APPENDIX E

Geology and Soil Discipline Report

SUBMITTED TO:
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GEOLOGY AND SOIL DISCIPLINE REPORT

La Brea Tar Pits Museum Master Plan Project

5801 WILSHIRE BOULEVARD, LOS ANGELES, CALIFORNIA

SHANNON & WILSON

January 27, 2023

Shannon & Wilson No: 109748-001

Submitted To: Natural History Museums of Los Angeles County
900 Exposition Boulevard
Los Angeles, CA 90007
Attn: Mr. Jesse Rocha

Subject: GEOLOGY AND SOIL DISCIPLINE REPORT, LA BREA TAR PITS MUSEUM MASTER PLAN PROJECT, 5801 WILSHIRE BOULEVARD, LOS ANGELES, CALIFORNIA

Shannon & Wilson prepared this report and participated in this project as a consultant to the Los Angeles County Museum of Natural History Foundation. Our scope of services was specified in Contract Service Agreement Ledger No. 1-1-2-102-470-4250, dated August 16, 2022. This report presents our geology and soils discipline report and was prepared by the undersigned.

We appreciate the opportunity to be of service to you on this project. If you have questions concerning this report, or we may be of further service, please contact us.

Sincerely,

SHANNON & WILSON

Dean G. Francuch Digitally signed by Dean G. Francuch Date: 2023.01.27 14:37:29 -08'00'

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BPT:CLZ:DGF:RTD/bpt

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ACRONYMS

AMMP	Academy Museum of Motion Pictures
BCAM	Broad Contemporary Art Museum
bgs	below ground surface
BPC	LACMA Building for Permanent Collection
CalGEM	State of California Department of Conservation, Geologic Energy Management Division
CBC	California Building Code
CDMG	California Division of Mines and Geology
CGS	California Geological Survey
City	City of Los Angeles
CLABC	County of Los Angeles Building Code
County	County of Los Angeles
DOGGR	State of California Department of Conservation, Division of Oil, Gas and Geothermal Resources
DWR	California Department of Water Resources
EI	Expansion Index
GMED	County of Los Angeles Department of Public Works Geotechnical and Materials Engineering Division
IBC	International Building Code
LACMA	Los Angeles County Museum of Art
LA Metro	Los Angeles County Metropolitan Transportation Authority
LCA	LeRoy Crandall and Associates
MCE	Maximum Considered Earthquake
MKA	Magnusson Klemencic Associates
mm	millimeter
M_w	Earthquake Moment Magnitude
NHMLAC	Natural History Museums of Los Angeles County
Page Museum	George C. Page Museum of La Brea Discoveries
PGA	peak ground acceleration
Project	La Brea Tar Pits Museum Transformation Master Plan Project
SF	square feet
S&W	Shannon & Wilson
SPT	Standard Penetration Test
USGS	U.S. Geological Survey
VB&B	Van Beveren & Butelo

1 INTRODUCTION

This report presents our geology and soil discipline study for the proposed La Brea Tar Pits Museum Transformation Master Plan Project (Project). The conclusions and recommendations in this report will be used to support the geology and soil discipline section of the Environmental Impact Report for the Project. A summary of our site reconnaissance, records review, hazards analyses, groundwater review, and recommended measures to mitigate the potential geologic hazards is presented in the following sections. We based our conclusions and recommendations on existing subsurface explorations and laboratory testing performed by us and others in the Project vicinity. We will perform additional subsurface explorations as the Project schedule advances to final design.

The Project is located at 5801 Wilshire Boulevard within the City of Los Angeles (City), as shown in the Vicinity Map, Figure 1, and the Site Plan, Figure 2. The Project consists of proposed improvements in an approximately 13-acre area within the eastern and northwestern portions of Hancock Park. This area includes the exhibits for the La Brea Tar Pits. The site is bounded by the Los Angeles County Museum of Art (LACMA) Campus to the west, Wilshire Boulevard to the south, Sixth Street to the north, and South Curson Avenue to the east.

Based on our review of the existing subsurface explorations performed on or adjacent to the Project site, the subsurface conditions consist of a relatively thin layer of artificial fill overlying alluvial deposits. The alluvial deposits consist of stiff clay and dense tar-bearing sands. The tar-bearing sands are saturated with hydrocarbons, while the upper clay soils contain less hydrocarbons. The presence of the hydrocarbons in the sediments is a result of the Project site being over an oil field.

Hydrogen sulfide and methane gasses generated within the oil field are present in the subsurface. Within the existing subsurface explorations, groundwater was encountered as shallow as 2 feet below ground surface (bgs) at the Project site (Law/Crandall, Inc., 1995), and 1-foot bgs within the LACMA Campus (AECOM, 2019).

Other geologic hazards present on the Project site with potential impacts to the proposed improvements include expansive soils and strong seismic ground shaking. Each of these hazards can be mitigated through the appropriate level of planning and design.

2 PROJECT DESCRIPTION

At the time of this report, we have not been provided with proposed Project design plan sheets. Our understanding of the proposed "Transformation" development is based on:

- Review of the Request for Qualifications/Proposal for the Project dated July 8, 2022;
- Our meeting with you at the Project site on July 19, 2022;
- Review of the provided Master Plan and Concept Design, Volume 1 and 2, prepared by the Project architect Weiss/Manfredi and dated 2021, which includes:
  - "La Brea Tar Pits Master Plan, Preliminary Civil Engineering Narrative," prepared by KPFF dated March 4, 2021, Project No. 1900236
  - "Structural Engineering," prepared by Magnusson Klemencic Associates (MKA) dated 2021; and
- Our previous experience at the Project site and vicinity.

2.1 Site History

Our understanding of the site's history comes from information provided on the Natural History Museums of Los Angeles County's (NHMLAC's) website, from an article published within Environmental & Engineering GeoScience journal titled "Geology of Los Angeles" (Bilodeau and others, 2007), and from our past experience working within the LACMA Campus.

The abundance of tar (or "pitch") at the site was recorded as early as the late 1700s, as noted within diary entries (Bilodeau and others, 2007). The inhabitants of the area would use the available tar as an adhesive and waterproofing material.

In 1828, the Project site was a part of a Mexican land grant called Rancho La Brea. Over time and with the overall growth of Los Angeles, Rancho La Brea was subdivided and developed. In 1902, the Salt Lake Oil Company constructed oil rigs in the general vicinity to extract crude oil from the oil field, and these operations continued through the early 1900s. By the 1920s, the oil field was mostly abandoned in favor of housing and commercial development (Deane and others, 2018).

The first published information with regard to fossils within Rancho La Brea occurred in 1875, and excavation operations to exhume the specimens began in the early 1900s (NHMLAC). Hancock Park was created in 1924 after George A. Hancock, the last owner of Rancho La Brea, donated 23 acres of land to the County of Los Angeles to promote the scientific discoveries exhumed from the tar pits. As part of the land donation, George Hancock stipulated that the fossils exhumed from the park be exhibited (NHMLAC).

The Rancho La Brea Project began in 1969 to gather additional fossil specimens, which were ignored by the earlier excavations, utilizing improved excavation and data gathering techniques (NHMLAC). In 1975, construction began for the George C. Page Museum of La Brea Discoveries (Page Museum), an onsite museum to study and house the fossils. During construction of the Page Museum, fossils were encountered within the building foundation area that were catalogued during the removal process. The Page Museum was opened to the public in 1977 (NHMLAC).

2.2 Existing Site Conditions

We performed a site reconnaissance on August 22, 2022, to review the existing site conditions in the areas of the proposed improvements. We observed the existing conditions of Hancock Park, the exhibits at the La Brea Tar Pits, and the interior of the Page Museum.

Multiple tar pit excavations are located within the park, and natural tar seeps occur randomly throughout the park and the parking lot. The park contains pedestrian pathways, recreational areas, and landscape features. The Page Museum is located within the central-eastern portion of the site. Other features include Lake Pit at the southern portion of the site, an existing at-surface parking lot at the northeastern portion of the site, and a public restroom and comfort station at the southeastern portion of the site. Exhibit 2-1 below shows a tar pit exhibit located within the northwestern portion of Hancock Park.

Exhibit 2-1: A Tar Pit Exhibit Within Hancock Park (View Towards North)

The existing Page Museum is a one-story structure with an accessible roof terrace. Per the "Structural Engineering" sheets prepared by MKA, we understand the structure measures 260 feet in the east-west direction and 230 feet in the north-south direction. On all sides of the structure, the outer 40 feet slopes downward from the upper roof terrace and extends to approximately 6 feet above the first-floor slab at the building perimeter. The sloped section is covered with approximately 12 inches of landscape.

The base of the ground floor is below the surrounding natural grade, embedding the building beneath the surrounding ground surface. The ground floor consists of an atrium within the center, which contains tropical plants and water features, and interior exhibit space housing the La Brea Tar Pit fossils surrounding the atrium. The roof terrace allows visitors to look down into the atrium and provides a view of the surrounding park. Based on the "Structural Engineering" sheets prepared by MKA, we understand the museum's existing foundation consists of a 30-inch-thick reinforced concrete mat slab that covers the entire footprint of the building. The mat slab steps down 4.5 feet withing the interior atrium area. Exhibits 2-2 and 2-3, presented below, show the existing outside and inside condition of the Page Museum.

Exhibit 2-2: Existing Side Slopes Surrounding the Museum (View Towards Northeast)

Exhibit 2-3: Eastern Exhibit Within the Museum (View Towards North)

The Project site is relatively level. The low point is at Lake Pit, where the surrounding grade slopes down towards the lake. The high point is at the Page Museum, in which the structure's slopes extend the grade up to the roof terrace of the building, approximately 15 feet above park grade.

2.3 Proposed Development

We understand the proposed Project involves full renovation and expansion of the existing Page Museum, and construction of new amenities within the surrounding portions of Hancock Park. The new amenities include a looping pedestrian pathway, a pedestrian bridge over Oil Creek, new lookout platforms overlooking excavation pits and tar pit exhibits, and overall transformation of the park experience. The Project will consist of:

- Expanding the Page Museum's gross area from 63,200 square feet (SF) to 104,300 SF. The Project includes seismic strengthening and renovating the existing Page Museum and construction of a one-story expansion towards the northwest.
  - The renovation of the existing structure will include structural demolition and structure modification. The renovation will allow for enlarged exhibition space,

research space, additional storage, retail space, and a ground floor café. The roof terrace will contain new classrooms, multipurpose space, and an outdoor café and bar. As part of the renovation, the existing central atrium will be removed.

- The proposed expansion will include a new lobby and exhibit spaces, two theaters, a mechanical equipment room, administration spaces, research and collections rooms, and loading dock. The expansion is anticipated to be supported on a mat slab foundation with a methane protection layer below the slab. The new and existing mat slab foundations will be connected so the slab deformations and stresses are uniform across the new-to-existing interface.

- A new simple-span bridge crossing over Oil Creek as part of the pedestrian pathway. Oil Creek is a natural spring flowing through the northwestern portion of the site. The abutments of the proposed bridge will be supported on deep foundations.
- Three new biofiltration systems to manage stormwater for the Project:
  - A 10,100 SF in-ground biofiltration planter within the southeastern portion of the site, east of Lake Pit.
  - A 6,400 SF biofiltration planter within the northeastern portion of the site, north of the Page Museum. The planter would be excavated approximately 4 to 5 feet and lined with an impermeable liner. The planter will then be filled with gravel subdrainage and a perforated pipe, amended soil, and plants. Supporting wall structures will likely be required underground to separate the compacted soil supporting traffic loading and the uncompacted biofiltration media.
  - Refurbishing Oil Creek as a bioswale within the northwestern portion of the site. The existing creek drainage will be cleared, lined with an impermeable liner, and then partially filled with gravel subdrainage and a perforated pipe, amended soil, and plants.
- New entry pavilions and canopies, located at:
  - Wilshire Gateway Entrance, at the corner of Wilshire Boulevard and South Curson Avenue.
  - Sixth Street Entrance, at the northwestern corner of the site.
  - Pit 91 Outdoor Classroom and Canopy. The proposed improvements include demolishing the existing viewing station and constructing a shaded outdoor classroom with canopy.

  Currently, the columns and walls for the pavilions and canopies are anticipated to be supported on a mat slab foundation. A methane protection layer will be installed below the mat slab.
- A new school bus drop-off zone on South Curson Avenue. The drop-off one will be approximately 215 to 230 feet long to accommodate school buses.
- Reconfiguration of the existing parking lot. The existing parking lot will be moved from its current position towards the north by approximately 50 to 70 feet, along the

boundary of West 6th Street. The parking lot will be expanded from 63,000 SF to 65,000 SF.

- Landscaped paths to provide connection between the Tar Pits and LACMA. The proposed improvements will reconfigure the existing pedestrian pathways into a continuous paved pedestrian pathway, linking the disparate existing elements of the site.

3 PREVIOUS STUDIES

We reviewed the geotechnical reports previously prepared for improvements in the Project area, the LACMA Campus, and the Purple Line Subway Extension by the Los Angeles County Metropolitan Transportation Authority (LA Metro). These include reports prepared by Shannon & Wilson (S&W) and our predecessor company, Van Beveren & Butelo (VB&B). Below is a list of projects reviewed, organized by geotechnical companies (including predecessor companies) and LA Metro.

The geologic hazards and recommendations are based on the results of our prior subsurface explorations and explorations by others listed below. Relevant boring logs prepared by S&W and VB&B are presented in Appendix A. Relevant boring logs prepared by others are presented in Appendix B.

3.1 Shannon & Wilson/Van Beveren & Butelo

- The Academy Museum of Motion Pictures (AMMP):
  - Geology and Soil Discipline Report (S&W, 2014a)
  - Geotechnical Design Reports (S&W, 2014b and 2015)
  - Construction Summary Report (S&W, 2018)
- Broad Contemporary Art Museum (BCAM) and Subterranean Garage:
  - Geotechnical Design Memo, Preliminary Findings (VB&B, 2004a)
  - Geotechnical Design Memo No. 2, Preliminary Recommendations for Temporary Dewatering System and Uplift Load Resistance (VB&B, 2004b)
  - Geotechnical Investigation Report (VB&B, 2005b) and follow up City Response Letters based on City of LA review comments and questions (VB&B, 2005d and 2005e)
  - Depth to Groundwater Memo (VB&B, 2005c)
  - Disposal of Site Runoff into Soils Letter (VB&B, 2006b)
  - Grading Over Tar Seep Letter (VB&B, 2007)
  - Interim and Final Construction Observation Reports (VB&B, 2006a and 2008a)

  - Geotechnical Investigation Report for Phase 2 of Project (VB&B, 2008b)
  - Final Construction Observation Report (S&W, 2010)
- Preliminary Findings and Conclusions, Sidewalk Heaving, 5801 West 6th Street (VB&B, 2005a)

3.2 AECOM/URS

- AECOM, Final Report for Geotechnical Investigation, LACMA Building for Permanent Collection (BPC) (AECOM, 2019)
- URS, Preliminary Geotechnical Recommendations for Proposed Broad Contemporary Art Museum (URS, 2003)
- URS, Preliminary Report, Geotechnical Evaluations for Proposed Museum Replacement Project (URS, 2002)

3.3 Los Angeles County Metropolitan Transportation Authority

- Los Angeles County Metropolitan Transportation Authority (LA Metro), Geotechnical Data Report - Tunnel Reach 2, Westside Subway Extension Project, Section 1 (LA Metro, 2014)
- Converse Consultants, Inc., Interim Geotechnical Report for Metro Project, Design Unit A250 (Converse, 1984)

3.4 Law/Crandall, Inc./LeRoy Crandall and Associates

- Law/Crandall, Inc., Geotechnical Investigation Reports for Proposed Additions to Hancock Park (Law/Crandall, 1995 and 1998)
- LeRoy Crandall and Associates (LCA):
  - Foundation Investigation for Proposed Additions at 5905 Wilshire Boulevard (LCA, 1982)
  - Completion of Exploration Program for Proposed Additions (LCA, 1984)

4 REGULATORY FRAMEWORK

This section provides an introduction to applicable federal, state, and local regulations and codes that will govern the Project development.

4.1 Federal Level

There are no specific federal regulations addressing geology and soils issues that are not addressed by the state or local requirements.

4.2 State Level

4.2.1 California Building Code

The State of California adopted the 2019 California Building Code (CBC), Volumes 1 and 2, which went into effect on January 1, 2020. Based in part on the 2018 International Building Code (IBC), the 2019 CBC makes up Part 2 of Title 24 of the California Code of Regulations. In Chapter 16 of Volume 2, the code contains provisions for structural design, including soil lateral loads (Section 1610) and earthquake loads (Section 1613). Provisions for soils and foundations include:

- Geotechnical explorations (Section 1803),
- Excavation, grading and fill (Section 1804), and
- Foundations (Sections 1808-1810).

Appendix J of the CBC applies to grading.

4.2.2 Seismic Hazard Regulations

The Alquist-Priolo Geologic Hazard Zones Act was passed by the State of California in 1972 to address the hazard and damage caused by surface fault rupture during an earthquake. The Act was renamed the Alquist-Priolo Earthquake Fault Zoning Act (Alquist-Priolo Act), effective January 1, 1994. The Alquist-Priolo Act has since been revised 12 times; most recently a version became available in 2018 (California Geological Survey [CGS], 2018a). The Alquist-Priolo Act requires the State Geologist to establish "earthquake fault zones" along known active faults (faults that have moved in the last ~11,000 years) in the state. Cities and counties with earthquake fault zones are required to regulate development projects within these zones.

The State Seismic Safety Commission was established by the Seismic Safety Act in 1975 with the intent of providing oversight, review, and recommendations to the Governor and State Legislature, as well as state and local governments regarding seismic issues. The commission was renamed the Alfred E. Alquist Seismic Safety Commission in 2006.

The Seismic Hazard Mapping Act of 1990 was enacted, in part, to address seismic hazards not included in the Alquist-Priolo Act, including strong ground shaking, liquefaction, landslides, and/or other seismic related ground failures. Under this Act, the State Geologist is assigned the responsibility of identifying and mapping seismic hazard zones. The recommended guidelines and criteria for the preparation of seismic hazard zones are presented in Special Publication 118, “Recommended Criteria for Delineating Seismic Hazard Zones in California” (CGS, 2004). The CGS, formerly the State of California, Division of Mines and Geology (CDMG), adopted seismic design provisions in Special Publication 117A, "Guidelines for Evaluating and Mitigating Seismic Hazards in California" (revised and readopted on September 11, 2008) (CGS, 2008) and Special Publication 118.

Additional guidelines published by the CGS/CDMG for evaluating geologic and seismic hazards with respect to a project development include the following:

- CGS Special Publication 42, "Earthquake Fault Zones, A Guide for Government Agencies, Property Owners/Developers, and Geoscience Practitioners for Assessing Fault Rupture Hazards in California" (CGS, 2018a)
- CGS Note 49, "Guidelines for Evaluating the Hazard of Surface Fault Rupture" (CGS, 2002)

4.3 Local Level

4.3.1 City of Los Angeles

The Project site is located within the City. However, the site is owned by the County of Los Angeles (County). As such, we understand the proposed Project is subject to the regulatory controls of the County. The recommendations provided below and future design recommendations which will be developed as the Project progresses follow the County requirements.

4.3.2 County of Los Angeles

4.3.2.1 Los Angeles County Building Code

The County adopted portions of the 2019 CBC and 2018 IBC together with a series of County amendments as the 2020 County of Los Angeles Building Code (CLABC), Volumes 1 and 2. The 2020 CLABC amendments were published on January 1, 2020. Together, the provisions in Volumes 1 and 2 of the CLABC address issues related to:

- Site grading,
- Cut and fill slope design,
- Soil expansion,
- Geotechnical studies before and during construction,
- Slope stability,
- Allowable bearing pressures and settlement below footings,
- Effects of adjacent slopes on foundations,
- Retaining and basement walls, and

- Shoring of adjacent properties.

Appendix J of the CLABC addresses grading and excavation requirements.

The County of Los Angeles Department of Public Works Building and Safety (Building and Safety) is responsible for implementing the provisions of the CLABC and grading standards. Building and Safety has jurisdiction over projects to be approved by the County where grading is required, to ensure Project design follows County regulations, to ensure the safety of the workers during construction, and to ensure the safety of the public once construction is complete.

4.3.2.2 Los Angeles County General Plan

The County General Plan is the County's guide for long-term development and conservation. The General Plan provides the policy framework for future development by establishing goals, policies, and programs adopted by the County. The newest edition of the General Plan was adopted by the Board of Supervisors on October 6, 2015. The current General Plan is applicable for development through 2035.

Chapter 12 consists of the Safety Element of the County General Plan. The purpose of the Safety Element is to reduce potential risks to both people and property within the County from seismic and geotechnical hazards, as well other hazards which will not be covered in this report. Seismic and geotechnical hazards are addressed within Goal S 1 of the Safety Element, which consists of four policies identified as Policy S 1.1 through Policy S 1.4.

Potential seismic hazards identified consist of surface fault (ground) rupture, liquefaction, earthquake-induced landslides, and coastal flooding generated from tsunamis. These seismic hazards could result in damage to infrastructure with secondary impacts including fire, flooding, and release of dangerous materials. The County General Plan requires new projects located in Alquist-Priolo Earthquake Fault Zones and other seismic hazard mapping zones produced by the state to have a geotechnical study to evaluate these hazards.

Potential geotechnical hazards identified consist of hillside hazards such as mud and debris flows, active deep-seated landslides, hillside erosion, and man-induced slope instability. Other geotechnical hazards identified include erosion or undercutting of slopes, and natural or artificial compaction of unstable ground.

In addition to the Safety Element, the General Plan consists of Hillside Management Areas Ordinance and Hillside Design Guidelines. The Ordinance and Guidelines regulate development in areas with 25% or greater natural slope inclinations, providing applicable design techniques, and an evaluation of potential hazards to address hillside geotechnical hazards.

5 ENVIRONMENTAL SETTING

5.1 Regional Geology

The Project site is located in the coastal Los Angeles Basin of southern California. The basin includes the low-lying area between the San Gabriel Mountains and the Pacific Ocean shoreline. Nearby hills and mountain ranges bordering the basin include the prominent Santa Monica Mountains to the north, the Hollywood Hills to the northeast, the Elysian and Repetto Hills to the east, the Peninsular Ranges to the southeast, and the Baldwin Hills to the south.

The Project site occupies the westerly extent of the La Brea Plain. The La Brea Plain is a broad, slightly elevated, and dissected surface underlain by coalescing Quaternary age (recent to 2.6 million years ago) alluvial fan and flood plain deposits. These alluvial sediments were deposited on the underlying Tertiary-age (2.6 to 66 million years ago) shallow marine sedimentary bedrock formations. Faulting and folding of the bedrock over millions of years has formed structural traps for petroleum deposits. Several oil and gas fields were developed within this portion of the Los Angeles Basin, including the Salt Lake and South Salt Lake fields.

At the Project site, crude oil and gas leaking from the petroleum deposits of the Salt Lake Field have migrated towards the ground surface through fractures and faults in the bedrock, permeating into the overlying alluvium. Upon reaching shallower depths, the lighter petroleum components are altered by evaporation and biologic processes resulting in a more viscous remnant tar (or asphalt) deposit.

5.2 Local Geology and Geologic Units

5.2.1 General

Regional geologic maps indicate the Project site is underlain by alluvial deposits, as shown on the Regional Geology Map, Figure 3 (Dibblee and Ehrenspeck, 1991). Specifically, the geologic map depicts the Project site being underlain by slightly elevated and dissected, older alluvium and alluvial fan sediments (mapped as Qae). Geotechnical explorations near the Project site indicate much of the alluvial deposits are covered by a layer of artificial fill. The subsurface conditions are described in more detail below.

5.2.2 Artificial Fill

Most of the subsurface explorations performed at the Project site encountered artificial fills extending to depths of approximately 1 to 8 feet bgs (Law/Crandall, 1995 and 1998). The fill is of variable composition, consisting of silty clay, sandy clay, clayey silt, and silty sand.

5.2.3 Alluvium

The Project site is underlain by units described as late-Pleistocene to Holocene (recent to about 11,000 years old) in age. The Pleistocene-age (about 11,000 to 1.8 million years) alluvial deposits consist of stiff to very stiff clays with some dense silt and silty sand layers. These relatively fine-grained materials overlie thicker deposits of dense to very dense sand. The fine-grained alluvial deposits belong to the Lakewood Formation, while the deeper sand beds correspond to the San Pedro Formation (California Department of Water Recourses [DWR], 1961). The youngest surficial deposits observed in this area are Holocene sediments of modern alluvial fans, stream channels (e.g., Los Angeles and San Gabriel Rivers), and their flood plains. These debris-flow, sheetflood, and fluvial deposits consist of boulder, cobble, and pebble gravel lenses and sheets, interbedded with sand, silt, and clay derived from the surrounding highlands (Bilodeau and others, 2007).

As noted previously, natural hydrocarbons are present in the alluvium due to the upward migration of crude oil leaking from oil deposits within the underlying bedrock. The crude oil has been altered near the ground surface to viscous tar, and the more permeable sand deposits are permeated with tar (Deane and others, 2018).

5.2.4 Bedrock

The Lakewood and San Pedro Formations are directly underlain by Tertiary-age sedimentary bedrock of the Fernando Formation. The bedrock consists primarily of well stratified, locally folded, interbedded claystone, siltstone, and sandstone (Converse, 1984). Borings from the adjacent LA Metro Westside Subway Extension project encountered Fernando Formation, consisting of primarily siltstone, beginning at depths of approximately 65 feet to 120 feet bgs (LA Metro, 2014). From the LACMA Building for Permanent Collection (BPC) project, Borings B-15-2 and B-15-3 did not encounter the Fernando Formation to a total depth explored of approximately 88 feet for both explorations. Boring B-15-4 encountered the Fernando Formation at an approximate depth of 94 feet bgs (AECOM, 2019).

