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Mr. Robi Arulanantham
Alameda County Department of Environmental Health
Hazardous Materials Division
80 Swan Way, Room 200
Oakland, California 94621

SUBJECT: **Feasibility Study Report, Industrial Asphalt Site, 52 El Charro Road, Pleasanton, California**

Dear Mr. Arulanantham:

Please find enclosed the following pages which should replace pages in the report postmarked to you August 14, 1991: pp. 1-2, 5-6, 15-16, 19-20, 21-22, 27-28, 35-42.

We regret any inconvenience.

Sincerely,

KLEINFELDER, INC.

Robert A Lindfors

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Project Engineer

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FEASIBILITY STUDY
FOR SOIL AND
GROUND WATER REMEDIATION
INDUSTRIAL ASPHALT, INC.
52 EL CHARRO ROAD
PLEASANTON, CALIFORNIA

19, 1997

August 14, 1991

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A Report Prepared for:

Industrial Asphalt, Incorporated
52 El Charro Road
Pleasanton, California

FEASIBILITY STUDY FOR SOIL AND GROUND WATER REMEDIATION

Kleinfelder Job No. 10-1682-07

by

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August 14, 1991

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1 EXECUTIVE SUMMARY

On behalf of Industrial Asphalt, Kleinfelder has performed a feasibility study (FS) to recommend remedial actions for soil and ground water affected by petroleum hydrocarbons and PCBs at the facility at 52 El Charro Road, Pleasanton, Alameda County, California.

The FS was a decision-making process involving the following steps:

- The conceptual model of subsurface chemical fate and transport developed during the recent remedial investigation (RI) was reexamined in order to assess the likely environmental fate and migration of petroleum hydrocarbons and PCBs found in the subsurface at the Industrial Asphalt site.
- Objectives of the remedial actions were arrived at by examining site characteristics, conceptual subsurface model, exposure pathways, land use, and actual and anticipated regulatory actions.
- General response actions for attaining remedial objectives were listed and evaluated.
- For the selected general response action, technology alternatives for remedial measures were developed and assessed for applicability to the Industrial Asphalt site.
- Technology alternatives which passed this initial assessment were subsequently evaluated against specific screening criteria.
- The recommended remedy which passed the screening evaluation was described.

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Kleinfelder has made the following findings:

- The objectives of remedial actions are: (1) to reduce the mobility of petroleum hydrocarbons and PCBs present in the subsurface; and (2) to reduce the amount of these chemicals in the subsurface.

- For soil, a no-action approach is the recommended general response action. There is an insignificant threat of exposure to human or ecological receptors to chemicals in the soil matrix at the Industrial Asphalt facility. The no-action alternative for soil would likely require a permit for Waste Discharge Requirements (WDR) from the State of California Regional Water Quality Control Board (RWQCB).

- For ground water, hydrodynamic control and treatment and disposal are the general response actions recommended for attaining remedial objectives.

- Extraction of ground water through a line of extraction wells is the recommended technology alternative for hydrodynamic control.

- Treatment of extracted ground water by granular activated carbon (GAC) and discharge of treated water to the surface water body adjacent to the Industrial Asphalt facility are the recommended technology alternatives for treatment and disposal. This disposal option would likely require a National Pollutant Discharge Elimination System (NPDES) permit from RWQCB.

- Recycling GAC in the onsite asphalt manufacturing process is the recommended method for disposing spent GAC.

The following issues and data needs should be addressed before the selected remedy can be implemented:

- Computer modeling of hydrogeologic conditions should be done to evaluate: (1) flowrates of extracted ground water; (2) capture zones of ground water extraction wells; and (3) sizing of ground water treatment system equipment.

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- Additional ground water chemistry data is needed to evaluate the necessity of pretreatment upstream of the GAC system (e.g., softening to prevent formation of scale).

- A study of leachability of chemicals from soil should be completed in order to demonstrate that the no-action alternative for the soil operable unit is acceptable, and to assess the timetable for final cleanup of the ground water operable unit.

- Options for disposal of treated ground water will require further discussions with the property owner and relevant regulatory agencies.

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2 BACKGROUND

2.1 SITE LOCATION AND DESCRIPTION

The Industrial Asphalt facility is located at 52 El Charro Road, Pleasanton, Alameda County, California, near the northwest corner of the intersection of East Stanley Boulevard and El Charro Road. The facility is situated in the Livermore Valley, approximately two miles south of Interstate 580 and 1.5 miles west of the Livermore Airport. Plate 1 is a site location map.

Industrial Asphalt runs its operations on part of a 177 acre parcel leased from the Jamieson Company, 501 El Charro Road, Pleasanton. The parcel is identified by the Alameda County Planning Department as Map Book #946, Block #1350, Parcel #5. The facility property and the surrounding area are zoned A (agricultural), though gravel quarrying is the predominant land use. The A zoning designation specifies a maximum population density of one residence per 100 acres. The nearest urban residential areas to the Industrial Asphalt facility are located approximately one mile west in the City of Pleasanton.

Plate 2 shows land uses adopted by the Alameda County Planning Department for the area near the Industrial Asphalt facility (Alameda County, 1987). Land use for the Industrial Asphalt facility and vicinity is for gravel and sand quarries. The area has been designated a significant regional mineral resource area under the California Surface Mining and Reclamation Act. Quarry operators in the area are granted long-term operating permits by the Alameda County Planning Department and must submit reclamation plans for long-term restoration. The Industrial Asphalt facility is located on a parcel of land which is permitted by Alameda County for gravel quarry operations; Jamieson Company holds the permit which runs through December 31, 2030 (Alameda County, 1987).

The Livermore Valley is generally surrounded by hilly to mountainous terrain. Topography of the Industrial Asphalt facility is nearly level, with a slight downward slope from the southwest corner to the northeast corner of the site. The approximate elevations range from 380 feet above mean sea level in the southwest corner to 376 feet above mean sea level in the northeast corner. There is no surface drainage system at the Industrial Asphalt facility.

Ground water at the Industrial Asphalt facility is located in the Livermore Valley Basin, as defined by the California Regional Water Quality Control Board, San Francisco Bay Region (RWQCB). The Livermore Valley Basin has been subdivided by the California Department of Water Resources based on fault traces and hydrologic discontinuities, so that the Industrial Asphalt facility is located in the Amador Subbasin (USGS, 1985). RWQCB has assigned the following beneficial uses of ground water for the Livermore Valley Basin: municipal supply, industrial process supply, industrial service supply, and agricultural supply (RWQCB, 1986).

The major surface water stream in the vicinity is Arroyo Mocho, located approximately 1500 feet east of the Industrial Asphalt facility. Arroyo Valle is located approximately 0.5 miles south-southeast of the facility. Streamflows in Arroyo Mocho and Arroyo Valle vary due to climatic (seasonal) effects. Also, reaches of both streams in the vicinity of the Industrial Asphalt facility are used for ground water recharge by the Alameda County Flood Control and Water Conservation District, Zone 7 (ACFCWCD). Sources of water used in these recharge operations include the South Bay aqueduct of the California State Water Project and dewatering operations at various local gravel pits. A surface water impoundment (estimated capacity = 200 million gallons), used by Jamieson for storage of process water for gravel washing operations, is located immediately north of the Industrial Asphalt facility.

Climate of the area is semi-arid. Summers are relatively hot and dry and winters are cool and moist; the region has received below-average rainfall for the past four winters. Temperature inversions are common during the summer due to presence of high pressure systems west of the Pacific Coast. The bowl-shaped topography of the Livermore Valley tends to restrict mixing and horizontal movement of air (Alameda County, 1987).

2.2 HISTORY OF SITE ACTIVITIES

Industrial Asphalt currently operates an asphalt manufacturing plant at the facility. The company started its operations at the site in 1963. The site was previously undeveloped land. Plate 3 is a site plan showing current facility features, including above ground tanks for asphalt storage, truck scales, aggregate storage facilities, mixing areas, and office buildings. The site is heavily impacted by truck traffic.

From 1963 to 1986, Industrial operated eight underground storage tanks (USTs) for storage of asphalt and diesel fuel (used as burner fuel in the asphalt batch plant). Plate 3 shows the location of the former UST area. The dimensions of the UST cavity were approximately 80 ft (east-west) by 60 ft (north-south) by 15 ft below grade. The cavity space around the tanks contained 1/4 to 1/2 inch pea gravel. Six tanks were used for asphalt storage (capacities: 6,400 gal, 14,120 gal, 6,870 gal, 12,430 gal, 2 X 5,634 gal). Two of these were excavated in February 1987, and the other four were excavated in September 1987 (Kleinfelder 1988a). Two tanks used for diesel fuel storage (capacities: 4,920 gal, 6,700 gal) were excavated in February 1987.

A leaking fill pipe to the diesel tanks was discovered and repaired in 1985 (Kleinfelder 1987a). No leaks or spills of asphalt have been reported.

There are currently no underground tanks at the Industrial Asphalt facility. After 1984, natural gas replaced diesel fuel to feed burners. Asphalt is trucked to the site. There are no reported underground pipelines or other potential subsurface sources of petrochemicals or PCBs onsite. A small concrete pad is used for machinery maintenance, including changing motor oil. Waste oil is drummed and shipped for disposal offsite. There is no reported use of chlorinated solvents.

2.3 HISTORY OF SITE INVESTIGATIONS AND REMOVAL ACTIONS

Diesel fuel was reportedly observed in the bottom of the UST cavity during removal of diesel fuel storage tanks in February 1987. Free product was recovered from the bottom of the UST cavity and disposed of at a Class I landfill facility. Analysis of a sample of free product indicated the presence of polychlorinated biphenyls (PCBs) at 12 parts per million (ppm).

In March 1987, Kleinfelder initiated environmental investigations of the subsurface on behalf of Industrial Asphalt. Six soil borings were completed in and around the UST cavity. Analyses of soil samples collected from borings installed at the north edge of the cavity indicated diesel fuel and PCBs (respective maximum concentrations = 4,600 ppm, 0.073 ppm) down to 45 feet below grade (Kleinfelder, 1987a).

4600ppm at 40-45'

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In the summer of 1987, Kleinfelder installed and sampled three wells (MW-1, MW-2, MW-3) to monitor ground water quality near the UST cavity. Water was encountered at approximately 75 feet below ground surface; wells were screened from approximately 60 to 90 feet below grade. Floating product was encountered in MW-2, north of the tank cavity, and diesel fuel and PCBs were detected in water samples collected from wells east and west of the UST cavity. Monthly sampling of the wells was initiated (Kleinfelder, 1987b).

MW-2 product

In September 1987, the four remaining underground tanks were removed. Analyses of soil samples collected from the excavation sidewalls and bottom indicated that clean soil was reached at the northern edge of the excavation at 15 feet below grade. Approximately 700 yards of affected soil were excavated, stockpiled, and subsequently recycled through the Industrial Asphalt process. The excavation was backfilled with clean fill and finished with asphalt concrete (Kleinfelder, 1988a).

In the spring of 1988, five additional monitoring wells (MW-4 through MW-8) were installed. Depth to water was approximately 80 feet below grade; screened intervals generally ranged from 70 to 110 feet below grade. Analyses of ground water samples indicated that diesel fuel chemicals had spread approximately 350 feet both east (MW-7) and west (MW-8), and 100 feet south (MW-6) from the former UST cavity. PCBs had spread approximately 20 feet south (MW-3) of the UST cavity. Monthly sampling of all wells was performed during summer 1988 (Kleinfelder, 1988b).

From August 1988 to March 1989, monitoring wells MW-1 through MW-3 were sampled roughly bimonthly and MW-4 through MW-7 monthly. Free product was encountered intermittently in wells MW-1, MW-2, MW-3, MW-4 and MW-8. Two gallons of product were skimmed from MW-2 and MW-8 in August 1988. Analyses of ground water samples indicated that PCBs had migrated approximately 350 feet west of the UST cavity (MW-8) (Kleinfelder, 1989a).

In May, 1989, the Alameda County Department of Environmental Health (ACDEH) requested that Industrial Asphalt define the extent of contamination and submit a plan for remediation. ACDEH also requested that onsite wells be analyzed for benzene, ethylbenzene, toluene, and xylenes (BETX).

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In July, 1989, monitoring wells MW-9, MW-10, and MW-11 were installed. Screened intervals for MW-9 and MW-10 were approximately 80-110 feet below grade; water was encountered at approximately 80 feet below grade. The screened interval for MW-11 was 55-75 feet below grade; MW-11 was designed specifically to monitor free product. Analyses of soil samples collected during well installation indicated that deep (75 feet below grade) soil zones had been impacted with petroleum hydrocarbons as far as 240 feet east (MW-9) and 160 feet west (MW-10) of the former UST cavity. BETX analyses of ground water samples collected from MW-4, MW-5, MW-6, MW-7, and MW-8 indicated no detectable concentrations, though petroleum hydrocarbons were detected in MW-7 and MW-8.

In August, 1989, onsite wells were sampled except for MW-1, MW-2, MW-3, and MW-11, which were dry. The ground water sampling round indicated that: (1) no detectable spreading of diesel fuel or PCBs had occurred since spring 1988; (2) petroleum hydrocarbons were not detected in samples from MW-6 and MW-7, where previous sampling rounds had indicated that water in these areas had been affected; (3) petroleum hydrocarbons were not detected in samples from MW-9 or MW-10, though soil samples collected during well installation at 75 feet below grade did contain petroleum hydrocarbons; and (4) no free product was encountered in any well. These phenomena may be attributed to the fact that the approximate level of ground water had decreased from 82 feet below grade in spring 1988 to 93 feet below grade in summer 1989 (Kleinfelder, 1989b). Monthly sampling rounds of all onsite wells were initiated in August, 1989.

In November, 1989, ACDEH requested that Industrial Asphalt perform site characterization and remedial action. ACDEH also stipulated that "hydrocarbon and PCB levels in soils must be reduced to a point that they will not further degrade groundwater quality in any way", and also, "hydrocarbon and PCB levels in groundwater must be reduced to non-detect."

In January 1990, Kleinfelder, on behalf of Industrial Asphalt, prepared a Remedial Investigation/Remedial Action Plan. The plan was subsequently submitted to ACDEH (Kleinfelder, 1990a).

In February 1990, Kleinfelder commenced field activities related to the Remedial Investigation (RI). Fourteen soil borings were drilled and sampled. Water was encountered at depths generally greater than 90 feet below grade. Three borings were completed as monitoring wells

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MW-14 through MW-16 with screened intervals lower than 90 feet below grade. MW-13 was completed as an extraction well with a screened interval from 76 to 116 feet below grade. MW-11 was abandoned. Approximately 300 cy of affected soil and 700 cy of unaffected overburden were removed from an area bordering the former UST cavity on the north; the affected soil was recycled through the asphalt process.

During the RI, a soil sample collected from boring SB-4 at 61 feet below grade, which contained diesel petroleum hydrocarbons at 370 ppm and PCBs at 0.11 ppm, was analyzed using EPA Method 8270 to detect polyaromatic hydrocarbons typically associated with diesel fuel (see Section 4.1.1). However, no analytes were detected.

Sections 3.3 and 3.4 of the RI summarize findings concerning extent of affected soil and ground water; the RI report should also be referenced for detailed descriptions of regional and site conditions, hydrogeological features, well construction logs, analytical laboratory reports, etc. (Kleinfelder, 1990c).

Monthly sampling of monitoring wells continued through June 1990. Bimonthly sampling then continued through December 1990.

In January 1991, approximately 1000 cy of affected soil were excavated from an area west of the RI excavation. The soil was recycled in the asphalt batch process onsite. The excavation was backfilled with clean fill and finished at the surface with asphalt concrete.

In February 1991, ACDEH stipulated that ground water cleanup should achieve "MCLs and below levels that could result in a one-in-a-million cancer risk." At a May 15, 1991 meeting between ACEDEH, RWQCB, Industrial Asphalt, and Kleinfelder, it was agreed that the feasibility of remediating the site would be fully assessed.

Quarterly sampling of all ground water monitoring wells onsite is ongoing. The sampling round conducted in April 1991, indicated the following chemicals were present in ground water samples collected from the noted wells: benzene in MW-2 (0.0007 ppm) and MW-3 (0.0009 ppm), ethylbenzene in MW-3 (0.006 ppm), toluene in MW-14 (0.0007 ppm), and xylenes in MW-3 (0.003 ppm). This was the first time BETX had been detected during sampling rounds at the site.

Plate 4 shows a site plan with locations of soil borings installed during the RI, all onsite monitoring wells, and limits of excavated soil. Table 1 shows construction details for the monitoring wells. Table 2 shows results of the April 1991 ground water sampling round.

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3 SITE CHARACTERISTICS

This chapter summarizes data gathered during previous subsurface environmental investigations, including the RI recently completed by Kleinfelder.

3.1 REGIONAL HYDROGEOLOGY OF THE LIVERMORE VALLEY

The ground water basin in the Livermore Valley is composed of alluvial deposits with varying depths; the depths range from less than 100 feet in the eastern part of the Valley to approximately 400 feet in areas east of Pleasanton. Water-bearing zones in the alluvium are composed of gravel, sand, and clay, and are moderately permeable. There are confining beds of silty clays at varying depths throughout the valley. These beds are extensive enough in certain areas to allow identification of totally separate aquifers. The direction of ground water flow in the Livermore Valley ground water basin is generally northwest.

The Livermore Valley alluvial deposits are underlain and are bordered on the south by the Livermore formation of Pliocene and Pleistocene age, composed of moderately permeable deposits of sand, gravel, and clay. The Valley alluvial deposits are bordered on the north by the Tassajara formation of Pliocene age, composed primarily of sandstone and claystone with low permeability. Both the Livermore and Tassajara formations are approximately 4,000 to 5,000 feet thick. Wells completed in these formations are generally of low yield and produce moderately poor quality sodium bicarbonate water (USGS, 1985).

There are several production wells within a one-mile radius of the Industrial Asphalt facility, generally used for water supply for gravel pit operations. The screened intervals of these supply wells are at varying depths, most between 100 and 350 feet below ground surface. The nearest municipal supply wells are located approximately two miles to the east of the site within the city limits of the City of Livermore (Kleinfelder, 1989b). Table 3 shows details of supply wells within a one-mile radius of the Industrial Asphalt facility. Plate 5 shows locations of supply wells.

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3.2 SITE-SPECIFIC HYDROGEOLOGY

Stratigraphy generally resembles an alluvial fan deposit, with interfingered beds containing varying amounts of clay, silt, sand, and gravel. Fine-grained material (silty clay and silt), identified as fill, is found to varying depths (60 feet maximum) below ground surface. Unconsolidated silty-clayey gravel deposits are found below the fill material to depths of 130 feet below ground surface.

Interfingered with the silty-clayey gravel deposits are discontinuous water-bearing zones of silty-sandy gravel, typically found at 90 to 110 feet below ground surface. At some locations (SB-5), the gravel becomes increasingly clayey with depth; this clayey gravel has been identified as having aquitard properties. At other locations (near soil borings SB-1, SB-9, and MW-14) a four foot thick layer of silt is found at 110 feet below ground surface. This deposit has also been classified as having aquitard properties. At 120 feet below ground surface, a deeper water-bearing zone is found; the water-bearing deposits contain amounts of sand and gravel that increase with depth. Onsite borings have not advanced deeper than 130 ft below grade.

The horizontal direction of ground water flow is generally to the northeast, though flow towards the north has been observed. The level of ground water was approximately 75 feet below grade in September 1987; the most recent ground water survey indicates that the level is approximately 90 feet below grade (Kleinfelder 1991b). Both the horizontal flow direction and level of ground water appear to be affected by seasonal variations, operations at nearby water supply wells, and recharge operations at Arroyo Mocho.

MW-13 was designed as an extraction well with a screened interval from 76 to 116 feet below ground surface. Data collected from a pumping test of this well conducted during the RI were analyzed; average transmissivity and storativity values were calculated to be 2,500 gpd/ft (330 ft^2/day) and 0.0017, respectively. During the test, a sustained yield of 2.5 gpm was maintained with 15 feet of drawdown. Estimates of capture zone dimensions for this pumping rate are 23 ft in the downgradient direction with a width of 145 ft (Kleinfelder, 1990c).

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Using the calculated transmissivity value and assuming the upper water-bearing zone is 20 ft thick, the hydraulic conductivity is 1.2 x 10^{-2} ft/min (5.8 x 10^{-3} cm/sec); with an observed gradient of 0.035 and an assumed effective porosity of 0.3, the estimated ground water flow rate in the upper water-bearing zone is approximately 2 ft/day.

3.3 EXTENT AND AMOUNT OF AFFECTED SOIL

Petroleum hydrocarbons and PCBs were detected during RI soil sampling activities (maximum concentration TPH (diesel) = 490 ppm at SB-1, 30 ft below grade, maximum concentration PCBs = 120 ppb at SB-3, 45 ft below grade). Plate 6 shows the areal extent of soil affected with hydrocarbons with depth-weighted average concentrations at each borehole. Plate 7 shows the areal extent of soil affected with PCBs. Plate 8 shows scaled vertical cross-sections which intersect the former UST cavity, illustrating subsurface conditions and the vertical variations of deposits of hydrocarbons. Plate 9 shows the identical cross-sections to illustrate PCBs in the soil matrix. As shown, zones of affected soil are typically encountered from 50 to 85 feet below ground surface.

Estimates of amounts of petroleum hydrocarbons and PCBs in soil as presented in the RI have been refined to take into account vertical variations.

- For an approximate area of soil affected with petroleum hydrocarbons of 115,000 ft^2 and a zone of affected soil 20 ft thick, the total affected volume is 85,000 cy (127,500 tons). Assuming an average concentration of petroleum hydrocarbons at 40 mg/kg (ppm), the approximate amount of petroleum hydrocarbons in soil is 10,000 lbs.

- For an approximate area of soil affected with PCBs of 5,600 ft^2 and a zone of affected soil 10 ft thick, the total affected volume is 950 cy (1,400 tons). Assuming an average concentration of PCBs at 0.020 mg/kg (ppm), the approximate amount of PCBs in soil is 0.06 lbs.

3.4 EXTENT OF AFFECTED GROUND WATER

Plate 10 shows the areal extent of petroleum hydrocarbons in ground water, based on the sampling round conducted in April 1991. The average concentration of petroleum

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hydrocarbons in ground water was estimated in the RI to be approximately 40 mg/l (ppm). Plate 11 shows the areal extent of PCBs in ground water, based on the sampling round conducted in April 1991. The average concentration of PCBs in ground water was estimated in the RI to be 0.02 mg/l (ppm) (Kleinfelder, 1990c).

It should be noted that concentrations of both petroleum hydrocarbons and PCBs detected in samples collected from wells differ significantly depending on screened interval depth. Table 4 shows results of the two most recent sampling rounds for four sets of paired wells, along with the screened intervals for each well. Paired wells are located approximately 15 feet from each other, and differ by their screened interval depths. The wells with screened intervals at 60-80 ft below grade have concentrations of hydrocarbons and PCBs orders of magnitude higher than wells with screened intervals at lower depths (80-110 ft below grade). This phenomenon may indicate that petroleum hydrocarbons and PCBs migrate in a relatively thin zone near the ground water surface.

The total amount of petroleum hydrocarbons in ground water is estimated at 0.5 kilograms, assuming an average concentration of 40 mg/l, an affected area of 84,000 ft^2, a water-bearing zone thickness of 20 feet, and a total porosity of 0.35. The estimated volume of affected ground water is 4.5 million gallons.

The Industrial Asphalt site has been classified as having two distinct water-bearing zones. "First water" has been encountered during the most recent drilling operations at approximately 85 feet below grade. At some areas of the site, a clayey gravel layer has been encountered at approximately 110 feet below ground surface; at other areas, a silt layer has been encountered at this approximate depth. As noted earlier, these deposits are apparent aquitards and serve as confining layers to lower water-bearing zone(s); the apparent aquitards are present at approximately 120 feet below ground surface.

There are no wells currently monitoring water-bearing zone(s) beneath the noted aquitard. However, extensive sampling of the subsurface indicates that soil found at depths greater than 90 feet has generally not been affected by either petroleum hydrocarbons or PCBs. Some monitoring wells have yielded water samples containing no detectable hydrocarbons, though soil samples collected during installation of the wells indicated affected soil zones above the ground water. Also, water samples collected from paired monitoring wells with different screened intervals indicate that the zone of affected ground water is relatively thin.

