SECTION H

GEOTECHNICAL EVALUATION

COUNTY SERVICE AREA 82
SEARLES VALLEY
SEWER IMPROVEMENT PROJECT

FOR

COUNTY SERVICE AREA (CSA) 82,
TRONA, CALIFORNIA

PROJECT NO.: 30.30.0158

Geotechnical Evaluation

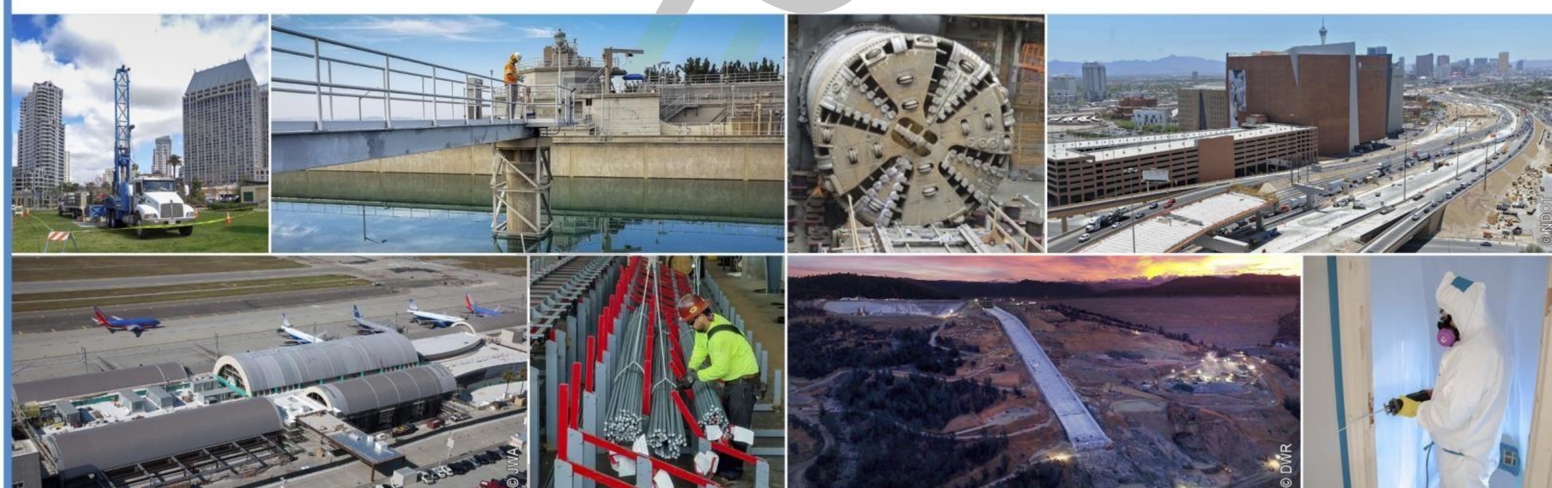
Searles Valley Sewer Improvement San Bernardino County Department of Public Works

Searles Valley, California

Kimley-Horn

401 B Street, Suite 600 | San Diego, California

January 22, 2024 | Project No. 30.30.0158



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Geotechnical Evaluation

Searles Valley Sewer Improvement
San Bernardino County Department of Public Works

Searles Valley, California

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1 INTRODUCTION

In accordance with your request and authorization, we have performed a geotechnical evaluation for the San Bernardino County Department of Public Works Special Districts (Department) Searles Valley Sewer Improvement project located in Searles Valley, California (Figure 1). The purpose of our study was to evaluate the soil, geologic, and groundwater conditions at the project site and to provide conclusions and recommendations regarding the geotechnical aspects of the project. This report presents our findings, conclusions, and recommendations for the proposed pipeline improvements.

2 SCOPE OF SERVICES

Our scope of services included the following:

- Project coordination, planning, and scheduling for subsurface exploration.
- Review of readily available background materials, including published geologic maps, fault and seismic hazard maps, groundwater data, topographic maps, aerial images, and plans provided by the client.
- Encroachment permit acquisition from San Bernardino County for drilling within the County road right-of-way.
- Site reconnaissance to locate the borings for coordination with Underground Services Alert for underground utility location.
- Subsurface exploration consisting of drilling, logging and sampling of ten (10) small-diameter borings to depths of up to approximately 21.5 feet below the ground surface. The borings were logged by a representative from our firm and bulk and relatively undisturbed soil samples were collected for laboratory testing.
- Geotechnical laboratory testing on selected representative soil samples to evaluate in-situ moisture content and dry density, gradation, percentage of particles finer than the No. 200 sieve, Atterberg limits, consolidation, direct shear strength, sand equivalent, and soil corrosivity.
- Data compilation and engineering analysis of the information obtained from our background review, subsurface evaluation, and laboratory testing.
- Preparation of this geotechnical report presenting our findings, conclusions, and recommendations for design and construction of the proposed improvements.

3 SITE DESCRIPTION AND PROPOSED CONSTRUCTION

The Searles Valley Sewer Improvement project is located in the Trona Road right-of-way in Searles Valley, California. The pipeline alignment is located on the east side of Trona Road, in an unpaved shoulder. The existing 12-inch sewer line spans approximately 11,317 feet from the Pioneer Point North Septic Tank site to the Trona Septic Tank Site (Figure 1). We understand the existing sewer line has experienced sagging approximately from Verbena Street to Athol Street.

The Department plans to replace the existing sewer line with a new 12-inch-diameter polyvinyl chloride (PVC) pipeline. The existing manholes will also be replaced. The new sewer line will be constructed at approximately the same location and invert as the existing pipeline. The invert depth of the pipeline ranges from approximately 5 to 17 feet below the ground surface. Surface elevations along the pipeline alignment range from approximately 1,634 to 1,647 feet above the mean sea level (Kimley-Horn, 2023).

4 SUBSURFACE EVALUATION AND LABORATORY TESTING

Our subsurface exploration was conducted on December 11 and 12, 2023, and consisted of drilling, logging, and sampling of ten (10) small-diameter borings to depths of up to approximately 21.5 feet. The borings were drilled using a truck-mounted drill rig utilizing 8-inch-diameter hollow-stem augers. Boring B-3 was terminated at a depth of approximately 13 feet due to a possible cobble or boulder. A representative from Ninyo & Moore logged the borings and obtained bulk and relatively undisturbed soil samples at selected depths for laboratory testing. The approximate boring locations are presented on Figures 2 through 8. Logs of the exploratory borings are presented in Appendix A.

Geotechnical laboratory testing was performed on representative soil samples to evaluate the in-situ moisture content and dry density, gradation, percentage of particles finer than the No. 200 sieve, Atterberg limits, consolidation, direct shear strength, sand equivalent, and soil corrosivity. The results of our in-situ moisture content and dry density tests are presented on the boring logs in Appendix A and the remaining laboratory testing results are presented in Appendix B.

5 GEOLOGIC AND SUBSURFACE CONDITIONS

5.1 Regional Geologic Setting

The subject site is located in Searles Valley, in the southern portion of the Basin and Range geomorphic province of southern California (Norris and Webb, 1990). The Basin and Range Geomorphic Province is located east of the Sierra Nevada geomorphic province and north of the Garlock Fault and the Mojave Desert geomorphic province, with the majority of the province extending into the State of Nevada. In general, the Basin and Range geomorphic province is characterized by horst and graben structure consisting of subparallel, fault-bounded ranges separated by down-dropped basins that resulted from regional extension (CGS, 2002).

Geologic mapping by Smith (2009) indicates that the site is underlain by older alluvium, alluvium, and lacustrine deposits. The alluvium generally consists of uppermost Holocene age gravel and sand deposited in active channels. The older alluvium generally consists of upper and middle

Holocene age medium to coarse sand. The lacustrine deposits generally consist of gravel, sand, and silt deposits. As indicated on the regional geologic map for the site vicinity (Figure 9), the pipeline alignment is generally located along the boundary between the older alluvium and the lacustrine deposits.

5.2 Site Geology

The materials encountered during our subsurface exploration generally consisted of asphalt concrete (AC) and interbedded older alluvial and lacustrine deposits. AC was encountered in boring B-6 and was approximately 3.5 inches in thickness. Interbedded older alluvium and lacustrine deposits were encountered beneath the AC in boring B-6 and from the ground surface in the remaining borings to the total depth explored of up to approximately 21.5 feet. These two geologic units are interfingered where the alluvium meets the lacustrine deposits of Searles Lake. The older alluvium generally consisted of moist to wet, very loose to very dense poorly graded sand with silt, silty sand, clayey sand, and sandy silt. The lacustrine deposits generally consisted of moist to wet, very soft to stiff fat clay with sand and fat clay. More detailed descriptions of the subsurface materials are presented on the boring logs in Appendix A.

6 GROUNDWATER

Groundwater was measured in boring B-5 approximately 15 minutes after drilling at a depth of approximately 11.6 feet below the ground surface. Groundwater was measured in boring B-6 approximately 30 minutes after drilling at a depth of approximately 15 feet below the ground surface. The groundwater depth measured during drilling is not considered a stabilized water level. Groundwater was not encountered in the remaining borings to the total depth explored of up to approximately 21.5 feet. However, many samples that were collected from the borings were observed to be wet, but measurable groundwater was not observed in the borehole at the completion of drilling (except for borings B-5 and B-6). The high moisture contents are probably related to the heavy rainfall that occurred from tropical storm Hilary in August, 2023.

Groundwater monitoring well data from the State of California Water Resources Control Board's GeoTracker website (2024) indicates that groundwater was measured at depths ranging from approximately 27 to 35 feet below the ground surface in groundwater monitoring wells located approximately 0.6 miles southwest of the site. Fluctuations in the level of groundwater will occur due to relatively slow rate of seepage in clay, variations in precipitation, ground surface topography, subsurface stratification, irrigation practices, groundwater pumping, and other factors that were not evident at the time of our field evaluation.

7 FAULTING AND SEISMICITY

The project site is located in a seismically active area, as is the majority of southern California. The numerous faults in southern California include active, potentially active, and inactive faults. As defined by the California Geological Survey (CGS), active faults are faults that have ruptured within Holocene time, or within approximately the last 11,000 years. Potentially active faults are those that show evidence of movement during Quaternary time (approximately the last 1.6 million years) but for which evidence of Holocene movement has not been established. Inactive faults have not ruptured in the last approximately 1.6 million years. The approximate locations of major active faults in the region and their geographic relationship to the project site are shown on Figure 10. The nearest mapped active fault to the site is the Tank Canyon fault located approximately 6.6 miles east of the site (United States Geological Survey [USGS], 2024). The potentially active Wilson Canyon fault is located approximately 1.0 mile northeast of the site. The Garlock Fault Zone is located about 16 miles south of the site.

Based on our review of seismic hazard maps, geologic literature, and geologic maps, the site is not located within a State of California Earthquake Fault Zone (formerly known as Alquist-Priolo Special Studies Zone) (CGS 2018), and no active faults are known to cross the subject site. The principal seismic hazards evaluated at the subject site are surface fault rupture, ground motion, and liquefaction. A brief description of these hazards and the potential for their occurrences on site are discussed in the following sections.

7.1 Surface Fault Rupture

Based on our review of the referenced literature and our site reconnaissance, no active faults are known to cross the project site. Therefore, the probability of damage from surface ground rupture is considered to be low. However, lurching or cracking of the ground surface as a result of nearby seismic events is possible.

7.2 Ground Motion

Considering the proximity of the site to active faults capable of producing a maximum moment magnitude of 6.0 or more, the project area has a high potential for experiencing strong ground motion. The 2022 California Building Code (CBC) specifies that the risk-targeted maximum considered earthquake (MCE_R) ground motion response accelerations be used to evaluate seismic loads for design of buildings and other structures. Based on our review of CGS's shear wave velocity map, the average shear wave velocity in the upper 30 meters (100 feet) of the subsurface profile (V_{S30}) is estimated to be approximately 294 meters per second (965 feet per second) (CGS, 2015). In accordance with Chapter 20 of the American Society of Civil Engineers

(ASCE) Publication 7-16 (2016) for the Minimum Design Loads and Associated Criteria for Building and Other Structures, the site classification is Site Class D.

In accordance with ASCE 7-16, the mapped MCE_R ground motion response accelerations were determined using the 2024 Applied Technology Council (ATC) seismic design tool (web-based). The MCE_R ground motion response accelerations are based on the spectral response accelerations for 5 percent damping in the direction of maximum horizontal response and incorporate a target risk for structural collapse equivalent to 1 percent in 50 years with deterministic limits. Spectral response acceleration parameters, consistent with the 2022 CBC, are provided in Section 9.2 for the evaluation of seismic loads on buildings and other structures. Since the anticipated improvements at the site will be relatively minor, we assumed that the exceptions in Section 11.4.8 of ASCE 7-16 will be applied to the project and a site-specific ground motion hazard analysis was not performed.

7.3 Liquefaction Potential

Liquefaction is the phenomenon in which loosely deposited granular soils and non-plastic silts located below the water table undergo rapid loss of shear strength when subjected to strong earthquake-induced ground shaking. Ground shaking of sufficient duration results in the loss of grain-to-grain contact due to a rapid rise in pore water pressure, and causes the soil to behave as a fluid for a short period of time. Liquefaction is known generally to occur in saturated or near-saturated cohesionless soils at depths shallower than 50 feet below the ground surface. Liquefaction is also known to occur in relatively fine-grained soils (i.e., sandy silt and clayey silt) with a plasticity index (PI) of less than 12 and an in-place moisture content more than 85 percent of the liquid limit and sensitive silts and clays with a PI of more than 18. Factors known to influence liquefaction potential include composition and thickness of soil layers, grain size, relative density, groundwater level, degree of saturation, and both intensity and duration of ground shaking.

Based on the San Bernardino County seismic hazard maps (San Bernardino County, 2009), the site is not located within a mapped area subject to seismically induced liquefaction hazards. Furthermore, the proposed pipeline does not include structures for human occupancy and evaluation of liquefaction potential at the site is not within the scope of our services for this study.

8 CONCLUSIONS

Based on our geotechnical evaluation, it is our opinion that the proposed improvements are feasible from a geotechnical standpoint provided that the following recommendations are incorporated into the design and construction of the project. The primary geotechnical concern for the project is the presence of highly compressible fat clay lacustrine deposits that were encountered in some of the borings and are anticipated to be exposed in some areas of the pipeline subgrade. It is our opinion that the sag in the pipeline is related to the long-term settlement of these compressible fat clay lacustrine deposits. In order to reduce the potential for future settlement of the new pipeline, overexcavation of the trench bottom where the fat clay is encountered, placing a layer of biaxial or triaxial geogrid (Tensar BX 1100 or equivalent) across the entire width of the trench, and replacing that over-excavated material with crushed rock wrapped in filter fabric or either Caltrans Class II base or crushed miscellaneous base will be appropriate. In general, the following additional conclusions were made.

- The subject site is underlain by interfingered older alluvium and lacustrine deposits generally consisting of moist to wet, very loose to very dense poorly graded sand with silt, silty sand, clayey sand, and sandy silt, and moist to wet, very soft to stiff fat clay with sand and fat clay.
- In general, excavations in the older alluvium and lacustrine deposits should be feasible with earthmoving equipment in good working condition.
- The clay soils encountered in portions of the pipeline alignment have very high moisture contents and bringing them near the laboratory optimum moisture content for compaction will be difficult. We anticipate that the clay soils will not suitable for reuse as trench backfill and imported material will be needed for trench backfill where clay is encountered. We anticipate that the on-site granular soils should be generally suitable for use as trench backfill provided they are free of trash, debris, roots, contamination, deleterious materials, and cobbles or hard lumps of material in excess of 4 inches in diameter. Processing of the materials to bring them near the laboratory optimum moisture content (i.e., drying and/or wetting) prior to use as fill should be planned by the contractor.
- On-site soils should be considered as Type C soils in accordance with Occupational Safety and Health Administration (OSHA) soil classifications. Temporary shoring should be provided in accordance with OSHA regulations. The granular soils encountered at the site have little cohesion and may be subject to caving.
- Groundwater was measured in borings B-5 and B-6 at depths of approximately 11.6 feet and 15 feet below the ground surface, respectively. Groundwater was not encountered in the remaining borings to the total depth explored of approximately 21.5 feet. However, wet soil was encountered in each boring at depths as shallow as 5 feet. Seepage should be anticipated and planned for by the contractor during construction. If light seepage is encountered during construction, groundwater may be removed with the use of sump pumps. Fluctuations in the level of groundwater will occur due to relatively slow rate of seepage in clay, variations in precipitation, ground surface topography, subsurface stratification, irrigation practices, groundwater pumping, and other factors that were not evident at the time of our field evaluation.
- The site is not located within a mapped Seismic Hazards Zone considered susceptible to liquefaction.
- The site is not located within a State of California Earthquake Fault Zone (Alquist-Priolo Special Studies Zone). Based on our review of published geologic maps and aerial photographs, no known active or potentially active faults transect the site. The potential for surface fault rupture at the site is considered low.

