GEOMATRIX

FINAL REPORT

WALNUT CREEK WATER TREATMENT PLANT EXPANSION SEISMIC STUDY - PHASE I

Prepared for

East Bay Municipal Utility District
375 Eleventh Street
P.O. Box 24055
Oakland, CA 94623

September 1995
Project No. 2983

Geomatrix Consultants

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GEOMATRIX

September 12, 1995
Project 2983

Ms. Marilyn L. Miller
East Bay Municipal Utility District
375 Eleventh Street
P.O. Box 24055
Oakland, California 94623

Subject: Walnut Creek Water Treatment Plant Expansion
Seismic Study-Phase I

Dear Ms. Miller:

In accordance with the District's request and authorization, Geomatrix Consultants has completed a Phase I seismic geology investigation for the Walnut Creek Water Treatment Plant Expansion project. A report of this investigation is enclosed. The District's comments on the draft report have been incorporated in this final report.

Geomatrix's lead geologist for this investigation was Charles Taylor. Other Geomatrix personnel who participated in the study were Timothy Hall and Michael Angell, geologists, and Maurice Power, geotechnical engineer.

We have enjoyed conducting this study for the District. Should you have any questions, please contact either of the undersigned.

Sincerely,

GEOMATRIX CONSULTANTS, INC.

Maurice S. Power
Project Manager and
Principal Engineer
CE #17174, GE #694

Charles L. Taylor
Principal Engineering Geologist
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MSP/cam

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WALNUT CREEK WATER TREATMENT PLANT EXPANSION SEISMIC STUDY - PHASE 1

1.0 INTRODUCTION

It is our understanding that the East Bay Municipal Utility District recently conducted an expansion feasibility study for the Walnut Creek Water Treatment Plant (WCWTP), which reported the potential for a geologic fault trace on the subject site. As a result of this study the District desired to perform an initial evaluation to assess the potential for future activity along fault trace(s) mapped as traversing the WCWTP property, and to address possible faulting concerns that may be raised with regard to the Clearwell expansion at the site. The location of the WCWTP and its major component are shown in Figure 1 with specific locations of the existing Operations Building and Filters, Clearwell, and Settling Basin. The approximate location of the Plant with respect to previously mapped regional faults, towns, and streets and highways is shown in Figure 2.

1.1 Objectives and Scope of Work

The purposes of this Phase I seismic study are to: (1) provide an initial assessment of the presence of and potential for future activity of the fault trace(s) mapped as traversing the Walnut Creek Water Treatment Plant property; (2) summarize previously conducted fault studies along the Franklin, Southampton, and Calaveras faults that may be significant to this fault assessment, and (3) if necessary, provide a Phase II scope of work including identification of potential sites for future exploration.

The following activities have been carried out for this investigation:

1. Discussions with representatives of the California Division of Mines and Geology (CDMG), United States Geological Survey (USGS), California Department of Transportation (Caltrans), and California Division of Safety of Dams (DSOD).

2. Review and evaluation of pertinent geological and geophysical publications, reports, and maps that address the geology of the site and vicinity.

3. Examination and interpretation of available aerial photographs for evidence of geomorphic features and/or linear features possibly associated with the fault traces mapped through the site, and for any evidence of geologically recent fault activity.

4. A regional aerial and ground reconnaissance of the Franklin, Southampton, and Calaveras faults to identify any geomorphic features characteristic of active faults, and to examine locations that appear to have the greatest potential for fault activity assessments should future exploration be necessary.

5. Reconnaissance mapping of the site and immediate vicinity to identify geologic materials and structures. This resulted in a preliminary site outcrop geologic map showing the locations of rock outcrops; nature of geologic materials, geomorphic surfaces, and representative strikes and dips of bedding. To assist in the mapping, two backhoe pits were excavated on the site using District equipment and personnel to expose the underlying soil and bedrock. During this study we also had the opportunity to examine a shallow (< 4-foot-deep) pipeline trench being excavated by the District north of the existing Clearwell.

6. Preliminary age estimates were made of the soil units based on examining the soils in test pits and outcrops. No carbon was found in the limited exposures in this preliminary study that could be used to assist in age-dating of the soil units.

Data sources reviewed during this investigation are listed in Section 7, References.

1.2 Definitions

To insure a common understanding, the following definitions of geologic time periods are provided. In assessing the activity of recent faulting and the possible recurrence of future faulting events, the Quaternary Period (present to about 1,600,000 years ago) is the most important. The Quaternary Period consists of the following three Epochs with estimated age spans (Hart, 1994): Historic (0 to 200 years ago for California); Holocene (200 to 11,000 years ago); and Pleistocene (11,000 - 1,600,000 years ago). In addition geologic ages are sometimes distinguished by informal terms such as: Late Quaternary (nearer the end of the Quaternary Period and probably within the past 700,000 years), Early Quaternary (within the early part of the Quaternary period between 700,000 to

1,600,000 years ago), Late Pleistocene (later part of the Pleistocene Epoch and probably between 11,000 to 700,000 years ago), Latest Pleistocene (very near the end of the Pleistocene Epoch and probably within the last 100,000 years), and Early Holocene (near the beginning of the Holocene Epoch about 10,000 to 11,000 years ago).

2.0 PREVIOUS INVESTIGATIONS AND REGIONAL AND LOCAL SETTING

2.1 Regional Setting

The WCWTP is located adjacent to the mapped Southhampton-Franklin fault, as shown in Figure 2, and north of the active portion of the Calaveras fault that may terminate near San Ramon/Danville. The term "Southhampton-Franklin" fault is used in this study to refer to the southern extension of the Southhampton (spelling after Graymer and others, 1994) and Franklin faults. Some geologic publications from the early 1900s to 1980s show the Calaveras fault as extending north along the Franklin or Southhampton fault to the Carquinez Strait, but this interpretation is not supported by recent publications, which show that: (1) the Holocene (within the last 11,000 years) activity on the Calaveras fault apparently terminates in the San Ramon/Danville area and does not extend into the Walnut Creek area (CDMG, 1980; Hart and others, 1982; Simpson and others 1992; Taylor, 1992); (2) The Calaveras fault is truncated by the Mount Diablo Thrust north of San Ramon (Crane, 1995a, 1995b, & 1995c; Graymer and others, 1994); and (3) the southern extension of the Southhampton and Franklin faults (Southhampton-Franklin fault) is believed to be truncated by other faults near Walnut Creek and not connected to the Calaveras fault (Graymer and others, 1994; Crane, 1995a,b,c). The Alquist-Priolo special studies zone for the Calaveras fault of the California Division of Mines and Geology (1980) does not extend north of the San Ramon/Danville area.

As part of the Alquist-Priolo special studies zones the CDMG has designated the Calaveras and Concord faults (Figure 2) as active - "had surface displacement within Holocene time (about last 11,000 years)." For purposes of evaluation for possible zonation, the CDMG also designates as potentially active other faults along which movements are known to have occurred within the last 1.6 million years. None of the faults on Figure 2 have been designated as potentially active (Jennings, 1994).

Graymer (1994) and Crane (1995a) show the northern continuation of the Calaveras fault being truncated by the Mount Diablo Domain basal thrust fault (Figure 2). This eastward dipping thrust fault is described as the basal structure associated with the Mount Diablo Domain located to the east (Crane, 1995c). Southwest of Walnut Creek (Figure 2) the leading edge of the Mount Diablo thrust fault is near vertical due to deformation of the upper plate. Little information is available on the Mount Diablo thrust fault. Crane (1995c) believes that this structure is "geologically active" and that it may be the source of earthquakes such as the "Danville Swarm". The fault has not been designated active by CDMG.

2.2 Regional Geology

Three published geologic maps cover the site area: Saul (1973); Dibblee (1980); and Graymer and others (1994). A fourth map, by Dr. R. Crane (1995a), is not yet published, but his work in the East Bay region is widely represented in local geology field guides. Copies of these four maps that also show the WCWTP location are presented in Appendix A. The regional structure indicated on all four maps is grossly similar. All depict an intra-range fault (Southhampton/Franklin thrust) near the base of the eastern hill front separating a northwest-trending syncline of Upper Miocene shallow marine sandstone on the southwest from southwest-dipping Eocene-Oligocene shallow marine sandstone and shale on the northeast. The maps of Graymer and others (1994) and Crane (1995a) are regional compilation maps with local original input by the authors, whereas the maps of Saul (1973) and Dibblee (1980) are based largely on their individual mapping efforts.

No geophysical data pertinent to the geology of the site was identified during our review of CDMG and USGS publications and maps.

2.3 Mapped Faults at the Site

Two possible locations of the northwest-trending Southhampton-Franklin mapped fault traces at the site, based on the work of Saul (1973), Dibblee (1980), Graymer and others (1994), and Crane (1995a), are shown in Figure 3. These locations are referred to as: (1) the approximate location, or zone, of mapped west fault traces (Saul, 1973; and Marliave, 1956); and (2) the approximate location, or zone, of mapped east fault traces (Dibblee, 1980; Graymer and others, 1994; and Crane, 1995a). These zones were established by blowing up the existing regional fault maps, transferring the fault locations onto a topographic map of the WCWTP site, drawing zones to bracket the resolution of the fault locations, and finally tracing the zones onto the base map for Figure 3.

Other northwest-to north-trending fault traces are mapped east of the area shown in Figure 3 and the WCWTP property by Saul (1973), Dibblee (1980), Graymer and others (1994), and Crane (1995a) (Figures A-1 through A-4). In addition, Saul (1973) mapped short north-to east-trending fault traces in the site vicinity (Figure A-1). One of these traces passes through the Operations Building and Filters area. The north-to east-trending features are not mapped through the Clearwell.