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4 SUMMARY OF CONCEPTUAL MODEL AND SITE RISKS

4.1 CONCEPTUAL MODEL OF SUBSURFACE FATE AND TRANSPORT

This section readdresses the conceptual model of environmental fate and transport (migration) of chemicals in the subsurface at the Industrial Asphalt facility originally presented in the RI report (Kleinfelder, 1990c, Chapter 10).

4.1.1 Chemicals of Concern

Diesel fuel was reportedly released into the subsurface at Industrial Asphalt during normal operation of a UST farm. There have been no reported releases of asphalt. Petroleum hydrocarbons detected in laboratory analyses of soil and ground water collected at the site have been identified as diesel fuel, oil and grease. Trained personnel at state-certified environmental laboratories have stated that the analyses reporting oil and grease could actually be reporting diesel fuel compounds, as there are typical overlaps in the detection chromatographs of these analyses. PCBs have also been detected in samples of soil, ground water, and free product collected at the Industrial Asphalt facility.

Diesel fuel is a mixture of more than 200 hydrocarbons generally consisting of molecules with eight to fourteen carbon atoms. Diesel fuel is a brown, slightly viscous fluid; it is considerably less volatile than gasoline, four to five times more viscous than gasoline, and slightly lighter than water. PCBs, or polychlorobiphenyls, are a group of chlorinated organic compounds. PCBs are generally highly viscous, non-volatile liquids at ambient temperatures. Water solubilities of PCBs decrease with increasing chlorination, and have been reported to range from 0.04 to 0.2 ppm. PCBs are heavier than water and are generally regarded as immobile and persistent in the subsurface.

Table 5 shows a typical composition of hydrocarbon classifications in diesel fuel. Table 6 shows selected constituents of diesel fuel and No. 2 fuel oil (which is similar to diesel), and their concentration ranges. Also shown are chemical and physical properties (e.g., Henry's constants, molecular weights, water solubilities, organic carbon and octanol/water partitioning coefficients, and volatilities) for these chemicals and for PCBs. These properties affect environmental fate and transport of these substances and selection of appropriate treatment technologies.

4.1.2 Fate and Transport of Chemicals of Concern

During the release of diesel fuel into the subsurface at the Industrial Asphalt facility, diesel chemicals may have existed as four states or phases in the soil and ground water environment, namely, vapor phase, non-aqueous phase liquid (NAPL), dissolved phase, and adsorbed phase. The portion of diesel chemicals currently existing in the vapor phase is likely to be negligible due to the facts that: (1) fresh diesel has not been released to the subsurface since 1985; (2) volatile chemicals make up only a small fraction of typical diesel; and (3) volatile chemicals are likely to have evaporated and dispersed during the time period subsequent to the release. For current conditions at the Industrial Asphalt facility, it is likely that diesel chemicals exist in the remaining three phases.

Diesel chemicals have specific gravities less than water; diesel fuel will tend to float on the surface of the first water encountered in the soil column. Water-soluble petroleum hydrocarbons will dissolve into ground water. Sampling rounds of soil and ground water at the Industrial Asphalt facility indicate that a plume of ground water affected with petroleum hydrocarbons has developed in the saturated zone, generally along the direction(s) of ground water flow, and that transfer of water-soluble diesel chemicals into ground water has likely occurred in a relatively thin zone near the surface of ground water. Operations at nearby supply wells and recharge facilities significantly impact the subsurface hydraulics, including potentiometric gradient, direction of ground water flow, and level of ground water.

Sampling rounds also indicate that PCBs, generally regarded as immobile, are present in ground water as far as 300 feet from the former UST cavity (MW-8). It is likely that PCBs have been transported through the subsurface environment with dissolved diesel chemicals due to cosolvent effects (EPA, 1989).

Dissolved petroleum hydrocarbons and PCBs adsorb to soil particles when they come in contact with organic matter or clay particles in the soil matrix. Adsorbed chemicals are redissolved when ground water comes into contact with the affected soil; i.e., the soil acts as a "secondary source".

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Scientific literature describes biotransformation of petroleum hydrocarbons by microorganisms attached to soil surfaces, though chlorinated organics seem less prone to biotransformation. Biotransformation will reduce amounts of chemicals in the subsurface over time.

4.2 EXPOSURE PATHWAYS AT THE INDUSTRIAL ASPHALT SITE

Potential exposure pathways of human and environmental receptors to chemicals that have been characterized in the subsurface at the Industrial Asphalt facility were evaluated in the RI. The pathways are reevaluated in the following sections.

4.2.1 Exposure Pathway by Soil

A potential exposure pathway exists when receptors come into contact with or ingest affected soil. At the Industrial Asphalt facility, there is no significant exposure pathway by direct contact with or ingestion of affected soil under normal facility operations due to the following: (1) shallow soil affected with diesel fuel and PCBs has been removed during excavation activities; (2) there are extensive paved areas at the site; and (3) access to the site is limited.

4.2.2 Exposure Pathway by Ground Water

A potential exposure pathway exists when receptors come into contact with or ingest affected water. Though sampling rounds indicate that diesel fuel chemicals and PCBs at the Industrial Asphalt site have migrated through ground water, there is little likelihood of short-term exposure to human or environmental receptors due to the following: (1) hydrogeology indicates that the surface water impoundment north of the facility is a recharging source for ground water; and (2) analyses of water samples collected from the supply well at the Jamieson site, located approximately 1000 feet from the former UST cavity at the Industrial Asphalt facility, indicated that no diesel fuel chemicals have impacted water quality. The baseline risk assessment conducted in the RI indicated that chemicals typically associated with diesel fuel (i.e., benzene and naphthalene) could potentially reach the Jamieson well over the long term; ground water is a potentially significant exposure pathway (Kleinfelder, 1990c). Plate 12 shows a conceptual model for this exposure pathway.

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4.2.3 Exposure to Vapors

A potential exposure pathway exists when receptors inhale chemical vapors. For reasons explained in Section 4.1.2, vapor phase chemicals are unlikely to be present in the subsurface at the Industrial Asphalt facility. At the Industrial Asphalt site, exposure to vapor phase chemicals is not considered significant due to the following: (1) there is extensive paving at the facility; (2) dispersive effects of vapor migration through a soil matrix; and (3) access to the site is limited.

4.3 SUMMARY OF IMPACTS TO HUMAN HEALTH AND THE ENVIRONMENT

Table 7 shows health-based criteria established for the chemicals typically found in diesel fuel and for PCBs. The criteria are explained in Section 6.4. It should be noted that none of the listed chemicals have been detected in samples of soil or ground water at concentrations exceeding the health-based criteria.

The baseline risk assessment presented in the RI report indicated that chemicals typically found in diesel fuel could potentially reach the supply well (Well 14A2, Table 3) at the Jamieson facility east of the Industrial Asphalt site, but that insignificant impacts to human health or the environment would exist (Kleinfelder, 1990c).

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5 INTRODUCTION TO THE FEASIBILITY STUDY

The purpose of the feasibility study (FS) is to arrive at the most appropriate method(s) for remedial actions for soil and ground water cleanup at the Industrial Asphalt site; the FS also provides a basis for setting final cleanup goals. The FS was developed in accordance with guidance documents issued by the State of California Department of Health Services (DHS) and the United States Environmental Protection Agency (EPA), and is consistent with the Remedial Investigation/Remedial Action Plan, submitted to Industrial Asphalt on January 15, 1990 (Kleinfelder, 1990a).

Plates 13 and 14 illustrate the overall decision-making processes and the methods of selecting technologies that meet remedial objectives for soil and ground water, respectively. General response actions were listed and evaluated against site-specific features of the Industrial Asphalt facility and anticipated regulatory actions. For each viable general response action, alternative technologies for remedial actions were developed and assessed for applicability to the Industrial Asphalt site. Technology alternatives which passed this assessment were subsequently evaluated against specific screening criteria, and final selections for recommended remedial actions were made.

Chapter 6 describes potential "applicable or relevant and appropriate requirements" (ARARs) which may influence regulatory actions, and includes a historical review of decisions concerning cleanup at similarly affected sites. Chapter 7 describes the objectives of remedial actions for the Industrial Asphalt facility, based on regulatory concerns, land use, environmental fate and transport, and exposure pathways; general response actions that are appropriate for meeting the objectives are also presented.

Screening criteria to evaluate alternatives are presented in Chapter 8. In Chapter 9, technology alternatives are screened against selected criteria to arrive at the most feasible technologies. Chapter 10 describes the recommended technologies. Chapter 11 lists current data requirements that will need to be addressed before recommended remedial technologies can be implemented.

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6 IDENTIFICATION OF POTENTIAL ARARS

ARARs are "applicable or relevant and appropriate requirements" which may influence the selection of remedial measures and the development of final cleanup goals. This section describes potential ARARs for the Industrial Asphalt site, based on anticipated regulatory actions.

6.1 IDENTIFICATION OF HAZARDOUS MATERIALS

6.1.1 TTLCs and STLCs

Title 22 of the California Code of Regulations (CCR) includes lists of TTLCs (Total Threshold Limit Concentrations) and STLCs (Soluble Threshold Limit Concentrations) established by the State of California Department of Health Services (DHS) for classification of hazardous materials. Any solid material that contains concentrations of a chemical exceeding the TTLC is automatically classified as a hazardous material by DHS. STLCs are related to the Waste Extraction Test (WET), also described in Title 22. If the WET produces an extract that contains concentrations of a chemical exceeding the STLC, the source material (i.e., solid material) is automatically classified as a hazardous material by DHS. Hazardous materials are subject to DHS requirements for handling, treatment and disposal.

Of the chemicals found in the subsurface at the Industrial Asphalt site, PCBs have a listed TTLC of 50 mg/kg (ppm) and a listed STLC of 5 mg/l (ppm). Soil and ground water sampling rounds conducted at the Industrial Asphalt site have not detected PCB concentrations in these ranges.

6.1.2 TCLP Program

Part 261 of 40 CFR (Code of Federal Regulations) describes the TCLP (Toxicity Characteristic and Leachate Procedure) program established by EPA to identify hazardous materials. Materials classified as hazardous by EPA are subject to regulations under Subtitle C of the Resource Conservation and Recovery Act (RCRA).

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The TCLP is a laboratory procedure specified by EPA and is an attempt to model worst case leachate conditions in a subsurface environment. If a material (e.g., soil) undergoes the TCLP procedure and concentrations in the extract exceed those listed in Part 261, the material is classified as hazardous.

Of the chemicals found in the subsurface at the Industrial Asphalt site, only benzene has a listed TCLP criteria of 0.5 mg/l. Soil at the Industrial Asphalt site would not qualify as hazardous based on the TCLP criteria, if one assumes that benzene concentrations in ground water will not increase over time. This assumption may be reasonable for the Industrial Asphalt site in that no recent spills or leaks of chemicals have been reported, the USTs were abandoned in 1987, and benzene biodegrades in typical subsurface environments (EPA, 1988).

6.2 CLEANUP GOALS FOR SOIL

The South Bay Toxics Division of RWQCB, San Francisco Bay Region, typically sets a concentration of 1 ppm (mg/kg) for volatile organic chemicals and 10 ppm for base-neutral organic chemicals as cleanup goals at sites where little is known about chemical behavior in the soil. (The majority of diesel fuel chemicals qualify as base-neutral organics.) These concentrations empirically represent no impacts to water quality (RWQCB, 1988).

As an alternative to these specific concentrations, RWQCB recommends using site specific data concerning leachability and attenuation (retardation) of chemicals in soil in order to assess future impacts to ground water and to establish site specific cleanup goals for soil. At the Industrial Asphalt facility, specific data could be obtained in order to calculate leachability and attenuation (retardation) of chemicals in the soil so that final cleanup goals may be set. See Section 11 - Data Requirements.

6.3 CLEANUP GOALS FOR GROUND WATER

6.3.1 San Francisco Bay Basin Plan

RWQCB adopted a Water Quality Control Plan (Basin Plan) for the San Francisco Bay Region

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on December 17, 1986. The plan identifies water quality objectives and beneficial uses of South San Francisco Bay and contiguous surface and ground water. RWQCB has identified the following beneficial uses for ground water underlying and adjacent to the Industrial Asphalt site:

- Municipal and Domestic Water Supply
- Agricultural Water Supply
- Industrial Service Water Supply
- Industrial Process Water Supply

The Basin Plan also states, "It shall be prohibited to discharge all conservative toxic and deleterious substances, above those levels which can be achieved by a program acceptable to the Board, to waters of the Basin."

The Basin Plan cites a Nondegradation Policy expressed in State Water Resources Control Board Resolution 68-16. The policy is quoted below:

"Whenever the existing quality of water is better than the quality established in policies as of the date on which such policies become effective, such existing high quality will be maintained until it has been demonstrated to the State that any change will be consistent with maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial use of such water, and will not result in water quality less than that prescribed in the policies."

RWQCB draws on the policies described above to make decisions regarding ground water cleanup activities and to establish ground water cleanup standards.

6.4 HEALTH-BASED CRITERIA

As previously mentioned, ACDEH has stipulated that ground water cleanup should achieve "MCLs and below levels that could result in a one-in-a-million cancer risk." MCLs and other health-based criteria are described in this section, including those criteria relating to cancer risks. Table 7 shows the limited available health-based creiteria established for diesel fuel chemicals and for PCBs.

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6.4.1 MCLs

EPA and DHS have established MCLs (Maximum Contaminant Levels) for certain chemicals and water quality parameters. The standards are enforceable by DHS on water suppliers. Primary MCLs are derived from health-based criteria and economic and technological factors related to the feasibility of attaining and detecting these concentrations in water supply systems. Secondary MCLs are not health-based criteria but are derived from human welfare considerations such as taste or odor.

EPA recommends that MCLs are generally not appropriate for ground water cleanup goals to sites where a supply well would never be placed and ground water would thus never be consumed (EPA, 1988c). MCLs are typically enforced by RWQCB as limitations on ground water treatment system discharges in NPDES and WDR permits.

NOT State Policy

6.4.2 Oral Slope Factor

EPA has established oral slope factors for selected chemicals. Oral slope factors relate to carcinogenic (cancer-causing) health effects, and are typically the result of applying a low-dose extrapolation procedure to results of laboratory animal experiments or human epidemiological studies. Oral slope factors are used in conjunction with risk assessments; the chronic (long-term) rate of chemical uptake experienced by a receptor and the oral slope factor for the chemical are used in the following equation to calculate cancer risk due to the chemical:

$$\text{Risk} = 1 - \exp(-\text{CDI} \times \text{SF})$$

$$\frac{mg}{kg + day} \times \frac{kg + day}{mg}$$

where:

Risk = a unitless probability of an individual developing cancer

exp = the exponential function

CDI = chronic daily chemical uptake averaged over 70 years in mg/kg-day

SF = slope factor in (mg/kg-day)-1

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6.4.3 Reference Dose

EPA has established reference doses (RfDs) for selected chemicals. RfDs relate to non-carcinogenic health impacts, and are established based on laboratory animal or human epidemiological studies. As with the other health-based criteria, RfDs are used in conjunction with risk assessments; when a receptor experiences a chemical uptake rate which exceeds the RfD, a negative health impact is likely.

6.4.4 AALs

DHS has established AALs (Applied Action Levels) for certain chemicals. AALs are health-based criteria and used in conjunction with the California Site Mitigation Decision Tree (DHS, 1986) to assess the potential of risks due to exposure to chemicals in the environment. AALs are specific for health affect (e.g., carcinogen, pulmonary toxin), media of exposure (e.g., air, water, soil), and receptor (e.g., human, fish).

It should be noted that the condition where a chemical concentration in a soil or ground water sample exceeds the specific AAL does not necessarily imply a negative health impact. Health impacts can only be quantified after the possible exposure to the chemical is quantified, as in a formal health risk assessment.

6.5 DISPOSAL OF TREATED WATER

RWQCB is mandated to prescribe requirements for any proposed discharge, whether the receiving waters are surface or subsurface waters. These requirements "must implement water quality control plans and must take into consideration the beneficial uses to be protected, the water quality objectives reasonably required for that purpose, other waste discharges, and the need to prevent nuisance".

Typically, RWQCB will require a Waste Discharge Requirements (WDR) permit for disposal into the subsurface, and an NPDES permit for disposal to a surface water or a storm sewer. If subsurface disposal includes injection wells, requirements as mandated by EPA Criteria and Standards for the Underground Injection Control Program, 40 CFR Parts 144, 145 and 146, will apply (see 7.7.3).

6.5.1 WDR Permit

The Porter-Cologne Water Quality Control Act of the State of California stipulates that Waste Discharge Requirements (WDR) be administered by RWQCB in order to "ensure reasonable protection of beneficial uses (of water) and the prevention of nuisance".

RWQCB also stipulates that when contaminated soil cannot be remediated, an application for a WDR permit may be required. Should the application be accepted and a permit issued, long-term ground water monitoring would be required.

6.5.2 NPDES Permit

The National Pollutant Discharge Elimination System (NPDES) permit program is part of the Federal Clean Water Act and is intended to reduce or eliminate point source pollution from industrial, municipal, commercial, and agricultural discharges. The program is now administered in California by RWQCB.

The Clean Water Act stipulates that the NPDES permit process be used as a mechanism for imposing on point source polluters uniform national effluent limitations and national performance standards which the EPA Office of Water and Waste Management is required to promulgate. In cases where effluent limitations or standard regulations have not been promulgated for a particular discharger, effluent limits will be set according to available and economically feasible abatement technology.

NPDES permits are issued on a-case-by-case basis only. The Clean Water Act stipulates that if established national effluent limits do not reduce pollutants enough to meet ambient water quality standards set by the State or EPA, the permit will impose more stringent effluent limitations as are necessary to meet water quality standards.

For the Industrial Asphalt site, an NPDES permit would be required for disposal of treated ground water to a surface water body, or to a storm sewer, which usually flows to a surface water body.

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6.5.3 EPA Underground Injection Control Program

If disposal wells are used for injecting treated ground water back into the subsurface, requirements from the Underground Injection Control Program will apply. A well is defined as "a bored, drilled or driven shaft, or a dug hole, whose depth is greater than the largest surface dimension". Ground water recharge wells qualify as Class V injection wells and would be subject to construction and permitting criteria described in 40 CFR Parts 144-146.

6.6 PCBs

PCBs are a special group of compounds and are specifically addressed in the California Code of Regulations (CCR), Title 22, Division 4, Chapter 30, and in the Federal Toxic Substances Control Act (TSCA), 40 CFR (Code of Federal Regulations), Part 761, Subparts C and D. A solid with less than 50 ppm PCB or liquid waste with less than 5 ppm PCB is classified as a nonhazardous material. Sampling rounds of soil and ground water at the Industrial Asphalt facility indicate that PCB concentrations are in nonhazardous ranges.

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7 REMEDIAL OBJECTIVES AND GENERAL RESPONSE ACTIONS

7.1 REMEDIAL OBJECTIVES

Remedial objectives for soil and ground water at Industrial Asphalt site should be site-specific and consider:

- type of chemical present
- land use
- volume and location of affected soil
- subsurface environmental chemical fate and transport model
- possible human and environmental receptors
- regulatory actions.

Based on these factors, remedial objectives for the Industrial Asphalt facility are: (1) to reduce the mobility of petroleum hydrocarbons and PCBs present in the subsurface; and (2) to reduce the amount of petroleum hydrocarbons and PCBs present in the subsurface.

Final cleanup goals for affected soil and ground water should be addressed after some period of remedial activity when the effectiveness of remedial actions can be assessed.

7.2 GENERAL RESPONSE ACTIONS

General response actions address remedial objectives and typically offer a range of distinct options for remedial measures (EPA, 1989).

7.2.1 General Response Actions for Soil Remediation

As previously described, there are approximately 85,000 cy (127,500 tons) of soil affected with petroleum hydrocarbons and PCBs at the Industrial Asphalt facility spread out over approximately 120,000 square feet. The estimated average concentration of petroleum hydrocarbons is 40 ppm; the estimated average concentration of PCBs in soil is 0.02 ppm. The affected soil is encountered at depths of no less than thirty and up to ninety feet below ground surface.

The following general response actions were evaluated for soil remediation at the Industrial Asphalt facility:

- No Action
- Institutional Control
- Source Control
- Removal of Affected Soil
- In Situ Treatment

7.2.1.1 No Action

A "no action" response means that the soil would be left "as is". The conceptual model of the Industrial Asphalt subsurface indicates that the only environmental migration pathway of diesel chemicals and PCBs is by ground water. There are no other migration pathways or exposure pathways for human or environmental receptors to the chemicals in the Industrial Asphalt subsurface.

The no-action response is consistent with the stated remedial objectives of Section 7.1, though regulatory agencies would likely require long-term ground water monitoring and periodic soil sampling. RWQCB would likely require a permit for Waste Discharge Requirements (WDR) mandating a containment system that will prevent migration of chemicals in the subsurface.

7.2.1.2 Institutional Controls

The no-action response would leave affected soil affected with petroleum hydrocarbons and PCBs in place at depths greater than 30 feet below grade. Institutional controls (such as deed restrictions which would limit uses of the site to prevent possible future exposure to affected soil) would be unnecessary, given the depth of affected soil zones.

7.2.1.3 Source Control

All USTs and related piping, the original sources of petroleum hydrocarbons and PCBs in the subsurface at the Industrial Asphalt facility, were removed in 1987. Free product and approximately 3000 cy of affected soil have also been removed.

The conceptual model of the Industrial Asphalt subsurface indicates that affected soil is acting as a secondary source of petroleum hydrocarbons and PCBs which dissolve into ground water. The areal extent and the depth of affected soil zones preclude isolation technologies such as capping or slurry walls.

7.2.1.4 Removal of Affected Soil

Approximately 3,000 cy of affected soil surrounding and at the bottom of the UST cavity has been excavated. Subsurface investigations indicate that approximately 85,000 cy (127,500 tons) of affected soil remain at the Industrial Asphalt facility, overlain by approximately 165,000 cy (250,000 tons) of clean overburden. Affected soil is encountered at depths greater than thirty and up to ninety feet below ground surface. Excavation would entail moving substantial site facilities including buildings, truck scales, silos, and storage tanks; all Industrial Asphalt operations, as well as operations at the adjacent Jamieson gravel quarry, would be ceased.

Removal of affected soil is not a feasible option.

7.2.1.5 In Situ Treatment

In situ treatment refers to treating affected soil in place, without removal. Several technology alternatives for in situ soil treatment are briefly described and evaluated for the Industrial Asphalt facility.

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7.2.1.5a Soil Washing

In situ soil washing involves flushing affected soil by injecting solutions of surfactants (detergents) or oxidants. This technology requires soil with relatively high porosity, hydrodynamic control of ground water, and extraction and treatment of ground water which contains spent washing solution and solubilized contaminants.

Soil types generally encountered at the Industrial Asphalt facility have low permeabilities. Affected soil zones are found over a large area and are relatively deep below ground surface. These characteristics would preclude soil washing as an effective remediation method.

7.2.1.5b Steam Injection

Steam is introduced through injection wells, causing chemicals to desorb from the soil matrix and enter a vapor phase. A vacuum is then applied to the ground through extraction wells. Steam and vapor phase chemicals are removed through the wells to a treatment system above ground.

This technology requires soil with relatively high porosity, hydrodynamic control of ground water, and extraction and treatment of ground water which may contain steam condensate and solubilized contaminants. Steam injection would not be an effective remediation method for the Industrial Asphalt facility due to the soil types and large areal extent of affected soil.

7.2.1.5c Enhanced or Augmented Bioremediation

Enhanced bioremediation entails injecting solutions containing nutrients into the subsurface to stimulate growth of naturally occurring soil microbes, resulting in greater rate of natural microbial breakdown of contaminants. Augmented bioremediation entails injecting solutions containing nutrients and microbes which have been developed specifically for the contaminant present in the soil.

These technologies require soil with relatively high porosity, hydrodynamic control of ground water, and extraction and treatment of ground water which may contain nutrients and microbial breakdown products; the technologies would be ineffective for the Industrial Asphalt site.

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7.2.1.5d Mixing for Solidification, Stabilization, and Fixation

Wide augers (up to 36 in) have been used for in situ soil mixing at depths up to 150 ft. Pozzolanic additives have been used to solidify and encapsulate contaminants.

