ARCADIS
Infrastructure · Water · Environment · Buildings

Imagine the result

Arizona Department of Environmental Quality

Final Feasibility Study Work Plan

West Central Phoenix North Plume WQARF Site

Phoenix, Arizona

February 1, 2013

ARCADIS

Final Feasibility Study Work Plan

West Central Phoenix North Plume WQARF Site
Phoenix, Arizona

Robert Forsberg, R.G.
Principal Geologist

Michael Nesky, P.E.
Principal Environmental Engineer

Prepared for:
Arizona Department of Environmental Quality

Prepared by:
ARCADIS U.S., Inc.
14201 N.87th Street
Suite 135
Scottsdale
Arizona 85260
Tel 480.905.9311
Fax 480.905.9353

Our Ref.:
ST006854.0013

Date:
February 1, 2013

Figures

ºF	degrees Fahrenheit
µg/L	micrograms per liter
A.A.C.	Arizona Administrative Code
ADEQ	Arizona Department of Environmental Quality
ARCADIS	ARCADIS U.S., Inc.
A.R.S.	Arizona Revised Statutes
AST	aboveground storage tank
AWQS	Aquifer Water Quality Standard
COP	City of Phoenix
1,1-DCE	1,1-dichloroethene
EPA	U.S. Environmental Protection Agency
ERA	Early Response Action
F&B	F&B Mfg. Co.
FS	Feasibility Study
Hill Brothers	Hill Brothers Chemical Company
LAU	lower alluvial unit
MAU	middle alluvial unit
MCL	maximum contaminant level
MEK	methyl ethyl ketone
MNA	Monitored Natural Attenuation
msl	mean sea level
PCE	tetrachloroethene
Pyramid	Pyramid Industries, Inc.
RI	Remedial Investigation
Rinchem	Rinchem Company
RO	Remedial Objectives
TCA	1,1,1-trichloroethane
TCE	trichloroethene
UAU	upper alluvial unit
USBR	United States Bureau of Reclamation
USGS	U.S. Geological Survey
VOC	volatile organic compound
WCP	West Central Phoenix

1 Introduction

ARCADIS U.S., Inc, (ARCADIS) has prepared this *Final Feasibility Study Work Plan* (FS Work Plan) for the West Central Phoenix (WCP) North Plume Water Quality Assurance Revolving Fund (WQARF) Site on behalf of the Arizona Department of Environmental Quality (ADEQ).

In 1982, the volatile organic compound (VOC), trichloroethene (TCE), was detected in several City of Phoenix (COP) municipal wells located in west central Phoenix. Subsequent groundwater sampling confirmed the presence of TCE at concentrations above the U.S. Environmental Protection Agency (EPA) Maximum Contaminant Level (MCL). ADEQ subsequently designated the area of groundwater contamination as the WCP WQARF site and recommended further study under the State Superfund WQARF program. The WCP WQARF area was placed in the WQARF Priority List in 1987. Based on data obtained during the Phase I investigation, the WQARF area boundaries were redefined in 1989 to encompass those areas where groundwater quality data indicated halogenated VOC contamination. The WCP WQARF area was bounded by 35th, 51st, and 59th Avenues on the west; Encanto Boulevard and McDowell Road on the south; Black Canyon Freeway, 27th Avenue, and Grand Avenues on the east; and Campbell Avenue and Indian School Road on the north (Figure 1).

The WCP WQARF investigation included the compilation of geological, hydrological, and land use information about the area and the development of a list of businesses in the area that potentially used, stored, or disposed of hazardous substances. Facilities on the list were evaluated based on the results of detailed literature searches, groundwater sampling investigations, limited field reconnaissance, and responses to questionnaires. Some facilities in the WCP area conducted site characterizations that included groundwater sampling and evaluation. ADEQ also installed monitoring wells and performed area-wide groundwater contamination and groundwater flow evaluations in the WCP area. ADEQ used the data from these investigations to identify VOC contaminant plume areas based on identified source areas and site-specific groundwater data.

Currently, the following five WQARF sites within the WCP area have been established pursuant to Arizona Revised Statutes (A.R.S.) §49-287.01: West Osborn Complex, West Grand Avenue, East Grand Avenue, North Canal, and North Plume.

The WCP North Plume WQARF site is bounded approximately by Highland Street to the north, 38th Avenue to the east, Indian School Road to the south, and 43rd Avenue to the west (Figure 2). The WCP North Plume WQARF site consists of four facilities: F&B Mfg. Co. (F&B) facility, Pyramid Industries, Inc. facility (Pyramid), Rinchem facility (Rinchem), and Hill Brothers Chemical Company facility (Hill Brothers) as shown on Figure 2.

1.1 Purpose and Scope

The Feasibility Study (FS) is a process to identify and evaluate remedial options. The goal of the FS is to identify the best option or options for achieving defined Remedial Objectives (ROs). The FS will evaluate the identified remedies based on prescribed comparison criteria to select a remedy that complies with relevant statutes and rules. The FS will evaluate and propose a preferred remedy from among the remedial alternatives which: 1) assures the protection of public health, welfare and the environment; 2) to the extent practicable, provides for control, management, or cleanup of hazardous substances so as to allow for the maximum beneficial use of waters of the state; 3) is reasonable, necessary, cost-effective, and technically feasible; and, 4) addresses any well that either supplies water for municipal, domestic, industrial, irrigation or agricultural uses or is a part of a public water supply system, if the well currently, or in the foreseeable future, would produce water that would not be fit for its current or reasonably foreseeable end use without treatment.

The FS will rely upon the data and findings of the Early Response Action (ERA) and subsequent Remedial Investigation (RI) activities that have been conducted by ADEQ at the WCP North Plume WQARF Site. The FS report will present and evaluate the proposed remedies, strategies and measures, and select a proposed remedy that best satisfies the criteria presented above. The FS will be conducted in accordance with the Arizona Administrative Code (A.A.C.) Title 18, Environmental Quality, Chapter 16, Department of Environmental Quality – Water Quality Assurance Revolving Fund Program, Article 4, Remedy Selection, R18-16-407 Feasibility Study.

2 Background

2.1 Land Use

The WCP North Plume WQARF site lies within a heavily industrialized area of west central Phoenix, and is zoned as general industrial by the COP Zoning Department. In general, commercial properties are concentrated near the intersections of major

streets (43rd Avenue, 39th Avenue, Indian School Road, and Grand Avenue). Industrial properties occupy most of the land enclosed by these thoroughfares. Residential areas are located north of Grand Avenue. Alhambra High School is located approximately 0.25 mile northeast of the WCP North Plume WQARF site (Figure 1).

2.2 Hydrogeologic Setting

The WCP North Plume WQARF site is located within the Western Salt River Valley Sub-basin of the Basin and Range physiographic province. The Western Salt River Valley Sub-basin is an alluvial-filled basin of sedimentary deposits ranging in thickness from less than 100 feet at the margins of the basin to over 10,000 feet in the central areas of the basin (Corkhill et al., 1993). The Sub-basin is mostly surrounded by mountains composed of Tertiary and older igneous and metamorphic rocks and minor amounts of Tertiary consolidated sedimentary rocks. The crystalline and consolidated sedimentary rocks also form the basement complex that lies beneath Quaternary and late-Tertiary unconsolidated or semi-consolidated basin-fill alluvial sediments.

