APPENDIX F: ALLOCATION PROCESS IN THE LOWER DUWAMISH RIVER NATURAL RESOURCE DAMAGE ASSESSMENT

Each site that contributed to contamination in Lower Duwamish River (LDR) sediments was allocated a percentage of the natural resource liability based on specified criteria and decision rules. Allocations were made to specific land parcels, called ‘sites’ and not to Potentially Responsible Parties (PRPs). A site is defined as a group of contiguous tax parcels that contributed chemicals responsible for natural resource damages in the LDR. Our approach allocates only to the current property owner and does not attempt to allocate damages among historical and current owners, tenants, operators, generators or transporters. This convention is not intended to limit the liability of any party involved with these sites. Many sites have had numerous owners and tenants over the past several decades and current owners are encouraged to engage with these entities as part of settlement negotiations.

Allocations are based on data from Washington Department of Ecology (ECY), the U.S. Environmental Protection Agency (EPA) and other publically available reports produced over the last several decades. While available data are extensive, it is possible that other data exist that might influence the allocations. If parties identify additional data that that could impact proposed allocations, these can be incorporated into the analysis.

This allocation apportions responsibility for contamination in sediment in the Lower Duwamish River using footprint maps created for 27 Substances of Concern (SOCs). Each footprint delineates sediment concentrations that exceed threshold levels for injury to aquatic resources. The thresholds for determining injury reflect Washington State Sediment Standards and Effects Thresholds established in the scientific literature (See Appendix D for additional information). Footprint maps were constructed using sediment contamination data from 1991 to 2008 for 27 substances of concern, including but not limited to PAHs, PCBs, metals, and chlorobenzenes. A contaminant footprint map was developed for each substance of concern, reflecting the degree of contamination relative to threshold concentrations.

The impact of the SOC footprints was quantified using a Habitat Equivalency Analysis (HEA), producing Discounted Service Acre Year (DSAY) values for each footprint. The HEA is described in detail in Chapter 2 of this document. Sites that were potential contributors to contamination were identified using King County tax parcel data:
(http://www.kingcounty.gov/operations/GIS/PropResearch/ParcelViewer.aspx). We considered all parcels of land adjacent to the LDR and all non-residential properties between the main roadways parallel to the LDR (East Marginal Way and West Marginal Way). King County International Airport and Boeing Field parcels were also included because they are known to drain directly to the LDR. In addition to properties, the allocation also included public storm drains and combined sewer outfalls (SDs/CSOs) that discharge into the LDR. Residential parcels were not included, because releases of SOCs from residential properties were expected to be low and would likely be part of the contributions from CSOs and storm drains.

This initial identification process resulted in the designation of 458 non-residential sites for evaluation. In many cases, contiguous tax parcels were combined by owners or operators to support a common set of activities. For example, the King County International Airport encompasses five tax parcels. For allocation purposes, tax parcels used to support a common set of activities are grouped together and considered a single site. The combined parcels are assumed to share a consistent SOC discharge profile.

While sites further inland contribute to contaminant loads in LDR sediments, their effects are assumed to be captured through storm drains (SDs) and combined sewer overflows (CSOs) in the drainage basin. The discharges from these drains were considered as a potential source of SOCs separate from the adjacent tax parcels.

For parcels adjacent to the river, information from EPA and ECY on activities occurring on the site, substances used or stored on site, wastewater, soil, groundwater and other sampling data, reports of spills and releases and other factors were incorporated into the allocation.

Based on the footprint maps, tax parcel information and data from EPA and ECY files, responsibility for contamination was allocated using a tiered, hybrid approach. Wherever possible, individual footprints were allocated to specific parcels, small groups of parcels, or SDs and CSOs. In general, a parcel allocated responsibility in this way is adjacent to a footprint and is known to have stored, used and/or released the substance of concern on site. We also considered patterns in the gradient of contamination such as shown in Figure F1. Here, highest concentrations are seen near the presumed source on land, and concentrations decrease with distance from the source. A footprint was assigned to a storm drain or CSO if the associated SOC is known to be a common component of storm drains or CSOs and the associated footprint exhibited a spatial pattern consistent with nearby contaminant releases from the drain (Figure F1).

