Model Remedies for Cleanup of Former Orchard Properties in Central and Eastern Washington

Sampling and Cleaning Up Arsenic- and Lead-Contaminated Soils

For the

Toxics Cleanup Program

Washington State Department of Ecology
Union Gap, Washington

July 2021, Publication 21-09-006

Publication Information

This document is available on the Department of Ecology's website at:
https://apps.ecology.wa.gov/publications/SummaryPages/2109006.html

Related Information

Former Orchard Property Soil Arsenic and Lead Levels. Ecology requires soil sampling for properties in areas that were occupied by orchards prior to 1950 and are being converted to another use.

For an interactive map, visit: Dirt Alert Map[1]

Contact Information

Toxics Cleanup Program

Central Regional Office
1250 W. Alder Street
Union Gap, WA 98903-0009
Phone: (509) 454-7838
Website[2]: Washington State Department of Ecology

ADA Accessibility

The Department of Ecology is committed to providing people with disabilities access to information and services by meeting or exceeding the requirements of the Americans with Disabilities Act (ADA), Section 504 and 508 of the Rehabilitation Act, and Washington State Policy #188.

To request an ADA accommodation, contact Ecology by phone at 360-407-6341 or email at ecyadacoordinator@ecy.wa.gov. For Washington Relay Service or TTY call 711 or 877-833-6341. Visit Ecology's website for more information.

[1] https://apps.ecology.wa.gov/dirtalert/
[2] www.ecology.wa.gov/contact

Department of Ecology's Regional Offices

Map of Counties Served

Region	Counties served	Mailing Address	Phone
Southwest	Clallam, Clark, Cowlitz, Grays Harbor, Jefferson, Mason, Lewis, Pacific, Pierce, Skamania, Thurston, Wahkiakum	PO Box 47775 Olympia, WA 98504	360-407-6300
Northwest	Island, King, Kitsap, San Juan, Skagit, Snohomish, Whatcom	PO Box 330316 Shoreline, WA 98133	206-594-0000
Central	Benton, Chelan, Douglas, Kittitas, Klickitat, Okanogan, Yakima	1250 W Alder St Union Gap, WA 98903	509-575-2490
Eastern	Adams, Asotin, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pend Oreille, Spokane, Stevens, Walla Walla, Whitman	4601 N Monroe Spokane, WA 99205	509-329-3400
Headquarters	Across Washington	PO Box 46700 Olympia, WA 98504	360-407-6000

Model Remedies for Cleanup of Former Orchard Properties in Central and Eastern Washington

Sampling and Cleaning Up Arsenic- and Lead-Contaminated Soils

Toxics Cleanup Program
Washington State Department of Ecology
Central Regional Office

Union Gap, WA

July 2021 | Publication 21-09-006

DEPARTMENT OF
ECOLOGY
State of Washington

Table of Contents

List of Figures and Tables

Figures

Tables

Acronyms & Abbreviations

Acronym or Abbreviation	Definition
<, >, =, ≤	Less than, greater than, equal to, less than or equal to
ADA	American Disabilities Act
As	Arsenic
Ch.	Chapter
CSWGP	Construction stormwater general permit
DDT	Dichlorodiphenyltrichloroethane
DU	Decision unit
Ecology	Washington State Department of Ecology
EPA	Environmental Protection Agency
ft	feet
GPS	Geographic positioning system
HEPA	High-efficiency particulate air
in.	Inches
L&I	Washington State Department of Labor and Industries
MTCA	Model Toxics Control Act
NFA	No further action
Pb	Lead
PLP	Potentially liable person
ppm	Parts per million
RCW	Revised Code of Washington
SEPA	State Environmental Policy Act
TCLP	Toxicity characteristic leaching procedure
TCP	Toxics Cleanup Program
VCP	Voluntary Cleanup Program
WAC	Washington Administrative Code
WISHA	Washington Industrial Safety and Health Act
XRF	X-ray fluorescence

Executive Summary

You may use this document if:

- You have knowledge that your property was occupied by an orchard prior to 1950; or
- Your property is within the footprint of historical orchards found on the Washington State Department of Ecology's Dirt Alert Map[3]; or
- Untested fill was imported onto your property; and
- Lead and arsenic are the only suspected soil contaminants on your property.

Additionally, if a site is managed to address lead and arsenic, Ecology believes that these activities will address exposure to other residual organic pesticides such as DDT. Furthermore, Ecology expects that organic pesticide residues will degrade below regulatory cleanup levels over time, unlike lead and arsenic.

If the criteria listed above apply, AND your property is no longer used solely for agricultural purposes, you can use this manual for sampling and cleaning up contamination from former orchard use. You can meet state cleanup requirements without doing your own feasibility study by carefully following the steps in this model remedy.

I need a No Further Action determination from Ecology

You may not need a formal evaluation from Ecology if your cleanup is being conducted in cooperation with a local government; however, if a local government permit office or lender requires Ecology's formal written concurrence of your cleanup, you may enter the Voluntary Cleanup Program (VCP) to receive a No Further Action determination. Also, a future buyer might want to see Ecology's written concurrence of your cleanup, so a formal NFA opinion through VCP may be valuable to you. The VCP provides non-binding, informal advice, and technical assistance in the form of a written opinion. Additionally, if your cleanup is completed within 210 days from the initial sampling that confirms contamination, Ecology may formally approve your cleanup without having to enter the VCP. Additional information is in Chapter 2: Planning for Cleanup – Pursue a No Further Action (NFA) Determination.

More information is available on Ecology's VCP web pages[4].

Or you may call 509-208-1288 or email at Hector.Casique@ecy.wa.gov to speak with Ecology's Area Wide Contamination Project Manager.

[3] https://apps.ecology.wa.gov/dirtalert/
[4] https://ecology.wa.gov/VCP

Introduction

Former orchard practices caused widespread soil contamination in agricultural areas throughout Washington. This guidance addresses properties that were impacted by the use of lead arsenate, a pesticide used from the late 1800s until approximately 1950. Though the resulting lead and arsenic contamination is similar to what is found within the smelter plumes of western and northeast Washington, this document is specifically for the arid, irrigated conditions in central and eastern Washington. Please contact your regional Washington State Department of Ecology (Ecology) office if you are unsure whether this guidance applies to your property.

Goals of this guidance:

- To provide simple sampling and cleanup guidance for any former orchard property;
- To encourage independent cleanup during property development;
- To provide consistency and clarity for developers and home builders; and
- To encourage independent cleanup during smaller projects involving soil movement, such as landscaping, building a deck, or putting in a swimming pool.

Health effects of arsenic and lead

Arsenic and lead are toxic metals. Exposure can increase the risk of certain health problems. Although these metals are not easily absorbed through the skin, living in close proximity to soils contaminated with lead and arsenic will likely result in ingestion of soil and inhalation of dust. Ecology is concerned about small children and people that are regularly exposed to soil, such as construction workers, landscapers, and gardeners.

Scientists have linked long-term exposure to arsenic to a variety of health problems, including heart disease; diabetes; and cancer of the bladder, lung, skin, kidney, liver, and prostate. Lead can cause behavioral problems, permanent learning difficulties, and reduced physical growth. Ecology's soil cleanup level for lead is based on preventing unacceptable levels in blood.

Whether someone is impacted depends on the amount of arsenic or lead taken into their body over time (EPA 2021). People exposed to contaminated soil on a regular basis may be affected.

Children and workers are at highest risk

Young children are of the greatest concern because lead can have a significant impact on the developing brain (EPA 2021). Children are also more likely to be exposed. They play on the ground and put their hands in their mouths. The small amount of arsenic or lead that they may swallow is more harmful because they are still growing. Children can be exposed to arsenic or lead while playing outside and inside. Soil and dust can easily be tracked into homes from outside.

Construction workers, gardeners, and landscapers can also be exposed to contaminated soil at a work site by accidentally ingesting soil or inhaling dust. Employers are responsible for meeting health and safety requirements at work sites to limit worker exposure. Employers should contact Washington Department of Labor and Industries (L&I)[5] for more information.

Why sample?

Ecology ***requires*** initial determination sampling when a property is within the footprint of historical orchards found on the Washington State Department of Ecology's Dirt Alert Map[6], and when that property is proposing a change in land use. The historical presence of an orchard on a property can be determined by looking up the address on Ecology's Dirt Alert website. More specifically, sampling is required when these properties transition from vacant or agricultural use to a use that may increase human exposure to these contaminants. Under certain circumstances, Ecology may be able to sample your property for you at no cost. Contact Ecology for more information.

Ecology is able to require sampling because there is a very strong correlation between elevated arsenic and lead concentrations and the presence of orchard on a property prior to 1950. As a result, properties that were occupied by orchard prior to 1950 are suspected to be contaminated, and sampling is required by State law.

Even if your property was formerly an orchard, you may not have elevated levels of arsenic and lead in your soil. Arsenic and lead levels in soil depend on the quantity of pesticides applied to your property and are highly variable from orchard to orchard. Initial determination sampling verifies whether your specific property contains concentrations of arsenic and lead above state cleanup levels. Once you know if contamination is present, and where the contamination is located, you can take actions to manage potential exposure on your property.

Washington State cleanup levels for unrestricted land use (all land uses, including residential) for arsenic and lead are available below in Table 1.

Table 1: State cleanup levels for arsenic and lead.

Contaminant	Cleanup level in parts per million (ppm)
Arsenic	20
Lead	250

Model remedies

[5] https://www.lni.wa.gov/
[6] https://apps.ecology.wa.gov/dirtalert/

Model Toxics Control Act (MTCA) regulations (WAC 173-340-390[7]) (Ecology 2013) specify that Ecology must identify the circumstances under which application of a model remedy meets the requirements for selection of cleanup actions established under WAC 173-340-360[8].

If a site meets the requirements for using a model remedy, it is not necessary to conduct a feasibility study (WAC 173-340-350(8)[9]) or a disproportionate cost analysis (WAC 173-340-360(3)[10]). If the process described in a model remedy is followed and a sufficient cleanup report is submitted to Ecology, your property will be eligible for a No Further Action determination.

Chapter 173-340-390[11] – Model remedies; lists the requirements for model remedies.
Appendix A of this guidance discusses:

- Developing a model remedy;
- Purpose of a model remedy;
- Eligibility criteria for this model remedy; and
- How model remedies meet the remedy selection and the compliance monitoring requirements in MTCA.

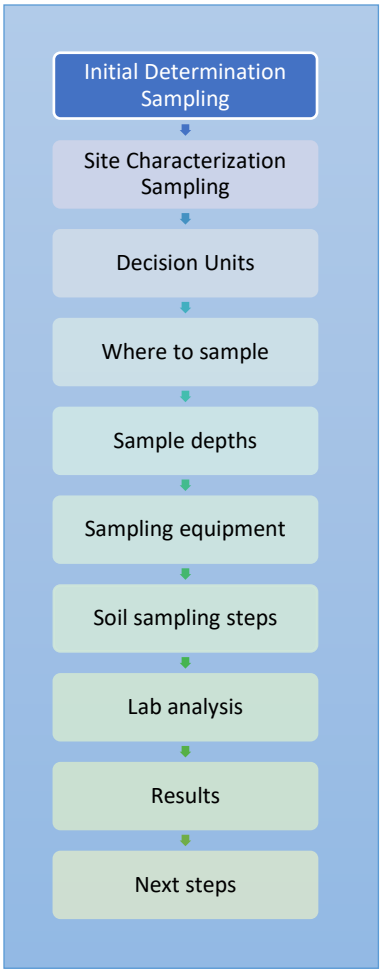
The table below contains the 4 model remedy options found in this document. The best option will depend on the specific conditions and proposed land use for your property. A combination of these options is acceptable, as long as all contaminated areas are addressed.

[7] https://apps.leg.wa.gov/wac/default.aspx?cite=173-340-390
[8] https://apps.leg.wa.gov/WAC/default.aspx?cite=173-340-360
[9] https://apps.leg.wa.gov/WAC/default.aspx?cite=173-340-350
[10] https://apps.leg.wa.gov/WAC/default.aspx?cite=173-340-360
[11] https://apps.leg.wa.gov/WAC/default.aspx?cite=173-340-390

Table 2: Model remedy options.

	Excavate and Remove (Ch. 3)		The top 6 inches of soil must have ≤ 20 ppm required.
	Mix (Ch. 4)	Mix contaminated soils with imported soils or deeper, clean soil.	
	Cap in Place (Ch. 5)	Cover contaminated soils with a marker material and soil cap or hard cap.	
	Consolidate and Cap (Ch. 6)	Excavate and consolidate contaminated soils into an area of the property and place under a cap (see above).	Compliance sampling of excavated areas required. Compliance sampling of import soil required. Institutional controls required.

Chapter 1: Soil Sampling



Purpose

This chapter describes the steps in sampling soil from your property. Three stages of soil sampling may be required during the cleanup process. They include:

1. Initial determination sampling
2. Site characterization sampling
3. Compliance sampling

Initial determination sampling will show whether a property or a portion of it is clean or contaminated. If the property is identified as clean during initial determination sampling, no other action is required.

Site characterization sampling may be required if initial determination sampling shows the property to be contaminated. Site characterization sampling will determine the extent and magnitude of contamination, and determine what remedial options are appropriate. If you elect to have Ecology conduct the initial determination sampling for you, you may be exempt from further characterization sampling requirements if you elect to use a capping remedy (See Chapter 5).

Compliance sampling is required if you use a remedy that includes mixing or excavation. Compliance sampling will demonstrate whether you have successfully excavated all contaminated soil, or whether soil has been successfully mixed so that concentrations are below State cleanup levels. Compliance sampling is discussed further with excavation and mixing remedies in Chapter 7, and with import soil sampling in Chapter 9.

Ecology encourages the use of X-ray fluorescence detector (XRF) technology for analyzing properties for arsenic and lead in soil. XRF analysis provides real-time data and allows highly efficient sampling and analysis. Changes to your sampling plan can be made in the field based on analytical results and can avoid multiple return sampling events that may be required when relying on delayed laboratory results. There are many brands and models of XRF. Ecology will accept data from any XRF that has detection limits below MTCA Method A cleanup levels (20 ppm for arsenic and 250 ppm for lead).

XRF equipment may cost more than $1500 per day for rental, and laboratory analysis can cost between $50 and $100 per sample. The size of your property, the number of samples you expect to take, and the flexibility in your timeline will determine which method is best for you.

Note: Ecology recommends that an experienced environmental consultant be hired to do soil sampling as well as reporting of sampling methods and results. If you choose to do such sampling yourself, Ecology expects documentation to be thorough and complete, and sampling procedures followed strictly to prevent potential cross-contamination and ensure high quality data.

Initial Determination Sampling

As stated in the introduction, Ecology ***requires*** initial determination sampling when a property is within the footprint of historical orchards found on the Dirt Alert Map[12], and when that property is proposing a change in land use that increases risk to human health and the environment.

Ecology will conduct initial determination sampling at your property at no cost. This sampling event will be used to determine whether your property is impacted and whether additional sampling and mitigation are required. If arsenic and lead are detected at concentrations above state cleanup levels, site characterization sampling may be required to determine which remedy is appropriate for your property. Under certain circumstances, primarily if a capping remedy is selected, you may have the option of saving the cost of additional sampling and assuming the entire property contains the arsenic and lead concentrations detected during the initial sampling event. Please contact Ecology to discuss this option further.

