# PROPOSED REMEDIAL ACTION PLAN

## WEST CENTRAL PHOENIX WEST OSBORN COMPLEX
## WATER QUALITY ASSURANCE REVOLVING FUND SITE

## PHOENIX, ARIZONA

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# Acronyms

| | |
|---|---|
| A.A.C. | Arizona Administrative Code |
| ADEQ | Arizona Department of Environmental Quality |
| ADWR | Arizona Department of Water Resources |
| A.R.S. | Arizona Revised Statute |
| AWQS | Aquifer Water Quality Standard |
| AS | air stripping |
| CAB | Community Advisory Board |
| COC | constituent of concern |
| COP | City of Phoenix |
| 1,1-DCE | 1,1-dichloroethene |
| ERA | Early Response Action |
| FS | Feasibility Study |
| ft bgs | feet below ground surface |
| gpm | gallons per minute |
| ISCO | in-situ chemical oxidation |
| LAU | Lower Alluvial Unit |
| LGAC | Liquid Phase Granular Activated Carbon |
| LSGS | Lower Sand and Gravel Subunit |
| MAU | Middle Alluvial Unit |
| MFGS | Middle Fine-Grained Subunit |
| µg/L | micrograms per liter |
| MNA | Monitored Natural Attenuation |
| NCP | North Canal Plume |
| PCE | tetrachloroethene |
| PRAP | Proposed Remedial Action Plan |
| P&T | pump and treat |
| RI | Remedial Investigation |
| RO(s) | Remedial Objective(s) |
| ROD | Record of Decision |
| SGWS | Shallow Groundwater System |
| SRP | Salt River Project |
| SVE | Soil Vapor Extraction |
| 1,2,3-TCA | 1,2,3-trichloroethane |
| TCE | trichloroethene |
| UAU | Upper Alluvial Unit |
| VGAC | Vapor-Phase Granular Activated Carbon |
| VOC | volatile organic compound |
| WCP | West Central Phoenix |
| WOC | West Osborn Complex |
| WQARF | Water Quality Assurance Revolving Fund |

## 1.0 INTRODUCTION

The Arizona Department of Environmental Quality (ADEQ) prepared this Proposed Remedial Action Plan (PRAP) for the West Central Phoenix (WCP) West Osborn Complex (WOC) Water Quality Assurance Revolving Fund (WQARF) Site (Site), located in Phoenix, Arizona (Figure 1). This PRAP was prepared in accordance with Arizona Revised Statute (A.R.S.) Section (§) 49-287.04 and Arizona Administrative Code (A.A.C.) R18-16-408. The PRAP is based on information contained in the following documents:

- *Remedial Investigation Report, West Osborn Complex, West Osborn Road, Phoenix, Arizona* (GeoTrans, 2004) (RI Report)
- *Final Feasibility Study Report for the Shallow Groundwater System, West Osborn Complex WQARF Site, Phoenix, Arizona* (URS, 2012a)
- *Final Feasibility Study Report for the Lower Sand and Gravel Subunit, West Osborn Complex WQARF Site, Phoenix, Arizona* (URS, 2012b)

Information presented in this PRAP is taken directly from the above-referenced reports without attribution other than that noted here. The detailed history of environmental investigations, Early Response Actions (ERAs), and preliminary screening of remedial alternatives identified for the Site are presented in the referenced documents and is not reiterated in detail in this document. Two separate PRAPs for the two distinct aquifers at the Site were prepared and finalized in June 2013. Based on new information, ADEQ has reevaluated the remedies proposed in the two PRAPs and has issued this one comprehensive PRAP with a new proposed remedy.

The purpose of this PRAP is to inform the public on the remedy selected from the alternatives evaluation presented in the Feasibility Study (FS), which addresses the site-specific Remedial Objectives (ROs). The PRAP is part of the final remedy selection process under the WQARF program, during which public input is solicited on the selected remedy and on the rationale for proposing the selected remedy. ADEQ will review the public comments and prepare a responsiveness summary to address the public comments. The responsiveness summary will be part of the Record of Decision (ROD). The remedy for the Site will be finalized by ADEQ in the ROD.

This PRAP, in accordance with A.R.S. §49-287.04, describes the following:

- The boundaries of the Site that is the subject of the remedial action;
- The results of the Remedial Investigation (RI) and the FS;
- The proposed remedy and estimated cost; and
- How the remediation goals and selection factors in A.R.S. §49-282.06 have been considered.

## 2.0 SITE BOUNDARIES

The WOC Site source area is approximately bounded by the Grand Canal to the north, Osborn Road to the south, 35th Avenue to the east, and 37th Avenue to the west (Figure 1). The groundwater impacts are generally bounded by the Grand Canal to the north, 35$^{th}$ Avenue to the east, Interstate 10 to the south, and 55$^{th}$ Avenue to the west.

## 3.0 REMEDIAL INVESTIGATION RESULTS

This section presents a summary of the remedial investigations conducted at the Site as presented in the following document:

- *Remedial Investigation Report, West Osborn Complex, West Osborn Road, Phoenix, Arizona* (GeoTrans, 2004)

### *3.1 Site History and Description*

The Site was initially utilized for agricultural purposes after irrigation was made possible by the construction of the Grand Canal in 1878, which is just north of the southern edge of the Site. In approximately 1957, the first building was constructed on what is now the East Parcel. A second building was added north of the first one between 1961 and 1964, and the two buildings were eventually connected. Buildings on what is now the Middle Parcel were constructed between 1958 and 1961, and the West Parcel was not developed until after 1980. The site has been fully developed and operated for commercial and industrial purposes since that time.

From 1957 to 1965, the WOC Site was owned by six different entities that were involved in the manufacturing of electronic components using trichloroethene (TCE) as a solvent. ADEQ evaluated manufacturing processes and solvent usage by conducting interviews with current and former employees. ADEQ also obtained purchase records for solvents and disposal records for wastes, and asked former and present owners and tenants to fill out hazardous waste questionnaires, the results of which are summarized in the RI Report (GeoTrans, 2004).

Components, Inc. acquired the WOC property in 1965 and in 1971 subdivided it into the East, Middle, and West Parcels. Beginning on October 27, 1976, Components, Inc. started to sell its interest in the property. After the subdivision and sale, the property continued to be used for electronics manufacturing and assembly. May Industries began operations at the West Parcel in approximately 1980 and used 1,2,3-trichloroethane (1,2,3-TCA) along with other chemicals. Lansdale Semiconductor leased the Middle Parcel from approximately 1976 through 1987 for the manufacture of transistors and used TCE for their processes.

Western Dynex Corporation (Western Dynex) began operations involving the assembly of computer disk drives at the East Parcel in 1978 and was still present in 1989 when ADEQ conducted its preliminary assessment. Western Dynex used 1,2,3-TCA along with TCE for their processes, however the company is not currently in business at the Site.

The Site is located in the West Salt River Valley of the Phoenix Basin, which is a broad alluvial valley filled with layers of unconsolidated sand, gravel, and silt, and consists of three alluvial units:

- Upper Alluvial Unit (UAU) - composed of silty to gravely sand, sandy silt, and gravel with interbedded clay lenses, extending 300 to 400 feet below ground surface (ft bgs).
- Middle Alluvial Unit (MAU) - composed of silt and clay interbedded with silty sand and gravel, extending to a depth of more than 800 ft bgs.
- Lower Alluvial Unit (LAU) - includes evaporate deposits and overlies the crystalline and volcanic bedrock.

Two distinct aquifers are present in the UAU underlying the Site. The Shallow Groundwater System (SGWS) is located in the UAU. The groundwater table coincides with the top of the SGWS and is currently present at an approximate average depth of 130 ft bgs. Below approximately 240 ft bgs, a course-grained zone commonly referred to as the Lower Sand and Gravel Subunit (LSGS) of the UAU extends to the top of the MAU. The two aquifers are separated by a semi-confining fine-grained unit referred to as the Middle Fine-Grained Subunit (MFGS). The LSGS is regarded as the primary regional water-bearing unit for production. Large vertical hydraulic gradients exist between the different hydrostratigraphic units underlying the Site, and downward vertical gradients from the SGWS to the LSGS potentially exist.

Groundwater potentiometric surface elevation contours for the SGWS and the LSGS, as measured during spring 2019, are presented on Figures 2 and 3, respectively.

## *3.2 Source of Contamination*

According to Maricopa County Environmental Services Department records, six septic tanks and ten seepage pits were permitted at the WOC Site. The septic tanks and seepage pits were used for onsite wastewater disposal since the WOC property was first constructed until 1966, when the properties were connected to the municipal sewer system. The connection to the sewer system did not necessarily mean that all industrial waste began to be discharged to the municipal sewer. Since 1989, these systems and other potential source areas have been the subject of several investigations. The onsite wastewater disposal systems were eventually excavated in 1996 during the RI.

A former irrigation supply well, sometimes referred to as the WOC Irrigation Well or “Pincus” well, located on the Middle Parcel, has also been suspected of serving as a conduit for impacts from the subsurface into the LSGS. It is unclear when the WOC Irrigation Well was constructed, and no driller’s log is available.

## *3.3 Contaminants of Concern*

The primary contaminant of concern (COC) for the WOC Site is TCE, although impacts from tetrachloroethene (PCE), 1,1-dichloroethene (1,1-DCE) and chromium associated with the adjoining North Canal Plume (NCP) WQARF site have been detected within the WOC Site boundary.

### 3.3.1 Groundwater

TCE that is attributable to the WOC property has been detected in both the SGWS and the LSGS at concentrations that exceed the Arizona Aquifer Water Quality Standard (AWQS). Both the SGWS and LSGS contain COCs from the adjoining NCP WQARF site commingled with the WOC Site impacts. Concentration isopleths for TCE and PCE for the monitoring event in spring 2019 for the SGWS are shown on Figures 4 and 5, respectively. Concentration isopleths for TCE and PCE for the LSGS are shown on Figures 6 and 7, respectively.

TCE impacts to groundwater are also sourced from the property which was the former Uni-Tek facility located near the intersection of North 35$^{th}$ Avenue and West Roanoke Avenue (Figure 4).

### 3.3.2 Soil and Soil Vapor

Residual volatile organic compounds (VOCs) have been detected in soil and soil vapor at the WOC property. However, soil impacts are not currently present at levels that require corrective action at either the WOC facility or the former Uni-Tek facility.

## *3.4 Nature and Extent of Contamination*

The lateral distribution of the COCs in groundwater defines the extent of contamination at the Site. The current estimated extent of COCs in groundwater at concentrations exceeding the AWQSs is presented on Figures 4 and 5 for the SGWS and Figures 6 and 7 for the LSGS. The maximum detected TCE concentrations for the WOC site in spring 2019 were 140 micrograms per liter (µg/L) for the SGWS and 59 µg/L for the LSGS. The groundwater flow and plume migration direction for the SGWS TCE plume is in a southerly to southwesterly direction (Figures 2 and 4). The groundwater flow and plume migration direction for the LSGS TCE plume is in a southwesterly direction (Figures 3 and 6).