- Our limited laboratory sand equivalent testing indicates that the silty sand encountered at the site is generally unsuitable for use as bedding material, however the poorly graded sand with silt may be suitable as bedding material.
- Our limited laboratory test results indicate that the near-surface site soils can be classified as corrosive based on California Department of Transportation (Caltrans, 2021) corrosion guidelines.

9 RECOMMENDATIONS

The following sections present our geotechnical recommendations for the project based on the results of our subsurface evaluation, laboratory testing, review of referenced geologic data, and engineering analysis. The work should be performed in conformance with the recommendations presented in this report, project specifications, and appropriate agency standards.

9.1 Earthwork

Based on our understanding of the project, earthwork is anticipated to include cut-and-cover trenching up to approximately 18 feet deep for the new sewer pipeline and manholes and backfilling and compaction around new pipelines. Earthwork should be performed in accordance with the requirements of the appropriate governing agencies and the recommendations presented in the following sections.

9.1.1 Pre-Construction Conference

We recommend that a pre-construction conference be held. The owner and/or their representative, the governing agency representatives, the civil engineer, the geotechnical engineer, and the contractor should be in attendance to discuss the work plan and project schedule. Discussions should include how earthwork will be performed, site safety, and regulatory agency requirements.

9.1.2 Site Preparation

Prior to performing excavations, the area should be cleared of pavements, debris, abandoned utilities, surface obstructions, and other deleterious materials. Existing utilities within the project limits should be re-routed or protected from damage by construction activities. Obstructions that extend below subgrade of the proposed pipelines, if any, should be removed and the resulting holes filled with compacted soils. Materials generated from the clearing operations should be removed from the project site and disposed of at a legal dumpsite.

9.1.3 Excavation Characteristics

We anticipate that excavations in the alluvial and lacustrine deposits should be feasible with earthmoving equipment in good working order. The alluvial materials generally consisted of moist to wet, very loose to very dense poorly graded sand with silt, silty sand, clayey sand, and sandy silt, and the lacustrine materials generally consisted of moist to wet, very soft to stiff fat clay with sand and fat clay. Caving should be anticipated in materials with low cohesion. Oversize material is not considered suitable for use as backfill. In the event that oversize material, including cobbles and/or construction debris is encountered during excavation operations, the oversize material should be disposed of off-site.

9.1.4 Temporary Excavations and Shoring

Soils at the project site include loose sand with little cohesion that are considered to be prone to caving. In particular, bedding materials for existing pipelines, if encountered, may be prone to caving. Temporary excavations should either be sloped at an inclination no steeper than 1½:1 (horizontal to vertical) or shored. Temporary excavations should be evaluated in the field and constructed in accordance with applicable OSHA guidelines. The on-site soils should be considered as OSHA Soil Type C. On-site safety of personnel is the responsibility of the contractor.

Shored trenches may be needed in portions of the alignment due to boundary constraints with existing streets. Shoring systems should be designed for the anticipated soil conditions using the lateral earth pressure values presented on Figures 11 and 12 for braced and cantilevered excavations, respectively. The recommended design pressures are based on the assumptions that the shoring system is constructed without raising the ground surface elevation behind the shoring system, that there are no surcharge loads, such as soil stockpiles and construction materials, and that no loads act above a 1:1 (horizontal to vertical) plane extending up and back from the base of the shoring system. For shoring systems subjected to the above-mentioned surcharge loads, the contractor should include the effect of these loads on the lateral pressures against the shoring system.

We anticipate that settlement of the ground surface will occur behind the shoring wall during excavation. The amount of settlement depends heavily on the type of shoring system, the contractor's workmanship, and the soil conditions. To reduce the potential for distress to adjacent structures, we recommend that the shoring system be designed to limit the ground settlement behind the shoring system to ½ inch or less.

The contractor should retain a licensed, qualified, and experienced engineer to design the shoring system. The shoring parameters presented in this report are preliminary in nature, and the contractor should evaluate the adequacy of these parameters and make the required modifications for their design.

9.1.1 Construction Dewatering

Groundwater was measured in borings B-5 and B-6 at depths of approximately 11.6 feet and 15 feet below the ground surface, respectively. Wet soils with high moisture contents were encountered in several of the other exploratory borings at the time of drilling. Based on these conditions, groundwater and/or seepage is anticipated to be encountered in some areas along the pipeline alignment.

Where groundwater is encountered during construction, dewatering may be needed in order to perform work in a dry condition. Where light seepage is encountered, groundwater may be removed with the use of sump pumps. Where sump pumps are insufficient, a dewatering system may be needed. The dewatering system design should be performed by a specialty dewatering contractor.

Drawing down of the water level within the excavation may affect the water level outside of the excavation. This will result in an increase in effective stresses and may induce settlement of the soils underlying adjacent improvements. Accordingly, we recommend that the dewatering be performed from inside the perimeter of the shoring walls and the groundwater level be lowered no more than 3 feet below the excavation bottom. Design of the groundwater withdrawal system is the responsibility of the contractor.

The soils at the project sites are generally comprised of interbedded sand and clay layers. The sands have relatively high permeability while the clays have relatively low permeability. Excavating around existing utilities could involve higher groundwater flow rates where drainage from sand or gravel bedding/backfill zones occurs. Disposal of groundwater should be performed in accordance with the guidelines of the Regional Water Quality Control Board.

9.1.2 Excavation Bottom Stability

Excavations close to or below the groundwater (before or after dewatering) may encounter wet and loose or soft ground conditions. Excavations that expose loose/soft soils or encounter seepage or groundwater, or that become disturbed during excavation, may be unstable. Furthermore, compressible fat clay with high moisture contents (up to about 128 percent) was encountered in borings B-5 through B-8.

In the area where the existing pipeline is experiencing sagging, and in areas where fat clay or other wet and loose/soft soils are present, unstable bottom conditions may be mitigated by over-excavating to a depth of approximately 1 to 2 feet below the proposed pipe subgrade, placing one layer of biaxial or triaxial geogrid (Tensar BX 1100 or equivalent) across the entire width of the trench, and replacing the excavated soil with crushed aggregate base or gravel wrapped in geofabric. If aggregate base is used, it should consist of either Caltrans Class II base or crushed miscellaneous base. Caltrans Class II base should conform to the State of California Standard Specifications, Section 26 1.02A. Crushed miscellaneous base should conform to the Standard Specifications for Public Works Construction, Section 200 2.4. Recommendations for over-excavation and stabilizing excavation bottoms should be based on evaluation in the field by a Ninyo & Moore representative at the time of construction. The crushed rock or aggregate base should be compacted to 90 percent or more as evaluated by ASTM International (ASTM) test method D 1557.

9.1.3 Pipe Bedding

The pipes should be supported on compacted crushed rock or aggregate base subgrade, as recommended above. Granular bedding material should be placed around pipe zones to 12 inches or more above the top of the pipes in accordance with the current "Greenbook" Standard Specifications for Public Works. The bedding material should be classified as sand, should be free of organic material, and have a sand equivalent (SE) of 30 or more. Representative samples of near-surface soil materials were evaluated for sand equivalent. Our limited laboratory sand equivalent testing indicates that the silty sand encountered at the site has a SE of 22, and the poorly graded sand with silt has a SE of 30. Therefore, the silty sand material is generally unsuitable for use as bedding material, however the poorly graded sand with silt may be suitable as bedding material. Additional SE testing should be performed during construction if the sand with silt will be segregated for later use as bedding material. Special care should be taken not to allow voids beneath and around the pipe. Compaction of the bedding material and backfill should proceed along both sides of the pipe concurrently. Trench backfill, including bedding material, should be placed and compacted with mechanical equipment in accordance with the recommendations presented in this report.

9.1.4 Fill Material

In general, the on-site granular soils should be suitable for reuse as trench backfill provided they are free of trash, debris, roots, vegetation, boulders, or other deleterious materials. Clay soils were encountered in portions of the pipeline alignment that have very high moisture contents and bringing them near the laboratory optimum moisture content for compaction will be difficult. We anticipate that the clay soils will not be suitable for reuse as trench backfill, and import fill will be needed for trench backfill where clay is encountered. Fill should generally be free of rocks or lumps of material in excess of 4 inches in diameter. Rocks or hard lumps larger than approximately 4 inches in diameter should be broken into smaller pieces or should be removed from the site. The on-site materials will involve moisture-conditioning to bring the materials near optimum moisture content prior to placement and compaction.

Imported materials, if needed, should consist of clean, non-expansive, granular material, which conforms to the "Greenbook" for structure backfill. "Non-expansive" can be defined as soil having an expansion index of 20 or less in accordance with ASTM D 4829. The imported materials should also meet the Caltrans (2021) criteria for non-corrosive soils (i.e., soils having a chloride concentration of less than 500 parts per million [ppm], a soluble sulfate content of less than approximately 0.15 percent [1,500 ppm], a pH value of more than 5.5, and an electrical resistivity of more than 1,500 ohm-centimeters [ohm-cm]). Materials for use as fill should be evaluated by Ninyo & Moore prior to importing. The contractor should be responsible for the uniformity of import material brought to the site.

9.1.5 Backfill Placement and Compaction

Trench backfill should be compacted in horizontal lifts to a relative compaction of 90 percent as evaluated by ASTM D 1557. The upper 12 inches of subgrade materials beneath pavements should be compacted to a relative compaction of 95 percent as evaluated by ASTM D 1557. Backfill soils should be placed at near optimum moisture content as evaluated by ASTM D 1557. The optimum lift thickness of fill will depend on the type of compaction equipment used, but generally should not exceed 8 inches in loose thickness. Special care should be taken to avoid pipe damage when compacting trench backfill above a pipe. Placement and compaction of the fill soils should be in general accordance with local grading ordinances and good construction practice.

9.1.6 Modulus of Soil Reaction

The modulus of soil reaction is used to characterize the stiffness of soil backfill placed on the sides of buried flexible pipelines for the purpose of evaluating lateral deflection caused by the weight of the backfill above the pipe. We recommend that a modulus of soil reaction of 700 pounds per square inch (psi) be used for design, provided that granular bedding material is placed adjacent to the pipe, as recommended in this report.

9.2 Seismic Design Considerations

Design of the proposed improvements should be performed in accordance with the requirements of governing jurisdictions and applicable building codes. Table 1 presents the seismic design parameters for the site in accordance with the 2022 CBC guidelines.

Table 1 – 2022 California Building Code Seismic Design Criteria	
Spectral Response Acceleration Parameters	**Values**
Site Classification	D
Mapped MCE_R Spectral Response Acceleration at Short Periods, S_S	1.247g
Mapped MCE_R Spectral Response Acceleration at 1.0-Second Period, S_1	0.419g
MCE_R Spectral Response Acceleration at Short Periods, Adjusted for Site Class, S_{MS}	1.249g
MCE_R Spectral Response Acceleration at 1.0-Second Period, Adjusted for Site Class, S_{M1}	0.788g
Design Spectral Response Acceleration at Short Periods, S_{DS}	0.832g
Design Spectral Response Acceleration at 1.0-Second Period, S_{D1}	0.525g
Maximum Considered Earthquake Geometric Mean (MCE_G) Peak Ground Acceleration, PGA_M	0.590g

9.3 Pavement Reconstruction

If trenching extends into Trona Road, pavement replacement will be needed. In general, pavement repair should conform to the material and compaction requirements of the adjacent pavement sections. Aggregate base (AB) material should conform to the latest specifications in Section 200-2.2 for crushed AB or Section 200-2.4 for crushed miscellaneous base (CMB) of the Greenbook and should be compacted to a relative compaction of 95 percent in accordance with ASTM D 1557. Grinding and recycling existing AC material may be considered as a potential source of CMB material provided they meet the requirements in the "Greenbook." AC should conform to Section 2036 of the Greenbook and should be compacted to a relative compaction of 95 percent in accordance with ASTM D 1560 or California Test Method (CT) 304. Actual pavement reconstruction should conform to the requirements of the appropriate governing agency.

9.4 Corrosivity

Laboratory testing was performed on selected representative samples of near-surface soils to evaluate pH, electrical resistivity, water-soluble chloride content, and water-soluble sulfate content. The soil pH and electrical resistivity tests were performed in general accordance with California Test Method (CT) 643. Chloride content test was performed in general accordance with CT 422. Sulfate testing was performed in general accordance with CT 417. The laboratory test results are presented in Appendix B.

The pH of the tested samples was measured to range from approximately 9.1 to 9.5. The electrical resistivity was measured to range from approximately 53 to 256 ohm-cm. The chloride content was measured to range from approximately 880 to 13,200 ppm, and the sulfate content was measured to range from approximately 0.011 to 0.090 percent (i.e., 110 to 900 ppm). Based on the laboratory test results and Caltrans (2021) corrosion criteria, the project site would be classified as a corrosive site due to high chloride concentration and low electrical resistivity of the samples tested. A corrosive site is defined as having earth materials with a chloride concentration of 500 ppm or more, sulfate concentration of 1,500 ppm or more, a pH of 5.5 or less, or an electrical resistivity of 1,500 ohm-cm or less. We recommend that a corrosion engineer be consulted for further evaluation and recommendations, if needed.

9.5 Concrete

Concrete in contact with soil or water that contains high concentrations of water-soluble sulfates can be subject to premature chemical and/or physical deterioration. Based on the American Concrete Institute (2022), the potential for sulfate attack is negligible for water-soluble sulfate contents in soil ranging from 0.00 to 0.10 percent by weight and moderate for water-soluble sulfate contents ranging from 0.10 to 0.20 percent by weight. The potential for sulfate attack is severe for water-soluble sulfate contents ranging from 0.20 to 2.00 percent by weight and very severe for water-soluble sulfate contents over 2.00 percent by weight. The soil samples tested for this evaluation, using Caltrans Test Method 417, indicate a water-soluble sulfate content ranging from 0.011 to 0.090 percent by weight (i.e., 110 to 900 ppm). Accordingly, the on-site soils are considered to have a negligible potential for sulfate attack. However, due to the potential variability of the on-site soils, consideration should be given to using Type II/V cement for the project. The structural engineer should be consulted for additional concrete specifications.

10 CONSTRUCTION OBSERVATION

The recommendations provided in this report are based on our understanding of the proposed project and our evaluation of the data collected based on subsurface conditions observed in our exploratory borings. It is imperative that the geotechnical consultant checks the subsurface conditions during construction. We recommend that Ninyo & Moore review the final project plans and specifications prior to construction. It should be noted that, upon review of these documents, some recommendations presented in this report may be revised or modified.

During construction, we recommend that the duties of the geotechnical consultant include, but not be limited to:

- Observing clearing, grubbing, and removals.
- Observing trench excavation bottoms, placement of geogrid, and compaction of crushed rock/aggregate base, bedding material, and trench backfill.
- Evaluating imported materials prior to their use as fill, if used.
- Performing field tests to evaluate compaction of fill materials, aggregate base, and AC.

The recommendations provided in this report are based on the assumption that Ninyo & Moore will provide geotechnical observation and testing services during constriction. In the event that the owner decides not to utilize the services of Ninyo & Moore during construction, we request that the selected consultant provide the owner with a letter (with a copy to Ninyo & Moore) indicating that they fully understand Ninyo & Moore's recommendations and that they are in full agreement with the design parameters and recommendations contained in this report.

11 LIMITATIONS

The field evaluation, laboratory testing, and geotechnical analyses presented in this geotechnical report have been conducted in general accordance with current practice and the standard of care exercised by geotechnical consultants performing similar tasks in the project area. No warranty, expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be encountered during construction. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation will be performed upon request. Please also note that our evaluation was limited to assessment of the geotechnical aspects of the project, and did not include evaluation of structural issues, environmental concerns, or the presence of hazardous materials.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Ninyo & Moore should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document.

