REMEDIAL INVESTIGATION REPORT
West Van Buren Area WQARF Registry Site
Phoenix, Arizona

Volume I

Terranext Project No. 03103154

Prepared For:

Arizona Department of Environmental Quality
1110 West Washington
Phoenix, Arizona 85007

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Prepared By:

REGISTERED GEOLOGIST
CERTIFICATE NO.
13937
ARTHUR J.
GORDON
Date Signed 8-10-12
ARIZONA, U.S.A.
Expires 12-31-14

Arthur J. Gordon, R.G.
Terranext Project Manager

Reviewed By:

Kevin C. Snyder, R.G.
Arizona Department of Environmental Quality

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1.0 WEST VAN BUREN AREA SITE CONCEPTUAL MODEL

1.1 Introduction

Terranext was retained by the Arizona Department of Environmental Quality (ADEQ) to perform a remedial investigation (RI) at the West Van Buren Area (WVBA) Water Quality Assurance Revolving Fund (WQARF) Registry Site. The project is being performed in accordance with Arizona Response Action Contract No. EV03-0073AA and Procurement Reference No. 04-0035.

The WVBA extends from approximately 7th Avenue west to 75th Avenue and from Buckeye Road north to Interstate 10. In addition, a finger shaped plume exists between 7th Avenue and 27th Avenue between Buckeye Road and Lower Buckeye Road. The WVBA is the areal projection of the western portion of a large commingled plume of contaminated groundwater in Phoenix, Arizona (Figure 1-1). Contributors to this commingled plume include industrial facilities and contaminated groundwater from the east, as regional groundwater flow is generally westward. The initial primary contaminants of concern (COCs) comprising the commingled WVBA plume included the following volatile organic compounds (VOCs): tetrachloroethene (PCE), trichloroethene (TCE), 1,1,1-trichloroethane (TCA), cis 1,2-dichloroethene (cis 1,2-DCE), 1,1-dichloroethane (1,1-DCA), and 1,1-dichloroethene (1,1-DCE). To a limited extent, chromium is also considered a COC. The RI was performed to identify sources of commingled COCs in groundwater and to evaluate the horizontal and vertical extent of groundwater contamination.

Benzene, toluene, ethylbenzene, and xylenes (BTEX) were part of the original COC list because of detections at various locations throughout the plume. BTEX was eventually dropped from the COC list because the BTEX was limited to leaking underground storage tank (LUST) facilities regulated by ADEQ's Underground Storage Tank (UST) Program, or limited in extent to beneath the above ground storage tanks at the Phoenix Terminal. Releases from USTs at the Phoenix Terminal are regulated under the authority of the UST Program. WQARF regulatory authority (Arizona Revised Statues [ARS] §49-283.02) does not include petroleum or constituents of petroleum if the release is regulated under the UST Program. Currently there is no ADEQ oversight of aboveground storage tanks that hold petroleum products.

Pursuant to A.A.C. R18-16-406, the purpose of the RI is to:

1. Establish the nature and extent of the contamination and the sources thereof,
2. Identify current and potential impacts to public health, welfare, and the environment,
3. Identify current and reasonably foreseeable use of land and water of the state, and
4. Obtain and evaluate any other information necessary for identification and comparison of alternative remedial action

1.2 WQARF Process

The WQARF process (A.R.S 49-287, A.A.C. R18-16-401 through 416) consists of sequential steps taken to evaluate and subsequently remediate a site contaminated with hazardous substances. A site can be any parcel(s) of land suspected to be polluted with hazardous process chemicals, substances or wastes. After a preliminary investigation, it may be determined that a site poses an actual hazard and/or potential risk to public health and the environment and may qualify as a registry site under the WQARF program. Once a site is designated as a WQARF registry site, the following activities may be performed sequentially:

- Preparation to perform RI and Feasibility Study (FS)
- Community Involvement Plan written and Community Advisory Board (CAB) formed
- RI performed
- Beneficial uses of land and water gathered and future land uses identified
- Draft RI report issued for public comment
- Remedial Objectives (ROs) report developed in accordance with public participation requirements
- RI report finalized
- FS conducted to evaluate options for clean-up
- Draft FS report issued for public comment
- FS report finalized
- Proposed Remedial Action Plan (PRAP) outlines preferred choice of technology for clean-up
- Public notice of the PRAP issued
- Record of Decision (ROD) formalizes decision on how clean-up will be performed
- Public notice of the ROD issued
- Clean-up actions performed

At any time during the WQARF process, an Early Response Action (ERA) may be deemed necessary by ADEQ and implemented per A.A.C R18-16-405.

1.3 Site Background

1.3.1 Site Description

The WVBA extends from approximately 7th Avenue west to 75th Avenue and from Buckeye Road north to Interstate 10. This corresponds to an area approximately eight miles in length and 1.5 miles in width (approximately 12 square miles). In addition, a finger shaped plume exists between 7th and 27th Avenues between Buckeye and Lower Buckeye Roads (Figure 1-1). Within the WVBA are industrial facilities that have used VOCs in former, and in some cases, current operations. Figures, tables and copies of laboratory reports for facilities which conducted groundwater investigations are contained in the appendices Based on observations made during performance of RI field

activities, typical industrial businesses within the WVBA WQARF Registry Site include automobile body repair, automobile painting operations, automobile repair, chemical mixing and distribution, dry cleaning operations, foundry operations, manufacturing operations, metal fabrication and plating, plastic manufacturing, printing operations, and vulcanizing operations.

Ninety seven monitor wells have been installed by ADEQ to delineate the extent and magnitude of groundwater contamination, and to further investigate potential source areas. Groundwater elevation information is collected quarterly while water quality data is collected on a semi-annual basis throughout the area. The City of Phoenix municipal water system serves residences and businesses in the WVBA with drinking water. In 2006, ADEQ collected samples from seven domestic wells that were identified by ADWR during a well search/inventory and results indicated that the COCs are not present above the aquifer water quality standard (AWQS) (Terranext, 2006b)

1.3.2 Site History

1.3.2.1 Early Regulatory Efforts

Groundwater contamination was first detected in the WVBA during groundwater sampling conducted by Chevron USA Inc. (Chevron) at their facility located in the Phoenix Terminal south of Van Buren Street between 51st Avenue and 55th Avenue (Dames & Moore, 1985). Because Chevron had reportedly never used the solvents detected, the Arizona Department of Water Resources (ADWR) conducted an areawide groundwater investigation in conjunction with the Arizona Department of Health Services (ADWR, 1987).

The WVBA WQARF Registry Site, originally called the Van Buren Tank Farm Study Area, was placed on the WQARF priority list in November 1987. ADEQ contracted with Kleinfelder, Inc. (Kleinfelder) to conduct the preliminary site investigation in May 1988 (Kleinfelder, 1988). Since 1988, ADEQ and several companies within the WVBA have conducted investigations of contaminated soil and groundwater. Initial field work included conducting groundwater monitoring, soil sampling, examining area land uses, reviewing past and current disposal practices of industrial operations, and analyzing the potential health risks of identified COCs. A Phase I report was finalized for ADEQ in July 1989 (Kleinfelder, 1989). The report concluded that five of the COCs identified above were found to be present at levels above U.S. Environmental Protection Agency (EPA) maximum contaminant levels (MCLs) in groundwater.

In October 1992, the Arizona Department of Health Services (ADHS) completed a health risk assessment addressing the potential threat to City of Tolleson drinking water wells. The study was conducted in anticipation of potential groundwater contamination of City of Tolleson wells by westerly groundwater movement of the WVBA plume. The study concluded there would be significant health effects from domestic consumption of groundwater containing COCs at concentrations similar to those found in ADEQ monitoring wells located near 67th Avenue and Van Buren Street. The City of Tolleson's

most easterly well is located at approximately 83rd Avenue and Harrison Street. Although the WVBA plume does not extend west of 80th Avenue, potentially affected wells have been removed from service. In addition, the City of Tolleson currently has an agreement with the City of Phoenix Water Services Department to provide drinking water. Also, two groundwater monitoring wells have been installed at 79th Avenue, north and south of the Roosevelt Irrigation District (RID) canal, between the leading edge of the plume and the City of Tolleson municipal well field to monitor groundwater quality in the area of concern.

Following the 1989 Phase I report, historical records were researched to identify currently operating facilities that use COCs. Closed facilities that had previously operated in the study area and had likely used COCs were also researched. The identified facilities were contacted and provided with the results of the preliminary investigation. In locations of the WVBA where potential contamination sources were identified, the current facilities were encouraged to undertake voluntary investigations and cleanup.

ADEQ conducted a soil investigation at the Maricopa County Materials Management (MCMM) facility in 1992 as a result of groundwater contamination detected in an ADEQ groundwater monitor well located downgradient of the MCMM facility. ADEQ also installed three groundwater monitor wells at the MCMM facility. Maricopa County then conducted site characterization of their facility and installed and operated a soil vapor extraction (SVE) system.

In November 1992, ADEQ encouraged approximately 50 parties to form a steering committee to address groundwater contamination issues in the WVBA. Participants of the steering committee formed the West Van Buren Group (WVBG).

1.3.2.2 WVBG

The WVBG was a key component of the steering committee. The makeup and formal membership of the WVBG varied during the mid-1990s, originally consisting of Reynolds Metals Co. (Reynolds), Van Waters & Rogers Inc. (VW&R), Maricopa County, Dolphin, Incorporated (Dolphin), American Linen Supply Company (ALSCo, formerly Maroney's Cleaners), and ChemResearch Company, Inc (CRC). CRC, ALSCo, and Maricopa County withdrew from the WVBG by 1995. The WVBG suspended further negotiations with ADEQ for a site-wide consent agreement in June 1996, after Arizona legislative changes were enacted.

Prior to suspension of the WVBG, members of the WVBG reviewed ADEQ files, results of the Maricopa County well inventory, and contacted well owners to identify groundwater wells which could be used for domestic purposes. After wells were identified, owners were contacted and those that responded were visited so that groundwater samples could be collected for VOC analyses. One well, Southwest Trail Boss, exhibited VOC concentrations greater than AWQS. TCE was detected in this well at a concentration of 6.9 micrograms per liter (µg/l), which exceeded its AWQS of 5 µg/l.

This well was previously sampled in October 1994 and neither VOCs nor chromium were detected at that time (West Van Buren Group, 1995).

1.3.2.3 Phoenix Terminal Group

The Phoenix Terminal is a petroleum storage and distribution facility located between 51st and 55th Avenues south of West Van Buren Street. Numerous releases of petroleum compounds have occurred from storage tanks and piping owned by various companies that have operated at the site (ENSR, 1988). Contamination from these releases has extended to groundwater. Groundwater monitor wells have been installed to evaluate the extent of contamination at the site. SVE systems have been used to remediate soil contamination, while skimmers have been installed to remove free product.

Ten companies that owned, operated, controlled, or had interests in petroleum facilities at the Phoenix Terminal formed the Phoenix Terminal Group in the early 1990s to work with ADEQ in resolving issues related to the soil and groundwater contamination. The original group consisted of Santa Fe Pacific Pipeline, Atlantic Richfield Co., Maricopa County, Chevron, Salt River Project (SRP), Texaco, Shell, Unocal, Powerine Oil Co., and Cal Jet Inc. The group name and membership has varied from year to year. An RI and FS have been completed by the Phoenix Terminal Group. ADEQ no longer provides oversight of Phoenix Terminal activities under the WQARF program.

1.3.2.4 Facility Histories

Reynolds Metals Co., a former aluminum extrusion facility, was located between 35th and 43rd Avenues, and between Van Buren and the Union Pacific Railroad tracks in Phoenix which encompasses approximately 320 acres of land (HydroGeoLogic, 2007a) (Appendix A). The facility was constructed at some time prior to 1946 under authority of the U.S. Government's Defense Plant Corporation as part of our country's war effort. Aluminum Corporation of America (ALCOA) operated the plant from the time of construction until 1946. Reynolds took over operational control in 1946 and remained in control through the 1980s. On October 21, 1983, all production was stopped.

Two different degreasing processes were used in the plant: Stoddard solvent and vapor recovery. The Stoddard solvent system operated from the construction date until the early 1970s. The Stoddard solvent consisted of 85 percent nonane and 15 percent trimethylbenzene. Still bottom sludge reportedly was sent to percolation ponds near the Salt River. New solvent was received by rail and stored in one of the two 25,000 gallon USTs near the still. The solvent recovery process used an enclosure that was partially filled with TCA. In 1979, Reynolds purchased 75,000 gallons of TCA to use in a vapor recovery degreasing unit. The vapor recovery degreasing unit was installed as a replacement unit for the Stoddard solvent degreasing unit in the early 1970s and used until closure of the plant in 1983. The difference between the volume of purchased TCA, and that shipped off site is between 62,600 and 72,300 gallons per year due to use, evaporation, spillage or leaking plumbing. Initial site investigations in 1988 identified chromium, petroleum hydrocarbons, and VOCs such as TCA, TCE, and PCE in soils

beneath Reynolds Metal Company property. Structures were removed from the site while the property was deeded to Reywest Development Company (Reywest), a subsidiary of Reynolds, to sell the property as subdivided parcels.

VW&R, now owned by Univar, is a chemical distribution facility located at 50 South 45th Avenue (HydroGeoLogic, 2007b) (Appendix B). The site was acquired in 1969 and in 1971 the office/warehouse was built. Prior to purchase by VW&R, the property was undeveloped farm land. Site activities are limited to the western half of the approximate nine acre site and include the warehousing, distributing, repackaging, and transporting of industrial chemicals. No development or activities have occurred on the eastern portion of the facility. Areas of operation include a waste water pretreatment system and sewer interceptor, bulk solvent tank farm, bulk corrosive tank farm, former Resource Conservation and Recovery Act (RCRA) interim status container storage unit, and office/warehouse building. The RCRA unit was used from 1982 through 1988, eventually receiving closure from ADEQ.

Maricopa County Materials Management is the current owner of the property located at 320 West Lincoln St (HydroGeoLogic, 2007c) (Appendix C). The property was formerly leased to Southwest Solvents and was formerly owned by Union Pacific Railroad; neither entity was part of the WVBG. The site is just over four acres and currently has two buildings, one approximately 76,000 square feet in size used as a warehouse, printing facility, and office space, and one building approximately 20,000 square feet used for storing county court records. The warehouse area of the main building is used primarily to store materials of a non-hazardous nature. The building was reportedly built in 1975.

Prior to purchase by Maricopa County, the property was divided into multiple lots. Previous occupants of the site included Southern Pacific Transportation Company (succeeded by Union Pacific Railroad Company), Linde Air Product Company, Arizona Public Service Company (APS), and Southwest Solvents, a cleaning solvent recycling company. Southwest Solvents operated in the northwest corner of the site for approximately ten years. In 1964, Southwest Solvents located its solvent reclaiming operation to the site and operated until its lease was terminated in 1974. Southwest Solvents initially purchased or was given spent solvent from local industrial facilities to be reclaimed. Upon distillation, Southwest Solvents sold the pure product. The company operated three stills on-site and disposed of its hazardous waste at disposal sites in California and Nevada. Spent solvent that Southwest Solvents primarily reclaimed on-site included PCE, TCE, TCA, and Freon. PCE came primarily from dry cleaning sludge and TCE from industrial customers who used the solvent to clean metal parts. The spent solvents were stored on-site in 55-gallon drums for short periods of time. Southwest Solvents had two 150-gallon stainless steel stills that were used to distill spent solvents at a rate of 55 gallons per hour. The company had a glass still that would separate solvents. After several hundred gallons of spent solvent were recycled, still-bottom sludge was cleaned out of the stills, placed in 55-gallon drums, solidified, and shipped out of state. Southwest Solvents used TCA in a drum washer machine. The machine cleaned the inside of reusable drums that were reconditioned for new solvents and redistilled products. In the late 1960s, Southwest Solvents began to accept acetone, methyl ethyl

ketone and isopropyl alcohol. In 1974, MCMM purchased the property and constructed a warehouse on the property, which housed a printing operation involving the use of multi-graphic blankwash cleaning solution and SafetyKleen cleaning solution, both containing PCE. The MCMM warehouse is located east of the former Southwest Solvents building.

APS, current owner of the adjacent eastern property at 501-505 S. 2nd Ave., once had a two-story building that held a Univac mainframe computer and accounting/treasury offices located on the eastern portion of the 320 W. Lincoln St. property. APS is conducting work under an agreement with EPA at their facility location at the western edge of the Operable Unit 3 (OU3) portion of the Motorola/52nd Street Federal Superfund site bordering the WVBA WQARF Registry site at the MCMM facility (AMEC Earth and Environmental, 2007).

Dolphin, Inc., located at 740 South 59th Avenue, is a precision metal casting facility which produces precision aviation components and custom golf club heads (HydroGeoLogic, 2007d) (Appendix D). Dolphin's manufacturing operations consisted of four main processes: wax pattern preparation, silica shell preparation, casting and cleaning and finishing. The property was first developed in 1968 by Rueter Inc. as an investment casting operation. Dolphin bought the property in 1972 and continued casting operations. Additional property purchases in 1984 and 1988 expanded the facility to its current size. The site contains eight buildings six of which were constructed specifically for Dolphin's operations. The facility includes approximately 13.5 acres consisting of five areas identified as Dolphin I, Dolphin III, Dolphin IV, Dolphin VI, and Dolphin VII. The building known as Dolphin IV was never used for manufacturing operations and was demolished several years ago. Dolphin I, Dolphin III, Dolphin VI, and Dolphin VII consist of manufacturing facilities, offices, warehouse, drum storage, vapor degreaser, and sewer interceptor. The vapor degreaser was a small unit inside one of the manufacturing buildings and was removed from the site in 1994 when Dolphin discontinued use of chlorinated solvents at the site. Two sewer interceptors were formerly used to remove solids from facility wastewater and were closed in the 1990's. Chromium is present in the steel used by Dolphin to manufacture its products while PCE and TCA were both used to degrease casting molds. PCE was among the chemicals used at the Dolphin site and had been used since the initial portion of the site was developed in 1968. PCE was dispensed from drums for use in vapor degreasing and other cleaning activities. Wax molds were cleaned by washing in aboveground dip tanks that contained solvent and rinse water. Equipment, work surfaces, and metal parts were cleaned by wipe cleaning and vapor degreasing. During 1990 and 1991, Dolphin instituted a source reduction of PCE and TCA cleaning operations by transitioning to citrus-based solvents. In September 1992, a release of liquid and sludge material occurred at Dolphin's production facility, known as Dolphin III. Analysis indicated that the release material contained PCE, TCE, 1,1-DCE, and total recoverable petroleum hydrocarbons (TRPH). PCE was limited to vapor degreasing and removal of seams from wax molds. PCE use was discontinued at the facility in 1994 and replaced with a terpene-based substance for degreasing operations. Cleaning solvents may have been present in wastewater discharged through Dolphin I's sanitary sewer pipes. In 1994, PCE was found downgradient and adjacent from the closed sewer interceptor. As of 1999, Dolphin had

four drywells on the property. Between 1992 and 2002, several investigations were conducted at the Dolphin facility to identify and characterize historical releases of hazardous substances. Those investigations identified 4 releases/source areas of hazardous substances - former drum storage areas at Dolphin I, former vapor degreaser at Dolphin I, former sewer interceptor at Dolphin III, and a liquid and sludge release at Dolphin III. Those investigations were conducted under the oversight of the hazardous waste unit at ADEQ.

ALSCo, located at 720 West Buchanan Street, is a commercial dry-cleaning operation (HydroGeoLogic, 2007e) (Appendix E). The facility is a dry cleaner/laundry that used PCE from 1956 to 1984. The site is approximately 1.5 acres with a 31,000 square foot laundry processing building and a paved parking lot. The site was operated as a Maroney's Cleaners & Laundry, Inc., from approximately 1969 to October 1979. No information regarding how Maroney's disposed of waste solvent, including any recycling efforts exist. ALSCo purchased the facility in 1979 and currently owns and operates the facility. ALSCo ceased dry cleaning operations at the site in 1995. ALSCo converted to a water wash system and operated the two dry cleaners occasionally until 1992. ADEQ has no information that ALSCo recycled its solvent at this time. ALSCo has been involved in several environmental sampling investigations at the facility.

ChemResearch Co., Inc. (CRC) is an electroplating, metal finishing, and metal parts plating company located at 1122 West Hilton Avenue, Phoenix (HydroGeoLogic, 2007f) (Appendix F). The site had consisted of four separate properties located at 1101, 1122, and 1130 West Hilton Avenue and 1120 West Watkins Street. The main plating activities are carried out at 1122 West Hilton Avenue. A laboratory and warehouse are also located at 1122 West Hilton Avenue. These two facilities occupy approximately 1.5 acres and were recently designated as one property by the City of Phoenix with the 1130 West Hilton Avenue address. The two facilities have had known releases. In 1989, CRC used an average of 208,000 pounds of PCE per year and about 14,000 pounds of chromic acid per year. CRC generated approximately 299,000 pounds of F006 sludge from the plating shop, and 49,500 lbs of F001 spent PCE and 4,500 lbs of D002 corrosive liquid containing 0.2 percent of chrome from the painting shop along with spent methyl ethyl ketone and waste paint. A 1988 inspection report documents numerous waste tanks ranging in size from 20 gallons to 10,000 gallons. According to a 1988 hazardous waste facility inspection report, there were no drywells, septic tanks, surface impoundments or injection wells reported at any of the four CRC facilities; however in 1995, two unregistered drywells were reported at CRC's leased facility located at 1120 West Watkins Street.

1122 West Hilton Avenue – Plating Shop

The plating site was first developed in 1953 when Francis Plating Company began hard chrome plating operations. CRC has conducted chrome plating in the building since 1959 and purchased the site in 1989. The following operations occurred at the property: PCE vapor degreasing, electroplating, anodizing, special processes, and wastewater treatment. Plating activities were moved from the east side of the building to the north

side in 1992 to conduct remedial activities in the east bay area. A variety of electroplating and anodizing processes occurred, which involved the use of several types of metals. Chrome plating is the most prevalent operation at this facility. CRC used PCE degreasers in this facility's operations to clean metal. Chromium and PCE have been released into the environment from this facility. CRC has undertaken remediation efforts to address the chromium contamination in the soil, and is investigating the extent or degree that chromium and PCE have contaminated soil and groundwater. Significant events at the 1122 West Hilton Ave facility included a release of 186 gallons of chromic acid to the City of Phoenix sanitary sewer in November 1984. In 1988, an unknown quantity of cyanide was released and reported to the ADEQ.

1120 West Watkins Street – Painting Shop

The 1120 West Watkins Street property had been operated by CRC for painting, and storage of waste and flammable liquids. The building was built in the early 1950's and was used as a distribution center for pool supplies, and more recently, as a location of various medical laboratories. CRC leased the property from 1979 through 1992. CRC used a portion of this facility to operate its painting operations. These operations involved the use of several paint booths and PCE degreasers. Hazardous materials and wastes have been stored on-site. The City of Phoenix has owned the property since 1996 when CRC ceased operations. The City of Phoenix currently uses it for storage and as an area to house homeless people. Test results indicated the presence of PCE in the soil at depths where the potential for groundwater contamination could exist. On March 21, 1996, ADEQ provided its evaluation of a Phase II environmental site assessment of the property. Based on the results of soil vapor and soil sampling, ADEQ determined that PCE had been released to soil and was present at a depth in the soil that suggested the potential for groundwater contamination. In an April 4, 1996 review of the Phase II environmental assessment, PCE appeared to have been released to soil at two locations. The first location was the former hazardous materials storage area and adjacent drum storage area, and the second was the former PCE vapor degreasing area.

1130 West Hilton Avenue

The 1130 West Hilton Avenue warehouse/laboratory building was built in 1951 by Lincoln A. and Virginia A. Pettinger. Business activities at this property have included cabinet making, wood molding, wood fabrication, warehousing of paper and a plastic products distribution center. In 1964, one company, ELKO, operated paint spray booths in the building. In 1983, Metal Surfaces Holding Company, an electroplating company, purchased the property and soon thereafter began leasing it to CRC. CRC purchased the property in 1989. It has been used for a variety of purposes, including chemical storage, maintenance, blasting of metal parts, and as a laboratory. As of 1988, the hazardous chemical storage area was equipped with secondary containment. For a period of time, waste material, such as spent PCE was transferred to this facility to await disposal by a waste hauler. In its 1991 response to an ADEQ questionnaire, CRC identified a variety of chemicals stored in the warehouse on the property. Chromic acid was the only chemical identified containing COC.

1101 West Hilton Avenue – Administration/Grinding Shop

The 1101 West Hilton Avenue site is currently used for office space, but past uses have included offices, laboratory, grinding shop, painting, and drum storage. This building was reportedly built in 1953 and originally occupied by Standard Printing Company. CRC leased the building in 1973 and bought the site in 1983. Chemical storage occurred at this location until this operation was moved to the 1122 West Hilton Avenue property. Painting operations occurred in this building as well until these operations were moved to the 1120 West Watkins Street Property in 1979. Painting operations at this building included the use of PCE, MEK, alcohol, and paint thinner. CRC moved its laboratory operations from this building to 1130 West Hilton Avenue in 1987.

Air Liquide America Specialty Gases LLC (ALASG) located at 301 South 45th Avenue, Phoenix is an international industrial group specializing in industrial and medical gases (HydroGeoLogic, 2007g) (Appendix G). The site contains three primary buildings: the fill plant, the acetylene plant and the former air separator unit (ASU). Other structures on the site include an office building, chemical storage enclosure, aboveground slurry tanks and cylinder cleaning racks. Cooling towers were formerly present south and east of the ASU. The first industrial operations at the 9.9 acre facility occurred in approximately 1963 when Dye Oxygen Company began industrial gas manufacturing. In 1973, Liquid Air Corporation purchased the stock of Dye Oxygen Company. Industrial gas manufacturing continued to operate under the name ALASG in 1994. The facility was operated as an air separation plant, producing liquid oxygen and nitrogen, from 1973 through August 1985. From 1987 to 1994, the company conducted cylinder hydrotest and internal cylinder cleaning operations. In 1987 acetylene manufacturing and gas repackaging operations began and remain active at the site. ALASG used TCA at the ASU to clean compressors, valves, and other equipment for oxygen service from 1973 to 1996. TCA solvent was also used as a degreaser for oxygen equipment during Dye Oxygen's operations. TCA and paint thinner were supplied to the site in 55-gallon drums. Spent TCA was disposed by evaporation until 1987 when ALASG began disposing as a hazardous waste. According to Liquid Air's June 1991 information request response, Freon-11 solvent was used as part of a vapor degreasing system in the early 1980s to clean equipment in oxygen service. The Freon-11 was recycled. Solvent which was not recycled was allowed to evaporate. Acetone was also used at the facility. A 1999 Basin & Range Site Investigation Work Plan indicated that acetone was used to stabilize acetylene gas in fill plant operations. Acetone was stored in a 600-gallon UST. Methylene chloride was used from 1973 to 1974 to clean compressors, valves, and other equipment for oxygen service. Synthetic lube oil was used from 1975 to 1985. According to a 1996 information request response, ALASG purchased 4,125 gallons of TCA for use in 1987 to 1996 and disposed of 2,610 lbs of waste TCA from 1987 to 1996. In 2004, ALASG excavated and removed two grease traps and the portion of the concrete trench that was present in the south room of the ASU.

Prudential Overall Supply (POS) located at 5102 West Roosevelt Street, Phoenix is an industrial laundry and dry cleaning operation (HydroGeoLogic, 2007h) (Appendix H).

POS has owned the property since December 3, 1980, and the first industrial operations at the POS facility occurred in approximately 1982 when laundry and dry cleaning operations began. The bulk of the facility's on-site operations have consisted of laundering and pressing uniforms, overalls, and shop towels from 1982 through the present. Dry cleaning operations began at the site in 1982 and were terminated in 1991. Included in the building are a supply room, boiler room, maintenance shop, and an automotive garage. An office is located on the south side of the building. The former dry cleaning room now contains detergent tanks, laundering supplies, and equipment. A canopy skirts the west and north side of the building, with a wastewater treatment area situated behind the canopy on the north side of the building. Aboveground process tanks are located in a containment area north of the building. A truck parking area, employee parking area, storm water retention basin, narrow strip of landscape, and unpaved vacant lot west of the retention basin are also situated on the property. Chemical and equipment deliveries are routed to the west and north side of the building.

Chemical storage has always been in the area north of the building or inside the building. PCE was used as the dry cleaning solvent during operations. The PCE was contained in a 750-gallon capacity internal tank housed in the dry cleaning machine. PCE was recycled in the dry cleaning machine to minimize waste PCE. The reported amount of PCE used and stored on-site varied dependant upon levels reported in industrial wastewater discharge surveys, hazardous materials permit applications and inspections, Tier Two emergency and hazardous chemical inventories, and hazardous waste shipping manifests. Approximately 4,800 gallons of PCE were used per year. Drums containing lint/PCE sludge were stored along the west wall in the dry cleaning room, north of the doorway until disposed of off-site. Additionally, "Safety-Clean", a solvent containing PCE, was used in a small parts washer located in POS's automotive garage. "Safety-Clean" was used from 1982 until 1997 when a water-based solvent was applied. POS had no record or knowledge of any liquid spills occurring in the dry cleaning room. POS estimates that any spill that did occur would have been less than three gallons and sopped up with soiled garments. POS is investigating the extent or degree that PCE has contaminated soil and groundwater. Three dry wells were located in the truck parking areas to drain storm water from the pavement. In 1995, the drywells were closed and converted to catch basins and a storm water retention basin was excavated and renovated in 1999 when a detergent spill occurred. The spill reportedly contained no solvents and was investigated through the excavation and sampling of soils. No VOCs were detected in soil samples collected from the retention basin.

U.S. Department of Energy (DOE) has property that consists of two separate parcels located at 615 South 43rd Avenue, Phoenix, Arizona 85009 (HydroGeoLogic, 2007i) (Appendix I). The parcel on the west side of 43rd Avenue is a substation that distributed electricity to south-central Arizona but currently is used to supply electricity to the DOE Western Area Power Administration (WAPA) Phoenix Area Office on the east side of 43rd Avenue. The parcel on the east side of 43rd Avenue is the WAPA operations and maintenance complex.

The substation has been operated by WAPA since it was constructed in 1941. The substation utilized a septic system which reportedly included two leach wells and two cesspools. These structures were not removed from the site when the substation buildings were demolished. Film processing chemicals were reportedly disposed to these structures. The complex on the east side of 43rd Avenue was originally constructed in 1951 by the Bureau of Reclamation. WAPA took over operation of the facility in 1980 with the Bureau of Reclamation still occupying the northwest corner of the property. The complex contains several buildings for conducting various activities including maintenance, storage, administrative duties, and a fueling system for facility vehicles. Five drywells have been abandoned at the site. Three of the drywells were reportedly part of a former maintenance building drainage and septic system. Six drywells are currently located at the facility. Various wastes and solvents have been stored and used at the facility including RCRA and Toxic Substances Control Act wastes, waste dielectric fluids containing PCBs, petroleum solvents, chlorinated solvents, pesticides, waste solvents, and fuels.

1.3.2.5 Recent Regulatory Efforts

As additional source information is gained through the remedial investigation efforts, ADEQ's WQARF program will continue to work with facilities to conduct investigation and clean-up efforts. ADEQ's WQARF program reviews work plans and has issued work orders on consent orders as necessary.

Reynolds. Reynolds received a No Further Action (NFA) letter for soils within 14 specific areas by ADEQ in 2000. Reynolds entered into a Consent Decree with the State of Arizona in September 2002. The Consent Decree resolved the alleged liability and potential liability of Reynolds by seeking recovery of costs, recovery for natural resource damages, injunctive relief, and declaratory judgment. Reynolds settled with ADEQ for $1,956,474 on October 2, 2002. Reynolds finished conducting operations as outlined in Section VIII of the Consent Decree and on January 6, 2006, received a letter of satisfaction of monitoring requirements. ADEQ currently samples eight groundwater monitor wells located on the Reynolds property.

VW&R. At the request of ADEQ, VW&R began conducting investigations at their facility in 1989. In 1990, VW&R and ADEQ signed a Consent Order to resolve Part A Hazardous Waste Permit Application (AHWPA) operating and record keeping issues. While the AHWPA issues were resolved, VW&R continued to conduct characterization of the facility and installed and operated SVE system. In 1996, a Consent Order for additional site work was signed by VW&R and ADEQ and terminated the 1990 Consent Order. The 1996 Consent Order stipulated that VW&R close the RCRA Interim Status Storage unit; conduct an investigation in a parking lot area; investigate the unsaturated cobble unit; continue groundwater investigation activities; and continue SVE operation. SVE operation included the submittal of quarterly SVE operation reports; radius of influence testing; and reporting. Upon completion of activities required by the 1996 Consent Order, VW&R submitted a work plan for confirmation soil sampling and upon receipt of approval conducted the confirmation soil sampling. VW&R then submitted a

Certificate of Completion for Soil Remedial Action and a Certificate of Completion for Groundwater Investigative Activities to ADEQ for review and approval. Upon reviewing the Certificates of Completion, ADEQ issued an NFA letter for soils and the 1996 Consent Order was terminated. VW&R paid ADEQ $7,711 for oversight costs incurred by the state. Currently ADEQ monitors and samples two groundwater monitor wells located at the VW&R facility.

Maricopa County. Upon completion of site characterization and soil remediation, Maricopa County and Union Pacific Railroad, one of the previous owners of the MCMM property, negotiated a settlement with ADEQ. In October 2001, Maricopa County and Union Pacific Railroad settled with ADEQ for $450,000 for ADEQ's response and oversight costs. ADEQ continues to investigate the ownership and tenant history of the facility to evaluate whether other entities may also be responsible for contamination detected at the MCMM facility. Currently, ADEQ monitors and samples three groundwater monitor wells located at the MCMM facility.

Dolphin. A RCRA Consent Decree was issued by ADEQ in January 2000. Dolphin received closure of the order in June 2006. On January 13, 2001, the WQARF Program collected $410,000 from Dolphin to be used in remedial action on the WVBA plume's threat to City of Tolleson drinking water wells. Dolphin installed three SVE systems and an air sparge system at the facility. During operation of the remediation systems, Dolphin prepared operation and maintenance plan, quarterly status reports, decommissioning plans and decommissioning reports. In April 2004, Dolphin completed rebound testing and decommissioning sampling and received ADEQ authorization for SVE shut down. On June 6, 2006, Dolphin satisfied the Consent Order and Consent Judgment which were closed. Dolphin currently samples the wells at their facility and submits semiannual reports to ADEQ.

ALSCo. Because of groundwater contamination detected in groundwater monitor wells downgradient of the ALSCo facility, ADEQ requested that an investigation be conducted at the facility to evaluate whether a release of PCE had occurred and if so to identify the extent and nature of the release. ADEQ also investigated property ownership and tenant history to evaluate whether other owners/tenants may have also contributed to contamination detected at the facility. Data obtained indicated that ALSCo and Maroney's Cleaners & Laundry, Inc. were responsible for the releases of contaminants that had occurred at the facility. In August 1997, a federal court approved a Consent Decree between ADEQ and ALSCo. ALSCo settled with ADEQ in May 1997 for $2 million. ADEQ subsequently conducted an ERA at the site and currently monitors and samples four groundwater monitor wells at the facility. No settlement agreement has been negotiated between ADEQ and Maroney's Cleaners & Laundry, Inc. ADEQ granted ALSCo an NFA determination for soil on March 24, 2008 (ADEQ, 2008).

CRC. At the request of ADEQ, CRC initiated a facility investigation in 1990 to determine if contaminants detected in groundwater within the WVBA had been released at the facility. Data collected indicated that releases had occurred at the facility. In 1994, CRC entered into a consent order with the RCRA division of ADEQ to address the

contamination. CRC has an ADEQ approved remedial action plan in-place to conduct additional soils investigation and soil remediation. Currently CRC monitors and samples groundwater monitor wells owned by CRC and ADEQ.

ALASG. Because of COCs detected in groundwater monitor wells downgradient of ALASG, ADEQ requested that ALASG conduct investigations at their facility to evaluate whether releases had occurred and fully characterize the releases. ALASG initiated investigations at their facility in 1998. In September 2007, ALASG entered into a Consent Order with ADEQ. ALASG has an approved work plan under Order of Consent to further investigate groundwater contamination at the facility. In accordance with the order, four additional groundwater monitor wells were installed at the facility during December 2007. Currently ALASG monitors and samples seven groundwater monitor wells at their facility.

DOE. During a LUST investigation at the DOE facility in 1992, COCs were detected in soil samples. Because of the presence of COCs in the soil samples and the apparent use of COCs at the facility, ADEQ requested that DOE conduct an investigation to identify the extent of COC contamination. ADEQ requested a soil investigation be completed around five disposal structures, the installation of additional groundwater monitor wells, and continued monitoring and sampling of onsite groundwater monitor wells.

POS. Because of contamination detected in groundwater monitor wells downgradient of the POS facility, ADEQ requested that an investigation be conducted at the facility to evaluate whether a release of PCE had occurred and if so to identify the extent and nature of the release, and POS entered into a Consent Order with ADEQ. POS has an approved work plan under Order of Consent to further investigate soil and groundwater contamination at the site. POS installed three groundwater monitor wells at their facility and currently monitors and samples the wells.

Industrial Surveys and Facility Investigations. ADEQ and its contractor, HydroGeoLogic, Inc. (HGL), are conducting an ongoing Potential Responsible Party (PRP) search. As per A.R.S. 49-287.04(C), the list of PRPs is not finalized until the PRAP stage of the WQARF process.

Several industrial surveys and facility investigations have been completed for the WVBA WQARF Registry site prior to and after it was added to the WQARF Registry on April 10, 1998. These investigations involved the review of records and have resulted in the identification of numerous facilities of interest for further evaluation by ADEQ. A brief summary of these investigations is found below, followed by more detailed descriptions.

A preliminary responsible party survey was conducted by the Arizona Department of Health Services (ADHS) during the area wide groundwater investigation completed by ADHS and ADWR in 1986. Results of the survey were reported in the ADWR report dated 1987. The survey covered the area bounded by 35th Avenue to the east, the Salt River to the south, 67th Avenue to the west, and McDowell Road to the north.

Two earlier investigations were conducted by ADEQ's contractor Kleinfelder in 1988 and 1989. The focus of the investigations was the West Van Buren Study Area, an area larger than, but encompassing the existing WVBA.

A series of industrial surveys were conducted on properties within the current WVBA after listing on the WQARF Registry. ADEQ's contractor Weston provided the results of its industrial survey in April 2001 and HGL completed two industrial surveys in June 2002 and a third in August 2002 involving other portions of the WQARF site. Appendix J, Figure J-1 is a map of the WVBA boundary that identifies the areas that were the subject of these investigations. Appendix J also includes two tables (Tables J-1 and J-2) that list 1686 facilities that were identified by the six industrial surveys by address and alphabetical order, respectively. Table J-3 identifies the 145 facilities currently under investigation. Below is a summary of the research methodology used for each of the investigations conducted for the WVBA and West Van Buren Study Area.

ADHS Investigation – October 1987. ADHS completed a preliminary responsible party survey within the central portion of the WVBA. The area surveyed extended from 35th Avenue west to 67th Avenue and from the Salt River north to McDowell Road. The survey identified 149 businesses that could have potentially stored, used or disposed of hazardous substances based on their Standard Identification Code (SIC). Data on the businesses was obtained by reviewing the Contracts Influential 1983 – 84 by Contacts Influential Corporation, a directory which listed commercial and industrial firms in various manners including address and SIC. The businesses were then sorted by SIC to group like businesses together. The sorting created 19 activity groups.

Kleinfelder Investigation - June 17, 1988. Kleinfelder completed a preliminary listing of facilities, wells and well locations within the WVBA. The first list included 863 facilities that potentially used, stored, produced, or disposed of chemicals, and was compiled from information found in the following resources: the Arizona Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Arizona Comprehensive Investigation and Data System (ACIDS) list; ADEQ list of USTs; ADEQ list of surface impoundments; City of Phoenix list of industrial users; Maricopa County Department of Civil Defense and Emergency Services list of facilities and agencies reporting extremely hazardous substances; Maricopa County Health Department list of septic tank users; and reports, records, and investigations available through ADEQ.