## *3.5 Early Response Action*

The following ERAs were performed at the Site to remove contamination and/or to mitigate the exposure of the contamination to potential receptors:

- Removal of contents of five septic tanks, ST-1 through ST-5 (as detailed in the RI Report)
- Removal of four concrete septic tanks (ST-1, ST-2, ST-3, and ST-5) and the associated piping connected to seepage pits

- Installation and operation of a Soil Vapor Extraction (SVE) system (a formal ERA activity) to remove VOCs in the vadose zone
- Abandonment of the on-site irrigation well (Pincus Well)

### *3.6 Risk Evaluation Summary*

Field investigation activities for the Site began in 1984. The data from historical investigations have been used to evaluate the risks that the contaminated soil, soil vapor, and groundwater pose to human health and the environment. Evaluations indicate there is presently a human health risk associated with groundwater contamination.

### *3.7 Remedial Objectives*

The results of the RI, including the Land and Water Use Study, were used to develop the ROs for remediation at the Site pursuant to A.A.C. R18-16-406. The results were presented in a Remedial Objectives Report (ADEQ, 2005).

After completion of SVE as an ERA to address TCE impacts in the vadose zone on the Middle Parcel, subsequent soil sampling results were non-detect for this TCE. As such, no RO was issued for soil for the WOC site.

The ROs for groundwater use at the Site are as follows:

- ***City of Phoenix (COP) Current Municipal Use:*** To restore, replace, or otherwise provide for the COP groundwater supply that has currently been lost due to PCE and/or TCE contamination associated with the WCP WOC Site. This action is needed as soon as possible. This action is needed for as long as the need for the water exists, the resource remains available, and PCE and/or TCE concentrations in the water prohibits or limits its use

- ***COP Future Municipal Supply Use:*** To protect for the use of the COP municipal groundwater supply threatened by the PCE and/or TCE contamination emanating from WCP WOC Site. According to the COP, this use may be needed by the year 2010. This action would be needed for as long as the level of contamination in the identified groundwater resource threatens or prohibits its use.

- ***Salt River Project (SRP) Current and Future Municipal and Irrigation Use:*** To project for the use of the SRP groundwater supply threatened by the PCE and/or TCE contamination emanating from WCP WOC Site. According to SRP, this use may be needed as soon as is technically feasible. This action would be needed for as long as the level of contamination in the identified groundwater resource threatens or prohibits its use.

Current surface water within the Site is utilized for irrigation and is supplied by groundwater sources outside the Site. The SRP's foreseeable plans are to use this surface water for drinking water purposes. However, the primary source of this surface water is from a water supply outside the Site. Therefore, no RO for surface water is necessary.

# 4.0 FEASIBILITY STUDY RESULTS

This section presents a summary of the FS conducted for the Site. The results of the FS are presented in the following documents:

- *Final Feasibility Study Report for the Shallow Groundwater System, West Osborn Complex WQARF Site, Phoenix, Arizona* (URS, 2012a)
- *Final Feasibility Study Report for the Lower Sand and Gravel Subunit, West Osborn Complex WQARF Site, Phoenix, Arizona* (URS, 2012b)

## *4.1 Identification and Screening of Remedial Technologies*

The FS identified several remedial technologies for addressing the groundwater impacts in both the SGWS and LSGS. These remedial technologies include carbon adsorption, air stripping (AS), ultraviolet oxidation, ion exchange, membrane filtration, biological treatment, and groundwater extraction and treatment also known as “pump-and-treat” (P&T).

These remedial technologies were screened based on the anticipated ability of the technology to address the ROs at the Site and reduce the contaminant concentration, mass, and/or toxicity. Each technology was screened for effectiveness, implementability, health and safety concerns, flexibility, expandability, and cost.

The following sections describe the remedial technologies retained for groundwater in the SGWS and LSGS.

**Shallow Groundwater System**

Based on the screening results for the SGWS, AS only for P&T, AS with vapor-phase granular activated carbon (VGAC) for P&T, AS with liquid-phase GAC (LGAC) for P&T, and LGAC only for P&T, were retained.

Based on screening results for the SGWS, the following remedial technologies were retained:

- P&T with AS only
- P&T with AS and vapor-phase granular activated carbon (VGAC) treatment
- P&T with AS and liquid-phase GAC (LGAC) treatment
- P&T with LGAC only

**Lower Sand and Gravel Subunit**

Based on screening results for the LSGS, the following remedial technologies were retained:

- P&T with AS only
- P&T with AS and VGAC treatment

- P&T with AS and LGAC treatment
- P&T with AS, VGAC and LGAC treatment
- P&T with LGAC only

## *4.2 Development of the Reference Remedy and Alternative Remedies*

The retained remedial technologies were used to develop a Reference Remedy and two alternative remedies (a Less Aggressive Remedy and a More Aggressive Remedy). The Reference Remedy and the alternative remedies are capable of achieving the ROs. The development of the Reference Remedy and alternative remedies considered the following:

- The data obtained from the remedial investigations;
- The best available engineering and scientific information concerning available remedial technologies; and
- Preliminary analysis of the comparison criteria and the ability of the remedies to comply with A.R.S. §49-282.06.

The following sections describe the Reference Remedy, Less Aggressive Remedy, and the More Aggressive Remedy alternatives for the SGWS and LSGS.

### 4.2.1 Reference Remedy

**Shallow Groundwater System**

The Reference Remedy at the SGWS includes a combination of groundwater remediation technologies including the following:

- **P&T System** – Installation of an estimated 30 gallons per minute (gpm) P&T system for hydraulic containment and remediation of contaminated groundwater at the downgradient margin of the WOC facility. Groundwater treatment would consist of bag filtration followed by LGAC for fine sediment/particulate and VOC removal.
- **Monitoring** – For the first two years of P&T system operations, monthly water levels and quarterly sampling of the existing SGWS monitoring well network would be performed, along with quarterly reporting for system performance/groundwater monitoring.
- **Monitored Natural Attenuation** – After the second year of P&T operation, implementation of monitored natural attenuation (MNA) to address the larger portion of the plume, which has migrated downgradient of the WOC facility, would be implemented. MNA would consist of conducting semi-annual groundwater monitoring of the existing SGWS well network at the Site to evaluate the efficacy of natural attenuation over time.

**Lower Sand and Gravel Subunit**

The Reference Remedy at the LSGS includes a combination of groundwater remediation technologies including the following:

- **Monitored Natural Attenuation –** Remediation of the LSGS aquifer over time would be accomplished by MNA. MNA would include both the gauging of water levels to assess the direction and magnitude of the hydraulic gradient, and water quality sampling to evaluate the concentrations and composition of VOCs. To assess efficacy of this remedy, groundwater samples would be collected and analyzed semiannually for VOCs, and annually for pertinent MNA parameters.
- **Restoration of Municipal Groundwater Supply –** Restoration of the municipal groundwater supply for the COP would be achieved by installing up to two new replacement production wells and an LGAC wellhead treatment plant at the COP-70/71 production well site to remove VOCs from pumped groundwater. The treated groundwater would then be pumped into the potable water distribution system on an as-desired/as-needed basis.

### 4.2.2 Less Aggressive Remedy

**Shallow Groundwater System**

The Less Aggressive Remedy involves solely MNA for SGWS groundwater that has been characterized with elevated VOCs at the WOC site.

**Lower Sand and Gravel Subunit**

The Less Aggressive Remedy involves solely MNA for LSGS groundwater that has been characterized with elevated VOCs at the WOC site.

### 4.2.3 More Aggressive Remedy

**Shallow Groundwater System**

The More Aggressive Remedy is similar to the Reference Remedy. The More Aggressive Remedy includes the remedial technologies proposed for the Reference Remedy plus the installation of three extraction wells for partial hydraulic containment and remediation of the central portion of the plume, which contains the highest VOC concentrations. Existing monitoring wells MW-206S and AVB123-01 would be used to evaluate capture zones of the three extraction wells. In addition, two supplemental monitoring wells/piezometers would be installed to evaluate the capture zone and water quality associated with the central area of remedy pumping.

**Lower Sand and Gravel Subunit**

The More Aggressive Remedy is similar to the Reference Remedy. The More Aggressive Remedy includes the remedial technologies proposed for the Reference Remedy plus the following:

- **P&T System –** The installation of a single extraction well for hydraulic containment and remediation of the groundwater at the downgradient margin of the plume would be implemented. A LGAC treatment plant would be installed at the wellhead areas, and depending on approvals from SRP, COP, and/or the Arizona Department of Water Resources (ADWR), the treated water would be discharged either to the Grand Canal, back into the LSGS aquifer using two injection wells, or to the COP storm sewer.
- **New Piezometer Wells –** The installation of two piezometer wells to evaluate the capture zone of the downgradient extraction wells in conjunction with existing monitoring well MW-108M would be implemented.
- **Monitoring –** For the first two years of P&T system operations, monthly water levels and quarterly sampling of existing LSGS monitoring well network would be performed, along with quarterly reporting for system performance/GW monitoring.
- **Post Two Year Monitoring –** After two years of P&T system operation, groundwater monitoring would involve quarterly gauging of water levels, semi-annual sampling for VOCs, and semiannual reporting of groundwater data and performance of the P&T system.
- **Continue Not Pumping SRP Wells –** This remedy entails continuing the current policy of not pumping SRP's production wells 8.5E-7.5N and 9.5E-7N due to the VOC impacts.

## *4.3 Proposed Remedy*

The remedy proposed for the Site for both the SGWS and the LSGS is the Reference Remedy. The Reference Remedy was selected with contingencies because it is considered to be the best combination of remedial effectiveness, practicality, cost, and benefit for restoration and timely use of the groundwater resource. The Reference Remedy would achieve the ROs, meet the remedial action criteria pursuant to A.R.S. §49-282.06, and be consistent with current and future land and water use.

# 5.0 PROPOSED REMEDY AND ESTIMATED COST

The Proposed Remedy for groundwater in the SGWS and LSGS are based on the remedial actions described in the FS reports, investigations and remedial actions conducted at the former Uni-Tek facility, and recent groundwater monitoring results. This section presents a description of the Proposed Remedies and the associated estimated costs. Potential contingencies and associated costs are also presented and discussed.

## *5.1 Remedy Description*

The Proposed Remedy is P&T in the SGWS to provide hydraulic containment of VOCs emanating from the WOC source area, and MNA downgradient from the P&T extraction well network. MNA is also proposed for the LSGS. These remedial technologies are described in the following subsections.

### 5.1.1 Proposed Remedial Action – SGWS and LSGS

Pump and Treat – SGWS

P&T is a technology for groundwater that can be effective for hydraulic containment for sites impacted by VOCs. P&T systems typically utilize submersible pumps in extraction wells to extract groundwater and transfer it via conveyance piping into an aboveground treatment system. The post-treatment water is subsequently discharged to a municipal sewer, a canal or other surface water conveyance, an infiltration basin, or re-injected into the subsurface with an injection well. P&T systems can control the subsurface flow of impacted groundwater, mitigating migration and/or reducing the footprint of the impacts. P&T systems can be used for aggressive remediation of a source area, or may be used for hydraulic containment to mitigate the migration of VOCs for broad, dilute plumes (such as the plumes at the Site). LGAC is typically utilized for removal of VOCs from groundwater.

For the Proposed Remedy, a network of three shallow extraction wells would be installed to intercept the VOC plumes emanating from the WOC source area within the SGWS. The extracted groundwater from the SGWS would be treated by a 50-gpm capacity system. The P&T system would comprise submersible extraction pumps, conveyance piping to a treatment compound, pretreatment with bag filtration to remove particulates, LGAC to remove VOCs, and discharge to the Grand Canal. This remedy assumes up to 20 years of operation. This proposed remedy is similar but not identical to the Reference Remedies as proposed in the FS Reports (URS, 2012a and 2012b); the remedial approach has been modified based on information collected in the time since the FS documents were prepared. Hydraulic containment would be provided for the highest concentration portion of the plume.

