Health Consultation

Evaluation of Water Sampling Results

Estes Landfill WQARF Registry Site

PHOENIX, MARICOPA COUNTY, ARIZONA

Prepared by the

Arizona Department of Health Services

January 21, 2016

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Executive Summary

Purpose:	The purpose of this health consultation is to determine if current vinyl chloride (VC) and cis-1,2-dichloroethene (c-1,2-DCE) concentrations in the groundwater of the Estes Landfill Water Quality Assurance Revolving Fund (WQARF) site present a human health risk. The health consultation will be used to aid the decision of whether to close the site early.
Background and Statement of Issues:	The Estes Landfill, located between 40th and 45th Streets south of the Salt River in Phoenix, was privately owned and operated between 1953 and 1973, and accepted industrial, commercial, residential, and liquid wastes. In the early 1980s, groundwater contamination was discovered in two industrial supply wells in the area. The site was identified as a WQARF site in 1998, and continued groundwater sampling and monitoring has occurred to evaluate specific groundwater quality contamination distribution and trends at the site. ADEQ submitted data to ADHS from a sampling event that occurred on 16 groundwater monitor wells located at the site from March 18-20, 2015. With the exception of well EW-PZ3, the vinyl chloride concentrations at the Estes Landfill have been naturally attenuating, and the cleanup goal for vinyl chloride of 2.0 µg/L should be achieved at these wells within seven years. Well EW-PZ3 may go dry within the next 5-6 years. Therefore, the declining water levels may promote groundwater remediation and ultimate closure of the site.
Discussion:	Environmental Data: ADHS analyzed the data for VC and c-1,2-DCE because their concentrations were above their respective Aquifer Water Quality Standard (AWQS) – all other chemicals tested for were below their respective AWQS. ADHS identified the 9 wells that contained c-1,2-DCE and/or VC concentrations above the AWQS at any of the three most recent sampling events. Exposure Pathway Analysis: The groundwater from the Estes Landfill was used for industrial purposes in the past, and could potentially be used for non-food-related industrial purposes in the future. Therefore, the potential exposure pathway to this water for adults is through incidental ingestion of industrial water. The exposure through inhalation and skin contact is not likely to be significant due to the limited amount of time that people would be in direct contact with the water. Comparison to Health-based Comparison Values: ADHS compared the exposure levels for VC to health-based comparison values such as its Environmental Media Evaluation Guide (EMEG) and Cancer Risk Evaluation Guide (CREG). Since an EMEG and CREG are not available for c-1,2-DCE, exposure levels for c-1,2-DCE were compared to its Reference Dose Media Evaluation Guide (RMEG). Since potential future exposure levels to c-1,2-DCE and VC were above the comparison values, a further risk evaluation for both chemicals is needed. General Toxicological Information: c-1,2-DCE enters the environment from chemical factories, landfills, and hazardous waste sites. The long-term human health effects after exposure to low concentrations of c-1,2-DCE are unknown, due to the lack of available human studies. Results of a recent animal study have suggested that a fetus

	exposed to c-1,2-DCE may not grow as quickly compared to one that is unexposed. There is inadequate information to assess c-1,2-DCE's carcinogenic potential. VC can be formed in the environment when substances such as trichloroethylene (TCE) and tetrachloroethylene (PCE) are broken down by certain microorganisms. Liver damage may result in humans from chronic exposure to vinyl chloride through both inhalation and oral exposure. Central nervous system effects as well as peripheral nervous system symptoms have been reported in workers exposed to vinyl chloride. ATSDR has determined that vinyl chloride is a human carcinogen, and that inhalation of vinyl chloride can lead to increases in liver cancer, brain cancer, lung cancer, and some cancers of the blood. Site-Specific Evaluation: Non-Cancer Health Risk Estimation: - ADHS estimated the daily exposure dose based on the exposure scenario (i.e. incidental exposure to industrial water). Workers were assumed to incidentally ingest 20 mL of water per day for 350 days a year for 30 years. Using the highest cis-1,2-DCE concentration, the estimated exposure dose was 0.00003 mg/kg/day for adults. This estimated daily exposure dose is well below the reference dose (RfD) of 0.002 mg/kg/day for cis-1,2-DCE. (EPA IRIS 2010) - VC: ADHS estimated the daily exposure dose based on the exposure scenario (i.e. incidental exposure to industrial water). The same ingestion and exposure assumptions were made as for c-1,2-DCE. Using the highest VC concentration, the estimated exposure dose was 0.00001 mg/kg/day for adults. This estimated daily exposure dose is well below the reference dose (RfD) of 0.003 mg/kg/day for VC. (EPA IRIS 2000) Cancer Health Risk Estimation: - No studies have been done to determine whether cancer in people or animals is caused by exposure to c-1,2-DCE. Therefore, it is not possible to conduct a cancer health risk assessment for c-1,2-DCE, and the cancer risk is indeterminate. - The estimated exposure dose for VC was assumed to be 0.00001 mg/kg/day for adults, as calculated previously. The exposure dose was multiplied by the oral slope factor for VC, which is 1.5 per mg/kg/day. For adults, the estimated cancer risk is 1.66×10^{-5}, which represents a possible 1-2 excess cancer cases in a population of one hundred thousand (100,000). EPA has established a target risk range of 1 in 1,000,000 to 10,000 (10^{-6} to 10^{-4}) for hazardous waste sites. The estimated cancer risk does not exceed the EPA target risk range of 10^{-6} to 10^{-4}.
Child Health Considerations:	Both ADHS and ATSDR recognize that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contaminants in environmental media. All health analyses in this report take into consideration the unique vulnerability of children.
Conclusions:	ADHS does not expect to see adverse non-cancer or cancer health effects related to c-1,2-DCE or VC among the potentially exposed population.

