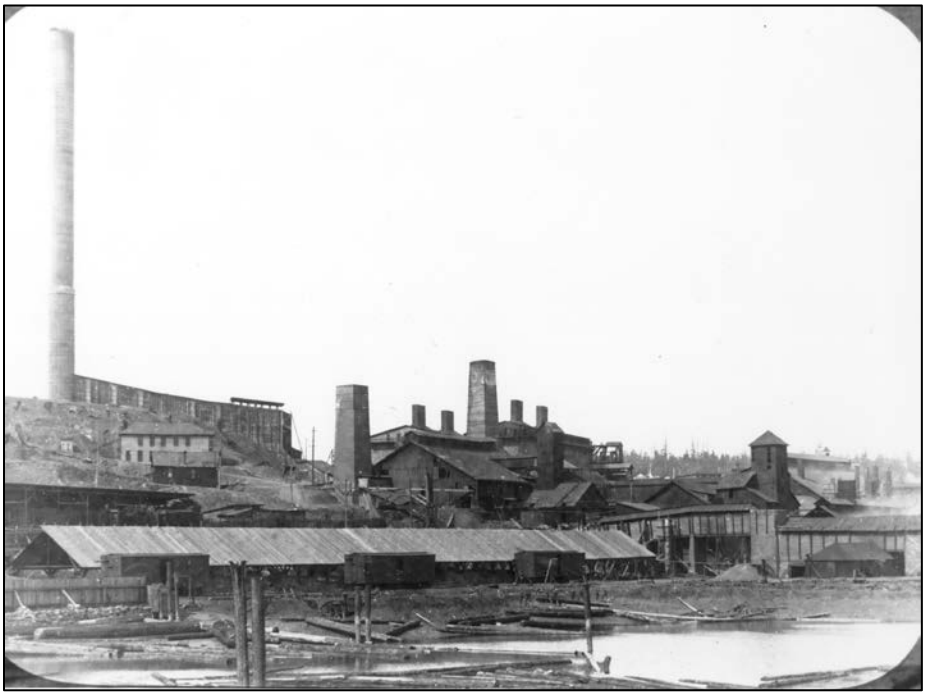
Tacoma Smelter Plume Model Remedies Guidance

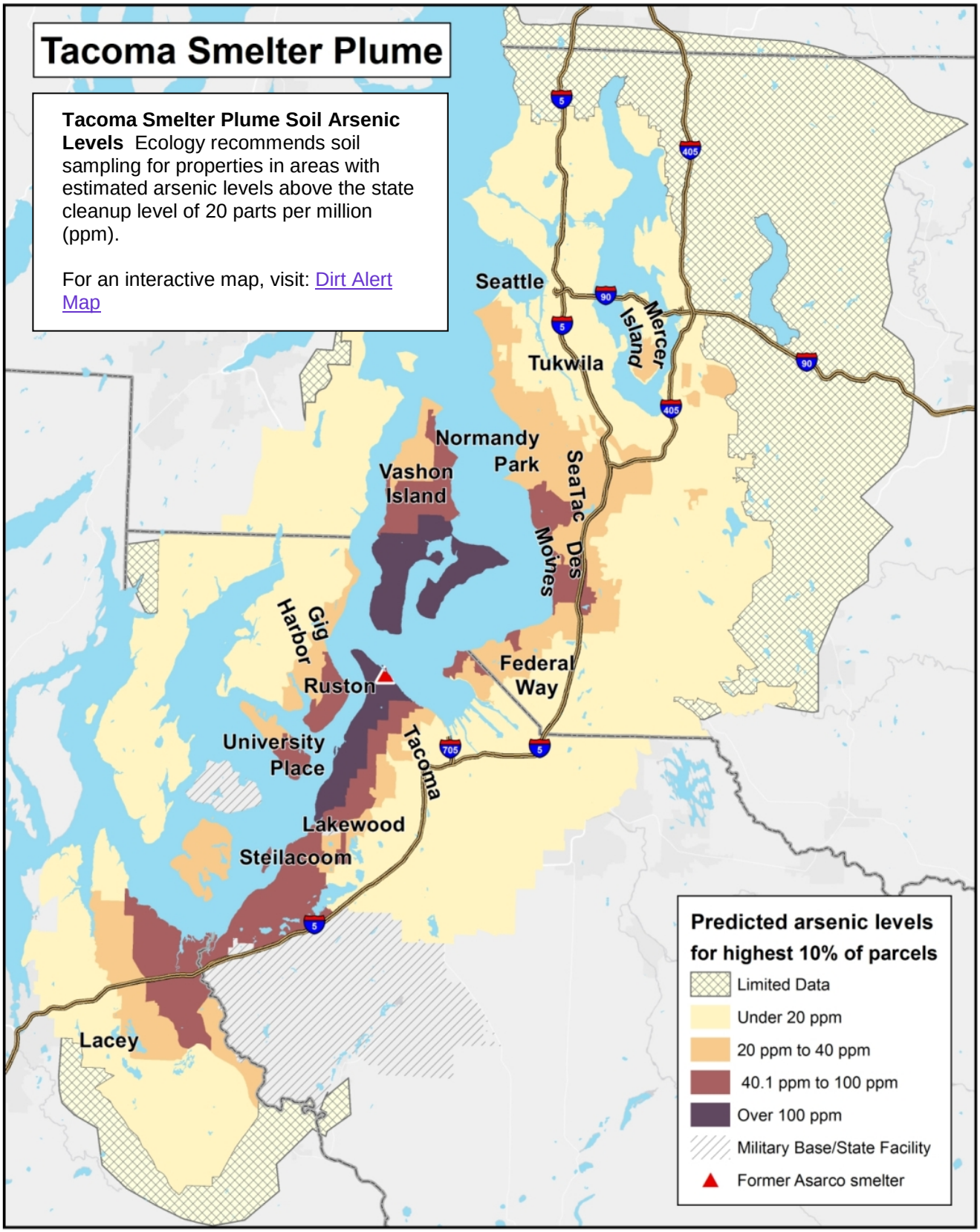
Sampling and cleanup of arsenic and lead contaminated soils

For:

Formal cleanup sites
Voluntary Cleanup Program
Properties under development
Projects involving soil movement



July 2019
Toxics Cleanup Program
Washington State Department of Ecology
Lacey, WA
Publication Number 19-09-101


Tacoma Smelter Plume
Tacoma Smelter Plume Soil Arsenic Levels Ecology recommends soil sampling for properties in areas with estimated arsenic levels above the state cleanup level of 20 parts per million (ppm).
For an interactive map, visit: Dirt Alert Map
Seattle
Mercer Island
Tukwila
Normandy Park
Vashon Island
SeaTac
Des Moines
Gig Harbor
Ruston
Federal Way
University Place
Tacoma
Lakewood
Steilacoom
Lacey
Predicted arsenic levels for highest 10% of parcels
Limited Data
Under 20 ppm
20 ppm to 40 ppm
40.1 ppm to 100 ppm
Over 100 ppm
Military Base/State Facility
Former Asarco smelter

Before you get started…

This guidance is intended exclusively for sampling and cleanup of soil contaminated with arsenic and lead in the Tacoma Smelter Plume. To find out, if your property is within the plume, use the link to the map. If your property in an area where soil arsenic is 20 ppm or higher use this manual for sampling and cleaning up Tacoma Smelter Plume contamination. You can meet state cleanup requirements without having to do your own feasibility study.

Sampling and cleanup steps

1. Take **characterization samples** to determine if your soil is contaminated.
2. Pick **cleanup remedies** that fit with your development plans:
    a. Excavation and removal
    b. Mixing
    c. Capping in place
    d. Consolidation and capping

Take **compliance samples** to make sure excavation or mixing worked.

Inform future property owners of remaining contamination under a cap or in a natural area through an **environmental covenant.**

Make sure that caps are protected and maintained.

Educate residents and property users about remaining contamination.

I need a No Further Action determination from Ecology

If a local government permit office or lender requires Ecology's written approval of your cleanup, you should enter the Voluntary Cleanup Program (VCP). In addition, a future buyer might want to see Ecology's written approval of your cleanup. The VCP provides technical assistance and a written opinion.

This guidance covers a set of Ecology-approved cleanup remedies that already have a feasibility study. When you join the VCP, you will work with your VCP site manager to use this guidance and ensure you are meeting all cleanup requirements. Early engagement with Ecology is important and can save you time. Visit Voluntary Cleanup Program

For more information, please call 360-407-6300 and ask for Ecology's Tacoma Smelter Plume Technical Assistance Coordinator.

Document Your Work

Keep a copy of the forms you fill out to pass on to future property owners so they know that cleanup was done and what they need to do to maintain any non-permanent remedies. Future property owners may want this level of detail when they sell the property.

As awareness about the Tacoma Smelter Plume grows, more buyers will be asking about soil contamination.

Disclaimer

Cleanups using these model remedies will meet state requirements under the Model Toxics Control Act (Chapter 70.105D) and its regulation (Chapter 173-340 WAC). To request Ecology review of your independent cleanup and approval in the form of a No Further Action determination, you must enter the Voluntary Cleanup Program.

Cleanups are not exempt from local, state, and federal permitting requirements.

In this guidance, "average" refers to the arithmetic mean of sampling results. The model remedies do not use the geometric mean. The average should be calculated for each depth interval sampled; for example 0 to 6 inches and 6 to 12 inches.

You may have to seek out other sources of information to complete your cleanup. This guidance is for Tacoma Smelter Plume arsenic and lead contamination only. If your property has contaminants other than lead and arsenic, like petroleum or industrial chemicals, contact Ecology. If you are in King County call 425-649-7000. If you are in Pierce or Thurston counties call 360-407-6300.

Contents

This page intentionally left blank

Introduction

The former Asarco copper smelter in Tacoma caused widespread soil contamination in parts of King, Pierce, Kitsap, and Thurston counties. This 1,000 square mile area is known as the Tacoma Smelter Plume.

Arsenic and lead contamination pose a long-term human health risk, especially for children. Property owners and developers can help protect future owners and residents by sampling and cleaning up impacted properties.

Goals of this guidance:

- To streamline cleanups under the Voluntary Cleanup Program
- To provide simple sampling guidance for any property in the plume
- To encourage independent cleanup during property development
- To encourage independent cleanup during smaller projects involving soil movement, such as landscaping, building a swimming pool or putting in a deck

Health effects of Arsenic and Lead

Arsenic and lead are toxic metals. Exposure can increase the risk of certain health problems. Although the metals are not easily absorbed through the skin, recurring exposure can increase the risk of accidental ingestion of soil or dust inhalation. Ecology is concerned about people that are regularly exposed to soil, such as children, 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.

Whether someone is impacted depends on the amount of arsenic or lead taken into his or her body over time. People exposed to contaminated soil on a regular basis may be impacted.

Children and workers are at highest risk

Young children are vulnerable because 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 come in contact with 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 be exposed to contaminated soil at a work site. Exposure can happen by accidental ingestion of soil or inhalation of 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 for more information.

Why sample?

The map in the front of this booklet is a model based on a small number of arsenic samples in contrast to the large size of the site. There is high variability in soil arsenic levels from property to property. Actual levels of arsenic and lead can only be found by sampling the soil.

Once you know where the contamination is on your property, you can take actions to manage potential exposure.

State Cleanup Level for Arsenic and Lead*

20 parts per million (ppm) arsenic

250 ppm lead

*Unrestricted land use (all land uses, including residential)

Model Remedies

Model Remedies are cleanup options that Ecology has pre-approved for Tacoma Smelter Plume contamination. Ecology did a feasibility study* to show that these cleanup remedies were appropriate under certain conditions. This guidance describes the conditions where model remedial can be used. This means you can meet state cleanup requirements by following this guidance, without having to do your own feasibility study.

Cleanups are not exempt from local, state, and federal permitting requirements.

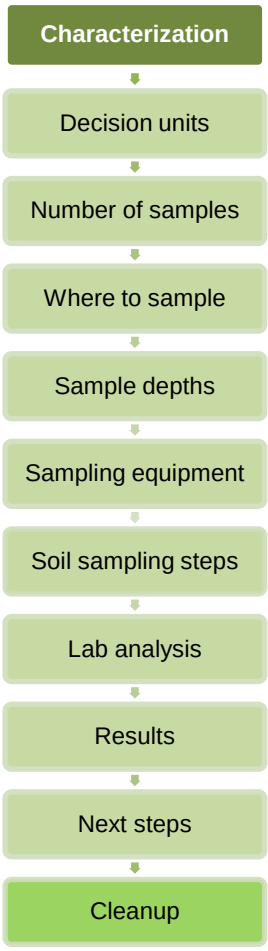
**The feasibility study is Appendix C of the Tacoma Smelter Plume Interim Action Plan, available on Ecology's website http://ecology.wa.gov/Tacoma-smelter*

Forms vs. Worksheets

Forms for tracking your sampling and cleanup work are in the back of this guidance. **At a minimum**, fill out these forms for your records and give to future property owners or others that need documentation of cleanup.

There are also **worksheets** at the end of some of the chapters. These are designed to help you estimate the cost of cleanup and do not need to be kept.

Chapter One: Soil and Duff Characterization Sampling



Purpose: Characterization sampling shows whether a property or a portion of it is clean or contaminated.

Thorough sampling helps plan for cleanup

Soil arsenic and lead levels can vary across a property. Sampling is the only reliable way to find out whether they pose health concerns. Once you know, where the contamination is and to what extent, you can take actions to reduce contact and manage potential exposure.

Planning for sampling

Think about land use history. Undisturbed areas like forests are more likely to have elevated arsenic or lead. **Forest duff** can contain arsenic and lead. Sample the duff before disposal or reuse.

Then, think about proposed future uses. Will children use this area? Will people be regularly in contact with soil or duff? If so, the risk to human health may be greater.

Track this information on a map of your property. Form 1 will help you document your planning.

Decision units

Identify decision units before starting sampling. This may save time and money when it comes to cleanup. Evaluate the natural settings on your property and arrange areas that have similar landscape features into separate areas – they will be your decision units.

Arsenic or lead may be below cleanup levels in a recently graded part of the property, and *above* cleanup levels in the undisturbed part. In this case, it would be more cost effective to treat each one of these as separate decision units, since you would only need to clean up the area that was above state cleanup levels.

Future use can also define decision units. Ecology expects permanent remedies (e.g., excavation or mixing) to be used during residential development. However, you could cap soils

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 and development history.

at a community center or in a common open space. Figure 1 shows two different properties, one that has decision units based on past use, and one based on future use. Defining these decision units early will help with sampling.