5.3 Tar Sands and Seeps

The depth to tar sand is anticipated to vary throughout the Project site. AECOM subsurface explorations encountered tar sands at depths of approximately 13 feet to 20 feet bgs, correlating to elevations of 151 feet to 156 feet (AECOM, 2019). The URS subsurface explorations encountered tar sands at depths of approximately 13 to 23 feet below grade, correlating to elevations of 142 feet to 157 feet (URS, 2002 and 2003). The LA Metro subsurface explorations showed more variability, with the subsurface explorations encountering tar sands at depths of approximately 6 feet to 30 feet bgs, correlating to elevations of 137 feet to 180 feet (LA Metro, 2014).

The subsurface explorations performed by AECOM indicated the tar content within the San Pedro Formation varied between approximately 11% and 18% within the collected soil samples (AECOM, 2019). The LA Metro subsurface explorations indicated the tar content within the San Pedro Formation varied between approximately 10% and 20% within the collected soil samples, though two samples collected (one within a gravel layer, and one within a sand with silt and gravel layer) resulted in tar contents of 2% and 4% (LA Metro, 2014).

Based on our previous experience at the LACMA Campus, we anticipate soil excavated above the groundwater likely would not contain significant natural oil or tar. As such, it likely could be disposed of as non-impacted soil. Spoils from excavations that extend below the groundwater could contain natural oil or tar. Excavation spoils will likely require chemical analyses for offsite disposal. In addition, the proposed deep foundations will likely penetrate the tar-impacted sands. Impacts from excavating the foundations into the tar sands will depend on the deep foundation system used, but likely will include drilling spoils generated from installation.

Tar seeps are locally found around the Project site. We understand the tar seeps occur randomly and are likely the result of methane and hydrogen sulfide gas pressure at depth mobilizing groundwater and tar to the surface. Where tar seeps occur below existing and proposed structures, barriers and ventilation should be designed in accordance with the Project methane specialist. Where tar seeps occur in landscaping or exterior portions of the park, temporary barriers should be installed until the gas driving the tar seeps dissipates.

5.4 Groundwater

The Project site is located within the Central Groundwater Basin of the Los Angeles Coastal Plain (DWR, 2004). The principal freshwater-bearing sediments of the Central Basin include the Holocene-age alluvial deposits, and the Pleistocene-age Lakewood and San Pedro Formations at depth (DWR, 1961).

According to the Seismic Hazard Zone Report for the Hollywood 7.5-Minute Quadrangle, the Project site lies within the 10-foot water level contour of the historically high groundwater levels, as shown in Figure 4 (CDMG, 1998). This indicates that the historical high groundwater depth is at or shallower than 10 feet bgs. The previous subsurface explorations encountered groundwater levels at depths less than 10 feet bgs. Exhibit 5-1, shown below, presents groundwater depths encountered within exploration borings at or adjacent to the Project site. Groundwater depth is anticipated to fluctuate in response to rainfall, seasonal variations, and other factors, and is anticipated to vary throughout the site.

Exhibit 5-1: Groundwater Level Measurements in Existing Borings

Boring ID	Date of Exploration	GW Depth Measurement (feet)	Approximate GW Elevation (feet)
VBB-2005-B-4	October 4, 2004	6.6 [1]	164.4
VBB-2005-B-5	October 5, 2004	5.5 [2]	164.6
AECOM-B-15-3	November 2-3, 2015	30	138.5
AMC-2014-G-121	May 16-18, 2011	14	163
AMC-2014-M-108	May 2-3, 2011	35	154
URS-2003-B-8	October 15, 2003	18 [3]	147
URS-2002-B-1	July 17, 2002	50	120
URS-2002-B-2	July 24, 2002	22	148
L/C-1998-B-5	January 7, 1998	4 [4]	167
L/C-1998-B-7	January 7, 1998	6 [5]	172
L/C-1998-B-9	January 6, 1998	5.5 [4]	178.5
L/C-1995-B-1	January 26, 1995	1 [5]	- [6]
L/C-1995-B-2	January 23, 1995	4.5	- [6]
L/C-1995-B-3	January 23, 1995	7	- [6]
L/C-1995-B-5	January 24, 1995	4	- [6]
L/C-1995-B-7	January 24, 1995	6	- [6]
L/C-1995-B-8	January 26, 1995	2	- [6]
L/C-1995-B-9	January 27, 1995	2.5 [5]	- [6]
LCA-1984-B-4	April 12, 1984	4 [7]	164.3
LCA-1982-B-1	December 14, 1981	6.5 [8]	163.5
LCA-1982-B-3	December 15, 1981	6.5 [9]	159.2

NOTES:

1 Groundwater measurement made 15 days after completion of drilling.
2 Groundwater measurement made 14 days after completion of drilling.
3 Groundwater encountered identified as being perched groundwater.
4 Groundwater encountered noted as "Water seepage" in boring log.
5 Groundwater encountered noted as "Slight water seepage" in boring log.
6 Ground surface elevation not listed on boring log.
7 Groundwater measurement made 12 days after completion of drilling.
8 Groundwater measurement made 3 days after completion of drilling.
9 Groundwater measurement made 2 days after completion of drilling.

In addition, AECOM (2019) converted Borings B-15-3 and B-15-4 into groundwater monitoring wells. Groundwater level data was collected at Boring B-15-3 for over two years and collected at Boring B-15-4 for approximately a year and a half. Over that time, the shallowest groundwater depth encountered was approximately 1-foot bgs within Boring B-15-3 (corresponding to an elevation of approximately 167.5 feet) and approximately 5.7 feet within Boring B-15-4 (corresponding to an elevation of 164 feet).

Per the "Civil Engineering" sheets prepared by KPFF, substantial groundwater intrusion has occurred within the lowest level of the existing Page Museum. The "Structural Engineering" sheets prepared by MKA presents a list of locations within the existing Page Museum where water infiltration was observed by members of the design team.

Tar occurs within the groundwater as observed at Lake Pit, and tar seeps occur randomly throughout the site. Both of these indicate the potential for near-surface groundwater and tar to be encountered. AECOM (2019) stated that tar was observed in the groundwater for the LACMA site, which can lead to a negative effect on the efficiency of dewatering and water disposal systems. As such, AECOM recommended additional considerations for the dewatering well development and well/pump operation and maintenance (AECOM, 2019).

5.5 Faulting and Seismicity

5.5.1 Faulting

The Project site is located within the seismically active southern California area and is expected to experience the effects of future earthquakes on active faults. Figure 5, Regional Fault Map, illustrates active and potentially active faults mapped in the vicinity of the Project site.

Active faults are those that have moved during the Holocene Age. Potentially active faults are those faults that display latest movement during Quaternary geologic time, where Holocene activity cannot be demonstrated. The Quaternary time includes the Holocene and Pleistocene Epochs and represents the last 2.6 million years of geologic time. Potentially active faults are not considered an imminent fault rupture hazard, but the potential cannot be completely dismissed. Inactive faults are those faults where the latest displacement is older than the Pleistocene and are not considered a surface rupture hazard.

Exhibits 5-2 and 5-3, shown below, provide a list of significant active or potentially active faults, respectfully, which are capable of generating strong seismic ground shaking at the Project site. This list does not encompass all active or potentially active faults within southern California. The Los Angeles Basin, and the southern California region as a whole, is located within a complex zone of faults, fault systems, folds, and other geologic features.

Exhibit 5-2: Major Faults Considered to Be Active in Southern California

Fault	MCE M_w [1]	Fault Type [2]	Slip Rate (mm/yr) [2]	Approximate Distance from Project Site (miles) [3]	Direction from Project Site
Elysian Park - Lower Thrust	Unspecified	T	1.0 - 5.0	1.7	SE
Hollywood	6.7	R	1.0 - 5.0 (1.5)	2.3 (2.6)	N
Newport-Inglewood-Rose Canyon Fault Zone	7.5	SS	1.0 - 5.0	2.8 (1.7)	SW
Santa Monica	7.4	R	1.0 - 5.0 (1.5)	3.5 (2.4)	W
Elysian Park - Upper Fault	6.7	R	0.2 - 1.0	4.2	E
Raymond	6.8	SS	1.0 - 5.0 (0.8)	8.8 (7.1)	NE
Verdugo	6.9	R	0.2 - 1.0	9.1	NE
Sierra Madre Fault Zone - Sierra Madre Section	7.3	R	1.0 - 5.0 (4.0)	14 (14)	NE
Sierra Madre Fault Zone – San Fernando Section	6.7	T	1.0 - 5.0 (3.0)	14 (14)	N
Northridge	6.9	T	1.0 - 5.0	17	N-NW
Elsinore Fault Zone – Whittier Section	7.0	SS	1.0 - 5.0 (3.5)	18 (21)	SE
Sierra Madre Fault Zone – Santa Susana Section	7.2	R	> 5.0 (7.0)	19 (19)	N-NW
Oak Ridge	7.2	R	Unspecified	32 (38)	NW
San Andreas Fault Zone – Mojave Section	7.5	SS	> 5.0 (20 - 40)	36 (36)	NE
Elsinore Fault Zone – Chino Section	6.9	R	1.0 - 5.0 (2.0)	38 (38)	SE
San Jacinto Fault Zone – San Bernardino Valley Section	7.1	SS	> 5.0 (18)	51 (48)	E

NOTES:

1 Information for the MCE Mw was provided from the U.S. Geological Survey (USGS) 2008 National Seismic Hazards Map - Fault Database. Note that the USGS 2014 Fault Database does not include California faults at the time of this report preparation.

2 Information for fault type and slip rate was provided from the USGS 2014 National Seismic Hazards Map - Interactive Fault Map for Quaternary Fault and Fold Database. For slip rate, the provided range is considered the slip rate category. The value in the parenthesis is the maximum assigned slip rate value from Peterson and others (1996) for probabilistic seismic hazard assessment for the State of California, with exception to the San Andreas Fault Zone in which the value in the parenthesis is based on Weldon and others (2002).

3 Distances between Project site and faults are approximate. They were determined using the USGS 2014 National Seismic Hazards Maps - Fault Source Map. Distance values in parenthesis were determined using the California Geological Survey's interactive online map, Earthquake Zones of Required Investigation.

MCE M_w = Maximum Considered Earthquake moment magnitude; R = reverse; SS = strike slip; T = thrust

Exhibit 5-3: Major Faults Considered to Be Potentially Active in Southern California

Fault	MCE M_w [1]	Fault Type [2]	Slip Rate (mm/yr) [2]	Approximate Distance from Project Site (miles) [3]	Direction from Project Site
Overland Avenue	Unspecified	Unspecified	Unspecified	4.2	SW
Charnock	Unspecified	Unspecified	Unspecified	6.0	SW
Los Alamitos	Unspecified	Unspecified	Unspecified	20	SE
San Jose	6.7	R	0.2 - 1.0	27	E

NOTES:

1 Information for the maximum considered earthquake moment magnitude was provided from the U.S. Geological Survey (USGS) 2008 National Seismic Hazards Map - Fault Database. Note that the USGS 2014 Fault Database does not include California faults at the time of this report preparation.

2 Information for fault type and slip rate was provided from the USGS 2014 National Seismic Hazards Map - Interactive Fault Map for Quaternary Fault and Fold Database. For slip rate, the provided range is considered the slip rate category. The value in the parenthesis is the maximum assigned slip rate value from Peterson and others (1996) for probabilistic seismic hazard assessment for the State of California.

3 Distances between Project site and faults are approximate. They were determined using the USGS 2014 National Seismic Hazards Maps - Fault Source Map.

MCE M_w = Maximum Considered Earthquake moment magnitude; R = reverse; SS = strike slip; T = thrust

The following sections provide a discussion of nearby active faults to the Project site.

The Santa Monica and Hollywood faults are located at the southern base of the Hollywood Hills. The faults are considered to be a part of the larger Malibu-Santa Monica-Hollywood-Raymond fault zone, which extends from Malibu to Pasadena. The Santa Monica fault is a strike-slip, oblique/left-reverse fault, which has a slip rate of approximately 0.5 to 1.5 millimeters (mm) per year and is predicted to be capable of generating a 6.5 to 7.4 moment magnitude (M_w) earthquake (U.S. Geological Survey [USGS] 2008 National Seismic Hazard Maps; Petersen and others, 1996). The Hollywood fault is a sinistral-reverse oblique fault which has a slip rate of approximately 0.5 to 1.5 mm per year and is predicted to be capable of generating a 6.5 to 6.7 M_w earthquake (USGS 2008 National Seismic Hazard Maps; Petersen and others, 1996). Neither fault has generated a major earthquake in historic times.

The Newport-Inglewood Fault is a right-lateral, strike-slip fault. The fault extends from Culver City southeast to Newport Beach, at which point it runs out into the Pacific Ocean and joins with the Rose Canyon fault offshore of San Diego, creating the Newport-Inglewood-Rose Canyon fault system. The fault has a slip rate of approximately 1 mm per year and is predicted to be capable of producing a 6.5 to 7.5 M_w earthquake (USGS 2008 and 2014 National Seismic Hazard Maps). The 1933 Long Beach Earthquake was generated by this fault.

The Elysian Park fold and thrust belt includes a blind fault (i.e., a buried fault that does not extend to the surface) capped by a fold and thrust structure. The axial trend of the fold extends through the Elysian Park-Repetto Hills from about Silver Lake on the west to

Whittier Narrows on the east. The 1987 Whittier Narrows earthquake (magnitude 5.9) has been attributed to subsurface thrust faults, which are reflected at the earth's surface by a west-northwest trending anticline known as the Elysian Park anticline, or the Elysian Park fold and thrust belt. The subsurface faults that create the structure are not exposed at the surface. However, as demonstrated by the 1987 earthquake and two smaller earthquakes on June 12, 1989, the faults are a source for future seismic activity.

The Oak Ridge fault is a blind thrust fault located beneath the Santa Susana Mountains. The Northridge thrust fault is an inferred blind thrust fault that is considered the western extension of the Oak Ridge fault, and is associated with generating the January 17, 1994, Northridge Earthquake. The Northridge thrust is located beneath the majority of the San Fernando Valley. This thrust fault is not exposed at the surface. The Northridge thrust is an active feature that can generate future earthquakes.

5.5.2 Recent Seismicity

Several earthquakes of moderate to large magnitude (greater than 5.0) have occurred in southern California area within the last 90 years. A list of some of these earthquakes (with magnitudes greater than 5.7) within approximately 150 miles of the site is included in Exhibit 5-4 below.

Exhibit 5-4: Major Historic Earthquakes in Southern California

Earthquake	Date of Earthquake	Moment Magnitude Scale (M_w)	Distance to Epicenter (miles)	Direction to Epicenter
Long Beach	March 10, 1933	6.4	38	SE
Kern County	July 21, 1952	7.5	75	N-NW
Borrego Mountain	April 9, 1968	6.5	143	SE
San Fernando	February 9, 1971	6.5	24	N
Whittier Narrows	October 1, 1987	5.9	16	E
Superstition Hills	November 24, 1987	6.6	162	SE
Sierra Madre	June 28, 1991	5.8	24	NE
Joshua Tree	April 22, 1992	6.1	117	E
Big Bear	June 28, 1992	6.4	88	E
Landers	June 28, 1992	7.3	110	E
Northridge	January 17, 1994	6.7	15	NW
Hector Mine	October 16, 1999	7.1	125	NE
Ridgecrest Sequence	July 4-5, 2019	6.4, 7.1	123, 125	NE

NOTES:

1 Information provided by the Southern California Earthquake Data Center (SCEDC).

2 Distances to epicenter values were determined based on the latitude and longitude values presented by SCEDC.

5.6 Oil Field and Adjacent Oil Wells

According to maps prepared by the State of California Department of Conservation, Geologic Energy Management Division (CalGEM; formerly known as Division of Oil, Gas and Geothermal Resources [DOGGR]), the site is located within the Salt Lake Oil Field (CalGEM, 2022), as shown in Figure 6. The closest oil and gas wells include:

- Chevron Salt Lake 38 to the north
- Chevron Salt Lake 32 to the north
- Chevron Salt Lake 406 to the east
- Mars Oil Co. Masselin 1 to the south

According to CalGEM records, these wells are plugged and abandoned. The CalGEM maps do not show abandoned or active oil wells within the footprint of the Project site. However, the CalGEM well locations are approximate and location errors may be possible. Although the likelihood of encountering an abandoned oil well is low, mitigation or abandonment would be required if a well was found under proposed improvements.

5.7 Methane and Hydrogen Sulfide Gas

The Project site is located within an area of known shallow methane and hydrogen sulfide gas accumulation. Crude oil and methane gas leak out from the petroleum deposits and migrate through fractures and faults located within the bedrock until encountering the alluvial soils, where it permeates into the alluvium and continues to travel upwards to the ground surface. Many of the light petroleum components are lost to evaporation and biogenic processes, resulting in viscous tar seeping out of the ground surface (Deane and others, 2018).

Information and design to mitigate the gassy ground conditions will be developed during final design of the Project. We understand a methane specialist will be developing the ventilation system and barriers to reduce gas seepage into enclosed structures.

6 HAZARDS ANALYSIS

6.1 General

This section provides an evaluation for potential adverse environmental impacts associated with potential geologic hazards for the proposed development. Specific potential adverse impacts applicable for the Project are strong seismic ground shaking, expansive soils, and gas. With the exception of methane gas, these potential impacts, along with other potential geologic hazards in the area, are described in the following sections.

6.2 Methodology

Our geotechnical study for the proposed improvements and our evaluation of potential effects and potential design measures is based on available published information and existing subsurface explorations and laboratory testing performed by us or others in the Project vicinity. S&W has extensive experience in the site vicinity, which we have utilized for our hazards analysis.

The potential impacts discussed in the following subsections is based on the general environmental setting of the Project site, discussed above, and is based on potential seismic or geotechnical hazards discussed within the Safety Element of the County General Plan.

6.3 Potential Geology and Soils Hazards and Project Design Recommendations

6.3.1 Seismic Hazards

As discussed above, the Project site is located within the seismically active southern California area and is expected to experience the effects of future earthquakes on active faults. Seismic hazards include surface fault rupture, strong seismic ground motion, and seismically induced settlement due to liquefaction.

6.3.1.1 Surface Fault Rupture

Our surface fault rupture hazard evaluation is based on criteria developed by the CGS for the Alquist-Priolo Act program. In accordance with the act, an active fault is one that has ruptured within the Holocene geologic time.

Based on the "Earthquake Zones of Required Investigation" map for the Hollywood Quadrangle (CGS, 2014), the Project Site does not lie within an Alquist-Priolo Earthquake Fault Zone (AP Zone), as shown in Figure 7, Seismic Hazard Zones Map. The nearest AP Zones are the Newport-Inglewood-Rose Canyon Fault Zone, located approximately 1.6 miles southwest of the site, and the Hollywood Fault Zone, located approximately 2.2 miles north-northwest of the site (CGS, 2014 and 2018b).

The trace of the Sixth Street Fault is projected through the south to southwest portion of Project site (Converse, 1984). The Sixth Street Fault is a near-vertical fault, with north side movement up relative to the south side. The near-surface location of the fault is not well defined, nor is the fault listed as an active or potentially active by the CGS. Therefore, it is not included in the AP Zone maps. The fault likely does not penetrate the Lakewood Formation or the San Pedro Formation (Converse, 1984). The location of the fault is inferred based on the projection of data related to the Salt Lake Oil Field. The fault likely acts as a barrier for gas and oil migration.

6.3.1.2 Seismic Ground Shaking

We anticipate the site will experience strong ground shaking during an earthquake generated from faults in the region. The intensity of earthquake motion and seismic hazards that may impact the Project site will depend on the characteristics of the generating fault, distance to the earthquake fault, earthquake magnitude, earthquake duration, and site-specific geologic conditions. Likely sources for strong ground motion are known active faults or potentially active faults. Ground motions may be amplified or attenuated at the site depending on the level of ground shaking in the underlying bedrock, underlying soil type, depth to bedrock, and other factors. Discussion towards applicable building code requirements to address potential strong ground shaking during an earthquake is provided below.

6.3.1.3 Liquefaction

Soil liquefaction is a phenomenon in which pore pressure in loose, saturated, granular soil increases during ground shaking to a level near the initial effective stress, resulting in a reduction of shear strength of the soil (i.e., quicksand like conditions). The loss in shear strength may generate ground settlement, lateral spreading (ground movement on gentle slopes), bearing capacity failure, and/or landslides. Liquefaction potential is greatest where loose granular soil (sand and non-plastic silt) is present below groundwater and is more likely to affect structures when it occurs at depths shallower than 50 feet. Liquefaction potential decreases as the fines (clay and silt content of soil) increases, and the liquefaction potential increases as ground shaking increases.

The seismic hazard zone map for the Hollywood Quadrangle includes liquefaction hazard zones for the quadrangle (CGS, 2014). The site is not mapped within a liquefaction hazard zone.

The geologic materials underlying the Project site generally consist of stiff cohesive (fine-grained) soil underlain by dense to very dense tar sand. Our previous explorations completed for the AMMP did encounter thin zones of loose silty sand that have a potential for liquefaction; however, the zones were discontinuous and localized. Furthermore, other previous explorations performed within the site vicinity did not encounter potentially liquefiable soil.

Based on the stiff and dense nature of the onsite subsurface materials, the potential for liquefaction to impact the proposed development is low.

6.3.1.4 Recommendations

Potential impacts associated with strong seismic ground shaking are anticipated for the proposed development. Implementation of the Project could expose the proposed development and people to strong seismic ground shaking, which represents a potentially significant adverse impact. However, these effects are not unique to the Project site as the general vicinity sits within a seismically active region.

The proposed improvements should be designed in accordance with the 2020 CLABC, which calls for consideration of seismic loading factors. Specifically, Section 1613 provides discussion towards earthquake loads and towards development of seismic ground motion design values. Per Section 1613, structures “shall be designed and constructed to resist the effects of earthquake motions in accordance with Chapters 11, 12, 13, 15, 17 and 18 of

ASCE 7, as applicable. The seismic design category for a structure is permitted to be determined in accordance with Section 1613 or ASCE 7." ASCE 7 refers to "Minimum Design Loads and Associated Criteria for Buildings and Other Structures", prepared by the American Society of Civil Engineers and the Structural Engineering Institute. Adherence to the code will address the potential hazards associated with strong seismic ground shaking. No additional measures are required to address potential hazards associated with surface fault rupture, strong seismic ground shaking, or seismic-related ground failure such as liquefaction.

For preliminary design purposes, ground motion design parameters are provided herein. These values will need to be confirmed within the geotechnical design report. The ground motion design parameters are in accordance with the 2019 CBC and were determined using web-based tools. We characterized the site using Standard Penetration Test (SPT) N-values noted within the exploration logs. Based on an average SPT N-value for the upper 100 feet of the soil profile, we recommend the site be characterized as Site Class D.

The 2019 CBC design criteria considers a maximum considered earthquake (MCE) hazard as a seismic event with a 2% probability of exceedance in 50 years, i.e., a 2,475-year return period, with a deterministic maximum cap in some regions. For seismic design of structures in accordance with the CBC, the design spectral accelerations peak ground acceleration (PGA), S_S, and S_1 are required. We obtained these values and the site soil response factors (F_{PGA}, F_a, and F_v) using the web-based interactive Seismic Design Maps tool developed by the Structural Engineers Association of California and California's Office of Statewide Health and Planning Development, following ASCE 7-16 design reference.

The spectral accelerations PGA, S_S, and S_1 are determined assuming Site Class B conditions, and then adjusted for Site Class D using the site soil response factors to determine the MCE parameters adjusted for site class effects (PGA_M, S_{MS}, and S_{M1}). The design-based values (S_{DS} and S_{D1}) are then determined by multiplying the site adjusted MCE parameters by two-thirds. Exhibit 6-1 below presents our recommended CBC seismic design parameters.

Exhibit 6-1: 2019 CBC Seismic Design Values

Return Period (years)	Parameters/ Coefficients	Peak Ground Acceleration (PGA) (0-second)	Short Period (0.2-second)	Long Period (1-second)
2,475	Mapped MCE SRA[1] Parameters	PGA = 0.87 g	S_S = 2.04 g	S_1 = 0.73 g
	Site Class Coefficients[2]	F_{PGA} = 1.1	F_a = 1.0	F_v = 1.7
	Adjusted MCE SRA Parameters	PGA_M = 0.96 g	S_{MS} = 2.04 g	S_{M1} = 1.24 g
	Design SRA Parameters	S_{DPGA} = 0.54 g	S_{DS} = 1.36 g	S_{D1} = 0.83 g

NOTES:

1 SRA = Spectral Response Acceleration

2 Site class coefficients correspond to a Site Class D.

g = gravity

6.3.2 Landslides, Mudflow, and Slope Stability

Hazards associated with slope stability include landslides and mudflows. The site and surrounding area are relatively level. Therefore, the potential for the site or the area surrounding the site to experience slope stability hazards is negligible.

No potential impacts associated with landslides, mudflow, or slope stability are anticipated for the project. As such, no additional measures associated with these potential issues are required.

6.3.3 Soil Erosion

Erosion is the process in which soil or earth material is worn away and removed from its original location by natural forces such as moving water or wind. Erosion or the loss of topsoil can potentially lead to instable soil conditions, especially for hillside development or development containing or adjacent to slopes.

Based on the site conditions, site topography, and the proposed improvements, the Project is not anticipated to result in significant impacts associated with erosion, sedimentation, or loss of topsoil. However, grading, excavation, and other earth-moving activities would result in disrupting the ground surface and could potentially result in erosion and loss of topsoil during construction, a potentially significant impact. Furthermore, as with most development, there is a potential adverse impact from uncontrolled drainage.

Potential impacts associated with soil erosion or loss of topsoil are anticipated during construction of the proposed development, as earthwork activities would disrupt the ground surface. No requirements beyond the implementation of existing regulations are required to address these potential impacts. Grading and earthwork shall be performed in accordance with the 2020 CLABC, specifically section 1804 and Appendix J of the CLABC. For grading performed in the "rainy season", as defined as the months of October to April by the CLABC, provisions will need to be made to control erosions. A Stormwater Pollution Prevention Plan should be prepared prior to the start of construction in accordance with County regulations and should be implemented during construction.

6.3.4 Geologic Instability, Including Lateral Spreading, Liquefaction, and Subsidence

6.3.4.1 Lateral Spreading or Liquefaction

Geologic instability resulting from liquefaction and lateral spreading is discussed above.

