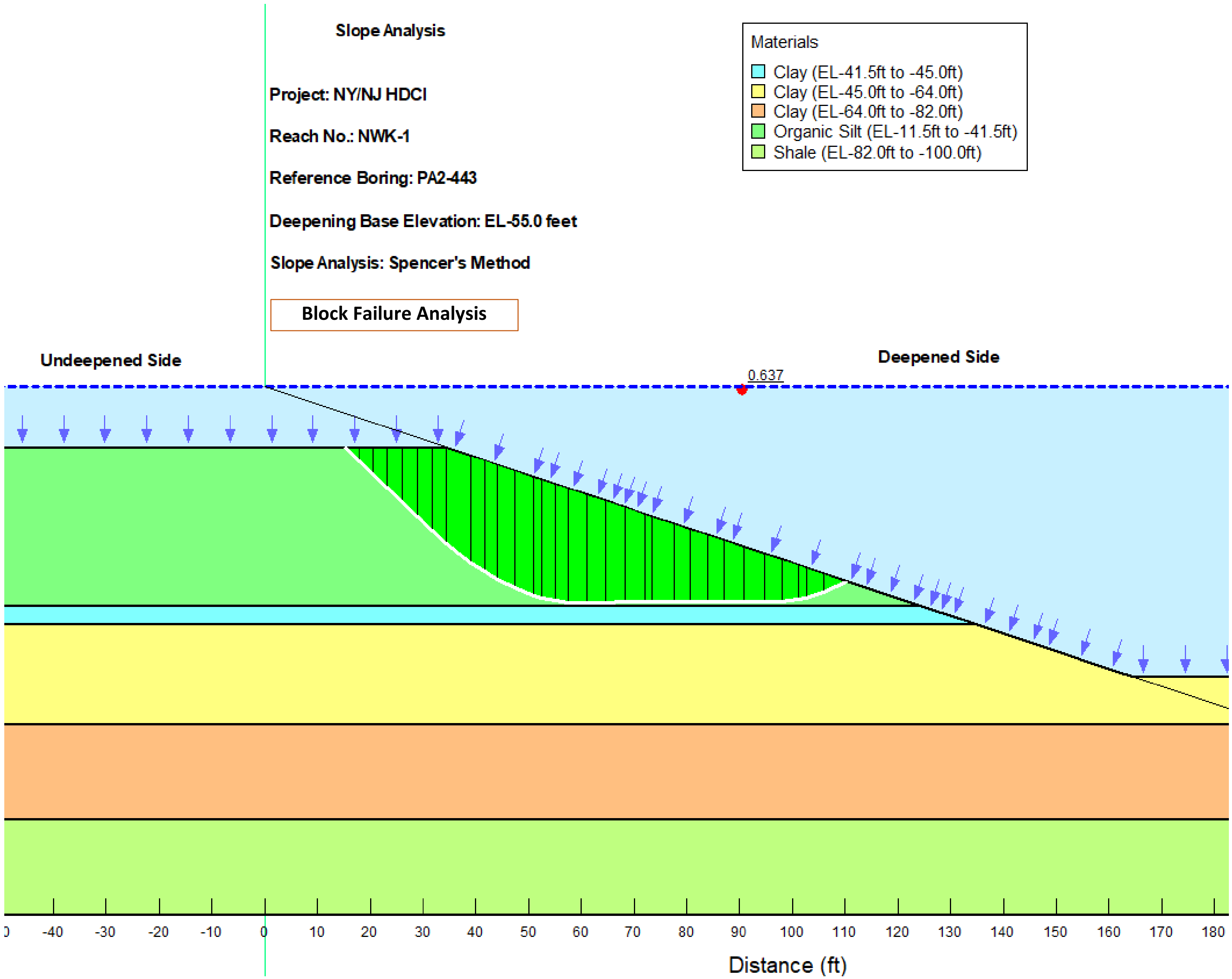


Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-1
Reference Boring: PA2-443
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Block Failure Analysis
Materials
Clay (EL-41.5ft to -45.0ft)
Clay (EL-45.0ft to -64.0ft)
Clay (EL-64.0ft to -82.0ft)
Organic Silt (EL-11.5ft to -41.5ft)
Shale (EL-82.0ft to -100.0ft)
Undeepened Side
Deepened Side
0.645
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
Distance (ft)

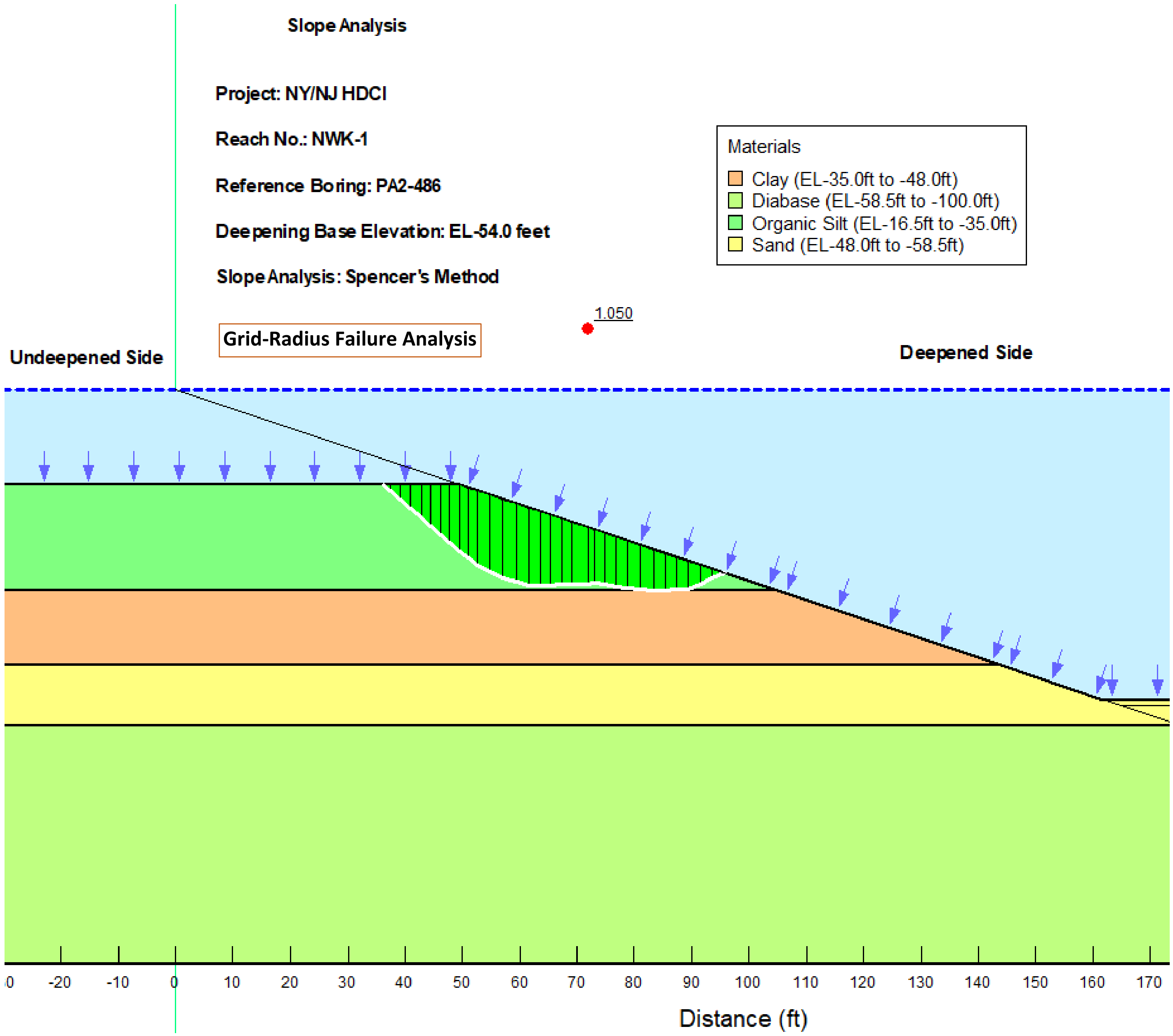

Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-1
Reference Boring: PA2-443
Deepening Base Elevation: EL-55.0 feet
Slope Analysis: Spencer's Method
Grid-Radius Failure Analysis
Materials
Clay (EL-41.5ft to -45.0ft)
Clay (EL-45.0ft to -64.0ft)
Clay (EL-64.0ft to -82.0ft)
Organic Silt (EL-11.5ft to -41.5ft)
Shale (EL-82.0ft to -100.0ft)
0.621
Undeepened Side
Deepened Side
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
Distance (ft)

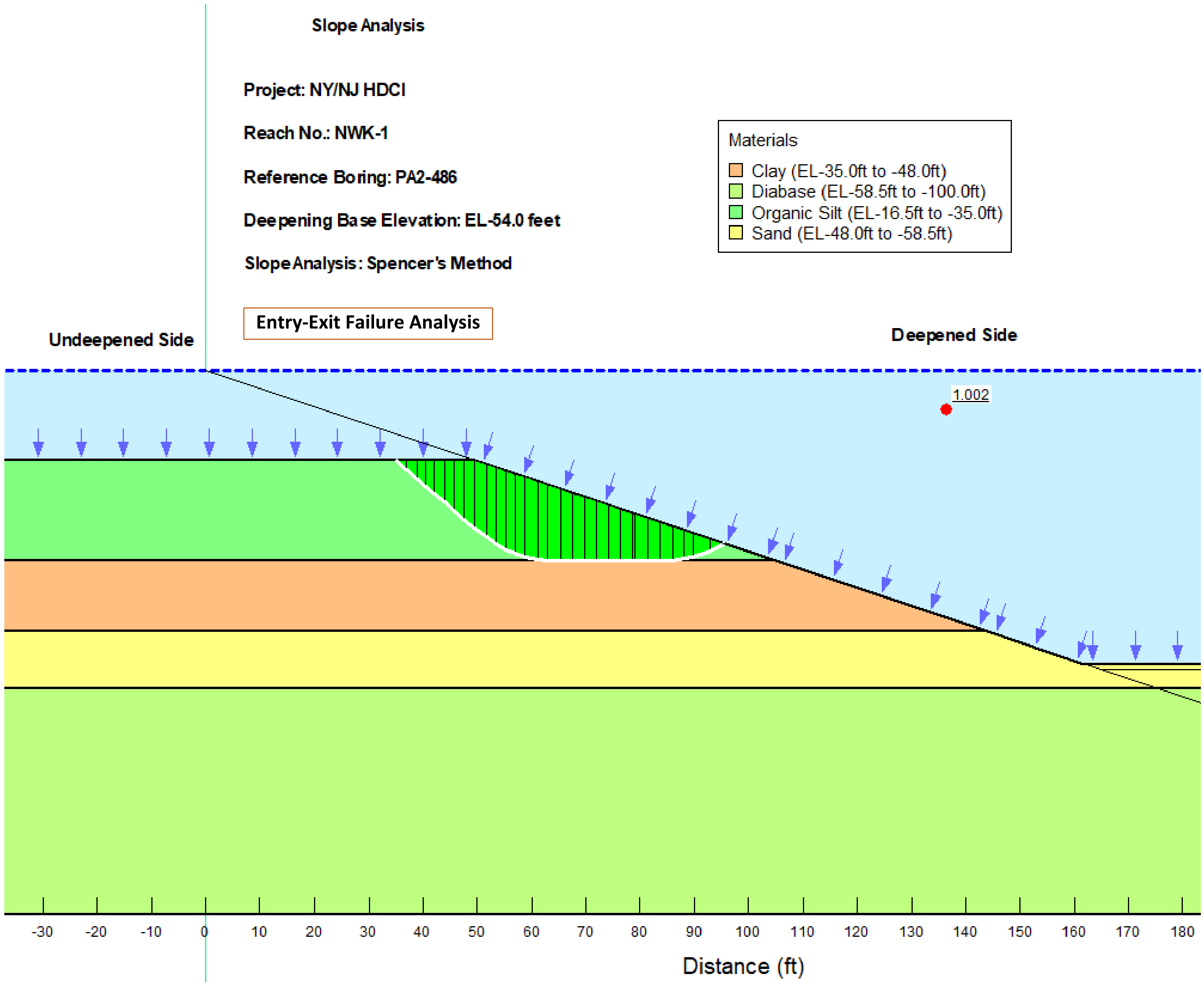


Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-1
Reference Boring: PA2-443
Deepening Base Elevation: EL-55.0 feet
Slope Analysis: Spencer's Method
Entry-Exit Failure Analysis
Materials
Clay (EL-41.5ft to -45.0ft)
Clay (EL-45.0ft to -64.0ft)
Clay (EL-64.0ft to -82.0ft)
Organic Silt (EL-11.5ft to -41.5ft)
Shale (EL-82.0ft to -100.0ft)
Undeepened Side
Deepened Side
0.617
0
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
Distance (ft)

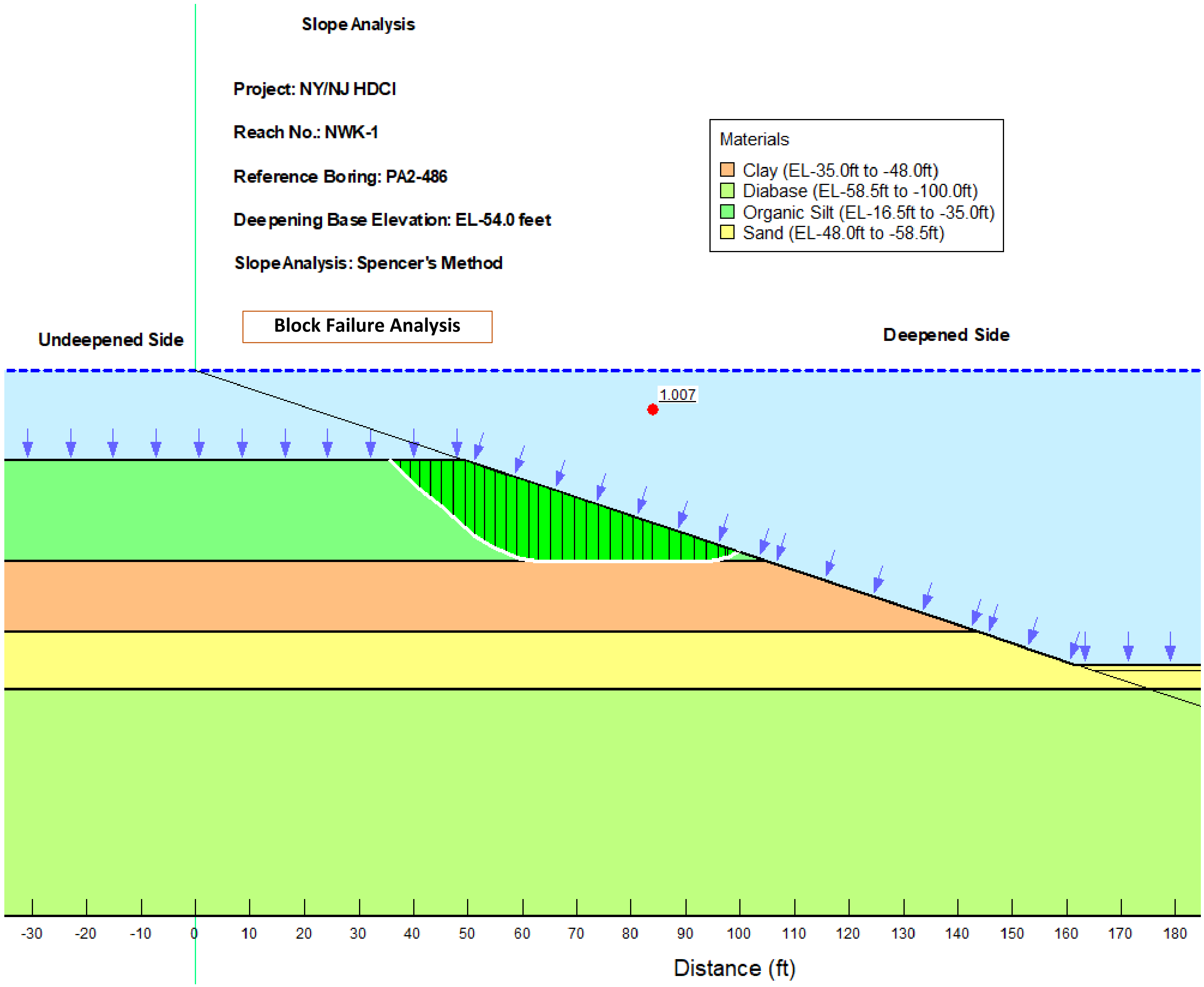


Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-1
Reference Boring: PA2-443
Deepening Base Elevation: EL-55.0 feet
Slope Analysis: Spencer's Method
Block Failure Analysis
Materials
Clay (EL-41.5ft to -45.0ft)
Clay (EL-45.0ft to -64.0ft)
Clay (EL-64.0ft to -82.0ft)
Organic Silt (EL-11.5ft to -41.5ft)
Shale (EL-82.0ft to -100.0ft)
Undeepened Side
Deepened Side
0.637
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
Distance (ft)

