WINTERHAVEN PUBLIC SAFETY FACILITY PROJECT

Funded by:
California Department of Housing and Community Development (HCD) through its Community Development Block Grant (CDBG) Program and the County of Imperial.

REGISTERED PROFESSIONAL ENGINEER
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EXP. 6/30/18
CIVIL
STATE OF CALIFORNIA

5/25/17

Prepared by:

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for

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PROJECT MANUAL
MARCH 2017
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VOLUME 2 OF 4
SPECIAL CONDITIONS

SPECIAL CONDITIONS

1. Scope

These Special Conditions supplement the General Conditions, Technical Specifications, and Plans. All requirements and provisions of the General Conditions, Technical Specifications and Plans apply. Where codes, procedures, conditions, specifications or requirements conflict, the more stringent shall apply. If there is a question or conflict regarding responsibility of costs, it shall be assumed and required the Contractor be responsible for the cost of any particular item or work requirement and it shall be assumed the Contractor has included the costs in the Proposal (Bid Form – Basis of Bid – Schedule of Values).

END OF SECTION 1

2. Description of Civil Engineering Plans and Building Bridging Documents

The Winterhaven Public Safety Facility Project is being constructed by the Imperial County Community and Economic Development Agency with the assistance of a Community Development Block Grant (“CDBG”). The Winterhaven Public Safety Facility Project was reviewed multiple times by the County of Imperial Departments to arrive at the Civil Engineering Plans and Architectural Plans for this project.

The Civil Engineering Plans for the Winterhaven Public Safety Facility Project were prepared by Dynamic Consulting Engineers, Inc. and are dated 03/17/2017. The improvement plans include the on-site and off-site improvements for this project. The off-site improvements include the widening of Railroad Avenue, installation of new concrete sidewalk, two new driveways and new gutter and fronting the project limits. The on-site improvements include demolition of existing fencing, demolition of existing concrete and removal of existing utilities. New improvements include the construction of the building pad and site grading per the geotechnical report recommendations. Improvements also include concrete sidewalks, curb and gutter, freestanding curbs, accessible ramps, utility extensions, new parking lot paving, construction of retention basins, installation of a dry well, landscaping, you trash enclosure, miscellaneous concrete flat work, concrete ribbon gutter, perimeter CMU block wall, wrought iron fence at parking lot, 30 ft. vehicular gate and pedestrian gate.

The architectural plans include the construction of a ±9,700 square foot public safety facility building. The building plans include structural plans, site plans, elevation views, electrical plans, mechanical plans and plumbing plans. See Architectural Drawings and Volume 4 (Building Technical Specifications) of the Project Manual.

A Geotechnical Report was prepared for this project by Landmark Consultants, Inc.; Report Number LE15031 dated May 6, 2015. The Geotechnical Report is included in the Special Conditions Section of the Specifications. The Geotechnical Report contains recommendations for the building foundation construction including seismic design data for the foundation structural calculations and design. The Geotechnical Report recommendation to construct a building support pad consisting of removal of existing material and placement of granular soil, placed in maximum 8-inch lifts shall be required as specified within the Geotechnical Report.

Water and sewer services were constructed for the temporary modular building. The contractor shall expand the existing water lines. The existing irrigation line shall be extended to the proposed landscaping area and a backflow preventer and water meter installed. The existing six-inch fire line that was installed up to the property line shall be extended to the back of the building and into the new building. A six-inch backflow preventer shall also be installed. The existing two inch water service line shall be disconnected from the existing modular building and be connected to the new building. The existing sewer lateral shall connect to the proposed building. The existing sewer lateral shall be disconnected from the existing modular building.

The County of Imperial Fire Department currently occupies a temporary modular unit located at the project site. The County Fire Department will remain in operation and occupy the existing modular building during construction of the new facility. The existing modular building and existing parking area are located within the proposed site improvements including the new parking lot, concrete work, trash enclosure and the south retention basin. The contractor shall coordinate construction activities with the County Fire Department as construction of this project shall be required to be completed in two phases. Phasing may include separate design schedules, as well as separate construction schedules, in order to maintain the ongoing operations of the Fire Department. Phasing will be at the discretion of the Department. The total Base construction will not be altered by phasing. The total construction award, including all phases, may not exceed the Base Construction.

The contractor shall coordinate and provide the County the required space for the Fire Department to continue operations. Once a temporary certificate of occupancy has been obtained for the new facility, and the Fire Department has relocated to the new facility, the contractor shall continue with the construction of improvements located within the temporary modular building and existing parking area. The contractor will be allowed additional working days for the days the County Fire Department requires for the relocation from the temporary modular building to the new facility. (The relocation of the Fire Department shall not exceed five (5) working days). The contractor shall coordinate the removal of the temporary modular building and temporary fence and gate with the Fire Department personnel and the existing vendors.

The contractor will not be allowed a change order for required work stoppage during relocation of the County Fire Department from the temporary modular building to the new facility. The contractor will be allowed additional working days for the days the County requires for the relocation. The contractor will not be allowed a change order for construction of the site improvements located within the existing modular building and existing parking lot due to the relocation of County departments and the work being completed in multiple phases. Phasing may include separate design schedules, as well as separate construction schedules, in order to maintain the ongoing operations of the Fire Department. Phasing will be at the discretion of the Department. The total Base construction will not be altered by phasing. The total construction award, including all phases, may not exceed the Base Construction.

The Contractor shall coordinate the removal of the temporary modular unit with the modular manufacturer and the County Departments. Contractor shall schedule accordingly the removal of the modular building prior to the temporary certificate of occupancy being issued to avoid construction downtime.

It will also be necessary to relocate and adjust existing utilities and install/extend new utilities to provide services to the new Winterhaven Public Safety Facility. A listing of the relocated, adjusted, and new utilities are as follows:

1. Contractor shall coordinate with Imperial Irrigation District power connection to the new facility.

2. The contractor shall install a 2-inch backflow preventer and extend the two-inch water service to the new facility and remove the existing two-inch service to the existing temporary modular building. The contractor shall inform and coordinate the installation/extension of the water service to the new facility with Winterhaven County Water District (Rick Miller, Phone No. 928-920-9056).

3. The contractor shall extend the six-inch fire service water line to the new facility. Contractor shall install a 6 inch water meter and backflow preventer.

4. The contractor shall extend and complete the installation of the 1-inch irrigation service line. Contractor shall install a 1-inch water meter and backflow preventer.

5. Contractor shall adjust to designed finish grade an existing sanitary sewer manhole located on Railroad Avenue.

The improvement plans, calculations, studies, reports and other documents shall conform to the Bridging Reference Document Plan guidelines and requirements. ***The County of Imperial Community and Economic Development Agency shall pay for all plan check submission fees and plan check costs for the Winterhaven Public Safety Facility.***

The Winterhaven Public Safety Facility improvement plans, calculations, studies, reports and other documents to be prepared by the contractor shall comply with the most current versions of the following codes as a minimum:

CALIFORNIA ADMINISTRATIVE CODE (CAC)
PART 1, TITLE 24, CALIFORNIA CODE OF REGULATIONS (CCR)

CALIFORNIA BUILDING CODE (CBC)
PART 2, TITLE 24, CALIFORNIA CODE OF REGULATIONS (CCR)
(2009 INTERNATIONAL BUILDING CODE (ICB) W/ CALIFORNIA
AMENDMENTS)

CALIFORNIA ELECTRICAL CODE (CEC)
PART 3, TITLE 24, CALIFORNIA CODE OF REGULATIONS (CCR)
(2008 NATIONAL ELECTRICAL CODE (NEC) W/ CALIFORNIA
AMENDMENTS)

CALIFORNIA MECHANICAL CODE (CMC)
PART 4, TITLE 24, CALIFORNIA CODE OF REGULATIONS (CCR)
(2009 UNIFORM MECHANICAL CODE (UMC) W/ CALIFORNIA
AMENDMENTS)

CALIFORNIA PLUMBING CODE (CPC)
PART 5, TITLE 24, CALIFORNIA CODE OF REGULATIONS (CCR)
(2009 UNIFORM PLUMBING CODE (UPC) W/ CALIFORNIA
AMENDMENTS)

CALIFORNIA FIRE CODE (CFC)
PART 9, TITLE 24, CALIFORNIA CODE OF REGULATIONS (CCR)
(2009 INTERNATIONAL FIRE CODE (IFC) W/ CALIFORNIA
AMENDMENTS)

CALIFORNIA ENERGY CODE
PART 6, TITLE 24, CALIFORNIA CODE OF REGULATIONS (CCR)

CALIFORNIA EXISTING BUILDING CODE (CEBC)
PART 10, TITLE 24, CALIFORNIA CODE OF REGULATIONS (CCR)
(2009 INTERNATIONAL EXISTING CODE (IEBC))

CALIFORNIA REFERENCED STANDARD CODE
PART 12, TITLE 24, CALIFORNIA CODE OF REGULATIONS (CCR)

AMERICANS WITH DISABILITIES ACT (ADA)
TITLE II- ACCESSIBILITY GUIDELINES FOR BUILDINGS AND
FACILITIES (ADAG)
1990 STATE FIRE MARSHAL REGULATIONS AND AMENDEMENTS TO
DATE

CALIFORNIA CODE OF REGULATIONS (CCR) TITLE 24, CALIFORNIA
ACCESSIBILITY STANDARDS
CALIFORNIA CODE OF REGULATIONS (CCR) TITLE 19

CALIFORNIA GREEN BUILDING CODE

END OF SECTION 2

3. Winterhaven Public Safety Facility – Building Permit

The County of Imperial will be acquiring the building permit for the project. All other permits shall be the contractor's responsibility. The contractor shall be responsible for coordinating all inspections with the appropriate enforcement agency. ***The County of Imperial Community and Economic Development Agency shall incur all costs with regard to the Building Permit Application and review process.***

END OF SECTION 3

4. Inspection of Work

1.1. All materials and equipment used in the construction of the project shall be subject to adequate inspection and testing in accordance with generally accepted standards, as required and defined in the Contract Documents.

1.2. The Contractor shall provide all inspection and testing services including all geotechnical inspection and testing services unless specified to be provided by the Owner. The Contactor shall pay for all costs relative to the Geotechnical Testing and include the costs in the Proposal (Bid Form – Article 5 – Basis of Bid – Schedule of Values). See the following Technical Specification Sections for earthwork, concrete, asphalt and mortar testing requirements:

1. Earthwork – Volume 3 of the Project Manual - Technical Specification 02200, Part 3 – Execution - 3.10 Compaction Test Schedule.
2. Concrete – Volume 3 of the Project Manual Technical Specification 03300.1.05 on Page 03300-4.
3. Mortar Testing – Volume 3 of the Project Manual Section 04200, Part 1 – General, 1.05 Mix Tests
4. Asphalt – Volume 3 of the Project Manual Section 02510.3.01

1.3. The Construction Manager shall provide at the Contractor's expense the testing and inspection services required by the Contract Documents if the Contractor fails or refuses to provide the required testing and inspection services.

1.4. If the Contract documents, laws, ordinances, rules, regulations or orders of any public authority having jurisdiction require any work to specifically be inspected, tested, or approved by someone other than the Construction Manager, the Contractor will give the Construction Manager timely notice of readiness. The Contractor will then furnish the Construction Manager the required certificates of inspection, testing or approval.

1.5. Inspections, tests, or approvals by the Construction Manager or others shall not relieve the Contractor from the obligations to perform the work in accordance with the requirements of the Contract Documents.

1.6. The Construction Manager and the Construction Manager's representative will at all times have access to the work. In addition, authorized representatives and agents of any participating Federal or State agency shall be permitted to inspect all work, materials, payrolls, records on personnel, invoices of materials, and other relevant data and records. The Contractor will provide proper facilities for such access and observation of the work and also for any inspection or testing thereof.

1.7. If any work is covered prior to inspection by the Construction Manager it must, if requested by the Construction Manager, be uncovered for the Construction Manager's observation and replaced at the Contractor's expense.

1.8. If the Construction Manager considers it necessary or advisable that covered work be inspected or tested by others, the Contractor, at the Construction Manager's request, will uncover, expose or otherwise make available for observation, inspection or testing as the Construction Manager may require, that portion of the work in question, furnishing all necessary labor, materials, tools, and equipment. If it is found that such work is defective, the Contractor will bear all the expenses of such uncovering, exposure, observation, inspection and testing and of satisfactory reconstruction. If, however, such work is not found to be defective, the Contractor will be allowed an increase in the contract price or any extension of the contract time, or both, directly attributable to such uncovering, exposure, observation, inspection, testing and construction and an appropriate change order shall be issued.

END OF SECTION 4

5. Surplus or Import Native Material

Surplus native material excavated for the construction of the project shall be removed and disposed of by the Contractor or imported to the project site as required by the Contractor. The costs relative to the import or export of native material shall be included in the Contractor's Proposal (Bid Form – Article 5 – Basis of Bid – Schedule of Values) submitted to the County of Imperial.

END OF SECTION 5

6. Air Pollution Control District Requirements

The Contractor shall be responsible for abiding with the latest edition of Regulation VIII set forth by Imperial County Air Pollution Control District. A copy of Regulation VIII, June 2, 2009 edition follows this sheet.

The Contractor shall also be responsible for preparation and submission of a Construction Notification Form and Dust Control Plan to the County of Imperial Air Pollution Control District. The Construction Notification Form and Dust Control Plan shall also be posted at the Project Site. A copy of the Construction Notification Form and Dust Control Plan follow Regulation VIII within this document.

The Contractor shall obtain a permit from County Air Pollution Control District for the installation of the Generator. The cost associated to prepare the application shall be part of the bid schedule Line Item "Dust Control Implementation and Permit Applications".

The Imperial County Air Pollution Control District contact information is:

150 South Ninth Street
El Centro, CA 92243
Phone: 760-482-4606
Fax: 760-353-9904
http://www.imperialcounty.net/AirPollution/
Contacts:
Reyes Romero, Assistant Air Pollution Control Officer
Monica Soucier, Division Manager Planning

The Contractor is to include the costs associated with the Air Pollution Control District requirements in the Proposal (Bid Form – Basis of Bid – Schedule of Values).

END OF SECTION 6

7. Environmental Report

The County of Imperial prepared Environmental Documents for this Project. The Documents satisfy California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA). Mitigation, Monitoring and Reporting Program were prepared as part of the Environmental Documentation. The Contractor is responsible for implementing the Mitigation, Monitoring and Reporting Program. The Contractor is to include the costs associated with the Environmental Report provisions in the Proposal (Bid Form – Basis of Bid – Schedule of Values).

Environmental documents can be obtained at the County website:
http://www.imperialcountyced.com/bids---rfps/

END OF SECTION 7

8. Geotechnical Investigation Report

Landmark Consultants prepared a Geotechnical Engineering Report (LCI Report No. LE 15031) on May 6, 2015. The purpose of the Landmark Geotechnical Report was to investigate subsurface soils and geotechnical conditions at the project site; estimate engineering properties of the subsurface soils and geotechnical conditions at the project site; estimate engineering properties of the subsurface soils with selected field and laboratory tests; perform engineering analysis for developing geotechnical design and construction recommendations for the proposed structures and piping at the project site. Landmark Consultants' report provides recommendations regarding site preparation and earthwork, removal of undocumented fill, corrosive soils, placement of imported fill material beneath structures, ground water table liquefaction, seismic considerations, settlements and bearing capacity.

The project design is based upon the recommendations of the geotechnical report. The recommendations of the geotechnical report apply to the construction of this project. If the Plans or Specifications conflict with geotechnical recommendations, the more stringent shall apply.

Landmark Consultants' Geotechnical Engineering Report (LCI Report No. LE 15031) for this project follows.

The Contractor is responsible for all costs associated with the Geotechnical Report Recommendations during construction, including all costs required for materials testing including compaction testing of all native material, subgrade and Class II base. Contractor shall also be responsible for the cost associated for all concrete testing and asphalt concrete testing. The costs associated with complying with the Geotechnical Report Recommendations and testing during the submittal process shall be included in the Proposal (Bid Form – Basis of Bid – Schedule of Values).

END OF SECTION 8

9. Staging Area

The Contractor is responsible for identifying and securing a staging area for this project, as required. The costs associated with securing a staging area shall be included in the Proposal (Bid Form – Basis of Bid – Schedule of Values).

END OF SECTION 9

10. Construction Water

The Contractor is responsible for obtaining construction water for this project. The Contractor may contact the Winterhaven County Water District or the Imperial Irrigation District and inquire as to the provisions and costs regarding construction water. The Contractor shall include the costs associated with construction water in the Proposal (Bid Form – Basis of Bid – Schedule of Values).

END OF SECTION 10

11. Electrical and Telecommunication Coordination

The Contractor shall be responsible for coordinating the submission of the Customer Service Proposal (CSP) application to the Imperial Irrigation District (IID) Energy Department. The Contractor shall monitor the processing of the Customer Service Proposal and the preparation of the Electrical Plans by the IID Energy Department. The County of Imperial Community and Economic Development Agency shall incur all costs with regard to the CSP Application, CSP, IID Electrical Plan preparation, the IID electrical connection and installation fees and any other IID fees associated with supplying the electrical power service for the Winterhaven Public Safety Facility.

The Contractor shall coordinate the installation of telephone and alarm services for the Winterhaven Public Safety Facility with the existing AT&T/Communication Company and the County of Imperial I.T. The County of Imperial Community and Economic Development Agency shall incur all costs with regard to the AT&T and Alarm System Application fees, connection fees and any other utility purveyor fees associated with the installation of the telephone and alarm systems.

END OF SECTION 11

12. Equal Products

Equal products may be considered in lieu of the specific make/model listed in the bid documents. A request for approvals of "equal" product/system, or "substitutions" shall be considered. "All products listed may be substituted with a pre-approved equal subject to the Architect's review and approval."

END OF SECTION 12

13. Special Notice – Senate Bill 854 and California Labor Code Section 1725.5

Pursuant to the requirements of Senate Bill 854 and California Labor Code section 1725.5, all contractors and subcontractors that wish to engage in public work through a public works contract must first register with the Department of Industrial Relations and pay all applicable fees.

Beginning March 1, 2015, no contractor or subcontractor may be listed on a bid proposal for a public works project unless registered with the Department of Industrial Relations, pursuant to labor code section 1725.5 (with limited exceptions from this requirement for bid purposes only under Labor Code section 1771.1(a)).

Beginning April 1, 2015, no contractor or subcontractor may be awarded a contract or public work on a public works project unless registered with the Department of Industrial Relations, pursuant to labor code section 1725.5

This project is subject to compliance monitoring and enforcement by the Department of Industrial Relations.

For more information concerning Senate Bill 854, please visit: http://www.dir.ca.gov/Public-Works/SB854.htmpl

END OF SECTION 13

Imperial County Air Pollution Control District
Construction Notification Form

Project Information

Project Name: ______

Project Address: ______

Major X-Streets: ______

City: ______ County: ______

Expected Construction Start Date: ______ Total project site area: ______ Acres

End Date: ______ Total disturbed surface area: ______ Acres

The project is: ☐ Residential ☐ Non-residential (commercial, industrial, institutional, pulbic, etc.)

Construction activities on any site will include ten acres or more of disturbed surface area for residential developments, or five acres or more for non-resiential developments, are required to submit a Dust Control Plan to the District prior t the start of any construction activity. The Construction Notification Form may not be used to circumvent any Dust Control Plan requirement.

Contacts

Property Owner: ______

Address: ______

City / State / Zip: ______

Phone: ______ Fax: ______ Cell: ______

Developer: ______

Address: ______

City / State / Zip: ______

Contact Person: ______

Phone: ______ Fax: ______ Cell: ______

General Contractor: ______

Address: ______

City / State / Zip: ______

Contact Person: ______

Phone: ______ Fax: ______ Cell: ______

Other Contact: ______

Company: ______

Address: ______

City / State / Zip: ______

Phone: ______ Fax: ______ Cell: ______

Mailing Address: 150 South 9th Street
El Centro, CA 92243
Office: (760) 482-4606
Fax: (760) 353-9904

AIR POLLUTION CONTROL DISTRICT
150 S. 9th Street, El Centro, CA 92243
Ph. (760) 482-4606
Fax (760) 353-9904

SAMPLE FORMAT

CONSTRUCTION DUST CONTROL PLAN

REGULATION VIII - Rules 800-805

PROJECT IDENTIFICATION

Project Name ____________________ Project CUP # ____________

Legal Name/Company ____________________ City ____________

Contact name ____________________ Contact Phone ____________

Description of the location of the project; such as Address and major cross roads

PROJECT CONTACTS

In order to comply with the requirements of Regulation VIII all contacts responsible for the submittal and implementation of the Dust Control Plan shall be identified below with an explanation of the responsibility of each contact. If additional space is needed please attach a sheet. (Rule 801, subsection F.2.c.1)

NAME ____________________ **TITLE** ____________

PHONE NUMBER ____________ **E-MAIL ADDRESS** ____________

Describe the association the named person above has to the identified project. What are that person's duties, responsibilities. Does the person named above have the primary responsibility for implementing the Dust Control Plan? Is this person responsible for the project site?

NAME ____________________ **TITLE** ____________

PHONE NUMBER ____________ **E-MAIL ADDRESS** ____________

Describe the association the named person above has to the identified project. What are that person's duties, responsibilities. Does the person named above have the primary responsibility for implementing the Dust Control Plan? Is this person responsible for the project site?

Please identify any known contractors, names, phone contact person etc., hired to work on the project site on separate cover.

Project Name ____________________ Project CUP # __________

PROJECT CONSTRUCTION OPERATIONS

Provide pertinent information concerning the projects **construction operations** - include a **plot plan** (which may be a tract map, site map or topographic map) which identifies the boundaries of the project, existing roads (including but not limited to paved, unpaved road ways, highways and freeways), where new proposed roads will be constructed, where the staging areas will be located, easements, entry and exit points (include whether these entry points will be permanent or temporary), whether or not sensitive receptors are adjacent to the project (including but not limited to residential areas, schools, day cares, churches, hospitals, nursing facilities, commercial and/or retail), include the distance between the project and the sensitive receptors and any other information as to allow for the proper evaluation of dust generating point sources and their impact. (Rule 801, subsection F.2.c.2&5)

The following checklist is provided solely as a guide and is not meant to be all inclusive. During the Plot Plan review process the Air District may identify additional dust generating point sources. For those instances where additional sources, not listed, have been identified please list under other. (Rule 801 subsection F.2.c.2&5)

List all identified actual and potential sources of fugitive dust emissions

☐ Bulk material handling and storage areas.
☐ Paved and unpaved access roads, haul roads, traffic areas, and equipment storage yards.
☐ Exit points where carryout and trackout onto paved public roads may occur.
☐ Water supply locations if water application will be used for controlling visible dust emissions.
☐ Other list below.

Check or list the relative locations of sensitive receptors within ¼ mile of the project. (Rule 407, Nuisance)

☐ No sensitive receptors within ¼ mile of the project.
☐ Residential areas, schools, day care, churches, hospitals, nursing facilities, commercial, retail, etc.
☐ Freeways, roads, or traffic areas that may be affected by the dust generating activities.
☐ Other list below.

Project Name ______________________ Project CUP # __________

DISTURBED SURFACE AREA

Report the total area of land surface to be disturbed, the daily throughput volume of earthmovement in cubic yards and the total area in acres of the entire project site. (Rule 801, subsection F.2.c.3&4)

Total area of project site __________ Acres Total surface area to be disturbed __________ Acres

Total disturbed areas left inactive for more than seven days __________ Acres

Daily average throughput volume of earthmoving __________ Cubic Yards

Daily maximum throughput volume of earthmoving __________ Cubic Yards

OTHER SITES

Identify whether any other locations should be included with this plan that are involved with this project. An example may include listing any site where materials will be imported from or exported to.

☐ No other locations are included with this project

Location 1: ______________________________

☐ No Dust Control Plan Required ☐ Included with this plan ☐ Included with another plan

Location 2: ______________________________

☐ No Dust Control Plan Required ☐ Included with this plan ☐ Included with another plan

Location 3: ______________________________

☐ No Dust Control Plan Required ☐ Included with this plan ☐ Included with another plan

DUST GENERATING ACTIVITY DATES

EXPECTED CONTRUCTION START AND END DATES

IF CONSTRUCTION IS NOT PHASED SIMPLY INCLUDE THE START AND END DATES UNDER THE PHASE 1 OPTION

Phase 1 Start Date ______________

Phase 1 End Date ______________

Phase 2 Start Date ______________

Phase 2 End Date ______________

Phase 3 Start Date ______________

Phase 3 End Date ______________

Phase 4 Start Date ______________

Phase 4 Start Date ______________

Project Name ______________________ Project CUP # __________

MINIMUM REQUIREMENTS

This section describes the minimum requirements for limiting visible dust emissions from activities that cause fugitive dust emissions. Each category must have one requirement check marked. (Rule 801 section F) For Enhanced Measures check all that apply.

Structural Demolition

☐ No demolitions are planned for this project explain below.

☐ Asbestos NESHAP notification has been submitted to the ARB and copy to the District.
Date notification submitted ______________

Pre-Activity (Rule 801 subsection F.1.a)

☐ Not applicable for this project explain below.

☐ The site will be pre-watered and work will be phased to reduce the amount of disturbed surface area at any one time. *(Complete section M-1 beginning with page 7)*

Active Operations (Rule 801, subsection F.1.b)

☐ Application of water or Chemical Stabilizers to earthmoving activities. *(Complete sections M-1 and/or M-2)*

☐ Construct & maintain wind barriers to limit visible dust emissions to 20%. *(Complete section M-3)*

Temporary stabilization: areas unused for seven or more days (Rule 801 subsection F.1.c)

☐ Not applicable for this project explain below.

☐ Vehicular access will be restricted and water or dust suppressants will be applied and maintained at all unvegetated areas. *(Complete sections M-2 and/or section M-3)*

Project Name ______________________ Project CUP # __________

MINIMUM REQUIREMENTS CONTINUED

This section describes the minimum requirements for limiting visible dust emissions from activities that cause fugitive dust emissions. Each category must have one requirement check marked. (Rule 801 section F) For Enhanced Measures check all that apply.

Unpaved Access, Haul Roads, Traffic & Equipment Storage Areas (Rule 805)

☐ Not applicable for this project explain below.

☐ Apply water or dust suppressants to unpaved haul and access roads. *(Complete sections M-1 and/or M-2)*

☐ Method of restricting unauthorized vehicle access. *(Complete section M-3)*

☐ Water or dust suppressants will be applied to vehicle traffic and equipment storage areas. (Complete sec M-1 and/or M-2)

☐ Establish vegetation on all previously disturbed areas .*(Complete section M-3)*

Outdoor Handling of Bulk Materials (Rule 802)

☐ No bulk materials will be handled during this project explain below.

☐ Water or dust suppressants will be applied when handling bulk materials. *(Complete sections M-1 and/or M-2)*

☐ Protection from wind erosion by sheltering or enclosing the operation and transfer line. *(Complete section M-3)*

Outdoor Storage of Bulk Materials (Rule 802)

☐ No bulk materials will be stored during this project explain below.

☐ Water or dust suppressants will be applied to storage piles. *(Complete sections M-1 and/or M-2)*

☐ Storage piles will be covered with tarps, plastic or other suitable material and anchored in such a manner that prevents the cover from being removed by wind action. *(Complete section M-3)*

Project Name ______________________ Project CUP # __________

MINIMUM REQUIREMENTS CONTINUED

This section describes the minimum requirements for limiting visible dust emissions from activities that cause fugitive dust emissions. Each category must have one requirement check marked. (Rule 801 section F) For Enhanced Measures check all that apply.

On-Site/Off Site Transporting of Bulk Materials

☐ No bulk materials will be transported on the project site explain below.

☐ Haul trucks will be covered with a tarp or other suitable cover. *(Complete section M-5)*

☐ All haul trucks will be loaded such that the freeboard is not less than six inches when transported across any paved public access road. *(Complete section M-5)*

☐ Cargo compartments are maintained so that ***no*** spillage and loss of bulk material will occur from holes or other openings in the floor, side and/or tailgate. *(Complete section M-5)*

☐ Cargo compartment is to be cleaned and/or washed at delivery site after removal of Bulk Material. *(Complete section M-5)*

Enhanced Measures: ***According to Regulation VIII stabilization must be met at all times. See Rule 801 subsection D.2***

☐ Cease dust generating activities when wind speeds exceed 25mph. *(Records of wind speeds and wind gusts must be maintained and provided to the APCD upon request.)*

☐ Application of water or dust suppressants once per hour when wind speeds exceed 15mph. *(Records of wind speeds and wind gusts must be maintained and provided to the APCD upon request.)*

☐ Apply water to maintain 12% soil moisture content when wind speed exceeds 15mph. *(Records of wind speeds and wind gusts must be maintained and provided to the APCD upon request.)*

☐ Construct fences 3-5 feet high with 50% or less porosity in conjunction with water application or dust suppressant when wind speeds exceed 15mph. *(Records of wind speeds and wind gusts must be maintained and provided to the APCD upon request.)*

☐ OTHER - If necessary attach separate sheet.

SECTION M-1

Project Name ______________________________ Project CUP # ____________

WATER APPLICATION

Complete this section if water application will be used as a control method for limiting visible dust emissions and stabilizing surface areas. Check and answer all sections that apply to this project. In addition, if there is no intention of applying water to any phase of the project explain below. (Rule 801 section F)

NO WATER APPLICATION - EXPLAIN?

WATER APPLICATION SUPPLY - THE LOCATION OF EACH MUST BE IDENTIFED ON THE PLOT PLAN

☐ Fire hydrants

Number of hydrants available On-Site ________ Off-Site ________

Approval granted by the owner or public agency to use their fire hydrants for this project.

Owner or Agency granting approval ______________________________

Contact Name and phone number ______________________________

☐ Storage tanks Number of tanks ________ Capacity of each ______________

☐ Wells Number of wells ________ Flow rate of each well ______________

☐ Canal, River, Pond, Lake etc.

Approval granted by the owner or public agency to use their water source for this project

Owner or Agency granting approval ______________________________

Contact Name and phone number ______________________________

☐ Other explain

SECTION M-1 CONTINUED

Project Name ______________________ Project CUP # __________

WATER APPLICATION CONTINUED

Complete this section if water application will be used as a control method for limiting visible dust emissions and stabilizing surface areas. Check and answer all sections that apply to this project. In addition, if there is no intention of applying water to any phase of the project explain above. (Rule 801 section F)

WATER APPLICATION EQUIPMENT: THE LOCATION OF EACH MUST BE IDENTIFED ON THE PLOT PLAN

☐ Sprinklers

Describe the activities that will utilize sprinklers

Minimum treated area __________ ☐ Square Feet ☐ Acres Frequency ______________________

Maximum treated area __________ ☐ Square Feet ☐ Acres Frequency ______________________

☐ Water Truck ☐ Other explain ______________________

Describe the activities that will utilize the equipment

Number of application equipment to be used __________ Hours of operation ______________

Application equipment capacity ______________________

Application frequency must be once per day or more explain frequency below

Water application equipment is available to operate after normal working hours, on weekends and holidays

Name of contact after hours ______________________ Phone No. ______________

Name of contact after hours ______________________ Phone No. ______________

SECTION M-2

Project Name ______________________ Project CUP # __________

DUST SUPPRESSANT PRODUCTS

Complete this section if a dust suppressant product will be used. These materials include but are not limited to: hygroscopic suppressants (road salts), adhesives, petroleum emulsions, polymer emulsions and bituminous materials (road oils).

