

GEOTECHNICAL FEASIBILITY STUDY

**Dublin Boulevard Extension
Fallon Road to Doolan Road
Federal Project No. RTPL 5432 (019)
City of Dublin and Alameda County, California**

PREPARED FOR:

**BKF ENGINEERS
4670 WILLOW ROAD, SUITE 250
PLEASANTON, CALIFORNIA 94588**



PREPARED BY:

**GEOCON CONSULTANTS, INC.
6671 BRISA STREET
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GEOCON PROJECT NO. E9027-04-01

JULY 2018



Project No. E9027-04-01
July 31, 2018

BKF Engineers
4670 Willow Road, Suite 250
Pleasanton, California 94588

Attention: Mr. Gordon Sweet

Subject: DUBLIN BOULEVARD EXTENSION
FALLON ROAD TO DOOLAN ROAD
CITY OF DUBLIN AND ALAMEDA COUNTY, CALIFORNIA
FEDERAL PROJECT NO. RTPL 5432 (019)
GEOTECHNICAL FEASIBILITY SUMMARY

Dear Mr. Sweet:

In accordance with your request, we herein submit our Geotechnical Feasibility Summary for the proposed extension of Dublin Boulevard in the City of Dublin and Alameda County, California. The accompanying report presents the findings and conclusions from our study. No field exploration or laboratory testing was performed for this preliminary study; future design-level studies should include both. Should project details change from those presented herein, we should review this report for applicability and possible revision.

If you have any questions regarding this report, or if we may be of further service, please contact the undersigned at your convenience.

Sincerely,

GEOCON CONSULTANTS, INC.

Shane Rodacker, PE, GE
Senior Engineer



(1/e-mail) Addressee
(1/e-mail) BKF Engineers
Attention: Mr. Blake Silkwood

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LIST OF REFERENCES

GEOTECHNICAL FEASIBILITY SUMMARY

1. INTRODUCTION

This report presents the results of a geotechnical feasibility summary for the proposed extension of Dublin Boulevard in the City of Dublin and Alameda County, California. The purpose of this study was to evaluate the background geologic setting along the proposed extension and identify geotechnical constraints that may impact the project.

2. SCOPE OF SERVICES

The scope of this study included:

- Reviewing published geologic maps, aerial photographs, project plans, in-house documents, and other literature pertaining to the site to aid in evaluating geologic conditions and hazards that may be present.
- Performing a field reconnaissance to observe the existing conditions at the site.

Subsurface exploration, laboratory testing and engineering analyses were not performed.

3. SITE AND PROJECT DESCRIPTION

The planned project will extend Dublin Boulevard from its existing terminus at Fallon Road approximately 1 ½ miles eastward to Doolan Road (see Vicinity Map, Figure 1). Based on the information provided by BKF Engineers (BKF), the alignment of the proposed extension generally trends just below the hills that ascend from the Livermore Valley north of I-580. The alignment traverses pasture land between Fallon Road and Croak Road. Between Croak Road and Doolan Road, the roadway will cross pasture land, a former farmstead and a staging yard for a landscaping business.

The alignment crosses several seasonal drainages, and Cottonwood Creek approximately ¼ mile west of Doolan Road. At the intersection with the proposed alignment, most of the seasonal drainages are incised only a few feet below adjacent grade. Cottonwood Creek is more significant with the creek bed approximately 8 feet below adjacent grade and near-vertical channel walls in some areas. Topographic information from BKF and aerial imagery indicate that grading associated with prior development of the farmstead and landscaping business, and possibly a gravel pit north of the project alignment, have obscured the natural course of some of the seasonal drainages that flow from the hills southward to the Livermore Valley.

The project plans indicate the Dublin Boulevard extension will consist of three travel lanes and shoulder bike lanes in each direction, a separate shared pedestrian-bike path on the north side of the roadway and a separate sidewalk on the south side of the roadway between Fallon Road and Croak Road. The roadway will narrow to two travel lanes in each direction east of Croak Road. The project will include a major bridge to convey traffic over Cottonwood Creek. The bridge is conceptually planned as a three- to four-span, 270-foot long structure with abutments on each end and bent supports. Stormwater treatment facilities and underground utilities are proposed along the entire alignment.

Detailed grading plans have not yet been prepared but we understand that grading will generally consist of cuts along the northern margin of the roadway and fills along the southern edge. General embankment heights

will be approximately eight feet or less with isolated areas up to 15 feet. Cuts of eight feet or less are anticipated throughout most of the alignment. Cuts up to 12 feet may be needed in isolated areas such as the northern side of the roadway, just east of Fallon Road.

4. CLIMATE

Monthly climate data near the project site are presented in Table 4. These data were obtained from information published on line by Western Regional Climate Center (www.wrcc.dri.edu). The monthly data were recorded from 1903 to 2016 and the station used for recording was located at Latitude 37.41°; Longitude -121.46°; Elevation 480 feet (Livermore, California #044997).

