Appendix J

Preliminary Geotechnical Design Recommendations

PARIKH
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MEMORANDUM

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May 22, 2020
Job No. 2018-121-GEO

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Subject: Preliminary Geotechnical Design Recommendations
San Rafael Transit Center
San Rafael, Marin County, California

Introduction

This memorandum presents preliminary geotechnical design recommendations for the proposed San Rafael Transit Center. This information was developed based on review of relevant as-built geotechnical data and data located within a few blocks of the currently considered site alternatives. The intent of this geotechnical input is to assist the project team in the alternative selection process. Once an alternative is selected, site-specific subsurface investigation needs to be performed for support of the actual design.

Proposed Construction

We understand that three alternative configurations for the new transit center are being considered. The three potential site are located between 2nd Street and 5th Street, between Tamalpais Avenue and Hetherton Street in San Rafael, California. A fourth “Under the Freeway” alternative has also been identified which extends from just south of 4th Street to 5th Avenue, between Hetherton and Irwin Street (see Plate 1 – Site and As-Built Boring Location Plan).

The “Under the Freeway” configuration on Caltrans property beneath the 101 Freeway was not included in PARIKH’s scope of work at the onset of the project. We understand that development of the transit center at this site would involve the construction of three new bridges (viaducts with bus bays) over Irwin Creek which transects the western portion of the site, parallel to Hetherton St. beneath southbound Highway 101, discharging to San Francisco Bay via San Rafael Creek. Investigation for the bridges would require considerably more permitting, investigation and design effort.

Based on a review of the preliminary drawings, the elements of the various transit center alternatives are summarized as follows:

Fourth Street Gateway Alternative

This concept utilizes the Citibank parcel, plus the block to the north bounded by 4th Street and 5th Avenue, Hetherton Street, Tamalpais Avenue.

- Three on-street bays at the west side of Hetherton St. between 4th Street and 5th Ave.
- Public plazas, customer service, bike parking, and/or transit-supportive land uses at the east side of both sites.
- Bus bays access via driveways on 3rd and 4th Streets, a driveway on Hetherton Street.
- Realignment of the existing Mahon Creek bike path around the site.
- Removal or relocation of Victorian homes south of 5th Avenue.
- Removal of several single story commercial buildings north of 4th Street, and the Citibank building south of 4th Street.
- Removal of the SMART pick-up/drop-off area on East Tamalpais.
- Pickup/drop-off space for six vehicles on Tamalpais Avenue between 3rd and 4th Street.
- Maintenance vehicle parking for eight Golden Gate Transit (GGT) vehicles on Tamalpais Ave. between 4th Street and 5th Avenue.

Whistlestop Block Alternative

This concept co-locates the transit center on the same block as the existing SMART station, by utilizing the Citibank parcel and curbside bays on both sides of Tamalpais Avenue between 3rd and 4th Streets.

- Renovating or remodeling the existing Whistlestop building (minus the Jackson Café) as GGT customer service and operations building space.
- Removal of the Citibank building at 3rd St. and Hetherton, and two -existing commercial structures (Trevor's Pub on Tamalpais Ave. and Extreme Pizza on 4th St.).
- Tamalpais Avenue between 3rd and 4th Streets would be limited to buses only.
- Bus bays on the Citibank parcel would be accessed via driveways along 3rd and 4th Streets.
- Bike parking at the southeast corner of the intersection of Tamalpais Ave. and 4th St.
- Removal of the SMART pick-up/drop-off area on East Tamalpais. Pickup/ drop-off space for eight vehicles on Tamalpais Ave. between 4th Street and 5thAvenue.
- Maintenance vehicle parking for four Golden Gate Transit vehicles would be provided on Tamalpais Ave. between 3rd and 4th Street.
- A new driveway on 4th Street between Tamalpais Ave. and Lincoln Ave. to replace the removed driveway on Tamalpais Avenue to the condo complex at Lincoln & 4th Street.

Move Whistlestop Alternative

This concept co-locates the transit center on the same block as the existing SMART station, by utilizing the Citibank parcel and curbside bays on both sides of Tamalpais Avenue between 3rd and 4th Streets. This alternative includes or requires:

- Shifting Tamalpais Avenue to the east, directly adjacent to the SMART tracks between 2nd and 4th Streets.
- Relocation of the Whistlestop building to the west side of Tamalpais Ave. between 3rd and 4th Streets. Alternatively, a new building could be constructed utilizing facades or architectural elements from the Whistlestop building. This building would include GGT customer service and operations building space.
- Removal of several existing commercial structures the Citibank building at 3rd St. and Hetherton, the transit building, Kosmos Kafe and Trevor's Pub on Tamalpais Ave., and Extreme Pizza on 4th St.).
- Curbside bays on both sides of Tamalpais Ave. between 3rd and 4th Streets.
- Tamalpais Avenue between 3rd and 4th Streets would be limited to buses only.
- Bus bays on the Citibank parcel would be accessed via driveways along 3rd and 4th Streets.
- Public plazas, customer service, bike parking, and/or transit-supportive land uses at the southwest corner of the intersection of Tamalpais Avenue and 4th Street (space not utilized by the relocated Whistlestop Building).
- Removal of the existing SMART pick-up/drop-off area on East Tamalpais. Pickup/ drop-off activity space for eight vehicles on Tamalpais Avenue, between 4th and 5th Avenue.
- Maintenance vehicle parking for 10 Golden Gate Transit vehicles on Tamalpais Avenue, between 2nd and 3rd Street.
- A new driveway would be installed on 4th Street between Tamalpais Avenue and Lincoln Avenue to replace the removed driveway on Tamalpais Avenue to the condo complex at Lincoln & 4th Street.

"Under the Freeway" Alternative

- This concept utilizes an area extending from just south of 4th Street to 5th Avenue, between Irwin Street and Hetherton Street. The western half of this block is located beneath US-101.
- Bus bays would be accessed via one driveway on 4th Street, two driveways on Irwin Street, and one driveway on Hetherton Street.
- Internal circulation would be provided to allow buses accessing bays from either side of the site to egress on either side as well, which is critical given the diverse bus routing accessing the site.

- Space would be provided for public plazas, customer service, and/or transit-supportive land uses in the area that is not limited by the Caltrans SMART Guidelines.
- Construction of three bridges/viaducts over Irwin Creek to connect Hetherton Street to the bus bays. Two bridges would be located north of 4th Street and one would be located on the block south of 4th Street. There would be some bus berths on the bridges.
- Demolition of two commercial buildings on the block south of 4th Street (Heritage Dry Cleaning and San Jose Taqueria), and four buildings north of 4th Street (Firestone Auto Care, a residence, Brady Law Group, and the Trips for Kids Bike Shop).
- Spaces within the existing Caltrans park-and-ride would be displaced. Uncertain if these will be replaced elsewhere.
- Pickup/ drop-off space for six vehicles and 110’ of curb space for paratransit activity would be provided on 5th Avenue, between Irwin Street and Hetherton Street.
- Maintenance vehicle parking for five Golden Gate Transit vehicles would be provided on the internal roadway with bus bays south of 4th Street with access from Irwin Street.

We understand the following core elements are included for all alternatives and require geotechnical design input.

- 17 straight-curb bus bays for transit, airport shuttles and greyhound services.
- Passenger platforms with a minimum width of 8 feet with sheltered or canopied seating.
- A 3000 sf building for customer service, public restrooms, driver relief facilities, small retail, maintenance, and security.

The following geotechnical information is based on the results of our review of available geologic maps for the project area and relevant as-built geotechnical data from previous investigations performed nearby the proposed alternatives.

Geology

The Geologic Map and Map Database of Parts of Marin, San Francisco, Alameda, Contra Costa, and Sonoma Counties, California, by M.C. Blake, R.W. Graymer and D.L. Jones, 2000 (USGS Miscellaneous Field Map MF-2337, Ver.1) show the bedrock unit in the vicinity of the site alternatives to consist of Franciscan Complex mélange. Mélange consists of a tectonic mixture of variably sheared shale and sandstone, high-grade metamorphic rocks, serpentinite, and variably resistant blocks of Greywacke sandstone, greenstone, and serpentinite.

A Marin County geologic map, Geology of the Eastern Part of the San Rafael Area, Marin County, California, by S.J. Rice, R.G. Strand, and T.C. Smith, 1976 shows alluvial stream deposits consisting of unconsolidated clay, silt, sand and gravel to be mapped in the area of the subject sites. The presence of alluvial deposits is consistent with available as-built geotechnical data for a property at 706 Third Street, immediately west of Tamalpais Avenue, and a boring north of Mission Avenue.

The Marin County Geologic map shows a geologic contact which extends from about Ritter Street and Lincoln Avenue to about 3rd Street and US 101, to about 4th St. and Irwin Street (see Site Plan – Plate 1). Southeast of this contact the near surface materials are mapped as fill of highly variable composition over soft Bay Mud.

Seismicity

The project is located within a seismically active part of northern California. Several active faults are within 13 to 14 km of the site. Movement along these faults can result in earthquakes and strong ground shaking at the site alternative locations. The proposed project is centrally located between northern traces of the San Andreas and Hayward faults; however, no active faults are known to pass through the project site, and the potential for ground surface rupture due to faulting within the project area is considered to be low. The potential for strong ground shaking at this site is high.

Subsurface Conditions

As-built data in Table 1 were considered for this preliminary report; no site-specific exploration has been performed.

Table 1 – Summary of As-Built Borings

Exploration Number	Boring Type	Elevation	SMART Track Segment 1 Station No.	Depth (ft)	Groundwater Depth (ft)
MPEG-157.36-B1	A	+8.0	804+20	16.5	6.0
PCI (2018) B-1	RW	+9.0	804+54	40.3	8.0
Caltrans B-3	RW	+5.2	805+01	45.2	----
Caltrans B-17	RW	+6.4	807+71	54.0	3.6
MPEG-1213.01B4	HSA	+7.0	808+66	22.0	----
MPEG-1213.01B3	HSA	+7.0	809+00	31.5	29.0
MPEG-1213.01B2	HSA	+7.0	809+23	22.0	19.0
Caltrans B-15	RW	+8.7	811+73	54.7	5.8
Caltrans B-12	RW	11.3	814+55	64.3	----
Caltrans B-8	RW	14.9	817+13	60.9	----
MPEG-1220.01B1	A	+28.0	824+00	12.0	8.5

Notes: MPEG (Miller Pacific Engineering Group); PCI (Parikh Consultants, Inc.)
Boring Types: A – Solid-Stem Auger; RW – Rotary-Wash; HSA – Hollow-Stem Auger

The as-built borehole data reveals on the order of 1.5 to 5 feet of fill mantles the native alluvial soil. The fill generally consists of clayey sand with gravel and stiff sandy clay of low to medium plasticity. Fill consisting of 2 feet of medium stiff silt was encountered at boring MPEG-1213.01B4 at depths of 1 to 3 feet. Below the fill, the as-built borings show the native alluvial soil to consist predominantly of very stiff sandy clay of low plasticity which near the subject sites extends to depths of 32 feet or more.