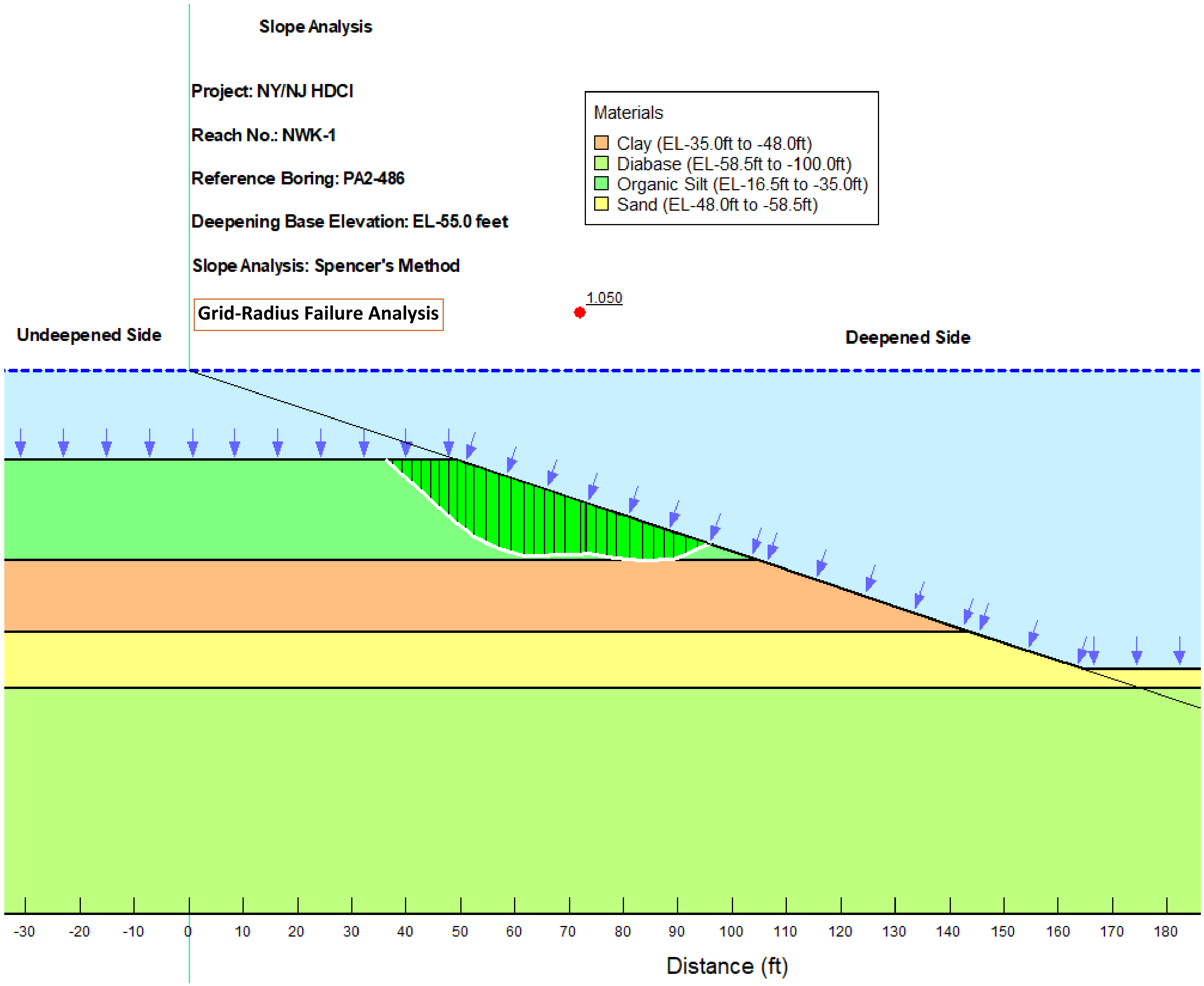

Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-1
Reference Boring: PA2-486
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Grid-Radius Failure Analysis
1.050
Materials
Clay (EL-35.0ft to -48.0ft)
Diabase (EL-58.5ft to -100.0ft)
Organic Silt (EL-16.5ft to -35.0ft)
Sand (EL-48.0ft to -58.5ft)
Undeepened Side
Deepened Side
0
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
Distance (ft)



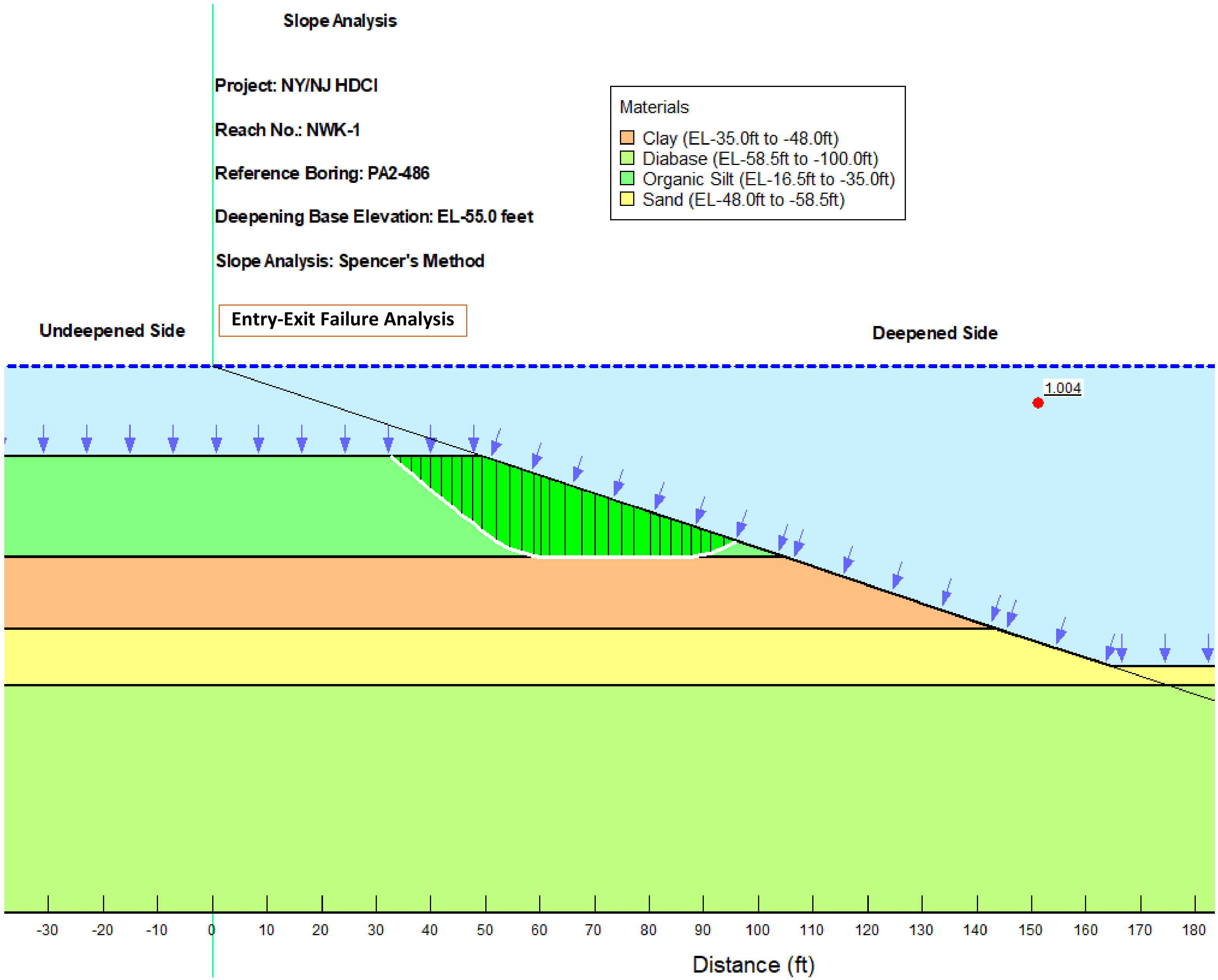
Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-1
Reference Boring: PA2-486
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Entry-Exit Failure Analysis
Materials
Clay (EL-35.0ft to -48.0ft)
Diabase (EL-58.5ft to -100.0ft)
Organic Silt (EL-16.5ft to -35.0ft)
Sand (EL-48.0ft to -58.5ft)
Undeepened Side
Deepened Side
1.002
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
Distance (ft)



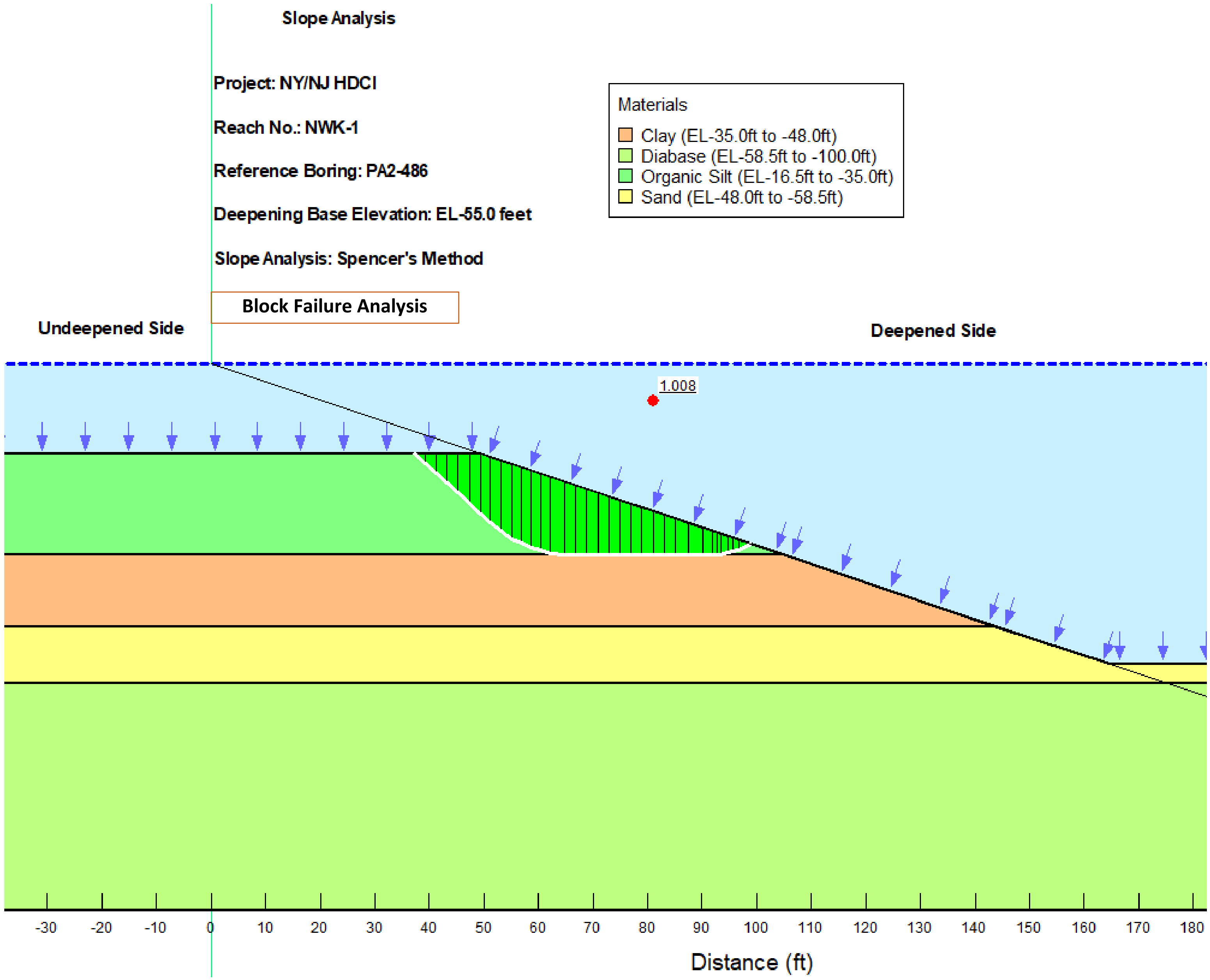
Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-1
Reference Boring: PA2-486
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Materials
Clay (EL-35.0ft to -48.0ft)
Diabase (EL-58.5ft to -100.0ft)
Organic Silt (EL-16.5ft to -35.0ft)
Sand (EL-48.0ft to -58.5ft)
Block Failure Analysis
Undeepened Side
Deepened Side
1.007
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
Distance (ft)



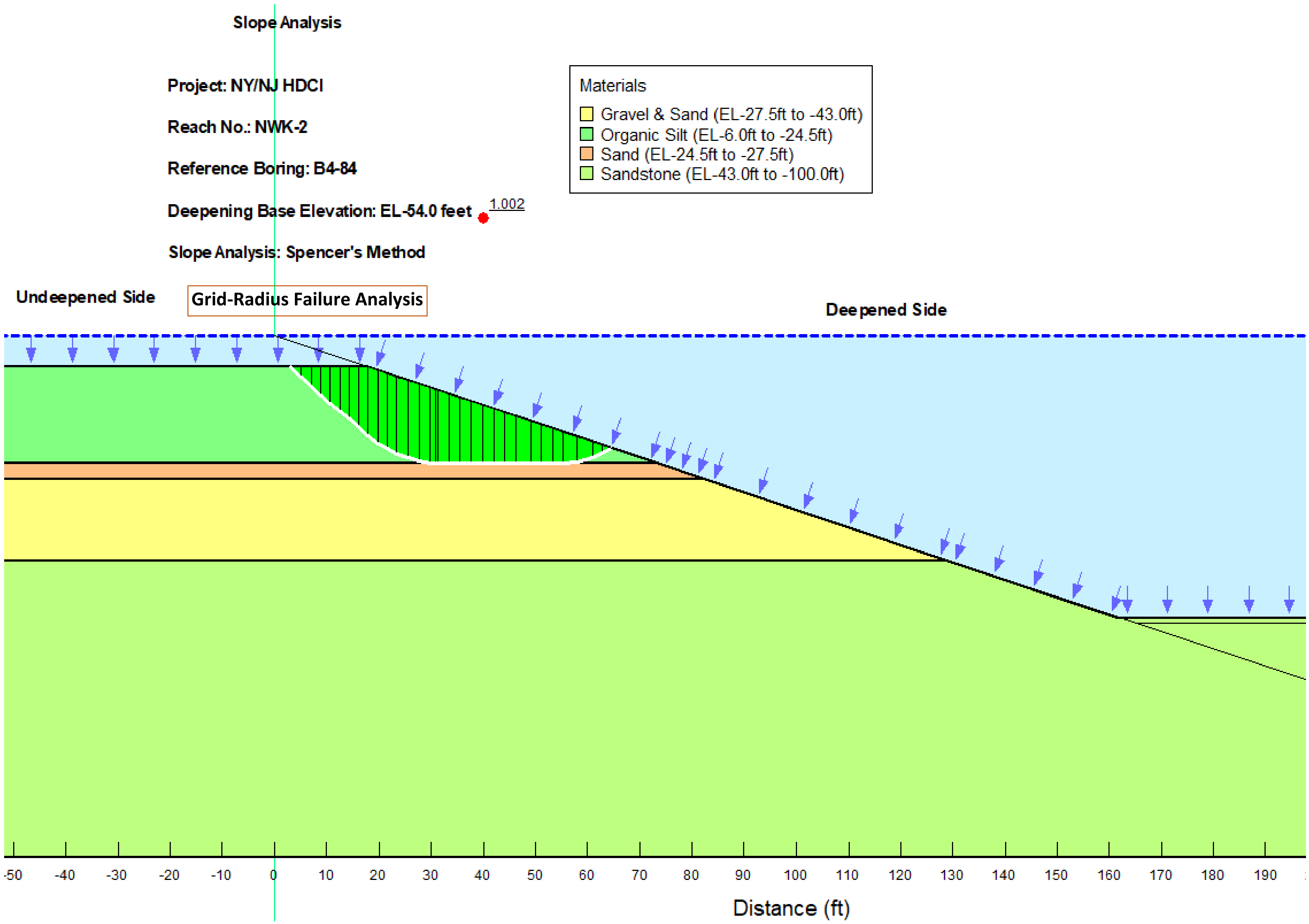
Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-1
Reference Boring: PA2-486
Deepening Base Elevation: EL-55.0 feet
Slope Analysis: Spencer's Method
Grid-Radius Failure Analysis
Materials
Clay (EL-35.0ft to -48.0ft)
Diabase (EL-58.5ft to -100.0ft)
Organic Silt (EL-16.5ft to -35.0ft)
Sand (EL-48.0ft to -58.5ft)
1.050
Undeepened Side
Deepened Side
-30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
Distance (ft)