2.4 Previous Studies at the Site and in the Site Vicinity

Geologic mapping and trench exploration were conducted at the WCWTP site prior to construction of the plant by C. Marliave (1955, 1956) and B. Marliave (1963). The geologic mapping was done at a scale of 1" equals 1,000 feet on existing U.S. Geological Survey topographic maps of the area.

C. Marliave (1955) believed that differential weathering produced the topographic saddles and knolls at the WCWTP site rather than faulting. He recognized that the Franklin Canyon fault was mapped as traversing the general area and identified three possible fault

locations: (1) a saddle situated between the Operations Building and the Settling Basin where Lawson (1914) had originally mapped the fault; (2) an upper saddle (probable fault trace) located within the "approximate location of mapped west fault traces" as shown in Figure 3; and (3) an eastern saddle (possible fault trace) located within the "approximate location of mapped east fault trace" as shown in Figure 3.

C. Marliave (1956) excavated and logged an almost continuous dozer trench along the ridge line that is now occupied by the Operations Building, Filters, and Settling Basin. He reports "...continuous bedrock exposed up both sides and across the bottom without any sign of faulting or rupturing." It is difficult to establish with any accuracy the location, extent, and length of the trenches because they are shown on a 1 inch equals 1,000 feet sketch based on a U.S. Geological Survey topographic map of the area. Marliave's letter report lacks any graphic trench logs or description of the trench exposures.

Geologic mapping of the site was also conducted by B. Marliave (1963). Based on his work and the work of C. Marliave (1955 and 1956), he believed that neither the main Franklin fault nor a branch fault traversed the site of the WCWTP. He shows the Franklin fault passing along the western side of the saddle location near the eastern edge of the property. His location for the main Franklin fault would be within the zone designated as "approximate location of mapped east fault trace" in Figure 3.

B. Marliave (1963) describes the sandstone on the site as jointed and fractured, which he attributes to local folding and the proximity to the Franklin fault. He provides a site geology map (scale 1" = 1000 feet), which shows a lens of Rodeo shale separating the Hambre and Briones formations from the area of the Clearwell/Operations Building to the south. However, C. Marliave (1956) does not mention the presence of this Rodeo shale in the dozer trench nor is it shown on his geology map. This apparent discrepancy raises some question about the validity of the observations and conclusions of these two reports.

The results of the above three studies are consistent with the geologic mapping of Dibblee (1980), Graymer and others (1994), and Crane (1995a), which indicate the Southhampton-Franklin fault passes through the saddle east of the Settling Basin (Figure 3). However, these studies are not consistent with the work of Saul (1973), who maps two fault traces though the western saddle trenched by Marliave (1956) within the zone designated as approximate location of mapped west fault traces. The dozer trench work by C. Marliave (1956) and the geologic mapping of B. Marliave (1963) suggests the absence of a fault trace through this western saddle, but their work does not preclude a fault in this western area because the map scale (1" = 1000 feet) used by C. Marliave (1956) to show the location of the dozer trench is not sufficient to accurately establish the extent of the trenching and whether or nor the dozer trench extended across Saul's mapped western fault traces. Also, as indicated above, the report of C. Marliave (1956) does not contain a log of the trench.

In 1983 Earth Sciences Associates (ESA) excavated a trench across a trace of the Franklin fault south of Highway 4, approximately 7 miles north of the WCWTP site. ESA concluded that recurrent offset of "...colluvium estimated to be on the order of 8,000 or 12,000 to about 20,000 years old" had occurred. Based on the results of the trenching, ESA considered the Franklin fault to be an active source of surface faulting and earthquakes. During the same study, ESA (1983) excavated three trenches up to 5 meters deep at a site along the Southhampton fault located approximately 7 miles north of the WCWTP. ESA found no evidence for late Quaternary activity in these trenches. However, the trenches apparently did not penetrate soils older than a few thousand years. ESA considered the Southhampton fault to have some seismic potential because it is located between two "active" faults (Concord and Hayward) and is in line with the projection of the Calaveras fault.

On the basis of the ESA studies and a tectonic model, Woodward-Clyde Consultants (1986), in studies conducted for Contra Costa County to revise the County Safety Element, categorized the Franklin fault as an active fault. Woodward-Clyde Consultants' tectonic model included the possible connection of the Franklin fault to the Calaveras fault. The

Southhampton fault was also inferred to be active on the basis of that tectonic model. Thus, the Franklin and Southhampton faults are designated as active faults in the current Contra Costa County Safety Element (Myers, 1995).

In seismic ground shaking studies conducted for Caltrans for the Carquinez Bridge, Geomatrix Consultants (1993) stated a belief that the results of the subsurface exploration by Earth Sciences Associates (1983) were insufficient to classify either the Franklin or Southhampton faults as active and encouraged more detailed field exploration before the State of California (CDMG) and/or Contra Costa County accept the fault as active under the Alquist-Priolo Earthquake Fault Act. For the deterministic assessment of seismic ground shaking of the bridge site, these faults were considered to be potential earthquake sources because of the interpretation of late Pleistocene activity on the Franklin fault by Earth Sciences Associates (1983), categorization of the faults as active faults in the Contra Costa County Safety Element, the lack of definitive data to refute those interpretations, and the critical nature of the bridge.

3.0 INVESTIGATIONS FOR THIS STUDY

3.1 Geologic Reconnaissance and Mapping at the Site

Geologic mapping was conducted at the site. Rock outcrops were examined and strikes and dips of bedding and prominent shears were measured. Three geomorphic surfaces were recognized at the site and are described in Section 4.1.2. These surfaces represent datum planes formed by erosional and/or depositional processes during a specific geologic period of time and thus they can be important in attempting to understand what geologic events may or may not have occurred at the site since they were formed. Two shallow (<5-foot-deep) pits were excavated by backhoe on the higher and older geomorphic surface (Figure 4) and then examined. Also examined was a shallow (≈ 4-foot-deep) pipeline trench excavated by the District across a portion of the site. A Site Outcrop Geologic Map (Figure 4) was prepared showing the locations of the pits and the pipeline trench, the locations and material descriptions of rock outcrops, strikes and dips of bedding and shears,

locations of fossils encountered during the outcrop examinations, and locations of geomorphic surfaces.

3.1.1 Exposed Bedrock. Bedrock exposed at the site and in the immediate vicinity consists predominantly of northwest-southeast striking and southwest-dipping massive to finely laminated fine-grained and medium-grained sandstones with minor silty claystones. Most of the bedrock is grossly similar in texture and color, but there are distinctive differences in the small-scale stratigraphic features (e.g., sedimentary structure and local variations in grain size, composition, and color). Confirmation of the bedrock formations would require examination of the outcrops during dry weather and identification of available fossils. Therefore, bedrock units are not shown on Figure 4.

Fossils were observed at many of the widely spaced outcrops, as shown on Figure 4. Analysis of the fossils for age and identification of formations was not performed during this study. Our geologic mapping identified some indications of minor northeast-southwest-trending intraformational shearing or faulting on the site, indicated by a northeast trending, 68 degree southeast dipping shear zone marked by sandy claystone and fine gravel located in the drainage canyon northwest of the clearwell (Figure 4). With the limited exposures, it was not possible to confirm or deny the existence of the previously mapped northwest trending regional faults on the site.

In the pipeline trench excavated by the District (Figure 4), bedrock was exposed in approximately 70% of the 600-foot-long excavation between the eastern terminus of this line (south of the settling basin) and the western edge of the bench (geomorphic surface). No northwest-trending faults were identified in the bedrock. The bedrock was overlain either by a thin soil, by colluvium with a black soil developed on it, or by artificial fill. Fill was exposed to the bottom of the excavation adjacent to the west side of the paved road leading to the pump station/settling basin complex (over a 36-inch culvert) and along a 40-foot-wide stretch across the modified, north-trending drainage canyon located northwest of the Clearwell. To the west, on the eastern flank of the highest area on the bench, bedrock

was concealed beneath black soil/colluvial deposits, indicating the presence of topographic irregularities in the underlying bedrock surface. Between the highest area on the bench and the western flank of the bench near the western end of the excavation shown on Figure 4, bedrock was largely concealed by fill.

Bedrock exposed in the pipeline excavation consists primarily of a fossiliferous, very fine silty sandstone to sandy siltstone that is highly to moderately fractured, moderately hard, and moderately weathered. Although bedding is obscure, beds near the drainage canyon north of the Clearwell appear to strike north-northeast to northeast and dip 55-75° southeast. We also observed a north-northwest-trending contact between sandstone and siltstone near the top of the high point on the bench. The northeast-trending, 68 degree southeast-dipping shear zone that is exposed in the drainage canyon is also present in the pipeline trench where expected from its projected trend.

Our brief examination of the shallow trench did not reveal any major fault or shear zone consistent with the northwest-southeast orientation of the Southhampton-Franklin fault mapped north and west of the existing Clearwell (zone of mapped west fault traces in Figure 3). However, along about 30% of the pipeline trench that we examined, the soil, colluvium, and/or fill was sufficiently thick to cover bedrock and conceal any shears or faults that may be present. Consequently, based on this examination, we cannot preclude such a fault from traversing one or more portions of this pipeline trench. Due to the ongoing construction effort, we were also not able to clean, examine, and log the walls of the trench with the detail used in subsurface fault investigations. However, examination of the trench did result in the identification of certain areas near the Clearwell where a major northwest-trending fault is not present.