**TABLE 4
MONTHLY CLIMATE SUMMARY**

Climate Data	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Avg. Total Precip. (inches)	2.97	2.47	2.15	1.00	0.44	0.11	0.02	0.04	0.22	0.67	1.54	2.56	14.18
Avg. High (°F)	56.8	61.2	65.2	70.5	76.4	83.1	89.0	88.2	86.0	77.7	66.3	57.5	73.2
Avg. Low (°F)	36.7	39.4	41.3	43.6	47.6	51.7	54.2	54.0	52.5	47.7	41.1	37.0	45.6

Based on the information obtained, the average precipitation for a calendar year is 14.18 inches. The majority of this precipitation (over 90 percent) falls between October and April. The warmest months are July and August with average highs and lows of approximately 89°F and 54°F, respectively. The coolest months are December and January with average highs and lows of approximately 57°F and 37°F, respectively.

5. GEOLOGIC CONSIDERATIONS

5.1 Site Geology

Geologic references map the hills along the northern margin of the proposed extension as Pliocene to Pleistocene age Livermore Gravels. Alluvial materials below (south of) the hills are variable with Late Pleistocene to Holocene age alluvial fan deposits and undifferentiated alluvial deposits mapped along the roadway alignment. Artificial fills were noted at the former farmstead on the eastern side of Croak Road during our site reconnaissance. A Geology Map is presented as Figure 2 (attached).

Caltrans performed four soil borings for the I-580 / Cottonwood Creek crossing in July of 1965. The borings extended to depths of approximately 80 feet or less and generally encountered very loose to medium dense silty sands, and stiff to very stiff sandy silts with hard consistency noted below a depth of approximately 60 feet. The log of test boring (LOTB) sheet and relevant site plans are presented in Appendix A. Soil borings performed in January of 1997 for improvements to the I-580 / Airport Boulevard interchange generally encountered stiff to hard lean clays.

5.2 Faulting

Geologists and seismologists recognize the San Francisco Bay Area as one of the most seismically-active regions in the United States. The significant earthquakes that occur in the Bay Area are typically associated with crustal movements along well-defined active fault zones that generally trend in a northwesterly direction.

The site is not located within an Alquist-Priolo Earthquake Fault Zone as established by the State Geologist around known active faults. Review of the Caltrans fault database and field reconnaissance did not reveal evidence of active faulting through or near the site. It should be noted that some geologic references place the inferred location of the Mt. Diablo Thrust Fault in close proximity to the project, and crossing the roadway alignment just west of the proposed bridge over Cottonwood Creek. The Caltrans fault database dates the fault as Late Quaternary age and places the fault approximately 1 ¾ miles north of the site. While Caltrans provides design guidance for bridges that cross faults, we are not aware of any special mitigation or design measures for Caltrans' roadways that cross active faults – including those with a known risk of surface rupture e.g. Hayward Fault, Calaveras Fault, etc.

Table 5 presents approximate distances to active faults in the site vicinity based on mapping by CGS as presented in an online fault database maintained by Caltrans. For the purposes of Table 5, we used the location of the planned Cottonwood Creek Bridge - site coordinates are N 37.7033°, W 121.8280°.

**TABLE 5
REGIONAL FAULT SUMMARY**

Fault Name	Approximate Distance to Site (miles)	Maximum Earthquake Magnitude, M_w	Fault Age
Mt. Diablo Thrust	1 ¾	6.6	Late Quaternary
Pleasanton	3 ¾	6.6	Holocene
Las Positas	5 ½	6.4	Holocene
Calaveras (North)	5 ½	6.9	Holocene
Greenville (North)	6 ¼	6.9	Holocene
Clayton	11	6.9	Holocene
Hayward (South)	12 ¼	7.3	Holocene
Greenville (South)	12 ½	6.9	Holocene
Great Valley 6	15 ¼	6.8	Holocene
Concord	16 ¼	6.6	Holocene
Hayward (South Extension)	16 ½	6.7	Holocene
Great Valley 7	16 ¾	6.7	Holocene
Calaveras (Central)	16 ¾	6.9	Holocene
Hayward (North)	17 ¼	7.3	Holocene
Silver Creek	17 ¼	6.9	Holocene
Los Medanos – Roe Island	19 ¼	6.8	Holocene
Contra Costa Shear Zone	20 ¾	6.5	Holocene
Great Valley 5	21 ½	6.6	Holocene

Faults tabulated above and many others in the Bay Area are sources of potential ground motion. However, earthquakes that might occur on other faults within the northern California area are also potential generators of significant ground motion and could cause ground shaking at the site.

5.3 Tsunamis and Seiches

Tsunamis are large sea waves caused by submarine earthquakes, landslides, or volcanic eruptions. A seiche is defined as a free or standing wave oscillation of the water surface in an enclosed basin. The potential of tsunamis and/or seiches to occur at the site is considered nil due to the large distance to the Pacific Ocean and enclosed bodies of water.

