

4.0 Remedial Actions

The site has been divided geographically into four zones as follows (Figure 2):

- **Zone 1–Onsite/Upper Mid-Canyon Area.** This zone includes the original 17-acre disposal area in the northern uppermost part of Pyrite Canyon, extending approximately 600 feet south of the clay barrier dam.
- **Zone 2–Mid-Canyon Area.** This zone is the middle reach of Pyrite Canyon extending approximately 800 feet south of Zone 1. The mid-canyon extraction wells are located along the southern, downgradient boundary of Zone 2.
- **Zone 3–Lower Canyon Area.** This zone is the lower reach of Pyrite Canyon extending approximately 2,400 feet south of Zone 2 to Highway 60. The lower canyon extraction wells are located along the southern, downgradient boundary of Zone 3.
- **Zone 4–Glen Avon Community.** This zone includes the area of Glen Avon south of Highway 60 and downstream of Pyrite Canyon, and extends to the current leading edge of the groundwater plume at the Santa Ana River, approximately 4 miles southwest of the former disposal ponds (located in Zone 1).

The following sections summarize, for each zone, the remedial actions selected in four ROD documents, describe the implemented remedial actions, and summarize the O&M activities of the existing remedial systems. The first ROD, issued on July 22, 1983, was for completion of several initial abatement activities, including fencing, erosion control, interim source control, and offsite hauling and disposal of contaminated liquids. The second ROD, issued on July 18, 1984, included construction of an onsite PTP to treat contaminated groundwater, and included installation of an expanded extraction system in Zone 2. The third ROD, issued on June 25, 1987, selected installation of a groundwater barrier system in Zone 3, and installation of peripheral surface channels to direct upgradient surface water runoff. The fourth ROD, issued on September 30, 1990, included dewatering in the original disposal area (Zone 1), installation of a groundwater extraction system in Zone 4, field testing of SVE, and field testing of reinjection of treated groundwater in the upper canyon area.

4.1 Zone 1 Remedial Actions

This section summarizes the remedial actions that have been selected and implemented in Zone 1, and presents a summary of current Zone 1 system operations.

4.1.1 Remedy Selection

All four RODs have selected remedial actions to address the hazards and risks posed by the original waste disposal area (Zone 1). These RODs focus primarily on remedial measures involving site fencing, erosion control, surface water management, and controlling the source of contaminants (by waste removal, capping/containment, groundwater barrier, and extraction). The primary remedial action objectives (RAO) for Zone 1 are to (1) prevent

direct and/or indirect contact with site-related contaminants in soils and surface water; (2) reduce the potential for the release and migration of site contaminants to groundwater; and (3) control, recover, and treat contaminated liquids in Zone 1 using diversion, dewatering, extraction, and onsite pretreatment systems.

4.1.2 Remedy Implementation

The remedy for Zone 1 consists of the following key elements:

- A clay cap and vegetative cover to retard infiltration of rainfall and prevent erosion.
- Upgradient groundwater and surface water interception system that consists of groundwater drainage trenches, surface drainage channels, and 15 upgradient interception wells.
- A hydraulic control and dewatering system that consists of 36 extraction wells operating with timed on/off cycles to maintain prescribed pumping water levels.
- A downgradient hydraulic control system consisting of 7 extraction wells and a french drain at the subsurface clay barrier dam.

Additional details on the components of the remedial actions performed in Zone 1 are summarized in Table 4-1. The remedial measures selected in the first ROD were undertaken primarily by DTSC under a cooperative agreement with USEPA. Improvements and expansion of erosion control systems were completed in accordance with the second and third RODs. The fourth ROD, issued in 1990, directed dewatering in Zone 1 to reduce the potential for further release of site contaminants and initiated SVE field testing to evaluate the feasibility of removing VOCs from the vadose zone in the source area.