Purpose

The Arizona Department of Health Services (ADHS) received a request from the Arizona Department of Environmental Quality (ADEQ) to evaluate potential human health risks associated with vinyl chloride and cis-1,2-dichloroethene concentrations in the groundwater of the Estes Landfill Water Quality Assurance Revolving Fund (WQARF) site. The purpose of the request is to determine if current vinyl chloride and cis-1,2-dichloroethene concentrations in the groundwater present a human health risk, since their levels are above the Aquifer Water Quality Standards (AWQS). This health consultation will be used to aid the decision of whether to close the site early.

Background and Statement of Issues

The Estes Landfill, located between 40th and 45th Streets south of the Salt River in Phoenix, was privately owned and operated between 1953 and 1973, and accepted industrial, commercial, residential, and liquid wastes. Between 1980 and 1982, groundwater contamination was discovered in two industrial water supply wells in the area – the primary contaminants detected were cis-1,2-dichloroethene (c-1,2-DCE) and vinyl chloride (VC). These are both degradation byproducts of the industrial solvent trichloroethene (TCE). Since 1987, several phases of remedial investigation have been conducted at the site. In 1998, the site was defined by ADEQ as the Estes Landfill WQARF Registry Site. Continued groundwater sampling and monitoring has occurred in order to evaluate specific groundwater quality contaminant distribution and trends at the site (ADEQ 2013).

ADEQ submitted data to ADHS from a sampling event that occurred on 16 groundwater monitor wells located at the site from March 18-20, 2015. With the exception of well EW-PZ3, the vinyl chloride concentrations at the Estes Landfill have been naturally attenuating, and the cleanup goal for vinyl chloride of 2.0 µg/L should be achieved at these wells within seven years. The rate of attenuation at well EW-PZ3 is much slower, however, at the current rate of water level decline, this well may go dry within the next 5-6 years. Therefore, the declining water levels may promote groundwater remediation and ultimate closure of the site. Groundwater remediation would occur to prevent water from this site from contaminating other water resources and causing incidental exposure to the chemicals.

Discussion

General Assessment Methodology

ADHS generally follows a three-step methodology to assess public health issues related to environmental exposures. First, ADHS obtains representative environmental data for the site of concern and compiles a comprehensive list of site-related contaminants. Second, ADHS identifies exposure pathways, and then uses health-based comparison values to find those contaminants that do not have a realistic possibility of causing adverse health effects. Finally, for the remaining contaminants, ADHS reviews recent scientific studies to determine if exposures are sufficient to impact public health.

Available Environmental Data

Per ADEQ's request, ADHS focused on the water sampling data collected for c-1,2-DCE and VC presented in the Groundwater Monitoring Report, 1st Quarter 2015 Monitoring Event, Estes Landfill WQARF Registry Site. ADHS analyzed the data for c-1,2-DCE and VC because their concentrations were above their respective AWQS – all other chemicals tested for were below their respective AWQS. The sampling data was provided by ADEQ, and analyzed by TestAmerica Laboratories, Inc. (located in Phoenix, Arizona) within 48 hours of sampling collection. Three duplicate groundwater samples were collected for QA/QC. The samples were analyzed for volatile organic compounds using EPA Test Method 8260B.

