WALNUT CREEK WATER TREATMENT PLANT
IMPROVEMENTS PROJECT

WALNUT CREEK, CALIFORNIA

GEOTECHNICAL INVESTIGATION REPORT

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by

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I. INTRODUCTION

This report presents the results and recommendations of a geotechnical investigation for site improvements at the Walnut Creek Water Treatment Plant (see Site Vicinity Map, Figure 1). The purpose of the project is to increase treatment capacity at the plant and to upgrade existing facilities to improve system reliability and control.

1. Project Description

The main elements of the project are the construction of two circular pre-stressed concrete tanks, a chemical storage building, a rapid-mix structure, new filters, washwater basins, recycle pump station, various pipelines, and retrofits of several existing structures (see Site Layout, Figure 2). The proposed facilities that require geotechnical investigations include:

Clearwell Tank

Clearwell storage will be provided by replacing the existing 8.3 MG open-cut reservoir with a 16 MG buried, pre-stressed concrete tank within the existing basin. The tank will be approximately 320 feet in diameter, 34 feet high and will have a maximum water depth of 26 feet.

Chemical Contact Chamber

A 5 MG pre-stressed concrete chemical contact chamber to be constructed along a hillside west of the existing clearwell will provide additional clearwell storage. This tank will be 180 feet in diameter, 34 feet high and will have a maximum water depth of 26 feet.

The location of the chemical contact chamber will require that a section of the Briones-Mt. Diablo Trail through the Walnut Creek WTP site will be altered. Additionally, the District's northern access road as well as the raw water influent pipeline will be relocated.

Chemical Storage Building

The proposed chemical storage building will be sited south of the existing clearwell. The proposed building will replace the existing chemical feed facilities, improve the safety and spill containment features, and modernize the chemical feed devices. The chemical storage building will include chemical storage areas, a water quality monitoring area, an electrical room and restrooms. The total building area will be about 16,000 square feet, and about 25 feet in height

with a 10-foot basement along the south and east ends.

South Filters

Two new filters each with a total surface area of 2304 square feet will be constructed to increase the treatment plant net capacity from 60 million gallons per day (MGD) to 91 MGD. Rehabilitation of the existing filters will occur after the new filters are in service. Flocculation also will be incorporated into future plant operations.

South Rapid-Mix Structure

The proposed south rapid-mix structure will be an underground vault approximately 6 feet long by 6 feet wide and 5 feet deep. The top of a proposed 72-inch raw water pipe that will bring aqueduct water to the filters will be 6 feet below the floor of the vault. The vault will house a chemical injection mixer and associated controls for primary coagulant feed, an injection mixer for coagulant polymer feed, a spare injection mixer, and an injection mixer for treatment aid polymer. The various injecting equipment will penetrate the flooring and pipe wall.

Weir Structure

The proposed weir structure is an underground structure 63 feet long by 23 feet wide and 27 feet deep and is located on the 96" filtered water pipeline. The purpose of the weir structure is to provide hydraulic control for the filters.

Blower Building

The proposed blower building structure will be an above ground masonry structure approximately 68 feet long by 29 feet wide and 15 feet high. The building will house scouring air system blower equipment, polymer storage room and transformer. A 12-inch blower pipe from the building provides air scouring to the filters.

Waste Stream Treatment Facilities

The major structural components of the waste stream treatment facilities include flow equalization basins for waste filter backwash water and filter to waste (FTW) basin. Equalization storage for backwash waste water is approximately 1.3 MG. The design equalization volume is provided via two concrete basins, each with a plan area of approximately 3,800 square feet and a maximum operating depth of 23 feet. The approximate top and bottom elevations of the structure are 335 feet and 310.5 feet, respectively. The FTW equalization basin provides a total

volume of approximately 850,000 gallons in a single concrete basin sized with a plan area of approximately 5,000 square feet and a maximum operating depth of 22.5 feet. The approximate top and bottom elevations of the FTW structure are 335 feet and 310.5 feet, respectively.

Raw Water Pipeline

A proposed 72" raw water pipeline, approximately 1850 feet long, will connect the existing Lafayette Aqueducts to the proposed south rapid-mix structure and the new filters.

Additionally, approximately 700 feet of 96" effluent pipeline, 200 feet of 96" inter-clearwell pipeline and 550 feet of 78" clearwell bypass pipelines will be built.

2. Scope of Work

The purpose of this investigation is to evaluate subsurface conditions at the treatment plant and to develop geotechnical recommendations for foundation design and construction of the proposed structures.

To provide this information, test borings, geophysical surveys, laboratory testing and engineering analyses were performed as part of this investigation.

II. SUMMARY

Information obtained from this investigation indicates that the site is suitable for the construction of the proposed structures from a geotechnical engineering standpoint.

The treatment plant and the existing clearwell were developed on hilly terrain with a relatively thin soil layer over bedrock formation materials. There were major drainage ravines at the site prior to the construction of the treatment facilities. Soil cover in ravines varied from about 5 to 16 feet deep. At the proposed clearwell site, the old drainage ravines have been filled and the fill will underlie the foundation level of the clearwell tank. A small portion of the foundation for the chemical contact chamber is underlain by fill placed within a drainage ravine. The foundation levels of the proposed structures, except the clearwell tank and the chemical storage building, are underlain by bedrock and/or shallow engineered fill. For these structures, conventional shallow footing foundations may be used to support them. The clearwell tank and the chemical storage

building are underlain by existing fill and will need to obtain foundation support from bedrock materials below the fill. Drilled and cast-in-place reinforced concrete piers deriving frictional support from the underlying bedrock are recommended.

Formational materials generally underlie the raw water alignment except for approximately 200 feet across an old drainage ravine. Fill was previously placed to a depth of about 30 feet at the centerline of the drainage ravine. Information obtained from a boring through the fill indicates that the soil can provide adequate foundation support for the pipelines.

The site is in the seismically active Bay Area and therefore the proposed structures will have to be designed to withstand strong ground shaking from nearby earthquakes. Studies have revealed several traces of the Franklin fault at the site; however, seismic activity and fault-induced ground rupture are considered very unlikely along these traces.

Groundwater was encountered at depths of 4 to 31 feet below the ground surface in several piezometers installed as part of this investigation. Well-designed backdrain systems extending below the level of structural floors should be provided for buried portions of walls to account for possible groundwater conditions.

Based on surface refraction surveys, it is expected that the formational materials to be encountered in excavations will be rippable to marginally rippable using conventional excavating equipment.

Some of the structures may be constructed on or excavated into the existing clearwell embankment while the reservoir is in service. The State Division of Safety of Dams has jurisdiction over the existing clearwell; therefore, written approval of the plans and specifications for such structures is required before construction.

III. SUBSURFACE INVESTIGATION

The subsurface investigation was performed by drilling 35 borings near existing and proposed structures (see Figure 3) to depths of up to 82 feet. The borings were performed with truck-mounted rotary-wash drilling rigs (Failing 750 and 1500). District personnel logged twenty of the borings. The District boring logs, the boring log legend, the Unified Soil Classification

System used to describe the soils, and the Physical Properties Criteria for Rock Descriptions are presented in Appendix A. Personnel from Olivia Chen Consultants (OCC) logged the remainder of the borings. The OCC boring logs, piezometer installation data, and boring log legend are presented in Appendix B. Samples for visual classification and laboratory testing were obtained by using the Standard Penetration Test (SPT), Modified California (MC), and Pitcher samplers. A 140-lb hammer falling 30 inches was used to drive the SPT and MC samplers.

IV. GEOPHYSICAL SURVEYS

Portola Geophysics conducted downhole geophysical surveys of the existing clearwell embankments and also surface seismic refraction surveys of the area near the proposed chemical contact chamber site. Additional surface seismic refraction surveys were conducted east of the existing filters. The purpose of the survey was to evaluate the characteristic of subsurface materials, and to assess the rippability of bedrock materials. The survey results at the proposed chemical contact chamber area indicate that there are generally three layers of foundation materials at the site. The zone closest to the surface ranges in depth from 7 feet to about 30 feet and corresponds to fill, colluvial materials and deeply weathered bedrock. The underlying zone ranges in depth from 20 to 50 feet and corresponds to moderately weathered bedrock. This zone overlies slightly weathered bedrock that was encountered to the depth limit of the survey (about 96 feet beneath the ground surface). The materials within the proposed zone of excavation are considered rippable to marginally rippable with conventional excavating equipment. The methods and results of the geophysical surveys are presented in Appendix C.

V. LABORATORY TESTING

Cooper Testing Laboratory, Soil Mechanics Laboratory and the District's Materials Testing Laboratory performed moisture content, unit weight, Atterberg limits, sieve analysis, triaxial shear strength, and consolidation tests to measure index properties, strength, and compressibility of the subsurface materials. The results of most of these laboratory tests are summarized on the boring logs. All of the laboratory test results are kept in the Materials Engineering Section project files and are available for review.

VI. SITE CONDITIONS

1. Surface and Existing Facilities

The treatment plant is situated on top of a northeasterly limb of a synclinal fold in a series of northwest trending ridges. The existing plant includes an operations building, a rapid-mix basin and dual-media filters. A clearwell is located directly west of the operations building; maintenance and storage buildings and washwater detention and settling basins are located north of the operations building. Lafayette and Mokelumne Aqueduct pipelines are respectively located west and north of the plant site.

A segment of the Briones-Mt. Diablo Regional Trail, operated by the East Bay Regional Park District (EBRPD), traverses the site. EBRPD operates the segment under a license agreement with the District.

Several ravines that directed surface runoff from the hills south of the site ran through the site prior to the construction of the treatment plant. The excavated materials from the clearwell construction were used to fill the drainage ravines that underlie the existing clearwell. Even though the original geologic report (Marliave) recommended drainage under fills within the ravines, there is no evidence that this was done at the clearwell tank site. However, a culvert was installed under the fill placed within a drainage ravine southwest of the proposed chemical contact chamber site.

The site generally slopes steeply from the base of the southerly hills at elevation 400 feet to the maintenance building at elevation 300 feet (Mean Sea Level datum). The surface conditions at the proposed facilities are described below:

Clearwell Tank

The proposed clearwell tank will be sited within the basin of the existing open-cut reservoir with portions of the existing embankments screening the tank from nearby residences. The embankment crests are at elevation 378 feet. The bottom of the existing clearwell is at elevation 346 feet.

Chemical Contact Chamber

An access road cuts through the site of the proposed chemical contact chamber. To the west of the site, fill has been placed within a drainage ravine. The site slopes from elevation 360 feet at the south end to elevation 330 feet at the northwest end of the site.

Chemical Storage Building

The area served as the low point for the collection of surface runoff. A small maintenance shed is sited at the north end of the site. The site slopes from elevation 378 feet at both the south and north ends to elevation 362 feet at the low point within the site interior.

South Filters

The area is adjacent to the operations building. It is covered with several small plants. The site slopes from elevation 383 feet at the north end to a low point of 375 feet at the south end.

South Rapid-Mix Structure

The structure will be sited in the existing access road to the operations building. It is a fairly flat area at about elevation 380 feet.

Weir Structure

The weir structure is to be buried into the southeast corner of the embankment crest. The embankment crest is at elevation 378 feet.

Blower Building

The blower building will be sited adjacent to the south filters. The area is fairly flat and is between elevations 380 and 383 feet.

Waste Stream Treatment Facilities

The waste stream facilities are at the northeast end of the plant and will replace the existing detention basin at the site. The north end of the site slopes steeply from elevation 330 feet to elevation 310 feet near the existing shops building.

Raw Water Pipeline

The proposed pipeline is generally at the base of the hills southwest of the plant.

2. Subsurface

The subsurface conditions for the projects fall into three general types. The clearwell and chemical storage building are partly underlain by thick sections of fill, the waste stream facilities and the chemical contact chamber are largely underlain by formational materials, and the rest generally underlain by thin sections of fill. The description of subsurface materials encountered at the major facilities is shown below:

Clearwell Tank

The clearwell tank will replace the existing open-cut reservoir. The footprint will cover the existing basin, the west embankment and most of the north embankment. At the foundation level for the proposed tank, test borings encountered fill and formational materials. The fill is made up of sandy, gravelly silt and silty sand; and the formational materials are sandstone, siltstone and claystone. The maximum thickness of the fill is about 36 feet. The formations are moderately- to well-cemented, fractured, friable to plastic, of low hardness and deeply weathered.

Chemical Contact Chamber

Borings and test trenches indicate that the proposed tank site is underlain partly by fill from the original plant construction and partly by a thin colluvial layer overlying weathered bedrock. The fill was placed within a large swale and is up to 20 feet deep at this location and is underlain by colluvial materials and bedrock. The fill consists primarily of clayey silts and silty clays with inter-layered silty and clayey sands and gravels. The colluvial materials consist of stiff to very stiff, moderately to highly plastic sandy silts and silty clays. Bedrock at this site consists mostly of deeply to moderately weathered, friable to plastic, moderately hard to hard silty claystone, shale and siltstone.

Chemical Storage Building

The site grading drawings and information obtained from the test borings indicate that the site is underlain by Type D fill over Type A fill from the original plant construction. The Type A fill is the select fill used for the construction of the existing clearwell embankments. The Type D fill was made from excavated overburden and primarily consisted of clayey and silty sand potentially with organic material. The maximum fill depth is about 30 feet and the fill extends down to elevation 350 feet at the north end of the proposed structure, to elevation 355 feet at the middle portion of the structure, and to elevation 370 feet near the existing access road to the

south. The non-engineered Type D fill is unsuitable as foundation material. Sandstone and siltstone formational materials underlie the fill.

It appears that the proposed layout will require partial excavation into the Type A structural clearwell embankment fill, which may require written approval from the State Division of Safety of Dams.

South Filters

The subsurface conditions encountered in borings at the proposed filters site consist of 5 to 20 feet of Type D fill over weathered siltstone and sandstone. The bottom of the fill at the site is at about elevation 373 feet.

South Rapid-Mix Structure

The boring at the proposed south rapid-mix structure site encountered about 2 feet of sandy, silty clay soil overlying weathered siltstone.

Weir Structure

The weir structure is to be constructed about 22 feet deep into the existing Type A embankment materials. The excavation may require written approval from DSOD. The embankment materials consist generally of medium dense to dense silty sand, and stiff to hard sandy, gravelly silt.

Blower Building

Borings at the site for the proposed blower structure encountered approximately 5 feet of Type D fill over weathered sandstone.

Waste Stream Treatment Facilities

Borings at the site for the proposed waste stream treatment facilities encountered moderately to deeply weathered sandstone and siltstone with little to about 4 feet of soil cover.

Raw Water Pipeline

The alignment for the pipeline is along the base of the southern slopes. Test borings along the alignment encountered formational materials at depths generally varying from approximately 3 feet to 12 feet. There is a 200-foot section where fill was placed within a drainage ravine. The

maximum depth of the fill within that section is about 30 feet. The overburden consists of silty, sandy clay fill and colluvial materials. The formational materials along the pipe alignment consist of claystone, shale, siltstone and sandstone materials.

3. Groundwater

Piezometers were installed in twelve of the fifteen borings drilled by Olivia Chen Consultants. Measurements indicate groundwater at depths of 4 to 31 feet below the ground surface in some of the borings. The groundwater levels in borings have been measured as follows:

Piezometer	Depth Drilled (feet)	Groundwater Level (depth below ground surface, in feet)			
		1/22/01	3/9/01	4/5/01	5/17/01
MN-23	40.9	NA	31.0	39.0	dry
MN-23A	35.8	dry	dry	dry	dry
MN-24	28.4	dry	dry	dry	dry
MN-25	47.5	23	23.4	23.4	23.9
MN-26	29	6	21.0?	4.4	5.7
MN-27	30.3	21	12.6	9.3	13.1
MN-28A	29.6	dry	25.5	24.8	25.4
MN-29A	29.6	11.5	3.9	5.3	7.6
MN-30	28.7	dry	dry	dry	dry
MN-31	31.7	dry	dry	dry	dry
MN-32	21.1	dry	dry	dry	dry
MN-33	19.6	dry	13.0	dry	dry

Groundwater levels may vary with seasonal and other conditions. Therefore, groundwater levels could be higher during construction than those shown above.

4. Geology and Seismicity

The geologic and seismicity descriptions below are summarized from reports prepared by Burton Marliave in 1963 and by Geomatrix Consultants in 1995 and 1998 for the District. The project

site area lies within the Franklin fault zone, which cuts northwesterly through the area separating the older Eocene sediments (greater than 54 million years old) to the northeast from the Miocene sediments (greater than 26 million years old) to the southwest. The sediments were marine deposited and are locally comprised of poorly consolidated siltstones, claystones and shale of the Rodeo formation, and weakly cemented sandstones of the Briones, Neroly and Hambre formations. Quarternary units (present to about 1.6 million years ago) at the site include a late Pleistocene (within the last 100 thousand years) geomorphic surface (a product of fluvial erosion and subsequent deposition), and Holocene colluvium and alluvium (less than 11 thousand years old) on hillslopes and along drainage swales, respectively.

The site is in the seismically active Bay Area. Significant active faults that could cause strong ground shaking at the site include the San Andreas, Hayward, Concord, Mt. Diablo and Calaveras faults. The San Andreas fault lies approximately 26 miles southwest of the site, and is capable of producing a Maximum Credible Earthquake (MCE) of moment magnitude 8. The Hayward fault lies approximately 9 miles to the southwest, and is capable of MCE moment magnitude 7.25. The Concord fault lies approximately 4 miles to the east and is capable of MCE moment magnitude of 6.5. The Mt. Diablo thrust fault lies approximately one-half mile to the south and is capable of MCE moment magnitude 6.7. The Calaveras fault lies approximately 8 miles to the south and is capable of MCE moment magnitude of 7.

The main trace of the Franklin fault lies approximately 700 feet east of the operations building. Studies conducted by Geomatrix Consultants have revealed several traces of the Franklin fault at the site (see Figure 4). One of the traces was revealed in a trench showing a narrow zone of closely spaced shears juxtaposing sandstone on the east against claystone on the west. A radiocarbon dating indicates a late Pleistocene or early Holocene slippage. The fault is therefore considered potentially active and capable of producing a moment magnitude of 6.5 to 6.75.

Even though potentially active fault traces are mapped at the site, seismic activity and fault-induced ground rupture are considered very unlikely due to the low slip rate on the Franklin fault.

Landslide maps do not indicate any areas of instability within the project site. Geomatrix Consultants mapped the toe of a landslide feature about 200 feet above the proposed alignment for the proposed 72" raw water line.

The potential for soil liquefaction at the sites is low due to the absence of saturated clean, fine-grained, cohesionless soils. Liquefaction occurs when saturated cohesionless soils lose shear strength due to cyclic shear stresses and pore water pressure increases caused by a seismic event.

VII. CONCLUSIONS

Information obtained from this investigation indicates that the site is suitable for the construction of the proposed facilities from a geotechnical engineering standpoint provided that the recommendations contained in this report are followed.

Conventional shallow foundations on competent bedrock materials may be used to support most of the structures. Any existing fill and colluvial materials underlying the proposed chemical contact chamber will have to be removed and replaced with lean concrete. Drilled and cast-in-place reinforced concrete piers are recommended to be used to support the chemical storage building and to support portions of the proposed clearwell not directly underlain by bedrock.

Maximum total settlement of pier-supported structures is estimated to be approximately ½ inch with negligible differential settlement. Maximum total and differential settlements of structures supported on shallow footings are estimated to be approximately 1 inch.

Based on the subsurface investigation and the seismic refraction surveys, it is expected that conventional excavating and drilling equipment may be used to achieve the design grades of the structures.

The site is in the seismically active Bay Area and therefore the proposed structures will have to be designed to withstand strong ground shaking from nearby earthquakes. Studies have revealed several traces of the Franklin fault at the site; however, seismic activity and fault-induced ground rupture are considered very unlikely along these traces.

A reactivation of the landslide feature is not likely to undermine the integrity of the raw water line or other proposed facilities at the site since there is a reasonable setback of the facilities from the landslide. Groundwater was encountered in some of the borings and will be encountered in foundation excavations and drilled pier holes.

VIII. DESIGN RECOMMENDATIONS

1. Foundations

For shallow foundations, allowable bearing pressures of 3,300 pounds per square foot (psf) for dead loads, 5,000 psf for dead and live loads, and 7,500 psf for total loads (including seismic or wind loads) may be used for the structures founded on bedrock. Allowable bearing pressures of 2,250 pounds per square foot (psf) for dead loads, 3,000 psf for dead and live loads, and 4,500 psf for total loads may be used for structures founded on engineered fill.

For the weir structure, allowable bearing pressures of 2,650 psf for dead loads, 4,000 psf for dead and live loads, and 6,000 psf for total loads may be used for the existing clearwell embankment materials.

Lateral forces on structures will be resisted by passive pressures against the side of footings and grade beams, and by friction between floors and foundation materials. It is recommended that an equivalent passive pressure of 350 pounds per cubic foot (pcf) in a triangular pressure distribution be used for structures founded in bedrock. For structures founded in engineered fill, equivalent pressures of 280 pcf may be used. Friction factors of 0.35 between concrete and asphaltic concrete, 0.5 between concrete and bedrock, and 0.4 between concrete and engineered fill materials may be used.

For structures where deep foundations are required, it is recommended that 24- to 30-inch diameter drilled piers extending at least 8 feet into bedrock should be used (see Figure 5 for estimated depths to bedrock at the chemical storage building and at the clearwell sites). The drilled piers should be designed as friction piles with adhesion of 1,000 psf applied to the surface area of the piers within bedrock. For lateral resistance of piers within newly compacted engineered fill, it is recommended that an equivalent passive pressure of 200 pcf in a triangular distribution plus a uniform pressure of 1,000 psf per foot be used. It is recommended that passive pressures be applied against twice the area of the pier and within the depth of four times the pier diameter. For lateral resistance of piers within existing Type D fill, an equivalent passive pressure of 160 pcf in a triangular distribution plus a uniform pressure of 400 psf per foot may be used. For lateral resistance of piers within formational materials, an equivalent passive pressure of 240 pcf plus uniform pressure of 1,000 psf may be used. To minimize group action, pier spacing should not be less than 3 pier diameters, center-to-center.

Rock anchors or soil nails may used to support the deep excavation for the clearwell tank and should be designed using 2,000 psf bond strength between the concrete grout and formational materials. Friction angle of 39 degrees plus a cohesion of 500 psf and total unit weight of 123 pcf may be used for the formational materials.

Clearwell Tank

The foundation footprint of this tank will be partially underlain by bedrock and partially underlain by existing fill. The existing fill is not recommended to be used as foundation support for the tank. The portion of the tank underlain by the fill will need to be supported by drilled reinforced concrete piers deriving their vertical support from skin friction in the underlying formational materials. Alternatively, the existing fill may be strengthened by soil improvement techniques to allow it to support the tank. The portion underlain by bedrock may be supported by conventional shallow foundation system. Figure 6 shows the plan area of the foundation underlain by fill.

Chemical Contact Chamber

Most of the footprint of the chemical contact chamber foundation will be founded on bedrock. A portion of the foundation footprint at the northwest side may be underlain by up to 10 feet of fill and colluvial materials. The fill and or colluvial materials underlying the tank will have to be removed and replaced with lean concrete. A conventional shallow footing may be used to support the tank. In addition, the tank will be partially buried by placing fill around the tank. The existing fill and colluvial materials underlying the proposed fill area must be removed and replaced with engineered fill.

Chemical Storage Building

The footprint for the chemical storage building will generally be underlain by existing unengineered fill. It is recommended that the structure be supported on reinforced concrete drilled piers deriving vertical support from the underlying bedrock. The area serves as a low point for collection of surface runoff from slopes south of the site; therefore, collection systems must be designed to divert runoff from the site.

South Filters

The foundation for the filter bed structure will be underlain by siltstone and sandstone bedrock. The materials at the foundation level for the filter gallery consist of about 6 feet of Type D fill

overlying siltstone and sandstone bedrock. It is recommended that the Type D fill be removed and replaced with engineered fill. The structures may be supported by conventional shallow footings.

South Rapid-Mix Structure

The foundation for the rapid-mix structure will be underlain by siltstone. The structure may be supported by conventional shallow footings.

Weir Structure

The foundation for the weir structure will be excavated into the existing embankment materials. Conventional shallow footings will be adequate to support this structure.

Blower Building

It is recommended that the Type D materials at the site be removed and replaced with engineered fill. The building may be supported by conventional shallow footings.

Waste Stream Treatment Facilities

The foundations for these structures will be underlain by sandstone. The structures may be supported by conventional shallow footings founded on the bedrock.

Raw Water Pipeline

The invert of the 72" raw water pipe that takes water from the Lafayette Aqueducts to the proposed south filters will be generally founded in formational materials except for a stretch of about 200 feet where it will be founded on existing fill materials. The depth to formational materials along the pipe alignment varies from approximately 3 feet to 12 feet. The overburden consists of silty, sandy clay fill and colluvial materials. The formational materials along the pipe alignment consist of claystone, shale, siltstone and sandstone materials. The siltstone and sandstone materials may be suitable for use as backfill materials. The design for the pipe trench should follow the District's Standard Drawing for Pipe Trench Excavation and Backfill.

Groundwater was encountered in some of the borings along the pipe alignment at depths of 4 to 25 feet below the ground surface.

2. Walls

Structural walls should be designed using the following lateral earth pressures based on 34 degrees of internal friction for granular backfill materials (drain rock), soil unit weight of 125 pounds per cubic foot, and no sloping backfill.

	With wall backdrain	No wall backdrain	
Active	35	80	psf/ft of depth
At-rest	55	90	psf/ft of depth
Passive	300	180	psf/ft of depth

Any surcharge loads next to the walls, such as vehicle and equipment loads, will induce additional lateral pressures. A wall backdrain system should be provided and should extend below the level of structural floors to account for possible groundwater conditions. The backdrain should consist of a drain fabric or District Class I drain rock directly behind the walls. Seepage should be collected into a 4-inch diameter perforated pipe surrounded by approximately 6 inches of District Class I drain rock or enveloped by filter fabric to reduce migration of fine soil particles from the adjacent soil into the backdrain. The pipe should be strong and relatively inflexible, and sloped to drain to a suitable outlet. A compacted impervious soil cap approximately 18 inches thick is recommended above the granular backfill to reduced surface water infiltration into the backdrain. A cleanout riser is recommended to provide access to the backdrain for maintenance.

3. Cut Slope Configuration

Permanent cut slopes in the formational materials should not be steeper than 2 horizontal to 1 vertical and should have a bench of at least 10 feet in width located 25 feet in slope height.

4. Seismic Design

Geomatrix Consultants performed probabilistic ground motion analyses for the site (Geomatrix 2001). The report estimated a peak horizontal ground acceleration of 0.73g for an equal hazard response spectra corresponding to 10% probability of exceedance in ~~10~~ 50 years (475 years return

period). Dynamic lateral pressures as estimated from the District's Engineering Standard Practice (ESP) 550.1 should be included in the design of below grade walls.

A soil profile type S_C, per the 1997 Uniform Building Code, should be used for the site seismic design.

Due to the possibility of strong ground shaking, the planned facilities should be designed and constructed in strict accordance with current seismic guidelines.

IX. CONSTRUCTION RECOMMENDATIONS

1. Site Preparation

Areas to be developed should be stripped of surface vegetation and any topsoil containing roots and other organic matter. The strippings should be removed from the site or stockpiled for reuse as topsoil. Site preparation also includes demolition and clearing of slabs, pavement, structures, utility lines, and disposal of these materials offsite. Existing buried utility lines, if affected by construction activities, should be relocated prior to any construction.