Site Characterization Sampling

Site Characterization sampling is used to understand how arsenic and lead area distributed throughout your property, and to help you select the best model remedy. **Appendix B (Form 1: Characterization Sampling)** will help you document your planning for this process.

Other sampling methods may be appropriate and can be used when approved by Ecology (e.g., Multi-Incremental Sampling).

[12] https://apps.ecology.wa.gov/dirtalert/

Decision units

You may want to break your property into separate decision units for characterization sampling. Property that was part of the same historical orchard that has not been regraded will have relatively consistent concentrations of arsenic and lead. If your property has been disturbed after 1950, or if it was made up of different orchards or uses, you may consider identifying separate decision units before starting sampling. This may save time and money when it comes to both sampling and cleanup.

> Decision Unit:
>
> Area of a property expected to have a different pattern of soil contamination than other areas. Some properties will only have one decision unit. Factors include current and past land uses, the size of the property, and development history.

Arsenic or lead may be below cleanup levels in re-graded portions of the property, and *above* cleanup levels in an undisturbed portion. It is more cost effective to treat these as separate decision units, since you would only clean up the area that was above state cleanup levels. You should also consider portions of the property that were known to be part of different historic orchards to be different decision units. Any known pesticide mixing or storage areas should be defined as a separate decision unit and sampled according to Tables 3 and 4.

Future use can also define decision units. Areas that will be covered in permanent hard surfaces will not need additional cleanup actions. However, you will likely need to cap soils in areas that will be landscaped and have permeable surfaces.

Thinking about possible cleanup methods and site excavation plans will help refine your decision units and sampling plan. More sampling will help to plan for excavation or mixing, for example:

Excavation and removal: It is critical to understand the depth of contaminated soil if you are considering excavation and removal as a remedy. Many historical orchard properties have elevated concentrations of arsenic and lead at depths of 36” or greater. Excavation and disposal is a very expensive remedy in this case. Your site characterization samples **must** identify the depth of clean soil if you are considering this remedy.

Mixing in place with deeper soils: Take samples from the depth you plan to mix, at six-inch intervals. More samples than are required throughout the entire mixing depth will give a better idea of whether the remedy will be effective.

Sampling for a capping remedy

Use Table 3 to find the number of sample locations you need for a capping remedy. Fewer samples are required for capping remedies because a cap is protective of the range of arsenic and lead concentrations found in former orchard soil.

The specific arsenic and lead concentrations are not critical if the property is properly capped. Take a sample from each location from the top 3-8 inches of soil, after clearing away grass, leaves, gravel, or debris on the surface.

Table 3: Minimum number of soil sample locations per decision unit for a capping remedy.

Sampling area in acres	Number of samples
<0.25	4
<1	8
<5	15
<10	20
<20	25
≥20	25 + 2 per 5 acres

Sampling for a mixing or excavation remedy

For a mixing or excavation remedy, 50% of site characterization sample locations will require samples at multiple depths to identify maximum depth of contaminated soil. The sample locations selected for depth profile samples should be equally distributed across the property, specifically including any locations that are suspected to have been disturbed after 1950. This information is critical to understand the quantity of soil that will be excavated or mixed. For those sample locations selected for depth analysis, samples should be taken at 6-inch depth intervals until clean soil is encountered. This process is much quicker when using an X-ray fluorescence detector rather than laboratory analysis. See discussion of XRF use later in this chapter. Use Table 4 to find the number of sample locations you need for an excavation or mixing remedy.

Table 4: Minimum number of soil sample locations per decision unit for mixing or excavation.

Sampling area in acres	Number of samples	Number of sample locations with depth profile samples
<0.25	6	3
<1	15	7
<5	30	15
<10	50	25
<20	80	40
<100	120	60
≥100	120 + 5 per 5 acres	60 + 5 per 10 acres

Additional factors

Other factors may influence the number of samples required. Please contact Ecology to discuss potential needs to modify the number of required samples. Additional factors may include the following:

1. **Assumptions** – Do you wish to use a capping remedy and assume the entire decision unit is contaminated and the entire area will be capped to save sampling costs? In this case, contact Ecology as a minimal number of samples may be required to characterize what will remain beneath the cap.
2. **Land use** – What is the **intended** use? Residential, or industrial zoning that will be inaccessible by the public? A higher level of land use (i.e., residential, childcare, or schools) typically requires a greater degree of data confidence to ensure protectiveness.

Soil: Where to sample

You will be required to attach a diagram to your final cleanup report showing the property dimensions and decision units. You do not need to sample where structures or pavement will exist after development unless soil in these areas will be relocated or removed from the property. These areas should be marked on the diagram. If you are seeking a no further action determination from Ecology, an environmental covenant will be necessary to document the contamination under permanent structures or pavement (see Chapter 10).

For each decision unit, lay out sample points in an evenly spaced grid. Use the number of locations from Tables 3 or 4. Grid points should cover as much area as possible. Adjust the grid or add locations to make it fit. All samples are **discrete**, which means the soils for one sample come from a single sampling location.

Areas with fill, topsoil, or sod

You may know of areas where fill dirt, topsoil, or sod was added in the past. If you plan to excavate and use deep soils from the property, it is important to verify you aren't uncovering contaminated soils that were buried and using them in areas where they will remain exposed at the surface. Deeper sampling is recommended in these areas to prevent wasted efforts during site grading and excavation.

Collecting samples for laboratory analysis

You will need the following equipment to collect soil samples for laboratory analysis:

- Stainless-steel tools to dig holes and remove soil (trowel and small shovel)
- Stainless-steel or glass bowl for mixing
- Lab-provided glass sample containers
- Permanent marking pen to record sample locations on the container labels
- Wash bucket, non-phosphate detergent such as Alconox, scrub brush, and rinse water (tap water and distilled or deionized water)
- Gloves and dust mask
- Paper towels
- Property diagrams with sampling grids
- Map or aerial photo of decision unit
- Cooler with ice to keep the samples cool
- Chain-of-custody forms

Sample collection steps

Take one sample from each depth range you need, at each sampling location marked on your decision unit diagrams (see Figure 1). These should be collected as separate samples. **Do not** mix soil samples from different sampling locations or depth ranges.

Healthy Sampling Steps

Limit dust by dampening soil before sampling or wear a dust mask.

Wear gloves. Wash hands, arms, and face after sampling.

Wash work clothing separately from other laundry.

1. Before taking any samples, contact an Ecology accredited lab (see Help Desk). The lab may have special instructions about labeling and delivering the samples.

2. Label each sampling location, in each decision unit, with a unique name or number. For better accuracy in recording your sample locations, use a Geographic Positioning System (GPS). Mark them on an aerial photo if you can.

3. Using a permanent marker, label your glass sample containers with:
    - The unique identifier for the sampling location
    - Your name
    - The date the sample is being taken
    - “Arsenic and lead”

4. Clear away grass, leaves, gravel, or debris from the soil surface to ensure your sample is all soil. Dig an eight to twelve-inch hole with the stainless-steel trowel, shovel, or hand auger, making an exposed vertical soil face to sample from.

5. Using a clean trowel or spoon for each depth, scrape soil from the sides of the hole at the depth interval you are sampling and put it in the clean, stainless steel mixing bowl. Avoid or discard pebbles, rocks, leaves, roots, and stems. Collect soil evenly from the desired sampling depth of the hole. It is important to mix the soil well in the stainless steel bowl.

6. Fill up the jar with the mixed soil and seal it securely. Discard any extra soil back into the hole. Do not composite (mix) samples from different locations.

7. Between each sample, scrub and wash the sampling tool and mixing bowl clean within the wash bucket, rinse with tap water followed by distilled or deionized water and pour the dirty water where it can soak into the ground on the same property. Don’t pour it down the storm drain.

8. For deeper samples, dig a few inches below your desired sample depth at the same location. This is a separate sample, so repeat steps 4 through 6, but only scrape the side of the hole at your next desired sample depth. Be cautious not to contaminate your sample with soil from shallower depths.

9. Place the samples in a cooler and fill out laboratory-provided chain-of-custody form to accompany the samples to the laboratory with the required information.

Figure 1: How to collect a soil sample.

Lab analysis

If you elect to use a laboratory for analysis, see the Help Desk section of this guidance to select a lab.

Keep samples in a cool, dry place until their analysis. Bring the samples to the lab or follow its instructions for shipping. Include a copy of the sample inventory sheet (Form 2) and the custody form provided by the lab. Keep copies for yourself.

The lab report should include a list or separate pages of results for each sampling location. It should have results for quality control samples done at the lab. This is standard practice for all metals analysis. You will also see the chain-of-custody form signed by the laboratory. Keep everything you receive from the lab.

If you anticipate pursuing a No Further Action determination from Ecology, you will have to submit laboratory data to Ecology's Electronic Information Management system (EIM). To facilitate this process, you should request that the laboratory provide your data in an electronic deliverable format that is compatible with EIM. Most laboratories are capable of producing this format.

Sampling by X-ray fluorescence detector

Sampling with an X-ray fluorescence detector (XRF) is a quick, efficient, accurate way to analyze soils on your property. XRF analysis should only be performed by someone trained in the safe operation and data extraction techniques of this equipment.

The same tools and techniques described above in 'Sample Collection Steps' should be used for XRF analysis, except that the XRF can be used without disturbing the soil to be analyzed. Surface soil can be carefully removed, exposing undisturbed soil at the desired depth. The tip of the instrument can be placed directly in contact with the soil to be analyzed. Deeper soils can be quickly analyzed by excavating test pits to the desired depth and leaving an undisturbed sidewall for analysis. This allows quick analysis at highly accurate depths.

Soil: Understanding your characterization results

Use the sample results to plan your next steps. If arsenic or lead levels are elevated for any decision unit on the property, it needs cleanup. Calculate the average of the samples collected from 3-8 inches below the ground surface. **Elevated means**:

- Average arsenic > 20 parts per million (ppm) or average lead > 250 ppm; **or**
- Maximum (any one sample) arsenic > 40 ppm or maximum lead > 500 ppm.

Use **Appendix B (Form 2: Characterization Sampling Results)** to calculate average and maximum arsenic and lead for each decision unit, at each depth. Mark which decision units exceeds state cleanup levels.

What to do next

If none of your decision units are elevated, stop here. If one or more decision units are elevated, select one or more cleanup options from Chapter 2. Ecology also recommends:

For assistance with interpreting your results and deciding on cleanup options, please contact Ecology.

- Cleaning up as part of your development project.
- Entering Ecology's Voluntary Cleanup Program[13] (VCP) to obtain an official opinion letter such as a No Further Action (NFA) determination, if needed.
- Communicate to all future owners and leasers when a protective cap is in place that needs protection. This should include information such as the depth of clean fill, the presence of a marking landscape fabric, and the requirement to contact Ecology before digging below the landscape fabric.
- Taking healthy actions like handwashing and taking shoes off at the door (see the Help Desk section).
- Notifying tenants or property users of healthy actions and why to use them.

[13] https://ecology.wa.gov/VCP

Chapter 2: Planning for Cleanup

Cleanup options

Table 2 summarizes model remedies for former orchard properties. Any combination of these remedies is acceptable. All contaminated areas of a property that are undergoing a change in land use to residential, commercial or any use that increases the potential exposure must be addressed. Areas of a project that remain agricultural or vacant and are excluded from use by occupants of the property may be exempt from cleanup. **Note:** Some model remedies can only be applied when arsenic and lead concentration are measured at or below a certain level (for example, mixing).

Excavation and mixing are the two permanent remedies, whereas capping needs ongoing monitoring, maintenance, and property restrictions.

Your selected remedy must also consider how stormwater will be addressed. Stormwater cannot be infiltrated through contaminated soil, regardless of which remedy you select. For example, if you choose capping as your remedy, any stormwater infiltration areas must be excavated down to clean soil during development. While arsenic and lead are relatively immobile during irrigation and natural precipitation, it is possible to increase leaching and mobility with concentrated infiltration of stormwater.

Remedy Selection

It is up to you to select the best remedy for your property. Below are general considerations for each model remedy. Each remedy is discussed in more detail in its respective Chapter. The property location, accessibility, and features can make certain options less expensive. Many cleanup activities can be incorporated into existing construction and development plans, which make them more cost-effective.

Capping: Capping is often the least costly remedy but is also requires the greatest amount of long-term maintenance and monitoring. Capping requires the least amount of sampling, because a cap is protective of the range of arsenic and lead concentrations found in former orchard soil. The specific arsenic and lead concentrations are not critical if the property is properly capped. The depth extent of contamination is also irrelevant for the capping remedy. Capping does require a significant source of clean soil; however, other remedies typically require the import of topsoil, as well. Institutional controls are required as part of this remedy.

Consolidation and capping: Consolidation and capping can be an excellent option for larger developments with relatively shallow contamination depths. If your property has room to designate an area specifically for consolidation and capping, contaminated soil from across the property can be placed in that area. The remainder of the property would be clean and would not require any additional work. The consolidation area is the only area requiring capping.

This is a particularly effective remedy when the depth of contamination is shallow and large amounts of excavation are not required. Institutional controls are required as part of this remedy for the portion of this property where you have capped contaminated soil.

Mixing: Mixing is an excellent option in very specific situations. Arsenic and lead concentrations must be very low; only slightly above cleanup levels. The depth of contaminated soil must be very shallow. A successful mixing site would have clean soil 12-inches below the surface and concentrations less than twice the cleanup level. When successfully mixed, a property does not require any additional action. No cap is required, and the cleanup is permanent. Successful mixing requires very thorough mechanical blending, resulting in a homogenous mixture.

Excavation and disposal: Excavation and disposal is often the most expensive option. It requires excavation of all contaminated soil from your property, and it requires disposal of this soil at a certified landfill. If contamination extends deep into the soil, as is typical, a large amount of soil must be excavated from your property. The benefit to excavation and disposal is that the remedy is permanent. No other actions are required.

Model remedy options can be combined, as appropriate. All contaminated portions of your property must be addressed by one of the model remedies.

Additional options

Contact Ecology to discuss other site-specific mitigation options. Other options will be considered that are equally protective of human health and the environment but would not qualify as a model remedy. When using an option that is not a specified model remedy, you will be required to submit your cleanup documentation to Ecology through the VCP if you want to obtain a NFA determination for your property.

If you wish to exclude a portion of your property from cleanup because it will remain in agricultural use or vacant, contact Ecology for approval. That portion of your property must by physically isolated from landscaped areas, and it's restricted use must be documented in the institutional controls selected for your property. See Chapter 10 for information on institutional controls.

Additional sampling requirements

Model remedies 1 and 2, excavation and removal, and mixing, require compliance sampling (Chapter 7) to show the cleanup is complete. When importing soils, request sample results from the soil provider or complete soil sampling yourself prior to accepting the imported soil or obtain approval from Ecology that the source of the fill should be sufficient to be considered clean fill (Chapter 9). Soil disposal may also require stockpile sampling (Chapter 8).

Follow other government requirements for your project

Model remedies are not exempt from local, state, or federal laws. Therefore, implementation must comply with all applicable procedural and substantive requirements, including any necessary permits. The information in this chapter involving government requirements serves as general guidelines but is by no means comprehensive. Additional information can be found at the Governor's Office for Regulatory Innovation and Assistance.

The information below is provided for example purposes only. Some provisions may not apply to your cleanup action, while additional requirements to those below may apply. Therefore, anyone considering one of the model remedies in this document should consult Ecology and other government entities (city or county authorities) to ensure compliance with all required permits, notifications, and other requirements.