This technology is relatively expensive and would not be feasible for the Industrial Asphalt site due to the significant areal extent of affected soil zones.

pilot pumping for enhanced vapor extraction

7.2.2 General Response Actions for Ground Water Remediation

Affected ground water is encountered under a large area of the Industrial Asphalt facility (Plate 10). The following general response actions were evaluated for ground water remediation at the Industrial Asphalt facility:

- No Action/Monitoring
- Institutional Control
- Hydrodynamic Control
- In-Situ Treatment
- Treatment and Disposal

7.2.2.1 No Action/Monitoring

A no action response means that ground water would be left "as is". Subsurface investigations and the conceptual model of the Industrial Asphalt subsurface indicate that petroleum hydrocarbons and PCBs in ground water have migrated and will continue to migrate. The no-action alternative is therefore not consistent with stated remedial objectives.

7.2.2.2 Institutional Control

Institutional controls to reduce chance of exposure to chemicals in ground water, such as deed restrictions prohibiting the installation of supply wells, would do nothing to prevent migration of chemicals in ground water and would not be consistent with stated remedial objectives.

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7.2.2.3 Hydrodynamic Control

Hydrodynamic control refers to measures that contain affected ground water. The conceptual model of the Industrial Asphalt subsurface indicates that hydrodynamic control is necessary to reduce migration of petroleum hydrocarbons and PCBs. Technologies for hydrodynamic control of affected ground water include: (1) isolation with slurry walls; and (2) extraction with wells or interceptor trenches or both.

For the Industrial Asphalt facility, slurry walls are not feasible due to the significant areal extent of affected ground water. Extraction appears to be a viable method of hydrodynamic control. Physical constraints and significant depth to affected ground water at the Industrial Asphalt facility would preclude interceptor trenches for extraction. Extraction wells are the recommended method for containing affected ground water at the Industrial Asphalt facility.

7.2.2.4 In Situ Treatment of Ground Water

In situ treatment alternatives involve the injection of chemical or biological components which react with and breakdown chemicals in ground water. In situ treatment typically requires relatively porous soils so that distribution of active components through the subsurface is possible.

In situ treatment would not be feasible for the Industrial Asphalt facility due to low soil porosity and significant areal extent of affected ground water.

7.2.2.5 Treatment and Disposal of Extracted Ground Water

Hydrodynamic control will be achieved by extracting ground water. Concentrations of petroleum hydrocarbons and PCBs in extracted ground water will warrant treatment and subsequent disposal. Treatment to remove petroleum hydrocarbons and PCBs from ground water is consistent with stated remedial objectives. Technology alternatives for treating extracted ground water and for disposal of treated water are briefly described here.

7.2.2.5a Granular Activated Carbon (GAC)

Adsorption by GAC is a widely-used technology for removing organic chemicals from ground water. Adsorption occurs when an organic molecule is brought to the activated carbon surface and held by physical forces. Generally, the quantity of organic compounds that can be adsorbed is a function of the type and concentration of the compound in the water and the surface area of the carbon. Factors that affect the efficiency of activated carbon for removal of organic compounds in ground water include molecular size of the compound and its solubility in water.

Petroleum hydrocarbons and PCBs are prone to removal by GAC; treatment by GAC is further evaluated in Section 9.1.

7.2.2.5b Ultraviolet/Chemical Oxidation

This technology destroys organic compounds using ultraviolet light (UV) in conjunction with a chemical oxidizers such as ozone or hydrogen peroxide (H_2O_2). UV light reacts with oxidizers to form hydroxyl radicals which decompose organic compounds. Organic compounds are decomposed to carbon dioxide (CO_2), water, and inorganic salts.

UV/chemical oxidation has been demonstrated to breakdown petroleum hydrocarbons and PCBs and is further evaluated in Section 9.2.

7.2.2.5c Ultraviolet-Photolysis

This alternative uses a different UV lamp design than UV/chemical oxidation. High intensity pulsed UV light reacts directly with organic compounds, which are decomposed to carbon dioxide (CO_2), water, and inorganic salts. Relatively small amounts of oxidizers may be used to bolster decomposition rates.

UV-photolysis has been demonstrated to breakdown petroleum hydrocarbons and PCBs and is further evaluated in Section 9.3.

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7.2.2.5d Options for Disposal of Treated Water

Usage rate of process water at the Industrial Asphalt facility is less than 100 gpd. The anticipated ground water extraction flowrates exceed the onsite use, making disposal necessary. Options for discharge of treated water at the Industrial Asphalt facility are:

1. Onsite injection or infiltration to the subsurface
2. Discharge to storm sewer or surface water body

Technology alternatives for injection or infiltration are (1) injection wells for injection under pressure; and (2) an infiltration galley or trench, typically consisting of a network of slotted pipe in a gravel bed to provide for gravity flow. A subsurface zone of cobbles or coarse gravels is typically required for either of these technologies to succeed. No subsurface zone of this type has been discovered during environmental investigations at the Industrial Asphalt site.

Disposal by discharge to a surface water body appears to be the most feasible option. There is a surface water impoundment immediately north of the Industrial Asphalt facility. Access to this water body is probable. This option may require a National Pollutant Discharge Elimination System permit (NPDES) issued by RWQCB.

No further screening of disposal options will be included in this document.

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8 IDENTIFICATION AND DEVELOPMENT OF SCREENING CRITERIA

The next step in the FS process is the identification and development of screening criteria for evaluating remedial technologies. The EPA typically uses nine screening criteria for Superfund sites. The criteria provide a comprehensive evaluation framework for comparing technology alternatives. The nine EPA criteria are:

1. Short-term effectiveness
2. Long-term effectiveness and permanence
3. Reduction of toxicity, mobility, or volume
4. Implementability
5. Cost
6. Compliance with ARARs
7. Overall protection of human health and the environment
8. State acceptance
9. Community acceptance (EPA, 1988b)

Criteria 1, 2, 3, and 7 have been incorporated into one effectiveness category. Criteria 6, 8, and 9 have been incorporated into one compliance category. Thus, the screening criteria used in this FS are: implementability, effectiveness, compliance with ARARs, and cost.

The following design basis was used for screening technology alternatives for treating ground water, based on site characterization and anticipated regulatory actions:

- extraction flowrate = 20 gpm
- concentration of petroleum hydrocarbons in treatment system influent = 40 ppm
- concentration of petroleum hydrocarbons in system effluent = 1 ppm (97.5% removal)
- concentrations of PCBs in treatment system influent = 0.02 ppm
- concentration of PCBs in effluent = 0.0005 ppm (97.5% removal).

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8.1 IMPLEMENTABILITY

Implementability of a technology alternative for ground water treatment consists of evaluating appropriateness and physical constraints. Access to the subsurface and space for treatment system equipment may be limiting factors. The selected remedial technology for ground water should conform to physical parameters of the Industrial Asphalt facility.

8.2 EFFECTIVENESS

Criteria for evaluating effectiveness of an alternative for ground water treatment is the removal of chemicals. Effectiveness will also consider containment of affected ground water, treatable flow rate, and proven applications of the technology for removing chemicals from ground water. Effectiveness includes evaluating worker safety during installation and operation of the system, and both short-term and long-term effectiveness. ("Short-term" refers to five years or less. "Long-term" refers to five to twenty years.)

8.3 COMPLIANCE WITH ARARS

Considerations of compliance of technology alternatives for treatment of ground water are similar to those for treatment of soil. During remedial construction and operation, compliance with relevant health and safety regulations must be met to protect the health of remediation workers and personnel at the facility and the general public. The treatment system should attain cleanup criteria for treatment system effluent, and should not adversely impact the quality of water bodies receiving disposed water.

8.4 COST

Capital and long-term operating costs of technology alternatives for treatment of ground water were estimated for comparison purposes only. Costs were based on experience and manufacturers' quotations, using the design basis previously described. Capital design costs for design and permitting of each technology alternative were assumed to be equal. Operating costs for sampling and analysis of each technology alternative were also assumed to be equal.

Table 9 presents operating and maintenance costs. Present worth of operating costs at five and ten years was added to capital costs for total comparison, presented in Table 10.

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9 SCREENING OF REMEDIAL TECHNOLOGY ALTERNATIVES

This chapter evaluates the feasibility of various technologies for treating ground water to remove chemicals. Issues concerning extraction of ground water and disposal of treated water have been addressed in previous sections of this document and are identical for each treatment technology.

Each alternative will be rated +1, 0, or -1 as follows:

+1 indicates an alternative that meets a remedial objective as specified by a specific criterion.

0 indicates an alternative that may meet a specific criterion but requires further study.

-1 indicates an alternative that will not meet the remedial objectives specified by a given criterion.

Table 11 summarizes the screening procedure and shows the ratings of alternative technologies for ground water treatment.

9.1 GRANULAR ACTIVATED CARBON (GAC)

Plate 15 shows a flow diagram for a GAC system. Extracted ground water passes through a filter to remove sediments and a UV sanitizing light to reduce biological fouling. Process water then enters the GAC system, typically two GAC drums operated in series. When the primary carbon drum is exhausted, either by fouling or by saturation, valves are manually operated so that the second drum becomes the primary. Exhausted carbon is replaced with virgin or regenerated carbon.

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Maintenance requirements include periodic servicing of the cannisters to exchange exhausted carbon. The carbon may be slurry-pumped to and from permanently installed cannisters or whole cannisters may be exchanged.

Size of the GAC system is dependant on type and concentrations of chemicals in the influent. Usage rates are estimated based on adsorption isotherms, influent concentrations, and flowrates. A 100 percent safety factor is typically used for GAC systems.

GAC must be disposed after it is spent due to microbial fouling or saturation of adsorptive sites. For typical remediation projects, a carbon replacement service contract can be negotiated for replacing and regenerating spent GAC, thereby reducing costs of purchasing virgin carbon. However, conversations with carbon service vendors indicate that due to the presence of PCBs in extracted ground water, typical regeneration is not possible. Options for offsite disposal would entail transport of GAC to a Class I landfill or to a permitted incinerator, representing substantial costs and environmental risks associated with handling and transport.

A possible disposal option for spent GAC is onsite recycling in the asphalt manufacturing process. State and local health departments have historically approved recycling of affected soil at the Industrial Asphalt facility. Preliminary calculations indicate that for a GAC drum containing 1000 lbs GAC, the concentration of PCBs would be approximately 0.01 lbs per 1000 lbs GAC, or 10 ppm; this concentration is less than hazardous criteria. The following evaluation of the GAC alternative assumes onsite disposal.

9.1.1 Implementability

Installation of the GAC system will have minimal impact on operations at the Industrial Asphalt facility. GAC systems do not require a large area and could be located anywhere onsite. There are no moving parts in the GAC system. Should spent GAC be recycled onsite, maintenance would include slurry-pumping the GAC into the asphalt mixer and replacing spent GAC.

GAC is given a +1 rating for implementability.

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9.1.2 Effectiveness

The use of GAC in removing organic chemicals from water is a proven technology. A GAC system could be sized to remove 100% of petroleum hydrocarbons and PCBs from extracted ground water at the Industrial Asphalt facility.

GAC is given a +1 rating for effectiveness.

9.1.3 Compliance with ARARs

GAC systems are a proven technology for removing organic chemicals from water to nondetectable concentrations in the system effluent.

GAC is given a +1 rating for compliance.

9.1.4 Cost

Capital costs for equipment and installation are relatively low (Table 9). Substantial costs are incurred during labor intensive changeover of carbon and replacement of the carbon itself. It should be noted that cost estimates for GAC shown in Table 9 assume disposal of GAC by onsite recycling; offsite disposal and transport would be a significant cost.

GAC is given a 0 rating for cost.

9.2. UV/CHEMICAL OXIDATION

Plate 16 shows a process flow diagram for a typical ground water remediation system using UV/chemical oxidation (UV/oxidation). Extracted ground water first passes through a filter and then is mixed with hydrogen peroxide in a static mixer. The process water then enters a reactor vessel where it is subjected to UV light and mixed with ozone. Ozone is produced onsite with an ozone generator and an air dryer. Peroxide and ozone produce hydroxyl radicals in the water; the hydroxl radicals attack organic compounds, converting them to carbon dioxide, water and inorganic salts. The UV light excites the organic molecules so they are more readily attacked.

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9.2.1 Implementability

Installation of the UV/oxidation system would have minimal impact on operations at the Industrial Asphalt facility. A typical UV/oxidation system is supplied as a skid-mounted operating unit with associated tanks, pumps, valves and controls.

Maintenance includes periodic cleaning and replacement of UV lamps and maintenance of the ozone generator and air dryer. Replenishment of hydrogen peroxide is typically done through a service contract with the equipment vendor. The equipment does not take up a large area and could be located anywhere onsite. Systems are not difficult to operate after a short training period.

UV/oxidation is given a +1 rating for implementability.

9.2.2 Effectiveness

The use of peroxide and ozone as oxidizing agents is a proven technology used by water suppliers. The use of UV/oxidation to remediate ground water is a relatively recent application of this technology with little proven track record. Theoretically, a UV/oxidation system could be designed to provide 100% destruction of chemicals in extracted ground water at the Industrial Asphalt site, though treatability tests would be required to fully evaluate effectiveness of this alternative.

UV/oxidation is given a 0 rating for effectiveness.

9.2.3 Compliance with ARARs

Compliance with effluent limitations would be assessed after analyzing treatability test results. Vapor emissions from UV/oxidation technology are minimal. BAAQMD must be notified if emissions are exhausted to atmosphere, though carbon dioxide emissions produced by this technology are currently not regulated.

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UV/oxidation is given a 0 rating for compliance.

9.2.4 Cost

Capital costs for equipment are substantial (see Table 9). There are also significant costs related to maintenance (e.g., lamp cleaning and replacement).

UV/oxidation is given a 0 rating for costs.

9.3 UV-PHOTOLYSIS

Plate 17 shows a process flow diagram for a typical ground water remediation system using UV-photolysis. Extracted ground water first passes through a filter and then enters the reactor vessel(s) where it is subjected to high intensity pulsed UV light. The UV light decomposes organic compounds to carbon dioxide, inorganic salts, and water. A GAC drum is shown as a polisher to remove any remaining compounds prior to discharge.

9.3.1 Implementability

Installation of the UV-photolysis system would have minimal impact on operations at the Industrial Asphalt facility. A typical system is supplied as a skid-mounted operating unit with associated vessels, pumps, valves and controls. Maintenance includes periodic cleaning and replacement of UV lamps. Lamp replacement and other maintenance may be contracted with the equipment manufacturer. The equipment does not take up a large area and could be located anywhere onsite. Systems are not difficult to operate after a short training period.

UV-photolysis is given a +1 rating for implementability.

9.3.2 Effectiveness

The use of UV-photolysis is a relatively recent application of this technology with little proven track record. Theoretically, a UV-photolysis system could be designed to provide 100%

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destruction of chemicals in extracted ground water at the Industrial Asphalt site, though treatability tests would be required to fully evaluate effectiveness of this alternative.

UV-photolysis is given a 0 rating for effectiveness.

9.3.3 Compliance with ARARs

Compliance with effluent limitations would be assessed after analyzing treatability test results.

Vapor emissions from UV-photolysis technology are insignificant. Emissions of carbon dioxide which would be produced by this technology are currently not regulated.

UV-photolysis is given a 0 for compliance.

9.3.4 Cost

Capital costs for equipment are relatively moderate; there are significant costs related to lamp replacement.

UV-photolysis is give a 0 rating for cost.

10 DESCRIPTION OF RECOMMENDED REMEDY

The recommended remedy for attaining remedial objectives at the Industrial Asphalt facility includes: (1) extraction wells to pump ground water; (2) a GAC system to treat extracted ground water; (3) discharging treated water to the surface water impoundment north of the facility; (4) recycling spent GAC through the onsite asphalt batch manufacturing process.

It is assumed that a flowrate of two gpm will be sustainable from a properly designed extraction well; computer modeling will help in locating wells to effectively achieve hydrodynamic control of affected water (see Section 11.1). Wells would be constructed to intercept ground water in the upper water-bearing zone (i.e., 85-110 feet below grade). Table 12 shows estimated capture zone dimensions for various flowrates based on the pumping test conducted during the RI. Plate 18 shows the site with possible locations of extraction wells and treatment system. Electric submersible pumps with automatic level controls would pump water to the treatment system which could be located on a small concrete pad located at the northern edge of the facility. Treated water would be discharged to a pipe running down to the adjacent surface water impoundment.

The recommended remedy would attain stated remedial objectives. Extraction of ground water will provide hydrodynamic control of the site, thereby reducing the mobility of petroleum hydrocarbons and PCBs through ground water. Treating extracted water with GAC will remove petroleum hydrocarbons and PCBs from the water, thereby reducing the amount of these chemicals in the subsurface.

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11 DATA REQUIREMENTS

There are data requirements which should be addressed prior to implementing the recommended remedy. This section describes those data needs; activities that would address these needs could take place concurrently with preliminary design of the recommended technology.

11.1 COMPUTER MODELING

Computer modeling of the site should be done to assess locations of extraction wells. Placement of extraction wells is a critical portion of designing an extraction system that will attain hydrodynamic control of affected water at the Industrial Asphalt facility.

Computer modeling is also helpful is assessing extraction flowrates and drawdown in the shallow water-bearing zone; extraction well designs and sizes of treatment system equipment are dependent on estimated flowrates.

11.2 WATER QUALITY

Inorganic water parameters such as bicarbonate alkalinity, calcium and magnesium hardness, and total suspended solids should be analyzed to assess the necessity of pretreatment to protect the GAC system. This data could be obtained during regularly scheduled sampling rounds.

11.3 LEACHABILITY

Leachability of petroleum hydrocarbons and PCBs from soil to ground water and retardation of these chemicals in soil should be assessed to estimate final cleanup goals of ground water. After final cleanup goals have been established, the full lifetime of the remediation project can be estimated.

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Data on leachability can be obtained by running Toxicity Characteristic Leaching Potential (TCLP) tests on soil samples. This sampling could possibly take place during installation of extraction wells.

11.4 NPDES PERMIT

The NPDES permitting process for discharging treated water to the surface water impoundment north of the Industrial Asphalt facility will necessarily include estimates of extraction flowrates. Negotiations with the property owner (Jamieson) should be initiated to fully assess the possibility of implementing this disposal option.

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12 LIMITATIONS

This report may be used only by the client, only for the purposes stated, and within a reasonable time from its issuance. Land use, site conditions (both onsite and offsite) or other factors may change over time, and additional work may be required with the passage of time. Any party other than the client who wishes to use this report shall notify Kleinfelder of such intended use by executing the "Application for Authorization to Use" which follows this document. Based on the intended use of the report, Kleinfelder may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the client or anyone else will release Kleinfelder from any liability resulting from the use of this report by any unauthorized party.

It should be recognized that definition and evaluation of hydrogeologic, geologic, and environmental conditions is a complex and inexact science. Hydrogeologic and geologic conditions can change seasonally, with time, and due to future onsite or adjacent land use. The information in this report is presented with an incomplete knowledge of the environmental and subsurface conditions present and conditions may be present which are unknown or went undetected due to the limited scope of our studies. More extensive studies, including additional subsurface investigations, can be conducted to further reduce the uncertainties beyond the level associated with this study.

Kleinfelder has conducted this feasibility study with the generally accepted standards of care which exist in Northern California at the time the work was performed. No other representations, expressed or implied, and no warranty or guarantee is included or intended.

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TABLE 1

MONITORING WELL CONSTRUCTION DATA
INDUSTRIAL ASPHALT FACILITY

Well No.	Total Depth[1] (ft)	Top of Casing[2] (ft)	Screen Interval[3] (ft)	Well Diameter[4] (inch)	Slot Size (inch)	Screen/Casing Material[5]	Top of Filter Pack[3] (ft)	Type of Filter Pack	Depth of Well Seal[5] (ft)	Completion Date
MW-1	88	379.41	58-88	2	0.020	PVC/PVC	56	#3	53	JUNE 1987
MW-2	90	379.80	65-90	4	0.020	PVC/PVC	62	#3	59	JULY 1987
MW-3	90	378.54	65-90	4	0.020	PVC/PVC	62	#3	59	JULY 1987
MW-4	95	376.26	55-95	4	0.020	PVC/PVC	52	#3	48	MARCH 1988
MW-5	110	382.55	57-107	4	0.020	PVC/PVC	53	#3	49	MARCH 1988
MW-6	109	379.15	69-109	4	0.020	PVC/PVC	64	2/12	61	JUNE 1988
MW-7	109	378.94	69-109	4	0.020	PVC/PVC	64	#3	61	JUNE 1988
MW-8	109	378.56	69-109	4	0.020	PVC/PVC	64	2/12	61	JUNE 1988
MW-9	108	377.40	78-108	4	0.020	PVC/PVC	75.4	2/12	70	JULY 1989
MW-10	111	378.04	81-111	4	0.020	PVC/PVC	78.2	2/12	73	JULY 1989
MW-11[6]	75	379.02	55-75	2	0.040	PVC/PVC	53	LA	51	JULY 1989
MW-13[7]	116	380.21	76-116	6	0.045	SS/PVC	64	MA	62	AUGUST 1990
MW-14	114.5	380.09	99.5-114.5	4	0.020	PVC/PVC	96.5	2M	94	JUNE 1990
MW-15	117	378.12	97-117	4	0.020	PVC/PVC	94	2M	91	JUNE 1990
MW-16	110	379.65	90-110	4	0.020	PVC/PVC	86.5	2M	83.5	JUNE 1990

NOTES:

1	Total depth of borehole below ground surface
2	Elevation in feet above mean sea level (USGS Datum)
3	Depth below ground surface
4	Nominal casing/screen diameter
5	PVC - Polyvinyl Chloride plastic (Schedule 40), SS - stainless steel
6	Well abandoned on 8 August 1990
7	Extraction well
MA	Medium aquarium sand
#2M	No. 2 Monterey sand
#3	No. 3 Monterey sand
LA	Lonestar aquarium sand

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TABLE 2A

RESULTS OF GROUND WATER SAMPLING, APRIL 1991
INDUSTRIAL ASPHALT FACILITY
(concentrations in ppm)

Monitoring Well	Total Depth (feet)	Depth to Water(1) (feet)	Ground Water Elevation(2) (feet)	Product Thickness (feet)	TPH as Diesel(3)	TPH as Waste Oil(4)	PCBs(5)	Oil & Grease(10)	Total Hydro-carbons(11)
MW-1	88	73.69	305.72	SHEEN	40	27	ND	91	74
MW-2	90	72.00	307.80	SHEEN	44	35	0.005	150	130
MW-3	90	72.34	306.20	SHEEN	19	14	0.0008	34	30
MW-4	95	70.71	305.55	NE	0.7	9.7	ND	11	6
MW-5	110	78.57	303.98	NE	ND	ND	ND	ND	ND
MW-6	109	NC	NA	NA	NT	NT	NT	NT	NT
MW-7	109	73.07	305.87	NE	0.5	ND	ND	1	ND
MW-8	109	72.82	305.74	NE	4.1	4.8	0.0008	15	11
MW-9	108	NC	NA	NA	NT	NT	NT	NT	NT
MW-10	111	72.02	306.02	NE	3	ND	ND	4	1
MW-11(8)	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-13(9)	116	73.62	306.59	SHEEN	0.7	ND	ND	ND	ND
MW-14	114.5	74.27	305.82	NE	ND	ND	ND	ND	ND
MW-15	117	73.03	305.09	NE	0.5	ND	ND	2	1
MW-16	110	73.27	306.38	NE	ND	0.5	ND	0.9	ND
14A2(12)	UNK	UNK	UNK	UNK	ND	ND	ND	ND	ND
SG	NA	1.5	301.5(7)	NA	NA	NA	NA	NA	NA

(1)	Below top of casing
(2)	Feet above mean sea level (USGS Datum)
(3)	Laboratory detection limits - 0.05 ppm
(4)	Laboratory detection limit - 0.1 ppm
(5)	Laboratory detection limit - 0.0005 ppm
(6)	Reading on the staff gage
(7)	Surface water elevation in the pit
(8)	Well abandoned on August 8, 1990
(9)	Extraction well
(10)	Laboratory detection limit - 0.5 ppm
(11)	Laboratory detection limit - 0.5 ppm
(12)	Jamieson Well

TPH	Total Petroleum Hydrocarbons
PCBs	Polychlorinated Biphenyls (Aroclor 1260)
NE	Not Encountered
ND	Not Detected at or above laboratory detection limits
NA	Not Applicable
SG	Staff Gage
NC	Not Acessible
NT	Not Tested
UNK	Unknown