6.3.4.2 Subsidence

Subsidence of the ground surface can be caused by the removal of groundwater and/or petroleum from subsurface sources. If groundwater levels or head in petroleum reservoirs are lowered sufficiently, permanent collapse of pore space would result in ground settlement and could potentially damage structural improvements.

The Project site is located in the southern part of the Salt Lake Oil Field. However, we did not find documentation indicating subsidence has occurred due to removal of petroleum. Similarly, we did not find evidence of subsidence from groundwater pumping. Therefore, we conclude that potentially damaging subsidence from extraction of groundwater and/or petroleum during construction or operation of the structures is unlikely.

Temporary dewatering will be required during construction for any excavation which extends beneath the existing groundwater level. Groundwater depth will be confirmed based on completion of our subsurface explorations and preparation of our geotechnical design report, however, based on the available data discussed above, we anticipate relatively shallow groundwater at the Project site, on the order of 5 to 10 feet beneath the ground surface. Based on this, we anticipate temporary dewatering will be required for excavations extending more than 10 feet bgs.

We anticipate groundwater extracted during temporary dewatering will be in relatively small volumes to produce localized drawdown around the excavations. We do not anticipate construction dewatering to adversely impact the existing structures or the proposed improvements. Additional details with respect to temporary dewatering system is discussed in the Recommendations section below.

6.3.4.3 Compressible and Collapsible Soils

Compressible soils are soils which undergo consolidation when subject to a new load, such as a structure load or fill placement. Collapsible soils are soils which significantly decrease in volume when they are wetted and experience an increase in moisture content, regardless of whether a new load is placed on them. Compressible or collapsible soils can lead to excessive settlement distress for structural improvements.

Artificial fill that was not engineered and the near-surface alluvial deposits may be weak and compressible and/or collapsible, particularly with the addition of water. The existing artificial fill may not be suitable to support foundations, slabs on grade, paving or new compacted fills. Furthermore, the surficial alluvial deposits may not be suitable for supporting building loads. Utilizing the existing artificial fill or upper alluvial soils for load support can result with potential significant impact for the proposed structures, as it can lead to structural distress due to total or differential settlement. We recommend removing and replacing unsuitable soil with structural fill or supporting structural loads on deep foundations as described below.

6.3.4.4 Recommendations

Temporary Dewatering:
Temporary dewatering will be required for excavations which extend below the existing groundwater level. As discussed above, we anticipate temporary dewatering will be required for excavations greater than 10 feet bgs. We anticipate the deepest excavations will be associated with the proposed Page Museum one-story addition, as excavations will be required for construction of the proposed mat foundation and associated new utility placement.

Dewatering should be performed prior to excavation. The dewatering system should be designed to lower the site groundwater sufficiently to permit a dry environment and to prevent water seepage from the temporary perimeter cut slopes. The groundwater will be pumped from the tar sands and will contain a relatively high percentage of tar. The tar will need to be removed and the groundwater treated prior to disposal. If dewatering will be utilized, we recommend that a test installation be constructed prior to proceeding with the actual design of the system to verify the design’s effectiveness.

It is important that the design of a temporary dewatering system should be performed by an experienced, qualified dewatering contractor, and a plan be developed to monitor the progress of the dewatering prior to proceeding with excavation. The design will need to balance the soil conditions with well spacing and well depth. The tar sands are relatively permeable, however the void spaces are filled with a mixture of tar and water. The water drains relatively quickly, but the presence of tar reduces the overall permeability of the sands. As such, the presence of tar results with a relatively low permeability of the tar sands and can result with high pore pressures in these deposits. Due to its relatively high viscosity, the tar drains relatively slowly in comparison to the water.

It is our opinion that the most effective method of dewatering will consist of relatively closely spaced wells around the excavation perimeter, referred to as well points. The wells should be properly designed to include perforated casing with annular space filled with suitable filter material. Even with proper design, we anticipate eventual plugging of the wells with tar will occur. The well points should extend past the depth of proposed excavation.

Based on information provided within the "Civil Engineering" sheets prepared by KPFF, we understand a current dewatering system is set up to periodically lower the water level within Lake Pit. The dewatering system consists of collection piping, sump pumps, a sand-oil separator device, and a micro-filter device. In a similar fashion, separator and filter devices should be considered for temporary dewatering pumps to help maintain the system's efficiency and increase the amount of time prior to the pumps being plugged up with tar.

Compressible/Collapsible Soils:
Using the existing artificial fill or upper alluvial soils for support without implementing proper design measures may lead to a significant impact to the proposed development.

Based on the provided Master Plan and Concept Design sheets, we understand the proposed one-story expansion and the proposed entry pavilions and canopies will be supported on shallow foundations. If the proposed shallow foundations are embedded within the existing artificial fill or compressible upper alluvial soils, the development may experience excessive load-induced total or differential settlement, causing structural distress. To address this potential impact, we recommend excavation and replacement of existing compressible materials within the areas of the proposed improvements.

Excavation and replacement consists of complete removal of artificial fill and/or compressible surficial alluvial soil beneath the areas of the proposed improvements and replacement with compacted structural fill. Based on the past available explorations, we anticipate existing artificial fill depth will range between 1 to 8 feet bgs. This value will be confirmed after completion of our subsurface explorations.

Due to the anticipated soil contamination, onsite soils are not anticipated to be suitable for reuse as fill material and will need to be exported for proper remediation and disposal. Thus, structural fill material will need to be imported onsite. For preliminary earthwork quantity estimates, the "Civil Engineering" sheets prepared by KPFF provide estimated cut and fill quantities. The estimated quantities consist of 7,500 cubic yards of cut material to be exported offsite, and approximately 36,000 cubic yards of fill material to be imported to the site.

The proposed bridge crossing Oil Creek is proposed to be supported on deep foundations. Deep foundations transfer the structure loads to deeper geologic units which are not significantly compressible, thus do not rely on the upper compressible/collapsible soils for support and are not susceptible to the potential load-induced settlement concern. Deep foundations should extend through the fill and upper alluvial soils (Lakewood Formation) and be embedded into the underlying stiff/dense alluvial deposits (San Pedro Formation).

6.3.5 Expansive Soil

Expansive soil occurs when clay particles of certain mineralogy interact with water, causing a volume change. Clay soil may swell with increasing moisture content and contract when dried. This phenomenon generally decreases in magnitude with increasing confining pressure at depth. These volume changes may damage spread footings, grade beams, floor slabs, pavement, and other shallow improvements.

Based on our review of the available data, the upper clay soils within the existing artificial fill and alluvium are subject to expansion and shrinkage resulting from changes in the moisture content. The available data with regard to potential expansive potential is discussed below.

Law/Crandall (1995) noted the onsite clayey soils are expansive. They recommended the expansive soil should not be used beneath building floor slabs or adjacent sidewalks and should not be placed behind retaining walls. Law/Crandall performed an expansion index test for soils collected from Boring B-4 at a depth range of 0 to 5 feet. The test resulted with an Expansion Index (EI) of 98, indicating a high expansion potential (Law/Crandall, 1995).

AECOM (2019) noted that expansion tests performed on collected samples indicated the clayey artificial fill and alluvium has a medium to high expansion potential, which would impact lightly loaded foundation elements and concrete flatwork. AECOM performed two expansion index tests, resulting with EI values of 21 and 64 (for Borings B-15-3 and B-15-4, respectively). An EI value of 21 indicates a low expansion potential, and an EI value of 64 indicates a medium expansion potential (AECOM, 2019).

VB&B (2005b) performed two expansion tests within alluvial clays. The tests resulted with EI values between 65 to 70, indicating a medium soil expansion potential (VB&B, 2005b).

VB&B also reviewed sidewalk heaving issues located north of the Project site (VB&B, 2005a). Prior to construction of the sidewalk, the underlying soils were excavated as deep as 5 feet bgs and recompacted. An expansion test performed on the sidewalk subgrade soil resulted with an EI value of 112, indicating a high expansion potential.

Based on the available data, we anticipate moderately to highly expansive soil to be present onsite, posing a potential significant impact to lightly loaded foundation elements and flatwork (e.g., sidewalks, driveways). Additional expansion testing should be performed for the proposed improvements, particularly in areas of proposed flatwork and lightly loaded canopy foundations. Options to address the potential adverse impact from expansive soils include over-excavation and replacement of the expansive material with a soil having low or non-expansive potential, soil treatment, or through structural design of the proposed improvements.

The recommended option is to overexcavate within the areas of the proposed improvements and replace the expansive material with a soil having a low or non-expansive potential. We recommend that the upper 2 feet of expansive soil (where encountered at the site) be removed and replaced with non-expansive fill.

Another option to address expansive soil potential is to improve the soil through chemical treatment, such as lime treatment. This generally involves mixing a certain percentage of the chemical into the subgrade soil, compacting the mixed soil-chemical material, and then allowing the material curing time prior to continuing construction. The percentage of the chemical addition and the associated engineering properties of the improved soil will need to be determined through geotechnical laboratory testing. If chosen, the geotechnical design report should provide design and construction recommendations related for this option.

A third option is through structural design of the proposed improvements. As discussed above, the expansion potential of soils generally decreases in magnitude with increasing confining pressure at depth. Therefore, structural design option would involve increasing the bearing pressure on the soil and/or extending the foundation or flatwork depth. However, while increasing the bearing pressure reduces the potential impact from expansive soil, it does increase the potential impact associated with excessive settlement. Settlement evaluation should be performed based on the proposed loading conditions and limited to a maximum differential of 1 inch over a 20-foot span within the structure.

6.3.6 Tsunami and Seiche Potential

A tsunami is generated in the ocean from large displacements of the sea floor, which could occur from an earthquake, volcanic explosion, or major submarine landslide. The Project site is located about eight and a half miles from the Pacific Ocean shoreline. In addition, based on the "Tsunami Hazard Areas" figure for the County, Figure 12.3 of the County's General Plan, the Project site does not lie within a tsunami hazard area. Given the distance from the shoreline, tsunamis are not considered a significant hazard to the Project site and the potential impact from a tsunami is considered negligible.

A seiche occurs when an earthquake or landslide disturbs or displaces water in an enclosed body of water, resulting in waves that extend beyond the normal shoreline. Large bodies of uncovered water such as reservoirs, lakes, or ponds are not located directly up gradient or in the vicinity of the Project site. The nearest applicable body of water is the Hollywood Reservoir, located approximately 4 miles toward the north-northeast. Given the distance, seiches are not considered a significant hazard to the Project site and the potential impact from a seiche is considered negligible.

The existing grades around Lake Pit are between 5 to 9 feet higher than the water surface elevation. Given the elevation differences, the potential for a seiche from Lake Pit to impact the Project is unlikely.

6.3.7 Tar-Impacted Soil and Groundwater Disposal

As discussed above, tar-impacted soil is anticipated for soil beneath the groundwater. Tar-impacted soils and groundwater should be anticipated for excavations deeper than about 10 feet bgs. Based on our experience in the site vicinity, tar content of impacted soil is typically between 10% and 20%. Higher tar content and/or shallower depth of tar-impacted soil could be encountered near tar seeps observed in the Project vicinity.

Spoils from drilling of deep foundations and other excavations that extend below the groundwater will likely contain natural oil or tar. Excavation spoils will require chemical analyses for offsite disposal characterization. If the spoils are characterized as non-hazardous, export to a normal disposal facility is likely. If the spoils are characterized as hazardous, they will require disposal at a designated hazardous waste facility, which is comparatively more expensive than a normal disposal facility. We anticipate groundwater pumped from excavations will require treatment before disposal.

6.3.8 Oil Wells

The likelihood of encountering any known or previously undiscovered oil production well at the site is low. However, if an oil production well is encountered during construction activities, construction work should halt in the immediate area. Both CalGEM and the City Fire Department should be notified immediately. The oil production well(s) should be abandoned in accordance with the requirements of CalGEM and the Los Angeles Fire Department.

6.4 Regulatory Requirements

6.4.1 Development of a Geotechnical Investigation and Geologic Hazard Report

Per Section 1803 of the CLABC, the Project-specific geotechnical investigation and geologic hazard report (i.e., geotechnical design report) will address final design of the Project, incorporating recommendations to mitigate the hazards identified herein. The report shall meet 2020 CLABC requirements and the most current guidelines developed by the County of Los Angeles Department of Public Works Geotechnical and Materials Engineering Division (GMED). Specifically, the report shall:

- Confirm seismic ground-motion parameters,
- Further develop the soil profile at the site,
- Confirm groundwater conditions at the site are as anticipated,
- Evaluate soil strength and adequacy of load-bearing soils,
- Evaluate total and differential settlement potential,
- Recommend structural fill material properties and testing,
- Provide recommendations and design criteria for deep foundation systems, and
- Provide special design and construction criteria for shallow foundations and flatwork founded on expansive soils.

The report shall be prepared by a California-registered geotechnical engineer and California-certified engineering geologist. The geotechnical design and construction recommendations outlined in the geotechnical design report should be incorporated into the Project plans and specifications. Construction of the proposed Project shall be in accordance with the approved plans.

6.4.2 Seismic Loading Conditions

Required earthquake loading considerations are outlined in Section 1613 of the 2020 CLABC. Per Section 1613, every structure or portion of a structure shall be designed to resist the effects of earthquake motions in accordance with the CLABC and ASCE 7, as applicable.

6.4.3 Earthwork Activities

Earthwork activities, such as excavation, grading, and fill placement, shall follow the 2020 CLABC standards outlined in Section 1804 and Appendix J. The final geotechnical design report should provide general design and construction recommendation for earthwork activities.

6.4.4 Drainage

Drainage is a significant factor in the long-term performance of any structure or slope. We recommend drainage devices be incorporated into the civil design to improve performances and limit the potential for foundation instability or excessive erosion. We recommend sloping grades and pavement surfaces to promote gravity flow to drainage swales and catch basins. As discussed above, site grading shall follow the requirements outlined in Section 1804 and Appendix J of the 2020 CLABC, which includes guidelines for site grading to promote positive drainage flow.

6.4.5 Compliance to Applicable Building Codes and Regulations

Project design and construction shall comply with the 2020 CLABC, the most current guidelines outlined by GMED, general County laws, applicable standards published by the State of California, and the recommendations set forth in the geotechnical design report.

7 LIMITATIONS

The recommendations provided in this report are based upon our understanding of the described Project information and our interpretation of the data collected from past subsurface explorations performed by us and others. We have made our recommendations based upon experience with similar subsurface conditions under similar loading conditions. The recommendations apply to the specific Project discussed in this report; therefore, any change in the structure configuration, loads, location, or the site grades should be provided to us so that we can review or conclusions and recommendations and make any necessary modifications.

S&W has prepared and included the document, "Important Information About Your Geology and Soils Discipline Report" to assist you and others in understanding the use and limitations of our report.

8 REFERENCES

8.1 Report Bibliography

Numerous geotechnical studies have been performed within or adjacent to the Project site. Those prior studies have formed the basis for the findings, conclusions and recommendations contained in this report. An alphabetical listing of the prior reports, by the firm responsible for preparation of those reports, is listed below.

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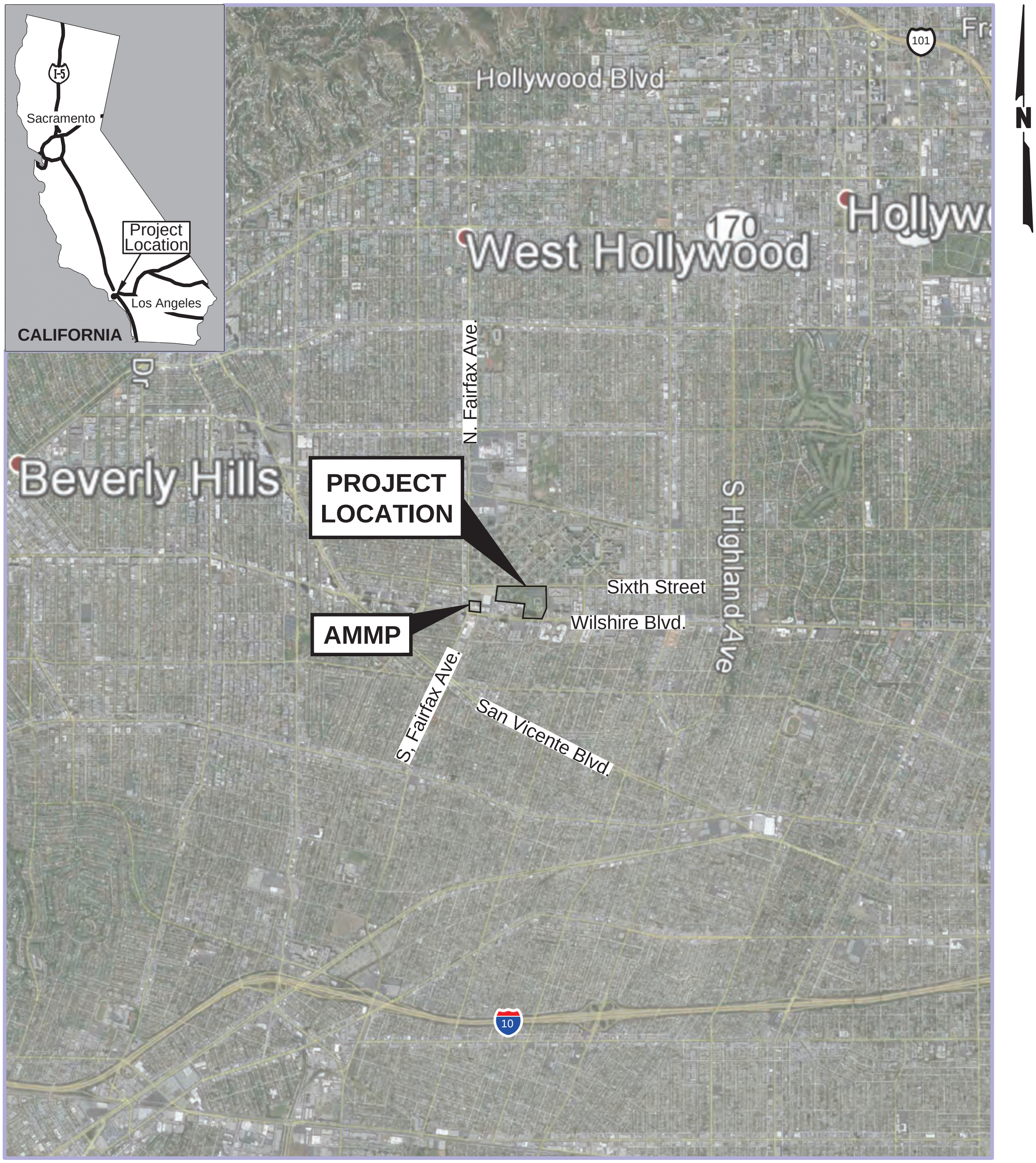

0 2000 4000 8000

SCALE: 1"=4000'

La Brea Tar Pits Museum Master Plan
Hancock Park
Los Angeles, California

VICINITY MAP

January 2023 109748-001

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 1

Filename: C:\Users\jrs\CAD Group Dropbox\JDrive_LAX\109748\001\109748-001 Vicinity Map.dwg Layout: Figure 1 Date: 09-20-2022 Login: JRS

LEGEND

Approximate Limit of Work

AECOM-B-15-4 Boring Designation and Approximate Location *(AECOM, 2019)*

AMC-2014-M-109 Boring Designation and Approximate Location *(Metro GDR, 2014)*

VBB-2005-B-5 Boring Designation and Approximate Location *(Van Beveren & Butelo, 2005)*

URS-2003-B-4 Boring Designation and Approximate Location *(URS, 2003)*

URS-2002-B-2 Boring Designation and Approximate Location *(URS, 2002)*

L/C-1998-B-9 Boring Designation and Approximate Location *(Law-Crandall, 1998)*

L/C-1995-B-9 Boring Designation and Approximate Location *(Law-Crandall, 1995)*

LCA-1984-B-4 Boring Designation and Approximate Location *(LeRoy Crandall, 1984)*

LCA-1982-B-3 Boring Designation and Approximate Location *(LeRoy Crandall, 1982)*

0 120 240

Scale in Feet

La Brea Tar Pits Museum Master Plan
Hancock Park
Los Angeles, California

SITE PLAN

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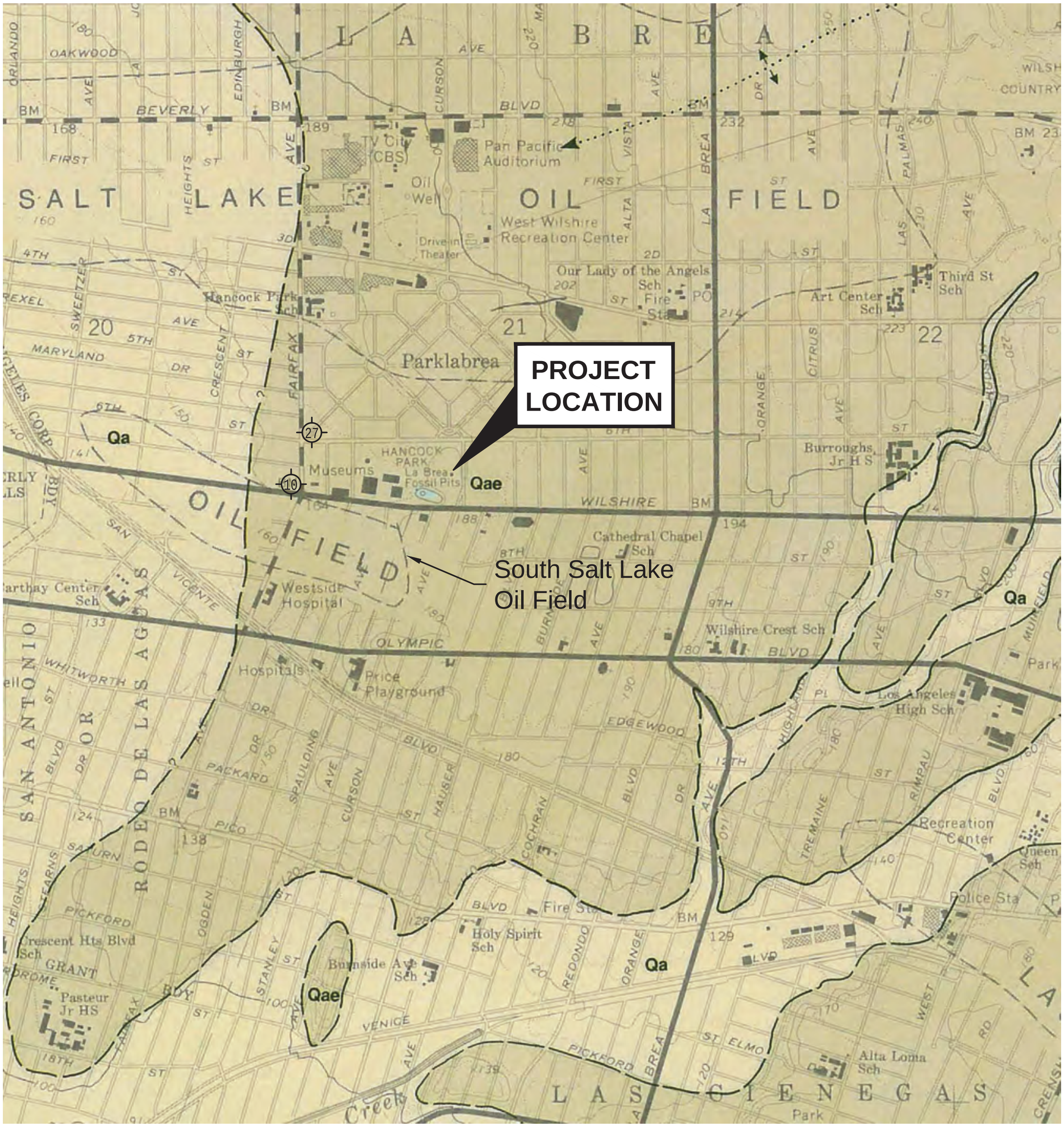
FIG. 2

Filename: C:\Users\jrs\CAD Group Dropbox\J Drive_LAX\109748\001\109748-001 Site Plan.dwg Layout: Figure 2 Date: 09-20-2022 Login: JRS



LEGEND

Geologic Units

Qa Alluvium

Qae Alluvium (Elevated)

Oil Wells

(10) Chevron 10

(27) Chevron Salt Lake 27

NOTE

Map adapted from drawing titled Geologic Map of the Hollywood and Burbank Quadrangle, by Thomas W. Dibblee, jr., 1991.