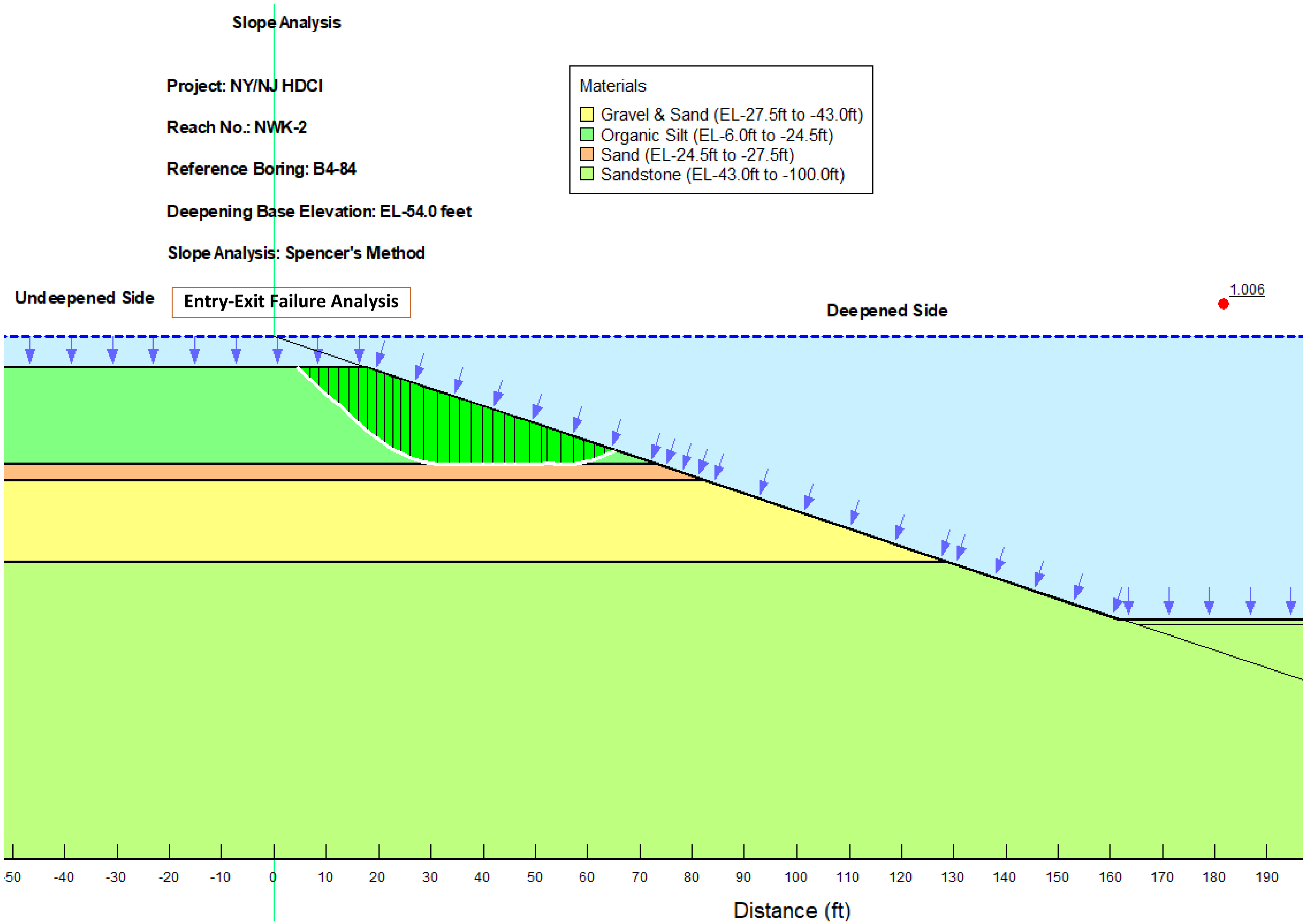
Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-1
Reference Boring: PA2-486
Deepening Base Elevation: EL-55.0 feet
Slope Analysis: Spencer's Method
Materials
Clay (EL-35.0ft to -48.0ft)
Diabase (EL-58.5ft to -100.0ft)
Organic Silt (EL-16.5ft to -35.0ft)
Sand (EL-48.0ft to -58.5ft)
Entry-Exit Failure Analysis
Undeepened Side
Deepened Side
1.004
-30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
Distance (ft)



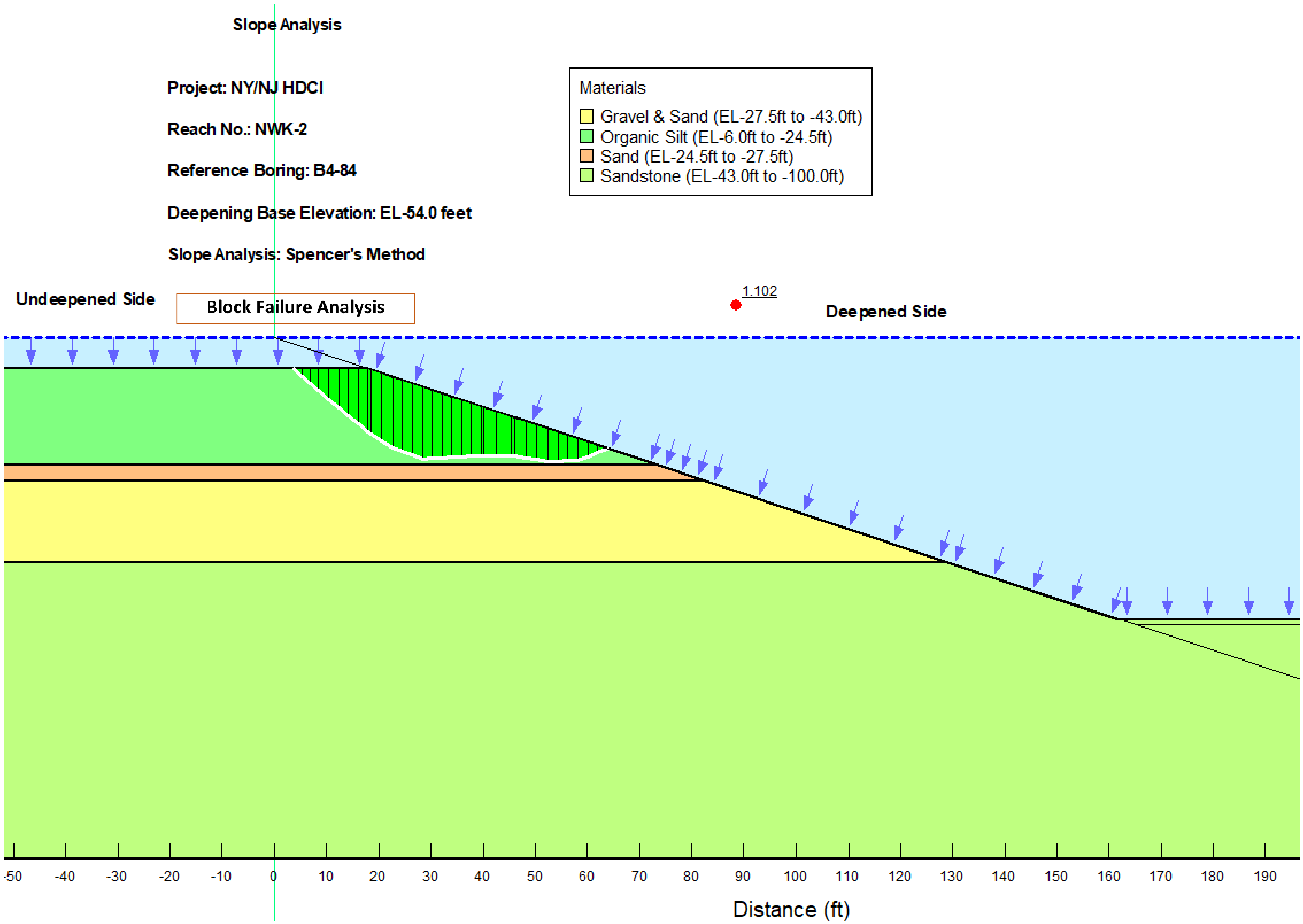
Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-1
Reference Boring: PA2-486
Deepening Base Elevation: EL-55.0 feet
Slope Analysis: Spencer's Method
Block Failure Analysis
Materials
Clay (EL-35.0ft to -48.0ft)
Diabase (EL-58.5ft to -100.0ft)
Organic Silt (EL-16.5ft to -35.0ft)
Sand (EL-48.0ft to -58.5ft)
Undeepened Side
Deepened Side
1.008
-30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
Distance (ft)

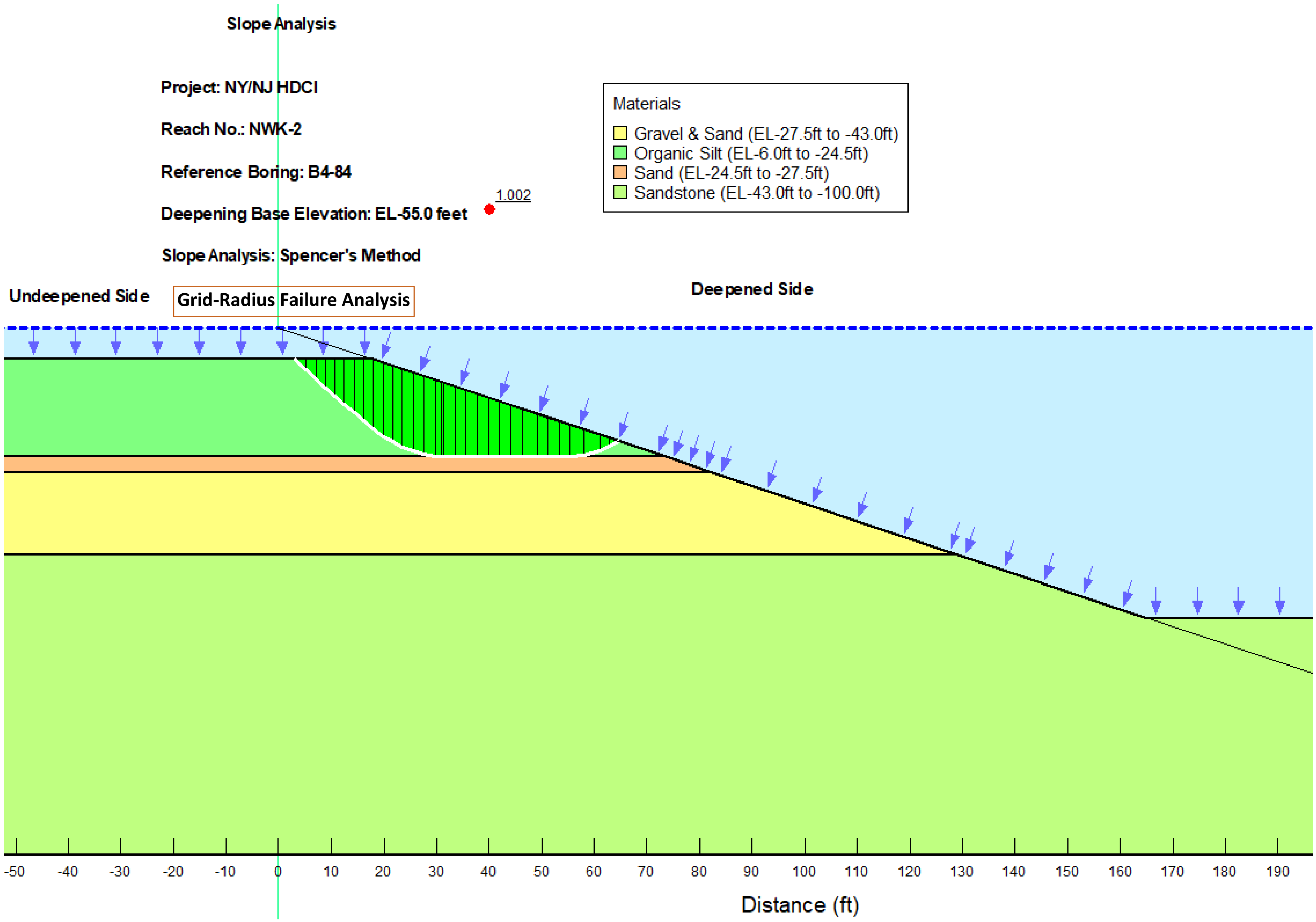


Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-2
Reference Boring: B4-84
Deepening Base Elevation: EL-54.0 feet
1.002
Slope Analysis: Spencer's Method
Materials
Gravel & Sand (EL-27.5ft to -43.0ft)
Organic Silt (EL-6.0ft to -24.5ft)
Sand (EL-24.5ft to -27.5ft)
Sandstone (EL-43.0ft to -100.0ft)
Undeepened Side
Grid-Radius Failure Analysis
Deepened Side
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
Distance (ft)