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TABLE 2B

RESULTS OF GROUND WATER SAMPLING, APRIL 1991
INDUSTRIAL ASPHALT FACILITY

Monitoring Well	Benzene(1)	Toluene(1)	Ethylbenzene(1)	Xylenes(2)
MW-1	ND	ND	ND	ND
MW-2	0.0007	ND	ND	ND
MW-3	0.0009	ND	0.006	0.003
MW-4	ND	ND	ND	ND
MW-5	ND	ND	ND	ND
MW-6	NT	NT	NT	NT
MW-7	ND	ND	ND	ND
MW-8	ND	ND	0.003	ND
MW-9	NT	NT	NT	NT
MW-10	ND	ND	ND	ND
MW-13	ND	ND	ND	ND
MW-14	ND	0.0007	ND	ND
MW-15	ND	ND	ND	ND
MW-16	ND	ND	ND	ND
14A2	ND	ND	ND	ND

Notes:

Concentrations in ppm

(1) Laboratory detection limit - 0.0005 ppm
(2) Laboratory detection limit - 0.0002 ppm

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TABLE 2C

RESULTS OF GROUND WATER SAMPLING, APRIL 1991
HALOGENATED ORGANICS(1)
INDUSTRIAL ASPHALT FACILITY

Monitoring Well	1,1 - DCA	1,2 - DCE	TCFM	VC
MW-1	ND	ND	ND	ND
MW-2	ND	ND	ND	ND
MW-3	0.002	ND	0.001	0.008
MW-4	ND	ND	ND	ND
MW-5	ND	ND	ND	ND
MW-6	NT	NT	NT	NT
MW-7	ND	ND	ND	ND
MW-8	ND	0.001	ND	ND
MW-9	NT	NT	NT	NT
MW-10	ND	ND	ND	ND
MW-13	ND	ND	ND	ND
MW-14	ND	ND	ND	ND
MW-15	ND	ND	ND	ND
MW-16	ND	ND	ND	ND
14A2	ND	ND	ND	ND

Notes:
Concentrations in ppm

(1)	Laboratory detection limits - 0.5 ppm
NT	Not Tested
1,1 - DCA	= 1,1 Dichloroethane
1,2 - DCE	= 1,2 Dichloroethene
TCFM	Trichlorochloromethane
VC	Vinyl Chloride
14A2	Jamieson Well

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TABLE 3

DATA FOR WATER SUPPLY WELLS IN THE VICINITY OF INDUSTRIAL ASPHALT FACILITY

Well No.[1]	Township Range Section	Use(s)[2]	Total Depth[3] (ft)	Perforation Interval[4] (ft)	Approximate Distance from I.A. Facility (ft)
11H1	3S/1E/11	Irrigation	303	223-231,262-295	5250(N)
11P4	3S/1E/11	Domestic	150	UN	2100 (NNW)
12A1	3S/1E/12	Not Used	98	UN	5250 (NE)
12Q3	3S/1E/12	Monitoring	95	UN	5100 (NE)
12P5	3S/1E/12	Irrigation	346	262-290,315-326, 336-346	4700(NE)
13E1	3S/1E/13	Monitoring	97	92-97	250(E)
13G1	3S/1E/13	Not Used	331	UN	950(E)
13K1	3S/1E/13	Not Used	750	180-200,220-260, 300-340,380-420, 460-500,640-660	5000(SE)
13K2	3S/1E/13	Not Used	600	UN	4900(SE)
13K2	3S/1E/13	Not Used	652	UN	5500(SE)
14A2	13/1E/14	Domestic	220	135-160,170-205	800(NE)
14J1	13/1E/14	Industrial	654	110-122,158-170 182-194,200-206	1750(SSE)
14K2	13/1E/14	Industrial	508	120-181,187-245,	2050(S)
14P1	13/1E/14	Not Used	48	UN	4500(SW)
14G1	13/1E/14	Industrial	500	150-300,350-500	950(SWW)
14F3	13/1E/14	Industrial	535	200-250,250-533	1400(SWW)
15J3	13/1E/15	Domestic	196	154-184	4700(SWW)
23D3	13/1E/23	Domestic	288	ND	4800(SW)
23D2	13/1E/23	Not Used(?)	157	UN	5000(SW)
23C1	13/1E/23	Not Used	UN	UN	4650(SSW)
23C2	13/1E/23	Irrigation	280	UN	4950(SSW)
23B2	13/1E/23	Irrigation	UN	UN	4900(S)
23H1	13/1E/23	Irrigation	200	UN	5280(S)

This list is compiled from the Alameda County Flood Control and Water Conservation District - Zone 7 files. Accuracy of this information has not been verified in the field. Specific weldl construction details and location should be confirmed by direct observation.

UN	Unknown
1	Well numbers are based on well numbering syhstem used by ACFCWCDd - Zone 7
2	Primary uses of water, as designated by owner, driller or ACFCWCD - Zone 7 personnel
3	Depth below gradfe (land surface datum) of completed well, as reported by driller or agency staff
4	Interval in which well casing is perforated in feet below land surface; in some wells this may be the interval between the bottom of the solid casing and the maximum depth.

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TABLE 4

RECENT SAMPLING RESULTS OF PAIRED MONITORING WELLS INDUSTRIAL ASPHALT FACILITY

		January 1991			April 1991		
Well No.	Screened Interval (ft Below Grade)	Depth to Ground Water (ft below grade)	Total Hydrocarbons* (ppm)	PCBs (ppm)	Depth to Ground Water (ft below grade)	Total Hydrocarbons (ppm)	PCBs (ppm)
MW-1	58-88	71.8	173	0.0096	73.7	74	ND
MW-13	76-116	72.0	0.7	ND	73.6	ND	ND
MW-2	65-90	73.4	340	0.0058	72.0	130	0.0051
MW-14	99.5-114.5	71.8	0.8	ND	74.3	ND	ND
MW-3	65-90	71.6	760	0.0073	72.3	30	0.0008
MW-16	90-110	70.2	0.7	ND	73.2	ND	ND

* = Sum of TPH as diesel and TPH as waste oil

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TABLE 5

TYPICAL COMPOSITION OF DIESEL FUEL BY HYDROCARBON CLASSIFICATIONS

Compound	Weight Per Cent
Straight-chain Paraffins and Isoparaffins	37-43
Cycloparaffins	
mono-	23
di-	8
tri-	2
total	26-33
Aromatics (substituted benzenes and polyaromatic hydrocarbons (PAHs))	
alkybenzenes	9
indans and tetralins	5
dinaphthenobenzenes	1
alkylnapthalenes	6
biphenyls, etc.	2
fluorenes, napthalenes, etc.	1-3
tricyclic aromatics	1
benzene	47 parts per million
Total	23-28

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TABLE 6

Chemical and Physical Properties of Constituents of Diesel Fuel and No. 2 Fuel Oil and PCBs

Chemical	CASRN	Concentration Range in No.2 Fuel Oil (ppm)⁽¹⁾	Molecular Weight (grams/mole)	Water Solubility (mg/l)	Vapor Pressure (mm Hg)	Henry's Law Constant (atm-m^3/mole)	K_{oc}⁽⁴⁾ (ml/g)	Log K_{ow}⁽⁵⁾
Volatile Organics								
Benzene	71-43-2	6-82	78	1.8×10^{3}	9.5×10^{1}	5.6×10^{-3}	83	2.1
Ethylbenzene	100-41-4	100-800	106	1.5×10^{2}	7.0	6.4×10^{-3}	1,100	3.2
Toluene	108-88-3	100-800	92	5.3×10^{2}	2.8×10^{1}	6.4×10^{-3}	300	2.7
Xylene⁽²⁾	1330-20-7	100-800	106	2.0×10^{2}	1.0×10^{1}	7.0×10^{-3}	240	3.3
Polycyclic Aromatic Hydrocarbons								
benzo(a)pyrene	50-32-8	0.001 - 0.6	252	1.2×10^{-3}	5.6×10^{-9}	$1.6 \times {}^{10-6}$	5,500,000	6.1
benzanthracene	56-55-3	0.01 - 1.2	228	5.7×10^{-3}	2.2×10^{-8}	1.2×10^{-6}	20,000	5.6
chrysene	218-01-9	1.4	228	1.8×10^{-3}	6.4×10^{-9}	1.0×10^{-6}	1,380,000	5.6
cresol	1319-77-3	54	108	3.1×10^{-4}	2.4×10^{-4}	1.0×10^{-6}	500	2.0
methylnaphthalene	1321-94-4	5,700 - 9,100	---	---	---	---	---	---
2-methylnaphthalene	91-57-6	6,700	142	---	---	---	---	---
naphthalene	91-20-3	2,730	128	3.0×10^{-1}	1 mm at 53°	---	---	3.3
phenanthrene	85-01-8	1,500	178	1.0	6.8×10^{-4}	1.6×10^{-4}	14,000	4.5
phenol	108-95-2	6.8	94	9.3×10^{-4}	3.4×10^{-1}	4.5×10^{-7}	14.2	1.5
quinoline	91-22-5	9.2	129	6.0×10^{-4}	1 mm at 60°	---	---	2.0
Polychlorinated Biphenyls ⁽³⁾	1336-36-3	---	328	3.1×10^{-2}	7.7×10^{-5}	1.1×10^{-3}	530,000	6.0

NOTES:

CASRN Chemical Abstract Service Registry Number.
ppm Parts per million.
(1) Stone, 1990.
(2) Entries for xylenes are for mixtures of three isomers.
(3) Polychlorinated biphenyls are not a typical component of diesel or fuel oil. They are included here because they have been detected in samples of diesel fuel product collected at the Industrial Asphalt site.
(4) K_{oc} = organic carbon partitioning coefficient.
(5) K_{ow} = octanol/water partitioning coefficient.

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TABLE 7

Available Health-Base Criteria Established for Diesel Fuel Chemicals and for PCBs

Chemical	MCL(1) (mg/l)	Oral Slope Factor (mg/kg-day)	Oral Reference Dose (mg/kg-day)	AAL(2) for Human Receptors (mg/l)	AAL(2) for Fresh Water Receptors (mg/l)
benzene	0.001	0.029	---	0.0002	0.001
ethylbenzene	0.680	---	0.1	2	---
toluene	---	---	0.3	2	0.09
xylenes	1.75	---	2	2	0.04
benzo(a)pyrene	---	---	---	0.00009	---
fluoranthene	---	---	004	0.020	---
naphthalene	---	---	---	0.020	0.6
PCBs	0.0005(3)	7.7	---	---	---

(1) MCL = Maximum Contaminant Level

(2) AAL = Applied Action Level

(3) EPA-proposed MCL for decachlorobiphenyl

TABLE 8
General Response Actions and Representative Technologies

Soil Response Actions	Appropriate	Technology Alternatives
No Action/Monitoring	Yes	---
Institutional Control	No	---
Source Control	No	---
Total Soil Removal	No	---
In-Situ Treatment	No	---

Ground Water Actions	Appropriate	Technology Alternatives
No Action/Monitoring	No	---
Institutional Control	No	---
Hydrodynamic Control	Yes	Extraction
Treatment and Disposal	Yes	GAC UV/Chemical Oxidation UV-Photolysis
In-Situ Treatment	No	---

TABLE 9

Capital and Operating Cost Comparison for Ground Water Treatment Alternatives
(20 gpm flow rate)

	GAC	UV/Chemical Oxidation	UV-Photolysis
Capital Costs			
Equipment	40,000	210,000	120,000
Construction	25,000	35,000	35,000
Total	65,000	245,000	155,000
Operating Costs - Annual			
Electrical	---	10,000	10,000
GAC Replacement	35,000	---	---
Maintenance (equipment andlabor)	15,000	20,000	20,000
Total	50,000	30,000	30,000

All Costs in Dollar Amounts.

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TABLE 10

Total Cost Comparison for Ground Water Treatment Alternatives

	GAC	UV/Oxidation	UV-Photolysis
Capital Costs	65,000	245,000	155,000
Operating Costs (5 years)	190,000	115,000	115,000
Operating Costs (10 years)	305,000	185,000	185,000
Total Costs (5 years)	255,000	360,000	270,000
Total Costs (10 years)	370,000	430,000	340,000

All Costs in Dollar Amounts.

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TABLE 11

SCREENING MATRIX OF GROUND WATER TREATMENT TECHNOLOGY ALTERNATIVES

Ground Water Technology	Implementability	Effectiveness	Compliance	Cost	Sum
GAC	+1	+1	+1	0	+3
UV/Chemical Oxidation	+1	0	0	0	1
UV/Photolysis	+1	0	0	0	1

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TABLE 12

CAPTURE ZONE DIMENSIONS(1) INDUSTRIAL ASPHALT FACILITY

Pumping Rate (gpm)	Distance To Stagnation Point (feet)(2)	Maximum Width of Capture Zone (feet)
1.0	9	56
1.5	13	82
2.0	18	113
2.6	23	145

Notes:

1. For well MW-13 as pumping well. Assumptions: transmissivity=2,500 gpd/ft, thickness of water bearing zone=20 ft, potentiometric gradient=0.035 feet/foot.
2. Downgradient extent of capture zone.

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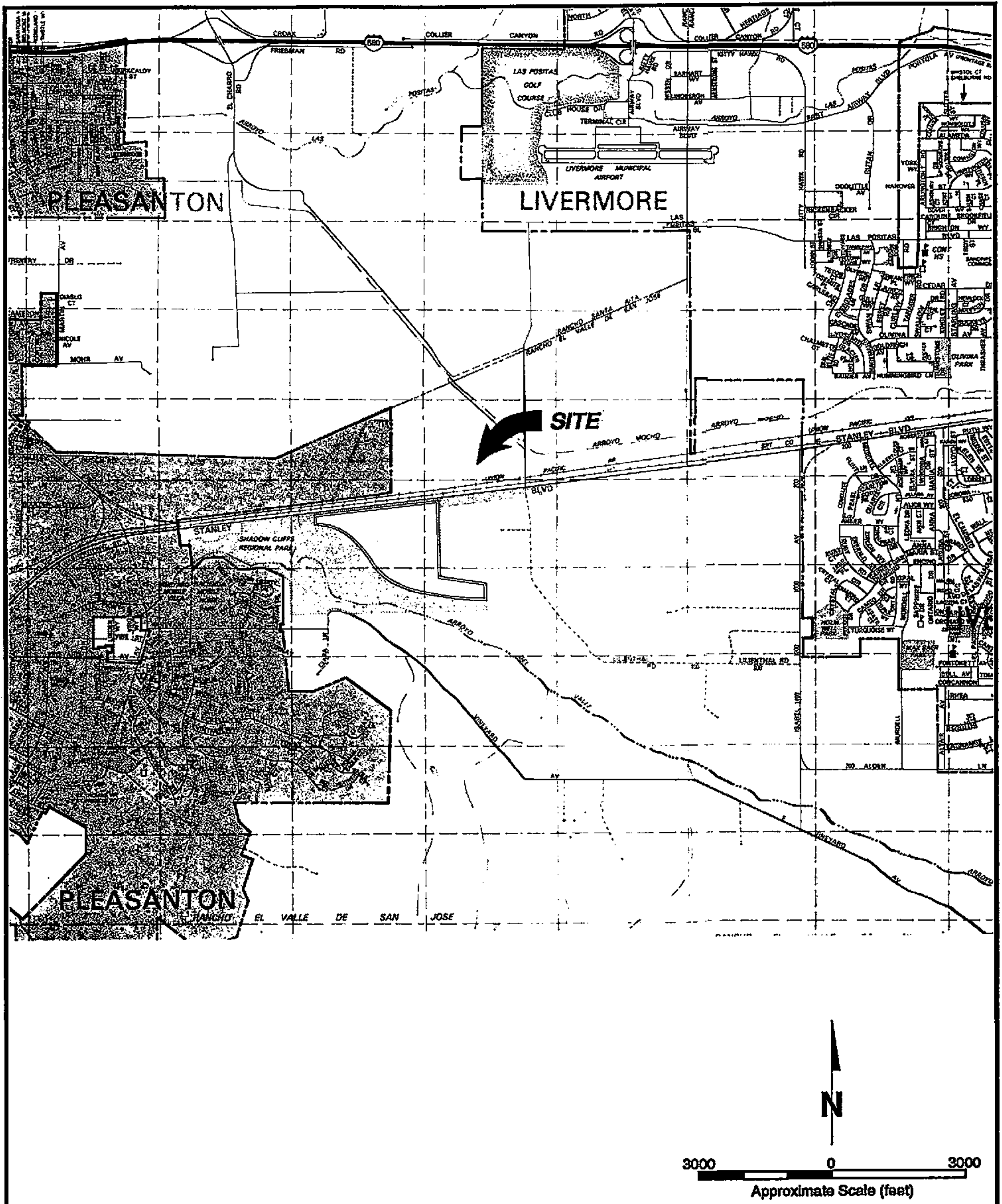


KLEINFELDER

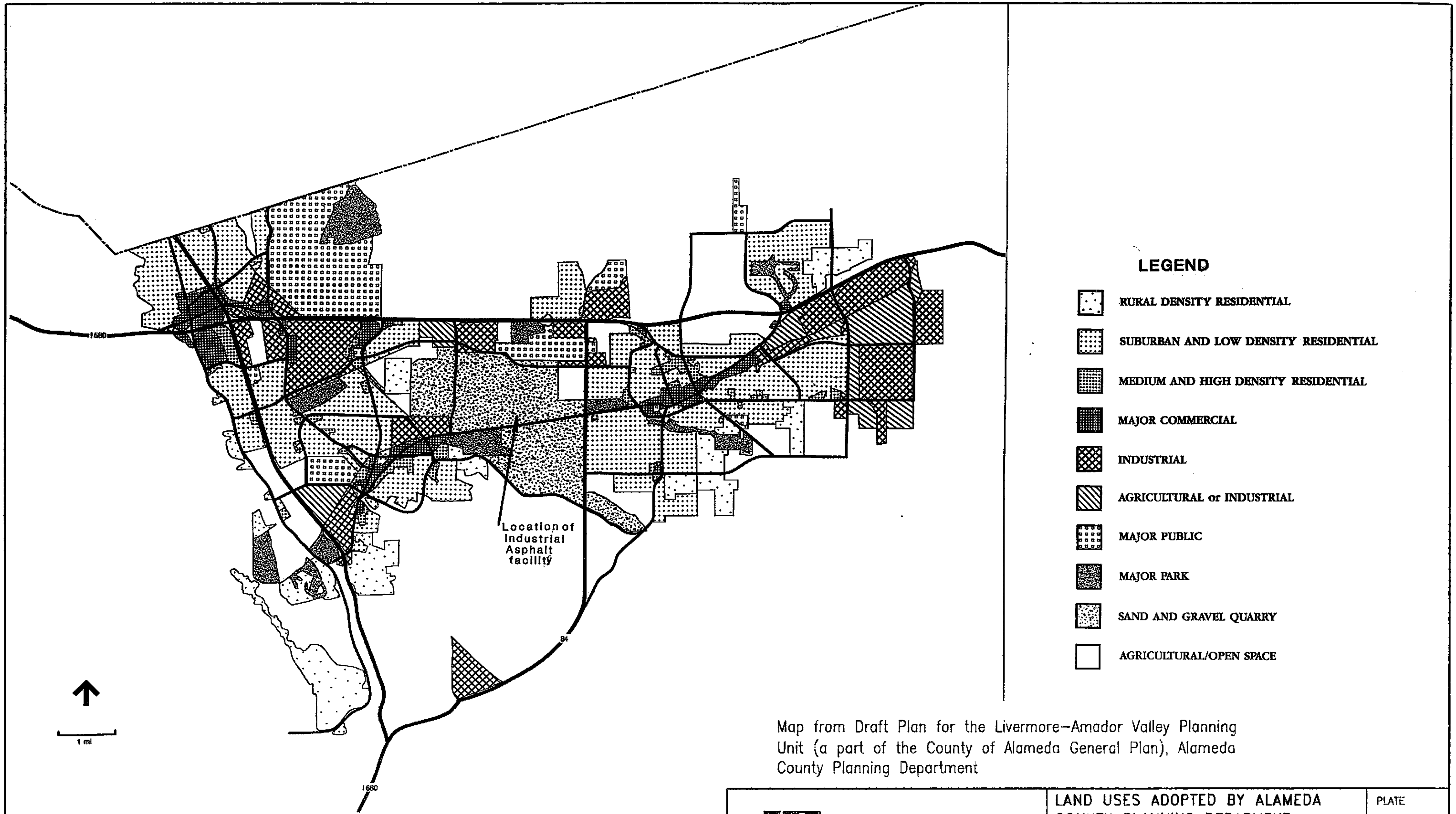
PROJECT NUMBER 10-1682-07

SITE LOCATION MAP

INDUSTRIAL ASPHALT
52 EL CHARRO ROAD
PLEASANTON, CALIFORNIA

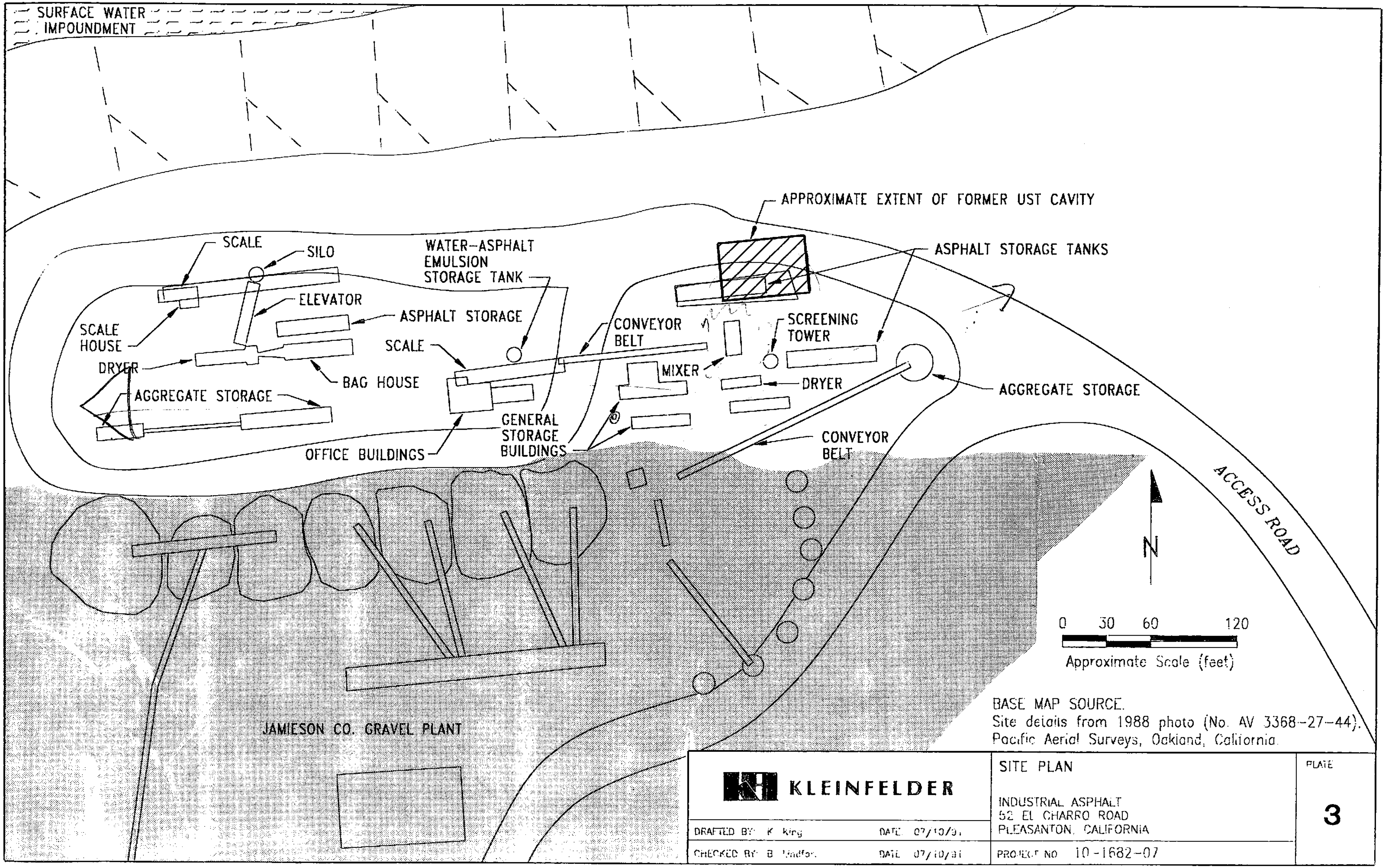
PLATE

1



Map from Draft Plan for the Livermore-Amador Valley Planning Unit (a part of the County of Alameda General Plan), Alameda County Planning Department

KLEINFELDER		LAND USES ADOPTED BY ALAMEDA COUNTY PLANNING DEPARMENT INDUSTRIAL ASPHALT 52 EL CHARRO ROAD PLEASANTON, CALIFORNIA	PLATE 2
DRAFTED BY: L. Lotnan	DATE: 07/24/91		
CHECKED BY: R. Lindfors	DATE: 07/25/91	PROJECT NO. 10-1682-07	



BASE MAP SOURCE.
Site details from 1988 photo (No. AV 3368-27-44).
Pacific Aerial Surveys, Oakland, California.