State Environmental Policy Act (SEPA)

SEPA (RCW 43.21C, Chapter 197-11 WAC, and the SEPA procedures found in Chapter 173-802 WAC[14]) is intended to ensure that state and local government officials consider environmental values when making decisions. The SEPA process is triggered whenever a local or state permit is required to conduct the cleanup. It begins by completing a SEPA Environmental Checklist and submitting it to the "lead agency" (usually the county or city where the property is located). The lead agency will use the checklist to decide whether the cleanup action is likely to cause a significant adverse impact to the environment. The SEPA Environmental Checklist form can be found in WAC 197-11-960[15]. Information on how to use the checklist can be found in WAC 197-11-315[16] and 330[17].

Grade and fill permit

Most local governments require a grade and fill permit for larger excavations. Prior to conducting a cleanup, contact the city or county development permitting department with jurisdiction for the area to determine if a permit is required.

Demolition permit

If the cleanup requires the demolition of a building or other structure, a permit will likely be needed from the local government. Contact the city or county development permitting department for additional information.

Electrical permit

[14] https://apps.leg.wa.gov/WAC/default.aspx?cite=173-802&full=true
[15] https://apps.leg.wa.gov/WAC/default.aspx?cite=197-11
[16] https://apps.leg.wa.gov/WAC/default.aspx?cite=197-11
[17] https://apps.leg.wa.gov/WAC/default.aspx?cite=197-11

If the cleanup involves changes to electrical systems, an electrical permit will often be necessary. Many smaller jurisdictions rely on L&I[18] for electrical permitting and inspections. Contact the city or county development permitting department for additional information.

Construction stormwater general permit (CSWGP)

Construction site operators are required to obtain a CSWGP (also known as a general permit) if:

1. Clearing, grading, and excavating activities are disturbing one or more acres; and
2. Stormwater will or may be discharged to surface waters of the state.

Construction activity that Ecology has determined to be a significant contributor of pollutants to waters of the state, and construction activity that has a reasonable expectation to cause a violation of any water quality standard, also require a CSWGP. CSWGPs typically apply only to situations where runoff does not contact contaminated soil or groundwater. Further information on the CSWGP can be found on Ecology's Construction Stormwater General Permit web pages[19].

Contaminated sites may not be eligible for a CSWGP if the stormwater and/or dewatering discharge from the construction site have the potential to violate water quality standards. In these situations, contact Ecology's Water Quality Program[20] for direction on the applicable permit submittal requirements and permitting options. Permitting options include individual permits and/or site-specific companion orders to a CSWGP.

Air emissions

Excavating petroleum-contaminated soils may trigger regulatory requirements related to volatile emissions, diesel equipment emissions, and dust. Although using local construction equipment and dust controls (such as wetting or covering exposed soils during construction) should limit diesel emissions and airborne particulates, contact the local authority to determine if any additional requirements apply.

Ecology notes that dust control should take place during any remedial activities that could results in soils with elevated arsenic and lead concentrations being suspended in the air as dust.

Noise ordinance requirements

[18] https://www.lni.wa.gov/
[19] http://www.ecology.wa.gov/programs/wq/stormwater/construction/
[20] https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Stormwater-general-permits/Construction-stormwater-permit#contact

Construction activities must comply with the local and state environmental noise standards (Chapter 173-60 WAC[21]). Contact the city or county development permitting department for additional information.

Minimum standards for constructing and maintaining wells

Groundwater monitoring wells that will be installed or removed as part of excavation activities must be constructed or decommissioned in accordance with Chapter 173-160 WAC[22].

Utility locating

Mark excavation locations with white paint and notify underground utility service providers by calling 811 or 800-424-5555. Notification to the utility locate service must be made not less than two business days and not more than 10 business days before the excavation.

Failure to provide notification can result in significant penalties. Owners and operators may also want to contract a private utility locating service to mark areas within their facilities that will not be addressed by the one-call service.

Reporting to Ecology

Under MTCA, when contamination is discovered, it must be reported to Ecology within 90 days of discovery. MTCA allows for Independent Cleanup of contaminated sites; however, Ecology should be notified when site characterization and cleanup work is done.

Once remedial work has been completed, compile the site characterization results, and describe the cleanup work in a remedial action report and submit it to Ecology. This report must provide adequate information to document that the selected model remedy meets the applicable cleanup standards, or that structures prevented complete removal of the contaminated soil.

For sites enrolled within the Voluntary Cleanup Program (VCP), the remedial action report needs to follow the format and requirements in Chapter 5 of *Guidelines for Property Cleanups under the Voluntary Cleanup Program* (Ecology 2015). In addition, electronic data must be submitted compatible with Ecology's EIM data management system. Indicate in the cover letter transmitting a remedial action report that an Ecology-approved model remedy was used so it is clear that a feasibility study, disproportionate cost analysis, and a review fee are not required.

Based on the selected model remedy, environmental covenants or other institutional controls may be necessary to help ensure the remedy remains protective of human health and the environment over the long-term. Institutional control options are discussed in Chapter 10. If an

[21] http://apps.leg.wa.gov/WAC/default.aspx?cite=173-60
[22] https://apps.leg.wa.gov/WAC/default.aspx?cite=173-160

environmental covenant is used, it must be filed with the Register of Deeds in the county where the site is located. The environmental covenant must meet all applicable requirements in WAC 173-340-440[23], and a copy of the draft restriction must be included in the final remedial action report. Under TCP Procedures is *Procedure 440A: Establishing Environmental Covenants under the Model Toxics Control Act*[24] (Ecology 2016). Document the impediments encountered and estimate the amount of contaminated soil remaining in the final remedial action report. Institutional controls are discussed further in Chapter 10.

For more information, visit Ecology's Toxics Cleanup Program (TCP) Policies and guidance for site cleanups web page[25].

Option to Pursue a No Further Action (NFA) determination

Property owners following the independent cleanup process who are interested in pursuing an NFA determination have two options detailed below:

NFA through initial investigation: If you are able to complete your cleanup within 210 days of initially sampling your property, you may be eligible for a NFA determination through Ecology's initial investigation process. Final cleanup documents must be submitted to Ecology within this timeframe. If the cleanup is conducted in accordance with a model remedy, no additional action may be required.

NFA through VCP review: You must apply to enter the VCP, including completing the application form and agreement. Indicate in Part 1 of the application form that you are requesting a no further action determination. While you aren't required to request an NFA for independent cleanups, the fees are waived when a model remedy is the remedial option. Therefore, Ecology encourages you to request an NFA after completing work. The procedures for submitting an NFA request are in Chapter 5 of *Guidelines for Property Cleanups under the Voluntary Cleanup Program*.[26] Ecology has checklists to help identify the information to provide when requesting our opinion. These documents are available on Ecology's Working with the Voluntary Cleanup Program webpage.[27]

For sites where Ecology oversight is being provided under an agreed order or consent decree, cleanup actions must be documented following the requirements in those legal agreements.

[23] https://apps.leg.wa.gov/WAC/default.aspx?cite=173-340-440
[24] https://apps.ecology.wa.gov/publications/SummaryPages/1509054.html
[25] https://ecology.wa.gov/Regulations-Permits/Plans-policies/Toxics-cleanup-policies
[26] https://apps.ecology.wa.gov/publications/summarypages/0809044.html
[27] https://ecology.wa.gov/Spills-Cleanup/Contamination-cleanup/Voluntary-Cleanup-Program/Working-with-VCP#RequestingOpinions

Chapter 3: Model Remedy 1 – Excavation and Removal

Purpose

The purpose of Model Remedy 1 is to permanently clean up any level of arsenic or lead contamination on your property by excavating soils, properly disposing of them at a landfill, and backfilling with uncontaminated soils if necessary.

Important: Excavation and removal is permanent to the maximum extent practicable. It does not require institutional controls or long-term monitoring and maintenance. Development also presents a chance to remove all contaminated soil during grading.

Things to consider

There are costs with removal, proper landfill disposal, and bringing in clean fill. However, there are no long-term costs for maintenance and monitoring because the remedy is permanent. Estimate costs using the worksheet at the end of the chapter.

Table 5: Pros and cons of excavating and removing contamination.

Pros	Cons
Only permanent remedy for sites with high levels of arsenic and lead	May require a waste disposal authorization for landfill disposal
Works for all levels of arsenic or lead soil contamination	Can be expensive to transport and dispose of soils and import new soil
No need for institutional controls	Requires sampling for disposal and for importing new soils
	Requires extensive confirmation sampling to make sure cleanup goals have been achieved

Excavation and disposal process

A worksheet to help plan the excavation and removal process is in **Appendix C (Worksheet 1: Planning for Excavation and Removal),** and a form to document the excavation and removal process is in **Appendix B (Form 3: Excavation and Removal).** The general steps are as follows:

1. **Determine your excavation area.** Excavate areas you do not plan to clean up using other methods. Make sure you have sufficiently narrowed down your decision units. Ample sampling can help you eliminate areas that already meet state cleanup levels for arsenic and lead.

2. **Prevent contaminated soils and dust from leaving the site.** Control dust on the worksite during dry months by watering down the soil.

   If you are storing soil until it can be disposed, cover it to prevent runoff. Install proper erosion-control devices to prevent contaminated soil from leaving the project area.

   a) You will need to apply for coverage under the CSWGP[28] if you disturb one or more acres. There may be additional local stormwater control requirements.
   b) If possible, trucks should avoid driving through contaminated soils. Tightly cover truck beds transporting contaminated soil and rinse their wheels to prevent contaminated soil from leaving the worksite. Use quarry spall at entrance.

3. **Plan to protect workers.** L&I regulates health and safety at worksites. Employers must comply with all workplace safety rules on toxic exposures, including:

   - Arsenic, Chapter 296-848, WAC
   - Lead, Chapter 296-62, WAC
   - Hazardous Waste Operations, Chapter 296-843, WAC

   For help understanding and complying with these rules, please contact L&I Safety & Health at 1-800-423-7233.

4. **Excavate and test soils before disposal.** For properties or decision units with arsenic or lead above state cleanup levels, all soil, sod, and duff must be disposed at a permitted landfill.
   a) Use stockpile sampling (Chapter 8) to determine your arsenic and lead levels. This information or a toxicity characteristic leaching procedure may be required for a Waste Disposal Authorization or to dispose of soils in a private landfill.
   b) If you are loading material directly into transport for disposal, you may also be able to use characterization sampling results. The highest sample concentrations from the area to be excavated should be used for disposal determination.
   c) For more information about waste disposal, contact your local health authority.

5. **Take compliance samples after excavation is complete.** Soils from 0–6 inches below the excavated surface should have average arsenic at or below 20 ppm and average lead at or below 250 ppm. If not, excavate further. Chapter 7 describes how to take compliance samples.

6. **Backfill the excavated areas with clean soil if needed.** Before you purchase soil, check with the supplier to ensure the soil has ≤ 20 ppm arsenic and ≤ 250 ppm lead.

[28] http://www.ecology.wa.gov/programs/wq/stormwater/construction/

Some questions to ask your supplier include:

a) Where does this soil come from?
b) Is it blended with compost or additives? If so, where do they come from?
c) Has it been tested for chemical contamination?
d) Will the soil support sod, vegetation, etc.?
e) If you are unsure of whether these soils meet state cleanup levels, use imported soils sampling (Chapter 9) or ask the supplier to sample. If you are planning to use onsite soils to backfill, do stockpile sampling to make sure they won't re-contaminate the excavated area.

Chapter 4: Model Remedy 2 – Mixing

Purpose

The purpose of Model Remedy 2 is to permanently clean up soils with relatively low levels of contamination. **Note:** this remedy is rarely successful with average concentrations of arsenic > 40 ppm (or average lead > 500 ppm), or if elevated concentrations of arsenic or lead are found at depth.

For example, even with 40 ppm arsenic and 500 ppm lead in the top 12 inches, the next 12 inches would need to have arsenic and lead concentrations of 0 ppm to pass, which is often not attainable because of naturally occurring arsenic and lead levels in soils. Meaning, it is quite possible to mix the soils yet still fail the cleanup levels in the remedy (20 ppm arsenic and 250 ppm lead) unless the characterization and mixing calculations indicate a high probability of success.

Mix contaminated soils or duff with clean imported soils or clean soils underneath the contaminated surface soils. Soil and duff can be mixed in place, or piled into rows, mixed, and spread back out. Mixing is only recommended for areas with average arsenic ≤ 40 ppm and average lead ≤ 500 ppm. Mixing effectiveness depends on how deep you mix, how deep contamination goes, the lead and arsenic concentrations in your 'clean' soil, and the efficiency of mixing equipment. Mixing frequently produces inconsistent results if not conducted with attention to detail. Diluting higher levels of arsenic or lead is impractical. If you want to dilute higher levels, you will need to conduct your own feasibility study including studies to demonstrate the effectiveness of mixing with higher levels of arsenic or lead. Keep in mind that clean soils have natural concentrations of lead and arsenic of at least 5–10 ppm.

At the completion of mixing, samples must be collected to the original depth of contaminated soil to demonstrate that the entire column of contaminated soil is now clean.

Things to consider

Table 6: Pros and cons of mixing contamination in with the soil.

Pros: Permanent Does not require excavation or off-site disposal Does not require institutional controls	Cons: Low remediation levels Only practical for contamination not deeper than 12 inches Higher sampling costs – a significant number of performance samples are needed to demonstrate sufficient mixing. Extra sampling may cause delays
Costs: Mixing can be labor-intensive. However, there are no long-term costs because the remedy is permanent. You also do not have the cost of soil disposal. Estimate costs using the worksheet at the end of the chapter.	

Characterization sampling helps to plan for mixing

Review your characterization sample results (Form 2) to make sure:

1. Average contaminant concentrations are < 40 ppm (arsenic) and < 500 ppm (lead) in the top 12 inches of soil; and

2. Arsenic and lead levels in deeper soils (12–18 inches and 18–24 inches) have low enough arsenic and lead concentrations to dilute the higher concentrated surficial soils, so that total contamination left on site is ≤ 20 ppm (arsenic) and ≤ 250 ppm (lead).

Use Worksheet 2 in Appendix C to calculate your mixing depth.

Mixing process

A worksheet to help plan the mixing process is in **Appendix C (Worksheet 2: Planning for Mixing)**; and a form to document the mixing process is in **Appendix B (Form 4: Mixing Process)**. Ecology has tested mixing methods on large areas of arsenic- and lead-contaminated soils in central Washington. However, there is no detailed guidance on how to use mixing as a cleanup method. There is some guesswork in knowing how much to mix soils, but compliance performance sampling (Chapter 7) will show if the cleanup level is met. These are the general steps:

1. **Determine your mixing area.** Only mix decision units with average arsenic ≤ 40 ppm (or lead ≤ 500 ppm).

2. **Calculate your mixing depth.** Use the worksheet at the end of this chapter to determine how deep to mix or how much clean soil to import.

3. **Prevent contaminated soils and dust from leaving the site.** Control dust on the worksite during dry months by watering down the soil. If you are storing soil until it can be mixed, cover it to prevent runoff. Install erosion-control devices to keep dirty water from leaving the project area. You will need to apply for coverage under the CSWGP[29] if you disturb one or more acres. There may be additional local stormwater control requirements.