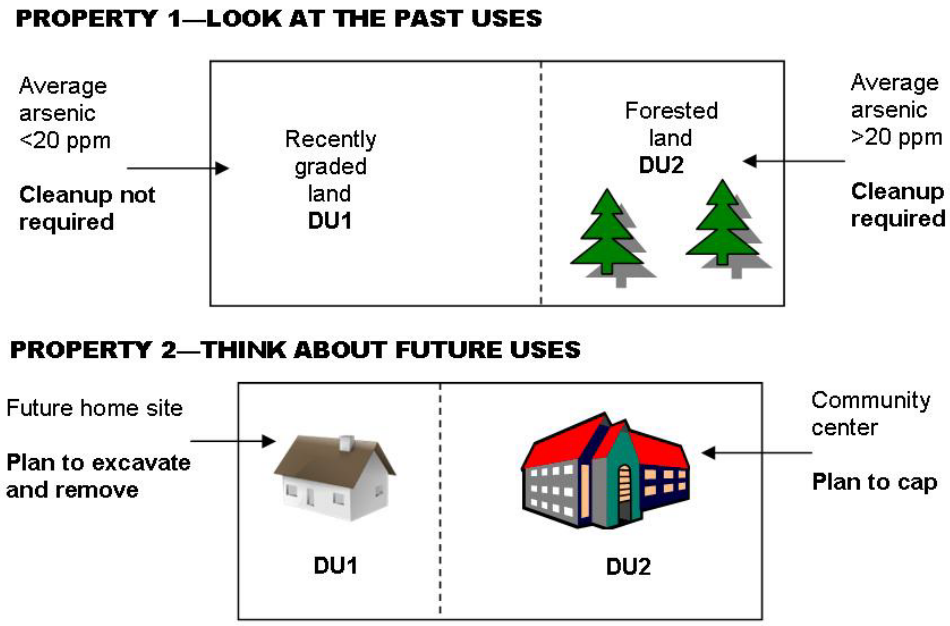


Figure 1. Dividing properties into decision units based on past or future uses

Soil: Number of samples per decision unit

Use Table 1 to find the number of sample locations you need. The number of sample locations will depend on:

Land use – What is the **intended** use? Development or open space?

Location – Is the property in an area where arsenic has been found in soils from 20 -100 ppm or over 100 ppm (see map on inside cover)?

Size – How big is the decision unit?

For example, an undeveloped piece of property (open land or forest) will be developed into a residential plat. A landowner would need to take the appropriate number of samples needed for a residential property, not forested or open land.

If you also have forest duff: Number of extra samples

Mark each decision unit with significant forest duff. Plan to take at least **one composite sample** from each decision unit with forest duff. The number of composite samples will depend on the size of the decision unit (Table 1a). The composite sample will have at least **six subsamples** mixed together.

What is forest duff? Moderately decomposed leaves, needles, and other plant material that has gathered on the soil surface.

Why sample? Duff can have high levels of arsenic and lead. Test before mulching, reusing, or disposing of it!

Table 1. Minimum number of soil sample locations per decision unit

Sampling area (X)	Residential	Parks, Commercial	Forest and	Open Land
	Samples needed (Y)	Samples needed (Y)	Samples needed (Y)	Samples needed (Y)
Acres	Arsenic >100 ppm	Arsenic 20-100 ppm	Arsenic >100 ppm	Arsenic 20-100 ppm
0.25	10*	8	8	8
1	20	16	16	12
5	40	32	30	24
10	60	48	40	32
20	80	64	50	40
100	120	90	70	60
>100	120 + 1 per 5 acres	90 + 1 per 5 acres	70 + 1 per 10 acres	60 + 1 per 10 acres

* The number of samples is calculated by a linear interpolation method, rounding up to the next whole number. Calculate the number of samples you need using the following formula:

$$Y = Y_a + (Y_b - Y_a)^* ((X - X_a) / (X_b - X_a))$$

a=smaller acre

b=larger acre

Example 1: 2-acre residential property in the estimated arsenic concentration over 100 ppm:

Y = 20 + (40 – 20)* ((**2** – 1) / (5 - 1))
Y = 25

The number of samples for a 2-acre property calculated with the above formula would be 25

a=smaller acre

b=larger acre

Example 2: 65-acre residential property in the estimated arsenic concentration between 20 and 100 ppm:

Y = 64 + (90 - 64)* ((**65** – 20) / (100 – 20))
Y = 79

The number of samples for a 65-acre property calculated with the above formula would be 79

For more information on sampling natural areas that are to remain natural, please review Chapter 10.

Soil: Where to sample

Fill out Form 1 and attach a diagram showing the property dimensions and decision units. For multiple decision units, attach a separate diagram for each, with dimensions and the location of any structures. In general, you do not need to sample under structures or pavement that will remain after development. These areas should be marked on the diagram. If you are seeking a No Further Action determination from Ecology, then you will need to characterize the property fully, which may include sampling under pavement. An environmental covenant may be necessary to document the contamination under structures or pavement (see Chapter 11).

Preparing a sampling grid

For each decision unit diagram, prepare a sampling grid (Figure 2):

Step 1: Enclose the entire decision unit inside a rectangle. It is fine to leave small margins around the edges.

Step 2: Mark a point towards one corner of this rectangle as a starting point.

Step 3: Start with this point and begin laying out sample points in an evenly spaced grid (Figure 2). Use the number of locations from Table 1. 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 soil for one sample comes from a single sampling location.

If you also have forest duff:

Depending on the size of the decision unit with forest duff, you will need at least one composite sample. Each composite sample must include at least six subsamples, collected from six evenly spaced locations throughout the decision unit. You **do not** need to take them from the soil sample locations.

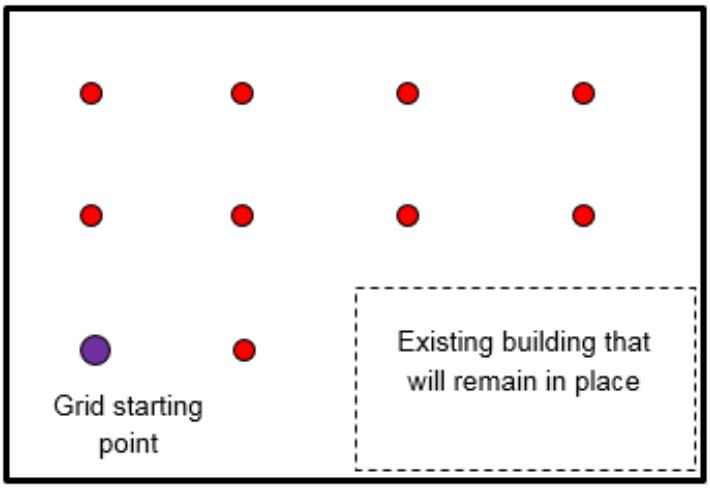


Figure 2. Laying out a sampling grid

Decision Unit Information

Use = Residential
Size < 0.25 acres (<11,000 ft^2)
Map area = arsenic >100 ppm

Samples needed = 10

Note: *You may subtract paved areas from the total area of the unit when calculating the number of samples if the paved areas encompass more than half of the total acreage of the property*

Sample depths

- **At every sample location:** Take characterization samples from the top 0-6 inches of soil, after clearing away grass, leaves, gravel, or debris on the surface (Figure 3); and

- **At every fourth sample location (25% of samples):** Collect a sample from the top 0-6 inches, and another sample from the 6-12 inch depth.

Sample Depths

0-6 inch sample: At every sample location

6-12 inch sample: At every fourth sample location

If you also have forest duff: Take each subsample from throughout the entire depth of the duff layer.

Residential development example:

For a one-acre decision unit in an area with >100 ppm arsenic and thick forest duff…

Take 20 samples from 0-6 inches
\+ 5 samples from 6-12 inches
\+ 5 forest duff composite samples
30 samples total

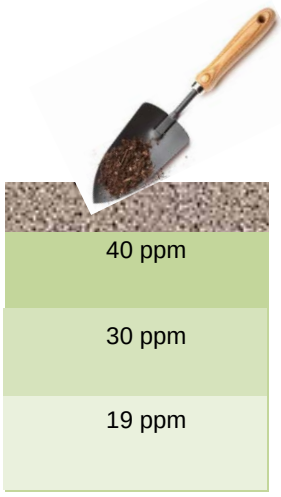


Figure 3. Example of a soil profile

Table 1a. Minimum number of composite duff samples* per decision unit

Sampling area	Residential, parks, Commercial		Forest and open land	
	Samples needed (Y)	Samples needed (Y)	Samples needed (Y)	Samples needed (Y)
Acres	Arsenic >100 ppm	Arsenic 20-100 ppm	Arsenic >100 ppm	Arsenic 20-100 ppm
0.25	1	1	1	1
1	5	4	4	2
5	10	8	6	4
10	15	12	10	8
20	20	16	12	10
100	30	22	16	12
>100	30 + 1 per 5 acres	22 + 1 per 5 acres	16 + 1 per 10 acres	12 + 1 per 10 acres

***** Each composite duff sample must include at least six subsamples

Areas with fill, topsoil or sod:

There may be areas where you know fill dirt, topsoil, or sod was added in the past. If these areas are deeper than 12 inches, collect a sample at every fourth sample location from the top 0-6 inches of the **original land surface**. For example, if the site has two feet of fill, take a 0-6 inch sample below the two feet (see figure 4) where the original land surface begins.

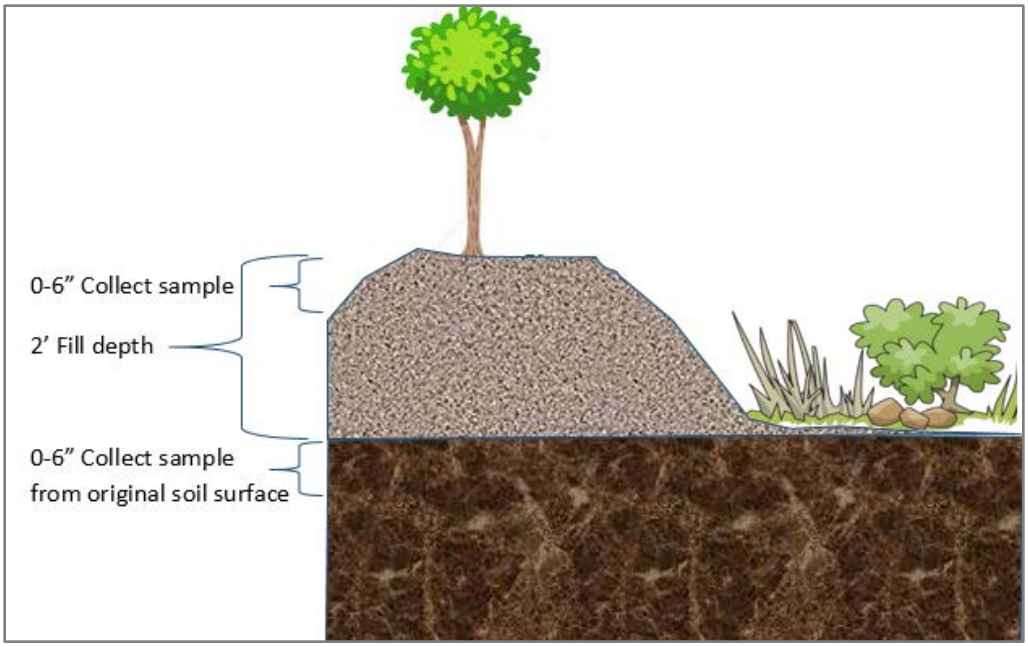


Figure 4. How to sample under fill

Make sure to take enough samples.

Thinking about a possible cleanup method now may help refine your sampling plan. More sampling will help to plan for excavation or mixing:

Excavation and removal

You must show that the 0-6 inches under the final excavated surface meets state cleanup levels. Most projects excavate more than six inches, so at every fourth sampling location (25% of the samples), also sample from 6 -12 inches. This will help you ensure you are excavating deep enough.

Mixing in place with deeper soils: Take samples at six-inch intervals throughout the depth you plan to mix. More samples than are required for the 6 to 12 inch depth will give a better idea of whether the remedy will be effective.

Equipment needed

- Stainless steel tools to dig holes and remove soil (trowel and small shovel)
- Stainless steel or glass bowl for mixing
- Clean glass containers from the lab or zip-top plastic bags
- Permanent marking pen to record sample locations on the jar or bag
- Wash bucket, soap, scrub brush, and rinse water (distilled or deionized)
- 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

Soil: Sampling steps

Take one sample from each depth range you need, at each sampling location marked on your decision unit diagrams (Figure 5). These should be collected as separate samples. **Do not** mix soil samples from different sampling locations or depth ranges.

1. Before taking any samples, contact an Ecology accredited lab (see Help Desk on page 73). 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 jars or zip-top plastic bags with:
    - The unique name or number 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 a six-inch hole with the stainless steel trowel, shovel, or hand auger.
5. Using a clean trowel or spoon for each depth, scrape soil from the sides of the hole and put it in the mixing bowl. Avoid or discard pebbles, rocks, leaves, roots, and stems. Collect soil evenly from throughout the depth of the hole. It is important to mix the soil well. If you mix the soil in a Ziploc bag or sampling container, shake the container or the bag well or use a clean spoon.
6. Fill up the glass jar or plastic bag with the mixed soil and seal it securely. Discard any extra soil back into the hole. Do not composite (mix) samples from different locations (unless it is forest duff).
7. Between each sample, scrub the sampling tool and mixing bowl clean in the wash bucket, rinse, and pour the dirty water down a sanitary sewer or in a place where it can soak into the ground. Do not pour it down the storm drain.
8. For the 6 to 12 inch samples, dig additional six inches deeper at the same location. This is a separate sample,

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.

Figure 5. Example of soil sampling

so repeat steps 4 through 6, but only scrape the side of the hole where it is 6 to 12 inches deep.

9. Immediately after collecting each sample, fill out the laboratory chain of custody form with the required information.

Forest duff: Sampling steps

1. For each subsample, dig a hole through the whole duff thickness of the layer and scrape duff all the way down the side of the hole. Use a clean trowel or spoon.
2. Wash the trowel or spoon between subsamples.
3. Mix all of the subsamples together in a stainless steel or glass mixing bowl. It is important to mix the duff well, preferably in a bowl.
4. Take one sample from the bowl and place it in a glass jar or a plastic bag. Make sure to label the jar or bag with the decision unit and type of sample (duff).
5. Follow the lab analysis guidelines.
6. Wash your bowl and sampling tools before taking another composite sample. Pour the dirty water down a sanitary sewer or in a place where it can soak into the ground. Do not pour it down the storm drain.

How deep should I sample the duff?

It can be hard to tell where the duff ends and soil begins. Sample down to the point where you can easily brush the duff away from the soil. If you have to scrape to get any deeper, you are likely in the soil.

Lab analysis

See the Help Desk section (page 73) of this guidance for how to select a lab. The lab must use EPA methods 6010, 6020, or 6200 for arsenic and lead.

Keep the 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 chain of 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 receive back the chain of custody form, which keeps track of the samples. Keep everything you receive from the lab.