This report is intended for design purposes only. It does not provide sufficient data to prepare an accurate bid by contractors. It is suggested that the bidders and their geotechnical consultant perform an independent evaluation of the subsurface conditions in the project areas. The independent evaluations may include, but not be limited to, review of other geotechnical reports prepared for the adjacent areas, site reconnaissance, and additional exploration and laboratory testing.

Our conclusions, recommendations, and opinions are based on an analysis of the observed site conditions. If geotechnical conditions different from those described in this report are encountered, our office should be notified, and additional recommendations, if warranted, will be provided upon request. It should be understood that the conditions of a site could change with time as a result of natural processes or the activities of man at the subject site or nearby sites. In addition, changes to the applicable laws, regulations, codes, and standards of practice may occur due to government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which Ninyo & Moore has no control.

This report is intended exclusively for use by the client. Any use or reuse of the findings, conclusions, and/or recommendations of this report by parties other than the client is undertaken at said parties' sole risk.

12 REFERENCES

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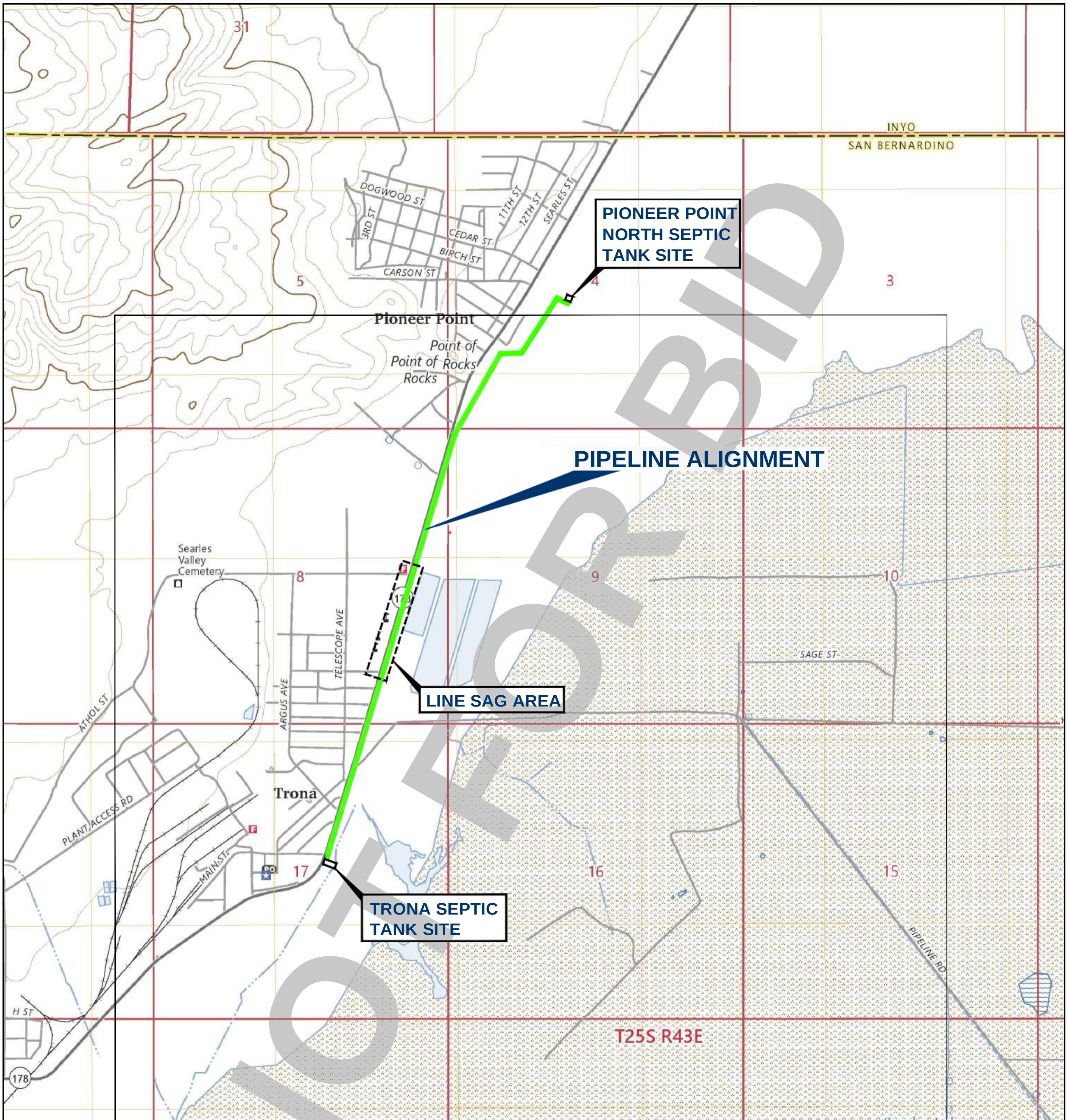
FIGURES



NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE. I REFERENCE: USGS, 2021.

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FIGURE 1

SITE LOCATION

SEARLES VALLEY SEWER IMPROVEMENT
SEARLES VALLEY, CALIFORNIA

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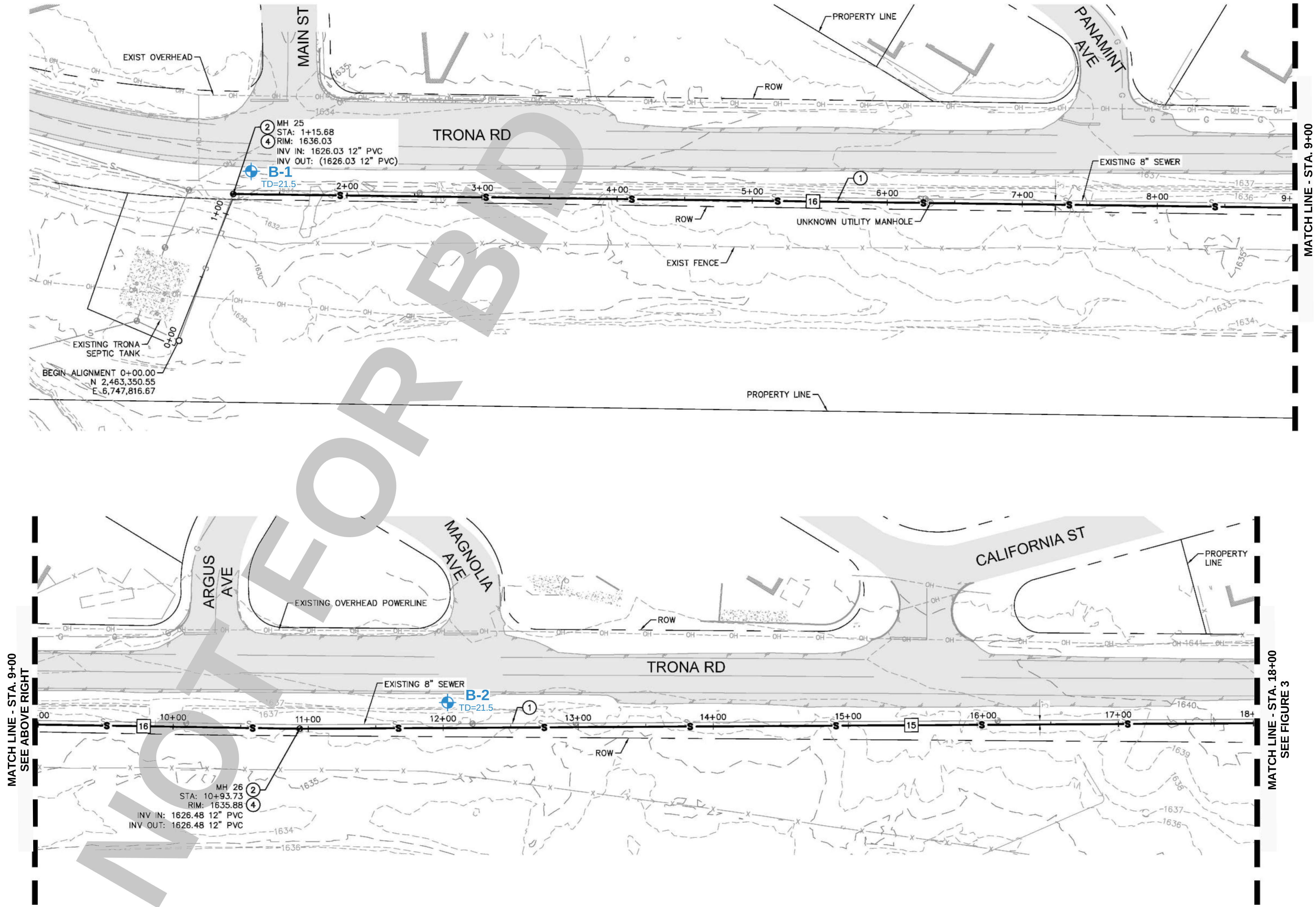

LEGEND

B-2 TD=21.5 — BORING; TD=TOTAL DEPTH IN FEET

FEET: 0 80 160

NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE. I REFERENCE: KIMLEY HORN, 2023.

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FIGURE 2

SEWER PIPELINE ALIGNMENT WITH BORING LOCATIONS

SEARLES VALLEY SEWER IMPROVEMENT
SEARLES VALLEY, CALIFORNIA

Ninyo & Moore
Geotechnical & Environmental Sciences Consultants

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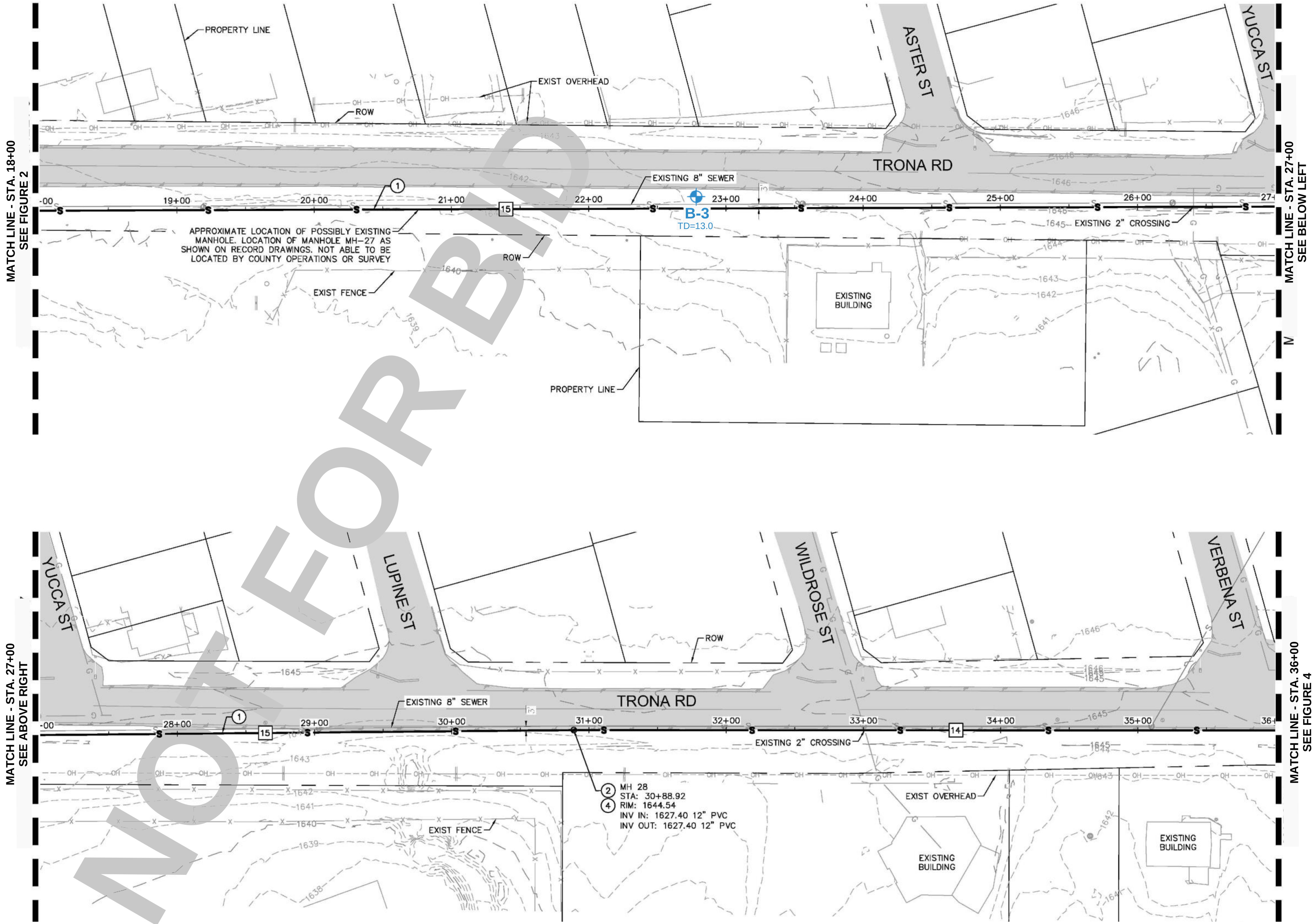

LEGEND

B-3 TD=13.0 — BORING; TD=TOTAL DEPTH IN FEET

FEET: 0 80 160

NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE. I REFERENCE: KIMLEY HORN, 2023.

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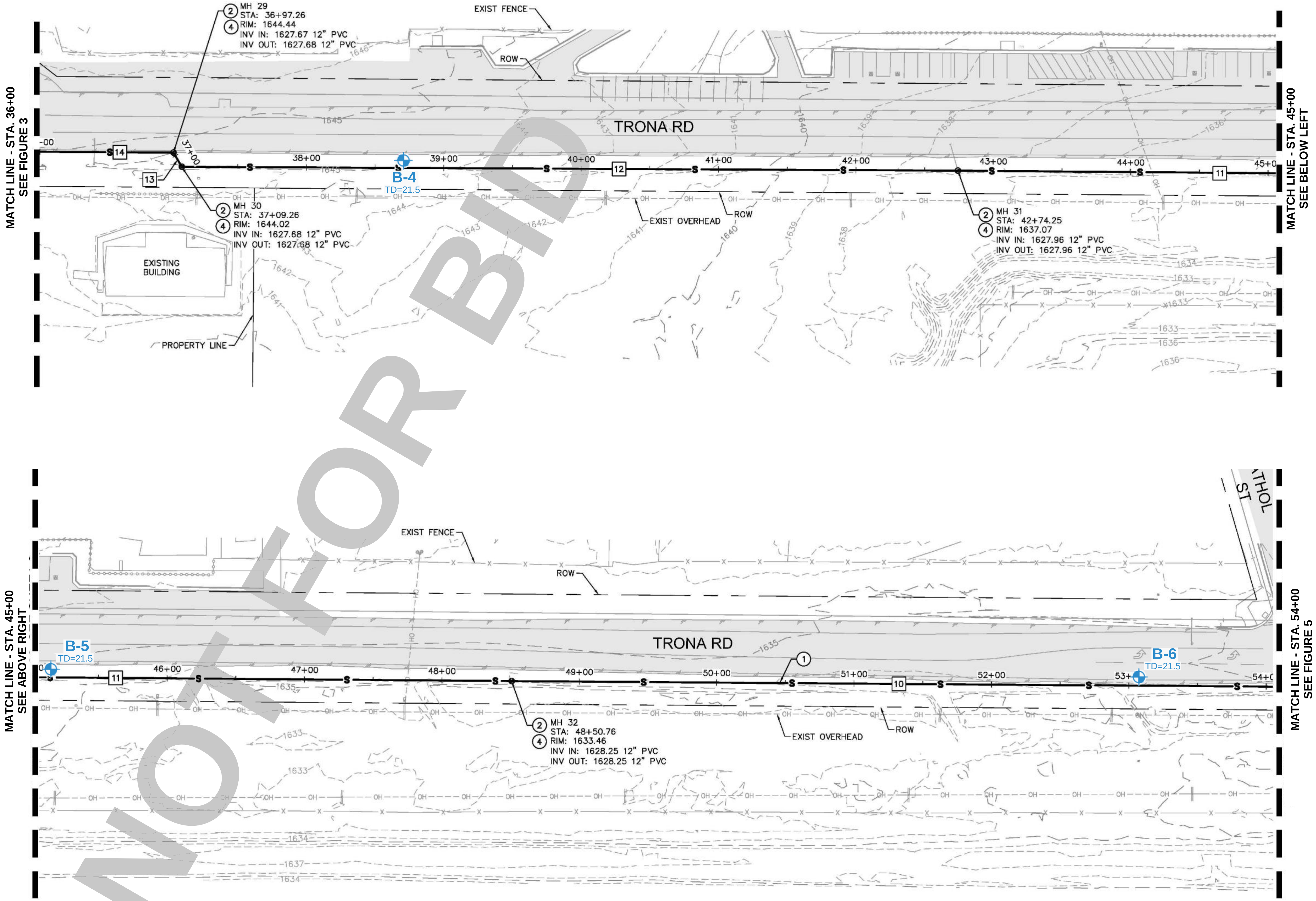
FIGURE 3

SEWER PIPELINE ALIGNMENT WITH BORING LOCATIONS

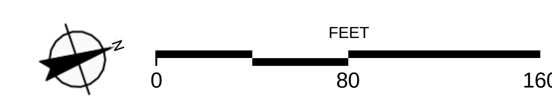
SEARLES VALLEY SEWER IMPROVEMENT
SEARLES VALLEY, CALIFORNIA

Ninyo & Moore
Geotechnical & Environmental Sciences Consultants



LEGEND

B-6 TD=21.5 — BORING; TD=TOTAL DEPTH IN FEET



NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE. I REFERENCE: KIMLEY HORN, 2023.