4. **Plan to protect workers.** L&I regulates health and safety at worksites. For guidance on arsenic in soils, visit their worker protection standard web page.[30]

5. **Begin tilling or mixing.** Using the calculated depth from the worksheet, add the appropriate depth of soil or mix to that depth. There are three ways to mix:

   a. **Till soils in place** using several passes of the equipment, blending contaminated surface soils with cleaner, deeper soils. This may be difficult when rocks or roots are present in the soil.
   b. **Import clean soils as needed and** till them into contaminated soils (see Chapter 9).
   c. **Dig up contaminated surface soils and stockpile them.** Either import clean soils or dig up cleaner, deeper soils. Next, mix these soils on the land surface. Use stockpile sampling (Chapter 8) to know if soils are clean enough before spreading them back over the site.

6. **Test your soils.** Once an area is well mixed, take soil samples. Analyze the samples for arsenic and lead with an x-ray fluorescence (XRF) device (Table 7) or send them to a lab. Lab analysis may take weeks, but samples can be rushed in about 24 hours.

7. **Continue mixing as needed.** If arsenic or lead is still above state cleanup levels, continue mixing.

8. **Take compliance samples after mixing is complete (Chapter 7).** Take samples every six inches from the soil surface down to the deepest point you mixed (Table 7). If an XRF is used for this step, at least 10% of samples must be sent to a lab for analysis.

[29] http://www.ecology.wa.gov/programs/wq/stormwater/construction/
[30] https://lni.wa.gov/safety-health/safety-rules/rulemaking-stakeholder-information/sh-rules-stakeholder-worker-protection-standard#more-information-and-resources

Table 7: Example of soil profile before and after 24-inch mixing.

Before Mixing				
Depth of contamination before mixing	33 ppm 5 ppm	< Soil surface < 6-inch depth < 12-inch depth < 18-inch depth < 24-inch depth		Calculated mix depth
After mixing				
Depth of contamination after mixing	19 ppm	0-12 inch depth 12-24 inch depth		Total mixed depth The average arsenic in every 12-inch depth interval must be ≤ 20 ppm, and the average lead must be ≤ 250 ppm. No single arsenic concentration > 40 ppm and no single lead concentration > 500 ppm.

Chapter 5: Model Remedy 3 – Capping in Place

Purpose

The purpose of Model Remedy 3 is to cover contaminated soil in place with a soft or hard cap. The cap prevents exposure to contaminated soils on the property.

A hard cap is a building, parking lot, pavement, or driveway. A soft cap is a minimum depth of clean soil, compacted gravel, rock, or other non-organic material over a geotextile. Part of the soft cap can be landscaping material.

Remember to follow proper engineering practices and local, state, and federal regulations when installing soft and hard caps.

Things to consider

Table 8: Pros and cons of capping contamination in place.

Caps are effective with any concentration of arsenic and lead as long as they are maintained.	
Pros: Can be integrated into existing development plans. Does not require off-site disposal. Certain cap types can be used for any arsenic or lead level.	Cons: Not permanent; potential for exposure if the cap is removed. Soft caps can add elevation to the final grade. Long-term monitoring and maintenance needed. Requires institutional controls (See Chapter 10).
Costs: The up-front costs of capping in place can be lower, especially if integrated into existing development plans. However, there may be long-term monitoring and maintenance costs. Estimate costs using the worksheet at the end of the chapter.	

Soft caps

Soft caps must be a minimum settled thickness of 6 inches, not including grass. Four inches of mechanically compacted gravel is also acceptable. For designated children's play areas, a minimum of 12 inches of clean soil cap is required. Soft cap materials must meet state cleanup levels for arsenic and lead. Otherwise, you could re-contaminate the property. Review imported soils sampling (Chapter 9) or ask the supplier to sample.

Figure 2. Illustration of soil cover.

Meaningful questions should include inquiring where the soil came from, if it has additives, and if it will support vegetation.

Landscaping materials

Figure 3: Illustration of landscaping materials.

A cap can consist of materials other than soil. Rock, gravel, and sand may be used as a cap like soil. If organic material is to be used, such as bark or mulch, it must be underlain by a 3-inch layer of compacted soil, gravel, or rock. The overall cap thickness including organic material must be a minimum of 6 inches. Organic material should not be used in high traffic areas. Gravel or rock is the preferred material for pathways and trails. If gravel is selected as a cap material and it is mechanically compacted, only 4 inches of cover is required. The homeowner should be informed that they are expected to inspect and maintain the soft cap, but it will not be inspected by Ecology.

Marker material

Figure 4: Illustration of marker material.

A durable marker material is necessary to indicate that soil beneath it is still contaminated and that it needs maintenance when it becomes exposed. Use a bright color to warn future property users. The marker also reduces the chance of capped soils from being brought to the surface by animals. Check with your supplier to make sure the marker material is not bio-degradable and durable enough to last underground. Consult with Ecology to confirm that your choice of material is acceptable. If a minimum of 18 inches of clean soil is used as a cap, marker material is not necessary.

Hard caps

Figure 5: Illustration of hard cap material.

Hard caps are most cost-effective when they are part of the original development plan, such as a building or driveway. But hard caps are encouraged for use wherever possible, as they are durable and highly effective at preventing exposure. Hard caps include building footprints, asphalt, gravel, or any other permanent surface approved by Ecology.

Capping process

A worksheet to help plan the capping in place process is in **Appendix C (Worksheet 3: Planning for Capping in Place);** and a form to document the capping in place process can be found in **Appendix B (Form 5: Capping in Place).** These are the general steps:

1. **Determine the capping area.** Use more sampling to narrow down the area.
2. **Pick a cap type.** Most developments use a combination of hard caps, such as buildings and paved areas, and soil caps for landscaped areas.

3. **Prevent contaminated soils and dust from leaving the site.** Control dust on the worksite during dry months by watering down the soil. Install proper erosion-control devices to prevent dirty water from leaving the project area.

   You will need to apply for coverage under the CSWGP[31] if you disturb one or more acres. There may also be additional local stormwater control requirements.

4. **Plan to protect workers.** L&I regulates health and safety at worksites. For guidance on arsenic in soils, visit their worker protection standard web page.[32]

5. **Build the cap.** Use enough materials to create the necessary cap depth. Make sure it covers the contaminated area.

6. **File an environmental covenant or alternative institutional control.** This warns future property owners that contamination remains on the property. It also restricts uses that would damage the cap and sets an inspection schedule and cap maintenance instructions. Alternative notification mechanisms may be accepted if approved by Ecology. See Chapter 10 for more information.

[31] http://www.ecology.wa.gov/programs/wq/stormwater/construction/
[32] https://lni.wa.gov/safety-health/safety-rules/rulemaking-stakeholder-information/sh-rules-stakeholder-worker-protection-standard#more-information-and-resources

Chapter 6: Model Remedy 4 – Consolidation and Capping

Purpose

The purpose of Model Remedy 4 is to dig out contaminated soils, consolidate them in one place, and cover them with a soft (soil) or hard cap. The consolidation reduces the footprint of contamination on the property, and the cap prevents exposure.

A hard cap is a building, parking lot, pavement, or driveway. A soft (soil) cap is a certain depth of clean soil material placed over a geotextile layer. Part of that soil cap can be landscaping material. Detailed capping information is available in Chapter 3.

Things to consider

Table 9: Pros and cons of consolidating and capping contamination.

Consolidation and capping are effective with any concentration of arsenic and lead as long as they are maintained.	
Pros: Can be integrated into existing development plans. Does not require off-site disposal. Confines contamination to a smaller footprint on the property. Can be used for high arsenic and lead levels.	Cons: Not permanent; potential for exposure if the cap is removed. Soft caps can add elevation to final grade. Long-term monitoring and maintenance needed. Requires environmental covenant. Excavated soils may not be suitable as subgrade for pavement or buildings.
Costs: The up-front costs of consolidation and capping can be lower, especially if integrated into existing development plans. There are long-term monitoring and maintenance costs. Estimate costs using the worksheet at the end of the chapter.	

Process for consolidation and capping

A worksheet to help plan the consolidation and capping process is in **Appendix C (Worksheet 4: Planning for Consolidation and Capping),** and a form to document the consolidation and capping process is in **Appendix B (Form 6: Consolidation and Capping).** These are the general steps:

1. **Determine the capping area.** Use additional sampling to narrow down the area that needs to be capped. Contaminated soil cannot be consolidated where stormwater infiltration will occur.
2. **Pick a cap type.** Many developments can use a combination of hard caps (buildings and paved areas) and soil caps (landscaped areas).

3. **Prevent contaminated soils and dust from leaving the site.** Control dust on the worksite during dry months by watering down the soil. Install proper erosion-control devices to prevent dirty water from leaving the project area. You will need to apply for coverage under the CSWGP[33] if you disturb one or more acres. There may be additional local stormwater control requirements.

4. **Plan to protect workers.** L&I regulates health and safety at worksites. For guidance on arsenic in soils, visit their worker protection standard web page.[34]

5. **Take contaminated soils from the entire decision unit.** Use the worksheet in this chapter to help determine your excavation depth.

6. **Take compliance samples after excavation is complete.** Soils from 0–6 inches below the excavated surface should have average arsenic ≤ 20 ppm and average lead ≤ 250 ppm. No individual sample should be > 40 ppm for arsenic and > 500 ppm for lead. Chapter 7 describes how to take compliance samples.

7. **Consolidate the soils.** Carefully transport excavated soils to the area where they will be capped. These soils can contaminate other parts of the property if they escape during transport.

8. **Build the cap.** Use enough materials to create the required 6-inch cap depth as described in Chapter 5. Make sure it covers the contaminated area. Sample any imported soils as described in Chapter 9, to make sure the cap material is not contaminated.

7. **File an environmental covenant or alternative institutional control.** This warns future property owners that contamination remains on the property. It also restricts uses that would damage the cap and sets an inspection schedule and cap maintenance instructions. Alternative notification mechanisms may be accepted if approved by Ecology. See Chapter 10 for more information.

[33] http://www.ecology.wa.gov/programs/wq/stormwater/construction/
[34] https://lni.wa.gov/safety-health/safety-rules/rulemaking-stakeholder-information/sh-rules-stakeholder-worker-protection-standard#more-information-and-resources

Chapter 7: Performance Compliance Sampling

Purpose

Performance compliance sampling determines if excavation or mixing worked and is protective. Samples must meet state cleanup levels for arsenic and lead, except where residual contamination is contained under a cap.

When to do compliance sampling

- Excavation and removal – After excavation and before backfilling.
- Mixing – After mixing is complete.
- Consolidation and capping – After excavation and before backfilling.

Sampling area

Use **Appendix B (Form 7: Compliance Sampling)** to record the sampling area, sample numbers, and locations. You may treat contiguous decision units that use the same cleanup remedy as one unit for compliance sampling (Figure 7).

However, you may want compliance sample results for different parts of the property. For example, if you plan to sell certain parcels, purchasers may wish to see compliance results for their parcel. In this case, determine the sampling area and number and location of samples for each area. Attach a separate diagram for each.

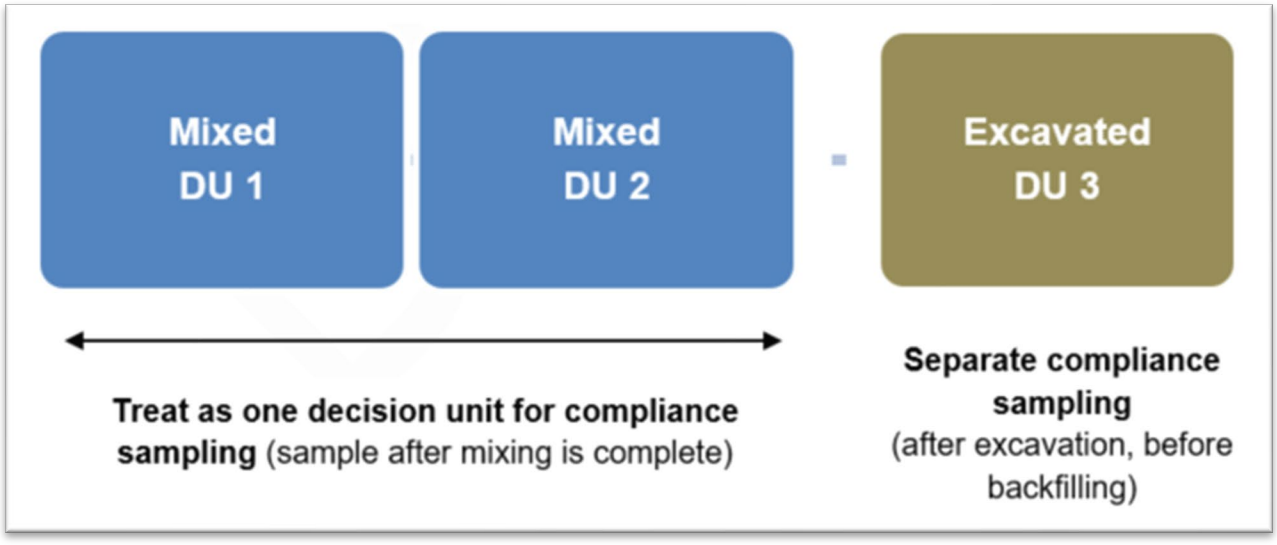


Figure 6: Combining decision units for compliance sampling.
DU = decision unit

Table 10: Minimum number of compliance sample locations per decision unit.

Sampling area in acres	Number of Samples
0.25	4
1	10
5	20
10	30
20	40
100	60
>100	60 + 1 per 5 acres

When to sample

Collect compliance samples once all excavating and mixing of soil is complete. If grading is still planned to get final grade, compliance samples should be taken at final grade.

If there is a stormwater infiltration pond, either temporary or permanent, compliance samples from the infiltration area must be taken as part of the compliance sampling. One sample should be taken at the mid-elevation of each of four sidewalls and two samples should be taken from the bottom of the infiltration area. Samples to determine appropriate disposal should be taken from any of the material excavated from the infiltration pond if you intend to export it off of your property.

Number of samples and sampling grid

Use Table 10 to find the number of sample locations.

Next, attach a diagram showing cleaned up areas of the property, and the location of buildings or paved areas, which are not included in compliance sampling. For each decision unit, lay out sample points in an evenly spaced grid. Use the number of locations from Table 3. Grid points should cover as much area as possible. Adjust the grid or add locations to make it fit. All samples are **discrete**, which means the soils for one sample come from a single sampling location.

Sample depth

Excavated soils

Take compliance samples from the remaining soil surface after excavating contaminated soil. Do this for every sampling location.

Mixed soils

For areas where soils have been mixed, at **every sample location**, take samples from the entire depth profile that has been mixed, at six-inch intervals. For example, if you mixed to a depth of 18 inches, you need to sample three depths: 0–6, 6–12, and 12–18 inches below the finished surface at **each sampling location**.

Sampling by X-ray fluorescence detector

Compliance sampling can be conducted by XRF, however 10% of samples should be submitted for laboratory analysis. XRF analysis should only be performed by someone trained in the safe operation and data extraction techniques of this equipment.

As described earlier, XRF analysis can be conducted without disturbing the soil to be analyzed. Surface soil can be carefully removed, exposing soil at the desired depth. The tip of the instrument can be placed directly in contact with the soil to be analyzed. Deeper soils can be quickly analyzed by excavating test pits to the desired depth and leaving an undisturbed sidewall for analysis. This allows quick analysis at highly accurate depths.

