# TIERRA

August 30, 2024

Johnson Engineering, Inc.
2122 Johnson Street
Fort Myers, Florida 33901-3408

Attn: Jordan L. Varble, P.E.

**RE: Geotechnical Engineering Services Report**
**Sanibel Slough Dredging**
**Lee County, Florida**
**Tierra Project No. 6511-24-165**

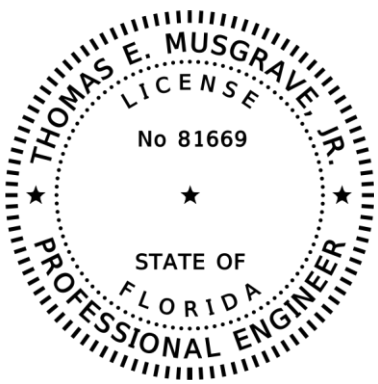
Mr. Varble:

Tierra, Inc. (Tierra) has completed geotechnical engineering services for the above-referenced project. The results of our field exploration program are presented in this report.

Tierra appreciates the opportunity to be of service to Johnson Engineering, Inc. (Johnson) on this this project. We look forward to working with you on future projects. If you have any questions or comments regarding this report, please contact Tierra at your earliest convenience.

Respectfully Submitted,

**TIERRA, INC.**




This item has been digitally signed and sealed by Thomas E. Musgrave on the date adjacent to the seal.

Thomas E Musgrave
2024.10.01 13:30:23-04'00'

Printed copies of this document are not considered signed and sealed and the signature must be verified on any electronic documents.

Sarah E. Strackbein, E.I.
Geotechnical Engineer Intern

Thomas E. Musgrave, P.E.
Senior Geotechnical Engineer
Florida License No. 81669

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## APPENDIX

# PROJECT DESCRIPTION

## Project Information

Based on our understanding, the project consists of preparing construction plans for proposed canal dredging of a portion of the Sanibel Slough and improvements to the bank slopes for the maintenance of the slough canal in Lee County, Florida. The project alignment consists of approximately 1,000 lineal feet on the east end of the Sanibel Slough basin as provided by Johnson.

The following report sections present the results of the geotechnical services performed to support the design of the Sanibel Slough dredging and slope repairs.

## Scope of Services

The objective of our study was to obtain information concerning subsurface conditions at the site in order to base engineering estimates and recommendations in each of the following areas:

1. General location and description of potentially deleterious materials discovered in the borings which may interfere with the construction progress, including existing fills, debris, or surficial organics.

2. General suitability of materials encountered within the borings for use as general backfill.

3. Evaluation of the canal slope stability and recommendations based on the soil conditions encountered.

In order to meet the preceding objectives, we provided the following services:

1. Conducted a visual site reconnaissance of the project site and coordinated utility clearance via Sunshine One-Call.

2. Reviewed the “Sanibel, Florida” Quadrangle Map published by the United States Geological Survey (USGS), as well as the Web Soil Survey of Lee County, Florida, published by the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS).

3. Requested permission from property owners and coordinated access to the boring locations.

4. Coordinated with Lee County and the City of Sanibel to obtain the appropriate permits to drill the Standard Penetration Test (SPT) borings.

5. Executed a program of subsurface exploration consisting of borings, subsurface sampling, and field-testing. Tierra performed a total of five (5) SPT borings to depths ranging from approximately 20 to 25 feet below existing site grades. The borings were performed in areas near and along the existing access points to the Sanibel slough.

6. Collected bulk soil samples from within the canal and canal slopes to evaluate the sediment material.

7. Collected groundwater level measurements at each boring location.

8. Visually classified the samples in the laboratory using the Unified Soil Classification System (USCS) and performed laboratory classification testing on selected samples to confirm visual review. Identified soil conditions at each boring location.

9. Prepared this engineering report that summarizes the course of study pursued, the field and laboratory data generated, the subsurface conditions encountered and our recommendations including general pavement and construction considerations.

The scope of our services did not include an environmental assessment for determining the presence or absence of wetlands or hazardous or toxic materials in the soil, bedrock, groundwater, or air, on or below or around this site. The scope of our services did not include an evaluation with respect to sinkhole potential at the site. Any statements in this report or on the boring logs regarding odors, colors, unusual or suspicious items or conditions are strictly for the information of our client.

# SITE AND SUBSURFACE CONDITIONS

## USGS Quadrangle Map

Based on the “Sanibel, Florida” United States Geological Survey (USGS) Quadrangle Map, ground elevations at the project site appear to be relatively flat at an approximate elevation of +5 feet National Geodetic Vertical Datum of 1929 (NGVD 29).

## USDA Soil Survey

Soil data published by the USDA Soil Survey of Lee County, Florida was reviewed as part of the subsurface investigation. This information indicates that there are two (2) primary mapping units within the vicinity of the proposed project site. The following paragraph and table provide a brief description of the soil units as presented in the Soil Survey.

*Canaveral fine sand-Urban land complex (Map Unit 4):* The Canaveral component makes up 50 percent of the map unit. Slopes are 0 to 2 percent. This component is on ridges on marine terraces on coastal plains. The parent material consists of sandy marine deposits. The depth to a root restrictive layer is greater than 60 inches. The natural drainage class is somewhat poorly drained. Water movement in the most restrictive layer is very high. Available water to a depth of 60 inches (or restricted depth) is low. Shrink-swell potential is low. This soil is not flooded, nor is it ponded. The seasonal zone of water saturation is at 30 inches during June, July, August, September, October, and November. Organic matter content in the surface horizon is about 1 percent.

*Captiva fine sand, ponded-Urban land complex (Map Unit 104):* The Captiva component makes up 48 percent of the map unit. Slopes are 0 to 1 percent. This component is on drainageways on marine terraces on coastal plains. The parent material consists of sandy marine deposits. The depth to a root restrictive layer is greater than 60 inches. The natural drainage class is poorly drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches (or restricted depth) is low. Shrink-swell potential is low. This soil is not flooded. It is frequently ponded. The seasonal zone of water saturation is at 0 inches during July, August, September, and October. Organic matter content in the surface horizon is about 3 percent.

Urban Land soil types consist of areas where most of the soil surface is covered with impervious materials, such as buildings and paved areas. This land type consists of areas where the original soil has been modified through cutting, grading, filling, and shaping or has been altered for urban development.

| **Summary of USDA Soil Survey Lee County, Florida** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **USDA Map Symbol and Soil Name** | **Depth (in)** | **Soil Classification** | | **Permeability (in/hr)** | **pH** | **Seasonal High Water Table** | |
| | | **USCS** | **AASHTO** | | | **Depth (feet)** | **Months** |
| (4) Canaveral – Urban land | 0-7 | SP-SM, SM | A-2-4, A-3 | 20.0 - 40.0 | 6.6-8.4 | 1.5-3.5 | Jun-Nov |
| | 7-15 | SP-SM | A-2-4, A-3 | 20.0 - 40.0 | 6.6-8.4 | | |
| | 15-80 | SP-SM | A-3, A-2-4 | 20.0 - 40.0 | 6.6-8.4 | | |
| | No Information Provided for Urban Land | | | | | | |
| (104) Captiva - Urban land | 0-6 | SM, SP-SM | A-2-4, A-3 | 6.0 - 20.0 | 7.4-8.4 | +1.0-0.0 | Jun- Nov |
| | 6-30 | SP-SM, SM | A-2-4, A-3 | 20.0 - 40.0 | 7.4-8.4 | | |
| | 30-80 | SP-SM | A-3, A-2-4 | 20.0 - 40.0 | 7.4-8.4 | | |
| | No Information Provided for Urban Land | | | | | | |

It should be noted that information contained in the USDA/NRCS Web Soil Survey may not be reflective of current subsurface conditions, particularly if recent development in the project vicinity has modified existing soils or surface/subsurface drainage.

## Subsurface Conditions

The subsurface conditions were explored using a total of five (5) SPT borings performed to depths ranging from approximately 20 to 25 feet below the ground surface and ten (10) hand auger borings/probes from within Sanibel Slough channel bed. The borings were located in the field by representatives of Tierra using handheld global positioning system (GPS) equipment. The approximate locations of the borings performed are presented on the **Boring Location Plan** in the **Appendix**.

The SPT borings were performed with the use of a drill rig equipped with an automatic hammer, using mud-rotary drilling procedures. The soil sampling was performed in general accordance with the American Society for Testing and Materials (ASTM) Test Designation D-1586. Within each SPT boring, the initial 4 feet of the SPT borings were advanced by hand auger to verify subsurface utility clearances. SPT resistance N-values were then taken continuously to a depth of 10 feet and at intervals of 5 feet thereafter. As each soil type was encountered, samples were collected and visually classified in the field. The samples were then transported to our Tampa laboratory for verification of the visual classification and testing.

The soil strata encountered in the borings performed at the project site are summarized in the following table:

| Stratum Number | Soil Description | Unified Soil Classification System Symbol |
|---|---|---|
| 1 | Light Brown Sand to Sand with Silt and Shell | SP/SP-SM |
| 2 | Dark Gray Organic Silty Sand to Muck | SM/Pt |
| 3 | Dark Gray Sand with Silt to Silty Sand | SP-SM/SM |

The subsurface soil stratification is of a generalized nature to highlight the major subsurface stratification features and material characteristics. The **Soil Profiles** sheet in the **Appendix** should be reviewed for specific information at individual boring locations. These profiles include soil descriptions, stratifications, and penetration resistances. The stratifications shown on the boring profiles represent the conditions only at the actual boring location. Variations occur and should be expected between boring locations. The stratifications represent the approximate boundary between subsurface materials and the actual transition may be gradual.

## Groundwater Information

At the time of our field activities, the groundwater table was encountered at depths ranging from at or above the ground surface to 3½ feet below the existing ground surface within the borings performed outside of the channel. These levels are illustrated on the **Soil Profiles** sheets in the **Appendix**. Within boring B-3, the groundwater table was not apparent prior to the introduction of drilling fluid into the borehole therefore, GNA (Groundwater Not Apparent) is indicated adjacent to this soil profile in the **Appendix**.

Groundwater conditions will vary with environmental variations and seasonal conditions, such as the frequency and magnitude of rainfall patterns, as well as man-made influences (i.e. existing swales, drainage ponds, underdrains, and areas of covered soils, such as paved parking lots). Additionally, due to the project site being adjacent to the waters of the Gulf of Mexico, the groundwater levels are tidally influenced.

# EVALUATION AND RECOMMENDATIONS

## General

Engineering evaluations and recommendations are provided herein for the anticipated improvements. The recommendations are based upon the subsurface conditions encountered, the design parameters anticipated for the proposed construction and our geotechnical engineering evaluations. The following report sections present our geotechnical recommendations and general construction considerations. Based on the results of our subsurface exploration, the soils encountered within the borings performed appear suitable for the proposed construction.

The project site will require proper site preparation before development including removal of any deleterious materials and compaction of the subgrade. Once site plans are finalized, Tierra should be retained to review and amend recommendations given in this report, if necessary.

In general, the soils of Stratum 1 (SP/SP-SM) and Stratum 3 (SP-SM/SM) may be moved and used for grading purposes, site leveling, general engineering fill, structural fill and backfill in other areas, provided the fill is free of organic materials, clay, debris or any other material deemed unsuitable for construction and evaluated against engineering fill requirements. It should be noted that Stratum 3 soils may be difficult to dry and compact due to their fines content. Stratum 3 soils should only be placed above the groundwater level at the time of construction.

**Organic silty sand to muck (Stratum 2) was encountered within some of the borings. Laboratory testing on the material encountered indicates organic contents in excess of 5 percent. Organic contents above 5 percent are considered detrimental to the support of structures and roadway embankments. Organic soils will consolidate when loaded and may decay/degrade over time resulting in settlement of the overlying soils. Settlement can occur over many years. Within proposed structures and pavement areas, any organic laden soils should be removed and replaced with compacted sand fill prior to foundation or pavement construction. Tierra should be retained to observe and document that organic soils are removed and replaced in accordance with the recommendations contained herein.**

**In addition, organic soils and sediment soils should be evaluated with respect to disposal requirements and usage potential in accordance with City of Sanibel and Lee County regulations.**

## Site Preparation

Prior to construction, the location of any existing underground utilities within the construction area should be established. Material suitable for re-use may be stockpiled; however, any material stockpiled for re-use shall be tested for conformance to material specifications as indicated in the following sections of this report. Provisions should then be made to relocate any interfering utility lines within the construction area to appropriate locations and backfilling the resulting excavations with compacted structural fill. In this regard, it should be noted that if abandoned underground pipes are not properly removed or plugged, they might serve as conduits for subsurface erosion, which subsequently may result in excessive settlement.

As a minimum, it is recommended that the clearing operations extend to the depth needed to remove material considered deleterious at least 5 feet beyond the proposed development area. Deleterious materials to be removed may include roots, organics, tree stumps or other buried or surface debris.