☐ **Not Applicable** - The only control method will be the application of water *(Complete section M-1)*

Application Area; Explain where the dust suppressant will be applied below

Product (Manufacturer) Name ______________________

Name of contractor ______________________ Phone No. __________

Explain the rate of application including the amount of gallons of undiluted material per mile or per acre below.

Explain the application frequency; type and number of equipment; capacity including the amount of gallons of undiluted material per mile or per acre below.

Utilizing the checklist below attach each of the following pieces of information that fully describes the product to be used. All information must be submitted with this plan.

☐ Product Specifications. (MSDS, Product Safety Data Sheet, etc.)

☐ Manufacturer's Usage Instructions. (method, frequency and intensity of application)

☐ Environmental impacts and approvals or certificaitons related to the appropriate and safe use for ground application.

☐ Check here if more than one dust suppressant will be utilized and include the necessary copies of this page with the information for each dust suppressant to be used.

SECTION M-3

Project Name ______________________ Project CUP # ____________

OTHER DUST CONTROL METHODS

Check below all other types of dust control methods that will be employed at the construction site.

☐ Physical barriers for restricting unauthorized vehicle access

☐ Fences ☐ Gates ☐ Posts ☐ Berms ☐ Concrete Barriers
☐ Other explain below

☐ Wind barriers describe below.

☐ Re-establish vegetation for temporarily stabilizing previously disturbed surfaces explain below.

☐ Apply Gravel- for the application of gravel identify where application will occur such as haul road, access roads, equipment storage yards (areas), vehicle traffic areas etc explain below.

☐ Apply pavement - explain where paving will occur.

☐ Other explain below.

AIR POLLUTION CONTROL DISTRICT
150 S. 9th Street, El Centro, CA 92243
Ph. (760) 482-4606
Fax (760) 353-9904

SAMPLE FORMAT

CONSTRUCTION DUST CONTROL PLAN

SECTION M-4

Project Name ______________________ Project CUP # __________

TREATMENTS FOR PREVENTING TRACKOUT

Select the control devices that will be used for preventing trackout from occurring onto paved public roads. Trackout is any material that adheres to vehicle tires and is deposited onto a paved public road or the paved shoulder of a paved public road. Check all that apple to this project below.

☐ **Grizzly:** Rails, pipes, or grates used to dislodge debris off of vehicles before exiting the site. Extends from the intersection with the paved public road surface for the full width of the unpaved exit surface for a distance of at least 25 feet. **Describe below**

☐ **Gravel Pad:** A layer of washed gravel at least three (3) inches deep which extends from the intersection with the public paved road surface for the full width of the unpaved exit surface for a distance of at least 50 feet. Identify gravel size in inches, the pad width in feet, including the length and depth of the gravel below.

☐ **Paved Surface:** Extends from the intersection with the paved public road surface for the full width of the unpaved access road for at least 50 feet to allow mud and dirt to drop off of vehicles before exiting the site. Identify the width and length of the paved surface below in feet.

Mud and dirt deposits within an urban area shall be cleaned immediately when trackout or carryout extends a cumulative distance of 50 linear feet or more otherwise clean up must be at the end of the workday.

☐ **Wheel Washer:** Uses water to dislodge debris from tires and vehicle undercarriage. If utilizing a wheel washer describe the location, type and operation of the wheel washer below.

☐ **Other** - describe any other measure utilized to prevent trackout below.

SECTION M-5

Project Name ____________________ Project CUP # ____________

TREATMENTS FOR PREVENTING CARRYOUT

Report the required treatments that will be used for preventing carryout from occurring on paved public roads. Carryout occurs when materials from emptied or loaded haul trucks, vehicles, or trailers fall onto a paved public road or paved shoulder of a paved public road. Check all that apply.

☐ No haul trucks will be routinely entering or leaving the project site explain below.

Emptied Haul Trucks:

☐ Interior cargo compartments will be cleaned before leaving the project site. Explain below how emptied haul truck will be washed and the source of the water supply.

☐ Cargo compartment will be covered with a tarp or suitable cover before leaving the project site.

Loaded Haul Trucks:

☐ Spillage or loss of materials from holes or other opening(s) in the cargo compartment will be prevented when material transported onto any paved public access road.

- ☐ Haul trucks will be loaded such that the freeboard is not less than six inches.
- ☐ Other describe below.

SECTION M-6

Project Name ____________________ Project CUP # __________

CLEANING UP CARRYOUT AND TRACKOUT

Check and report below the methods and frequency for cleaning up carryout and trackout from the surface and paved shoulder of paved public roads. All material tracked or carried out onto paved road must be removed. Check all that apply.

The project is located in

☐ **An Urban Area**

Identify the urban area by location, description etc. below.

☐ Minimum cleanup frequency will be at the end of the workday and removed immediately if carryout and trackout, extends beyond 50 feet.

☐ **Non Urban Area**

Identify the non urban area by location, description etc. below.

☐ At the end of the workday

Optional - Clean up Method

☐ Manually sweeping and picking up.

☐ Mechanical sweeping with a rotary brush or broom accompanied or preceded by water.

Describe types of equipment that will be used.

The use of blower devices, or dry rotary brushers or brooms, for removal of carryout and trackout from paved public roads is not recommended.

Project Name ______________________ Project CUP # ____________

RECORD KEEPING

Records and/or any other supporting documents used for the demonstration of compliance must be maintained for two years and provided to the Air Pollution Control District upon request.

CERTIFICATION

I certify that all information contained herein and information submitted in the attachments to these documents are true and correct.

______________________ ______________________
Print Name Title

______________________ ______________________
Signature Date

Phone Number ______________________ Fax Number ______________________

Cell Number ______________________

Geotechnical Report

Public Safety Facility

518 Railroad Avenue
Winterhaven, California

Prepared for:

Dynamic Consulting Engineers, Inc.
2415 Imperial Business Park Drive, Suite B
Imperial, CA 92251

Prepared by:

LANDMARK
Geo-Engineers and Geologists

Landmark Consultants, Inc.
780 N. 4th Street
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May 2015

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May 6, 2015

Mr. Carlos Beltran, PE
Dynamic Consulting Engineers, Inc.
2415 Imperial Business Park Drive, Suite B
Imperial, CA 92251

Geotechnical Report
Proposed Public Safety Facility
518 Railroad Avenue
Winterhaven, California
LCI Report No. LE15031

Dear Mr. Beltran:

We are pleased to present this geotechnical report for the proposed construction of the new Public Safety Facility located at 518 Railroad Avenue in Winterhaven, California. Our geotechnical investigation was conducted in response to your request for our services. The enclosed report describes our soil engineering investigation and presents our professional opinions regarding geotechnical aspects for design and construction of the project.

This executive summary presents ***selected*** elements of our findings and professional opinions only. It ***may not*** present all details needed for the proper application of our findings and professional opinions. Our findings, professional opinions, and application options are related ***only through reading the full report***, and are best evaluated with the active participation of the engineer of record who developed them. The findings of this study are summarized below:

- Silt (ML) and silty clay soils (CL) of low to medium expansion predominate the site.

- Foundation designs should mitigate expansive soil conditions by one of the following methods:

  1. Remove and replace upper 3.0 feet of clay soils with non-expansive sands.
  2. Design foundations to resist expansive forces in accordance with the 2013 California Building Code (CBC) Chapter 18, Section 1806 or the Post-Tensioning Institute, 3rd Edition. This requires grade-beam stiffened of floor slabs (20 feet maximum on center) or flat-plate mat slabs. Design soil bearing pressure = 1,500 psf. Differential movement of 1 inch can be expected for slab on grade foundations placed on clay soils.
  3. A combination of the methods described above.

- The risk of liquefaction induced settlement is moderate (estimated settlement of ¾ to 1¾ inches at 12 to 49 feet below ground surface. There is a low risk of ground rupture should liquefaction occur. Optional measures used to reduce that potential include the following:

    1. Deep foundations (drilled piers, piles, auger-cast piles)
    2. Foundations tied with grade beams
    3. Structural flat-plate mats
    4. Flexible utility connections to foundation

- The native soils are aggressive to concrete and steel. Concrete mixes shall have a maximum water cement ratio of 0.45 and a minimum compressive strength of 4,500 psi (minimum of 6.25 sacks Type V cement per cubic yard).

- All reinforcing bars, anchor bolts and hold down bolts shall have a minimum concrete cover of 3.0 inches unless epoxy coated (ASTM D3963/A934). Hold-down straps are not allowed at the foundation perimeter. No pressurized water lines are allowed below or within the foundations.

- Pavement structural sections may be designed for clay subgrade soils (R-Value = 10).

We appreciate the opportunity to provide our professional services. If you have any questions or comments regarding our findings, please call our office at (760) 370-3000.

Respectfully Submitted,
Landmark Consultants, Inc.

STEVEN K. WILLIAMS
No. 2261

Steven K. Williams, CEG
Senior Engineering Geologist

JEFFREY O. LYON
No. 31921
Ren. 12/31/16

Jeffrey O. Lyon, PE
Principal Engineer

JOSEPH R SIDOR
No. 776
EXPIRATION DATE
12-31-15

Joseph Sidor, GE
Geotechnical Engineer

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Section 1
INTRODUCTION

1.1 Project Description

The proposed project will consist of construction of the new Public Safety Facility located at 518 Railroad Avenue in Winterhaven, California. The proposed facility will consist of an approximately 8,000 square foot building that will house the Imperial County Fire Department and Sheriff's Department.

The buildings are planned to consist of single story construction with slab-on-grade, with either wood or masonry walls. Foundations are expected to be lightly loaded. For the purposes of our analysis and report, we have assumed that structural loads will not exceed 5 kips per linear foot for wall footings and 50 kips for the column footings.

If structural loads exceed those used in our analysis, we should be notified so we may evaluate their impact on settlement estimates for the foundations. Site development will include grading (cuts and fills for the buildings are expected to be no more than 2 feet), building pad preparation, installation of underground utilities, concrete sidewalk and hardscape construction.

1.2 Purpose and Scope of Work

The purpose of our geotechnical investigation was to evaluate the physical characteristics of the on-site soils and to provide geotechnical criteria for site grading, design of foundations and slabs. Our scope of work included the following:

- Review of background information including available published geologic maps and literature.
- Field exploration consisting of performing two (2) Cone Penetrometer soundings to a depth of 50 feet and two mechanical auger borings; one to 9 feet and one to three feet below the existing ground surface.
- Laboratory testing of selected soil samples including: plasticity index tests, grain size analysis, and chemical analyses (soluble sulfate, chloride content, pH, and resistivity).
- Engineering analysis and evaluation of the data collected.

- Preparation of this report presenting our findings, professional opinions, and design criteria for the geotechnical aspects of the project development.

Our scope of work specifically excluded an evaluation of the site for the presence of hazardous materials or conditions.

1.3 Authorization

Mr. Carlos Beltran, PE with Dynamic Consulting Engineers, Inc. provided written authorization to proceed with our work on February 18, 2015. We conducted our work according to our written proposal dated February 4, 2015.

Section 2
METHODS OF INVESTIGATION

2.1 Field Exploration

Subsurface exploration was performed on March 23, 2015 using Middle Earth Geo-Testing, Inc. of Orange, California to advance two (2) electric cone penetrometer (CPT) soundings to an approximate depth of 50 feet below existing ground surface. The soundings were made at the locations shown on the Site and Exploration Plan (Plate A-2). A shallow (3-foot deep) hand auger boring (3-inch diameter) was made adjacent to the CPT-1 sounding in order to obtain near a surface soil sample for laboratory analysis. On April 28, 2015 a nine (9) foot deep auger boring was drilled in the southeast corner of the site.

The approximate sounding and boring locations were established in the field and plotted on the site map by sighting to discernible site features. CPT soundings provide a continuous profile of the soil stratigraphy with readings every 2.5cm (1 inch) in depth. Direct sampling for visual and physical confirmation of soil properties has been used by our firm to establish direct correlations with CPT exploration in this geographical region.

The CPT exploration was conducted by hydraulically advancing an instrumented Hogentogler 10cm^2 conical probe into the ground at a rate of 2 cm per second using a 23-ton truck as a reaction mass. An electronic data acquisition system recorded a nearly continuous log of the resistance of the soil against the cone tip (Qc) and soil friction against the cone sleeve (Fs) as the probe was advanced. Empirical relationships (Robertson and Campanella, 1989) were then applied to the data to give a continuous profile of the soil stratigraphy. Interpretation of CPT data provides correlations for SPT blow count, phi (ϕ) angle (soil friction angle), undrained shear strength (S_u) of clays and over-consolidation ratio (OCR). These correlations may then be used to evaluate vertical and lateral soil bearing capacities and consolidation characteristics of the subsurface soil.

Interpretive logs of the CPT soundings and boring logs were produced after review of field and laboratory test data and are presented on Plates B-1 thru B-3 in Appendix B of this report. A key to the interpretation of CPT soundings and boring log key are presented on Plate B-3 and B-4.

The stratification lines shown on the subsurface logs represent the approximate boundaries between the various strata. However, the transition from one stratum to another may be gradual over some range of depth.

2.2 Laboratory Testing

Laboratory tests were conducted on selected bulk soil samples obtained from hand auger borings made adjacent to the CPT locations to aid in classification and evaluation of selected engineering properties of the near surface soils. The tests were conducted in general conformance to the procedures of the American Society for Testing and Materials (ASTM) or other standardized methods as referenced below. The laboratory testing program consisted of the following tests:

- Plasticity Index (ASTM D4318) – used for soil classification and expansive soil design criteria
- Grain Size Analysis (ASTM D422) – used for evaluating relative expansion and soil classification
- Chemical Analyses (soluble sulfates & chlorides, pH, and resistivity) (Caltrans Methods) – used for concrete mix design parameters and corrosion protection requirements.

The laboratory test results are presented on Plates C-1 through C-3 in Appendix C of this report.

Section 3
DISCUSSION

3.1 Site Conditions

The proposed Public Safety Facility is located at 518 Railroad Avenue in Winterhaven, California. The project location is depicted on Plate A-1, Vicinity Map. The coordinates of the project site are 32.7394N -114.6344W. The project site is comprised of an approximately 1.4-acre parcel (Imperial County APN 056-285-001) that is currently a vacant. The surface contains scattered brush and weeds. The site is square in plan view. A concrete slab (approximately 50 ft. x 100 ft.) is located in the southwest corner of the site. Two palm trees are located in the northeast corner of the site. A railroad tie post and chain link fence is located along the west margin of the site. The topography in the site vicinity is planar as presented in Plate A-4, Topographic Map.

Properties to the north, east and south consist of residential units. Properties to the west across from Railroad Avenue consist of both residential and commercial property (small telecommunication office/yard and a small grocery market) to the south of the residential property.

3.2 Geologic Setting

The Winterhaven area straddles the dividing line between the Salton Trough and the Sonoran Desert section of the Basin and Range physiographic province. The Salton Trough is a geologic structural depression resulting from large scale regional faulting. The trough is bounded on the northeast by the Sand Hills and Algodones Faults and the southwest by faults of the San Jacinto Fault Zone. The Salton Trough represents the northward extension of the Gulf of California that has experienced continual in-filling with both marine and non-marine sediments since its approximate formation in the Miocene Epoch.

The region is underlain by Holocene (0 - 11,000 years B.P.) flood plain deposits of the Colorado and Gila Rivers that periodically flooded before dams and reservoirs were constructed upstream on both rivers. The Holocene flood plain deposits consist of sands, silts and clays and are believed to be more than 100 feet thick at this site.

Coarser sands and gravel underlay the most recent fluvial deposits forming a transition zone between the upper soils and the underlying Pliocene marine unit, known as the Bouse Formation. The transition zone is characterized by marine strata intertonguing with non-marine strata reflecting the interaction of the fluvial environment of the ancestral Colorado and Gila Rivers and the marginal marine environment of the ancestral Gulf of California.

The project site lies within the Colorado River alluvial valley that consist of river deposits (silts, clays, sands) with groundwater fluctuating with the Colorado River stages and local agricultural irrigation. The surface geology of the site is depicted on Plate A-5.

3.3 Site Subsurface Conditions

The results of our subsurface investigation at the site, along with the review of available geologic maps and literature, indicate that the site is underlain by Colorado River floodplain deposits to the maximum depth explored of 50 feet. Interbedded silty sands, sandy silts, clayey silts, and silty clays were encountered from the ground surface to a depth of about 12 to 17 feet. Dense to very dense silty sands (SM) and sandy silts (ML) extend from 12-17 feet to 50 feet the maximum depth of exploration. Thin interbeds of silty sand/sandy silt were encountered at approximately 30, 38, and 48 feet below the ground surface. The site soils have been classified as Site Class D (stiff soil profile) based on density of the subsurface soils. A schematic geologic cross section is presented on Plate A-6.

Groundwater was not detected in the CPT soundings during the time of exploration. Groundwater is reported at a depth of 12 to 14 feet in groundwater monitoring wells located approximately 300 feet south of the project site. There is uncertainty in the accuracy of short-term water level measurements, particularly in fine-grained soil. Groundwater levels may fluctuate with precipitation, irrigation of adjacent properties, drainage, and site grading. The referenced groundwater level should not be interpreted to represent an accurate or permanent condition.

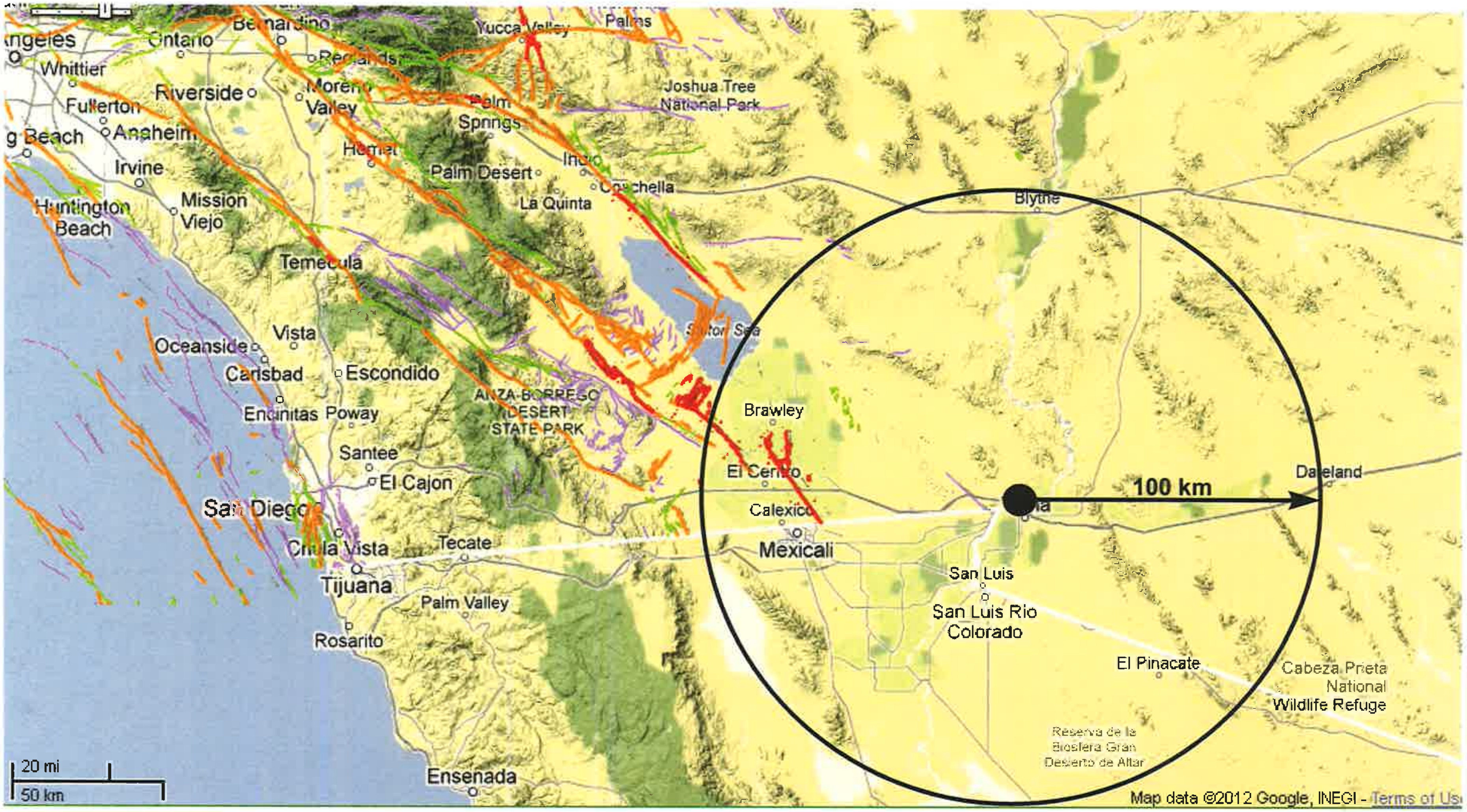
3.4 Seismic Hazards

3.4.1 Faulting and Seismicity

The project site is located in the seismically active southern California region and is expected to be subjected to moderate to strong ground shaking during the design life of the project. A fault map illustrating known active faults relative to the site is presented on Figure 1, *Regional Fault Map*. Figure 2 shows the project site in relation to local faults. The criterion for fault classification adopted by the California Geological Survey defines Earthquake Fault Zones along active or potentially active faults. An active fault is one that has ruptured during Holocene time (roughly within the last 11,000 years). A fault that has ruptured during the last 1.8 million years (Quaternary time), but has not been proven by direct evidence to have not moved within Holocene time is considered to be potentially active. A fault that has not moved during Quaternary time is considered to be inactive. Review of the current Alquist-Priolo Earthquake Fault Zone maps (CGS, 2000a) indicates that the nearest mapped Earthquake Fault Zones are the Imperial fault located approximately 2.5 miles east of the project site and the Superstition Hills fault located approximately 3.0 miles west of the project site. Table 1 lists known faults or seismic zones that lie within a 76 mile (122 kilometer) radius of the project site.

The site is not located within a currently designated Earthquake Fault-Rupture Hazard Zone (CDMG Special Publication 42). The closest known active fault to the site is the Imperial fault, located about 39 miles southwest of the site. The possibility of ground surface rupture related to active faulting on currently unrecognized faults exists. However, given the current state of knowledge regarding seismicity of the region, the potential for fault rupture at the project site is considered low.

The Algodones Fault, shown on most geologic and fault maps of the Yuma area, is concealed by young sediments and crosses approximately 10.5 kilometers southwest of the project site. Studies by Woodward-McNeill (1974) and Dames and Moore (1985) for the Salt River Dual Use Nuclear Plant siting and The Yuma Water Users Hydroelectric Plant project, respectively, have stated that the most recent activity along the Algodones Fault was pre-Holocene (11,000 years before present).



Source: California Geological Survey 2010 Fault Activity Map of California
http://www.quake.ca.gov/gmaps/FAM/faultactivitymap.html#

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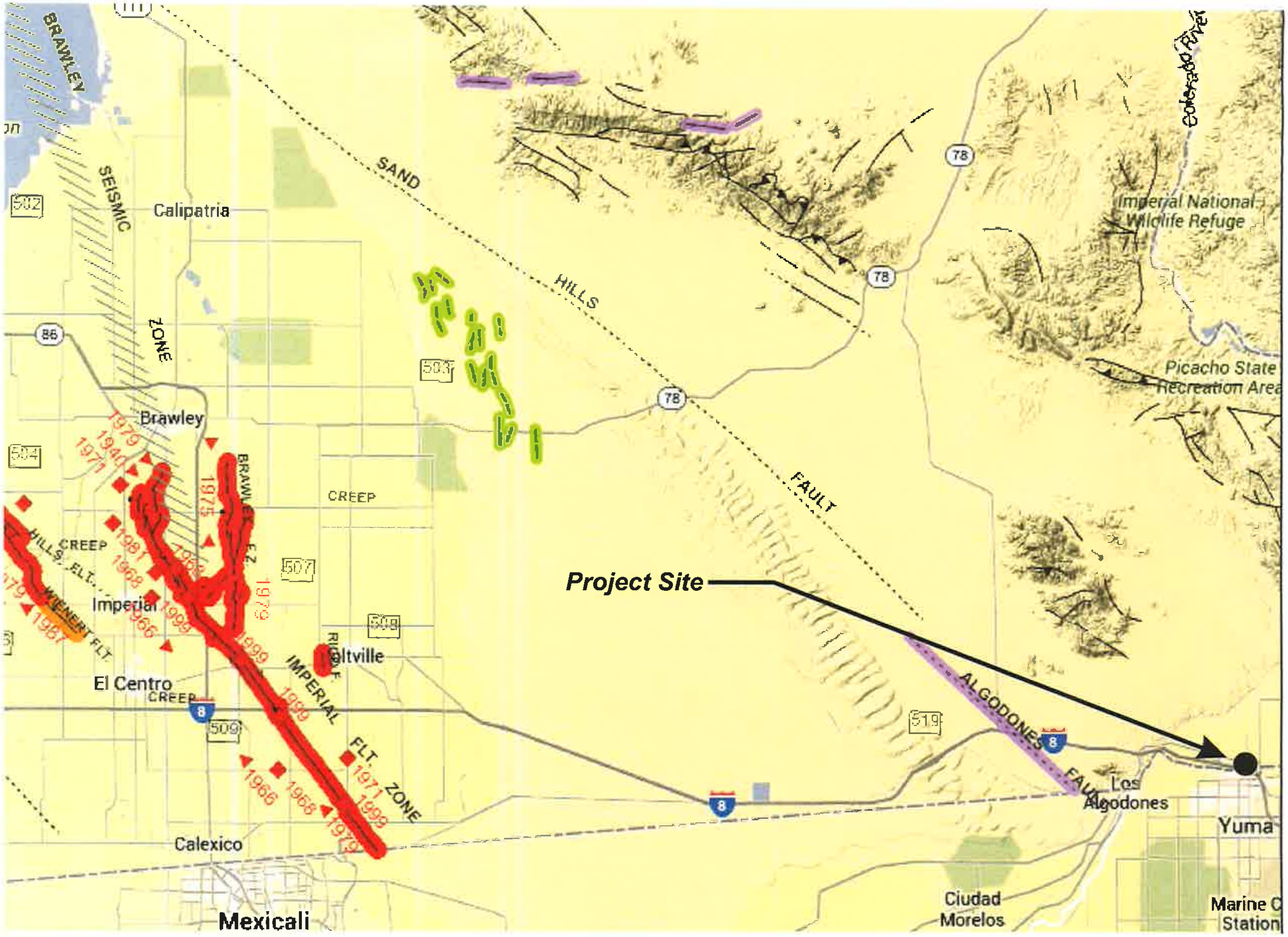
Regional Fault Map

Figure 1



Source: California Geological Survey 2010 Fault Activity Map of California
http://www.quake.ca.gov/gmaps/FAM/faultactivitymap.html#

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Map of Local Faults

Figure 2

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. Concealed faults in the Great Valley are based on maps of selected subsurface horizons, so locations shown are approximate and may indicate structural trend only. All offshore faults based on seismic reflection profile records are shown as solid lines where well defined, dashed where inferred, queried where uncertain.

FAULT CLASSIFICATION COLOR CODE
(Indicating Recency of Movement)

Fault along which historic (last 200 years) displacement has occurred and is associated with one or more of the following:

(a) a recorded earthquake with surface rupture. (Also included are some well-defined surface breaks caused by ground shaking during earthquakes, e.g. extensive ground breakage, not on the White Wolf fault, caused by the Arvin-Tehachapi earthquake of 1952). The date of the associated earthquake is indicated. Where repeated surface ruptures on the same fault have occurred, only the date of the latest movement may be indicated, especially if earlier reports are not well documented as to location of ground breaks.

(b) fault creep slippage - slow ground displacement usually without accompanying earthquakes.

(c) displaced survey lines.

A triangle to the right or left of the date indicates termination point of observed surface displacement. Solid red triangle indicates known location of rupture termination point. Open black triangle indicates uncertain or estimated location of rupture termination point.

Date bracketed by triangles indicates local fault break.

No triangle by date indicates an intermediate point along fault break.

Fault that exhibits fault creep slippage. Hachures indicate linear extent of fault creep. Annotation (creep with leader) indicates representative locations where fault creep has been observed and recorded.

Square on fault indicates where fault creep slippage has occured that has been triggered by an earthquake on some other fault. Date of causative earthquake indicated. Squares to right and left of date indicate terminal points between which triggered creep slippage has occurred (creep either continuous or intermittent between these end points).

Holocene fault displacement (during past 11,700 years) without historic record. Geomorphic evidence for Holocene faulting includes sag ponds, scarps showing little erosion, or the following features in Holocene age deposits: offset stream courses, linear scarps, shutter ridges, and triangular faceted spurs. Recency of faulting offshore is based on the interpreted age of the youngest strata displaced by faulting.

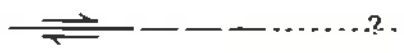
Late Quaternary fault displacement (during past 700,000 years). Geomorphic evidence similar to that described for Holocene faults except features are less distinct. Faulting may be younger, but lack of younger overlying deposits precludes more accurate age classification.

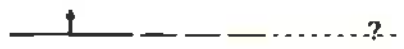
Quaternary fault (age undifferentiated). Most faults of this category show evidence of displacement sometime during the past 1.6 million years; possible exceptions are faults which displace rocks of undifferentiated Plio-Pleistocene age. Unnumbered Quaternary faults were based on Fault Map of California, 1975. See Bulletin 201, Appendix D for source data.

Pre-Quaternary fault (older that 1.6 million years) or fault without recognized Quaternary displacement. Some faults are shown in this category because the source of mapping used was of reconnaissnce nature, or was not done with the object of dating fault displacements. Faults in this category are not necessarily inactive.

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). Fault surface generally dips less than 45° but locally may have been subsequently steepened. On offshore faults, barbs simply indicate a reverse fault regardless of steepness of dip.

OTHER SYMBOLS

Numbers refer to annotations listed in the appendices of the accompanying report. Annotations include fault name, age of fault displacement, and pertinent references including Earthquake Fault Zone maps where a fault has been zoned by the Alquist-Priolo Earthquake Fault Zoning Act. This Act requires the State Geologist to delineate zones to encompass faults with Holocene displacement.


Structural discontinuity (offshore) separating differing Neogene structural domains. May indicate discontinuities between basement rocks.


Brawley Seismic Zone, a linear zone of seismicity locally up to 10 km wide associated with the releasing step between the Imperial and San Andreas faults.

