GEOTECHNICAL INVESTIGATION
BANNING MDP LINE D-2 AND LINE D-2A
[Project No. 5-0-00169]
HARGRAVE STREET AND THEODORE STREET
BANNING, CALIFORNIA

PREPARED FOR:

Attention: Kyle W. Gallup, P.E.,
Senior Civil Engineer
RIVERSIDE COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
1995 Market Street
Riverside, California 92501

PREPARED BY:

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May 22, 2014
Project No.: R206-017

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May 22, 2014
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Attention: Kyle W. Gallup, P.E., Senior Civil Engineer
RIVERSIDE COUNTY FLOOD CONTROL AND
WATER CONSERVATION DISTRICT
1995 Market Street
Riverside, California 92501

Re: Geotechnical Investigation
Banning MDP Line D-2 and Line D-2A [Project No. 5-0-00169]
Hargrave Street and Theodore Street, Banning, California

Dear Mr. Gallup:

We are pleased to submit this geotechnical investigation report prepared for the referenced project. This investigation was conducted in general accordance with our proposal dated March 5, 2014.

The results of our investigation indicate that the proposed storm drain project is feasible from a geotechnical engineering standpoint. Our report includes design recommendations along with the field and laboratory data.

We appreciate the opportunity of being of service to the District on this project. If there are any questions, please contact our office.

Respectfully,
INLAND FOUNDATION ENGINEERING, INC.

Daniel R. Lind, Project Geologist
P.G. 7581/C.E.G. 2451

PROFESSIONAL GEOLOGIST · STATE OF CALIFORNIA

REGISTERED GEOTECHNICAL ENGINEER · ALLEN D. EVANS · No. 2060 · Exp. 03-31-15 · STATE OF CALIFORNIA

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I. SCOPE OF SERVICES

This geotechnical investigation was conducted to evaluate engineering characteristics of the subsoil conditions and to develop recommendations for the design of the Riverside County Flood Control and Water Conservation District's Banning MDP Line D-2 & Line D-2A Storm Drains [Project No. 5-0-00169]. Our investigation included field exploration, laboratory testing, engineering analysis and the preparation of this report. Our investigation was performed in accordance with our proposal dated March 15, 2014. Preliminary alignment and profile plans entitled "Banning MDP Line D-2 & Line D-2A", prepared by Riverside County Flood Control and Water Conservation District, were provided as a reference during this study.

Limitations: Our investigation was conducted for Riverside County Flood Control and Water Conservation District for their use in the design and construction of the proposed storm drain. This report may only be used by Riverside County Flood Control and Water Conservation District for these purposes. The use of this report by parties other than Riverside County Flood Control and Water Conservation District or for other purposes is not authorized without written permission by Inland Foundation Engineering, Inc. Inland Foundation Engineering, Inc. will not be liable for any projects connected with the unauthorized use of this report.

Scope of Services: The purpose of the geotechnical investigation was to provide geotechnical parameters for design and construction of the proposed project. The scope of the geotechnical investigation included:

- A review of the general geologic conditions and specific subsurface conditions of the project alignments.
- An evaluation of the engineering and geologic data collected for the project.
- Preparation of this report providing geotechnical conclusions and recommendations for design and construction.

The tasks performed in order to achieve these objectives included:

- The collection and review of data in order to develop an exploration program.
- Subsurface exploration to evaluate the nature and stratigraphy of the subsurface soils and to obtain representative samples for laboratory testing.
- A visual reconnaissance of the site and surrounding area to ascertain the existence of unstable or adverse geologic conditions.

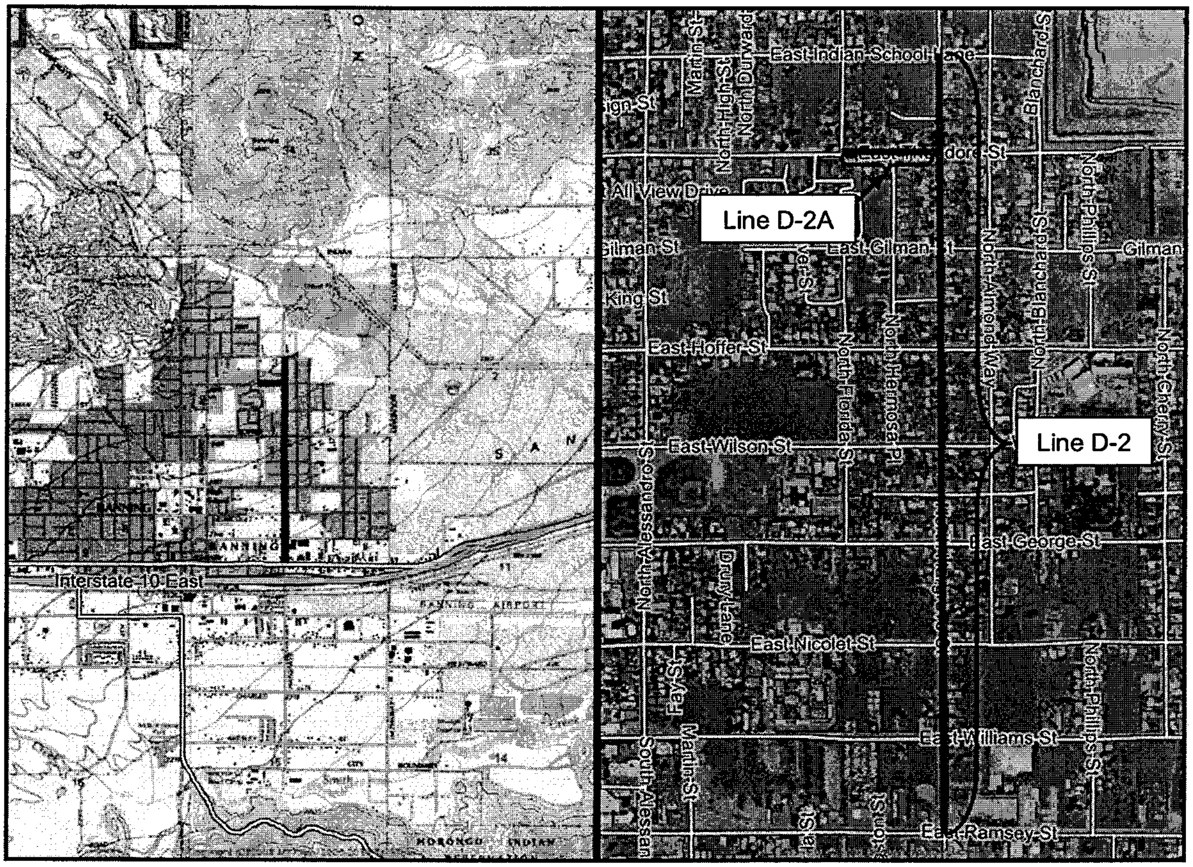
- Laboratory testing of representative samples in order to establish the classification and engineering properties of the soils.

- Analysis of the data collected and the preparation of this report presenting our geotechnical conclusions and recommendations.

The information in this report represents professional opinions that have been developed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical consultants practicing in this or similar localities. No other warranty, either expressed or implied, is made as to the professional advice included in this report.

II. PROJECT DESCRIPTION

The project consists of the proposed construction of underground storm drains (Line D-2 and Line D-2A) in the City of Banning, California. The proposed Line D-2 storm drain will be located along Hargrave Street, between Ramsey Street and Indian School Lane. The Line D-2A storm drain will be located along Theodore Street, between Hargrave Street and Florida Street.



U.S.G.S. Topography Map, Cabazon 7.5' Quadrangle, and Aerial Photograph (2010)

Proposed Improvements: The project under consideration consists of the construction of approximately 215 lineal feet of 8' wide by 4' high reinforced concrete box (RCB), and approximately 5,750 lineal feet of 30" to 60" reinforced concrete pipe (RCP). Preliminary project plans prepared by the District indicate that the cover depth over the storm drain ranges from approximately 2 to 8 feet. The planned invert depth of the storm drain ranges from approximately 5 to 15 feet below the existing ground surface.

Line D-2: The Line D-2 storm drain will be located along Hargrave Street, between Ramsey Street and Indian School Lane. This storm drain will include RCB and RCP. The 8' wide by 4' high RCB is to be constructed within Hargrave Street, extending from Ramsey Street north approximately 215 feet. A transition from the reinforced concrete box to a reinforced concrete pipe occurs between Stations 12+20 and 12+50. The RCP extends northerly along Hargrave Street to Indian School Lane. The reinforced concrete pipe along Line D-2 varies in dimension from 60" to 42". The planned excavation depth of Line D-2 ranges from approximately 12 to 15 feet below the existing ground surface. The topography along Line D-2 may be described as relatively planar and sloping to the south. Existing ground elevations along this segment range from an approximate high elevation of ±2492' above mean seal level (msl) at the north end of Line D-2 (Sta. 63+06) to a low elevation of approximately ±2304' above msl at Ramsey Street (Sta. 10+06). The ground surface slopes to the south at a gradient of approximately 3.5 percent.

Line D-2A: The Line D-2A storm drain will be located along Theodore Street, between Hargrave Street and Florida Street. The length of this line is approximately 677 lineal feet. This storm drain line will be constructed with 30" diameter RCP. The planned excavation depth of Line D-2A ranges from approximately 8 to 12 feet below the existing ground surface. The topography along Line D-2A may be described as planar and slightly sloping to the east. Existing ground elevations along this segment range from an approximate high elevation of ±2482' above mean seal level (msl) at the west end of Line D-2A (Sta. 10+00) to a low elevation of approximately ±2466' above msl at Hargrave Street (Sta. 16+77). The ground surface slopes to the east at a gradient of approximately two percent.

Hargrave Street and Theodore Street are both paved with asphalt concrete. The thickness of the structural section at each of the boring locations is shown on the boring logs. Both alignments are bounded predominately by single-family residences.

Project plans indicate numerous existing underground utilities in close proximity to the proposed storm drain at various locations. These include, but may not be limited to, water, sewer, electric, gas, and telephone utilities.

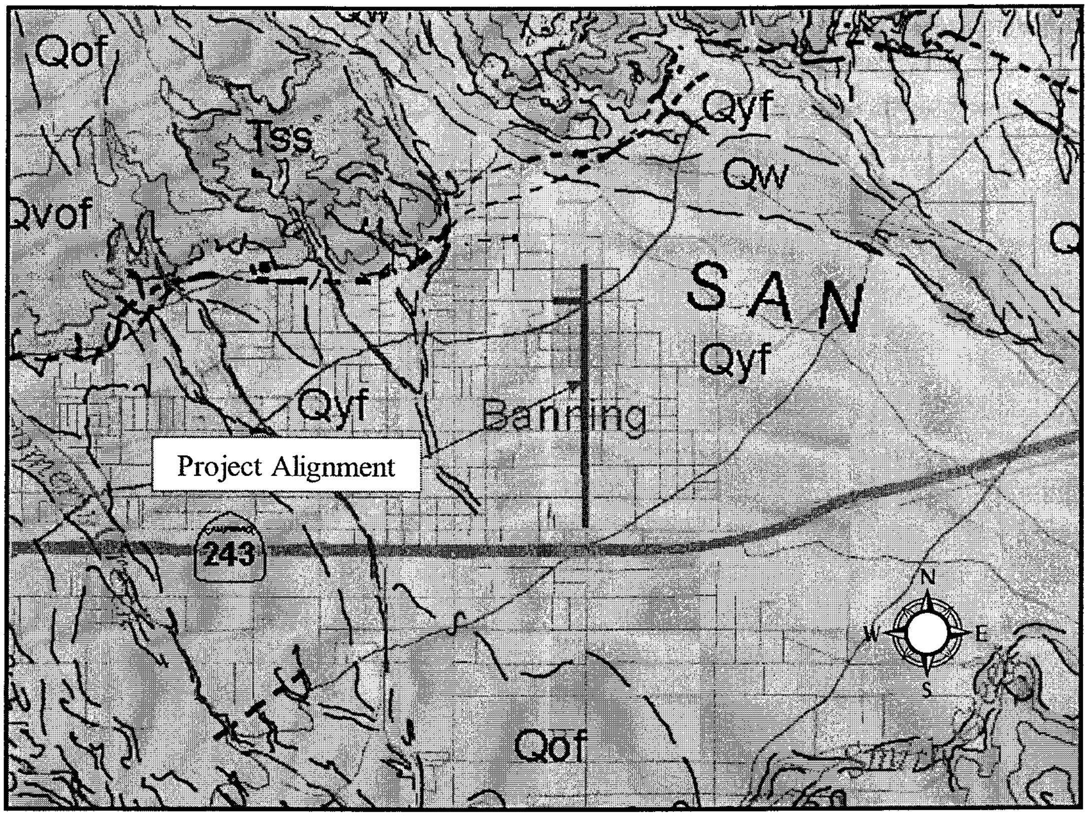
III. GEOLOGIC SETTING

Regional Geology: The subject site is situated near the boundary of the Transverse Ranges and Peninsular Ranges geomorphic provinces. Most of the City of Banning lies within the Transverse Ranges geomorphic province, while the southern edge of the Banning area is located within the Peninsular Ranges geomorphic province, with the San Gorgonio Pass generally defining the boundary between the two regions. The San Gorgonio Pass is a down-thrown block between two faults (rock fractures) as a result of the relative right- lateral motion between the North American and Pacific tectonic plates. The valley floor is generally characterized as a series of alluvial fans comprised of sediments originating primarily from the San Bernardino Mountains (RBF, 2011).

Within the Transverse Ranges, thick sequences of Quaternary-age alluvial deposits are extensive along the base of the San Bernardino and Little San Bernardino Mountains. Along the southern San Bernardino Mountains alluvium has formed in drainages and as alluvial fans from Millard Canyon, Banning Canyon and others. These deposits form moderately sloping alluvial fans that terminate on the south side of the valley (CGS, 2012).

Local Geology: A review of a map entitled Geologic Compilation of Quaternary Surficial Sediments in Southern California, Palm Springs 30' x 60' Quadrangle (CGS, 2012) indicates that the proposed storm drain is underlain by mapped young alluvial fan deposits (Holocene to late Pleistocene) comprised of boulder (12 inches and larger), cobble (3 inches to 12 inches), gravel (+No. 4 screen to 3 inches), sand (-No. 4 screen / + No. 200 screen) and silt (-No. 200 screen) deposits.

Following is a portion of the CGS geologic map of the Palm Springs 30' x 60' Quadrangle depicting the mapped geologic units in the vicinity of the project.

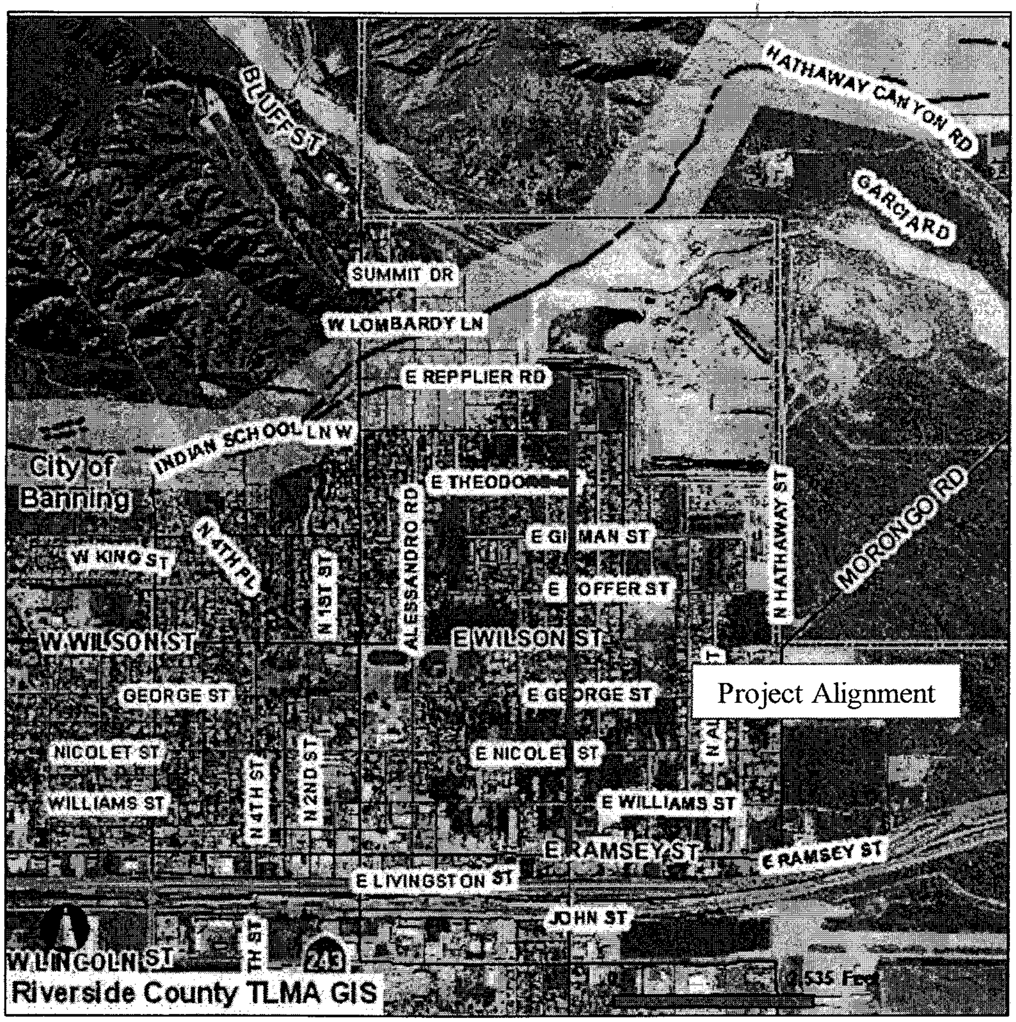


Qyf **Young Alluvial Fan Deposits (Holocene to late Pleistocene)** – unconsolidated to slightly consolidated, undissected to slightly dissected boulder, cobble, gravel, sand, and silt deposits issued from a confined valley or canyon.

Faulting: There are at least 34 major late Quaternary active/potentially active faults that are within a ±100-kilometer radius of the site. The closest mapped fault zone is the San Gorgonio Pass Fault Zone, located approximately 1,600 feet to the northwest of the project alignment. The San Gorgonio Pass fault zone is a series of north-dipping reverse and thrust faults connected by strike tear faults, resulting in a surface trace that appears like an irregular, saw-tooth. This east-west trending fault zone contains faults that were formed during the Pleistocene Epoch, of which some have been active in the later Holocene Epoch. The most recently active strands of faults occur at the base of the Banning Bench, in the central part of Banning (Banning General Plan, 2004).

For informational purposes, below is a County of Riverside TMLA GIS map (2014) indicating the mapped San Gorgonio Pass Earthquake Fault Zone, and approximate locations of some of the fault splays associated with this fault zone. It is important to note that the mapped faults are not precisely plotted and are presented on large-scale geologic maps. The locations presented should be considered as estimations only.