In addition, a field canvass was completed in late March 1988 to further identify facilities of interest through observations of land use and chemical storage practices. Observations such as the number of tanks, EPA identification numbers, number of employees, and business operations were included on the first list. Of the 863 facilities listed, 136 were considered "high priority facilities" that were located near areas of historical elevated chemical concentrations in groundwater or found to use chemicals based on a review of aerial photographs and field observations.

The second list identified 242 wells within the study area and was compiled from published records and the results of a well reconnaissance performed in late March 1988.

The list includes well numbers; well status such as whether the wells were active, abandoned, inactive, etc.; general observations such as the size of the well pump, whether the wells were used for irrigation or drinking water purposes; and, where available, the names or descriptions of the facilities where the wells were located.

Kleinfelder Phase I Investigation - July 1989. Kleinfelder's July 1989 "Phase I Report, West Van Buren Area" was compiled from a literature and records search to provide background information on geology, hydrogeology, and land use, and to identify potential chemical manufacturers, users, and disposers within the West Van Buren Study Area. Figure J-1 in Appendix J depicts the location of the study area.

The table below includes a list of local, state, and federal agency records that Kleinfelder reviewed for the Phase I investigation for facilities located within the West Van Buren Study Area.

Kleinfelder Records Review

Agency	Department/Type of Records
ADEQ	Groundwater quality analysis; available waste permit data; UST listings; drywell listings; previous geologic and hydrogeologic reports; compliance files; permits; list of permitted hazardous waste transporters; and CERCLA, Superfund Amendments and Reauthorization Act (SARA), and RCRA files
	Fire department incident reports regarding information about chemical users, disposers, and accidental spills
ADHS	Disease prevention studies
ADWR	Well registration, groundwater survey inventory, and well logs
Arizona State Structural Pest Control	List of certified pesticide applicators in the Phoenix area
City of Phoenix	City of Phoenix industrial waste discharge files and permits on facilities disposing waste into the sewer system
	City of Phoenix Planning Department regarding land use and zoning information
	Water well locations, construction details, and use
EPA	National Pollutant Discharge Elimination System permit list for Maricopa County
	Preliminary Assessment, RCRA, CERCLA, and SARA files
Maricopa County	Maricopa County Bureau of Air Pollution Control regarding information on facilities using volatile organic compounds; files included information on the number of degreasing units in operation and the types of chemicals utilized for degreasing operations on-site

Agency	Department/Type of Records
	Maricopa County Department of Civil Defense and Emergency Services community right-to-know filings for local industries to determine which facilities may have had activities that used the chemicals detected in groundwater within the study area
	Maricopa County Department of Public Health list of septic tank users and registered public water companies within the study area
	Maricopa County Planning Department regarding land-use and zoning information to identify the distribution of industrial and commercial property within the study area
	Maricopa County Tax Assessor regarding parcel information, subdivision maps, parcel owners, and legal addresses[1]
Maricopa County Association of Governments	Regional information pertaining to groundwater use and 1985 census data for Maricopa County
RID	Well construction, pumping schedules, and chemical analysis data for wells
Salt River Project	Well location, status, construction data, previous groundwater quality analysis, and operational history of wells within the study area
United States Geological Survey	Geological and hydrogeologic information
	Well construction, location, and water quality
United States Soil Conservation Service	Maps and publications to determine soil characteristics, such as soil texture and infiltration rates

In addition to records review, Kleinfelder analyzed historical groundwater data, and collected and analyzed groundwater and soil samples. Based on the results of records and literature searches and groundwater and soil sampling conducted as part of the Phase I investigation, Kleinfelder identified approximately 850 facilities for further study.

In July 1988, a questionnaire was mailed to the 850 facilities requesting information on chemical use and past handling practices, and the nature of facility activities. Kleinfelder received approximately 300 responses. The facilities were then evaluated by the following criteria: review of available documents and literature; observation of existing facilities and environmental practices during field reconnaissance; review of responses to the questionnaires; and an assessment of the proximity of the facilities to observed chemical concentrations in groundwater.

Weston Industrial Survey - April 18, 2001. Weston's industrial survey included a review of city directories to identify businesses located in a one-square-mile parcel within

[1] Kleinfelder recorded the parcel owner and identification information in a database if, based on observations or documented activities, the property land use was suggestive of chemical use, waste handling, or disposal.

Township 1 North, Range 2 East, Section 9 (Appendix J). The property searched was within the WVBA. Weston did not review regulatory agency records for the facilities listed in the industrial survey. Weston listed 219 addresses and three intersections in the industrial survey. Approximately 584 businesses and 31 individuals found through a review of city directories were associated with the 219 addresses and three intersections.

HGL Industrial Surveys Nos. 1, 2, and 3 - June 13, 2002 and August 27, 2002. HGL conducted three industrial surveys to identify potential source areas for PCE, TCE, TCA, DCE, and DCA contamination (HGL, 2002a, 2002b, and 2002c). The focus of the industrial surveys was to locate significant users of COC for the purpose of assisting ADEQ in its RI of the WQARF site. Although chromium is identified as a COC for the WQARF site, it was not one of the COC under investigation for the industrial surveys.

The figure in Appendix J depicts the three industrial survey boundaries. The boundary for Industrial Survey No. 1 is Township 1 North, Range 3 East, Section 6, Quarter C (Southwest); and Township 1 North, Range 3 East, Section 7, Quarter B (Northwest). The boundary for Industrial Survey No. 2 is Township 1 North, Range 3 East, Section 6, Quarter D; and Township 1 North, Range 3 East, Section 7, Quarter A. The Industrial Survey No. 3 boundary includes Sections 11 and 12 of Township 1 North, Range 2 East.

The industrial surveys were based on a review of Phoenix city directories from 1935 to 2000 to identify the address ranges within Industrial Survey Nos. 1 and 2 boundaries. For Industrial Survey No. 3, Phoenix city directories from 1935 through 2001 were reviewed.[2] Some of the properties within the designated boundaries were used for commercial or industrial purposes prior to 1935; however, it was ascertained that the use of the COC prior to 1935 was improbable based on the historical use of these chemicals. For Industrial Survey No. 3, information from the City of Phoenix Planning Department was obtained to ascertain the street ranges within the industrial survey boundary.

For Industrial Surveys Nos. 1, 2, and 3, a list of the classified business directory categories from multiple years was compiled and evaluated for businesses with a likelihood of usage of COC in their operations. Businesses with operations using COC were included in the industrial surveys.

HGL's records search consisted of reviewing ADEQ files for Industrial Surveys Nos. 1 and 2 and reviewing ADEQ, City of Phoenix, EPA, and Maricopa County files for Industrial Survey No. 3. For Industrial Survey No. 1, HGL investigated 47 addresses and about 62 businesses, and 143 addresses and about 182 businesses were investigated for Industrial Survey No. 2. For Industrial Survey No. 3, 186 addresses and about 228 businesses were investigated. Specific details about these records searches are provided below.

ADEQ Files. For Industrial Surveys Nos. 1 and 2, the following ADEQ files were reviewed for companies located within these industrial survey boundaries that used waste oil, COC, or unknown chemicals: preliminary assessment/site investigation (PA/SI) files,

[2] City directories for 1943, 1944, and 1954 were not available for review.

RCRA notification files, RCRA open and closed case files, and UST and LUST files.[3] HGL reviewed the above-mentioned ADEQ files as well as drywell files for Industrial Survey No. 3. Also for Industrial Survey No. 3, ADEQ conducted a search of the ADEQ State Permits List for information in the application and permits section of the water quality database.

City of Phoenix Files. The City of Phoenix Fire Department was contacted regarding incidents which may have occurred at addresses within the Industrial Survey No. 3 site boundary.[4] Search parameters included a list of individual addresses identified through a review of both the city directories and ADEQ files. HGL also reviewed files at the Pollution Control Division of the City of Phoenix Water Services Department to find pre-treatment violation reports for the years 1988 to 2000.[5]

EPA Files. For Industrial Survey No. 3, a CERCLA search was conducted by querying the EPA's CERCLIS via the internet. HGL reviewed the list of facilities in Phoenix, Arizona, that were included in CERCLIS to evaluate whether the listed facilities were located within the industrial survey boundary. In addition, HGL reviewed the facilities in Phoenix, Arizona, that were included in the EPA's archived sites database to ascertain which facilities were located within the industrial survey boundary. The EPA lists facilities on the archived sites database when it has completed its assessment of the property, and it has ascertained that no further steps will be taken to list that facility on the National Priorities List.

Maricopa County Files. HGL provided the Environmental Services Department of Maricopa County a list of addresses obtained through a city directory review and the corresponding legal descriptions of properties located within the Industrial Survey No. 3 boundary to request non-residential septic tank information. To obtain the legal property descriptions, the Maricopa County Assessor's website was accessed. HGL also provided the Air Quality Department of the Maricopa County Environmental Services Division a list of facility names identified through its city directory search to request information pertaining to air quality violations within the industrial survey boundary. Because air quality records only date back five years, the focus of this search was on facilities known to have operated within the past five years.

Other Searches. For Industrial Survey No. 3, HGL also queried the U.S. Department of Labor Occupational Safety and Health Act facility inspection database by entering the names of facilities identified through the city directory search. HGL also identified two aerial photographs within its document collection for the WQARF site that were inclusive of the Industrial Survey No. 3 boundary. The dates and source of the aerial photographs are unknown. An aerial photograph analysis was conducted to evaluate the presence of

[3] UST and LUST files were only reviewed for those companies that were identified as having a tank containing waste oil, solvents, or unknown chemicals.
[4] The search of City of Phoenix Fire Department records was inclusive of records dating from 1995 to 2002.
[5] Information is not maintained for the years prior to 1988.

commercial or industrial operations and to identify any evidence of environmental contamination within the industrial survey boundary.

HGL RI Support for the West Van Buren Area WQARF Site - October 2003 - January 2007. The RI Support task assignment consisted of two phases of investigation. For the initial phase, a boundary of the investigation was not established because ADEQ specifically assigned certain facilities to be investigated based on known information regarding the possible releases of COC at the facilities located within the WVBA boundary. From October 2003 to July 2005, HGL investigated 59 facilities and issued 35 facility letter reports with research findings on these facilities, including a summary of site operations and ownership. Relevant supporting documents were included in the facility letter reports for ADEQ to review while evaluating whether further investigation was necessary at the facilities. Research involved the review of ADEQ records to locate information on releases of the COC with regard to the facilities. Search parameters included company name and address, when available. Below is a list of the files and databases that were reviewed.

- Drywell Files
- Former 202 Facility Files[6]
- Hazardous Material Incident Logbook Files
- PA/SI Files
- Potentially Responsible Party (PRP) Site Files[7]
- RCRA Compliance Files
- RCRA Archived Files
- RCRA Open and Closed Case Files
- Records Information Management System (RIMS)[8]
- UST and LUST Files
- Water Quality Database/State Permits List Files
- West Van Buren WQARF Site Central File

From August 2005 to January 2007, HGL conducted the second phase of the investigation. This phase represented a more expansive search to locate facilities within the WVBA that were not previously investigated by HGL under the industrial surveys or facility investigations mentioned above (Appendix J). HGL also re-reviewed ADEQ records for facilities that were previously investigated under three HGL industrial surveys to expand its search to include chromium releases.[9] In addition, HGL investigated facilities listed in the April 18, 2001 Weston industrial survey as that industrial survey did not include the review of regulatory agency records for the facilities listed. The final

[6] The former 202 facility files consist of the West Van Buren Investigative files that were previously located at ADEQ's facility on 202 E. Earll Drive.
[7] PRP Site files for the West Van Buren, Estes Landfill, and Broadway-Pantano Landfill WQARF Registry sites were reviewed.
[8] An ADEQ database available at the ADEQ records management center that listed different file types available at the ADEQ. Files found through a review of RIMS included pollution prevention, air, oil, voluntary remediation program, emergency response, and WQARF files.
[9] Chromium was not a part of the original scope of HGL Industrial Surveys Nos. 1, 2, and 3.

aspect of this investigation included a search for facilities located within zip codes 85003, 85004, 85007, 85009, and 85043 present within the WVBA. Search results were compiled into facility letter reports.

The investigation consisted of a review of PRP site files, former 202 facility files, ADEQ records collections, and EPA records for information on releases of the WVBA COC. For facilities listed in the Weston industrial survey and HGL's three industrial surveys, HGL conducted a search of finding aids by facility name and address.[10] HGL then conducted a search of ADEQ finding aids using the five zip codes associated with the WVBA. Specifically, HGL conducted a review of finding aids for the files listed below for facilities HGL previously investigated under its three industrial surveys, facilities located within the Weston industrial survey boundary, and for facilities located within the WVBA boundary that had not been previously investigated.

- Arizona Attorney General's Office (AGO) Files[11]
- City of Phoenix Fire Department Hazardous Material Incident Files[12]
- Drywell Files
- EPA CERCLIS Database
- Former 202 Facility Files
- Hazardous Materials Incident Logbook Files
- Hazardous Waste Box Storage Files
- PA/SI Files
- PRP Site Files
- RCRA Archived Files
- RCRA Compliance Files
- RCRA Open and Closed Case Files
- Hummingbird (formerly RIMS)[13]
- UST and LUST Files
- Water Quality Database Files

Once the finding aids were reviewed, online mapping systems were used to evaluate whether the facilities were located within the WVBA. If facilities were located within the WVBA, HGL requested and reviewed available files. Another evaluation that HGL made prior to requesting files was using industrial research to evaluate whether a facility would have used the COC. If, by the facility name or other research efforts, HGL could not ascertain what chemicals a facility used, a file review was conducted.

[10] Finding aids are ADEQ and HGL indexes and databases that list available files for review.
[11] AGO files were considered secondary sources and would only be reviewed if requested by the ADEQ after its review of facility letter reports.
[12] The City of Phoenix Fire Department stated it did not have the staff to respond to a broad file request and the ADEQ decided that those records would only be reviewed if additional information was needed for a facility based on its review of the facility letter reports.
[13] A search was conducted on Hummingbird for file information on 21 of the 58 facilities that were investigated from February 3, 2004 to July 29, 2005 as Hummingbird was not available to HGL when conducting the original research of the facilities.

HGL created a Microsoft Access database that has 1,656 entries comprised of facilities and locations reviewed under HGL's three industrial surveys and RI support. These data are available in Appendix J, Tables J-1 and J-2. In addition, an assessment of relevant records was conducted and confidential facility letter reports were drafted on a facility-by facility basis with information regarding releases of COC. The 137 facilities assessed can be found in Appendix J in Table J-3.

1.4 Site Contaminants

The primary COCs comprising the commingled WVBA plume include the following VOCs: PCE, TCE, TCA, cis 1,2-DCE, 1,1-DCA, and 1,1-DCE. To a limited extent, chromium is also considered a COC. Groundwater contamination enters the WVBA from the east from the Motorola 52nd Street Federal Superfund Site OU3 area. Notable COCs for OU3 are TCE, TCA, PCE, 1,1,2-TCA, vinyl chloride, chloroethane, 1,1-DCA, 1,1-DCE, 1,2-DCA, cis 1,2-DCE, trans 1,2-DCE and 1,4-dioxane. Contaminated groundwater also appears to enter the WVBA from the north in the central portion of the site from the West Osborn Complex (WOC) WWQARF Registry Site. The current COCs in groundwater at the WOC include TCE, 1,1-DCE, and PCE.

1.5 Contaminant Sources

Reynolds Metals Co., TCA was the primary solvent used at this facility along with Stoddard Solvent. TCA, TCE, PCE, chromium, and petroleum hydrocarbons have been detected in soils beneath this facility. Areas of investigation include: anodizing area, tanks including USTs and aboveground storage tanks (ASTs), manufacturing equipment foundations, dip tanks, and distilling areas.

Van Waters & Rogers Inc. Numerous chemicals are stored and packaged at this facility. PCE, TCE, TCA, and 1,1-DCE have been detected in the soils underlying this facility. Areas of investigation include: waste water pretreatment system and sewer interceptor, bulk solvent tank farm, bulk corrosive tank farm, drum storage areas, and former Resource Conservation and Recovery Act (RCRA) interim status container storage unit.

Maricopa County Materials Management Numerous cleaning solvents were stored and recycled at this facility while the Southwest Solvents Recycling was in operation. PCE, TCE, 1,1,1-TCA, 1,1-DCE, cis & trans-1,2-DCE, and 1,1-DCA have been detected in soils underlying this facility. Areas of investigation include: Southwest Solvent Recycling facility and the parking area.

Dolphin, Inc. Solvents were used at this facility during the casting process of metals. PCE, TCE, TCA, 1,1-DCE, and 1,1-DCA have been detected in soils beneath this facility. Area of concern include: septic system, interceptor tanks, degreasing/parts cleaning areas, acid etching building, drum storage areas, and drywell.

American Linen Supply Co. PCE was used at this facility as part of dry cleaning operations. PCE, TCE, benzene, and TCA have been detected in soils beneath this facility. Areas of investigation include: waste water disposal areas and dry cleaning machine locations.

ChemResearch Co., Inc. PCE and metals processing chemicals associated with metal plating and finishing were used at this facility. PCE, TCE, 1,1-DCE, 1,2-dichlorobenzene, cadmium, chromium, and lead have been detected in the soils underlying this facility. Areas of investigation include: plating areas, UST, and waste water treatment plant.

Air Liquide America Specialty Gases LLC Solvents used at this facility have included TCA, paint thinner, acetone, and Freon-11. PCE, TCE, TCA, and 1,1-DCE have been detected in soils beneath this facility. Area of concern includes: the grease trap and associated piping.

Prudential Overall Supply PCE was used at this facility as part of dry cleaning operations. The cleaning solvent Safety Clean was also used at this facility for maintenance purposes. PCE and TCE have been detected in soils beneath the facility. Areas of investigation include: dry cleaning area, waste water flume, and parts cleaning area.

U.S. Department of Energy Petroleum based solvents, chlorinated based solvents, and various types of wastes have been used/stored at this facility. PCE, TCE, 1,1-DCE, cis-1,2-DCE, and 1,1-DCA have been detected in soils underlying the facility. Area of concern includes the Craneway building.

1.6 Physiography

The WVBA extends from 7th Avenue to 75th Avenue and from Buckeye Road to Interstate 10. This corresponds to an area approximately eight miles in length and 1.5 miles in width (approximately 12 square miles). In addition, a finger shaped plume exists between 7th and 27th Avenues between Buckeye and Lower Buckeye Roads. The WVBA covers portions of two U.S. Geological Survey topographic quadrangles; Fowler and Phoenix, Arizona (Figure 1-1).

The highest elevation in the WVBA is 1,082 feet above mean sea level (msl) at 7th and Grand Avenues, and the lowest elevation is 1024 feet above msl at 75th Avenue and Buckeye Road. There is a gentle (10 to 15 feet per mile) southwestern topographic gradient towards the Salt River. Two east-west and one north-south trending man-made features break up the topography within the WVBA. The east-west trending features are the railroad tracks located mid-way between Van Buren Street and Buckeye Road, and the bermed RID canal which originates at 19th Avenue south of Interstate 17. The RID canal flows westward south of Buckeye Road to 67th Avenue, and then zigzags northwesterly to 75th Avenue north of the railroad tracks where it egresses from the

WVBA. The north-south trending feature is Interstate 17, which is depressed through the WVBA adjacent to 23rd Avenue.

The WVBA is largely urbanized, particularly in the eastern and central portions. Irrigated agricultural fields are located to the west, but are increasingly becoming developed, particularly by large warehouse structures.

1.7 Meteorology

The climate of the Phoenix area is semi-arid, with hot summers and mild winters. Daytime high temperatures in July average between 100 and 110 degrees Fahrenheit (F), with nighttime low temperatures between 70 and 80 degrees F. Daytime high temperatures in January average between 65 and 70 degrees F, with nighttime low temperatures between 35 and 40 degrees F. Most of the area has an average annual frost-free period of between 210 and 280 days.

Precipitation averages between 7 and 8 inches per year; most of this occurs from thunderstorms associated with the summer monsoon (July through September), with the remainder generally occurring during the winter (December through March). Most of the precipitation evaporates, with evaporation rates varying between about 65 to 75 inches per year.

1.8 Surface Water Features

1.8.1 Salt River

The west-flowing Salt River is located south of the site along its entire length. Treated effluent from the City of Phoenix 23rd Avenue wastewater treatment facility is discharged into the Salt River bed under an EPA-issued National Pollution Discharge Elimination System (NPDES) permit and into the RID canal. Additionally, during periods of heavy regional precipitation, upstream dam releases and local runoff result in additional surface water flow. When upstream dam releases occur, the Salt River acts as a source of groundwater recharge, raising water levels and altering the direction of groundwater flow. This is discussed further in Section 3.3.

1.8.2 RID Canal System

The RID canal originates at 19th Avenue south of Interstate 17. Year-round discharge of water into the canal occurs at the COP 23rd Avenue wastewater treatment facility where 30,000 acre-feet per year of treated wastewater is discharged into the canal (BE&K/ Terranext, 2001c). Water within the canal is utilized for non-potable agricultural purposes. The canal is also fed by a number of RID production wells located throughout the WVBA; these wells discharge an additional 135,000 acre-feet per year of pumped groundwater into the canal. The wells pump during the warmer months of the year, are dormant during the winter (with the exception of a few wells which are pumped during the entire year), and either discharge directly into the canal, or discharge into both

exposed and unexposed lateral canals that feed the main canal. When the RID wells are pumping, they act as a source of groundwater discharge, lowering water levels and altering the direction of groundwater flow. This is discussed further in Section 3.3.

1.8.3 SRP Lateral Canals

SRP's Grand Canal trends east-west north of the WVBA. Oriented north-south from the Grand Canal, at approximate 0.5 mile intervals, are open and piped lateral canals that transport water by gravity flow southwards. These lateral canals are located from 19th Avenue westward beyond 83rd Avenue. Water within the lateral canals is utilized for non-potable agricultural purposes. The lateral canals are also fed by a number of SRP production wells located in areas surrounding the WVBA; no SRP wells are located within the WVBA.

1.9 Hydrogeologic Setting

The WVBA is located within the West Salt River Valley (SRV), an alluvial basin consisting of basin-fill deposits of unconsolidated to semi-consolidated Late Tertiary to Quaternary sediments (Weston, 2000). They range up to several thousand feet thick within the center of the basin and consist of interbedded cobbles, gravel, sand, silt, clay, and evaporites. The rocks that form the bounding mountains and valley floor of the SRV are predominantly crystalline rocks. The basin-fill deposits are subdivided into three hydrogeologic units that comprise the regional aquifer in the SRV. In ascending order, they are the Lower Alluvial Unit (LAU), Middle Alluvial Unit (MAU) and the Upper Alluvial Unit (UAU).

The LAU consists mainly of conglomerate and gravel grading into finer-grained mudstones toward the center of the basin and locally contains volcanic rocks. The LAU does not appear to be contaminated within the WVBA. The MAU overlies the LAU and consists predominantly of silt and clay with interbedded sand and gravel lenses. The UAU extends from the ground surface to the top of the MAU. The UAU consists mainly of unconsolidated silt, sand, and gravel deposited during the final stages of SRV basin development.

Groundwater occurs in the basin-fill deposits through out most of the SRV (Hammett and Herther, 1995). The three major units, the UAU, MAU and LAU, contain measurable quantities of water. However, this water is stored and moves under different regimes for the UAU and the two deeper layers. Water in the UAU is unconfined. According to Weston (2000), the MAU and LAU are both confined. Groundwater movement is generally to groundwater depressions located across the SRV which are created by extensive groundwater withdrawals (Hammett and Herther, 1995). Where groundwater flow is not affected by excessive pumping, flow is generally to the west.

As mentioned above, the Salt River is the largest surface drainage feature in the vicinity of the SRV. Although dry during most of the year, winter and early spring precipitation combined with runoff from melting snow from the upper watershed can produce runoff.

These events, although short in duration, contribute significant groundwater recharge. As a result of this flow, water levels rose dramatically in wells within several hundred feet of the river.

1.10 Ecology

The WVBA is located just west of downtown Phoenix, and thus, comprises an urban environment. This reduces the potential for unique flora/fauna or endangered species or their habitats in the area. Neither are there sensitive environments such as wildlife breeding areas, wildlife refuges, or specially designated areas such as wild and scenic rivers, or national parks. Because contamination is present at depth below ground surface, there is little to no threat to flora/fauna, species or habitats.

The RID canal has been identified as wetlands (U.S. Fish and Wildlife Service, 1989). Specifically, the RID canal is classified as a riverine, lower perennial, unconsolidated bottom, permanently flooded excavation.

According to the Federal Emergency Management Agency (2005), portions of the WVBA are located within a 100 year floodplain (floodplain). In the eastern portion of the WVBA, Interstate 17 from approximately Roosevelt Street to Buckeye Road lies within the floodplain due to its subgrade construction. Additionally an area bound by approximately Interstate 17 and 17th Avenue is also located within the floodplain; this area was the former location of Cave Creek Wash prior to urbanization.

Portions of the western end of the WVBA are also located in the floodplain. At approximately 69th Avenue and Sherman Street, the RID canal bends 90 degrees to the north. The bermed canal at this location has created a floodplain within an adjacent agricultural field. Another floodplain is located within undeveloped property north of the railroad tracks between 69th and 75th Avenues, and was created by the raised railroad tracks. An additional floodplain is located within a storm water retention basin constructed at the southeast corner of 75th Avenue and Van Buren Street.

2.0 PREVIOUS INVESTIGATIONS

COCs for the WVBA are identified as PCE, TCE, TCA, cis 1,2-DCE, 1,1-DCA, 1,1-DCE, and to a limited extent, chromium. Contaminant sources have been investigated/documented throughout the WVBA. COCs have been detected in soil, soil gas, and groundwater at the following facilities: Reynolds, VW&R, MCMM, Dolphin, ALSCo, POS, DOE, CRC, and ALASG.

Regulatory standards that these contaminants have been/are compared to include HBGLs implemented by ADEQ in 1992, SRLs implemented by ADEQ in December 1997 and revised in May 2007, GPLs implemented by ADEQ in September 1996, EPA MCLs promulgated in 1987, and AWQSs implemented by ADEQ in September 1996. Regulatory standards applicable for each facility are dependant upon when the facility was fully characterized. The most recent version of the SRLs will be applicable to facilities which have not been fully characterized by 2007 or remediated by 2010. The following table lists the standards established for WVBA COC:

					Original SRLs		Revised SRLs			
Contaminant of Concern	MCL (µg/l)	AWQS (µg/l)	HBGL (mg/kg)	GPL (mg/kg)	Residential SRL (mg/kg)	Non Residential SRL (mg/kg)	Residential SRL (mg/kg)			Non Residential SRL (mg/kg)
							10^{-6} Risk	10^{-5} Risk	Non-carcinogen	
PCE	5.0	5.0	27	1.3	53	170	0.51	5.1	NE	13
TCE	5.0	5.0	120	0.61	27	70	3.0	30	17	65
TCA	200	200	3,300	1.0	1,200	4,800	NE	NE	1,200	1,200
Cis 1,2-DCE	70	70	1,200	4.9	31	100	NE	NE	43	150
1,1-DCA	NE	NE	NE	NE	500	500	NE	NE	510	1,700
1,1-DCE	7.0	7.0	110	0.81	0.36	0.8	NE	NE	120	410
1,2-DCA	5.0	5.0	15	0.21	2.5	5.5	0.28	2.8	NE	6.0
Chromium Total	100	100	1,700	590	2,100	4,500	NE	NE	NE	NE
Chromium III	NE	NE	NE	590	77,000	1,000,000	NE	NE	120,000	1,000,000
Chromium VI	NE	NE	NE	590	30	64	30	NA	NE	65

SRLs: Soil Remediation Levels MCL: Maximum Contaminant level AWQS: Aquifer Water Quality Standard HBGL: Health Based Guidance Level GPL: Groundwater Protection Level NE: Not Established µg/l: Micrograms per Liter Mg/kg: Milligrams per kilogram

Numerous groundwater and soil investigations have been conducted within the WVBA. Initial groundwater sampling was conducted by ADWR and ADHS personnel in May 1986 after groundwater contamination by halogenated VOCs was detected at the Chevron fuel storage facility at the Phoenix Terminal (Arizona Department of Water Resources, 1987). Groundwater samples were collected from 12 wells resulting in the detection of groundwater contamination at seven of the well locations. This prompted the initiation of numerous investigations to identify sources of the contamination and characterize the groundwater contamination. Initial soil sampling was conducted

by ADEQ's contractor, Kleinfelder, during September 1988 (Kleinfelder, 1989). Soil sampling was conducted at 17 sites during this first phase of investigation which included areas where land use could not be confirmed, aerial photographs indicated the possible presence of stained soils at chemical storage facilities, in areas where groundwater quality data indicated contamination, and at areas inspected during field reconnaissance. TCA and/or TCE were detected at 16 of the 17 sites. These two compounds were also detected in the two background soil samples collected during this phase of investigation. The TCE concentration detected in one of the background soil samples was greater than the TCE concentrations detected at various facilities. Also, the TCA concentration detected in one of the background soil samples was greater than all but five of the soil sample TCA concentrations detected at various facilities. Xylenes were detected in soil samples collected from seven of the sites and toluene was detected in two soil samples.

Based on the results of the Phase I investigation, six facilities, were recommended for physical testing, 38 were recommended for site inspections, 99 were recommended for record searches, and 63 were recommended for additional questionnaires (Kleinfelder, 1989). As ADEQ investigated the recommended facilities, Kleinfelder, on behalf of ADEQ, conducted four rounds of groundwater sampling from November 1989 to May 1991 and installed four groundwater monitor wells as part of a Phase II investigation (Kleinfelder, 1992a). Based on data obtained during this phase of investigation, continued groundwater monitoring, characterization of the aquifer, contaminant transport modeling, and installation of additional groundwater monitor wells were recommended. These activities were undertaken by ADEQ and select facilities located within the WVBA.

As previously mentioned, based on the results of the Phase I soil sampling, six facilities were recommended for additional physical testing at their individual facilities. Five of the six facilities conducted investigations with ADEQ oversight. Of these five, three conducted soil investigations that indicated the need to also conduct groundwater investigations and two facilities did not require additional investigation.

Facilities of interest that conducted investigations within the WVBA were required to follow the remedy selection rules which outline the requirements for completing an RI. As the ADEQ led RI continues ADEQ conducts the PRP search. A PRP list will be provided once ARS 287.04 Notices are issued after the PRAP is issued for public comment. The PRP search information remains confidential until the allocation process at the site is completed.

2.1 Facilities Not Required To Investigate Groundwater

Additional facilities were investigated by ADEQ or were asked by ADEQ to conduct investigational work to evaluate whether soil contamination at their facilities exacerbated site-wide groundwater contamination. Data and reports resulting from the investigations can be found within the WVBA public file held at ADEQ. The following facilities (Figure 2-1) conducted investigational soil and/or soil gas work as requested; however, these facilities were not required to conduct further groundwater investigations or requested investigations were not completed:

1. American National Can Co., 211 N. 51st Ave. – COCs detected in soils but did not appear to reach groundwater. Aquifer Protection Permit No. P-102508

dated 10/3/94 issued a drywell clean closure for American National Can Co. UST Section issued Case Closure letter for UST release on 4/18/95. ADEQ letter to EPA dated Nov. 16, 1999 recommended no further action under CERCLA.

2. Anderson Clayton/Western Cotton Services Co., 615 S 51st Ave – TCE detected in soil sample collected during Phase I investigation but at concentration less than background sample. Onsite industrial well sample contained no COCs, however, no COCs were identified as used at facility. PASI report dated 3/21/90 indicated no need for additional investigation.
3. Arizona Parts Master, 15 N. 57th Dr. – Contamination found at the facility was from petroleum hydrocarbons. Not investigated under WQARF program.
4. Arnold Corporation, 40 S. 45th Ave – COCs detected in soils during investigations conducted at site. Risk assessment completed following ADHS comments. No closure letter issued by ADEQ. Letter from ADEQ dated October 18, 1991 stated that discharges from Arnold unlikely to have resulted in groundwater contamination.
5. AT&T, 505 N.51st Ave – COCs detected in soils during investigations. ADEQ notified AT&T considered closed in a letter dated 6/19/1996.
6. AWECO, 3918 W. Lincoln St. – No COCs documented in release. No closure letter issued by ADEQ.
7. BC Assemblage, 333 N. Black Canyon Highway – During a preliminary site assessment, soils were sampled and analyzed for pesticides, herbicides, PCBs, and petroleum hydrocarbons; ADEQ requested copies of report. Not sampled for WVBA COCs. No letter issued.
8. Blue Circle West, 1510 W. Lincoln St. – No COCs were detected in soil sample collected during Phase I investigation.
9. Brake Supply, 420 S. 7th Ave – PCE & TCE detected in soils but preliminary site investigation report prepared by Roy F. Weston, Inc. on behalf of ADEQ dated 4/15/93 recommended that further investigation was not warranted. ADEQ Internal Memo dated 5/17/93 was in agreement.
10. Bud's Oil, 1340 W. Lincoln St – COCs detected in soil samples but limited in depth. No apparent affect on groundwater. ADEQ issued letter dated 10/12/89 stating that ADEQ does not intend to initiate further evaluations at the facility.
11. Chevron, U.S.A., Inc., 3050 S. 19th Ave. – TCA and TCE detected at concentrations slightly greater than detection limits in soil sample collected during Phase I investigation but less than concentrations detected in background samples.
12. CoStar Corp/Data Packaging Corp, 425 S. 67th Ave – Investigated soil release at oil separator and at drywell where contaminated soil was excavated to 25 feet below ground surface (bgs). Soil remediation confirmed and groundwater monitor wells requested by ADEQ in letter dated 9/9/93 but were never completed.
13. Grow Group, Inc. 4940 W. Jefferson St. – During a preliminary site assessment, soils were sampled and analyzed for pesticides, herbicides, PCBs,

and petroleum hydrocarbons, ADEQ requested copies of report. Not sampled for WVBA COCs.

14. Hi-Tech Plating, Inc., 4313 W. Van Buren St. – PCE & TCE detected in drywell. Investigated area adjacent to and below the drywell but found no VOCs in soil or groundwater. No letter issued by ADEQ.
15. Jacquay's Equipment Co., 1219 S. 19th Ave. – Recommended for physical testing in Kleinfelder Phase I report but no record of testing in file. No letter from ADEQ.
16. Joe's Diesel Repair, 6316 W. Van Buren St. – TCA and TCE detected at concentrations slightly greater than the detection limits in soil sample collected during Phase I investigation but less than concentrations detected in background samples.
17. LaSalle Draperies, 710 W. Buchanan St. – PCE and TCE detected in soil gas but not soil samples. Tom Curry, former ADEQ project manager for WVBA, telephone record dated 7/30/92 indicated that additional sampling could result in issuing a no action letter.
18. Research Chemicals, 8220 W. Harrison St., Tolleson – TCA and TCE detected at concentrations slightly greater than the detection limits in soil sample collected during Phase I investigation but less than concentrations detected in background samples. Investigated/operated under RCRA according to facility permit.
19. Owens-Corning Fiberglass Corp., 1880 W. Fillmore St. – Submitted preliminary site assessment report as part of questionnaire request response to ADEQ. ADEQ letter dated February 9, 1990 stated that the facility was not considered for further evaluations.
20. Penn Athletic, 306 S. 45th Ave – Conducted soil investigations associated with UST release which indicated that no COCs released. Preliminary assessment report by ADEQ 6/18/90 recommended no further action under CERCLA. ADEQ Voluntary Remediation Program issued a NFA letter dated 6/4/02.
21. Petco, Inc., W. Side of 67th Ave. N. of railroad – TCA and TCE detected at concentrations slightly greater than the detection limits in soil sample collected during Phase I investigation but less than concentrations detected in background samples.
22. Unocal, 10 S. 51st Ave. – PCE detected in soil samples collected from property leased from Santa Fe Pacific Pipeline Partners, L.P. Soil data collected by Brown and Caldwell (1990a & b) and Levine Fricke (1994), and groundwater data collected from groundwater monitor wells upgradient and downgradient of the area indicate that COC concentrations are similar, possibly indicating that the release did not affect groundwater quality.
23. Ray & Bob's Truck Salvage, 101 S. 35th Ave. – TCA and TCE detected at concentrations slightly greater than the detection limits in soil sample collected during Phase I investigation but less than concentrations detected in background samples.
24. Revlon, 4301 W Buckeye Rd – Conducted soil sampling and soil remediation for releases of contaminants other than WVBA COCs. ADEQ Preliminary Assessment dated 2/28/90 recommended no further action under CERCLA.

Following additional investigations, ADEQ issued a letter dated 2/21/01; no further testing will be required if Revlon provided a revised report addendum.

25. Roadway Express, 2021 S. 51st Ave. – TCE detected at concentration slightly greater than the detection limit in soil sample collected during Phase I investigation but less than concentration detected in background samples.
26. Salesco Systems/Turken Industrial Properties, 5736 W. Jefferson St. – COCs detected in drywell sludge. ADEQ requested that full extent of drywell contamination be investigated in a letter dated 2/19/92 but no information in the file indicating that it was completed.
27. Santa Fe Railroad Yard, W. of 19th Ave. between McDowell Rd. and Fillmore St. – TCA and TCE detected at concentrations slightly greater than the detection limits in soil sample collected during Phase I investigation but less than concentrations detected in background samples.
28. Schuff Steel, 4420 S. 19th Ave. – TCA and TCE detected at concentrations slightly greater than the detection limits in soil sample collected during Phase I investigation but less than concentrations detected in background samples.
29. Seaport Petroleum, 57 N. 57th Ave. – Contamination found at the facility was from petroleum hydrocarbons. Not under WQARF jurisdiction.
30. Smithey Recycling Co., 3640 S. 35th Ave. – TCA and TCE detected at concentrations slightly greater than the detection limits in soil sample collected during Phase I investigation but less than concentrations detected in background samples.
31. Southwest Feed & Seed, 350 S. 75th Ave. – TCA and TCE detected at concentrations slightly greater than the detection limits in soil sample collected during Phase I investigation but less than concentrations detected in background samples.
32. Sta-Rite Industries, Inc., 1146 W. Hilton St. – Had a release of PCE to soil. Excavated contaminated soil. No response by ADEQ.
33. Sun State Builders, 43rd Ave/Gibson Lane – Soil sampling did not detect COCs. ADEQ issued letter stating not considered PRP dated 6/24/88.
34. Transco Lines, 3839 W. Buckeye Rd. – TCA and TCE detected at concentrations slightly greater than the detection limits in soil sample collected during Phase I investigation but less than concentrations detected in background samples.
35. Triple E Properties, 1909 W. Fillmore St. – Investigated release of petroleum hydrocarbons from aboveground storage tank. ADEQ letter dated October 21, 1991 stated that the facility was not considered for further evaluation.
36. Tritech Manufacturing, Inc./Tri-Star Quality Metal Finishing, Inc., 5144 W McKinley St – Sampling around drywell indicated no COCs present in subsurface. ADEQ installed well upgradient on site is higher in VOCs than downgradient wells.
37. Western States Petroleum, Inc., 450 S. 15th Ave. – Facility submitted a workplan to do soil sampling but no sampling data are contained in file. Two USTs were removed from the facility and ADEQ issued a letter dated 12/29/93 stating that the case was closed because no release of regulated substances had occurred from the USTs.

38. Phoenix Vegetable Distribution, S. Side of Buckeye Rd. E. of 83rd Ave. – TCE detected at concentration slightly greater than the detection limit in soil sample collected during Phase I investigation but less than concentrations detected in background samples.
39. World Resources Co., 8113 W. Sherman St. – TCA and TCE detected at concentrations slightly greater than the detection limits in soil sample collected during Phase I investigation but less than concentrations detected in background samples. Investigated/operated under RCRA according to facility permit.