Several classification systems have been used to describe the alluvial fill underlying the Western Salt River Valley. In 1976, the United States Bureau of Reclamation (USBR) developed the widely recognized classification system that divided the alluvial fill into the upper alluvial unit (UAU), middle alluvial unit (MAU), and lower alluvial unit (LAU). The MAU was defined by the predominance of fine-grained materials. The LAU was described as a conglomerate. The UAU was defined as a mixture of coarse and fine-grained materials. This led to some confusion as to where the contact between the UAU and MAU was located.

In 1989, the U.S. Geological Survey (USGS) published its regional basin study of the Western Salt River Valley that included a similar classification for the alluvial fill (Brown and Pool, 1989). Differences between the two classification systems included the division of the LAU into an Upper and Lower LAU, where the Upper LAU was the equivalent of the USBR's MAU. In addition, the USGS' MAU classification incorporated the lower fine-grained interval of the USBR's UAU. The USGS classification was said to correlate with previous classifications by the USGS in the Eastern Salt River Valley. That classification system defined the UAU as a coarse-grained and mostly de-watered unit, the MAU as a predominately fine-grained unit, and the LAU as a weakly to moderately cemented sand and gravel unit. Underlying the LAU were the conglomeratic Tertiary Red Unit and Precambrian crystalline rocks.

Groundwater occurs primarily in the basin-fill alluvium. Historically, accumulation of groundwater resulted as mountain-front recharge near basin margins or as infiltration in ephemeral streams and washes. More recently, artificial recharge has been introduced as deep percolation of excess irrigation, sewage effluent, and from man-made surface-water features. Much of the developed portion of the Salt River Valley was historically used for crop irrigation. In these areas, even after irrigation ceases and the land is put to different uses, residual water saturation in the vadose zone remains relatively high compared to native undeveloped areas.

The natural groundwater gradient in the WCP North Plume WQARF site vicinity is to the west-southwest. Regional groundwater flow is greatly influenced by groundwater pumping. The introduction of the turbine pump in the late 1940s enabled groundwater to be extracted from greater depths and over expanded applications. Increased groundwater usage resulted in pumping centers that altered the natural gradient. Seasonal variations in groundwater demand and pumping also resulted in transient groundwater conditions. More recently, reduced dependency on groundwater and increased surface-water utilization has resulted in rebounding of groundwater elevations in some areas.

2.3 Topography

The elevation of the WCP North Plume WQARF site ranges between approximately 1,117 feet above mean sea level (msl) to approximately 1,133 feet msl. The regional ground surface slopes to the south with a gradient from approximately 20 feet per mile.

2.4 Climate

The West Salt River Valley Sub-basin lies in the northern Sonoran desert and is characterized by hot summers and cool winters. In July, the average maximum and minimum daily temperatures are 105 degrees Fahrenheit (°F) and 80 °F. In December, the average maximum and minimum daily temperatures are 65 °F and 39 °F (Sellers and Hill, 1974). Average rainfall on the valley floor is approximately 7.5 inches per year. The average annual pan evaporation rate measured in Tempe, Arizona, for the period from 1969 through 1973 was 72 inches (Sellers and Hill, 1974). Potential evapotranspiration may equal pan evaporation, with both averaging approximately 10 times the average annual rainfall amount (Brown and Pool, 1989).

2.5 Surface Water

Surface-water runoff flow is primarily controlled by the COP storm sewer system. The valley is drained by several ephemeral streams and washes that generally flow only during large storm events. Several man-made surface-water features exist, including lakes and canals. These features can serve as areas of groundwater recharge particularly where they are unlined. The Grand Canal is located approximately 1 mile to the south. Historically, the canal has influenced groundwater flow in the region. A concrete liner was placed in the canal in January 1998 (Weston, 1998). The canal was originally constructed above grade to prevent surface-water runoff from entering the canal. Prior to emplacement of the concrete liner, considerable water percolated through the bottom of the canal into the vadose zone. It was generally believed that this caused a groundwater mound along the axis of the canal creating horizontal gradients to the north and south of the canal axis. However, since the emplacement of the concrete liner, the canal's influence on local groundwater flow has diminished.

3 WCP North Plume Area Facility Descriptions

3.1 F&B Mfg. Co. Facility

The F&B Mfg. Co. facility is located at 4316 North 39th Avenue in Phoenix, Arizona (Figure 3). F&B manufactures metal aircraft and spacecraft parts and performs sheet metal forming, light machining, and assembly at the facility. F&B utilizes solvents, hydraulic oils, and chromic acid in its operations. The property on which the F&B facility stands was cultivated land until F&B began leasing the location in 1967. By March 1967, F&B had completed construction of its facility and begun operations. The following discussion of F&B's operations was obtained from *Results of Data Collection Activities for F&B Mfg. Co. Environmental Investigation,* prepared by Basin & Range Hydrogeologists, Inc. (Basin & Range, 1991). In March of 2012, F&B Mfg. Co. acquired the two parcels (parcel numbers 107-12-019L and 107-12-019M) directly west of its current facility (Figure 3).

Fabrication processes include metal parts forming, cutting, grinding, and welding. F&B's finishing processes involve deburring, degreasing, and heat corrosion treating. Metal part forming is accomplished using hydraulically operated presses and punches that require the use of hydraulic oil. Spent hydraulic oil is reportedly disposed of offsite. Water-based cutting fluids are reportedly used with grinding and cutting machinery to protect the equipment and facilitate the grinding process. Following removal of excess water, waste cutting fluids are reportedly disposed of as

hazardous waste. In some of F&B's machinery, an ethylene glycol mixture or water is reportedly used as a coolant.

Grinding and deburring, degreasing, heat treating, and corrosion treating (alodining) are performed during finishing operations. Deburring tumblers contain abrasive pellets and a mixture of water, soap, and a lubricant containing alcohol. That liquid mixture is reportedly discharged to the sewer.

Degreasing operations were performed in a vapor degreasing tank located above a concrete vault. F&B used tetrachloroethene (PCE) and 1,1,1-trichloroethane (TCA) as its degreasing solvent; however, PCE was reportedly used until approximately October 1987. Vapors were produced when the TCA was heated and parts were lowered into the tank (above the liquid) for vapor degreasing. Some of the TCA was reportedly reclaimed, and the sludge that accumulated on the bottom of the tank was reportedly disposed of as hazardous waste. However, much of the TCA was lost to evaporation. F&B reportedly used approximately 500 gallons of TCA per month.

Metal parts are heat treated in a vacuum furnace containing argon gas. Following the heat treatment process, parts are cooled in water quench tanks.

Alodining or corrosion treating involves submerging parts in a series of nine 550-gallon (approximate capacity) tanks containing dilute chromic acid, alkaline soap, alkaline etching solution, and rinse water. Spent solution from the tanks is pumped to F&B's pretreatment facility where it is treated (by chrome destruction, neutralization, pH adjustment) prior to discharging to the sewer.

Before construction of the on-site pretreatment facility, spent chromic acid was reportedly pumped into a 1,000-gallon tank where it was neutralized and metals were precipitated out of the liquid. Sludge generated during this process was reportedly contained in 55-gallon drums and disposed of as a hazardous waste. Following treatment, samples of effluent were reportedly analyzed for chromium and the effluent was discharged to the sewer system.