The preliminary findings as presented in this report are based solely on a review and interpretation of existing published geologic data. No subsurface exploration or photogeologic analysis was performed for this evaluation.



According to maps compiled by the California Department of Conservation, Division of Mines and Geology (CDMG) the major faults influencing the site, distances and maximum earthquake magnitudes are as follow:

Fault Zone	Approximate Distance (km)	Earthquake Magnitude (M_w)	Slip Rate (mm/yr)
San Andreas - Southern	4.6	7.4	24.0
San Jacinto-San Jacinto Valley	18.2	6.9	12.0
Pinto Mountain	19.2	7.0	2.5
San Jacinto-Anza	22.1	6.7	12.0
North Frontal Fault Zone (East)	35.2	6.7	0.5

Seismic Parameters: On the bases of the subsurface conditions and local fault characteristics, AWWA D100-11 provides the following seismic design parameters:

AWWA D100-11 Seismic Parameter	Recommended Value
Site Class	D
Mapped Spectral Acceleration - S_s	1.50
Mapped Spectral Acceleration - S_1	0.61
MCE Spectral Acceleration - S_{MS}	1.50
MCE Spectral Acceleration - S_{M1}	0.92
Design Spectral Acceleration - S_{DS}	1.00
Design Spectral Acceleration - S_{D1}	0.61
Seismic Design Category	D

The primary geologic hazard affecting the project is that of ground shaking. Other secondary effects and geologic hazards include slope failure, lurching, seismic settlement, seiches, and tsunamis. These are not considered to be of significance to the project.

Groundwater: Groundwater was not encountered within our exploratory borings, which extended to a maximum depth of 26.5 feet. According to the City of Banning Water Division, the depth to groundwater beneath the site is greater than 100 feet. According to Perry Gerdes, Water/Wastewater Superintendent with the City of Banning, a well located near the intersection of San Gorgonio Avenue and Lincoln Street was recently monitored. This well is located approximately 3,000 feet southwest of the southerly end of the project alignment. Mr. Gerdes stated that the static water level at this well is on the order of 648' below the existing ground surface. Mr. Gerdes indicates that another well, is located near the intersection of San Gorgonio Avenue and Mias Canyon Road, approximately one mile to the northwest of the site. Mr.

Gerdes stated that the depth to groundwater at this location was 76.8 feet during a recent reading. He stated that this well was in a groundwater basin and was north of a fault that acted as a groundwater barrier between this basin and the much deeper groundwater to the south of the fault.

Liquefaction: Liquefaction is a phenomenon where soil temporarily loses strength due to cyclic stresses such as those caused by an earthquake. The primary effects of liquefaction are loss of foundation support, sand boils, lateral spreading and seismically induced settlement. Liquefaction is generally considered a hazard in relatively loose sandy soils with the groundwater table within fifty feet of the surface.

Groundwater was not encountered within our exploratory borings, which extended to a maximum depth of 26.5 feet. We have estimated a high groundwater depth of 200 feet at the site. Based on the depth to groundwater beneath the alignment, it is our opinion that the potential for liquefaction beneath the site is negligible.

IV. SUBSURFACE CONDITIONS

Our field exploration consisted of drilling 11 exploratory borings ranging in depth from approximately 11 to 26.5 feet. The borings were excavated by means of both truck- and track-mounted rotary auger drill rigs at the approximate locations shown on Figure Nos. A-14 through A-19. A description of our drilling and sampling procedures and the Boring Logs are presented in Appendix A. Laboratory testing was performed on selected samples of the subsurface soils. Results of these tests are presented in Appendix B.

Due to the amount of gravel (+ No. 4 screen to 3 inches) and cobbles (3 inches to 12 inches) encountered within our borings, many of the samples were disturbed or not recoverable. Retention of undisturbed drive samples in gravelly soils is difficult because there is little to no adhesion between individual particles and the size of the drive samplers (inner diameters of 1.375 and 2.41 inches) results in re-arrangement of the soil particle orientation during the sampling process. In some case, the sample becomes so disturbed that it cannot be retained in the sampler (not recoverable).

Drilling advancement rates and auger response indicated the presence of significant amounts of cobbles and/or boulders at various depths within the exploratory borings. In most cases the auger was able to penetrate these deposits with additional effort. However, as noted on Logs of Boring Nos. B-10 and B-11, practical refusal was encountered at depths of 4 feet and 16 feet, respectively, i.e. deeper advancement of the auger was not possible.

In addition to the subsurface exploration, we reviewed the Soil Survey of Western Riverside Area, California and the UC Davis/NRCS Soilweb website. This review reveals that the predominate agricultural soil type (Series) present along the project alignment is Gorgonio gravelly and cobbly loamy fine sand (GmD, GnD). Smaller areas in the northerly portion of the project include Tujunga gravelly loamy sand (TwC) and Soboba cobbly loam sand (SrE). The predominate soil series along the alignment are described as:

> Gorgonio gravelly and cobbly loamy fine sand (GmD, GnD) – These are somewhat excessively drained soils on alluvial fans. These soils developed in alluvium that was derived mainly from granitic materials. In a typical profile, the surface layer is dark grayish brown to brown gravelly loamy fine sand about 15 inches thick. The underlying material is brown stratified gravelly loamy sand and gravelly loamy fine sand, and it extends to a depth of more than 60 inches. These soils typically have a low shrink-swell potential, typically 5 to 20 percent fines (passing No. 200 Sieve) and 30 to 55 percent gravel, have very slight to

slight compressibility, fair to good stability and good to poor resistance to piping.

Soboba cobbly loamy sand (SrE) – Soils of the Soboba series are on talus slopes and alluvial fans. These excessively drained soils developed in alluvium from predominately very gravelly, very cobbly, or stony granitic materials. In a typical profile, the surface layer is grayish brown stony loamy sand about 11 inches thick. The substratum is grayish brown stratified very gravelly and cobbly and loamy sand. These soils typically have a low shrink-swell potential, typically 0 to 5 percent fines (passing No. 200 Sieve) and 50 to 75 percent stone and cobble larger than 3-inches, have very slight compressibility, good to fair stability and good resistance to piping.

Tujunga gravelly loamy sand (TrC) – Soils of the Tujunga series are excessively well-drained and are present on alluvial fans and flood plains. In a typical profile, the surface layer is light gray loamy sand about 10 inches thick. Below this layer are light gray fine sand and sand. These soils typically have a low shrink-swell potential, typically 0 to 20 percent fines (passing No. 200 Sieve) and 0 to 50 percent gravel, have very slight to slight compressibility, poor to fair stability and fair to poor resistance to piping.

Following is a portion of a NRCS soil survey map (UC Davis/NRCS, 2014) depicting the mapped agricultural soil types in the vicinity of the project alignment.

The results of our subsurface exploration revealed conditions that appear to be fairly consistent with those indicated by the Soil Survey for the surficial materials.

In general, our field exploration indicates that the project alignment is underlain by alluvial fan deposits consisting of granular sandy gravels, gravelly sands, sands, and silty sands with gravel. The alluvial soils were generally found to be medium dense to dense, based on sampler blow count data. Larger cobbles and stones were encountered throughout the anticipated depth of the storm drain. Most of the split-spoon samples obtained were too disturbed for accurate density testing due to their gravelly nature.

The moisture content of the soil at the time of our investigation ranged from approximately 1 to 8 percent within the planned excavation depths. A detailed description of the subsurface soil conditions encountered is presented on the attached boring logs.

Sand equivalent values of soil samples tested within the depth of excavation ranged from 33 to 47. The following table presents the sand equivalent values on representative samples along the alignments:

Boring No.	Depth (ft.)	SE
B-01	1.5-13.0	47
B-04	4.0-26.5	44
B-07	0.67-8.0	43
B-09	7.0-16.2	33
B-11	0.0-9.0	37

The soils within the planned excavation depths were observed to be non-plastic to very slightly plastic. Overall plasticity index testing revealed plasticity indices (PI's) ranging from 0 to 2. Liquid limits (LL's) ranged from 16 to 17.

A soil corrosivity evaluation for this project was conducted by HDR Schiff Consulting Corrosion Engineers. The soil corrosivity evaluation report prepared by HDR Schiff is appended.

Asphalt concrete (AC) pavement was observed to range in thickness from approximately three to eight inches in our borings. The AC was generally underlain by native soil or a leveling course of silty sand. No aggregate base was encountered within any of the borings.

Although not encountered in our exploratory borings, artificial fill and/or backfill material associated with adjacent underground utilities will likely be encountered during construction. The compaction and other characteristics of any unknown fill/backfill is not known. If undocumented artificial fill, backfill or other unknown materials are encountered, they should be excavated with care and evaluated by the contractor for caving potential.

Groundwater was not encountered within our exploratory borings, which extended to a maximum depth of 26.5 feet. We have estimated a high groundwater level of 200 feet along the project alignment.

V. CONCLUSIONS AND RECOMMENDATIONS

On the basis of our field and laboratory exploration and testing, it is our opinion that the proposed storm drain construction will be feasible from a geotechnical standpoint. The following sections present recommendations and conclusions that may be applied to each stage of this project. Our scope of services for this project included a discussion and presentation of:

- Overall feasibility
- Soil types expected to be encountered/boring logs
- Geologic setting/seismicity
- Excavation/rippability characteristics
- Recommendations for trenching, temporary excavations and soil parameters for the design of shoring
- Description of groundwater, site and subsurface conditions
- Recommendations for unusual soil conditions or groundwater conditions during construction, if encountered
- Soil compressibility, preliminary soil strength
- Soluble sulfate and chloride content analysis
- Existing pavement thickness at each boring location

Design parameters for the storm drain including:

- Allowable bearing pressure
- Design lateral earth pressures
- Shoring/trench safety
- Coefficient of friction
- Sand equivalent values and soil density
- Site preparation including compaction requirements and compaction characteristics of native soils
- Shrinkage and subsidence
- Corrosion evaluation and recommendations for cement type and corrosion protection of steel
- General site grading/backfilling recommendations
- Recommendations for storm drain construction in close proximity to existing utilities
- RCP design variables for Marston-Spangler method of pipe design, including soil unit weight in the compacted backfill prism (γ_w), and the dimensionless product of the Rankine ratio and sidewall friction coefficient (K_μ').
- Values to determine the Soil Erodibility Factor (K) using the Erickson triangular nomograph, including the percentages of sand, very fine sand, silt and clay (hydrometer test)

Overall Feasibility: Based on our investigation, the project appears to be feasible from geotechnical and geologic standpoints, provided our conclusions and recommendations for this project are considered. Predominately granular soils are present along the alignment consisting of sandy gravels, gravelly sands, sands, and silty sands with gravel. The alluvial soils were generally found to be medium dense to dense. Larger cobbles and boulders were encountered throughout the anticipated depth of the storm drain excavations. Some of the soils encountered may be susceptible to caving.

The most problematic condition encountered is the extensive amount of cobbles and boulders within the proposed depth of excavation. These materials will be subject to caving during excavation. Additionally, they are not suitable for RCB or RCP bedding. Screening of the excavated materials or importing of suitable material will be required.

A soil corrosion evaluation report has been prepared by HDR| Schiff and is appended. General recommendations for mitigation are included.

Groundwater was not encountered within the planned excavation limits. Historical groundwater levels are well below the planned excavation limits.

Expected Soil Types to be Encountered: The surface and subsurface materials that will be encountered during the construction of this project will include predominately granular alluvial deposits consisting of sandy gravels, gravelly sands, sands, and silty sands with gravel. The alluvial soils were found to be a medium dense to dense condition. Larger cobbles and stones were encountered throughout the anticipated depth of the storm drain.

Sand Equivalent Values and Soil Density: Split-spoon samples obtained during field exploration were generally too disturbed for accurate density testing. We have assumed a unit weight of 135 pounds per cubic foot in our analyses.

Sand equivalent values ranged from 33 to 47. The following table presents the sand equivalent values on representative samples along the alignments:

Boring No.	Depth (ft.)	SE
B-01	1.5-13.0	47
B-04	4.0-26.5	44
B-07	0.67-8.0	43
B-09	7.0-16.2	33
B-11	0.0-9.0	37

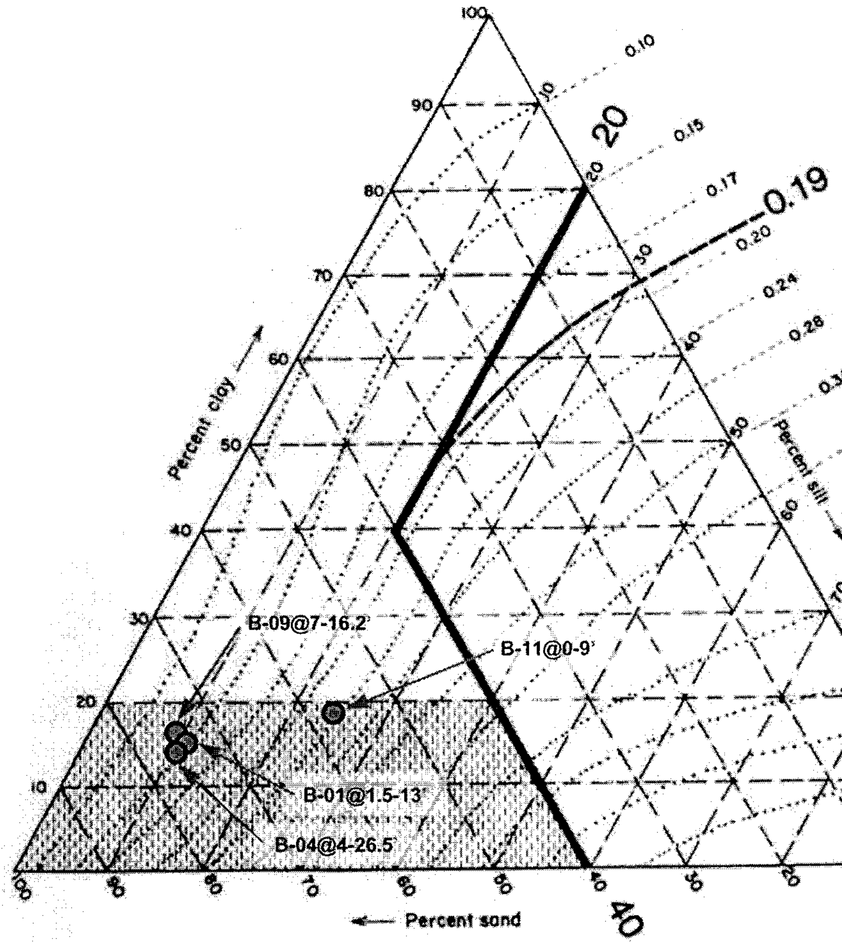
Pavement Sections: The thickness of the AC was variable along the alignments. As indicated previously, no aggregate base was encountered in any of our borings. The following table presents the existing pavement sections.

Boring No.	AC Thickness (in)	Class 2 Base Thickness (in)
B-01	6½	None
B-02	6	None
B-03	8	None
B-04	7½	None
B-05	6½	None
B-06	5	None
B-07	8	None
B-08	4	None
B-09	5	None
B-10	3	None
B-11	5½	None

Excavation Characteristics/Rippability Concerns: Our investigation did not reveal materials expected to cause excavation difficulties for conventional equipment. It is likely that extensive amounts of cobbles and boulders could be encountered along portions of the alignment.

The alluvial deposits are not expected to present difficulties during excavation with the exception of caving, which should be anticipated. Shoring designs would be based upon the field conditions as observed by the "Competent Person" on the site. In most cases, we anticipate that a trench shield will be feasible. However, given the width of the excavation, sloping or benching may be more appropriate.

Soil Erodibility Factor (K): The K factor can be determined by using the nomograph method, which requires that a particle size analysis (ASTM D-422) be done to determine the percentages of sand, very fine sand, silt and clay. On the basis of classification testing, the value for K is estimated to be between 0.15 and 0.26 as indicated on the following chart.



Erickson triangular nomograph used to estimate soil erodibility (K) factor. USDA nomograph from Erickson 1977 as referenced by Goldman et al., 1986.

Unusual Soil Conditions or Groundwater Conditions: No unusual or unanticipated soil conditions were encountered. Groundwater was not encountered in any of our borings.

Soil Compressibility, Preliminary Soil Strength: The alignments are generally underlain by sandy gravel and gravelly sand. Based on sampler blow count data, these soils are medium dense to dense. Cohesive strengths should be considered to be negligible.

Water Soluble Sulfates: Testing indicates negligible concentrations of water-soluble sulfates. This is addressed in the report of the Soil Corrosivity Evaluation which is appended.

Trenching and Shoring Recommendations: All trenches should be configured and shored in accordance with the requirements of Cal/OSHA. The soils should be classified as Type C. Cohesionless soils will be encountered at depths that will likely be subject to caving when exposed in unshored vertical excavation sidewalls. If a trench shield is used, careful monitoring will be required.

The contractor should have a "competent person" on-site for the purpose of assuring safety within and about all construction excavations. Unshored excavations should have a maximum slope of 1.5:1 (H:V) and should not exceed twenty feet in height. Shoring, shields, or other protective systems should be used in accordance with all specifications, recommendations, and limitations provided by the manufacturer. Shoring should be designed using an at-rest earth pressure of 60 pounds per cubic foot. We have assumed a unit weight of compacted backfill to be 135 pounds per cubic foot for this evaluation. This is based upon compacted soil at near optimum moisture content. A Registered Professional Engineer should design shoring or benching for excavations deeper than twenty feet.

Protection of Existing Facilities: Where existing utilities cross or are exposed by the planned excavation, we recommend that these lines be assessed for sensitivity to post-construction settlements. Typically, this is a concern for rigid pipelines such as water and sewer lines. In these cases, we recommend that the placement of compacted backfill be terminated no closer than 12 inches from the line. At that point, the backfill should consist of a sand-cement slurry (one-sack) or controlled density fill (CDF) placed to at-least the springline of the pipe. This will provide post-construction support and will reduce the effects of the overlying backfill.

Allowable Bearing Pressure: A conservative design value for any proposed foundations would be 1500 pounds per square foot assuming foundations supported upon undisturbed soil having an in-place relative compaction of at least 85 percent. For soil that is recompacted to at least 90 percent relative compaction, an allowable soil bearing pressure of 2000 pounds per square foot may be assumed. This assumes a minimum footing depth of 24 inches below the lowest adjacent final grade.

Settlements under foundations designed using the above allowable bearing pressures are expected to be minor. Maximum settlements are expected to be on the order of one inch.

Earth Pressures: Cantilever walls supporting compacted fill soils should be designed using an equivalent active earth pressure of 40 pounds per cubic foot (pcf) for level backfill. Braced walls should be designed for at-rest earth pressure of 60 pcf, with the resultant applied at mid-height.

Any applicable construction and seismic surcharges should be added to the above pressures. The effects of seismic forces may be characterized as an Equivalent Fluid Pressure of 15 pounds per cubic foot.