The ground surface elevations of the Miller Pacific Engineering Group (MPEG) borings drilled in 2005 immediately west of the site were Elev. 7 feet at the time of drilling; about 3 to 4 feet lower than the current ground surface elevation (Elev. 10 to 11 feet) at the proposed transit center sites. Hence, the fill at the proposed transit center sites may be thicker than indicated by the as-built logs; the as-built borehole data does not reflect the nature of this fill.

The presence of thick fill of variable composition over Bay Mud was confirmed by data from as-built boringsMPEG-157.36-B1 for the San Rafael Storm Drain, and PARIKH PCI Boring B-1, for the nearby Que-Cutter project at 2nd Street and Caltrans B-3 for the Irwin Creek bridge at 2nd Street which was reportedly constructed on concrete piles approximately 35 feet deep.

Caltrans Logs of Test Borings (LOTB) prepared in 1964 and 1966 reveal the presence of loose fills over layers of soft Bay Mud (or organic estuary silt and clay) with shells along the Irwin Creek/US 101 alignment. The fill is on the order of 10 to 15 feet thick between 2nd and 3rd Street and thins to about 4 feet at 5th Avenue (the northern boundary of the Under the Freeway Alternative). The soft Bay Mud or estuary silts and clays are about 9 feet thick at 2nd Street, and thin to about 5 feet thick at 4th Street. At 5th Avenue the materials in the upper 15 feet consist of loose sandy silt and soft clay without shells. While these materials may not be marine deposits; the depth to supportive material for bridge support remains on the order of 15 feet.

Bedrock is shown to be on the order of 50 to 60 feet between 3rd Street and 5th Avenue. In the area proposed for the Under-the-Freeway Alternative supportive material for bridge support for begins at depths of about 15 to 19 feet.

The ground surface elevation beneath the US 101 Freeway increases from about Elev. +10 feet at 2nd Street to Elev. +17 feet at Mission Avenue. The early as-built logs for the Caltrans borings show that the borings were drilled at elevations about 2 to 5 feet lower than the current surface elevations. This is likely due to a 2 to 3 foot difference between the National Geodetic Vertical Datum (NGVD29) and the WGS84 EGM96 datum used by Google Earth, with any remaining difference resulting from minor fills and paving.

Groundwater

Groundwater is indicated on the MPEG as-built boring logs (north of Third Street) at depths varying between 19 and 29 feet (22 to 32 feet below the current ground surface).

Caltrans reports and plans for the San Rafael Viaduct (Bridge No 27-0035L), US 101 reveal that, historically, Irwin Creek was tidally influenced. Caltrans as-built borings from 1964 and 1966 show groundwater depths along the Irwin Creek between Third and Fourth Street to be about 4 to 6 feet. As-built borehole MPEG- 1220.01B1 north of Mission shows groundwater at a depth of 8.5 feet (see Table 1). However, because this boring is further from the proposed sites, and at a higher elevation, the groundwater information is considered less relevant.

Groundwater levels will vary with the passage of time due to seasonal groundwater fluctuations, water levels in nearby creeks, surface and subsurface flow, and other factors.

Liquefaction

As-built data west of US 101 extends to depths of about 20 to 40 feet with subsurface profiles consisting predominantly of stiff to very stiff clayey soils with SPT blow counts between 10 and 45. Liquefaction potential of such material is low. Given that, and the groundwater level is on the order of 22 feet, the potential for liquefaction for materials deeper than the as-built boring depths will be verified with site-specific investigation data at final design stage. In our opinion, the potential impact on the project design west of US 101 is likely to be low.

Caltrans as-built borehole data along the Irwin Creek/US 101 alignment extends to depths of about 60 feet. The as-builts reveal loose granular materials at depths of 10 to 20 feet with SPT blow counts between about 1 and 8. Given the groundwater along Irwin Creek is on the order of 5 feet deep, and the potential for strong ground shaking at the site, the liquefaction potential for these layers is likely to be high.

Preliminary Recommendations

Site Grading

Based on the as-built data, and a preliminary rigid pavement section thickness estimate, we anticipate that the site(s) will need to be excavated on the order of 2 feet. The exposed subgrade is anticipated to be fill consisting of clayey sand with gravel or sandy clay with gravel. The subgrade soil(s) will need to be reworked, either proof-rolled, or ripped, moisture-conditioned to near optimum moisture content and compacted. The subgrade, and aggregate base in areas to be paved should be compacted in accordance with project specifications. The subgrade in all paved areas should be graded with positive gradient to direct water away from the paved areas, or to collection drains to prevent water perching beneath the pavement sections.

Soft or wet subgrade soil, if encountered, should either be excavated and replaced with Engineered Fill, or moisture conditioned for re-use as Engineered Fill. Should such soil be pervasive, placement of a biaxial geogrid geotextile on the subgrade may be considered for areas to be paved.

Existing asphalt removed by grinding and any underlying aggregate base may be stockpiled and mixed with the aggregate base for the pavement sections. Voids resulting from the removal of existing trees, building foundations and utility excavations should be backfilled with Engineered Fill.

Minimal soil import is anticipated. It appears that majority of the on-site material may meet the requirements for engineered fill. Re-use of the on-site soils will require re-working and aeration. If needed, any materials imported to the site for use as engineered fill should be non-expansive and consist of relatively granular material having a P.I. of less than 15 and Sand Equivalent greater than 10. It should also be free of vegetation and other deleterious materials.

Import of Class-2 Aggregate Base will be needed for the pavement section(s). This material should meet the requirements of Caltrans 2018 Standard Specifications Chapter 26, and gradation requirements of Section 26-1.02B.

Grading work adjacent to Irwin Creek for the “Under the Freeway” alternative presents additional concerns which are discussed in the Construction Considerations Section of this report.

Seismic Design Criteria

The ground motion parameters are based on ASCE7-16, the 2019 California Building Code (CBC) and as-built Log of Test Borings (LOTB). The as-built LOTBs are limited in total boring depth (<60ft) and the borings were drilled in 1960s. Based on this, the default Site Class D is assumed for the site. The U.S. Seismic Design Map Web Services SEAOC/OSHPD Seismic Design Maps Tool by the United States Geologic Survey (USGS) was used to generate the seismic design parameters presented in Table 2 using “Default Site Class D” and may be used for preliminary seismic design of the proposed customer service building structures.

TABLE 2 – USGS Seismic Design Parameters

Approximate Location	N 37.3354° & W 121.8907°
Site Class	Default D
Mapped Spectral Acceleration for Short Period, S_s (Site Class BC boundary with 5% damping)	1.50 g
Mapped Spectral Acceleration for 1-second Period, S_1 (Site Class BC boundary with 5% damping)	0.60 g
Fa	1.20
Fv	1.70
S_{MS} (Default Site Class D)	1.80 g
S_{M1} (Default Site Class D)	1.02 g

S_{DS} (Default Site Class D)	1.20 g
S_{D1} (Default Site Class D)	0.68 g
Peak Ground Acceleration (PGA)	0.56g
Site Amplification Factor at PGA (F_{PGA})	1.20
Site Modified Peak Ground Acceleration (PGA_M)	0.67 g
Short Period Transition Period (T_S) in Seconds	0.57
Long Period Transition Period (T_L) in Seconds	12.0

References: https://earthquake.usgs.gov/hazards/designmaps and ASCE7-16

Notes:

(1) Default Site Class D was used for this 2019 CBC seismic parameter assessment. A ground motion hazard analysis is required for structures on Site Class D sites with S1 greater than or equal to 0.2, but is not required provided the value of the Seismic Response Coefficient Cs is determined by ASCE7-16 Equations 12.8-2, 12.8-3 and 12.8-4 as outlined in ASCE7-16 Section 11.4.8.

(2) Due to insufficient resources, and the recent development of similar web tools by third parties, the USGS has replaced its former U.S. Seismic Design Maps web applications with web services that can be used through third-party tools. The results above were determined using the "SEAOC/OSHPD Seismic Design Maps Tool" (https://seismicmaps.org/) and listed at the reference website as one of the third-party tool options.

Foundation Recommendations

Pile Foundation

The proposed bridges over Irwin Creek at Hetherton Street Between 3rd Street and 5th Avenue for the "Under the Freeway" alternative would need to be supported on a CIDH pile foundations. No foundation loadings have been provided at this time. For preliminary design purposes, the following general subsurface profile, probable unit weights and soil strength parameters were developed using relevant Caltrans as-built data (Caltrans Boring B-12, 15 and 17). The recommended LPILE parameters are summarized in the following table. An average ground surface elevation of +12 feet at 4th Street and US 101 (Google Earth WGS84/EGM96 Vertical Datum) was adopted for development of the profile.

Table 1 – Generalized Subsurface Profile and Estimated Strength Parameters

Location	Elevation (ft)	LPILE Soil Type	Unit Weights (pcf)	Probable Soil Strengths
Bridges at Irwin Creek 3rd St. to 5th Ave. "Under the Freeway" Alternative	+12 to +2	Sand (Reese) w/ Liquefaction	120	phi=32 deg
	+2 to -6	Soft Clay w/o Free Water	120	c= 500 psf
	-6 to -24	Sand (Reese) (1)	125	phi=36 deg
		Stiff Clay w/o Free Water(2)	125	c=2000 psf
	-24 to -37.5	Stiff Clay w/o Free Water(1)	125	c=200o psf

Location	Elevation (ft)	LPILE Soil Type	Unit Weights (pcf)	Probable Soil Strengths
		Sand (Reese)(2)	125	phi=32 deg
	Below -37.5	Stiff Clay w/o Free Water	135	c=4000 psf

Notes:

(1) Use this layer in the profile between 3rd an 4th Street.

(2) Use this layer in the profile between 4 th Street and 5th Avenue.

(3) The default k and e50 should be used for LPILE analysis.

(4) Pile moment of inertia reduced 50% to consider a cracked pile section.

(5) Elevations shown are approximate due to differences in elevation datum of Caltrans as-built borings.

Pile construction for the “Under the Freeway” alternative will be subject to height clearance issues with the existing freeway. These issues are discussed further in the Construction Considerations section of this report.

Spread Footings

We anticipate that the bus platforms and the combined customer service/bathroom buildings may be supported on continuous spread footings. Based on nearby as-built borehole data, the footings are anticipated to bear on fill consisting of clayey sand (SC) or sandy clay (CL) of low plasticity, which has been proof-rolled or re-worked and compacted as Engineered Fill. Due to the presence of additional fill placed since the as-built borings were drilled, the materials in the upper few feet will need to be confirmed once an alternative has been selected. For preliminary design purposes, the footings may be designed to be minimum 15-inches wide and be embedded a minimum of 2 feet deep below the lowest adjacent pavement grade. The intent of the bus platform footing depth is to provide lateral support for the rigid pavement section(s). The footings may be designed using an allowable bearing capacity of 3,000 psf for dead plus live loads.

Slabs-On-Grade

Concrete slabs-on-grade are anticipated for the bus platforms and customer service buildings. The slab thickness and reinforcement should be designed in accordance with the anticipated use and loading. The slabs should be provided with control joints to regulate cracking.

We recommend that a 6-inch layer of clean ¾-inch crushed rock material be placed between the finished subgrade and the platform slabs. In areas where floor moisture would be undesirable, a water vapor retarder membrane should be placed between the crushed rock material and the slabs. The membrane should be covered by a 2-inch layer of sand to protect the membrane during construction. Prior to placement of concrete, the sand should be wetted until a moisture equilibrium state is reached.