Soil: Understanding your characterization results

Use the sample results to plan your next steps. **Calculate the average for each sample depth: 0 to 6 inches and 6 to 12 inches.** If arsenic or lead levels are "elevated" for any decision unit on the property, that decision unit needs cleanup. "Elevated" is analogous to exceeding Model Toxic Control Act (MTCA) Method A cleanup level for unrestricted land use.

"Elevated" arsenic and lead levels in duff

- Any composite arsenic sample > 20 ppm
- Any composite lead sample > 250

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 Form 2 to calculate average and maximum arsenic and lead for each decision unit, at each depth. Mark, which decision units, exceed state cleanup levels.

Forest duff: Understanding your results

If you have multiple composite duff samples, do not average them. They are already composites of six subsamples. Evaluate your duff samples individually. Elevated means:

- Duff composite sample arsenic > 20 ppm or
- Duff composite sample lead > 250 ppm

If **all** of your composite samples are under 20 ppm for arsenic or 250 for ppm lead, you may mix the duff with the soil. To mix duff with the underlying soil, your average soil arsenic levels must be under 40 ppm and average soil lead levels must be under 500 ppm.

If any of the composite samples are over 20 ppm for arsenic or 250 ppm lead, the duff will pose a risk if reused or composted. Do not mix. You must dispose of the duff at an appropriate disposal facility.

"Elevated" arsenic and lead levels in soil:

- Average* arsenic >20 parts per million (ppm)
- Max arsenic >40 ppm

- Average* lead >250 ppm
- Max lead >500 ppm

**Arithmetic average*

Soil disposal

For information about waste disposal within the Tacoma Smelter Plume:

Tacoma-Pierce County Health Department
https://www.co.pierce.wa.us/1519/Dirt

King County Landfills
Waste acceptance and clearance

Thurston County Health Department
https://www.co.thurston.wa.us/health/ehhw/index.html

What to do next

If none of your decision units is "elevated," you do not need to conduct cleanup. Compile the results of the soil sampling and send them to Ecology. If one or more decision units are elevated, select one or more cleanup options from Chapter 2. Ecology also recommends:

- Conducting cleanup as part of your development project
- Entering Ecology's Voluntary Cleanup Program to obtain an official opinion letter.
- Taking healthy actions like hand-washing 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

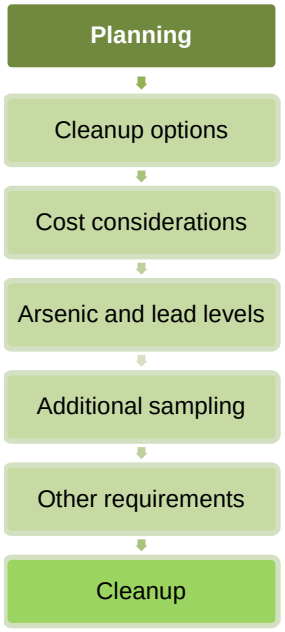
For assistance with interpreting your results and deciding on cleanup options, call 360-407-6300 and ask for Ecology's Tacoma Smelter Plume Technical Assistance Coordinator

For information about the Voluntary Cleanup Program, visit: Voluntary Cleanup Program

For a list of healthy actions, visit: Dirt Alert program

This page left blank intentionally

Chapter Two: Planning for Cleanup



Model Remedies

Model Remedies are predetermined cleanup options. Table 2 summarizes the four Tacoma Smelter Plume Model Remedies. You can only use some of the Model Remedies if arsenic and lead are at or below a certain level (Table 3).

Table 2 breaks out Model Remedies into permanent and nonpermanent remedies. Excavation and mixing are the two permanent remedies, whereas capping requires ongoing monitoring, maintenance, and property restrictions.

Cost

The location, accessibility, and features of the property can make certain cleanup options less expensive. Many cleanup activities can be incorporated into existing development plans, which can be more cost-effective.

Table 2. Model Remedy options

	Model Remedy	Action	Considerations
Permanent	**Excavate & Remove (Ch. 3)**	Excavate contaminated soils and properly dispose of them.	⇒ The top 6" of soil must have <20 ppm average arsenic and <250 ppm average lead after excavation. Take samples at depth to make sure you remove all contamination. ⇒ Performance monitoring required.
Permanent	**Mix (Ch. 4)**	Mix the top 6-12" of contaminated soils with imported soils or deeper, clean soil.	⇒ Not for soils >40 ppm average arsenic, average lead >500 ppm. ⇒ Performance monitoring required.
Non-Permanent	**Cap in Place (Ch. 5)**	Cover contaminated soils with a geotextile barrier and soil cap, or a hard cap.	⇒ Hard caps include asphalt or concrete. ⇒ Thicker soil cap required for higher levels. ⇒ Institutional controls required. ⇒ Performance monitoring required. ⇒ Confirmational monitoring required.
Non-Permanent	**Consolidate and Cap (Ch. 6)**	Excavate and consolidate contaminated soils into an area of the property and place under a cap (above).	⇒ Thicker cap required for higher levels. ⇒ Not for average arsenic >200 ppm or lead >1000 ppm ⇒ Performance monitoring required. ⇒ Confirmational monitoring required. ⇒ Institutional controls required.

Natural Areas

Guidance on how to sample soil in natural areas is included in Chapter 10.

Table 3. Model remedies by arsenic and lead soil level

<table>
<tr><th>Soil sampling results in parts per million (ppm)</th><th colspan="2">Permanent</th><th colspan="4">Non-Permanent</th></tr>
<tr><th>Average</th><th>Excavate & Remove</th><th>Mix</th><th colspan="4">Cap in place/Consolidate and cap</th></tr>
<tr><td>Arsenic 20-40
Lead 250-500</td><td>Yes</td><td>Yes</td><td colspan="4">Yes</td></tr>
<tr><td rowspan="2">Arsenic 40-100
Lead 250-500</td><td rowspan="2">Yes</td><td rowspan="2">No</td><td>Max <200
Max <1000</td><td rowspan="2">Type 1 or 2*cap</td><td>Max >200
Max >1000</td><td rowspan="2">Type 2 cap</td></tr>
<tr><td>Arsenic 100-200
Lead 500-1000</td><td>Yes</td><td>No</td><td colspan="4">Type 2 cap</td></tr>
<tr><td>Arsenic >200
Lead > 1000</td><td>Yes</td><td>No</td><td colspan="4">Type 2 cap (only for capping in place)</td></tr>
</table>

*Type 1 and 2 caps are described in Chapter 5.

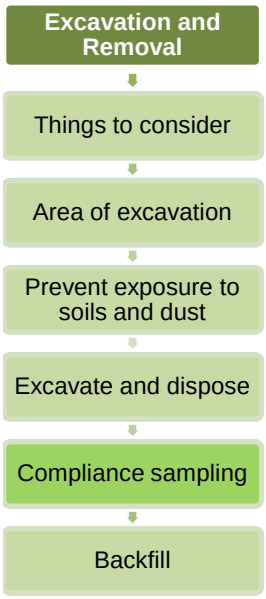
Additional sampling

Excavation, removal, and mixing require compliance sampling (Chapter 7) to show the cleanup is complete. When importing soils, Ecology recommends requesting sample results from the soil provider or sampling imported soil yourself (Chapter 9). Soil disposal may also require stockpile sampling (Chapter 8).

Follow other government requirements for your project

This guidance only covers Model Toxics Control Act requirements. It does not cover other federal, state, and local rules and regulations that may apply to your project.

Chapter Three: Excavation and Removal



Purpose: To permanently clean up any level of arsenic or lead contamination on your property by digging out soils, properly disposing of them at a landfill, and backfilling with clean soils.

Important:

Ecology expects permanent remedies for residential development. Excavation and removal is permanent to the maximum extent practicable. Development also presents a chance to remove all contaminated soil during grading.

Things to Consider

Arsenic and lead levels: Use excavation at any level of contamination	
Pros: • Permanent • Only permanent remedy for average arsenic > 40 ppm, lead > 500 ppm • Works for all levels of arsenic or lead soil contamination • No need for institutional controls	**Cons:** • May require a waste disposal authorization for landfill • Can be expensive to and dispose of soils and new soils • Requires sampling for and for importing new soils
Costs: There are certain costs with removal, proper landfill disposal, and bringing in clean fill. However, there are no long-term maintenance costs for maintenance and monitoring because the remedy is permanent. Estimate costs using the worksheet at the end of the chapter.	

Excavation and removal process (See Form 3)

1. Determine your area of excavation. Excavate areas that you do not plan to clean up using other methods. Make sure that you have sufficiently narrowed down your decision units. Adequate 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 of, cover it to prevent runoff. Install proper erosion control devices to prevent contaminated soil from leaving the project area.

You will need to apply for coverage under the construction stormwater general permit (Construction Stormwater General Permit) if you disturb one or more acres. There may be additional local stormwater control requirements.

If possible, trucks should avoid driving through contaminated soils. Tightly cover the contaminated soil loads during transport and rinse wheels to prevent contaminated soil from leaving the worksite. Use quarry spalls at the exit from the work site.

3. Plan to protect workers. The Washington Department of Labor and Industries regulates health and safety at worksites. For guidance on arsenic in soils, visit: http://www.lni.wa.gov/safety/topics/atoz/topic.asp?KWID=23

4. Excavate and test soils before disposal. For any property or decision unit with arsenic or lead above state cleanup levels, all soil, sod, and duff must be disposed of at a permitted landfill.

Use stockpile sampling (Chapter 8) to determine your arsenic and lead levels. This information or a toxicity characteristic leaching procedure (TCLP) may be required for a Waste Disposal Authorization, or to dispose of soils in a private landfill. You may also be able to use characterization sampling results.

For information about waste disposal within the Tacoma Smelter Plume:

> ***Tacoma-Pierce County Health Department*** https://www.tpchd.org/healthy-places/waste-management/waste-disposal-authorization
>
> ***King County Landfills***
> https://kingcounty.gov/depts/dnrp/solid-waste/facilities/landfills.aspx
>
> ***Thurston County Health Department***
> http://www.co.thurston.wa.us/health/ehhw/hwdisposal.html

5. Collect compliance samples after excavation is complete. Soils from 0-6" below the excavated surface should have average arsenic at or below 20 ppm and average lead at or below 250 ppm. If the compliance samples are above these limits, excavate further. Chapter 7 describes how to collect compliance samples.

6. Backfill the excavated areas with clean soil if needed. Before you purchase soil, check with the supplier to ensure the soil is below 20 ppm arsenic and below 250 ppm lead. Some questions to ask your supplier include:

- 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 you are unsure of whether backfill soils meet state cleanup levels, sample and test the imported soil (Chapter 9) or ask the supplier to sample and test. If you are planning to use onsite soils to backfill, sample and test stockpiles to make sure they will not re-contaminate the excavated area.

Worksheet: Planning for excavation and removal

1. Calculate soil removal depth by decision unit

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

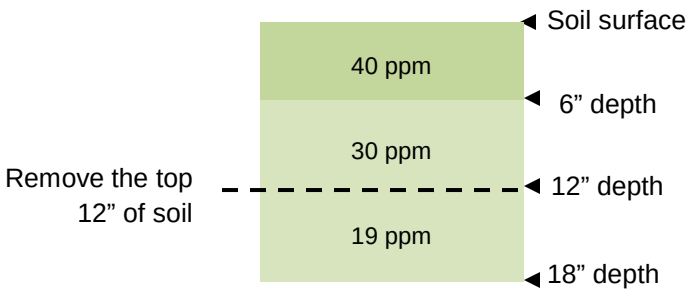


Figure 6. Example soil profile for arsenic

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.** They may require stockpile sampling (Chapter 8) or toxicity characteristic leaching procedure (TCLP) testing to determine if the soil is safe for landfill disposal. Ask your lab if they can do TCLP.

   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	+ $ _____
		= $ _____

Chapter Four: Mixing

Mixing

- Area of mixing
- MIxing depth
- Prevent exposure to soils and dust
- Till or mix
- Test soils
- Continue mixing
- Compliance sampling

Purpose: To permanently clean up soils with average arsenic of 40 ppm or less (or average lead of 500 ppm or less) through dilution.

Incorporating cleanup into property development can reduce the cost of your cleanup

Mix contaminated soils or duff with clean imported soils or clean soils, which are typically found underneath the contaminated surface soils. Soil and duff can be mixed in place, or piled into rows or stockpiles, mixed, and spread back out. Mixing is only for areas with average arsenic in the soil at or below 40 ppm and average lead at or below 500 ppm. The effectiveness of mixing depends on how deep you mix, how deep the contamination extends and the efficiency of mixing equipment. Based on Ecology's Feasibility Study*, we determined that it is impractical to dilute higher levels of arsenic or lead. 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.

Important

Ecology expects that you will use permanent remedies during residential development. Development is also a good time to do mixing if arsenic levels are below 40 ppm and lead is below 500 ppm. Mixing can be less expensive because it does not require landfill disposal and can be done with the same equipment used for grading.

Things to consider

Arsenic and lead levels: Mix only when ≤40 ppm arsenic and ≤500 ppm lead (average)	
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 • 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.	

**Ecology's Feasibility Study is in Appendix C of the Final Interim Action Plan*

Characterization sampling helps to plan for mixing

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

1. Average arsenic is below 40 ppm and average lead is below 500 ppm.
2. Contamination is not deeper than 12 inches.
3. Arsenic and lead levels in deeper soils (12-18" and 18-24") have low enough arsenic and lead levels to dilute surface soils.

Use the worksheet in this chapter to calculate your mixing depth.

Mixing process (see Form 4)

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 deciding how much to mix soils, but compliance sampling (Chapter 7) will show if the cleanup level is met.

1. **Determine your mixing area.** Only mix decision units with average arsenic at or below 40 ppm (or lead at or below 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, make sure it is covered to prevent runoff. Install erosion control devices to keep dirty water from leaving the site. You will need to apply for coverage under the construction Stormwater General Permit if you disturb one or more acre. There may be additional local stormwater control requirements.

4. **Plan to protect workers.** The Washington Department of Labor and Industries regulates health and safety at worksites. For guidance on arsenic in soils, visit: Safety Standards for Arsenic.

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** 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 tell 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 or send them to a lab. Lab analysis may take weeks, but samples can be rushed in about 24 hours.

7. **Continue mixing.** 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 (Figure 7) and send them to a lab. Soil samples collected under step 6 and analyzed with an XRF do not meet compliance requirements. Compliance samples must be analyzed by the lab.