## Slope Stability

*General*

The analysis of stability for unrestrained slopes consists of comparing the shear stress developed along calculated rupture surfaces with the shear strength of in-situ soil. In general, the Safety Factor for slope stability is defined as:

$$Safety\ Factor = \frac{Average\ Shear\ Strength\ of\ Soil}{Average\ Shear\ Strength\ Developed\ along\ Potential\ Failure\ Surface}$$

The Safety Factors for slope stability are calculated using geotechnical models for translational and/or rotational failure surfaces based on boring data, slope geometry, and industry-specific mathematical methods. The "critical surface" (i.e., lowest Safety Factor) is the presumed rupture surface calculated using the geotechnical model for a given set of slope analyses and a given data set.

When the Safety Factor is less than 1.0, the slope is typically in a state of high potential failure. Safety Factors equal to 1.0 suggests the slope could have potential impending failures. The current FDOT and AASHTO criteria have a minimum requirement of a resistance factor of 0.75 (Safety Factor of 1.3) for slope stability evaluation.

The existing canal side slopes are categorized as finite slopes for the purposes of evaluating stability. When analyzing finite slope failures, circular or rotational analysis typically occurs in one of the following modes:

- Slope failure – the critical surface is a circular failure surface calculated to intersect the slope at or above the toe-of-slope.
- Base failure - the critical surface is a circular failure surface calculated to pass some distance below the toe-of-slope.

The analyses were performed using the computer program "ReSSA+" which is an FDOT approved software and widely used in Florida and other states for slope stability analyses. The program uses the Bishop's Simplified Method of Slices to determine the safety factor against deep-seated rotational (circular) failure. Bishop's Simplified Method of Slices is a numerical method to calculate representative trial failure surfaces for a given set of slope analyses and a given data set by dividing the slope into several vertical "slices". Based on the soil conditions input into the model, the Normal and Shearing forces are calculated on the sides of each representative "slice", and the results of each slice calculation are summed to determine the shear stress developed along calculated rupture surfaces and, therefore, determines the Safety Factor.

For the purposes of this study, Tierra evaluated multiple geometry configurations along the project alignment with the intent to evaluate project wide conditions along the channel. Based on discussions with Johnson, the design geometry of the channel is a 15-foot bottom width at an elevation of -7.5 feet, NAVD88. The sample slope geometries evaluated include 1V:1.5H, 1V:2H, and 1V:3H. Sample "ReSSA+" computer outputs from these analyses are presented in the **Appendix**.

*Recommendations and Considerations*

Based on the cross-sectional information, the encountered soil conditions and our slope stability analyses, Tierra recommends the Sanibel Slough channel slopes be 1V:3H minimum to satisfy the minimum requirement for a Safety Factor of 1.3 (resistance factor of 0.75). If right of way constraints or other limitations prevent slopes being graded at 1V:3H, reinforced slopes (geosynthetics, anchors, nails, etc.) will need to be evaluated.

Tierra recommends that appropriate consideration of erosion control and Slope armoring be included in the final design of the proposed dredging and canal repairs.

### Sediment Material

Tierra performed laboratory soil testing including grain-size analyses, moisture content tests, and organic content tests. The grain-size analyses were conducted in general accordance with the AASHTO test designation T-088 (ASTM test designation D-1140). The organic tests were performed in general accordance with the AASHTO test designation T-267. The results of our laboratory testing are presented in the attached **Summary of Laboratory Test Results for Soil Classification**. In addition, the Grain Size Distribution Reports provided to the No. 230 sieve are also presented in the **Attachments**.

**In addition, organic soils and sediment soils should be evaluated with respect to disposal requirements and usage potential in accordance with City of Sanibel and Lee County regulations.**

## CONSTRUCTION CONSIDERATIONS

### General

Tierra should be retained to provide observation and testing of construction activities involved in the foundation earthwork and related activities of this project. Tierra cannot accept any responsibility for any conditions which deviate from those described in this report, if not engaged to provide construction observation and testing for this project.

### Fill Placement and Subgrade Preparation

The following are our recommendations for overall site preparation and mechanical densification work following the ground improvement/remediation program for the construction of the proposed improvements based on the anticipated construction and our test boring results. These recommendations should be used as a guideline for the project general specifications prepared by the design engineer with respect to any earthwork related construction activities.

1. The site should be cleared in areas of proposed earthwork; this primarily includes removing any deleterious materials currently on the site such as roots, organics, tree stumps or other buried or surface debris. It is recommended that any undesirable material be removed to the satisfaction of Tierra prior to beginning construction at the site. Resulting excavations should be backfilled with compacted structural fill. It is important that pavement and structure remnants be removed in their entirety. As a minimum, it is recommended that the clearing operations extend at least five (5) feet beyond the development perimeters.

2. Following the clearing, the development area should be proofrolled. The proofrolling may consist of compaction with a large diameter, heavy vibratory drum roller (if not within 50 feet of existing structures). The vibratory drum roller should have a static drum weight on the order of 8 to 10 tons and should be capable of exerting a minimum impact force of 36,000 pounds (DYNAPAC CA-250 or equivalent is expected to provide acceptable results). **Vibratory rollers should not be used within 50 feet of any existing structures.** Areas within 50 feet of existing

structures should be compacted using a fully loaded 2 cubic yard capacity front-end loader or equivalent (i.e. through non-vibratory means). The proofrolling equipment should make a minimum of eight (8) overlapping passes over the structure and pavement areas with the successive passes aligned perpendicular.

3. Careful observations should be made during proofrolling to help identify any areas of soft yielding soils that may require over excavation and replacement. The backfilling may be done with well-compacted, suitable fill such as clean sand (i.e. less than 12% passing the No. 200 sieve), gravel, or crushed FDOT No. 57 or FDOT No. 67 stone.

4. It is recommended that the subgrade within any building and pavement areas, if applicable be compacted to a dry density of at least 95% of the Modified Proctor maximum dry density to a minimum depth of one (1) foot below stripped grade.

5. Following satisfactory completion of the initial compaction and proofrolling, the structure and pavement areas, if applicable may be brought up to finished subgrade levels, if needed, using structural fill. Imported fill should consist of fine sand with less than 12% passing the No. 200 sieve, free of rubble, organics, clay, debris and other unsuitable material. Fill should be tested and approved prior to acquisition. Approved sand fill should be placed in loose lifts not exceeding 12 inches in thickness and should be compacted to a minimum density of 95% of the Modified Proctor maximum dry density. Density tests to confirm compaction should be performed in each fill lift before the next lift is placed.

6. Prior to beginning compaction, soil moisture contents may need to be controlled in order to facilitate proper compaction. If additional moisture is necessary to achieve compaction objectives, then water should be applied in such a way that it will not cause erosion or removal of the subgrade soils. Moisture content within the percentage range needed to achieve compaction (typically ± 2 percent of optimum) is recommended prior to compaction of the natural ground and fill.

7. After compaction of insitu soils or fill lifts, building foundation excavations can begin if applicable. Foundation excavations should be observed by the geotechnical engineer or a representative to explore the extent of any loose, soft, or otherwise undesirable materials.

8. If foundation excavations appear suitable as load bearing materials, the bottom of the foundation excavations should be compacted to a minimum density of 95% of the Modified Proctor maximum dry density to a minimum depth of one (1) foot below the bottom of the footing depth, as determined by field density compaction tests.

9. If soft pockets are encountered in the footing excavations, the unsuitable materials should be removed, and the proposed footing elevation may be re-established by backfilling. This backfilling may be done with a well-compacted, suitable fill such as clean sand, gravel, or crushed FDOT No. 57 or FDOT No. 67 stone. Sand backfill should be compacted to a minimum density of 95% of the Modified Proctor maximum dry density.

10. Immediately prior to reinforcing steel placement, it is suggested that the bearing surfaces of all footing and floor slab areas be compacted using hand operated mechanical tampers. In this manner, any localized areas, which have been loosened by excavation operations, should be adequately re-compacted.

11. Backfill soils placed adjacent to footings or walls should be carefully compacted with a light rubber-tired roller or vibratory plate compactor to avoid damaging the footings or walls. Approved sand fills to provide foundation embedment constraint should be placed in loose lifts not exceeding 6 inches and should be compacted to a minimum density of 95% of the Modified Proctor maximum dry density.

A representative from our firm should be retained to provide on-site observation of earthwork and ground modification activities. Density tests should be performed in the top one (1) foot of compacted existing ground, each fill lift, and the bottom of foundation excavations within sandy soils. It is important that Tierra be retained to observe that the subsurface conditions are as we have discussed herein, and that foundation construction ground modification and fill placement is in accordance with our recommendations.

## Drainage and Groundwater Concerns

The groundwater levels presented in this report are the levels that were measured at the time of our field activities. Fluctuation should be anticipated. We recommend that the Contractor determine the actual groundwater levels at the time of the construction to determine groundwater impact on this construction procedure.

## Structural Fill

If necessary, all materials to be used for structural fill or backfill should be evaluated and tested by Tierra prior to placement to determine if the materials are suitable for the intended use. Suitable fill materials should consist of fine to medium sand with less than 12% passing the No. 200 sieve, free of demolition debris, rubble, pavement remnants, organics, clay, debris and other unsuitable material and evaluated against project engineering requirements.

In general, the soils of Stratum 1 (SP/SP-SM) and Stratum 3 (SP-SM/SM) may be moved and used for grading purposes, site leveling, general engineering fill, structural fill and backfill in other areas, provided the fill is free of organic materials, clay, debris or any other material deemed unsuitable for construction and evaluated against engineering fill requirements. It should be noted that Stratum 3 soils may be difficult to dry and compact due to their fines content. Stratum 3 soils should only be placed above the groundwater level at the time of construction.

**Organic silty sand to muck (Stratum 2) was encountered within some of the borings. Laboratory testing on the material encountered indicates organic contents in excess of 5 percent. Organic contents above 5 percent are considered detrimental to the support of structures and roadway embankments. Organic soils will consolidate when loaded and may decay/degrade over time resulting in settlement of the overlying soils. Settlement can occur over many years. Within proposed structures and pavement areas, any organic laden soils should be removed and replaced with compacted sand fill prior to foundation or pavement construction. Tierra should be retained to observe and document that organic soils are removed and replaced in accordance with the recommendations contained herein.**

**In addition, organic soils and sediment soils should be evaluated with respect to disposal requirements and usage potential in accordance with City of Sanibel and Lee County regulations.**

## Excavations

Excavations and temporary side slopes should comply with the Occupational Safety and Health Administration's (OSHA) trench safety standards, 29 C.F.R., s. 1926.650, Subpart P, all subsequent revisions or updates of OSHA's referenced standard adopted by the Department of Labor and Employment Security and Florida's Trench Safety Act, Section 553.62, Florida Statutes.

# REPORT LIMITATIONS

The analyses, conclusions and recommendations contained in this report are professional opinions based on the site conditions and project layout described herein and further assume that the conditions observed in the exploratory borings are representative of the subsurface conditions throughout the site, i.e., the subsurface conditions elsewhere on the site are the same as those disclosed by the borings. If, during construction, subsurface conditions different from those encountered in the exploratory borings are observed or appear to be present beneath excavations, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. If there is a substantial lapse in time between the submittal of this report and the start of work at the site, or if conditions or project layout are changed due to natural causes or construction operations at or adjacent to the site, we recommend that this report be reviewed to determine the applicability of conclusions and recommendations considering the changed conditions and time lapse.

This report was prepared for the exclusive use of Johnson Engineering, Inc., and their client for evaluating the design of the project as it relates to the geotechnical aspects discussed herein. It should be made available to prospective contractors for information on factual data only and not as a warranty of subsurface conditions included in this report. Unanticipated soil conditions may require that additional expense be made to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs.