Structural Pavement Section

A rigid pavement sections were determined for the site based on the nearby as-built data, a Low Mountain climate zone per Caltrans Highway Design Manual (HDM 2017) Chapter 610, Table 613.3A, and Ch. 620, Table 623.1K. For preliminary design, Traffic Indices (T.I. values) of 9.0, 10.0, and 11.0 were used for design of the Jointed Plain Concrete Pavement (JPCP) section options presented below. These pavement sections assume Type II Sandy Clay (CL) subgrade soil, without lateral support.

Table 3 – Rigid Pavement Section Options

Traffic Index (T.I)	Jointed Plain Concrete Pavement (JPCP) (feet)	Class 2 Aggregate Base (feet)	Total Thickness (feet)
9.0	0.75	1.00	1.75
10.0	0.85	1.00	1.85
11.0	0.90	1.30	2.20

The pavement section design should include construction and contraction joints. The thicknesses shown are for doweled pavement only. Isolation joints should be included in the design between the pavement and adjacent passenger platform footings.

Drainage

The pavement should be designed with a positive gradient to direct surface water to pavement drains and the project drainage control system; ponding of water on the pavement should not be allowed.

Construction Considerations

From a geotechnical standpoint, additional grading may be required for site configurations which will involve removal of existing structures and their foundations, trees and trench backfill for relocated utilities, if any. Site excavation and compaction of the subgrade should be observed by the geotechnical engineer or regulatory agency prior to the placement of reinforcement and concrete so that if conditions differ from these anticipated, appropriate recommendations can be made. Materials exposed by footing excavations should also be observed prior to placement of steel or concrete.

The lateral extent of the subsurface conditions revealed by the Caltrans as-built borings at the Under-the-Freeway Alternative site are not known, and therefore additional grading and possibly pile support of the building structures may be needed to address loose or soft ground conditions. Additional exploration is anticipated to be needed to assess the subsurface conditions, particularly for structures near or extending to Irwin Creek.

The moisture content of near surface soils may be high. If so, grading and efforts to achieve compaction of the subgrade may be impacted. Working slabs may also be needed to protect the subgrade of footing excavations during construction. Such conditions might be mitigated by cement or lime treatment of the subgrade, and/or placement of a biaxial geogrid. Near Irwin Creek, high moisture content of the near surface soil is more likely due to the relatively shallow depth to groundwater.

For construction of the bridges over Irwin Creek, flow in the creek will need to be controlled during the grading work and pile construction. This would consist of re-routing of the creek around the construction area, so that piles and bridge abutments at east and west sides of Irwin Creek could be completed. State of California Fish and Game permitting and oversight will likely be needed for any grading proximal to Irwin Creek.

Height clearance beneath the San Rafael Viaduct limits the choices for pile types and imposes special construction methods. For CIDH piles special equipment for low-overhead conditions would likely need to perform the drilling. Temporary steel casing will likely be needed due to the high groundwater and loose conditions of upper subsoil and may need to be installed segmentally (welding between casing sections). Likewise, steel reinforcing cages for the piles may need to be placed in segments using smaller equipment and spliced a length at a time. The limitation may also preclude use of a boom by a concrete pumping truck to place concrete Tremmie method (from the bottom of the pile excavation). The above-noted construction methods are likely to increase the time required to complete the grading and foundation construction.

Irwin Creek is reported as unlined by bridge inspection reports for the San Rafael Viaduct but appears to be partially lined (concrete-lined) in some places. A hydraulic study (HEC-RAS) should be considered to address scour depth, flooding potential, and the need for creek-bank protection (culvert design, concrete lining and/or rip-rap) in the vicinity of the bridges.

Caltrans standard specifications and standard special provisions (SSP) for “Cast-in-Place Concrete Piling” should be used for the construction of CIDH piles. It is anticipated that groundwater will be encountered during construction and “dry” condition as per the standard specifications Section 49-4 could not be maintained. The “wet” specifications are contained in Caltrans SSP.

Vertical inspection pipes for acceptance testing should be provided in all CIDH piles that are 24 inches in diameter or larger, except when the holes are dry or when the holes are dewatered without the use of temporary casing to control groundwater. The acceptance test should include Gamma- Gamma Logging and may also include cross-hole sonic logging. Gamma-Gamma Logging should be performed in accordance with California Test 233 Standard (CT233) to check the homogeneity of CIDH piles. CT233 defines pile rejection criteria based on the statistical principles of mean and three standard deviations to analyze the homogeneity of a pile. Anomalies detected should be evaluated by the designer for their significance and potential impact on design and to see if mitigation plans are required. Details of the acceptance testing and Gamma-Gamma Logging are contained in Caltrans SSP and CT233.

Due to the presence of granular material and groundwater, raveling or caving is expected which may require additional drilling and cleaning effort and may increase the concrete volume for the piles. It is prudent to make the contractor aware of these conditions so that he takes appropriate steps to comply with the standards and maintain the integrity of the CIDH piles. The use of temporary steel casing should be anticipated to maintain the integrity of the piles during drilling. It is also recommended that the specifications set certain criteria for qualifications and previous work experience requirements to pre-qualify the potential contractors. The intent is to help select qualified contractors to reduce construction issues.

The CIDH pile excavation should be observed by the geotechnical engineer or regulatory agency prior to the placement of reinforcement and concrete so that if conditions differ from these anticipated, appropriate recommendations can be made.

Investigation Limitations

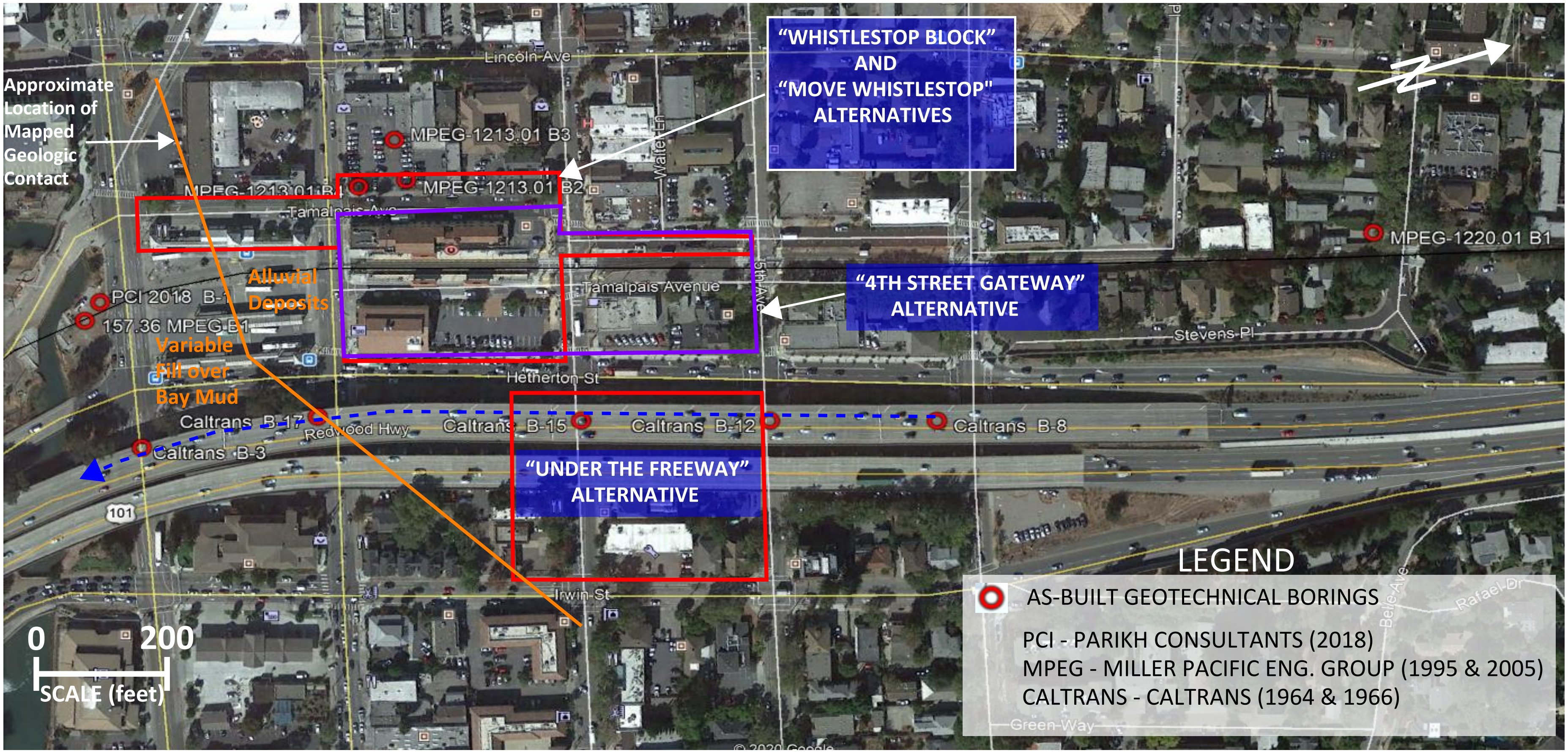
Our services consist of professional opinions and recommendations made in accordance with generally accepted geotechnical engineering principles and practices and are based on our review of as-built geotechnical data, and the assumption that the subsurface conditions do not deviate from at conditions presented in the as-built borings. All work done is in accordance with generally accepted geotechnical engineering principles and practices. No warranty expressed or implied, of merchantability or fitness, is made or intended in connection with our work or by the furnishing of oral or written reports or findings. The scope of our services did not include site-specific subsurface exploration, or any environmental assessment or investigation for the presence or absence of hazardous or toxic materials in structures, soil, surface water, groundwater, or air, below or around this site.

This report has been prepared for the proposed project as described earlier, to assist the engineers in the preliminary design of this project. In the event, any changes in the design or location of the structures is planned, our conclusions and recommendations shall not be considered valid unless the changes or variations are reviewed and our recommendations modified or approved by us in writing.

The following attachment completes this report.