Design lateral loads may be resisted by passive earth pressure on foundations on compacted fill or dense native soils. This resistance may be determined from a design passive pressure based on an equivalent fluid pressure of 400 pcf. This value includes a factor safety of 1.0 on the ultimate passive pressure.
Appropriate drainage should be provided behind any retaining walls to prevent the build-up of hydrostatic pressures. All subdrain systems must be protected against piping by means of graded filters or filter fabrics.

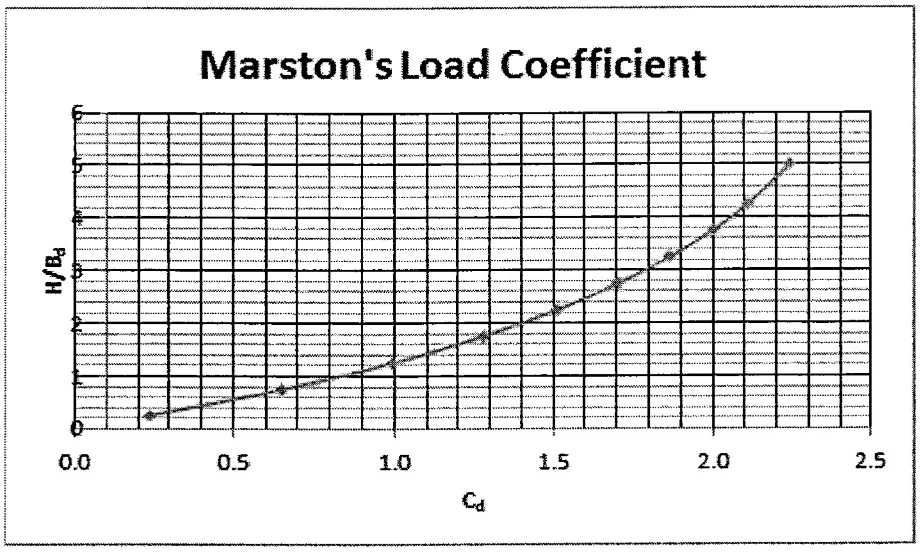
Coefficient of Friction: A coefficient of friction of 0.45 between soil and concrete may be used with dead load forces only.

Unit Weight: Our recommendations are based upon a total unit weight of 135 pounds per cubic foot for compacted backfill. Our testing indicates the product of the Rankine ratio and sidewall friction coefficient ($K\mu'$) to be approximately 0.19. Loads under trench conditions are to be estimated using Marston's Formula:

$$W_c = C_d w B_d^2$$

Where:
W_c = Load on Pipe
w = Unit Weight of Backfill (135 pcf)
B_d = Trench Width (ft.)

H = Height of Fill above Pipe (H<20ft.)
C_d = Marston's Load Coefficient as shown in the following chart:



Corrosivity: A corrosivity evaluation for this project was conducted by HDR|Schiff Associates. The report indicates that the soils are classified as moderately corrosive to ferrous metals, aggressive to copper, and aggressive to aluminum.

The entire report is appended and includes test data.

Earthwork/Backfilling: The on-site materials are suitable for use as compacted backfill. Soils should be brought to near optimum moisture content, and compacted in 6 to 8 inch thick lifts to a minimum of 90 percent of the maximum dry density as determined by Caltrans test method 216 or ASTM Standard D1557, whichever is indicated in the project specifications. Soils should be mechanically compacted. Compaction by jetting is not recommended and should be avoided. All work shall be in accordance with District requirements. The following specifications have been developed on the basis of our field and laboratory testing:

> Trench Backfill: Trench backfill material should be native or approved granular materials which are free of organic and deleterious materials, rocks or lumps greater than 3 inches in greatest dimension and other unsuitable materials. If on-site excavated material is to be used as backfill, it should be screened to remove all material larger than 3 inches. We recommend that all backfill be either non-expansive or have an Expansion Index of less than 20. Trench backfill may be compacted at near optimum moisture content by mechanical means as necessary for the achievement of satisfactory compaction. Controlled Density Fill (CDF) or Sand-Cement Slurry may be used in lieu of mechanically compacted native soils as backfill material. Unless otherwise specified by the drawings, specifications or encroachment permits, the minimum acceptable degree of compaction should be 90 percent of the maximum dry density. This is

with the exception of the upper 12 inches within roadway areas which should be compacted to a minimum of 95 percent relative compaction.

Foundations/Structures: The surfaces to receive concrete for foundations should be recompacted to at least 90 percent relative compaction for a depth of at least 12 inches below the footing base. The placement of a layer of aggregate base compacted to at least 95 percent relative compaction is recommended below the bases of the reinforced box culverts (RCBs) in order to establish uniform support for these structures. The soil below the base course should be compacted to at least 90 percent relative compaction.

Import Materials: All proposed import soils should be reviewed by the soils engineering consultant prior to use. Expansive soils should not be imported for this project. At least two working days notice should be allowed for the soil engineer to review and approve any proposed imported soils. If laboratory testing is necessary to obtain approval of import soils, an additional one to two days should be allowed. To provide protection from particle migration, imported pipe embedment material should be in accordance with the following criteria:

Imported Embedment Material Criteria
D_{15} >0.015 mm, and D_{50} <1.25 mm

where D_{15} and D_{50} represent bedding material particle sizes corresponding to 15 and 50 percent passing by weight, respectively. Washed Concrete Sand satisfies these criteria.

Observations and Compaction Testing: During backfilling, observations and compaction testing should be conducted in order to verify satisfactory compaction. The Maximum Dry Density-Optimum Moisture Content relationship should be determined by means of either ASTM Standard D1557 test method or California Test Method No. 216, whichever is indicated in the project specifications. The field density should be determined by either the ASTM Standard D1556 (Sand Cone) or ASTM 6938 (Nuclear) test method. The compaction should be verified at maximum intervals of 250 feet for each 2-foot vertical lift or as otherwise determined to be necessary by the inspector in the field during backfilling. Some backfill and compaction methodologies will dictate much shorter test intervals.

Retests: Should testing reveal insufficient compaction, additional testing may be necessary in order to define the area requiring recompaction. Without further testing, it should be assumed that the area between a failing test and a passing test is not properly compacted. As a guideline for evaluation, one test may be taken at a distance from the failing test equal to 20 percent of the distance to the next passing test. If the test reveals satisfactory compaction, the area between the failing test and the passing test should be recompacted. If the test reveals inadequate compaction, the process should be repeated in order to delineate the unsatisfactory area. After recompaction of "failing" areas, retesting should be conducted in order to confirm satisfactory compaction. At least one retest is required for each failing test, even if failing tests are for the purpose of delineating the area requiring additional work.

VI. GENERAL

The findings and recommendations presented in this report are based upon an interpolation of the soil conditions between boring locations. Due to the type of exploration and the limited soil exposures resulting from exploratory borings, the boring logs may not present a thorough characterization of the actual subsurface conditions. Conditions should be anticipated to vary between boring locations. Significant changes may require revisions in the recommendations presented herein. Should conditions be encountered during construction that appears to be different than those indicated by this report, this office should be notified. We recommend that a pre-job conference be held on the site prior to the initiation of construction. The purpose of this meeting will be to assure a complete understanding of the recommendations presented in this report as they apply to the actual work to be performed.

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APPENDIX A

FIELD AND LABORATORY EXPLORATION AND TESTING

For our current field exploration, 11 exploratory borings were excavated by means of a truck mounted rotary auger rig in at the approximate locations shown on Figure Nos. A-14 through A-19. Logs of the materials encountered were made on the site by a staff geologist. These are presented on Figures A-3 through A-13.

Representative relatively undisturbed samples were obtained within our borings by driving an 18-inch long thin-walled Steel Penetration Sampler (SPT) with successive 30-inch drops of a 140-pound hammer. The number of blows required to achieve each six inches of penetration were recorded on our boring logs and used for estimating the relative consistency of the subsoils. Two different samplers were used. The first sampler used was a Standard Penetration Test Sampler (SPT), with an outer diameter of 2.0 inches and an inside diameter of 1.375 inches, for which published correlations relating the number of hammer blows to the strength of the soil are available. The second sampler type was a Modified California split barrel sampler, which is larger in diameter, carrying brass sample rings having inner diameters of 2.41 inches. Relatively undisturbed samples were removed from the sampler and placed in moisture sealed containers in order to preserve the natural soil moisture content. They were then transported to our laboratory for further observations and testing.

Representative bulk samples were obtained and returned to our laboratory for further testing and observations. The results of this testing are discussed and presented in Appendix B.

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D2487)

PRIMARY DIVISIONS			GROUP SYMBOLS	SECONDARY DIVISIONS
COARSE GRAINED SOILS MORE THAN HALF OF MATERIALS IS LARGER THAN #200 SIEVE SIZE	GRAVELS MORE THAN HALF OF COARSE FRACTION IS LARGER THAN #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
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN #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
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAINED SOILS MORE THAN HALF OF MATERIALS IS SMALLER THAN #200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT IS LESS THAN 50	ML	INORGANIC SILTS, VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS AND ORGANIC SILT-CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT IS GREATER THAN 50	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDS OR SILTS, ELASTIC SILTS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
	HIGHLY ORGANIC SOILS		PT	PEAT, MUCK AND OTHER HIGHLY ORGANIC SOILS
TYPICAL FORMATIONAL MATERIALS	SANDSTONES		SS	
	SILTSTONES		SH	
	CLAYSTONES		CS	
	LIMESTONES		LS	
	SHALE		SL	

CONSISTENCY CRITERIA BASES ON FIELD TESTS

RELATIVE DENSITY – COARSE – GRAIN SOIL

RELATIVE DENSITY	SPT * (# BLOWS/FT)	RELATIVE DENSITY (%)
VERY LOOSE	<4	0-15
LOOSE	4-10	15-35
MEDIUM DENSE	10-30	35-65
DENSE	30-50	65-85
VERY DENSE	>50	85-100

CONSISTENCY – FINE-GRAIN SOIL

CONSISTENCY	SPT* (# BLOWS/FT)	TORVANE UNDRAINED SHEAR STRENGTH (tsf)	POCKET ** PENETROMETER UNCONFINED COMPRESSIVE STRENGTH (tsf)
Very Soft	<2	<0.13	<0.25
Soft	2-4	0.13-0.25	0.25-0.5
Medium Stiff	4-8	0.25-0.5	0.5-1.0
Stiff	8-15	0.5-1.0	1.0-2.0
Very Stiff	15-30	1.0-2.0	2.0-4.0
Hard	>30	>2.0	>4.0

* NUMBER OF BLOWS OF 140 POUND HAMMER FALLING 30 INCHES TO DRIVE A 2 INCH O.D. (1 3/8 INCH I.D.) SPLIT BARREL SAMPLER (ASTM -1586 STANDARD PENETRATION TEST)

** UNCONFINED COMPRESSIVE STRENGTH IN TONS/SQ.FT. READ FROM POCKET PENETROMETER

MOISTURE CONTENT

DESCRIPTION	FIELD TEST
DRY	Absence of moisture, dusty, dry to the touch
MOIST	Damp but no visible water
WET	Visible free water, usually soil is below water table

CEMENTATION

DESCRIPTION	FIELD TEST
Weakly	Crumbled or breaks with handling or slight finger pressure
Moderately	Crumbles or breaks with considerable finger pressure
Strongly	Will not crumble or break with finger pressure

LOG OF BORING B-01

Elevation:	2314.0 Date(s) Drilled: 3/25/14	Logged by:	FWC
Drilling Method:	Rotary Auger	Hammer Type:	Auto-Trip
Drilling Rig:	Mobile B-61	Hammer Weight:	140 lb.
Boring Diameter:	8-inches	Hammer Drop:	30-inches

SUMMARY OF SUBSURFACE CONDITIONS

This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered and is representative of interpretations made during drilling. Contrasting data derived from laboratory analysis may not be reflected in these representations.

DEPTH (ft)	USCS	DESCRIPTION	SAMPLE TYPE	BLOWS/6"	MOISTURE (%)	DRY UNIT WT. (pcf)	RELATIVE COMPACTION (%)
		ASPHALT CONCRETE, (6.5 inches)					
	GS	**ARTIFICIAL FILL**, SILTY SAND, fine- to medium grained with gravel, brown, moist, dense, brick.	BLK				
		SANDY GRAVEL with COBBLES/BOULDERS, (GRAVEL, COBBLES, AND BOULDERS in SAND MATRIX), fine- to coarse-grained, olive-brown, slightly moist, dense.					
5			SS	27 33	3		
			SS	26 37	3		
10							
			SS BLK	12 12	8		
	SM	**SILTY SAND**, fine- to medium-grained, dark yellow-brown, moist, medium dense.					
15	SP SM	**SAND with SILT**, fine- to medium-grained, gray-brown, slightly moist, medium dense.					
	GS	**SANDY GRAVEL**, (GRAVEL, COBBLES, AND BOULDERS in SAND MATRIX), fine- to coarse-grained with cobbles and boulders, gray-brown, slightly moist, dense.	SS	20 27	1		
20							
			SPT	18 36	2		
		End of boring at 23.5 feet. No groundwater or mottling encountered.					

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Figure No. **A-3**

LOG OF BORING B-02

Elevation:	2330.8	Date(s) Drilled:	3/25/14
Drilling Method:	Rotary Auger	Logged by:	FWC
Drilling Rig:	Mobile B-61	Hammer Type:	Auto-Trip
Boring Diameter:	8-inches	Hammer Weight:	140 lb.
		Hammer Drop:	30-inches

SUMMARY OF SUBSURFACE CONDITIONS

This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered and is representative of interpretations made during drilling. Contrasting data derived from laboratory analysis may not be reflected in these representations.

DEPTH (ft)	USCS	DESCRIPTION	SAMPLE TYPE	BLOWS/6"	MOISTURE (%)	DRY UNIT WT. (pcf)	RELATIVE COMPACTION (%)
		ASPHALT CONCRETE, (6 inches)					
	SM	**SILTY SAND with GRAVEL**, fine- to medium-grained, brown, moist, medium dense to dense.	BLK				
			SS	12 22	4		
			BLK				
	GS	**SANDY GRAVEL with SILT**, (GRAVEL, COBBLES, AND BOULDERS in SAND MATRIX), fine- to coarse-grained with cobbles and boulders, olive-brown, slightly moist, medium dense, with thin interbeds of sand.					
5	GS	**SANDY GRAVEL**, (GRAVEL, COBBLES, AND BOULDERS in SAND MATRIX), fine- to coarse-grained, olive-brown, moist, medium dense to dense.	SS BLK	25 37	2		
			SS	57 51	2		
10							
		LARGE COBBLE/BOULDER	SS	50/3" NR			
15	GS	**SANDY GRAVEL**, (GRAVEL, COBBLES, AND BOULDERS in SAND MATRIX), fine- to coarse-grained, olive-brown, slightly moist, medium dense.	BLK				
			SS	38 55	2		
20							
			SPT	12 10	2		
	SM	**SILTY SAND**, fine- to medium-grained with trace graveland clay, dark yellow-brown, moist, medium dense to dense.					
		End of boring at 24.5 feet. No groundwater or mottling encountered.					

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Figure No. **A-4**

LOG OF BORING B-03

Elevation:	2347.5	Date(s) Drilled:	3/25/14
Drilling Method:	Rotary Auger	Logged by:	FWC
Drilling Rig:	Mobile B-61	Hammer Type:	Auto-Trip
Boring Diameter:	8-inches	Hammer Weight:	140 lb.
		Hammer Drop:	30-inches

SUMMARY OF SUBSURFACE CONDITIONS

This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered and is representative of interpretations made during drilling. Contrasting data derived from laboratory analysis may not be reflected in these representations.

DEPTH (ft)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	SAMPLE TYPE	BLOWS/6"	MOISTURE (%)	DRY UNIT WT. (pcf)	RELATIVE COMPACTION (%)
		ASPHALT CONCRETE, (8 inches)					
		ARTIFICIAL FILL, SILTY SAND, fine- to medium-grained with trace gravel, brown, moist, dense.	BLK				
	GS	**SANDY GRAVEL with SILT**, (GRAVEL, COBBLES, AND BOULDERS in SAND MATRIX), fine- to coarse-grained, gray-brown, moist, medium dense to dense.	BLK				
			SS	21 18	4		
5	GS	**SANDY GRAVEL**, (GRAVEL, COBBLES, AND BOULDERS in SAND MATRIX), fine- to coarse-grained, olive-brown, slightly moist, medium dense to dense.	BLK				
			SS	24 55	3		
10		**COBBLE/BOULDER**	SS	50/2" NR			
	GS	**SANDY GRAVEL**, (GRAVEL, COBBLES, AND BOULDERS in SAND MATRIX), fine- to coarse-grained, olive-brown, slightly moist, dense.					
15		**COBBLE/BOULDER**	SS	44 50/4"	1		
	GS	**SANDY GRAVEL**, (GRAVEL, COBBLES, AND BOULDERS in SAND MATRIX), fine- to coarse-grained, olive-brown, slightly moist, medium dense to dense.					
20			SS	31 50/5"	2		
			SPT	50/4" NR			

End of boring at 24.33 feet. No groundwater or mottling encountered.

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Figure No. A-5

LOG OF BORING B-04

Elevation:	2364.4	Date(s) Drilled:	3/25/14
Drilling Method:	Rotary Auger	Logged by:	FWC
Drilling Rig:	Mobile B-61	Hammer Type:	Auto-Trip
Boring Diameter:	8-inches	Hammer Weight:	140 lb.
		Hammer Drop:	30-inches

SUMMARY OF SUBSURFACE CONDITIONS

This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered and is representative of interpretations made during drilling. Contrasting data derived from laboratory analysis may not be reflected in these representations.

DEPTH (ft)	USCS	DESCRIPTION	SAMPLE TYPE	BLOWS/6"	MOISTURE (%)	DRY UNIT WT. (pcf)	RELATIVE COMPACTION (%)
		ASPHALT CONCRETE, (7.5 inches)					
	GS	**ARTIFICIAL FILL**, SILTY SAND, fine- to medium-grained, olive-brown, slightly moist, dense.	BLK				
		SANDY GRAVEL with SILT, (GRAVEL, COBBLES, AND BOULDERS in SAND MATRIX), fine- to coarse-grained, olive-brown, slightly moist, medium dense to dense.					
	GS	**SANDY GRAVEL**, (GRAVEL, COBBLES, AND BOULDERS in SAND MATRIX), fine- to coarse-grained, olive-brown, slightly moist, medium dense to dense.	BLK				
5			SS	18 26	2		
10		easy to moderate drilling	SS	48 50/5"	2		
15			SS	35 54	1		
20			SS	18 50	2		
25			SPT	42 55	1		
		End of boring at 26.5 feet. No groundwater or mottling encountered.					