Example:

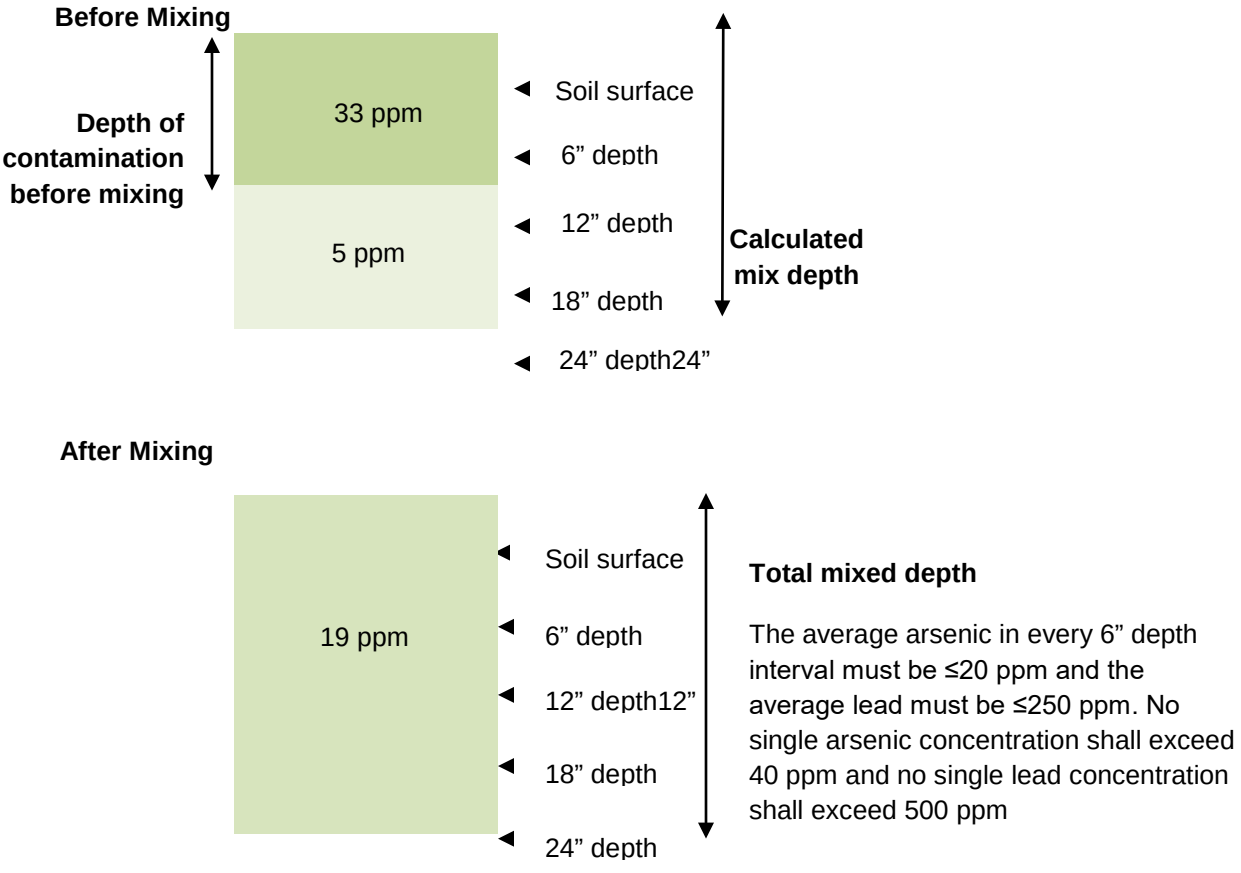


Figure 7. Soil profile before and after mixing

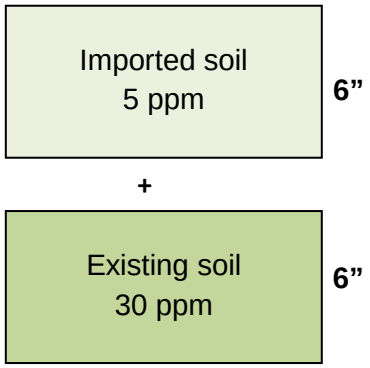
Worksheet: Planning for mixing

1. Mixing depth examples

For lead, use the same mixing depth calculations, with 250 ppm as the cleanup level.

A. 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 test results or stockpile sample imported soils. To calculate whether a certain depth of imported soils will dilute the contaminated soils:



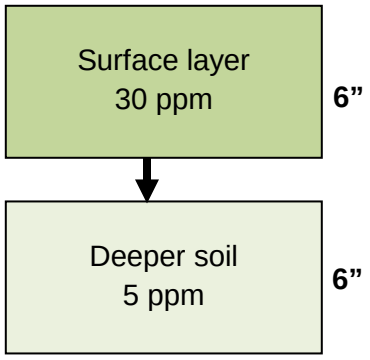
$$\frac{\text{Imported soil arsenic x depth + existing soil arsenic x depth}}{\text{Imported depth + existing depth}}$$

(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.

B. Mixing with deeper soils (undisturbed areas)

Undisturbed soils tend to have contamination mainly in the top 6" of soil. To calculate how deep to mix:



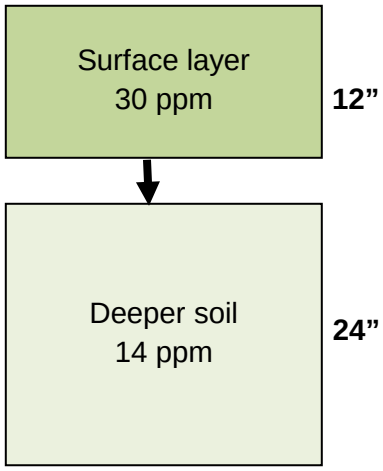
$$\frac{\text{Surface soil arsenic x depth + Deeper soil arsenic x depth}}{\text{Surface depth + deeper depth}}$$

(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.

C. 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" or deeper. This example uses characterization samples down to 36". To calculate how deep to mix:



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

(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

2. Imported soil volume

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

3. Imported soil cost

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

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

4. Equipment

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.

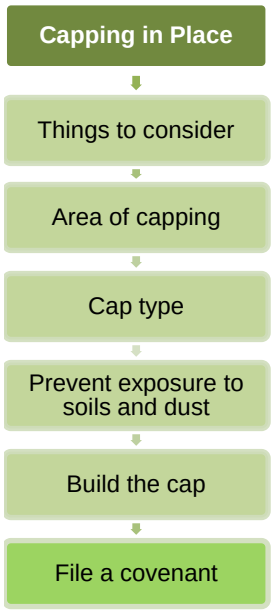
$_____

5. Total estimated costs

3	Imported soil	$ _____
4a	Mixing equipment	+ $ _____
4b	Lab samples	+ $ _____
4c	Labor	+ $ _____
	Total	= $ _____

This page left blank intentionally

Chapter Five: Capping in Place



Purpose: To cover contaminated soil where it lies with a soil cap or hard cap. The cap prevents exposure to contaminated soils on the property.

A hard cap may be a building, parking lot, pavement, or driveway. A soil cap is a certain depth of clean soil over a geotextile (see box). Part of the soil cap can be landscaping material. Select a cap type (Figure 8) based on the arsenic and lead levels.

Important:
Ecology expects permanent remedies to be used during residential development, rather than capping yards. Excavation and removal (Chapter 3) or mixing (Chapter 4) are permanent to the maximum extent practicable.

Things to consider

Arsenic and lead levels:
Use Type 1 caps only when average <100 ppm arsenic and <500 ppm lead or maximum <200 ppm arsenic and <1000 ppm for lead.
Use Type 2 caps at any level of contamination.

Pros:	**Cons:**
• 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	• Not permanent; potential for exposure if the cap is removed • Soil caps add 1-2 feet of elevation • Long-term monitoring and maintenance needed • Requires environmental covenant (See Chapter 11)

Costs: The up-front costs of capping in place can be lower, especially if integrated into existing development plans. However, there are long-term monitoring and maintenance costs. Estimate costs using the worksheet at the end of the chapter.

Geotextiles are permeable fabrics, which when used with soil, have the ability to separate, filter, reinforce, protect, or drain. They can also serve as a warning prior to digging

Soil caps

Cap soils must meet state cleanup levels for arsenic and lead. Otherwise you will re-contaminate the property. Do imported soils sampling (Chapter 9) or ask the supplier to sample. Ask where the soil came from, if it has additives, and if it will support vegetation.

Landscaping materials

Up to 6 inches of the Type 1 or Type 2 soil cap can be materials other than soil. This includes wood chips, bark, mulch, sand, and gravel. Keep in mind that these materials can wear away quickly if they are in a play area or high traffic area. Gravel is better for pathways and trails. The landowner must inspect and maintain the cap.

Geotextiles

A geotextile indicates that soil beneath it may still be contaminated, and that it needs maintenance when it becomes exposed. Use a bright color to warn future property users. The fabric also minimizes the chance of capped soils brought to the surface by animals. Check with your supplier to make sure the geotextile is not biodegradable, thick, and durable enough to last underground.

Hard caps

Hard caps are most cost-effective when they are part of the original development plan, like a building, walkway, or a driveway.

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

Capping Process (See Form 5)

1. **Determine the capping area.** Use more sampling to narrow down the area.
2. **Pick a cap type.** Many developments can 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. Be sure install proper erosion control devices to prevent dirty contaminated water from leaving the project area. You will need to apply for coverage under the construction stormwater general permit if you disturb one or more acres https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Stormwater-general-permits/Construction-stormwater-permit). There may also be additional local stormwater control requirements.

4. **Plan to protect workers.** The Washington Department of Labor and Industries regulates health and safety at worksites. For guidance on arsenic in soils, visit: Safety Standards for Arsenic

5. **Build the cap.** Use enough materials to create the necessary cap depth (Figure 8). Make sure it covers the contaminated area.

6. **File an environmental covenant.** This is a legal mechanism that 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. See Chapter 11 for more information.

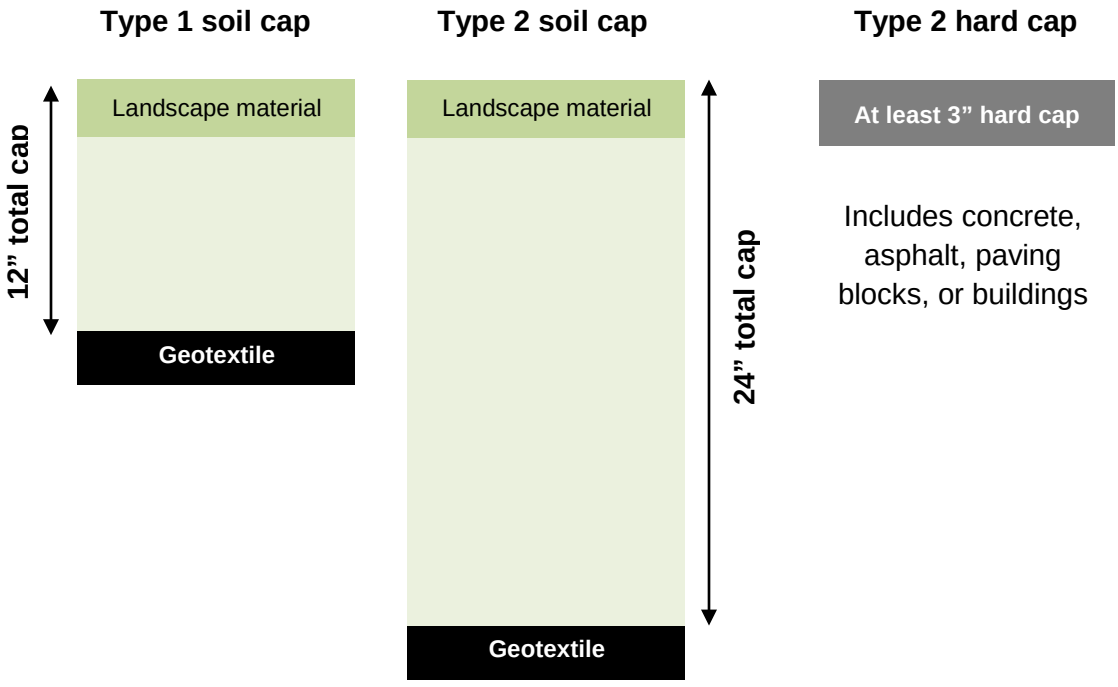


Figure 8. Cap types

Worksheet: Planning for capping in place

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

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

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 $_____

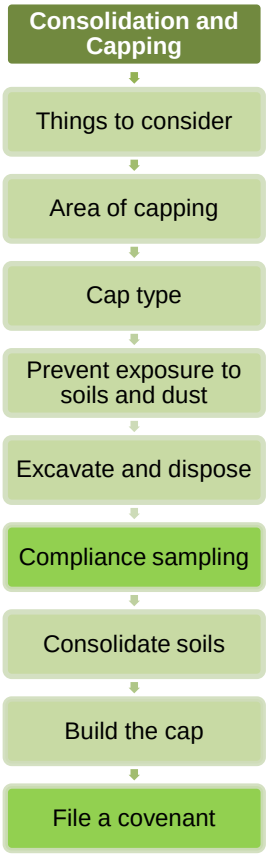
3. Monitoring and maintenance

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

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

Chapter Six: Consolidation and Capping



Purpose: To dig out contaminated soils, consolidate them in one place, and cover them with a soil cap or hard cap. 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 soil cap is a certain depth of clean soil over a geotextile. Part of the soil cap can be landscaping material. Figure 8 in Chapter 5 shows both cap types.

Important

Ecology expects permanent remedies to be used during residential development, rather than capping yards. Excavation and removal (Chapter 3) or mixing (Chapter 4) are permanent to the maximum extent practicable.

Things to consider

Arsenic and lead levels:	
Use Type 1 caps only when average <100 ppm arsenic and <500 ppm	Use Type 2 caps only when average <200 ppm arsenic and <1000 ppm lead
Pros: • Can be integrated into existing development plans; • Does not require off-site disposal • Confines contamination to a smaller footprint on the • Can be used for high arsenic lead levels • Lower up-front costs	**Cons:** • Not permanent: potential for exposure if the cap is removed; • Soil caps add 1-2 feet of elevation: • 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 (See Form 6)

1. **Determine the capping area.** Use additional sampling to narrow down the area that needs to be capped.

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. Be sure install proper erosion control devices to prevent dirty contaminated water from leaving the project area. If you disturb more than one acre you will need to apply for coverage under the construction stormwater general permit (https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Stormwater-general-permits/Construction-stormwater-permit). There may be additional local stormwater control requirements.

4. **Plan to protect workers.** The Washington Department of Labor and Industries regulates health and safety at worksites. For guidance on arsenic in soils, visit: Safety Standards for Arsenic

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" below the excavated surface should have average arsenic at or below 20 ppm and average lead at or below 250 ppm. No individual sample may exceed 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 needed cap depth (Figure 8 in Chapter 5). Make sure it covers the contaminated area. Sample any imported soils (Chapter 9) to make sure the cap material is not contaminated.