2.2 ADEQ Area Wide Investigations

2.2.1 Activities from 1986-1998

Initial groundwater sampling was conducted by ADWR and ADHS personnel in May 1986 (Arizona Department of Water Resources, 1987). After the creation of the WVBA WQARF site in 1987, ADEQ retained Kleinfelder as their contractor to perform site investigations. A Phase I investigation was conducted in 1988 and reported in July 1989 (Kleinfelder, 1989). The Phase I included an assessment of existing information from record reviews, questionnaires, field reconnaissance (including historical water data) and sampling. This was followed by a 1991 Phase II groundwater investigation and sampling report (Kleinfelder, 1992a).

During 1991 through 1998, ADEQ continued site characterization activities, and its contractors installed and sampled monitor wells within the WVBA. The following lists ADEQ contractor, year monitor wells were installed, and monitor well designation from 1991 - 1998:

<u>Kleinfelder (8 wells)</u>
- 1991: AVB10-01 through AVB10-04, AVB12-01, AVB14-01, AVB18-01, and AVB22-01

<u>Weston (14 wells)</u>
- 1992: AVB34-01, AVB35-01 and AVB38-01 through AVB38-04
- 1993: AVB42-01 through AVB42-03, AVB46-01, AVB47-01, and AVB57-01
- 1994: AVB60-01 and AVB61-01

<u>Fluor Daniel GTI (6 wells)</u>
- 1997-98: AVB69-01 and 02, and AVB77-01 through AVB77-04

<u>GEC (7 wells)</u>
- 1998: AVB70-01, AVB71-01, AVB72-01, AVB73-01, AVB74-01, AVB75-01 and AVB76-01

ADEQ also gained access to several current and former LUST site, private, and industrial monitor wells throughout the project timeframe. ADEQ currently utilizes the "AVB" designation followed by the facility identification number (location-specific) and site identification number (well-specific) to identify monitoring well and groundwater samples.

Two well inventories were conducted during this time frame in an attempt to identify groundwater wells located within and adjacent to the WVBA. These surveys were conducted by ADEQ contractors Kleinfelder and Weston. Information obtained from the surveys was used to identify wells for collecting groundwater samples and for lithologic interpretation.

2.2.1.1 Kleinfelder Inventory

ADEQ's former contractor, Kleinfelder, Inc., conducted a review of groundwater wells located within and adjacent to the WVBA as part of the original WVBA investigation (Kleinfelder, 1992b). The inventory contained well information obtained from ADWR, RID, reports submitted to ADEQ by various consultants, and from information Kleinfelder personnel obtained in the field. The report identified 510 wells potentially existing within and adjacent to the WVBA. Of these, 295 were verified by Kleinfelder personnel.

2.2.1.2 Weston Inventory/Model Preparation

Roy F. Weston, Inc. reviewed records at ADWR, files at ADEQ, and data from consultants to identify groundwater wells in the vicinity of the WVBA as part of the development of a transient groundwater flow model for the Central Phoenix area (Weston, 2000). Information obtained from this well inventory was used to identify lithologic characteristics, well completions, and pumping information. This inventory included wells a considerable distance from the WVBA because the model covered a much larger portion of Phoenix.

Concurrent with the well inventory, Weston developed a Phase I database followed by a conceptual model. Weston developed a five-layer model with seasonal stress periods as a final end product. Modeling activities are described in further detail in Section 5.2.2 of this report and in the June 9, 2000 Weston report "Central Phoenix Groundwater Model".

2.2.2 Activities from 1999-Current

ADEQ retained Terranext (then BE&K/Terranext) in 1999 to perform RI activities. Terranext developed project plans (BE&K/Terranext, 2000a, b, and c) and initiated the following ongoing site characterization activities:

- Well inventory - BE&K/Terranext performed a well inventory to identify existing wells registered with ADWR. The well inventory assists ADEQ in complying with ARS § 49-282.06(B)(4)(b), which indicates that selected remedial actions must address any well that would produce water that is not fit for its current or reasonably foreseeable use. BE&K/Terranext identified locations and uses of wells in the WVBA by reviewing ADWR's well registry database (BE&K/Terranext 2000d). The boundaries of the inventory were 7th and 91st Avenues on the east and west, respectively, and McDowell and Lower Buckeye Roads on the north and south, respectively. This information was used to identify groundwater wells which may be located in the WVBA whose uses could be affected by the degradation of water quality. This inventory identified 971 wells between 7th and 91st Avenues, and McDowell and Lower Buckeye Roads. Of these, over 160 wells were

identified as production wells. Based on current WVBA boundaries, slightly less than half of the wells are located within the WVBA which could be affected by groundwater quality degradation. Half of these wells had a water use listed as irrigation. The remainder had water uses listed as domestic, municipal, or industrial, however, no municipal wells are currently operable in the WVBA.

- Monitor well installation - Since early 2001, ADEQ initiated eight rounds of monitor well installation by Terranext within the WVBA:

  - Early 2001 (9 wells): AVB81-01 through AVB88-01 (BE&K/Terranext, 2001a)
  - December 2001 and March 2002 (14 wells): AVB91-01 through AVB100-01 (BE&K/Terranext, 2002a)
  - Spring 2003 (9 Wells): AVB115-01 through AVB122-02 (BE&K/Terranext 2003a)
  - Spring 2004 (10 Wells): AVB116-02 and AVB122-03 through AVB125-01 and AVB127-01 through AVB130-01 (Terranext, 2004a)
  - May 2005 and October 2005 (5 wells): AVB124-02, AVB131-01, AVB133-01, AVB132-01 and 02 (Terranext, 2005a)
  - Spring 2006 (7 Wells): AVB126-01 and –02, AVB134-01 and –02, and AVB135-01 through 137-01 (Terranext, 2006a)
  - Spring 2007 (6 wells): AVB82-02, AVB91-03, AVB121-02, AVB126-03, AVB139-01, and AVB141-01 (Terranext, 2007)
  - Spring 2008 (2 wells): AVB140-01 And AVB142-01 (Terranext, 2008a)

- Water-level measurements – water levels have been measured on a monthly, quarterly, or semi-annually basis since 2000. Monitor wells, either newly constructed by ADEQ or constructed by other parties which ADEQ has gained access, have been added to the WVBA monitor well network over time. Water-level monitoring reports (up to first quarter 2002) and semi-annual water quality reports (post first quarter 2002) contain the collected water level data.

- Groundwater sampling – groundwater sample collection occurs semi-annually within the WVBA monitor well network. BE&K/Terranext's initial sampling event occurred during second quarter 2000 followed by another event during first quarter 2001. Currently, collection of groundwater samples occurs during the first and third quarters of each calendar year. Along with the results of the sampling, water quality reports contain water level data and maps, sampling procedures, laboratory analyses and quality assurance/quality control verification.

- Map preparation - BE&K/Terranext prepared water level and COC concentration contour maps covering the period 1993 through 1999 utilizing data collected from ADEQ wells and wells installed during site investigations by facilities identified in Section 1.3.2 (BE&K/Terranext, 2000e). Specific contaminant concentrations mapped consisted of PCE, TCE, 1,1-DCE, and chromium. These maps were prepared for two aquifers identified as the upper alluvial aquifer (UAU) and the middle alluvial aquifer (MAU). A primary objective of the preparation of these maps was to aid in site characterization of the groundwater plume. Terranext continued with contouring efforts for the 2000 through 2003 time period

(Terranext, 2005b). Prepared maps include contours for the contaminants PCE, TCE, 1,1-DCE, and total chromium. These maps were prepared for aquifers identified as the upper portion of the UAU (UAU1), lower portion of the UAU (UAU2), and the upper portion of the MAU. Section 4.1 of this report further discusses this effort.

As new wells were installed, some existing wells required abandonment due to changes by landowners who made changes to the land use. Abandonment was performed in accordance with ADWR requirements, and included monitor wells AVB10-03 and –04, AVB22-01, AVB38-01, AVB38-02, AVB38-03, AVB46-01, and AVB78-01. Figures 2-2 through 2-5 show locations of wells within the WVBA**.** Table 2-1 details construction information and wellhead elevations of currently and previously monitored wells.

In addition to the above activities performed by Terranext, ADWR conducted a review of their database, ADEQ files, and conducted field surveys to identify groundwater wells within and adjacent to the WVBA (ADWR 2005). Information from this survey was used to identify duplicates in the ADEQ database and identify private wells for sampling. The data were submitted to ADEQ in database format for incorporation into the ADEQ database in September 2005. Twenty-nine domestic wells were identified in or near the WVBA; of these, five are located within the WVBA and provide groundwater for domestic use. In order to gain access to domestic wells, ADEQ attempted to contact domestic well owners through certified letters and residential visits. ADEQ was able to gain access to four domestic wells for sampling; ADEQ was not able to obtain access to the fifth well. No VOCs (EPA Method 8260B) were detected in any of the groundwater samples collected from the four domestic wells; results and detection limits ranged from <0.50 µg/l to <20 µg/l and are provided in Terranext, 2006b.

2.2.2.1 Land and Water Use Study

Pursuant to A.A.C. R18-16-406(D) a Land and Water Use Study was prepared for the WVBA. The report was issued in draft form on October 31, 2001. Terranext gathered information on current and foreseeable land and water usage through interviews, City of Phoenix General Plan maps, ADWR well database, aerial photographs, facility reports submitted to ADEQ and zoning maps from the City of Phoenix, City of Tolleson, and Maricopa County.

Land use within the WVBA is predominantly zoned industrial with smaller tracts of residential and commercial. Water uses for production wells located in the WVBA include domestic, industrial, irrigation, utility, commercial, stock, test and municipal. Canal and surface water can be found within the RID and SRP canal systems, respectively. RID and SRP currently provide their members with water for agricultural irrigation.

Updates since 2001 were obtained through researching current information and issuing a questionnaire to stakeholders within the WQARF site. Two different questionnaires were developed for stakeholders. One focused on property owners within the WVBA and one focused on Municipalities/Utilities. A final Land and Water Use Study can be found in Appendix K along with sample questionnaires. A total of 57 questionnaires were mailed and of these, 25 were completed and returned. Following lists the company/facility name or address of those whom returned the questionnaire :

- 710 W. Buchanan
- 5727 W. Van Buren
- 6510 W. Buckeye Road
- 7300 W. Van Buren
- Action Fabricating of Arizona
- ALASG
- Americold Logistics
- Arizona Public Service
- BP West Coast Products/ARCO
- Caljet Monroe I
- City of Phoenix
- CRC
- DOE
- Dolphin.
- HEAD/Penn Racquet Sports
- LA/Yuma Freight Lines
- MCMM
- POS
- RID
- Salt River Project (SRP) Tank Farm Substation
- Specialty Textile Services
- SRV Water User's Association
- Straight Arrow Enterprises
- Trail Boss
- Univar USA Inc.

The questionnaires requested specific information in the following areas:

- Property information
- On-site wells
- Water use
- Waste streams

2.2.2.2 Passive Diffusion Bag Sampler Evaluation

A three-week deployment of passive diffusion bags (PDBs) in eight wells within and around the WVBA was performed during third quarter 2001 to assist in comparing the results of this sampling method with the traditional purge and sample method (BE&K/Terranext, 2001b). PDBs are capsules approximately 16 inches in length which are constructed of flexible four-mil polyethylene membrane and filled with distilled water. PDBs are suspended in the saturated portion of the well and allowed to equalize for a period of at least two weeks. While suspended in groundwater, dissolved VOCs in groundwater equilibrate with the distilled water contained within the PDB. This method of sampling is less expensive then the typical purge and sample

technique used to collect groundwater samples. Good correlation between the traditional and PDB samples was observed; the approximate average variation for detected compounds was 20 percent. Data indicated good correlation (correlation coefficient of 0.9968) between PDB and traditional sampling methods. Concentrations ranged from not detected (detection limits provided in referenced report) to 120 µg/l for PCE. In general, larger variations were observed in samples with low concentrations, because higher relative differences would occur with smaller absolute differences.

The three-week deployment of PDBs was followed by a six-month deployment of PDBs in nine wells (BE&K/Terranext, 2002b). Again, review of the results suggested good correlation between the traditional and PDB sampling methods. The relative percent difference of detected compounds averaged approximately 14 percent. Data indicated good correlation (correlation coefficient of 0.8992) between PDB and traditional sampling methods. Currently, ADEQ deploys over 50 passive diffusion bags in select monitor wells for semiannual groundwater sample collection.

2.2.2.3 Chromium-Initiated Well Development

Sampling of the WVBA monitor well network detected elevated total chromium concentrations (up to 63 mg/l) in selected wells in September and November 2002, and March and September 2003 (BE&K/Terranext, 2002c, 2003d). However, analytical results for dissolved chromium analyses were less than or only slightly greater than the laboratory reporting limit of 0.01 mg/l. As a result, ADEQ redeveloped wells exhibiting elevated chromium concentrations in February/March 2003 and in February 2004. The objective of well redevelopment was to remove fine-grained sediment within and immediately adjacent to the wells. It was hypothesized that the sediment may be the origin of the elevated chromium concentrations (BE&K/Terranext 2003b, Terranext 2004b). Chromium concentrations in groundwater samples declined substantially after redevelopment of the monitor wells. Detected total chromium concentrations ranged from 12 µg/l to 529 µg/l. Based on this information, ADEQ believes that the detected chromium in most of the wells (AVB10-01, AVB57-01, AVB69-02, AVB70-01, AVB72-01, AVB73-01, AVB74-01, AVB75-01, and AVB76-01) may be due to deterioration of the stainless steel well casing, where present, or naturally occurring in subsurface soils.

2.2.3 RID System Characterization

ADEQ contracted BE&K/Terranext to conduct two investigations to evaluate the effect of pumping groundwater from the WVBA into the RID canal (BE&K/Terranext, 2001c, 2003c). Locations of RID pumping wells and canals within the WVBA are shown on Figure 2-6. The objectives of the canal characterization were to:

- Assess concentrations of VOCs in RID wells within the WVBA.
- Evaluate VOC concentrations within RID canal water downstream of discharging RID wells.

The investigation's approach was as follows:

- Sample RID wells in the WVBA;

- Evaluate resulting groundwater quality data to select specific well/canal locations for further investigation;
- Perform a temperature survey to assess the mixing of the well discharge into the canal. Use survey results to identify downgradient canal locations for water quality sampling;
- Perform water quality sampling at selected locations to assess the mixing of VOCs from well discharges into the canal.

BE&K/Terranext sampled 17 RID wells in April 2000. Well RID-84 contained the highest concentration of PCE of the sampled RID wells (76 µg/l) and was subsequently selected for further investigation. The groundwater sample collected from well RID-92 contained the highest TCE concentration of the sampled RID wells (70 µg/l) and was also subsequently selected for further investigation.

Subsequently, BE&K/Terranext conducted a survey of physical parameters of the canal water including surface water flow, temperature, and conductivity at locations up and down stream of RID-84 (BE&K/Terranext, 2001c). Based on the results of the survey, BE&K/Terranext collected eight samples from the canal in the vicinity of RID-84.

Analytical results for the samples collected from well RID-84 and the adjacent canal indicate that elevated concentrations of VOCs are present in groundwater at well RID-84; however, VOC concentrations in the canal are substantially lower than the well water (BE&K/Terranext, 2001c) (Table 2-2). Analytical results for the samples collected from well RID-92 and the adjacent canal indicate that elevated concentrations of VOCs are present in groundwater and in the canal. VOC concentrations do not decrease substantially with distance from RID-92 as with RID-84. Based upon the results of the RID canal sampling in 2000, it appears that contaminant concentrations at well RID-84 decrease rapidly in the canal within approximately 125 feet of the well as a result of dilution and/or volatilization. VOC concentrations in the canal adjacent to well RID-92 dropped slightly within 200 feet of the well discharge but then remained steady for at least 1,000 feet from the well discharge. The discrepancy in the change in VOC concentrations at the two canals is probably due of the increased volume of water that passes through the canal adjacent to well RID-84.

Select RID wells and related canals were again sampled in 2003 (BE&K/Terranext, 2003c) (Table 2-3). The objective of this sampling event differed as it was to evaluate the nature and extent of contamination in groundwater in the area of RID wells and in the adjacent canals within the WVBA. ADEQ identified 26 RID wells within the WVBA and seven canal locations including two lateral canals, the south main canal, and north canal for sampling. The canal samples were collected approximately ¼ to ½ mile downstream of sampled RID wells with the exception of the sample collected downstream of well RID-103 which was approximately 43 feet downstream of the well.

PCE was the most prevalent VOC detected in the RID wells, exceeding the AWQS of 5 µg/l in 18 of the 26 sampled wells. Of these 18 wells, 14 exceeded the AWQS of 5 µg/l for TCE, and four of these 14 wells exceeded the AWQS of 7 µg/l for 1,1-DCE. The majority of contaminant concentrations in the samples collected from the canals had not decreased substantially when

compared to the well samples. Contaminants detected during both rounds of canal sampling do not have applicable surface water quality standards for crop irrigation for livestock consumption.

Select RID wells have been sampled throughout the history of the WVBA investigation with the permission of the RID. In 1986, six RID wells were sampled during the groundwater investigation conducted by ADWR and ADHS (Arizona Department of Water Resources, 1987). COCs were detected in five of the RID wells at concentrations greater than their respective AWQS. Sporadic sampling of the RID wells occurred until 2003 when ADEQ began sampling the RID wells on a more regular basis. Between June 2003 and March 2008, eight sampling rounds of select RID wells occurred. Additional detail regarding the regular sampling and analysis of the RID wells can be reviewed in the sampling reports (BE&K/Terranext 2003c, Terranext 2004c, 2004d, 2005c, 2005d, 2006b, 2006c, and 2008b). RID wells are screened over multiple aquifers, and data collected from the RID wells are presented on UAU1 and UAU2 figures and discussed further in Section 4.3. The most recent round of RID well sampling occurred in September 2008 and data are presented in Table 2-4.

2.3 Facility Investigational Work

2.3.1 Reynolds

In 1988, Reynolds conducted initial site investigations including soil and soil gas sampling, and detected chromium, petroleum hydrocarbons, and chlorinated hydrocarbons such as TCA and PCE in soils beneath the Reynolds property (Dames & Moore, 1988) (Table 2-5) (Appendix A). Additional soil sampling, soil gas extraction well installation, and soil gas sampling were conducted in 1989 and 1990 (Dames & Moore, 1991a). Soils encountered at the Reynolds facility consisted of clayey sand/sandy clay to approximately 40 feet bgs; sand, gravel, and cobbles were encountered below 40 feet. TCE and TCA were detected in soil samples along with ethylbenzene, xylenes, toluene, and Stoddard solvent. PCE, TCE, and TCA were detected in soil gas samples along with petroleum hydrocarbons and Stoddard solvent. Additional soil gas sampling was conducted in 1994, 1995, 1996, and 1999 (Geotechnical and Environmental Consultants, Inc. [GEC], 1995b, 1995c, 1996a, & 1999a & b). TCA was the most commonly detected COC.

The highest TCA soil gas concentrations detected at the Reynolds facility were 4,000 µg/l and 1,600 µg/l (Table 2-5). The 4,000 µg/l sample was collected at a depth of approximately 20 to 40 feet bgs from a soil vapor probe. This probe was located in the vicinity of the former east Stoddard solvent dip tank. This screened interval is completed in the lower portion of the fine-grained soil underlying the facility. The depth of the other sample was not reported but was also collected from the same area.

Based on the results of initial soil gas sampling, soil investigations were conducted in 1991, 1992, 1994, 1995, 1997, 1998, and 1999 (GEC, 1991, 1995a, 1996b, 1997a, 1997b, 1998a, 1999a) (Sergent, Hauskins & Beckwith, 1991). As was identified during the soil gas sampling, TCA was the most commonly detected COC during the soil investigations. The highest TCA concentration detected in the soil was 510 milligrams per kilogram (mg/kg) (Table 2-5). This soil sample was collected at the former location of the east Stoddard solvent degreasing tank

from a depth of approximately three feet bgs. This concentration is less than the nonresidential soil remediation level (SRL) and residential SRL for TCA of 4,800 mg/kg and 1,200 mg/kg, respectively, but greater than the minimum groundwater protection level (GPL) which is 1.0 mg/kg (Table 2-5). TCE was not detected in soil samples collected at the Reynolds facility at concentrations greater than the nonresidential SRL of 70 mg/kg. One soil sample collected at the Reynolds facility contained TCE at a concentration greater than the residential SRL of 27 mg/kg (Table 2-5). The sample contained TCE at a concentration of 27.9 mg/kg and was collected at a depth of approximately 15 feet bgs from the vicinity of the east Stoddard dip tank and east Stoddard UST. This soil sample and 15 other soil samples collected at the Reynolds facility contained TCE at concentrations greater than the minimum GPL for TCE of 0.61 mg/kg. Two soil samples collected from the Reynolds facility exceeded the minimum GPL for PCE of 1.3 mg/kg. PCE concentrations of 2.0 mg/kg and 1.5 mg/kg were detected at depths of approximately 15 feet bgs and 25 feet bgs, respectively. These two soil samples were collected in the vicinity of former plant manufacturing equipment. 1,1-DCE was detected at a concentration of 1.1 mg/kg in a soil sample collected at a depth of approximately ten feet bgs in the vicinity of the east Stoddard solvent dip tank (Table 2-5). This concentration exceeded the nonresidential SRL, residential SRL, and minimum GPL for 1,1-DCE of 0.8 mg/kg, 0.36 mg/kg, and 0.81 mg/kg, respectively. No other soil samples collected at the Reynolds facility contained VOCs at concentrations greater than SRLs.

TCA, TCE, and PCE are not believed to be constituents of Stoddard solvent so their origin is unclear unless Stoddard solvent wasn't the only solvent used in this area. Petroleum hydrocarbons, Stoddard solvent, and PCBs were also detected during the soil and soil gas investigations. Chromium was detected in shallow soils while conducting excavating activities near the western end of the former main plant building. The highest chromium concentration was 938 mg/kg at a depth of approximately two feet bgs which is less than the Human Health Based Guidance Level (HBGL) of 1,700 mg/kg. (Dames & Moore, 1992) (Table 2-5). In 1992, the HBGL was the soil cleanup guidance standard.

Concurrent with the soil investigations, groundwater was investigated through the installation, monitoring, and sampling of groundwater monitor wells (Appendix A). Initially five groundwater monitor wells were installed at the Reynolds facility in 1990 (Dames & Moore, 1990). Limited aquifer testing was conducted at each of the five wells to estimate aquifer parameters in the vicinity of the wells. Results of the aquifer testing indicated that aquifer characteristics beneath the Reynolds facility were similar to aquifer characteristics documented in previously conducted regional investigations. Groundwater monitoring indicated that groundwater elevations fluctuated with seasonal groundwater withdrawals as did horizontal flow directions and gradients which were in general similar to regional groundwater data. Depths to groundwater fluctuate seasonally due to regional groundwater pumping by more than 20 feet. The horizontal groundwater flow direction is westerly fluctuating from north-northwesterly to southerly and the gradient ranged from approximately 0.0004 feet per feet (ft/ft) to 0.0025 ft/ft. The deepest groundwater levels are typically at the end of the summer just before regional irrigation pumps are turned off and shallowest in the spring prior to the startup of the pumping season. PCE, TCE, TCA, and 1,1-DCE were detected in groundwater samples collected from the monitor wells. The highest concentrations of TCA (39.6 µg/l and 130 µg/l) and 1,1-DCE (14.2 µg/l and 62.5 µg/l) were detected in groundwater samples collected from wells PS-1 and

PS-2, respectively, which are located adjacent to the solvent still area and the east Stoddard dip tank, respectively (Appendix A). PCE (19.1 µg/l) and TCE (43.3 µg/l) concentrations in groundwater samples collected from upgradient well PS-4 were higher than groundwater samples collected from the other four monitor wells (PCE – 4.0 µg/l to 12.3 µg/l, TCE – 2.9 µg/l to 32.5 µg/l). A sixth groundwater monitor well was installed at the facility in 1991 (Dames & Moore, 1991b). In 1994 three additional groundwater monitor wells were installed at the Reynolds facility (GEC, 1995a).

Numerous rounds of groundwater monitoring and sampling have been conducted at the facility since the well installations. COCs including PCE, TCE, TCA, 1,1-DCA, 1,1-DCE, and cis 1,2-DCE have been detected in groundwater samples collected from the wells. PCE, TCE, TCA, and 1,1-DCE are the only COCs that have been detected at concentrations greater than the AWQS. The highest COC concentrations detected in the groundwater samples included PCE at 55 µg/l, TCE at 363 µg/l, TCA at 228 µg/l, 1,1-DCA at 208µg/l, 1,1-DCE at 65.9 µg/l, and cis 1,2-DCE at 7 µg/l. The highest PCE and TCE concentrations detected in groundwater samples varied from the upgradient well to wells in the vicinity of the former solvent still area and the east Stoddard dip tank The highest concentrations of the other COCs were detected in groundwater samples collected from the vicinity of the former solvent still area and the east Stoddard dip tank.

Continued groundwater monitoring and sampling indicated that groundwater elevations continued to fluctuate seasonally along with flow directions. Contaminant concentrations declined with time but continued to remain greater than AWQSs for PCE, TCE, and occasionally 1,1-DCE. Currently, ADEQ collects samples from select wells previously installed by Reynolds.

During site characterization, remedial activities including vapor extraction and soil excavation were conducted to mitigate contaminant concentrations. Site specific remediation standards were calculated for petroleum hydrocarbons, which was the only contaminant to exceed non-residential HBGLs, and for TCA, which was the only contaminant to exceed site-specific GPLs calculated using site-specific parameter input values for the ADEQ GPL model to evaluate the effectiveness of remediation (Reynolds Metals Company, 1996). Following site activities, risk analyses were conducted for areas which still contained contaminants exceeding residential and non-residential SRLs (Reynolds Metals Company, 1998 & 1999). These were eventually approved by ADEQ and an NFA was issued on February 29, 2000 for 14 locations where releases had occurred (ADEQ, 2000). The following lists the areas of releases, area description, contaminants detected, and corrective actions taken:

- Right-of-Way (ROW) Area I – Former Anodizing Area – Chromium in soils – Excavated – NFA location
- ROW Area IIId – Large Manufacturing Equipment – Petroleum Hydrocarbons – Excavated – NFA location
- ROW Area IIIf – Large Manufacturing Equipment – Petroleum Hydrocarbons – Excavated – NFA location
- Former Manufacturing Equipment Foundations (Trenches 1 through 8) – Polynuclear Aromatic Hydrocarbons (PAHs) and VOCs – Excavation/Risk Analysis/Voluntary Environmental Mitigation Use Restriction (VEMUR) – NFA location

- Northwest Stoddard Dip Tank – Solvent Use/Storage – Stoddard Solvent and TCA – Soil Vapor Extraction/Excavation/Risk Analysis/VEMUR – NFA location
- East Stoddard UST – Solvent Use/Storage – Stoddard Solvent and TCA – Soil Vapor Extraction/Excavation/Risk Analysis/VEMUR – NFA location
- Stoddard Solvent Distilling Operations at Building #150 – Solvent Use/Storage – Stoddard Solvent and TCA – Soil Vapor Extraction/Excavation/Risk Analysis/ VEMUR – NFA location
- Southwest Stoddard Dip Tank – Solvent Use/Storage – Stoddard Solvent and TCA – Soil Vapor Extraction/Excavation/Risk Analysis/VEMUR – NFA location
- West Stoddard USTs – Solvent Use/Storage – Stoddard Solvent and TCA – Soil Vapor Extraction/Excavation/Risk Analysis/VEMUR – NFA location
- Building #150 USTs – Solvent Use/Storage – Stoddard Solvent and TCA – Soil Vapor Extraction/Excavation/Risk Analysis/VEMUR – NFA location
- East Aboveground Storage Tank (AST) – Solvent Storage – Stoddard Solvent – Excavation/Risk Analysis – NFA location
- Former Oil Pump Pit Area – Solvent Storage – No Contaminants Present – No Action Required – NFA location
- Drywell South of Building #150 – Drainage – No Contaminants Present – No Action Required – NFA location
- East Soil Gas Area – Solvent Use/Storage – Stoddard Solvent and TCA – Soil Vapor Extraction/Excavation/Risk Analysis/VEMUR – NFA location
- East Stoddard Tank – Solvent Use/Storage – Stoddard Solvent and TCA – Soil Vapor Extraction/Excavation/Risk Analysis/VEMUR

2.3.2 VW&R

VW&R conducted a property assessment including the collection of numerous soil and soil gas samples, and installation and monitoring of 11 groundwater monitor wells (Appendix B). Initial site activities were conducted in 1989 with the completion of a soil gas survey and soil sampling by Harding Lawson Associates (HLA) (1990a). PCE, TCE, TCA, and 1,1-DCE were detected in soil vapors at several locations across the facility with PCE detected at the highest concentration of 1,330 µg/l near the southern end of the solvent tank farm (Table 2-5). The highest TCE soil gas concentration detected at the VW&R facility was 484 µg/l from a depth of approximately 15 feet bgs (Table 2-5). This soil gas sample was also collected from the south end of the solvent tank farm. The highest TCA concentration detected in the soil gas was 1,200 µg/l from a depth of approximately ten feet bgs (Table 2-5). This sample was also collected from the area adjacent to the south end of the solvent tank farm. 1,1-DCE was detected at a maximum concentration of 323 µg/l (Table 2-5). This soil gas sample was collected at a depth of approximately five feet bgs from the northwestern portion of the VW&R facility. These data were used to identify areas where soil samples should be collected. Additional soil gas samples were collected in 1997 in the vicinity of a former laboratory waste storage drum (HLA, 1997a). Soil sampling investigations were conducted in 1990, 1991, and 1997 (HLA, 1990b, 1991, 1997a & b). Contaminants of concern detected during the soil investigations included PCE, TCE, TCA, 1,1-DCE, and 1,1-DCA. Soils encountered consisted primarily of clay, silt, and sand to approximately 40 to 50 feet bgs, underlain by gravel with varying amounts of sand, cobbles, and fine-grained materials. PCE was detected at the highest concentration of 4.250 mg/kg near the

west edge of the corrosive tank farm (Table 2-5). This concentration exceeded the minimum GPL of 1.3 mg/kg for PCE. No other VOCs were detected in soil samples at concentrations greater than applicable soil standards at the time. Following soil characterization, an SVE system was installed in November 1992 and operated in the area north of the solvent tank farm, the area south of the solvent tank farm and the areas north and west of the corrosive tank farm (Ensolutions, Inc., 1998).

Following the soil investigations, eight groundwater monitor wells were installed at the VW&R facility (HLA, 1992) (Appendix B). Groundwater monitoring indicated that groundwater elevations fluctuated with seasonal groundwater withdrawals by as much as 20 feet annually. Horizontal flow directions and gradients were similar to regional groundwater flow directions and gradients with flow directions varying from northwesterly to southwesterly and gradients were in the range of approximately 0.0006 ft/ft to 0.0013 ft/ft. PCE, TCE, TCA, 1,1-DCE, and 1,2-DCE were detected in groundwater samples collected from the monitor wells. PCE, TCE, TCA, and 1,1-DCE were detected at concentrations that exceeded the AWQS. The highest concentrations of PCE were detected in groundwater samples collected from the wells located adjacent to the facility's western boundary. The highest PCE concentration detected at the facility was 1,400 µg/l. TCE concentrations were typically highest in groundwater samples collected from the upgradient monitor wells. However, the highest TCE concentration detected was 200 µg/l detected in a groundwater sample collected from well MW-7 located along the western boundary of the facility. TCA and 1,1-DCE were typically highest in concentration in the groundwater samples collected from the monitor wells adjacent to the facility's western boundary. The highest TCA concentration detected was 220 µg/l. The highest 1,1-DCE concentration detected was 110 µg/l. Vertical profiling was conducted at select wells at the facility in February and August 1994 to investigate the possibility of a vertical gradient within the aquifer beneath the VW&R facility using down-hole geophysical tools including a temperature gage and a spinner tool and the collection of depth specific groundwater samples (HLA, 1994a & 1994b). Results of profiling indicated that downward vertical movement was present within the wells investigated. In June and July 1997, three additional groundwater monitor wells were installed at the facility to collect groundwater data from deeper within the UAU (HLA, 1997c). Data collected from the deeper wells indicated that groundwater contamination was limited in depth to the shallow zone investigated by the original eight monitor wells. Following remediation of the vadose zone by SVE, contaminant concentrations in groundwater declined and VW&R ceased groundwater monitoring and sampling with ADEQ concurrence. Currently ADEQ collects groundwater samples from two groundwater monitor wells at the facility and the other wells were abandoned by VW&R.

The SVE system was operated periodically until 1998 (Ensoultions, Inc., 2000) (Appendix B). In July 2001, confirmation soil sampling was conducted at the VW&R facility to evaluate whether soil contamination concentrations had declined to levels less than SRLs and minimum GPLs (Geotrans, Inc., 2001). Analytical results of the soil samples indicated that none of the COC were present at concentrations greater than the applicable regulatory standards. Based on these data, ADEQ issued a NFA determination for the facility soils in 2002 (ADEQ, 2002).

Several areas have been investigated at the VW&R facility. Four of these areas, the area north of the solvent tank farm, south of the solvent tank farm and areas north and west of the corrosive

tank farm were identified as source areas. The following lists the areas investigated, area description, contaminants detected, and corrective actions taken:

- Corrosive Tank Farm – Chemical Storage/Mixing – VOCs – Soil Vapor Extraction
- Solvent Tank Farm – Chemical Storage/Mixing – VOCs – Soil Vapor Extraction
- Freon Handling Area – Chemical Storage – No Contaminants Present – No Action Required
- RCRA Drum Storage Area – Chemical Storage – No Contaminants Present – No Action Required
- Waste Water Pretreatment System and Associated Piping – Waste Water Neutralization – VOCs – No Action Required
- Sewer Interceptor – Waste Water Disposal – VOCs – No Action Required
- North Central Area of Facility – Drum Storage – VOCs – No Action Required
- Northwest Area of Facility – Drum Storage – VOCs – No Action Required
- Area Adjacent to Neighboring Drywell – VOCs – No Action Required
- Former Laboratory Drum Storage Area – VOCs – No Action Required
- Unimproved East Area – No Activities – VOCs – No Action Required

2.3.3 MCMM

Maricopa County conducted soil gas and soil sampling on-site and installed/operated an SVE system for approximately six months (Appendix C). To investigate groundwater contamination, several groundwater monitor wells were also installed and periodically sampled. MCMM facility investigations were initiated by ADEQ in 1992 in response to groundwater contamination detected in a monitoring well downgradient of the facility. Soils observed at the MCMM facility in the vadose zone included clay and silt with variable amounts of sand to approximately 20 feet bgs. Below approximately 20 feet, sand and gravel were encountered with varying amounts of clay, silt, and cobbles. A soil gas survey conducted in June 1992 at the facility detected PCE, TCE, 1,1,1-TCA, 1,1-DCE, cis & trans-1,2-DCE, and 1,1-DCA in the soil vapor collected from beneath the western portion of the facility (Weston, 1992a) (HydroGeoChem, Inc. [HGC],1992a). PCE and TCE were the most commonly detected VOCs with PCE at a concentration in excess of 1,000 µg/l and TCE at a concentration in excess of 800 µg/l (Table 2-5). These soil vapor concentrations were detected in the vicinity of the former Southwest Solvent Reclamation facility at a depth of approximately five feet bgs.

Based on the 1992 soil gas survey, soil sampling was conducted at the MCMM facility and adjacent properties of US WEST Communications and Southern Pacific Transportation Company in conjunction with the installation of three groundwater monitor wells at the MCMM facility in February 1993 (Weston, 1993b) (Appendix C). PCE and TCE were the only VOCs detected in the soil samples analyzed during this investigation. PCE was detected at a maximum concentration of 0.7 mg/kg and TCE was detected at a maximum concentration of 4.2 mg/kg (Table 2-5). These concentrations were detected in soil samples collected during the drilling and installation of groundwater monitor well MC-02 located in the north central portion of the facility. The TCE concentration exceeded the minimum GPL for TCE of 0.61 mg/kg. No other VOCs were detected in soil samples collected at the MCMM facility at concentrations greater

than SRLs. Groundwater concentrations of PCE detected at the MCMM facility were 33µg/l at monitoring well MC-02, 63 µg/L in monitoring well MC-01 and 900 µg/L in monitoring well MC-03. TCE concentrations detected in groundwater at MCMM ranged from 82 µg/L at MC-02 to 290 µg/L at MC-03. PCE and TCE contamination were also detected in soil samples collected from borings drilled at the US WEST Communications property west of the MCMM facility. Based on the distribution of PCE and TCE, this contamination was believed to be related to the soil contamination discovered at MCMM. No VOC soil contamination was detected in boreholes drilled at Southern Pacific Transportation Company north of the MCMM facility.

During March 1995, a Gore Sorber Screening Survey was conducted to augment soil gas data gathered in June 1992. The results of the survey indicated a low-level presence of PCE and TCE across the site with an area of relatively higher vapor-phase PCE, TCE and 1,1-DCA in the northwest portion of the property (Flour Daniel GTI, 1996b). According to the Gore Sorber Screening Survey, the highest mass of TCE was noted at the southeast corner of the property. This was consistent with groundwater quality data collected from well MC-01, also located near the southeast corner of the property. A geophysical survey utilizing ground penetrating radar was conducted at the site in the northwest portion of the facility to investigate the possible presence of a well. Two anomalies were detected but further investigation uncovered rebar reinforced concrete in one anomaly and nothing in the other anomaly. Soil samples collected at the anomalies did not contain detectable VOCs. Soil samples were also collected during this investigation along with the installation of a vapor extraction well, groundwater extraction well, two groundwater monitor wells, three nested groundwater piezometers with screened intervals in the upper portion of the UAU1, the lower portion of the UAU1, and the UAU2, and a groundwater piezometer. PCE and TCE were the only VOCs detected in soil samples with the exception of 1,1-DCE which was detected in one soil sample. The highest PCE concentration detected was 0.15 mg/kg which was collected from the northwest corner of the facility. The highest TCE concentration detected was 0.21 mg/kg which was collected from the northeast corner of the facility.

An additional soil gas survey was conducted in the southeast portion of the MCMM facility in 1997 to confirm the presence of PCE and TCE in soil vapors in this area (Fluor Daniel GTI, 1997). Samples were only analyzed for PCE and TCE. Analytical results indicated the presence of both VOCs with PCE detected at a highest concentration of 62 µg/l and TCE detected at a highest concentration of 98 µg/l.

In November 1995, an SVE pilot test was conducted at the facility in the vicinity of the former Southwest Solvents Reclamation facility to investigate the suitability of the facility for remediation by SVE (Fluor Daniel GTI, 1996c). Data collected during the pilot test indicated that the area was suitable for remediation via SVE. VOCs detected in the soil vapors during the pilot test included PCE, TCE, 1,1,1-TCA, 1,1-DCE, 1,1-DCA, chloroform, and Freon 113. PCE was detected at the highest concentration of 2,238 µg/L (Table 2-5). The highest TCE concentration detected was 462 µg/l. SVE was conducted from mid August to early September and mid October to late November 1997 (Fluor Daniel GTI, 1998a & b). The system was shut down after soil vapor concentrations had reached asymptotic levels as was agreed by ADEQ personnel. The highest PCE and TCE concentrations detected were PCE at a concentration of 531.8 µg/l, TCE at a concentration of 524.5 µg/l.