5.4 Groundwater

Information from the CGS seismic hazard zone report for the project area indicates historic high groundwater levels are on the order of 20 to 25 feet below grade along the project alignment. The same CGS source indicates historic high groundwater levels closer to 10 feet below grade in the area northwest of the existing I-580 / Fallon Road interchange. An approximately 80-foot-deep boring performed by Caltrans in 1965 for the I-580 / Cottonwood Creek crossing encountered groundwater at a depth of approximately 32 feet. See Caltrans Boring No. B-2 on the LOTB sheet in Appendix A. A deep soil boring performed in January 1997 at the I-580 / Airport Boulevard interchange encountered groundwater at a depth of approximately 39 feet.

Shallower groundwater levels may be present throughout the proposed roadway alignment, particularly at the Cottonwood Creek crossing.

6. GEOTECHNICAL CONSIDERATIONS

6.1 Preliminary Foundation Recommendations

Based on the anticipated soil and geologic conditions at the location of the planned creek crossing, cast-in-drilled-hole (CIDH) concrete piles or driven steel pipe piles are potential foundation types for the Cottonwood Creek Bridge. Other foundation types may also be feasible. Casing for CIDH piles may be required if loose sands or other soils and/or groundwater conditions susceptible to caving are present.

Various geologic references map Late Pleistocene to Holocene age alluvial deposits at the Cottonwood Creek Bridge crossing, with the hills north of the crossing mapped as Livermore Gravels. Soil borings for the I-580 / Cottonwood Creek Bridge extended to maximum depths of 80 feet with no significant occurrences of gravel noted. However, Livermore Gravels could be encountered at depth in foundation excavations for the bridge. If present, the gravels could influence foundation type selection for the bridge or foundation construction techniques.

6.2 Liquefaction Potential

Liquefaction is a phenomenon in which loose, saturated, and relatively cohesionless soil deposits located beneath the groundwater table lose strength during strong ground motions. Primary factors controlling liquefaction include intensity and duration of ground accelerations, characteristics of the subsurface soil, in-situ stress conditions, and depth to groundwater. USGS mapping indicates a low susceptibility to liquefaction throughout the majority of the project site. However, the Cottonwood Creek drainage is mapped with a very high susceptibility to liquefaction (see Figure 2) and an area of moderate susceptibility is mapped to the east

of the bridge. Liquefaction potential at the Cottonwood Creek crossing could necessitate foundation elements deeper than those required for structural loading purposes.

The banks of Cottonwood Creek present free-face geometry that may be susceptible to lateral spreading if liquefiable soils exist at depths that correspond to elevations within the creek banks or near the creek bottom. Lateral spreading potential may require mitigation measures such as remedial earthwork to remove susceptible soils and replace with engineered fill, ground improvement, or a containment mechanism such as a slurry cut-off wall. Other mitigation measures may be considered. The potential for liquefaction and lateral spreading should be evaluated during project design, based on site-specific subsurface explorations.

6.3 Seismically-Induced Settlement

Seismically-induced settlement is possible at the proposed bridge location, commensurate with the very high liquefaction potential along Cottonwood Creek. Settlements due to liquefaction may require consideration in foundation design for Cottonwood Creek Bridge, which is not unusual for bridges and other infrastructure throughout the Bay Area.

6.4 Embankments

We do not anticipate the need for a surcharge program or settlement monitoring for the project embankments, given the thickness of proposed embankments and anticipated soils conditions. The compressibility of soils below project embankments should be evaluated in future design-level geotechnical studies.

6.5 Slopes

The project proposes significant cuts on the northern side of the Dublin Boulevard Extension just east of Fallon Road. We understand that cut slopes for the project will be inclined at 3:1. Fill slopes of 2:1 or flatter are anticipated throughout the project. Based on the referenced geologic mapping and our experience in the area, we do not anticipate that significant mitigation measures will be required. We anticipate that slopes at the proposed inclinations and heights should possess adequate factor of safety against deep-seated instability. We do not anticipate that interim benches will be required in the slopes for stability purposes but may be considered for slope maintenance. The stability of proposed cut and fill slopes should be evaluated during future studies for the project.

Fill slopes constructed of predominantly clayey materials can be prone to surficial slumping, especially when not properly vegetated after grading operations. If clayey soils are used for fill slopes, some future maintenance to repair surficial slumps, skin failures, etc. may be required. The suitability of existing soils for re-use in fill slopes should be addressed in future design-level studies for the project. Selective grading provisions may be implemented to mitigate the potential for clayey materials in fill slopes.

6.6 Expansive Soils

Expansive soils are common in the Livermore Valley and are likely present along the project alignment. Depending on the extent of expansive soils and level of expansion potential, mitigation measures such as lime-treatment, selective grading or select import fill materials may be necessary.

