OU2-406
AR

EXPLANATION OF SIGNIFICANT DIFFERENCES
OPERABLE UNIT 2, FORT ORD LANDFILLS
FORT ORD, CALIFORNIA

United States Department of the Army *August 3, 1995*

INTRODUCTION

Site Name and Location

Fort Ord is located near Monterey Bay in northwestern Monterey County, California, approximately 80 miles south of San Francisco. The base comprises approximately 28,000 acres adjacent to the cities of Seaside, Sand City, Monterey, and Del Rey Oaks to the south and Marina to the north. The Southern Pacific Railroad and Highway 1 pass through the western portion of Fort Ord, separating the beach front from the rest of the base. Laguna Seca Recreation Area and Toro Regional Park border Fort Ord to the south and southeast, respectively. Land use east of Fort Ord is primarily agricultural. Operable Unit 2 (OU 2), the Fort Ord Landfills, comprises approximately 150 acres and is located in the northern portion of Fort Ord.

Identification of Lead and Support Agencies

Environmental investigations began at Fort Ord in 1984 at Fritzsche Army Airfield (FAAF) under Regional Water Quality Control Board (RWQCB) cleanup or abatement orders 84-92, 86-86, and 86-315. In 1986, further investigations began at the Fort Ord Landfills (Operable Unit 2, or OU 2), and the preliminary site characterization was completed in 1988. In 1990, Fort Ord was placed on the U.S. EPA's National Priorities List (NPL), primarily because of volatile organic compounds (VOCs) found in groundwater beneath OU 2. A Federal Facility Agreement (FFA) was signed by the Army as the lead agency, and the EPA, the California Environmental Protection Agency's Department of Toxic Substances Control (DTSC; formerly the Toxic Substances Control Program of Department of Health Services or DHS), and RWQCB as support agencies.

Explanation of Significant Differences

If the lead agency (the Army) determines that a significant change to the selected remedy, as described in the Record of Decision (ROD), is necessary after the ROD is signed, section 117(c) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and 40 CFR 300.435 (c)(2)(i) require the lead agency to address post-ROD significant changes.

This explanation of significant differences (ESD), addresses groundwater cleanup goals for the Upper 180-foot aquifer. When the OU 2 ROD was prepared, cleanup of the 180-foot aquifer was proposed as an interim action because certain data was unavailable at the time and the Army could not complete an economic and technical feasibility analysis for the Cleanup Standard as required by a State Applicable or Relevant and Appropriate Requirement (ARAR). Consequently, provisional groundwater cleanup goals were set at maximum contaminant levels (MCLs) and risk-based concentrations. These were based upon similar cleanup standards finalized for the A-aquifer, which lies on the Upper 180-foot aquifer. Subsequent data collection indicated that the 180-foot aquifer was composed of an upper 180 and lower 180-foot units and hydraulic conductivities for the upper 180 were determined. The Army is therefore finalizing the cleanup standard for the Upper 180-foot aquifer consistent with those approved for the A-aquifer to facilitate the coordinated cleanup strategy for both aquifers. The Lower 180-foot aquifer does not require remediation.

This ESD will become part of the Administrative Record for Fort Ord, and will be available to the public at the following locations: Fort Ord Post Library, Building 4275, North-South Road, Fort Ord, California, and Seaside Branch Library, 550 Harcourt Avenue, Seaside, California. The Administrative Record is available at 1143 Echo

Avenue, Suite F, Seaside, California, Monday through Friday from 9 a.m. to 5 p.m.

SUMMARY OF SITE HISTORY, CONTAMINATION PROBLEMS, AND SELECTED REMEDY

Site History

Since its opening in 1917, Fort Ord has primarily served as a training and staging facility for infantry troops. In 1991, Fort Ord was selected for closure in 1993; the majority of the soldiers were reassigned to other Army posts.

OU 2 is comprised of two landfills. Both were used for residential and commercial waste disposal. The north landfill was used from 1956 to 1966. The main landfill was operated from 1960 until 1987 and may have received a small amount of chemical waste along with household and commercial refuse. The main landfill facility stopped accepting waste for disposal in May 1987 because of the initiation of interim closure of the facility.

Contamination and Hydrogeologic Characteristics

The results of the remedial investigation (RI) at the Fort Ord Landfills indicate that landfill materials were buried in relatively uniform sand dune deposits in shallow trenches approximately 30 feet wide that extend from ground surface to 10 to 12 feet bgs. Soil samples collected below the landfills do not contain chemicals associated with the landfills. Chemicals associated with landfilled materials, however, have been detected in soil vapor samples obtained from soil overlying the landfills and in groundwater collected from beneath the landfills. The chemicals are believed to have migrated away from the landfilled materials as vapors or as solutes in leachate.

Chemicals are present in two groundwater aquifers: the shallow A-aquifer, and the Upper 180-foot aquifer. The groundwater in the A-aquifer occurs at approximately 50 to 100 feet bgs; groundwater in the Upper 180-foot aquifer occurs at approximately 100 to 300 feet bgs. Results of the RI indicate that the greatest number of chemicals and highest concentrations were detected in the A-aquifer.

Water in the A-aquifer flows toward the west and the Pacific Ocean. Due to extensive local and regional pumping of water from the Upper 180-foot aquifer for agricultural and domestic use, the natural flow toward the west is reversed, and water in the Upper 180-foot aquifer flows inland (eastward). Beneath the landfill, the A- and the Upper 180-foot aquifers are separated by an impermeable layer, or aquiclude, known as the Salinas Valley Aquiclude (SVA). Near the Pacific Ocean, however, the two aquifers are connected because the aquiclude pinches out in this area. Thus, chemicals in the A-aquifer can or may (over many years) migrate into the Upper 180-foot aquifer.