Parts are inspected through exposure to a penetrant (known as Zyglo) which is followed by observation under ultraviolet light. Spent penetrant is reportedly discharged to the sewer.

Construction of F&B's secured hazardous waste storage facility was completed during July 1990. That storage facility is located near the southwestern corner of the property and is used to store chemicals as well as wastes. The following types of hazardous waste were stored in the hazardous waste storage facility:

F001-spent oil/toluene/TCA

F002-spent cutting oil, oil/TCA

F003-spent cutting oil, oil/TCA

F019-sludge from pre-treatment plant

D001-spent Acetone

Acetone was reportedly stored inside the main building. TCA, Draw Clean 366 L (38 percent TCA), mineral spirits, and Chem-tool (38 percent TCA) were stored in the hazardous waste storage facility.

Above ground storage tank (AST) containing liquid argon is located near the southwestern corner of the parking lot outside of the building. Liquid argon is reportedly used in the vacuum furnace and for welding activities.

A number of solvents have reportedly been used at the F&B facility, including PCE, TCA, acetone, and toluene. A number of hazardous wastes have reportedly been generated at the F&B facility, including spent oil and sludge containing chromic acid and alkaline etching solution.

F&B Mfg. Co. performed degreasing operations in a vapor degreasing tank located above a concrete vault. PCE was used as the degreasing solvent until approximately October 1987. F&B reportedly used TCA as the degreasing solvent thereafter until the late 1990s. This degreasing tank (solvent dip tank) was located in the northwestern portion of the building, east of monitoring wells F&B-1 and F&B-2. The highest concentrations of PCE in soil and groundwater have been detected near this portion of the building. F&B's hazardous waste storage facility is located near the southwestern corner of the property and is used to store chemicals as well as wastes (LFR, 2009).

3.2 Pyramid Facility

The Pyramid facility is located at 4330 North 39th Avenue (Figure 4). Pyramid operated a telephone and television cable riser box manufacturing facility from 1977 to 1994. Operations at the facility required the use of acids, caustics, heavy metals, paints, and methylene chloride. The facility property consists of two adjoining parcels. Since 1997, National Environmental Waste, a plastic recycling company, and Intermountain Lumber Company have occupied the southern parcel. Since 1999, the northern parcel has been occupied by M&S Enterprise, a scrap metal recycler.

The manufacturing process at the Pyramid facility was initiated with the cutting and forming of galvanized metal in presses. The metal parts were then hung on a conveyor, passed over five chemical tanks, and then sprayed with chemicals. The first tank contained a caustic wash (primarily sodium hydroxide). The second tank contained a water rinse. The third tank contained a zinc-phosphate solution. The fourth tank was a water rinse. The fifth tank was a chromic acid rinse (ADEQ, 1990). The solutions were piped to a wastewater pre-treatment system and then discharged into the COP sanitary sewer in accordance with Pyramid's Industrial Wastewater Discharge Permit. The metal parts were then dried and painted. Locations of historical operations are shown in Figure 4.

The wastewater pre-treatment process removed metals from solution by precipitation. The resulting process sludge reportedly contained zinc, lead, and chromium and was stored in containers until removal from the facility by Disposal Control Services, Inc. (ADEQ, 1990).

Pyramid also reportedly operated three spray-painting booths at the facility. Paint hooks were reportedly cleaned by dipping them into a Sno-Flake Cold Stripper, which is 80 to 90 percent methylene chloride. Most of the methylene chloride reportedly was lost to evaporation, and the remaining spent solvent was transported off site for disposal by Disposal Control Services, Inc (LFR, 2009). Methylene chloride is the only chlorinated solvent reported by Pyramid to have been used at the facility (ADEQ, 1990).

3.3 Rinchem Facility

Rinchem is located at 4115 West Turney Avenue. Rinchem operated a chemical warehouse and distribution facility that handled solvents, oils, and fuels (Figure 5). Rinchem also blended custom solvents at this facility. Rinchem was the only company that operated at the facility from construction of the facility in 1982 through June 1993. The property is currently occupied by Tarr, Inc., which operates a chemical warehouse and distribution operation.

Chemicals were stored in the warehouse and the bulk storage area of the facility depending on compatibility. Packaged chemicals were stored in original containers and 55-gallon drums in the warehouse. Bulk chemicals were stored in an AST farm, which contained approximately 30 tanks of various sizes. The tank farm was located on the southern side of the property. A pumping station for bulk rail shipments of chemicals, including TCE, PCE, TCA, methylene chloride, acetone, methyl ethyl ketone (MEK), toluene, chlorinated solvent blend, and a methylene chloride/TCA

blend, was located in the southeastern corner of the property, adjacent to an aboveground pipeline and dry well.

Chemicals stored in the tank farm were either delivered by truck or in bulk by railroad tank car. Shipments delivered by truck were delivered to the south end of the tank farm for transfer or storage. Chemicals delivered by rail car were pumped from the southeastern corner of the property to the tank farm via the pipeline along the southern boundary of the property.

Custom mixes were created in the repackaging and blending area south of the tank farm. The repackaging and blending area was concrete floored and sloped to a concrete-lined sump located in the northern portion of the area. Approximately 20,000 to 25,000 gallons of solvents were reportedly packaged in this area each week (Four Corners, 1994). Following packaging, solvents were stored in the repackaging and blending area while awaiting shipment (LFR, 2009).

3.4 Hill Brothers Facility

The Hill Brothers facility is located at 4450 North 42nd Avenue (Figure 6). Hill Brothers has operated a chemical distribution facility at this location since 1969. Prior to 1969, the location was developed as agricultural land.

Bulk chemicals are received at the Hill Brothers facility via railroad cars and tanker trucks. Chemicals that include acids, bases, alcohols, acetone, methylene chloride, PCE, toluene, TCA, xylene, chlorine, and concrete additives have been or currently are stored in ASTs on site prior to transfer into containers for distribution. Wastewater is treated by neutralizing pH prior to discharge to the COP sewer system. The handling and repackaging of solvents was discontinued in 1989 (LFR, 2009).

4 Remedial Objectives

ROs have been established for current and reasonably foreseeable uses of land and waters of the State that have been or are threatened to be affected by a release of a hazardous substance. An RO report has been prepared by ADEQ (2008) with stakeholder input gathered during the WCP Community Advisory Board and public meetings, written comments received during the 45 day public comment period as well as land and water use study questionnaires gathered during the RI.

According to A.A.C. R-18-16-406(D) the foreseeable uses of land are those likely to occur at the Site, and the reasonably foreseeable uses of water are those likely to occur within 100 years unless site-specific information suggests a longer time period is

more appropriate. Reasonably foreseeable uses are those likely to occur based on information provided by water providers, well owners, land owners, government agencies, and others. Not every use identified in the RI will have a corresponding RO. Uses identified in the RI may or may not be addressed based on information gathered during the public involvement process, WQARF limitations, and whether the use is reasonably foreseeable.

The ROs chosen for the Site will be evaluated in the FS, which will compare remedial measures and strategies required to meet the ROs. A remedial strategy is one or a combination of the six general strategies identified in Paragraph B.4 of A.R.S. 49-282.06 (plume remediation, physical containment, controlled migration, source control, monitoring, or no action). A remedial measure is a specific action taken in conjunction with remedial strategies to achieve one or more ROs (for example, well replacement, well modification, water treatment, water supply replacement, or engineering controls).

