1.0 INTRODUCTION

This report, prepared to augment the Newmark Groundwater Contamination Superfund Site, Muscoy Plume Operable Unit (OU) remedial investigation, documents:

- Installation of five extraction wells (EW), EW-108 through EW-112, and their associated piezometers;
- Installation of six triple-completion monitoring wells (MW), MW-135 through MW-140;
- Analytical data from groundwater sampling; and
- Conclusions based on interpretation of sampling results.

The extraction and monitoring wells are part of the remedial action for the Muscoy Plume OU. This report provides construction details, including drilling and well construction logs. The groundwater sampling events discussed in this report include events associated with the Newmark Source OU Long-Term Monitoring Program (LTMP) as well as special sampling events at selected wells. The analytical data were used to create concentration isocontour maps for the Muscoy Plume OU.

The remainder of Section 1.0 provides background information for the Newmark Site in general and the Muscoy Plume OU in particular.

1.1 SITE BACKGROUND

1.1.1 Overview

The California State Department of Health Services (DHS) discovered and investigated the presence of chlorinated solvents in several municipal water-supply wells (municipal wells) within the northern San Bernardino/Muscoy region during a 1980 groundwater investigation. Following this discovery, several investigations were conducted to locate the potential source(s) of contamination. On March 30, 1989, the United States Environmental Protection Agency (EPA) placed this region on the National Priorities List (NPL) Comprehensive Environmental Response, Compensation and Liability Act Identification System (CERCLIS), Site #CAD981434517, thereby releasing federal funds for cleanup of this region, now identified as the Newmark Groundwater Contamination Superfund Site (Newmark Site).

The EPA initiated the remedial investigation/feasibility study (RI/FS) process for Newmark Site in 1990. Initial investigations indicated that two groundwater contamination plumes were present within the site. The two plumes were believed to have separate sources and were therefore separated into two OUs – the Newmark OU and the Muscoy Plume OU – to more effectively focus the search for potential source(s) of contamination. A third, the Source OU, was designated in 1993 as a means to more efficiently investigate the suspected source areas for both plumes.

Figure 1-1 shows the OU investigation areas, prominent geographic features, and approximate extent of the Newmark and Muscoy OU plumes. The Newmark OU consists of a 5-mile-long chlorinated solvent plume extending from northwest of the Shandin Hills to approximately Baseline Avenue in the city of San Bernardino, California. Contamination within the Newmark OU plume has caused the closure of a number of municipal wells and continues to threaten downgradient wells that supply water for approximately 500,000

people. The Muscoy Plume OU has contaminated approximately 3 miles of aquifer on the west side of the Shandin Hills in the city of Muscoy, California.

The principal contaminants identified in investigations since 1980, and the chemicals of concern for this sampling program are, trichloroethene (TCE) and tetrachloroethene (PCE). Historically, the concentrations of these contaminants have exceeded California maximum contaminant levels (MCLs) for drinking water in several municipal wells.

The remedy selected for the Newmark OU is documented in a record of decision (ROD) issued on August 4, 1993. A remedial design (RD) was developed to achieve the remediation goals specified in the ROD and implemented in a remedial action (RA). The RA includes the construction of five groundwater extraction wells, construction of a water transmission pipeline, construction and renovation of granular activated carbon (GAC) treatment systems, and construction of monitoring wells to assess system performance; followed by one year operation and performance monitoring. The San Bernardino Municipal Water District (SBMWD) operated the RA and constructed the extraction wells and pipeline. Construction of the treatment system was completed in 1998, the one-year performance monitoring phase has been completed, and the system is currently operating as intended.

For the Muscoy Plume OU, the selected remedy is documented in a ROD issued on March 25, 1995. The Muscoy Plume OU RA, implemented in accordance with the objectives of the RD, included the construction of a network of five groundwater extraction wells, the construction of raw and treated water transmission pipelines, the construction of a GAC treatment system, the construction of a treated water booster station, and the construction of five multiple completion monitoring wells to assess the performance of the extraction well network. Construction of the treatment system was completed in 2005. The one-year performance monitoring phase began July 25, 2005, and is in progress as of the publication of this report.

Overall long-term Muscoy Plume OU site activities are designed to fulfill the following objectives:

- Control contaminant plume migration by designing a system of extraction wells and treatment facilities; and
- Remove groundwater contaminants and restore the aquifer to beneficial uses, as practicable.