2. Excavation

The construction contractor should be responsible for the design and construction of excavation support systems. The support system should be designed, constructed and maintained by the contractor to prevent damage to adjacent pavement, utilities or structures, to provide safe conditions for workers and equipment, and as required by OSHA and other applicable government regulations. Dewatering will likely be required for foundation excavations due to the high groundwater levels encountered at the site.

3. Pipe and Utility Trench Backfill

Trenches should be backfilled according to the District's Standard Specifications.

4. Fill Material and Compaction Requirements

Engineered fill should have low expansion potential (a plasticity index less than 15) and should be free of organic matter and of rocks or lumps larger than 4 inches in diameter. District aggregate base fill material is recommended. Engineered fill should be uniformly moisture conditioned to near optimum moisture content, placed in thin lifts (8 inches maximum), and compacted to at least 90% relative compaction in accordance with the ASTM D-1557 test procedure.

Areas on which engineered fill is to be placed should consist of competent unyielding subgrade material approved by a representative of the Materials Engineering Section. Fills placed on slopes should be benched and keyed into underlying formational materials. In addition, subdrainage should be installed to lower groundwater levels in these fills. After site preparation and grading, at least 6 inches of the soil below the fill should be scarified, moisture conditioned to about 2% above the soil's optimum moisture content, and compacted to at least 90% relative compaction. The excavations should be monitored by a representative of the Materials Engineering Section for suitable soil and soil moisture conditions prior to engineered fill placement.

5. Construction Monitoring

It is recommended that Materials Engineering staff monitor and approve earthwork and foundation construction including site preparation, foundation excavations, pier drilling and placement of engineered fill. Materials Engineering staff should observe soil and groundwater conditions to verify the assumptions and recommendations included in this report.

X. REFERENCES

Marliave, B., 1963, "Preliminary Report on Walnut Creek Filter Plant Site No. 2", for EBMUD.

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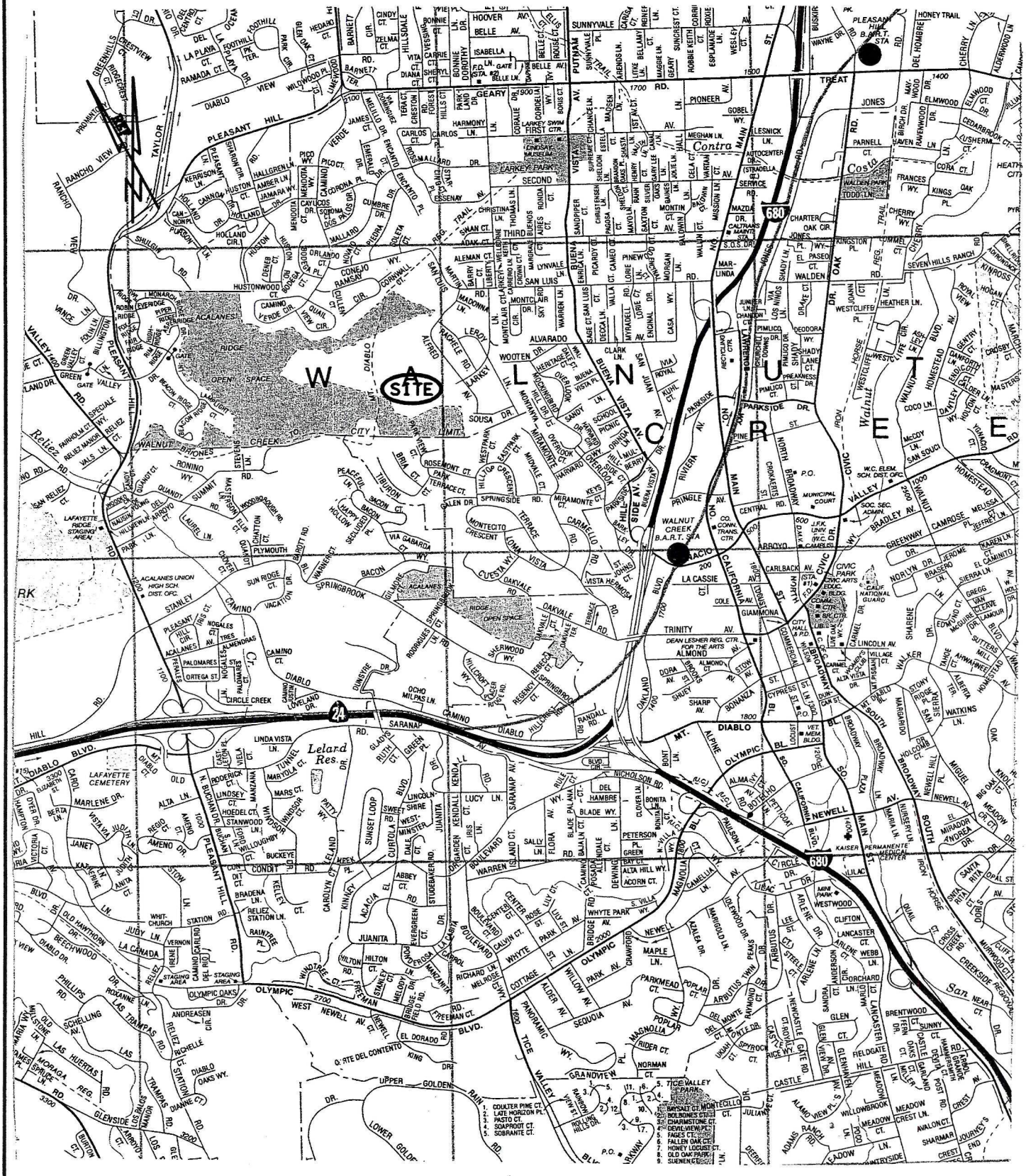
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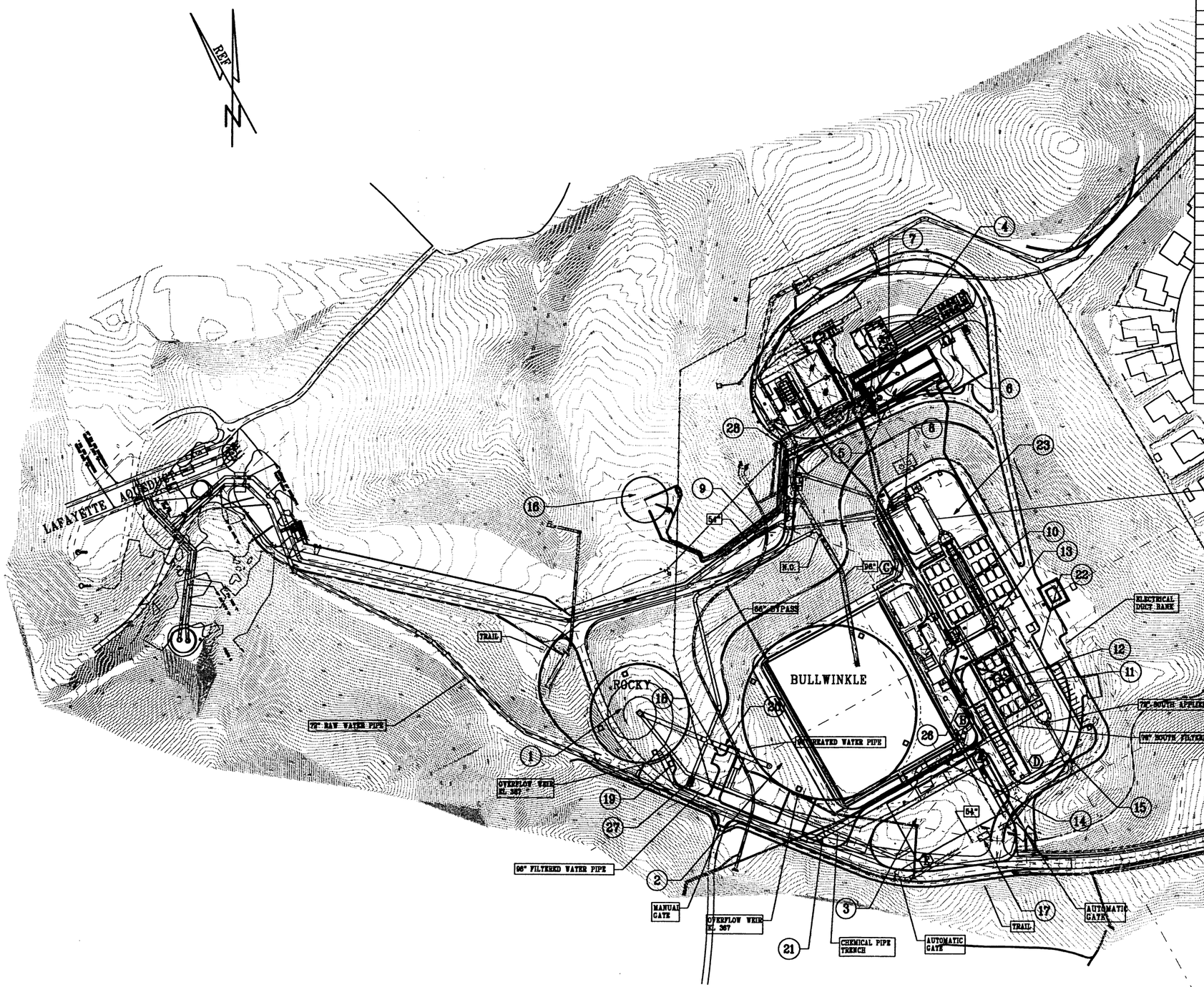


EAST BAY MUNICIPAL UTILITY DISTRICT
OAKLAND, CALIFORNIA

WALNUT CREEK WTP IMPROVEMENTS
SITE VICINITY MAP

DRAWN BY	ABY
SCALE	1" = 1800' (approx)
REF. DRWG.	CSAA 2/97
DATE	January 2001

FIGURE 1



LEGEND

ITEM	DESCRIPTION	BOTTOM EL.	TOP EL.	GENERAL COMMENTS
1	5MG (180'ΦCHEMICAL CONTACT CHAMBER - "ROCKY"	336'	369.5'	ROOF HIGH POINT EL-370.85
2	16MG (320'ΦCLEARWELL - "BULLWINKLE"	336'	369.5	ROOF HIGH POINT EL-371.9
3	CHEMICAL STORAGE BUILDING	381'	406'	
4	SEDIMENTATION BASIN	310'	326'	EL VARIES
5	WASHWATER BASIN	310'	335'	
6	FILTER TO WASTE BASIN	310'	335'	
7	RECLAIM BUILDING AND PUMP STATION	320'	334'& 338'	
8	NORTH RAPID MIXER, MODIFY EXISTING	370'	387'	
9	NORTH RAW WATER FLOW CONTROL ,	--	--	
	SAMPLING & INJECTION STRUCTURE			
10	EXIST FILTER GALLERY - NEW ROOF & WALL	384'	394.33'	
11	FILTER GALLERY	384'	394.33'	
12	FILTER BEDS	367.5'	383'	
13	EXIST OPERATIONS BLDG - NEW ROOF & WALL	384'		
14	WEIR, SAMPLING & INJECTION STRUCTURE	358'	380'	
15	SOUTH RAPID MIX STRUCTURE	370'	387'	
16	TEMPORARY WASTE STREAM TANK	305'	320'	
17	SOUTH RAW WATER FLOW CONTROL ,			
	SAMPLING & INJECTION STRUCTURE			
18	WATER QUALITY MONITORING STATION			
19	POST CHLORINE CONTACT CHAMBER SAMPLING STATION			
20	PRE-CLEARWELL SAMPLING & INJECTION STRUCTURE & FLOOD METER			
21	EFFLUENT FLOW METER & SAMPLING MANHOLE 8X10 PRE CAST CONCRETE			
22	TEMPORARY FACILITIES			
23	STAGING AREA NO. 1			
24	STAGING AREA NO. 2			
26	BLOWER BUILDING			
27	CHLORINE CONTACT CHAMBER BYPASS VALVE STRUCTURE			
28	SWITCHGEAR & GENERATOR BUILDING			

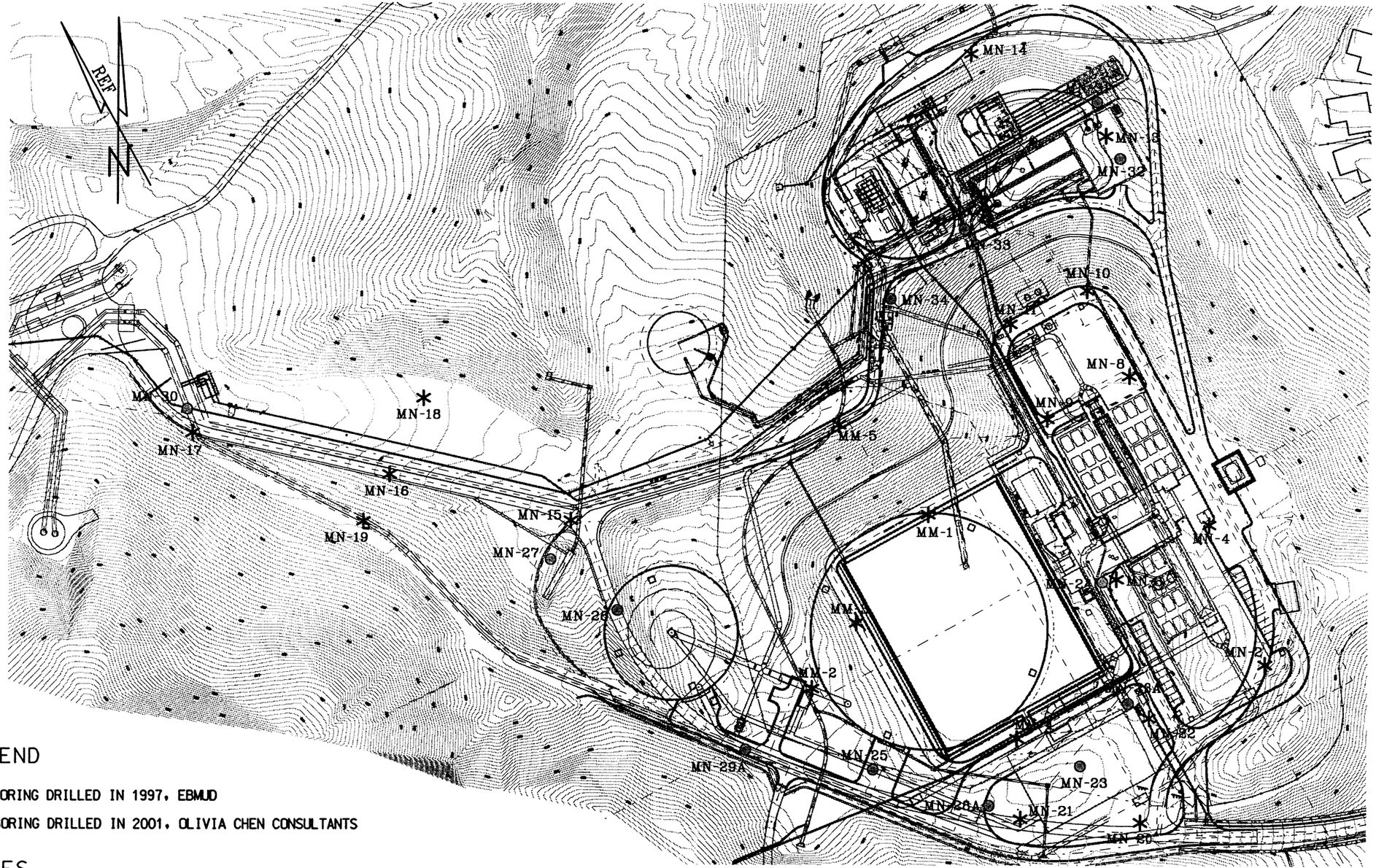
EAST BAY MUNICIPAL UTILITY DISTRICT
OAKLAND, CALIFORNIA

WALNUT CREEK WATER TREATMENT PLANT IMPROVEMENT PROJECT

SITE LAYOUT

SCALE: 1" = 200'
DATE: 2/28/2001

FIGURE 2



LEGEND

- ✱ BORING DRILLED IN 1997, EBMUD
- ● BORING DRILLED IN 2001, OLIVIA CHEN CONSULTANTS

NOTES

- TEST TRENCHES DUG BY GEOMATRIC CONSULTANTS ARE NOT SHOWN HERE (SEE GEOMATRIX, 1998).
- PREVIOUS BORINGS BY THE DISTRICT ARE ALSO NOT SHOWN HERE (SEE EBMUD, 1964 AND EBMUD, 1987).

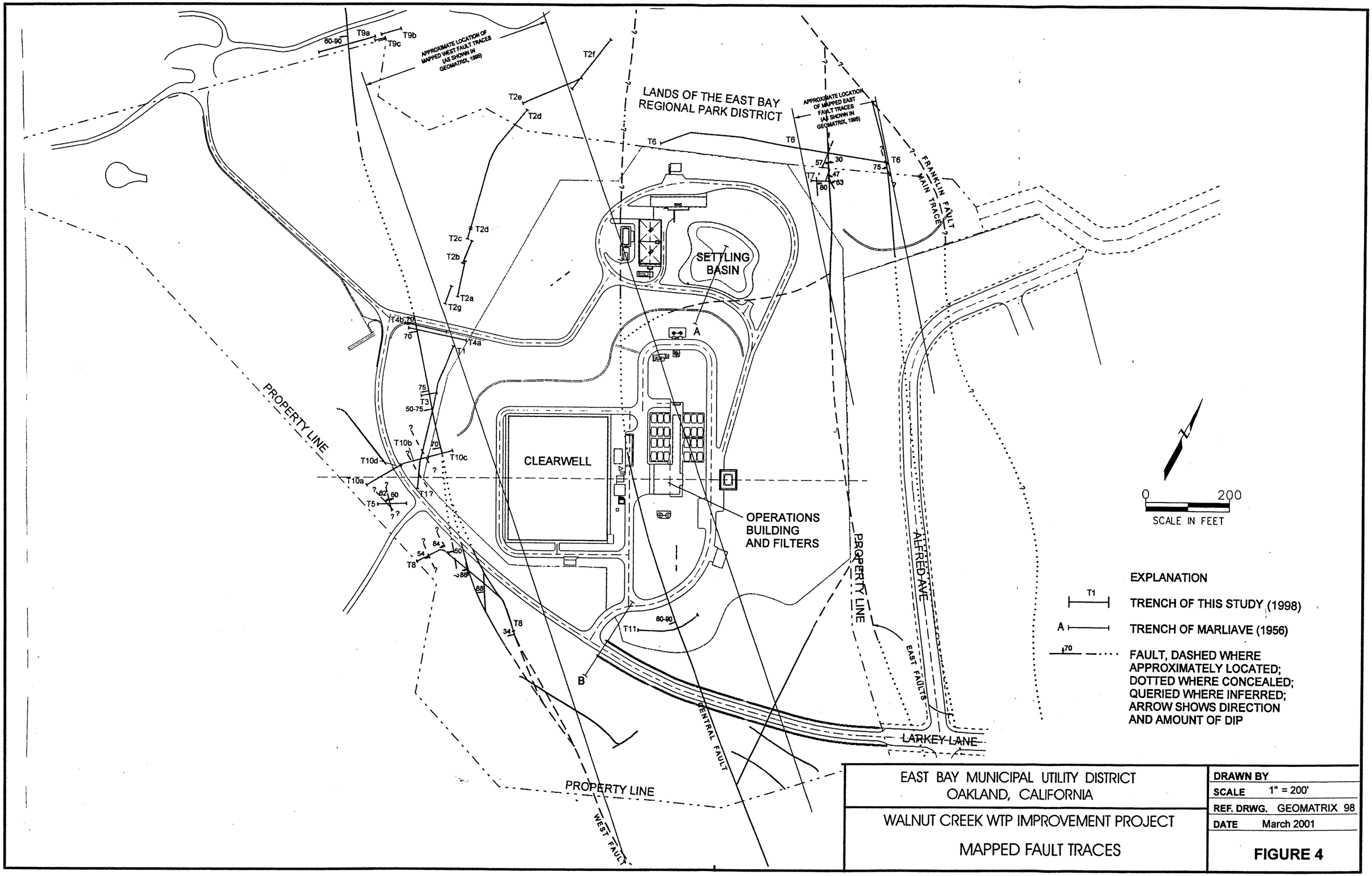
EAST BAY MUNICIPAL UTILITY DISTRICT
OAKLAND, CALIFORNIA

WALNUT CREEK WATER TREATMENT PLANT IMPROVEMENT PROJECT

LOCATION OF BORINGS

SCALE: 1" = 150'
DATE: 2/28/2001

FIGURE 3



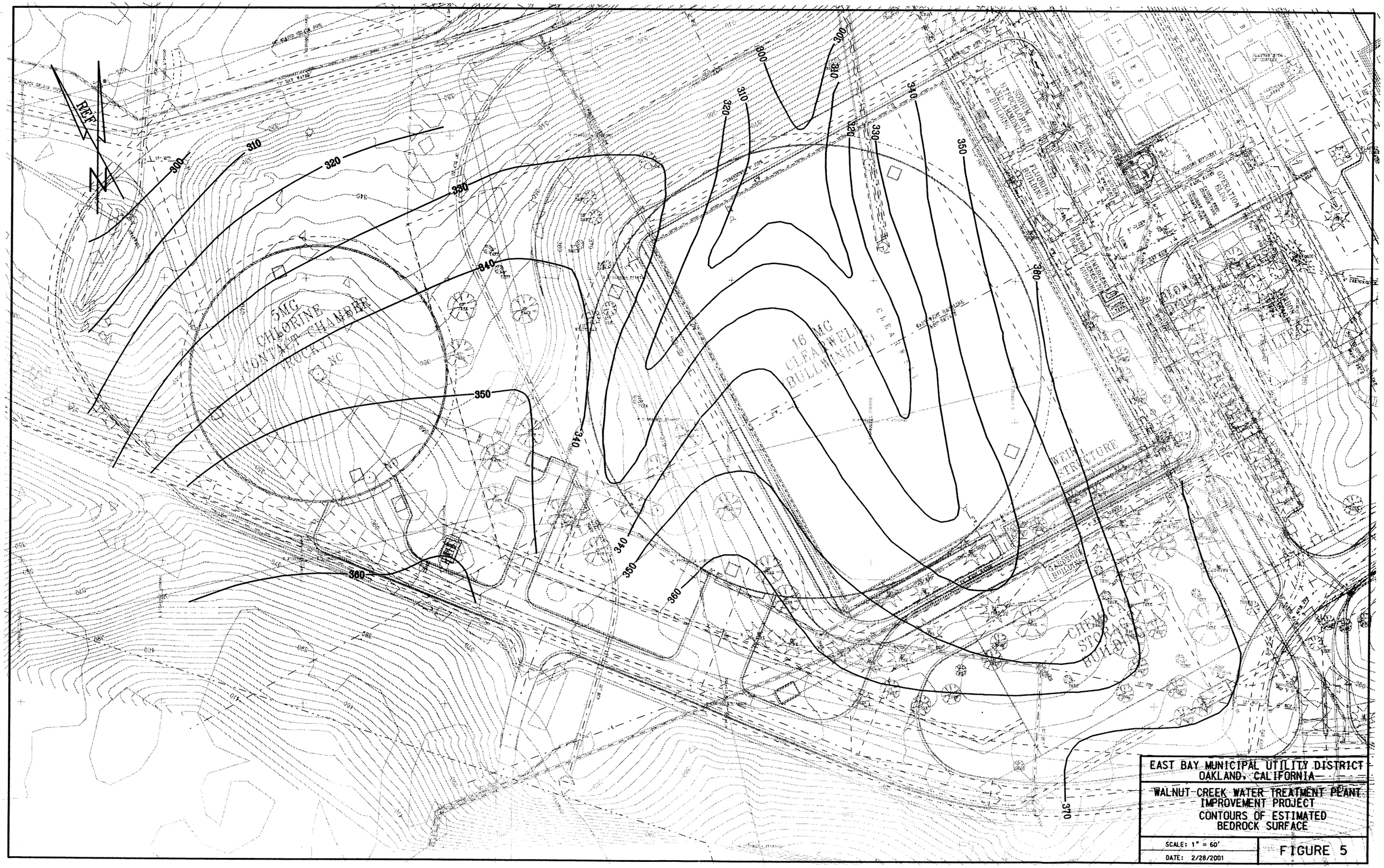
EAST BAY MUNICIPAL UTILITY DISTRICT
OAKLAND, CALIFORNIA

WALNUT CREEK WTP IMPROVEMENT PROJECT

MAPPED FAULT TRACES

DRAWN BY	
SCALE	1" = 200'
REF. DRWG.	GEOMATRIX 98
DATE	March 2001

FIGURE 4



EAST BAY MUNICIPAL UTILITY DISTRICT
OAKLAND, CALIFORNIA

WALNUT CREEK WATER TREATMENT PLANT
IMPROVEMENT PROJECT
CONTOURS OF ESTIMATED
BEDROCK SURFACE

SCALE: 1" = 60'
DATE: 2/28/2001

FIGURE 5

LEGEND

FILL AREA

EAST BAY MUNICIPAL UTILITY DISTRICT
OAKLAND, CALIFORNIA

WALNUT CREEK WATER TREATMENT PLANT
IMPROVEMENT PROJECT
FILL AREA UNDER PROPOSED
CLEARWELL FOUNDATION LEVEL

SCALE: 1" = 60'

DATE: 2/28/2001

FIGURE 6

APPENDIX A

LOGS OF BORINGS (DISTRICT)

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

MAJOR DIVISIONS			SYMBOLS	SECONDARY DIVISIONS
COARSE-GRAINED SOILS more than half is larger than No. 200 sieve	GRAVELS more than half coarse fraction is larger than No. 4 sieve size	CLEAN GRAVELS (less than 5% fines)	GW	well graded gravels, gravel-sand mixtures, little or no fines
			GP	poorly graded gravels, gravel-sand mixtures, little or no fines
		GRAVELS with fines	GM	silty gravels, gravel-sand-silt mixtures, non-plastic fines
			GC	clayey gravels, gravel-sand-clay mixtures, plastic fines
	SANDS more than half coarse fraction is smaller than No. 4 sieve size	CLEAN SANDS (less than 5% fines)	SW	well graded sands, gravelly sands, little or no fines
			SP	poorly graded sand or gravelly sands, little or no fines
		SANDS with fines	SM	silty sands, sand-silt mixtures, non-plastic fines
			SC	clayey sands, sand-clay mixtures, plastic fines
FINE-GRAINED SOILS (fines) more than half is smaller than No. 200 sieve	SILTS AND CLAYS liquid limit is less than 50		ML	inorganic silts and very fine sands,rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
			CL	inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL	organic silts and organic silty clays of low plasticity
	SILTS AND CLAYS liquid limit is greater than 50		MH	inorganic silts, micaceous or diatomacious fine sandy or silty soils, elastic silts
			CH	inorganic clays of high plasticity, fat clays
			OH	organic clays of medium to high plasticity, organic silts
	HIGHLY ORGANIC SOILS		PT	peat and other highly organic soils

PENETRATION RESISTANCE

(RECORDED AS BLOWS/FOOT)

SANDS AND GRAVELS

RELATIVE DENSITY	BLOWS/FOOT *
VERY LOOSE	0 - 4
LOOSE	4 - 10
MEDIUM DENSE	10 - 30
DENSE	30 - 50
VERY DENSE	OVER 50

CLAYS AND SILTS

CONSISTENCY	BLOWS/FOOT *	STRENGTH **
VERY SOFT	0 - 2	0 - 1/4
SOFT	2 - 4	1/4 - 1/2
MEDIUM STIFF	4 - 8	1/2 - 1
STIFF	8 -16	1 - 2
VERY STIFF	16 - 32	2 - 4
HARD	OVER 32	OVER 4

* Number of blows of 140 pound hammer falling 30 inches to drive a 2-inch O.D (1-3/8 inch I.D.) split-barrel sampler (ASTM-1586 standard penetration test).

