BART
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT
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ENVIRONMENTAL PROTECTION
00 JUL 19 PM 3:52

July 14, 2000
ESD-00-0016

Mr. Barney Chan
Hazardous Materials Specialist
Alameda County Health Care Services Agency
1131 Harbor Bay Parkway, Suite 250
Alameda, CA 94602-6577

Re: Site Mitigation and Soil Removal Work Plan
Former Union Pacific Railroad Site
Western Edge of Fruitvale Avenue to the Eastern Edge of 37th Avenue, Oakland, CA

Dear Mr. Chan:

As I have previously discussed with you over the phone, BART is taking over the management and implementation of contaminant mitigation measures on the above-mentioned site from Fruitvale Development Corporation. I will be your point-of-contact for this purpose.

BART intends to develop this property as a parking garage and passenger drop-off area. As part of this construction BART will excavate between 1½ and 3 feet of soil and pave the site with asphalt. We propose to follow the general approach outlined in the workplan submitted to you by ARS with some amendments to facilitate our construction schedule. Our proposed approach is outlined below.

1. In-situ soil and groundwater sampling. Designed to
   - Characterize soil for disposal
   - Evaluate current groundwater depth and quality, if encountered
   - Screen contaminants in potentially reusable soils
   - Identify contaminants that will remain after excavation
2. Proper handling and disposal of contaminated soil.
3. Proposal to leave contaminants below excavation depth in place.
   - Site will be capped with asphalt or two feet of clean fill ?
   - A deed notification/restriction will be recorded as appropriate
4. Proposal to reuse contaminated soil on-site.
   - Reuse excavated contaminated soils that are not hazardous waste
   - Test soil after excavation for contaminants of concern
   - Reuse soil under parking structure ramp where it will be encased in concrete

Each element of our proposed approach is described in detail below.

In-situ Sampling

BART has already conducted sampling on the property to characterize, for purposes of disposal, the soil that will be excavated for construction of the passenger drop-off area. This sampling primarily looked at metals concentrations. Samples were taken from 1 foot and 3 feet below ground surface. Based on our results, approximately 80% of the soil being excavated is classified as a California hazardous waste due to leachable arsenic concentrations. A copy of this report is attached.

BART is currently proposing additional soil sampling to screen the site for additional contaminants about which the county has raised a concern. BART will be testing for VOC, SVOC, TPH-g, TPH-d, TPH-mo, and MTBE. During this sampling, we are only proposing to take samples at 1 foot below ground surface in those areas that may be potentially reusable. We feel this testing is not necessary for soil we have already determined to be a hazardous waste. The workplan for this sampling will be submitted under separate cover by July 17.

In our second sampling event BART will attempt to take up to 4 groundwater samples. Recent geotechnical borings between 20 and 100 feet away from the site have encountered groundwater at various depths from 11 feet to more than 21 feet. BART will drill to a depth of 30 feet. If we encounter groundwater, the samples will be analyzed for metals and all the constituents mentioned above.

In both sampling events BART is taking soil samples at a depth of 3 feet below ground surface (BGS) to determine what will remain in place after the proposed excavation has been completed. This should obviate the need for confirmatory sampling after excavation, thus allowing all excavation to be done in a single mobilization.

replaces confirm. sampling

Proper Handling and Disposal of Contaminated Soil

All earthwork on this site will be done by a licensed contractor with a HAZ certification. The work will be done in accordance with the requirements of 8CCR §5192, Hazardous Waste Operations and Emergency Response, and 8CCR §5214, Inorganic Arsenic.

All excavated soil, which is classified as a hazardous waste by 22CCR or is otherwise unsuitable for use on-site, will be transported by an appropriately licensed hauler to a facility permitted to accept such waste.

Proposal to Leave Contaminants in Place

BART proposes that soil below the planned excavation depth be left in place, subject to the following restrictions.

1. All contaminants are present below their industrial preliminary remediation goals (PRG) except as noted below.

2. Total arsenic will be less than 500 mg/kg. (This level is used because it is below the Title 22 TTLC level for arsenic and has been shown to be protective of human health based on analysis done for the Upland Operable Unit of the Rhone-Poulenc Superfund Site, East Palo Alto, CA.)
3. Individual polynuclear aromatic hydrocarbons (PNA) can exceed the industrial PRG as long as the total PNAs are less than 12 mg/kg. (This level is based on analysis conducted for Migration Management Zone 2 at the San Francisco International Airport.)
4. Total Petroleum Hydrocarbons will be less than 1000 mg/kg. (This level has previously been accepted by the RWQCB. If the county has accepted higher levels, we would propose to use what the county thinks is prudent.)
5. Contaminated soil will be covered with either 3 inches of asphalt or at least 2 feet of clean fill in the case of landscaping areas.
6. BART will record a deed restriction or deed notice as required by Alameda County or the Regional Water Quality Control Board.

These conditions are based on the Soil Management Plan for the BART San Francisco Airport Extension prepared by Camp Dresser and McKee and approved by the Regional Water Quality Control Board on August 24, 1998, portions of which are attached for your information.

The development of these criteria was based on a review of clean-up levels for the San Francisco International Airport Migration Management Zone 2. This zone was defined as areas at least 1,300 feet from any surface water and 1,000 feet from any ecologically sensitive area. The Fruitvale site is approximately 2,800 from any surface waters or ecologically sensitive areas.

Proposal to Reuse Contaminated Soils On-site

There are approximately 2000 cubic yards of soil that will be excavated for the BART construction that is not hazardous waste, but contains arsenic above PRGs. BART proposes to reuse this soil as fill for its construction.

This reuse will conform to the requirements described above for leaving contaminated soil in place. The soil will be excavated and stockpiled by BART's contractor. BART will then take one 4-point composite sample for each 500 cubic yards of soil. The samples will be tested for any constituents determined to be of concern during the in-situ sampling program. If the soil is not a hazardous waste and is suitable for reuse, it will be placed beneath the ramp of the parking structure as shown in Attachment C. In this location the soil will be surrounded and covered by concrete.

I have attached several documents, some in support of our proposal and others you had previously requested from ARS. Below is a summary of all documents attached.

Attachment	Title
A	Revised Final In-situ Soil Characterization Report, Fruitvale Intermodal Station, CDM, May 30, 2000
B	Soil Management Plan, BART SFO Extension, CDM, August 5, 1998
C	Diagram of Proposed Soil Reuse Area

D	BART Grading Plans with Cross-sections
E	Geotechnical Feasibility Investigation Report, Parikh Consultants, July 1997

BART expects to award a construction contract for this work by October of this year. Work would probably begin in November. BART requests your approval of our proposed activities at this site.

If you have any questions, please do not hesitate to contact me at (650) 689-8439.

Sincerely,

Gary C. Jensen, REA
Senior Engineer
System Safety Department

cc: J. Layton
J. Ordway (w/o attachments)
R. Engle (w/o attachments)
R. Rattray (w/o attachments)
M. Gray, CDM (w/o attachments)

ATTACHMENT A

REVISED FINAL IN-SITU SOIL CHARACTERIZATION REPORT, FRUITVALE INTERMODAL STATION

CDM Camp Dresser & McKee Inc.

consulting
engineering
construction
operations

One Walnut Creek Center
100 Pringle Avenue, Suite 300
Walnut Creek, California 94596
Tel: 925 933-2900 Fax: 925 933-4174

May 30, 2000

Mr. Gary Jensen
GES Project Director
Bay Area Rapid Transit District
979 Broadway
Millbrae, California 94030

Subject: *Revised Final In-Situ Soil Characterization Report*
Fruitvale Station Intermodal Station
BART General Environmental Services Agreement No. 7G8210
CDM Project No.: 8245-28614-WD21

Dear Mr. Jensen:

Camp Dresser & McKee Inc. (CDM) presents this revised final letter report to summarize the results of the in-situ soil characterization performed within the former Union Pacific Railroad (UPRR) Corridor (site). This report updates and supercedes CDM's final in-situ soil characterization report dated April 25, 2000. The site is located adjacent to the San Francisco Bay Area Rapid Transit District (BART) Fruitvale Station (see Figure 1, Site Location Map). Planned improvement activities at the site include construction of an intermodal transit facility, and an at grade and an elevated parking structure for BART patrons. As part of the construction, surficial soil will be removed to an approximate depth of 2 feet below ground surface (bgs) across the site between Fruitvale Avenue and 37th Street, and thirteen sets of foundation piers will be constructed between Fruitvale Avenue and 33rd Street.

To support BART's construction efforts, soil sampling was performed to define areas of impacted soil from the ground surface to a depth of 2 feet bgs for waste disposal purposes, and to identify areas of impacted soils from a depth of 2 to 5 feet bgs that may remain in-place following construction. This work was designed to minimize the volume of impacted soil requiring special handling prior to and during construction and to characterize the extent of potentially impacted soils that will remain in place following grading and construction. In addition, soil disposal designation and volumetric estimates were determined for each area of impacted soil. The scope of this work was presented in Camp Dresser & McKee Inc.'s (CDM's) proposal to BART, dated March 22, 2000.

Table 1
Project-Specific Action Levels
BART Fruitvale Station

Analyte	Project-Specific Action Level
VOCs, SVOCs	EPA Residential PRGs
Metals	Ten times STLC
Arsenic	19 mg/kg
TEPH	300 mg/kg

NOTES:
VOCs - Volatile Organic Compounds
SVOCs - Semi-Volatile Organic Compounds
STLC - Soluble Threshold Limit Concentration
TEPH - Total Extractable Petroleum Hydrocarbons

Project-Specific Action Levels

Areas of impact were identified by comparing soil analytical results against the project-specific action levels. These levels are presented in Table 1, Project-Specific Action Levels.

Except for arsenic, ten times the soluble limit threshold concentration (STLC) was used as an action level for metals because it is more stringent than EPA residential PRGs for metals. The project-specific action level for arsenic was established at 19 milligrams per kilogram (mg/kg) based upon personal communication with Ms. Barbara Cook of the DTSC (CH2MHill/DMJM and CDM, 1997). According to Ms. Cook, background arsenic concentrations for the San Francisco Bay Area are typically 10 to 20 mg/kg. Because total extractable petroleum hydrocarbon (TEPH) has not been assigned an EPA preliminary remediation goal (PRG), the site-specific action level for TEPH was established at 300 mg/kg.

Soil Sample Collection

The rationale and methodology for the soil sample collection was presented in CDM's Field Sampling Workplan, dated March 28, 2000 (CDM, 2000). On March 30, 2000, a Geoprobe drill rig was used to collect discrete soil samples at the required depth.

In accordance with local Class II landfill acceptance criteria for lead-impacted soils, one four-point composite sample was collected for every 750 cubic yards of excavated soil. Based on an estimated total excavated soil volume of approximately 8,400 cubic yards (1,470 feet long x 60 feet wide x 2 feet deep x 1.3 soil bulking factor), the site was divided into 12 sample groups (areas A through L). Based upon site maps provided by BART, the initial soil volume estimates have been reduced. As a result, each sample group represents approximately 690 cubic yards of soil, except for sample groups G and L which represent approximately 530 and 260 cubic yards of excavated soil, respectively.

In addition to the four-point composite samples, two discrete samples were collected at a depth of 3-feet bgs from each sample group and four discrete samples were collected at depths of 4- and 5-feet bgs from sample groups A and B only. A total of 80 discrete samples were collected at the site (see Figures 2a and 2b – Area of Impact Map).

At each sample location, undisturbed samples were collected by hydraulically pushing a pre-cleaned core barrel equipped with a 2-inch diameter polyvinyl chloride liner into the subsurface. Following retrieval of the core barrel, the liner was cut at the desired sample interval, capped on both ends with Teflon patches and plastic end caps and were secured with duct tape. Each sample was properly labeled with the sample ID (sample group-depth), date, time, site name, and sampler's initials. All samples were stored in a cooler chilled with ice and maintained under chain-of-custody pending submittal to the laboratory.

Soil Sample Analyses

On March 30, 2000, all samples were submitted to Chromalab and selected samples were analyzed for the following:

Analytes	EPA Method
Volatile organic compounds (VOCs)	8260
Semi-volatile organic compounds (SVOCs)	8270
TEPH as motor oil and diesel	8025M
TEPH as gas	8015
CAM 17 metals	6010B/7471

Samples collected from exploration points B1/B2 and I1/I2 at depths from 0.5 to 1.5 feet were composited by the laboratory into two four-point composite samples (B1-0.5-1.5, B2-0.5-1.5 and I1-0.5-1.5, I2-0.5-1.5) and analyzed for the constituents presented above. Based on the results of these two four-point composite samples, arsenic and lead were detected at concentrations greater than the project-specific action levels. Therefore, only total arsenic and lead were analyzed for the remaining ten sample groups.

To facilitate waste characterization, the methodology described below was employed. If a sample contained a constituent concentration greater than 10 times the soluble threshold limit concentration (STLC), the sample was analyzed for that constituent using STLC analysis. If the sample exceeded a concentration of 5 milligrams/liter (mg/l) using STLC analysis, the sample was analyzed using toxicity characteristic leaching procedure (TCLP) for the constituent of concern. Soil analytical results from the samples collected during this investigation are summarized in Attachment 1.

Identification of Areas of Impact and Waste Classification

Based upon soil analytical results, areas of impact were identified according to the following criteria and assumptions:

- Sample groups with soil concentrations less the project-specific action levels are considered non-impacted and are designated as non-hazardous.
- Sample groups with soil concentrations greater than the project-specific action levels are considered impacted and are designated as either Non-RCRA (California hazardous) or RCRA Hazardous Waste.
- Impacted soils identified from composite samples extend to the width of the UPRR Corridor, to a depth of 2 feet bgs, and to the midpoint of the adjacent sample group.
- Impacted soils identified from discrete samples extend to the lateral and vertical midpoint from the sample with constituent concentrations greater than the project-

specific action levels to the sample with constituent concentrations less than the project-specific action levels, to the midpoint of the adjacent sample group.

Presented below is a discussion of the analytical results for each Area of Impact. Of the twelve sample groups, only three groups A, E, and F are designated as non-hazardous. The analytical results are presented in Attachment 1 and the waste category designation of the Areas of Impact is shown on Figures 2a and 2b in Attachment 2.

Sample Group A

The four-point composite analytical results from this sample group did not indicate elevated concentrations of arsenic or lead. Soil associated with this sample group are characterized as Non-Hazardous Waste.

The discrete analytical results did not indicate elevated concentrations of arsenic or lead.

Sample Group B

The four-point composite analytical results from this sample group indicated elevated concentrations of arsenic and lead. In addition, the STLC for arsenic was exceeded. The TCLP result for arsenic was non-detect. Soil associated with this sample group are characterized as Non-RCRA Hazardous Waste.

The discrete analytical results indicated elevated arsenic concentrations from sample B2-3, however the STLC for arsenic from this sample was not exceeded. The elevated arsenic concentrations are located within Area B and extend from the midpoint of exploration points B1 and B2 and across the southern half of the alignment, and from 2 feet to 3.5 feet bgs.

Sample Group C

The four-point composite analytical results from this sample group indicated elevated concentrations of arsenic. In addition, the STLC for arsenic was exceeded. The TCLP result for arsenic was non-detect. Soil associated with this sample group are characterized as Non-RCRA Hazardous Waste.

The discrete analytical results did not indicate elevated concentrations of arsenic.

Sample Group D

The four-point composite analytical results from this sample group indicated elevated concentrations of arsenic and lead. In addition, the STLC for arsenic and lead was exceeded. The TCLP results for arsenic and lead were non-detect. Soil associated with this sample group are characterized as Non-RCRA Hazardous Waste.

The discrete analytical results indicated elevated arsenic concentrations from sample D2-3. The elevated arsenic concentrations are located within Area D and extend from the midpoint of exploration points D1 and D2 across the southern half of the alignment. Additional samples are required to identify the depth of arsenic impact at this location.

Sample Group E

The four-point composite analytical results from this sample group did not indicate elevated concentrations of arsenic or lead. Soil associated with this sample group are characterized as Non-Hazardous Waste.

The discrete analytical results indicated elevated concentrations of arsenic and lead from sample E1-3. The elevated arsenic and lead concentrations are located within Area E and extend from the midpoint of exploration points E1 and E2 across the northern half of the alignment. Additional samples are required to identify the depth of arsenic and lead impact at this location.

Sample Group F

The four-point composite analytical results from this sample group did not indicate elevated concentrations of arsenic or lead. Soil associated with this sample group are characterized as Non-Hazardous Waste.

The discrete analytical results indicated elevated concentrations of lead from sample F1-3. The elevated lead concentrations are located within Area F and extend from the midpoint of exploration points F1 and F2 across the northern half of the alignment. Additional samples are required to identify the depth of lead impact at this location.

Sample Group G

The four-point composite analytical results from this sample group indicated elevated concentrations of arsenic and lead. In addition, the STLC for arsenic was exceeded. The TCLP result for arsenic was non-detect. Soil associated with this sample group are characterized as Non-RCRA Hazardous Waste.

The discrete analytical results did not indicate elevated concentrations of arsenic or lead.

Sample Group H

The four-point composite analytical results from this sample group indicated elevated concentrations of arsenic. In addition, the STLC for arsenic was exceeded. The TCLP result for arsenic did not exceed Federal waste criteria. Soil associated with this sample group are characterized as Non-RCRA Hazardous Waste.

The discrete analytical results did not indicate elevated concentrations of arsenic or lead.

Sample Group I

The four-point composite analytical results from this sample group indicated elevated concentrations of arsenic and lead. In addition, the STLC for arsenic was exceeded. The TCLP result for arsenic was non-detect. Soil associated with this sample group are characterized as Non-RCRA Hazardous Waste.

The discrete analytical results did not indicate elevated concentrations of arsenic or lead.

Sample Group J

The four-point composite analytical results from this sample group indicated elevated concentrations of arsenic and lead. In addition, the STLC results for arsenic and lead were exceeded. TCLP results for arsenic and lead were non-detect. Soil associated with this sample group are characterized as Non-RCRA Hazardous Waste.

The discrete analytical results did not indicate elevated concentrations of arsenic or lead.

Sample Group K

The four-point composite analytical results from this sample group indicated elevated concentrations of arsenic and lead. In addition, the STLC results for arsenic and lead were exceeded. The TCLP results for arsenic and lead were non-detect. Soil associated with this sample group are characterized as Non-RCRA Hazardous Waste.

The discrete analytical results did not indicate elevated concentrations of arsenic or lead.

Sample Group L

The four-point composite analytical results from this sample group indicated elevated concentrations of arsenic and lead. In addition, the STLC for lead was exceeded. The TCLP result for lead was non-detect. Soil associated with this sample group are characterized as Non-RCRA Hazardous Waste.

The discrete analytical results indicated elevated arsenic concentrations from sample L1-3. The elevated arsenic concentrations are located within Area L and extend from the midpoint of exploration points L1 and L2 across the northern half of the alignment. Additional samples are required to identify the depth of arsenic impact at this location.

If you have any questions or require additional information regarding this report, please do not hesitate to call us at (925) 933-2900.

Very truly yours,

CAMP DRESSER & McKEE INC.

Michael G. Gray, R.G., C.E.G.
Work Directive Manager

CERTIFIED ENGINEERING GEOLOGIST
MICHAEL G. GRAY
No. 2002
Exp. 2/28/01
STATE OF CALIFORNIA

Charles B. O'Neill, R.G.
Task Manager

REGISTERED GEOLOGIST
CHARLES B. O'NEILL
No. 6401
Exp. 6/30/01
STATE OF CALIFORNIA

Attachments

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References

CDM, 2000. *Field Sampling Workplan, BART Fruitvale Station.* Camp Dresser & McKee Inc., March 28, 2000.

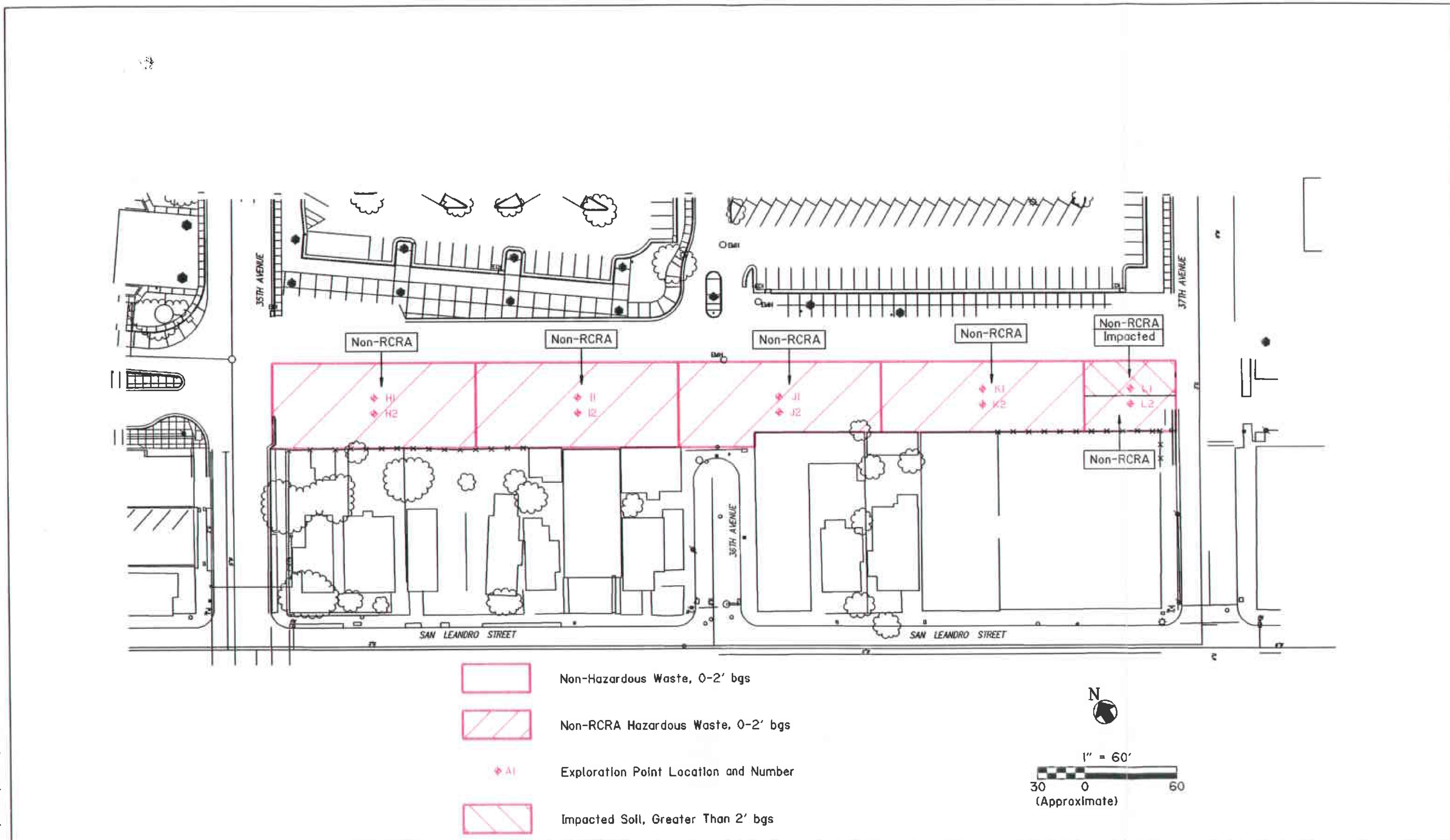
CH2MHill/DMJM and CDM, 1997. *Technical Memorandum, Status of the Phase II Site Investigation for BART's SFO Extension.* CH2MHill/DMJM and Camp Dresser & McKee Inc. November 7, 1997.

Attachment 1
Soil Analytical Results

Attachment 1
Summary of Selected Soil Analytical Results
BART Fruitvale Station

SAMPLE INFORMATION			TOTAL EXTRACTABLE PETROLEUM HYDROCARBONS (EPA 8015M)			CAM 17 METALS (ICP)																	SOLUBLE METALS (STLC)		SOLUBLE METALS (TCLP)	
																							5	5	5	5
			GASOLINE	DIESEL	MOTOR OIL	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CHROMIUM	COBALT	COPPER	LEAD	MOLYBDENUM	NICKEL	SELENIUM	SILVER	THALLIUM	VANADIUM	ZINC	MERCURY	ARSENIC	LEAD	ARSENIC	LEAD
PROJECT-SPECIFIC ACTION LEVEL (mg/kg)			300	300	300	150	19	1000	7.5	10	50	800	250	50	3500	200	10	50	70	240	2500	2	5	**5**	5	5
DETECTION LIMIT (mg/kg)			1	1	50	2	1	1	0.5	0.5	1	1	1	1	1	1	2	1	1	1	1	0.05	0.5	0.5	0.5	0.5
EXPLORATION POINTS	SAMPLE ID	SAMPLE DATE	RESULTS (mg/kg)																				RESULTS (mg/L)		RESULTS (mg/L)	
A1 & A2	A1-0.5-1.5, A2-0.5-1.5	3/30/2000	--	--	--	--	22	--	--	--	--	--	--	28	--	--	--	--	--	--	--	--	--	ND	--	--
A1	A1-3	3/30/2000	--	--	--	--	4.4	--	--	--	--	--	--	7.9	--	--	--	--	--	--	--	--	--	--	--	--
A2	A2-3	3/30/2000	--	--	--	--	3.5	--	--	--	--	--	--	5.4	--	--	--	--	--	--	--	--	--	--	--	--
B1 & B2	B1-0.5-1.5, B2-0.5-1.5	3/30/2000	ND	6.9	54	ND	120	190	ND	ND	43	8.1	39	90	ND	50	ND	ND	ND	33	160	0.16	**11**	3.9	ND	--
B1	B1-3	3/30/2000	--	--	--	--	3.6	--	--	--	--	--	--	7.6	--	--	--	--	--	--	--	--	--	--	--	--
B1	B1-4	3/30/2000	--	--	--	--	9	--	--	--	--	--	--	4.5	--	--	--	--	--	--	--	--	--	--	--	--
B1	B1-5	3/30/2000	--	--	--	--	2.8	--	--	--	--	--	--	4.4	--	--	--	--	--	--	--	--	--	--	--	--
B2	B2-3	3/30/2000	--	--	--	--	120	--	--	--	--	--	--	9.9	--	--	--	--	--	--	--	--	2.4	--	--	--
B2	B2-4	3/30/2000	--	--	--	--	5.1	--	--	--	--	--	--	8	--	--	--	--	--	--	--	--	--	--	--	--
B2	B2-5	3/30/2000	--	--	--	--	4.6	--	--	--	--	--	--	8.8	--	--	--	--	--	--	--	--	--	--	--	--
C1 & C2	C1-0.5-1.5, C2-0.5-1.5	3/30/2000	--	--	--	--	98	--	--	--	--	--	--	29	--	--	--	--	--	--	--	--	**5.1**	--	ND	--
C1	C1-3	3/30/2000	--	--	--	--	8.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C2	C2-3	3/30/2000	--	--	--	--	2.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
D1 & D2	D1-0.5-1.5, D2-0.5-1.5	3/30/2000	--	--	--	--	120	--	--	--	--	--	--	180	--	--	--	--	--	--	--	--	**6.8**	6.5	ND	ND
D1	D1-3	3/30/2000	--	--	--	--	2.3	--	--	--	--	--	--	6.1	--	--	--	--	--	--	--	--	--	--	--	--
D2	D2-3	3/30/2000	--	--	--	--	120	--	--	--	--	--	--	7.7	--	--	--	--	--	--	--	--	--	--	--	--
E1 & E2	E1-0.5-1.5, E2-0.5-1.5	3/30/2000	--	--	--	--	56	--	--	--	--	--	--	110	--	--	--	--	--	--	--	--	1.8	1.8	--	--
E1	E1-3	3/30/2000	--	--	--	--	130	--	--	--	--	--	--	150	--	--	--	--	--	--	--	--	--	--	--	--
E2	E2-3	3/30/2000	--	--	--	--	6	--	--	--	--	--	--	7.6	--	--	--	--	--	--	--	--	--	--	--	--
F1 & F2	F1-0.5-1.5, F2-0.5-1.5	3/30/2000	--	--	--	--	120	--	--	--	--	--	--	72	--	--	--	--	--	--	--	--	4.9	--	--	--
F1	F1-3	3/30/2000	--	--	--	--	4.1	--	--	--	--	--	--	50	--	--	--	--	--	--	--	--	--	--	--	--
F2	F2-3	3/30/2000	--	--	--	--	2	--	--	--	--	--	--	24	--	--	--	--	--	--	--	--	--	--	--	--
G1 & G2	G1-0.5-1.5, G2-0.5-1.5	3/30/2000	--	--	--	--	230	--	--	--	--	--	--	170	--	--	--	--	--	--	--	--	**8.1**	3.8	ND	--
G1	G1-3	3/30/2000	--	--	--	--	20	--	--	--	--	--	--	22	--	--	--	--	--	--	--	--	--	--	--	--
G2	G2-3	3/30/2000	--	--	--	--	3.8	--	--	--	--	--	--	13	--	--	--	--	--	--	--	--	--	--	--	--
H1 & H2	H1-0.5-1.5, H2-0.5-1.5	3/30/2000	--	--	--	--	160	--	--	--	--	--	--	36	--	--	--	--	--	--	--	--	**7.1**	--	0.62	--
H1	H1-3	3/30/2000	--	--	--	--	17	--	--	--	--	--	--	9.3	--	--	--	--	--	--	--	--	--	--	--	--
H2	H2-3	3/30/2000	--	--	--	--	17	--	--	--	--	--	--	8.6	--	--	--	--	--	--	--	--	--	--	--	--
I1 & I2	I1-0.5-1.5, I2-0.5-1.5	3/30/2000	ND	15	110	ND	80	230	ND	0.52	48	9.9	72	96	3.6	71	ND	ND	ND	28	200	0.13	**6.8**	4.6	ND	--
I1	I1-3	3/30/2000	--	--	--	--	10	--	--	--	--	--	--	8.3	--	--	--	--	--	--	--	--	--	--	--	--
I2	I2-3	3/30/2000	--	--	--	--	2.5	--	--	--	--	--	--	19	--	--	--	--	--	--	--	--	--	--	--	--
J1 & J2	J1-0.5-1.5, J2-0.5-1.5	3/30/2000	--	--	--	--	150	--	--	--	--	--	--	310	--	--	--	--	--	--	--	--	**8.9**	**16**	ND	ND
J1	J1-3	3/30/2000	--	--	--	--	2.1	--	--	--	--	--	--	6.7	--	--	--	--	--	--	--	--	--	--	--	--
J2	J2-3	3/30/2000	--	--	--	--	2	--	--	--	--	--	--	5.2	--	--	--	--	--	--	--	--	--	--	--	--
K1 & K2	K1-0.5-1.5, K2-0.5-1.5	3/30/2000	--	--	--	--	150	--	--	--	--	--	--	140	--	--	--	--	--	--	--	--	**5.4**	**6.2**	ND	ND
K1	K1-3	3/30/2000	--	--	--	--	3.7	--	--	--	--	--	--	6.1	--	--	--	--	--	--	--	--	--	--	--	--
K2	K2-3	3/30/2000	--	--	--	--	2.7	--	--	--	--	--	--	5.9	--	--	--	--	--	--	--	--	--	--	--	--
L1 & L2	L1-0.5-1.5, L2-0.5-1.5	3/30/2000	--	--	--	--	110	--	--	--	--	--	--	250	--	--	--	--	--	--	--	--	3.9	**8.5**	--	ND
L1	L1-3	3/30/2000	--	--	--	--	130	--	--	--	--	--	--	9.4	--	--	--	--	--	--	--	--	--	--	--	--
L2	L2-3	3/30/2000	--	--	--	--	3.5	--	--	--	--	--	--	7	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
Samples B1-0.5-1.5, B2-0.5-1.5 and I1-0.5-1.5, I2-0.5-1.5 were non-detect for SVOCs by EPA Method 8270A
Samples B1-0.5-1.5, B2-0.5-1.5 and I1-0.5-1.5, I2-0.5-1.5 were non-detect for VOCs by EPA Method 8260A
ND = Not Detected
mg/kg = milligrams per kilogram
mg/L = milligrams per liter
-- = Not Analyzed
Sample results in shaded cells indicate constituent reported at concentration greater than ten times the Soluble Threshold Limit Concentration
Sample results in bold text indicate constituent reported at concentration greater than the Soluble Threshold Limit Concentration



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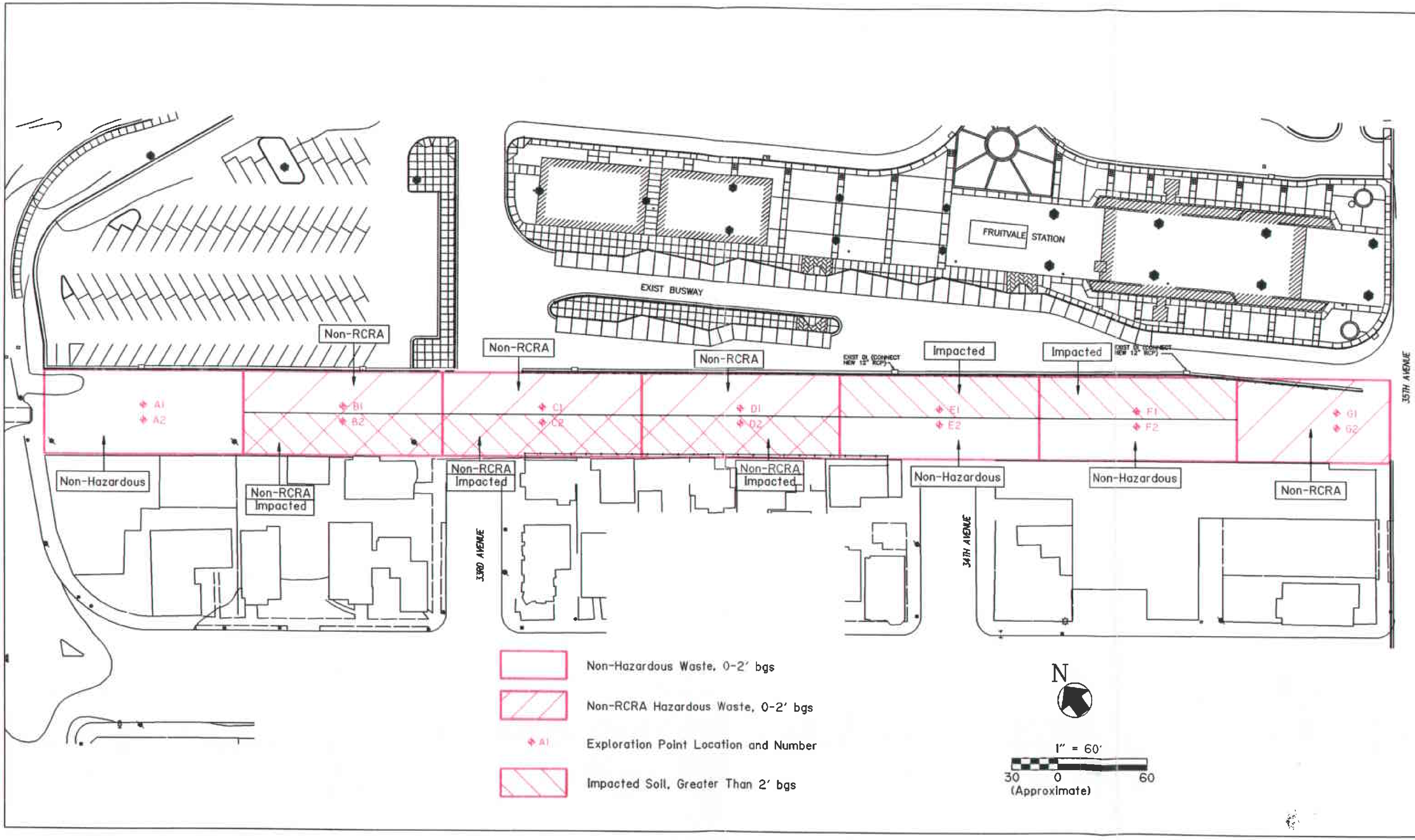
CDM Camp Dresser & McKee

Area of Impact Map

35th Avenue to 37th Avenue
BART Fruitvale Station
Oakland, CA

Figure 2b



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CDM Camp Dresser & McKee

Area of Impact Map

Fruitvale Avenue to 35th Avenue
BART Fruitvale Station
Oakland, CA

Figure 2a

ATTACHMENT B

EXCERPTS FROM THE SOIL MANAGEMENT PLAN, BART SFO EXTENSION

Cal/EPA

San Francisco Bay Regional Water Quality Control Board

1515 Clay Street
Suite 1400
Oakland, CA 94612
(510) 622-2300
FAX (510) 622-2464

Pete Wilson
Governor

August 24, 1998

Mr. Gary Jensen
Senior Engineer, System Safety Department
Bay Area Rapid Transit (BART) District
Main Office
800 Madison St./P.O. Box 12688
Oakland, CA 94604-2688

Re: Soil Management Plan, BART SFO Extension

Dear Mr. Jensen:

Please be advised that Board staff has reviewed and approved the proposed Soil Management Plan dated August 5, 1998, prepared by Camp Dresser & McKee, on behalf of San Francisco Bay Area Rapid Transit District (BART), for the San Francisco International Airport (SFO) extension project.

If you have any questions concerning this matter, please contact Randy Lee of my staff at (510) 622-2375.

Sincerely,

LORETTA K. BARSAMIAN
Executive Officer

STEPHEN I. MORSE, Chief
Toxic Cleanup Division

cc: Ms. Denise Tsuji
Cal/EPA
Department of Toxic Substances Control
700 Heinz Avenue, Suite 200
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Mr. Michael Gray, Project Manager
Camp Dresser & McKee Inc.
One Walnut Creek Center
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Our mission is to preserve and enhance the quality of California's water resources, and ensure their proper allocation and efficient use for the benefit of present and future generations.

CDM Camp Dresser & McKee Inc.

consulting engineering construction operations

One Walnut Creek Center
100 Pringle Avenue, Suite 300
Walnut Creek, California 94596
Tel: 510 933-2900 Fax: 510 933-4174

August 5, 1998

Mr. Randy Lee
Associate Water Resource Control Engineer
San Francisco Bay
Regional Water Quality Control Board
1515 Clay Street, Suite 700
Oakland, CA 94612

Subject *Soil Management Plan*
San Francisco Bay Area Rapid Transit District (BART)
San Francisco International Airport (SFO) Extension

CDM Project Number: 8245-24097-REUSE.PLAN

Dear Mr. Lee:

On behalf of BART, Camp Dresser & McKee Inc. (CDM) is pleased to submit one copy of the *Soil Management Plan for the SFO Extension*. This document presents a brief project background, identifies the locations, magnitude, and type of soil constituents above project-specific action levels; identifies impacted areas requiring soil excavation and areas requiring fill placement; and proposes guidelines for reuse of impacted soils within the project.

If you have any questions regarding this document, please call Mr. Gary Jensen, BART, at 650-689-8439, or Mr. Michael Gray, CDM, at 925-933-2900.

Very truly yours,

CAMP DRESSER & McKEE INC.

Michael G. Gray, R.G., C.E.G.
Project Manager

attachment

cc: Gary Jensen, BART

W98/8245/071

Memorandum

To: *Regional Water Quality Control Board, San Francisco Bay Region*

From: *Gary Jensen*
Bay Area Rapid Transit District

Date: *August 5, 1998*

Subject: *Soil Management Plan*
BART SFO Extension

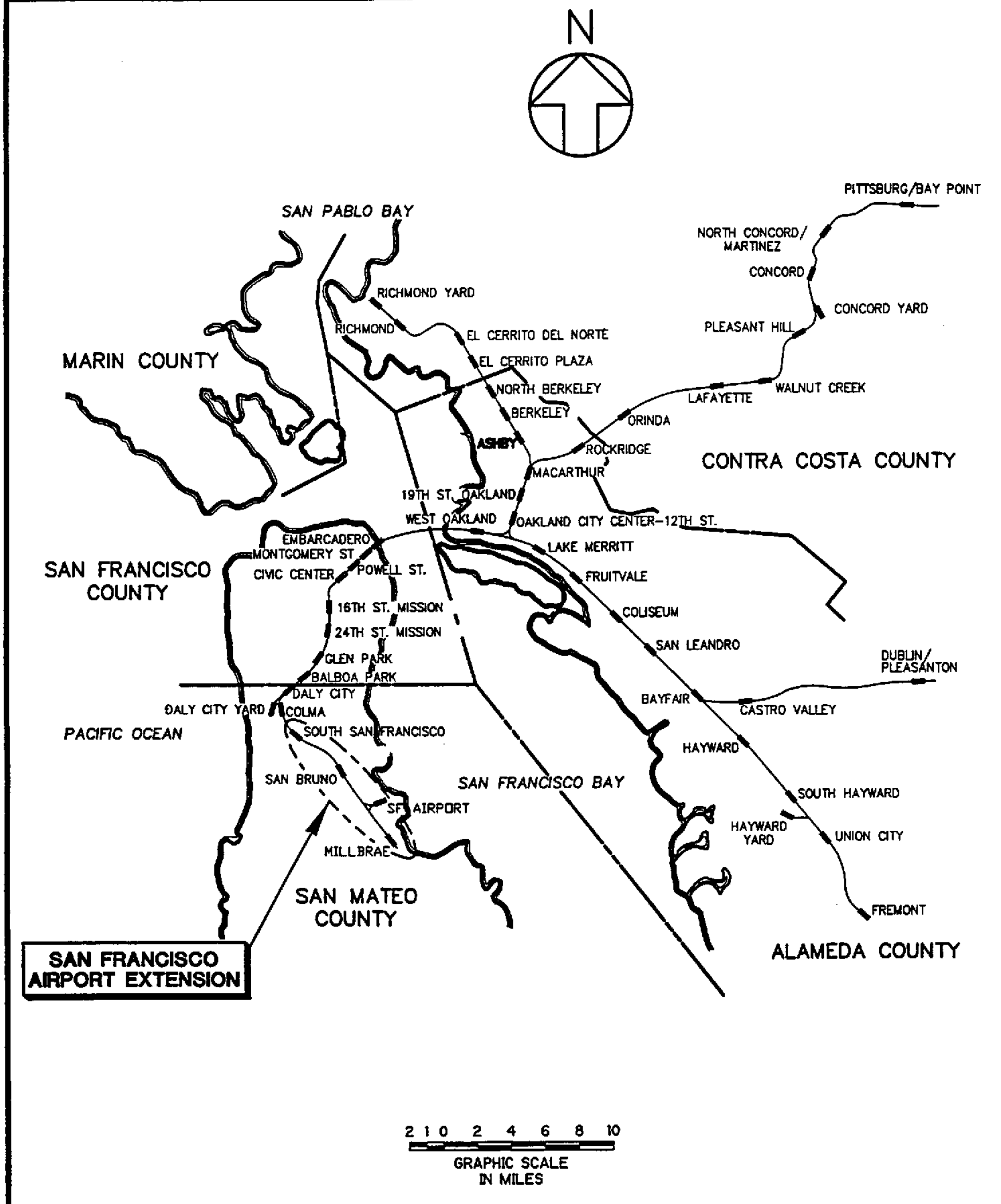
This memorandum presents a plan for management and reuse of soil that will be excavated during the construction of the Bay Area Rapid Transit District (BART) San Francisco International Airport (SFO) Extension. Based upon extensive soil sample data, soils with contaminant concentrations greater than project-specific action levels (impacted soils) have been identified within specific areas of the BART SFO Extension right-of-way. To minimize construction costs and soil disposal costs, BART proposes to reuse impacted soils as structural fill to the extent such soils satisfy the reuse criteria presented in this plan.

This plan presents a brief project background; identifies the locations, magnitude, and type of soil constituents above project-specific action levels; identifies impacted areas requiring soil excavation and areas requiring fill placement; and establishes guidelines for reuse of impacted soils. The purpose of the soil reuse plan is to minimize construction costs while ensuring the protection of worker health and safety, public health, and the environment. To meet these goals, soil reuse criteria, engineering controls, and institutional controls will be implemented.

Background

The BART SFO Extension project is located in San Mateo County, California, and includes portions of the town of Colma and the cities of South San Francisco, San Bruno, Millbrae, and Burlingame (see Figure 1, Site Location Map). The project will consist of a 7.5 mile rail extension from the existing Colma station to Millbrae, with stations in South San Francisco, San Bruno, Millbrae and at the San Francisco International Airport (see Figure 2, Site Map). The rail extension from the existing Colma station to Sylvan Avenue in San Bruno and from Center Street in Millbrae to near the Millbrae Station will be constructed underground while the remainder of the extension will be constructed aboveground.

The underground portion of the project will be constructed using a cut and cover technique. This construction method consists of excavation and shoring of a trench, installation of a cast-in-place rail box, and backfilling (covering) the rail box with fill soil. Fill soils will also be used to create finish grades at the proposed train stations. Based upon project specifications, approximately 1.8 million cubic yards of soil will be excavated and approximately 0.7 million



SITE LOCATION MAP
BART SFO EXTENSION

CDM
environmental engineers, scientists, planners, & management consultants

FIGURE 1

Z:\ACAD\BART\ FIG-1 06/16/98 13:28:12 2:25:06 CDM/CADD/STC RAC cubic yards of soil will be reused on the project as fill and the balance will be exported off-site. Construction of the SFO Extension project is scheduled to commence in July 1998 and extend through January 2001. Because BART anticipated encountering impacted soils during construction, several studies have been conducted by BART to identify impacted areas prior to the start of construction.

Areas of Impacted Soil

To assist BART in the identification of soil impact along the SFO Extension, Camp Dresser & McKee Inc., (CDM) and CH2MHILL/DMJM collected soil samples along the entire length of the alignment. Tabulated soil analytical results exceeding project-specific action levels are presented in Appendix A - Phase II Soil Analytical Results Exceeding Action Levels. Areas of impacted soils and groundwater were delineated on maps and are presented in Appendix B - Areas of Identified Impact. Generalized areas of identified impact within the alignment are presented on Figures 3a and 3b, Areas of Identified Impact.

Project-specific action levels used for identification of impacted soils are presented in Table 1, Project-Specific Action Levels.

Table 1
Project-Specific Action Levels
BART SFO Extension

Analyte	*Project-Specific Action Level*
VOCs, SVOCs, MTBE	EPA Residential PRGs
Metals	Ten times STLC
Arsenic	19 mg/kg
TEPH	100 mg/kg

VOCs - Volatile Organic Compounds
SVOCs - Semi-Volatile Organic Compounds
MTBE - Methyl Tertiary Butyl Ether
STLC - Soluble Threshold Limit Concentration
TEPH - Total Extractable Petroleum Hydrocarbons

Except for arsenic, ten times the soluble limit threshold concentration (STLC) was used as an action level for metals because it is more stringent than EPA residential PRGs for metals. The project-specific action level for arsenic was established at 19 milligrams per kilogram (mg/kg) based upon personal communication with Ms. Barbara Cook of the DTSC. According to Ms. Cook, background arsenic concentrations for the San Francisco Bay Area are typically 10 to 20 mg/kg. Because TEPH has not been assigned an EPA PRG, the action level for TEPH was established at 100 mg/kg. Soils with constituent concentrations below these action levels will be released by BART to the Contractor for on- or off-site reuse. Soils with constituent concentrations above the project-specific action levels will be excavated and managed in accordance with the guidelines presented in this document.

Using project-specific action levels, localized areas of metals (predominately arsenic and lead), petroleum hydrocarbons, and SVOC impacted soils were identified from the northern end of the alignment to approximately Hickey Blvd. (see Figure 3a). In the central portion of the alignment immediately north of Hickey Blvd. to approximately Interstate 380, three continuous areas of arsenic, lead, and SVOC impacted soil were identified. From Interstate 380 to the southern end of the alignment, several localized areas of arsenic, lead, and SVOC impacted soil were identified (see Figure 3b). Throughout the alignment, impacted soil was found to extend to an approximate depth of two feet below ground surface. Detailed maps depicting areas of impact are presented in Appendix B - Areas of Identified Impact.

Based upon existing soil analytical data, CDM estimates that approximately 75,000 cubic yards of impacted soil will be excavated during construction of the line and trackwork. In addition to excavation of impacted soil, approximately 1.725 million cubic yards of non-impacted soil will also be excavated. However, these volume estimates are subject to change based upon soil analytical results from the Phase III Hazardous Material Investigation.

The purpose of the Phase III Hazardous Materials Investigation is to better define limits of identified impacted areas by collection and analysis of additional soil samples. The Phase III Hazardous Materials Investigation consists of hand-augering over 300 exploration points and the conduct of more than 1,200 analyses. Throughout most of the alignment, soil borings will be oriented in two rows at intervals of 150 feet located approximately 15 feet inside of the alignment boundaries. To better define locations impacted by petroleum hydrocarbons, four exploration points will be located along two rows within 50 feet of the exploration point(s) where petroleum hydrocarbons were identified during the Phase II Hazardous Materials Investigation. Three samples will be collected from each boring which will be advanced to a depth of four feet. Samples will be analyzed for constituents identified during the Phase II Hazardous Materials Investigation.

Discovery Of Unknown Impact

If during excavation, previously unidentified impacted soil is encountered (based upon observations during excavation) that poses a potential threat to worker health and safety or the environment, construction in the immediate vicinity of the soil contamination will be suspended until the type and extent of the potential hazard can be identified. Site control measures will be implemented to minimize exposure to hazardous substances and the San Mateo County Department of Health Services will be notified. Constituent characterization activities will be conducted in accordance with 29 CFR 1910.120, OSHA Standards for Construction Work, and 8 CCR 5192, Hazardous Waste Operations and Emergency Response. After characterization, mitigation measures including soil excavation will resume.

Soil Reuse Strategy

BART intends to use in-place soil analytical results from the Phase II and Phase III Hazardous Materials Investigations to classify soils in accordance with the reuse criteria specified below. If in-place soil analytical results indicate that the soil is suitable for reuse, the soils will be excavated and transported to the reuse area. As an exception procedure or in areas where the amount of soil analytical data is insufficient to classify the soil for reuse or disposal, BART will excavate, stockpile, and characterize soils to determine reuse or disposal criteria. Non-impacted soils will be excavated and reused onsite, or transported to a soil broker. When fill soil is required, it will be to supplied to BART by the soil broker or taken from project excavations.