Trichloroethene (TCE) was the most important chemical detected, in terms of frequency and concentration, in water samples obtained from the A- and Upper 180-foot aquifers. The maximum concentration of TCE detected in water samples obtained during groundwater sampling of the A-aquifer was 80 parts per billion. The highest TCE concentration detected in the Upper 180-foot aquifer was 50 parts per billion. The allowable state and federal drinking water standard, the MCL, is 5 parts per billion for TCE. In addition to TCE, other VOCs have been detected in groundwater beneath the site, including: tetrachloroethene, benzene, cis-1,2-dichloroethene, and dichloromethane.

Selected Remedy

The ROD for OU 2 was signed on August 23, 1994, and included the following remedies for soil and groundwater:

Soil

A cover system for the landfills was selected to prevent rainwater from percolating through the landfilled areas and into the underlying drinking water aquifers, to contain and collect and remove methane offgas (if necessary), and to prevent exposure of sanitary waste in the landfills to the surrounding environment. The cover system specifications are driven by applicable or relevant and appropriate requirements (ARARs) for landfill closure. Institutional controls (i.e., deed restrictions) will be placed on the property to ensure that the integrity of the cover system is maintained and will prevent potential direct exposures of VOCs to the environment or people associated with future use of the site.

Groundwater

The selected remedy includes groundwater extraction and treatment for an estimated period of 30 years, during which time the system's performance will be carefully monitored on a regular basis and adjusted as warranted by the performance data collected during operation. Modifications may include any or all of the following:

- Discontinuing pumping at individual wells where cleanup goals have been attained
- Alternating pumping wells to eliminate stagnation points
- Pulse pumping to allow aquifer equilibration and to allow adsorbed contaminants to partition into groundwater; and
- Adding additional extraction wells to facilitate or accelerate cleanup of the contaminant plume.

The points of compliance for the remediation goals are any monitoring wells screened in the A- and Upper 180-foot aquifers within the plume area. Remedial Design/Remedial Action documentation will define at what point the remediation goals will be considered to have been attained. To ensure that remediation goals continue to be maintained, the aquifer will be monitored in the vicinity of wells where pumping has ceased until the Army, EPA, and the State agree that cleanup is complete. Remediation goals for chemicals present in contaminated groundwater are either based on ARARs or on values determined by human health risk assessment (RA). The estimated total aggregate excess cancer risk for all chemicals at their respective remediation goals is 6×10^{-5}. This cumulative risk is within the acceptable range, and is health protective.

DESCRIPTION AND BASIS OF SIGNIFICANT DIFFERENCES

Cleanup standards for the Upper 180-foot aquifer need to be finalized because cleanup of the aquifer as described in the ROD was to be performed under interim action with provisional cleanup goals. The Army considered whether the current provisional goals should be retained and finalized as cleanup standards or whether a more stringent standard, e.g., background levels, should be set (see Table 1). The Army has determined that the current provisional goals should be finalized for the following reasons:

1. The Upper 180-foot aquifer cleanup level should be consistent with the A-aquifer cleanup level because:
   - The A-aquifer supplies the Upper 180-foot aquifer and the two aquifers and plumes are basically continuous, as shown by more recent data,
   - From a risk assessment exposure perspective, the water would be used in the same way for either aquifer,
   - If cleanup goals for the Upper 180-foot aquifer are lower (i.e. background levels) than those for the A-aquifer, extended pumping and operation of the treatment system for the Upper 180-foot aquifer would be required, because it would be recharged with groundwater containing concentrations of chemicals above background levels from the A-aquifer,
2. No significant reduction in risk would be achieved if the aquifer was remediated below MCLs (i.e., in an attempt to achieve background levels) because MCLs are already health protective,
3. Hydrogeologic information obtained since the ROD confirm that there are no other sources for the plume (i.e. Sites 2/12 plume) and that saltwater intrusion does not impact the plume and can be effectively controlled during remediation.

EVALUATION OF CHAPTER 15, SECTION 2550.4, AND RESOLUTION 92-49 REGARDING ALTERNATIVE CLEANUP LEVELS

The ARARs set forth in the ROD continue to apply to the soils and groundwater remedies at OU 2. By finalizing the cleanup standards for the Upper 180-foot aquifer, two ARARs have been considered: Discharges of Waste to Land, Title 23 CCR, Div. 3, Chapter 15, section 2550.4 and Policies and Procedures for Investigation and Cleanup and Abatement of Discharges, Resolution 92-49. Both allow for aquifer cleanup levels ranging between background and the MCL under certain conditions. Based upon the discussion presented in the ESD, the final cleanup standard for the Upper 180 foot aquifer satisfies these ARARs.

Under the applicable provisions of Chapter 15, a concentration limit for a constituent of concern that is greater than the background value may be established if it is technologically or economically infeasible to achieve the background value and if the constituent will not pose a substantial present or potential hazard to human health or the environment.

In establishing a concentration limit greater than background for a constituent of concern, the following factors are considered:

- Potential adverse effects on groundwater quality and beneficial uses, considering,
- The physical and chemical characteristics of the waste in the waste management unit;
- The hydrogeological characteristics of the facility and surrounding land
- The quantity of groundwater and the direction of groundwater flow
- The proximity and withdrawal rates of groundwater users
- The current and potential future uses of groundwater in the area
- The existing quality of groundwater, including other sources of contamination or pollution and their cumulative impact on the groundwater quality
- The potential for health risks caused by human exposure to waste constituents
- The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents
- The persistence and permanence of the potential adverse effects."

State Water Resources Control Board Resolution 92-49 (92-49) contains requirements and considerations (similar to those cited in Chapter 15) regarding the establishment of cleanup levels greater than background. Resolution 92-49 requires cleanup in a manner that promotes attainment of either background water quality or the best water quality that is reasonable considering all demands being made on those waters and the total values involved, beneficial and detrimental, economic and social, tangible and intangible. Any alternative cleanup level must be consistent with the maximum benefit to the people of the state and not unreasonably affect present and anticipated beneficial use of such water.