9. **File an environmental covenant.** This is a legal mechanism that 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. See Chapter 11 for more information.

Worksheet: Planning for consolidation and capping

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

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

3. **Soil cap -** 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 $_____

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

5. **Total estimated costs**

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

This page left blank intentionally

Chapter Seven: Compliance Sampling

Purpose: Sampling to determine if excavation or mixing worked. Samples must meet state cleanup levels for arsenic and lead.

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 Form 7 to record the sampling area, sample numbers, and locations. You may treat contiguous decision units with the same cleanup remedy all as one unit for compliance sampling (Figure 9).

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 specific parcel. In this case, determine the sampling area, and number and location of samples for each of the areas. Attach a separate diagram for each.

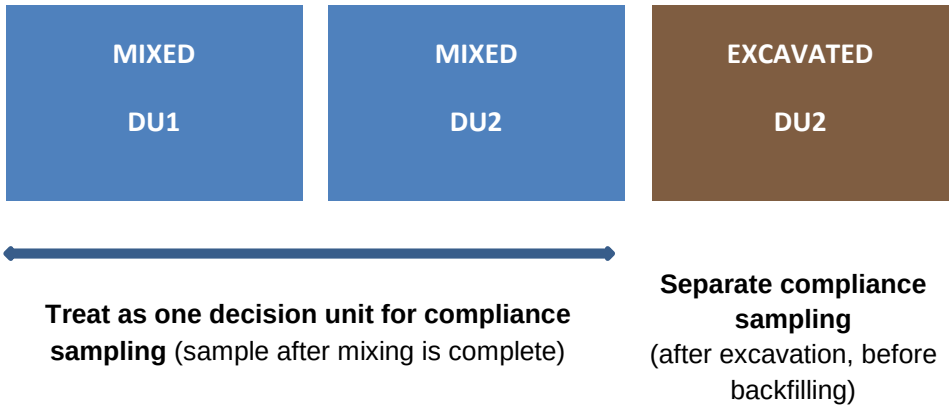


Figure 9. Combining decision units for compliance sampling

Table 4. Minimum number of compliance sample locations per decision unit

Sampling area size (acres) (X)	Samples needed (Y) Mapped arsenic >100 ppm	Samples needed (Y) Mapped arsenic <100 ppm
0.25*	**10***	**8**
1	**20**	**16**
5	**40**	**32**
10	**60**	**48**
20	**80**	**64**
100	**120**	**90**
>100	**120 + 1 per 5 acres**	**90 + 1 per 10 acres**

* The number of samples is calculated by a linear interpolation method, rounding up to the next whole number. Calculate the number of samples you need, using the following formula:

$$Y = Y_a + (Y_b - Y_a)* ((X - X_a) / (X_b - X_a))$$

a=lower acre
b=higher acre

Example 1: 2-acre residential property in the estimated arsenic concentration over 100 ppm:

Y = 20 + (40 – 20)* ((**2** – 1) / (5 - 1))
Y = 25

The number of samples for a 2-acre property calculated with the above formula would be 25

a=lower acre
b=higher acre

Example 2: 65-acre residential property in the estimated arsenic concentration between 20 and 100 ppm:

Y = 64 + (90 - 64)* ((**65** – 20) / (100 – 20))
Y = 79

The number of samples for a 65-acre property calculated with the above formula would be 79

When to sample

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

Number of samples and sampling grid

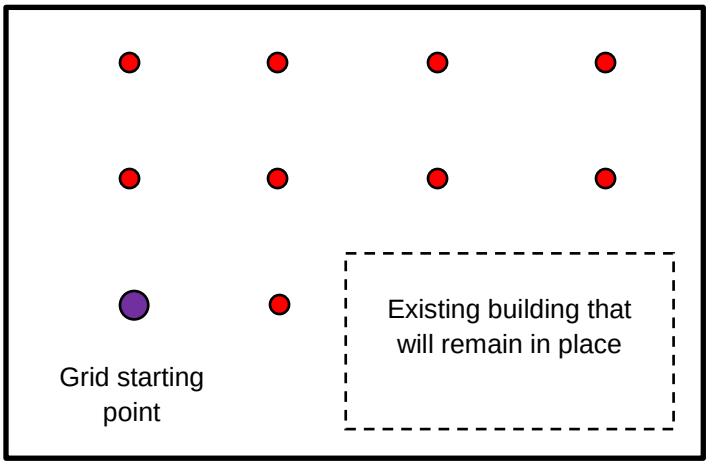
Use Table 4 to find the number of sample locations. It depends on the acreage and if the property is in a map zone where arsenic is over 100 ppm (see inside cover).

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 diagram, prepare a sampling grid (Figure 10):

Step 1: Enclose the entire decision unit inside a rectangle.

Step 2: Mark a location towards one corner of this rectangle as a starting point.

Step 3: Lay out sample locations in an evenly-spaced grid (Figure 10). Use the number of sample locations from Table 4. Grid points should cover as much of the decision unit area as possible.



Decision Unit Information

Use = Residential
Size < 0.25 acres (<11,000 ft^2)
Map area = arsenic >100 ppm

Samples needed = 10

Figure 10. How to lay out a sampling grid on a decision unit

Sample depth

Excavated soils: Take compliance samples from the top six inches of the soil surface after excavating the top layer (but not filled back in). Do this for every sampling location.

Mixed soils: For areas where you mix the soil, at **each sample location**, take samples at six- inch intervals from the entire mixed depth profile. For example, if you mixed to a depth of 18 inches, you need to sample at three depths—0-6, 6-12, and 12-18 inches below the surface.

Sampling process

Compliance sampling is similar to characterization sampling (Chapter 1). Begin by preparing the same type of equipment:

- Stainless steel tools to dig holes and remove soil (trowel or small shovel)
- Stainless steel or glass bowl for mixing
- Clean glass containers from the lab or zip-top plastic bags
- Permanent marking pen to record sample locations on the jar or bag
- Wash bucket, soap, scrub brush, and rinse water (distilled or deionized)
- Gloves and dust mask
- Paper towels
- Property diagrams with sampling grids
- Map or aerial photo of the decision unit

As in Chapter 1, take samples from each location marked on the decision unit diagrams. These should be collected as separate samples. Do not composite (mix) samples from different locations.

1. Before taking any samples, contact Ecology accredited lab. To find out more information see the Help Desk section (page 73) of this guidance. The lab may have special instructions about labeling and delivering the samples to their labs.
2. On your diagram, label each sampling location with a unique name or number.
3. With permanent marker, label the jars or zip-top bags with the sampling location identifier from the diagram. Mark your name, the date the sample is being taken, and "arsenic and lead".
4. Dig a six or twelve inch hole with the trowel or hand augur. Using a separate, clean trowel or spoon for each depth, scrape soil evenly from the sides of the hole and place it in the stainless steel mixing bowl.
5. Mix soil thoroughly in the bowl. It is important to mix the soil well. If you mix the soil in a Ziploc bag or sampling container, shake the container or the bag well or use a clean spoon. Fill up the jar or plastic bag with the mixed soil and seal it securely. Discard any extra soil back into the hole.
6. Scrub the trowel or shovel clean in the wash bucket and pour the dirty water down a sanitary sewer or in a place where it can soak into the ground. Do not pour it down the storm drain.
7. List all of the soil samples in the sample inventory on Form 7.

See the Help Desk section (page 73) of this guidance for how to select a lab. The lab must use methods 6010, 6020, or 6200 for arsenic and lead. Keep samples in a cool, dry place until they are analyzed. 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 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:

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

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

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. A complete packet should include:

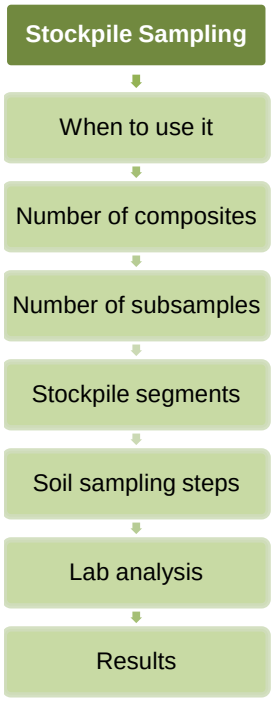
- Characterization sampling lab report and chain of custody
- Forms 1 and 2 (characterization sampling)
- Form 7 (compliance sampling)
- Compliance sampling lab report and chain of custody
- One completed form for each cleanup method used for all decision units
- Maps documenting characterization and 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 that cleanup was done and how to maintain any non-permanent remedies. Future property owners may want information if they sell their property. As awareness about the Tacoma Smelter Plume grows, more buyers will ask about soil contamination.

This page intentionally left blank

Chapter Eight: Stockpile Sampling



Purpose: To determine if a stockpile of soil meets state cleanup levels for arsenic and lead.

When to do stockpile sampling

- When sampling soils after excavation and 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 dispose of.

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 of or reuse onsite as clean. The samples are known as "composite" samples, meaning you are taking several subsamples and mixing them together for analysis. Use Form 8 to track your sampling.

Planning for sampling

Prepare the same type of equipment used in Chapter 2.

- 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 or plastic bags
- Permanent marking pen to record sample locations on the jar or bag
- 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 5 shows how many samples you need to collect for a certain volume stockpile. The number also depends on arsenic levels. Each composite should contain six subsamples that you mix into a single sample (Figure 11).

Table 5. Number of composite samples per stockpile

Stockpile volume (cubic yards)	# of composite samples (DU arsenic >100 ppm)	# of composite samples (DU 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	20 + 1 per 4,000 cubic yards	14 + 1 per 5,000 cubic yards

Example: Stockpile volume = 600 cubic yards

1. Divide the stockpile into four segments for four total composite samples.

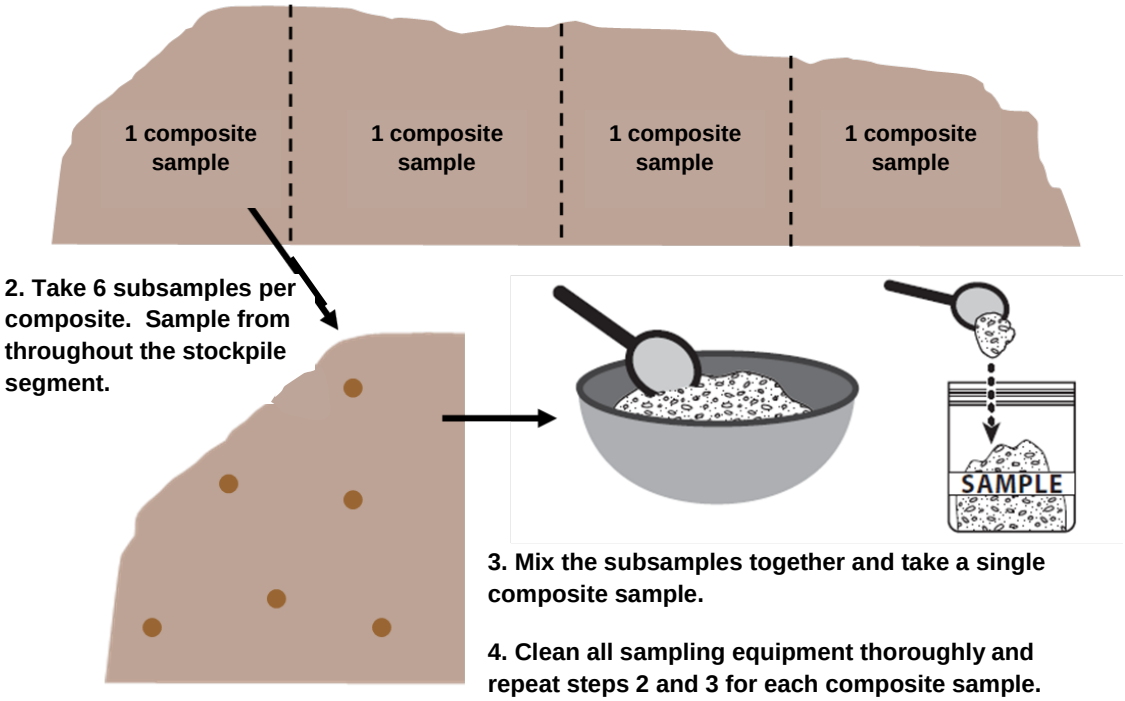


Figure 11. Stockpile sampling process

Sampling process

1. Before taking any samples, contact an Ecology accredited lab. To find out 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 11).
3. Using the permanent marker, label the glass jars or plastic bags 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, for 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. If you mix the soil in a Ziploc bag or sampling container, shake the container or the bag well or use a clean spoon. All subsamples should be the same size. Mix thoroughly with the stainless steel spoon. Scoop a jarful or bagful as your composite sample.
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 down a sanitary sewer or in a place 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 over 20 ppm for arsenic or 250 ppm for lead, that segment must be properly disposed of. If you want to reuse it on the property, you must cap it to meet model remedies requirements. If arsenic is at or below 40 ppm, you can mix the contaminated stockpiles with clean soils and test to ensure that arsenic is at or below 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.

Tacoma-Pierce County Health Department
http://www.co.pierce.wa.us/1519/Dirt

King County Landfills
http://your.kingcounty.gov/solidwaste/facilities/wasteclearance.asp

Thurston County Health Department
http://www.co.thurston.wa.us/health/ehhw/hwdisposal.html

Reusing soil on site as clean soil

For any stockpiles that do not exceed the unrestricted cleanup standards (page 20 0f this guidance), you may reuse the soils on the property.

Reusing soil off site (not to a permitted landfill)

For any stockpiles that do not exceed the unrestricted cleanup standards (page 20 of this guidance), you may reuse the soils off site under most circumstances. If soils are going to a location of terrestrial animal or plant importance (e.g. presence of endangered species), unrestricted cleanup levels may not be adequate. If contaminants are present that do not have an unrestricted cleanup standard, a different cleanup standard will need to be calculated. In these circumstances, you need to contact your local health department to assess what contaminant concentrations must be met before reuse the soil can be considered.

Chapter Nine: Imported Soils Sampling

Purpose: To determine if imported soil meets state cleanup levels for arsenic and lead.

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

Before you purchase soil, check with the supplier to ensure it has below 20 ppm arsenic and below 250 ppm lead. Some questions to ask your supplier include:

- 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 you are unsure of whether these soils meet state cleanup levels, sample the imported soil or ask the supplier to sample. Sometimes, imported soil can have other contamination too, such as petroleum. Consider testing the soil for other contaminants if you are unsure of its origin.

The samples are called “composite” samples, meaning you are taking many subsamples and mixing them together for analysis. Use Form 10 to track your sampling.

Number of composite samples: Take three composite samples from each stockpile of the imported soil source. Each composite should have three subsamples (Figure 12).