Assuming an average impacted soil removal depth of two feet and an alignment width of 90 feet, BART will rely upon eight discrete in-place sampling points for every 1,000 cubic yards of impacted soil to be excavated and reused. If excavation of impacted soil extends to a depth of four feet, BART will rely upon twelve discrete in-place sampling points for every 2,000 cubic yards of soil.

When soil is to be characterized ex-situ, BART will collect one four-point composite sample for every 500 cubic yards excavated of soil. Soil stockpile sampling procedures are presented in Appendix C - Soil Stockpile Sampling Plan.

Using a strategy of in-place soil characterization and transferring non-impacted soil to a broker, BART will be able to minimize the amount of soil handling (transportation and stockpiling) at the project site while facilitating the construction schedule and minimizing visual impacts to the community. Due to the configuration of the SFO Extension, the majority of reusable soil will be placed between the existing Colma station and Sylvan Avenue in San Bruno. BART does not intend to reuse any soils which classify as California hazardous waste.

Soil Transportation Plan

After excavation, impacted soils will be transported by BART's Contractor in accordance with the BART's construction Contract Specifications - Section 01163 (Appendix D). Soil transportation will primarily occur on public roads using designated truck routes and avoiding residential areas where possible in accordance with the certified project environmental impact report. A detailed soil transportation plan will be prepared under a separate cover.

Soil Staging Area

One staging area, located at the planned South San Francisco station, will be used to stockpile unclassified or impacted soil excavated as part of the SFO Extension project (see Figure 2, Site Map). To protect the public from contact with the stockpiled soils, temporary fencing will be constructed around the perimeter of the staging area. Impacted soil stockpiles will be managed by the contractor in accordance with the specifications presented in the Contract Specifications - Section 01162 (Appendix D). BART has modified Section 3.04 Article B of these specifications such that only saturated soils will be required to be placed on high density polyethylene sheeting. Non-saturated soils will be placed on a gravel base, or equivalent material. Abbreviated details regarding soil stockpile management are presented below.

Impacted soil will be placed in piles not to exceed 500 cubic yards, and will not remain on-site for more than 60 days. Unsaturated soils will be placed on 1-foot of gravel baserock, or equivalent materials. Saturated soil will be placed on 40-mil high density polyethylene sheeting. All soil stockpiles will be covered to minimize wind-blown dust or infiltration of rain water. During the rainy season, berms will be constructed around each stockpile to prevent infiltration or exfiltration of water. Each stockpile will be clearly labeled.

To prevent mixing of non-impacted soil with impacted soil, the excavation contractor will implement a soil tracking system to track all impacted soil between collection, excavation, stockpiling, and final disposition. The tracking system shall include identification of the source of the material, staging location, and stockpile identification. If soil is deemed unsuitable for reuse because of its physical characteristics (i.e., contains excess debris or organic material), composite soil samples will be collected to assess disposal criteria. Soil reuse criteria is presented below.

Soil Reuse Criteria

Soil reuse will be based on its suitability for use as structural fill and upon constituent concentrations from in-place or ex-situ analytical results (see Figure 4, Soil Management Flow Chart). Four soil reuse categories have been established. Each category is presented in Table 2, Soil Reuse Criteria. Reuse criteria are based upon a project site arsenic background concentration of 19 mg/kg, USEPA residential and industrial PRGs, site cleanup requirements for arsenic established for the Upland Operable Unit, located at 1990 Bay Road, East Palo Alto, San Mateo County (RWQCB, 1992), and upon site cleanup requirements for total polynuclear aromatic hydrocarbons (PNAs) established for the property at the San Francisco International Airport, San Mateo County, (RWQCB, 1995).

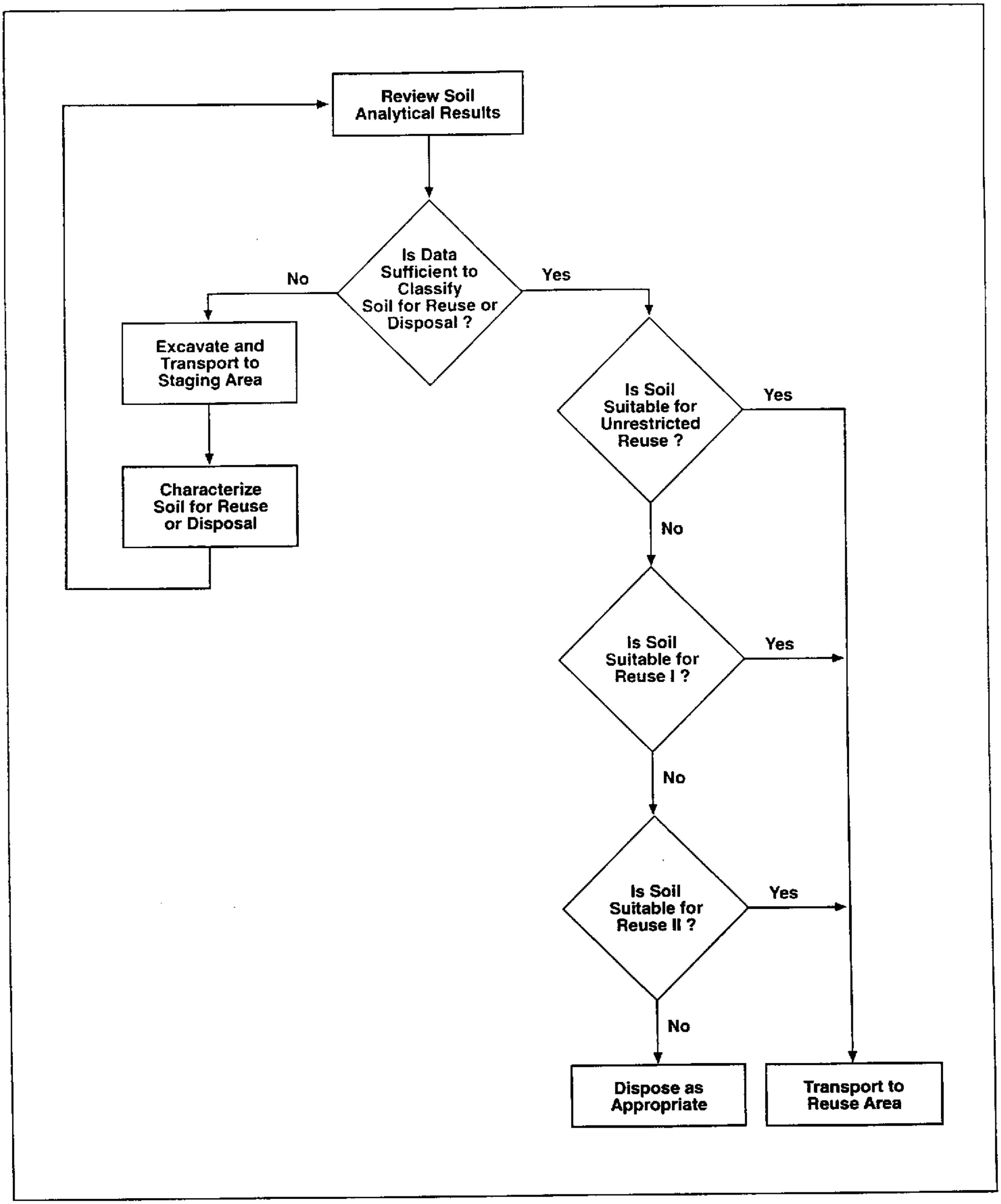


Figure 4
Soil Management Flow Chart
BART SFO Extension

CDM Camp Dresser & McKee Inc.

Table 2
Soil Reuse Criteria

Reuse Category	Reuse Criteria	Reuse Restrictions/Engineering Controls
Unrestricted Reuse	Constituents ≤ EPA residential PRGs, and Arsenic ≤ 19 mg/kg, and TEPH ≤ 100 mg/kg	None
Restricted Reuse I	Constituents ≤ EPA industrial PRGs, and 19 mg/kg < Arsenic ≤ 70 mg/kg, and TEPH ≤ 1,000 mg/kg	Soil placed minimum of 5 feet above highest measured groundwater elevation and, Minimum two feet unrestricted reuse soil cover or, Minimum three inches asphalt cover, and Grade site to minimize ponding of water
Restricted Reuse II	Constituents ≤ EPA industrial PRGs, and 70 mg/kg < Arsenic ≤ 500 mg/kg, and EPA industrial PRGs ≤ Total PNAs ≤ 12 mg/kg, and TEPH ≤ 1,000 mg/kg	Soil placed minimum of 5 feet above highest measured groundwater elevation and, Minimum two feet unrestricted reuse soil cover or, Minimum three inches asphalt cover, and Grade site to minimize ponding of water, and Implement deed restrictions, and PNA impacted soils reused only at the planned South San Francisco station
No Reuse	Constituents > EPA industrial PRGs, or Arsenic > 500 mg/kg, or Total PNAs > 12 mg/kg, or TEPH > 1,000 mg/kg, or California Hazardous Waste	Soil will be removed from project site and transported to an appropriate waste disposal facility.

Assessment of Arsenic Cleanup Standards

To assess applicability and accuracy of cleanup standards established for arsenic at the Upland Operable Unit (RWQCB, 1992) to the BART SFO Extension, BART conducted a review of the risk assessment used to document calculation of health-based goals (HBGs) for arsenic in soil at the Upland Operable Unit. This review identified three findings pertaining to soil exposure assumptions and toxicity criteria for arsenic. A detailed discussion regarding the assumptions used in the risk assessment is presented in Appendix E - Health-Based Goals for Arsenic in Soil. The three findings are summarized below.

- A oral cancer slope factor for arsenic of 1.8 mg/kg/d-1 was used in PRC's report. Currently, the cancer slope factor recommended by EPA and commonly used to assess oral exposure to arsenic is 1.5 mg/kg/d-1 (EPA 1998).

- The reference dose (RfD) for oral exposure to arsenic currently found on the Integrated Risk Information System (IRIS) (EPA 1998) is 3E-04. The RfD used by PRC is 1E-03.

- Recent data on uptake of arsenic from soil indicate that absorption is significantly reduced from that observed for inorganic arsenic dissolved in water. Because the basis for arsenic toxicity criteria is exposure of large Taiwanese populations to dissolved arsenic in well water, significantly lower bioavailability from soil should be considered in calculation of risks and HBGs. Based on recent data on absorption of arsenic from several different soils and several test species, EPA Region VIII has determined that an absorption factor of 0.5 can be used in assessing oral exposure to arsenic in soil in the absence of site specific data.

Based upon these findings, HBGs for arsenic-impacted soil can be somewhat higher than those recommended in the risk assessment for the Upland Operable Unit. However, to ensure sufficient protection of worker health and safety, public health, and the environment, BART proposes to use the more conservative (lower arsenic soil concentrations listed in Table 2) presented in the Upland Operable Unit risk assessment.

Assessment of PNA Cleanup Standards

To assess applicability and accuracy of cleanup requirements established for total PNAs at the San Francisco International Airport, BART reviewed the RWQCBs site cleanup requirements established for this site with respect to reuse of soil with PNA concentrations greater than industrial PRGs at BART's planned South San Francisco station. A detailed discussion regarding the assumptions used in the risk assessment is presented in Appendix F - Health-Based Goals for Polynuclear Aromatics in Soil. This review identified the following:

- The RWQCB document established five Remediation Management Zones (RMZs) for distinguishing different soil and groundwater cleanup objectives appropriate to the risk to water quality, public health, and the environment. Soil and groundwater cleanup standards were then established for each RMZ based upon the risks identified within the individual zone. The cleanup objectives for soil and groundwater were such that when groundwater reaches the Bay, it is protective of the beneficial uses and does not pose a significant risk to aquatic species or people using the Bay.

- The planned South San Francisco station can be classified as corresponding to Migration Management Zone 2 (MM2). This zone is defined by the RWQCB as being a minimum of 1,300 feet from any freshwater or saltwater surface water and 1,000 feet away from an ecological protection zone. An ecological protection zone is a ecologically sensitive area bordering a surface water. Total PNA cleanup requirements for MM2 are 12 mg/kg.

- HBGs based on the risk assessment for RWQCB Order No 95-136 are conservative and will provide adequate protection for construction workers.

- The clean-up goal for protection of groundwater (12 mg/kg) appears to be very conservative for contamination in the vadose zone. Groundwater is very unlikely to be threatened by soils used as backfill when concentrations of PNAs are 12 mg/kg or less.

The closest surface water to the planned South San Francisco station is the existing concrete-lined Colma Creek channel located within the boundaries of the planned station. As part of construction of the planned station, Colma Creek will be diverted into a cast in-place concrete box with with an invert elevation of about 55 feet mean sea level (msl). Colma Creek discharges to the Bay located approximately 3.5 miles from the planned station. BART plans to reuse approximately 40,000 cubic yards of PNA-impacted soil in the southwest corner of the planned South San Francisco station. Restricted Reuse II PNA impacted soil placement will extend north and west to within 50 feet of the new Colma Creek, and will not be placed within 15 feet of planned utility corridors.

Engineering Controls

To ensure future protection of public health and the environment, engineering controls will be implemented in areas where Restricted Reuse I and Restricted Reuse II soils will be used. Engineering controls are identified in Table 2 and are graphically presented on Figure 5. Engineering controls will consist of soil or asphalt covers, site grading to maintain positive drainage, and placement of Restricted Reuse I and II soils five feet above highest measured groundwater. It is BARTs intent to sufficiently construct the engineering controls so as to eliminate any programs to maintain the integrity of the soil or asphalt covers.

At the planned South San Francisco station, the existing ground surface elevation where Reuse II soils will be placed is approximately 70 feet msl. As planned, approximately 10 to 15 feet of Reuse II soils will be placed on top of the existing grade. Based upon groundwater elevation data, the Reuse II soils will be placed a minimum of 10 feet above the highest measured groundwater and covered with asphalt for vehicle parking. In addition, Restricted Reuse I soils will be placed between unrestricted reuse soils above the Colma Creek box. A plan view of the South San Francisco station is presented on Figure 6, and a cross-section through the station site is presented on Figure 7.

BART anticipates that surface water infiltration at this site will be restricted by the asphalt parking areas and that contributions to groundwater from the existing Colma Creek will be further restricted by construction of the planned creek box structure. Therefore, the separation between groundwater and the Reuse II soil should maintained at a minimum of five feet. These measures should reduce the potential for migration of PNAs through the soil toward any surface water receptors.

Institutional Controls

To ensure future protection of public health and the environment, deed restrictions will be implemented in areas where Restricted Reuse II soils will be used. As required, deed restrictions will be prepared by BART and subject to approval by the RWQCB.

Soil Reuse Locations

The primary locations for placement of reusable soils will be along the top and sides of the underground rail boxes from the northern end of the SFO Extension to Sylvan Avenue in San Bruno, and at the planned South San Francisco station (see Figures 5, 6, 7, and Figure 8, Soil Reuse Areas). Restricted Reuse II soils impacted with PNAs will only be reused at the South San Francisco station, or equivalent areas meeting MM2 criteria at the South San Francisco Station not illustrated on Figures 6 and 7. BART is evaluating additional areas (e.g., parking lot and roadway areas between South San Francisco Station and Mission Road) for reuse of Restricted Reuse II soils impacted with PNAs. Soil will not be reused outside of the project site boundaries. No reusable fill soil will be placed south of Sylvan Avenue in San Bruno. Due to the presence of relatively shallow groundwater in the central and southern portion of the alignment from South Spruce Avenue to the Millbrae Station, Restricted Reuse I and II soil will only be used from the existing Colma station to South Spruce Avenue (see Figure 8).

References

CDM, 1998. *Tudor - Saliba Contaminant Mitigation*. Technical Memorandum from Mike Gray, to Gary Jensen, BART. May 11, 1998.

CDM, CH2MHILL/DMJM, 1998. Technical Memorandum, *Summary of Results from Phase II Site Investigation for BART's SFO Extension*. May 18, 1998

PRC, 1992. *Baseline Risk Estimation and Revision of Preliminary Health-based Goals for Chemicals of Potential Concern in the Soils at the Upland Portion of the Rhone-Poulenc Superfund Site*. February 18, 1992.

RWQCB, 1992. *Site Cleanup Requirements for: Upland Operable Unit, 1990 Bay Road Site, East Palo Alto, San Mateo County. Dischargers: Rhone-Poulenc and Sandoz Crop Protection Corporation.* California Regional Water Quality Control Board, San Francisco Bay Region, Order 92-022. February 19, 1992.

RWQCB, 1995. *Revised Site Cleanup Requirements for: City and County of San Francisco and San Francisco International Airport Tenants, for the Property at San Francisco International Airport, San Mateo County*. California Regional Water Quality Control Board, San Francisco Bay Region, Order 95-018. June 26, 1995.

Appendix E
Health-Based Goals for Arsenic in Soil

Appendix E
Health-Based Goals for Arsenic in Soil

Introduction

BART has prepared this review of the risk assessment memorandum prepared by PRC to Rose Marie Caraway dated February 18, 1992 *(Baseline Risk Estimation and Revision of Preliminary Health-based Goals for Chemicals of Potential Concern in the Soils at the Upland Portion of the Rhone-Poulenc Superfund Site)*, to evaluate assumptions used to calculate health-based goals (HGBs) for arsenic in soil. This review indicates that the HBGs established in the risk assessment do not reflect current guidance and science. The following table summarizes recommended final HBGs for arsenic at the Rhone-Poulenc site based on current best risk assessment practice. Although this review of the risk assesment indicates that the HBGs for arsenic in soil can be increased for both residential and industrial scenarios, BART intends to use the more conservative HBGs established for the Rhone-Poulenc Superfund Site at the BART SFO Extension project site. Details of the review and revised calculations are presented below.

Table 1
Comparison of Original and Revised HBGs for Arsenic in Soil at the Rhone-Poulenc Superfund Site

Exposure Scenario	Original HBG	Revised HBG	Target Cancer Risk
Residential	70 mg/kg	160 mg/kg	1E-04
Commercial/Industrial	500 mg/kg	760 mg/kg	1E-04

Reconstruction of PRC Calculations

PRC (1992) does not provide exposure parameters for their risk and HBG calculations explicitly. However, PRC cites EPA (1991) as a source of standard exposure assumptions. These assumptions were used to duplicate calculations summarized in PRC's memorandum. The results of these reconstructions are in Tables 2 through 5.

PRC's HBGs could not be exactly reproduced. For example, the residential HBG for arsenic based on cancer risk is 70 mg/kg in PRC's memorandum and 66 mg/kg in the duplicate calculations. This small difference is very likely due simply to rounding and may not indicate an error in PRC's calculations. The same is true for HBGs based on noncancer hazards where PRC's and the duplicate calculations for the HBG (500 mg/kg and 513 mg/kg, respectively) differ only slightly.

HBGs for the commercial/industrial scenarios reported by PRC were also slightly different than the duplicate calculations. Again, differences between HBGs can be explained on the basis of rounding. For cancer risk, HBGs calculated by PRC and the duplicate calculations are 300 mg/kg and 315 mg/kg, respectively. Analogous HBGs based on noncancer hazard are 2000 mg/kg and 2044 mg/kg.

Given the uncertainties in risk assessment, rounding to one significant figure is appropriate and PRC probably used rounded figures when reporting HBGs in their memorandum. Therefore, considering these assumptions, PRC's calculations were accurately reproduced.

Updating HBGs for the Rhone-Poulenc Site

Three significant issues were identified related to exposure assumptions and toxicity criteria used by PRC in its calculations.

Oral Cancer Slope Factor

A oral cancer slope factor for arsenic of 1.8 mg/kg/d^{-1} was used in PRC's report. Currently, the cancer slope factor recommended by EPA and commonly used to assess oral exposure to arsenic is 1.5 mg/kg/d^{-1} (EPA 1998).

Oral Reference Dose

The reference dose (RfD) for oral exposure to arsenic currently found on the Integrated Risk Information System (IRIS) (EPA 1998) is 3E-04. The RfD used by PRC is 1E-03.

Bioavailability of Arsenic in Soil

Recent data on uptake of arsenic from soil indicate that absorption is significantly reduced from that observed for inorganic arsenic dissolved in water. Since the basis for arsenic toxicity criteria is exposure of large Taiwanese populations to dissolved arsenic in well water, significantly lower bioavailability from soil should be considered in calculation of risks and HBGs.

Results from several recent studies are summarized in Table 6. These results and others indicate that the highest values for absorption of arsenic from soil do not exceed 50%. This conclusion is supported by findings that absorption of soluble arsenic (Na_2AsO_3) added to soil and adminstered to rabbits was generally below 50% and ranged as low as 21% (Griffin and Turck 1991). Based on these recent data on absorption of arsenic from several different soils and several test species, EPA Region VIII has determined that an absorption factor of 0.5 can be used in assessing oral exposure to arsenic in soil in the absence of site specific data. The weight of evidence indicates significantly reduced absorption of arsenic from soils, and that, at a minimum, an absorption factor of 0.5 should be used in calculating risks and HBGs.

Revised Calculations

Revised HBGs were calculated using the reconstructed spreadsheets (Tables 3 and 5) and making the following changes to input parameters (Tables 2 and 4).

Table 2
Revised Residential HBG Calculations for Arsenic[1]

HBG (Cancer Risk) (mg/kg)	Target Risk	Oral Slope Factor (mg/kg/d)-1	Bioavailability of Soluble As in Soil	Soil Ingestion Rate (mg/d)	Exposure Frequency (d/y)	Exposure Duration (y)	Body Weight (kg)	Averaging Time (d)
161	1.0E-04	1.5	0.5	120	350	30	59	25550
HBG (Noncancer Hazard) (mg/kg)	**Target HI**	**Reference Dose (mg/kg/d)**	**Bioavailability of Soluble As in Soil**	**Soil Ingestion Rate (mg/d)**	**Exposure Frequency (d/y)**	**Exposure Duration (y)**	**Body Weight (kg)**	**Averaging Time (d)**
308	1.0	0.0003	0.5	120	350	30	59	10950

Table 3
Original Residential HBG Calculations for Arsenic

HBG (Cancer Risk) (mg/kg)	Target Risk	Oral Slope Factor (mg/kg/d)-1	Bioavailability of Soluble As in Soil	Soil Ingestion Rate (mg/d)	Exposure Frequency (d/y)	Exposure Duration (y)	Body Weight (kg)	Averaging Time (d)
66	9.9E-05	1.8	1	120	350	30	59	25550
HBG (Noncancer Hazard) (mg/kg)	**Target HI**	**Reference Dose (mg/kg/d)**	**Bioavailability of Soluble As in Soil**	**Soil Ingestion Rate (mg/d)**	**Exposure Frequency (d/y)**	**Exposure Duration (y)**	**Body Weight (kg)**	**Averaging Time (d)**
513	1.0	0.001	1	120	350	30	59	10950

[1]Actual exposure assumptions are not provided in the PRC report entitled "*Baseline Risk Estimation and* Revision of Preliminary Health-based Goals for Chemicals of Potential Concern in the Soils at the Upland Portion of the Rhone-Poulenc Superfund Site". Exposure assumptions are standard EPA assumptions found in Guidance cited in this document

Table 4
Revised Commercial/Industrial HBG Calculations for Arsenic

HBG (Cancer Risk) (mg/kg)	Target Risk	Oral Slope Factor (mg/kg/d)-[1]	Bioavailability of Soluble As in Soil	Soil Ingestion Rate (mg/d)	Exposure Frequency (d/y)	Exposure Duration (y)	Body Weight (kg)	Averaging Time (d)
763	1.0E-04	1.5	0.5	50	250	25	70	25550
HBG (Noncancer Hazard) (mg/kg)	**Target HI**	**Reference Dose (mg/kg/d)**	**Bioavailability of Soluble As in Soil**	**Soil Ingestion Rate (mg/d)**	**Exposure Frequency (d/y)**	**Exposure Duration (y)**	**Body Weight (kg)**	**Averaging Time (d)**
1472	1.0	0.0003	0.5	50	250	25	70	10950

Table 5
Original Commercial/Industrial HBG Calculations for Arsenic[1]

HBG (Cancer Risk) (mg/kg)	Target Risk	Oral Slope Factor (mg/kg/d)-1	Bioavailability of Soluble As in Soil	Soil Ingestion Rate (mg/d)	Exposure Frequency (d/y)	Exposure Duration (y)	Body Weight (kg)	Averaging Time (d)
315	9.9E-05	1.8	1	50	250	25	70	25550
HBG (Noncancer Hazard) (mg/kg)	**Target HI**	**Reference Dose (mg/kg/d)**	**Bioavailability of Soluble As in Soil**	**Soil Ingestion Rate (mg/d)**	**Exposure Frequency (d/y)**	**Exposure Duration (y)**	**Body Weight (kg)**	**Averaging Time (d)**
2044	1.0	0.001	1	50	250	25	70	9125

[1] Actual exposure assumptions are not provided in the PRC report entitled "*Baseline Risk Estimation and Revision of Preliminary Health-based Goals for Chemicals of Potential Concern in the Soils at the Upland Portion of the Rhone-Poulenc Superfund Site*". Exposure assumptions are standard EPA assumptions found in Guidance cited in this document.

Table 6
Comparison of Swine Study Variability with Variability Observed in Other Studies

Animal	Material Tested	Bioavailability Means ± SD (%)	Coefficient of Variation
Casteel, et al. (1997)			
Young Swine	Murray Smelter Slag	51 ± 36	0.70
	Murray Smelter Soil	34 ± 13	0.38
	Midvale Slag	18 ± 17.4	0.97
	Butte Soil	10 ± 20.6	2.06
	Leadville Soil	-8 ± 36	-4.5
	FeMnPb Oxide	28 ± 56	2.0
	AV Slag	15 ± 6.6	0.44
	Oregon Gulch	7 ± 20.6	2.94
	Palmerton Location 2	39 ± 39	1.0
	Palmerton Location 4	52 ± 65	1.25
	Grant Kohrs Tailings	49 ± 27.8	0.57
	Bingham Creek	37 ± 65.8	1.78
Groen, et al. (1994)			
Beagle Dog	Bog Ore	8.3 ± 2.0	0.24
Freeman, et al. (1993)			
New Zealand White Rabbit	Smelter Community Soil	24 ± 3.2	0.13
Freeman, et al. (1995)			
Cynomolgus Monkey (Female)	Smelter Community Soil and House Dust	19.2 ± 2.6 dust 13.8 ± 5.7 soil	0.14 dust 0.41 soil 3 Study Average = 0.23

- The oral arsenic slope factor was changed from 1.8 to 1.5 mg/kg/d^{-1}.
- The oral reference dose for arsenic was changed from 1E-03 to 3E-04 mg/kg/d.
- An absorption term of 0.5 was added to reflect intestinal absorption of even the most soluble forms of arsenic from soil.

HBGs for arsenic based on cancer risk are always lower than those based on noncancer hazard (Tables 2 and 4). As a result, revised HBG reported in Table 1 are based on a target cancer risk of 1E-04. A similar result for arsenic was obtained by PRC in their memorandum.

Revised HBGs are somewhat higher than those recommended by PRC. The revised HBGs are, however, equally protective, and can be used with high confidence that public health will not be compromised. Note also that the revised commercial/industrial HBG of 760 is based on a target cancer risk of 1 E-04. PRC's calculations previously suggested that the cancer risk associated with an HBG of 500 mg/kg would be 2E-04. If this same target risk was used, the resulting revised commercial/industrial HBG would be about 1500 mg/kg.

Summary

Results of the review of PRC HBG indicate:

- PRC accurately calculated HBGs based on their assumptions and standard exposure and risk equations used by EPA.
- PRCs HBGs overstate potential threats from exposure to arsenic based on the most current guidance and science.
- Use of PRCs HBGs will be protective of human health for future residents or commercial/industrial workers.

References

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Appendix F
Health-Based Goals for Polynuclear Aromatics

Appendix F
Health-Based Goals for Polynuclear Aromatics

BART reviewed the RWQCB's Order No. 95-136 *Revised Site Cleanup Requirements for: City and County of San Francisco and San Francisco International Airport Tenants* (Order) to assess its:

- Accuracy compared against current health-based standards;
- Accuracy regarding protection of construction workers; and
- Applicability of the cleanup requirements established in Order for the San Francisco International Airport with respect to reuse of polynuclear aromatic hydrocarbon (PNA) impacted soil at BART's planned South San Francisco station.

This review indicates that the health-based goals (HBGs) (referred to as Tier 1 Standards by the RWQCB) established in the Order do not reflect current California EPA guidance and science. However, the differences are small, are well within the uncertainty range of the risk estimates on which the remediation goals are based, and will make no substantive difference for any protective actions based on these goals. Table 1 summarizes differences between estimates included in the Order and those calculated using current Cal EPA guidance and risk assessment known as the CalTOX model. Details of the review and revised calculations are presented below.

Table 1
Comparison of Original and Revised Hbgs for PNAs in Soil

Exposure Scenario	*Original HBG (Total PNAs)*	*Revised HBG (Carcinogenic PNAs[1])*	*Target Cancer Risk*
General Construction Worker	5 mg/kg	5.2 mg/kg	1E-05
Temporary "Earth" Worker	5 mg/kg	6.4 mg/kg	1E-05

[1] Carcinogenic PNAs presented in Table 4

Reconstruction of Calculations

The RWQCB does not provide equations and descriptions of models used for the calculation of remediation goals. Thus, it was not possible to easily reconstruct its calculations. Instead, it was assumed that the original calculations were correct and the original values were used for comparison against alternative calculations derived from current Cal EPA guidance (CalTOX). The CalTOX model (Cal EPA, 1997) was developed by the Regents of the University of California and by the Department of Toxic Substances Control for use in estimating risks and calculating HBGs for organic chemicals commonly encountered at hazardous waste sites in California. The model is appropriate for use in estimating HBGs for the exposure scenarios outlined in the Order.

Updating RWQCB Human Health Protection Zone Tier 1 Standards

Four potentially significant issues related to exposure assumptions and toxicity criteria used in the Order are identified below:

Oral Cancer Slope Factor

The Order indicates that EPA slope factors from either IRIS or HEAST were used in the calculations. Cal EPA has developed its own cancer slope factors for many chemicals including the carcinogenic PNAs. Differences between EPA and Cal EPA slope factors may cause small differences in calculated HBGs.

Assumption for Carcinogenic Content of PNAs

The Order indictes that the HBGs (Tier 1 Standards) for benzo(a)pyrene and for total PNAs are essentially the same for both general construction workers and temporary "earth" workers (Appendix 1, Table 6, "Human Health Protection Zone Tier 1 Standards"). Total PNAs include many compounds (e.g. pyrene, anthracene, acenaphthalene) that are not considered carcinogenic. Often, these chemicals make up the bulk of the total PNAs in soil. Considering that all of these PNAs are carcinogenic will result in a very conservative HBG.

Half-Life of PNAs in Soil

Cal EPA recognizes that most organic chemicals are degraded to a significant extent in soils when one is considering exposure durations of several years. The most recent risk assessment guidance from Cal EPA (CalTOX) incorporates estimates of degradation when estimating exposures to soil contaminants. Default values for half-lives of several specific PNAs are included in the CalTOX model (Cal EPA, 1997).

Leaching of PNAs to Groundwater

PNAs, especially the high molecular weight species associated with carcinogenic activity, tend to be very immobile. The Order suggests that a benzo(a)pyrene concentration of 12 mg/kg would be necessary to protect against migration of chemical from soil to groundwater. This concentration appears low given the extremely low solubility of benzo(a)pyrene and its binding to organic matter in the soil. The CalTOX model estimates impacts to groundwater via leaching from subsurface soil and is appropriate for assessing mobility of PNAs.

Revised Calculations

Revised HBGs were calculated using the CalTOX model (Table 2). Default inputs to this model were modified to reflect construction worker scenarios described in the Order as indicted in Table 3.

Table 2
HBGs Estimated Using CalTOX

Scenario	Soil HGB based on Carcinogenic PNAs[1] (mg/kg)	Sensitive Input Parameters
Protection of General Construction and Temporary "Earth" Workers		
General Construction Worker	5.2	Soil ingestion rate, all parameters used in dermal exposure estimates
Temporary "Earth" Worker	6.4	Soil ingestion rate, all parameters used in dermal exposure estimates
Protection of Groundwater		
Leaching from Subsurface Soils	10,000 mg/kg	NA

[1] Carcinogenic PNAs presented in Table 4

Changes to inputs were necessary because the CalTOX model includes only exposure parameters appropriate for residential exposures. For the BART SFO Extension project, PNA-impacted soils will only be reused as backfill at the planned South San Francisco station. This backfill material will be covered with non-impacted soils and asphalt for vehicle parking and virtually no exposure is expected after completion of the station. Therefore, human exposure to PNA-impacted soils will only occur during construction and the minimization of worker exposure will be the primary concern regarding the protection of human health.

Once in place, PNAs in backfill material could conceivably leach to groundwater. For protection of groundwater, some estimate of the leaching potential of PNAs is necessary. Thus, the estimation of HBGs must also consider protection of local shallow groundwater.

Inputs to CalTOX are summarized and explained in Table 3. All inputs to the model not included in this table were left at the CalTOX default values. Output from the model is included as an attachment to this appendix.

It should be noted that CalTOX is designed for use with stochastic modeling (Monte Carlo analysis) and default inputs are means or "expected" values. When calculating HBGs, a mix of average and upper range values are commonly used for inputs such that resulting HBGs reflect an upper range estimate of possible human health risks. Site-specific inputs to CalTOX were taken from the Order and reflect upper range estimates for most exposure parameters. Thus, the CalTOX HBG estimates presented in this appendix are based on appropriate upper range estimates of potential risks.

Table 3
Site-specific Inputs to the CalTOX Model

Input Parameter	Order	Site-Specific	Comments
Inhalation Rate (Active breathing rate in CalTOX)	20 m^3/d	0.036 m^3/kg/h	The inhalation rate for general construction workers and temporary earth workers from the order was converted to units used in CalTOX by dividing by body weight (70 kg) and by hours in normal working day (8 h/d).
Soil Ingestion Rate	50 mg/d (GCW) 480 mg/d (TEW)	4.89E-07 kg/kg/d 3.5E-06 kg/kg/d	The soil ingestion rates for general construction workers and temporary earth workers from the order were converted to units used in CalTOX by dividing by mg/kg (1E+06), by body weight (70 kg) and multiplying by the fraction of days on which exposure might occur (250/365 or 0.68). 250 is the estimated number of work days per year, and exposure is assumed to occur each work day.
Skin Surface Area	3,300 cm^2	0.0046 m^2/kg	Body surface area used for general construction workers and temporary earth workers from the order was converted to units used in CalTOX by dividing by cm^2/m^2 (10,000) and by body weight (70 kg)
Exposure Frequency	250 d/y	250 d/y	The exposure frequency used in the Order was adopted for the CalTOX runs
Exposure Duration	4 y (GCW) 2 y (TEW)	4 y (GCW) 2 y (TEW)	The exposure duration used in the Order was adopted for the CalTOX runs
Body Weight	70 kg	70 kg	The body weight used in the Order was adopted for the CalTOX runs
Cancer Slope Factors and Reference Doses	Chemical-specific from IRIS or HEAST	Chemical-specific from CalTOX database	California cancer slope factors, as incorporated into the CalTOX model, were used to estimate HBGs. Chemical-specific parameters are included in the attached CalTOX run printouts.
Soil and Groundwater Concentrations	NA	1 mg/kg (soil) 0.001 mg/L (groundwater)	CalTOX requires starting media concentrations for estimation of both risks and HBGs. "Dummy" unit concentrations were used in all CalTOX runs.

GCW = General Construction Worker
TEW = Temporary Earth Worker

Discussion of CalTOX Modeling Results

CalTOX output indicates that concentrations in the range of 5 mg/kg for benzo(a)pyrene would be acceptable for construction activities related to the proposed BART expansion, and that concentrations as high as 10,000 mg/kg[1] would not impact shallow groundwater. Concentrations of other carcinogenic PNAs can be expressed as benzo(a)pyrene equivalents based on estimated differences in toxicity. Since benzo(a)pyrene is the most potent of the carcinogenic PNAs, if total carcinogenic PNA concentrations are at or below 5 mg/kg, workers involved in the BART SFO Extension project would not be adversely affected.

However, total PNA concentrations could be much greater than 5 mg/kg and still be protective of human health and environment. For example, an HBG based on the above scenarios for pyrene in soils is 43,000 mg/kg for protection of human health and 100,000 mg/kg for protection of groundwater (CalTOX output is attached). Pyrene is among the more toxic of the noncarcinogenic PNAs and its HBGs reasonably represents this PNA fraction. Where total PNAs are less than 43,000 mg/kg and the carcinogenic fraction is less than 5 mg/kg, worker health will be protected.

Use of 5 mg/kg total carcinogenic PNA is still very conservative and assumes that the workers are not using protective gear i.e. tyvek coveralls, gloves, or dust masks. For example, chrysene, one of seven carcinogenic PNAs (Table 4), is one one-thousandth as potent as benzo(a)pyrene. If the bulk of carcinogenic PNAs is chrysene, as much as 500 mg/kg carcinogenic PNA could be acceptable.

Table 4
CalEPA Carcinogenic PNAs

Benzo(a)pyrene	Benzo(a)anthracene
Benzo(b)fluoranthene	Benzo(k)fluoranthene
Dibenz(a,h)anthracene	Chrysene
Indeno(1,2,3-cd)pyrene	

In addition, exposure durations for workers in the Order (2 and 4 years) may greatly exaggerate the amount of time spent in contaminated areas during BART construction. Handling (excavation, transportation and placement) of PNA-impacted soil comprises only a small fraction of the total duration of the project. Work in contaminated areas might therefore occur in much shorter time frames than those estimated in the Order. If construction scheduling is available, it might be used to supply more reasonable estimates of exposure durations for future site workers. A decrease in exposure duration would increase estimated HBGs proportionally.

[1] CalTOX printout suggest 100,000 mg/kg. However, this estimate is based on a target risk of 1×10^{-5}. An HBG of 10,000 mg/kg would be appropriate for a target risk of 1×10^{-6}.

Summary

The findings of this review are presented below:

- The HBGs (Tier 1 Standards) established in the Order do not reflect current California EPA guidance and science. However, the differences are small, are well within the uncertainty range of the risk estimates on which the remediation goals are based, and will make no substantive difference for any protective actions based on these goals.

- To ensure protection of worker health and safety, construction workers should be required to don personnel protective equipment in those areas where the total concentration of carcinogenic PNAs exceed 5.2 mg/kg.

- To ensure protection of local groundwater resources, soils impacted with carcinogenic PNAs should not be reused when the total concentration of carcinogenic PNAs exceed 10,000 mg/kg.

- HBGs based on the risk assessment for RWQCB Order No 95-136 are conservative and will provide adequate protection for construction workers.

- The clean-up goal for protection of groundwater (12 mg/kg) appears to be very conservative for contamination in the vadose zone. Groundwater is very unlikely to be threatened by soils used as backfill when concentrations of PNAs are 12 mg/kg or less.

References

RWQCB, 1995. *Revised Site Cleanup Requirements for City and County of San Francisco and San Francisco International Airport Tenants for the Property at San Francisco International Airport, San Mateo County.* California Regional Water Quality Control Board Order No. 95-136.

Cal EPA, 1997. CalTOX Version 2.3 (*beta*) California Environmental Protection Agency, Department of Toxic Substances Control, Office of Environmental Health Hazard Assessment.

CalTOX™ 2.3 (beta): Eight-Compartment Multimedia Exposure Model

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Inputs:

Chemical name==>	Benzo(a)pyrene	
Site name ====>	SFO Temporary Construction	

Toxicity Data ==>	Cancer potencies 1/(mg/kg-d)	Non-cancer ADIs (mg/kg-d)
Inhalation	3.9 E+00	0
Ingestion	1.2 E+01	0
Dermal	1.2 E+01	0
Total dose		0

	Risk	Hazard quotient
Target Risk/Hazard =	1.0 E-05	1.00
	current value	should be >
Root-soil thickness ===>	3	OK
Alter root soil thickness to?	n/a	
Distance off-site for air exposure=	0.0 E+00	meters
Time after initial concentrations when exposure begins =	0.0 E+00	days

Measured Concentrations (at time = 0)

Root-zone soil	1	ppm (mg/kg)
Vadose-zone soil	1	ppm (mg/kg)
Ground water	0.001	ppm (mg/L)

Continuous inputs

Source term to air (mol/d)	0.0 E+00	Sa
Source term to ground-surface soil (mol/d)	0.0 E+00	Sg
Source term to root-zone soil (mol/d)	0.0 E+00	Ss
Source term to surface water(mol/d)	0.0 E+00	Sw

Outputs: See Warnings Please

Target Soil Concentrations (in ppm)

Based on cancer risk:		
Root soil	5.2 E+0	
Vadose soil	1.0 E+5	>conc limit
Based on hazard:		
Root soil	0.0 E+0	not avlbl.
Vadose soil	0.0 E+0	not avlbl.

Root Soil	5.2 E+0
Vadose soil	1.0 E+5

Un-mitigated risk and/or hazard ratio

Risk	1.9 E-6	
Hazard ratio	0.0 E+0	

Concentration limits without NAPL

Root soil	1.8 E+01	mg/kg solid
Vadose soil	1.5 E+00	mg/kg solid
	2.6 E-03	mg/L water

Time avrg. Conc. in on-site environmental media

Air	2.8 E-08	mg/m3
Plants	1.3 E-03	mg/kg(FM)
Grnd-surface soil	6.5 E-03	mg/kg(total)
Root-zone soil	1.0 E+00	mg/kg(total)
Vadose-zone soil	1.0 E+00	mg/kg(total)
Ground water	5.8 E-12	mg/L(water)
Surface water	4.9 E-08	mg/L
Sediment	4.4 E-04	mg/kg

Chemical properties

0.00297 0.003 .... 1 8.1 E+01

ompound name	Benzo(a)pyrene	Value used	Mean value	Coeff. Var.	Adjustment	Notes
Molecular weight (g/mol)	MW	2.52 E+02	2.52 E+02	0.0090271	1	
Octanol-water partition coefficient	Kow	2.20 E+06	2.20 E+06	0.7243531	1	
Melting point (K)	Tm	4.51 E+02	4.51 E+02	0.028	1	
Vapor Pressure in (Pa)	VP	7.13 E-07	7.13 E-07	0.067586	1	
Solubility in mol/m3	S	1.03 E-05	1.03 E-05	0.6322445	1	
Henry's law constant (Pa-m^3/mol)	**H -**	9.20 E-02	0.092	1	1	
Diffusion coefficient in pure air (m2/d)	Dair	4.36 E-01	4.36 E-01	0.08	1	5.04 E-06
Diffusion coefficient: pure water (m2/d)	Dwater	5.26 E-05	5.26 E-05	0.25	1	6.09 E-10
Organic carbon partition coefficient Koc	**Koc -**	2.49 E+06	2488414.062	0.9062255	1	m^2/s
Partition coefficient in ground/root soil layer	**Kd_s -**	7.47 E+03	-99	0.1	1	
Partition coefficient in vadose-zone soil layer	**Kd_v -**	6.72 E+02	-99	0.1	1	
Partition coefficient in aquifer layer	**Kd_q -**	2.49 E+04	-99	0.1	1	
Partition coeffic. in surface wtr sediments	**Kd_d -**	7.96 E+04	-99	0.1	1	
Prtn cff. plnt(abv-grd)/sl (kg(s)/kg(pFM))	**Kps -**	1.55 E-02	0.015464386	1	1	
Biotrnsfr fctr. plant/air (m3(a)/kg(pFM))	**Kpa -**	5.92 E+05	591675.1923	14	1	
Biotransfer factor; cattle-diet/milk (d/L)	**Bk -**	8.85 E-03	0.008848659	10.77033	1	
Biotransfer factor; cattle-diet/meat (d/L)	**Bt -**	2.93 E-02	0.029321969	12.589678	1	
Biotransfer factor; hen-diet/eggs (d/L)	**Be -**	1.75 E+01	17.45376954	14	1	
Biotrnsfr fctr; brst mlk/mthr intake (d/kg)	**Bbmk -**	4.39 E-01	0.43945988	10	1	
Bioconcentration factor; fish/water	**BCF -**	3.29 E+02	328.6666667	0.4084036	1	
Skin permeability coefficient; cm/h	**Kp_w -**	1.20 E-02	0.011974979	2.4	1	
Fraction dermal uptake from soil	**dfct_sl-**	1.00 E+00	29611.52573	0.27	1	
Reaction half-life in air (d)	Thalf_a	6.32 E-02	6.3 E-02	1	1	
Reaction half-life in surface soil (d)	Thalf_g	2.29 E+02	2.3 E+02	1.1	1	
Reaction half-life in root-zone soil (d)	Thalf_s	2.29 E+02	2.3 E+02	1.2	1	
Reaction half-life in vadose-zone soil (d)	Thalf_v	8.80 E+02	8.8 E+02	1	1	
Reaction half-life in ground water (d)	Thalf_q	8.80 E+02	8.8 E+02	1.3	1	
Reaction half-life in surface water (d)	Thalf_w	2.34 E+00	2.3 E+00	1.2	1	
Reaction half-life in sediments (d)	Thalf_d	1.17 E+03	1.2 E+03	1.4	1	

Landscape properties

site name	SFO Temporary Construction	Value used	Mean value	Coeff. Var.	Adjustment	Notes
contaminated area in m2	Area	1.00 E+03	1.00 E+03	0.1	1	(m/y)
annual average precipitation (m/d)	rain	1.48 E-03	1.48 E-03	0.55	1	5.40 E-01
flux; surface water into landscape (m/d)	inflow	0.00 E+00	0.00 E+00	0.1	1	0.00 E+00
land surface runoff (m/d)	runoff	6.40 E-04	6.40 E-04	0.55	1	2.34 E-01
atmospheric dust load (kg/m3)	rhob_a	1.00 E-05	1.00 E-05	0.64	1	
deposition velocity of air particles (m/d)	v_d	6.90 E+02	6.90 E+02	1.5	1	
plant dry mass inventory (kg(DM)/m2)	bio_inv	2.80 E+00	2.80 E+00	1.05	1	
plant dry-mass fraction	bio_dm	2.20 E-01	2.20 E-01	0.4	1	
plant fresh-mass density kg/m^3	rho_p	8.30 E+02	8.30 E+02	0.2	1	
ground-water recharge (m/d)	recharge	8.20 E-06	8.20 E-06	0.55	1	2.99 E-03
evaporation of water from surface wtr (m/d)	evaporate	4.38 E-06	4.38 E-06	1	1	
thickness of the ground soil layer (m)	d_g	1.00 E-02	1.00 E-02	1	1	
soil particle density (kg/m3)	rhos_s	2.65 E+03	2.65 E+03	0.05	1	
water content in surface soil (vol fraction)	beta_g	1.31 E-01	1.31 E-01	0.24	1	
air content in the surface soil (vol frctn)	alpha_g	2.42 E-01	2.42 E-01	0.29	1	cm/y
erosion of surface soil (kg/m2-d)	erosion_g	3.00 E-04	3.00 E-04	0.2	1	0.0064099
thickness of the root-zone soil (m)	d_s	3.00 E+00	3.00 E+00	0.49	1	
water content of root-zone soil (vol. frctn.)	beta_s	1.25 E-01	1.25 E-01	0.3	1	
air content of root-zone soil (vol. frctn.)	alpha_s	2.23 E-01	2.23 E-01	0.31	1	
thickness of the vadose-zone soil (m)	d_v	3.40 E+01	3.40 E+01	0.56	1	
water content; vadose-zone soil (vol. frctn.)	beta_v	2.80 E-01	2.80 E-01	0.2	1	
air content of vadose-zone soil (vol. frctn.)	alpha_v	1.70 E-01	1.70 E-01	0.2	1	
thickness of the aquifer layer (m)	d_q	3.00 E+00	3.00 E+00	0.3	1	
solid material density in aquifer (kg/m3)	rhos_q	2.65 E+03	2.65 E+03	0.05	1	
porosity of the aquifer zone	beta_q	2.00 E-01	2.00 E-01	0.2	1	
fraction of land area in surface water	f_arw	4.70 E-02	4.70 E-02	1.57	1	
average depth of surface waters (m)	d_w	5.00 E+00	5.00 E+00	1.58	1	
suspended sedmnt in surface wtr (kg/m3)	rhob_w	8.80 E-02	8.80 E-02	1	1	