The allocation process requires the use of professional judgment, largely to address variability in the amount, type and quality of data available for each site. Sites are allocated responsibility only if there is a link (called a 'nexus' in the CERCLA regulations) between the site and contamination found in the LDR (Table F1). For each site and substance of concern, we examine three criteria:

1. Is there a pathway for the contamination to travel from the site to the LDR?

2. Is it more likely than not that the SOC was used or generated at the site or were actions conducted at the site which could result in the transfer of the substance of concern to the LDR?

3. Is the chemical found in the LDR adjacent to the site, on-site groundwater, on-site surface water, an NPDES discharge, or potentially erodible soil or sediment?

Figure F1. Hypothetical injury footprint showing a gradient of contamination emanating from a land-based source.

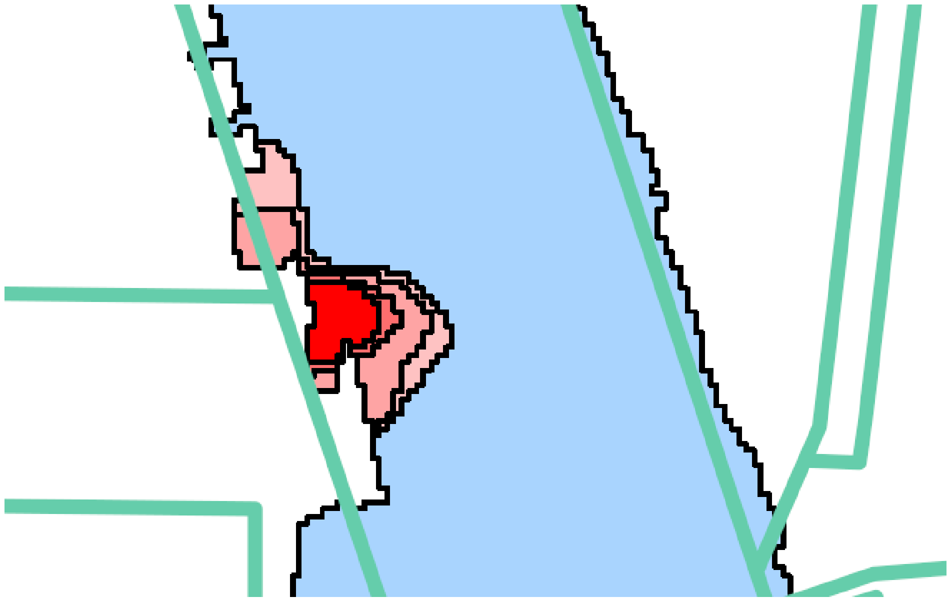


Table F1. Factors Considered to Trigger Allocation to a Site

1. Pathway. Is there a pathway for process water, surface water, groundwater, or sediment to travel from the site to the Duwamish Waterway?	Yes/No
2. Activity. Was an activity conducted at the site that is a likely source of an SOC or which resulted in the release of a chemical likely to exacerbate the impact of an SOC?	Yes/No
3. Evidence of Contamination	
a. NPDES violations	Yes/No
b. Surface water contamination	Yes/No
c. Groundwater contamination	Yes/No
d. Soil or sediment contamination	Yes/No
e. Sediment "footprint" in very close proximity to site.	Yes/No
To trigger continuation in the allocation process, the answers to 1, 2 and at least one component of 3 must be "**Yes**".	

A site is considered to be a source of the SOC if (and only if) the answer to all three questions is yes. First, a pathway must exist for process water[1], surface water, groundwater, or sediment to travel from the site to the LDR. Because sites identified for this allocation border or drain directly to the LDR, it is reasonable to assume the existence of a viable pathway for SOC transport at every site. Groundwater is very shallow along the LDR (5-10 feet below the soil surface), so contamination in soils can easily leach into the groundwater. Second, there must be evidence of on-site activities that could be a source of one or more SOCs or result in the release of substances that mobilized or otherwise exacerbated the release of one or more SOCs to the LDR. For example, the transport of lead from lead-painted surfaces would not be considered a potential release to the LDR. However, sandblasting of lead-painted surfaces to the adjacent ground would be considered a potential source of lead to the LDR, because of the deposition of waste grit material in shipways and other areas susceptible to stormwater or erosional transport.

Finally, we require evidence that one or more SOCs were present in site wastewater, discharges, soil, surface water and/or groundwater. Information used to make this determination included records of NPDES violations and contamination measured in surface water, ground water, soil or sediment.