The FS will propose at least three remedies (a reference remedy and generally two alternative remedies) considered capable of meeting the ROs. A reference remedy is a combination of remedial strategies and measures that is compared with alternative remedies for purposes of selecting a proposed remedy. An alternative remedy is a combination of remedial strategies and measures different from the reference remedy. Proposed remedies will also be generally compatible with future land use specified by land owners. Remedial actions should be reasonable, appropriate and cost-effective.

Based upon review of public comment, the ROs are based on the following:

- Protect against possible exposure to hazardous substances in surface and subsurface soil that could occur during development of property based upon applicable zoning regulations.
- Protect against possible leaching of hazardous substances from the upper portion of the aquifer into deeper portions of the aquifer where groundwater use is occurring.

ROs for this Site have been established for the following groundwater uses:

- municipal; and
- agricultural.

Based on public comment, proposed ROs for current and future municipal groundwater use in the WCP North Plume WQARF site are:

- To protect the supply of groundwater for municipal use and for the associated recharge capacity that is threatened by contamination emanating from the WCP North Plume WQARF Site. To restore, replace or otherwise provide for the groundwater supply lost due to contamination associated with the WCP North Plume WQARF Site. This action will be needed for as long as the need for the water exists, the resource remains available and the contamination associated with the WCP North Plume WQARF Site prohibits or limits groundwater use.

Based on public comment, proposed ROs for current and future agricultural groundwater use in the WCP North Plume WQARF site are:

- To protect the supply of groundwater for irrigation use and for the associated recharge capacity that is threatened by contamination emanating from the WCP North Plume WQARF site. To restore, replace or otherwise provide for the groundwater supply lost due to contamination associated with the WCP North Plume WQARF site. This action will be needed for as long as the need for the water exists, the resource remains available and the contamination associated with the WCP North Plume WQARF site prohibits or limits groundwater use.

5 Identify and Screen Appropriate Remedial Technologies

During the FS, appropriate remedial technologies for groundwater will be identified and screened according to the following criteria:

- contaminant treatment effectiveness;
- compatibility with drinking water systems;
- constructability;
- flexibility/expandability;
- operation and maintenance requirements;
- management of residual waste products;
- chemical use/operational hazards; and

- cost/effectiveness.

The following site assumptions and system requirements will be used during the identification and screening of the remedial technologies:

- Contaminants in shallow groundwater wells (screen interval 100 ft to 180 ft) - PCE up to 19,000 micrograms per liter (µg/L), TCE up to 59 µg/L, and 1,1-dichloroethene (1,1-DCE) up to 430 µg/L.
- Contaminants in middle groundwater wells (screen interval 250 ft to 280 ft) - PCE up to 2,000 µg/L, TCE up to 1.1 µg/L, and 1,1-DCE up to 1.4 µg/L.
- Contaminants in deep groundwater wells (screen interval below 350 ft) - PCE up to 8.0 µg/L and TCE up to 2.9 µg/L.
- Remedial Efficiency- Must achieve Aquifer Water Quality Standards (AWQSs) at agriculture, municipal supply and domestic wells.
- End Use – agricultural and municipal.
- Cost – Compared, based on each remedial scenario.

The remediation technologies that pass the technology screening will be retained for use in development of the reference remedy and alternative remedies.

5.1 Remediation Technology

Technologies that have been identified and will be screened for groundwater will include, but will not be limited to:

- Monitored Natural Attenuation (MNA);
- In-situ Chemical Oxidation;
- Enhanced Bioremediation;
- Air-sparge; and
- Pump-and-Treat Remediation.

5.2 Retained Technologies

Following screening, the treatment technologies which have been retained for future consideration will be evaluated as to compatibility with applicable state and federal regulations, the effectiveness at treating the target contaminants, the operation and maintenance requirements, and the overall costs.

Selected retained technologies will then be assembled with selected strategies and measures to develop the reference remedy and alternative remedies.

6 Develop Reference Remedy and Remedial Alternatives

Based upon the retained remedial technologies, a reference remedy and two alternative studies will be developed and compared. The reference remedy and each alternative remedy also may include contingent remedial strategies or remedial measures to address reasonable uncertainties regarding the achievement of ROs or uncertain time-frames in which ROs will be achieved. The reference remedy and alternative remedies will be described in the FS report in sufficient detail to allow evaluation using the comparison criteria, but plans at construction level details are not required at this time. Where appropriate, the reference remedy and an alternative remedy may incorporate different strategies for different aquifers, or portions of aquifers.

The remedial strategies to be developed, consistent with A.A.C. R18-16-407 (F), are listed below. A strategy may incorporate more than on remediation technology or methodology.

- plume remediation;
- physical containment;
- controlled migration;
- source control;
- monitoring; and
- no action alternative.

In identifying remedial measures, the needs of the well owners and the water providers and their customers will be considered, including quantity and quality of water, water

rights and other legal constraints on water supplies, reliability of water suppliers, and any operational implications. Such remedial measures may include, but will not be limited to, well replacement, well modification, water treatment, provision of replacement water supplies and engineering controls. Where remedial measures are relied upon to achieve ROs, such remedial measures will remain in effect as long as required to ensure the continued achievement of those objectives.

6.1 Reference Remedy: Strategy and Measures

The reference remedy will be developed based upon the best engineering, geological, or hydrogeological judgment following industry standards of practice and considering the following:

- The information in the RI report;
- The base available scientific information concerning available remedial technologies; and
- Preliminary analysis of the comparison criteria and the ability of the reference remedy to comply with ARS §49-282.06.

6.2 More Aggressive Alternatives Remedy: Strategy and Measures

At least one of the alternative remedies must employ a remedial strategy or combination of strategies that is more aggressive than the reference remedy. A more aggressive strategy is a strategy that requires additional remedial measures to achieve ROs, a strategy that achieves ROs in a shorter period of time, or a strategy that is more certain in the long term and requires fewer contingencies. One of the more aggressive alternative remedies may use the same strategy as the reference remedy but may use different viable technologies or a more intensive use of the same technology utilized in the reference remedy.

6.3 Less Aggressive Alternative Remedy: Strategy and Measures

At least one of the alternatives must employ a remedial strategy or combination of strategies that is less aggressive than the reference remedy. This alternative will still be capable of achieving the defined ROs but may use less intensive or fewer remedial measures than the reference remedy.

7 Additional Studies

7.1 Data Gaps

Potential data gaps may be identified during the development of the reference remedy and remedial alternatives. Data gaps may include the need to collect additional field data and/or perform laboratory studies to be able to complete an evaluation of the reference remedy and remedial alternatives. If necessary, an addendum to this work plan will be prepared to present the methodologies and data quality objectives for additional data collection. The work plan addendum may also include a description of potential permitting requirements, investigative derived waste management, data management, abbreviated quality assurance project plan, and a health and safety plan.

8 Description Analysis of Reference Remedy and Alternatives

8.1 Description of Evaluation Criteria

A comparative evaluation of the reference remedy and the alternative remedies developed will be conducted. In accordance with A.A.C. §18-16-407 (H) each remedial alternative will be evaluated using the following:

1. A demonstration that the remedial alternative will achieve the ROs.

2. An evaluation of consistency with the water management plans of the affected water providers and the general land use plans of the local governments with land use jurisdiction.