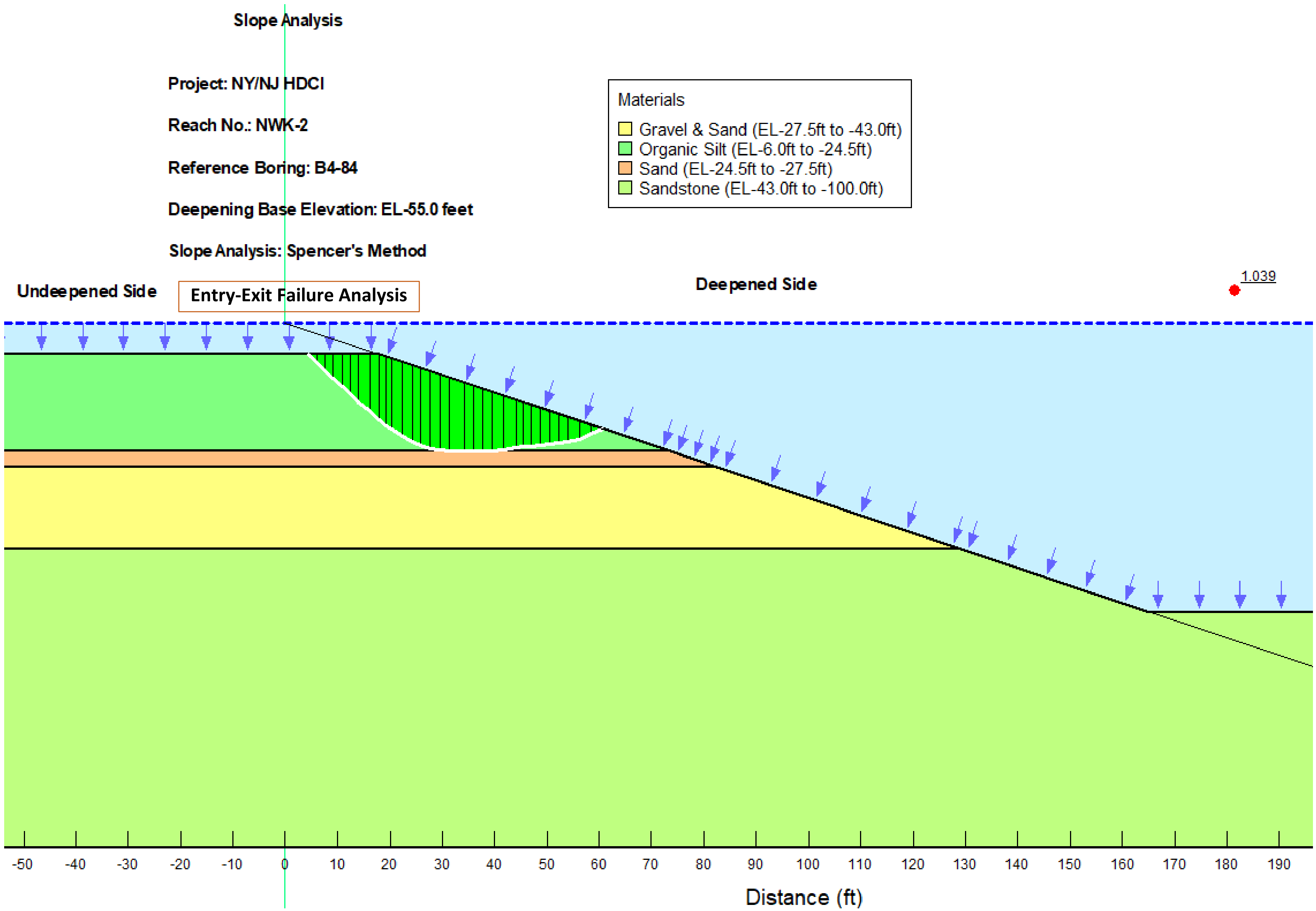


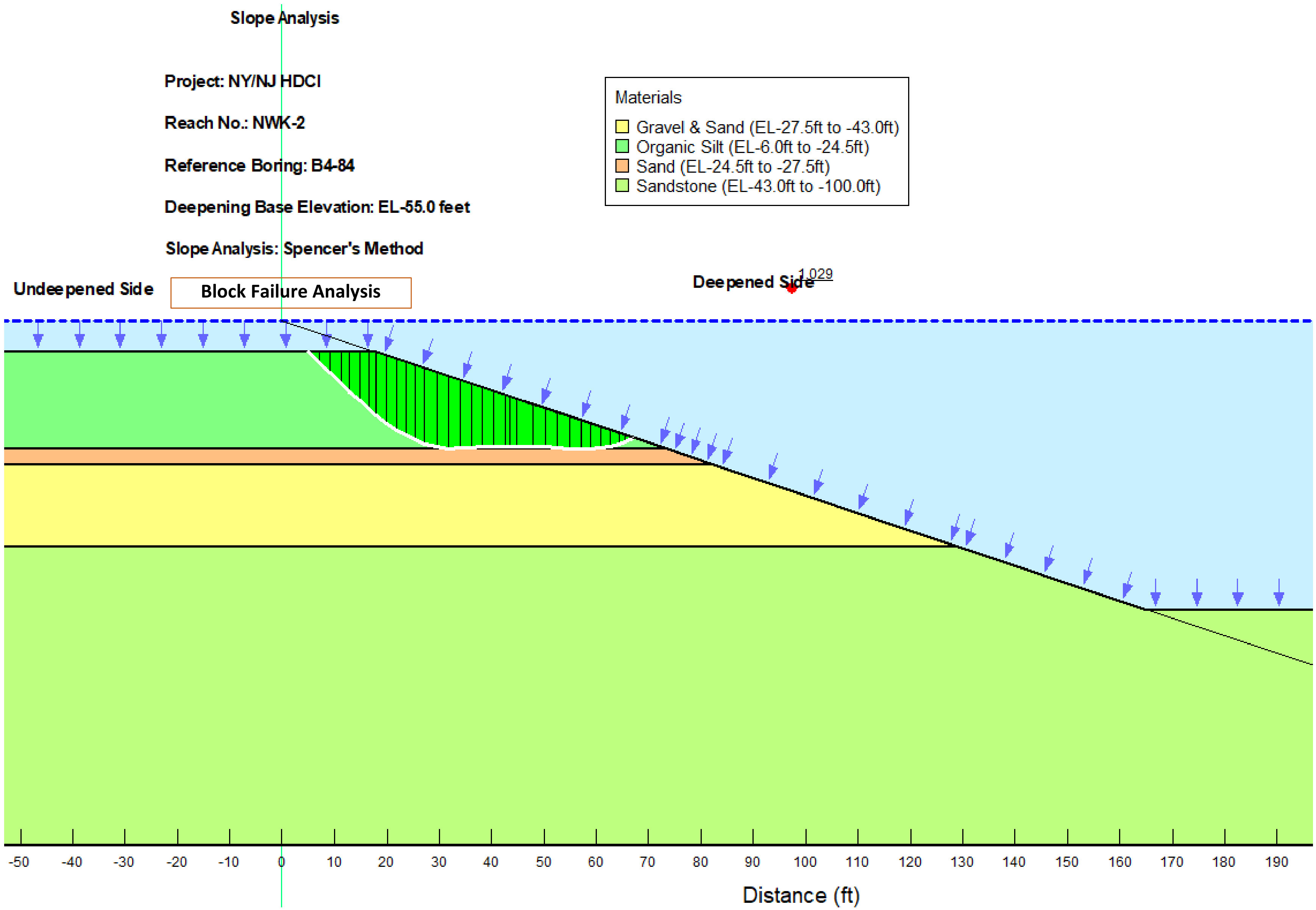
Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-2
Reference Boring: B4-84
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Materials
Gravel & Sand (EL-27.5ft to -43.0ft)
Organic Silt (EL-6.0ft to -24.5ft)
Sand (EL-24.5ft to -27.5ft)
Sandstone (EL-43.0ft to -100.0ft)
Undeepened Side
Entry-Exit Failure Analysis
1.006
Deepened Side
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
Distance (ft)


Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-2
Reference Boring: B4-84
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Materials
Gravel & Sand (EL-27.5ft to -43.0ft)
Organic Silt (EL-6.0ft to -24.5ft)
Sand (EL-24.5ft to -27.5ft)
Sandstone (EL-43.0ft to -100.0ft)
Undeepened Side
Block Failure Analysis
1.102
Deepened Side
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
Distance (ft)

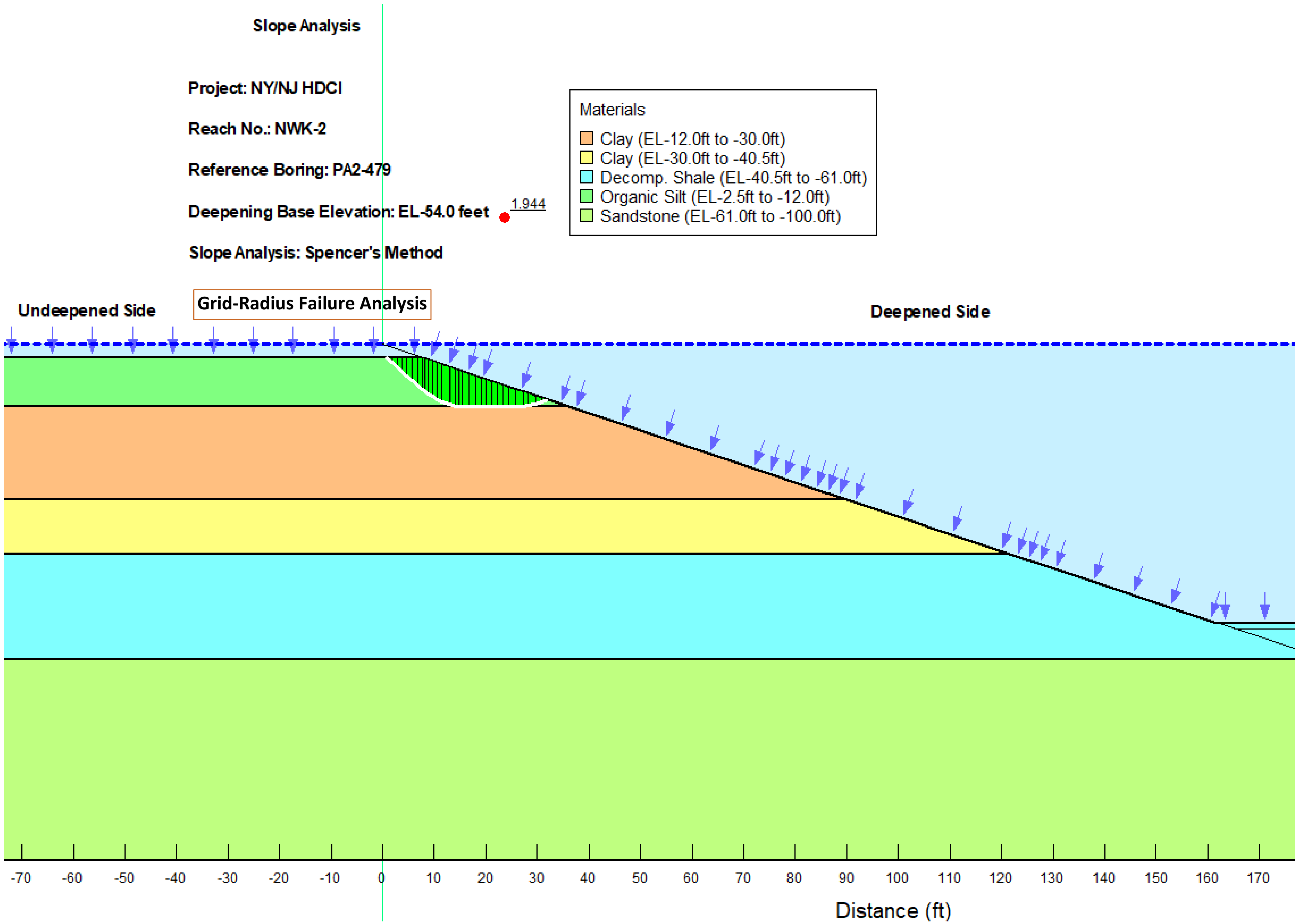


Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-2
Reference Boring: B4-84
Deepening Base Elevation: EL-55.0 feet
Slope Analysis: Spencer's Method
1.002
Materials
Gravel & Sand (EL-27.5ft to -43.0ft)
Organic Silt (EL-6.0ft to -24.5ft)
Sand (EL-24.5ft to -27.5ft)
Sandstone (EL-43.0ft to -100.0ft)
Undeepened Side
Grid-Radius Failure Analysis
Deepened Side
-50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190
Distance (ft)

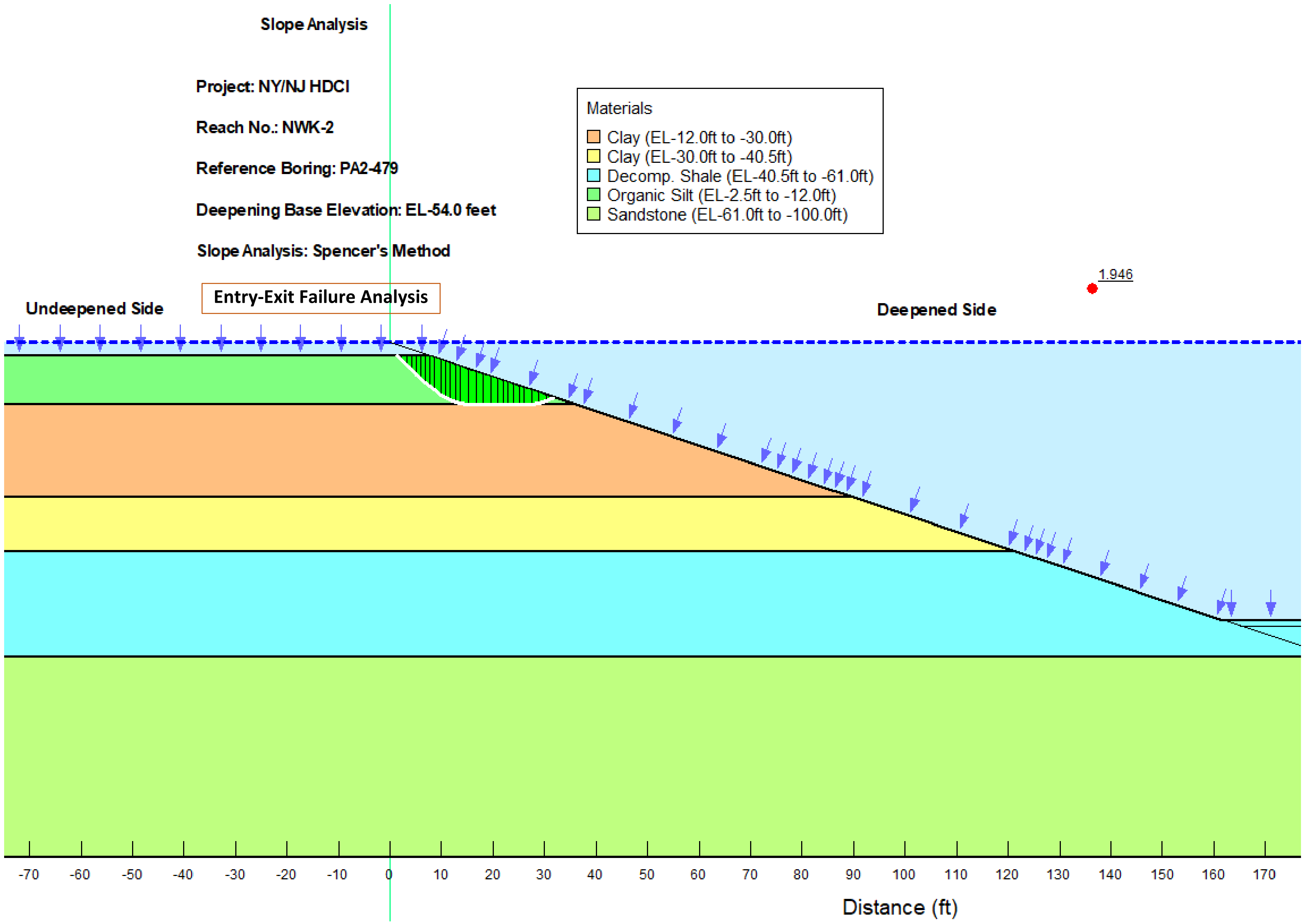

Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-2
Reference Boring: B4-84
Deepening Base Elevation: EL-55.0 feet
Slope Analysis: Spencer's Method
Materials
Gravel & Sand (EL-27.5ft to -43.0ft)
Organic Silt (EL-6.0ft to -24.5ft)
Sand (EL-24.5ft to -27.5ft)
Sandstone (EL-43.0ft to -100.0ft)
Undeepened Side
Entry-Exit Failure Analysis
Deepened Side
1.039
-50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190
Distance (ft)