3.1.2 Geomorphic Surfaces. As stated in Section 4.1, three geomorphic surfaces were identified in the site area. These three features consist of an older higher surface, a younger terrace, and the present intermittent stream bed. The older surface has been dissected by stream erosion, resulting in two individual areas (as shown on Figure 4)

separated by a central drainage draw. The test pits were excavated on the western of these two areas. The older surface may be the remnant of a regional erosional surface. At the northern end of the easternmost older geomorphic surface, there is an overlying fluvial gravel deposit with an older soil development (Figure 4). A younger terrace cuts into the older geomorphic surface and occurs as a discontinuous terrace along the upper margins of the drainage draw. This terrace is not large enough to map at the scale of Figure 4. The present intermittent stream bed is located within the central drainage draw. Significant portions of the geomorphic surfaces exist north of the District property, on lands belonging to the East Bay Regional Park District.

Two soils have developed on the site; a younger soil and an older soil. A thin (0.5-1.5 m) poorly developed soil representative of a very young age (several hundred to several thousand years) exists over most of the area. This younger soil is not useful for fault studies to establish inactivity of a fault. The older soil developed on the fluvial deposits above the older geomorphic surface is about 1.4 m thick and has a very weakly developed, approximately 60- to 80-cm-thick Bt soil horizon, weak to moderate-subangular blocky structure, and very thin clay films lining pores and bridging sand grains. This older soil apparently has not developed on the younger terrace. No carbon was identified in our reconnaissance-level examination of these soils. Based on this one exposure and the absence of materials for radiocarbon dating, it is not possible at the present time to assign a confident age range to this soil; however, the presence of this older soil gives promise for any future work to constrain the age of the geomorphic surfaces. Our observations and experience in this area indicate that the age most likely ranges from a few thousand years to a few tens of thousands of years (Holocene to Latest Pleistocene). It is unlikely but possible that the soils are older than 100,000 years. It is possible that older soils and surfaces may occur at other locations along the Southhampton-Franklin fault.

The upper geomorphic surface identified at the site certainly represents some antiquity as evidenced by the its aerial extent, location above stream channels, and the overlying fluvial deposit and associated older soil. No obvious indications of faulting were observed where

faults are mapped crossing this upper geomorphic surface. The absence of obvious indications of faulting across this surface suggests that either regional northwest-southeast trending faults do not exist at the site, it has been a long time since significant displacement has occurred on these faults at the site, or displacements are small and infrequent.

3.1.3 Discussion. In detail, the structural and stratigraphic relationships at the site depicted on the published maps (Saul, 1973; Dibblee, 1980; Crane, 1995a) are quite different. On these maps the stratigraphic nomenclature is not consistent and in many areas basic lithologies do not agree with each other or with bedrock exposures we observed in the field.

We observed evidence for a minor northeast-southeast trending shear in bedrock along the western portion of the site within the zone of the mapped west fault traces (western zone, Figure 3) of Saul (1973). Minor faulting with a northeast-southwest trend is suggested by local shearing and intense fracturing of the bedrock, significant changes in lithology, and in the divergent directions of strike of rocks exposed on opposite sides of the drainage draw. These observations were made near the head of the drainage draw located just northwest of the Clearwell where a prominent fracture set with shear fabric dipping 68 degrees southeast is plotted (Figure 4). Continuation of this shear fabric was also observed on trend to the south during examination of the pipeline excavation. Note that the strike of this feature is northeast as compared to the northwest strike for previously mentioned mapped regional faults.

The absence or presence of any major faults on the site can be verified by detailed stratigraphic and paleontologic studies of the rocks and fossils available at the site. Such studies could identify the formations present on the site and the locations where formations change abruptly or are absent either due to faulting or non-deposition. Such locations would be preferred sites for detailed subsurface trenching to identify and assess possible faults.

3.2 Aerial and Surface Reconnaissance

On March 28 a regional aerial reconnaissance was made along the mapped traces of the Franklin, Southhampton, and Calaveras faults to identify any geomorphic features characteristic of active faults, and to examine locations that appear to have the greatest potential for assessing fault activity should future exploration be necessary. A ground reconnaissance was also made of the Franklin and Southhampton faults. Prior to the aerial reconnaissance, available aerial photos were interpreted for evidence of geomorphic features and/or linear features possibly associated with the fault traces mapped through the site, and for any evidence of geologically recent activity. These photographs are listed in Section 7.

A dissected elevated Quaternary geomorphic surface was observed a few miles north of the site near the Carquinez Strait. This suggests that relative uplift has occurred in the region, but the cause, timing, and extent of the uplift is unknown. Movement along the Franklin and/or Southhampton faults could be a possible cause of the uplift.

In general, subdued linear features are recognized along the Franklin and Southhampton faults, but there is a lack of offset of drainages and alluvial units considered to be of late Quaternary age. Some well-developed linear canyons have been eroded along portions of the faults that traverse the higher hilly elevations. These linear features are absent across eroded lower elevations and in alluvial filled valleys. These observations suggest that the origin of these linear features is due to erosion along bedrock faults rather than geologically recent displacement along the faults.

No geomorphic features suggestive of Holocene or late Quaternary age were observed along the Franklin or Southhampton faults. The aerial reconnaissance did not identify any evidence of fault displacement on the geomorphic surfaces previously described at the WCWTP site.

Along the Calaveras fault south of San Ramon, features characteristic of active faults were observed, such as linear tonal features caused by groundwater barriers, systematic aligned

offset drainages, saddles, and side hill benches. These features are indications of late Quaternary to Holocene fault activity. While some subdued and discontinuous geomorphic features were observed north of San Ramon, the linear fault features so characteristic of the Calaveras fault to the south were not observed. The lack of distinctive geomorphic evidence north of San Ramon suggests an absence of late Quaternary to Holocene slip on the northern Calaveras fault, or that the Calaveras fault does not extend into this area.

4.0 SUMMARY AND CONCLUSIONS

1. We believe that the available regional data are insufficient to classify the Southhampton-Franklin fault as active, or to demonstrate that major fault traces cross the WCWTP site and the proposed Clearwell. However, based on a lack of site-specific data, it is our opinion that the presence of faults traversing the site cannot be precluded.

2. The presence of early Holocene or late Quaternary movement on the Southhampton-Franklin fault cannot be assessed directly based on this preliminary study. The presence of an elevated and dissected Quaternary geomorphic surface observed a few miles north of the site near the Carquinez Strait, suggests that relative uplift in the region has occurred, but the cause, timing, and extent of the uplift is unknown.

3. A previous study was conducted along the Franklin fault by Earth Sciences Associates (1983), and the results of limited trenching in that study were interpreted by the investigators to represent late Pleistocene displacement. We do not believe that the results of the ESA study are sufficient to classify the Southhampton-Franklin fault as active under the Alquist-Priolo Earthquake Fault Zoning Act, but based partly on that study, the Contra Costa County Safety Element considered the Franklin fault to be active, inferred the Southhampton fault to be active, and considered both faults to be potential future locations of earthquakes and surface faulting.

4. Published geologic maps show possible traces of the Southhampton-Franklin fault traversing the WCWTP site within an eastern zone and a western zone. The eastern zone of mapped fault traces is located near the eastern limits of the facility and east of the settling pond. The western zone of mapped fault traces is located west of the Operations Building and traverses the area of the existing and proposed Clearwell.

5. Our limited geologic mapping at the site during this study has identified minor northeast-trending shearing within the western zone of mapped fault traces that may be related to the folding that formed the East Bay hills several million years ago. The mapping failed to identify any shearing or other geological evidence of a fault consistent with the northwest-southeast-trending mapped traces of the Southampton-Franklin faults. However, because of the limited field exposures and limited scope of study, the results are not sufficient to preclude the presence of either major or minor faults on the site. An older geomorphic surface that is likely to be at least thousands to a few tens of thousands of years old has been identified on the site, and this surface is crossed by mapped fault traces without any evidence of disturbance.

6. Based on our reconnaissance observations and site mapping, the likelihood of Holocene activity on the fault traces mapped though the site is considered to be low for the mapped west traces and moderate to low for the mapped east fault trace (Figure 3). This judgment is based on the absence of obvious geomorphic and/or topographic expression of a fault trace and the apparent lack of vertical displacement or tilting of the previously described geomorphic surfaces. However, the expression of a low-slip-rate fault in this environment is likely to be subtle, particularly if the feature is a low-angle thrust fault. Proper evaluation of such features requires detailed geologic studies of Quaternary units, geomorphic analysis, and stratigraphic and paleontologic analysis.

7. The lack of surface expression, field data, or evidence of disturbance across the geomorphic surfaces suggests that the Southhampton-Franklin fault may not exist on the site, or that the fault is inactive or the rate of activity is very low.

8. The potential for successfully locating and characterizing faults in bedrock at the site during a detailed geologic investigation is judged to be good based on the presence of bedrock close to the surface and the presence of abundant fossils. In addition, there is a good potential for characterizing the geologically recent fault activity due to the presence of Quaternary (Holocene and latest Pleistocene) deposits and geomorphic surfaces at and in the vicinity of the site. Based on our experience and observations at this site, the older soil and upper geomorphic surface appears to be less than 100,000 years old (upper range of Latest Pleistocene). The presence of soils older than 100,000 years are unlikely at this site, but they may occur elsewhere along the Southhampton-Franklin fault. Any future fault studies at the site will likely require subsurface exploration and require access to the lands located immediately north of the District property. We understand that at least some of these lands belong to the East Bay Regional Park District.