Sampling process

The compliance sampling process should be completed the same as characterization sampling for both XRF and laboratory samples (Chapter 1). Other sampling methods may be used when approved by Ecology (e.g., Multi-Incremental Sampling).

Understanding compliance results

Evaluate the compliance sample results to confirm that each decision unit meets state cleanup levels (box to the right). If arsenic or lead levels do not meet the state cleanup levels for any decision unit, you will have to take further action to clean up the soils:

Compliance results meet state cleanup levels if soil within each depth interval shows:

- Average arsenic ≤ 20 ppm
- Max arsenic ≤ 40 ppm
- Average lead ≤ 250 ppm
- Max lead ≤ 500 ppm

- **Excavate** at least six inches deeper and do compliance sampling again.
- **Mix** in more clean soil, or mix deeper.

When am I done?

Cleanup is complete when all excavated or mixed areas meet state cleanup levels for soil arsenic and lead. Make sure that you have a complete packet for Ecology, future property owners, and your own records. This packet should include:

- Characterization sampling lab report and chain of custody
- Forms 1 and 2 (characterization sampling)
- Form 7 (compliance sampling)
- Compliance sampling lab report and chain of custody
- One completed form for each cleanup method used for all decision units
- Maps documenting characterization and compliance sample locations and cleanup work
- For capping, consolidation and capping, or institutional controls, a copy of the environmental covenant filed at the County Auditor for the property

Next steps

Keep a copy of the forms you filled out to pass on to future property owners so they know cleanup was done and how to maintain any non-permanent remedies. Future property owners may want information if they sell the property. As awareness about the residual pesticide contamination grows, more buyers will ask about soil contamination.

Chapter 8: Stockpile Sampling

Purpose

As your project develops, you will save time and money be segregating clean soil and contaminated soil. When possible, all soil should be sampled prior to excavation and placed in clean and contaminated soil stockpiles. For soil leaving your property for disposal or reuse, it must be sampled prior to transport to confirm whether it meets state cleanup levels for arsenic and lead.

When to do stockpile sampling

- Sample soils after excavation but before transporting offsite. It may be required for a Waste Disposal Authorization (see note below right).
- Ensure soils mixed in stockpiles are clean enough to reuse onsite or for disposal.

Stockpile sampling is different from characterization sampling. You will be taking your samples from a pile of soil that you excavated and plan to dispose or reuse onsite as clean. The samples are "composite," meaning you are taking several subsamples and mixing them together for analysis. **Use Appendix B (Form 8: Stockpile Sampling)** to track your sampling.

Planning for sampling

Use the same equipment as in Chapter 3.

- Stainless-steel tools for digging sampling holes and removing soil
- Stainless-steel mixing bowl and spoon for compositing.
- Clean glass containers from the analytical lab
- Permanent marking pen to record sample locations on the jar
- Wash bucket, soap, scrub brush, and rinse water (distilled or deionized)
- Gloves and dust mask

Note on disposing soils: Check with the local health department's waste management staff about specific guidance for sampling and interpreting results.

They may be able to use results from characterization samples instead of re-sampling stockpiles.

Number of samples

Take composite samples from each stockpile. Table 11 shows how many samples you need to collect for a certain size stockpile. The number also depends on arsenic levels. Each composite should contain six subsamples that you mix into a single sample (Figure 7).

Table 11: Number of composite samples per stockpile.

Stockpile volume (cubic yards)	# of composites
<500	2
500-999	4
1,000 – 4,999	6
5,000 – 9,999	10
10,000 – 19,999	14
≥20,000	14 + 1 per 5,000 cubic yards

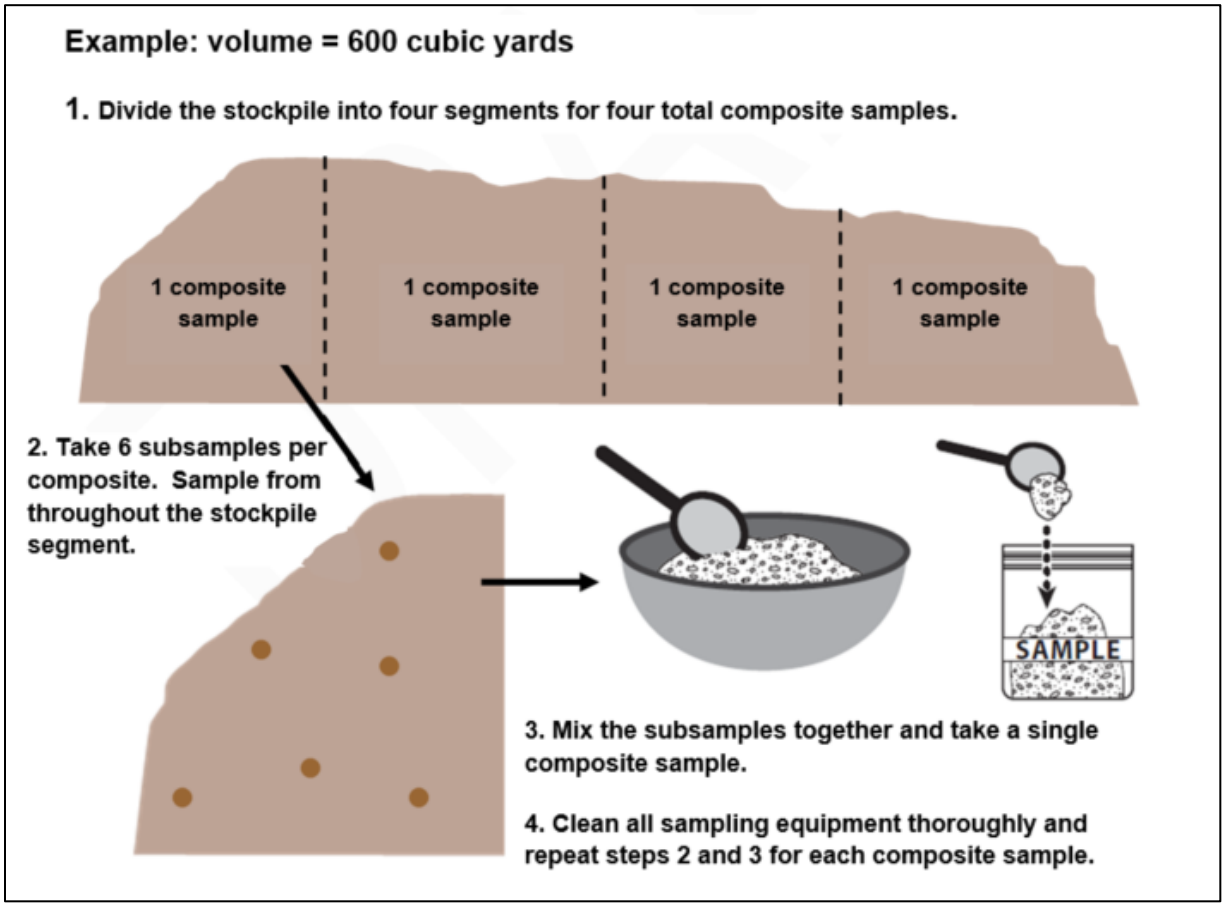


Figure 7: Stockpile sampling process.

Sampling process

1. Before taking any samples, contact an Ecology-accredited lab. For more information, see the Help Desk section of this guidance. The lab may have special instructions about labeling and delivering the samples to their labs.

2. Check the number of composites needed and divide your stockpile into that many sections. Plan to take one composite per segment, to have a good distribution throughout the stockpile (Figure 8).

3. Using the permanent marker, label the glass jars with:

    - The stockpile identifier
    - Composite number (you will take multiple composites per stockpile)
    - Your name
    - The date the sample is being taken
    - "Arsenic and lead"

For each composite sample, from each stockpile segment:

4. Divide your six subsamples evenly among surface samples, mid-depth samples, and deep samples. Make sure to collect samples from several different parts of the pile. Clean the trowel in the wash bucket and change the dirty water between samples.

5. Place all subsamples for a single composite into the stainless-steel bowl. It is important to mix the soil well. All subsamples should be the same size. Mix thoroughly with the stainless-steel spoon, fill up the sample jar with the mixture, and seal it securely. This is your composite sample for an individual segment.

6. Repeat the sampling process.

7. Between individual composite samples, scrub the bowl and spoon clean in the wash bucket, rinse, and pour the dirty water on the property where the sample was collected where it can soak into the ground. Do not pour dirty water down the storm drain.

8. List all of the composite soil samples in the sample inventory on Form 8.

Keep samples in a cool, dry place until their analysis. Bring the samples into the lab in person or follow the lab's instructions for shipping. Be sure to include a copy of the sample inventory sheet and the lab custody form provided by the lab with the samples. Keep copies for yourself.

Understanding your results

If any composite result is > 20 ppm for arsenic or > 250 ppm for lead, that segment must be properly disposed. If you want to reuse it on the property, you must cap it to meet model remedies requirements. If arsenic is ≤ 40 ppm, you can mix the contaminated stockpiles with clean soils and test to ensure that arsenic ends up ≤ 20 ppm.

Disposal

If you plan to dispose of these soils, check with your local health department's solid waste division about their requirements. A waste disposal authorization form may be needed.

Reusing soils on site as "clean" soils

For any stockpiles that do not exceed state cleanup standards, you may reuse the soils on the property.

Important: Transporting stockpiled soils offsite for use on another property, even if sampling shows they meet state cleanup levels, is not a model remedy and not advised, as it might violate local anti-degradation policies. Consider taking the soil to an inert waste facility or use it under pavement.

Chapter 9: Imported Soils Sampling

Purpose

To determine if imported soil meets state cleanup levels for arsenic and lead, or other contaminants.

When to do imported soils sampling

- When backfilling an excavation
- When mixing with existing soils to dilute contamination
- When creating a soil cap
- Bringing imported fill for construction projects, gardening, or landscaping projects

What contaminants to test for in imported soils

The potential contaminants in your import soil are dependent on the source. You may choose to purchase soil from a commercial supplier, or you may have your own source.
If you purchase soil, ask your supplier:

- Does the soil contain ≤ 20 ppm arsenic and ≤ 250 ppm lead?
- Where does this soil come from?
- Is it blended with compost or additives? If so, where do they come from?
- Has it been tested for chemical contamination?
- Will the soil support sod, vegetation, etc.?

If the supplier cannot answer these questions, you should strongly consider another source. At a minimum the soil should be sampled for arsenic and lead prior to purchase. If the source of the soil indicates the potential for other contaminants, sample for those contaminants prior to purchase.

If you have found your own source of soil, consider its location carefully. Steps to evaluate this source may include:

- Does the source location fall within the historic orchard footprint found on the Dirt Alert map on Ecology's website? If so, you should test this soil for arsenic and lead at a minimum. There is a high probability that this soil contains elevated concentrations of arsenic and lead, and you should likely find another source. The map is available here: Dirt Alert Map[35]

[35] https://apps.ecology.wa.gov/dirtalert/

- Is this soil from a native, undisturbed location? If that is the case, the likelihood of contamination is low. You may still wish to collect one composite sample and analyze for arsenic and lead. Native, undisturbed soils sources are the ideal choice.
- Is this soil from a quarry? Soil is often supplied from the fine material collected at a rock quarry. This material is not likely to contain contaminants but is also not likely to contain the nutrients required to support vegetation.
- Is this soil from a commercial or industrial location? Consider the activities conducted at the source location and analyze soil samples accordingly. For example, if there were storage tanks or other types of chemical storage located in the vicinity of your source, consider sampling for petroleum and other specific chemicals found at the site.

As with stockpile sampling in Chapter 8, **composite samples** are allowed when evaluating import soils. Use **Appendix B (Form 9: Imported Soils Sampling)** to track your sampling.

Number of composite samples

Use Table 11 from Chapter 8 to determine the appropriate number of composite samples from each stockpile of the imported soil source. Each composite should have three subsamples (Figure 8).

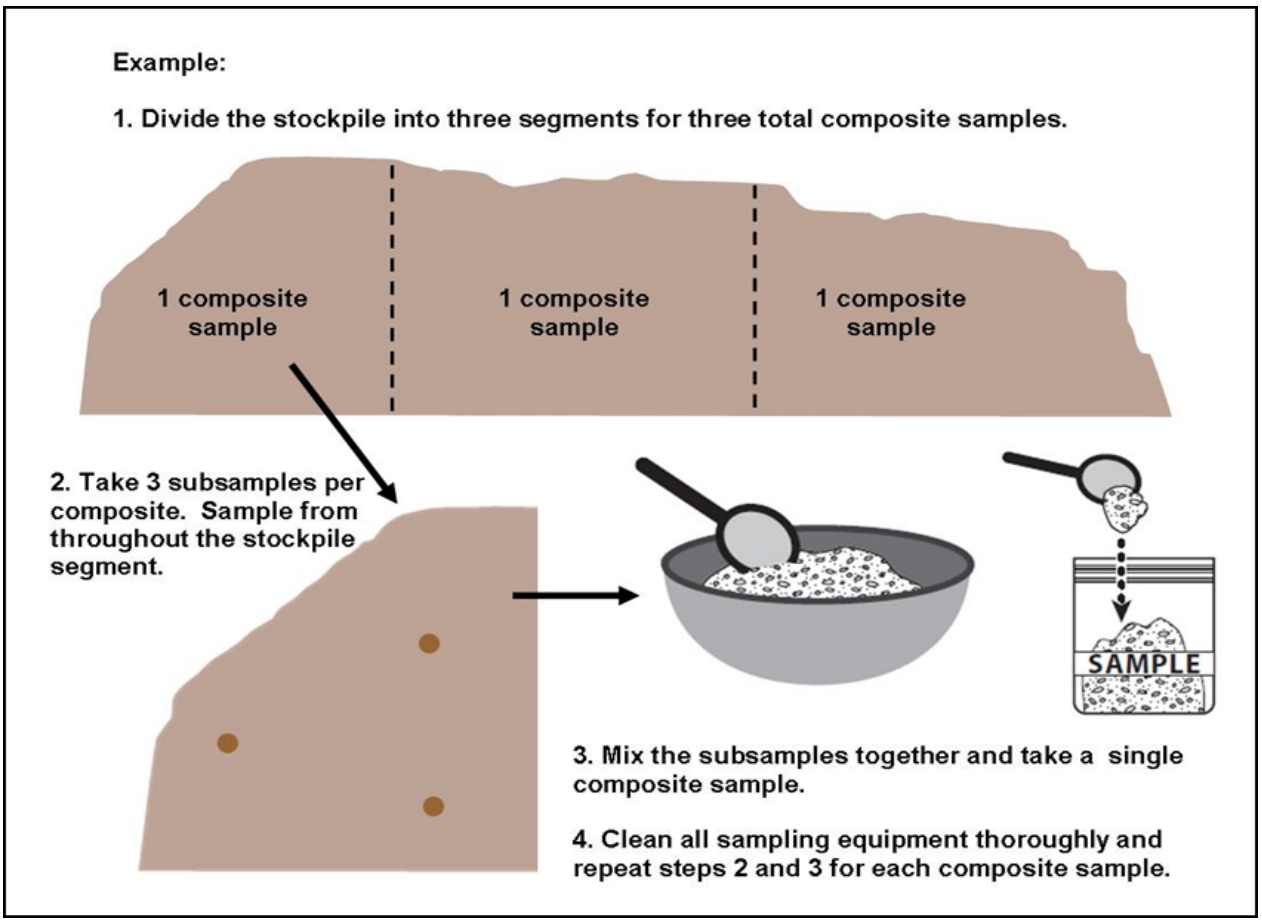


Figure 8: Imported soil sampling process (similar to stockpile sampling).