6.7 Corrosive Soils

Soil corrosivity is not a visually discernable characteristic and soil sampling and testing to evaluate soil corrosion parameters have not been performed. Sampling and testing should be performed in future design level studies. If corrosive soils exist onsite, the use of select pipe materials and concrete mixes should effectively mitigate the effects thereof.

6.8 Cut-Fill Transitions

Portions of the new roadway will be constructed in side-hill terrain with cuts planned on the northern side of the roadway and fills on the opposite (southern) side, thereby creating a cut-fill transition in the roadway. In our experience, such cut-fill transitions can cause distress within roadways due to the difference in support characteristics. Project-specific grading provisions may be required to mitigate the potential for adverse effects of cut-fill transitions within the roadway. Such provisions can include undercuts with the cut portions of the roadway. In general, undercuts should be backfilled with soil possessing an R-value of 15 or higher. Portions of the native site soils should be suitable to re-use as backfill in the undercut areas but some selective grading may be necessary. The suitability of existing soils for re-use as fill material should be a focal point of future geotechnical studies.

6.9 Retaining Walls

We understand that project retaining walls may be considered to minimize right-of-way impacts and reduce the overall project footprint. Based on the information reviewed for this feasibility study and our experience in the area, we do not anticipate geotechnical conditions that would preclude the use of standard Caltrans retaining walls with shallow continuous footings for foundation support. Depending on the geometry at each wall location and potential logistical constraints, CIDH pile foundations may be selected and should be feasible from a geotechnical standpoint.

6.10 Culverts

The proposed roadway extension will cross several minor drainages and preliminary project design indicates that pipe or box culverts may be used to convey flows beneath the roadway. Soils conditions in the drainages may be loose or soft and over-excavations may be required to provide suitable subgrade support for culverts and associated wing walls.

6.11 Pavements

Based on information from BKF Engineers, we understand a design Traffic Index (TI) of 10.5 is anticipated for the new roadway. Specific subgrade soil conditions will be evaluated during future design level studies. The table below presents recommended flexible pavement sections for various subgrade R-values, reflective of the anticipated low R-value soils that are common in the area; and the potential for selective grading or lime treatment as mitigation measures to improve subgrade soil support. We developed the following pavement structural sections in general accordance with Caltrans design methodology using a 20-year design life.

TABLE 6
FLEXIBLE PAVEMENT SECTION RECOMMENDATIONS

Alignment	Subgrade R-value = 5			Subgrade R-value = 15 (Select Grading Scenario)			Subgrade R-value = 40 (Lime Treated Subgrade Scenario)		
	HMA	AB	Total Section Thickness	HMA	AB	Total Section Thickness	HMA	AB	Total Section Thickness
Dublin Boulevard (TI =10.5)	6.5	24.5	31	6.5	21	27.5	6.5	12	18.5

Notes:

1. All thicknesses are in inches.
2. AB: Class 2 AB with a minimum R-Value of 78 and meeting the requirements of Section 26 of the latest Caltrans Standard Specifications.
3. HMA: Hot Mix Asphalt meeting the requirements of Section 39 of the latest Caltrans Standard Specification.
4. Lime-treated subgrade assumed to be at least 12 inches thick.

7. FUTURE GEOTECHNICAL AND GEOLOGICAL STUDIES

Design-level studies for the project should include a comprehensive evaluation of the geotechnical and geologic considerations discussed herein. Future studies should include subsurface exploration, laboratory testing and engineering analyses. Key considerations include, but may not be exclusive to:

- o The potential for liquefaction and related seismically-induced settlements, particularly at the proposed Cottonwood Creek Bridge.
- o The stability of proposed cut and fill slopes for the project.
- o The suitability of existing soils for re-use as fill material.