As mentioned above, three rounds of groundwater monitor well installations were conducted at the MCMM facility (Appendix C). Numerous rounds of groundwater monitoring and sampling have been conducted at the facility since the well installations. COCs including PCE, TCE, TCA, 1,1-DCE, 1,1-DCA, and cis 1,2-DCE have been detected in groundwater samples collected from the wells. PCE, TCE, 1,1-DCE and cis 1,2-DCE were detected at concentrations greater than the AWQS. 1,2-Dichloroethane (1,2-DCA) was also detected at concentrations greater than the AWQS. PCE and TCE were the most commonly detected COCs with PCE detected at a highest concentration of 3,800 µg/l and TCE with a highest concentration of 1,800 µg/l. The highest 1,1-DCE concentration detected was 35 µg/l. The highest cis 1,2-DCE concentration detected was 2,500 µg/l. The highest 1,2-DCA concentration detected was 500 µg/l. The highest PCE concentrations were detected in groundwater samples collected from the vicinity of the former Southwest Solvent recycling facility in the northwest portion of the MCMM property. The highest TCE concentrations have been detected in groundwater samples collected from the vicinity of the former Southwest Solvent recycling facility and the middle of the southeast parking lot. COCs were also detected at concentrations greater than AWQS in the deeper nested piezometers. Groundwater monitoring indicates that groundwater elevations fluctuate with seasonal groundwater withdrawals as do horizontal flow directions and gradients. Depths to groundwater fluctuate by ten feet or more; the horizontal flow direction ranges from northwest to west-southwest, and gradients fluctuate from approximately 0.0007 ft/ft to 0.008 ft/ft. An aquifer test was conducted at the groundwater extraction well in July 1995 (Groundwater Technology, Inc. [GTI], 1995). Results of the aquifer testing indicated that the coarse-grained aquifer beneath the MCMM facility is similar to aquifer characteristics documented in previously conducted regional investigations. ADEQ currently monitors/samples wells MC-05 (AVB106-01, MC-N06 #2 (AVB106-02), and MC-N06 #3 (AVB106-03) at the facility.

Maricopa County personnel reviewed the Kleinfelder well survey results and ADWR well database, and conducted field surveys to identify wells which could be used for human consumption or other domestic use (Maricopa County Division of Water and Waste Management, 1994). This survey identified 82 wells that could potentially be used for domestic purposes. Further investigation, however, ascertained that of these, only 14 were actually used for domestic purposes. Maricopa County personnel were able to sample 12 of the wells for analyses of VOCs. One of the two wells not sampled was discovered to be regularly sampled by ADEQ and the other well was not sampled because the well owner would not allow the county personnel to sample the well. The samples were analyzed using EPA Test Methods 601 and 602. No VOCs were detected. The detection limits ranged from 0.5 µg/l to 5.0 µg/l.

Several areas have been investigated at the MCMM facility. Two of these areas, the former Southwest Solvent Recycling facility and southeast parking lot, were identified to be source areas. Active remediation by SVE was completed at the facility in the vicinity of the former Southwest Solvent Recycling facility. The following lists areas investigated, area description, contaminants detected, and corrective actions taken:

- Former Southwest Solvent Recycling Facility – Chemical Recycling –VOCs – Soil Vapor Extraction
- Southeast Parking Lot – Vehicle Parking – VOCs – No Action Taken

- Anomaly #1 – Unknown – No Contaminants – No Action Required
- Anomaly #2 – Unknown – No Contaminants – No Action Required

2.3.4 Dolphin

Dolphin initiated subsurface investigations at their 740 South 59th Avenue facility in June 1988 to investigate soil contamination at a discharge pipe and drainage area (Scott, Allard & Bohannan, Inc. [SAB], 1988) (Appendix D). Analytical results of soil samples collected during this investigation detected TCA, 1,1-DCE, and 1,1-DCA. In September 1992, a release of liquid and sludge material occurred at Dolphin's production facility, known as Dolphin III. Analysis indicated that the release material contained PCE ranging in concentration from 2,300 mg/kg to 77,000 mg/kg (Basin & Range Hydrogeologists, Inc. [BRH], 1993a). TCE and 1,1-DCE were also detected in extracts of the release liquid and sludge samples at concentrations that exceeded regulatory levels for the hazardous waste characteristic of toxicity. The highest PCE concentration detected in soil at the Dolphin facility was 8,040 mg/kg (Table 2-5). This concentration exceeds the nonresidential SRL of 170 mg/kg, residential SRL of 53 mg/kg, and minimum GPL of 1.3 mg/kg. This was a sample of soil excavated from a release area north of the Dolphin III building. The highest TCE soil concentration detected at the Dolphin facility was 30 mg/kg (Table 2-5). This TCE concentration was detected in the same soil sample which contained the highest PCE concentration. Additionally, TRPH were detected in one release area sample at a concentration of 25,000 mg/kg.

Since 1992, several investigations of soil, soil vapor, and groundwater have been conducted at the site (Appendix D). Shallow soils encountered at the Dolphin, Inc. facility consisted of sand with varying amounts of silt and gravel to approximately 20 to 25 feet bgs. A fine grained unit of silt and clay was then encountered for approximately 10 to 35 feet. The fine-grained unit is underlain by gravel with varying amounts of sand, cobbles, and to a lesser extent silt and clay. Soil samples collected to depths of approximately 63 feet bgs from the vicinity of the former drum storage areas and a PCE degreaser area contained concentrations of PCE in soil greater than the minimum GPL of 1.3 mg/kg. Soil gas sampling was conducted at the site in September and November 1994 (Tracer Research Corporation, 1994). PCE, TCE 1,1,1-TCA, 1,1-DCE and 1,2-DCE were detected at the facility. The highest soil gas PCE concentration detected at the Dolphin facility was at a concentration of 33,000 µg/l, near the center of the western edge of the Dolphin I building near former drum storage areas and a PCE degreaser. Other VOCs detected in soil gas samples were at concentrations of 2 to 3 orders of magnitude less than the highest PCE concentration. In 1995 and 1996, soil investigations including the collection of soil samples and the installation of 12 SVE wells were conducted (BRH, 1996b). PCE and 1,1,1-TCA were the only COCs detected in the soil samples. PCE was the most commonly detected contaminant. The highest PCE concentration was detected at 42 mg/kg. This concentration exceeded the minimum GPL for PCE of 1.3 mg/kg. PCE was also detected at concentrations greater than the minimum GPL in the vicinity of the former drum storage area and PCE degreaser. No other VOCs were detected.

An SVE pilot test was conducted at the facility in 1996. Data from this pilot test ascertained that SVE would be a cost effective method for site remediation, and were used to help design an SVE system. In 1996, Dolphin closed a drywell (#1) which was located west of the Dolphin I

building in the area of former drum storage and near a PCE degreaser (Dolphin, Inc., 1996). A sediment sample collected from the upper chamber of the drywell contained detectable concentrations of PCE, TCE, cis-1,2-DCE, and 1,1,1-TCA. The highest PCE concentration detected in the drywell sediment was at 220 mg/kg. In 1997, a bermed retention area was investigated for metals and VOCs (Dolphin, Inc., 1997). Chromium was detected in concrete core samples and soil samples at concentrations less than the ADEQ HBGL. PCE was detected in two soil samples collected from the retention area at concentrations of 1.5 mg/kg and 0.450 mg/kg. In 1998, two additional drywells (#2 and #3) were sampled prior to abandonment (Brown and Caldwell, 1999a). No VOCs were detected in sediment samples collected from the drywell chambers.

In 2000 and 2001, additional soil vapor and soil samples were collected at the site (Brown & Caldwell, 2001 & 2002a). The 2000 investigation was conducted at the property north of the main plant known as the Dolphin II/V facility. PCE, TCE, and 1,1-DCE were detected in soil vapor samples at this facility. The highest PCE concentration was detected at 110 µg/l. VOCs were not detected in soil samples collected at the Dolphin II/V facility. Metals including chromium and lead were detected in soil samples, but were less than or equal to background concentrations for these compounds. Results of the investigation conducted at the main facility in 2001 indicated that PCE was the only VOC detected during the soil gas survey with the exception of dichlorodifluoromethane which was detected in one soil gas sample. The highest PCE concentration was 19 µg/l which was collected between the Dolphin I building and the southwest building. PCE was also the only VOC detected in soil samples collected during the investigation conducted at the main plant. The highest PCE concentration detected was 0.76 mg/kg which was collected near the closed Dolphin I interceptor. Soil samples were also analyzed for metals. Hexavalent chromium, arsenic, and beryllium, were detected at concentrations which exceeded regulatory standards. However, a site specific risk analysis was conducted which ascertained that the concentrations did not pose a risk to human health or the environment.

Groundwater investigations were conducted concurrent with the soil investigations at the Dolphin facility. Three groundwater monitor wells with Westbay MP Systems (Westbay) were installed at the site in June 1993 and October 1994 (BRH, 1996a). Sampling ports were installed across the UAU1 and UAU2 and into the top of the MAU1. PCE, TCE, 1,1-DCE, cis-1,2-DCE, 1,1,1-TCA, and 1,1-DCA, are COCs which have been detected in groundwater samples collected from the monitor wells. PCE, TCE, 1,1-DCE and cis 1,2-DCE are the only COCs which have been detected at concentrations greater than their respective AWQSs. PCE has been the most commonly detected contaminant and has been detected at the highest concentration of 95,000 µg/l (Basin & Range Hydrogeologists, Inc., 1998). COCs have also been detected in groundwater samples collected from the upgradient wells at the facility with TCE and 1,1-DCE at concentrations similar to the source area well. However, the highest TCE concentration detected at the facility was 340 µg/l which was detected in a groundwater sample collected from the well located in the release area. The highest 1,1-DCE concentration detected at the facility was 68 µg/l. The highest cis 1,2-DCE concentration detected at the facility was 4,000 µg/l. Groundwater monitor well analytical results have detected groundwater contamination to approximately 400 feet bgs. Additional groundwater monitor wells were installed at the facility in 2000 (Brown and Caldwell, 2000a). Four groundwater monitor wells were completed in the

UAU1 and two were completed in the MAU. The monitor wells were installed downgradient of the previously installed groundwater monitor wells. Analytical results of groundwater samples collected from the UAU1 monitor wells indicated that COC were present in groundwater downgradient of the source area well at lower concentrations but still greater than the AWQS. No VOCs were detected in the groundwater samples collected from the MAU monitor wells.

Groundwater monitoring has indicated that groundwater elevations fluctuate with seasonal groundwater withdrawals as do horizontal flow directions and gradients. However, the groundwater data were, in general, similar to regional groundwater characteristics, i.e., depths to groundwater fluctuated by 15 feet or more; westerly flow direction ranged from northwest to southwest; and gradients fluctuated from approximately 0.0003 ft/ft to 0.0021 ft/ft. Dolphin currently conducts quarterly monitoring and semiannual sampling of its groundwater monitor well network.

During site characterization, Dolphin installed three SVE systems and an air sparge (AS) system at their facility (Brown and Caldwell, 1999b) (Appendix D). Two SVE systems were installed in the vicinity of the former PCE degreaser and former drum storage areas near the Dolphin I building. These systems were designed to separately extract soil vapors from the coarse-grained soil zone (high-flow [HF] system) and the fine-grained soil zone (low-flow [LF] system). The third SVE system was installed in the vicinity of the closed sewer interceptor at the Dolphin III building. The AS wells were installed in vicinity of the former PCE degreaser and former drum storage area near the Dolphin I building. The Dolphin I HF and LF systems operated from October 1998 until April 2002 (Brown and Caldwell, 2004a). Decommissioning sampling of the SVE systems indicated that soils had been remediated to below SRLs. The Dolphin III SVE system was operated from November 1998 to November 2001 (Brown and Caldwell, 2002b). Decommissioning sampling of this SVE system indicated that soils had also been remediated to levels below SRLs. During the operation of the remediation systems, COC concentrations in the groundwater beneath the facility dropped substantially. Currently COC concentrations detected in groundwater samples collected from the groundwater monitor wells located at and downgradient of the release areas are similar in concentration to COC concentrations detected in groundwater samples collected from the upgradient groundwater monitor wells.

Several areas have been investigated at the Dolphin facility. Three of these areas, former drum storage near Dolphin I building, former PCE degreaser at Dolphin I building and closed sewer interceptor at Dolphin III building were identified to be source areas (Brown and Caldwell, 2004a). Active remediation including soil excavation, SVE, and AS have been completed at the facility. The following lists areas investigated, area description, contaminants detected, and corrective actions taken:

- Alden Leeds Building Septic and Interceptor Tanks – Waste Water Disposal – VOCs – No Action Required
- Former Acid Etch Building – Metal Parts Cleaning With Acid – Chromium and PCE – Concrete Removal & Soil Vapor Extraction
- Former Drum Storage Areas – Chemical Storage – VOCs – Soil Vapor Extraction & Air Sparging

- Former PCE Degreaser – Metal Parts Cleaning – VOCs – Soil Vapor Extraction & Air Sparging
- Former Satellite PCE Drum Storage Area – Chemical Storage – VOCs – No Action Required
- Closed Dolphin I Interceptor – Waste Water Disposal – VOCs – No Action Required
- Closed Dolphin III Interceptor – Waste Water Treatment – VOCs – Soil Vapor Extraction
- Discharge Pipe and Drainage Area – – VOCs – No Action Required
- Liquid and Sludge Material Spill Area – No Operations Area – VOCs – Soil Excavation
- Former Flammable Materials Storage Areas – Chemical Storage Area – VOCs – No Action Required.
- Drainage Basin – Facility Storm Water Holding – No Contaminants – No Action Required
- Former Saw Shed – Cutoff and De-gate – No Contaminants – No Action Required
- Parking Areas – Employee Parking – No Contaminants – No Action Required
- Unused Areas – No Activities – No Contaminants – No Action Required
- Dolphin II/V Facility – Parts Testing and Machining – VOCs – No Action Required
- Drywell # 1 – Storm Water Discharge – VOCs – Soil Vapor Extraction & Air Sparging
- Drywell #2 – Storm Water Discharge – No Contaminants – No Action Required
- Drywell # 3 – Storm Water Discharge – No Contaminants – No Action Required

2.3.5 ALSCo

At the request of ADEQ, several subsurface investigations were conducted at the ALSCo facility. An initial soil gas survey was conducted in June 1992 (Environmental Geosciences Engineering, 1992) (Appendix E). Analytical results of soil gas samples indicated the presence of PCE, TCE, benzene, and to a lesser extent TCA. The highest PCE concentration was detected at 4,796 µg/l in the vicinity of the former sump adjacent to the center of the western edge of the building (Table 2-5). TCE was detected in the same soil gas sample at a concentration of 336 µg/l. The highest TCA concentration was detected at a concentration of 170 µg/l. This soil gas sample was collected from the southwest corner of the facility building. Based on data collected during the soil gas survey, soil sampling was conducted at the facility. Soil sampling was conducted in July, August, October, and November 1992 (Jennings, Strouss & Salmon, 1992). Vadose zone soils encountered at the ALSCo facility included mostly sand with varying amounts of clay, silt, and gravel. Gravel content increases after approximately 30 feet bgs to become the dominant component with cobbles. A layer of silt and clay approximately ten feet thick was encountered at approximately 50 feet bgs. PCE was the most prevalent contaminant detected with detections of TCE and total 1,2-DCE to a lesser degree. The highest PCE concentration detected was in a split soil sample collected by ADEQ representatives at a concentration of 3.2 mg/kg (Analytical Technologies, Inc., 1992) (Table 2-5). This concentration exceeds the minimum GPL for PCE of 1.3 mg/kg. This split sample was also reported as having a PCE

concentration of 160 µg/kg in a table included in a split sampling report by Weston (1993a) but the report contained no laboratory reports for backup. This sample was collected during the installation of monitor well MW-2 (AVB40-07) at a depth of approximately 60 feet bgs adjacent to the center of the west property boundary. One other soil sample collected at the ALSCo facility contained PCE at a concentration greater than the minimum GPL. This soil sample contained PCE at a concentration of 1.57 mg/kg (Table 2-5). It was collected at a depth of approximately five feet bgs in the southwest corner of the facility building. The highest TCE concentration detected was 0.4 mg/kg. The highest total 1,2-DCE concentration detected was 0.08 mg/kg. No other COCs were detected in the soil samples. Soil samples analyzed by ALSCo contractors prior to November 1993 were not adequately extracted for VOC analysis and therefore are suspected to be reported at concentrations lower than what may have been actually present in soil samples (CEC/WRA, 1994).

Soil vapor monitor wells were installed at the site in 1998 (Fluor Daniel GTI, 1998c & IT Corp, 1999) (Appendix E). Soil gas samples collected from the vapor wells included detectable concentrations of PCE, TCE, cis-1,2-DCE, and benzene. The highest PCE concentration of 26,929 µg/l was detected west of the northwest corner of the building (Table 2-5). This sample was collected from a depth of approximately 65 feet to 68 feet bgs. The highest TCE concentration detected was 336 µg/l. The highest cis 1,2-DCE concentration detected was 61 µg/l. Benzene was detected in two samples at concentrations of 1.9 µg/l and 2.2 µg/l. ADEQ (HGC 1999b) conducted an SVE pilot test at the ALSCo facility in February 1999 using previously installed SVE and monitoring wells. Data from this pilot test indicated that conditions at the facility were favorable for remediation by SVE. As part of an ERA, a SVE, AS, and groundwater extraction and treatment remediation system was installed and operated at the facility.

Based on analytical data, four groundwater monitor wells were installed at the facility and at the neighboring property upgradient of the facility (CEC/WRA, 1993) (Appendix E). Additional groundwater monitor wells were installed during vadose zone characterization (Fluor Daniel GTI, 1998c). These included three nested wells in the central portion of the parking lot which were screened in the upper and lower zone of the UAU. COCs detected in groundwater samples collected at the facility include PCE, TCE, 1,1-DCE, 1,1-DCA, cis 1,2-DCE and chromium. Contaminants detected at concentrations greater then their AWQS included PCE, TCE, 1,1-DCE, and cis 1,2-DCE,. The highest PCE concentration was detected at 42,000 µg/l from groundwater monitor well MW-2 (AVB40-07). As mentioned above, this well is adjacent to the center of the west property boundary. The highest TCE concentration detected was 670 µg/l. This concentration was also detected in a groundwater sample collected from monitor well MW-2. The highest 1,1-DCE concentration detected was 18 µg/l. The highest cis 1,2-DCE concentration detected was 400 µg/l. These were both also detected in groundwater samples collected from monitor well MW-2. Data collected from the nested wells indicate that groundwater in deeper zones within UAU1 and UAU2 is not contaminated. A well was installed by ADEQ in the north portion of the parking lot near a drywell in December 1998 to assess the northern extent of groundwater contamination at the facility (IT Corp, 1999). Contaminants detected in the groundwater samples collected from this well were greater than their respective AWQS.

Groundwater monitoring indicated that groundwater elevations fluctuated with seasonal groundwater withdrawals as did horizontal flow directions and gradients. These data were, in general, similar to regional groundwater data, i.e., depths to groundwater fluctuated by ten feet or more; westerly flow direction ranged from northwest to southwest; and gradients fluctuated from approximately 0.0017 ft/ft to 0.0034 ft/ft.

The remediation system was operated periodically from 2001 to 2003. Testing after system shut down indicated that the ERA remedial action objectives (RAOs) were accomplished. The ending soil gas PCE and TCE concentrations indicated that the vadose zone RAOs of 20µg/L for PCE and 14 µg/L for TCE were met, and VOC concentrations detected in downgradient wells were similar to those in upgradient wells. Following groundwater and soil remediation, select groundwater monitor wells were abandoned by ADEQ. Currently ADEQ monitors two downgradient and one upgradient groundwater monitor wells and the three onsite nested monitor wells. ADEQ granted ALSCo an NFA determination for soil on March 24, 2008. Soil gas concentrations when converted to total soil concentrations equal 0.03 mg/kg PCE and 0.04 mg/kg TCE. Both of these values are below the current residential SRLs and minimum GPLs for PCE and TCE.

Several areas have been investigated at the ALSCo facility. Five of these areas, former sump, area of south door, area of north door, northwest corner of the old building, and northwest corner of the building addition, were identified to be source areas (HGC, 1996). The following lists the areas investigated, area description, contaminants detected, and corrective actions taken:

- Former Sump – Waste Water Disposal – VOCs – Soil Vapor Extraction
- Area of South Door – Surface Disposal of Waste Water – VOCs – Soil Vapor Extraction
- Area of North Door – Surface Disposal of Waste Water – VOCs – Soil Vapor Extraction
- Northwest Corner of the Old Building – Surface Disposal of Waste Water – VOCs – Soil Vapor Extraction
- Northwest Corner of the Building Addition – Surface Disposal of Waste Water – VOCs – No Action Taken
- Southwest Area of Parking Lot– Disposal of Waste Water – VOCs – Soil Vapor Extraction
- Central Area of Parking Lot– Disposal of Waste Water – VOCs – Soil Vapor Extraction
- North Area of Parking Lot – Disposal of Waste Water – VOCs – Soil Vapor Extraction
- Maroney's Cleaners #1 Machine – Dry Cleaning – VOCs – Soil Vapor Extraction
- Maroney's Cleaners #2 Machine – Dry Cleaning – VOCs – Soil Vapor Extraction
- Historical Solvent Use Area – Dry Cleaning – VOCs – No Action Taken

2.3.6 CRC

Site investigation activities conducted at the CRC facility were initiated in April 1990 (Pegler-Welch, Inc., 1990) (Appendix F). Analytical results of soil samples collected during initial

sampling indicated the presence of PCE, 1,2-dichlorobenzene, cadmium, chromium, and lead. The highest PCE concentration detected was 53.8 parts per billion (ppb) and was located in the west bay area near the anodize area. The highest chromium concentration was 1,100 parts per million (ppm) and was located in the chrome plating area. Soils encountered in the vadose zone at the CRC facility included silt and sand with varying amounts of gravel to approximately ten feet bgs. Gravel with varying amounts of silt, sand, and cobbles were encountered below approximately ten feet bgs. A soil vapor survey was conducted at the facility and adjacent properties in October 1992 (Weston, 1992b) (HGC, 1992b). Data collected during this investigation indicated that PCE, TCE and 1,1-DCE were present in the soil vapor beneath the facility. The most commonly detected COC was PCE. The highest PCE concentration was detected at 1,100 µg/l (Table 2-5). This was detected in the vicinity of the former PCE UST at a depth of approximately five feet bgs. The highest TCE concentration detected was 13.2 µg/l. 1,1-DCE was detected at concentrations of 0.17 µg/l and 0.21 µg/l. Additional soil sampling was conducted at the site in the area of the chrome plating operations in 1994 and the anodizing area in 1996 (Hargis + Associates, Inc. [HAI], 1995a and 1997). Chromium was detected at a maximum concentration of 223 mg/kg in two soil samples collected at ten feet bgs and 14 feet bgs of the chrome plating area, which is greater than the nonresidential and residential SRLs of 65 mg/kg and 30 mg/kg, respectively, for chromium assuming that the chromium concentration is in the form of hexavalent chromium. VOCs were not analyzed for in chrome plating area soil samples.

Chromium was detected at concentrations of up to 663 mg/kg in soil samples collected from the anodizing area and PCE was detected at concentrations of up to 3,500 mg/kg (Table 2-5). The chromium concentration exceeds the minimum GPL of 590 mg/kg. This chromium concentration also exceeds the current SRLs for chromium in the form of hexavalent chromium. The PCE concentration exceeds the nonresidential and residential SRLs of 13 mg/kg and 0.51 mg/kg, respectively, and the minimum GPL of 1.3 mg/kg. In 2005, soil samples were collected from the area of the waste water treatment plant (HAI, 2006). Chromium and other metals were detected in the soil samples with chromium exceeding the residential SRL in one sample.

In 1995, soil beneath the chrome plating east bay area was excavated and transported offsite for disposal (HAI, 1995b) (Appendix F). Chromium concentrations of up to 32,000 mg/kg were detected in soil during excavation (Table 2-5). Soil was excavated to approximately 10.5 feet bgs. Remaining concentrations of chromium detected in confirmation soil samples were as high as 1,760 mg/kg which exceeds the nonresidential and residential SRLs of 65 mg/kg and 30 mg/kg, respectively, for chromium in the form of hexavalent chromium and the minimum GPL of 590 mg/kg, and PCE was detected at a concentration of 1.10 mg/kg. The only other COC detected in soil samples collected at the facility was 1,1-DCE, which was detected in one soil sample at a concentration of 0.05 mg/kg.

Concurrent with excavation activities, two groundwater monitor wells were installed at the facility (Appendix F). PCE and hexavalent chromium were detected in the groundwater samples collected from the groundwater monitor well located downgradient of the chrome plating area at concentrations greater than AWQSs. A groundwater monitor well was installed downgradient of the CRC facility in 1997 (HAI, 1997). Chromium was not detected in the initial groundwater samples collected from the downgradient well but PCE was detected at concentrations greater

than the AWQS. In 1998, two groundwater monitor wells were installed downgradient of the facility and a deep well was installed at the facility into the UAU2 (HAI, 1999). Data collected from the deep well indicated that groundwater in the UAU2 is not contaminated. Groundwater samples collected from the downgradient wells have contained chromium at concentrations greater than the AWQS on occasion and have consistently contained PCE at concentrations greater than the AWQS. TCE, 1,1-DCE, and cis 1,2-DCE have also been detected in groundwater samples collected from monitor wells associated with this facility but the concentrations have been less than the AWQS. The highest chromium and PCE concentrations detected at the facility are 25 mg/L and 1,800 µg/L, respectively. Groundwater monitoring indicates that groundwater elevations fluctuate with seasonal groundwater withdrawals as do horizontal flow directions and gradients. Depths to groundwater fluctuate by ten feet or more; the horizontal flow direction ranges from northwest to west-northwest; and gradients fluctuate from approximately 0.003 ft/ft to 0.009 ft/ft. CRC continues to collect groundwater samples from the groundwater monitor wells on a quarterly basis.

CRC currently has an approved remedial action plan in place to excavate contaminated soil in the vicinity of the anodizing area. Several areas have been investigated at the CRC facility. Three of these areas, former chrome plating area, anodizing area, and the former PCE UST have had releases of contaminants. The following lists the areas investigated, area description, contaminants detected, and corrective actions taken:

- Former Chrome Plating Area – Metal Plating – Metals/VOCs – Soil Excavation
- Anodizing Area – Metal Plating – Metals/VOCs – No Actions Taken
- Former PCE UST – Chemical Storage – Metals/VOCs – No Actions taken
- Waste Water Treatment Plant – Waste Water Treatment – Metals – No Action Taken

2.3.7 U.S. DOE WAPA

In June 1992, during UST release investigations, PCE and TCA were detected in six soil samples but at concentrations less than HBGLs (Woodward-Clyde Consultants, 1994) (Appendix I). PCE concentrations ranged from 0.011 mg/kg to 0.23 mg/kg. TCA was detected in one soil sample at a concentration of 0.032 mg/kg. Soils encountered in the vadose zone consisted of clay and silt to approximately 30 feet bgs with an occasional thin sand lens at approximately 15 feet bgs. Gravel with sand and cobbles underlie the fine-grained soils. Three groundwater monitor wells were installed during the UST investigation. Detected COCs included PCE, TCE, 1,1-DCE, cis-1,2-DCE, and 1,1-DCA. Groundwater samples collected from the wells contained PCE and TCE at concentrations that exceeded the AWQS of 5 µg/l for both VOCs. The highest PCE concentration detected was 62 µg/l. The highest TCE concentration detected in groundwater samples collected at the facility was 77 µg/l.

In 2001, ADEQ began sampling of three on-site groundwater monitor wells and a production well used for irrigation (Appendix I). In May 2003, U.S. DOE sampled two drywells at the site, DW-1 (the southern drywell) and DW-2 (the northern drywell) (SCS Engineers, 2003). Both drywells contained wet sediment and DW-2 contained liquid. Sample DW-2 did not contain detectable VOCs, however, sample DW-1 contained 1,1-DCE at 0.32 mg/kg.

A soil vapor survey was conducted in the operations area of the DOE complex in April 2005 (SCS Engineers, 2005) (Appendix I). The site was divided into six investigation areas and sampling was performed in each of the areas judged to contain potential sources of VOCs. A total of 103 samples were collected at the six areas. The highest PCE concentration was detected in two of the samples at 0.72 µg/L. TCE was detected in five soil vapor samples collected by DOE's consultant and in three split soil vapor samples collected by ADEQ. SCS Engineers analyzed the samples using EPA Method 624 Modified and ADEQ analyzed the samples using EPA Method TO-15 Modified. The concentrations were less than 1 µg/L in all but one ADEQ sample which contained PCE (0.92 µg/L) TCE (1.6 µg/L), 1,1-DCE (0.1 µg/L), and cis 1,2-DCE (0.011 µg/L) in sample PAO-SV-A4-8-18. Trichlorofluoromethane was detected in one soil vapor sample at 2,900 µg/L in PAO-SV-A6-5.

ADEQ has met with WAPA personnel and requested that DOE conduct a soils investigation at the substation to evaluate whether releases to the environment have occurred at this facility, and have requested additional groundwater investigation at the operations and maintenance complex.

Several areas have been investigated at the DOE facility. One of these areas, the craneway building, experienced a release of contaminants. The following lists the areas investigated, area description, contaminants detected, and corrective actions taken:

- Craneway Building – Equipment Maintenance –VOCs – No Action Taken
- Drywells – Storm Water Runoff – No Contaminants – No Action Required
- Heavy Equipment Storage Area – Equipment Storage – No Contaminants – No Action Required
- Warehouse Storage Area – Storage – No Contaminants – No Action Required
- Service Station – Vehicle Fueling – No Contaminants – No Action Required
- Vehicle Repair Shop – Vehicle Repair – No Contaminants – No Action Required
- Paint Shop – Painting – No Contaminants – No Actions Required
- Shop Building – Maintenance – No Contaminants – No Action Required

2.3.8 POS

POS has conducted three soil investigations including characterization of a UST release and two laundry area investigations (Appendix H). Soils within the vadose zone beneath the POS facility consist of interfingered layers of sand, silt, and clay to 107 feet bgs, the maximum depth explored. In December 2004, a soil and soil gas investigation was conducted at the facility (Miller Brooks, 2005). Soil samples were collected from six locations (SG-1, SG-5, SG-6, SG-7, SG-8, and SG-9) and soil gas samples were collected from nine locations (SG-1 through SG-9). Soil samples were collected at depths of 5 to 6 ft bgs and 7 to 8 ft bgs. Laboratory analysis did not detect COC above the minimum laboratory reporting limits in the soil samples. Laboratory analysis of each of the soil gas samples detected PCE concentrations in each soil gas sample. The PCE concentrations ranged from a minimum of 15.6 µg/l to a maximum of 950 µg/l. The highest PCE concentration, 950 µg/l, was detected in sample SG-8 at a depth of 11 feet bgs, adjacent to the wastewater flume and the wastewater discharge line. In addition to PCE, TCE

was also detected in the three soil gas samples that had the highest PCE concentrations. The highest TCE concentration detected was 5.37 µg/l. TCE was not detected above minimum laboratory limits in the other six soil gas samples, possibly because of elevated detection limits due to dilution of the samples by the laboratory because of high PCE concentrations.

Based on the results of the initial investigation, a soil and soil gas investigation was conducted at two locations on the POS property on October 16 though 19, 2006 (Miller Brooks, 2007) (Appendix H). Soil samples and soil gas samples were collected from the northwest corner of the former dry-cleaning room and under the canopy, adjacent to the reclaim equipment. The highest PCE concentration detected in soil beneath the former dry-cleaning room was 1.7 mg/kg collected at 95 ft bgs. The highest PCE concentration detected in soil beneath the reclaim equipment was 1.9 mg/kg collected at 85 ft bgs. Both concentrations exceed the residential SRL of 0.51 mg/kg and the minimum GPL of 1.3 mg/kg. Two other soil samples collected in the former dry-cleaning room and three other soil samples collected near the reclaim equipment contained PCE at concentrations greater than the residential SRL but less than the minimum GPL. No other VOCs were detected. Laboratory analysis of each of the soil gas samples detected PCE concentrations. The highest PCE concentration detected was 2,985 µg/l from a depth of 105 ft bgs. This soil gas sample was collected from beneath the former dry-cleaning room. PCE was also detected beneath the reclaim equipment at a maximum concentration of 2,900 µg/l at 85 ft bgs. TCE was detected in soil gas samples collected from beneath the former dry-cleaning room but not in soil gas samples collected from beneath the reclaim equipment. The highest TCE concentration detected in soil gas was 27.4 µg/l. collected from a depth of 105 feet bgs. Although not detected, the method reporting limits for additional COC were elevated due to the high PCE concentrations.

Several areas have been investigated at the POS facility. Three of these areas, former dry cleaning area, waste water flume, and parts washer area have had releases of contaminants. The following lists the areas investigated, area description, contaminants detected, and corrective actions taken:

- Former Dry-Cleaning Area – Cleaning and PCE Storage –VOCs – No Actions Taken
- Former Dry Wells – Storm Water Runoff – VOCs – No Action Required
- Waste Water Flume – Waste Water Disposal – VOCs – No Action Taken
- Parts Washer – Parts Cleaning – VOCs – No Action Taken

2.3.9 ALASG

ALASG has investigated soil at their facility through the collection of soil gas and soil samples. Soils encountered beneath the site include sand with gravel to approximately 19 feet bgs. Underlying the surficial unit is clayey silt to approximately 39 feet bgs. Gravel, cobbles, and sand underlie the clayey silt. A soil gas survey was initially conducted at ALASG in July 1998 (ENSR, 1998) (Appendix G). VOCs detected during the investigation included PCE, TCE, TCA, and 1,1-DCE. The highest concentrations were detected in the building which contained the former ASU located adjacent to the eastern boundary of the facility. TCA was detected at the highest concentration of the VOCs analyzed for at a concentration of 440 µg/l. This sample was

collected from a depth of approximately 18 feet bgs in the south end of the ASU building. The highest PCE concentration detected was 150 µg/l. This soil gas sample was collected at a depth of 16.5 feet bgs located near the center of the facility between the acetylene plant and the fill plant. One soil gas sample, SG 2-6', yielded liquid containing TCA and PCE. This sample was collected at a depth of approximately six feet bgs near the west grease trap in the ASU building.

Additional soil sampling, soil gas extraction well installation, and soil gas sampling were conducted at the ALASG facility in 2000, 2003, and 2004 (BRH, 2001a, 2004, 2005) (Appendix G). VOCs were detected during these investigations including PCE, TCE, TCA, 1,1-DCE, 1,1-DCA, and 1,2-DCA. TCA was detected at the highest soil gas concentration of the VOCs analyzed at a concentration of 55,000 µg/l (Table 2-5). This soil gas sample was collected at a depth of five feet bgs at the west grease trap in the ASU building. 1,1-DCA was detected at a concentration of 1,700 ug/l in the same soil gas sample. The highest 1,1-DCE concentration detected was 440 µg/l in the same sample. The highest soil gas concentration detected for PCE during this phase of investigation was 90 µg/l. This concentration was detected at two locations, in the northwest corner of the facility at a depth of approximately 55 feet bgs and in the north central portion of the facility at a depth of approximately 55 feet bgs. The highest VOC concentration detected in soil samples was TCA detected at a concentration of 6,300 mg/kg. This sample was collected at a depth of approximately four feet bgs in the vicinity of the west grease trap in the air separation unit building. This concentration exceeds the residential and nonresidential SRL of 1,200 mg/kg and the minimum GPL of 1 mg/kg. TCA was also detected at a concentration of 1,100 mg/kg from the same depth in another area of the west grease trap. 1,1-DCE was detected at a maximum concentration of 100 mg/kg in soil samples collected at the ALASG facility. This concentration is greater than the minimum GPL for 1,1-DCE of 0.81 mg/kg. This soil sample was collected from a depth of approximately four feet bgs in the vicinity of the west grease trap. Two soil samples collected from the area of the west grease trap contained TCE at concentrations greater than the minimum GPL for TCE of 0.61 mg/kg. 1,2-DCA was also detected in a soil sample from this area with a concentration greater than the nonresidential SRL, residential SRL, and minimum GPL of 5.5 mg/kg, 2.5 mg/kg, and 0.21 mg/kg, respectively. PCE was not detected at concentrations greater than the SRLs or minimum GPL in soil samples collected at the ALASG facility. Chromium was detected in three soil samples collected at the grease trap at concentrations less than the regulatory standards for chromium.

Three groundwater monitor wells were installed at the ALASG facility in November 2000 (BRH, 2001b) (Appendix G). The wells were located in the vicinity of the ASU building. COCs detected in groundwater samples collected at the facility include PCE, TCE, 1,1-DCA, 1,1-DCE, TCA and cis 1,2-DCE. PCE and TCE were detected at concentrations greater than the AWQS in groundwater samples collected from the monitor wells (BRH, 2001b, 2001c, 2001d, 2003). The highest PCE concentration detected was 22µg/l. The highest TCE concentration detected was 18 µg/l. PCE and TCE concentrations were slightly higher in groundwater samples collected from the downgradient monitor well as opposed to the upgradient and cross-gradient monitor wells. Four additional groundwater monitor wells have been installed at the facility under a consent order; however, no reports have been submitted to ADEQ to date.

Several areas have been investigated at the ALASG facility. One of these areas, grease trap and associated conduits within the former air separation unit, has had a release of contaminants. The following lists the areas investigated, area description, contaminants detected, and corrective actions taken:

- Grease Trap and Associated Conduits – Water Disposal –VOCs – No Actions Taken
- Acetylene Plant – Acetylene Gas Production/Packaging – VOCs – No Action Required
- Plant and Former Truck Maintenance Area – Gas Mixing/Packaging & Vehicle Repair – VOCs – No Action Required
- Northwest Parking Area – Vehicle Parking – No Contaminants – No Action Required
- Chemical Storage Area – Chemical Storage – No Contaminants – No Action required
- Cylinder Cleaning Racks – Cylinder Cleaning – No Contaminants – No Action Required

2.4 Remedial Activities

2.4.1 Facility Activities

2.4.1.1 Reynolds

Reynolds operated an SVE system installed at the site in 1989 and operated it periodically until 1991 (Reynolds Metals Co., 1994). Operation was discontinued because of air permit limitations. The mass of contaminants removed by the SVE system is not available. The SVE system was to be restarted following modifications to the system and permit but Reynolds completed risk analyses instead of operating the SVE system. Trenching and excavation activities were also conducted at several areas across the Reynolds facility to remove contaminated soils, mostly contaminated with petroleum hydrocarbons. Reynolds excavated and removed approximately 3,100 tons of contaminated soil from the site. Risk assessments were conducted for the release areas where residual soil contamination was present. ADEQ subsequently issued NFAs for 14 release areas at the facility (ADEQ, 2000).

2.4.1.2 VW&R

In an effort to remediate soil at the site, VW&R installed an SVE system at the site and began operating the system in November 1992 under Maricopa County Division of Air Pollution Control Permit No. 9301590 (Ensolutions, Inc., 1998) (Appendix B). Installation and operation of the SVE system was a voluntary remedial action to remove soil vapors containing VOCs from the subsurface. The system consisted of a positive displacement blower to create a vacuum at seven vapor extraction wells located in the area north of the solvent tank farm, the area south of the solvent tank farm, and the area north and west of the corrosive tank farm. Extracted vapors were routed through an air water separator, inlet filter, and two granular-activated carbon (GAC) canisters connected in series. Radius of influence testing was conducted at the facility to

demonstrate the effectiveness of the remediation system on November 1, 1997 (Ensolutions, Inc., 1998). Results of the radius of influence testing indicated that the SVE system was designed and operated to effectively remediate the source areas targeted by the remediation system. The system ran periodically until October 25, 1998 when it was shut down (Van Waters & Rogers Inc., 1999). After the system was shut down, a calculation of the amount of VOCs removed was completed resulting in an estimation of 580 pounds to 870 pounds of VOCs removed from the subsurface (Ensolutions, Inc., 2000). After the system was shut down, soil samples were collected from the source areas to evaluate contaminant concentrations (Geotrans, Inc., 2001). Confirmation soil samples indicated that soil contamination had been remediated and ADEQ issued an NFA letter to VW&R for the remediated soil contamination (ADEQ, 2002).

