DRAFT FINAL
Evaluation of
Existing Interim Remedial Measures
and Work Plan for Implementation of
Future Interim Remedial Measures
Sherwin-Williams Facility
Emeryville, California

May 20, 1998
6215.00-015

Prepared for
The Sherwin-Williams Company
101 Prospect Avenue, N.W.
Cleveland, Ohio 44115

Levine·Fricke·Recon
ENGINEERS, HYDROGEOLOGISTS & APPLIED SCIENTISTS

May 20, 1998 6215.00-015

Mr. Mark Johnson
California Regional Water Quality Control Board
2101 Webster Street, Suite 500
Oakland, California 94612

Subject: Draft Final Evaluation of Existing Interim Remedial Measures and Work Plan for Implementation of Future Interim Remedial Measures, Sherwin-Williams Facility, Emeryville, California

Dear Mr. Johnson:

Enclosed is the subject draft final report. Levine·Fricke·Recon (LFR) has prepared this Evaluation of Existing Interim Remedial Measures (IRMs) and Work Plan for Implementation of Future Interim Remedial Measures at the Sherwin-Williams Facility in Emeryville, California, on behalf of The Sherwin-Williams Company ("Sherwin-Williams") in accordance with Site Cleanup Requirements Order 98-009 adopted by the Regional Water Quality Control Board (RWQCB) on February 19, 1998.

The subject report presents an evaluation of the effectiveness of existing IRMs at the Site in meeting remedial objectives. These IRMs and remedial objectives were first described in the "Evaluation of Interim Remedial Measures" submitted to the RWQCB on December 20, 1991 (EIRM). The subject report is limited to the IRMs previously implemented on site for Sherwin-Williams as described in the EIRM.

If you have any questions, please call Larry Mencin at (216) 566-1768 or Mark Knox or Mike Marsden of LFR at (510) 652-4500.

Sincerely,

Mark D. Knox

Mark D. Knox, P.E.
Principal Engineer

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Enclosure

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All information, conclusions, and recommendations in this document have been prepared under the supervision of and reviewed by a Levine·Fricke·Recon California Professional Engineer.

Mark D. Knox — Date
Principal Engineer
California Professional Engineer (33194)

1.0 INTRODUCTION

Levine·Fricke·Recon, Inc. (LFR) has prepared this Evaluation of Existing Interim Remedial Measures (IRMs) and Work Plan for Implementation of Future Interim Remedial Measures at the Sherwin-Williams Facility in Emeryville, California, on behalf of The Sherwin-Williams Company ("Sherwin-Williams") for submittal to the Regional Water Quality Control Board (RWQCB). This report is submitted pursuant to the RWQCB Site Cleanup Requirements Order 98-009 on February 19, 1998 ("the SCR Order"). This report presents an evaluation of the effectiveness of existing IRMs at the Sherwin-Williams Facility in Emeryville, California ("the Site"; see Figure 1) in meeting remedial objectives. These IRMs and remedial objectives were first described in the "Evaluation of Interim Remedial Measures" submitted to the RWQCB on December 20, 1991 ("the EIRM"). The subject report is limited to the IRMs implemented on site for Sherwin-Williams as described in the EIRM.

The IRMs discussed include the slurry wall, cap and storm-water collection system, groundwater extraction system, and groundwater treatment system. The storm-water collection system is discussed briefly, a full report on the temporary remedial measures implemented during the 1997/1998 rainy season will be submitted to the RWQCB as a separate report. Remedial activities associated with the Horton Street removal action, implemented last year, will also be documented in a separate report to the RWQCB.

1.1 Site Background

The following sections present a brief history of the Site, remedial investigation, and development and implementation of existing IRMs.

1.1.1 Site History

The Sherwin-Williams Company owns and operates a coatings manufacturing plant located at the corner of Horton Street and Sherwin Avenue (1450 Sherwin Avenue) in Emeryville, California. The plant has been in operation since the early 1900s, manufacturing various types of coating products. It also produced lead-arsenate pesticides from the 1920s until the 1940s. In 1987, Sherwin-Williams changed its manufacturing at the Site from oil-based products to water-based products. The change in manufacturing operations included the closure and dismantling of an oil tank storage facility, solvent tank storage facilities, alkyd resin manufacturing facility, lacquer manufacturing facility, and the former pesticide manufacturing area.

1.1.2 Remedial Investigation

Several soil and groundwater investigation phases were subsequently conducted from 1988 to 1991 to assess the nature and extent of a range of volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and certain inorganic compounds (mostly arsenic and lead) detected at the Site as a result of the investigation of the tank storage and production facilities.

Soil investigations conducted at the Site included the following areas:

- former oil tank storage
- former solvent tank storage
- a paved parking area near the former solvent tank storage
- Arsenic source area

VOCs, SVOCs including total petroleum hydrocarbons (TPHs), and arsenic were identified in A-zone groundwater in the site vicinity. Analytical data collected during the initial phases of investigation and monitoring indicated that chemical compounds detected in A-zone groundwater did not appear to affect B-zone groundwater at concentrations requiring remediation.

1.1.3 Development of IRM Alternatives

In 1990, the Sherwin-Williams Company retained LFR to develop IRMs to address source areas for the Site. An evaluation was conducted in accordance with site investigation and treatability study work plans prepared by LFR for Sherwin-Williams. The objectives of the IRMs were to reduce or eliminate potential human exposure to affected soil and groundwater, prevent or minimize off-site migration of the affected groundwater, and control source areas. Sherwin-Williams evaluated various interim remedial measures for the Site (using National Contingency Plan guidelines for interim actions) according to the feasibility, effectiveness, and implementability of the alternative IRMs. Based on these evaluations, Sherwin-Williams proposed IRMs for the Site.

The IRMs for the Site were presented in LFR's EIRM report dated December 20, 1991. The RWQCB concurred with the proposed IRMs in a letter signed by the Executive Officer, Steve Ritchie, dated March 10, 1992.

1.1.4 Implementation of Interim Remedial Measures

As part of the IRMs, Sherwin-Williams installed the following items:

- slurry wall to contain chemically affected areas and inhibit further off-site migration of affected groundwater
- cap and storm-water collection system to prevent infiltration into chemically affected soils from storm-water runoff

- groundwater extraction and treatment system (GWETS) to pump groundwater within the slurry wall, create an inward hydraulic gradient, and treat extracted groundwater

Implementation of Interim Remedial Measures began in July 1993 with the start of construction on the slurry wall. The slurry wall was completed in November 1994. Construction of the cap and storm-water collection system took place between March 1995 and September 1995. The groundwater extraction and treatment system (treated as two separate IRMs for the purposes of this report) were started up in September 1995. An overview and objectives of the IRMs are presented in greater detail in Section 1.2.

Overall periodic groundwater monitoring in on- and off-site groundwater monitoring wells has been conducted at the Site since 1989. Monitoring was conducted on- and off-site throughout the period of IRM construction and afterward to show the effectiveness of the IRMs in controlling off-site migration of affected groundwater.

In 1994 and 1995, activities were conducted to remove underground storage tanks (USTs), owned by Southern Pacific Lines (SPL) and located near the western Sherwin-Williams property line (adjacent to SPL railroad lines), that were discovered during Sherwin-Williams site remediation construction work. The USTs were encountered during cap and slurry wall construction activities. The tanks contained petroleum products historically used by SPL. Four buried railroad tank cars were found on the western property boundary with SPL, which agreed to take responsibility for their removal. Two smaller torpedo tanks were later located in the vicinity of the buried railroad tank cars. The adjacent property owner, the SPL, took responsibility for these tanks, which were removed and disposed of at an approved facility.

The slurry wall and the cap and storm-water collection system are passive IRMs, and do not require frequent monitoring to maintain their effectiveness. The groundwater extraction system (GWES) and the groundwater treatment system (GWTS) are active IRMs that require periodic maintenance and monitoring to operate effectively and maintain compliance.

1.2 Overview and Objectives of Interim Remedial Measures

A site plan showing the location of the selected IRMs is presented in Figure 2. Descriptions of the IRMs and their corresponding remedial objectives are presented below.

IRM 1: Installation of a slurry wall to contain chemical-affected areas and inhibit further off-site migration of affected groundwater. The slurry wall is intended to contain on-site affected groundwater and inhibit migration of affected groundwater off site. In addition, the slurry wall helps reduce the amount of groundwater requiring extraction and subsequent treatment, which addresses regulatory guidelines focused on reducing the unnecessary pumping of groundwater. Implementation of this IRM involved excavating a slurry wall trench (keyed into the underlying low-permeability Bay Muds), then backfilling with a soil-bentonite or cement-bentonite mixture to create a relatively impermeable barrier around affected areas of the Site.

IRM 2: Installation of a cap and storm-water collection system to eliminate human exposure pathways and to prevent infiltration into chemical-affected soils from storm-water runoff. The purpose of this IRM is to significantly reduce the potential for vertical leaching of chemicals into groundwater from rainwater infiltration, while providing a direct barrier to wind or water erosion. The cap also eliminates potential human exposure pathways. Implementation of this IRM involved grading the Site for storm-water collection, construction of a storm-water collection system of drains, catch basins, conveyance piping, and appurtenances, and capping the Site with concrete or asphalt.

IRM 3: Installation of a GWES to create an inward hydraulic gradient. The purpose of this IRM is to provide a zone of lower hydraulic potential and to create an inward hydraulic gradient across the slurry wall. The GWES consists of three shallow groundwater extraction wells and conveyance piping to pump groundwater back to the GWTS. LFR currently performs operation, maintenance, and monitoring activities for the GWES.

IRM 4: Installation of a GWTS to treat extracted groundwater. Extracted groundwater from the GWES contains arsenic and other heavy metals, VOCs, and SVOCs. The GWTS initially consisted of an electrochemical system for removal of heavy metals ("Andco System") and a biological system for removal of organics ("Tri-Bio System"). The Tri-Bio system was later replaced by carbon drums to treat the organic phase in the groundwater (see Section 2.4.2). Treated water is normally discharged into an on-site storm drain which discharges into Temescal Creek to the north of the Site. Temescal Creek empties into San Francisco Bay. Discharge of treated groundwater has been authorized under the RWQCB's General Waste Discharge Requirements Order 94-087, NPDES No. CAG912003, issued March 15, 1995. LFR assisted with treatment system startup, and is currently conducting operation, maintenance, and monitoring activities for the GWTS.

2.0 EVALUATION OF EXISTING INTERIM REMEDIAL MEASURES

The following sections discuss the effectiveness of IRMs at the Sherwin-Williams site. The IRMs discussed include the slurry wall, cap and storm-water collection system, groundwater extraction system, and groundwater treatment system.

2.1 Slurry Wall

The following sections discuss the effectiveness of the slurry wall IRM and possible future actions.

2.1.1 Evaluation of Effectiveness

To assess the effectiveness of the slurry wall, LFR monitors water levels immediately inside and outside the slurry wall. In general, a water-level difference (in excess of the natural gradient) between wells within a well pair is evidence that the slurry wall is functioning as a barrier to groundwater flow. Additionally, differences in groundwater flow direction inside versus outside the slurry wall illustrate the wall's effectiveness.

At the time the slurry wall was installed, permeability testing was conducted that verified that the permeability met the objectives for construction of the slurry wall. Water-level measurements taken at A-zone piezometers and monitoring wells during periodic monitoring events since slurry wall completion have consistently shown a difference in groundwater elevations inside and outside the slurry wall. These water-level differences demonstrate that the slurry wall has always been effective as a barrier to impede flow. Table 1 presents historical water-level data for wells and piezometer pairs. In November of 1997, four additional piezometer pairs were installed immediately adjacent to the slurry wall. Piezometers were installed both inside and outside the slurry wall to gather additional data and to more precisely assess the effectiveness of the slurry wall. Data collected from these new piezometers are consistent with historical data and further demonstrate that the slurry wall is an effective impediment to groundwater flow.