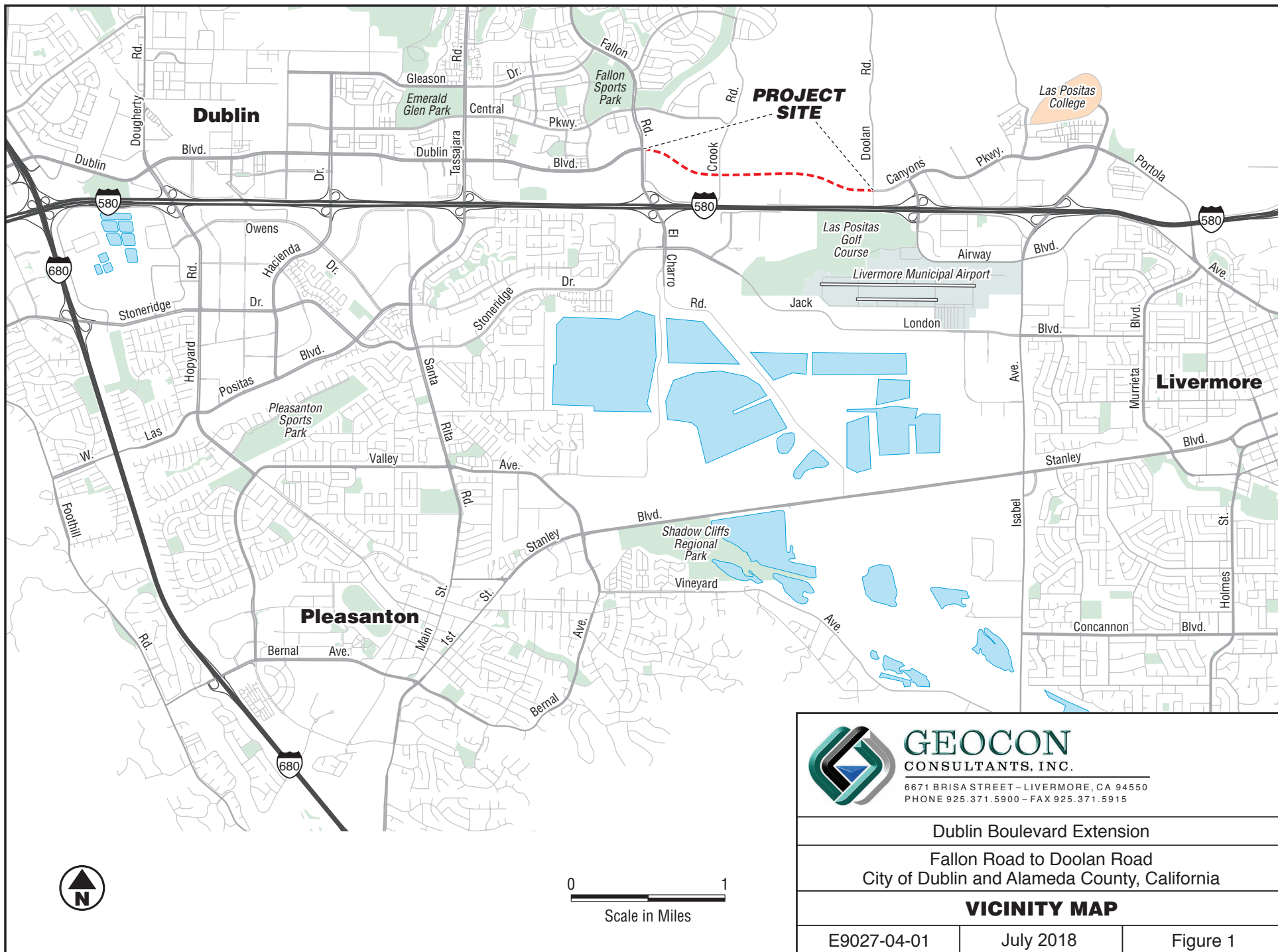
Future subsurface exploration should generally include soil borings at approximate 500-foot intervals along the roadway extension. In addition, borings should specifically be performed for cut slopes over 8 feet, at retaining wall locations, at bridge support locations, and at culvert crossing locations. Additional borings may be necessary for other project components. The field investigation program should consider project design details at the time.

LIMITATIONS AND UNIFORMITY OF CONDITIONS

The recommendations of this report pertain only to the site investigated and are based upon the assumption that the soil conditions do not deviate from those disclosed in the investigation. If any variations or undesirable conditions are encountered during construction, or if the proposed construction will differ from that anticipated herein, Geocon. should be notified so that supplemental recommendations can be given. The evaluation or identification of the potential presence of hazardous or corrosive materials was not part of the scope of services provided by Geocon.

This report is issued with the understanding that it is the responsibility of the owner or his representative to ensure that the information and recommendations contained herein are brought to the attention of the architect and engineer for the project and incorporated into the plans, and the necessary steps are taken to see that the contractor and subcontractors carry out such recommendations in the field.

The findings of this report are valid as of the present date. However, changes in the conditions of a property can occur with the passage of time, whether due to natural processes or the works of man on this or adjacent properties. In addition, changes in applicable or appropriate standards may occur, whether they result from legislation or the broadening of knowledge. Accordingly, the findings of this report may be invalidated wholly or partially by changes outside our control. Therefore, this report is subject to review and should not be relied upon after a period of three years.