KLEINFELDER

SITE PLAN

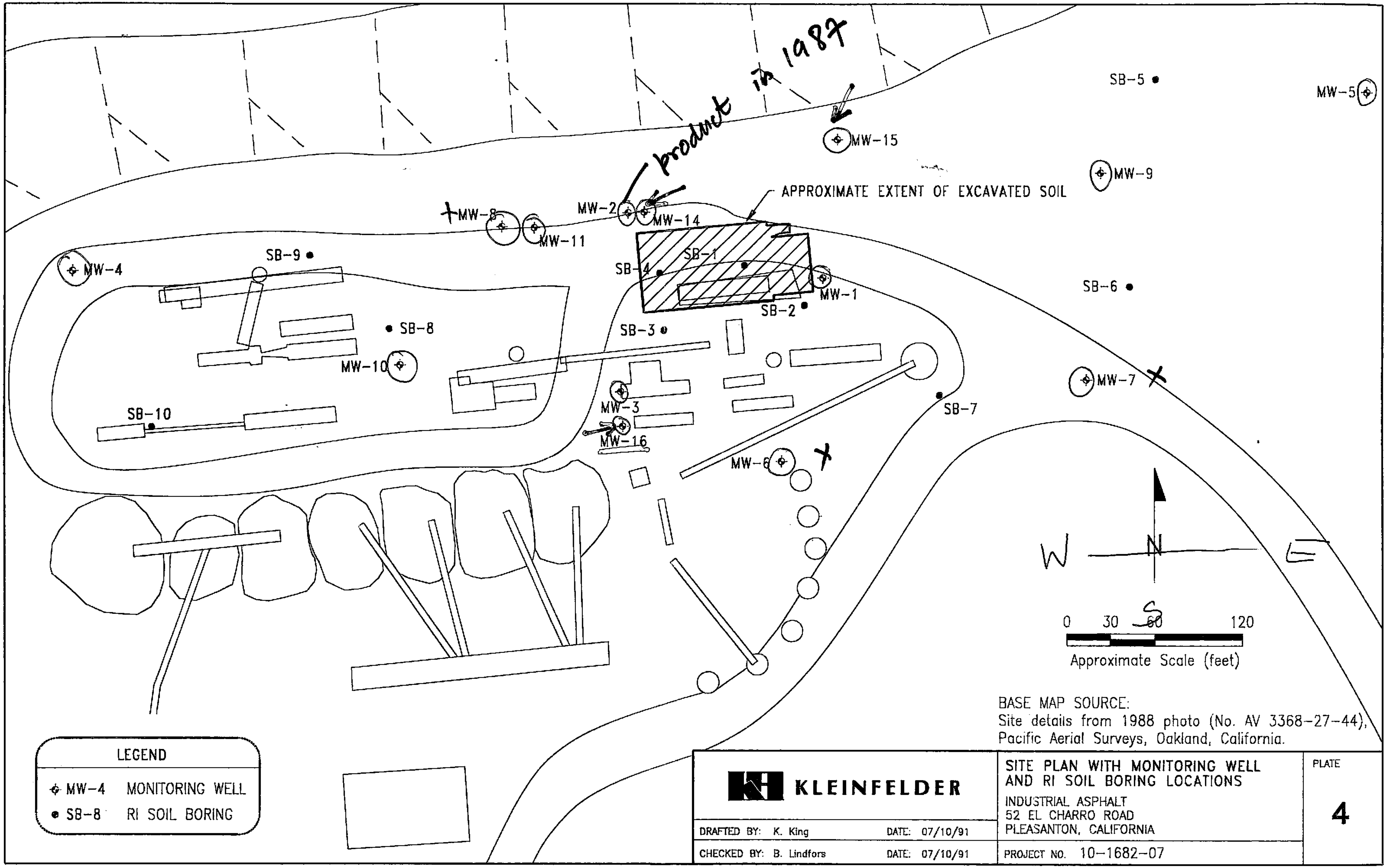
INDUSTRIAL ASPHALT
52 EL CHARRO ROAD
PLEASANTON, CALIFORNIA

PLATE 3

DRAFTED BY: K King DATE: 07/10/91

CHECKED BY: B [illegible] DATE: 07/10/91

PROJECT NO 10-1682-07



LEGEND

⌖ MW-4	MONITORING WELL
● SB-8	RI SOIL BORING

BASE MAP SOURCE:
Site details from 1988 photo (No. AV 3368-27-44),
Pacific Aerial Surveys, Oakland, California.

KLEINFELDER

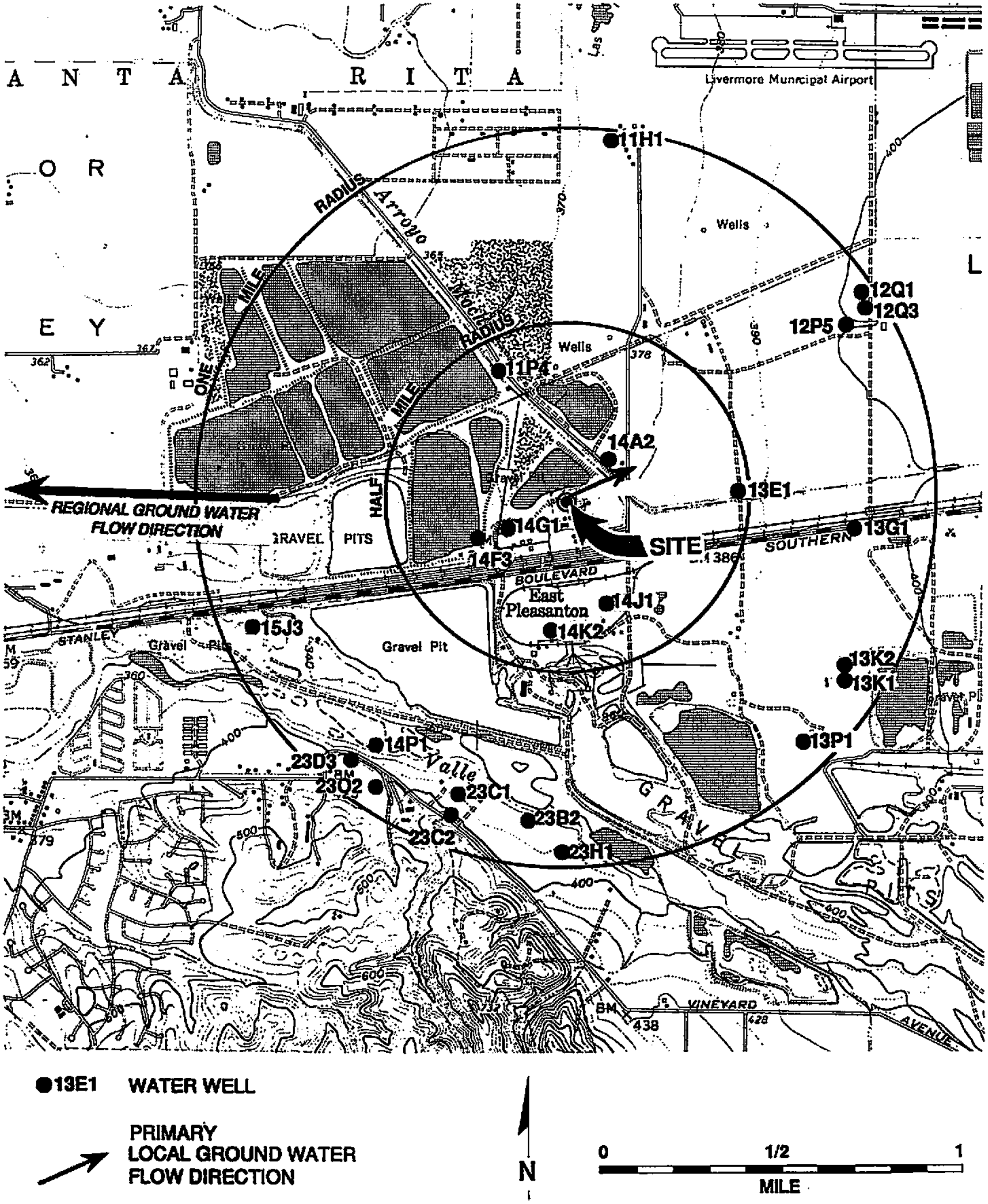
DRAFTED BY: K. King DATE: 07/10/91
CHECKED BY: B. Lindfors DATE: 07/10/91

SITE PLAN WITH MONITORING WELL AND RI SOIL BORING LOCATIONS

INDUSTRIAL ASPHALT
52 EL CHARRO ROAD
PLEASANTON, CALIFORNIA

PROJECT NO. 10-1682-07

PLATE
4



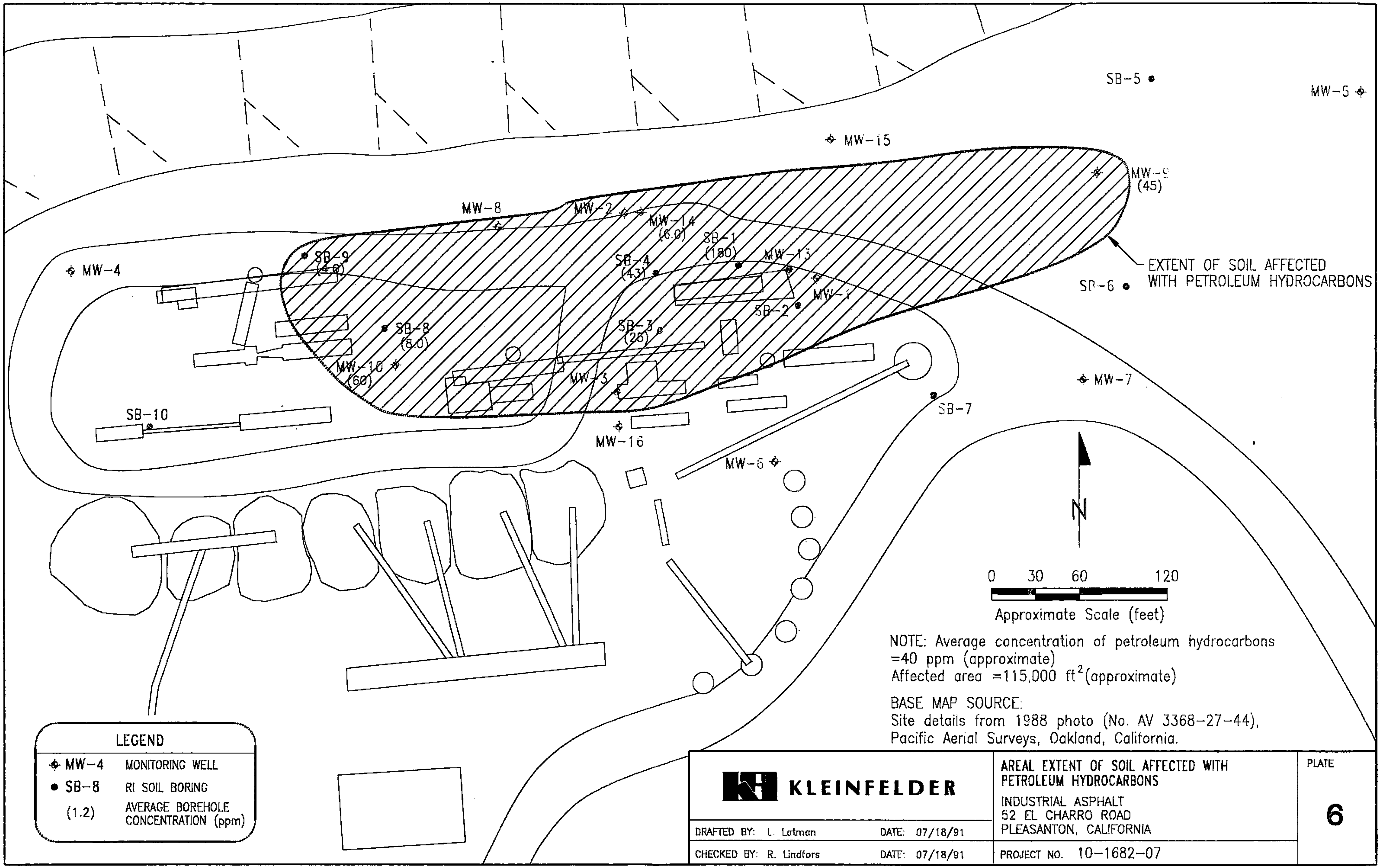
KLEINFELDER

PROJECT NUMBER 10-1682-07

LOCATION OF SUPPLY WELLS IN THE VICINITY OF THE INDUSTRIAL ASPHALT FACILITY

INDUSTRIAL ASPHALT
52 EL CHARRO ROAD
PLEASANTON, CALIFORNIA

PLATE
5



LEGEND

⌖ MW-4	MONITORING WELL
● SB-8	RI SOIL BORING
(1.2)	AVERAGE BOREHOLE CONCENTRATION (ppm)

NOTE: Average concentration of petroleum hydrocarbons =40 ppm (approximate)
Affected area =115,000 ft^2 (approximate)

BASE MAP SOURCE:
Site details from 1988 photo (No. AV 3368-27-44), Pacific Aerial Surveys, Oakland, California.

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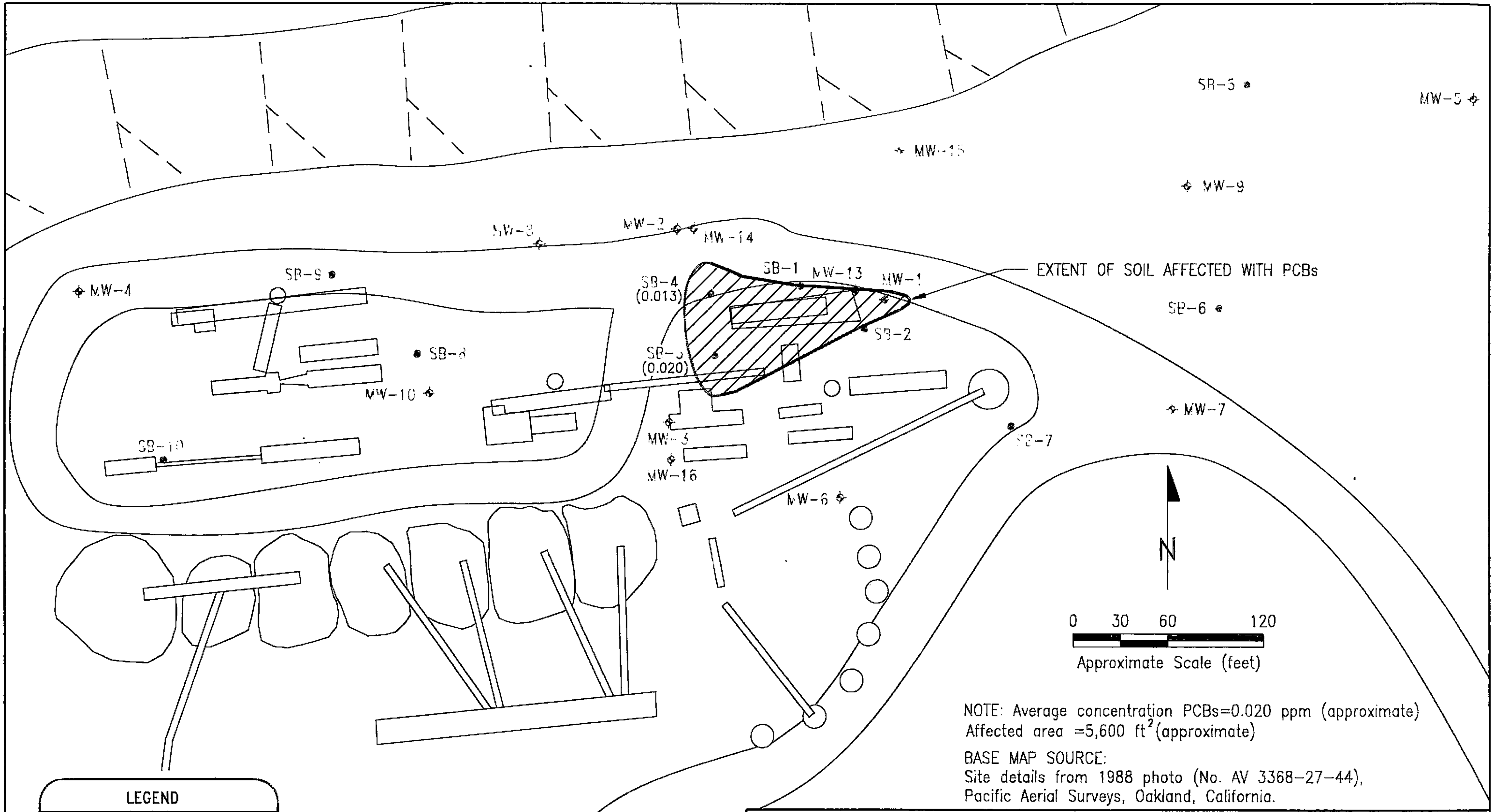
DRAFTED BY: L. Latman DATE: 07/18/91
CHECKED BY: R. Lindfors DATE: 07/18/91

AREAL EXTENT OF SOIL AFFECTED WITH PETROLEUM HYDROCARBONS
INDUSTRIAL ASPHALT
52 EL CHARRO ROAD
PLEASANTON, CALIFORNIA

PROJECT NO. 10-1682-07

PLATE
6



LEGEND

- ⌖ MW-4 MONITORING WELL
- ● SB-8 RI SOIL BORING
- (1.2) CONCENTRATION (ppm)

NOTE: Average concentration PCBs=0.020 ppm (approximate)
Affected area =5,600 ft^2 (approximate)

BASE MAP SOURCE:
Site details from 1988 photo (No. AV 3368-27-44),
Pacific Aerial Surveys, Oakland, California.