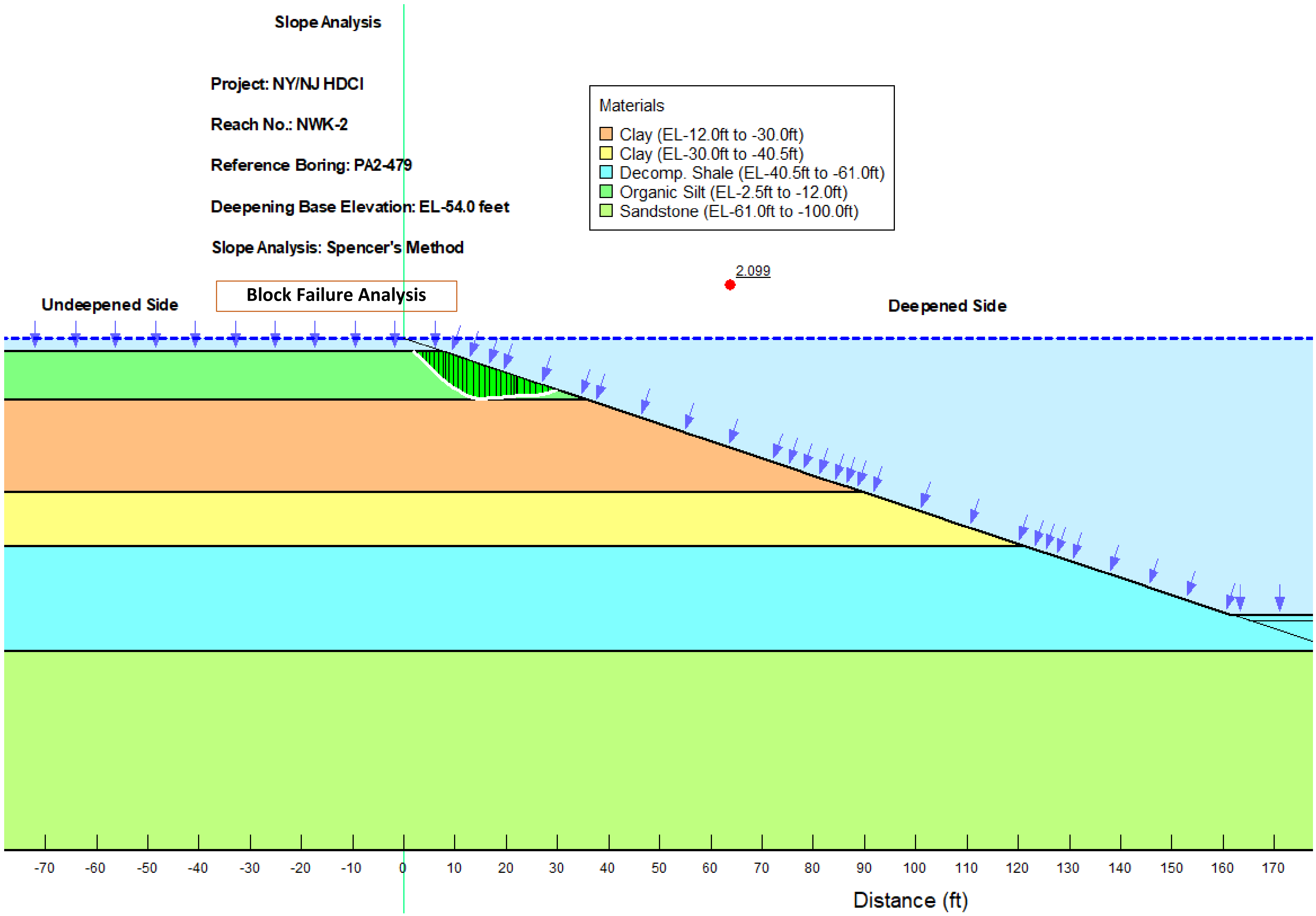
Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-2
Reference Boring: B4-84
Deepening Base Elevation: EL-55.0 feet
Slope Analysis: Spencer's Method
Materials
Gravel & Sand (EL-27.5ft to -43.0ft)
Organic Silt (EL-6.0ft to -24.5ft)
Sand (EL-24.5ft to -27.5ft)
Sandstone (EL-43.0ft to -100.0ft)
Undeepened Side
Block Failure Analysis
Deepened Side
1.029
-50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190
Distance (ft)

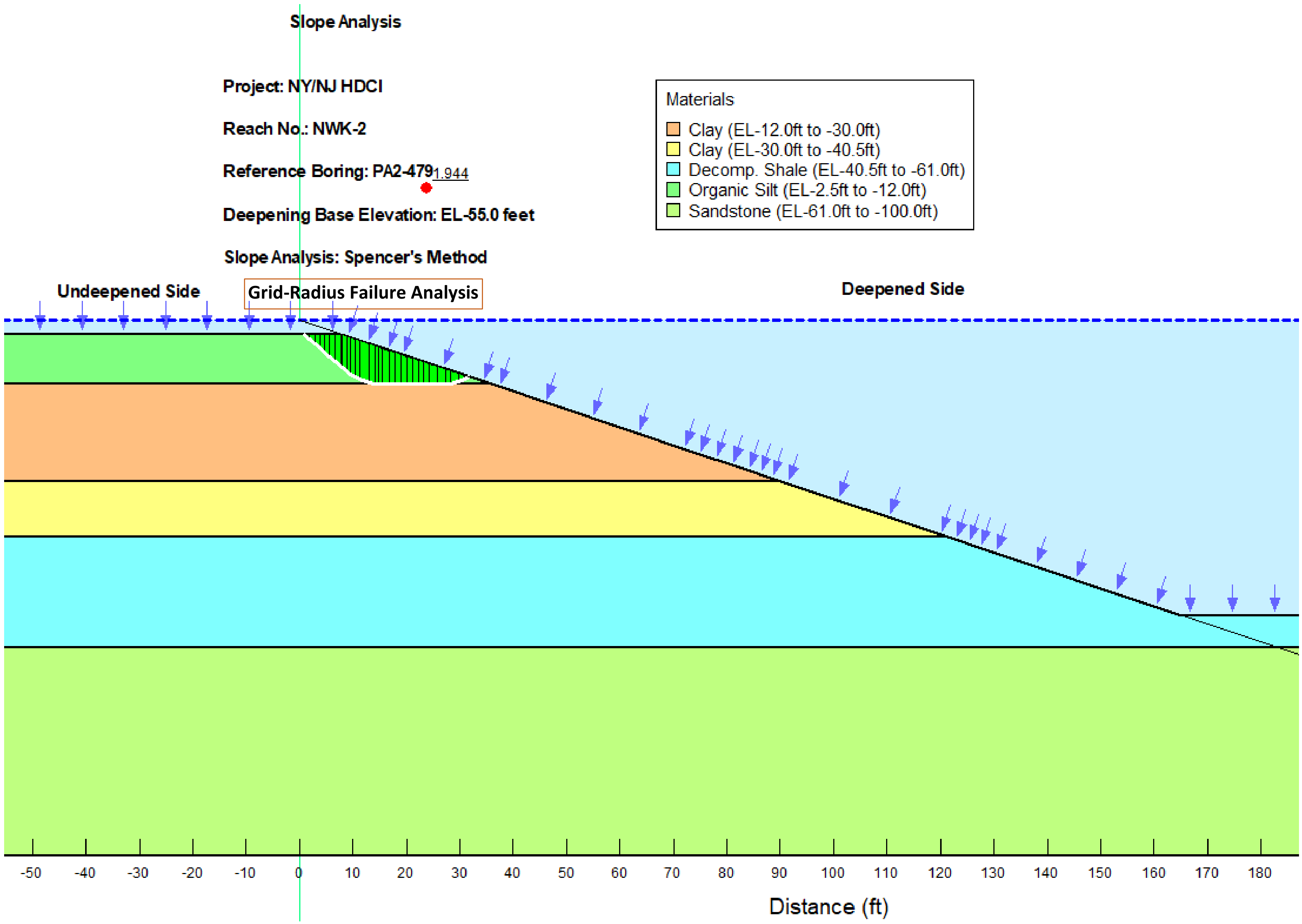


Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-2
Reference Boring: PA2-479
Deepening Base Elevation: EL-54.0 feet
1.944
Slope Analysis: Spencer's Method
Materials
Clay (EL-12.0ft to -30.0ft)
Clay (EL-30.0ft to -40.5ft)
Decomp. Shale (EL-40.5ft to -61.0ft)
Organic Silt (EL-2.5ft to -12.0ft)
Sandstone (EL-61.0ft to -100.0ft)
Grid-Radius Failure Analysis
Undeepened Side
Deepened Side
-70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170
Distance (ft)

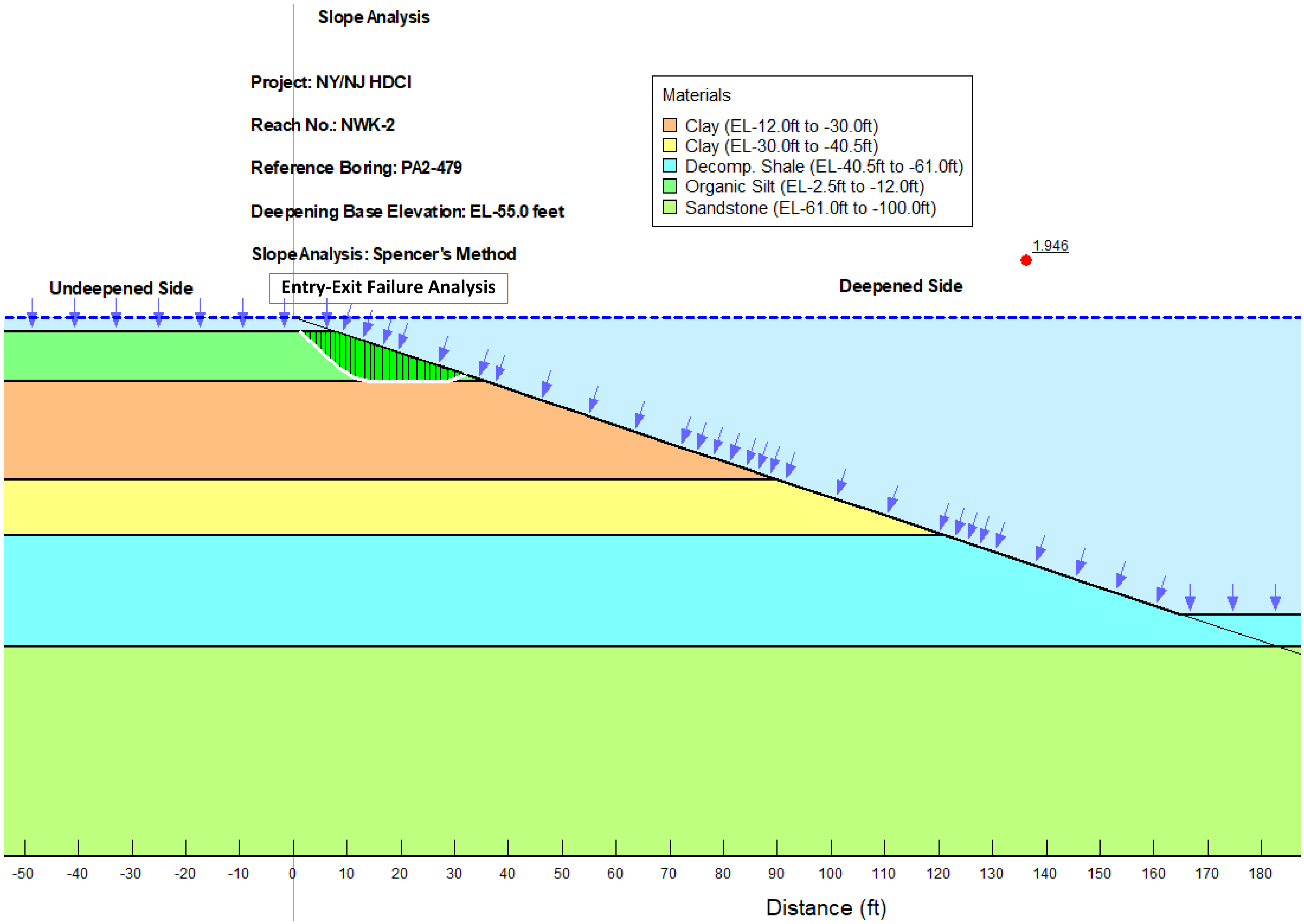


Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-2
Reference Boring: PA2-479
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Entry-Exit Failure Analysis
Materials
Clay (EL-12.0ft to -30.0ft)
Clay (EL-30.0ft to -40.5ft)
Decomp. Shale (EL-40.5ft to -61.0ft)
Organic Silt (EL-2.5ft to -12.0ft)
Sandstone (EL-61.0ft to -100.0ft)
1.946
Undeepened Side
Deepened Side
-70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170
Distance (ft)

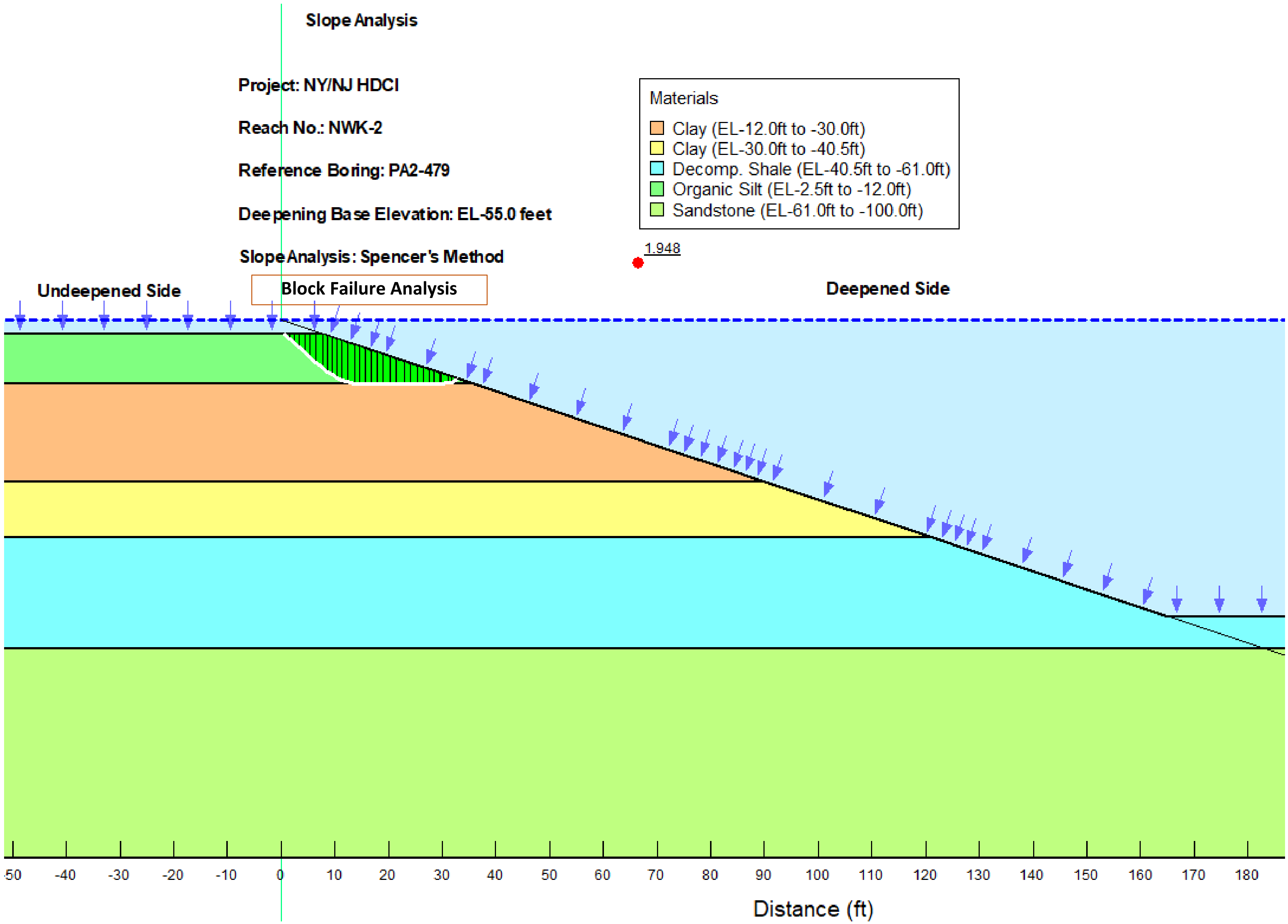

Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-2
Reference Boring: PA2-479
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Block Failure Analysis
Materials
Clay (EL-12.0ft to -30.0ft)
Clay (EL-30.0ft to -40.5ft)
Decomp. Shale (EL-40.5ft to -61.0ft)
Organic Silt (EL-2.5ft to -12.0ft)
Sandstone (EL-61.0ft to -100.0ft)
2.099
Undeepened Side
Deepened Side
-70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170
Distance (ft)