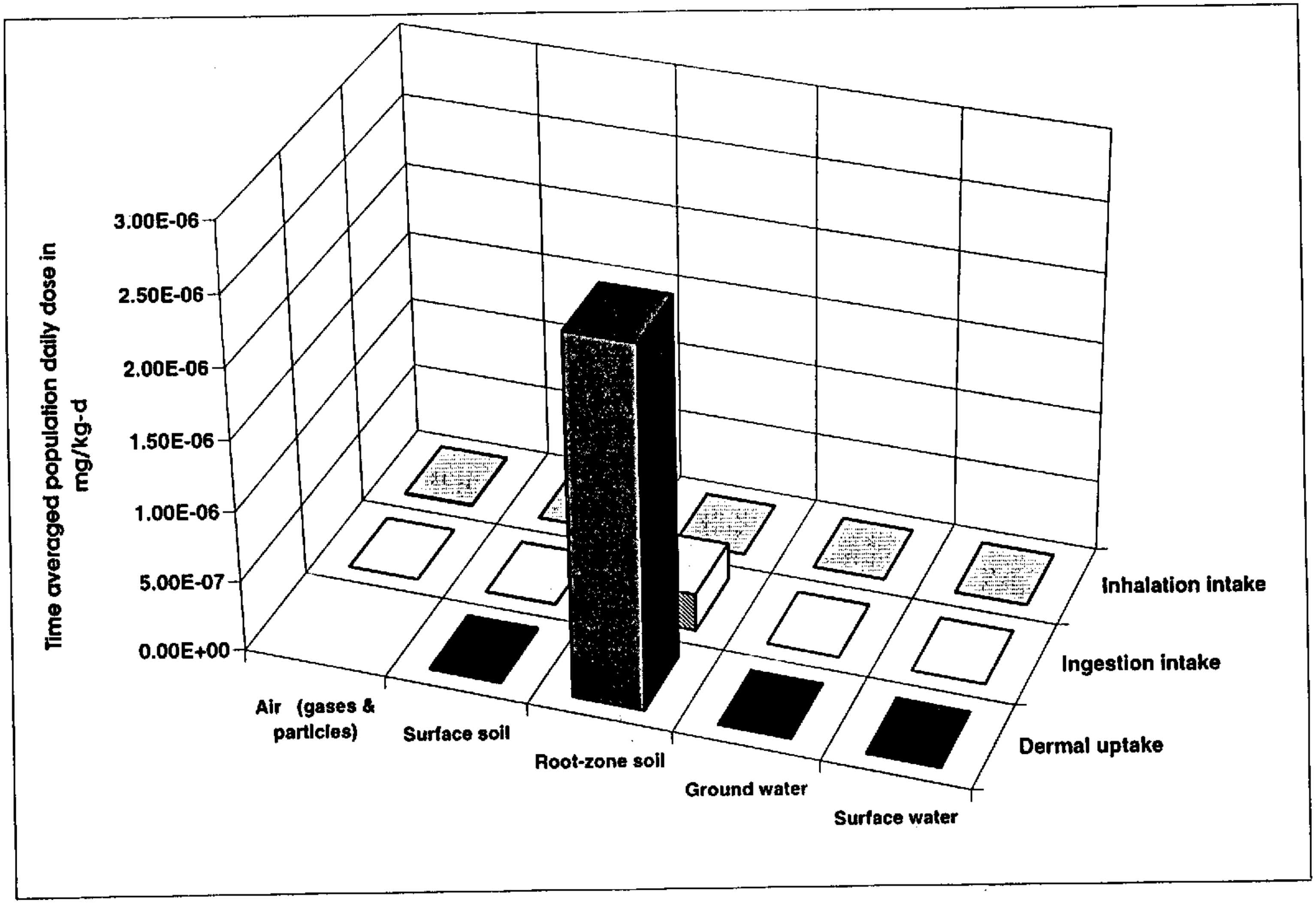
Landscape properties (continued)

site name	SFO Temporary Construction	Value used	Mean value	Coeff. Var.	Adjustment	Notes
suspended sdmnt deposition (kg/m2/d)	deposit	1.05 E+01	1.05 E+01	0.3	1	(m/s)
thickness of the sediment layer (m)	d_d	5.00 E-02	5.00 E-02	1	1	
solid material density in sediment (kg/m3)	rhos_d	2.65 E+03	2.65 E+03	0.05	1	
porosity of the sediment zone	beta_d	2.00 E-01	2.00 E-01	0.2	1	m/y
sediment burial rate (m/d)	bury_d	1.00 E-06	1.00 E-06	5	1	3.65 E-04
ambient environmental temperature (K)	Temp	2.88 E+02	2.88 E+02	0.01	1	(m/s)
Surface water current in m/d	current_w	0.00 E+00	0.00 E+00	1	1	0.00 E+00
organic carbon fraction in upper soil zone	foc_s	3.00 E-03	3.00 E-03	0.37	1	
organic carbon fraction in vadose zone	foc_v	2.70 E-04	2.70 E-04	1.4	1	
organic carbon fraction in aquifer zone	foc_q	1.00 E-02	1.00 E-02	1	1	
organic carbon fraction in sediments	foc_d	3.20 E-02	3.20 E-02	0.84	1	
bndry lyr thickness in air above soil (m)	del_ag	5.00 E-03	5.00 E-03	0.2	1	(m/s)
yearly average wind speed (m/d)	v_w	1.50 E+05	1.50 E+05	0.67	1	1.74 E+00
distance to first well (m)	d_well	0.00 E+00	0.00 E+00		1	
Darcy veleocity (m/d)	v_darc	1.00 E-01	1.00 E-01		1	
water dispersion coeff. (m2/d)	D_T	5.00 E-02	5.00 E-02		1	

(General Construction) Exposure Factors		Value used	Mean value	Coeff. Var.	Adjustment	Notes
Body weight (kg)	BW	7.00 E+01	7.00 E+01	0.2	1	
Surface area (m2/kg)	SAb	4.60 E-03	4.60 E-03	0.07	1	
Active breathing rate (m3/kg-h)	BRa	3.60 E-02	3.60 E-02	0.3	1	
Resting breathing rate (m3/kg-h)	BRr	6.40 E-03	6.40 E-03	0.2	1	
Fluid intake (L/kg-d)	Ifl	2.20 E-02	2.20 E-02	0.2	1	
Fruit and vegetable intake (kg/kg-d)	Ifv	4.90 E-03	4.90 E-03	0.2	1	
Grain intake (kg/kg-d)	Ig	3.70 E-03	3.70 E-03	0.2	1	
Milk intake (kg/kg-d)	Imk	6.50 E-03	6.50 E-03	0.2	1	
Meat intake (kg/kg-d)	Imt	3.00 E-03	3.00 E-03	0.2	1	
Egg intake (kg/kg-d)	Iegg	4.60 E-04	4.60 E-04	0.3	1	
Fish intake (kg/kg-d)	Ifsh	2.90 E-04	2.90 E-04	0.4	1	
Soil ingestion (kg/kg-d)	Isl	4.89 E-07	4.89 E-07	3	1	
Breast milk ingestion by infants (kg/kg-d)	Ibm	1.10 E-01	1.10 E-01	0.2	1	
Inhalation by cattle (m3/d)	Inc	1.22 E+02	1.22 E+02	0.3	1	
Inhalation by hens (m3/d)	Inh	2.20 E+00	2.20 E+00	0.3	1	
Ingestion of pasture, dairy cattle (kg(FM)/d)	Ivdc	8.50 E+01	8.50 E+01	0.2	1	
Ingestion of pasture, beef cattle (kg(FM)/d)	Ivbc	6.00 E+01	6.00 E+01	0.4	1	
Ingestion of pasture by hens (kg(FM)/d)	Ivh	1.20 E-01	1.20 E-01	0.04	1	
Ingestion of water by dairy cattle (L/d)	Iwdc	3.50 E+01	3.50 E+01	0.2	1	
Ingestion of water by beef cattle (L/d)	Iwbc	3.50 E+01	3.50 E+01	0.2	1	
Ingestion of water by hens (L/d)	Iwh	8.40 E-02	8.40 E-02	0.1	1	
Ingestion of soil by cattle (kg/d)	Isc	4.00 E-01	4.00 E-01	0.7	1	
Ingestion of soil by hens (kg/d)	Ish	1.30 E-05	1.30 E-05	1	1	
Fraction of water needs from ground water	fw_gw	8.00 E-01	8.00 E-01	0.1	1	
Fraction of water needs from surface water	fw_sw	2.00 E-01	2.00 E-01	0.1	1	
Frctn irrgtn wtr contamnnts trnsfrd to soil	f_ir	2.50 E-01	2.50 E-01	1	1	
Frctn frts & vgtbls that are exposed produce	fabv_grd_v	4.70 E-01	4.70 E-01	0.1	1	
Fraction of fruits and vegetables local	flocal_v	2.40 E-01	2.40 E-01	0.7	1	
Fraction of grains local	flocal_g	1.20 E-01	1.20 E-01	0.7	1	

Human Exposure Factors (continued)		Value used	Mean value	Coeff. Var.	Adjustment	Notes
Fraction of milk local	flocal_mk	4.00 E-01	4.00 E-01	0.7	1	
Fraction of meat local	flocal_mt	4.40 E-01	4.40 E-01	0.5	1	
Fraction of eggs local	flocal_egg	4.00 E-01	4.00 E-01	0.7	1	
Fraction of fish local	flocal_fsh	7.00 E-01	7.00 E-01	0.3	1	
Plant-air prttn fctr, particles, m3/kg(FM)	Kpa_part	3.30 E+03	3.30 E+03	1.8	1	
Rainsplash (mg/kg(plnt FM))/(mg/kg(soil))	rainsplash	3.40 E-03	3.40 E-03	1	1	
Water use in the shower (L/min)	Wshower	8.00 E+00	8.00 E+00	0.4	1	
Water use in the House (L/h)	Whouse	4.00 E+01	4.00 E+01	0.4	1	
Room ventilation rate, bathroom (m3/min)	VRbath	1.00 E+00	1.00 E+00	0.4	1	
Room ventilation rate, house (m3/h)	VRhouse	7.50 E+02	7.50 E+02	0.3	1	
Exposure time, in shower or bath (h/day)	ETsb	2.70 E-01	2.70 E-01	0.6	1	
Exposure time, active indoors (h/day)	ETai	0.00 E+00	0.00 E+00	0.14	1	
Exposure time, outdoors at work (h/day)	ETao	8.00 E+00	8.00 E+00	0.14	1	
Exposure time, indoors resting (h/day)	ETri	0.00 E+00	0.00 E+00	0.04	1	
Indoor dust load (kg/m^3)	dust_in	3.00 E-08	3.00 E-08	0.4	1	
Exposure frequency to soil on skin, (d/y)	EFsl	2.50 E+02	2.50 E+02	0.6	1	
Soil adherence to skin (mg/cm^2)	Slsk	5.00 E-01	5.00 E-01	0.4	1	
Ratio of indoor gas conc. to soil gas conc.	alpha_inair	1.00 E-04	1.00 E-04	2	1	
Exposure time swimming (h/d)	ETsw	5.00 E-01	5.00 E-01	0.5	1	
Exposure frequency, swimming (d/y)	EFsw	1.50 E+01	1.50 E+01	4	1	
Water ingestion while swimming (L/kg-h)	Isww	7.00 E-04	7.00 E-04	1	1	
Exposure duration (years)	ED	4.00 E+00	4.00 E+00	1.15	1	
Averaging time (days)	AT	2.56 E+04	2.56 E+04	0.1	1	

Constants		
Gas Constant (Pa-m^3/mol-K)	8.31E+00	Rgas


Time averaged population daily dose in mg/kg-d
3.00E-06
2.50E-06
2.00E-06
1.50E-06
1.00E-06
5.00E-07
0.00E+00
Air (gases & particles)
Surface soil
Root-zone soil
Ground water
Surface water
Inhalation intake
Ingestion intake
Dermal uptake

Exposure Pathway-Include-and-Exclude Toggles

All inhalation exposures indoors active	0	Contaminant transfer, air to plants surfaces	0
All inhalation exposures indoors resting	0	ntmnnt. transfer, grnd. soil to plant surfaces	0
Inhalation exposure in shower/bath	0	ontamnnt. transfer, root soil to plant tissues	0
Inhalation exposures outdoors active	1	On-site grazing of animals	0
Inhalation of air particles indoors	0		
Transfer of soil dust to indoor air	0	ngestion of home-grown exposed produce	0
Transfer of soil vapors to indoor air	0	estion of home-grown unexposed produce	0
On-site inhalation by animals	0	Ingestion of home-grown meat	0
		Ingestion of home-grown milk	0
Use of ground water as tap water	1	Ingestion of home-grown eggs	0
Use of surface water as tap water	0	Ingestion of locally caught fish	0
Ingestion of tap water	1	Direct soil ingestion	1
Use of ground water for irrigation	0	Soil contact exposure at home or at work	1
Use of surface water for irrigation	0	Dermal exposure during shower/bath	0
		Dermal & ingstn exposures while swimming	0
Use of ground water for feeding animals	0		
Use of surface water for feeding animals	0	Breast-milk ingestion by infants	0

To return to the **CalTOX** Flowchart press the X button on the toolbar

MEDIA AND CORRESPONDING POTENTIAL DOSES IN mg/kg-d (averaged over the exposure duration)

PATHWAYS	Air (gases & particles)	Surface soil	Root-zone soil	Ground water	Surface water	Totals	%
INHALATION	8.20E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**8.20E-09**	0.29
INGESTION:							
Water				1.02E-13	0.00E+00	1.02E-13	0.00
Exposed produce	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
Unexposed produce			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
Meat	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
Milk	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
Eggs	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
Fish					0.00E+00	0.00E+00	0.00
Soil		1.71E-09	2.63E-07			2.65E-07	9.35
Total ingestion	0.00 E+00	1.71 E-09	2.63 E-07	1.02 E-13	0.00 E+00	**2.65 E-07**	9.35
DERMAL UPTAKE		1.65E-08	2.54E-06	0.00E+00	0.00E+00	**2.56 E-06**	90.36
Dose SUM	**8.20E-09**	**1.82E-08**	**2.81E-06**	**1.02E-13**	**0.00E+00**	**2.83E-06**	100.0

	Air (gases & particles)	Surface soil	Root-zone soil	Ground water	Surface water	total
Breast milk concentration	2.36 E-07	5.24 E-07	8.07 E-05	2.94 E-12	0.00 E+00	8.14 E-05
						dose_bm
Infant dose	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	**0.00 E+00**

Ingestion dose used =>	2.65 E-07
Total dose used =>	2.83 E-06

ENVIRONMENTAL Media CONCENTRATIONS	Air (gases) mg/m^3	Air (dust) mg/m^3	Ground soil mg/kg	Root soil mg/kg	Ground wate mg/L	Surface water mg/L
	8.37 E-11	**2.84 E-08**	**6.99 E-03**	**1.08 E+00**	**5.81 E-12**	**6.09 E-09**

EXPOSURE MEDIA CONCENTRATIONS (averaged over the exposure duration)

EXPOSURE	Air (gases)	Air (dust)	Ground soil	Root soil	Ground wate	Surface water
Indoor air (mg/m^3)	8.37 E-11	0.00 E+00	0.00 E+00	0.00 E+00	5.48 E-15	0.00 E+00
Bathroom air (mg/m^3)					7.04 E-13	0.00 E+00
Outdoor air (mg/m^3)	8.37 E-11	2.84 E-08				
Tap water (mg/L)					4.65 E-12	0.00 E+00
Exposed produce (mg/k	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00
Unexposed produce (mg/				0.00 E+00	0.00 E+00	0.00 E+00
Meat (mg/kg)	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00
Milk (mg/kg)	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00
Eggs (mg/kg)	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00
Fish and seafood (mg/kg)						2.00 E-06
Household soil (mg/kg)			3.50 E-03	5.38 E-01		
Swimming water (mg/L)						6.09 E-09

PATHWAY CONTACT FACTORS (CR/BW*FI)

EXPOSURE Media	Units	Inhalation	Ingestion	Dermal
Indoor air (active)		0.00 E+00		
Indoor air (resting)		0.00 E+00		
Indoor air (shower/bath)		0.00 E+00		
Outdoor air (active)		2.88 E-01		
Tap water			2.20 E-02	0.00 E+00
Exposed produce			0.00 E+00	
Unexposed produce			0.00 E+00	
Meat			0.00 E+00	
Milk			0.00 E+00	
Eggs			0.00 E+00	
Fish and seafood			0.00 E+00	
Household soil			4.89 E-07	4.73 E-06
Swimming wtr			0.00 E+00	0.00 E+00

Dose ratios	Inh-dose/Ns	Ing-dose/Ns	drml-dose/Ns	Inh-dose/Nq	Ing-dose/Nq	drml-dose/Nq
	3.9 E-10	1.3 E-08	1.2 E-07	0.0 E+00	2.8 E-08	0.0 E+00

Time (y)	Total inhalation dose	Total ingestion dose	Total dermal dose	Total dose	Total dose from root soil	Total dose from ground water
0	8.2 E-09	2.6 E-07	2.6 E-06	2.8 E-06	2.8 E-06	1.0 E-13
0.4	8.2 E-09	2.6 E-07	2.6 E-06	2.8 E-06	2.8 E-06	1.0 E-13
0.8	8.2 E-09	2.6 E-07	2.6 E-06	2.8 E-06	2.8 E-06	1.0 E-13
1.2	8.2 E-09	2.6 E-07	2.6 E-06	2.8 E-06	2.8 E-06	1.0 E-13
1.6	8.2 E-09	2.6 E-07	2.6 E-06	2.8 E-06	2.8 E-06	1.0 E-13
2	8.2 E-09	2.6 E-07	2.6 E-06	2.8 E-06	2.8 E-06	1.0 E-13
2.4	8.2 E-09	2.6 E-07	2.6 E-06	2.8 E-06	2.8 E-06	1.0 E-13
2.8	8.2 E-09	2.6 E-07	2.6 E-06	2.8 E-06	2.8 E-06	1.0 E-13
3.2	8.2 E-09	2.6 E-07	2.6 E-06	2.8 E-06	2.8 E-06	1.0 E-13
3.6	8.2 E-09	2.6 E-07	2.6 E-06	2.8 E-06	2.8 E-06	1.0 E-13
4	8.2 E-09	2.6 E-07	2.6 E-06	2.8 E-06	2.8 E-06	1.0 E-13
Cumulative doses				0.004137388		
over ED by route, mg/kg	1.2 E-05	3.9 E-04	3.7 E-03	4.1 E-03	4.1 E-03	1.5 E-10
fraction	0.0029	0.0935	0.9036	1.0000	1.000	0.000
Average doses						
over ED by route, mg/kg-	8.2 E-09	2.6 E-07	2.6 E-06	2.8 E-06	2.8 E-06	1.0 E-13
Maximum doses						
over ED by route, mg/kg-	8.2 E-09	2.6 E-07	2.6 E-06	2.8 E-06	2.8 E-06	1.0 E-13
fraction	0.0029	0.0935	0.9036	1.0000	1.000	0.000

Max breast-milk dose	0.0 E+00	mg/kg-d	Max_ing	2.6 E-07

Off-site 1-h max X/Q (mol/m3-s)	2.0 E-01
Off-site Long-term X/Q	1.6 E-02
On-site Long-term X/Q	2.2 E-02
Off-site air dilution factor	1.0 E+00

Off-site pseudo Sa =	5.2 E-07 mol/day
bbb2 =	3.9 E-10
bbb3 =	2.5 E-05
bbb4 =	4.2 E-03
bbb5 =	4.0 E-06

			fugacity off-site	**fugacity on-site**	
Off-site air concentration (gases)	8.4 E-11	**mg/m3**	7.9 E-13	7.9 E-13	air
Off-site concentration (particles)	2.8 E-08	**mg/m3**			
Off-site surface-water concentrtn.	1.9 E-09	**mg/L**	6.8 E-13	2.2 E-12	water
Off-site surface soil concentration	4.0 E-04	**mg/kg**	2.0 E-11	3.4 E-10	ground soil
Off-site root-soil concentration	2.2 E-04	**mg/kg**	1.1 E-11	5.3 E-08	root soil

Off-site ground-water dilution	**0**

w	erf(w)
0.0 E+00	0.0 E+00
Dispsn redctn	1.0 E+00
decay reductn	1.0 E+00

On-site aquifer dilution zone	d_v into q	2.6 E-03 m
Darcy velocly of water	v_darc	1.0 E-01 m/d
Contaminant velocity	Vc	1.9 E-06 m/d
Trnsvrs. disprsn. coeff. (water)	D_T	5.0 E-02 m2/d
Trnsvrs. disprsn. coeff. (chem)	D_Tc	9.5 E-07 m2/d
Dispersion depth	dzz	3.0 m
Thickness of aquifer	d_q	3 m
Transverse dispersivity (chem)	alpha_t	5.0 E-01 m
Width of the contaminated area	Y	32 m
Distrance to off-site location	X	0 m

Calculated Properties

fugacity capacity of pure air	4.18 E-04	Zair		
fugacity capacity of pure water	1.09 E+01	Zwater		
height of the air compartment (m)	3.49 E+00	d_a		
Plant-root volume frctn (m3(plnts)/m3(sl))	2.68 E-03	pr_vol		
evapotranspiration of water from soil (m/d)	7.62 E-04	evapotran	2.78 E-01	m/y
transpiration of water from plants (m/d)	9.15 E-04	transpire	3.34 E-01	m/y
Total surface water runoff (m/d)	7.05 E-04	outflow	2.57 E-01	m/y
bndry lyr thickness in air above wtr (m)	3.44 E-03	del_aw		
bndry lyr thickness in wtr below air (m)	2.19 E-04	del_wa		
diffusion length in surface soil (m)	5.78 E-04	del_g		
diffusion length in upper soil (m)	4.88 E-05	del_s		
Thickness of the root-zone soil layer	3.00 E+00	d_s		
wtr-side bndry lyr thickness with sed (m)	2.00 E-02	del_wd		
sed-side bndry lyr thickness with wtr (m)	2.36 E-05	del_dw		
Initial concentration in soil (mol/m3)	7.34E-03	Cs0		
Initial conc. in the vadose zone (mol/m3)	6.89E-03	Cv0		
Sediment resuspension rate (kg/m2-d)	1.05E+01	resuspend		
soil particle density; surface layer(kg/m3)	2650	rhos_g		
soil particle density; vadose layer(kg/m3)	2650	rhos_v		
Initial iventory in groundwater zone	0	Nq0		
diffusion lag time in skin (h)	1.03 E+03	tlag		
Skin/water partition coefficient	2.96 E+04	Km		
Reaction rate constant in air (1/d)	10.96519	Ra		
Reaction rate constant, ground soil (1/d)	0.0030311	Rg		
Reaction rate constant, root-zone soil (1/d)	2.949E-08	Rs		
Reaction rate constant, vadose-zone soil (1/d)	2.251E-07	Rv		
Reaction rate constant, ground water (1/d)	2.986E-09	Rq		
Reaction rate constant, surface water (1/d)	0.2965683	Rw		
Reaction rate constant, sediment (1/d)	7.002E-10	Rd		

Continuous source term to air (mol/d)	0.00E+00	Sa		
Fraction deposited matrl intercepted by vegtn	0.9996063	IntrcptV		
Net trnfr, phloem soltn frm plnts to roots (m/d)	0.0002	Phlm-flow		
Boundary layer thickness of soil on plant (m)	0.000005	del_slyr		
depth of plants compartment in m	0.0073067	d_p		
Leaf area index m2 leaves/m2 land	15.6	LAI		
Dry depsoition velocity of particles m/d	334	Vdep		

Warnings

0 Ground soil depth greater than 2 cm
0 Root-zone soil too shallow for accuracy of diffusion model (must be at least 1.4*del_s)
1 Starting time cannot be 0 and should be greater than 365 day
0 Recharge velocity is negative
0 Recharge velocity is too large accuracy of model
0 Concentration in root-zone soil-water <0 or exceeds solubility when there are non-zero sources
0 Concentration in vadose-zone soil-water <0 or exceeds solubility when there are non-zero sources
0 Concentration in groundwater exceeds solubility or < 0
0 Concentration in surface water exceeds solubility
0 Concentration in sediment-zone water exceeds solubility
0 Exposure time indoors and outdoors at home or at work exceeds 24 h
0 Risk from breast milk exposure is large compared to other ingestion pathways
0 Hazard from breast milk exposure is large compared to other ingestion pathways
0 Fraction of water from groundwater plus fraction from surface >1
1 total

Fugacity (Pa)

Air	fa	7.95E-13
Plants	fp	7.41E-12
Ground	fg	3.42E-10
Root	fs	5.26E-08
Vadose	fv	6.47E-07
Water	fw	2.22E-12
Sediment	fd	2.22E-12
Groundwater	fq	2.12E-15

Compartment Volumes (m^3)

Va	3.5 E+03	Air compartment
Vpp	7.3 E+00	Plants compartment
Vg	9.5 E+00	Ground-soil compartment
Vs	2.9 E+03	Root-zone compartment
Vv	3.2 E+04	Vadose compartment volume
Vw	2.4 E+02	Water compartment
Vd	2.4 E+00	Sediment compartment
Vq	3.0 E+03	aquifer compartment

Fugacity Capacities (mol/m^3 per Pa)

Zap	3.75E+07	fugacity capacity of air particles in mol/m3(s)-Pa
Zgp	2.15E+05	fugacity capacity of ground soil compartment particles in mol/m3(s)-Pa
Zsp	2.15E+05	fugacity capacity of root zone compartment particles in mol/m3(s)-Pa
Zvp	1.94E+04	fugacity capacity of vadose zone compartment particles in mol/m3(s)-Pa
Zwp	2.29E+06	fugacity capacity of suspended sediment in surface water in mol/m3(s)-Pa
Zdp	2.29E+06	fugacity capacity of bottom sediment particles in mol/m3(s)-Pa
Zqp	7.17E+05	fugacity capacity of aquifer solids in mol/m3-Pa
Zpr	**1.04E+03**	**fugacity capacity of plant roots**
Zphl	**9.78E+00**	**fugacity capacity of phloem**
Za	1.42E-01	fugacity capacity of air compartment in mol/m3-Pa
Zp	**5.93E+05**	**fugacity capacity of above-ground plant biomass**
Zg	1.35E+05	fugacity capacity of ground soil compartment in mol/m3-Pa
Zs	**1.40E+05**	fugacity capacity of root-soil compartment in mol/m3-Pa
Zv	1.06E+04	fugacity capacity of vadose-zone compartment in mol/m3-Pa
Zw	8.70E+01	fugacity capacity of water compartment in mol/m3-Pa
Zd	1.83E+06	fugacity capacity of sediment compartment in mol/m3-Pa
Zq	5.73E+05	fugacity capacity of aquifer compartment in mol/m3-Pa

Diffusion coefficients in m2/d				Boundary-layer thickness (del)	Fugacity mass-transfer coefficients mol/Pa-m2-d Y		Overall intercompartment mass transfer rate constants (1/day) T			
Compartment Phase		Compartment			one-sided	both-sides	Diffusion	Advection	Total	Compartment Interf
Dair	4.36E-01	Da	1.28E-03	3.44E-03	5.29E-02	5.18E-02	4.92E-03	9.28E+00	9.28 E+00	air-water, T_aw
Dwater	5.26E-05	Dw	6.57E-06	2.19E-04	2.61E+00		1.19 E-04	0	1.19 E-04	water-air, T_wa
Dair_g	2.77E-02	Dg	1.20E-10	5.00E-03	1.24E+01	2.80E-02	5.40E-02	1.88E+02	1.88 E+02	air-ground, T_ag
Dwater_	4.32E-07			5.78E-04	2.81E-02		2.08E-05	4.15E-04	4.36 E-04	ground-air, T_ga
Dair_s	2.42E-02	Ds	1.05E-10	5.78E-04	2.81E-02	2.57E-02	1.91E-05	6.61E-08	1.91 E-05	ground-soil, T_gs
Dwater_	4.24E-07			4.88E-05	3.01E-01		6.14E-08	0	6.14 E-08	soil-ground, T_sg
Dair_v	5.86E-03	Dv	4.04E-09	4.88E-05	3.01E-01	5.88E-02		2.13E-10	2.13 E-10	soil-vadose, T_sv
Dwater_	3.73E-06			5.89E-04	7.30E-02			2.46E-10	2.46 E-10	vadose-aquifer, T_vq
Dwater_	6.15E-06	Dd	3.64E-11	2.00E-02	2.29E-01	2.12E-01	4.87E-04	2.09E+01	2.09 E+01	water-sediment, T_w
				2.36E-05	2.83E+00		2.31E-06	9.89E-02	9.89 E-02	sediment-water, T_d
r_stom	1.26E-02			5.00E-03	3.64E-02	3.59E-02	2.18E+00	9.55E+01	9.76 E+01	air-plants, T_ap
				5.00E-06	2.94E+00		2.49E-04	1.09E-02	1.12 E-02	plants-air, T_pa
								2.50E-05	2.50 E-05	sediment-out, T_do
								1.09E+03	1.09 E+03	air-out, T_ao
								5.56E-03	5.56 E-03	plants-ground, T_pg
								4.52E-07	4.52 E-07	plants-soil, T_ps
								0	0.00 E+00	ground-plants, T_gp
								2.32E-05	2.32 E-05	ground-water, T_gw
								2.37E-08	2.37 E-08	soil-plants, T_sp
								3.00E-03	3.00 E-03	water-out, T_wo

r_stom	Resistance to mass transfer accross the stomata (
2.065	Diffusion coefficient of water vapor in air m2/d
2.66E-03	stomatal resistance to water vapor in d/m

aaa1	3.04E+01	bbb1	0.00E+00
aaa2	7.61E-05	bbb2	0.00E+00
aaa3	3.27E-07	bbb3	0.00E+00
aaa4	1.19E-11	**bbb4**	**0.00E+00**
aaa5	2.09E-05	bbb5	0.00E+00
aaa6	2.10E+01		
aaa7	2.23E+02		
aaa8	4.03E-02	Lam1	1.14E-07

Source term (g/d)

air	0.0 E+00	
ground	0.0 E+00	
water	0.0 E+00	

Compartment Name		Loss-rate constant (1/day) L	Total Inventory (moles) N	Concen-tration (mol/m3) C	Mass distri-bution %	Gains g/d	Losses g/d	Residence Time (days)
air	a	1.40 E+03	3.9 E-10	1.1 E-13	0.00%	1.39 E-04	1.39E-04	7.16 E-04
plants	p	1.67 E-02	3.2 E-05	4.4 E-06	0.00%	1.35 E-04	1.35E-04	5.98 E+01
ground-soil	g	3.51 E-03	4.4 E-04	4.6 E-05	0.00%	3.89 E-04	3.89E-04	2.85 E+02
root-soil	s	1.15 E-07	2.1 E+01	7.3 E-03	8.60%	2.12 E-06	6.08E-04	8.71 E+06
vadose-zone	v	2.25 E-07	2.2 E+02	6.9 E-03	91.40%	1.13 E-06	1.27E-02	4.44 E+06
surface water	w	2.12 E+01	4.5 E-08	1.9 E-10	0.00%	2.43 E-04	2.43E-04	4.72 E-02
sediment	d	9.90 E-02	9.6 E-06	4.1 E-06	0.00%	2.39 E-04	2.39E-04	1.01 E+01
aquifer	q	1.51 E-02	3.6 E-06	1.2 E-09	0.00%	1.39 E-05	1.39E-05	6.64 E+01

Mass Flows (g/d)

air-ground	1.87 E-05	Tag*Na*MW
air-water	9.21 E-07	Taw*Na*MW
air-out	1.08 E-04	Tao*Na*MW
air-plants	9.70 E-06	Tap*Na*MW
air-transform	1.09 E-06	Ra*Na*MW
plants-air	9.04 E-05	Tpa*Np*MW
plants-ground	4.50 E-05	Tpg*Np*MW
plants-soil	3.66 E-09	Tps*Np*MW
plants-trnsfrm	0.00 E+00	
ground-air	4.83 E-05	Tga*Ng*MW
ground-plants	0.00 E+00	Tgp*Ng*MW
ground-soil	2.12 E-06	Tgs*Ng*MW
ground-water	2.57 E-06	Tgw*Ng*MW
ground-trnsfrm	3.36 E-04	Rg*Ng*MW

soil-ground	3.25 E-04	
soil-plants	1.26 E-04	
soil-vadose	1.13 E-06	
soil-trnsfrm	1.56 E-04	
vadose-aquifer	1.39 E-05	
vadose-trnsfrm	1.27 E-02	
aquifer-removal	1.39 E-05	
water-air	1.36 E-09	
water-sediment	2.39 E-04	
water-out	3.44 E-08	
water-trnsfrm	3.40 E-06	
sediment-water	2.39 E-04	
sedmnt-trnsfrm	1.69 E-12	
sediment-out	6.04 e-08	

Time-dependent Compartment Inventories

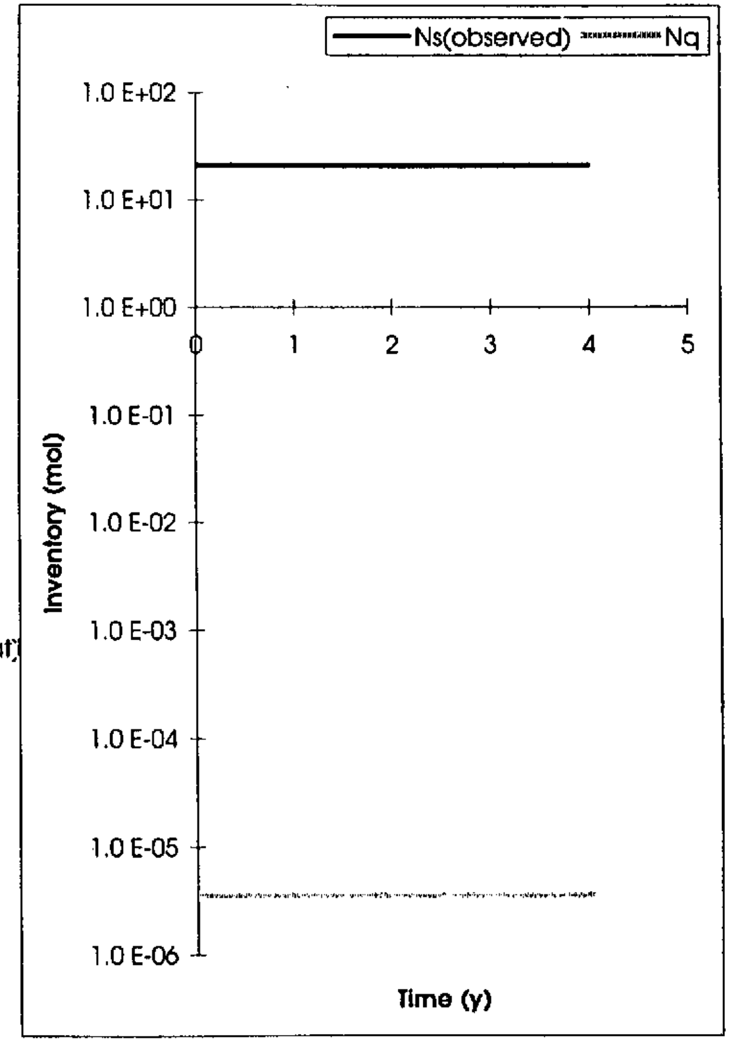
Time (y)	Time (d)	Ns(observed	Plot Nq
0	0	2.1 E+01	3.6 E-06
0.4	146	2.1 E+01	3.6 E-06
0.8	292	2.1 E+01	3.6 E-06
1.2	438	2.1 E+01	3.6 E-06
1.6	584	2.1 E+01	3.6 E-06
2	730	2.1 E+01	3.6 E-06
2.4	876	2.1 E+01	3.6 E-06
2.8	1022	2.1 E+01	3.6 E-06
3.2	1168	2.1 E+01	3.6 E-06
3.6	1314	2.1 E+01	3.6 E-06
4	1460	2.1 E+01	3.6 E-06

Ns(0)(total)
2.1 E+01

const_sat
-4.3156E-05

Ns(sat)
3.8E+02

t*	Ns(@Ns>=Nsat)	Ns(total)	Nv(@Ns=sat
0	2.10 E+01	2.1E+01	2.2E+02
0	2.10 E+01	2.1E+01	2.2E+02
0	2.10 E+01	2.1E+01	2.2E+02
0	2.10 E+01	2.1E+01	2.2E+02
0	2.10 E+01	2.1E+01	2.2E+02
0	2.10 E+01	2.1E+01	2.2E+02
0	2.10 E+01	2.1E+01	2.2E+02
0	2.10 E+01	2.1E+01	2.2E+02
0	2.10 E+01	2.1E+01	2.2E+02
0	2.10 E+01	2.1E+01	2.2E+02
0	2.10 E+01	2.1E+01	2.2E+02



CalTOX™ 2.3 (beta): Eight-Compartment Multimedia Exposure Model

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Inputs:

Chemical name==>	Benzo(a)pyrene	
Site name ====>	SFO Temporary Construction	
Toxicity Data ==>	Cancer potencies 1/(mg/kg-d)	Non-cancer ADIs (mg/kg-d)
Inhalation	3.9 E+00	0
Ingestion	1.2 E+01	0
Dermal	1.2 E+01	0
Total dose		0
	Risk	Hazard quotient
Target Risk/Hazard =	1.0 E-05	1.00
	current value	should be >
Root-soil thickness ===>	3	OK
Alter root soil thickness to?	n/a	
Distance off-site for air exposure=	0.0 E+00	meters
Time after initial concentrations when exposure begins =	0.0 E+00	days

Measured Concentrations (at time = 0)

Root-zone soil	1	ppm (mg/kg)
Vadose-zone soil	1	ppm (mg/kg)
Ground water	0.001	ppm (mg/L)

Continuous Inputs

Source term to air (mol/d)	0.0 E+00	Sa
Source term to ground-surface soil (mol/d)	0.0 E+00	Sg
Source term to root-zone soil (mol/d)	0.0 E+00	Ss
Source term to surface water(mol/d)	0.0 E+00	Sw

Outputs: See Warnings Please

Target Soil Concentrations (in ppm)

Based on cancer risk:

Root soil	6.5 E+0	
Vadose soil	1.0 E+5	>conc limit

Root Soil	6.5 E+0
Vadose soil	1.0 E+5

Based on hazard:

Root soil	0.0 E+0	not avlbl.
Vadose soil	0.0 E+0	not avlbl.

Un-mitigated risk and/or hazard ratio

Risk	1.5 E-6	
Hazard ratio	0.0 E+0	

Concentration limits without NAPL

Root soil	1.8 E+01	mg/kg solid
Vadose soil	1.5 E+00	mg/kg solid
	2.6 E-03	mg/L water

Time avrg. Conc. in on-site environmental media

Air	1.1 E-08	mg/m3
Plants	2.4 E-03	mg/kg(FM)
Grnd-surface soil	7.7 E-03	mg/kg(total)
Root-zone soil	1.0 E+00	mg/kg(total)
Vadose-zone soil	1.0 E+00	mg/kg(total)
Ground water	5.8 E-12	mg/L(water)
Surface water	4.8 E-08	mg/L
Sediment	4.4 E-04	mg/kg

Chemical properties

0.00297 0.003 1 8.5 E+01

ompound name	Benzo(a)pyrene	Value used	Mean value	Coeff. Var.	Adjustment	Notes
Molecular weight (g/mol)	MW	2.52 E+02	2.52 E+02	0.0090271	1	
Octanol-water partition coefficient	Kow	2.20 E+06	2.20 E+06	0.7243531	1	
Melting point (K)	Tm	4.51 E+02	4.51 E+02	0.028	1	
Vapor Pressure in (Pa)	VP	7.13 E-07	7.13 E-07	0.067586	1	
Solubility in mol/m3	S	1.03 E-05	1.03 E-05	0.6322445	1	
Henry's law constant (Pa-m^3/mol)	**H -**	9.20 E-02	0.092	1	1	
Diffusion coefficient in pure air (m2/d)	Dair	4.36 E-01	4.36 E-01	0.08	1	5.04 E-06
Diffusion coefficient; pure water (m2/d)	Dwater	5.26 E-05	5.26 E-05	0.25	1	6.09 E-10
Organic carbon partition coefficient Koc	**Koc -**	2.49 E+06	2488414.062	0.9062255	1	m^2/s
Partition coefficient in ground/root soil layer	**Kd_s -**	7.47 E+03	-99	0.1	1	
Partition coefficient in vadose-zone soil layer	**Kd_v -**	6.72 E+02	-99	0.1	1	
Partition coefficient in aquifer layer	**Kd_q -**	2.49 E+04	-99	0.1	1	
Partition coeffic. in surface wtr sediments	**Kd_d -**	7.96 E+04	-99	0.1	1	
Prtn cff. plnt(abv-grd)/sl (kg(s)/kg(pFM))	**Kps -**	1.55 E-02	0.015464386	1	1	
Biotrnsfr fctr, plant/air (m3(a)/kg(pFM))	**Kpa -**	5.92 E+05	591675.1923	14	1	
Biotransfer factor; cattle-diet/milk (d/L)	**Bk -**	8.85 E-03	0.008848659	10.77033	1	
Biotransfer factor; cattle-diet/meat (d/L)	**Bt -**	2.93 E-02	0.029321969	12.589678	1	
Biotransfer factor; hen-diet/eggs (d/L)	**Be -**	1.75 E+01	17.45376954	14	1	
Biotrnsfr fctr; brst mlk/mthr intake (d/kg)	**Bbmk -**	4.39 E-01	0.43945988	10	1	
Bioconcentration factor; fish/water	**BCF -**	3.29 E+02	328.6666667	0.4084036	1	
Skin permeability coefficient; cm/h	**Kp_w -**	1.20 E-02	0.011974979	2.4	1	
Fraction dermal uptake from soil	**dfct_sl-**	1.00 E+00	29611.52573	0.27	1	
Reaction half-life in air (d)	Thalf_a	6.32 E-02	6.3 E-02	1	1	
Reaction half-life in surface soil (d)	Thalf_g	2.29 E+02	2.3 E+02	1.1	1	
Reaction half-life in root-zone soil (d)	Thalf_s	2.29 E+02	2.3 E+02	1.2	1	
Reaction half-life in vadose-zone soil (d)	Thalf_v	8.80 E+02	8.8 E+02	1	1	
Reaction half-life in ground water (d)	Thalf_q	8.80 E+02	8.8 E+02	1.3	1	
Reaction half-life in surface water (d)	Thalf_w	2.34 E+00	2.3 E+00	1.2	1	
Reaction half-life in sediments (d)	Thalf_d	1.17 E+03	1.2 E+03	1.4	1	

Landscape properties

site name	SFO Temporary Construction	Value used	Mean value	Coeff. Var.	Adjustment	Notes
contaminated area in m2	Area	1.00 E+03	1.00 E+03	0.1	1	(m/y)
annual average precipitation (m/d)	rain	1.48 E-03	1.48 E-03	0.55	1	5.40 E-01
flux; surface water into landscape (m/d)	inflow	0.00 E+00	0.00 E+00	0.1	1	0.00 E+00
land surface runoff (m/d)	runoff	6.40 E-04	6.40 E-04	0.55	1	2.34 E-01
atmospheric dust load (kg/m3)	rhob_a	1.00 E-06	1.00 E-06	0.64	1	
deposition velocity of air particles (m/d)	v_d	6.90 E+02	6.90 E+02	1.5	1	
plant dry mass inventory (kg(DM)/m2)	bio_inv	2.80 E+00	2.80 E+00	1.05	1	
plant dry-mass fraction	bio_dm	2.20 E-01	2.20 E-01	0.4	1	
plant fresh-mass density kg/m^3	rho_p	8.30 E+02	8.30 E+02	0.2	1	
ground-water recharge (m/d)	recharge	8.20 E-06	8.20 E-06	0.55	1	2.99 E-03
evaporation of water from surface wtr (m/d)	evaporate	4.38 E-06	4.38 E-06	1	1	
thickness of the ground soil layer (m)	d_g	1.00 E-02	1.00 E-02	1	1	
soil particle density (kg/m3)	rhos_s	2.65 E+03	2.65 E+03	0.05	1	
water content in surface soil (vol fraction)	beta_g	1.31 E-01	1.31 E-01	0.24	1	
air content in the surface soil (vol frctn)	alpha_g	2.42 E-01	2.42 E-01	0.29	1	cm/y
erosion of surface soil (kg/m2-d)	erosion_g	3.00 E-04	3.00 E-04	0.2	1	0.0064099
thickness of the root-zone soil (m)	d_s	3.00 E+00	3.00 E+00	0.49	1	
water content of root-zone soil (vol. frctn.)	beta_s	1.25 E-01	1.25 E-01	0.3	1	
air content of root-zone soil (vol. frctn.)	alpha_s	2.23 E-01	2.23 E-01	0.31	1	
thickness of the vadose-zone soil (m)	d_v	3.40 E+01	3.40 E+01	0.56	1	
water content; vadose-zone soil (vol. frctn.)	beta_v	2.80 E-01	2.80 E-01	0.2	1	
air content of vadose-zone soil (vol. frctn.)	alpha_v	1.70 E-01	1.70 E-01	0.2	1	
thickness of the aquifer layer (m)	d_q	3.00 E+00	3.00 E+00	0.3	1	
solid material density in aquifer (kg/m3)	rhos_q	2.65 E+03	2.65 E+03	0.05	1	
porosity of the aquifer zone	beta_q	2.00 E-01	2.00 E-01	0.2	1	
fraction of land area in surface water	f_arw	4.70 E-02	4.70 E-02	1.57	1	
average depth of surface waters (m)	d_w	5.00 E+00	5.00 E+00	1.58	1	
suspended sedmnt in surface wtr (kg/m3)	rhob_w	8.80 E-02	8.80 E-02	1	1	

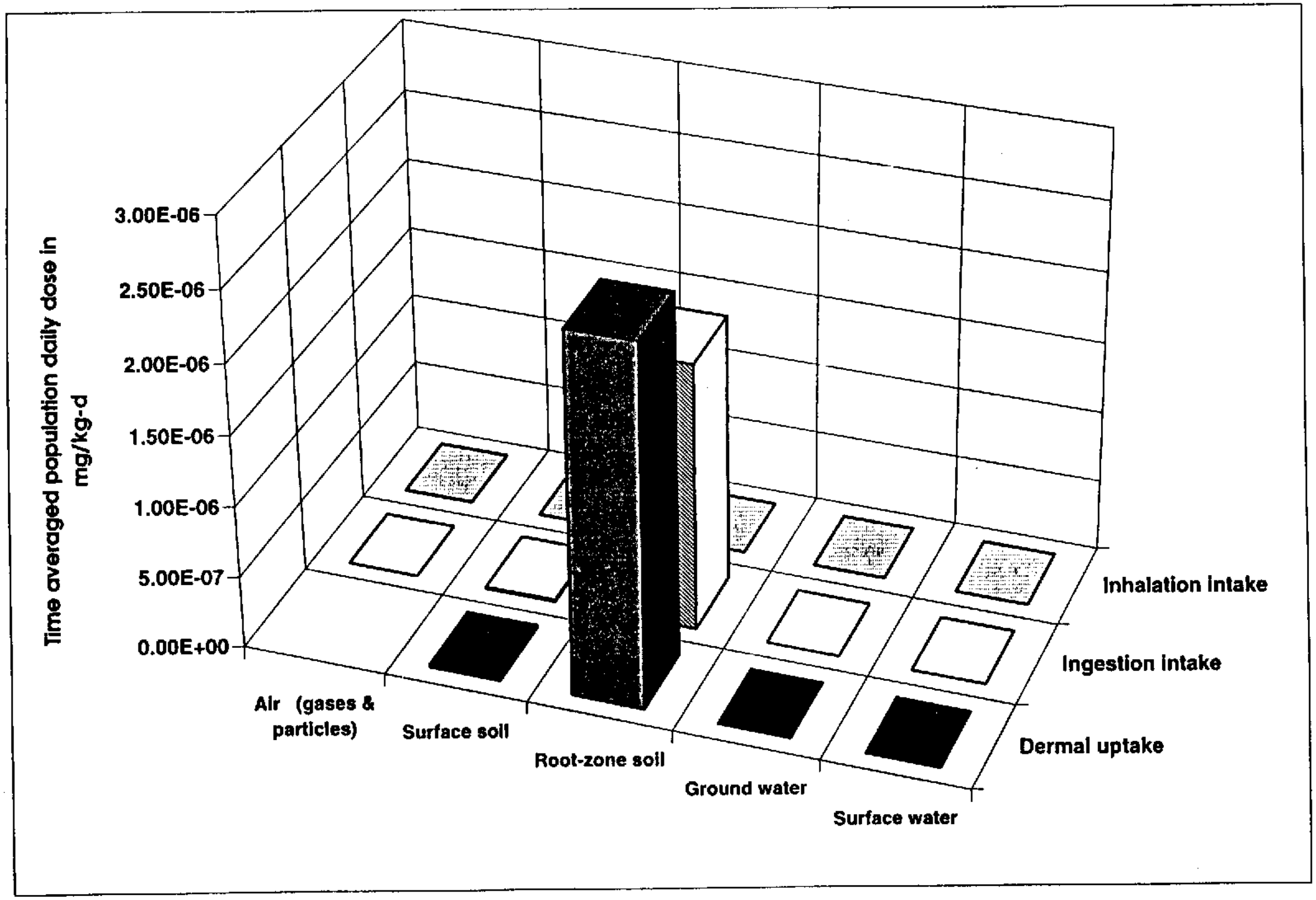
Landscape properties (continued)

site name	SFO Temporary Construction	Value used	Mean value	Coeff. Var.	Adjustment	Notes
suspended sdmnt deposition (kg/m2/d)	deposit	1.05 E+01	1.05 E+01	0.3	1	(m/s)
thickness of the sediment layer (m)	d_d	5.00 E-02	5.00 E-02	1	1	
solid material density in sediment (kg/m3)	rhos_d	2.65 E+03	2.65 E+03	0.05	1	
porosity of the sediment zone	beta_d	2.00 E-01	2.00 E-01	0.2	1	m/y
sediment burial rate (m/d)	bury_d	1.00 E-06	1.00 E-06	5	1	3.65 E-04
ambient environmental temperature (K)	Temp	2.88 E+02	2.88 E+02	0.01	1	(m/s)
Surface water current in m/d	current_w	0.00 E+00	0.00 E+00	1	1	0.00 E+00
organic carbon fraction in upper soil zone	foc_s	3.00 E-03	3.00 E-03	0.37	1	
organic carbon fraction in vadose zone	foc_v	2.70 E-04	2.70 E-04	1.4	1	
organic carbon fraction in aquifer zone	foc_q	1.00 E-02	1.00 E-02	1	1	
organic carbon fraction in sediments	foc_d	3.20 E-02	3.20 E-02	0.84	1	
bndry lyr thickness in air above soil (m)	del_ag	5.00 E-03	5.00 E-03	0.2	1	(m/s)
yearly average wind speed (m/d)	v_w	1.50 E+05	1.50 E+05	0.67	1	1.74 E+00
distance to first well (m)	d_well	0.00 E+00	0.00 E+00		1	
Darcy veleocity (m/d)	v_darc	1.00 E-01	1.00 E-01		1	
water dispersion coeff. (m2/d)	D_T	5.00 E-02	5.00 E-02		1	