2.4.1.3 MCMM

MCMM installed/operated an SVE system from mid August to early September and mid October to late November 1997 (Appendix C). Subsequent soil vapor testing indicated that PCE and TCE levels were asymptotic and were calculated to have been reduced below minimum GPLs (Fluor Daniel GTI, 1998b). Final PCE and TCE concentrations were measured at 532 µg/l and 525 µg/l, respectively. The minimum GPLs calculated for the facility were 2,707 µg/l for PCE and 1,403 µg/l for TCE. An estimated 145 pounds of VOCs were removed from the subsurface via the SVE system (Fluor Daniel GTI, 1998a). In October 2001, Maricopa County and Union Pacific Railroad settled with ADEQ.

2.4.1.4 Dolphin

As previously mentioned, three SVE systems and an AS system were operated at the Dolphin facility under a RCRA consent order. (Brown and Caldwell, 1999b) (Appendix D). The two SVE systems installed in the vicinity of the former PCE degreaser and former drum storage areas near the Dolphin I building included six nested well clusters (Brown and Caldwell, 2000b). The well clusters included a well screened in the shallow coarse-grained unit which extends to a depth of approximately 18 to 20 feet bgs, the fine-grained deeper unit which extend to approximately 50 feet bgs, and the deeper coarse-grained unit which extends to the groundwater table. The Dolphin I HF SVE system extracted soil vapors from the two coarse-grained units. The Dolphin I LF SVE system extracted soil vapors from the fine-grained unit. The third SVE system was installed in the vicinity of the closed sewer interceptor at the Dolphin III building. This system utilized one SVE well screened in the lower coarse-grained unit. The SVE extraction systems each consisted of a positive displacement blower, air and water separator, and two 2000-pound GAC canisters connected in series. A radius of influence study was conducted at the facility during the pilot test in 1996 and determined that the systems would be a viable method of remediation.

The AS system included three wells installed adjacent to SVE extraction wells in vicinity of the former PCE degreaser and former drum storage area near the Dolphin I building (Brown and Caldwell, 2000b) (Appendix D). The wells were screened at 120 to 130 feet bgs. The AS system was operated concurrent to the Dolphin I SVE system. Although there is no method to measure the amount of VOCs removed from the groundwater by the AS system, concentrations of COCs contained in the groundwater samples dropped substantially including PCE from a high

concentration of 95,000 µg/l to as low as 5.2 µg/l. Currently, COC concentrations contained in groundwater samples collected from upgradient wells are similar to concentrations detected in groundwater samples collected from source wells.

The Dolphin I HF and LF systems operated from October 1998 until April 2002 when soil vapor concentrations had reached asymptotic concentrations (Brown and Caldwell, 2004a). Final PCE concentrations contained in soil vapor samples ranged from less than the detection limit of 0.50 µg/l to 1,500 µg/l. TCE concentrations contained in soil vapor samples ranged from less than the detection limit of 0.50 µg/l to 2.7 µg/l. 1,1-DCE concentrations contained in soil vapor samples ranged from less than the detection limit of 1.0 µg/l to 5.6 µg/l. The remediation criteria for PCE, TCE, and 1,1-DCE were 2,120 µg/l, 976 µg/l, and 1,389 µg/l, respectively. GAC sampling indicated that approximately 5,290 pounds of VOCs were removed from the two coarse-grained units in the vicinity of the Dolphin I building and approximately 5,168 pounds of VOCs from the fine-grained unit in the vicinity of the Dolphin I building. Decommissioning sampling of the SVE systems indicated that VOCs in soil vapors had been reduced to concentrations indicative that the soil concentrations are less than the residential SRLs and minimum GPLs. The Dolphin III SVE system was operated from November 1998 to November 2001 when soil vapor concentrations had reached asymptotic concentrations (Brown and Caldwell, 2002b). Final PCE concentrations contained in soil vapor samples ranged from 4.0 µ/l to 9.5 µg/l. TCE and 1,1-DCE soil vapor concentrations were all less than the detection limit of 0.50 UG/l and 1.0 µg/l, respectively. The remediation criteria for PCE, TCE, and 1,1-DCE were 2,120 µg/l, 976 µg/l, and 1,389 µg/l, respectively. GAC sampling indicated that approximately 1,200 pounds of VOCs were removed from the lower coarse-grained unit in the vicinity of the Dolphin III sewer interceptor.

2.4.1.5 CRC

In 1995, soil beneath the chrome plating east bay area was excavated and transported offsite for disposal (HAI, 1995b) (Appendix F). Chromium concentrations of up to 32,000 mg/kg were detected in soil during excavation (Table 2-5). Soil was excavated to approximately 10.5 feet bgs. Logistics and the coarse-grained nature of the soils encountered prevented the excavation of additional soil. Remaining concentrations of chromium detected in confirmation soil samples exceeded the nonresidential and residential SRLs and the minimum GPL for chromium. PCE was also detected in confirmation soil samples but at concentrations less than soil standards. Additional remediation activities are proposed for the west bay area of the facility for chromium and PCE if present.

2.4.2 ADEQ ERA

An ERA is a remedial action performed at the site prior to the final remedy, and often prior to the completion of the RI. Pursuant to A.A.C. R18-16-405, an ERA is conducted to address current risks to public health, welfare, and the environment; protect or provide a supply of water; addresses sources of contamination; or controls or contains contamination where such actions are expected to reduce the scope or cost of the final remedy at the WQARF site. The purpose of the ERA at this facility was to remove the source so as not to exacerbate the soil and groundwater contamination.

An ERA was conducted for the WVBA WQARF site at the ALSCo facility at 722 W. Buchanan Street in Phoenix, Arizona (Appendix E). As described in Section 1.3.2.4, the facility has provided industrial laundry and linen supply services to the Phoenix area for many years. ALSCo had settled liability with the State on May 15, 1997. The ERA was initiated to control the migration of COC plume and reduce VOC concentrations, particularly PCE, in soils at the site to concentrations that would not cause additional groundwater contamination. Groundwater extraction and treatment, SVE, and AS were employed to complete the ERA.

The initial ERA evaluation was conducted by ADEQ's contractor HydroGeoChem, Inc. As previously mentioned in Section 2.3.5, HGC (1999b) conducted an SVE pilot test at the ALSCo facility in February 1999. The data obtained from the pilot test were used to design the SVE system. In July 1999, HGC recommended a remedial design. Further refinements to the design and specifications were developed following an aquifer test conducted by HGC (2000). Following approval, ADEQ retained BE&K/Terranext to serve as the oversight contractor and to install the groundwater extraction well and injection well, the six AS wells, and five of the seven SVE wells.

ADEQ ascertained that RAOs for groundwater at ALSCo were to reduce PCE and TCE concentrations in groundwater beneath the site to levels that were relatively the same as upgradient water quality, and the treatment system was no longer efficiently removing groundwater contamination. The RAOs for PCE and TCE in soil gas concentrations within the vadose zone soil were calculated by HGC to be 20 µg/l and 14 µg/l, respectively.

The SVE system was designed to extract soil gas from seven soil vapor extraction wells at a total flow rate of up to 400 cubic feet per minute (cfm). The SVE system was operated in conjunction with the AS system to capture VOCs liberated from groundwater as a results of AS. The SVE system could also be operated as a stand-alone system for remediation of PCE from the unsaturated zone. The AS system was designed to operate in conjunction with the SVE system only. The groundwater extraction system was designed to operate independent of the SVE/AS systems. Extracted groundwater was routed through the heat exchanger to cool the extracted vapor stream prior to entry into the GAC canisters. Therefore, the SVE system was not operated without the groundwater extraction system operating.

The groundwater extraction well was installed along the central area of the west property boundary and the injection well was installed near the southeast corner of the property in November 1999 (BE&K/Terranext, 2000f) (Appendix E). The extraction well was completed to a depth of 122 feet bgs with a screened interval of 67 feet bgs to 122 feet bgs. The injection well was completed to a depth of 123 feet bgs with a screened interval of 68 feet bgs to 123 feet bgs. During September through November 2000, a submersible pump with 150 gallons per minute (gpm) capacity at 185 feet total head was installed in the extraction well and the groundwater extraction well and the injection wells were piped to the groundwater treatment system (BE&K/Terranext, 2001d). The groundwater treatment system consisted of two bag filters to remove suspended solids and two 5,000-pound liquid phase GAC containing canisters to remove VOCs. In August 2001, the extraction well was removed from service because of sand intrusion. This well was replaced in November with an adjacent similarly designed well. The

extraction/injection wells were operated in compliance with ADWR Poor Quality Groundwater Withdrawal Permit 59-582827.

Five AS/SVE well clusters and one AS well were installed in July 2000 in the area of the facility west of the building (BE&K/Terranext, 2001d). Two vapor extraction wells had been previously installed at the facility in December 1998 in the area of the former grease trap adjacent to the west end of the facility building (IT Corp, 1999). One of these two extraction wells was completed with a screened interval of 35 feet bgs to 55 feet bgs and one with a screened interval of 65 feet bgs to 95 feet bgs. The AS wells were completed with screened intervals of 105 feet bgs to 115 feet bgs. The SVE wells were installed with screened intervals of 45 feet bgs to 70 feet bgs. During September through November, the remediation wells were piped to the treatment compound. The SVE system consisted of a moisture knockout tank, condensate storage tank, heat exchanger, two 5,000-pound vapor phase GAC containing canisters, and an SVE blower with a design capacity of 370 standard cfm at five inches mercury inlet vacuum pressure and 1.5 inches mercury outlet pressure. The AS system consisted of a receiver tank and oil-cooled rotary screw air compressor with a capacity of 40 cfm at 125 pounds per square inch (psi). The remediation systems were connected to a telecommunications system for remote monitoring and notification of system failure.

Following remediation system installation, the system was prepared for startup (URS, 2001). Initial startup involved the testing of the SVE system in January 2001. The optimal air flow was set to 310 to 350 standard cfm with initial PCE concentrations measured at the well heads ranging from 86,000 to 660,000 parts per billion volume (ppbv). The PCE concentration upstream of the GAC was 280,000 ppbv and at the exhaust stack at 3,600 ppbv. The SVE system was operated in accordance with Maricopa County Environmental Services Air Quality Division Air Quality Permit No. 000164. The AS system was designed to volatize VOCs contained in the groundwater beneath the facility. Initial testing was conducted in February 2001. Based on AS testing, the system was set to operate at wellhead pressures of 12.5 to 30 psi. Start-up of the entire remedial system was on March 7, 2001. Sampling of the waste streams was conducted following startup with the following results:

Vapor In		Vapor Out – Canister 1		Vapor Out – Canister 2	
Compound	Concentration ppbv	Compound	Concentration ppbv	Compound	Concentration ppbv
PCE	260,000	PCE	11,000	PCE	<5
TCE	6,000	TCE	140	TCE	<5
Cis-1,2-DCE	2,800	Cis-1,2-DCE	33	Cis-1,2-DCE	<5
Groundwater In		Groundwater Out – Canister 1		Groundwater Out – Canister 2	
Compound	Concentration µg/l	Compound	Concentration µg/l	Compound	Concentration µg/l
PCE	39	PCE	<2	PCE	<2
TCE	6.4	TCE	<2	TCE	<2

The groundwater extraction and treatment system was operated from March 2001 to September 2003. As mentioned above, problems developed with the extraction well in August 2001 and the groundwater extraction system was shut down while a replacement well was completed. Groundwater levels were measured at onsite and offsite groundwater monitor wells monthly by BE&K/Terranext to calculate the capture zone. Data indicated that the capture zone covered the ALSCo facility. Groundwater samples were collected from onsite groundwater monitor wells and the groundwater treatment system quarterly. Analytical data for the groundwater samples indicated a decrease in concentrations with time and no breakthrough occurred at the groundwater treatment system. As of September 2003, an estimated 24 pounds of VOCs had been removed from groundwater and over 118 million gallons of water had been treated (BE&K/Terranext, 2003d, URS, 2003, ADEQ, 2004). Groundwater influent concentrations for March 2003 were PCE at <2.0 µg/l and TCE at 2.5 µg/l. Groundwater data collected from downgradient wells were similar in concentration to upgradient wells. Based on these data, it was ascertained that the RAOs for groundwater had been met.

The SVE system was operated to maximize contaminant mass removal within air permit operating limits (URS, 2001). This required regular monitoring and adjustment of the SVE system by URS to maintain the highest flow rate and concentration of contamination from the extraction wells while insuring compliance with the air quality permit. Prior to system startup, the highest soil concentrations detected at the facility were PCE at 3,969,400 ppbv, TCE at 14,590 ppbv, and 1,2-DCE at 15,510 ppbv (IT Corp, 1999). During SVE system operation, soil vapor concentrations rapidly dropped until reaching asymptotic levels by the end of the first year of operation. To augment the recovery of contaminants from the vadose zone, air injection was conducted at select SVE wells starting in December 2001 (BE&K/Terranext, 2003d). This process increased the recovery of VOCs from the vadose zone but operational problems with the SVE equipment limited the effectiveness of the process. By October 2002, soil vapor concentrations had dropped to levels less than the RAOs.

The groundwater extraction and treatment system ceased operation in September 2003 after treating approximately 118 million gallons of groundwater and removing approximately 17.8 lbs of PCE, 6.0 lbs of TCE and 0.1 lbs of DCE (BE&K/Terranext, 2003d, URS, 2003, ADEQ, 2004). The system was temporarily shut down to allow for any “rebound” in the presence of dissolved halogenated organic compounds in groundwater within the former source area. During the “rebound” period, groundwater sampling and groundwater elevation measurement events were conducted. Data could not be collected in September 2003 because of declining groundwater levels. One year of groundwater rebound testing did not support re-starting the remedial system. Since shutdown of the groundwater extraction system, PCE concentrations in groundwater samples collected from the downgradient well, AVB40-7, have been only slightly greater than concentrations detected in the upgradient well AVB40-08. TCE concentrations in groundwater samples collected from the downgradient well have been less than the concentrations in the upgradient well. PCE and TCE concentrations in groundwater samples collected from the crossgradient well, AVB77-04, have been less than the concentrations in groundwater samples collected from the upgradient well.

The SVE system ceased operation in October 2002 after the removal of over 900 pounds of VOCs from the vadose zone (BE&K/Terranext, 2003d). ADEQ then evaluated if the SVE system had accomplished its goal of remediating the soil. Rebound sampling was performed by sampling the SVE vapor stream on a monthly basis until January 2003 and then again in four months. These data were evaluated to evaluate whether significant concentrations of contaminants were still present in the vadose zone. Results of a mass balance analysis of remaining VOCs in soils and the operation optimization study mentioned above indicated that soil contamination concentrations were less than minimum GPLs. Given the results of the vadose zone investigation relative to the remaining presence of PCE and TCE in soil (under equilibrium conditions) as of May 22, 2003, the vadose zone soil within the source area had been substantially remediated within the depth interval of 13.5 feet bgs to 68 feet bgs. Further, the RAOs for soil within this interval were initially achieved by May 22, 2003. As a result, further soil remediation and soil gas sampling for analysis within the depth interval of 13.5 to 68 feet bgs were no longer necessary. Beneath 68 feet bgs to the water table surface, vadose zone soil within the source area had been substantially remediated relative to ADEQ minimum GPLs and the RAOs. Further soil remediation beneath 68 feet bgs was no longer recommended.

During the first quarter of 2005, Terranext performed field tasks in several phases, regarding the closure of the ERA remediation systems. The field tasks consisted of well abandonments, remediation compound closure, and restoration of the asphalt parking lot within the former remediation compound and at the abandoned wells. On March 24, 2008, ADEQ granted ALSCo an NFA determination for soil (ADEQ, 2008).

3.0 HYDROGEOLOGY

3.1 Regional Geology

As previously mentioned, The WVBA is located within the West SRV, an alluvial basin characteristic of Basin and Range physiography. The rocks that form the bounding mountains and valley floor of the SRV are predominantly crystalline rocks.

The SRV alluvial basin consists of basin-fill deposits of unconsolidated to semi-consolidated Late Tertiary to Quaternary sediments (Weston, 2000). They range up to several thousand feet thick within the center of the basin and consist of interbedded cobbles, gravel, sand, silt, clay, and evaporites. The lithologic relationships appear to represent alluvial fan and playa deposits formed in a closed basin during the early and middle stages of basin development followed by fluvial and alluvial fan deposits formed during the late stages of basin development after the establishment of through-flowing drainages (Corkhill and others, 1993). These deposits are subdivided into three hydrogeologic units that comprise the regional aquifer in the SRV:

- Lower Alluvial Unit (LAU)
- Middle Alluvial Unit (MAU)
- Upper Alluvial Unit (UAU)

The LAU consists mainly of conglomerate and gravel grading into finer-grained mudstones toward the center of the basin and locally contains volcanic rocks. The LAU reaches thicknesses of up to 10,000 feet in the center of the basin. The LAU was deposited during the early stages of basin development. The increasing thickness and decreasing particle size of the LAU with increasing distance from the surrounding mountains suggest that the alluvial basin was closed during deposition of the LAU (Laney and Hahn, 1986). Few wells penetrate the LAU due to its depth and low yield. The LAU does not appear to be contaminated within the WVBA.

The MAU overlies the LAU and consists predominantly of silt and clay with interbedded sand and gravel lenses. Many of the fine-grained deposits in the MAU can be associated with ancient playa environments based on the extensive evaporite deposits encountered (Brown and Pool, 1989). As more through-flowing streams developed, the lithologic sequence grades into fluvial sands and gravels interspersed with clays associated with backwater areas. Although minor in thickness when compared to the silt and clay, the sand and gravel lenses can yield large quantities of water to wells. Near the basin margin, the MAU consists mainly of sand and gravel, and is difficult to distinguish from the UAU. The MAU reaches thicknesses of 1,600 feet in the SRV.

The UAU extends from the ground surface to the top of the MAU. The UAU consists mainly of unconsolidated silt, sand, and gravel deposited during the final stages of SRV basin development. The association of coarse-grained deposits within the vicinity of the Salt River suggests that the UAU was deposited by the ancestral Salt River. The UAU grades from predominantly gravel and cobbles near the Salt River to finer floodplain

deposits in adjacent areas (Brown and Pool, 1989). The UAU ranges between 200 and 500 feet in thickness, and most water production wells extract a large portion of their water from the UAU (Weston, 2000).

3.2 WVBA Geology

Terranext (2006d) prepared geologic cross-sections across the WVBA and used these cross sections to evaluate alluvial unit stratigraphy. Numerous geologic logs of varying quality are available for the WVBA. The logs were first reviewed for quality and those with minimal lithologic descriptions (exclusively ADWR well logs) or of shallow (less than 200 feet bgs) wells were excluded; logs of shallow wells were excluded because, in most instances, these wells did not penetrate the base of UAU1 as described below. Locations of the remaining logs were then plotted. Based upon the spatial distribution of available well logs, six cross-section locations were identified. These include two east-west sections and four north-south sections spread out across the WVBA (Figure 3-1). Boring and geophysical logs used in cross-section preparation are included as Appendix L.

Each of the cross-sections was then created by an Arizona registered geologist. The cross-sections were scaled horizontally and vertically, and the vertical exaggeration calculated. Wellhead elevations were then obtained for each well. The geology of each individual log was first plotted using a minimum ten-foot thickness interval. Depending on the detail of each log, sometimes a predominant lithology was plotted, ignoring thin interbeds. It should also be noted that lithologies and depths identified on each log were assumed accurate; in most cases, these logs were developed from drill cuttings as opposed to depth-specific sample collection.

After the geology of each log was plotted, correlations were performed utilizing the units identified in Weston (2000). These units as identified by Weston are described below.

Weston (2000) found that enough gradation exists within the UAU to allow separation into two sublayers. The uppermost layer is comprised of loose surface soils grading downward into interfingered sand and gravel lenses. Clay lenses, when present, are thin and usually characterized as clayey sands. Termed UAU1 for purposes of identification, the breakpoint between this and the lower UAU (termed UAU2) is the point where clay lenses within the unit increase in number until clays dominate the lithologic horizons.

Weston (2000) identified the transition between the UAU and MAU as that area within the lithologic sequence characterized by at least 40 feet of material often referred to as hard brown clay or sticky brown clay. Below this point, the lithology usually shows a marked increase in the amount of fine-grained material present.

Cross-section A-A' (Figure 3-2) is an east-west cross-section across the WVBA, and extends from monitor well OU3-11C in downtown Phoenix west to monitor well AVB60-01 (79th Avenue south of Van Buren). UAU1 is present from the ground surface to depths ranging from approximately 180 feet to 310 feet bgs. In the western portion of the cross-section (AVB60-01 and 98-01), UAU1 appears to become finer grained. The

MAU appears to have been penetrated by the deeper wells comprising this cross-section, thus the thickness of UAU2 along this cross-section ranges from approximately 30 feet to 200 feet or greater. UAU2 also appears to become finer-grained to the west (beginning at monitor well DIMW-8D).

Cross-section B-B' (Figure 3-3) is an east-west cross-section across the northern portion of the WVBA, and extends from monitor well AVB129-02 in the northwest portion of the WVBA east to COP production well AVB95-02. COP no longer uses this well located at 35th Avenue south of I-10 for groundwater withdrawal. UAU1 is present from the ground surface to depths ranging from approximately 245 feet to 300 feet bgs. As with cross-section A-A', UAU1 appears to become finer-grained to the west (AVB129-02 and 91-02) within cross-section B-B'. The MAU does not appear to have been penetrated by the wells comprising this cross-section, thus the thickness of UAU2 along this cross-section is unknown. As with UAU1, UAU2 also appears to become more fine-grained west of AVB96-02.

Cross-section C-C' (Figure 3-4) is the westernmost of the north-south cross-sections, and extends from piezometer P-1 (near 83rd Avenue and Thomas) south to privately owned production well Viss-2 (Broadway and 75th Avenue). UAU1 is present from the ground surface to depths ranging from approximately 210 feet to 265 feet bgs. The southern portion of UAU1 approaching the Salt River (BTE-2 and Viss-2) appears to coarsen considerably. The MAU appears to have been penetrated by the deeper wells comprising this cross-section, thus the thickness of UAU2 along this cross-section ranges from approximately 200 feet to 260 feet or greater. Conversely to UAU1, UAU2 and the MAU appear to coarsen northwards.

Cross-section D-D' (Figure 3-5) extends from SRP production well SRP-067 (67th Avenue and Encanto) south to privately owned production well King-2 (Elwood and 59th Avenue). UAU1 is present from the ground surface to depths ranging from approximately 220 feet to 320 feet bgs, generally thickening to the north. The MAU appears to have been penetrated by the deeper wells comprising this cross-section, thus the thickness of UAU2 along this cross-section ranges from approximately 65 feet to 100 feet or greater. It should be noted that the UAU2/MAU contact in monitor well DIMW-8D was selected based upon the geophysical log of this well. As with cross-section C-C', UAU1 appears to coarsen southwards and UAU2 appears to coarsen northwards; the lithology of the MAU appears constant within this cross-section.

Cross-section E-E' (Figure 3-6) is the central-most of the north-south cross-sections, and extends from monitor well AVB94-02 (43rd Avenue and I-10) south to production well RID-90 (RID canal and 47th Avenue). UAU1 is present from the ground surface to approximately 295 feet bgs across the entire cross-section, and thus the UAU1/UAU2 contact slopes gently southward paralleling the surficial topography. UAU1 is generally coarse throughout, perhaps becoming slightly more fine-grained in the northernmost well (AVB94-02). The MAU appears to have been penetrated by the deeper wells comprising this cross-section; the thickness of UAU2 in the wells comprising the cross-section

ranges from approximately 30 feet to 85 feet or greater. As with the other north-south cross-sections, UAU2 appears to coarsen northwards.

Cross-section F-F' (Figure 3-7) is the easternmost of the north-south cross-sections, and extends from monitor well AVB131-01 (18th Avenue and I-10) south to monitor well DM-3-D (the 19th Avenue Landfill on the north bank of the Salt River). UAU1 is present from the ground surface to depths ranging from 170 feet to 240 feet bgs, generally thickening to the south. The MAU appears to have been penetrated by the deeper wells comprising this cross-section, thus the thickness of UAU2 along this cross-section ranges from approximately 30 feet to 165 feet or greater. UAU1 is coarse throughout the cross-section; UAU2 appears to coarsen southwards.

Based upon the prepared cross-sections (Figures 3-2 through 3-7), the following generalized observations regarding the alluvial unit stratigraphy of the WVBA have been developed.

UAU1 This uppermost layer is comprised of loose surface soils grading downward into interfingered sand and gravel lenses; clay lenses, when present, are thin and usually characterized as clayey sands (Weston, 2000). UAU1 ranges in thickness from approximately 170 feet to 310 feet bgs. Based upon the east-west cross-sections, UAU1 appears to become finer-grained west of about 75th Avenue. Except in the eastern portion of the WVBA (cross-section F-F'), UAU1 also appears to become finer-grained northwards, particularly in the northwest portion of the WVBA (cross-sections C-C' and D-D'). Currently, 100 groundwater wells screened within UAU1 are monitored.

UAU2 This intermediate layer occurs where clay lenses increase in number until clays dominate the lithologic horizons (Weston, 2000). UAU2 is encountered at depths ranging from approximately 170 feet to 310 feet bgs, and exhibits a considerable range in thickness, from approximately 30 feet to 260 feet or greater. UAU2 appears thickest in the western portion of the WVBA (cross-section C-C'). Based upon the east-west cross-sections, UAU2 appears to become more fine-grained west of about 67th Avenue. Conversely to UAU1, except in the eastern portion of the WVBA (cross-section F-F'), UAU2 appears to become finer-grained southwards; UAU2 appears to become coarser in the southern portion of cross-section F-F' where the cross-section terminates at the Salt River. Currently, 45 groundwater wells screened within UAU2 are monitored.

MAU Weston (2000) identified the transition between the UAU and MAU as that area within the lithologic sequence characterized by at least 40 feet of material often referred to as hard brown clay or sticky brown clay. Below this point, the lithology usually shows a marked increase in the amount of fine-grained material present. The MAU is encountered at depths ranging from approximately 260 feet to 500 feet bgs. The shallowest depth to the MAU is in the east (cross-section F-F'), deepening in the west (cross-section C-C'). Currently, eight groundwater wells screened within the MAU are monitored.

3.3 Regional Hydrogeology

As previously mentioned, groundwater occurs in the basin-fill deposits through out most of the SRV (Hammett and Herther, 1995). The aquifer system consists of the hydrostratigraphy identified in Sections 1.7 and 3.1. The three major units, the UAU, MAU and LAU, contain measurable quantities of water. However, this water is stored and moves under different regimes for the UAU and the two deeper layers. Water in the UAU is unconfined. According to Weston (2000), the MAU and LAU are both confined. However, it is apparent from pumping data and water level responses in nearby wells that the three units are hydraulically interconnected. Whether water in the MAU and LAU is always confined is not clear because of the heterogeneous nature of the sediments and the limited data (Weston, 2000).

Groundwater movement is generally to groundwater depressions located across the SRV which are created by extensive groundwater withdrawals (Hammett and Herther, 1995). Where groundwater flow is not affected by excessive pumping, flow is generally to the west. Groundwater levels have fluctuated across the SRV with time dependant on groundwater pumpage and surface water infiltration. From the 1920s through the 1960s groundwater levels dropped primarily due to groundwater pumpage (Reeter and Remick, 1986). Groundwater production was reduced in the 1970s and early 1980s across the SRV and groundwater levels in general rose. Groundwater levels in the early 1990s continued to rise because of periods of flow in the Salt River due to increased precipitation and reduced groundwater pumpage. In the mid to late 1990s and early 2000s, water levels in areas of former excessive groundwater pumpage in the east SRV continued to rise while groundwater levels in the remainder of the east SRV and most of the west SRV declined (ADWR, 2004) (Rascona, 2005).

Hydraulic properties across the SRV vary among the aquifer units and within the units due to the heterogeneity of the units. Calculations have been made for the individual units based on aquifer testing and lithologic makeup. However, available data are limited in part because numerous wells are screened across multiple units. Hydraulic conductivities (K) in the LAU range from approximately 0.001 feet per day (ft/d) to 24 ft/d (Brown and Pool, 1989) (Laney and Hahn, 1986). Hydraulic conductivities in the MAU range from approximately 4 ft/d to 100 ft/d with the higher hydraulic conductivities occurring in the eastern portion of the SRV. Hydraulic conductivities in the UAU are the highest ranging from approximately 50 ft/d to 1,700 ft/d. Transmissivities for the LAU can range from approximately 1,000 square feet per day (ft^2/d) to greater than 15,000 ft^2/d. Transmissivities are estimated for the MAU and the UAU with the MAU ranging up to 60,000 ft^2/d and the UAU ranging from approximately 2,500 ft^2/d to 150,000 ft^2/d. Storage coefficient/specific yields for the SRV were estimated by Corell and Corkhill (1994) as part of modeling efforts conducted for the ADWR. A storage coefficient of 0.005 was given to the MAU for confined conditions. Specific yield values for the MAU were estimated to range from 0.03 to 0.10. Specific yields for the UAU were estimated to range from 0.08 to 0.20.

The Salt River is the largest surface drainage feature in the vicinity of the SRV. Although dry during most of the year, winter and early spring precipitation combined with runoff from melting snow from the upper watershed can produce runoff. These events, although short in duration, contribute significant groundwater recharge. In 1966, infiltration rates in the Salt River were calculated to average 1.1 ft/d (Briggs and Werho, 1966). As a result of this flow, water levels rose dramatically in wells within several hundred feet of the river.

Mann and Rohne (1983) examined flood events of February 1978 to June 1980, which totaled 5.45 million acre-feet (AF). They concluded that the total stream flow loss in the 74-mile reach between Granite Reef Dam and Gillespie Dam was at least 474,000 AF. During that same time period, groundwater pumpage in the area was reduced by about 35 percent (1.9 million AF). Water levels were measured in 169 shallow wells along the Salt River. Water level increases ranged from 1 to 45 feet in 157 wells and declines ranged from 1 to 43 ft in 11 wells with the greatest rise occurring near the Salt River. The average 35-foot rise in water levels was attributed to both recharge from the Salt River and reduction in groundwater pumpage. The average infiltration rate was calculated at 0.45 ft/d.

3.4 WVBA Hydrogeology

Information on hydraulic properties within the WVBA was compiled by Weston (2000). Production wells used for aquifer testing were screened across multiple aquifer units. Therefore, available production well aquifer tests provided average data for multiple aquifer units. Transmissivity values in the vicinity of the WVBA were found to range from 4,000 to 160,000 gallons per day per foot (gpd/ft). Transmissivity values were converted to hydraulic conductivity values by Weston, who found the hydraulic conductivity of the UAU ranges from 5 to 700 ft/d, the range for the MAU is 7 to 30 ft/d, and the range for the LAU is 3 to 20 ft/d.

Weston (2000) developed storage coefficient/specific yield values for the WVBA. The specific yield ranges from 0.08 to 0.20 in the shallow UAU. Deeper UAU storage coefficients/specific yields range from 0.009 to 0.02. MAU storage coefficients range from 0.0003 to 0.0005. LAU storage coefficients range from 0.001 to 0.0009.

Groundwater pumpage represents the major outflow from the groundwater system within the WVBA. The primary production wells within the WVBA are those operated by RID. Groundwater pumpage within the WVBA is discussed further in Appendix K.

Groundwater recharge in the WVBA occurs when water at the land surface infiltrates and reaches the groundwater table. Sources of recharge include the infiltration of excess irrigation water, leakage from irrigation canals and lateral canals, and effluent discharge and naturally occurring recharge from flood flows within the Salt River. While the Salt River itself is not located within the WVBA, its proximity makes the riverbed a significant source of groundwater recharge within the WVBA.

Much of the western portion of the WVBA consists of irrigated agriculture. Fields are irrigated using flood application, and excess irrigation water historically applied to these fields characteristically reached the local water table as recharge. As agricultural fields are converted to urban uses, groundwater recharge from excess irrigation is lessened. One of the more comprehensive attempts to quantify recharge from agricultural fields was performed by ADWR (Corell and Corkhill, 1994). An appropriate travel time had to be established between the land surface and the aquifer. This travel time, based upon the thickness of the unsaturated zone beneath the field, was termed the lag time for agricultural recharge and averaged ten years. Thus, once the WVBA is fully urbanized, it will take approximately ten years for groundwater recharge from excess irrigation to cease. Weston (2000) calculated the recharge rate from irrigated agriculture at 1.82 feet/year/acre of irrigated agriculture.

Canals also constitute a source of groundwater recharge. Unlined (earthen) canals, contribute substantially more water than lined channels. Concrete lining does not entirely eliminate seepage from these systems. The RID canal was relined in 1986 (Corkhill and others, 1993). Prior to 1986, the recharge rate was calculated at 0.21 AF per year per lineal foot. After relining in 1986, this appears to have been reduced by approximately 90 percent.

At the COP 23rd Avenue wastewater treatment facility, treated sewage effluent is discharged to the Salt River. Flow continues in the Salt River to about 67th Avenue, and 100 percent of the discharge is assumed to recharge the groundwater table (Corkhill and others, 1993).

Corkhill and others (1993) estimated that the average annual recharge along the Salt River from Tempe Butte to the 91st Avenue wastewater treatment facility was approximately 12 percent of the annual Granite Reef Dam discharge. Weston (2000) concluded that recharge from Salt River runoff is highly localized and of little consequence from a volumetric standpoint, but runoff is important in changing the direction of groundwater movement that may be experienced as a result of sudden rise in the water table.

In addition to discharge and recharge, groundwater flows through the WVBA. Within UAU1, groundwater generally flows into the WVBA from the east and north, and out of the WVBA to the west and south. Within UAU2 and the MAU, groundwater generally flows into the WVBA from the east and out of the WVBA to the west. Further details on hydraulic gradients within the WVBA are presented in Section 3.5.2.2.

3.4.1 Water Levels

Water level monitoring has been performed regularly in the WVBA since 1993. The frequency of groundwater monitoring was reduced from monthly to semiannual at the beginning of 2002. However, due to lowering water levels in the WVBA, quarterly water level monitoring of the water quality network was implemented beginning December 2002. The hydrographs in Appendix M document an overall decrease in water levels since

monitoring was initiated in 1993. Since 1993, water levels in both shallow and deeper wells have declined approximately 35 feet, an average of approximately two and 1/3 feet per year for the 15-year time frame. The decline in water levels appears to have stopped within the past two years and was most likely due to the drought which has extended the pumping season for irrigation wells in the WVBA and reduced surface water quantities available for infiltration.

As demonstrated by the hydrographs in Appendix M, water levels fluctuate in most of the wells on a semi-annual basis, with water levels lower in the summer and higher in the winter. This is likely due to a cyclical combination of rebound within the aquifer following production well pump shutdown and to a lesser degree local area precipitation during the winter months, and seasonal pumpage of area irrigation wells during the summer months. The largest semi-annual water level changes are observed in monitor wells AVB69-01 and –02 (Appendix M). These wells are located close to production irrigation well RID-104. The large semi-annual water level changes observed in these wells are likely due to the operation of this RID well during the summer months.

3.4.2 Hydraulic Gradients

The static depth to groundwater was measured to the nearest 0.01 foot with an electronic water level indicator. The water levels were measured from a known surveyed measuring point at each well; groundwater elevations were then calculated from the surveyed measuring point.

Depth to groundwater measurements and groundwater elevations for the periods 1993, 1998, 2003, and First Quarter 2008 are presented in Table 3-1. Five year intervals for presenting groundwater elevation data were selected to reduce the volume of data contained in this report. Data for other years are contained in monitoring reports at ADEQ. Locations of wells completed within UAU1, UAU2, and the MAU are presented on Figures 2-2 through 2-5. Contouring software (SURFER) was used to generate contours within UAU1, UAU2, and the MAU over the time period covered by Tables 3-1a through 31q.

Groundwater contours for the upper portion of the UAU (UAU1) are shown on Figures 3-8 through 3-18. In the eastern portion of the WVBA (east of approximately 35th Avenue), groundwater flow is in a general westerly direction at quarterly gradients ranging from about 9 to 20 feet per mile. The central portion and part of the western portion of the WVBA (between approximately 35th and 63rd Avenues) is characterized by a flattening of the water table, with southerly groundwater flow in the north-central portion of the WVBA. In the western portion of the WVBA (west of approximately 63rd Avenue), an apparent depression/trough of the surface of the groundwater table is located in the northwestern portion of the WVBA centered at approximately Roosevelt Street and 75th Avenue. Because of this apparent depression/trough, groundwater flow south of Van Buren Street and west of 75th Avenue is northward. The change in direction is possible caused by surface water leaking from the RID cannel and irrigation of fields south and west of the

cannel. It should be noted that the wellhead of AVB74-01 was resurveyed to confirm the accuracy of groundwater elevations collected from this well.

Groundwater contours for the lower portion of the UAU (UAU2) are shown on Figures 3-19 through 3-27. Based upon these contours, groundwater flow in UAU2 is westerly, with deviations ranging from southwesterly to northwesterly. Quarterly gradients across the entire WVBA were observed at approximately nine feet per mile with some flattening of the gradient in the central portions during 2003 and the first quarter 2008. In the eastern end of the WVBA during 2nd and 3rd Quarters 2003, the difference in groundwater elevations between the southeastern most well AVB69-01 and the nearest well, AVB77-02 is greater than 40 feet. This high gradient is likely due to the high drawdown experienced at well AVB69-01 due to its proximity to production well RID-104.

Groundwater contours for the MAU are shown on Figures 3-28 to 3-36. Based upon these contours, groundwater flow in the MAU varies by season as a result of the pumping of RID wells during the summer months. During non-pumping conditions (first and fourth quarters), groundwater flow is westerly at approximately eight feet per mile. However, during pumping conditions (second and third quarters), groundwater flow in the eastern portion of the WVBA is southwesterly towards RID-104 at a gradient of about 38 to 40 feet per mile. Groundwater flow in the western portion of the WVBA during pumping conditions is westerly at a gradient of approximately five feet per mile.

3.4.3 Vertical Gradients

There are a number of paired wells in the WVBA where adjacent wells were installed to different depths. Water level data from these paired wells have been used to quantify vertical gradients within the WVBA. Tables 3-2a through 3-2d contain calculated vertical hydraulic gradients over four consecutive quarters of water level monitoring. To calculate vertical gradients, it was first necessary to calculate the vertical distance between the midpoints of the perforated intervals (dl) of the paired wells. Then, the difference in potentiometric elevations (dh) of the paired wells was obtained, and the vertical gradient (dh/dl) calculated. Downward vertical gradients are demonstrated by negative gradient values.

The calculated vertical hydraulic gradients over four consecutive quarters of water level monitoring for each of the paired wells were plotted (Figures 3-37 to 3-40). Several conclusions can be drawn from the data:

- Six paired wells consistently exhibited downward vertical flow [AVB10, AVB96, AVB106, AVB116, AVB124 (monitored for two consecutive quarters), and AVB129].
- Paired wells AVB77, 91, and 94 consistently exhibited upward vertical flow.
- The eight remaining paired wells exhibited both upward and downward vertical flow through four consecutive quarters of water level monitoring (AVB68, AVB69, AVB81, AVB92, AVB95, AVB108, AVB120, and AVB 122).

- Upward vertical flow was most prevalent during fourth quarter 2004 and first quarter 2005, diminishing during the second and third quarters of 2005. This trend corresponds to the seasonal pumping of the RID wells, which were pumping when water levels were measured during the second and third quarters of 2005.
- The presence of partially confined conditions at depth at those locations where upward vertical flow was consistently observed.

3.4.4 Aquifer Tests

Water levels and aquifer tests are used to confirm the groundwater flow direction and the flow characteristics. To better understand the characteristics of the aquifers underlying the WVBA, a number of aquifer tests have been performed across the WVBA by ADEQ and others. ADEQ conducted five aquifer tests across the WVBA. Aquifer tests were also conducted at the MCMM and Reynolds facilities. The following are brief summaries of the aquifer tests performed within the WVBA.

