EARLY CLEANUP TECHNOLOGY DEPLOYMENT GUIDANCE

This document contains instructions to identify and implement early onsite cleanup, concurrently with site investigation activities. The intent of this guidance is to accelerate closure of releases from Underground Storage Tank (UST) systems in an efficient and cost effective manner. This guidance does not require preparation of additional reports than those required by the UST rules.

Step 1 – Identify Source/Release Area

1. If the location and area of source/release is unknown, it may be necessary to conduct a passive or active shallow soil vapor survey. The depth of the sample locations should be selected based on the depth of the tank/piping and the surface cover of the site, however this is typically not deeper than 5 feet. Refer to the ADEQ guidance document "Soil Vapor Sampling Guidance" dated May 19, 2011 for conducting a soil vapor survey.

2. To select the survey locations, an understanding of the subject UST site may be required. If the UST system's design drawings are not available, UST system has been removed, and/or location of the former UST excavation zone cannot be ascertained, a review of available records such as fire department, building permit and inspection record, and/or historical aerial photography may be necessary.

3. Sufficient number of soil vapor sample locations should be selected in and around the UST excavation zone to identify the release location(s). See "ADEQ UST Program Analytical Data Information" dated June 2016 for appropriate analyte list.

Step 2 – Define the Extent of Release

1. If laboratory data is available indicating the location of release, a vertical extent boring should be drilled in each release location. If laboratory data is not available, vertical extent boring should be located based on available data including results of a soil vapor survey. Complete step-out borings to estimate/determine lateral extent of contamination. Refer to "Site Investigation Guidance Manual" dated October 2014 for these investigations.

2. In order to assist with selection of an early cleanup technology and risk assessment, collect minimum geotechnical information from the vertical/lateral extent borings. Geotechnical data should include particle size, dry bulk density, moisture content etc. that could be used to establish Tier 3 modeling parameters. If groundwater contamination is present, evaluate groundwater composition/aquifer characteristics such as metals, nutrients, chemical oxygen demand, transmissivity, effective porosity, etc. All data should be incorporated into a site conceptual model (CSM).

3. If the concentration(s) of compounds of concern (COC) in the vadose zone or groundwater indicate that active remediation (either alone or in combination with a site-specific human health risk

assessment) will be required, identify early clean up technology/technologies to be implemented concurrently during site investigation.

4. If groundwater investigation indicates the presence of free product and a free product recovery test indicates sufficient quantities may be recovered, one or more early recovery methods may be implemented.

Step 3 – Select Early Cleanup Technologies

At any time following completion of source area investigation, it is be possible to evaluate, select, and implement one or more early cleanup technologies from Table 1 to be implemented as a means of rapidly removing the mass of contamination in the release area and reducing risk. Implementation of early cleanup should be considered shortly after completion of the vertical/lateral extent investigation and concurrent with the remainder of the release investigation. Early cleanup efforts should be implemented to accelerate removal of the mass of contamination in and around the release area and reduce associated risks to human health and environment in an efficient and cost effective manner.

Table 1 identifies some technologies that may be employed as part of an early cleanup effort. Other technologies that are not included in Table 1, should also be considered and evaluated carefully. Owners/operators and their consultants are encouraged to contact ADEQ prior to implementing early clean up strategies that are not listed in Table 1.

Table 1 – Acceptable Early Cleanup Technologies

Media	Technologies	Where Applied
Vadose zone	Soil vapor extraction (SVE)	The vertical extent of the release extends more than 10 feet. As a vapor abatement and fugitive vapor management in conjunction with some groundwater sparging using air and/or ozone.
	Limited soil excavation	The release is from a dispenser or piping. Majority of the mass of the release is limited to the upper 10 feet of the surface (excavation deeper than 10 feet may be considered based on site specific conditions). Majority of the mass of the release can be removed via excavation. The excavation will not impact the stability of the underground or aboveground structures.

Groundwater	Air sparging	Groundwater is deeper than 15 feet. Recommended in combination with soil vapor extraction. Reduction of concentration of COCs in groundwater is necessary prior to site closure.
	In-situ chemical oxidation	Groundwater is deeper than 15 feet. Shallow underground structures or other subsurface material(s) are not in close proximity of the treatment zone. Excessive pressure is not necessary to deliver the oxidant into the treatment zone. Volume of the release as determined in Step 4 may be required for estimation of quantities of oxidant(s) to be delivered into the treatment zone.
Free product	Soil vapor extraction	Used when vapor extraction from the monitoring well is possible. Soil contamination extends to groundwater. Can be combined with skimming for enhanced recovery.
	Vacuum truck	May be used to conduct a free product recovery test. Can be conducted at any time and in combination with other remedial option(s). Should be applied where immediate draw down of groundwater using the vacuum truck is possible. Free product thickness is greater than 12 inches. High recovery of free product is possible.
	Skimming	May be used to conduct a free recovery test. Limited recovery of free product is possible. Can be conducted at any time and in combination with other remedial option(s).

Step 4 – Estimate Volume of Release

If information concerning the volume of the release is not available (from inventory records for example), ADEQ requires the released product volume be estimated. Since the released product may be present in

the vadose zone, in groundwater, or as free product on top of groundwater, volume estimates are to be made for each of these media conditions.