The conceptual extraction well locations for the Proposed Remedy (base wells EW-1 through EW-3) and treatment system locations are shown on Figure 8. A contingency for adding three supplemental extraction wells (EW-4 through EW-6) and upgrading the capacity of the treatment system is presented in Subsection 5.1.2.

Monitored Natural Attenuation – SGWS and LSGS

MNA is a remedial measure that involves routine groundwater sampling, analysis, and predictive modeling to assess when cleanup objectives may be achieved passively through transformation processes that reduce the mass, toxicity, volume, or concentration of chemicals in groundwater. MNA is a mechanism by which COCs are reduced by natural means without other control, removal, treatment, or aquifer-modifying activities. These in-situ processes may include dilution, chemical and biological degradation, adsorption, and volatilization of the contaminants in groundwater.

MNA would consist of groundwater modeling, including trend analyses, and routine groundwater monitoring using the full existing groundwater network for a period of up to 30 years. Groundwater monitoring would be semi-annual for the first five years, followed by annual monitoring for the remaining 25 years. Monitoring would include groundwater potentiometric surface level measurements and sampling for the relevant COCs and MNA parameters.

The number of wells to be monitored and the frequency of monitoring may be adjusted over time in response to changing conditions. At a minimum, the number of wells and the frequency of monitoring will be evaluated and updated every five years. The existing monitoring well network would be used to collect data to monitor and evaluate the nature and extent of impacts to the Site during groundwater remediation.

If groundwater monitoring results of the most distal wells from the source area are greater than applicable AWQS, a new sentinel well may be required to delineate the horizontal extent of the plumes; a contingency for constructing a new sentinel well is presented in Subsection 5.1.3. In-situ chemical oxidation (ISCO) will be implemented as a contingency for the SGWS after the first five year evaluation, or sooner based on professional judgement, if it is determined that the concentrations of contaminants are not declining at a rate to where Site closure will be possible within 30 years.

### 5.1.2 Proposed Contingencies – SGWS

Contingencies to accelerate remediation of the SGWS are included should they be warranted based on intermediate monitoring results. SGWS contingencies include:

- ISCO at the WOC source area and/or at the former Uni-Tek facility;
- Additional groundwater extraction well installation; and
- Additional monitoring wells construction within the SGWS to replace wells that can no longer be sampled due to water levels declining below the bottom of the well screen intervals.

Details for how the contingencies may be implemented are discussed below. Cost estimates for these contingencies are summarized in Subsection 5.2 and associated cost detail tables are provided in Appendix A.

In-Situ Chemical Oxidation

If groundwater modeling or monitoring results indicate that VOCs are unlikely to naturally attenuate within a reasonable time frame, then a contingency for ISCO remediation may be implemented to accelerate the remedy. ISCO is a frequently used technology that includes the injection of chemical oxidants into the subsurface to treat soil and groundwater impacts. Common amendments used for ISCO include permanganate, persulfate, hydrogen peroxide, and ozone. These highly reactive amendments oxidize the COCs to produce innocuous byproducts. Chemical oxidizers are typically injected through wells or temporary injection points using gravity or pressurized injection methods to achieve the prescribed distribution. Catalysts may be included or required to promote reactions for some amendments, such as sodium persulfate.

If ongoing monitoring of wells downgradient from the hydraulic barrier near the WOC source area or the former Uni-Tek facility indicate that TCE concentrations are unlikely to naturally attenuate within a reasonable time frame, then a contingency for ISCO remediation may be implemented for one or both of these source areas. The ISCO remedy conceptual approach for either location is anticipated to consist of injecting a solution of liquid oxidant into 11 injection wells constructed on approximately 20-foot spacings, for treatment of an approximately 5,600 square foot footprint area. Bench scale and injection testing would be conducted prior to implementation of the ISCO remedy to optimize injection well spacing, injection rates, and to obtain other critical design information. The injection wells are anticipated to be constructed with 2-inch diameter schedule 40 PVC, with 10-foot screen intervals located immediately below the groundwater surface. Injection well surface completions would be constructed within 18-inch diameter traffic rated well vaults.

Two new groundwater monitoring wells would also be constructed as part of the ISCO remediation contingency per source area to monitor the effectiveness of the ISCO remedy. The additional groundwater monitoring wells would be advanced to approximately five feet below the bottom of the screen intervals of the injection wells. An elevated monitoring frequency for the new wells would be performed to evaluate the effectiveness of the ISCO remedy, which is anticipated to consist of quarterly monitoring for the first year. This contingency also conservatively assumes that a re-application of the oxidant would be required approximately one year following the initial injection. Semiannual monitoring would be implemented for one year following the second application, after which monitoring would be discontinued. The contingency cost estimate in the following subsection conservatively assumes that ISCO would be required at both the WOC source area and at the former Uni-Tek facility.

Additional Groundwater Monitoring Wells

Due to declining groundwater levels in the SGWS, several groundwater monitoring wells screened in the SGWS can no longer be sampled. Groundwater levels are anticipated to continue to decline. Therefore, a contingency for construction of additional groundwater monitor wells is included to replace monitor wells that cannot be sampled currently or within the next 30 years due to declining water levels in the SGWS. It is assumed up to 19 replacement groundwater monitoring wells will be required to be installed.

### 5.1.3 Proposed Contingencies – LSGS

Wellhead Treatment

A contingency plan for wellhead treatment is included to meet COP and/or SRP demands if groundwater production from the impacted plume area is required to meet water supply needs prior to the natural attenuation of COC impacts to below AWQSs. Two existing production wells could reasonably be impacted by VOCs emanating from the WOC site: COP well COP-157 and SRP well 9.5E-7.7N. Production well COP-157 is currently inactive and contains no pumping infrastructure. However, this well could potentially be impacted by VOCs in the LSGS if pumping is resumed. SRP well 9.5E-7.7N is currently active, but is only operated intermittently. This well has documented VOC impacts.

For the COP and SRP wells a contingency is included for wellhead treatment if COC concentrations exceed the applicable AWQS for PCE and TCE. Wellhead treatment would consist of LGAC treatment to remove VOCs from extracted groundwater from the production well and production rates would be similar to historical pumping rates: 700 gpm for COP-157 and 3,900 gpm for SRP well 9.5E-7.7N.

Well Sleeving

Prior to fully instituting LGAC wellhead treatment, the option of well sleeving would be explored for the reinstated or threatened production well(s). Sleeving would involve vertically profiling the reinstated or threatened production wells to assess if elevated COC concentrations are associated with a discrete formation interval. Video and spinner logging may also be performed to provide additional information on well and aquifer conditions, and modelling could be conducted to assess if well sleeving is a viable alternative for restoring the groundwater resource. If well sleeving is found to be a viable option, then well sleeves would be installed within the production well(s) to exclude extraction from zones with elevated COC impacts. The production wells would continue to be monitored after the well sleeve installation.

Additional Sentinel Well

If groundwater monitoring results from downgradient wells (i.e., COP-157) exceed applicable AWQSs, a new sentinel well or wells may be installed to delineate the downgradient extent of the plume. A contingency for one additional sentinel well is included in the contingency costs.

### 5.1.4 Performance Monitoring, and Periodic Reviews

Inspections, performance monitoring, and periodic reviews, including for potentially implemented contingencies, will be used to judge the effectiveness and adequacy of the implemented remedies. Monitoring will include the following:

- **Groundwater Monitoring** – Routine groundwater monitoring will be performed to assess the effectiveness of the hydraulic barrier and the downgradient MNA. Groundwater monitoring and reporting will be performed on a semiannual basis for the first five years, and annually thereafter.

Focused groundwater monitoring, in addition to MNA, will be conducted to evaluate the performance and the post treatment impacts of a potential ISCO implementation at the Site. The performance monitoring would include up to eight sampling events conducted at up to 11 wells located within the target treatment zone during the implementation of ISCO.

- **Periodic Reviews** – Periodic reviews of remedial progress will be conducted as necessary to assess the effectiveness of the remedy in achieving the ROs. These reviews will be conducted on a 5-year basis, at a minimum.

### *5.2 Estimated Cost*

The estimated cost of the Proposed Remedy without contingencies is $5.4 million.  The estimated cost with contingencies is $26.9 million. A summary of the costs associated with the remedy is presented in the table below. The detailed costs are presented in Appendix A.

| Summary of Costs for Proposed Remedy | |
|---|---|
| **Remedial Technology** | **Cost** |
| Monitored Natural Attenuation | $2,988,000 |
| Pump and Treat - SGWS | $2,486,000 |
| ***SUBTOTAL*** | **$5,474,000** |
| **Contingencies** | |
| Groundwater Extraction Well Installation - SGWS | $2,249,000 |
| Groundwater Monitor Well Installation | $829,000 |
| Wellhead Treatment - LSGS | $16,464,000 |
| In-Situ Chemical Oxidation - SGWS | $1,796,000 |
| Well Sleeving - LSGS | $52,000 |
| ***SUBTOTAL*** | **$21,390,000** |
| **TOTAL** | **$26,864,000** |
| **Note: costs assume 3% annual inflation rate** | |

### *5.3 Duration*

The overall duration of the Proposed Remedy is up to 30 years.

## 6.0 CONSIDERATION OF REMEDIATION GOALS AND SELECTION FACTORS

This section presents how the remediation goals and selection factors outlined in A.R.S. §49-282.06 were considered for the proposed remedy.

### *6.1 Rationale for Selection of the Remedy*

The Proposed Remedy includes source control, containment, and monitoring of the contamination. The Proposed Remedy provides the best combination of remedial effectiveness, practicability, cost, and benefit for the restoration and use of the groundwater resource. There is currently a human health risk associated with the contaminated groundwater at the Site and the components of the Proposed Remedy will be protective of the public health and the environment.

The components of the Proposed Remedy are proven, reliable remedial alternatives that will be protective of public health and the environment. The risk to human health and the environment with these remedies is low and known exposure pathways have been addressed. Over time, the remedial actions will reduce the concentrations and the volume of contaminated groundwater. Environmental sampling is included to monitor that the remedy is protective of public health and the environment during and after remedy implementation. The combined components of the Proposed Remedy is consistent and compatible with current and anticipated future land and resource use. Upon implementation, these remedies are considered to have positive impacts in terms of enhancement of future land uses and the local economy.

### *6.2 Achievement of Remedial Objectives*

Per A.A.C. R18-16-408(B)(3), the Proposed Remedy must achieve the ROs established by ADEQ for the Site. The Proposed Remedy for the SGWS and LSGS will achieve the ROs as described in Section 3. The Proposed Remedy, combined with the contingencies, will be protective of the groundwater resource for use by COP and SRP.  The Proposed Remedies for groundwater will achieve the ROs by hydraulic containment and MNA.  Environmental sampling and groundwater modeling will be used to verify that the ROs are being met.

### *6.3 Achievement of Remedial Action Criteria*

A.R.S. § 49-282.06 requires that remedial actions shall:

- Assure the protection of public health and welfare and the environment.
- To the extent practicable, provide for the control, management, or cleanup of the hazardous substances to allow the maximum beneficial use of the waters of the state.
- Be reasonable, necessary, cost-effective, and technically feasible.