Reynolds In March 1990, five short-term aquifer tests were conducted at newly installed groundwater monitor wells (Dames & Moore, 1990). The wells were pumped at a rate of 5.5 gpm for approximately one hour. Water-level measurements were collected at the wells using a steel tape and chalk. Data were analyzed using the Cooper-Jacob method and an estimated 20 percent specific yield. Calculated transmissivities ranged from 40,000 gpd/ft to more than 500,000 gpd/ft and calculated hydraulic conductivities ranged from 150 ft/d to 1,700 ft/d.

RID Well 84 In October 1992, ADEQ conducted an aquifer pump test on RID Well 84 (Weston, 1993c) (Appendix N). RID Well 84 was chosen as the pumping well because of its high pumping rate, location in front of the plume, and easy access for piezometers in the nearby area. The RID well is completed across UAU1 and UAU2 aquifers. In May and September 1992, four piezometers (PZ-1 through PZ-4) were installed at different distances and bearings from the pumping well. The piezometers were drilled and installed to a maximum depth of 150 feet based on the assumption that the aquifer would respond as a continuous unconfined aquifer without excessive drawdown and only partial penetration would be required. In addition to the piezometers, previously installed groundwater monitor wells AVB10-01 through AVB10-04 at the Estrella Business Park were also monitored during the aquifer test. Discharge was monitored with a flow meter.

From the first week of September 1992 through the start of the aquifer test on October 13, 1992, water levels were monitored with hand-held water level indicators in the piezometers and four monitor wells at the Estrella Business Park (AVB10-01 through -04). Review of water level measurements indicates a slow rebound caused from the cessation of regional pumping.

The aquifer test commenced on October 13, 1992, and ran continuously at an average pumping rate of 3,000 gpm for approximately 48 hours. The aquifer test was ended prematurely because SRP crews working in the area disrupted power to the pump. After shutting the pump off, personnel immediately monitored the piezometers and wells for

early time recovery data; however, some initial data were not obtained. Recovery was monitored for approximately 24 hours. During this 24-hour period, more than 90 percent of the recovery was recorded on the wells and piezometers.

During the pumping and recovery portion of the test, periodic visual observations in the surrounding area showed that none of the large-capacity production/irrigation wells were pumping within an approximate one mile radius of the site. This confirmed that outside influences on the test were kept at a minimum.

The aquifer test revealed that there are two aquifers that respond differently to pumping of the RID well. The upper unconfined aquifer had a saturated thickness of approximately 140 ft with a depth to the base of the aquifer at 225 ft. Beneath the aquifer is a 25 ft thick leaky aquitard. The semi-confined aquifer beneath the aquitard is approximately 70 ft thick and underlain by a thick clay sequence. The unconfined aquifer exhibited a delayed response. For purposes of analysis, half of the 3,000 gpm pumping rate was also applied to each aquifer.

Data collected from the lower semi-confined aquifer were analyzed using the Hantush method. The data collected from the unconfined aquifer were analyzed using the Neuman method. The transmissivity for the semi-confined aquifer was calculated to range from 258,250 gpd/ft for the 1,500 gpm pumping rate to 508,956 gpd/ft. for the 3,000 gpm pumping rate. Using the estimated saturated thickness of 70 feet for the semi-confined aquifer, the hydraulic conductivity for the 1,500 and 3,000 gpm rates were 490 ft/d and 970 ft/d, respectively. The storativity of the semi-confined aquifer was calculated at 0.00034. The transmissivity of the unconfined aquifer is approximately 221,170 to 1,457,240 gpd/ft. Using the estimated aquifer saturated thickness of 140 feet, the hydraulic conductivity was calculated to range from 210 to 1,390 ft/d. The specific yield was calculated to range from 0.044 to 0.134

MCMM In July 1995, MCMM conducted an aquifer pump test at their facility (GTI, 1995) (Appendix O). The aquifer test was designed and implemented to evaluate aquifer characteristics under the site to estimate groundwater and VOC migration rates. Site lithology and regional information indicate a permeable aquifer and a review of onsite lithologic logs indicates variations in sediment grain size, resulting in varying hydraulic conductivities, and locally heterogeneous soil conditions. Four wells at the site were used during the aquifer test: one extraction well (EW-01) and three observation wells (PZ-01, MC-03 and MC-04) located 41, 50 and 156 ft from the extraction well, respectively. The wells were screened in the same interval in the saturated zone, with about 37 ft of screen from the groundwater level to the bottom of the well. To assure extraction of groundwater, a submersible pump used for groundwater extraction was set at the depth of the gravel layer (about 80 ft bgs). Groundwater levels in the extraction and observation wells were recorded using data loggers equipped with pressure transducers.

After evaluating background variations in groundwater levels, a step-drawdown test was performed on extraction well EW-01 in July 1995 to identify appropriate pumping rates.

A 15-hour constant-rate extraction test was then conducted at a pumping rate of 50 gpm. Groundwater levels were recorded in the extraction well and three observation wells. Under the constant 50-gpm groundwater extraction, the rate increase of groundwater drawdown was stable. No aquifer boundary conditions were observed, with a relatively homogeneous aquifer response. The groundwater elevation data were corrected for an assumed linear background decrease in groundwater level of about 0.07 ft/d. The drawdown data was interpreted using the Theis equation, through approximation by the Cooper/Jacob method and through the use of the computer software curve matching program, Groundwater Well Analysis Program.

The results of the aquifer test indicate that the upper zone of the aquifer has a high transmissivity, ranging from 100,000 to 264,000 gpd/ft. Hydraulic conductivities were calculated based on the transmissivities and an aquifer thickness of 37 feet which was equal to the screened interval of the extraction well. The resulting hydraulic conductivity was estimated to range from 350 ft/d to 930 ft/d. The storage coefficient was calculated to range from 0.001 to 0.008.

During the groundwater extraction test, samples of extracted groundwater were collected for analysis of contaminants. Groundwater samples were collected after extraction of 1,000, 15,000, and 56,000 gallons of groundwater from well EW-01. The analytical results confirm the presence of VOCs in groundwater at the site, indicating VOC concentrations decreased slightly and are within the same order of magnitude as the average dissolved VOC concentrations for PCE/TCE in up and cross-gradient wells MC-01, MC-02, and MC-05. During the pump test, PCE and TCE concentrations in extracted water averaged 160 and 140 µg/l, respectively, while 1,2-DCA averaged 21.7 µg/l.

North Sentinel Well In March 1997, ADEQ conducted an aquifer pump test at the North Sentinel Well (NSW) located near 79th Avenue and West Van Buren Street (Weston, 1997a) (Appendix P). The NSW aquifer test was conducted to evaluate aquifer properties of the MAU. Drawdown was measured at RID irrigation well RID-83 which had been pumping prior to the test and remained pumping during the test. The RID well is approximately 500 feet south of the NSW. A step draw-down aquifer test was first conducted to identify a suitable pump rate. The submersible pump was set at a depth of approximately 220 ft bgs or about 130 ft below the water level. Flow rates were monitored with a flow meter equipped with a totalizer. Time and drawdown data were collected using a water level indicator with numerous early-time readings, with increased intervals between readings as the test progressed. The constant rate extraction test was run at an average flow rate of 61 gpm. Approximately 29,300 gallons of water were pumped over the eight-hour testing period. Recovery was monitored for 50 minutes. At that time, 98 percent of the drawdown had been recovered and the test was completed. Drawdown data obtained during the aquifer test were analyzed using the Theis curve matching method, Jacob-Cooper straight-line method, Moench Solution, and Papadopulos-Cooper solution for confined aquifers. Recovery data were analyzed using the Theis recovery method.

In this area, the MAU appears to be a leaky confined aquifer. Transmissivities ranged from 3,717 gpd/ft to 8,889 gpd/ft. However, the value derived from the use of the Moench solution (3,916 gpd/ft) was ascertained to be the most representative transmissivity estimate. Based on a saturated thickness of 60 feet and using the transmissivity calculated using the Moench solution (3,916 gpd/ft), the hydraulic conductivity was calculated to be 8.726 ft/d.

Water quality samples were collected during the test to evaluate water quality changes with time. Samples were collected in the first and last hour of the test. PCE was the only constituent detected in the samples at concentrations of 1.4 and 1.1 µg/l in the first and last sample, respectively.

Madison Street Well In June 1997, ADEQ conducted an aquifer pump test at the Madison Street well located between 13th and 15th Avenues in Phoenix (Weston, 1997b) (Appendix Q). The purpose of this aquifer test was to evaluate aquifer properties of the MAU and to monitor drawdown in the UAU while pumping from the MAU. The project involved installing one six-inch diameter production well (AVB68-01) screened in the MAU, an observation well (AVB68-04, four-inch diameter) screened in the MAU, and a nested piezometer pair (AVB 68-02 and AVB68-03, two-inch diameter) screened in the UAU and MAU. The pretest water level was measured in the wells and indicated a downward vertical hydraulic gradient between the UAU (as represented by the water level in piezometer AVB68-02) and MAU (as represented by the water levels in the other three wells) at this location. A step drawdown test was conducted on June 3, 1997. A submersible pump was installed at a depth of approximately 225 ft bgs or about 140 ft below the water level. Discharge was monitored with a flow meter equipped with a totalizer. Pressure transducers equipped with a data logger were lowered into AVB68-02 and AVB68-03. Water level data were collected in the pumping well by using a water level indicator. Numerous early-time readings were collected and the intervals between readings were increased as the test progressed. Based on results of the step drawdown test, a pumping rate of 100 gpm was selected. A 48-hour constant rate test was completed with a flow rate that average 86.7 gpm. Approximately 127,700 gallons of water was pumped over the first 24-hour testing period. After 24 hours of pumping, data were sufficient to evaluate the transmissivity and storativity of the MAU. During this period, the water level in the UAU piezometer (AVB68-02) did not fluctuate appreciably. For the last portion of the test, the flow rate was increased to 120 gpm. Recovery was monitored for six hours and 98 percent of the drawdown had been recovered, and the test was completed. At the completion of the 48-hour constant rate test, 293,790 gallons had been pumped, bringing the total, including the step test, to 312,220 gallons of groundwater pumped. Drawdown data obtained during the aquifer test were analyzed using the Theis curve matching method, Jacob-Cooper straight-line method, Moench Solution, and Papadopulos-Cooper solution for confined aquifers. Recovery data were analyzed using the Theis recovery method.

The upper portion of the MAU, at a depth of 240 to 254 ft bgs, appears to be the producing zone. Transmissivity was calculated at 1,522 gpd/ft. Storativity was calculated to range from 0.000021 to 0.00012. Hydraulic conductivity was calculated

using the transmissivity and a saturated thickness of 14 feet. The resulting hydraulic conductivities ranged from 14.54 ft/d to 84.39 ft/d. The range of calculated storativity values indicates confined, rather than leaky confined conditions in the producing interval at this location. This is supported by the lack of drawdown in the observation well completed in the overlying UAU. Additionally, the calculated transmissivity value and relatively high pumping rate indicate that aquifer materials, rather than aquitard materials, are tapped by well AVB68-01.

Groundwater samples were collected in the first and last hour of the test to evaluate water quality changes with time. The analytical results indicated some presence of aromatic and halogenated hydrocarbons. The highest concentrations of PCE/TCE were 4.37 and 22.8 µg/l, respectively.

RID Well 104 In September 1997, ADEQ installed transducers in two wells adjacent to RID Well 104 near 19th Avenue and Pima Street in Phoenix (Weston, 1999) (Appendix R). Instead of running a short-term (less than 72 hours) aquifer test, ADEQ opted to collect water level measurements during normal pumping of RID Well 104. The observation wells, AVB-69-01 and AVB69-02, were constructed in the UAU2/MAU and UAU1, respectively. Continuous water level recorders were installed in each observation well and water levels were collected through the 1998 pumping season (approximately six months). Because Well 104 is an integral part of the RID irrigation system, it was not possible to install a flow meter on the well's discharge line. RID was able, however, to provide continuous discharge records based upon the daily electrical consumption logs of the pump. According to these records, the well pumps an average of 17.36 AF per day. Because RID could not take the well out of service long enough for water levels in the aquifer to return to static conditions, the water level measurement program was begun while the well was pumping. Data sets were selected which corresponded with periods when the well had shut down and water levels had recovered for at least 24 hours. Data from AVB69-01 and AVB69-02 provided the long-term drawdown information required to evaluate the overall utility of short-term aquifer tests in the development of a model spanning decades of intense pumping.

During the first few hours of pumping, it appears that most of the water withdrawn is extracted from the most conductive layers within the aquifer system. The resulting calculated transmissivities were high, ranging from 166,000 to 196,000 gpd/ft, and implied that the entire penetrated section of the aquifer exhibited a conductivity that represented only a few lenses within the system. As pumping continued, however, drawdown increased geometrically with time and the corresponding calculated transmissivity decreased to less than 50,000 gpd/ft. This indicates that with continued pumping the more conductive layers within the system are dewatered and only the less conductive layers become available to deliver water to the well. Interestingly, the calculated transmissivities for both pumping durations were nearly identical for both the UAU and MAU within the specified time period implying a high degree of connection between the systems. This aquifer test demonstrated that aquifer tests conducted for a shorter duration may not stress the system sufficiently to provide good results and should

not be utilized within the context of long-term model development. Groundwater samples were not collected during this aquifer test.

ALSCo In December 1999, aquifer tests were conducted at ALSCo in UAU1 to collect data pertinent to the design of the groundwater remediation system to be installed at the facility (HGC, 2000) (Appendix S). A constant pumping rate aquifer test was conducted at the extraction well (EX1) utilizing three groundwater monitor wells (MW-2, MW-5S, and MW-5M) as observation wells. A step drawdown test was conducted at the injection well (INJ1) utilizing groundwater monitor well MW-3 as an observation well. Transducers were used to obtain water-level measurements and a flow meter was used to measure flow rates. The extraction well was pumped at an average of 148.4 gpm for five hours. Rebound was monitored for two hours.

Data collected during the constant rate test were analyzed using the Cooper-Jacob method. Transmissivities were calculated to range from 24,000 ft^2/d to 36,000 ft^2/d. Using a saturated thickness of 140 feet, the hydraulic conductivity was calculated to range from 170 ft/d to 260 ft/d. The vertical hydraulic conductivity was calculated using the software program WHIP. This resulted in a calculated vertical hydraulic conductivity of 19 ft/d. These data were then used to calculate the pumping rate that would create an appropriate capture zone for the ALSCo ERA.

Data collected during the step-drawdown test were evaluated using the Bierschenk graphical method to estimate specific capacity and potential drawdown. The results indicated that injecting 300 gpm through the injection well would create a ten-foot groundwater mound.

4.0 NATURE AND EXTENT OF CONTAMINATION

As indicated in Section 1.0, the WVBA WQARF site extends across a large area of southwestern Phoenix. Overlying the groundwater contaminant plume that comprises the WVBA WQARF registry site is a mixture of industrial, commercial, and residential properties. Groundwater contamination in the WVBA was first discovered in 1984 during routine groundwater sampling at the Phoenix Terminal (Dames & Moore, 1985). Since then, data have been collected in an attempt to characterize the contaminant plume, identify sources of the plume, and remediate the plume to reduce the risk to human health and the environment. The extent and concentrations of COCs detected in the groundwater plume suggest that multiple sources have contributed to the plume over time.

Soils that comprise the vadose zone across the WVBA consist of unconsolidated mixtures of clay, silt, sand, gravel, and cobbles. Typically the uppermost portion of the vadose zone consists of clay, silt, and sand with minor amounts of gravel. The lower portion of the vadose zone consists of gravels and cobbles with varying amounts of sand, clay, and silt. The coarse lower portion of the vadose zone is encountered at greater depths from east to west, and south to north within the WVBA. For instance, gravel/cobble soils have been encountered at a depth of approximately ten feet bgs in the vicinity of CRC Company, Inc. (1130 West Hilton Avenue), and at a depth of approximately 50 feet bgs at the Dolphin facility (740 South 59th Avenue).

The overall coarse-grained nature of the vadose zone is not conducive to the retention of contaminants which may be released to the subsurface. Also, the heterogeneous nature of the vadose zone prevents contaminants from migrating uniformly through the vadose zone. Therefore, it is sometimes difficult to collect soil and soil gas samples from the vadose zone which may be ideally located for the detection and characterization of contaminants in the vadose zone. However, COCs have been identified and characterized to the best extent possible. The following is a summation of the highest concentrations of COCs that have been detected within the WVBA in the vadose zone, and in ground and surface water.

4.1 Identification of Contaminants and Contaminant Sources

COCs at concentrations greater than minimum GPLs, SRLs, and/or HBGLs have been detected at the following facilities: ALSCo (PCE), CRC (PCE and Cr), Dolphin (PCE, TCE and Cr), MCMM (TCE), Reynolds (PCE, TCE, TCA, 1,1-DCE, and Cr), VW&R (PCE), ALASG (TCE, 1,1-DCE, TCA, and 1,2-DCA), and POS (PCE) (Table 2-5). Detection limits for some of the COCs exceed regulatory standards as indicated in Table 2-5 because of dilution of the samples by the laboratory during analysis due to higher concentrations of other COCs.

COCs have been detected at concentrations greater than AWQSs in groundwater samples collected from the following facilities: ALSCo (PCE, TCE, cis 1,2-DCE, and 1,1-DCE), CRC (PCE and Cr), Dolphin (PCE, TCE, cis 1,2-DCE, and 1,1-DCE), MCMM (PCE,

TCE, cis 1,2-DCE, and 1,1-DCE), Reynolds (PCE, TCE, 1,1-DCE, and TCA), VW&R (PCE, TCE, 1,1-DCE, and TCA), ALASG (PCE, TCE, and 1,1-DCE), and DOE (PCE and TCE) (Tables 4-1 through 4-5) (Appendices T through Y). Other COCs may have been present at concentrations greater than regulatory standards but cannot be ascertained because the laboratory diluted samples during analyses thus increasing detection limits to levels greater than regulatory standards.

The highest concentration of PCE detected in soil gas was 33,000 µg/l, collected in 1994 at the Dolphin, Inc. facility (Tracer Research Corp., 1994) (Table 2-5). TCE was detected in soil gas at a concentration of greater than 800 µg/l in 1992 at the MCMM facility (HGC, 1992a). In a sample collected from the ALASG facility in 2003, 1,1-DCE was detected at a concentration of 440 µg/l and TCA was detected at a concentration of 5,500 µg/l (Basin & Range Hydrogeologists, Inc., 2004).

The highest concentrations of PCE and TCE detected in a soil sample were 8,040 and 30 mg/kg, respectively, in 1992 at the Dolphin, Inc. facility (Basin & Range Hydrogeologists, Inc., 1993a) (Table 2-5). The highest 1,1-DCE and TCA concentrations were detected in a soil sample collected at the ALASG facility in 2004 at concentrations of 100 and 6,300 mg/kg, respectively (Basin & Range Hydrogeologists, Inc., 2005). The highest detected concentration of chromium in soil was 32,000 mg/kg, collected at the CRC facility in 1995 (Hargis + Associates, 1995b).

The highest concentration of PCE detected in groundwater was 95,000 µg/l, collected in 1998 from well DIMW-1 at the Dolphin Inc. facility (Basin & Range Hydrogeologists, Inc., 1998). TCE was detected at its highest concentration of 1,800 µg/l in 1996 from MCMM facility well PZ-01 (Fluor Daniel GTI, 1996a). The highest concentration of 1,1-DCE detected was 290 µg/l in a sample collected from well CT-W-03 in 1987 at the Chevron terminal in the Phoenix tank farm (Groundwater Technology, Inc., 1988). The highest detected concentration of chromium was 40,500 µg/l from ADEQ well AVB72-01 in September 2003 (BE&K/Terranext, 2004).

PCE and TCE were detected at concentrations greater than the AWQS in canal water samples collected from the RID canals in 2000 and 2003 (Tables 2-2 and 2-3) (BE&K/Terranext, 2001c, 2003c). However, because water in the RID canals is designated for use as agricultural irrigation, PCE and TCE have not been assigned surface water standards. The highest PCE and TCE concentrations were 21 and 70 µg/L, respectively, and were collected from the lateral canal adjacent to well RID-92. Based on the data collected, it was concluded that VOC concentrations in the main RID canal are primarily reduced by dilution due to significant base flow from the 23rd Avenue Wastewater Treatment Plant and from RID wells pumping uncontaminated groundwater. However, VOC concentrations in the smaller lateral RID canals do not appear to significantly drop in concentration with distance from the RID wells.

4.2 Source Investigations

As previously discussed, PCE is the predominant COC for the WVBA. However, in certain areas of the WVBA other COCs have been detected. The following is a discussion of COC contamination concentrations segregated into different portions of the WVBA; the "Eastern Portion" extending from 7th to 35th Avenues, "Central Portion" extending from 35th to 51st Avenues, and "Western Portion" extending from 51st to 75th Avenues. It should be noted that ADEQ is continuing to conduct a PRP search for the WVBA and may identify other contaminant sources beyond those identified below.

4.2.1 Eastern Portion of WVBA

Sixteen facilities were investigated by ADEQ or were requested by ADEQ to conduct investigations in the eastern portion of the WVBA. The eastern portion of the WVBA extends from 35th Avenue to the eastern site boundary. The following facilities conducted investigations or had investigations conducted at their facilities; facility locations are shown on Figures 1-1 and 2-1:

1. ALSCo, 720 West Buchanan St. – Investigated soil and groundwater, conducted remediation, settled with ADEQ, ADEQ completed remediation.
2. CRC, 1122 West Hilton Ave. – Investigated soil and groundwater, conducted remediation, work plan approved by ADEQ Hazardous Waste Unit to continue investigation and conduct remediation.
3. MCMM, 320 West Lincoln St – Investigated soil and groundwater, conducted remediation, settled with ADEQ.
4. BC Assembledge, 333 N. Black Canyon Highway – Petroleum hydrocarbon release.
5. Blue Circle West, 1510 W. Lincoln St. – Phase I soil sample collected but contained no detectable COC.
6. Brake Supply, 420 S. 7th Ave. – ADEQ conducted soil gas and soil sampling, recommended no further action.
7. Bud's Oil, 1340 W. Lincoln St – Investigated soil but not groundwater.
8. Chevron, U.S.A., Inc., 3050 S. 19th Ave. – Phase I soil sample collected but not recommended for additional investigation.
9. LaSalle Draperies, 710 W. Buchanan St. – ADEQ conducted soil gas and soil sampling, recommended no further action.
10. Owens-Corning Fiberglass Corp., 1880 W. Fillmore St. – Conducted their own preliminary site assessment, not requested to conduct additional investigation.
11. Ray & Bob's Truck Salavage, 101 S. 35th Ave. – Phase I soil sample collected but not recommended for additional investigation.
12. Santa Fe Railroad Yard, W. of 19th Ave. between McDowell Rd. and Fillmore St. – Phase I soil sample collected but not recommended for additional investigation.

13. Schuff Steel, 4420 S. 19th Ave. – Phase I soil sample collected but not recommended for additional investigation.
14. Sta-Rite Industries, Inc., 1146 W. Hilton St. – Investigated soil, remediated PCE contaminated soil by excavation, no groundwater investigation.
15. Triple E Properties, 1909 W. Fillmore St. – Investigated soil and identified to be petroleum hydrocarbon release.
16. Western States Petroleum, Inc., 450 S. 15th Ave. – Conducted UST removal investigation under ADEQ UST Section but no record of completing investigation requested under ADEQ WQARF program.

Of these, three facilities, ALSCo and MCMM in the east-central area and CRC in the southeastern area, were asked to conduct groundwater investigations because of COC detected in the vadose zone. COC detected at concentrations greater than regulatory standards in the vadose zone in the eastern portion of the WVBA have included PCE, TCE, and chromium.

4.2.1.1 ALSCo

PCE was the most prevalent COC detected in the vadose zone in both soil and soil gas samples in the eastern portion of the WVBA. The highest PCE concentrations detected in soil gas samples collected in the eastern portion of the WVBA were from the ALSCo facility. PCE was detected in soil gas and soil samples across the site with the highest concentrations in the west-central section of the ALSCo facility. Groundwater data presented on Figures 4-1, 4-2, 4-3, 4-7, and 4-11, along with data presented in Section 2.1, indicate that releases of PCE at the ALSCo facility extended vertically to groundwater. However, data indicate that PCE did not migrate vertically into UAU2 and the MAU. An ERA conducted at the ALSCo facility remediated soil to concentrations less than SRLs and minimum GPLs. The ERA also reduced PCE concentrations in groundwater beneath the facility to concentrations similar to upgradient concentrations. First Quarter 2008 PCE concentrations in groundwater beneath the ALSCo facility ranged from less than 0.50 to 19 µg/l. The detected concentrations are similar to concentrations detected in upgradient groundwater monitor wells.

TCE was detected in soil gas samples at concentrations an order of magnitude less than PCE at the ALSCo facility and was not detected in soil samples at concentrations greater than SRLs or the minimum GPL. TCE was detected in soil gas samples across the site but only detected in soil samples collected from the western section of the facility. The presence of TCE in soils beneath the ALSCo facility may be due to the degradation of PCE or the release of the contaminant. Groundwater data obtained from beneath the facility indicate that TCE present in soils beneath the ALSCo facility migrated vertically to groundwater. However, TCE did not migrate vertically into UAU2 and the MAU. First quarter 2008 TCE concentrations in groundwater beneath the ALSCo facility ranged from 1.3 to 6.4 µg/l. The detected concentrations are similar to concentrations detected in upgradient groundwater monitor wells.

Cis/total 1,2-DCE were detected in soil gas samples at concentrations similar to TCE soil gas concentrations at the ALSCo facility. Total 1,2-DCE was detected in a few soil samples at concentrations slightly greater than the method detection limit. Cis 1,2-DCE detection may be the result of a release of this COC or a result of the degradation of PCE and TCE. Based on these data and groundwater data for the eastern portion of the WVBA, cis 1,2-DCE detected in the vadose zone may have migrated vertically to groundwater at the ALSCo facility but not into UAU2 and the MAU. Cis 1,2-DCE was not detected in groundwater samples collected beneath ALSCo during First Quarter 2008.

None of the other COCs were detected in soil samples collected at the ALSCo facility. TCA was detected in soil gas across the site but at low concentrations. Therefore, none of these COCs are believed to have been released at the facility. None of these COCs were detected in groundwater samples collected from the ALSCo facility during First Quarter 2008.

4.2.1.2 MCMM

PCE was detected in soil gas and soil samples collected from the MCMM facility but at concentrations less than SRLs and the minimum GPL. The focus of characterization at the MCMM facility was the northwest corner, where the former Southwest Solvent reclamation operations occurred. However, a passive soil gas survey was conducted across the facility which detected PCE in soil gas across the facility. Groundwater data presented on Figures 4-1, 4-2, 4-3, 4-7, and 4-11, along with data presented in Section 2.1, indicate that the releases of PCE which occurred at the MCMM facility affected groundwater quality in UAU1 but not UAU2 and the MAU. First Quarter 2008 PCE concentrations in groundwater beneath the MCMM facility ranged from less than 0.50 to 5.9 µg/l. The detected concentrations are similar to concentrations detected in upgradient groundwater monitor wells.

TCE was detected in soil gas at concentrations similar to PCE concentrations detected at the MCMM facility. TCE was only detected in one soil sample collected from the MCMM facility at a concentration greater than regulatory standards. Groundwater and soil data collected from the MCMM facility indicate that a TCE release to the vadose zone and UAU1 occurred at the MCMM facility, but not to UAU2 and the MAU. First Quarter 2008 TCE concentrations in groundwater beneath the MCMM facility ranged from less than 0.50 to 20 µg/l. The detected concentrations are similar to concentrations detected in upgradient groundwater monitor wells.

Each of the other COCs was detected in soil gas samples collected at the MCMM facility but 1,2-DCA was the only other COC detected in soil samples. 1,2-DCA was detected in one soil sample collected from the northwest corner of the MCMM facility. 1,2-DCA is also the only other COC detected in groundwater samples collected from beneath the MCMM facility at a concentration greater than the AWQS. Based on these data, it appears that a release of 1,2-DCA from the MCMM facility affected groundwater quality beneath the facility. No COC other than PCE and TCE were detected in groundwater samples collected during First Quarter 2008 beneath the MCMM facility.

4.2.1.3 CRC

PCE was detected in soil gas and soil samples collected at the CRC facility. PCE was detected in soil samples at concentrations greater than SRLs and the minimum GPL. Groundwater data presented on Figures 4-1, 4-2, 4-3, 4-7, and 4-11, along with data presented in Section 2.1, indicate that releases of PCE occurred in the east and west bays of the CRC facility and migrated vertically to UAU1. PCE releases did not affect UAU2 and the MAU. PCE was detected in groundwater samples collected during First Quarter 2008 beneath the facility at concentrations up to 390 µg/l.

TCE was detected in soil gas samples at the CRC facility but not in soil samples. Based on this and groundwater data collected from beneath the CRC facility, it does not appear that a release of TCE occurred at the CRC facility. TCE was not detected in groundwater samples collected at the CRC facility during First Quarter 2008.

1,1-DCE was the only other VOC COC that was detected in soil gas and/or soil samples at the CRC facility. These data coupled with groundwater data collected from beneath the facility indicate that 1,1-DCE and the other COCs were not released from the facility. These COCs for First Quarter 2008 were not detected beneath the CRC facility.

Chromium was only investigated in the eastern portion of the WVBA at the CRC facility. Chromium was detected at concentrations greater than regulatory standards as total chromium, but no data are available to evaluate the percentage of hexavalent chromium. Hexavalent chromium is suspected to be present in soils in this area because it is present in underlying groundwater. Limited remediation of chromium in the vadose zone at the CRC facility was conducted; logistics prevented the complete removal of the contaminant from the vadose zone. Data included in Section 2.1 and groundwater data for chromium presented on Figures 4-6 and 4-10 suggest sources of chromium at the CRC facility. Total chromium concentrations in groundwater for First Quarter 2008 beneath the CRC facility ranged up to 18 mg/l.

4.2.1.4 Operable Unit 3

Groundwater contaminated with chlorinated solvents has been identified at the Motorola 52nd Street Federal Superfund Site OU3 area directly east of the WVBA. OU3 is bordered roughly on the north by McDowell Road, on the east by 20th Street, on the south by Buckeye Road, and on the west by 7th Avenue.

EPA is the lead agency for OU3, and has directed PRPs to conduct facility specific RI/FS's. In addition, a group of OU3 PRPs has formed the OU3 working group, and will conduct an OU3 site-wide RI. The OU3 site-wide RI will take place concurrently with facility specific investigations. The scope of work and administrative order of consent between the OU3 working group and EPA is under negotiation. The site-wide RI is expected to start in early 2009. Notable COCs for OU3 are TCE, TCA, PCE, 1,1,2-TCA,

vinyl chloride, chloroethane, 1,1-DCA, 1,1-DCE, 1,2-DCA, cis 1,2-DCE, trans 1,2-DCE and 1,4-dioxane.

Federal Superfund sites are governed under CERCLA, commonly known as Superfund. EPA identifies PRPs and collects evidence of COC use by sending CERCLA Section 104(e) information request letters to identified parties, reviewing documents, conducting interviews, and performing research as a PRP search. The following parties have been identified as PRPs at OU3:

1. APS, 502 South 2nd Avenue – Investigated soil gas, soil and groundwater
2. Arvin Meritor, et. al., 500 South 15th Street – Investigated soil gas, soil and groundwater
3. Former Baker Metals Facility, 1601 East Madison Street – Investigated soil gas, soil and groundwater
4. Capitol Engineering, 724 East Southern Pacific Drive – Have not yet conducted investigations
5. McCoy's, 1624 East Washington Street – Will not be conducting any soil or groundwater sampling. Facility has settled with U.S. EPA based on ability to pay.
6. Phoenix Newspapers, Inc., 120 East Van Buren Street – Investigated soil gas, soil and groundwater
7. SRP, 1616 East Lincoln Street – Investigated soil gas, soil and groundwater
8. Walker Power/Tiernay Turbines, 1301 East Jackson Street – In process of investigating soil gas, soil and groundwater
9. Union Pacific Railroad, 1301 Harrison Street – Have not yet conducted investigations
10. Wabash/Fruehauf, 902 South 7th Street – Have not yet conducted investigations
11. Westinghouse, 1824 East Jefferson Street – Have not yet conducted investigations
12. Milum Textile Services Company, 333 North 7th Avenue – Have not yet conducted investigations

WVBA groundwater data indicate that TCE and 1,1-DCE (and to a lesser extent, PCE) groundwater contamination originates from the OU3 area east of Seventh Avenue and flows into the WVBA WQARF site from the east. First Quarter 2008 TCE concentrations in groundwater in the eastern portion of the WVBA ranged from less than 0.50 µg/l to 160 µg/l. First Quarter 2008 1,1-DCE concentrations in groundwater in the eastern portion of the WVBA ranged from less than 0.50 µg/l to 23 µg/l. First Quarter 2008 PCE concentrations in groundwater in the eastern portion of the WVBA ranged from less than 0.50 µg/l to 76 µg/l.

4.2.2 Central Portion of WVBA

Vadose zone contamination investigations have been conducted in the central portion of the WVBA at 18 facilities. The central portion of the WVBA is located between 35th and 51st Avenues. The following facilities conducted investigations or had investigations conducted at their facilities; facility locations are shown on Figures 1-1 and 2-1:

1. ALASG, 301 S. 45th Ave. – Investigated soil and currently investigating groundwater.
2. Reynolds, located between 35th and 43rd Avenues, and between Van Buren and the Union Pacific Railroad tracks – Investigated soil and groundwater, conducted remediation, settled with ADEQ.
3. U.S. DOE, 615 S. 43rd Ave. – Investigated soil and currently investigating groundwater.
4. VW&R, 50 S. 45th Ave. – Investigated soil and groundwater, conducted remediation, received NFA for soil contamination.
5. American National Can Co., 211 N. 51st Ave. – COC detected in soils but were not requested to investigate groundwater.
6. Anderson Clayton/Western Cotton Services Co., 615 S 51st Ave – ADEQ sampled soil and groundwater and did not require additional investigation.
7. Arnold Corporation, 40 S. 45th Ave – Investigated soil and conducted risk assessment.
8. AT&T, 505 N.51st Ave – Conducted soil investigation, not required to investigate groundwater.
9. AWECO, 3918 W. Lincoln St. – Conducted soil investigation, not required to investigate groundwater.
10. Grow Group, Inc. 4940 W. Jefferson St. – Conducted soil investigation, not required to investigate groundwater.
11. Hi-Tech Plating, Inc., 4313 W. Van Buren St. – Conducted soil investigation, not required to investigate groundwater.
12. Penn Athletic, 306 S. 45th Ave – Investigated soil and groundwater, closed site under ADEQ Voluntary Remediation Program (VRP).
13. Revlon, 4301 W Buckeye Rd – Conducted soil investigation and remediation but not requested to investigate groundwater.
14. Roadway Express, 2021 S. 51st Ave. – Phase I soil sample collected but not recommended for additional investigation.
15. Smithey Recycling Co., 3640 S. 35th Ave. – Phase I soil sample collected but not recommended for additional investigation.
16. Sun State Builders, 43rd Ave/Gibson Lane – Conducted soil investigation, not requested to investigate groundwater.
17. Transco Lines, 3839 W. Buckeye Rd. – Phase I soil sample collected but not recommended for additional investigation.

Of these, five facilities, Reynolds, U.S. DOE, ALASG, Penn Athletic, and VW&R were requested to conduct groundwater investigations. Because the contaminants at Penn

Athletic were not COCs for WVBA, they were not required to conduct additional investigations after groundwater monitor wells were installed and sampled. The primary COCs at the Penn Athletic facility were normal hexane and naphthenic distillates suspected to have leaked from USTs. Upon completing their investigation, Penn Athletic was issued an NFA by ADEQ's VRP. COCs detected at concentrations greater than regulatory standards in the vadose zone in the central portion of the WVBA have included TCA, PCE, TCE, 1,1-DCE, 1,2-DCA, and chromium (Table 2-5).

4.2.2.1 Reynolds

PCE was detected at low concentrations in several soil gas samples collected at the Reynolds facility. Two soil samples collected from the Trench 6 area east of the East Stoddard Solvent dip tank at the Reynolds facility exhibited PCE at concentrations greater than the minimum GPL. Soil and groundwater data collected from the Reynolds facility indicate that releases of PCE may have affected groundwater quality; however, upgradient groundwater data are similar in concentration to data collected from beneath the facility so the impact on groundwater may have been minimal when compared to upgradient facilities. First Quarter 2008 PCE concentrations in groundwater samples collected from the Reynolds facility ranged from 2.4 to 6.4 µg/l. The detected concentrations are similar to concentrations detected in upgradient groundwater monitor wells.

TCE was detected in soil gas samples collected across the Reynolds facility but at low concentrations. Several soil samples collected at the Reynolds facility exhibited TCE at concentrations greater than the minimum GPL. Most of these were collected in the vicinity of the former Stoddard Solvent dip tanks. Soil and groundwater data indicate that TCE source areas at the Reynolds facility may have also affected groundwater quality, but upgradient groundwater data are slightly greater in concentrations then the groundwater collected at the facility. First Quarter 2008 TCE concentrations in groundwater beneath the Reynolds facility ranged from 1.8 to 16 µg/l. The detected concentrations are similar to concentrations detected in upgradient groundwater monitor wells.

TCA was detected in numerous soil gas samples collected across the Reynolds facility and at the highest concentrations of any of the COC detected at the facility. Soil samples collected in the vicinity of the East Stoddard Solvent dip tank exhibited TCA at concentrations greater than the minimum GPL. Soil and groundwater data indicated that TCA releases at the Reynolds facility migrated vertically to UAU1. However, TCA does not appear to have migrated vertically to the deeper aquifers. TCA was detected in one groundwater sample collected during First Quarter 2008 at the Reynolds facility at a concentration of 0.96 µg/l. The detected concentration is similar to concentrations detected in upgradient groundwater monitor wells.

1,1-DCE was detected in one soil sample at the Reynolds facility at a concentration which exceeded the SRLs and the minimum GPL. 1,1-DCE was also detected in soil gas samples collected from the Reynolds facility. The presence of 1,1-DCE detected in the

vadose zone may indicate that its presence is due to use and release and/or degradation of TCA and/or PCE and TCE. The presence of 1,1-DCE in groundwater beneath the Reynolds facility is believed to be caused by the degradation of TCA and possibly PCE/TCE. First Quarter 2008 1,1-DCE concentrations in groundwater beneath the Reynolds facility ranged from less than 0.50 to 1.6 µg/l. The detected concentrations are similar to concentrations detected in upgradient groundwater monitor wells.

Chromium was only detected in one soil sample at a concentration greater than regulatory standards in the central portion of the WVBA; this was at the Reynolds facility. In First Quarter 2008, chromium was detected in groundwater samples collected at the Reynolds facility at concentrations ranging from less than 0.010 to 0.063 mg/l. The detected concentrations are similar to concentrations detected in upgradient groundwater monitor wells.

1,1-DCA was the only other COC detected in soil gas or soil samples collected from the Reynolds facility, however, at concentrations less than regulatory standards. The presence of 1,1-DCA may be due to a release of the COC to the vadose zone or more likely a result of degradation of TCA. Based on soil and groundwater data for the central WVBA, it does not appear that releases of 1,1-DCA to the vadose zone in the central portion of the WVBA migrated to groundwater.

4.2.2.2 U.S. DOE

PCE and TCE were detected in soil gas samples collected at the DOE facility at low concentrations primarily in the area of the facility's maintenance buildings. PCE was also detected in soil samples collected in the vicinity of the former craneway building but at concentrations less than SRLs and the minimum GPL. TCA was detected in one soil sample collected at the DOE facility at a concentration less than SRLs and the minimum GPL. No other COCs were detected in soil samples collected at the DOE facility. Groundwater investigations are ongoing by the U.S. DOE.