(General Construction) Exposure Factors		Value used	Mean value	Coeff. Var.	Adjustment	Notes
Body weight (kg)	BW	7.00 E+01	7.00 E+01	0.2	1	
Surface area (m2/kg)	SAb	4.60 E-03	4.60 E-03	0.07	1	
Active breathing rate (m3/kg-h)	BRa	3.60 E-02	3.60 E-02	0.3	1	
Resting breathing rate (m3/kg-h)	BRr	6.40 E-03	6.40 E-03	0.2	1	
Fluid intake (L/kg-d)	Ifl	2.20 E-02	2.20 E-02	0.2	1	
Fruit and vegetable intake (kg/kg-d)	Ifv	4.90 E-03	4.90 E-03	0.2	1	
Grain intake (kg/kg-d)	Ig	3.70 E-03	3.70 E-03	0.2	1	
Milk intake (kg/kg-d)	Imk	6.50 E-03	6.50 E-03	0.2	1	
Meat intake (kg/kg-d)	Imt	3.00 E-03	3.00 E-03	0.2	1	
Egg intake (kg/kg-d)	Iegg	4.60 E-04	4.60 E-04	0.3	1	
Fish intake (kg/kg-d)	Ifsh	2.90 E-04	2.90 E-04	0.4	1	
Soil ingestion (kg/kg-d)	Isl	3.50 E-06	3.50 E-06	3	1	
Breast milk ingestion by infants (kg/kg-d)	Ibm	1.10 E-01	1.10 E-01	0.2	1	
Inhalation by cattle (m3/d)	Inc	1.22 E+02	1.22 E+02	0.3	1	
Inhalation by hens (m3/d)	Inh	2.20 E+00	2.20 E+00	0.3	1	
Ingestion of pasture, dairy cattle (kg(FM)/d)	Ivdc	8.50 E+01	8.50 E+01	0.2	1	
Ingestion of pasture, beef cattle (kg(FM)/d)	Ivbc	6.00 E+01	6.00 E+01	0.4	1	
Ingestion of pasture by hens (kg(FM)/d)	Ivh	1.20 E-01	1.20 E-01	0.04	1	
Ingestion of water by dairy cattle (L/d)	Iwdc	3.50 E+01	3.50 E+01	0.2	1	
Ingestion of water by beef cattle (L/d)	Iwbc	3.50 E+01	3.50 E+01	0.2	1	
Ingestion of water by hens (L/d)	Iwh	8.40 E-02	8.40 E-02	0.1	1	
Ingestion of soil by cattle (kg/d)	Isc	4.00 E-01	4.00 E-01	0.7	1	
Ingestion of soil by hens (kg/d)	Ish	1.30 E-05	1.30 E-05	1	1	
Fraction of water needs from ground water	fw_gw	8.00 E-01	8.00 E-01	0.1	1	
Fraction of water needs from surface water	fw_sw	2.00 E-01	2.00 E-01	0.1	1	
Frctn irrgtn wtr contamnnts trnsfrd to soil	f_ir	2.50 E-01	2.50 E-01	1	1	
Frctn frts & vgtbls that are exposed produce	fabv_grd_v	4.70 E-01	4.70 E-01	0.1	1	
Fraction of fruits and vegetables local	flocal_v	2.40 E-01	2.40 E-01	0.7	1	
Fraction of grains local	flocal_g	1.20 E-01	1.20 E-01	0.7	1	

Human Exposure Factors (continued)		Value used	Mean value	Coeff. Var.	Adjustment	Notes
Fraction of milk local	flocal_mk	4.00 E-01	4.00 E-01	0.7	1	
Fraction of meat local	flocal_mt	4.40 E-01	4.40 E-01	0.5	1	
Fraction of eggs local	flocal_egg	4.00 E-01	4.00 E-01	0.7	1	
Fraction of fish local	flocal_fsh	7.00 E-01	7.00 E-01	0.3	1	
Plant-air prttn fctr, particles, m3/kg(FM)	Kpa_part	3.30 E+03	3.30 E+03	1.8	1	
Rainsplash (mg/kg(plnt FM))/(mg/kg(soil))	rainsplash	3.40 E-03	3.40 E-03	1	1	
Water use in the shower (L/min)	Wshower	8.00 E+00	8.00 E+00	0.4	1	
Water use in the House (L/h)	Whouse	4.00 E+01	4.00 E+01	0.4	1	
Room ventilation rate, bathroom (m3/min)	VRbath	1.00 E+00	1.00 E+00	0.4	1	
Room ventilation rate, house (m3/h)	VRhouse	7.50 E+02	7.50 E+02	0.3	1	
Exposure time, in shower or bath (h/day)	ETsb	2.70 E-01	2.70 E-01	0.6	1	
Exposure time, active indoors (h/day)	ETai	0.00 E+00	0.00 E+00	0.14	1	
Exposure time, outdoors at work (h/day)	ETao	8.00 E+00	8.00 E+00	0.14	1	
Exposure time, indoors resting (h/day)	ETri	0.00 E+00	0.00 E+00	0.04	1	
Indoor dust load (kg/m^3)	dust_in	3.00 E-08	3.00 E-08	0.4	1	
Exposure frequency to soil on skin, (d/y)	EFsl	2.50 E+02	2.50 E+02	0.6	1	
Soil adherence to skin (mg/cm^2)	Slsk	5.00 E-01	5.00 E-01	0.4	1	
Ratio of indoor gas conc. to soil gas conc.	alpha_inair	1.00 E-04	1.00 E-04	2	1	
Exposure time swimming (h/d)	ETsw	5.00 E-01	5.00 E-01	0.5	1	
Exposure frequency, swimming (d/y)	EFsw	1.50 E+01	1.50 E+01	4	1	
Water ingestion while swimming (L/kg-h)	Isww	7.00 E-04	7.00 E-04	1	1	
Exposure duration (years)	ED	2.00 E+00	2.00 E+00	1.15	1	
Averaging time (days)	AT	2.56 E+04	2.56 E+04	0.1	1	

Constants		
Gas Constant (Pa-m^3/mol-K)	8.31E+00	Rgas


Time averaged population daily dose in mg/kg-d
3.00E-06
2.50E-06
2.00E-06
1.50E-06
1.00E-06
5.00E-07
0.00E+00
Air (gases & particles)
Surface soil
Root-zone soil
Ground water
Surface water
Inhalation intake
Ingestion intake
Dermal uptake

Exposure Pathway-Include-and-Exclude Toggles

All inhalation exposures indoors active	0	Contaminant transfer, air to plants surfaces	0
All inhalation exposures indoors resting	0	ntmnnt. transfer, grnd. soil to plant surfaces	0
Inhalation exposure in shower/bath	0	ontamnnt. transfer, root soil to plant tissues	0
Inhalation exposures outdoors active	1	On-site grazing of animals	0
Inhalation of air particles indoors	0		
Transfer of soil dust to indoor air	0	ngestion of home-grown exposed produce	0
Transfer of soil vapors to indoor air	0	estion of home-grown unexposed produce	0
On-site inhalation by animals	0	Ingestion of home-grown meat	0
		Ingestion of home-grown milk	0
Use of ground water as tap water	1	Ingestion of home-grown eggs	0
Use of surface water as tap water	0	Ingestion of locally caught fish	0
Ingestion of tap water	1	Direct soil ingestion	1
Use of ground water for irrigation	0	Soil contact exposure at home or at work	1
Use of surface water for irrigation	0	Dermal exposure during shower/bath	0
		Dermal & ingstn exposures while swimming	0
Use of ground water for feeding animals	0		
Use of surface water for feeding animals	0	Breast-milk ingestion by infants	0

To return to the **CalTOX** Flowchart press the [X] button on the toolbar

MEDIA AND CORRESPONDING POTENTIAL DOSES IN mg/kg-d (averaged over the exposure duration)

PATHWAYS	Air (gases & particles)	Surface soil	Root-zone soil	Ground water	Surface water	Totals	%
INHALATION	3.30E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**3.30E-09**	0.07
INGESTION:							
Water				1.02E-13	0.00E+00	1.02E-13	0.00
Exposed produce	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
Unexposed produce			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
Meat	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
Milk	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
Eggs	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
Fish					0.00E+00	0.00E+00	0.00
Soil		1.46E-08	1.88E-06			1.90E-06	42.52
Total ingestion	0.00 E+00	1.46 E-08	1.88 E-06	1.02 E-13	0.00 E+00	**1.90 E-06**	42.52
DERMAL UPTAKE		1.97E-08	2.54E-06	0.00E+00	0.00E+00	**2.56 E-06**	57.41
Dose SUM	**3.30E-09**	**3.43E-08**	**4.43E-06**	**1.02E-13**	**0.00E+00**	**4.47E-06**	100.0

	Air (gases & particles)	Surface soil	Root-zone soil	Ground water	Surface water	total
Breast milk concentration	9.49 E-08	9.87 E-07	1.27 E-04	2.94 E-12	0.00 E+00	1.28 E-04
						dose_bm
Infant dose	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	**0.00 E+00**

Ingestion dose used =>	1.90 E-06
Total dose used =>	4.47 E-06

ENVIRONMENTAL Media CONCENTRATIONS	**Air (gases) mg/m^3**	**Air (dust) mg/m^3**	**Ground soil mg/kg**	**Root soil mg/kg**	**Ground wate mg/L**	**Surface water mg/L**
	3.28 E-10	**1.11 E-08**	**8.35 E-03**	**1.08 E+00**	**5.81 E-12**	**5.98 E-09**

EXPOSURE MEDIA CONCENTRATIONS (averaged over the exposure duration)

EXPOSURE	Air (gases)	Air (dust)	Ground soil	Root soil	Ground wate	Surface water
Indoor air (mg/m^3)	3.28 E-10	0.00 E+00	0.00 E+00	0.00 E+00	5.48 E-15	0.00 E+00
Bathroom air (mg/m^3)					7.04 E-13	0.00 E+00
Outdoor air (mg/m^3)	3.28 E-10	1.11 E-08				
Tap water (mg/L)					4.65 E-12	0.00 E+00
Exposed produce (mg/k	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00
Unexposed produce (mg/				0.00 E+00	0.00 E+00	0.00 E+00
Meat (mg/kg)	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00
Milk (mg/kg)	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00
Eggs (mg/kg)	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00
Fish and seafood (mg/kg)						1.97 E-06
Household soil (mg/kg)			4.17 E-03	5.38 E-01		
Swimming water (mg/L)						5.98 E-09

PATHWAY CONTACT FACTORS (CR/BW*FI)

EXPOSURE Media	Units	Inhalation	Ingestion	Dermal
Indoor air (active)		0.00 E+00		
Indoor air (resting)		0.00 E+00		
Indoor air (shower/bath)		0.00 E+00		
Outdoor air (active)		2.88 E-01		
Tap water			2.20 E-02	0.00 E+00
Exposed produce			0.00 E+00	
Unexposed produce			0.00 E+00	
Meat			0.00 E+00	
Milk			0.00 E+00	
Eggs			0.00 E+00	
Fish and seafood			0.00 E+00	
Household soil			3.50 E-06	4.73 E-06
Swimming wtr			0.00 E+00	0.00 E+00

Dose ratios	inh-dose/Ns	ing-dose/Ns	drml-dose/Ns	inh-dose/Nq	ing-dose/Nq	drml-dose/Nq
	1.6 E-10	9.0 E-08	1.2 E-07	0.0 E+00	2.8 E-08	0.0 E+00

Time (y)	Total inhalation dose	Total ingestion dose	Total dermal dose	Total dose	Total dose from root soil	Total dose from ground water
0	3.3 E-09	1.9 E-06	2.6 E-06	4.5 E-06	4.5 E-06	1.0 E-13
0.2	3.3 E-09	1.9 E-06	2.6 E-06	4.5 E-06	4.5 E-06	1.0 E-13
0.4	3.3 E-09	1.9 E-06	2.6 E-06	4.5 E-06	4.5 E-06	1.0 E-13
0.6	3.3 E-09	1.9 E-06	2.6 E-06	4.5 E-06	4.5 E-06	1.0 E-13
0.8	3.3 E-09	1.9 E-06	2.6 E-06	4.5 E-06	4.5 E-06	1.0 E-13
1	3.3 E-09	1.9 E-06	2.6 E-06	4.5 E-06	4.5 E-06	1.0 E-13
1.2	3.3 E-09	1.9 E-06	2.6 E-06	4.5 E-06	4.5 E-06	1.0 E-13
1.4	3.3 E-09	1.9 E-06	2.6 E-06	4.5 E-06	4.5 E-06	1.0 E-13
1.6	3.3 E-09	1.9 E-06	2.6 E-06	4.5 E-06	4.5 E-06	1.0 E-13
1.8	3.3 E-09	1.9 E-06	2.6 E-06	4.5 E-06	4.5 E-06	1.0 E-13
2	3.3 E-09	1.9 E-06	2.6 E-06	4.5 E-06	4.5 E-06	1.0 E-13
Cumulative doses				0.003260265		
over ED by route, mg/kg	2.4 E-06	1.4 E-03	1.9 E-03	3.3 E-03	3.3 E-03	7.5 E-11
fraction	0.0007	0.4252	0.5741	1.0000	1.000	0.000
Average doses						
over ED by route, mg/kg-	3.3 E-09	1.9 E-06	2.6 E-06	4.5 E-06	4.5 E-06	1.0 E-13
Maximum doses						
over ED by route, mg/kg-	3.3 E-09	1.9 E-06	2.6 E-06	4.5 E-06	4.5 E-06	1.0 E-13
fraction	0.0007	0.4252	0.5741	1.0000	1.000	0.000

Max breast-milk dose 0.0 E+00 mg/kg-d

Max_ing	1.9 E-06

Off-site 1-h max X/Q (mol/m3-s)	2.0 E-01
Off-site Long-term X/Q	1.6 E-02
On-site Long-term X/Q	2.2 E-02
Off-site air dilution factor	1.0 E+00

Off-site pseudo Sa =	2.2 E-07	mol/day	
bbb2 =	1.6 E-10	bbb4 =	2.2 E-03
bbb3 =	1.3 E-05	bbb5 =	2.1 E-06

			fugacity off-site	**fugacity on-site**	
Off-site air concentration (gases)	3.3 E-10	**mg/m3**	3.1 E-12	3.1 E-12	air
Off-site concentration (particles)	1.1 E-08	**mg/m3**			
Off-site surface-water concentrtn.	7.7 E-10	**mg/L**	2.8 E-13	2.2 E-12	water
Off-site surface soil concentration	2.1 E-04	**mg/kg**	1.0 E-11	4.1 E-10	ground soil
Off-site root-soil concentration	1.1 E-04	**mg/kg**	5.4 E-12	5.3 E-08	root soil

Off-site ground-water dilution	0

w	erf(w)
0.0 E+00	0.0 E+00
Dispsn redctn	1.0 E+00
decay reducti	1.0 E+00

On-site aquifer dilution zone	d_v into q	2.6 E-03	m
Darcy velociy of water	v_darc	1.0 E-01	m/d
Contaminant velocity	Vc	1.9 E-06	m/d
Trnsvrs. disprsn. coeff. (water)	D_T	5.0 E-02	m2/d
Trnsvrs. disprsn. coeff. (chem)	D_Tc	9.5 E-07	m2/d
Dispersion depth	dzz	3.0	m
Thickness of aquifer	d_q	3	m
Transverse dispersivity (chem)	alpha_t	5.0 E-01	m
Width of the contaminated area	Y	32	m
Distrance to off-site location	X	0	m

Calculated Properties

fugacity capacity of pure air	4.18 E-04	Zair		
fugacity capacity of pure water	1.09 E+01	Zwater		
height of the air compartment (m)	3.49 E+00	d_a		
Plant-root volume frctn (m3(plnts)/m3(sl))	2.68 E-03	pr_vol		
evapotranspiration of water from soil (m/d)	7.62 E-04	evapotran	2.78 E-01	m/y
transpiration of water from plants (m/d)	9.15 E-04	transpire	3.34 E-01	m/y
Total surface water runoff (m/d)	7.05 E-04	outflow	2.57 E-01	m/y
bndry lyr thickness in air above wtr (m)	3.44 E-03	del_aw		
bndry lyr thickness in wtr below air (m)	2.19 E-04	del_wa		
diffusion length in surface soil (m)	5.78 E-04	del_g		
diffusion length in upper soil (m)	4.88 E-05	del_s		
Thickness of the root-zone soil layer	3.00 E+00	d_s		
wtr-side bndry lyr thickness with sed (m)	2.00 E-02	del_wd		
sed-side bndry lyr thickness with wtr (m)	2.36 E-05	del_dw		
Initial concentration in soil (mol/m3)	7.34E-03	Cs0		
Initial conc. in the vadose zone (mol/m3)	6.89E-03	Cv0		
Sediment resuspension rate (kg/m2-d)	1.05E+01	resuspend		
soil particle density; surface layer(kg/m3)	2650	rhos_g		
soil particle density; vadose layer(kg/m3)	2650	rhos_v		
Initial iventory in groundwater zone	0	Nq0		
diffusion lag time in skin (h)	1.03 E+03	tlag		
Skin/water partition coefficient	2.96 E+04	Km		
Reaction rate constant in air (1/d)	10.96519	Ra		
Reaction rate constant, ground soil (1/d)	0.0030311	Rg		
Reaction rate constant, root-zone soil (1/d)	2.949E-08	Rs		
Reaction rate constant, vadose-zone soil (1/d)	2.251E-07	Rv		
Reaction rate constant, ground water (1/d)	2.986E-09	Rq		
Reaction rate constant, surface water (1/d)	0.2965683	Rw		
Reaction rate constant, sediment (1/d)	7.002E-10	Rd		

Continuous source term to air (mol/d)	0.00E+00	Sa		
Fraction deposited matrl intercepted by vegtn	0.9996063	IntrcptV		
Net trnfr. phloem soltn frm plnts to roots (m/d)	0.0002	Phlm-flow		
Boundary layer thickness of soil on plant (m)	0.000005	del_slyr		
depth of plants compartment in m	0.0073067	d_p		
Leaf area index m2 leaves/m2 land	15.6	LAI		
Dry depsoition velocity of particles m/d	334	Vdep		

Warnings

0 Ground soil depth greater than 2 cm
0 Root-zone soil too shallow for accuracy of diffusion model (must be at least 1.4*del_s)
1 Starting time cannot be 0 and should be greater than 365 day
0 Recharge velocity is negative
0 Recharge velocity is too large accuracy of model
0 Concentration in root-zone soil-water <0 or exceeds solubility when there are non-zero sources
0 Concentration in vadose-zone soil-water <0 or exceeds solubility when there are non-zero sources
0 Concentration in groundwater exceeds solubility or < 0
0 Concentration in surface water exceeds solubility
0 Concentration in sediment-zone water exceeds solubility
0 Exposure time indoors and outdoors at home or at work exceeds 24 h
0 Risk from breast milk exposure is large compared to other ingestion pathways
0 Hazard from breast milk exposure is large compared to other ingestion pathways
0 Fraction of water from groundwater plus fraction from surface >1
1 total

Fugacity (Pa)

Air	fa	3.12E-12
Plants	fp	3.29E-11
Ground	fg	4.08E-10
Root	fs	5.26E-08
Vadose	fv	6.47E-07
Water	fw	2.18E-12
Sediment	fd	2.18E-12
Groundwater	fq	2.12E-15

Compartment Volumes (m^3)

Va	3.5 E+03	Air compartment
Vpp	7.3 E+00	Plants compartment
Vg	9.5 E+00	Ground-soil compartment
Vs	2.9 E+03	Root-zone compartment
Vv	3.2 E+04	Vadose compartment volume
Vw	2.4 E+02	Water compartment
Vd	2.4 E+00	Sediment compartment
Vq	3.0 E+03	aquifer compartment

Fugacity Capacities (mol/m^3 per Pa)

Zap	3.75E+07	fugacity capacity of air particles in mol/m3(s)-Pa
Zgp	2.15E+05	fugacity capacity of ground soil compartment particles in mol/m3(s)-Pa
Zsp	2.15E+05	fugacity capacity of root zone compartment particles in mol/m3(s)-Pa
Zvp	1.94E+04	fugacity capacity of vadose zone compartment particles in mol/m3(s)-Pa
Zwp	2.29E+06	fugacity capacity of suspended sediment in surface water in mol/m3(s)-Pa
Zdp	2.29E+06	fugacity capacity of bottom sediment particles in mol/m3(s)-Pa
Zqp	7.17E+05	fugacity capacity of aquifer solids in mol/m3-Pa
Zpr	**1.04E+03**	**fugacity capacity of plant roots**
Zphl	**9.78E+00**	**fugacity capacity of phloem**
Za	1.46E-02	fugacity capacity of air compartment in mol/m3-Pa
Zp	**2.44E+05**	**fugacity capacity of above-ground plant biomass**
Zg	1.35E+05	fugacity capacity of ground soil compartment in mol/m3-Pa
Zs	**1.40E+05**	fugacity capacity of root-soil compartment in mol/m3-Pa
Zv	1.06E+04	fugacity capacity of vadose-zone compartment in mol/m3-Pa
Zw	8.70E+01	fugacity capacity of water compartment in mol/m3-Pa
Zd	1.83E+06	fugacity capacity of sediment compartment in mol/m3-Pa
Zq	5.73E+05	fugacity capacity of aquifer compartment in mol/m3-Pa

Diffusion coefficients in m2/d

Compartment Phase		Compartment		Boundary-layer thickness (del)	Fugacity mass-transfer coefficients mol/Pa-m2-d Y one-sided	both-sides
Dair	4.36E-01	Da	1.25E-02	3.44E-03	5.29E-02	5.18E-02
Dwater	5.26E-05	Dw	6.57E-06	2.19E-04	2.61E+00	
Dair_g	2.77E-02	Dg	1.20E-10	5.00E-03	1.27E+00	2.75E-02
Dwater_	4.32E-07			5.78E-04	2.81E-02	
Dair_s	2.42E-02	Ds	1.05E-10	5.78E-04	2.81E-02	2.57E-02
Dwater_	4.24E-07			4.88E-05	3.01E-01	
Dair_v	5.86E-03	Dv	4.04E-09	4.88E-05	3.01E-01	5.88E-02
Dwater_	3.73E-06			5.89E-04	7.30E-02	
Dwater_	6.15E-06	Dd	3.64E-11	2.00E-02	2.29E-01	2.12E-01
				2.36E-05	2.83E+00	
r_stom	1.26E-02			5.00E-03	3.64E-02	3.59E-02
				5.00E-06	2.94E+00	

Overall intercompartment mass transfer rate constants (1/day)

Diffusion	Advection	T Total	Compartment interf
4.79E-02	9.05E+00	9.10 E+00	air-water, T_aw
1.19 E-04	0	1.19 E-04	water-air, T_wa
5.15E-01	1.83E+02	1.84 E+02	air-ground, T_ag
2.04E-05	4.15E-05	6.19 E-05	ground-air, T_ga
1.91E-05	6.61E-08	1.91 E-05	ground-soil, T_gs
6.14E-08	0	6.14 E-08	soil-ground, T_sg
	2.13E-10	2.13 E-10	soil-vadose, T_sv
	2.46E-10	2.46 E-10	vadose-aquifer, T_va
4.87E-04	2.09E+01	2.09 E+01	water-sediment, T_w
2.31E-06	9.90E-02	9.90 E-02	sediment-water, T_d
2.12E+01	9.30E+01	1.14 E+02	air-plants, T_ap
6.05E-04	2.65E-03	3.26 E-03	plants-air, T_pa
	2.50E-05	2.50 E-05	sediment-out, T_do
	1.09E+03	1.09 E+03	air-out, T_ao
	5.56E-03	5.56 E-03	plants-ground, T_pg
	1.10E-06	1.10 E-06	plants-soil, T_ps
	0	0.00 E+00	ground-plants, T_gp
	2.32E-05	2.32 E-05	ground-water, T_gw
	2.37E-08	2.37 E-08	soil-plants, T_sp
	3.00E-03	3.00 E-03	water-out, T_wo

r_stom		Resistance to mass transfer accross the stomata (
	2.065	Diffusion coefficient of water vapor in air m2/d
	2.66E-03	stomatal resistance to water vapor in d/m

aaa1	2.98E+01	bbb1	0.00E+00
aaa2	7.61E-05	bbb2	0.00E+00
aaa3	4.53E-08	bbb3	0.00E+00
aaa4	6.42E-12	**bbb4**	**0.00E+00**
aaa5	2.50E-05	bbb5	0.00E+00
aaa6	2.10E+01		
aaa7	2.23E+02		
aaa8	4.02E-02	Lam1	1.14E-07

Pnas_tw.xls

Source term (g/d)

air	0.0 E+00	
ground	0.0 E+00	
water	0.0 E+00	

Compartment Name		Loss-rate constant (1/day) L	Total Inventory (moles) N	Concen-tration (mol/m3) C	Mass distri-bution %	Gains g/d	Losses g/d	Residence Time (days)
air	a	1.41 E+03	1.6 E-10	4.5 E-14	0.00%	5.63 E-05	5.63E-05	7.10 E-04
plants	p	8.81 E-03	5.9 E-05	8.0 E-06	0.00%	1.30 E-04	1.30E-04	1.13 E+02
ground-soil	g	3.14 E-03	5.2 E-04	5.5 E-05	0.00%	4.15 E-04	4.15E-04	3.19 E+02
root-soil	s	1.15 E-07	2.1 E+01	7.3 E-03	8.60%	2.55 E-06	6.08E-04	8.71 E+06
vadose-zone	v	2.25 E-07	2.2 E+02	6.9 E-03	91.40%	1.13 E-06	1.27E-02	4.44 E+06
surface water	w	2.12 E+01	4.5 E-08	1.9 E-10	0.00%	2.38 E-04	2.38E-04	4.72 E-02
sediment	d	9.90 E-02	9.4 E-06	4.0 E-06	0.00%	2.35 E-04	2.35E-04	1.01 E+01
aquifer	q	1.51 E-02	3.6 E-06	1.2 E-09	0.00%	1.39 E-05	1.39E-05	6.64 E+01

Mass Flows (g/d)

air-ground	7.36 E-06	Tag*Na*MW
air-water	3.64 E-07	Taw*Na*MW
air-out	4.36 E-05	Tao*Na*MW
air-plants	4.57 E-06	Tap*Na*MW
air-transform	4.38 E-07	Ra*Na*MW
plants-air	4.82 E-05	Tpa*Np*MW
plants-ground	8.21 E-05	Tpg*Np*MW
plants-soil	1.62 E-08	Tps*Np*MW
plants-trnsfrm	0.00 E+00	
ground-air	8.19 E-06	Tga*Ng*MW
ground-plants	0.00 E+00	Tgp*Ng*MW
ground-soil	2.53 E-06	Tgs*Ng*MW
ground-water	3.07 E-06	Tgw*Ng*MW
ground-trnsfrm	4.01 E-04	Rg*Ng*MW

soil-ground	3.25 E-04	
soil-plants	1.26 E-04	
soil-vadose	1.13 E-06	
soil-trnsfrm	1.56 E-04	
vadose-aquifer	1.39 E-05	
vadose-trnsfrm	1.27 E-02	
aquifer-removal	1.39 E-05	
water-air	1.34 E-09	
water-sediment	2.35 E-04	
water-out	3.38 E-08	
water-trnsfrm	3.34 E-06	
sediment-water	2.35 E-04	
sedmnt-trnsfrm	1.66 E-12	
sediment-out	5.93 e-08	

Time-dependent Compartment Inventories

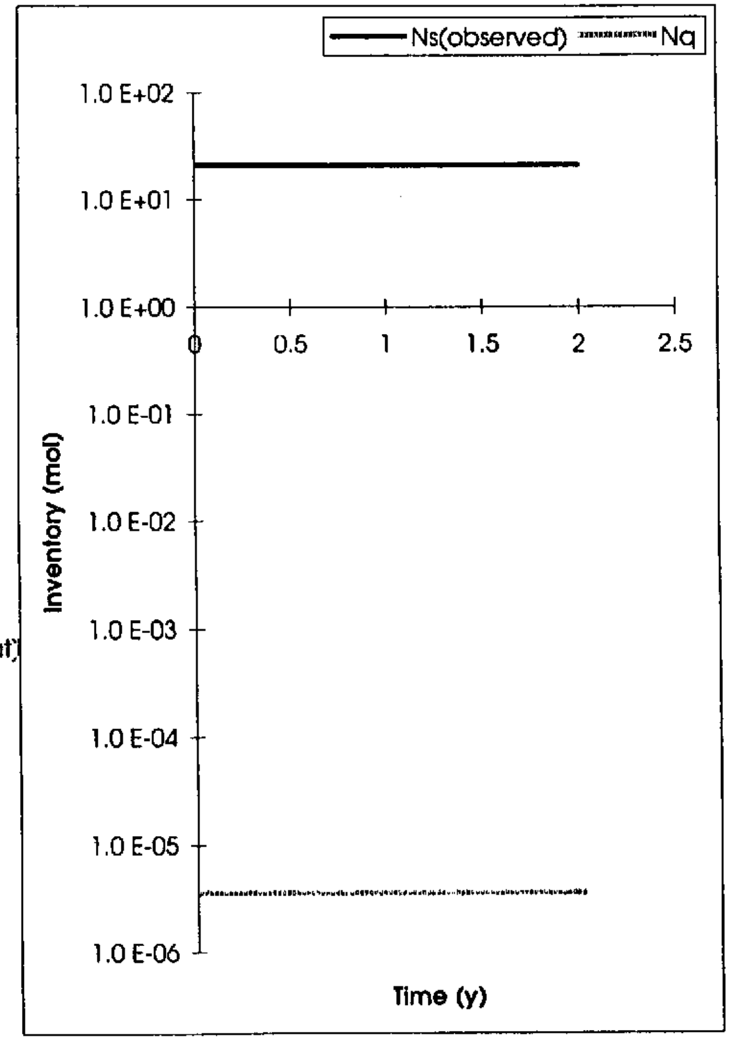
Time (y)	Time (d)	Ns(observed)	Plot Nq
0	0	2.1 E+01	3.6 E-06
0.2	73	2.1 E+01	3.6 E-06
0.4	146	2.1 E+01	3.6 E-06
0.6	219	2.1 E+01	3.6 E-06
0.8	292	2.1 E+01	3.6 E-06
1	365	2.1 E+01	3.6 E-06
1.2	438	2.1 E+01	3.6 E-06
1.4	511	2.1 E+01	3.6 E-06
1.6	584	2.1 E+01	3.6 E-06
1.8	657	2.1 E+01	3.6 E-06
2	730	2.1 E+01	3.6 E-06

Ns(0)(total)
2.1 E+01

const_sat
-4.31268E-05

Ns(sat)
3.8E+02

t*	Ns(@Ns>=Nsat)	Ns(total)	Nv(@Ns=sat)
0	2.10 E+01	2.1E+01	2.2E+02
0	2.10 E+01	2.1E+01	2.2E+02
0	2.10 E+01	2.1E+01	2.2E+02
0	2.10 E+01	2.1E+01	2.2E+02
0	2.10 E+01	2.1E+01	2.2E+02
0	2.10 E+01	2.1E+01	2.2E+02
0	2.10 E+01	2.1E+01	2.2E+02
0	2.10 E+01	2.1E+01	2.2E+02
0	2.10 E+01	2.1E+01	2.2E+02
0	2.10 E+01	2.1E+01	2.2E+02
0	2.10 E+01	2.1E+01	2.2E+02



CalTOX™ 2.3 (beta): Eight-Compartment Multimedia Exposure Model

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Inputs:

Chemical name==> Vinyl chloride

Site name ====> SFO Temporary Construction

Toxicity Data ==>

	Cancer potencies 1/(mg/kg-d)	Non-cancer ADIs (mg/kg-d)
Inhalation	2.7 E-01	0
Ingestion	2.7 E-01	0
Dermal	2.7 E-01	0
Total dose		0

	Risk	Hazard quotient
Target Risk/Hazard =	1.0 E-06	1.00
	current value	should be >
Root-soil thickness ===>	3	9.6 E+1
Alter root soil thickness to?	n/a	
Distance off-site for air exposure=	0.0 E+00	meters
Time after initial concentrations when exposure begins =	0.0 E+00	days

Measured Concentrations (at time = 0)

Root-zone soil	0.4	ppm (mg/kg)
Vadose-zone soil	1.20E+01	ppm (mg/kg)
Ground water	0.1	ppm (mg/L)

Continuous inputs

Source term to air (mol/d)	0.0 E+00	Sa
Source term to ground-surface soil (mol/d)	0.0 E+00	Sg
Source term to root-zone soil (mol/d)	0.0 E+00	Ss
Source term to surface water(mol/d)	0.0 E+00	Sw

Outputs: See Warnings Please

Target Soil Concentrations (in ppm)

Based on cancer risk:

Root soil	4.0 E-1	
Vadose soil	1.2 E+1	

Root Soil	4.0 E-1
Vadose soil	1.2 E+1

Based on hazard:

Root soil	0.0 E+0	not avlbl.
Vadose soil	0.0 E+0	not avlbl.

Un-mitigated risk and/or hazard ratio

Risk	2.0 E-6	
Hazard ratio	0.0 E+0	

Concentration limits without NAPL

Root soil	6.9 E+02	mg/kg solid
Vadose soil	6.7 E+02	mg/kg solid
	2.5 E+03	mg/L water

Time avrg. Conc. in on-site environmental media

Air	2.3 E-04	mg/m3
Plants	4.4 E-07	mg/kg(FM)
Grnd-surface soil	1.3 E-04	mg/kg(total)
Root-zone soil	1.5 E-01	mg/kg(total)
Vadose-zone soil	4.7 E+00	mg/kg(total)
Ground water	3.7 E-03	mg/L(water)
Surface water	2.3 E-05	mg/L
Sediment	2.1 E-05	mg/kg

Chemical properties

0.00297 0.003 -- 1 -1.0 E+02

ompound name	Vinyl chloride	Value used	Mean value	Coeff. Var.	Adjustment	Notes
Molecular weight (g/mol)	MW	6.25 E+01	6.25 E+01	0.0090271	1	
Octanol-water partition coefficient	Kow	1.52 E+01	1.52 E+01	0.6856922	1	
Melting point (K)	Tm	1.19 E+02	1.19 E+02	0.028	1	
Vapor Pressure in (Pa)	VP	1.01 E+05	3.67 E+05	0.0857913	1	
Solubility in mol/m3	S	3.94 E+01	3.94 E+01	0.3125064	1	
Henry's law constant (Pa-m^3/mol)	**H -**	2.57 E+03	2566.9	0.1268287	1	
Diffusion coefficient in pure air (m2/d)	Dair	9.14 E-01	9.14 E-01	0.05	1	1.06 E-05
Diffusion coefficient; pure water (m2/d)	Dwater	1.21 E-04	1.21 E-04	0.25	1	1.40 E-09
Organic carbon partition coefficient Koc	**Koc -**	2.92 E+01	29.15995099	1.3582056	1	m^2/s
Partition coefficient in ground/root soil layer	**Kd_s -**	8.75 E-02	-99	0.1	1	
Partition coefficient in vadose-zone soil layer	**Kd_v -**	7.87 E-03	-99	0.1	1	
Partition coefficient in aquifer layer	**Kd_q -**	2.92 E-01	-99	0.1	1	
Partition coeffic. in surface wtr sediments	**Kd_d -**	9.33 E-01	-99	0.1	1	
Prtn cff. plnt(abv-grd)/sl (kg(s)/kg(pFM))	**Kps -**	1.45 E+00	1.45373444	4	1	
Biotrnsfr fctr. plant/air (m3(a)/kg(pFM))	**Kpa -**	1.03 E-03	0.001032439	14	1	
Biotransfer factor; cattle-diet/milk (d/L)	**Bk -**	3.80 E-07	3.80219E-07	10.77033	1	
Biotransfer factor; cattle-diet/meat (d/L)	**Bt -**	4.72 E-06	4.72341E-06	12.589678	1	
Biotransfer factor; hen-diet/eggs (d/L)	**Be -**	1.21 E-04	0.000120501	14	1	
Biotrnsfr fctr; brst mlk/mthr intake (d/kg)	**Bbmk -**	3.03 E-06	3.03404E-06	10	1	
Bioconcentration factor; fish/water	**BCF -**	1.02 E+01	10.17249641	1	1	
Skin permeability coefficient; cm/h	**Kp_w -**	8.12 E-01	0.812063829	2.4	1	
Fraction dermal uptake from soil	**dfct_sl-**	1.00 E+00	2.841572713	0.27	1	
Reaction half-life in air (d)	Thalf_a	3.22 E+00	3.2 E+00	1	1	
Reaction half-life in surface soil (d)	Thalf_g	2.78 E+02	2.8 E+02	1.1	1	
Reaction half-life in root-zone soil (d)	Thalf_s	2.78 E+02	2.8 E+02	1.2	1	
Reaction half-life in vadose-zone soil (d)	Thalf_v	2.60 E+02	2.6 E+02	1	1	
Reaction half-life in ground water (d)	Thalf_q	4.35 E+03	4.3 E+03	1.3	1	
Reaction half-life in surface water (d)	Thalf_w	1.35 E+03	1.4 E+03	1.2	1	
Reaction half-life in sediments (d)	Thalf_d	1.11 E+03	1.1 E+03	1.4	1	

Landscape properties

site name	SFO Temporary Construction	Value used	Mean value	Coeff. Var.	Adjustment	Notes
contaminated area in m2	Area	1.00 E+03	1.00 E+03	0.1	1	(m/y)
annual average precipitation (m/d)	rain	1.48 E-03	1.48 E-03	0.55	1	5.40 E-01
flux; surface water into landscape (m/d)	inflow	0.00 E+00	0.00 E+00	0.1	1	0.00 E+00
land surface runoff (m/d)	runoff	6.40 E-04	6.40 E-04	0.55	1	2.34 E-01
atmospheric dust load (kg/m3)	rhob_a	1.00 E-05	1.00 E-05	0.64	1	
deposition velocity of air particles (m/d)	v_d	6.90 E+02	6.90 E+02	1.5	1	
plant dry mass inventory (kg(DM)/m2)	bio_inv	2.80 E+00	2.80 E+00	1.05	1	
plant dry-mass fraction	bio_dm	2.20 E-01	2.20 E-01	0.4	1	
plant fresh-mass density kg/m^3	rho_p	8.30 E+02	8.30 E+02	0.2	1	
ground-water recharge (m/d)	recharge	8.20 E-06	8.20 E-06	0.55	1	2.99 E-03
evaporation of water from surface wtr (m/d)	evaporate	4.38 E-06	4.38 E-06	1	1	
thickness of the ground soil layer (m)	d_g	1.00 E-02	1.00 E-02	1	1	
soil particle density (kg/m3)	rhos_s	2.65 E+03	2.65 E+03	0.05	1	
water content in surface soil (vol fraction)	beta_g	1.31 E-01	1.31 E-01	0.24	1	
air content in the surface soil (vol frctn)	alpha_g	2.42 E-01	2.42 E-01	0.29	1	cm/y
erosion of surface soil (kg/m2-d)	erosion_g	3.00 E-04	3.00 E-04	0.2	1	0.0064099
thickness of the root-zone soil (m)	d_s	3.00 E+00	3.00 E+00	0.49	1	
water content of root-zone soil (vol. frctn.)	beta_s	1.25 E-01	1.25 E-01	0.3	1	
air content of root-zone soil (vol. frctn.)	alpha_s	2.23 E-01	2.23 E-01	0.31	1	
thickness of the vadose-zone soil (m)	d_v	3.40 E+01	3.40 E+01	0.56	1	
water content; vadose-zone soil (vol. frctn.)	beta_v	2.80 E-01	2.80 E-01	0.2	1	
air content of vadose-zone soil (vol. frctn.)	alpha_v	1.70 E-01	1.70 E-01	0.2	1	
thickness of the aquifer layer (m)	d_q	3.00 E+00	3.00 E+00	0.3	1	
solid material density in aquifer (kg/m3)	rhos_q	2.65 E+03	2.65 E+03	0.05	1	
porosity of the aquifer zone	beta_q	2.00 E-01	2.00 E-01	0.2	1	
fraction of land area in surface water	f_arw	4.70 E-02	4.70 E-02	1.57	1	
average depth of surface waters (m)	d_w	5.00 E+00	5.00 E+00	1.58	1	
suspended sedmnt in surface wtr (kg/m3)	rhob_w	8.80 E-02	8.80 E-02	1	1	

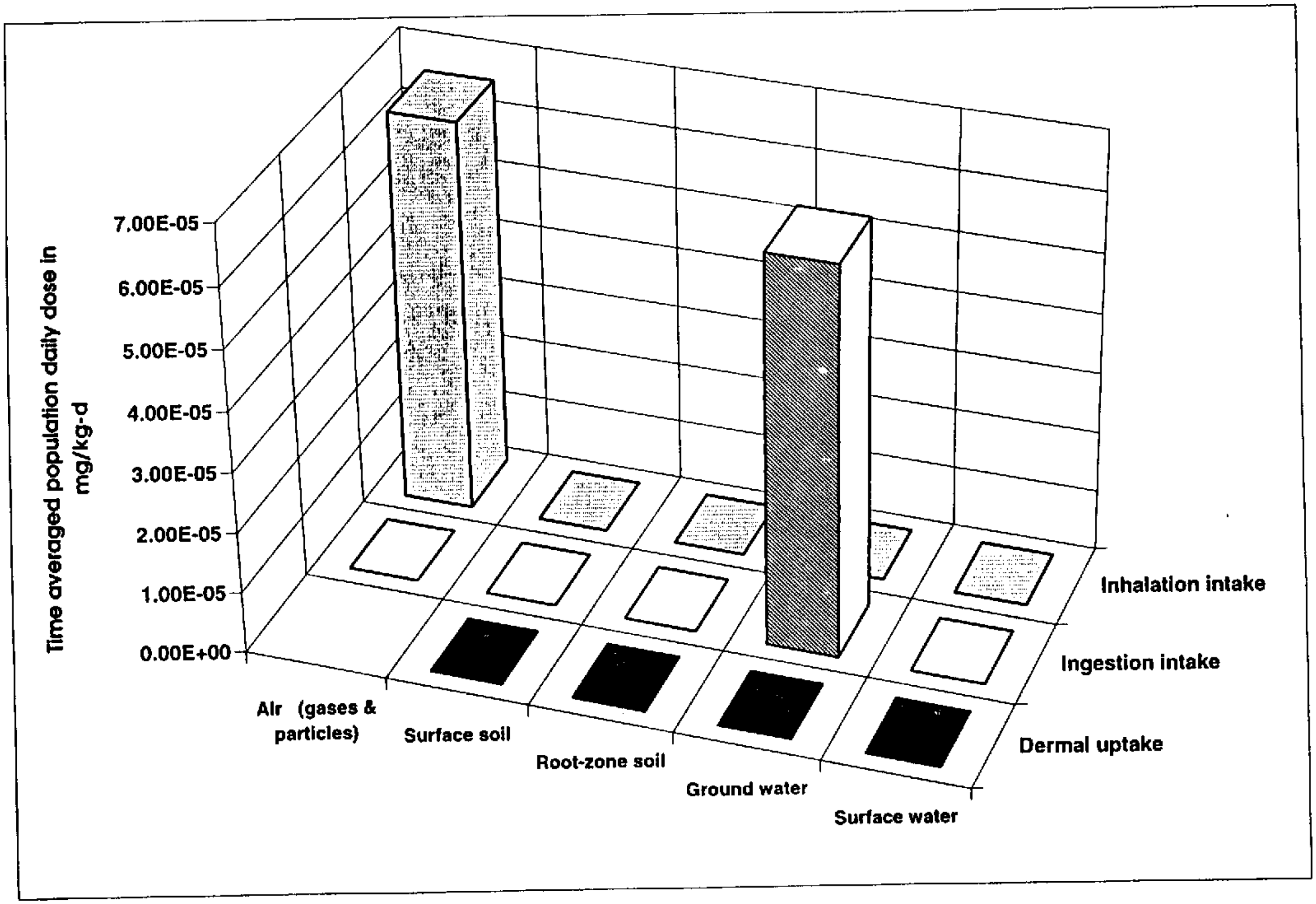
Landscape properties (continued)

site name	SFO Temporary Construction	Value used	Mean value	Coeff. Var.	Adjustment	Notes
suspended sdmnt deposition (kg/m2/d)	deposit	1.05 E+01	1.05 E+01	0.3	1	(m/s)
thickness of the sediment layer (m)	d_d	5.00 E-02	5.00 E-02	1	1	
solid material density in sediment (kg/m3)	rhos_d	2.65 E+03	2.65 E+03	0.05	1	
porosity of the sediment zone	beta_d	2.00 E-01	2.00 E-01	0.2	1	m/y
sediment burial rate (m/d)	bury_d	1.00 E-06	1.00 E-06	5	1	3.65 E-04
ambient environmental temperature (K)	Temp	2.88 E+02	2.88 E+02	0.01	1	(m/s)
Surface water current in m/d	current_w	0.00 E+00	0.00 E+00	1	1	0.00 E+00
organic carbon fraction in upper soil zone	foc_s	3.00 E-03	3.00 E-03	0.37	1	
organic carbon fraction in vadose zone	foc_v	2.70 E-04	2.70 E-04	1.4	1	
organic carbon fraction in aquifer zone	foc_q	1.00 E-02	1.00 E-02	1	1	
organic carbon fraction in sediments	foc_d	3.20 E-02	3.20 E-02	0.84	1	
bndry lyr thickness in air above soil (m)	del_ag	5.00 E-03	5.00 E-03	0.2	1	(m/s)
yearly average wind speed (m/d)	v_w	1.50 E+05	1.50 E+05	0.67	1	1.74 E+00
distance to first well (m)	d_well	0.00 E+00	0.00 E+00		1	
Darcy veleocity (m/d)	v_darc	1.00 E-01	1.00 E-01		1	
water dispersion coeff. (m2/d)	D_T	5.00 E-02	5.00 E-02		1	

(General Construction) Exposure Factors		Value used	Mean value	Coeff. Var.	Adjustment	Notes
Body weight (kg)	BW	7.00 E+01	7.00 E+01	0.2	1	
Surface area (m2/kg)	SAb	4.60 E-03	4.60 E-03	0.07	1	
Active breathing rate (m3/kg-h)	BRa	3.60 E-02	3.60 E-02	0.3	1	
Resting breathing rate (m3/kg-h)	BRr	6.40 E-03	6.40 E-03	0.2	1	
Fluid intake (L/kg-d)	Ifl	2.20 E-02	2.20 E-02	0.2	1	
Fruit and vegetable intake (kg/kg-d)	Ifv	4.90 E-03	4.90 E-03	0.2	1	
Grain intake (kg/kg-d)	Ig	3.70 E-03	3.70 E-03	0.2	1	
Milk intake (kg/kg-d)	Imk	6.50 E-03	6.50 E-03	0.2	1	
Meat intake (kg/kg-d)	Imt	3.00 E-03	3.00 E-03	0.2	1	
Egg intake (kg/kg-d)	Iegg	4.60 E-04	4.60 E-04	0.3	1	
Fish intake (kg/kg-d)	Ifsh	2.90 E-04	2.90 E-04	0.4	1	
Soil ingestion (kg/kg-d)	Isl	4.89 E-07	4.89 E-07	3	1	
Breast milk ingestion by infants (kg/kg-d)	Ibm	1.10 E-01	1.10 E-01	0.2	1	
Inhalation by cattle (m3/d)	Inc	1.22 E+02	1.22 E+02	0.3	1	
Inhalation by hens (m3/d)	Inh	2.20 E+00	2.20 E+00	0.3	1	
Ingestion of pasture, dairy cattle (kg(FM)/d)	Ivdc	8.50 E+01	8.50 E+01	0.2	1	
Ingestion of pasture, beef cattle (kg(FM)/d)	Ivbc	6.00 E+01	6.00 E+01	0.4	1	
Ingestion of pasture by hens (kg(FM)/d)	Ivh	1.20 E-01	1.20 E-01	0.04	1	
Ingestion of water by dairy cattle (L/d)	Iwdc	3.50 E+01	3.50 E+01	0.2	1	
Ingestion of water by beef cattle (L/d)	Iwbc	3.50 E+01	3.50 E+01	0.2	1	
Ingestion of water by hens (L/d)	Iwh	8.40 E-02	8.40 E-02	0.1	1	
Ingestion of soil by cattle (kg/d)	Isc	4.00 E-01	4.00 E-01	0.7	1	
Ingestion of soil by hens (kg/d)	Ish	1.30 E-05	1.30 E-05	1	1	
Fraction of water needs from ground water	fw_gw	8.00 E-01	8.00 E-01	0.1	1	
Fraction of water needs from surface water	fw_sw	2.00 E-01	2.00 E-01	0.1	1	
Frctn irrgtn wtr contamnnts trnsfrd to soil	f_ir	2.50 E-01	2.50 E-01	1	1	
Frctn frts & vgtbls that are exposed produce	fabv_grd_v	4.70 E-01	4.70 E-01	0.1	1	
Fraction of fruits and vegetables local	flocal_v	2.40 E-01	2.40 E-01	0.7	1	
Fraction of grains local	flocal_g	1.20 E-01	1.20 E-01	0.7	1	