9. The Southhampton-Franklin fault is mapped as a low- to high-angle reverse fault, and, at the site, is assumed to be dipping to the west with possible thrusting to the east. Given the orientation of the Southhampton-Franklin fault and its assumed dip to the west, the facilities at the site are likely located on the upper plate of a fault (fault plane dipping back westward beneath the structures). During any future displacement on this fault, there could be a significant vertical component of slip, and the zone of surface disturbance above the upper plate might be wider than typical of strike-slip faults. The hazard of surface disturbance and offsets above the upper plate would be greatest along preexisting faults or shear planes at the site, especially on those that have a similar strike as that of the fault. There is the possibility that faults at the site dip to the east or are near vertical, in which case, the structures might not be located on an upper plate. The above possibilities could be evaluated by surface trenching at

the WCWTP site. Subsurface exploration including borings may be necessary to assess the downdip geometry of any faults.

5.0 ADDITIONAL STUDIES

In order to increase the database and evaluate the potential for surface faulting at the site, the District may wish to consider conducting a Phase II Exploration and Evaluation Program to (1) assess the location and dip of possible fault traces at and near the Walnut Creek Water Treatment Plant site by stratigraphic and paleontologic studies and by subsurface exploration, (2) assess the age of the geomorphic surfaces previously identified, (3) assess the activity of any fault traces identified at the site, (4) assess the activity of the Franklin and Southhampton faults by surface and subsurface exploration at specific sites along the faults, and (5) synthesize the results of the study into a report that assesses the potential for surface faulting on the Walnut Creek Water Treatment Plant property, the activity of any fault traces mapped on the property, and the activity of the Southhampton-Franklin fault.

Should the District wish to consider additional work, we have provided a generalized Phase II scope of work in Appendix B. Also included as part of Appendix B is a list of specific sites that can be considered for future surface and subsurface exploration.

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AV-3582-7-6 through -8, dated 06-14-89, 1:36000
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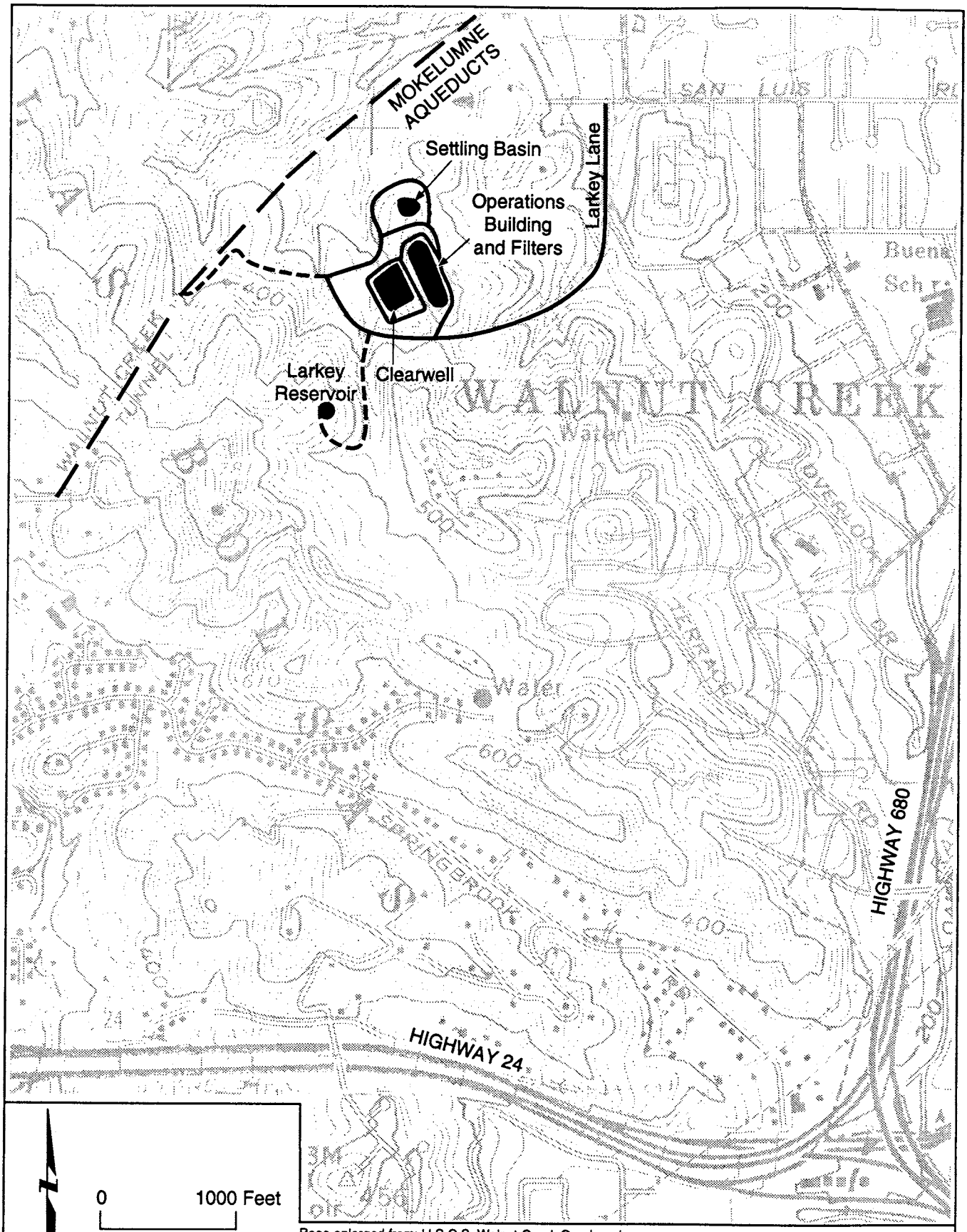
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Base enlarged from: U.S.G.S. Walnut Creek Quadrangle
7.5 Minute Series (Topographic)

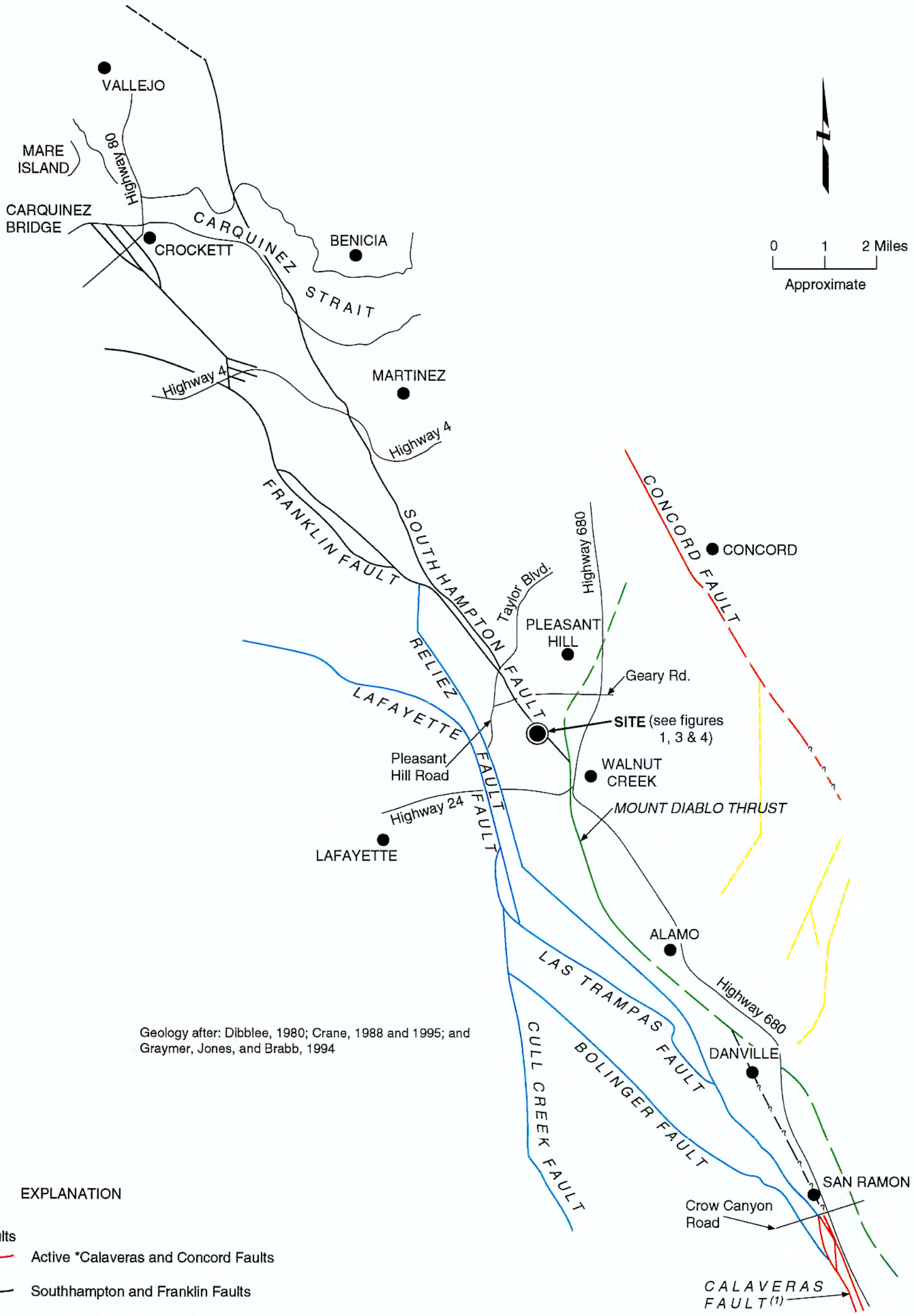
GEOMATRIX

LOCATION MAP
Walnut Creek Treatment Plant
East Bay Municipal Utility District

Figure
1

Project No.
2983

2983.002



Geology after: Dibblee, 1980; Crane, 1988 and 1995; and Graymer, Jones, and Brabb, 1994

