LACO

GEOTECHNICAL DESIGN MEMORANDUM

Alderpoint Road Water Tank
Humboldt County, California
Garberville Sanitary District

Date:	April 30, 2014
Project No.:	7714.02
Prepared For:	Garberville Sanitary District
Prepared By:	Gary L. Manhart PG No. 7169, EXP. 10/31/15
Reviewed By:	Erich Rauber GE No. 2887, EXP. 9/30/15
Enclosures:	Figure 1: Location/Geologic Map Figure 2: Geologic Map Legend Figure 3: Site Plan Appendix 1: Boring Logs Appendix 2: Laboratory Test Results

PROFESSIONAL GEOLOGIST GARY LEE MANHART No. 7169 Exp. 10/31/14 STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER JOHN ERICH RAUBER No. 2887 GEOTECHNICAL STATE OF CALIFORNIA

INTRODUCTION

This memorandum has been prepared by LACO Associates (LACO) to present the results of our geotechnical exploration in connection with Garberville Sanitary District's (GSD's) Alderpoint Road Water Tank project in Garberville, California. The project site is on the north side of Alderpoint Road, approximately 1.1 miles east of the Redwood Drive/Alderpoint Road intersection. GSD plans to replace the existing 30,000-gallon, wooden water storage tank with a 200,000-gallon, steel tank. In general, we anticipate the upper 4 to 5 feet of soil will be removed to accommodate the new tank.

Our scope of services was authorized by Ralph Emerson, GSD General Manager, and was limited to the following services.

- Review existing published geologic maps and readily available unpublished soils and geologic reports pertinent to the site.
- Conduct a field exploration program limited to geologic/geomorphic mapping and subsoil exploration with a backhoe.

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- Review existing published geologic maps and readily available unpublished soils and geologic reports pertinent to the site.
- Conduct a field exploration program limited to geologic/geomorphic mapping and subsoil exploration with a backhoe.
- Conduct a laboratory testing program of selected soil/rock samples to characterize relevant soil/rock properties.
- Prepare this technical memorandum documenting existing subsurface conditions and providing foundation and earthwork recommendations for the proposed tower and related structures.

FIELD EXPLORATION AND LABORATORY TESTING

On April 14, 2014, LACO explored subsurface conditions by drilling three test borings, extending 26.5 to 38.4 feet below ground surface (bgs), utilizing a Deep Rock DR8K Drill rig. The approximate test boring locations are shown on Figure 1. Our geologist logged the materials encountered in the test borings and collected soil samples using a 1.5-inch inside diameter Standard Penetration Test sampler, and a 2.5-inch inside diameter modified California sampler. Soils were logged in accordance with ASTM D 2488 (Visual-Manual Procedure); the boring logs are presented in Appendix 1. Upon completion, the soil borings were backfilled with grout slurry and soil cuttings to approximately match adjacent existing grades.

Select soil samples were submitted to LACO's materials testing laboratory for analysis. Laboratory analysis was performed to estimate pertinent soil parameters and included the following:

- Direct Shear Test (ASTM D3080)
- In-Place Density and Moisture Content (ASTM D2216 and D2937)
- Fraction finer than #200 Sieve (ASTM C117)
- Atterberg Limits Test (ASTM D4943)

Laboratory test results are included as Appendix 2 and are summarized in Table 1.

Table 1: Laboratory Test Results

Boring	Depth (feet bgs)	ASTM C117 Finer than #200 Sieve	ASTM D3080 Friction Angle (degrees)	Cohesion (psf)	ASTM 2216 Dry Density (pcf)	ASTM D2937 Moisture Content (percent H_2O)	ASTM D4943 Atterberg Limits Test LL	PI
B-1	5.0 – 6.5	28%	---	---	---	---	25	5
	15 – 16.5	32%	---	---	---	---	---	---
B-2	5.0 – 5.5	17%	---	---	---	---	---	---
	10.0 – 10.5	46%	40	104	113	14	---	---
B-3	5.0 – 5.5	25%	---	---	---	---	---	---

Note: bgs = below the ground surface; psf = pounds per square foot; pcf = pounds per cubic foot, --- = not tested

LACO will archive the soil samples collected for this project for 30 days following the issuance of this memorandum. Unless directed otherwise by the Client, all samples will be discarded after the 30-day archive period.

GEOLOGIC AND GEOMORPHIC SETTING

The site is located within a seismically active region which is subject to frequent moderate to large earthquakes. North of the Mendocino Triple Junction, the regional tectonic framework is controlled by the Cascadia Subduction Zone (CSZ), wherein the oceanic crust of the Juan de Fuca/Gorda plate is being actively subducted beneath the leading edge of the North American plate. The CSZ in its entirety extends from the Mendocino Triple Junction to British Columbia. Plate convergence along the Gorda segment of the CSZ is occurring at a rate of approximately 30 to 40 millimeters per year (mm/yr) (Heaton & Kanamori 1984). Rupture along the entire CSZ boundary has the potential to produce an earthquake with a moment magnitude (Mw) of 9.0 or greater (Satake 2003).

Based on a review of natural exposures in the vicinity of the site and published geologic mapping (Figures 2 and 3), the site is underlain by undifferentiated sedimentary soils of the Pleistocene to Miocene Wildcat Group. These sediments are typically composed of fine-grained, massive sandstone with minor amounts of siltstone, mudstone, and conglomerate (CDMG 1983). Structurally, the Wildcat Group in the vicinity of the site has a northwest-southeast strike with a shallow (20 degrees) dip to the northeast.

Several inactive fault splays associated with the northwest-trending Garberville-Briceland fault zone is mapped approximately 1.25 miles to the southwest of the site (Figure 1 and 2; CDMG 1983).

The Garberville-Briceland fault zone is reportedly the northern extension of the active Maacama and Hayward-Rogers Creek fault zones to the south (Petersen *et al* 1996). In the vicinity of the town of Garberville, the Garberville-Briceland fault zone is approximately 2 miles wide and comprises multiple, sub-parallel fault traces oriented in a northwesterly direction (CDMG1983).

The slip rates on the Maacama and Garberville-Briceland fault zones are not well constrained, but are assumed to be equal to that of the Hayward-Rogers Creek fault zone, reported to be 9 millimeters per year (mm/yr). GPS studies in the region suggest approximately 14 mm/year of slip occurs on the Maacama fault (Freymueller *et al* 1999), while the Garberville-Briceland segment accommodates 5.3 ± 3.5 mm/year.

The site is surrounded by mapped slope instability. A small debris slide is mapped to the east of the site (CDMG1983). Site Slope instability was observed in the vicinity of the project during field reconnaissance. Areas of “inactive” slope instability were noted to the northeast and a small “inactive” debris slide to the east. An “inactive” rotational slide is located approximately 50 feet to the west-northwest of the proposed tank footing (Figure 3).

Table 2 presents a summary of geologic and seismic hazards as required by section 1803.5.11 of the 2013 CBC.

Table 2: Summary of Geologic and Seismic Hazards

Hazard	Risk	Note/Reference
Slope Instability	Low to moderate	• Site is located on a ridge • <10 feet setback from slopes 2:1 or steeper • Not within a mapped area of instability (CDMG 1983); however, there is a small debris flow mapped just north-northeast of the tank site, down slope of the access road. • Evidence of recent or incipient slope instability was observed approximately 50 feet from the proposed tank footprint.
Liquefaction	Negligible	• Pleistocene age soil
Settlement	Low[1]	• Primarily granular soil
Surface Displacement	Negligible	• Not located within an Alquist-Priolo earthquake fault hazard zone (CGS 2007) • Negligible liquefaction hazard (see above)

[1]Design loads for the proposed structures have not been provided to LACO. LACO assumes lightly-loaded structures.

SURFACE AND SUBSURFACE CONDITIONS

Surface

The proposed tank site is generally flat lying with slopes falling to the north and a cutbank to the south. The site has several large trees within the proposed development area. Surface soils are generally less than 1 foot in depth. The existing tank site is surrounded by brush to the south, west, and north. It is accessed from the east off Alderpoint Road (Figure 3).