Establishing the potential for an SOC release to the LDR depends on the amount of information available for each site. If site records are incomplete and therefore insufficient to satisfy the criteria discussed above, the site is not included in the allocation. As a result, the allocations may exclude viable contributors of SOCs to the LDR for which there are no publicly available data. Our evaluation process systematically and objectively used all data available at the time of the analysis. If additional information is made available it can be incorporated into the allocation at a later date.

The sequential steps and decision junctions in the allocation process are shown in Figure F2. This methodology produces a separate allocation for each of the 27 SOCs. For many of these SOCs, individual footprints could be linked to specific parcels. For others, we relied on a combination of footprint-specific and mass balance approaches. For example, some stretches of the LDR are broadly contaminated with a substance of concern potentially attributable to a large number of parcels. In addition, some discrete footprints are located in places that potentially implicate several sites and/or SDs/CSOs. In these cases, the allocation relied on a mass-balance approach. Sites in close proximity to the footprint that used, stored and/or released the substance of concern were given partial responsibility for the footprint, taking into account contamination gradients and likely contaminant transport dynamics. Estimates of each sites' relative contribution of the substance of concern were derived from EPA and ECY data and general reference information from the scientific literature. For Polycyclic aromatic hydrocarbons (PAH), the allocation relied solely on the mass balance approach, because PAH contamination is pervasive throughout the LDR at concentrations above injury thresholds. This was the only SOC treated in this manner.

[1] Process water is water used in a manufacturing or treatment process or in the actual product manufactured. Examples would include water used for washing, rinsing, direct contact, cooling, solution make-up, chemical reactions, and gas scrubbing in industrial and food processing applications.

A small set of footprints could not be allocated using either methodology. "Type I" unallocated footprints are those that could not be linked to a particular site, group of sites, or SD/CSO. "Type II" unallocated footprints are those that appear to be linked to a particular site, group of sites, or SD/CSO, but available data is not sufficient to trigger an allocation. However, a methodology was developed to allocate these footprints to parcels with a history of use of the particular SOCs.

Allocation by Unique Footprint

Under this approach, individual footprints were allocated to specific sites or SDs/CSOs. In general, the site allocated responsibility in this way is adjacent to the associated footprint, is known to have stored, used and/or released the substance of concern on site, and exhibits contamination gradients consistent with nearby contaminant release and LDR transport dynamics. In the case of CSOs or SDs, if the footprint is located next to the CSO or SD discharge to the river, and is a commonly detected contaminant in storm water discharge, then the footprint was assigned to the CSO or SD.

In assigning footprints to individual sites or SDs/CSOs, the following criteria were used:

- The footprint must be within or immediately adjacent to the tax parcel boundary of the “paired” site and no other site; or at the approximate point of discharge of a SD or CSO and not shared with a site, and
- The paired site must have an activity that could potentially result in the release of the SOC in question; or the contaminant must be commonly detected in storm water if the footprint is associated with a SD or CSO.

This approach reflects the common sense notion that discrete, elevated concentrations of SOCs found in sediments bordering a site should be attributed to that site when activities that used those SOCs took place. There is a possibility that these footprints received minor contributions from other sources. However, when a spatial and causal link between a footprint and a bordering site is apparent, we presume that impact diminishes with distance and thus rely on the likelihood that sources closer to the footprint dominate. The “Allocation by Unique Footprint” approach was the default allocation methodology used in the analysis. If a particular footprint did not meet the criteria listed above, the “Allocation by Mass Loading” approach was applied.

Allocation by Mass Loading

In some cases, SOC contamination is so widespread and diffuse that contamination footprints blend together and are not readily linked to specific sites. Footprints potentially associated with several sites are best allocated using a mass loading approach. The mass loading allocation is based on establishing the total loading of an SOC to the LDR from each site.

When the data are available, the most direct method to determine the mass released to the LDR is based on ’Flux’. The term flux applies to the time rate of release: for example, pounds per day. If the rate is multiplied by the duration (e.g., in days), total loadings released to the LDR can be calculated and relative contributions assessed through comparisons of loadings estimates. Unfortunately, in almost all cases, information was not sufficient to estimate SOC flux.

In most cases, the approach used assumed that the SOC mass released to the LDR will be a function of the type of activity, the scale and duration of the activity, and the fate and transport mechanisms for the contaminant. Under this 'Activity Ratings' approach, the scale and duration of the activity generally can be quantified (e.g. acres and years). While it is difficult to quantify the amount of an SOC potentially released by different activities, the absolute quantity of a release is less important than the relative quantity compared to other sources of the same SOC. Relative amounts can be estimated from information in the general literature and by analyzing site-specific information (e.g., groundwater and surface water data). The fate and transport mechanisms depend on the physical and chemical characteristics of the SOC and the location of the site and pathways by which the SOC could reach the LDR. In some cases the footprints for certain SOCs can be used to estimate the releases of other SOCs with less clearly defined footprints.