As demonstrated in this PRAP, the Proposed Remedy and contingencies for the Site meet the requirements of A.R.S. §49-282.06. The Proposed Remedy is protective of public health and the environment, compliant with applicable laws, and allow for the maximum beneficial use of the waters of the State with the lowest cost. The Proposed Remedy is the best combination of practicability, risk, cost, and benefit to achieve the ROs.

### *6.4 Consistency with Water Management Plans*

The Proposed Remedy and contingencies are consistent with the water management plans of local water providers and will protect water quality. The Remedy will allow for the maximum beneficial use of the waters of the State, protect the groundwater supply for future use, and monitor that future water development options are not impacted for wider areas.

### *6.5 Consistency with General Land Use Planning*

The Proposed Remedy and contingencies are consistent with the current land use and are not anticipated to negatively impact current or future land use.

### *6.6 Lead Agency Statement for Proposed Remedy*

Based on the information currently available, ADEQ believes the Proposed Remedy and contingencies provide the best option when compared to alternative remedies with respect to the comparison criteria. ADEQ expects the Proposed Remedy and contingencies will satisfy the remedial action criteria pursuant to A.R.S. § 49-282.06 and the ROs.

### *6.7 Uncertainties*

Uncertainties associated with the proposed remedies at the Site include the following:

- **The duration of time required to remediate the groundwater at the Site.** For cost estimating purposes, 30 years is an industry standard assumption when a project duration is understood to be long-term but is not accurately known. Whereas MNA is expected to achieve the ROs for the Site, modeling has not yet been performed to estimate the time that would be needed to achieve the ROs for the plumes. Modeling will be performed as part of MNA implementation.

### *6.8 Public Comment Period*

The PRAP will be issued for a 90-day public comment period. A Community Advisory Board (CAB) meeting may be held during the public comment period. ADEQ will accept written comments on this PRAP that are postmarked within the comment period and submitted to:

Arizona Department of Environmental Quality
Attention: Eric Mannlein, Project Manager
1110 West Washington Street
Phoenix, Arizona 85007

Email: Mannlein.Eric@azdeq.gov

## 7.0 REFERENCES

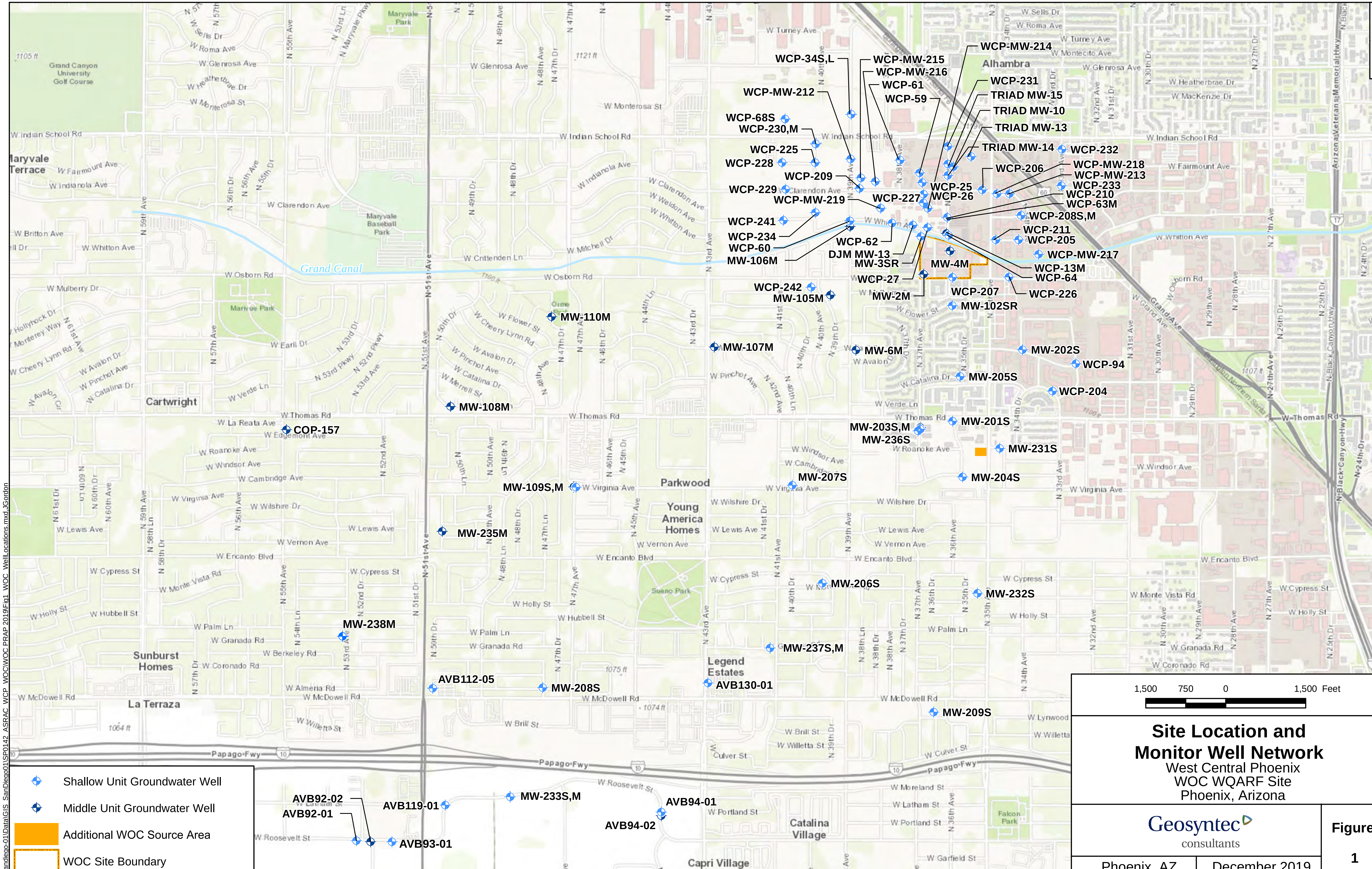
ADEQ, 2005. Remedial Objectives Report, West Central Phoenix – West Osborn Complex Site, Phoenix, Arizona, May.

GeoTrans, Inc., 2004. Remedial Investigation Report, West Osborn Complex, West Osborn Road, Phoenix, Arizona, 22 July.

URS, 2012a. Final Feasibility Study Report for the Shallow Groundwater System, West Osborn Complex WQARF Site, Phoenix, Arizona, 27 January.

URS, 2012b. Final Feasibility Study Report for the Lower Sand and Gravel Subunit, West Osborn Complex WQARF Site, Phoenix, Arizona, 16 May.