** Unconfined compressive strength in tons per square foot

DEFINITION OF TERMS

GRAIN SIZES

U.S. STANDARD SERIES SIEVE

#200 #50 #16 #4 3/4" 3" 12"

SILTS & CLAYS DISTINGUISHED ON BASIS OF PLASTICITY	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		

GRADATION

Well-graded gravels and sands: Specimen with a ***wide*** range of grain sizes.
Poorly-graded gravels and sands: Specimen with a ***narrow*** range of grain sizes.

MOISTURE CONDITION

DRY SLIGHTLY DAMP DAMP MOIST VERY MOIST WET (SATURATED)

EBMUD

WALNUT CREEK WTP IMPROVEMENTS PROJECT

Date: 4/1/2001

Figure:

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LEGEND

EBMUD

SAMPLE #

MC	Modified California Sampler
SPT	Standard Penetration Test Sampler
1	First Sample Interval (2=second, etc.)
I	First Sample Tube Recovered (II=second, etc.)

TEST RESULTS

LL	Liquid Limit (%)	} ATTERBERG LIMITS
PL	Plastic Limit (%)	
PI	Plasticity Index (%)	
SG	Specific Gravity	
FINES	Percentage Passing #200 Sieve	
TX (1000)	Triaxial Shear Strength, psf (Confining Stress) (Strength taken at peak stress ratio)	

UU - Unconsolidated Undrained
CU - Consolidated Undrained

NOTES

$\underline{\nabla}_{10/27}$ Indicates approximate ground water level on October 27.

Elevations are referenced to National Geodetic Vertical Datum (1929) [redacted]

Blow counts shown are actual counts recorded for the 12 inches of penetration after the first 6 inches. 50/3" indicates 50 blows to drive the sampler 3" total. Each sampler was driven as follows:

Sampler Type	Hammer Wt. (pound)	Hammer Drop (inches)	Sampler penetration (inches)
MC	140	30	18
SPT	140	30	18

PHYSICAL PROPERTIES CRITERIA FOR ROCK DESCRIPTIONS

I. CONSOLIDATION OF SEDIMENTARY ROCKS: Usually determined from unweathered samples. Largely dependant on cementation.

U = Unconsolidated
P = Poorly consolidated
M = Moderately consolidated
W = Well consolidated

II. BEDDING OF SEDIMENTARY ROCKS

SPLITTING PROPERTY	THICKNESS (IN FEET)	STRATIFICATION
Massive	Greater than 4.0	Very thick-bedded
Blocky	2.0 to 4.0	Thick-bedded
Slabby	0.2 to 2.0	Thin-bedded
Flaggy	0.05 to 0.2	Very thin-bedded
Shaly or Platy	0.01 to 0.05	Laminated
Papery	Less than 0.01	Thinly laminated

III. FRACTURING

INTENSITY	SIZE OF PIECES (IN FEET)
Very little fractured	Greater than 4.0
Occasionally fractured	1.0 to 4.0
Moderately fractured	0.5 to 1.0
Closely fractured	0.1 to 0.5
Intensely fractured	0.05 to 0.1
Crushed	Less than 0.05

IV. HARDNESS

1. SOFT - Reserved for plastic material alone.
2. LOW HARDNESS - Can be gouged deeply or carved easily with a knife.
3. MODERATELY HARD - Can be readily scratched by a knife; scratch leaves a heavy trace of dust and is readily visible after the powder is blown away.
4. HARD - Can be scratched with difficulty; scratch produces little powder and is often faintly visible.
5. VERY HARD - Cannot be scratched with knife blade; leaves a metallic streak.

V. STRENGTH

1. PLASTIC or very low strength
2. FRIABLE - Crumbles easily by rubbing with fingers.
3. WEAK - An unfractured specimen of such material will crumble under light hammer blows.
4. MODERATELY STRONG - Specimen will fracture with a few hammer blows.
5. STRONG - Specimen will withstand a few heavy ringing hammer blows and will yield with difficulty only dust and small flying fragments.

VI. WEATHERING The physical and chemical disintegration and decomposition of rocks and minerals by natural processes such as oxidation, reduction, hydration, solution, carbonation, and freezing and thawing.

D. DEEP - Moderate to complete mineral decomposition; extensive disintegration; deep and thorough discoloration; many fractures, all extensively coated or filled with oxides, carbonates, and/or clay or silt.
M. MODERATE - Slight change or partial decomposition of minerals; little disintegration; cementation little to unaffected. Moderate to occasional intense discoloration. Moderately coated fractures.
L. LITTLE - No megascopic decomposition of minerals; little or no effect on normal cementation. Slight and intermittent or localized discoloration. Few stains on fracture surfaces.
F. FRESH - Unaffected by weathering agents. No disintegration or discoloration. Fractures usually less numerous than joints.

EAST BAY MUNICIPAL UTILITY DISTRICT
OAKLAND, CALIFORNIA

WALNUT CREEK WTP
IMPROVEMENTS PROJECT

	DRAWN BY: A. B. YIADOM
	SCALE: NONE
	DATE: April 2001

LOG OF BORING

PROJECT : Dam Seismic Evaluation
LOCATION : Walnut Creek Clearwell
LOGGED BY : Catherine Anderson
CHECKED BY : Derek Kawaii

DATE : October 28, 1997
CONTRACTOR : Pitcher Drilling
EQUIPMENT : Failing 750
JOB NUMBER : 56248

EBMUD

BORING NO MM -1

SURFACE ELEV. : 376.8

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
				0		brown silty CLAY (CH), stiff (fill)
SG=2.75 LL=54, PI=33	27.4		19		MC-1	
FINES=74.4% LL=52, PI=30	32.2		17	5	SPT-2	
LL=40, PI=8	27.4		30		SPT-3	olive brown sandy SILT (ML), very stiff (fill)
TX-CU=2700 (1300) SG=2.69 FINES=35.8%	27.4	94.5		10	P-4	brown silty SAND (SM), dense, with gravel and a few cobbles. Gravel is crushed sandstone, siltstone and claystone (fill)
FINES=47.2%	30.4		34		SPT-5	
	27.6		38	15	SPT-6	
FINES=44.6%	29.6		26		SPT-7	
TX-CU=3100 (2600) FINES=34.9%	25.2	96.2		20	P-8	
FINES=42.6%	24.9		47		SPT-9	
	22.1		34	25	SPT-10	
FINES=44.3%	21.6		52		SPT-11	
				30		

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LOG OF BORING

PROJECT : Dam Seismic Evaluation
LOCATION : Walnut Creek Clearwell
LOGGED BY : Catherine Anderson
CHECKED BY : Derek Kawaii

DATE : October 28, 1997
CONTRACTOR : Pitcher Drilling
EQUIPMENT : Failing 750
JOB NUMBER : 56248

EBMUD

BORING NO MM -1

SURFACE ELEV. : 376.8

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
				30	P-12	brown silty SAND (SM), dense, with gravel and a few cobbles. Gravel is crushed sandstone, siltstone, and claystone (fill)
FINES=38.8%	24.6		47		SPT-13	
	22.3		34	35	SPT-14	
FINES=42.9%	24.8		37		SPT-15	
TX-CU=6600 (5100)	22.1	97.2		40	P-16	
FINES=33.7%						
LL=41, PI=14	25.7		30		SPT-17	
				45		
FINES=27.9%	24.2		49		SPT-18	
TX-CU=6400 (5900)						
FINES=36.5%	24.1	92.7			P-19	
TX-CU=4950 (6600)				50	P-20	
FINES=44.8%	32.1	89.4			P-21	
LL=39, PI=9				55		
	30.3		56		SPT-22	
TX-CU=3150 (2400) 6100 (4900) 8550 (7100)	30.2	89.8			P-23	dark brown sandy SILT (ML), hard (fill)
				60		

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LOG OF BORING

PROJECT : Dam Seismic Evaluation
LOCATION : Walnut Creek Clearwell
LOGGED BY : Catherine Anderson
CHECKED BY : Derek Kawaii

DATE : October 28, 1997
CONTRACTOR : Pitcher Drilling
EQUIPMENT : Failing 750
JOB NUMBER : 56248

EBMUD

BORING NO MM -1

SURFACE ELEV. : 376.8

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
	30.5		35	60	SPT-24	mottled dark brown sandy SILT (ML), hard (fill)
			50	65	SPT-25	
				70	P-26	grey SANDSTONE, SILTSTONE and CLAYSTONE, friable to moderately strong, moderately weathered
			50/3"	75	SPT-27	
						Bottom of Boring at 76.0'
				80		
				85		
				90		

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LOG OF BORING

PROJECT : Dam Seismic Evaluation
LOCATION : Walnut Creek Clearwell
LOGGED BY : Catherine Anderson
CHECKED BY : Derek Kawaii

DATE : November 5, 1997
CONTRACTOR : Pitcher Drilling
EQUIPMENT : Failing 750
JOB NUMBER : 56248

EBMUD

BORING NO MM -2

SURFACE ELEV. : 359'

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
				0		dark brown sandy SILT (ML), stiff (fill)
FINES=52.7% LL=42, PI=25	17.9		20		SPT-1	
				5		
LL=53, PI=31	31.5		14		SPT-2	gravelly
						brown silty SAND (SM), medium dense (fill)
FINES=38.3% LL=54, PI=22	34.5		25		SPT-3	
						reddish brown silty SAND (SM) with gravel. Gravel is crushed sandstone, siltstone, and claystone (fill)
TX-CU=1400 (1100) SG=2.61 LL=40, PI=7	27.7	91.3		10	P-4	
FINES=30.4%	28.6		29		SPT-5	
				15		
	31.6		33		SPT-6	
FINES=32.2%	35.3		23		SPT-7	
				20		
					P-8	
FINES=36.3%	26.2		28		SPT-9	
						brown SANDSTONE, SILTSTONE, CLAYSTONE, friable to moderately strong, deep to moderately weathered
				25		
			50/5"		SPT-10	
			50/3"		SPT-11	
				30		

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LOG OF BORING

PROJECT : Dam Seismic Evaluation
LOCATION : Walnut Creek Clearwell
LOGGED BY : Catherine Anderson
CHECKED BY : Derek Kawaii

DATE : November 5, 1997
CONTRACTOR : Pitcher Drilling
EQUIPMENT : Failing 750
JOB NUMBER : 56248

EBMUD

BORING NO MM -2

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
				30	P-12	orange-brown clayey SANDSTONE, weak, deeply weathered
			50/6"		SPT-13	
						Bottom of Boring at 33.0'
				35		
				40		
				45		
				50		
				55		
				60		

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LOG OF BORING

PROJECT : Dam Seismic Evaluation
LOCATION : Walnut Creek Clearwell
LOGGED BY : Catherine Anderson
CHECKED BY : Derek Kawaii

DATE : November 3, 1997
CONTRACTOR : Pitcher Drilling
EQUIPMENT : Failing 750
JOB NUMBER : 56248

EBMUD

BORING NO MM -3

SURFACE ELEV. : 376'

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
				0		brown clayey SILTY SAND (SM), medium dense with gravel. Gravel is crushed sandstone, siltstone and claystone (fill)
FINES=29%	24.3		49		SPT-1	
LL=48;PI=16	31.4		16	5	SPT-2	sandy CLAY layer
LL=45;PI=16	36.1		24		SPT-3	
TX-CU=1750 (2400) LL=30;PI=4 FINES=23.4%	24.5	98.5		10	P-4	
			28		SPT-5	sandy CLAY layer clayey SAND layer
	32.8		29	15	SPT-6	
	25.1		30		SPT-7	
TX-CU=5700 (4500) LL=40;PI=13 FINES=29.7%	36.4	81.8		20	P-8	
	35.4		26		SPT-9	
	34.5		22	25	SPT-10	
	22.3		48		SPT-11	
				30		

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LOG OF BORING

PROJECT : Dam Seismic Evaluation
LOCATION : Walnut Creek Clearwell
LOGGED BY : Catherine Anderson
CHECKED BY : Derek Kawaii

DATE : November 3, 1997
CONTRACTOR : Pitcher Drilling
EQUIPMENT : Failing 750
JOB NUMBER : 56248

EBMUD

BORING NO MM -3

SURFACE ELEV. : 376'

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
				30	P-12	brown silty SAND (SM), medium dense, with gravel. Gravel is crushed sandstone, siltstone and claystone (fill)
LL=36, PI=5	25.9		28		SPT-13	
TX-CU=4400 (4500)				35		
SG=2.65	25.8	95.2			P-14	
FINES=29.4% LL=42, PI=12	29.3		35		SPT-15	grey
FINES=27.3%				40	P-16	
LL=39, PI=8	31.2		27		SPT-17	
LL=37, PI=6	30.6		45	45	SPT-18	
TX-CU=6200 (6400) FINES=35.4% LL=44, PI=13	30.8		40		SPT-19	Orange-brown
FINES=34.7	29.8	90.0		50	P-20	
FINES=40.7% LL=39, PI=5	24.8		55		SPT-21	greyish-brown SANDSTONE and SILTSTONE, friable to moderately strong, deep to moderately weathered
			50	55	SPT-22	
			50/5"		SPT-23	
				60		

LOG OF BORING

PROJECT : Dam Seismic Evaluation
LOCATION : Walnut Creek Clearwell
LOGGED BY : Catherine Anderson
CHECKED BY : Derek Kawaii

DATE : November 3, 1997
CONTRACTOR : Pitcher Drilling
EQUIPMENT : Failing 750
JOB NUMBER : 56248

EBMUD

BORING NO MM -3

SURFACE ELEV. : 376'

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
TX-CU=7550 (7610)	27.0	95.9		60	P-24	dark grey SILTSTONE, moderately strong, moderately weathered
			50/3"	65	SPT-25	Bottom of Boring at 65.5'
				70		
				75		
				80		
				85		
				90		

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LOG OF BORING

PROJECT : Dam Seismic Evaluation
LOCATION : Walnut Creek Clearwell
LOGGED BY : Catherine Anderson
CHECKED BY : Derek Kawaii

DATE : November 5, 1997
CONTRACTOR : Pitcher Drilling
EQUIPMENT : Failing 750
JOB NUMBER : 56248

EBMUD

BORING NO MM -4

SURFACE ELEV. : 376'

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
				0		brown sandy CLAY (CL), hard (fill)
LL=36, PI=16	12.6		36		SPT-1	
				5		tan silty SAND (SM), medium dense, with gravel (fill)
FINES=39.2%	23.8		22		SPT-2	
LL=45, PI=17	33.0		31		SPT-3	
				10		
TX-CU=1800 (1200) FINES=23.1%	32.9	84.0			P-4	
	32.9		27		SPT-5	reddish brown
				15		
LL=58, PI=29	35.3		27		SPT-6	reddish brown gravelly CLAY (CH) with sand, very stiff (fill)
LL=55, PI=28	31.9		25		SPT-7	silt layer
TX-CU=2650 (2600) SG=2.72 FINES=18.4% LL=55, PI=22	33.4	87.9		20	P-8	alternating layers of brown silty SAND (SM), medium dense; and grey sandy SILT (ML), stiff, both with gravel and some cobbles (fill)
	36.8		28		SPT-9	
				25		
FINES=51.2%	24.3		41		SPT-10	
LL=38, PI=9	27.3		35		SPT-11	
				30		

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LOG OF BORING

PROJECT : Dam Seismic Evaluation
DATE : November 5, 1997
LOCATION : Walnut Creek Clearwell
CONTRACTOR : Pitcher Drilling
LOGGED BY : Catherine Anderson
EQUIPMENT : Failing 750
CHECKED BY : Derek Kawaii
JOB NUMBER : 56248

EBMUD

BORING NO MM -4

SURFACE ELEV. : 376'

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
TX-CU=4300 (4100) 7050 (5000) 9750 (7000)	25.3	98.1	50/5"	30 35 40 45 50 55 60	P-12 SPT-13	brown sandy CLAY (CL), hard (fill) tan SILTSTONE, weak to moderately strong, deeply weathered Bottom of Boring at 34.0'

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LOG OF BORING

PROJECT : Dam Seismic Evaluation
DATE : November 6, 1997
LOCATION : Walnut Creek Clearwell
CONTRACTOR : Pitcher Drilling
LOGGED BY : Catherine Anderson
EQUIPMENT : Failing 1500
CHECKED BY : Derek Kawaii
JOB NUMBER : 56248

EBMUD

BORING NO MM -5

SURFACE ELEV. : 315'

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
				0		brown gravelly CLAY (CL), very stiff, with some sand (fill)
			25		SPT-1	orange-brown sandstone COBBLES and GRAVEL (GP),medium dense (fill)
				5		
LL=47, PI=18	27.5		21		SPT-2	brown gravelly SILT (ML), very stiff (fill)
LL=45, PI=16	32.7		11		SPT-3	
				10	P-4	brown SANDSTONE, moderately strong, moderately weathered
					P-5	
			50/4"		SPT-6	
				15		Bottom of Boring at 14.0'
				20		
				25		
				30		

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LOG OF BORING

PROJECT : WC WTP Improvements
DATE : November 4, 1997
LOCATION : Walnut Creek Filter Plant
CONTRACTOR : Pitcher Drilling
LOGGED BY : Catherine Anderson
EQUIPMENT : Failing 750
CHECKED BY : Derek Kawaii
JOB NUMBER : 25692

EBMUD

BORING NO MN-2

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
				0		tan, sandy, silty CLAY (CL)
LL = 36, PI = 5	14		78		SPT-1	tan, deeply to moderately weathered, sandy SILTSTONE
% fines = 74.2 LL = 34, PI = 1	17		80	5	SPT-2	
						Bottom of Boring at 6.5'
				10		
				15		
				20		
				25		
				30		

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LOG OF BORING

PROJECT : WC WTP Improvements
LOCATION : Walnut Creek Filter Plant
LOGGED BY : Catherine Anderson
CHECKED BY : Derek Kawaii

DATE : October 30, 1997
CONTRACTOR : Pitcher Drilling
EQUIPMENT : Failing 750
JOB NUMBER : 25692

EBMUD

BORING NO MN-3

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
				0		brown, sandy CLAY (CL)
% fines = 35.9			40		SPT-1	gravelly, silty SAND (SC)
				5		brown, moderately to deeply weathered SILTSTONE
% fines = 60.4			42/6"		SPT-2	
TX-UU =1619 (1195) SG = 2.62	21.6	95.9		10	P-3	tan, moderately weathered and fractured SANDSTONE, very fine grained
				15		
				20	P-4	
TX-UU = 853 (2405) SG = 2.62	23.1	100.3				
				25		Bottom of Boring at 23.5'
				30		

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LOG OF BORING

PROJECT : WC WTP Improvements
LOCATION : Walnut Creek Filter Plant
LOGGED BY : Catherine Anderson
CHECKED BY : Derek Kawaii

DATE : October 27, 1997
CONTRACTOR : Pitcher Drilling
EQUIPMENT : Failing 750
JOB NUMBER : 25692

EBMUD

BORING NO MN-4

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
				0		ASPHALT CONCRETE
						BASE ROCK
						dark brown CLAY
LL = 52, PI = 14	27		37		SPT-1	
						brown, deeply weathered and fractured CLAYSTONE
						with sand
SG = 2.55			30/4"	5	MC-2	
						brown to orange, deeply weathered and fractured SANDSTONE, with calcite seams, fine grained,
% fines = 45.7			40/4"	10	SPT-3	
				15		
TX-UU = 4449 (1800) SG = 2.57	22.1	100.8			P-4	very dark grey, slightly weathered SILTSTONE
				20	P-5	
				25		
				30		harder drilling at 29.5'

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LOG OF BORING

PROJECT :WC WTP Improvements
DATE : October 27, 1997
LOCATION : Walnut Creek Filter Plant
CONTRACTOR : Pitcher Drilling
LOGGED BY : Catherine Anderson
EQUIPMENT : Failing 750
CHECKED BY : Derek Kawaii
JOB NUMBER : 25692

EBMUD

BORING NO MN-4

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
				30	P-6	very dark grey, slightly weathered SILTSTONE with organic and calcite seams
						Bottom of Boring at 32.5'
				35		
				40		
				45		
				50		
				55		
				60		

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LOG OF BORING

PROJECT : WC WTP Improvements
DATE : November 4, 1997
LOCATION : Walnut Creek Filter Plant
CONTRACTOR: Pitcher Drilling
LOGGED BY : Catherine Anderson
EQUIPMENT : Failing 750
CHECKED BY : Derek Kawaii
JOB NO. : 25692

EBMUD

BORING NO MN-8

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
				0		ASPHALT CONCRETE
						BASE ROCK
			50/4"		SPT-1	tan, friable, silty SANDSTONE, fine grained
				5		
			50/4"		SPT-2	tan, friable, deeply weathered SANDSTONE with a lot of oxidized seams
TX-UU = 9945 (1195) SG = 2.71	19.8	104.0		10	P-3	
			50/6"		SPT-4	
						Bottom of Boring at 13.0'
				15		
				20		
				25		
				30		

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LOG OF BORING

PROJECT : WC WTP Improvements
DATE : October 31, 1997
LOCATION : Walnut Creek Filter Plant
CONTRACTOR: Pitcher Drilling
LOGGED BY : Catherine Anderson
EQUIPMENT : Failing 750
CHECKED BY : Derek Kawaii
JOB NO. : 25692

EBMUD

BORING NO MN-9

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
				0		4" ASPHALT CONCRETE 6" BASE ROCK brown, sandy CLAY (fill) (CL)
LL = 38, PI = 18	20		25		SPT-1	bluish grey, gravelly
LL = 43, PI = 21	25		11	5	SPT-2	greyish brown, stiff, sandy SILT (ML), with clay
% fines = 65.6			15		SPT-3	
				10		with gravels
% fines = 44.2	22		63		SPT-4	
				15		mottled brown , deeply weathered, SANDSTONE, with organics, fine grained,
TX-UU = 382 (2203) SG = 2.57	25.6	96.4			P-5	
				20		brown, deeply weathered and fractured SILTSTONE cuttings with clay
			50/4"		SPT-6	grey, moderately weathered, CLAYSTONE, with calcite seams
				25		Bottom of Boring at 24.0'
				30		

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LOG OF BORING

PROJECT : WC WTP Improvements
DATE : October 31, 1997
LOCATION : Walnut Creek Filter Plant
CONTRACTOR: Pitcher Drilling
LOGGED BY : Catherine Anderson
EQUIPMENT : Failing 750
CHECKED BY : Derek Kawaii
JOB NO. : 25692

EBMUD

BORING NO MN-10

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
				0		3" ASPHALT CONCRETE
						BASE ROCK
			51		SPT-1	grey, very dense, silty SAND (SM) with cemented gravels, (fill)
	17.2		32	5	SPT-2	
	18.3		54	10	SPT-3	grey, friable, deeply weathered and friable, clayey SANDSTONE, with bluish black clay seams
SG = 2.61	16.0			15	P-4	harder drilling at 14.5'
						brown
			50/5"		SPT-5	with oxidized seams
				20		Bottom of Boring at 18.0'
				25		
				30		

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LOG OF BORING

PROJECT : WC WTP Improvements
DATE : November 6, 1997
LOCATION : Walnut Creek Filter Plant
CONTRACTOR: Pitcher Drilling
LOGGED BY : Catherine Anderson
EQUIPMENT : Failing 750
CHECKED BY : Derek Kawaii
JOB NO. : 25692

EBMUD

TEST RESULTS

MOISTURE CONTENT %

DRY DENSITY (PCF)

BLOWS/FT*

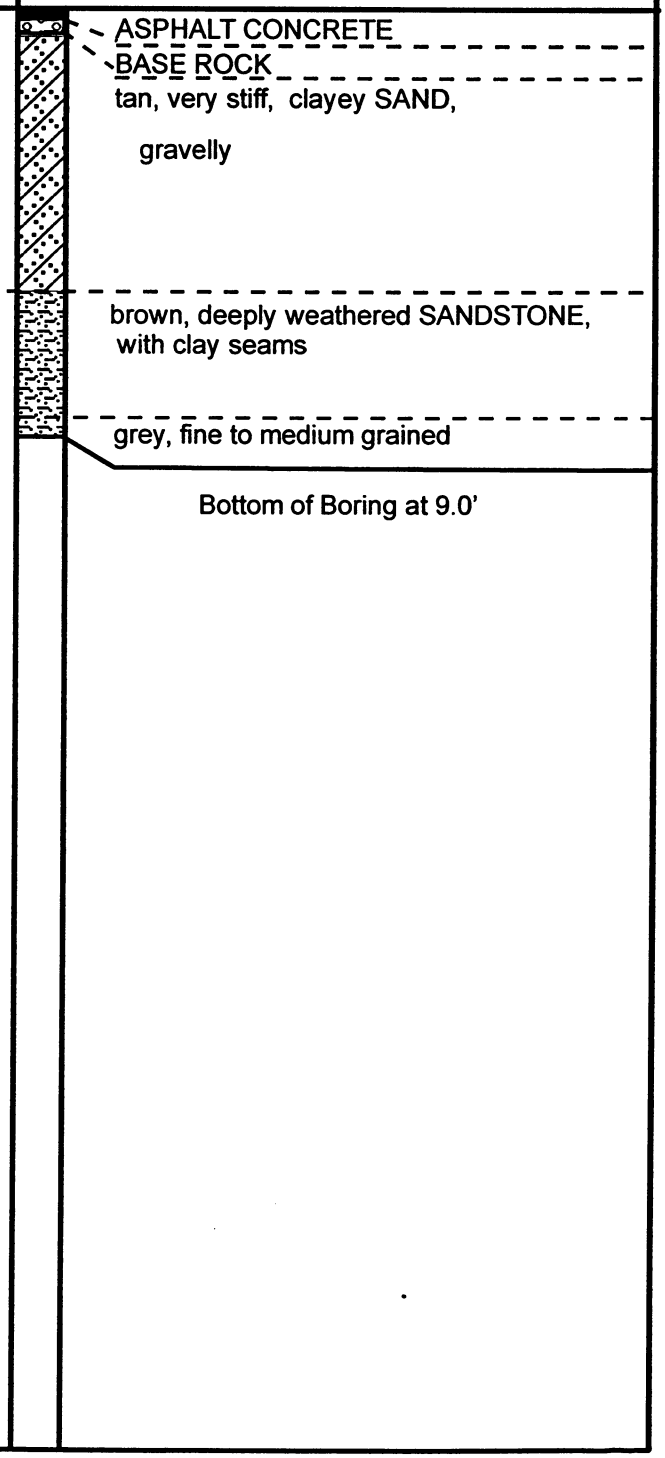
DEPTH (FT)

SAMPLE NO.