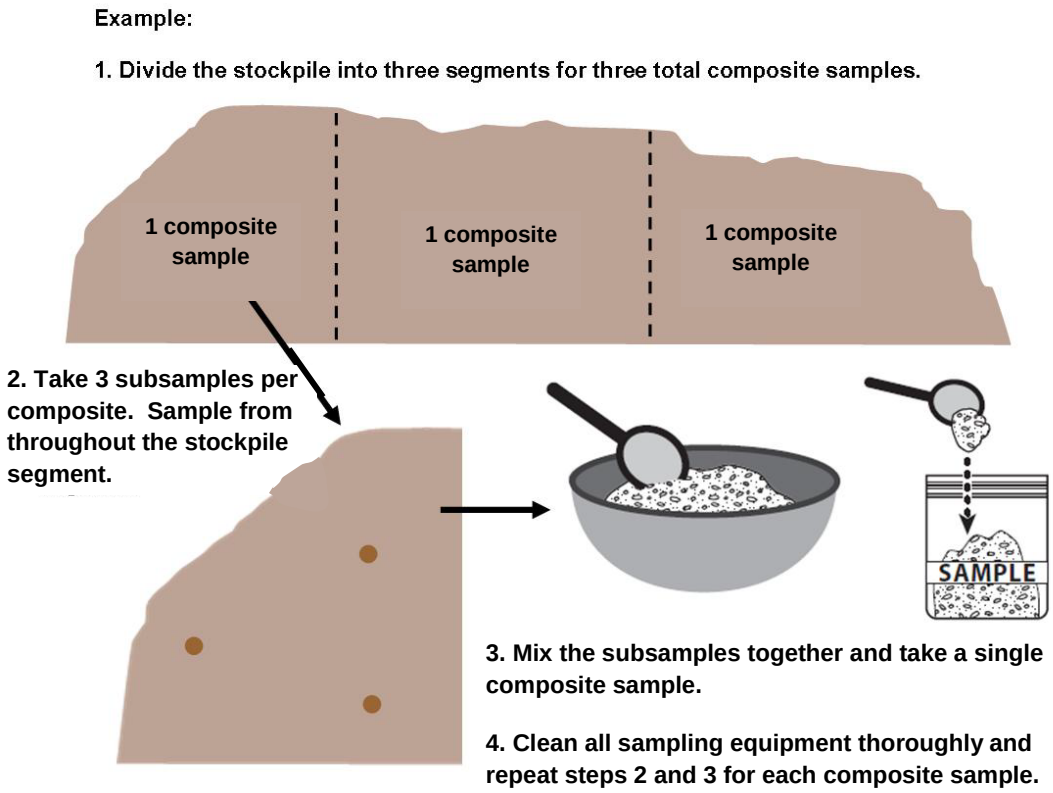


Figure 12. Imported soil sampling process (similar to stockpile sampling)

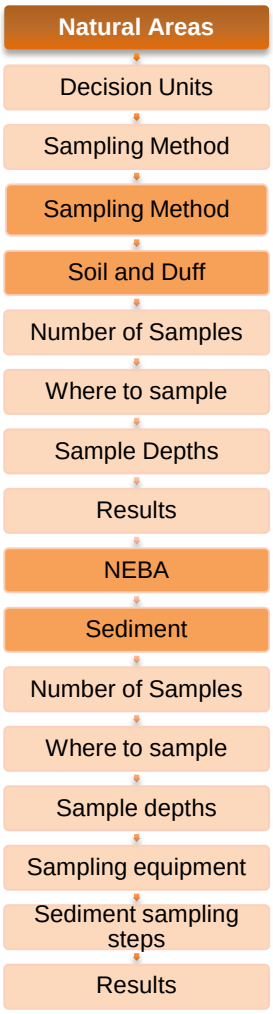
Sampling process

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 over 20 ppm arsenic or 250 ppm lead, the soil should not be used on the property.

Chapter Ten: Natural Areas



Purpose: To determine contamination levels and cleanup options for the natural areas of the property that are to remain undeveloped.

You may be planning to leave some of your property undeveloped. The property may have steep slopes, wetlands and wetland buffers, tree preservation areas, prairies, and other open space areas. Local government may require to leave an open space area or to limit the impervious surfaces, preserve valuable habitat or to provide a wildlife corridor. You must still sample these areas to determine the levels of the potential contaminants, and cleanup may be necessary.

Important: In order for a property to receive a No Further Action decision from Ecology, you must sample all parts of the property and cleanup may be required. For steep slopes and high quality habitat, it may be determined better for the environment not to conduct cleanup regardless of the contamination.

Ecology uses a Net Environmental Benefit Analysis (**NEBA**) to weigh the benefits of an active cleanup against the impacts of the cleanup on the environment. The **NEBA** evaluates the undeveloped areas for presence of mature forests, wetlands, prairies or other areas that provide high quality habitat for wildlife species, including species listed under the Endangered Species Act (ESA). Disturbing high quality habitat with soil cleanup may be more harmful to the environment than leaving the contamination in place. Institutional controls (fencing, signs, and environmental covenants) and long-term monitoring, discussed in see Chapter 11 may be agreed upon as an alternative to active cleanup.

Decision units

Prior to sampling, identify the different types of environment in the natural areas on your property. You may have forested areas, steeply sloped areas, wetlands, wetland buffers, patches of trees, or open grassy areas. Separate the different areas and mark them as different decision units. They may have different patterns of soil contamination and may require different methods of sampling and remediation or none. The number of samples you will need to collect will be the same across the decision units. The sampling depths, however, will vary, depending on the type and quality of the environment in your

What is a Natural Area? Natural areas may include steep slopes, forested areas or areas covered with native shrubs, tree preservation areas, and native prairies.

What is NOT a Natural Area? Tidelands, shorelines, developed areas, parking lots, or areas that were clear-cut within the last five years.

decision units. Track the decision units on a map of your property (Figure 13). Future use may also define decision units. Some decision units may have areas that will not have public access; some may have trails or walkways.

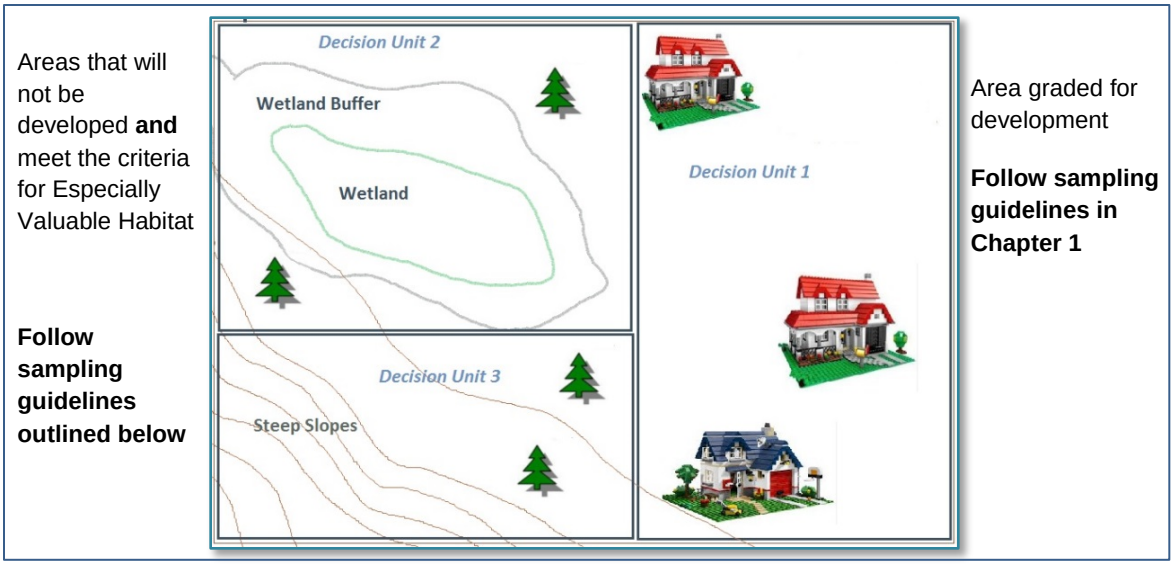


Figure 13. Dividing properties into decision units based on future uses

Selecting sampling method

When outlining your decision unit, separate disturbed areas from natural areas. Separating areas of native vegetation from areas with mostly invasive species helps to select the appropriate sampling method and then cleanup alternatives if the arsenic or lead levels are elevated. Also, separate wetlands from upland natural areas (wetlands from wetland buffers). Wetlands will involve sediment sampling, while upland natural areas involve soil sampling. Next, using Table 6, evaluate the habitat on your property to determine if you can designate it as an Especially Valuable Habitat (EVH).

If you can designate it as EVH, follow the sampling method outlined in this chapter. If your habitat does not qualify as an EVH, follow sampling method outlined in Chapter 1 of this guidance.

Especially Valuable Habitat

The determination of the existence of the EVH on your property early on in the planning process may speed the cleanup on your property. It will allow you to select the appropriate sampling method, so no resampling will be necessary**. Establishing whether you have EVH will enable you to use NEBA as an alternative to active cleanup.** You can evaluate the natural area on your property based on the habitat characteristics outlined in Table 6 below. If the natural area on your property matches at least one of the habitat characteristics listed in the left column, you can

designate it as an EVH. ***Note: this will be a preliminary determination. The VCP Site manager will make the ultimate decision on the EVH determination.***
Your property may also qualify as an EVH if an experienced field biologist visits your property and determines that your property may be potentially used by federally or state listed species:

- Threatened or endangered species protected under the ESA may potentially use this area
- Priority species or species of concern may potentially use this area
- Endangered or threatened or sensitive plants may potentially be found within this area

Table 6. Determination of Especially Valuable Habitat

EVH – Qualifies for NEBA*	Not EVH – Perform active cleanup
Forests with native plant and animal species	Noxious weeds, like Scotch broom or Himalayan blackberries
Threatened or endangered species habitat (both plants and animals)	Recently logged, cleared, or similarly disturbed
Wetlands or banks of water bodies (rivers, streams, ponds, lakes)	Current or former agricultural lands
Native prairies	Fields covered with non-native grass
Steep slopes, ravines, or other areas prone to erosion	Reclaimed areas that were under pavement

***** For more information, refer to WAC 173-340-7490 (Terrestrial ecological evaluation procedures).

If the natural upland areas on your property do not meet the criteria for an EVH, you cannot use NEBA for the natural areas on your property. Sample the soil and duff on your property following the guidance in Chapter 1. Your property will likely have to be remediated if the arsenic and lead levels are elevated (See Figure 14). If you are not sure, which category your natural area falls into, contact the Technical Assistance Coordinator, who will assist you with the determination.

You can also involve an experienced field biologist to determine if the area on your property qualifies as EVH. The biologist must visit the property and document the following:

- Threatened or endangered species protected under the ESA may potentially use this area

- Priority species or species of concern may potentially use this area
- Endangered or threatened or sensitive plants may potentially be found within this area

If you or the biologist determines that the natural area qualifies as an EVH, follow the soil sampling guidance in this chapter and proceed with NEBA.

If you have wetlands on your property, sample the upland areas following the guidance outlined in Section 10.1 **and** the sediment, following the guidance outlined in Section 10.2

Figure 14. Determination of the sampling methodology

10.1 Upland Natural Areas Qualifying as Exceptionally Valuable Habitat – Soil and Duff Sampling

Number of soil samples

Use Table 7 to find the number of samples, which will depend on:

1. **Location** – Is the property in an area with estimated arsenic between 20 and 100 ppm or over 100 ppm (see map on inside cover)?
2. **Size** – How big is the area?

Table 7. Minimum number of soil sample locations in natural areas

Sampling area (X)	Forest and open land Samples needed (Y)	
Acres	**Arsenic >100 ppm**	**Arsenic 20-100 ppm**
0.25	8*	8
1	16	12
5	30	24
10	40	32
20	50	40
100	70	60
>100	70 + 1 per 10 acres	60 + 1 per 10 acres

* The number of samples is calculated by a linear interpolation method, rounding up to the next whole number. Calculate the number of samples you need by using the following formula:

$$Y = Y_a + (Y_b - Y_a)^* ((X - X_a) / (X_b - X_a))$$

a=smaller acre

b=larger acre

Example: 2-acre property in the estimated arsenic concentration over 100 ppm:

Y = 16 + (30-16)* ((2 -– 1) /(5 – 1))
Y = 20

The number of samples for a 2-acre property calculated with the above formula would be 20

Soil: Where to sample

With Form 1, attach a diagram showing the property dimensions and decision units. For multiple decision units, attach a separate diagram for each, with dimensions and showing the location of any wetlands and wetland buffers. For each decision unit diagram, prepare a sampling grid (Figure 15).

Step 1: Enclose the entire decision unit inside a rectangle. It is fine to have small margins around the edges.

Step 2: Mark a point towards one corner of this rectangle as a starting point.

Step 3: Start with this point and begin laying out sample points in a grid. Whenever possible, lay the grid in an evenly spaced pattern (Figure 15). Use the number of locations from Table 7. 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.

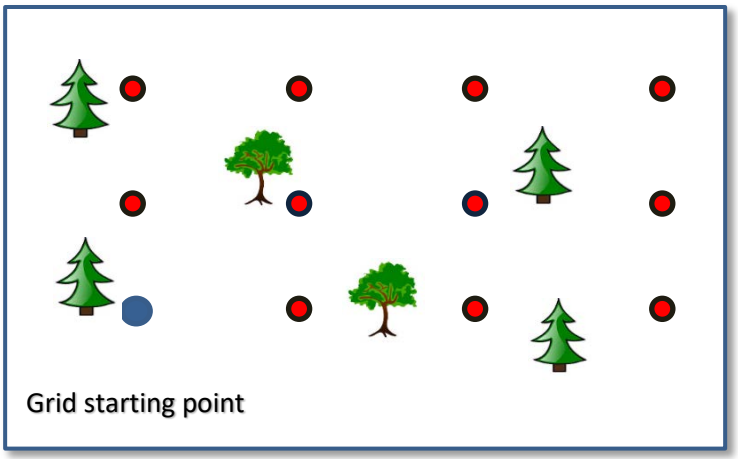


Figure 15. How to lay out a sampling grid

If you have steep slopes: It is important to determine the contamination level in steep areas. Some situations, however, will require balancing between the safety of the sampling crew, the stability of the slopes and the adequate characterization of the contamination. When planning your sampling, exclude areas that are hazardous to sample and are subject to sloughing. Choose areas that are safe to sample, but are representative of the entire area. When excluding the areas that are too hazardous, sample safer areas that are similar in vegetation, soil composition, and topography.

Soil sampling depths: At every location, take soil samples from four depth intervals (Table 8). These additional depths will be used to evaluate possible impacts to plants and animals. At every sample location, clear away the larger, undecomposed organic material that you can easily identify, such as grass, leaves, twigs, rocks, or other debris from the surface. If you have forest duff, do not scrape it off, but collect it as part of your upper layer soil sample.