# FIGURES



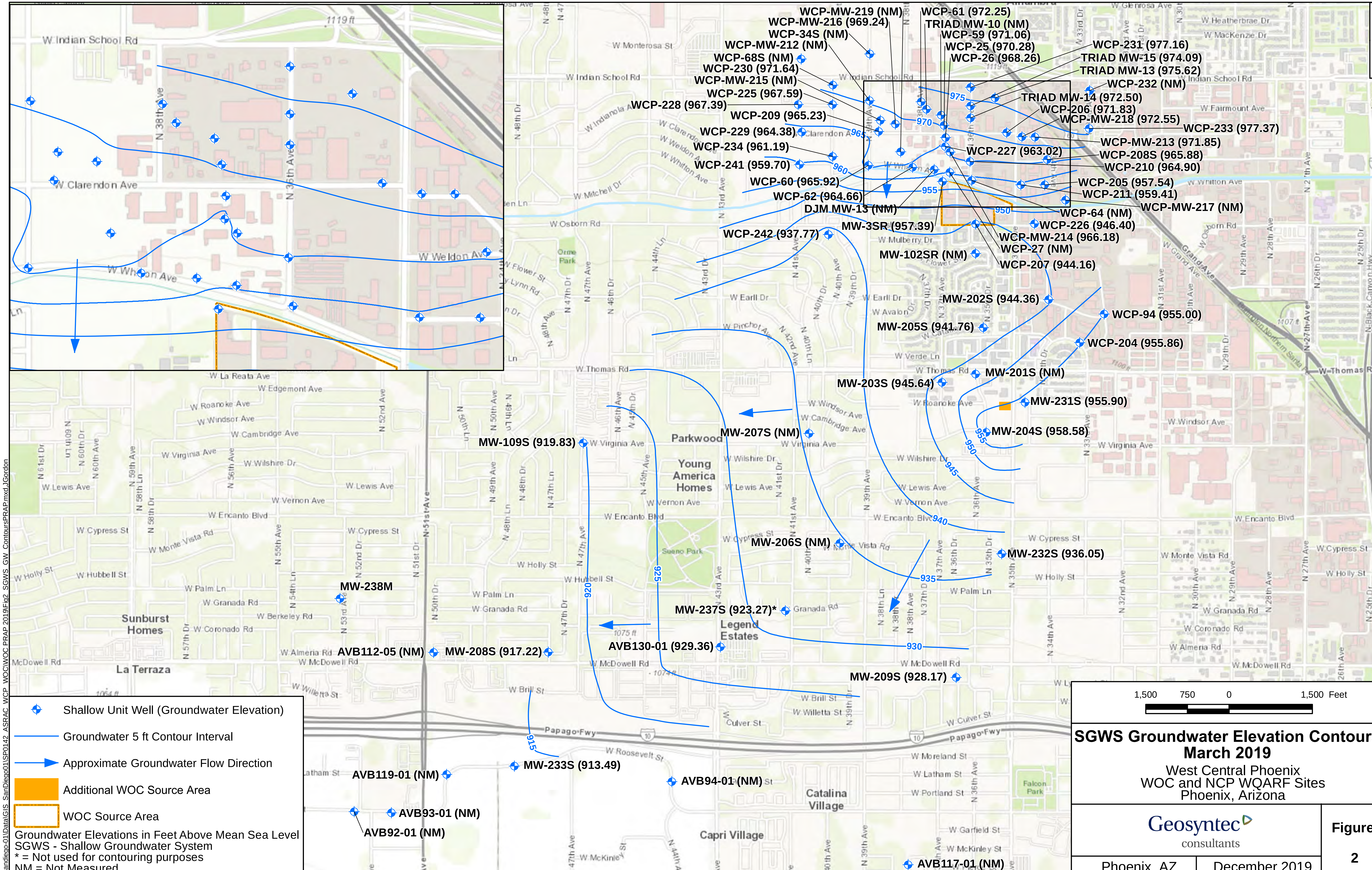

**Site Location and Monitor Well Network**

West Central Phoenix
WOC WQARF Site
Phoenix, Arizona

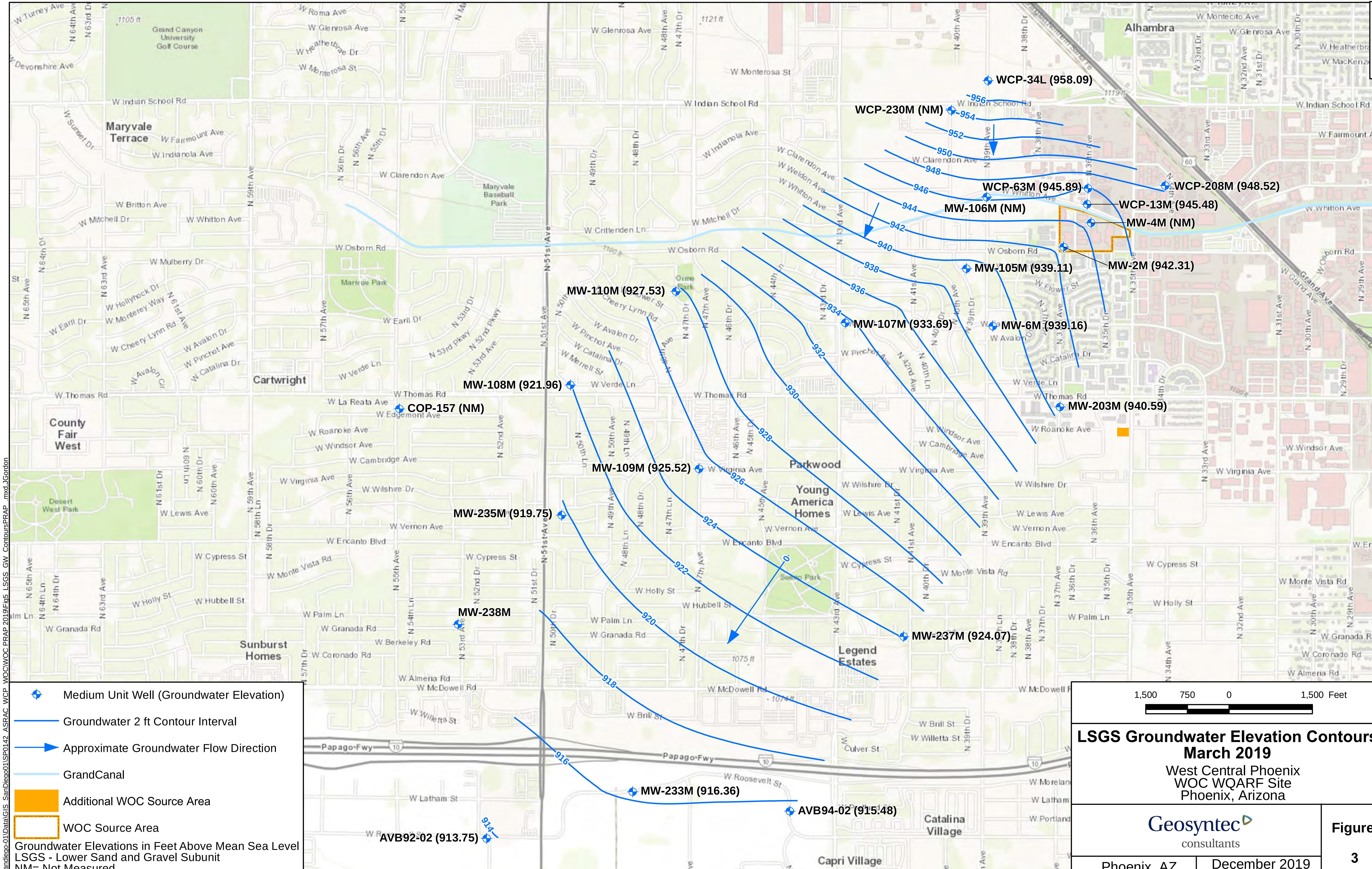
Geosyntec consultants

Phoenix, AZ | December 2019

Figure 1



WCP-MW-219 (NM)
WCP-MW-216 (969.24)
WCP-34S (NM)
WCP-MW-212 (NM)
WCP-68S (NM)
WCP-230 (971.64)
WCP-MW-215 (NM)
WCP-225 (967.59)
WCP-228 (967.39)
WCP-209 (965.23)
WCP-229 (964.38)
WCP-234 (961.19)
WCP-241 (959.70)
WCP-60 (965.92)
WCP-62 (964.66)
DJM MW-13 (NM)
MW-3SR (957.39)
WCP-242 (937.77)
MW-102SR (NM)
WCP-61 (972.25)
TRIAD MW-10 (NM)
WCP-59 (971.06)
WCP-25 (970.28)
WCP-26 (968.26)
WCP-231 (977.16)
TRIAD MW-15 (974.09)
TRIAD MW-13 (975.62)
WCP-232 (NM)
TRIAD MW-14 (972.50)
WCP-206 (971.83)
WCP-MW-218 (972.55)
WCP-233 (977.37)
WCP-MW-213 (971.85)
WCP-227 (963.02)
WCP-208S (965.88)
WCP-210 (964.90)
WCP-205 (957.54)
WCP-211 (959.41)
WCP-MW-217 (NM)
WCP-64 (NM)
WCP-226 (946.40)
WCP-MW-214 (966.18)
WCP-27 (NM)
WCP-207 (944.16)
MW-202S (944.36)
WCP-94 (955.00)
MW-205S (941.76)
WCP-204 (955.86)
MW-201S (NM)
MW-203S (945.64)
MW-231S (955.90)
MW-204S (958.58)
MW-207S (NM)
MW-109S (919.83)
MW-206S (NM)
MW-232S (936.05)
MW-238M
MW-237S (923.27)*
AVB130-01 (929.36)
AVB112-05 (NM)
MW-208S (917.22)
MW-209S (928.17)
MW-233S (913.49)
AVB119-01 (NM)
AVB94-01 (NM)
AVB93-01 (NM)
AVB92-01 (NM)
AVB117-01 (NM)
975
970
965
960
955
950
945
940
935
930
925
920
915
Parkwood
Young America Homes
Legend Estates
Sunburst Homes
La Terraza
Catalina Village
Capri Village
W Indian School Rd
W Clarendon Ave
W Weldon Ave
W Whitton Ave
W Osborn Rd
W Thomas Rd
W Encanto Blvd
W McDowell Rd
Papago Fwy
Shallow Unit Well (Groundwater Elevation)
Groundwater 5 ft Contour Interval
Approximate Groundwater Flow Direction
Additional WOC Source Area
WOC Source Area
Groundwater Elevations in Feet Above Mean Sea Level
SGWS - Shallow Groundwater System
* = Not used for contouring purposes
NM = Not Measured
1,500 750 0 1,500 Feet
SGWS Groundwater Elevation Contours
March 2019
West Central Phoenix
WOC and NCP WQARF Sites
Phoenix, Arizona
Geosyntec consultants
Figure
2
Phoenix, AZ
December 2019



WCP-34L (958.09)
WCP-230M (NM)
WCP-63M (945.89)
WCP-208M (948.52)
WCP-13M (945.48)
MW-106M (NM)
MW-4M (NM)
MW-2M (942.31)
MW-105M (939.11)
MW-110M (927.53)
MW-107M (933.69)
MW-6M (939.16)
MW-108M (921.96)
COP-157 (NM)
MW-203M (940.59)
MW-109M (925.52)
MW-235M (919.75)
MW-238M
MW-237M (924.07)
MW-233M (916.36)
AVB94-02 (915.48)
AVB92-02 (913.75)
956
954
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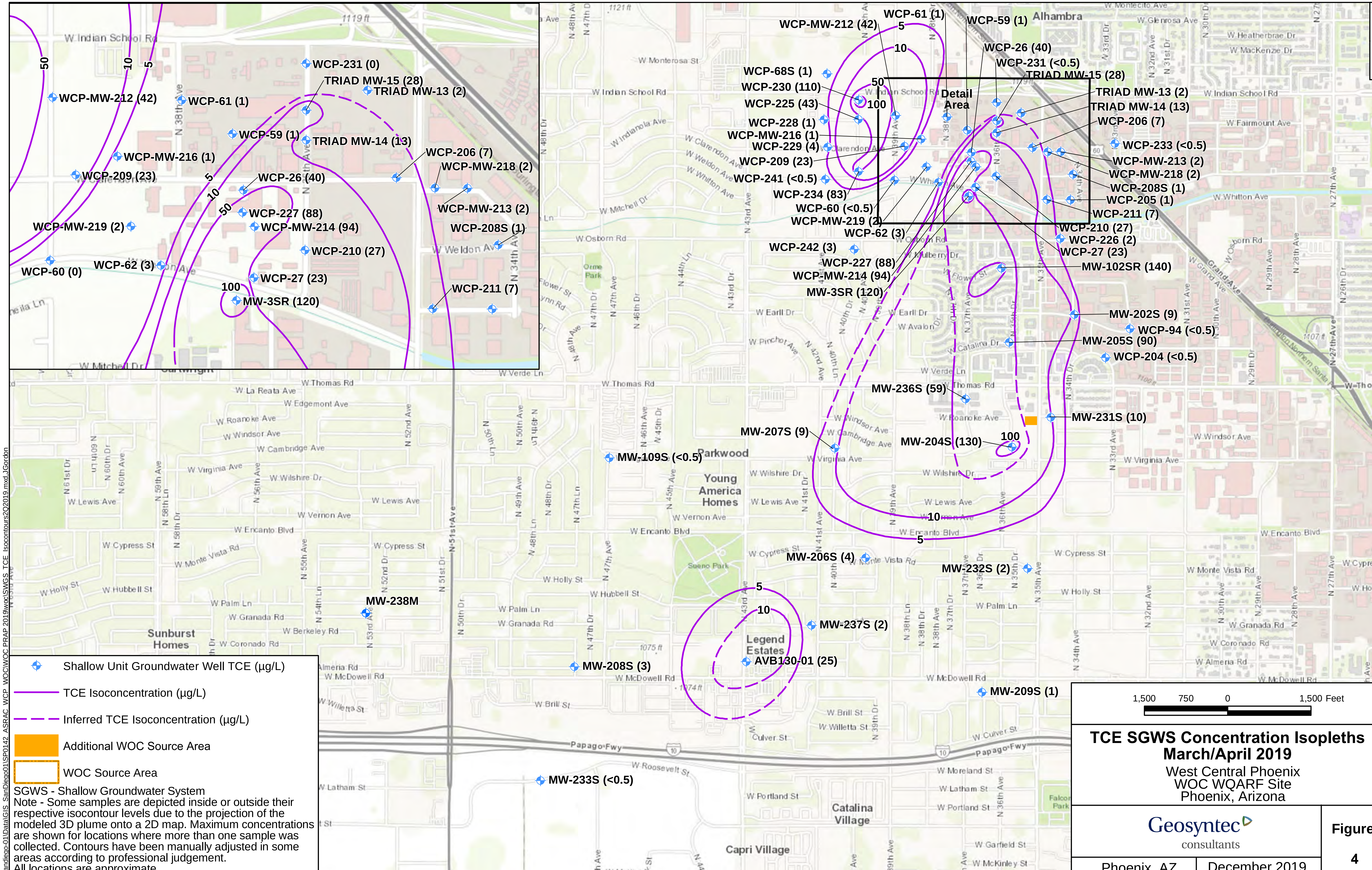
924
922
920
918
916
914
Alhambra
Maryvale Terrace
Cartwright
County Fair West
Parkwood
Young America Homes
Sunburst Homes
Legend Estates
Catalina Village
Capri Village
Medium Unit Well (Groundwater Elevation)
Groundwater 2 ft Contour Interval
Approximate Groundwater Flow Direction
GrandCanal
Additional WOC Source Area
WOC Source Area
Groundwater Elevations in Feet Above Mean Sea Level
LSGS - Lower Sand and Gravel Subunit
NM= Not Measured
1,500 750 0 1,500 Feet
LSGS Groundwater Elevation Contours
March 2019
West Central Phoenix
WOC WQARF Site
Phoenix, Arizona
Geosyntec consultants
Phoenix, AZ
December 2019
Figure
3




- Shallow Unit Groundwater Well TCE (µg/L)
- TCE Isoconcentration (µg/L)
- Inferred TCE Isoconcentration (µg/L)
- Additional WOC Source Area
- WOC Source Area

SGWS - Shallow Groundwater System

Note - Some samples are depicted inside or outside their respective isocontour levels due to the projection of the modeled 3D plume onto a 2D map. Maximum concentrations are shown for locations where more than one sample was collected. Contours have been manually adjusted in some areas according to professional judgement. All locations are approximate.