BORING NO MN-11

SURFACE ELEV. :

DESCRIPTION



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LOG OF BORING

PROJECT : WC WTP Improvements
LOCATION : Walnut Creek Filter Plant
LOGGED BY : Catherine Anderson
CHECKED BY : Derek Kawaii

DATE : October 27, 1997
CONTRACTOR: Pitcher Drilling
EQUIPMENT : Failing 750
JOB NO. : 25692

EBMUD

BORING NO MN-13

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
TX-UU = 3581 (605) SG = 2.63	17.8	109.3	50/5" 50/5"	0 5 10 15 20 25 30	SPT-1 P-2 P-3 SPT-4 P-4	tan-grey, moderately weathered and fractured SANDSTONE, fine grained, Bottom of Boring at 22.5'

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LOG OF BORING

PROJECT : WC WTP Improvements
LOCATION : Walnut Creek Filter Plant
LOGGED BY : Catherine Anderson
CHECKED BY : Derek Kawaii

DATE : October 28, 1997
CONTRACTOR: Pitcher Drilling
EQUIPMENT : Failing 750
JOB NO. : 25692

EBMUD

BORING NO MN-14

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
				0		brown, sandy CLAY (CL) (fill)
LL =52, PI = 33	15.0		41		SPT-1	dark brown, hard, sandy CLAY, (CH)
			50/4"	5	SPT-2	tan, deeply weathered SANDSTONE, fine grained,
SG = 2.63	19.8	112.7		10	P-3	slightly to moderately weathered
				15		
SG = 2.55	18.9	103.4			P-4	soft zone between 17.5' and 18.0'
				20		Bottom of Boring at 20.0'
				25		
				30		

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LOG OF BORING

PROJECT : WC WTP Improvements
LOCATION : Walnut Creek Filter Plant
LOGGED BY : Catherine Anderson
CHECKED BY : Derek Kawaii

DATE : October 23, 1997
CONTRACTOR: Pitcher Drilling
EQUIPMENT : Failing 750
JOB NO. : 25692

EBMUD

BORING NO MN-15

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
				0		4" ASPHALT CONCRETE
						4" BASE ROCK
						brown, sandy CLAY (CL) (fill)
	17		15		SPT-1	dark brown, stiff, sandy CLAY (CH)
						grey gravel (GP)
				5		brown, clayey SAND (SC) (fill)
LL = 43, PI = 26	23.6	104.3	25		MC-2	gravelly
						dark brown, stiff CLAY (CH)
LL = 58, PI = 29	23		16	10	SPT-3	
				15		
SG = 2.5	28.7	93.7	16		MC-4	dark greyish brown, with calcite
				20		
	19.3		8		SPT-5	brown, very stiff
						orange brown, deeply weathered silty CLAYSTONE
				25		
LL = 68, PI = 43	28		31		MC-6	
				30		

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LOG OF BORING

PROJECT : WC WTP Improvements
LOCATION : Walnut Creek Filter Plant
LOGGED BY : Catherine Anderson
CHECKED BY : Derek Kawaii

DATE : October 23, 1997
CONTRACTOR: Pitcher Drilling
EQUIPMENT : Failing 750
JOB NO. : 25692

EBMUD

BORING NO MN-15

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
	26.1		43	30	SPT-7	orange brown, deeply weathered and fractured, silty CLAYSTONE harder drilling between 31' and 34' dark green cuttings at 34'
TX-UU = 3316 (4205) SG = 2.6	25.1	99.7	66	35	MC-8	dark grey SILTSTONE / SHALE, vertical fractures started to use rock bit at 35'
TX-CU = 4617 (5400) SG = 2.63	13.5	116.8		40 45	P-9	
				50 55 60		Bottom of Boring at 47.5'

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LOG OF BORING

PROJECT : WC WTP Improvements
LOCATION : Walnut Creek Filter Plant
LOGGED BY : Catherine Anderson
CHECKED BY : Derek Kawaii

DATE : October 23, 1997
CONTRACTOR: Pitcher Drilling
EQUIPMENT : Failing 750
JOB NO. : 25692

EBMUD

BORING NO MN-16

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
				0		dark brown, sandy CLAY
LL = 62, PI = 34 SG = 2.71	28.8	92.1	29		MC-1	orange brown , deeply weathered and fractured CLAYSTONE
LL = 65, PI = 36	23		35	5	SPT-2	harder drilling at 7'
LL =66, PI = 36	29		29	10	SPT-3	greyish brown to orange brown
TX-CU = 7044 (1800)	19.9	103.4	16	15	MC-4	
	19.3		50/6"	20	SPT-5	mottled brown and orange brown, moderately weathered changed to rock bit at 20'
TX-UU = 3409 (2995)	18.9	107.3		25	P-6	very dark grey SILTSTONE / SHALE
				30		

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LOG OF BORING

PROJECT : WC WTP Improvements
DATE : October 22, 1997
LOCATION : Walnut Creek Filter Plant
CONTRACTOR: Pitcher Drilling
LOGGED BY : Catherine Anderson
EQUIPMENT : Failing 750
CHECKED BY : Derek Kawaii
JOB NO. : 25692

EBMUD

BORING NO MN-16

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
			30/3"	30	SPT-7	very dark grey SILTSTONE/SHALE
			35	35		harder drilling at 38'
TX-CU = 4970 (2995) = 5900 (4003) = 7063 (4997) SG = 2.64	11.9	116.5		40	P-8	
				45		Bottom of Boring at 42.5'
				50		
				55		
				60		

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LOG OF BORING

PROJECT : WC WTP Improvements
DATE : October 23, 1997
LOCATION : Walnut Creek Filter Plant
CONTRACTOR: Pitcher Drilling
LOGGED BY : Catherine Anderson
EQUIPMENT : Failing 750
CHECKED BY : Derek Kawaii
JOB NO. : 25692

EBMUD

BORING NO MN-17

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
				0		brown, stiff, gravelly sandy CLAY (CL)
LL = 51, PI = 32	14		20		STP-1	
						orange brown, deeply weathered , silty CLAYSTONE
TX-CU = 857 (504) = 992 (994)	22.9	84.2	33	5	MC-2	
LL = 79, PI = 41	34		30	10	SPT-3	
TX-CU = 1853 (1800) SG = 2.53	32.7	87.2	42	15	MC-4	
	32.8		38	20	SPT-5	moderately weathered
TX-UU = 5564 (2995) SG = 2.5	30.4	88.8	70	25	MC-6	
				30		dark grey SILTSTONE/SHALE

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LOG OF BORING

PROJECT : WC WTP Improvements
LOCATION : Walnut Creek Filter Plant
LOGGED BY : Catherine Anderson
CHECKED BY : Derek Kawaii

DATE : October 23, 1997
CONTRACTOR: Pitcher Drilling
EQUIPMENT : Failing 750
JOB NO. : 25692

EBMUD

BORING NO MN-17

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
	27.2		45/6"	30	SPT-7	very dark grey SILTSTONE/SHALE
				35		harder drilling at 35'
TX-CU = 13358 (4997) SG = 2.43	12.7	112.7		40	P-8	
				45		Bottom of Boring at 42.5'
				50		
				55		
				60		

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LOG OF BORING

PROJECT : WC WTP Improvements
LOCATION : Walnut Creek Filter Plant
LOGGED BY : Catherine Anderson
CHECKED BY : Derek Kawaii

DATE : October 21, 1997
CONTRACTOR: Pitcher Drilling
EQUIPMENT : Failing 750
JOB NO. : 25692

EBMUD

BORING NO MN-18

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
				0		brown, sandy, silty CLAY (CL) with few gravels (fill)
LL = 40, PI = 20			38		SPT-1	
						with sand
LL = 38, PI = 13	21		33	5	SPT-2	
						greenish grey
SG = 2.58	23.3	104.8	21	10	MC-3	
LL = 45, PI = 24	28		17	15	SPT-4	mottled grey
						stiffer drilling at 19.0'
TX-CU 2007 (2405) SG = 2.47	29.3	88.9	23	20	MC-5	greyish brown, deeply weathered and fractured CLAYSTONE
LL = 64, PI = 30	34		28	25	SPT-6	mottled dark tan and orange
				30		

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LOG OF BORING

PROJECT : WC WTP Improvements
DATE : October 21, 1997
LOCATION : Walnut Creek Filter Plant
CONTRACTOR: Pitcher Drilling
LOGGED BY : Catherine Anderson
EQUIPMENT : Failing 750
CHECKED BY : Derek Kawaii
JOB NO. : 25692

EBMUD

BORING NO MN-18

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
TX-UU = 1528 (3600)	33.1	86.9	61/16"	30	MC-7	dark grey and mottled orange, moderately weathered and fractured, silty CLAYSTONE
						light grey
	48.4		32	35	SPT-8	
						dark grey, slightly to moderately weathered SHALE
			50/4"	40	MC-9	
						changed to rock bit at 40'
	24.4		63	45	SPT-10	slightly clayey, fractured
TX-UU = 901 (6005) SG = 2.62	20.4	109.6		50	P-11	
						harder drilling at 53'
	18.9		50/5"	55	SPT-12	
						softer drilling and with brown rock fragments at 59'
				60		

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LOG OF BORING

PROJECT : WC WTP Improvements
LOCATION : Walnut Creek Filter Plant
LOGGED BY : Catherine Anderson
CHECKED BY : Derek Kawaii

DATE : October 21, 1997
CONTRACTOR: Pitcher Drilling
EQUIPMENT : Failing 750
JOB NO. : 25692

EBMUD

BORING NO MN-18

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
				60	P-13	harder drilling at 60.5'
TX-CU = 2508 (4997) = 3070 (6005) = 3270 (6998) SG = 2.58	20.3	105.4	50/5"	70	MC-14	
				75		
TX-UU = 1708 (8006)	18.1	110.1		80	P-15	dark grey to black silty CLAYSTONE and SHALE
						Bottom of Boring at 82.0'
				90		

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LOG OF BORING

PROJECT : WC WTP Improvements
LOCATION : Walnut Creek Filter Plant
LOGGED BY : Catherine Anderson
CHECKED BY : Derek Kawaii

DATE : October 22, 1997
CONTRACTOR: Pitcher Drilling
EQUIPMENT : Failing 750
JOB NO. : 25692

EBMUD

BORING NO MN-19

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
				0		dark brown, sandy CLAY (CH) (fill)
LL = 85, PI = 54	24		9		SPT-1	
						orange brown, silty CLAY (CH) (fill)
TX-CU = 4384 (605) SG = 2.58	21.7	90.4	33	5	MC-2	mottled tan orange brown, deeply weathered SILTSTONE with calcite on fracture surfaces
LL = 68, PI = 36	34		28	10	SPT-3	greenish tan, deeply weathered CLAYTONE, with organic clay seams
TX-CU = 2215 (1800) = 4217 (2405) = 5347 (3600)	25.9	90.3	72	15	MC-4	greyish brown
	28.2		53	20	SPT-5	light brown
TX-UU = 6837 (2995) SG = 2.59	30.4	90.6	40/4"	25	MC-6	moderately weathered
				30		

U\data\borelogs\Walnut Creek\25692\MN-19.1.CDR

LOG OF BORING

PROJECT : WC WTP Improvements
LOCATION : Walnut Creek Filter Plant
LOGGED BY : Catherine Anderson
CHECKED BY : Derek Kawaii

DATE : October 22, 1997
CONTRACTOR: Pitcher Drilling
EQUIPMENT : Failing 750
JOB NO. : 25692

EBMUD

BORING NO MN-19

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
	32		48	30	SPT-7	brown silty CLAYSTONE, with fractures at 45 degrees, deeply weathered
				35		
						dark grey, SHALE, with shell fragments
TX-CU = 5738 (4795) SG = question	28.7	93.0	50/5"	40	MC-8	Bottom of Boring at 40.7'
				45		
				50		
				55		
				60		

U\data\borelogs\Walnut Creek\25692\MN-19.2.CDR

LOG OF BORING

PROJECT : WC WTP Improvements
DATE : November 5, 1997
LOCATION : Walnut Creek Filter Plant
CONTRACTOR: Pitcher Drilling
LOGGED BY : Catherine Anderson
EQUIPMENT : Failing 750
CHECKED BY : Derek Kawaii
JOB NO. : 25692

EBMUD

BORING NO MN-20

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
				0		brown, gravelly, sandy CLAY (CL) (fill)
LL = 68, PI= 38	24		38		SPT-1	tan, deeply weathered SILTSTONE
LL = 47, PI = 17	17		43/6"	5	SPT-2	Bottom of Boring at 7'
				10		
				15		
				20		
				25		
				30		

U\data\borelogs\Walnut Creek\25692\MN-20.CDR

LOG OF BORING

PROJECT : WC WTP Improvements
LOCATION : Walnut Creek Filter Plant
LOGGED BY : Catherine Anderson
CHECKED BY : Derek Kawaii

DATE : October 24, 1997
CONTRACTOR: Pitcher Drilling
EQUIPMENT : Failing 750
JOB NO. : 25692

EBMUD

BORING NO MN-21

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
				0		BASE ROCK
LL = 78, PI = 52	21		25		SPT-1	brown, stiff, sandy CLAY (CH)
						orange brown, deeply weathered SILTSTONE
LL = 48, PI =27	19		13	5	SPT-2	
LL = 71, PI = 37 TX-UU = 2545 (1195) SG = 2.58	30.5	88.2	21	10	MC-3	orange brown, deeply weathered and fractured CLAYSTONE
						becomes harder drilling at 13.5'
LL = 64, PI = 29	34		24	15	SPT-4	rock fragments, calcite and carbonaceous materials
TX-UU 4235 (2390) SG = 2.66	22.3	100.1	58	20	MC-5	dark grey to tan orange, deeply weathered SILTSTONE / SHALE with oxidized and calcareous seams
	20.7		59/16"	25	SPT-6	
				30		

U\data\borelogs\Walnut Creek\25692\MN-21.1.CDR

LOG OF BORING

PROJECT : WC WTP Improvements
LOCATION : Walnut Creek Filter Plant
LOGGED BY : Catherine Anderson
CHECKED BY : Derek Kawaii

DATE : October 24, 1997
CONTRACTOR: Pitcher Drilling
EQUIPMENT : Failing 750
JOB NO. : 25692

EBMUD

BORING NO MN-21

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
TX-UU = 4328 (3499) SG = 2.71	26.5	98.1	33/6"	30	MC-7	brown, moderately weathered and fractured CLAYSTONE
						dark grey SILTSTONE chips in drilling fluid
				35		very hard drilling at 35'
						Bottom of Boring at 35'
				40		
				45		
				50		
				55		
				60		

U\data\borelogs\Walnut Creek\25692\MN-21.2.CDR

LOG OF BORING

PROJECT : WC WTP Improvements
DATE : October 30, 1997
LOCATION : Walnut Creek Filter Plant
CONTRACTOR: Pitcher Drilling
LOGGED BY : Catherine Anderson
EQUIPMENT : Failing 750
CHECKED BY : Derek Kawaii
JOB NO. : 25692

EBMUD

BORING NO MN-22

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
				0		tan, silty SAND (SM) (fill)
	10.5		35/6"		SPT-1	
	5.8		50/6"	5	STP-2	
TX-UU = 1085 (1195) SG =2.58	17.5	113.2		10	P-3	clay seam
				15		
TX-UU 9735 (2405) SG = 2.57				20	P-4	brown, moderately weathered and fractured SANDSTONE, fine grained
				25		
				30		

U\data\borelogs\Walnut Creek\25692\MN-22.1.CDR

LOG OF BORING

PROJECT : WC WTP Improvements
DATE : October 30, 1997
LOCATION : Walnut Creek Filter Plant
CONTRACTOR: Pitcher Drilling
LOGGED BY : Catherine Anderson
EQUIPMENT : Failing 750
CHECKED BY : Derek Kawaii
JOB NO. : 25692

EBMUD

BORING NO MN-22

SURFACE ELEV. :

TEST RESULTS	MOISTURE CONTENT %	DRY DENSITY (PCF)	BLOWS/FT*	DEPTH (FT)	SAMPLE NO.	DESCRIPTION
TX-UU = 2282* (3600) SG = 2.63 * sample stopped deforming at 0.7% strain	14.8	114.5		30 35 40 45 50 55 60	P-5	slightly to moderately weathered SANDSTONE, fine-grained Bottom of Boring at 32.0'

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APPENDIX B

LOGS OF BORINGS (Olivia Chen Consultants)

LOG OF BORING MN23	DRILLING DATE: 2-12-01	SURFACE ELEV: N/A
	DRILLING METHOD: Mud Rotary	DATUM: Ground Surface
	DRILL RIG TYPE: Failing 1500	LOGGED BY: CT
	HAMMER TYPE: 140 LBS. SAFETY HAMMER	CHECKED BY: CBK

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DEPTH (FEET)	SAMPLE TYPE	SAMPLE NO.	BLOW COUNT	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
		1	87		LEAN CLAY with Sand (CL), light brownish gray, hard, dry to moist, gravel-sized sandstone fragments (fill).	83.5	18.0	41	19	72.7
5		2	39		SANDY LEAN CLAY (CL-ML), sandy.		20.9	40	15	69.4
10		3	52		SANDY LEAN CLAY, dark gray with rust striations, hard, dry, sandy.		20.3	35	9	54.2
15		4	37		LEAN CLAY with Sand (CL), dark greenish gray, hard, moist, medium to high toughness, plastic, organic odor (colluvium).		25.0	39	18	82.7
20		5	17				22.2			
25		6			Olive brown with rust striations, moist, strongly cemented.	106.3	21.4	37	17	83.9
30		7	50/2"		Yellowish brown, hard, weakly cemented.					
35		8			SANDSTONE, dark gray, moist, silty, closely fractured, slightly to moderately weathered, weak to moderately strong.		17.1			
		9	50/3"		Brownish beige with rust striations, dry, weakly cemented.					76.4
					SILTSTONE, dark gray, moist, closely to moderately fractured, strong.					

LOG OF BORING L:\EBMUD\1320WA~1\BORINGS\GINTWPROJECTS\FINAL\1132001A.GPJ OLV_CHEN.GDT 4/10/01

JOB NO. 1320.01	PROJECT: Walnut Creek Water Treatment Plant	SHEET 1 of 2	FIGURE 1

LOG OF BORING MN23	DRILLING DATE: 2-12-01	SURFACE ELEV: N/A
	DRILLING METHOD: Mud Rotary	DATUM: Ground Surface
	DRILL RIG TYPE: Failing 1500	LOGGED BY: CT
	HAMMER TYPE: 140 LBS. SAFETY HAMMER	CHECKED BY: CBK

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DEPTH (FEET)	SAMPLE TYPE	SAMPLE NO.	BLOW COUNT	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
		10			SILTSTONE, dark gray, moist, closely to moderately fractured, strong. *(Continued)*		18.9			
		11	50/3"		Bottom of boring at 43.25' below ground surface.					
45										
50										
55										
60										
65										
70										
75										

LOG OF BORING L:\EBMUD\1320WA~1\BORINGS\GINTWPROJECTS\FINAL\132001A.GPJ OLV_CHEN.GDT 4/10/01

JOB NO. 1320.01	PROJECT: Walnut Creek Water Treatment Plant	SHEET 2 of 2	FIGURE 1

LOG OF BORING MN 23A	DRILLING DATE: 1-4-01	SURFACE ELEV: N/A
	DRILLING METHOD: Mud Rotary	DATUM: Ground Surface
	DRILL RIG TYPE: Failing 1500	LOGGED BY: SI
	HAMMER TYPE: 140 LBS. SAFETY HAMMER	CHECKED BY: CBK

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DEPTH (FEET)	SAMPLE TYPE	SAMPLE NO.	BLOW COUNT	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
		1	50/ 5.5"		LEAN CLAY with Sand (CL), light brownish gray, very dense, dry, (fill).		12.6	45	22	84.3
5		2	49		Small rock fragments present.					
10		3	50/3"		LEAN CLAY with Sand (CL), dark brown, hard, moist, medium toughness, none to low dilatency (fill).					
15		4	50/3"							
20		5	50/3"		SANDSTONE, greenish gray, moist, silty, fine-grained, moderately weathered, friable to moderately strong, weakly cemented.		18.8			
25		6	50/3"							
30		7	50/2"				17.8			
35		8	50/3"							

JOB NO. 1320.01	PROJECT: Walnut Creek Water Treatment Plant	SHEET 1 of 2	FIGURE 1a

LOG OF BORING L:\EBMUD\1320WA~1\BORINGS\GINTWPROJECTS\FINAL\1132001A.GPJ OLV_CHEN.GDT 4/10/01

LOG OF BORING MN 23A	DRILLING DATE: 1-4-01	SURFACE ELEV: N/A
	DRILLING METHOD: Mud Rotary	DATUM: Ground Surface
	DRILL RIG TYPE: Failing 1500	LOGGED BY: SI
	HAMMER TYPE: 140 LBS. SAFETY HAMMER	CHECKED BY: CBK

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DEPTH (FEET)	SAMPLE TYPE	SAMPLE NO.	BLOW COUNT	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
		9	50/2.5		SANDSTONE, greenish gray with rust striations, moist, weakly cemented.		20.1			
					Bottom of boring at 40.25' below ground surface. Piezometer installed on 1/4/01; refer to completion diagram. Groundwater not encountered during field visit on 1/22/01.					
45										
50										
55										
60										
65										
70										
75										

LOG OF BORING L:\EBMUD\1320WA~1\BORINGS\GINTWPROJECTS\FINAL\1320001A.GPJ OLV_CHEN.GDT 4/10/01

JOB NO. 1320.01	PROJECT: Walnut Creek Water Treatment Plant	SHEET 2 of 2	FIGURE 1a

LOG OF BORING MN 24	DRILLING DATE: 1-4-01	SURFACE ELEV: N/A
	DRILLING METHOD: Mud Rotary	DATUM: Ground Surface
	DRILL RIG TYPE: Failing 1500	LOGGED BY: SI
	HAMMER TYPE: 140 LBS. SAFETY HAMMER	CHECKED BY: CBK

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DEPTH (FEET)	SAMPLE TYPE	SAMPLE NO.	BLOW COUNT	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
					4" ASPHALT.					
		1	50/6"		SILTY SAND / CLAYEY SAND (SC-SM), light brownish beige some rust striations, dry, sandstone fragments.		13.4	33	9	47.9
5		2	50/4"				17.2			
10		3	50/4"		SANDSTONE, beige, dry, silty, fine-grained, moderate cementation, slight to moderately weathered, moderately strong.		21.0			45.0
15		4	50/4.5"		SILTSTONE, brownish orange, dry to moist, closely fractured, rust striations (iron stains), slight to moderately weathered, moderately strong.					
20		5	50/6"				25.8			
25		6	50/4"							
30		7			Moderately fractured.	102.6	21.2			
35					Bottom of boring at 33' below ground surface. Piezometer installed on 1/4/01; refer to completion diagram. Groundwater not encountered during field visit on 1/22/01.					

LOG OF BORING L:\EBMUD\1320WA~1\BORINGS\GINTWPROJECTS\FINAL\1320O1A.GPJ OLV_CHEN.GDT 4/10/01

JOB NO. 1320.01	PROJECT: Walnut Creek Water Treatment Plant	SHEET 1 of 1	FIGURE 2

LOG OF BORING MN 25	DRILLING DATE: 1-3-01	SURFACE ELEV: N/A
	DRILLING METHOD: Mud Rotary	DATUM: Ground Surface
	DRILL RIG TYPE: Failing 1500	LOGGED BY: KG
	HAMMER TYPE: 140 LBS. SAFETY HAMMER	CHECKED BY: CBK

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DEPTH (FEET)	SAMPLE TYPE	SAMPLE NO.	BLOW COUNT	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
		1	46		LEAN CLAY with Sand (CL), grayish brown with white & orange mottles, hard, moist, (fill).		19.8	43	20	70.2
5		2	52		LEAN CLAY with Sand (CL), dark gray, hard, dry to moist, (fill).		20.2	40	18	74.1
10		3	25		CLAYSTONE, tannish beige, moist, deeply to moderately weathered, weak to moderately strong, moderate cementation.		28.6			
15		4	46		Tannish beige with orange striations.					
20		5	29				29.9			
25		6			Friable to plastic.	80.1	38.4			
30		7	68		CLAYSTONE, dark gray, moist, slightly to moderately weathered. moderately strong, moderate cementation.		20.9			
35		8	93		CLAYSTONE, silty, slightly weathered, moderately strong.					

LOG OF BORING L:\EBMUD\1320WA~1\BORINGS\GINTWPROJECTS\FINAL\132001A.GPJ OLV_CHEN.GDT 4/10/01

JOB NO. 1320.01	PROJECT: Walnut Creek Water Treatment Plant	SHEET 1 of 2	FIGURE 3

LOG OF BORING MN 25	DRILLING DATE: 1-3-01	SURFACE ELEV: N/A
	DRILLING METHOD: Mud Rotary	DATUM: Ground Surface
	DRILL RIG TYPE: Failing 1500	LOGGED BY: KG
	HAMMER TYPE: 140 LBS. SAFETY HAMMER	CHECKED BY: CBK

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DEPTH (FEET)	SAMPLE TYPE	SAMPLE NO.	BLOW COUNT	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
		9	88		CLAYSTONE, tannish beige, moist, deeply to moderately weathered, weak to moderately strong, moderate cementation. *(Continued)*					
					CLAYSTONE, silty, slightly weathered, moderately strong.					
45		10				121.5	14.3			
					Bottom of boring at 48' below ground surface.					
50					Piezometer installed on 1/3/01; refer to completion diagram.					
					Groundwater encountered at 23 feet below ground surface during field visit on 1/22/01.					
55										
60										
65										
70										
75										

JOB NO. 1320.01	PROJECT: Walnut Creek Water Treatment Plant	SHEET 2 of 2	FIGURE 3

LOG OF BORING L:\EBMUD\1320WA~1\BORINGS\GINTW\PROJECTS\FINAL\1320001A.GPJ OLV_CHEN.GDT 4/10/01

LOG OF BORING MN 26	DRILLING DATE: 1-2-01	SURFACE ELEV: N/A
	DRILLING METHOD: Mud Rotary	DATUM: Ground Surface
	DRILL RIG TYPE: Failing 1500	LOGGED BY: KG
	HAMMER TYPE: 140 LBS. SAFETY HAMMER	CHECKED BY: CBK

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DEPTH (FEET)	SAMPLE TYPE	SAMPLE NO.	BLOW COUNT	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
					4" ASPHALT.					
					6" CONCRETE.					
		1	27		CLAYSTONE, reddish brown with rust striations, dry to moist, silty, slightly to moderately fractured, weak to moderate cementation.		29.7			
5		2	36		Slightly to moderately weathered, weak to moderately strong. ▼		28.9			
10		3	52							
15		4				93.0	28.9			
20		5	80				28.6			
25		6	50/6"							
30		7	50/5.5"		Bottom of boring at 30.5' below ground surface. Piezometer installed on 1/2/01; refer to completion diagram. Groundwater encountered at 6 feet below ground surface during field visit on 1/22/01.					
35										

LOG OF BORING L:\EBMUD\1320WA~1\BORINGS\GINTW\PROJECTS\FINAL\1320001A.GPJ OLV_CHEN.GDT 4/10/01

JOB NO. 1320.01	PROJECT: Walnut Creek Water Treatment Plant	SHEET 1 of 1	FIGURE 4

LOG OF BORING MN 27	DRILLING DATE: 1-9-01	SURFACE ELEV: N/A
	DRILLING METHOD: Mud Rotary	DATUM: Ground Surface
	DRILL RIG TYPE: Failing 1500	LOGGED BY: KG
	HAMMER TYPE: 140 LBS. SAFETY HAMMER	CHECKED BY: CBK

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DEPTH (FEET)	SAMPLE TYPE	SAMPLE NO.	BLOW COUNT	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
		1	39		SANDY LEAN CLAY (CL), greenish brown with orange and gray mottles, dense, dry, (fill).		14.8	46	25	66.7
5		2	28		SANDY LEAN CLAY, medium dense, silty.		19.6	44	23	
10		3	9		FAT CLAY (CH), dark gray, stiff, moist, none to low dilatency, low to medium toughness, highly plastic (colluvium).		36.2	72	50	89.8
		4	17		FAT CLAY.	88.5	32.5	76	52	89.8
15		5	15			85.9	34.5			
20		6	62		CLAYSTONE, dark gray, moist, slightly to moderately weathered, rust striations, friable to weak.	91.1	30.7			
25		7			Weak to moderately strong.	97.9	26.7			
30		8	50/4.5		Bottom of boring at 30.4' below ground surface. Piezometer installed on 1/9/01; refer to completion diagram. Groundwater encountered at 21 feet below ground surface during field visit on 1/22/01.					
35										

JOB NO. 1320.01	PROJECT: Walnut Creek Water Treatment Plant	SHEET 1 of 1	FIGURE 5

LOG OF BORING L:\EBMUD\1320WA~1\BORINGS\GINTWPROJECTS\FINAL\1132001A.GPJ OLV_CHEN.GDT 4/10/01

LOG OF BORING MN 28A	DRILLING DATE: 1-3-01	SURFACE ELEV: N/A
	DRILLING METHOD: Mud Rotary	DATUM: Ground Surface
	DRILL RIG TYPE: Failing 1500	LOGGED BY: KG
	HAMMER TYPE: 140 LBS. SAFETY HAMMER	CHECKED BY: CBK

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DEPTH (FEET)	SAMPLE TYPE	SAMPLE NO.	BLOW COUNT	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
		1	26		LEAN CLAY with Sand (CL), brownish yellow, very stiff, dry, (fill).		14.0	38	17	71.6
5		2	45		LEAN CLAY with Sand (CL), brownish yellow with orange and white mottles, hard, dry, (fill).		17.6	46	21	77.2
10		3	19		NO RECOVERY, very stiff.					
15		4	30		CLAYSTONE, grayish brown with orange, gray, and white mottles, dry to moist, moderate cementation, moderately weathered, calcite veins, weak to moderately strong.		29.8			
20		5				87.3	35.4			
25		6	44		CLAYSTONE/SILTSTONE, grayish brown with orange, gray, and white mottles, rust striations, dry to moist, moderate cementation, moderately weathered, calcite seams, closely to intensely fractured, moderately strong.		24.3			
30		7	90		CLAYSTONE, silty.		24.5			
35					Bottom of boring at 31.5' below ground surface. Piezometer installed on 1/3/01; refer to completion diagram. Groundwater not encountered during field visit on 1/22/01.					