Human Exposure Factors (continued)		Value used	Mean value	Coeff. Var.	Adjustment	Notes
Fraction of milk local	flocal_mk	4.00 E-01	4.00 E-01	0.7	1	
Fraction of meat local	flocal_mt	4.40 E-01	4.40 E-01	0.5	1	
Fraction of eggs local	flocal_egg	4.00 E-01	4.00 E-01	0.7	1	
Fraction of fish local	flocal_fsh	7.00 E-01	7.00 E-01	0.3	1	
Plant-air prttn fctr, particles, m3/kg(FM)	Kpa_part	3.30 E+03	3.30 E+03	1.8	1	
Rainsplash (mg/kg(plnt FM))/(mg/kg(soil))	rainsplash	3.40 E-03	3.40 E-03	1	1	
Water use in the shower (L/min)	Wshower	8.00 E+00	8.00 E+00	0.4	1	
Water use in the House (L/h)	Whouse	4.00 E+01	4.00 E+01	0.4	1	
Room ventilation rate, bathroom (m3/min)	VRbath	1.00 E+00	1.00 E+00	0.4	1	
Room ventilation rate, house (m3/h)	VRhouse	7.50 E+02	7.50 E+02	0.3	1	
Exposure time, in shower or bath (h/day)	ETsb	2.70 E-01	2.70 E-01	0.6	1	
Exposure time, active indoors (h/day)	ETai	0.00 E+00	0.00 E+00	0.14	1	
Exposure time, outdoors at work (h/day)	ETao	8.00 E+00	8.00 E+00	0.14	1	
Exposure time, indoors resting (h/day)	ETri	0.00 E+00	0.00 E+00	0.04	1	
Indoor dust load (kg/m^3)	dust_in	3.00 E-08	3.00 E-08	0.4	1	
Exposure frequency to soil on skin, (d/y)	EFsl	2.50 E+02	2.50 E+02	0.6	1	
Soil adherence to skin (mg/cm^2)	Slsk	5.00 E-01	5.00 E-01	0.4	1	
Ratio of indoor gas conc. to soil gas conc.	alpha_inair	1.00 E-04	1.00 E-04	2	1	
Exposure time swimming (h/d)	ETsw	5.00 E-01	5.00 E-01	0.5	1	
Exposure frequency, swimming (d/y)	EFsw	1.50 E+01	1.50 E+01	4	1	
Water ingestion while swimming (L/kg-h)	Isww	7.00 E-04	7.00 E-04	1	1	
Exposure duration (years)	ED	4.00 E+00	4.00 E+00	1.15	1	
Averaging time (days)	AT	2.56 E+04	2.56 E+04	0.1	1	

Constants		
Gas Constant (Pa-m^3/mol-K)	8.31E+00	Rgas


Time averaged population daily dose in mg/kg-d
7.00E-05
6.00E-05
5.00E-05
4.00E-05
3.00E-05
2.00E-05
1.00E-05
0.00E+00
Air (gases & particles)
Surface soil
Root-zone soil
Ground water
Surface water
Inhalation intake
Ingestion intake
Dermal uptake

Exposure Pathway-Include-and-Exclude Toggles

All inhalation exposures indoors active	0
All inhalation exposures indoors resting	0
Inhalation exposure in shower/bath	0
Inhalation exposures outdoors active	1
Inhalation of air particles indoors	0
Transfer of soil dust to indoor air	0
Transfer of soil vapors to indoor air	0
On-site inhalation by animals	0
Use of ground water as tap water	1
Use of surface water as tap water	0
Ingestion of tap water	1
Use of ground water for irrigation	0
Use of surface water for irrigation	0
Use of ground water for feeding animals	0
Use of surface water for feeding animals	0

ontaminant transfer, air to plants surfaces	0
ntmnnt. transfer, grnd. soil to plant surfaces	0
ontamnnt. transfer, root soil to plant tissues	0
On-site grazing of animals	0
ngestion of home-grown exposed produce	0
estion of home-grown unexposed produce	0
Ingestion of home-grown meat	0
Ingestion of home-grown milk	0
Ingestion of home-grown eggs	0
Ingestion of locally caught fish	0
Direct soil ingestion	1
Soil contact exposure at home or at work	1
Dermal exposure during shower/bath	0
Dermal & ingstn exposures while swimming	0
Breast-milk ingestion by infants	0

To return to the **CalTOX** Flowchart press the button on the toolbar

MEDIA AND CORRESPONDING POTENTIAL DOSES IN mg/kg-d (averaged over the exposure duration)

PATHWAYS	Air (gases & particles)	Surface soil	Root-zone soil	Ground water	Surface water	Totals	%
INHALATION	6.53E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	**6.53E-05**	50.35
INGESTION:							
Water				6.43E-05	0.00E+00	6.43E-05	49.55
Exposed produce	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
Unexposed produce			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
Meat	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
Milk	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
Eggs	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00
Fish					0.00E+00	0.00E+00	0.00
Soil		9.58E-12	1.13E-08			1.14E-08	0.01
Total ingestion	0.00 E+00	9.58 E-12	1.13 E-08	6.43 E-05	0.00 E+00	**6.43 E-05**	49.56
DERMAL UPTAKE		9.26E-11	1.10E-07	0.00E+00	0.00E+00	**1.10 E-07**	0.08
Dose SUM	**6.53E-05**	**1.02E-10**	**1.21E-07**	**6.43E-05**	**0.00E+00**	**1.30E-04**	100.0

	Air (gases & particles)	Surface soil	Root-zone soil	Ground water	Surface water	total
Breast milk concentration	1.30 E-08	2.03 E-14	2.40 E-11	1.28 E-08	0.00 E+00	2.57 E-08
Infant dose	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	dose_bm **0.00 E+00**

Ingestion dose used =>	6.43 E-05
Total dose used =>	1.30 E-04

ENVIRONMENTAL Media CONCENTRATIONS	Air (gases) mg/m^3	Air (dust) mg/m^3	Ground soil mg/kg	Root soil mg/kg	Ground wate mg/L	Surface water mg/L
	2.27 E-04	**2.54 E-11**	**3.92 E-05**	**4.64 E-02**	**3.65 E-03**	**2.28 E-05**

EXPOSURE MEDIA CONCENTRATIONS (averaged over the exposure duration)

EXPOSURE	Air (gases)	Air (dust)	Ground soil	Root soil	Ground wate	Surface water
Indoor air (mg/m^3)	2.27 E-04	0.00 E+00	0.00 E+00	0.00 E+00	1.64 E-04	0.00 E+00
Bathroom air (mg/m^3)					2.11 E-02	0.00 E+00
Outdoor air (mg/m^3)	2.27 E-04	2.54 E-11				
Tap water (mg/L)					2.92 E-03	0.00 E+00
Exposed produce (mg/k	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00
Unexposed produce (mg/				0.00 E+00	0.00 E+00	0.00 E+00
Meat (mg/kg)	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00
Milk (mg/kg)	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00
Eggs (mg/kg)	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00	0.00 E+00
Fish and seafood (mg/kg)						2.32 E-04
Household soil (mg/kg)			1.96 E-05	2.32 E-02		
Swimming water (mg/L)						2.28 E-05

PATHWAY CONTACT FACTORS (CR/BW*FI)

EXPOSURE Media	Units	Inhalation	Ingestion	Dermal
Indoor air (active)		0.00 E+00		
Indoor air (resting)		0.00 E+00		
Indoor air (shower/bath)		0.00 E+00		
Outdoor air (active)		2.88 E-01		
Tap water			2.20 E-02	0.00 E+00
Exposed produce			0.00 E+00	
Unexposed produce			0.00 E+00	
Meat			0.00 E+00	
Milk			0.00 E+00	
Eggs			0.00 E+00	
Fish and seafood			0.00 E+00	
Household soil			4.89 E-07	4.73 E-06
Swimming wtr			0.00 E+00	0.00 E+00

Dose ratios	inh-dose/Ns	ing-dose/Ns	drml-dose/Ns	inh-dose/Nq	ing-dose/Nq	drml-dose/Nq
	5.2 E-06	9.1 E-10	8.8 E-09	0.0 E+00	4.5 E-04	0.0 E+00

Time (y)	Total inhalation dose	Total ingestion dose	Total dermal dose	Total dose	Total dose from root soil	Total dose from ground water
0	1.8 E-04	1.6 E-04	3.0 E-07	3.4 E-04	1.8 E-04	1.6 E-04
0.4	1.4 E-04	1.3 E-04	2.3 E-07	2.7 E-04	1.4 E-04	1.3 E-04
0.8	1.1 E-04	1.0 E-04	1.8 E-07	2.1 E-04	1.1 E-04	1.0 E-04
1.2	8.4 E-05	8.2 E-05	1.4 E-07	1.7 E-04	8.4 E-05	8.2 E-05
1.6	6.5 E-05	6.5 E-05	1.1 E-07	1.3 E-04	6.5 E-05	6.5 E-05
2	5.1 E-05	5.2 E-05	8.5 E-08	1.0 E-04	5.1 E-05	5.2 E-05
2.4	3.9 E-05	4.1 E-05	6.6 E-08	8.1 E-05	4.0 E-05	4.1 E-05
2.8	3.1 E-05	3.3 E-05	5.2 E-08	6.4 E-05	3.1 E-05	3.3 E-05
3.2	2.4 E-05	2.6 E-05	4.0 E-08	5.0 E-05	2.4 E-05	2.6 E-05
3.6	1.9 E-05	2.1 E-05	3.1 E-08	3.9 E-05	1.9 E-05	2.1 E-05
4	1.5 E-05	1.6 E-05	2.4 E-08	3.1 E-05	1.5 E-05	1.6 E-05
Cumulative doses				0.189421234		
over ED by route, mg/kg	9.5 E-02	9.4 E-02	1.6 E-04	1.9 E-01	9.6 E-02	9.4 E-02
fraction	0.5035	0.4956	0.0008	1.0000	0.504	0.496
Average doses						
over ED by route, mg/kg-	6.5 E-05	6.4 E-05	1.1 E-07	1.3 E-04	6.5 E-05	6.4 E-05
Maximum doses						
over ED by route, mg/kg-	1.8 E-04	1.6 E-04	3.0 E-07	3.4 E-04	1.8 E-04	1.6 E-04
fraction	0.5191	0.4800	0.0009	1.0000	0.520	0.480

Max breast-milk dose	0.0 E+00	mg/kg-d	Max_ing	1.6 E-04

Off-site 1-h max X/Q (mol/m3-s)	2.0 E-01	
Off-site Long-term X/Q	1.6 E-02	
On-site Long-term X/Q	2.2 E-02	
Off-site air dilution factor	1.0 E+00	

Off-site pseudo Sa =	1.4 E-02 mol/day
bbb2 =	1.3 E-05
bbb3 =	1.7 E-08
bbb4 =	1.5 E-06
bbb5 =	5.1 E-09

			fugacity off-site	**fugacity on-site**	
Off-site air concentration (gases)	2.3 E-04	**mg/m3**	8.7 E-06	8.7 E-06	air
Off-site concentration (particles)	2.5 E-11	**mg/m3**			
Off-site surface-water concentrtn.	2.1 E-07	**mg/L**	8.6 E-06	9.4 E-04	water
Off-site surface soil concentration	1.9 E-08	**mg/kg**	8.7 E-06	1.8 E-02	ground soil
Off-site root-soil concentration	5.6 E-09	**mg/kg**	2.6 E-06	2.2 E+01	root soil

Off-site ground-water dilution	**0**

w	erf(w)
0.0 E+00	0.0 E+00
Dispsn redctn	1.0 E+00
decay reducti	1.0 E+00

On-site aquifer dilution zone	d_v into q	2.6 E-03	m
Darcy velocly of water	v_darc	1.0 E-01	m/d
Contaminant velocity	Vc	1.2 E-01	m/d
Trnsvrs. disprsn. coeff. (water)	D_T	5.0 E-02	m2/d
Trnsvrs. disprsn. coeff. (chem)	D_Tc	6.1 E-02	m2/d
Dispersion depth	dzz	3.0	m
Thickness of aquifer	d_q	3	m
Transverse dispersivity (chem)	alpha_t	5.0 E-01	m
Width of the contaminated area	Y	32	m
Distrance to off-site location	X	0	m

Calculated Properties

fugacity capacity of pure air	4.18 E-04	Zair		
fugacity capacity of pure water	3.90 E-04	Zwater		
height of the air compartment (m)	3.49 E+00	d_a		
Plant-root volume frctn (m3(plnts)/m3(sl))	2.68 E-03	pr_vol		
evapotranspiration of water from soil (m/d)	7.62 E-04	evapotran	2.78 E-01	m/y
transpiration of water from plants (m/d)	9.15 E-04	transpire	3.34 E-01	m/y
Total surface water runoff (m/d)	7.05 E-04	outflow	2.57 E-01	m/y
bndry lyr thickness in air above wtr (m)	3.59 E-03	del_aw		
bndry lyr thickness in wtr below air (m)	5.05 E-04	del_wa		
diffusion length in surface soil (m)	6.60 E-02	del_g		
diffusion length in upper soil (m)	6.86 E+01	del_s		
Thickness of the root-zone soil layer	3.00 E+00	d_s		
wtr-side bndry lyr thickness with sed (m)	2.00 E-02	del_wd		
sed-side bndry lyr thickness with wtr (m)	9.14 E-02	del_dw		
Initial concentration in soil (mol/m3)	1.19E-02	Cs0		
Initial conc. in the vadose zone (mol/m3)	3.34E-01	Cv0		
Sediment resuspension rate (kg/m2-d)	1.05E+01	resuspend		
soil particle density; surface layer(kg/m3)	2650	rhos_g		
soil particle density; vadose layer(kg/m3)	2650	rhos_v		
Initial iventory in groundwater zone	0	Nq0		
diffusion lag time in skin (h)	1.46 E-03	tlag		
Skin/water partition coefficient	2.84 E+00	Km		
Reaction rate constant in air (1/d)	0.2149848	Ra		
Reaction rate constant, ground soil (1/d)	0.0024892	Rg		
Reaction rate constant, root-zone soil (1/d)	0.0006035	Rs		
Reaction rate constant, vadose-zone soil (1/d)	0.0015754	Rv		
Reaction rate constant, ground water (1/d)	3.895E-05	Rq		
Reaction rate constant, surface water (1/d)	0.0005131	Rw		
Reaction rate constant, sediment (1/d)	5.714E-05	Rd		

Continuous source term to air (mol/d)	0.00E+00	Sa		
Fraction deposited matrl intercepted by vegtn	0.9996063	IntrcptV		
Net trnfr. phloem soltn frm plnts to roots (m/d)	0.0002	Phlm-flow		
Boundary layer thickness of soil on plant (m)	0.000005	del_slyr		
depth of plants compartment in m	0.0073067	d_p		
Leaf area index m2 leaves/m2 land	15.6	LAI		
Dry depsoltion velocity of particles m/d	334	Vdep		

Warnings

0 Ground soil depth greater than 2 cm
1 Root-zone soil too shallow for accuracy of diffusion model (must be at least 1.4*del_s)
1 Starting time cannot be 0 and should be greater than 365 day
0 Recharge velocity is negative
0 Recharge velocity is too large accuracy of model
0 Concentration in root-zone soil-water <0 or exceeds solubility when there are non-zero sources
0 Concentration in vadose-zone soil-water <0 or exceeds solubility when there are non-zero sources
0 Concentration in groundwater exceeds solubility or < 0
0 Concentration in surface water exceeds solubility
0 Concentration in sediment-zone water exceeds solubility
0 Exposure time indoors and outdoors at home or at work exceeds 24 h
0 Risk from breast milk exposure is large compared to other ingestion pathways
0 Hazard from breast milk exposure is large compared to other ingestion pathways
0 Fraction of water from groundwater plus fraction from surface >1
2 total

Fugacity (Pa)

Air	fa	8.69E-06
Plants	fp	1.20E-05
Ground	fg	1.84E-02
Root	fs	2.18E+01
Vadose	fv	7.10E+02
Water	fw	9.35E-04
Sediment	fd	9.36E-04
Groundwater	fq	1.50E-01

Compartment Volumes (m^3)

Va	3.5 E+03	Air compartment
Vpp	7.3 E+00	Plants compartment
Vg	9.5 E+00	Ground-soil compartment
Vs	2.9 E+03	Root-zone compartment
Vv	3.2 E+04	Vadose compartment volume
Vw	2.4 E+02	Water compartment
Vd	2.4 E+00	Sediment compartment
Vq	3.0 E+03	aquifer compartment

Fugacity Capacities (mol/m^3 per Pa)

Zap	1.24E-02	fugacity capacity of air particles in mol/m3(s)-Pa
Zgp	9.03E-05	fugacity capacity of ground soil compartment particles in mol/m3(s)-Pa
Zsp	9.03E-05	fugacity capacity of root zone compartment particles in mol/m3(s)-Pa
Zvp	8.13E-06	fugacity capacity of vadose zone compartment particles in mol/m3(s)-Pa
Zwp	9.63E-04	fugacity capacity of suspended sediment in surface water in mol/m3(s)-Pa
Zdp	9.63E-04	fugacity capacity of bottom sediment particles in mol/m3(s)-Pa
Zqp	3.01E-04	fugacity capacity of aquifer solids in mol/m3-Pa
Zpr	**1.40E-04**	**fugacity capacity of plant roots**
Zphl	**3.51E-04**	**fugacity capacity of phloem**
Za	4.18E-04	fugacity capacity of air compartment in mol/m3-Pa
Zp	**4.86E-04**	**fugacity capacity of above-ground plant biomass**
Zg	2.09E-04	fugacity capacity of ground soil compartment in mol/m3-Pa
Zs	**2.01E-04**	fugacity capacity of root-soil compartment in mol/m3-Pa
Zv	1.85E-04	fugacity capacity of vadose-zone compartment in mol/m3-Pa
Zw	3.90E-04	fugacity capacity of water compartment in mol/m3-Pa
Zd	8.49E-04	fugacity capacity of sediment compartment in mol/m3-Pa
Zq	3.19E-04	fugacity capacity of aquifer compartment in mol/m3-Pa

Diffusion coefficients in m2/d

Compartment Phase		Compartment		Boundary-layer thickness (del)	Fugacity mass-transfer coefficients mol/Pa-m2-d Y one-sided	both-sides
Dair	9.14E-01	Da	9.14E-01	3.59E-03	1.06E-01	9.34E-05
Dwater	1.21E-04	Dw	1.21E-04	5.05E-04	9.35E-05	
Dair_g	5.80E-02	Dg	1.16E-01	5.00E-03	7.64E-02	3.66E-04
Dwater_	9.96E-07			6.60E-02	3.67E-04	
Dair_s	5.08E-02	Ds	1.06E-01	6.60E-02	3.67E-04	3.09E-07
Dwater_	9.78E-07			6.86E+01	3.09E-07	
Dair_v	1.23E-02	Dv	2.78E-02	6.86E+01	3.09E-07	1.16E-07
Dwater_	8.60E-06			2.76E+01	1.86E-07	
Dwater_	1.42E-05	Dd	6.51E-06	2.00E-02	2.36E-06	5.90E-08
				9.14E-02	6.05E-08	
r_stom	6.01E-03			5.00E-03	7.64E-02	7.50E-02
				5.00E-06	4.24E+00	

Overall intercompartment mass transfer rate constants (1/day)

Diffusion	Advection	T Total	Compartment Interfc
3.02E-03	1.96E-05	3.03 E-03	air-water, T_aw
4.80 E-02	0	4.80 E-02	water-air, T_wa
2.39E-01	3.98E-04	2.40 E-01	air-ground, T_ag
1.75E+02	1.13E-04	1.75 E+02	ground-air, T_ga
1.48E-01	1.53E-03	1.50 E-01	ground-soil, T_gs
5.13E-04	0	5.13 E-04	soil-ground, T_sg
	5.30E-06	5.30 E-06	soil-vadose, T_sv
	5.09E-07	5.09 E-07	vadose-aquifer, T_va
3.03E-05	1.96E-03	1.99 E-03	water-sediment, T_w
1.39E-03	8.99E-02	9.12 E-02	sediment-water, T_d
1.55E+03	1.07E-05	1.55 E+03	air-plants, T_ap
6.35E+05	4.39E-03	6.35 E+05	plants-air, T_pa
	2.27E-05	2.27 E-05	sediment-out, T_do
	1.09E+03	1.09 E+03	air-out, T_ao
	5.56E-03	5.56 E-03	plants-ground, T_pg
	1.98E-02	1.98 E-02	plants-soil, T_ps
	0	0.00 E+00	ground-plants, T_gp
	1.19E-01	1.19 E-01	ground-water, T_gw
	5.91E-04	5.91 E-04	soil-plants, T_sp
	3.00E-03	3.00 E-03	water-out, T_wo

r_stom		Resistance to mass transfer accross the stomata (
	2.065	Diffusion coefficient of water vapor in air m2/d
	2.66E-03	stomatal resistance to water vapor in d/m

aaa1	5.90E-02	bbb1	0.00E+00
aaa2	2.32E+00	bbb2	0.00E+00
aaa3	1.61E-01	bbb3	0.00E+00
aaa4	5.42E-07	**bbb4**	**0.00E+00**
aaa5	2.92E-06	bbb5	0.00E+00
aaa6	3.39E+01		
aaa7	1.08E+04		
aaa8	-1.31E+00	Lam1	1.71E-03

Source term (g/d)

air	0.0 E+00	
ground	0.0 E+00	
water	0.0 E+00	

Compartment Name		Loss-rate constant (1/day) L	Total Inventory (moles) N	Concen-tration (mol/m3) C	Mass distri-bution %	Gains g/d	Losses g/d	Residence Time (days)
air	a	2.64 E+03	1.3 E-05	3.6 E-09	0.00%	2.09 E+00	2.09E+00	3.79 E-04
plants	p	6.35 E+05	4.2 E-08	5.8 E-09	0.00%	1.69 E+00	1.69E+00	1.57 E-06
ground-soil	g	1.75 E+02	3.7 E-05	3.8 E-06	0.00%	4.01 E-01	4.01E-01	5.70 E-03
root-soil	s	1.71 E-03	1.3 E+01	4.4 E-03	0.29%	3.42 E-04	1.34E+00	5.84 E+02
vadose-zone	v	1.58 E-03	4.2 E+03	1.3 E-01	99.70%	4.15 E-03	4.18E+02	6.35 E+02
surface water	w	5.35 E-02	8.6 E-05	3.6 E-07	0.00%	2.86 E-04	2.86E-04	1.87 E+01
sediment	d	9.13 E-02	1.9 E-06	7.9 E-07	0.00%	1.07 E-05	1.07E-05	1.10 E+01
aquifer	q	1.51 E-02	1.4 E-01	4.8 E-05	0.00%	1.35 E-01	1.35E-01	6.64 E+01

Mass Flows (g/d)

air-ground	1.90 E-04	Tag*Na*MW
air-water	2.40 E-06	Taw*Na*MW
air-out	8.63 E-01	Tao*Na*MW
air-plants	1.22 E+00	Tap*Na*MW
air-transform	1.70 E-04	Ra*Na*MW
plants-air	1.69 E+00	Tpa*Np*MW
plants-ground	1.48 E-08	Tpg*Np*MW
plants-soil	5.25 E-08	Tps*Np*MW
plants-trnsfrm	0.00 E+00	
ground-air	4.01 E-01	Tga*Ng*MW
ground-plants	0.00 E+00	Tgp*Ng*MW
ground-soil	3.42 E-04	Tgs*Ng*MW
ground-water	2.73 E-04	Tgw*Ng*MW
ground-trnsfrm	5.69 E-06	Rg*Ng*MW

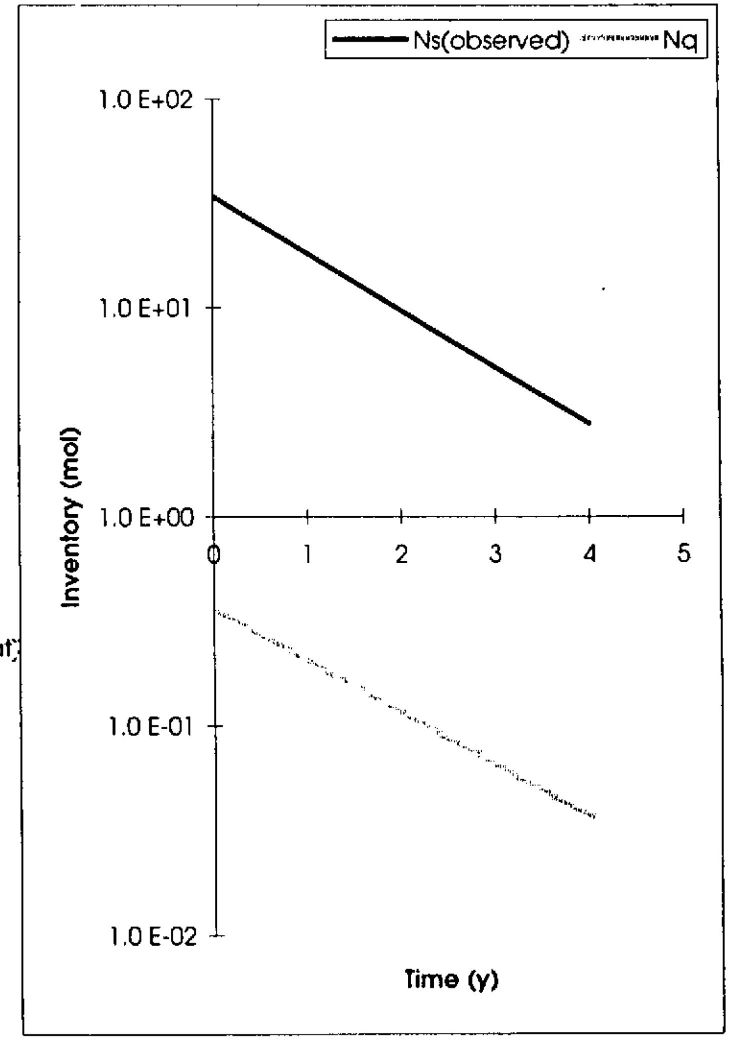
soil-ground	4.01 E-01	
soil-plants	4.62 E-01	
soil-vadose	4.15 E-03	
soil-trnsfrm	4.72 E-01	
vadose-aquifer	1.35 E-01	
vadose-trnsfrm	4.18 E+02	
aquifer-removal	1.35 E-01	
water-air	2.57 E-04	
water-sediment	1.07 E-05	
water-out	1.61 E-05	
water-trnsfrm	2.75 E-06	
sediment-water	1.06 E-05	
sedmnt-trnsfrm	6.66 E-09	
sediment-out	2.65 e-09	

Time-dependent Compartment Inventories

Time (y)	Time (d)	Ns(observed)	Plot Nq
0	0	3.4 E+01	3.7 E-01
0.4	146	2.6 E+01	2.9 E-01
0.8	292	2.1 E+01	2.3 E-01
1.2	438	1.6 E+01	1.8 E-01
1.6	584	1.2 E+01	1.5 E-01
2	730	9.7 E+00	1.2 E-01
2.4	876	7.6 E+00	9.2 E-02
2.8	1022	5.9 E+00	7.3 E-02
3.2	1168	4.6 E+00	5.8 E-02
3.6	1314	3.6 E+00	4.6 E-02
4	1460	2.8 E+00	3.7 E-02

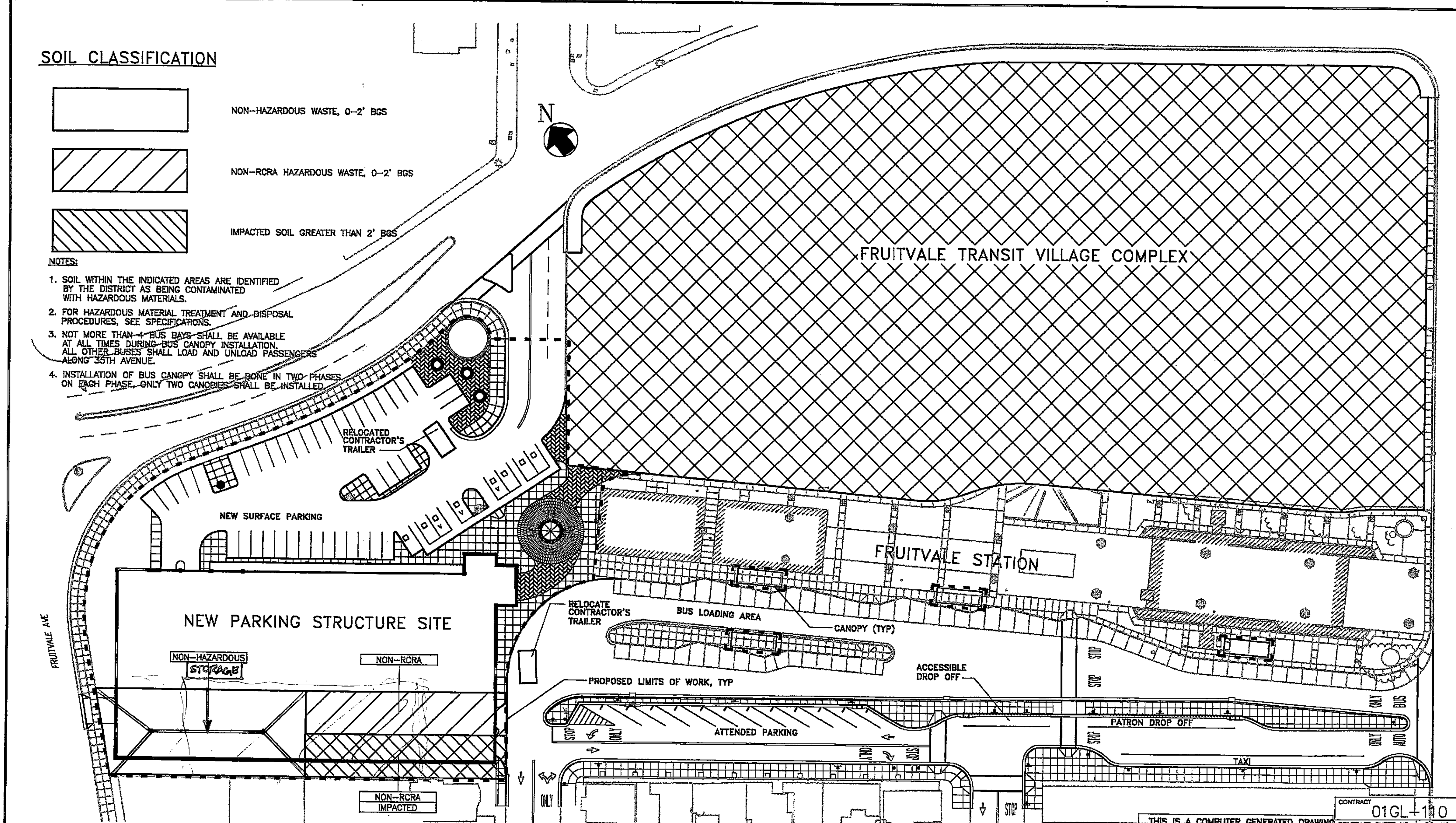
Ns(0)(total)
3.4 E+01

	const_sat	Ns(sat)	
	-99.49150842	5.8E+04	
t*	Ns(@Ns>=Nsat)	Ns(total)	Nv(@Ns=sat)
0	3.39 E+01	3.4E+01	1.1E+04
0	-1.45 E+04	2.6E+01	8.6E+03
0	-1.45 E+04	2.1E+01	6.9E+03
0	-1.45 E+04	1.6E+01	5.5E+03
0	-1.45 E+04	1.2E+01	4.3E+03
0	-1.45 E+04	9.7E+00	3.5E+03
0	-1.45 E+04	7.6E+00	2.8E+03
0	-1.45 E+04	5.9E+00	2.2E+03
0	-1.45 E+04	4.6E+00	1.8E+03
0	-1.45 E+04	3.6E+00	1.4E+03
0	-1.45 E+04	2.8E+00	1.1E+03



ATTACHMENT C

DIAGRAM OF PROPOSED SOIL REUSE AREA



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CONTRACT 01GL-110
CONTRACT SHEET NO. CT001
PG. NO. 003

REV.	DATE	BY	CHKD.	APP.	DESCRIPTION	REV.	DATE	BY	CHKD.	APP.	DESCRIPTION

DESIGNER/ENGINEER:
June 2, 2000

APPROVED: CHIEF OF SECTION

APPROVED: MANAGER OF DESIGN

BART

DESIGNED: DATE:
DRAWN:
CHECKED:
APPROVED:

TITLE:
FRUITVALE STATION PARKING STRUCTURE
SITE PLAN

SIZE: D
REF. NO.
DWG. NO.
REV. 00
SCALE 1" = 30'
BART STOCK NO.
SHEET 001 OF 001

BART EXTENTION PROGRAM **CALCULATION SHEET**

DESIGN FIRM BART SAFETY

PROJECT NAME FRUITVALE PARKING STRUCTURE

FACILITY / SUBJECT CONTAMINATED SOIL REUSE AREA

COMPONENT SCHEMATIC

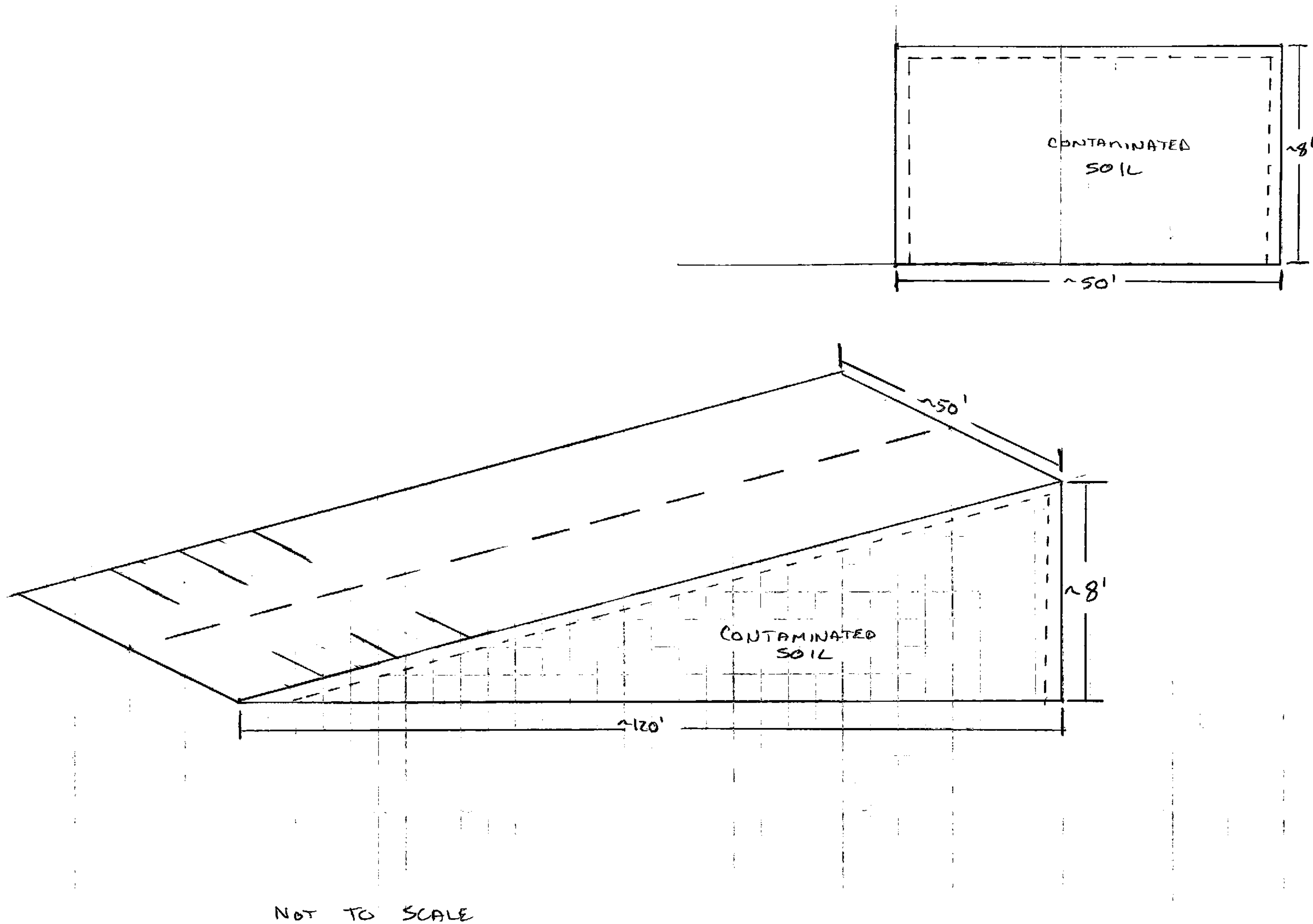
CALCULATION NO.

SHEET NO.

DICIPLINE

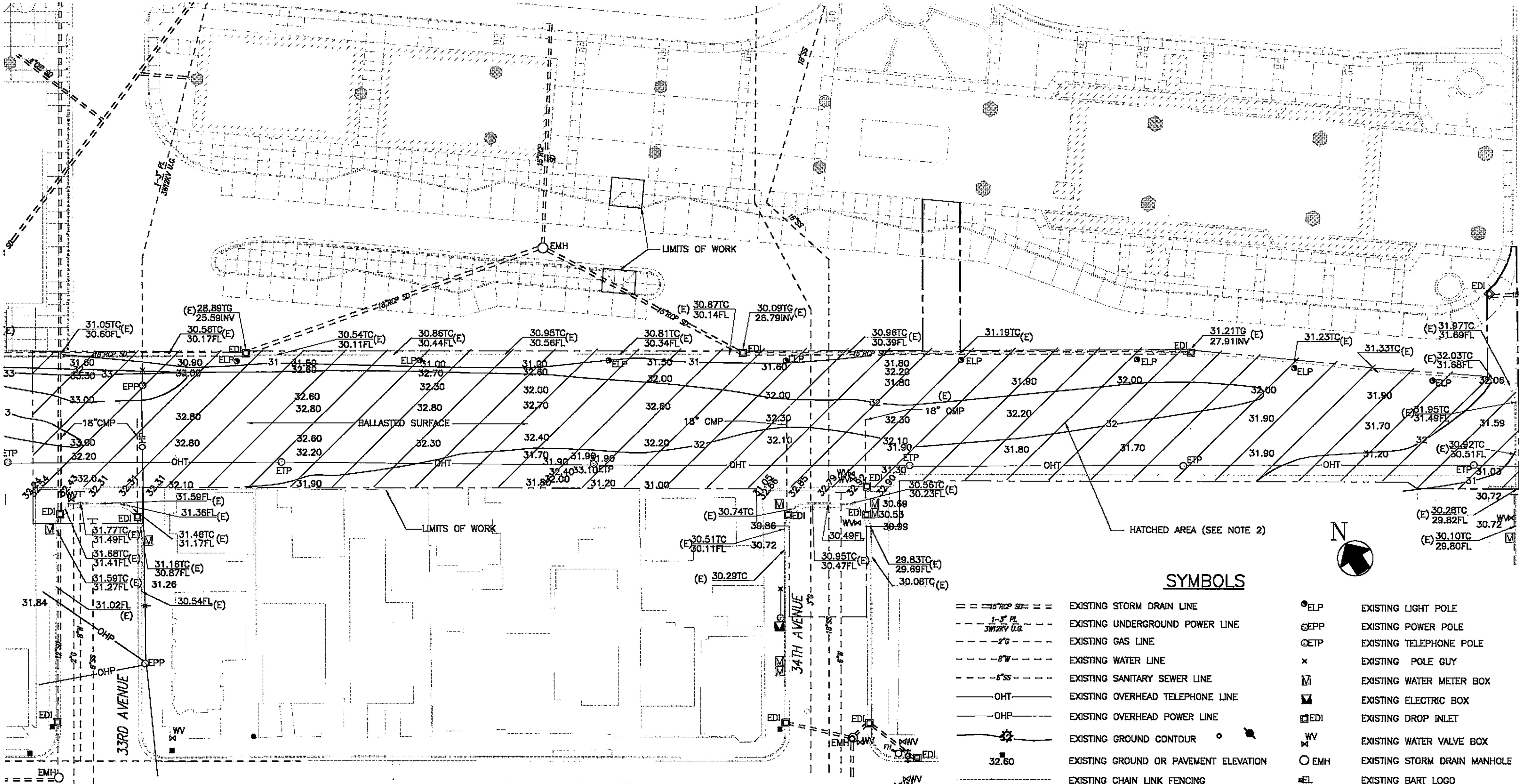
ORIGINATOR DATE

CHECKER DATE



ATTACHMENT D

BART GRADING PLAN WITH CROSS-SECTIONS



SYMBOLS

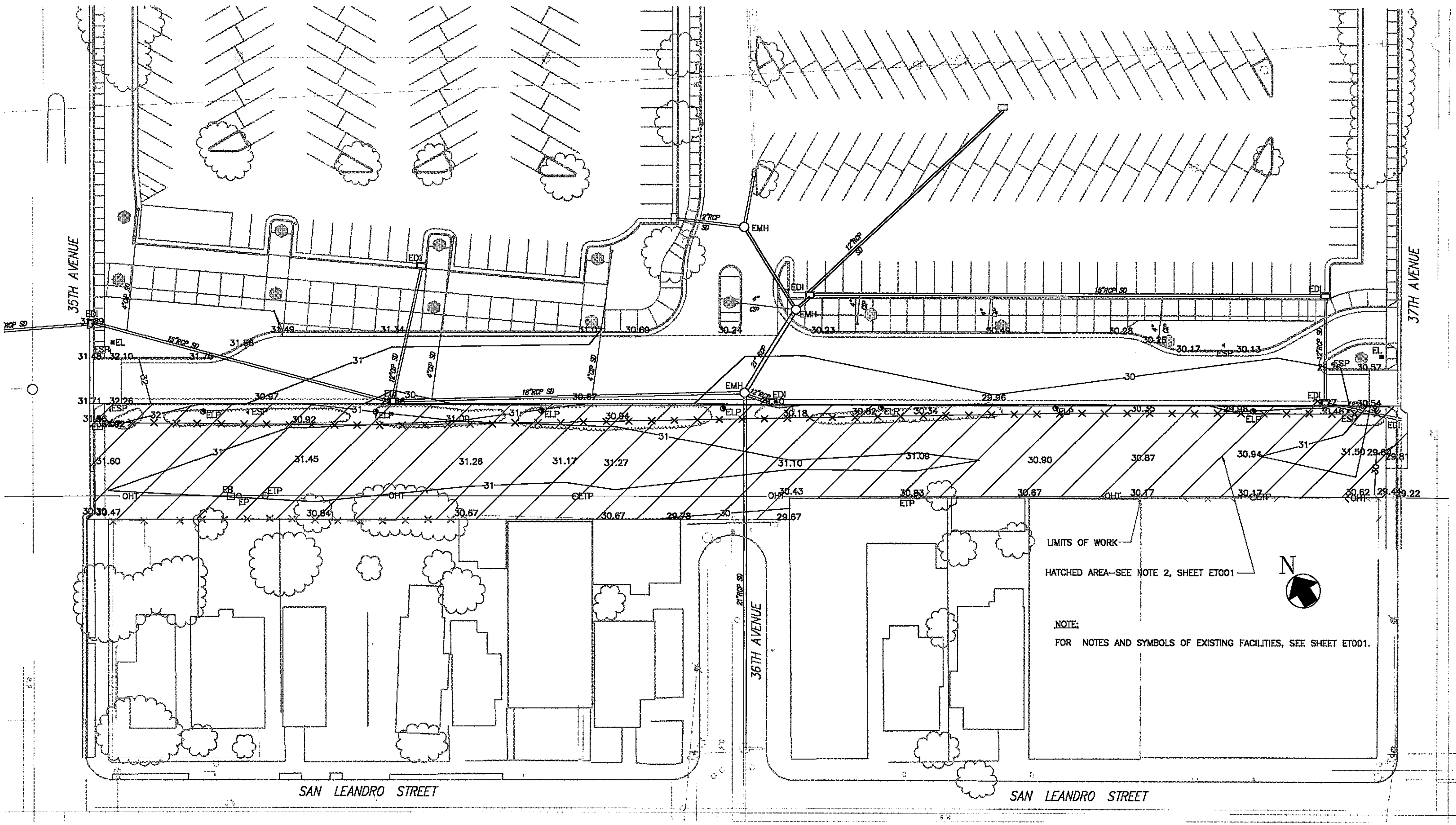
15"RCP SD	EXISTING STORM DRAIN LINE
1-3" PL 3W12KV U.G.	EXISTING UNDERGROUND POWER LINE
2"G	EXISTING GAS LINE
8"W	EXISTING WATER LINE
6"SS	EXISTING SANITARY SEWER LINE
OHT	EXISTING OVERHEAD TELEPHONE LINE
OHP	EXISTING OVERHEAD POWER LINE
	EXISTING GROUND CONTOUR
32.60	EXISTING GROUND OR PAVEMENT ELEVATION
	EXISTING CHAIN LINK FENCING
ELP	EXISTING LIGHT POLE
EPP	EXISTING POWER POLE
ETP	EXISTING TELEPHONE POLE
×	EXISTING POLE GUY
M	EXISTING WATER METER BOX
	EXISTING ELECTRIC BOX
EDI	EXISTING DROP INLET
WV	EXISTING WATER VALVE BOX
EMH	EXISTING STORM DRAIN MANHOLE
EL	EXISTING BART LOGO

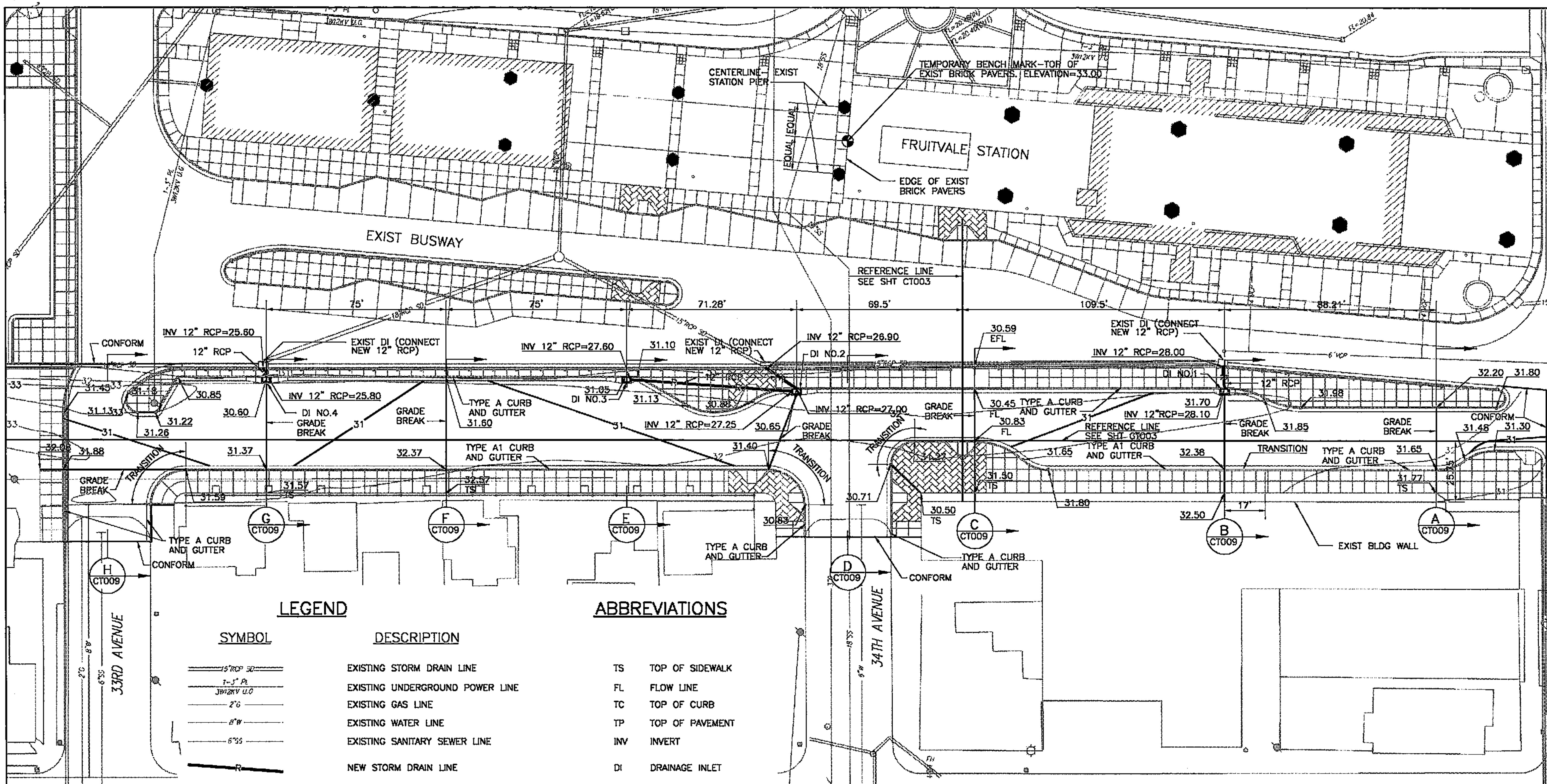
30.95TC / 30.56FL (E): TOP OF CURB ELEVATION; INDICATES EXISTING; GUTTER FLOW LINE ELEVATION

30.09TG / 26.79INV (E): DROP INLET GRATE ELEVATION; INDICATES EXISTING; DROP INLET INVERT ELEVATION

NOTES:

1. SEE ELECTRICAL AND MECHANICAL DRAWINGS FOR EXISTING IRRIGATION AND BUSWAY LIGHTING LINES.
2. HATCH AREA INDICATES EXACT LIMITS OF AREAS IDENTIFIED BY THE DISTRICT AS BEING CONTAMINATED WITH HAZARDOUS MATERIALS.


35TH AVENUE
36TH AVENUE
37TH AVENUE
SAN LEANDRO STREET
SAN LEANDRO STREET
EMH
EDI
ELP
ESP
ETP
OHT
12"RCP SD
15"RCP SD
18"RCP SD
21"RCP SD
LIMITS OF WORK
HATCHED AREA—SEE NOTE 2, SHEET ET001
NOTE:
FOR NOTES AND SYMBOLS OF EXISTING FACILITIES, SEE SHEET ET001.
N



LEGEND

SYMBOL	DESCRIPTION
15"RCP SD	EXISTING STORM DRAIN LINE
1-3" PL 3W12KV U.G	EXISTING UNDERGROUND POWER LINE
2"G	EXISTING GAS LINE
8"W	EXISTING WATER LINE
6"SS	EXISTING SANITARY SEWER LINE
R	NEW STORM DRAIN LINE
31	EXISTING GROUND CONTOUR
31	NEW FINISHED GRADE CONTOUR
32.37	FINISHED SURFACE ELEVATION
31.70	EXISTING SURFACE ELEVATION

ABBREVIATIONS

TS	TOP OF SIDEWALK
FL	FLOW LINE
TC	TOP OF CURB
TP	TOP OF PAVEMENT
INV	INVERT
DI	DRAINAGE INLET

NOTES:

1. UNLESS OTHERWISE NOTED, ALL FINISH ELEVATIONS ARE TO TOP OF CURB.
2. SEE SHEET CT011 FOR INLET DETAILS.
3. SEE SHEET ET001 FOR EXISTING TOPOGRAPHY OF THE SITE.