Sampling process

Use the same sampling process as in Chapter 8.

Understanding your results

On the inventory sheet, fill in each sample result. If any of the composite samples are > 20 ppm arsenic or > 250 ppm lead, the soil should not be used on the property.

Chapter 10: Environmental Covenants and Institutional Controls

Purpose

Institutional controls are required if contaminated soils remain on the property as part of the remedy. For the purpose of this model remedy, institutional controls are required for any cleanup remedy that caps contaminated soil on your property. Institutional controls are also required for any portion of your property that is not being cleaned up because it will remain exclusively in agricultural use or vacant. Institutional controls restrict activities in areas with remaining contamination and they inform future property owners about contamination left on the property. They may also provide direction for regular maintenance and inspection of capped areas. The traditional form of institutional control is an environmental covenant, but they can include any instrument that effectively limits disturbing capped areas and notifies all future landowners of the conditions found on your property.

Types of institutional controls

For the purposes of this model remedy, there are several types of institutional controls that are acceptable. The best option is a combination of those listed below.

Environmental covenant: an environmental covenant (EC) is the most effective institutional control available for this model remedy. An EC is a legal document that is recorded with your county. It is discovered during any property transaction during title searches, and therefore is very effective at communicating property conditions to future owners. Environmental covenants are the preferred institutional control for commercial properties using a capping remedy, but residential properties may consider other options listed below.

Covenants, Conditions and Restrictions (CCRs): CCRs are rules and limitations put on lots within developments. They are generally used in situations where there is a homeowner's association to monitor and enforce the limitations. They are not enforced by outside municipal authorities. For the purpose of this model remedy, they are a valuable notification tool. They are disclosed by title searches during property transactions and can effectively communicate property conditions to future owners. If CCRs are not going to be implemented for your project, this is not an option for implementing institutional controls.

Plat notes: Plat notes are restrictions and requirements written on the plat map for a property or subdivision. They are generally enforceable by the local planning authority. In theory they are discovered by a title search and disclosed during a property transaction, however an uneducated property buyer may not look at these notes in detail. This form of institutional control should be used in combination with other methods, such as CCRs.

Other methods: Ecology will consider other forms of institutional controls that limit cap disturbance and notify all future owners of property conditions.

What to include in your institutional controls

For whichever institutional controls are used for your property, the following information should be included:

- Location of remaining contamination, including maps
- Nature of remaining contamination, including sampling results
- How and when lessees, users, and future property owners will be notified
- Cap locations and dimensions
- Cap depth and materials used
- Inspection schedule and cap maintenance

How to prepare an environmental covenant

Prepare the environmental covenant using Ecology's template. Download the template by visiting the Publication Summary web page for "Toxics Cleanup Program Procedure 440A: Establishing Environmental Covenants under the Model Toxics Control Act"[36] (Publication 15-09-054) and clicking Microsoft Word format[37] in the View Now field.

Options for restricting access to capped areas

Access restrictions can help limit wear and tear on a cap through physical barriers or education. Physical barriers are fencing or plantings that discourage foot traffic or use of the area. If the development will have residents or regular users, they should receive educational materials about the remaining contamination. Posting signs or the use of fencing can also help protect a capped area.

For more about educational materials, visit Ecology's Dirt Alert[38] website.

[36] https://apps.ecology.wa.gov/publications/SummaryPages/1509054.html
[37] https://apps.ecology.wa.gov/publications/othersupplements/1509054other.docx
[38] https://ecology.wa.gov/Spills-Cleanup/Contamination-cleanup/Dirt-Alert-program

Help Desk

Selecting an analytical lab

Ecology's Laboratory Accreditation[39] website lists state-accredited labs that analyze soil. The lab must use methods 6010, 6020, or 6200 for arsenic and lead. Our website lists what methods each lab uses.

Labs can also be found in the Yellow Pages under "Laboratories-Analytical." You do not have to use a local lab, since many labs can work with you through the mail. Most labs should be able to provide results within three to four weeks. Costs vary.

When you talk to the lab, ask them the following questions:

- Can they screen the soil sample to 2 millimeters?
- Can they report the results on a dry weight basis?
- Will they provide a quality review of the data and a summary of the quality control results?
- How long will it take to get results?
- How much it will cost? (Typically, $30–60 per sample.)

Hiring and working with a consultant

Ecology has a guide for finding and hiring a consultant, *Hazardous Waste Cleanups: Selecting an Environmental Consulting Firm*.[40]

You may want to start the search by asking other companies in your industry (if applicable), environmental professional organizations, and banks for recommendations. Follow up with your own research. Environmental consultants are also listed in the Yellow Pages. Ask questions and get at least three different proposals and cost estimates.

Questions you may want to ask include:

- What is your firm's experience with soil sampling and related cleanup work? Request a list of completed projects and references.
- What work might be subcontracted? Request the names of their subcontractors and check their experience.

[39] https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Laboratory-Accreditation
[40] https://apps.ecology.wa.gov/publications/SummaryPages/FTCP92116.html

- What is your firm's experience with regulatory requirements?
- Which staff members will be assigned to my project? Ask for resumes, roles, and the project manager.
- Is your field staff trained in safety procedures required by the Washington Industrial Safety and Health Act (WISHA)?
- Does your firm and their subcontractors have environmental liability insurance?
- How will you plan to be cost-effective?

Ask each firm to prepare a proposal for the sampling work. The proposal should include a detailed approach and cost estimate by specific task. It may be difficult to provide specific estimates for future work because they will depend on the characterization sampling results.

Special situations: Rights of way, utility trenches, swales, small construction

For all projects, check if federal, state, or local land use permits are needed.

Rights of way

Some developments may include roadways that will eventually be owned and maintained by local government, a homeowner association, etc. If contaminated soils are consolidated under a roadway cap, the future owner must adhere to the restrictions in the covenant.

Utility trenches

Utility trenches are excavations. Typically, contamination will not extend deeper than the trench bottom. For deeper contamination, Ecology recommends further excavation and backfilling with clean soils to bring the trench to the correct depth. **Do not use contaminated soils to fill in the trench once utility lines are placed.** It will pose a risk to anyone working on the utility line in the future.

Stormwater swales

Areas planned for stormwater swales should have a permanent cleanup remedy—excavation or mixing. Contamination left in the swale could be carried into groundwater or run off.

Small structure construction (cell towers, pump stations, sheds)

It may not be practical to go through the full sampling and cleanup process when building small structures with minor soil disturbance. For example, a portion of a completely paved area is opened up to place a concrete pad or shed. At a minimum:

- Properly dispose of any soils coming from the property—stockpile sampling (Chapter 9) will be needed for a waste disposal authorization

- Follow L&I[41] worker safety regulations
- Ensure that the final construction covers any bare soil

Other situations

For situations not covered by this guidance, please call 509-454-7842 for Ecology's Area-Wide Contamination Project Manager.

Healthy actions to reduce exposure to contaminated soils

Anyone living on former orchard land, or working or playing in potentially contaminated soils, should follow a few simple actions:

- Wash hands after working or playing outside, and before eating
- Take off shoes at the door or use a doormat
- Damp dust, damp mop, and vacuum with a HEPA filter regularly
- Wear gloves when working in soil
- Wash fruits and vegetables well, peeling or scrubbing root vegetables
- Keep pets clean

For a full list of healthy actions, visit Healthy actions – protect yourself from arsenic and lead in dirt.[42]

[41] https://www.lni.wa.gov/
[42] https://ecology.wa.gov/Spills-Cleanup/Contamination-cleanup/Dirt-Alert-program/Healthy-actions

Literature Cited

Ecology. (2007b). *Interim Action Report: Orondo Elementary School. Orondo, WA.* Washington State Department of Ecology, Toxics Cleanup Program.

Ecology. (2007c). *Interim Action Report: Bridgeport School Site. Bridgeport, WA.* Facility/Site ID 724755. Washington State Department of Ecology, Toxics Cleanup Program.

Ecology. (2008). *Interim Action Report: Progress Elementary School. Spokane, WA.* Facility/Site 1740049. Washington State Department of Ecology, Toxics Cleanup Program.

Ecology. (2010). *Interim Action Report: Gilbert Elementary School. Yakima, WA.* Facility/Site ID 5154076. Washington State Department of Ecology, Toxics Cleanup Program.

Ecology. (2011a). *Interim Action Report: Hoover Elementary School. Yakima, WA.* Facility/Site ID 9465028. Washington State Department of Ecology, Toxics Cleanup Program.

Ecology. (2011b). *Interim Action Report: Barge-Lincoln Elementary School. Yakima, WA.* Facility/Site ID 5075703. Washington State Department of Ecology, Toxics Cleanup Program.

Ecology. (2012). *Asarco Tacoma Smelter Site. Final Interim Action Plan for the Tacoma Smelter Plume.* (Publication No. 12-09-086). Olympia, WA: Washington State Department of Ecology, Toxics Cleanup Program. Retrieved from: https://apps.ecology.wa.gov/publications/SummaryPages/1209086.html

Ecology. (2013). *Model Toxics Control Act regulation and statute: MTCA Cleanup Regulation Chapter 173-340 WAC, Model Toxics Control Act Chapter 70.105D RCW, Uniform Environmental Covenants Act Chapter 64.70 RCW*. (Publication No. 94-06). Olympia, WA: Washington State Department of Ecology, Toxics Cleanup Program. Retrieved from: https://apps.ecology.wa.gov/publications/summarypages/9406.html

Ecology. (2015). *Guidelines for property cleanups under the Voluntary Cleanup Program*. (Publication No. 08-09-044). Olympia, WA: Washington State Department of Ecology, Toxics Cleanup Program. Retrieved from: https://apps.ecology.wa.gov/publications/summarypages/0809044.html

Ecology. (2016). *Procedure 440A: Establishing Environmental Covenants under the Model Toxics Control Act.* (Publication No. 15-09-054). Olympia, WA: Washington State Department of Ecology, Toxics Cleanup Program. Retrieved from: https://apps.ecology.wa.gov/publications/SummaryPages/1509054.html

Ecology. (2017). *Model remedies for sites with petroleum impacts to groundwater* (Publication No. 16-09-057). Olympia, WA: Washington State Department of Ecology, Toxics Cleanup Program. Retrieved from: https://apps.ecology.wa.gov/publications/SummaryPages/1609057.html

Fulcrum Environmental Consulting. (2007a). *Hilltop Apartments Site: Remedial Actions Summary.* Wenatchee WA. Project Number 06-111. Fulcrum Environmental Consulting. Yakima, WA.

USEPA. (2021). Integrated Risk Information System. Chemical Assessment Summary: Arsenic. United States Environmental Protection Agency. National Center for Environmental Assessment. Retrieved from: https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0278_summary.pdf

Appendix A: Model Remedies

Development of a model remedy

MTCA regulations (WAC 173-340-390[43]) specify that Ecology must identify the circumstances under which application of a model remedy meets the requirements for selection of cleanup actions established under WAC 173-340-360.[44] If a site meets the requirements for using a model remedy, it is not necessary to conduct a feasibility study (WAC 173-340-350(8)[45]) or a disproportionate cost analysis (WAC 173-340-360(3)).

A feasibility study evaluates remedial technologies that may be appropriate for addressing contamination at a site. A disproportionate cost analysis compares more costly remedial actions against the most practicable permanent remedy to determine whether the increased costs are warranted. If the cost to implement the more aggressive remedy is significantly higher than the incremental increase in benefits achieved, then selecting the more costly remedy is not required.

Additionally, Ecology has the option to waive fees for the time spent reviewing NFA requests at cleanups that qualify for and appropriately use a model remedy. As a matter of policy, Ecology will not require a fee to review NFA requests for sites in the VCP if the selected remedy meets the specified criteria and implementation follows the provisions in this document.

Developing a model remedy includes the following elements:

- Requirements for characterizing a site;
- A description of how the model remedy meets the cleanup standards and remedy selection provisions in MTCA;
- Monitoring requirements; and
- Public notice and the opportunity to comment on the proposed model remedy and the conditions under which it may be used.

Purpose of a model remedy

The purpose of model remedies is to streamline and accelerate the selection of cleanup actions that protect human health and the environment, with a preference for permanent solutions to the maximum extent practicable.

[43] https://apps.leg.wa.gov/wac/default.aspx?cite=173-340-390
[44] https://apps.leg.wa.gov/wac/default.aspx?cite=173-340-360
[45] https://apps.leg.wa.gov/wac/default.aspx?cite=173-340-350

This document provides information to establish model remedies for cleanup at sites with arsenic and lead contamination due to legacy pesticide application, including: a) the eligibility criteria each project must meet, and b) a discussion of how the model remedies comply with the requirements of MTCA.

Before considering a model remedy, the following steps in the remedial process must have already been completed:

- A release to the environment has been confirmed;
- Ecology has been notified of the release;
- Emergency/interim actions have been implemented (if appropriate); and
- An adequate site characterization has been completed.

Model remedies are most appropriate for routine cleanup projects at lower risk sites and are generally more applicable to independent cleanups. This includes those seeking an NFA letter under the VCP or situations where the potentially liable person is implementing the cleanup with no Ecology oversight. However, these model remedies can also apply to Ecology-supervised cleanups.

Eligibility criteria for this model remedy

The following criteria apply to all model remedies identified in this document unless otherwise noted.

Geographic area

The model remedies in this document are applicable throughout the Central and Eastern regions of Washington State.

Release confirmation and Ecology notification

A release of arsenic and lead (due to legacy pesticide application) has been confirmed and Ecology notification of the release has been completed.

Affected media

These model remedies do not apply to properties with surface water immediately adjacent to soil with elevated concentrations of arsenic or lead, or with groundwater less than 5 feet below the ground surface. Soil cleanup levels are intended to address the direct contact exposure pathway. These model remedies do not apply to sites with contaminated soil below the water table.

After the selected remedy is implemented and adequate compliance monitoring is completed, the Method A soil cleanup levels cannot be exceeded beyond the source property. This will help ensure the potential for future impacts to other pathways is minimized.

Given the importance of conducting an adequate site characterization, Ecology strongly recommends selecting a consultant who has significant experience performing this type of work and is very familiar with the information in Chapter 1, "Soil Sampling" of this document.

Emergency/interim actions

These model remedies can be used if emergency or interim actions are not required due to the lower risk nature of the site, or if the necessary emergency/interim actions required by WAC 173-340-430[46] have already been implemented.

Terrestrial ecological evaluation

The site must: a) meet the criteria in WAC 173-340-7491[47] and therefore be excluded from a terrestrial ecological evaluation, or b) the simplified terrestrial ecological evaluation can be ended under WAC 173-340-7492.[48] There may be situations where a simplified terrestrial ecological evaluation results in adjusting the cleanup standards for certain compounds to meet the provisions in Table 749-2 of WAC 173-340-900.[49] Note: the model remedy will not apply when a site-specific terrestrial evaluation (WAC 173-340-7493) is required.

Remedy selection

The remedial action that will be used for site cleanup is source removal, including arsenic- and lead-contaminated soil excavation and removal to the maximum extent practicable.