JOB NO. 1320.01	PROJECT: Walnut Creek Water Treatment Plant	SHEET 1 of 1	FIGURE 6

LOG OF BORING L:\EBMUD\1320WA~1\BORINGS\GINTWPROJECTS\FINAL\132001A.GPJ OLV_CHEN.GDT 4/10/01

LOG OF BORING MN 29A	DRILLING DATE: 1-9-01	SURFACE ELEV: N/A
	DRILLING METHOD: Mud Rotary	DATUM: Ground Surface
	DRILL RIG TYPE: Failing 1500	LOGGED BY: KG
	HAMMER TYPE: 140 LBS. SAFETY HAMMER	CHECKED BY: CBK

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DEPTH (FEET)	SAMPLE TYPE	SAMPLE NO.	BLOW COUNT	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
					2" ASPHALT.					
		1	22		CLAYSTONE, brownish yellow with rust striations, moist, silty, moderately weathered, moderate cementation, weak.		30.3			
5		2	38		SILTSTONE, brownish yellow with rust striations, dry to moist, clayey, moderately weathered, moderate cementation, weak.		30.7			
10		3	31		Closely fractured. ▼		29.3			
15		4	51				29.8			
20		5			CLAYSTONE, dark gray, moist, silty, closely fractured, moderately weathered, weak to moderately strong, weak cementation.	94.3	27.3			98.1
25		6	50/4"		Platy.		25.7			
30		7	50/3.5"		SILTSTONE, clayey, platy, slightly to moderately weathered, moderately strong.		25.1			
					Bottom of boring at 30.3' below ground surface. Piezometer installed on 1/9/01; refer to completion diagram. Groundwater encountered at 11.5 feet below ground surface during field visit on 1/22/01.					
35										

JOB NO. 1320.01	PROJECT: Walnut Creek Water Treatment Plant	SHEET 1 of 1	FIGURE 7

LOG OF BORING L:\EBMUD\1320WA~1\BORINGS\GINTWPROJECTS\FINAL\1320001A.GPJ OLV_CHEN.GDT 4/10/01

LOG OF BORING MN 30	DRILLING DATE: 1-2-01	SURFACE ELEV: N/A
	DRILLING METHOD: Mud Rotary	DATUM: Ground Surface
	DRILL RIG TYPE: Failing 1500	LOGGED BY: KG
	HAMMER TYPE: 140 LBS. SAFETY HAMMER	CHECKED BY: CBK

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DEPTH (FEET)	SAMPLE TYPE	SAMPLE NO.	BLOW COUNT	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
		1	65		SANDY LEAN CLAY (CL), grayish brown with white mottles, dry to moist, sandstone fragments (fill).		12.8	47	26	67.5
5		2	39		LEAN CLAY with Sand (CL).		8.5	32	13	76.4
10		3	24		CLAYSTONE, brownish beige with rust striations, moist, moderately weathered, friable to weak, moderate cementation.		31.4			
15		4	26				32.0			
20		5	38		Closely fractured, moderately strong.		30.8			
25		6	52		Calcareous clay seams.		31.7			
30		7	57		SILTSTONE, clayey, slightly to moderately weathered, closely fractured, moderately strong.		29.9			
					Bottom of boring at 31.5' below ground surface. Piezometer installed on 1/2/01; refer to completion diagram. Groundwater not encountered during field visit on 1/22/01.					
35										

LOG OF BORING L:\EBMUD\1320WA~1\BORINGS\GINTWPROJECTS\FINAL\1132001A.GPJ OLV_CHEN.GDT 4/10/01

JOB NO. 1320.01	PROJECT: Walnut Creek Water Treatment Plant	SHEET 1 of 1	FIGURE 8

LOG OF BORING MN 31	DRILLING DATE: 1-8-01	SURFACE ELEV: N/A
	DRILLING METHOD: Mud Rotary	DATUM: Ground Surface
	DRILL RIG TYPE: Failing 1500	LOGGED BY: XS
	HAMMER TYPE: 140 LBS. SAFETY HAMMER	CHECKED BY: CBK

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DEPTH (FEET)	SAMPLE TYPE	SAMPLE NO.	BLOW COUNT	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
		1	50/3"		SANDY LEAN CLAY (CL), grayish brown, hard, moist.		21.6			56.2
5		2	50/4"		SANDSTONE, grayish brown with rust striations, moderately weathered, weak to moderately strong.		19.6			
10		3	50/3"		More gray in color.					
15		4	50/2"		Slightly weathered.		14.9			
20		5	50/2"		Moderately strong to strong.					
25		6			Closely fractured.	113.4	17.4			
30		7	50/4"							
35		8	50/3"		Rust color striations.		18.6			

Bottom of boring at 41.33' below ground surface.
Piezometer installed on 1/8/01; refer to completion diagram.
Groundwater not encountered during field visit on 1/22/01.

JOB NO. 1320.01	PROJECT: Walnut Creek Water Treatment Plant	SHEET 1 of 2	FIGURE 9

LOG OF BORING L:\EBMUD\1320WA~1\BORINGS\GINTW\PROJECTS\FINAL\1132001A.GPJ OLV_CHEN.GDT 4/10/01

LOG OF BORING MN 31	DRILLING DATE: 1-8-01	SURFACE ELEV: N/A
	DRILLING METHOD: Mud Rotary	DATUM: Ground Surface
	DRILL RIG TYPE: Failing 1500	LOGGED BY: XS
	HAMMER TYPE: 140 LBS. SAFETY HAMMER	CHECKED BY: CBK

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DEPTH (FEET)	SAMPLE TYPE	SAMPLE NO.	BLOW COUNT	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
		9	50/4"							
45										
50										
55										
60										
65										
70										
75										

LOG OF BORING L:\EBMUD\1320WA~1\BORINGS\GINTWPROJECTS\FINAL\1132001A.GPJ OLV_CHEN.GDT 4/10/01

JOB NO. 1320.01	PROJECT: Walnut Creek Water Treatment Plant	SHEET 2 of 2	FIGURE 9

LOG OF BORING MN 32	DRILLING DATE: 1-5-01	SURFACE ELEV: N/A
	DRILLING METHOD: Mud Rotary	DATUM: Ground Surface
	DRILL RIG TYPE: Failing 1500	LOGGED BY: KG
	HAMMER TYPE: 140 LBS. SAFETY HAMMER	CHECKED BY: CBK

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DEPTH (FEET)	SAMPLE TYPE	SAMPLE NO.	BLOW COUNT	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
		1	50/1"		NO RECOVERY.					
5		2	50/4.5"		CLAYEY SAND (SC), dark brown, very dense, moist.		36.4			34.0
10		3	50/3.5"		SILTSTONE, fine grained, grayish yellow with rust striations, dry, silty, moderate to strong cementation, slightly weathered, moderately strong.		19.8			
15		4	50/4"		Closely fractured.		17.0			56.6
20		5			Strong.	108.5	18.0			
25					Bottom of boring at 23' below ground surface. Piezometer installed on 1/5/01; refer to completion diagram. Groundwater not encountered during field visit on 1/22/01.					
30										
35										

JOB NO. 1320.01	PROJECT: Walnut Creek Water Treatment Plant	SHEET 1 of 1	FIGURE 10

LOG OF BORING L:\EBMUD\1320WA~1\BORINGS\GINTWPROJECTS\FINAL\1320O1A.GPJ OLV_CHEN.GDT 4/10/01

LOG OF BORING MN 33	DRILLING DATE: 1-5-01	SURFACE ELEV: N/A
	DRILLING METHOD: Mud Rotary	DATUM: Ground Surface
	DRILL RIG TYPE: Failing 1500	LOGGED BY: KG
	HAMMER TYPE: 140 LBS. SAFETY HAMMER	CHECKED BY: CBK

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DEPTH (FEET)	SAMPLE TYPE	SAMPLE NO.	BLOW COUNT	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
		1	50/6"		SILTSTONE, fine grained, brownish yellow beige, dry to moist, moderate cementation, closely fractured, slightly weathered, moderately strong.		13.0			65.6
5		2	50/6"		Dark gray with rust striations, dry to moist.					
10		3	50/4.5"				22.0			52.5
15		4	50/3.5"							
20		5			Strong.	110.5	17.6			
25					Bottom of boring at 23' below ground surface. Piezometer installed on 1/5/01; refer to completion diagram. Groundwater not encountered during field visit on 1/22/01.					
30										
35										

LOG OF BORING L:\EBMUD\1320WA~1\BORINGS\GINTWPROJECTS\FINAL\132001A.GPJ OLV_CHEN.GDT 4/10/01

JOB NO. 1320.01	PROJECT: Walnut Creek Water Treatment Plant	SHEET 1 of 1	FIGURE 11

LOG OF BORING MN 34	DRILLING DATE: 1-5-01	SURFACE ELEV: N/A
	DRILLING METHOD: Mud Rotary	DATUM: Ground Surface
	DRILL RIG TYPE: Failing 1500	LOGGED BY: XS
	HAMMER TYPE: 140 LBS. SAFETY HAMMER	CHECKED BY: CBK

Olivia Chen Consultants, Inc.
Civil • Environmental • Geotechnical

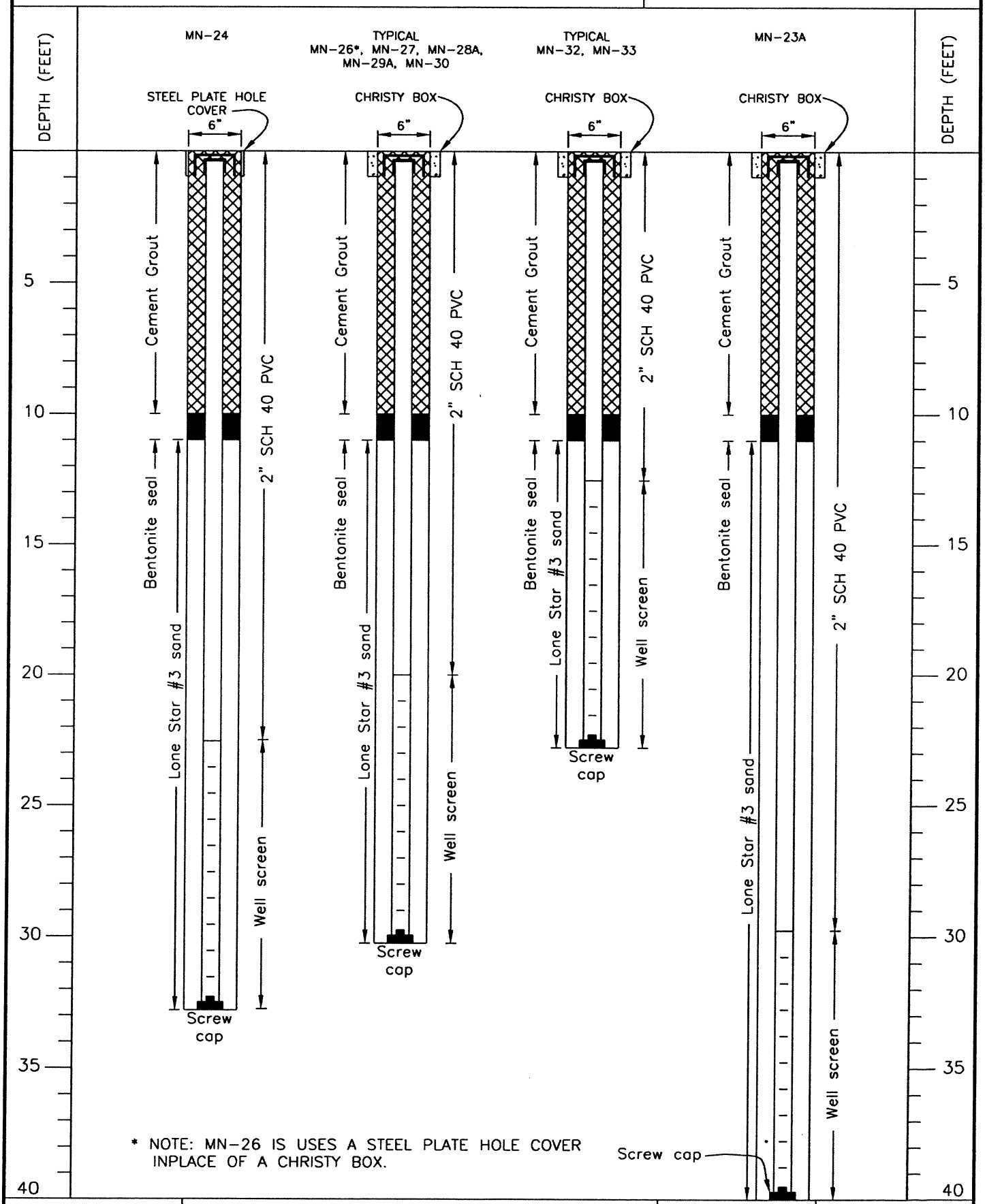
DEPTH (FEET)	SAMPLE TYPE	SAMPLE NO.	BLOW COUNT	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
		1	76		SILTSTONE, fine grained, brownish yellow with rust striations, dry to moist, weak to moderate cementation, slightly to moderately weathered, moderate strong to strong.		16.2			60.2
5		2	50/2"				17.0			
10		3	50/5"				15.0			
		4	50/3"				11.3			
15					Bottom of boring at 14.25' below ground surface. Piezometer installed on 2/12/01; refer to completion diagram. Groundwater not encountered during drilling.					
20										
25										
30										
35										

LOG OF BORING L:\EBMUD\1320WA~1\BORINGS\GINTWPROJECTS\FINAL\1320001A.GPJ OLV_CHEN.GDT 4/10/01

JOB NO. 1320.01	PROJECT: Walnut Creek Water Treatment Plant	SHEET 1 of 1	FIGURE 12

PIEZOMETER COMPLETION DIAGRAM

OC Consultants, Inc.
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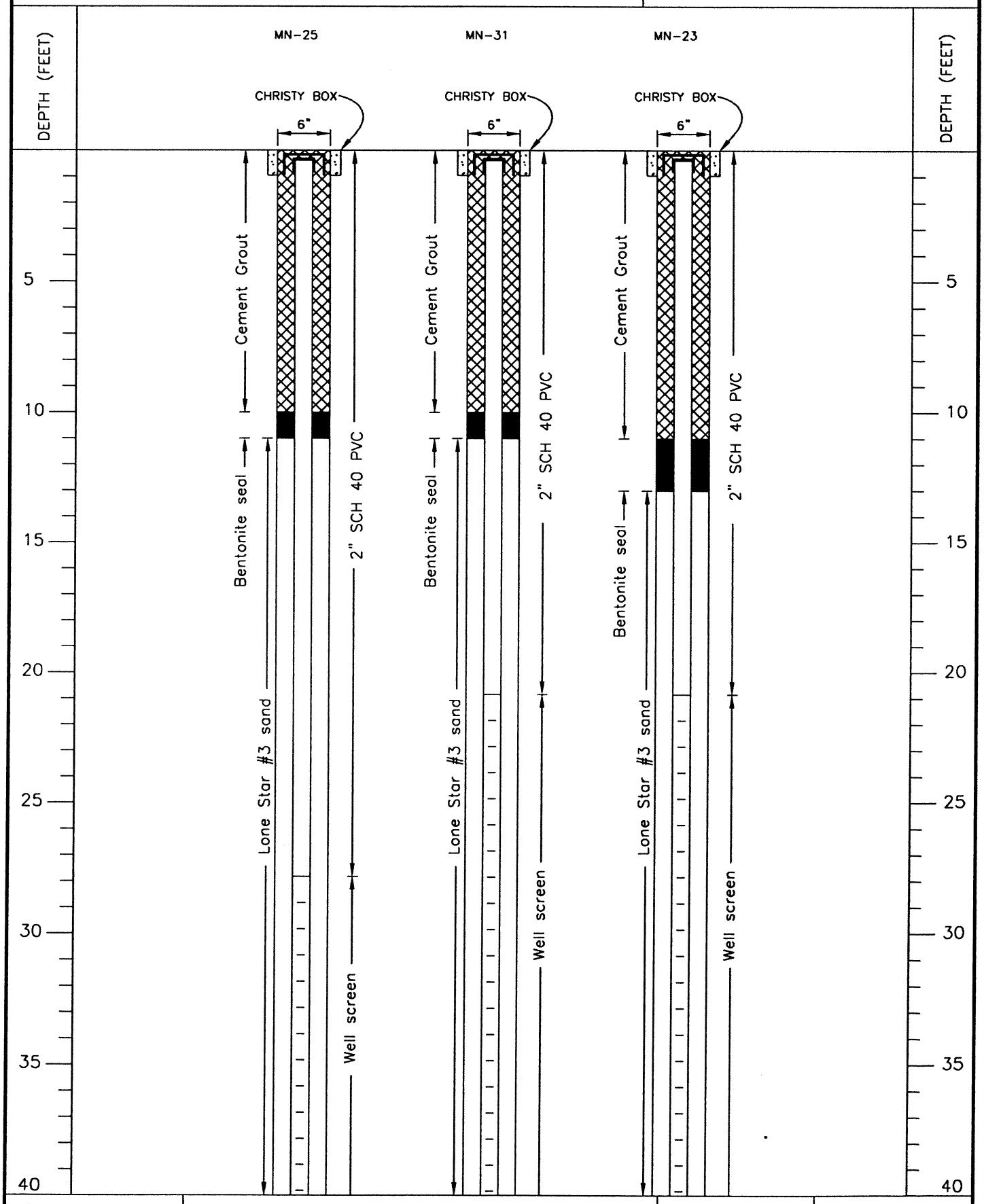


JOB NO. 1320	PROJECT: WALNUT CREEK WTP	SHEET 1 OF 1	FIGURE 13

L:\EBMUD\1320 WALNUT CREEK WTP\BORINGS\WELL DIAGRAM.DWG

PIEZOMETER COMPLETION DIAGRAM

OC Consultants, Inc.
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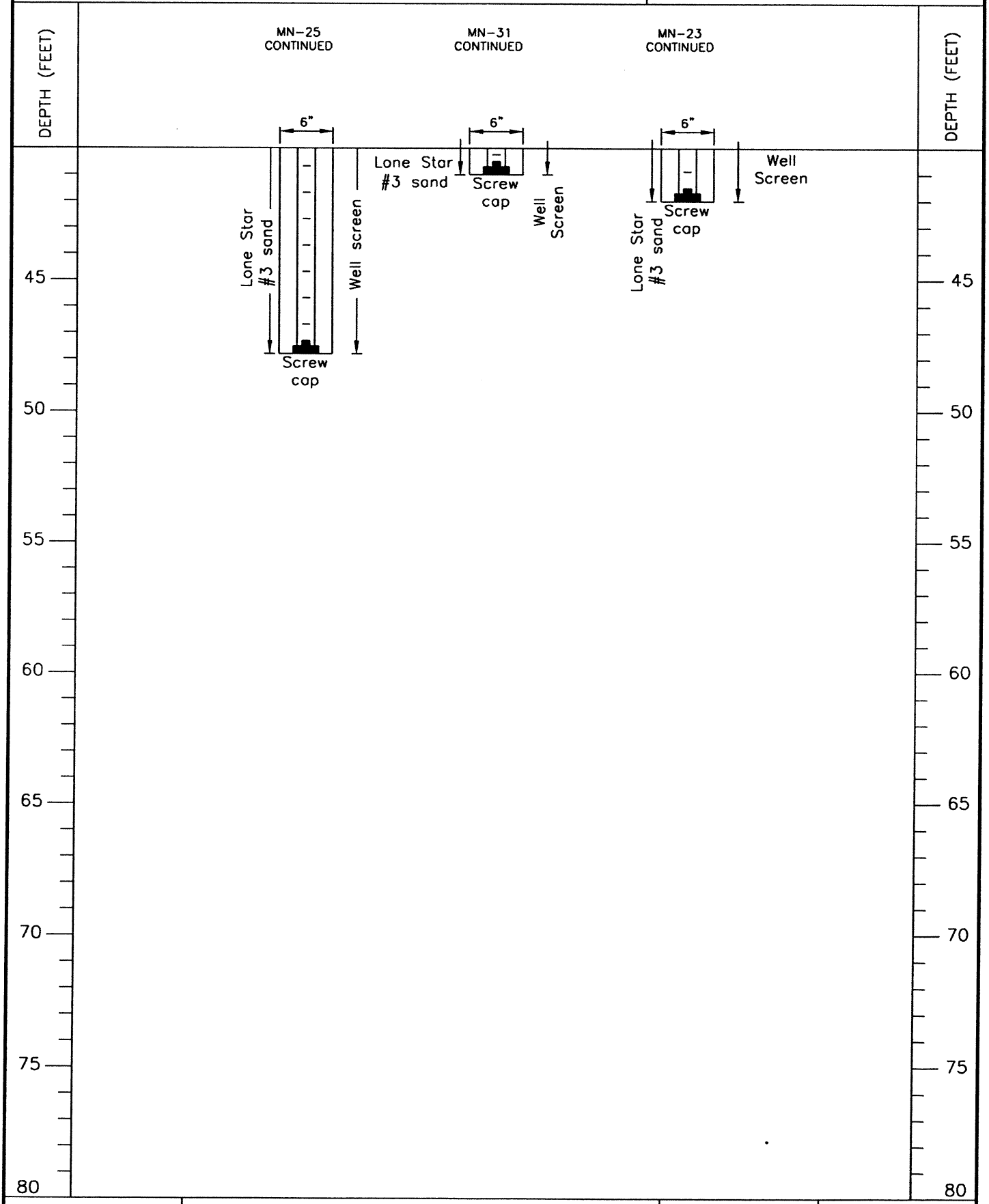


JOB NO. 1320	PROJECT: WALNUT CREEK WTP	SHEET 1 OF 2	FIGURE 14

L:\EBMUD\1320 WALNUT CREEK WTP\BORINGS\WELL DIAGRAM.DWG

PIEZOMETER COMPLETION DIAGRAM

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JOB NO. 1320	PROJECT: WALNUT CREEK WTP	SHEET 2 OF 2	FIGURE 14

L:\EBMUD\1320 WALNUT CREEK WTP\BORINGS\WELL DIAGRAM.DWG

UNIFIED SOIL CLASSIFICATION (ASTM D-2487-98)

MATERIAL TYPES	CRITERIA FOR ASSIGNING SOIL GROUP NAMES			GROUP SYMBOL	SOIL GROUP NAMES & LEGEND
COARSE-GRAINED SOILS >50% RETAINED ON NO. 200 SIEVE	GRAVELS >50% OF COARSE FRACTION RETAINED ON NO 4. SIEVE	CLEAN GRAVELS <5% FINES	Cu>4 AND 1<Cc<3	GW	WELL-GRADED GRAVEL
			Cu>4 AND 1>Cc>3	GP	POORLY-GRADED GRAVEL
		GRAVELS WITH FINES >12% FINES	FINES CLASSIFY AS ML OR CL	GM	SILTY GRAVEL
			FINES CLASSIFY AS CL OR CH	GC	CLAYEY GRAVEL
	SANDS >50% OF COARSE FRACTION PASSES ON NO 4. SIEVE	CLEAN SANDS <5% FINES	Cu>6 AND 1<Cc<3	SW	WELL-GRADED SAND
			Cu>6 AND 1>Cc>3	SP	POORLY-GRADED SAND
		SANDS AND FINES >12% FINES	FINES CLASSIFY AS ML OR CL	SM	SILTY SAND
			FINES CLASSIFY AS CL OR CH	SC	CLAYEY SAND
FINE-GRAINED SOILS >50% PASSES NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT<50	INORGANIC	PI>7 AND PLOTS>"A" LINE	CL	LEAN CLAY
			PI>4 AND PLOTS<"A" LINE	ML	SILT
		ORGANIC	LL (oven dried)/LL (not dried)<0.75	OL	ORGANIC CLAY OR SILT
	SILTS AND CLAYS LIQUID LIMIT>50	INORGANIC	PI PLOTS >"A" LINE	CH	FAT CLAY
			PI PLOTS <"A" LINE	MH	ELASTIC SILT
		ORGANIC	LL (oven dried)/LL (not dried)<0.75	OH	ORGANIC CLAY OR SILT
HIGHLY ORGANIC SOILS		PRIMARILY ORGANIC MATTER, DARK IN COLOR, AND ORGANIC ODOR		PT	PEAT

NOTE: $Cu = \frac{D_{60}}{D_{10}}$; $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

BLOW COUNT

THE NUMBER OF BLOWS OF THE SAMPLING HAMMER REQUIRED TO DRIVE THE SAMPLER THE LAST 12 IN. OF AN 18-IN. DRIVE. THE NOTATION 100/9 INDICATES 9 IN. OF PENETRATION ACHIEVED IN 100 BLOWS. THE NUMBER "50+" INDICATES THAT >50 BLOWS WERE REQUIRED TO DRIVE THE SAMPLER THE LAST 12 INCHES.