Subsurface

Site soils generally consist of medium-dense to dense silty sands with 7 to 40 percent fine gravel. These materials are underlain by hard to very hard fine sandy silt to maximum depth explored. Expansive soils generally consisting of cohesive, fine-grained clay soils represent a significant structural hazard to buildings founded on them, especially where seasonal fluctuations in soil moisture occur at the foundation-bearing depth. The soils encountered during our field exploration consist primarily of granular soils (sands). Atterberg limit testing performed on sample B-1 at 5.0 to 6.5 feet, recorded Liquid Limit (LL) of 25 and a plasticity index (PI) of 5. The LL and PI value are associated with soil having a low expansion potential (Day 1999). Based on the above, we conclude the risk of expansive soils detrimentally affecting the proposed development at the site is negligible. Groundwater was not encountered at depths of 26.5 to 38.4 feet bgs. Therefore, the risk of encountering groundwater in relatively shallow utility trenches or other required earthwork excavations for the proposed development is considered low.

CONCLUSIONS AND RECOMMENDATIONS

General

The results of our exploration indicate the project is feasible from a geotechnical standpoint. The tank can be supported on shallow ring wall footing or directly on grade. If designed and constructed consistent with the following recommendations, we estimate the tank will experience total settlement of approximately 1 inch with differential settlement across the tank of approximately ½ inch.

Foundations

The foundation system should bear on native medium-dense to dense gravelly silty sand approximately 1 foot bgs. For design, use a maximum allowable bearing pressure of 2,000 pounds per square foot (psf) for dead loads. This value may be increased by one-third when considering the effects of wind or seismic loads. The ring wall footing should be at least 12 inches wide and extend at least 18 inches below the lowest adjacent finish grade. Setbacks of the face of foundation elements to breaks in slope 2:1or steeper should be a minimum of 10 feet.

Resistance to lateral forces can be generated by friction between the foundations and underlying soil and passive pressure against the vertical faces of foundations. Use an allowable passive pressure of 150 pounds per cubic foot, and an allowable coefficient of friction of 0.3 between the footing bottoms and underlying soil. If friction and passive pressures are combined, the lesser value should be reduced by 50 percent.

Footing concrete should generally be placed neat against a firm soil surface that is relatively free of loose debris material. If backfill against formed footings is required, it should be a structural fill material that is placed and compacted as recommended in the earthwork section of this memorandum.

SLOPE STABILITY

To qualitatively evaluate the stability of slopes, we utilized software based on assumed conservative soil strength parameters and observed soil conditions. Although numerical results are presented below, our analysis should be considered preliminary.

We evaluated the potential for rotational failure of the existing slopes under several idealized configurations. The analysis was performed using Slide (version 5.0) software. The Slide software assesses the stability of the slope using both Bishop' Modified and Janbu methods to compare the forces resisting failure to the forces driving failure. The ratio of the two forces is defined as a "factor of safety" (F). In a stable slope, the forces resisting failure exceed the driving forces and the resultant F is greater than 1.0. The greater the F, the greater the stability of the slope. Our analysis assumed a simplified one-layer model to represent the slope with homogenous materials.

Based on laboratory test results of the site soils and our experience with similar soils, our analysis assumed the following soil strength and weight values:

• Cohesion	1000 pounds per square foot
• Friction Angle	30 degrees
• Unit Weight (moist)	130 pounds per cubic foot
• Unit Weight (saturated)	145 pounds per cubic foot

Two different surface water conditions were modeled for the slope to simulate saturated and unsaturated conditions.

Our analysis included a uniform slope configuration of 2:1 (Horizontal: Vertical). With the exception of the vertical face scenario, slope configurations were modeled with 300 feet of vertical relief (the height between the top and bottom of the modeled slope). The vertical slope configuration was modeled under a variety of static, psudostatic, loaded and unloaded scenarios.

The static factor of safety of the modeled slopes and groundwater conditions are summarized in Table 3. A graphical representation of the results is presented in Attachment 2.

Table 3: Summary of Static Factor of Safety Results

Slope Gradient (Horizontal : Vertical)	Drained	undrained
2:1	1.7	0.7

Based on the result of the slope stability analysis, existing slopes with or without the water tank load are stable. The factor of safety in the drained condition is what can be expected for the site. Typical practice is to consider a static factor of safety of 1.5 or greater as acceptable for most developments. Three other conditions were modeled to evaluate the stability of the slopes with or without the water tank. Groundwater conditions were modeled where the groundwater was at the surface of the site and the undrained conditions are under a simplified seismic load. While the factor of safety is below 1, indicating the slopes have already failed, none of the conditions modeled are representative of actual site conditions and were only produced to evaluate whether the loading of the slopes from the water tank would increase the likelihood of slope failure. The results are presented in Attachment 2. The map and observed "inactive" slope instabilities in our opinion should not impact development at the site, provided our recommendations are adhered to. Drainage of surface water at the site should be directed away from areas of slope instability. Drainage should be controlled such that concentrated flows do not occur.

Earthwork

The following sections provide earthwork recommendations to suitably prepare the site for construction of the new structures. Recommendations for site and subgrade preparation; excavation criteria; fill and backfill quality and compaction; and surface drainage control are presented.

Site Preparation and Grading

We recommend proposed new structure foundation locations be stripped of surface debris and topsoils to expose the underlying undisturbed subsoils. Actual removal depths required should be evaluated at the time of construction by a LACO engineer/geologist. The stripped and removed materials should be used as fill in landscape area or disposed of offsite.

Areas to receive fill should be scarified, moisture conditioned as necessary and compacted as described in the Fill Quality and Compaction section of this memorandum. If placed on slopes steeper than 4:1 (horizontal : vertical), a keyway should be constructed, The keyway bottom should be relatively flat and level, at least 8 feet wide, extend at least 2 feet into stiff/dense natural soil, and should be observed by a

LACO engineer/geologist prior to fill placement. Cut and fill slopes should be no steeper than 2:1. Our investigation indicates on-site soils are suitable for use as fill. Where new fill is needed to provide the desired subgrade for planned foundation elements or site access requirements, it should meet the quality and compaction standards presented below.

Earthwork including, but not limited to, site clearing, stripping, grubbing, and excavation should be conducted during dry-weather conditions, if feasible. If wet-weather site preparation is to be conducted, dewatering of excavations may be required.

Fill Quality and Compaction Standard

Fill materials used in building/tank areas should be composed of soil material having a low expansion potential, and be free of organic content, debris, and/or other deleterious matter. It should be placed on an approved excavation bottom as described above. The fill material should not generally contain rocks larger than 3 inches in greatest dimension, or more than 15 percent larger than 2 inches and conform to the following specifications:

Plasticity Index:	less than 15%
Liquid Limit:	less than 40%
Percent passing No. 200 sieve:	50 maximum, 5 minimum

Fill materials placed within structure areas having perimeter foundations and slabs should be moisture conditioned to near optimum and compacted by mechanical means to a minimum of 90 percent of the maximum dry density as determined by the ASTM D1557 test procedure. Structural fill materials should generally be placed in lifts not to exceed 8 inches in loose thickness.

Seismic Design Parameters

The site is not located within an Alquist-Priolo Earthquake Fault Zone. The closest active fault, as zoned by the State, is the San Andreas Fault, located about 17 miles southwest of the site. Our exploration indicates the site and proximity can be assigned a Site Class D based on average soil properties in the top 100 feet and Section 1613.3.2 of the 2013 CBC. Site Class D is defined as a "Stiff soil" with average standard penetration test (SPT) blow count of 15 to 50 and a shear wave velocity of 600 to 1,200 feet per second.

The design spectral response accelerations S_S, S_1, Fa, Fv, S_{MS}, S_{M1}, S_{DS}, and S_{D1} were determined using the USGS U.S. Seismic Design Map application (Last Modified, March 10, 2013), and based on the American Society of Civil Engineers (ASCE) Standard 7-10, Minimum Design Loads for Buildings and Other Structures analysis option. Calculated values are presented in Table 5.