Summary of Technical Evaluation of Final Upper 180-Foot Aquifer Cleanup Goals

A technical memorandum that evaluates final Upper 180-foot aquifer cleanup standards is presented in Appendix A and is summarized below.

The difference in cleanup times that would result from applying two different cleanup goals, i.e., (1) the provisional goals of MCLs and risk-based levels, and (2) background levels, was evaluated. Existing OU 2 groundwater model results were used to estimate associated pore-volume flush times to remove contaminated groundwater from the Upper 180-foot aquifer to both cleanup goals. Based on the models and inspection of aquifer flow lines, contaminated groundwater from the Upper 180-foot aquifer may take approximately 25 years to be captured and restored to the current provisional goals. This estimate is based on predicted advective flow paths only, and due to limitations inherent in the model, does not account for chemical retardation, degradation, hydrodynamic dispersion, or chemical diffusion.

An estimate of the time required to achieve background cleanup goals in the Upper 180-foot Aquifer was more difficult to quantify due to the limitations inherent in the model and the low organic content of saturated soils recently measured in the Upper 180-foot aquifer. In addition, the A-aquifer would continually be recharging the Upper 180-foot aquifer with concentrations at or below MCLs and risk-based levels for an indefinite period of time. Estimated organic carbon contents from an aquifer are typically used to calculated solute transport retardation. The estimated average organic carbon content for the Upper 180-foot aquifer (0.034 percent) is lower than the minimum content of 0.16 percent recommended for application of the retardation estimation technique. However, solute transport retardation may still exist in the aquifer due to the physical and chemical effects of mineral surfaces retarding solute transport. To date, there are no theoretical models for calculating mineral surface retardation.

An example of potential TCE desorption during OU 2 groundwater remediation and its effect on cleanup times is illustrated in the Appendix. A chemical mass distribution coefficient (K_d) of 0.04 ml/g estimated for TCE for the Upper 180-foot aquifer results in an estimate that one pore-volume flush (approximately 25 years) would remove the contaminated groundwater from the 180-foot aquifer to provisional or background goals. This result is due to the fact that no retardation of TCE in saturated soil could be quantified using the current model. However, it is likely that some retardation would occur in the aquifer that cannot be accounted for by the model. In addition, there is a ten-fold difference in concentrations between MCLs and background (detection) levels; therefore, intuitively, it would take longer to achieve background levels.

For comparison to the above scenario where no retardation can be accounted for in the model, an assumption that retardation of contaminants occurs in the aquifer at a K_d value of 0.16 ml/g (minimum necessary for model) yields an estimate that removal of two pore-volumes (approximately 50 years) would be required to achieve background levels. In conclusion, at a minimum, it is estimated that removal of one pore volume from the Upper 180-foot aquifer would be required to achieve provisional goals. At a maximum, if some retardation occurs, several pore volumes (2 or more) would have to be removed to achieve background levels.

Comparison of Economic Impact of Cleanup to Provisional or Background Goals

For the purposes of this discussion, the economic impact of cleaning up the Upper 180-foot aquifer to provisional goals versus background levels is assessed using the following cleanup time estimates: (1) 25 years for Upper 180-foot cleanup to provisional goals, and (2) 25 years for A-aquifer cleanup plus 25 years (1 additional pore-volume flush) for subsequent cleanup of the Upper 180-foot aquifer to background levels, for a total of 50 years. Assuming the treatment system would operate at 1,200 gallons per minute (gpm), the two different cleanup scenarios would have estimated operation and maintenance costs as follows:

(1) $1,225,000 for 25 years of extraction and treatment to reach provisional goals in the Upper 180-foot aquifer, or

(2) $2,450,000 for 50 years of extraction and treatment in an attempt to reach background levels.

Cleanup to provisional goals would be health protective and in compliance with ARARs. Approximately $1,225,000 of additional expenditures would be required to achieve background levels in the Upper 180-foot aquifer and would not result in a significant risk reduction.

Compliance with ARARs

Attainment of the cleanup standard would protect beneficial uses of groundwater in the Upper 180-foot aquifer because it would not pose a substantial present or future risk to human health and the environment. MCLs are risk-based levels and are already protective of human health and environmental receptors are not known to be in contact with groundwater in the Upper 180-foot aquifer. In addition, sampling and monitoring of chemical concentrations in both aquifers would be performed as part of remediation activities. Residual contamination would be addressed through post-remediation sampling: however, residual concentrations of chemicals below MCLs and risk-based levels would not pose significant detrimental effects to future beneficial uses of groundwater.

Beneficial uses of groundwater in the Upper 180-foot aquifer may in fact be compromised in the long term if pumping of groundwater continues over a long period of time (50 years) in an attempt to achieve background levels. Because OU 2 groundwater in this aquifer is in communication with the Monterey Bay, extended pumping at the site, when coupled with other demands on the aquifer over time from agricultural and domestic uses, may add to the potential for saltwater intrusion into the aquifer. Although the extraction and treatment system for OU 2 is designed to minimize the potential for saltwater intrusion by reinjecting treated water at OU 2, the effects of future additional demands on regional groundwater over a period of several decades may result in potential adverse effects to groundwater quality. Other portions of the regional aquifer could be affected by saltwater intrusion if drought conditions continue and increasing demands are made on the aquifer. Saltwater intrusion would be damaging to beneficial uses of regional agricultural and domestic importance.

The hydrogeologic characteristics of the Upper 180-foot aquifer indicate that groundwater in this aquifer is supplied by the A-aquifer. Therefore, cleanup goals for the A-aquifer should be applied to and be consistent with goals for the Upper 180-foot aquifer. If cleanup goals were different for the two aquifers, i.e., MCLs and risk-based levels would be applied to the A-aquifer and background levels would be applied to the Upper 180-foot aquifer, the A-aquifer would recharge the Upper 180-foot aquifer with concentrations below MCLs but above background levels. This scenario would require that background levels be achieved in the A-aquifer before they could be achieved in the Upper 180-foot aquifer. This is not technically or economically feasible for the A-aquifer because the organic carbon content in this aquifer that retards flushing of contaminants is significant enough to make cleanup to background levels impractical (see Attachment A to Appendix A). In addition, health-protective cleanup levels have already been established for the A-aquifer above background levels.