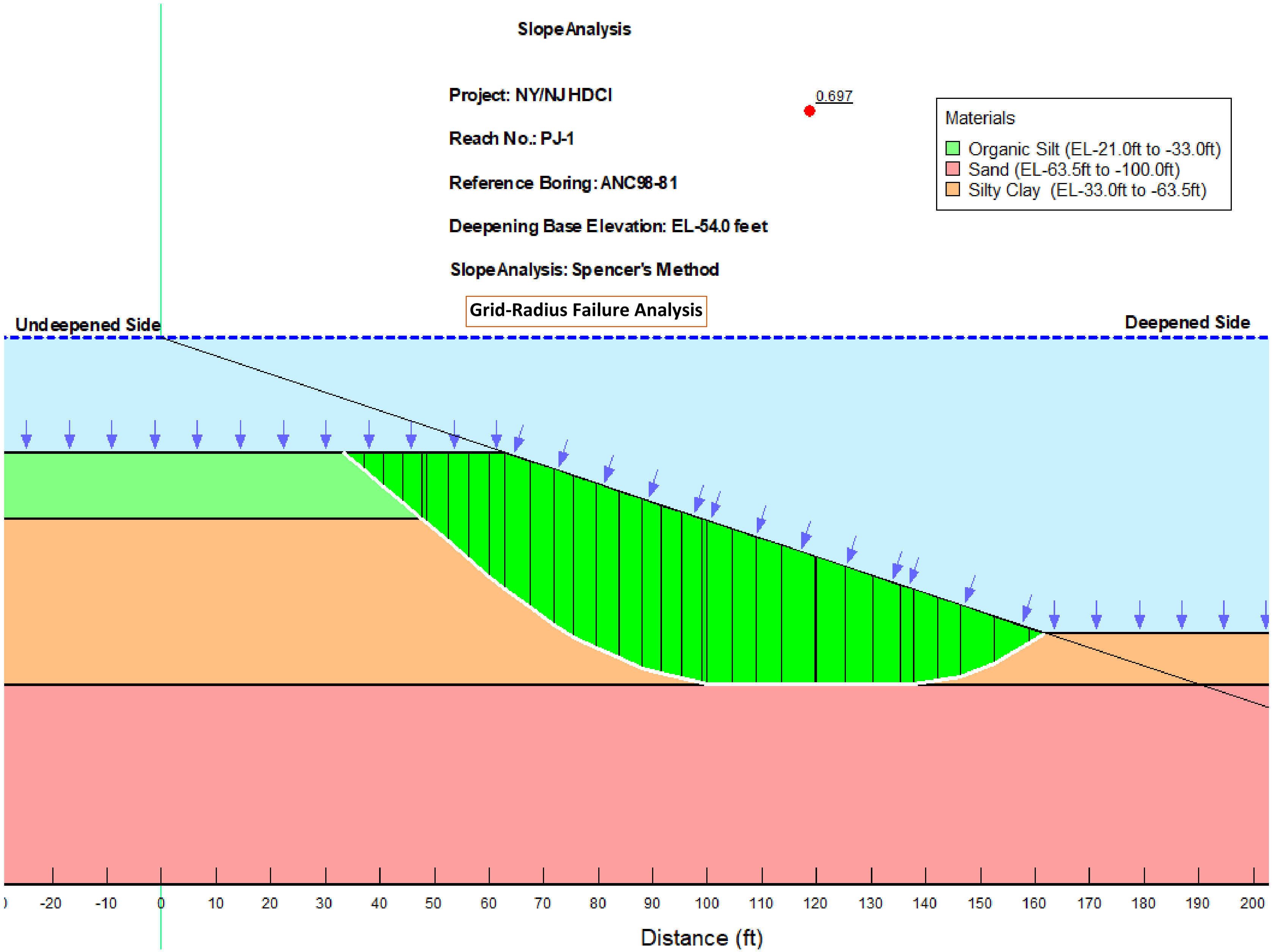
Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-2
Reference Boring: PA2-479
1.944
Deepening Base Elevation: EL-55.0 feet
Slope Analysis: Spencer's Method
Materials
Clay (EL-12.0ft to -30.0ft)
Clay (EL-30.0ft to -40.5ft)
Decomp. Shale (EL-40.5ft to -61.0ft)
Organic Silt (EL-2.5ft to -12.0ft)
Sandstone (EL-61.0ft to -100.0ft)
Undeepened Side
Grid-Radius Failure Analysis
Deepened Side
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
Distance (ft)



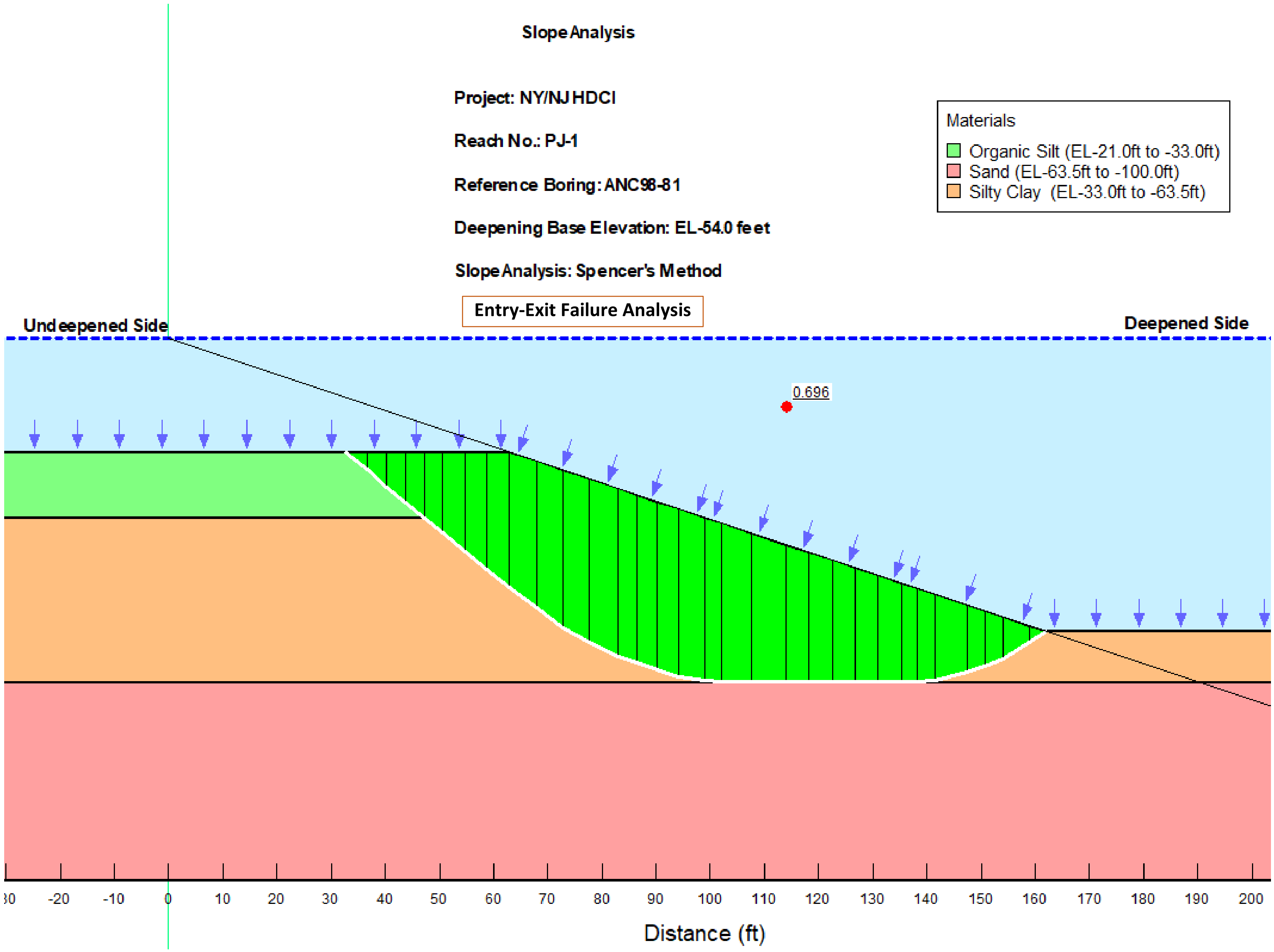
Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-2
Reference Boring: PA2-479
Deepening Base Elevation: EL-55.0 feet
Slope Analysis: Spencer's Method
Entry-Exit Failure Analysis
Materials
Clay (EL-12.0ft to -30.0ft)
Clay (EL-30.0ft to -40.5ft)
Decomp. Shale (EL-40.5ft to -61.0ft)
Organic Silt (EL-2.5ft to -12.0ft)
Sandstone (EL-61.0ft to -100.0ft)
1.946
Undeepened Side
Deepened Side
-50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
Distance (ft)

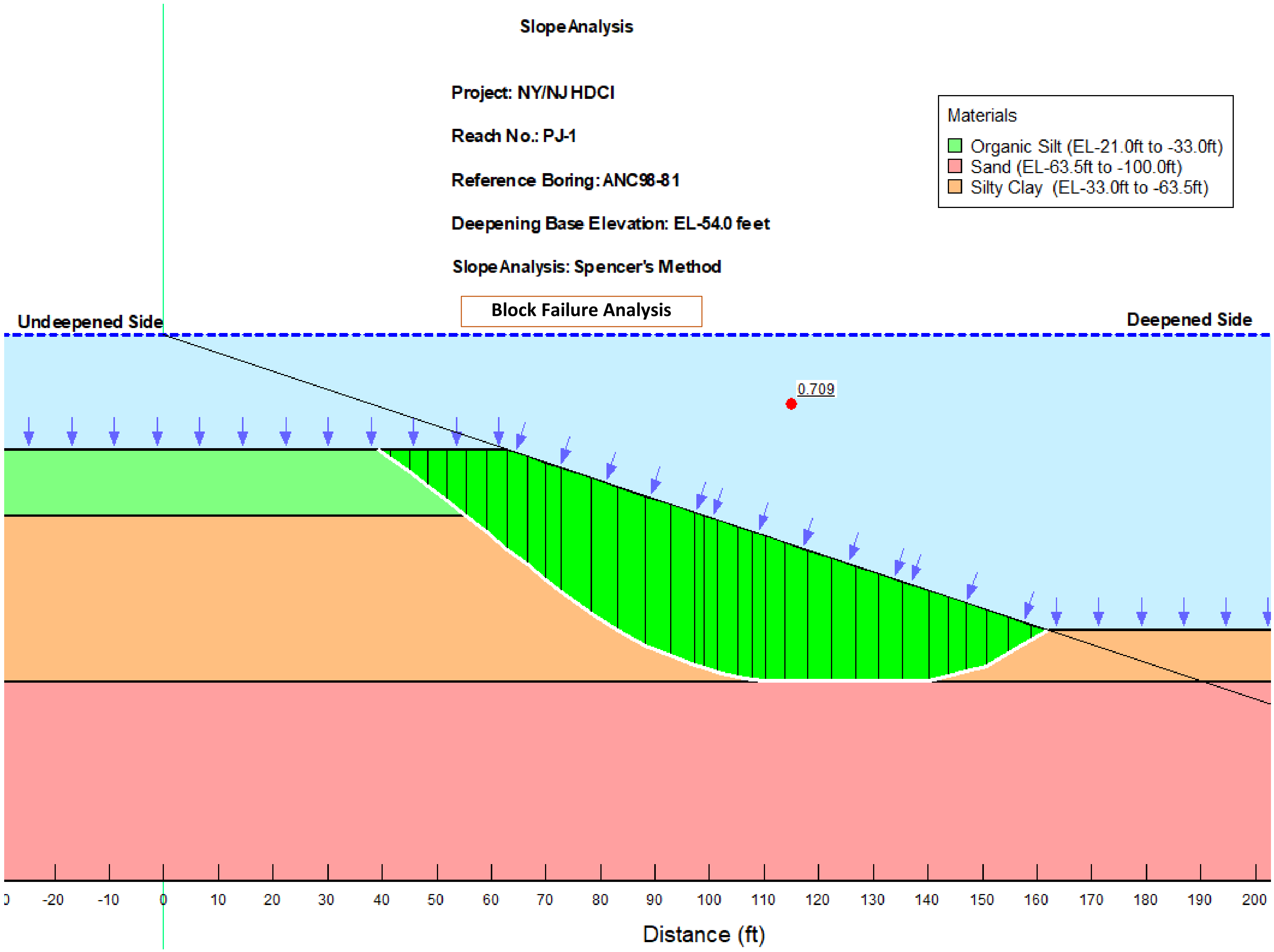


Slope Analysis
Project: NY/NJ HDCI
Reach No.: NWK-2
Reference Boring: PA2-479
Deepening Base Elevation: EL-55.0 feet
Slope Analysis: Spencer's Method
Block Failure Analysis
Materials
Clay (EL-12.0ft to -30.0ft)
Clay (EL-30.0ft to -40.5ft)
Decomp. Shale (EL-40.5ft to -61.0ft)
Organic Silt (EL-2.5ft to -12.0ft)
Sandstone (EL-61.0ft to -100.0ft)
1.948
Undeepened Side
Deepened Side
-50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
Distance (ft)