# APPENDIX

Boring Location Plan

Soil Profiles

Summary of Laboratory Test Results for Soil Classification

ReSSA Output Files


# BORING LOCATION PLAN

0 100'

PLAN SCALE

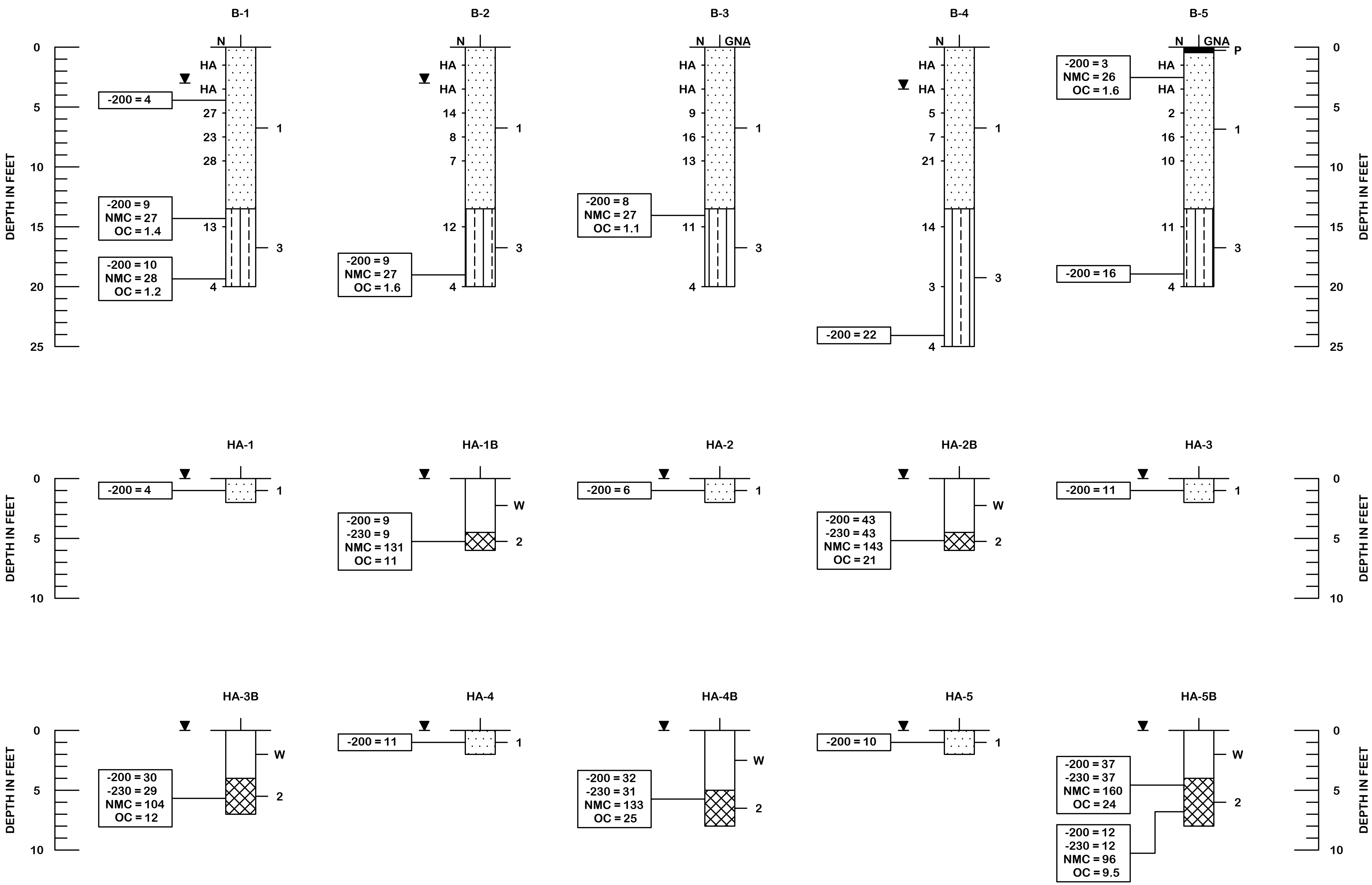
# LEGEND

APPROXIMATE LOCATION OF AUGER BORING

APPROXIMATE LOCATION OF SPT BORING

| DRAWN BY: SW<br>CHECKED BY: SS | APPROVED BY: TEM<br>DATE: AUG 2024 | ENGINEER OF RECORD: THOMAS E. MUSGRAVE, JR., P.E.<br>FLORIDA LICENSE NO.: 81669 | TIERRA<br>7351 Temple Terrace Highway<br>Tampa, Florida 33637<br>Phone: 813-989-1354 Fax: 813-989-1355 | SCALE: NOTED | PROJECT NUMBER: 6511-24-165 | GEOTECHNICAL ENGINEERING SERVICES<br>SANIBEL SLOUGH<br>LEE COUNTY, FLORIDA | SHEET 1 |
|---|---|---|---|---|---|---|---|

# SOIL PROFILES




# LEGEND

1 — LIGHT BROWN SAND TO SAND WITH SILT AND SHELL (SP/SP-SM)

2 — DARK GRAY ORGANIC SILTY SAND TO MUCK (SM/Pt)

3 — DARK GRAY SAND WITH SILT TO SILTY SAND (SP-SM/SM)

P — ASPHALT PAVEMENT

W - WATER

▼ — GROUNDWATER LEVEL ENCOUNTERED DURING INVESTIGATION

GNA — GROUNDWATER NOT APPARENT DUE TO DRILLING METHOD USED

N — SPT N-VALUE IN BLOWS/FOOT FOR 12 INCHES OF PENETRATION (UNLESS OTHERWISE NOTED)

SP — UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2488) GROUP SYMBOL AS DETERMINED BY VISUAL REVIEW AND LABORATORY TESTING ON SELECTED SAMPLES FOR CONFIRMATION OF VISUAL REVIEW

HA — HAND AUGERED TO VERIFY UTILITY CLEARANCES

-200 — PERCENT PASSING #200 SIEVE

NMC — NATURAL MOISTURE CONTENT (%)

OC — ORGANIC CONTENT (%)

| AUTOMATIC HAMMER | |
|---|---|
| GRANULAR MATERIALS-RELATIVE DENSITY | SPT (BLOWS/FT.) |
| VERY LOOSE | LESS THAN 3 |
| LOOSE | 3 TO 8 |
| MEDIUM | 8 TO 24 |
| DENSE | 24 TO 40 |
| VERY DENSE | GREATER THAN 40 |
| SILTS AND CLAYS CONSISTENCY | SPT (BLOWS/FT.) |
| VERY SOFT | LESS THAN 1 |
| SOFT | 1 TO 3 |
| FIRM | 3 TO 6 |
| STIFF | 6 TO 12 |
| VERY STIFF | 12 TO 24 |
| HARD | GREATER THAN 24 |

DRAWN BY: SW
CHECKED BY: SS
APPROVED BY: TEM
DATE: AUG 2024
ENGINEER OF RECORD: THOMAS E. MUSGRAVE, JR., P.E.
FLORIDA LICENSE NO.: 81669

TIERRA
7351 Temple Terrace Highway
Tampa, Florida 33637
Phone: 813-989-1354 Fax: 813-989-1355

SCALE: NOTED
PROJECT NUMBER: 6511-24-165

GEOTECHNICAL ENGINEERING SERVICES
SANIBEL SLOUGH
LEE COUNTY, FLORIDA

SHEET 2

## Summary of Laboratory Test Results for Soil Classification
## Sanibel Slough Dredging
## Lee County, Florida
## Tierra Project No.: 6511-24-165

| Boring Number | Sample Depth (ft) | USCS Symbol | Sieve Analysis | | | | | | | | | Organic Content (%) | Moisture Content (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | #3/4 | #3/8 | #4 | #10 | #40 | #60 | #100 | #200 | #230 | | |
| HA-1 | 0.0 - 2.0 | SP | 100 | 97 | 91 | 82 | 65 | 53 | 26 | 4 | --- | --- | --- |
| HA-2 | 0.0 - 2.0 | SP-SM | 95 | 91 | 85 | 74 | 53 | 43 | 19 | 6 | --- | --- | --- |
| HA-3 | 0.0 - 2.0 | SP-SM | 93 | 87 | 82 | 73 | 51 | 39 | 22 | 11 | --- | --- | --- |
| HA-4 | 0.0 - 2.0 | SP-SM | 98 | 95 | 91 | 77 | 66 | 55 | 32 | 11 | --- | --- | --- |
| HA-5 | 0.0 - 2.0 | SP-SM | 100 | 98 | 95 | 95 | 84 | 66 | 29 | 10 | --- | --- | --- |
| HA-1B | 0.0 - 2.5 | PT | 100 | 100 | 100 | 100 | 80 | 58 | 26 | 9 | 9 | 11 | 131 |
| HA-2B | 0.0 - 1.5 | PT | 100 | 100 | 100 | 100 | 89 | 78 | 56 | 43 | 43 | 21 | 143 |
| HA-3B | 0.0 - 3.0 | PT | 100 | 100 | 100 | 100 | 89 | 76 | 48 | 30 | 29 | 12 | 104 |
| HA-4B | 0.0 - 3.0 | PT | 100 | 100 | 100 | 100 | 85 | 72 | 50 | 32 | 31 | 25 | 133 |
| HA-5B | 0.0 - 2.0 | PT | 100 | 100 | 100 | 100 | 84 | 71 | 53 | 37 | 37 | 24 | 160 |
| HA-5B | 0.0 - 2.0 | PT | 100 | 100 | 100 | 100 | 93 | 81 | 39 | 12 | 12 | 9.5 | 96 |
| B-1 | 4.0 - 6.0 | SP | --- | --- | --- | --- | --- | --- | --- | 4 | --- | --- | --- |
| B-1 | 13.5 - 15.0 | SP-SM | --- | --- | --- | --- | --- | --- | --- | 9 | --- | 1.4 | 27 |
| B-1 | 18.5 - 20.0 | SP-SM | --- | --- | --- | --- | --- | --- | --- | 10 | --- | 1.2 | 28 |
| B-2 | 18.5 - 20.0 | SP-SM | --- | --- | --- | --- | --- | --- | --- | 9 | --- | 1.6 | 27 |
| B-3 | 13.5 - 15.0 | SP-SM | --- | --- | --- | --- | --- | --- | --- | 8 | --- | 1.1 | 27 |
| B-4 | 23.5 - 25.0 | SM | --- | --- | --- | --- | --- | --- | --- | 22 | --- | --- | --- |
| B-5 | 2.0 - 4.0 | SP | --- | --- | --- | --- | --- | --- | --- | 3 | --- | 1.6 | 26 |
| B-5 | 18.5 - 20.0 | SM | --- | --- | --- | --- | --- | --- | --- | 16 | --- | --- | --- |

# Sanibel Slough Dredging



## PROJECT IDENTIFICATION

Title: Sanibel Slough Dredging
Project Number: -
Client: Johnson Engineering
Designer: Tierra, Inc. (SES)

**Description:**
Slope stability analysis of Sanibel Slough for 1V:1.5H slope.

**Company's information:**

Name: Tierra, Inc.
Street: 7351 Temple Terrace Highway
Tampa, FL 33637
Telephone #: 813-989-1354
Fax #:
E-Mail:

**File path and name:** J:\6511\20 ..... 65 Sanibel Slough\ReSSA\SanibelSlough_1.5 to1.MSEp
**Original date and time of creating this file:** Mon Aug 12 10:54:45 2024

**PROGRAM MODE:** Analysis of a General Slope using NO reinforcement material.

## INPUT DATA (EXCLUDING REINFORCEMENT LAYOUT)

### SOIL DATA

| ========== Soil Layer #: ========== | Unit weight, γ [lb/ft ³] | Internal angle of friction, ϕ [deg.] | Cohesion, c [lb/ft ²] |
|---|---|---|---|
| .1.......Shelly Sand (Navg=7)........................... | 105.0 | 29.0 | 0.0 |
| .2.......Silty Sand (Navg=4)............................. | 102.0 | 28.0 | 0.0 |

### REINFORCEMENT

Analysis of slope WITHOUT reinforcement.

### WATER

Unit weight of water = 62.45 [lb/ft ³]
Water pressure is defined by phreatic surface in Effective Stress Analysis.

### SEISMICITY

Not Applicable

### DRAWING OF SPECIFIED GEOMETRY - GENERAL

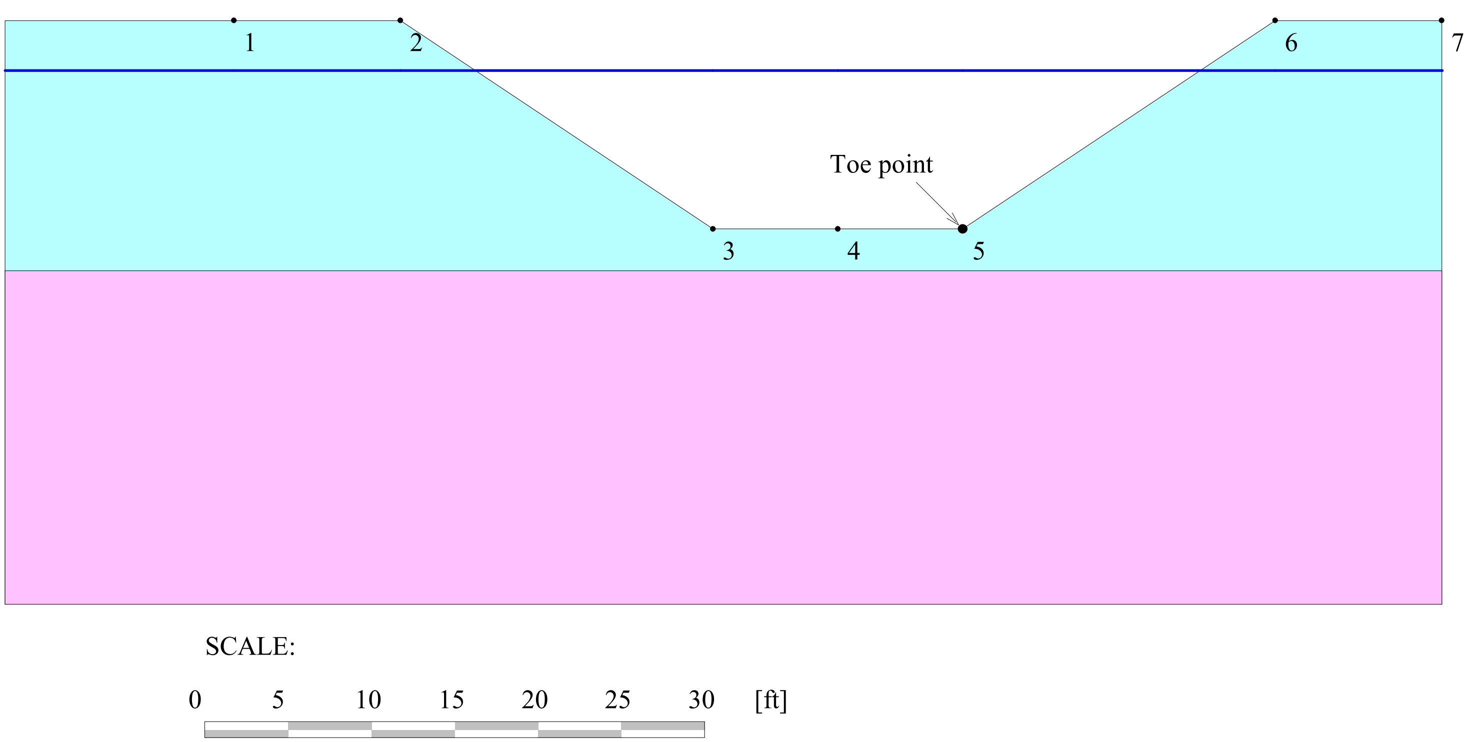
-- Problem geometry is defined along sections selected by user at x,y coordinates.
-- X1,Y1 represents the coordinates of soil surface. X2,Y2 represent the coordinates of the end of soil layer 1 and start of soil layer 2, and so on.
-- Xw,Yw represents the coordinates of phreatic surface.