The 1st Quarter 2015 Groundwater Monitoring Report provided data on the three most recent sampling events, which occurred on April 1-3, 2014, December 17-19, 2014, and March 18-20, 2015. Based on this data, ADHS identified the wells that contained c-1,2-DCE and/or VC concentrations above the Aquifer Water Quality Standard (AWQS) at any of the three most recent sampling events. The AWQS is 70 µg/L for c-1,2-DCE, and 2 µg/L for VC. Table 1 below presents the highest c-1,2-DCE concentrations of the three most recent sampling events at wells where concentrations were above the AWQS:

Table 1. c-1,2-DCE Concentrations Above the AWQS (70 µg/L)

Well	Highest c-1,2-DCE Concentration (µg/L)	Number of Samples Above the AWQS
EW-PZ9	280	2
EW-PZ10	130	1

Table 2 below presents the highest VC concentrations of the three most recent sampling events at wells where concentrations were above the AWQS:

Table 2. VC Concentrations Above the AWQS (2 µg/L)

Well	Highest VC Concentration (µg/L)	Number of Samples Above the AWQS
EW-PZ1	37	1
EW-PZ5	17	3
EW-PZ9	88	3
EW-6	6.8	2
EW-9	3.8	1
EW-W	4.9	2
EW-E	19	3
EW-PZ3	120	3
EW-PZ10	36	3
EW-15	2.6	1

See Appendix A for a map of the Estes Landfill WQARF site groundwater wells.

Exposure Pathway Analysis

Identifying exposure pathways is important in a health consultation because adverse health impacts from contaminants can only happen if people are exposed to them. The presence of a contaminant in the environment does not necessarily mean that people are actually coming into contact with it. Exposure pathways have been divided into three categories: completed, potential, and eliminated.

There are five elements considered in the evaluation of exposure pathways:

1) A source of contamination
2) A medium such as soil or groundwater through which the contaminant is transported
3) A point of exposure where people come into contact with the environment
4) A route of exposure by which the contaminant enters or comes into contact with the body
5) A receptor population (i.e. exposed population)

Completed pathways exist when all five elements are present and indicate that exposure to a contaminant has occurred in the past and/or is occurring presently. In a potential exposure pathway, one or more elements of the pathway cannot be identified, but it is possible that the element might be present or might have been present. In eliminated pathways, at least one of the five elements is or was missing, and will never be present. Completed and potential pathways, however, may be eliminated when they are unlikely to be significant.

After discussion with ADEQ, it was concluded that the groundwater from the Estes Landfill WQARF Registry Site is not expected to be used for drinking or irrigation water purposes. It is also not expected to be used in any industrial water supplies that could come in contact with food processing. Instead, the groundwater was used for industrial purposes in the past, and could potentially be used for non-food-related industrial purposes in the future. Therefore, the potential exposure pathway to this water for adults is through incidental ingestion of industrial water. The exposure through inhalation and skin contact is not likely to be significant due to the limited amount of time that people would be in direct contact with the water. The potential exposure pathway to this water for children has been eliminated.

Table 3. Exposure Pathway Evaluation

Location	Exposure Pathway Elements					Time Frame	Type of Exposure Pathway
	Source	Media	Point of Exposure	Route of Exposure	Estimated Exposed Population		
Groundwater Wells	Estes Landfill	Groundwater	Industrial Use	Incidental Ingestion	Adult Workers	Past	Potential
						Current	Eliminated
						Future	Potential

Comparison to Health-based Comparison Values for Groundwater Well Samples

Health-based comparison values (CVs) are screening tools used to evaluate environmental data relevant to exposure pathways. These comparison values are quite conservative, and usually include uncertainty factors that account for the most sensitive populations. Adverse health effects are not expected to occur if an exposure concentration/dose is below a CV. However, an exposure concentration/dose at or above the CV doesn't mean adverse effects will occur. Rather, it means that there is a need to conduct a site-specific exposure scenario evaluation. The health risk for an individual depends on individual human factors (e.g. personal habits, occupation, and/or overall health), and site-specific environmental exposure factors (e.g. duration and amount of exposure). Therefore, the comparison values should not be used to predict the occurrence of adverse health effects without looking at site-specific conditions.