For the reasons stated above, the Army has determined that the MCLs and risk-based levels are the final cleanup standard for the Upper 180-foot aquifer.

AFFIRMATION OF STATUTORY DETERMINATIONS

This final remedy satisfies the requirements of CERCLA Section 121. Considering the new information that has been developed and the need to determine a final cleanup standard for the Upper 180-foot aquifer for the selected remedy, the Army, U.S. EPA, and Cal/EPA believes that a consistent final cleanup goal of MCLs and risk-based levels applied to both aquifers remains protective of human health and the environment, complies with federal and state ARARs for this remedial action, and is able to be achieved in a cost effective manner. In addition, the final cleanup standard under the revised remedy still utilize permanent solutions and alternative treatment technologies to the maximum extent practicable for this site.

PUBLIC PARTICIPATION

A notification to the public concerning this ESD will take place in August 1995. The administrative record is available for review by the public.

United States Department of the Army

16 Aug 95

Ila Mettee-McCutchon Date
Colonel, U.S. Army
Garrison Commander
Presidio of Monterey

15 Aug 95

Gail Youngblood Date
BRAC Environmental Coordinator
Presidio of Monterey

U.S. Environmental Protection Agency

8/23/95

Julie Anderson Date
Director, Federal Facilities Cleanup Office
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California Environmental Protection Agency

8-16-95

Anthony J. Landis, P.E. Date
Chief of Operations, Office of Military Facilities
California Environmental Protection Agency
Department of Toxic Substances Control

8-18-95

Roger W. Briggs Date
Executive Officer
California Environmental Protection Agency
Central Coast Regional Water Quality Control Board

APPENDIX

TECHNICAL MEMORANDUM: EVALUATION OF FINAL UPPER 180-FOOT AQUIFER CLEANUP GOALS

TECHNICAL MEMORANDUM: EVALUATION OF FINAL UPPER 180-FOOT AQUIFER CLEANUP GOALS

This memorandum presents potential aquifer restoration times (periods of remediation system operation) necessary to achieve each of two different sets of groundwater restoration goals. The groundwater restoration goals considered were (1) the current Upper 180-foot aquifer provisional goals and (2) aquifer chemical background conditions, considered to be current analytical laboratory method detection limits. The Upper 180-foot aquifer provisional goals are the same as the A-aquifer final goals. The A-aquifer groundwater cleanup levels were established in the OU 2 record of decision (ROD) which was signed on August 23, 1994. Table 1 lists the provisional goals and the analytical detection limits representative of background conditions.

To evaluate potential cleanup times and the relative differences between provisional and background goals, existing OU 2 groundwater modeling results were used. The Fort Ord OU 2 three-dimensional MODFLOW/PATH3D model (*HLA, 1995*) was used to estimate groundwater flow paths, travel times, and associated pore-volume flush times. An analytical batch flush sorption model previously employed during the evaluation of the A-aquifer was used to evaluate potential solute sorption/desorption during groundwater remediation. A three-dimensional solute transport model was not used to evaluate cleanup times because the solute transport modeling will not significantly increase the precision of the time estimate.

Analysis of Flushing Times and Solute Transport

The times required to attain the provisional goals and the background goals were approximated using the pore volume flush times (the time required to remove the entire volume of contaminated groundwater) estimated with the advective groundwater flow model, and applying retardation factors to estimate solute concentrations during desorption.

The simulated groundwater flow lines and travel times associated with the proposed OU 2 groundwater extraction system are presented in the Draft Design Analysis, OU 2 Groundwater Remedy (*HLA, 1995*). Plates 1 through 3 (reproductions of Plates 16 through 18, *HLA, 1995*) display the simulated aquifer flow lines for the extraction and injection wells in both the A- and Upper 180-foot aquifers, respectively. Plate 2 indicates that hydraulic capture of the VOC plume currently residing in the Upper 180-foot aquifer may occur within a 10- to 15-year time period. Additionally, inspection of Plate 3, which depicts capture by 180-foot aquifer extraction wells of A-aquifer groundwater flowing off the Salinas Valley Aquiclude (SVA), indicates that contaminated groundwater from a portion of the A-aquifer may take as long as approximately 25 years to be ultimately captured in the Upper 180-foot aquifer. Based on this information, a conservative estimate of approximately 25 years is estimated for Upper 180-foot aquifer restoration to the provisional goals. This estimate is based on predicted advective flow paths only, and does not account for chemical retardation, degradation, hydrodynamic dispersion or chemical diffusion.

Solute Desorption and Retardation

Chemical retardation and desorption during flushing and cleanup was evaluated using site chemistry data and theoretical sorption models. Sorption and retardation are generally represented using a chemical mass distribution coefficient (K_d); which in turn can be estimated by performing batch experiments in the laboratory, performing field experiments, or using theoretical approximations based on chemical properties and aquifer matrix organic carbon content. Because batch tests or field experiments have not been performed, the theoretical method was used with site aquifer organic carbon data collected during the site investigation.

The estimated average organic carbon content of the Upper 180-foot aquifer is 0.00034 (0.034 percent) (*HLA, 1994*). This aquifer organic carbon content is lower than the minimum content of 0.1 percent recommended for the application of an aquifer organic carbon content based retardation estimation technique (*Olsen and Davis, 1990a,b*). The Upper 180-foot aquifer organic carbon content is approximately 10-fold lower than that estimated for the A-aquifer (0.25).