Attachments:

Plate No. 1 - Site and As-Built Boring Location Plan
As-Built Borehole Data



REFERENCES :Google Maps
https://www.google.com/maps and
Preliminary Drawings

SITE AND AS-BUILT BORING LOCATION PLAN -

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

PROPOSED SAN RAFAEL TRANSIT CENTER
SAN RAFAEL, CALIFORNIA

JOB NO.: 2018-121-GEO	PLATE NO.: 1

BORING MPEG–B1

EQUIPMENT: 6–inch Solid Auger
DATE: May 17, 1995
ELEVATION: Approx. +8.0 feet NVGD

SHEAR STRENGTH psf	BLOWS PER FOOT	MOIST. CONT. %	DRY DENSITY pcf	DEPTH feet	
				0	**CLAYEY GRAVEL WITH SAND (GC) (FILL)** brown, loose, dry, some fine sand, 60% gravels to 2 inches
	35	5.6 6.8	100		
					SILTY CLAY (CH) (BAY MUD) dark gray, soft, wet, minor peat, organic odor
TV=400 UC=250	5	66.8 71.7	53 50	5	
					no recovery
	1/8"				
				10	**SANDY CLAY (CL)** olive gray, medium stiff, moist, coarse sand, no recovery
	20				
				15	light brown, medium stiff, moist, coarse sand
UC=550	37	14.6	111		
					Bottom of Boring at 16.5 feet Groundwater Measured at 6.0 feet After Drilling
				20	

157–36.B1

ILLER
ACIFIC
GINEERING
ROUP

BORING LOG
San Rafael Storm Drain
San Rafael, California

JOB NO: 157.36

APPROVED BY:

A–2
FIGURE

LOGGED BY **J. Zhang**	BEGIN DATE **8-22-18**	COMPLETION DATE **8-22-18**	
DRILLING CONTRACTOR **Pitcher Drilling Company**			
DRILLING METHOD **Rotary Wash**			
SAMPLER TYPE(S) AND SIZE(S) ID **MC and SPT**			
BOREHOLE BACKFILL AND COMPLETION **Soil-Cement Grout**			
BOREHOLE LOCATION (Lat/Long or North/East and Datum) **37° 58' 13.84" / -122° 31' 21.95"**			HOLE ID **B-1**
BOREHOLE LOCATION (Offset, Station, Line)			SURFACE ELEVATION **9.0 ft**
DRILL RIG **Failing 1500 Truck-Mounted Rig**			BOREHOLE DIAMETER **4 in**
SPT HAMMER TYPE **Automatic 140 lb 30"**			HAMMER EFFICIENCY, ERi **70%**
GROUNDWATER READINGS	DURING DRILLING **8.0 ft**	AFTER DRILLING (DATE) **Not measured**	TOTAL DEPTH OF BORING **40.3 ft**

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Depth	Sample Number	Blows per 6 in.	Blows per foot	Moisture Content (%)	Dry Unit Weight (pcf)	UC/UU in Shear. Str. (tsf)	Recovery (%)	RQD (%)	Drilling Method	Casing Depth	Remarks
	0		Well-graded SAND with SILTY CLAY and GRAVEL (SW-SC); medium dense; dark yellowish brown; moist; fine GRAVEL; coarse to fine SAND; uncemented (Fill).												
	1														
7.00	2														
	3		(+#4=34.2%, -#200=9.4%).		1	12 16 10	26	7 5	115		83				PA
5.00	4														
	5		SILTY CLAYEY SAND with GRAVEL (SC-SM); loose; brown to grayish brown; wet; fine SAND; medium to high plasticity fines. (UC=0.6 tsf), (+#4=18.1%, -#200=39%).		2	2 4 6	10	18 17	110	0.3	56				PA, UC
3.00	6														
	7														
1.00	8		Fat CLAY with GRAVEL (CH); soft; bluish gray; wet; some angular fine GRAVEL (Fill).												
	9														
-1.00	10		(LL=103, PI=62); (UC=0.3 tsf).		3					0.15	100				95 psi pull-down pressure during Shelby sampling. PI, UC
	11		(PTV=0.23 tsf).					108	49						
-3.00	12		Poorly graded SAND (SP); gray; wet; medium to fine SAND; uncemented (Fill).					22	77						
	13														
-5.00	14		SANDY lean to fat CLAY with GRAVEL (CL/CH); stiff; gray and yellowish brown; wet; fine SAND; medium to high plasticity fines; some angular fine GRAVEL (Fill).												
	15		PP=1.0 tsf.		4	3 11 16	27	28	93		78				
-7.00	16		CLAYEY GRAVEL (GC); medium dense; dark yellowish brown; moist; fine GRAVEL; some clasts of gray SANDY CLAY (Fill).												
	17														
-9.00	18														
	19		SILTY SAND (SM); medium dense; dark yellowish brown; wet; fine SAND; uncemented (Native Soil / Alluvium).												
-11.00	20				5	9 11 20	31	18 22	108 104		78				
	21		SANDY SILTY CLAY (CL-ML); very stiff; dark yellowish brown; moist; fine SAND; low plasticity fines; PP=3.0 tsf; (+#4=1.3%, -#200=51.6%).												PA
-13.00	22														
	23														
-15.00	24		CLAYEY SAND with GRAVEL (SC); medium dense; yellowish brown; wet; fine GRAVEL; fine SAND; low to medium plasticity fines.												
	25														

(continued)

LOG OF TEST BORING

PARIKH
Practicing in the Geosciences

SMART QUE-CUTTER SIGNAL STRUCTURE

2ND STREET, SAN RAFAEL, CALIFORNIA

Date:

Boring ID: B-1

Job No.: 2018-125-GEO

Plate: A--1A

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Depth	Sample Number	Blows per 6 in.	Blows per foot	Moisture Content (%)	Dry Unit Weight (pcf)	UC/UU in Shear. Str. (tsf)	Recovery (%)	RQD (%)	Drilling Method	Casing Depth	Remarks
	25		CLAYEY SAND with GRAVEL (SC).		6	7 17 11	28	10			39				
-17.00	26														
	27														
-19.00	28		CLAYEY GRAVEL with SAND (GC); dense; yellowish brown; wet; coarse to fine GRAVEL; fine SAND.												
	29														
-21.00	30				7	20 24 40	64	15	120	2.1	67				UC
	31		Lean CLAY with SAND (CL); hard; dark yellowish brown and gray; moist; trace fine GRAVEL; fine SAND; low plasticity fines; clasts of gray CLAY (Residlial Soil); (UC=4.2 tsf).												
-23.00	32														
	33														
-25.00	34														
	35				8	20 32 50/3"	82/9	15	118		67				
-27.00	36		SEDIMENTARY ROCK (SILTSTONE), dark yellowish brown and gray, intensely weathered, very weak to weak, soft, intensely fractured, with CLAY seams, (Bedrock).												
	37														
-29.00	38														
	39		Dark gray, clayey SHALE interbed, weak, soft.												
-31.00	40				9	50/4"	REF	9			100				
	41		Bottom of borehole at 40.3 ft bgs/Elev. -31.3 ft												
-33.00	42		Groundwater not encountered prior to switching to rotary-wash drilling; groundwater level tidally influenced, estimated at a depth of 5 feet at end of drilling. Borehole was backfilled with cement grout.												
	43		This Boring Record was developed in accordance with the Caltrans Soil & Rock Logging, Classification, and Presentation Manual (2010) except as noted on the Soil or Rock Legend or below.												
-35.00	44														
	45														
-37.00	46														
	47														
-39.00	48														
	49														
-41.00	50														
	51														
-43.00	52														
	53														
-45.00	54														
	55														

PCI-CT 5 BR 2018-125-GEO.GPJ TEMPLATE 7-22-11.GDT 1/4/19

LOG OF TEST BORING

PARIKH
Practicing in the Geosciences

SMART QUE-CUTTER SIGNAL STRUCTURE

2ND STREET, SAN RAFAEL, CALIFORNIA

Date:

Boring ID: B-1

Job No.: 2018-125-GEO

This log is part of the report prepared by Parikh Consultants, Inc. for the named project and should be read together with that report for complete interpretation. This summary applies only at the location of this 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.

Plate:

A--1B

BORING 2

EQUIPMENT: Mobile B-53 with 6" hollow stem augers
DATE: 3/17/05
ELEVATION*: 7 Feet
*REFERENCE: Topographic Plan, City of San Rafael Dept. of Public Works, 1988

OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters feet	SAMPLE	SYMBOL (3)	
					0 - 0			**GRAVELLY SAND w/ CLAY (SC) (FILL)** orange-gray mottled, loose, moist
								SANDY CLAY/CLAYEY SAND (SC/CL) (ALLUVIUM) orange-gray mottled, moist, soft, low plasticity, equal parts fine sand and clay
P200= 48.3%		17	18.0	108	1	■		
		33	18.4	109	5	■		grades to ~5% subrounded gravel to 3/8", medium stiff/dense
					2			
		64	18.8	109		■		**SANDY CLAY (CL)** orange-gray mottled, moist, low plasticity, stiff, ~45% fine sand, <5% gravels to 3/8"
					3 10			
	3750	70	20.2	107	4	■		grades to 5-10% subangular gravel to 1/2", very stiff, black veining
					15			
					5			
								drilling softens
					▽			
					6 20	■		

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
(3) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

FILE: 1213.01BL.dwg

Miller Pacific
ENGINEERING GROUP

BORING LOG
706 Third Street
San Rafael, California

A-5

Project No. 1213.01
Date 3/28/05
Approved By:

Figure

OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	meters DEPTH feet	SAMPLE	SYMBOL (3)	BORING 2 (CONTINUED)
P200= 68.7%		51	21.3		20	■	▨	grades to 5% fine rounded gravels
								Bottom of boring at 22.0 feet Groundwater encountered at 19 feet at completion
					7			
					25			
					8			
					9			
					30			
					10			
					35			
					11			
					12			
					40			

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3= 0.1571 x DRY UNIT WEIGHT (pcf)
(3) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

FILE: 1213.01BL.dwg

Miller Pacific
ENGINEERING GROUP

BORING LOG
706 Third Street
San Rafael, California

A-6

Project No. 1213.01 Date 4/14/05 Approved By:

Figure

BORING 3

EQUIPMENT: Mobile B-53 with 6' hollow stem augers
DATE: 3/17/05
ELEVATION*: 7 Feet
*REFERENCE: Topographic Plan, City of San Rafael Dept. of Public Works, 1988

OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters	DEPTH feet	SAMPLE	SYMBOL (3)	
					0	0			2" AC
									6-8" AGGREGATE BASE
	450	16	12.0	116					SANDY CLAY w/ GRAVEL (CL) (FILL) brown-black mottled, moist, soft, low plasticity, 15-20% angular to subrounded gravel to 1/2"
		20	17.1	87	1				occasional 1-2" gravels
						5			SANDY CLAY (CL) (ALLUVIUM) orange-gray mottled, moist, medium stiff, medium plasticity, 30-40% fine sand
		36	20.4	104	2				
					3	10			CLAYEY SAND/SANDY CLAY (SC/CL) white-orange mottled, moist, medium stiff, low to medium plasticity, black veining, 45-55% fine sand drilling softens
		40	20.3	106					
					4				
						15			Grades to stiff to very stiff
	3200	63	21.0	106	5				
									Gravelly sand lens at approximately 18.5 to 19.5'
					6	20			Grades to medium stiff, increased black veining
	2250	32	25.3	99					(continued on next page)

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3 = 0.1571 x DRY UNIT WEIGHT (pcf)
(3) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

FILE: 1213.01BL.dwg

Miller Pacific
ENGINEERING GROUP

BORING LOG
706 Third Street
San Rafael, California

A-7

Project No. 1213.01
Date 4/14/05
Approved By:

Figure

BORING 3
(CONTINUED)

OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters	DEPTH feet	SAMPLE	SYMBOL (3)	
	2250	32	25.3	99		20	■	▨	**CLAYEY SAND/SANDY CLAY (SC/CL)** white-orange mottled, moist, medium stiff, low to medium plasticity, black veining, 45-55% fine sand
					7			▨	
		38	22.4	104		25	■	▨	grades to 5% fine rounded gravels
					8			▨	
					9 ▽			▨	
P200= 50.9%		36	18.6	110		30	■	▨	grades to <5% fine rounded gravels, saturated
									Bottom of boring at 31.5 feet Groundwater encountered at 29 feet
					10				
						35			
					11				
					12				
						40			