### GEOMETRY
Soil profile contains 2 layers (see details in next page)

### WATER GEOMETRY
Phreatic line was specified.

### UNIFORM SURCHARGE
Surcharge load, Q1 .................................... None
Surcharge load, Q2 .................................... None
Surcharge load, Q3 .................................... None

### STRIP LOAD
............................None...................................



## TABULATED DETAILS OF GENERAL SPECIFIED GEOMETRY

Soil profile contains 2 layers. Coordinates in [ft.]
Water was described by phreatic line.

| | # | Xi | Yi |
|---|---|---|---|
| Top of Layer 1 | 1 | -36.25 | 5.00 |
| | 2 | -26.25 | 5.00 |
| | 3 | -7.50 | -7.50 |
| | 4 | 0.00 | -7.50 |
| | 5 | 7.50 | -7.50 |
| | 6 | 26.25 | 5.00 |
| | 7 | 36.25 | 5.00 |
| Top of Layer 2 | 8 | 0.00 | -10.00 |
| Top of Phreatic Line | 10 | 0.00 | 2.00 |

## TABULATED DETAILS OF SPECIFIED GEOMETRY

Soil profile contains 2 layers. Coordinates in [ft.]
Water was described by phreatic line. Y values are tabulated in the right most column.

| # | X | Y1 | Y2 | Yw (phreatic) |
|---|---|---|---|---|
| 1 | -36.25 | 5.00 | -10.00 | 2.00 |
| 2 | -26.25 | 5.00 | -10.00 | 2.00 |
| 3 | -7.50 | -7.50 | -10.00 | 2.00 |
| 4 | 0.00 | -7.50 | -10.00 | 2.00 |
| 5 | 7.50 | -7.50 | -10.00 | 2.00 |
| 6 | 26.25 | 5.00 | -10.00 | 2.00 |
| 7 | 36.25 | 5.00 | -10.00 | 2.00 |

## RESULTS OF ROTATIONAL STABILITY ANALYSIS

Results in the tables below represent critical circles identified between specified points on entry and exit. (Theta-exit set to 50.00 deg.)
The most critical circle is obtained from a search considering all the combinations of input entry and exit points.

**Critical circles for each entry point (considering all specified exit points)**

| Entry Point # | Entry Point (X, Y) [ft] | | Exit Point (X, Y) [ft] | | Critical Circle (Xc, Yc, R) [ft] | | | Fs | STATUS |
|---|---|---|---|---|---|---|---|---|---|
| . 1 | 28.25 | 5.00 | 7.29 | -7.61 | -70.15 | 144.90 | 171.04 | 0.78 | . On extreme X-entry |
| 2 | 28.87 | 5.00 | 7.27 | -7.57 | -8.21 | 43.89 | 53.74 | 0.82 | |
| 3 | 29.50 | 5.00 | 7.28 | -7.58 | -18.42 | 63.72 | 75.79 | 0.85 | |
| 4 | 30.12 | 5.00 | 7.28 | -7.59 | -32.63 | 91.83 | 107.14 | 0.88 | |
| 5 | 30.74 | 5.00 | 7.24 | -7.56 | -3.77 | 41.30 | 50.08 | 0.91 | |
| 6 | 31.36 | 5.00 | 7.25 | -7.56 | -4.48 | 44.40 | 53.26 | 0.93 | |
| 7 | 31.98 | 5.00 | 7.23 | -7.56 | -5.24 | 47.68 | 56.63 | 0.96 | |
| 8 | 32.61 | 5.00 | 7.23 | -7.56 | -4.17 | 47.40 | 56.12 | 0.99 | |
| 9 | 33.23 | 5.00 | 7.24 | -7.54 | -1.56 | 43.87 | 52.16 | 1.02 | |
| 10 | 33.85 | 5.00 | 7.21 | -7.54 | -0.59 | 43.57 | 51.71 | 1.04 | |
| 11 | 34.47 | 5.00 | 7.23 | -7.53 | 2.70 | 38.21 | 45.96 | 1.08 | |
| 12 | 35.09 | 5.00 | 7.23 | -7.56 | -9.78 | 67.34 | 76.81 | 1.10 | |
| 13 | 35.71 | 5.00 | 7.22 | -7.55 | -3.66 | 55.77 | 64.25 | 1.13 | |
| 14 | 36.34 | 5.00 | 7.20 | -7.54 | 0.73 | 47.62 | 55.54 | 1.16 | |
| 15 | 36.96 | 5.00 | 7.30 | -7.54 | -4.86 | 62.58 | 71.16 | 1.19 | |
| 16 | 37.58 | 5.00 | 7.20 | -7.55 | -3.36 | 61.08 | 69.43 | 1.21 | |
| 17 | 38.20 | 5.00 | 7.17 | -7.53 | 2.60 | 48.48 | 56.19 | 1.24 | |
| 18 | 38.82 | 5.00 | 7.20 | -7.55 | -6.87 | 74.01 | 82.76 | 1.27 | |
| 19 | 39.44 | 5.00 | 7.18 | -7.53 | 2.20 | 53.12 | 60.85 | 1.30 | |
| 20 | 40.07 | 5.00 | 7.26 | -7.53 | -3.29 | 69.29 | 77.54 | 1.33 | |
| 21 | 40.69 | 5.00 | 7.16 | -7.53 | 1.77 | 58.03 | 65.78 | 1.36 | |
| 22 | 41.31 | 5.00 | 7.27 | -7.53 | -2.05 | 70.31 | 78.40 | 1.39 | |
| 23 | 41.93 | 5.00 | 7.15 | -7.52 | 2.85 | 58.97 | 66.64 | 1.42 | |
| 24 | 42.55 | 5.00 | 7.22 | -7.53 | -2.87 | 76.99 | 85.12 | 1.45 | |
| 25 | 43.17 | 5.00 | -0.97 | -7.50 | 6.94 | 48.75 | 56.81 | 1.48 | |
| 26 | 43.80 | 5.00 | 7.15 | -7.54 | -3.75 | 84.11 | 92.29 | 1.51 | |
| 27 | 44.42 | 5.00 | -0.96 | -7.50 | 7.95 | 48.77 | 56.97 | 1.53 | |
| 28 | 45.04 | 5.00 | -0.29 | -7.49 | 8.01 | 50.89 | 58.97 | 1.57 | |
| 29 | 45.66 | 5.00 | -2.17 | -7.49 | 7.51 | 53.27 | 61.52 | 1.59 | |
| 30 | 46.28 | 5.00 | -2.15 | -7.49 | 7.70 | 54.45 | 62.73 | 1.62 | |
| 31 | 46.90 | 5.00 | -2.14 | -7.50 | 8.56 | 53.02 | 61.45 | 1.65 | |
| 32 | 47.53 | 5.00 | -2.13 | -7.50 | 8.76 | 54.15 | 62.60 | 1.67 | |
| 33 | 48.15 | 5.00 | -2.12 | -7.50 | 8.96 | 55.29 | 63.76 | 1.70 | |
| 34 | 48.77 | 5.00 | -3.27 | -7.50 | 9.04 | 55.83 | 64.51 | 1.73 | |
| 35 | 49.39 | 5.00 | 0.17 | -7.50 | 10.25 | 55.99 | 64.28 | 1.76 | |
| 36 | 50.01 | 5.00 | -3.80 | -7.47 | 9.22 | 58.70 | 67.44 | 1.79 | |
| 37 | 50.63 | 5.00 | -6.00 | -7.49 | 8.59 | 60.98 | 70.01 | 1.82 | |
| 38 | 51.26 | 5.00 | -5.97 | -7.50 | 8.82 | 62.04 | 71.10 | 1.84 | |
| 39 | 51.88 | 5.00 | -4.85 | -7.49 | 9.78 | 61.13 | 70.16 | 1.87 | |
| 40 | 52.50 | 5.00 | -4.83 | -7.50 | 10.01 | 62.20 | 71.25 | 1.90 | |

Note: In the 'Status' column, OK means the critical circle was identified within the specified search domain. 'On extreme X-entry' means that the critical result is on the edge of the search domain; a lower Fs may result if the search domain is expanded.

## RESULTS OF ROTATIONAL STABILITY ANALYSIS

Results in the tables below represent critical circles identified between specified points on entry and exit. (Theta-exit set to 50.00 deg.) The most critical circle is obtained from a search considering all the combinations of input entry and exit points.

**Critical circles for each exit point (considering all specified entry points).**

| Exit Point # | Exit Point (X, Y) [ft] | | Entry Point (X, Y) [ft] | | Critical Circle (Xc, Yc, R) [ft] | | | Fs | STATUS |
|---|---|---|---|---|---|---|---|---|---|
| 1 | -7.59 | -7.48 | 29.50 | 5.00 | 0.03 | 31.22 | 39.45 | 1.03 | |
| 2 | -7.15 | -7.49 | 28.25 | 5.00 | 0.36 | 27.65 | 35.93 | 1.03 | |
| 3 | -6.95 | -7.46 | 28.87 | 5.00 | 0.40 | 29.16 | 37.35 | 1.02 | |
| 4 | -6.40 | -7.49 | 28.87 | 5.00 | 0.67 | 28.60 | 36.78 | 1.00 | |
| 5 | -6.17 | -7.46 | 30.12 | 5.00 | 0.85 | 31.15 | 39.25 | 1.02 | |
| 6 | -5.65 | -7.49 | 29.50 | 5.00 | 0.96 | 29.60 | 37.67 | 0.99 | |
| 7 | -5.49 | -7.45 | 29.50 | 5.00 | 1.25 | 29.02 | 37.08 | 1.00 | |
| 8 | -4.96 | -7.47 | 28.87 | 5.00 | 1.36 | 27.50 | 35.54 | 0.97 | |
| 9 | -4.44 | -7.50 | 28.25 | 5.00 | 1.89 | 24.96 | 33.07 | 0.97 | |
| 10 | -4.25 | -7.46 | 28.25 | 5.00 | 1.77 | 25.45 | 33.46 | 0.96 | |
| 11 | -3.69 | -7.49 | 28.25 | 5.00 | 2.06 | 24.89 | 32.89 | 0.94 | |
| 12 | -3.49 | -7.46 | 28.25 | 5.00 | 2.34 | 24.34 | 32.33 | 0.96 | |
| 13 | -2.90 | -7.50 | 28.87 | 5.00 | 2.38 | 25.73 | 33.64 | 0.93 | |
| 14 | -2.71 | -7.47 | 28.25 | 5.00 | 2.52 | 24.22 | 32.12 | 0.93 | |
| 15 | -2.14 | -7.50 | 28.25 | 5.00 | 2.82 | 23.65 | 31.54 | 0.92 | |
| 16 | -1.92 | -7.47 | 28.25 | 5.00 | 3.11 | 23.09 | 30.97 | 0.93 | |
| 17 | -1.35 | -7.50 | 28.25 | 5.00 | 3.41 | 22.53 | 30.41 | 0.91 | |
| 18 | -1.11 | -7.48 | 28.25 | 5.00 | 3.31 | 22.90 | 30.70 | 0.91 | |
| 19 | -0.87 | -7.46 | 28.25 | 5.00 | 3.62 | 22.33 | 30.12 | 0.92 | |
| 20 | -0.29 | -7.49 | 28.25 | 5.00 | 3.92 | 21.76 | 29.55 | 0.91 | |
| 21 | 0.11 | -7.49 | 28.25 | 5.00 | 4.22 | 21.19 | 28.98 | 0.91 | |
| 22 | 0.39 | -7.48 | 28.25 | 5.00 | 4.14 | 21.50 | 29.22 | 0.90 | |
| 23 | 0.79 | -7.48 | 28.25 | 5.00 | 4.45 | 20.92 | 28.64 | 0.90 | |
| 24 | 1.20 | -7.48 | 28.25 | 5.00 | 4.77 | 20.35 | 28.06 | 0.90 | |
| 25 | 1.48 | -7.47 | 28.25 | 5.00 | 4.69 | 20.62 | 28.27 | 0.90 | |
| 26 | 1.89 | -7.48 | 28.25 | 5.00 | 5.01 | 20.03 | 27.68 | 0.90 | |
| 27 | 2.46 | -7.50 | 28.87 | 5.00 | 5.02 | 21.27 | 28.88 | 0.90 | |
| 28 | 2.88 | -7.50 | 28.25 | 5.00 | 5.26 | 19.67 | 27.27 | 0.89 | |
| 29 | 2.99 | -7.47 | 28.25 | 5.00 | 5.59 | 19.07 | 26.67 | 0.90 | |
| 30 | 3.57 | -7.49 | 28.87 | 5.00 | 5.60 | 20.28 | 27.84 | 0.90 | |
| 31 | 3.98 | -7.50 | 28.25 | 5.00 | 5.87 | 18.66 | 26.22 | 0.89 | |
| 32 | 4.38 | -7.50 | 28.25 | 5.00 | 6.21 | 18.06 | 25.62 | 0.90 | |
| 33 | 4.69 | -7.49 | 28.25 | 5.00 | 6.16 | 18.21 | 25.75 | 0.89 | |
| 34 | 5.09 | -7.49 | 28.25 | 5.00 | 6.51 | 17.60 | 25.13 | 0.90 | |
| 35 | 5.48 | -7.49 | 28.25 | 5.00 | 6.86 | 16.99 | 24.52 | 0.90 | |
| 36 | 5.80 | -7.49 | 28.25 | 5.00 | 6.82 | 17.10 | 24.61 | 0.90 | |
| 37 | 6.19 | -7.49 | 28.25 | 5.00 | 7.18 | 16.48 | 23.99 | 0.91 | |
| 38 | 6.52 | -7.50 | 28.25 | 5.00 | 7.15 | 16.56 | 24.06 | 0.91 | |
| 39 | 6.92 | -7.50 | 28.25 | 5.00 | 7.52 | 15.93 | 23.43 | 0.91 | |
| 40 | 7.29 | -7.61 | 28.25 | 5.00 | -70.15 | 144.90 | 171.04 | 0.78 | . On extreme X-exit |