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CONTRACT 01GB-120
CONTRACT SHEET NO. CT007 PG. NO. 019

REV.	DATE	BY	CHKD.	APP.	DESCRIPTION
00					DRAWN PER BECO EM938

APPROVED: CHIEF OF SECTION

APPROVED: MANAGER OF DESIGN

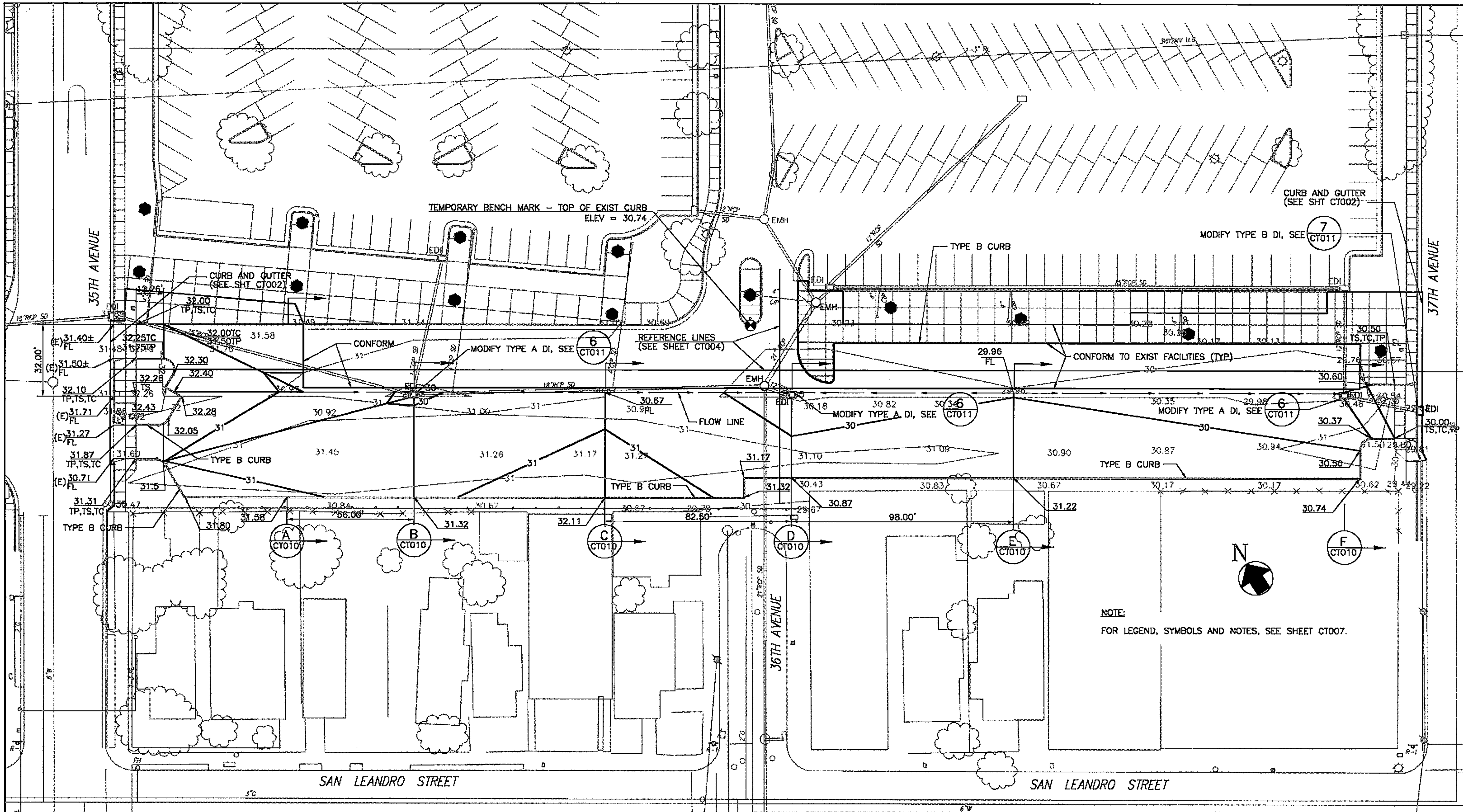
REGISTERED PROFESSIONAL ENGINEER KRISTEN T. TAKADA No. C40366 Exp. CIVIL STATE OF CALIFORNIA

BART

DESIGNED: DATE:
DRAWN:
CHECKED:
APPROVED:

TITLE: FRUITVALE STATION INTERMODAL PROJECT, PHASE II
GRADING AND DRAINAGE PLAN – AREA 1

SIZE: D REF. NO. DWG. NO. REV. 00
SCALE 1"=20' BART STOCK NO. SHEET 001 OF 001



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CONTRACT	01GB-120
CONTRACT SHEET NO.	CT008
PG. NO.	020

REV.	DATE	BY	CHKD.	APP.	DESCRIPTION
00					DRAWN PER BECO EM938

APPROVED: CHIEF OF SECTION

APPROVED: MANAGER OF DESIGN

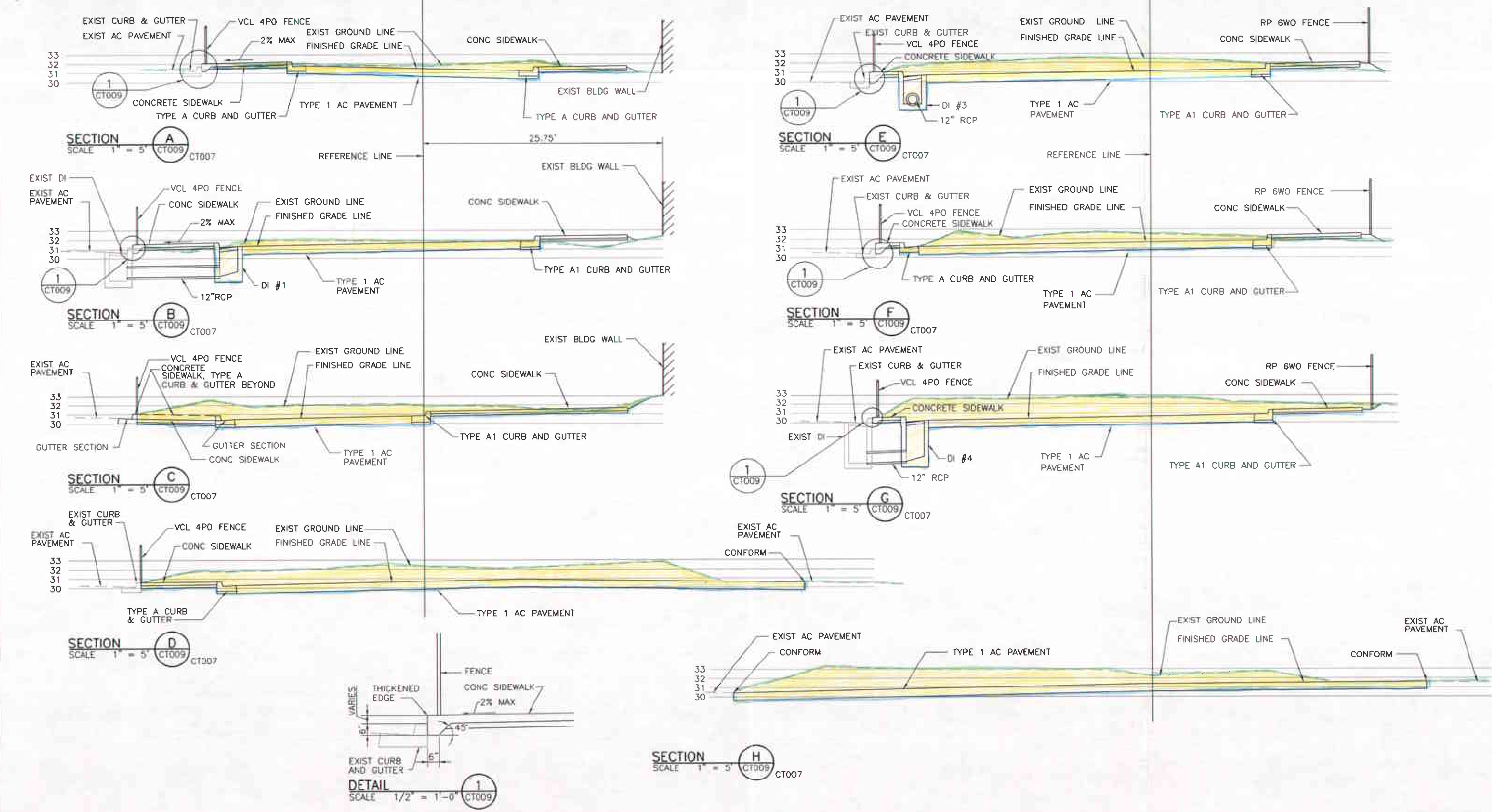
REGISTERED PROFESSIONAL ENGINEER
KRISTEN Y. IMADA
No. C40366
CIVIL
STATE OF CALIFORNIA

BART

DESIGNED: | DATE:
DRAWN:
CHECKED:
APPROVED:

TITLE:
FRUITVALE STATION
INTERMODAL PROJECT, PHASE II
GRADING AND DRAINAGE PLAN - AREA 2

SIZE: D | REF. NO. | DWG. NO. | REV. 00
SCALE 1"=20' | BART STOCK NO. | SHEET 001 OF 001



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CONTRACT 01GB-120
CONTRACT SHEET NO. CT009 PG. NO. 021

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APPROVED: CHIEF OF SECTION

APPROVED: MANAGER OF DESIGN

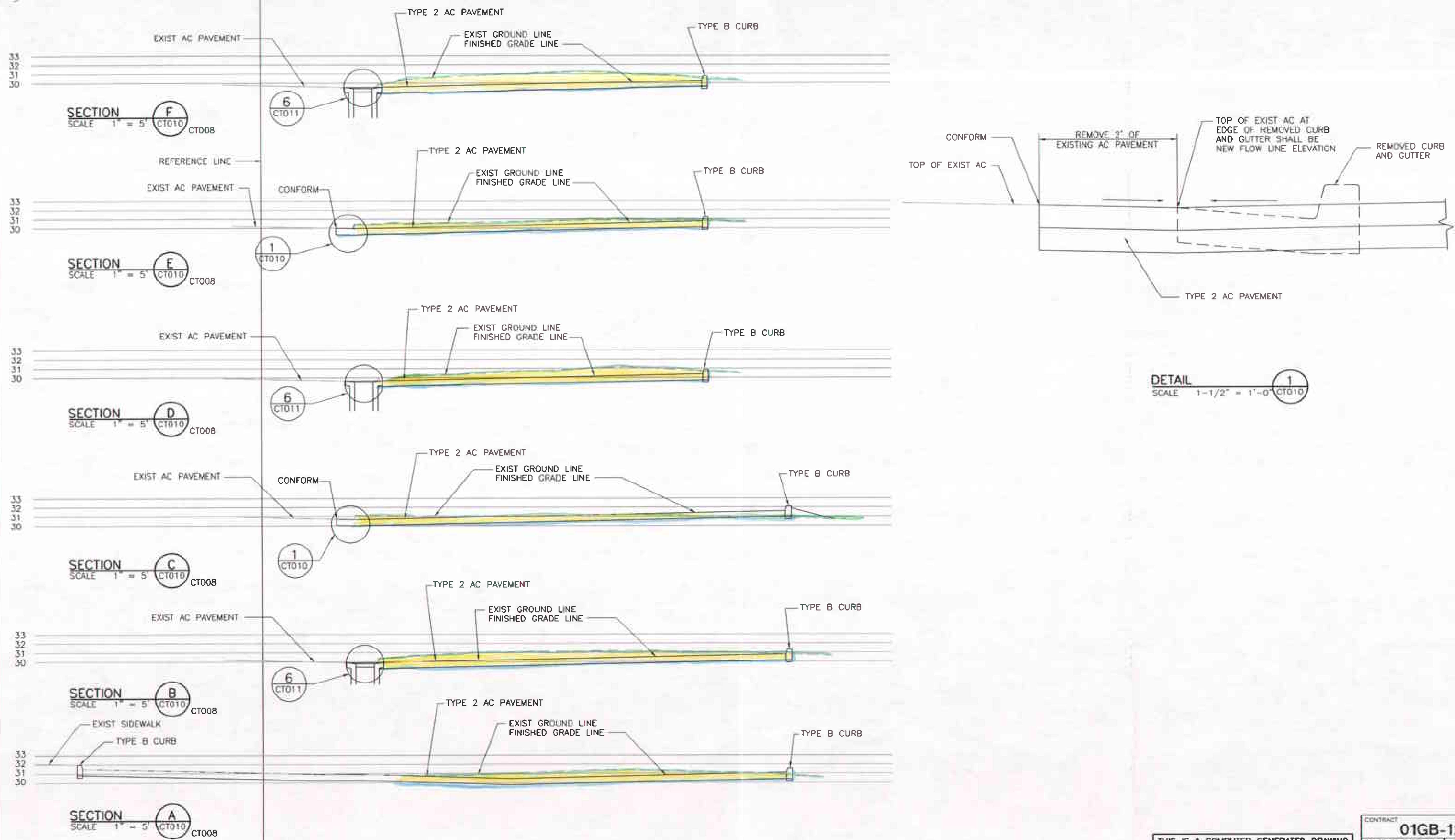
REGISTERED PROFESSIONAL ENGINEER — No. C40366 — CIVIL — STATE OF CALIFORNIA

BART

DESIGNED: DATE:
DRAWN:
CHECKED:
APPROVED:

TITLE:
FRUITVALE STATION
INTERMODAL PROJECT, PHASE II
SECTIONS – AREA 1

SIZE D | REF. NO. | DWG. NO. | REV. 00
SCALE NOTED | BART STOCK NO. | SHEET 001 OF 001



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CONTRACT 01GB-120
CONTRACT SHEET NO. CT010 | PG. NO. 022

00 | DRAWN PER BECO EM938

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APPROVED: CHIEF OF SECTION

APPROVED: MANAGER OF DESIGN

BART

DESIGNED: | DATE:
DRAWN:
CHECKED:
APPROVED:

TITLE:
FRUITVALE STATION
INTERMODAL PROJECT, PHASE II
SECTIONS – AREA 2

SIZE D | REF. NO. | DWG. NO. | REV. 00
SCALE NOTED | BART STOCK NO. | SHEET 001 OF 001

ATTACHMENT E

GEOTECHNICAL FEASIBILITY INVESTIGATION REPORT

GEOTECHNICAL FEASIBILITY INVESTIGATION REPORT
FRUITVALE BART STATION TRANSIT VILLAGE
CITY OF OAKLAND, CALIFORNIA

For

FRUITVALE DEVELOPMENT CORPORATION, INC.
1900 Fruitvale Avenue, Suite 2A
Oakland, CA 94601

PARIKH CONSULTANTS, INC.
481 Valley Way, Bldg. 1, Milpitas, CA 95035
(408) 945-1011

July 1997

Job No. 97134.10

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

GEOTECHNICAL FEASIBILITY INVESTIGATION REPORT
FRUITVALE BART STATION TRANSIT VILLAGE
CITY OF OAKLAND, CALIFORNIA

INTRODUCTION

This report presents the results of our Geotechnical Feasibility Investigation for the proposed Fruitvale BART Station Transit Village project to be constructed in the City of Oakland, California. The attached Plate 1, Project Location Map, shows the location of the site relative to major highways, roads, streets and other existing features.

This report presents our understanding of the project, existing site conditions, purpose and scope of investigation followed by description of field exploration, general geology at the site, seismicity, our interpretation of the subsurface and groundwater conditions, and our findings and recommendations.

The recommendations presented in this report are intended for design input for a preliminary feasibility evaluation of the project and are not intended to be used for the design of specific structures and improvements proposed for the project. In addition, these geotechnical recommendations should not be used for specifications, for bidding purposes or directly for construction cost estimates.

PURPOSE AND SCOPE

The purpose of this investigation was to evaluate the general soil conditions at the site, to determine their engineering properties and to provide preliminary recommendations for feasibility evaluation of the project.

The scope of work for this investigation included review of readily available soils and geologic literature pertaining to the site; obtaining representative samples and logging soil materials encountered in seven exploratory borings, laboratory testing of collected samples, engineering analysis of the field and laboratory data; and preparation of this report. A detailed scope of our work is presented in our contract with Fruitvale Development Corporation, Inc. dated June 1, 1997.

It should be noted that this study is to provide preliminary recommendations to evaluate feasibility of planned structures and land use. Site specific recommendations are to be followed during a detail study requiring additional borings, laboratory tests and engineering analysis.

PROPOSED CONSTRUCTION

As per our discussions with ARS, Inc., the proposed project will construct a Transit Village within the existing parking lot of the BART's Fruitvale Station. The Transit Village will consist of residential units, office buildings, a pedestrian bridge which will span from East 12th Street to the BART Station and several 3 to 4 level above-grade and/or subterranean parking structures. The locations and anticipated loadings for the proposed developments are not known at this time.

Our recommendations presented in this report are based on the above information. We understand that site specific studies will be performed for the proposed structures during the final design phase of the project.

SITE CONDITIONS

The project site is the existing parking lot for BART's Fruitvale Station located along East 12th Street between Fruitvale Avenue and 37th Avenue. The project site is bounded by the Southern Pacific Railway line along the western property line.

The existing parking lot is paved and appears to be sloping gently towards the west end of the site. The BART line which passes through the site, is supported on an elevated structure. The BART's Fruitvale Station is also located within the project site.

GEOLOGY

The general geology at the site and its vicinity was mainly studied from a 1:62500 scale geologic map of Late Cenozoic Deposits, Alameda County by Helley, Lajoie and Burke (1972). A portion of this map and the surrounding area is presented on Geologic Map, Plate 3. Helley et. al. have mapped the surficial native deposits at the site as Younger Alluvial Fan Deposits. They describe these deposits as unconsolidated gravel and sand containing clays/silts.

The Areal and Engineering Geology Map of the Oakland East Quadrangle by Radbruch (1969) was also referenced for the study. According to geologic map by Radbruch, the site is underlain by the Undivided Quaternary deposit which comprises of alluvial soils consisting of interfingered lenses of clayey gravel, sandy silty clay and sand/clay/silt mixtures.

FIELD EXPLORATION AND LABORATORY TESTING

Seven borings were drilled for this study to depths varying from 16½ feet to 51½ feet below the existing ground surface. The locations of these borings were decided by ARS, Inc. during drilling which was part of their overall environmental investigation. A representative from our office logged these borings and collected soil samples for further evaluation and testing.

The test borings were advanced with a truck-mounted drill rig using an 6-inch diameter hollow stem auger. Selected drive samples were obtained from the borings at various depths using a 2.5 inches I.D. Modified California Sampler or a 1.4 inches I.D. Standard Penetration Sampler.

The sampler was driven into the subsurface soils under the impact of a 140 pound hammer having a free fall of 30 inches. The blow counts required to drive the sampler for the last 12 inches are presented on the boring logs attached in Appendix A. (When correlating standard penetration data, the blow counts for the Modified California Sampler can be taken as roughly twice that for the Standard Penetration Test in similar soils). The soil samples obtained during drilling were visually classified in the field and then transported to our laboratory for further evaluation and testing.

Laboratory tests were performed on soil samples collected during field exploration to determine the physical and engineering properties of the subsurface soils. Test methods and test results are presented on plates attached in Appendix B. Laboratory test results for moisture content, dry density and unconfined compression tests are presented on the boring logs included in Appendix A.

The description of the soils encountered and relevant boring information are presented on the logs included in Appendix A. The bore logs were prepared from the field logs which were edited after visual examination of the soil samples in the laboratory and results of classification tests on selected soil samples as indicated on the logs. The abrupt stratum changes shown on these logs may be gradual and relatively minor changes in soil types within a stratum may not be noted on the logs due to field limitations.

To supplement this study, reference was made to a previous investigation on the site performed by Bechtel Corporation for the BART Project (dated December, 1965). The boring information from this investigation is attached in Appendix C.

SUBSURFACE CONDITIONS

Based on our field exploration and study of boring logs prepared by Bechtel Corporation for a previous investigation at the site for the BART project, the on-site native soils are alluvial deposits consisting of alternating layers of clays and sands.

Fill was not encountered in our borings. However, we anticipate localized fill on the site based on the past land use. The fill at the site may include concrete rubble, remnants of old foundations, fragments of bricks, rocks, wood, etc.

The surficial native soil layer (i.e. upper 1½ to 5 feet) encountered in our borings generally consist of clay with high plasticity i.e. fat clay. This gray/black fat clay is generally stiff to very stiff in consistency. In our opinion it has a moderate to high expansion potential.

The surficial fat clay layer is underlain by alternating layers of lean clay (i.e. clays with low to medium plasticities) and sand/gravel. These layers extend to the bottom of the boreholes i.e. to a maximum depth of 51½ feet below the existing ground surface. The lean clay layers encountered in our borings are generally stiff to very stiff. They contain significant amounts of sand and gravel at many locations. Their contact with sand/gravel layers appear to be gradational.

The sand/gravel layers encountered in the borings are generally poorly graded. At many locations, they contain substantial amounts of plastic and non-plastic fines and grade to silty or clayey sand/gravel. The layers of these sands/gravels are usually about 5 to 10 feet thick and appear to be discontinuous. The sands/gravels encountered in our borings are generally medium to coarse grained, weakly cemented at some locations and have relative densities ranging from medium dense to very dense.

Groundwater was encountered at depths varying from about 15 feet to about 30 feet below the existing grade at the time of drilling. The presence of groundwater generally was noted either near the top of a sand/gravel stratum or within the gradational zone above it. Once the clay layer overlying the sand/gravel unit had been penetrated, the groundwater level was found to rise rapidly, suggesting that an artesian condition exists within the confined sand/gravel layer. This condition was most notable in boring A-1 located towards the north end of the site (i.e. towards Fruitvale Avenue). In this boring the groundwater level rose from a depth of 30 feet below the existing grade at the time of drilling to 11 feet below the existing ground surface just after drilling. It should be noted that the groundwater level at the site may change with passage of time due to groundwater fluctuations from season to season, weather conditions, pumping and dewatering in the area and other factors which may not have been present at the time of the investigation.

Detailed descriptions of the materials encountered in the exploratory borings are presented on boring logs attached in Appendix A. Referenced borings from previous investigation performed on the site by Bechtel Corporation for BART project are attached in Appendix C.

The descriptions and related information presented on these logs depict subsurface conditions only at the locations indicated on the Site Plan, Plate 2 and on the particular date noted on the logs. Subsurface conditions at other locations may differ from conditions occurring at the locations explored. Also, the passage of time may result in a change in the soil conditions at these locations due to environmental changes.

SEISMIC CONSIDERATIONS

The project site is located in a seismically active part of northern California. Many faults exist in the San Francisco Bay Area which are capable of producing earthquakes which may cause strong ground shaking at the site. These regional faults include the San Andreas, Hayward and Calaveras faults. The attached Plate 4, Fault Map presents the locations of these and other fault systems relative to the project site. The Fault Map has been prepared from the Caltrans Seismic Hazard Map (Mualchin, 1996) and presents the maximum credible earthquake magnitudes for the fault systems and the anticipated peak bedrock accelerations at various locations due to seismic activity in the area.

Potential seismic hazards at a site may arise from three sources: surface fault rupture, strong ground shaking and liquefaction. Since no mapped active fault appears to pass through the site, in our opinion, the potential for fault rupture at the site is considered low. The Hayward Fault which is the closest active fault to the site, is located about 2½ miles towards east. A peak bedrock acceleration of about 0.6 g is anticipated at the site. Based on the deterministic charts prepared by Seed and Idriss (1982), the corresponding peak ground acceleration at the site may be on the order of 0.45 g.

Soil liquefaction is a phenomenon in which saturated cohesionless soils are subjected to a temporary and considerable loss of shear strength under the reversing, cyclic shear stresses such as those associated with earthquake shaking. Submerged cohesionless silts and sands of low relative density are the type of soils which usually are susceptible to liquefaction. Clays and gravels are generally not susceptible to liquefaction. Most of the deposits encountered in our borings are clays or dense sand/gravel and do not fit the criteria for high liquefaction susceptibility and therefore, the potential for liquefaction at the site is considered low.

FINDINGS AND RECOMMENDATIONS

General

Based on the results of our exploration, it is our opinion that the site is feasible for the proposed project provided a site specific investigation is performed during the final design phase. It should be noted that the recommendations presented in this section are for feasibility evaluation of the project. Normal construction procedures were assumed throughout our analysis and represent one of the basis of the recommendations presented herein. Our preliminary design criteria presented in this section are based upon the materials encountered in the field exploration. The recommendations may be modified when more data on location of proposed improvements, loading conditions, etc. is made available or when site specific studies are performed.

Grading

Grading is anticipated for construction of building pads, access roads, etc. In addition, due to the presence of surficial moderately to highly expansive soils it is recommended to remove these expansive soils and provide predominantly granular engineered fill below the footings and the slabs-on-grade. Details of these are discussed in the "Foundation Systems" and "Slabs-on-grade" sections of this report. A representative from our office should observe all excavated areas during grading and perform moisture and density tests on prepared subgrades and compacted fill material. Any fill material imported to the site should be non-expansive relatively granular material and should be reviewed by the Geotechnical Engineer.

It will be necessary to completely strip all existing old pavements and vegetation from areas to be developed. Depressions resulting from stripping and other construction activities should be backfilled and properly compacted to 90 percent relative compaction as per ASTM D1557-91.

After stripping, subgrades and areas to receive engineered fill should then be excavated of any and all loose soils. The resulting surface upon which fill is to be placed should be observed by the Geotechnical Engineer. Areas receiving fill should be scarified to a depth of 6 inches, moisture conditioned and compacted to 90 percent relative compaction per ASTM D 1557-91. This prepared subgrade should be sealed and kept moist before receiving engineered fill.

Engineered Fill

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 20. The on-site upper soils are moderately expansive and should not be used as engineered fill.

Compaction of Fill and Subgrades

Recommendations for required compaction as per ASTM D1557-91 are as follows:

- 90% for backfilling after removing buried utilities and structures, depressions caused due to other construction activities, etc.
- 95% for upper 6" of pavement; and, slab/footing *subgrades*.
- 95% for all *engineered fill* under the footings and the slabs-on-grade.

<u>**Expansive Soils**</u>

Based on our field exploration, laboratory testing and study of site geology, the upper about 5 feet of clays at the site have a moderate to high expansion potential (swell and shrink with variations in moisture content). Shallow foundations such as spread footings, mats, etc., slabs-on-grade and pavements should be designed for this condition. Without mitigation, structures supported on the expansive soil could undergo significant movement causing damage to the structures.

Because of the upper layer of expansive soils at the site, probably the most important factor affecting the long term performance of the wood-frame and other light structures is satisfactory control of moisture content of the near surface soils. Moisture is usually controlled both during construction and after construction (during design life of the structure) to reduce the amount of shrink and swell of these soils to tolerable limits. After construction is completed the moisture content of the soils can be controlled somewhat by proper control of surface runoff and by eliminating heavy landscaping irrigation to prevent excessive watering or ponding in the vicinity of foundations. Other mitigation measures such as extending foundations below the zone of seasonal moisture variation, providing a moisture barrier to keep the soil at a relatively constant moisture content, modifying the soil conditions (lime treatment) etc. may also be considered to mitigate expansive soil conditions.

Foundation Systems

Several residential and commercial units, a pedestrian bridge and several subterranean and/or at-grade parking structures are planned for the Transit Village. Lightly to heavily loaded structures are anticipated for the project. Foundation systems including Spread/Continuous footings or small diameter (12- to 16-inch) Pier & Grade beam foundations may be used to support structures with light to medium column and wall loads. These structures include 3 to 4 story wood-frame residential and commercial buildings. Relatively heavier structures such as multi-story buildings and parking structures and the pedestrian bridge may have to be supported on either driven piles or relatively large diameter (more than 24-inch diameter) Cast-In-Drilled-

Hole (CIDH) piles. A general discussion and recommendations for these foundation systems are presented in the following subsections.

Spread/Continuous Footings

Lightly and moderately loaded structures may be supported on conventional continuous and isolated spread footings that are tied with grade beams. Because of the anticipated expansive soils, the footings should be supported on a pad of compacted fill with low expansion potential (PI less than 15 and Sand Equivalent greater than 20) that is uniform in thickness and of consistent quality.

The footings for these structures are usually 12 to 18 inches wide and are typically founded 12 to 24 inches below the lowest adjacent finish grade. An 24-inch thick pad of compacted engineered fill is recommended below the bottom of the footing to mitigate expansive conditions. This compacted engineered fill under the footings should also extends B/2 (where B is the width of the footing) beyond the edges of the footing.

Lime treating the upper soils may also be considered to mitigate the expansive soil conditions at the site if the site conditions can accommodate the construction operation. Expansive soils are usually treated with 4 to 5 percent lime by weight. The lime treatment should extend at least 24 inches below the footing bottom.

For preliminary design, footings supported in the manner described above may be designed for an allowable bearing capacity of 3000 psf for dead plus live loads. These values of allowable bearing capacities may be increased by one-third for transient wind or seismic loads.

Grade beams that are used between isolated column footings and wall footings are designed with the assumption that no support may be gained from any soil in contact with beam. The grade beams are also placed on about 6 inches of styrofoam material to allow for expansion of the underlying clays where they are constructed on native expansive soils.

When the total area of the footings is more than about 50 percent of the building footprint area, mat foundations may be more economical than spread/continuous footings. Mats do not require slab-on-grade floor. For moderate loadings, mats are usually 1 to 2 feet thick.

Pier and grade beam foundation system may also be used to mitigate expansive soil conditions. This foundation system may be used if lime treatment or fill pad under the spread/continuous footings is not desirable. Recommendations for pier and grade beam foundations are presented in the "Pier & Grade Beam Foundation" subsection of this report.

Excavations for construction of footings and mats may encounter rubble, remnants of old buried footings, etc. This may require additional excavation and replacement of engineered fill and special equipment for removal.

Pier & Grade Beam Foundation

Lightly and moderately heavy column loads may alternatively be supported on a pier and grade beam type foundation. Pier and Grade beam foundations may also be used to mitigate expansive soil conditions at the site. Twelve to 16-inch diameter concrete piers are typically used for this type of foundation system. The piers are typically embedded at least 8 feet into the native soils to mitigate expansive soil conditions.

Allowable skin friction for the design of the concrete piers is anticipated to be about 400 pounds per square foot for dead load and live loads. This may be increased by one-third for transient loads such as wind loads and earthquake loads. The piers are typically spaced at a minimum distance of three times of diameter of the piers measured on centers.

The grade beams which carry the loads between the columns are designed with the assumption that no support may be gained from any soil in contact with the beam. The grade beams are placed on at least 6 inches of Styrofoam material to allow for expansion of the underlying clays.

Groundwater is anticipated for pier excavations deeper than about 10 feet. This may cause sloughing of the pier excavation walls and may result in difficult installation conditions. Temporary casings are usually provided to mitigate these conditions. Presence of groundwater in the excavations may cause delays in pier construction resulting in additional costs due to additional cleaning and dewatering efforts.

Where piers are drilled through existing fill, concrete rubble, fragments of concrete, rocks, wood, bricks, etc. may be encountered. These may cause difficult drilling conditions and may require special equipment for removal. These conditions can be further investigated during a site specific study.

Driven Pile Foundation

Heavier buildings such as multi-story buildings and parking structures and the pedestrian bridge may be supported on driven piles. Various types and sizes of piles could be used for the project, however, commonly used 12-inch square prestressed concrete piles were evaluated for the feasibility study. For 45-ton and 70-ton capacity piles, 30-35 feet and 40-45 feet long piles below the pile footings, respectively are anticipated. The number of piles per pile cap will depend on the actual structural loads. The piles are usually driven with center-to-center spacing of at least three times the minimum pile dimension. This corresponds to approximately 3-foot spacing for 12-inch square piles.

In general, hard driving conditions and obstruction to piling due to presence of concrete rubble, remnants of old foundations, etc. are anticipated during pile installation. Predrilling is usually used to mitigate hard driving conditions. Predrilling also aids in achieving uniform pile penetration and minimizing pile cut off. Predrilling is also advantageous in reducing ground heave, particularly near the existing buildings, by removing soil that must be displaced by the piles; in locating obstructions if any; and in minimizing the effects of vibration and noise related to pile driving. Cavings may be encountered during predrilling operations in the sand layers below the groundwater table. Generally, indicator piles are driven prior to production pile driving to evaluate hard driving and predrilling conditions and to estimate the pile lengths at the site. Vibration/noise control may be required during pile driving close to an existing structure.

Cast-In-Drilled-Holes (CIDH) Pile Foundations

Cast-in-drilled-holes may also be used to support relatively heavy structures. These structures may be supported on 24-inch diameter, CIDH piles. Using a 24-inch diameter pile, we anticipate a 30-35 feet long pile below the pile cap for 45-ton capacity and a 40-45 feet long pile below the pile cap for 70-ton capacity. A minimum center-to-center pile spacing of three times pile diameter is typically used. The number of piles per column will depend on actual loading conditions.

Groundwater is anticipated during CIDH pile construction. This may cause sloughing of the pier excavation walls and may result in difficulty during installation. Temporary casings are usually provided to mitigate these conditions. Presence of groundwater in pile excavations may cause delays in pile installation resulting in additional costs due to additional cleaning and dewatering efforts.

Where the piles are drilled through existing fill, concrete rubble, fragments of concrete, rocks, wood, bricks, etc. may be encountered. These may cause difficult drilling conditions and may require special equipment for removal.

Slab-On-Grade

Due to expansive soil conditions, the slab-on-grade should be supported on about 12 inches of compacted engineered fill (excluding the moisture barrier and the capillary break).

Concrete slab-on-grade on expansive soils are typically 6 inches thick and are provided with minimum reinforcement of 6 x 6 #6 welded wire mesh or the equivalent in deformed bars. Structural requirements may necessitate a thicker concrete slab and additional reinforcement.

If moisture migration through the slabs is undesirable, a moisture barrier and capillary break are provided between the slab and the compacted layer of engineered fill. The moisture barrier generally consists of 4-inch of free draining pea gravel or clean crushed rock. A capillary break is generally an impervious membrane between the slab and the moisture barrier. The membrane is covered with a 2-inch layer of sand to protect it during construction. The sand is kept slightly moist just prior to pouring the slab to aid in curing the concrete.

Lime treatment may be considered to improve the soil conditions if the site conditions can accommodate the construction operations. Four to 5 percent lime by weight is usually used for lime treatment. The lime treatment should extend at least 12 inches below the 6 inch vapor barrier provided under the slab.

UBC Seismic Zone and Site Coefficient

The subject site is in Seismic Zone 4, as shown on Figure 23-2 of the UBC. This site is represented by Seismic Coefficient S_2, as described in Table 23-J of the UBC.

Construction Considerations

Temporary Excavations & Shoring

Deep excavations are anticipated for construction of basements planned for the subterranean parking structures. In our opinion, conventional equipment could be used to excavate on-site soil materials. The materials to be excavated will mostly be stiff clays and medium dense to dense sands/gravels. It is possible that unknown old buried utilities are located at the site. It might require special equipment and additional efforts to remove these buried objects.

Groundwater should be expected in excavations deeper than about 10 feet. Excavations should not be expected to stand vertically without any support. According to OSHA Safety Standards, temporary excavations with personnel working within the excavations should be sloped or shored if the excavations are deeper than 5 feet. All excavations side slopes should be made and supported in accordance with OSHA Safety Standards.

All excavations extending beyond the right-of-way or within the zone of influence of existing improvements and facilities will require shoring. The type of shoring system, design of the shoring system, and the performance of the system is generally the responsibility of the Contractor.

Dewatering

As described in the section entitled "Subsurface Conditions", groundwater at the site was encountered at depths ranging from 10 feet to 30 feet below the existing ground surface. Groundwater should therefore be anticipated during basement excavations extending 10 feet below the existing ground surface. Groundwater may cause instability of excavation walls (piping, erosion, etc.), instability of the excavation bottom (blow-outs, piping, etc.) and may also result in difficult working conditions at the bottom of the excavation. Unstable excavation walls and bottom may cause slope failures, damage the shoring system, etc., causing excessive settlements of surrounding ground, damage to adjacent underground and above ground utilities. Excessive water in the excavations may also result in difficult working conditions at the bottom causing subsequent delays in work and/or additional efforts during construction. A dewatering system is usually implemented to mitigate these conditions. Selection of dewatering system, implementation and performance of the dewatering system is usually the Contractor's responsibility. This program should also be developed in conjunction with the environmental constraints and conditions of existing improvements in the area.

Study of geology of the area in the general vicinity of the site and the present investigation revealed the existence of buried stream channels filled with sands, and gravels. Artesian conditions were encountered at these and other locations on the site. Dewatering difficulties should be anticipated at these locations. Possibly hazardous materials may be present where construction dewatering is required. An investigation for subsurface environmental contamination was beyond the scope of our services.

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 site exploration and the assumption that the conditions do not deviate from observed conditions. 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 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. Unanticipated soil conditions are commonly encountered and cannot be fully determined by taking soil samples and excavating test borings; different soil conditions may require that additional expenditures be made during construction to attain a properly constructed project. Some contingency fund is thus recommended to accommodate these possible extra costs.

This report has been prepared for the proposed Fruitvale BART Station - Transit Village project as described earlier, to assist the engineer in the feasibility evaluation of this project. In the event any changes in the design or location of the facilities are planned, or if any variations or undesirable conditions are encountered during construction, our conclusions and recommendations shall not be considered valid unless the changes or variations are reviewed and our recommendations modified or approval by us in writing.

This report is issued with the understanding that it is the designer's responsibility to ensure that the information and recommendations contained herein are incorporated into the project and that necessary steps are also taken to see that the recommendations are carried out in the field.

The findings in this report are valid as of the present date. However, changes in the soil conditions can occur with the passage of time, whether they be due to natural processes or to the works of man, or this or adjacent properties. In addition, changes in applicable or appropriate standards occur, whether they result from legislation or from the broadening of knowledge. Accordingly, the findings in this report might be invalidated, wholly or partially, by changes outside of our control. Therefore, this report is subject to review by the controlling government agencies.

Respectfully submitted,

PARIKH CONSULTANTS, INC.

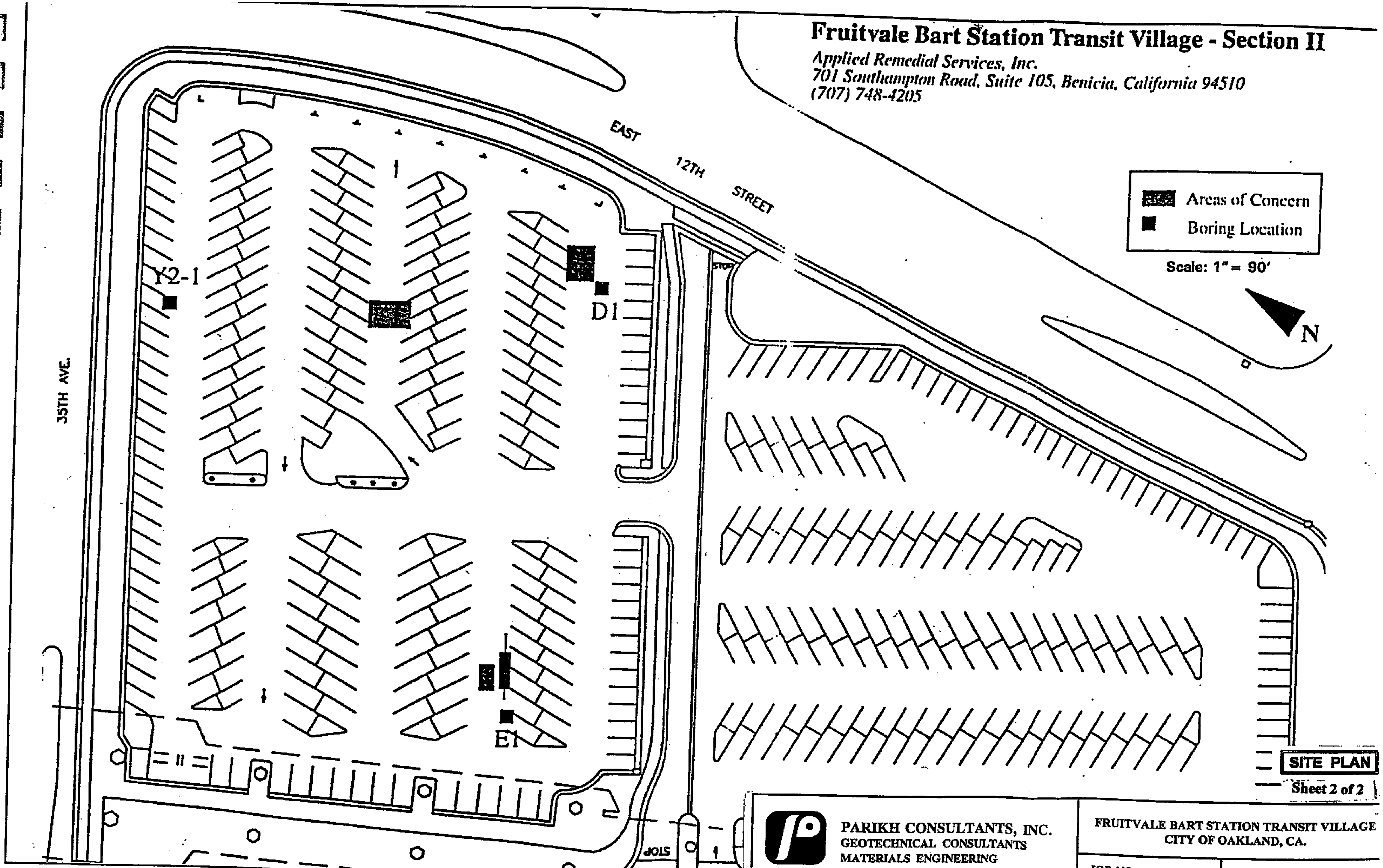
Hemang Desai
Project Engineer
HD/GP 9713410.rpt

PROFESSIONAL ... RANG R. PA... No. 666 EXP. 12-31-97 ... GEOTECHNICAL ...

Gary Parikh, P.E., G.E.#666
Project Manager

Fruitvale Bart Station Transit Village - Section II

Applied Remedial Services, Inc.
701 Southampton Road, Suite 105, Benicia, California 94510
(707) 748-4205



SITE PLAN

Sheet 2 of 2

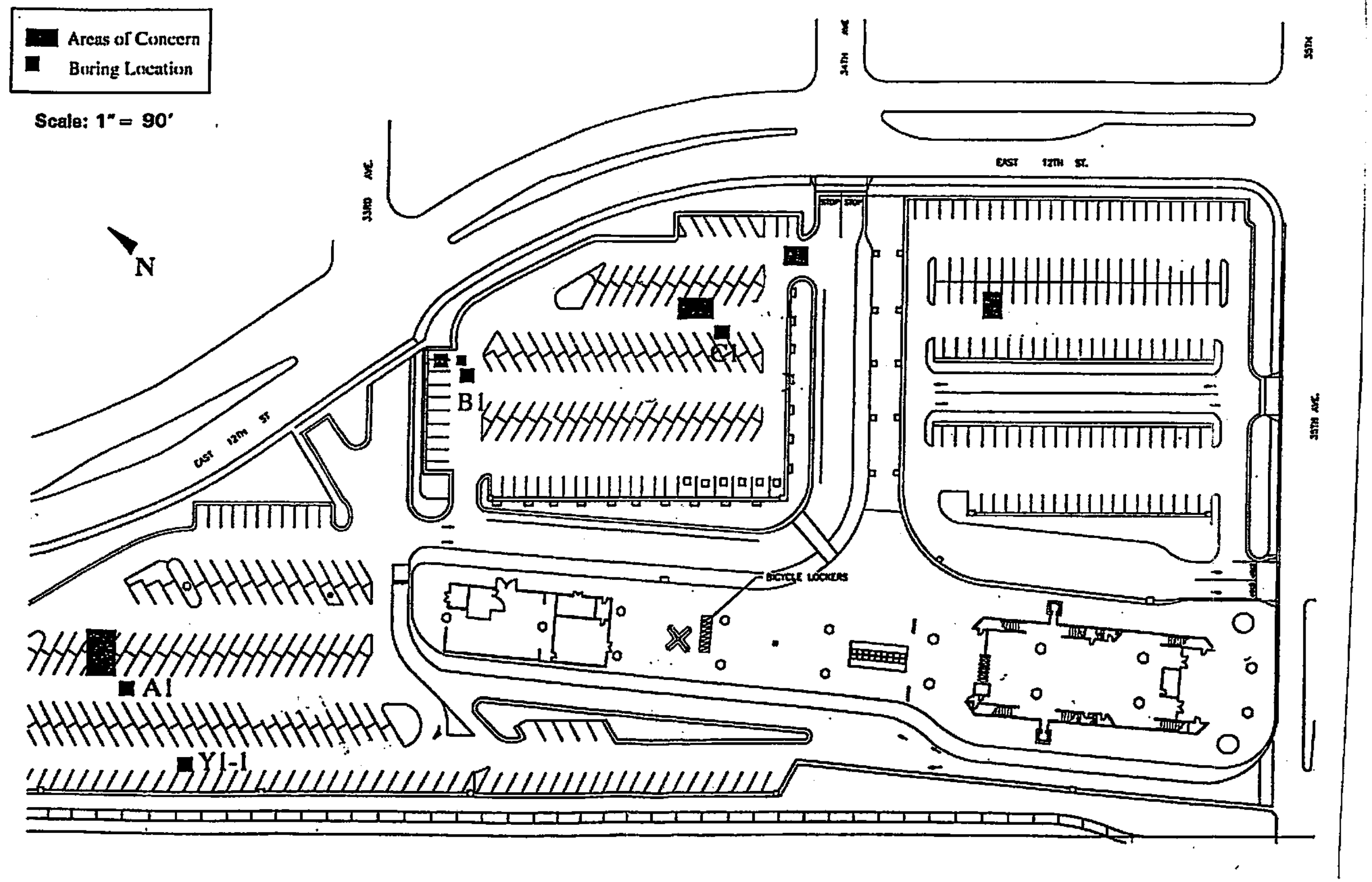
PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

FRUITVALE BART STATION TRANSIT VILLAGE
CITY OF OAKLAND, CA.