NOTES:
(1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3= 0.1571 x DRY UNIT WEIGHT (pcf)
(3) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

FILE: 1213.01BL.dwg

Miller Pacific
ENGINEERING GROUP

BORING LOG
706 Third Street
San Rafael, California

A-8

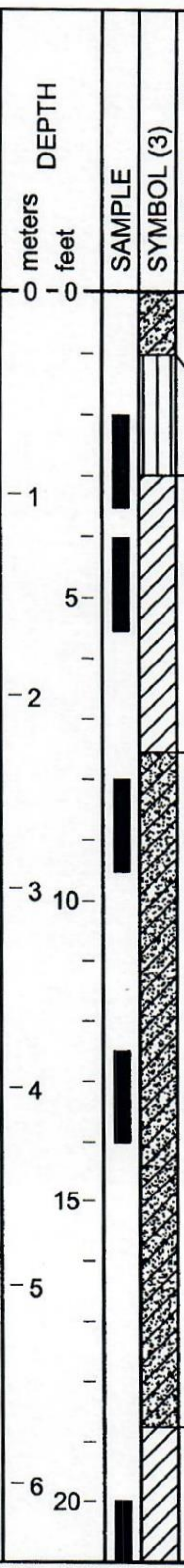
Project No. 1213.01
Date 4/14/05
Approved By:

Figure

BORING 4

EQUIPMENT: Mobile B-53 with 6' hollow stem augers
DATE: 3/17/05
ELEVATION*: 7 Feet
*REFERENCE: Topographic Plan, City of San Rafael Dept. of Public Works, 1988

OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)
	400	17	25.0	99
		40	22.8	101
		62	22.1	104
		42	19.9	108



GRAVELLY CLAYEY SAND (SC) (FILL)
black-orange mottled, moist

CLAYEY SILT (ML) (FILL)
black, moist, soft, low plasticity, red veining (Fe oxide)

SANDY CLAY (CL) (ALLUVIUM)
orange-gray mottled, moist, medium stiff, medium plasticity, 35% fine sand

CLAYEY SAND (SC)
white-orange mottled, moist, dense, low to medium plasticity, black veining, 55% fine sand

Grades to medium dense, 80% (mostly) fine sand, low to medium plasticity clay

SANDY CLAY (CL)
orange-gray mottled, wet, stiff, medium to high plasticity, 35% fine sand

(continued on next page)

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3= 0.1571 x DRY UNIT WEIGHT (pcf)
(3) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

FILE: 1213.01BL.dwg

Miller Pacific
ENGINEERING GROUP

BORING LOG
706 Third Street
San Rafael, California

A-9

Project No. 1213.01
Date 4/14/05
Approved By:

Figure

OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	meters DEPTH feet	SAMPLE	SYMBOL (3)	BORING 4 (CONTINUED)
	2300	44	23.3	103	20	■	▨	SANDY CLAY (CL) orange-gray mottled, wet, stiff, medium to high plasticity, 35% fine sand
					7			Bottom of boring at 22 feet No groundwater encountered
					25			
					8			
					9			
					30			
					10			
					35			
					11			
					12			
					40			

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m^3= 0.1571 x DRY UNIT WEIGHT (pcf)
(3) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

FILE: 1213.01BL.dwg

Miller Pacific
ENGINEERING GROUP

BORING LOG
706 Third Street
San Rafael, California

A-10

Project No. 1213.01 Date 4/14/05 Approved By:

Figure

BORING 1

EQUIPMENT: Minuteman with 4" augers

DATE: 3/29/05
ELEVATION: 28-Feet*
*REFERENCE: City of San Rafael, 1988

OTHER TEST DATA	UNDRAINED SHEAR STRENGTH psf (1)	BLOWS PER FOOT	MOISTURE CONTENT (%)	DRY UNIT WEIGHT pcf (2)	DEPTH meters	DEPTH feet	SAMPLE	SYMBOL (3)	
					0	0		▨	**SANDY CLAY (CL)** black, medium stiff, moderate plasticity, moist, abundant rootlets and grass
AL: LL=36 PI=14		16	23.3	95			■	▨	
								▨	**SANDY CLAY (CL)** brown with orange mottling, stiff, low plasticity, moist, 30% fine to medium sand
	2500	31	20.7	107	1		■	▨	
						5		▨	
		24	18.3				■	▨	
					2			▨	
						▽		▨	
					3	10		▨	
		22	21.4	106			■	▨	
									Bottom of boring at 12 feet Groundwater encountered at 9.5 feet
					4				
						15			
					5				
					6	20			

NOTES: (1) METRIC EQUIVALENT STRENGTH (kPa) = 0.0479 x STRENGTH (psf)
(2) METRIC EQUIVALENT DRY UNIT WEIGHT kN/m³ = 0.1571 x DRY UNIT WEIGHT (pcf)
(3) GRAPHIC SYMBOLS ARE ILLUSTRATIVE ONLY

FILE: 1220.01BL.dwg

[redacted]

BORING LOG
Gordon Property
San Rafael, California

5

Project No. 1220.01
Date 4/19/05
Approved By:

Figure

DIST.	COUNTY	ROUTE	POST MILES—TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	Mrn	101			

BRIDGE ENGINEER REGISTERED CIVIL ENGINEER NO. 5565

DATE APPROVED

BRIDGE DEPARTMENT
ENGINEERING GEOLOGY SECTION

FIELD STUDY	By T. Nelson	11-66
DRAWN	By R. Castle	2/1/67
CHECKED	By W.T. Nelson	6-29-67

Approval Recommended by ________ Engineering Geologist

LEGEND OF BORING OPERATIONS

1" SOIL TUBE

ROTARY BORING

PENETRATION BORING

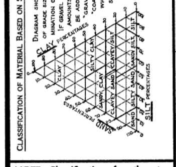
- ● PENETROMETER
- ◉ 2¼" CONE PENETROMETER
- ▭ SAMPLER BORING (DRY)
- ▭ ROTARY BORING (WET)
- ▭ AUGER BORING (DRY)
- ▭ JET BORING
- ◇ CORE BORING
- ⬚ TEST PIT

LEGEND OF EARTH MATERIALS

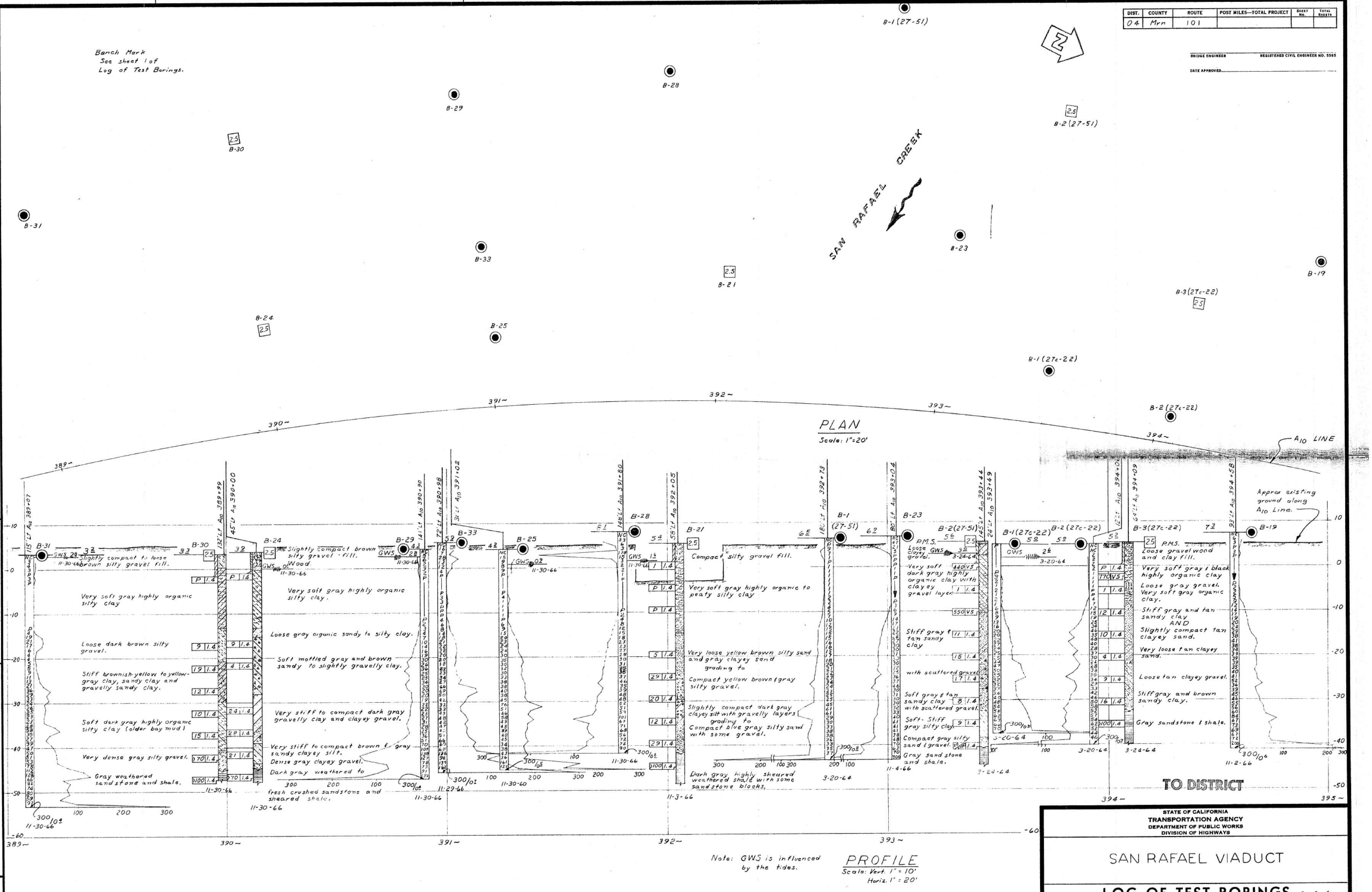
▨	GRAVEL	▨	SILTY CLAY OR CLAYEY SILT
▨	SAND	▨	PEAT AND/OR ORGANIC MATTER
▨	SILT	▨	FILL MATERIAL
▨	CLAY	▨	IGNEOUS ROCK
▨	SANDY CLAY OR CLAYEY SAND	▨	SEDIMENTARY ROCK
▨	SANDY SILT OR SILTY SAND	▨	METAMORPHIC ROCK

CLASSIFICATION OF MATERIAL BASED ON STANDARD GRADE SIZE LIMITS

DIAGRAM SHOWING THE BASIS FOR ESTIMATES OF GRADE SIZE DISTRIBUTION USED IN DETERMINATION OF CLASS NAMES. IF GRAVEL IS PRESENT IN APPRECIABLE AMOUNTS THE TERM "GRAVELLY" MAY BE ADDED TO THE CLASS NAME, VIZ. "GRAVELLY SAND". THE TERMS "COARSE", "MEDIUM" AND "FINE" WHEN USED TO DESCRIBE SAND, SILT AND GRAVEL REFER TO STANDARD GRADE SIZE LIMITS.