1.1.2 Environmental Setting

Geography. The Newmark Site (Figure 1-1) lies in the southwestern portion of San Bernardino County, California, at the base of the San Bernardino Mountains. Geology of the study area consists of a series of confluent alluvial fans (bajadas) derived from the San Gabriel Mountains to the northwest and the San Bernardino Mountains to the northeast. Together, these mountains form the boundaries of San Bernardino Valley. The alluvial fans form where major drainages leave the mountains and coalesce to form part of a broad alluvial plain in the central part of the San Bernardino Valley (Dutcher and Garrett, 1963).

The northwest-trending San Andreas and San Jacinto Faults form the boundary of the San Bernardino Valley. The dissected scarp of the San Andreas Fault rises above the valley to elevations ranging from about 2,700 feet at the mouth of Cajon Creek to more than 5,500 feet at the mouth of the Santa Ana River canyon. The San Jacinto Fault branches from the San Andreas Fault north of the study area and is the only major fault crossing the valley where topographic evidence of movement has been preserved. Ridges associated with the San Jacinto Fault are major structural features in southern California.

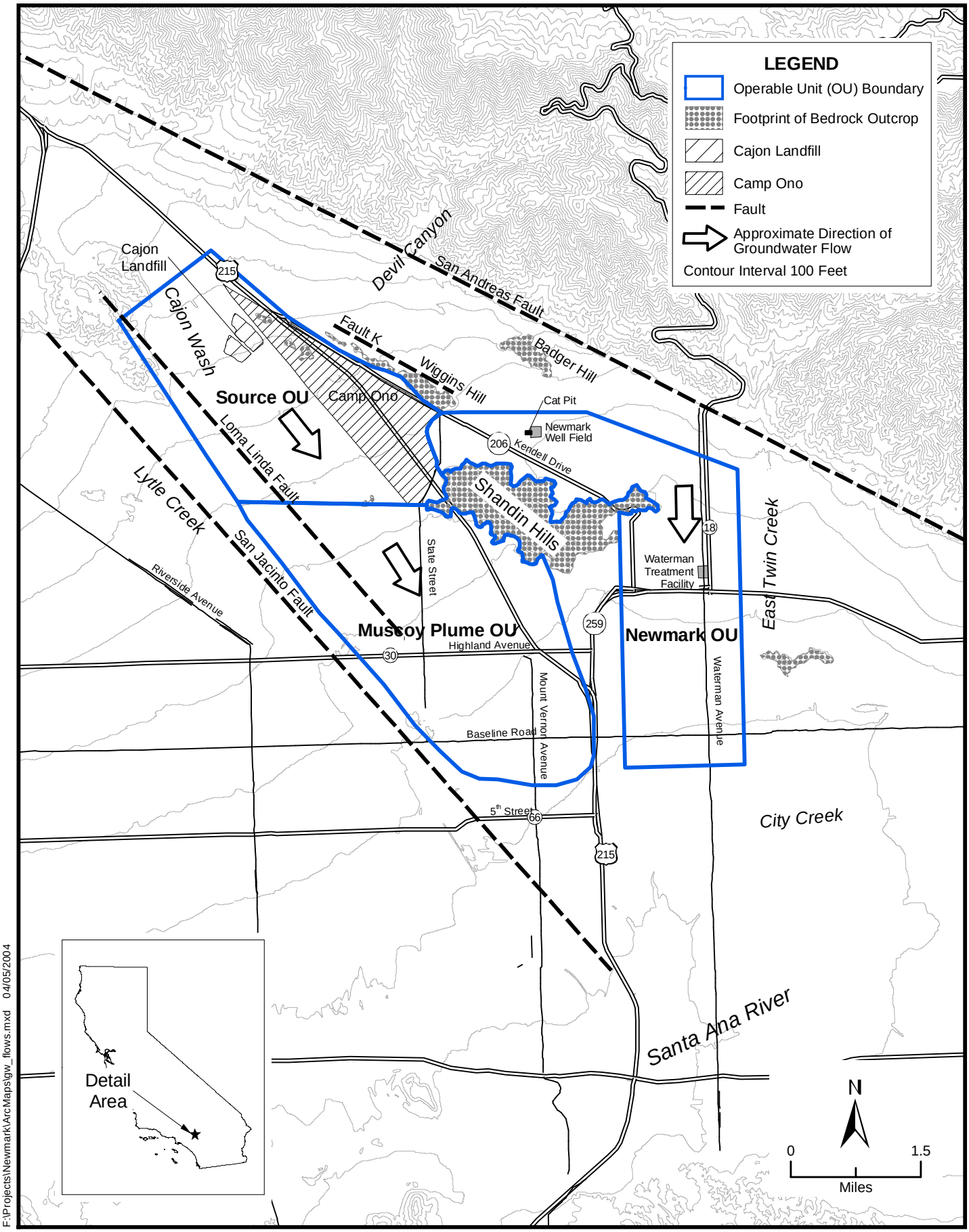
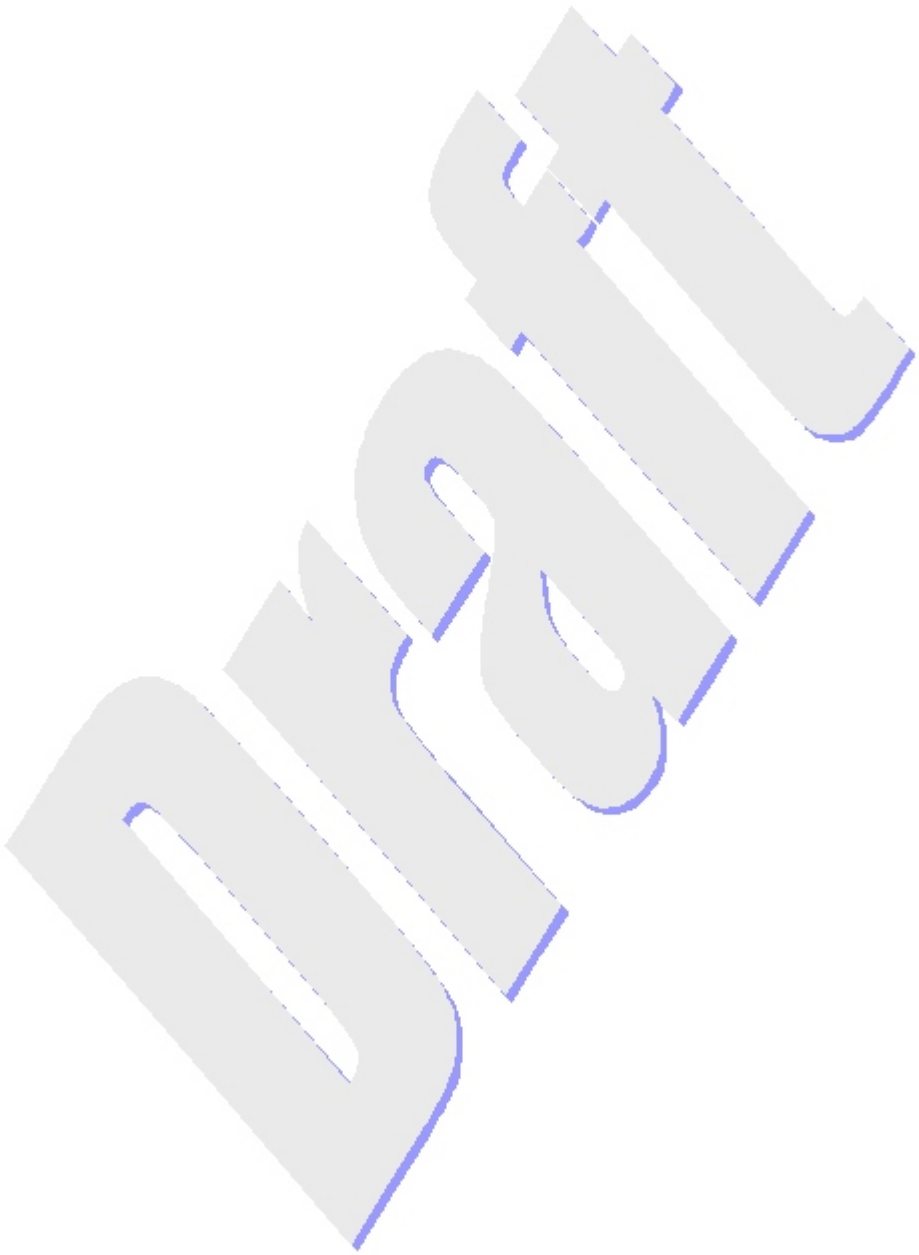


Figure 1-1.
Location of Major Features, Newmark Groundwater Contamination Superfund Site, San Bernardino, California

This page intentionally left blank



Several bedrock hills protrude above the alluvial fans. North of the Santa Ana River, between the San Jacinto and San Andreas faults, Shandin, Perris, Badger, and Wiggins Hills rise 50 to 550 feet above the valley floor. All are believed to have been elevated by differential movement along bedrock faults (Dutcher and Garrett, 1963).