Geologic Time Scale			Years Before Present (Approx.)	Fault Symbol	Recency of Movement	DESCRIPTION	
						ON LAND	OFFSHORE
Quaternary	Late Quaternary	Historic	200	—		Displacement during historic time (e.g. San Andreas fault 1906). Includes areas of known fault creep.	
		Holocene	11,700	—	? ? ?	Displacement during Holocene time.	Fault offsets seafloor sediments or strata of Holocene age.
		Pleistocene	700,000	—	? ?	Faults showing evidence of displacement during late Quaternary time.	Fault cuts strata of Late Pleistocene age.
	Early Quaternary		1,600,000*	—	?	Undivided Quaternary faults - most faults in this category show evidence of displacement during the last 1,600,000 years; possible exceptions are faults which displace rocks of undifferentiated Plio-Pleistocene age.	Fault cuts strata of Quaternary age.
Pre-Quaternary			4.5 billion (Age of Earth)	—		Faults without recognized Quaternary displacement or showing evidence of no displacement during Quaternary time. Not necessarily inactive.	Fault cuts strata of Pliocene or older age.

---

* Quaternary now recognized as extending to 2.6 Ma (Walker and Geissman, 2009). Quaternary faults in this map were established using the previous 1.6 Ma criterion.

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Fault Map Legend

Figure 3b

Table 1
Summary of Characteristics of Closest Known Active Faults

Fault Name	Approximate Distance (miles)	Approximate Distance (km)	Maximum Moment Magnitude (Mw)	Fault Length (km)	Slip Rate (mm/yr)
Algodones *	6.5	10.5			
Imperial	38.8	62.1	7	62 ± 6	20 ± 5
Cerro Prieto *	44.6	71.4			
Rico *	44.7	71.5			
Brawley *	49.1	78.5			
Cucapah (Mexico)*	49.4	79.0			
Pescadores (Mexico)*	50.6	81.0			
Borrego (Mexico)*	51.7	82.8			
Superstition Hills	56.5	90.4	6.6	23 ± 2	4 ± 2
Laguna Salada	57.3	91.7	7	67 ± 7	3.5 ± 1.5
Unnamed 2*	60.8	97.3			
Superstition Mountain	61.9	99.0	6.6	24 ± 2	5 ± 3
Unnamed 1*	64.4	103.0			
Pisgah Mtn. - Mesquite Lake	65.3	104.4	7.3	89 ± 9	0.6 ± 0.4
Yuha*	65.8	105.2			
Elmore Ranch	68.4	109.4	6.6	29 ± 3	1 ± 0.5
Shell Beds	69.5	111.2			
Yuha Well *	69.9	111.9			
Vista de Anza*	72.9	116.6			
Hot Springs *	73.0	116.8			
Painted Gorge Wash*	74.4	119.1			
San Andreas - Coachella	75.9	121.5	7.2	96 ± 10	25 ± 5

* Note: Faults not included in CGS database.

Additionally, this fault is believed to exhibit normal dip-slip movement between the Salton Trough and the Basin and Range provinces rather than strike-slip movement, which characterizes most seismic activity. Bausch and Brumbaugh (1996) consider the Algodones fault to be potentially active based on fault trenching of the fault trace. Bausch and Brumbaugh (1996) suggest a magnitude of 6.5 to 7.5 is possible for the Algodones Fault.

3.4.2 Historic Seismicity

The lower Yuma Valley abuts the Imperial and Mexicali Valleys, an area of seismic activity. The following briefly outlines significant historical events (6.5M or greater) that have affected the Yuma area since about 1850.

El Mayor-Cucapah Event – April 4, 2010. A magnitude $7.2M_w$ earthquake ruptured the Borrego and Pescadores faults south of Mexicali, Mexico. The Borrego and Pescadores faults exhibited approximately 60 miles of surface rupture with a dip-slip displacement of up to 250 cm (8 feet). Widespread liquefaction and lateral spreading occurred in the Mexicali and Imperial Valleys during this event.

Imperial Valley Event – On October 15, 1979 a magnitude $6.6M_S$ ($6.5M_W$) earthquake ruptured the Imperial Fault with horizontal offsets of about 2 feet (USGS, 1982).

Imperial Valley Event – On May 19, 1940 a magnitude $7.1M_S$ ($7.0M_W$) earthquake ruptured the Imperial Fault with horizontal offsets up to 19 feet. The event along this fault caused large areas of liquefaction along the most recent alluvial deposits in the Yuma Valley near the present Colorado River course (Sylvester, 1979).

Cerro Prieto Events – On December 30 and 31, 1934 magnitude 6.5 and $7.1M_L$ (6.4 and $7.1M_W$) earthquakes ruptured the Cerro Prieto Fault in Mexico (Ellsworth, 1990).

Volcano Lake Events – On November 29, 1852 and again November 21, 1915 magnitude 6½M and $7.1M_S$ earthquakes triggered spectacular steam eruptions of a mud volcano at the north end of the Cerro Prieto Fault that was observed at Fort Yuma (Ellsworth, 1990).

3.5 General Ground Motion Analysis

The project site is considered likely to be subjected to moderate to strong ground motion from earthquakes in the region. Ground motions are dependent primarily on the earthquake magnitude and distance to the seismogenic (rupture) zone. Accelerations also are dependent upon attenuation by rock and soil deposits, direction of rupture and type of fault; therefore, ground motions may vary considerably in the same general area.

CBC General Ground Motion Parameters: The 2013 CBC general ground motion parameters are based on the Risk-Targeted Maximum Considered Earthquake (MCE_R). The U.S. Geological Survey "U.S. Seismic Design Maps Web Application" (USGS, 2014) was used to obtain the site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters. **The site soils have been classified as Site Class D (stiff soil profile).**

Design spectral response acceleration parameters are defined as the earthquake ground motions that are two-thirds (2/3) of the corresponding MCE_R ground motions. Design earthquake ground motion parameters are provided in Table 2. **A Risk Category IV was determined using Table 1604A.5 and the Seismic Design Category is D since S_1 is less than 0.75g.**

The Maximum Considered Earthquake Geometric Mean (MCE_G) peak ground acceleration (PGA_M) value was determined from the "U.S. Seismic Design Maps Web Application" (USGS, 2014) for liquefaction and seismic settlement analysis in accordance with 2013 CBC Section 1803A.5.12 and CGS Note 48 ($PGA_M = F_{PGA}*PGA$). **A PGA_M value of 0.32g is determined for the project site.**

3.6 Liquefaction

Liquefaction occurs when granular soil below the water table is subjected to vibratory motions, such as produced by earthquakes. With strong ground shaking, an increase in pore water pressure develops as the soil tends to reduce in volume. If the increase in pore water pressure is sufficient to reduce the vertical effective stress (suspending the soil particles in water), the soil strength decreases and the soil behaves as a liquid (similar to quicksand).

Table 2
2013 California Building Code (CBC) and ASCE 7-10 Seismic Parameters

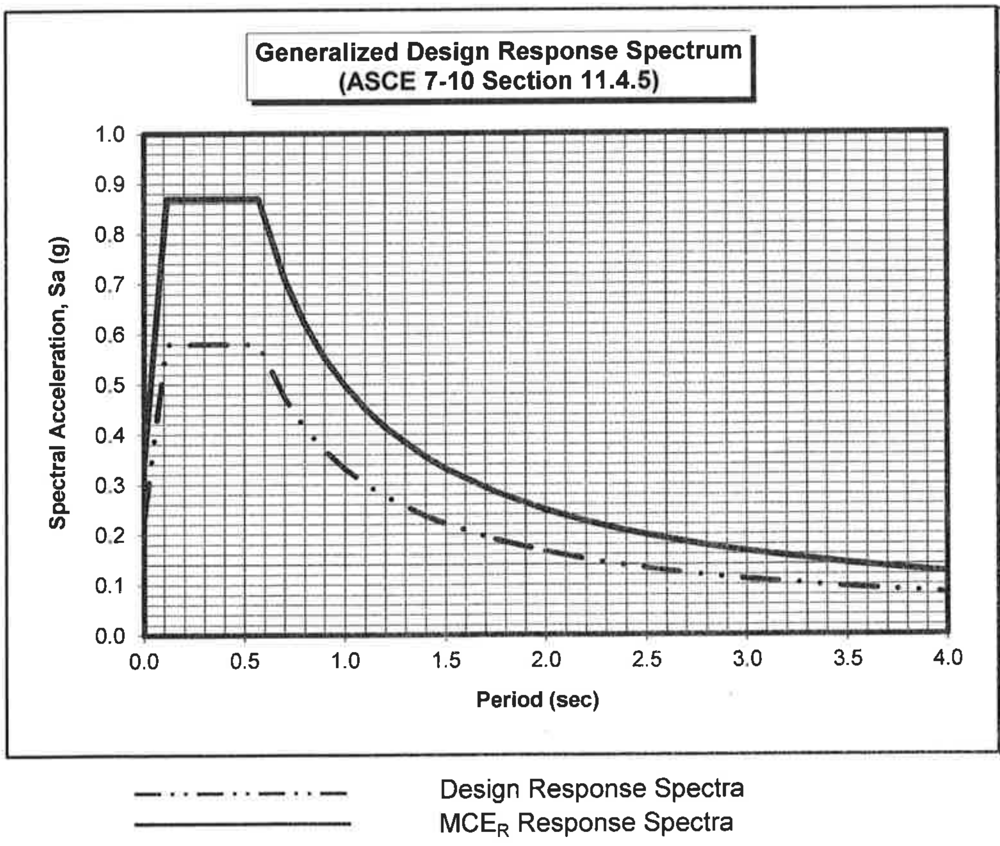
		CBC Reference
Soil Site Class:	**D**	Table 20.3-1
Latitude:	32.7394 N	
Longitude:	-114.6344 W	
Risk Category:	IV	
Seismic Design Category:	D	

Maximum Considered Earthquake (MCE) Ground Motion

Mapped MCE$_R$ Short Period Spectral Response	S_s	0.703 g	Figure 1613.3.1(1)	
Mapped MCE$_R$ 1 second Spectral Response	S_1	0.266 g	Figure 1613.3.1(2)	
Short Period (0.2 s) Site Coefficient	F_a	1.24	Table 1613.3.3(1)	
Long Period (1.0 s) Site Coefficient	F_v	1.87	Table 1613.3.3(2)	
MCE$_R$ Spectral Response Acceleration Parameter (0.2 s)	S_{MS}	0.870 g	$= F_a * S_s$	Equation 16-37
MCE$_R$ Spectral Response Acceleration Parameter (1.0 s)	S_{M1}	0.497 g	$= F_v * S_1$	Equation 16-38

Design Earthquake Ground Motion

Design Spectral Response Acceleration Parameter (0.2 s)	S_{DS}	0.580 g	$= 2/3*S_{MS}$	Equation 16-39
Design Spectral Response Acceleration Parameter (1.0 s)	S_{D1}	0.331 g	$= 2/3*S_{M1}$	Equation 16-40
	T_L	8.00 sec		ASCE Figure 22-12
	T_O	0.11 sec	$=0.2*S_{D1}/S_{DS}$	
	T_S	0.57 sec	$=S_{D1}/S_{DS}$	
Peak Ground Acceleration	PGA_M	0.32 g		ASCE Equation 11.8-1



Period T (sec)	Sa (g)	MCE$_R$ Sa (g)
0.00	0.23	0.35
0.11	0.58	0.87
0.57	0.58	0.87
0.70	0.47	0.71
0.80	0.41	0.62
0.90	0.37	0.55
1.00	0.33	0.50
1.10	0.30	0.45
1.20	0.28	0.41
1.20	0.28	0.41
1.40	0.24	0.36
1.50	0.22	0.33
1.75	0.19	0.28
2.00	0.17	0.25
2.20	0.15	0.23
2.40	0.14	0.21
2.60	0.13	0.19
2.80	0.12	0.18
3.00	0.11	0.17
3.50	0.09	0.14
4.00	0.08	0.12

Liquefaction can produce excessive settlement, ground rupture, lateral spreading, or failure of shallow bearing foundations. Four conditions are generally required for liquefaction to occur:

(1) the soil must be saturated (relatively shallow groundwater);
(2) the soil must be loosely packed (low to medium relative density);
(3) the soil must be relatively cohesionless (not clayey); and
(4) groundshaking of sufficient intensity must occur to function as a trigger mechanism.

All of these conditions exist to some degree at this site.

<u>Methods of Analysis:</u> Liquefaction potential at the project site was evaluated using the 1997 NCEER Liquefaction Workshop methods. The 1997 NCEER methods utilize direct SPT blow counts or CPT cone readings from site exploration and earthquake magnitude/PGA estimates from the seismic hazard analysis. The resistance to liquefaction is plotted on a chart of cyclic shear stress ratio (CSR) versus a corrected blow count $N_{1(60)}$ or Qc_{1N}. The CPT tip pressures (Qc) were adjusted to an equivalent clean sand pressure (Q_{C1Ncs}).

A PGA_M value of 0.32g was used in the analysis with a 7-foot groundwater depth and a threshold factor of safety (FS) of 1.3. The computer program CLiq (Version 1.7.6.34, Geologismiki, 2014) was utilized for liquefaction assessment at the project site. The estimated settlements have been adjusted for transition zones between layers and the post liquefaction volumetric strain has been weighed with depth (Robertson, 2014 and Cetin et al., 2009). Computer printouts of the liquefaction analyses are provided in Appendix D.

The soil encountered at the points of exploration included saturated silts and silty sands that could liquefy during a Risk-Targeted Maximum Considered Earthquake (MCE_R). Liquefaction can occur within several isolated silt and sand layers between depths of 12 to 49 feet.

<u>Liquefaction Induced Settlements:</u> ***Based on empirical relationships, total induced settlements are estimated to be between ¾ and 1¾ inches should liquefaction occur.*** The magnitude of potential liquefaction induced *differential* settlement is estimated at be one-half of the *total* potential settlement in accordance with California Special Publication 117; therefore, ***there is a potential for ½ to 1 inches of liquefaction induced differential settlement at the project site.*** The differential settlement based on seismic settlements is estimated at 1 inch over a distance of 100 feet. Foundations should be designed for a maximum deflection of L/720. The analysis is summarized in the table below.

Table 3. Summary of Liquefaction Analysis

Boring Location	Depth To First Liquefiable Zone (ft)	Potential Induced Settlement (in)
CPT-1	15.0	¾
CPT-2	12.0	1¾

<u>Liquefaction Induced Ground Failure:</u> Based on research from Ishihara (1985) and Youd and Garris (1995) small ground fissure or sand boil formation is unlikely because of the thickness of the overlying unliquefiable soil. Sand boils are conical piles of sand derived from the upward flow of groundwater caused by excess porewater pressures created during strong ground shaking. Sand boils are not inherently damaging by themselves, but are an indication that liquefaction occurred at depth (Jones, 2003). Liquefaction induced lateral spreading is not expected to occur at this site due to the planar topography. According to Youd (2005), if the liquefiable layer lies at a depth greater that about twice the height of a free face, lateral spread is not likely to develop. No slopes or free faces occur at this site except for the shallow retention basin, which depth is substantially above the first liquefiable layer.

<u>Mitigation:</u> Means to mitigate liquefaction damage include either a deep foundation system, rigid mat foundations and grade-beam reinforced foundations that can withstand some differential movement or tilting, but may not protect fracturing of buried utilities.

Because of the potential for differential settlement upon liquefaction, the designer should consider the structures be either founded on:

1) Deep foundations (drilled piers, auger-cast or driven piles).
2) Foundations that use grade-beam footings to tie floor slabs and isolated columns to continuous footings (conventional or post-tensioned).
3) Structural flat-plate mats, either conventionally reinforced or tied with post-tensioned tendons.

These alternatives reduce the potential effects of liquefaction-induced settlements by making the structures more able to withstand differential settlement. Flexible utility connections to the building foundation should be utilized.

3.7 Other Geologic Hazards

- **Landsliding.** No indications of landsliding were observed within the immediate vicinity of the project site from the geologic maps and during our site investigation. Based on the relatively planar topography of the site, the potential for landsliding is considered remote.
- **Volcanic hazards.** The site is not located proximal to any known volcanically active area and the risk of volcanic hazards is considered very low.
- **Tsunamis, sieches, and flooding.** The site does not lie near any large bodies of water, so the threat of tsunami, sieches, or other seismically-induced flooding is unlikely. The project site is located in FEMA Other Flood Areas Zone X, an area determined to have a 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood (FIRM Panel 06025C2250C).
- **Expansive soil.** The near surface soils at the project site consist of silts and clays which have a low expansion potential. The clay is expansive when wetted and can shrink with moisture loss (drying). Development of building foundations, concrete flatwork, and asphaltic concrete pavements should include provisions for mitigating potential swelling forces and reduction in soil strength, which can occur from saturation of the soil.

- **Hazardous Materials.** The site is not located in proximity to any known hazardous materials (methane gas, tar seeps, hydrogen sulfide gas), and the risk of hazardous materials is considered very low.
- **Radon 222 Gas.** Radon gas is not believed to be a potential hazard at the site.
- **Naturally occurring asbestos.** The site is not located in proximity to any known naturally occurring asbestos, and the risk of naturally occurring asbestos is considered very low.
- **Hydrocollapse.** The site is dominantly underlain by stiff silty clays and clays and dense to very dense sand and silty that are not susceptible to collapse with the addition of water to the site. The risk of hydrocollapse is considered very low.
- **Regional Subsidence.** The project site is not located within an area of reported regional subsidence. Due to the small size of the project site, the project site would be expected to subside relatively uniformly (if subsidence occurs).

Section 4
CONCLUSIONS

Based on the results of our field investigation and laboratory tests, it is our opinion that the proposed development of the Winterhaven Public Safety Facility is feasible from a geotechnical standpoint, provided that the conclusions and professional opinions contained in this report are incorporated in the project plans and specifications, and implemented during construction of the project. The following summarizes some of the pertinent geotechnical issues identified in our study:

- No known active or potentially active faults cross the site. The closest active fault to the site is the Imperial fault, located approximately 39 miles to the southwest.
- The site is considered likely to be subjected to moderate ground accelerations related to regional fault activity. A PGA_M value of 0.32g was determined for liquefaction and seismic settlement analysis in accordance with California Geological Survey Note 48.
- The on-site soils consist of low plasticity silty clay (CL). These soils have low expansion potential. If clays are allowed to exist in close proximity to building slabs, pavements, and exterior flatwork, specialized design and construction procedures will be necessary to resist expansive forces. To provide more uniform support, one of the following options for mitigating the effects of expansive soils on the proposed improvements may be implemented:

  OPTION 1: Remove the upper 3 feet of soils beneath buildings and the upper 12 inches beneath paved and hardscaped areas and replace with compacted non-expansive compacted granular fill.

  OPTION 2: Support the structures on foundation and slab systems designed to resist expansive soil movement. This design method requires grade-beam stiffening of floor slabs at a maximum spacing of 25 feet on center or grade-beam stiffened post-tensioned slabs.

- Interbedded sandy silt/silty sand layers at a depth of 12 to 49 feet may liquefy under seismically induced groundshaking, potentially resulting in an estimated ¾ to 1¾ inches of deep seated settlement. Liquefaction site risks are considered to be low to moderate.

- The potential for other geologic hazards including landsliding, tsunamis/seiches, volcanic hazards, hazardous materials, radon gas, naturally occurring asbestos, hydrocollapse, and regional subsidence are considered low.
- Groundwater is expected to be encountered at a depth of about 12 to 14 feet below ground surface at the project site.
- The on-site native soils have a very high potential for corrosivity with respect to buried steel and sulfate attack to concrete materials.

Section 5
DESIGN CRITERIA

5.1 Site Preparation

5.1.1 Clearing and Grubbing

At the time of construction, all existing pavement, debris and vegetation such as grass, brush, and trees on the site should be removed. Organic strippings should be hauled from the site and should not be incorporated into any engineered fills. Any trash, construction debris, concrete slabs, old pavement, landfill, and buried obstructions should be located by the grading contractor and removed under our observation. Excavations resulting from site clearing should be dish-shaped to the lowest depth of disturbance and backfilled with engineered fill as described below under continuous observations by the geotechnical engineer's representative.

5.1.2 Mass Grading

The surface soils are loose with 2 to 4 inches of "fluff' on the surface, as indicated by wheel load depressions. Prior to placing any fills, the surface 24 inches of soil should be removed, the exposed surface uniformly moisture conditioned to a depth of 8 inches by discing and wetting to a minimum of optimum plus 5% and recompacted to 87% to 92% of ASTM D1557 maximum density. Onsite native clays placed as engineer fill should be uniformly moisture conditioned by discing and wetting or drying to optimum plus 5 to 10% and compacted in 6 inch maximum lifts to 87% to 92% relative compaction. Clods shall be reduced by discing to a maximum dimension of 1.0 inch prior to being placed as fill.

5.1.3 Building Pad Preparation

To provide more uniform support, one of the following options for mitigating the effects of expansive soils on the proposed improvements may be implemented:

OPTION 1: Remove the upper 3 feet of soils beneath buildings and the upper 12 inches beneath paved and hardscaped areas and replace with compacted non-expansive compacted granular fill.

OPTION 2: Support the structures on foundation and slab systems designed to resist expansive soil movement. This design method requires grade-beam stiffening of floor slabs at a maximum spacing of 25 feet on center or grade-beam stiffened post-tensioned slabs.

If foundation designs are to be utilized which do not include provisions for expansive soil, an engineered building support pad consisting of 3.0 feet of granular soil, placed in maximum 8-inch lifts (loose), compacted to a minimum of 95% of ASTM D1557 maximum density at 2% below to 4% above optimum moisture, should be placed below the bottom of the slab.

Removal and replacement should extend at least 5 feet beyond the building footprint and at least 1 foot beyond sidewalks located next to the building. After removal of native soils, the bottom of the excavation should be scarified to a depth of 8 inches, moisture conditioned to 5 to 10% above optimum, and recompacted to 87 to 92% of ASTM D1557 maximum density. If the exposed soils are soft, a stabilizing geotextile or additional granular fill spread ahead of any construction equipment may be used at the bottom of the excavation to provide a more stable base for compaction.

5.1.4 Engineered Fill Soils

The on-site soils, minus any debris or organic matter, may be used as engineered fill. These soils should be moisture conditioned to 5 to 10% above optimum moisture content, placed in maximum 6-inch loose lifts, and compacted to between 87 to 92% of ASTM D1557 maximum dry density.

Imported fill soils for a granular building support pad should consist of non-expansive (Expansion Index less than 10) granular soils that meet the USCS classifications of SM, SP-SM, or SW-SM, with a maximum rock size of 3 inches, and 5 to 20% passing the No. 200 sieve and a minimum Sand Equivalent of 20. The geotechnical engineer should approve the fill soils prior to importing. Granular imported fill should be placed in lifts no greater than 8 inches in loose thickness and compacted to a minimum of 95% of ASTM D1557 maximum dry density. The moisture content of the non-expansive soils should be maintained within 2% of optimum moisture at the time of compaction.

5.1.5 Utility Trench Backfill

Trench backfill for utilities should conform to San Diego Regional Standard Drawing S-4 (Appendix E), using either Type A, B or C backfill.

Type A backfill for HDPE pipe consists of a 4 to 6 inch bed of ¾-inch crushed rock below the pipe and pipezone backfill (to 12" above top of pipe) consisting of crusher fines (sand). Sewer pipes (SDR-35), water mains, and stormdrain pipes of other that HDPE pipe may use crusher fines for bedding. The crusher fines shall be compacted to a minimum of 90% of ASTM D1557 maximum density. Pipe deflection should be checked to not exceed 2% of pipe diameter. Native clay/silt soils may be used to backfill the remainder of the trench and shall be compacted to at least 90% of ASTM D1557 maximum density.

Type B backfill for HDPE pipe requires 6 inches of ¾-inch crushed rock as bedding and to springline of the pipe. Thereafter, sand/cement slurry (3 sack cement factor) should be used to 12 inches above the top of the pipe. Native clay and silt soils may be used in the remainder of the trench backfill as specified above.

Type C backfill for HDPE pipe shall consist of a geotextile filter fabric encapsulating ¾-inch crushed rock. The crushed rock thickness shall be 6 inches below and to the sides of the pipe and shall extend to 12 inches above the top of the pipe. The filter fabric shall cover the trench bottom, sidewalls and over the top of the crushed rock.

Native clay and silt soils may be used in the remainder of the trench backfill as specified above.

Type C backfill must be used in wet soils and below groundwater for all buried utility pipelines unless dewatered (by well points) to at least 24 inches below the trench bottom prior to excavation. Type A backfill may be used in the case of a dewatered trench condition.

On-site soil free of debris, vegetation, and other deleterious matter may be suitable for use as utility trench backfill above pipezone, but may be difficult to uniformly maintain at specified moistures and compact to the specified densities. Native backfill should only be placed and compacted after encapsulating buried pipes with suitable bedding and pipe envelope material.

Imported granular material is acceptable for backfill of utility trenches. Granular trench backfill used in native clay building pad areas should be plugged with a solid (no clods or voids) 2-foot width of native clay soils at each end of the building foundation to prevent landscape water migration into the trench below the building.

Backfill soil of utility trenches within paved areas should be placed in layers not more than 6 inches in thickness and mechanically compacted to a minimum of 90% of the ASTM D1557 maximum dry density.

5.1.6 Observation and Density Testing

All site preparation and fill placement should be continuously observed and tested by a representative of a qualified geotechnical engineering firm as required by the CBC. This includes the excavation and scarification process to detect any undesirable materials, conditions or soft areas that may be encountered in the construction area. The geotechnical firm that provides observation and testing during construction shall assume the responsibility of "*geotechnical engineer of record*", and as such, shall perform additional testing/investigation as necessary to satisfy themselves as to the site conditions and the geotechnical recommendations for site development.

The geotechnical engineer should provide a verified report of the as-graded site and building support pad conditions.

5.1.7 Auxiliary Structures Foundation Preparation

Auxiliary structures such as retaining walls may be supported in the manner recommended for building pads, except the overexcavation and replacement may be limited to 3 feet beyond the footing line.

5.2 Foundations and Settlements

Spread and continuous wall footings are suitable for building support provided they are designed with rigid elements to reduce the potential for differential settlement due to liquefaction (see Section 3.6 of this report). Flat plate structural mats or grade-beam reinforced foundations may be used to mitigate expansive soil heave and/or liquefaction related movement.

Flat Plate Structural Mats: Flat plate structural mats may be used to mitigate expansive soils at the project site. The structural mat shall have a double mat of steel (minimum No. 4's @ 12" O.C. each way – top and bottom) and a minimum thickness of 10 inches. Mat edges shall have a minimum edge footing of 12 inches width and 18 inches depth (below the building pad surface). Mats may be designed by CBC Chapter 18, Section 1808.6.2 methods.

Structural mats may be designed for a modulus of subgrade reaction (Ks) of 50 pci when placed on compacted clay or a subgrade modulus of 300 pci when placed on 3.0 feet of granular fill. Mats shall overlay 2 inches of sand and a 10-mil polyethylene vapor retarder. The building support pad shall be moisture conditioned and recompacted as specified in Section 5.1.3 of this report.

Grade-beam Reinforced Foundations: Specific soil data for structures with grade-beam reinforced foundations placed on the native clays or 3.0 feet of granular fill are presented below in accordance with the design method given in CBC Chapter 18 (2013) Section 1808.6.2A (WRI/CRSI Design of Slab-on-Ground Foundations):

Weighted Plasticity Index (PI) = 9
Slope Coefficient (C_s) = 1.0
Strength Coefficient (C_o) = 1.0
Climatic Rating (C_w) = 15
Effective PI = 9
Maximum Grade-beam Spacing = 25 feet

Note: Slab stiffening for liquefaction settlement should not exceed 20 feet on center.

When the upper 3 feet of subgrade soils are removed and replaced with compacted, non-expansive granular fill soils, the proposed structures may be supported on shallow foundations. The non-expansive, compacted soil layer should extend a minimum of 1.5 feet below the base of all footings and should extend at least 2 feet laterally from the edge of the footings.

The spread and continuous wall footings may be designed using an allowable soil bearing pressure of 2,000 pounds per square foot for dead and live loads. The allowable soil pressure may be increased by 20% for each foot of depth below 18 inches up to a maximum of 3,000 psf and by one-third for short-term loads induced by winds or seismic events. The bearing capacity of the imported fill soils should be verified during construction.

Exterior footings placed on granular fill should be embedded a minimum of 1.5 feet below the lowest adjacent final grade. A minimum of 1.5 feet of compacted granular fill should underlie all footings. Continuous wall footings should have a minimum width of 1.5 feet. Column footings should have a minimum width of 2.5 feet. Design of foundation reinforcement should be provided by the structural engineer.

Resistance to horizontal loads will be developed by passive earth pressure on the sides of footings and frictional resistance developed along the bases of footings and concrete slabs.

The passive resistance of the granular fill may be assumed to be equal to an equivalent fluid pressure of 300 pounds per cubic foot for the non-expansive granular fills. The top one foot of embedment should not be considered in computing passive resistance unless the adjacent area is confined by a slab or pavement. An allowable friction coefficient of 0.35 may be used between the base of the footings and the granular fill to resist lateral loading.

Non-seismically induced foundation movements are estimated to be on the order of ¾-inch with differential movements of about two-thirds of total settlement for the loading assumptions stated above when the subgrade preparation guidelines given above are followed. Seismically induced (post-liquefaction) settlements are addressed in Section 3.6 of this report.

5.3 Slabs-On-Grade

Concrete floor slabs should be a minimum of 5 inches thick when placed over 3 feet of non-expansive, compacted fill. Concrete floor slabs should be monolithically placed with the foundations or dowelled to footings placed in a 2-stage pour. The concrete slabs should be placed on a 2-inch concrete sand layer and a 10-mil polyethylene vapor retarder placed over the granular fill pad that has been compacted to 95% of ASTM D1557 maximum dry density and moistened to approximately optimum moisture just before the concrete placement. Concrete slab and flatwork reinforcement should consist of a minimum of No. 3 bars at 18-inch centers, both horizontal directions for slabs placed over non-expansive fill.

Slab and steel reinforcement should be provided by the structural engineer/architect knowing the actual project loadings. The *inspector of record* should continually observe all reinforcing steel in slabs during placement of concrete to check for proper location within the slab.

Control joints may be provided in all concrete slabs-on-grade at a maximum spacing of 2 to 3 times (in feet) the slab thickness (in inches) (12 feet maximum on-center, each way) as recommended by American Concrete Institute (ACI). All joints should form approximately square patterns to reduce randomly oriented contraction cracks. Contraction joints in the slabs should be tooled at the time of the pour or sawcut (¼ of slab depth) within 8 hours of concrete placement.

Construction (cold) joints should either be thickened butt-joints with dowels or a thickened keyed-joint designed to resist vertical deflection at the joint. All construction joints in exterior flatwork should be sealed to prevent moisture or foreign material intrusion. Precautions should be taken to prevent curling of slabs in this arid desert region.

Prewetting of clay subgrade soils (5 to 10% above optimum) to a depth of 24 inches is required below area concrete flatwork. The placement and configuration of the concrete reinforcement and joints are guidelines only. The final design should be provided by the structural engineer.