Since completion of the slurry wall, groundwater flow direction within the slurry wall has deviated from the natural flow outside the wall. The flow within the slurry wall is controlled by the extraction well system when operational (Section 2.3). Groundwater flow outside the slurry wall is not affected by the extraction system. Figure 3 illustrates the most recent A-zone groundwater elevation data, which were presented in the Quarterly Groundwater Monitoring report dated April 30, 1998. The groundwater elevation contours shown in the figure, which illustrates groundwater flow within the slurry wall, deviate significantly from flow outside. This deviation demonstrates that the slurry wall acts as a substantial barrier to flow.

2.1.2 Future Action

Since completion of the slurry wall in November 1994, the wall has met the IRM objectives of containing chemical-affected areas and inhibiting further off-site migration of affected groundwater. As a result, no further actions are planned for the slurry wall. Groundwater monitoring, including water-level measurements and well sampling, will continue in accordance with the SCR Order to verify that the slurry wall is meeting the IRM objectives.

2.2 Cap and Storm-Water Collection System

The following sections discuss the effectiveness of the cap and storm-water collection system and possible future action.

2.2.1 Evaluation of Effectiveness

In September 1995, the site cap and storm-water collection system were completed with the purpose of eliminating the human exposure pathway from underlying soils and to minimize contact between rainfall and affected underlying soil. The cap material is asphalt and concrete within discrete cells that are sloped to drain into catch basins to collect surface-water runoff. The storm-water collection system consists of a network of trench drains, catch basins, manholes, and conveyance piping that collects surface-water runoff and ultimately discharges into Temescal Creek.

In September 1997 LFR performed a surficial inspection of the concrete and asphaltic concrete cap at the Site. The field observations are noted on Figure 4. The observations noted indicate some minor maintenance items for the cap that can be addressed when the cap is periodically resealed as part of the routine maintenance for the Site. Overall, the results of the inspection verified that the environmental cap is in good to excellent condition. The only notable condition in the cap that could potentially result in any significant infiltration was the area between the cap and the railroad track and switch gear.

In November 1996, water levels within the slurry wall began to rise in spite of the ongoing operation of the extraction system. Shortly thereafter, an investigation began of possible water sources within the slurry wall. Though a city water source has not been ruled out, one has not been identified. The railroad tracks appear to be a likely source of infiltration of water within the slurry wall. It appears that during rain events, storm-water runoff infiltrates underneath the railroad track and switch gear. During a recent shutdown of the extraction system, water levels were collected from across the Site. The shutdown of the extraction system took place during the heavy rains of January 1998. Figure 5 illustrates a mound of groundwater developing along the tracks, supporting the conclusion that the railroad tracks are a possible source of infiltration.

The cap and storm-water collection system has been effective at conveying surface runoff to the Creek and minimizing infiltration to groundwater. However, in October 1997, affected groundwater was discovered to be infiltrating into the storm-water collection system. Though no major breaks were detected in the system, groundwater was able to enter the system through joints and at manhole/catch basin connections.

Because of the affected groundwater in the storm-water collection system, prompt steps were taken to prevent discharge of contaminated water to Temescal Creek. These steps included:

- insertion of inflatable plugs in the storm drain piping to prevent discharge of affected storm water to Temescal Creek
- evacuation of infiltrating groundwater from the underground storm-water system
- collecting the groundwater from the underground storm-water system and storm-water runoff into 20,000-gallon aboveground portable tanks on site

As a short-term solution to retrofit the storm-water collection system, LFR designed and constructed a temporary system to convert the catch basins into a multipoint collection system to prevent flooding of the site facility during rain events and to prevent groundwater from infiltrating the catch basins. The multipoint collection system consisted of installing steel liners into the catch basins to completely isolate the catch basins from infiltrating groundwater. The steel liners also collected storm-water runoff during rain events, and with submersible pumps installed in the steel liners, the storm-water runoff was discharged to Temescal Creek. LFR collected samples of the storm-water discharge to analyze for arsenic concentrations when water was discharged to the creek. A more detailed summary of the storm-water response actions will be submitted to the RWQCB under separate cover.

The existing storm-water collection system is still considered to be effective, assuming that water levels can be brought down below the storm drain piping. The reduction of the water levels in the slurry wall will be addressed by expanding the GWES and GWTS as discussed below.

2.2.2 Future Action

The objectives for the cap and storm-water collection system, eliminating human exposure pathways and preventing water infiltration, have been substantially met with the exception of the possible infiltration identified around the railroad tracks. The minor items noted during the cap inspection will be addressed as part of the future routine maintenance of the cap. The cap will also be inspected periodically to verify that the integrity of the cap is maintained.

LFR will take action to address the infiltration along the railroad tracks. These actions may include steps to minimize or collect infiltration. An assessment of the railroad tracks will be necessary to identify alternatives to seal the area between the railroad tracks and the cap.

The lowering of water levels to prevent infiltration to the storm-water collection system is addressed as part of the groundwater extraction and treatment system expansion (Section 2.3.2). No further actions are identified with respect to the storm drain system.

2.3 Groundwater Extraction System

In 1995, extraction wells EX-1, EX-2, and EX-3 were installed in the shallow aquifer within the slurry wall. The extraction wells are constructed of 5-inch-diameter polyvinyl chloride (PVC) casing installed to a depth of approximately 20 feet below ground surface. The wells pump at rates ranging from 1 to 5 gallons per minute (gpm). The wells are piped to the GWTS as illustrated in Figure 2. The three wells and the associated piping constitute the current GWES.

In the EIRM, LFR determined that discharge of the treated groundwater to the East Bay Municipal Utilities District (EBMUD) sanitary sewer was preferred over discharge to Temescal Creek. At the time that the EIRM was prepared, the arsenic discharge limit into the sanitary sewer was 2,000 parts per billion (ppb). After submission of the EIRM to the RWQCB, EBMUD revised its arsenic discharge limit for treated groundwater from 2,000 ppb to a technically unfeasible level of 2 ppb. EBMUD also indicated that one of the reasons for such a low discharge limit was to discourage the discharge of groundwater to the sanitary sewer. As a result of this EBMUD policy change, Sherwin-Williams obtained a National Pollutant Discharge Elimination System (NPDES) permit (Order No. 94-087, NPDES Permit No. CAG912003 issued March 15, 1995) authorizing direct discharge of treated groundwater to Temescal Creek.

The electrochemical co-precipitation treatment currently operating at the Sherwin-Williams Emeryville Facility was designed in 1993 to meet a conservative 25-ppb arsenic discharge limit. This limit was based on the United States Environmental Protection Agency (U.S. EPA) drinking water standard of 50 ppb arsenic and the San Francisco Basin Plan shallow marine environment NPDES discharge limit of 36 ppb arsenic that were in effect during the design period. The 25 ppb limit was chosen because it was 50% of the drinking water standard, and below the shallow marine discharge limit by approximately 30%.

In August 1993, the RWQCB requested that LFR analyze the technical feasibility of a discharge limit for treated groundwater of 5 micrograms per liter (μg/l; equivalent to ppb) of arsenic. In a letter to LFR dated September 9, 1993, Andco Environmental Processes, Inc. ("Andco") indicated that achieving a 5-ppb arsenic discharge limit was not technically feasible. At this very low concentration, the reactions leading to arsenic removal become much less efficient because of the various forms of arsenic present in the on-site groundwater. In addition, the complexity of the on-site groundwater may interfere with and reduce the effectiveness of the electrochemical reactions. Andco determined that a 25-ppb arsenic discharge limit was the only technically achievable and cost-effective limit on a consistent basis.

The RWQCB established a 10-ppb general NPDES discharge limit for arsenic on July 20, 1994, based on the Basin Plan. At the time this general NPDES discharge limit for arsenic was established, Sherwin-Williams had already purchased the existing GWETS from Andco. On March 15, 1995, the RWQCB issued the NPDES discharge permit to Sherwin-Williams, taking these factors into account by approving the discharge of arsenic within a 25-ppb site-specific NPDES limit, providing that the requirements described in Provision E.4 of the General Waste Discharge Requirements, Order No. 94-087, NPDES No. CAG912003 were followed.

In March 1997, LFR prepared a cost and feasibility analysis report to comply with requirements described in Provision E.4 of the general permit. The RWQCB issued the requirement for the feasibility and cost analysis report after three water samples collected from the groundwater treatment system's final effluent in July and September 1996 contained arsenic above the general NPDES discharge limit of 10 ppb. The report evaluated the feasibility and cost of adopting a single 25-ppb site-specific NPDES arsenic discharge limit, eliminating the 10-ppb general NPDES arsenic discharge limit for the Site. This limit is below the State of California's four-day average allowable concentration of 36 ppb of arsenic (III) in saline environments. Based on the information presented in the feasibility and cost analysis report, LFR recommended and the RWQCB concurred with this single site-specific NPDES arsenic discharge limit of 25 ppb.

In a letter to EBMUD on behalf of Sherwin-Williams, dated November 21, 1997, LFR resubmitted an application for discharge of treated groundwater to the EBMUD Publicly Owned Treatment Works (POTW). This application was resubmitted since EBMUD's revised Ordinance No. 311 allows for exceptions to EBMUD's general policy of prohibiting groundwater discharge to the sewer. Specifically, Title I, Section 6 of Ordinance No. 311 allows for groundwater discharge exceptions where "unusual conditions compel special terms and conditions." As part of the permit application, Sherwin-Williams requested a discharge limit of 200 ppb for arsenic and a revised request for a 20-gpm flow rate. For reference, the 200-ppb discharge limit for arsenic is well below the general industrial discharge limit of 2,000 ppb for arsenic applicable to EBMUD's industrial water discharges.

On December 1, 1997, EBMUD's POTW approved the Sherwin-Williams application for GWTS discharge into the sanitary sewer system. The EBMUD permit allows a discharge for one year to the POTW with the requirement to renew the permit annually since the discharge is an exception to EBMUD's sewer ordinance. The POTW permit discharge requirement for arsenic is 200 ppb. Sherwin-Williams subsequently installed the majority of the necessary piping to connect to an off-site sanitary sewer to allow for final discharge of treated water to the POTW.

The City of Emeryville, however, has delayed approval for connection to the sanitary sewer collection system because of disagreements over the terms of the encroachment permits, including substantial fees for a permanent connection to the sewer. Sherwin-Williams is currently negotiating for connection approval with the City. Connection to the sewer for even one year would greatly facilitate lowering of groundwater levels because the current Andco system could operate at a higher flow rate with less frequent shutdowns while the retrofit to a 30-gpm system is implemented.

2.4.2 Overview of the Existing Groundwater Treatment System and Evaluation of Effectiveness

As noted above, the GWETS began discharging treated groundwater to Temescal Creek in October 1995. The GWES consists of three pneumatic extraction pumps and conveyance piping (Section 2.3). The original GWTS, installed in October 1995, consisted of an electrochemical system to remove heavy metals (Andco System) and a biological system to remove organic compounds (Tri-Bio System).

Because of decreasing concentrations of organic compounds in the GWTS influent water, LFR took the Tri-Bio System off line on April 8, 1997 (following notification to the RWQCB) and replaced it with three 200-pound aqueous-phase carbon drums connected in series. The carbon system has since been updated to nine 200-pound aqueous-phase carbon drums arranged in three parallel series of three drums each. The two additional parallel sets of three drums were installed to compensate for pressure restrictions that were limiting the flow rate from the Andco System. Regenerated bituminous granular activated carbon can be a potential source of arsenic and other heavy metals, so virgin coconut-shell carbon is used to minimize the potential of the carbon to act as a source of arsenic.