With the exception of the Shandin and Wiggins Hills, which rise almost 500 feet above the eastern valley floor, topography slopes from the north and northwest to the south. The surface elevation drops from about 1,700 feet above sea level in the north to 1,100 feet in the south at gradients of 75 to 95 feet per mile (United States Geological Survey [USGS] 7.5' topographic map).

Manmade features present in the study area include a series of percolation basins scattered throughout the area. These basins range in size from approximately 5,000 square feet to 20 million square feet.

Geology. Bedrock underlying the alluvium of the San Bernardino Valley is composed of pre-Tertiary igneous and metamorphic rocks. The San Gabriel Mountains, the San Bernardino Mountains, and the various hills scattered throughout the study area also are composed of bedrock materials. The alluvium consists of boulders, gravel, sand, silt, and clay of late Tertiary and Quaternary age (Dutcher and Garrett, 1963).

A number of en echelon faults are present in the region between the two major faults. The Loma Linda Fault is approximately 1 mile northeast of the San Jacinto Fault and extends across the area in a north west/southeast trend. Fault K is approximately 1½ miles south of the San Andreas Fault and trends northwest/southeast. Fault K extends from the vicinity of the Newmark Well Field directly north of the Shandin Hills to the northwest, north of Wiggins Hill, and out of the study area.

Well logs indicate that bedrock exists at shallow depths beneath the valley floor in several areas. Shallow bedrock areas are significant in controlling the distribution and character of the older, water-bearing alluvium. Alluvial thicknesses in the San Bernardino Valley area vary considerably, with maximum alluvial thickness occurring adjacent to the northeastern side of the San Jacinto Fault (Fife et al., 1976; Hardt and Hutchinson, 1980). Alluvial thicknesses increase from 400 feet at the Newmark Well Field, near the base of the San Bernardino Mountains, to at least 2,100 feet at the Loma Linda/San Jacinto Fault zone, near the center of the San Bernardino Valley (Youngs et al., 1981). The northern portion of the study area, just south of the San Bernardino Mountains, consists predominantly of sand, gravel, and boulders, with little or no clay. The driller's log for the Waterman Avenue well (adjacent to the southern edge of the Shandin Hills) indicates the presence of a substantial amount of clay. Clay lenses increase in number and thickness toward the central and southern portion of the valley.

Hydrogeology. Within the Newmark Site, ground- and surface-water issues are confined to the area occupied by the Bunker Hill Groundwater Basin, as described by Dutcher and Garrett (1963). This basin is bounded by the San Bernardino Mountains to the northeast, by the Crafton Hills and the Badlands on the south, and by the San Jacinto Fault on the southwest.

The principal aquifer in the Bunker Hill basin consists of older alluvium which is overlain by younger alluvium. This aquifer is further divided into two units: the unconfined upper aquifer and the lower aquifer, which is confined by the overlying zone of inter-fingered silt and clay lenses. The division of these two aquifers becomes more defined as the thickness of the clay units increases toward the central and southern portion of the Newmark Site.

Groundwater movement in the study area generally follows surface drainage/topography. The groundwater within the basin generally flows southward. Groundwater under Lytle Creek flows southeast. Bedrock hills that protrude above the alluvial fans, including the Shandin Hills and Wiggins Hill, cause localized variations in flow direction as groundwater flows around the less permeable bedrock. The faults present in the region off-set the bedrock (Pelona Schist), creating clay-rich shear zones that may act as barriers to lateral groundwater flow.

Flowing artesian wells have been historically observed within the study area. Where the potentiometric head (the groundwater-level potential) is above the confining beds in this area, and the San Jacinto Fault ("Bunker Hill Dike") restricts lateral groundwater flow, groundwater is forced through and around the clay beds into the overlying strata and onto the land surface.

