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★ **Stellar Environmental Solutions, Inc.**

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Geoscience & Engineering Consulting

June 29, 2004

Mr. Scott O. Seery - Hazardous Materials Specialist
Alameda County Health Care Services Agency
Department of Environmental Health, Hazardous Materials Division
1131 Harbor Bay Parkway, Suite 250
Alameda, California 94502

Subject: Status of Bioventing Pilot Test Program, Redwood Regional Park Service Yard Site
7867 Redwood Road, Oakland, California.

Dear Mr. Seery:

This letter summarizes the salient findings of the recent bioventing pilot test well installations and proposes a schedule for pilot test implementation. Well installations were conducted in accordance with the protocols discussed in our February 6, 2004 letter to Alameda County Health, which was then discussed in detail in our April 6, 2004 meeting at your offices.

The bioventing wells — one vent well (VW) and three vapor monitoring points (VMPs) — were installed on June 8 and 9, 2004. The VW was screened between 6 and 16 feet below ground surface (bgs). Each of the three VMPs was screened at two discrete depths: a shallow screen at approximately 10 feet bgs and a deeper screen at approximately 14 feet bgs.

Petroleum contamination was generally detected in soil samples collected at depths corresponding to the deeper screened intervals (i.e. below 10 feet bgs); however, it was also detected in the shallower soil sample collected at VMP-2 at 10 feet bgs. VMP-2 was located specifically in the area previously known to have a thick interval of unsaturated zone soil contamination. These results confirm that even in relatively higher seasonal groundwater conditions (discussed below), bioventing will likely be feasible and effective in reducing contaminant mass in the area upgradient of MW-8, where a substantial mass of residual soil contamination exists.

Following well installation, water levels were measured in the bioventing wells. Water was present in the lower 3.5 feet of VW-1 (i.e. at a depth of approximately 12.5 feet bgs). The shallow screen in each of the three VMPs was dry; however, water was present in the deeper screens for all VMPs. All the wells were purged dry to confirm that the water was not residual water from well installations; the wells all recharged to pre-purge levels. The deeper screened intervals of the VW/VMPs are currently flooded, indicating saturated conditions at depths below approximately 12.5 feet bgs. The deeper screened intervals have either intersected the water table, or at least are acting as low-pressure zones allowing groundwater to rise

into the wells by capillary action. This suggests that bioventing may be seasonally less effective at the lower depths where residual soil contamination exists.

As documented in previous SES reports, water levels at the site fluctuate seasonally up to several feet. The historical data indicate that water levels drop in the late summer/fall to depths that would potentially expose the deeper VW/VMP screened intervals for at least a few months. Since even a few months out of the year of aeration can significantly reduce the more soluble fraction of contaminant mass over time, bioventing is still potentially viable at the lower depths. The locations and depths of any additional VWs and VMPs should be designed to account for these variations.

If the bioventing pilot test were conducted now, it would demonstrate bioventing feasibility and provide design data (e.g., radius of influence, mass reduction rate) characteristic of "high water" conditions expected to be the case for most of the year. However, it would be more optimum to perform the test during lower water conditions when a portion of the bottom screen is exposed to air. Therefore, we plan the following actions and schedule for the pilot test:

- Conduct water level measurements in pilot test wells and nearby groundwater monitoring wells approximately every two weeks.
- Evaluate the water levels in the context of decreases over time and determine when water levels have dropped in the pilot test wells to a depth that exposes the deeper screened intervals (indicating that air transmission by bivoenting is potentially feasible at the lower depths).
- When it has been determined that the deeper screened intervals are no longer flooded, or that water levels have reached their minima, implement the pilot test as previously specified.

If you have any questions or would like to discuss, please contact us directly at (510) 644-3123.

Sincerely,

Bruce M. Rucker, R.G., R.E.A.
Project Manager

Michael B. Phelps, P.E.
Principal Engineer

cc: Michael Rugg - California Department of Fish and Game
Roger Brewer - California Regional Water Quality Control Board, San Francisco Bay Region
Neal Fujita - East Bay Regional Park District
Richard Makdisi - SES

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POINTS FOR DISCUSSION - ROUNDTABLE MEETING

Date: April 13, 2004

Attending: Neal Fujita and Ken Burger (District)
Scott Seery (Alameda County Environmental Health)
Bruce Rucker, Michael Phelps, and Richard Makdisi (SES)

Subject: Corrective Action Remedy Options for Redwood Regional Park Site

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Problem Overview

- ORC injection program reduced plume size at the periphery, but central portion of plume rebounded, likely due to seasonal TPH mass input from vadose zone soil sources.
- Completed additional boreholes based on persistent high concentrations at MW-7, MW-8, and MW-11. Findings: significant TPH in soil was still present in vadose zone soil and upgradient of MW-8 (see cross-section figure).
- Three potentially affected media are: surface water, groundwater, and soil. Unsaturated zone soil and groundwater are the primary concern.
- Bioventing is most promising approach to remedy unsaturated zone soil contamination.