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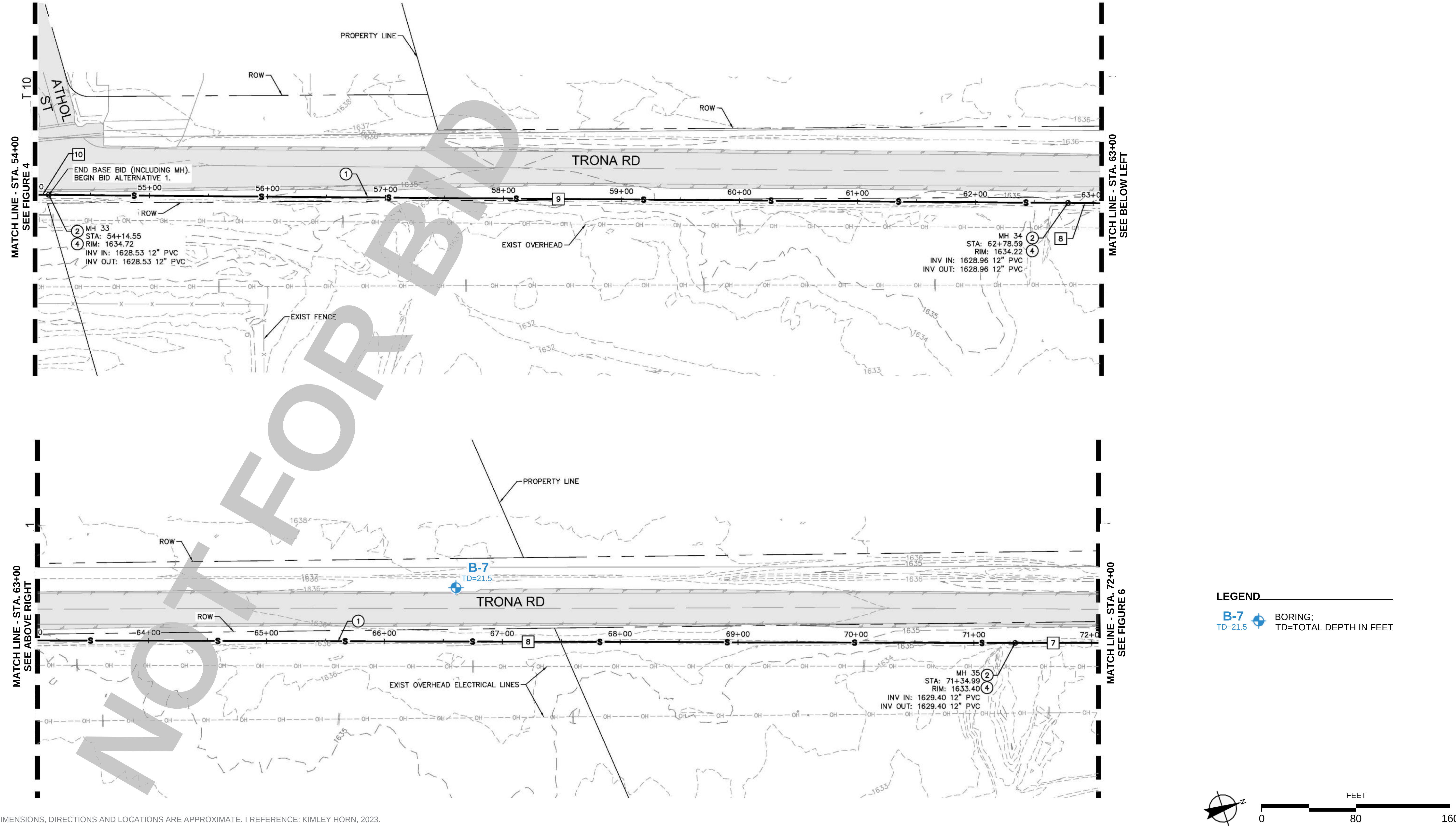
FIGURE 4

SEWER PIPELINE ALIGNMENT WITH BORING LOCATIONS

SEARLES VALLEY SEWER IMPROVEMENT
SEARLES VALLEY, CALIFORNIA

Ninyo & Moore
Geotechnical & Environmental Sciences Consultants

212290001 I 1/24



NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE. I REFERENCE: KIMLEY HORN, 2023.

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Ninyo & Moore
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FIGURE 5

SEWER PIPELINE ALIGNMENT WITH BORING LOCATIONS

SEARLES VALLEY SEWER IMPROVEMENT
SEARLES VALLEY, CALIFORNIA

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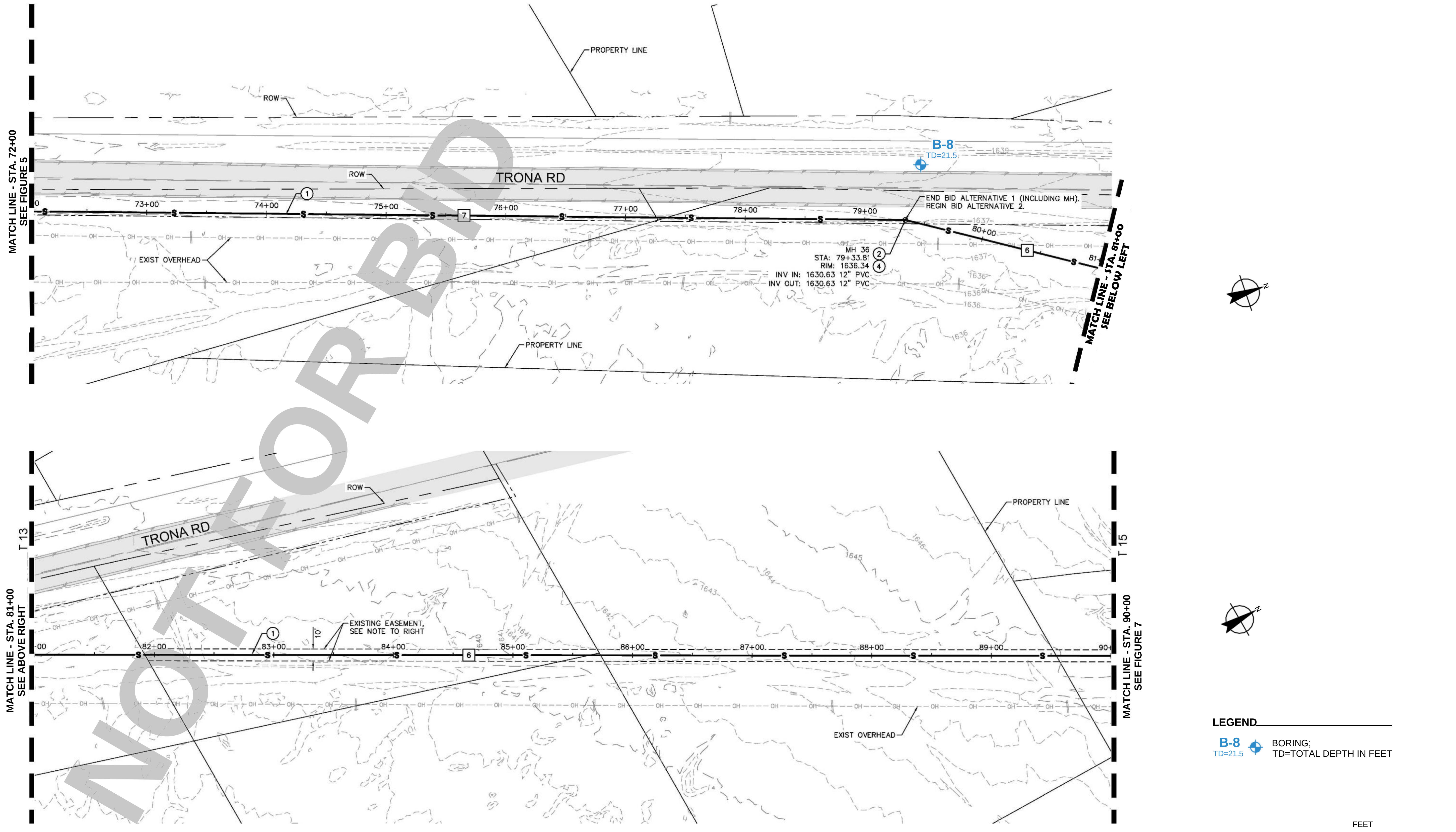

NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE. I REFERENCE: KIMLEY HORN, 2023.

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FIGURE 6

SEWER PIPELINE ALIGNMENT WITH BORING LOCATIONS

SEARLES VALLEY SEWER IMPROVEMENT
SEARLES VALLEY, CALIFORNIA

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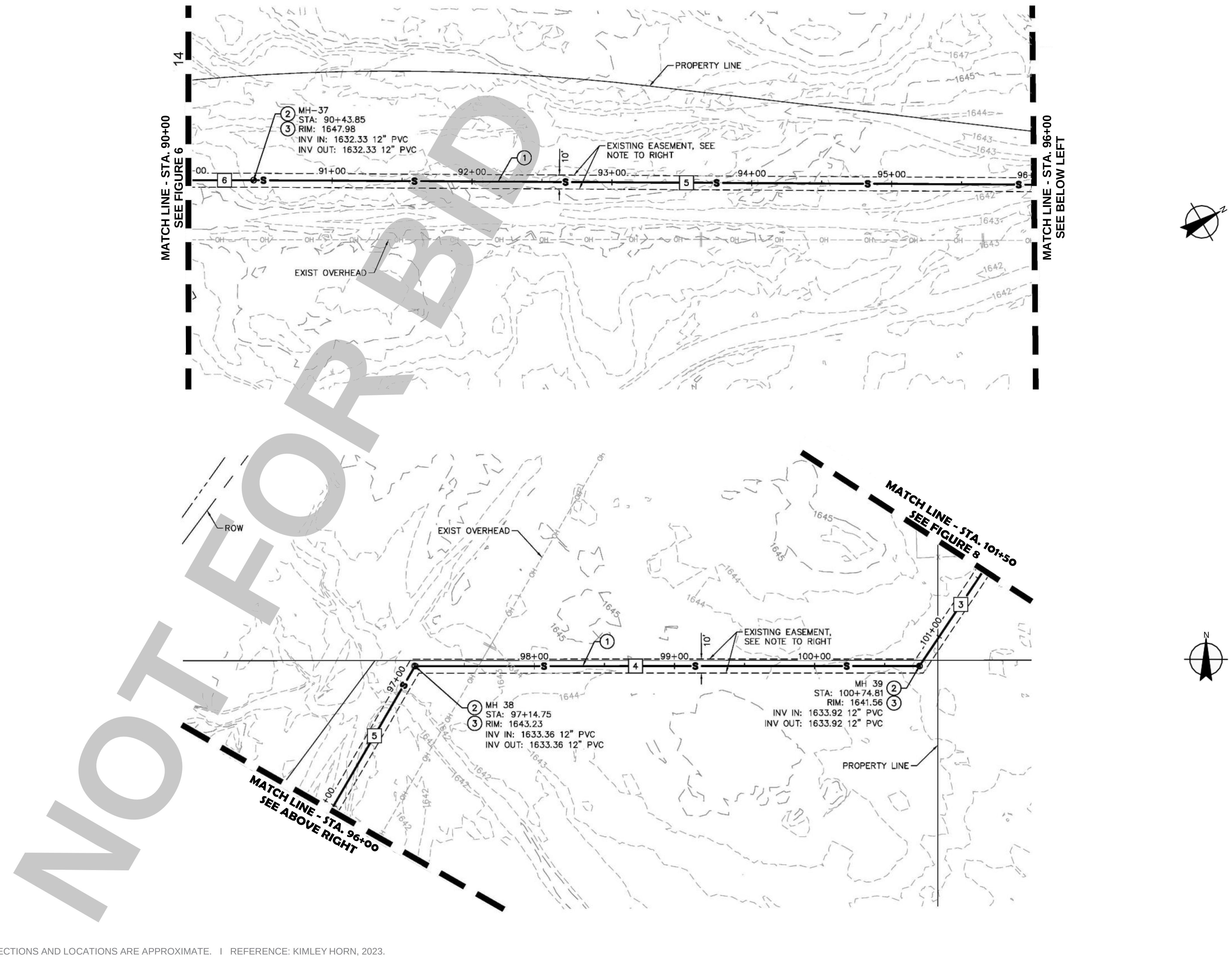


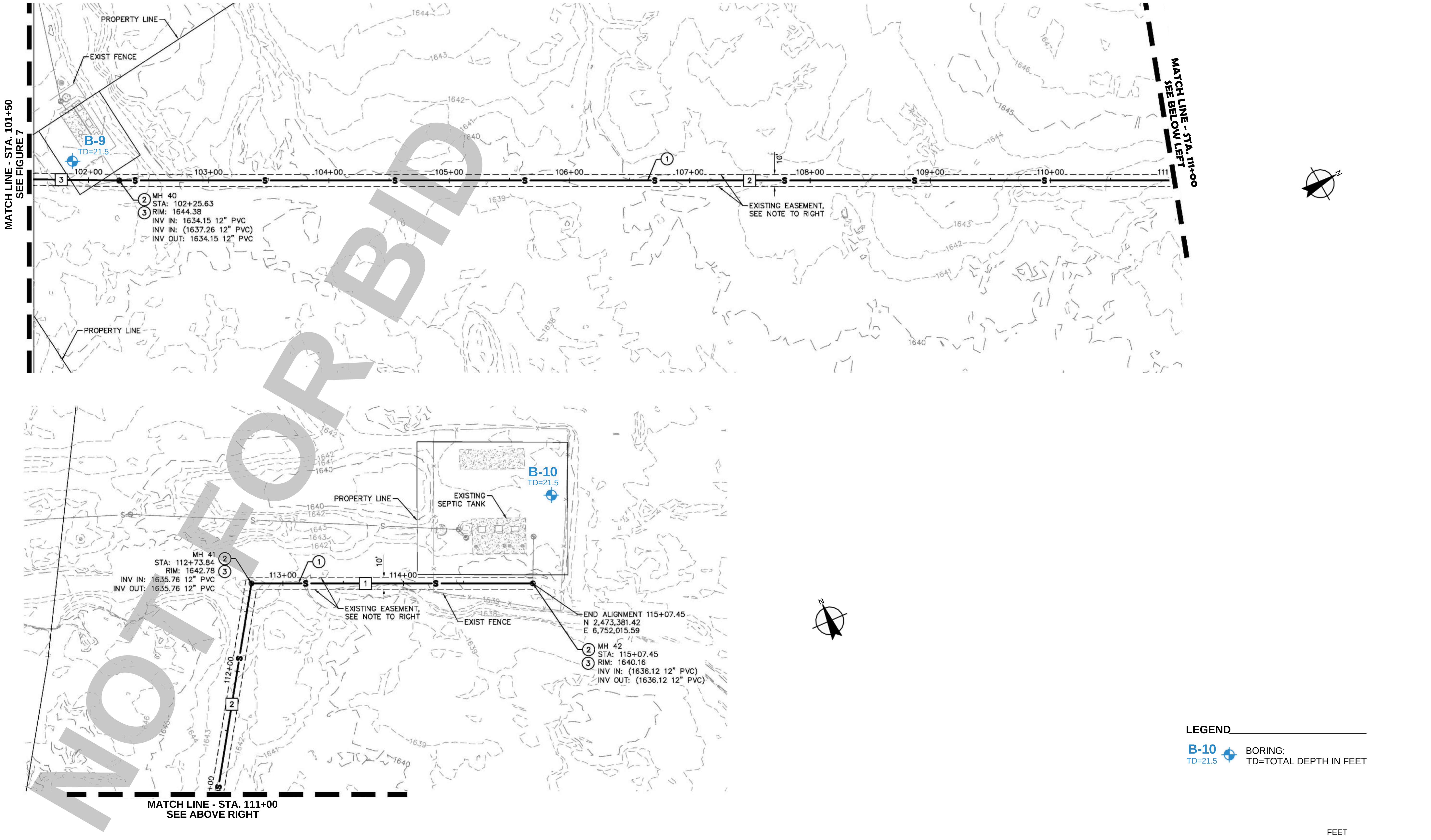
NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE. I REFERENCE: KIMLEY HORN, 2023.