Although the organic carbon content is too low to technically estimate solute retardation in the model, it does not mean that solute transport retardation does not exist. The physical and chemical effects of mineral surfaces (predominantly clays) creates solute transport retardation. When aquifer organic carbon content is high, it's sorptive potential for organic chemicals predominates over inorganic sorption. When aquifer organic carbon is low (below 0.1%), inorganic mineral surface sorption is more important. Unfortunately, to date, there has not been any theoretical models developed to provide estimates of solute sorption caused by mineral surfaces.

An example of the range of potential TCE desorption during OU 2 groundwater remediation and its effect on times required to reach provisional and background goals is illustrated on Plate 4. The theoretical aquifer organic carbon sorption model yields an OU 2 TCE K_d of 0.04 ml/g which underestimates the actual K_d (which includes organic and inorganic components see above). Because this TCE K_d value is based solely on an organic carbon content lower than the default value, retardation is assumed to be insignificant and the K_d is assumed to be 0 by the model. Therefore, the model results indicate that only one pore volume flush is necessary to reduce the average 180-foot aquifer TCE concentration to below provisional and background concentration simultaneously. However, since a 10-fold difference exists between these cleanup levels, it seems likely that cleanup to background will require removal of more than one pore volume of groundwater. Assuming that the removal of one pore volume of groundwater will lower the VOC plume concentration to the provisional goals, the hypothetical time (i.e., background assuming solute sorption does affect cleanup time) required to reach other cleanup goals is presented on Plate 4. Using a TCE K_d of 0.16 ml/g (which is the minimum that is recognized by the model) results in one pore volume flush required to achieve provisional goals, and approximately one additional pore volume flush is required to achieve background goals. A TCE K_d of 0.18 ml/g (an increase of only 0.02) results in an estimated 8 additional years required to achieve background goals. Thus, small changes (increments of 0.02) to the TCE K_d value could have a significant effect on the time required to meet the treatment goals. The preceding analyses displays the significant additional cleanup time potentially associated with the attempt to achieve background cleanup goals and the potential effect on cleanup time of small changes in solute sorption and retardation in the OU 2 Upper 180-foot aquifer.

Effect of Difference Between A-Aquifer Final Cleanup Goals and Upper 180-Foot Aquifer Background Goals

The A-aquifer final cleanup goals are equal to the provisional goals for the Upper 180-foot aquifer and are greater than the background goals. This relationship allows groundwater recharging the Upper 180-foot aquifer from the A-aquifer to contain VOCs at concentrations slightly lower than the provisional goals but greater than the background goals. Recharging the Upper 180-foot aquifer with A-aquifer groundwater containing VOC concentrations above background implies that the A-aquifer must first reach the background goals before they can be achieved in the Upper 180-foot aquifer. Final cleanup goals for the Upper 180-foot aquifer that are lower than those for the A-aquifer will create a condition where groundwater is considered remediated in the A-aquifer and at the same time would likely constitute the source of VOCs to the Upper 180-foot aquifer. The effect of using background goals for the Upper 180-foot aquifer instead of the current provisional goals (A-aquifer final goals) is that the aquifer restoration time could be extended by the time required to clean up the A-aquifer to background which is currently estimated to be approximately 47 years.

Summary and Conclusions

Large-scale groundwater remediation systems similar to the proposed OU 2 system usually operate for many years, and system operation is assessed over time using performance data. However, estimates of cleanup times are necessary prior to system operation in order to evaluate long-term remediation goals, feasibility, and cost.

The cleanup time estimate is approximate due to the following assumptions: (1) no solute velocity retardation is assumed, (2) hydraulic conductivity data used as the basis for groundwater velocity estimation may not accurately represent true conductivities and velocities, (3) the mass of VOC present within the FO-SVA and other fine-grained and/or higher organic carbon layers in communication with the Upper 180-foot aquifer is insignificant, and (4) there are no longer any VOC sources contributing mass to either of the aquifer systems.

Based on the above analyses, it is likely the time required to achieve provisional goals in the Upper 180-foot aquifer is approximately 25 years, and the cleanup time required to achieve background goals could be 50 years or longer. Because of the uncertainty in contaminant desorption and the effects of recharge of the Upper 180-foot aquifer from A-aquifer water containing VOCs above background, the actual cleanup times to achieve background cannot be accurately predicted; however, aquifer cleanup time will be periodically evaluated during system operation. The potential cleanup time difference between provisional and background goals may result in significant additional operating costs (additional 25 years or longer).

References

HLA, 1994. *Draft Final Data Summary Report, Basewide Hydrogeologic Characterization, Fort Ord, California*. Prepared for Sacramento COE. November 15.

_____, 1995. *Draft Design Analysis, OU 2 Groundwater Remedy, Fort Ord, California.* Prepared for Sacramento COE. February 24.

Olsen, R.L., and Davis, A., 1990a. *Predicting the Fate and Transport of Organic Compounds in Groundwater, Part 1*. HMC, May/June 1990.

_____, 1990b. *Predicting the Fate and Transport of Organic Compounds in Groundwater, Part 2*. HMC, July/August 1990.

Attachments

Table 1	Upper 180-Foot Aquifer Potential Cleanup Goals
Plate 1	A-Aquifer Groundwater Capture
Plate 2	Upper 180-Foot Aquifer Groundwater Capture
Plate 3	Upper 180-Foot Aquifer Capture of A-aquifer Groundwater
Plate 4	Upper 180-foot Aquifer TCE Cleanup Time Projection

Table 1. Upper 180-foot Aquifer Potential Cleanup Goals
Fort Ord, California

Chemical of Concern	Provisional Cleanup Goals $\mu g/l$	Background Cleanup Goals $\mu g/l$
Benzene	1.0	0.5
Carbon Tetrachloride	0.5	0.5
Chloroform	2.0	0.5
1,1-Dichloroethane	5.0	0.5
1,2-Dichloroethane	0.5	0.5
cis-1,2-Dichloroethene	6.0	0.5
1,2-Dichloropropane	1.0	0.5
Methylene Chloride	5.0	0.5
Tetrachloroethene (PCE)	3.0	0.5
Trichloroethene (TCE)	5.0	0.5
Vinyl Chloride	0.1	0.1