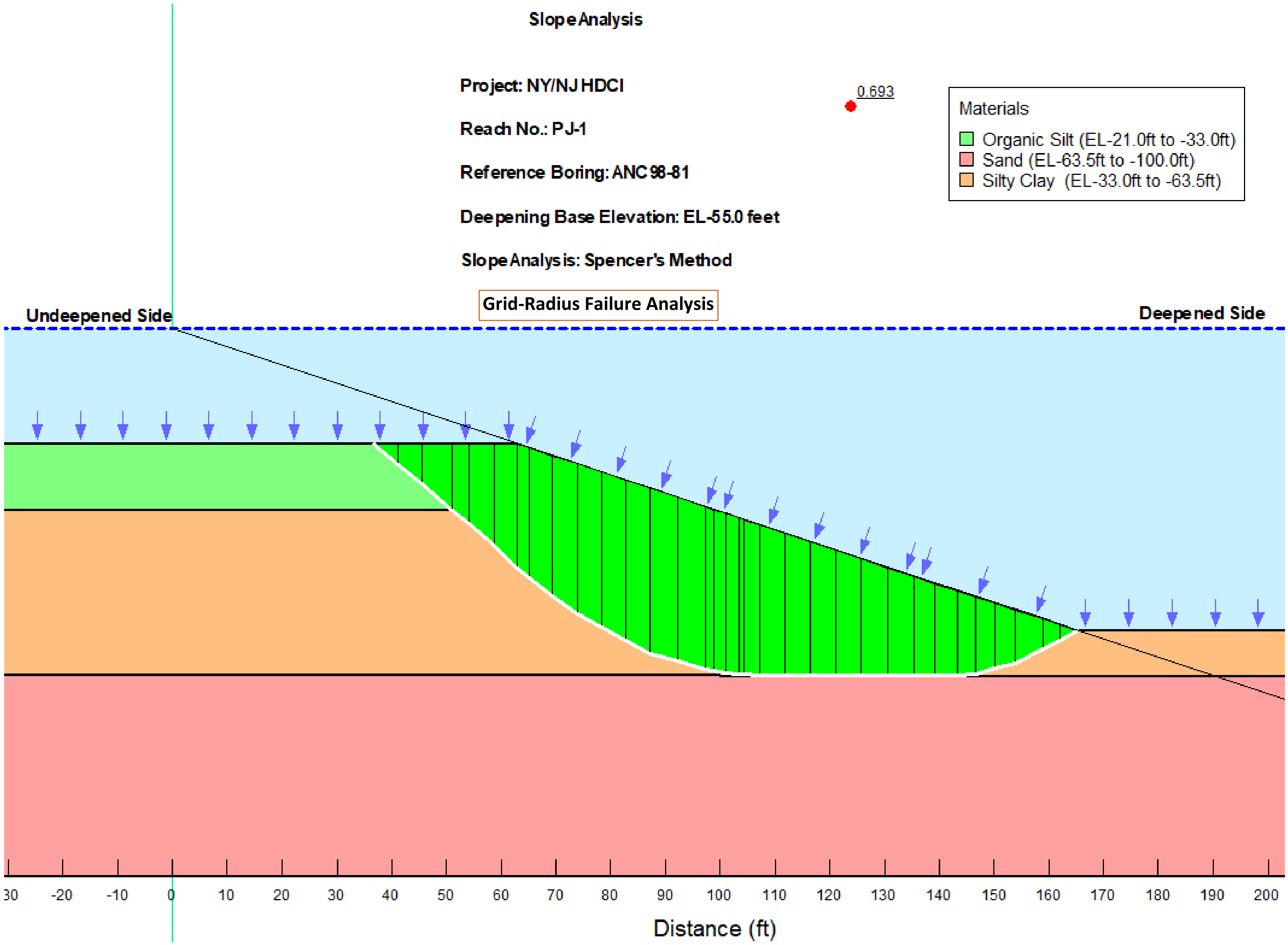


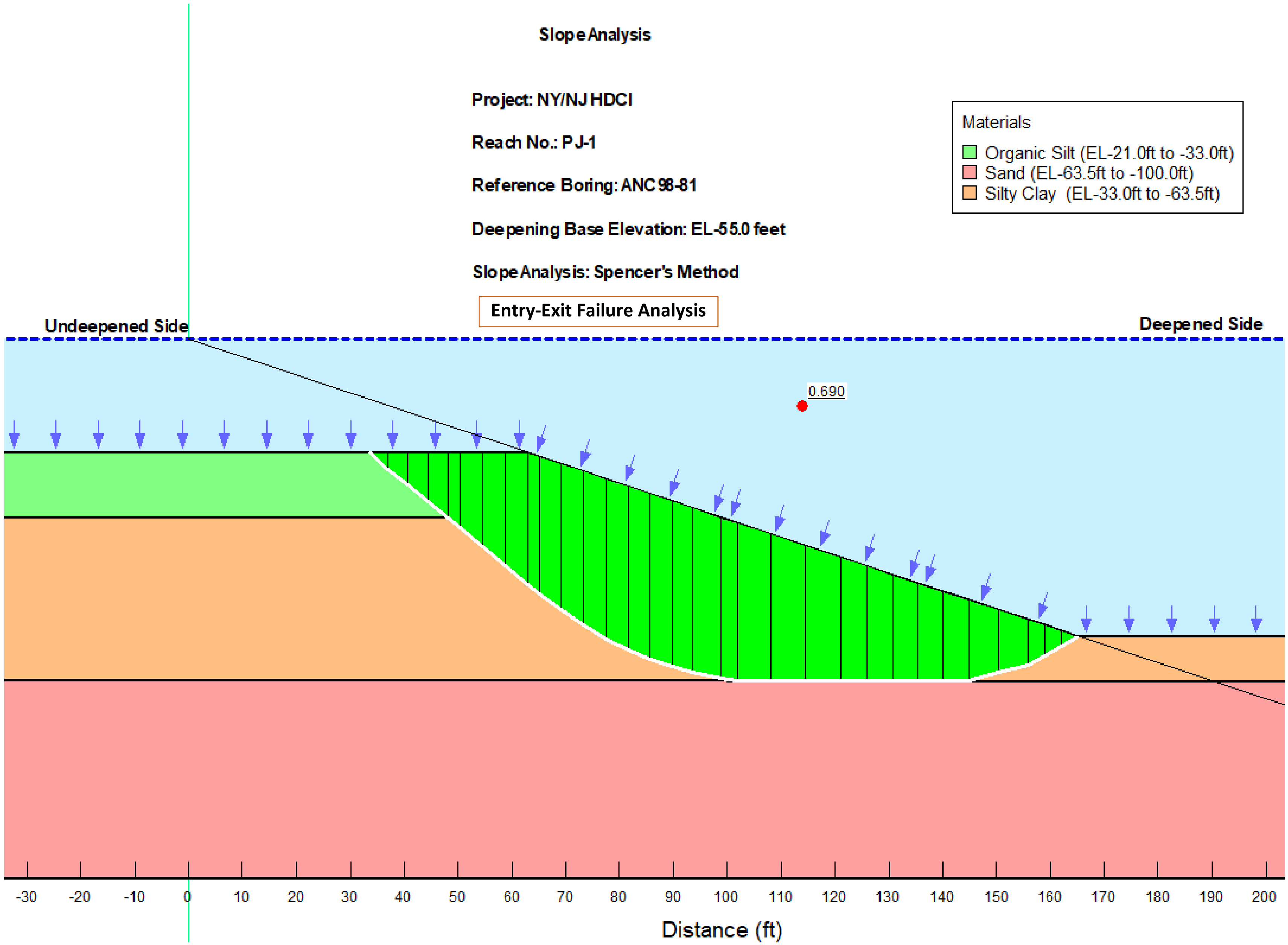
Slope Analysis
Project: NY/NJ HDCI
Reach No.: PJ-1
Reference Boring: ANC98-81
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Grid-Radius Failure Analysis
0.697
Materials
Organic Silt (EL-21.0ft to -33.0ft)
Sand (EL-63.5ft to -100.0ft)
Silty Clay (EL-33.0ft to -63.5ft)
Undeepened Side
Deepened Side
-20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Distance (ft)


Slope Analysis
Project: NY/NJ HDCI
Reach No.: PJ-1
Reference Boring: ANC98-81
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Entry-Exit Failure Analysis
Materials
Organic Silt (EL-21.0ft to -33.0ft)
Sand (EL-63.5ft to -100.0ft)
Silty Clay (EL-33.0ft to -63.5ft)
Undeepened Side
Deepened Side
0.696
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
Distance (ft)

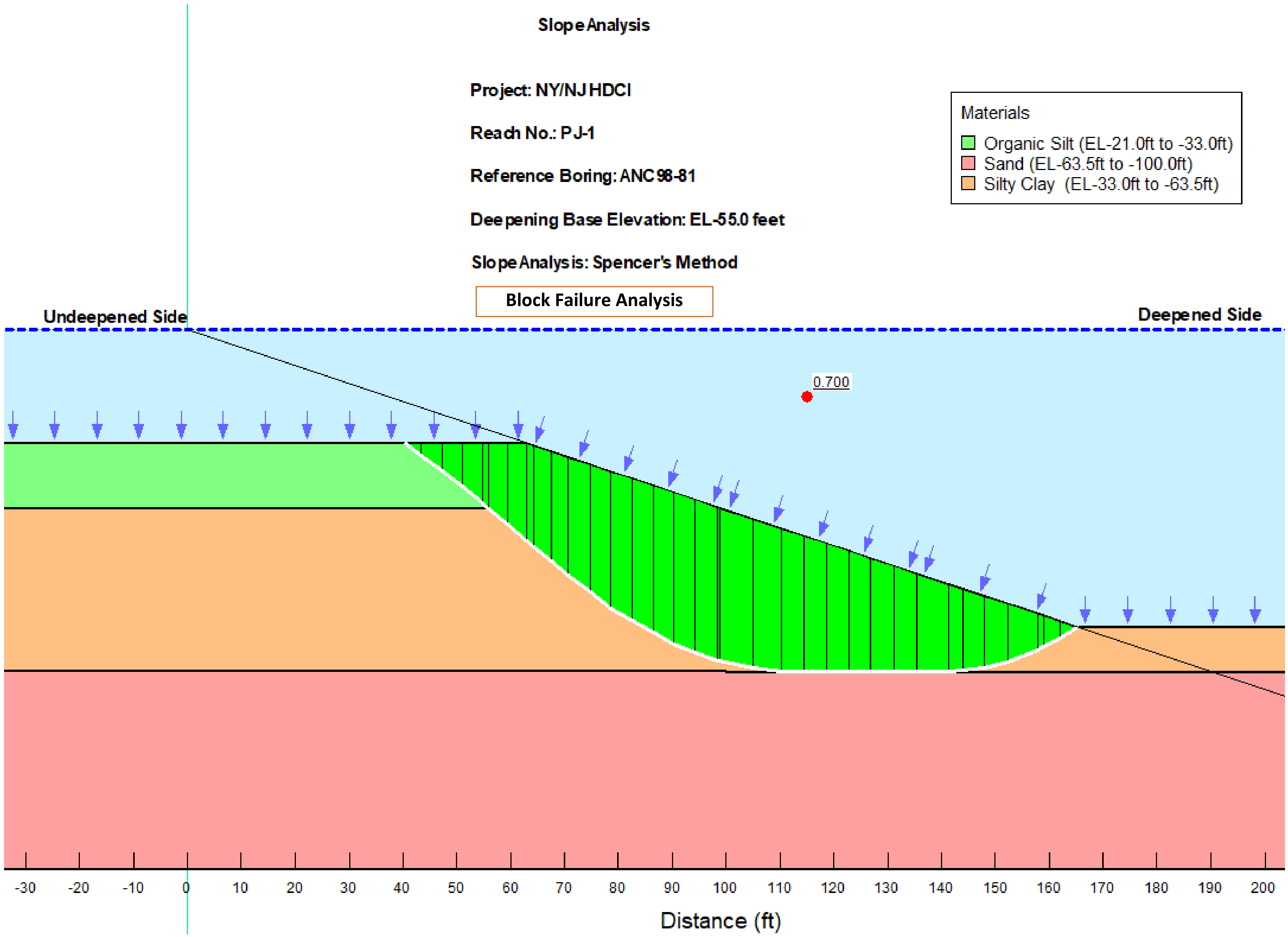


Slope Analysis
Project: NY/NJ HDCI
Reach No.: PJ-1
Reference Boring: ANC98-81
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Block Failure Analysis
Materials
Organic Silt (EL-21.0ft to -33.0ft)
Sand (EL-63.5ft to -100.0ft)
Silty Clay (EL-33.0ft to -63.5ft)
Undeepened Side
Deepened Side
0.709
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
Distance (ft)

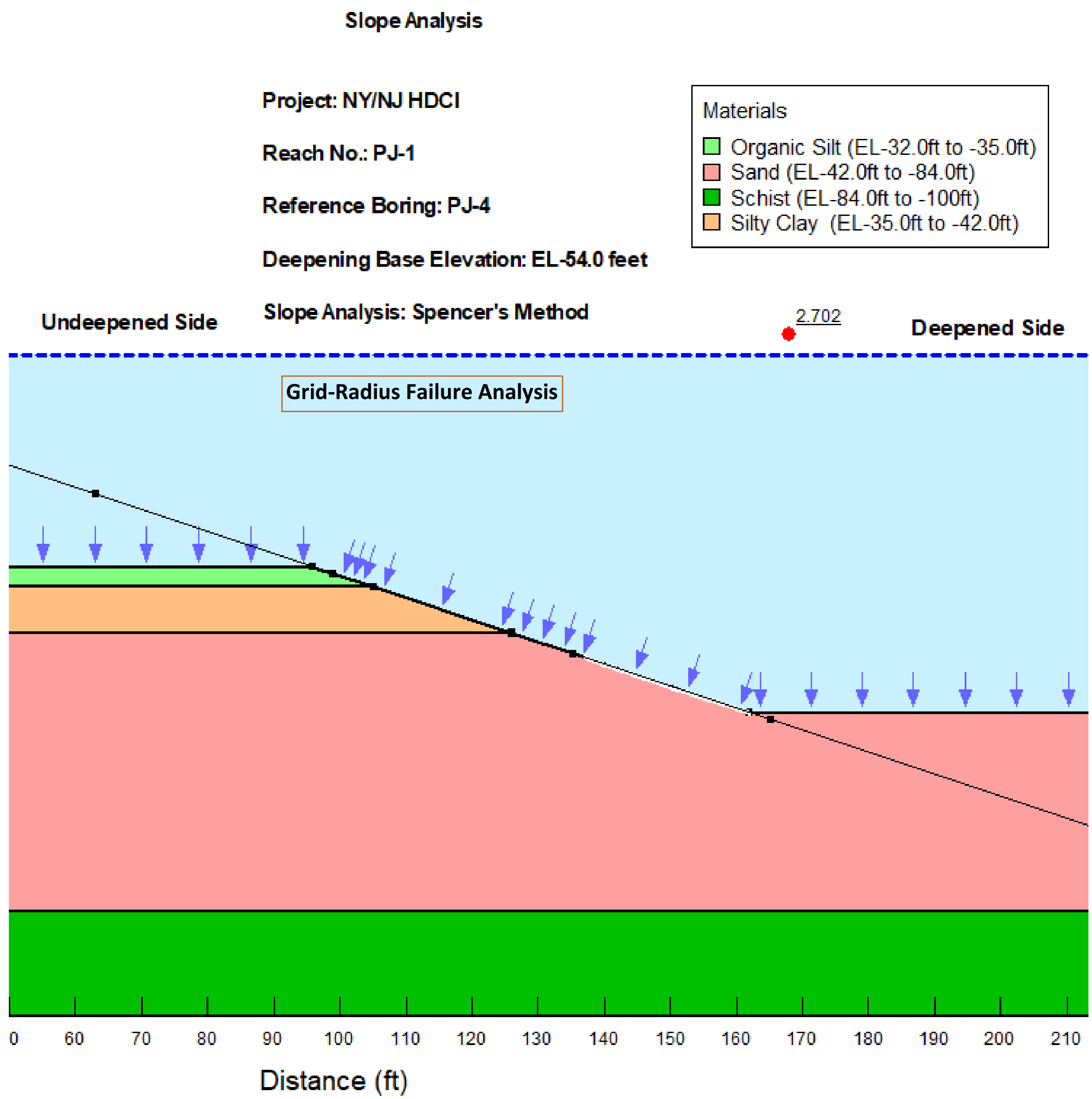

Slope Analysis
Project: NY/NJ HDCI
Reach No.: PJ-1
Reference Boring: ANC98-81
Deepening Base Elevation: EL-55.0 feet
Slope Analysis: Spencer's Method
Grid-Radius Failure Analysis
0.693
Materials
Organic Silt (EL-21.0ft to -33.0ft)
Sand (EL-63.5ft to -100.0ft)
Silty Clay (EL-33.0ft to -63.5ft)
Undeepened Side
Deepened Side
30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
Distance (ft)



Slope Analysis
Project: NY/NJ HDCI
Reach No.: PJ-1
Reference Boring: ANC98-81
Deepening Base Elevation: EL-55.0 feet
Slope Analysis: Spencer's Method
Entry-Exit Failure Analysis
Materials
Organic Silt (EL-21.0ft to -33.0ft)
Sand (EL-63.5ft to -100.0ft)
Silty Clay (EL-33.0ft to -63.5ft)
Undeepened Side
Deepened Side
0.690
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
Distance (ft)



Slope Analysis
Project: NY/NJ HDCI
Reach No.: PJ-1
Reference Boring: ANC 98-81
Deepening Base Elevation: EL-55.0 feet
Slope Analysis: Spencer's Method
Block Failure Analysis
Materials
Organic Silt (EL-21.0ft to -33.0ft)
Sand (EL-63.5ft to -100.0ft)
Silty Clay (EL-33.0ft to -63.5ft)
Undeepened Side
Deepened Side
0.700
-30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Distance (ft)



Slope Analysis
Project: NY/NJ HDCI
Reach No.: PJ-1
Reference Boring: PJ-4
Deepening Base Elevation: EL-54.0 feet
Slope Analysis: Spencer's Method
Materials
Organic Silt (EL-32.0ft to -35.0ft)
Sand (EL-42.0ft to -84.0ft)
Schist (EL-84.0ft to -100ft)
Silty Clay (EL-35.0ft to -42.0ft)
Undeepened Side
2.702
Deepened Side
Grid-Radius Failure Analysis
0
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
Distance (ft)