Table 5: Summary of Seismic Design Factors

Site Class	F_a	F_v	S_s	S_1	S_{MS}	S_{M1}	S_{DS}	S_{D1}
D	1.000	1.500	1.900	0.766	1.900	1.148	1.267	0.766

**Latitude and longitude are 39.727078° North and -121.790329° West, respectively, based on coordinates provided by Google Earth.*

These design spectral response accelerations are further defined as follows:

- Fa — Short period coefficient to modify 0.2-second period of mapped spectral response accelerations for Site Class E.
- Fv — Long period coefficient to modify 1.0-second period of mapped spectral response accelerations for Site Class E.
- S_S — Mapped spectral response acceleration, 5 percent damped, at 0.2-second period for Site Class B (%g).
- S_1 — Mapped spectral response acceleration, 5 percent damped, at 1.0-second period for Site Class B (%g).
- S_{MS} — Maximum considered earthquake spectral response acceleration, 5 percent damped, at 0.2-second for Site Class effects (%g).
- S_{M1} — Maximum considered earthquake spectral response acceleration, 5 percent damped, at 1.0-second period for Site Class effects (%g).
- S_{DS} — Design spectral response acceleration, 5 percent damped, at 0.2-second period (%g).
- S_{D1} — Design spectral response acceleration, 5 percent damped, at 1.0-second period (%g).

Construction Considerations

Based on the subsurface conditions encountered at the boring locations, required excavations will be made in residual soils. These materials should be easily dug with an excavator or backhoe.

Temporary excavations and construction slopes should be designed, planned, constructed, and maintained by the Contractor and should conform to applicable local, state, and federal regulations including the current Occupational Safety and Health Administration (OSHA) Excavation and Trench Safety Standards. To help minimize the risk of ground movement and/or settlement, construction equipment, building materials, excavated soil, vehicular traffic, and other similar loads should not be allowed near the top of any unshored excavation. Where the stability of adjoining buildings, walls, pavements, or other similar improvements may be endangered by excavation operations, and to protect personnel working in the excavation, support systems such as shoring, bracing, or underpinning may be required to provide structure and trench wall stability.

Excavation operations are dependent on construction methods and schedules and, as such, the Contractor shall be solely responsible for the design, installation, maintenance, and performance of all shoring, bracing, underpinning, and other similar excavation-related systems. Under no circumstances should anything written herein be inferred to mean that LACO assumes any responsibility for temporary excavations or the safety thereof. Nor does LACO assume any responsibility for the design, installation, maintenance, and performance of any shoring, bracing, underpinning, or other similar excavation-related systems.

The site is in a relative remote area; however, there are several buried utility lines in the vicinity of the planned tank site that need to be protected or otherwise avoided during construction.

CONSULTATION, OBSERVATION, AND TESTING

Prior to construction, LACO should review the design drawings to check that they conform to the intent of the recommendations contained in this memorandum. During construction, to check that the geotechnical aspects of the work are performed in accordance with the drawings and specifications, and that the conditions exposed are consistent with those assumed in the preparation of this memorandum are valid, LACO should be retained for the following:

- Observe site grading and exposed grades prior to placement of engineered (structural) fills;
- Observe foundation excavations prior to placement of any forms or reinforcing steel;
- Observe the placement of engineered fill, and perform in-place field density tests; and
- Test fill to check that the required relative compaction is achieved.

The fee for these services is not included in LACO's current investigation scope of services. LACO would be pleased to provide a scope and fee estimate for these services at the time the project plans are near completion, and when project construction schedules are known.

LIMITATIONS

This Geotechnical Design Memorandum has been prepared for the exclusive use of Garberville Sanitary District, their contractors and sub-consultants, and appropriate public authorities for specific application to development of the site as described in this report. LACO has endeavored to comply with the generally accepted geotechnical engineering standard of care common to the local area. LACO makes no other warranty, express or implied.

The findings, analyses, and recommendations contained in this memorandum are based on data obtained from subsurface explorations and laboratory tests. The exploration methods used indicate subsurface conditions only at specific locations where samples were obtained, only at the time they were obtained, and only to the depths penetrated. Samples cannot always be relied upon to accurately reflect stratigraphic variations that commonly exist between sampling locations, nor do they necessarily represent conditions at any other time.

The recommendations included in this memorandum are based in part on assumptions about subsurface conditions that may only be confirmed during earthwork. Accordingly, the validity of these recommendations is contingent upon LACO being retained to provide additional professional services during project design and construction. LACO cannot assume responsibility or liability for the adequacy of the report recommendations when they are applied in the field unless LACO is retained to observe and test during project construction. Please contact us to further discuss the extent of such observations and tests required to check the validity of our recommendations.

This reports findings, conclusions, and/or recommendations should not be used if the nature, design, or location of the proposed development is changed. If changes are contemplated, LACO should be consulted to review the impact on the applicability of the findings, conclusions, and/or recommendations contained in this report. Also, LACO will not be responsible for any claims, damages, or liability associated with any other party's interpretation of the subsurface data or reuse of this memo for other projects, or at other locations, without our express written authorization.

REFERENCES

CBC (California Building Code), 2013 edition.

California Division of Mines and Geology (CDMG), 1983, Geology and Geomorphic Features Related to Landsliding, Garberville 7.5' Quadrangle, Humboldt County, California, Scale 1:24,000, DMG OFR 83-26.

Day, R. (1999), Geotechnical and Foundation Engineering, Design and Construction, McGraw – Hill, New York, NY 10121-2298.

Freymueller, J. T., Murray, M. H., Segall, P., Castillo, D., 1999. Kinematics of the Pacific-North America plate boundary zone, Northern California Journal of Geophysical Research, v. 104, no B4, p. 7419-7441.

Heaton, T. H., Kanamori, H., 1984, Seismic potential associated with subduction in the northwestern United States, Bulletin of the Seismological Society of America; June 1984; v. 74; no. 3; p. 933-941.

Petersen, M. D., D. Beeby, W. A. Bryant, C. H. Cramer, T. Cao, M. S. Reichle, A. D. Frankel, J. J. Lienkamper, P. A. McCrory, and D. P. Schwartz, 1996, Probabilistic Seismic Hazard Assessment for the State of California, California Division of Mines Open-File Report 96-08; (issued jointly as: U.S. Geological Survey, Open-File Report 96-706), Sacramento, California, 33 pp.

Satake, K., Wang, K., Atwater, B., 2003, Fault slip and seismic moment of the 1700 Cascadia earthquake inferred from Japanese tsunami descriptions. Journal of Geophysical Research. Vol. 108, No. B11, 2535