EXPLANATION

Faults

- Active *Calaveras and Concord Faults
- Southhampton and Franklin Faults
- Mount Diablo Thrust Fault
- Other faults (Cull Creek, Bolinger, Las Trampas, Lafayette, and Reliez)
- Faults mapped between Calaveras and Concord Faults

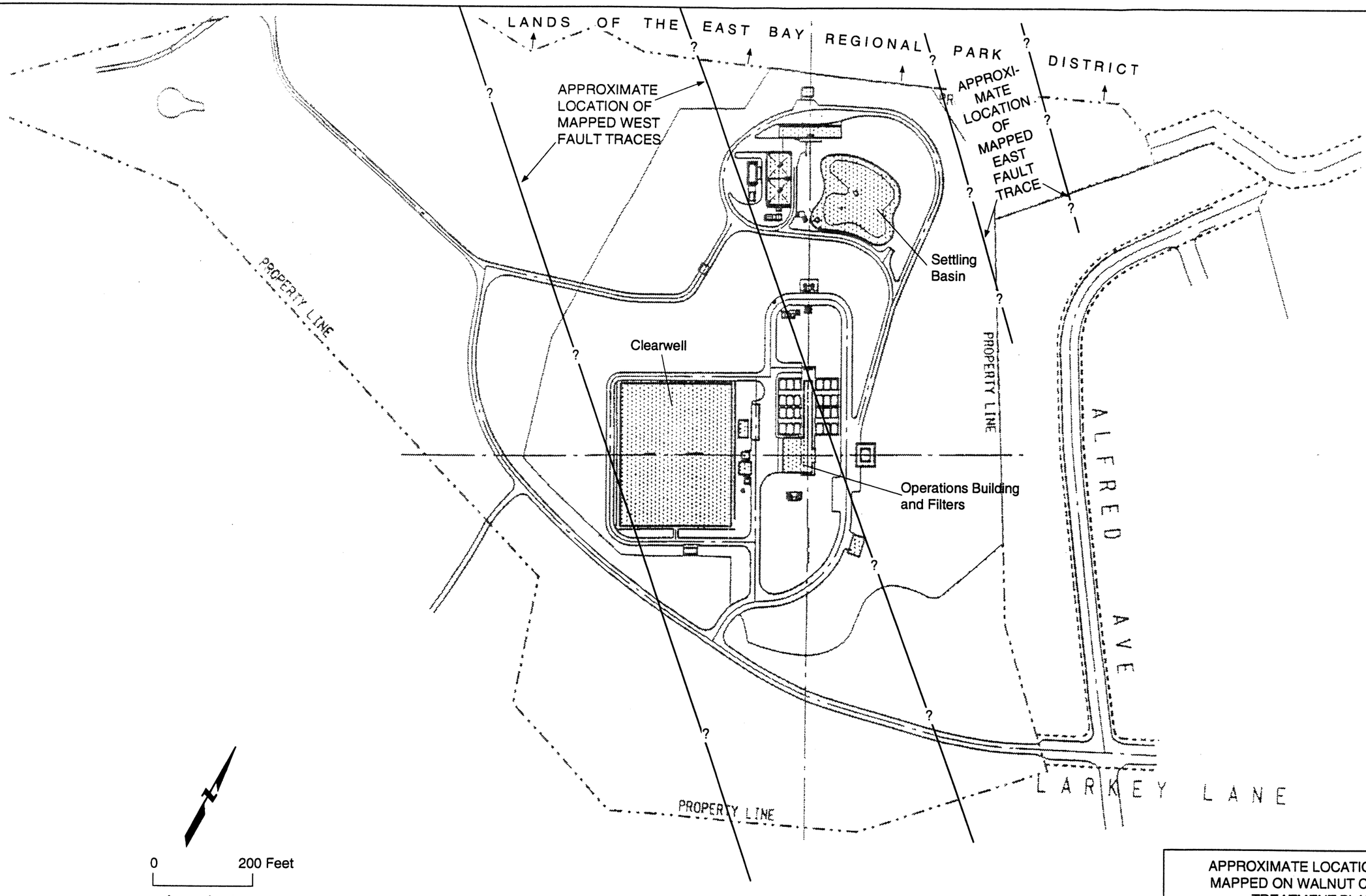
(1) Note: The active Calaveras Fault is not known to extend north of San Ramon.

* Designated active by California Division of Mines and Geology; none of the other faults are so designated.

REGIONAL FAULT MAP
WALNUT CREEK WATER TREATMENT PLANT
East Bay Municipal Utility District

GEOMATRIX	Project No. 2983	Figure 2

2983.005

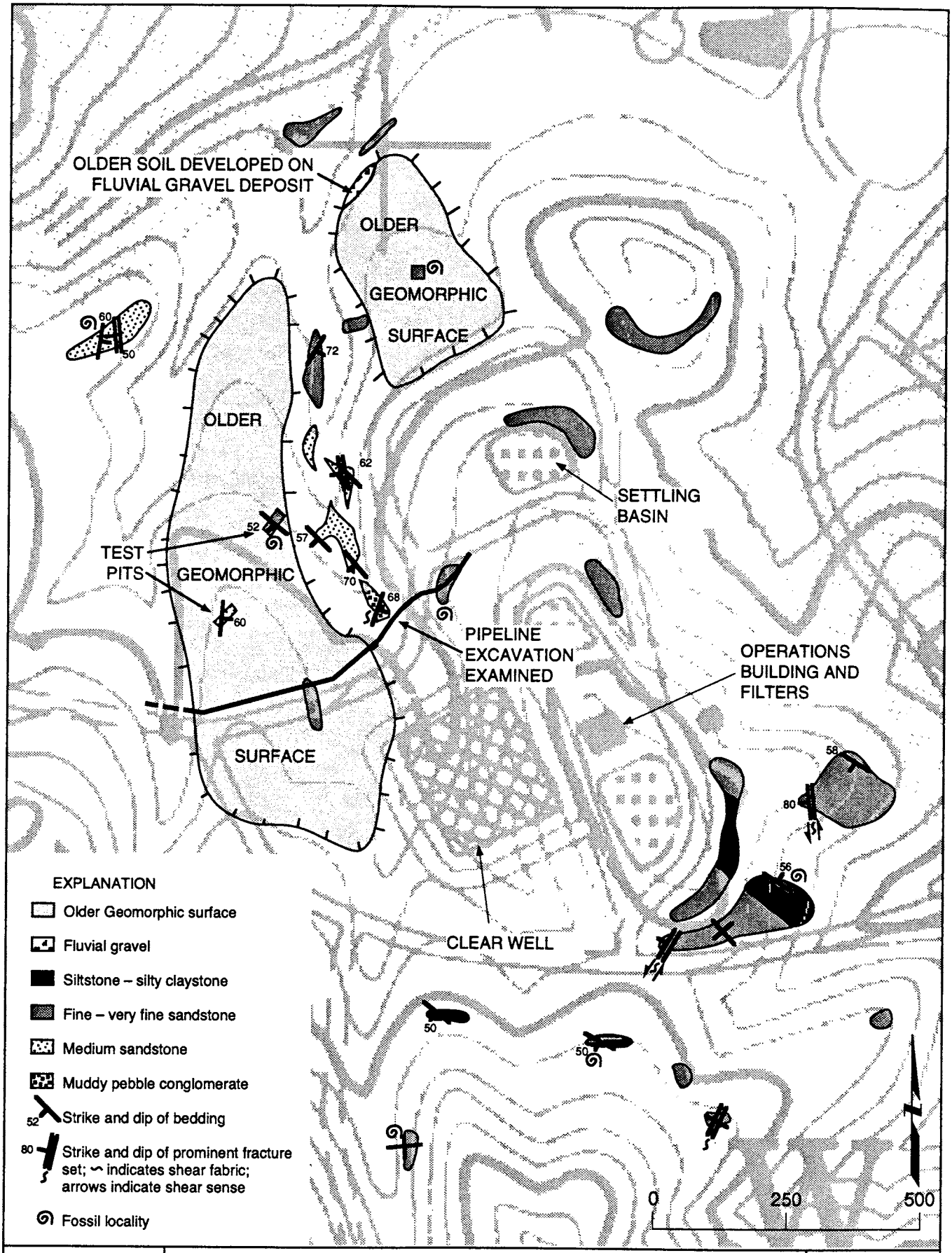


NOTE:
Location of fault traces after Saul (1973); Dibblee (1980); Crane, 1988 and 1995a; and Graymer, Jones, and Brabb, 1994.