Equipment needed for soil sampling is listed in Chapter 1 of this guidance.

Soil sampling steps are listed in Chapter 1 on page 14 and 15 of this guidance.

Lab analysis - See the Help Desk section of this guidance (page 73) for how to select a lab. The lab must use EPA methods 6010, 6020, or 6200 (for arsenic and lead).

Keep samples dry at a temperature of 4°C or lower 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.

What is forest duff? Moderately decomposed leaves, needles, and other plant material that has gathered on the soil surface. Duff is under the litter, which is organic material such as leaves, twigs

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 a chain of custody form to track the samples. Keep everything you receive from the lab.

Table 8. Sampling depth profile

Upland open areas, steep slopes, forested areas, wetland buffers
0-6" - collect at **every** location*
6-12" – collect at **every** location
12-24" – collect at **every** location
24-36" – collect at **every fourth** location

* includes duff

"Elevated" arsenic and lead levels in soil

- Average* arsenic >20 parts per million (ppm)
- Max arsenic >40 ppm

- Average* lead >250 ppm
- Max lead >500 ppm

**Arithmetic average*

Upland Natural Areas: Soil - Understanding your characterization results

Review the results to determine if arsenic or lead are "elevated." Calculate the average arsenic and lead for **each sampling depth and for each sampling location**. See Table 9 for an example on calculating the average arsenic and lead concentrations for your samples. Mark the locations with elevated levels of arsenic or lead.

Table 9. Example of calculating the average for sampling depths and locations

Sampling depth (inches)	Sampling location	Arsenic (ppm)	Lead (ppm)	Average arsenic across sample depth (ppm)	Average lead across sample depth (ppm)
0 to 6	1A	46	82	28	81
6 to 12	1B	24	64	17	63
12 to 24	1C	10	24	10	29
24 to 36	1D	8	12	7	16
Location Average:		22	46		
0 to 6	2A	27	60	28	81
6 to 12	2B	18	44	17	63
12 to 24	2C	12	22	10	29
24 to 36	2D	7	16	7	16
Location Average:		16	36		
0 to 6	3A	12	100	28	81
6 to 12	3B	10	80	17	63
12 to 24	3C	8	40	10	29
24 to 36	3D	6	20	7	16
Location Average:		9	60		

If arsenic and lead are **not** elevated in **any** of the locations **and** if the averages for **each** sampling depth are **not** elevated, stop here. You are done. You do not need to remediate the soil. None of the individual samples may exceed 40 ppm for arsenic or 500 ppm for lead.

If arsenic or lead levels are elevated in any of the locations or any of the sampling depths, you may be able to use NEBA in place of active remediation or you may need to remediate the area. This is the time to contact Ecology's VCP Site Manager for assistance (See page 3 for how to contact the VCP Site Manager).

The NEBA Process

The first steps involve documenting plant and wildlife species found on the property. The next steps involve evaluating the potential effects of soil contamination on the documented species. The NEBA process may also include collecting additional soil samples for invertebrate analysis. These tasks are done by an experienced field biologist, who must document the following for the entire area that will remain undeveloped:

1. Document native and non-native plant and wildlife species found at the property
2. Document if the native plants are well established (primary or secondary

growth)

3. Document signs of uptake of the contaminants by plants by observing if there is:
    - ✓ Wilting
    - ✓ Chlorosis (pale, yellow off white plan tissue)
    - ✓ Browning
    - ✓ Excess mortality
    - ✓ Reduced growth, photosynthesis, mitosis, or dehydration

Document signs of contaminant uptake in soil biota:

- ✓ Limited numbers of plants

Document signs of uptake of the contaminants by wildlife:

- ✓ Muscular incoordination
- ✓ Debility
- ✓ Slowness
- ✓ Jerkiness
- ✓ Falling
- ✓ Hyperactivity

Soil Sampling for Invertebrate Analysis

Recommend consulting with Ecology's VCP Site Manger before proceeding with sampling for invertebrate analysis.

Number of samples: Depends on the number of soil samples you originally collected to characterize the contamination. Collect soil samples for invertebrate analysis at every fourth sample location. For example, if you originally collected 20 soil samples – you will need to collect five soil samples for invertebrate analysis. At a minimum, collect two soil samples for invertebrate analysis.

Where to sample: Choose sampling locations in areas that look similar to each other in terms of terrain, vegetation, soil depth, or color. Collect one sample from every fourth location of the original soil sampling. Mark the locations of the samples on the original diagram, where you collected the soil samples for chemical analysis.

Equipment needed:

1. 25cm by 25cm wooden frame
2. Shovel
3. Clean and labeled 2-gallon plastic bucket with a lid
4. Distilled water

Soil Sampling Steps:

1. Place the wooden frame at each sampling location (See Figure 16). Remove the leaves, forest duff, and soil from within the sample frame to a depth of 6 inches
2. Place the duff and the soil scraped off from within the frame into the plastic bucket
3. Add 50 ml of distilled water to the plastic bucket
4. Seal the bucket with a tight seal and transport to the laboratory. Store samples at room temperature until processed

Lab analysis: Use the procedures outlined in the Environmental Protection Agency (EPA) Standard Operating Procedure for Benthic Invertebrate Laboratory Analysis, Publication No. LG 407, revised April 9, 2015.

Figure 16. Soil sampling

Report your findings: Prepare a report summarizing the findings of the field biologist and contact Ecology's TA Coordinator. The TA Coordinator will review the findings and conduct a site visit. They will then make a determination of whether the natural area on your property will require soil remediation and will recommend next steps in the process. Figure 14 outlines the general NEBA process.

10.2 Wetland – Sediment Sampling

Sediment: Number of sediment sampling stations per wetland

Use Table 10 to find the number of sample stations you need. Depending on the time of year, there may not be enough standing water to collect water samples. Take and analyze the sediment samples throughout the delineated (by a professional wetland biologist) wetland area nonetheless. Freshwater sediment cleanup levels for arsenic and lead that are protective of bottom-dwelling organisms are 14 ppm and 360 ppm, respectively.

Table 10. Minimum number of sediment sample stations

Sampling Area Acres*	Sampling Stations Needed
0.25	2
0.5	3
1	5
5	6
10	7
20	8
>20	8 + 1 per 10

*If the size of your wetland is in between the sizes in the left column, round down or up the number of sample locations to the next sampling area size. For example for a wetland that is <2.5-acres round down to the number of samples for the 1-acre wetland; for a wetland that is >2.5-acres round up to the numbers of samples you will need to take for a 5-acre size.

Calculate the size of each area separately to estimate the number of samples needed. For example if the open water area is 0.25 acres, and the remainder of the delineated wetland is 1 acre, take 2 samples from the open water area and 5 samples from the dry area of the wetland.

Sediment: Where to sample

Before you sample the wetland, make sure that the wetland has been delineated within the last 10 years. If not, wetland delineation needs to be conducted by a professional. Wetland delineation includes sampling hydrophytic vegetation, looking for signs of hydric soils or for indicators of wetland hydrology. Wetland delineation based on vegetation sampling during drier portions of the growing season or during atypical seasons can be challenging. At these times, professional judgment may be required to adapt vegetation sampling or other sources of information to determine the extent of your wetland. Follow the methodology outlined in the Regional Supplement to the Corps of Engineers Wetland Delineation Manual.

Create a map of your project. Using the map, estimate the size of the wetland and select the appropriate number of random sampling stations based on Table 10. Calculate the size of each area separately to estimate the number of samples needed. For example if the open water area is 0.25 acres, and the rest of the delineated wetland (excluding the wet area) is one acre, take two samples from the

open water area and five samples from the dry area of the wetland.
You will be taking samples from two depths at each sampling location. Mark them on your map and designate them as sampling stations (see Figure 17 for an example). Obtain GPS coordinates for all sample stations and record them in latitude and longitude using state plane coordinates (Washington State Plane North or South Zone with a datum of NAD 83 HARN in units of U.S. survey feet).

Sediment sampling depths: Table 11 outlines the depths at which to sample. Avoid sampling in any areas that may skew the sampling results. Sediment accumulation may differ near fallen logs, boats, docks, or other structures. In areas where the potential arsenic contamination is over 100 ppm, you may want to collect twice the volume of sediments and archive them. This may save time and money in cases where samples show concentrations are above cleanup levels. You may need to conduct further biological investigation to determine if the cleanup will be necessary if instructed by the VCP Site Manager. The maximum amount of time you can retain samples for future bioassay analysis is 8 weeks at 4°C.

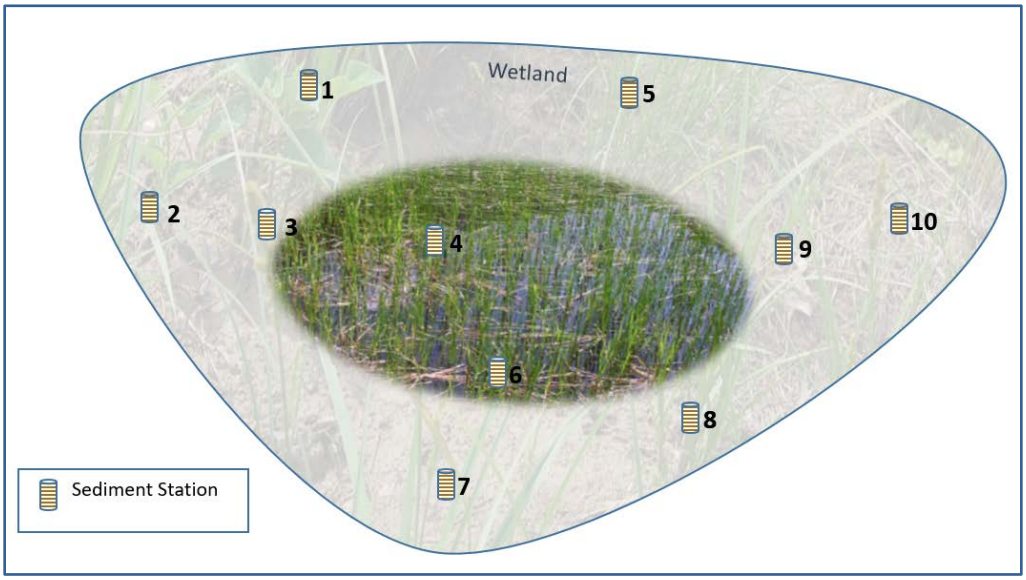


Figure 17. Example of a sampling layout in a wetland

Table 11. Samples needed in each sampling depth in a wetland

Sample Depth	Sediment Sampling Stations									
	1	2	3	4	5	6	7	8	9	10
0-4”	1	1	1	1	1	1	1	1	1	1
4-8”	1	1	1	1	1	1	1	1	1	1
Total per station	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**

Equipment needed: Sediment sampler: hand-held core sampler (auger) with 2" plastic tube for smaller wetlands. For larger wetlands, it may be advantageous to use larger grab samplers, such as Ponar or Petite Ponar that require operation form a boat and a winch. See Appendix A for a comparison of sediment samplers

- ✓ Ice chest with extra ice
- ✓ Wash bucket, Liquinox (or other phosphate-free) detergent, scrub brush and rinse water (deionized or distilled)
- ✓ Paper towels
- ✓ Plastic bags (ziploc, trash)
- ✓ Clean glass or polyethylene sample containers provided by the chemical laboratory
- ✓ Aluminium foil to wrap cleaned equipment
- ✓ Non-talc, disposable nitrile gloves
- ✓ Permanent marking pen to record sample location on the sample container
- ✓ Stainless steel scoop or spoons
- ✓ Map or aerial photo of the area with delineated decision unit and sampling grid
- ✓ GPS unit
- ✓ Ruler for measuring depth (stainless steel)
- ✓ Chain of custody forms
- ✓ Chain of custody seals (provided by the chemical laboratory)
- ✓ Field log
- ✓ Personal gear, appropriate for the project (boots, waders, rain gear, etc.)
- ✓ Pipetter for siphoning water out

1. Stainless standard steel Ponar grab

2. Hand corer with 2-inch tube

3. Stainless steel scoop and spoon, pipette

4. Miscellaneous supplies

Sediment sampling steps: Sample from the least contaminated station to the most contaminated station if possible.

Selection of the sampling equipment: In smaller wetlands and shallow water, where the use of a boat is not feasible use small grab samplers or hand-held sediment corers. For larger wetlands, select the sampler appropriate for the site and feasible to use (See Appendix A).

1. Before you sample, clean all non-disposable sampling equipment with Liquinox of other equivalent detergent, followed by a rinse with deionized water.

2. Dry your equipment and wrap in aluminum foil or plastic wrap for

transportation to the sampling site.

3. Lower the sampler at a slow, controlled speed to avoid creating turbidity. Pull the sampler back up with the same steady speed. When using a Ponar grab, make sure not to over-fill it and that the overlaying water is not excessively turbid. The sediment surface needs to be flat. When collecting sediment samples wading in water, sample in front of you and not in the areas that you waded through to avoid excessive turbidity.

4. If the use of an auger is not practical due to the presence of water, use a smaller grab sampler.

5. When using the Ponar grab, siphon off the overlying water with a pipette and remove the sediment with a stainless steel scoop. Avoid collecting sediment in contact with the sides of the sampler or cut away the outer most layer of the core sample and discard it. The smearing action that occurs during sample collection can contaminate adjacent sections of the core and bias the results.

6. Wear gloves when collecting the samples.

7. Make sure that you achieved the sampling depth (~ 1 – 2 inches more than the targeted depth).

8. Remove debris from the samples – large pieces of wood, bark, leaves, and rocks and note these in the sampling log.

9. If the sediment sample does not meet all the criteria outlined in steps 1 – 3, discard the sample and take another. Collect at least 4 ounces of sediment for each discrete sample (since analysis for metals requires approximately 2 ounces of sediment, this allows for an additional sample in case there are problems with the first).

10. Section the samples according to the required sample depths outlined in Table 11 and place the sections into the appropriate sample containers. If you cannot process the samples immediately, place the core samples on ice in vertical position and transfer them to the lab until you can process them. Do not composite samples collected from the same depths at different stations.

Freezing the samples helps cut away the outermost layer of samples to prevent cross contamination between sediment layers

11. Use the brush to clean the sampler and the stainless steel scoop. Rinse them with deionized water between sampling stations.

12. Use clean glass or polyethylene tubes for sample containers. Store samples from each sampling depth in separate containers to avoid cross-

contamination. Consult your laboratory on appropriate containers and volumes required for your specific project. Most labs will supply clean sample containers with instructions.

13. Label samples clearly with the sample ID and related information according to the sampling plan. Make sure that the sample containers are not leaking. If necessary, secure them with tape. Wrap glass sample containers with bubble wrap to prevent breakage.