ADHS determined the potential future exposure level to c-1,2-DCE and VC by using the highest concentrations found in Tables 1 and 2 (280 µg/L for c-1,2-DCE, 120 µg/L for VC).

The Aquifer Water Quality Standards (AWQS) for c-1,2-DCE and VC are the same as EPA's MCLs of 70 µg/L and 2 µg/L, respectively. AWQSs establish the water quality goals for groundwater in Arizona, which is to maintain and protect groundwater quality for drinking water use. ADEQ has established aquifer water quality standards, based on the primary MCLs under the Safe Drinking Water Act for all aquifers in the state. (ADEQ 2015) MCLs are enforceable standards set by the EPA for the highest level of a contaminant allowed in drinking water. MCLs are set as close to MCL goals (MCLGs, the level of a contaminant in drinking water below which there is no known or expected risk to health) as is feasible, using the best available treatment technology, and taking cost into consideration. MCLs are not health-based standards.

During the initial screening process, ADHS compared the exposure levels for VC to health-based comparison values such as its Environmental Media Evaluation Guide (EMEG) and Cancer Risk Evaluation Guide (CREG). Since an EMEG and CREG are not available for c-1,2-DCE, exposure levels for c-1,2-DCE were compared to its Reference Dose Media Evaluation Guide (RMEG). These comparison values are determined by the Agency for Toxic Substances and Disease Registry (ATSDR).

EMEGs represent concentrations of substances in water, soil, and air. If humans are exposed at or below these concentrations, they are not expected to experience adverse health effects. Substances found at concentrations below EMEGs are not expected to pose public health hazards. A substance found at concentrations above EMEGs does not necessarily mean that the substance poses a health risk, but a further evaluation is required before drawing a public health conclusion. ATSDR makes three assumptions when deriving EMEGs: 1) exposures are occurring through contact with a single medium, 2) a single substance is responsible for the exposure, and 3) only noncarcinogenic health effects will occur. It is important to remember that EMEGs are screening values only, and not indicators of adverse public health effects (ATSDR).

CREGs are media-specific comparison values that are used to identify concentrations of cancer-causing substances, and are unlikely to result in an increase of cancer rates in an exposed population. ATSDR develops CREGs using EPA's cancer slope factor (CSF), a target risk level (10^{-6}), and default exposure

assumptions. The target risk level of 10^{-6} represents a risk of 1 excess cancer case in a population of 1 million. CREGs assume a lifetime (70 years' worth) exposure to chemicals. In developing the CREGs, ATSDR assumes that 1) exposures are occurring through contact with a single medium, 2) a single substance is responsible for the exposure, and 3) only cancer health effects will occur. It is important to remember that CREGs should serve only as a screening tool and not as an indication that cancer is expected or predicted (ATSDR).

RMEGs are health-based guidelines that have built-in uncertainty or safety factors, making them considerably lower than the levels at which health effects have been observed. When a substance is found at concentrations below the RMEG, the contaminant is not expected to pose a public health concern, and no further evaluation would be required. However, it serves only as a screening value, and is not an indicator of public health hazard. When a substance is found at a concentration above the RMEG, it is an indication that ADHS should further examine the potential harmful effect levels reported in the scientific literature and more fully review the potential for exposure.

Table 4. Comparison to Initial Screening Values

Chemical	Highest Concentration (µg/L)	EMEG (µg/L)	CREG (µg/L)	RMEG (µg/L)	MCL (µg/L)
c-1,2-DCE	280			20 (child), 70 (adult)	70
VC	120	30 (child), 110 (adult)	0.025	30 (child), 110 (adult)	2

Since potential future exposure levels to c-1,2-DCE and VC are above the comparison values, a further risk evaluation for both chemicals is needed.

Public Health Implications: *This section will provide general toxicological information and site-specific exposure evaluation for each contaminant of interest.*

Cis-1,2-dichloroethene (c-1,2-DCE) enters the environment through industrial activity. It is released to the environment from chemical factories, landfills, and hazardous waste sites, and can be emitted from the burning of objects made with vinyl and the breakdown of other chlorinated chemicals. There is another form of 1,2-DCE, called trans-1,2-DCE, and sometimes both forms of 1,2-DCE are present as a mixture.

The long-term human health effects after exposure to low concentrations of cis-1,2-dichloroethene are unknown, due to the lack of available human studies. Results of a recent animal study have suggested that an exposed fetus may not grow as quickly compared to one that is unexposed. No studies have been done to determine whether cancer in people or animals is caused by exposure to 1,2-dichloroethene (ATSDR 1996). The EPA's cancer classification for cis-1,2-dichloroethene is "IN", meaning that there is inadequate information to assess its carcinogenic potential.