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Figure No. A-6

LOG OF BORING B-05

Elevation:	2383.5	Date(s) Drilled:	3/25/14
Drilling Method:	Rotary Auger	Logged by:	FWC
Drilling Rig:	Mobile B-61	Hammer Type:	Auto-Trip
Boring Diameter:	8-inches	Hammer Weight:	140 lb.
		Hammer Drop:	30-inches

SUMMARY OF SUBSURFACE CONDITIONS

This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered and is representative of interpretations made during drilling. Contrasting data derived from laboratory analysis may not be reflected in these representations.

DEPTH (ft)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	DRIVE SAMPLE	BULK SAMPLE	SAMPLE TYPE	BLOWS/6"	MOISTURE (%)	DRY UNIT WT. (pcf)	RELATIVE COMPACTION (%)
		ASPHALT CONCRETE, (6.5 inches)							
	GS	**ARTIFICIAL FILL**, SILTY SAND, fine- to medium-grained with trace gravel, brown, moist, dense.							
	GS	**SANDY GRAVEL with SILT**, (GRAVEL, COBBLES, AND BOULDERS in SAND MATRIX), fine- to coarse-grained, brown, moist, dense.							
5		**SANDY GRAVEL**, (GRAVEL, COBBLES, AND BOULDERS in SAND MATRIX), fine- to coarse-grained, olive-brown, slightly moist, medium dense to dense.	X		SS	24 27	2		
10			X		SS	33 56	2		
		COBBLE/ BOULDER							
15		**SANDY GRAVEL**, (GRAVEL, COBBLES, AND BOULDERS in SAND MATRIX), fine- to coarse-grained, olive-brown, slightly moist, medium dense to dense.	X		SS	42 50/4"	1		
20		rocky	X		SS	30 50'5"	2		
		very rocky							
			X		SPT	50/4"	0		
		End of boring at 24.33 feet. No groundwater or mottling encountered.							

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Figure No. **A-7**

LOG OF BORING B-06

Elevation:	2401.5	Date(s) Drilled:	3/25/14
Drilling Method:	Rotary Auger	Logged by:	FWC
Drilling Rig:	Mobile B-61	Hammer Type:	Auto-Trip
Boring Diameter:	8-inches	Hammer Weight:	140 lb.
		Hammer Drop:	30-inches

SUMMARY OF SUBSURFACE CONDITIONS

This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered and is representative of interpretations made during drilling. Contrasting data derived from laboratory analysis may not be reflected in these representations.

DEPTH (ft)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	SAMPLE TYPE	BLOWS/6"	MOISTURE (%)	DRY UNIT WT. (pcf)	RELATIVE COMPACTION (%)
		ASPHALT CONCRETE, (5 inches)					
	GS	**ARTIFICIAL FILL**, SILTY SAND, fine- to medium-grained with trace gravel, brown, moist, dense.	BLK				
	GS	**SANDY GRAVEL with SILT**, (GRAVEL, COBBLES, AND BOULDERS in SAND MATRIX), fine- to coarse-grained, olive-brown, slightly moist, medium dense to dense.	BLK				
			SS	17 21	1		
5		**SANDY GRAVEL**, (GRAVEL, COBBLES, AND BOULDERS in SAND MATRIX), fine- to coarse-grained, olive-brown, slightly moist, dense.					
		rocky	SS	40 42	1		
10							
		COBBLE/BOULDER					
	GS	**SANDY GRAVEL with SILT**, (GRAVEL, COBBLES, AND BOULDERS in SAND MATRIX), fine- to coarse-grained, olive-brown, slightly moist, dense.	SS	42 55	1		
15							
			SPT	43 50	1		
20							
			SPT	25 50/5"	1		
		End of boring at 23.92 feet. No groundwater or mottling encountered.					

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Figure No. **A-8**

LOG OF BORING B-07

Elevation:	2424.0	Logged by:	DL
Date(s) Drilled:	3/26/14	Hammer Type:	Auto-Trip
Drilling Method:	Rotary Auger	Hammer Weight:	140 lb.
Drilling Rig:	Mobile L 10T	Hammer Drop:	30-inches
Boring Diameter:	8-inches		

SUMMARY OF SUBSURFACE CONDITIONS

This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered and is representative of interpretations made during drilling. Contrasting data derived from laboratory analysis may not be reflected in these representations.

DEPTH (ft)	GRAPHIC	USCS	DESCRIPTION	DRIVE SAMPLE	BULK SAMPLE	SAMPLE TYPE	BLOWS/6"	MOISTURE (%)	DRY UNIT WT. (pcf)	RELATIVE COMPACTION (%)
			ASPHALT CONCRETE, (8 inches)							
		SG	**GRAVELLY SAND with SILT**, fine- to coarse-grained with cobbles, light brown to gray brown, slightly moist, dense, moderatly cemented.		X	BLK				
				X	X	SS	29 32	1		
5			abundant gravel and cobbles, hard drilling		X					
				X	X	SS	31	1		
		SG	**GRAVELLY SAND**, fine- to coarse-grained with cobbles, light brown to gray-brown, slightly moist, dense, moderately cemented. rocks, difficult drilling		X	BLK	50/5"			
10					X					
				X	X	SS	50/5" NR			
15					X					
			End of boring at 16.1 feet. Refusal due to cobble/boulder. No groundwater or mottling encountered.							

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Figure No. A-9

LOG OF BORING B-08

Elevation:	2439.5	Date(s) Drilled:	3/26/14
Drilling Method:	Rotary Auger	Logged by:	DL
Drilling Rig:	Mobile L 10T	Hammer Type:	Auto-Trip
Boring Diameter:	8-inches	Hammer Weight:	140 lb.
		Hammer Drop:	30-inches

SUMMARY OF SUBSURFACE CONDITIONS

This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered and is representative of interpretations made during drilling. Contrasting data derived from laboratory analysis may not be reflected in these representations.

DEPTH (ft)	USCS	DESCRIPTION	DRIVE SAMPLE	BULK SAMPLE	SAMPLE TYPE	BLOWS/6"	MOISTURE (%)	DRY UNIT WT. (pcf)	RELATIVE COMPACTION (%)
0		**ASPHALT CONCRETE**, (4 inches)							
	SG	**GRAVELLY SAND**, fine- to coarse-grained with trace cobbles, gray-brown to brown, moist, dense, moderately cemented/consolidated.							
			X		SS	23 50	3		
5									
	SG	**GRAVELLY SAND**, fine- to coarse-grained with cobbles and trace silt, gray-brown, slightly moist, medium dense, well consolidated.	X		SS	35 50/5" NR			
		large cobbles/gravel							
10									
			X		SS	50/4"	2		
15		abundant cobbles							
		End of boring at 16.1 feet. Refusal due to cobble/boulder. No groundwater or mottling encountered.	X		SS	50/1" NR			

LOG OF BORING B-09

Elevation:	2459.2	Logged by:	DL
Date(s) Drilled:	3/26/14	Hammer Type:	Auto-Trip
Drilling Method:	Rotary Auger	Hammer Weight:	140 lb.
Drilling Rig:	Mobile L 10T	Hammer Drop:	30-inches
Boring Diameter:	8-inches		

SUMMARY OF SUBSURFACE CONDITIONS

This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered and is representative of interpretations made during drilling. Contrasting data derived from laboratory analysis may not be reflected in these representations.

DEPTH (ft)	GRAPHIC	USCS	SUMMARY OF SUBSURFACE CONDITIONS	DRIVE SAMPLE	BULK SAMPLE	SAMPLE TYPE	BLOWS/6"	MOISTURE (%)	DRY UNIT WT. (pcf)	RELATIVE COMPACTION (%)
			ASPHALT CONCRETE over SUBBASE, (5 inches over 12 inches silty sand)							
		SG	**GRAVELLY SAND**, fine- to coarse-grained, gray-brown to brown, moist, dense, cobbles and boulders present.		X	BLK				
				X		SS	27 31	2		
5										
		SG	**GRAVELLY SAND**, fine- to coarse-grained with cobbles, brown, slightly moist, dense, moderately cemented/consolidated.	X	X	SS BLK	50 NR			
10										
				X		SS	50	1		
				X		SPT	35 50/3" NR			
15			large cobbles/boulders							
				X		SPT	50/2"			
			End of boring at 16.2 feet. No groundwater or mottling encountered.							

LOG OF BORING B-10

Elevation:	2478.0	Date(s) Drilled:	3/26/14
Drilling Method:	Rotary Auger	Logged by:	DL
Drilling Rig:	Mobile L 10T	Hammer Type:	Auto-Trip
Boring Diameter:	8-inches	Hammer Weight:	140 lb.
		Hammer Drop:	30-inches

SUMMARY OF SUBSURFACE CONDITIONS

This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered and is representative of interpretations made during drilling. Contrasting data derived from laboratory analysis may not be reflected in these representations.

DEPTH (ft)	GRAPHIC	USCS	SUMMARY OF SUBSURFACE CONDITIONS	SAMPLES: DRIVE SAMPLE	SAMPLES: BULK SAMPLE	SAMPLES: SAMPLE TYPE	BLOWS/6"	MOISTURE (%)	DRY UNIT WT. (pcf)	RELATIVE COMPACTION (%)
			ASPHALT CONCRETE over SUBBASE, (3 inches over 9 inches silty sand)							
1		SG	**GRAVELLY SAND**, fine- to coarse-grained with cobbles, gray brown, slightly moist, dense.			BLK				
2										
3										
						SS	35 50/1"	2		
			End of boring at 4 feet. Refusal due to cobbles/boulders. No groundwater or mottling encountered.							

INLAND FOUNDATION ENGINEERING, INC.

MDP Lines D-2 & D-2A
Hargrave St.
Banning, CA
Project No. R206-017

Figure No. A-12

LOG OF BORING B-11

Elevation:	2474.5	Date(s) Drilled:	3/26/14
Drilling Method:	Rotary Auger		
Drilling Rig:	Mobile L 10T		
Boring Diameter:	8-inches		
Logged by:	DL		
Hammer Type:	Auto-Trip		
Hammer Weight:	140 lb.		
Hammer Drop:	30-inches		

SUMMARY OF SUBSURFACE CONDITIONS

This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered and is representative of interpretations made during drilling. Contrasting data derived from laboratory analysis may not be reflected in these representations.

DEPTH (ft)	USCS	DESCRIPTION	DRIVE SAMPLE	BULK SAMPLE	SAMPLE TYPE	BLOWS/6"	MOISTURE (%)	DRY UNIT WT. (pcf)	RELATIVE COMPACTION (%)
0		**ASPHALT CONCRETE**, (5.5 inches)							
	SG	**GRAVELLY SAND with SILT**, fine- to coarse-grained, brown, moist, medium dense, moderately consolidated, cobbles.		X	BLK				
			X		SS	6 11	2		
5									
			X		SS	23 50/3"	1		
	SG	**GRAVELLY SAND**, fine- to coarse-grained with cobbles, light brown to gray-brown, slightly moist to moist, dense, moderately cemented/consolidated.							
10			X		SS	31 50	1		
		rocks							
			X		SS	50/1" NR			
15		large cobbles/boulders							
16		End of boring at 16 feet. Refusal due to large boulder/cobble. No groundwater or mottling encountered.			SPT	50/0" NR			

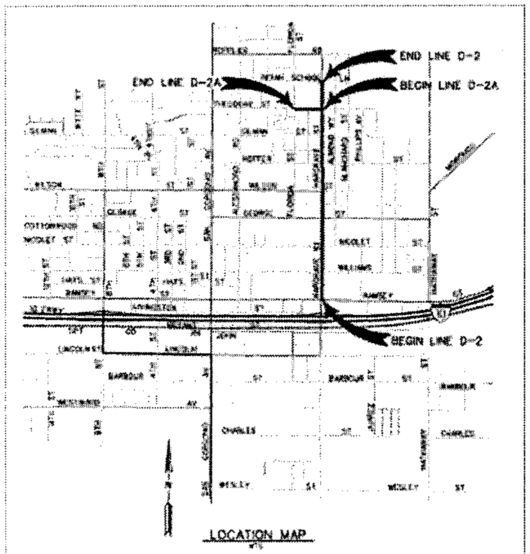
INLAND FOUNDATION ENGINEERING, INC.

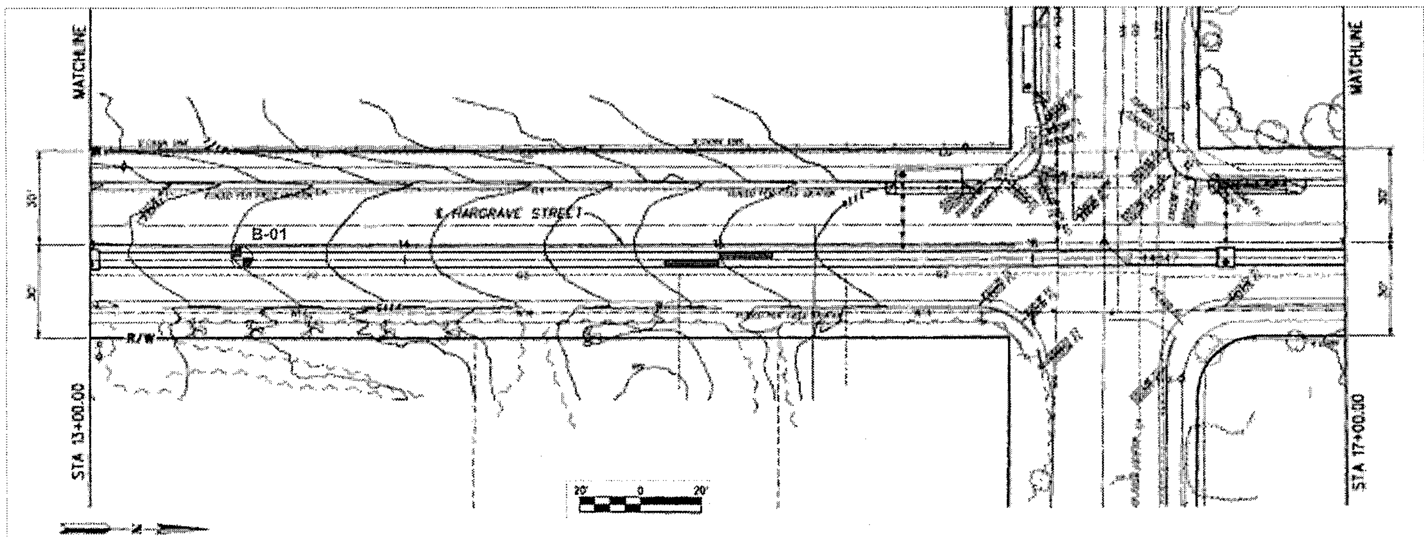
MDP Lines D-2 & D-2A
Hargrave St.
Banning, CA
Project No. R206-017

Figure No. A-13

SITE PLAN

Riverside County Flood Control and Water Conservation District
Banning MDP Line D-2 and D-2A



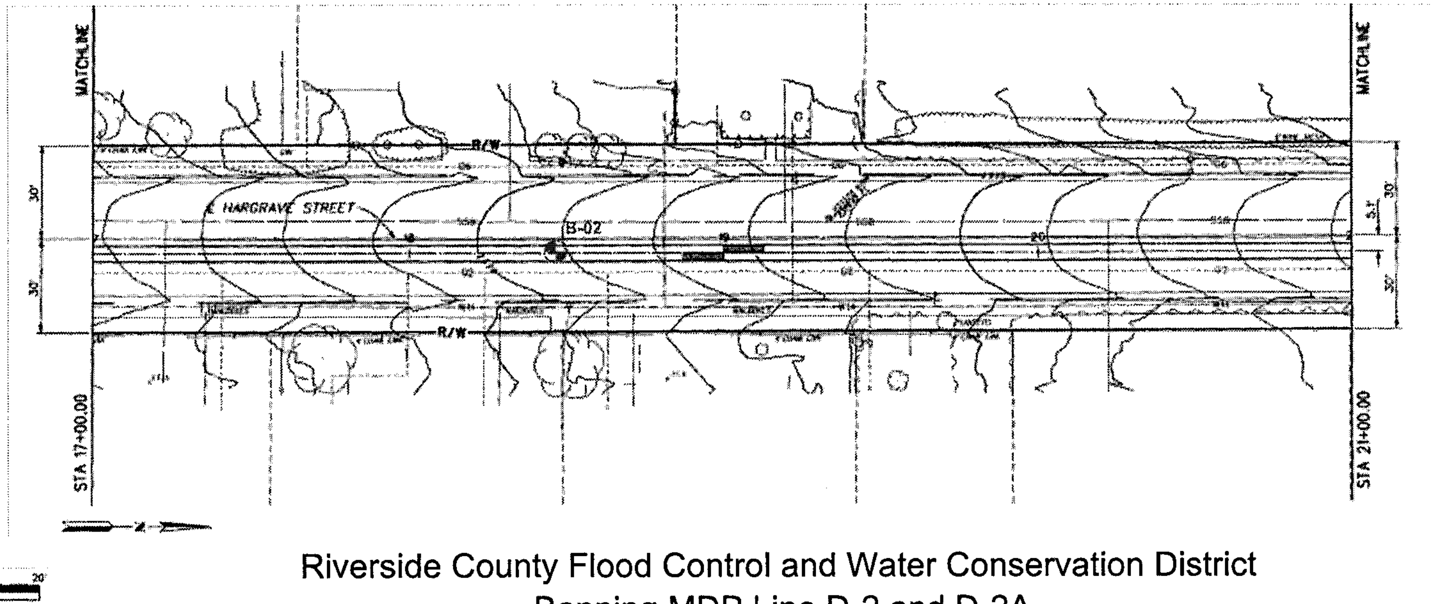


LEGEND

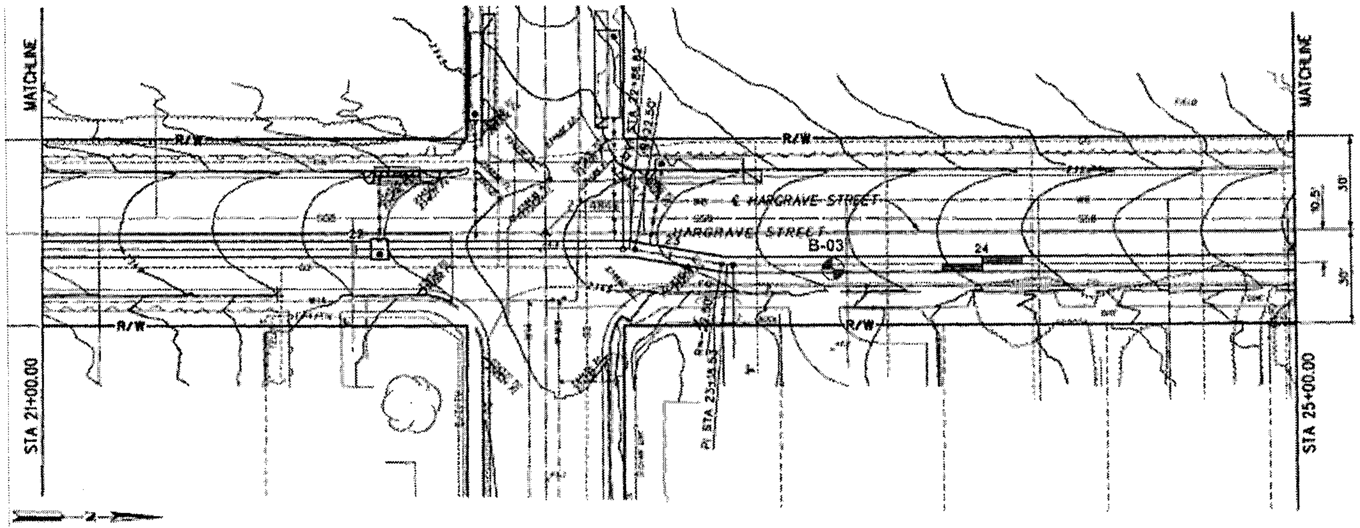
= Approximate Location of Boring

INLAND FOUNDATION ENGINEERING, INC.
1310 South Santa Fe Avenue
San Jacinto, California
(951) 654-1555 FAX (951) 654-0551