Investigation and Corrective Action History

- 1993: UFST removals and source area excavation.
- 10 years of quarterly groundwater and surface water monitoring.
- Two-phase ORC injection program (September 2001 and July 2002) was successful in reducing the extent and partially successful in reducing magnitude of groundwater plume.
- Several phases of site characterization (borehole drilling and sampling), including October 2003 program, evaluated mass of residual soil contamination in the unsaturated zone.

Geologic and Hydrogeologic Conditions

- Plume area has been well characterized.
- Seasonally unsaturated, low-permeability sediments overlie 5 to 10 foot thick water-bearing zone, which overlies siltstone bedrock.
- Relatively clay-rich sediments, steep hydraulic gradient, and seasonally-fluctuating water levels result in a large interface zone of seasonally-saturated sediments where desorption of residual TPH occurs from soil into groundwater.
- The groundwater gradient is relatively steep, at an average of 0.1 feet/feet. The groundwater velocity has not been estimated with any direct testing, but could be expected to be as high as 50 to 100 feet per year given the subsurface conditions.
- Bedrock surface generally slopes toward Redwood Creek, with perpendicular elongate ridge/valley features suggestive of paleochannels – localized low water levels coincide with bedrock isopleth depressions (see isopleth map and cross-section).
- Groundwater occurs under unconfined to semi-confined conditions, with water levels varying seasonally up to several feet (see water level historical plot/table).

Surface Water TPH Impacts

- Surface water contaminant mass discharge is seasonal (late summer/early fall) and confined to SW-2 location, at a maximum TPH concentration of 1,300 ug/L (Dec 1999), but typically only between 100 and 500 ug/L.
- Year 2000 California Fish and Game instream bioassessment events (2) showed no impacts to benthic macroinvertebrate community.
- Creek/groundwater interface suggests Redwood Creek is a mainly discharging (rather than receiving) surface water body.

Groundwater TPH Impacts

- Projected 1,000 ug/L TPH area of impact is approximately 4,000 ft^2, with the narrower centerline of plume at 5,000 to 10,000 ug/L TPH.
- ORC injection program (September 2001 and July 2002) resulted in temporary reductions in plume core, but only showed "permanent" mass reductions mass on plume periphery.
- Seasonal trends in the TPH concentration are clearly observed in wells along the centerline of the plume.

- Along the plume centerline, downgradient well MW-7 most positively affected by the ORC while upgradient wells MW-8 and MW-11 show more fluctuations in dissolved TPH concentrations (see historical plots).

Soil TPH Impacts

- Residual TPH in vadose zone soil estimated at 1,400 to 7,000 pounds (100 to 600 gallons of gasoline), compared to mass of TPH in groundwater estimated at 1 to 10 pounds (0.1 to 1.0 gallon of gasoline).

- Residual TPH mass in unsaturated zone soil is acting as a long-term source of GW contamination.

- Without remediating the soil, groundwater and surface water monitoring will need to continue and site closure will be elusive.

Plume Geometry and Stability

- Historical visual evidence (and occasional analytical detections) of contaminated groundwater discharge to Redwood Creek; however, instream bioassessment found no adverse impacts to benthic macroinvertebrate community.

- Dissolved-phase contamination has become disconnected from original UFST source area.

- Seasonal shifts in center of contaminant mass result from water table fluctuations and desorption of residual TPH from vadose zone soil into groundwater.

- Reductions in contaminant mass and concentrations were achieved by the ORC injection, however rebound has occurred along the plume centerline.

- Maximum site-wide contaminant concentrations and Redwood Creek worst-case discharge conditions appear to have been realized.

Corrective Action Evaluation

- Groundwater concentrations and residual mass in the unsaturated zone soil (low-permeability soils) may require separate remedial approaches.

- Since unsaturated zone contamination appears to be primary source of TPH to groundwater, the most cost-effective corrective action should address that medium.

- Groundwater-specific corrective action will likely not appreciably reduce overall system contaminant mass by itself; however, it may be needed in the future to reduce groundwater concentrations to acceptable closure criteria.

- Bioventing has been shown (via a site-specific feasibility evaluation) to be the most appropriate unsaturated zone corrective action remedy for this site.

Advantages of Bioventing

- Minimal O&M cost and uses District's available resources.

- Removal of contaminant mass feeding the groundwater plume.

- Larger effective radius includes ORC-inaccessible area.

- Off-the-shelf, robust technology that has proven successful at low-permeability sites.

- Measurable mass reduction through vapor monitoring, respiration testing, and reporting (combined with ongoing groundwater monitoring program).