APPROXIMATE LOCATION OF FAULTS
MAPPED ON WALNUT CREEK WATER
TREATMENT PLANT SITE
Walnut Creek Water Treatment Plant
East Bay Municipal Utility District

GEOMATRIX	Project No. 2983	Figure 3

2983.004



GEOMATRIX

SITE OUTCROP GEOLOGIC MAP
Walnut Creek Water Treatment Plant
East Bay Municipal Utility District

Figure 4

Project No. 2983

2983.009

GEOMATRIX

APPENDIX A

GEOLOGY AND FAULTS IN VICINITY OF WALNUT CREEK WATER TREATMENT PLANT

APPENDIX A

GEOLOGY AND FAULTS IN VICINITY OF WALNUT CREEK WATER TREATMENT PLANT

A.1 REGIONAL SETTING - CALAVERAS FAULT

In preparing the Fault Evaluation Report for the Las Trampas Ridge Quadrangle, the California Division of Mines and Geology (1980) stated that "It appears that the Calveras fault north of San Ramon lacks the recent linear fault features so characteristic to the south. Previous workers seem to disagree as to the location, significance, and nomenclature of what may comprise the northwest extension of the Calaveras fault." It was concluded that in the Las Trampas Ridge Quadrangle, the Calaveras fault zone is a complexity of strike-slip and reverse faults; in the Walnut Creek Quadrangle the recent traces are even less well-defined in terms of geomorphic evidence; the fault and branches were "most active during Pliocene and Early Pleistocene time as evidenced by major offset of the Pliocene Orinda and Mulholland formations and the lack of systematic offset of drainages and alluvial units and surfaces considered to be late Quaternary age"; and no faults were identified that were "sufficiently active and well-defined" to warrant zoning under the Alquist-Priolo Zone Act.

It has been proposed that the Holocene activity on the Calaveras fault terminates north of Danville (Taylor, 1992), and that the Calaveras fault does not extend as a prominent feature to the Walnut Creek basin (Simpson and others, 1992). This is supported by two recent publications: Graymer and others (1994) and Crane (1995a). The Preliminary Geologic Map of Contra Costa County by Graymer and others (1994) does not show a continuous Calaveras fault extending north from San Ramon. It shows two discontinuous dashed and queried fault traces; one trace extends from the Calaveras fault near San Ramon to the Danville Area, and another trace extends from just west of Walnut Creek northward and east of Pleasant Hill (see Figure A-4). The Southhampton-Franklin fault is truncated by another north-south trending fault located west of Walnut Creek. Geologic quadrangle maps of the Walnut Creek area prepared by Crane (1995a) show the Calaveras fault being truncated by the Mount Diablo Thrust (Figure 2) which also truncates the Southhampton-Franklin fault. Presently available geologic data does not support continuation of the Holocene active Calaveras fault northward of Danville into the Walnut Creek area, or connection of the Calaveras fault with the Southhampton-Franklin fault.

A.2 REGIONAL SETTING - SOUTHHAMPTON AND FRANKLIN FAULTS

The Southhampton and Franklin faults extend from the Carquinez Strait southward toward Walnut Creek. The southern extension of these faults as mapped in the vicinity of the Walnut Creek Water Treatment Plant is shown on Figure 2.

The Franklin fault is described as a high-angle to low-angle thrust fault dipping to the east. Major reverse dip-slip separation with the east side up about 1200 to 2000 m with a significant right-slip component is believed to have occurred since Miocene time (Earth Sciences Associates, 1983). Lawson (1914) and Weaver (1953) indicate that the Franklin fault intersects the western end of the Santa Fe Railroad Franklin Canyon tunnel with a low dip to the northeast. Lawson (1914) indicates that Cretaceous sandstones on the northeast have been thrust to the southwest over the Monterey group, and that as a result of the fault movement the shales of the Monterey formation have been reduced to a clayey mass which when wet flows into the tunnel.

A.3 SOUTHHAMPTON AND FRANKLIN FAULTS - DIFFERING REGIONAL INTERPRETATIONS

In the geological literature there are three significant differing interpretations regarding the relationship between the Southhampton fault and Franklin fault, and their relationship to the Calaveras fault. The differing interpretations are described below.

1. Dip of Faults

Near the Carquinez Straits the Franklin fault is mapped as a west verging fault with an eastward dip toward the Concord fault, and the Southhampton fault is an east verging back-thrust off of the Franklin (Crane, 1995c; Figures, 1991). Farther south toward the WCWTP site, Crane (1995c) depicts both the Franklin and Southhampton faults as being deformed and apparently overturned and dipping towards the west. The Southhampton fault as mapped at the WCWTP site is dipping to the west (Crane, 1995a) as shown on Figure A-3. We are not able to confirm the dip of any faults at the site. Thus it is possible that any regional fault located at the WCWTP site may be upright and dip to the east as does the Franklin fault near the Carquinez Straits (Crane 1995c), be overturned and dip to the west as proposed by Crane (1995c), be upright and dip to the west toward the Hayward fault as do other reverse faults to the south (Bollinger Canyon, Las Trampas, Miller Creek), or be near vertical as proposed by Saul (1973).

2. Continuity/merging of the Two Faults

Lawson (1914), Jennings (1975), Pampeyan (1979), and Graymer and others (1994) map the Franklin fault as a continuous feature from the Carquinez Straits to the Walnut Creek area with the Southhampton fault either merging with, or being truncated by, the Franklin fault. By contrast, Dibblee (1980), Earth Sciences Associates (1983), and Crane (1988 and 1995a) show the Southhampton fault to be the continuous feature, with the Franklin fault either merging with, or being truncated by, the Southhampton fault.

3. Continuity with Calaveras Fault

The Calaveras fault has been depicted as connecting to the Franklin fault and continuing to the Carquinez Straits (Radbruch-Hall, 1974). Recent maps by Graymer and others (1994) and Crane (1995a) do not show the Franklin and Southhampton faults connecting to the Calaveras fault, but show them being truncated by other faults just north of the I-680/Highway 24 Interchange in Walnut Creek.

The model that we have used in this study is that the Southhampton fault is the continuous fault; that it dips westward towards the Hayward fault like other reverse faults in the area (Bollinger Canyon, Las Trampas, Miller Creek) but that it may be overturned as proposed by Crane (1995a); and that the Franklin fault either merges with, or is truncated by, the Southhampton fault a shore distance northwest of the WCWTP. The resulting fault is referred to as the Southhampton-Franklin fault. It appears that the Southhampton-Franklin fault continues a short distance to the south where it is truncated by the Mount Diablo Thrust (Crane, 1995a). These relationships are shown on Figure 2.

A.4 LOCAL SETTING - GEOLOGY AND FAULTS AT WALNUT CREEK CENTER

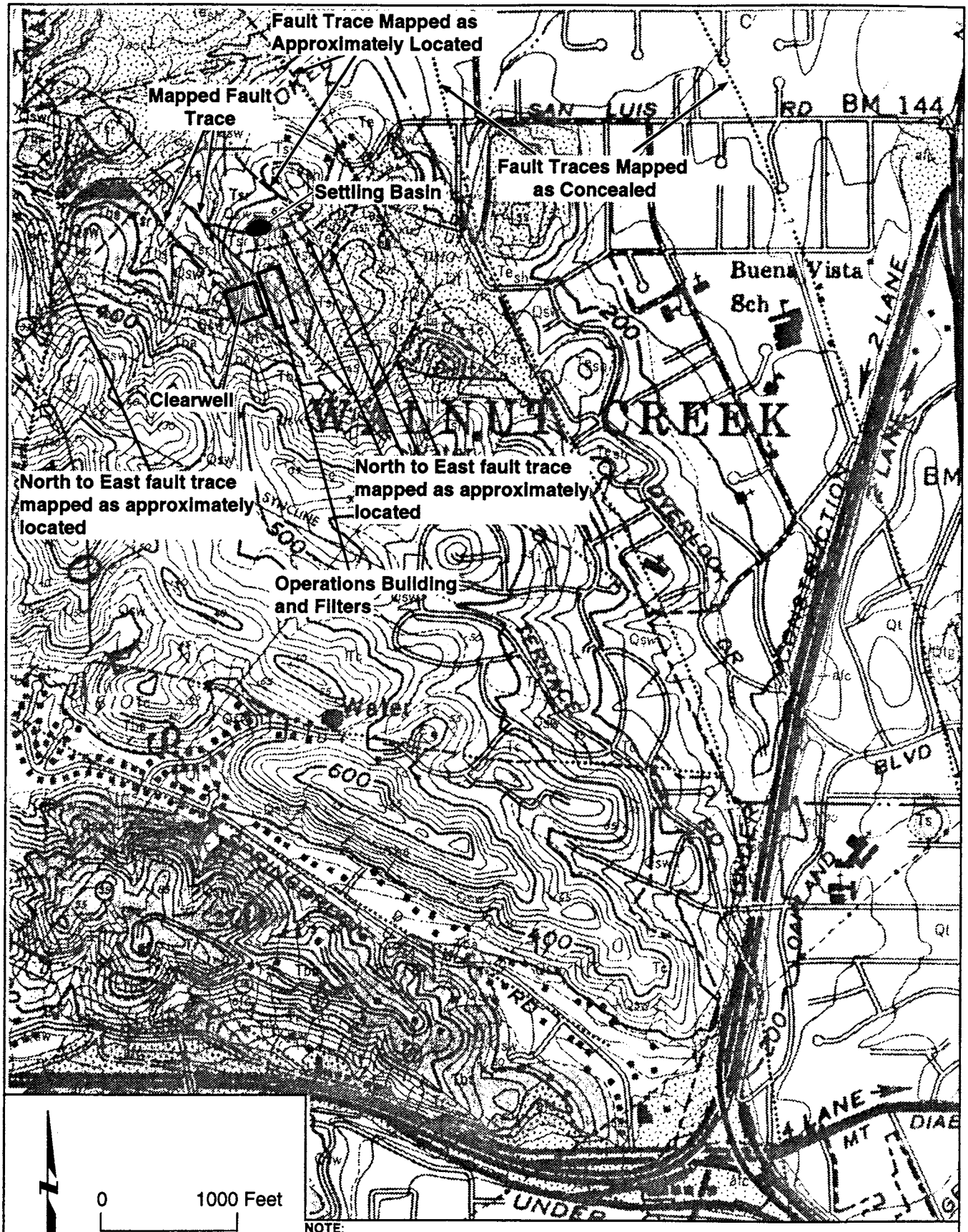
The geology and faults mapped in the vicinity of the Walnut Creek Water Treatment Plant are shown on Figure A-1 (Saul, 1973), Figure A-2 (Dibblee, 1980), Figure A-3 (Crane, 1995a), and Figure A-4 (Graymer and others, 1994). Faults shown on these figures and summarized below are assumed to be traces of the Southhampton-Franklin fault.