All exterior flatwork (sidewalks, hardscape, and patios) should be placed on a minimum of 12 inches of compacted granular fill over 24 inches of presaturated clay soils (5% to 10% above optimum moisture content). If some movement of exterior flatwork is acceptable, exterior concrete may be placed over 4 inches of concrete sand, aggregate base, or crushed rock directly overlying the prewetted native clay soils. Concrete flatwork may be doweled to the perimeter foundations where adjacent to the building, and sloped 2% or more away from the building.

Where clay soils underlie flatwork, the upper 8 inches of subgrade soils should be compacted to 87 to 92% of the ASTM D1557 maximum density. The moisture content of the clay soils should be maintained 5 to 10% above optimum by pre-saturating the subgrade soils to a depth of 24 inches within 2 days prior to placement of concrete. The clay soils shall be firm and not pumping.

5.4 Concrete Mixes and Corrosivity

Selected chemical analyses for corrosivity were conducted on samples from the project site (Plate C-2). The native soils were found to have moderate to severe sulfate ion concentrations (5,440 ppm). Sulfate ions can attack the cementitious material in concrete, causing weakening of the cement matrix and eventual deterioration by raveling. The California Building Code recommends that Type V Portland Cement is recommended when the concrete is subjected to soil with severe sulfate concentration.

A minimum of 6.25 sacks per cubic yard of concrete (4,500 psi) of Type V Portland Cement with a maximum water/cement ratio of 0.45 (by weight) should be used ***for concrete placed in contact with native soils*** on this project. Admixtures may be required to facilitate placement of this low water/cement ratio concrete.

The native soils were also found to have very severe chloride ion concentrations (5,320 ppm). Chloride ions can cause corrosion of reinforcing steel and buried utilities. Resistivity determinations on the soils indicate very severe potential for metal loss due to electrochemical corrosion processes.

Mitigation of the corrosion of steel can either be achieved by using steel pipes coated with epoxy corrosion inhibitors, asphaltic coatings, cathodic protection or by encapsulating the portion of the pipe with densely consolidated concrete.

Foundations placed on native soils shall provide a minimum concrete cover of four (4) inches around steel reinforcing or embedded components (anchor bolts, etc.) exposed to native soil or landscape water (to 18 inches above grade). If the 4-inch concrete edge distance cannot be achieved, all embedded steel components (anchor bolts, etc.) shall be epoxy coated for corrosion protection (in accordance with ASTM D3963/A934) or a corrosion inhibitor and a permanent waterproofing membrane shall be placed along the exterior face of the exterior footings. ***Hold-down straps should not be used at foundation edges due to corrosion of metal at its protrusion from the slab edge.*** Additionally, the concrete should be thoroughly vibrated at footings during placement to decrease the permeability of the concrete.

Exterior foundation faces exposed to native soils (without adjacent mowstrips, sidewalks, or patios) should be coated with a permanent waterproofing membrane to prevent salt migration into concrete.

Copper water piping (except for trap primers) should not be placed under floor slabs. All copper piping within 18 inches of ground surface shall be wrapped with two layers of 10 mil plumbers tape or sleeved with PVC piping to prevent contact with soil. The trap primer pipe shall be completely encapsulated in a PVC sleeve and Type K copper should be utilized if polyethylene tubing cannot be used. Pressurized waterlines are not allowed under the floor slab. ***Fire protection piping (risers) should be placed outside of the building foundation.***

5.5 Excavations

All site excavations should conform to CalOSHA requirements for Type B soil. The contractor is solely responsible for the safety of workers entering trenches. Temporary excavations with depths of 4 feet or less may be cut nearly vertical for short duration. Excavations deeper than 4 feet will require shoring or slope inclinations in conformance to CAL/OSHA regulations for Type B soil. Surcharge loads of stockpiled soil or construction materials should be set back from the top of the slope a minimum distance equal to the height of the slope. All permanent slopes should not be steeper than 3:1 to reduce wind and rain erosion. Protected slopes with ground cover may be as steep as 2:1. However, maintenance with motorized equipment may not be possible at this inclination.

Groundwater is encountered at a depth of 12 to 14 feet in groundwater monitoring wells located approximately 300 feet south of the project site. The contractor is cautioned to evaluate soil moisture and groundwater conditions at the time of bidding. Running ground conditions should be anticipated below 12 feet.

5.6 Pavements

Pavements should be designed according to CALTRANS or other acceptable methods. Traffic indices were not provided by the project engineer or owner; therefore, we have provided structural sections for several traffic indices for comparative evaluation. The public agency or design engineer should decide the appropriate traffic index for the site. Maintenance of proper drainage is necessary to prolong the service life of the pavements.

Based on the current State of California CALTRANS method, an R-value of 10 for the subgrade soil and assumed traffic indices, the following table provides our estimates for asphaltic concrete (AC) and Portland Cement Concrete (PCC) pavement sections.

Table 4. Pavement Structural Sections

R-Value of Subgrade Soil - 10 Design Method - CALTRANS 2006

Traffic Index (assumed)	**Flexible Pavements**		**Rigid (PCC) Pavements**	
	Asphaltic Concrete Thickness (in.)	**Aggregate Base Thickness (in.)**	**Concrete Thickness (in.)**	**Aggregate Base Thickness (in.)**
4.0	3.0	6.0	5.0	6.0
5.0	3.0	9.0	5.5	6.0
6.0	3.0	12.5	6.0	8.0
6.5	4.0	12.5	7.0	8.0
8.0	4.0	18.0	8.0	11.0
10.0	5.0	23.5	9.0	13.0
11.0	6.0	25.0	10.0	15.0

Notes:

1) Asphaltic concrete shall be Caltrans, Type B, ¾ inch maximum (½ inch maximum for parking areas), medium grading with PG70-10 asphalt cement, compacted to a minimum of 95% of the Hveem density (CAL 366).
2) Aggregate base shall conform to Caltrans Class 2 (¾ in. maximum), compacted to a minimum of 95% of ASTM D1557 maximum dry density.
3) Place pavements on 12 inches of moisture conditioned (minimum 4% above optimum if clays) native clay soil compacted to a minimum of 90% (95% if sand subgrade) of the maximum dry density determined by ASTM D1557.
4) Portland cement concrete for pavements should have Type V cement, a minimum compressive strength of 4,500 psi at 28 days, and a maximum water-cement ratio of 0.45.
5) Typical Street Classifications (Imperial County)

Parking Areas:	TI = 4.0
Cul-de-Sacs:	TI = 5.0
Local Streets:	TI = 6.0
Minor Collectors:	TI = 6.5
Major Collectors:	TI = 8.0
Minor Arterial:	TI = 10.0
Primary Arterial:	TI = 11.0

Section 6
LIMITATIONS AND ADDITIONAL SERVICES

6.1 Limitations

The professional opinions and conclusions within this report are based on current information regarding the proposed construction of the new Public Safety Facility located at 518 Railroad Avenue in Winterhaven, California. The conclusions of this report are invalid if:

- Structural loads change from those stated or the structures are relocated.
- The Additional Services section of this report is not followed.
- This report is used for adjacent or other property.
- Changes of grade or groundwater occur between the issuance of this report and construction other than those anticipated in this report.
- Any other change that materially alters the project from that proposed at the time this report was prepared.

We have based our findings and professional opinions in this report on selected points of field exploration, laboratory testing, and our understanding of the proposed project. Furthermore, findings and professional opinions are based on the assumption that soil conditions do not vary significantly from those found at specific exploratory locations. Variations in soil conditions could exist between and beyond the exploration points and groundwater conditions may change. These conditions may require additional studies, consultation, and possible design revisions.

This report contains information that may be useful in the preparation of contract specifications. However, the report is not worded is such a manner that we recommend its use as a construction specification document without proper modification. The use of information contained in this report for bidding purposes should be done at the contractor's option and risk.

This report was prepared according to the generally accepted *geotechnical engineering standards of practice* that existed in Imperial County at the time the report was prepared. No warranty, express or implied, is made in connection with our services. Because of potential changes in the Geotechnical Engineering Standards of Practice, this report should be considered invalid for periods after three years from the report date without a review of the validity of the findings and professional opinions by our firm.

The client has responsibility to see that all parties to the project including designer, contractor, subcontractor, and future owners are made aware of this entire report. The use of information contained in this report for bidding purposes should be done at the contractor's option and risk.

6.2 Additional Services

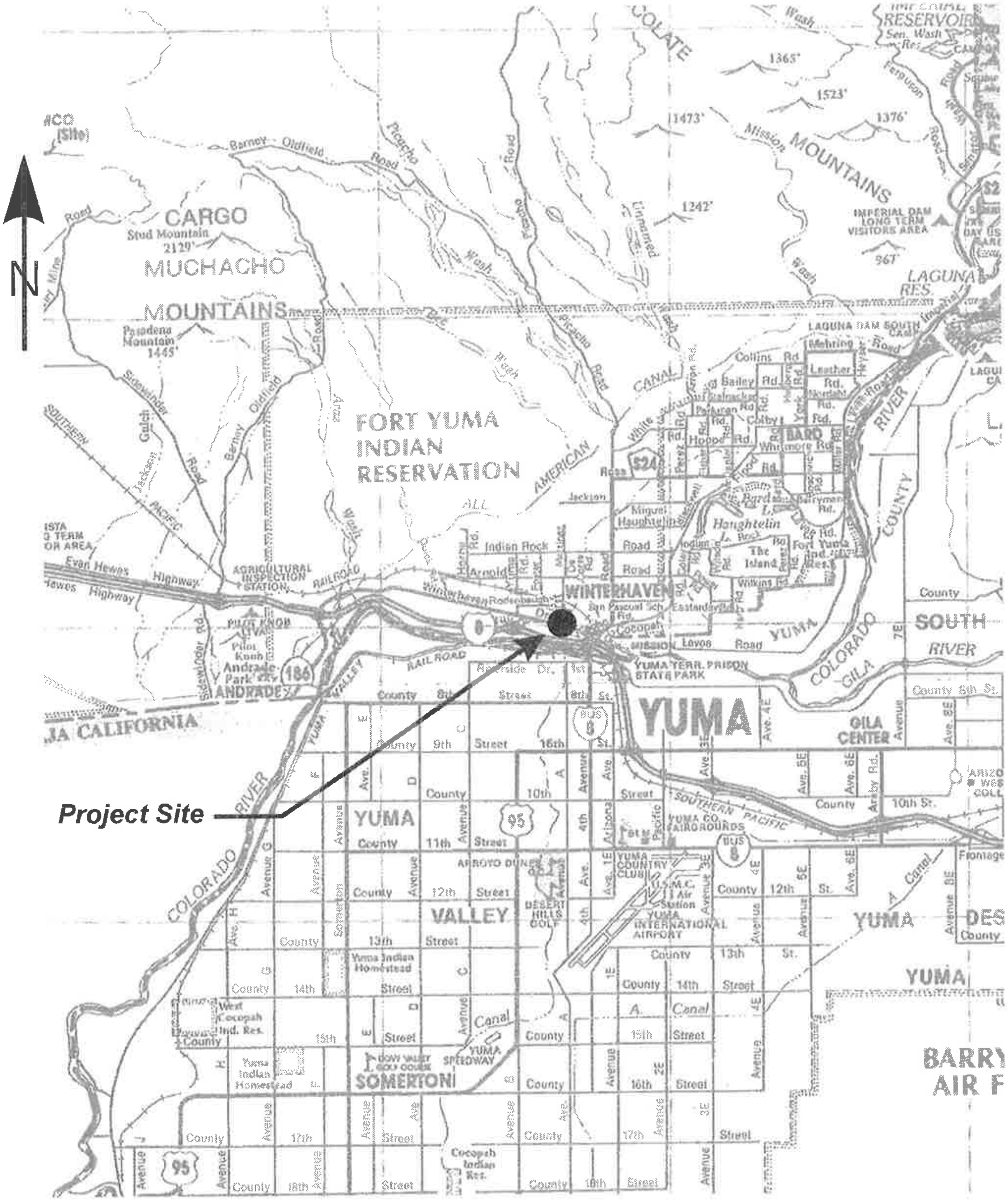
The professional opinions presented in this report are based on the assumption that an adequate program of tests and observations will be conducted during construction to check the field subsurface conditions and compliance of the professional opinions that are the basis of this report. *The geotechnical engineering firm providing the tests and observations shall assume the responsibility of geotechnical engineer of record.*

Additional tests and observations should include, but not necessarily be limited to the following:

- Review of project plans and specifications, prior to their issuance for bidding, to check for compatibility with our professional opinions and conclusions;
- Observation and testing by the geotechnical consultant of record during site clearing, grading, excavation, placement of fills, building pad and subgrade preparation, and backfilling of utility trenches;
- Observation of foundation excavations and reinforcing steel before concrete placement;
- Consultation as may be required during construction.

Additional information concerning the scope and cost of these services can be obtained from our office.

APPENDIX A



LANDMARK
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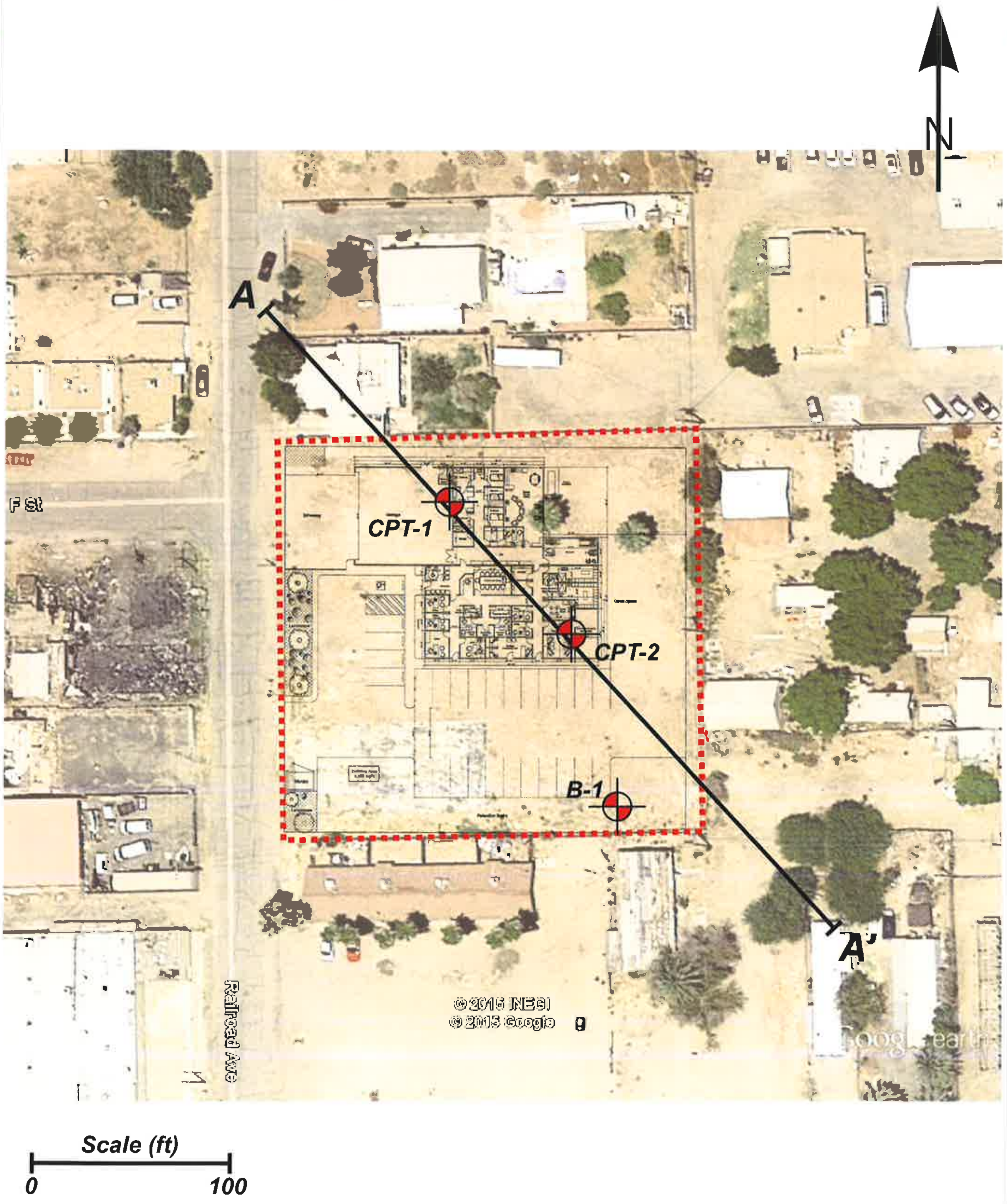
Vicinity Map

Plate A-1



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Project No.: LE15031

Site and Exploration Map

Plate
A-2

LANDMARK
Geo-Engineers and Geologists

Project No.: LE15031

Soil Survey Map

Plate
A-3

SOIL SURVEY OF

YUMA-WELLTON AREA

PARTS OF YUMA COUNTY, ARIZONA, and IMPERIAL COUNTY, CALIFORN

United States Department of Agriculture
Soil Conservation Service
in cooperation with the
Arizona Agricultural Experiment Station and th
California Agricultural Experiment Station

TABLE 14.--ENGINEERING INDEX PROPERTIES

[The symbol > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
1 Antho	0-4	Sandy loam	SM	A-2	0	90-100	80-90	55-65	25-35	---	NP
	4-60	Sandy loam, fine sandy loam.	SM	A-2	0	90-100	80-90	55-65	25-30	---	NP
2 Antho	0-3	Fine sandy loam	SM	A-4	0	90-100	80-90	65-75	45-50	---	NP
	3-60	Sandy loam, fine sandy loam, gravelly sandy loam.	SM	A-2, A-4, A-1	0	70-100	65-95	35-60	15-40	---	NP
3 Carrizo	0-3	Very gravelly sand.	SP-SM, GP, GP-GM	A-1	0-10	55-65	50-55	15-35	0-15	---	NP
	3-64	Very gravelly coarse sand, very gravelly sand, very gravelly loamy sand.	GP, GP-GM, SP, SP-SM	A-1	0-25	30-65	15-60	5-35	0-15	---	NP
4*: Cherioni	0-6	Extremely cobbly loam.	GM	A-1	35-80	40-65	30-45	20-30	15-25	20-30	NP-5
	6-13	Extremely gravelly loam.	GP-GM, GM	A-1	15-35	30-40	25-50	15-25	5-15	15-20	NP-5
	13-15	Indurated	---	---	---	---	---	---	---	---	---
	15	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Rock outcrop.											
5 Dateland	0-6	Loamy fine sand	SM	A-2	0	90-100	85-95	50-60	15-30	---	NP
	6-38	Fine sandy loam, loam.	SM, SM-SC	A-2	0	95-100	90-95	55-65	25-35	20-30	NP-10
	38-60	Gravelly sandy loam, sandy loam.	SM, SM-SC	A-2, A-1	0	70-80	50-80	30-50	15-30	20-30	NP-10
6 Dateland	0-6	Fine sandy loam	SM, SM-SC	A-2	0	90-100	85-95	60-70	25-35	20-30	NP-10
	6-27	Fine sandy loam	SM, SM-SC	A-2	0	95-100	90-95	55-65	25-35	20-30	NP-10
	27-54	Loam	ML, CL-ML	A-4	0	95-100	90-95	75-85	50-70	20-30	NP-10
	54-60	Fine sandy loam	SM, SM-SC	A-2	0	90-100	85-95	60-70	25-35	20-30	NP-10
7 Gachado	0-1	Very gravelly loam.	SM-SC, GM-GC	A-2, A-1	20-40	50-60	30-35	25-30	15-20	15-25	5-10
	1-6	Extremely gravelly sandy clay loam.	GC, SC	A-2	35-55	35-80	25-40	20-35	20-35	30-40	10-20
	6-12	Extremely gravelly loam.	GC, SC	A-2	35-55	50-60	20-35	20-25	15-20	30-40	10-15
	12	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
8 Gadsden	0-10	Clay	CH	A-7	0	100	100	90-100	80-90	50-60	25-35
	10-60	Clay, silty clay loam.	CH	A-7	0	100	100	90-100	80-90	50-60	25-35
9 Gilman	0-15	Loam	ML, SM, SM-SC, CL-ML	A-4	0	100	95-100	70-100	40-75	20-30	NP-7
	15-24	Very fine sandy loam.	ML	A-4	0	100	95-100	80-100	60-75	25-35	NP-10
	24-60	Fine sandy loam	SM, SM-SC	A-4	0	100	95-100	75-90	40-50	20-30	NP-10

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
10 Glenbar	0-16	Silty clay loam	CL	A-6	0	100	100	90-100	70-95	35-45	15-30
	16-60	Silty clay loam	CL	A-6	0	100	100	90-100	75-95	35-45	15-30
11*: Harqua	0-5	Gravelly loam	ML	A-4	0-5	90-100	65-75	60-70	50-55	30-40	5-10
	5-32	Gravelly clay loam, clay loam.	CL, SC	A-6	0	90-100	55-80	50-70	45-65	30-40	10-20
	32-60	Clay loam, gravelly clay loam.	CL	A-6	0	90-100	85-95	80-90	70-80	30-40	10-20
Tremant	0-12	Loam	ML	A-4	0-5	90-100	80-95	70-80	60-70	30-40	5-10
	12-23	Gravelly sandy clay loam.	CL, SC	A-6	0-10	70-95	50-90	50-70	45-60	30-40	10-20
	23-60	Gravelly clay loam.	CL, SC	A-6	0-10	80-90	50-75	50-70	45-55	20-30	10-20
12 Holtville	0-13	Clay	CH	A-7	0	100	100	95-100	85-95	55-75	35-50
	13-23	Clay	CH	A-7	0	100	100	95-100	85-95	55-75	35-50
	23-75	Very fine sandy loam, silty clay loam.	ML	A-4	0	100	100	95-100	65-85	25-35	NP-10
13 Indio	0-6	Silt loam	ML	A-4	0	95-100	95-100	85-100	75-90	20-30	NP-5
	6-63	Stratified very fine sandy loam to silt.	ML	A-4	0	95-100	95-100	85-100	75-90	20-30	NP-5
14 Indio	0-12	Silt loam	ML	A-4	0	100	100	90-100	75-90	20-30	NP-5
	12-60	Stratified very fine sandy loam to silt.	ML	A-4	0	100	100	90-100	85-90	20-30	NP-5
15 Indio	0-4	Silt loam	ML	A-4	0	100	100	90-100	75-90	20-30	NP-5
	4-60	Stratified very fine sandy loam to silt.	ML	A-4	0	100	100	90-100	85-90	20-30	NP-5
16*: Indio	0-6	Silt loam	ML	A-4	0	95-100	95-100	85-100	75-90	20-30	NP-5
	6-63	Stratified very fine sandy loam to silt.	ML	A-4	0	95-100	95-100	85-100	75-90	20-30	NP-5
Lagunita	0-8	Loamy sand	SM	A-1, A-2	0	95-100	80-90	45-55	15-30	---	NP
	8-60	Loamy sand	SM	A-1, A-2	0	95-100	80-90	45-55	15-30	---	NP
Ripley	0-6	Silt loam	CL-ML, ML	A-4	0	100	100	90-100	80-90	20-35	5-10
	6-25	Very fine sandy loam.	CL-ML, ML	A-4	0	100	100	90-100	80-90	20-35	5-10
	25-60	Sand	SM, SP-SM	A-2	0	100	100	50-80	10-20	---	NP
17 Kofa	0-12	Clay	CH	A-7	0	100	100	95-100	85-95	55-75	35-50
	12-28	Clay	CH	A-7	0	100	100	95-100	85-95	55-75	35-50
	28-60	Sand	SM, SP-SM	A-2, A-3	0	100	100	60-80	5-15	<20	NP-5
18 Lagunita	0-8	Loamy sand	SM	A-1, A-2	0	95-100	80-90	45-55	15-30	---	NP
	8-60	Loamy sand	SM	A-1, A-2	0	95-100	80-90	45-55	15-30	---	NP
19 Lagunita	0-12	Silt loam	ML, CL-ML	A-4	0	100	100	95-100	85-95	20-30	NP-10
	12-60	Sand, loamy fine sand.	SP, SP-SM	A-1, A-2	0	70-90	65-75	30-40	0-10	---	NP
20*: Laposa	0-3	Extremely gravelly loam.	GM, SM	A-1	15-45	25-55	10-35	10-30	10-25	20-30	NP-5
	3-32	Extremely gravelly loam.	GM, SM	A-1	15-45	25-65	15-45	15-30	10-25	20-30	NP-5
	32	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

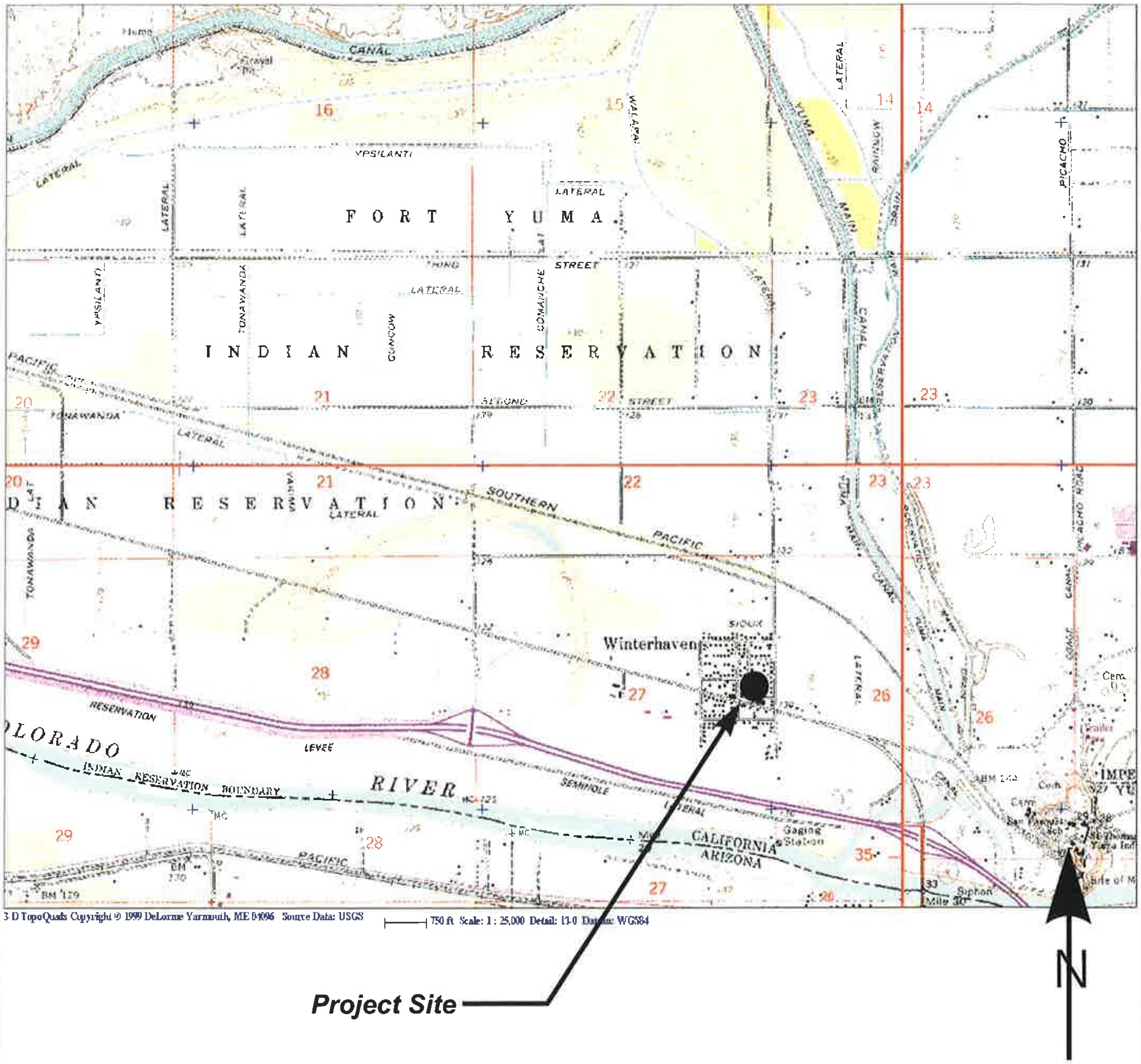
Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
20*: Rock outcrop.											
21*: Ligurta------------	0-2	Very gravelly loam.	GC, SC	A-2	0-5	50-60	30-35	20-25	15-20	30-40	10-15
	2-60	Gravelly clay loam, clay loam, gravelly loam.	GC, SC	A-2, A-6	0-5	50-80	50-80	45-75	25-50	30-40	10-20
Cristobal----------	0-2	Very gravelly loam.	GM, GM-GC, SM, SM-SC	A-1, A-2	0-5	50-60	30-35	20-25	15-20	20-25	NP-10
	2-25	Very gravelly clay loam, extremely gravelly clay loam, gravelly sandy clay loam	GM, GM-GC, SM, SM-SC	A-1, A-2	0-5	40-70	10-55	10-30	15-20	20-30	NP-10
	25-60	Very gravelly clay loam, gravelly clay loam.	GC, SC	A-2, A-6	0-5	40-70	10-55	10-30	15-20	30-40	10-20
22, 23*. Pits											
24------------------ Ripley	0-6	Silt loam--------	CL-ML, ML	A-4	0	100	100	90-100	80-90	20-35	5-10
	6-25	Very fine sandy loam.	CL-ML, ML	A-4	0	100	100	90-100	80-90	20-35	5-10
	25-60	Sand-------------	SM, SP-SM	A-2	0	100	100	50-80	10-20	---	NP
25------------------ Rositas	0-5	Sand-------------	SM, SP-SM	A-2, A-3	0	100	80-100	50-70	5-25	---	NP
	5-60	Sand-------------	SM, SP-SM	A-2, A-3	0	100	80-100	50-70	5-30	---	NP
26*: Rositas------------	0-5	Sand-------------	SM, SP-SM	A-2, A-3	0	100	80-100	50-70	5-25	---	NP
	5-60	Sand-------------	SM, SP-SM	A-2, A-3	0	100	80-100	50-70	5-30	---	NP
Ligurta------------	0-2	Very gravelly loam.	GC, SC	A-2	0-5	50-60	30-35	20-25	15-20	30-40	10-15
	2-60	Gravelly clay loam, clay loam, gravelly loam.	GC, SC	A-2, A-6	0-5	50-80	50-80	45-75	25-50	30-40	10-20
27*. Salorthids											
28------------------ Superstition	0-5	Sand-------------	SM	A-2	0	100	80-100	50-70	15-25	---	NP
	5-60	Sand-------------	SM	A-2	0	100	80-100	50-70	15-25	---	NP
29*: Superstition-------	0-5	Clay-------------	CH	A-7	0	100	100	90-100	80-90	50-60	25-35
	5-60	Sand-------------	SM	A-2	0	100	95-100	70-85	15-25	---	NP
Superstition-------	0-10	Sandy clay loam	SM-SC	A-4	0	100	100	80-90	35-50	25-30	5-10
	10-60	Sand-------------	SM	A-2	0	100	95-100	70-85	15-25	---	NP
Superstition-------	0-10	Loam-------------	ML, CL-ML	A-4	0	100	100	90-100	70-80	20-30	NP-10
	10-60	Sand-------------	SM	A-2	0	100	95-100	70-85	15-25	---	NP
30*: Torriorthents.											
Torrifluvents.											