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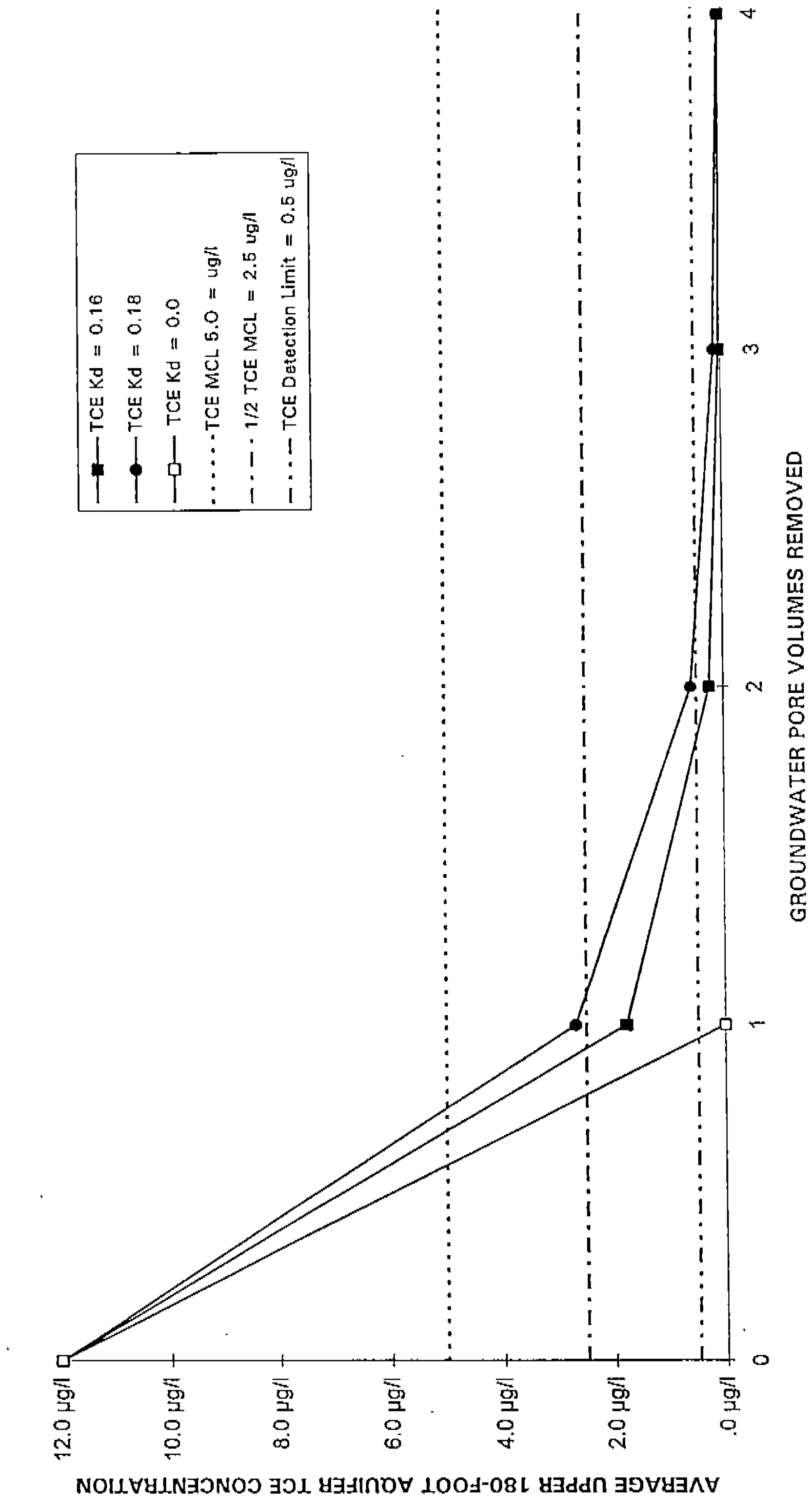

Note: One groundwater pore volume equals approximately 25 years.