DRAWN BY: ES	JOB NO.: R206-017	
SCALE: 1" = 40'	DATE: May 2014	A-14



Riverside County Flood Control and Water Conservation District
Banning MDP Line D-2 and D-2A

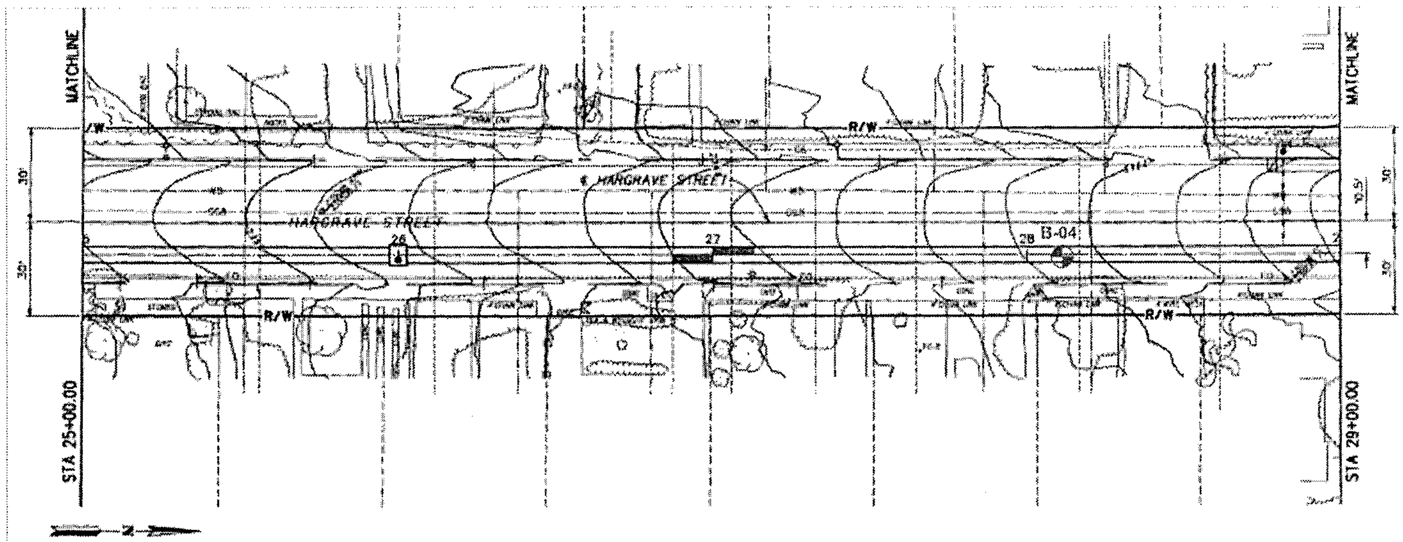


LEGEND

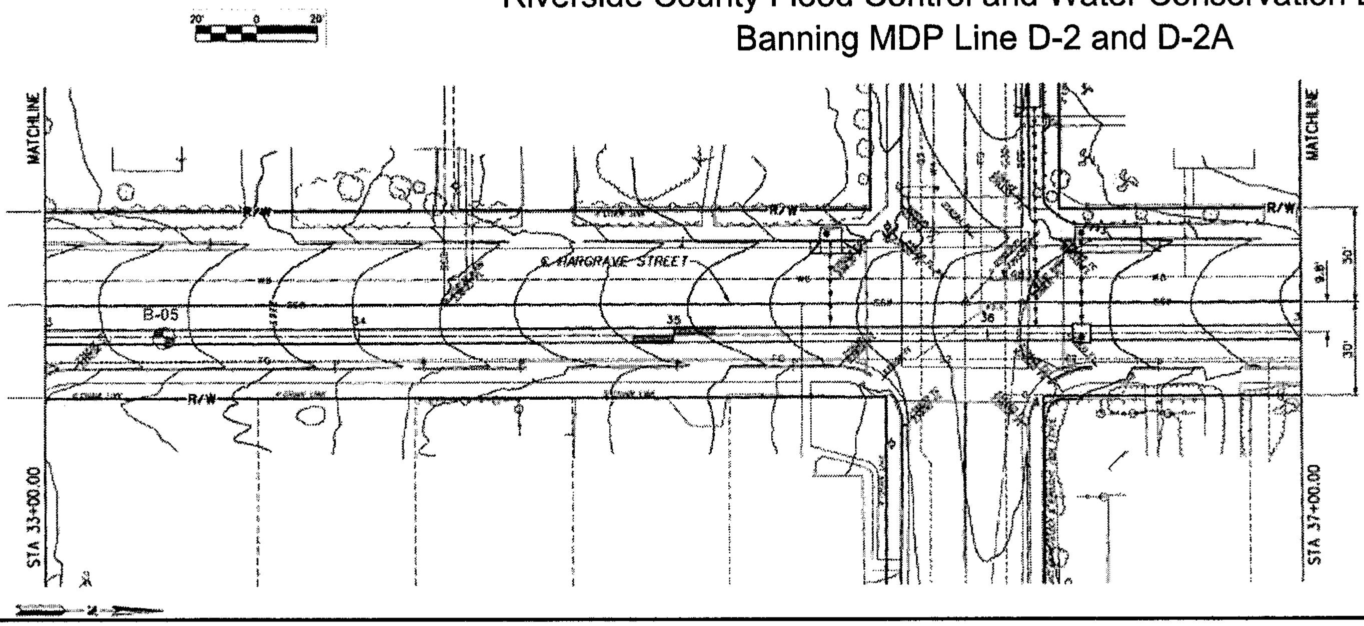
= Approximate Location of Boring

INLAND FOUNDATION ENGINEERING, INC.
1310 South Santa Fe Avenue
San Jacinto, California
(951) 654-1555 FAX (951) 654-0551

DRAWN BY: ES	JOB NO.: R206-017	
SCALE: 1" = 40'	DATE: May 2014	A-15



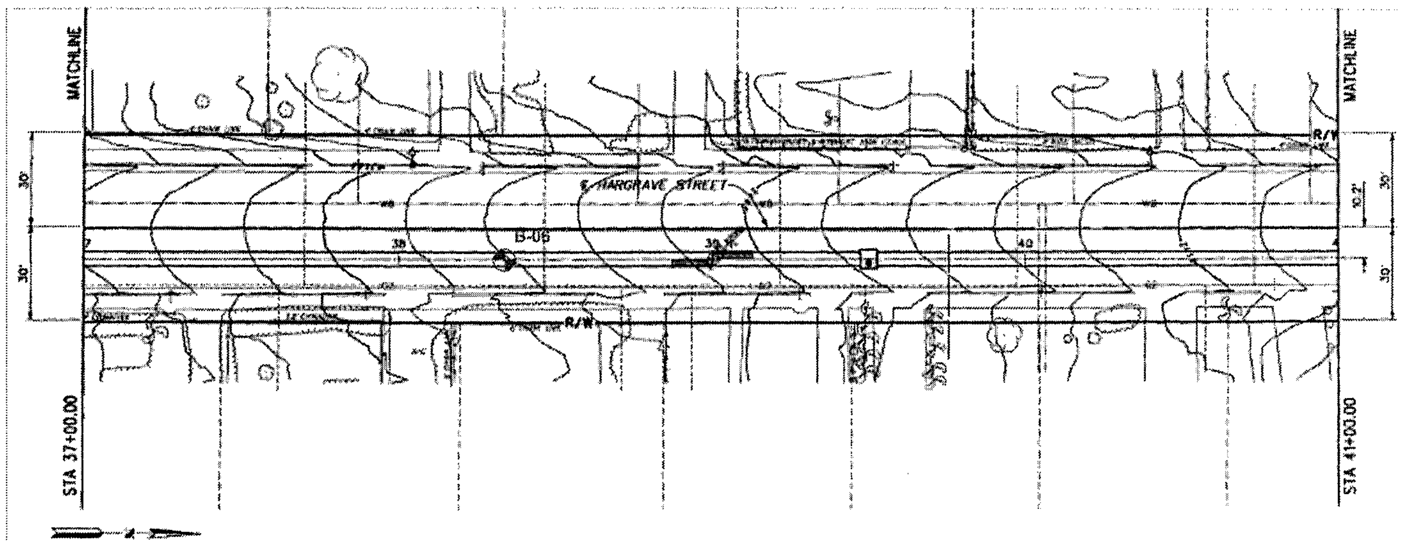
Riverside County Flood Control and Water Conservation District
Banning MDP Line D-2 and D-2A



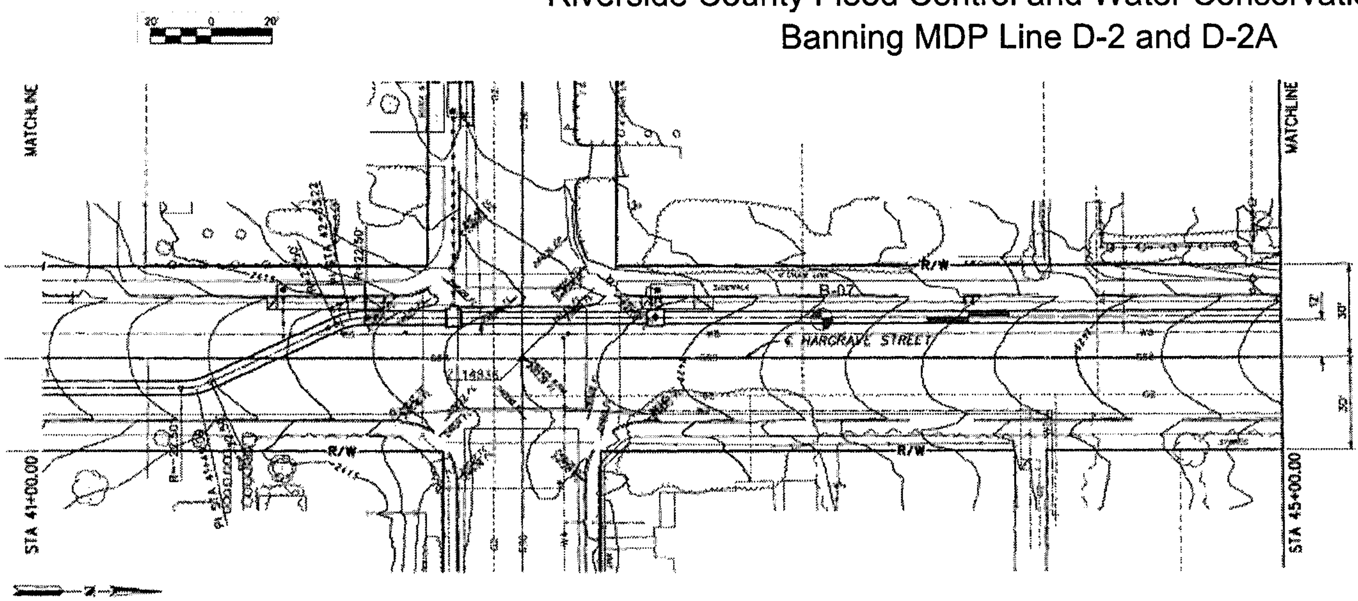
LEGEND

= Approximate Location of Boring

INLAND FOUNDATION ENGINEERING, INC. 1310 South Santa Fe Avenue San Jacinto, California (951) 654-1555 FAX (951) 654-0551		
DRAWN BY: ES	JOB NO.: R206-017	
SCALE: 1" = 40'	DATE: May 2014	A-16



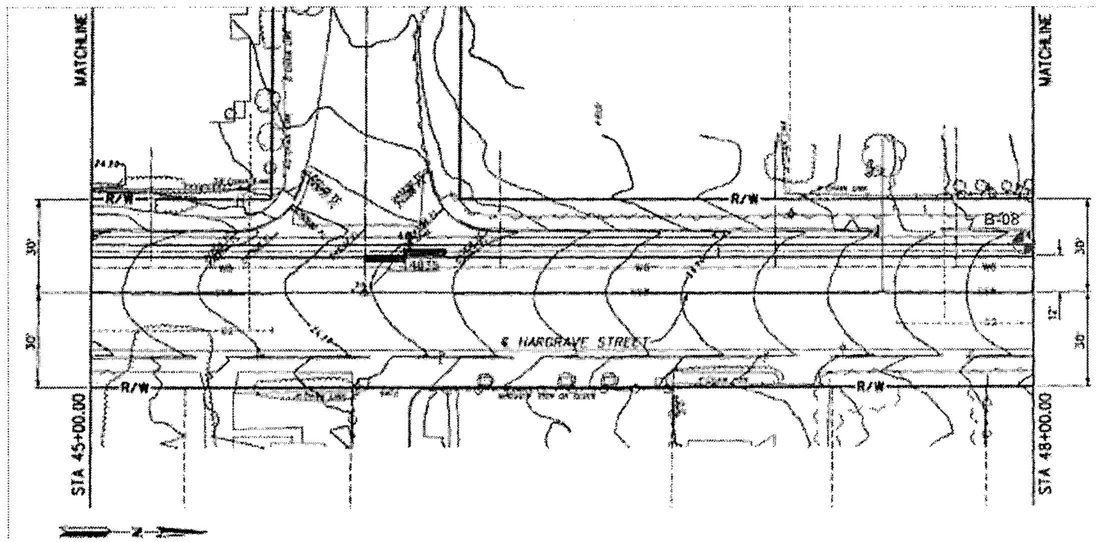
Riverside County Flood Control and Water Conservation District
Banning MDP Line D-2 and D-2A



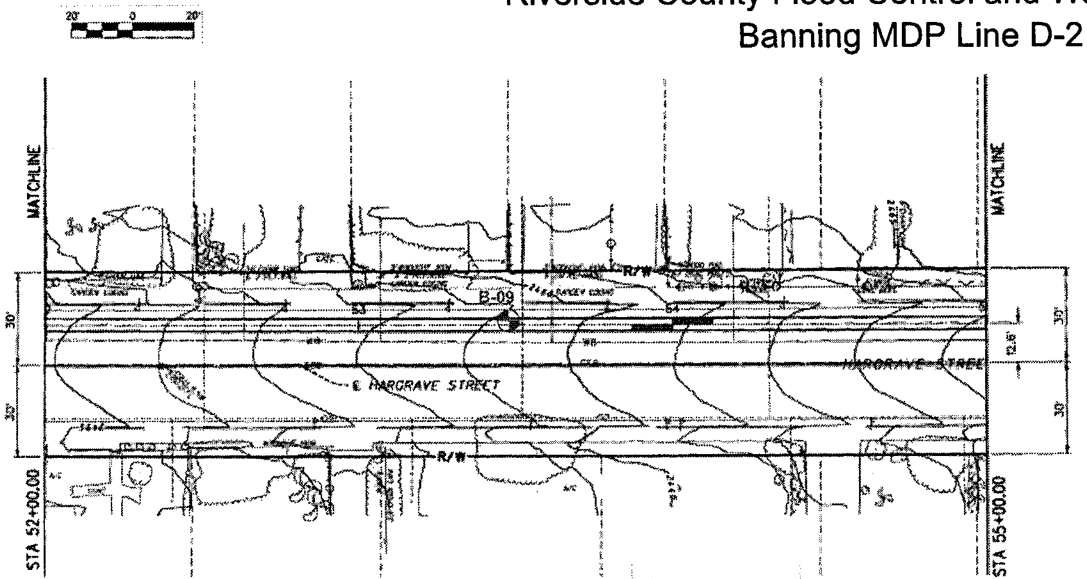
LEGEND

= Approximate Location of Boring

INLAND FOUNDATION ENGINEERING, INC. 1310 South Santa Fe Avenue San Jacinto, California (951) 654-1555 FAX (951) 654-0551		
DRAWN BY: ES	JOB NO.: R206-017	
SCALE: 1" = 40'	DATE: May 2014	A-17



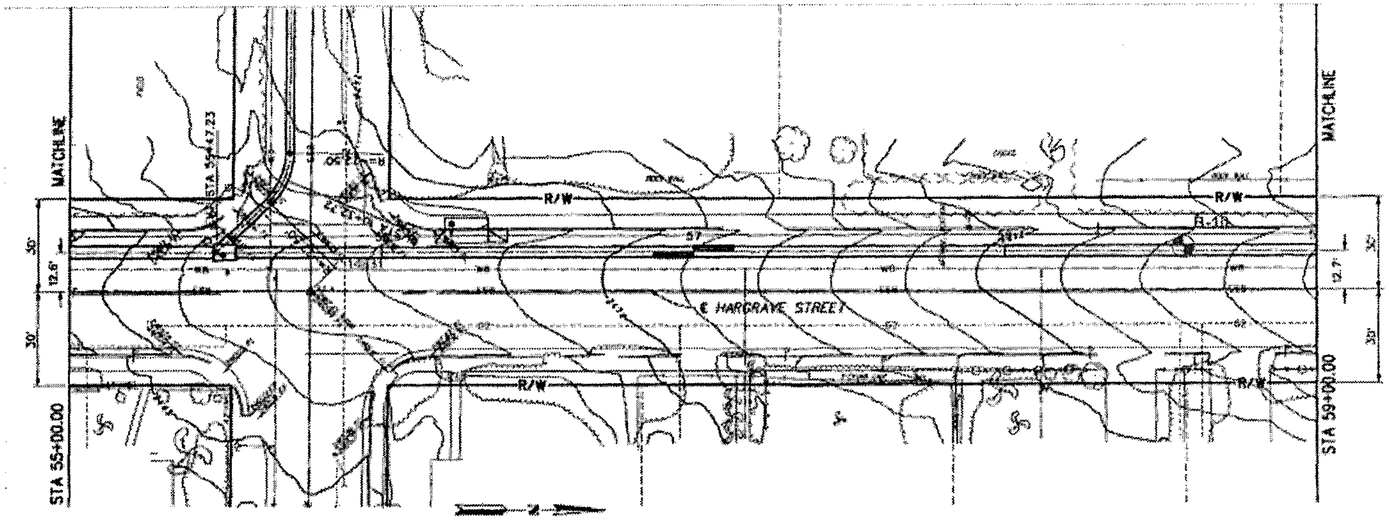
Riverside County Flood Control and Water Conservation District
Banning MDP Line D-2 and D-2A