JOB NO.: 97134.10 | PLATE NO.: 2

Fruitvale Bart Station Transit Village - Section I

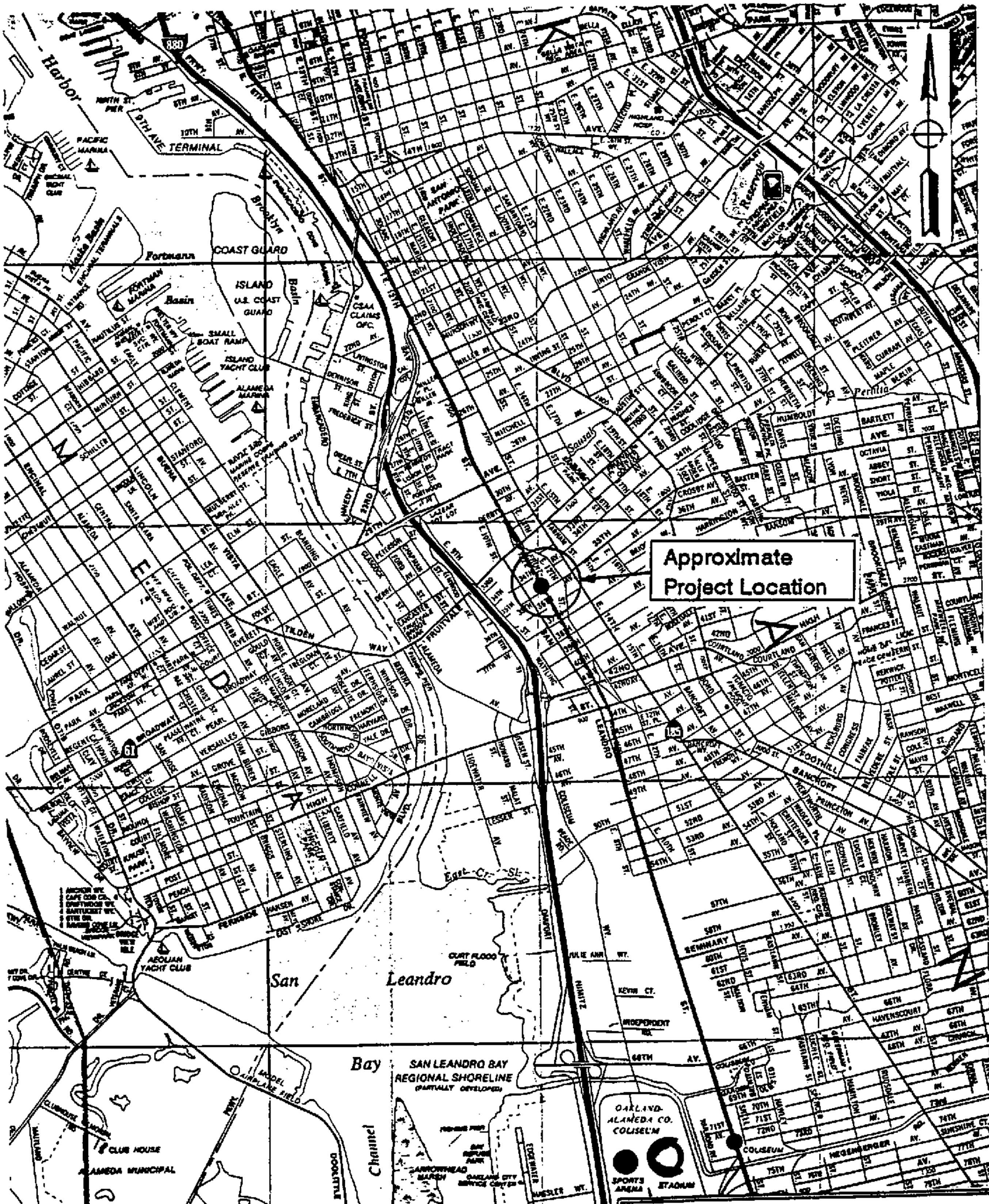
Applied Remedial Services, Inc.
701 Southampton Road, Suite 105, Benicia, California 94510
(707) 748-4205



SITE PLAN

Sheet 1 of 2

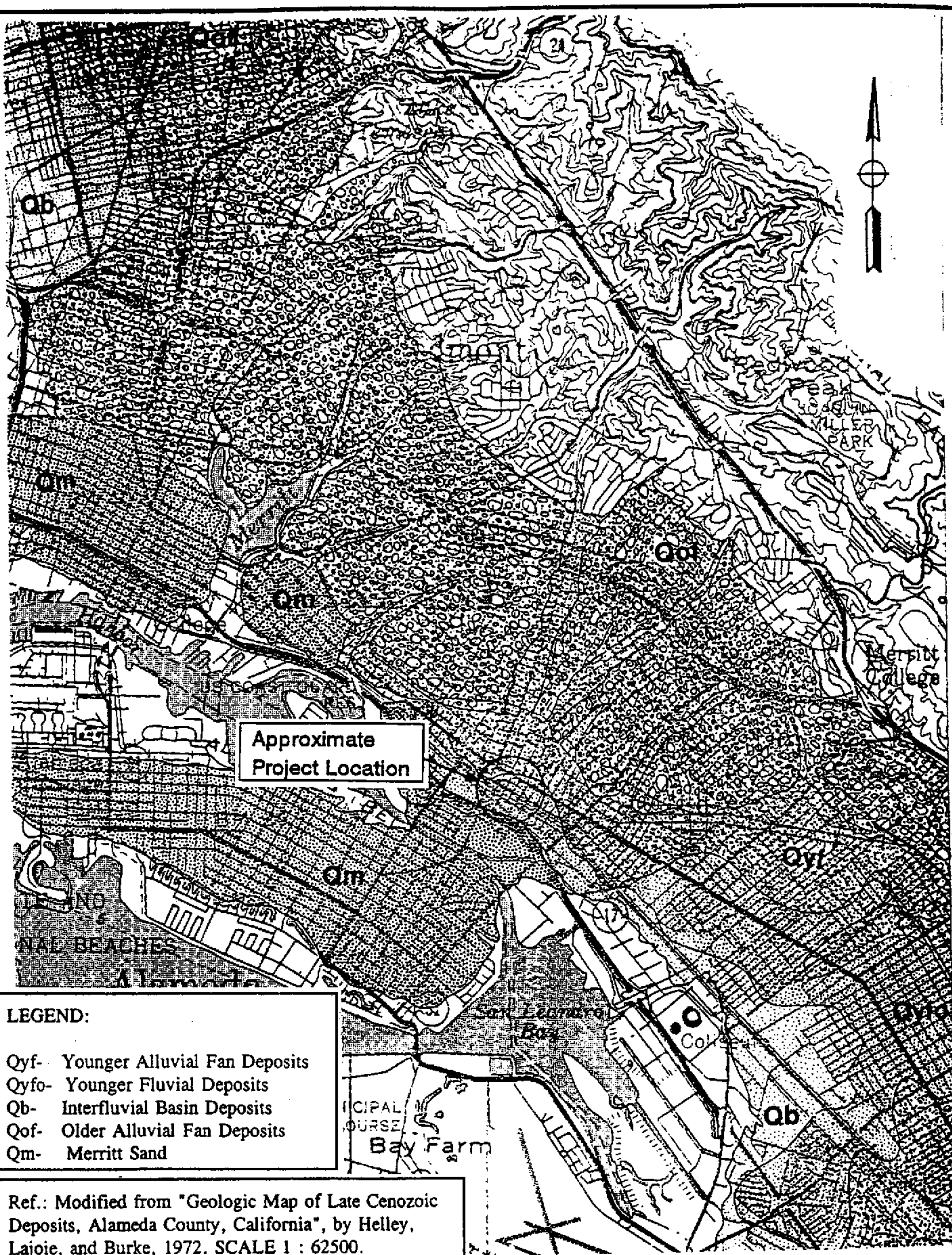
PARIKH CONSULTANTS, INC. GEOTECHNICAL CONSULTANTS MATERIALS ENGINEERING	FRUITVALE BART STATION TRANSIT VILLAGE CITY OF OAKLAND, CA.
JOB NO.: 97134.10	PLATE NO.: 2



PROJECT LOCATION MAP

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

FRUITVALE BART STATION TRANSIT VILLAGE	
CITY OF OAKLAND, CA	
JOB NO. 97134.10	PLATE NO. 1

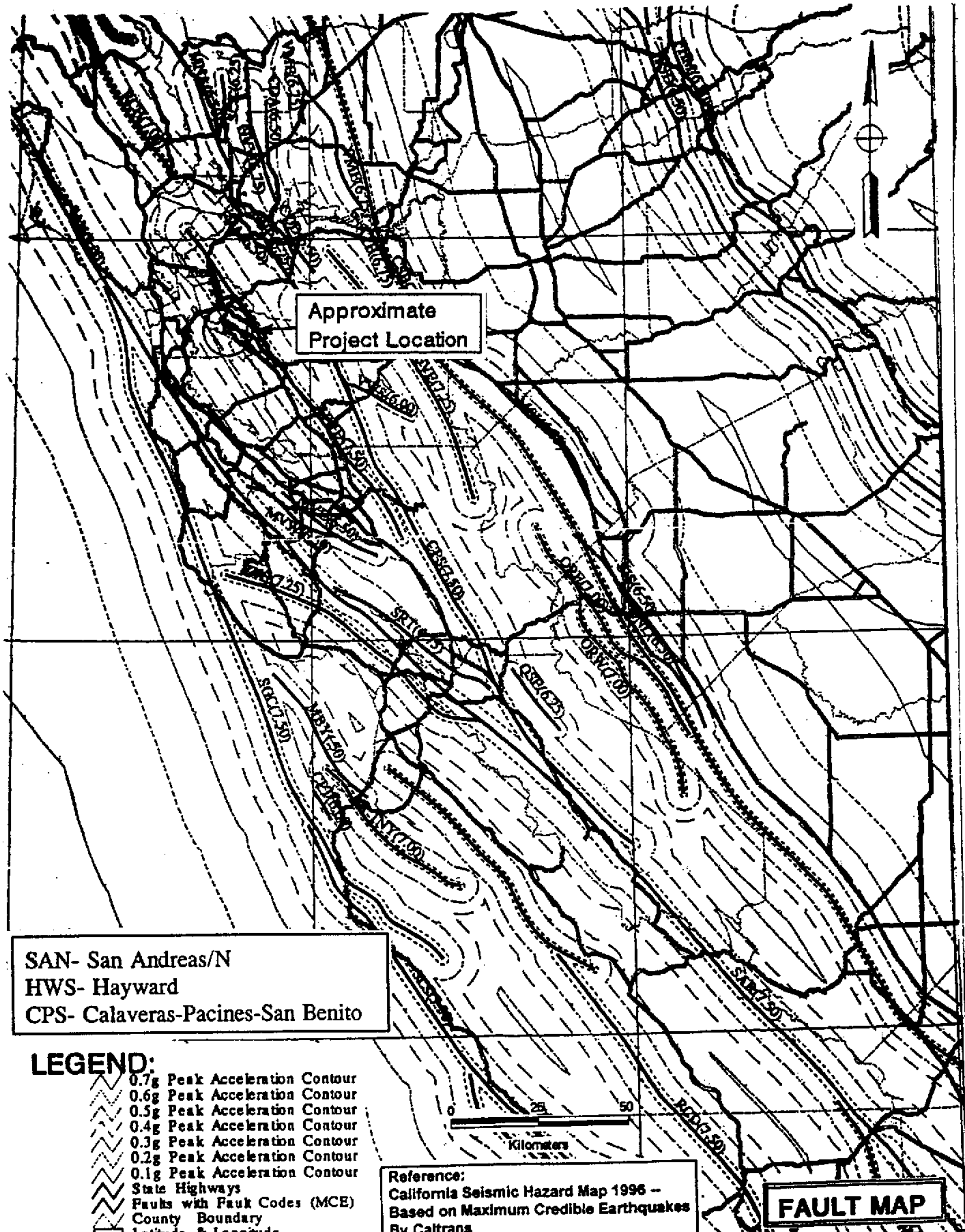


LEGEND:

Qyf- Younger Alluvial Fan Deposits
Qyfo- Younger Fluvial Deposits
Qb- Interfluvial Basin Deposits
Qof- Older Alluvial Fan Deposits
Qm- Merritt Sand

Ref.: Modified from "Geologic Map of Late Cenozoic Deposits, Alameda County, California", by Helley, Lajoie, and Burke, 1972. SCALE 1 : 62500.

PARIKH CONSULTANTS, INC. GEOTECHNICAL CONSULTANTS MATERIALS ENGINEERING	FRUITVALE BART STATION TRANSIT VILLAGE CITY OF OAKLAND, CA
	JOB NO. 97134.10 — PLATE NO. 3



PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

FRUITVALE BART STATION TRANSIT VILLAGE

CITY OF OAKLAND, CA

JOB NO. 97134.10	PLATE NO. 4

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOLS	ILLUSTRATIVE GROUP NAMES
COARSE-GRAINED SOILS More than 50% retained on No. 200 sieve	GRAVELS More than 50% of coarse fraction retained on No. 4 sieve	CLEAN GRAVELS Less than 5% fines	GW	Well graded gravel, Well graded gravel with sand
			GP	Poorly graded gravel, Poorly graded gravel with sand
		GRAVELS WITH FINES More than 12% fines	GM	Silty gravel, Silty gravel with sand
			GC	Clayey gravel, Clayey gravel with sand
	SANDS 50% or more of coarse fraction passes No. 4 sieve	CLEAN SANDS Less than 5% fines	SW	Well graded sands, Well graded sand with gravel
			SP	Poorly graded sand, Poorly graded sand with gravel
		SANDS WITH FINES More than 12% fines	SM	Silty sand, Silty sand with gravel
			SC	Clayey sand, Clayey sand with gravel
FINE-GRAINED SOILS 50% or more passing No. 200 sieve	SILTS AND CLAYS Liquid Limit less than 50%		ML	Silt, Sandy silt with gravel
			CL	Lean clay, Sandy lean clay with gravel
			OL	Organic clay, Sandy organic clay with gravel
	SILTS AND CLAYS Liquid Limit 50% or more		MH	Elastic silt, Sandy elastic silt with gravel
			CH	Fat clay, Sandy fat clay with gravel
			OH	Organic clay, Sandy organic clay with gravel
HIGHLY ORGANIC			PT	Peat, Highly organic silts

NOTE:

1. Coarse-grained soils receive dual symbols if: (a) their fines are CL-ML (e.g. SC-SM or GC-GM) or (b) they contain 5-12% fines (e.g. SW-SM, GP-GC, etc.). Fine-grained solis receive dual symbols if their limits plot in the hatched zone on the Plasticity Chart (CL-ML).
2. The table lists 30 out of a possible 110 Group Names, all of which are assigned to unique proportions of constitents soils. Flow charts in ASTM D 2487-93 aid assignment of the Group Names.

Boring Location, Elevation & Date Drilled:	Drilling Method:	BORING NUMBER **LEGEND**
	Sampling Method:	Sheet 1 of 1

Sample Type & No.	Dry Density (pcf)	Water Content (%)	Blows Per Foot	Compress. Strength (tsf)	Depth (ft) Soil Graph & U.S.C.S.	Description	
					0	Compressive strength as measured by Pocket Penetrometer, in tsf.	pp=1.0tsf
1	110	12	23	1.2	5	2-1/2 inch I.D. Modified California Sampler (MC).	
2	98	28	100 psi	0.8		3-inch I.D. Osterberg Piston Sampler (Pushed).	
					10		
3	-	10	35	-		1-3/8 inch I.D. Standard Splitspoon Sampler (SPT).	
4	95	20		0.7	15	1.9 inch I.D. Hand Sampler driven with a slide hammer.	
						Groundwater level first encountered during drilling	
					20	Groundwater level at completion of boring	
						Liquid Limit (LL), in percent Plasticity Index (PI), in percent	LL=30 PI=10
					25		
						Percent gravel and coarser in sample,(+#4) Percent fines (silt/clay) in sample, (-#200)	+#4=20% -#200=50%
					30		

LEGENED FOR LOG OF BORING

PARIKH CONSULTANTS, INC.
Geotechnical & Materials Engineering

FRUITVALE BART STATION TRANSIT VILLAGE
CITY OF OAKLAND, CA.

Date: 7/96 | Job No.: 97134.10

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

LEGEND LEGEN 8-4-97

Boring Location, Elevation & Date Drilled: See attached Site Plan; Elev. approx. ft.; drilled on 6-28-97	Drilling Method: 8-inch dia. Hollow Stem Auger Mobil, B-61	BORING NUMBER **A-1**
	Sampling Method: 2 1/2 " I.D. Mod. Calif. (MC), 140 lb hammer, 30 inch drop.	Sheet 1 of 2

Sample Type & No.	Dry Density (pcf)	Water Content (%)	Blows Per Foot	Compress. Strength (tsf)	Depth (ft)	U.S.C.S.	Description
					0		2 inch Asphalt Concrete over 2 inch Aggregate Base
						CH	
MC-1	-	-	40				Dark gray FAT CLAY, stiff, moist
						CL	Yellow with rust mottling SANDY LEAN CLAY WITH GRAVEL, hard, moist, gravel up to 2", subangular to angular
					5		
MC-2	117	14	50/4"				
						CL	Yellow/brown, LEAN CLAY with pockets of sand/gravel, very stiff, moist, gravel up to 1", subangular
MC-3	109	18	46	2.85	10		
					▼		
MC-4	-	-	70		15		(No recovery), very stiff
						CL	Brown/gray LEAN CLAY with pockets of medium to coarse sand/gravel, gravel up to 1/2", moist to wet
MC-5	112	14	60	0.85	20		Very stiff, smell of gasoline
						CL	Yellow/brown/gray with mottling LEAN CLAY, trace sand, pockets of fine sand, very stiff to hard, moist to wet
MC-6	110	19	66	2.05	25		
						CL	Yellow/brown SANDY LEAN CLAY, stiff, wet
					▽30		

LOG OF BORING

PARIKH CONSULTANTS, INC.
Geotechnical & Materials Engineering

FRUITVALE BART STATION TRANSIT VILLAGE
CITY OF OAKLAND, CA.

Date: 6/97 | Job No.: 97134.10 | Plate: A-2A

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.

LB 97134 8-4-97

Boring Location, Elevation & Date Drilled:	Drilling Method:	BORING NUMBER
See attached Site Plan; Elev. approx. ft.; drilled on 6-28-97	6-inch dia. Hollow Stem Auger Mobile, B-61	**B-1**
	Sampling Method: 2 1/2 " I.D. Mod. Calif. (MC), 140 lb hammer, 30 inch drop.	Sheet 1 of 1

Sample Type & No.	Dry Density (pcf)	Water Content (%)	Blows Per Foot	Compress. Strength (tsf)	Depth (ft)	U.S.C.S.	Description	
					0		2 inch Asphalt Concrete over 6 inch Aggregate Base	
						CH	Dark gray FAT CLAY, trace sand, stiff, moist	
					5	CL	Yellow/gray with orange mottling LEAN CLAY, trace medium to coarse gravel, hard, moist to dry	
MC-1	113	11	65					
					10	GC	Yellow brown CLAYEY GRAVEL WITH SAND, gravel up to 1.5", dense, moist	+#4=11 -#200=17%
MC-2	122	12	45					
						CL	Grayish yellow LEAN CLAY WITH SAND, trace fine gravel, medium stiff to stiff, moist	
MC-3	103	22	30	1.0	15		Gray coloration, stiff, moist to wet, trace coarse sand and fine gravel, smell of gasoline	
					20		Boring terminated at 20 feet. Groundwater was not encountered at the time of drilling.	
					25			
					30			

LOG OF BORING

FRUITVALE BART STATION TRANSIT VILLAGE
CITY OF OAKLAND, CA.

PARIKH CONSULTANTS, INC.
Geotechnical & Materials Engineering

Date: 6/97 Job No.: 97134.10

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Plate: A-3

LB 97134 8-4-97

Boring Location, Elevation & Date Drilled:	Drilling Method:	BORING NUMBER
See attached Site Plan; Elev. approx. ft.; drilled on 6-21-97	6-inch dia. Hollow stem Auger Mobile, b-61	C-1
	Sampling Method: 2 1/2 " I.D. Mod. Calif. (MC), 140 lb hammer, 30 inch drop.	Sheet 1 of 1

Sample Type & No.	Dry Density (pcf)	Water Content (%)	Blows Per Foot	Compress. Strength (tsf)	Depth (ft)	U.S.C.S.	Description	
					0		2 inch Asphalt Concrete over 4 inch Aggregate Base	
						CH	Dark gray/black FAT CLAY, stiff, moist to dry	
MC-1	115	36	44		5	CL	Yellow/brown with rust mottling LEAN CLAY, trace fine gravel and coarse sand, stiff to very stiff, moist	
MC-2	108	19	34	0.6	10	CL	Yellow/brown with mottling LEAN CLAY WITH SAND, pockets of sand/gravel, gravel up to 1", medium stiff to stiff, wet	
MC-3	112	18	44		▽ 15		Trace sand/gravel, angular	+#4=0% -#200=74%
						SC	Yellow/brown CLAYEY SAND WITH GRAVEL, dense, wet	
					20		Boring terminated at 20 feet. Groundwater was encountered at a depth of 15 feet at the time of drilling.	
					25			
					30			

LOG OF BORING

PARIKH CONSULTANTS, INC.
Geotechnical & Materials Engineering

FRUITVALE BART STATION TRANSIT VILLAGE
CITY OF OAKLAND, CA.

Date: 6/97 | Job No.: 97134.10

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Plate: A-4

LB 97134 6-4-97

Boring Location, Elevation & Date Drilled: See attached Site Plan; Elev. approx. ft.; drilled on 6-29-97	Drilling Method: 6-inch dia. Hollow Stem Auger Mobil, B-61	BORING NUMBER D-1
	Sampling Method: 2 1/2 " I.D. Mod. Calif. (MC), 140 lb hammer, 30 inch drop.	Sheet 1 of 1

Sample Type & No.	Dry Density (pcf)	Water Content (%)	Blows Per Foot	Compress. Strength (tsf)	Depth (ft)	U.S.C.S.	Description	
					0		2.5 inch Asphalt Concrete over 4 inch Aggregate Base	
						CH	Dark gray FAT CLAY, stiff, moist	
MC-1	113	9	52		5	CL	Yellow/brown LEAN CLAY, trace sand, hard, dry, coarse to fine sand	
MC-2	114	14	64	3.1	10			
						CL	Grayish green/brown LEAN CLAY WITH SAND, trace fine gravel, very stiff, moist	
MC-3	129	11	54		15 ▽	SW SC	Gray/blue WELL-GRADED SAND WITH CLAY, trace gravel up to 2", wet, medium dense, wet, smell of gasoline	+#4=15% -#200=12%
							Boring terminated at 16.5 feet. Groundwater was encountered at a depth of 15 feet at the time of drilling.	
					20			
					25			
					30			

LOG OF BORING

PARIKH CONSULTANTS, INC.
Geotechnical & Materials Engineering

FRUITVALE BART STATION TRANSIT VILLAGE
CITY OF OAKLAND, CA.

Date: 6/97 | Job No.: 97134.10

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-5

LB 97134 8-4-97

Boring Location, Elevation & Date Drilled: See attached Site Plan; Elev. approx. ft.; drilled on 6-29-97	Drilling Method: 6-inch dia. Hollow Stem Auger Mobil, B-61	BORING NUMBER E-1
	Sampling Method: 2 1/2 " I.D. Mod. Calif. (MC), 140 lb hammer, 30 inch drop.	Sheet 1 of 1

Sample Type & No.	Dry Density (pcf)	Water Content (%)	Blows Per Foot	Compress. Strength (tsf)	Depth (ft)	U.S.C.S.	Description	
					0		2 inch Asphalt Concrete over 6 inch Aggregate Base	
						CH	Dark gray FAT CLAY, stiff, moist	
MC-1	116	14	41	2.85	5	CL	Yellow brown LEAN CLAY, trace fine gravel and sand, very stiff, moist	
MC-2	115	11	39	3.1	10	CL	Yellow/brown with rust mottling LEAN CLAY, trace coarse sand, stiff, moist	
MC-3	115	16	79		15 ▽	SC	Yellow/brown with rust mottling CLAYEY SAND WITH GRAVEL, some gravel pockets, very dense, wet	+#4=18% -#200=14%
							Boring terminated at 16.5 feet. Groundwater was encountered at a depth of 15 feet at the time of drilling.	
					20			
					25			
					30			

LOG OF BORING

PARIKH CONSULTANTS, INC.
Geotechnical & Materials Engineering

FRUITVALE BART STATION TRANSIT VILLAGE
CITY OF OAKLAND, CA.

Date: 6/97 | Job No.: 97134.10

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-6

LB 97134 8-4-97

Boring Location, Elevation & Date Drilled:
See attached Site Plan; Elev. approx. ft.; drilled on 6-28-97

Drilling Method:
6-inch dia. Hollow Stem Auger
Mobil, B-61

BORING NUMBER
Y1-1

Sampling Method:
2 1/2 " I.D. Mod. Calif. (MC), 140 lb hammer, 30 inch drop.

Sheet 1 of 1

Sample Type & No.	Dry Density (pcf)	Water Content (%)	Blows Per Foot	Compress. Strength (tsf)	Depth (ft)	U.S.C.S.	Description	
					0		2 inch Asphalt Concrete over 4 inch Aggregate Base	
						CH	Dark gray FAT CLAY, stiff, moist	
						CL	Yellow/brown SANDY LEAN CLAY, medium to coarse sand, stiff, moist	
MC-1	108	18	27	1.4	5			
						CL	Yellow/brown with rust mottling LEAN CLAY, trace sand, stiff, moist	
						SC	Yellow/brown CLAYEY SAND WITH GRAVEL, medium dense, moist, pockets of cemented sand	
MC-2	124	12	43		10			+#4=13% -#200=15%
						CL	Yellow/brown with rust and gray mottling LEAN CLAY, stiff, wet	
MC-3	-	-	31		15		(No recovery)	
MC-4	101	23	40	2.45	20		Very stiff, trace sand	
							Boring terminated at 21.5 feet. Groundwater was not encountered at the time of drilling.	
					25			
					30			

LOG OF BORING

PARIKH CONSULTANTS, INC.
Geotechnical & Materials Engineering

FRUITVALE BART STATION TRANSIT VILLAGE
CITY OF OAKLAND, CA.

Date: 6/97

Job No.: 97134.10

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Plate:
A-7

LB 97134 8-4-97

Boring Location, Elevation & Date Drilled:	Drilling Method:	BORING NUMBER
See attached Site Plan; Elev. approx. ft.; drilled on 6-29-97	6-inch dia. Hollow Stem Auger Mobil, B-61	Y2-1
	Sampling Method: 2 1/2 " I.D. Mod. Calif. (MC), 140 lb hammer, 30 inch drop.	Sheet 1 of 2

Sample Type & No.	Dry Density (pcf)	Water Content (%)	Blows Per Foot	Compress. Strength (tsf)	Depth (ft)	U.S.C.S.	Description	
					0		2 inch Asphalt Concrete over 4 inch Aggregate Base	
						CH	Dark gray/black FAT CLAY, stiff, moist	
MC-1	117	14	44	2.75	5	CL	Yellow/brown with rust mottling LEAN CLAY WITH SAND, very stiff, moist, medium to coarse sand	LL=30% PL=14% PI=16
MC-2	122	11	66		10	SW SC	Yellow/brown WELL-GRADED SAND WITH CLAY, pockets of gravel up to 1.5", dense, partially cemented, wet to moist, angular to subangular	+#4=18% -#200=11%
MC-3	-	-	51		15	CL	Yellow/brown with rust brown mottling LEAN CLAY WITH SAND, coarse to medium, trace fine gravel, stiff, wet to moist (No recovery)	
						CL	Yellow/brown/gray with dark brown mottling LEAN CLAY, stiff, wet	
MC-4	91	31	23	0.6	20			
						CL	Yellow/brown SANDY LEAN CLAY, trace gravel, stiff, wet	
MC-5	105	21	73		25	SC	Yellow/brown with rust mottling CLAYEY SAND WITH GRAVEL, gravel up to 2", pockets of partially cemented subangular clayey gravel, very dense, wet	+#4=4% -#200=36%
					30			

LOG OF BORING

PARIKH CONSULTANTS, INC.
Geotechnical & Materials Engineering

FRUITVALE BART STATION TRANSIT VILLAGE
CITY OF OAKLAND, CA.

Date: 6/97 | Job No.: 97134.10

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-8A

LB 97134 8-4-97

Boring Location, Elevation & Date Drilled: See attached Site Plan; Elev. approx. ft.; drilled on 6-29-97	Drilling Method: 6-inch dia. Hollow Stem Auger Mobil, B-61	BORING NUMBER **Y2-1**
	Sampling Method: 2 1/2 " I.D. Mod. Calif. (MC), 140 lb hammer, 30 inch drop.	Sheet 2 of 2

Sample Type & No.	Dry Density (pcf)	Water Content (%)	Blows Per Foot	Compress. Strength (tsf)	Depth (ft)	U.S.C.S.	Description	
MC-6	105	21	50/6"		30			
						SM	Yellow/brown/gray rust brown SILTY SAND, pockets of poorly graded fine sand, very dense, wet	+#4=0% -#200=42%
						SC	Yellow/brown CLAYEY SAND, trace fine gravel, wet	
MC-7	95	27	62	2.0	35	CL	Yellow/brown with rust mottling LEAN CLAY WITH SAND, hard, wet	
MC-8	-	-	83		40		(No recovery), stiff to hard, trace sand in cuttings	
						CL	Yellow/brown LEAN CLAY, very stiff to hard, wet	
MC-9	122	14	50/3"		45	SC	Yellow/orange/brown CLAYEY SAND WITH GRAVEL, trace fine angular gravel, very dense, wet, pockets sand	
MC-10	119	16	50/4"		50			+#4=13% -#200=20%
							Boring terminated at 51.5 feet. Groundwater was encountered at a depth of 17 feet at the time of drilling.	
					55			
					60			

LOG OF BORING

PARIKH CONSULTANTS, INC.
Geotechnical & Materials Engineering

FRUITVALE BART STATION TRANSIT VILLAGE
CITY OF OAKLAND, CA.

Date: 6/97 | Job No.: 97134.10

Plate: A-8B

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.

LB 97134 8-4-97

APPENDIX B

LABORATORY TESTS

Classification Tests

The field classification of the samples was visually verified in the laboratory according to the Unified Soil Classification System. The results are presented on "Log of Borings", Appendix A.

Moisture-Density

The natural moisture contents and dry unit weights were determined for selected undisturbed samples of the soils in general accordance with ASTM Test Method D 2216-92. This information was used to classify and correlate the soils. The results are presented at the appropriate depths on the "Log of Borings", Appendix A.

Grain Size Classification

Grain size classification tests (ASTM Test Method D 422-63) were performed on selected samples of granular soil to aid in the classification. The results are presented on Plates B-3A to B-3E, "Grain Size Distribution Curves".

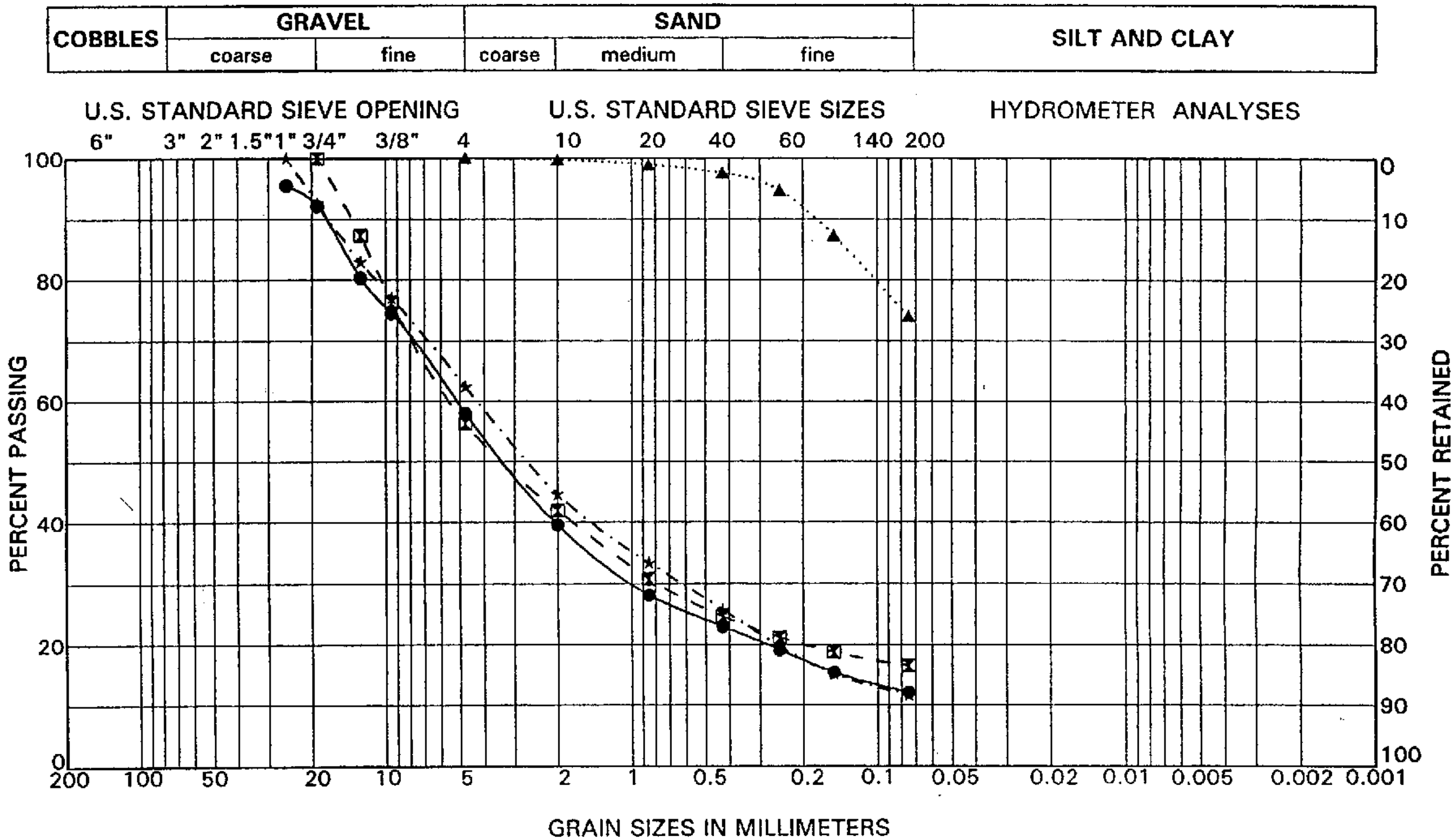
Atterberg Limits

The Atterberg Limits were determined for selected samples of the fine-grained materials. These results were used to classify the soils, as well as to obtain an indication of the expansion potential with variations in moisture content. The Atterberg Limits were determined in general accordance with ASTM Test Method D 4318-93. The results of these tests are presented on Plate B-2 "Plasticity Chart".

Unconfined Compression Tests

Strength tests were performed on selected undisturbed sample using unconfined compression machine. Unconfined compression test was performed in general accordance with ASTM Test Method D 2166-91. The results are presented on "Log of Borings".

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
A-1	8	35.0	●			CLAYEY SAND WITH GRAVEL
B-1	2	10.0	⊠			CALYEY GRAVEL WITH SAND
C-1	3	15.0	▲			SANDY LEAN CLAY
D-1	3	15.0	★			WELL-GRADED SAND WITH CLAY

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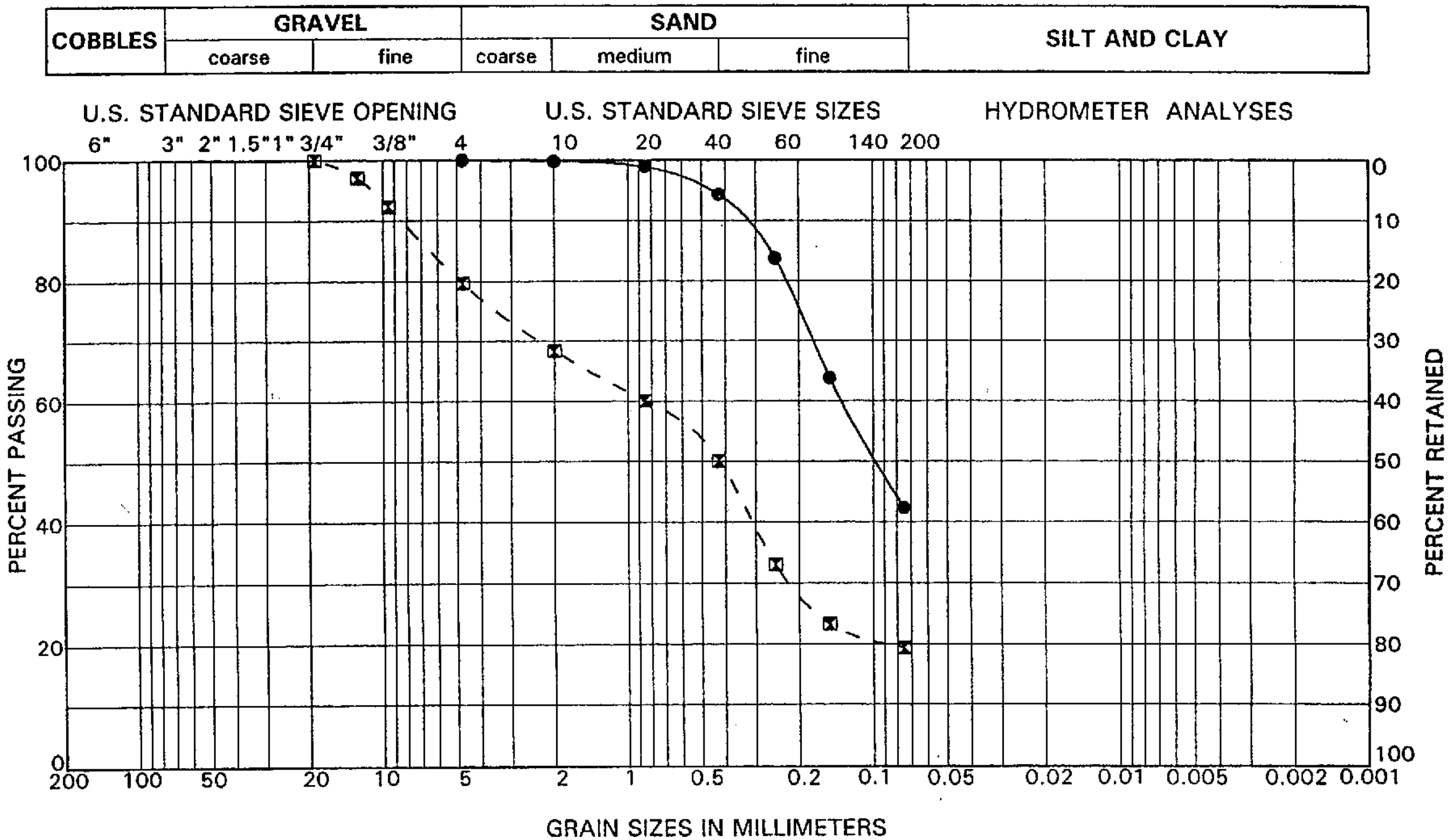
CITY OF OAKLAND, CA.

JOB NO: 97134.10

PLATE NO: B-2A

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
Y2-1	6	30.0	●			SILTY SAND
Y2-1	10	50.0	⊠			CLAYEY SAND

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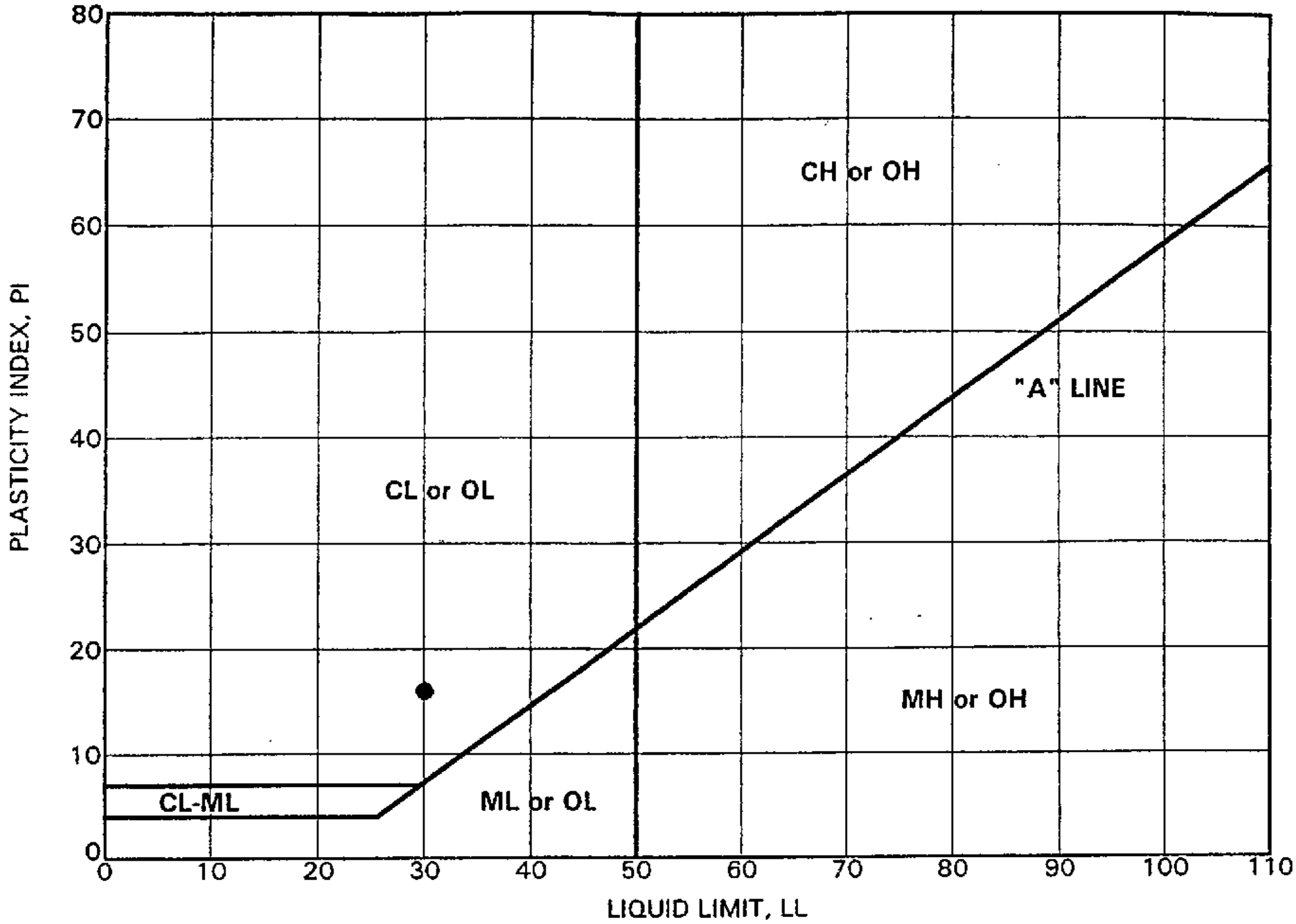
FRUITVALE BART STATION TRANSIT VILLAGE
CITY OF OAKLAND, CA.

JOB NO: 97134.10

PLATE NO: B-2C



PLASTICITY CHART

Boring Number	Sample Number	Depth (feet)	Test Symbol	Moisture Content (%)	LL	PL	PI	Description
Y2-1	1	5.0	●	14	30	14	16	LEAN CLAY

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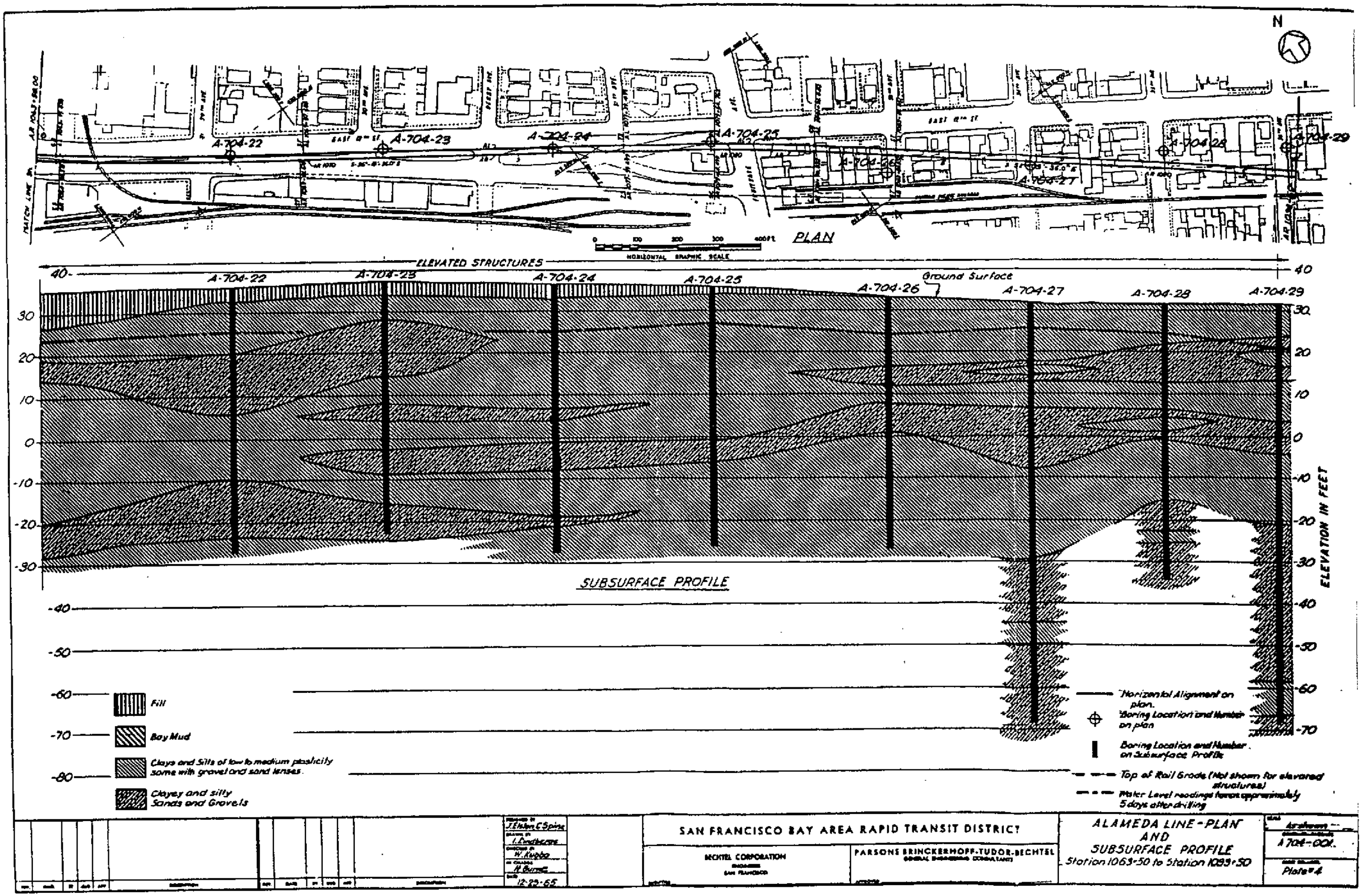
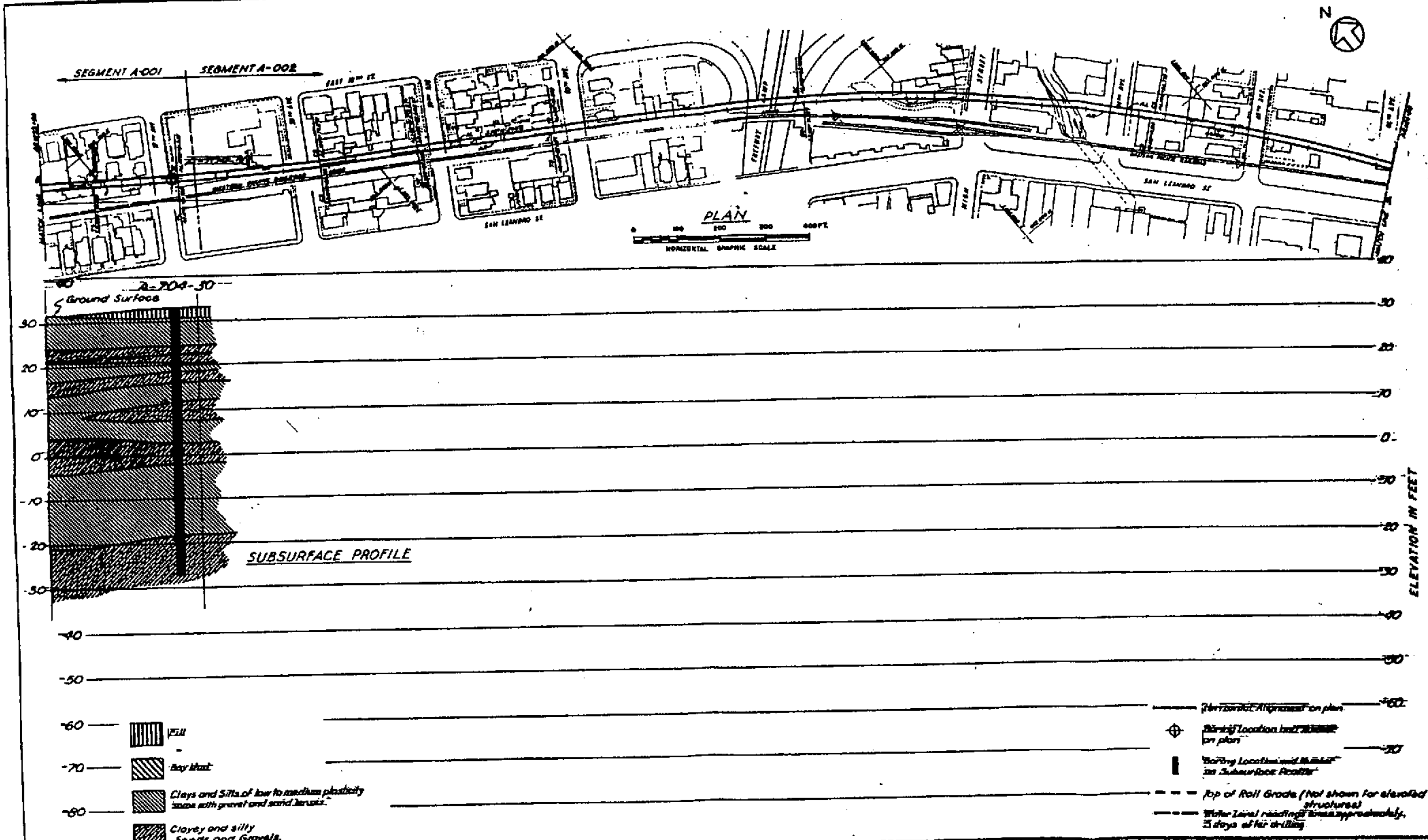
FRUITVALE BART STATION TRANSIT VILLAGE
CITY OF OAKLAND, CA.

JOB NO: 97134.10

PLATE NO: B-3


N
A-704-22
A-704-23
A-704-24
A-704-25
A-704-26
A-704-27
A-704-28
A-704-29
EAST 12TH ST
PLAN
HORIZONTAL GRAPHIC SCALE
0 100 200 300 400 FT
ELEVATED STRUCTURES
Ground Surface
SUBSURFACE PROFILE
ELEVATION IN FEET
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Fill
Bay Mud
Clays and Silts of low to medium plasticity some with gravel and sand lenses.
Clayey and silty Sands and Gravels
Horizontal Alignment on plan.
Boring Location and Number on plan
Boring Location and Number on Subsurface Profile
Top of Rail Grade (Not shown for elevated structures)
Water Level readings taken approximately 5 days after drilling
J. Elston C. Spina
I. Lindberg
W. Kubba
H. Burns
12-23-65
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT
BECHTEL CORPORATION
SAN FRANCISCO
PARSONS BRINCKERHOFF-TUDOR-BECHTEL
ALAMEDA LINE - PLAN AND SUBSURFACE PROFILE
Station 1063+50 to Station 1093+50
As shown
A 704-001.
Plate #4



12-23-65

SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT

BECHTEL CORPORATION

PARSONS BRINCKERHOFF-TUDOR-BECHTEL

ALAMEDA LINE - PLAN AND SUBSURFACE PROFILE

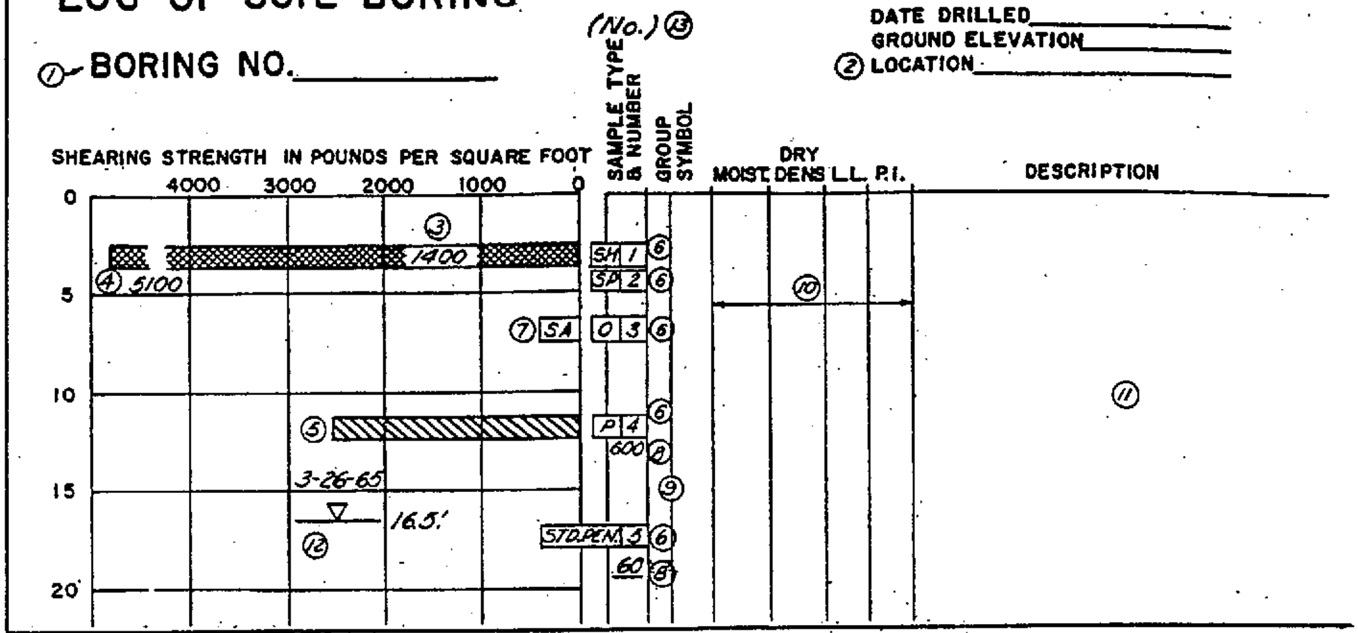
Station 1033+50 to Station 1057+00

As shown

A704-001

Plate 5

LOG OF SOIL BORING



(1) Boring number as shown on plates A-1 thru A-38

(2) Locations by stations.