KLEINFELDER

AREAL EXTENT OF SOIL AFFECTED WITH PCBs

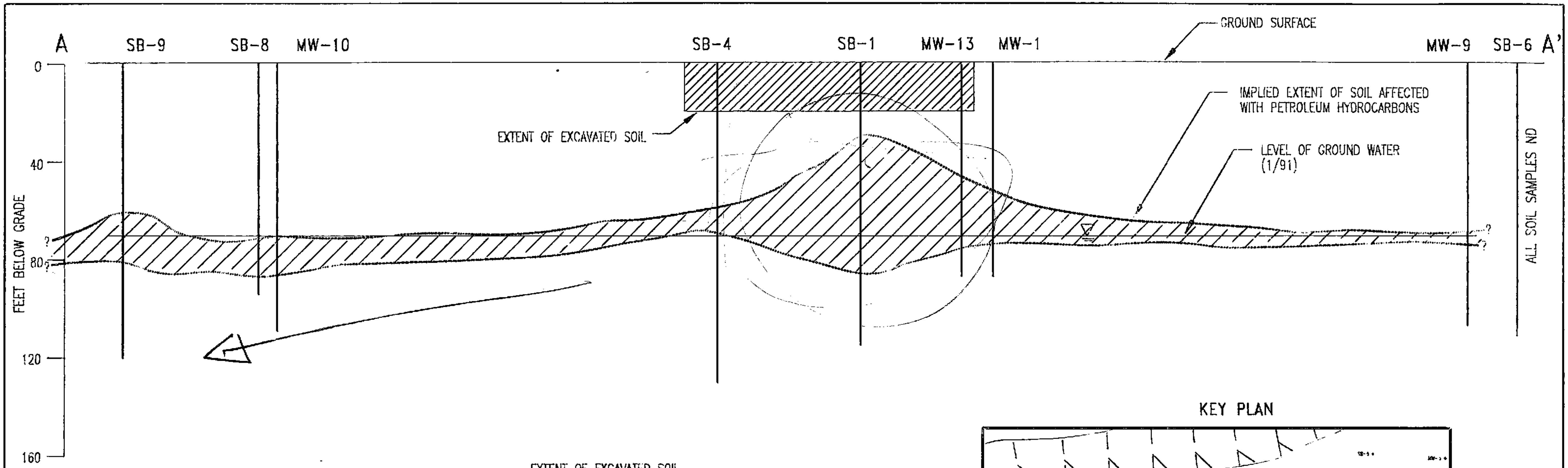
INDUSTRIAL ASPHALT
52 EL CHARRO ROAD
PLEASANTON, CALIFORNIA

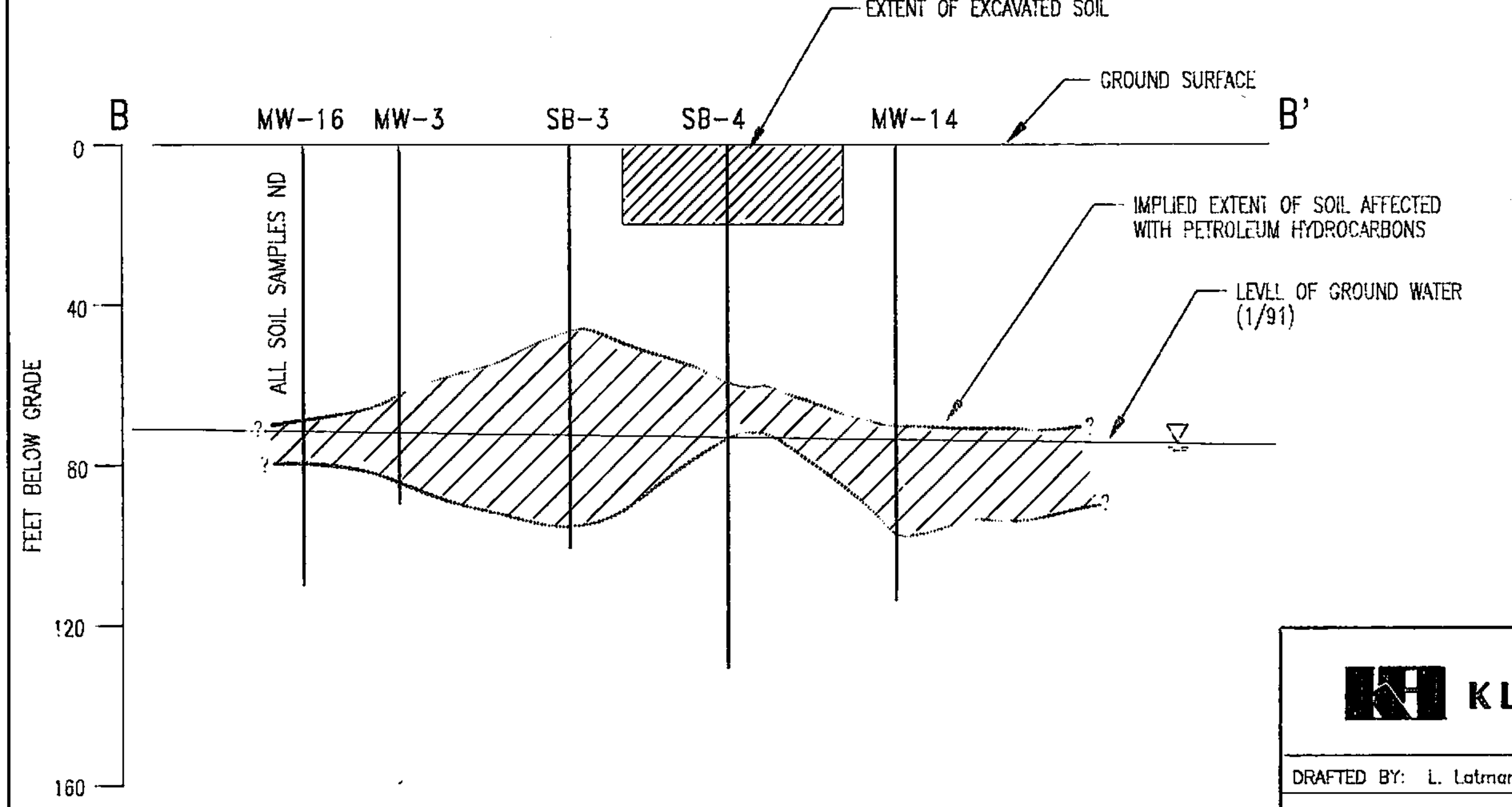
PLATE 7

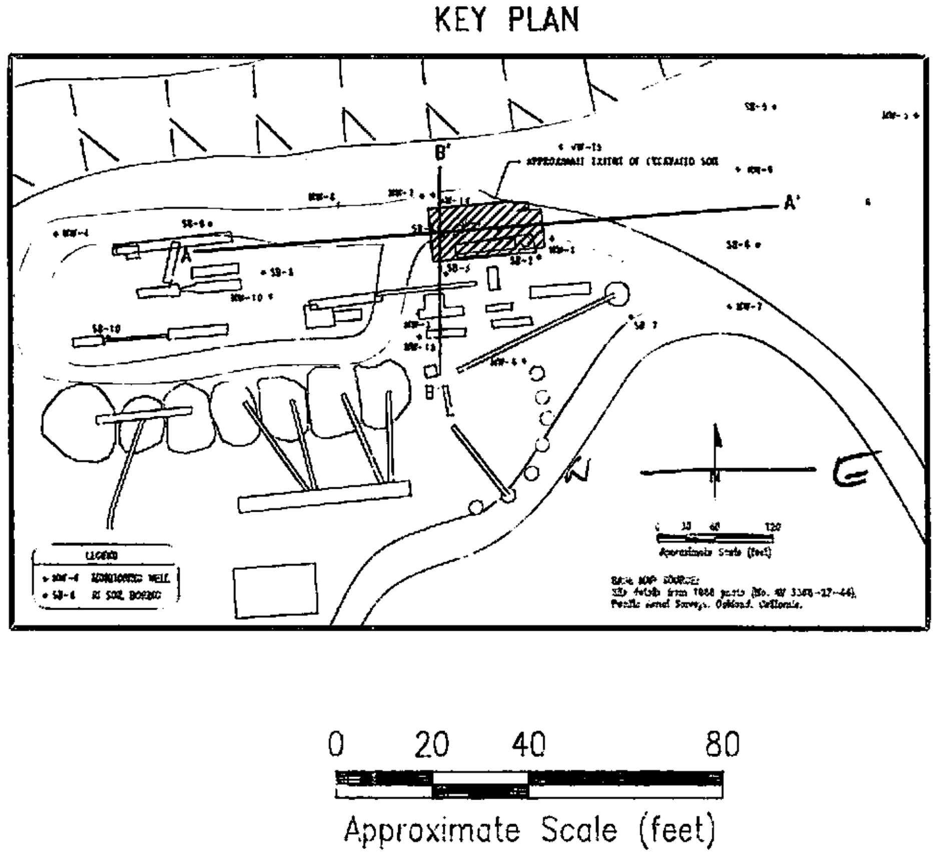
DRAFTED BY: L. Latman DATE: 07/18/91

CHECKED BY: R. Lindfors DATE: 07/18/91

PROJECT NO. 10-1682-07







KLEINFELDER

GENERALIZED CROSS-SECTIONS A-A', B-B', AND IMPLIED EXTENT OF SOIL AFFECTED WITH PETROLEUM HYDROCARBONS

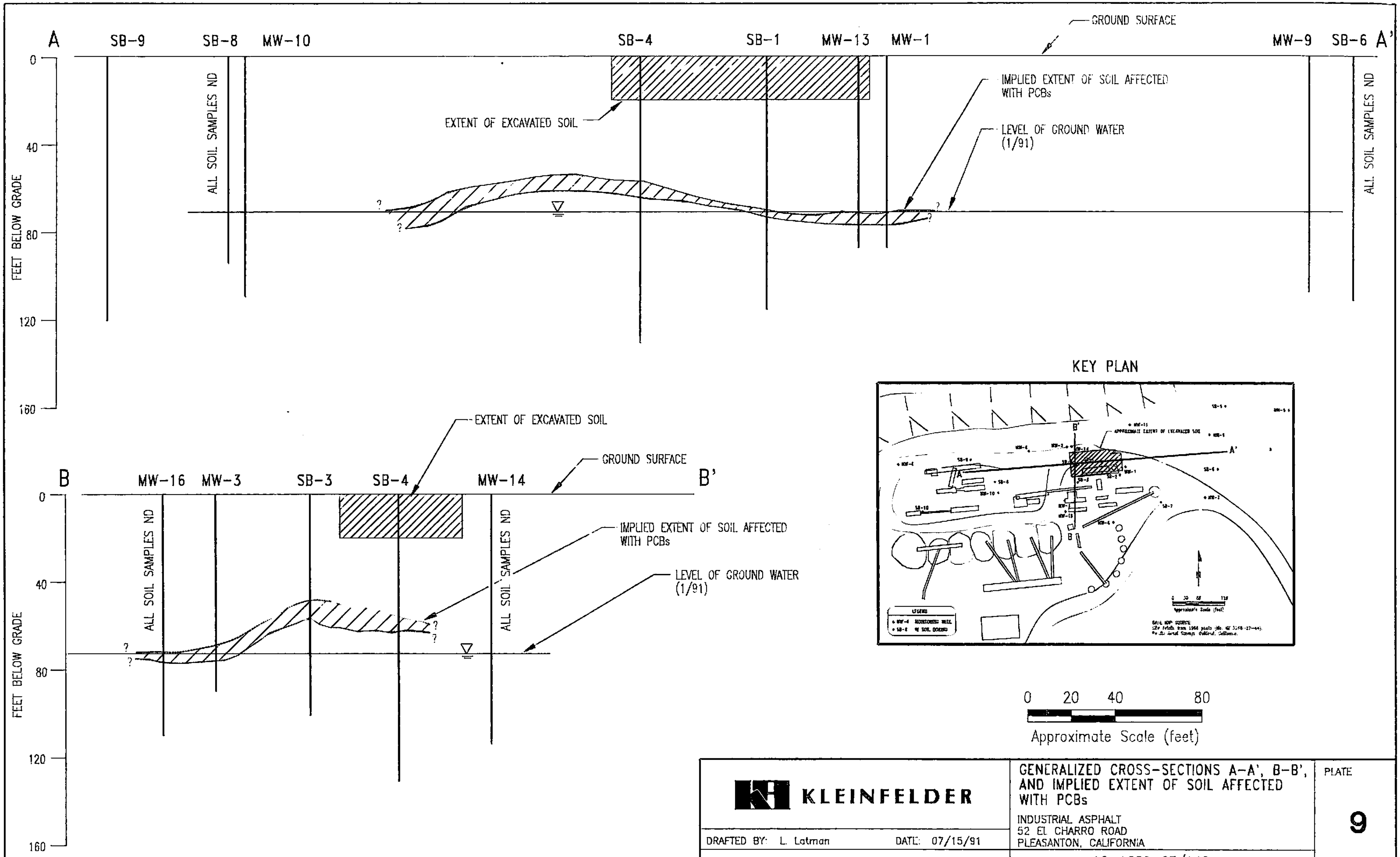
INDUSTRIAL ASPHALT
52 EL CHARRO ROAD
PLEASANTON, CALIFORNIA

PLATE
8

DRAFTED BY: L. Latman DATE: 07/15/91

CHECKED BY: R. Lindfors DATE: 07/16/91

PROJECT NO. 10-1682-07/140



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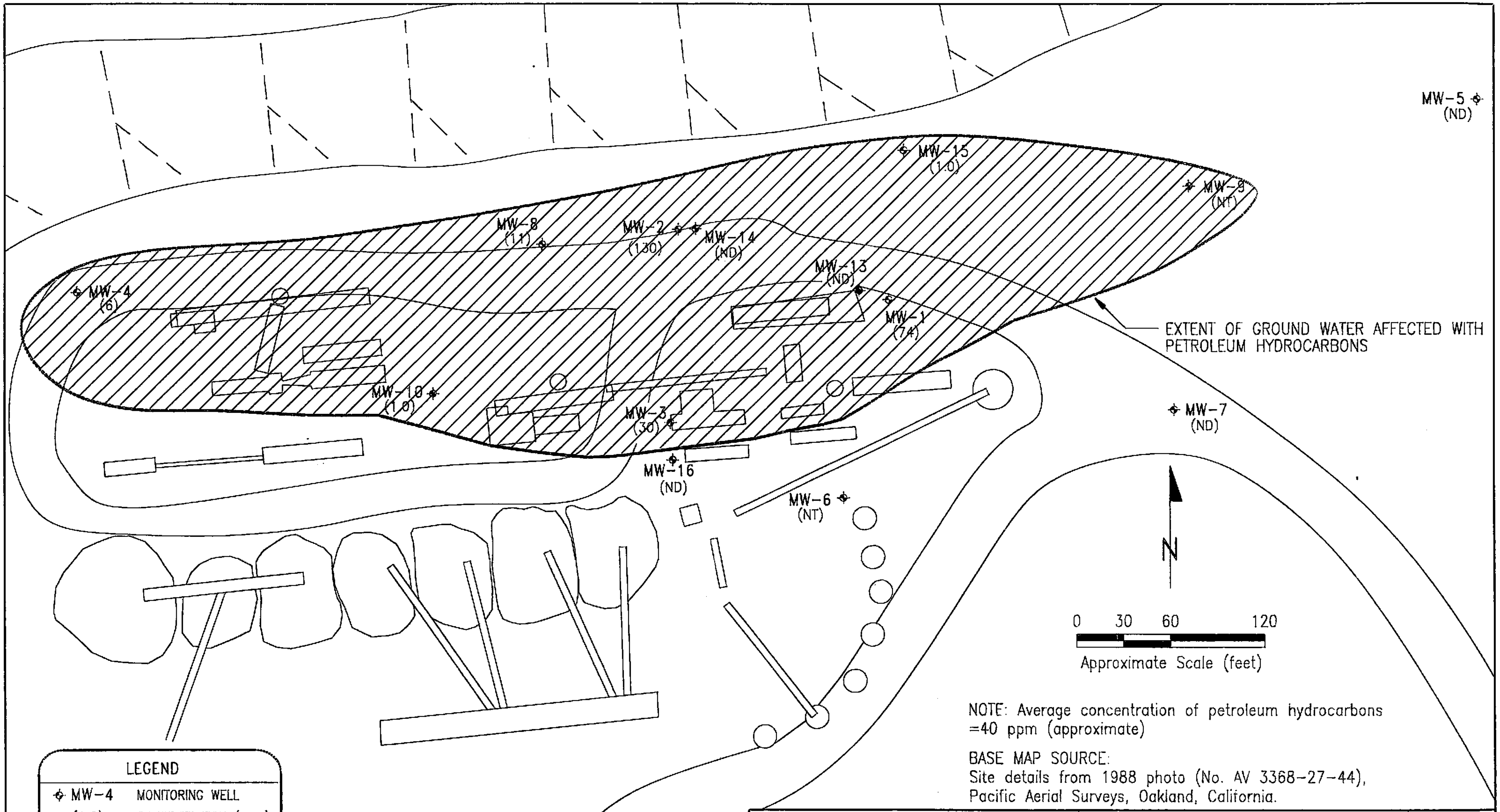
GENERALIZED CROSS-SECTIONS A-A', B-B', AND IMPLIED EXTENT OF SOIL AFFECTED WITH PCBs

INDUSTRIAL ASPHALT
52 EL CHARRO ROAD
PLEASANTON, CALIFORNIA

DRAFTED BY: L. Latman	DATE: 07/15/91	PLATE 9
CHECKED BY: R. Lindfors	DATE: 07/16/91	PROJECT NO. 10-1682-07/140



LEGEND	
⌖ MW-4	MONITORING WELL
(1.2)	CONCENTRATION (ppm)
(ND)	NOT DETECTED
(NT)	NOT TESTED

NOTE: Average concentration of petroleum hydrocarbons =40 ppm (approximate)

BASE MAP SOURCE:
Site details from 1988 photo (No. AV 3368-27-44),
Pacific Aerial Surveys, Oakland, California.

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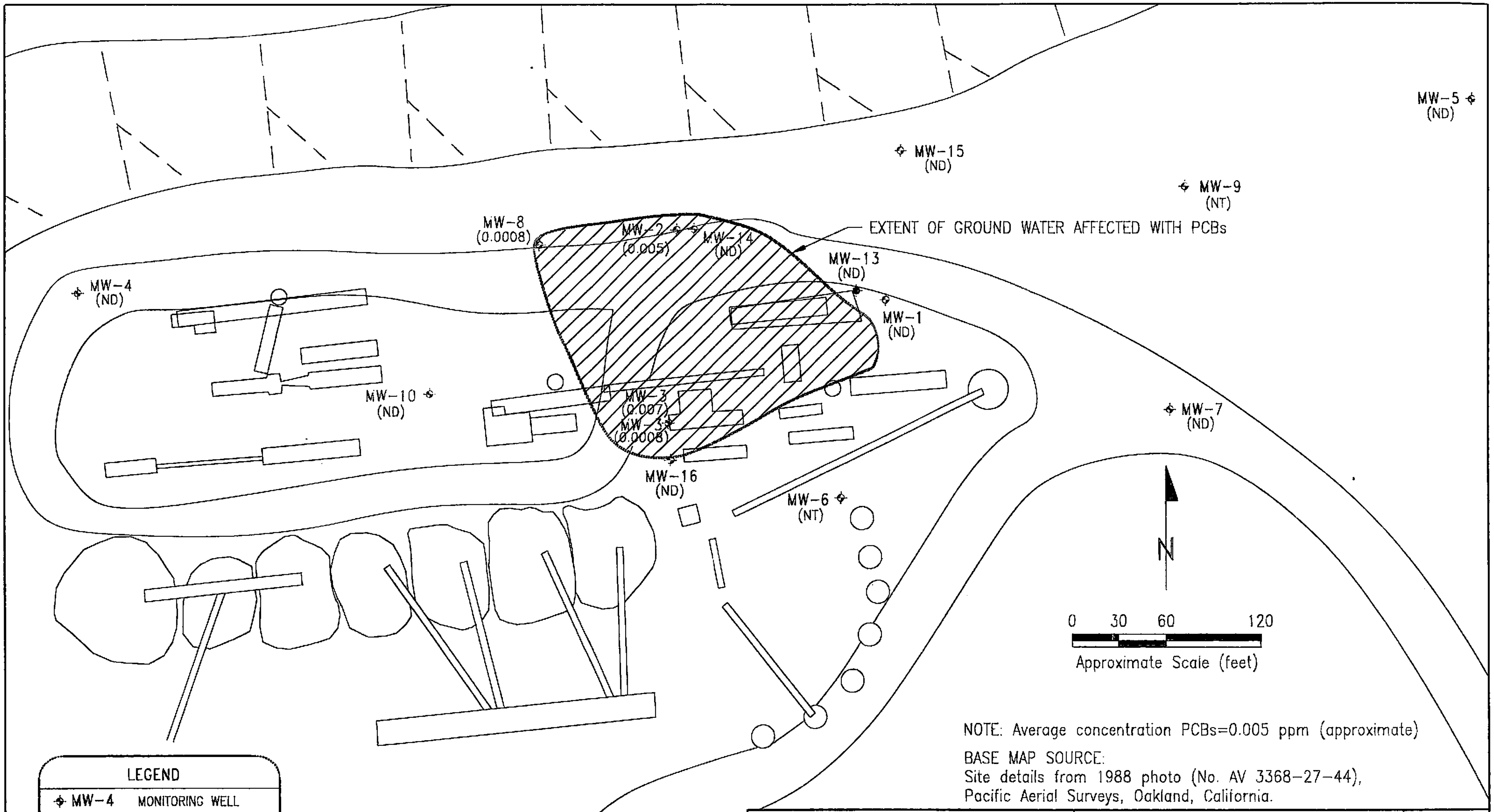
DRAFTED BY: L. Latman DATE: 07/18/91
CHECKED BY: R. Lindfors DATE: 07/18/91

AREAL EXTENT OF GROUND WATER AFFECTED WITH PETROLEUM HYDROCARBONS (April 1991)
INDUSTRIAL ASPHALT
52 EL CHARRO ROAD
PLEASANTON, CALIFORNIA
PROJECT NO. 10-1682-07

PLATE
10



LEGEND

⌖ MW-4	MONITORING WELL
(1.2)	CONCENTRATION (ppm)
(ND)	NOT DETECTED
(NT)	NOT TESTED

NOTE: Average concentration PCBs=0.005 ppm (approximate)

BASE MAP SOURCE:
Site details from 1988 photo (No. AV 3368-27-44),
Pacific Aerial Surveys, Oakland, California.

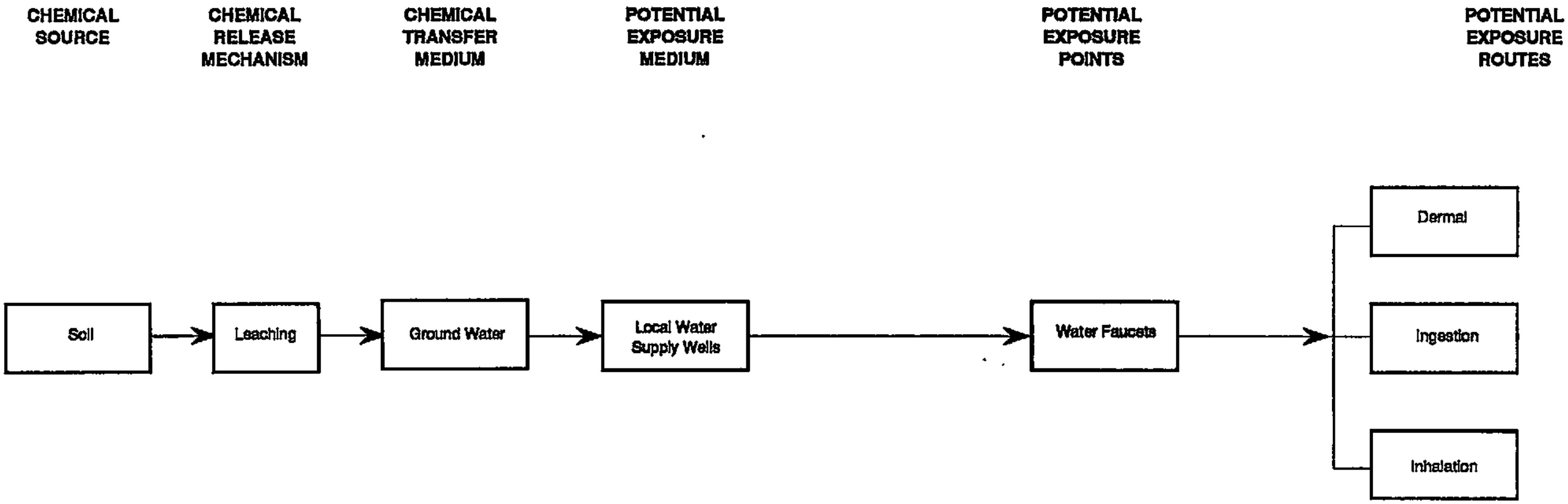
KLEINFELDER

DRAFTED BY: L. Latman DATE: 07/18/91
CHECKED BY: R. Lindfors DATE: 07/18/91

AREAL EXTENT OF GROUND WATER
AFFECTED WITH PCBs (April 1991)
INDUSTRIAL ASPHALT
52 EL CHARRO ROAD
PLEASANTON, CALIFORNIA

PROJECT NO. 10-1682-07

PLATE
11



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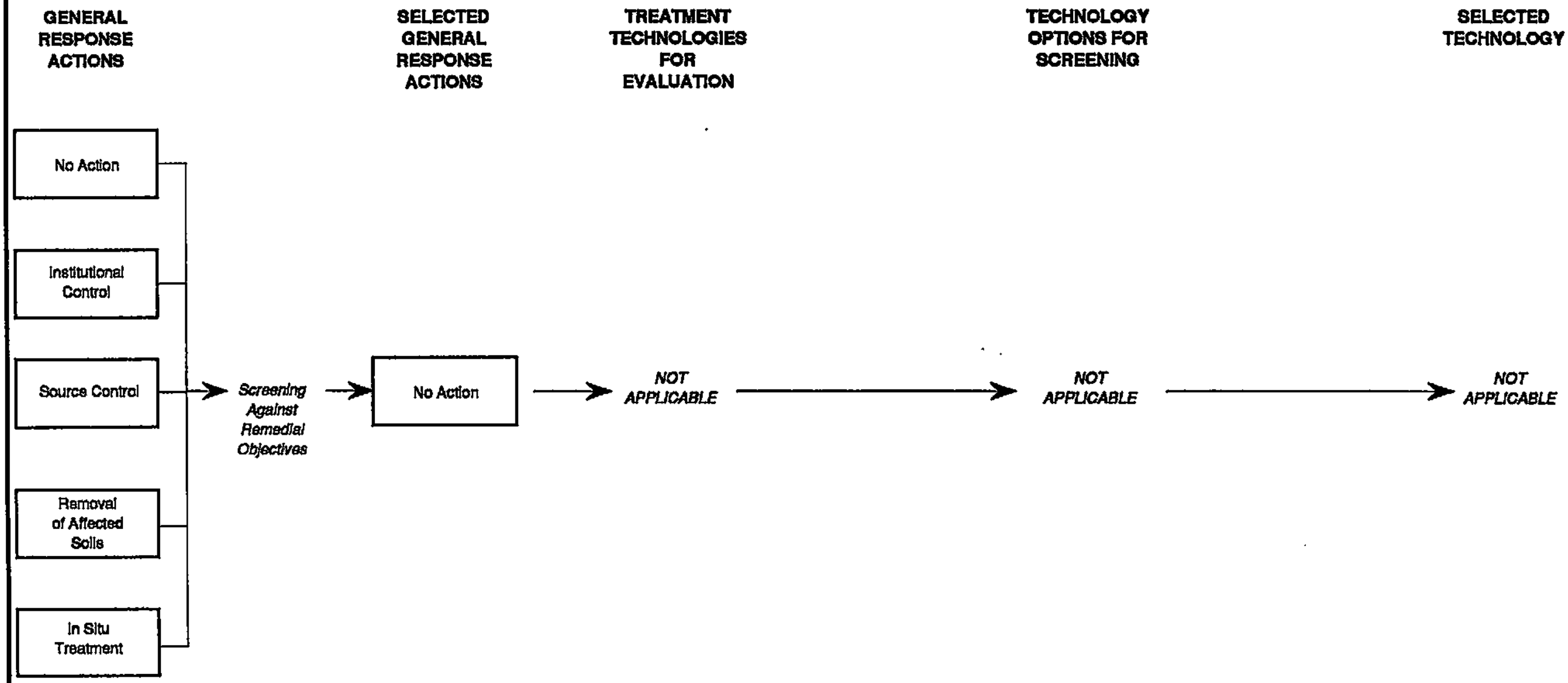
CONCEPTUAL EXPOSURE MODEL

INDUSTRIAL ASPHALT
52 EL CHARRO ROAD
PLEASANTON, CALIFORNIA

PLATE 12

DRAFTED BY: L. Sue DATE: 7-31-91
CHECKED BY: R. Lindfors DATE: 7-31-91
PROJECT NUMBER 10-1682-07



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DRAFTED BY: L. Sue **DATE:** 7-24-91