GLM/JER/CJW:kc

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FIGURES

Figure 1 **Garberville 7.5 Minute Quad Landslide Map**

Figure 2 **Landslide Map Legend**

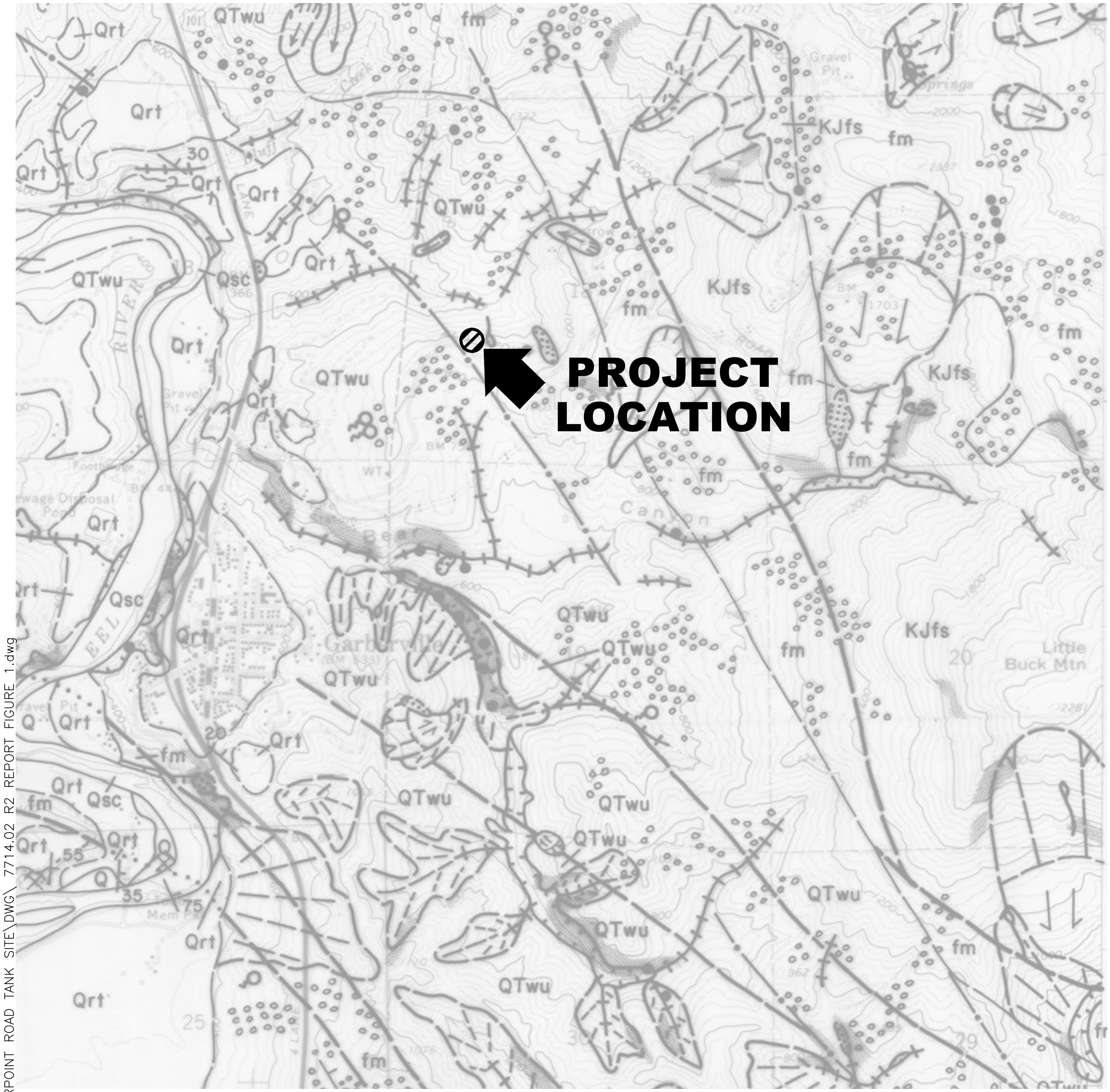
Figure 3 **Site Map with Boring Locations**

LACO

EUREKA • UKIAH • SANTA ROSA

1-800-515-5054 www.lacoassociates.com

PROJECT GEOTECHNICAL DESIGN REPORT	BY JB	FIGURE 1
CLIENT GARBERVILLE SANITARY DISTRICT	DATE 4/29/14	
LOCATION GARBERVILLE, CA.	CHECK GLM	JOB NO. 7714.02
GARBERVILLE 7.5 MINUTE QUAD LANDSLIDE MAP		



GARBERVILLE 7.5 MINUTE QUADRANGLE LANDSLIDE MAP

0 1000' 2000'

SCALE: 1"=2000'

Compiled by
Thomas E. Spittler, Geologist
California Department of Conservation
Division of Mines and Geology
1983

Apr 29,2014–8:22am
T:\Cadfiles\7700\7714.02 GSD ALDERPOINT ROAD TANK SITE\DWG\ 7714.02 R2 REPORT FIGURE 1.dwg

LACO				
EUREKA • UKIAH • SANTA ROSA	PROJECT: GEOTECHNICAL DESIGN REPORT	BY: JB	FIGURE: 2
1-800-515-5054 www.lacoassociates.com	CLIENT: GARBERVILLE SANITARY DISTRICT	DATE: 4/29/14	
	LOCATION: GARBERVILLE, CA.	CHECK: GLM	JOB NO. 7714.02
	LANDSLIDE MAP LEGEND	SCALE: N.T.S.	

EXPLANATION

TRANSLATIONAL/ROTATIONAL SLIDE: indicates scarp, indicates direction of movement; solid where active, dashed where dormant, queried where uncertain.

EARTHFLOW: indicates scarp, ←— indicates general direction of movement; solid where active, dashed where dormant.

DEBRIS SLIDE: includes scarp and slide deposits; solid where active, dashed where dormant.

DEBRIS FLOW/TORRENT TRACK: solid where active, dashed where dormant.

DEBRIS SLIDE AMPHITHEATER/SLOPE

INNER GORGE: +++ where too narrow to delineate at this scale.

ACTIVE SLIDE: too small to delineate at this scale.

DISRUPTED GROUND: irregular ground surface caused by complex landsliding processes resulting in features that are indistinguishable or too small to delineate individually at this scale; also may include areas affected by downslope creep, expansive soils, and/or erosion; boundaries usually are indistinct.

Qsc STREAM/RIVER CHANNEL DEPOSITS (Holocene): dominantly sand and gravel with minor amounts of silt and clay in active stream channel along major streams and rivers; characteristically unvegetated.

Q ALLUVIUM (Holocene): dominantly sand and gravel with minor amounts of silt and clay deposited by streams above active channel; characteristically vegetated.

Qf ALLUVIAL FAN DEPOSITS (Holocene): alluvial sand and gravel deposited in characteristic fan-cone shape at the mouths of eroding stream canyons.

Qrt RIVER TERRACE DEPOSITS (Holocene-Pleistocene): dominantly sand and gravel with minor amounts of silt and clay deposited during higher stands of major streams and rivers.

Qort OLDER RIVER TERRACES (Pleistocene?): flat-lying elevated surfaces along major streams and rivers, generally capped by sand and gravel.

QTwu WILDCAT GROUP UNDIFFERENTIATED (Pleistocene-Miocene): fine-grained, massive sandstone with minor amounts of siltstone, mudstone, and pebbly conglomerate.

TKfs FRANCISCAN COASTAL BELT SEDIMENTARY ROCKS (Tertiary-Cretaceous): siltstone, shale, sandstone, and mudstone; highly sheared in places; generally more deformed than Yager Formation.

TKy YAGER FORMATION (Tertiary-Cretaceous): well-consolidated silty shale, siltstone, sandstone, mudstone, and conglomerate; highly sheared in places; silty shale and mudstone often disaggregate by slaking when wetted.

KJfs FRANCISCAN CENTRAL BELT SANDSTONE (Cretaceous-Jurassic): sandstone with interbedded siltstone, shale, and conglomerate; sandstone generally consolidated and gray-green; sheared in places.

fm FRANCISCAN MELANGE (Cretaceous-Jurassic): pervasively sheared argillaceous matrix containing pebble-sized to individually mappable blocks of graywacke sandstone, greenstone, chert, blue schist, serpentine, metagraywacke, gabbro, and diorite.

gb GABBRO (Cretaceous-Jurassic): medium-grained, crystalline, dark gray intrusive rock observed as large mappable blocks in Franciscan melange.

LITHOLOGIC CONTACT: dashed where approximately located.

FAULT: dashed where approximately located, dotted where projected.

LINEAMENT: linear features of unknown origin observed on aerial photographs.

45 STRIKE AND DIP OF BEDDING: symbol in Q or Qsc refers to underlying bedrock unit.

45 STRIKE AND DIP OF FOLIATION, FRACTURE OR SHEAR

ANTICLINAL AXIS: small-scale fold away from which beds dip.

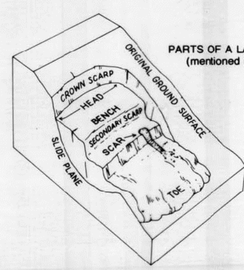
SYNCLINAL AXIS: small-scale fold into which beds dip.