WATER LEVEL DATA AND TRENDLINES

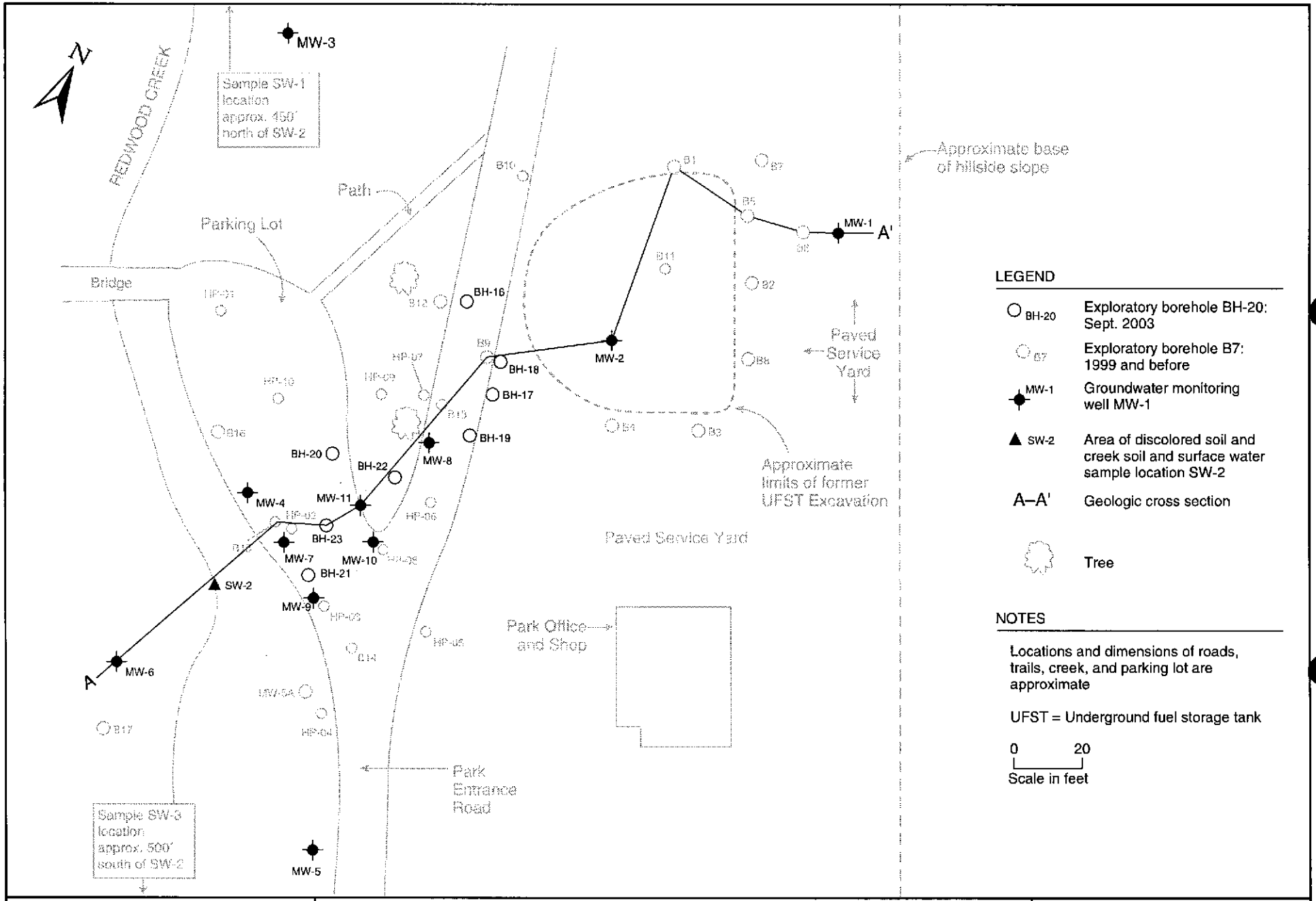
HISTORICAL GROUNDWATER ELEVATIONS IN MONITORING WELLS
REDWOOD REGIONAL PARK SERVICE YARD
7867 REDWOOD ROAD, OAKLAND, CALIFORNIA

Well I.D.	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	MW-9	MW-10	MW-11
TOC Elevation	565.90	566.50	560.90	548.10	547.50	545.60	547.70	549.20	549.40	547.30	547.90
Date Monitored	Groundwater Elevations (feet above mean sea level)										
September 18, 1998	563.72	544.19	540.80	534.51	531.06	545.60					
April 6, 1999	565.15	546.90	542.25	535.59	532.30	532.88					
December 20, 1999	562.90	544.70	541.46	534.89	531.16	532.22					
September 28, 2000	562.80	542.74	538.34	532.21	530.90	531.95					
January 11, 2001	562.90	545.10	541.70	535.00	531.20	532.30	534.90	538.10			
April 13, 2001	562.10	545.70	541.70	535.10	531.50	532.40	535.30	539.80			
September 1, 2001	560.90	542.00	537.70	533.90	530.70	531.80	534.00	535.60			
December 17, 2001	562.20	545.20	542.20	534.80	531.40	532.40	534.80	538.40	534.60	535.70	535.20
March 14, 2002	563.00	547.10	542.20	535.50	532.40	533.30	535.70	541.80	535.00	537.60	536.60
June 18, 2002	562.10	544.70	541.10	534.60	531.20	532.20	534.80	537.90	534.70	535.60	535.30
September 24, 2002	561.40	542.20	537.30	533.50	530.60	531.80	533.50	535.50	535.30	533.80	531.70
December 18, 2002	562.40	545.00	542.00	534.80	531.50	532.50	534.60	537.10	536.50	535.20	532.80
March 27, 2003	562.60	545.70	541.70	534.80	531.60	532.40	535.10	539.90	537.20	536.20	533.60
June 19, 2003	562.30	544.90	541.50	534.80	531.30	532.30	534.90	538.20	536.90	535.70	533.20
September 10, 2003	561.60	542.10	537.90	533.80	530.80	531.90	533.70	535.60	535.60	534.10	531.90
December 10, 2003	562.40	542.70	537.60	533.70	530.90	531.90	533.70	535.20	535.50	533.80	531.70
March 18, 2004	563.10	546.60	541.90	535.00	531.70	532.40	535.20	540.90	537.40	536.60	533.80