1,500 750 0 1,500 Feet

# TCE SGWS Concentration Isopleths March/April 2019

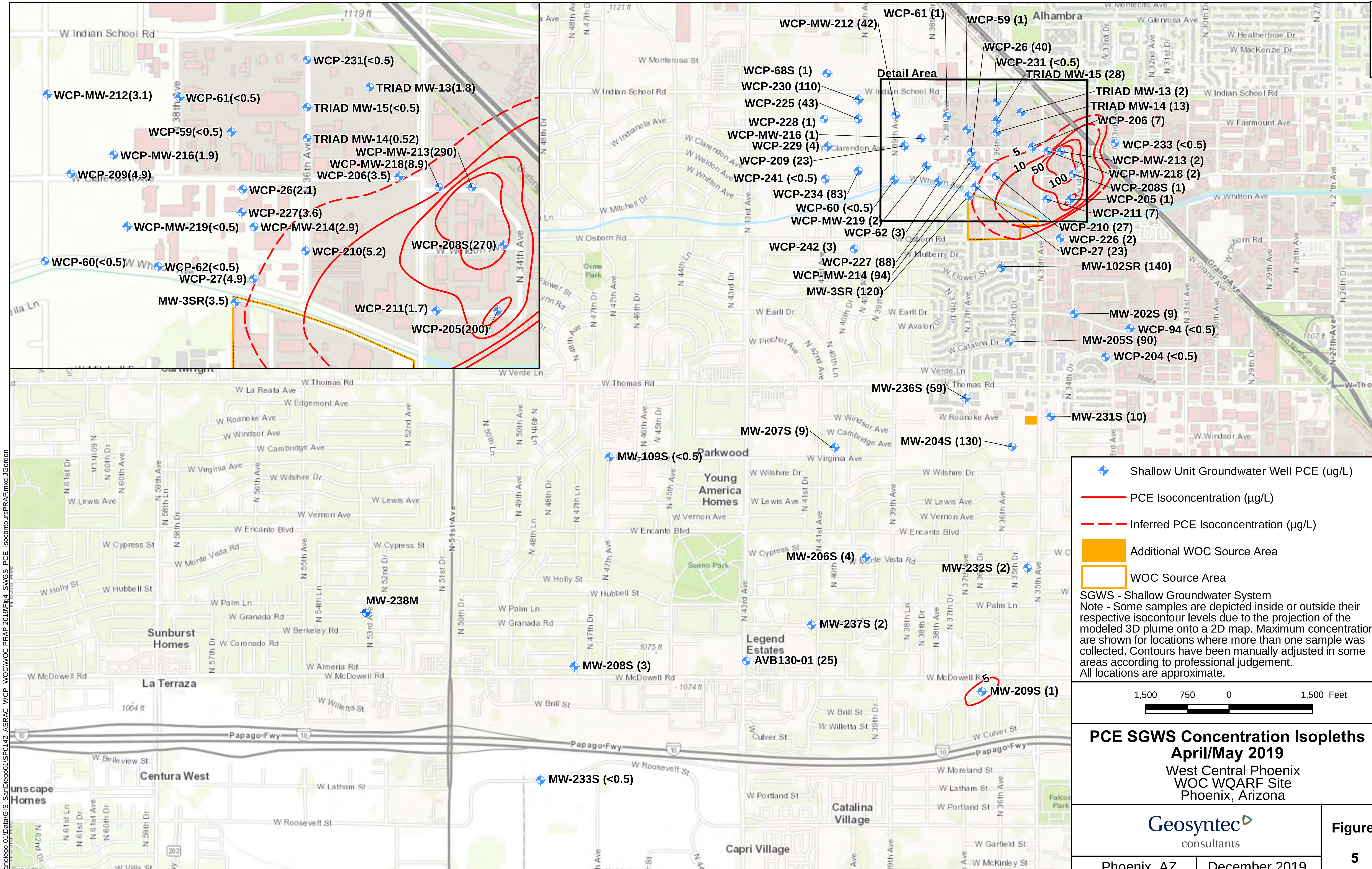
West Central Phoenix
WOC WQARF Site
Phoenix, Arizona

Geosyntec consultants

Figure 4

Phoenix, AZ | December 2019

\\sandiego-01\Data\GIS_SanDiego01\SP0142_ASRAC_WCP_WOC\WOC PRAP 2019\mxd\SWGS_TCE_Isocontours2Q2019.mxd JGordon




Shallow Unit Groundwater Well PCE (ug/L)

PCE Isoconcentration (µg/L)

Inferred PCE Isoconcentration (µg/L)

Additional WOC Source Area

WOC Source Area

SGWS - Shallow Groundwater System

Note - Some samples are depicted inside or outside their respective isocontour levels due to the projection of the modeled 3D plume onto a 2D map. Maximum concentrations are shown for locations where more than one sample was collected. Contours have been manually adjusted in some areas according to professional judgement.
All locations are approximate.

1,500 750 0 1,500 Feet

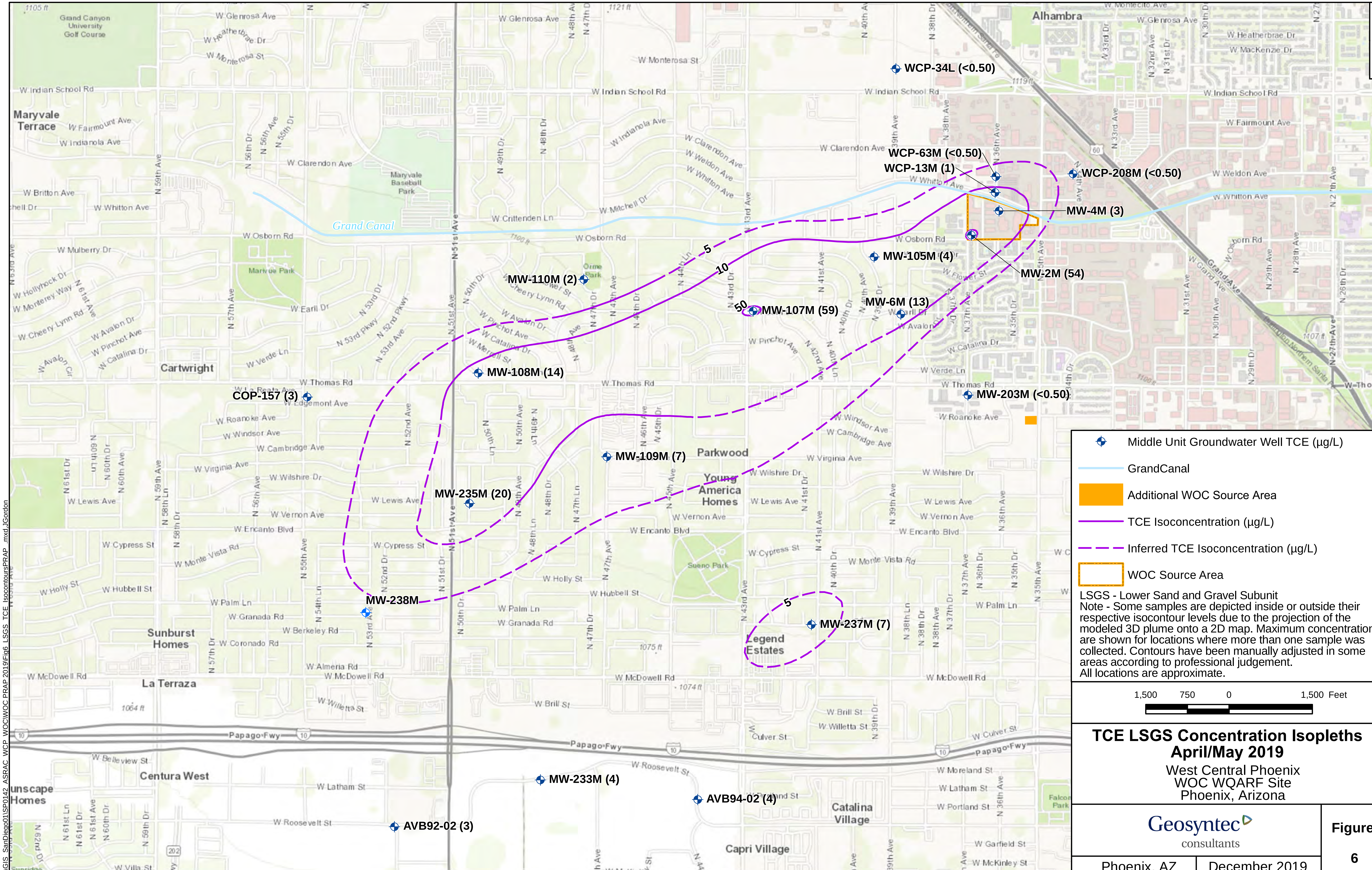
## PCE SGWS Concentration Isopleths April/May 2019