CHECKED BY: R. Lindfors **DATE:** 7-24-91

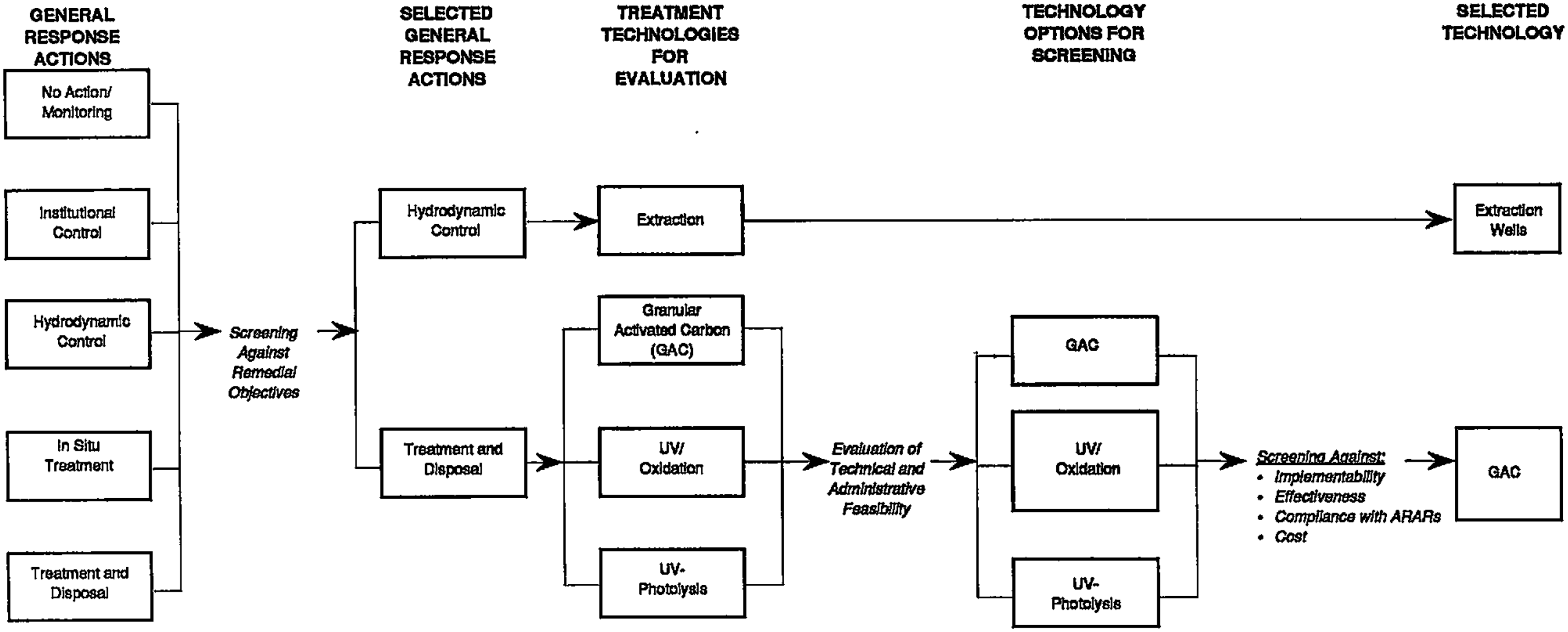
DECISION FLOW CHART — FEASIBILITY STUDY FOR SOIL REMEDIATION

INDUSTRIAL ASPHALT
52 EL CHARRO ROAD
PLEASANTON, CALIFORNIA

PROJECT NUMBER 10-1682-07

PLATE

13



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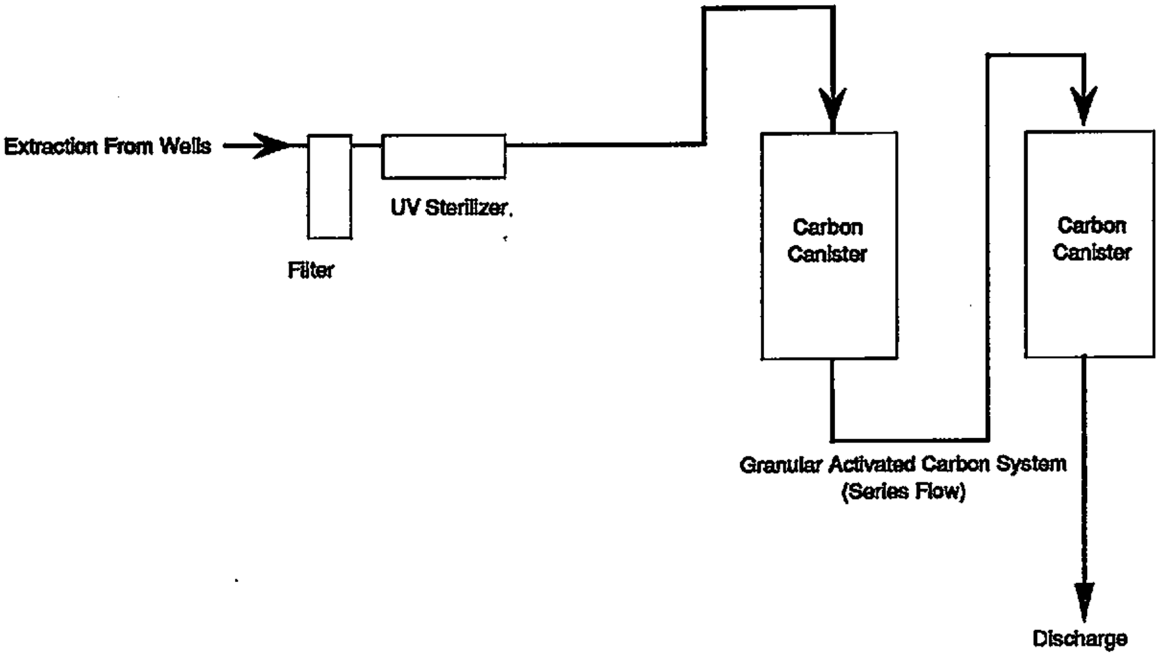
DECISION FLOW CHART — FEASIBILITY STUDY FOR GROUND WATER REMEDIATION

INDUSTRIAL ASPHALT
52 EL CHARRO ROAD
PLEASANTON, CALIFORNIA

PLATE
14

DRAFTED BY: L. Sue DATE: 7-24-91
CHECKED BY: R. Lindfors DATE: 7-24-91

PROJECT NUMBER 10-1682-07



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DRAFTED BY: L. Sue DATE: 7-24-91

CHECKED BY: R. Lindfors DATE: 7-24-91

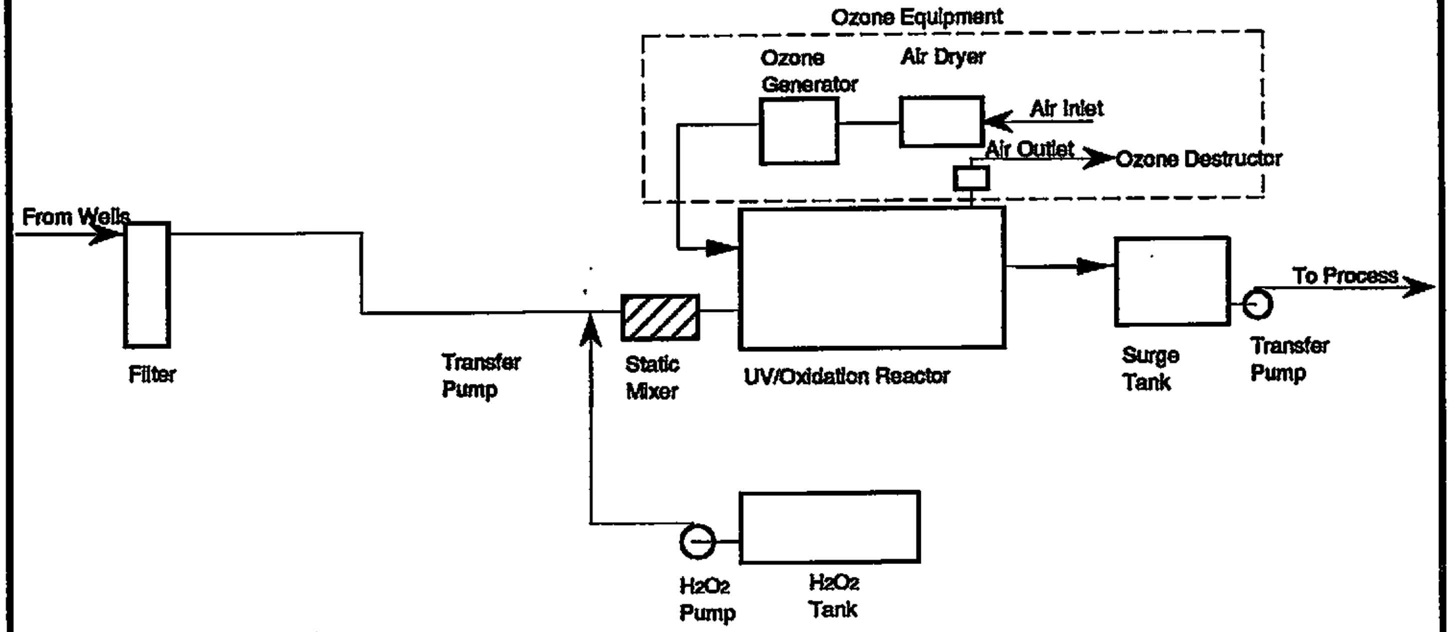
PROCESS FLOW DIAGRAM FOR GAC WATER TREATMENT SYSTEM

INDUSTRIAL ASPHALT
52 EL CHARRO ROAD
PLEASANTON, CALIFORNIA

PROJECT NO. 10-1682-07

PLATE

15



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DRAFTED BY: L. Sue DATE: 7-24-91

CHECKED BY: R. Lindfors DATE: 7-24-91

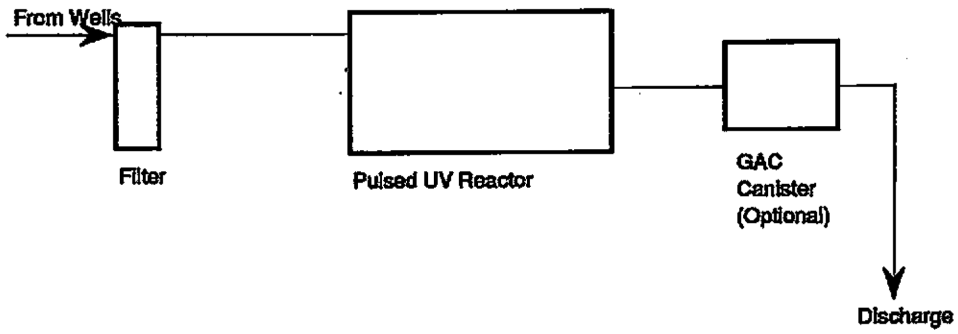
FLOW DIAGRAM FOR UV/OXIDATION TREATMENT SYSTEM

INDUSTRIAL ASPHALT
52 EL CHARRO ROAD
PLEASANTON, CALIFORNIA

PROJECT NO. 10-1682-07

PLATE

16



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DRAFTED BY: L. Sue DATE: 7-24-91

CHECKED BY: R. Lindfors DATE: 7-24-91

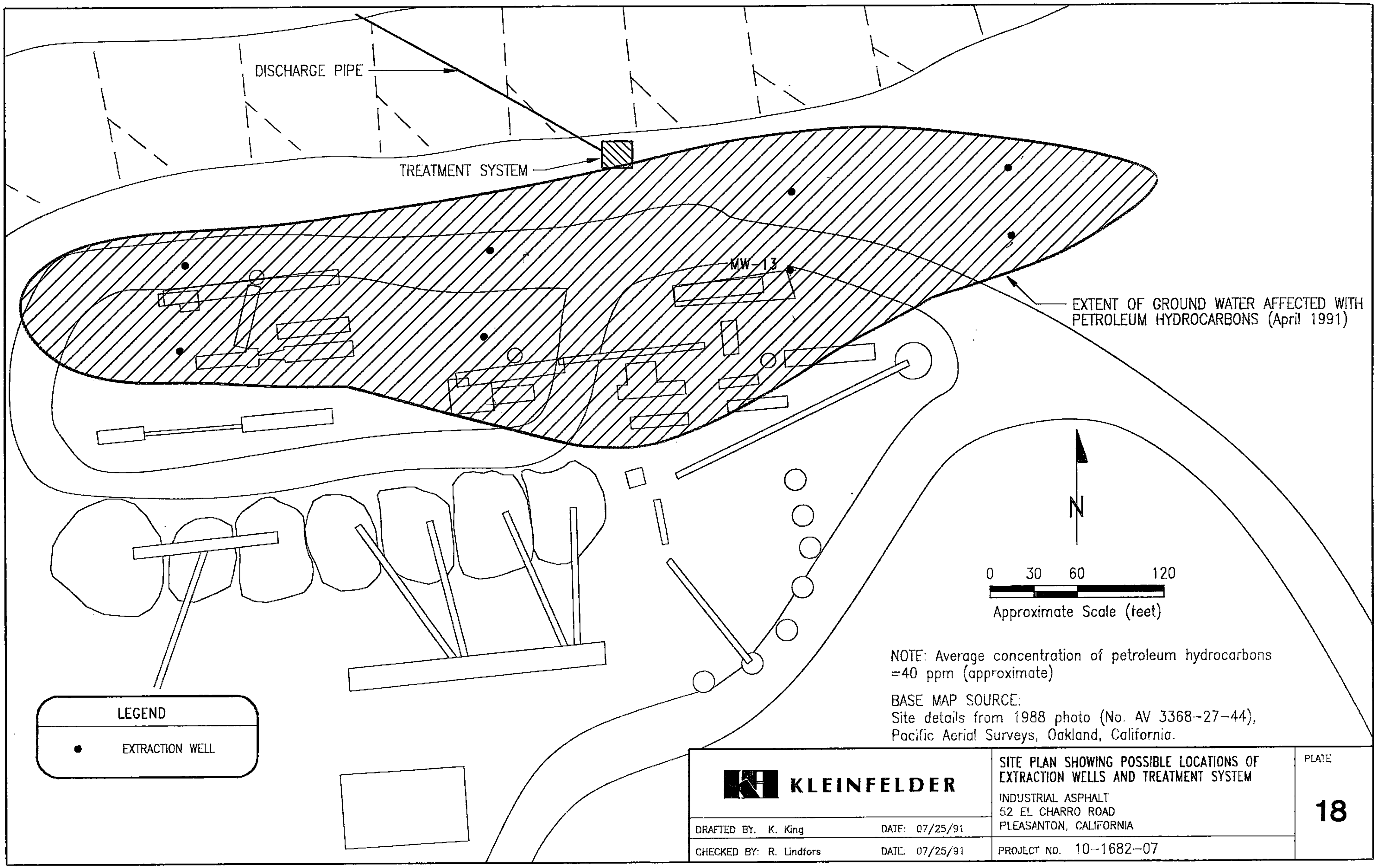
FLOW DIAGRAM FOR UV-PHOTOLYSIS TREATMENT SYSTEM

INDUSTRIAL ASPHALT
52 EL CHARRO ROAD
PLEASANTON, CALIFORNIA

PROJECT NO. 10-1682-07

PLATE

17



NOTE: Average concentration of petroleum hydrocarbons =40 ppm (approximate)

BASE MAP SOURCE:
Site details from 1988 photo (No. AV 3368-27-44),
Pacific Aerial Surveys, Oakland, California.

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SITE PLAN SHOWING POSSIBLE LOCATIONS OF EXTRACTION WELLS AND TREATMENT SYSTEM

INDUSTRIAL ASPHALT
52 EL CHARRO ROAD
PLEASANTON, CALIFORNIA

PLATE 18

DRAFTED BY: K. King DATE: 07/25/91

CHECKED BY: R. Lindfors DATE: 07/25/91

PROJECT NO. 10-1682-07

APPENDIX A

WATER QUALITY GOALS
FOR
HUMAN HEALTH AND WELFARE

(As Published by the California Regional Water Quality Control Board)

Reference: A Compilation of Water Quality Goals, RWQCB,
Central Valley Region, February 1991

ORGANIC CONSTITUENTS
WATER QUALITY GOALS — HUMAN HEALTH AND WELFARE

ORGANIC CONSTITUENT	Drinking Water Standards (DHS & EPA) Maximum Contaminant Levels (MCLs)			California State Action Levels Department of Health Services (DHS)		Health Advisories or Suggested No-Adverse-Response Levels (SNARLs) (also see cancer risk estimates)		California Proposition 65 Regulatory Level as Water Quality Criterion (14)	One-in-a-Million Incremental Cancer Risk Estimates			EPA National Ambient Water Quality Criteria based on:	
	California MCLs unless noted with "‡"		EPA						EPA National Ambient Water Quality Criteria	EPA Health or Water Quality Advisories	National Academy of Sciences (NAS)		
	Primary MCL	Secondary MCL	MCL Goal	Toxicity	Taste & Odor	EPA	NAS					Public Health Effects	Taste & Odor or Welfare
Acenaphthene													20
Acenaphthylene									0.0028 (41)	(D)			
Acetaldehyde								45					
Acifluorfen						2000 (10-day)				1 (B2)			
Acrolein										(C)		320	
Acrylamide	‡(105)		zero (93)			20 / 7 (7-yr,7)		0.1		0.01 (B2)	0.024		
Acrylonitrile						1 / 4 (7-yr,7,68)		0.35	0.058	0.07 (B1,68)	0.38		
Alachlor	2‡ (93)		zero (93)	0.2		100 (10-day)	700			0.4 (B2)			
Aldicarb	3‡ (100)		1 (100)	10		10	0.2 / 0.7 (7)			(D)	2.3 (21)		
Aldicarb sulfone	3‡ (100)		2 (100)			40				(D)			
Aldicarb sulfoxide	3‡ (100)		1 (100)			10				(D)			
Aldrin				0.05		0.3 (10-day,68)		0.02	0.000074	0.002 (B2,68)	0.003		
Ametryn						60				(D)			
Aniline								50					
Anthracene									0.0028 (41)	(D)			
Atrazine	3 / 3‡(93)		3 (93)			3	150			(C)			
Azinphos-methyl							87.5						
Azobenzene								3					
Baygon				90		3				(C)			
Benefin							700						
Bentazon	18					20				(D)			
Benz(a)anthracene	0.2‡ (100)		zero (100)						0.0028 (41)	(B2)			
Benzene	1 / 5‡		zero			200 (10-day)		3.5	0.66	1 (A)			
Benzenes, chlorinated													
Benzenes, dichloro-												400	
Benzenes, trichloro-													
Benzidine								0.0005	0.00012	(A)			
Benzidines, dichloro-									0.01				
Benzo(b)fluoranthene	0.2‡ (100)		zero (100)						0.0028 (41)	(B2)			
Benzo(k)fluoranthene	0.2‡ (100)		zero (100)						0.0028 (41)	(B2)			
Benzo(g,h,i)perylene									0.0028 (41)	(D)			
Benzo(a)pyrene	0.2‡ (100)		zero (100)					0.03	0.0028 (41)	(B2)			
alpha-BHC				0.7			500 (7-day,43)	0.15	0.0092		0.33		
beta-BHC				0.3			500 (7-day,43)	0.25	0.0163		0.12		
gamma-BHC (Lindane)	4 / 0.2‡(93)		0.2 (93)			0.2	500 (7-day,43)	0.3	0.0186	0.03 (C)	0.054		
delta-BHC							500 (7-day,43)						
technical-BHC							500 (7-day)	0.1	0.0123				
Bis(2-chloroethyl) ether								0.15	0.03		0.42		
Bis(2-chloroethoxy) methane													
Bis(2-chloroisopropyl) ether						300						34.7	
Bis(chloromethyl) ether								0.01	0.00000378				
Bromacil						90	87.5			(C)			
Bromochloromethane						90 (68)							
Bromodichloromethane	100 (19)					400 / 1300 (7-yr,7,68)			0.19	0.3 (B2,68)			
Bromoform	100 (19)					2000 (10-day,68)			0.19	(B2)			
Bromomethane						10			0.19	(D)			
4-Bromophenyl phenyl ether													
Butachlor							70						
1,3-Butadiene								0.2					
Butylate						350				(D)			
n-Butyl benzyl phthalate	100‡ (100)		100 (100)							(C)			
Captan				350			350			(B2)			
Carbaryl				60		700	574			(D)			
Carbofuran	18 / 40‡(93)		40 (93)			40				(E)			
Carbon tetrachloride	0.5 / 5‡		zero			70 / 300 (7-yr,7)	200 (7-day)	2.5	0.4	0.3 (B2)	4.5		
Carboxin						700				(D)			
Catechol							2200 (24-hr)						
Chloramben						100	1750			(D)			
Chlordane	0.1 / 2‡(93)		zero (93)			60 (10-day)		0.25	0.00048	0.03 (B2)	0.028		
Chlorobenzene	30 / 100‡(93)		100 (93)			100				(D)	2.3 (21)	488	20

Values are in µg/l (ppb) unless otherwise indicated. Numbers in parentheses indicate footnotes.

ORGANIC CONSTITUENTS
WATER QUALITY GOALS — HUMAN HEALTH AND WELFARE

ORGANIC CONSTITUENT	Drinking Water Standards (DHS & EPA) Maximum Contaminent Levels (MCLs)			California State Action Levels Department of Health Services (DHS)		Health Advisories or Suggested No-Adverse-Response Levels (SNARLs) (also see cancer risk estimates)		California Proposition 65 Regulatory Level as Water Quality Criterion (14)	One-in-a-Million Incremental Cancer Risk Estimates			EPA National Ambient Water Quality Criteria based on:	
	California MCLs unless noted with "‡"		EPA MCL Goal										
	Primary MCL	Secondary MCL		Toxicity	Taste & Odor	EPA	NAS		EPA National Ambient Water Quality Criteria	EPA Health or Water Quality Advisories	National Academy of Sciences (NAS)	Public Health Effects	Taste & Odor or Welfare
4-Chloro-o-cresol													1800
4-Chloro-m-cresol													3000
6-Chloro-m-cresol													20
Chloroform	100 (19)					100 / 500 (7-yr,7,68)		4.5	0.19	6 (B2,68)	0.28 / 5.6 (44)		
Chloromethane						3 (68)			0.19	(C)			
2-Chloronaphthalene													
2-Chlorophenol						40 (68)				(D)			0.1
3-Chlorophenol													0.1
4-Chlorophenol													0.1
Chloropicrin				50	37		12 / 40 (7)	15					
3-Chloropropene													
Chlorothalonil						200 (10-day)				1.5 (B2)			
2-Chlorotoluene						100				(D)			
4-Chlorotoluene						100				(D)			
Chlorpropham				350									
Chlorpyrifos						20 (68)				(D)			
Chrysene	0.2‡ (100)		zero (100)						0.0028 (41)	(B2)			
Cyanazine						10				(D)			
2,4-D	100 / 70‡(93)		70 (93)			70	87.5			(D)		100	
Dacthal (DCPA)						4000				(D)			
Dalapon	200‡ (100)		200 (100)			200				(D)			
DBCP	0.2 / 0.2‡(93)		zero (93)			50 (10-day)		0.05	0.025	0.03 (B2)	0.051		
DDD								1 (50)					
DDE								1 (50)					
DDT								1 (50)	0.000024	(B2)	0.042		
Demeton													
Diazinon				14		0.6	14			(E)			
Dibenz(a,h)anthracene	0.2‡ (100)		zero (100)						0.0028 (41)	(B2)			
Dibromoacetonitrile						20 (68)	23 / 161 (7)			(C)			
Dibromochloromethane	100 (19)					20 (68)	18,000 (24-hr)			(C)	0.8		
Dibutyl phthalate	4 (100)		zero (100)				770			(D)		34,000	
Dicamba						200	8.75			(D)			
Dichloroacetic acid						3 (68)	175 / 420 (7)			(C)			
Dichloroacetonitrile						6 (68)				(C)			
1,2-Dichlorobenzene	600‡ (93)	10‡ (100)	600 (93)	130 (77)	10	600	300 (25)			(D)		400 (24)	
1,3-Dichlorobenzene	600‡ (100)		600 (100)	130 (77)	20	600				(D)		400 (24)	
1,4-Dichlorobenzene	5 / 75‡	5‡ (100)	75			75	94 (25)	10		(C)		400 (24)	
3,3'-Dichlorobenzidine								0.3	0.01 (52)				
Dichlorodifluoromethane						1000	5600 (7-day)		0.19	(D)			
1,1-Dichloroethane	5									(C)			
1,2-Dichloroethane	0.5 / 5‡		zero			700 (10-day)		5	0.94	0.4 (B2)	0.71		
1,1-Dichloroethylene	6 / 7‡		7			7	100		0.033	0.0002 (C)			
cis-1,2-Dichloroethylene	6 / 70‡(93)		70 (93)			70				(D)			
trans-1,2-Dichloroethylene	10 / 100‡(93)		100 (93)			100				(D)			
Dichloromethane	5‡ (100)		zero (100)	40		1500 (10-day)	5000 (7-day)	25	0.19	5 (B2)			
2,3-Dichlorophenol													0.04
2,4-Dichlorophenol						20 (68)	2000/7000 (7)			(D)		3090	0.3
2,5-Dichlorophenol													0.5
2,6-Dichlorophenol													0.2
3,4-Dichlorophenol													0.3
1,2-Dichloropropane	5 / 5‡(93)		zero (93)							0.5 (B2)			
1,3-Dichloropropene	0.5					30 (10-day)				0.2 (B2)	0.45	87 (29)	
Dichlorvos								1					
Dieldrin				0.05		0.5 (10-day)		0.02	0.000071	0.002 (B2)	0.0019		
Diesel Oil						100 (10-day)							
Di(ethylhexyl) adipate	500‡ (100)		500 (100)			500				(C)			
Di(2-ethylhexyl) phthalate	4 / 4‡(100)		zero (100)				4200	40		3 (B2,68)	2.4	15,000	
Diethyl phthalate	4‡(100)		zero (100)							(D)		350000	
Diisopropyl methyl phosphonate						600				(D)			
Dimethoate				140									