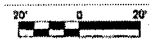


LEGEND

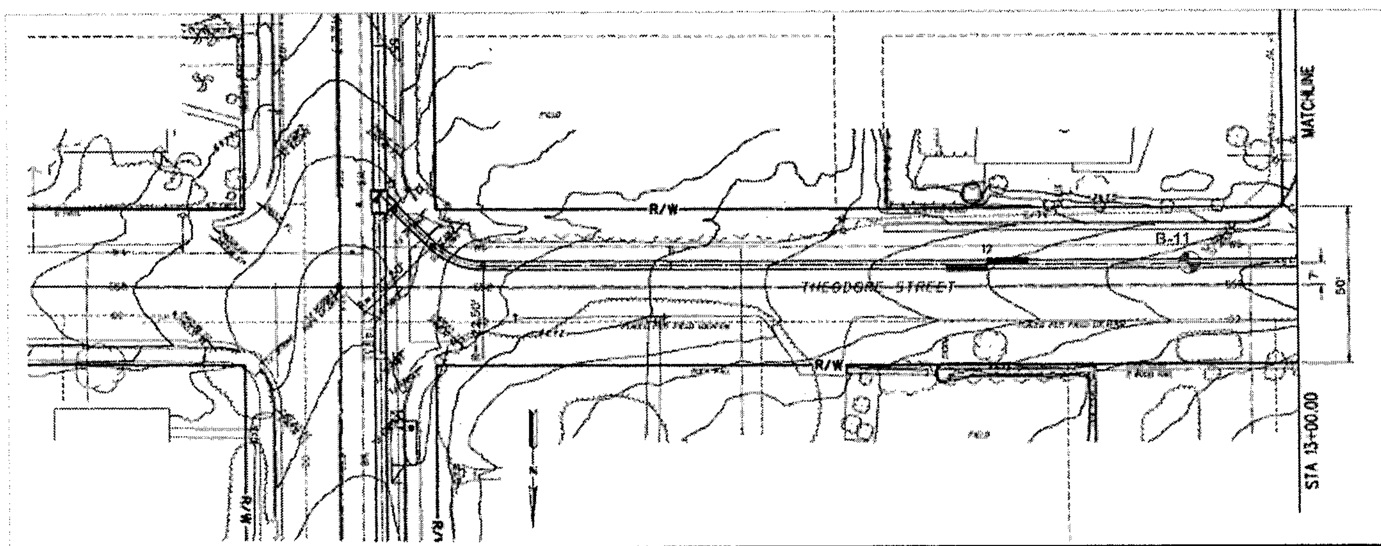
= Approximate Location of Boring

INLAND FOUNDATION ENGINEERING, INC. 1310 South Santa Fe Avenue San Jacinto, California (951) 654-1555 FAX (951) 654-0551		
DRAWN BY: ES	JOB NO.: R206-017	
SCALE: 1" = 40'	DATE: May 2014	A-18





Riverside County Flood Control and Water Conservation District
Banning MDP Line D-2 and D-2A



LEGEND

= Approximate Location of Boring

INLAND FOUNDATION ENGINEERING, INC.
1310 South Santa Fe Avenue
San Jacinto, California
(951) 654-1555 FAX (951) 654-0551

DRAWN BY: ES	JOB NO.: R206-017	
SCALE: 1" = 40'	DATE: May 2014	A-19

APPENDIX B

LABORATORY DATA

Representative bulk soil samples were obtained in the field and returned to our laboratory for additional observations and testing.

CLASSIFICATION AND COMPACTION TESTING

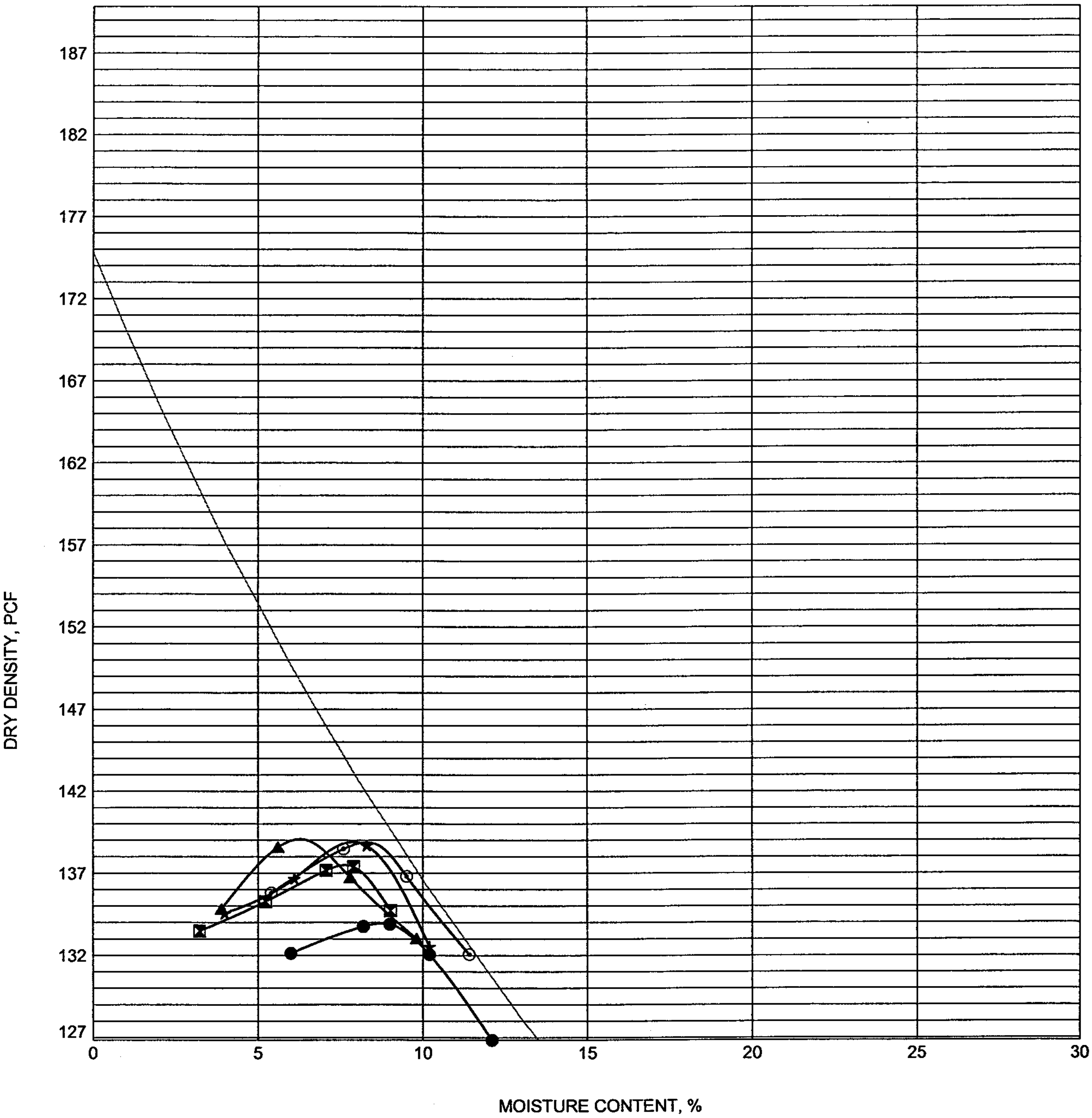
Unit Weight and Moisture Content: Each ring sample was weighed and measured to evaluate its unit weight. A small portion of each sample was then subjected to testing to evaluate its moisture content. This testing was performed per the current ASTM Standards D2937 and D2216. This was used in order to evaluate the dry density of the soil in its natural condition. The results of this testing are shown on the Boring Logs (Figure Nos. A-3 through A-13).

Maximum Density-Optimum Moisture: Representative soil types were selected for maximum density tests. This testing was performed per the current ASTM Standard D1557 test method A. The results of this testing are presented graphically on Figure No. B-3. The maximum densities are compared to the field densities of the soil to evaluate the existing relative compaction to the soil. This is shown on the boring logs, and is useful in estimating the strength and compressibility of the soil.

Classification Testing: Five soil samples were selected for classification testing. This testing consists of mechanical grain size analyses and Atterberg Limit tests. This testing was performed per the current ASTM Standards D422 -63(2007) and D4318-10. These tests provide information for developing classifications for the soil in accordance with the Unified Classification System. This classification system categorizes the soil into groups having similar engineering characteristics. The results of this testing are very useful in detecting variations in the soils. Most of the split-spoon samples obtained were too disturbed for accurate density testing due to their gravelly nature. The results of this testing are presented on Figure Nos. B 4.

GENERAL

All laboratory testing has been conducted in conformance with the applicable ASTM test methods by personnel trained and supervised in conformance with our QA/QC policy. Our test data only relates to the specific soils tested. Soil conditions typically vary and any significant variations should be reported to our laboratory for review and possible testing. The data presented in this report are for the use of Riverside County Flood Control and Water Conservation District only and may not be reproduced or used by others without written approval of Inland Foundation Engineering, Inc.



	Specimen Identification		Classification	Max.Density	MC%
●	**B-01**	**1.5**	**POORLY GRADED SAND with SILT and GRAVEL SP-SM**	**134.0**	**9.0**
⊠	**B-04**	**4.0**	**POORLY GRADED SAND with SILT and GRAVEL SP-SM**	**137.5**	**7.5**
▲	**B-07**	**0.7**	**SILTY GRAVEL with SAND GM**	**139.0**	**6.5**
★	**B-09**	**7.0**	**WELL-GRADED GRAVEL with SILT and SAND GW-GM**	**139.0**	**8.0**
⊙	**B-11**	**0.0**	**SILTY SAND with GRAVEL SM**	**139.0**	**8.5**

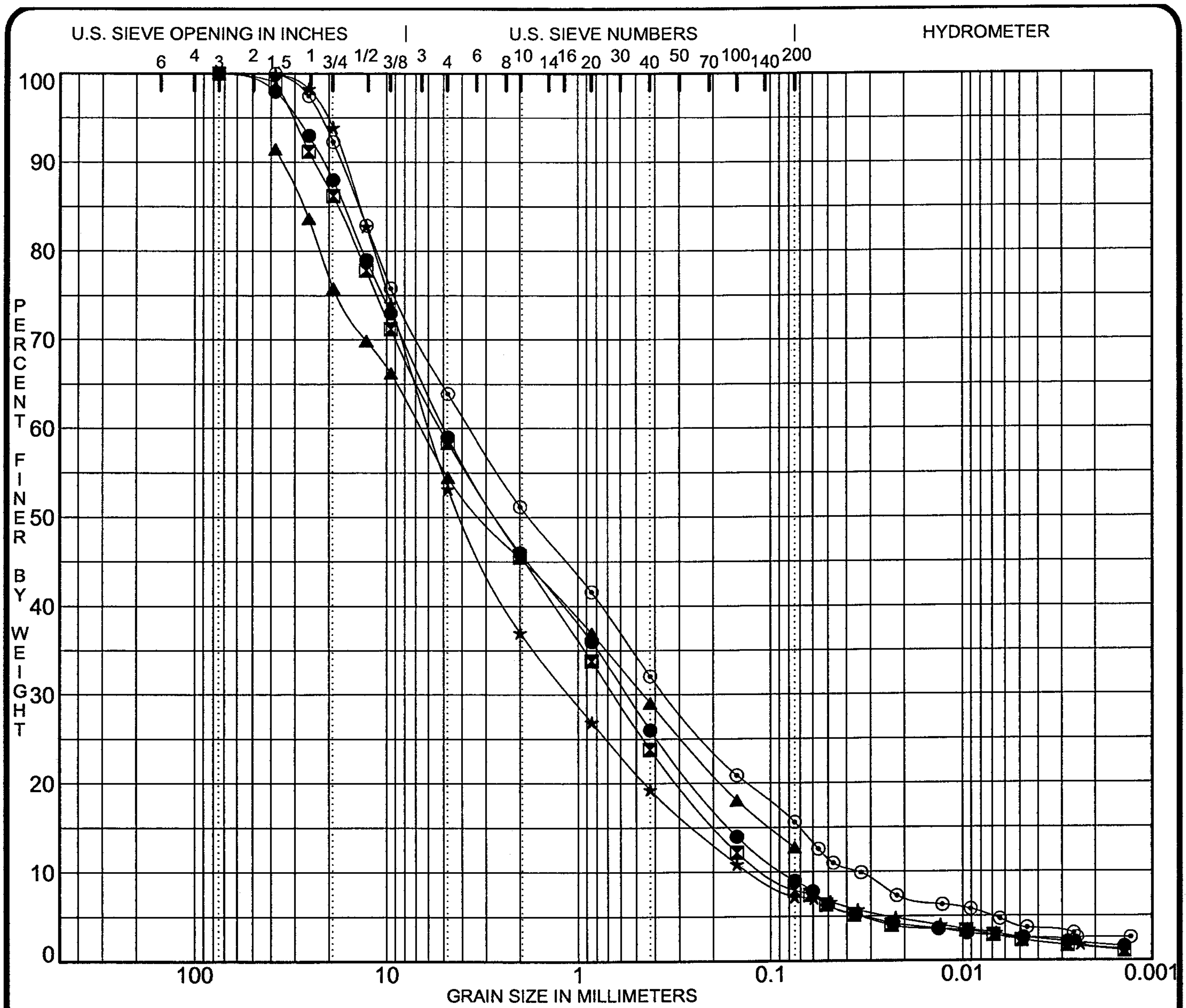
PROJECT MDP Lines D-2 & D-2A
Hargrave St.

PROJECT NO. R206-017
DATE May 14, 2014

MAXIMUM DENSITY-OPTIMUM MOISTURE CURVES

Inland Foundation Engineering, Inc.
San Jacinto, CA

FIGURE NO. B-3



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	LL	PL	S.E.	Cc	Cu
●	B-01	1.5	POORLY GRADED SAND with SILT and GRAVEL SP-SM	17	16	47	0.73	57.9
⊠	B-04	4.0	POORLY GRADED SAND with SILT and GRAVEL SP-SM	17	16	44	0.78	49.2
▲	B-07	0.7	SILTY GRAVEL with SAND GM	16	15	43		
★	B-09	7.0	WELL-GRADED GRAVEL with SILT and SAND GW-GM	16	15	33	1.62	47.0
⊙	B-11	0.0	SILTY SAND with GRAVEL SM	17	15	37	0.97	104.8

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-01	1.5	75.00	4.99	0.561	0.0862	41.0	50.0	6.4	2.6
⊠	B-04	4.0	75.00	5.18	0.653	0.1052	41.6	50.5	5.6	2.3
▲	B-07	0.7	38.00	6.58	0.462		37.0	41.7	12.8	
★	B-09	7.0	38.00	5.95	1.105	0.1267	46.8	46.0	4.5	2.7
⊙	B-11	0.0	38.00	3.64	0.350	0.0347	36.1	48.3	11.6	4.0

PROJECT MDP Lines D-2 & D-2A
Hargrave St.

PROJECT NO. R206-017
DATE May 14, 2014

GRADATION CURVES

Inland Foundation Engineering, Inc.

San Jacinto, CA

FIGURE NO. B-4

APPENDIX C

SOIL CORROSIVITY EVALUATION – HDR | SCHIFF

HDR | SCHIFF

www.hdrinc.com/schiff
Corrosion Control and Condition Assessment (C3A) Department

SOIL CORROSIVITY EVALUATION

for the

BANNING MDP, LINE D-2 AND LINE D-2A STORM DRAIN

in

BANNING, CALIFORNIA

prepared for

INLAND FOUNDATION ENGINEERING, INC.
1310 South Santa Fe Avenue, P.O. Box 937
San Jacinto, CA 92581

PROJECT MANAGER: MR. DAN LIND, P.E., C.E.G.

prepared by

HDR | SCHIFF
Consulting Corrosion Engineers
431 West Baseline Road
Claremont, California 91711

HDR #231655

April 25, 2014

EXECUTIVE SUMMARY

The proposed storm drain construction consists of approximately 5,650 linear feet of 30- to 60-inch diameter reinforced concrete pipe (RCP). Preliminary project plans prepared by the District indicated that the cover depth over the storm drain ranges from approximately 2 to 8 feet. The planned invert depth of the storm drain ranges from approximately 5 to 15 feet below the existing ground surface.

The proposed Line D-2 storm drain will be located along Hargrave Street, between Ramsey Street and Indian School Lane. The Line D-2A storm drain will be located along Theodore Street, between Hargrave Street and Florida Street.

A soil corrosivity analysis along the proposed storm drain alignment was requested. Laboratory tests on six soil samples selected by HDR Engineering, Inc. (HDR|Schiff) from boring logs provided for the Banning MDP, Line D-2 and LineD-2A Storm Drain project have been completed. The purpose of these tests was to determine soil corrosivity regarding the proposed storm drain and concrete structures.

Groundwater was reported to be greater than 100 feet deep.

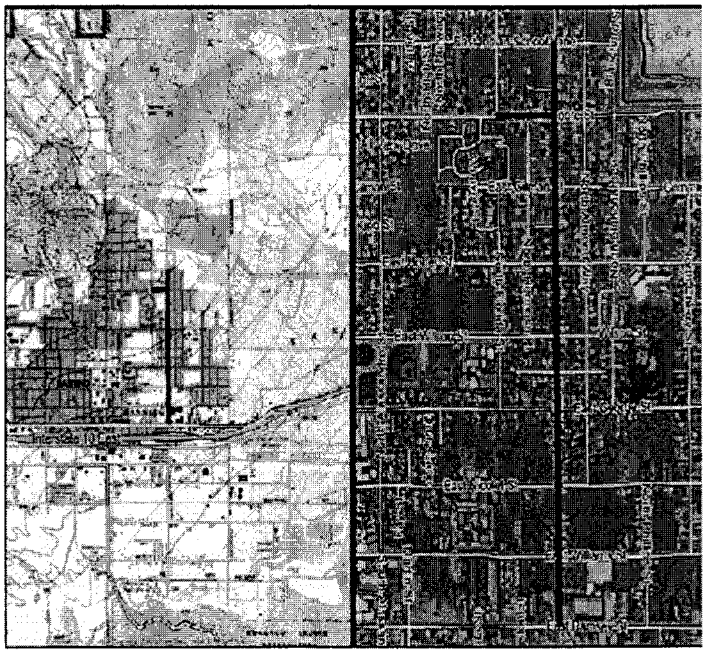
The soils along the proposed alignment are classified as mildly to moderately corrosive to ferrous metals.

Based on this investigation, reinforced concrete construction materials are satisfactory for the entire alignment. From a corrosion standpoint, any type of ASTM C150 Portland cement may be used for concrete structures and pipe because the sulfate concentration is negligible, 0 to 0.1 percent. Standard concrete cover over reinforcing steel may be used for concrete structures and pipe in contact with these soils due to the low chloride concentration found onsite.