The current GWETS consists of the three pneumatic extraction pumps and associated conveyance piping, the Andco system, and the aqueous-phase granular activated carbon ("the carbon system"). Figure 2 shows a site plan including locations of the GWETS, and Figure 8 presents a schematic of the existing treatment system.

The GWTS has experienced difficulty in consistently achieving the NPDES limit of 25 ppb. Review of data over a two-year period indicates that arsenic concentrations in the GWTS influent water have ranged between 11,000 and 81,000 ppb. The 25-ppb NPDES limit has been periodically exceeded in the effluent despite Sherwin-Williams' implementation of the best available technology, which results in removal of arsenic in excess of 99.97% from the influent water. Data from over two years of system operation show that effluent arsenic concentrations have ranged from less than 2 ppb to 110 ppb. The GWETS must be shut down and water recirculated every time an arsenic level in excess of 25 ppb is detected. Operating the system in this manner since startup has resulted in the extraction system operating less than 60 percent of the time.

Since the system startup in October 1995, LFR has made a considerable effort to identify and resolve problems associated with the electrochemical treatment system performance. Specifically, LFR has modified and redesigned the Andco System to correct several design deficiencies, which have prevented the system from continuously meeting the discharge limit of 25 ppb. LFR addressed the Andco System's design deficiencies by focusing on three main controllable parameters critical for control of the system's arsenic removal efficiency: the system flow rate, the hydrogen peroxide injection rate, and the amperage levels across the electrochemical cells that control iron concentration. LFR focused its corrective efforts on retrofitting the Andco System with feedback loop control systems for each of these three main controllable parameters. These efforts helped provide more precise monitoring and control systems essential to meet the required treatment level for arsenic.

Ongoing improvements to the Andco system made by LFR include performing more frequent changeouts of the electrochemical cells than recommended by Andco; monitoring and correcting the influent tank pH; increasing the frequency of monitoring the iron-generating efficiency in electrochemical cells using a field test kit; installing a new variable frequency drive (VFD) motor controller on the process pump to maintain a steady flow rate across the electrochemical cells; replacing faulty flow meters to provide more precise flow control after the electrochemical cells; increasing the monitoring of influent arsenic concentrations by sending weekly samples to the Sherwin-Williams internal quality control laboratory; installing and troubleshooting a prototype hydrogen peroxide control unit; upgrading the silicon controlled rectifier (SCR) supplied by Andco to provide better control of amperage across the electrochemical cells; and adding a field technician during the swing shift to adjust treatment system operation parameters and increase operating time of the GWETS.

The extensive efforts to modify the GWETS, revise operation and maintenance procedures, and adjust treatment system operation parameters have met with varying success even though the system manufacturer (Andco) originally claimed to be able to meet the 25-ppb limit. Andco has provided very limited technical support to Sherwin-Williams and LFR in answering process questions and solving design problems with its electrochemical co-precipitation system. Discharges to Temescal Creek from the treatment system have been below 25 ppb of arsenic in 1998; however, this may result in part from the fact that the influent water has had lower concentrations of arsenic (portion of the time treating storm water/groundwater mixture) than in the past. As a result of these developments with the Andco system, LFR has proceeded with evaluating alternatives for improving the treatment system performance in addition to expanding the electrochemical co-precipitation technology.

2.4.3 Evaluation of Alternative or Additional Treatment

The March 1997 cost and feasibility analysis report evaluated the technical feasibility of various arsenic treatment technologies to be used either in place of or in addition to the existing GWTS to achieve the general NPDES arsenic discharge limit of 10 μg/l. A number of technologies were reviewed and the arsenic treatment technologies that appeared to be viable alternatives to electrochemical co-precipitation or potential complimenting technologies were retained for further consideration based on their cost and technical effectiveness.

Under the cost and feasibility analysis report, LFR performed an evaluation of the following treatment technologies as alternatives to the Andco electrochemical co-precipitation system:

- ion exchange
- reverse osmosis
- hydroxide precipitation with lime
- sulfide precipitation

LFR investigated whether there had been significant advances in these technologies since the 1991 EIRM report. The results of this evaluation confirmed the conclusions of the 1991 EIRM report that the electrochemical co-precipitation treatment technology was the most feasible and cost effective and did not warrant replacement.

In addition, LFR evaluated the following technologies for use as additional treatment to the existing electrochemical and carbon treatment systems to cost-effectively and consistently meet the NPDES limit for arsenic:

- ion exchange
- reverse osmosis
- arsenic filter bags

The evaluation of these additional technologies indicated that there were significant space and technical constraints limiting the installation of another groundwater treatment system in addition to the Andco and carbon treatment systems currently operating.

In 1997 and early 1998, LFR evaluated potential present and future actions, as well as expansion options to improve the performance of the GWETS. LFR identified several equipment limitations (e.g., filter press, clarifier, and hydrogen peroxide controller unit) in the existing Andco system. As outlined in Section 2.4.2, the current GWTS system has difficulty in consistently meeting the NPDES discharge requirements of 25 ppb at flow rates between 7 and 9 gpm. In addition, normal operation and maintenance of the GWTS is labor intensive and the Andco system generates a large volume of sludge that is difficult to dewater using the existing filter press. It is uncertain whether it is technologically feasible to consistently meet the NPDES discharge limit using electrochemical co-precipitation technology. Additionally, a significant capital expenditure will be required to upgrade the existing Andco system to handle a flow rate of 30 gpm.

In January 1998, LFR identified to Sherwin-Williams three potential alternative arsenic-removal technologies. A bench-scale treatability study was performed on the first technology, which uses a proprietary chemical (KB-1™) developed by Klean Earth Environmental Company (KEECO). KB-1™ chemically bonds to the dissolved metals, encapsulates the metals in a silica matrix, and facilitates their rapid precipitation. Although the KEECO technology reduced arsenic concentrations from 39 milligrams per liter (mg/l; equivalent to parts per million [ppm]) to less than 25 ppb, the technology was eliminated from further consideration because of implementability limitations. The KEECO process requires a specialized silica sand that is highly abrasive to process equipment resulting in frequent changeouts of specially designed mixing blades. LFR concluded this technology would not be technically feasible for a 30-gpm treatment system.

The two remaining arsenic removal technologies evaluated by LFR were developed by MSE Technology Applications, Inc. (MSE). MSE has developed two proprietary arsenic removal technologies in conjunction with the University of Montana at Butte ("Montana Tech"), with funding from the U.S. EPA Mine Waste Technology Program. A bench-scale treatability study was performed on a 10-gallon composite water sample collected from the three on-site extraction wells. The first proprietary MSE technology, mineral-like precipitation, was able to lower the arsenic concentration from 81 ppm to a concentration of 50 ppb. The second proprietary MSE technology, catalyzed cementation, was able to lower the arsenic concentration from 61.5 ppm to 9 ppb.

After favorable results were obtained from the bench-scale treatability study, LFR contracted MSE to perform a seven-day pilot-scale demonstration at the Sherwin-Williams Facility. On March 9, 1998, LFR submitted a work plan to the RWQCB outlining the objectives and sample schedule for the seven-day MSE pilot-scale demonstration. Results from the first demonstration, conducted during the second week of March 1998, indicated the mineral-like precipitation process reduced the arsenic concentration in the process water from 46 ppm to 160 ppb and the catalyzed cementation process reduced arsenic concentrations from 46 ppm to 70 ppb. Several factors limiting the effectiveness of the catalyzed cementation process were identified following completion of the first pilot-scale demonstration.

During the first week of April 1998, MSE performed a second pilot-scale demonstration using a modified catalyzed cementation process that addressed the limitation of the first pilot-scale demonstration. The overall objective for the second pilot-scale demonstration was achieved with arsenic concentrations in the process water consistently reduced from 53 ppm to less than 20 ppb as shown in Table 3.

MSE performed several bench-scale tests during the second pilot-scale demonstration to evaluate the effectiveness of using alternate proprietary reagents for the catalyzed cementation process. The results of the bench-scale tests indicated that the proprietary reagent used during the initial step of the catalyzed cementation process could be replaced by a more efficient and cost-effective proprietary reagent. In addition, the results indicated that the intermediate step of the catalyzed cementation process could potentially be eliminated and the process would still reduce arsenic concentrations to below 25 ppb. Sherwin-Williams contracted MSE to perform a third pilot-scale demonstration using the revised treatment process (reductive precipitation) during the week from May 18 through 22, 1998. The objective of the third pilot-scale demonstration was to provide necessary data and evaluate the effectiveness of the reductive-precipitation process in reducing arsenic concentrations to below the NPDES permit limit of 25 ppb. The reductive-precipitation process was performed and evaluated at flow rates between 1 and 5 gpm.

Based on the results of the second pilot-scale demonstration, MSE has started the initial engineering design of a 30-gpm GWTS. MSE personnel performed a walkthrough of the Andco GWTS on May 19 and 20, 1998, to inspect existing equipment used in the Andco GWTS (e.g., clarifier, filter press, multimedia filters, and metering pumps). The equipment was inspected to help determine if several pieces of existing equipment can be utilized in the MSE process or whether new equipment will need to be designed for the new GWTS. The MSE personnel also made initial assessments of the general layout of the treatment system area, piping and electrical requirements, and reviewed project issues with LFR staff.

2.4.4 Future Actions

The IRM objective to treat extracted groundwater is not being met for the Site. To meet the pump-and-treat IRM objectives of maintaining an inward hydraulic gradient and lowering the groundwater level to below the storm-water catch basin invert depths, a higher rate of groundwater extraction is needed. In the present configuration, the Andco treatment system instantaneous capacity is approximately 8 gpm. Data from the past two years show that the overall groundwater extraction rate has been 2 to 3 gpm because of treatment system technology limitations. As a result, LFR has determined that the electrochemical co-precipitation technology is inadequate to meet the project objectives.

Based on the positive results of the second MSE pilot-scale demonstration, Sherwin-Williams will contract with MSE to design and build a 30-gpm GWTS, using either the proprietary modified catalyzed cementation technology or reductive-precipitation technology, to replace the existing Andco co-precipitation process.

A preliminary design schematic for the MSE reductive-precipitation technology is presented in Figure 9. This schematic may be subject to change based on the results of third phase of treatability study and the final design to be completed.

Because the connection to the sanitary sewer is uncertain, and EBMUD will only provide annual permits for groundwater discharge, we have assumed that the treatment system will still have to be designed for a 25-ppb discharge limit in accordance with the NPDES permit. Sherwin-Williams still wishes to receive a one year encroachment permit from the City of Emeryville to connect to the sanitary sewer system. Discharge to the sewer for even one year would greatly facilitate lowering of groundwater levels because the current Andco system could operate at a higher flow rate with less frequent shutdowns while the retrofit to a 30-gpm system is implemented.

3.0 WORK PLAN FOR IMPLEMENTATION OF FUTURE INTERIM REMEDIAL MEASURES

The following sections summarize the tasks that will be implemented to enhance the performance of the IRMs that have been implemented at the Site. A schedule for all the tasks is presented in Figure 10.

3.1 Slurry Wall

As discussed in Section 2.1, the slurry wall has proven to be an effective IRM since the completion of its installation in 1994. The success of the slurry wall is demonstrated by the water-level differences measured across the slurry wall and the differences in groundwater flow direction inside and outside the slurry wall. Previous QA/QC testing of the slurry wall at the time of installation demonstrated that the slurry wall is significantly less permeable than the surrounding subsurface soils. Therefore, the slurry wall has met the IRM objective of containing chemical-affected areas and inhibiting further off-site migration of affected groundwater. As a result, no further actions are necessary to improve the slurry wall performance.