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Dublin Boulevard Extension

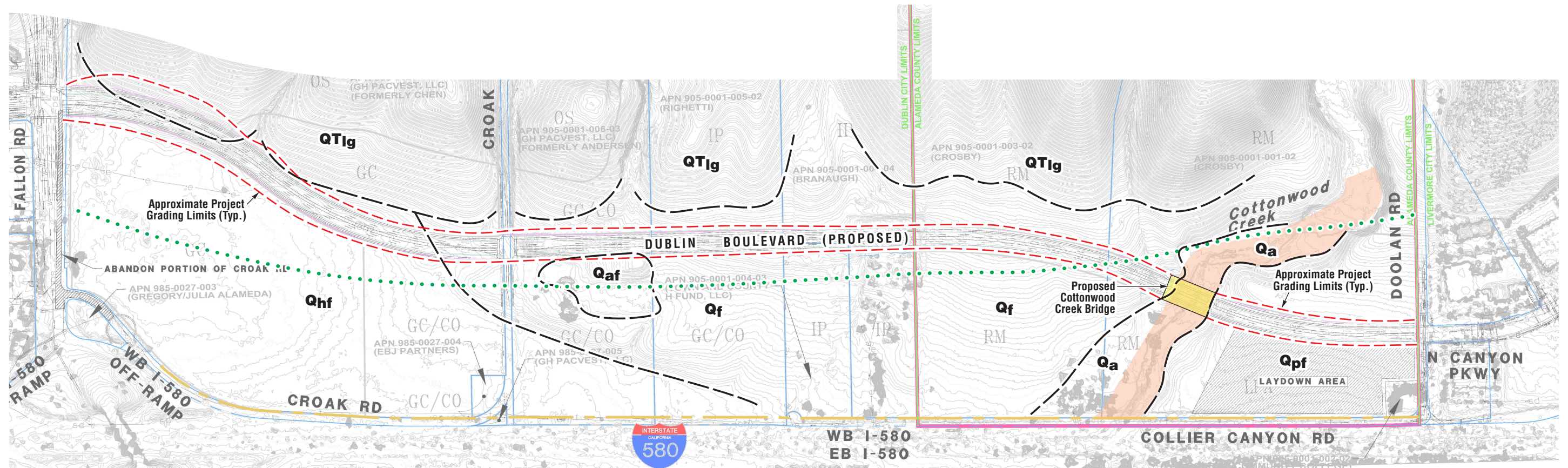
Fallon Road to Doolan Road
City of Dublin and Alameda County, California

VICINITY MAP

E9027-04-01

July 2018

Figure 1



Note: Site geology derived from various geologic references and site-specific mapping. See List of References.

LEGEND:

- Approximate Geologic Contact
- Approximate Location of Buried Thrust Fault (Inferred)
- Very High Susceptibility to Liquefaction
- Qaf** Artificial Fill
- Qhf** Holocene Age Alluvial Fan
- Qa** Undifferentiated Late Pleistocene to Holocene Age Alluvium
- Qf** Late Pleistocene to Holocene Alluvial Fan
- Qpf** Late Pleistocene Alluvial Fan
- QTlg** Livermore Gravels, Pliocene to Early Pleistocene Age