How model remedies meet MTCA remedy selection and compliance monitoring requirements

All of the model remedies in this document provide for removing the contaminant source as well as the impacted soil to the maximum extent practicable so that:

1. The remaining soil meets the cleanup levels established in accordance with MTCA (either through excavation and removal or mixing); or

2. When hazardous substances remain on-site at concentrations exceeding cleanup levels, those hazardous substances will be capped in place or consolidated and capped to the maximum extent practicable where needed to minimize the potential for direct contact and migration of hazardous substances using engineered controls (such as containment).

[46] https://app.leg.wa.gov/wac/default.aspx?cite=173-340-430
[47] https://apps.leg.wa.gov/WAC/default.aspx?cite=173-340-7491
[48] https://apps.leg.wa.gov/WAC/default.aspx?cite=173-340-7492
[49] https://apps.leg.wa.gov/WAC/default.aspx?cite=173-340-900

Note: In cases with engineered controls (such as containment) or structural impediments, contaminated soil must be removed to the greatest degree practicable. In these situations, institutional controls (typically environmental covenants) that meet the provisions in WAC 173-340-440[50] must be implemented to ensure the remedy remains protective.

Ecology recommends that cleanup standards, including points of compliance, be developed as early as possible in the cleanup process, but no later than immediately following site characterization. When developing cleanup standards, use the provisions in:

- WAC 173-340-740[51] – Unrestricted land use soil cleanup standards; and
- WAC 173-340-745[52] – Soil cleanup standards for industrial properties; and
- WAC 173-340-750[53] – Cleanup standards to protect air quality.

The following discussion documents how the model remedies meet the minimum requirements found in WAC 173-340-360[54] and WAC 173-340-390.[55]

1. **Threshold Requirements:**

    a. *Protect human health and the environment.* Model remedies must comply with the appropriate cleanup standards as well as all applicable state and federal laws. Cleanups complying with these two threshold requirements are presumed to be protective of human health and the environment (WAC 173-340-702[56]).

    b. Comply with cleanup standards in WAC 173-340-700 to 760. All of the model remedies identified in this document require compliance with the soil and air quality standards in MTCA. Adequate characterization must be completed to document that the site has not impacted groundwater, surface water, or sediment.

        i. Model Remedy No. 1 is excavation and removal of the contamination (see Chapter 3). This remedy removes contaminated soil so cleanup standards are met at the point of compliance.

[50] https://apps.leg.wa.gov/wac/default.aspx?cite=173-340-440
[51] https://apps.leg.wa.gov/wac/default.aspx?cite=173-340-740
[52] https://apps.leg.wa.gov/wac/default.aspx?cite=173-340-745
[53] https://apps.leg.wa.gov/wac/default.aspx?cite=173-340-750
[54] https://apps.leg.wa.gov/wac/default.aspx?cite=173-340-360
[55] https://apps.leg.wa.gov/wac/default.aspx?cite=173-340-390
[56] https://apps.leg.wa.gov/wac/default.aspx?cite=173-340-702

ii. Model Remedy No. 2 is mixing of soils (see Chapter 4). This remedy mixes clean soil into the contamination until it is at or below 40 ppm (arsenic) and 500 ppm (lead) so cleanup standards are met at the point of compliance.

iii. Model Remedy No. 3 is capping in place (see Chapter 5). This remedy is where soils with hazardous substances above cleanup levels are contained. The cleanup action may be determined to comply with cleanup standards, provided the compliance monitoring program ensures the long-term integrity of the containment system, and other requirements for containment are met. This remedy requires an environmental covenant (see Chapter 10).

iv. Model Remedy No. 4 is consolidation and capping (see Chapter 6). This remedy is where contaminated soils are excavated, consolidated in one place, and covered with a soil or hard cap. The cleanup action may be determined to comply with cleanup standards, provided the compliance monitoring program is designed to ensure the long-term integrity of the containment system, and other requirements for containment are met. This remedy requires an environmental covenant (see Chapter 10).

c. Finally, the site characteristics must qualify the site for an exclusion from a terrestrial ecological evaluation, or the simplified terrestrial ecological evaluation can be ended under WAC 173-340-7492.[57]

d. *Comply with applicable state and federal laws.* Due to the lower risk nature of sites eligible to use model remedies, many state of federal laws will not be applicable. For example, releases from the site cannot have impacted sediments, and therefore requirements found in the Sediment Management Standards (Chapter 173-204 WAC[58]) will not be applicable. Although implementing any of these model remedies is unlikely to trigger compliance with an excessive number of state or federal laws, several laws will apply (for example, transporting and managing contaminated soil in accordance with the state's solid waste management rules). Conduct an evaluation to determine compliance with applicable state and federal laws.

e. *Provisions for compliance monitoring.* There are three types of compliance monitoring: 1) protection, 2) performance, and 3) conformational monitoring. Protection monitoring includes preparing a health and safety plan, which should be completed before implementing any model remedy.

[57] https://apps.leg.wa.gov/WAC/default.aspx?cite=173-340-7492
[58] https://apps.leg.wa.gov/WAC/default.aspx?cite=173-204

Due to the simplified nature of these types of cleanups, it is anticipated the discussion will typically be short and less detailed than for other sites. Performance and conformational monitoring can likely be combined and are necessary to: a) document that that applicable cleanup standards have been met, or b) to estimate the amount of contaminant mass that remains.

2. Other Requirements:

a. *Use a preference for permanent solutions to the maximum extent practicable.* A disproportionate cost analysis determines whether the selected remedy used permanent solutions to the maximum extent practicable. If the incremental increase in costs for an alternative remedy is disproportionate to the benefits achieved, then selection of the more costly remedy is not warranted. Model remedies are, by definition, exempt from the requirement to evaluate cleanup action alternatives by preparing a feasibility study and a disproportionate cost analysis.

To establish model remedies that meet the criterion of "a preference for permanent solutions to the maximum extent practicable," Ecology reviewed remedies proposed for arsenic and lead that include capping consistent with the proposal in this document:

- Asarco Tacoma Smelter Plume Site:
  - *Final Interim Action Plan for the Tacoma Smelter Plume* (Ecology, 2012).
- Progress Elementary School Site:
  - *Interim Action Report: Progress Elementary School. Spokane, WA* (Ecology, 2008).
- Hilltop Apartments Site:
  - *Hilltop Apartments Site Remedial Actions Summary. 1509 South Mission Street, Wenatchee, WA* (Fulcrum Environmental Consulting, 2007a).
- Hoover Elementary School Site:
  - *Interim Action Report: Hoover Elementary School. Yakima, WA* (Ecology 2011a).
- Orondo Elementary School Site:
  - *Interim Action Report: Orondo Elementary School. Orondo, WA* (Ecology, 2007b).
- Bridgeport School Site:
  - *Interim Action Report: Bridgeport School Site. Bridgeport, WA* (Ecology, 2007c).
- Gilbert Elementary School Site:
  - *Interim Action Report: Gilbert Elementary School. Yakima, WA* (Ecology 2010).

- Barge-Lincoln Elementary School Site:
    - *Interim Action Report: Barge-Lincoln Elementary School. Yakima, WA* (Ecology, 2011b).

If an engineered control or structural impediment precludes complete removal of all contaminated soil, an environmental covenant must be used with the remedy to reduce the overall risk and help ensure that the site remains protective over the long-term. As provided under WAC 173-340-420[59], Ecology will perform periodic reviews of sites where environmental covenants are required.

b. Provide for a reasonable restoration time frame. All of the model remedies are based on soil being the only media impacted by the release. Implementation of a soil removal remedy will limit the time frame needed to achieve compliance to the greatest degree practicable.

c. *Consideration of public concerns.* This guidance document was modified in response to feedback received during the public comment period.

[59] https://apps.leg.wa.gov/WAC/default.aspx?cite=173-340-420

Appendix B: Forms

Form 1: Characterization Sampling

Reminder: Keep a copy of the completed forms to pass on to future property owners.

Part 1: Determine your decision units

1. Total property size: _____ acres
2. Is the property in an area of arsenic > 100 ppm (see map on inside cover): Yes No
3. Check all that apply and identify decision units in any of these cases:
   - ☐ Property is > 0.25 acres
   - ☐ Property currently or historically had a mix of developed and undeveloped land
   - ☐ More than one type of land use is planned for the development
   - ☐ Parts of the property will be play areas, gardens, or other high-use areas
   - ☐ Property has geographic features, such as steep slopes or other unusable areas
   - ☐ Areas have forest duff that need separate sampling
4. On the next page in Table 1, list the decision units on your property and their size. Use Table 2 to determine the number of samples needed for each decision unit.

Part 2: Soil sample depth in upland areas

5. Complete Table 1 on the next page with the sample depths.
   - **At every location:** Take samples from the top 0–6 inches of soil, after clearing away grass, leaves, gravel, or debris on the surface (Figure 3)
   - **At every fourth location (25% of the samples):** Also take a sample from the 6–12 inch depth
   - **If you are sampling in natural areas:** At every location, take one soil sample at the following depths below ground surface: 0–6 inches , 6–12 inches, 12–24 inches, and 24–36 inches
   - **Areas where fill dirt or topsoil was added in the past:** At every fourth location, take a sample from the top 0-6 inches of the original land surface, if it is deeper than 12 inches
   - **If using mixing as a remedy:** At every fourth sample location, take a sample from the depth to which you will mix

Part 3: Overlay a sampling grid for each decision unit

6. Attach a diagram showing property dimensions and locations of decision units.
7. Attach a separate diagram for each decision unit, including dimensions, existing structures, and which structures will remain after development.

Table 1. Characterization sampling plan

Decision unit description (past use, planned use)	Acres/ft^2	# of samples	Sample depth/duff layer
1.			
2.			
3.			
4.			

Table 2. Number of sample locations per decision unit

Sampling area in acres	Final cover will be permeable	Final cover will be permanent and impermeable
0.25		
1		
5	20	
10	30	15
20	40	20
100	60	30
	60 + 1 per 5 acres	30 + 1 per 10 acres

*0.25 acres ~11,000 square feet

Form 2: Characterization Sampling Results

Reminder: Keep a copy of the completed forms to pass on to future property owners.

Completing the sample inventory

1. List the samples by decision unit in the inventory on the back of this page. Enter the depth of each sample. When sampling multiple depths at a single location, mark each depth as a separate sample number.

   Reminder: If you have duff, sample, and analyze that separately from the soil.
2. Record the date and time. Note any unusual observations (high soil disturbance, heavy rain, etc.) in the Comments column.
3. Complete the rest of the columns when you get the sampling results.

Determining if arsenic or lead is elevated

4. Calculate average arsenic and lead levels **for each sampling depth** and **each decision unit and** enter them on the inventory sheet. For each decision unit, circle the arsenic average that is > 20 ppm, or average lead that is > 250 ppm.* For decision units in natural areas, calculate average arsenic and lead for **each sampling location** in addition to calculating the averages for **each sampling depth**.
5. Circle every value where maximum arsenic is > 40 ppm and where maximum lead is > 500 ppm.
6. Attach a copy of your lab results and chain of custody.
7. For decision units with a circled value (maximum or average), note in the Comments column that cleanup is needed for that entire decision unit. See Chapter 2 to review options for cleaning up those decision units.

   If no decision units have elevated arsenic or lead, no cleanup is necessary. Because no cleanup is being done, you do not need to take any compliance samples. The characterization samples demonstrate that your soils meet state standards. Treat these results as compliance sampling results and read Chapter 7 for next steps.

* Milligrams per kilogram is equivalent to ppm.

Soil Characterization Sampling Inventory Sheet

Property address: Phone: Sampled by:						Testing parameters (ppm)			
DU no.	Sample no.	Soil depth/ duff	Date	Time	Comments	Arsenic	DU Avg. arsenic	Lead	DU Avg. lead

Form 3: Excavation and Removal

Reminder: Keep a copy of the completed forms to pass on to future property owners.

1. **List decision units being excavated:** **Depth**

_____ _____
_____ _____
_____ _____

2. **Prevent soils from escaping the site and plan for worker safety:**
   - ☐ Make a water source available for dust control
   - ☐ Install erosion-control devices
   - ☐ Cover trucks carrying contaminated soil
   - ☐ Set up rinsing area for truck wheels and quarry spall at the entrance
   - ☐ Follow Department of Labor & Industries worker safety regulations

3. **Record soil disposal information:**

Name of landfill facility: _____

Contact name and phone: _____

- ☐ Attached a copy of the Waste Disposal Authorization form

4. **Record the clean fill soil source:**
   - ☐ Off-site soils —Supplier: _____

     Supplier phone: _____
   - ☐ On-site soils

5. **Conduct stockpile sampling or imported soil sampling:**
   - ☐ Completed stockpile sampling for onsite soils and filled out Form 8
   - ☐ Completed imported soil sampling and filled out Form 9, or soils were certified to be clean by the supplier

6. **Conduct compliance sampling:**
   - ☐ Filled out Form 7
   - ☐ Attached a map showing areas excavated and the depth of excavation and performance sampling locations

Form 4: Mixing

Reminder: Keep a copy of the completed forms to pass on to future property owners.

1. List the decision units and mixing information for each one.

Decision unit	Area	Mixing depth

2. Prevent soils from escaping the site and plan for worker safety:

- ☐ Follow dust- and erosion-control practices
- ☐ Follow Department of Labor & Industries worker safety regulations

3. Record the type of mixing equipment used:: _____

4. Select the mixing method (check all that apply)**:**

- ☐ Mixing in place
- ☐ Mixing with imported soils
- ☐ Mixing on land surface and reusing

5. Conduct stockpile sampling before spreading or disposal:

- ☐ Filled out Form 8

6. **Conduct compliance sampling:**

- ☐ Filled out Form 7 (required for all mixed soils left on the property)
- ☐ Map showing performance sampling locations

Form 5: Capping in place

Reminder: Keep a copy of the completed forms to pass on to future property owners.

1. List the decision units and cap information for each one.

Decision unit	Type of cap	Cap depth	Geotextile used?

2. Prevent soils from escaping the site and plan for worker safety:

- ☐ Follow dust- and erosion-control practices
- ☐ Follow Department of Labor & Industries worker safety regulations

3. Record the soil source:

- ☐ Off-site soils —Supplier: _____

  Supplier phone: _____
- ☐ On-site soils

4. File the environmental covenant:

- ☐ Filed a deed notice with: _____ County

Recording number: _____

5. Compile the following attachments:

- ☐ Map showing areas with results above cleanup levels capped and any additional details about the cap a future property owner would need to know
- ☐ Maintenance and monitoring plan
- ☐ A copy of the environmental covenant

Form 6: Consolidation and capping

Reminder: Keep a copy of the completed forms to pass on to future property owners.

1. List the decision units and excavation and consolidation information for each one.

Decision unit	Excavation depth

2. Conduct compliance sampling after excavation.

- ☐ Filled out Form 7

3. Prevent soils from escaping the site and plan for worker safety:

- ☐ Follow dust- and erosion-control practices
- ☐ Follow Department of Labor & Industries worker safety regulations

4. Record cap information:

Cap type: _____ Cap depth: _____

- ☐ Used a geotextile barrier
- ☐ Attached a map showing both excavated and consolidated capped areas and included details about the cap a future property owner would need to know

5. Record the soil source:

- ☐ Off-site soils —Supplier: _____

  Supplier phone: _____
- ☐ On-site soils

6. File the environmental covenant:

- ☐ Filed a deed notice with: _____ County

  Recording number: _____

7. Compile the following attachments:

- ☐ Map showing areas with results above cleanup levels capped and any additional details about the cap a future property owner would need to know
- ☐ Maintenance and monitoring plan
- ☐ A copy of the environmental covenant

Form 7: Compliance sampling

Reminder: Keep a copy of the completed forms to pass on to future property owners.