QUARRY OR BORROW PIT

SPRING

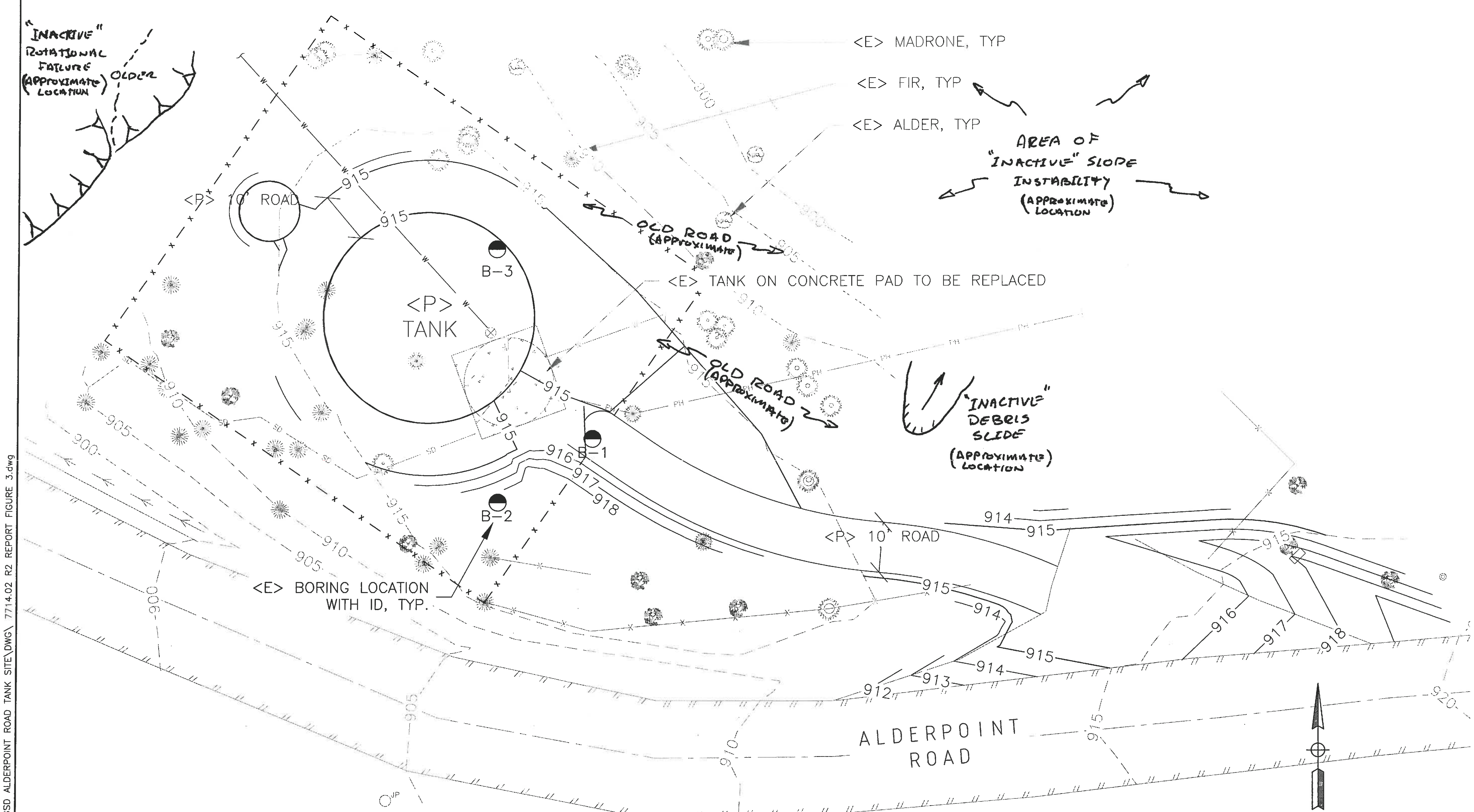
MARSH

SLOPES > 70 PERCENT: determined from map contours, aerial photo interpretation, and field reconnaissance.



PARTS OF A LANDSLIDE (mentioned in text)

Apr 29,2014-8:18am
T:\Cadfiles\7700\7714.02 GSD ALDERPOINT ROAD TANK SITE\DWG\ 7714.02 R2 REPORT FIGURE 2.dwg



0' 10' 20'

SCALE: 1"=20'

NOTE:

BORING LOCATIONS ARE APPROXIMATE. LOCATIONS ARE BASED OFF SWING TIE INFORMATION FROM FIELD VISIT, 4/2014.

Apr 28,2014–4:41pm
T:\Cadfiles\7700\7714.02 GSD ALDERPOINT ROAD TANK SITE\DWG\ 7714.02 R2 REPORT FIGURE 3.dwg

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NO.	HISTORY / REVISION	BY	CHK.	DATE

R1/R2 GEOLOGIC REPORT
SITE MAP WITH BORING LOCATIONS

GARBERVILLE SANITARY DISTRICT
GARBERVILLE, CA.

DRAWN	JB
CHECK	GLM
APPROVED	
DATE	4/25/14
JOB NUMBER	7714.02
FIGURE	3

APPENDIX 1

Boring Logs

BORING NUMBER B-1

LACO

CLIENT Garberville Sanitary District
PROJECT NAME Alderpoint Road Water Tank
PROJECT NUMBER 7714.02
PROJECT LOCATION Alderpoint Road, Garberville
DATE STARTED 4/14/14 COMPLETED 4/14/14
GROUND ELEVATION 918.5 feet HOLE SIZE 6 inches
DRILLING CONTRACTOR Clear Heart Drilling
GROUND WATER LEVELS:
DRILLING METHOD DR7KTrack Mounted
AT TIME OF DRILLING ---
LOGGED BY GLM CHECKED BY
AT END OF DRILLING ---
NOTES

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	WET UNIT WT. (pcf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		Leaf litter and duff										
		(SM) yellow brown, moist, medium dense to dense, ~10% to 15% fine gravel										
5			SPT	100	14-14-14 (28)				25	20	5	28
10			SPT	100	11-11-15 (26)							
15			SPT	100	10-9-14 (23)							32
20			SPT	100	16-23-21 (44)							
		(ML) dark gray, moist, hard										
25			SPT	100	12-20-24 (44)							
30			MC	89	18-26-35 (61)							
35			MC	61	36-50							
			SPT	92	20-34-50 (84)							

Refusal at 38.4 feet.
Bottom of borehole at 38.4 feet.

BORING NUMBER B-2

LACO

CLIENT Garberville Sanitary District
PROJECT NAME Alderpoint Road Water Tank
PROJECT NUMBER 7714.02
PROJECT LOCATION Alderpoint Road, Garberville
DATE STARTED 4/14/14 **COMPLETED** 4/14/14
GROUND ELEVATION 917.75 feet **HOLE SIZE** 6 inches
DRILLING CONTRACTOR Clear Heart Drilling
GROUND WATER LEVELS:
DRILLING METHOD DR7KTrack Mounted
AT TIME OF DRILLING ---
LOGGED BY GLM **CHECKED BY**
AT END OF DRILLING ---
NOTES

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	WET UNIT WT. (pcf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		Leaf litter and duff										
		(SM) yellow brown, moist, medium dense to dense, ~10% fine gravel										
5			MC	100	8-11-12 (23)							17
10		(SM) yellow brown, moist, medium dense to dense	MC	89	7-8-10 (18)	129	113	14				46
15		wellow brown to gray, moist, hard	MC	100	11-24-35 (59)							
20			MC	56	33-50							
25			SPT	100	20-31-30 (61)							

Bottom of borehole at 26.5 feet.

BORING NUMBER B-3

LACO

CLIENT Garberville Sanitary District
PROJECT NAME Alderpoint Road Water Tank
PROJECT NUMBER 7714.02
PROJECT LOCATION Alderpoint Road, Garberville
DATE STARTED 4/14/14 **COMPLETED** 4/14/14
GROUND ELEVATION 918 feet **HOLE SIZE** 6 inches
DRILLING CONTRACTOR Clear Heart Drilling
GROUND WATER LEVELS:
DRILLING METHOD DR7KTrack Mounted
AT TIME OF DRILLING ---
LOGGED BY GLM **CHECKED BY**
AT END OF DRILLING ---
NOTES

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	WET UNIT WT. (pcf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		Leaf litter and duff										
		(SM) yellow brown, moist, medium dense to dense, ~10% to 15% fine gravel										
5			MC	89	21-30-37 (67)							25
10			MC	28	50							
15			SPT	100	31-39-50 (89)							
20		(ML) yellow brown to light brown, moist, hard	SPT	56	20-18-24 (42)							
25			SPT	100	12-16-21 (37)							

Bottom of borehole at 26.5 feet.