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
31*:											
Tremant-----------	0-2	Gravelly loam---	SM, SM-SC	A-4, A-2	0-5	90-100	45-75	35-60	25-50	20-30	NP-10
	2-60	Clay loam, gravelly loam, gravelly sandy clay loam.	CL, SC	A-6	0-10	70-95	50-90	50-70	45-60	30-40	10-20
Rositas-----------	0-5	Sand------------	SM, SP-SM	A-2, A-3	0	100	80-100	50-70	5-25	---	NP
	5-60	Sand------------	SM, SP-SM	A-2, A-3	0	100	80-100	50-70	5-30	---	NP
32----------------- Vint	0-16	Loamy fine sand	SM	A-2	0	95-100	95-100	70-80	25-35	---	NP
	16-60	Stratified loamy fine sand to silty clay loam	SM	A-2	0	95-100	95-100	70-80	20-30	---	NP
33----------------- Wellton	0-8	Loamy sand------	SM, SP-SM	A-1	0	90-100	70-90	30-40	5-15	---	NP
	8-60	Fine gravelly sandy loam, fine gravelly coarse sandy loam.	SM	A-1	0	85-95	50-75	30-50	15-25	15-20	NP-5
34*:											
Wellton-----------	0-8	Loamy sand------	SM, SP-SM	A-1	0	90-100	70-90	30-40	5-15	---	NP
	8-60	Gravelly sandy loam, loamy sand, sandy loam.	SM	A-1	0	85-95	50-75	30-50	15-25	15-20	NP-5
Dateland----------	0-6	Loamy fine sand	SM	A-2	0	90-100	85-95	50-60	15-30	---	NP
	6-27	Sandy loam------	SM, SM-SC	A-2	0	95-100	90-95	55-65	25-35	20-30	NP-10
	27-54	Loam------------	ML, CL-ML	A-4	0	95-100	90-95	75-85	50-70	20-30	NP-10
	54-60	Fine sandy loam, loam.	SM, SM-SC	A-2	0	70-80	50-80	30-50	15-30	20-30	NP-10
Rositas-----------	0-5	Sand------------	SM, SP-SM	A-2, A-3	0	100	80-100	50-70	5-25	---	NP
	5-60	Sand------------	SM, SP-SM	A-2, A-3	0	100	80-100	50-70	5-30	---	NP

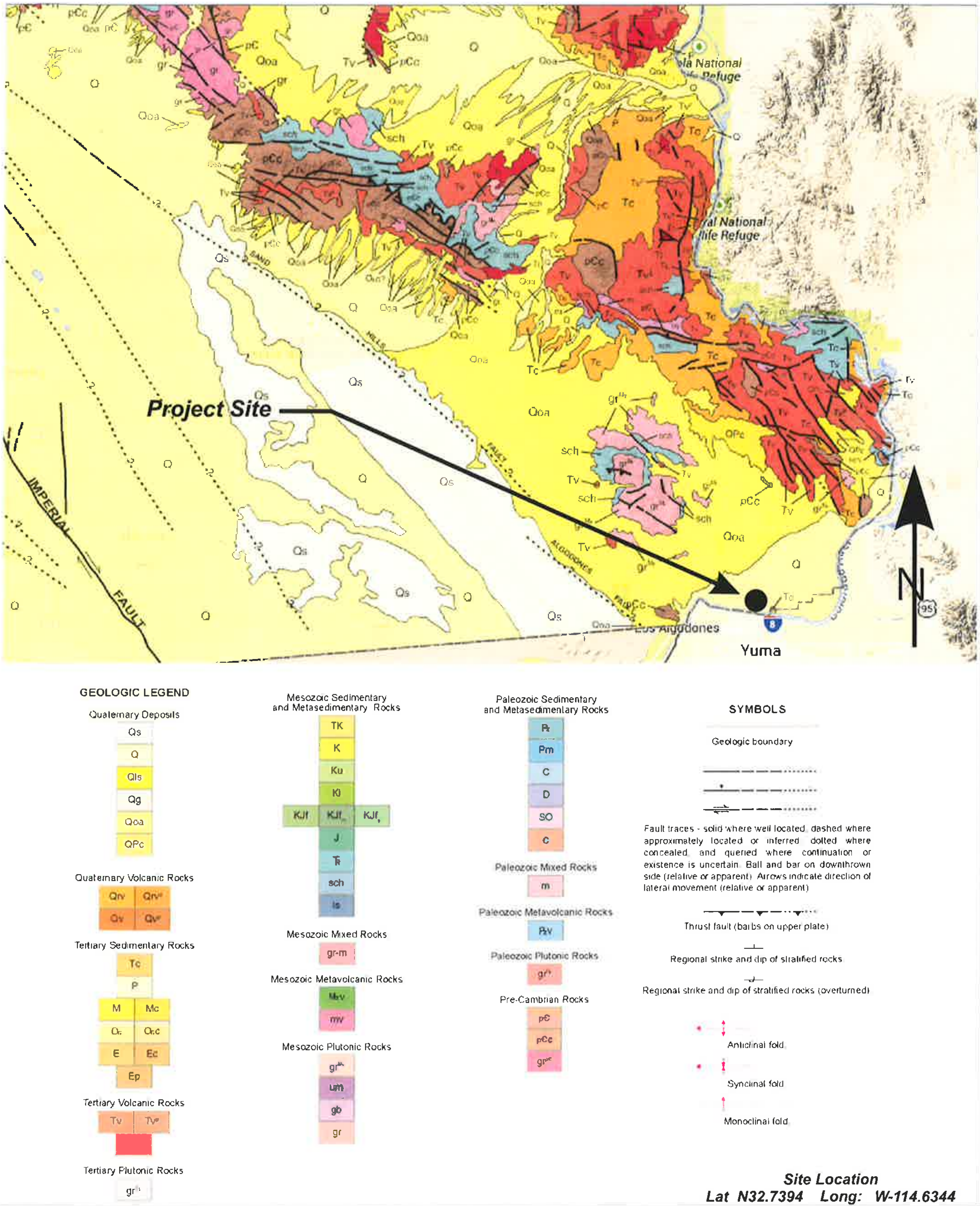
* See description of the map unit for composition and behavior characteristics of the map unit.



3 D TopoQuads Copyright © 1999 DeLorme Yarmouth, ME 04096 Source Data: USGS

750 ft Scale: 1 : 25,000 Detail: 13-0 Datum: WGS84

LANDMARK Geo-Engineers and Geologists **Project No.: LE15031**	**Topographic Map**	**Plate** **A-4**



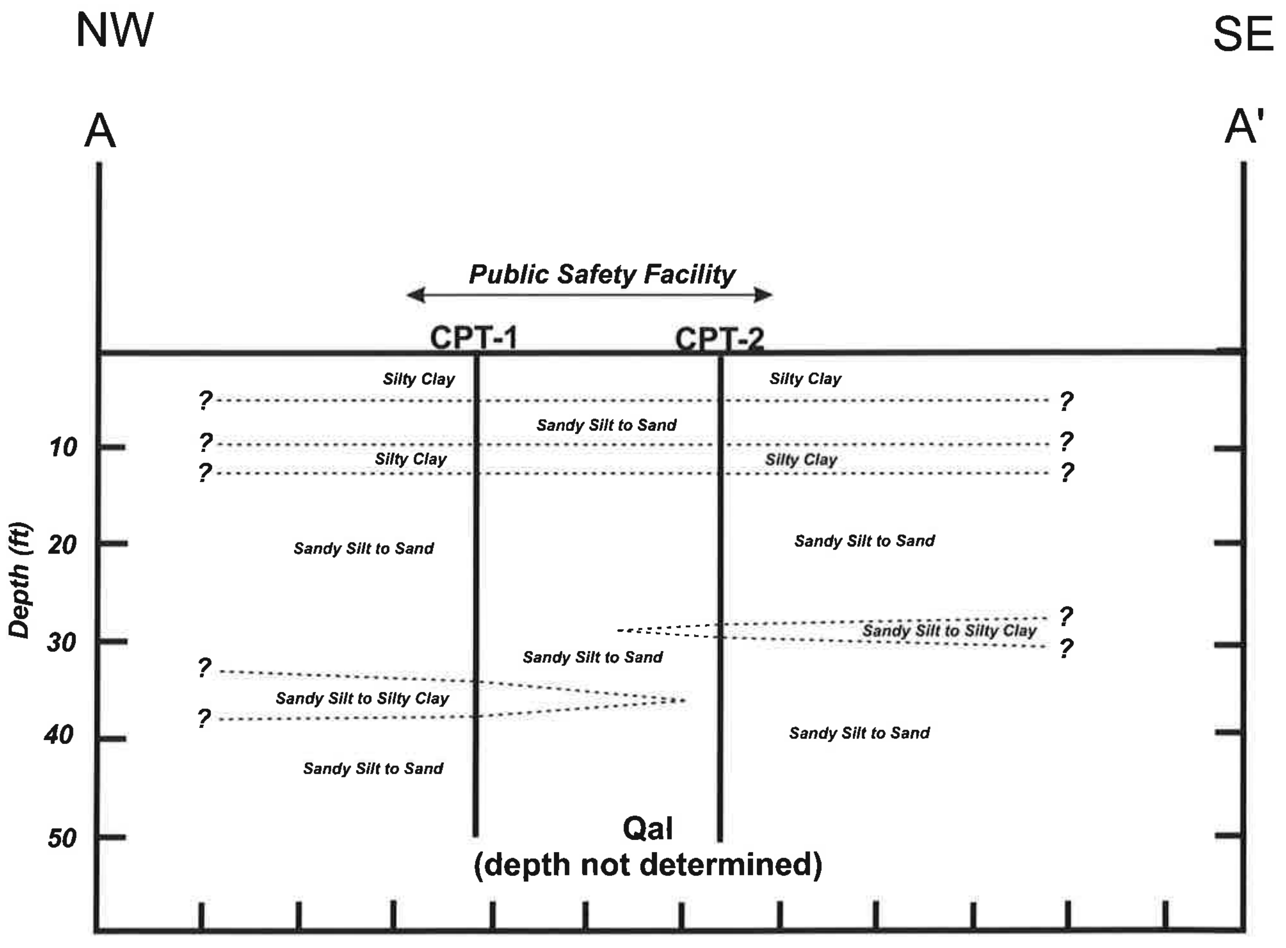
Site Location
Lat N32.7394 Long: W-114.6344

LANDMARK
Geo-Engineers and Geologists

Project No.: LE15031

Regional Geologic Map

Plate A-5



Scale
1" = 70' Horizontal
1" = 20' Vertical

LANDMARK
Geo-Engineers and Geologists

Project No.: LE15031

Schematic Geologic Cross-section

Plate A-6

APPENDIX B

CLIENT: Dynamic Consulting Engineers, Inc.
PROJECT: Public Safety Facility - Winterhaven, CA

LOCATION: See Site and Boring Location Plan

CONE PENETROMETER: Middle Earth Geotesting Truck Mounted Electric Cone with 23 ton reaction weight

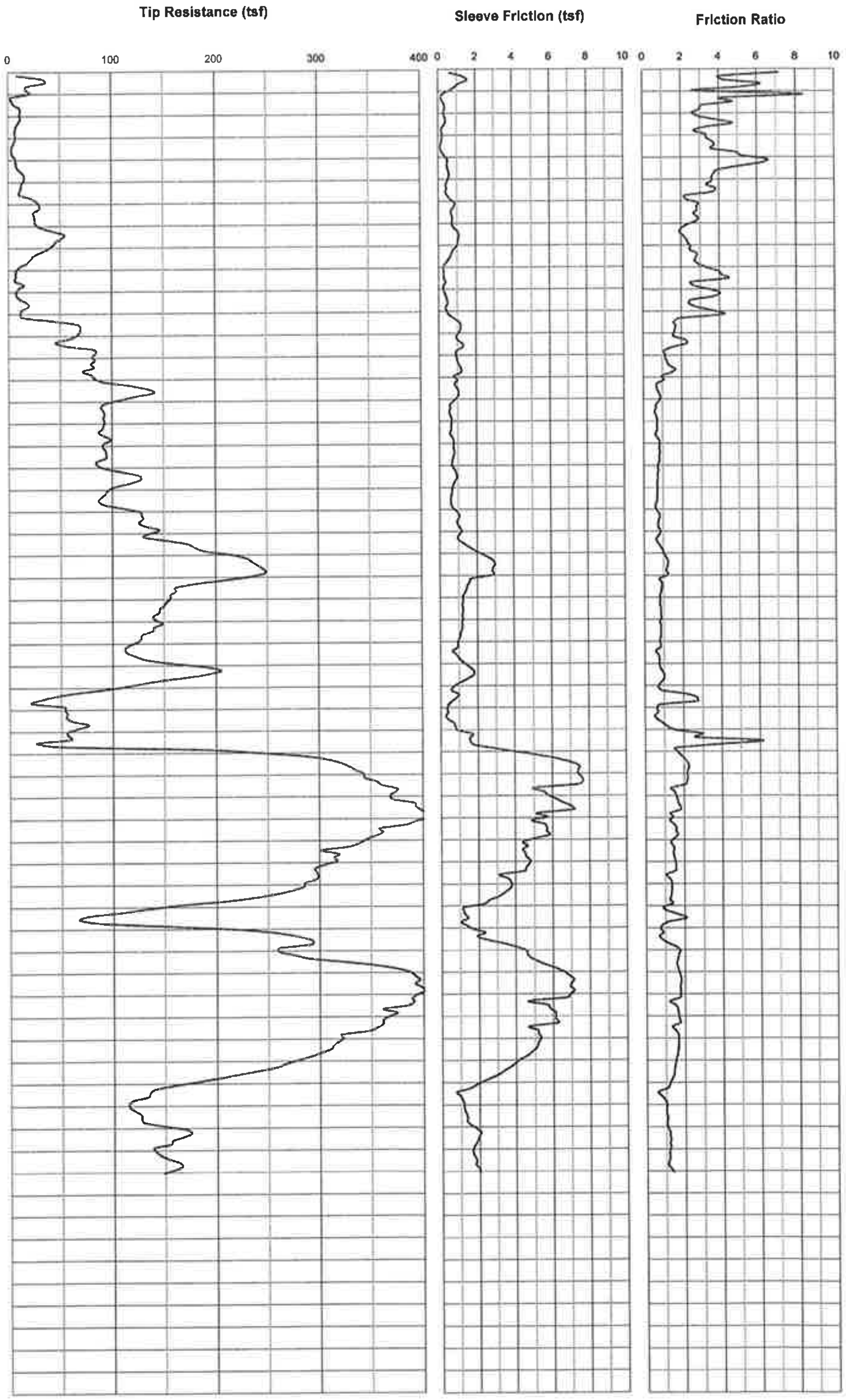
DATE: 3/23/2015

CONE SOUNDING DATA CPT-1

INTERPRETED SOIL PROFILE
From Robertson and Campanella (1989

GROUND ELEVATION +/-		
Clay	CL/CH	very stiff
Clay	" "	firm
Clay	" "	firm
Clay	" "	firm
Clay	" "	stiff
Clayey Silt to Silty Clay	ML/CL	very stiff
Clayey Silt to Silty Clay	" "	very stiff
Sandy Silt to Clayey Silt	ML	medium dense
Clayey Silt to Silty Clay	ML/CL	very stiff
Clay	CL/CH	firm
Silty Clay to Clay	CL	stiff
Sandy Silt to Clayey Silt	ML	medium dense
Silty Sand to Sandy Silt	SM/ML	dense
Sand to Silty Sand	SP/SM	dense
Sand	SP	dense
Sand to Silty Sand	SP/SM	dense
Sand to Silty Sand	" "	dense
Sand to Silty Sand	" "	dense
Sand	SP	dense
Sand	" "	dense
Sand	" "	dense
Sand	" "	very dense
Sand	" "	very dense
Sand	" "	very dense
Sand	" "	dense
Sand	" "	dense
Sand	" "	dense
Sand	" "	dense
Silty Sand to Sandy Silt	SM/ML	medium dense
Sand to Silty Sand	SP/SM	medium dense
Sandy Silt to Clayey Silt	ML	dense
Sand to Silty Sand	SP/SM	very dense
Sand to Silty Sand	" "	very dense
Sand to Silty Sand	" "	very dense
Sand	SP	very dense
Sand	" "	very dense
Sand	" "	very dense
Sand	" "	very dense
Sand to Silty Sand	SP/SM	dense
Sand	SP	very dense
Sand to Silty Sand	SP/SM	very dense
Sand to Silty Sand	" "	very dense
Sand	SP	very dense
Sand	" "	very dense
Sand to Silty Sand	SP/SM	very dense
Sand	SP	very dense
Sand	" "	dense
Sand to Silty Sand	SP/SM	dense
Sand to Silty Sand	" "	dense
Sand to Silty Sand	" "	dense

END OF SOUNDING AT 50 ft.



Project No.
LE15031

LANDMARK
Geo-Engineers and Geologists

PLATE
B-1

LANDMARK CONSULTANTS, INC.

CONE PENETROMETER INTERPRETATION (based on Robertson & Campanella, 1989, refer to Key to CPT logs)

Project: Public Safety Facility - Winterhaven, CA **Project No:** LE15031 **Date:** 3/23/2015

CONE SOUNDING: CPT-1

Est. GWT (ft): 5

Phi Correlation: 0 0-Schm(78),1-R&C(83),2-PHT(74)

Base Depth (m)	Base Depth (ft)	Avg Tip Qc, tsf	Avg Friction Ratio, %	Soil Classification	USCS	Density or Consistency	Est. Density (pcf)	SPT N(60)	Norm. Qc1n	Est. % Fines	Rel. Dens. Dr (%)	Nk: Phi (deg.)	17 Su (tsf)	OCR
0.15	0.5	26.07	5.15	Clay	CL/CH	very stiff	125	21		75			1.53	>10
0.30	1.0	18.52	4.66	Clay	CL/CH	very stiff	125	15		85			1.09	>10
0.45	1.5	3.77	5.71	Clay	CL/CH	soft	125	3		100			0.22	>10
0.60	2.0	11.08	2.90	Silty Clay to Clay	CL	stiff	125	6		90			0.65	>10
0.75	2.5	9.69	3.84	Clay	CL/CH	stiff	125	8		100			0.56	>10
0.93	3.0	6.67	3.10	Clay	CL/CH	firm	125	5		100			0.38	>10
1.08	3.5	4.79	3.59	Clay	CL/CH	firm	125	4		100			0.27	>10
1.23	4.0	4.66	4.57	Clay	CL/CH	firm	125	4		100			0.26	7.27
1.38	4.5	8.17	5.89	Clay	CL/CH	firm	125	7		100			0.46	>10
1.53	5.0	14.51	3.74	Silty Clay to Clay	CL	stiff	125	8		85			0.84	>10
1.68	5.5	11.59	3.61	Silty Clay to Clay	CL	stiff	125	7		95			0.66	>10
1.83	6.0	26.56	2.45	Sandy Silt to Clayey Silt	ML	medium dense	115	8	45.2	55	49	35		
1.98	6.5	26.47	2.77	Clayey Silt to Silty Clay	ML/CL	very stiff	120	11		60			1.54	>10
2.13	7.0	27.38	2.67	Clayey Silt to Silty Clay	ML/CL	very stiff	120	11		60			1.59	>10
2.28	7.5	49.41	2.02	Sandy Silt to Clayey Silt	ML	medium dense	115	14	79.1	40	66	37		
2.45	8.0	43.00	2.38	Sandy Silt to Clayey Silt	ML	medium dense	115	12	67.6	45	61	37		
2.60	8.5	25.83	2.69	Clayey Silt to Silty Clay	ML/CL	very stiff	120	10		60			1.50	>10
2.75	9.0	12.05	3.01	Silty Clay to Clay	CL	stiff	125	7		85			0.68	>10
2.90	9.5	6.75	4.19	Clay	CL/CH	firm	125	5		100			0.37	5.00
3.05	10.0	10.68	2.88	Silty Clay to Clay	CL	stiff	125	6		90			0.60	>10
3.20	10.5	12.37	3.40	Silty Clay to Clay	CL	stiff	125	7		90			0.70	>10
3.35	11.0	14.67	3.00	Clayey Silt to Silty Clay	ML/CL	stiff	120	6		80			0.83	>10
3.50	11.5	40.76	2.58	Sandy Silt to Clayey Silt	ML	medium dense	115	12	56.8	50	56	36		
3.65	12.0	68.63	1.65	Silty Sand to Sandy Silt	SM/ML	dense	115	15	94.4	30	71	38		
3.80	12.5	53.72	2.02	Silty Sand to Sandy Silt	SM/ML	medium dense	115	12	72.9	35	63	37		
3.95	13.0	83.24	1.24	Sand to Silty Sand	SP/SM	dense	115	15	111.6	20	76	39		
4.13	13.5	82.14	1.24	Sand to Silty Sand	SP/SM	dense	115	15	108.7	20	75	38		
4.28	14.0	78.58	1.36	Silty Sand to Sandy Silt	SM/ML	dense	115	17	102.8	25	73	38		
4.43	14.5	114.93	0.82	Sand	SP	dense	110	18	148.7	15	84	40		
4.58	15.0	124.33	0.82	Sand	SP	dense	110	19	159.2	10	86	40		
4.73	15.5	91.62	0.69	Sand to Silty Sand	SP/SM	dense	115	17	116.0	15	77	39		
4.88	16.0	92.32	0.66	Sand to Silty Sand	SP/SM	dense	115	17	115.6	15	77	39		
5.03	16.5	90.37	0.67	Sand to Silty Sand	SP/SM	dense	115	16	112.0	15	76	39		
5.18	17.0	94.15	0.79	Sand to Silty Sand	SP/SM	dense	115	17	115.4	15	77	39		
5.33	17.5	94.13	0.82	Sand to Silty Sand	SP/SM	dense	115	17	114.2	15	76	39		
5.48	18.0	88.56	0.77	Sand to Silty Sand	SP/SM	dense	115	16	106.4	20	74	38		
5.65	18.5	122.12	0.73	Sand	SP	dense	110	19	145.3	15	84	40		
5.80	19.0	105.47	0.70	Sand	SP	dense	110	16	124.4	15	79	39		
5.95	19.5	89.94	0.69	Sand to Silty Sand	SP/SM	dense	115	16	105.1	15	74	38		
6.10	20.0	110.16	0.62	Sand	SP	dense	110	17	127.6	15	80	39		
6.25	20.5	128.04	0.78	Sand	SP	dense	110	20	147.1	15	84	40		
6.40	21.0	137.94	0.78	Sand	SP	dense	110	21	157.1	15	86	40		
6.55	21.5	152.15	0.69	Sand	SP	dense	110	23	171.9	10	88	40		
6.70	22.0	194.42	0.92	Sand	SP	very dense	110	30	217.9	10	95	41		
6.85	22.5	235.51	1.18	Sand	SP	very dense	110	36	262.0	15	101	42		
7.00	23.0	243.50	1.18	Sand	SP	very dense	110	37	268.8	10	102	42		
7.18	23.5	183.40	0.86	Sand	SP	very dense	110	28	200.9	10	93	41		
7.33	24.0	157.91	0.84	Sand	SP	dense	110	24	171.7	15	88	40		
7.48	24.5	149.16	0.82	Sand	SP	dense	110	23	161.0	15	87	40		
7.63	25.0	142.01	0.86	Sand	SP	dense	110	22	152.1	15	85	40		
7.78	25.5	142.43	0.83	Sand	SP	dense	110	22	151.5	15	85	40		
7.93	26.0	126.89	0.82	Sand	SP	dense	110	20	134.0	15	81	39		
8.08	26.5	116.09	0.72	Sand	SP	dense	110	18	121.8	15	78	39		
8.23	27.0	159.71	0.76	Sand	SP	dense	110	25	166.4	15	88	40		
8.38	27.5	188.74	0.93	Sand	SP	very dense	110	29	195.3	15	92	41		
8.53	28.0	119.34	0.81	Sand	SP	dense	110	18	122.6	20	79	39		
8.68	28.5	48.00	1.90	Silty Sand to Sandy Silt	SM/ML	medium dense	115	11	49.0	50	51	35		
8.85	29.0	43.00	1.36	Silty Sand to Sandy Silt	SM/ML	medium dense	115	10	43.6	50	48	35		
9.00	29.5	57.62	0.60	Sand to Silty Sand	SP/SM	medium dense	115	10	58.0	30	56	36		
9.15	30.0	66.69	1.21	Silty Sand to Sandy Silt	SM/ML	medium dense	115	15	66.6	35	60	36		
9.30	30.5	47.51	3.92	Clayey Silt to Silty Clay	ML/CL	hard	120	19		75			2.74	>10
9.45	31.0	157.42	2.33	Silty Sand to Sandy Silt	SM/ML	dense	115	35	155.0	30	85	40		
9.60	31.5	307.00	2.03	Sand to Silty Sand	SP/SM	very dense	115	56	300.3	20	105	43		
9.75	32.0	336.79	2.21	Sand to Silty Sand	SP/SM	very dense	115	61	327.3	20	107	43		
9.90	32.5	353.23	2.14	Sand to Silty Sand	SP/SM	very dense	115	64	341.1	20	109	43		
10.05	33.0	372.14	1.46	Sand	SP	very dense	110	57	357.1	15	110	43		
10.20	33.5	385.60	1.71	Sand to Silty Sand	SP/SM	very dense	115	70	367.8	15	111	44		
10.38	34.0	403.63	1.49	Sand	SP	very dense	110	62	382.7	15	112	44		
10.53	34.5	378.29	1.43	Sand	SP	very dense	110	58	356.7	15	110	43		
10.68	35.0	353.68	1.56	Sand to Silty Sand	SP/SM	very dense	115	64	331.5	15	108	43		
10.83	35.5	322.96	1.39	Sand	SP	very dense	110	50	301.0	15	105	43		
10.98	36.0	316.55	1.46	Sand	SP	very dense	110	49	293.4	15	104	43		
11.13	36.5	299.10	1.41	Sand	SP	very dense	110	46	275.7	15	102	42		
11.28	37.0	289.23	1.28	Sand	SP	very dense	110	44	265.2	15	101	42		
11.43	37.5	257.28	1.31	Sand	SP	very dense	110	40	234.7	20	98	42		
11.58	38.0	170.52	1.16	Sand to Silty Sand	SP/SM	dense	115	31	154.7	20	85	40		
11.73	38.5	84.34	1.61	Silty Sand to Sandy Silt	SM/ML	medium dense	115	19	76.1	40	64	37		

LANDMARK CONSULTANTS, INC.