Harding Lawson Associates
Engineering and
Environmental Services

Cleanup Time Projection
Upper 180-foot Aquifer TCE
Fort Ord, California

PLATE **4**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
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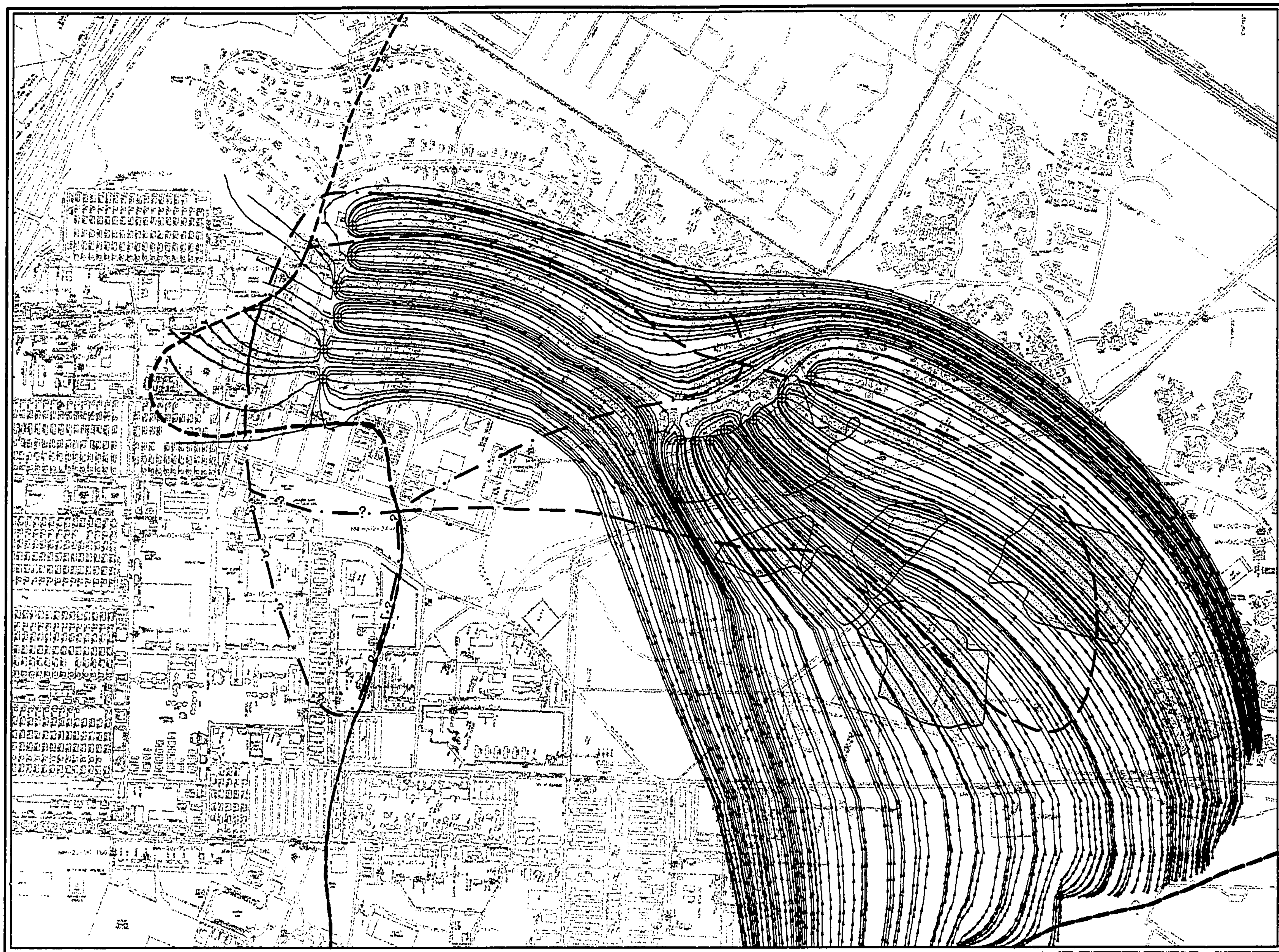

EXPLANATION

- EXTRACTION WELL
- MONITORING WELL (HLA)
- MONITORING WELL (BY OTHERS)
- APPROXIMATE EDGE OF FORT ORD–SALINAS VALLEY AQUICLUDE BOUNDARY, QUERIED WHERE UNCERTAIN
- APPROXIMATE EXTENT OF FORT ORD LANDFILLS. HLA, JANUARY 5, 1995
- GROUNDWATER STREAMLINE (5 YEAR TRAVEL DISTANCE BETWEEN ARROWS)
- OUTLINE OU2 A-AQUIFER GROUNDWATER CAPTURE AREA
- OUTLINE OU2 UPPER 180-FOOT AQUIFER GROUNDWATER CAPTURE AREA

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SCALE IN FEET

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Environmental Services

A-Aquifer Groundwater Capture
Reproduction of Plate 16
Design Analysis
OU 2 Groundwater Remedy
Fort Ord, California

PLATE **1**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
JEB	23366 06151		4/95	

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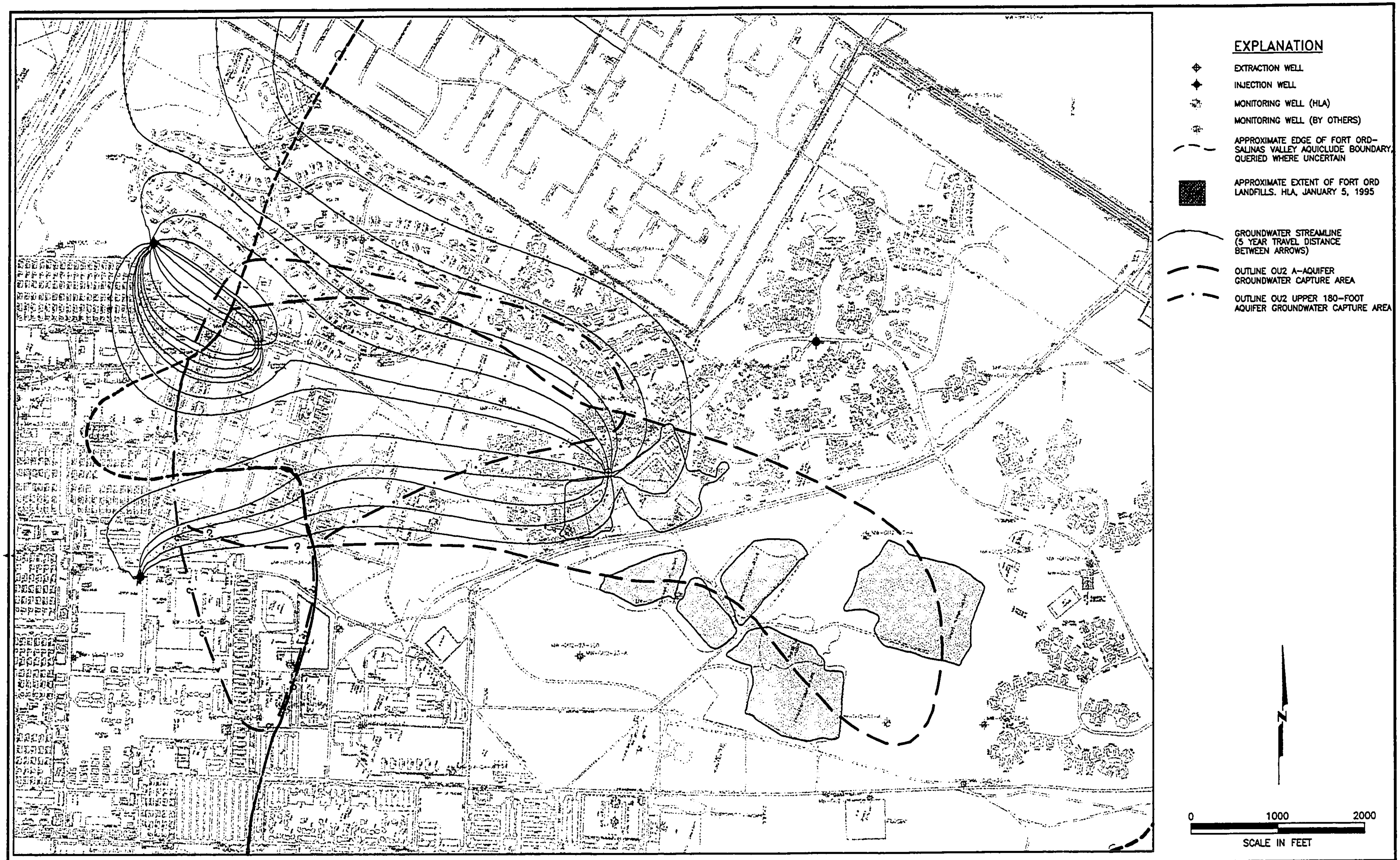
19950412.0845