GEOTECH LOG - COLUMNS - GINT STD US LAB.GDT - 4/29/14 15:44 - P:\GINT FILES\PROJECTS\7714.02 GSD WATER TANK ALDERPOINT ROAD.GPJ

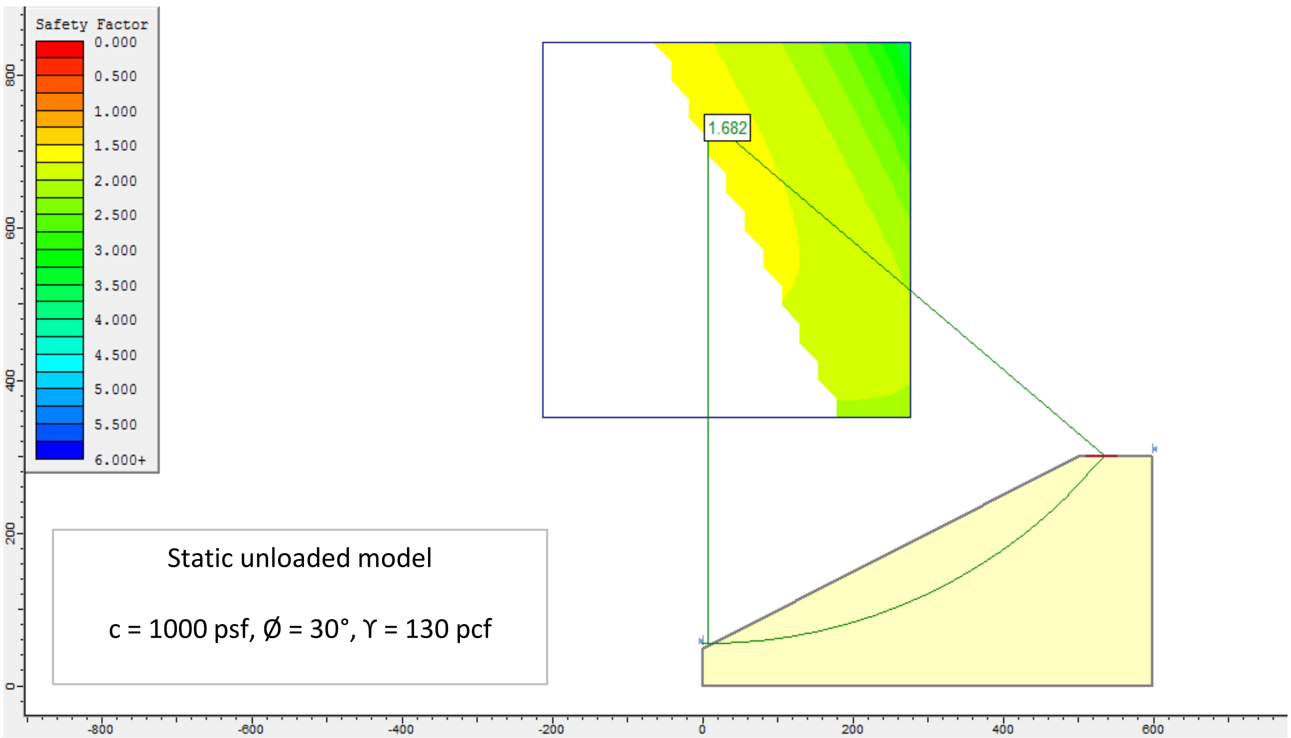
APPENDIX 2

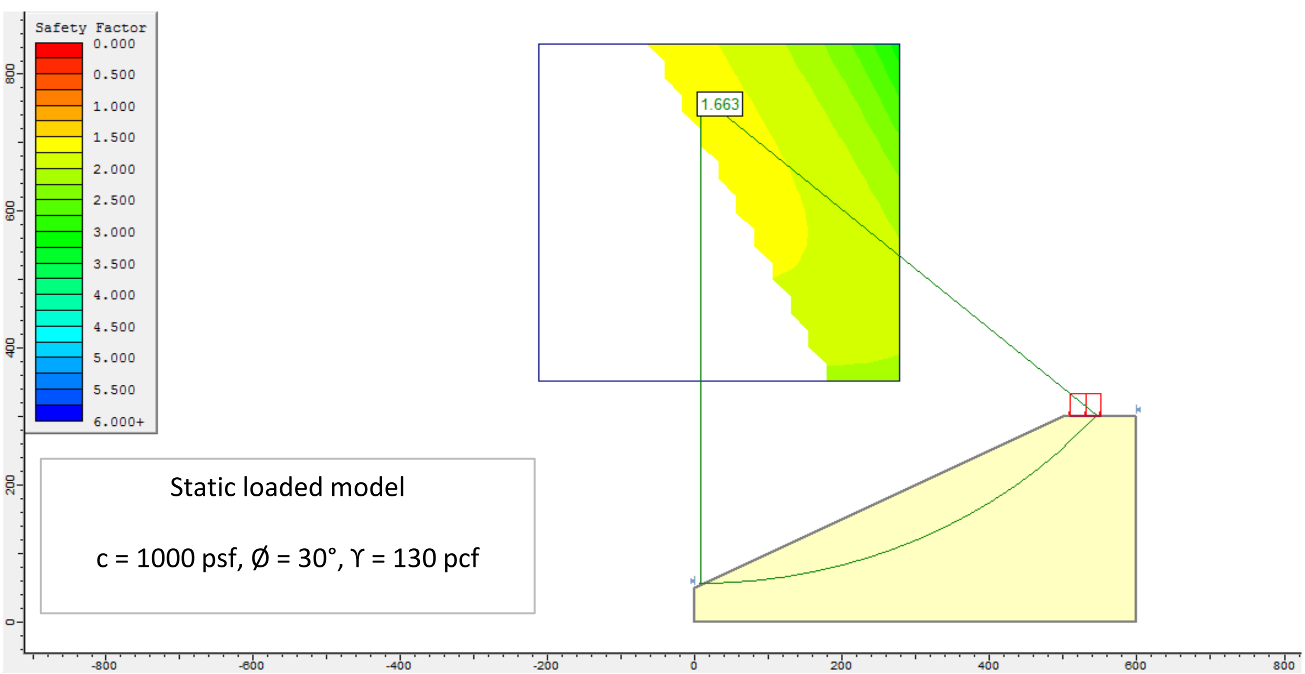
Graphic Slope Stability Analysis

LACO

Project	Alderpoint Road Tank	By	GLM
Client	Garbeville Sanitary District	Date	4/29/2014
Proj. No.	7714.02	Page	1 of 4

Slope Stability Analysis (2:1 Slope)