3. An evaluation of the comparison criteria, including:

    a. practicability of the alternative;

    b. risk of the alternative;

    c. cost of the alternative; and

    d. benefit or value of the alternative.

9 Proposed Remedy

Based upon the evaluation and comparison of the reference remedy and the other alternative remedies developed, a proposed remedy will be selected. The FS report will describe the following for the proposed remedy:

- process and reason for the selection;
- comparison criteria;
- achievement of ROs;
- achievement of remedial action criteria, pursuant to A.R.S. § 49-282.06;
- consistency with water management plans;
- consistency with general land use planning; and
- contingencies.

10 Feasibility Study Report

An FS report will be prepared documenting the FS process. The FS report will include the following sections:

- Section 1.0 Introduction
- Section 2.0 Site Background
- Section 3.0 Feasibility Study Scoping
- Section 4.0 Identification and Screening of Remediation Technologies
- Section 5.0 Development of Reference Remedy and Alternative Remedies
- Section 6.0 Summary of Additional Studies Necessary to Complete Analysis of Remedial Alternatives
- Section 7.0 Detailed Comparison of the Reference Remedy and the Alternative Remedies
- Section 8.0 Proposed Remedy
- Section 9.0 Community Involvement

11 References

ADEQ. 1990. Preliminary Assessment, West Phoenix Industrial Area. Phoenix, Arizona.

Basin & Range. 1991. Results of Data Collection Activities for F&B Mfg. Co.'s Environmental Investigation. Prepared for F&B Mfg. Co.

Brown, J.G., and D.R. Pool. 1989. Hydrogeology of the Western Part of the Salt River Valley Area, Maricopa County, Arizona, U.S. Geological Survey Water Resources Investigations Report 88-4202.

Corkhill, E.F., S. Corell, B.M. Hill, and D.A. Carr. 1993. A Regional Groundwater Flow Model of the Salt River Valley – Phase I Phoenix Active Management Area Hydrogeologic Framework and Basic Data Report, Arizona Department of Water Resources Modeling Report No. 6.

Four Corners Environmental, Inc (Four Corners). 1994. Final Work Plan Preliminary Site Characterization, 4115 West Turney, Phoenix, Arizona. Prepared for Phoenix Investors No. 2 Limited Partnership. September.

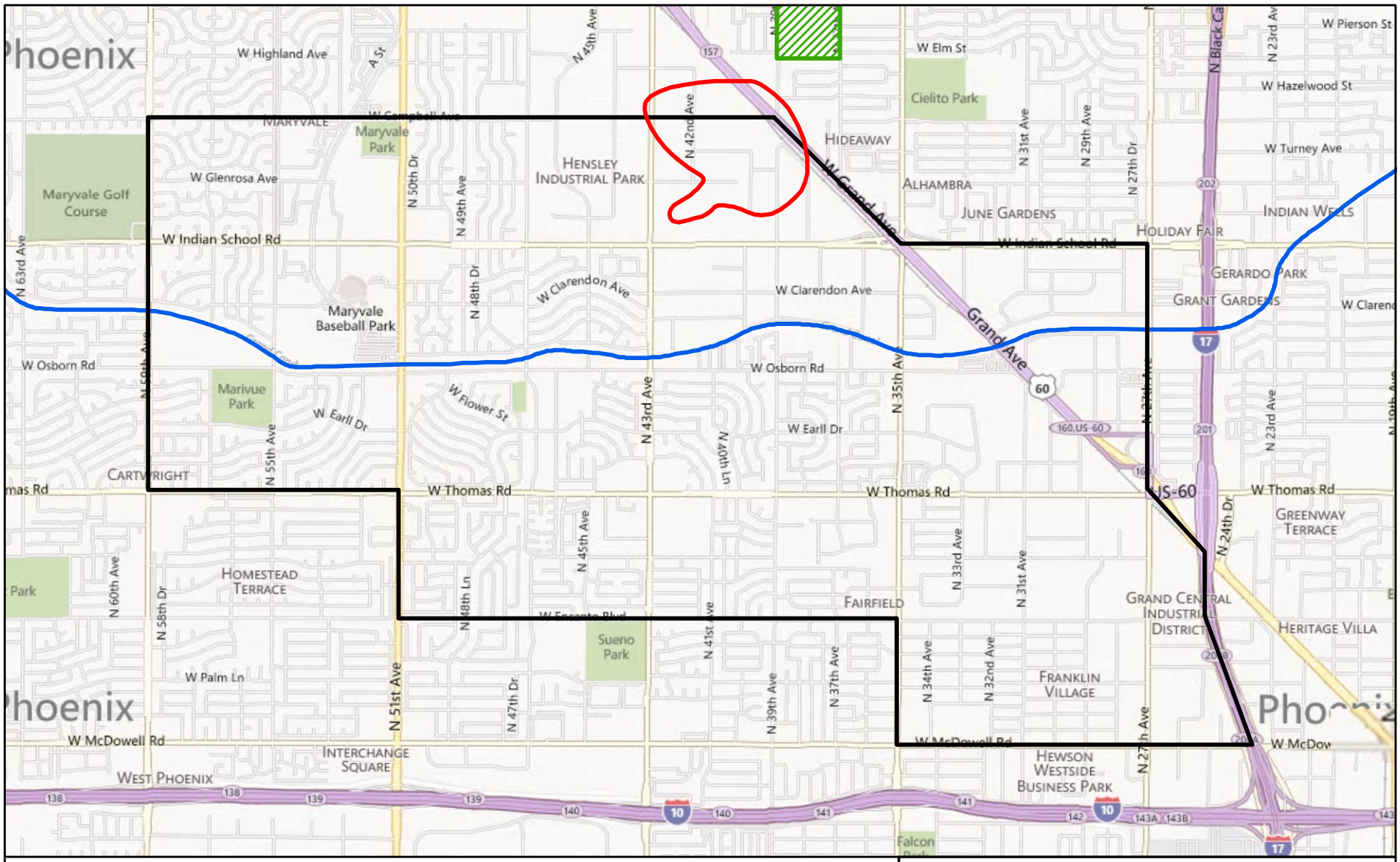
LFR. 2009. Final Remedial Investigation Report, West Central Phoenix North Plume Site, Phoenix, Arizona. Volume I of IV, January.

Sellers, W.D. and Hill, R.H. 1974. Arizona Climate 1931-1972, University of Arizona Press, Tucson.

Weston. 1998. Phase I Remedial Investigation Report, Pyramid Industries Site, 4330 North 39th Avenue, Phoenix, Arizona. Prepared for Arizona Department of Environmental Quality.

ARCADIS

Figures



LEGEND

- 1989 historical West Central Phoenix WQARF Area boundary
- West Central Phoenix North Plume WQARF Registry Site
- Alhambra High School
- Grand Canal

NOTES

- Map source: Bing Maps.
- WQARF = Water Quality Assurance Revolving Fund.