TABLE 4-1
Remedial Actions Implemented in Zone 1, Original Disposal Area
Third Five-Year Review Report, Stringfellow Superfund Site, Riverside County, California

Decision Document	Remedial Action / Components
First ROD, July 1983	Sitewide Fencing Erosion Control <ul style="list-style-type: none"> • Maintenance of existing cap and surface drainage Source Control <ul style="list-style-type: none"> • Offsite disposal of leachate • Neutralize acid soils; offsite disposal of DDT-contaminated soils • Installation of clay barrier dam • Vegetative cover to retard infiltration of rainfall and prevent erosion • Groundwater extraction and monitoring wells
Second ROD, July 1984	Onsite Pretreatment System <ul style="list-style-type: none"> • Heavy metals and organics removal • Off-site disposal of sludge • Effluent discharge to publicly owned treatment works (POTW)
Third ROD, June 1987	Erosion Control <ul style="list-style-type: none"> • Install peripheral drainage channel and extend existing drainage channels for diversion of upgradient surface water
Fourth ROD, September	Source Area Dewatering

TABLE 4-1
Remedial Actions Implemented in Zone 1, Original Disposal Area
Third Five-Year Review Report, Stringfellow Superfund Site, Riverside County, California

Decision Document	Remedial Action / Components
1990	<ul style="list-style-type: none"> • Groundwater extraction well upgradient of barrier dam • Field Studies • SVE field testing for VOC removal in unsaturated zone

4.1.3 System Operations

Groundwater monitoring is currently performed on a semiannual basis, or as required, at the approximately 100 monitoring wells located within Zone 1. Water intercepted or extracted upgradient of Zone 1 is discharged to the surface drainage channels that drain to Pyrite Creek. All groundwater recovered from extraction wells within Zone 1 is treated at the onsite mid-canyon PTP located in Zone 2 (described in the following section).

Groundwater extracted from wells located in the waste disposal area is designated “A-stream” and groundwater extracted from wells located on the perimeter of Zone 1 is designated “F-stream.” Average annual flow in the A-stream was approximately 10,200, 7,300, 9,715, 8,549, and 21,478 gallons per day (gpd) in 2001, 2002, 2003, 2004, and 2005, respectively (Tetra Tech, 2004a, 2004b, 2006). For the F-stream, the average annual flow was approximately 1,900, 1,900, 1,427, and 537 gpd in 2001, 2002, 2003, and 2004, respectively (Tetra Tech, 2004a, 2004b, and 2006). The F-stream wells did not operate during 2005.

The remedial components in Zone 1 are operated and maintained according to the *Stringfellow Site Maintenance Plan* (Earth Tech, 2000), the *Contractor Quality Control Plan* (Earth Tech, 2005a), and the *Stringfellow Site, Pretreatment Plant Operations, Monitoring, and Maintenance Manual* (Earth Tech, 2006). The remedial components in Zone 1 are inspected on a daily or weekly basis, in accordance with the *Site Maintenance Plan* (Earth Tech, 2000). Table 4-2 presents a summary of the inspections routinely performed at the remedial components in Zone 1.

4.2 Zone 2 Remedial Actions

This section summarizes the remedial actions that have been selected and implemented at Zone 2, and presents a summary of current system operations in Zone 2.

4.2.1 Remedy Selection

The remedy selected for Zone 2 in the second ROD included construction of an onsite PTP (for all site-related contaminated groundwater) and installation of a groundwater extraction and barrier system in Zone 2. The RAO for the groundwater remedial system was to prevent further downgradient migration of contaminated groundwater from Zone 2 to Zone 3. Because specific requirements for the groundwater remedy were not identified in the second ROD, pumping tests and evaluations were later conducted to complete the design of the extraction system.