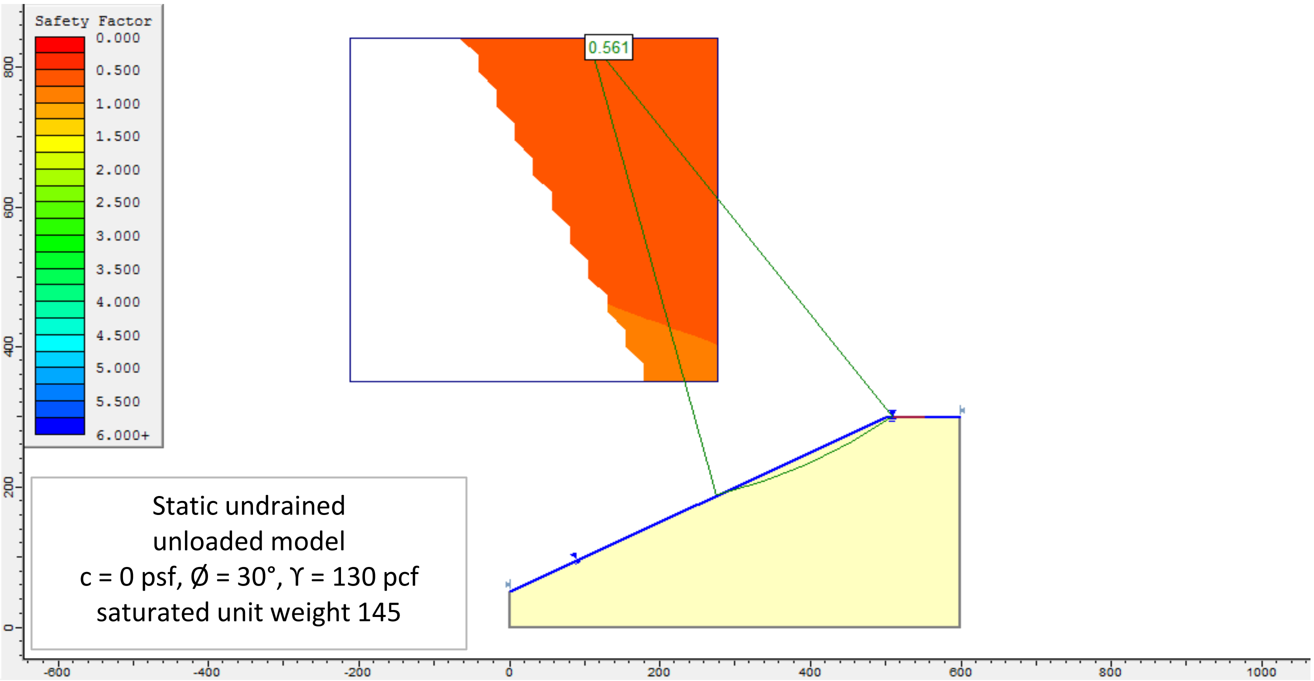
*All axes in units of feet

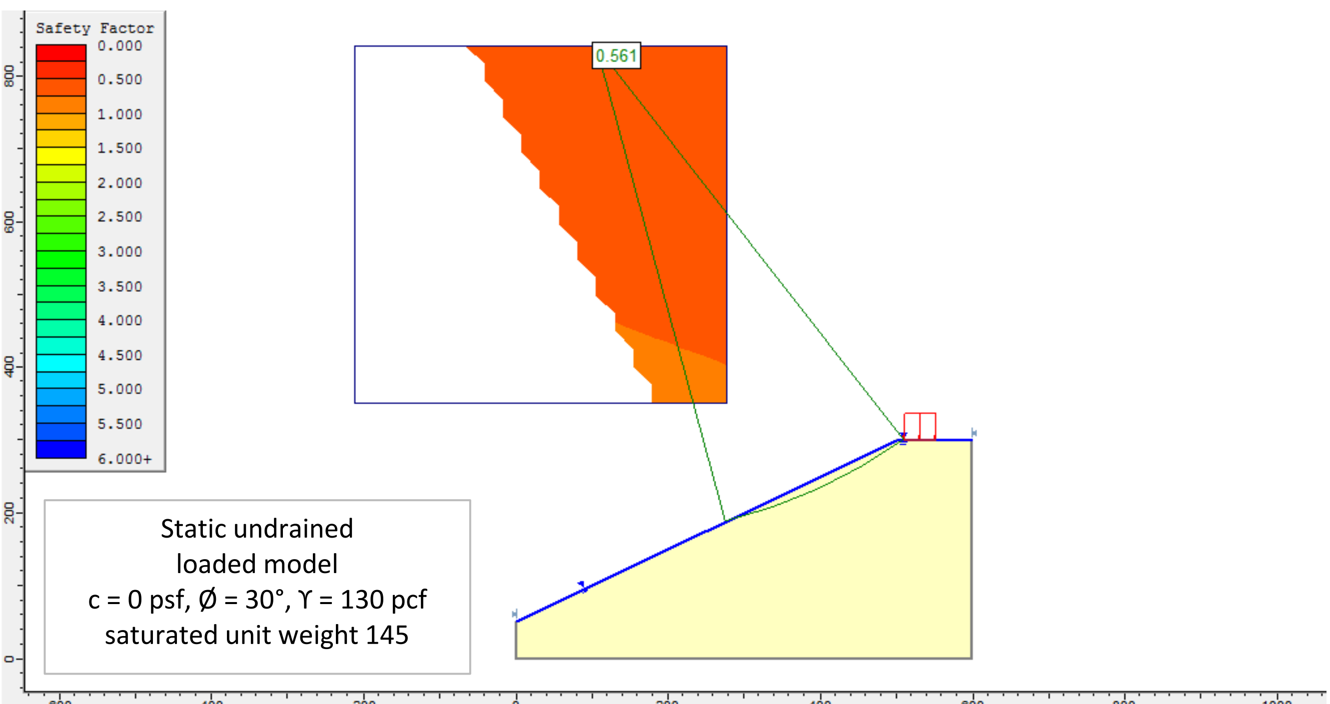
Project Alderpoint Road Tank | By GLM

Client Garbeville Sanitary District | Date 4/29/2014

Proj. No. 7714.02 | Page 2 of 4

Slope Stability Analysis (2:1 Slope)