NOTE: Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.



STATE OF CALIFORNIA
TRANSPORTATION AGENCY
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

SAN RAFAEL VIADUCT

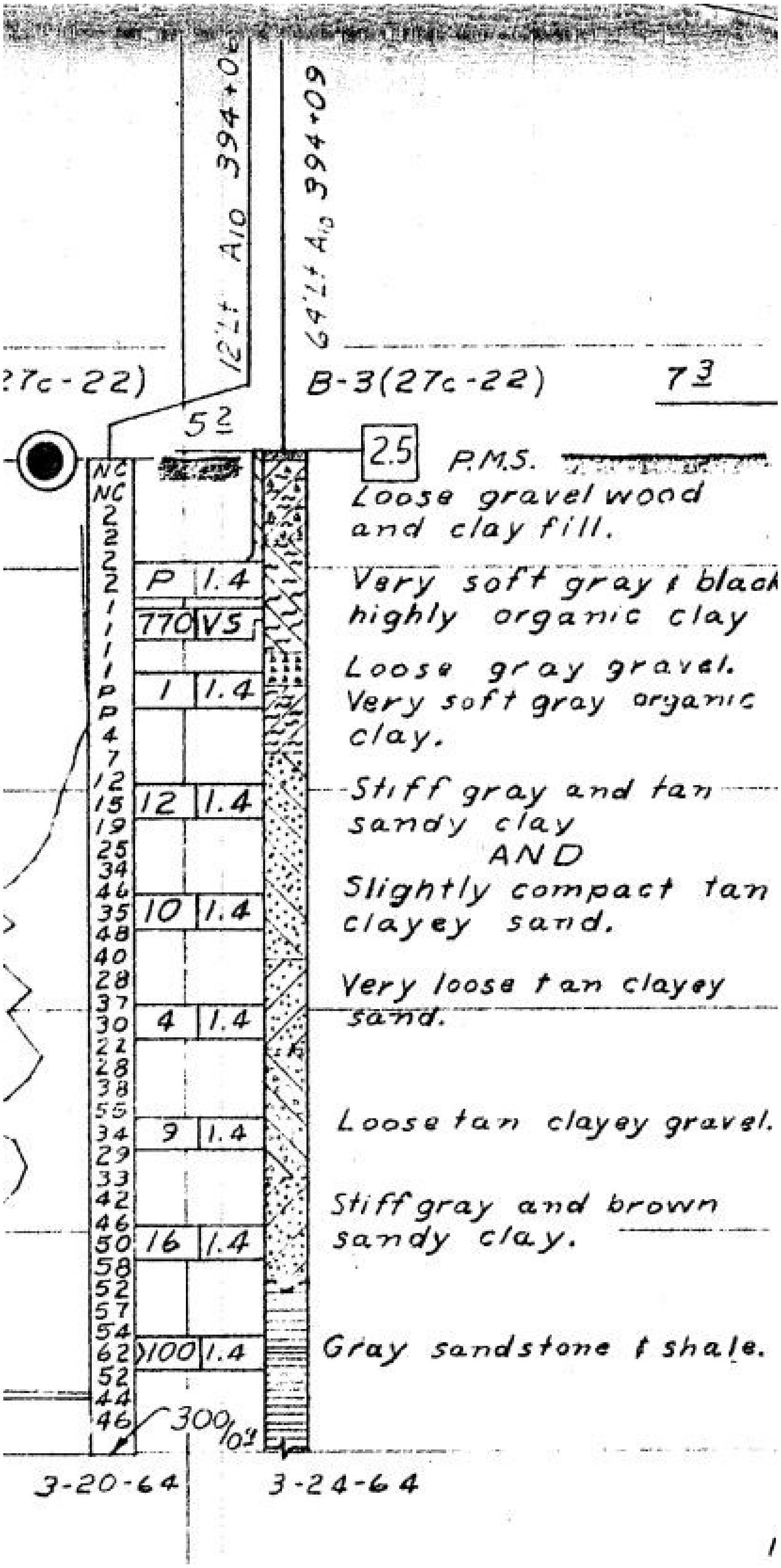
LOG OF TEST BORINGS 3 of 6

BRIDGE NO.	POST MILE	DRAWING NO.	SHEET	OF
27-35L	10.72			

WO 153431
CU 04219

Disregard prints bearing earlier revision dates →

REVISION DATES (PRELIMINARY STAGE ONLY)
2/9/67



Loose gravel wood and clay fill.

Very soft gray & black highly organic clay

Loose gray gravel.
Very soft gray organic clay.

Stiff gray and tan sandy clay
AND
Slightly compact tan clayey sand.

Very loose tan clayey sand.

Loose tan clayey gravel.

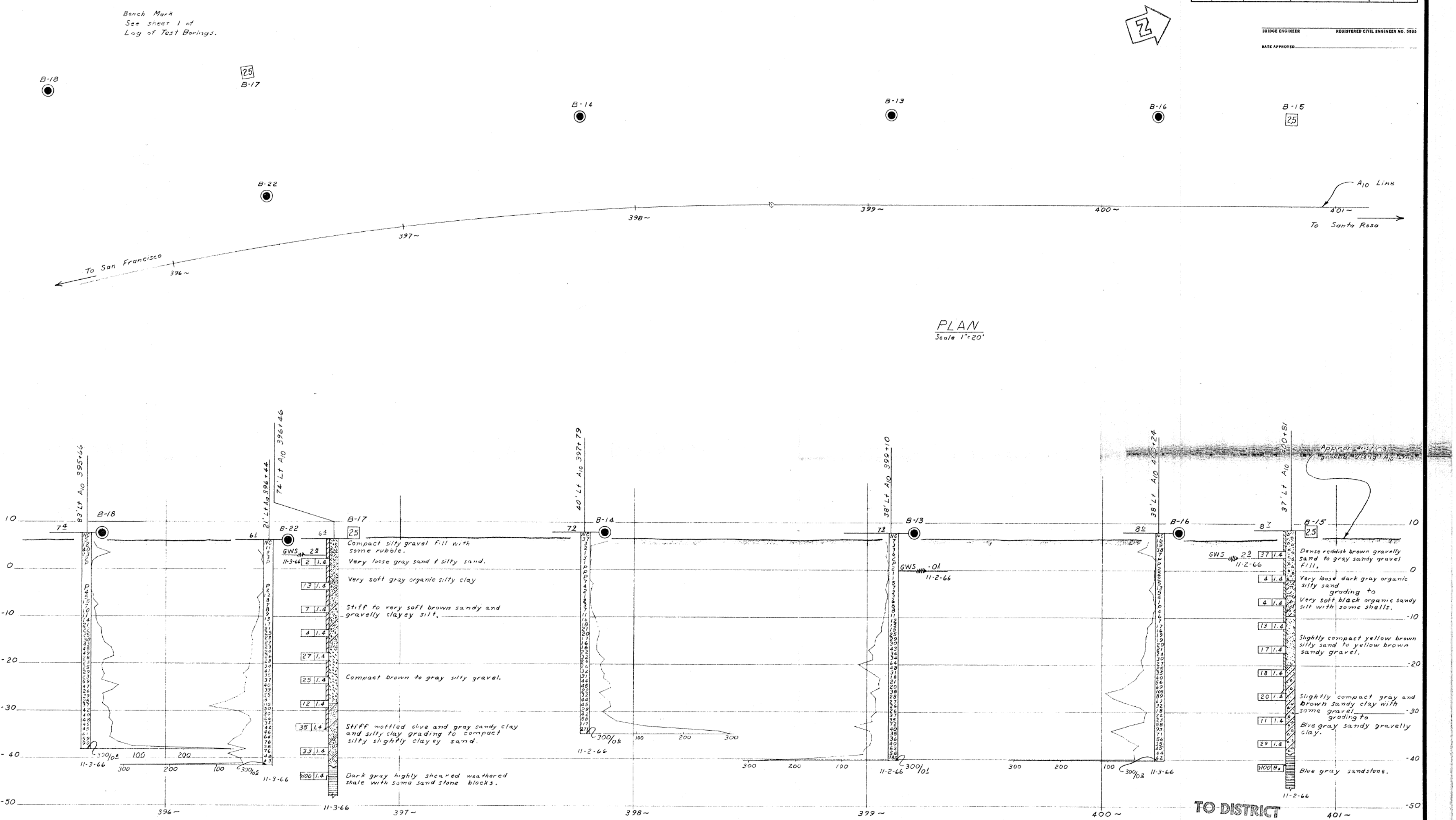
Stiff gray and brown sandy clay.

Gray sandstone & shale.

DIST.	COUNTY	ROUTE	POST MILES—TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	Mrn	101			

BRIDGE ENGINEER REGISTERED CIVIL ENGINEER NO. 5585

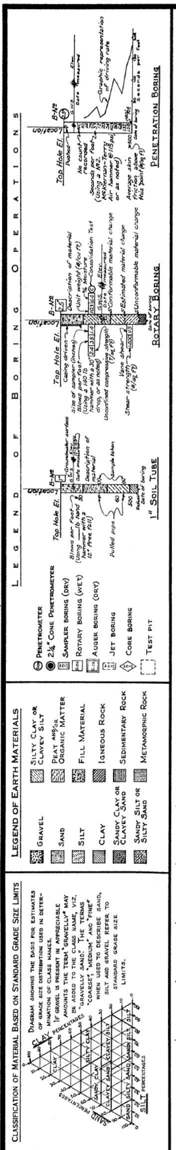
DATE APPROVED



TO DISTRICT

Note: GWS is influenced by the tides.

PROFILE
Scale: Vert. 1"=10'
Horiz. 1"=20'



NOTE: Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.