0 1000 2000 4000

SCALE: 1"=2000'

La Brea Tar Pits Museum Master Plan
Hancock Park
Los Angeles, California

REGIONAL GEOLOGY MAP

January 2023 109748-001

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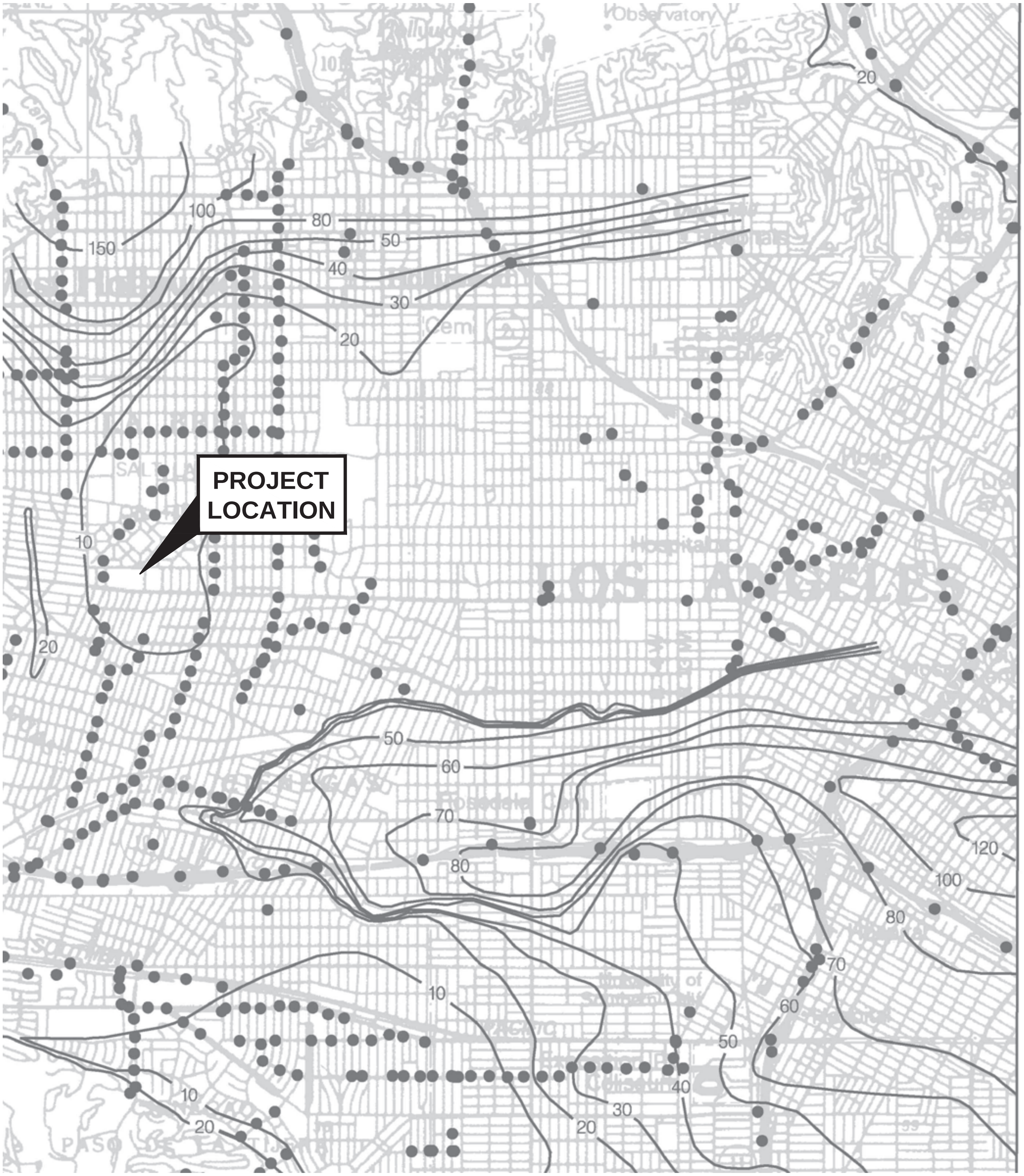
FIG. 3

Filename: C:\Users\jrs\CAD Group Dropbox\JDrive_LAX\109748\001\109748-001 Geology Map.dwg Layout: Figure 3 Date: 08-25-2022 Login: JRS



0 0.5 1 2

SCALE: 1 inch = 1 mile

NOTES

1. Numbers are depth below ground surface.
2. Map adapted from Seismic Hazard Zone Report For the Hollywood 7.5-Minute Quadrangle, Los Angeles County, California, Plate 1.2, 1998.

N

La Brea Tar Pits Museum Master Plan
Hancock Park
Los Angeles, California

HISTORICAL HIGH GROUNDWATER MAP

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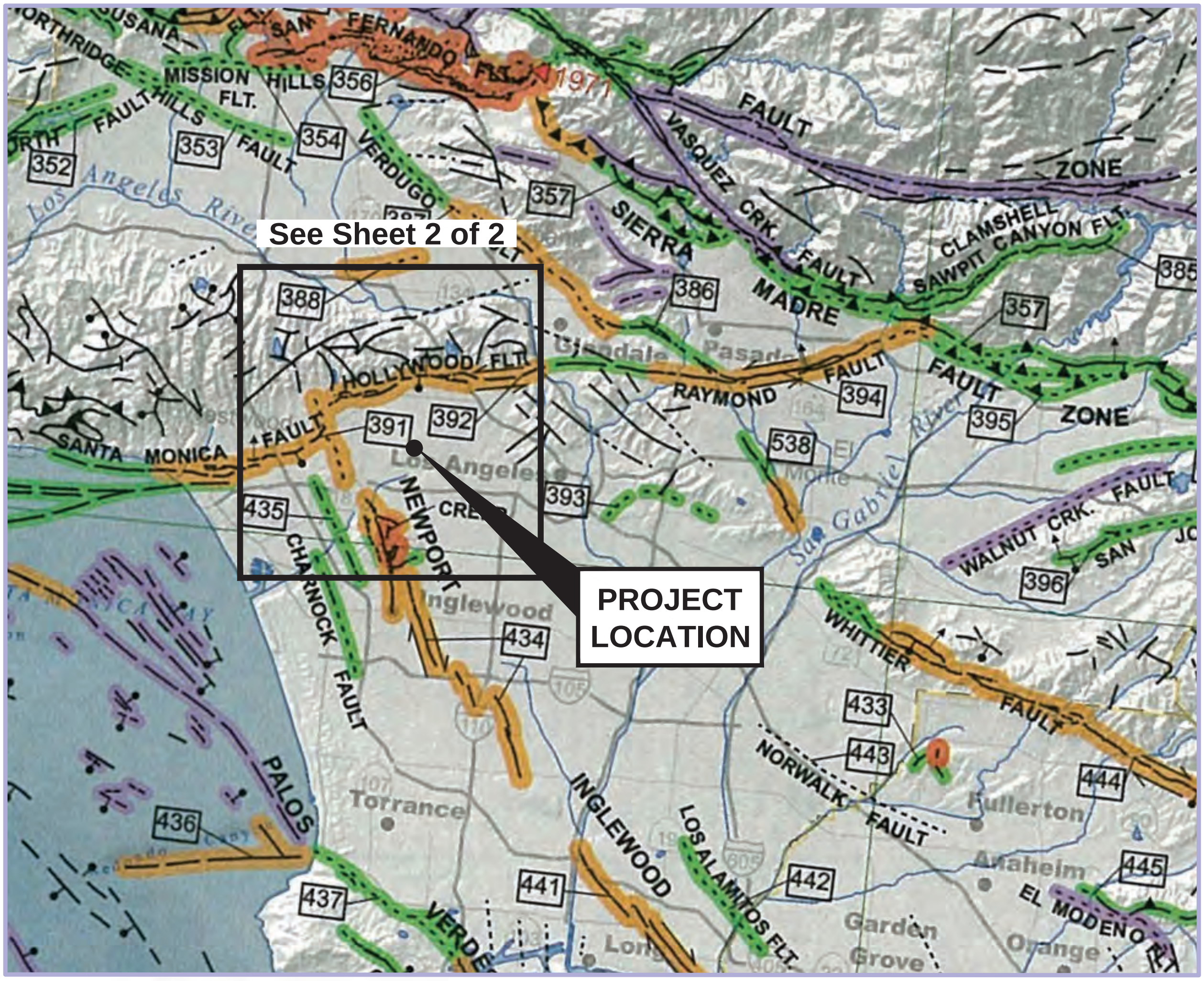
FIG. 4

Filename: C:\Users\jrs\CAD Group Dropbox\JDrive_LAX\109748\001\109748-001 Hist High GW.dwg Layout: Figure 4 Date: 08-25-2022 Login: JRS



EXPLANATION

Fault traces on land are indicated by solid lines where well located, by dashed lines where approximately located or inferred, and by dotted lines where concealed by younger rocks or by lakes or bays. Fault traces are queried where continuation or existence is uncertain.

FAULT CLASSIFICATION COLOR CODE
(Indicating Recency of Movement)

Fault along which historic (last 200 years) displacement has occurred.

Holocene fault displacement (during past 11,700 years) without historic record.

Late Quaternary fault displacement (during past 700,000 years).

Quaternary fault (age undifferentiated).

Pre-Quaternary fault (older that 1.6 million years) or fault without recognized Quaternary displacement.

ADDITIONAL FAULT SYMBOLS

Bar and ball on downthrown side (relative or apparent).

Arrows along fault indicate relative or apparent direction of lateral movement.

Arrow on fault indicates direction of dip.

Low angle fault (barbs on upper plate).

0 20,000 40,000 80,000

SCALE: 1"=40,000'

NOTE

Map adapted from Fault Activity Map of California, 2010 by California Geological Survey.

La Brea Tar Pits Museum Master Plan
Hancock Park
Los Angeles, California

REGIONAL FAULT MAP

January 2023 109748-001

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FIG. 5
Sheet 1 of 2

Filename: C:\Users\jrs\CAD Group Dropbox\JDrive_LAX\109748\001\109748-001 Fault Map.dwg Layout: Figure 5-1 Date: 08-25-2022 Login: JRS

N

EXPLANATION

Fault traces on land are indicated by solid lines where well located, by dashed lines where approximately located or inferred, and by dotted lines where concealed by younger rocks or by lakes or bays. Fault traces are queried where continuation or existence is uncertain.

FAULT CLASSIFICATION COLOR CODE
(Indicating Recency of Movement)

Fault along which historic (last 200 years) displacement has occurred.

Holocene fault displacement (during past 11,700 years) without historic record.

Late Quaternary fault displacement (during past 700,000 years).

Quaternary fault (age undifferentiated).

Pre-Quaternary fault (older that 1.6 million years) or fault without recognized Quaternary displacement.

ADDITIONAL FAULT SYMBOLS

Bar and ball on downthrown side (relative or apparent).

Arrows along fault indicate relative or apparent direction of lateral movement.

Arrow on fault indicates direction of dip.

Low angle fault (barbs on upper plate).

0 5,000 10,000 20,000

SCALE: 1"=10,000'

NOTE

Map adapted from Fault Activity Map of California, 2010 by California Geological Survey.

La Brea Tar Pits Museum Master Plan
Hancock Park
Los Angeles, California

REGIONAL FAULT MAP

January 2023 109748-001

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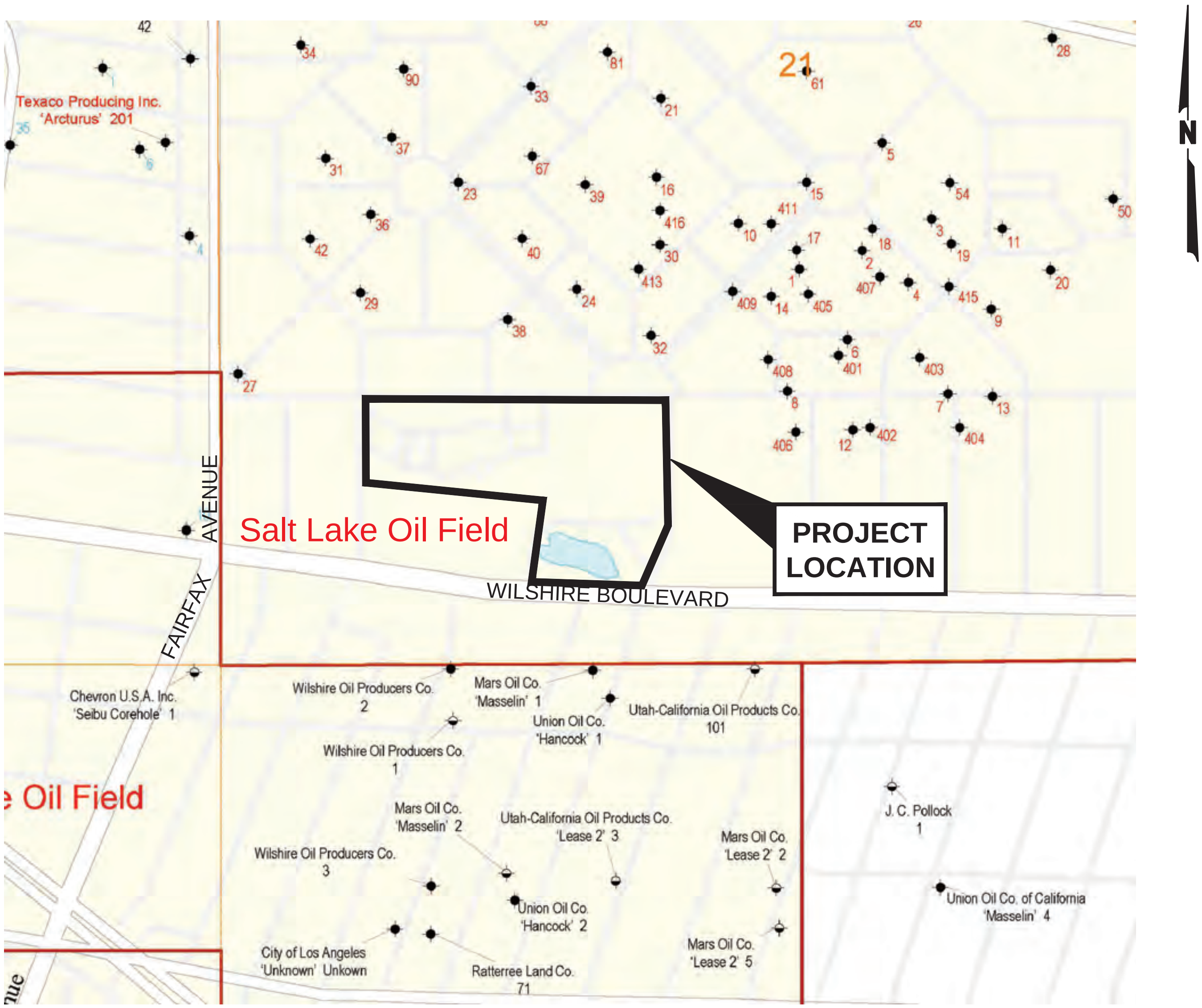
FIG. 5
Sheet 2 of 2

Filename: C:\Users\jrs\CAD Group Dropbox\JDrive_LAX\109748\001\109748-001 Fault Map.dwg Layout: Figure 5-2 Date: 08-25-2022 Login: JRS



0 1000 2000

Scale in Feet

LEGEND

- Plugged and abandoned - oil
- Drilling - idle
- Plugged and abandoned - dry hole

NOTE

Map adapted from Oil Field Map, District 1, Map 118, by Division of Oil, Gas, and Geothermal Resources, dated September 17, 2003.

La Brea Tar Pits Museum Master Plan
Hancock Park
Los Angeles, California

OIL WELL AND FIELD MAP

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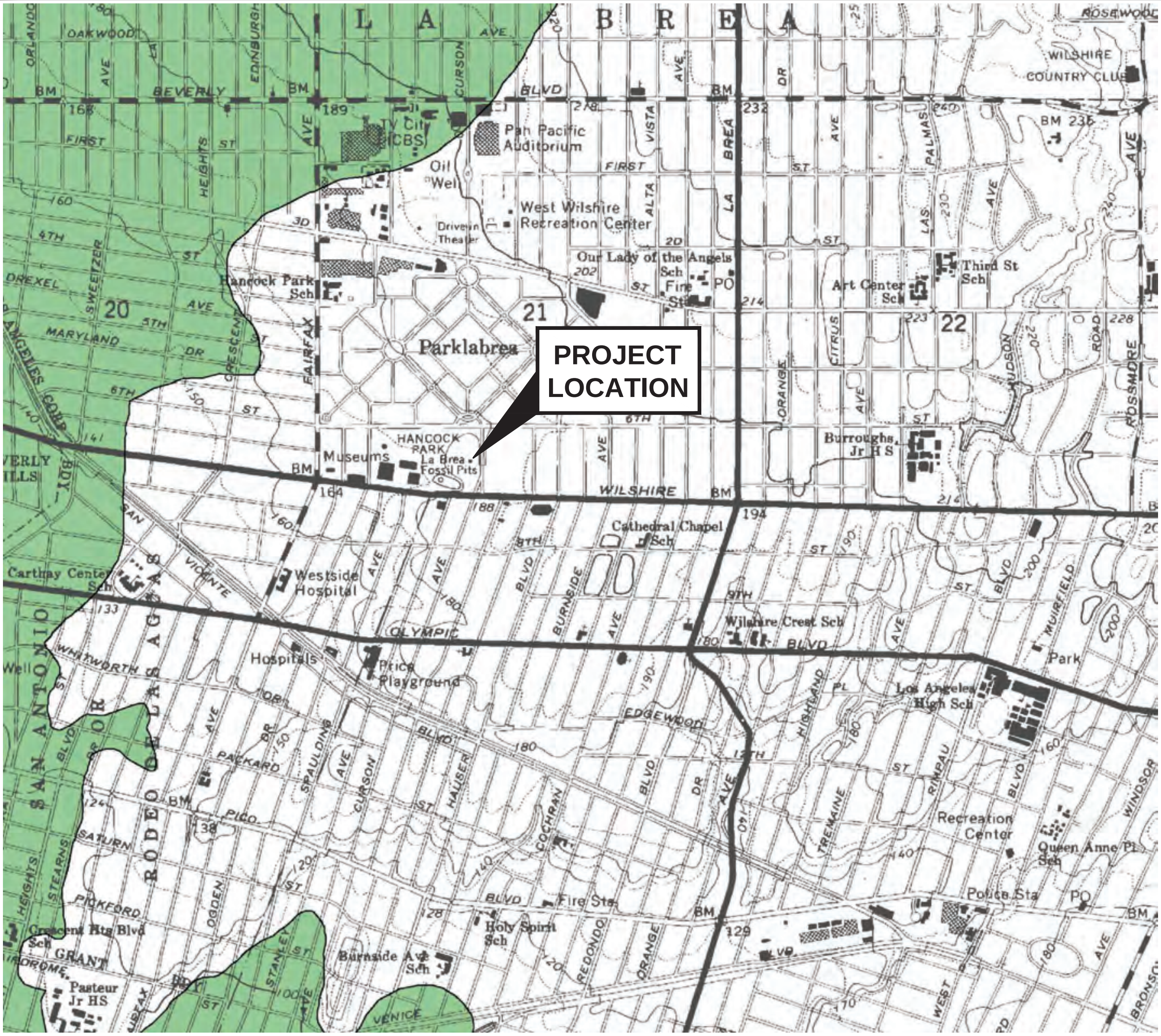
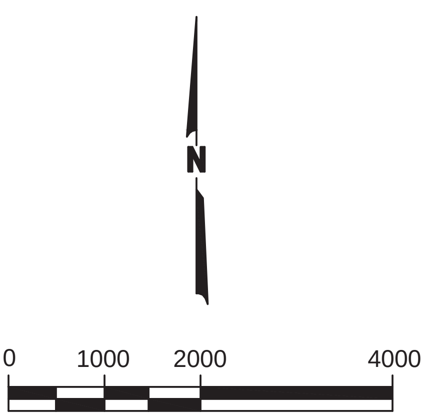
FIG. 6

Filename: C:\Users\jrs\CAD Group Dropbox\JDrive_LAX\109748\001\109748-001 Oil Well and Field.dwg Layout: Figure 7 Date: 09-20-2022 Login: JRS





SCALE: 1"=2000'

NOTE

Map adapted from drawing titled State of California Seismic Hazards Zones, Hollywood Quadrangle, By Division of Mines and Geology, Dated March 25, 1999.

MAP EXPLANATION

Zones of Required Investigation:

Liquefaction
Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Earthquake-Induced Landslides
Areas where previous occurrence of landslide movement, or local topographic, geological, geotechnical and subsurface water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

La Brea Tar Pits Museum Master Plan
Hancock Park
Los Angeles, California

SEISMIC HAZARD ZONES MAP

January 2023 | 109748-001

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 7

Filename: C:\Users\jrs\CAD Group Dropbox\JDrive_LAX\109748\001\109748-001 Seismic Hazards.dwg Layout: Figure 6 Date: 08-25-2022 Login: JRS

APPENDIX A: PAST S&W AND VB&B FIELD EXPLORATIONS

Appendix A

Past S&W and VB&B Field Explorations

CONTENTS

BORING 4

Date Drilled: October 4, 2004
Equipment Used: Rotary Wash (5-inch-dia.)

Depth to Water: 6.6 feet
Driving Weight & Drop: 400 lbs. / 18 inches (Sample)
140 lbs. / 30 inches (SPT)

SURFACE ELEVATION: 171.0 feet MSL

ELEVATION (feet)	DEPTH (feet)	MOISTURE* (% of dry wt.)	DRY DENSITY** (pcf)	N VALUE (SPT)	BLOW COUNT (blows/foot)	DESCRIPTION
170						Landscape Layer **FILL** SC - SANDY CLAY - brown
		18.2	107		12	
	5					
165		19.5	105		14	bluish gray to brown
						some gravel (up to 1")
						NATURAL CH - CLAY - some sand, bluish gray
	10					
160		38.3	82		8	[LL=57, PI=45]
	15					
155		24.8	99		17	some asphalt stains
						SM - SILTY SAND - fine to medium, some asphalt stains, brown
	20					
150		19.0	105		17	SP - ASPHALT SAND - fine, black
		16.0	104		19	
	25					
145		14.0	102		27	
		6.9	111		28	
					31	[No Sample Recovery]
	30					
140		7.8	110		35	
		5.9	114		35	
	35					
135				55 for 6"		few gravel (up to 3/4")
	40					

(Continued on next page)

* MOISTURE = VOLATILE LIQUIDS

** DRY DENSITIES INCLUDE THE WEIGHT OF SOIL AND NON-VOLATILE ASPHALT

LOG OF BORING

VAN BEVEREN & BUTELO, INC.

FIGURE A-1.4a

Job No: 04-053 By: FA Date: 10-18-2004 Checked: VB Printed: 10-25-04 [LOG FOR FIELD; 04-053.GPJ]

The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

BORING 4
(Continued)

Date Drilled: October 4, 2004
Equipment Used: Rotary Wash (5-inch-dia.)

Depth to Water: 6.6 feet
Driving Weight & Drop: 400 lbs. / 18 inches (Sample)
140 lbs. / 30 inches (SPT)

SURFACE ELEVATION: 171.0 feet MSL

ELEVATION (feet)	DEPTH (feet)	MOISTURE* (% of dry wt.)	DRY DENSITY** (pcf)	N VALUE (SPT)	BLOW COUNT (blows/foot)	SAMPLE LOCATION	DESCRIPTION
130							*SP - ASPHALT SAND - (Continued)*
		5.2	103		58	Sample	few gravel (up to 1")
125	45						
				53 for 6"		SPT	
120	50						
		4.8	114		53	Sample	few shells
115	55						
				57 for 6"		SPT	
110	60						
		4.7	100		50	Sample	
105	65						
				35 for 6" 50 for 4"		SPT	
100	70						
		6.8	103		50	Sample	
95	75						**END OF BORING AT 75 FEET.**
	80						

Notes:

1) Fill to 8 feet.

2) Groundwater measured at a depth of 6.6 feet, 15 days after completion of drilling.

3) Installed two-inch-diameter PVC casing to permit future groundwater monitoring. Casing bottom covered with cap and sealed. Drilling mud removed before well construction.

4) Boring covered with traffic cover. Soil cuttings and drilling mud placed in disposal barrels.

The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

Job No: 04-053 By: FA Date: 10-18-2004 Checked: VB Printed: 10-25-04 [LOG FOR FIELD; 04-053.GPJ]

* MOISTURE = VOLATILE LIQUIDS

** DRY DENSITIES INCLUDE THE WEIGHT OF SOIL AND NON-VOLATILE ASPHALT

LOG OF BORING

VAN BEVEREN & BUTELO, INC.

FIGURE A-1.4b

BORING 5

Date Drilled: October 5, 2004
Equipment Used: Rotary Wash (5-inch-dia.)
Depth to Water: 5.5 feet
Driving Weight & Drop: 400 lbs. / 18 inches (Sample)
140 lbs. / 30 inches (SPT)

SURFACE ELEVATION: 170.1 feet MSL

ELEVATION (feet)	DEPTH (feet)	MOISTURE* (% of dry wt.)	DRY DENSITY** (pcf)	N VALUE (SPT)	BLOW COUNT (blows/foot)	SAMPLE LOCATION	DESCRIPTION
							Landscape Layer
							FILL SC - SANDY CLAY - brown
							NATURAL SM - SILTY SAND - fine to medium, brown
		18.0	105		12	■	
							SP/SM - SAND/SILTY SAND - fine to medium, some gravel (up to 2"), brown
165	5						
		14.4	116		17	■	[11.5% Passing 200 Sieve]
160	10						CH - CLAY - some sand and peat, some asphalt stains, bluish gray to dark gray
					11	☒	[No Sample Recovery]
155	15						
		38.3	76		12	■	
150	20						
		25.8	91		12	■	few gravel (up to 2")
							SP - ASPHALT SAND - fine, black
145	25	6.1	110		50	■	
		6.6	111		40	■	few gravel (up to 1½")
		6.9	109		40	■	
140	30	4.9	108		50	■	
		6.4	111		50	■	
135	35	4.8	105		50	■	
	40			53 for 6"		◩	

(Continued on next page)

* MOISTURE = VOLATILE LIQUIDS

** DRY DENSITIES INCLUDE THE WEIGHT OF SOIL AND NON-VOLATILE ASPHALT

LOG OF BORING

Job No: 04-053 By: FA Date: 10-18-2004 Checked: VB Printed: 10-25-04 [LOG FOR FIELD; 04-053.GPJ]

The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

VAN BEVEREN & BUTELO, INC.

FIGURE A-1.5a

BORING 5

(Continued)

Date Drilled: October 5, 2004
Equipment Used: Rotary Wash (5-inch-dia.)

Depth to Water: 5.5 feet
Driving Weight & Drop: 400 lbs. / 18 inches (Sample)
140 lbs. / 30 inches (SPT)

SURFACE ELEVATION: 170.1 feet MSL

ELEVATION (feet)	DEPTH (feet)	MOISTURE* (% of dry wt.)	DRY DENSITY** (pcf)	N VALUE (SPT)	BLOW COUNT (blows/foot)	SAMPLE LOCATION	DESCRIPTION
							SP - ASPHALT SAND - (Continued)
125	45	3.4	104		50	■	
							few thin gravelly layers [Rig Chattering]
120	50			40 for 6" 50 for 6"		◪	
115	55	5.2	107		50	■	few gravel (up to 1")
110	60			43 for 6" 50 for 3"		◪	
105	65	3.6	111		50	■	few gravel (up to ½")
100	70			39 for 6" 50 for 2"		◪	
							few shells
95	75	3.7	118		50	■	**END OF BORING AT 75 FEET.**
	80						

Notes:

1) Fill to 2 feet.
2) Groundwater measured at a depth of 5.5 feet, 14 days after completion of drilling.
3) Installed two-inch-diameter PVC casing to permit future groundwater monitoring. Casing bottom covered with cap and sealed. Drilling mud removed before well construction.
4) Boring covered with traffic cover. Soil cuttings and drilling mud placed in disposal barrels.