Note: In the 'Status' column, OK means the critical circle was identified within the specified search domain. 'On extreme X-exit' means that the critical result is on the edge of the search domain; a lower Fs may result if the search domain is expanded.

## CRITICAL RESULTS OF ROTATIONAL AND TRANSLATIONAL STABILITY ANALYSES

### Rotational (Circular Arc; Bishop) Stability Analysis

Minimum Factor of Safety = 0.78
Critical Circle: Xc = -70.15[ft], Yc = 144.90[ft], R = 171.04[ft]. (Number of slices used = 51 )

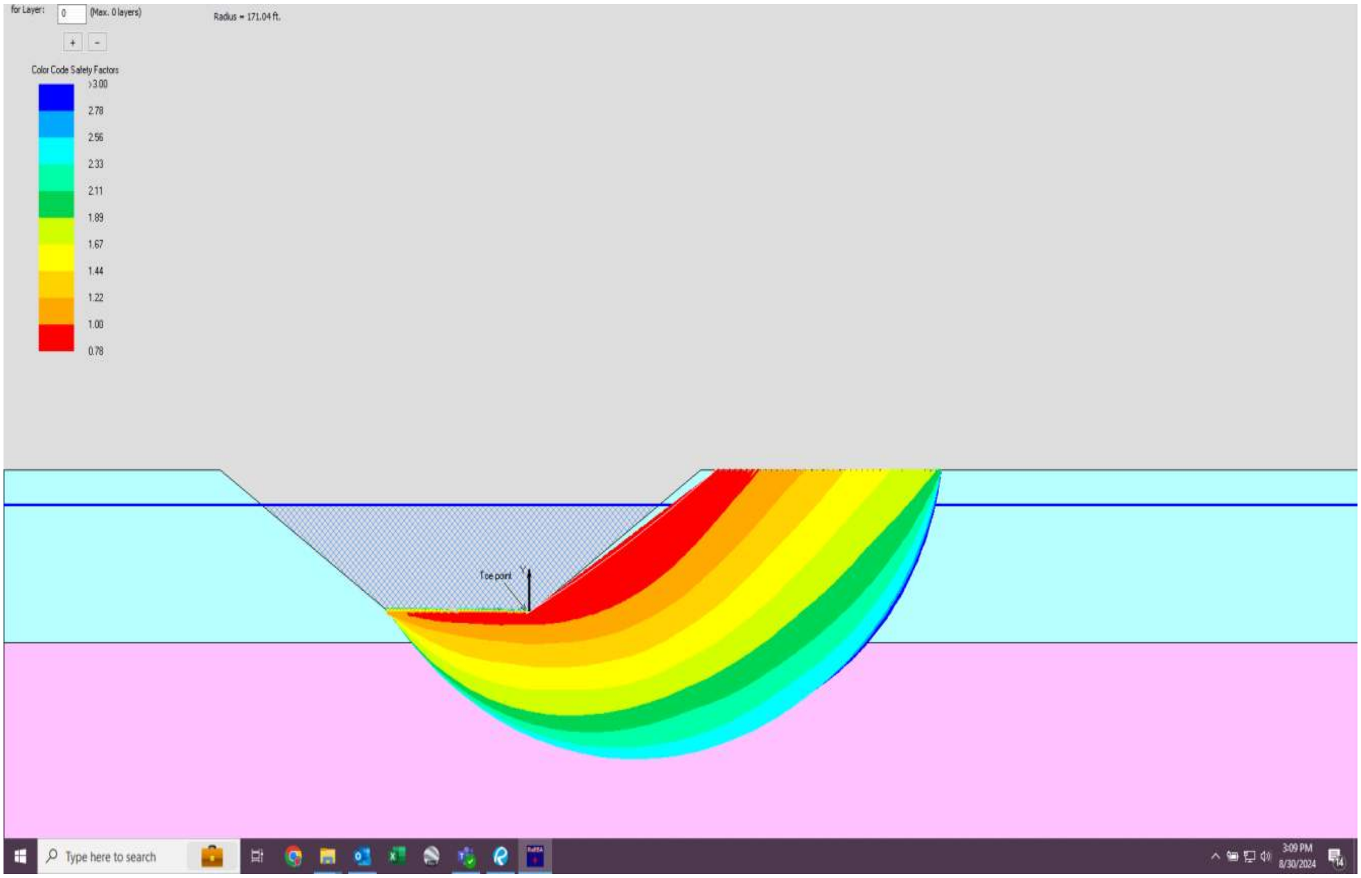
### Translational (2-Part Wedge; Spencer), Direct Sliding, Stability Analysis

N O T C O N D U C T E D

### Three-Part Wedge Stability Analysis

N O T C O N D U C T E D

SAFETY MAP: BISHOP ROTATIONAL ANALYSIS MODE



# Sanibel Slough Dredging



## PROJECT IDENTIFICATION

Title: Sanibel Slough Dredging
Project Number: -
Client: Johnson Engineering
Designer: Tierra, Inc. (SES)

**Description:**

Slope stability analysis of Sanibel Slough for 1V:2H slope.

**Company's information:**

Name: Tierra, Inc.
Street: 7351 Temple Terrace Highway
Tampa, FL 33637
Telephone #: 813-989-1354
Fax #:
E-Mail:

**File path and name:** J:\6511\20 ..... -165 Sanibel Slough\ReSSA\SanibelSlough_2 to1.MSEp
**Original date and time of creating this file:** Mon Aug 12 10:54:45 2024

**PROGRAM MODE:** Analysis of a General Slope using NO reinforcement material.

## INPUT DATA (EXCLUDING REINFORCEMENT LAYOUT)

### SOIL DATA

| ========== Soil Layer #: ========== | Unit weight, γ [lb/ft ³] | Internal angle of friction, ϕ [deg.] | Cohesion, c [lb/ft ²] |
|---|---|---|---|
| .1......Shelly Sand (Navg=7).......................... | 105.0 | 29.0 | 0.0 |
| .2......Silty Sand (Navg=4)............................ | 102.0 | 28.0 | 0.0 |

### REINFORCEMENT

Analysis of slope WITHOUT reinforcement.

### WATER

Unit weight of water = 62.45 [lb/ft ³]
Water pressure is defined by phreatic surface in Effective Stress Analysis.

### SEISMICITY

Not Applicable

## DRAWING OF SPECIFIED GEOMETRY - GENERAL

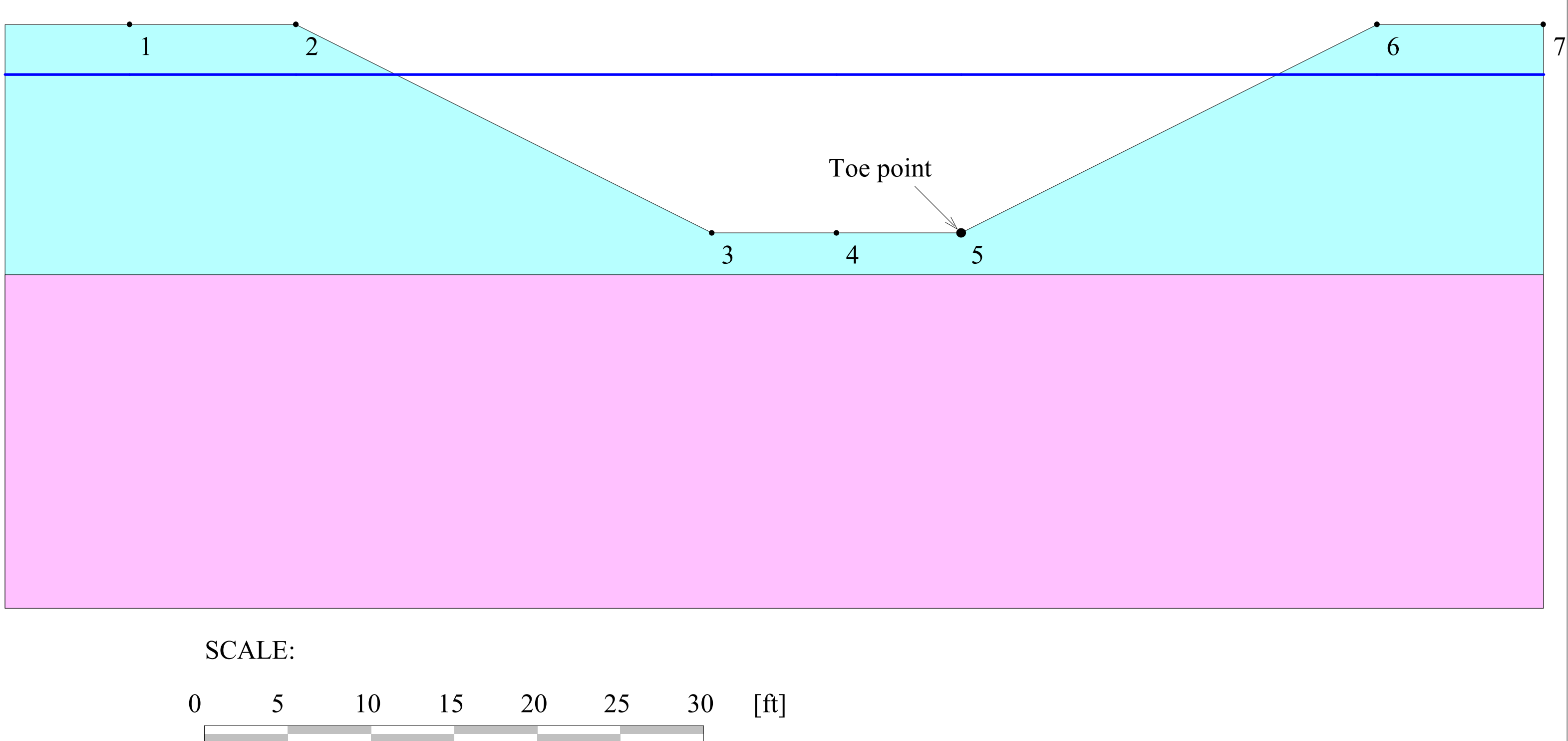
-- Problem geometry is defined along sections selected by user at x,y coordinates.
-- X1,Y1 represents the coordinates of soil surface. X2,Y2 represent the coordinates of the end of soil layer 1 and start of soil layer 2, and so on.
-- Xw,Yw represents the coordinates of phreatic surface.