Table F2. Mass Loading Allocation Method for Shared Footprints (not PAH). For each Substance of Concern choose the best method – depending on data:

Allocation Index = (Duration Index) x (Flux)

Allocation Index = (Size Index) x (Duration Index) x (Activity Index)

Allocation to Site A = Allocation Index for Site A / ∑ Allocation Indices in Segment

Size and Duration Indices:

Size Index: Use the size of the site, or area of activity, in acres. If the size has changed, use the weighted size (weighted by years of different size)

Duration Index: Years from start of activity to present for on-going activities, termination of activity (for activities leaving no residual upland or groundwater contamination) or final cleanup. Use the same weighting for pre-1981 and post-1981 (it is assumed that waste generated prior to 1981 could lead to post-1981 releases).

Ultimately, both mass balance approaches (Activity Ratings and Flux) generate allocation indices that become the basis for apportioning responsibility for contamination between multiple sites. The Flux approach is used when sufficient data are available to quantify actual releases from the sites subject to a mass loading allocation. When such data were not available, the Activity Ratings approach was used to assign index values based on the type, duration, and size of activities that took place on site and are associated with relevant SOCs. Table F2 summarizes the Flux and Activity Ratings approaches for mass loading. Table F3 describes the Activity Ratings in greater detail. These methods require consideration of the fate and transport properties listed in Table F4, particularly when:

- The flux or release is measured at a significant distance from the LDR.
- The activity takes place at some distance from the LDR.
- Releases involving different pathways (surface water, groundwater, and soil/sediment erosion) are being added together or compared.

One SOC (PAH) was allocated solely through use of the mass loading approach because the contaminant concentrations were widely diffused throughout the LDR. Concentration gradients were discernable, but footprints were not readily defined. Thus, allocation to each site within the entire LDR was determined by mass loading, taking into account various sources of PAH to the Lower Duwamish River.

For all other SOCs, if a footprint was associated with more than one site, then the mass loading approach was used for allocation among sites. If one or more CSOs or SDs was located in the vicinity of a footprint and no site triggered within that area, then the footprint was assigned to the CSO and/or SD.

Unallocated Footprints

Some footprints could not be allocated using any of the methods described above. These unallocated footprints fit one of the following two categories:

- **Type I Unallocated:** The SOC footprints are not clearly adjacent to or otherwise linked to specific sites.
- **Type II Unallocated:** The SOC footprints abut or are adjacent to an individual site according to the criteria outlined above but no documentation exists to establish that activities at the site represent a likely source of the SOC in question.

To allocate the unallocated footprints we developed an approach based on a site’s share of the particular SOC allocated by the abovementioned methods. The total allocated and unallocated DSAYs in the study area were determined for each SOC. For each site that had DSAYs allocated for a particular SOC, the percentage of the total allocated DSAYs for that SOC was determined. Then, the site’s share of the unallocated DSAYs was calculated by multiplying the total unallocated DSAYs for a particular SOC by the site’s percentage of the allocated DSAYs for that SOC.

Here is a hypothetical example that illustrates the process described above:

- The HEA calculates a total of 200 DSAYs for contaminant A for the entire study area.
- Of the 200 DSAYs, 180 are allocated to multiple sites, 20 are from unallocated footprints.
- Site X, one of the sites responsible for contaminant A, is allocated 45 of the 180 DSAYs, or 25% of the total allocated DSAYs (45/180 = 25%).
- Site X's share of the DSAYs associated with the unallocated footprints for contaminant A is, therefore, 25%.
- Site X receives five additional DSAYs for contaminant A as their share of the unallocated footprints (20 unallocated footprint DSAYs * 0.25 = 5).
- Site X's total allocation for contaminant A is 50 DSAYs (45 allocated + 5 unallocated share).

Table F3. Activity Ratings

This table is intended to represent an initial screening of the relative ranking of activities with respect to their potential to release PCBs. Thus, all other things being equal (e.g. size, duration, degree of case, fate and transport, chemical concentrations, etc.) an activity near the top of the list is expected to result in the release of a greater mass of SOCs than an activity near the bottom of the list. However, where things are not equal the actual mass contribution could be much different than that implied by the order noted in the table.