3.2 Cap and Storm-water Collection System

The cap and storm-water collection system have substantially met their IRM objectives of eliminating human exposure pathways and preventing water infiltration. As discussed in Section 2.2.1, the cap was inspected by LFR in September 1997 and found to be in good to excellent condition. The only area that requires attention is where surface storm water appears to be infiltrating at the railroad tracks and associated switch gear. LFR will identify a qualified railroad design engineer to evaluate alternatives to prevent surface water from infiltrating the cap underneath the railroad track and switch gear. Specific recommendations for preventing infiltration around the railroad tracks will be submitted to the RWQCB upon completion of an engineering analysis by a railroad design engineer and LFR.

The multipoint collection system is considered a short-term solution to prevent affected groundwater from entering the storm-water collection system. LFR evaluated several long-term solutions, including lining the storm drain pipes, installing surface trench drains, and lowering water levels within the slurry wall. The selected alternative is to lower the water table below the storm-water collection system piping and catch basins. The selected measure includes expanding the GWETS so that the network of existing and new extraction wells will lower the water table below the storm-water collection system piping. Increased extraction system capacity, with the lowered water table, will prevent the affected groundwater from infiltrating into the storm-water collection system piping. The proposed expanded groundwater extraction and treatment systems are discussed in Sections 3.3 and 3.4, respectively. The storm-water collection system, however, requires no further action and will effectively convey surface storm water to Temescal Creek once the water levels have been lowered within the slurry wall.

In conclusion, the only recommended future actions with respect to the cap and storm-water collection system are to prevent infiltration around the railroad tracks and to continue performing periodic maintenance of the cap. The schedule for implementing these tasks is shown in Figure 10.

3.3 Groundwater Extraction System

The GWES has not met IRM objectives and needs to be expanded to increase the groundwater extraction rate. Figure 7 shows the preliminary design for location and layout of the proposed expanded GWES. The plan for design and installation of the expanded extraction system comprises the following items:

- strategically placing seven additional on-site extraction wells at selected locations to enhance groundwater extraction, which will result in achieving an inward hydraulic gradient
- design of the containment piping with conveyance hose (air supply to pneumatic pumps and groundwater extraction) and associated trench work connecting the seven additional wells to the groundwater treatment system
- design and selection of the down well pneumatic pumps to accommodate the anticipated extraction rates for each well

As shown in Figure 7, new extraction wells EX-4, EX-5, and EX-6 are located next to the existing storm drain line. Extraction from these new wells will contribute to achieving an inward hydraulic gradient within the slurry wall as well as lowering the water table below the storm drain line. Location of EX-7 through EX-10 will also lower water levels and assist in maintaining an inward gradient in the water table at the Site.

The new extraction wells will pump water to the groundwater treatment system via containment piping at the Site. Figure 7 shows the location of the subsurface trenches with containment piping. Subsurface trench work for the containment piping will be installed with geo-membrane fabric liner around the trench as containment to prevent potential downward migration of storm water. Aboveground containment piping to the groundwater treatment system will be secured to the existing facility buildings. The interior of the containment piping will contain air supply hose to operate the down well pneumatic pumps, and hose to transport extracted groundwater to the treatment system. The new extraction wells' vaults and wellhead will also be redesigned with better access for maintenance technicians to monitor the operation of the wells. LFR is currently preparing plans and specifications for construction of the expanded GWES. Upon completion of the design, the plans and specifications will be submitted to several contractors for bidding. A contractor will then be selected who will complete the work.

The schedule for completing the GWES design, bidding, and construction is shown on Figure 10.

3.4 Groundwater Treatment System

LFR has evaluated the performance and capacity of the existing GWETS. Upgrading of the existing GWETS to accommodate increased flows is necessary because of the need for additional extraction wells on site to lower the groundwater table. A conservative estimated flow rate of 6.5 gpm will be required to maintain lower water levels during rainy periods. In addition, future expansion of the extraction system outside the slurry wall may be necessary, depending on results of the site remedial investigation/feasibility study to be conducted in 1998 and 1999. As a result, the overall expansion of the treatment system will be designed for 30 gpm, which, based on engineering judgement, should accommodate off-site wells that may be installed in the future.

LFR identified several equipment limitations (e.g., filter press, clarifier, and hydrogen peroxide controller unit) in the existing Andco system. The current Andco GWTS system has difficulty in consistently meeting the NPDES discharge requirements of 25 ppb at flow rates of 7 to 9 gpm. It is uncertain whether it is technologically feasible to consistently meet the NPDES discharge limit using electrochemical co-precipitation technology. Additionally, a significant capital expenditure will be required to upgrade the existing Andco system to handle a flow rate of 30 gpm, and it is questionable whether sustained flow rates can be achieved.

The modified catalyzed cementation process offers numerous advantages over the current Andco GWTS:

- the equipment needed for the process is easier to operate and maintain, resulting in less down time and reduced labor costs
- lower capital costs to build a 30-gpm system
- smaller sludge volumes are produced and sludge is easy to dewater

The process is anticipated to consistently meet the discharge limit of 25 ppb for arsenic. Therefore, the modified catalyzed cementation process will replace the current treatment system.

The following tasks will be implemented for expanding the groundwater treatment system:

- develop contract and licensing agreement between Sherwin-Williams and MSE
- design the groundwater treatment system
- purchase parts and equipment
- install process tanks, pumps, piping, valves, electrical and controls on site
- start up system

A preliminary schematic of the modified catalyzed cementation process is shown on Figure 9. This schematic may be subject to change based on the treatability study results and the final design to be implemented. A schedule for designing and constructing the GWTS is shown on Figure 10.

4.0 SCHEDULE

The IRM Work Plan proposed schedule is shown on Figure 10. This schedule may be subject to change once the design for the various IRMs is substantially complete and upon determination of equipment purchase lead times and contractor availability.

Table 1
Historical Water Levels for Wells and Piezometer Pairs, Post Slurry-Wall Construction
Sherwin Williams Company
Emeryville, California
(all measurements are in feet above mean sea level [msl])

Date	LF-7 (a)	LF-19 (b)	GWE Diff.	LF-8 (a)	LF-18 (b)	GWE Diff.	LF-26 (a)	LF-20 (b)	GWE Diff.	LF-10 (a)	LF-21 (b)	GWE Diff.	LF-PZ13 (a)	LF-PZ12 (b)	GWE Diff.	LF-17 (a)	LF-3 (b)	GWE Diff.
04/24/96	5.79	6.26	+0.47	5.77	4.84	-0.93	5.00	4.22	-0.78	5.89	6.72	+0.83	nm	nm	nc	7.18	7.13	-0.05
07/29/96	4.74	6.42	+1.68	4.70	4.40	-0.30	4.82	3.86	-0.96	nm	5.76	nc	nm	nm	nc	6.43	6.43	0.00
12/13/96	7.45	9.33	+1.88	7.79	6.61	-1.18	6.15	4.06	-2.09	7.31	5.31	-2.00	nm	nm	nc	9.94	7.11	-2.83
04/15/97	6.23	6.82	+0.59	5.70	4.55	-1.15	5.69	3.92	-1.77	6.32	4.79	-1.53	nm	nm	nc	8.49	6.22	-2.27
09/19/97	6.22	6.49	+0.27	5.66	4.74	-0.92	5.29	3.86	-1.43	6.34	4.95	-1.39	nm	nm	nc	8.53	6.29	-2.24
12/03/97	7.02	7.38	+0.36	7.26	5.73	-1.53	3.94	4.19	+0.25	6.94	5.05	-1.89	nm	nm	nc	7.98	6.82	-1.16
12/15/97	8.49	6.32	-2.17	8.35	6.03	-2.32	5.79	4.24	-1.55	8.18	5.10	-3.08	8.15	6.63	-1.52	8.74	7.39	-1.35
01/13/98	9.55	nm	nc	9.40	7.16	-2.24	8.85	4.47	-4.38	9.22	5.34	-3.88	9.15	7.34	-1.81	10.08	8.38	-1.70
01/30/98	9.42	8.17	-1.25	9.28	6.73	-2.55	9.05	4.35	-4.70	9.04	5.33	-3.71	8.88	6.97	-1.91	9.73	7.82	-1.91
02/24/98	9.22	8.90	-0.32	9.23	6.71	-2.52	9.01	4.34	-4.67	8.86	5.54	-3.32	8.92	7.33	-1.59	10.13	8.35	-1.78
04/06/98	6.92	7.67	+0.75	7.00	5.56	-1.44	6.99	4.16	-2.83	6.63	5.37	-1.26	nm	nm	nc	8.40	6.95	-1.45
04/07/98	nm	nm	nc	nm	nm	nc	nm	nm	nc	nm	nm	nc	6.90	6.40	-0.50	nm	nm	nc

Notes: Piezometers were installed in late November and early December of 1997
(a) The first well in each pair shown is located INSIDE the slurry-wall
(b) The second well in each pair shown is located OUTSIDE the slurry-wall
GWE differences for each pair are calculated by GWE (b) - GWE (a)
Positive (+) values indicate an INWARD gradient, negative (-) values indicate an OUTWARD gradient
nm = no measurement, nc = no calculation

Table 1 (continued)

Historical Water Levels for Wells and Piezometer Pairs, Post Slurry-Wall Construction

Sherwin Williams Company

Emeryville, California

(all measurements are in feet above mean sea level [msl])

Date	LF-PZ9 (a)	LF-PZ11 (b)	GWE Diff.	LF-22 (a)	LF-12 (b)	GWE Diff.	LF-PZ3 (a)	LF-PZ2 (b)	GWE Diff.	LF-PZ5 (a)	LF-PZ4 (b)	GWE Diff.
04/24/96	nm	nm	nc	7.61	8.38	+0.77	nm	nm	nc	nm	nm	nc
07/29/96	nm	nm	nc	6.94	7.66	+0.72	nm	nm	nc	nm	nm	nc
12/13/96	nm	nm	nc	10.09	9.26	-0.83	nm	nm	nc	nm	nm	nc
04/15/97	nm	nm	nc	9.02	8.01	-1.01	nm	nm	nc	nm	nm	nc
09/19/97	nm	nm	nc	9.15	7.95	-1.20	nm	nm	nc	nm	nm	nc
12/03/97	nm	nm	nc	8.44	8.83	+0.39	nm	nm	nc	nm	nm	nc
12/15/97	8.85	6.87	-1.98	8.76	8.84	+0.08	8.55	8.72	+0.17	8.47	8.01	-0.46
01/13/98	10.10	9.02	-1.08	9.59	9.42	-0.17	9.69	7.93	-1.76	8.71	8.42	-0.29
01/30/98	9.67	8.38	-1.29	9.56	9.10	-0.46	9.54	8.61	-0.93	9.31	8.49	-0.82
02/24/98	10.12	8.75	-1.37	10.08	9.38	-0.70	10.19	9.28	-0.91	10.03	8.94	-1.09
04/06/98	8.35	7.64	-0.71	8.42	8.68	+0.26	8.05	8.25	+0.20	8.30	8.05	-0.25
04/07/98	nm	nm	nc	nm	nm	nc	nm	nm	nc	nm	nm	nc

Notes: Piezometers were installed in late November and early December of 1997

(a) The first well in each pair shown is located INSIDE the slurry-wall

(b) The second well in each pair shown is located OUTSIDE the slurry-wall

GWE differences for each pair are calculated by GWE (b) - GWE (a)

Positive (+) values indicate an INWARD gradient, negative (-) values indicate an OUTWARD gradient

nm = no measurement, nc = no calculation

Table 2
Water Balance Calculations
The Sherwin-Williams Company
Emeryville, California

Area of slurry wall enclosure

	45,225	ft^2
	14,238	
	48,720	
	51,250	
Total	159,433	ft^2

Change in water elevation 12/15/97 - 1/30/98

Spreadsheet = waterlvlchange.xls

Average rise = 0.9 ft

Standard deviation = 0.09 ft

Porosity

Assume porosity = 0.4

Volume of water

Volume of water = (area)(change in water elevation)(porosity)