(3) Lateral pressure for triaxial unconsolidated undrained shear test.

(4) Shearing strength for triaxial test. Values indicated when pressures are over 5000 p.s.i.

(5) Shearing strength for unconfined compression test.

(6) Number in box indicates sample number: Letter designation indicates sampler type : SH = Shelby; SP = Split Spoon; Std. Pen. = Standard Penetration Test; O = Osterberg; P = Pitcher.

(7) Indicates other laboratory tests performed : SA = Sieve Analysis; SG = Specific Gravity; O = Organic Content; C = Consolidation Tests.

(8) Numbers under sample number box indicate driving force : numbers underlined indicate blows per foot; numbers not underlined indicate hydraulic pressure in p.s.i. Where two numbers are shown, this indicates the pressure range.

(9) Group symbol and letter designation based on Unified Soil Classification System.

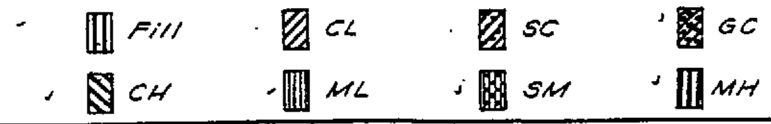
(10) Results of Laboratory Tests.

(11) Material description and remarks; Terminology for consistency of clay is as shown on P.31, Soil Mechanics in Engineering Practice, Terzaghi & Peck

(12) Water level by depth and date.

(13) Weight of hammer used with Split Spoon Sampler:
342 pound hammer with a drop of 15 inches
425 pound hammer with a drop of 18 inches

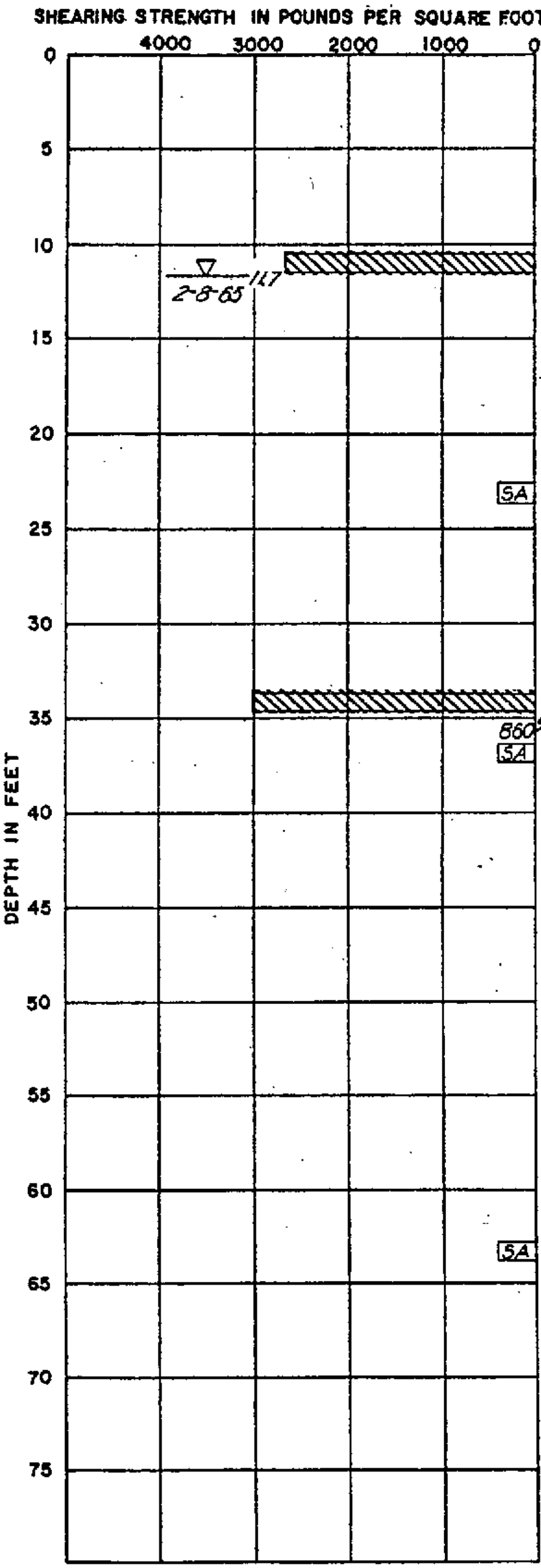
Legend of Symbols:



BECHTEL CORPORATION	KEY TO ALAMEDA LINE SEGMENT A 704-001 BORING LOGS

BORING NO. *A-704-22* (425*)

DATE DRILLED *1-28-65 to 1-29-65*
GROUND ELEVATION *36.21*
LOCATION *STA. 1068 + 20*



Depth (ft)	Sample Type & Number	Group Symbol	Moist.	Dry Dens.	L.L.	P.I.	Description
0							Concrete pavement
							FILL - Clayey gravel
3							CH-CLAY, gray-black, stiff.
6	SH 1 / 680	CH	25.9	98.5	54	33	
9							Some gravel.
11	SH 2 / 660		24.3	101.6	52	31	Grades to very stiff. Color change to gray-brown with black streaks
16	SH 3 / 580		18.1	109.9			SM- SILTY SAND, brown. Sample destroyed @ 21.0' 800 p.s.i.
20							Sandy clay layer, soft, with gravel.
22	SP 5 / 100-300 (SA)	SM	11.3	131.4			Silty, sandy gravel layer.
25							Clay layer, stiff
27							Sample lost @ 27.0' 520 p.s.i.
29	SH 7 / 500-700		17.5	115.0			Clayey sand layer, some gravel
30			20.2	108.1	45	27	CL- SANDY CLAY, yellow, stiff, some sand and gravel
34	SH 8		15.5	118.1	39	21	Clay becomes very stiff.
35	SP 9 / 94 (SA)	CL	16.2	117.8			Clayey Sand layer, yellow-brown. Some gravel.
39							Color change to brown.
41	SP 10 / 98		19.1	111.4	41	24	
45							Sample lost @ 46.0' 650 p.s.i.
46							SM- SILTY SAND Sample lost @ 47.5' 170 blows.
49	SP 12 / 85	SM	18.5	111.5			Medium to fine grained sand with gravel to 2."
55	SP 13 / 74		17.9	113.7			SC-CLAYEY SAND with gravel; Sandy clay layer.
57	SP 14 / 128	SC	18.6	112.1	37	20	
59	P 15 / 500		23.3	103.6			CL- SANDY CLAY, some silt, stiff.
61	SP 16 / 70 (SA)	CL	20.6	108.4	32	13	more sand.
62.5							62.5' Bottom of Hole.

Plate A-23
A 001

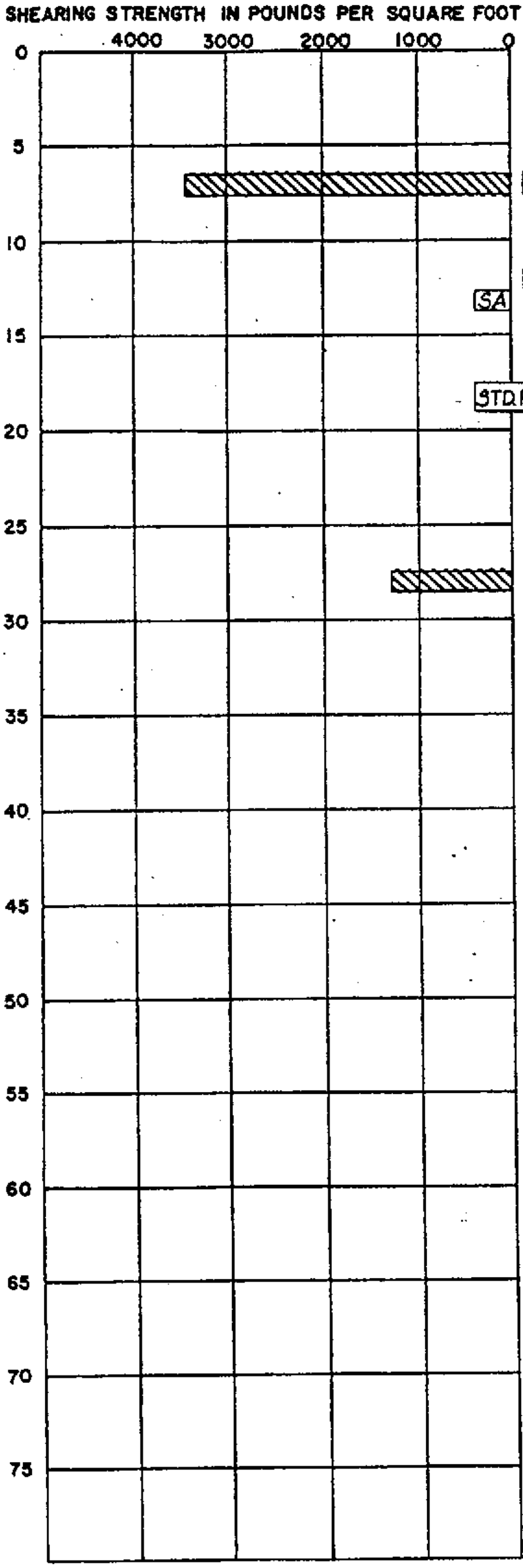
LOG OF SOIL BORING

DRAWN BY: JAK
CHECKED BY: CMS.

BECHTEL CORPORATION

BORING NO. A-704-23 (425*)

DATE DRILLED 2-1-65 to 2-2-65
GROUND ELEVATION 37.19
LOCATION STA. 1071 + 75



SAMPLE TYPE & NUMBER		GROUP SYMBOL	MOIST.	DRY DENS	L.L.	P.I.
SH 1	700	CL	17.5	111.5	36	17
SP 2	31	GC	12.4	126.9		
STD. PEN 4	46	GC				
SP 6	41	CL	29.4	94.7	37	18
SH 7	480 / 620	CL	23.0	103.6	39	21
SP 8	78	CL	14.7	120.4	54	38
SH 9	500 / 660	CL	22.3	105.2	43	23
SP 10	106	SC	18.1	113.2		
SH 11	600 / 680	CL	24.1	100.2	32	10
SP 12	140	SC	17.8	115.0		
SP 13	119	SC	21.1	107.2	36	17

DESCRIPTION

Concrete
FILL - clayey gravel, grading sandy clay
CL SANDY CLAY, brown. very stiff.
GC - SANDY CLAYEY GRAVEL. Gravel to 2½"
Clay layer.
Sample destroyed @ 16.0' 126 blows.
Becomes very dense.
CL - CLAY, gray, stiff, with some black inclusions.
Color change to brown. Gravel layers in clay.
Silty gravelly sand layer, very dense, gravel to ½".
SC - CLAYEY SAND, yellow-gray, some gravel.
CL - SANDY CLAY, with some black inclusions, stiff.
SC - CLAYEY GRAVELLY SAND, brown to yellow w/red inclusions.
Gravel to 2."
Clay layer.
Grading more clay, gray-brown, stiff.
59.5' Bottom of Hole.

NOTE: No water observations were made.

Plate A-24
A001

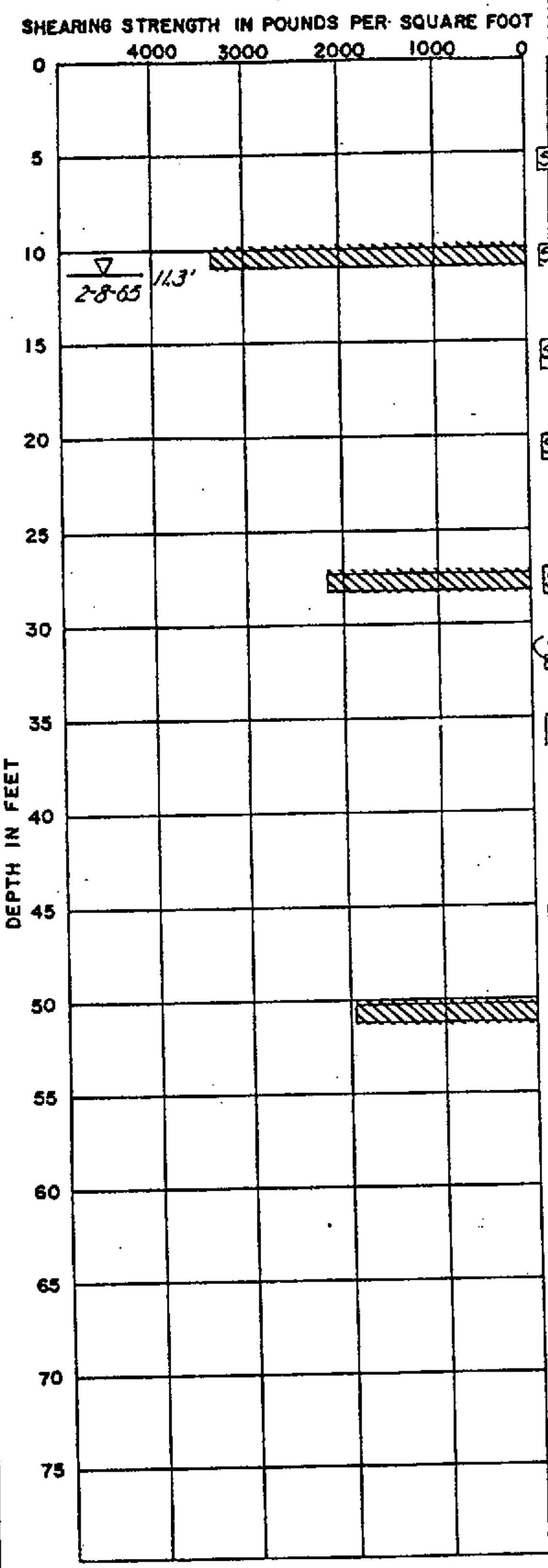
LOG OF SOIL BORING

DRAWN BY: JAK
CHECKED BY: C.H.J.

BECHTEL CORPORATION

BORING NO. A-704-24 (342#)

DATE DRILLED 2-1-65 to 2-2-65
GROUND ELEVATION 36.46
LOCATION STA. 1075+80



Depth (ft)	Sample Type & Number	Group Symbol	Moist.	Dry Dens	L.L.	P.I.	Description
0							Concrete pavement. FILL-clay, asphalt, & gravel, brown-black, loose.
5	SH 1 / 900	CL	12.6	120.9	37	19	CL-SANDY CLAY, orange-tan, stiff, some coarse sand.
10	SH 2 / 750	CL	17.4	114.0	34	17	Grading to clay, very stiff.
15	SH 3 / 700	CL	19.2	111.5	37	20	Grading to sandy clay.
20	SH 4 / 900	CL	20.0	109.9	56	36	Dry, hard, red-orange inclusions.
25		CL					Sample lost @ 25.0' 500 p.s.i. Color change to brown.
27	SH 6 / 600	CL	20.2	108.9	42	26	Sample destroyed @ 31.0' 1000 p.s.i. Gravel to 1."
30	SP 8 / 42	CL	15.2	119.4			Clayey Sand layer. Color change to brown-orange.
			20.1	110.2	40	21	Color change to tan with black streaks. Sand coarse grained.
35	SH 9 / 650	CL	19.6	108.6	50	30	
37		SM					SM-SILTY SAND, dk. brown, fine grained. Sample destroyed @ 40.0'
41	SP 11 / 46	SM	16.8	115.2			Gravel to 3/4"
45	SP 12 / 29	CL	21.3	107.0			CL-SANDY CLAY, orange-brown with black streaks, stiff, some sand & gravel to 1."
			23.8	103.4	45	25	
50	SH 13 / 550	CL	20.2	108.6	38	21	
55		CL					Coarse sand. Sample destroyed @ 55.0' 1000 p.s.i. Clayey gravel layer with red & orange inclusions. Sample destroyed @ 56.0' 240 blows.
58	SP 16 / 77	CL	19.4	110.8	37	19	
62	SP 17 / 63	CL	12.7	90.1	41	24	63.5' Bottom of Hole.

Plate A-25
A 001

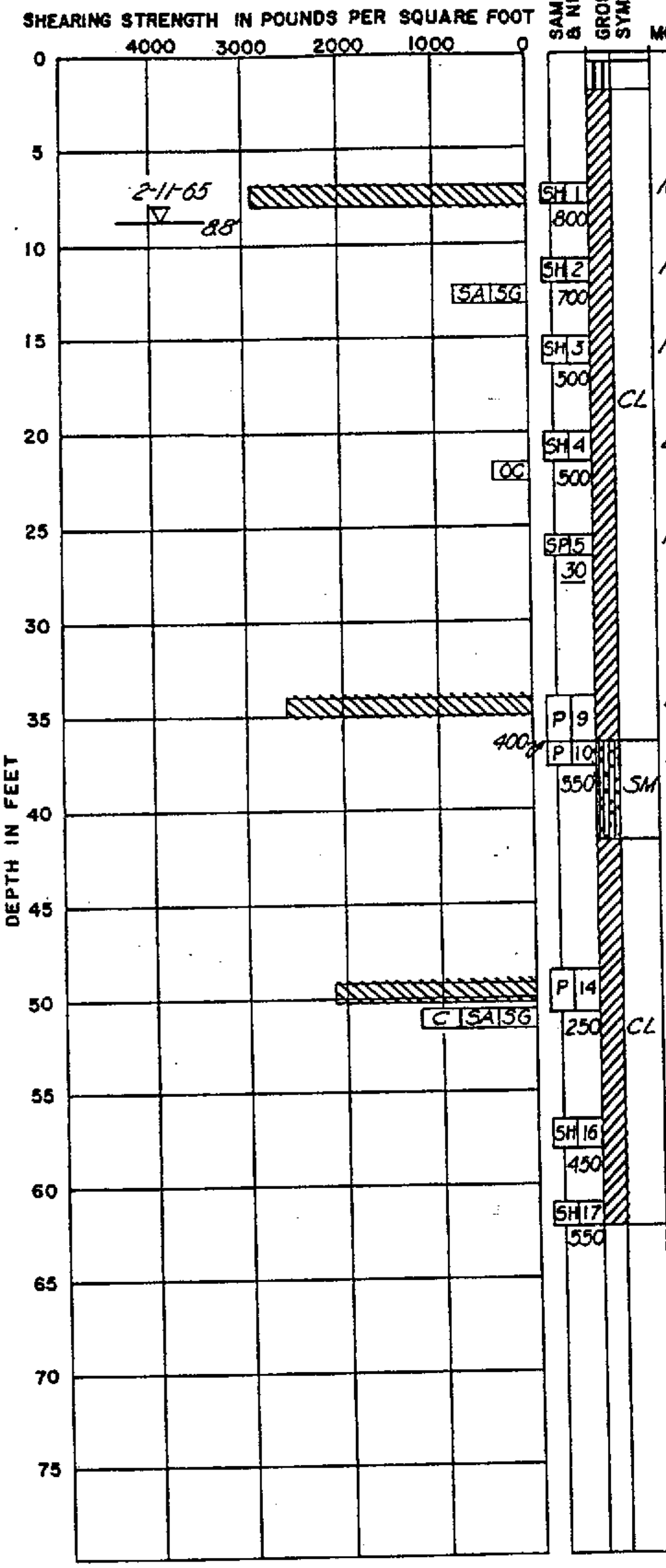
LOG OF SOIL BORING

DRAWN BY: JAK
CHECKED BY: C.M.S.

BECHTEL CORPORATION

BORING NO. A-704-25 (342#)

DATE DRILLED 2-2-65 to 2-4-65
GROUND ELEVATION 35.99
LOCATION STA. 1079+55



Sample Type & Number	Moist.	Dry Dens	L.L.	P.I.
SH 1 / 800	16.0	111.5	25	8
SH 2 / 700	17.4	112.9		
SH 3 / 500	18.6	111.5	38	22
SH 4 / 500	21.8	106.0	32	14
SP 5 / 30	19.7	110.9	48	31
P 9	18.3	113.0	43	27
P 10 / 550	15.0	118.7		
P 14 / 250	23.1	103.3	40	19
SH 16 / 450	29.1	95.7	53	31
SH 17 / 550	30.3	92.9	47	19

DESCRIPTION

Concrete pavement
FILL - sand, gravel, asphalt, clay, brown-black, organic.
CL - SANDY CLAY, green-black. Color change to brown, very stiff.
Color change to gray-brown. Considerable sand, gravel to 3/4".
Loose, with black streaks.
Considerable sand, fine grained.
Sand and gravel layer.
Color change to yellow-brown.
Some coarse to fine sand. Sample lost @ 30.0' 650 p.s.i.
Sample lost @ 33.0' 600 p.s.i. Sample destroyed @ 33.5' 850 p.s.i.
SM - SILTY GRAVELLY SAND, tan-brown.
Gravel to 1."
CL - SANDY CLAY, brown with black streaks, medium. Sample lost @ 41.0' 30 blows Sample destroyed @ 44.5' 500 p.s.i. Sample destroyed @ 46.5' 43 blows.
Grades to very stiff.
Sample destroyed @ 53.5' 300 p.s.i.
Color change to tan.
Color change to gray.
Color change to tan with orange streaks. Considerable silt.
62.3' Bottom of Hole.

Plate A-26
A 001

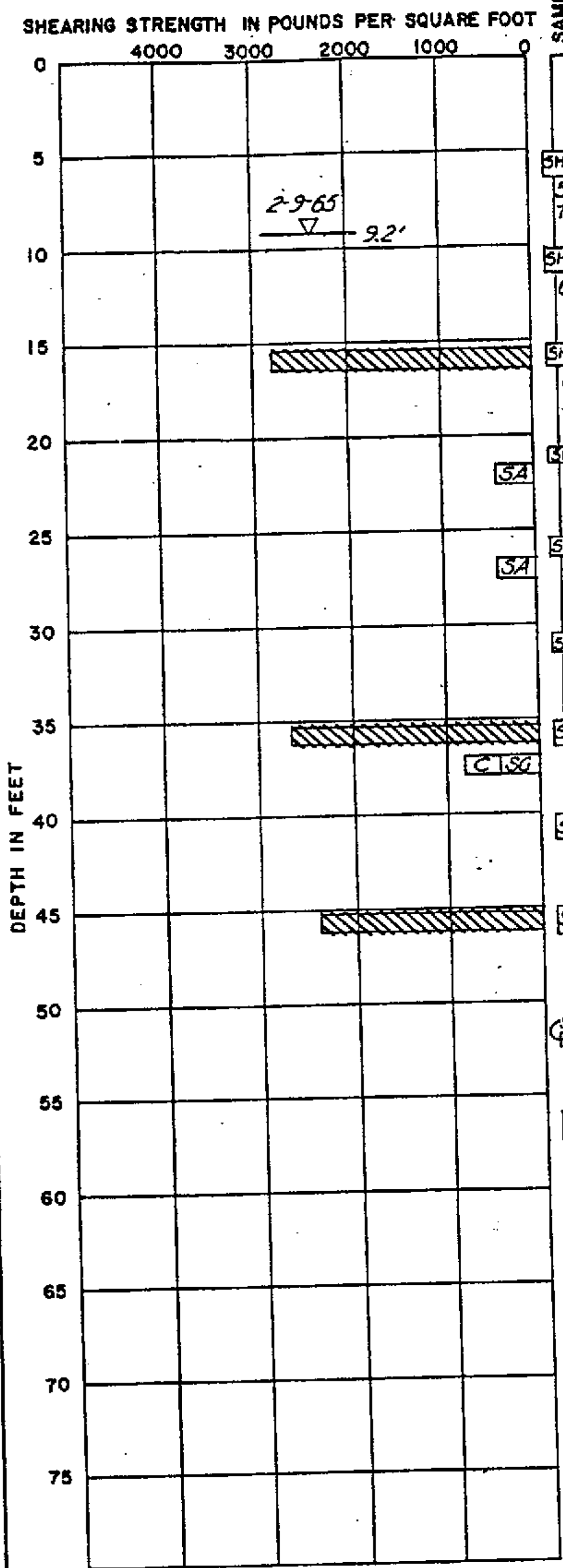
LOG OF SOIL BORING

DRAWN BY: JAK
CHECKED BY: C.A.J.

BECHTEL CORPORATION

BORING NO. A-704-26 (425#)

DATE DRILLED 2-2-65 to 2-3-65
GROUND ELEVATION 33.30
LOCATION STA. 1083+65



Depth (ft)	Sample Type & Number	Group Symbol	Moist.	Dry Dens	L.L.	P.I.	Description
0							Concrete pavement
							CL-SANDY CLAY, black w/yellow streaks, very stiff.
							Color change to yellow.
5	SH 1 / 580 / 720	CL	17.4	114.1	36	20	Some gravelly sand.
10	SH 2 / 620		17.4	115.4	49	32	Color change to gray.
15	SH 3 / 600 / 900		18.1	112.3	35	19	SM-SILTY GRAVELLY SAND, gray-brown. Gravel to 1½," dense.
		SM					
20	SP 4 / 87	CH	23.8	117.1	51	34	CH-CLAY, very stiff, brown, with some black streaks.
25	SH 5 / 500 / 1000	GC	19.1	111.2	37	21	GC-CLAYEY SANDY GRAVEL, brown. Gravel to 1½," dense.
							Color change to yellow, red, & black inclusions
30	SP 6 / 136		11.6	128.7			CL-CLAY, gray, with brown-black inclusions, very stiff.
35	SH 7 / 760	CL	23.9	96.1	45	24	
40	SH 8 / 500 / 660	ML	11.7	105.6	41	14	ML-CLAYEY SILT, brown with yellow streaks
45	SH 9 / 640		21.2	106.0	34	14	CL-SANDY CLAY, brown with yellow streaks, very stiff.
50	SH 10 / 1000	CL	23.0	112.3	54	32	Considerable sand. Color change to brown, with black inclusions.
55	SH 11 / 540 / 800		13.1	110.6	44	19	Color change to gray w/brown streaks. Grading to Silty Clay.
60							60.0' Bottom of Hole.

Plate A-27
A001

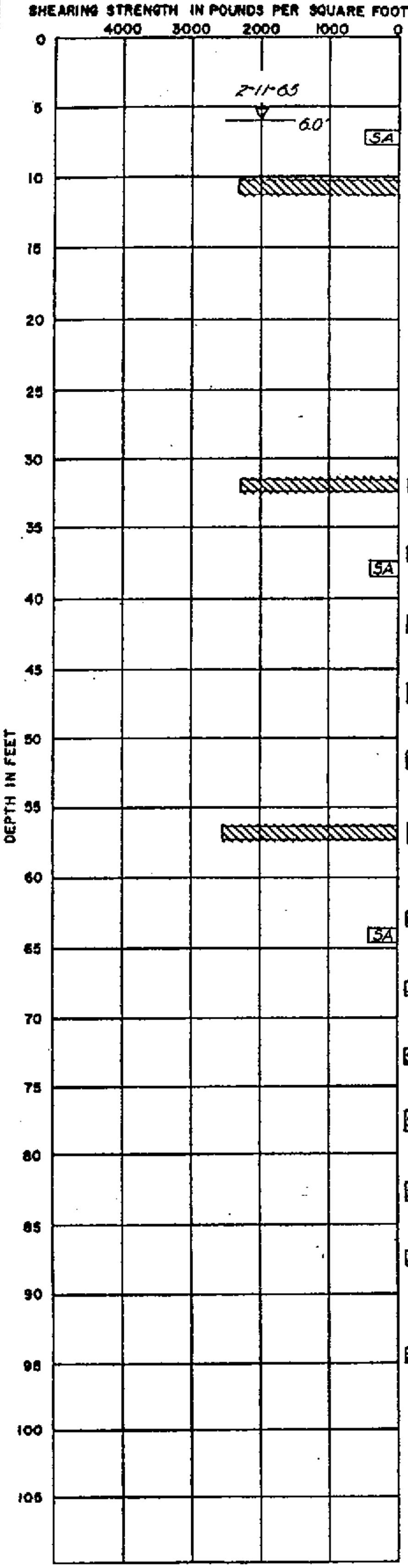
LOG OF SOIL BORING

DRAWN BY: JAK
CHECKED BY: C.M.S.

BECHTEL CORPORATION

BORING NO. A-704-27 (425#)

DATE DRILLED 2-4-65 to 2-5-65
GROUND ELEVATION 31.65
LOCATION STA. 1087+10



SAMPLE TYPE & NUMBER	GROUP SYMBOL	MOIST.	DRY DENS	L.L.	P.I.	DESCRIPTION
						Pavement
						CL-SANDY CLAY, gray-black,
SH 1 500 900		18.5	111.4	44	29	Color change to lt. gray with yellow streaks. Some gravel with sand.
SH 2 540	CL	19.6	109.1	41	25	Very stiff.
						Clayey Gravelly Sand layer.
SP 3 12		25.7	100.3	41	21	Grading to Clay, yellow to brown with black streaks.
						Gravel layer.
SH 4 500 600		18.2	112.2	32	17	Grading to Sandy Clay, brown with some gravel.
SP 5 127		20.4	109.3			SC-CLAYEY SAND, brown-yellow, with gravel to 1," some inclusions.
SH 6 540 860	SC	25.5	95.6	46	24	Clay layer, gray-brown, very stiff, some gravel.
SH 7 600 1000		16.9	104.4			Grading to silty sand, brown, some gravel.
						CL-SANDY CLAY, gray with yellow streaks, very stiff.
SH 8 500 740		19.1	109.9	53	33	
SH 9 540 800		22.5	104.3	49	26	Grading to Clay, very stiff, brown with gray-black streaks. Some gravel.
SH 10 540 780	CL	21.8	103.0	39	18	
SH 11 600 900		19.6	106.3	36	13	Grading to silty clay. Color change to gray with yellow streaks, very stiff.
SP 12 152		12.5	124.7			SC-CLAYEY GRAVELLY SAND, brown. Sand med. grained, dense. Gravel to 1."
SP 13 166		13.8	119.2			Grading to Silty Gravelly Sand. Gravel to 2," dense.
SP 14 95	SC	22.7	103.7			Color change to brown.
SH 15 800		17.6	110.7	33	16	Sandy Clay layer.
		22.6	98.6			
SH 16 1000						
SP 17 200		14.2	118.8			GC-CLAYEY GRAVEL, considerable sand. Gravel to 2.
	GC					Less sand.
SP 18 246		15.3	116.0			Sample destroyed @ 99.0' 115 blows.
						99.7' Bottom of Hole.

Plate A-26
A001

LOG OF SOIL BORING

DRAWN BY: JAK
CHECKED BY: C.H.S.

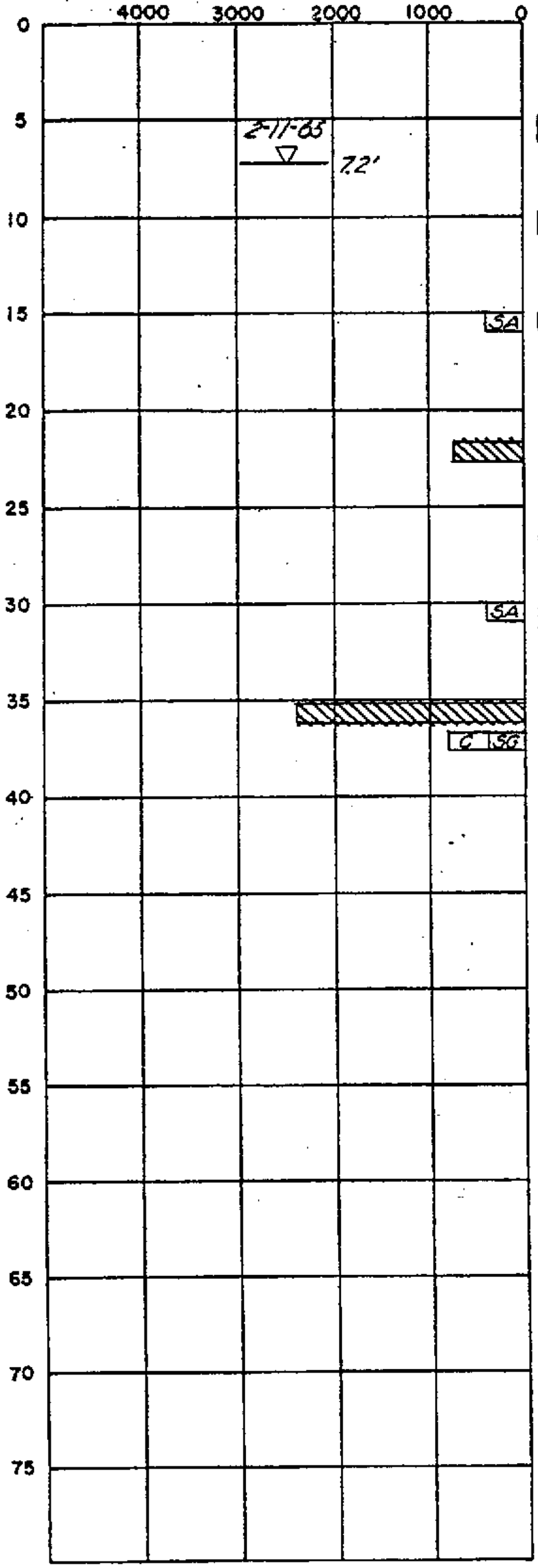
BECHTEL CORPORATION

BORING NO. A-704-28

(342*)

DATE DRILLED 2-4-65 to 2-5-65
GROUND ELEVATION 31.61
LOCATION STA. 1090+20

SHEARING STRENGTH IN POUNDS PER SQUARE FOOT (4000, 3000, 2000, 1000, 0) — DEPTH IN FEET (0–75)



Depth (ft)	Sample Type & Number	Group Symbol	Moist.	Dry Dens.	L.L.	P.I.	Description
0							TOPSOIL. CH-CLAY, black, stiff.
5	SH 1 / 500	CH	21.3	96.3	62	41	Color change to brown-black, medium.
10	SP 2 / 39		9.8	125.0			SM-CLAYEY GRAVELLY SAND Green with inclusions. Gravel to 1".
15	SP 3 / 20	SM	17.7	116.0			Sandy Clay layer. Sample destroyed @ 20.0' 350 p.s.i.
19							CL- SANDY CLAY, (Clay grading to Sandy Clay), brown, medium. Gravel to 3/4".
22	SH 4		26.1	96.6	51	32	
25	SP 5 / 82						Sample destroyed @ 25.0' 350 p.s.i. Clayey Sandy Gravel layer; gravel to 3", sand coarse grained.
30	SH 6 / 650	CL	14.3	113.0	29	15	Clayey sand layer. Some gravel.
35	SH 7 / 800		23.7	101.5	34	10	Sandy Clayey Silt layer, very stiff.
40							Sample destroyed @ 40.0' 650 p.s.i.
43	SH 9 / 400 / 800		21.1	101.0	41	25	Considerable fine grained sand. Sample lost @ 46.0' 800 p.s.i.
47	SP 11 / 100		19.4	116.0			SC-CLAYEY SAND, orange-brown-red. Some gravel and inclusions.
50	SP 12 / 100		12.5	126.0			Clayey gravelly sand layer, loose.
55	SP 13 / 46	SC	24.1	97.5	33	13	Sandy Clay layer, orange-gray. Some gravel.
60	SH 14 / 900		18.3	104.0			Silty Sand layer, orange-tan, fine grained. Sand-gravel layer. Gravel to 1/2".
65	SP 15 / 113		14.1	122.0			65.4' Bottom of Hole

Plate A-29
A 001

LOG OF SOIL BORING

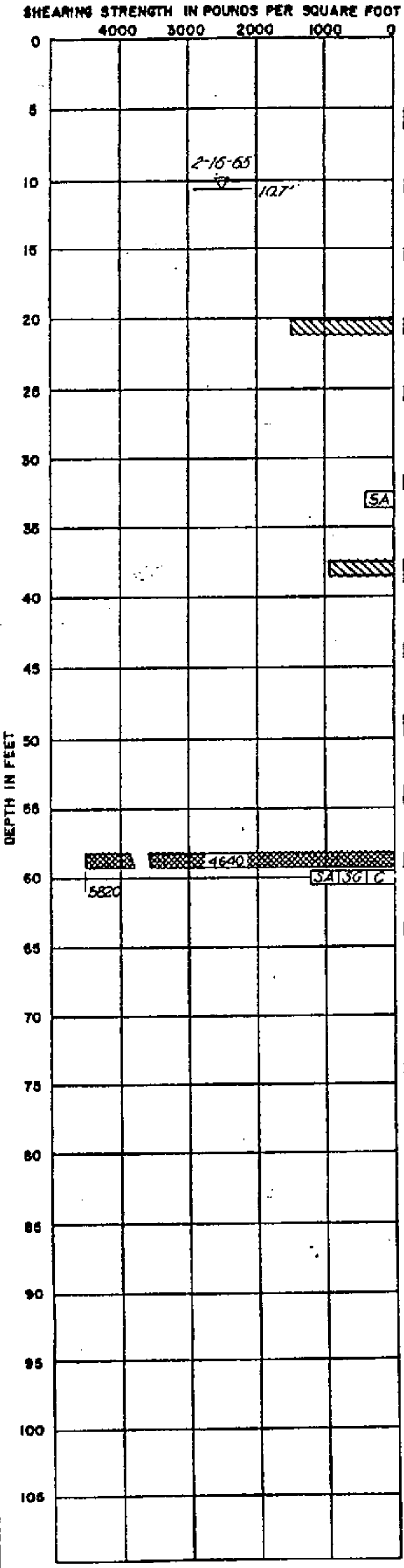
DRAWN BY: J.A.K.
CHECKED BY: C.A.S.

BECHTEL CORPORATION

BORING NO. A-704-29 (425F)

DATE DRILLED 2-5-65 to 2-8-65
GROUND ELEVATION 30.81
LOCATION STA. 1093 +20

SHEARING STRENGTH IN POUNDS PER SQUARE FOOT



Sample Type & Number	Group Symbol	Moist.	Dry Dens.	L.L.	P.I.
SH 1 / 850	CL	19.5	108.0	51	32
SH 2 / 34	GC	18.1	115.0		
SH 3 / 700 / 800	SC	16.4	109.5	45	24
SH 4 / 650	CL	21.1	106.0	40	23
SP 5 / 63	CL	30.9	92.7	67	43
SP 7 / 152	SC	14.3	121.5		
SH 9 / 820	CH	35.6	95.7	54	30
SP 11 / 79	CH	21.2	106.5		
SH 12 / 1000	CH	16.0	115.5	48	26
SH 13 / 720	SC	21.9	103.8		
SH 14 / 880	SC	19.6	102.4		
SP 15 / 260	SC	13.3	120.5		
SP 16 / 184	SC	13.0	123.1		
SP 17 / 237	SC	13.8	121.8		
SP 19 / 169	SC	17.1	112.8		
SH 20 / 301	SC	19.7	107.0		
SP 21 / 160	CL	14.5	126.5	47	25
SP 23 / 266	CL	21.5	105.3	32	9
SP 24	SM	15.3	120.0		

DESCRIPTION

- CL-SANDY CLAY, gray-black, organic, stiff.
- Color change to brown.
- GC-CLAYEY SANDY GRAVEL.
- CL-SANDY CLAY, stiff.
- SC-CLAYEY SAND, with gravel, some silt.
- CL-SANDY CLAY, light brown, stiff.
- Gravel layer.
- Grading to clay.
- SC-GRAVELLY CLAYEY SAND, Sample destroyed @ 30.0' 1000 p.s.i.
- Sample lost @ 36.0' 800 p.s.i.
- CH-CLAY, lt. brown, medium.
- Sample destroyed @ 42.5' 600-1000 p.s.i.
- Clayey Gravelly Sand layer, dk. brown.
- Grading to Sandy Clay.
- Considerable sand.
- SC-CLAYEY SAND, lt. brown.
- Sandy Clay layer, very stiff.
- Clayey gravelly sand layers. Gravel to 1."
- Silty Gravelly Sand layers.
- Some Silty Sand.
- Sample destroyed @ 78.5' 1000 p.s.i.
- Occasional sandy clay layers. Gravel to 1." Some silty sand.
- CL-SANDY CLAY, brown, stiff.
- Gravel layer
- Sample destroyed @ 94.0' 600-1000 p.s.i.
- Color change to gray-brown, some silt.
- SM-SILTY SAND Some gravel.
- 100.0' Bottom of Hole.

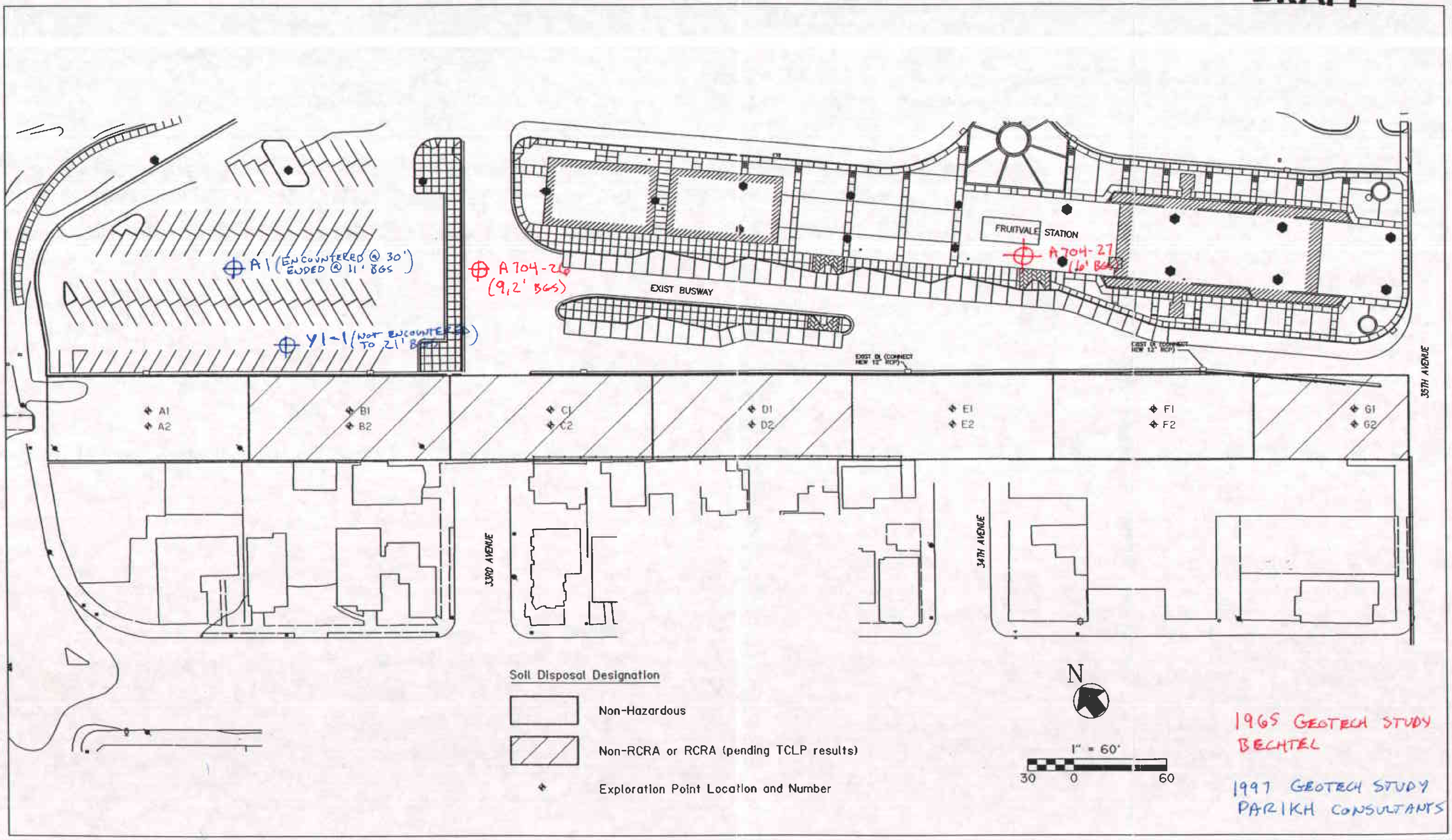
Plate A-30
ACOI

LOG OF SOIL BORING

DRAWN BY: JAK
CHECKED BY: CMS

BECHTEL CORPORATION

DRAFT



GROUNDWATER DEPTHS

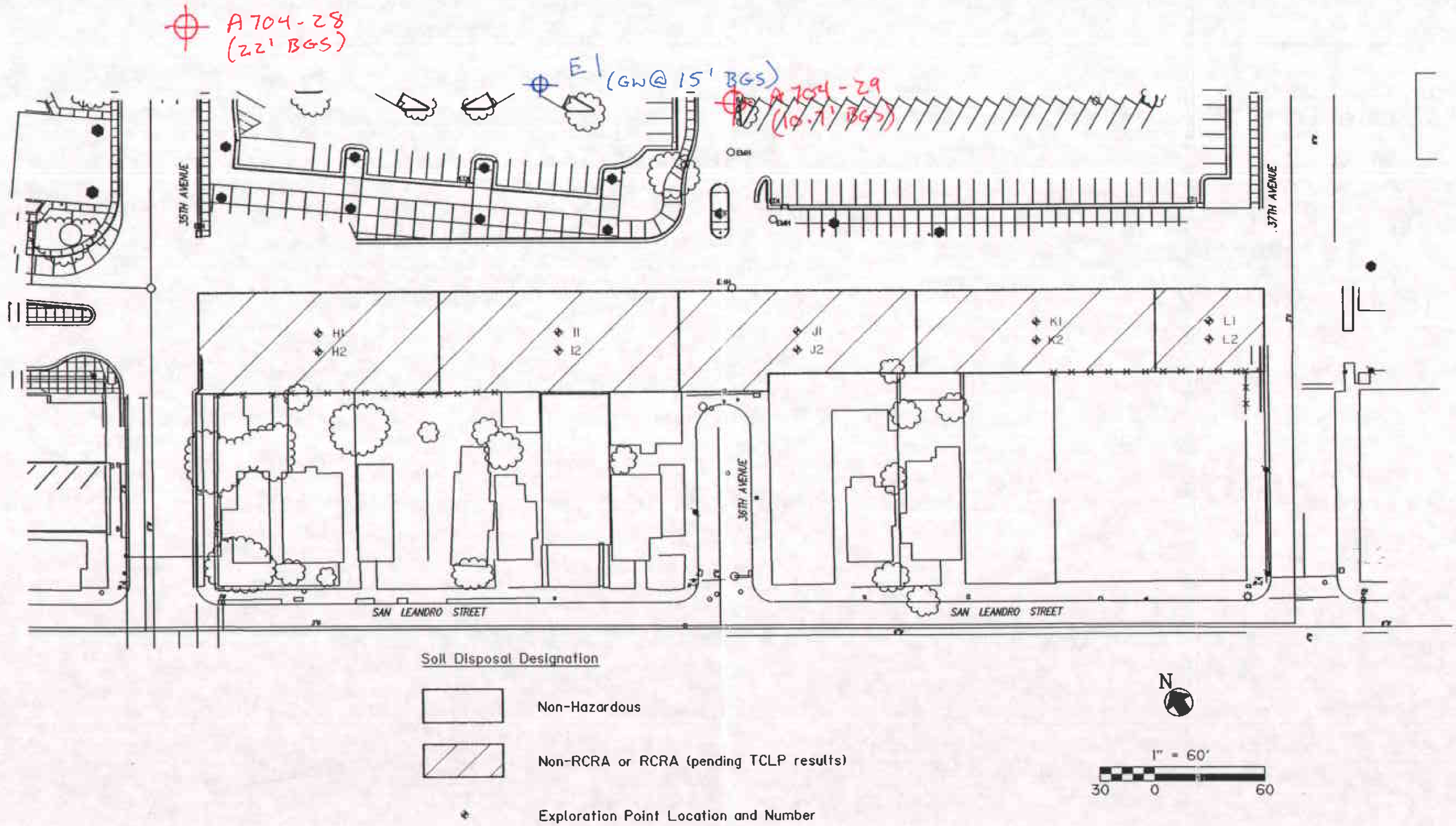
Sample Location Map

Fruitvale Avenue to 35th Avenue
BART Fruitvale Station
Oakland, CA

Figure 2

CDM Camp Dresser & McKee

DRAFT



CDM Camp Dresser & McKee

Sample Location Map

35th Avenue to 37th Avenue
BART Fruitvale Station
Oakland, CA

Figure 3