TABLE 4-2
 Inspection Activities for Site Features in Zone 1
Third Five-Year Review Report, Stringfellow Superfund Site, Riverside County, California

Site Feature	Focus of Inspection	Frequency
Access roads	Accessibility, compaction, general condition	Daily
Perimeter Fence	Integrity	Daily
Drainage channels	Blockage	Daily
	Leaks	Weekly
Culvert	Debris build-up	Weekly
Site Cap	Erosion, subsidence	Daily
	Seepage, subsidence	Weekly
Rain gauge	Operation, temperature	Daily
Clean water and holding tanks	Corrosion, leaks, piping, valves	Daily
Pipelines	Check for wetness and flooding	Weekly
Extraction pumps	Operation	Daily
Influent/effluent conveyance system	Operation of pumps, gauges, valves	Daily
	Integrity of fences, gates, manholes	Daily

4.2.2 Remedy Implementation

The components of the remedial actions installed and operating in Zone 2 are summarized in Table 4-3. The Zone 2 groundwater extraction system was completed in 1985 and consists of a total of seven extraction wells located near the southern downgradient boundary of Zone 2. The extraction wells, electrical panels, power systems, and collector pipelines in Zone 2 were upgraded and replaced in 2004.

The PTP was constructed in the mid-canyon area of Pyrite Canyon and has been in operation since 1985. The PTP utilizes lime precipitation for metals removal, followed by granular activated carbon (GAC) for removal of organic contaminants. The PTP treats all contaminated groundwater recovered from extraction systems operating in Zones 1 and 2. Prior to 1998, the treated effluent from the PTP was transported by truck to a pipeline collection point then conveyed to the local POTW, the SARI industrial wastewater treatment plant. In October 1998, construction of a new PTP effluent pipeline, which conveys effluent from the PTP to the SARI pipeline, was completed.

Recent additions to the PTP include a vapor recovery system to control VOC emissions from the PTP process units and a PRS preceding metals removal. A new PTP will be designed under the fourth ROD amendment to address the need to remove new contaminants of concern (COC) that are not specified in the second ROD and also in anticipation of future regulatory-driven effluent discharge limits. Pilot-scale tests are underway for the new PTP, including pilot testing for VOC removal through air stripping.

TABLE 4-3
Remedial Actions Implemented in Zone 2, Mid-Canyon Area
Third Five-Year Review Report, Stringfellow Superfund Site, Riverside County, California

Decision Document	Remedial Action / Components
Second ROD, July 1984	Onsite Pretreatment System <ul style="list-style-type: none"> • Mid-Canyon PTP • Extracted groundwater (Zones 1 and 2) treatment • Effluent discharge to POTW • Pretreatment system O&M Midcanyon Interceptor Well System <ul style="list-style-type: none"> • Seven groundwater extraction wells and 19 monitoring wells
Fourth ROD, September 1990	Evaluate Feasibility of ReInjection <ul style="list-style-type: none"> • Field studies of reinjection of treated groundwater into Zones 2 and 3
ESD, 1998	<ul style="list-style-type: none"> • Construction of effluent pipeline to convey effluent from the PTP to the SARI pipeline.

4.2.3 System Operations

Groundwater monitoring performed on a semiannual basis, or as required, at the monitoring wells located within Zone 2. All groundwater recovered from the Zone 2 extraction system (designated “B-stream”) is treated at the PTP and is then discharged to the SARI pipeline. Average annual well production from the Zone 2 groundwater interceptor system was approximately 18,000, 13,800, 13,373, 8,695, and 36,165 gpd in 2001, 2002, 2003, 2004, and 2005, respectively (Tetra Tech, 2004a, 2004b, 2006).

The remedial components in Zone 2 are operated and maintained according to the *Stringfellow Site Maintenance Plan* (Earth Tech, 2000), the *Contractor Quality Control Plan* (Earth Tech, 2005a), and the *Stringfellow Site, Pretreatment Plant Operations, Monitoring, and Maintenance Manual* (Earth Tech, 2006). The remedial components in Zone 2 are inspected on a daily or weekly basis, in accordance with the *Site Maintenance Plan* (Earth Tech, 2000). Table 4-4 presents a summary of the inspections routinely performed at the remedial components in Zone 2. Routine maintenance of filters, pumps, valves, and meters at the PTP are performed on either a weekly or monthly basis.