Notes:

TOC = Top of well Casing

CROSS-SECTION AND BEDROCK ISOPLETH



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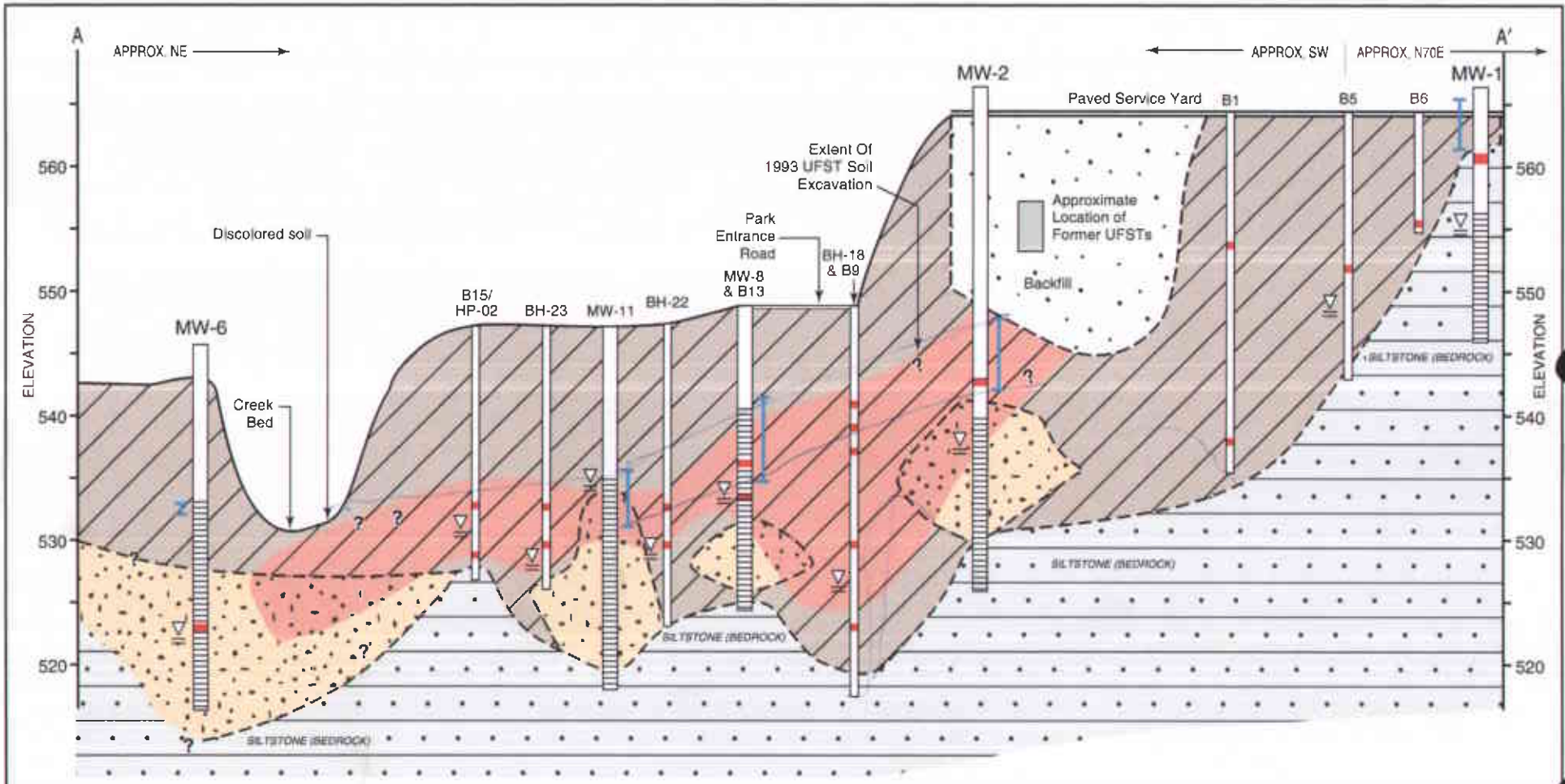
SITE PLAN AND HISTORICAL SAMPLING LOCATIONS
Redwood Regional Park Service Yard, Oakland, CA

Figure 2

by: MJC | APRIL 2004

2003-02-38



LEGEND

- B1 Exploratory Boring B1
- Location of soil sample collected for laboratory analysis
- MW-1 Monitoring Well MW-1
- Location of soil sample collected for laboratory analysis
- Well screen interval
- First occurance of groundwater during drilling
- Historical range of equilibrated water levels in wells
- Silt/clay
- Sand/gravel
- Backfill
- Area of unsaturated zone soil contamination
- Siltstone (bedrock)