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Dublin Boulevard Extension

Fallon Road to Doolan Road
City of Dublin and Alameda County, California

GEOLOGY MAP

E9027-04-01

July 2018

Figure 2

APPENDIX

A

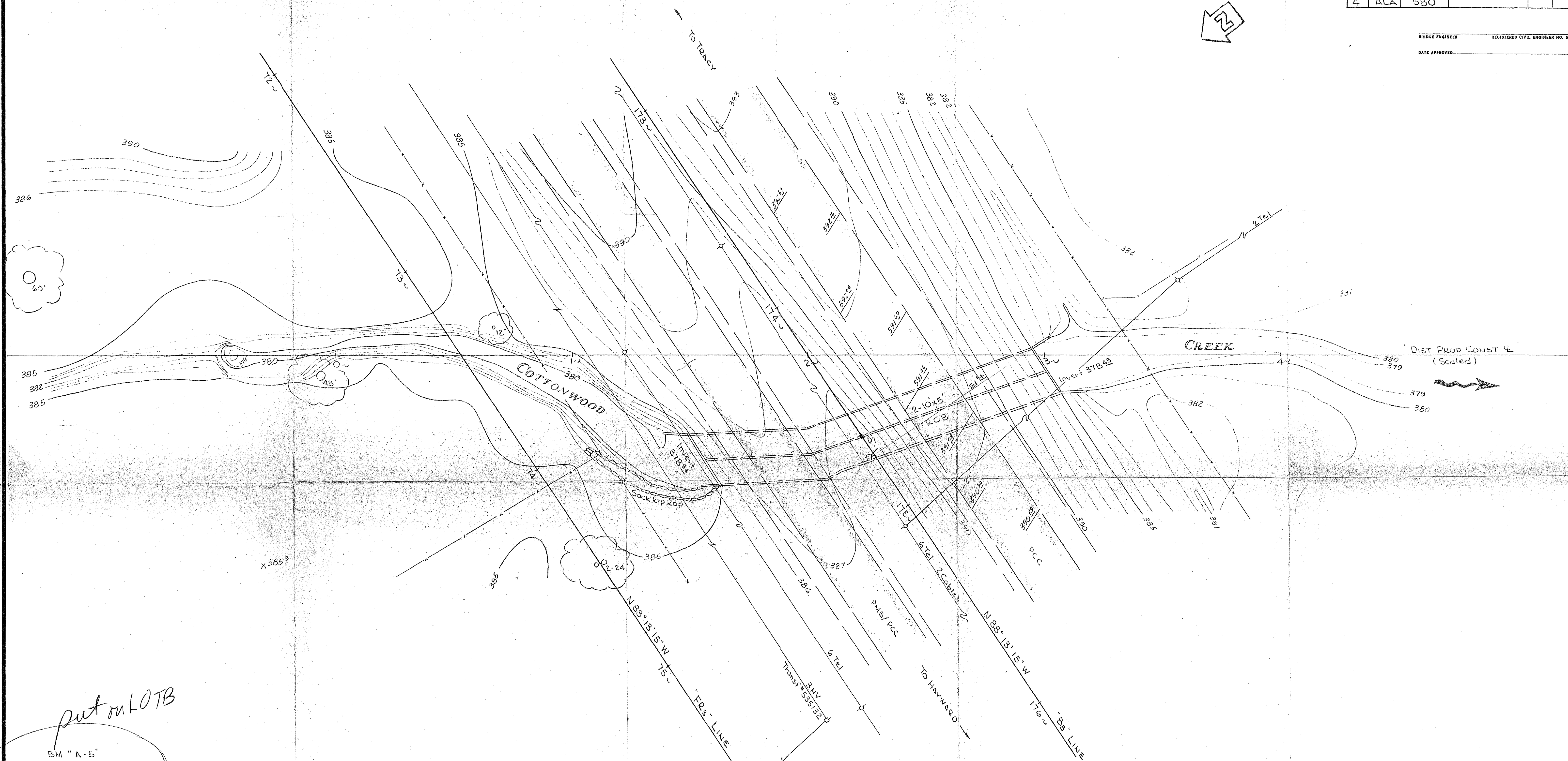
APPENDIX A

**CALTRANS INFORMATION FROM I-580 CROSSING AT COTTONWOOD CREEK AND
I-580 / AIRPORT BOULEVARD INTERCHANGE**

DIST.	COUNTY	ROUTE	SECTION	SHEET NO.	TOTAL SHEETS
4	ALA	580			

BRIDGE ENGINEER _____ REGISTERED CIVIL ENGINEER NO. 5595

DATE APPROVED _____



BM "A-5"
Fd - CHC disc in casing
in med c "B8" 179+96.99
EL 362.65

BM "A"
Set checked "a" top hdl
@ 2 P4 WW 80.3 Lf "B8" 174+74.1
EL 385.12

174+74.1 ← Correct Sta.

SCALE 1"=20'
LEVEL DATUM: USC&GS MSL
FOR ALIGNMENT TIES SEE PR-3313-3
CONTOURS AS OF 5-19-65
SITE PLAN TO SUPPLEMENT DISTRICT DATA
SURVEY BY D.J.B. DATE 5-65
DRAWN BY R.R.B. DATE 7-65
TRACED BY J.S. DATE 8-9-65

used this one
OK - location
"wrong"
quarto
Baumgardner
P.B.

BRIDGE DEPARTMENT DESIGN SECTION

Section Supervisor	
DESIGN	By _____
	Checked _____
DETAILS	By _____
	Checked _____
QUANTITIES	By _____
	Checked _____

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

COTTONWOOD CREEK

SITE PLAN

BRIDGE NO. 33-13 R/L	DRAWING NO.	SHEET	OF
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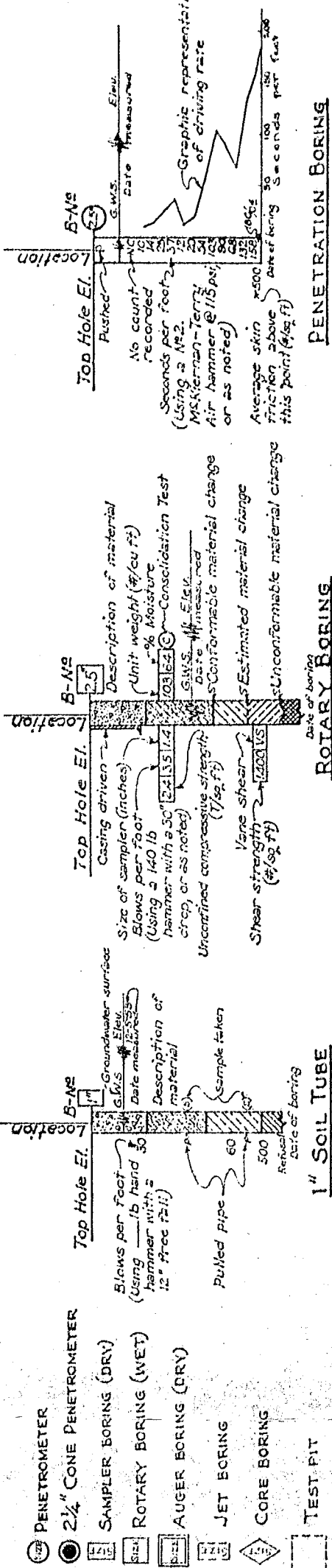
WO 04204
136441