4.2.2.3 ALASG

PCE along with TCA were detected at the ALASG facility in liquid collected from shallow soil during a soil gas investigation. The liquid was detected at the grease trap in the ASU building. PCE was not detected in soil samples at concentrations greater than SRLs or the minimum GPL. Soil and groundwater data may indicate that releases of PCE at the ALASG facility affected groundwater quality. Groundwater investigations are ongoing by ALASG under consent order with ADEQ.

TCE was detected in soil gas samples collected at the ALASG facility but at concentrations lower than concentrations of PCE, typically by an order of magnitude. Two soil samples collected from the ALASG facility exceeded the minimum GPL for TCE. These soil samples were collected from the area of the former grease trap in the ASU building. Because TCE is not reported to have been used at the ALASG facility the presence of TCE in the soil may be due to the degradation of PCE or may have been in

use without the knowledge of ALASG personnel. Groundwater data collection is not complete at the facility to evaluate whether TCE detected in the soil has migrated to groundwater.

1,1-DCE was detected soil gas samples collected across the ALASG facility. The highest concentrations were detected at the grease trap in the ASU building. Several soil samples collected from the grease trap area within the ASU of the ALASG facility exhibited 1,1-DCE at concentrations greater than the minimum GPL for 1,1-DCE. The presence of 1,1-DCE may be due to the degradation of PCE, TCE, and/or TCA. Data are not conclusive at this time if 1,1-DCE present in the soil beneath the ALASG facility has affected groundwater.

TCA was detected in soil gas samples collected across the ALASG facility with the highest concentrations detected in the area of the grease trap in the ASU building. Several soil samples collected at the ALASG facility exhibited TCA at concentrations greater than the minimum GPL. One soil sample also exceeded the SRLs for TCA. These soil samples were collected in the vicinity of the grease trap in the ASU building. Groundwater data collection is not complete at the facility to evaluate whether TCA detected in the soil has migrated to groundwater.

1,2-DCA was not detected in soil gas samples collected at the ALASG facility and was only detected in one soil sample collected from the ALASG facility. The soil sample exceeded the SRLs and the minimum GPL for 1,2-DCA and was collected in the vicinity of the grease trap in the ASU building. Data do not indicate that 1,2-DCA migrated vertically to groundwater.

Cis 1,2-DCE was detected at low concentrations in four soil gas samples collected from the ALASG facility and was not detected in any soil samples. Soil gas samples exhibited low concentrations of 1,1-DCA at the ALASG facility. 1,1-DCA was detected in soil samples collected from the ALASG facility but at concentrations less than regulatory standards. The presence of 1,1-DCA may be due to the degradation of TCA in the soil.

4.2.2.4 VW&R

PCE was the most commonly detected COC at the VW&R facility. PCE was most commonly detected in soil gas samples collected in the vicinity of the two tank farms in the west portion of the VW&R facility. One soil sample collected from this facility exhibited PCE at a concentration greater than the minimum GPL for PCE. This soil sample was collected from the west side of the corrosive tank farm. Groundwater data presented on Figures 4-1, 4-2, 4-3, 4-7, and 4-11 along with data included in Section 2.1 indicate that the release of PCE at the VW&R facility contaminated groundwater beneath the facility and migrated downgradient of the facility. PCE was detected at a concentration of 12 µg/l in the groundwater sample collected from beneath the VW&R facility during First Quarter 2008. The detected concentration is similar to concentrations detected in upgradient groundwater monitor wells.

TCE was detected in soil gas samples collected from the VW&R facility but at concentrations typically an order of magnitude less than the PCE concentrations. TCE was also detected in soil samples collected from the VW&R facility but at concentrations less than regulatory standards. The presence of TCE in the soil may be due to releases of TCE or the degradation of PCE. Based on a review of soil and groundwater data beneath the VW&R facility, it does not appear that TCE has migrated vertically to groundwater. TCE was detected at a concentration of 13 µg/l in the groundwater sample collected from beneath the VW&R facility during First Quarter 2008. The detected concentration is similar to concentrations detected in upgradient groundwater monitor wells.

1,1-DCE was detected in soil gas samples collected from the VW&R facility but at concentrations typically an order of magnitude less than the PCE concentrations. However, the 1,1-DCE concentrations were typically greater than the TCE soil gas concentrations. 1,1-DCE was also detected in soil samples collected from the VW&R facility but at concentrations less than regulatory standards. The presence of 1,1-DCE in the soil may be due to releases of 1,1-DCE or the degradation of PCE, TCE, and/or TCA. Based on a review of soil and groundwater data beneath the VW&R facility, it does not appear that 1,1-DCE has migrated vertically to groundwater. 1,1-DCE was detected at a concentration of 1.5 µg/l in the groundwater sample collected from beneath the VW&R facility during First Quarter 2008. The detected concentration is similar to concentrations detected in upgradient groundwater monitor wells.

TCA was detected in soil gas samples collected at the VW&R facility at concentrations similar to TCE concentrations. TCA was also detected in soil samples collected from the VW&R facility but not at concentrations greater than SRLs and the minimum GPL. Soil and groundwater data indicate that the TCA release at the VW&R facility may have affected groundwater quality. TCA was not detected in the groundwater sample collected from beneath the VW&R facility during First Quarter 2008.

Cis 1,2-DCE, 1,1-DCA, and 1,2-DCA were not analyzed for in soil gas samples collected at the VW&R facility. Cis 1,2-DCE was also not analyzed for in soil samples but trans 1,2-DCE was analyzed for in soil samples. These COC were detected in soil samples at low concentrations at the VW&R facility. However, none of these COC were detected at concentrations greater than SRLs or minimum GPLs. These COC are not believed to have contaminated groundwater at the VW&R facility. Cis 1,2-DCE, 1,1-DCA, and 1,2-DCA were not detected in the groundwater sample collected from beneath the VW&R facility during First Quarter 2008.

4.2.2.5 West Central Phoenix Area WQARF Site

TCE and other VOCs appear to be entering the central portion of the WVBA from the north. Investigations have been conducted within the West Central Phoenix (WCP) WQARF Registry Site, north of the central portion of the WVBA and hydraulically upgradient. In the summer of 1998, the WCP was split into five separate plumes. The West Osborn Complex (WOC) site is the southernmost of five plumes in the WCP and is closest to the WVBA. The WOC is bounded approximately by the Grand Canal to the

north, 31st Avenue to the east, McDowell Road to the south, and 55th Avenue to the west. VOC contamination in the area was first detected in groundwater in July 1982.

Three facilities have been identified as likely sources of groundwater contamination in the WOC:

1. United Industrial Corporation (UIC), Investigated soil and groundwater, conducted SVE soil remediation, entered into a consent decree, settled with ADEQ, preparing two FS's, groundwater investigation is ongoing.
2. Corning Inc./Components Incorporated, Investigated soil and groundwater, settled with ADEQ.
3. NUCOR Corporation, settled with ADEQ.

ADEQ, in conjunction with UIC, agreed that the deep aquifer and the shallow aquifer should be further characterized and are to be remediated separately. The current COCs in groundwater at the WOC include TCE, 1,1-DCE, and PCE. TCE presents the highest contaminant concentration in the WOC. Currently, ADEQ is evaluating the FS for the deep aquifer and is awaiting the submittal of the FS for the shallow aquifer. ADEQ issued the final remedial objectives report in May 2005.

4.2.3 Western Portion of WVBA

Vadose zone contamination investigations have been conducted in the western portion of the WVBA at 15 facilities. The western portion of the WVBA extends from 51st Avenue to the western site boundary. The following facilities conducted investigations or had investigations conducted at their facilities; facility locations are shown on Figures 1-1 and 2-1:

1. Dolphin, 740 S. 59th Ave. – Investigated soil and groundwater, conducted remediation, received RCRA closure of consent order for soils.
2. POS, 5102 W. Roosevelt St. – Currently investigating soil and groundwater.
3. CoStar Corp/Data Packaging Corp, 425 S. 67th Ave – Conducted soil investigation, requested to investigate groundwater but never completed.
4. Arizona Parts Master, 15 N. 57th Dr. – Conducted soil investigation ascertained release was limited to petroleum hydrocarbons, not investigated further under WQARF.
5. Joe's Diesel Repair, 6316 W. Van Buren St. – Phase I soil sample collected but not recommended for additional investigation.
6. Petco, Inc., W. Side of 67th Ave. N. of railroad – Phase I soil sample collected but not recommended for additional investigation.
7. Phoenix Vegetable Distribution, S. Side of Buckeye Rd. E. of 83rd Ave. – Phase I soil sample collected but not recommended for additional investigation.

8. Phoenix Tank Farm, 51st Ave/Van Buren St. – Petroleum contaminants, not a COC of WVBA.
9. Unocal, 10 S. 51st Ave. – Conducted soil investigation, not required to investigate groundwater.
10. Research Chemicals, 8220 W. Harrison St., Tolleson – Phase I soil sample collected but not recommended for additional investigation.
11. Salesco Systems/Turken Industrial Properties, 5736 W. Jefferson St. – Conducted soil investigation, requested to do additional investigation but no record of being conducted.
12. Seaport Petroleum, 57 N. 57th Ave. – Conducted soil investigation determined release was limited to petroleum hydrocarbons, not investigated further under WQARF.
13. Southwest Feed & Seed, 350 S. 75th Ave. – Phase I soil sample collected but not recommended for additional investigation.
14. Tritech Manufacturing, Inc./Tri-Star Quality Metal Finishing, Inc., 5144 W McKinley St – Conducted soil investigation, not requested to investigate groundwater.
15. World Resources Co., 8113 W. Sherman St. – Phase I soil sample collected but not recommended for additional investigation.

Three facilities, Dolphin, POS, and CoStar Corp/Data Packaging Corp were requested to conduct groundwater investigations. CoStar Corp/Data Packaging Corp went bankrupt before any wells were installed at this facility. Groundwater data collected from surrounding groundwater monitor wells indicate that COC concentrations are higher in monitor wells upgradient of CoStar Corp/Data Packaging Corp than in monitor wells downgradient of the facility. COC detected at concentrations greater than regulatory standards in the vadose zone in the western portion of the WVBA have included PCE, TCE, 1,2-DCE, and chromium.

4.2.3.1 Dolphin

PCE was detected in the vadose zone in both soil and soil gas samples collected at the Dolphin facility. The highest soil gas concentrations were detected in the vicinity of drum storage, PCE degreaser, drain pipes and a leach field. Several soil samples collected from the Dolphin facility exhibited PCE at concentrations greater than the residential SRL and the minimum GPL. Groundwater data shown on Figures 4-3, 4-7, and 4-11 along with data presented in Section 2.1 indicate that the release of PCE occurring at the Dolphin facility contaminated groundwater beneath the facility and migrated downgradient of the facility. In First Quarter 2008, PCE concentrations in groundwater samples collected from Dolphin wells ranged from less than 0.50 to 51 µg/l.

TCE was only detected in soil gas samples collected from the Dolphin facility in the areas of the drum storage, PCE degreaser, and the southwest building but at concentrations of up to three orders of magnitude less than PCE soil gas concentrations. TCE was only detected in one soil sample, collected from soil

excavated from a spill area, at a concentration greater than the residential SRL and the minimum GPL. The presence of TCE in the vadose zone at the Dolphin facility is likely due to the degradation of PCE but may have also been due to an unknown release of TCE even though the owner/operator does not have documented use of TCE at the facility. Data presented in Section 2.1 and shown on Figures 4-4, 4-8, and 4-12 indicate that TCE at the Dolphin facility has not migrated to groundwater. First Quarter 2008 TCE concentrations in groundwater beneath the Dolphin facility ranged from less than 0.50 to 7.7 µg/l.

1,1-DCE was detected in soil gas samples collected from the Dolphin facility in the areas of drum storage, PCE degreaser, and the southwest building but again at concentrations of up to three orders of magnitude less than PCE soil gas concentrations. 1,1-DCE was only detected in soil samples collected from a drainage area at the Dolphin facility, but not at concentrations which exceeded regulatory standards. The use of 1,1-DCE is not documented, so 1,1-DCE detected in the vadose zone may indicate that its presence is due to use/release without the knowledge of the owner/operator or due to the degradation of PCE and/or TCA. Data presented in Section 2.1 and shown on Figures 4-5, 4-9, and 4-13 for 1,1-DCE indicate that the presence of 1,1-DCE in the vadose zone at the Dolphin facility has not affected groundwater quality. First Quarter 2008 1,1-DCE concentrations in groundwater beneath the Dolphin facility ranged from less than 0.50 to 1.7 µg/l.

Chromium was only detected in one soil sample at a concentration greater than regulatory standards at the Dolphin facility. Based on soil and groundwater data, a release of this COC has occurred but does not appear to have migrated to groundwater. In First Quarter 2008, chromium was not analyzed for in groundwater samples collected at the Dolphin facility.

Cis 1,2-DCE was only detected in one soil sample collected from the western portion of the WVBA at a concentration greater than regulatory standards. This sample was collected from soil excavated from the same spill area where PCE and TCE were detected at the Dolphin facility. Cis 1,2-DCE was detected in soil gas samples collected from the Dolphin facility at locations and concentrations similar to TCE soil gas concentrations. Cis 1,2-DCE detection is probably a result of the degradation of PCE. Based on these data and groundwater data for the western portion of the WVBA, cis 1,2-DCE detected in the vadose zone at the Dolphin facility has not migrated to groundwater. First Quarter 2008 cis 1,2-DCE concentrations in groundwater beneath the Dolphin facility ranged from less than 0.50 to 5 µg/l.

TCA was detected in the vadose zone at the Dolphin facility, but at concentrations less than regulatory standards; TCA was also detected in soil gas samples. The presence of TCA in the vadose zone indicates that a release of this COC occurred but when soil data are reviewed with groundwater data, no resulting groundwater contamination is evident. TCA was not detected in groundwater samples collected during First Quarter 2008 beneath the Dolphin facility.

1,1-DCA was detected in soil at the Dolphin facility but at concentrations less than regulatory standards. Based on soil and groundwater data for the Dolphin facility, it does not appear that releases of 1,1-DCA at the Dolphin facility migrated to groundwater. First quarter 2008 1,1-DCA concentrations in groundwater beneath the Dolphin facility were less than the practical quantification limit.

4.2.3.2 POS

The POS facility has been requested to conduct a groundwater investigation under the WQARF program and signed a consent order in May 2008, but has not completed a groundwater investigation at this time. PCE was detected in the vadose zone in both soil gas and soil samples collected at the POS facility. Soil samples collected from the POS facility exhibited PCE at concentrations greater than regulatory standards. Groundwater data shown on Figures 4-1, 4-2, 4-3, 4-7, and 4-11 along with data presented in Section 2.1 indicate that the releases of PCE occurring at the POS facility contaminated groundwater beneath the facility and migrated downgradient of the facility.

TCE and cis 1,2-DCE were detected in soil gas samples collected from the POS facility but at concentrations of up to three orders of magnitude less than PCE soil gas concentrations. Locations where TCE and cis 1,2-DCE were detected in soil gas samples do not have documented uses of these COCs. The presence of TCE and cis 1,2-DCE in the vadose zone at the POS facility may be a result of degradation of PCE or it could be a release of these COCs without the owner's knowledge of its use.

1,1-DCE was not detected in soil gas or soil samples collected at the POS facility. TCA, 1,1-DCA, and 1,2-DCA were not analyzed for in samples collected at the facility.

4.3 Groundwater

As discussed in Section 3.4.2, the alluvial units of interest in the WVBA are as follows:

- UAU1 – The uppermost alluvial unit, UAU1 ranges in thickness from approximately 170 to 310 feet bgs.

- UAU2 - This intermediate layer occurs where clay lenses increase in number until clays dominate the lithologic horizons. UAU2 exhibits a considerable range in thickness, from approximately 30 to 260 feet or greater. UAU2 appears thickest in the western portion of the WVBA.

- MAU - The MAU is encountered at depths ranging from approximately 260 to 500 feet bgs. The shallowest depth to the MAU is in the east, deepening in the west.

Initial sampling activities in the WVBA did not differentiate between alluvial units, since there were fewer monitor wells in which to sample. Tables 4-1 and 4-2 contain water quality data for wells sampled in 1988 and 1993, and these data are plotted on Figures 4-1 and 4-2, respectively. Copies of the laboratory reports are contained in Appendices T

and U, respectively. In 1988, several wells in the central and eastern portions of the WVBA exhibited contaminant concentrations exceeding AWQSs, prompting further groundwater investigation. By 1993, the groundwater monitor well network had been expanded, providing further detail into the extent and magnitude of groundwater contamination within the WVBA. COC were detected at concentrations greater than AWQS in wells from the eastern boundary to 67th Avenue. Areas of elevated PCE and TCE concentrations are present in the east at the ALSCo facility, in the center at the VW&R facility, and in the west downgradient of the Dolphin facility. ADEQ has continued the expansion of the WVBA monitor well network through the incorporation of existing monitor wells and installation of new monitor wells, and semiannual monitoring of these wells has been and continues to be performed by ADEQ contractors. Historic contaminant concentration trends are presented in Appendix Y.

4.3.1 UAU1

4.3.1.1 1998

Water quality data (PCE, TCE, 1,1-DCE, and total chromium) for groundwater samples collected January through July 1998 are presented in Table 4-3. Copies of the laboratory reports are contained in Appendix V. Figures 4-3 through 4-6 show UAU1 contaminant concentrations for data collected in 1998. In general, COC concentrations are lower in the east and center of the WVBA when compared to concentrations detected in 1993, and are higher in the west. The decline in concentrations may be due to remedial activities and declining groundwater levels. The apparent increase in concentrations may be due to the expansion of the groundwater monitoring program.

- PCE concentrations are contoured on Figure 4-3. Based upon the contours, PCE contamination exceeding the AWQS of 5 µg/l extends from the eastern boundary of the WVBA to approximately 69th Avenue, and north of the RID canal; the northern extent of PCE contamination was not delineated. Areas of elevated PCE concentrations are present in the east in the vicinity of the ALSCo facility, in the southeast in the vicinity of the CRC facility, in the center in the vicinity of the VW&R facility, and in the west at the Dolphin facility.

- TCE concentrations are contoured on Figure 4-4. Based upon the contours, TCE contamination exceeding the AWQS of 5 µg/l also extends from the eastern boundary of the WVBA to approximately 69th Avenue, and north of the RID canal. The northern extent of TCE contamination exceeding the AWQS appears to be limited to south of Roosevelt Street. Areas of elevated TCE concentrations are present in the east in the vicinity of the MCMM facility, north of the MCMM facility extending from the OU3 site to just east of the Reynolds facility, and in the west downgradient of the Dolphin facility.

- 1,1-DCE concentrations are contoured on Figure 4-5. Based upon the contours, 1,1-DCE contamination exceeding the AWQS of 7 µg/l is present in three discrete areas. In the eastern WVBA, a 1,1-DCE plume extends from the eastern boundary of

the WVBA to 27th Avenue. In the north-central WVBA, a 1,1-DCE plume trends northwest from 43rd Avenue to between 51st and 55th Avenues. In the western WVBA, a 1,1-DCE plume extends from 59th Avenue north of Buckeye to RID-84. Elevated 1,1-DCE concentrations occur at well AVB14-01 in the east, well AVB37-01 in the center, and well AVB10-04 in the west.

- Total chromium concentrations are presented on Figure 4-6. Five wells were sampled and analyzed for total chromium; four of them exceed the AWQS of 0.1 mg/l. These are located in the vicinity of the CRC facility.

4.3.1.2 2003

Water quality data for groundwater samples collected March through June 2003 are presented in Table 4-4. Copies of the laboratory reports are contained in Appendix V. Figures 4-7 through 4-10 show UAU1 contaminant concentrations for data collected in 2003. COC concentrations are lower when compared to concentrations detected in 1993 and 1998. The decline in concentrations may be due to remedial activities conducted within the WVBA and declining groundwater levels.

- PCE concentrations are contoured on Figure 4-7. Based upon the contours, PCE contamination exceeding the AWQS extends from the eastern boundary of the WVBA to at least 75th Avenue, and north of the RID canal except between 67th and 71st Avenues. The northern extent of PCE contamination exceeding the AWQS appears to be limited to south of Roosevelt Street except between 51st and 59th Avenues. Areas of elevated PCE concentrations are present in the east in the vicinity of the ALSCo facility, in the southeast in the vicinity of the CRC facility, in the north-center in the vicinity of the POS facility, and in the west downgradient of the Dolphin facility.

- TCE concentrations are contoured on Figure 4-8. Based upon the contours, TCE contamination exceeding the AWQS extends from the eastern boundary of the WVBA to approximately 71st Avenue, and north of the RID canal except in the vicinity of RID-84. The northern extent of TCE contamination exceeding the AWQS appears to be limited to south of Roosevelt Street except between 39th and 47th Avenues. Areas of elevated TCE concentrations are present in the east downgradient of the MCMM facility, north of the MCMM facility extending from the OU3 site to the DOE facility, at well AVB94-01 in the north-center, and in the west at well AVB122-02.

- 1,1-DCE concentrations are contoured on Figure 4-9. Based upon the contours, 1,1-DCE contamination exceeding the AWQS is again present in three discrete areas. In the eastern WVBA, a 1,1-DCE plume extends from the eastern boundary of the WVBA to 27th Avenue. In the north-central WVBA, a 1,1-DCE plume trends south in the vicinity of 43rd Avenue in a triangular pattern from 37th to 51st Avenues. In the western WVBA, a 1,1-DCE plume extends from 59th Avenue and Van Buren to RID-84.

- Total chromium concentrations are presented on Figure 4-10. Ten wells exceed the AWQS of 100 µg/l. Areas of elevated chromium concentrations are present in the southeast in the vicinity of the CRC facility, in the east at well AVB72-01, and in the west at wells AVB73-01, AVB75-01, and AVB76-01.

4.3.1.3 2008

Water quality data for groundwater samples collected during First Quarter 2008 are presented in Table 4-5. Copies of the laboratory reports are contained in Appendix X. Figures 4-11 through 4-14 show UAU1 contaminant concentrations for data collected in First Quarter 2008. COC concentrations appear to have continued to decline with the exception of chromium, PCE in the southeast and north-center, and TCE in the east.

- PCE concentrations are contoured on Figure 4-11. Based upon the contours, PCE contamination exceeding the AWQS extends from the eastern boundary of the WVBA to approximately 69th Avenue, and north of the RID canal except between 67th and 71st Avenues. The northern extent of PCE contamination exceeding the AWQS appears to be limited to south of Roosevelt Street, except between 47th and 55th Avenues where it extends to approximately Interstate 10. Areas of elevated PCE concentrations continue to be present downgradient of the ALSCo facility, in the southeast at the CRC facility, and in the north-center at the POS facility.

- TCE concentrations are contoured on Figure 4-12. Based upon the contours, TCE contamination exceeding the AWQS extends from the eastern boundary of the WVBA to approximately 59th Avenue, and north of the RID canal. The northern extent of TCE contamination exceeding the AWQS appears to be limited to south of Roosevelt Street except between 41st and 55th Avenues. Areas of elevated TCE concentrations are present in the east extending from the eastern site boundary to the DOE facility, and at well AVB94-01.

- 1,1-DCE concentrations are contoured on Figure 4-13. Based upon the contours, 1,1-DCE contamination exceeding the AWQS is present primarily in the eastern WVBA, a 1,1-DCE plume extends from the eastern boundary of the WVBA to approximately 35th Avenue. Additionally, the 1,1-DCE concentration of RID-106, located in the western portion of the WVBA, also exceeded the AWQS.

- Total chromium concentrations are presented on Figure 4-14. Ten samples exceed the total chromium AWQS of 0.10 mg/l. Areas of elevated chromium concentrations are present in the southeast in the vicinity of the CRC facility, in the east at well AVB72-01, and in the west at wells AVB73-01, AVB75-01, and AVB76-01.

4.3.2 UAU2

4.3.2.1 1998

Groundwater data collected from UAU2 in January through July 1998 were limited to the western portion of the site. Figures 4-15 through 4-17 show UAU2 contaminant concentrations for data collected in 1998. Data are also included in Table 4-3 and copies of the laboratory reports are contained in Appendix V.

- PCE concentrations are presented on Figure 4-15, and exceed the AWQS in groundwater samples collected from AVB10-02 (94 µg/l), AVB69-01 (26 µg/l), RID-109 (13 µg/l), and DIMW-1 (61 µg/l).

- TCE concentrations are presented on Figure 4-16. TCE concentrations exceeding the AWQS were detected in groundwater samples collected from AVB10-02 (18 µg/l) and RID-109 (5.9 µg/l).

- 1,1-DCE concentrations are presented on Figure 4-17. 1,1-DCE concentrations exceeding the AWQS were detected in the groundwater sample collected from AVB10-02 (26 µg/l).

4.3.2.2 2003

Figures 4-18 through 4-21 show UAU2 contaminant concentrations for data collected March through June 2003. Data are also included in Table 4-4 and copies of the laboratory reports are contained in Appendix W.

- PCE concentrations are contoured on Figure 4-18. Based upon the contours, PCE contamination exceeding the AWQS extends from 19th Avenue to at least 75th Avenue, and north of the RID canal except between 67th and 71st Avenues. The northern extent of PCE contamination exceeding the AWQS appears to coincide with Van Buren Street in the area of 51st Avenue but is undefined in the east and west.

- TCE concentrations are contoured on Figure 4-19. Based upon the contours, TCE contamination exceeding the AWQS extends from the eastern boundary of the WVBA to approximately 71st Avenue, and north of the RID canal except in the vicinity of RID-84. The northern extent of TCE contamination exceeding the AWQS is undefined in the east and appears to be limited to south of Roosevelt Street west of approximately 59th Avenue.

- 1,1-DCE concentrations are contoured on Figure 4-20. Based upon the contours, 1,1-DCE contamination exceeding the AWQS is present in two discrete areas. In the eastern WVBA, 1,1-DCE exceeding the AWQS was detected in the groundwater sample collected from RID-100. In the western WVBA, a 1,1-DCE plume extends from approximately 59th Avenue and Van Buren to RID-84 and RID-106.

- Total chromium concentrations are presented on Figure 4-21. None of the sampled wells analyzed for total chromium exceeded the AWQS.

4.3.2.3 2008

Figures 4-22 through 4-25 show UAU2 contaminant concentrations for data collected in First Quarter 2008. Data are also presented in Table 4-5 and copies of the laboratory reports are contained in Appendix X.

- PCE concentrations are contoured on Figure 4-22. Based upon the contours, PCE contamination exceeding the AWQS discontinuously extends from approximately the eastern boundary to 75th Avenue north of the RID canal. The northern extent of PCE contamination exceeding the AWQS appears to be limited to north of Van Buren Street in the eastern WVBA and Interstate 10 in the western WVBA.

- TCE concentrations are contoured on Figure 4-23. Based upon the contours, TCE contamination exceeding the AWQS extends from the eastern boundary of the WVBA to approximately 51st Avenue north of the RID canal. The northern extent of TCE contamination exceeding the AWQS appears to be limited to south of Roosevelt Street except in the eastern edge of the WVBA.

- 1,1-DCE concentrations are contoured on Figure 4-24. Based upon the contours, 1,1-DCE contamination exceeding the AWQS is limited to the eastern WVBA. A westerly-trending 1,1-DCE plume exceeding the AWQS extends from approximately the eastern boundary to 35th Avenue.

- Total chromium concentrations are presented on Figure 4-25. One groundwater sample, collected from well AVB134-02, exceeded the total chromium AWQS of 100 µg/l.

4.3.3 MAU

4.3.3.1 1998

Figures 4-26 through 4-28 show MAU contaminant concentrations for data collected January through July 1998. Data are also presented in Table 4-3 and copies of the laboratory reports are contained in Appendix V.

- PCE concentrations are presented on Figure 4-26. PCE concentrations exceeding the AWQS were detected in groundwater samples collected from AVB69-01 (26 µg/l) and DIMW-1 (18 µg/l).

- TCE concentrations are presented on Figure 4-27. The only detectable TCE concentration was from the groundwater sample collected from DIMW-1 (0.9 µg/l).

- 1,1-DCE concentrations are presented on Figure 4-28. None of the analyzed groundwater samples exhibited detectable 1,1-DCE concentrations.

4.3.3.2 2003

Figures 4-29 through 4-32 show MAU contaminant concentrations for data collected March through June 2003. Data are also presented in Table 4-4 and copies of the laboratory reports are contained in Appendix W.

- PCE concentrations are presented on Figure 4-29. The only PCE concentration exceeding the AWQS was detected in the groundwater sample collected from AVB82-01 (30 µg/l).

- TCE concentrations are presented on Figure 4-30. The only detectable TCE concentration was from the groundwater sample collected from AVB82-01 (2.5 µg/l).

- 1,1-DCE concentrations are presented on Figure 4-31. The only 1,1-DCE concentration exceeding the AWQS was detected in the groundwater sample collected from AVB82-01 (8.9 µg/l).

- Total chromium concentrations are presented on Figure 4-32. Of the five wells analyzed for total chromium, one (AVB61-01) exceeded the AWQS.

4.3.3.3 2008

Figures 4-33 through 4-36 show MAU contaminant concentrations for data collected in First Quarter 2008. Data are also presented in Table 4-5 and copies of the laboratory reports are contained in Appendix X.

- PCE concentrations are presented on Figure 4-33. The only PCE concentration exceeding the AWQS was detected in the groundwater sample collected from AVB82-01 (60 µg/l).

- TCE concentrations are presented on Figure 4-34. The only TCE concentration exceeding the AWQS was detected in the groundwater sample collected from AVB82-01 (16 µg/l).

- 1,1-DCE concentrations are presented on Figure 4-35. The only 1,1-DCE concentration exceeding the AWQS was detected in the groundwater sample collected from AVB82-01 (22 µg/l).

- Total chromium concentrations are presented on Figure 4-36. Of the four wells analyzed for total chromium, none exceeded the AWQS.

4.4 Canal Water

The RID wells and canal system were first sampled by Terranext in 2000, followed by additional sampling in 2003 (BE&K/Terranext, 2001c, 2003c). The RID canal system within the WVBA is presented on Figure 2-6.

BE&K/Terranext sampled 17 RID wells in April 2000 to identify where canal water sampling would take place. Well RID-84 exhibited the highest concentration of PCE and well RID-92 exhibited the highest TCE concentration, and therefore the canal system at these locations was selected for canal water sampling.

In June 2000, the RID lateral canal downgradient of RID-92 was sampled at the well discharge and at downgradient distances of 200, 500, and 1,000 feet. These data are summarized in Table 2-2, and demonstrate a stabilization of VOC concentrations within 200 feet of the well discharge point into the lateral canal.

Upstream and downstream of RID-84, BE&K/Terranext conducted a survey of physical parameters of the canal water including flow, temperature, and conductivity. Based on the results of the survey, BE&K/Terranext collected eight samples from the canal in the vicinity of RID-84 in July 2000. Table 2-2 and Figure 4-37 identify the sample locations relative to RID-84 with corresponding VOC concentrations. Based on the data collected, it was concluded that VOC concentrations in the RID canal are primarily controlled by dilution. Due to the significant base flow from the 23rd Avenue Wastewater Treatment Plant and from RID wells pumping uncontaminated groundwater, the effect of RID well discharge of groundwater containing VOCs into the canal is not appreciable; VOC concentrations are diluted to below AWQSs within 125 feet of the point of discharge. Beyond 125 feet of the point of discharge, the diluted/reduced VOC concentrations stabilized, and remained persistent a minimum of two miles downstream of the discharge point.

Sampling of RID canal water at seven locations was performed in June 2003. Canal water sampling procedures first consisted of a measurement of each location's physical structure followed by a measurement of canal water field parameters. Physical measurements included the following:

- Canal/lateral bottom width (feet)
- Water depth (feet)
- Canal/lateral width at water surface (feet)
- Water velocity (counts per second converted to centimeters per second)

Canal water field parameters were measured using a Horiba multiple meter sensor. The instrument probe was submerged directly into each lateral; a five-gallon bucket was used to collect a sample from the RID canal. The following parameters were measured at each sample location:

- Temperature
- pH
- electrical conductivity (EC)

- turbidity
- dissolved oxygen (DO)
- oxidation reduction potential (ORP)

Using the channel and velocity measurements, water flow in cubic feet per second was estimated for each location.

Halogenated contaminants of concern in the RID canal system are displayed below with their highest detected concentration and corresponding canal location; results are summarized in Table 2-3.

Contaminant	Sample ID/location	Concentration (µg/l)
PCE	RID-92 Ditch	21
TCE	RID-92 Ditch	70
1,1-DCE	RID-89 Ditch	3.1
cis-1,2-DCE	RID-92 Ditch	3.0
1,1-DCA	RID-89 Ditch	0.69
TCA	None Detected	

Figure 4-38 depicts concentrations of 1,1-DCE, PCE, and TCE at canal sample locations. PCE exceeded the AWQS (for comparison only) of 5 µg/l in 6 of 7 canal water samples. TCE exceeded the AWQS of 5 µg/l in 5 of 7 canal water samples. Contaminants detected during both rounds of canal sampling do not have applicable surface water standards.

5.0 CONTAMINANT FATE AND TRANSPORT

5.1 Potential Routes of Migration

The following four potential routes of migration have been identified for VOCs released into the vadose zone in the WVBA:

- Unsaturated flow
- Saturated flow (groundwater)
- Surface water
- Vapor intrusion

5.1.1 Unsaturated Flow (Soils)

Once released to the vadose zone, depending on the VOC release rate, unsaturated VOC transport occurs either as a dissolved component of vadose zone moisture (low release rate) or as a non-aqueous phase liquid (high release rate). Either way, unsaturated flow is primarily vertically downward until either a change in lithology or the groundwater table are encountered. As a result of this primarily vertically downward migration, unsaturated flow occurs at or near the source area. As vadose zone soils within the WVBA are generally permeable, unsaturated flow in the WVBA typically continues to the groundwater table.

The rate of unsaturated VOC flow is dependent upon vadose zone soil physical properties including permeability, moisture content, and total organic carbon (TOC) content, and specific VOC physical properties including specific gravity, Henry's Law constant, solubility, octanol-water partition coefficient (K_{ow}), and organic carbon partition coefficient (K_{oc}). With respect to VOC physical properties, the rate of unsaturated VOC flow will increase as solubility and Henry's Law constant increase, and K_{oc} decreases. Table 5-1 lists some physical properties for PCE, TCE, and 1,1-DCE. Based on their K_{oc} values, the COC in general will migrate through the vadose zone at a greater rate than water.

Few site-specific measured vadose zone soil physical properties for the WVBA are available. Physical properties were analyzed at the MCMM facility located on the eastern edge of the WVBA during well installation and soil sampling in 1995 (Fluor Daniel GTI, Inc., 1996b). Physical property analyses were conducted on soil samples from 10 to 220 feet bgs. Analyses consisted of moisture content, density, effective porosity, pore fluid saturation, native state effective permeability to air, native state effective air conductivity, and TOC. Soil physical parameters were analyzed on six soil samples collected at depths of 10 to 30 feet bgs at the Reynolds Metals Company facility in 1996 (Geotechnical and Environmental Consultants, Inc., 1996a). The samples were analyzed for TOC, bulk density, moisture content, and total porosity. Physical properties were analyzed on soil samples collected at depths from 10 to 120 feet bgs at the ALASG facility located near the center of the WVBA (Basin & Range Hydrogeologists, 2001a). Analyses consisted of dry bulk density, specific gravity, moisture content, TOC, and

grain size distribution. Based on dry bulk density and specific gravity, porosities were estimated. Physical properties were also analyzed on soil samples collected at the Dolphin, Inc. facility located in the west- central portion of the WVBA (Basin & Range Hydrogeologists, 1996b). Physical properties (moisture content, dry density, TOC, and grain size analysis) were also analyzed on soil samples collected at the VW&R facility located in the central portion of the WVBA (Harding Lawson Associates, 1997b).

The following generalizations can be made using existing data, and field observations of drill cuttings and soil samples continuously collected during rotosonic drilling:

- The vadose zone is comprised of unsaturated UAU1 soils. As described in Section 3.4.2, UAU1 is comprised of loose surface soils grading downward into interfingered sand and gravel lenses; clay lenses, when present, are typically thin and usually characterized as clayey sands. Based upon the east-west cross-sections, UAU1 appears to become finer-grained west of about 75th Avenue. Except in the eastern portion of the WVBA, UAU1 also appears to become finer-grained northwards, particularly in the northwest portion of the WVBA.

- Depth to groundwater within the WVBA currently ranges from approximately 75 to 140 feet bgs depending on location and season; thus, this is the range in thickness of the vadose zone. In general, depth to groundwater is greatest in the north-central portion of the WVBA and shallowest along the eastern boundary of the WVBA.

- Based upon the observed generalizations of UAU1 lithology, except in the eastern portion of the WVBA, the permeability of vadose zone soils decreases northward within the WVBA, and is likely lowest west of about 75th Avenue. .

- The moisture content of vadose zone soils has been measured, ranging from 2.6 percent (dry) to moist at 22 percent (Fluor Daniel GTI, Inc., 1996b, Geotechnical and Environmental Consultants, Inc., 1996, Harding Lawson Associates, 1997b, and Basin & Range Hydrogeologists, 1996b and 2001a). Dry bulk densities ranged from 1.15 grams per cubic centimeter (g/cc) to 1.92 g/cc. Porosities were calculated to range from 22 to 45 percent. TOC ranged from 74 to 3,650 mg/kg.

5.1.2 Saturated Flow (Groundwater)

Upon reaching the groundwater table as unsaturated flow in the WVBA, VOCs dissolve into the uppermost UAU1 aquifer. The presence of dense non-aqueous phase liquids in the WVBA has not been identified. Once dissolved, VOCs have migrated both vertically and horizontally within UAU1.

As described in Section 3.5.2.3, downward vertical flow within the WVBA has been quantified. Thus, dissolved VOCs in UAU1 have been transported downwards into UAU2, as presented in Section 4.3.2. Figures 4-15 through 4-24 document the current extent of VOC contamination in UAU2. VOC contamination within UAU2 has also been

transported downwards into the MAU, as described in Section 4.3.3. VOC contamination within the MAU appears limited to the western portion of the MAU; since 2003, PCE, TCE, and/or 1,1-DCE concentrations near or above corresponding AWQSs have been detected in groundwater samples collected from MAU monitor wells DIMW-1 and/or AVB82-01 (Figures 4-26 through 4-35).

As described in Section 3.5.2.2, horizontal flow within the WVBA has also been quantified. Thus, dissolved VOCs in the UAU1, UAU2, and MAU are transported horizontally within the existing hydraulic gradients.

5.1.3 Canal Water

As discussed in Section 3.3.2, the RID canal originates at 19th Avenue south of Interstate 17, continuing on to the 23rd Avenue wastewater treatment facility where 30,000 acre-feet per year (AFY) of treated wastewater is discharged into the canal. The canal is also fed by a number of RID production wells located throughout the WVBA; these wells discharge an additional 135,000 acre-feet per year of pumped groundwater into the canal. Some of these wells extract VOC-contaminated groundwater which has been detected in canal water. Concentrations of VOCs in canal water in the vicinity of select wells exceed the AWQSs but because the end use of the RID canal water is agricultural there are no applicable surface water standards.

As discussed in Section 4.4, BE&K/Terranext collected eight samples from the RID canal in July 2000 upstream and downstream of well RID-84. Based on the data collected, it was concluded that VOC concentrations in the RID canal are primarily controlled by dilution. Due to the significant base flow from the 23rd Avenue wastewater treatment facility and from RID wells pumping uncontaminated groundwater, the effect of RID well discharge of groundwater containing VOCs into the canal is not appreciable; VOC concentrations are diluted to below AWQSs within 125 feet of the point of discharge to 4.0 µg/L or less. Beyond 125 feet of the point of discharge, however, the diluted/reduced VOC concentrations stabilized, and remained persistent a minimum of two miles downstream from the discharge point.