NOTES

- Locations and dimensions of roads, trails and parking lot are approximate
- UFST = Underground fuel storage tank
- UFSTs not drawn to scale
- All elevations are expressed as feet above mean sea level (MSL)
- Well casing and boring widths not to scale
- Some borings projected into cross section (see Figure 2)

Scale in feet
10
0
0
20
Vertical exaggeration Is 2.5x

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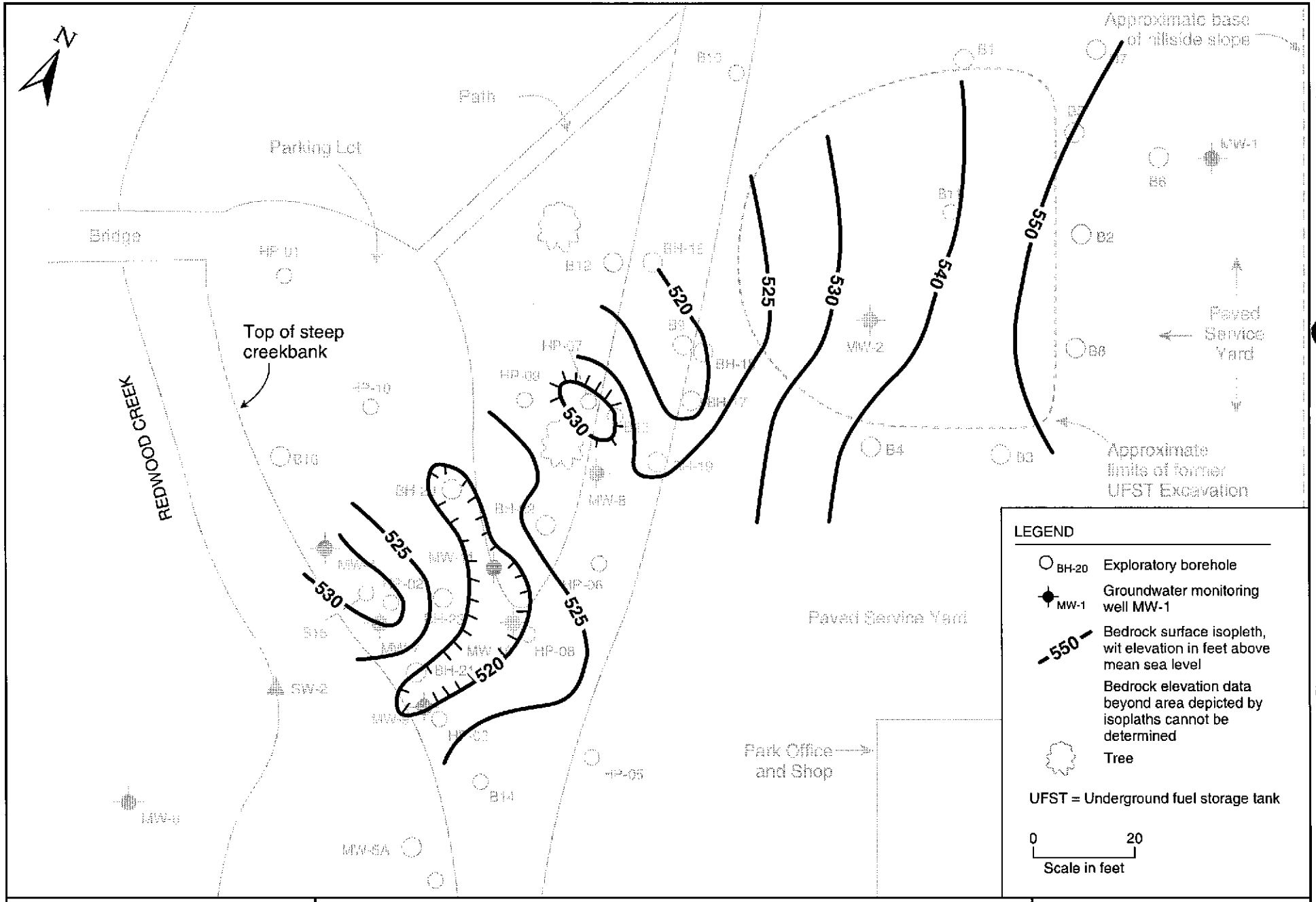
Cross Section A-A'
Redwood Regional Park Service Yard, Oakland, CA

Figure 3

by: MJC | APRIL 2004

2003-02-39



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BEDROCK SURFACE ISOPLETH MAP
Redwood Regional Park Service Yard, Oakland, CA