Pretreatment Plant (PTP)

Treatment processes at the PTP include pH control, pesticide removal, metals removal, and a GAC adsorption system for VOC removal. Since 1985, the PTP has treated groundwater extracted from the Zone 1 extraction system (A- and F-streams), and since 1989, has also treated groundwater extracted from the Zone 2 extraction system (B-stream).

All treated wastewater from the PTP is discharged to the Fountain Valley Treatment Plant (a SARI industrial treatment facility), which is operated by the County Sanitation Districts of Orange County. Discharges from the PTP (and the Lower Canyon Treatment Facility [LCTF] in Zone 3) must comply with the requirements of Permit No. 4D-98-S101 from the Santa Ana Watershed Project Authority. The maximum permitted total discharge from the PTP and the LCTF is 187,000 gpd (average annual daily flow). Based on effluent characteristics reported

in annual reports and monthly O&M reports, water discharged from the PTP to the SARI pipeline has met the permitted discharge requirements over the last 5 years¹.

TABLE 4-4

Inspection Activities for Site Features in Zone 2
Third Five-Year Review Report, Stringfellow Superfund Site, Riverside County, California

Site Feature	Focus of Inspection	Frequency
Perimeter Fence	Integrity	Daily
Drainage channels	Blockage	Daily
Gunite, channel, drop structures and weir	Debris build-up	Weekly
Pipelines	Check for wetness and flooding	Weekly
Stream gauges	Integrity, operation	Daily
Extraction pumps	Operation	Daily
Influent/effluent conveyance system	Operation of pumps, gauges, valves	Daily
	Integrity of fences, gates, manholes	Daily
Pretreatment Plant		
Paved areas, site	Cleanliness	Daily
Fence, gates	Integrity	Daily
Drainage channels	Blockage	Daily
Tanks, pipes	Integrity	Daily
Instruments, valves	Operation	Daily

During the treatment process, the plant produces metal-rich sludges (filter cake) from the filter presses and treated groundwater, which are disposed of. Most filter cake is disposed in a Class I landfill. However, because pesticide concentrations exceeded landfill disposal restrictions in the past, some of the filter cake had to be transported to separate facilities for incineration. In order to reduce system operating costs by reducing the quantity of pesticide-rich filter cake, the PTP was modified in 2003 with the addition of an IPRS that added lime and an anionic polymer to aid in pesticide removal prior to GAC treatment.

Currently, the PTP usually operates 8 hours per day, 5 days per week (ENVIRON, 2000). Additional operating time is occasionally required due to precipitation and seasonal variations in flow. Solid residues from the metals removal treatment are transported by truck to a federally approved hazardous waste disposal facility. A DTSC contractor (Earth Tech) currently operates the PTP and performs related treatment and disposal activities.

¹ Effluent concentrations for specific analytes exceeded permitted discharge requirements in a few, isolated instances over the reporting period. Discharge requirements were otherwise achieved over the reporting period.

4.3 Zone 3 Remedial Actions

This section summarizes the remedial actions that have been selected and implemented at Zone 3, and presents a summary of current system operations in Zone 3.

4.3.1 Remedy Selection

The third ROD, issued in June 1987, established the following RAOs for Zone 3: (1) to remove contaminated groundwater and (2) to stop additional contaminated groundwater from moving south into the community of Glen Avon. The remedy selected for Zone 3 specified the installation of a groundwater interception system in the Lower Canyon area and treatment of extracted groundwater, followed by discharge to a POTW.

4.3.2 Remedy Implementation

The PRPs designed and installed the Zone 3 extraction system between 1987 and 1990 to intercept and remove groundwater contaminated with VOCs. Five groundwater extraction wells, located near the downgradient boundary of Zone 3, have been operational since 1989. A sixth extraction well was established in 2000, through conversion of an existing monitoring well. The extraction wells, electrical panels, power systems, and collector pipelines in Zone 3 were upgraded and replaced in 2003. Additional monitoring wells were installed in 2002 to support the existing groundwater monitoring network. Extracted groundwater from Zone 3 is treated for organics at the LCTF. The components of the implemented groundwater remedial action in Zone 3 are summarized in Table 4-5.