CONE PENETROMETER INTERPRETATION (based on Robertson & Campanella, 1989, refer to Key to CPT logs)

Project: Public Safety Facility - Winterhaven, CA **Project No:** LE15031 **Date:** 3/23/2015

CONE SOUNDING: CPT-1
Est. GWT (ft): 5
Phi Correlation: **0** 0-Schm(78),1-R&C(83),2-PHT(74)

Base Depth (m)	Base Depth (ft)	Avg Tip Qc, tsf	Avg Friction Ratio, %	Soil Classification	USCS	Density or Consistency	Est. Density (pcf)	SPT N(60)	Norm. Qc1n	Est. % Fines	Rel. Dens. Dr (%)	**Nk:** Phi (deg.)	**17** Su (tsf)	OCR
11.88	39.0	160.21	0.91	Sand	SP	dense	110	25	143.7	20	83	40		
12.05	39.5	278.79	0.80	Sand	SP	very dense	110	43	248.9	10	99	42		
12.20	40.0	271.16	1.49	Sand to Silty Sand	SP/SM	very dense	115	49	240.8	20	98	42		
12.35	40.5	298.15	1.64	Sand to Silty Sand	SP/SM	very dense	115	54	263.3	20	101	42		
12.50	41.0	374.27	1.65	Sand to Silty Sand	SP/SM	very dense	115	68	328.8	20	108	43		
12.65	41.5	393.55	1.78	Sand to Silty Sand	SP/SM	very dense	115	72	343.9	20	109	43		
12.80	42.0	398.12	1.76	Sand to Silty Sand	SP/SM	very dense	115	72	346.0	20	109	43		
12.95	42.5	388.36	1.47	Sand	SP	very dense	110	60	335.9	15	108	43		
13.10	43.0	367.60	1.64	Sand to Silty Sand	SP/SM	very dense	115	67	316.3	20	106	43		
13.25	43.5	359.36	1.59	Sand to Silty Sand	SP/SM	very dense	115	65	307.7	20	106	43		
13.40	44.0	330.31	1.59	Sand to Silty Sand	SP/SM	very dense	115	60	281.4	20	103	42		
13.58	44.5	313.95	1.64	Sand to Silty Sand	SP/SM	very dense	115	57	266.1	20	101	42		
13.73	45.0	290.63	1.56	Sand to Silty Sand	SP/SM	very dense	115	53	245.1	20	99	42		
13.88	45.5	254.98	1.45	Sand	SP	very dense	110	39	214.0	20	95	41		
14.03	46.0	199.55	1.33	Sand to Silty Sand	SP/SM	dense	115	36	166.7	25	88	40		
14.18	46.5	143.21	0.93	Sand	SP	dense	110	22	119.1	25	78	39		
14.33	47.0	120.38	0.90	Sand to Silty Sand	SP/SM	dense	115	22	99.7	25	72	38		
14.48	47.5	124.85	1.02	Sand to Silty Sand	SP/SM	dense	115	23	102.9	30	73	38		
14.63	48.0	148.49	1.05	Sand	SP	dense	110	23	121.8	25	78	39		
14.78	48.5	166.45	1.19	Sand to Silty Sand	SP/SM	dense	115	30	135.9	25	82	39		
14.93	49.0	144.75	1.18	Sand to Silty Sand	SP/SM	dense	115	26	117.7	30	77	39		
15.10	49.5	152.78	1.14	Sand to Silty Sand	SP/SM	dense	115	28	123.6	25	79	39		
15.25	50.0	157.87	1.22	Sand to Silty Sand	SP/SM	dense	115	29	127.2	30	80	39		

CLIENT: Dynamic Consulting Engineers, Inc.
PROJECT: Public Safety Facility - Winterhaven, CA

CONE PENETROMETER: Middle Earth Geotesting Truck Mounted Electric Cone with 23 ton reaction weight

LOCATION: See Site and Boring Location Plan

DATE: 3/23/2015

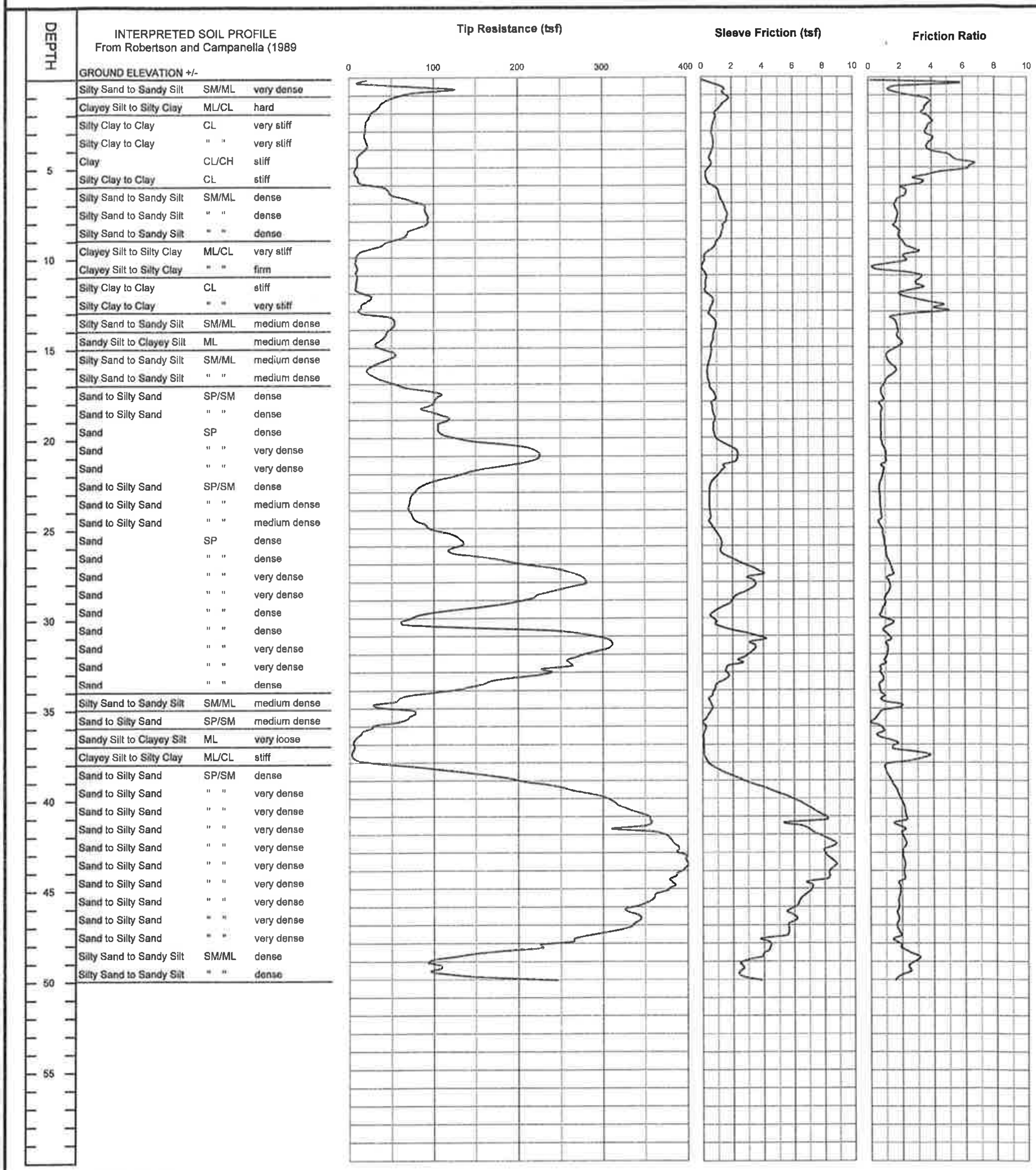
CONE SOUNDING DATA CPT-2

DEPTH

INTERPRETED SOIL PROFILE
From Robertson and Campanella (1989

GROUND ELEVATION +/-

Silty Sand to Sandy Silt	SM/ML	very dense
Clayey Silt to Silty Clay	ML/CL	hard
Silty Clay to Clay	CL	very stiff
Silty Clay to Clay	" "	very stiff
Clay	CL/CH	stiff
Silty Clay to Clay	CL	stiff
Silty Sand to Sandy Silt	SM/ML	dense
Silty Sand to Sandy Silt	" "	dense
Silty Sand to Sandy Silt	" "	dense
Clayey Silt to Silty Clay	ML/CL	very stiff
Clayey Silt to Silty Clay	" "	firm
Silty Clay to Clay	CL	stiff
Silty Clay to Clay	" "	very stiff
Silty Sand to Sandy Silt	SM/ML	medium dense
Sandy Silt to Clayey Silt	ML	medium dense
Silty Sand to Sandy Silt	SM/ML	medium dense
Silty Sand to Sandy Silt	" "	medium dense
Sand to Silty Sand	SP/SM	dense
Sand to Silty Sand	" "	dense
Sand	SP	dense
Sand	" "	very dense
Sand	" "	very dense
Sand to Silty Sand	SP/SM	dense
Sand to Silty Sand	" "	medium dense
Sand to Silty Sand	" "	medium dense
Sand	SP	dense
Sand	" "	dense
Sand	" "	very dense
Sand	" "	very dense
Sand	" "	dense
Sand	" "	dense
Sand	" "	very dense
Sand	" "	very dense
Sand	" "	dense
Silty Sand to Sandy Silt	SM/ML	medium dense
Sand to Silty Sand	SP/SM	medium dense
Sandy Silt to Clayey Silt	ML	very loose
Clayey Silt to Silty Clay	ML/CL	stiff
Sand to Silty Sand	SP/SM	dense
Sand to Silty Sand	" "	very dense
Sand to Silty Sand	" "	very dense
Sand to Silty Sand	" "	very dense
Sand to Silty Sand	" "	very dense
Sand to Silty Sand	" "	very dense
Sand to Silty Sand	" "	very dense
Sand to Silty Sand	" "	very dense
Sand to Silty Sand	" "	very dense
Sand to Silty Sand	" "	very dense
Silty Sand to Sandy Silt	SM/ML	dense
Silty Sand to Sandy Silt	" "	dense



END OF SOUNDING AT 50 ft

Project No.

LE15031

LANDMARK
Geo-Engineers and Geologists

PLATE

B-2

LANDMARK CONSULTANTS, INC.

CONE PENETROMETER INTERPRETATION (based on Robertson & Campanella, 1989, refer to Key to CPT logs)

Project: Public Safety Facility - Winterhaven, CA **Project No:** LE15031 **Date:** 3/23/2015

CONE SOUNDING: CPT-2

Est. GWT (ft): 5

Phi Correlation: 0 0-Schm(78),1-R&C(83),2-PHT(74)

Base Depth (m)	Base Depth (ft)	Avg Tip Qc, tsf	Avg Friction Ratio, %	Soil Classification	USCS	Density or Consistency	Est. Density (pcf)	SPT N(60)	Norm. Qc1n	Est. % Fines	Rel. Dens. Dr (%)	Nk: Phi (deg.)	17 Su (tsf)	OCR
0.15	0.5	34.04	2.56	Sandy Silt to Clayey Silt	ML	very dense	115	10	64.3	50	102	42		
0.30	1.0	89.54	1.82	Silty Sand to Sandy Silt	SM/ML	very dense	115	20	169.3	25	115	44		
0.45	1.5	43.52	3.75	Clayey Silt to Silty Clay	ML/CL	hard	120	17		55			2.56	>10
0.60	2.0	30.95	3.48	Clayey Silt to Silty Clay	ML/CL	very stiff	120	12		60			1.81	>10
0.75	2.5	22.59	3.94	Silty Clay to Clay	CL	very stiff	125	13		75			1.32	>10
0.93	3.0	19.62	3.73	Silty Clay to Clay	CL	very stiff	125	11		75			1.14	>10
1.08	3.5	18.80	3.92	Silty Clay to Clay	CL	very stiff	125	11		80			1.09	>10
1.23	4.0	20.91	3.76	Silty Clay to Clay	CL	very stiff	125	12		75			1.22	>10
1.38	4.5	13.02	4.80	Clay	CL/CH	stiff	125	10		100			0.75	>10
1.53	5.0	9.72	6.26	Clay	CL/CH	stiff	125	8		100			0.55	>10
1.68	5.5	7.78	4.34	Clay	CL/CH	firm	125	6		100			0.44	>10
1.83	6.0	21.35	2.94	Clayey Silt to Silty Clay	ML/CL	very stiff	120	9		65			1.24	>10
1.98	6.5	48.36	2.34	Sandy Silt to Clayey Silt	ML	medium dense	115	14	81.4	40	66	37		
2.13	7.0	77.50	1.76	Silty Sand to Sandy Silt	SM/ML	dense	115	17	127.9	25	80	39		
2.28	7.5	90.32	1.78	Silty Sand to Sandy Silt	SM/ML	dense	115	20	146.3	25	84	40		
2.45	8.0	93.06	1.78	Silty Sand to Sandy Silt	SM/ML	dense	115	21	148.1	25	84	40		
2.60	8.5	80.06	1.77	Silty Sand to Sandy Silt	SM/ML	dense	115	18	125.2	25	79	39		
2.75	9.0	62.38	1.98	Silty Sand to Sandy Silt	SM/ML	dense	115	14	95.9	35	71	38		
2.90	9.5	35.89	2.48	Sandy Silt to Clayey Silt	ML	medium dense	115	10	54.3	50	54	36		
3.05	10.0	10.87	2.57	Clayey Silt to Silty Clay	ML/CL	stiff	120	4		85			0.61	>10
3.20	10.5	8.18	1.30	Clayey Silt to Silty Clay	ML/CL	firm	120	3		80			0.46	>10
3.35	11.0	8.94	2.12	Clayey Silt to Silty Clay	ML/CL	firm	120	4		90			0.50	>10
3.50	11.5	8.84	3.11	Silty Clay to Clay	CL	firm	125	5		100			0.49	8.85
3.65	12.0	10.63	2.70	Silty Clay to Clay	CL	stiff	125	6		90			0.60	>10
3.80	12.5	23.63	3.01	Clayey Silt to Silty Clay	ML/CL	very stiff	120	9		65			1.36	>10
3.95	13.0	13.30	4.65	Clay	CL/CH	stiff	125	11		100			0.75	>10
4.13	13.5	38.97	1.90	Sandy Silt to Clayey Silt	ML	medium dense	115	11	52.0	45	53	35		
4.28	14.0	52.02	1.79	Silty Sand to Sandy Silt	SM/ML	medium dense	115	12	68.6	35	61	37		
4.43	14.5	43.16	1.83	Silty Sand to Sandy Silt	SM/ML	medium dense	115	10	56.2	40	55	36		
4.58	15.0	33.39	2.01	Sandy Silt to Clayey Silt	ML	medium dense	115	10	43.0	50	48	35		
4.73	15.5	49.67	1.29	Silty Sand to Sandy Silt	SM/ML	medium dense	115	11	63.2	35	59	36		
4.88	16.0	36.20	1.35	Silty Sand to Sandy Silt	SM/ML	medium dense	115	8	45.6	40	49	35		
5.03	16.5	24.14	1.56	Sandy Silt to Clayey Silt	ML	loose	115	7	30.1	55	37	33		
5.18	17.0	46.99	1.01	Silty Sand to Sandy Silt	SM/ML	medium dense	115	10	57.9	30	56	36		
5.33	17.5	90.99	0.76	Sand to Silty Sand	SP/SM	dense	115	17	111.0	15	76	39		
5.48	18.0	101.84	0.80	Sand to Silty Sand	SP/SM	dense	115	19	122.9	15	79	39		
5.65	18.5	92.34	0.76	Sand to Silty Sand	SP/SM	dense	115	17	110.3	15	75	39		
5.80	19.0	113.87	0.74	Sand	SP	dense	110	18	134.8	15	81	39		
5.95	19.5	105.21	0.73	Sand	SP	dense	110	16	123.5	15	79	39		
6.10	20.0	116.47	0.74	Sand	SP	dense	110	18	135.5	15	81	39		
6.25	20.5	180.56	0.84	Sand	SP	very dense	110	28	208.3	10	94	41		
6.40	21.0	223.52	1.04	Sand	SP	very dense	110	34	255.7	10	100	42		
6.55	21.5	207.05	0.95	Sand	SP	very dense	110	32	235.0	10	98	42		
6.70	22.0	148.04	0.88	Sand to Silty Sand	SP/SM	dense	115	27	166.6	15	88	40		
6.85	22.5	106.41	0.74	Sand	SP	dense	110	16	118.7	15	78	39		
7.00	23.0	81.23	0.63	Sand to Silty Sand	SP/SM	medium dense	115	15	89.9	20	69	38		
7.18	23.5	72.79	0.67	Sand to Silty Sand	SP/SM	medium dense	115	13	79.9	20	66	37		
7.33	24.0	70.53	0.70	Sand to Silty Sand	SP/SM	medium dense	115	13	76.8	25	65	37		
7.48	24.5	74.57	0.75	Sand to Silty Sand	SP/SM	medium dense	115	14	80.5	25	66	37		
7.63	25.0	87.71	0.65	Sand to Silty Sand	SP/SM	dense	115	16	93.9	20	71	38		
7.78	25.5	114.51	0.84	Sand	SP	dense	110	18	121.7	20	78	39		
7.93	26.0	133.23	0.95	Sand	SP	dense	110	20	140.6	20	83	40		
8.08	26.5	129.46	1.05	Sand to Silty Sand	SP/SM	dense	115	24	135.6	20	81	39		
8.23	27.0	196.67	1.26	Sand to Silty Sand	SP/SM	very dense	115	36	204.5	15	94	41		
8.38	27.5	256.38	1.45	Sand to Silty Sand	SP/SM	very dense	115	47	264.6	15	101	42		
8.53	28.0	278.83	1.17	Sand	SP	very dense	110	43	285.8	15	103	42		
8.68	28.5	250.76	1.25	Sand	SP	very dense	110	39	255.3	15	100	42		
8.85	29.0	214.75	0.99	Sand	SP	very dense	110	33	217.2	15	95	41		
9.00	29.5	155.66	0.88	Sand	SP	dense	110	24	156.5	15	86	40		
9.15	30.0	82.99	0.80	Sand to Silty Sand	SP/SM	medium dense	115	15	82.9	25	67	37		
9.30	30.5	86.74	1.28	Sand to Silty Sand	SP/SM	medium dense	115	16	86.0	30	68	38		
9.45	31.0	266.39	1.06	Sand	SP	very dense	110	41	262.4	10	101	42		
9.60	31.5	309.46	1.16	Sand	SP	very dense	110	48	303.0	10	105	43		
9.75	32.0	292.64	1.12	Sand	SP	very dense	110	45	284.8	10	103	42		
9.90	32.5	262.36	0.99	Sand	SP	very dense	110	40	253.9	10	100	42		
10.05	33.0	243.89	0.66	Sand	SP	very dense	110	38	234.6	10	98	42		
10.20	33.5	194.97	0.81	Sand	SP	very dense	110	30	186.5	15	91	41		
10.38	34.0	143.34	0.61	Sand	SP	dense	110	22	136.3	15	82	39		
10.53	34.5	75.31	0.77	Sand to Silty Sand	SP/SM	medium dense	115	14	71.2	30	62	37		
10.68	35.0	39.75	1.60	Silty Sand to Sandy Silt	SM/ML	medium dense	115	9	37.3	60	43	34		
10.83	35.5	75.50	0.58	Sand to Silty Sand	SP/SM	medium dense	115	14	70.5	25	62	37		
10.98	36.0	51.28	0.28	Sand to Silty Sand	SP/SM	medium dense	115	9	47.6	25	51	35		
11.13	36.5	16.45	0.69	Sandy Silt to Clayey Silt	ML	very loose	115	5	15.2	75	17	30		
11.28	37.0	5.50	1.51	Sensitive fine grained	ML	firm	120	3		100			0.26	1.63
11.43	37.5	3.81	2.72	Clay	CL/CH	soft	125	3		100			0.16	0.58
11.58	38.0	18.81	2.29	Clayey Silt to Silty Clay	ML/CL	very stiff	120	8		100			1.04	9.79
11.73	38.5	108.45	0.98	Sand to Silty Sand	SP/SM	dense	115	20	97.6	25	72	38		

LOG OF BORING No. 1

SHEET 1 OF 1

DEPTH	FIELD				DESCRIPTION OF MATERIAL	LABORATORY		
	SAMPLE	USCS CLASS.	BLOW COUNT	POCKET PEN. (tsf)		DRY DENSITY (pcf)	MOISTURE CONTENT (% dry wt.)	OTHER TESTS
		▨			SILTY CLAY/CLAYEY SILT (CL/ML): Brown, dry to moist, stiff.			
5	●	▨			SILTY CLAY (CL): Brown, moist, stiff to very stiff.			
	●	▨			SILTY SAND (SM): Light brown, moist to saturated, very fine grained.			
10					Total Depth = 9' Backfilled with excavated soil No groundwater encountered			
15								
20								
25								
30								
35								
40								
45								
50								
55								
60								

DATE DRILLED: 4/28/15

TOTAL DEPTH: 10 Feet

DEPTH TO WATER: NA

LOGGED BY: J. Leroy

TYPE OF BIT: Solid Stem Auger

DIAMETER: 6 in.

SURFACE ELEVATION: Approximately 130'

HAMMER WT.: N/A

DROP: N/A

PROJECT NO. LE15031

LANDMARK
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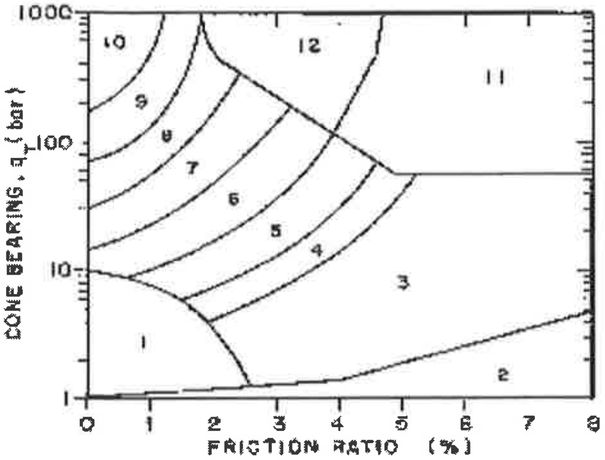
PLATE B-3

Simplified Soil Classification Chart

After Robertson & Campanella (1989)



Geotechnical Parameters from CPT Data:

Equivalent SPT N(60) blow count = Qc/(Qc/N Ratio)

N1(60) = Cn*N(60) Normalized SPT blow count

Cn = 1/(p'o)^0.5 < 1.6 max. from Liao & Whitman (1986)

p'o = effective overburden pressure (tsf) using unit densities given below and estimated groundwater table.

Dr = Relative density (%) from Jamiolkowski et. al. (1986) relationship
= -98 +68*log(Qc/p'o^0.5) where Qc, p'o in tonne/sqm

Note: 1 tonne/sqm = 0.1024 tsf, 1 bar =1.0443 tsf

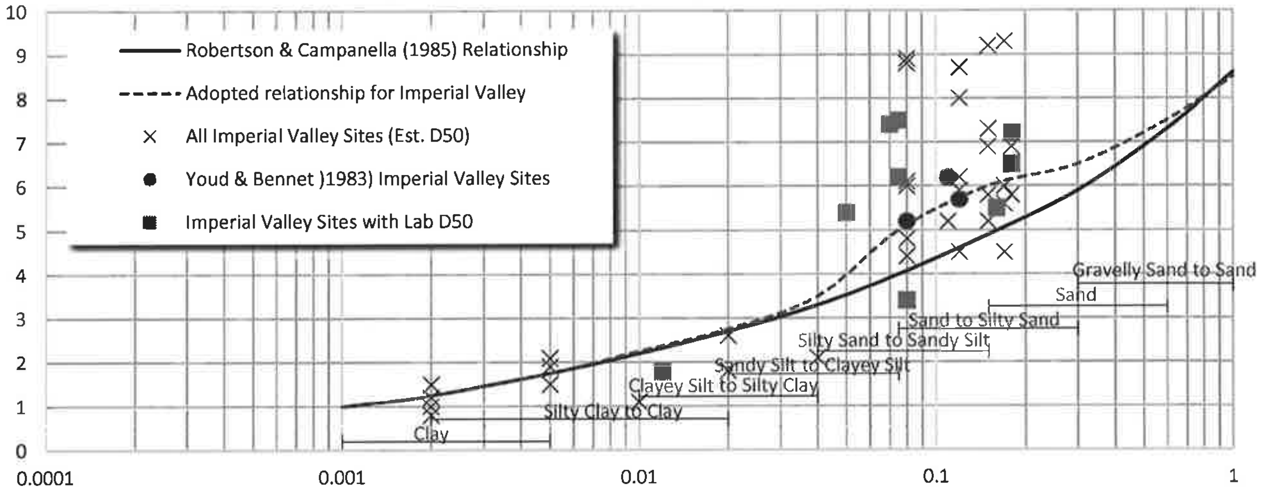
Phi = Friction Angle estimated from either:

1. Roberton & Campanella (1983) chart:
   Phi = 5.3 + 24*(log(Qc/p'o))+3(log(Qc/p'o))^2
2. Peck, Hansen & Thornburn (1974) N-Phi Correlation
3. Schmertman (1978) chart [Phi = 28+0.14*Dr for fine uniform sands]

Su = undrained shear strength (tsf)
= (Qc-p'o)/Nk where Nk varies from 10 to 22, 17 for OC clays

OCR = Overconsolidation Ratio estimated from Schmertman (1978) chart using Su/p'o ratio and estimated normal consolidated Su/p'o

Variation of Qc/N Ratio with Grain Size



Note: Assumed Properties and Adopted Qc/N Ratio based on correlations from Imperial Valley, California soils

Table of Soil Types and Assumed Properties

Zone	Soil Classification	UCS	Density (pcf)	R&C Qc/N	Adopted Qc/N	Est. PI	Fines (%)	D50 (mm)
1	Sensitive fine grained	ML	120	2	2	NP-15	65-100	0.02
2	Organic Material	OL/OH	120	1	1	--	--	--
3	Clay	CL/CH	125	1	1.25	25-40+	90-100	0.002
4	Silty Clay to Clay	CL	125	1.5	2	15-40	90-100	0.01
5	Clayey Silt to Silty Clay	ML/CL	120	2	2.75	25-May	90-100	0.02
6	Sandy Silt to Clayey Silt	ML	115	2.5	3.5	NP-10	65-100	0.04
7	Silty Sand to Sandy Silt	SM/ML	115	3	5	NP	35-75	0.075
8	Sand to Silty Sand	SP/SM	115	4	6	NP	May-35	0.15
9	Sand	SP	110	5	6.5	NP	0-5	0.3
10	Gravelly Sand to Sand	SW	115	6	7.5	NP	0-5	0.6
11	Overconsolidated Soil	--	120	1	1	NP	90-100	0.01
12	Sand to Clayey Sand	SP/SC	115	2	2	NP-5	--	---

Su (tsf)	Consistency
0-0.13	very soft
0.13-.25	soft
0.25-0.5	firm
0.5-1.0	stiff
1.0-2.0	very stiff
>2.0	hard
Dr (%)	**Relative Density**
0-15	very loose
15-35	loose
35-65	medium dense
65-85	dense
>85	very dense

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Geo-Engineers and Geologists

Project No: LE15031

Key to CPT Interpretation of Logs

Plate B-4

DEFINITION OF TERMS

PRIMARY DIVISIONS			SYMBOLS		SECONDARY DIVISIONS
Coarse grained soils More than half of material is larger that No. 200 sieve	**Gravels** More than half of coarse fraction is larger than No. 4 sieve	Clean gravels (less than 5% fines)	▨	GW	Well graded gravels, gravel-sand mixtures, little or no fines
			▨	GP	Poorly graded gravels, or gravel-sand mixtures, little or no fines
		Gravel with fines	▨	GM	Silty gravels, gravel-sand-silt mixtures, non-plastic fines
			▨	GC	Clayey gravels, gravel-sand-clay mixtures, plastic fines
	Sands More than half of coarse fraction is smaller than No. 4 sieve	Clean sands (less than 5% fines)	▨	SW	Well graded sands, gravelly sands, little or no fines
			▨	SP	Poorly graded sands or gravelly sands, little or no fines
		Sands with fines	▨	SM	Silty sands, sand-silt mixtures, non-plastic fines
			▨	SC	Clayey sands, sand-clay mixtures, plastic fines
Fine grained soils More than half of material is smaller than No. 200 sieve	**Silts and clays**		▨	ML	Inorganic silts, clayey silts with slight plasticity
	Liquid limit is less than 50%		▨	CL	Inorganic clays of low to medium plasticity, gravely, sandy, or lean clays
			▨	OL	Organic silts and organic clays of low plasticity
	Silts and clays		▨	MH	Inorganic silts, micaceous or diatomaceous silty soils, elastic silts
	Liquid limit is more than 50%		▨	CH	Inorganic clays of high plasticity, fat clays
			▨	OH	Organic clays of medium to high plasticity, organic silts
Highly organic soils			▨	PT	Peat and other highly organic soils

GRAIN SIZES

Silts and Clays	Sand			Gravel		Cobbles	Boulders
	Fine	Medium	Coarse	Fine	Coarse		

200 40 10 4 3/4" 3" 12"

US Standard Series Sieve Clear Square Openings

Sands, Gravels, etc.	Blows/ft. *
Very Loose	0-4
Loose	4-10
Medium Dense	10-30
Dense	30-50
Very Dense	Over 50

Clays & Plastic Silts	Strength **	Blows/ft. *
Very Soft	0-0.25	0-2
Soft	0.25-0.5	2-4
Firm	0.5-1.0	4-8
Stiff	1.0-2.0	8-16
Very Stiff	2.0-4.0	16-32
Hard	Over 4.0	Over 32

* Number of blows of 140 lb. hammer falling 30 inches to drive a 2 inch O.D. (1 3/8 in. I.D.) split spoon (ASTM D1586).

** Unconfined compressive strength in tons/s.f. as determined by laboratory testing or approximated by the Standard Penetration Test (ASTM D1586), Pocket Penetrometer, Torvane, or visual observation.

Type of Samples:

◼ Ring Sample ◻ Standard Penetration Test I Shelby Tube ● Bulk (Bag) Sample

Drilling Notes:

1. Sampling and Blow Counts
    - Ring Sampler - Number of blows per foot of a 140 lb. hammer falling 30 inches.
    - Standard Penetration Test - Number of blows per foot.
    - Shelby Tube - Three (3) inch nominal diameter tube hydraulically pushed.
2. P. P. = Pocket Penetrometer (tons/s.f.).
3. NR = No recovery.
4. GWT ▼ = Ground Water Table observed @ specified time.

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Project No. **LE15031**

Key to Logs

Plate
B-5

APPENDIX C

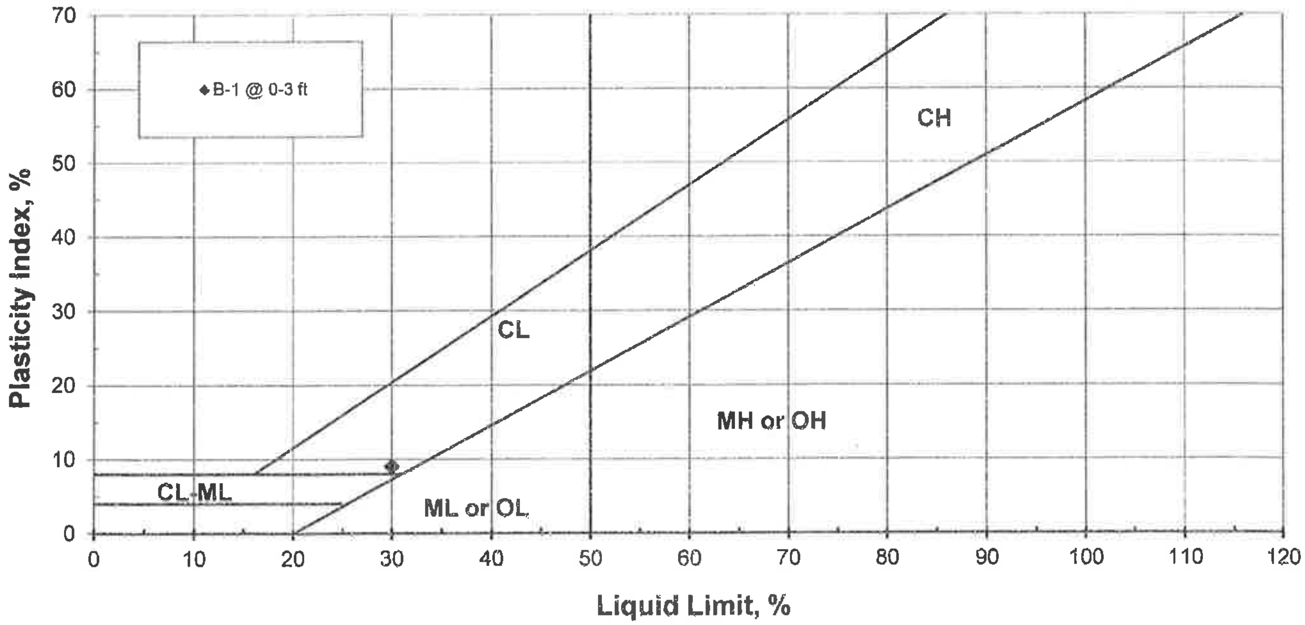
LANDMARK CONSULTANTS, INC.

CLIENT: Dynamic Consulting Engineers, Inc.
PROJECT: Winterhaven Public Safety Facility -- Winterhaven, CA
JOB No.: LE15031
DATE: 03/30/15

ATTERBERG LIMITS (ASTM D4318)

Sample Location	Sample Depth (ft)	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	USCS Classification
B-1	0-3	30	21	9	CL

PLASTICITY CHART



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Project No.: LE15031

Atterberg Limits Test Results

Plate C-1

LANDMARK CONSULTANTS, INC.