### GEOMETRY
Soil profile contains 2 layers (see details in next page)

### WATER GEOMETRY
Phreatic line was specified.

### UNIFORM SURCHARGE
Surcharge load, Q1 .................................... None
Surcharge load, Q2 .................................... None
Surcharge load, Q3 .................................... None

### STRIP LOAD
............................None...................................



## TABULATED DETAILS OF GENERAL SPECIFIED GEOMETRY

Soil profile contains 2 layers. Coordinates in [ft.]
Water was described by phreatic line.

| | # | Xi | Yi |
|---|---|---|---|
| Top of Layer 1 | 1 | -42.50 | 5.00 |
| | 2 | -32.50 | 5.00 |
| | 3 | -7.50 | -7.50 |
| | 4 | 0.00 | -7.50 |
| | 5 | 7.50 | -7.50 |
| | 6 | 32.50 | 5.00 |
| | 7 | 42.50 | 5.00 |
| Top of Layer 2 | 8 | 0.00 | -10.00 |
| Top of Phreatic Line | 10 | 0.00 | 2.00 |

## TABULATED DETAILS OF SPECIFIED GEOMETRY

Soil profile contains 2 layers. Coordinates in [ft.]
Water was described by phreatic line. Y values are tabulated in the right most column.

| # | X | Y1 | Y2 | (phreatic) Yw |
|---|---|---|---|---|
| 1 | -42.50 | 5.00 | -10.00 | 2.00 |
| 2 | -32.50 | 5.00 | -10.00 | 2.00 |
| 3 | -7.50 | -7.50 | -10.00 | 2.00 |
| 4 | 0.00 | -7.50 | -10.00 | 2.00 |
| 5 | 7.50 | -7.50 | -10.00 | 2.00 |
| 6 | 32.50 | 5.00 | -10.00 | 2.00 |
| 7 | 42.50 | 5.00 | -10.00 | 2.00 |

## RESULTS OF ROTATIONAL STABILITY ANALYSIS

Results in the tables below represent critical circles identified between specified points on entry and exit. (Theta-exit set to 50.00 deg.)
The most critical circle is obtained from a search considering all the combinations of input entry and exit points.

**Critical circles for each entry point (considering all specified exit points)**

| Entry Point # | Entry Point (X, Y) [ft] | | Exit Point (X, Y) [ft] | | Critical Circle (Xc, Yc, R) [ft] | | | Fs | STATUS |
|---|---|---|---|---|---|---|---|---|---|
| . 1 | 35.50 | 5.00 | 7.20 | -7.55 | -3.46 | 54.68 | 63.14 | 1.08 | . On extreme X-entry |
| 2 | 35.94 | 5.00 | 7.19 | -7.53 | 2.17 | 43.23 | 51.01 | 1.11 | |
| 3 | 36.37 | 5.00 | 7.20 | -7.59 | -33.71 | 127.30 | 140.96 | 1.12 | |
| 4 | 36.81 | 5.00 | 7.19 | -7.56 | -7.01 | 67.13 | 76.03 | 1.13 | |
| 5 | 37.25 | 5.00 | 7.18 | -7.53 | 1.66 | 48.03 | 55.84 | 1.15 | |
| 6 | 37.68 | 5.00 | 7.25 | -7.55 | -11.14 | 80.20 | 89.66 | 1.17 | |
| 7 | 38.12 | 5.00 | 7.18 | -7.55 | -3.82 | 63.98 | 72.37 | 1.18 | |
| 8 | 38.55 | 5.00 | 7.19 | -7.52 | 4.80 | 44.03 | 51.60 | 1.21 | |
| 9 | 38.99 | 5.00 | 7.21 | -7.55 | -4.60 | 68.90 | 77.35 | 1.22 | |
| 10 | 39.43 | 5.00 | 7.15 | -7.53 | 2.20 | 53.05 | 60.78 | 1.23 | |
| 11 | 39.86 | 5.00 | 7.28 | -7.53 | -1.17 | 63.07 | 71.10 | 1.26 | |
| 12 | 40.30 | 5.00 | 7.16 | -7.53 | 1.90 | 56.46 | 64.20 | 1.27 | |
| 13 | 40.73 | 5.00 | 7.36 | -7.51 | 3.17 | 54.44 | 62.09 | 1.29 | |
| 14 | 41.17 | 5.00 | 7.16 | -7.52 | 3.06 | 56.07 | 63.72 | 1.31 | |
| 15 | 41.60 | 5.00 | 7.36 | -7.51 | 4.27 | 54.08 | 61.66 | 1.33 | |
| 16 | 42.04 | 5.00 | 7.15 | -7.52 | 4.19 | 55.61 | 63.20 | 1.34 | |
| 17 | 42.48 | 5.00 | 7.34 | -7.51 | 5.36 | 53.66 | 61.20 | 1.36 | |
| 18 | 42.91 | 5.00 | 7.12 | -7.51 | 5.31 | 55.10 | 62.64 | 1.38 | |
| 19 | 43.35 | 5.00 | 7.24 | -7.51 | 3.94 | 60.35 | 67.94 | 1.40 | |
| 20 | 43.78 | 5.00 | 4.01 | -7.50 | 8.01 | 49.31 | 56.95 | 1.42 | |
| 21 | 44.22 | 5.00 | 4.03 | -7.50 | 8.88 | 47.78 | 55.49 | 1.44 | |
| 22 | 44.66 | 5.00 | 4.74 | -7.50 | 8.80 | 49.55 | 57.19 | 1.45 | |
| 23 | 45.09 | 5.00 | 4.75 | -7.50 | 8.87 | 50.57 | 58.22 | 1.47 | |
| 24 | 45.53 | 5.00 | 2.85 | -7.50 | 9.00 | 50.64 | 58.46 | 1.49 | |
| 25 | 45.96 | 5.00 | 2.87 | -7.50 | 9.09 | 51.58 | 59.41 | 1.51 | |
| 26 | 46.40 | 5.00 | 4.79 | -7.50 | 9.92 | 50.93 | 58.66 | 1.53 | |
| 27 | 46.83 | 5.00 | 1.72 | -7.50 | 9.19 | 53.22 | 61.18 | 1.54 | |
| 28 | 47.27 | 5.00 | 0.57 | -7.50 | 8.44 | 56.57 | 64.55 | 1.56 | |
| 29 | 47.71 | 5.00 | 3.60 | -7.49 | 10.09 | 53.70 | 61.54 | 1.58 | |
| 30 | 48.14 | 5.00 | 3.62 | -7.50 | 10.95 | 51.94 | 59.89 | 1.60 | |
| 31 | 48.58 | 5.00 | 3.64 | -7.50 | 11.06 | 52.85 | 60.80 | 1.62 | |
| 32 | 49.01 | 5.00 | 2.46 | -7.49 | 11.06 | 53.43 | 61.53 | 1.64 | |
| 33 | 49.45 | 5.00 | 2.48 | -7.50 | 11.19 | 54.30 | 62.41 | 1.66 | |
| 34 | 49.89 | 5.00 | 1.34 | -7.50 | 11.20 | 54.72 | 63.00 | 1.67 | |
| 35 | 50.32 | 5.00 | -0.29 | -7.48 | 10.27 | 58.54 | 66.87 | 1.70 | |
| 36 | 50.76 | 5.00 | -0.29 | -7.48 | 10.40 | 59.40 | 67.73 | 1.71 | |
| 37 | 51.19 | 5.00 | 0.86 | -7.48 | 11.33 | 57.99 | 66.31 | 1.73 | |
| 38 | 51.63 | 5.00 | 0.89 | -7.49 | 11.47 | 58.84 | 67.17 | 1.75 | |
| 39 | 52.06 | 5.00 | 0.91 | -7.49 | 11.60 | 59.70 | 68.04 | 1.77 | |
| 40 | 52.50 | 5.00 | 0.94 | -7.50 | 12.45 | 57.64 | 66.15 | 1.79 | |

Note: In the 'Status' column, OK means the critical circle was identified within the specified search domain. 'On extreme X-entry' means that the critical result is on the edge of the search domain; a lower Fs may result if the search domain is expanded.

## RESULTS OF ROTATIONAL STABILITY ANALYSIS

Results in the tables below represent critical circles identified between specified points on entry and exit. (Theta-exit set to 50.00 deg.) The most critical circle is obtained from a search considering all the combinations of input entry and exit points.

**Critical circles for each exit point (considering all specified entry points).**

| Exit Point # | Exit Point (X, Y) [ft] | | Entry Point (X, Y) [ft] | | Critical Circle (Xc, Yc, R) [ft] | | | Fs | STATUS |
|---|---|---|---|---|---|---|---|---|---|
| 1 | -7.57 | -7.49 | 35.50 | 5.00 | 0.10 | 46.58 | 54.61 | 1.22 | |
| 2 | -7.48 | -7.45 | 35.50 | 5.00 | 0.38 | 45.84 | 53.87 | 1.23 | |
| 3 | -6.93 | -7.47 | 35.50 | 5.00 | 0.66 | 45.11 | 53.13 | 1.22 | |
| 4 | -6.38 | -7.50 | 35.50 | 5.00 | 0.95 | 44.39 | 52.40 | 1.20 | |
| 5 | -6.22 | -7.47 | 36.37 | 5.00 | 0.80 | 47.55 | 55.46 | 1.21 | |
| 6 | -5.70 | -7.49 | 35.94 | 5.00 | 0.98 | 45.91 | 53.81 | 1.19 | |
| 7 | -5.60 | -7.45 | 35.50 | 5.00 | 1.17 | 44.29 | 52.18 | 1.20 | |
| 8 | -5.04 | -7.47 | 35.50 | 5.00 | 1.46 | 43.54 | 51.42 | 1.18 | |
| 9 | -4.49 | -7.49 | 35.50 | 5.00 | 1.75 | 42.79 | 50.67 | 1.17 | |
| 10 | -4.35 | -7.46 | 35.50 | 5.00 | 2.05 | 42.05 | 49.92 | 1.18 | |
| 11 | -3.79 | -7.48 | 35.50 | 5.00 | 2.34 | 41.31 | 49.17 | 1.17 | |
| 12 | -3.65 | -7.45 | 35.50 | 5.00 | 2.63 | 40.57 | 48.43 | 1.18 | |
| 13 | -3.07 | -7.48 | 35.94 | 5.00 | 2.39 | 42.67 | 50.44 | 1.17 | |
| 14 | -2.52 | -7.50 | 35.50 | 5.00 | 2.60 | 41.02 | 48.78 | 1.15 | |
| 15 | -2.36 | -7.47 | 35.50 | 5.00 | 2.90 | 40.25 | 48.02 | 1.16 | |
| 16 | -1.79 | -7.49 | 35.50 | 5.00 | 3.21 | 39.49 | 47.25 | 1.15 | |
| 17 | -1.62 | -7.47 | 35.50 | 5.00 | 3.51 | 38.74 | 46.49 | 1.16 | |
| 18 | -1.05 | -7.49 | 35.50 | 5.00 | 3.82 | 37.99 | 45.74 | 1.15 | |
| 19 | -0.87 | -7.47 | 35.50 | 5.00 | 3.50 | 39.06 | 46.74 | 1.14 | |
| 20 | -0.29 | -7.49 | 35.50 | 5.00 | 3.81 | 38.28 | 45.95 | 1.14 | |
| 21 | 0.15 | -7.50 | 35.50 | 5.00 | 4.13 | 37.50 | 45.17 | 1.13 | |
| 22 | 0.55 | -7.50 | 35.50 | 5.00 | 4.45 | 36.73 | 44.40 | 1.13 | |
| 23 | 0.95 | -7.50 | 35.50 | 5.00 | 4.76 | 35.97 | 43.63 | 1.13 | |
| 24 | 1.29 | -7.50 | 35.50 | 5.00 | 4.45 | 36.93 | 44.54 | 1.13 | |
| 25 | 1.69 | -7.50 | 35.50 | 5.00 | 4.78 | 36.13 | 43.74 | 1.13 | |
| 26 | 2.09 | -7.50 | 35.50 | 5.00 | 5.11 | 35.34 | 42.94 | 1.13 | |
| 27 | 2.48 | -7.50 | 35.50 | 5.00 | 5.44 | 34.55 | 42.16 | 1.13 | |
| 28 | 2.88 | -7.50 | 35.50 | 5.00 | 5.77 | 33.78 | 41.38 | 1.13 | |
| 29 | 3.23 | -7.50 | 35.50 | 5.00 | 5.48 | 34.62 | 42.18 | 1.13 | |
| 30 | 3.63 | -7.50 | 35.50 | 5.00 | 5.82 | 33.81 | 41.37 | 1.13 | |
| 31 | 4.02 | -7.50 | 35.50 | 5.00 | 6.16 | 33.01 | 40.56 | 1.13 | |
| 32 | 4.42 | -7.50 | 35.50 | 5.00 | 6.50 | 32.21 | 39.77 | 1.13 | |
| 33 | 4.78 | -7.50 | 35.50 | 5.00 | 6.22 | 32.97 | 40.49 | 1.13 | |
| 34 | 5.18 | -7.50 | 35.50 | 5.00 | 6.58 | 32.14 | 39.67 | 1.13 | |
| 35 | 5.57 | -7.50 | 35.50 | 5.00 | 6.93 | 31.33 | 38.85 | 1.13 | |
| 36 | 5.96 | -7.50 | 35.50 | 5.00 | 7.29 | 30.52 | 38.04 | 1.13 | |
| 37 | 6.34 | -7.50 | 35.50 | 5.00 | 7.02 | 31.18 | 38.69 | 1.13 | |
| 38 | 6.72 | -7.50 | 35.50 | 5.00 | 7.39 | 30.34 | 37.85 | 1.13 | |
| 39 | 6.92 | -7.50 | 35.50 | 5.00 | 7.76 | 29.52 | 37.02 | 1.14 | |
| 40 | 7.20 | -7.55 | 35.50 | 5.00 | -3.46 | 54.68 | 63.14 | 1.08 | . On extreme X-exit |

Note: In the 'Status' column, OK means the critical circle was identified within the specified search domain. 'On extreme X-exit' means that the critical result is on the edge of the search domain; a lower Fs may result if the search domain is expanded.