Volume = 57,396 ft^3

429,320 gallons

Average Flow

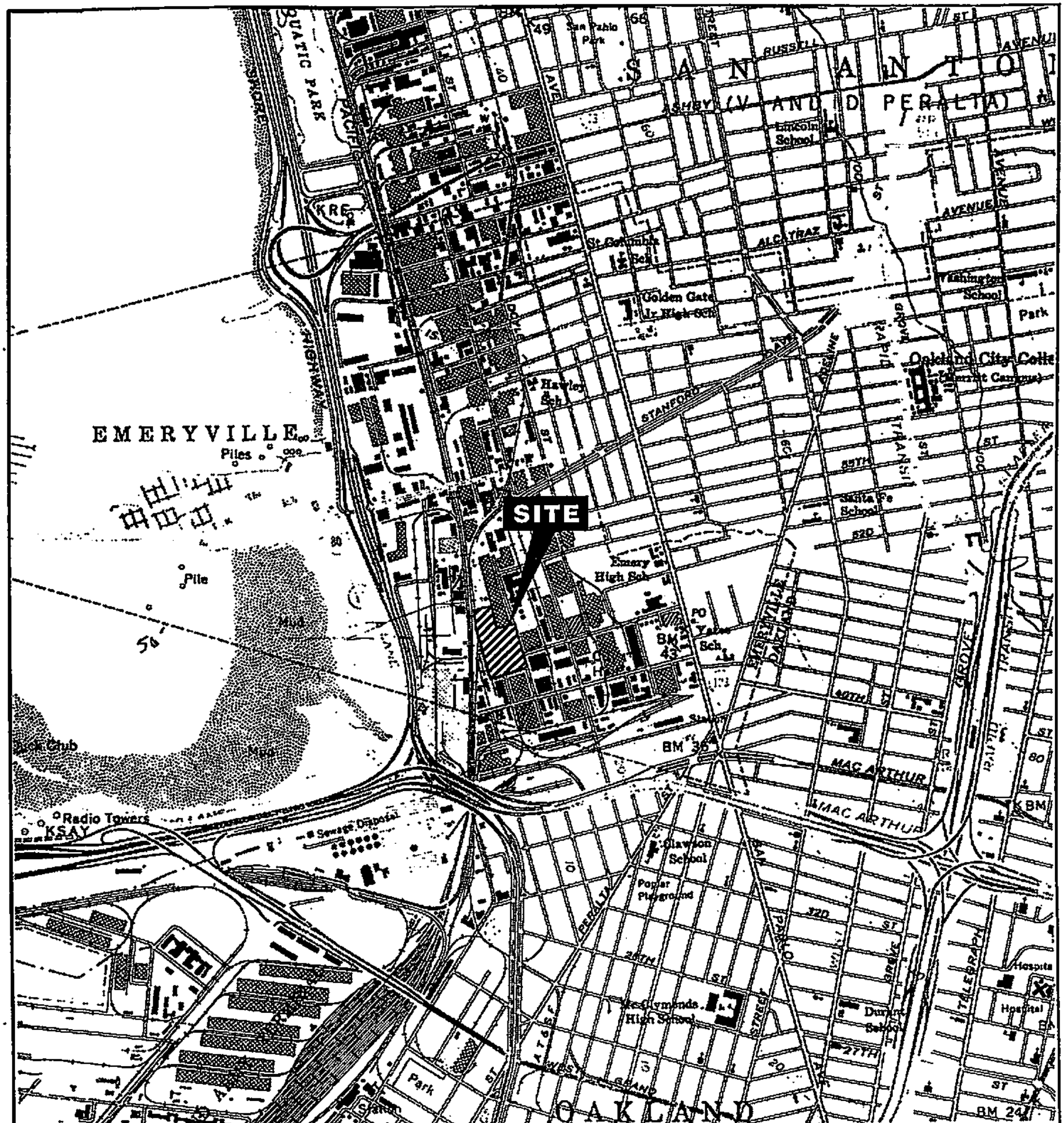
Time: Dec. 15, 1997 - Jan. 30, 1998

46 days = 66240 minutes

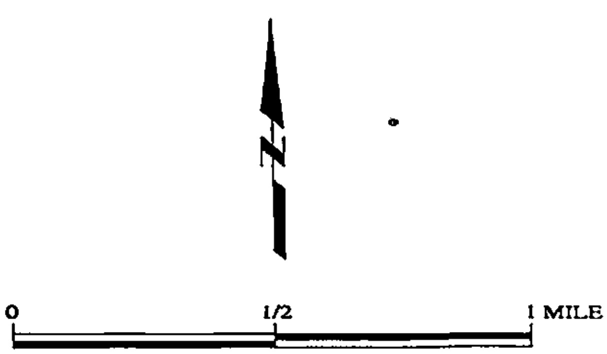
Average Flow = 6.5 gpm

Table 3
Summary of Analytical Results for Second MSE Pilot-Scale Demonstration
The Sherwin-Williams Company
Emeryville, California

Sample Number	Date Sampled	Analysis Method	Analyte	Concentration Detected at Sample Port 106 (ppb)	NPDES Limit (ppb)
CEM-106-D1-01	4/2/98	6010	Arsenic	96	25
	4/2/98	6010	Copper	33	23.6
	4/2/98	6010	Iron	ND	No Limit
CEM-106-D1-02	4/2/98	6010	Arsenic	90	25
	4/2/98	6010	Copper	31	23.6
	4/2/98	6010	Iron	ND	No Limit
CEM-106-D2-01	4/3/98	6010	Arsenic	9.9	25
	4/3/98	6010	Copper	14	23.6
	4/3/98	6010	Iron	ND	No Limit
CEM-106-D2-02	4/3/98	6010	Arsenic	11	25
	4/3/98	6010	Copper	15	23.6
	4/3/98	6010	Iron	ND	No Limit
CEM-106-D2-03	4/3/98	6010	Arsenic	ND	25
	4/3/98	6010	Copper	ND	23.6
	4/3/98	6010	Iron	ND	No Limit
CEM-106-D2-04	4/3/98	6010	Arsenic	19	25
	4/3/98	6010	Iron	ND	No Limit
CEM-106-D2-05	4/3/98	6010	Arsenic	ND	25
CEM-106-D2-06	4/3/98	6010	Arsenic	6	25
CEM-106-D2-07	4/3/98	6010	Arsenic	7.3	25
CEM-106-D2-08	4/3/98	6010	Arsenic	ND	25
CEM-106-D3-01	4/4/98	6010	Arsenic	7.4	25
CEM-106-D3-02	4/4/98	6010	Arsenic	ND	25
CEM-106-D3-03	4/4/98	6010	Arsenic	7.6	25
CEM-106-D3-04	4/4/98	6010	Arsenic	ND	25
CEM-106-D3-05	4/4/98	6010	Arsenic	13	25
CEM-106-D4-01	4/5/98	6010	Arsenic	18	25
	4/5/98	6010	Cadmium	ND	2.2
	4/5/98	6010	Chromium (total)	ND	22.0 (Cr-6)
	4/5/98	6010	Copper	ND	23.6
	4/5/98	6010	Iron	620	No Limit
	4/5/98	6010	Lead	ND	6.4
	4/5/98	6010	Mercury	ND	No Limit
	4/5/98	6010	Nickel	ND	320
	4/5/98	6010	Selenium	ND	10
	4/5/98	6010	Silver	ND	8.2
	4/5/98	6010	Zinc	ND	220
	4/5/98	8015M	TPH-gasoline	1200	50
	4/5/98	8015M	TPH-diesel	430	50
	4/5/98	8/12/22	Benzene	ND	5
	4/5/98	8260	Toluene	110	5
	4/5/98	8260	Ethylbenzene	4.3	5
	4/5/98	8260	m,p-Xylene	64	5 (total Xylene)
	4/5/98	8260	o-xylene	25	5 (total Xylene)
CEM-106-D4-02	4/5/98	6010	Arsenic	10	25
CEM-106-D4-02	4/5/98	6010	Iron	ND	No Limit



Map Source:
U.S.G.S. Oakland West Quadrangle,
Oakland West, California
7.5 Minute Series