CLIENT: Dynamic Consulting Engineers, Inc.
PROJECT: Winterhaven Public Safety Facility -- Winterhaven, CA
JOB No.: LE15031
DATE: 03/30/15

CHEMICAL ANALYSIS

		Caltrans Method
Boring:	B-1	
Sample Depth, ft:	0-3	
pH:	7.8	643
Electrical Conductivity (mmhos):	5.4	424
Resistivity (ohm-cm):	110	643
Chloride (Cl), ppm:	5,320	422
Sulfate (SO4), ppm:	5,440	417

General Guidelines for Soil Corrosivity

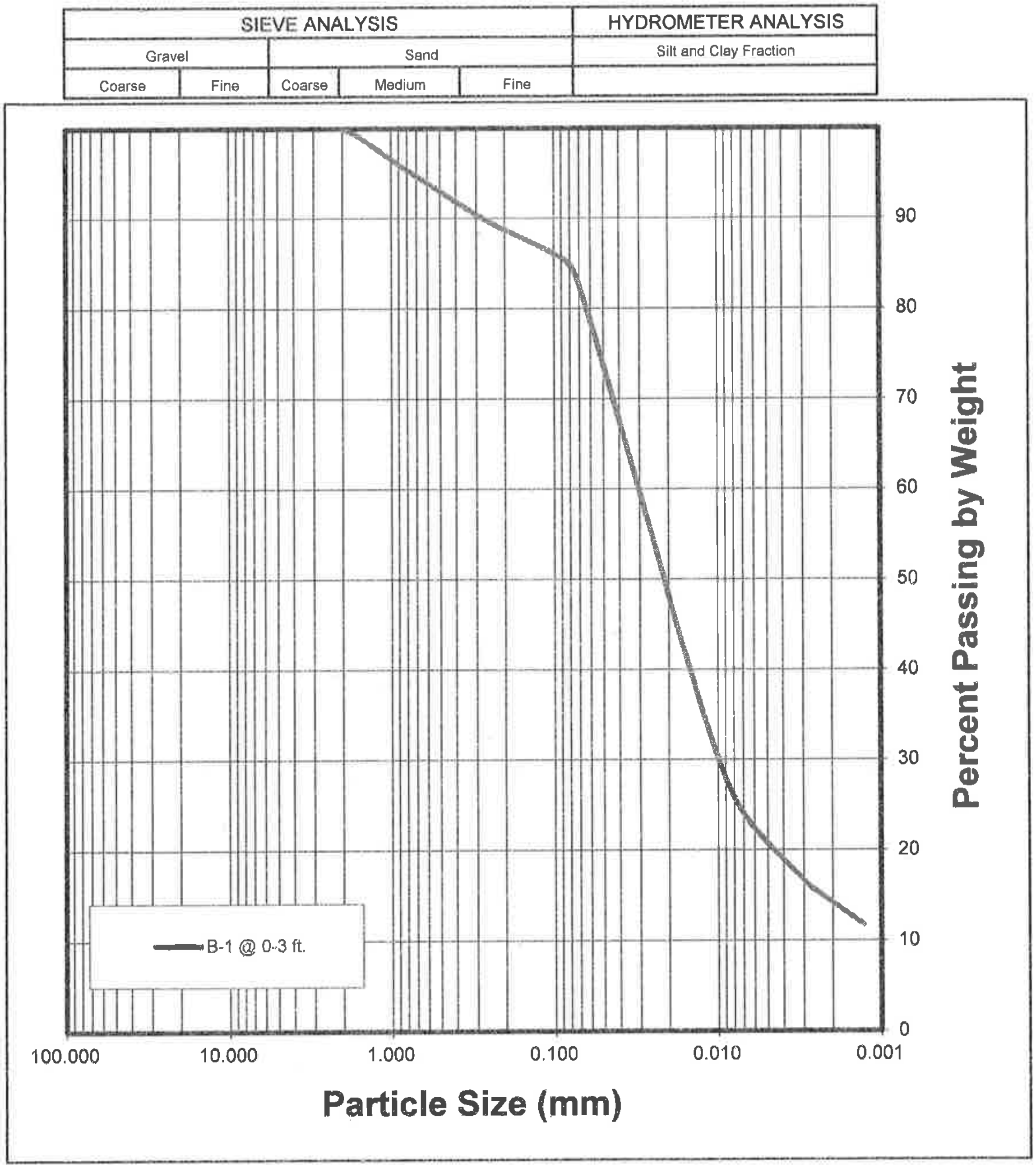
Material Affected	Chemical Agent	Amount in Soil (ppm)	Degree of Corrosivity
Concrete	Soluble Sulfates	0 - 1,000	Low
		1,000 - 2,000	Moderate
		2,000 - 20,000	Severe
		> 20,000	Very Severe
Normal Grade Steel	Soluble Chlorides	0 - 200	Low
		200 - 700	Moderate
		700 - 1,500	Severe
		> 1,500	Very Severe
Normal Grade Steel	Resistivity	1 - 1,000	Very Severe
		1,000 - 2,000	Severe
		2,000 - 10,000	Moderate
		> 10,000	Low

LANDMARK
Geo-Engineers and Geologists

Project No.: LE15031

Selected Chemical Test Results

Plate C-2



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Geo-Engineers and Geologists

Project No.: LE15031

Grain Size Analysis

Plate
C-3

APPENDIX D

LANDMARK
Geo-Engineers and Geologists

Landmark Consultants, Inc.
780 N. 4th Street
El Centro, CA 92243

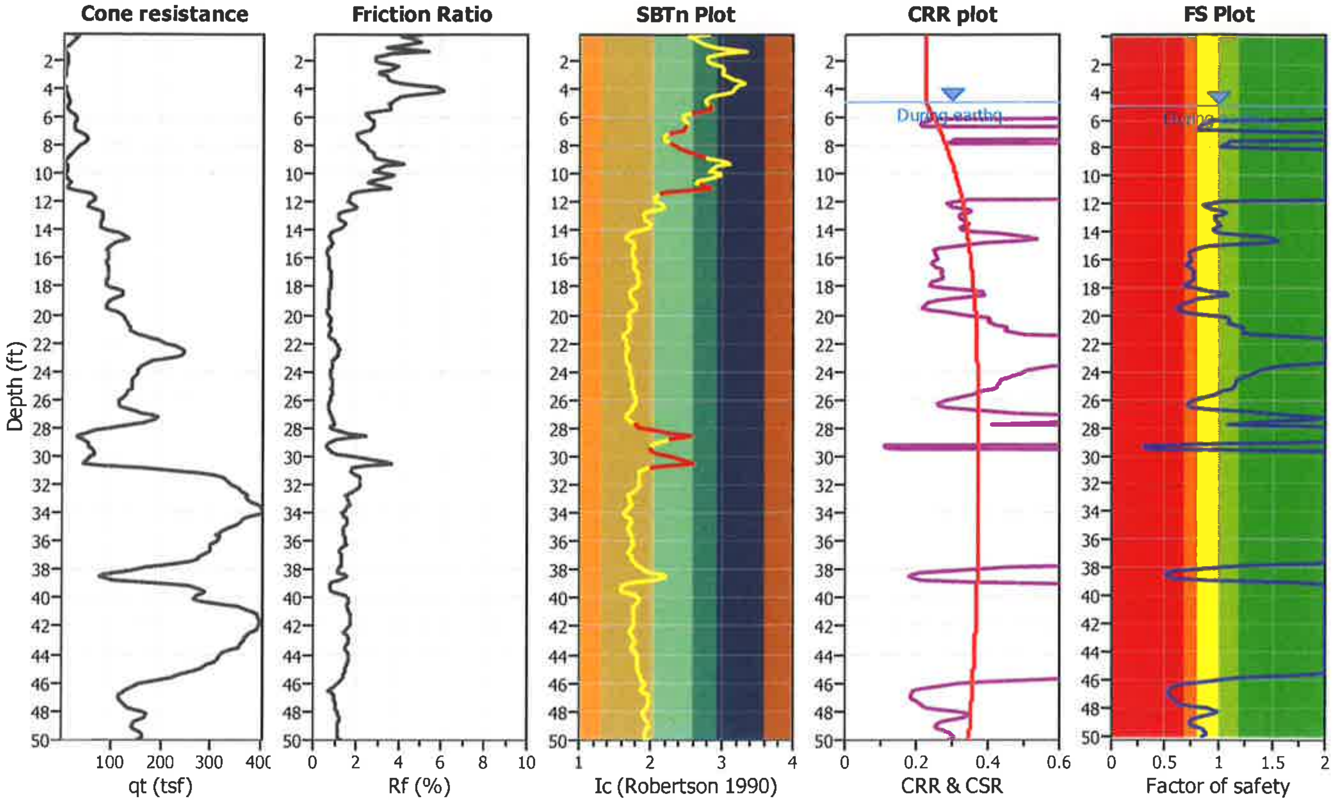
LIQUEFACTION ANALYSIS REPORT

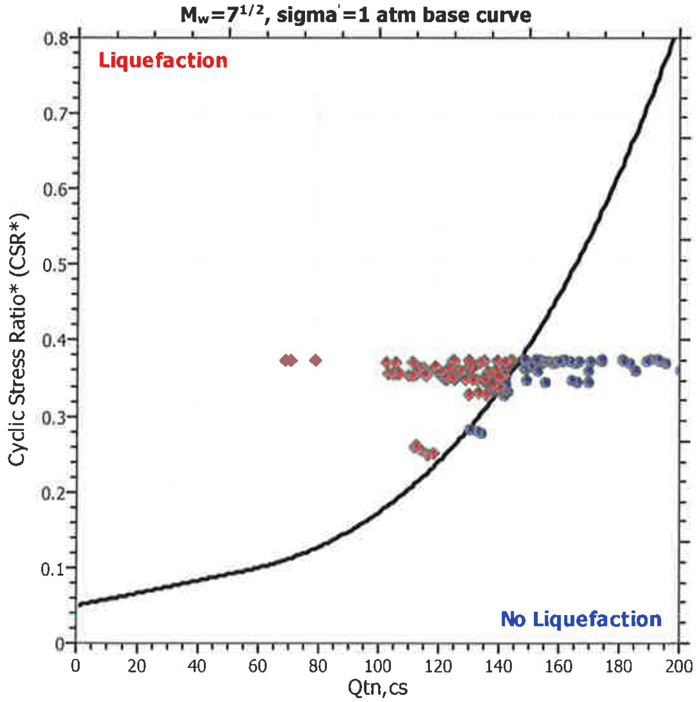
Project title : Public Safety Facility **Location : 518 Railroad Avenue - Winterhaven, CA**

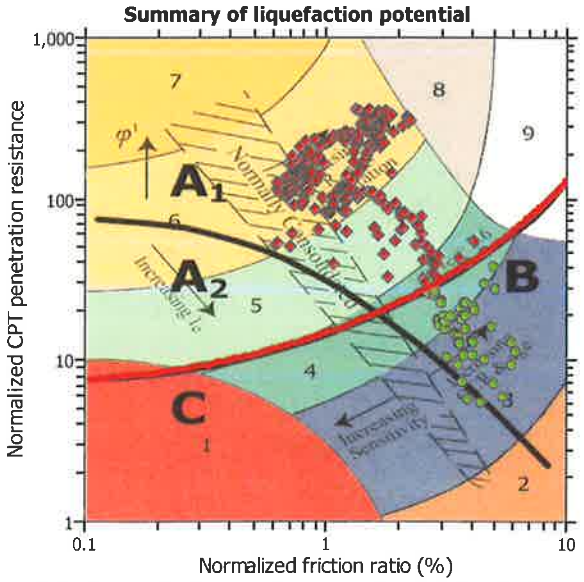
CPT file : CPT-1

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	7.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	5.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.00	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.32	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

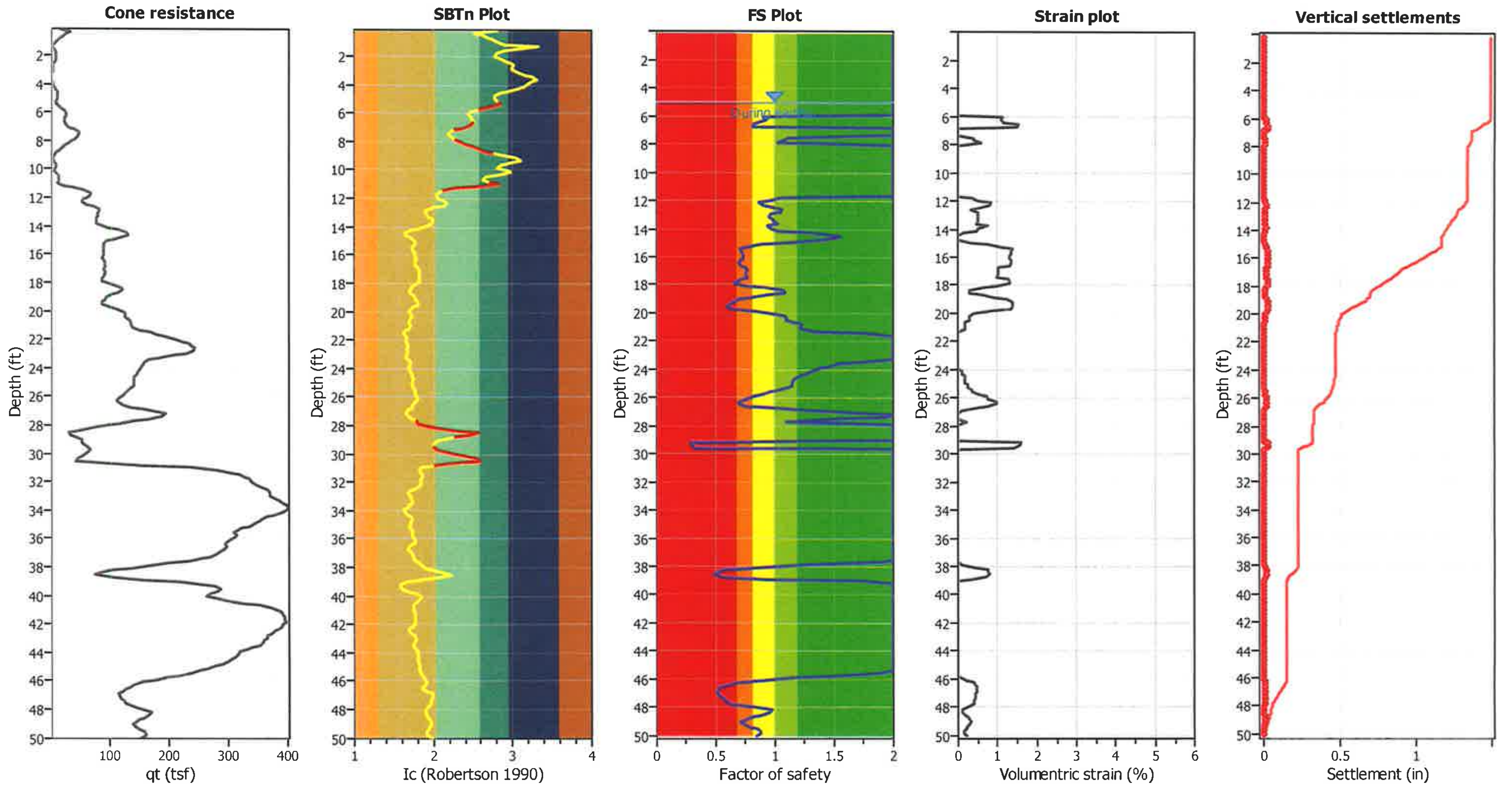

Cone resistance **Friction Ratio** **SBTn Plot** **CRR plot** **FS Plot**


$M_w=7^{1/2}$, sigma'=1 atm base curve


Summary of liquefaction potential

Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

Estimation of post-earthquake settlements



Abbreviations

q

q_t: Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c: Soil Behaviour Type Index
FS: Calculated Factor of Safety against liquefaction
Volumentric strain: Post-liquefaction volumentric strain

:: Post-earthquake settlement due to soil liquefaction ::

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
5.09	97.89	2.00	0.00	0.91	0.00	5.25	94.58	2.00	0.00	0.91	0.00
5.41	92.44	2.00	0.00	0.91	0.00	5.58	93.17	2.00	0.00	0.91	0.00
5.74	96.46	2.00	0.00	0.90	0.00	5.91	107.67	2.00	0.00	0.90	0.00
6.07	116.26	0.91	1.13	0.90	0.02	6.23	118.37	0.93	1.09	0.89	0.02
6.40	113.90	0.85	1.15	0.89	0.02	6.56	111.86	0.81	1.53	0.89	0.03
6.73	112.76	0.82	1.51	0.89	0.03	6.89	112.87	2.00	0.00	0.88	0.00
7.05	113.82	2.00	0.00	0.88	0.00	7.22	120.59	2.00	0.00	0.88	0.00
7.38	129.93	2.00	0.00	0.87	0.00	7.55	134.30	1.11	0.40	0.87	0.01
7.71	133.30	1.08	0.40	0.87	0.01	7.87	130.49	1.02	0.60	0.87	0.01
8.04	124.71	2.00	0.00	0.86	0.00	8.20	118.02	2.00	0.00	0.86	0.00
8.37	110.56	2.00	0.00	0.86	0.00	8.53	104.56	2.00	0.00	0.86	0.00
8.69	95.72	2.00	0.00	0.85	0.00	8.86	86.23	2.00	0.00	0.85	0.00
9.02	79.99	2.00	0.00	0.85	0.00	9.19	78.31	2.00	0.00	0.84	0.00
9.35	79.53	2.00	0.00	0.84	0.00	9.51	83.03	2.00	0.00	0.84	0.00
9.68	81.85	2.00	0.00	0.84	0.00	9.84	80.54	2.00	0.00	0.83	0.00
10.01	79.37	2.00	0.00	0.83	0.00	10.17	85.14	2.00	0.00	0.83	0.00
10.33	90.58	2.00	0.00	0.82	0.00	10.50	93.47	2.00	0.00	0.82	0.00
10.66	91.75	2.00	0.00	0.82	0.00	10.83	92.70	2.00	0.00	0.82	0.00
10.99	96.37	2.00	0.00	0.81	0.00	11.15	104.18	2.00	0.00	0.81	0.00
11.32	116.70	2.00	0.00	0.81	0.00	11.48	134.12	2.00	0.00	0.81	0.00
11.65	142.93	2.00	0.00	0.80	0.00	11.81	142.04	1.06	0.35	0.80	0.01
11.98	135.74	0.95	0.53	0.80	0.01	12.14	130.15	0.87	0.84	0.79	0.02
12.30	133.15	0.91	0.81	0.79	0.02	12.47	140.42	1.02	0.51	0.79	0.01
12.63	143.39	1.06	0.34	0.79	0.01	12.80	142.61	1.05	0.50	0.78	0.01
12.96	137.85	0.97	0.51	0.78	0.01	13.12	137.41	0.96	0.51	0.78	0.01
13.29	139.65	0.99	0.50	0.77	0.01	13.45	140.04	0.99	0.50	0.77	0.01
13.62	142.13	1.02	0.49	0.77	0.01	13.78	137.38	0.94	0.75	0.77	0.01
13.94	138.42	0.96	0.50	0.76	0.01	14.11	142.40	1.02	0.48	0.76	0.01
14.27	155.81	1.26	0.16	0.76	0.00	14.44	166.40	1.48	0.00	0.76	0.00
14.60	170.08	1.56	0.00	0.75	0.00	14.76	164.32	1.43	0.00	0.75	0.00
14.93	149.25	1.12	0.32	0.75	0.01	15.09	134.72	0.89	0.75	0.74	0.01
15.26	125.29	0.76	1.08	0.74	0.02	15.42	121.77	0.71	1.37	0.74	0.03
15.58	122.41	0.72	1.36	0.74	0.03	15.75	123.36	0.73	1.34	0.73	0.03
15.91	124.30	0.74	1.32	0.73	0.03	16.08	124.07	0.73	1.32	0.73	0.03
16.24	121.88	0.70	1.35	0.72	0.03	16.40	120.75	0.69	1.36	0.72	0.03
16.57	123.45	0.72	1.31	0.72	0.03	16.73	126.13	0.75	1.04	0.72	0.02
16.90	127.60	0.77	1.02	0.71	0.02	17.06	126.61	0.75	1.02	0.71	0.02
17.22	127.24	0.76	1.01	0.71	0.02	17.39	127.63	0.76	1.00	0.71	0.02
17.55	124.47	0.72	1.27	0.70	0.02	17.72	120.45	0.68	1.32	0.70	0.03
17.88	119.39	0.66	1.33	0.70	0.03	18.04	127.00	0.75	0.99	0.69	0.02
18.21	138.99	0.91	0.67	0.69	0.01	18.37	148.74	1.07	0.29	0.69	0.01
18.54	149.45	1.08	0.29	0.69	0.01	18.70	141.60	0.95	0.64	0.68	0.01
18.86	131.09	0.80	0.93	0.68	0.02	19.03	123.11	0.70	1.24	0.68	0.02
19.19	118.34	0.64	1.37	0.67	0.03	19.36	115.03	0.61	1.40	0.67	0.03
19.52	113.91	0.60	1.41	0.67	0.03	19.69	118.78	0.65	1.35	0.67	0.03
19.85	130.14	0.78	0.92	0.66	0.02	20.01	142.32	0.95	0.42	0.66	0.01
20.18	150.76	1.09	0.28	0.66	0.01	20.34	151.38	1.10	0.28	0.66	0.01
20.51	151.18	1.09	0.27	0.65	0.01	20.67	154.57	1.15	0.19	0.65	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
20.83	158.86	1.23	0.19	0.65	0.00	21.00	158.65	1.23	0.19	0.64	0.00
21.16	158.43	1.22	0.19	0.64	0.00	21.33	165.34	1.36	0.00	0.64	0.00
21.49	183.57	1.77	0.00	0.64	0.00	21.65	195.87	2.00	0.00	0.63	0.00
21.82	211.48	2.00	0.00	0.63	0.00	21.98	230.25	2.00	0.00	0.63	0.00
22.15	247.93	2.00	0.00	0.62	0.00	22.31	259.10	2.00	0.00	0.62	0.00
22.47	264.18	2.00	0.00	0.62	0.00	22.64	265.81	2.00	0.00	0.62	0.00
22.80	263.33	2.00	0.00	0.61	0.00	22.97	245.82	2.00	0.00	0.61	0.00
23.13	221.64	2.00	0.00	0.61	0.00	23.29	194.05	2.00	0.00	0.61	0.00
23.46	181.88	1.72	0.00	0.60	0.00	23.62	174.17	1.54	0.00	0.60	0.00
23.79	170.76	1.46	0.00	0.60	0.00	23.95	166.87	1.38	0.00	0.59	0.00
24.11	163.98	1.32	0.12	0.59	0.00	24.28	161.32	1.26	0.12	0.59	0.00
24.44	159.38	1.23	0.17	0.59	0.00	24.61	156.65	1.18	0.17	0.58	0.00
24.77	155.55	1.15	0.17	0.58	0.00	24.93	155.35	1.15	0.17	0.58	0.00
25.10	155.26	1.15	0.24	0.57	0.00	25.26	153.80	1.12	0.24	0.57	0.00
25.43	148.49	1.03	0.35	0.57	0.01	25.59	144.44	0.97	0.36	0.57	0.01
25.75	139.30	0.89	0.54	0.56	0.01	25.92	134.90	0.83	0.74	0.56	0.01
26.08	129.90	0.76	0.77	0.56	0.02	26.25	124.49	0.69	1.00	0.56	0.02
26.41	124.97	0.70	0.99	0.55	0.02	26.57	129.92	0.76	0.76	0.55	0.02
26.74	143.49	0.95	0.50	0.55	0.01	26.90	161.78	1.27	0.11	0.54	0.00
27.07	181.20	1.69	0.00	0.54	0.00	27.23	192.91	2.00	0.00	0.54	0.00
27.40	190.58	1.94	0.00	0.54	0.00	27.56	174.27	1.53	0.00	0.53	0.00
27.72	152.24	1.09	0.22	0.53	0.00	27.89	128.98	2.00	0.00	0.53	0.00
28.05	107.23	2.00	0.00	0.52	0.00	28.22	94.25	2.00	0.00	0.52	0.00
28.38	92.24	2.00	0.00	0.52	0.00	28.54	95.75	2.00	0.00	0.52	0.00
28.71	82.71	2.00	0.00	0.51	0.00	28.87	71.61	2.00	0.00	0.51	0.00
29.04	70.84	2.00	0.00	0.51	0.00	29.20	68.95	0.30	1.60	0.51	0.03
29.36	70.77	0.30	1.56	0.50	0.03	29.53	78.61	0.33	1.42	0.50	0.03
29.69	86.89	2.00	0.00	0.50	0.00	29.86	93.06	2.00	0.00	0.49	0.00
30.02	106.36	2.00	0.00	0.49	0.00	30.18	118.02	2.00	0.00	0.49	0.00
30.35	130.87	2.00	0.00	0.49	0.00	30.51	132.65	2.00	0.00	0.48	0.00
30.68	141.96	2.00	0.00	0.48	0.00	30.84	185.97	2.00	0.00	0.48	0.00
31.00	251.48	2.00	0.00	0.47	0.00	31.17	293.40	2.00	0.00	0.47	0.00
31.33	322.19	2.00	0.00	0.47	0.00	31.50	338.94	2.00	0.00	0.47	0.00
31.66	347.70	2.00	0.00	0.46	0.00	31.82	352.37	2.00	0.00	0.46	0.00
31.99	354.59	2.00	0.00	0.46	0.00	32.15	358.55	2.00	0.00	0.46	0.00
32.32	361.23	2.00	0.00	0.45	0.00	32.48	356.76	2.00	0.00	0.45	0.00
32.64	350.61	2.00	0.00	0.45	0.00	32.81	343.57	2.00	0.00	0.44	0.00
32.97	347.43	2.00	0.00	0.44	0.00	33.14	354.86	2.00	0.00	0.44	0.00
33.30	364.25	2.00	0.00	0.44	0.00	33.46	372.79	2.00	0.00	0.43	0.00
33.63	368.76	2.00	0.00	0.43	0.00	33.79	364.77	2.00	0.00	0.43	0.00
33.96	356.70	2.00	0.00	0.42	0.00	34.12	348.87	2.00	0.00	0.42	0.00
34.28	339.15	2.00	0.00	0.42	0.00	34.45	336.11	2.00	0.00	0.42	0.00
34.61	330.65	2.00	0.00	0.41	0.00	34.78	324.61	2.00	0.00	0.41	0.00
34.94	313.87	2.00	0.00	0.41	0.00	35.10	302.98	2.00	0.00	0.41	0.00
35.27	291.09	2.00	0.00	0.40	0.00	35.43	287.15	2.00	0.00	0.40	0.00
35.60	283.38	2.00	0.00	0.40	0.00	35.76	287.39	2.00	0.00	0.39	0.00
35.93	285.00	2.00	0.00	0.39	0.00	36.09	280.66	2.00	0.00	0.39	0.00
36.25	274.94	2.00	0.00	0.39	0.00	36.42	266.35	2.00	0.00	0.38	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
36.58	261.68	2.00	0.00	0.38	0.00	36.75	255.52	2.00	0.00	0.38	0.00
36.91	255.62	2.00	0.00	0.37	0.00	37.07	251.11	2.00	0.00	0.37	0.00
37.24	243.79	2.00	0.00	0.37	0.00	37.40	230.86	2.00	0.00	0.37	0.00
37.57	212.80	2.00	0.00	0.36	0.00	37.73	189.37	1.91	0.00	0.36	0.00
37.89	160.15	1.24	0.10	0.36	0.00	38.06	133.60	0.81	0.47	0.35	0.01
38.22	111.34	0.56	0.75	0.35	0.01	38.39	105.58	0.51	0.78	0.35	0.02
38.55	102.45	0.48	0.79	0.35	0.02	38.71	111.44	0.56	0.74	0.34	0.01
38.88	141.89	0.93	0.32	0.34	0.01	39.04	181.72	1.72	0.00	0.34	0.00
39.21	211.74	2.00	0.00	0.34	0.00	39.37	229.05	2.00	0.00	0.33	0.00
39.53	237.00	2.00	0.00	0.33	0.00	39.70	238.43	2.00	0.00	0.33	0.00
39.86	240.08	2.00	0.00	0.32	0.00	40.03	241.12	2.00	0.00	0.32	0.00
40.19	249.40	2.00	0.00	0.32	0.00	40.35	264.02	2.00	0.00	0.32	0.00
40.52	283.00	2.00	0.00	0.31	0.00	40.68	303.81	2.00	0.00	0.31	0.00
40.85	319.92	2.00	0.00	0.31	0.00	41.01	330.11	2.00	0.00	0.30	0.00
41.17	336.02	2.00	0.00	0.30	0.00	41.34	337.19	2.00	0.00	0.30	0.00
41.50	337.79	2.00	0.00	0.30	0.00	41.67	338.23	2.00	0.00	0.29	0.00
41.83	337.86	2.00	0.00	0.29	0.00	41.99	334.76	2.00	0.00	0.29	0.00
42.16	324.08	2.00	0.00	0.29	0.00	42.32	317.48	2.00	0.00	0.28	0.00
42.49	308.43	2.00	0.00	0.28	0.00	42.65	309.74	2.00	0.00	0.28	0.00
42.81	307.08	2.00	0.00	0.27	0.00	42.98	307.42	2.00	0.00	0.27	0.00
43.14	304.82	2.00	0.00	0.27	0.00	43.31	297.58	2.00	0.00	0.27	0.00
43.47	291.51	2.00	0.00	0.26	0.00	43.64	279.69	2.00	0.00	0.26	0.00
43.80	274.83	2.00	0.00	0.26	0.00	43.96	268.82	2.00	0.00	0.25	0.00
44.13	266.76	2.00	0.00	0.25	0.00	44.29	263.22	2.00	0.00	0.25	0.00
44.46	258.26	2.00	0.00	0.25	0.00	44.62	251.91	2.00	0.00	0.24	0.00
44.78	242.73	2.00	0.00	0.24	0.00	44.95	233.10	2.00	0.00	0.24	0.00
45.11	223.58	2.00	0.00	0.24	0.00	45.28	212.87	2.00	0.00	0.23	0.00
45.44	200.50	2.00	0.00	0.23	0.00	45.60	185.65	1.88	0.00	0.23	0.00
45.77	169.85	1.49	0.00	0.22	0.00	45.93	152.85	1.15	0.07	0.22	0.00
46.10	136.35	0.88	0.22	0.22	0.00	46.26	121.11	0.69	0.40	0.22	0.01
46.42	112.27	0.59	0.45	0.21	0.01	46.59	106.18	0.54	0.47	0.21	0.01
46.75	104.77	0.52	0.47	0.21	0.01	46.92	103.23	0.51	0.47	0.20	0.01
47.08	104.42	0.52	0.46	0.20	0.01	47.24	106.98	0.55	0.44	0.20	0.01
47.41	109.70	0.57	0.43	0.20	0.01	47.57	111.46	0.59	0.41	0.19	0.01
47.74	115.90	0.63	0.40	0.19	0.01	47.90	125.35	0.74	0.34	0.19	0.01
48.06	136.64	0.90	0.18	0.19	0.00	48.23	142.02	0.98	0.12	0.18	0.00
48.39	140.00	0.95	0.12	0.18	0.00	48.56	135.29	0.88	0.18	0.18	0.00
48.72	129.11	0.80	0.24	0.17	0.00	48.88	124.96	0.74	0.31	0.17	0.01
49.05	122.33	0.71	0.31	0.17	0.01	49.21	124.48	0.74	0.30	0.17	0.01
49.38	128.68	0.79	0.23	0.16	0.00	49.54	132.63	0.85	0.22	0.16	0.00
49.70	134.70	0.88	0.16	0.16	0.00	49.87	134.73	0.88	0.16	0.15	0.00
50.03	131.41	0.84	0.21	0.15	0.00						

Total estimated settlement: 1.49

Abbreviations

$Q_{tn,cs}$:	Equivalent clean sand normalized cone resistance
FS:	Factor of safety against liquefaction
e_v (%):	Post-liquefaction volumentric strain
DF:	e_v depth weighting factor
Settlement:	Calculated settlement