If this image is not as legible as this overlay, it's due to the poor quality of the original document

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Upper 180-Foot Aquifer Groundwater Capture
Reproduction of Plate 17
Design Analysis
OU 2 Groundwater Remedy
Fort Ord, California

PLATE **2**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
JEB	23366 06151		2/95	

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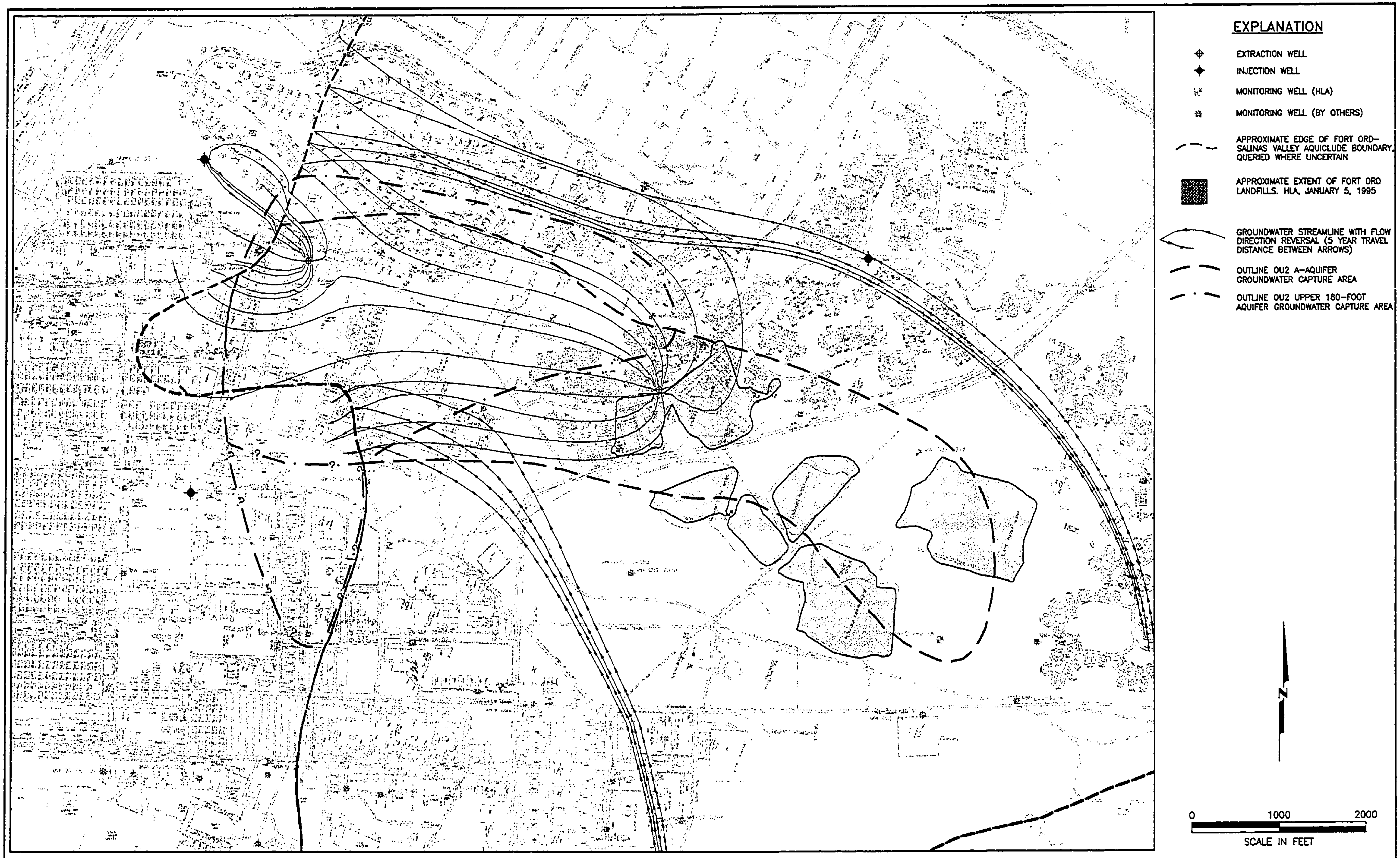
19950412.1029



If this image is not as legible as this overlay, it's due to the poor quality of the original document

Harding Lawson Associates
Engineering and Environmental Services

Upper 180-Foot Aquifer Capture of A-Aquifer Groundwater
Reproduction of Plate 18
Design Analysis
OU 2 Groundwater Remedy
Fort Ord, California

PLATE **3**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
JEB	23366 06151		2/95	