SHERWIN-WILLIAMS COMPANY

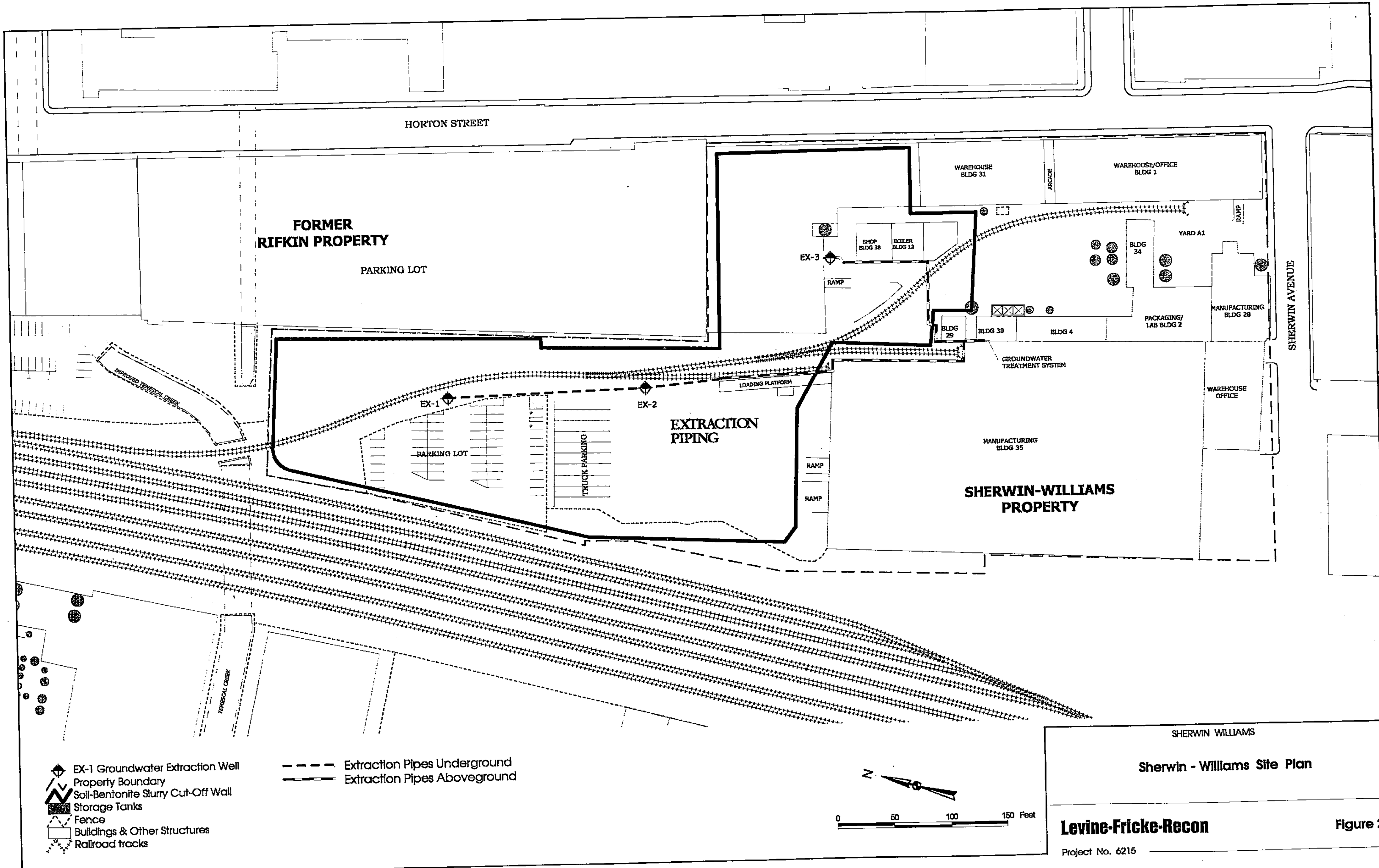
Site Location Map

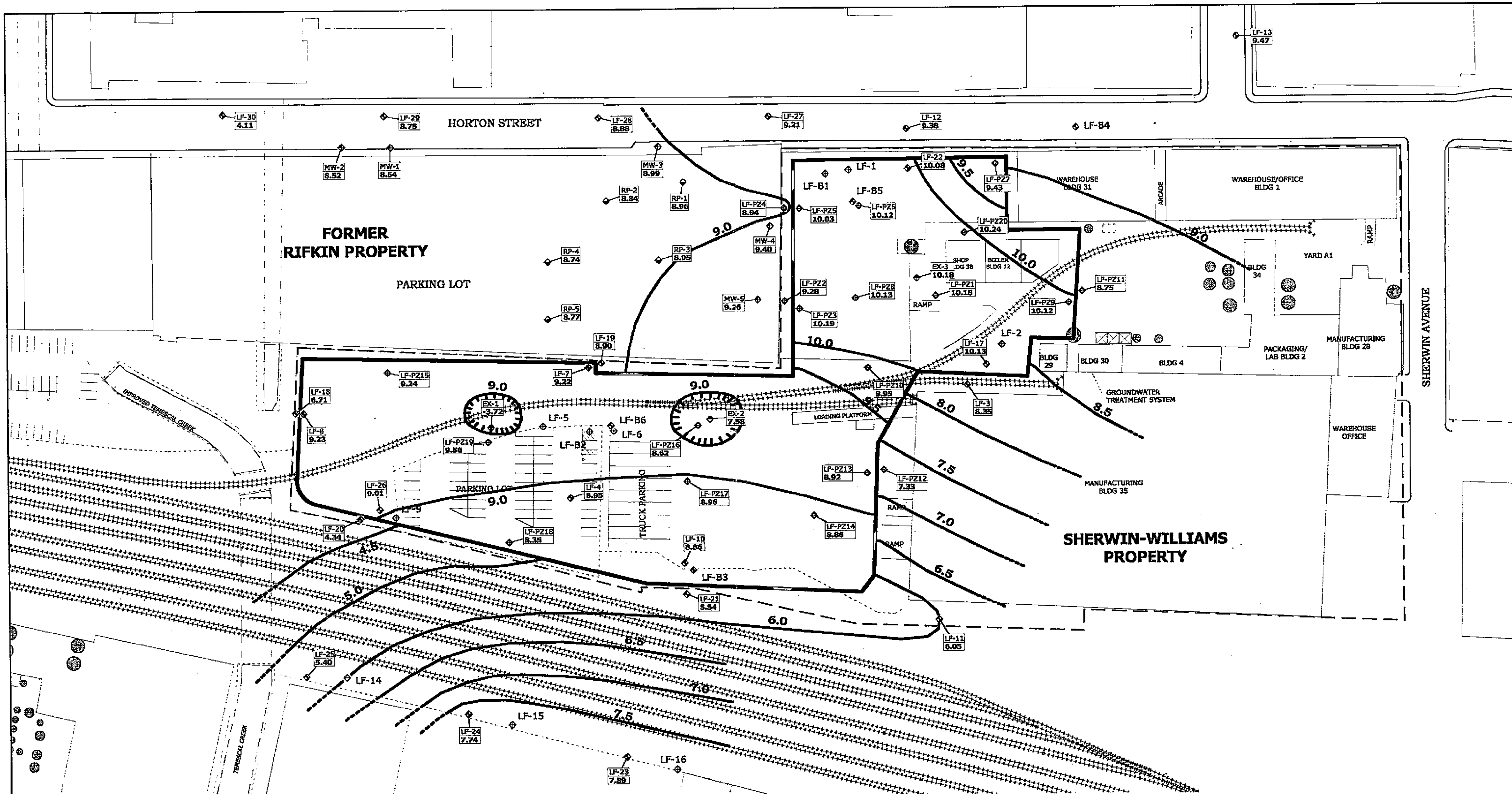
Levine·Fricke·Recon

Figure 1

Project No. 6215

6215SV01.CDR 050898


HORTON STREET
FORMER RIFKIN PROPERTY
PARKING LOT
IMPROVED TEMESCAL CREEK
TEMESCAL CREEK
WAREHOUSE BLDG 31
ARCADE
WAREHOUSE/OFFICE BLDG 1
SHOP BLDG 38
BOILER BLDG 12
EX-3
RAMP
YARD A1
BLDG 34
MANUFACTURING BLDG 28
PACKAGING/ LAB BLDG 2
BLDG 29
BLDG 30
BLDG 4
GROUNDWATER TREATMENT SYSTEM
SHERWIN AVENUE
LOADING PLATFORM
EX-1
EX-2
EXTRACTION PIPING
PARKING LOT
TRUCK PARKING
RAMP
RAMP
WAREHOUSE OFFICE
MANUFACTURING BLDG 35
SHERWIN-WILLIAMS PROPERTY
EX-1 Groundwater Extraction Well
Property Boundary
Soil-Bentonite Slurry Cut-Off Wall
Storage Tanks
Fence
Buildings & Other Structures
Railroad tracks
Extraction Pipes Underground
Extraction Pipes Aboveground
N
0 50 100 150 Feet
SHERWIN WILLIAMS
Sherwin - Williams Site Plan
Levine-Fricke-Recon
Figure 2
Project No. 6215



Groundwater Elevation Contour
Property Boundary
Slurrywall
Storage Tanks
Fence
Buildings & Other Structures
Railroad tracks

LF-10 A-Zone Monitoring Well
LF-B3 B-Zone Monitoring Well
EX-1 Groundwater Extraction Well
RP-1 Rifkin Property Monitoring Well (LFR)
MW-4 Rifkin Property Monitoring Well (TMC)
LF-PZ1 A-Zone Piezometer
Monitoring well destroyed or abandoned

9.0 Groundwater Elevation Contour
Depression in Groundwater Surface

N

0 50 100 150 Feet

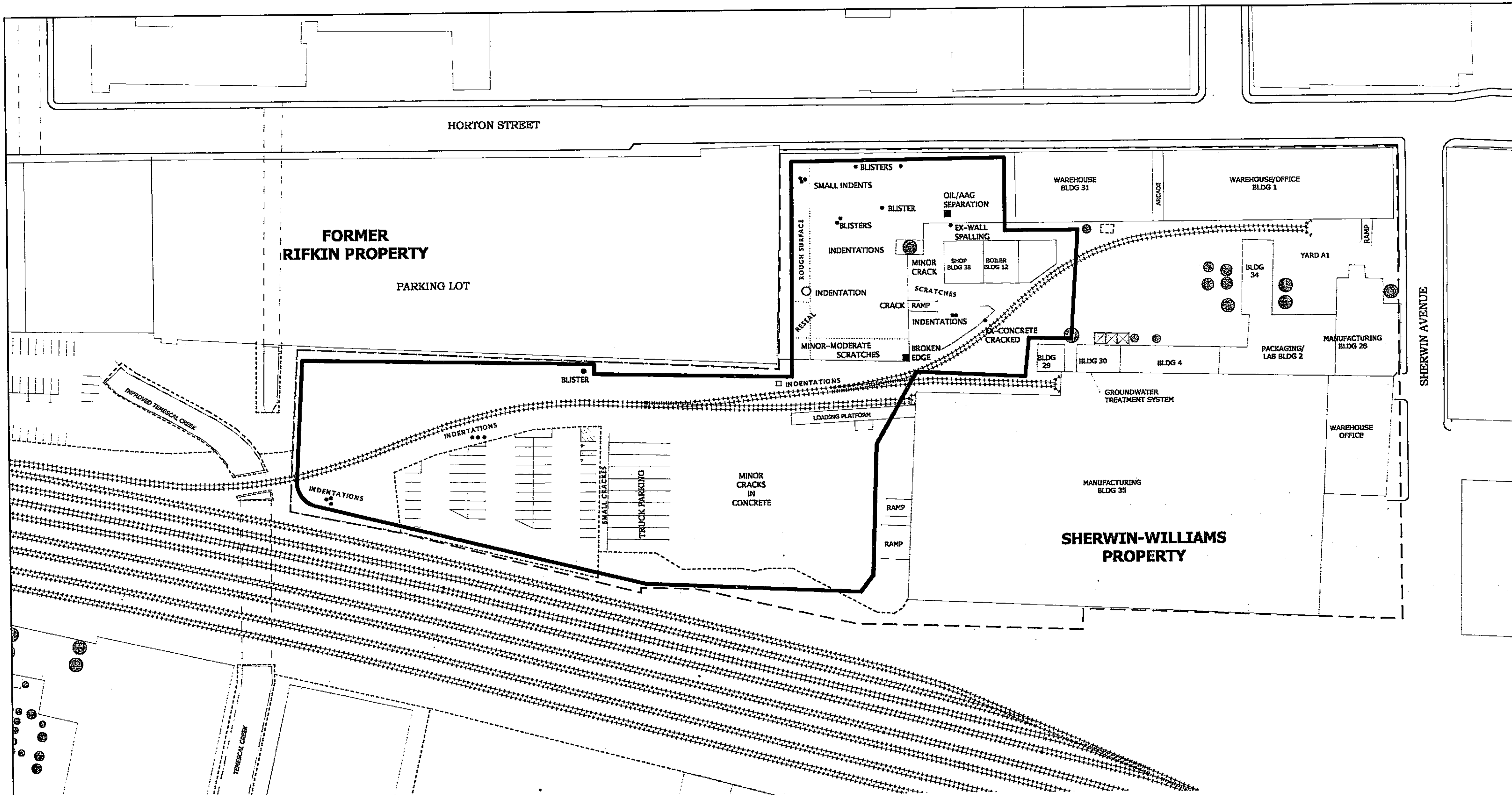
SHERWIN WILLIAMS

Groundwater Elevation Contours
A - Zone Groundwater
February 24, 1998

Levine·Fricke·Recon

Figure 3

Project No. 6215



Property Boundary
Soil-Bentonite Slurry Cut-Off Wall
Storage Tanks
Fence
Buildings & Other Structures
Railroad tracks