Surface water within the study area performs the critical function of recharging the groundwater aquifer. Three main tributary streams, the Santa Ana River, Mill Creek, and Lytle Creek, contribute more than 60% of the recharge to the groundwater system. During storm periods, stream flow emerges from mountain canyons along the valley perimeter and moves down the alluvial fans, where a large part of the flow infiltrates into these permeable surficial deposits. In the 20-year period from 1964 through 1983, recharge to the groundwater basin increased substantially. A sequence of wet years in the late-1970s and early-1980s produced above-average natural stream flow and increased percolation through the stream-beds. Recharge to the groundwater basin then decreased during the 20-year period from 1984 through 2003, with only a few sporadic wet years in the 1990s.

1.1.3 Regulatory History

In 1980, eight municipal wells in the City of San Bernardino were found to contain concentrations of TCE and PCE exceeding state drinking water action levels (currently 5.0 micrograms per liter [µg/L] for each). Four of these wells were in the Newmark Treatment Facility at Reservoir Drive and Magnolia Avenue; the other four were in the Waterman Treatment Facility in the vicinity of 31st Street and Waterman Avenue. Following a more extensive groundwater sampling program initiated by the Regional Water Quality Control Board (RWQCB), Santa Ana Region, eight additional wells were shut down because of elevated concentrations of TCE and PCE. The pattern of well contamination indicated the relatively rapid southward (downgradient) migration of these two organic chemicals.

In September 1985, the RWQCB, Santa Ana Region, authorized a contract between the RWQCB and URS to study the local hydrogeology and identify potential contaminant sources. A report of those activities, completed in August 1986, summarized 50 possible sources of groundwater contamination, including the now abandoned San Bernardino Airport (URS, 1986).

In November 1986, the Department of Health Services – Department of Toxic Substances Control (DHS-DTSC) (formerly the Toxic Substances Control Division) signed a Determination of Imminent and Substantial Endangerment for the northern San Bernardino/Muscoy region based on the municipal well closures and the potential threat to downgradient wells. This action released state Superfund money for an interim RA in the Newmark Well Field project and allowed DHS-DTSC and the City of San Bernardino to construct four air-stripping towers. Two became operational in 1988, at the Newmark Well Field, and the remaining two were brought on line in July 1989, at the Waterman Well Field.

Several additional studies have been undertaken in the northern San Bernardino/Muscoy regional area. In 1987, the county completed a study of small quantity hazardous waste users in San Bernardino (including

TCE and PCE users) to quantify and regulate the amount of these contaminants used in the area (Ecology and Environment, Inc. [E&E], 1989). As the zone contractor for DHS-DTSC, E&E completed a preliminary assessment of the site in 1989. During 1988, E&E drilled nine monitoring wells at three separate locations (E&E, 1989).

In March 1989, the Newmark Well Field was placed on the NPL and thereby acquired federal Superfund financing for site remediation. The EPA conducted a search to identify potentially responsible parties (PRPs) that contributed to the Newmark Well Field contamination. In 1990, the EPA's Environmental Monitoring Systems Laboratory (EMSL) reviewed aerial photographs of the Newmark Well Field to locate evidence of potential contamination sources. EPA conducted an RI/FS for the Newmark Groundwater Contamination project from 1990 until March 1993 and issued the Newmark OU Interim ROD in August 1993 (EPA, 1993). The Muscoy OU Interim ROD was issued on March 3, 1995.

1.1.4 Description of Operable Units

Newmark Operable Unit. The Newmark OU is a 6.7-square-mile area extending approximately 0.2 mile north and west of University Parkway and continuing southeast roughly to 40th Street. There it extends south approximately 3 miles to approximately 0.4 mile south of Baseline Road (Figure 1-1). Generally, the Newmark OU encompasses the groundwater contamination north and east of the Shandin Hills.

Muscoy Plume Operable Unit. The Muscoy Plume OU is a 7.75-square-mile area that extends west from the Shandin Hills to the Cajon Wash and south from the Shandin Hills to approximately 0.5 mile south of Baseline Road. Generally, the Muscoy Plume OU encompasses the downgradient portion of the groundwater contamination west of the Shandin Hills.

Source Operable Unit. The Source OU is a 6.3-square-mile area located northwest of the Shandin Hills. The area extends approximately 0.75 mile northwest of Institution Road and continues southeast approximately 2 miles to University Parkway. Lytle Creek defines the western boundary, and the eastern boundary coincides with Highway 215, south of State College Parkway, and Kendall Drive, north of State College Parkway. The Source OU, which encompasses both the Cajon Landfill and former Camp Ono, was initiated as a way to more efficiently identify the source(s) for the groundwater contamination in the Newmark and Muscoy Plume OUs.