5.1.4 Vapor Intrusion

Once released to the vadose zone, VOCs can volatilize into soil gas which can migrate upwards to the ground surface. Depending on the land use/surface cover, soil gas can either be released directly to the atmosphere, become trapped beneath impermeable structures, or migrate into structures either beneath or at the ground surface. Typically, vapor intrusion will occur at or near the contaminant (in this case VOC) source area, but can also occur via off-gassing from the groundwater. The likelihood of vapor intrusion via this pathway decreases with increasing depth to groundwater.

5.2 Contaminant Migration

5.2.1 Factors Affecting Contaminant Migration

As VOCs are dissolved in groundwater within UAU1, UAU2, and the MAU, the factors affecting contaminant migration are the same as those affecting groundwater flow, both vertically and horizontally. As indicated in Section 3.5.1, groundwater flow in the WVBA is dominated by seasonal pumping of the RID wells, with recharge occurring from flood events in the Salt River supplemented with excess agricultural irrigation, canal leakage, and inflow from the east.

5.2.1.1 Naturally Occurring Factors

One naturally occurring factor affecting contaminant migration is the variability in aquifer characteristics. Transmissivity values in the vicinity of the WVBA were found to range from 4,000 to 160,000 gallons per day per foot. Transmissivity values were converted to hydraulic conductivity values by Weston (2000), who found the hydraulic conductivity of the UAU ranges from 5 to 700 ft/d and the range for the MAU is 7 to 30 ft/d. In accordance with Darcy's law, the rate of VOC migration increases with increased hydraulic conductivity and gradient.

Groundwater recharge in the WVBA occurs when water at the land surface infiltrates and reaches the groundwater table. Sources of recharge include the infiltration of excess irrigation water, leakage from irrigation canals and laterals, and effluent discharge and naturally occurring recharge from precipitation-created flood flows within the Salt River. While the Salt River itself is not located within the WVBA, its proximity makes the riverbed a significant naturally occurring source of groundwater recharge within the WVBA. Additionally, as regional groundwater flow in UAU1 is from the east and north, groundwater enters the WVBA from these directions.

The Salt River is the largest surface drainage feature in the vicinity of the WVBA. Although dry during most of the year, winter and early spring precipitation combined with runoff from melting snow from the upper watershed can produce runoff. These events, although short in duration, contribute significant groundwater recharge. In 1965, infiltration rates in the Salt River were calculated to average 1.1 ft/d (Briggs and Werho, 1966). As a result of this flow, water levels rose dramatically in wells within several hundred feet of the river.

Mann and Rohne (1983) examined flood events of February 1978 to June 1980, which totaled 5.45 million AF. They concluded that the total streamflow loss in the 74-mile reach between Granite Reef and Gillespie Dams was at least 474,000 AF. During that same time period, groundwater pumpage in the area was reduced by about 35 percent (1.9 million AF). Water levels were measured in 169 shallow wells along the Salt River. Water levels rose from 1 to 45 feet in 157 wells and declined 1 to 43 ft in 11 wells with the greatest rise occurring near the Salt River. The average 35-foot rise in water levels

was attributed to both recharge from the Salt River and reduction in groundwater pumpage. The average infiltration rate was calculated at 0.45 ft/d.

Corkhill and others (1993) estimated that the average annual recharge along the Salt River from Tempe Butte to the 91st Avenue wastewater treatment facility was approximately 12 percent of the annual Granite Reef Dam discharge. Weston (2000) concluded that recharge from Salt River runoff is highly localized and of little consequence from a volumetric standpoint, but runoff is important in changing the direction of groundwater movement that may be experienced as a result of sudden rise in the water table.

Another process affecting VOC transport in groundwater is retardation, the process of adsorption/desorption. The affinity of a VOC for organic carbon in soil is expressed by the solid-water partition (distribution) coefficient identified as K_d, which relates to the dissolved contaminant mass in groundwater to the mass sorbed to soil, and calculated as follows:

$K_d = K_{oc}\ (f_{oc})$, where

K_d = distribution coefficient [milliliter $(ml)_{water}/g_{soil}$]
K_{oc} = organic carbon partition coefficient (ml_{water}/g_{oc})
f_{oc} = organic carbon fraction (g_{oc}/g_{soil})

The retardation factor of a VOC in soil can be calculated as follows:

$R_d = 1 + [p_b\ (K_d) / n_e]$, where

R_d = retardation factor (unitless)
p_b = bulk density (g/cm^3)
n_e = effective porosity $(ml_{water}/\ cm^3_{soil})$

As indicated in Section 5.1.1, TOC was found to range from 74 to 3,650 mg/kg, average bulk density values ranged from 1.15 to 1.92 g/cm^3, and effective porosity ranged from 22 to 45 percent. Using the mean of these values and ADEQ-supplied values for K_{oc}, the following average retardation factors for the WVBA were calculated:

- PCE - $R_d = 4.1$
- TCE - $R_d = 2.1$
- 1,1-DCE - $R_d = 1.6$

Based upon the above values, 1,1-DCE will exhibit the highest contaminant velocity of the three identified VOCs.

5.2.1.2 Man-Induced Factors

Groundwater pumpage represents the major outflow from the groundwater system within the WVBA. The primary production wells within the WVBA are those operated by RID, which are operated seasonally during the hotter months of the year. RID provides its members with water for agricultural irrigation. The total number of RID production wells is approximately 104. Of these wells, 31 (30 operational) are located within or adjacent to the WVBA. The RID wells are pumped from approximately March into September.

There are two sources of RID water. Approximately 30,000 AFY is obtained as effluent from the 23rd Avenue wastewater treatment facility and approximately 135,000 AFY is obtained from pumped groundwater. According to Mr. Stan Ashby (2001), no wells have been shut down due to contamination.

As farmland currently being served by RID becomes developed, less water will be needed (Ashby, 2001). As addressed in the Land and Water Use Study (Appendix K), RID's prediction is that for at least the next ten years, delivery rates will remain similar to those of today. RID does not generate written documents addressing future water use projections.

Much of the western portion of the WVBA consists of irrigated agriculture. Fields are irrigated using flood application, and excess irrigation water historically applied to these fields characteristically reached the local water table as recharge. As agricultural fields are converted to urban uses, groundwater recharge from excess irrigation is lessened. One of the more comprehensive attempts to quantify recharge from agricultural fields was performed by ADWR (Corell and Corkhill, 1994). An appropriate travel time had to be established between the land surface and the aquifer. This travel time, based upon the thickness of the unsaturated zone beneath the field, was termed the lag time for agricultural recharge and averaged ten years. Thus, once the WVBA is fully urbanized, it will take approximately ten years for groundwater recharge from excess irrigation to cease. Weston (2000) calculated the recharge rate from irrigated agriculture at 1.82 feet/year/acre of irrigated agriculture.

Canals also constitute a source of groundwater recharge. Unlined (earthen) canals, contribute substantially more water than lined channels. Concrete lining does not entirely eliminate seepage from these systems. The RID canal was relined in 1986 (Corkhill and others, 1993). Prior to 1986, the recharge rate was calculated at 0.21 AF per year per lineal foot. After relining in 1986, this appears to have been reduced by approximately 90 percent.

At the COP 23rd Avenue wastewater treatment facility, treated sewage effluent not pumped to the RID canal is discharged to the Salt River. Flow continues in the Salt River to about 67th Avenue, and 100 percent of the discharge is assumed to recharge the groundwater table (Corkhill and others, 1993).

5.2.2 Groundwater Modeling Methods and Results

ADEQ and its former contractor, Weston, developed a five-layer, transient, groundwater flow model for the Central Phoenix Area (Weston, 2000). The Central Phoenix Plume Model (CPM) was designed to model aquifer conditions and groundwater movement including the effects of existing groundwater pumping. The CPM was constructed using Groundwater Vistas, MODFLOW, and MODFLOW-SURFACT to simulate the groundwater flow. Its purpose is to assist in the evaluation of remedial strategies and their effects on groundwater movement and the contaminant plume. Specific fate and transport modeling was not conducted because the scale of the model was too large and the data requirements too extensive. The CPM has the potential to be modified to develop fate and transport models for specific areas.

Prior to the CPM, four models were developed in the study area. These included the ADWR/ADEQ Central Phoenix Target Model (Corell, 1992), ADWR Salt River Valley (SRV) model (Corell and Corkhill, 1994), Motorola 52nd Street Facility (M52) Model (Dames & Moore, 1995) and the VW&R model for the WVBA (Harding Lawson Associates, 1997d). The SRV model covered the entire Salt River Valley while the M52 model partially covered the east portion of the CPM, extending from McDowell Road to Air Lane, and 52nd Street to Seventh Avenue. The VW&R model partially covered the western portion of the CPM extending from Camelback to Elliot Roads, and from Seventh Street to 99th Avenue. The models are three-dimensional using MODFLOW to simulate groundwater flow. Information and data from these models were used in the development of the CPM; however, none of the models alone were sufficient to meet the requirements of the CPM.

The CPM was developed by first creating a conceptual model to identify and summarize the major flow components of the aquifer system. Flow components include outflow in the form of pumping and groundwater movement, inflow from canals, agricultural irrigation, Salt River recharge, and groundwater movement; and changes in storage. The time period covered by the model was selected to be 1972 to 1996 based on the pumping history of the area, water level data, and the model purpose.

The conceptual model was developed by the collection of available data including well records, annual pumping volumes, water levels, water use, river discharge, land use, and recharge, followed by the preparation of a database to contain the data. The CPM was originally scoped as a three layer model but was eventually changed to a five layer model as a result of Technical Exchange Meetings. Development of the three-layer transient model was conducted using the UAU, MAU, and LAU as model layers. The five-layer seasonal transient model is the final version of the CPM. The five-layer seasonal transient model was completed by separating the UAU and the MAU into two layers each, modifying aquifer parameters to reflect changes in layer thicknesses and compositions, converting transient data arrays into seasonal rates, conversion of head boundaries to transient conditions from steady-state conditions, and three stress periods per year were added instead of a single annual stress period.

The division of the UAU is based on the content of fine-grained material while the MAU is subdivided based on thickness because a definitive marker horizon could not be established. As described in Section 3.4.2, the upper portion of the UAU (UAU1) is comprised of interfingered sand and gravel lenses with minimal clay lenses. The lower portion of the UAU (UAU2) begins where clay lenses increase in number until clays dominate the lithology. The transition between the UAU and MAU is interpreted to begin where at least 40 feet of hard brown clay or sticky brown clay is encountered. Below this point, the lithology usually shows a marked increase in the amount of fine-grained material present.

The UAU is considered to be under unconfined conditions while the other aquifers are considered to be confined, but become unconfined as groundwater is withdrawn. Aquifer parameters used in the model were collected from available reports presenting aquifer test results for the model area. Hydraulic conductivities were calculated from existing transmissivity data and lithologic information. Hydraulic conductivities used for the UAU ranged from 5 to 700 ft/d. Hydraulic conductivities used for the MAU ranged from 7 to 30 ft/d, and for the LAU ranged from 3 to 20 ft/d. Vertical hydraulic conductivities were not available for the CPM area so they were set at ten percent of the horizontal hydraulic conductivity. Storage coefficient/specific yield for UAU1 was taken from Corell and Corkhill (1994) at 0.08 to 0.20. Discussions during Technical Exchange Meetings ascertained that the storage coefficient/specific yield for UAU2 should range from 0.009 to 0.02; the MAU should range from 0.0003 to 0.0005; and the LAU should range from 0.001 to 0.0009. Values used for the aquifer parameters varied across the site within each aquifer and between different aquifers. Specific values used for different areas of the model are shown in Weston (2000) on Figures 38 through 44.

Outflow in the CPM area includes groundwater pumping and underflow across the boundaries. Groundwater pumping volumes were obtained from well owners including municipalities and agencies. Private wells were not included because of the limited data available and the minimal volume of groundwater pumped by these wells. After annual pumping volumes were identified, the volume pumped from each model layer was calculated based on the screened interval of the pumping well and the hydrologic properties of the screened zone. Because of the variation in pumping volumes during the year, pumping volumes were also divided to reflect this variation. Outflow in the CPM by underflow across the boundaries could not be calculated due to the lack of data and uncertainties involved, and therefore was not used for the conceptual model. However, even though no outflow was used in the conceptual model, during model calibration and validation outflow in the CPM by underflow across the boundaries was estimated at an order of magnitude less than pumping.

Inflow to the CPM area includes canals, agricultural irrigation, Salt River recharge, and underflow across the boundaries. The annual volume of water for the model time frame from the various possible recharge sources was calculated using available sources, and totaled for the CPM area. If information indicated that a possible source was not providing water to the CPM area for a given time frame (i.e., no flow in the Salt River), then this source was given a value of zero for that time period. As in identifying outflow,

underflow as an inflow component into the CPM was not used in the conceptual model because of the uncertainties making it impossible to calculate. During calibration and validation of the CPM, underflow as an inflow component into the CPM was estimated using water levels at adjacent wells. Once inflow and outflow volumes were calculated, the annual water budget was calculated and then divided into the three annual stress periods.

Because model boundaries could not be set at physical features which control flow, the boundaries were set by an artificial mechanism that simulates underflow with time across the boundaries. Three types of flow conditions were set for the boundaries; zones of no flow across the boundaries, zones with time variant flow and heads, and zones with constant flow and head.

The CPM is constructed with a uniform grid of 80 rows and 144 columns. Nodal spacing is 660 feet. The model units are days and feet and Ks are feet per day per model mode.

As mentioned above, the CPM covers a 25 year period from 1972 through 1996. Each year is divided into three stress periods based on the VW&R model and verified by pumping data provided by RID for 1992 through 1998. The stress periods were divided into periods of January and February for a total of 59 days, March through September for a total of 214 days, and October through December for a total of 92 days.

Data arrays selected for the CPM included those that stay constant with time and that change with time. The constant arrays included K, storage coefficient/specific yield and bottom elevations for all five layers; locations of boundary conditions; no flow locations; constant flow rates and locations; river node locations; starting water level data; calibration target data; and vertical conductance. Data arrays that change with time included pumping, recharge, water levels at time-variant flow boundaries, and stress periods when there is river flow.

Following model construction, model calibration was conducted. The CPM was run 59 times as a three layer model and 57 times as a five layer model. Adjustments were made to the data arrays as appropriate depending on the mass balance error and how calculated data and observed data matched at the calibration targets; 156 calibration targets were used to evaluate the model's accuracy.

Model calibration was considered complete when the mass balance error was 0.17 percent, the residual mean was one foot, the residual standard deviation was 9.3, the residual standard deviation divided by the range was four percent, and the absolute residual mean (ARM) was 7.2 feet. These statistics are considered good, meeting the criteria originally established for the CPM including an ARM of less than ten feet and residual standard deviation of less than ten percent.

Following model calibration, a sensitivity analysis was conducted. Parameters examined to test the CPM sensitivity included agricultural recharge rates; canal recharge rates; storage coefficient/specific yield; river conductance, discharge volume for COP 23rd Ave

wastewater treatment facility; horizontal and vertical K; pumping rates; and general head boundary conductance. Results indicated that the CPM is most sensitive to agricultural recharge and river conductance. The least sensitive parameters were storage coefficient or specific yield.

Because of the groundwater pumping history for the area, the CPM starts in transient conditions. The sensitivity analysis and calibration completed on the model ensure that the model meets the purpose of the CPM. Specifics regarding input data, model simulations, calibration procedures and sensitivity analysis, can be obtained from Weston (2000).

Following model calibration, validation of the model was completed for the time frame 1996 through 1998 (Weston, 2001). Validation indicated that CPM calibration meets the purpose of the model using the newer data set. The mass balance remained the same as the original data set at 0.17 percent. The residual mean was 2.62 feet as compared to one foot for the earlier data set. The residual standard deviation divided by the range in target values was three percent which is slightly more accurate than the original four percent. The ARM was 7.12 feet which is slightly more accurate than the calibration ARM of 7.2 feet.

Measured water levels and simulated water levels are, in general, less than ten feet in difference. The gradients and water-level contour maps for the simulated and observed data are similar in direction of flow and shape. Overall modeling results indicate that the simulated results match well with observed data. There are areas, however, that need more data to improve model calibration. Based on model calibration and validation, the CPM meets its intended purpose to evaluate remedial alternatives and contaminant movement in the CPM area.

6.0 SUMMARY

6.1 Site Physical Characteristics

- The WVBA is the areal projection of the western portion of a large commingled plume of contaminated groundwater in Phoenix, Arizona. Contributors to this plume include both industrial facilities and contaminated groundwater from the east and north, as regional groundwater flow is generally west and southwesterly. The initial primary COC for the WVBA include the following VOCs: PCE, TCE, TCA, cis 1,2-DCE, 1,1-DCA, and 1,1-DCE. To a limited extent, chromium is also being considered a COC. The RI was performed to evaluate the horizontal and vertical extent of groundwater contamination in the WVBA.

- The WVBA extends from 7th to 75th Avenues and from Buckeye Road to Interstate 10. This corresponds to an area approximately eight miles in length and 1.5 miles in width (approximately 12 square miles). In addition, a finger shaped plume exists between 7th and 27th Avenues between Buckeye and Lower Buckeye Roads. Within the WVBA are industrial facilities that have used VOCs in former, and in some cases, current operations. Typical industrial businesses within the WVBA WQARF Registry Site include automobile body repair, automobile painting operations, automobile repair, chemical mixing and distribution, dry cleaning operations, foundry operations, manufacturing operations, metal fabrication and plating, plastic manufacturing, printing operations, and vulcanizing operations.

- The west-flowing Salt River is located south of the site along the entire length of the WVBA. Treated effluent from the 23rd Avenue wastewater treatment facility is discharged into the Salt River bed under an EPA-issued NPDES permit. Additionally, during periods of heavy regional precipitation, upstream dam releases and local runoff result in additional surface water flow. When upstream dam releases occur, the Salt River acts as a source of groundwater recharge, raising water levels and altering the direction of groundwater flow to a more northward direction.

- The RID main canal originates at 19th Avenue south of Interstate 17. Year-round discharge of water into the canal occurs at the 23rd Avenue wastewater treatment facility where 30,000 acre-feet per year of treated wastewater is discharged into the canal. Water within the canal is utilized for non-potable agricultural purposes. The canal is also fed by a number of RID production wells located throughout the WVBA; these wells discharge an additional 135,000 acre-feet per year of pumped groundwater into the canal. The wells pump during the warmer months of the year, are dormant during the winter (with the exception of a few wells which are pumped during the entire year), and either discharge directly into the canal, or discharge into both exposed and unexposed lateral canals that feed the canal. When the RID wells are pumping, they act as a source of groundwater discharge,

lowering water levels and altering the direction of groundwater flow in the eastern portion of the WVBA from westerly to southwesterly.

- The WVBA is located within the SRV, an alluvial basin characteristic of Basin and Range physiography. The SRV alluvial basin consists of basin-fill deposits of unconsolidated to semi-consolidated late Tertiary to Quaternary sediments ranging up to several thousand feet thick within the center of the basin and consisting of interbedded cobbles, gravel, sand, silt, clay, and evaporites. The basin-fill deposits are subdivided into three hydrogeologic units that comprise the regional aquifer in the SRV:

    - Lower Alluvial Unit (LAU)
    - Middle Alluvial Unit (MAU)
    - Upper Alluvial Unit (UAU)

  Few wells penetrate the LAU due to its depth and low yield. The LAU does not appear to be contaminated within the WVBA. The MAU overlies the LAU and consists predominantly of silt and clay with interbedded sand and gravel lenses. The MAU reaches thicknesses of 1,600 feet in the SRV. The UAU extends from the ground surface to the top of the MAU. The UAU consists mainly of unconsolidated silt, sand, and gravel deposited during the final stages of SRV basin development. The association of coarse-grained deposits within the vicinity of the Salt River suggests that the UAU was deposited by the ancestral Salt River. The UAU ranges between 200 and 500 feet in thickness.

- Based upon site-specific WVBA cross-sections, the following generalized observations regarding the alluvial unit stratigraphy of the WVBA have been developed.

  <u>UAU1</u> This uppermost layer is comprised of loose surface soils grading downward into interfingered sand and gravel lenses; clay lenses, when present, are thin and usually characterized as clayey sands. UAU1 ranges in thickness from approximately 170 feet to 310 feet. Based upon the east-west cross-sections, UAU1 appears to become finer-grained west of about 75th Avenue. Except in the eastern portion of the WVBA, UAU1 also appears to become finer-grained northwards, particularly in the northwest portion of the WVBA.

  <u>UAU2</u> This intermediate layer occurs where clay lenses increase in number until clays dominate the lithologic horizons. UAU2 is encountered at depths ranging from approximately 170 feet to 310 feet bgs, and exhibits a considerable range in thickness, from approximately 30 feet to 260 feet or greater. UAU2 appears thickest in the western portion of the WVBA. Based upon the east-west cross-sections, UAU2 appears to become more fine-grained west of about 67th Avenue. Conversely to UAU1, except in the eastern portion of the WVBA, UAU2 appears to become finer-grained southwards.

MAU The transition between the UAU and MAU is that area within the lithologic sequence characterized by at least 40 feet of material often referred to as hard brown clay or sticky brown clay. Below this point, the lithology usually shows a marked increase in the amount of fine-grained material present. The MAU is encountered at depths ranging from approximately 260 feet to 500 feet bgs. The shallowest depth to the MAU is in the east, deepening in the west.

6.2 Site Hydrogeology

- Groundwater flow in the WVBA is dominated by regional pumping centers (RID wells) with recharge occurring from flood events in the Salt River supplemented with excess agricultural irrigation and canal leakage. Groundwater movement within the region is predominantly controlled by the aerial distribution of Salt River recharge and RID well pumping. The aquifer system consists of the hydrostratigraphic units identified above. It is apparent from pumping data and water level responses in nearby wells that the three units are hydraulically interconnected. The Salt River is the largest surface drainage feature in the vicinity of the SRV. Although dry during most of the year, winter and early spring precipitation combined with runoff from melting snow from the upper watershed can produce runoff. These events, although short in duration, contribute significant groundwater recharge.

- Water level monitoring has been performed regularly in the WVBA since 1993. Hydrographs document an overall decrease in water levels since monitoring was initiated in 1993. Since 1993, water levels in both shallow and deeper wells have declined approximately 35 feet, an average of approximately three feet per year. Water levels fluctuate in most of the wells on a semi-annual basis, with water levels lower in the summer and higher in the winter. This is likely due to a cyclical combination of rebound within the aquifer following production well pump shutdown and to a lesser degree local area precipitation during the winter months, and seasonal pumpage of area irrigation wells during the summer months.

- In the eastern portion of the WVBA (east of approximately 35th Avenue), groundwater flow within UAU1 is in a general westerly direction at quarterly gradients ranging from about 9 to 20 feet per mile. The central portion of the WVBA (between approximately 35th and 63rd Avenues) is characterized by a flattening of the water table, with southerly groundwater flow in the north-central portion of the WVBA. In the western portion of the WVBA (west of approximately 63rd Avenue), a depression of the surface of the groundwater table is located in the northwestern portion of the WVBA centered at approximately Roosevelt Street and 75th Avenue. Because of this depression, groundwater flow south of Van Buren Street and west of 75th Avenue is northward.

- Groundwater contours for the lower portion of the UAU (UAU2) indicate that groundwater flow in UAU2 is westerly, with deviations ranging from

southwesterly to northwesterly. Quarterly gradients across the entire WVBA were observed at approximately nine feet per mile.

- Groundwater flow in the MAU varies by season as a result of the pumping of RID wells during the summer months. During non-pumping conditions (first and fourth quarters), groundwater flow is westerly at approximately eight feet per mile. However, during pumping conditions (second and third quarters), groundwater flow in the eastern portion of the WVBA is southwesterly towards RID-104 at a gradient of about 38 to 40 feet per mile. Groundwater flow in the western portion of the WVBA during pumping conditions is westerly at a gradient of approximately five feet per mile.

6.3 Nature and Extent of Contamination

- Contaminant sources have been investigated/ documented throughout the WVBA. The COCs have been detected in soil gas, soil, canal water, and groundwater samples. The highest PCE and TCE concentrations detected in a soil sample collected in the WVBA were 8,040 and 30 mg/kg in 1992 at the Dolphin, Inc. facility. The highest 1,1-DCE and TCA concentrations detected in soil were 100 and 6,300 mg/kg, collected in 2004 from the ALASG facility. The highest detected concentration of chromium in soil was 32,000 mg/kg, collected at the CRC, Inc. facility in 1995. The highest concentration of PCE detected in groundwater was 95,000 µg/l, collected in 1998 from well DIMW-1 at the Dolphin Inc. facility. TCE was detected at its highest concentration of 1,800 µg/l in 1996 from MCMM facility well PZ-01. The highest concentration of 1,1-DCE detected was 290 µg/l in a sample collected from well CT-W-03 in 1987 at the Chevron terminal in the Phoenix tank farm. The highest detected concentration of chromium was 40.5 mg/l from ADEQ well AVB72-01 in September 2003.

- Water quality data (PCE, TCE, 1,1-DCE, and total chromium) for 55 UAU1 wells from groundwater samples collected January through July 1998 are as follows:

  - PCE contamination exceeding the AWQS of 5 µg/l extended from the eastern boundary of the WVBA to approximately 69th Avenue, and north of the RID canal; the northern extent of PCE contamination was not delineated.

  - TCE contamination exceeding the AWQS of 5 µg/l also extended from the eastern boundary of the WVBA to approximately 69th Avenue, and north of the RID canal. The northern extent of TCE contamination exceeding the AWQS appears to be limited to south of Roosevelt Street.

  - 1,1-DCE contamination exceeding the AWQS of 7 µg/l is present in three discrete areas. In the eastern WVBA, a 1,1-DCE plume extends from the eastern boundary of the WVBA to 27th Avenue. In the north-central WVBA, a 1,1-DCE plume trends northwest from 43rd Avenue to between 51st and 55th Avenues. In

the western WVBA, a 1,1-DCE plume extends from 59th Avenue north of Buckeye to RID-84.

- Total chromium was analyzed for in five wells completed in the UAU1 during this period. Each of the groundwater samples contained detectable concentrations of total chromium with four of them exceeding the AWQS of 0.1 mg/l.

- Water quality data for 90 UAU1 wells from groundwater samples collected March through June 2003 are as follows:

  - PCE contamination exceeding the AWQS extends from the eastern boundary of the WVBA to at least 75th Avenue, and north of the RID canal except between 67th and 71st Avenues. The northern extent of PCE contamination exceeding the AWQS appears to be limited to south of Roosevelt Street except between 51st and 59th Avenues. As a result of elevated PCE concentrations in this area, a PRP (POS) initiated site characterization, under a consent order, to evaluate the possible source of PCE north of Roosevelt Street.

  - TCE contamination exceeding the AWQS extends from the eastern boundary of the WVBA to approximately 71st Avenue, and north of the RID canal except in the vicinity of RID-84. The northern extent of TCE contamination exceeding the AWQS appears to be limited to south of Roosevelt Street except between 39th and 47th Avenues. The possible source of this contamination north of Roosevelt Street is currently under investigation by a PRP located in the WCP WQARF Registry Site.

  - 1,1-DCE contamination exceeding the AWQS is present in three discrete areas. In the eastern WVBA, a 1,1-DCE plume extends from the eastern boundary of the WVBA to 27th Avenue. In the north-central WVBA, a 1,1-DCE plume trends south in the vicinity of 43rd Avenue in a triangular pattern from 37th to 51st Avenues. In the western WVBA, a 1,1-DCE plume extends from 59th Avenue and Van Buren to RID-84.

  - Total chromium was analyzed in groundwater samples collected from 81 wells with screened intervals in the UAU1. Total chromium was detected in 40 of these samples with ten samples exceeding the total chromium AWQS of 0.1 mg/l. With the exception of the southeast corner of the site, these wells are spread across the entire WVBA without a distinct pattern to identify a manmade source. Therefore, data interpretation suggests that the chromium in the wells not located in the southeast corner of the WVBA is possibly from deterioration of stainless steel well casing, or naturally occurring within native soils.

- Water quality data for 100 UAU1 wells from groundwater samples collected in 2008 are as follows:

- PCE contamination exceeding the AWQS extends from the eastern boundary of the WVBA to approximately 71st Avenue, and north of the RID canal except between 67th and 71st Avenues. The northern extent of PCE contamination exceeding the AWQS appears to be limited to south of Roosevelt Street except between 47th and 55th Avenues, where POS investigative activities continue.

- TCE contamination exceeding the AWQS extends from the eastern boundary of the WVBA to approximately 67th Avenue, and north of the RID canal. The northern extent of TCE contamination exceeding the AWQS appears to be limited to south of Roosevelt Street except between 41st and 55th Avenues.

- 1,1-DCE contamination exceeding the AWQS extends from the eastern boundary of the WVBA to approximately 35th Avenue, north of the RID canal and south of Van Buren Street. Additionally, well RID-106 in the western portion of the WVBA also exceeds the AWQS for 1,1-DCE.

- Total chromium was analyzed for in groundwater samples collected from 57 wells with screened intervals in the UAU1. Total chromium was detected in 33 of these samples with ten samples exceeding the total chromium AWQS of 0.10 mg/l. With the exception of the southeast corner of the site, these wells are spread across the entire WVBA without a distinct pattern to identify a manmade source. Therefore, data interpretation suggests that the chromium in the wells not located in the southeast corner of the WVBA is possibly from deterioration of stainless steel well casing, or naturally occurring within native soils.

- Groundwater data were collected from seven UAU2 wells in 1998 in the western and southeastern portions of the site. Water quality data for UAU2 wells for data collected January through July 1998 are as follows:

  - PCE concentrations exceeding the AWQS were detected in groundwater samples collected from wells AVB10-02, AVB69-01, RID-109, and DIMW-1.

  - TCE concentrations exceeding the AWQS were detected in groundwater samples collected from AVB10-02 and RID-109.

  - 1,1-DCE concentrations exceeding the AWQS were detected in the groundwater sample collected from AVB10-02.

- Water quality data for 38 UAU2 wells from samples collected March through June 2003 are as follows:

  - PCE contamination exceeding the AWQS extends from 19th Avenue to at least 75th Avenue, and north of the RID canal except between 67th and 71st Avenues. The northern extent of PCE contamination exceeding the AWQS appears to coincide with Van Buren Street in the area of 51st Avenue but is undefined in the east and west.

- TCE contamination exceeding the AWQS extends from the eastern boundary of the WVBA to approximately 55th Avenue and from approximately 59th Avenue to east of 75th Avenue, and north of the RID canal except in the vicinity of RID-84. The northern extent of TCE contamination exceeding the AWQS is undefined in the east and appears to be limited to south of Roosevelt Street west of approximately 59th Avenue.

- 1,1-DCE contamination exceeding the AWQS is present in two discrete areas. In the eastern WVBA, 1,1-DCE exceeding the AWQS was detected in the groundwater sample collected from RID-100. In the western WVBA, a 1,1-DCE plume extends from approximately 59th Avenue and Van Buren to RID-84 and RID-106.

- Total chromium was analyzed in eighteen wells completed in the UAU2. Eight of the samples contained detectable concentrations of total chromium; however, none of the concentrations exceeded the AWQS.

- Water quality data for 45 UAU2 wells from groundwater samples collected in 2008 are as follows:

  - PCE contamination exceeding the AWQS discontinuously extends from the eastern boundary of the WVBA to approximately 75th Avenue, and north of the RID canal. The northern extent of PCE contamination exceeding the AWQS appears to be limited to north of Van Buren Street in the eastern WVBA and Interstate 10 in the western WVBA.

  - TCE contamination exceeding the AWQS extends from the eastern boundary of the WVBA to approximately 55th Avenue, and north of the RID canal. TCE was also detected at a concentration exceeding the AWQS at well RID-106. The northern extent of TCE contamination exceeding the AWQS appears to be limited to south of Van Buren Street except in the eastern edge of the WVBA.

  - 1,1-DCE contamination exceeding the AWQS extends from the eastern boundary of the WVBA to approximately 35th Avenue. 1,1-DCE was also detected at a concentration exceeding the AWQS at well RID-106. The northern extent of TCE contamination exceeding the AWQS appears to be limited to south of Roosevelt Street.

  - Total chromium was analyzed in 32 of the 45 UAU2 wells. Nine samples contained detectable concentrations of total chromium with one groundwater sample, collected from well AVB134-02, exceeding the total chromium AWQS of 100 µg/l.

- Water quality data for seven MAU wells from groundwater samples collected in 1998 are as follows:

- PCE concentrations exceeding the AWQS were detected in groundwater samples collected from AVB69-01 (26 µg/l) and DIMW-1 (18 µg/l).

- The only detectable TCE concentration was from the groundwater sample collected from DIMW-1 (0.9 µg/l).

- 1,1-DCE was not detected in any of the groundwater samples collected during this round of sampling at the MAU wells.

- Water quality data for ten MAU wells from groundwater samples collected in 2003 are as follows:

  - The only PCE concentration exceeding the AWQS was detected in the groundwater sample collected from AVB82-01 (30 µg/l).

  - The only detectable TCE concentration was from the groundwater sample collected from AVB82-01 (2.5 µg/l).

  - 1,1-DCE was only detected in one sample collected from the MAU wells. This groundwater sample was collected from monitor well AVB82-01 and exceeded the AWQS at a concentration of 8.9 µg/l.

  - Total chromium was analyzed in five of the ten MAU wells. The groundwater sample collected from well AVB61-01 contained total chromium at a concentration which exceeded the AWQS.

- Water quality data for eight MAU wells from groundwater samples collected in 2008 are as follows:

  - The only PCE concentration exceeding the AWQS was detected in the groundwater sample collected from AVB82-01 (60 µg/l). AVB82-02 exhibited a concentration of 4.9 µg/l of PCE.

  - The only TCE concentration exceeding the AWQS was detected in the groundwater sample collected from AVB82-01 (16 µg/l).

  - The only 1,1-DCE concentration exceeding the AWQS was detected in the groundwater sample collected from AVB82-01 (22 µg/l).

  - Total chromium was analyzed in four of the eight MAU wells sampled. Total chromium was detected in each of the samples but at concentrations less than the AWQS.

- Sampling of RID canal water at seven locations was performed in June 2003. PCE exceeded the AWQS (for comparison only) of 5 µg/l in 6 of 7 canal water

samples. TCE exceeded the AWQS of 5 µg/l in 5 of 7 canal water samples. The end use of RID canal water is for irrigation; no surface water quality standards are established for PCE and TCE.

6.4 Contaminant Fate and Transport

- The following four potential routes of migration have been identified for VOCs released into the vadose zone in the WVBA: unsaturated flow (soils), saturated flow (groundwater), canal water and vapor intrusion.

- The following generalizations can be made using existing data, and field observations of drill cuttings and soil samples continuously collected during rotosonic drilling:

  - The vadose zone is comprised of unsaturated UAU1 soils, consisting of loose surface soils grading into interfingered sand and gravel lenses; clay lenses, when present, are thin and usually characterized as clayey sands. Based upon the east-west cross-sections, UAU1 appears to become finer-grained west of about 75th Avenue. Except in the eastern portion of the WVBA, UAU1 also appears to become finer-grained northwards, particularly in the northwest portion of the WVBA.

  - Depth to groundwater within the WVBA currently ranges from approximately 75 to 140 feet bgs depending on location and season; thus, this is the range in thickness of the vadose zone. In general, depth to groundwater is greatest in the north-central portion of the WVBA and shallowest along the eastern boundary of the WVBA.

  - Based upon the observed generalizations of UAU1 lithology, the permeability of vadose zone soils within the WVBA is likely lowest west of about 75th Avenue and except in the eastern portion of the WVBA, decreases northward.

  - The moisture content of vadose zone soils has been measured, ranging from 2.6 percent (dry) to moist at 19 percent. Dry bulk densities ranged from 1.15 to 1.92 g/cc. Porosities were calculated to range from 22 to 45 percent. TOC ranged from 74 to 3,650 mg/kg.

- One naturally occurring factor affecting contaminant migration is variability in aquifer characteristics. Transmissivity values in the vicinity of the WVBA were found to range from 4,000 to 160,000 gallons per day per foot. Transmissivity values converted to hydraulic conductivity values indicate that the hydraulic conductivity of the UAU ranges from 5 to 700 ft/d and the range for the MAU is 7 to 30 ft/d. In accordance with Darcy's law, the rate of VOC migration increases with increased hydraulic conductivity and gradient.

- Another process affecting VOC transport in groundwater is retardation, the process of adsorption/desorption. The affinity of a VOC for soil is expressed by the solid-water partition (distribution) coefficient which relates to the dissolved contaminant mass in groundwater to the mass sorbed to soil. Based upon calculated values, 1,1-DCE will exhibit the highest contaminant velocity of the three identified VOCs.

Groundwater pumpage represents the major outflow from the groundwater system within the WVBA. The primary production wells within the WVBA are those operated by RID, which are operated seasonally during the hotter months of the year. Thirty operable RID wells are located within or adjacent to the WVBA, and are pumped from approximately March to September. There are two sources of RID water. Approximately 30,000 AFY is obtained as effluent from the COP 23rd Avenue wastewater treatment facility and approximately 135,000 AFY is obtained from pumped groundwater. The RID was formed in 1928 after securing an agreement with SRP to pump and deliver water in 1923.

- Much of the western portion of the WVBA consists of irrigated agriculture. Fields are irrigated using flood application, and excess irrigation water historically applied to these fields characteristically reached the local water table as recharge. As agricultural fields are converted to urban uses, groundwater recharge from excess irrigation is lessened. Once the WVBA is fully urbanized, it will take approximately ten years for groundwater recharge from excess irrigation to cease.

- The CPM was designed to model aquifer conditions and groundwater movement including the effects of existing groundwater pumping. Its purpose is to assist in the evaluation of remedial strategies and their effects on groundwater movement and the contaminant plume. The CPM has the potential to be modified to develop fate and transport models for specific areas. The time period covered by the model was selected to be 1972 to 1996 based on the pumping history of the area, water level data, and the model purpose. Each year is divided into three stress periods and verified by pumping data provided by RID for 1992 through 1998. The stress periods were divided into periods of January and February for a total of 59 days, March through September for a total of 214 days, and October through December for a total of 92 days. Measured water levels and simulated water levels are, in general, less than ten feet in difference. The gradients and water-level contour maps for the simulated and observed data are similar in direction of flow and shape. Overall modeling results indicate that the simulated results match well with observed data. There are areas, however, that need more data to improve model calibration. Based on model calibration and validation, the CPM meets its intended purpose to evaluate remedial alternatives and contaminant movement in the CPM area.

- The RID canal originates at 19th Avenue south of Interstate 17 continuing on to the 23rd Avenue wastewater treatment facility where 30,000 AFY of treated wastewater is discharged into the canal. The canal is also fed by a number of RID production wells located throughout the WVBA; these wells discharge an

additional 135,000 AFY of pumped groundwater into the canal. Some of these wells extract VOC-contaminated groundwater which is discharged into the canal. Concentrations of VOCs in canal water do not exceed surface water standards. Due to the significant base flow from the 23rd Avenue wastewater treatment facility and from RID wells pumping uncontaminated groundwater, the effect of RID well discharge of groundwater containing VOCs into the canal is not appreciable; VOC concentrations are diluted to below AWQSs within 125 feet of the point of discharge. Beyond 125 feet of the point of discharge, however, the diluted/ reduced VOC concentrations stabilize, and remained consistent at 4.0 µg/l and less a minimum of two miles downstream from the discharge point.

- Once released to the vadose zone, VOCs can volatilize into soil gas which can migrate upwards to the ground surface. Depending on the land use/surface cover, soil gas can either be released directly to the atmosphere, become trapped beneath impermeable structures, or migrate into structures either beneath or at the ground surface. Typically, vapor intrusion will occur at or near the contaminant (in this case VOC) source area, but can also occur via off-gassing from the groundwater. The likelihood of vapor intrusion via this pathway decreases with increasing depth to groundwater.

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TABLES