Job No: 04-053 By: FA Date: 10-18-2004 Checked: VB Printed: 10-25-04 [LOG FOR FIELD: 04-053.GPJ]

The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

* MOISTURE = VOLATILE LIQUIDS

** DRY DENSITIES INCLUDE THE WEIGHT OF SOIL AND NON-VOLATILE ASPHALT

LOG OF BORING

VAN BEVEREN & BUTELO, INC.

FIGURE A-1.5b

Appendix B

Previous Explorations by Others

CONTENTS

- Law/Crandall, Inc. (1995), Report for Proposed Additions to Hancock Park
  - Boring B-1
  - Boring B-2
  - Boring B-3
  - Boring B-4
  - Boring B-5
  - Boring B-6
  - Boring B-7
  - Boring B-8
  - Boring B-9
- LeRoy Crandall and Associates (1982), Proposed Additions at 5905 Wilshire Boulevard
  - Boring B-1
  - Boring B-3
- LeRoy Crandall and Associates (1984), Completion of Exploration Program
  - Boring B-4

Date(s) Drilled	11/20/15	Logged By	ALC
Drilling Method	Hollow Stem Auger	Drill Bit Size/Type	7-1/2" bullet bit
Drill Rig Type	CME 75	Hammer Data	140 lbs, 30-inch drop
Sampling Method(s)	Bulk, SPT, MC		
Approximate Groundwater Depth and Date Measured	No groundwater encountered		
Coordinate System		Location (ft and/or °)	Latitude 34.06332 Longitude -118.35712

Boring B-15-2

Sheet 1 of 3

Job Number	60440464
Total Depth Drilled (ft)	87.5
Approximate Ground Surface Elevation (ft)	171.2

Elevation (ft)	Depth (ft)	SAMPLES Type	Number	Blows per foot	Blows per 6 inches	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	% Passing No. 200 Sieve	Liquid Limit (%)	Plasticity Index (%)	PID Reading (ppm)	OTHER TESTS AND REMARKS
	0					AC	**4-inch thick Asphalt**							
170						BASE	**14-inch thick Base**							
						CH	**ALLUVIUM [Qal]** **Sandy Fat CLAY** medium stiff to stiff, greenish gray mottled with dark brown, moist, high plasticity, some fine to coarse SAND, bedded with 5-inch thin layer of Sandy Lean CLAY, dark brown, moist, fine-grained sand							
	5	SPT	1	7	2 3 4			28		54	56	36		
	10					SC	**Clayey SAND** dense, dark grayish brown to very dark brown, moist, low to medium plasticity							
160		MC	2	43	16 19 24			20	81	40	46	19		DSCD, CORR, CON
	15					CL	**LAKEWOOD FORMATION [Qlw]** **Sandy Lean CLAY** stiff to very stiff, very dark brown, moist, some fine SAND, low to medium plasticity, with tar veins							
		SPT	3	12	2 4 8			19		65				Tar Content (6.1%)
	20					SM	**SAN PEDRO FORMATION [Qsp]** **Silty SAND** very dense, black, slightly moist, fine to medium, with tar, strong hydrocarbon odor							
150		MC	4	100+	24 48 50/2"			13	98					TXCU
	25					SM	**Silty SAND with GRAVEL** very dense, black mottled with olive, slightly moist, little fine subangular GRAVEL, bedded with 2-inch thin layer of bluish gray SILT							
		SPT	5	100+	33 41 50/4"			4						Tar Content (11.4%)
	30													

This log is part of the report prepared by AECOM for this project and should be read together with the report. This summary applies only at the location of the exploration and at the time of drilling or excavation. Subsurface conditions may differ at other locations and may change at this location with time. Data presented are a simplification of actual conditions encountered.

LOG OF BORING

LACMA Phase III Transformation Project
5905 Wilshire Blvd, Los Angeles, CA
FOR: Los Angeles County Museum of Art

AECOM

Report: DMG4; Project File: C:\USERS\DENNIS.NGUYEN\DESKTOP\EARLY SITE PREPARATION\BORING LOGS REV3.GPJ; Data Template:URS HSA LOGS 2010.GDT Printed: 7/30/19

Elevation (ft)	Depth (ft)	Type	Number	Blows per foot	Blows per 6 inches	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	% Passing No. 200 Sieve	Liquid Limit (%)	Plasticity Index (%)	PID Reading (ppm)	OTHER TESTS AND REMARKS
	30						SP	**Poorly graded SAND with GRAVEL**							
140			6	100+	49 50/4"			very dense, black, slightly moist, fine to medium, little coarse sand, little fine gravel, trace of coarse subrounded to rounded gravel, strong hydrocarbon odor							
	35						SP-SM	**Poorly graded SAND with SILT and GRAVEL**							
			7	58	14 24 34			very dense, black, slightly moist, fine to medium, little coarse, little fine subrounded gravel, strong hydrocarbon odor	2						Tar Content (17.5%)
	40						SP-SM	**Poorly graded SAND with SILT**							
130			8	100+	32 50/5"			very dense, black, moist, fine to medium grained, trace fine subangular gravel, trace shell fragments	3	121					TXCU
	45														
			9	100+	32 50/4"			some coarse grained, few fine angular gravel							
	50														
120			10	100+	32 48 50/5"			fine SAND, trace coarse, trace fine angular gravel							
	55														
			11	36	12 15 21		CL	little shell fragments **Lean CLAY** hard, very dark grayish brown, moist, medium plasticity, few tar veins	21						Tar Content (14.9%)
	60														
110			12	100+	50/5"			dark brown, few fine sand	21	98					
	65														
			13	34	9 12			very dark grayish brown, light hydrocarbon odor							

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Elevation (ft)	Depth (ft)	Samples: Type	Samples: Number	Samples: Blows per foot	Samples: Blows per 6 inches	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	% Passing No. 200 Sieve	Liquid Limit (%)	Plasticity Index (%)	PID Reading (ppm)	OTHER TESTS AND REMARKS
					22		CL	**Lean CLAY** *(continued)*							
	70														
100			14	100+	20 50/5"			very dark grayish brown mottled with dark olive brown, some tar veins, strong hydrocarbon odor							
	75														
			15	45	10 19 26			very dark grayish brown, trace tar veins	20						Tar Content (10.6%)
	80														
90			16	100+	21 50/5"			no tar veins	14	95					
	85														
			17	42	10 17 25			very dark brown, trace tar veins							
								Bottom of boring at 87.5 feet bgs. No groundwater was encoundered during drilling. Boring backfilled with cement bentonite grout.							
	90														
80															
	95														
	100														
70															
	105														

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LOG OF BORING

LACMA Phase III Transformation Project

AECOM

Date(s) Drilled	11/2/15-11/3/15	Logged By	ALC
Drilling Method	Hollow Stem Auger	Drill Bit Size/Type	7-1/2" bullet bit
Drill Rig Type	CME 75 (Limited Access)	Hammer Data	140 lbs, 30-inch drop
Sampling Method(s)	Bulk, SPT, MC		
Approximate Groundwater Depth and Date Measured	Groundwater encountered approximately at 30' bgs.		
Coordinate System		Location (ft and/or °)	Latitude 34.06282 Longitude -118.35757

Boring B-15-3

Sheet 1 of 3

Job Number	60440464
Total Depth Drilled (ft)	88.5
Approximate Ground Surface Elevation (ft)	168.5

Elevation (ft)	Depth (ft)	Samples: Type	Samples: Number	Samples: Blows per foot	Samples: Blows per 6 inches	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	% Passing No. 200 Sieve	Liquid Limit (%)	Plasticity Index (%)	PID Reading (ppm)	OTHER TESTS AND REMARKS
	0						CONC	**16-inch thick Concrete**							
							CL	**ARTIFICIAL FILL [af]** **Sandy Lean CLAY** very stiff to hard, black, moist, low to medium plasticity, very fine grained sand							
	5	Bulk	BLK-1												EI (21)
			1	53	33 29 24										
160															
							CL	**LAKEWOOD FORMATION [Qlw]** **Sandy Lean CLAY** very stiff, very dark brown, medium plasticity, with little tar along fractures							
	10														
			2	19	4 9 10										
	15	Bulk	BLK-2												
							SM	**SAN PEDRO FORMATION [Qsp]** **Silty SAND** dense, black, moist, fine- to medium grained							
			3	46	13 19 27				3	121					TXCU
150															
	20														
			4	32	11 13 19			fine- to medium-grained sand, increase in tar	2						Tar Content (14.1%)
	25	Bulk	BLK-3												
							SP-SM	**Poorly graded SAND with SILT** very dense, black, moist, medium-grained sand, trace subrounded gravel							
			5	100+	22 50/6"				4	118					TXCU
140															
	30														

This log is part of the report prepared by AECOM for this project and should be read together with the report. This summary applies only at the location of the exploration and at the time of drilling or excavation. Subsurface conditions may differ at other locations and may change at this location with time. Data presented are a simplification of actual conditions encountered.

LOG OF BORING

LACMA Phase III Transformation Project
5905 Wilshire Blvd, Los Angeles, CA
FOR: Los Angeles County Museum of Art

AECOM

Report: DMG4; Project File: C:\USERS\DENNIS.NGUYEN\DESKTOP\EARLY SITE PREPARATION\BORING LOGS REV3.GPJ; Data Template:URS HSA LOGS 2010.GDT Printed: 7/30/19

Elevation (ft)	Depth (ft)	Type	Number	Blows per foot	Blows per 6 inches	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	% Passing No. 200 Sieve	Liquid Limit (%)	Plasticity Index (%)	PID Reading (ppm)	OTHER TESTS AND REMARKS
	30					SM	**Silty SAND** very dense, balck, moist, with three 1-inch layers of fine subrounded to rounded gravel, trace of well lenses							
			6	45	15 17 28			5						Tar Content (14.6%)
	35		BLK-4											
						SM	**Silty SAND with GRAVEL** very dense, black, moist, fine to medium grained, little fine gravel, with tar, strong hydrocarbon odor							
			7	100+	29 49 50/3"			20	74					TXCU
130														
	40													Tar Content (17.7%)
						SP-SM	**Poorly graded SAND with SILT** very dense, black, moist, trace of shell fragments							
			8	42	15 19 23			4						Tar Content (16.8%)
	45		BLK-5											
						SM	**Silty SAND** black, moist, fine to medium grained, with pockets of clay, trace subrounded coarse gravel							
			9	100+	42 50/3"									
120														
	50													
			10	41	14 18 23		no clay, no gravel							
	55		BLK-6											
			11	100+	26 52/6"		little coarse grained sand	11	98					
110						CL	**Lean CLAY** hard, dark brown, moist, low to medium plasticity							
	60													
			12	35	9 15 20			20						Tar Content (15.9%)
	65		BLK-7											
			13	100+	20									

LOG OF BORING
LACMA Phase III Transformation Project

AECOM

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Elevation (ft)	Depth (ft)	Type	Number	Blows per foot	Blows per 6 inches	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	% Passing No. 200 Sieve	Liquid Limit (%)	Plasticity Index (%)	PID Reading (ppm)	OTHER TESTS AND REMARKS
					58/6"		CL	**Lean CLAY***(continued)*							
100															
	70														
			14	44	10 17 27			top 6-inches with spots of tar along fractures							Tar Content (12.7%)
	75		BLK-8												
			15	100+	30 50/4.5"			trace of tar along fractures	18	91					
90															
	80														
			16	40	10 16 24			tar along fractures	18						Tar Content (10.8%)
	85														
			17	100+	25 52/6"										
80								Bottom of boring at 88.5 feet bgs. Borehole was backfilled with cement bentonite grout to 59 feet bgs, and was converted to groundwater monitoring well.							
	90														
	95														
70															
	100														
	105														

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LOG OF BORING

LACMA Phase III Transformation Project

AECOM

Date(s) Drilled	10/15/15-10/16/16	Logged By	ALC
Drilling Method	Rotary Wash	Drill Bit Size/Type	3-7/8" tricone bit
Drill Rig Type	D20	Hammer Data	140 lbs, 30-inch drop
Sampling Method(s)	Bulk, SPT, MC		
Approximate Groundwater Depth and Date Measured	Not measured		
Coordinate System		Location (ft and/or °)	Latitude 34.06401 Longitude -118.35857

Boring B-15-4

Sheet 1 of 4

Job Number	60440464
Total Depth Drilled (ft)	121.5
Approximate Ground Surface Elevation (ft)	169.8

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Elevation (ft)	Depth (ft)	SAMPLES Type	Number	Blows per foot	Blows per 6 inches	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	% Passing No. 200 Sieve	Liquid Limit (%)	Plasticity Index (%)	PID Reading (ppm)	OTHER TESTS AND REMARKS
	0	Bulk	Blk-1				AC	**6-inch thick ASPHALT**							
							BASE	**12-inch thick BASE**							EI (64), R-Value
							CL	**ALLUVIUM [Qal]** **Lean CLAY** stiff, black, moist, medium plasticity, few coarse grained sand, with little calcification and organics							
	5		1	7	1 3 4										
							CL	**LAKEWOOD FORMATION [Qlw]** **Sandy Lean CLAY** stiff, mottled black and olive, moist, very fine-grained sand, with silt, medium plasticity							
160	10		2	13	2 4 9				25	89					PP = 1.5 tsf DSCD Tar Content (3.8%)
							SC	**SAN PEDRO FORMATION [Qsp]** **Clayey SAND** dense, black with very dark grayish green mottles, moist, fine to medium grained, with tar, hydrocarbon odor							
	15		3	25	6 9 16										
150	20		4	50	23 23 27			very dark grayish green, medium- to coarse-grained sand, increase in tar	10	118					TXCU
	25		5	40	4 7 33			very dense							
140	30														

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LOG OF BORING

LACMA Phase III Transformation Project
5905 Wilshire Blvd, Los Angeles, CA
FOR: Los Angeles County Museum of Art

AECOM

Elevation (ft)	Depth (ft)	Type	Number	Blows per foot	Blows per 6 inches	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	% Passing No. 200 Sieve	Liquid Limit (%)	Plasticity Index (%)	PID Reading (ppm)	OTHER TESTS AND REMARKS
	30		6	100+	23 50/4"		SC	**Clayey SAND** *(continued)* black, little tar	13						Tar Content (16.2%)
	35		7	38	17 15 23			dense, medium grained, with tar, little coarse sand, hydrocarbon odor							
130	40		8	100+	37 50/4"			very dense	12	92					
	45		9	100+	39 50/4"			increase in sand							
							SP	**Poorly graded SAND with GRAVEL** very dense, black, moist, medium-grained sand, some fine angular gravel, increase in tar							
120	50		10	100+	33 50/2"				3						Tar Content (13.8%)
							SP-SM	**Poorly graded SAND with SILT** very dense, black, moist, fine to medium grained							
	55		11	100+	28 50/6"				9						Tar Content (17.9%)
							SM	**Silty SAND** very dense, black, moist							
110	60		12	100+	44 50/3"				19	85					
							CL	**Sandy Lean CLAY** hard, very dark grayish green, moist, medium plasticity, fine-grained sand with little coarse-grained sand, trace of fine angular gravel, with mottled white sand pockets							
	65		13	70	29 27 43										

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LOG OF BORING

LACMA Phase III Transformation Project

AECOM

Elevation (ft)	Depth (ft)	Type	Number	Blows per foot	Blows per 6 inches	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	% Passing No. 200 Sieve	Liquid Limit (%)	Plasticity Index (%)	PID Reading (ppm)	OTHER TESTS AND REMARKS
							CL								
100	70		14	62	16 23 39			very dark brown	28	80					PP > 4.5 tsf Tar Content (9.9%) DSCD
	75		15	52	8 19 33			with tar along fractures							
90	80		16	100+	16 35 50/4"			decrease in tar	15	85					PP > 4.5 tsf
	85		17	54	10 21 33										
							SP-SM	**Poorly graded SAND with SILT** very dense, black, moist, fine-grained sand, with strong hydrocarbon odor							
80	90		18	100+	23 50/5"										PP > 4.5 tsf
							CL	**FERNANDO FORMATION [Tf]** **Lean CLAY** very dark grayish brown, moist, medium plasticity, with little tar along fractures							
	95		19	43	11 19 24										
70	100		20	100+	38 48 50/5"			No recovery							
	105														

Report: DMG4; Project File: C:\USERS\DENNIS.NGUYEN\DESKTOP\EARLY SITE PREPARATION\BORING LOGS REV3.GPJ; Data Template:URS HSA LOGS 2010.GDT Printed: 7/30/19

LOG OF BORING
LACMA Phase III Transformation Project

AECOM

Elevation (ft)	Depth (ft)	Samples: Type	Samples: Number	Samples: Blows per foot	Samples: Blows per 6 inches	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	% Passing No. 200 Sieve	Liquid Limit (%)	Plasticity Index (%)	PID Reading (ppm)	OTHER TESTS AND REMARKS
	105		21	45	12 17 28		CL	**Lean CLAY** *(continued)*							
							CL	**Sandy Lean CLAY** hard, black, moist, very fine-grained sand, heavy tar							
60	110		22	100+	21 50/6"										PP > 4.5 tsf
	115		23	58	12 24 34										
50	120		24	100+	44 50/2"			No recovery							
								Bottom of boring at 121.5 feet bgs. Boring was backfilled with cement bentonite grout to 32 feet bgs, and was reamed to 8-inch diameter between existing ground and 32 feet bgs by hollow stem auger to convert to groundwater monitoring well.							
	125														
40	130														
	135														
30	140														

Report: DMG4; Project File: C:\USERS\DENNIS.NGUYEN\DESKTOP\EARLY SITE PREPARATION\BORING LOGS REV3.GPJ; Data Template:URS HSA LOGS 2010.GDT Printed: 7/30/19

LOG OF BORING
LACMA Phase III Transformation Project

AECOM

Date(s) Drilled	10/15/03	Logged By	Joe Gratzer
Drilling Method	Hollow Stem Auger	Drill Bit Size/Type	8-inch O.D.
Drill Rig Type	B61	Hammer Data	140 lbs, 30-inch drop
Sampling Method(s)	SPT, Dames & Moore Type-U, Bulk		
Approximate Groundwater Depth and Date Measured	Perched groundwater at 18 feet below the existing ground surface		
Comments			

Boring B-8

Sheet 1 of 2

Job Number	29401607.00002
Total Depth Drilled (ft)	41.0
Approximate Ground Surface Elevation(ft)	165 feet MSL

Elevation (ft)	Depth (ft)	SAMPLES Type	SAMPLES Number	SAMPLES Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
	0	Bulk	BK-1			CL	**FILL** Sandy CLAY dark brown, moist, fine			
							Grades light brown			
160	5									
						SC	**ALLUVIUM** Clayey SAND mottled reddish-brown and brown, loose, moist, fine to medium, with trace hydrocarbon like materials			
	10	■	1	12				19		-200 (38) CON
						SC-CL	Interbedded layers of Clayey SAND and Sandy CLAY brown to black, medium dense to very stiff, moist, fine			
150	15	◪	2	21						
						CL	▼ CLAY dark brown, hard, moist			
	20	■	3	70/1"				22	94	Trace oil odor
						SP	SAND dark brown to black, dense, moist, fine, sticky			
140	25	◪	4	28				6		Hydrocarbon odor and stain
	30	■	5	70/4"			Grades very dense and noticed oil deposits	11	104	
130	35	◪	6	56				5		
	40									

Report: DMG4; Project File: G:\NESA\PROJECTS\MUSEUM\LACMA2\LACMA.GPJ; Data Template:DMLA.GDT Printed: 11/12/03

This log is part of the report prepared by URS for this project and should be read together with the report. This summary applies only at the location of the exploration and at the time of drilling or excavation. Subsurface conditions may differ at other locations and may change at this location with time. Data presented are a simplification of actual conditions encountered.

LOG OF BORING

PROPOSED BROAD CONTEMPORARY ART MUSEUM
LOS ANGELES, CALIFORNIA

FOR: LAC MUSEUM OF ARTS FIGURE 12

URS

LOS ANGELES, CALIFORNIA
FOR: LAC MUSEUM OF ARTS

Boring B-8

Elevation (ft)	Depth (ft)	SAMPLES Type	SAMPLES Number	SAMPLES Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
	40	■	7	70/8"			Grades very dense			
120	45									
	50									
110	55									
	60									
100	65									
	70									
90	75									
	80									
80	85									
	90									

Report: UMG4; Project File: G:\WESA\PROJECTS\MUSEUM\LACMA2\LACMA.GPJ; Data Template:UMLA.GDT Printed: 11/12/03

Date(s) Drilled	07/17/02	Logged By	Joe Gratzer
Drilling Method	Hollow Stem Auger	Drill Bit Size/Type	8-inch O.D.
Drill Rig Type	B61	Hammer Data	140 lbs, 30-inch drop
Sampling Method(s)	SPT, Dames & Moore Type-U, Bulk		
Approximate Groundwater Depth and Date Measured	Groundwater at 50 feet below the existing ground surface		
Comments	Groundwater was measured immediately after completion of the boring on the same day		

Boring B-1

Sheet 1 of 2

Job Number	59401607.00001
Total Depth Drilled (ft)	51.5
Approximate Ground Surface Elevation(ft)	170 feet MSL

Elevation (ft)	Depth (ft)	SAMPLES Type	SAMPLES Number	SAMPLES Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
170	0		BK-1			SC	4-inch thick Asphaltic Concrete Pavement			
							FILL Clayey SAND dark brown, stiff, moist, fine			CORR
			1	29						-200(48)
						CL	**ALLUVIUM** Sandy to silty CLAY greenish-gray, soft to firm, moist, fine			
	5		2	17						
			3	33			Grades mottled greenish-gray and dark brown, stiff with more sand	26	94	DSCD CON
						CL	CLAY dark brown, very stiff, moist, with interlayered fine sand			Slight hydrocarbon odor
160	10		4	28						
						SP	SAND dark gray, dense, moist, fine, with tar, sticky			Hydrocarbon odor
	15		5	64						
150	20		6	86/11"			Grades dark brown to black, very dense			
	25		7	75/5"			Grades black, with trace gravel			
140	30		8	50/5"			Grades with interlayered clay, sticky			
	35		9	50/5"			Grades wet, with less clay			
130	40									

Report: DMG4; Project File: G:\NESAPROJECTS\MUSEUM\LACMA.GPJ; Data Template:DMLA.GDT Printed: 9/5/02

This log is part of the report prepared by URS for this project and should be read together with the report. This summary applies only at the location of the exploration and at the time of drilling or excavation. Subsurface conditions may differ at other locations and may change at this location with time. Data presented are a simplification of actual conditions encountered.

LOG OF BORING

PROPOSED REPLACEMENT MUSEUM PROJECT
LOS ANGELES, CALIFORNIA
FOR: LAC MUSEUM OF ARTS

Elevation (ft)	Depth (ft)	SAMPLES: Type Number	SAMPLES: Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
130	40	10	50/5"		SP	SAND black, very dense, moist, fine to medium, with tar, sticky			
	45	11	75/6"						
120	50	12	59			∇ Grades fine to coarse			
	55								
110	60								
	65								
100	70								
	75								
90	80								
	85								
80	90								

Report: DMG4; Project File: G:\NESAPROJECTS\MUSEUM\LACMA.GPJ; Data Template:DMLA.GDT Printed: 9/5/02

Date(s) Drilled	07/24/02	Logged By	Jeff Pyska
Drilling Method	Hollow Stem Auger	Drill Bit Size/Type	8-inch O.D.
Drill Rig Type	B61	Hammer Data	140 lbs, 30-inch drop
Sampling Method(s)	SPT, Dames & Moore Type-U, Bulk		
Approximate Groundwater Depth and Date Measured	Groundwater at 22 feet below the existing ground surface		
Comments	Groundwater was measured immediately after completion of the boring on the same day		

Boring B-2

Sheet 1 of 2

Job Number	59401607.00001
Total Depth Drilled (ft)	86.0
Approximate Ground Surface Elevation(ft)	170 feet MSL

Elevation (ft)	Depth (ft)	SAMPLES: Type Number	SAMPLES: Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
170	0	BK-1			SM	5-inch thick Asphaltic Concrete Pavement			
					CL	**FILL:** Silty SAND brown, moist, fine to coarse, with fine to coarse gravel			CORR
					CL	CLAY dark gray and black, slightly moist, with roots and trace bricks, concrete pieces, and ceremic pieces			
	5	1	24			**ALLUVIUM:** Sandy to silty CLAY olive-gray, soft to firm, moist, fine, with some black tar deposits	26	97	-200 (64) DSCD CON
		2	18			Grades olive-brown			
						Grades white, chalky			
160	10	3	24			Grades bluish-gray, stiff Grades with tar deposits			Slight hydrocarbon odor
	15	4	33		SM/ML	Silty SAND and Sandy SILT dark brown and gray, dense, moist, fine, with tar deposits			Slight hydrocarbon odor
					SM	Silty SAND dark gray and black, dense, wet, fine, with more tar			
150	20	5	39						
	25	6	38						
140	30	7	100/6"			Grades black, very dense, very sticky			
	35	8	50			Grades with trace fine gravel			
130	40								

This log is part of the report prepared by URS for this project and should be read together with the report. This summary applies only at the location of the exploration and at the time of drilling or excavation. Subsurface conditions may differ at other locations and may change at this location with time. Data presented are a simplification of actual conditions encountered.