1.2 PREVIOUS MUSCOY PLUME OPERABLE UNIT INVESTIGATIONS

Numerous investigations have been conducted to determine a source and to monitor contaminant concentrations and movements since contamination was first discovered in the Bunker Hill Groundwater Basin in 1980. This section summarizes the principal investigations conducted in the Muscoy Plume OU.

1.2.1 Muscoy Area Soil Gas Survey

In 1989, the RWQCB, Santa Ana Region, conducted a soil gas survey of the former site of Camp Ono in the Muscoy area of San Bernardino. Twenty-four soil gas collection tubes were placed at two site locations. PCE ions were present throughout the soil at both locations. Toluene and petroleum hydrocarbons were present in all samples, but TCE was only tentatively identified at two sample locations. In addition, 1,1,1- or 1,1,2-trichloroethane (TCA) and phenols were detected at one location. It was not determined whether the vapors were originating from groundwater, unsaturated soil, or both. Nevertheless, PCE, toluene, and petroleum

hydrocarbons were present in the subsurface beneath both surveyed sites. These findings indicate that the former camp may be a source of the PCE contaminants found in eight Muscoy Plume OU municipal wells south of Muscoy and downgradient of Camp Ono. The phenols and TCA were detected in soils south (downgradient) of an old leach field. TCA was probably used as a solvent at the site, and the phenols most likely were used at a former precious metal processing facility.

1.2.2 Muscoy Plume Operable Unit Remedial Investigation/Feasability Study

The Muscoy Plume OU RI/FS (URS, 1994) was developed based on information acquired during the Muscoy interim sampling phase (URS, 1993). The interim sampling phase involved sampling 17 municipal wells and 21 monitoring wells within the Newmark and Muscoy Plume OUs.

The contaminants identified in the Muscoy Plume OU are similar in nature and concentration to those previously identified in the Newmark OU, which may indicate a similar source for the two plumes. Analytical results from the Muscoy interim sampling activities indicated the presence of several VOCs. PCE and its breakdown products, along with Freon® 11 and Freon® 12 were the most commonly detected compounds. Groundwater sampling in the Muscoy Plume OU wells did not definitively identify the Muscoy Plume OU contamination source(s).

1.2.3 Source Operable Unit Detailed Hydrogeologic Investigation

URS, under contract with the EPA, conducted a detailed hydrogeologic investigation in the Source OU and Muscoy Plume OU to locate potential subsurface groundwater contamination source(s) and select a remedy to control the source(s) (URS, 1996). To support these objectives, two groundwater piezometers and two monitoring wells were installed in the central portion of the Source OU, and one triple completion monitoring well was installed in the central portion of the Muscoy Plume OU (MW-128).

The Muscoy Plume OU multiple completion monitoring well, MW-128, was constructed to further evaluate groundwater quality in the southern portion of the Muscoy plume area and to investigate the potential for the mixing of the Newmark and Muscoy plumes. The results of this investigation were inconclusive with regards to mixing of the two plumes. Groundwater sample analytical results obtained from MW-128 indicate that contamination is limited to the upper portions of the confined (deep) aquifer within the Muscoy plume.

1.2.4 Muscoy Plume Operable Unit Detailed Hydrogeologic Investigation

URS, under contract with the EPA, conducted a detailed hydrogeologic investigation in the Muscoy Plume OU to aid in delineating the leading edge of the Muscoy plume and to identify potential extraction well locations (URS, 1997). To support these objectives, two triple-completion monitoring wells (MW-129 and MW-130) were installed in the central portion of the Muscoy Plume OU to provide chemical and aquifer parameter data. The results of this investigation indicated that the leading edge of the Muscoy plume was located downgradient of the two newly installed wells.

1.2.5 Site-Wide Groundwater Sampling

Ongoing site-wide groundwater sampling events have taken place from 1996 to the present. The most recent concentrations of volatile organic contaminants (VOCs) of concern detected in Muscoy Plume OU wells are discussed in detail in Section 3.0 of this report. Historical detected concentrations of VOCs of concern, for

wells selected to represent chemical concentrations across the entire plume, are presented in Appendix A of the *Newmark Groundwater Contamination Superfund Site, Site-Wide Field Sampling Plan* (URS, 2005).

This page intentionally left blank