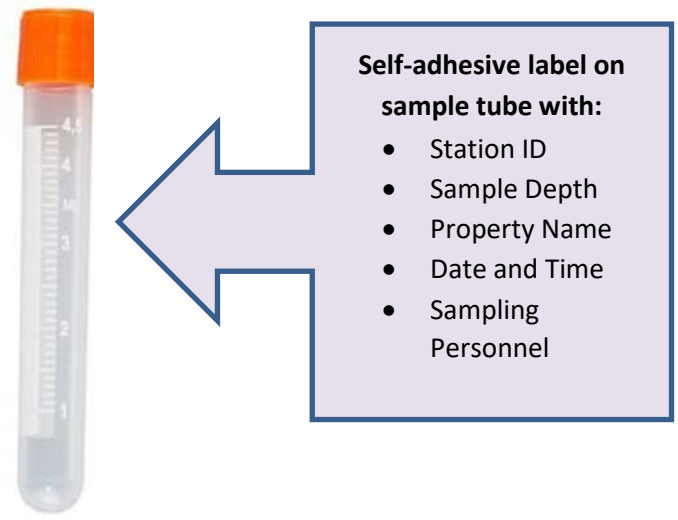
14. Generally, you can dispose of samples that will not be used back to the water at the station where you collected them. However, if you see obvious signs of contamination (oily sheen, smell, other waste), retain the sample for appropriate disposal. Where to dispose the samples will depend on the results of the other samples collected at the same station.

15. Take photographs of the sediment samples.

16. Transport the samples to the laboratory on ice (at 4 °C).

17. Field log – keep detailed records of your sampling. In your log, record site name, sample IDs, GIS coordinates, stations, date, time, gear, sediment sampling interval (lower and upper depths within the sediments relative to the sediment-water interface), water depth and deviations from standard procedures.

18. Fill out chain-of-custody form and send it to the laboratory accompanying the samples. Include in your form, sample ID, time and date of the sample collection, project name, and the name of the person who collected the samples.



Wetlands: Sediments - Understanding your characterization results

For protection of benthic invertebrates in freshwater sediment, "elevated" arsenic is > 14 ppm and for lead is >360 ppm.

Calculate the average arsenic and lead for each sediment depth sampling station. Arrange your sampling results by the sampling depths and sort them by decreasing values. Calculate the averages for the three highest arsenic concentrations within each depth interval. Repeat for lead. Note that the highest lead concentrations may be in different stations than the highest arsenic concentrations (See example in Table 12).

Table 12. Calculating average arsenic

Sample Station	Sample Depth	Arsenic (ppm*)	Lead (ppm)
1	0 - 4"	20	30
2	0 - 4"	15	50
3	0 - 4"	15	40
4	0 - 4"	10	60
5	0 - 4"	5	20
Average of highest three		17	50
Average for all 0 - 4" interval		13	40
6	4 - 8"	15	80
7	4 - 8"	20	70
8	4 - 8"	15	60
9	4 - 8"	25	50
10	4 - 8"	10	40
Average of highest three		20	70
Average for all 4" - 8" interval		17	60

*ppm – parts per million

If none of the stations within the wetland have "elevated" arsenic or lead levels, stop here. Report your findings to the VCP Site Manager. The manager will review your findings to verify that the arsenic and lead levels meet the state sediment cleanup levels.

Generate a report of your findings including the sampling stations and the laboratory results. Indicate in your report the stations with elevated arsenic and lead levels. Elevated levels of arsenic or lead in sediment do not necessary lead to active remediation. The VCP Site Manger will discuss with you upon the review of your report the most effective and feasible options of managing the elevated levels of a

Chapter Eleven: Environmental Covenants and Institutional Controls

Purpose of institutional controls: To restrict access to areas with remaining contamination, to protect the remedy, and to protect human health.

Purpose of environmental covenants: To inform future property owners of contamination left on the property and the need to maintain the remedy.

Institutional controls include:

Site access restrictions, which prevent or discourage people from accessing a contaminated area. Common access restrictions are fencing, warning signs, or a combination of both.

Land use restrictions, which are legal measures such as environmental covenants. They warn future landowners of contamination. They also prevent activities or land uses that could make the cleanup less effective, such as removing or digging through a cap.

Environmental covenants or clauses in sales contracts can ensure ongoing monitoring and maintenance even when land ownership changes.

Land use restrictions can discourage direct contact, but unlike site access restrictions, they do not provide a physical barrier to contact.

When to file an environmental covenant

Capping in place and consolidation and capping model remedies both require environmental covenants. If portions of your property have elevated arsenic or lead levels and you can qualify to use NEBA in lieu of active cleanup, you also need the environmental covenant.

Environmental covenants are recorded with the county and remain with the land until all contamination is cleaned up. They warn future property owners that contamination remains, and explain how to maintain the cap or access restrictions such as fencing and educational materials.

What to include in an environmental covenant

Prepare the environmental covenant using Ecology's template, found at the bottom of: Establishing Environmental Covenants.

At a minimum, the covenant should include:

- 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

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 may be 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 can also help protect a capped area.

For more educational materials, visit: Dirt Alert Program

Help Desk

Selecting an analytical lab

Ecology maintains a list of labs accredited by the state to do soil analysis (Laboratory Accreditation). The lab must use methods 6010, 6020, or6200 for arsenic and lead. The above 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? (Currently $30-60 per sample.)

Hiring and working with a consultant

You may want to start the search by asking other companies in your industry, environmental professional organizations, and banks for recommendations. Follow up with your own research. 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 similar completed projects and references.
- What work might be subcontracted? Request the names of their subcontractors and check their experience.
- 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)?
- Do your firm and 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 it 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 sign the covenant.

Utility trenches - Utility trenches are excavations. Typically, contamination will not extend any 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.

Storm water swales - Areas planned for storm water 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 8) will be needed for a Waste Disposal Authorization
- Follow Department of Labor & Industries worker safety regulations
- Ensure that the final construction covers any bare soil

Other situations - For situations not covered by this guidance, call 360-407-6300 and ask for Ecology's Tacoma Smelter Plume Technical Assistance Coordinator.

Healthy actions to reduce exposure to contaminated soils

Anyone living in the Tacoma Smelter Plume, or working or playing in 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
- Keep pets clean

For a full list of healthy actions, visit: Healthy actions – protect yourself from arsenic and lead in dirt

This page intentionally left blank

Form 1 Characterization Sampling

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

Part 1: Determine your decision units

1. Total property size: _____ acres

2. 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 larger than 0.25 acres
- ☐ Property currently or historically had a mix of forested and developed 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 wetlands
- ☐ Areas have forest duff that needs separate sampling

4. On the next page, list the decision units on your property and their size in Table 1. Use Table 2 to determine the number of samples needed for each decision unit.

Part 2: Soil sample depth in upland areas

5. Fill in Table 1 on the following 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:** Take soil samples from 0-6 inches below ground surface (bgs), 6-12 inches bgs, 12-24 inches bgs, 24-36 inches bgs from every location
- **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 you to which you will mix
- **For forest duff:** Take six subsamples throughout the decision unit and combine into one sample. If your decision unit is larger than 0.25 acres,

calculate how many composite duff samples to take using Table 1a in Chapter 1 of this guidance

Part 2A: Soil sample depth in wetlands

- **At every location:** Take samples from the top 0-4 inches of sediment
- **At every location:** Take samples from the top 4-8 inches of sediment

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 by planned use and estimated arsenic level.

Sampling area	Residential, parks, commercial **(# samples needed)**		Forest and open land **(# samples needed)**	
Acres	Arsenic >100 ppm	Arsenic <100 ppm	Arsenic >100 ppm	Arsenic 20-100 ppm
0.25*	**10**	**8**	**8**	**8**
1	**20**	**16**	**16**	**12**
5	**40**	**32**	**30**	**24**
10	**60**	**48**	**40**	**32**
20	**80**	**64**	**50**	**40**
100	**120**	**90**	**70**	**60**
>100	**120 +1 per 5 acres**	**90 + 1 per 5 acres**	**70 + 1 per 5 acres**	**60 + 1 per 5 acres**

*0.25 acres ~11,000 square feet

This page intentionally left blank

Form 2 Characterization Sampling Results

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

Filling in the sample inventory

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.

Optional: If you have duff, remember to sample and analyze that separately from the soil.

Next, fill in the date and time. Note any unusual observations (high soil disturbance, heavy rain, etc.) in the "Comments" column.

Complete the rest of the columns when you get the sampling results.

Determining if arsenic or lead is elevated

1. 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 exceeds 20 ppm, or average lead that exceeds 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**.
2. Circle every value where maximum **arsenic exceeds 40 ppm** and where maximum **lead exceeds 500 ppm**.
3. Attach a copy of your lab results and chain of custody.
4. For decision units with a circled value (maximum or average), note in the "Comment" column that cleanup is needed for that entire decision unit. Turn to 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.

Soil Characterization Sampling Inventory Sheet

Property address: Phone: Sampled by:						Testing Parameters (ppm)			
DU	Sample no.	Soil Depth /Duff	Date	Time	Notes	Arsenic	Avg. arsenic	Lead	Avg lead

Sediment Characterization Sampling Inventory Sheet

Property address: Phone: Sampled by:						Testing Parameters (ppm)			
DU	Sample no.	Sediment depth	Date	Time	Type of samples collected (grab, core)	Arsenic	Avg. Arsenic	Lead	Avg Lead

Form 3 Excavation and Removal

Reminder: Keep a copy of the filled out forms to pass on to future property owners

1. Decision units being excavated **Depth**

_____ _____

_____ _____

_____ _____

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

- ☐ Water source for dust control
- ☐ Install erosion control devices
- ☐ Cover trucks carrying contaminated soil
- ☐ Rinsing area for truck wheels and quarry spall at the entrance
- ☐ Follow Department of Labor & Industries worker safety regulations

3. Soil disposal

Name of landfill facility: _____

Contact name and phone: _____

- ☐ Attached a copy of the Waste Disposal Authorization form

4. Source of new soils:

- ☐ Off-site soils - Supplier: _____

  Supplier phone: _____
- ☐ On-site soils

5. 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 certified to be clean by the supplier

6. Compliance sampling:

- ☐ Filled out Form 7
- ☐ Attached a map showing areas excavated and the depth of excavation

Form 4

Mixing

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

Decision unit	Area	Mixing depth

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

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

3. Equipment used

Type of mixing equipment: _____

4. Mixing method (check all that apply)

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

5. Stockpile sampling
Use stockpile sampling before spreading or disposal

- ☐ Filled out Form 8

6. Compliance sampling:

- ☐ Filled out Form 7 - required for all mixed soils left on the property

Form 5 Capping in Place

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

Decision unit	Type of cap	Cap depth	Geotextile used?

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

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

3. Source of soils: _____

Phone: _____

4. Environmental covenant

- ☐ Filed a deed notice with: _____ County

  Recording number: _____

5. Attachments

- ☐ Attached a map showing areas capped and any additional details about the cap a future property owner would need to know
- ☐ Attached a maintenance and monitoring plan
- ☐ Attached a copy of the environmental covenant

Form 6 Consolidation and Capping

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

1. Excavation and consolidation

Decision unit	Excavation depth

☐ Did compliance sampling after excavation and filled out Form 7.

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

☐ Have dust and erosion practices installed
☐ Follow Department of Labor & Industries worker safety regulations

3. Cap description (type and depth)

☐ Geotextile barrier used
☐ Attached a map showing both excavated and consolidated capped areas
Include details about the cap a future property owner would need to know

4. Source of soils: _____

Phone: _____

5. Environmental covenant

☐ Filed a deed notice with: _____ County

Recording number: _____

6. Attachments

☐ Attached a map showing areas capped and any additional details about the cap a future property owner would need to know
☐ Attached a maintenance and monitoring plan
☐ Attached a copy of the environmental covenant

Form 7 Compliance Sampling

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

1. Total acreage for each area excavated: _____acres

or mixed: _____acres

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

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

Table 1: Compliance samples by acre

Sampling area	**Samples needed**	
Acres	**Arsenic >100 ppm**	**Arsenic <100 ppm**
0.25*	10	8
1	20	16
5	40	32
10	60	48
20	80	64
100	120	90
>100	120 +1 per 5 acres	90 + 1 per 5 acres

* 0.25 acres ~ 11,000 square feet

3. Sample depth

Excavated areas = 0-6”

Mixed areas = total mixing depth profile: _____

samples per sampling location : _____ (one per 12” depth)

4. Attachments

- ☐ Attached a property diagram with compliance sampling grid overlaid (see Chapter 7). Show which areas were cleaned up and the locations of paved or built areas.

Filling in the sample inventory

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

Next, fill in the date and time. Note any unusual observations (high soil disturbance, heavy rain, etc.) in the "Comments" column.

Complete the rest of the columns when you get the sampling results.

Determining if arsenic or lead is elevated

1. Calculate average arsenic and lead levels for the area sampled and enter them on the inventory sheet. For each decision unit where average arsenic exceeds 20 ppm, or average lead exceeds 250 ppm, circle the average.*
2. Circle every value where maximum arsenic exceeds 40 ppm and where maximum lead exceeds 500 ppm.
3. Attach a copy of the lab results and chain of custody.
4. For each sampled area with a circled value (maximum or average), note in the "Comment" column that more cleanup is needed for that area. Return to Chapter 2 to review options for cleaning up those decision units.

If no decision units have elevated arsenic or lead, read Chapter 7 for next steps.

Compliance Sampling Inventory Sheet

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

Form 8 Stockpile Sampling

Reminder: Keep a copy of the filled out 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.

Filling in the sample inventory

List the composite samples by stockpile in the inventory on the next page. Next, fill in the date and time. Note any unusual observations in the "Comments" column. Complete the rest of the columns when you get the sampling results.

Determining if arsenic or lead is elevated

1. Mark each composite over 20 ppm arsenic or 250 ppm lead. These segments cannot be reused on the property. See Chapter 8 for next steps.
2. Attach a copy of the lab results and chain of custody.

Stockpile Sampling Inventory Sheet

Property address: Phone: Sampled by:					Testing Parameters (ppm)	
Stockpile no.	Composite Sample no.	Date	Time	Notes	Arsenic	Lead

Form 9 Imported Soils Sampling

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

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

Longer projects: If the project goes for 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 source soil 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 over 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: Planning for Sampling with sampling grid maps

- ☐ Appropriate number of samples per decision unit (0-6" depth)
- ☐ 25% of samples from 6-12"
- ☐ Sediment samples at two depth intervals (if applicable)

Form 2: Sample Inventory and Whether Soils Are Elevated

- ☐ 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".

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

Take compliance samples every 6" 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 Chapter 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.*

811 Know what's below. Call before you dig.

DEPARTMENT OF ECOLOGY
State of Washington

Southwest Regional Office
P.O. Box 47775
Olympia, WA 98504-7775
Reception: (360) 407-6300