N

0 1,500 3,000 Feet

Scale: 1" = 3,000'

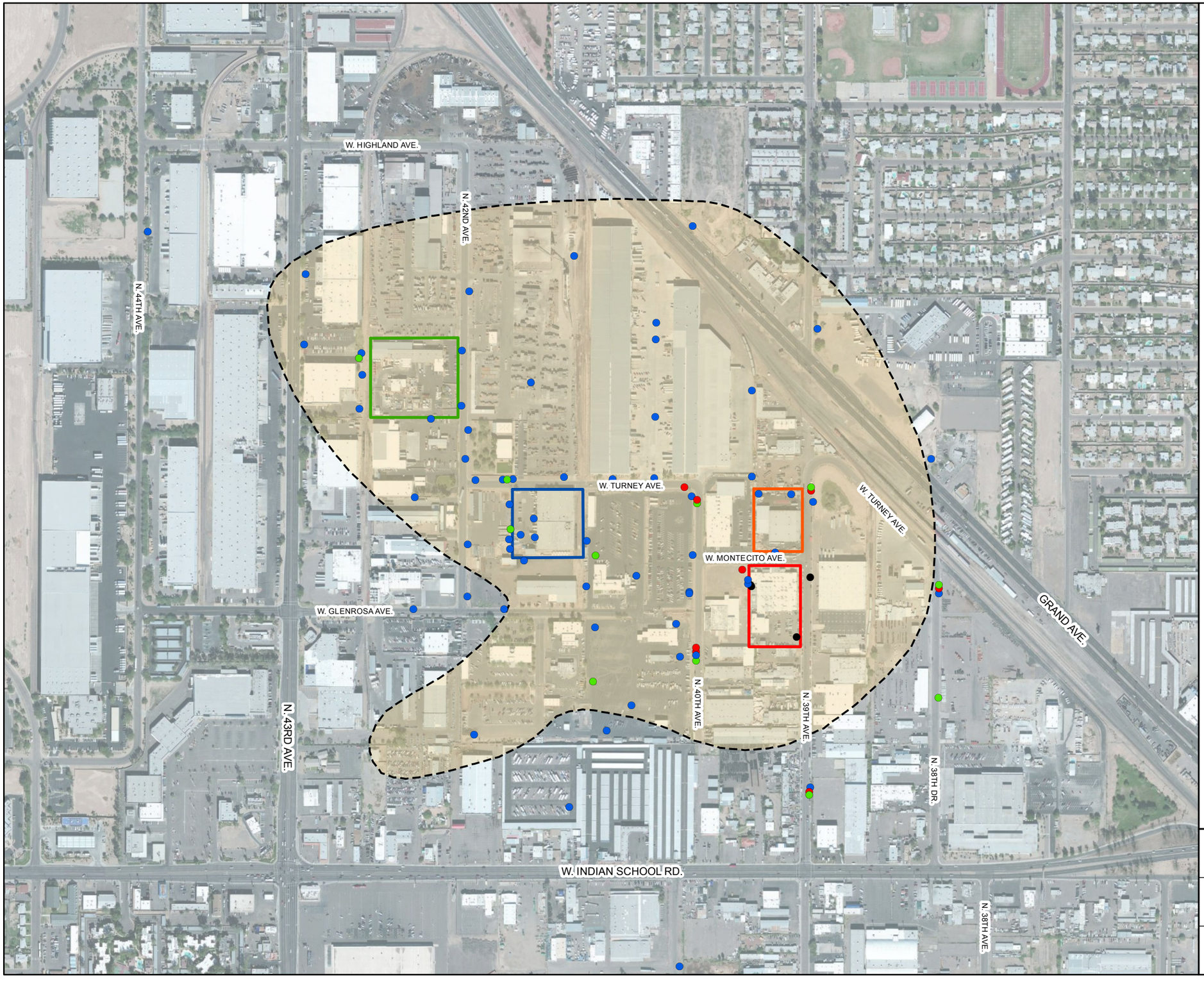
WEST CENTRAL PHOENIX NORTH PLUME WQARF SITE
PHOENIX, ARIZONA
FEASIBILITY STUDY WORK PLAN

WEST CENTRAL PHOENIX WQARF AREA

ARCADIS

FIGURE
1

G:\Project\ADEQ (Arizona Department of Environmental Quality)\North PlumeNP GIS\Projects\FS Work Plan 11-2012\Figure 1 WCP WQARF area.mxd 12/18/2012



LEGEND

- Shallow MAU monitor well
- Intermediate MAU monitor well
- Deep MAU monitor well
- F&B Westbay well
- F&B Manufacturing Co. facility
- Pyramid facility
- Hill Brothers facility
- Rinchem facility
- West Central Phoenix North Plume area

NOTES

· Aerial photo source: Bing Maps.

N

0 250 500 Feet

Scale: 1" = 500'

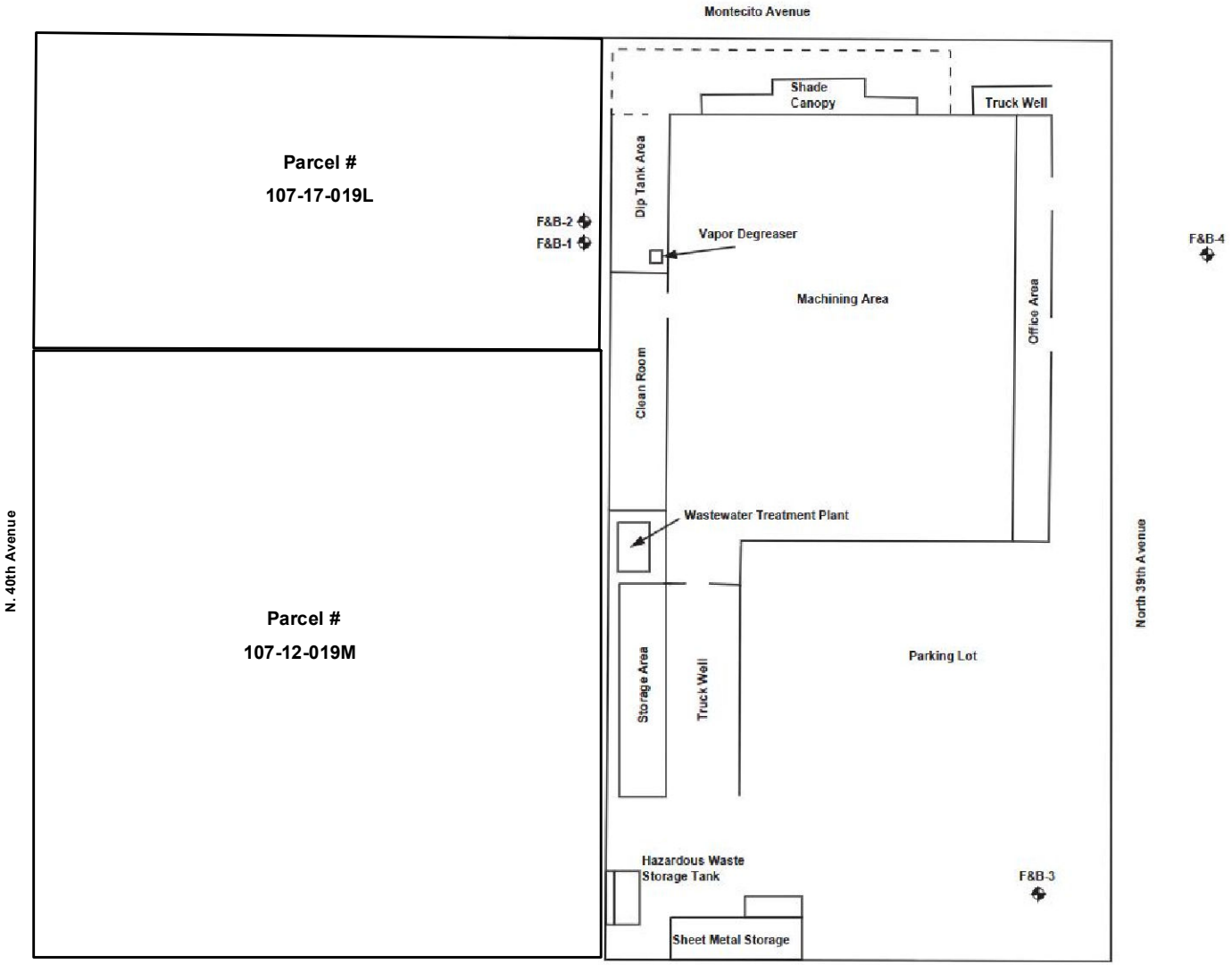
WEST CENTRAL PHOENIX NORTH PLUME WQARF SITE
PHOENIX, ARIZONA
FEASIBILITY STUDY WORK PLAN