Landmark Consultants, Inc.
780 N. 4th Street
El Centro, CA 92243

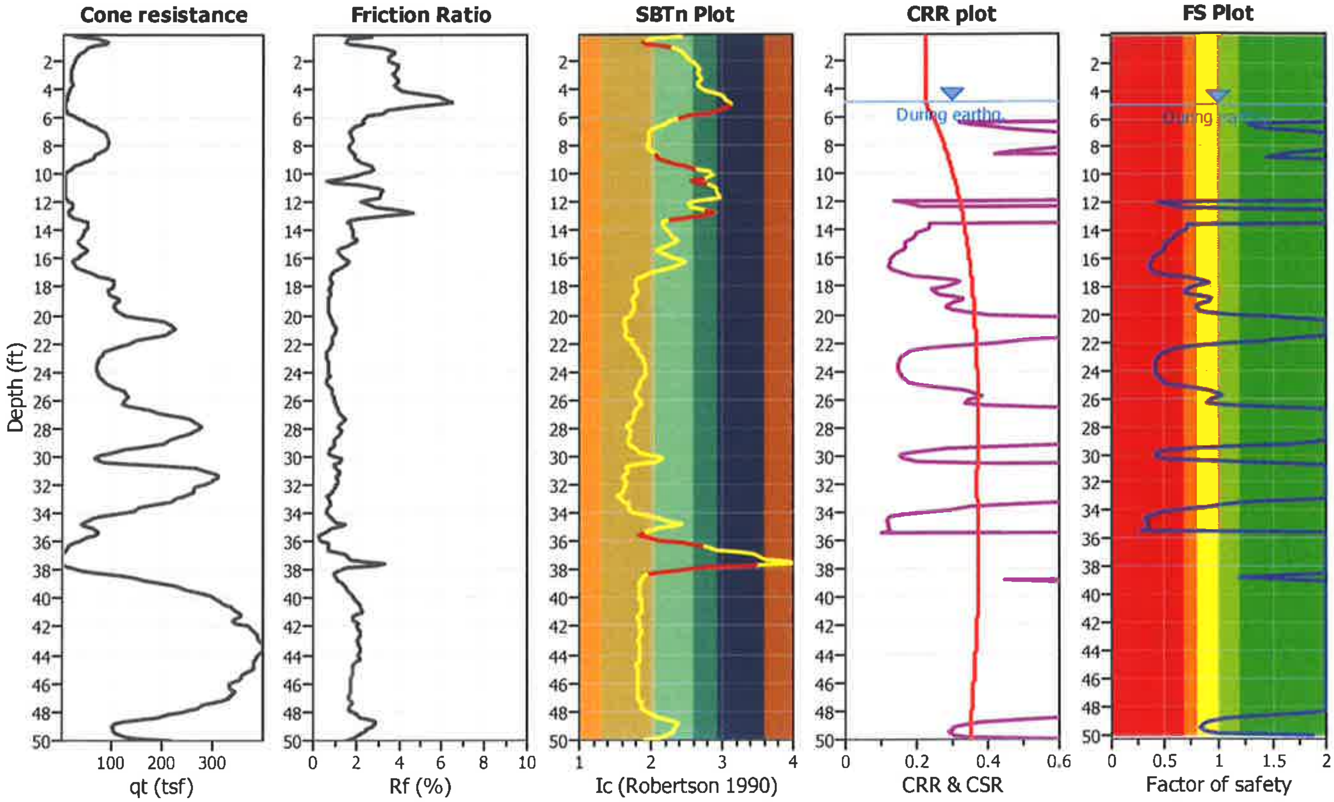
LIQUEFACTION ANALYSIS REPORT

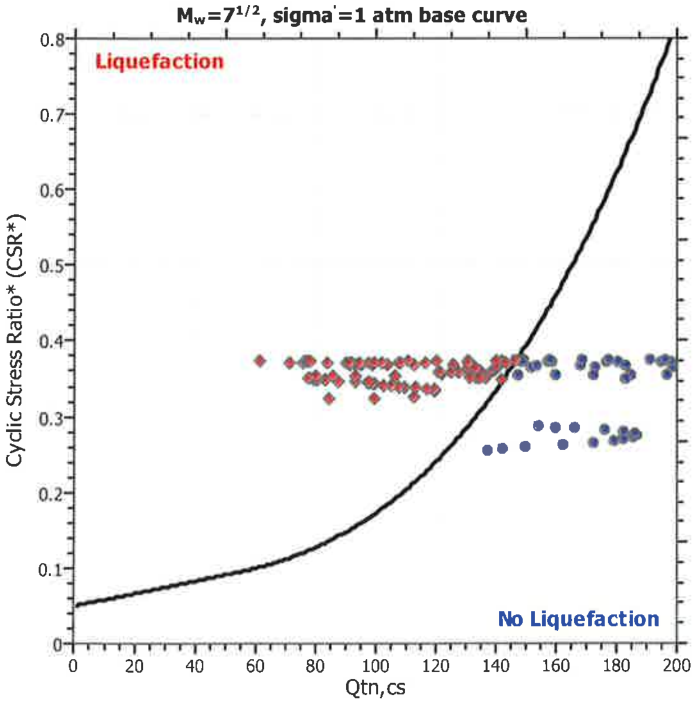
Project title : Public Safety Facility **Location : 518 Railroad Avenue - Winterhaven, CA**

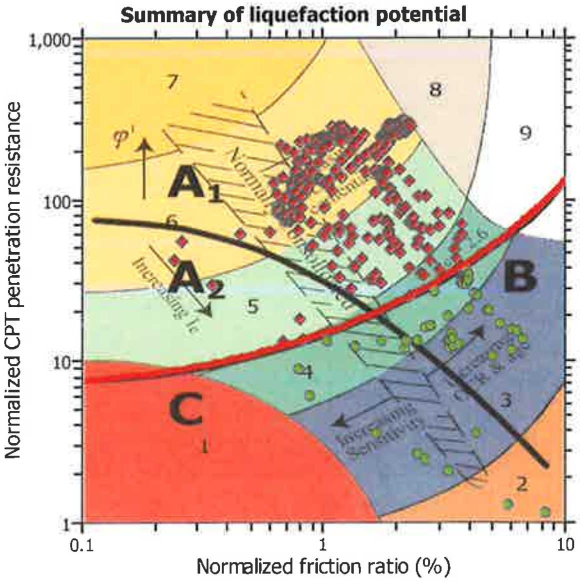
CPT file : CPT-2

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	7.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	5.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.00	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.32	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

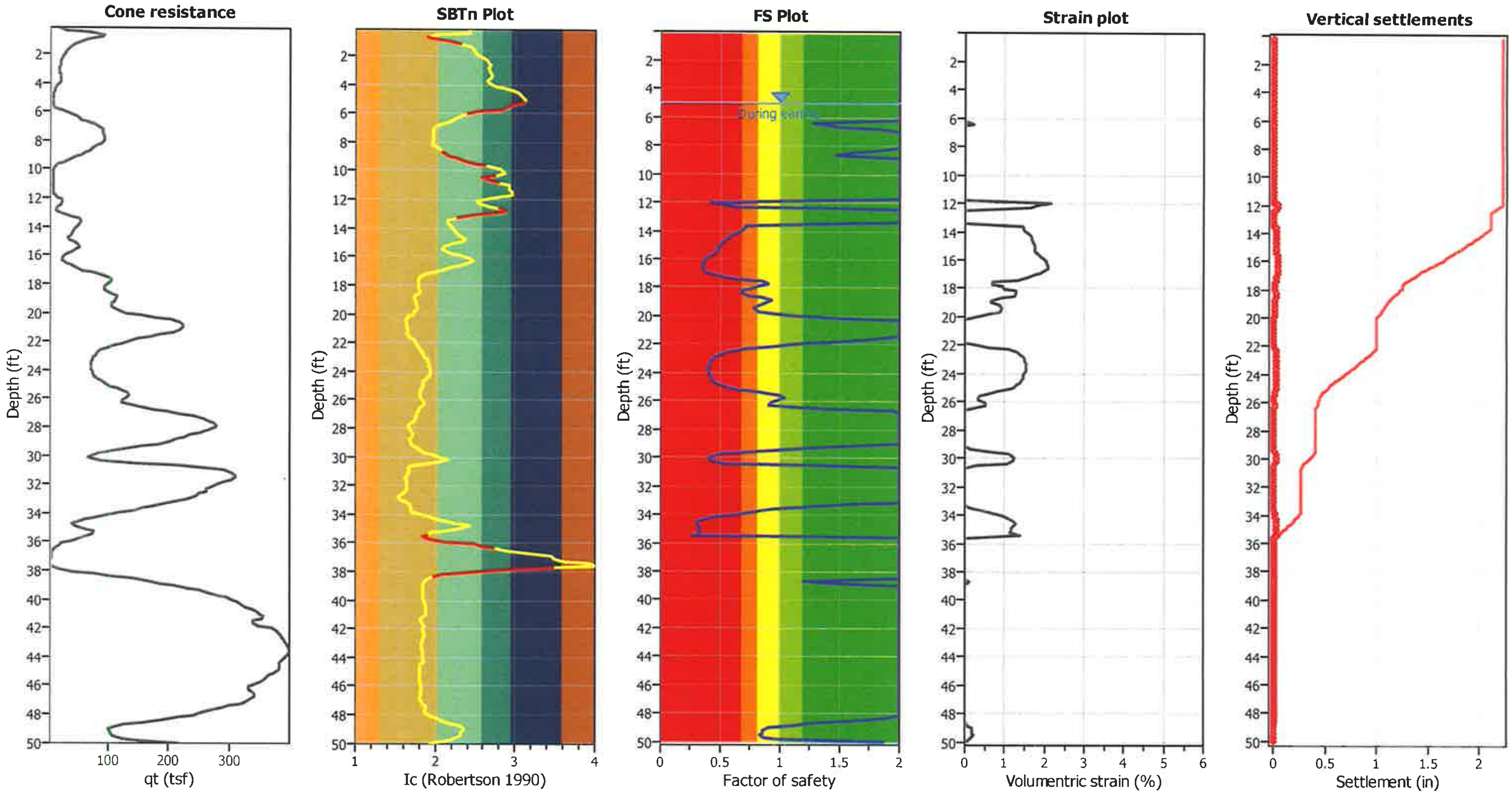






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

Estimation of post-earthquake settlements



Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

:: Post-earthquake settlement due to soil liquefaction ::

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
5.09	96.75	2.00	0.00	0.91	0.00	5.25	85.33	2.00	0.00	0.91	0.00
5.41	80.21	2.00	0.00	0.91	0.00	5.58	83.00	2.00	0.00	0.91	0.00
5.74	89.67	2.00	0.00	0.90	0.00	5.91	100.54	2.00	0.00	0.90	0.00
6.07	115.64	2.00	0.00	0.90	0.00	6.23	129.50	2.00	0.00	0.89	0.00
6.40	137.72	1.27	0.21	0.89	0.00	6.56	142.30	1.36	0.00	0.89	0.00
6.73	150.31	1.53	0.00	0.89	0.00	6.89	162.71	1.83	0.00	0.88	0.00
7.05	172.65	2.00	0.00	0.88	0.00	7.22	179.33	2.00	0.00	0.88	0.00
7.38	182.61	2.00	0.00	0.87	0.00	7.55	185.66	2.00	0.00	0.87	0.00
7.71	186.89	2.00	0.00	0.87	0.00	7.87	186.53	2.00	0.00	0.87	0.00
8.04	182.27	2.00	0.00	0.86	0.00	8.20	176.06	2.00	0.00	0.86	0.00
8.37	166.53	1.80	0.00	0.86	0.00	8.53	159.92	1.61	0.00	0.86	0.00
8.69	154.15	1.46	0.00	0.85	0.00	8.86	147.33	2.00	0.00	0.85	0.00
9.02	137.81	2.00	0.00	0.85	0.00	9.19	129.14	2.00	0.00	0.84	0.00
9.35	121.34	2.00	0.00	0.84	0.00	9.51	111.72	2.00	0.00	0.84	0.00
9.68	96.72	2.00	0.00	0.84	0.00	9.84	79.61	2.00	0.00	0.83	0.00
10.01	68.85	2.00	0.00	0.83	0.00	10.17	62.58	2.00	0.00	0.83	0.00
10.33	52.48	2.00	0.00	0.82	0.00	10.50	41.87	2.00	0.00	0.82	0.00
10.66	48.91	2.00	0.00	0.82	0.00	10.83	66.21	2.00	0.00	0.82	0.00
10.99	78.14	2.00	0.00	0.81	0.00	11.15	81.00	2.00	0.00	0.81	0.00
11.32	78.74	2.00	0.00	0.81	0.00	11.48	77.61	2.00	0.00	0.81	0.00
11.65	75.43	2.00	0.00	0.80	0.00	11.81	76.74	2.00	0.00	0.80	0.00
11.98	84.23	0.42	2.14	0.80	0.04	12.14	99.46	0.53	1.86	0.79	0.04
12.30	112.32	0.65	1.65	0.79	0.03	12.47	118.85	2.00	0.00	0.79	0.00
12.63	116.77	2.00	0.00	0.79	0.00	12.80	112.40	2.00	0.00	0.78	0.00
12.96	104.08	2.00	0.00	0.78	0.00	13.12	98.20	2.00	0.00	0.78	0.00
13.29	101.69	2.00	0.00	0.77	0.00	13.45	113.31	2.00	0.00	0.77	0.00
13.62	119.08	0.71	1.48	0.77	0.03	13.78	119.49	0.71	1.46	0.77	0.03
13.94	117.02	0.68	1.50	0.76	0.03	14.11	113.06	0.63	1.61	0.76	0.03
14.27	109.64	0.60	1.64	0.76	0.03	14.44	107.36	0.57	1.67	0.76	0.03
14.60	105.28	0.55	1.69	0.75	0.03	14.76	102.21	0.52	1.72	0.75	0.03
14.93	99.26	0.50	1.76	0.75	0.03	15.09	97.68	0.48	1.77	0.74	0.03
15.26	98.65	0.49	1.75	0.74	0.03	15.42	97.30	0.48	1.77	0.74	0.03
15.58	92.90	0.45	1.83	0.74	0.04	15.75	87.21	0.41	1.92	0.73	0.04
15.91	82.91	0.38	1.99	0.73	0.04	16.08	80.47	0.37	2.03	0.73	0.04
16.24	79.18	0.36	2.05	0.72	0.04	16.40	77.82	0.35	2.07	0.72	0.04
16.57	77.37	0.35	2.07	0.72	0.04	16.73	80.12	0.36	2.01	0.72	0.04
16.90	85.70	0.39	1.89	0.71	0.04	17.06	93.02	0.44	1.76	0.71	0.03
17.22	106.10	0.54	1.58	0.71	0.03	17.39	121.84	0.70	1.31	0.71	0.03
17.55	134.21	0.86	0.71	0.70	0.01	17.72	137.72	0.91	0.68	0.70	0.01
17.88	132.68	0.83	0.94	0.70	0.02	18.04	127.50	0.76	0.99	0.69	0.02
18.21	120.87	0.68	1.30	0.69	0.03	18.37	121.01	0.68	1.29	0.69	0.03
18.54	124.86	0.73	1.23	0.69	0.02	18.70	134.15	0.85	0.90	0.68	0.02
18.86	139.58	0.92	0.65	0.68	0.01	19.03	138.60	0.91	0.66	0.68	0.01
19.19	134.21	0.84	0.89	0.67	0.02	19.36	130.10	0.79	0.93	0.67	0.02
19.52	130.36	0.79	0.92	0.67	0.02	19.69	132.83	0.82	0.89	0.67	0.02
19.85	139.72	0.92	0.63	0.66	0.01	20.01	152.08	1.12	0.28	0.66	0.01
20.18	173.29	1.55	0.00	0.66	0.00	20.34	198.89	2.00	0.00	0.66	0.00
20.51	225.68	2.00	0.00	0.65	0.00	20.67	239.87	2.00	0.00	0.65	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
20.83	244.67	2.00	0.00	0.65	0.00	21.00	245.14	2.00	0.00	0.64	0.00
21.16	239.96	2.00	0.00	0.64	0.00	21.33	223.86	2.00	0.00	0.64	0.00
21.49	204.65	2.00	0.00	0.64	0.00	21.65	182.87	1.77	0.00	0.63	0.00
21.82	168.32	1.43	0.00	0.63	0.00	21.98	153.85	1.14	0.26	0.63	0.01
22.15	139.78	0.91	0.60	0.62	0.01	22.31	125.32	0.72	1.11	0.62	0.02
22.47	112.40	0.58	1.31	0.62	0.03	22.64	103.61	0.50	1.40	0.62	0.03
22.80	98.54	0.46	1.45	0.61	0.03	22.97	95.20	0.43	1.49	0.61	0.03
23.13	93.10	0.42	1.51	0.61	0.03	23.29	91.48	0.41	1.52	0.61	0.03
23.46	90.73	0.40	1.52	0.60	0.03	23.62	90.04	0.40	1.53	0.60	0.03
23.79	89.84	0.40	1.52	0.60	0.03	23.95	90.47	0.40	1.51	0.59	0.03
24.11	92.18	0.41	1.48	0.59	0.03	24.28	94.08	0.42	1.45	0.59	0.03
24.44	94.35	0.43	1.44	0.59	0.03	24.61	97.63	0.45	1.39	0.58	0.03
24.77	102.16	0.48	1.33	0.58	0.03	24.93	110.39	0.55	1.24	0.58	0.02
25.10	119.70	0.64	1.16	0.57	0.02	25.26	130.44	0.77	0.79	0.57	0.02
25.43	139.93	0.90	0.54	0.57	0.01	25.59	146.10	0.99	0.35	0.57	0.01
25.75	148.86	1.04	0.34	0.56	0.01	25.92	146.93	1.00	0.35	0.56	0.01
26.08	142.13	0.93	0.52	0.56	0.01	26.25	140.08	0.90	0.53	0.56	0.01
26.41	149.69	1.05	0.34	0.55	0.01	26.57	168.84	1.41	0.00	0.55	0.00
26.74	191.07	1.95	0.00	0.55	0.00	26.90	212.11	2.00	0.00	0.54	0.00
27.07	233.27	2.00	0.00	0.54	0.00	27.23	253.45	2.00	0.00	0.54	0.00
27.40	269.75	2.00	0.00	0.54	0.00	27.56	273.39	2.00	0.00	0.53	0.00
27.72	274.78	2.00	0.00	0.53	0.00	27.89	272.93	2.00	0.00	0.53	0.00
28.05	273.46	2.00	0.00	0.52	0.00	28.22	265.85	2.00	0.00	0.52	0.00
28.38	252.26	2.00	0.00	0.52	0.00	28.54	236.17	2.00	0.00	0.52	0.00
28.71	222.37	2.00	0.00	0.51	0.00	28.87	209.70	2.00	0.00	0.51	0.00
29.04	198.17	2.00	0.00	0.51	0.00	29.20	180.80	1.69	0.00	0.51	0.00
29.36	157.71	1.20	0.15	0.50	0.00	29.53	131.11	0.78	0.68	0.50	0.01
29.69	107.64	0.53	1.09	0.50	0.02	29.86	94.65	0.43	1.21	0.49	0.02
30.02	91.52	0.41	1.23	0.49	0.02	30.18	94.32	0.43	1.20	0.49	0.02
30.35	108.12	0.53	1.06	0.49	0.02	30.51	148.96	1.04	0.29	0.48	0.01
30.68	204.01	2.00	0.00	0.48	0.00	30.84	247.89	2.00	0.00	0.48	0.00
31.00	273.68	2.00	0.00	0.47	0.00	31.17	281.60	2.00	0.00	0.47	0.00
31.33	284.55	2.00	0.00	0.47	0.00	31.50	283.73	2.00	0.00	0.47	0.00
31.66	277.61	2.00	0.00	0.46	0.00	31.82	266.85	2.00	0.00	0.46	0.00
31.99	255.14	2.00	0.00	0.46	0.00	32.15	243.13	2.00	0.00	0.46	0.00
32.32	237.25	2.00	0.00	0.45	0.00	32.48	235.29	2.00	0.00	0.45	0.00
32.64	225.78	2.00	0.00	0.45	0.00	32.81	218.84	2.00	0.00	0.44	0.00
32.97	206.32	2.00	0.00	0.44	0.00	33.14	195.18	2.00	0.00	0.44	0.00
33.30	176.68	1.60	0.00	0.44	0.00	33.46	158.73	1.22	0.13	0.43	0.00
33.63	143.31	0.95	0.27	0.43	0.01	33.79	130.86	0.78	0.59	0.43	0.01
33.96	116.12	0.61	0.88	0.42	0.02	34.12	99.53	0.46	0.99	0.42	0.02
34.28	83.46	0.36	1.14	0.42	0.02	34.45	75.53	0.32	1.22	0.42	0.02
34.61	71.24	0.30	1.28	0.41	0.03	34.78	76.29	0.33	1.20	0.41	0.02
34.94	76.97	0.33	1.18	0.41	0.02	35.10	77.53	0.33	1.17	0.41	0.02
35.27	78.23	0.33	1.15	0.40	0.02	35.43	61.05	0.27	1.40	0.40	0.03
35.60	54.70	2.00	0.00	0.40	0.00	35.76	42.20	2.00	0.00	0.39	0.00
35.93	29.86	2.00	0.00	0.39	0.00	36.09	48.40	2.00	0.00	0.39	0.00
36.25	45.16	2.00	0.00	0.39	0.00	36.42	39.67	2.00	0.00	0.38	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

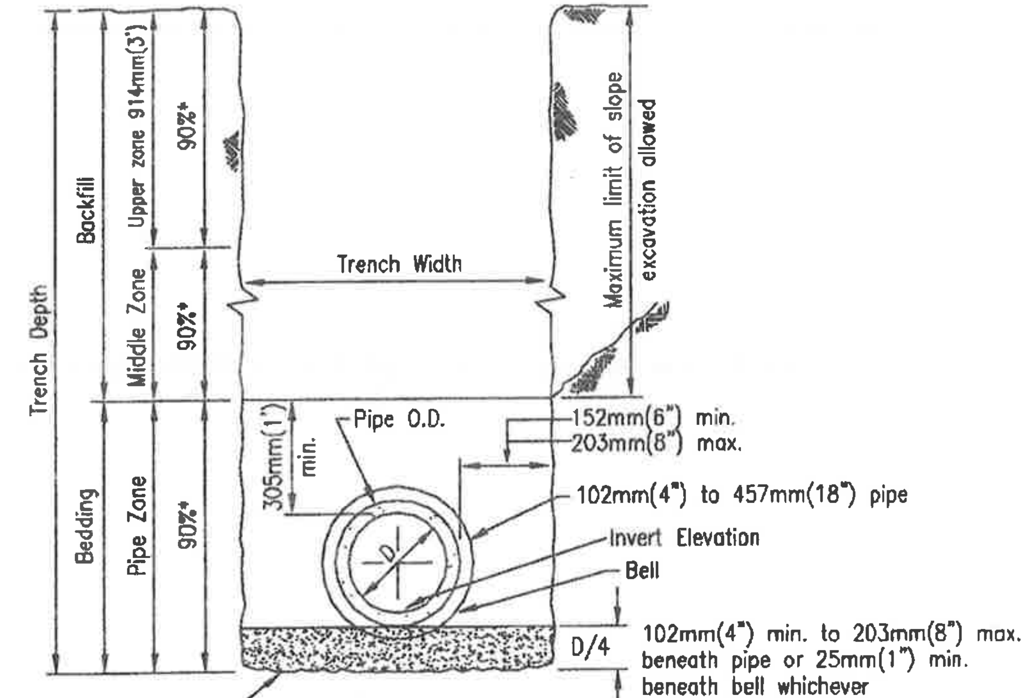
Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
36.58	36.21	2.00	0.00	0.38	0.00	36.75	35.57	2.00	0.00	0.38	0.00
36.91	34.73	2.00	0.00	0.37	0.00	37.07	34.07	2.00	0.00	0.37	0.00
37.24	32.98	2.00	0.00	0.37	0.00	37.40	28.83	2.00	0.00	0.37	0.00
37.57	29.66	2.00	0.00	0.36	0.00	37.73	47.18	2.00	0.00	0.36	0.00
37.89	59.85	2.00	0.00	0.36	0.00	38.06	68.78	2.00	0.00	0.35	0.00
38.22	85.96	2.00	0.00	0.35	0.00	38.39	110.38	2.00	0.00	0.35	0.00
38.55	134.68	2.00	0.00	0.35	0.00	38.71	157.98	1.19	0.10	0.34	0.00
38.88	177.40	1.60	0.00	0.34	0.00	39.04	196.46	2.00	0.00	0.34	0.00
39.21	214.86	2.00	0.00	0.34	0.00	39.37	232.60	2.00	0.00	0.33	0.00
39.53	247.96	2.00	0.00	0.33	0.00	39.70	262.39	2.00	0.00	0.33	0.00
39.86	275.83	2.00	0.00	0.32	0.00	40.03	286.63	2.00	0.00	0.32	0.00
40.19	294.05	2.00	0.00	0.32	0.00	40.35	301.20	2.00	0.00	0.32	0.00
40.52	308.25	2.00	0.00	0.31	0.00	40.68	316.56	2.00	0.00	0.31	0.00
40.85	324.70	2.00	0.00	0.31	0.00	41.01	330.39	2.00	0.00	0.30	0.00
41.17	323.75	2.00	0.00	0.30	0.00	41.34	316.63	2.00	0.00	0.30	0.00
41.50	302.98	2.00	0.00	0.30	0.00	41.67	308.94	2.00	0.00	0.29	0.00
41.83	316.60	2.00	0.00	0.29	0.00	41.99	332.54	2.00	0.00	0.29	0.00
42.16	339.93	2.00	0.00	0.29	0.00	42.32	344.70	2.00	0.00	0.28	0.00
42.49	347.50	2.00	0.00	0.28	0.00	42.65	346.88	2.00	0.00	0.28	0.00
42.81	344.68	2.00	0.00	0.27	0.00	42.98	344.49	2.00	0.00	0.27	0.00
43.14	346.45	2.00	0.00	0.27	0.00	43.31	349.53	2.00	0.00	0.27	0.00
43.47	351.52	2.00	0.00	0.26	0.00	43.64	351.55	2.00	0.00	0.26	0.00
43.80	349.38	2.00	0.00	0.26	0.00	43.96	344.48	2.00	0.00	0.25	0.00
44.13	340.72	2.00	0.00	0.25	0.00	44.29	336.40	2.00	0.00	0.25	0.00
44.46	330.22	2.00	0.00	0.25	0.00	44.62	326.10	2.00	0.00	0.24	0.00
44.78	322.65	2.00	0.00	0.24	0.00	44.95	321.38	2.00	0.00	0.24	0.00
45.11	315.09	2.00	0.00	0.24	0.00	45.28	309.09	2.00	0.00	0.23	0.00
45.44	303.16	2.00	0.00	0.23	0.00	45.60	298.91	2.00	0.00	0.23	0.00
45.77	293.67	2.00	0.00	0.22	0.00	45.93	285.46	2.00	0.00	0.22	0.00
46.10	278.53	2.00	0.00	0.22	0.00	46.26	276.98	2.00	0.00	0.22	0.00
46.42	281.02	2.00	0.00	0.21	0.00	46.59	284.59	2.00	0.00	0.21	0.00
46.75	282.46	2.00	0.00	0.21	0.00	46.92	278.16	2.00	0.00	0.20	0.00
47.08	272.43	2.00	0.00	0.20	0.00	47.24	265.35	2.00	0.00	0.20	0.00
47.41	254.94	2.00	0.00	0.20	0.00	47.57	238.60	2.00	0.00	0.19	0.00
47.74	227.19	2.00	0.00	0.19	0.00	47.90	213.48	2.00	0.00	0.19	0.00
48.06	208.93	2.00	0.00	0.19	0.00	48.23	197.12	2.00	0.00	0.18	0.00
48.39	184.76	1.88	0.00	0.18	0.00	48.56	172.58	1.58	0.00	0.18	0.00
48.72	159.75	1.30	0.04	0.17	0.00	48.88	147.52	1.07	0.07	0.17	0.00
49.05	136.40	0.90	0.17	0.17	0.00	49.21	133.37	0.85	0.17	0.17	0.00
49.38	133.00	0.85	0.17	0.16	0.00	49.54	131.26	0.83	0.22	0.16	0.00
49.70	134.25	0.87	0.16	0.16	0.00	49.87	141.78	0.99	0.10	0.15	0.00
50.03	183.37	1.87	0.00	0.15	0.00						

Total estimated settlement: 2.22

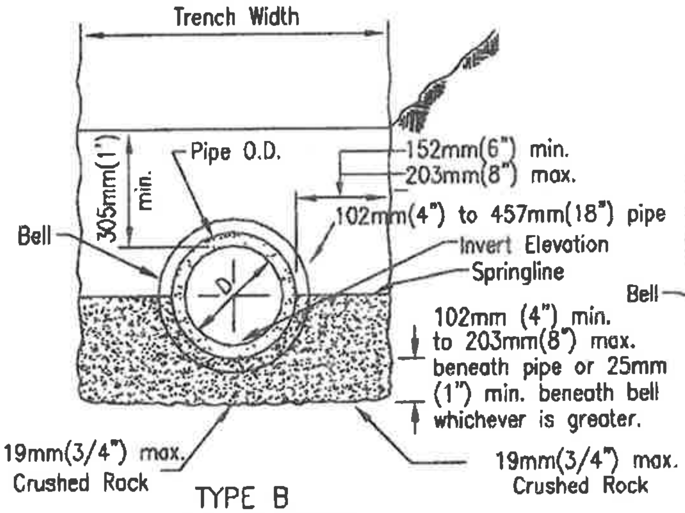
Abbreviations

$Q_{tn,cs}$:	Equivalent clean sand normalized cone resistance
FS:	Factor of safety against liquefaction
e_v (%):	Post-liquefaction volumentric strain
DF:	e_v depth weighting factor
Settlement:	Calculated settlement

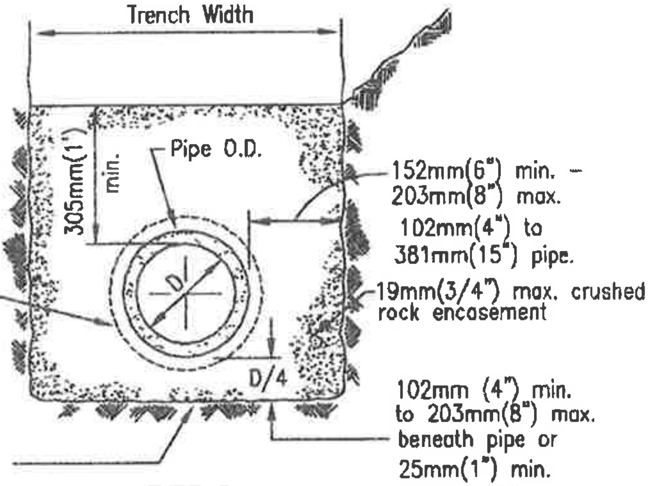
APPENDIX E



TYPE A
STANDARD INSTALLATION



TYPE B
ROCK TO SPRINGLINE



TYPE C
ROCK ENVELOPE

NOTES

1. For trenching in improved streets, see Standard Drawings G-24 or G-25 for trench resurfacing.
2. (*) indicates minimum relative compaction.
3. Minimum depth of cover from the top of pipe to finish grade for all sanitary sewer installations shall be 914mm(3') For cover less tnan 914mm(3'), see Standard Drawing S-7 for concrete encasement.
4. See Type A installation for details not shown for Types B and C.

LANDMARK
Geo-Engineers and Geologists

Project No.: LE15031

Pipe Bedding and Trench Backfill Recommendations

Plate E-1

APPENDIX F

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