Figure 4

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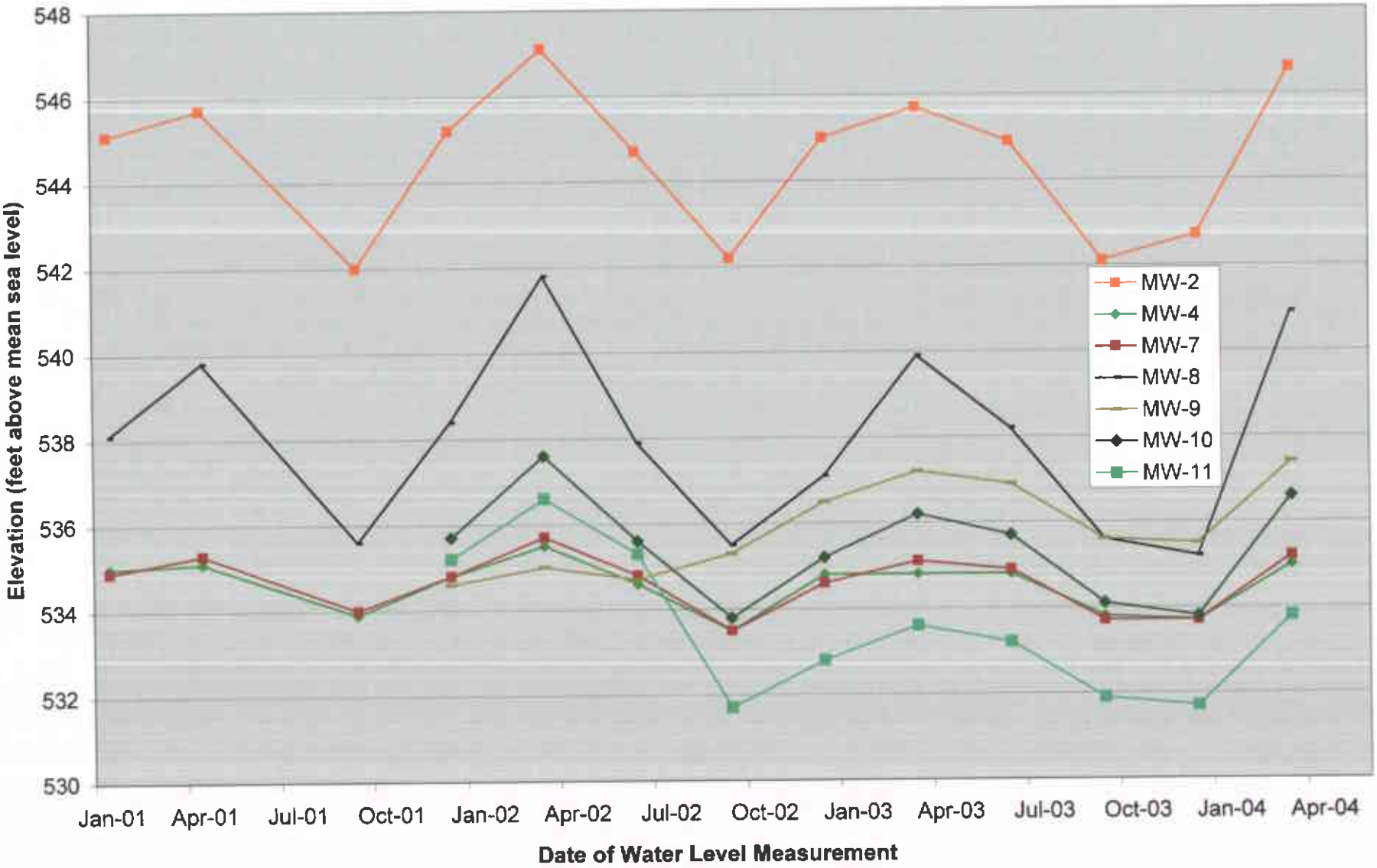
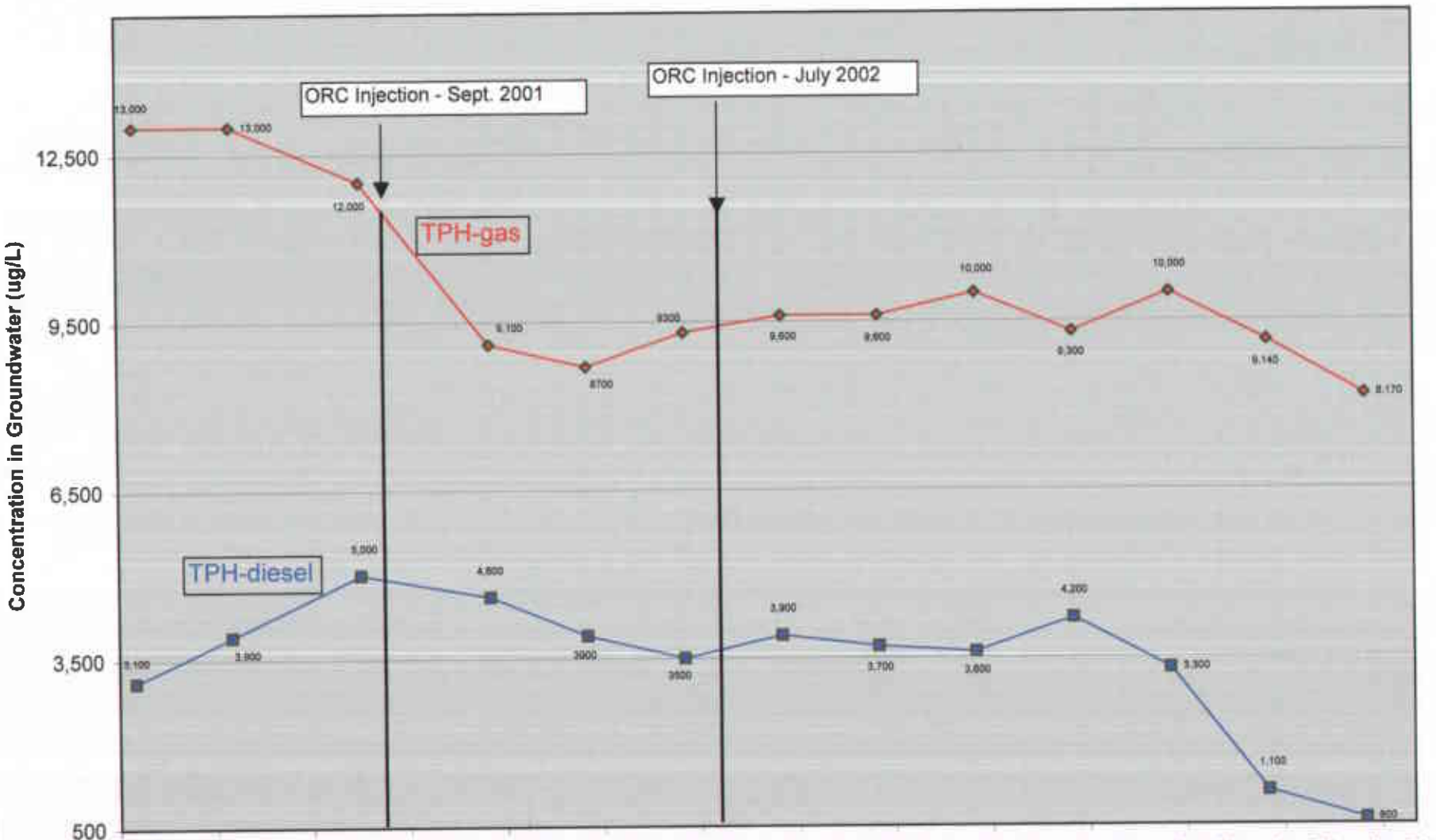
2003-02-37