Saul, 1973 (Figure A-1)
Two fault traces are shown traversing the western portion of the site. They pass through the Clearwell area and the Operations Building and Filters. A short fault segment is shown east of the Settling Basin and near the eastern edge of the property. Another fault trace is shown beyond the property. Several northeast-trending faults are shown on the WCWTP site and one is located in the vicinity of the operations building and filters.

Dibblee, 1980 (Figure A-2)
No fault traces are shown along the western portion of the site, but a single fault trace is shown east of the Settling Basin near the eastern edge of the property.

Crane, 1995 (Figure A-3)
No fault traces are shown along the western portion of the site, but an unconformity is mapped as passing beneath the Clearwell and Operations Building and Filters, and a fault trace is shown east of the Settling Basin near the eastern edge of the property. The unconformity, a time of erosion that left a gap in the geologic record, is not considered a fault or a potential source of fault displacement.

Graymer and others, 1994
A trace of the Southhampton-Franklin fault is shown on the Contra Costa County Geology Map as passing in the vicinity of the site. This location is approximately as depicted by Dibblee (1980) and Crane (1995a).



NOTE:
The purpose of this map is to show the location of faults mapped in the vicinity of the WCWTP site. Please consult the original reference for legend, description of units, and details away from the WCWTP site.

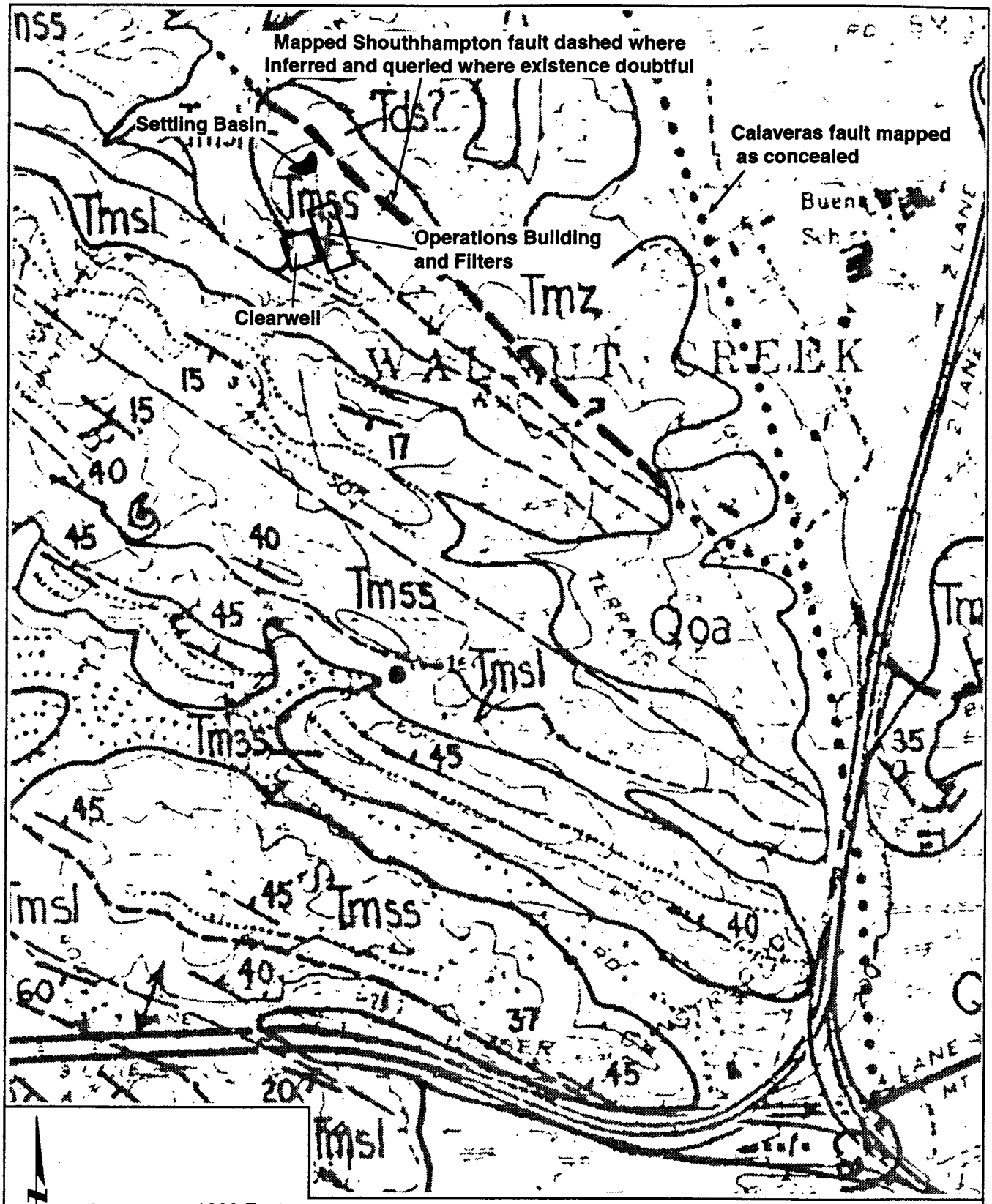
GEOMATRIX

GEOLOGY IN VICINITY OF
WALNUT CREEK WATER TREATMENT PLANT (SAUL, 1973)
Walnut Creek Water Treatment Plant
East Bay Municipal Utility District

Figure
A-1

Project No.
2983

2983.003



NOTE:
The purpose of this map is to show the location of faults mapped in the vicinity of the WCWTP site. Please consult the original reference for legend, description of units, and details away from the WCWTP site.

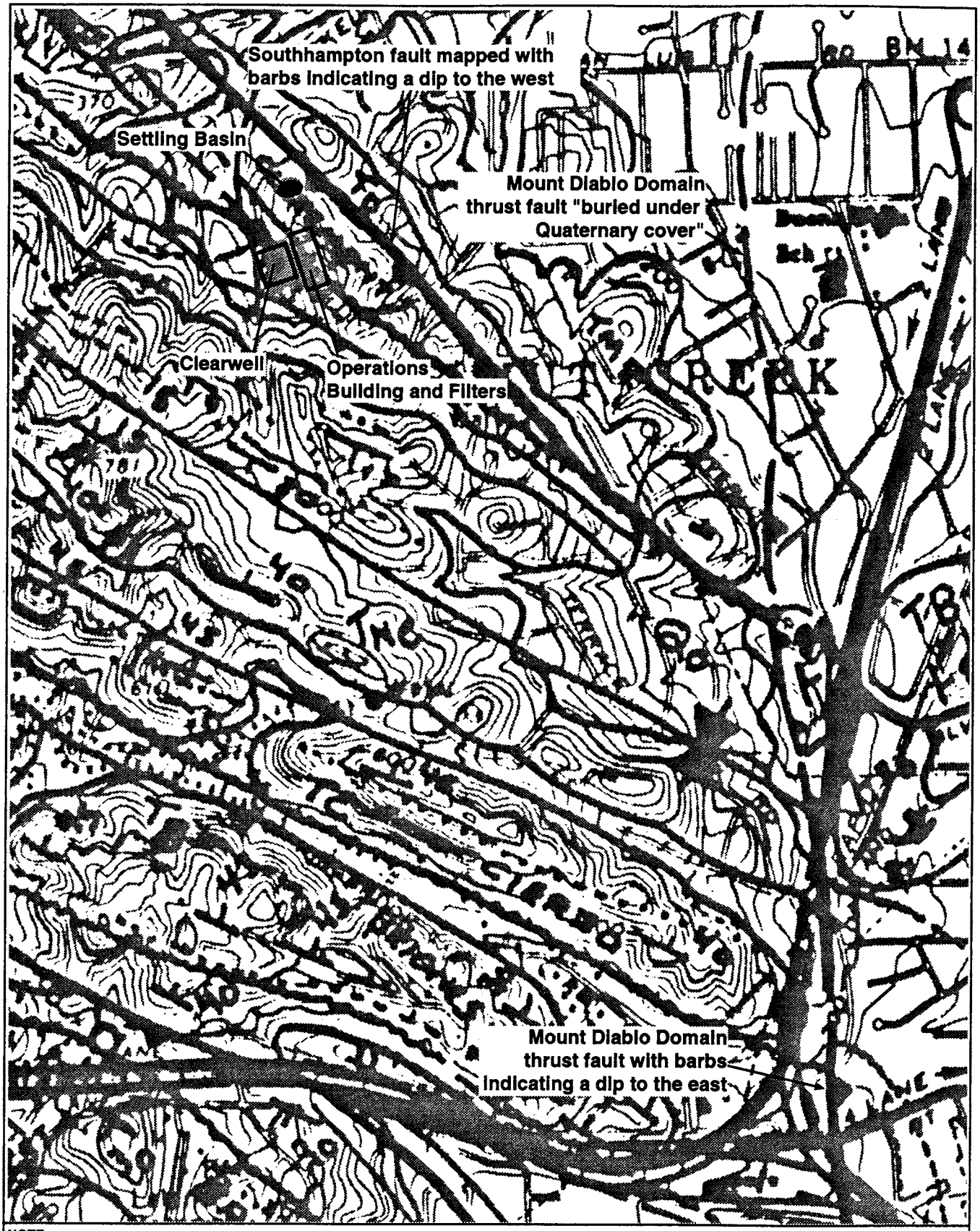
GEOMATRIX

GEOLOGY IN VICINITY OF WALNUT CREEK CENTER (DIBBLEE, 1980)
Walnut Creek Water Treatment Plant
East Bay Municipal Utility District

Figure
A-2

Project No.
2983

2983.006



NOTE:
The purpose of this map is to show the location of faults mapped in the vicinity of the WCWTP site. Please consult the original reference for legend, description of units, and details away from the WCWTP site.