FIGURE 7

SEWER PIPELINE ALIGNMENT WITH BORING LOCATIONS

SEARLES VALLEY SEWER IMPROVEMENT
SEARLES VALLEY, CALIFORNIA

Ninyo & Moore
Geotechnical & Environmental Sciences Consultants



NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE. I REFERENCE: KIMLEY HORN, 2023.

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FIGURE 8

SEWER PIPELINE ALIGNMENT WITH BORING LOCATIONS

SEARLES VALLEY SEWER IMPROVEMENT
SEARLES VALLEY, CALIFORNIA

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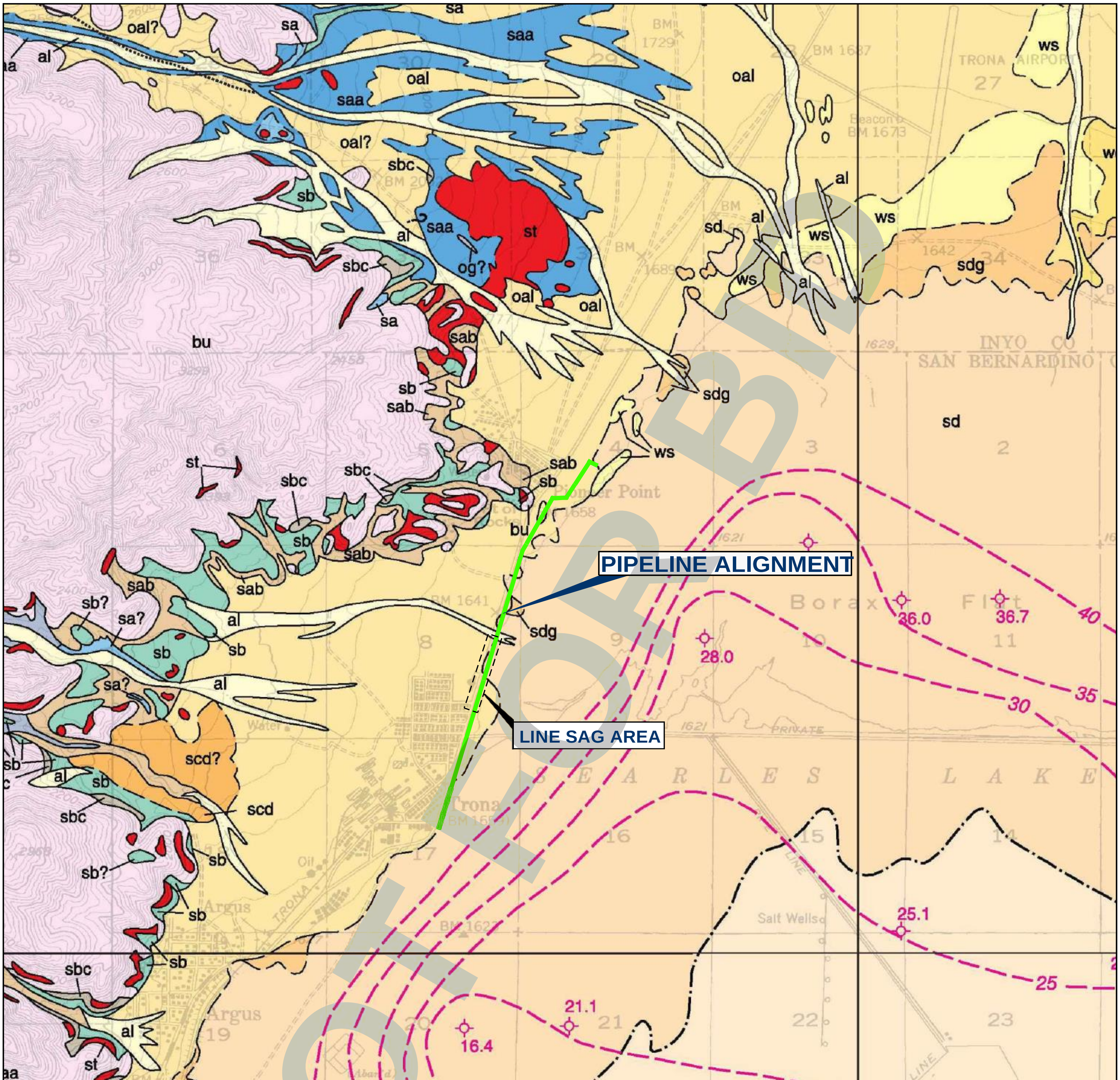
Geotechnical & Environmental Sciences Consultants



LEGEND

oal	OLDER ALLUVIUM
al	ALLUVIUM
sd	SAND AND SILT LACUSTRINE DEPOSITS
sdg	GRAVEL AND SAND LACUSTRINE DEPOSITS
ws	WINDBLOWN SAND AND COLLUVIUM
(line)	GEOLOGIC CONTACT
(dashed line)	ISOPACH CONTOUR SHOWING THICKNESS OF UNIT sd

N

FEET

0 4,000 8,000

NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE. I REFERENCE: SMITH, 2009.

FIGURE 9

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REGIONAL GEOLOGY

SEARLES VALLEY SEWER IMPROVEMENT
SEARLES VALLEY, CALIFORNIA

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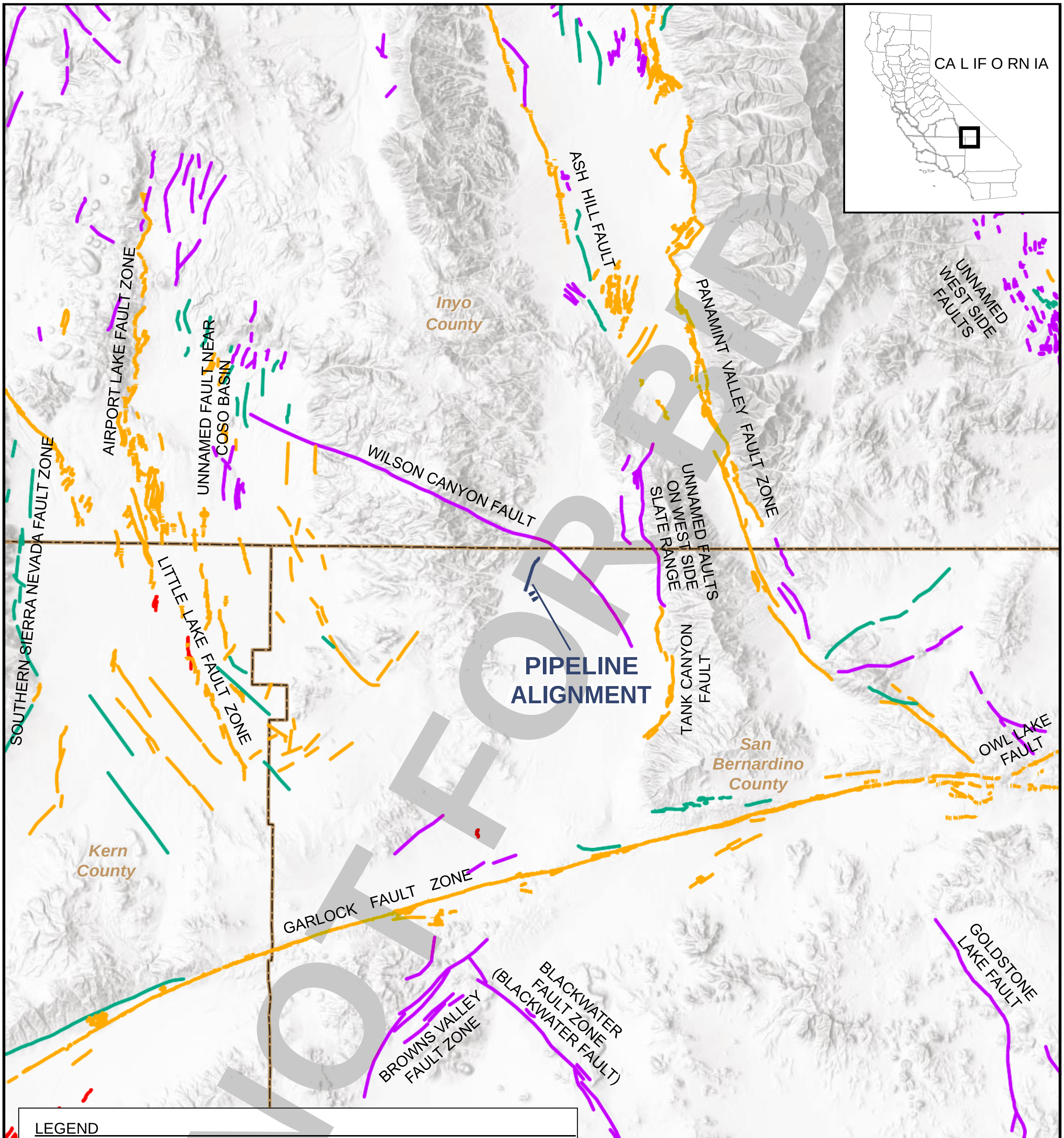

LEGEND

CALIFORNIA FAULT ACTIVITY

- HISTORICALLY ACTIVE
- HOLOCENE ACTIVE
- LATE QUATERNARY (POTENTIALLY ACTIVE)
- QUATERNARY (POTENTIALLY ACTIVE)
- STATE/COUNTY BOUNDARY

SOURCES: QUATERNARY FAULTS DATABASE - U.S. GEOLOGICAL SURVEY AND CALIFORNIA GEOLOGICAL SURVEY, QUATERNARY FAULT AND FOLD DATABASE FOR THE UNITED STATES, ACCESSED MARCH 17, 2023, AT: https://www.usgs.gov/programs/earthquake-hazards/faults, ESRI, 2023.

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE.

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FIGURE 10

FAULT LOCATIONS

SEARLES VALLEY SEWER IMPROVEMENT
SEARLES VALLEY, CALIFORNIA

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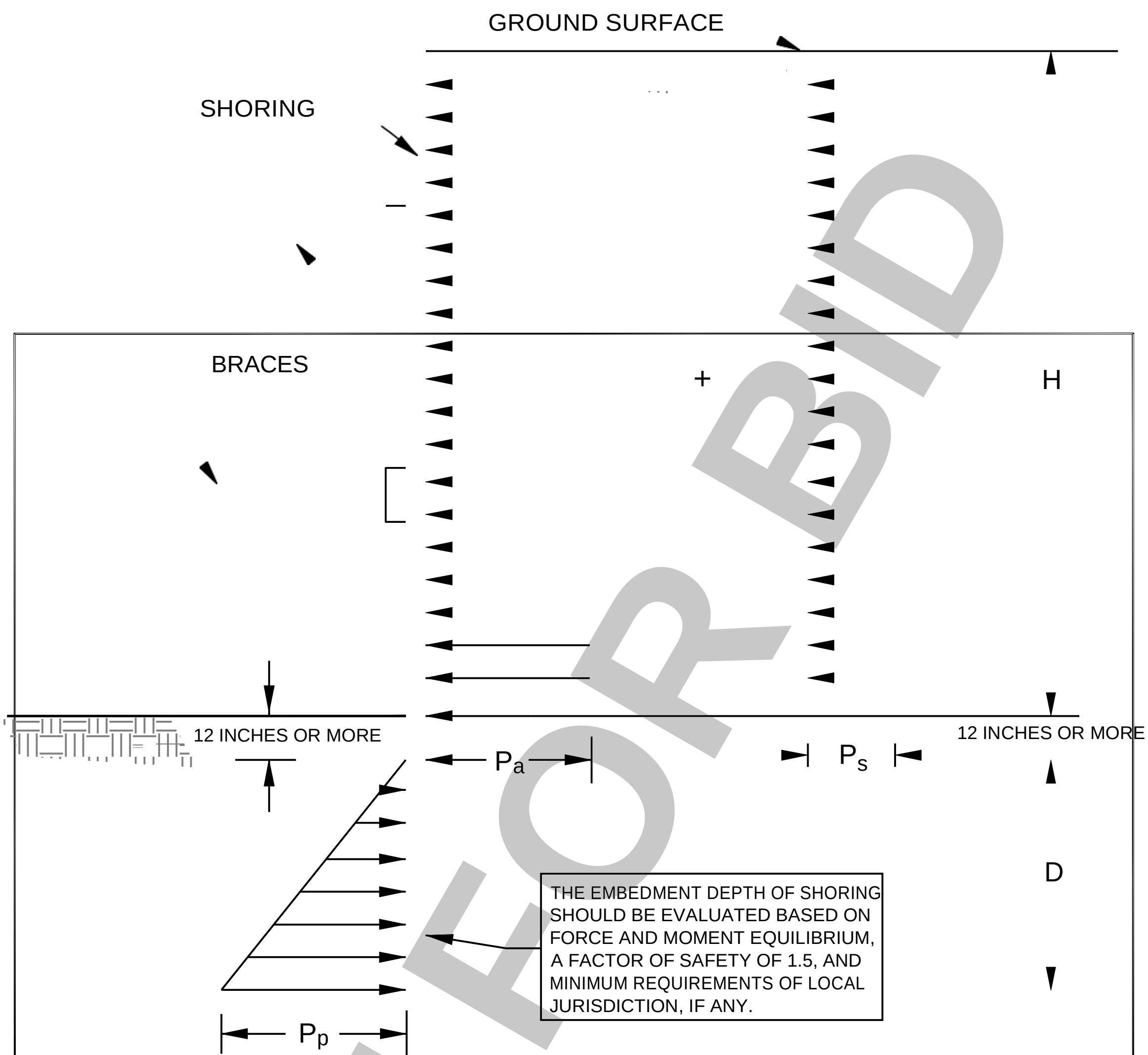

NOTES:

1. APPARENT LATERAL EARTH PRESSURE, P_a
   P_a = 25H psf
2. CONSTRUCTION TRAFFIC INDUCED SURCHARGE PRESSURE, P_s
   P_s = 120 psf
3. PASSIVE LATERAL EARTH PRESSURE, P_p
   P_p = 350D psf
4. ASSUMES GROUNDWATER IS NOT PRESENT
5. SURCHARGES FROM EXCAVATED SOIL OR CONSTRUCTION MATERIALS ARE NOT INCLUDED
6. H AND D ARE IN FEET