Disregard prints bearing earlier revision dates

REVISION DATES (PRELIMINARY STAGE ONLY)

PR-3313-1

LEGEND OF BORING OPERATIONS



PENETRATION BORING

DATE OF BORING

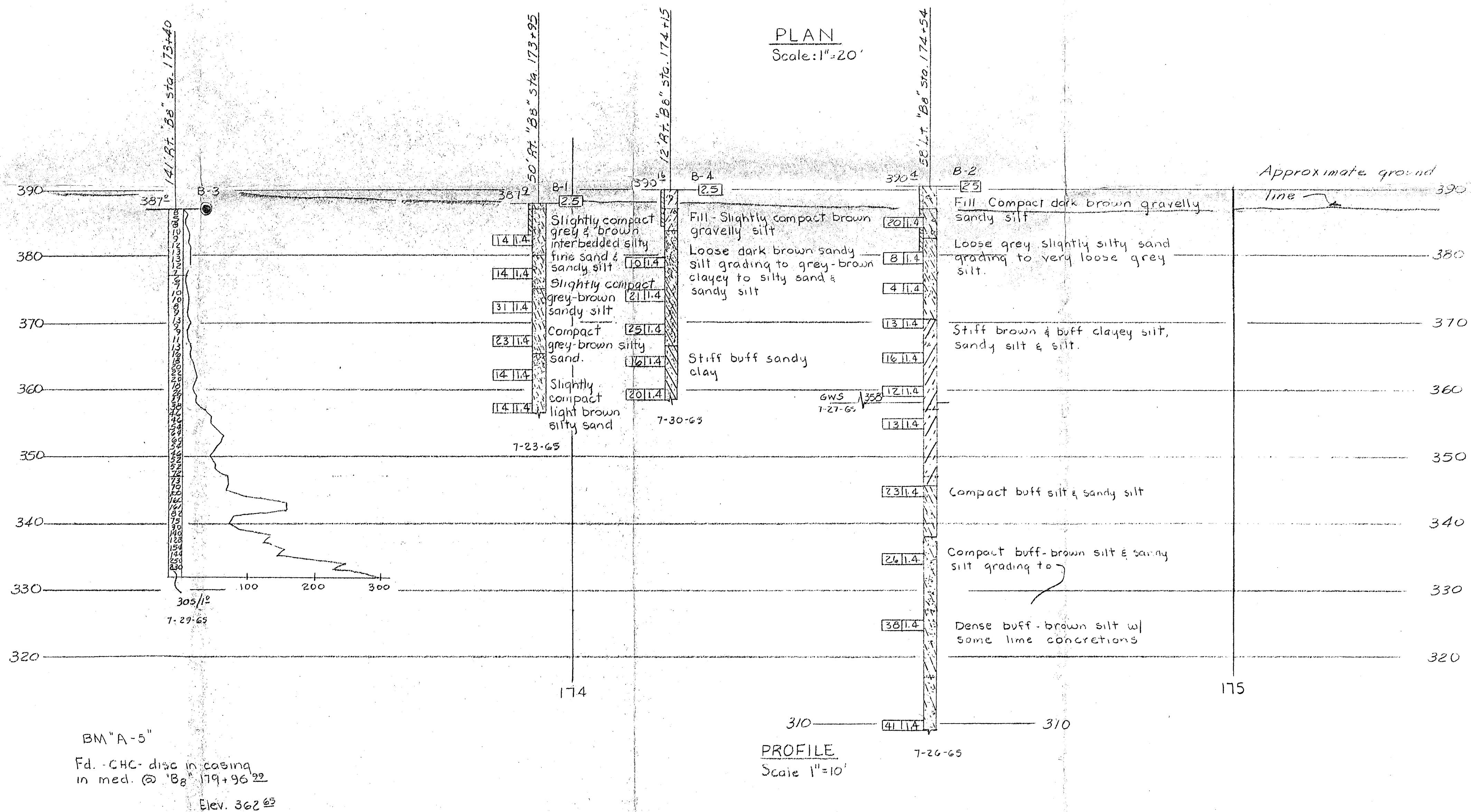
1" SOIL TUBE

LEGEND OF EARTH MATERIALS

CLASSIFICATION OF MATERIAL BASED ON 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.

BRIDGE DEPARTMENT
ENGINEERING GEOLOGY SECTION



PLAN
Scale: 1"=20'

PROFILE
Scale 1"=10'

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

COTTONWOOD CREEK

LOG OF TEST BORINGS

5.

SCALE As shown	BRIDGE 33-13R/L	FILE	DRAWING
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04204.
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Disregard prints bearing earlier numbers

PREL. DRAWING No. PR-5315 2



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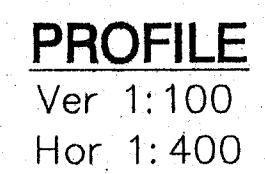
[illegible]

Plate A-1

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8. Unpublished reports, aerial photographs, and maps on file with Geocon Consultants.
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