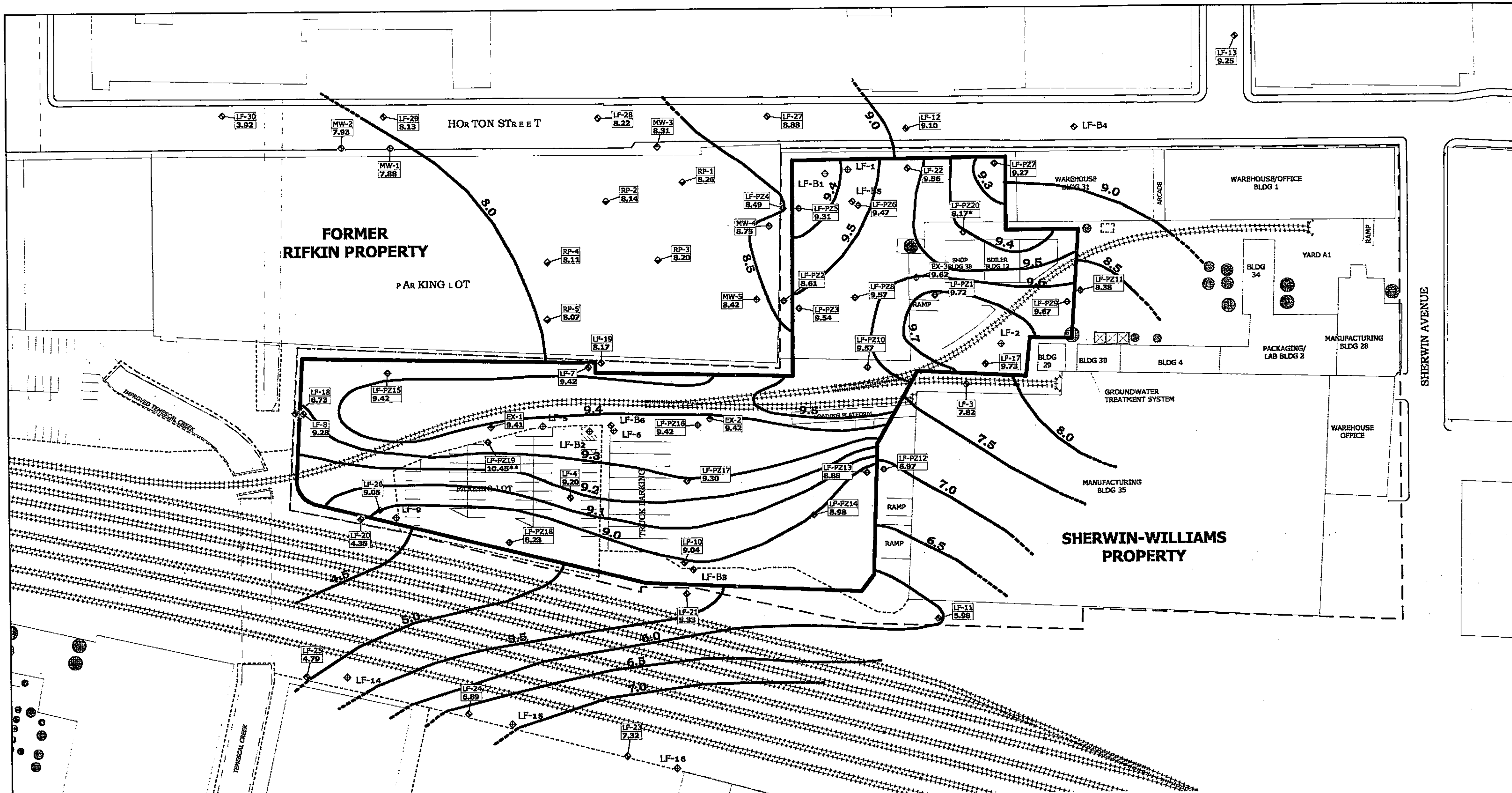
SHERWIN WILLIAMS

Results of Surficial Inspection of Concrete and Asphalt Concrete Cap

Levine·Fricke·Recon

Figure 4

Project No. 6215



- Groundwater Elevation Contour
- Property Boundary
- Slurrywall
- Storage Tanks
- Fence
- Buildings & Other Structures
- Railroad tracks

- LF-10 A-Zone Monitoring Well
- LF-B3 B-Zone Monitoring Well
- EX-1 Groundwater Extraction Well
- RP-1 Rifkin Property Monitoring Well (LFR)
- MW-4 Rifkin Property Monitoring Well (TMC)
- LF-PZ1 A-Zone Piezometer
- Monitoring well destroyed or abandoned

9.0 Groundwater Elevation Contour

* Water level believed to be the result of measurement error, based on historical measurements. Reading not used in contouring.