NOT TO SCALE

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FIGURE 11

LATERAL EARTH PRESSURES FOR BRACED EXCAVATION

SEARLES VALLEY SEWER IMPROVEMENT
SEARLES VALLEY, CALIFORNIA

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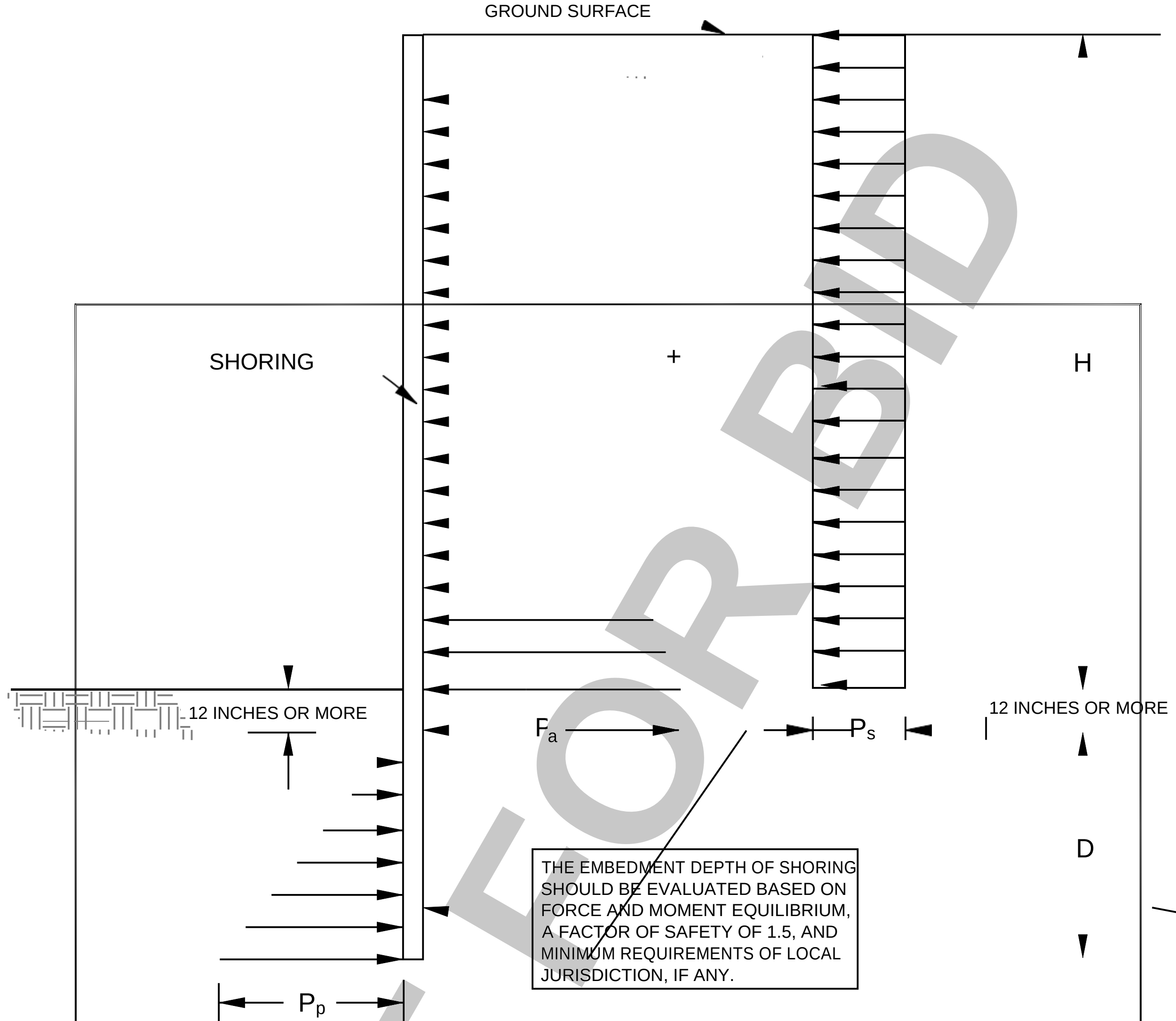
Geotechnical & Environmental Sciences Consultants



NOTES:

1. ACTIVE LATERAL EARTH PRESSURE, P_a
   P_a= 38H psf
2. CONSTRUCTION TRAFFIC INDUCED SURCHARGE PRESSURE, P_s
   P_s= 72 psf
3. PASSIVE LATERAL EARTH PRESSURE, P_p
   P_p= 350D psf
4. ASSUMES GROUNDWATER IS NOT PRESENT
5. H AND D ARE IN FEET

NOT TO SCALE

FIGURE 12

LATERAL EARTH PRESSURES FOR TEMPORARY CANTILEVERED SHORING

SEARLES VALLEY SEWER IMPROVEMENT
SEARLES VALLEY, CALIFORNIA

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APPENDIX A

Boring Logs

APPENDIX A

BORING LOGS

Field Procedure for the Collection of Disturbed Samples

Disturbed soil samples were obtained in the field using the following method.

Bulk Samples

Bulk samples of representative earth materials were obtained from the exploratory borings. The samples were bagged and transported to the laboratory for testing.

The Standard Penetration Test (SPT) Sampler

Disturbed drive samples of earth materials were obtained by means of a Standard Penetration Test sampler. The sampler is composed of a split barrel with an external diameter of 2 inches and an unlined internal diameter of 1-3/8 inches. The sampler was driven into the ground 18 inches with a 140-pound hammer falling freely from a height of 30 inches in general accordance with ASTM D 1586. The blow counts were recorded for every 6 inches of penetration; the blow counts reported on the logs are those for the last 12 inches of penetration. Soil samples were observed and removed from the sampler, bagged, sealed and transported to the laboratory for testing.

Field Procedure for the Collection of Relatively Undisturbed Samples

Relatively undisturbed soil samples were obtained in the field using the following method.

The Modified Split-Barrel Drive Sampler

The sampler, with an external diameter of 3 inches, was lined with 1-inch-long, thin brass rings with inside diameters of approximately 2.4 inches. The sample barrel was driven into the ground with the weight of a hammer in general accordance with ASTM D 3550. The driving weight was permitted to fall freely. The approximate length of the fall, the weight of the hammer, and the number of blows per foot of driving are presented on the boring logs as an index to the relative resistance of the materials sampled. The samples were removed from the sample barrel in the brass rings, sealed, and transported to the laboratory for testing.

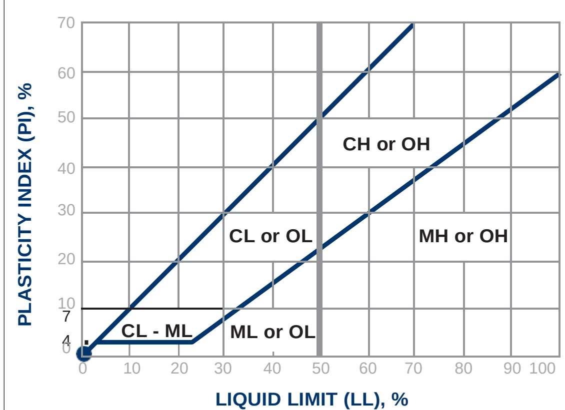
Soil Classification Chart Per ASTM D 2488

Primary Divisions		Secondary Divisions		
			Group Symbol	Group Name
COARSE-GRAINED SOILS more than 50% retained on No. 200 sieve	GRAVEL more than 50% of coarse fraction retained on No. 4 sieve	CLEAN GRAVEL less than 5% fines	GW	well-graded GRAVEL
			GP	poorly graded GRAVEL
		GRAVEL with DUAL CLASSIFICATIONS 5% to 12% fines	GW-GM	well-graded GRAVEL with silt
			GP-GM	poorly graded GRAVEL with silt
			GW-GC	well-graded GRAVEL with clay
			GP-GC	poorly graded GRAVEL with clay
		GRAVEL with FINES more than 12% fines	GM	silty GRAVEL
			GC	clayey GRAVEL
			GC-GM	silty, clayey GRAVEL
	SAND 50% or more of coarse fraction passes No. 4 sieve	CLEAN SAND less than 5% fines	SW	well-graded SAND
			SP	poorly graded SAND
		SAND with DUAL CLASSIFICATIONS 5% to 12% fines	SW-SM	well-graded SAND with silt
			SP-SM	poorly graded SAND with silt
			SW-SC	well-graded SAND with clay
			SP-SC	poorly graded SAND with clay
		SAND with FINES more than 12% fines	SM	silty SAND
			SC	clayey SAND
			SC-SM	silty, clayey SAND
FINE-GRAINED SOILS 50% or more passes No. 200 sieve	SILT and CLAY liquid limit less than 50%	INORGANIC	CL	lean CLAY
			ML	SILT
			CL-ML	silty CLAY
		ORGANIC	OL (PI > 4)	organic CLAY
			OL (PI < 4)	organic SILT
	SILT and CLAY liquid limit 50% or more	INORGANIC	CH	fat CLAY
			MH	elastic SILT
		ORGANIC	OH (plots on or above "A"-line)	organic CLAY
			OH (plots below "A"-line)	organic SILT
	Highly Organic Soils		PT	Peat

Grain Size

Description		Sieve Size	Grain Size	Approximate Size
Boulders		> 12"	> 12"	Larger than basketball-sized
Cobbles		3 - 12"	3 - 12"	Fist-sized to basketball-sized
Gravel	Coarse	3/4 - 3"	3/4 - 3"	Thumb-sized to fist-sized
	Fine	#4 - 3/4"	0.19 - 0.75"	Pea-sized to thumb-sized
Sand	Coarse	#10 - #4	0.079 - 0.19"	Rock-salt-sized to pea-sized
	Medium	#40 - #10	0.017 - 0.079"	Sugar-sized to rock-salt-sized
	Fine	#200 - #40	0.0029 - 0.017"	Flour-sized to sugar-sized
Fines		Passing #200	< 0.0029"	Flour-sized and smaller

Plasticity Chart



Apparent Density - Coarse-Grained Soil

Apparent Density	Spooling Cable or Cathead		Automatic Trip Hammer	
	SPT (blows/foot)	Modified Split Barrel (blows/foot)	SPT (blows/foot)	Modified Split Barrel (blows/foot)
Very Loose	≤ 4	≤ 8	≤ 3	≤ 5
Loose	5 - 10	9 - 21	4 - 7	6 - 14
Medium Dense	11 - 30	22 - 63	8 - 20	15 - 42
Dense	31 - 50	64 - 105	21 - 33	43 - 70
Very Dense	> 50	> 105	> 33	> 70

Consistency - Fine-Grained Soil

Consistency	Spooling Cable or Cathead		Automatic Trip Hammer	
	SPT (blows/foot)	Modified Split Barrel (blows/foot)	SPT (blows/foot)	Modified Split Barrel (blows/foot)
Very Soft	< 2	< 3	< 1	< 2
Soft	2 - 4	3 - 5	1 - 3	2 - 3
Firm	5 - 8	6 - 10	4 - 5	4 - 6
Stiff	9 - 15	11 - 20	6 - 10	7 - 13
Very Stiff	16 - 30	21 - 39	11 - 20	14 - 26
Hard	> 30	> 39	> 20	> 26

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USCS METHOD OF SOIL CLASSIFICATION

BORING LOG EXPLANATION SHEET

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	
0								Bulk sample.
								Modified split-barrel drive sampler.
								No recovery with modified split-barrel drive sampler.
								Sample retained by others.
								Standard Penetration Test (SPT).
5								No recovery with a SPT.
			XX/XX					Shelby tube sample. Distance pushed in inches/length of sample recovered in inches.
								No recovery with Shelby tube sampler.
								Continuous Push Sample.
								Seepage.
10								Groundwater encountered during drilling.
								Groundwater measured after drilling.
							SM	MAJOR MATERIAL TYPE (SOIL): Solid line denotes unit change.
							CL	Dashed line denotes material change.
15								Attitudes: Strike/Dip b: Bedding c: Contact j: Joint f: Fracture F: Fault cs: Clay Seam s: Shear bss: Basal Slide Surface sf: Shear Fracture sz: Shear Zone sbs: Shear Bedding Surface
20								The total depth line is a solid line that is drawn at the bottom of the boring.

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BORING LOG

DEPTH (feet)	SAMPLES: Bulk	SAMPLES: Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0	X						SM	INTERBEDDED OLDER ALLUVIUM AND LACUSTRINE DEPOSITS: Brown, moist, medium dense, silty SAND; few gravel.
		X	22	16.2	110.9			Wet.
10		X	12	17.7	113.8			Gray; loose.
		X	12					
							CH	Gray to black, wet, stiff, fat CLAY.
20		X	7					Black to dark gray.
30								Total Depth = 21.5 feet. Groundwater was not encountered during drilling Backfilled with soil cuttings on 12/12/23.
40								

DATE DRILLED 12/12/23 BORING NO. B-1

GROUND ELEVATION 1,635' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING 8" Hollow Stem Auger (2R Drilling)

DRIVE WEIGHT 140 lbs. (Auto. Trip Hammer) DROP 30"

SAMPLED BY RAF LOGGED BY RAF REVIEWED BY MLP

Notes:
Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.

The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.

DATE DRILLED	12/11/23	BORING NO.	B-2
GROUND ELEVATION	1,638' ± (MSL)	SHEET	1 OF 1
METHOD OF DRILLING	8" Hollow Stem Auger (2R Drilling)		
DRIVE WEIGHT	140 lbs. (Auto. Trip Hammer)	DROP	30"
SAMPLED BY	RAF	LOGGED BY	RAF
REVIEWED BY	MLP		

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							SM	INTERBEDDED OLDER ALLUVIUM AND LACUSTRINE DEPOSITS: Brown, moist, loose, silty SAND; trace gravel.
			11				SP-SM	Brown, wet, loose, poorly graded SAND with silt; few gravel.
10			5					
			32	12.8	120.2			Black to dark brown; medium dense.
							CH	Black to dark gray, wet, firm, fat CLAY.
20			5					
								Total Depth = 21.5 feet. Groundwater was not encountered during drilling Backfilled with soil cuttings on 12/11/23. Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
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DEPTH (feet)	SAMPLES: Bulk	SAMPLES: Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0	■						SP-SM	OLDER ALLUVIUM: Yellowish brown, moist, loose, poorly graded SAND with silt; trace gravel.
		■	9	4.1	105.6			
10		■	9	15.8	108.7			Wet.
								Encountered obstruction at 13 feet. Possible cobble or boulder. Stopped drilling.
								Total Depth = 13 feet. Groundwater was not encountered during drilling. Backfilled with soil cuttings on 12/11/23.
								Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.
20								The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
30								
40								

DATE DRILLED 12/11/23 BORING NO. B-3

GROUND ELEVATION 1,643' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING 8" Hollow Stem Auger (2R Drilling)

DRIVE WEIGHT 140 lbs. (Auto. Trip Hammer) DROP 30"

SAMPLED BY RAF LOGGED BY RAF REVIEWED BY MLP

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0	■						SP-SM	OLDER ALLUVIUM: Brown, moist, medium dense, poorly graded SAND with silt; trace gravel.
		■	23					
		■	10	3.7	105.3			Loose.
10		■	10					
		■	10	21.4	107.3			Gray; wet.
		■	11	8.7	97.0			
		■	16					Medium dense.
20		■	16					Black.
								Total Depth = 21.5 feet. Groundwater was not encountered during drilling. Backfilled with soil cuttings on 12/12/23. Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
30								
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DATE DRILLED 12/12/23 BORING NO. B-4

GROUND ELEVATION 1,645' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING 8" Hollow Stem Auger (2R Drilling)

DRIVE WEIGHT 140 lbs. (Auto. Trip Hammer) DROP 30"

SAMPLED BY RAF LOGGED BY RAF REVIEWED BY MLP

DATE DRILLED	12/12/23	BORING NO.	B-5
GROUND ELEVATION	1,635' ± (MSL)	SHEET 1 OF 1	
METHOD OF DRILLING	8" Hollow Stem Auger (2R Drilling)		
DRIVE WEIGHT	140 lbs. (Auto. Trip Hammer)	DROP	30"
SAMPLED BY RAF	LOGGED BY RAF	REVIEWED BY	MLP

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0	Bulk					SM	INTERBEDDED OLDER ALLUVIUM AND LACUSTRINE DEPOSITS: Brown to yellowish brown, moist, loose, silty SAND; trace gravel.
	Driven	11					
	Driven	17	16.8	112.5			Gray; medium dense.
	Driven	3	38.7	79.8		CH	Light gray to white, wet, soft, fat CLAY.
10	Driven	Push	123.3	38.9			Very soft.
			▼				@ 11.6': Groundwater measured 15 minutes after completion of drilling.
	Driven	Push					
	Driven	3					Soft.
						SM	Gray, wet, loose, silty SAND.
	Driven	9					
20	Driven	10					

Total Depth = 21.5 feet.
Groundwater was measured 15 minutes after completion of drilling at approximately 11.6 feet.
Backfilled with soil cuttings on 12/12/23.

Notes:
Groundwater may rise to a level higher than that measured in borehole due to relatively slow rate of seepage in clay and several other factors as discussed in the report. Please refer to the report for groundwater monitoring recommendations.

The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.