WEST CENTRAL PHOENIX NORTH PLUME AREA

ARCADIS

FIGURE
2

G:\Project\ADEQ (Arizona Department of Environmental Quality)\North Plume\NP GIS\Projects\FS Work Plan 11-2012\Figure 2 WCP North Plume area.mxd 11/15/2012



LEGEND

Monitor well

NOTES

· Drawing not to scale.

N

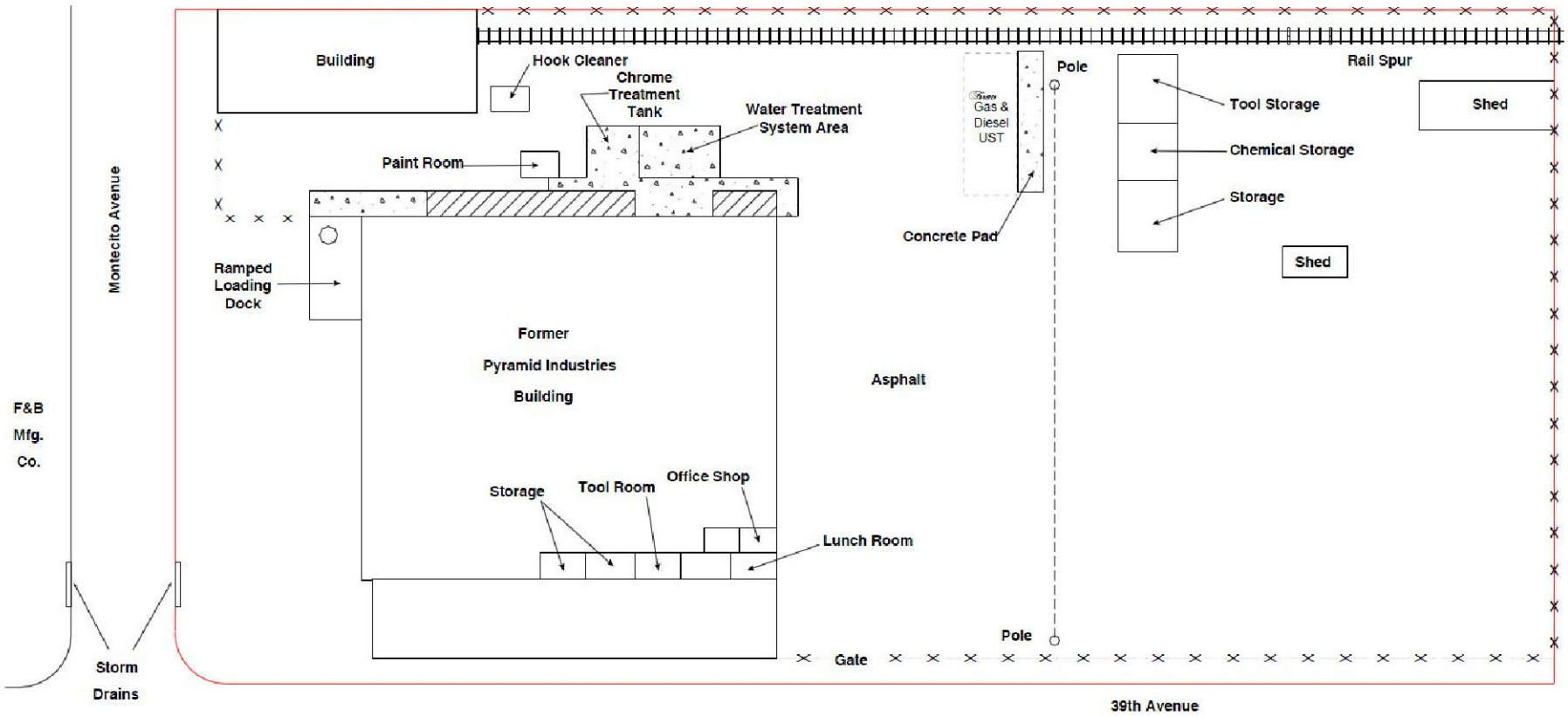
WEST CENTRAL PHOENIX NORTH PLUME WQARF SITE
PHOENIX, ARIZONA
FEASIBILITY STUDY WORK PLAN

F&B MFG. CO. FACILITY

ARCADIS

FIGURE
3

G:\Project\ADEQ (Arizona Department of Environmental Quality)\North Plume\NP GIS\Projects\FS Work Plan 11-2012\Figure 3 F&B facility.mxd 11/15/2012



LEGEND

- Property boundary
- Concrete
- Dry well
- Fence line
- Overhead electrical line

NOTES

· Source: Weston's *Phase II RI/FS Workplan*.
· Drawing not to scale.