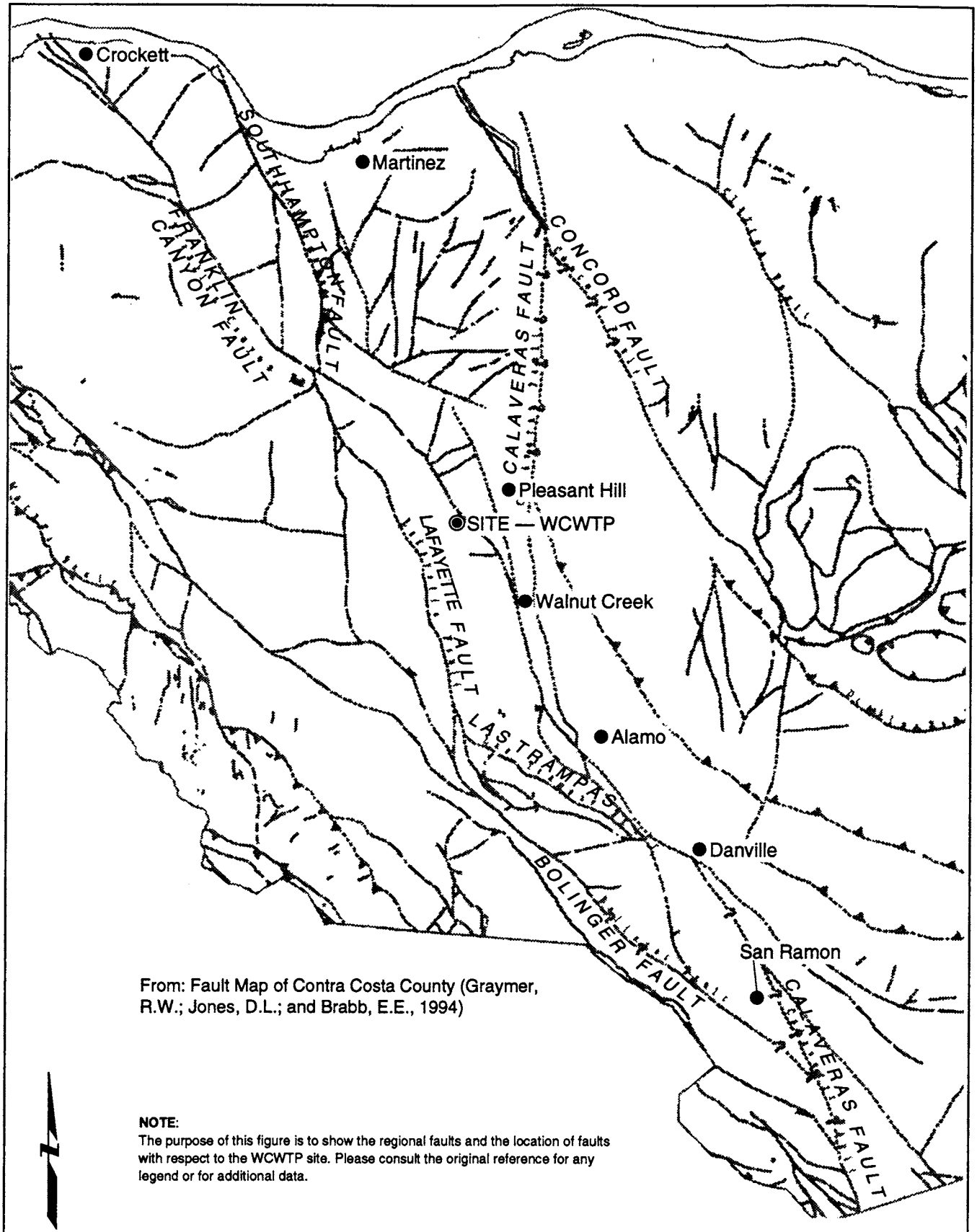
GEOMATRIX

GEOLOGY IN VICINITY OF WALNUT CREEK CENTER (CRANE, 1995a)
Walnut Creek Water Treatment Plant
East Bay Municipal Utility District

Figure
A-3

Project No.
2983

2983.007



From: Fault Map of Contra Costa County (Graymer, R.W.; Jones, D.L.; and Brabb, E.E., 1994)

NOTE:
The purpose of this figure is to show the regional faults and the location of faults with respect to the WCWTP site. Please consult the original reference for any legend or for additional data.

No scale given by authors

GEOMATRIX

FAULT MAP OF A PORTION OF CONTRA COSTA COUNTY
Walnut Creek Water Treatment Plant
East Bay Municipal Utility District

Figure
A-4

Project No.
2983

2983.006

APPENDIX B

GENERALIZED PHASE II SCOPE OF WORK FOR ADDITIONAL STUDIES AND SITES FOR CONSIDERATION DURING FUTURE EXPLORATION

APPENDIX B

GENERALIZED PHASE II SCOPE OF WORK FOR ADDITIONAL STUDIES AND SITES FOR CONSIDERATION DURING FUTURE EXPLORATION

B-1. SCOPE OF WORK

The objective of Phase II work would be to locate and assess the activity of fault traces potentially traversing the Walnut Creek Water Treatment Plant property and specifically assess the potential for surface faulting at the existing and proposed Clearwell site. It is important to understand that subsurface trenching may be required during any additional work, and that subsurface trenching will probably be necessary on the lands immediately north of the District property. It is our understanding that at least part of these lands belong to the East Bay Regional Park District. To accomplish these objectives, we have divided the generalized scope of work into three categories--local, regional, and reporting.

Local Studies (Walnut Creek Water Treatment Plant Site)

1. Assess the location, activity, and geometry of possible fault traces mapped across the Walnut Creek Water Treatment Plant by stratigraphic and paleontologic studies, subsurface exploration, and soil dating techniques.

2. Assess the extent and age of the geomorphic surfaces previously identified at the Plant site by subsurface exploration and soil dating techniques.

3. Assess the potential for future fault displacement at the Plant site.

Regional Studies (Southhampton-Franklin fault)

1. Evaluate the activity of the Franklin and Southhampton faults by surface and subsurface exploration at specific sites along the faults.

2. Conduct seismological studies to identify and locate earthquake epicenters in the vicinity of the Southhampton-Franklin fault and assess focal mechanisms of earthquakes.

3. Consider the relationship of the Franklin-Southhampton fault traces to regional faults and folds and the potential for blind thrust faulting.

4. Confirm the likely location of the Southhampton-Franklin fault at or in proximity to the Walnut Creek Water Treatment Plant.

Reporting

Synthesize the results of the study into a report that assesses the potential for surface faulting on the Walnut Creek Water Treatment Plant site, the activity of any fault traces mapped on the site, and the activity of the Southhampton-Franklin fault.

B-2. POSSIBLE SPECIFIC WORK ITEMS

Work items required to accomplish the above scope may include the following;

- Interpretation of aerial photographs
- Ground and aerial reconnaissance
- On-site geologic mapping
- Fossil collection and identification and stratigraphic analysis
- Locate, excavate, and log on-site trenches
- Assess age of soils/units exposed in trenches
- Select off-site locations for reconnaissance mapping and exploration and conduct these investigations
- Borings to assess downdip geometry of faults
- Prepare detailed site geologic map based on exploration
- Prepare geologic cross sections of site and construct balanced cross sections
- Estimate slip rate (strike-slip and thrust) and level of activity
- Compare level of activity with Hayward and Calaveras faults

B-3. POSSIBLE SITES FOR EXPLORATION

1. Walnut Creek Quadrangle - Walnut Creek Water Treatment Plant and vicinity; two geomorphic surfaces identified extending across the mapped fault traces.

2. Benicia Quadrangle - Previous trench site of ESA along the Franklin fault; topographic swale south of Highway 4 and south of large debris landslide.

3. Benicia Quadrangle - North of ESA trench site along the Franklin fault and south of Highway 4; alluvial/colluvial-filled valley that extends across mapped fault traces.

4. Benicia Quadrangle - Previous trench site of ESA along the Southhampton fault; alluvial/colluvial-filled valley north of Highway 4.

5. Benicia Quadrangle - Adjacent to dirt road north of previous ESA trench site along the Southhampton fault; located in well-expressed swale.

6. Benicia Quadrangle - Located in northeast-southwest-trending valley south of fuel depot; alluvial-filled valley occurs across or adjacent to mapped fault trace.

7. Briones Valley Quadrangle - Located adjacent to Rodeo Creek south of west portal of railroad tunnel near Christie; alluvial-filled valley crosses two traces of the Franklin fault.

8. Briones Valley Quadrangle - Located between Franklin Canyon Road and Highway 4 and very near the north edge of the map sheet; a broad alluvial filled valley across a trace of the Southhampton fault.