** Anomalous reading not used in contouring.

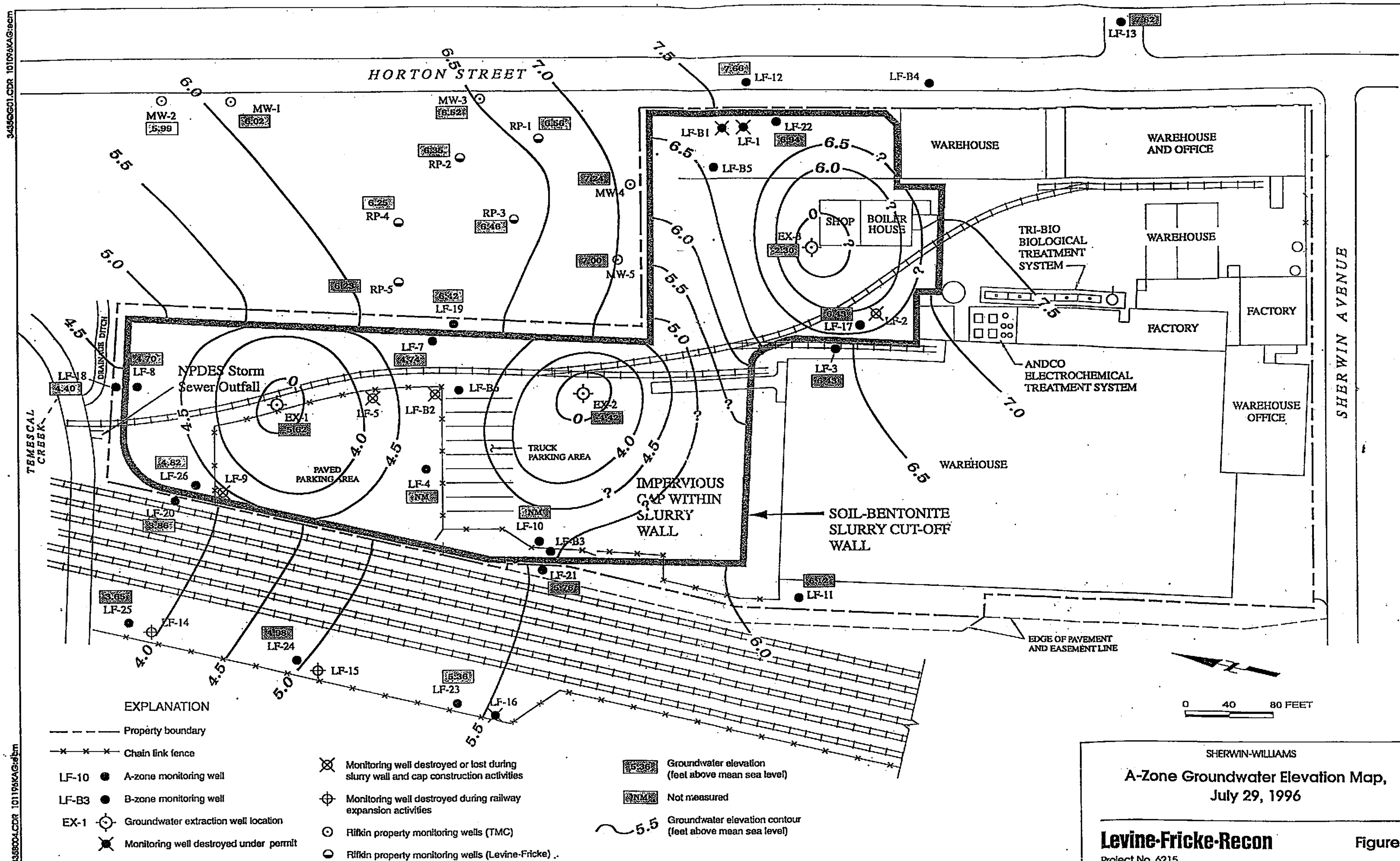
SHERWIN WILLIAMS

Groundwater Elevation Contours
A - Zone Groundwater
January 24, 1998

Levine-Fricke-Recon

Figure 5

Project No. 6215



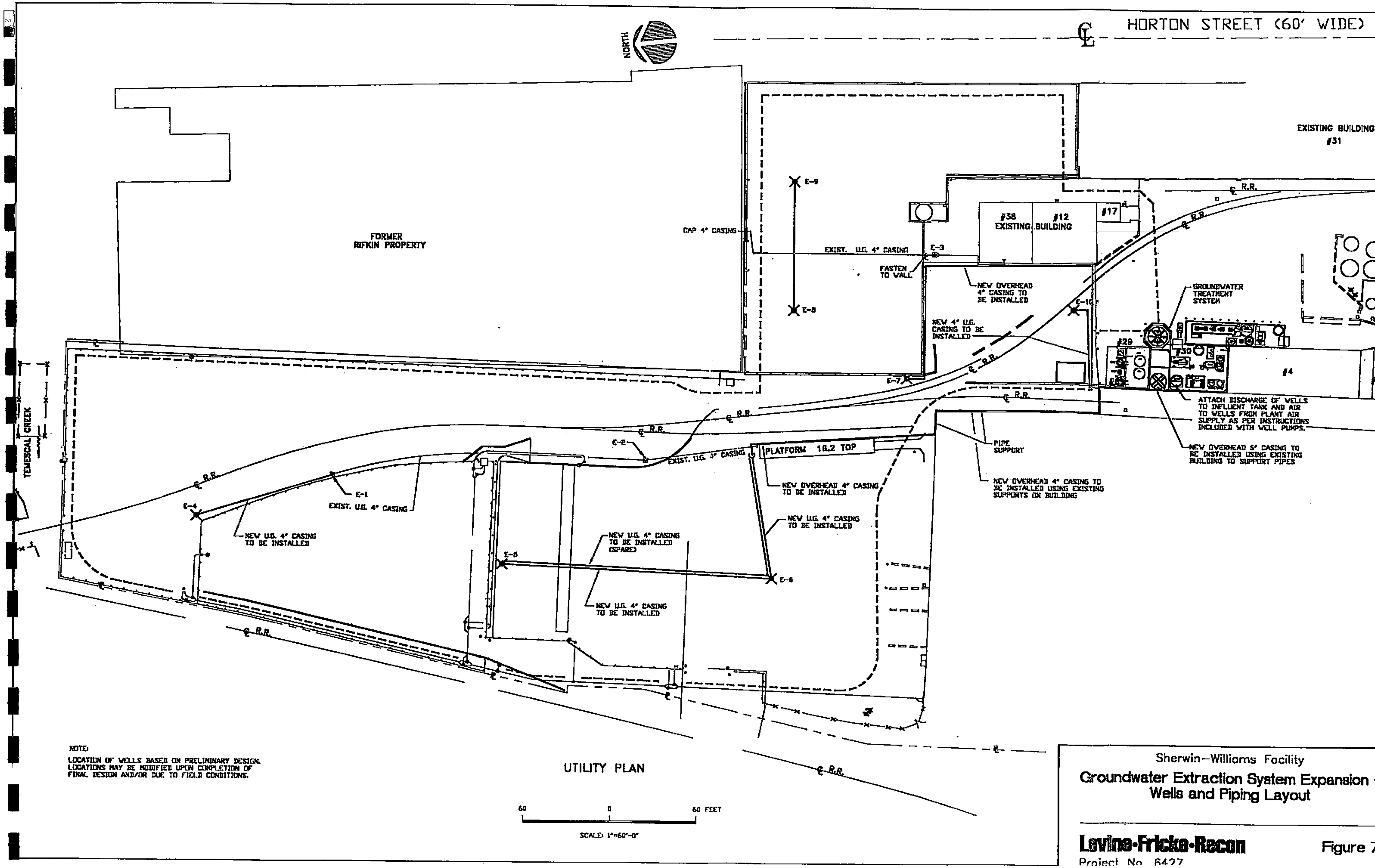
SHERWIN-WILLIAMS

A-Zone Groundwater Elevation Map, July 29, 1996

Levine-Fricke-Recon

Project No. 6215

Figure 6



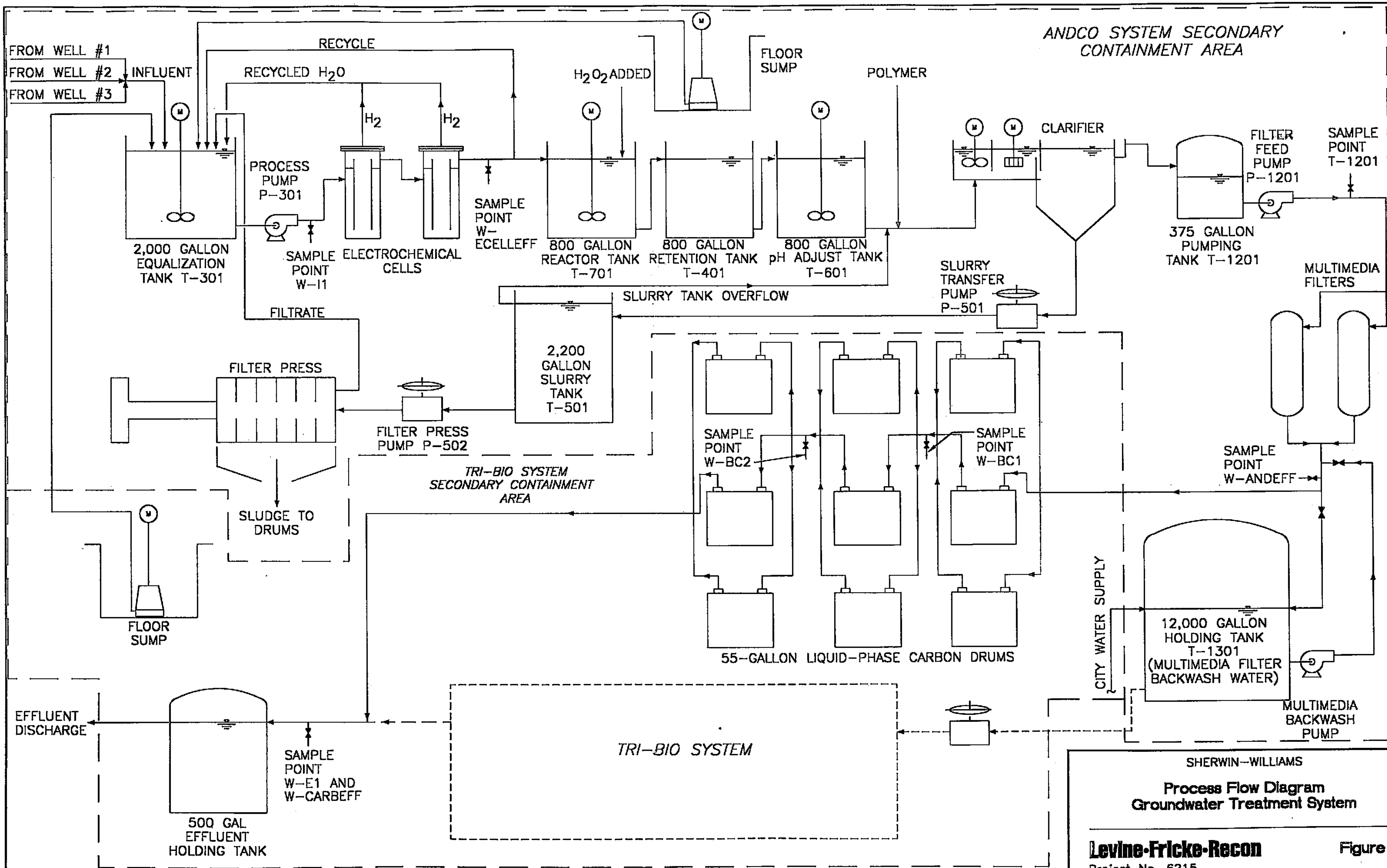
Sherwin-Williams Facility

Groundwater Extraction System Expansion - Wells and Piping Layout

Levine·Fricke·Recon

Figure 7

Project No. 6427



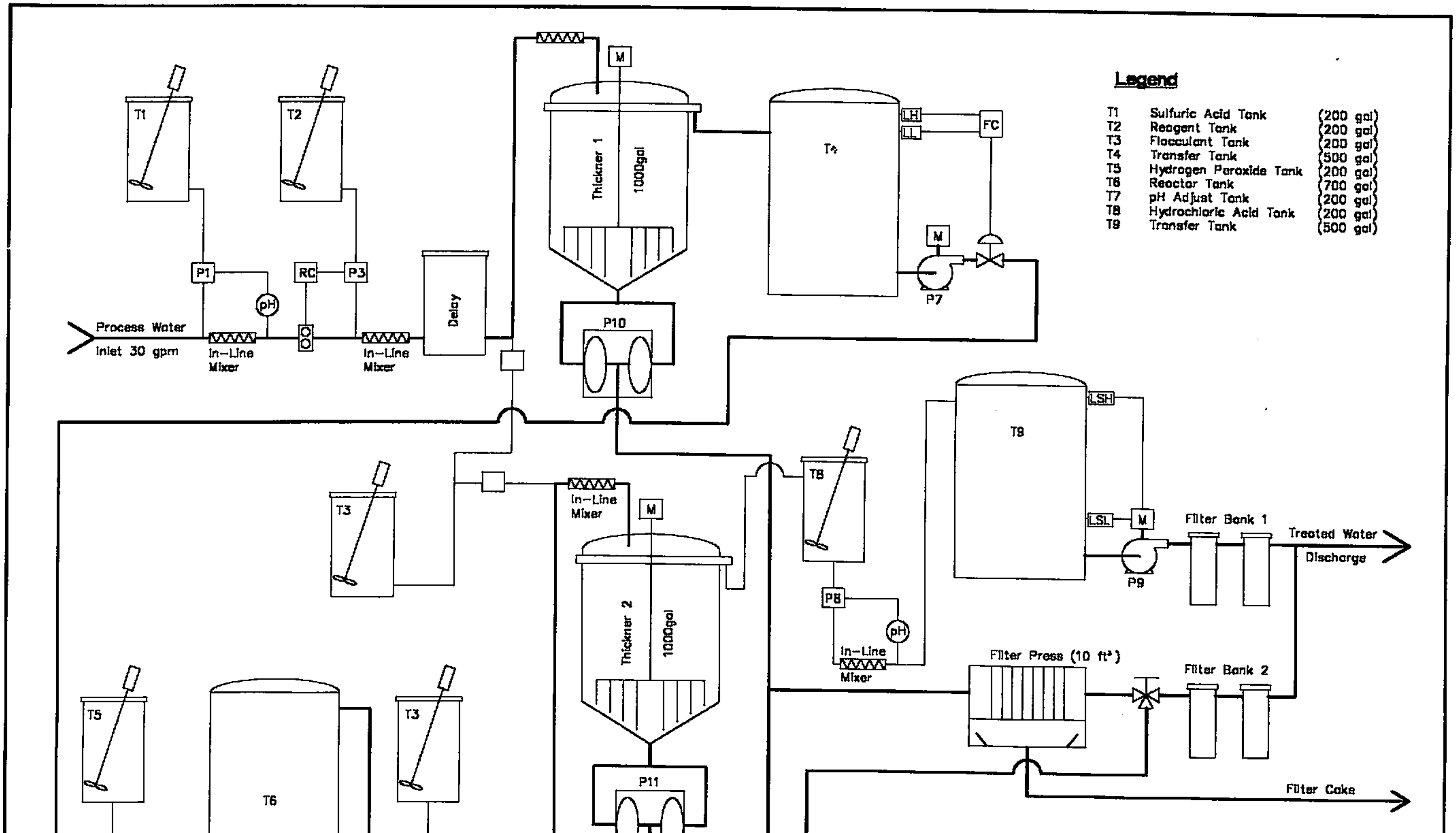
SHERWIN–WILLIAMS

Process Flow Diagram
Groundwater Treatment System

Levine·Fricke·Recon Project No. 6215

Figure 8

5/8/1998 4:19 P.M. 1:Scale: 0.63 Drawing File(.DWG): J:\ENGCAD\SHERWIN\6215\PD-2.DWG



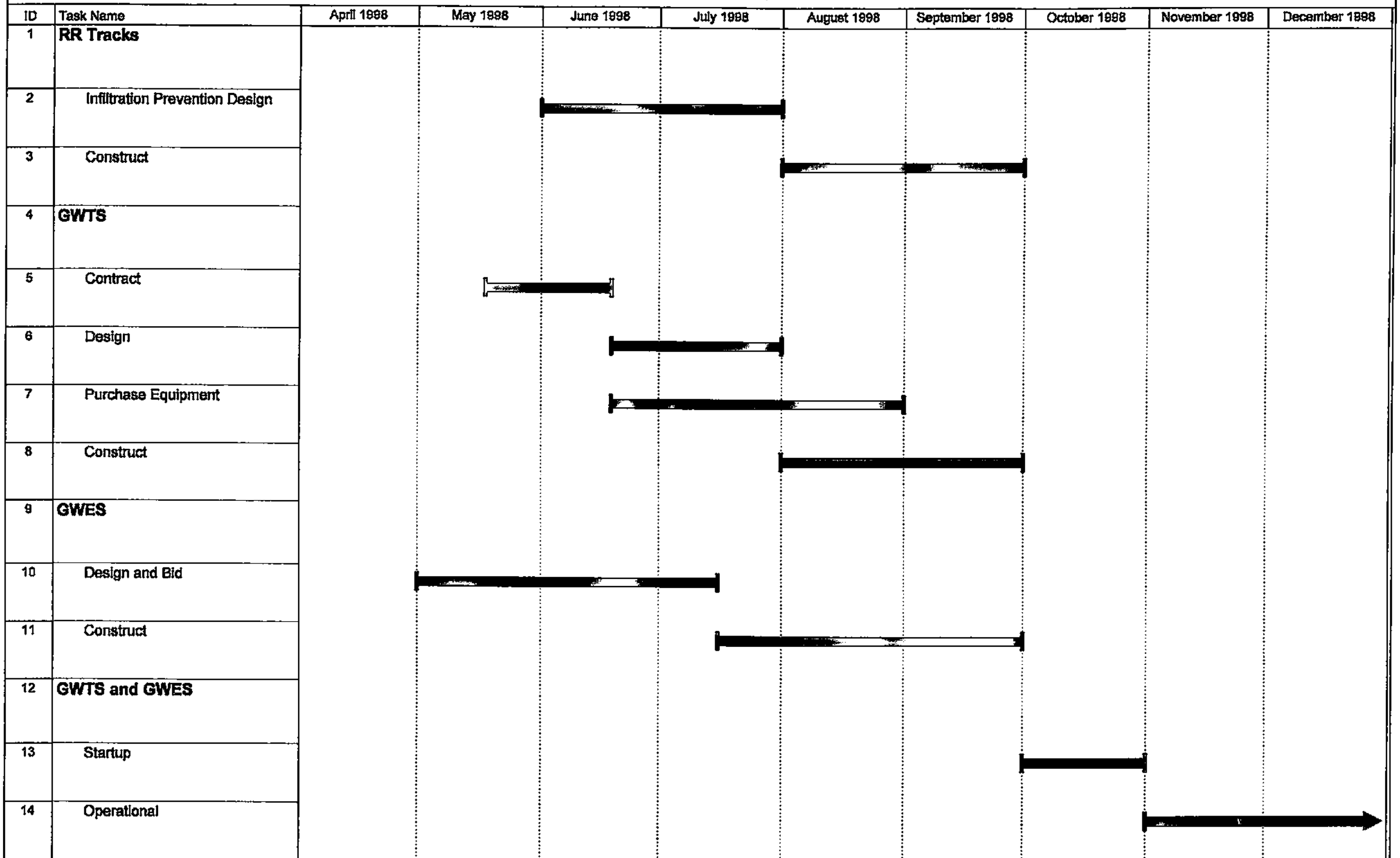
SHERWIN-WILLIAMS

Arsenic Removal System
Preliminary Block Flow Diagram

MSE Technology Applications, Inc. **Figure 9**

DCB 5/14/1998 4:58 P.M. LTScale: 0.50 Drawing File(.DWG): J:\ENGCAD\SHERWIN\6215\ARSENICREMOVALSYSTEM.DWG

FIGURE 10
IRM Workplan Schedule
Sherwin-Williams Facility, Emeryville, California



Project:Figure 10 Schedule
Date: Wed 5/20/98