CEMENTATION

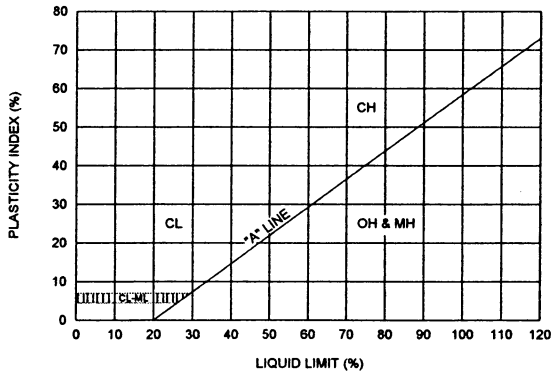
WEAK - CRUMBLES OR BREAKS WITH HANDLING OR LITTLE FINGER PRESSURE

MODERATE - CRUMBLES OR BREAKS WITH CONSIDERABLE FINGER PRESSURE

STRONG - WILL NOT CRUMBLE OR BREAK WITH FINGER PRESSURE

SOURCE: U.S. DEPARTMENT OF INTERIOR, BUREAU OF RECLAMATION; PUB. YEAR, NOT AVAILABLE; ENGINEERING GEOLOGY FIELD MANUAL, P. 37.

PLASTICITY CHART



SAMPLE TYPES

- STANDARD PENETRATION
- ROCK CORE
- PITCHER SAMPLE
- MODIFIED CALIFORNIA
- PUSHED SHELBY TUBE

ADDITIONAL TESTS

CA	-	CHEMICAL ANALYSIS (CORROSIVITY)	(200)	-	(WITH % PASSING NO. 200 SIEVE
CD	-	CONSOLIDATED DRAINED TRIAXIAL			
CN	-	CONSOLIDATION	SW	-	SWELL TEST
CU	-	CONSOLIDATED UNDRAINED TRIAXIAL	TC	-	CYCLIC TRIAXIAL
DS	-	DIRECT SHEAR	TV	-	TORVANE SHEAR
PP	-	POCKET PENETROMETER (TSF)	UC	-	UNCONFINED COMPRESSION
(3.0)	-	(WITH SHEAR STRENGTH IN KSF)	(1.5)	-	(WITH SHEAR STRENGTH IN KSF)
RV	-	R-VALUE			
SA	-	SIEVE ANALYSIS: % PASSING #200 SIEVE	UU	-	UNCONSOLIDATED UNDRAINED TRIAXIAL
▽	-	WATER LEVEL (WITH DATE OF) MEASUREMENT	WA	-	WASH ANALYSIS
			(200%)	-	(WITH % PASSING NO. 200 SIEVE)

PENETRATION RESISTANCE
(RECORDED AS BLOWS / 0.5 FT)

SAND & GRAVEL		SILT & CLAY		
RELATIVE DENSITY	BLOWS/FOOT*	CONSISTENCY	BLOWS/FOOT*	COMPRESSIVE STRENGTH (TSF)
VERY LOOSE	0 - 4	VERY SOFT	0 - 2	0 - 0.25
LOOSE	4 - 10	SOFT	2 - 4	0.25 - 0.50
MEDIUM DENSE	10 - 30	FIRM	4 - 8	0.50 - 1.0
DENSE	30 - 50	STIFF	8 - 15	1.0 - 2.0
VERY DENSE	OVER 50	VERY STIFF	15 - 30	2.0 - 4.0
		HARD	OVER 30	OVER 4.0

* NUMBER OF BLOWS OF 140 LB HAMMER FALLING 30 INCHES TO DRIVE A 2 INCH O.D. (1-3/8 INCH I.D.) SPLIT-BARREL SAMPLER THE LAST 12 INCHES OF AN 18-INCH DRIVE (ASTM-1586 STANDARD PENETRATION TEST).

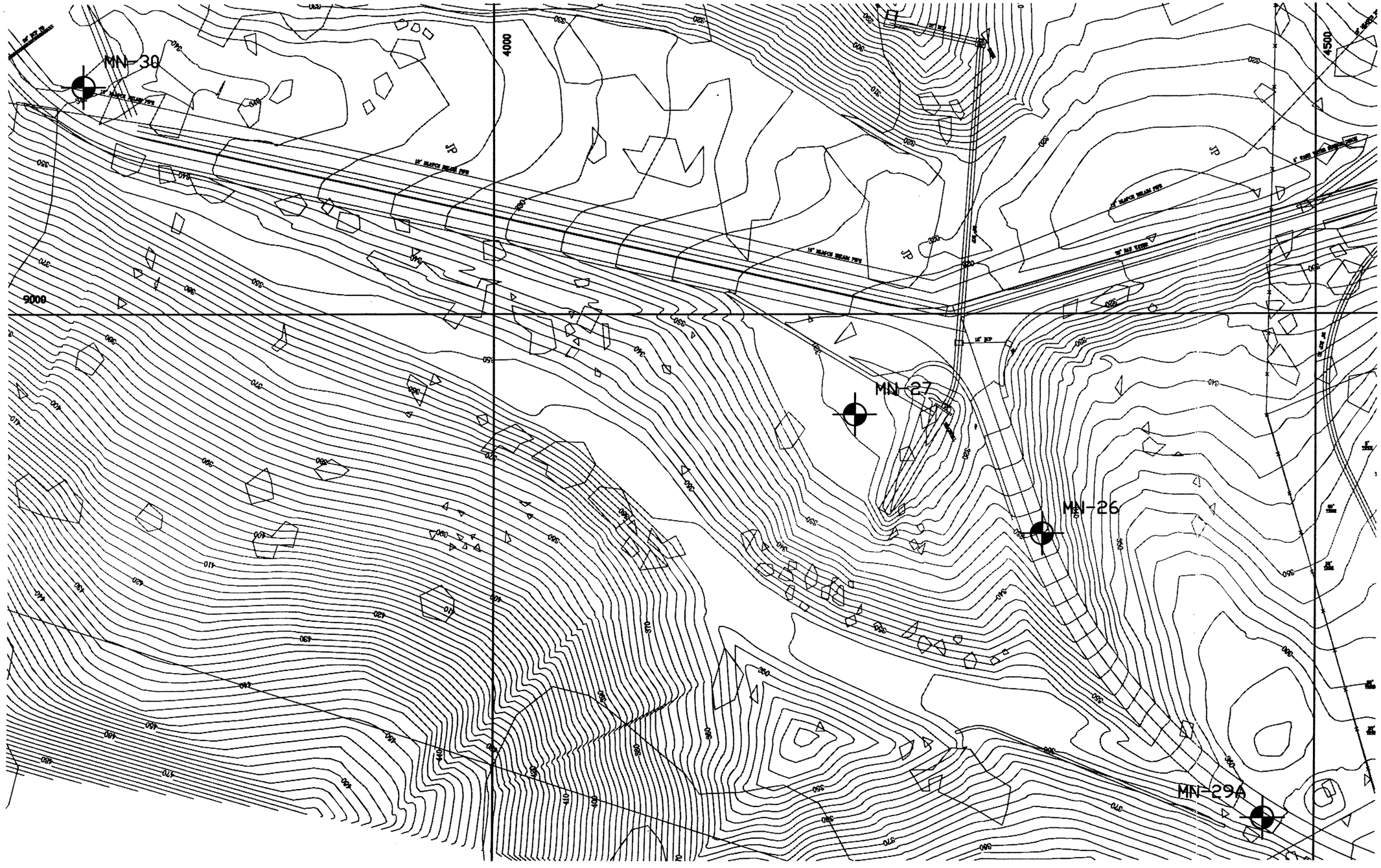
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Job No. 1320.01

LEGEND TO SOIL DESCRIPTIONS

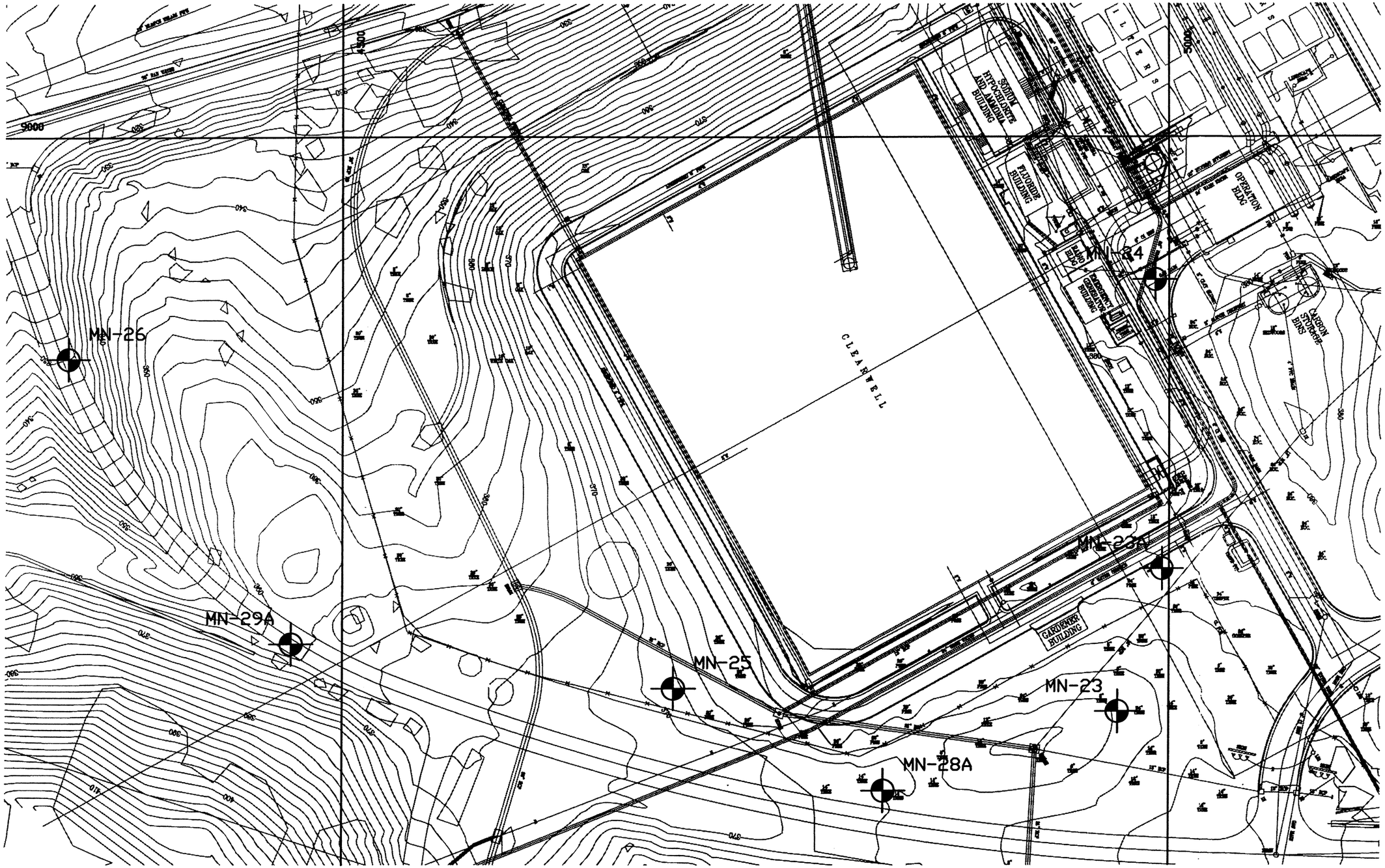
FIGURE 15

LEGEND L:\EBMUD\1320WA~1\BORINGS\GINTW\PROJECTS\FINAL\1320001A.GPJ OLV_CHEN.GDT 4/10/01



Olivia Chen Consultants, Inc. **Civil · Environmental · Geotechnical** Job No. 1320.01	EAST BAY MUNICIPAL UTILITY DISTRICT WALNUT CREEK WATER TREATMENT PLANT WALNUT CREEK, CALIFORNIA	SCALE: 1" = 60' HORIZONTAL BORING LOCATION MAP	1" = 60' VERTICAL FIGURE A

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Olivia Chen Consultants, Inc. **Civil · Environmental · Geotechnical** Job No. 1320.01	EAST BAY MUNICIPAL UTILITY DISTRICT WALNUT CREEK WATER TREATMENT PLANT WALNUT CREEK, CALIFORNIA	SCALE: 1" = 60' HORIZONTAL BORING LOCATION MAP	1" = 60' VERTICAL FIGURE B

L:\EBMUD\1320\BORINGS\BORING_LOC.DWG



Olivia Chen Consultants, Inc. **Civil · Environmental · Geotechnical** Job No. 1320.01	EAST BAY MUNICIPAL UTILITY DISTRICT WALNUT CREEK WATER TREATMENT PLANT WALNUT CREEK, CALIFORNIA	SCALE: 1" = 60' HORIZONTAL BORING LOCATION MAP	1" = 60' VERTICAL FIGURE C

L:\EBMUD\1320\BORINGS\BORING_LOC.DWG

APPENDIX C

GEOPHYSICAL SURVEYS

DOWNHOLE SEISMIC SURVEY

Walnut Creek Clearwell Seismic Evaluation Project

Walnut Creek, California

for

EAST BAY MUNICIPAL UTILITY DISTRICT

P.O. Box 24055

Oakland, California 94623

by

Portola Geophysics

900 Wayside Road

Portola Valley, California 94028

December 1997

Portola Geophysics
900 Wayside Road, Portola Valley, CA 94028 Phone & FAX (650) 851-5342

December 8, 1997
9707

Mr. Derek Kawaii, Project Engineer
Materials Engineering
EAST BAY MUNICIPAL UTILITY DISTRICT
P.O. Box 24055
Oakland, California 94623

SUBJECT: **Downhole Seismic Survey**
RE: Walnut Creek Clearwell Seismic Evaluation Project
Walnut Creek, California

Dear Mr. Kawaii:

The following report describes the findings and conclusions of our downhole seismic geophysical investigation of the East Bay Municipal Utility District's Walnut Creek Clearwell Seismic Evaluation Project in Walnut Creek, California. This geophysical investigation was conducted in accordance with our proposal to you dated October 31, 1997.

We appreciate the opportunity to have been of service to you on this project. If you have any questions regarding this report, any aspect of our investigation, or if you need additional services, please contact our office.

Very truly yours,

PORTOLA GEOPHYSICS

Patrick O. Shires
Principal Geophysicist
RGP 879

POS:st

DOWNHOLE SEISMIC SURVEY
Walnut Creek Clearwell Seismic Evaluation Project
Walnut Creek, California

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2.0	DOWNHOLE SEISMIC SURVEY	1
	2.1 Method and Equipment	1
	2.2 Interpreted Results	2
3.0	INVESTIGATION LIMITATIONS	4
4.0	SUMMARY OF CONCLUSIONS	4

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2	Velocity/Density Calculations, Boring MM-3	3

FIGURES

1 Downhole Seismic Results, Boring MM-1
2 Downhole Seismic Results, Boring MM-3

1.0 INTRODUCTION

This report describes the results of a downhole seismic survey conducted for the East Bay Municipal Utility District's Walnut Creek Clearwell Seismic Evaluation Project in Walnut Creek, California. This investigation was conducted in accordance with our proposal to you dated October 31, 1997, and consists of a downhole seismic (compression and shear wave) survey of two borings drilled to the north and west of the Walnut Creek Clearwell.

2.0 DOWNHOLE SEISMIC SURVEY

Downhole seismic (compression and shear wave) surveys were conducted in two borings (Boring MM-1 and Boring MM-3) cased to depths of approximately 55 and 65 feet, respectively, with downhole geophone refusal at depths of 54 and 64 feet, respectively.

2.1 Method and Equipment Used

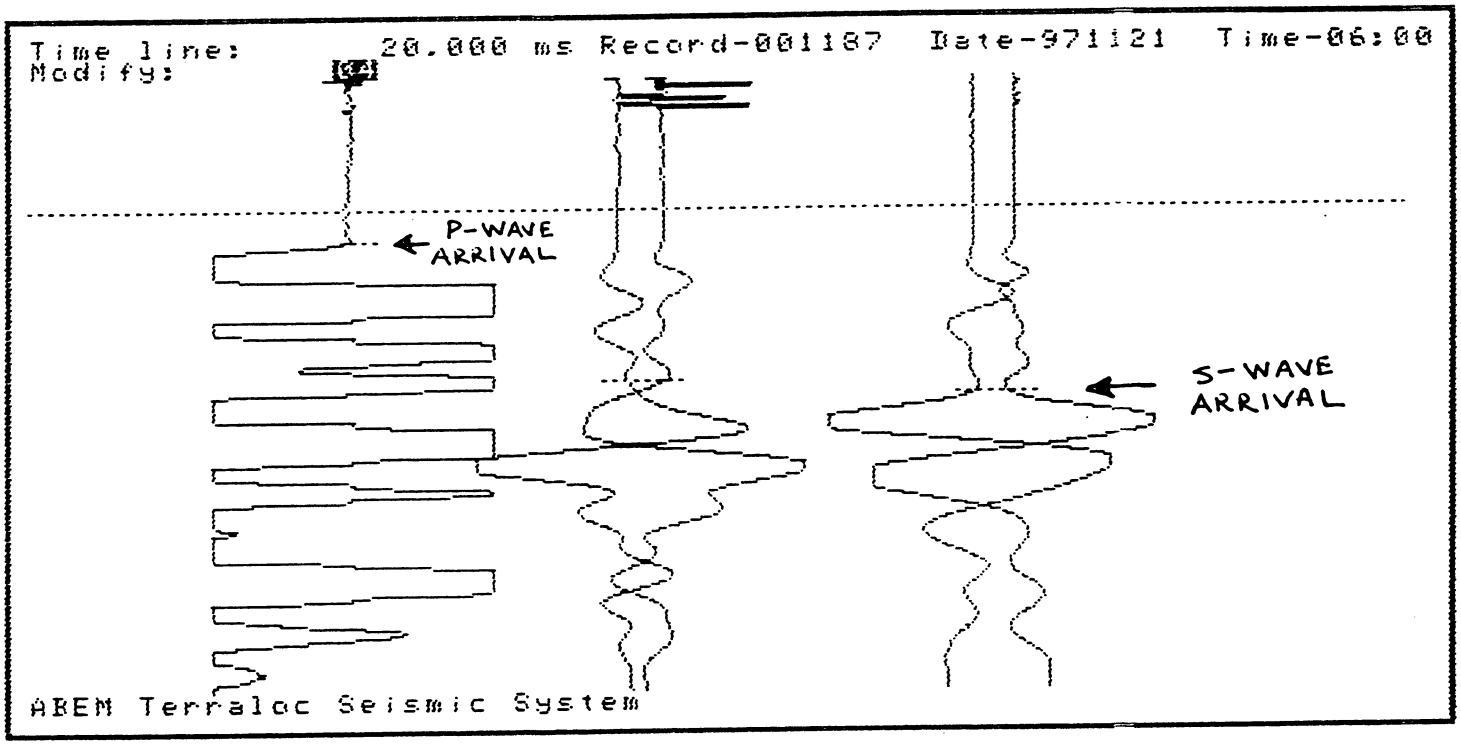
The downhole seismic survey procedure used for all recordings consisted of placing a triaxial geophone bundle at 5-foot depth intervals (except where restricted to a shorter interval at the bottom of the casings) within the cased (3.0-inch inside diameter PVC) and grouted borings.

The geophone bundle was clamped against the inside of the casing at successive 5-foot depth intervals by inflation of a pneumatic bladder. An 8.0-foot long wooden plank was held in place by the weight of the 4-wheel drive field vehicle at a distance of about 10 feet from the borings. A 16-pound sledge hammer equipped with seismograph/oscillograph triggering switch was impacted horizontally on a steel plate placed against both ends of the wooden plank to produce successive shear waves of reversed polarity. The hammer was also impacted vertically on the steel plate placed flat on the ground surface (also at about 10 feet from the boring) to produce compression waves. The hammer impacts generated shear and compression waves which travelled from the ground surface through the subsurface materials and were received by the deployed geophone bundle at successive depth intervals. The geophones were monitored digitally and displayed graphically in analog form on a portable 24-channel ABEM™ Terraloc Mark 3 Seismic System. Records were stored on magnetic disk and returned to the office for processing, printing, data reduction and interpretation.

Compression and shear wave velocity results and assumed bulk densities were used to calculate engineering parameters by spreadsheet.

The equipment used for the downhole seismic survey consisted of one triaxial geophone bundle of 4.5 Hz natural frequency with 300 feet of cabling and a pneumatic bladder (with 300 feet of supply tube). The geophone bundle was connected to a 24-channel ABEM™ Terraloc Mark 3 Seismic System using cabling with Mueller clips. The sweep traces for each horizontal (transverse and longitudinal) geophone were juxtaposed on the records so that successive shear waves of reversed polarity would make the first arrivals stand out (see representative record print-out below).

SAMPLE RECORD, MM-3 @ 60'



2.2 Interpreted Results

The downhole seismic recordings were conducted borings MM-1 and MM-3 drilled through fill embankments to the north and west of the Walnut Creek Clearwell, respectively. These holes were drilled vertically slightly offset to the north and west of the center of the embankment crest.

The borings were cased to depths of about 55 and 65 feet, respectively, and were downhole seismic surveyed to depths of 54 and 64 feet below ground surface (top of pavement just above top of casing), respectively. Survey results are presented on Figure 1 for Boring MM-1, and Figure 2 for Boring MM-3, in terms of time-distance plots of shear and compression wave arrivals (and velocities). The plots reflect actual distance from the offset energy source (sledge hammer on plate or plank) to the receiving geophone bundle. In order to correlate this information with boring logs, the assumption is made that velocities for the longer angular distances are representative for the velocities within the shorter vertical depth intervals surveyed. Tables 1 and 2, below, list shear and compression wave velocities as well as velocity/density calculations as a function of vertical depth interval for borings MM-1 and MM-3, respectively.

TABLE 1
Velocity/Density Calculations, Boring MM-1

Depth Interval (feet)	Compression Velocity (ft./sec.)	Shear Velocity (ft./sec.)	Bulk Density (pcf)	Poisson's Ratio (μ)	Compression Modulus (psf)	Shear Modulus (psf)
0.0-20.0	2,080	1,040	115	0.33	1.04E+07	3.89E+06
20.0-25.0	2,800	1,800	120	0.15	2.79E+07	1.22E+07
25.0-35.0	2,130	1,230	120	0.25	1.42E+07	5.67E+06
35.0-40.0	4,800	860	120	0.48	8.23E+06	2.77E+06
40.0-54.0	2,100	1,240	120	0.23	1.42E+07	5.77E+06

TABLE 2
Velocity/Density Calculations, Boring MM-3

Depth Interval (feet)	Compression Velocity (ft./sec.)	Shear Velocity (ft./sec.)	Bulk Density (pcf)	Poisson's Ratio (μ)	Compression Modulus (psf)	Shear Modulus (psf)
0.0-5.0	3,100	1,570	115	0.33	2.35E+07	8.86E+06
5.0-15.0	1,450	770	115	0.30	5.56E+06	2.13E+06
15.0-30.0	2,810	1,800	120	0.15	2.80E+07	1.22E+07
30.0-40.0	2,050	960	120	0.36	9.40E+06	3.46E+06
40.0-50.0	5,400	1,380	120	0.47	2.09E+07	7.14E+06
50.0-64.0	4,900	2,010	125	0.40	4.42E+07	1.58E+07

Using measured shear and compression wave velocities and assumed bulk densities, velocity/density calculations were made with the following formulae for Poisson's ratio (μ), compression (Young's) modulus (E) and

shear modulus (G), where √=bulk density, Vp=compression wave velocity, and Vs=shear wave velocity:

=[Vp/Vs) 2-2]/[2(Vp/Vs)2-2], E=2Vs2(√/32)(1+), and G=Vs2(√/32).

3.0 INVESTIGATION LIMITATIONS

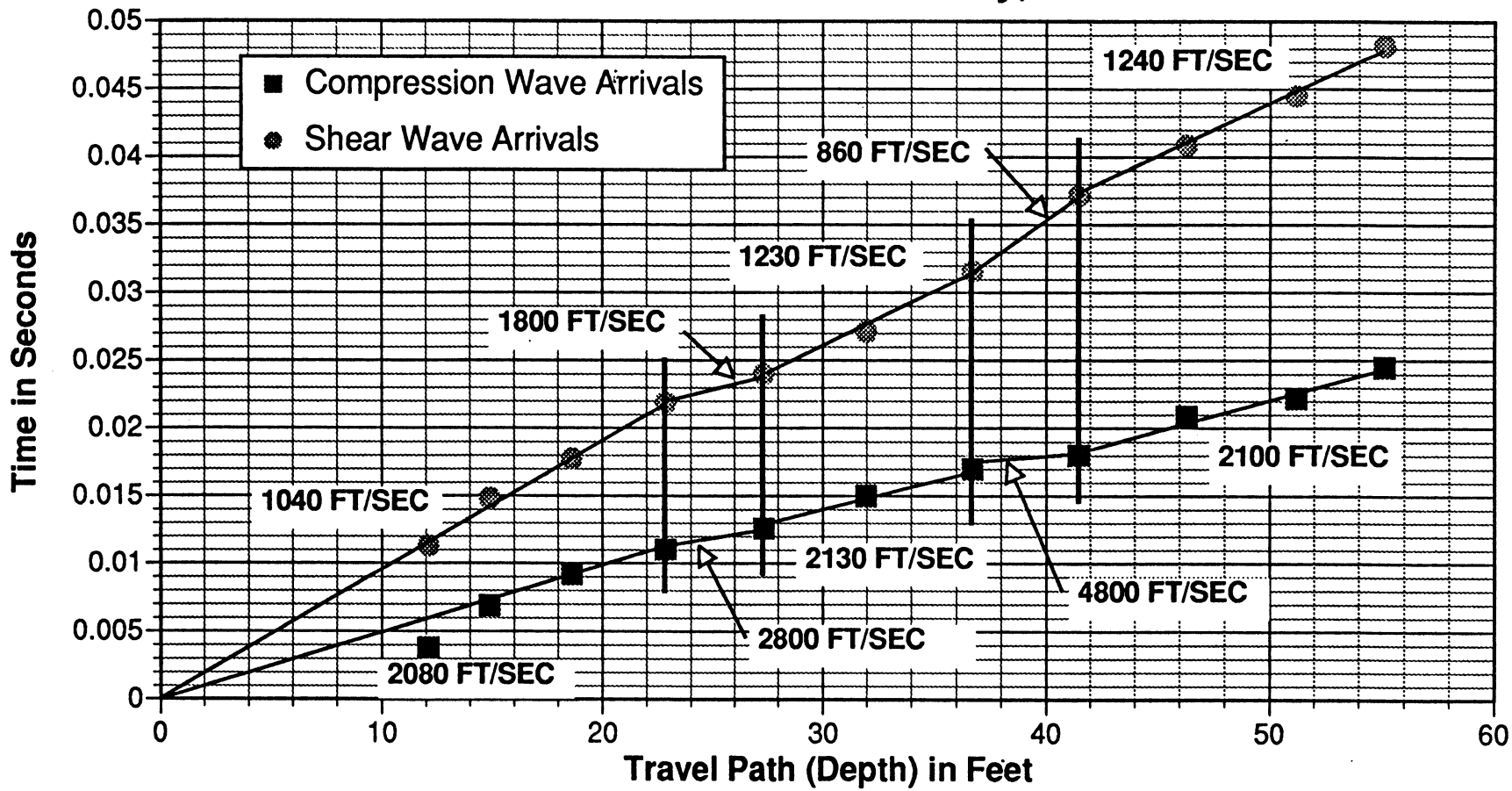
The downhole seismic results presented in this report represent the most reasonable interpretation of geophysical survey data based on our limited knowledge of the existing geologic conditions at the site. The results were not correlated with the logs for nearby exploratory borings, a correlation which, if completed, might affect interpretation of data. In addition, calculations were made using assumed densities for earth materials. Use of actual laboratory test data might also affect results. The results are presented for design information only and are not intended to serve as information for determining construction procedures. Interpretations were made in accordance with generally accepted geophysical methods and practices. This warranty is in lieu of all other warranties, express or implied.