HYDROCHEMICAL TRENDLINES

Historical Groundwater Elevations
Redwood Regional Park Service Yard - Oakland, California



Gasoline and Diesel Hydrochemical Trends: Well MW-7
Redwood Regional Park Service Yard, Oakland, California



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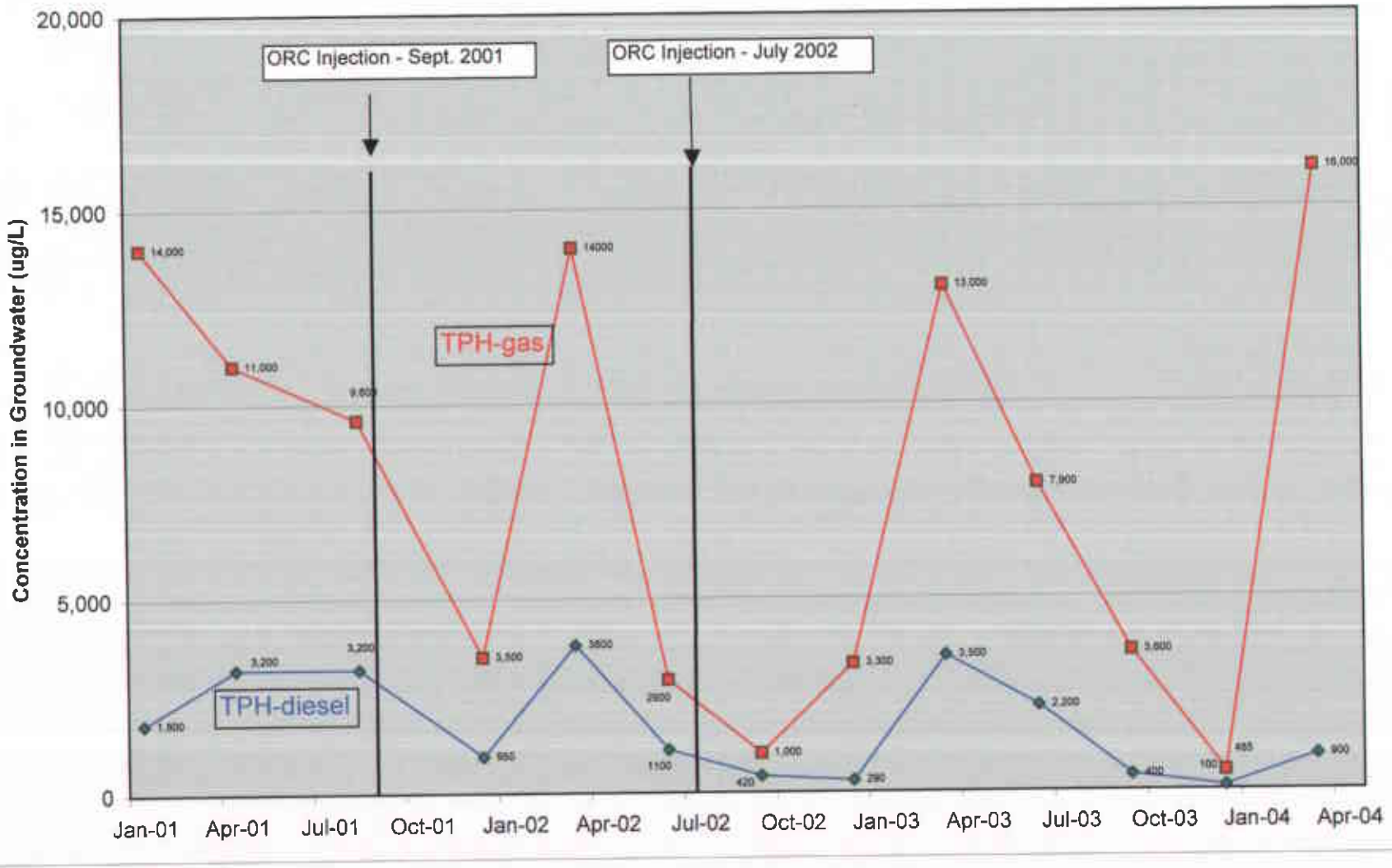
Gasoline and Diesel Hydrochemical Trends: Well MW-8
Redwood Regional Park Service Yard, Oakland, California