TABLE 4-5
Remedial Actions Implemented in Zone 3, Lower Canyon Area
Third Five-Year Review Report, Stringfellow Superfund Site, Riverside County, California

Decision Document	Remedial Action / Components
Third ROD, June 1987	Lower Canyon Interceptor Well System <ul style="list-style-type: none"> • Five extraction wells • Treatment at Lower Canyon Treatment System • Effluent discharge to POTW
Fourth ROD, September 1990	Evaluate Feasibility of ReInjection <ul style="list-style-type: none"> • Field studies of reinjection of treated groundwater into Zones 2 and 3

4.3.3 System Operations

Groundwater monitoring performed on a semiannual basis, or as required, at a subset of the 84 monitoring wells located within Zone 3. Groundwater extracted from Zone 3 (designated "C-stream") is currently sent to the LCTF prior to being sent to the PTP storage tanks. The treated groundwater is then discharged to the SARI pipeline. Annual average flow of the C-stream was approximately 9,200, 5,800, 5,225, 3,981, and 17,325 gpd in 2001, 2002, 2003, 2004, and 2005, respectively (Tetra Tech, 2004a, 2004b, 2006).

The remedial components in Zone 3 are operated and maintained according to the *Stringfellow Site Maintenance Plan* (Earth Tech, 2000), the *Contractor Quality Control Plan* (Earth Tech, 2005a), and the *Stringfellow Site Lower Canyon Treatment Facility, Operations*,

Monitoring, and Maintenance Manual (Earth Tech, 2005b). The remedial components in Zone 3 are inspected on a daily or weekly basis, in accordance with the *Site Maintenance Plan* (Earth Tech, 2000). Table 4-6 presents a summary of the inspections routinely performed at the remedial components in Zone 3. Activities performed at the LCTF are consistent with those performed at the PTP (Table 4-4).

TABLE 4-6
Inspection Activities for Site Features in Zone 3
Third Five-Year Review Report Stringfellow Superfund Site, Riverside County, California

Site Feature	Focus of Inspection	Frequency
Perimeter Fence	Integrity	Daily
Drainage channels	Blockage	Daily
Stream gauges	Integrity, operation	Daily
Influent/effluent conveyance system	Operation of pumps, gauges, valves	Daily
	Integrity of fences, gates, manholes	Daily
Gunite, channel, drop structures and weir	Debris build-up	Weekly
Pipelines	Check for wetness and flooding	Weekly
LCTF: Paved areas	Cleanliness	Daily

Lower Canyon Treatment Facility (LCTF)

Since 1989, the LCTF has treated groundwater from Zones 3 and 4 (C- and D-streams) for organic compounds. The primary purpose of the LCTF is to remove TCE and chloroform from the groundwater through GAC treatment. The effluent from the LCTF is routed to the PTP holding tanks and is discharged to the SARI pipeline with effluent from the PTP. Based on effluent characteristics reported in annual and monthly O&M reports, water discharged from the LCTF to the SARI pipeline has met the permitted discharge requirements over the last five years².

4.4 Zone 4 Remedial Actions

This section summarizes the remedial actions that have been selected and implemented at Zone 4, and presents a summary of current system operations in Zone 4.

4.4.1 Remedy Selection

The remedy selected for Zone 4 in the fourth ROD (issued September 1990) was the installation of the Community Extraction System for pumping and treatment of site-related groundwater contamination in the Glen Avon area. The RAOs for the Zone 4 groundwater remedy were (1) to prevent further migration of contaminated groundwater and (2) to

² Effluent concentrations for specific analytes exceeded permitted discharge requirements in a few, isolated instances over the reporting period. Discharge requirements were otherwise achieved over the reporting period.

restore groundwater to applicable or relevant and appropriate requirements (ARAR) or background levels. If background levels exceeded ARARs, the ARARs levels were used in the selection of a remediation goal. Restoration of groundwater quality in the area is intended to allow the unrestricted use of groundwater in this Zone, consistent with the Water Board's Water Quality Control Plan for the Santa Ana River Basin, which designates groundwater in this Zone as having a present or potential beneficial use for municipal supply (Water Board, 1995).