FIELD STUDY	By T. Nelson	11-66
DRAWN	By R C[illegible]	2-1-67
CHECKED	By W T Nelson	6-29-67

Approval Recommended by
Engineering Geologist

BRIDGE DEPARTMENT
ENGINEERING GEOLOGY SECTION

STATE OF CALIFORNIA
TRANSPORTATION AGENCY
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

SAN RAFAEL VIADUCT

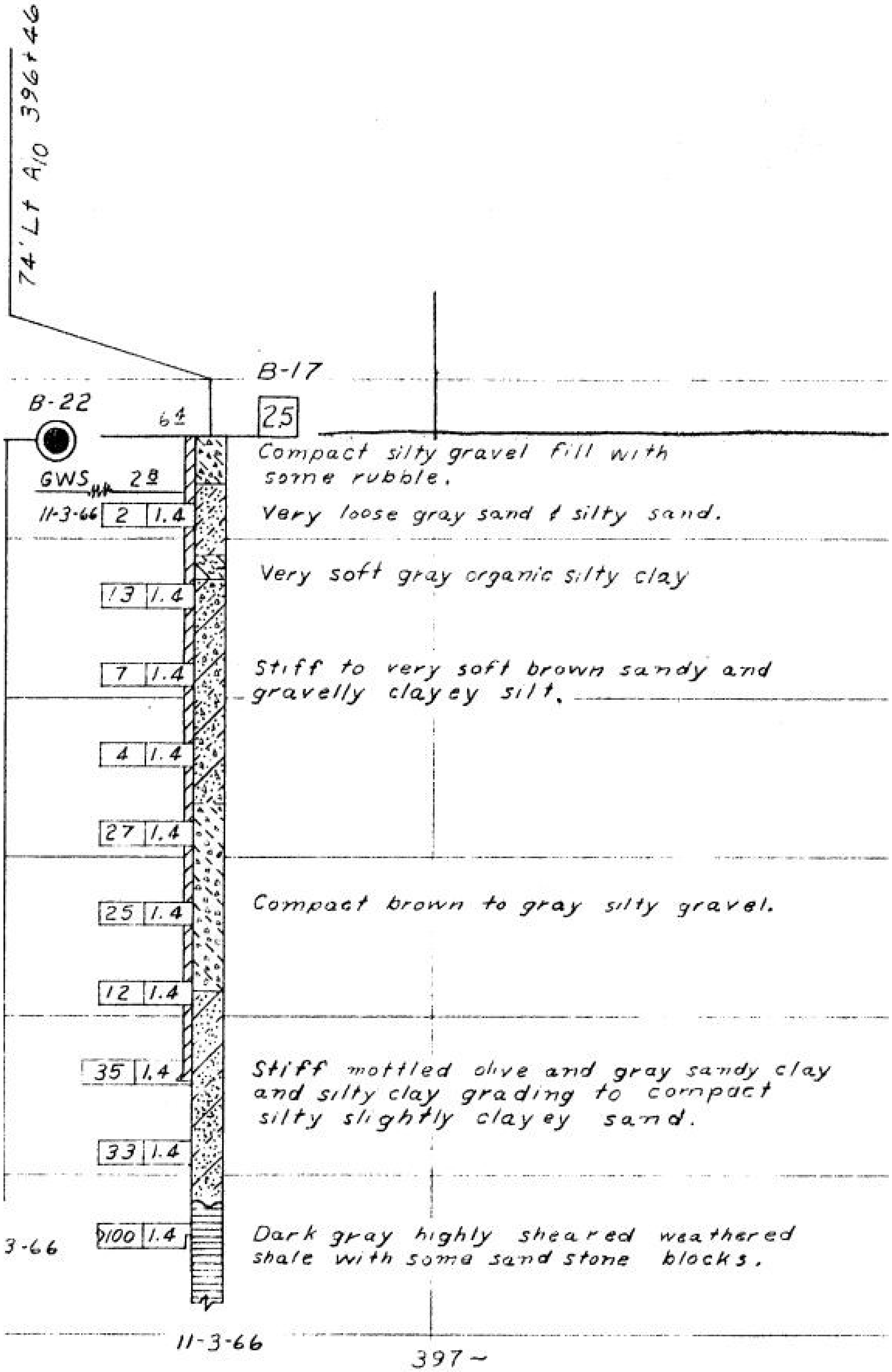
LOG OF TEST BORINGS 4 of 6

BRIDGE NO.	POST MILE	DRAWING NO.	SHEET	OF
27-35L	10.72			

WO 153431
CU 04219

Disregard prints bearing earlier revision dates →

REVISION DATES (PRELIMINARY STAGE ONLY)
2/9/67



Compact silty gravel fill with some rubble.

Very loose gray sand & silty sand.

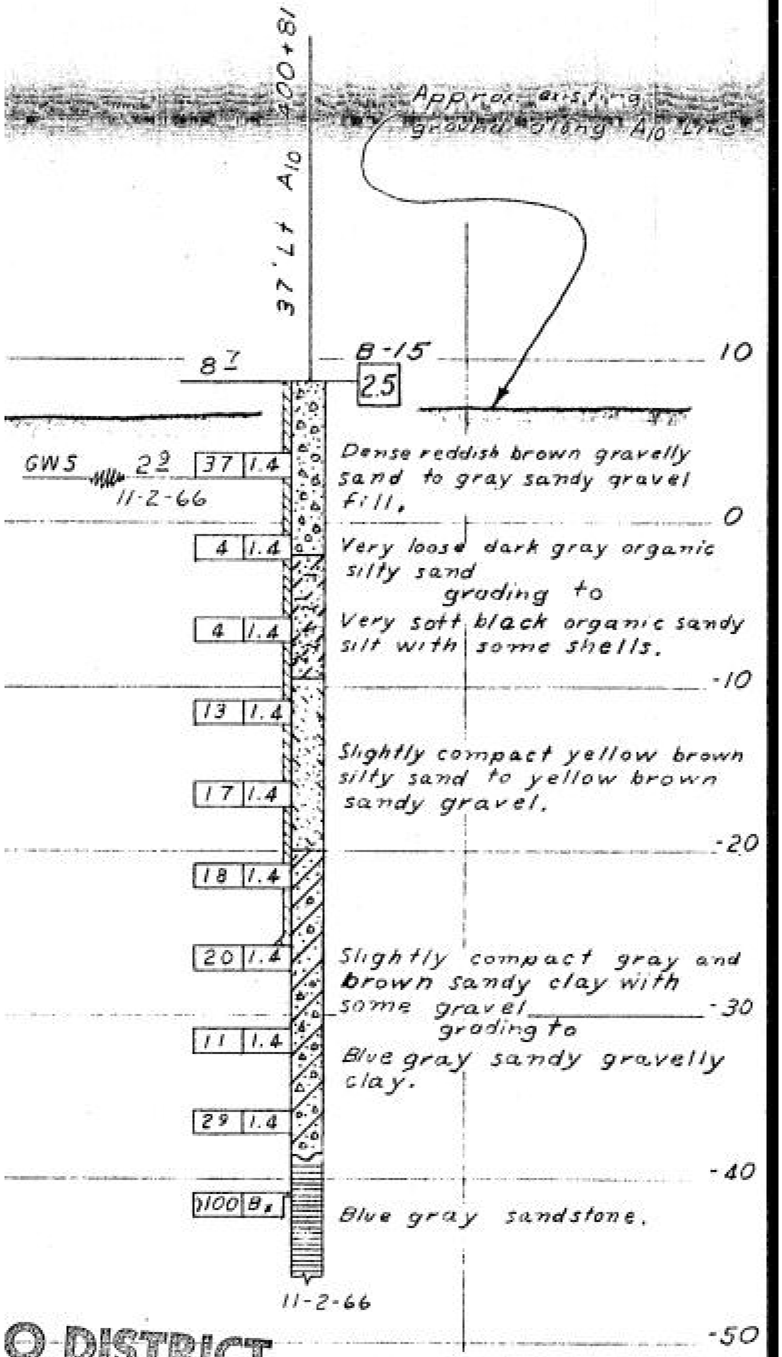
Very soft gray organic silty clay

Stiff to very soft brown sandy and gravelly clayey silt.

Compact brown to gray silty gravel.

Stiff mottled olive and gray sandy clay and silty clay grading to compact silty slightly clayey sand.

Dark gray highly sheared weathered shale with some sand stone blocks.



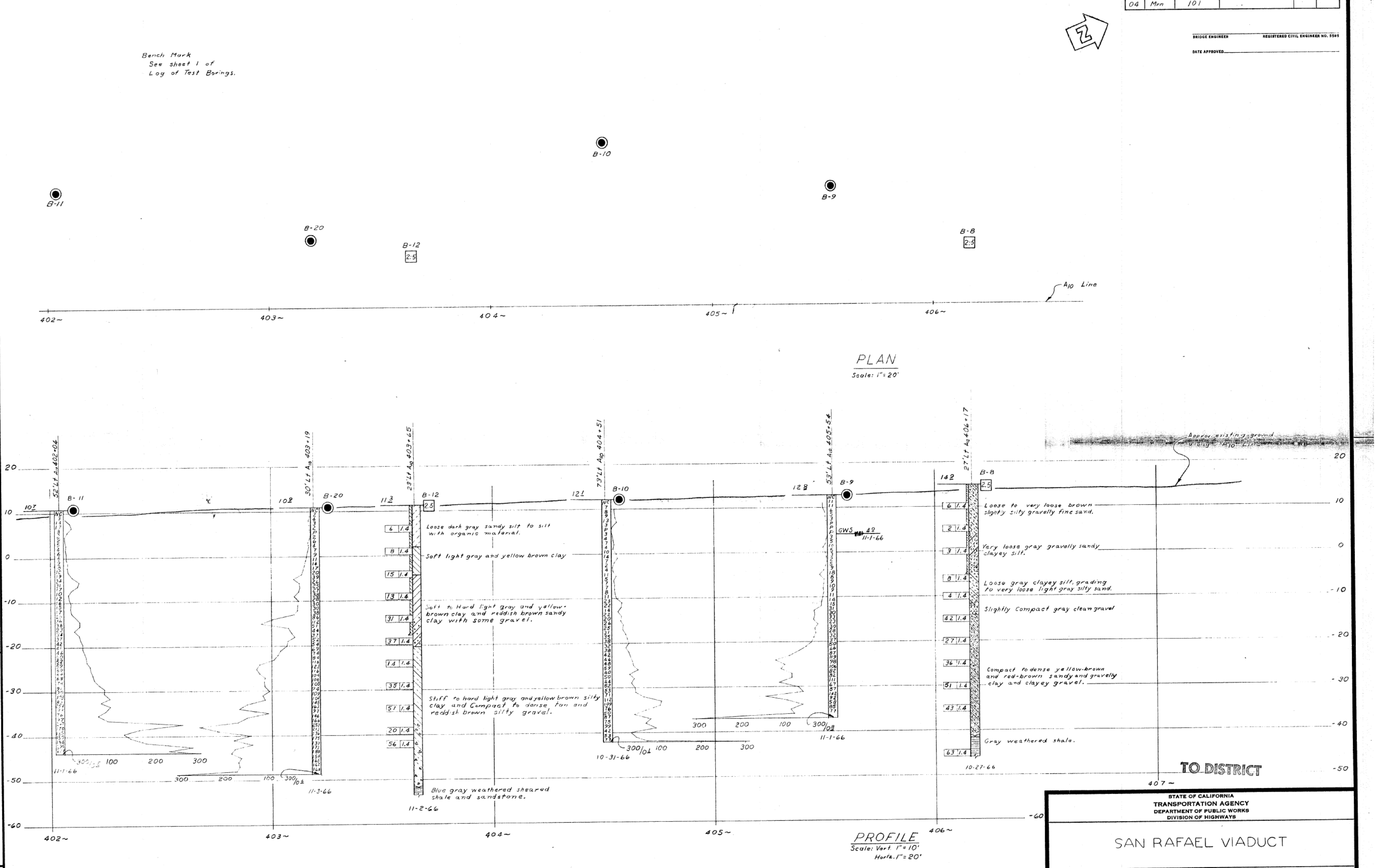
37' Lt A10 400+81
Approx. existing ground along A10 Line
B-15
2.5
8 7
10
GWS 2 9
11-2-66
37 1.4
Dense reddish brown gravelly sand to gray sandy gravel fill.
0
4 1.4
Very loose dark gray organic silty sand
grading to
4 1.4
Very soft black organic sandy silt with some shells.
-10
13 1.4
17 1.4
Slightly compact yellow brown silty sand to yellow brown sandy gravel.
-20
18 1.4
20 1.4
Slightly compact gray and brown sandy clay with some gravel
grading to
-30
11 1.4
Blue gray sandy gravelly clay.
29 1.4
-40
>100 Bx
Blue gray sandstone.
11-2-66
-50