1. **Record the total acreage for each of the following areas:**
   Excavated: _____acres
   Mixed: _____acres

Include only areas where soil is accessible for sampling (not paved or built over).

2. **Calculate the number of samples needed using Table 1: _____**

Table 1: Minimum number of compliance sample locations per decision unit

Sampling area in acres	Number of samples
0.25	4
1	10
5	20
10	30
20	40
100	60
≥100	60 + 1 per 5 acres

* 0.25 acres ~ 11,000 square feet

3. **Record sample depth.**
   Excavated areas = 0–6 inches
   Mixed areas = total mixing depth profile: _____
   Samples per sampling location: _____ (one per each 12-inch depth)

4. **Attach a property diagram with compliance sampling grid overlaid (see Chapter 7), showing which areas were cleaned up and the locations of paved or built areas.**

5. **Complete the sample inventory.**
   a) List the samples by decision unit on the Compliance Sampling Inventory (page 73). Enter the depth of each sample. When sampling multiple depths at a single location, mark each depth as a separate sample number.
   b) Next, fill in the date and time. Note any unusual observations (high soil disturbance, heavy rain, etc.) in the Comments column.
   c) Complete the rest of the columns when you get the sampling results.

6. Determine if arsenic or lead is elevated.

a) Calculate average arsenic and lead levels for the area sampled and enter them on the inventory sheet. For each decision unit where, average arsenic is > 20 ppm, or average lead is > 250 ppm, circle the average.*

b) Circle every value where maximum arsenic is > 40 ppm and where maximum lead is > 500 ppm.

c) Attach a copy of the lab results and chain of custody.

d) For each sampled area with a circled value (maximum or average), note in the Comments column that more cleanup is needed for that area. Return to Chapter 3 to review options for cleaning up those decision units. If no decision units have elevated arsenic or lead, read Chapter 8 for next steps.

Compliance Sampling Inventory

Property address: Phone: Sampled by:						Testing parameters (ppm)			
DU no.	Sample no.	Depth	Date	Time	Comments	Arsenic	Avg. arsenic	Lead	Avg. lead

Form 8: Stockpile sampling

Reminder: Keep a copy of the completed forms to pass on to future property owners.

Each composite should contain six subsamples mixed together. In Table 1, fill in the number of composite samples needed for each stockpile, based on its size (Table 2).

Table 1. Planning for stockpile sampling

Stockpile identifier	Stockpile volume	# of subsamples	# of composites
		6	
		6	
		6	
		6	

Table 2. Composites per stockpile

Stockpile volume (cubic yards)	# of composites (arsenic > 100 ppm)*	# of composites (arsenic < 100 ppm)*
< 500	2	2
500–999	4	4
1,000–4,999	8	6
5,000–9,999	14	10
10,000–19,999	20	14
> 20,000	+1 per 4,000 cubic yards	+1 per 5,000 cubic yards

*When removing soils from a property, refer to the map on the inside cover to find the estimated arsenic levels for the area the property is in.

1. **Complete the sample inventory.**
   a) List the composite samples by stockpile in the inventory on the next page.
   b) Fill in the date and time.
   c) Note any unusual observations in the Comments column.
   d) Complete the rest of the columns when you get the sampling results.

2. **Determine if arsenic or lead is elevated.**
   a) Mark each composite > 20 ppm arsenic or > 250 ppm lead. These segments cannot be reused on the property. See Chapter 8 for next steps.
   b) Attach a copy of the lab results and chain of custody.

Stockpile Sampling Inventory

Property address: Phone: Sampled by:					Testing parameters (ppm)	
Stockpile no.	Composite sample no.	Date	Time	Comments	Arsenic	Lead

Form 9: Imported soils sampling

Reminder: Keep a copy of the completed forms to pass on to future property owners.

Shorter projects: For projects lasting less than six months, collect one data set from the imported soil source. This should include three composites, with six subsamples in each composite.

Longer projects: If the project lasts longer than six months, collect a new set of three composites, with six subsamples in each composite, every six months.

New soil source: If the soil source changes, then collect a new set of three composites, with six subsamples in each composite.

1. Once you have the results from your three composite samples, enter the arsenic and lead levels into the table below.

2. Attach a copy of the lab results and chain of custody.

Do not import soils from the supplier if any composite sample is > 20 ppm arsenic or > 250 ppm lead.

Soil supplier name: Phone: Sampled by:				Testing parameters (ppm)	
Sample no.	Date	Time	Notes	Arsenic	Lead
1					
2					
3					
1					
2					
3					

Sampling and Cleanup Checklist

Characterization sampling

Form 1: Characterization Sampling

- ☐ Appropriate number of samples per decision unit (0–6 inch depth)
- ☐ 25 percent of samples from 6–12 inches
- ☐ Sediment samples at two depth intervals (if applicable)

Form 2: Characterization Sampling Results

- ☐ Maximum arsenic ≤ 40 ppm and average arsenic ≤ 20 ppm (stop here)
- ☐ Maximum arsenic > 40 ppm or average arsenic > 20 ppm (continue below)

Cleanup and compliance sampling

1. Excavation and removal
   - ☐ **Form 3** with cleanup map
   - ☐ **Form 7** with sampling grid map
   - ☐ **Form 8** stockpile sampling (if applicable)
   - ☐ **Form 9** imported soils (if applicable)

Compliance sample depth should be at least 6 inches.

2. Mixing
   - ☐ **Form 4** with cleanup map
   - ☐ Compliance sampling grid map

Take compliance samples every 6 inches throughout the mixing depth.

3. Capping in place
   - ☐ **Form 5**
   - ☐ Environmental covenant*

4. Consolidation and capping
   - ☐ **Form 6**
   - ☐ Environmental covenant*

To be protective, cap depth should meet the guidelines in chapters 5 or 6. Ensure future owners know to maintain the remedy by providing them with the sample results and cleanup information.

**The environmental covenant should describe remaining contamination and how to inspect and maintain the remedy.*

Appendix C: Worksheets

Worksheet 1: Planning for excavation and removal

1. Calculate soil removal depth by decision unit.

Remove enough soil to reach soils meeting state cleanup levels below the contaminated surface soils (Figure 6).

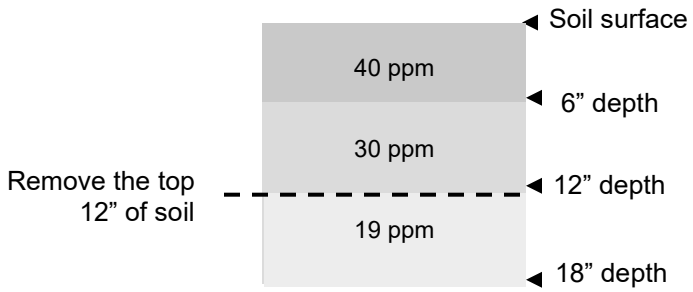


Figure 6. Example soil profile for arsenic

2. Calculate the volume of soil to be removed in cubic yards (yds^3) by decision unit (DU).

DU1 area _____ sq ft **x** removal depth _____ ft**/**27 = _____ yds^3

DU2 area _____ sq ft **x** removal depth _____ ft**/**27 = _____ yds^3

DU3 area _____ sq ft **x** removal depth _____ ft**/**27 = _____ yds^3

DU4 area _____ sq ft **x** removal depth _____ ft**/**27 = _____ yds^3

3. Calculate soil transport cost by volume.

_____ yds^3 (from step 1) x 1.5 tons/yds^3 x $_____ /ton = $_____

4. Select a municipal or private permitted landfill and call for waste disposal authorization fee information.

Landfill name: _____

Phone: (____) _____ Fee: $_____

5. Ask the permitted landfill or your local health department what type of sampling is required for soil disposal. It may require stockpile sampling (Chapter 8) or toxicity characteristic leaching procedure (TCLP) testing. This test determines if soil is safe for landfill disposal. Ask your lab if they can do TCLP, which typically costs $75–100.

Sampling or TCLP: $ _____

6. Calculate the soil disposal cost by volume.

_____tons of soil x $_____ /ton= $_____

7. Calculate the fill cost by volume: Use the excavated soil volume from step 1 as your backfill volume. To ensure you are not re-contaminating the property, check the soil quality with your supplier. Ask if they have any data on metals in their soils. If not, ask if they can sample for you (see Chapter 9).

_____ yds^3 fill x $_____ /cubic yd = $_____

8. Other costs: Estimate the labor and equipment costs of soil removal and backfilling. Also, think about the cost of compliance sampling (Chapter 7) and possible imported soil sampling (Chapter 9).

$_____

9. Total the costs:

3	Soil transport	$ _____
6	Soil disposal	+ $ _____
7	Backfill	+ $ _____
8	Other costs	+ $ _____
		= $ _____

Worksheet 2: Planning for mixing

Mixing depth examples

The following examples address arsenic contamination. For lead, use the same mixing depth calculations, with 250 ppm as the cleanup level.

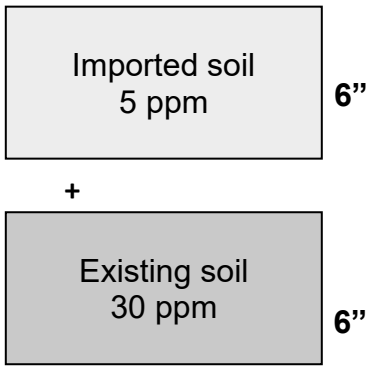
Importing soil to mix in

This example assumes some level of background arsenic in local soils. Don't bring contaminated soils onto the property—ask the supplier for soil sampling results or sample the soil prior to its arrival on-site. To calculate whether a certain depth of imported soils will dilute the contaminated soils, use the following equation:

$$\frac{\text{Imported soil arsenic x depth + existing soil arsenic x depth}}{\text{Imported depth + existing depth}}$$

(5 ppm x 6" + 30 ppm x 6")/(6"+6") = 210 ppm"/12" = **17.5 ppm**

→ 17.5 ppm meets the cleanup level of 20 ppm for arsenic.



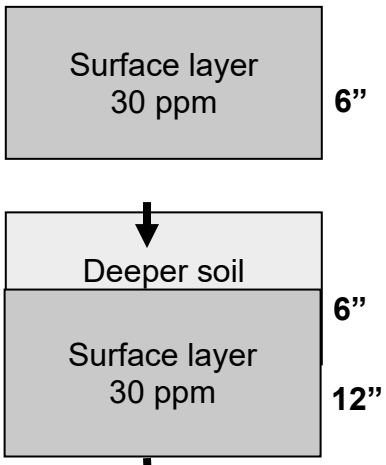
Mixing with deeper soils (undisturbed areas)

Undisturbed soils tend to have contamination mainly in the top 6 inches of soil. To calculate how deep to mix, use the following equation:

$$\frac{\text{Surface soil arsenic x depth + Deeper soil arsenic x depth}}{\text{Surface depth + deeper depth}}$$

(30 ppm x 6" + 5 ppm x 6")/(6"+6") = 210 ppm"/12" = **17.5 ppm**

→ 17.5 ppm meets the cleanup level of 20 ppm.



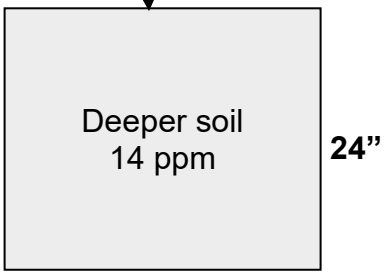
Mixing with deeper soils (disturbed areas)

Areas that have been graded, sloped, or otherwise disturbed may have higher levels in deeper soils. Characterization samples may be needed at 12–18 inches or deeper. This example uses characterization samples down to 36 inches. To calculate how deep to mix, use the following equation:

$$\frac{\text{Surface soil arsenic x depth + Deeper soil arsenic x depth}}{\text{Surface depth + deeper depth}}$$

(30 ppm x 12" + 14 ppm x 24")/(12"+24") = 696 ppm"/36" = **19.3 ppm**

→ 19.3 ppm meets the cleanup level of 20 ppm.



1. Calculate imported soil volume.

_____ ft mix depth **x** _____ ft^2 decision unit /27 = _____ yd^3 soil

2. Calculate imported soil cost.

Fill cost by volume. Check the soil quality with your supplier (Chapter 9).

_____ cubic yards of soil x $_____ /cubic yard = _____

3. Estimate equipment, soil sampling, and labor costs.

a. Describe soil type and mixing depth when asking about rental costs for mixing equipment.

$_____

b. Take soil samples to a lab.

$_____

c. Labor—Mixing cannot be done with a single pass from a tiller. Go over each section several times to ensure contamination is diluted. This process can be labor intensive. Account for the time it will take to sample soils along the way.

$_____

4. Total estimated costs:

2	Imported soil	$ _____
3a	Mixing equipment	+ $ _____
3b	Lab samples	+ $ _____
3c	Labor	+ $ _____
	Total	= $ _____

Worksheet 3: Planning for capping in place

Hard cap—There should be no extra cost to your project if the building or pavement area was part of the original plan.

Soil cap—There should be little additional cost for areas where landscaping was part of the original plan.

1. **Calculate soil cap cost.**
   a. Calculate the volume of soil by decision unit (DU):

DU area _____ft^2 **x** _____ft depth of cap **/** 27 = _____ yd^3

   b. Request a cost estimate for the new soil and delivery.

$ _____/yd^3 **x** _____yd^3 = $_____

   c. Calculate the cost of the geotextile:

DU area _____ ft^2 **/** 9 **x** $ _____/yd^2 material = $ _____

   d. Labor cost of installing the cap = $_____

2. **Estimate monitoring and maintenance costs.**

Inspect caps at least once every year. Factor in the cost of regular inspections and repairs. Maintenance may include replenishing soil or landscaping materials.

3. **Total estimated costs:**

1b	Soil cap	$ _____
1c	Geotextile	+ $ _____
1d	Labor	+ $ _____
2	Monitoring and maintenance	+ $ _____
	Total	= $ _____

Worksheet 4: Planning for consolidation and capping

1. **Calculate consolidation costs**—Labor and equipment costs may vary depending on the volume of contaminated soil and how far it is being moved.

Hard cap—There should be no additional cost to your project if the building or pavement area was part of the original plan.

2. **Calculate the soil cap cost**—There should be little extra cost for areas where landscaping was part of the original development plan.

   a. Calculate the volume of soil:

Consolidated area _____ft^2 **x** ____ft depth of soil cap **/** 27 = _____ yd^3

   b. Request a cost estimate for the soil:

$ _____/yd^3 **x** _____yd^3 = $_____

   c. Calculate the cost of the geotextile:

DU area _____ ft^2 **/** 9 **x** $ _____/yd^2 material = $ _____

   d. Labor cost of installing the cap = $_____

3. Estimate the monitoring and maintenance costs.

Inspect caps at least once every year. Factor in the cost of regular inspections and repairs. Maintenance may include replenishing soil or landscaping materials.

4. Total estimated costs:

1	Consolidation	$ _____
2b	Soil cap	+ $ _____
2c	Geotextile	+ $ _____
2d	Labor	+ $ _____
3	Monitoring and maintenance	+ $ _____
	Total	= $ _____