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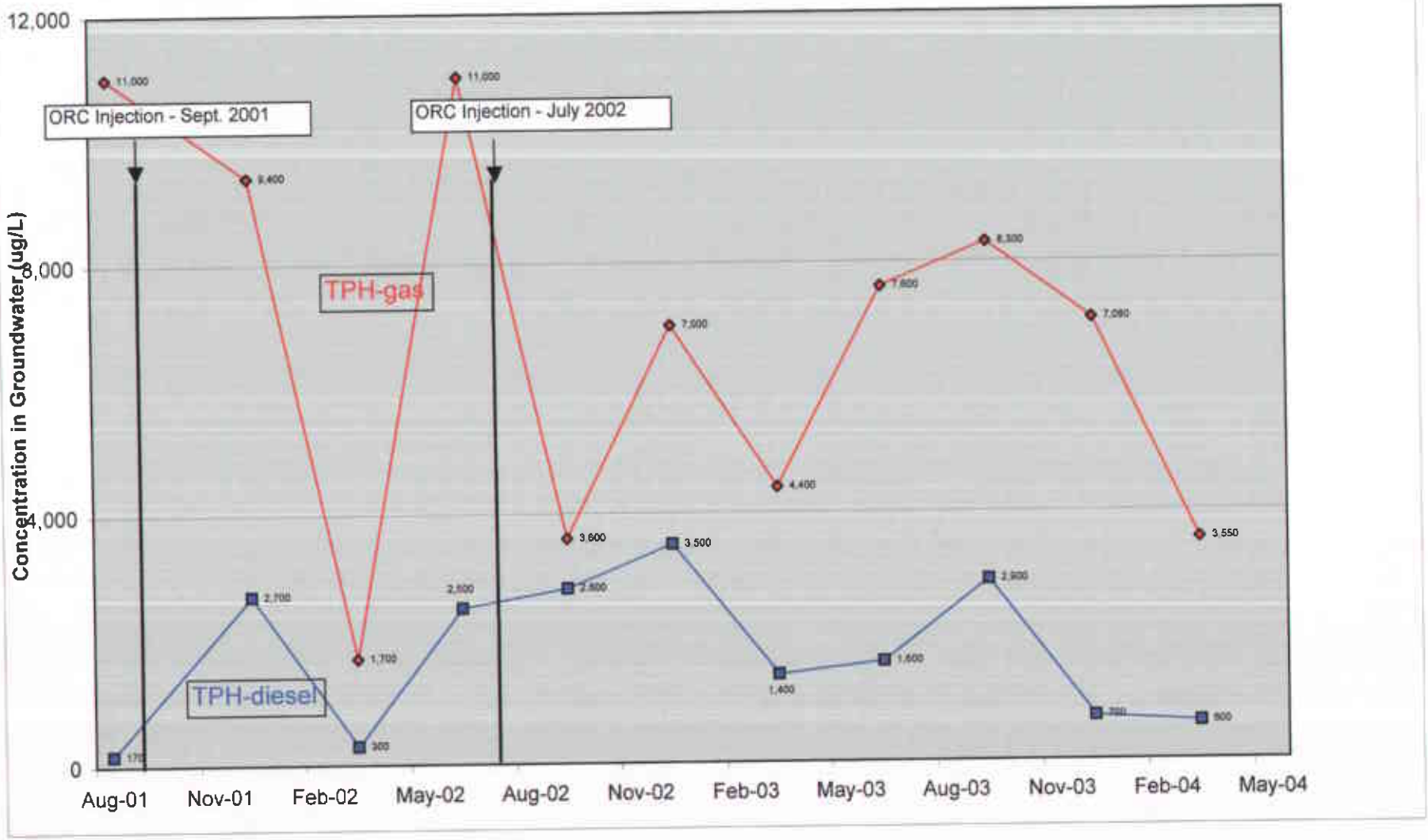
TPH-gasoline and TPH-diesel Hydrochemical Trends: Well MW-9
Redwood Regional Park Service Yard, Oakland, California



Gasoline and Diesel Hydrochemical Trends: Well MW-11
Redwood Regional Park Service Yard, Oakland, California