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ORGANIC CONSTITUENT	Drinking Water Standards (DHS & EPA) Maximum Contaminant Levels (MCLs)			California State Action Levels Department of Health Services (DHS)		Health Advisories or Suggested No-Adverse-Response Levels (SNARLs) (also see cancer risk estimates)		California Proposition 65 Regulatory Level as Water Quality Criterion (14)	One-in-a-Million Incremental Cancer Risk Estimates			EPA National Ambient Water Quality Criteria based on:	
	California MCLs unless noted with "‡"		EPA						EPA National Ambient Water Quality Criteria	EPA Health or Water Quality Advisories	National Academy of Sciences (NAS)		
	Primary MCL	Secondary MCL	MCL Goal	Toxicity	Taste & Odor	EPA	NAS					Public Health Effects	Taste & Odor or Welfare
Dimethrin						2000				(D)			
2,4-Dimethylphenol					400								400
Dimethyl phthalate	4‡ (100)		zero (100)							(D)		313000	
1,3-Dinitrobenzene						1 (58)				(D)			
2,4-Dinitro-o-cresol												13.4	
Dinitrophenol							110					70	
2,4-Dinitrophenol							110					70	
2,4-Dinitrotoluene								1	0.11	0.113			
2,6-Dinitrotoluene													
Dinoseb	7‡ (100)		7 (100)			7	39			(D)			
Di(n-octyl) phthalate													
1,4-Dioxane						400 (10-day)		15		7 (B2)			
Diphenamid				40		200				(D)			
1,2-Diphenylhydrazine									0.042				
Diquat	20‡ (100)		20 (100)							(D)			
Disyston						0.3	0.7			(E)			
Diuron						10				(D)			
Endosulfan												74	
Endosulfan sulfate						74 (104)							
Endothall	100‡ (100)		100 (100)			100				(D)			
Endrin	0.2 / 2‡(100)		2 (100)			2				(D)		0.2	
Epichlorohydrin	‡(105)		zero (93)			70 (7-yr)	530 (7-day)	4.5		4 (B2)			
Ethers, chloroalkyl-													
Ethers, halo-													
Ethion				35									
Ethylbenzene	680 / 700‡(93)	30‡ (100)	700 (93)			700				(D)		1400	
Ethylene dibromide (EDB)	0.02 / 0.05‡(93)		zero (93)			8 (10-day)		0.1		0.0004 (B2)	0.055		
Ethylene glycol						7000				(D)			
Ethylene oxide (ETO)								10(5) / 1					
Ethylenes, dichloro-													
Ethylene thiourea (ETU)						100 / 400 (7-yr,7)				0.06 (B2)	0.23		
Fenamiphos						2				(D)			
Ferbam							87.5						
Fluometuron						90				(D)			
Fluoranthene										(D)		42	
Fluorene	0.2‡ (100)		zero (100)						0.0028 (41)	(D)			
Folpet							1120	100		(B2)			
Fonofos						10				(D)			
Formaldehyde				30		1000 (68)		7.5		(B1-inhalation)			
Furmecyclox								10					
Glyphosate	700 / 700‡(100)		700 (100)			700				(D)			
Heptachlor	0.01 / 0.4‡(93)		zero (93)			5 (7-yr)		0.1	0.00028	0.008 (B2)	0.012		
Heptachlor epoxide	0.01 / 0.2‡(93)		zero (93)			0.1 (7-yr)		0.04		0.004 (B2)			
Hexachlorobenzene	1‡ (100)		zero (100)			50 (10-day)	30 (7-day)	0.2	0.00072	0.02 (B2)	0.017		
Hexachlorobutadiene						1			0.45	0.5 (C)			
Hexachlorocyclopentadiene	50‡ (100)	8‡ (100)	50 (100)							(D)		206	1
Hexachloroethane						1 (68)			1.9	(C)			
Hexachlorophene						0.35 (68)	7						
n-Hexane						4000 (10-day)				(D)			
Hexazinone						200				(D)			
HMX						400				(D)			
Indeno(1,2,3-c,d)pyrene	0.2‡ (100)		zero (100)						0.0028 (41)	(B2)			
Isophorone						100 (68)				8 (C)		5200	
Isopropanol						1000 (24-hr,68)							
Kepone											0.011		
Kerosene						100 (10-day)							
Malathion				160		200 (68)	160			(D)			
Maleic hydrazide						4000				(D)			
Maneb							35						
MCPA						11	8.75			(E)			

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ORGANIC CONSTITUENT	Drinking Water Standards (DHS & EPA) Maximum Contaminant Levels (MCLs)			California State Action Levels Department of Health Services (DHS)		Health Advisories or Suggested No-Adverse-Response Levels (SNARLs) (also see cancer risk estimates)		California Proposition 65 Regulatory Level as Water Quality Criterion (14)	One-in-a-Million Incremental Cancer Risk Estimates			EPA National Ambient Water Quality Criteria based on:	
	California MCLs unless noted with "‡"		EPA						EPA National Ambient Water Quality Criteria	EPA Health or Water Quality Advisories	National Academy of Sciences (NAS)	Public Health Effects	Taste & Odor or Welfare
	Primary MCL	Secondary MCL	MCL Goal	Toxicity	Taste & Odor	EPA	NAS						
Methanes, halo-	100 (19)												
Methomyl						200	175			(D)			
Methoxychlor	100 / 40‡(93)		40 (93)			400	700			(D)		100	
Methyl t-butyl ether (MTBE)						40 (68)				(D)			
4,4'-Methylene bis(N,N-dimethyl)aniline								10					
Methyl ethyl ketone (MEK)						200				(D)			
Methyl methacrylate						35 (68)	800						
Methyl parathion				30		2	30			(D)			
Metolachlor						100				(C)			
Metribuzin						200				(D)			
Mirex										4.9 / 0.090ng/l (51,82)			
Molinate	20												
Nabam													
Naphthalene						20 (68)				(D)			
Naphthalenes, chlorinated													
Nitralin							700						
Nitrobenzene							5 (7-day)					19,800	30
Nitrofen											0.0089		
Nitroguanidine						700				(D)			
2-Nitrophenol							290 (7-day,37)						
4-Nitrophenol						60 (68)	290 (7-day,37)			(D)			
Nitrophenol							290 (7-day)						
Nitrosamines													
N-Nitrosodi-n-butylamine								0.03	0.0064	0.0064			
N-Nitrosodiethanolamine								0.15					
N-Nitrosodiethylamine								0.01	0.0008				
N-Nitrosodimethylamine								0.02	0.0014				
N-Nitrosodiphenylamine								40	4.9				
N-Nitrosodipropylamine								0.05					
N-Nitroso-N-ethylurea								0.015					
N-Nitrosomethylethylamine								0.015					
N-Nitroso-N-methylurea								0.003					
N-Nitrosopyrrolidine								0.15	0.016				
trans-Nonachlor													
Oil & grease													
Oxamyl	200‡ (100)		200 (100)			200				(E)			
Oxychlordane													
PAHs	see individual chemicals		see individ. chemicals	see individ. chemicals		see individual chemicals			0.0028				
Paraquat						30	59.5			(E)			
Parathion				30			30			(C)			
Pentachlorobenzene												74	
Pentachloroethane													
Pentachloronitrobenzene				0.9						(C)	3.6		
Pentachlorophenol	1‡ (100)	30‡ (100)	zero (100)	30		300 (10-day)	6 / 21 (7)	20		0.3 (B2)		1010	30
Phenanthrene	0.2‡ (100)		zero (100)						0.0028 (41)				
Phenol					5.0 (39)	4000 (68)				(D)		3500	300
Phenols, chlorinated													
Phenols, nitro-													
Phenols, non-chlorinated													
Phorate							0.7						
Phthalate esters													
Picloram	500‡ (100)		500 (100)			500	1050			(D)			
Polybrominated biphenyls								0.01					
Polychlorinated biphenyls	0.5‡ (106)		zero (106)				50 (7-day)	0.045	0.000079	0.005 (B2)	0.16 (69)		
Prometon						100				(D)			
Pronamide						50				(C)			
Propachlor						90	700			(D)			
Propenes, dichloro-													
Propanil							140						
Propazine						10	325			(C)			

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WATER QUALITY GOALS — HUMAN HEALTH AND WELFARE

ORGANIC CONSTITUENT	Drinking Water Standards (DHS & EPA) Maximum Contaminant Levels (MCLs) — California MCLs unless noted with "‡"		EPA	California State Action Levels Department of Health Services (DHS)		Health Advisories or Suggested No-Adverse-Response Levels (SNARLs) (also see cancer risk estimates)		California Proposition 65 Regulatory Level as Water Quality Criterion (14)	One-in-a-Million Incremental Cancer Risk Estimates			EPA National Ambient Water Quality Criteria based on:	
	Primary MCL	Secondary MCL	MCL Goal	Toxicity	Taste & Odor	EPA	NAS		EPA National Ambient Water Quality Criteria	EPA Health or Water Quality Advisories	National Academy of Sciences (NAS)	Public Health Effects	Taste & Odor or Welfare
Propenes, dichloro-												87	
Propham						100				(D)			
Pyrene	0.2‡ (100)		zero (100)						0.0028 (41)	(D)			
RDX (Cyclonite)						2				0.3 (C)			
Resorcinol							500 (7-day)						
Rotenone							14						
Simazine	10 / 1‡ (100)		1 (100)			1	1505			(C)			
Styrene	100 ‡(93)	10‡ (100)	100 (93)			100	931			0.01 (C)			
Sulfallate											0.31		
2,4,5-T						70	700			(D)			
2,3,7,8-TCDD (Dioxin)	0.00005‡ (100)		zero (100)			0.00001 / 0.00004 (7-yr,7)	0.0007	0.0000025	0.000000013	0.0000002 (B2)			
Tebuthiuron						500				(D)			
Terbacil						90				(E)			
Terbufos						0.9				(D)			
1,2,4,5-Tetrachlorobenzene												38	
1,1,1,2-Tetrachloroethane						70				1 (C)			
1,1,2,2-Tetrachloroethane	1								0.17	(C)			
Tetrachloroethylene (PCE)	5 / 5‡(93)		zero (93)			2000 (10-day)		7	0.8	0.7 (B2)	3.6		
2,3,4,6-Tetrachlorophenol													1
2,3,5,6-Tetrachlorophenol													
Thiobencarb	70	1											
Thiram							35						
Toluene	1000‡ (93)	40‡ (100)	1000 (93)	100		1000	340			(D)		14,300	
Toxaphene	5 / 3‡(93)		zero (93)			40 (10-day)	8.75	0.3	0.00071	0.03 (B2)			
2,4,5-TP (Silvex)	10 / 50‡(93)		50 (93)			50	5.25			(D)		10	
Tributyltin													
Trichloroacetaldehyde, hydrated						50 (68)				(D)			
Trichloroacetic acid						200 (68)	50 / 120 (7)			(C)			
Trichloroacetonitrile						50 (10-day,68)							
Trichlorfon							26 / 88 (7)						
1,2,4-Trichlorobenzene	9‡ (100)		9 (100)			9				(D)			
1,3,5-Trichlorobenzene						40				(D)			
1,1,1-Trichloroethane	200		200			200	3800			(D)	17 (21)	18,400	
1,1,2-Trichloroethane	32 / 5‡ (100)		3 (100)			3			0.6	0.6 (C)			
Trichloroethylene (TCE)	5		zero					30	2.7	3 (B2)	1.5 (21)		
Trichlorofluoromethane	150					2000	8000 (7-day)		0.19	(D)			
2,4,5-Trichlorophenol												2600	1
2,4,6-Trichlorophenol							2500 (7-day)	5	1.2	3 (B2,68)			2
1,2,3-Trichloropropane						40							
1,1,2-Trichloro-1,2,2-trifluoroethane	1200												
Trifluralin						5	700			5 (C)			
Trinitroglycerol						5							
Trinitrophenol							200 (7-day)						
Trinitrotoluene (TNT)						2				1 (C)			
Trithion				7									
Urethane								0.35					
Vinyl chloride	0.5 / 2‡		zero			10 / 50 (7-yr,7)		0.15	2	0.015 (A)	1.1		
Xylene(s)	1750 / 10,000‡(93)	20‡ (100)	10,000 (93)			10,000				(D)			
Zineb							35						
Ziram							87.5						

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FOOTNOTES

(7-day) For exposure of 7 days or less.
(10-day) For exposure of 10 days or less.
(24-hr) For exposure of 24 hours or less.
(7-yr) For "longer-term" exposure (7 years or less, EPA).

(A) Known human carcinogen; sufficient epidemiologic evidence in humans.
(B1) Probable human carcinogen; limited epidemiologic evidence in humans.
(B2) Probable human carcinogen; sufficient evidence from animal studies; no or inadequate human data.
(C) Possible human carcinogen; limited evidence from animal studies; no human data.
(D) Not classified as to human carcinogenicity; no data or inadequate evidence.
(E) Evidence of non-carcinogenicity for humans.

(1) For hardness in mg/l as CaCO3, criterion = e(0.8473[ln(hardness)]+0.8604) µg/l; see Inorganics pages 6 & 13.
(2) Value based on hardness of 40 mg/l; value increases with increasing hardness.
(3) Varies from 1.4 to 2.4 mg/l with air temperature; see Title 22, CCR, §64435, Table 4.
(4) For dissolved chloride associated with sodium; criterion probably will not be adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium.
(5) Based on reproductive toxicity.
(6) Pentavalent arsenic [As(V)] effects on plants.
(7) Calculated for child / for adult.
(8) Advisory; Reference 11.
(9) For hardness in mg/l as CaCO3, criterion = e(0.8473[ln(hardness)]+0.7614) µg/l; see Inorganics pages 6 & 13.
(10) For hardness in mg/l as CaCO3, criterion = e(0.7852[ln(hardness)]-3.490) µg/l; see Inorganics pages 6 & 7.
(11) Criterion = e[1.005(pH)-4.830] µg/l.
(12) Use for total chromium if valence unknown.
(13) Criterion = e[1.005(pH)-5.290] µg/l.
(14) Calculated from CCR, Title 22, Division2, Articles 7 and 8 regulatory levels assuming 2 liters/day water consumption; cancer risk unless otherwise footnoted.
(15) Determined by CA Health & Welfare Agency regulation not to pose a risk of cancer through ingestion.
(16) Toxicity to one species of fish after 2600 hours of exposure.
(17) Mortality in a fish species after 30 day exposure.
(18) Estimated protective value; Reference 11.
(19) For total trihalomethanes (sum of bromoform, bromodichloromethane, chloroform & dibromochloromethane); based largely on technology and economics.
(20) For sum of halomethanes.
(21) Based on limited evidence.
(22) For sum of chlorinated benzenes.
(23) Toxicity to a fish species exposed for 7.5 days.
(24) For sum of dichlorobenzenes.
(25) 1983 SNARL; to be reviewed in the future.
(26) National Ambient Water Quality Criterion; Reference 13.
(27) For sum of dichloroethylenes.
(28) For sum of dichloropropanes.
(29) For sum of dichloropropenes.
(30) For sum of heptachlor and heptachlor epoxide.
(31) Adverse behavioral effects occur to one species.
(32) As CaCO3; minimum criterion except where natural conditions are less.
(33) For hardness in mg/l as CaCO3, criterion = e(1.128[ln(hardness)]-3.828) µg/l; see Inorganics pages 6 & 7.
(34) Flavor impairment in a fish species occurs.
(35) Mortality to early life stages of a fish species occurs.
(36) For industrial supply criteria see Reference 13.
(37) For sum of mononitrophenols.
(38) Toxicity to algae occurs.
(39) For chlorinated systems.
(40) For white phosphorus.
(41) For sum of polynuclear aromatic hydrocarbons.
(42) 1970 World Health Organization (WHO) European Standards for drinking water based on the composite analysis of fluoranthene, benzo(a)pyrene, benzo(g,h,i)perylene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.
(43) For sum of benzene hexachloride isomers.
(44) Calculated from corn oil gavage animal study / from drinking water animal study.
(45) For sum of phthalate esters.
(46) For sum of chloroalkyl ethers.
(47) For sum of tetrachloroethanes.
(48) For sum of chlorinated naphthalenes.
(49) For hardness in mg/l as CaCO3, criterion = e(1.72[ln(hardness)]-6.52) µg/l; see Inorganics pages 6 & 12.
(50) For sum of DDT, DDD, and DDE.
(51) Based on exposure through water only / through water and fish; Reference 11.
(52) For sum of dichlorobenzidines.
(53) For sum of dinitrotoluenes.
(54) From Reference 15.
(55) For hardness in mg/l as CaCO3, criterion = e(0.8190[ln(hardness)]+1.561) µg/l; see Inorganics pages 6 & 8.
(56) For sum of nitrosamines.
(57) Guidance level; Reference 7; assumes relative source contribution of 10% from drinking water.
(58) For sum of haloethers.
(59) Chronic SNARL was estimated to be 100-fold lower than the listed 24-hour value in calculating this level.
(60) For hardness in mg/l as CaCO3, criterion = e(0.8190[ln(hardness)]+3.688) µg/l; see Inorganics pages 6 & 8.
(61) Acceptable Residue Limit in drinking water under the Federal Insecticide, Fungicide, and Rodenticide Act.
(62) For pH between 6.5 and 9.0.
(63) For hardness in mg/l as CaCO3, criterion = e(0.8545[ln(hardness)]-1.465) µg/l; see Inorganics pages 6 & 9.
(64) Based on kepone.
(65) For hardness in mg/l as CaCO3, criterion = e(0.9422[ln(hardness)]-1.464) µg/l; see Inorganics pages 6 & 9.
(66) For hardness in mg/l as CaCO3, criterion = e(1.273[ln(hardness)]-4.705) µg/l; see Inorganics pages 6 & 10.
(67) For hardness in mg/l as CaCO3, criterion = e(1.273[ln(hardness)]-1.460) µg/l; see Inorganics pages 6 & 10.
(68) Draft/tentative.
(69) For Arochlor 1260.
(70) At pH 6.8, caused 50% reduction in growth of yearling sockeye salmon in 56–day test.
(71) May be present as a decomposition product in Ferbam, Maneb, Nabam, Thiram, Zineb, and Ziram.
(72) As NO3.
(73) Recommended level; Upper level = 500 mg/l; Short-term level = 600 mg/l.
(74) Recommended level; Upper level = 1600; Short-term level = 2200.
(75) Recommended level; Upper level = 1000; Short-term level = 1500 mg/l.
(76) For "TCDD equivalents" calculated as the sum of 2,3,7,8-chlorinated dibenzodioxin and dibenzofuran concentrations multiplied by their respective U.S. EPA Toxicity Equivalency Factors.
(77) For sum of 1,2- and 1-3-dichlorobenzenes.
(78) Reference 16 unless noted otherwise.
(79) For elemental phosphorus; marine or estuarine.
(80) Dischargers may at their option meet this limitation as a total chromium level.
(81) For hardness in mg/l as CaCO3, criterion = e(0.8460[ln(hardness)]+1.1645) µg/l; see Inorganics pages 6 & 11.
(82) For the sum of oxychlordane and alpha and gamma isomers of chlordane, chlordene and nonachlor.
(83) A decrease in the number of algal cells occurs.
(84) Adverse effects on a fish species exposed for 168 days.
(85) For hardness in mg/l as CaCO3, criterion = e(0.8460[ln(hardness)]+3.3612) µg/l; see Inorganics pages 6 & 11.
(86) For sum of nonchlorinated phenolic compounds.
(87) For sum of chlorinated phenolic compounds.
(88) For sum of nitrophenols.
(89) Expressed as nitrogen.
(90) For total chlorine residual; for intermittent chlorine sources see Reference 20, Chapter IV, Table B.
(91) See Reference 13.
(92) For sum of 3,3'-Dichlorobenzidine and its salts.
(93) Effective July 1992.
(94) For the trivalent form.
(95) For the pentavalent form.
(96) EC50 for eastern oyster embryos.
(97) Varies with pH and temperature; see Inorganics Page 4 to select water quality goal.
(98) For total residual chlorine.
(99) For sum of chlorine-produced oxidants.
(100) Proposed.
(101) 7,000,000 fibers/liter; limited to fibers longer than 10 µm.
(102) Recommended level; not yet formally proposed.
(103) Effective July 1992; as nitrogen; in addition, value for total nitrate + nitrite = 10,000 µg/l (as N).
(104) Based on endosulfan; Reference 11.
(105) Value based on drinking water treatment technique; effective July 1992.
(106) As decachlorobiphenyl; effective July 1992.
(107)
(108) For molecules with 60 percent chlorine or greater by molecular weight.
(109) MCL varies with air temperature; ≤ 53.7 °F - 2.4 mg/l; 53.8 to 58.3 °F - 2.2 mg/l; 58.4 to 63.8 °F - 2.0 mg/l; 63.9 to 70.6 °F - 1.8 mg/l; 70.0 to 79.2 °F - 1.6 mg/l 79.3 to 90.5 °F - 1.4 mg/l.
(110) Includes Radium 226 but excludes Radon and Uranium.
(111)
(112) Unionized ammonia concentrations; criteria based on total ammonia are shown on Inorganics page 5.
(113) For sum of bromoform, bromomethane, chloromethane, dibromochloromethane, and bromodichloromethane.
(114) As CaCO3; minimum concentration except where natural concentrations are less.
(115) For sum of acenaphthylene, anthracene, benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluorene, indeno(1,2,3-c,d)pyrene, phenanthrene, and pyrene.

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2. California Department of Health Services, Notices of Proposed Rulemaking: Maximum Contaminant Levels for for (various pollutants) in Drinking Water (R–9–89) dated 26 June 1989.
3. U. S. Environmental Protection Agency, 40 Code of Federal Regulations, Parts 141.11 to 141.16.
4. U. S. Environmental Protection Agency, Region 9, Drinking Water Branch, "Drinking Water Standards and Health Advisory Table" (November 1990).
5. U. S. Environmental Protection Agency, Federal Register, Volume 56, No. 20 (Wednesday, 30 January 1991), Final Rule, pages 3526, et seq.
6. U. S. Environmental Protection Agency, Federal Register, Volume 55, No. 143 (Wednesday, 25 July 1990), pages 30370-30448.
7. U. S. Environmental Protection Agency, Office of Drinking Water, "Drinking Water Regulations and Health Advisories" table (November 1990).

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8. California Department of Health Services, Office of Drinking Water, "Summary: Maximum Contaminant Levels (MCLs) and Action Levels (ALs)" (18 October 1990).

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References 4 and 7.

9. U. S. Environmental Protection Agency, Office of Drinking Water "Health Advisory" documents (various dates).
10. National Academy of Sciences, "Drinking Water and Health", Vol.1 (1977), Vol. 3 (1980), Vol. 4 (1982), Vol. 5 (1983), Vol. 6 (1986), and Vol. 7 (1987).
11. U. S. Environmental Protection Agency, "Water Quality Advisory" documents (March 1986, September 1987).

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California Ocean Plan - Limiting Concentrations

20. California State Water Resources Control Board, "Water Quality Control Plan: Ocean Waters of California", Chapter IV (22 March 1990).

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21. U. S. Environmental Protection Agency, "Ambient Water Quality Criteria" documents (various dates).

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