LOG OF BORING

PROPOSED REPLACEMENT MUSEUM PROJECT
LOS ANGELES, CALIFORNIA
FOR: LAC MUSEUM OF ARTS

Report: DMG4; Project File: G:\NESA\PROJECTS\MUSEUM\LACMA.GPJ; Data Template:DMLA.GDT Printed: 9/5/02

LOS ANGELES, CALIFORNIA
FOR: LAC MUSEUM OF ARTS

Boring B-2
Sheet 2 of 2

Elevation (ft)	Depth (ft)	Samples: Type	Samples: Number	Samples: Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
130	40	■	9	100/7"		SM	Silty SAND dark black, very dense, wet, fine, with fine to coarse gravel and tar			
	45	◪	10	50/6"						
120	50	■	11	50/4"						
	55	◪	12	50/6"						
110	60	■	13	100/8"			Grades with trace olive-brown clay pockets			
	65	◪	14	50/4"						
100	70	■	15	50/5"						
						CL	CLAY dark olive-gray, hard, moist			
	75	◪	16	50/6"		SM	Silty SAND dark black, very dense, wet, fine, with fine to coarse gravel and tar, trace clay			
90	80	■	17	50/3"		CL	CLAY dark olive-gray, hard, moist, with tar			
	85	◪	18	53			Grades with some black sands			
80	90									

Report: DMG4; Project File: G:\NESA\PROJECTS\MUSEUM\LACMA.GPJ; Data Template:DMLA.GDT Printed: 9/5/02

URS

FIGURE 6

LA METRO PB L:\70131 GEOTECH\GINTW\LIBRARY AMEC JUNE2012.GLB
G:\PROJECT_DIRECTORIES\4953\2010\101561_METRO_WESTSIDE_EXTENSION\6.2.3.1 GEOTECHNICAL DESIGN\3.2 ALL FIELD NOTES\GINT LOG\ROTARY WASH GINT LOGS\4953-10-1561_(120-139).GPJ 9/17/12

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
C & L Drilling / Mayhew 1000		**G-121**
DRILLING METHOD	**BOREHOLE LOCATION**	
Rotary Wash	Sta 516+36, Rt 14 feet	
DATES DRILLED	**HOLE DIAMETER**	**GROUND EL.**
5/16/2011 - 5/18/2011	4-7/8 inches	177 feet

GROUND-WATER READINGS
Drilling mud bailed. Ground-water level measured at 14 feet below the ground surface.

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD.PEN.TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS	USCS	DESCRIPTION
175										CL	4-inch thick Asphalt Concrete over 7-inch Portland Cement Concrete **FILL [Af]** SANDY LEAN CLAY - moist, brown, fine to medium sand, occasional fine gravel
	5		0.0	24.5	90	Push		⊠			More gravel
170											
	10	23	0.0	29.0	-		3	☒		GP	**LAKEWOOD FORMATION [Qlw]** ***TAR IMPACTED SOILS*** POORLY GRADED GRAVEL with SAND - medium dense, wet, olive brown to bluish gray with light brown mottled, fine to coarse sand, fine gravel (up to 3/4 inch in size), saturated with tar (16%)
165										SP-SM	▼ **SAN PEDRO FORMATION [Qsp]** POORLY GRADED SAND with SILT - medium dense, moist, black to dark brown, fine-grained
	15		0.0	18.0	77	18		⊠			
160										GM	SILTY GRAVEL with SAND - wet, dark reddish brown, fine to coarse sand
										ML	SANDY SILT - very stiff, moist, black, fine sand, some medium to coarse, occasional gravel (up to 3/8 inch in size), saturated with tar (17%)
	20	24	0.0	13.6	-		59	☒			
155											
	25		0.0	29.3	84	7		⊠			Becomes medium stiff, wet, dark brown
150										SP-SM	POORLY GRADED SAND with SILT - dense, moist, black, fine to medium-grained, moderately infused tar
	30	33	0.0	12.1	-			☒			
145											
	35		0.0	6.9	101	10	7	⊠			Becomes loose, fine-grained, trace medium, saturated with tar (17%)
140											
	40										

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: HTY
Prepared/Date: YN 6/20/2011
Checked/Date: LT/RM 9/21/2011

MTA Westside Subway Extension
Los Angeles, California

amec

LOG OF BORING
Project No.: 4953-10-1561 Figure: A-1.3.4a

DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
C & L Drilling / Mayhew 1000		**G-121 (Continued)**
DRILLING METHOD Rotary Wash	**BOREHOLE LOCATION** Sta 516+36, Rt 14 feet	
DATES DRILLED 5/16/2011 - 5/18/2011	**HOLE DIAMETER** 4-7/8 inches	**GROUND EL.** 177 feet

GROUND-WATER READINGS
Drilling mud bailed. Ground-water level measured at 14 feet below the ground surface.

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD.PEN.TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS		DESCRIPTION
135									PMT		
	45	56	0.0	8.0	-			☒		GC	CLAYEY GRAVEL with SAND - very dense, moist, black, fine to coarse gravel, moderately infused tar
130										SP	POORLY GRADED SAND - dense, moist, dark brown, fine to medium-grained, saturated with tar
	50	41	0.0	10.2	-			☒			
125										GW	WELL GRADED GRAVEL with SAND - wet, black, fine to coarse gravel, saturated with tar
										SP	POORLY GRADED SAND - medium dense, moist, black, fine to medium-grained, trace gravel, saturated with tar
	55			-	-	13		☒			
120										GP	POORLY GRADED GRAVEL with SAND - medium dense, wet, black, fine to coarse, fine sand
	60			-	-	15		☒			
115											
	65	16	0.0	3.4	-		2	☒			Becomes fine (up to 3/4 inch in size), coarse sand, some fine to coarse sand, slightly infused tar (2%)
110											
	70	23	0.0	6.8	-		8	☒		SW-SM	WELL GRADED SAND with SILT and GRAVEL - medium dense, moist, fine to coarse-grained, fine gravel (up to 1/2 inch in size), slightly infused tar (4%)
105										ML	SILT with SAND - hard, moist, dark brown, fine sand, moderately infused tar
	75	53	0.0	25.5	-			☒			
100											
	80										

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: HTY
Prepared/Date: YN 6/20/2011
Checked/Date: LT/RM 9/21/2011

MTA Westside Subway Extension
Los Angeles, California

amec

LOG OF BORING
Project No.: 4953-10-1561 Figure A-1.3.4b

LA METRO PB L:\70131 GEOTECH\GINTW\LIBRARY AMEC JUNE2012.GLB
G:\PROJECT_DIRECTORIES\4953\2010\101561_METRO_WESTSIDE_EXTENSION\6.2.3.1 GEOTECHNICAL DESIGN\3.2 ALL FIELD NOTES\GINT LOG\ROTARY WASH GINT LOGS\4953-10-1561_(120-139).GPJ 9/17/12

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
C & L Drilling / Mayhew 1000		**G-121 (Continued)**
DRILLING METHOD Rotary Wash	**BOREHOLE LOCATION** Sta 516+36, Rt 14 feet	
DATES DRILLED 5/16/2011 - 5/18/2011	**HOLE DIAMETER** 4-7/8 inches	**GROUND EL.** 177 feet

GROUND-WATER READINGS
Drilling mud bailed. Ground-water level measured at 14 feet below the ground surface.

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD.PEN.TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS	DESCRIPTION
95			0.0	21.5	91	18	77	⊠		Becomes very stiff, some medium sand, saturated with tar (19%)
90	85	45	0.0	22.2	-			☒		Becomes hard Trace gravel
85	90		0.0	21.4	-	21		⊠		GM SILTY GRAVEL with SAND - medium dense, wet, dark brown, fine gravel (up to 3/4 inch in size), fine to coarse sand, moderately infused tar, (sample disturbed)
80	95	54	0.0	23.5	-		33	☒		Becomes dense, moderately infused tar (11%)
75	100		0.0	14.0	-	17		⊠		**FERNANDO FORMATION [Tf]** SILTSTONE - very stiff to hard (Sample disturbed)
70	105	62	0.0	24.8	-			☒		More sand
65	110		0.0	22.3	88	21		⊠		Less sand
60	115									
	120									

END OF BORING AT 111 FEET

NOTES:
Hand augered upper 5 feet to avoid damage to utilities.
Borehole grouted with cement-bentonite slurry and patched with asphalt concrete.
"N" Value Standard Penetration Test: Number of blows required to drive the SPT sampler 18 inches using a 140 pound automatic hammer falling 30 inches

*Number of blows required to drive the Crandall Sampler 12 inches using a 380 pound hammer falling 18 inches

**Photo Ionization Detector used for OVA readings
Downhole Test: PMT = Pressuremeter

Field Tech: HTY
Prepared/Date: YN 6/20/2011
Checked/Date: LT/RM 9/21/2011

BORING M-108

DATE DRILLED: 5/2/2011 - 5/3/2011
EQUIPMENT USED: CME-75, Martini Drilling
HOLE DIAMETER (in.): 11.3
ELEVATION: 189 **

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD.PEN.TEST	MOISTURE (% of dry wt.)	PID	BLOW COUNT* (blows/ft)	SAMPLE LOC.
185	5					
180	10				10	X
175	15				22	X
170	20				20	X
165	25				15	X
160	30				9	X
155	35				22	X
150	40					

0.58 feet of Asphalt
0.75 feet of Base, fine to coarse grained
0.58 feet of Base, coarse gravel up to 2" in diameter, some cobble sized

CL/ML

CLAYEY SILT (cl-ml) - (GLEY1 2.5/N) black, stiff, moist, no odor

Becomes more clayey

CLAYEY SILT (cl-ml) - (GLEY1, 3/2) very dark greenish gray, stiff, moist, weak sulfuric odor

Becomes (2.5/1) black, strong hydrocarbon odor

CLAYEY SILT (cl-ml) - (5Y, 2.5/1) black, very stiff, moist, some asphaltic sand, strong odor

SM

TAR IMPACTED SOILS, SAN PEDRO FORMATION (Qsp)
SILTY SAND (sm) - (5Y, 2.5/1) black, damp, fine grained, asphaltic tar sand

ML

SILT (ml) - (GLEY1, 3/N) very dark gray, very stiff, moist, strong odor

CLAYEY SILT (cl-ml) - (5Y, 2.5/1) black, stiff, moist, strong odor

Becomes (GLEY1, 3/N) very dark greenish gray

SP

FINE TAR SAND (sp) - (5Y, 2.5/1) black, medium dense, damp to wet, some silt, fine grained, strong odor

(CONTINUED ON FOLLOWING FIGURE)

Field Geol: PK & RM
Prepared By: KP

B2SOIL_AMEC_PID G:\PROJECT_DIRECTORIES\4953\2010\101561_METRO_WESTSIDE_EXTENSION\6.2.3.5 SUBSURFACE GAS\3.2 ALL FIELD NOTES\LIBRARY MACTEC OCT11.GLB
G:\PROJECT_DIRECTORIES\4953\2010\101561_METRO_WESTSIDE_EXTENSION\6.2.3.5 SUBSURFACE GAS\3.2 ALL FIELD NOTES\4953-10-1561_NEUHAUS_OCT 21 2011.GPJ 5/21/13

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

BORING M-108 (Continued)

DATE DRILLED: 5/2/2011 - 5/3/2011
EQUIPMENT USED: CME-75, Martini Drilling
HOLE DIAMETER (in.): 11.3
ELEVATION: 189 **

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD.PEN.TEST	MOISTURE (% of dry wt.)	PID	BLOW COUNT* (blows/ft)	SAMPLE LOC.	USCS	DESCRIPTION
	40				44	X		Same as above
145	45				45	X		Same as above
140							ML	
	50				45	X		PETROLIFEROUS SILT (ml) - (5Y, 2.5/1) black, hard, damp, strong odor
135	55				69	X		Same as above
130	60				61	X		Same as above
							ML	
125	65				31	X		CLAYEY SILT (cl-ml) - (5Y, 2.5/1) black, hard, moist, some tar, strong odor
							ML	
120	70				50/2"	X		SILTSTONE (ml) - dark greenish gray, strongly indurated
115	75							
110	80							

NOTES:
Total depth = 71 feet bgs, refusal
Groundwater measured at 35 feet bgs
Hand augered to 5 feet bgs
The boring was initialy drilled with 8-inch O.D. augers and later reamed with 11.25-inch O.D. augers.
Soil samples collected using an SPT sampler.
After reaming, a nested well was installed. See well construction diagram for details.

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

B2SOIL_AMEC_PID G:\PROJECT_DIRECTORIES\4953\2010\101561_METRO_WESTSIDE_EXTENSION\6.2.3.5 SUBSURFACE GAS\3.2 ALL FIELD NOTES\LIBRARY MACTEC OCT11.GLB
G:\PROJECT_DIRECTORIES\4953\2010\101561_METRO_WESTSIDE_EXTENSION\6.2.3.5 SUBSURFACE GAS\3.2 ALL FIELD NOTES\4953-10-1561_NEUHAUS_OCT 21 2011.GPJ 5/21/13

Field Geol: PK & RM
Prepared By: KP

MTA Westside Subway Extension
Los Angeles, California

amec

LOG OF BORING
Project: 4953-10-1561 Figure: A-2.2.8b

BORING M-109

DATE DRILLED: 5/10/2011 - 5/12/2011
EQUIPMENT USED: CME-75, Martini Drilling
HOLE DIAMETER (in.): 8.5
ELEVATION: 185 **

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD.PEN.TEST	MOISTURE (% of dry wt.)	PID	BLOW COUNT* (blows/ft)	SAMPLE LOC.	USCS	DESCRIPTION
	0							0.58 feet of Asphalt 0.75 feet of Base
							SM	
180	5							
175	10			0.0	21	X		SILTY SAND (sm) - (10YR, 3/3) dark brown, medium grained, tar odor
							ML	
170	15			0.0	17	X		CLAYEY PETROLIFEROUS SILT (ml) - (10YR, 2/2) very dark brown, slightly moist, hydrocarbon odor Driller notes perched water zone at approximately 15 feet due to wet sample rod.
165	20			0.0	23	X		TAR IMPACTED SOILS Same as above, oil stringers
160	25			0.0	20	X		Same as above
							SP	
155	30			0.0	50/6"	X		TAR SAND (sp) - (10YR, 2/2) very dark brown, sticky, saturated with tar, fine to medium grained
150	35			0.0	29	X		Same as above
	40							

(CONTINUED ON FOLLOWING FIGURE)

Field Geol: RM
Prepared By: KP

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

B2SOIL_AMEC_PID G:\PROJECT_DIRECTORIES\4953\2010\101561_METRO_WESTSIDE_EXTENSION\6.2.3.5 SUBSURFACE GAS\3.2 ALL FIELD NOTES\LIBRARY MACTEC OCT11.GLB
G:\PROJECT_DIRECTORIES\4953\2010\101561_METRO_WESTSIDE_EXTENSION\6.2.3.5 SUBSURFACE GAS\3.2 ALL FIELD NOTES\4953-10-1561_NEUHAUS_OCT 21 2011.GPJ 5/21/13

BORING M-109 (Continued)

DATE DRILLED: 5/10/2011 - 5/12/2011
EQUIPMENT USED: CME-75, Martini Drilling
HOLE DIAMETER (in.): 8.5
ELEVATION: 185 **

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD.PEN.TEST	MOISTURE (% of dry wt.)	PID	BLOW COUNT* (blows/ft)	SAMPLE LOC.	USCS	DESCRIPTION
				0.0	34	X		Same as above
140	45			0.0	41	X		Same as above
135	50			0.0	68	X		Same as above Broken shale fragments present at 51 feet
130	55			0.0	87/10.5"	X		Same as above, no shale fragments present
							SM/ ML	
125	60			0.0	64	X		PETROLIFEROUS SILT (ml) to SILTY SAND (sm) - (10YR, 2/2) very dark brown, fine grained sand
							SP	TAR SAND (sp) - (10YR, 2/2) very dark brown, fine to medium grained
120	65			0.0	55	X		
							ML	PETROLIFEROUS SILT (ml) - (10YR, 2/2) very dark brown, slightly moist, wood chip/fragment at 66 feet
115	70			0.0	27	X		Same as above, tar pods present
							CL	
110	75			0.0	38	X		SILTY PETROLIFEROUS CLAY (cl) - (10YR, 2/2) very dark brown, slightly moist, tar pods present, shale fragments at bottom of sampler
	80							

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B2SOIL_AMEC_PID G:\PROJECT_DIRECTORIES\4953\2010\101561_METRO_WESTSIDE_EXTENSION\6.2.3.5 SUBSURFACE GAS\3.2 ALL FIELD NOTES\LIBRARY MACTEC OCT11.GLB
G:\PROJECT_DIRECTORIES\4953\2010\101561_METRO_WESTSIDE_EXTENSION\6.2.3.5 SUBSURFACE GAS\3.2 ALL FIELD NOTES\4953-10-1561_NEUHAUS_OCT 21 2011.GPJ 5/21/13

(CONTINUED ON FOLLOWING FIGURE)

Field Geol: RM
Prepared By: KP

BORING M-109 (Continued)

DATE DRILLED: 5/10/2011 - 5/12/2011
EQUIPMENT USED: CME-75, Martini Drilling
HOLE DIAMETER (in.): 8.5
ELEVATION: 185 **

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD.PEN.TEST	MOISTURE (% of dry wt.)	PID	BLOW COUNT* (blows/ft)	SAMPLE LOC.	USCS	DESCRIPTION
				0.0	31	☒		Same as above, no shale fragments present
							ML	
100	85			0.0	32	☒		CLAYEY PETROLIFEROUS SILT (ml) - (10YR, 2/2) very dark brown, slightly moist, tar pods present
95	90			0.0	27	☒		Same as above
90	95			0.0	29	☒		Same as above, no tar pods present (not noted)
85	100			0.0	25	☒		Same as above
80	105							
75	110							
70	115							
	120							

NOTES:
Total depth = 101.5 feet bgs
Groundwater apparently not encountered
Hand augered to 6 feet bgs
Backfilled with hydrated bentonite chips
Groundwater sample taken using disposable PVC casing and bailer.

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

B2SOIL_AMEC_PID G:\PROJECT_DIRECTORIES\4953\2010\101561_METRO_WESTSIDE_EXTENSION\6.2.3.5 SUBSURFACE GAS\3.2 ALL FIELD NOTES\LIBRARY MACTEC OCT11.GLB
G:\PROJECT_DIRECTORIES\4953\2010\101561_METRO_WESTSIDE_EXTENSION\6.2.3.5 SUBSURFACE GAS\3.2 ALL FIELD NOTES\4953-10-1561_NEUHAUS_OCT 21 2011.GPJ 5/21/13

Field Geol: RM
Prepared By: KP

BORING E-114A

DATE DRILLED: July 17, 2012
EQUIPMENT USED: CME 75
HOLE DIAMETER (in.): 8
ELEVATION: 169**

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	PID (ppm)	BLOW COUNT* (blows/ft)	SAMPLE LOC.	USCS	DESCRIPTION
	0						6-inch asphalt concrete over 5-inch concrete
						CL-ML	**LAKEWOOD FORMATION (Qlw)** SILTY CLAY - moist, black, some fine sand
165	5						
160	10					ML	SANDY SILT - moist, greenish gray (GLEY1 2.5/1)
155	15						
150						SM	***TAR IMPACTED SOILS*** SILTY SAND - moist, black (GLEY1 2.5/N), fine grained, some clay, trace tar
	20		3.0				
145							No clay
	25						
						SP-SM	**SAN PEDRO FORMATION (Qsp)** POORLY GRADED SAND with SILT - moist, black (GLEY1 2.5/N), fine grained
140	30		51.3				
135	35						
130						SM	SILTY SAND - moist, black (GLEY1 2.5/N), fine-grained, trace medium to coarse
	40						

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: PK
Prepared By: PWK
Checked By: PK

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE; REFER TO PLOT PLAN FOR MORE ACCURATE LOCATION INFORMATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

METRO ENVIRO "N" L:\70131 GEOTECH\GINTW\LIBRARY AMEC JUNE2012.GLB
G:\PROJECT DIRECTORIES\4953\2011\111421 WESTSIDE - APE\3.2 ALL FIELD NOTES\GINT LOG\ENVIRONMENTAL\4953-11-1421 ENVIRONMENTAL.GPJ 10/12/12

BORING E-114A (Continued)

DATE DRILLED: July 17, 2012
EQUIPMENT USED: CME 75
HOLE DIAMETER (in.): 8
ELEVATION: 169**

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	PID (ppm)	BLOW COUNT* (blows/ft)	SAMPLE LOC.	USCS	DESCRIPTION
			32.6				
125	45		29.4				
120						SP-SM	POORLY GRADED SAND with SILT - moist, black (GLEY1 2.5/N), fine-grained
	50		17.5				
115						SM	SILTY SAND - moist, black (GLEY1 2.5/N), fine grained
	55		27.0				
110	60		82.1				
105	65		43.1			ML	SILT
100	70		162.0				Less tar
95						SW	WELL GRADED SAND - moist, black (GLEY1 2.5/N), fine to coarse-grained
	75		132.0			ML	SILT - moist, black, fine sand
90	80		140.0				Becomes dark olive gray, some clay, trace tar END OF BORING AT 80 FEET

NOTES:

Hand augered upper 5 feet to avoid damage to utilities. Borehole grouted with cement-bentonite slurry and patched with asphalt concrete.

Groundwater was not measured at the time of drilling.

**Elevations based on topographic map provided by PB on 8/22/2012

Field Tech: PK
Prepared By: PWK
Checked By: PK

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE; REFER TO PLOT PLAN FOR MORE ACCURATE LOCATION INFORMATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

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G:\PROJECT DIRECTORIES\4953\2011\111421 WESTSIDE - APE\3.2 ALL FIELD NOTES\GINT LOG\ENVIRONMENTAL\4953-11-1421 ENVIRONMENTAL.GPJ 10/12/12

MTA Westside Subway Extension
Los Angeles, California

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LOG OF BORING
Project: 4953-11-1421 Figure: A-3.2.1b

BORING E-114B

DATE DRILLED: July 17, 2012
EQUIPMENT USED: CME 75
HOLE DIAMETER (in.): 8
ELEVATION: 167**

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	PID (ppm)	BLOW COUNT* (blows/ft)	SAMPLE LOC.	USCS	DESCRIPTION
	0						6-inch asphalt concrete over 5-inch concrete
165						CL-ML	**FILL [Af]** SILTY CLAY - moist, mottled
160	5						
	10					ML	**LAKEWOOD FORMATION** SANDY SILT - very stiff, moist, dark yellowish brown
155		18			X		
	15					CL	LEAN CLAY - moist, dark olive gray, trace silt
150						SM	SILTY SAND - very dense, moist, dark greenish gray (GLEY1 4/1), some clay, hydrogen-sulfide oder, with tar stains
							Becomes greenish black
	20	79	11.2		X		
145							
	25						
140							
	30	69	63.7		X	SP-SM	***TAR IMPACTED SOILS*** **SAN PEDRO FORMATION (Qsp)** POORLY GRADED SAND with SILT - very dense, moist, black (GLEY1 2.5/N), fine grained, trace clay
135							
	35						
130							
	40						

Field Tech: PK
Prepared By: PWK
Checked By: PK

(CONTINUED ON FOLLOWING FIGURE)

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE; REFER TO PLOT PLAN FOR MORE ACCURATE LOCATION INFORMATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

METRO ENVIRO "N" L:\70131 GEOTECH\GINTW\LIBRARY AMEC JUNE2012.GLB
G:\PROJECT DIRECTORIES\4953\2011\111421 WESTSIDE - APE\3.2 ALL FIELD NOTES\GINT LOG\ENVIRONMENTAL\4953-11-1421 ENVIRONMENTAL.GPJ 10/12/12

BORING E-114B (Continued)

DATE DRILLED: July 17, 2012
EQUIPMENT USED: CME 75
HOLE DIAMETER (in.): 8
ELEVATION: 167**

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	PID (ppm)	BLOW COUNT* (blows/ft)	SAMPLE LOC.	USCS	DESCRIPTION
		82	64.4		X		
125							
	45	50/4"	72.6		X		
120						SP-SM	POORLY GRADED SAND with SILT - very dense, moist, black (GLEY1 2.5/N), fine-grained
	50	50/4"	30.5		X		
115							
	55	71	84.9		X		
110						SP	POORLY GRADED SAND - very dense, moist, black (GLEY1 2.5/N), medium to coarse-grained
	60	85	169.0		X		
105						ML	SILT - very stiff to hard, moist, black (GLEY1 2.5/N), trace fine sand, some clay
	65	30	57.2		X		
100							Less tar
	70	48	56.9		X		
95						SM/SP	SILTY SAND to POORLY GRADED SAND - very dense, moist, black (GLEY1 2.5/N), fine to medium-grained
	75	64	56.2		X		
90							
		28	130.0		X	ML	SILT - very stiff, moist, black (GLEY1 2.5/N), some clay
	80						

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE; REFER TO PLOT PLAN FOR MORE ACCURATE LOCATION INFORMATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: PK
Prepared By: PWK
Checked By: PK

METRO ENVIRO "N" L:\70131 GEOTECH\GINTW\LIBRARY AMEC JUNE2012.GLB
G:\PROJECT DIRECTORIES\4953\2011\111421 WESTSIDE - APE\3.2 ALL FIELD NOTES\GINT LOG\ENVIRONMENTAL\4953-11-1421 ENVIRONMENTAL.GPJ 10/12/12

BORING E-114B (Continued)

DATE DRILLED: July 17, 2012
EQUIPMENT USED: CME 75
HOLE DIAMETER (in.): 8
ELEVATION: 167**

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	PID (ppm)	BLOW COUNT* (blows/ft)	SAMPLE LOC.
85					
80	85				
75	90				
70	95				
65	100				
60	105				
55	110				
50	115				
	120				

END OF BORING AT 80 FEET

NOTES:

Hand augered upper 5 feet to avoid damage to utilities. Borehole grouted with cement-bentonite slurry and patched with asphalt concrete.

Groundwater was not measured at the time of drilling.

"N" Value Standard Penetration Test: Number of blows required to drive the SPT sampler 18 inches using a 140 pound automatic hammer falling 30 inches

**Elevations based on topographic map provided by PB on 8/22/2012

Field Tech: PK
Prepared By: PWK
Checked By: PK

METRO ENVIRO "N" L:\70131 GEOTECH\GINTW\LIBRARY AMEC JUNE2012.GLB
G:\PROJECT DIRECTORIES\4953\2011\111421 WESTSIDE - APE\3.2 ALL FIELD NOTES\GINT LOG\ENVIRONMENTAL\4953-11-1421 ENVIRONMENTAL.GPJ 10/12/12

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE; REFER TO PLOT PLAN FOR MORE ACCURATE LOCATION INFORMATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
Boart Longyear / 600T Trusonic Drilling Rig		**S-105**
DRILLING METHOD Sonic Coring	**BOREHOLE LOCATION** 508+89, Lt 20 feet	
DATES DRILLED 4/7/11, 4/8/11 and 4/11/11	**HOLE DIAMETER** 6 inches	**GROUND EL.** 188 feet
GROUND-WATER READINGS Ground-water level not measured.		