## CRITICAL RESULTS OF ROTATIONAL AND TRANSLATIONAL STABILITY ANALYSES

### Rotational (Circular Arc; Bishop) Stability Analysis

Minimum Factor of Safety = 1.08

Critical Circle: Xc = -3.46[ft], Yc = 54.68[ft], R = 63.14[ft]. (Number of slices used = 51 )

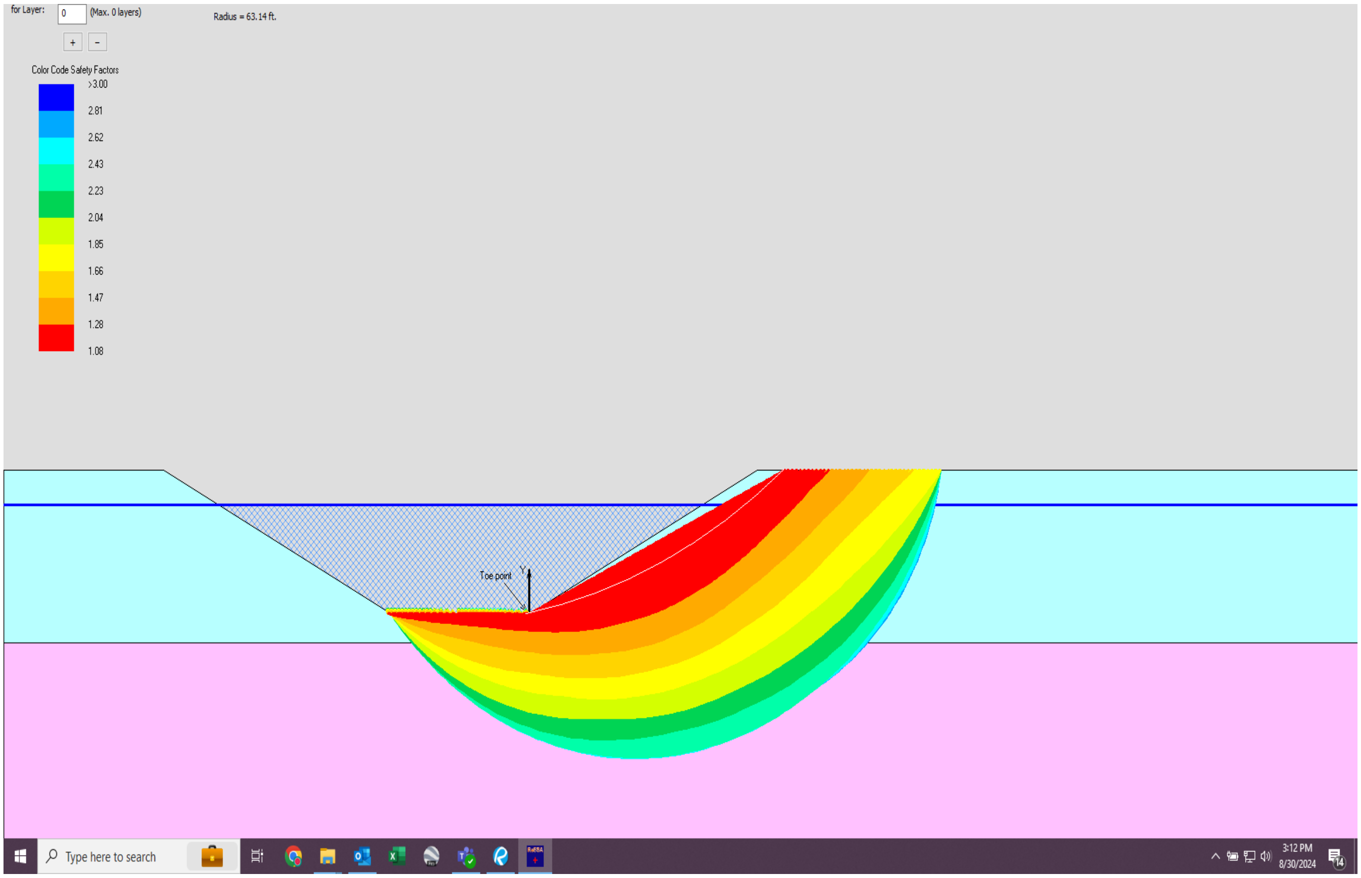
### Translational (2-Part Wedge; Spencer), Direct Sliding, Stability Analysis

N O T  C O N D U C T E D

### Three-Part Wedge Stability Analysis

N O T  C O N D U C T E D

SAFETY MAP: BISHOP ROTATIONAL ANALYSIS MODE



# Sanibel Slough Dredging



## PROJECT IDENTIFICATION

| | |
|---|---|
| Title: | Sanibel Slough Dredging |
| Project Number: | - |
| Client: | Johnson Engineering |
| Designer: | Tierra, Inc. (SES) |

**Description:**
Slope stability analysis of Sanibel Slough for 1V:3H slope.

**Company's information:**

| | |
|---|---|
| Name: | Tierra, Inc. |
| Street: | 7351 Temple Terrace Highway<br>Tampa, FL 33637 |
| Telephone #: | 813-989-1354 |
| Fax #: | |
| E-Mail: | |

**File path and name:** J:\6511\20 ..... -165 Sanibel Slough\ReSSA\SanibelSlough_3 to1.MSEp
**Original date and time of creating this file:** Mon Aug 12 10:54:45 2024

**PROGRAM MODE:** Analysis of a General Slope using NO reinforcement material.

## INPUT DATA (EXCLUDING REINFORCEMENT LAYOUT)

### SOIL DATA

| =========== Soil Layer #: =========== | Unit weight, $\gamma$ [lb/ft ³] | Internal angle of friction, $\phi$ [deg.] | Cohesion, c [lb/ft ²] |
|---|---|---|---|
| .1.......Shelly Sand (Navg=7)........................... | 105.0 | 29.0 | 0.0 |
| .2.......Silty Sand (Navg=4)............................. | 102.0 | 28.0 | 0.0 |

### REINFORCEMENT

Analysis of slope WITHOUT reinforcement.

### WATER

Unit weight of water = 62.45 [lb/ft ³]
Water pressure is defined by phreatic surface in Effective Stress Analysis.

### SEISMICITY

Not Applicable

## DRAWING OF SPECIFIED GEOMETRY - GENERAL

-- Problem geometry is defined along sections selected by user at x,y coordinates.
-- X1,Y1 represents the coordinates of soil surface. X2,Y2 represent the coordinates of the end of soil layer 1 and start of soil layer 2, and so on.
-- Xw,Yw represents the coordinates of phreatic surface.

## GEOMETRY

Soil profile contains 2 layers (see details in next page)

## WATER GEOMETRY

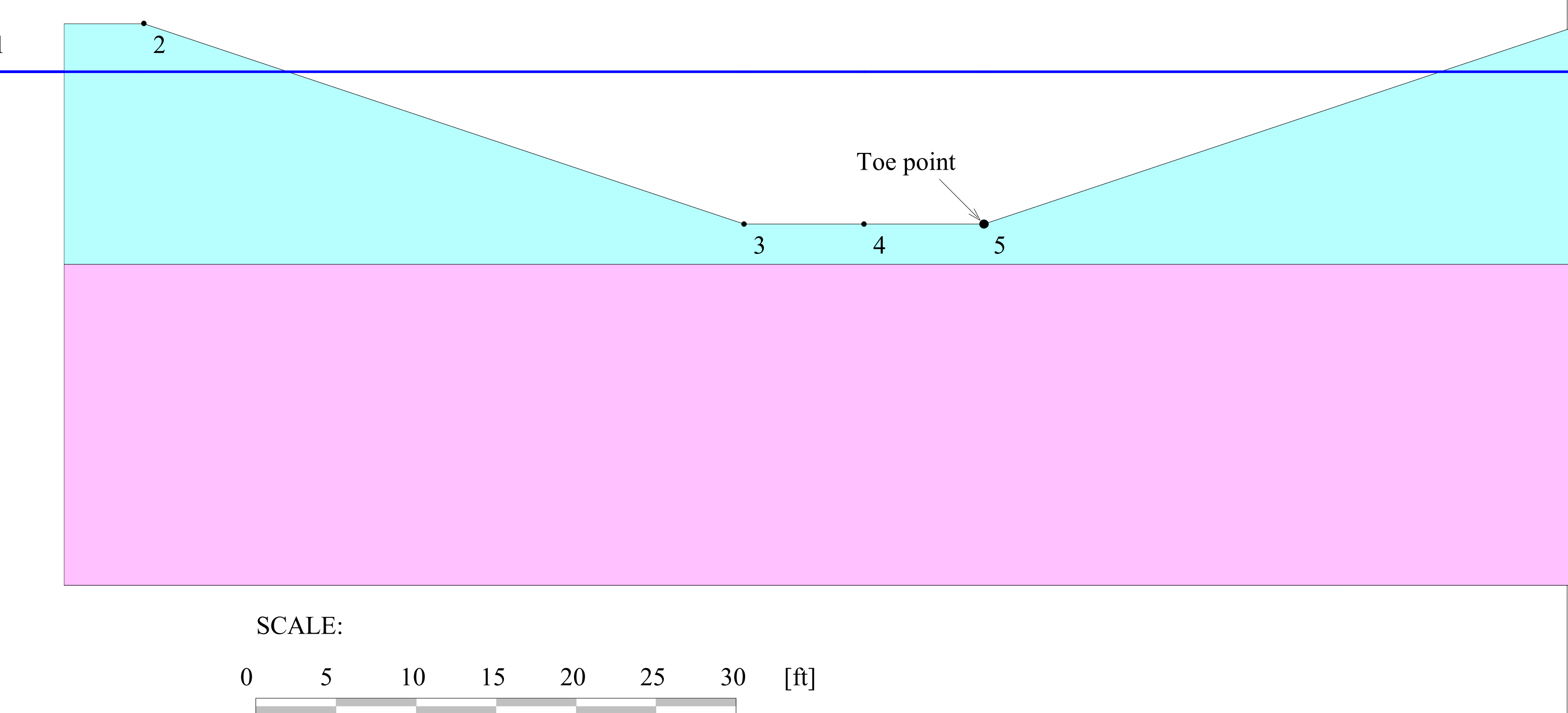
Phreatic line was specified.

## UNIFORM SURCHARGE

Surcharge load, Q1 .................................... None
Surcharge load, Q2 .................................... None
Surcharge load, Q3 .................................... None

## STRIP LOAD

............................None...................................



## TABULATED DETAILS OF GENERAL SPECIFIED GEOMETRY

Soil profile contains 2 layers. Coordinates in [ft.]
Water was described by phreatic line.

| | # | Xi | Yi |
|---|---|---|---|
| Top of Layer 1 | 1 | -55.00 | 5.00 |
| | 2 | -45.00 | 5.00 |
| | 3 | -7.50 | -7.50 |
| | 4 | 0.00 | -7.50 |
| | 5 | 7.50 | -7.50 |
| | 6 | 45.00 | 5.00 |
| | 7 | 55.00 | 5.00 |
| Top of Layer 2 | 8 | 0.00 | -10.00 |
| Top of Phreatic Line | 10 | 0.00 | 2.00 |

## TABULATED DETAILS OF SPECIFIED GEOMETRY

Soil profile contains 2 layers. Coordinates in [ft.]
Water was described by phreatic line. Y values are tabulated in the right most column.

| # | X | Y1 | Y2 | (phreatic) Yw |
|---|---|---|---|---|
| 1 | -55.00 | 5.00 | -10.00 | 2.00 |
| 2 | -45.00 | 5.00 | -10.00 | 2.00 |
| 3 | -7.50 | -7.50 | -10.00 | 2.00 |
| 4 | 0.00 | -7.50 | -10.00 | 2.00 |
| 5 | 7.50 | -7.50 | -10.00 | 2.00 |
| 6 | 45.00 | 5.00 | -10.00 | 2.00 |
| 7 | 55.00 | 5.00 | -10.00 | 2.00 |

## RESULTS OF ROTATIONAL STABILITY ANALYSIS

Results in the tables below represent critical circles identified between specified points on entry and exit. (Theta-exit set to 50.00 deg.) The most critical circle is obtained from a search considering all the combinations of input entry and exit points.