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DATE DRILLED	12/12/23	BORING NO.	B-6		
GROUND ELEVATION	1,635' ± (MSL)	SHEET	1	OF	1
METHOD OF DRILLING	8" Hollow Stem Auger (2R Drilling)				
DRIVE WEIGHT	140 lbs. (Auto. Trip Hammer)	DROP	30"		
SAMPLED BY	RAF	LOGGED BY	RAF	REVIEWED BY	MLP

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							SM	ASPHALT CONCRETE: Approximately 3.5 inches thick.
	X							INTERBEDDED OLDER ALLUVIUM AND LACUSTRINE DEPOSITS: Brown, moist, medium dense, silty SAND; trace gravel.
		X	27	14.2	111.2			Gray.
		X	2	128.2	38.8		CH	Dark gray to light gray, moist, soft, fat CLAY with sand.
10		X	3	108.0	42.8			Very thin alternating black and white layers.
		X	4					Firm.
							SC	Gray, wet, very loose, clayey SAND.
		X	10	▼			CH	Gray to dark gray, wet, stiff, fat CLAY. @ 15': Groundwater was measured 30 minutes after completion of drilling.
							SP-SM	Gray to light gray, wet, loose, poorly graded SAND with silt.
		X	4				CH	Dark gray to light gray, wet, firm, fat CLAY.
20		X	Push					Very soft.
30								
40								

Total Depth = 21.5 feet.
Groundwater was measured 30 minutes after completion of drilling at approximately 15 feet.
Backfilled with soil cuttings and capped with cold patch asphalt on 12/12/23.

Notes:
Groundwater may rise to a level higher than that measured in borehole due to relatively slow rate of seepage in clay and several other factors as discussed in the report. Please refer to the report for groundwater monitoring recommendations.

The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.

DATE DRILLED	12/11/23	BORING NO.	B-7
GROUND ELEVATION	1,636' ± (MSL)	SHEET 1 OF 1	
METHOD OF DRILLING	8" Hollow Stem Auger (2R Drilling)		
DRIVE WEIGHT	140 lbs. (Auto. Trip Hammer)	DROP	30"
SAMPLED BY	RAF	LOGGED BY RAF	REVIEWED BY MLP

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0	■						SM	INTERBEDDED OLDER ALLUVIUM AND LACUSTRINE DEPOSITS: Light brown to yellowish brown, moist, medium dense, silty SAND; trace gravel; iron oxidation.
		■	26	11.8	104.1			
							CH	Light gray to white, wet, firm, fat CLAY.
10		■	5	89.8	48.7			
							SP-SM	Gray, wet, very loose, poorly graded SAND with silt.
		■	3					
							CH	Gray to dark gray, wet, soft, fat CLAY with silt.
20		■	4					Firm.
30								
40								

Total Depth = 21.5 feet.
Groundwater was not encountered during drilling.
Backfilled with soil cuttings on 12/11/23.

Notes:
Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.

The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0	X						SP-SM	INTERBEDDED OLDER ALLUVIUM AND LACUSTRINE DEPOSITS: Brown, moist, loose, poorly graded SAND with silt and clay; trace gravel.
							CH	Light gray, wet, firm, sandy fat CLAY.
		X	4	83.5	51.1			
10		X	2	68.5	59.4			Soft.
		X	1					Light gray to gray; very soft.
							SP-SM	Gray, moist, dense, poorly graded SAND with silt.
20		X	69					
								Total Depth = 21.5 feet. Groundwater was not encountered during drilling. Backfilled with soil cuttings on 12/11/23.
								Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.
								The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
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DATE DRILLED 12/11/23 BORING NO. B-8

GROUND ELEVATION 1,637' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING 8" Hollow Stem Auger (2R Drilling)

DRIVE WEIGHT 140 lbs. (Auto. Trip Hammer) DROP 30"

SAMPLED BY RAF LOGGED BY RAF REVIEWED BY MLP

DATE DRILLED	12/11/23	BORING NO.	B-9
GROUND ELEVATION	1,643' ± (MSL)	SHEET 1 OF 1	
METHOD OF DRILLING	8" Hollow Stem Auger (2R Drilling)		
DRIVE WEIGHT	140 lbs. (Auto. Trip Hammer)	DROP	30"
SAMPLED BY RAF	LOGGED BY RAF	REVIEWED BY	MLP

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0	X						SP-SM	INTERBEDDED OLDER ALLUVIUM AND LACUSTRINE DEPOSITS: Light brown, moist, loose, poorly graded SAND with silt; trace gravel.
		X	8				ML	Light gray to white, moist, loose, sandy SILT.
10		X	20	2.3	101.1		SM	Light brown, moist, medium dense, silty SAND.
		X	43					Wet; dense.
20		X	82				SP-SM	Light brown to light gray, wet, very dense, poorly graded SAND with silt.
30								Total Depth = 21.5 feet. Groundwater was not encountered during drilling. Backfilled with soil cuttings on 12/11/23. Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
40								

DATE DRILLED 12/11/23 BORING NO. B-10

GROUND ELEVATION 1,642' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING 8" Hollow Stem Auger (2R Drilling)

DRIVE WEIGHT 140 lbs. (Auto. Trip Hammer) DROP 30"

SAMPLED BY RAF LOGGED BY RAF REVIEWED BY MLP

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0	Bulk (0–5)			11.0	72.8		SM	INTERBEDDED OLDER ALLUVIUM AND LACUSTRINE DEPOSITS: Yellowish brown, moist, loose, silty SAND; trace gravel.
		Driven	12				ML	Light brown, moist, loose, sandy SILT.
10		Driven	54	2.4	107.1		SM	Light brown to gray, moist, dense, silty SAND.
		Driven	25				SP-SM	Light brown to gray, wet, medium dense, poorly graded SAND with silt.
20		Driven	3				CH	Grayish brown, wet, soft, fat CLAY; sulfur odor.
30								
40								

Total Depth = 21.5 feet.
Groundwater was not encountered during drilling.
Backfilled with soil cuttings on 12/11/23.

Notes:
Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.

The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.

APPENDIX B

Laboratory Testing

APPENDIX B

LABORATORY TESTING

Classification
Soils were visually and texturally classified in accordance with the Unified Soil Classification System (USCS) in general accordance with ASTM D 2488. Soil classifications are indicated on the logs of the exploratory borings in Appendix A.

In-Place Moisture and Density Tests
The moisture content and dry density of relatively undisturbed samples obtained from the exploratory borings were evaluated in general accordance with ASTM D 2937. The test results are presented on the logs of the exploratory borings in Appendix A.

Gradation Analysis
Gradation analysis tests were performed on selected representative soil samples in general accordance with ASTM D 422. The grain-size distribution curves are shown on Figures B-1 and B-2. These test results were utilized in evaluating the soil classifications in accordance with the USCS.

200 Wash
An evaluation of the percentage of particles finer than the No. 200 sieve in selected soil samples was performed in general accordance with ASTM D 1140. The results of the tests are presented on Figure B-3.

Atterberg Limits
Tests were performed on selected representative fine-grained soil samples to evaluate the liquid limit, plastic limit, and plasticity index in general accordance with ASTM D 4318. These test results were utilized to evaluate the soil classification in accordance with the USCS. The test results and classifications are shown on Figure B-4.

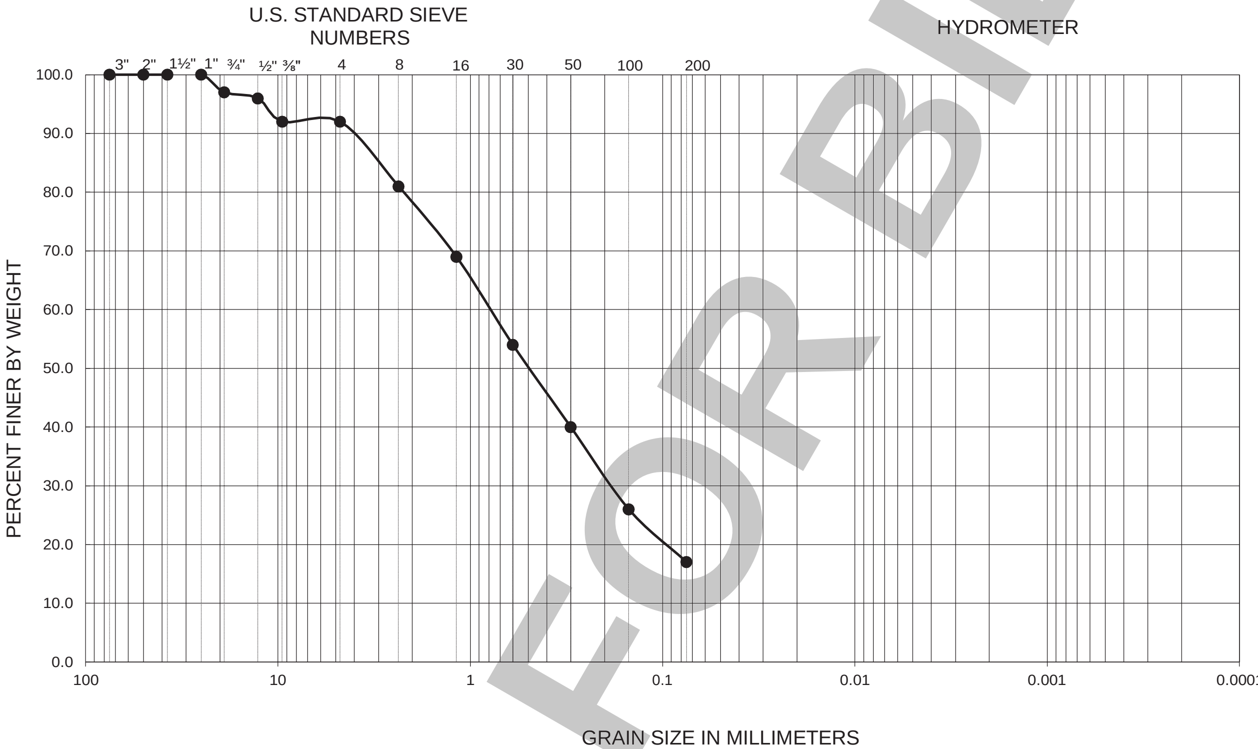
Consolidation Test
A consolidation test was performed on a selected relatively undisturbed soil sample in general accordance with ASTM D 2435. The sample was inundated during testing to represent adverse field conditions. The percent of consolidation for each load cycle was recorded as a ratio of the amount of vertical compression to the original height of the sample. The result of the test is summarized on Figure B-5.

Direct Shear Tests
Direct shear tests were performed on relatively undisturbed samples in general accordance with ASTM D 3080 to evaluate the drained shear strength characteristics of the selected materials. The samples were inundated during shearing to represent the adverse field conditions. The results are shown on Figures B-6 and B-7.

Sand Equivalent
Sand equivalent (SE) tests were performed on selected representative samples in general accordance with California Test (CT) 217/American Association of State Highway and Transportation Officials (AASHTO) T 176. The SE values reported on Figure B-8 are the ratio of the coarse- to fine-grained particles in the selected samples.

Soil Corrosivity Tests
Soil pH and resistivity tests were performed on representative samples in general accordance with California Test (CT) 643. The soluble sulfate and chloride content of the selected samples were evaluated in general accordance with CT 417 and CT 422, respectively. The test results are presented on Figure B-9.

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (percent)	USCS
●	B-1	0.0-5.0	--	--	--	--	--	--	--	--	17	SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 6913

FIGURE B-1

GRADATION TEST RESULTS

SEARLES VALLEY SEWER IMPROVEMENT
SEARLES VALLEY, CALIFORNIA

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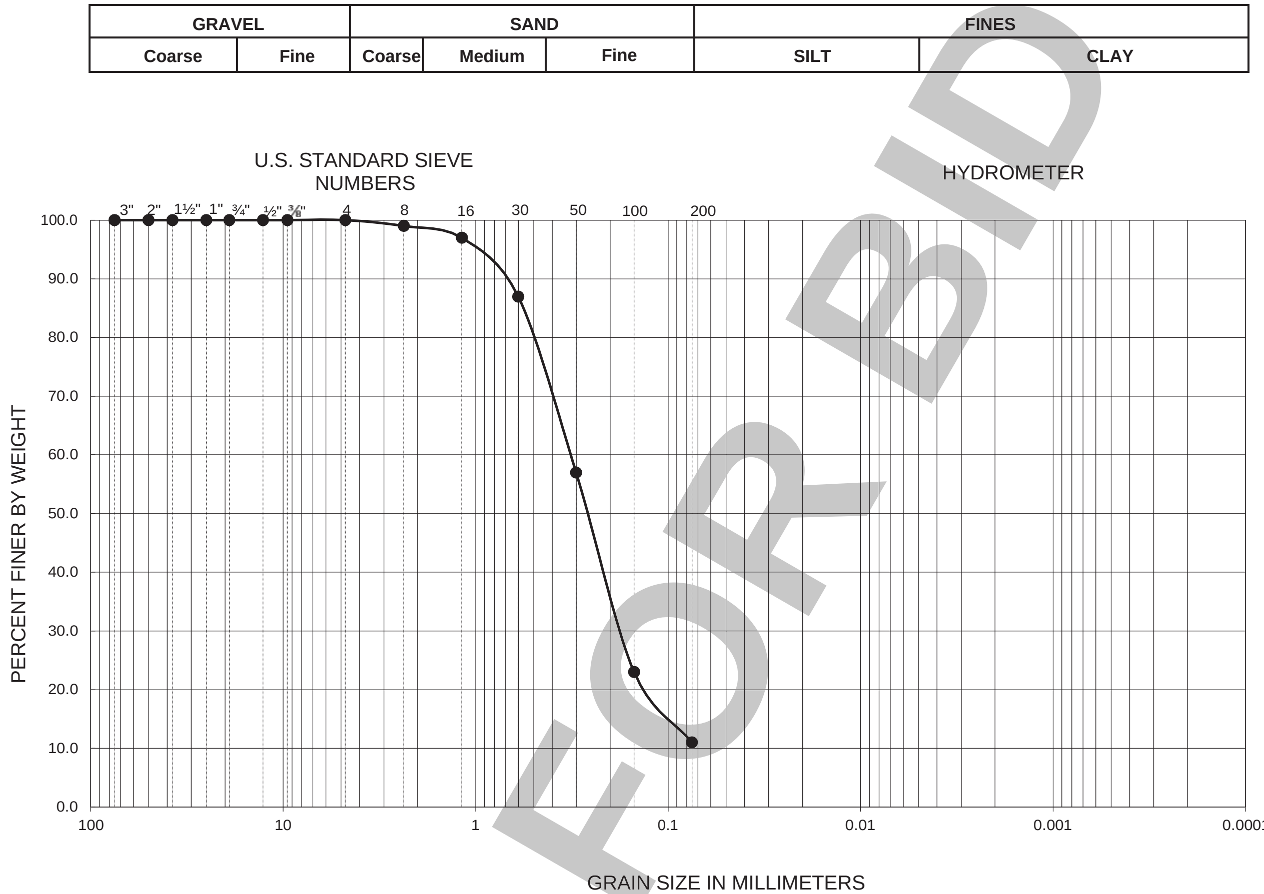

Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (percent)	USCS
●	B-9	0.0-5.0	--	--	--	--	0.18	0.32	--	--	11	SP-SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 6913

FIGURE B-2

GRADATION TEST RESULTS

SEARLES VALLEY SEWER IMPROVEMENT
SEARLES VALLEY, CALIFORNIA

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SAMPLE LOCATION	SAMPLE DEPTH (ft)	DESCRIPTION	PERCENT PASSING NO. 4	PERCENT PASSING NO. 200	USCS (TOTAL SAMPLE)
B-2	10.0-11.5	POORLY GRADED SAND WITH SILT	95	10	SP-SM
B-3	5.0-6.5	POORLY GRADED SAND WITH SILT	96	7	SP-SM
B-4	7.5-9.0	POORLY GRADED SAND WITH SILT	98	6	SP-SM
B-4	15.0-16.5	POORLY GRADED SAND WITH SILT	98	7	SP-SM
B-5	5.0-6.5	SILTY SAND	100	20	SM
B-6	5.0-6.5	SILTY SAND	100	15	SM
B-7	5.0-6.5	SILTY SAND	100	20	SM
B-8	10.0-11.5	SANDY FAT CLAY	100	56	CH