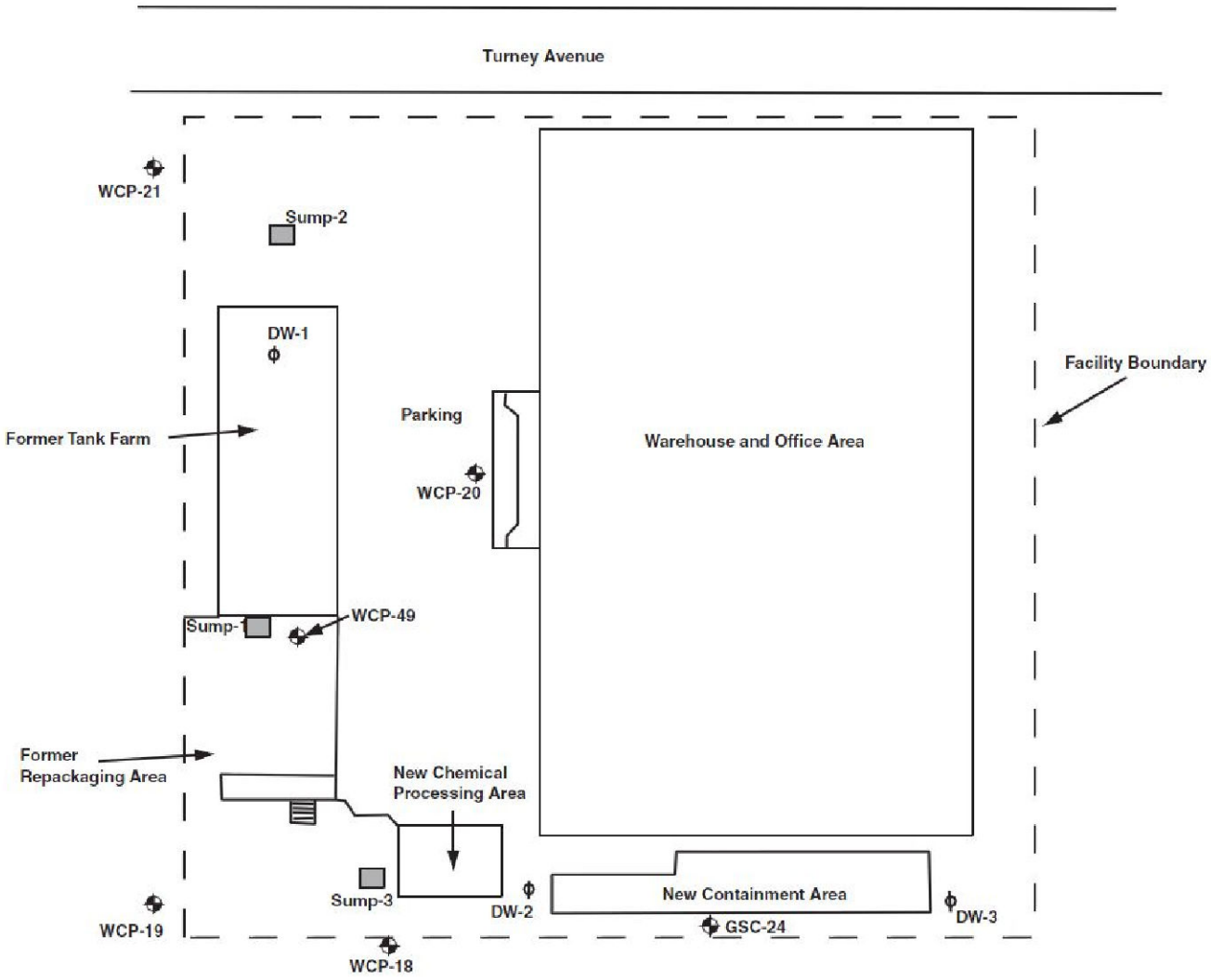
N

WEST CENTRAL PHOENIX NORTH PLUME WQARF SITE
PHOENIX, ARIZONA
FEASIBILITY STUDY WORK PLAN

PYRAMID INDUSTRIES FACILITY

ARCADIS

FIGURE
4



LEGEND

- Monitor well
- Dry well
- Sump

NOTES

· Source: adapted from Four Corners' *Preliminary Site Characerization Report*.
· Drawing not to scale.

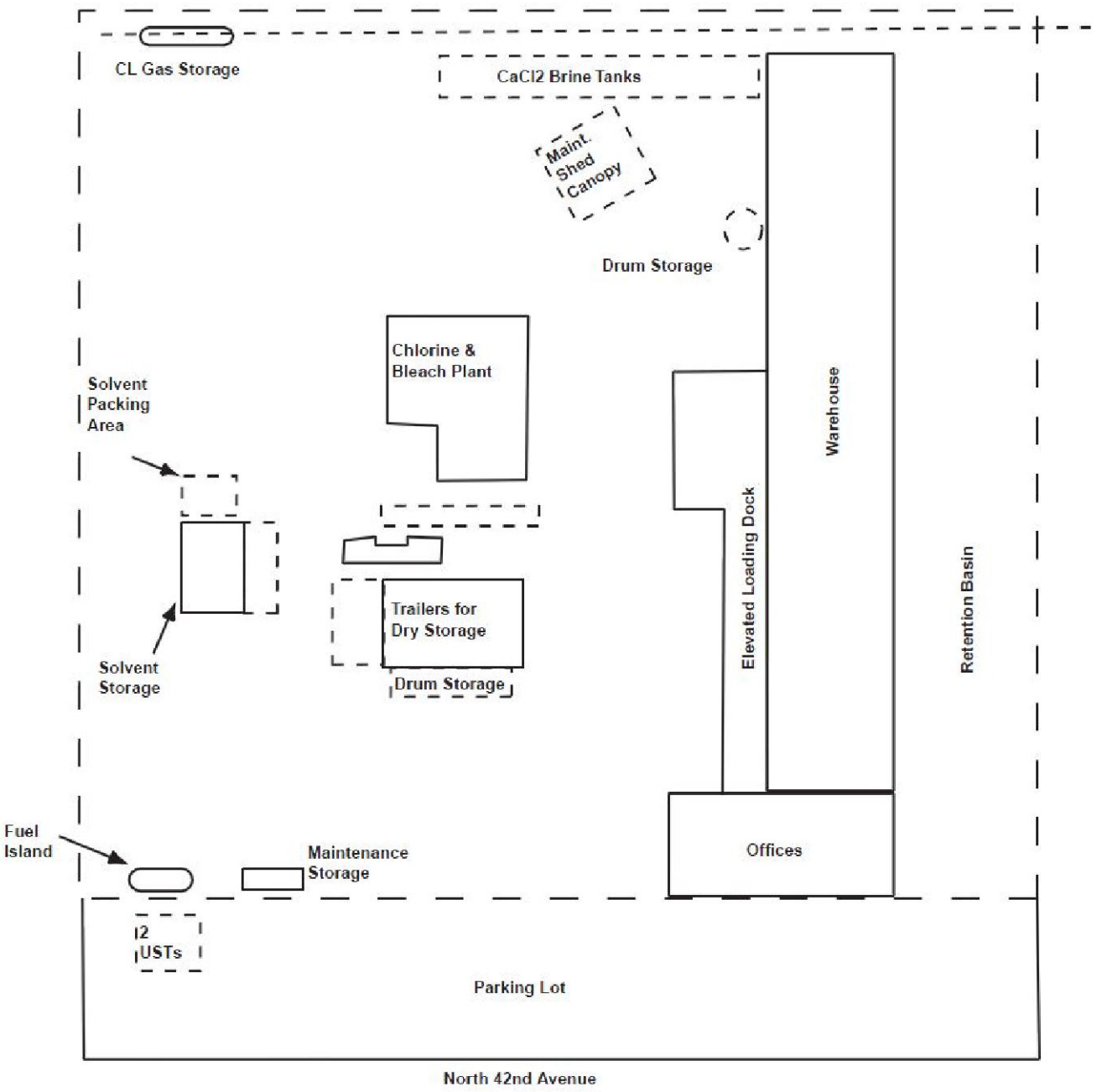
N

WEST CENTRAL PHOENIX NORTH PLUME WQARF SITE
PHOENIX, ARIZONA
FEASIBILITY STUDY WORK PLAN

RINCHEM FACILITY

ARCADIS

FIGURE
5



NOTES

· Source: adapted from EMCON's *Preliminary Site Characterization Report*.
· Drawing not to scale.

N

WEST CENTRAL PHOENIX NORTH PLUME WQARF SITE
PHOENIX, ARIZONA
FEASIBILITY STUDY WORK PLAN

HILL BROTHERS FACILITY

ARCADIS

FIGURE
6

G:\Project\ADEQ (Arizona Department of Environmental Quality)\North Plume\NP GIS\Projects\FS Work Plan 11-2012\Figure 6 Hill Brothers facility.mxd 11/15/2012