**Critical circles for each entry point (considering all specified exit points)**

| Entry Point # | Entry Point (X, Y) [ft] | | Exit Point (X, Y) [ft] | | Critical Circle (Xc, Yc, R) [ft] | | | Fs | STATUS |
|---|---|---|---|---|---|---|---|---|---|
| . 1 | 46.00 | 5.00 | 7.23 | -7.58 | -336.43 | 1117.45 | 1176.35 | 1.34 | . On extreme X-entry |
| 2 | 46.49 | 5.00 | 7.10 | -7.57 | -18.78 | 141.52 | 151.32 | 1.51 | |
| 3 | 46.98 | 5.00 | 7.31 | -7.56 | -601.34 | 1983.93 | 2082.42 | 1.54 | |
| 4 | 47.46 | 5.00 | 7.14 | -7.61 | -944.32 | 3105.75 | 3255.50 | 1.46 | |
| 5 | 47.95 | 5.00 | 7.08 | -7.51 | 4.68 | 73.34 | 80.89 | 1.58 | |
| 6 | 48.44 | 5.00 | 7.30 | -7.51 | 0.85 | 87.56 | 95.29 | 1.59 | |
| 7 | 48.93 | 5.00 | 7.07 | -7.55 | -8.01 | 118.78 | 127.23 | 1.59 | |
| 8 | 49.41 | 5.00 | 7.40 | -7.50 | 6.08 | 73.77 | 81.29 | 1.62 | |
| 9 | 49.90 | 5.00 | 7.16 | -7.52 | 2.52 | 87.56 | 95.19 | 1.63 | |
| 10 | 50.39 | 5.00 | 5.56 | -7.50 | 8.26 | 69.44 | 76.98 | 1.64 | |
| 11 | 50.87 | 5.00 | 5.57 | -7.50 | 9.47 | 66.73 | 74.33 | 1.65 | |
| 12 | 51.36 | 5.00 | 7.49 | -7.50 | 12.17 | 59.31 | 66.97 | 1.67 | |
| 13 | 51.85 | 5.00 | 7.50 | -7.50 | 11.25 | 64.11 | 71.71 | 1.68 | |
| 14 | 52.34 | 5.00 | 7.48 | -7.50 | 11.32 | 65.45 | 73.05 | 1.69 | |
| 15 | 52.82 | 5.00 | 7.47 | -7.50 | 11.39 | 66.80 | 74.40 | 1.71 | |
| 16 | 53.31 | 5.00 | 7.45 | -7.50 | 11.47 | 68.16 | 75.76 | 1.72 | |
| 17 | 53.80 | 5.00 | 7.43 | -7.50 | 11.54 | 69.53 | 77.14 | 1.74 | |
| 18 | 54.28 | 5.00 | 6.27 | -7.49 | 12.78 | 66.01 | 73.79 | 1.76 | |
| 19 | 54.77 | 5.00 | 6.28 | -7.49 | 12.88 | 67.22 | 75.01 | 1.77 | |
| 20 | 55.26 | 5.00 | 6.28 | -7.49 | 13.94 | 64.74 | 72.63 | 1.79 | |
| 21 | 55.75 | 5.00 | 6.29 | -7.49 | 14.06 | 65.88 | 73.79 | 1.80 | |
| 22 | 56.23 | 5.00 | 6.29 | -7.49 | 14.18 | 67.03 | 74.94 | 1.82 | |
| 23 | 56.72 | 5.00 | 6.30 | -7.49 | 15.20 | 64.58 | 72.62 | 1.84 | |
| 24 | 57.21 | 5.00 | 6.30 | -7.49 | 15.33 | 65.67 | 73.72 | 1.85 | |
| 25 | 57.69 | 5.00 | 6.31 | -7.50 | 15.46 | 66.76 | 74.82 | 1.87 | |
| 26 | 58.18 | 5.00 | 5.14 | -7.49 | 14.77 | 70.48 | 78.56 | 1.89 | |
| 27 | 58.67 | 5.00 | 4.01 | -7.50 | 14.98 | 70.32 | 78.59 | 1.90 | |
| 28 | 59.15 | 5.00 | 4.03 | -7.50 | 15.12 | 71.38 | 79.66 | 1.92 | |
| 29 | 59.64 | 5.00 | 5.17 | -7.50 | 16.08 | 69.94 | 78.20 | 1.94 | |
| 30 | 60.13 | 5.00 | 5.18 | -7.50 | 16.22 | 70.99 | 79.26 | 1.96 | |
| 31 | 60.62 | 5.00 | 5.19 | -7.50 | 17.21 | 68.35 | 76.80 | 1.98 | |
| 32 | 61.10 | 5.00 | 6.34 | -7.50 | 17.32 | 70.60 | 78.87 | 2.00 | |
| 33 | 61.59 | 5.00 | 2.45 | -7.49 | 16.53 | 72.08 | 80.81 | 2.01 | |
| 34 | 62.08 | 5.00 | 2.47 | -7.49 | 16.70 | 73.04 | 81.78 | 2.03 | |
| 35 | 62.56 | 5.00 | 2.49 | -7.50 | 16.87 | 74.00 | 82.76 | 2.05 | |
| 36 | 63.05 | 5.00 | 3.58 | -7.49 | 17.79 | 72.69 | 81.42 | 2.07 | |
| 37 | 63.54 | 5.00 | 0.93 | -7.49 | 17.01 | 75.05 | 84.10 | 2.09 | |
| 38 | 64.03 | 5.00 | 0.94 | -7.49 | 20.84 | 57.53 | 68.00 | 2.11 | |
| 39 | 64.51 | 5.00 | 0.96 | -7.50 | 21.05 | 58.19 | 68.69 | 2.12 | |
| 40 | 65.00 | 5.00 | -1.35 | -7.50 | 20.40 | 59.42 | 70.36 | 2.14 | |

Note: In the 'Status' column, OK means the critical circle was identified within the specified search domain. 'On extreme X-entry' means that the critical result is on the edge of the search domain; a lower Fs may result if the search domain is expanded.

### RESULTS OF ROTATIONAL STABILITY ANALYSIS

Results in the tables below represent critical circles identified between specified points on entry and exit. (Theta-exit set to 50.00 deg.) The most critical circle is obtained from a search considering all the combinations of input entry and exit points.

**Critical circles for each exit point (considering all specified entry points).**

| Exit Point # | Exit Point (X, Y) [ft] | | Entry Point (X, Y) [ft] | | Critical Circle (Xc, Yc, R) [ft] | | | Fs | STATUS |
|---|---|---|---|---|---|---|---|---|---|
| 1 | -7.82 | -7.47 | 47.46 | 5.00 | 0.53 | 84.28 | 92.14 | 1.67 | |
| 2 | -7.26 | -7.49 | 47.46 | 5.00 | 0.82 | 83.24 | 91.09 | 1.66 | |
| 3 | -6.74 | -7.50 | 46.98 | 5.00 | 1.00 | 80.90 | 88.74 | 1.65 | |
| 4 | -6.71 | -7.47 | 47.46 | 5.00 | 1.41 | 81.18 | 89.01 | 1.67 | |
| 5 | -6.09 | -7.49 | 48.93 | 5.00 | 0.82 | 89.48 | 97.21 | 1.65 | |
| 6 | -5.62 | -7.50 | 46.98 | 5.00 | 1.89 | 77.84 | 85.66 | 1.64 | |
| 7 | -5.57 | -7.47 | 47.95 | 5.00 | 1.23 | 84.40 | 92.12 | 1.65 | |
| 8 | -5.05 | -7.48 | 46.98 | 5.00 | 1.35 | 80.52 | 88.23 | 1.63 | |
| 9 | -4.51 | -7.49 | 46.49 | 5.00 | 1.56 | 78.07 | 85.78 | 1.62 | |
| 10 | -4.47 | -7.47 | 46.49 | 5.00 | 1.87 | 76.99 | 84.70 | 1.63 | |
| 11 | -3.91 | -7.48 | 46.49 | 5.00 | 2.18 | 75.93 | 83.63 | 1.62 | |
| 12 | -3.34 | -7.49 | 46.49 | 5.00 | 2.49 | 74.86 | 82.56 | 1.61 | |
| 13 | -3.29 | -7.47 | 46.49 | 5.00 | 2.80 | 73.81 | 81.51 | 1.63 | |
| 14 | -2.72 | -7.48 | 46.49 | 5.00 | 3.11 | 72.76 | 80.45 | 1.62 | |
| 15 | -2.15 | -7.50 | 46.49 | 5.00 | 3.42 | 71.71 | 79.41 | 1.60 | |
| 16 | -2.09 | -7.47 | 46.49 | 5.00 | 3.74 | 70.67 | 78.36 | 1.62 | |
| 17 | -1.50 | -7.49 | 47.95 | 5.00 | 3.15 | 78.24 | 85.86 | 1.61 | |
| 18 | -1.44 | -7.47 | 46.98 | 5.00 | 3.32 | 74.25 | 81.86 | 1.61 | |
| 19 | -0.87 | -7.48 | 46.49 | 5.00 | 3.58 | 71.73 | 79.34 | 1.60 | |
| 20 | -0.29 | -7.49 | 46.49 | 5.00 | 3.90 | 70.63 | 78.24 | 1.59 | |
| 21 | 0.12 | -7.50 | 46.49 | 5.00 | 4.23 | 69.54 | 77.14 | 1.59 | |
| 22 | 0.52 | -7.50 | 46.49 | 5.00 | 4.56 | 68.45 | 76.06 | 1.59 | |
| 23 | 0.92 | -7.50 | 46.49 | 5.00 | 4.89 | 67.37 | 74.98 | 1.59 | |
| 24 | 1.32 | -7.50 | 46.49 | 5.00 | 5.21 | 66.30 | 73.90 | 1.59 | |
| 25 | 1.72 | -7.50 | 46.49 | 5.00 | 5.54 | 65.24 | 72.84 | 1.59 | |
| 26 | 2.11 | -7.50 | 46.49 | 5.00 | 5.87 | 64.18 | 71.78 | 1.59 | |
| 27 | 2.49 | -7.50 | 46.98 | 5.00 | 6.27 | 64.46 | 72.06 | 1.59 | |
| 28 | 2.53 | -7.49 | 46.49 | 5.00 | 5.45 | 65.87 | 73.42 | 1.59 | |
| 29 | 2.92 | -7.49 | 46.49 | 5.00 | 5.79 | 64.75 | 72.29 | 1.59 | |
| 30 | 3.32 | -7.49 | 46.49 | 5.00 | 6.14 | 63.64 | 71.18 | 1.59 | |
| 31 | 3.72 | -7.49 | 46.49 | 5.00 | 6.48 | 62.53 | 70.07 | 1.59 | |
| 32 | 4.11 | -7.49 | 46.49 | 5.00 | 6.83 | 61.43 | 68.98 | 1.59 | |
| 33 | 4.79 | -7.50 | 46.49 | 5.00 | 8.19 | 56.98 | 64.57 | 1.59 | |
| 34 | 5.02 | -7.50 | 46.49 | 5.00 | 6.42 | 62.91 | 70.42 | 1.58 | |
| 35 | 5.41 | -7.50 | 46.49 | 5.00 | 6.79 | 61.75 | 69.26 | 1.58 | |
| 36 | 5.80 | -7.50 | 46.49 | 5.00 | 7.15 | 60.60 | 68.11 | 1.58 | |
| 37 | 6.20 | -7.50 | 46.49 | 5.00 | 7.51 | 59.46 | 66.97 | 1.58 | |
| 38 | 6.35 | -7.49 | 46.49 | 5.00 | 7.88 | 58.33 | 65.84 | 1.59 | |
| 39 | 6.92 | -7.50 | 46.49 | 5.00 | 8.24 | 57.21 | 64.72 | 1.59 | |
| 40 | 7.23 | -7.58 | 46.00 | 5.00 | -336.43 | 1117.45 | 1176.35 | 1.34 | On extreme X-exit |

Note: In the 'Status' column, OK means the critical circle was identified within the specified search domain. 'On extreme X-exit' means that the critical result is on the edge of the search domain; a lower Fs may result if the search domain is expanded.

## CRITICAL RESULTS OF ROTATIONAL AND TRANSLATIONAL STABILITY ANALYSES

### Rotational (Circular Arc; Bishop) Stability Analysis

Minimum Factor of Safety = 1.34
Critical Circle: Xc = -336.43[ft], Yc = 1117.45[ft], R = 1176.35[ft]. (Number of slices used = 51 )

### Translational (2-Part Wedge; Spencer), Direct Sliding, Stability Analysis

N O T C O N D U C T E D

### Three-Part Wedge Stability Analysis

N O T C O N D U C T E D

SAFETY MAP: BISHOP ROTATIONAL ANALYSIS MODE