PCBs	
Activity	**Activity Index**
PCB transformer recycling	High
PCB contaminated oil spill	↓
Recycling waste oil	↓
PCB transformer use	↓
Ship dismantling	↓
Vehicle recycling	↓
PCB use in oils and fluids for machining	↓
PCB use in paints, resins, sealants, and adhesives	↓
Ship maintenance	↓
Solvent mobilization of PCB's in the environment	Low

Table F4. Fate and Transport Considerations

Surface Water

- Flow path to the Waterway (e.g., distance, velocity)
- Presence of free product
- Chemical concentration
- Potential for volatilization and degradation
- Adsorption to sediments

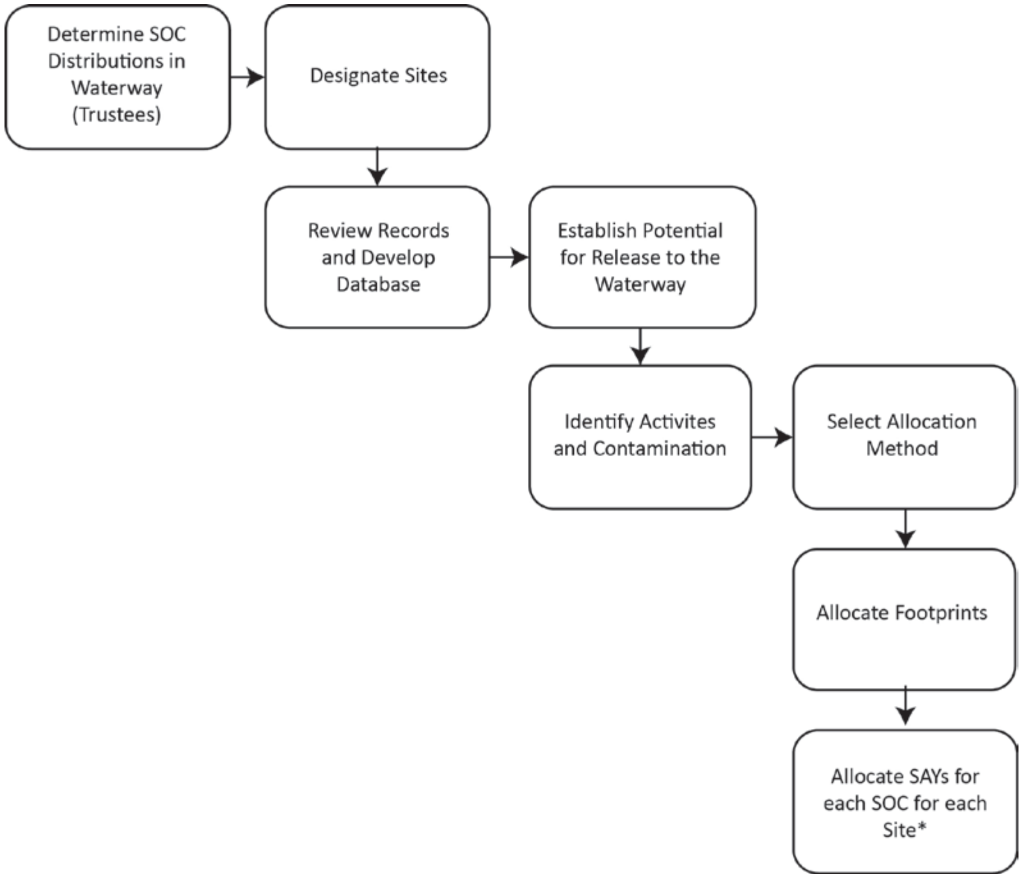
Groundwater

- Flow path to the Waterway (e.g., distance, gradient)
- Transmissivity of aquifer
- Floating or sinking free product
- Chemical concentration
- Potential for adsorption by aquifer soil
- Potential for volatilization and degradation
- Mobilization by other chemicals
- Mobilization of natural substances
- Adsorption to sediments

Sediments

- Proximity to ditch, swale, or waterway
- Covered or uncovered
- Velocity of eroding water
- Particle size
- Potential to settle before reaching Waterway

Figure F2. Overview of Allocation Steps



Note: this step does not include allocation to individual parties, but rather allocates contaminants to physical sites (or land parcels). Each site may have multiple owners and/or operators.