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 1140

FIGURE B-3

NO. 200 SIEVE ANALYSIS TEST RESULTS

SEARLES VALLEY SEWER IMPROVEMENT
SEARLES VALLEY, CALIFORNIA

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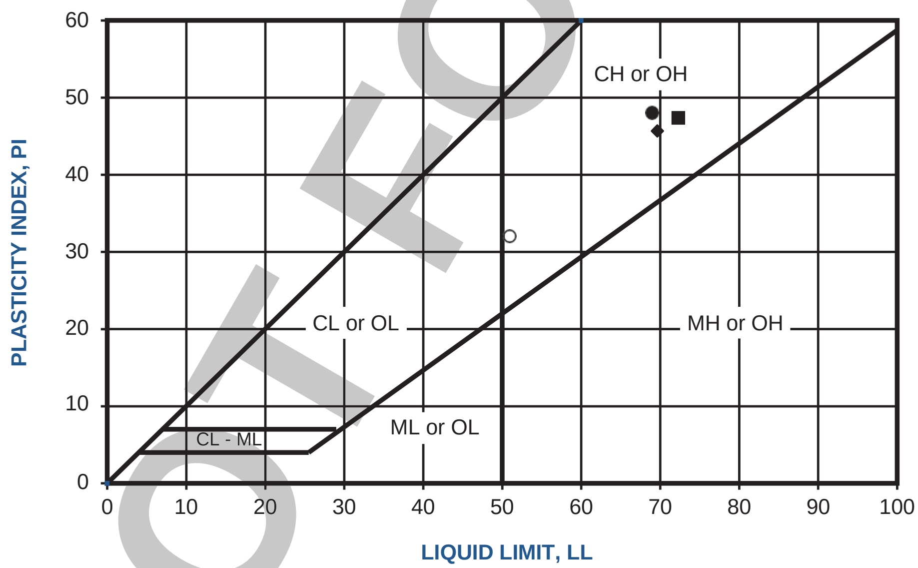
SYMBOL	LOCATION	DEPTH (ft)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	USCS CLASSIFICATION (Fraction Finer Than No. 40 Sieve)	USCS
●	B-5	10.0-11.5	69	21	48	CH	CH
■	B-6	7.5-9.0	72	25	47	CH	CH
◆	B-7	10.0-11.5	70	24	46	CH	CH
○	B-8	10.0-11.5	51	19	32	CH	CH



PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 4318

FIGURE B-4

ATTERBERG LIMITS TEST RESULTS

SEARLES VALLEY SEWER IMPROVEMENT
SEARLES VALLEY, CALIFORNIA

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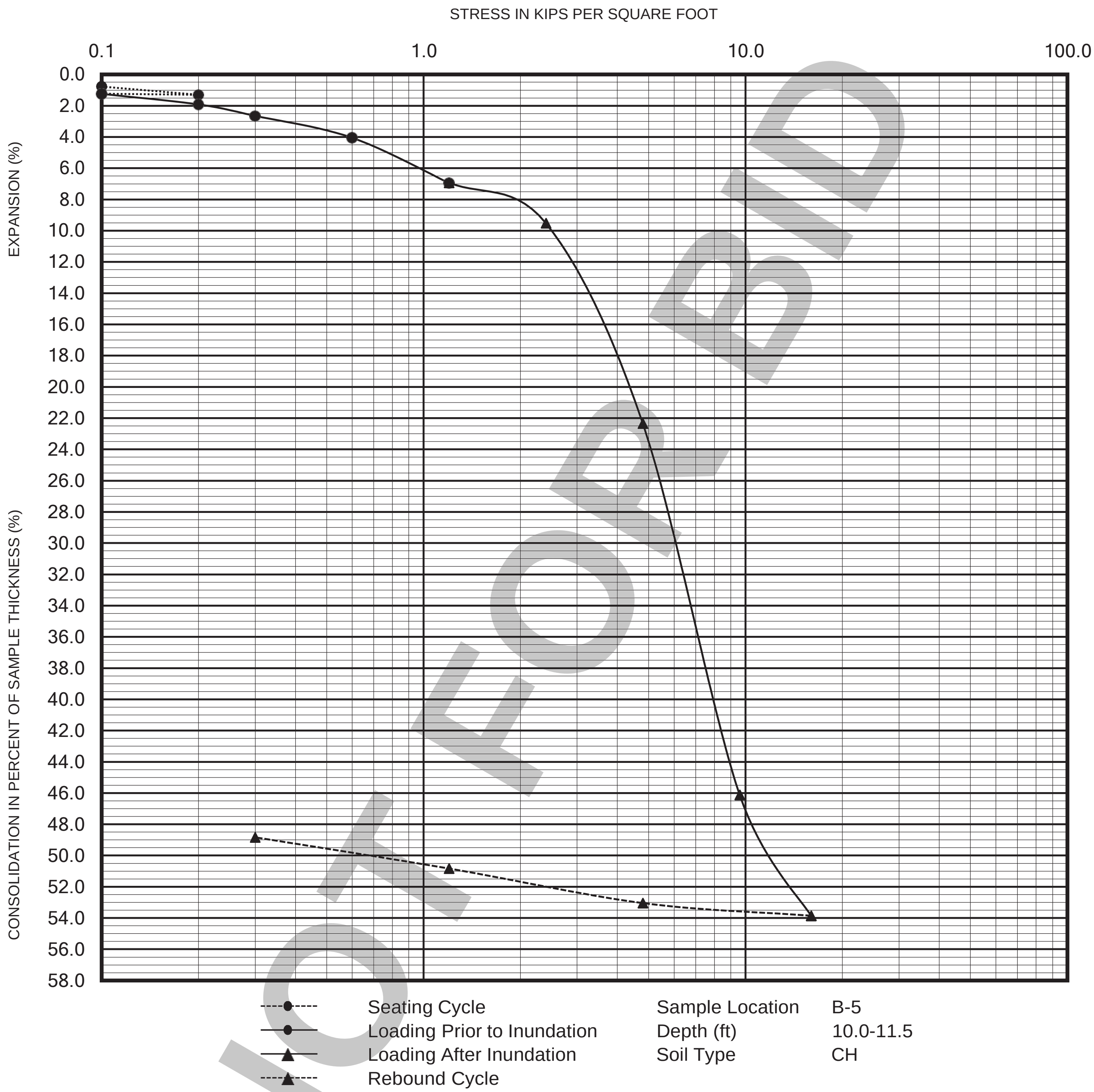

Sample Location	B-5
Depth (ft)	10.0-11.5
Soil Type	CH

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

FIGURE B-5

CONSOLIDATION TEST RESULTS

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SEARLES VALLEY SEWER IMPROVEMENT
SEARLES VALLEY, CALIFORNIA

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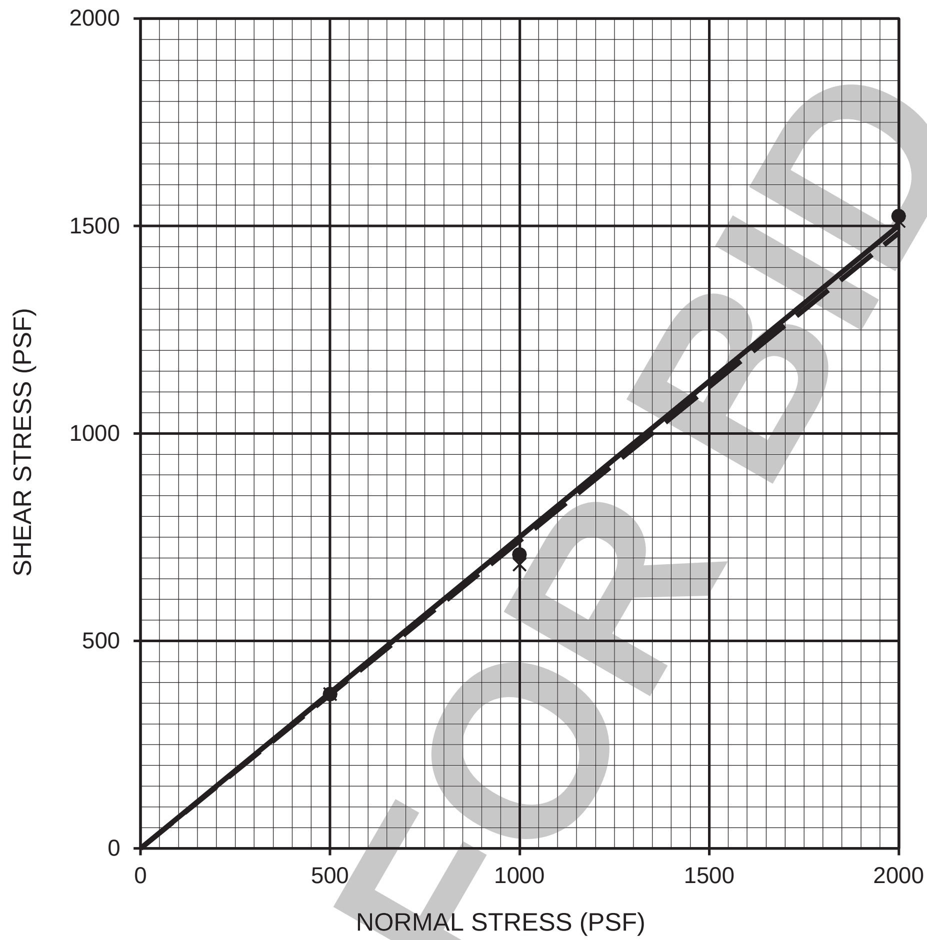

Description	Symbol	Sample Location	Depth (ft)	Shear Strength	Cohesion (psf)	Friction Angle (degrees)	Soil Type
POORLY GRADED SAND WITH SILT	—●—	B-3	5.0-6.5	Peak	0	38	SP-SM
POORLY GRADED SAND WITH SILT	– – X – –	B-3	5.0-6.5	Ultimate	0	38	SP-SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 3080

FIGURE B-6

DIRECT SHEAR TEST RESULTS

SEARLES VALLEY SEWER IMPROVEMENT
SEARLES VALLEY, CALIFORNIA

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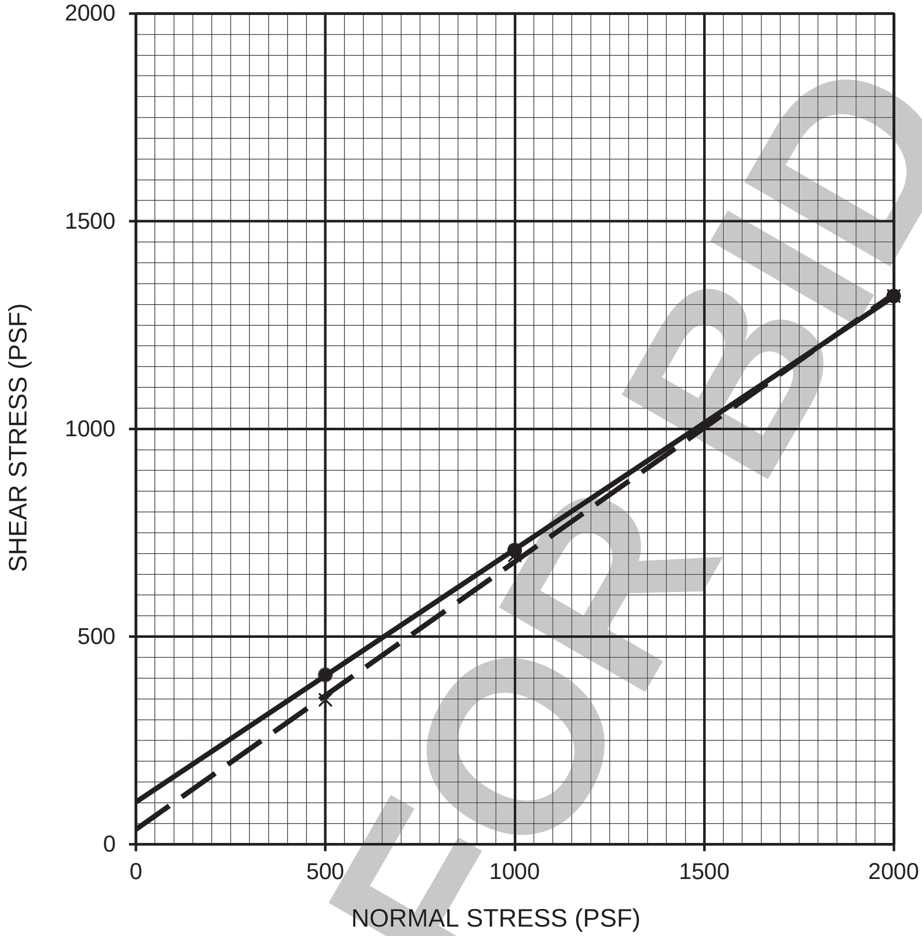

Description	Symbol	Sample Location	Depth (ft)	Shear Strength	Cohesion (psf)	Friction Angle (degrees)	Soil Type
FAT CLAY WITH SAND	——●——	B-6	7.5-9.0	Peak	102	31	CH
FAT CLAY WITH SAND	– – X – –	B-6	7.5-9.0	Ultimate	36	33	CH

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 3080

FIGURE B-7

DIRECT SHEAR TEST RESULTS

SEARLES VALLEY SEWER IMPROVEMENT
SEARLES VALLEY, CALIFORNIA

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SAMPLE LOCATION	SAMPLE DEPTH (ft)	SOIL TYPE	SAND EQUIVALENT
B-1	0.0-5.0	SM	22
B-9	0.0-5.0	SP-SM	30

PERFORMED IN GENERAL ACCORDANCE WITH AASHTO T176/CT 217

FIGURE B-8

SAND EQUIVALENT VALUE

SEARLES VALLEY SEWER IMPROVEMENT
SEARLES VALLEY, CALIFORNIA

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SAMPLE LOCATION	SAMPLE DEPTH (ft)	pH [1]	RESISTIVITY [1] (ohm-cm)	SULFATE CONTENT [2]		CHLORIDE CONTENT [3] (ppm)
				(ppm)	(%)	
B-5	7.5-9.0	9.5	256	110	0.011	880
B-8	5.0-6.5	9.1	53	900	0.090	13,200

[1] PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 643
[2] PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 417
[3] PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 422

FIGURE B-9

CORROSIVITY TEST RESULTS

SEARLES VALLEY SEWER IMPROVEMENT
SEARLES VALLEY, CALIFORNIA

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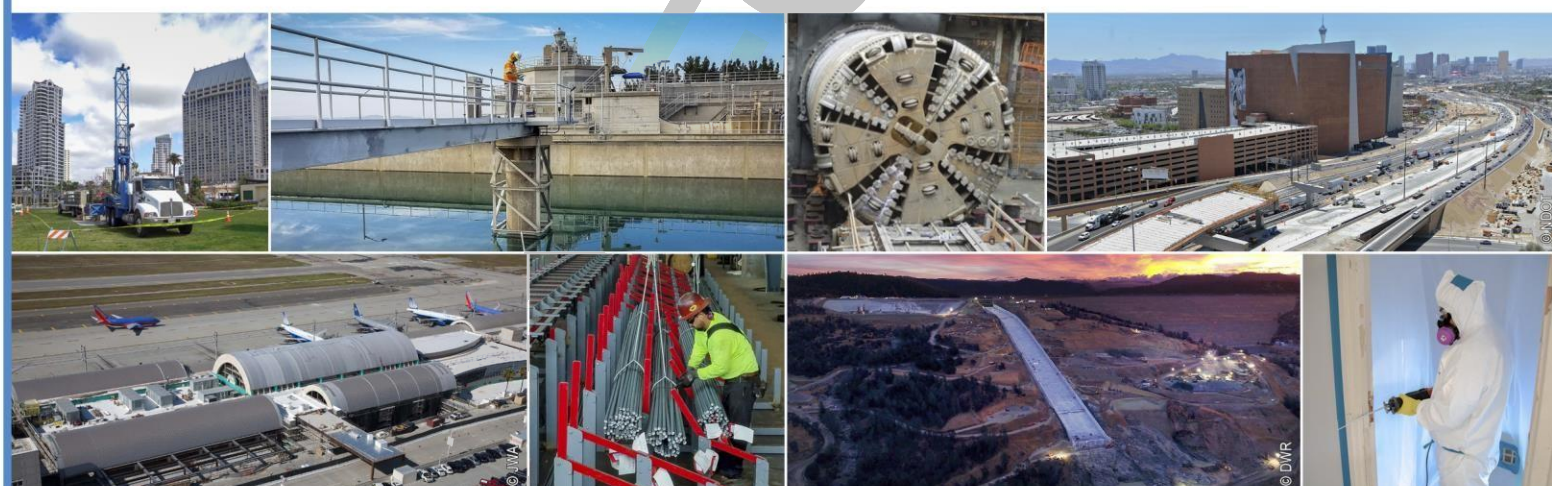

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