The fourth ROD identified the following contaminants that exceed MCLs or ARARs in groundwater in Zone 4: TCE, chloroform, nitrate, and sulfate. The remediation goals established in the fourth ROD were the groundwater MCL of 5 micrograms per liter ($\mu\text{g}/\text{L}$) for TCE and the health-based level of 6 $\mu\text{g}/\text{L}$ for chloroform.

4.4.2 Remedy Implementation

The components of the remedial actions installed and operating in Zone 4 are summarized in Table 4-7. The fourth ROD directed installation of two extraction wells in the community area as the initial groundwater response action. The two extraction wells, designated as the north and south wells, were installed and have continued to operate for plume control in Zone 4 since 1992. Groundwater extracted from these wells (the D-stream wells) is treated at the LCTF. Two additional extraction wells, referred to as "tree farm wells," were installed in 1998. Groundwater extracted from the tree farm wells is treated at the CWTS.

TABLE 4-7
Remedial Actions Implemented in Zone 4, Glen Avon Community
Third Five-Year Review Report, Stringfellow Superfund Site, Riverside County, California

Decision Document	Remedial Action / Components
Fourth ROD, September 1990	Community Groundwater Pump and Treat <ul style="list-style-type: none"> • Four groundwater extraction wells and 84 monitoring wells • Groundwater treatment at LCTF and CWTS • Effluent discharge to POTW and/or irrigation reuse Surface Water Management <ul style="list-style-type: none"> • Discharge under National Pollutant Discharge Elimination System (NPDES) permit and/or reuse

4.4.3 System Operations

Groundwater monitoring is performed on a semiannual basis, or as required, at the 84 monitoring wells located within Zone 4. Based on recent groundwater monitoring data, the Zone 4 extraction system is performing to meet the goals of the fourth ROD. The plume of TCE-contaminated groundwater is being remediated, and the treatment actions are meeting the RAOs. Analytical data for samples collected from monitoring wells within Zone 4 in Fall 2005 did not show increasing trends in concentrations of TCE or chloroform (GLA, 2006a). Annual average flow for the D-stream wells was approximately 92,300, 88,600 gpd, 70,032, 71,470, and 71,845 gpd in 2001, 2002, 2003, 2004, and 2005, respectively (Tetra Tech, 2004a, 2004b, 2006). Annual average flow for the E-stream wells was approximately 92,300,

88,600 gpd, 16,721, 22,575, and 31,230 gpd in 2001, 2002, 2003, 2004, and 2005, respectively (Tetra Tech, 2004a, 2004b, 2006).

The remedial components in Zone 4 are operated and maintained according to the *Stringfellow Site Maintenance Plan* (Earth Tech, 2000), the *Contractor Quality Control Plan* (Earth Tech, 2005a), and the *Stringfellow Site Community Wellhead Treatment System, Operations, Monitoring, and Maintenance Manual* (Earth Tech, 2005c). Table 4-8 presents a summary of the inspections routinely performed at the remedial components in Zone 4. Inspection activities performed at the CWTS are consistent with those performed at the PTP (Table 4-4).

TABLE 4-8

Inspection Activities for Site Features in Zone 4
Third Five-Year Review Report, Stringfellow Superfund Site, Riverside County, California

Site Feature	Focus of Inspection	Frequency
Perimeter Fence	Integrity	Daily
Drainage channels	Blockage	Daily
Influent/effluent conveyance system	Operation of pumps, gauges, valves	Daily
	Integrity of fences, gates, manholes	Daily

Community Wellhead Treatment System (CWTS)

The CWTS treats of organic compounds in groundwater from the E-stream extraction wells in Zone 4. Since 1993, the CWTS has treated groundwater through GAC treatment. The effluent from the CWTS is discharged to Pyrite Creek or is reused for irrigation. Discharges to Pyrite Creek are performed in accordance with Water Board Order R8-2002-007, NPDES No. CAG918001.