West Central Phoenix
WOC WQARF Site
Phoenix, Arizona

Geosyntec consultants

Phoenix, AZ | December 2019

Figure 5

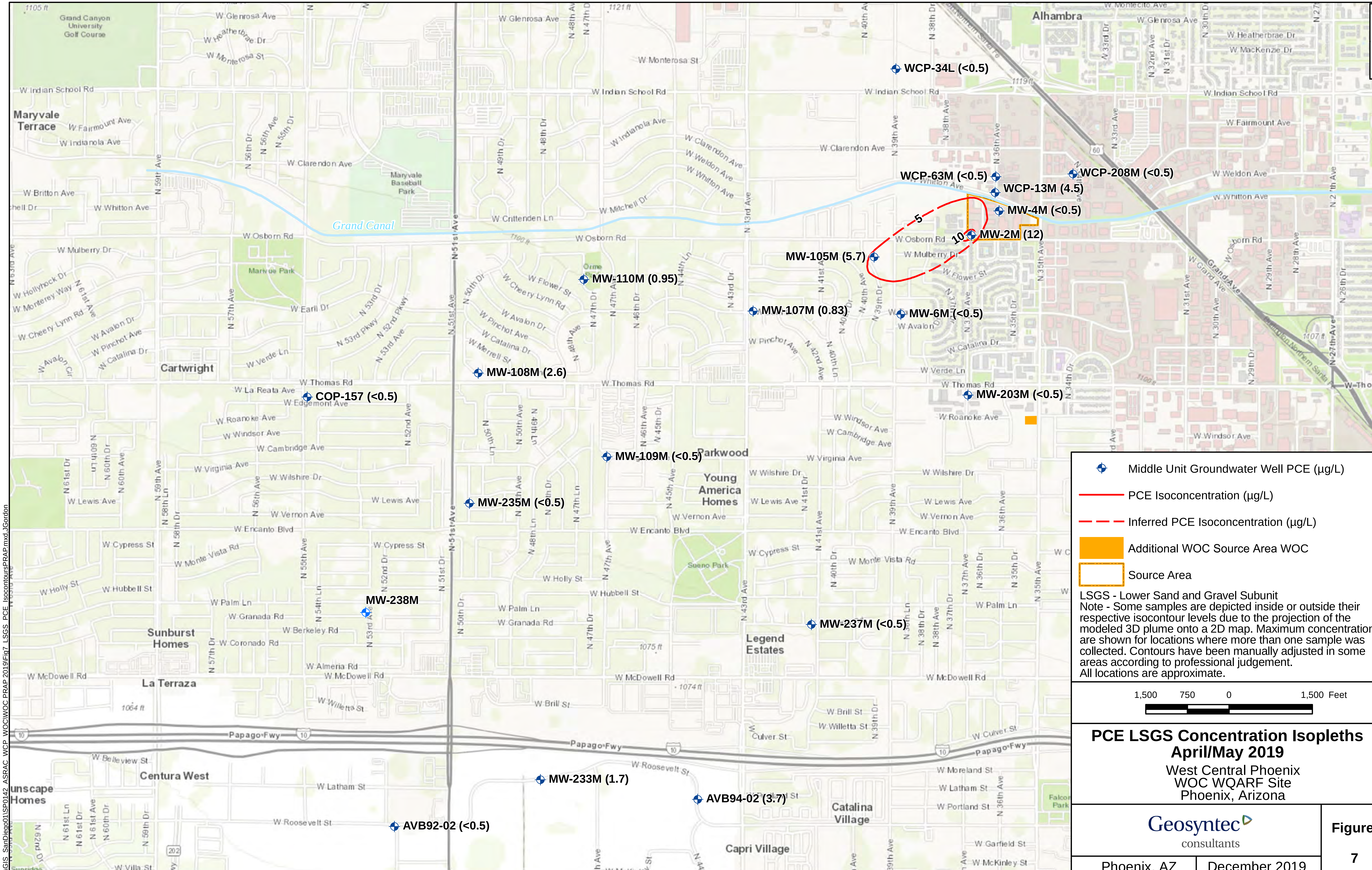



**TCE LSGS Concentration Isopleths April/May 2019**

West Central Phoenix
WOC WQARF Site
Phoenix, Arizona

Phoenix, AZ | December 2019

Figure 6




**PCE LSGS Concentration Isopleths April/May 2019**

West Central Phoenix
WOC WQARF Site
Phoenix, Arizona

Geosyntec consultants

Phoenix, AZ | December 2019

Figure 7

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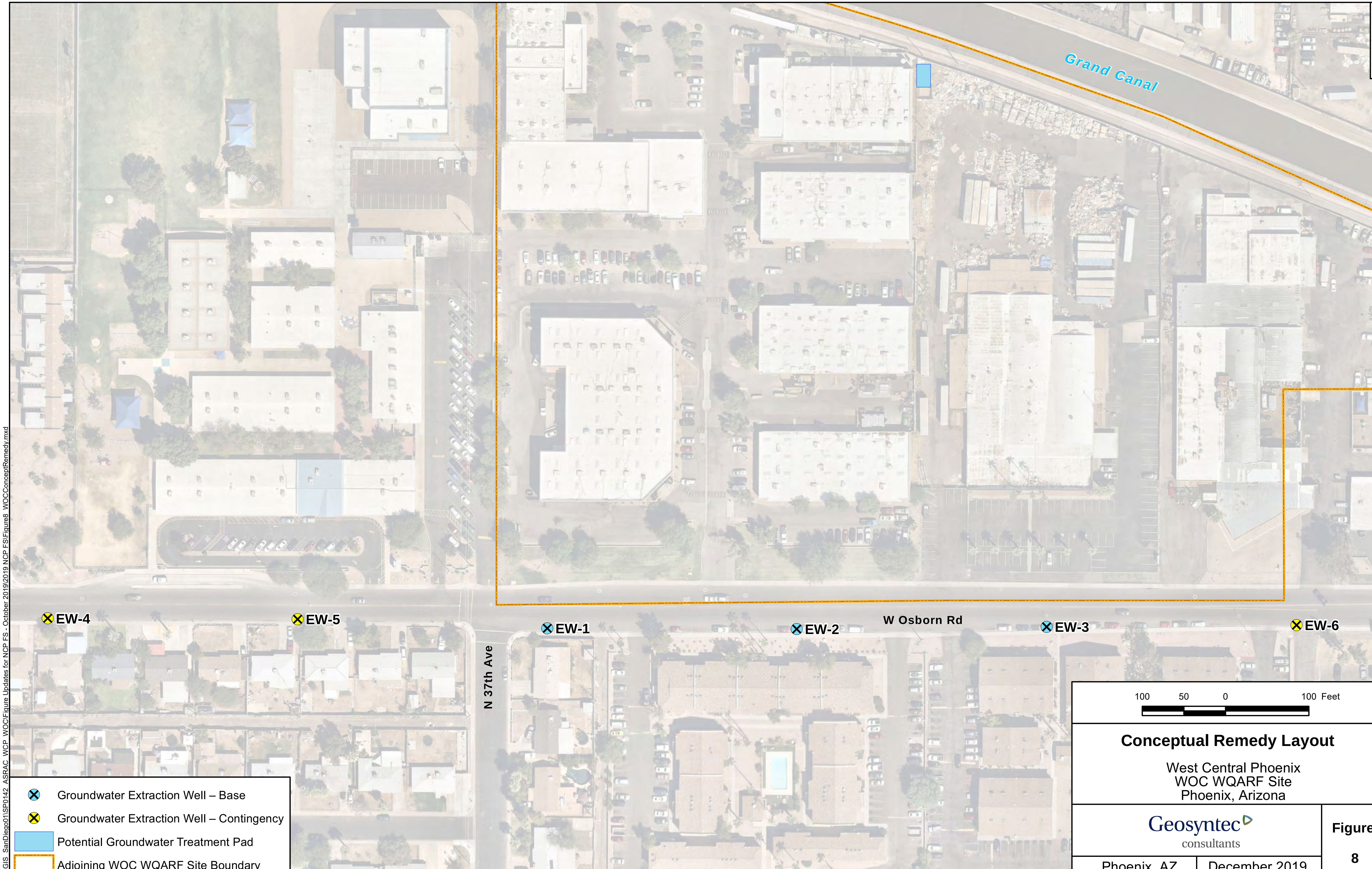


**Conceptual Remedy Layout**

West Central Phoenix
WOC WQARF Site
Phoenix, Arizona

Geosyntec consultants

Phoenix, AZ | December 2019

Figure 8

P:\GIS_SanDiego01\SP0142_ASRAC_WCP_WOC\Figure Updates for NCP FS - October 2019\2019 NCP FS\Figure8_WOCConceptRemedy.mxd

# APPENDIX A

# DETAILED COST SUMMARY

**Table A1**
**Monitored Natural Attenuation Cost Summary**
**Groundwater Proposed Remedial Action Plan**
**West Osborn Complex WQARF Site**
**Phoenix, Arizona**
**July 2020**

| **Groundwater MNA Monitoring (41 wells) and Reporting** | **Subtotal** |
|---|---|
| Year 1 | $113,000 |
| Year 2 | $116,400 |
| Year 3 | $119,900 |
| Year 4 | $123,500 |
| Year 5 | $127,200 |
| Year 6 | $65,500 |
| Year 7 | $67,500 |
| Year 8 | $69,500 |
| Year 9 | $71,600 |
| Year 10 | $73,700 |
| Year 11 | $75,900 |
| Year 12 | $78,200 |
| Year 13 | $80,500 |
| Year 14 | $83,000 |
| Year 15 | $85,500 |
| Year 16 | $88,000 |
| Year 17 | $90,700 |
| Year 18 | $93,400 |
| Year 19 | $96,200 |
| Year 20 | $99,100 |
| Year 21 | $102,000 |
| Year 22 | $105,100 |
| Year 23 | $108,300 |
| Year 24 | $111,500 |
| Year 25 | $114,800 |
| Year 26 | $118,300 |
| Year 27 | $121,800 |
| Year 28 | $125,500 |
| Year 29 | $129,300 |
| Year 30 | $133,100 |
| | |
| ***Total 30 Year MNA Costs (With 3% Inflation per Year)*** | ***$2,988,000*** |

**Notes and Assumptions:**

MNA = Monitored Natural Attenuation
Inflation Rate = 3% per year
MNA Annual Monitoring Cost = $1,700/well (Years 1-5)
MNA Annual Monitoring Cost = $850/well (Years 6-30)
MNA Reporting Cost = $10,000/event

**Table A2**
**Pump and Treat Cost Summary - SGWS**
**Groundwater Proposed Remedial Action Plan**
**West Osborn Complex WQARF Site**
**Phoenix, Arizona**
**July 2020**

| Description | Quantity | Unit | Unit Cost | Subtotal |
|---|---|---|---|---|
| ***P&T Treatment System Capital Costs (50 gpm)*** | | | | |
| Shallow groundwater extraction wells (well & pump) | 3 | Each | $70,000 | $210,000 |
| LGAC system (two vessels, bag filter break tank, piping) | 1 | Lump Sum | $50,000 | $50,000 |
| Treatment compound (foundation, fence, power drop, controls) | 1 | Lump Sum | $130,000 | $130,000 |
| Conveyance piping (trenchwork, piping) | 600 | Lineal Feet | $200 | $120,000 |
| Project management (design, engineering, permitting, etc.) | - | - | 25% | $130,000 |
| ***Capital Costs Subtotal (Pre-Inflation)*** | | | | ***$640,000*** |
| | | | | |
| ***P&T Treatment System Annual Operation, Maintenance, and Monitoring Costs (50 gpm)*** | | | | |
| Treatment system operation and maintenance | 250 | Hour | $100 | $25,000 |
| P&T electric power (three 2-hp wells, one 1-hp transfer pump) | 46,000 | kW-hr | $0.17 | $7,800 |
| LGAC media exchange (per vessel) | 1 | Each | $10,000 | $10,000 |
| Treatment system sampling (VOCs) | 1 | Lump Sum | $3,000 | $3,000 |
| Project management and reporting | 1 | Lump Sum | $20,000 | $20,000 |
| ***Annual OMM Subtotal (Pre-Inflation)*** | | | | ***$66,000*** |
| | | | | |
| **Total Annual Cost (With 3% Inflation per Year)** | | | | **Subtotal** |
| Year 1 | | | | $727,200 |
| Year 2 | | | | $70,000 |
| Year 3 | | | | $72,100 |
| Year 4 | | | | $74,300 |
| Year 5 | | | | $76,500 |
| Year 6 | | | | $78,800 |
| Year 7 | | | | $81,200 |
| Year 8 | | | | $83,600 |
| Year 9 | | | | $86,100 |
| Year 10 | | | | $88,700 |
| Year 11 | | | | $91,400 |
| Year 12 | | | | $94,100 |
| Year 13 | | | | $96,900 |
| Year 14 | | | | $99,800 |
| Year 15 | | | | $102,800 |
| Year 16 | | | | $105,900 |
| Year 17 | | | | $109,100 |
| Year 18 | | | | $112,400 |
| Year 19 | | | | $115,700 |
| Year 20 | | | | $119,200 |
| | | | | |
| ***Total 20 Year P&T Treatment Costs (With 3% Inflation per Year)*** | | | | ***$2,486,000*** |