O-DISTRICT

DIST.	COUNTY	ROUTE	POST MILES—TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	Mrn	101			

BRIDGE ENGINEER REGISTERED CIVIL ENGINEER NO. 5585

DATE APPROVED



TO DISTRICT

STATE OF CALIFORNIA
TRANSPORTATION AGENCY
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

SAN RAFAEL VIADUCT

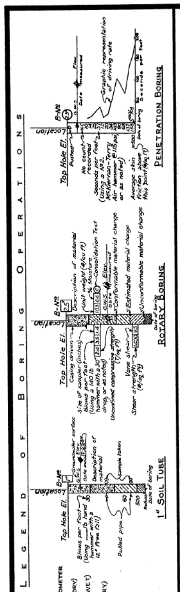
LOG OF TEST BORINGS 5 of 6

BRIDGE NO.	POST MILE	DRAWING NO.	SHEET	OF
27-35L	10.72			

WO 153431
CU 04219

Disregard prints bearing earlier revision dates →

REVISION DATES (PRELIMINARY STAGE ONLY)
2/9/67



Penetrometer
2¼" Cone Penetrometer
Sampler boring (dry)
Rotary boring (wet)
Auger boring (dry)
Jet boring
Core boring
Test pit

LEGEND OF EARTH MATERIALS

Gravel	Silty Clay or Clayey Silt
Sand	Peat and/or Organic Matter
Silt	Fill Material
Clay	Igneous Rock
Sandy Clay or Clayey Sand	Sedimentary Rock
Sandy Silt or Silty Sand	Metamorphic Rock

CLASSIFICATION OF MATERIAL BASED ON STANDARD GRADE SIZE LIMITS

Diagram showing the basis for estimates of grade size distribution used in determination of class names.

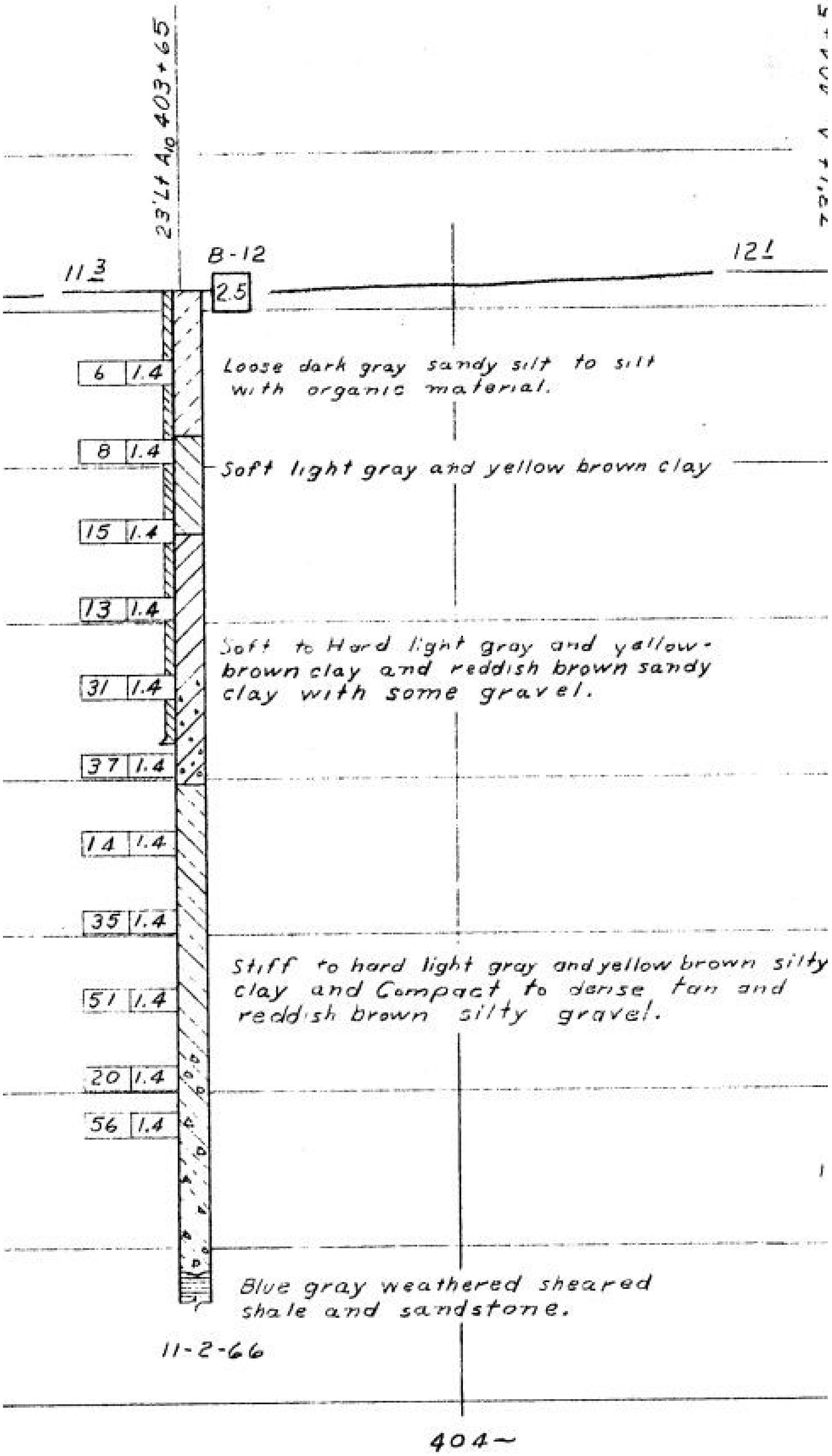
If gravel is present in appreciable amounts the term "gravelly" may be added to the class name, viz. "gravelly sand". The terms "coarse", "medium" and "fine" when used to describe sand, silt and gravel refer to standard grade size limits.

NOTE: Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.

FIELD STUDY	By T. Nelson	11/66
DRAWN	By R. Castle	2/9/67
CHECKED	By W. T. Nelson	6-29-67

Approval Recommended by ____ Engineering Geologist

BRIDGE DEPARTMENT
ENGINEERING GEOLOGY SECTION



Loose dark gray sandy silt to silt with organic material.

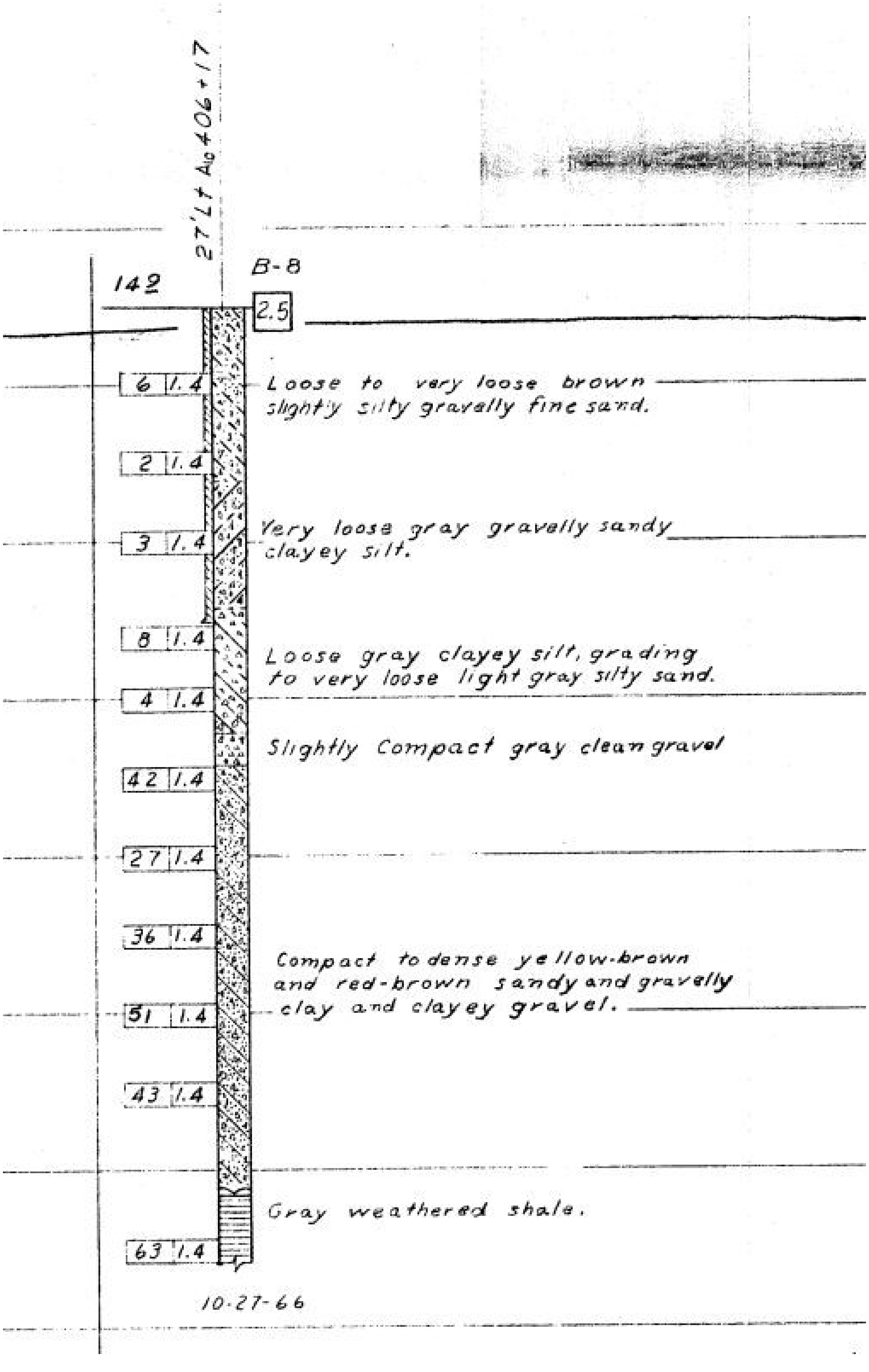
Soft light gray and yellow brown clay

Soft to Hard light gray and yellow-brown clay and reddish brown sandy clay with some gravel.

Stiff to hard light gray and yellow brown silty clay and Compact to dense tan and reddish brown silty gravel.

Blue gray weathered sheared shale and sandstone.

11-2-66


27' Lt A10 406+17
B-8
142
2.5
6 1.4
Loose to very loose brown slightly silty gravelly fine sand.
2 1.4
Very loose gray gravelly sandy clayey silt.
3 1.4
8 1.4
Loose gray clayey silt, grading to very loose light gray silty sand.
4 1.4
Slightly Compact gray clean gravel
42 1.4
27 1.4
36 1.4
Compact to dense yellow-brown and red-brown sandy and gravelly clay and clayey gravel.
51 1.4
43 1.4
Gray weathered shale.
63 1.4

10-27-66