4.0 SUMMARY OF CONCLUSIONS

The embankment surveyed is composed of artificial fill materials underlain by sandstone, siltstone and claystone bedrock. Compression and shear wave velocities are generally low to medium (1,450 to 5,400 ft/sec for compression waves and 770 to 2,010 ft/sec for shear waves) and consistant with what would be expected for compacted fill and weathered bedrock materials. Velocities vary within the fill and are generally higher in weathered bedrock and the data does not indicate that particularly loose soils are present.

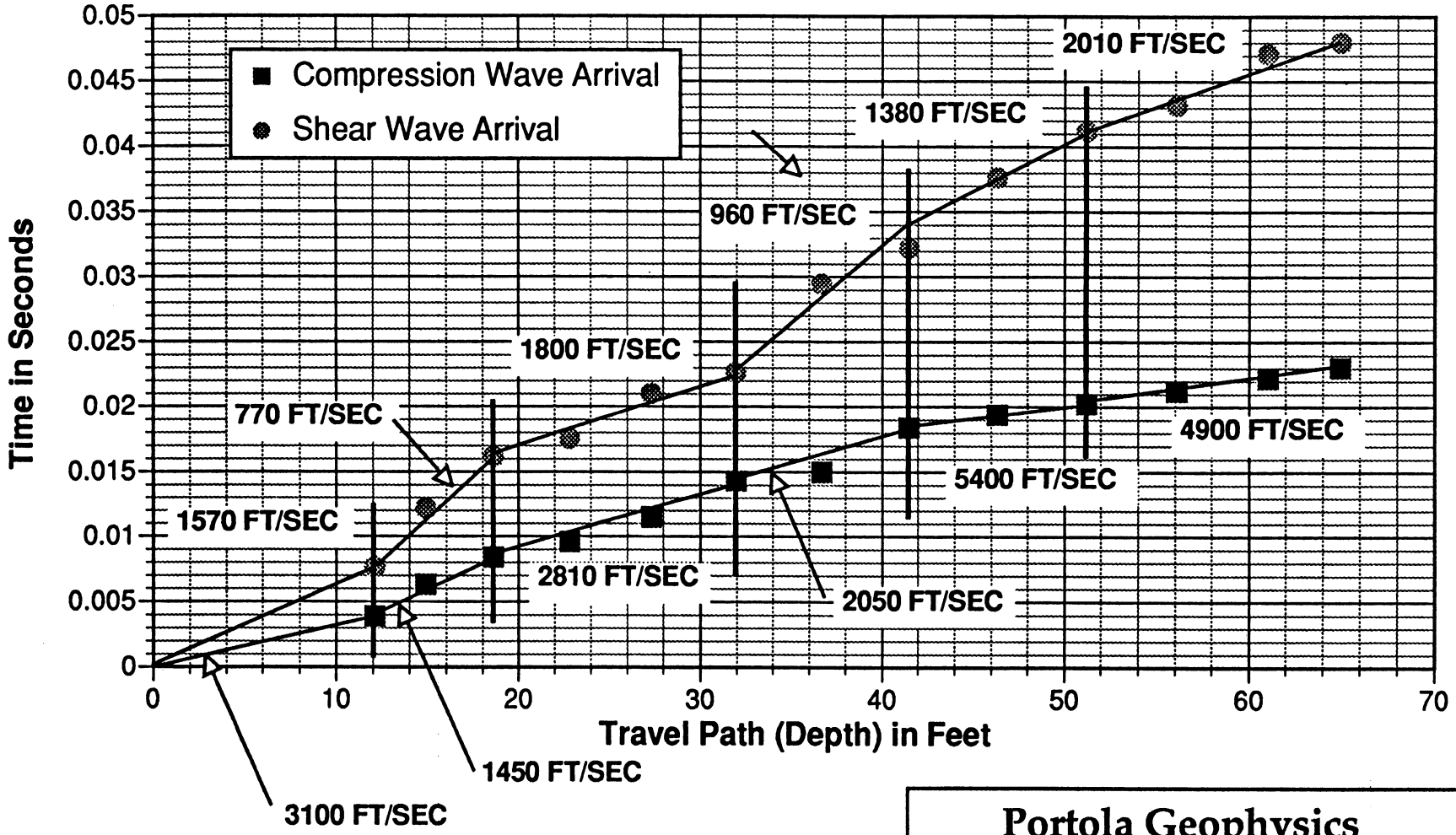
FIGURES

1 Downhole Seismic Results, Boring MM-1
2 Downhole Seismic Results, Boring MM-3



Portola Geophysics		
Downhole Seismic Results, Boring MM-1 Walnut Creek Clearwell Project Walnut Creek, California		
GEOPHYS. BY POS	SCALE AS SHOWN	PROJECT NO. 9707
APPROVED BY POS	DATE 11/21/97	FIGURE NO. 1

Downhole Seismic Survey, MM-3



Portola Geophysics		
Downhole Seismic Results, Boring MM-3 Walnut Creek Clearwell Project Walnut Creek, California		
GEOPHYS. BY POS	SCALE AS SHOWN	PROJECT NO. 9707
APPROVED BY POS	DATE 11/21/97	FIGURE NO. 2

SEISMIC REFRACTION SURVEY
EBMUD Walnut Creek Filter Plant Expansion
Walnut Creek, California

for

EAST BAY MUNICIPAL UTILITY DISTRICT
375 11th Street, MS-610
Oakland, California 94607

by

Portola Geophysics
900 Wayside Road
Portola Valley, California 94028

April 1998

Portola Geophysics
900 Wayside Road, Portola Valley, CA 94028 Phone & FAX (650) 851-5342

April 22, 1998
9802

Mr. Derek Kawaii, Project Engineer
Materials Engineering
EAST BAY MUNICIPAL UTILITY DISTRICT
P.O. Box 24055
Oakland, California 94623

SUBJECT: **Seismic Refraction Survey**
RE: EBMUD Walnut Creek Filter Plant Expansion Project
P.O. No. 562-57464-AX
Walnut Creek, California

Dear Mr. Kawaii:

The following report describes the findings and conclusions of our surface seismic refraction survey geophysical investigation of the EBMUD Walnut Creek Filter Plant Expansion Project in Walnut Creek, Contra Costa County, California. This geophysical investigation was conducted in accordance with our proposal to you dated March 6, 1998.

We appreciate the opportunity to have been of service to you on this project. If you have any questions regarding this report, any aspect of our investigation, or if you need additional services, please contact our office.

Very truly yours,

PORTOLA GEOPHYSICS

Patrick O. Shires
Principal Geophysicist
RGP 879

POS:st

SEISMIC REFRACTION SURVEY

EBMUD Walnut Creek Filter Plant Expansion

Contra Costa County, California

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6 Seismic Refraction Survey Data and Interpreted Subsurface Velocity Profiles, Seismic Line Nos. S-7 and S-8
7 Seismic Refraction Survey Data and Interpreted Subsurface Velocity Profiles, Seismic Line Nos. S-9 and S-10
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1.0 INTRODUCTION

This report describes the methods and equipment used, interpreted results, limitations and conclusions of a seismic refraction geophysical survey of the East Bay Municipal Utility District (EBMUD) Walnut Creek Filter Plant Expansion Project site located in the Walnut Creek area of Contra Costa County, California. This investigation was conducted for EBMUD in accordance with our proposal dated March 6, 1998.

1.1 Project Description

The proposed project consists of expansion of the existing Walnut Creek Filter Plant by construction of two, new 236-foot diameter steel tank water reservoirs on a north-facing, moderately steep slope and a new chemical storage structure closer to the administration facilities of the plant in the Walnut Creek area of Contra Costa County, California.

1.2 Purpose and Scope of Investigation

The purpose of our investigation was to: 1) investigate subsurface conditions in the vicinity of the proposed dual reservoir site using the seismic refraction geophysical method, and to 2) evaluate the depth to and characteristics of the bedrock, including the rippability of materials in the vicinity of the proposed excavations.

The scope of work included a field seismic refraction survey followed by geophysical analysis of the acquired data, and preparation of this report.

1.3 Geologic Setting

The project area is characterized by moderately to steeply sloping, north-facing hillside terrain underlain by surficial soils and artificial fill over weathered Orinda Formation sedimentary bedrock.

2.0 SEISMIC REFRACTION SURVEY

A total of eleven (11) individual seismic refraction lines* with a combined spread length of 2,790 feet were recorded at two sites, the first three at the chemical building site near the existing plant administration facilities, and the remaining lines southwest of the existing plant in the vicinity of the proposed tanks. These seismic refraction lines were recorded on March 27 and 28, 1998, in the locations shown on figures 1 and 2. The interpreted results are presented on figures 3 through 8. Rippability correlations are presented on Figure 9. The method and equipment used, the interpreted results, limitations and a summary of pertinent conclusions are discussed in the following sections of this report.

2.1 Method and Equipment Used

The seismic refraction survey procedure used consisted of placing twelve (12)

---

* For the purposes of this report, a seismic refraction line is defined as twelve geophones spaced at equal intervals of 25 feet along a straight line and monitored simultaneously while a sledge hammer is repeatedly impacted 12.5 feet off each end, and at the center, of the line.

geophones in as straight a line as practical (in plan) spaced at 10-foot or 25-foot intervals along as constant a slope as practical (in profile). A large sledge hammer was impacted at 10 or 12.5 feet off both ends of each line and at the center of the longer lines. The hammer impacts generated seismic compression waves which were refracted through subsurface materials and received by the deployed geophones. The signal from the energy source initiation (time break) started the instrument sweep as signals from the geophones were monitored (amplified, filtered and stacked) simultaneously by a digital seismograph with an on-board computer and displayed graphically in analog form on the built-in computer monitor. Digital records stored in the computer were field checked, stored on magnetic disk and returned to our office for printing, data reduction and interpretation.

Seismic refraction lines were marked for location and elevation using an existing base map combined with hand level, Brunton compass and measuring tape methods. Lines were marked with stakes and flags in the field and located on the base map. Locations and relative elevations should be considered approximate.

The data reduction and interpretation procedure consisted of the following sequence of tasks:

- computerized picking of first breaks of compression waves (P-waves) from the digital records of the seismic system computer,
- visual adjustment of first break picks by observing the analog record,
- plotting of time-distance graphs utilizing raw data,
- preliminary determination of apparent velocities,
- plotting of elevation data along the profiles,
- measurement of differences between actual geophone elevations and a constant slope profile,
- computer analysis of preliminary apparent velocities and elevation differences to determine travel-time corrections,
- adjustment of the time-distance graphs and refinement of apparent velocity determinations satisfying reciprocity,
- comparison of time-distance and velocity data with a catalog of subsurface structures to interpret an appropriate seismic refraction model,
- computer analysis (using computer program developed by Shires, 1983, involving principles published by Mooney, 1977, Handbook of Engineering Geophysics, satisfying the condition of reciprocity, travel-time = distance/velocity, and Snell's Law of Refraction) of apparent velocity and intercept time data to determine depths of refractors, true velocities, dips of refractors, and angles of wave incidence (seismic ray paths),
- measurement of time deviations from "best fit" apparent velocity slopes on the time-distance graphs,

- computer analysis of apparent velocities and time deviations to determine refractor profile corrections,
- adjustment of refractor depths to reflect time deviations,
- correlation of results with known geologic factors (from mapping and/or borehole logs), with adjacent or overlapping seismic refraction data, and
- final preparation of interpreted subsurface velocity profiles.

The equipment used for the seismic refraction survey consisted of twelve (12) geophones at one time of 10 Hz natural frequency. The geophones were connected to 10-foot or 25-foot take-out spacing cables using Mueller clips. The combination seismograph/oscillograph used was a 24-channel ABEM™ Terraloc Mark 3 Seismic System mounted on a pack frame for portability.

The energy source used consisted of a 16-pound sledge hammer equipped with a seismograph triggering mechanism. The sledge hammer was repeatedly impacted on a steel plate placed in a cleared area on the ground surface. Repeated impact signals were stacked for each seismic record.

2.2 Interpreted Results

Seismic refraction lines S-1, S-2 and S-3 were recorded at the proposed chemical building site in the locations shown on Figure 1. Results are presented on Figure 3. All three lines incorporated 12 geophones spaced at 10 feet with a spread lengths of 130 feet with shots at 10 feet off of both ends of each line.

Line S-1 is interpreted to be underlain by one velocity zone (refractor) to the depth surveyed. This zone is characterized by low to medium velocity (2020 ft/sec) material extending from the ground surface on down to the depth limit of information obtained (about 40 feet beneath the ground surface). This zone likely corresponds to weathered bedrock materials.

Lines S-2 and S-3 are interpreted to be underlain by two velocity zones (refractors) to the depth surveyed. The zone closest to the ground surface is characterized by low velocity (1110 to 1270 ft/sec) materials to a thickness of 3.5 to 10.7 feet beneath the ground surface. This upper zone corresponds to soil and deeply weathered bedrock materials that are relatively dry. The underlying zone consists of low to medium velocity (2950 to 3070 ft/sec) materials extending from 3.5 to 10.7 feet on down to the depth limit of information obtained (about 40 feet beneath the ground surface). This zone likely corresponds to weathered bedrock materials.

Based on geomorphology, the northeasterly end of Line S-3, where the low velocity zone thickens, may be underlain by landslide debris or thickening colluvium. Additional mapping and/or direct observation subsurface exploration should be carried out by your engineering geologist in this area to evaluate this feature.

Seismic refraction lines S-4, S-5, the northern one-half of Line S-6, and Line S-7 were recorded in a relatively flat area of artificial fill in the locations shown on Figure 2. Results are presented on figures 4 and 5. All lines incorporated 12 geophones spaced at

25 feet with a spread lengths of 300 feet with shots at 12.5 feet off of both ends and at the center of each line.

Lines S-4 through S-7 are interpreted to be underlain by two or three (2 or 3) velocity zones (refractors) to the depth surveyed. The zone closest to the ground surface is characterized by low velocity (1150 to 1530 ft/sec) materials to a thickness of 7.7 to 29.9 feet beneath the ground surface. This upper zone corresponds to artificial fill, soil and deeply weathered bedrock materials that are relatively dry. The underlying zone consists of medium velocity (4120 to 5790 ft/sec) materials extending from 7.7 to 29.9 feet on down to 39.3 to 76.3 feet beneath the ground surface. This zone likely corresponds to weathered bedrock materials that may be saturated. The medium velocity materials are underlain in turn (in lines S-4, S-5 and S-7) by high velocity (8310 to 9240 ft/sec) materials to the depth limit of information obtained (about 96 feet beneath the ground surface). This zone likely corresponds to less weathered bedrock materials.

Seismic refraction lines S-8 through S-11 were recorded on the slope above the artificial fill area in the vicinity of the proposed twin tanks in the locations shown on Figure 2. Results are presented on figures 6 through 8. All lines incorporated 12 geophones spaced at 25 feet with a spread lengths of 300 feet with shots at 12.5 feet off of both ends and at the center of each line.

Lines S-8 and S-9 are interpreted to be underlain by three (3) velocity zones (refractors) to the depth surveyed. The zone closest to the ground surface is characterized by low velocity (1140 to 1280 ft/sec) materials to a thickness of 9.0 to 21.3 feet beneath the ground surface. This upper zone corresponds to soil and deeply weathered bedrock materials that are relatively dry. The underlying zone consists of low to medium velocity (2710 to 4960 ft/sec) materials extending from 9.0 to 21.3 feet on down to 30.1 to 73.2 feet beneath the ground surface. This zone likely corresponds to weathered bedrock materials. The low to medium velocity materials are underlain in turn by medium to high velocity (5550 to 7980 ft/sec) materials to the depth limit of information obtained (about 96 feet beneath the ground surface). This zone likely corresponds to less weathered bedrock materials that may be saturated.

Lines S-10 and S-11 are interpreted to be underlain by two velocity zones (refractors) to the depth surveyed. The zone closest to the ground surface is characterized by low velocity (980 to 1130 ft/sec) materials to a thickness of 10.8 to 19.6 feet beneath the ground surface. This upper zone corresponds to soil and deeply weathered bedrock materials that are relatively dry. The underlying zone consists of medium velocity (5300 to 5600 ft/sec) materials extending from 10.8 to 19.6 feet on down to the depth limit of information obtained (about 96 feet beneath the ground surface). This zone likely corresponds to weathered bedrock materials that may be saturated.

2.3 Rippability

Rippability is strongly influenced by the physical condition of the rock masses to be ripped. Structural features in rock such as bedding planes, cleavage planes, joints, fractures and shear zones influence rippability. Rock masses tend to be rippable if they have closely-spaced fractures, joints, or other planes of weakness. Massive rock materials lacking discontinuities, even where partially weathered, may exhibit marginal rippability, requiring blasting for removal.

Seismic compression wave velocities can be related to both rock hardness and fracture density. Seismic refraction velocities have been related to rippability by Caterpillar Inc. (1990) as displayed on graphs relating seismic velocity for various rock types to rippability with various types of equipment (combinations of dozers and rippers). Two examples of these graphs are presented on Figure 9 for both D8L and D9N dozer/ripper combinations. In general, rocks such as the sedimentary claystone rocks present at this site become marginally rippable above about 7,400 feet/second and non-rippable above about 9,700 feet/second using either a D8 Dozer with a Multi or Single Shank No. 8 Ripper, or a D9 Dozer with a Multi or Single Shank No. 9 Ripper.

The charts of ripper performance should be considered as being only one indicator of rippability. The following precautions should be observed when evaluating the rippability of a given rock formation:

- Ripper tooth penetration is usually the key to successful ripping, regardless of seismic velocity. This is particularly true in finer-grained homogeneous materials and in tightly cemented formations.

- Although low seismic velocities in sedimentary rocks indicate probable rippability, if the fractures and bedding joints do not allow tooth penetration, the material may not be ripped effectively.

- Pre-blasting or "popping" may be required to induce sufficient fracturing to allow tooth penetration, but the economics of this should be checked carefully in the higher grades of sandstones, limestones and granites.

- Impact ripping may be used in marginal situations because significant boosts in production may be possible relative to conventional ripping by using an impact ripper mounted on a D10N or D11N dozer.

- Ripping success may well depend on the operator finding the proper combination of number of shanks used, length and depth of shank, tooth angle and direction and throttle position.

Based on the seismic velocities measured at this site, it appears that materials characterized by high velocities (i.e., greater than 7400 ft/sec) will be marginally to non-rippable with either the D8 dozer with No. 8 ripper combination, or a D9 dozer with No. 9 ripper. Based on seismic velocity correlation's, the surficial soil and weathered bedrock at this site (with velocities well under 7400 ft/sec) that are contemplated for removal should not pose significant problems to mass grading with heavy construction equipment.

3.0 INVESTIGATION LIMITATIONS

The subsurface velocity profiles presented in this report represent the most reasonable interpretation of geophysical survey data based on our limited knowledge of the existing geologic conditions at the site. The results are presented for design information only and are not intended to serve as information for determining construction procedures. Interpretations were made in accordance with generally accepted geophysical methods and practices. This warranty is in lieu of all other warranties, express or implied.

It is best to correlate seismic refraction data with direct subsurface exploration data and this was not accomplished for the chemical building lines and some of the water storage tank lines conducted for this investigation.

The quality of seismic refraction data for this survey was good, but in some cases affected by background noise, irregular terrain, and lateral inhomogeneity. These factors produced noise signals and/or scatter in the recorded data, limiting the accuracy of first break compression wave picks and interpretation. The seismic refraction method used has some inherent limitations such as the possibility for undetectable hidden layers, blind zones, and velocity inversions. The maximum depth of reliable seismic information obtained during this survey can be assumed to be approximately one-third of the length of the individual lines, with information at a maximum depth underlying the middle one-third of the lines. For example, a seismic refraction line 300 feet in length will typically yield reliable data on subsurface materials to a depth of about 100 feet beneath the middle 100 feet of the line.

4.0 SUMMARY OF CONCLUSIONS

The proposed chemical storage building site surveyed was generally underlain by one to two velocity zones to the depth limit surveyed (about 40 feet beneath the ground surface). These zones were generally characterized by lower velocities where surficial soils and deeply weathered bedrock were present (to depths of 3.5 to 10.7 feet) and low to medium velocities where weathered bedrock materials were present (from 3.5 to 10.7 feet up to at least about 40 feet deep). Based on velocity/rippability correlation's, surficial materials in the area of the chemical storage building should be rippable with heavy conventional excavation equipment. Based on geomorphology and a thicker low velocity zone, the northern end of Line S-3 may be underlain by landslide debris. This area should be investigated more thoroughly by engineering geologic mapping and direct observation subsurface exploration.

The proposed water tanks site was generally underlain by two to three velocity zones to the depth limit surveyed (about 96 feet beneath the ground surface). These zones were generally characterized by lower velocities where artificial fill, surficial soils and deeply weathered bedrock were present (to depths of 7.7 to 29.9 feet), low to medium velocities where weathered bedrock materials were present (from 7.7 to 29.9 feet down to 30.1 to at least about 96 feet), and medium to high velocities where less weathered bedrock materials were present (from 30.1 to greater than 96 feet down to greater than 96 feet). Based on velocity/rippability correlation's, surficial materials in the area of the proposed water tanks should be rippable with heavy conventional excavation equipment, provided that the higher velocity materials recorded at depth are not encountered. Based on geomorphology, there appears to be an earth slump/flow on the slope above the tank site (near the head of the mapped landslide) and there is a near-vertical, somewhat arcuate topographic lineament (scarp?) in the artificial fill slope downslope of the tanks pad. These areas should be investigated more thoroughly by engineering geologic mapping and/or direct observation subsurface exploration.

5.0 REFERENCES

ABEM, (1987), "ABEM Terraloc Mark 3 Operator's Manual".

Caterpillar, Inc., (1990), "Caterpillar™ Performance Handbook", a CAT™ Publication by Caterpillar, Inc., Peoria, Illinois, U.S.A.

Dobrin, M. B., (1960), "Introduction to Geophysical Prospecting", McGraw-Hill Book Company.

Shires, P. O., (1983), "A Seismic Refraction Interpretation Program for Multi-Dipping Layers".

FIGURES

1 Location Map (Chemical Building Site)

2 Location Map (Twin Water Tanks Site)

3 Seismic Refraction Survey Data and Interpreted Subsurface Velocity Profiles, Seismic Line Nos. S-1, S-2, and S-3

4 Seismic Refraction Survey Data and Interpreted Subsurface Velocity Profiles, Seismic Line Nos. S-4 and S-5

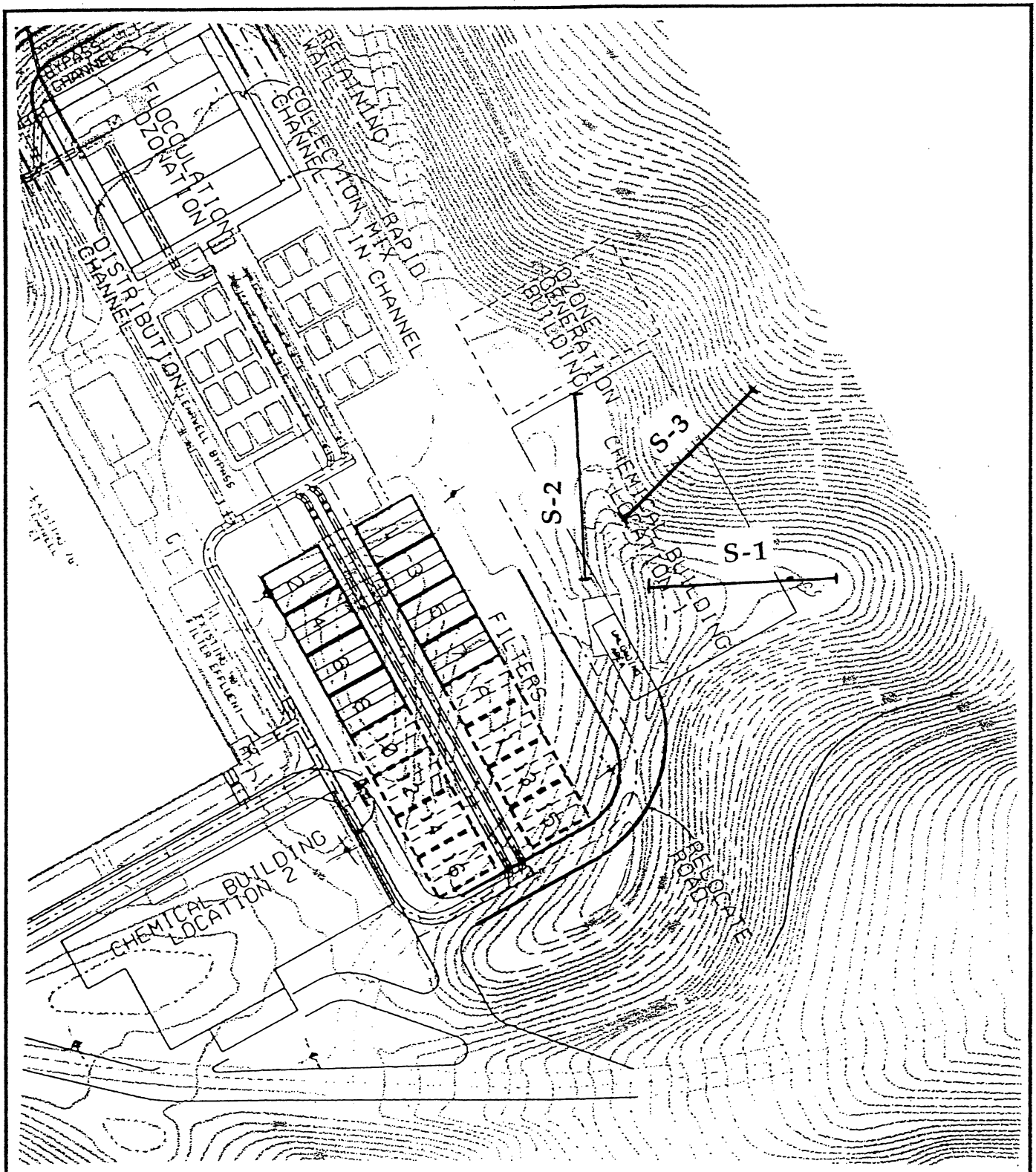
5 Seismic Refraction Survey Data and Interpreted Subsurface Velocity Profile, Seismic Line No. S-6