**Notes and Assumptions:**

SGWS - Shallow Groundwater System
LGAC is liquid-phase granular activated carbon
P&T is pump and treat (i.e., groundwater extraction and treatment)
VOCs is volatile organic compounds
hp is horsepower
kW-hr is kilowatt-hour
OMM is operation, maintenance, and monitoring
LSGS - Lower Sand and Gravel Subunit

**Table A3**
**Groundwater Extraction Well Installation Contingency Cost Summary - SGWS**
**Groundwater Proposed Remedial Action Plan**
**West Osborn Complex WQARF Site**
**Phoenix, Arizona**
**July 2020**

| Description | Quantity | Unit | Unit Cost | Subtotal |
|---|---|---|---|---|
| ***Extraction Well Installation Capital Costs (50 gpm)*** | | | | |
| Shallow groundwater extraction wells (well & pump) | 3 | Each | $70,000 | $210,000 |
| Conveyance piping (trenchwork, piping) | 600 | Lineal Feet | $200 | $120,000 |
| Project management (design, engineering, permitting, etc.) | - | - | 25% | $80,000 |
| ***Capital Costs Subtotal (Pre-Inflation)*** | | | | ***$410,000*** |
| | | | | |
| ***Extraction Well Treatment System Annual Operation, Maintenance, and Monitoring Costs (50 gpm)*** | | | | |
| Treatment system operation and maintenance | 250 | Hour | $100 | $25,000 |
| P&T electric power (three 2-hp wells, one 1-hp transfer pump) | 46,000 | kW-hr | $0.17 | $7,800 |
| LGAC media exchange (per vessel) | 1 | Each | $10,000 | $10,000 |
| Treatment system sampling | 1 | Lump Sum | $3,000 | $3,000 |
| Project management and reporting | 1 | Lump Sum | $20,000 | $20,000 |
| ***Annual OMM Subtotal (Pre-Inflation)*** | | | | ***$66,000*** |
| | | | | |
| **Total Annual Cost (With 3% Inflation per Year)** | | | | **Subtotal** |
| Year 1 | | | | $490,300 |
| Year 2 | | | | $70,000 |
| Year 3 | | | | $72,100 |
| Year 4 | | | | $74,300 |
| Year 5 | | | | $76,500 |
| Year 6 | | | | $78,800 |
| Year 7 | | | | $81,200 |
| Year 8 | | | | $83,600 |
| Year 9 | | | | $86,100 |
| Year 10 | | | | $88,700 |
| Year 11 | | | | $91,400 |
| Year 12 | | | | $94,100 |
| Year 13 | | | | $96,900 |
| Year 14 | | | | $99,800 |
| Year 15 | | | | $102,800 |
| Year 16 | | | | $105,900 |
| Year 17 | | | | $109,100 |
| Year 18 | | | | $112,400 |
| Year 19 | | | | $115,700 |
| Year 20 | | | | $119,200 |
| | | | | |
| ***Total 20 Year P&T Treatment Costs (With 3% Inflation per Year)*** | | | | ***$2,249,000*** |

**Notes and Assumptions:**

LGAC is liquid-phase granular activated carbon
P&T is pump and treat (i.e., groundwater extraction and treatment)
VOCs is volatile organic compounds
hp is horsepower
kW-hr is kilowatt-hour
OMM is operation, maintenance, and monitoring
Inflation Rate = 3% per year

**Table A4**
**Groundwater Monitor Well Installation Contingency Cost Summary**
**Groundwater Proposed Remedial Action Plan**
**West Osborn Complex WQARF Site**
**Phoenix, Arizona**
**July 2020**

| Description | Quantity | Unit | Unit Cost | Subtotal |
|---|---|---|---|---|
| ***SGWS Groundwater Monitor Well Replacement Costs*** | | | | |
| Well installation | 19 | Each | $30,000 | $570,000 |
| Project management (design, engineering, permitting, etc.) | - | - | 25% | $140,000 |
| ***Costs Subtotal (Pre-Inflation)*** | | | | ***$710,000*** |
| | | | | |
| ***LSGS Sentinel Well Installation Costs*** | | | | |
| Well installation | 1 | Lump Sum | $75,000 | $75,000 |
| Project management (design, engineering, permitting, etc.) | - | - | 25% | $20,000 |
| ***Costs Subtotal (Pre-Inflation)*** | | | | ***$95,000*** |
| | | | | |
| ***Total Costs (With 3% Inflation)*** | | | | ***$829,000*** |

**Notes and Assumptions:**

SGWS - Shallow Groundwater System
LSGS - Lower Sand and Gravel Subunit
Inflation Rate = 3% per year

**Table A5**
**Wellhead Treatment Contingency Cost Summary - LSGS**
**Groundwater Proposed Remedial Action Plan**
**West Osborn Complex WQARF Site**
**Phoenix, Arizona**
**July 2020**

| Description | Quantity | Unit | Unit Cost | Subtotal |
|---|---|---|---|---|
| ***Wellhead Treatment Capital Costs*** | | | | |
| Design | | | | |
| *COP Well: COP-157* | 1 | Lump Sum | $113,000 | $113,000 |
| *SRP Well: 9.5E-7.7N* | 1 | Lump Sum | $760,000 | $760,000 |
| Project management (design, engineering, permitting, etc.) | - | - | 25% | $220,000 |
| ***Capital Costs Subtotal (Pre-Inflation)*** | | | | ***$1,093,000*** |
| | | | | |
| ***Wellhead Treatment Annual Operation, Maintenance, and Monitoring Costs*** | | | | |
| LGAC Changeouts | | | | |
| *COP Well: COP-157* | 1 | Event | $22,000 | $22,000 |
| *SRP Well: 9.5E-7.7N* | 1 | Event | $66,000 | $66,000 |
| Treatment Sytem O&M | | | | |
| *COP Well: COP-157* | 1 | Lump Sum | $75,000 | $75,000 |
| *SRP Well: 9.5E-7.7N* | 1 | Lump Sum | $100,000 | $100,000 |
| Project Management (COP) | | | | |
| *COP Well: COP-157* | 1 | Lump Sum | $10,000 | $10,000 |
| *SRP Well: 9.5E-7.7N* | 1 | Lump Sum | $40,000 | $40,000 |
| ***Annual OMM Subtotal (Pre-Inflation)*** | | | | ***$313,000*** |
| | | | | |
| **Total Annual Cost (With 3% Inflation per Year)** | | | | **Subtotal** |
| Year 1 | | | | $1,448,200 |
| Year 2 | | | | $332,100 |
| Year 3 | | | | $342,000 |
| Year 4 | | | | $352,300 |
| Year 5 | | | | $362,900 |
| Year 6 | | | | $373,700 |
| Year 7 | | | | $385,000 |
| Year 8 | | | | $396,500 |
| Year 9 | | | | $408,400 |
| Year 10 | | | | $420,600 |
| Year 11 | | | | $433,300 |
| Year 12 | | | | $446,300 |
| Year 13 | | | | $459,700 |
| Year 14 | | | | $473,400 |
| Year 15 | | | | $487,600 |
| Year 16 | | | | $502,300 |
| Year 17 | | | | $517,300 |
| Year 18 | | | | $532,900 |
| Year 19 | | | | $548,800 |
| Year 20 | | | | $565,300 |
| Year 21 | | | | $582,300 |
| Year 22 | | | | $599,700 |
| Year 23 | | | | $617,700 |
| Year 24 | | | | $636,300 |
| Year 25 | | | | $655,400 |
| Year 26 | | | | $675,000 |
| Year 27 | | | | $695,300 |
| Year 28 | | | | $716,100 |
| Year 29 | | | | $737,600 |
| Year 30 | | | | $759,700 |
| | | | | |
| ***Total 30 Year Wellhead Treatment Costs (With 3% Inflation per Year)*** | | | | ***$16,464,000*** |

**Notes and Assumptions:**

LSGS - Lower Sand and Gravel Subunit
LGAC is liquid-phase granular activated carbon
OMM is operation, maintenance, and monitoring
SRP - Salt River Project
COP - City of Phoenix
Inflation Rate = 3% per year

**Table A6**
**In-Situ Chemical Oxidation Contingency Cost Summary - SGWS**
**Groundwater Proposed Remedial Action Plan**
**West Osborn Complex WQARF Site**
**Phoenix, Arizona**
**July 2020**

| Description | Quantity | Unit | Unit Cost | Subtotal |
|---|---|---|---|---|
| ***ISCO Capital Costs*** | | | | |
| Coordination, Design, and Bench Testing | 2 | Lump Sum | $60,000 | $120,000 |
| Injection and Monitoring Well Installation | 26 | Each | $30,000 | $780,000 |
| Demobilization / Closeout | 2 | Lump Sum | $45,000 | $90,000 |
| Project management (design, engineering, permitting, etc.) | - | - | 25% | $250,000 |
| ***Capital Costs Subtotal (Pre-Inflation)*** | | | | ***$1,240,000*** |
| | | | | |
| ***ISCO Annual Costs (Year 1)*** | | | | |
| ISCO Injections | 4 | Year | $65,000 | $260,000 |
| Post-Injection Monitoring | 2 | Year | $20,000 | $40,000 |
| Project Management and Reporting | 2 | Year | $40,000 | $80,000 |
| ***Annual Costs Subtotal (Pre-Inflation)*** | | | | ***$380,000*** |
| | | | | |
| ***ISCO Annual Costs (Year 2)*** | | | | |
| Post-Injection Monitoring | 2 | Year | $20,000 | $40,000 |
| Project Management and Reporting | 2 | Year | $40,000 | $80,000 |
| ***Annual Costs Subtotal (Pre-Inflation)*** | | | | ***$120,000*** |
| | | | | |
| **Total Annual Cost (With 3% Inflation per Year)** | | | | **Subtotal** |
| Year 1 | | | | $1,668,600 |
| Year 2 | | | | $127,300 |
| | | | | |
| ***Total 2 Years Costs (With 3% Inflation per Year)*** | | | | ***$1,796,000*** |

**Notes and Assumptions:**

SGWS - Shallow Groundwater System
ISCO is in-situ chemical oxidation
OMM is operation, maintenance, and monitoring
Inflation Rate = 3% per year

**Table A7**
**Well Sleeving Contingency Cost Summary - LSGS**
**Groundwater Proposed Remedial Action Plan**
**West Osborn Complex WQARF Site**
**Phoenix, Arizona**
**July 2020**

| Description | Quantity | Unit | Unit Cost | Subtotal |
|---|---|---|---|---|
| ***Well Sleeving Costs*** | | | | |
| Well sleeving COP Well: COP-157 | 1 | Lump Sum | $40,000 | $40,000 |
| Professional services (design, engineering, permitting, etc.) | - | - | 25% | $10,000 |
| ***Capital Costs Total (Pre-Inflation)*** | | | | ***$50,000*** |
| ***Capital Costs Total (With 3% Inflation per Year)*** | | | | ***$52,000*** |

**Notes and Assumptions:**

LSGS - Lower Sand and Gravel Subunit
Inflation Rate = 3% per year