Slope Analysis

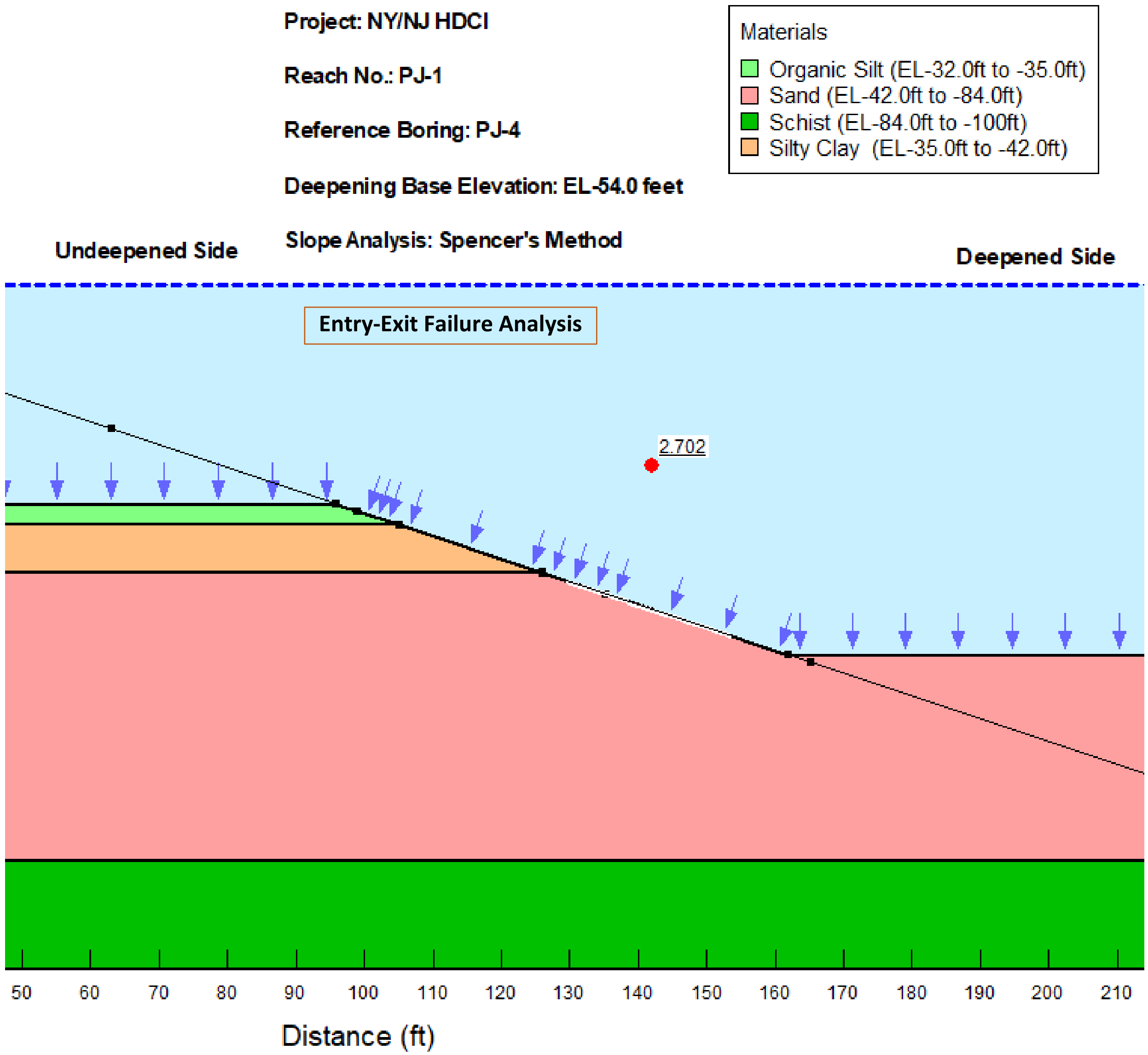
Project: NY/NJ HDCI

Reach No.: PJ-1

Reference Boring: PJ-4

Deepening Base Elevation: EL-54.0 feet

Slope Analysis: Spencer's Method



Slope Analysis

Project: NY/NJ HDCI

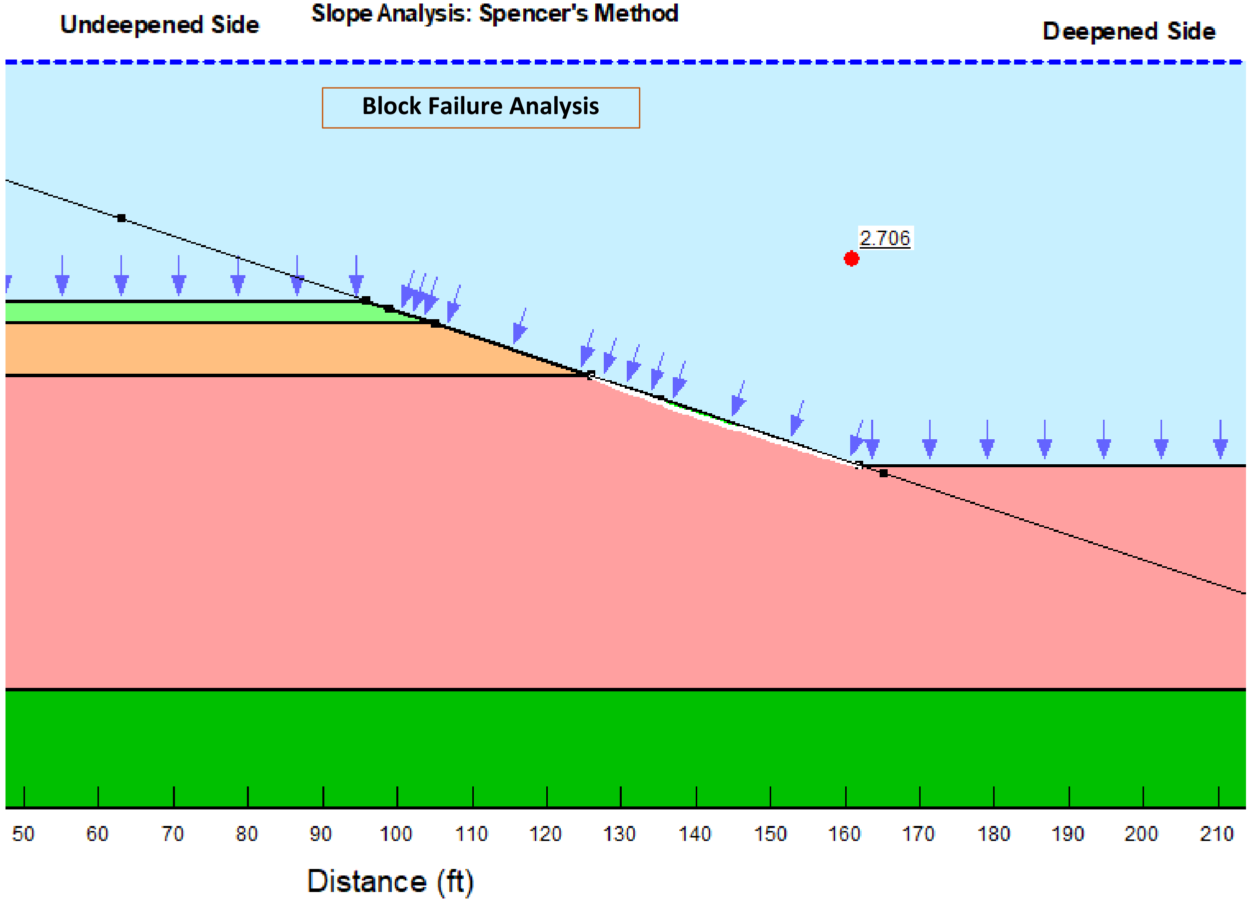
Reach No.: PJ-1

Reference Boring: PJ-4

Deepening Base Elevation: EL-54.0 feet

Slope Analysis: Spencer's Method

Materials
- Organic Silt (EL-32.0ft to -35.0ft)
- Sand (EL-42.0ft to -84.0ft)
- Schist (EL-84.0ft to -100ft)
- Silty Clay (EL-35.0ft to -42.0ft)



Slope Analysis

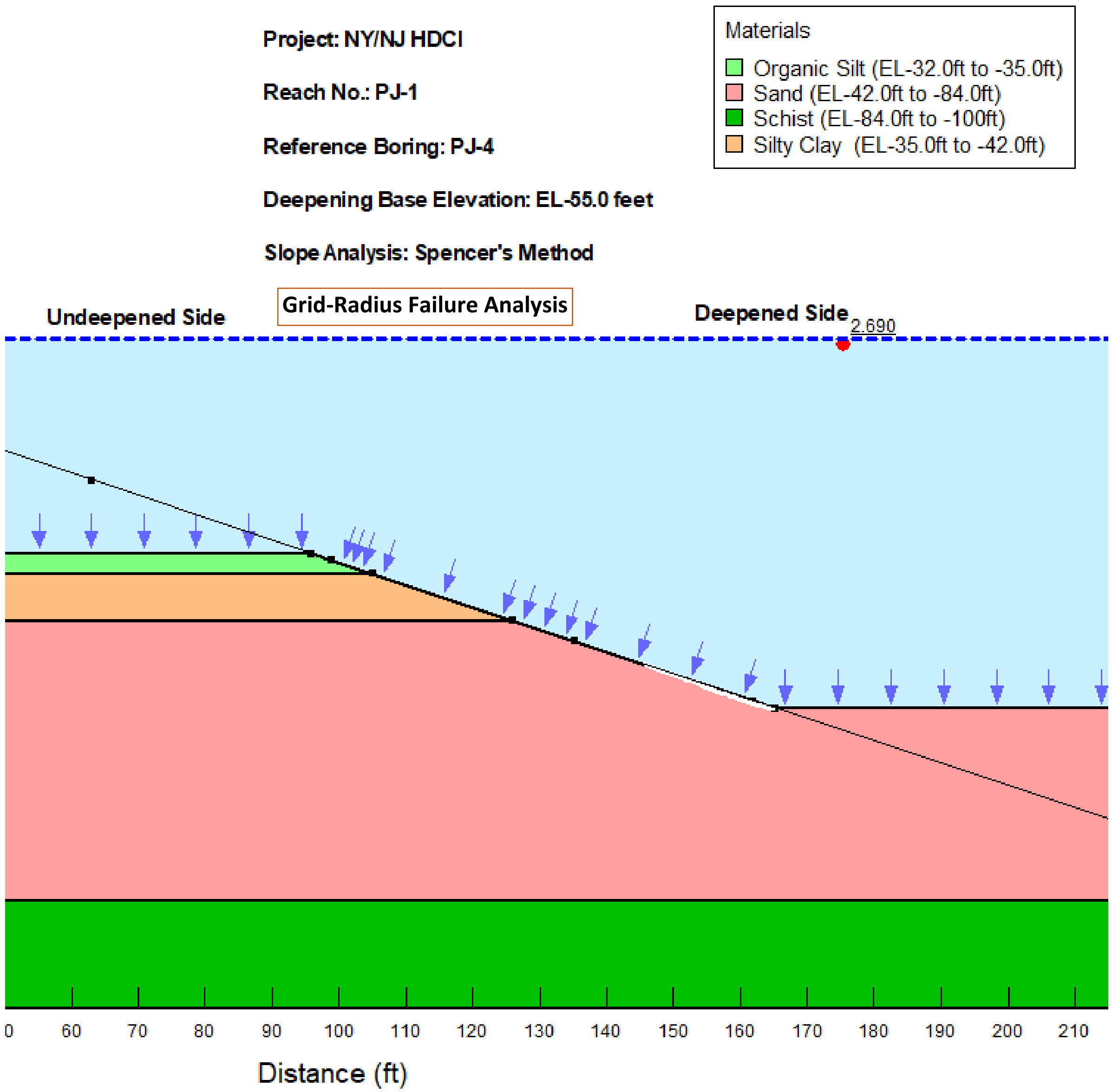
Project: NY/NJ HDCI

Reach No.: PJ-1

Reference Boring: PJ-4

Deepening Base Elevation: EL-55.0 feet

Slope Analysis: Spencer's Method



Slope Analysis

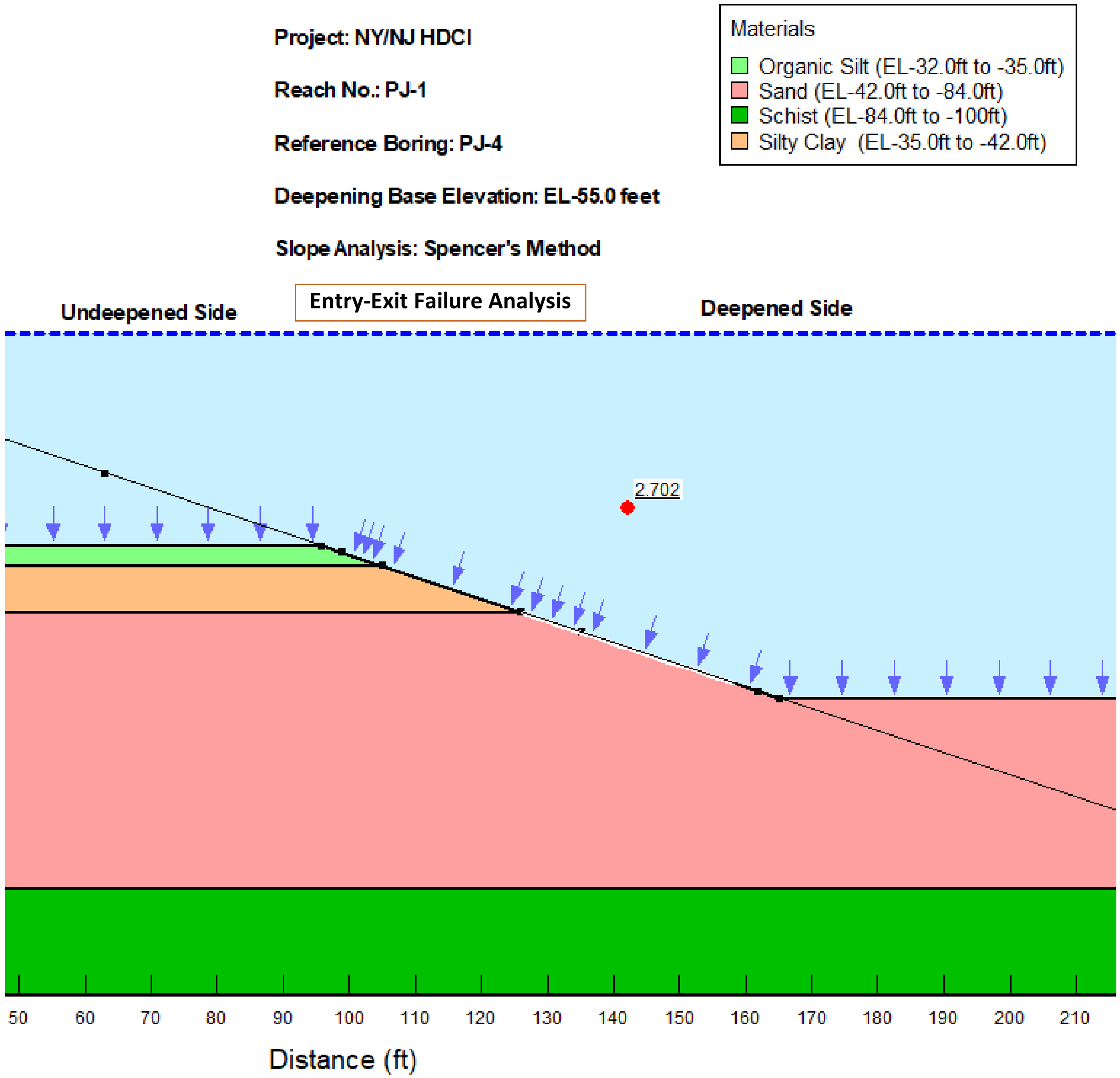
Project: NY/NJ HDCI

Reach No.: PJ-1

Reference Boring: PJ-4

Deepening Base Elevation: EL-55.0 feet

Slope Analysis: Spencer's Method



Slope Analysis

Project: NY/NJ HDCI

Reach No.: PJ-1

Reference Boring: PJ-4

Deepening Base Elevation: EL-55.0 feet

Slope Analysis: Spencer's Method