TABLE OF CONTENTS

INTRODUCTION

A soil corrosivity analysis along the proposed storm drain alignment was requested. Laboratory tests on six soil samples, selected by HDR|Schiff from boring logs provided for the Banning MDP, Line D-2 and LineD-2A Storm Drain project, have been completed under laboratory number 14-0245SCS. The purpose of these tests was to determine soil corrosivity regarding the proposed storm drain and concrete structures.



The proposed construction consists of approximately 5,650 lineal feet of underground storm drain. The storm drain will be constructed of reinforced concrete pipe (RCP) with mainline pipe diameters varying between 30 and 60 inches. Depth of cover along the storm drain ranges from 2–8 feet.

The proposed Line D-2 storm drain will be located along Hargrave Street, between Ramsey Street and Indian School Lane. The Line D-2A storm drain will be located along Theodore Street, between Hargrave Street and Florida Street. Groundwater was reported to be greater than 100 feet deep.

The scope of this study is limited to a determination of soil corrosivity and general corrosion control recommendations for materials planned for construction.

TEST PROCEDURES

Laboratory Tests on Soil Samples

The electrical resistivity of each of the eight samples was measured in a soil box per ASTM G187 in its as-received condition and again after saturation with distilled water. Resistivities are at about their lowest value when the soil is saturated. The pH of the saturated samples was measured per CTM 643. A 5:1 water:soil extract from each sample was chemically analyzed for the major soluble salts commonly found in soil per ASTM D4327 and D6919. Laboratory analysis was performed under HDR|Schiff number 14-0245SCS and the test results are shown in Table 1 in the Appendix.

DISCUSSION

A major factor in determining soil corrosivity is electrical resistivity. The electrical resistivity of a soil is a measure of its resistance to the flow of electrical current. Corrosion of buried metal is an electrochemical process in which the amount of metal loss due to corrosion is directly proportional to the flow of electrical current (DC) from the metal into the soil. Corrosion currents, following Ohm's Law, are inversely proportional to soil resistivity. Lower electrical resistivities result from higher moisture and soluble salt contents and indicate corrosive soil.

A correlation between electrical resistivity and corrosivity toward ferrous metals is (Romanoff, 1989):

Soil Resistivity in ohm-centimeters	Corrosivity Category
Greater than 10,000	Mildly Corrosive
2,001 to 10,000	Moderately Corrosive
1,001 to 2,000	Corrosive
0 to 1,000	Severely Corrosive

Other soil characteristics that may influence corrosivity towards metals are pH, soluble salt content, soil types, aeration, anaerobic conditions, and site drainage.

Electrical resistivities were in the mildly corrosive category with as-received moisture. When saturated, the resistivities were in the mildly to moderately corrosive categories. The resistivities dropped considerably with added moisture because the samples were dry as-received.

Soil pH values varied from 7.6 to 8.5. This range is mildly to strongly alkaline.[1] Soil with a pH greater than 8.5 may be aggressive to aluminum.

The soluble salt content of the samples was low.

Ammonium was detected in low concentrations. The nitrate concentration was high enough to be aggressive to copper.

Tests were not made for sulfide and negative oxidation-reduction (redox) potential because these samples did not exhibit characteristics typically associated with anaerobic conditions.

CONCLUSIONS

This soil is classified as moderately corrosive to ferrous metals, aggressive to copper, and aggressive to aluminum.

[1] *Romanoff, Melvin. Underground Corrosion, NBS Circular 579. Reprinted by NACE. Houston, TX, 1989, p. 8.*

Base on this investigation, reinforced concrete construction materials are satisfactory for the entire alignment. From a corrosion standpoint, any type of ASTM C150 Portland cement may be used for concrete structures and pipe because the sulfate concentration is negligible, 0 to 0.1 percent. Standard concrete cover over reinforcing steel may be used for concrete structures and pipe in contact with these soils due to the low chloride concentration found onsite.

RECOMMENDATIONS

Concrete Structures and Reinforced Concrete Pipe

1. From a corrosion standpoint, any type of ASTM C150 Portland cement may be used for concrete structures and pipe because the sulfate concentration is negligible, 0 to 0.1 percent.

2. Standard concrete cover over reinforcing steel may be used for concrete structures and pipe in contact with these soils due to the low chloride concentration found onsite.

All Pipe

1. On all pipes, appurtenances, and fittings not protected by cathodic protection or encased in concrete, coat pipe specials such as valves, bolts, flange joints, joint harnesses, and flexible couplings with wax tape per AWWA C217 after assembly.

2. Where metallic pipelines penetrate concrete structures such as building floors, vault walls, and thrust blocks use plastic sleeves, rubber seals, or other dielectric material to prevent pipe contact with the concrete and reinforcing steel.

CLOSURE

The analysis and recommendations presented in this report are based upon data obtained from the laboratory samples. This report does not reflect variations that may occur across the site or due to the modifying effects of construction. If variations appear, HDR|Schiff should be notified immediately so that further evaluation and supplemental recommendations can be provided.

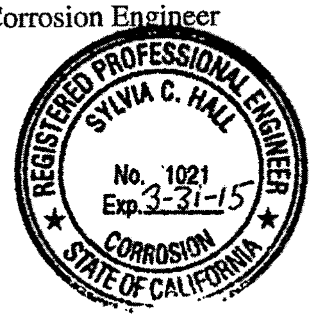
Our services have been performed with the usual thoroughness and competence of the engineering profession. No other warranty or representation, either expressed or implied, is included or intended.

Please call if you have any questions.

Respectfully Submitted,
HDR ENGINEERING, INC.

Leobardo Solis
Laboratory Services Manager

Sylvia C. Hall, P.E.
Sr. Corrosion Engineer



231655_Rpt_LS-rev00_SCH

WORKS CITED

Romanoff, M. (1989). Underground Corrosion, National Bureau of Standards (NBS) Circular 579. Houston, TX, United States of America: Reprinted by NACE.

Table 1 - Laboratory Tests on Soil Samples

Inland Foundation Engineering, Inc.
Riverside County Flood Control
HDR|Schiff #14-0245LAB
17-Apr-14

Sample ID			B-1 @ 1.5-13'	B-2 @ 9-10'	B-4 @ 15-16'	B-7 @ 0.67-8'	B-9 @ 7-16'
Resistivity		**Units**					
as-received		ohm-cm	4,400,000	1,200,000	1,360,000	2,480,000	124,000
saturated		ohm-cm	7,600	25,600	20,400	7,600	17,600
pH			8.3	8.5	8.3	7.6	8.3
Electrical Conductivity		mS/cm	0.08	0.03	0.03	0.06	0.07
Chemical Analyses							
Cations							
calcium	Ca^{2+}	mg/kg	71	13	20	38	51
magnesium	Mg^{2+}	mg/kg	7.5	2.5	6.5	6.5	9.1
sodium	Na^{1+}	mg/kg	12	17	9	13	19
potassium	K^{1+}	mg/kg	9.0	2.3	2.5	12	5.5
Anions							
carbonate	CO_3^{2-}	mg/kg	3.0	ND	ND	ND	3.0
bicarbonate	HCO_3^{1-}	mg/kg	110	55	61	64	114
fluoride	F^{1-}	mg/kg	ND	ND	0.5	ND	0.8
chloride	Cl^{1-}	mg/kg	8.8	3.6	4.3	18	4.6
sulfate	SO_4^{2-}	mg/kg	18	4.1	8.1	20	11
phosphate	PO_4^{3-}	mg/kg	3.7	ND	ND	2.0	ND
Other Tests							
ammonium	NH_4^{1+}	mg/kg	1.0	ND	ND	ND	ND
nitrate	NO_3^{1-}	mg/kg	54	ND	11	42	17
sulfide	S^{2-}	qual	na	na	na	na	na
Redox		mV	na	na	na	na	na

Electrical conductivity in millisiemens/cm and chemical analysis were made on a 1:5 soil-to-water extract.
mg/kg = milligrams per kilogram (parts per million) of dry soil.
Redox = oxidation-reduction potential in millivolts
ND = not detected
na = not analyzed

Table 1 - Laboratory Tests on Soil Samples

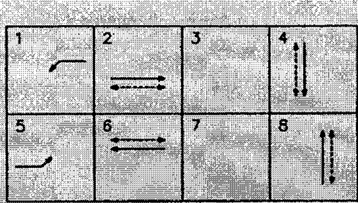
Inland Foundation Engineering, Inc.
Riverside County Flood Control
HDR|Schiff #14-0245LAB
17-Apr-14

Sample ID			B-11 @ 0-9'
Resistivity		**Units**	
as-received		ohm-cm	328,000
saturated		ohm-cm	10,000
pH			8.1
Electrical Conductivity		mS/cm	0.08
Chemical Analyses			
Cations			
calcium	Ca^{2+}	mg/kg	52
magnesium	Mg^{2+}	mg/kg	7.1
sodium	Na^{1+}	mg/kg	26
potassium	K^{1+}	mg/kg	7.3
Anions			
carbonate	CO_3^{2-}	mg/kg	ND
bicarbonate	HCO_3^{1-}	mg/kg	119
fluoride	F^{1-}	mg/kg	1.1
chloride	Cl^{1-}	mg/kg	8.1
sulfate	SO_4^{2-}	mg/kg	36
phosphate	PO_4^{3-}	mg/kg	3.0
Other Tests			
ammonium	NH_4^{1+}	mg/kg	ND
nitrate	NO_3^{1-}	mg/kg	36
sulfide	S^{2-}	qual	na
Redox		mV	na

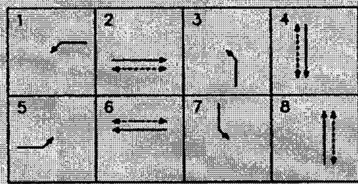
Electrical conductivity in millisiemens/cm and chemical analysis were made on a 1:5 soil-to-water extract.
mg/kg = milligrams per kilogram (parts per million) of dry soil.
Redox = oxidation-reduction potential in millivolts
ND = not detected
na = not analyzed

APPENDIX "D"

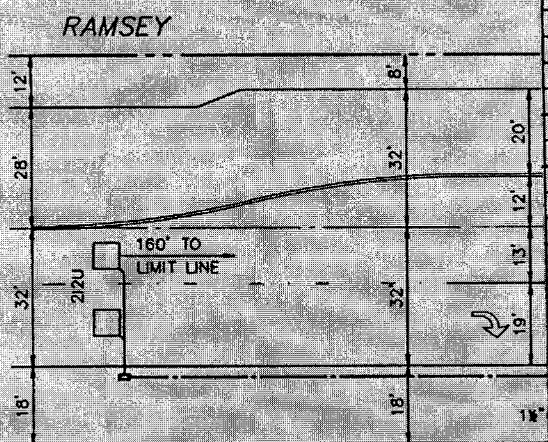
CITY OF BANNING
TRAFFIC SIGNAL PLAN
RAMSEY STREET AT HARGRAVE STREET (RS 109)



(1) PROPOSED PHASE DIAGRAM



(2) FUTURE PHASE DIAGRAM



CONDUCTOR SCHEDULE

CIRCUIT	RUN NUMBER 1	2	3	4	5	*6	7	8	9
ø1	–	–	3	3	–	3	–	3	–
ø2	–	3	–	3	–	3	–	3	–
ø3	–	–	–	–	3	3	–	3	–
ø4	–	–	–	3	–	3	–	3	–
ø5	–	3	–	3	–	3	3	3	–
ø6	–	–	–	–	–	3	–	3	–
ø7	3	3	–	3	–	3	–	3	–
ø8	–	–	–	–	–	–	–	3	–
ø2P	–	2	2	2	–	2	–	2	–
ø4P	–	–	–	2	2	2	–	2	–
ø6P	–	–	–	–	–	2	2	2	–
ø8P	2	2	–	2	–	2	–	2	–
ø2 PPB	1	1	–	1	–	1	–	1	–
ø4 PPB	–	–	1	1	–	1	–	1	–
ø6 PPB	–	–	–	–	1	1	–	1	–
ø8 PPB	–	1	–	1	–	1	1	1	–
PPB COMMON	1	1	1	1	1	1	1	1	–
SPARES	3	3	3	3	3	3	3	3	–
TOTAL #14	10	19	10	28	10	37	10	40	–
I.I.S.N.S.	–	2	–	2	–	2	–	–	2
TOTAL #12	–	2	–	2	–	2	–	–	2
LUMINAIRE	–	2	–	2	–	2	–	–	2
SIGN & SIGNAL COMMON	1	1	1	1	1	1	1	1	–
TOTAL #10	1	3	1	3	1	3	1	1	2
SERVICE	–	–	–	–	–	–	–	2	2
TOTAL #8	–	–	–	–	–	–	–	2	2
ø1 DET	–	–	–	–	–	–	1	1	–
ø2 DET	–	–	3	3	–	3	–	3	–
ø3 DET	1	1	–	1	–	1	–	1	–
ø4 DET	–	–	–	–	2	2	–	2	–
ø5 DET	–	–	1	1	–	1	–	1	–
ø6 DET	–	–	–	–	–	–	3	3	–
ø7 DET	–	–	–	–	1	1	–	1	–
ø8 DET	2	2	–	2	–	2	–	2	–
TOTAL DLC	3	3	4	7	3	10	4	14	–
IDUIT SIZE	2"	2"(E)	2"	2"(E)	2"	3"	2"	3"	2"

EXISTING CONDUIT
CONDUIT RUN TO INCLUDE INTERCONNECT CABLE

GENERAL NOTES:

1. ALL WORK AND MATERIAL SHALL CONFORM TO THE CALTRANS STA SPECIFICATIONS, JULY 1992 AND THE SPECIAL PROVISIONS.
2. IT SHALL BE CONTRACTOR'S RESPONSIBILITY TO VERIFY THE EXIST LOCATION OF ALL UNDERGROUND UTILITIES.
3. ALL SIGNAL HEADS SHALL BE 12". LEFT TURN HEADS SHALL HAVE ARROWS.
4. PEDESTRIAN HEADS SHALL BE THE INTERNATIONAL SYMBOL.
5. PEDESTRIAN PUSH BUTTON SHALL BE TYPE B.
6. PULL BOXES SHALL BE NO. 5 UNLESS OTHERWISE NOTED ON PLAN
7. ALL CONDUITS SHALL BE RIGID STEEL.
8. ALL LOOP DETECTORS SHALL BE 6'X6' TYPE A. DETECTORS SHALL UNLESS OTHERWISE NOTED ON PLAN. LEAD LOOP SHALL ENCROACH
9. ALL SIGNAL EQUIPMENT SHALL BE WIRED IN ACCORDANCE WITH THI THIS PROJECT. THE OPERATION SHALL BE IN ACCORDANCE WITH TH

NT SCHEDULE

NG	PED SIGNAL MOUNTING	PED PUSH BUTTON ø	ARROW	STREET NAME SIGN LEGEND	POLE LOCATION A	B	C	D	E
T	SP-1-T	4	←	HARGRAVE ST	–	–	–	5'	–
T	SP-1-T	6	→	–	0'	–	–	–	–
T	SP-1-T	6	←	RAMSEY ST	–	–	3'	–	–
T	SP-1-T	8	→	–	4'	–	–	–	–
T	SP-1-T	8	←	HARGRAVE ST	–	–	4'	–	5'
T	SP-1-T	2	→	–	0'	–	–	–	–
T	SP-1-T	2	←	RAMSEY ST	–	–	3'	–	–
T	SP-1-T	4	→	–	5'	–	–	–	–

ates, Inc.
Civil - CAD
Suite 113
2708

CITY OF BANNING

TRAFFIC SIGNAL PLAN
RAMSEY STREET AT
HARGRAVE STREET

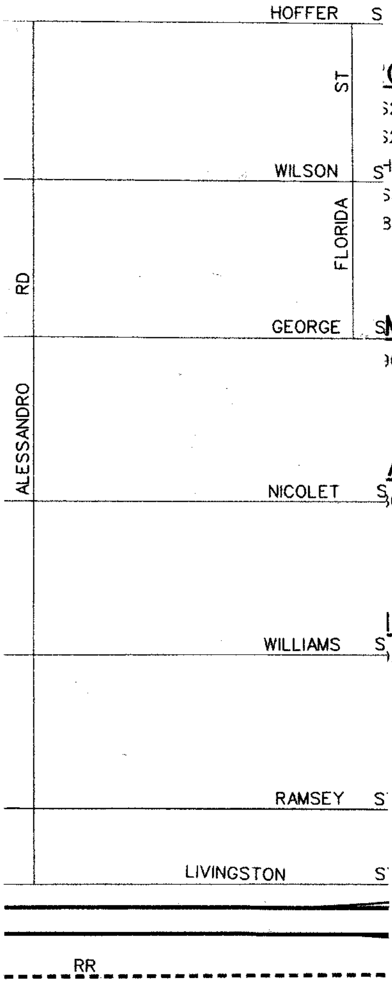
W.O. | FOR | F.B.

SHEET NO. 5 OF 11 SHTS
DWG NO.