ELEVATION (ft)	DEPTH (ft)	BOX #	RUN #	% RECOVERY	MOISTURE CONTENT (% of dry wt.)	PERCENT PASSING No. 200 SIEVE	USCS	DESCRIPTION
								6-inch thick Asphalt Concrete over 8-inch thick Portland Cement Concrete and no Base Coarse
							CL-ML	**FILL [Af]** SILTY CLAY - moist, grayish brown, trace rock
185							CH	**QUATERNARY OLDER ALLUVIUM [Qalo]** FAT CLAY - moist, dark gray black
							CL-ML	SILTY CLAY - moist, light gray to black, trace sand, gravel
	5						CL	LEAN CLAY - moist, light grayish green, medium plastic
								Becomes light grayish green, trace sand, medium plastic
								No Core Recovery from 7.0 to 7.5 feet
180							SP	***TAR IMPACTED SOILS*** POORLY GRADED SAND - dense, moist, light gray (5Y 7/2) to greenish gray, coarse grained, tar around clean core
							CL	**SAN PEDRO FORMATION [Qsp]** SANDY LEAN CLAY - medium stiff to stiff, moist, black, fine to medium sand, slightly to moderate tar
	10						SM	SILTY SAND - dense to very dense, moist, black, fine to medium grained, some calcium carbonate nodules
		1	1	85	8.9	13		Moderately infused tar (11%)
								No Core Recovery from 12.0 to 13.0 feet
175							ML	SANDY SILT - stiff, moist, black, fine sand, saturated with tar
					4.6			
	15						SM	SILTY SAND - dense to very dense, moist, black, fine to medium grained, occasional gravel (up to 3/8 inch in size), moderately infused tar
								Layer of Silt, hard, moist, black, some clay
					6.7	15		Moderately infused tar (12%)
170								
							ML	SILT - stiff, moist, black, trace fine grained, moderately infused tar
	20							

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(CONTINUED ON FOLLOWING FIGURE)

Logged By: RH
Prepared/Date: DR/WL 9/28/2011
Checked/Date: LT/PE 9/28/2011

MTA Westside Subway Extension
Los Angeles, California

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LOG OF BORING

Project No.: 4953-10-1561 Figure: B-1.1.2a

METRO SOIL CORE MC 200 L:\70131 GEOTECH\GINTW\LIBRARY AMEC JUNE2012.GLB
G:\PROJECT_DIRECTORIES\4953\2010\101561_METRO_WESTSIDE_EXTENSION\6.2.3.1 GEOTECHNICAL DESIGN\3.2 ALL FIELD NOTES\GINT LOG\SONIC CORE GINT LOGS\101561 SONIC (101-110).GPJ 9/17/12

DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
Boart Longyear / 600T Trusonic Drilling Rig		**S-105 (Continued)**
DRILLING METHOD Sonic Coring	**BOREHOLE LOCATION** 508+89, Lt 20 feet	
DATES DRILLED 4/7/11, 4/8/11 and 4/11/11	**HOLE DIAMETER** 6 inches	**GROUND EL.** 188 feet
GROUND-WATER READINGS Ground-water level not measured.		

ELEVATION (ft)	DEPTH (ft)	BOX #	RUN #	% RECOVERY	MOISTURE CONTENT (% of dry wt.)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	USCS	DESCRIPTION
								ML	
		2	2	95					
					17.8				Becomes hard, dark brown to black, trace coarse gravel, moderately infused tar
165									
	25								
					23.4	46		SM	SILTY SAND - medium dense, moist, black to dark brown, fine to medium grained, saturated with tar (20%)
					23.4				
160									
	30								
									Moderately infused tar
		3	3	95					
					3.4	9		SP-SM	POORLY GRADED SAND with SILT - dense, moist, black, fine to medium grained, trace coarse, trace fine gravel (up to 3/4 inch in size), moderately infused tar (14%)
155									
	35								Trace coarse gravel (up to 3 inches in size)
									More silt
									No Core Recovery from 37.0 to 38.0 feet
150					2.0				
									More gravel, fine to coarse (up to 3 inches in size)
	40								

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

(CONTINUED ON FOLLOWING FIGURE)

Logged By: RH
Prepared/Date: DR/WL 9/28/2011
Checked/Date: LT/PE 9/28/2011

DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
Boart Longyear / 600T Trusonic Drilling Rig		**S-105 (Continued)**
DRILLING METHOD Sonic Coring	**BOREHOLE LOCATION** 508+89, Lt 20 feet	
DATES DRILLED 4/7/11, 4/8/11 and 4/11/11	**HOLE DIAMETER** 6 inches	**GROUND EL.** 188 feet
GROUND-WATER READINGS Ground-water level not measured.		

ELEVATION (ft)	DEPTH (ft)	BOX #	RUN #	% RECOVERY	MOISTURE CONTENT (% of dry wt.)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	USCS	DESCRIPTION
								SP-SM	Less gravel
		4	4	95	2.1				Becomes saturated with tar (17%)
145	45				2.4				
140								SM	SILTY SAND - medium dense to dense, moist, black, fine to medium grained, saturated with tar
	50		5	100	2.1				
					2.3	8		SP-SM	POORLY GRADED SAND with SILT and GRAVEL - medium dense to dense, moist, black, fine to medium grained, some coarse, fine gravel (up to 3/4 inch in size), moderately infused tar (11%)
135								SM	SILTY SAND - medium dense to dense, moist, black, fine to coarse grained, moderately infused tar
			6	90	1.5			SW	WELL GRADED SAND - dense, moist, black, fine to coarse grained, fine to coarse gravel, moderately infused tar
	55							SM	SILTY SAND - dense, moist, black, fine to coarse grained, moderately infused tar
					2.5	10		SW-SM	WELL GRADED SAND with SILT - dense, moist, black, fine to coarse grained, trace fine gravel (up to 3/8 inch in size), moderately infused tar (12%)
130								ML	SANDY SILT - medium stiff, moist, black, fine sand, moderately infused tar
			7	100					
	60								

(CONTINUED ON FOLLOWING FIGURE)

Logged By: RH
Prepared/Date: DR/WL 9/28/2011
Checked/Date: LT/PE 9/28/2011

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

METRO SOIL CORE MC 200 L:\70131 GEOTECH\GINTW\LIBRARY AMEC JUNE2012.GLB
G:\PROJECT_DIRECTORIES\4953\2010\101561_METRO_WESTSIDE_EXTENSION\6.2.3.1 GEOTECHNICAL DESIGN\3.2 ALL FIELD NOTES\GINT LOG\SONIC CORE GINT LOGS\101561 SONIC (101-110).GPJ 9/17/12

DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
Boart Longyear / 600T Trusonic Drilling Rig		**S-105 (Continued)**
DRILLING METHOD Sonic Coring	**BOREHOLE LOCATION** 508+89, Lt 20 feet	
DATES DRILLED 4/7/11, 4/8/11 and 4/11/11	**HOLE DIAMETER** 6 inches	**GROUND EL.** 188 feet
GROUND-WATER READINGS Ground-water level not measured.		

ELEVATION (ft)	DEPTH (ft)	BOX #	RUN #	% RECOVERY	MOISTURE CONTENT (% of dry wt.)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	USCS	DESCRIPTION
					5.8			ML	
125					5.0				
									FERNANDO FORMATION [Tf] SANDY SILTSTONE - hard, moist, very dark grayish brown, fine to medium sand, slightly to moderately infused tar
			8	100					
	65				21.5				
120			9	100					
									Becomes very dark brown to black
	70		10	100	20.0				
					19.8	67			About 6-inch thick layer of Sandy Siltstone, saturated with tar (19%)
115			11	100					
	75				17.6				
110					19.1				
			12	100					
	80								

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

(CONTINUED ON FOLLOWING FIGURE)

Logged By: RH
Prepared/Date: DR/WL 9/28/2011
Checked/Date: LT/PE 9/28/2011

METRO SOIL CORE MC 200 L:\70131 GEOTECH\GINTW\LIBRARY AMEC JUNE2012.GLB
G:\PROJECT_DIRECTORIES\4953\2010\101561_METRO_WESTSIDE_EXTENSION\6.2.3.1 GEOTECHNICAL DESIGN\3.2 ALL FIELD NOTES\GINT LOG\SONIC CORE GINT LOGS\10561 SONIC (101-110).GPJ 9/17/12

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

DRILLING COMPANY/DRILLING EQUIPMENT Boart Longyear / 600T Trusonic Drilling Rig		BORING NO. **S-105** **(Continued)**
DRILLING METHOD Sonic Coring	**BOREHOLE LOCATION** 508+89, Lt 20 feet	
DATES DRILLED 4/7/11, 4/8/11 and 4/11/11	**HOLE DIAMETER** 6 inches	**GROUND EL.** 188 feet
GROUND-WATER READINGS Ground-water level not measured.		

ELEVATION (ft)	DEPTH (ft)	BOX #	RUN #	% RECOVERY	MOISTURE CONTENT (% of dry wt.)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DESCRIPTION
								About 6-inch thick layer of Sandy Siltstone, black, saturated with tar, less sand
					20.1	75		Saturated with tar (18%)
105								
			13	100				
	85							
					19.5			
100								
			14	100				
	90							
					22.4			
95								
			15	100				
	95							
					21.0	79		Less sand, saturated with tar (19%)
90								
			16	100				
	100							

(CONTINUED ON FOLLOWING FIGURE)

Logged By: RH
Prepared/Date: DR/WL 9/28/2011
Checked/Date: LT/PE 9/28/2011

DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
Boart Longyear / 600T Trusonic Drilling Rig		**S-105 (Continued)**
DRILLING METHOD Sonic Coring	**BOREHOLE LOCATION** 508+89, Lt 20 feet	
DATES DRILLED 4/7/11, 4/8/11 and 4/11/11	**HOLE DIAMETER** 6 inches	**GROUND EL.** 188 feet
GROUND-WATER READINGS Ground-water level not measured.		

ELEVATION (ft)	DEPTH (ft)	BOX #	RUN #	% RECOVERY	MOISTURE CONTENT (% of dry wt.)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	Description
					19.0			
85	105							END OF BORING AT 102 FEET
80	110							
75	115							
70	120							

END OF BORING AT 102 FEET

NOTES:

Consistency description on this log is based on pocket penetrometer test results and/or visual observation of soil samples.

Hand augered upper 7 feet to avoid damage to utilities.

Borehole grouted with cement-bentonite slurry and patched with asphalt concrete.

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

Logged By: RH
Prepared/Date: DR/WL 9/28/2011
Checked/Date: LT/PE 9/28/2011

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LOG OF BORING

Project No.: 4953-10-1561 Figure: B-1.1.2f

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G:\PROJECT_DIRECTORIES\4953\2010\101561_METRO_WESTSIDE_EXTENSION\6.2.3.1 GEOTECHNICAL DESIGN\3.2 ALL FIELD NOTES\GINT LOG\SONIC CORE GINT LOGS\101561 SONIC (101-110).GPJ 9/17/12

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G:\PROJECT_DIRECTORIES\4953\2010\101561_METRO_WESTSIDE_EXTENSION\6.2.3.1 GEOTECHNICAL DESIGN\3.2 ALL FIELD NOTES\GINT LOG\SONIC CORE GINT LOGS\101561 SONIC (111-120).GPJ 9/17/12

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DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
Boart Longyear / 600T Trusonic drill rig		**S-116**
DRILLING METHOD Sonic Coring	**BOREHOLE LOCATION** 512+50, Lt 17 feet	
DATES DRILLED 4/11/11 and 4/12/11	**HOLE DIAMETER** 6 inches	**GROUND EL.** 185 feet
GROUND-WATER READINGS Ground-water level not measured.		

ELEVATION (ft)	DEPTH (ft)	BOX #	RUN #	% RECOVERY	MOISTURE CONTENT (% of dry wt.)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	USCS	DESCRIPTION
	0								12-inch thick Asphalt Concrete over 4 inch thick Portland Cement Concrete, 2-inch thick Base Course
								CL-ML	**FILL [Af]** SILTY CLAY - moist, blueish-gray, trace black gravel, trace orange brick fragments (less than 4 inches in size)
180	5								
	7								No Core Recovery from 7 to 9 feet
	9							CL	**QUATERNARY OLDER ALLUVIUM [Qalo]** ***TAR IMPACTED SOILS*** LEAN CLAY with SAND - stiff to medium stiff, wet, dark greenish gray (5G 3/1) with black to dark brown tar spots, fine to coarse sand, trace fine to coarse gravel (up to 1 inch in size), some calcium carbonate nodules, tar content increases with depth, some Sandy Clay seams
175	10								
		1	1	80					
	13							ML	**SAN PEDRO FORMATION [Qsp]** SANDY SILT - hard, moist, dark brown to black, trace fine gravel, slightly to moderately infused tar
								ML	SILT with SAND - hard, moist, dark brown to black, varying shades of dark greenish gray, fine to medium sand, slightly to moderately infused tar
170	15								
					13.1				Layers of Sandy Silt
	17								No Core Recovery between 17 to 18 feet
	18				3.3			SP-SM	POORLY GRADED SAND with SILT - dense, moist, fine to medium-grained, saturated with tar (19%)
	20								

(CONTINUED ON FOLLOWING FIGURE)

Logged By: RS/RH
Prepared/Date: YN/WL 9/29/2011
Checked/Date: LT/PE 9/29/2011

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
Boart Longyear / 600T Trusonic drill rig		**S-116 (Continued)**
DRILLING METHOD Sonic Coring	**BOREHOLE LOCATION** 512+50, Lt 17 feet	
DATES DRILLED 4/11/11 and 4/12/11	**HOLE DIAMETER** 6 inches	**GROUND EL.** 185 feet
GROUND-WATER READINGS Ground-water level not measured.		

ELEVATION (ft)	DEPTH (ft)	BOX #	RUN #	% RECOVERY	MOISTURE CONTENT (% of dry wt.)	PERCENT PASSING No. 200 SIEVE	USCS	DESCRIPTION
							ML	SANDY SILT - hard, moist, dark brown to black, shades of dark greenish gray, moist, slightly to moderately infused tar
		2	2	90				
					15.2			
								Less sand, some clay
160	25							
								No Core Recovery between 27 to 29 feet
					5.3		SP-SM	POORLY GRADED SAND with SILT - medium dense to dense, moist, dark greenish gray, fine to medium grained, saturated with tar
155	30							
		3	3	80				
150	35							
					3.1			
								No Core Recovery between 37 to 38 feet
					2.3	6		Becomes fine grained, some medium and coarse, saturated with tar (17%)
	40							

(CONTINUED ON FOLLOWING FIGURE)

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Prepared/Date: YN/WL 9/29/2011
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G:\PROJECT_DIRECTORIES\4953\2010\101561_METRO_WESTSIDE_EXTENSION\6.2.3.1 GEOTECHNICAL DESIGN\3.2 ALL FIELD NOTES\GINT LOG\SONIC CORE GINT LOGS\101561 SONIC (111-120).GPJ 9/17/12

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
Boart Longyear / 600T Trusonic drill rig		**S-116 (Continued)**
DRILLING METHOD Sonic Coring	**BOREHOLE LOCATION** 512+50, Lt 17 feet	
DATES DRILLED 4/11/11 and 4/12/11	**HOLE DIAMETER** 6 inches	**GROUND EL.** 185 feet
GROUND-WATER READINGS Ground-water level not measured.		

ELEVATION (ft)	DEPTH (ft)	BOX #	RUN #	% RECOVERY	MOISTURE CONTENT (% of dry wt.)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	USCS	DESCRIPTION
								SP-SM	
		4	4	90					
									Trace fine slate gravel
					3.9				Trace fine to coarse gravel (up to 1½ inches in size), subrounded
140	45								
					5.2	16			Layer of Silty Sand, fine grained, occasional medium and coarse, trace gravel (up to 3/8 inch in size), saturated with tar (18%)
		5	5	100					
									Trace fine gravel
135	50								
					4.1				Saturated with tar (17%)
					5.9				More fine to coarse gravel (up to 2½ inches in size), fine to coarse sand
		6	6	100					
									No gravel, fine to medium sand
130	55								
									Fine to coarse sand, trace fine to coarse gravel
					1.5				
					1.1	13		SM	SILTY SAND with GRAVEL - moist, dark gray, fine to medium grained, moderately infused tar (12%)
		7	7	100				ML	SANDY SILT - wet, black, fine sand, saturated with tar
	60								

Logged By: RS/RH
Prepared/Date: YN/WL 9/29/2011
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(CONTINUED ON FOLLOWING FIGURE)

DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
Boart Longyear / 600T Trusonic drill rig		**S-116** **(Continued)**
DRILLING METHOD Sonic Coring	**BOREHOLE LOCATION** 512+50, Lt 17 feet	
DATES DRILLED 4/11/11 and 4/12/11	**HOLE DIAMETER** 6 inches	**GROUND EL.** 185 feet
GROUND-WATER READINGS Ground-water level not measured.		

ELEVATION (ft)	DEPTH (ft)	BOX #	RUN #	% RECOVERY	MOISTURE CONTENT (% of dry wt.)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DESCRIPTION
								ML
					4.8			
					5.1			Trace fine gravel, saturated with tar (18%)
		8	8	100	4.4			
120	65							
								Some shell fragments
					15.0			**FERNANDO FORMATION [Tf]** SILTSTONE with Sand - hard, moist, dark brown, fine sand, fine to medum sands, slightly to moderately infused tar
		9	9	100				
115	70							
					19.1			
		10	10	100				
110	75							
					12.1	78		Saturated with tar (20%)
								No Core Recovery from 77.7 to 78.2 feet
								Thin layer of Silty Sand, moist, black, medium to coarse grained, saturated with tar
		11	11	95	19.6			
	80							

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

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(CONTINUED ON FOLLOWING FIGURE)

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DRILLING COMPANY/DRILLING EQUIPMENT Boart Longyear / 600T Trusonic drill rig		BORING NO. **S-116** **(Continued)**
DRILLING METHOD Sonic Coring	**BOREHOLE LOCATION** 512+50, Lt 17 feet	
DATES DRILLED 4/11/11 and 4/12/11	**HOLE DIAMETER** 6 inches	**GROUND EL.** 185 feet
GROUND-WATER READINGS Ground-water level not measured.		

ELEVATION (ft)	DEPTH (ft)	BOX #	RUN #	% RECOVERY	MOISTURE CONTENT (% of dry wt.)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DESCRIPTION
					16.1	77		Saturated with tar (23%)
		12	12	96				No Core Recovery from 84 to 87 feet
100	85							
					13.8			
								No Core Recovery from 87.3 to 87.6 feet
								No Core Recovery from 88.5 to 88.6 feet
		13	13	94	9.9			
95	90							
					15.4	80		Saturated with tar (18%)
					20.5			
		14	14	96				
90	95							
								No Core Recovery from 95.1 to 95.3 feet
					25.5			
					11.3			Saturated with tar (17%)
		15	15	100				
	100							

(CONTINUED ON FOLLOWING FIGURE)

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Prepared/Date: YN/WL 9/29/2011
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THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
Boart Longyear / 600T Trusonic drill rig		**S-116 (Continued)**
DRILLING METHOD Sonic Coring	**BOREHOLE LOCATION** 512+50, Lt 17 feet	
DATES DRILLED 4/11/11 and 4/12/11	**HOLE DIAMETER** 6 inches	**GROUND EL.** 185 feet
GROUND-WATER READINGS Ground-water level not measured.		

ELEVATION (ft)	DEPTH (ft)	BOX #	RUN #	% RECOVERY	MOISTURE CONTENT (% of dry wt.)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DESCRIPTION
					17.1	76		Saturated with tar (19%)
								No Core Recovery from 102.2 to 102.4 feet and from 102.5 to 102.7 feet
		16	16	92	20.8			
80	105							
					19.2	77		Saturated with tar (19%)
								END OF BORING AT 107 FEET
75	110							
70	115							
	120							

NOTES:

Consistency description on this log is based on pocket penetrometer test results and/or visual observation of soil samples.

Hand augered upper 7 feet to avoid damage to utilities. Borehole grouted with cement-bentonite slurry and patched with asphalt concrete.

This boring was originally planned as a rotary wash boring G-120, converted to sonic core boring.

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Prepared/Date: YN/WL 9/29/2011
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DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
Boart Longyear / 600T Trusonic drill rig		**S-117**
DRILLING METHOD Sonic Coring	**BOREHOLE LOCATION** 521+50, Lt 18 feet	
DATES DRILLED 4/14/11 - 4/18/11	**HOLE DIAMETER** 6 inches	**GROUND EL.** 167 feet
GROUND-WATER READINGS Ground-water level not measured.		

ELEVATION (ft)	DEPTH (ft)	BOX #	RUN #	% RECOVERY	MOISTURE CONTENT (% of dry wt.)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	USCS	DESCRIPTION
	0								12 inch thick Asphalt Concrete over 6 inch thick Base Course
165								ML	**LAKEWOOD FORMATION [Qlw]** SILT - moist, dark brown, some clay
								CL-ML	SILTY CLAY - moist, dark brown
	5								
								SC	***TAR IMPACTED SOILS*** CLAYEY SAND - fine grained, tar content
160									
									Becomes brown
	10								
		1	1	96	20.8			ML	SANDY SILT - medium stiff, moist, olive (5Y 5/4), fine to medium sand, non-plastic
155									
					22.3				
									Pockets of tar sand, slightly infused tar, black, dark greenish gray (5G 4/1)
	15								Moderately infused tar (13%), black (5Y 25/1)
					14.5				
150									No Core Recovery between 17 to 18 feet
					6.8			SM	SILTY SAND - dense, moist, black, fine grained, some medium to coarse, moderately infused tar
	20								

Logged By: RS/RH
Prepared/Date: YN/WL 9/28/2011
Checked/Date: LT/PE 9/28/2011

(CONTINUED ON FOLLOWING FIGURE)

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LOG OF BORING

Project No.: 4953-10-1561 Figure B-1.1.4a

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DRILLING COMPANY/DRILLING EQUIPMENT
Boart Longyear / 600T Trusonic drill rig

BORING NO. S-117 (Continued)

DRILLING METHOD
Sonic Coring

BOREHOLE LOCATION
521+50, Lt 18 feet

DATES DRILLED
4/14/11 - 4/18/11

HOLE DIAMETER
6 inches

GROUND EL.
167 feet

GROUND-WATER READINGS
Ground-water level not measured.

ELEVATION (ft)	DEPTH (ft)	BOX #	RUN #	% RECOVERY	MOISTURE CONTENT (% of dry wt.)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	USCS	DESCRIPTION
								SM	
		2	2	90					Becomes very dark brown, slightly infused tar
145									
					5.8	13			Fine grained, occasional medium to coarse, non-plastic, saturated with tar (16%)
	25								
140									**SAN PEDRO FORMATION [Qsp]** No Core Recovery from 27 to 29 feet
								SP-SM	POORLY GRADED SAND with SILT- dense, moist, black, fine to medium grained, trace medium to fine gravel, saturated with tar
	30				2.4				
		3	3	90					
135									
									More gravel (up to 1 inch in size)
	35								Becomes medium to coarse grained
					2.8	11			Fine grained, some medium, trace coarse, occasional gravel (up to 3/8 inch in size), saturated with tar (16%)
130					2.0				
								SM	SILTY SAND - medium dense, moist, black, fine grained, occasional medium to coarse, fine subrounded slate gravel (up to 3/8 inch in size), alternating layers of Clayey Sand, saturated with tar (18%)
		4	4	80					
					5.4	15			
	40								

Logged By: RS/RH
Prepared/Date: YN/WL 9/28/2011
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(CONTINUED ON FOLLOWING FIGURE)

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SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
Boart Longyear / 600T Trusonic drill rig		**S-117 (Continued)**
DRILLING METHOD Sonic Coring	**BOREHOLE LOCATION** 521+50, Lt 18 feet	
DATES DRILLED 4/14/11 - 4/18/11	**HOLE DIAMETER** 6 inches	**GROUND EL.** 167 feet
GROUND-WATER READINGS Ground-water level not measured.		

ELEVATION (ft)	DEPTH (ft)	BOX #	RUN #	% RECOVERY	MOISTURE CONTENT (% of dry wt.)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	USCS	DESCRIPTION
								SM	
125									
		5	5	100	4.8				Gravel (up to 1 inch in size)
	45								
120					3.1	11		SP-SM	POORLY GRADED SAND with SILT - dense, moist, black, fine to coarse grained, moderately infused tar (14%) Becomes medium to coarse grained
									Becomes fine to coarse grained, trace silt
		6	6	100					
	50								
					2.2				
115									
									Becomes coarse grained
		7	7	100	2.9				
	55				2.1	9			Fine to coarse grained, trace gravel (up to ½ inch in size), moderately infused tar (13%)
110								SM	SILTY SAND - dense, moist, black, fine to medium grained, trace fine gravel, saturated with tar, small shell fragments, some clay
		8	8	100					
	60								

(CONTINUED ON FOLLOWING FIGURE)

Logged By: RS/RH
Prepared/Date: YN/WL 9/28/2011
Checked/Date: LT/PE 9/28/2011

METRO SOIL CORE MC 200 L:\70131 GEOTECH\GINTW\LIBRARY AMEC JUNE2012.GLB
G:\PROJECT_DIRECTORIES\4953\2010\101561_METRO_WESTSIDE_EXTENSION\6.2.3.1 GEOTECHNICAL DESIGN\3.2 ALL FIELD NOTES\GINT LOG\SONIC CORE GINT LOGS\101561 SONIC (111-120).GPJ 9/17/12

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
Boart Longyear / 600T Trusonic drill rig		**S-117 (Continued)**
DRILLING METHOD Sonic Coring	**BOREHOLE LOCATION** 521+50, Lt 18 feet	
DATES DRILLED 4/14/11 - 4/18/11	**HOLE DIAMETER** 6 inches	**GROUND EL.** 167 feet
GROUND-WATER READINGS Ground-water level not measured.		