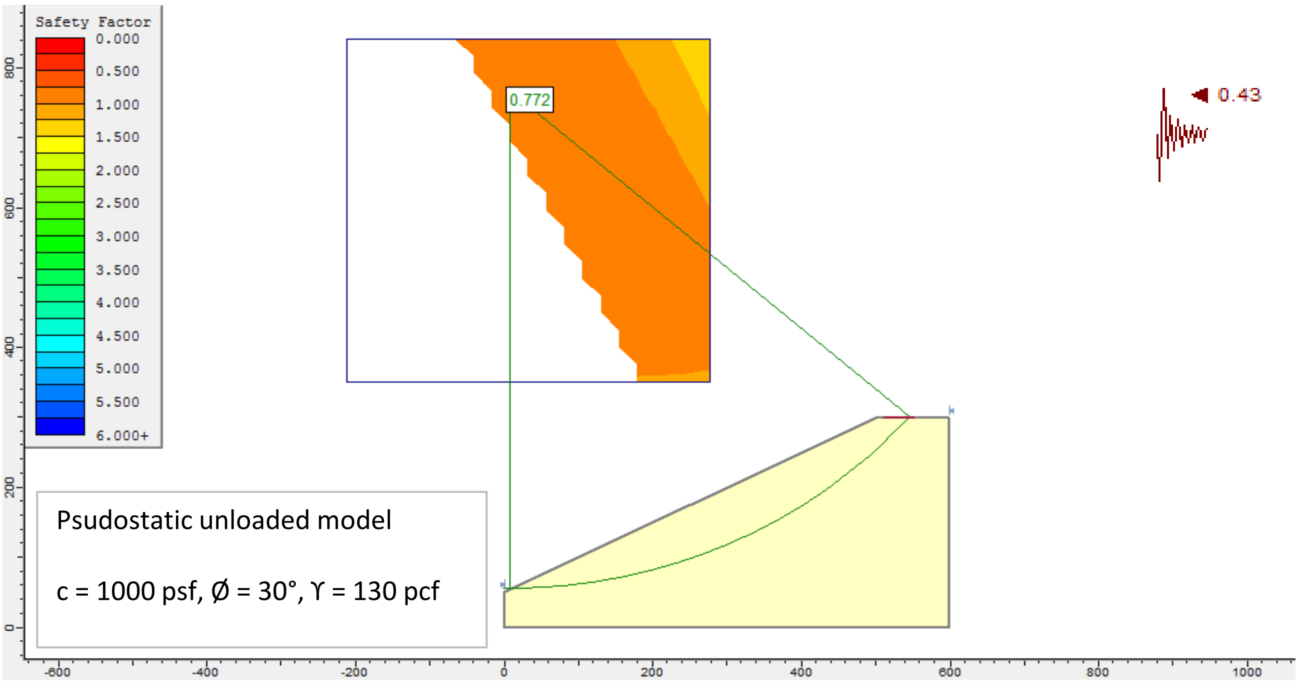


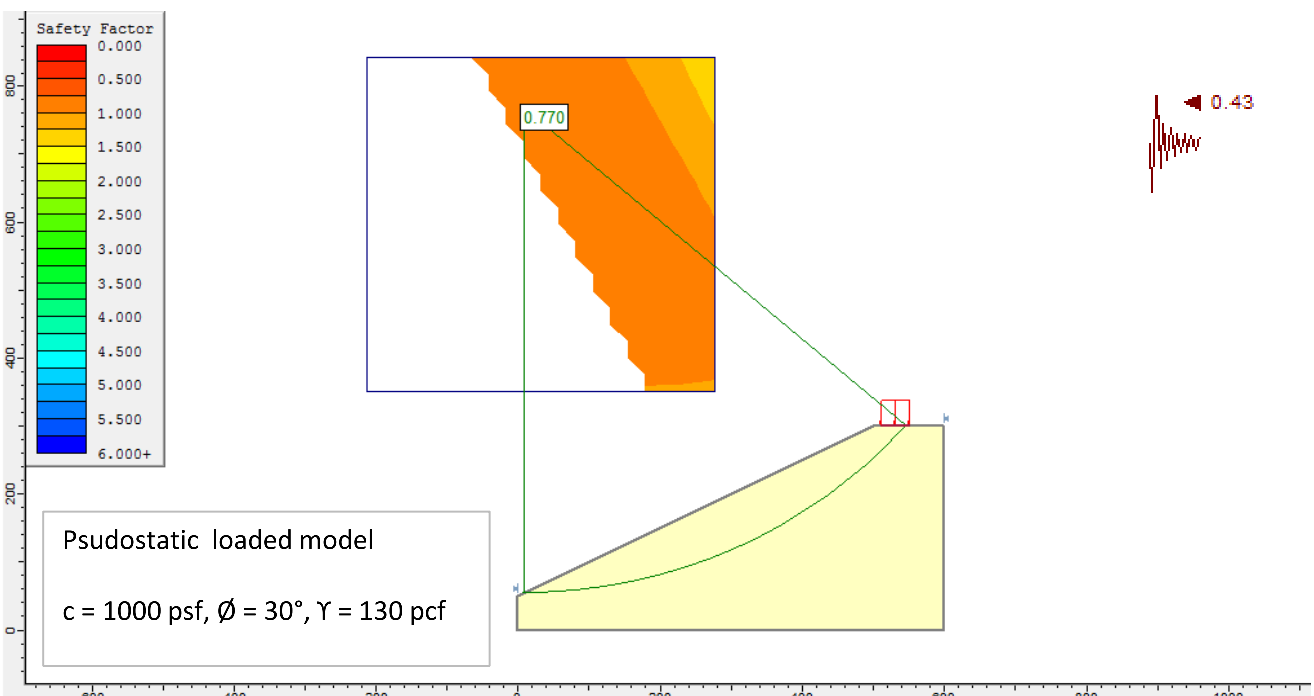


*All axes in units of feet

Project	Alderpoint Road Tank	By	GLM
Client	Garbeville Sanitary District	Date	4/29/2014
Proj. No.	7714.02	Page	3 of 4

Slope Stability Analysis (2:1 Slope)



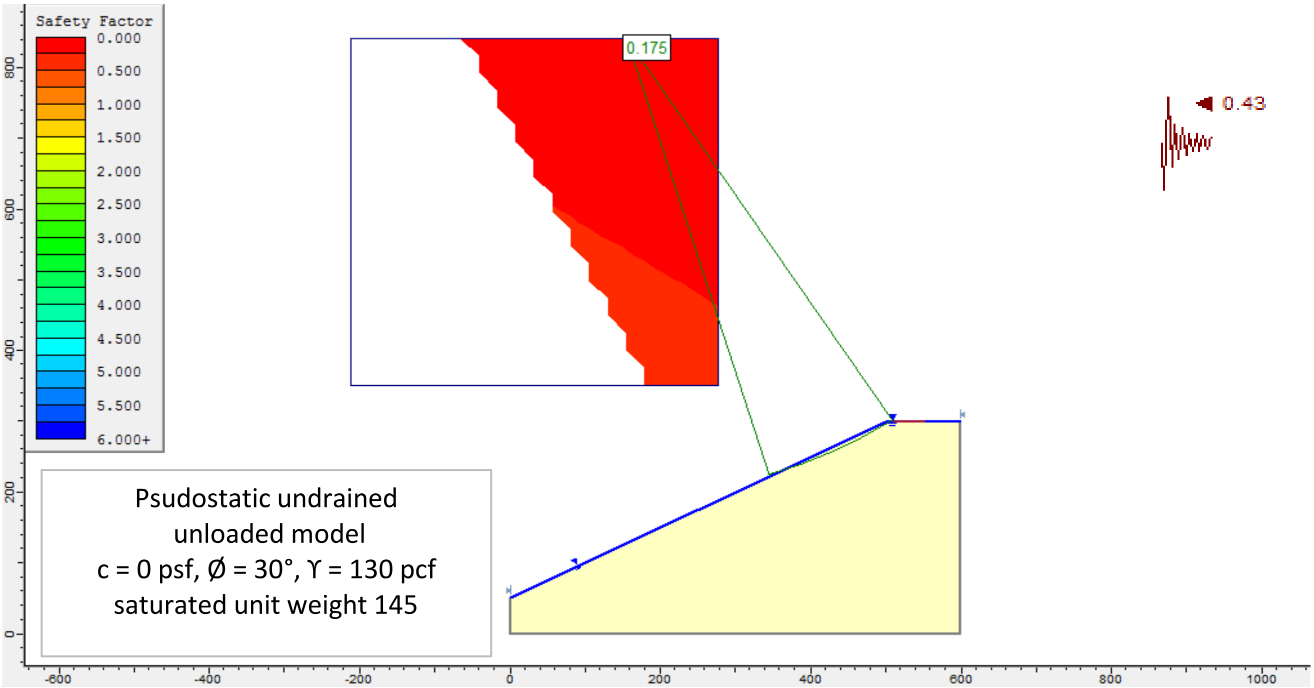


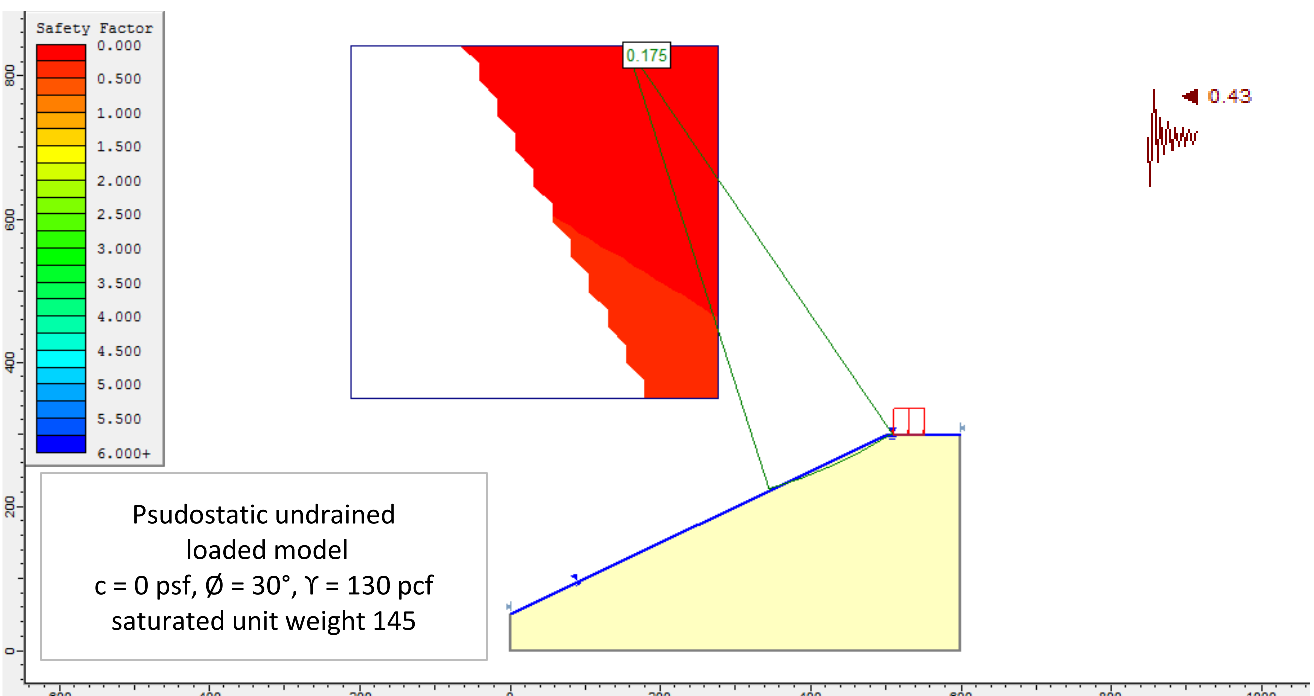
*All axes in units of feet

LACO

Project Alderpoint Road Tank
By GLM
Client Garbeville Sanitary District
Date 4/29/2014
Proj. No. 7714.02

Slope Stability Analysis (2:1 Slope)





*All axes in units of feet