Vinyl chloride (VC) is a manufactured substance that does not occur naturally. However, it can be formed in the environment when substances such as trichloroethylene (TCE) and tetrachloroethylene (PCE) are broken down by certain microorganisms. Most of the vinyl chloride produced in the US is used to make a polymer called polyvinyl chloride (PVC), which is used to make a variety of products including pipes, coating for wires and cables, and packaging materials.

Liver damage may result in humans from chronic exposure to vinyl chloride through both inhalation and oral exposure. Central nervous system (CNS) effects as well as peripheral nervous system symptoms have been reported in workers exposed to vinyl chloride. Animal studies have also reported effects on the liver, kidney, and CNS from chronic exposure to vinyl chloride (EPA 2000). ATSDR has determined that vinyl chloride is a human carcinogen, and that inhalation of vinyl chloride can lead to increases in liver cancer, brain cancer, lung cancer, and some cancers of the blood. Results from several studies have suggested that breathing air or drinking water containing moderate levels of vinyl chloride might increase their risk for cancer (ATSDR 2006).

Site-Specific Evaluation

Non-cancer Health Risk Estimation:

- c-1,2-DCE: The highest c-1,2-DCE concentration found was 280 µg/L. ADHS estimated the daily exposure dose based on the exposure scenario (i.e. incidental exposure to industrial water). Workers were assumed to incidentally ingest 20 mL of water per day for 350 days a year for 30 years. (The 20mL of water per day value comes from Table T-14 in EPA guidance). The average body weight was assumed to be 80 kg for adults based on ATSDR guidance. Using the highest cis-1,2-DCE concentration, the estimated exposure doses was 0.00003 mg/kg/day for adults. This estimated daily exposure dose is well below the reference dose (RfD) of 0.002 mg/kg/day for cis-1,2-DCE. (EPA IRIS 2010) RfD is an estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause non-cancerous health effects in humans. (ATSDR does not have a chronic MRL for c-1,2-DCE.) Therefore, ADHS does not expect to see adverse non-cancer health effects related to c-1,2-DCE among the potentially exposed population.
- VC: The highest VC concentration found was 120 µg/L. ADHS estimated the daily exposure dose based on the exposure scenario (i.e. incidental exposure to industrial water). The same ingestion and exposure assumptions were made as for c-1,2-DCE. Using the highest VC concentration, the estimated exposure dose was 0.00001 mg/kg/day for adults. This estimated daily exposure dose is well below the reference dose (RfD) of 0.003 mg/kg/day for VC. (EPA IRIS 2000) ATSDR has recently adopted the RfD as its minimal risk level (MRL) for VC. Therefore, ADHS does not expect to see adverse non-cancer health effects related to VC among the potentially exposed population.

Cancer Health Risk Estimation:

- c-1,2-DCE: No studies have been done to determine whether cancer in people or animals is caused by exposure to c-1,2-DCE. Therefore, it is not possible to conduct a cancer health risk assessment for c-1,2-DCE, and the cancer risk is indeterminate.
- VC: The estimated exposure dose for VC was assumed to be 0.00001 mg/kg/day for adults, as calculated previously. The exposure dose was multiplied by the oral slope factor for VC, which is 1.5 per mg/kg/day. (EPA IRIS 2000) For adults, the estimated cancer risk is 1.66×10^{-5}, which represents a possible 1-2 excess cancer cases in a population of one hundred thousand (100,000). EPA has established a target risk range of 1 in 1,000,000 to 10,000 (10^{-6} to 10^{-4}) for hazardous waste sites. The estimated cancer risk does not exceed the EPA target risk range of 10^{-6} to 10^{-4}.

Child Health Considerations

Both ADHS and ATSDR recognize that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contaminants in environmental media. A child's developing body systems can sustain permanent damage if toxic exposures occur during critical growth stages. Children ingest a larger amount of water relative to body weight than adults, resulting in a higher burden of pollutants. Furthermore, children often engage in vigorous activities, making them more sensitive to pollution than healthy adults. All health analyses in this report take into consideration the unique vulnerability of children.