RS 109

DISTRICT

INDEX



'CFC STD DRAWINGS

;228	JUNCTION STRUCTURE NO. 3
;229	JUNCTION STRUCTURE NO. 4
-1252	MANHOLE NO. 2
;301	TRANSITION STRUCTURE NO. 1
316	CONCRETE BULKHEAD

MERICAN PUBLIC WORKS ASSOCIATION STANDARDS

30–0	PRECAST REINFORCED CONCRETE BOX

ALTRANS STANDARD PLANS 2010

30	CAST–IN–PLACE REINFORCED CONCRETE SINGLE BOX CULVERT

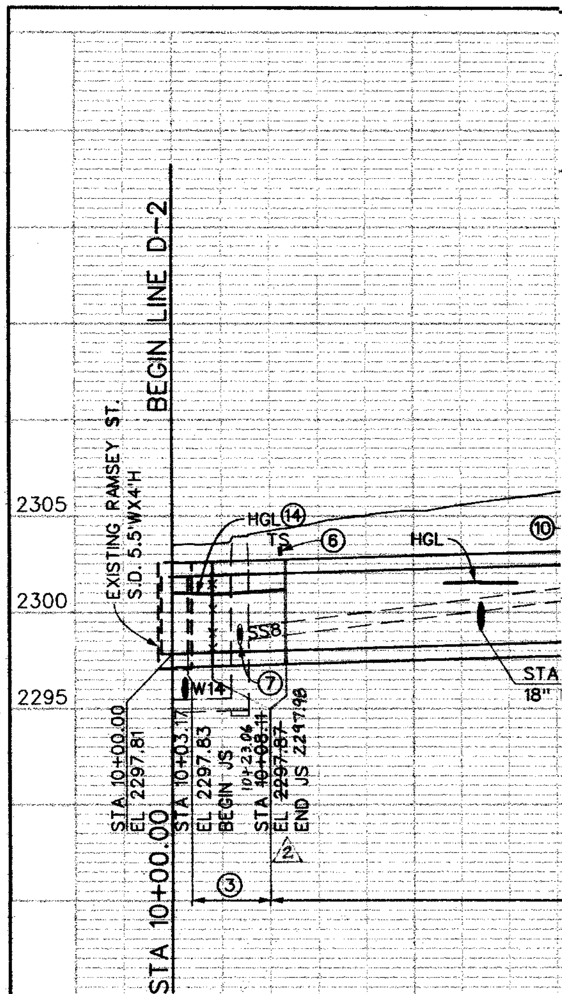
IVERSIDE COUNTY STD DRAWINGS

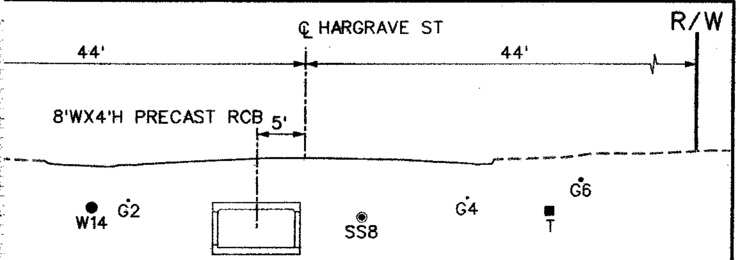
). 300	CURB INLET CATCH BASIN

LC

PROFESSIONAL ENGINEER
EN D. WILLIAMS
No. 32336
CIVIL
E OF CALIFORNIA

CITY C APPROVED BY: CITY ENGINEER DATE: 8/1	D BY: MANAGER–CHIEF ENGINEER 8/13/14	BANNING MDP LINE D–2 (STAGES 1 & 2) & LATERAL D-2A STAGE 1 TITLE SHEET	PROJECT NO. 5-0-00169 5-0-00172 DRAWING NO. 5–0223 SHEET NO. 1 OF 6

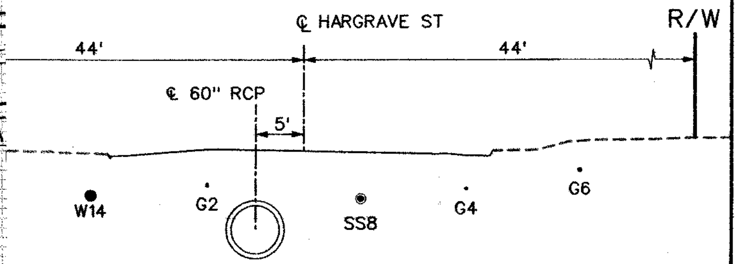




SECTION AT STA 12+00

TYPICAL FROM STA 10+08.11 TO 12+20

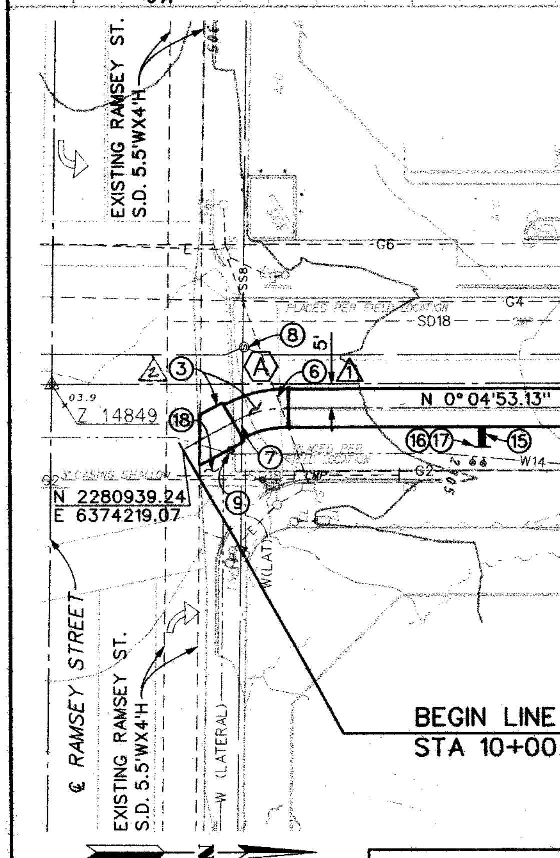
10' 0 10'



SECTION AT STA 13+00

TYPICAL FROM STA 12+50 TO 14+00

10' 0 10'



PLAN

20' 0 20'

ES

LL PRECAST RCB PER APWA STANDARD NO. 390-1,
_ SCHEDULE 0' TO 2' OF COVER AND STEEL COVER 2.5".

LL REINFORCED CONCRETE PIPE.

TRUCT RCB TO RCB JUNCTION STRUCTURE PER DETAIL ON SHEETS 5-6, AND CFC STD M819.

TRUCT TS NO. 1. PER CALTRANS D80 REINFORCEMENT SCHEDULE FOR A
X 4'H (10FT EARTH COVER) RCB.

USED

SE, AND VERIFY ENCASED TRAFFIC SIGNAL CONDUIT CLEARANCE WITH
OSED RCB. IF IN DIRECT CONFLICT, AS DETERMINED BY ENGINEER, RELOCATE
FIC SIGNAL CONDUIT PER CITY OF BANNING TRAFFIC SIGNAL PLAN
SEY ST. AT HARGRAVE ST.) RS 109.

PLUG, AND REMOVE INTERFERING PORTION OF EXISTING 8" VCP
R LINE.

EAST SEWER LINE IN MANHOLE SHAFT WITH CLASS B CONCRETE.

CATE INTERFERING WATER VALVE 10 FEET EAST OF JUNCTION STRUCTURE
CITY OF BANNING WATER STANDARDS. COORDINATE WITH CITY OF BANNING
NSPECTION/APPROVAL.

NG 2" WATER LINE TO BE RELOCATED BY CITY OF BANNING.

ECT IN PLACE EXISTING 3" AND 4" PVC ELECTRICAL LINES.

USED

USED

SHOWN FOR THE ULTIMATE CONDITION OF THE RAMSEY ST. S.D.

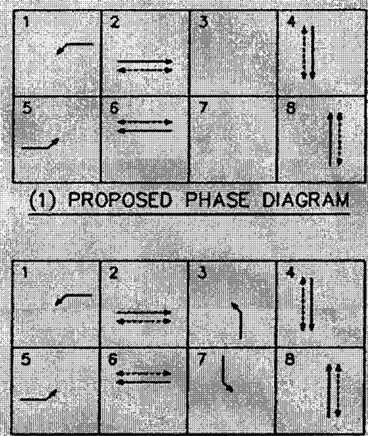
TRUCT JS NO. 3 PER STD JS 228. A=90, B=18". CONSTRUCT 4 LF – 18"
CLASS IV, S=0.0502.

LL CONCRETE BULKHEAD PER STD M816.

ACT RCFC & WCD 48 HOURS PRIOR TO PLACEMENT OF BULKHEAD TO
DINATE SURVEY CREW TO OBTAIN X, Y, Z COORDINATES.

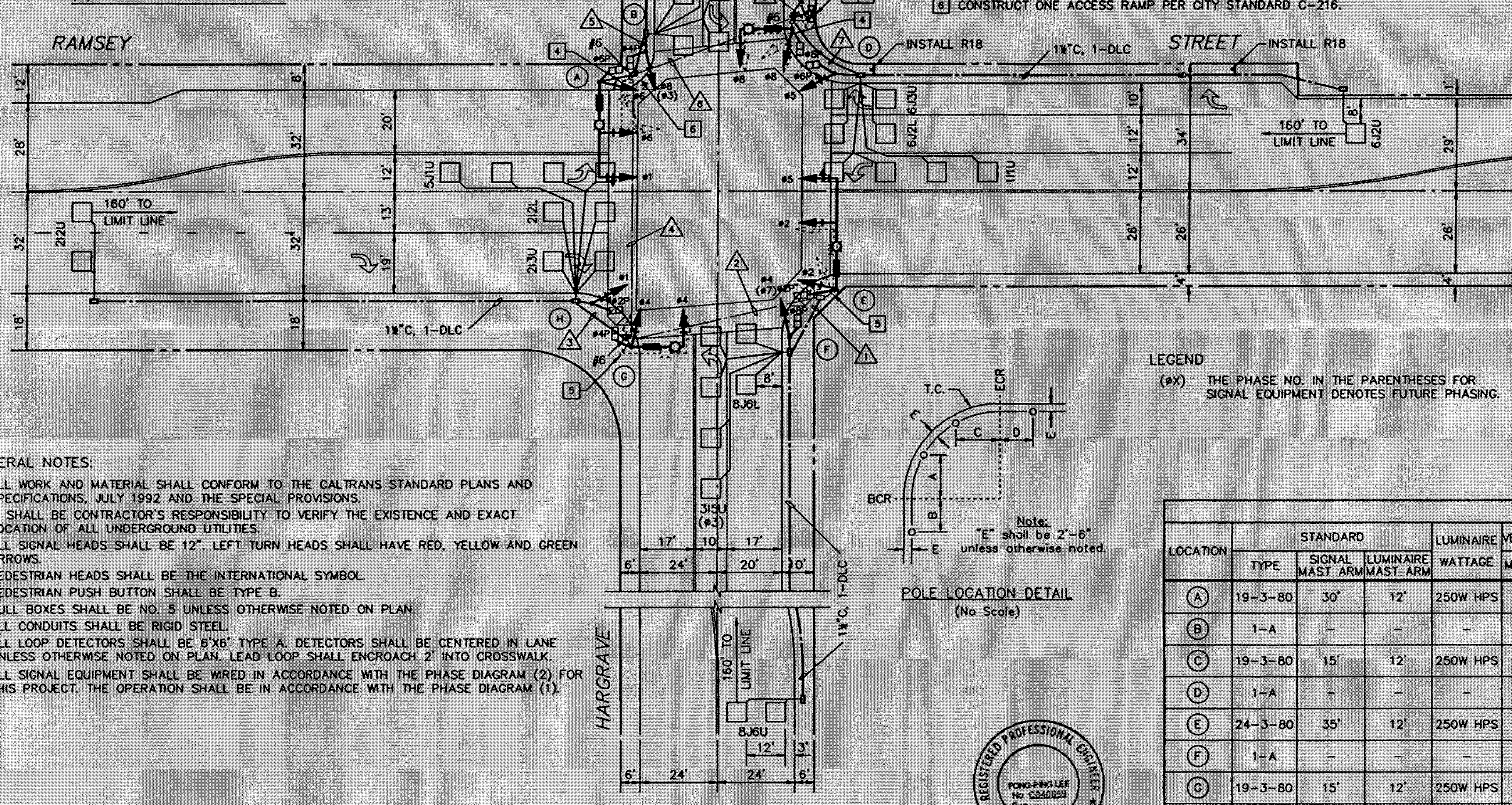
JT AND REMOVE INTERFERING PORTION OF CROSS GUTTER AND SPANDREL
OLD JOINTS. REPLACE PER BANNING STD C-211, EXCEPT THICKNESS SHALL
CREASE TO MEET TOP OF RCB JUNCTION STRUCTURE.

CITY OF BANN APPROVED BY: [signature] CITY ENGINEER DATE: 8-2-16	BANNING MDP LINE D-2 (STAGE 1) STA 10+00 TO STA 14+00 PLAN AND PROFILE	PROJECT NO. 5-0-00169-1 DRAWING NO. 5-0223	SHEET NO. 2A OF 6



(1) PROPOSED PHASE DIAGRAM

(2) FUTURE PHASE DIAGRAM



PROJECT NOTES:

1. REMOVE AND SALVAGE EXISTING CONTROLLER ASSEMBLY AND CABINET.
2. INSTALL MODEL 170 CONTROLLER ASSEMBLY IN TYPE 332 CABINET.
3. MODIFY EXISTING SERVICE TO 120/240V TYPE "E" SERVICE WITH BREAKER ASSIGNMENTS AS FOLLOWS:
   MAIN: 100A LIGHTING: 20A
   SIGNAL: 50A IISNS: 20A
4. REMOVE AND SALVAGE EXISTING SIGNAL STANDARD, MAST ARM, LUMINAIRE ARM, LUMINAIRE AND SIGNAL HEADS.
5. RELOCATE EXISTING SIGNAL STANDARD, MAST ARM AND LUMINAIRE ARM TO RAMSEY STREET AND 4TH STREET (SEE SHEET 3). REMOVE AND SALVAGE LUMINAIRE AND SIGNAL HEADS.
6. CONSTRUCT ONE ACCESS RAMP PER CITY STANDARD C-216.

GENERAL NOTES:

1. ALL WORK AND MATERIAL SHALL CONFORM TO THE CALTRANS STANDARD PLANS AND SPECIFICATIONS, JULY 1992 AND THE SPECIAL PROVISIONS.
2. IT SHALL BE CONTRACTOR'S RESPONSIBILITY TO VERIFY THE EXISTENCE AND EXACT LOCATION OF ALL UNDERGROUND UTILITIES.
3. ALL SIGNAL HEADS SHALL BE 12". LEFT TURN HEADS SHALL HAVE RED, YELLOW AND GREEN ARROWS.
4. PEDESTRIAN HEADS SHALL BE THE INTERNATIONAL SYMBOL.
5. PEDESTRIAN PUSH BUTTON SHALL BE TYPE B.
6. PULL BOXES SHALL BE NO. 5 UNLESS OTHERWISE NOTED ON PLAN.
7. ALL CONDUITS SHALL BE RIGID STEEL.
8. ALL LOOP DETECTORS SHALL BE 6'X6' TYPE A. DETECTORS SHALL BE CENTERED IN LANE UNLESS OTHERWISE NOTED ON PLAN. LEAD LOOP SHALL ENCROACH 2' INTO CROSSWALK.
9. ALL SIGNAL EQUIPMENT SHALL BE WIRED IN ACCORDANCE WITH THE PHASE DIAGRAM (2) FOR THIS PROJECT. THE OPERATION SHALL BE IN ACCORDANCE WITH THE PHASE DIAGRAM (1).

CONDUCTOR SCHEDULE

AWG	CIRCUIT	RUN NUMBER 1	2	3	4	5	*6	7	8	9
# 14	ø1	–	–	3	3	–	3	–	3	–
	ø2	–	3	–	3	–	3	–	3	–
	ø3	–	–	–	–	3	3	–	3	–
	ø4	–	–	–	3	–	3	–	3	–
	ø5	–	3	–	3	–	3	3	3	–
	ø6	–	–	–	–	–	3	–	3	–
	ø7	3	3	–	3	–	3	–	3	–
	ø8	–	–	–	–	–	–	–	3	–
	ø2P	–	2	2	2	–	2	–	2	–
	ø4P	–	–	–	2	2	2	–	2	–
	ø6P	–	–	–	–	–	2	2	2	–
	ø8P	2	2	–	2	–	2	–	2	–
	ø2 PPB	1	1	–	1	–	1	–	1	–
	ø4 PPB	–	–	1	1	–	1	–	1	–
	ø6 PPB	–	–	–	–	1	1	–	1	–
	ø8 PPB	–	1	–	1	–	1	1	1	–
	PPB COMMON	1	1	1	1	1	1	1	1	–
	SPARES	3	3	3	3	3	3	3	3	–
	TOTAL #14	10	19	10	28	10	37	10	40	–
# 12	I.I.S.N.S.	–	2	–	2	–	2	–	–	2
	TOTAL #12	–	2	–	2	–	2	–	–	2
# 10	LUMINAIRE	–	2	–	2	–	2	–	–	2
	SIGN & SIGNAL COMMON	1	1	1	1	1	1	1	1	–
	TOTAL #10	1	3	1	3	1	3	1	1	2
# 8	SERVICE	–	–	–	–	–	–	–	2	2
	TOTAL #8	–	–	–	–	–	–	–	2	2
DLC	ø1 DET	–	–	–	–	–	–	1	1	–
	ø2 DET	–	–	3	3	–	3	–	3	–
	ø3 DET	1	1	–	1	–	1	–	1	–
	ø4 DET	–	–	–	–	2	2	–	2	–
	ø5 DET	–	–	1	1	–	1	–	1	–
	ø6 DET	–	–	–	–	–	–	3	3	–
	ø7 DET	–	–	–	–	1	1	–	1	–
	ø8 DET	2	2	–	2	–	2	–	2	–
	TOTAL DLC	3	3	4	7	3	10	4	14	–
CONDUIT SIZE		2"	2"(E)	2"	2"(E)	2"	3"	2"	3"	2"

(E) EXISTING CONDUIT
* CONDUIT RUN TO INCLUDE INTERCONNECT CABLE

EQUIPMENT SCHEDULE

LOCATION	STANDARD TYPE	SIGNAL MAST ARM	LUMINAIRE MAST ARM	LUMINAIRE WATTAGE	VEH SIGNAL MOUNTING MAST ARM	POLE	PED SIGNAL MOUNTING	PED PUSH BUTTON ø	ARROW	STREET NAME SIGN LEGEND	POLE LOCATION A	B	C	D	E
A	19-3-80	30'	12'	250W HPS	2-MAS	SV-1-T	SP-1-T	4	←	HARGRAVE ST	–	–	–	5'	–
B	1-A	–	–	–	–	TV-1-T	SP-1-T	6	→	–	0'	–	–	–	–
C	19-3-80	15'	12'	250W HPS	MAS	SV-1-T	SP-1-T	6	←	RAMSEY ST	–	–	3'	–	–
D	1-A	–	–	–	–	TV-1-T	SP-1-T	8	→	–	4'	–	–	–	–
E	24-3-80	35'	12'	250W HPS	2-MAS	SV-1-T	SP-1-T	8	←	HARGRAVE ST	–	–	4'	–	5'
F	1-A	–	–	–	–	TV-1-T	SP-1-T	2	→	–	0'	–	–	–	–
G	19-3-80	15'	12'	250W HPS	MAS	SV-1-T	SP-1-T	2	←	RAMSEY ST	–	–	3'	–	–
H	1-A	–	–	–	–	TV-1-T	SP-1-T	4	→	–	5'	–	–	–	–

REGISTERED PROFESSIONAL ENGINEER · FONG-PING LEE · No. C040869 · Exp. · CIVIL · STATE OF CALIFORNIA

DATE	BY	MARK	REVISIONS	APPR.	DATE

ENGINEER · DESIGNED BY YC · DRAWN BY YC · CHECKED BY RMH · CITY

APPROVED BY [signature] DATE 4/2/93
PAUL TOOR, CITY ENGINEER
R.C.E. NO. 46281 EXP. DATE

APPROVED BY [signature] DATE
R.C.E. NO. 040869 EXP. DATE 03/31/95

SCALE 1"=20'
DATE

BENCHMARK

FPL and Associates, Inc.
Traffic · Transportation · Civil · CAD
10231 Slater Avenue, Suite 113
Fountain Valley, CA 92708
(714) 964-2778

CITY OF BANNING

TRAFFIC SIGNAL PLAN
RAMSEY STREET AT
HARGRAVE STREET

W.O. | FOR | F.B.

SHEET NO. 5 OF 11 SHTS
DWG NO.

RS 109