Simplified equations to be used to estimate release volume are presented in Table 2 below. ADEQ considers the use of these equations as a minimum requirement to determine the volume of the petroleum release in the subsurface. ADEQ recognizes that these equations may not represent actual subsurface conditions beneath all sites. Therefore, ADEQ encourages more detailed estimation of released volume using other available methods. More detailed estimation of release volume may require investigations beyond the source area, especially in the case of impacted groundwater. Several monitoring wells might be needed to characterize the extent and estimate the volume of the release.

In some cases, when collection of soil solid concentration data near the release area is not feasible, collection of soil vapor data may be attempted from multiple locations and depths near the release location. Soil vapor concentration data may be converted to equivalent soil solid concentrations utilizing the three-phase partitioning equation found in ADEQ's Soil Vapor Sampling Guidance May 2011 and/or Groundwater Protection Level (GPL) Excel spreadsheet. Be aware that the presence of fine grained layers may affect the soil vapor concentration levels reported. Collection of multiple soil vapor samples in the fine grained layer should be attempted for better estimation.

The equations in Table 2 assume the following:

- A homogenously distributed average concentration in the vadose zone and/or groundwater;
- An elliptically shaped plume/free product surface area;
- A uniform plume thickness;
- In the case of soil and groundwater, the source of the plume is fresh product; and
- The concentration of one or more compounds can be used to estimate the original volume of released fuel.

Table 2 – Equations for Estimating Release Volume

Media	Equation	Default Values
Vadose zone	$Vol_{fuel} = \frac{C.\pi.W.L.T.\sigma_{soil}.cf}{\sigma_{coc}.w}$	σ_{soil} = 1.5 cf = 1.9E-4 ($\frac{gal.kg}{feet^3.mg}$)
Groundwater	$Vol_{fuel} = \frac{C.\pi.W.L.T.\rho.cf}{\sigma_{coc}.w}$	p = 0.3 cf = 1.9E-7 ($\frac{gal.g.L}{feet^3.\mu g.cm^3}$)
Free product	$Vol_{fuel} = \frac{\pi.W.L.T.cf}{\tau}$	τ_{sand}[1] = 2 τ_{silt}[1]= 5 τ_{clay}[1]= 6 cf = 1.9 ($\frac{gal}{feet^3}$) 1. Source: U.S. EPA, EPA 510-R-96-001, September 1996. How to Effectively Recover Free Product at Leaking Underground Storage Tanks Sites. Chapter III, Exhibit III – 12.

Where,

Release area is elliptical: ($area = \pi . \frac{Width}{2} . \frac{Length}{2}$)
Vol = Release volume (gallons)
C = Concentration (mg/kg, µg/L)
L = Average Length of Plume/Free Product (feet)
W = Average Width of Plume (feet)
T = Average Thickness (feet)
w = Fuel Fraction (%)
σ_{soil} = Soil dry bulk density (g/cm^3)
σ_{COC} = Chemical density (g/cm^3)
p = Effective porosity
τ = Estimated apparent to true free product thickness ratio
cf = Conversion factor (equation–specific)

Table 3 – Select Chemical Default Values for Gasoline and Diesel

Compound	Density (g/cm^3)	Fuel Fraction Percent[a]
Benzene (in gasoline)	0.88	1.9[b]
Ethylbenzene (in gasoline)	0.87	1.7[b]
Naphthalene (in diesel)	1.14	0.26[c]
Pyrene (in diesel)	1.27	0.0046[c]
Toluene (in gasoline)	0.87	8.1[b]
Xylenes (in gasoline)	0.87	9.0[b]

Notes:

a. *Use directly in the equation (i.e. do not divide by 100).*
b. *TPH Criteria Working Group Series, May 1998. Composition of Petroleum Mixtures. Volume 2. Table 4.*
c. *TPH Criteria Working Group Series, May 1998. Composition of Petroleum Mixtures. Volume 2. Table 10.*

Step 5 – Implement Early Cleanup

Early cleanup efforts should be implemented following completion of release area investigation and estimation of the volume of the release. Some early cleanup technologies can be implemented approximately within a month following completion of the source area investigation. Availability of onsite power, use of portable power, or use of propane tanks should be evaluated when considering the deployment of early cleanup technologies while power drop and/or natural gas service is being acquired. Operation of an SVE system will require an air quality permit. It is not anticipated that other listed technologies in Table 1 require extensive permitting. Where possible, early cleanup technologies should be implemented in such a manner that they could cost effectively be put into service as part of the final remedy if applicable.

REFERENCES:

1. Arizona Department of Environmental Quality (ADEQ), October 2014. Site Investigation Guidance Manual.

2. ADEQ, June 2016. UST Program Analytical Data Information.

3. ADEQ, May 2011. Soil Vapor Sampling Guidance.

4. Total Petroleum Hydrocarbon Criteria Working Group Series, May 1998. Composition of Petroleum Mixtures. Volume 2.

5. U.S. Environmental Protection Agency, EPA 510-R-96-001, September 1996. How to Effectively Recover Free Product at Leaking Underground Storage Tanks Sites. Chapter III.