Conclusions

This health consultation evaluated the potential health risks associated with exposure to cis-1,2-dichloroethene (c-1,2-DCE) and vinyl chloride (VC) in water potentially used for industrial purposes. Based on the available information, ADHS reached the following conclusions:

- ADHS does not expect to see adverse non-cancer health effects related to c-1,2-DCE or VC among the potentially exposed population.
- It is not possible to conduct a cancer health risk assessment for c-1,2-DCE due to a lack of cancer studies. The estimated cancer risk for VC does not exceed the EPA target risk range.

Therefore, ADHS does not expect any non-cancer or cancer health effects to occur due to the levels of c-1,2-DCE and VC at the site.

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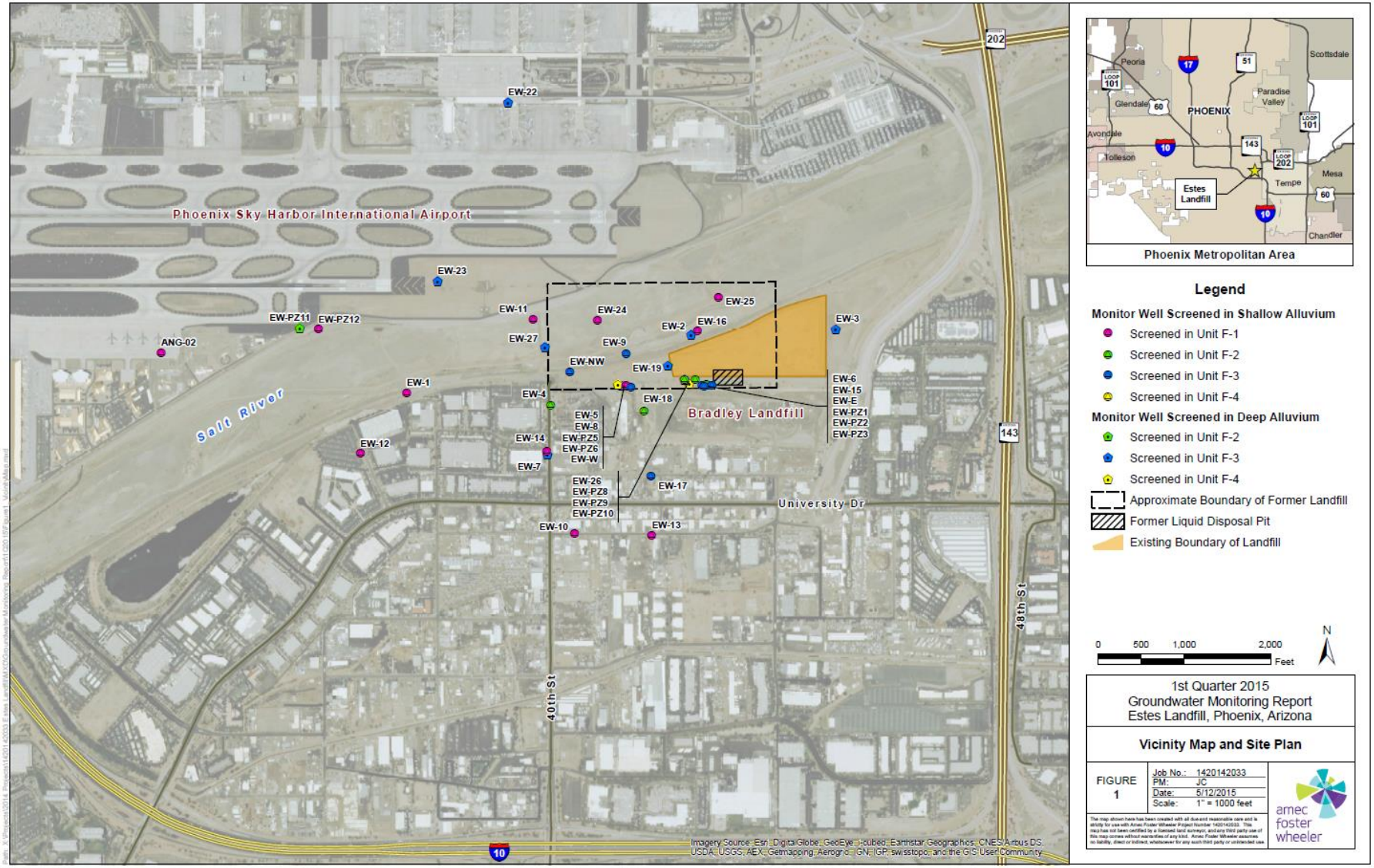
Appendix A: Map of Groundwater Wells