6 Seismic Refraction Survey Data and Interpreted Subsurface Velocity Profiles, Seismic Line Nos. S-7 and S-8

7 Seismic Refraction Survey Data and Interpreted Subsurface Velocity Profiles, Seismic Line Nos. S-9 and S-10

8 Seismic Refraction Survey Data and Interpreted Subsurface Velocity Profile, Seismic Line No. S-11

9 Rippability Charts (Caterpillar, Inc., 1990)



N

0 100 200

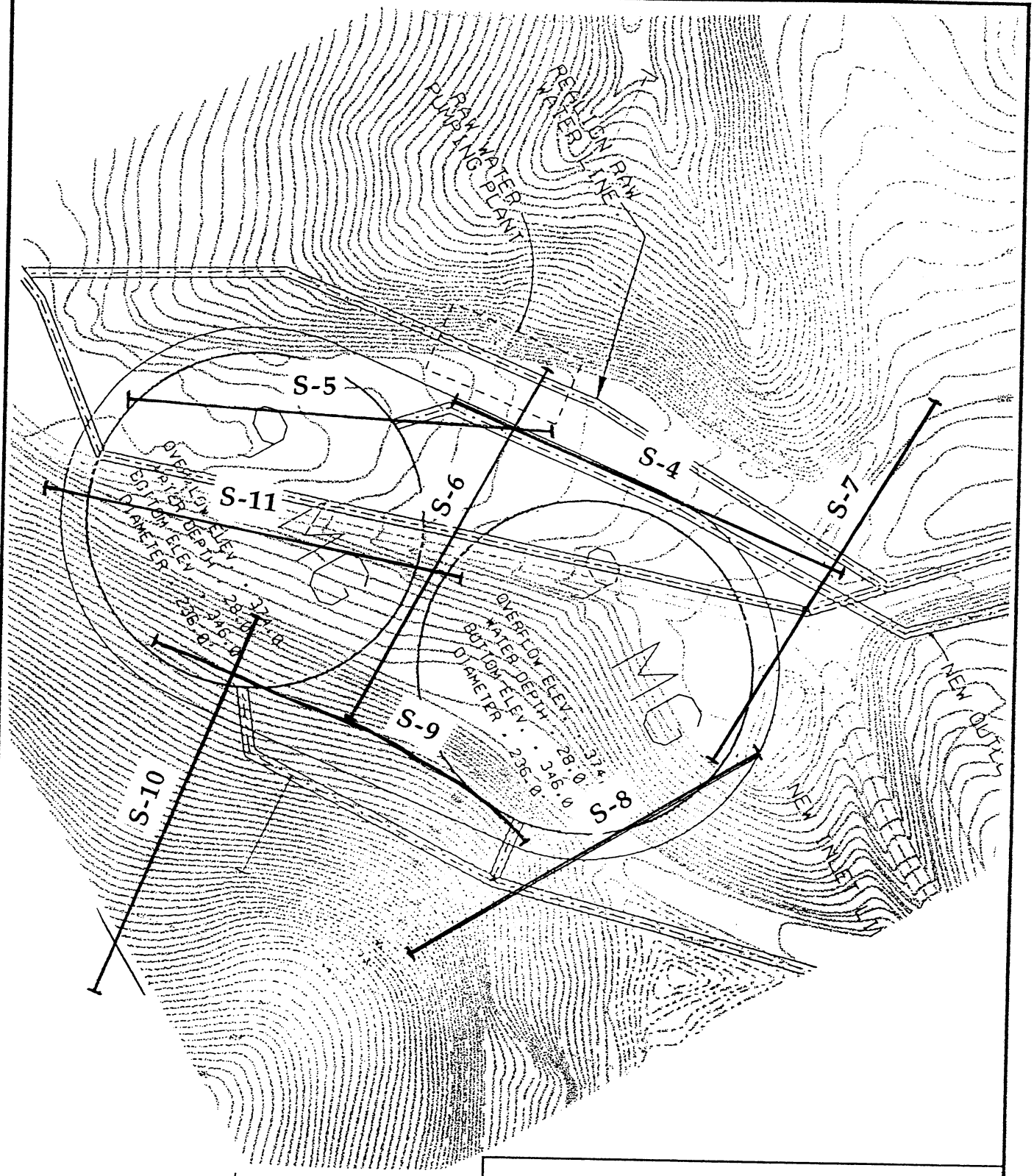
FEET

Portola Geophysics

LOCATION MAP (CHEMICAL BUILDING SITE)

SEISMIC REFRACTION SURVEY
EBMUD WALNUT CREEK FILTER PLANT EXPANSION
CONTRA COSTA COUNTY, CALIFORNIA

GEOPHYS. BY	SCALE	PROJECT NO.
POS	1"=100'	9802
APPROVED BY	DATE	FIGURE NO.
POS	4/22/98	1



Portola Geophysics

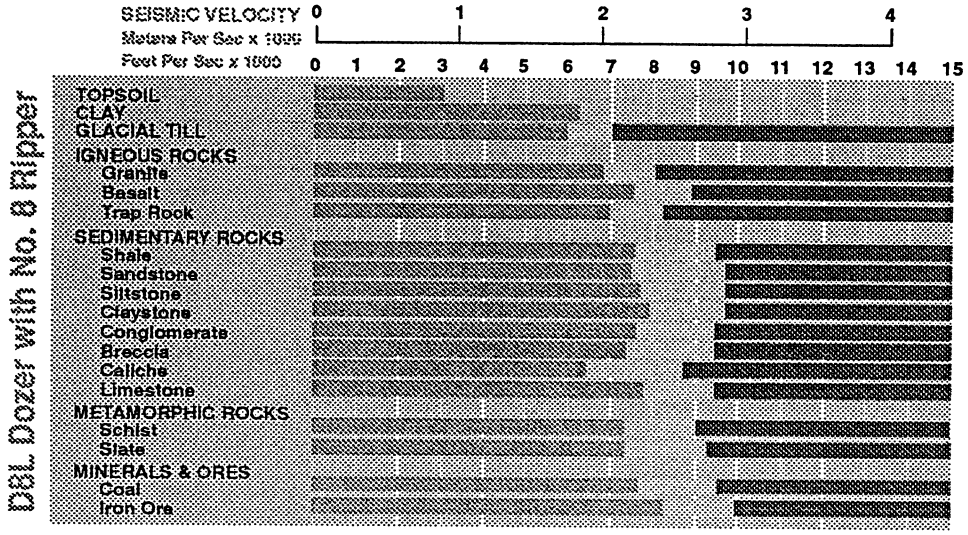
LOCATION MAP (TWIN WATER TANKS SITE)

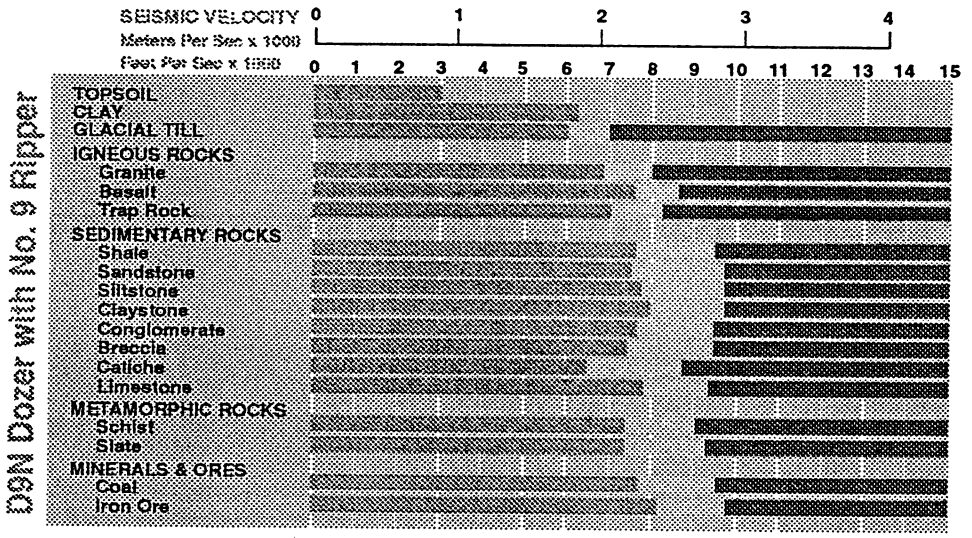
SEISMIC REFRACTION SURVEY
EBMUD WALNUT CREEK FILTER PLANT EXPANSION
CONTRA COSTA COUNTY, CALIFORNIA

GEOPHYS. BY	SCALE	PROJECT NO.
POS	1"=100'	9802
APPROVED BY	DATE	FIGURE NO.
POS	4/22/98	2

RIPPER PERFORMANCE

Multi or Single Shank Rippers
Estimated by Seismic Wave Velocities





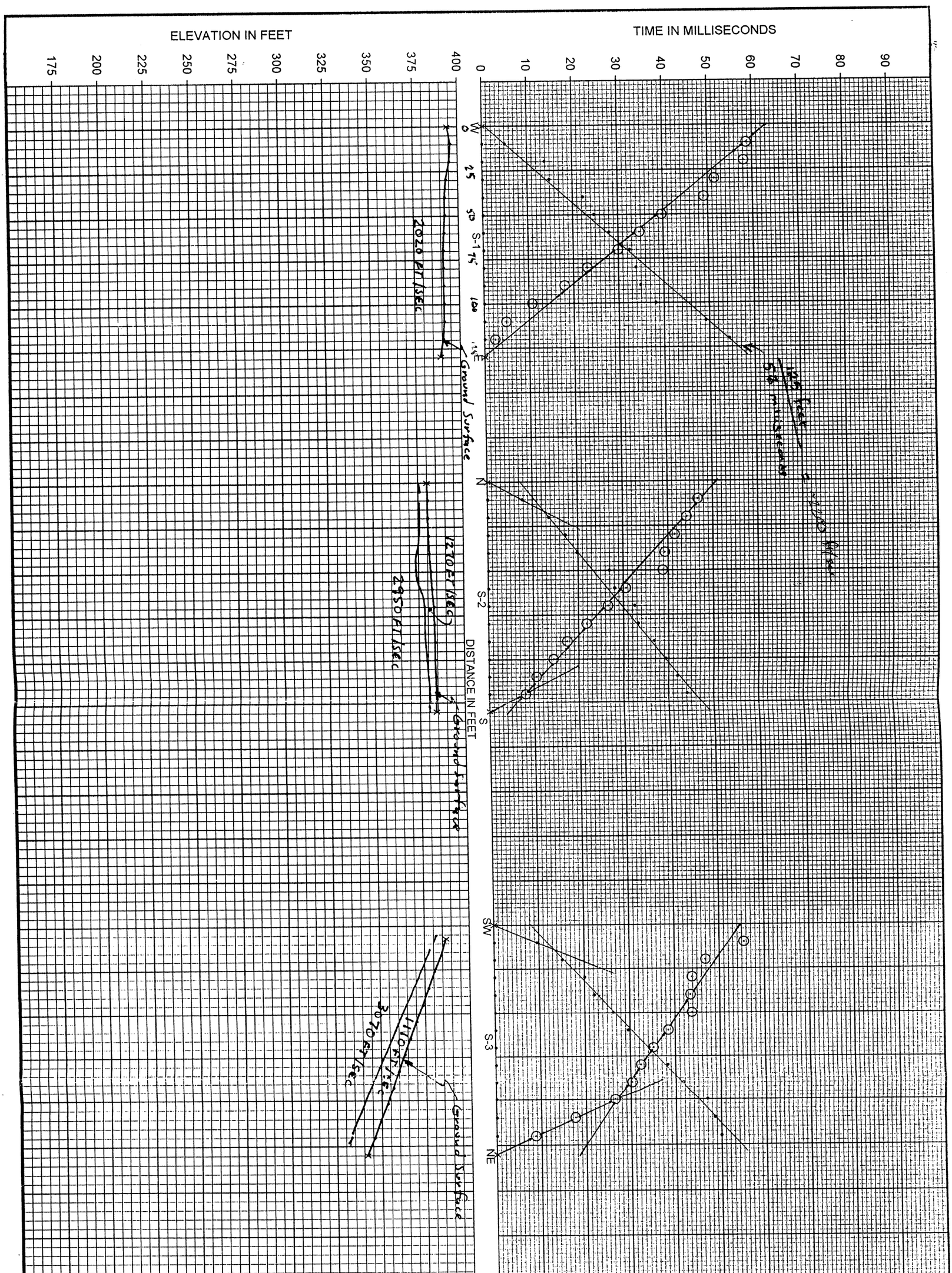
Rippable Marginal Non-Rippable

Source: Caterpillar™, 1990

Portola Geophysics

RIPPABILITY CHARTS (Caterpillar, Inc., 1990)
SEISMIC REFRACTION SURVEY
WALNUT CREEK FILTER PLANT EXPANSION
CONTRA COSTA COUNTY, CALIFORNIA

GEOPHYS. BY	SCALE	PROJECT NO.
POS	As Noted	9802
APPROVED BY	DATE	FIGURE NO.
POS	4/22/98	9



EXPLANATION

1. TIME-DISTANCE GRAPHS AT TOP OF FIGURE REPRESENT SEISMIC REFRACTION SURVEY DATA; DOTS ON BOTTOM LINE OF GRAPHS REPRESENT GEOPHONE LOCATIONS, X'S REPRESENT SHOT POINT LOCATIONS.
   VERTICAL SCALE: 1" = 20 MILLISECONDS
   HORIZONTAL SCALE: 1" = 50 FEET
2. SUBSURFACE VELOCITY PROFILES AT BOTTOM OF FIGURE REPRESENT INTERPRETATIONS OF SEISMIC REFRACTION DATA AND ARE INTENDED FOR DESIGN PURPOSES ONLY.
   VERTICAL AND HORIZONTAL SCALE: 1" = 50 FEET
3. LOCATION OF SEISMIC LINES SHOWN ON FIGURE NO.(S)

REGISTERED GEOPHYSICIST
PATRICK O. SHIRES
No. 879
STATE OF CALIFORNIA

Portola Geophysics
900 Wayside Road Portola Valley,CA 94028

SEISMIC REFRACTION SURVEY
DATA AND INTERPRETED SUBSURFACE VELOCITY PROFILES

EBMUD Walnut Creek Filter Plant Expansion
Contra Costa County, CA

FIGURE NO.: 3
PROJECT NO.: 9802
DATE: APRIL, 1998
SEISMIC LINE NO.(S): S-1, S-2 & S-3

TIME IN MILLISECONDS

90
80
70
60
50
40
30
20
10
0

W S-5 E W S-4 E

DISTANCE IN FEET

400
375
350
325
300
275
250
225
200
175

ELEVATION IN FEET

Ground Surface
Lines S-4 & S-6
cross

Boring
MW-18

Lines S-5 & S-6
cross

Line S-7
crosses

1200 FT/SEC
1150 FT/SEC
1530 FT/SEC
4930 FT/SEC
5560 FT/SEC
4460 FT/SEC
1530 FT/SEC
1470 FT/SEC
1250 FT/SEC
5650 FT/SEC
5790 FT/SEC
5660 FT/SEC
9090 FT/SEC

EXPLANATION

1. TIME-DISTANCE GRAPHS AT TOP OF FIGURE REPRESENT SEISMIC REFRACTION SURVEY DATA; DOTS ON BOTTOM LINE OF GRAPHS REPRESENT GEOPHONE LOCATIONS, X'S REPRESENT SHOT POINT LOCATIONS.
   VERTICAL SCALE: 1" = 20 MILLISECONDS
   HORIZONTAL SCALE: 1" = 50 FEET
2. SUBSURFACE VELOCITY PROFILES AT BOTTOM OF FIGURE REPRESENT INTERPRETATIONS OF SEISMIC REFRACTION DATA AND ARE INTENDED FOR DESIGN PURPOSES ONLY.
   VERTICAL AND HORIZONTAL SCALE: 1" = 50 FEET
3. LOCATION OF SEISMIC LINES SHOWN ON FIGURE NO.(S)

Portola Geophysics
900 Wayside Road Portola Valley,CA 94028

SEISMIC REFRACTION SURVEY
DATA AND INTERPRETED SUBSURFACE VELOCITY PROFILES

EBMUD Walnut Creek Filter Plant Expansion
Contra Costa County, CA

REGISTERED GEOPHYSICIST
PATRICK O. SHIRES
No. 879
STATE OF CALIFORNIA

SEISMIC LINE NO.(S):
S-4 & S-5

DATE: APRIL, 1998

PROJECT NO.: 9802

FIGURE NO.: 4

TIME IN MILLISECONDS

90
80
70
60
50
40
30
20
10
0

S
S-6
N

DISTANCE IN FEET

ELEVATION IN FEET

400
375
350
325
300
275
250
225
200
175

Ground Surface

Line S-11 Crosses

Boring MN-16

Lines S-4 & S-5 Cross

1380 FT/SEC

1220 FT/SEC

5050 FT/SEC

5550 FT/SEC

1240 FT/SEC

5050 FT/SEC

Portola Geophysics
900 Wayside Road Portola Valley,CA 94028

SEISMIC REFRACTION SURVEY
DATA AND INTERPRETED SUBSURFACE VELOCITY PROFILES

EBMUD Walnut Creek Filter Plant Expansion
Contra Costa County, CA

REGISTERED GEOPHYSICIST
PATRICK O. SHIRES
No. 879
STATE OF CALIFORNIA

EXPLANATION

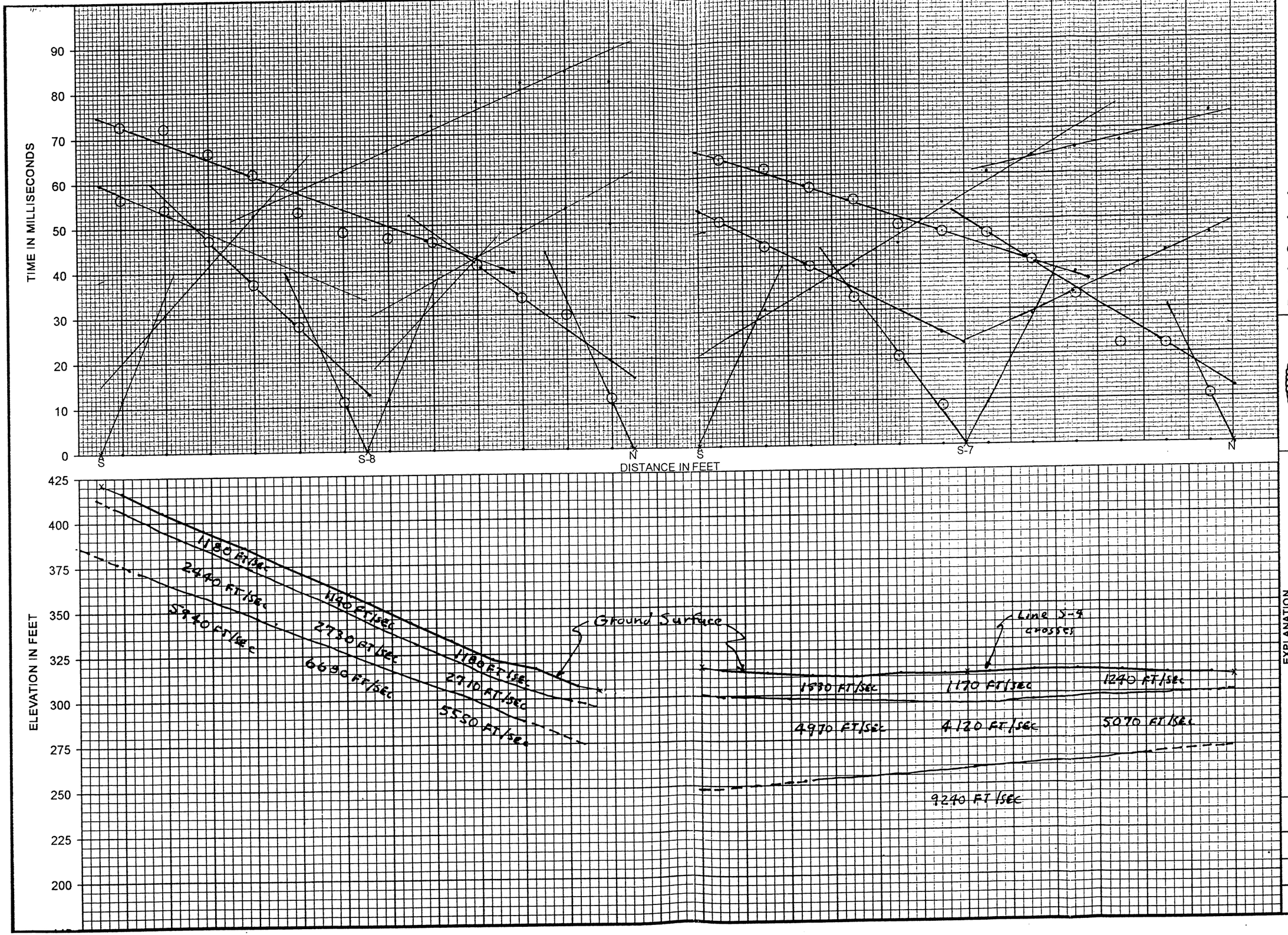
1. TIME-DISTANCE GRAPHS AT TOP OF FIGURE REPRESENT SEISMIC REFRACTION SURVEY DATA; DOTS ON BOTTOM LINE OF GRAPHS REPRESENT GEOPHONE LOCATIONS, X'S REPRESENT SHOT POINT LOCATIONS.
   VERTICAL SCALE: 1" = 20 MILLISECONDS
   HORIZONTAL SCALE: 1" = 50 FEET
2. SUBSURFACE VELOCITY PROFILES AT BOTTOM OF FIGURE REPRESENT INTERPRETATIONS OF SEISMIC REFRACTION DATA AND ARE INTENDED FOR DESIGN PURPOSES ONLY.
   VERTICAL AND HORIZONTAL SCALE: 1" = 50 FEET
3. LOCATION OF SEISMIC LINES SHOWN ON FIGURE NO.(S) 2

SEISMIC LINE NO.(S):
S-6

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FIGURE NO.: 5



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SEISMIC REFRACTION SURVEY
DATA AND INTERPRETED SUBSURFACE VELOCITY PROFILES

EBMUD Walnut Creek Filter Plant Expansion
Contra Costa County, CA

REGISTERED GEOPHYSICIST
PATRICK O. SHIRES
No. 879
STATE OF CALIFORNIA

EXPLANATION

1. TIME-DISTANCE GRAPHS AT TOP OF FIGURE REPRESENT SEISMIC REFRACTION SURVEY DATA; DOTS ON BOTTOM LINE OF GRAPHS REPRESENT GEOPHONE LOCATIONS, X'S REPRESENT SHOT POINT LOCATIONS.
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3. LOCATION OF SEISMIC LINES SHOWN ON FIGURE NO.(S) **2**

SEISMIC LINE NO.(S): S-7&S-8

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FIGURE NO.: **6**

TIME IN MILLISECONDS

90
80
70
60
50
40
30
20
10
0

W
S-9
E
S
S-10
N

DISTANCE IN FEET

ELEVATION IN FEET

475
450
425
400
375
350
325
300
275
250

Ground Surface

Line S-10 crosses

1170 FT/SEC

1270 FT/SEC

1280 FT/SEC

4980 FT/SEC

4970 FT/SEC

4660 FT/SEC

7980 FT/SEC

Line S-9 crosses

1130 FT/SEC

5340 FT/SEC

1130 FT/SEC

5300 FT/SEC

Ground Surface

1120 FT/SEC

5490 FT/SEC

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EXPLANATION

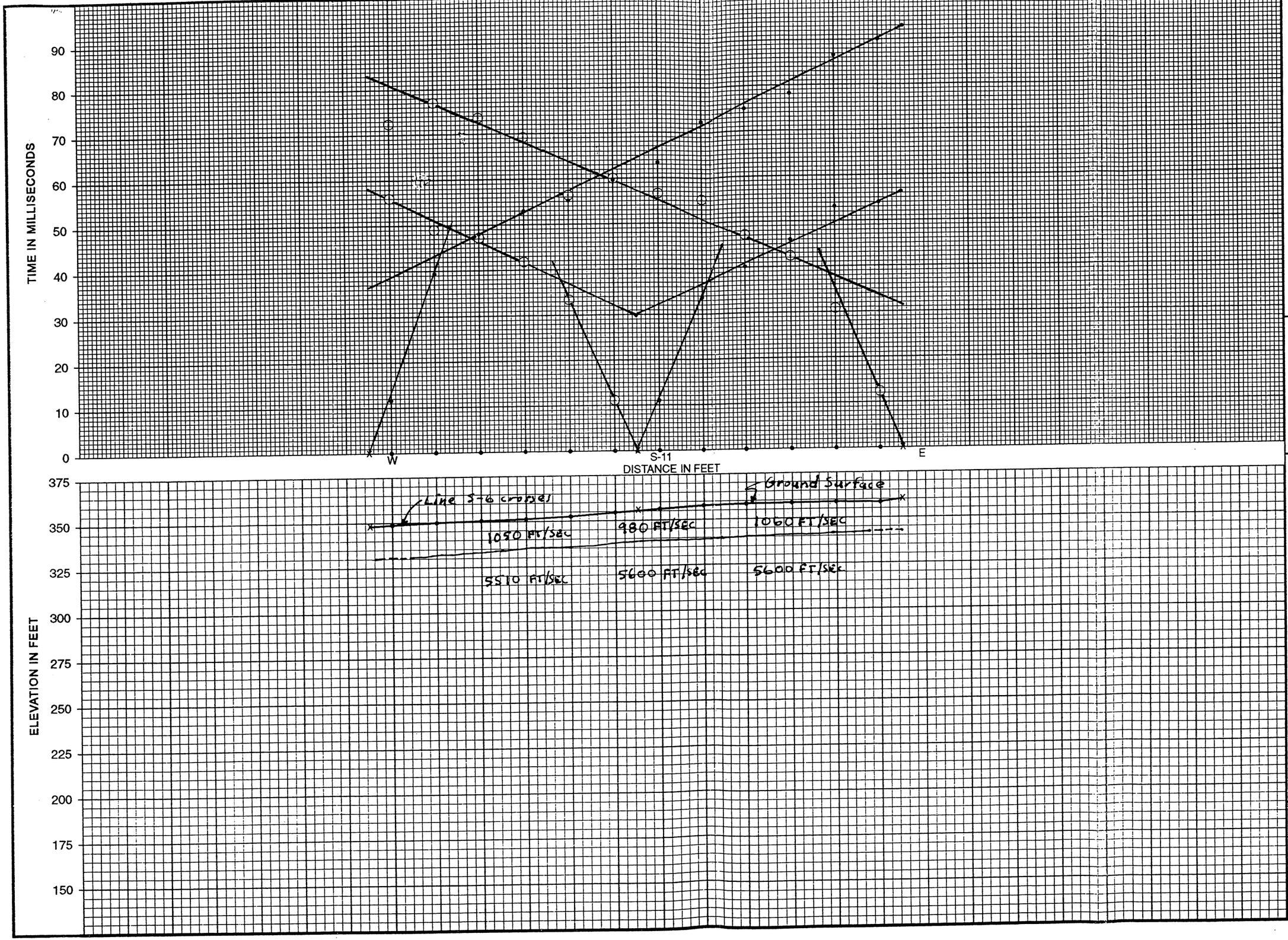
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SEISMIC LINE NO.(S): S-9&S-10

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FIGURE NO.: 7



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3. LOCATION OF SEISMIC LINES SHOWN ON FIGURE NO.(S) 2

SEISMIC LINE NO.(S): S-11

DATE: APRIL, 1998

PROJECT NO.: 9802

FIGURE NO.: 8