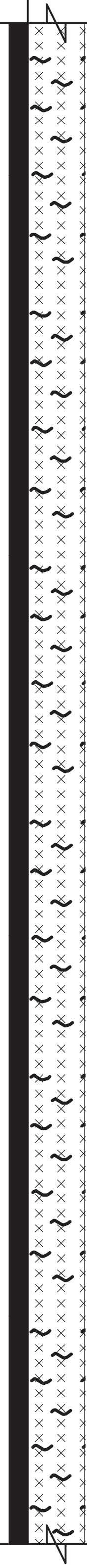
ELEVATION (ft)	DEPTH (ft)	BOX #	RUN #	% RECOVERY	MOISTURE CONTENT (% of dry wt.)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	USCS	DESCRIPTION
								SM	
105					5.4	41			Fine grained, occasional medium; no gravel, non-plastic, saturated with tar (18%)
								SP	POORLY GRADED SAND - dense, moist, black, medium to coarse grained, trace silt, trace fine to medium gravel, saturated with tar, shell fragments, moderately infused tar (10%)
		9	9	100	4.1				
	65								
								ML	SILT - hard, moist, black and dark brown(10YR 2/2), trace fine sand, moderately infused tar, large shell fragments Becomes very dark brown (10YR 2/2)
100					10.2	94			Saturated with tar (20%)
		10	10	100					
	70								Less sand
95					14.0				
		11	11	100					
	75								Some shell fragments
90					11.7				**FERNANDO FORMATION [Tf]** SILTSTONE - hard, moist, very dark brown (10YR 2/2), trace fine sand
		12	12	100					
	80								

Logged By: RS/RH
Prepared/Date: YN/WL 9/28/2011
Checked/Date: LT/PE 9/28/2011

(CONTINUED ON FOLLOWING FIGURE)

DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
Boart Longyear / 600T Trusonic drill rig		**S-117 (Continued)**
DRILLING METHOD Sonic Coring	**BOREHOLE LOCATION** 521+50, Lt 18 feet	
DATES DRILLED 4/14/11 - 4/18/11	**HOLE DIAMETER** 6 inches	**GROUND EL.** 167 feet
GROUND-WATER READINGS Ground-water level not measured.		

ELEVATION (ft)	DEPTH (ft)	BOX #	RUN #	% RECOVERY	MOISTURE CONTENT (% of dry wt.)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.
85	85	13	13	100	12.0		
80	90	14	14	100	25.7		
75	95	15	15	100	25.6	96	
70	100	16	16	100	21.0		



Layer of Sandstone, fine to medium sand, occasional gravel (up to 3/8 inch in size)

Trace fine sand, saturated with tar (18%)

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

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G:\PROJECT_DIRECTORIES\4953\2010\101561_METRO_WESTSIDE_EXTENSION\6.2.3.1 GEOTECHNICAL DESIGN\3.2 ALL FIELD NOTES\GINT LOG\SONIC CORE GINT LOGS\10156I SONIC (111-120).GPJ 9/17/12

(CONTINUED ON FOLLOWING FIGURE)

Logged By: RS/RH
Prepared/Date: YN/WL 9/28/2011
Checked/Date: LT/PE 9/28/2011

METRO SOIL CORE MC 200 L:\70131 GEOTECH\GINTW\LIBRARY AMEC JUNE2012.GLB
G:\PROJECT_DIRECTORIES\4953\2010\101561_METRO_WESTSIDE_EXTENSION\6.2.3.1 GEOTECHNICAL DESIGN\3.2 ALL FIELD NOTES\GINT LOG\SONIC CORE GINT LOGS\10561 SONIC (111-120).GPJ 9/17/12

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
Boart Longyear / 600T Trusonic drill rig		**S-117** **(Continued)**
DRILLING METHOD Sonic Coring	**BOREHOLE LOCATION** 521+50, Lt 18 feet	
DATES DRILLED 4/14/11 - 4/18/11	**HOLE DIAMETER** 6 inches	**GROUND EL.** 167 feet
GROUND-WATER READINGS Ground-water level not measured.		

ELEVATION (ft)	DEPTH (ft)	BOX #	RUN #	% RECOVERY	MOISTURE CONTENT (% of dry wt.)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.
65							
	105						
60							
	110						
55							
	115						
50							
	120						

END OF BORING AT 102 FEET

NOTES:

Consistency description on this log is based on pocket penetrometer test results and/or visual observation of soil samples.

Hand augered upper 11 feet to avoid damage to utilities.

Borehole grouted with cement-bentonite slurry and patched with asphalt concrete.

This boring was originally planned as a rotary wash boring G-122, converted to sonic core boring.

Logged By: RS/RH
Prepared/Date: YN/WL 9/28/2011
Checked/Date: LT/PE 9/28/2011

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	BLOW COUNT* (blows/ft.)	SAMPLE LOC.
		18.4	84	25	■
170		20.3	93	17	■
	5	24.3	95	58	■

BORING 1

DATE DRILLED: January 7, 1998
EQUIPMENT USED: 8" - Diameter Hollow Stem Auger
ELEVATION: 173**

CL — FILL - SILTY CLAY - some Sand, some pieces of brick, light brown

SURFACE OF NATURAL SOIL

CL — SANDY CLAY light brown

CL — SILTY CLAY - light grey

END OF BORING AT 6'.

NOTE: Water not encountered.

* Number of blows required to drive the Crandall sampler 12 inches using a 140 pound hammer falling 30 inches.

** Elevations refer to datum of reference survey; see Figure 1

JOB 70131.70548.0002 DATE 1/21/1998 F.T. GMC DR. O.E. MS CHKD MS

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

LOG OF BORING

LAW/CRANDALL

FIGURE 2.1

JOB 70131.70548.0002 DATE 1/21/1998 F.T. GMC DR. ____ O.E. MS CHKD ____

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

BORING 2

DATE DRILLED: January 7, 1998
EQUIPMENT USED: 8" - Diameter Hollow Stem Auger
ELEVATION: 174

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	BLOW COUNT* (blows/ft.)	SAMPLE LOC.		
						CL	SILTY CLAY - some caliche, light grey
		26.9	89	18	■		
						CL	SANDY CLAY - white to light grey
170		21.2	106	11	■		
							END OF BORING AT 4'.
							NOTE: Water not encountered.

LOG OF BORING

LAW/CRANDALL

FIGURE 2.2

BORING 3

DATE DRILLED: January 7, 1998
EQUIPMENT USED: 8" - Diameter Hollow Stem Auger
ELEVATION: 174

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of cry wt.)	DRY DENSITY (lbs./cu. ft.)	BLOW COUNT* (blows/ft.)	SAMPLE LOC.	USCS	DESCRIPTION
						CL	SILTY CLAY - dark brown to black
		26.4	94	15	■		
170		30.8	81	17	■	CL	SANDY CLAY - white to light grey
	5						
		21.7	105	18	■		

END OF BORING AT 6'.

NOTE: Water not encountered.

JOB 70131.70548.0002 DATE 1/21/1998 F.T. GMC DR. O.E. MS CHKD MS

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

LOG OF BORING

LAW/CRANDALL

FIGURE 2.3

BORING 4

DATE DRILLED: January 7, 1998
EQUIPMENT USED: 8" - Diameter Hollow Stem Auger
ELEVATION: 173

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	BLOW COUNT* (blows/ft.)	SAMPLE LOC.		
						CL	SILTY CLAY - dark brown to black
		18.5	95	47	■		
170							
		23.3	85	22	■		
	5						
		21.4	106	16	■		
							END OF BORING AT 6'.
							NOTE: Water not encountered.

JOB 70131.70548.0002 DATE 1/21/1998 F.T. GMC DR. ___ O.E. MS CHKD MS

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

LOG OF BORING

LAW/CRANDALL

FIGURE 2.4

BORING 5

DATE DRILLED: January 7, 1998
EQUIPMENT USED: 8" - Diameter Hollow Stem Auger
ELEVATION: 171

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of cry wt.)	DRY DENSITY (lbs./cu. ft.)	BLOW COUNT* (blows/ft.)	SAMPLE LOC.		DESCRIPTION
170						CL	SILTY CLAY - dark grey to black
		25.0	93	20	■		
		31.9	88	23	■		Some Sand
	5						
165		34.8	88	20	■		Light grey
							END OF BORING AT 6'.
							NOTE: Water seepage encountered at a depth of 4'.

JOB 70131.70548.0002 DATE 1/21/1998 F.T. GMC DR. O.E. MS CHKD MS

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

LOG OF BORING

LAW/CRANDALL

FIGURE 2.5

BORING 6

DATE DRILLED: January 7, 1998
EQUIPMENT USED: 8" - Diameter Hollow Stem Auger
ELEVATION: 169

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	BLOW COUNT* (blows/ft.)	SAMPLE LOC.		Description
						CL	FILL - SILTY CLAY - mottled brown and grey
							SURFACE OF NATURAL SOIL
		24.2	99	20	■	CL	SILTY CLAY - some rootlets, dark grey to black
165		21.9	88	28	■		
	5						
		29.5	67	30	■		Layer of Asphaltic Sand
							END OF BORING AT 6'.

NOTE: Water not encountered.

JOB 70131.70548.0002 DATE 1/21/1998 F.T. GMC DR. O.E. MS CHKD

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

LOG OF BORING

LAW/CRANDALL

FIGURE 2.6

BORING 7

DATE DRILLED: January 7, 1998
EQUIPMENT USED: 8" - Diameter Hollow Stem Auger
ELEVATION: 178

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	BLOW COUNT* (blows/ft.)	SAMPLE LOC.	Symbol	Description
						CL	FILL - SILTY CLAY - mottled brown and grey
		21.1	98	12	■		SURFACE OF NATURAL SOIL
175						CL	SILTY CLAY - some caliche, grey
		26.1	94	12	■		
						ML	CLAYEY SILT - dark grey to black
	5						
		33.4	76	7	■		
							END OF BORING AT 6'.

NOTE: Slight water seepage encountered at a depth of 6'.

JOB 70131.70548.0002 DATE 1/21/1998 F.T. GMC DR. ____ O.E. MS CHKD ____ MS

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

LOG OF BORING

LAW/CRANDALL

FIGURE 2.7

JOB 70131.70548.0002 DATE 1/21/1998 F.T. GMC DR. O.E. MS CHKD MS

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

BORING 8

DATE DRILLED: January 6, 1998
EQUIPMENT USED: 8" - Diameter Hollow Stem Auger
ELEVATION: 182

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	BLOW COUNT* (blows/ft.)	SAMPLE LOC.	USCS	DESCRIPTION
						CL	FILL - SANDY CLAY - mottled grey and dark grey
180		25.1	101	21	■		SURFACE OF NATURAL SOIL
						CL	SANDY CLAY dark greysih brown
		25.0	87	42	■		
	5	17.7	109	14	■		Some roots, light grey
175		22.0	74	16 for 9"	■		Layer of Asphaltic Sand
							END OF BORING AT 8'.
							NOTE: Water not encountered.

LOG OF BORING

LAW/CRANDALL

FIGURE 2.8

BORING 9

DATE DRILLED: January 6, 1998
EQUIPMENT USED: 8" - Diameter Hollow Stem Auger
ELEVATION: 184

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	BLOW COUNT* (blows/ft.)	SAMPLE LOC.		DESCRIPTION
		29.9	77	38	■	CL	FILL - SANDY CLAY - some pieces of decayed vegetation and roots, dark brown to black
							SURFACE OF NATURAL SOIL
180		27.6	64	16	■	CL	SANDY CLAY - dark brown
	5						Large Cobble
		28.2	82	16	■	CL	SILTY CLAY - some organics, black
175		38.6	79	29	■		

END OF BORING AT 9'.

NOTE: Water seepage encountered at a depth of 5½'.

JOB 70131.70548.0002 DATE 1/21/1998 F.T. GMC DR. O.E. MS CH'D

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

LOG OF BORING

LAW/CRANDALL

FIGURE 2.9

BORING 1

DATE DRILLED: January 26, 1995
EQUIPMENT USED: 6" - Diameter Hand Auger

DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	BLOW COUNT* (blows/ft.)	SAMPLE TYPE			DESCRIPTION
						CL	FILL - SILTY CLAY - few rootlets, dark grey to black
	39.7	75	16	■			
							SURFACE OF NATURAL SOIL
						CL	SILTY CLAY - some asphalt, light grey and black
	25.7	95	25	■			
5							
	24.8	95	40	■			
							END OF BORING AT 6'

* Number of blows required to drive the Crandall sampler 12 inches using a 50 pound hammer falling 12 inches.

NOTE: Slight water seepage encountered at a depth of 1'. No caving.

JB 2661.40813.0001 DATE 2/3/1995 F.T. AR DR. ___ O.E. JB CHKD ___

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

LOG OF BORING

LAW/CRANDALL, INC.

FIGURE A-1.1

BORING 2

DATE DRILLED: January 23, 1995
EQUIPMENT USED: 6" - Diameter Hand Auger

DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	BLOW COUNT* (blows/ft.)	SAMPLE TYPE			
						CL	FILL - SILTY CLAY - dark grey to black
	53.2	60	35	■			
	54.2	60	70 for 10"	■			SURFACE OF NATURAL SOIL
5						CL	SANDY CLAY - some asphalt, light grey
	26.6	89	70	■			
	19.8	111	35	■			
	21.4	107	40	■			
10							END OF BORING AT 10'

NOTE: Slight water seepage encountered at a depth of 4'. Water level measured at a depth of 4½' after completion of drilling. No caving.

JOB 2661.40813.0001 DATE 2/3/1995 F.T. AR DR. ___ O.E. JB CHKD MS

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

LOG OF BORING

LAW/CRANDALL, INC.

FIGURE A-1.2

BORING 3

DATE DRILLED: January 23, 1995
EQUIPMENT USED: 6" - Diameter Hand Auger

DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	BLOW COUNT* (blows/ft.)	SAMPLE TYPE		DESCRIPTION
					CL	FILL - SILTY CLAY - few rootlets and brick fragments, dark grey to black
	39.0	81	16	■		
					CL	▽ SURFACE OF NATURAL SOIL SANDY CLAY - light grey
5						
	22.1	103	35	■		
	23.7	101	45	■	SC	CLAYEY SAND - fine to medium, light brownish grey
10	25.3	94	60	■		END OF BORING AT 10'

NOTE: Water seepage encountered at a depth of 7'. Water level measured at a depth of 7' 10 minutes after completion of drilling. No caving.

JOB 2001.40813.0001 DATE 2/3/1995 F.T. AR DR. ___ O.E. JB CHKD [signature]

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

LOG OF BORING

LAW/CRANDALL, INC.

FIGURE A-1.3

BORING 4

DATE DRILLED: January 23, 1995
EQUIPMENT USED: 6" - Diameter Hand Auger

DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	BLOW COUNT* (blows/ft.)	SAMPLE TYPE			
						CL	FILL - SILTY CLAY - some Sand, some rootlets and pieces of brick, dark grey to black
	40.3	72	30	■			
	34.8	78	45	■			SURFACE OF NATURAL SOIL
5	22.6	101	35	■		CL	SILTY CLAY - some Sand, light grey
	19.0	106	35	■		CL	SANDY CLAY - some asphalt, light grey and black
10	27.0	80	60	■			END OF BORING AT 10'
							NOTE: Water not encountered. No caving.

JOB 2661.40813.0001 DATE 2/3/1995 F.T. AR DR. ___ O.E. JB CHKD ~~WS~~

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

LOG OF BORING

LAW/CRANDALL, INC.

FIGURE A-1.4

BORING 5

DATE DRILLED: January 24, 1995
EQUIPMENT USED: 6" - Diameter Hand Auger

DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	BLOW COUNT* (blows/ft.)	SAMPLE TYPE	USCS	DESCRIPTION
					CL	FILL - SANDY CLAY - some asphalt, light brown and grey
						Cemented layer
	40.2	60	15	■		
						Some pieces of cemented asphalt
	29.6	76	50	■		▼ SURFACE OF NATURAL SOIL
					SP	ASPHALTIC SAND - fine to coarse, brownish grey
5						
	13.2	112	100	■		
	11.4	116	100	■		
						END OF BORING AT 8'

NOTE: Water seepage encountered on top of concrete slab at a depth of 1'. Water level measured at a depth of 4'after completion of drilling. No caving.

LOG OF BORING

LAW/CRANDALL, INC.

FIGURE A-1.5

JOB 2661.40813.0001 DATE 2/14/1995 F.T. AR DR. ____ O.E. JB CHKD MS

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

BORING 6

DATE DRILLED: January 27, 1995
EQUIPMENT USED: 6" - Diameter Hand Auger

DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	BLOW COUNT* (blows/ft.)	SAMPLE TYPE	USCS	DESCRIPTION
						4½" Asphaltic Paving - 5" Sand and Gravel Base
	31.2	90	15	■	ML	FILL - CLAYEY SILT - some Sand, dark grey
						SURFACE OF NATURAL SOIL
	31.3	92	40	■	CL	SILTY CLAY - light brownish grey
5	19.1	104	45	■	SC	CLAYEY SAND - fine to medium, light brownish grey
						END OF BORING AT 6'

NOTE: Water not encountered. No caving.

JOB 2661.40813.0001 DATE 2/3/1995 F.T. AR DR. ___ O.E. JB CHKD ___

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

LOG OF BORING

LAW/CRANDALL, INC.

FIGURE A-1.6

JOB 2661.40813.0001 DATE 2/3/1995 F.T. AR DR. O.E. JB CHKD

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

BORING 7

DATE DRILLED: January 24, 1995
EQUIPMENT USED: 6" - Diameter Hand Auger

DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	BLOW COUNT* (blows/ft.)	SAMPLE TYPE		
					ML	FILL - CLAYEY SILT - some Sand, dark grey to black
	24.1	66	25	■		
	32.3	79	30	■	CL	FILL - SANDY CLAY - some asphalt, dark brownish grey
5	22.6	97	30	■		
						↓ SURFACE OF NATURAL SOIL
					SP	ASPHALTIC SAND - fine to medium, dark grey to black
	24.0	94	34	■		
10	6.3	115	70	■		
						END OF BORING AT 11'

NOTE: Slight water seepage encountered at depths of 1'and 2'. Water level measured at a depth of 6' after completion of drilling. No caving.

LOG OF BORING

LAW/CRANDALL, INC.

FIGURE A-1.7

BORING 8

DATE DRILLED: January 26, 1995
EQUIPMENT USED: 6" - Diameter Hand Auger

DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	BLOW COUNT* (blows/ft.)	SAMPLE TYPE		Description
					CL	FILL - SILTY CLAY - some Sand, brown and dark grey
	26.9	88	12	■		Piece of concrete
	36.3	78	9	■		(ENCOUNTERED AN OBSTRUCTION AT A DEPTH OF 3'; MOVED BORING 1' TO THE WEST)
5						SURFACE OF NATURAL SOIL
	32.0	83	30	■	CL	SILTY CLAY - greyish brown
	33.2	71	50	■	SP	ASPHALTIC SAND - fine to medium, black
10	15.0	106	100	■		END OF BORING AT 11'

NOTE: Water level measured at a depth of 2' 5 minutes after completion of drilling. No caving.

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

JOB 2661.40813.0001 DATE 2/3/1995 F.T. AR DR. O.E. JB CHKD

LOG OF BORING

LAW/CRANDALL, INC.

FIGURE A-1.8

BORING 9

DATE DRILLED: January 27, 1995
EQUIPMENT USED: 6" - Diameter Hand Auger

DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	BLOW COUNT* (blows/ft.)	SAMPLE TYPE		DESCRIPTION
					CL	FILL - SILTY CLAY and SANDY CLAY - some rootlets, dark brownish grey
	15.0	81	25	■		
	19.2	100	20	■		
5					CL	SURFACE OF NATURAL SOIL SANDY CLAY - light yellowish grey
	38.8	85	30	■		
	43.9	79	30	■		
10					ML	CLAYEY SILT - some asphalt, dark grey
	45.0	70	60	■		
						END OF BORING AT 11'

NOTE: Slight water seepage encountered at a depth of 2½'. No caving.

JOB 2661.40813.0001 DATE 2/3/1995 F.T. AR DR. O.E. JB CHKD

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

LOG OF BORING

LAW/CRANDALL, INC.

FIGURE A-1.9

BORING I

DATE DRILLED: December 14, 1981

EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION: 170.0***

Elevation (ft)	Depth (ft)	Volatile Liquids * (% of dry wt)	Dry Density ** (lbs/cu ft)	Energy	Soil	Description
					CL	4" Concrete Slab FILL - SANDY CLAY - streaks of asphalt, some gravel, black and grey Pieces of tile
		27.8	88	2		
165	5	28.0	88	1		
					ML	SANDY SILT - some Clay, dark greyish-brown
		28.0	93	<1		
160	10				CL	SANDY CLAY - dark greyish-brown
		28.0	85	2		
155	15	26.3	95	2	CL	SILTY CLAY - grey and brown Streaks of asphalt Petroleum odor
		16.3	102	6		
					SP	SAND - IMPREGNATED WITH ASPHALT - fine, black
150	20	6.1	118	8		
145	25	6.6	114	13		
140	30	7.3	110	14		
135	35	4.6	118	14		Some gravel
130	40					

* Liquids that are evaporated at 105°C.

** Within the asphaltic soils, the dry densities include the weight of soil and non-volatile asphalt.

*** Elevations refer to datum of reference drawing; see Plate 1 for location and elevation of bench mark.

∇ Indicates surface of firm soils.

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

JOB A-81396 DATE 12/18/81 DR JOHN F MD W.P. fm CHKD

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LeROY CRANDALL AND ASSOCIATES

PLATE A-1.1a

JOB A-81396 DATE 12/18/81 DR JOHN ... MD W.P. fm CHKD

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

BORING 1 (CONTINUED)

DATE DRILLED: December 14, 1981

EQUIPMENT USED: 5"-Diameter Rotary Wash

Elevation (ft.)	Depth (ft.)	Volatile Liquids (% of dry wt.)	Dry Density (lbs./cu.ft.)	Drive Energy (ft-kips/ft.)	Sample Loc.	Description
		5.1	114	13	■	About 20% gravel
125	45	7.5	115	14	■	Less gravel
120	50					About 10% gravel
115	55	6.2	110	13	■	Coarse Sand, about 20% gravel
110	60	13.3	104	10	■	
						SILTSTONE - weathered, streaks of asphalt, dark greyish-brown
105	65	27.1	79	11	■	
100	70	26.0	87	11	■	
95	75	14.5	98	26	■	
90	80					

NOTE: Drilling mud used in drilling process. Mud removed to 25' at completion of drilling. Water level measured at about 6½' 3 days after completion of drilling.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.1b

Form 124

Form 123 JOB A-81396 DATE 12/18/81 DR JOHN W.P. CHKD

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

BORING 3

DATE DRILLED December 15, 1981

EQUIPMENT USED 5"-Diameter Rotary Wash

ELEVATION 165.7

DEPTH (ft.)	VOLATILE LIQUIDS (% of dry wt.)	DRY DENSITY (lbs/cu.ft.)	DRIVE ENERGY (ft. kips/ft.)
	11.4	115	5
	33.3	86	<1
	20.9	105	8
15	10.3	116	6
20	8.6	125	14
25	7.7	119	13
30	5.4	118	19
35	5.9	119	11

Elevation scale (ft.): 165, 160, 155, 150, 145, 140, 135. Depth scale (ft.): 5, 10, 15, 20, 25, 30, 35. Water level ▽ shown between 5 and 10 ft.

	Description
CL	FILL - SANDY CLAY - about 20% gravel, some cobbles, brown and grey Pieces of concrete and brick
ML	CLAYEY SILT - some Sand, black
CL	SILTY CLAY - streaks of asphalt, grey
ML	SANDY SILT - some Clay, streaks of asphalt, dark brown
SP	SAND - IMPREGNATED WITH ASPHALT - fine, dark grey to black Some fines Some gravel

NOTE: Drilling mud used in drilling process. Mud removed to 20' at completion of drilling. Water level measured at 6½' 2 days after completion of drilling.

LOG OF BORING

Appendix B

LeROY CRANDALL AND ASSOCIATES

Figure B-68

PLATE A-1.3

BORING 4

DATE DRILLED: April 12, 1984

EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION 168.3***

ELEVATION (ft.)	DEPTH (ft.)	VOLATILE LIQUIDS (% of dry wt.) *	DRY DENSITY (lbs./cu. ft.) **	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
165		30.9	100	< 1	■
	5				
		19.6	108	2	■
160					
		16.8	99	10	▽ ■
	10				
		19.1	103	3	■
155					
	15	17.2	99	7	■
150		7.0	116	11	■
	20				
		6.5	119	11	■
145					
	25				
		7.3	116	14	■
140					
	30				
		6.5	124	19	■
135					
	35				
		4.2	116	19	■
130					
	40				

CL FILL - SILTY CLAY - few gravel, roots, dark grey

Exposed sewer pipe (moved boring 5' south)

CL SILTY CLAY (POSSIBLY FILL) - dark grey

ML SANDY SILT - streaks of asphalt, dark grey

CL SILTY CLAY - streaks of asphalt, dark grey

Some fine Sand

SP SAND - IMPREGNATED WITH ASPHALT - fine, black

NOTE: Drilling mud used in drilling process. Mud removed at completion of drilling. Water level measured at 4' 12 days after removal of mud.

Some gravel

* Liquids that are evaporated at 105°C.

** Within the asphaltic soils, the dry densities include the weight of soil and non-volatile asphalt.

*** Elevations refer to datum of reference drawing; see Plate 1 for location and elevation of bench mark.

▽ Indicates surface of firm soils.

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

Form 123 JOB A-81396-B DATE 4/18/84 DR. JOHN D.E. W.P. CHKD

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

PLATE 2

IMPORTANT INFORMATION

Important Information

About Your Geology and Soils Discipline Report

IMPORTANT INFORMATION

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors that were considered in the development of the report have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary, because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims

IMPORTANT INFORMATION

being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports, and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland