Restoring our River; Protecting our Investment: Duwamish River Pollution Source Control

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Introduction

The Duwamish River is a highly disturbed ecosystem. Historic dredging, channeling and fill activities destroyed much of the original estuarine wetland and intertidal habitat. The development of major industrial centers in the Duwamish Valley surrounded by dense urbanization of Seattle has resulted in a legacy of historic pollutants such as PCBs, combined with current contaminants such as phthalates (plasticizers) that are carried in stormwater runoff and have accumulated in the river sediments. Health advisories warn residents to avoid or reduce consumption of bottom fish and shellfish from the river and to avoid swimming.

The health of the Duwamish River is today being turned around by the cleanup of pollutants and creation of new habitat. Designation as a Superfund Site in 2001 by the United States Environmental Protection Agency (EPA) accelerated the process towards revitalization that had been initiated by citizen groups and state, local and federal agencies in the 1980s and 1990s. Seven highly polluted "early action areas" were selected for accelerated cleanup while ongoing studies of the river continue through additional investigations. Four of these early action areas have been cleaned up or are under way now. An integral part of the work at the early action areas is pollution source control. Millions of dollars will be expended, and possibly wasted, if sources of continuing pollution are not identified and largely eliminated before cleanup occurs at early action areas and throughout the river.

King County, the Port of Seattle, the City of Seattle and The Boeing Company, under an order with EPA and the Washington Department of Ecology, are undertaking a Remedial Investigation and Feasibility Study (RI/FS) of the river. EPA is the lead agency for this study. The Department of Ecology is the lead agency for source control. The estimated source control area for the Duwamish site is 20,500 acres, or 32 square miles, and includes industrialized zones, a major interstate highway and residential and commercial areas that are drained by both a stormdrain and a combined sewage/stormdrain system.

This report reviews and assesses ongoing source control efforts on the Lower Duwamish River. This assessment is based primarily on a review of publicly available technical reports related to each early action area and a limited number of meetings with key staff at the government agencies. The report is not meant as a comprehensive critique of specific actions by the agencies but as an assessment of the overall progress being made towards source control for the river, including challenges, barriers and successes. Some source control issues that are included in this report, such as recontamination by propeller scour, are not considered part of the current source control effort and will be addressed in Phase II of the Remedial Investigation (RI) Superfund work or later. The first section of this report addresses big picture issues, especially the need for more funding. The second section of the report reviews each of the active early action areas and potential source control actions. By summarizing and bringing the information from the four active early action sites together in one document, we hope to help facilitate review of upcoming source control action plans and future status updates.

Big Picture Issues – Source Control for the Duwamish

This section focuses on the barriers, challenges and success of source control actions for the Duwamish River and emphasizes the need for additional resources. The main factors hampering timely implementation of source control measures for the Duwamish River Superfund Early Action Areas are: 1) prioritization of cleanup over source control, 2) need for additional resources for source control efforts, especially at the Washington Department of Ecology, and 3) lack of a systematic approach by agencies implementing source control. Environmental and community groups can help communicate these needs to decision makers, especially those involved with budgeting and resource allocation.

Source Control Working Group

Staff from regulatory agencies involved with source control for the Duwamish River Superfund Site meet monthly to coordinate actions. These agencies are the United States Environmental Protection Agency (EPA), Washington Department of Ecology, King County, City of Seattle and Port of Seattle. Every other month, these interagency meetings are followed in the afternoon by an expanded "Focus Group" meeting that includes representatives of various Trustees and stakeholders, including the National Oceanic and Atmospheric Administration (NOAA), the Muckleshoot Tribe, and community and environmental representatives comprising the Duwamish River Cleanup Coalition (DRCC), EPA's Community Advisory Group (CAG) for the site. Communication between the Source Control Working Group, Trustees and stakeholders was spotty and limited until recently (November 2004) when, under the leadership of the Department of Ecology, a change was made to ensure that the Focus Group meetings are more productive, with more detailed communication and agendas planned. There is now an opportunity for more assistance and cooperation between all groups and agencies. All parties involved share the goal of preventing the expenditure of millions of extra dollars to cleanup re-contaminated sites.

Variability of efforts at the different sites

A close reading of source control-related documents for the four active Duwamish River early action areas shows that different approaches are being taken for each site. This disparity appears to be due not only to the difference in the configuration of each site, but also to the divergence in style of each lead entity (Port vs. City vs. County) and the initiation of cleanup at some sites prior to the official Superfund listing. The history of contamination in the Duwamish also contributes to the variation in management styles observed today. When contaminants began entering the river, the majority of current environmental laws and programs did not exist. Legacy contaminants such as PCBs have therefore been handled in different ways over time – early efforts involved dredging the river and dumping the PCB-contaminated soil near and on the riverbanks, for example. With stricter environmental controls in the 1970s, the focus shifted to cleanup and regulation of industrial discharges of wastewater to the river, but many widespread pollutants such as those from cars, lawns and fallout from the air were not addressed. Certain chemicals were not perceived as problems in the 1970s, but are now seen as important health and/or ecological risks. Finally, different cleanup programs focus on different chemicals. For instance, a chemical regulated by one program may not have been considered as an issue under another regulation. Several widespread contaminants that are now considered threats are being addressed as part of the Duwamish River Superfund cleanup effort for the first time and in many ways, source control is "catching up." As documents are being prepared for the early action areas, as well as for the entire river, this history will be incorporated into the current management approach.

Reports for each early action area do not cover all of the basic source control topics in a similar manner, even taking into consideration the unique characteristics of each site. If the best aspects of each effort

were combined and used as *the* model for addressing each site, source control actions could be more efficient as well as more easily understood by the public. For example, the reports for some sites cover local properties thoroughly with reviews of past land use history, investigations, and cleanup actions, while reports for other sites focus solely on current conditions at the site. Some reports describe shoreline conditions in detail, while reports for other areas barely mention the banks. The Source Control Action Plans being prepared by the Department of Ecology will be much improved if they are able to proscribe, in a systematic way, plans that combine the best elements of each site's current actions as well as additional measures needed, rather than just restating material that is already described in past reports for each site.

Lessons learned from other Superfund sites

At an EPA workshop[1] in April 2003, Leah Evison, of the Office of Emergency and Remedial Response, noted the following bullet points based on review of sediment Superfund sites across the country. It should be noted that some of these recommendations relate to the ongoing source control effort and some will be handled during Phase II RI work on the Duwamish River:

- "Too often there is not a clear rationale between remedy selected and risk reduction expected.
- Low cleanup levels are very hard to achieve, especially with wet dredging.
- ***Re-contamination is a significant problem, both from uncontrolled sources and redistributed residuals.***
- Both short-term and long-term monitoring are insufficient to fully evaluate effectiveness at many sites.
- We recommend that managers:
    - ***Understand and control sources before taking actions – or if concurrent, be very sure it's working.***
    - In predicting outcomes, don't ignore: sources outside the site, background contamination, and wide-ranging biota.
    - Understand the risk reduction mechanisms and be sure the action will reduce risk
    - Take great care to select cleanup levels which are achievable, especially with wet dredging
    - Accurately predict the extent of surficial sediment redistribution following cleanup – underestimates lead to under-prediction of recontamination
    - Accurately predict the extent of subsurface sediment likely to be exposed in the future –overestimates lead to over-predictions of risk reduction
    - Monitor, monitor, monitor." [italics added]

Evison stated that there are approximately 350 sediment sites under Superfund, 140 with an approved plan and about 40 that have completed construction. Interestingly, for the 126 sites with ROD/Action Memos in place, PCBs was the number one contaminant driving risk, followed by metals (non-mercury) and PAHs. At the Duwamish River site, the lessons stated above are critical to the overall success of restoring the river. For example, assessing effectiveness of the source control measures by waiting to see if the sediment cap becomes recontaminated is expensive, inefficient and may result in new hotspots that never get revisited. The valuable lessons learned from other sites should be applied here, as the Duwamish is a relatively "young" Superfund site.

[1] Workshop on: Environmental Stability of Chemicals in Sediment Lessons learned from review of superfund site progress so far.

CSTAG source control recommendations

The Contaminated Sediments Technical Advisory Group (CSTAG), a national committee that was formed by EPA to review complicated sediment sites, sent recommendations to EPA Region 10 about the Duwamish River Superfund Site on December 2, 2003. The CSTAG group did not indicate that the current source control effort is deficient, but were bringing forward lessons learned from elsewhere. Their source control recommendations were listed under the header "Control Sources Early":

- "Measure or estimate the amount of key contaminants discharged at major Combined Sewer Overflows in order to evaluate the potential for recontamination
- Optimize the aerial extent of planned early source control actions, including localized hot spots in order to reduce recontamination potential and to minimize the scope of any future remedial actions. Post-response monitoring should also be performed in order to evaluate if there is any significant recontamination in these early action areas.
- Continue to assess other key potential contamination transport pathways to the LDW (e.g. ground water at Rhone-Poulenc and PACCAR, 60,000 cubic yards of cement kiln dust in ravine, etc.) in order to evaluate if they are significant contributors to sediment contamination or may affect the effectiveness of any future response action."

Later recommendations in their report relevant to source control include (paraphrasing):

- Collect at least 40 specifically located cores to more completely characterize contamination at depth and resuspension potential.
- Be realistic about the timing and effectiveness of source control actions when developing goals and cleanup levels.
- Maximize effectiveness of Institutional Controls and recognize their limitations (evaluate whether Institutional Controls are necessary to protect the integrity of the Norfolk CSO cap).

These recommendations mirror past comments from DRCC and others. While emphasizing early source control, the CSTAG group's recommendations recognize that it is impossible to wait for 100% control of sources before cleanup begins – that would unreasonably delay cleanup and prolong harmful exposures for wildlife and humans. The CSTAG group clearly would like Region 10 to benefit from lessons learned at other Superfund sites regarding source control. EPA's response letter (dated Feb 6, 2004) primarily reflects the Department of Ecology's *Source Control Strategy* or defers answers until the process is further along. When contacted recently, the CSTAG chair indicated that they would be following up on the Duwamish River Superfund site when they return to Seattle to discuss all of the Region 10 sediment sites; these meetings occur on a rotating schedule.

Timing and communication about source control actions

The Department of Ecology, EPA, and local agencies are conducting extensive source control work, but communication about these activities to the public needs improvement. The publication of area-specific Source Control Action Plans, as well as some of the necessary source control work, is lagging behind cleanup efforts. There are numerous reasons for this lag. The major reason is the need for more resources to help compile and publish the action plans. Another reason that sediment cleanup is happening faster than source control is the focus that EPA has put on cleaning up the early action areas and implementing elements of the RI Phase I and II workplans. The schedules for sediment work in the river are tied directly to the joint Superfund order, which makes them relatively easy to manage. Source control, however, is actually being implemented by the Department of Ecology under a Memorandum of Agreement with EPA. The Department of Ecology has not had the resources to devote staff and technical services towards source control at the same level as the EPA has available for managing the sediment work, nor is the work plan and schedule as clearly defined. This creates a situation where

source control (managed by the Department of Ecology) and sediment investigation (managed by EPA) are on parallel tracks, but not always on the same schedule. Source control is a much more time consuming and resource intensive process than sediment cleanup for the agencies because there is a much larger geographic area to cover and more diverse investigations and actions are required. A variety of source control "tools" (such as MTCA, RCRA and NPDES programs) are being used to tackle many problems at one time and this requires more internal coordination at state and local levels.

Some specific timing issues are explained by the following comments from source control managers:

- The cleanup process at the Norfolk and Duwamish/Diagonal early action areas were already underway before the river was listed as a Superfund site. Although source control was a required element of cleanups conducted under the Elliott Bay/Duwamish Restoration Panel, a coordinated riverwide effort was not implemented until after the Superfund listing.
- The Department of Ecology does not have unilateral authority over all businesses and other regulatory entities in the Duwamish basin to implement source control, nor would it be possible to put all property owners and businesses under a unilateral order to recover costs for doing source control. Thus, the agency is dependent on other, unrecoverable, funding sources.

Source control is a slow process because of its broad-sweeping scope. Source control is a process where "success" is proportional to the ability of those with programmatic and enforcement authorities to recognize aligned interests, such as finding and controlling sources to reduce sediment contamination. It is necessary to organize actions efficiently, such as combining inspection and sampling efforts to share data and fill information gaps. A cooperating partnership between the agencies, businesses, the tribes, and advocacy groups could help speed the source control process.

Difficulty in targeting contaminants

Because the Superfund process uses a risk and exposure-based approach, without going back to the full Phase I RI dataset it is difficult to get a handle on a tiered list of contaminants of concern for each site that could then be used as targets for source control. The lists now available are subsets of the total problem chemicals focused on benthic impacts, salmon impacts, human health risk impacts, etc. In the early action candidate report[2] contaminants are listed in Table 1 by number of hits for the river as a whole. The contaminants are listed (in the appendix) by sample number rather than being listed as ranked contaminants for each early action area. Thus there is no clear guide to what pollutants need to be controlled at each cleanup area.

Because of enhanced and more thorough sampling methods described in the Phase II/RI workplan for the next round of sediment sampling, it is likely that a number of new contaminants will be elevated to the level of concern – but it is unclear whether these will be addressed in the current round of source control. Also, in Phase II/RI sediment analysis, some contaminants might appear be overshadowed in the data analyses of other chemicals – that is, the lab dilution factor might be off and so a contaminant is not reported as a "hit." It is not safe to assume that enough data is being gathered overall that a few "misses" will not impede the big picture – it's the site-specific information that *is* needed. Samples for which the dilution factor is off need to be re-analyzed.

Source control is an iterative process and new chemicals may be added to the target list over time. Sampling at businesses, however, may not occur again for some time, and the source control process might be too far down the road to capture new contaminants found during Phase II.

[2] Task 5: Identification Of Candidate Sites For Early Action Technical Memorandum: Data Analysis And Candidate Site Identification Final, 2003

For each early action area, the existing technical documents do not provide simple lists of contaminants of concern upfront. One must glean the contaminants of concern from various tables and maps. While this approach may be useful for a risk-based Superfund assessment, it makes it more difficult to develop a comprehensive source control program. A chemical might become considered a more significant contaminant in the future for a specific site – new uses or new sources might be in place but the chemical would not be tracked because the contaminant is currently considered insignificant. **Documents for each site should include be a comprehensive and ranked list of *all* contaminants detected in the surface sediment, subsurface sediment, water column, and tissue samples, with supporting information such as number and degree of above standard "hits."**

Quantifying the problem

If the targeted contaminants are not listed for each cleanup area (see above) and the mass of contaminants being input (i.e., discharged, resuspended from upriver, etc) into the area is not known, then it is extremely difficult to implement and measure the effectiveness of source control actions. It is inefficient and likely costly in the long run to rely on measuring effectiveness of source control by testing whether new cleanup areas become recontaminated. A significant effort should be put toward quantifying the total volume of contaminants coming into the system from all sources, rather than just cataloging a laundry list of problems that have been found at various businesses throughout the watershed. It is challenging to agree on a model and on assumptions, but a loading model *is* needed to conduct effective source control. The source control agencies should work together towards the creation of a mutually agreeable model right away. A high quality computer model could be adjusted over time as new information becomes available and as data become refined.

King County's computer model of its combined sewer system is an important first step towards quantifying the contributions to the system. The model's inputs, as reported in the technical documents, however, do not include other storm drains, direct surface runoff, industrial discharges, aerial deposition and other sources. The Department of Ecology does not currently have the resources to develop such a model for the system – or even for an individual site. This will require a multi-agency effort.

The city and county are making a concerted effort to track down pollutants within subbasins, notably phthalates at businesses in the Duwamish/Diagonal basin. Catch basins and in-line sediment traps are being used to sample contaminants in the sediment accumulating in the stormdrain system. In conjunction with this project, Washington Department of Transportation is testing stormwater filters for their efficiency in removing phthalates and other toxic chemicals at their test pad under the I-5 bridge at Lake Union. Seattle, King County and the City of Tacoma are also sampling a range of household, automotive and commercial products for phthalate content. Roadways have recently been added to the investigation. The King County Environmental Laboratory performs the product sample analysis. This effort is proceeding slowly and it appears that more resources could help speed expansion of this effort into other Duwamish River basins.

Phthalates are proving difficult to trace. Despite numerous samples, both in the Duwamish/Diagonal drainage and in the City of Tacoma, no "smoking gun" has been identified. Phthalates are found everywhere and a consistent pollutant pattern has not yet emerged. For example, high phthalate concentrations at fast food locations suggest that they are related to automobiles. However, a sediment sample collected from a storm drain serving I-5 did not have high phthalate concentrations. More sampling is needed to identify sources. Unless specific sources of high levels of phthalates are identified, it will be extremely difficult to eliminate phthalates from stormwater entering the Duwamish River without treatment.

Superfund requires source control

Source control is a fundamental part of the Superfund process and here it appears to be lagging behind, most notably at the early action areas. The Norfolk and Duwamish/Diagonal early action areas have already had partial clean up actions without source control plans in place, and it is unclear at this point whether source control programs will be in place prior to cleanups at the Slip 4 and T-117 areas. Although some source control work at Slip 4 and T-117 is underway, most of the specific activities are not being communicated to the public and are not yet part of a comprehensive plan identifying needs and necessary actions.

The Department of Ecology should be able to direct businesses and other entities to implement source control work or to conduct the work itself and recover costs. The Department of Ecology directs source control at Volunteer Cleanup Program sites and at locations where formal agreed orders or consent decrees are in place. Source control is part of the site managers' responsibilities at MTCA cleanup sites. The Department of Ecology also has the authority to direct source control through NPDES permits and 401 water quality certifications. Unfortunately, the Department of Ecology does not currently have the authority to issue source control directives on an area-wide scale.

Relying heavily on old data

At many sites, there is a heavy reliance on old data for source control information. Much of the data at cleanup sites within the Duwamish basin are from older investigations related to leaking underground storage tanks – usually fuel. These sites may have historic or continuing pollution problems related to contaminants of concern in the Duwamish – but the data in the files are not particularly helpful to the current source control needs. It is not recommended, however, that new samples be collected from a site unless there is evidence that a contaminant of concern may be continuing to enter that site. Examples of where new data *should* be collected are upper watershed locations where contaminants are noted in downgradient or downstream locations that point back to those sites as potential sources.

Another example of old data sets is groundwater data for properties adjacent to the river. At Slip 4, old groundwater samples from a number of adjacent properties had hits of phthalates, PAHs, arsenic and other contaminants. The phthalate data had been previously dismissed as laboratory errors; this is now in doubt and these wells should be resampled to determine if they are potential sources. PAHs were detected in the water column in Slip 4, near the Crowley dock, and a significant PAH hotspot is evident in the adjacent sediments. For combined sewer overflow influent data, the studies cited in the various technical documents are from 1996/1997 when King County did an investigation of the water quality and from an earlier 1988 study by Tetratech. Comprehensive sampling of the combined sewer overflow system should be repeated now – sampling techniques and technology have significantly improved and sources in the wasteshed may have changed. The earlier studies did identify problems such as pollutants an order of magnitude higher at some outfalls than others; this information needs to be updated.

Lessons from elsewhere

Lessons can be learned from the Commencement Bay Superfund Site. It should be noted, however, that significantly more staff and resources were dedicated to that location than are allocated for the Duwamish River. The Department of Ecology had eight staff persons for Commencement Bay, while only three are assigned to the Duwamish site. Both sites have comparable drainage acreage requiring source control: 22,000 acres at Commencement Bay and 20,500 acres for the Duwamish River.

For the Thea Foss/Wheeler-Osgood Waterways in the Commencement Bay Superfund Site, the City of Tacoma prepared "Drain-by-Drain Reports" for the major storm drains. These reports documented the

City's progress toward identifying and controlling sources of contamination to stormwater, according to the citywide Stormwater Management Plan. The Drain-by-Drain Reports described the City's investigations for each drain and included maps, lists of businesses or sources to the drain, which ones were inspected, what the results of inspections were, follow-up work and visits, as well as results of catch basin or other sampling and inspections of and maintenance work on city-maintained portions of the drainage. Currently, Tacoma issues Quarterly Stormwater Source Control Reports that update information on the City's stormwater work as well as the issues and problems that are encountered. Similar organization of investigations and reports would be valuable contributions to the Duwamish River source control effort.

As documented in *Source Control: The First Step in Cleaning up Commencement Bay* (1999) by Dave Smith et al., a systematic and aggressive source control program for the Commencement Bay Superfund Site resulted in the reduction of metal concentrations by a factor of 10 between 1984 and 1997. A team of state, federal and city staff focused intensively on pollution problems one property at a time and devised a variety of solutions to address pollutants. Enforcement orders were often needed to get work started but they also employed a variety of administrative mechanisms, using existing laws as well as voluntary actions and state grants. It appears that the effort was successful because of a solid commitment of agency funds as well as a flexible, creative and aggressive team of staff working together. The Commencement Bay source control team had an added benefit of addressing large industrial properties whereas there are relatively more small businesses on smaller lots in the Duwamish.

The Commencement Bay source control process provided a good training ground for the staff involved in the Duwamish River effort. The 1992 EPA/Ecology Source Control Strategy for the Commencement Bay Superfund Site required the following performance standards for source control to be met for each problem area:

- Milestone 1 = sources identified and organized into 3 classifications (potential, probable, confirmed)
- Milestone 2 = essential administrative actions in place for major sources of problem chemicals
- Milestone 3 = essential remedial actions implemented for major sources of problem chemicals
- Milestone 4 = administrative actions in place for all confirmed ongoing sources of problem chemicals
- Milestone 5 = remedial actions for all sources of problem chemicals implemented

The Commencement Bay Superfund site was divided into eight problem areas with targeted lists of problem chemicals for each. The chemical lists were identified at the end of the sediment RI/FS process and published in the Record Of Decision (ROD). They were much shorter than the list of Sediment Management Standards (SMS) chemicals that is being used to identify source control problems along the Duwamish River. In addition, the Commencement Bay Source Control Strategy was written after the RI/FS and Record of Decision, after a great deal of sediment sampling for problem chemicals had already occurred (but not necessarily before cleanup occurred) and made tracing and investigating sources much more straightforward than it has been so far on the Duwamish.[3] Another difference is that in contrast to the Commencement Bay waterways, the source area for Duwamish is not nearly as well sub-divided, therefore requiring a different approach. It is important to note that the Duwamish River Source Control Strategy was issued much earlier in the process, which means Duwamish River source control is progressing while additional RI-level sediment data is being collected. While the strategy was developed with less data available than in Commencement Bay and lacks specificity, it has the advantage of helping to guide source control work earlier in the process.

[3] Kris Flint, EPA, 2004

A recent and unfortunate "lesson learned" at the Commencement Bay Site was the re-contamination of a portion of the Foss Waterway in September 2004. Clean sediments were placed near Foss Landing marina in February 2004 by a group of utilities at a cost of $8.5 million. This site is now contaminated with concentrations greater than the Commencement Bay sediment cleanup goals of mercury, phthalates, PCBs, PAHS, pesticides and other chemicals. Potential sources of the recontamination are the dredging of an adjacent site, an oily slime that was seeping to the surface, or stormdrains. The site will likely have to be cleaned up again (Seattle PI, 11/04/04, News Tribune 11/07/04).

Combined sewer overflow (CSO) priorities – not the Duwamish

King County's highest priority for control of combined sewer overflows (CSOs) is Lake Washington, the pollution of which led to the creation of Metro and the construction two new treatment plants at Renton in 1962 and West Point in 1964. The second priority for CSO control is Lake Union and the bathing beaches on Puget Sound. The last priority for CSO control is the Duwamish River.

METRO/King County must control their CSO discharges to one event per year at each CSO location by the year 2030. They developed an interim goal of achieving an overall reduction of 75 percent in CSO volume throughout their jurisdiction by the end of the year 2005. "As its highest priority for controlling CSO discharges, King County will target discharges that have the greatest potential to impact human health, bathing beaches, and species listed under the Endangered Species Act. CSO Projects along Puget Sound beaches and the East End of the Lake Washington Ship Canal will be constructed first, followed by projects along the Duwamish River and the West End of the Ship Canal." CSO control projects in the Duwamish River are not scheduled to be completed until the 2020s.[4]

These schedules and priorities predate much of the information that has now been collected on human use and fishing in the Duwamish River, following the Superfund listing of the river and the Endangered Species Act listing of its salmon. We recommend that the King County Council obtain more specific information about the CSO impacts and consider reordering the priority for CSO improvements to accelerate CSO control on the Duwamish River.

As it stands, the 20 year delay between river cleanup and CSO control highlights the need to control the release of contaminants of concern *to* the CSOs, rather than waiting for the CSO discharges themselves to be significantly removed from the river, as current releases will likely recontaminate the river and risk our investment in cleanup.

The Department of Ecology's *Source Control Strategy* and database

The Department of Ecology's Source Control Strategy relies heavily on ongoing agency programs and old databases, and focuses on good housekeeping practices and other stormwater-related best management practices. This approach may reflect the lack of new resources the agency feels can be directed towards this effort. While this tactic is good for long-term stormwater control, it does not appear to be an effective method for short-term source control. Source control for upcoming early action cleanup areas require a more comprehensive sampling-based approach. A systematic, detective-like investigation would be more appropriate and effective in order to identify and reduce contaminant loads quickly. Such a sampling-based approach for phthalate sources is underway by the City and County in

[4] Regional Wastewater Services Plan, Operational Master Plan King County, Department of Natural Resources (December 1999) and King Co Web page (http://dnr.metrokc.gov/wtd/rwsp/approved/schedule.htm)

the Duwamish/Diagonal basin, but this program is limited by funding and resources and is not being applied to all sources. In Slip 4, sampling of the drains and catch basins appears to be commencing closer in time to the business inspections. It should be noted that the business inspections are comprehensive and have caught some significant contamination problems – catch basin sediment samples at some sites have revealed large concentrations of contaminants of concern.

There is excellent communication and sharing of information among members of the Source Control Working Group, which meets on a regular basis and also shares written information. As was evident in a meeting between DRCC and the Department of Ecology staff, however, there is poor coordination between databases of the City/County and the Department of Ecology. As a result, they are not able to share data on basic activities, such as site inspections, via shared computer databases. Within the Department of Ecology, staff have limited access to their own databases and GIS services, due to staff and budget limitations. The availability of GIS staff to assist the Department of Ecology source control effort is minimal - yet source control is essentially a mapping-based type of effort. The City and County GIS maps are being used for the bulk of the source control work to date, but the Department of Ecology does not have access to their system, nor do they have similar capabilities available at this time.

Sensitivity analysis needed

Currently the City, State, Port, and County are taking an approach of doing everything at once – looking at all potential sources in a broad sweep. Part of the reason for this is that the list of target contaminants has not been clearly identified and ranked. The effort has also been largely incorporated into ongoing inspection activities. A more systematic approach – considering where the pending cleanup areas are located geographically and assessing the quantities of contaminants entering the system (i.e., loading) – would facilitate a more directed approach to target the most significant problems. A sensitivity analysis could then be done to show what source control actions will create the most benefit for pollution control. The agencies are likely prioritizing some of their actions, but it is not clear in the published documents what the priorities are or whether they are appropriate.

Source Control Action Plans that address all aspects of source control using a standard format would allow the public to understand which actions are being prioritized and which actions have been determined to be less important for a specific area. A complete picture should be described in each plan so that the agencies and the public can see a roadmap of how all the potential sources will be addressed for each early action area.

The *Source Control Strategy* outlines a tiered approach for addressing source control. Properties adjacent to the river – near to the contaminated zones – are scrutinized first, along with the associated combined sewage and stormwater drains. Sources are to be traced from the river, to the banks and then to the upland sites and drainage systems. This strategy is similar to what we propose as a model source control approach (see below). The technical documents published thus far, however, do not document actions that support this method, nor do they propose a systematic detective-like approach that reflects proximity to the river or loading.

Lack of significance placed on large events

Huge rainstorms, which can displace large amounts of sediments and significantly alter the distribution and availability of contaminants, have been largely discounted in the source control and cleanup process. Comprehensive site assessments need to include consideration of the effects of both long-term, periodic variations and infrequent, but often significant events. At the Norfolk CSO site, for example, the County assumed sediment erosion did not need to be factored in because high river discharges or high

tidal surges are rare and "therefore the likelihood of sediment erosion and subsequent resettling is considered to be small." No technical references, however, for this assumption are provided. Technical justification for a low risk of major floods or catastrophic events should be published in the early action area and river-wide documents.

Phased cleanup favored over more cost-effective larger cleanups

A review of the technical documents for each early action area makes it is clear that the managers of each site wish to handle the cleanup, source control and other issues within narrowly defined boundaries. At Slip 4, for example, issues related to the PAH plume off of the Crowley property are being deferred to Phase II/RI work. "Partial" cleanup of PCBs are being implemented at other areas. The threat of recontamination due to future dredging projects is mentioned in Duwamish/Diagonal technical documents, concluding, "…coordination of dredging projects could reduce potential recontamination. Propeller wash and river currents will resuspend some of the high PCB sediment." Cleanup at early action areas should be inclusive enough so that recontamination from the river itself is not a threat. Only part of Slip 4 is proposed for cleanup during the early action because of its limited scope, despite the existence of phthalates and PAHs above standards throughout the entire slip. It would be more cost-effective to clean up all of Slip 4 at once. This would have the added benefit of allowing for the installation of a large habitat project that would not be under threat of disturbance by later cleanup actions.

Potentially significant outstanding issues

Additional issues that need more attention in the source control effort include:

- Arsenic: The Phase II/RI workplan states that arsenic samples will be taken upriver in the Duwamish. Arsenic is a widespread contaminant that potentially resulted from 1) industrial activities within the lower Duwamish area, 2) historic pole dipping activities, and 3) the Tacoma ASARCO smelter arsenic plume.

- Dioxins/furans: Dioxins and furans are similarly considered elevated in the background and will be investigated in the Phase II/RI work. In Phase 1 sampling, dioxins/furans were high at a few locations, including the Duwamish/Diagonal site and another area in the intertidal zone on the west side of the river at RM 1.5. One of many potential sources may be cement kiln dust; additional samples are planned in Phase II work plan near cement plants.

- TBT: TBT was found in higher concentrations in the northern portion of the river, probably due to closer proximity to shipyards.

- Several issues are not being addressed as part of the source control program. These issues are being deferred to the Superfund Feasibility Study:
    - Aerial deposition from cement plants or other facilities.
    - Resuspension potential by propeller wash.
    - Recontamination potential by high concentrations left in place at depth in the sediment.

A Model Source Control Strategy

An ideal strategy for source control would include the following steps carried out in a systematic manner, with complete cross communication among all of the agencies involved.

- **List and rank target chemicals at each site**
  - Legacy: Determine which of these contaminants can be considered strictly historic – but keep them on the list because of possible resuspension issues
  - Ongoing: Quantify, to the extent possible, the total loading (volume) of each contaminant currently entering the site
- **Track down sources in a targeted manner using detective-based sampling**
  - Sample each outfall for each chemical found in that part of the river
  - Work up the pipe to locate areas where the chemical is coming from
  - Use dye studies, smoke studies or other pipe-related techniques to determine connections where unknown
  - By reverse sampling or observations (using dye, for example) work backwards from the outfalls to isolate specific problem subwatersheds
  - Look at historic aerial photos, records and agency files only to augment ongoing investigations at sites – do current assessments
  - Request material data sheets and other chemical information from companies, conduct environmental audits (focused specifically on contaminants of concern), and do complete sampling efforts for shorebanks, local groundwater/seeps, roadways, landfills, etc.
  - Take samples at sites where evidence exists of contaminants of concern (often not done)
- **Quantify and prioritize sources and pathways to site** (overland flow, stormdrain flow, groundwater, resuspension, etc.)
- **Remove chemicals at the source**
  - Provide technical assistance to businesses to help them eliminate releases to river drains; follow up with enforcement if necessary
  - Cleanup polluted land and groundwater affecting the river
  - Redirect storm drains away from the river; introduce natural drainage methods
  - Institute changes to reduce sources such as encouraging Best Management Practices, taking regulatory actions or changing City/County code
  - Develop education and outreach programs for chemicals coming from homes and yards
  - Promote product substitution, consumer education and government purchasing and practices
  - Research and install filters or treatment for chemicals coming from highways and roads
- **Install additional treatment or filters at end of the pipe, where appropriate**
- **Confirmation**
  - Keep track of decisions made and work done or required
  - Follow-up to ensure compliance
  - Look systematically at historical spills, discharges and problems to definitely eliminate these as continuing problems
  - Look at potential for recontamination from upriver cleanups, dredging, and boat action – coordinate cleanup actions throughout river (and at adjacent sites)
  - Measure real-time effectiveness of source control in pipes and other transport locations
  - Re-sample outfalls and other areas to determine if source control is working**.**

Studies and References Reviewed

King County and Seattle Public Utilities Source Control Program for the Lower Duwamish Waterway, June 2004 Progress Report, by King Co and City of Seattle.

Lower Duwamish Waterway Source Control Strategy, 2004 (February), by Department of Ecology.

Review of Early Action Areas

This section reviews each early action area and potential source control actions. By summarizing and bringing the information from the four active early action sites in one place, it will help in public review of upcoming source control action plans and status update documents.

Duwamish/Diagonal (Early Action Area 1)

Action

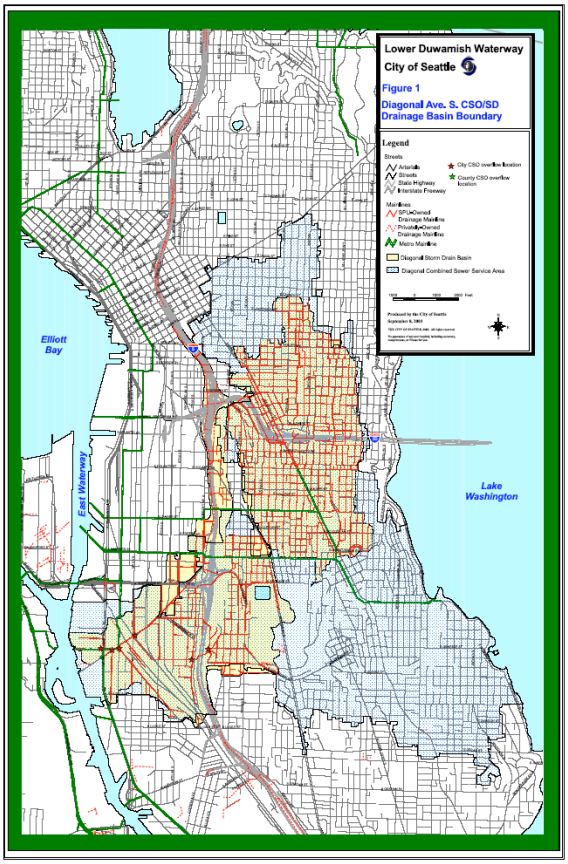
Duwamish/Diagonal Summary
Major Contaminants of Concern: Phthalates, PCBs, mercury, along with other metals and organic chemicals
Project Coordinator: King County
Current Status: Post "partial" cleanup monitoring and assessment
Main potential sources: Combined sewage and stormwater discharges, adjacent sites, river dredging

The Duwamish/Diagonal area is one of seven sites within the Lower Duwamish Waterway (LDW) Superfund site chosen for early cleanup actions because of its potential for higher levels of risk due to elevated PCB levels. A 1991 consent decree settling a lawsuit by NOAA and the Washington Department of Ecology against Seattle and King County for damages due to combined sewer overflow and stormdrain discharges created the Elliott Bay/Duwamish Restoration Panel. The parties provided $12 million for sediment cleanup at outfalls, $5 million for nearshore habitat restoration, up to $5 million for real estate, and $2 million for source control at habitat and cleanup sites. The Duwamish/Diagonal site was selected for inclusion in the Panel's projects, and a several acre "partial" cleanup was completed in early 2004. Source control work by the Panel has included cleaning out the Duwamish/Diagonal pipe as well as business inspections and enforcement actions by both the City and the County. The lead for the cleanup of the Duwamish/Diagonal site is King County.

Location and Cleanup

The Duwamish/Diagonal site is named for four outfalls that are located about 500 feet apart on the east side of the Duwamish River at about river mile 0.5 measured from the tip of Harbor Island: the Duwamish combined sewer overflow, Diagonal Avenue S storm drain, the former Diagonal Avenue Treatment Plant outfall and the Diagonal Avenue South storm drain outfall. Additional contamination at the site was due to historic spills and land sources. Two PCB hotspots as well as phthalate hotspots were identified in the investigation process. Cleanup was initiated in the fall of 2003 for two contiguous hotspot areas: Area A (4.8 acres) and the upstream Area B (2.1 acres). Contaminated sediment was dredged to a minimum depth of 3 feet (average depth of 5 feet), with a total removal of 68,250 cubic yards, from November 2003 to March 2004. A 62,000 cubic yard sediment cap was engineered as a cap with a minimum thickness of 3 feet. The existing riprap layer on the bank as well as areas of the new sediment cap were given a dressing layer of armor stone and fish mix. The new material brought in

included: 79,739 sand, 18,064 tons habitat mix, 5,529 tons quarry spall, 7,141 tons light loose rip rap and 2,371 tons special light loose rip rap. This site is considered a "partial cleanup" because adjacent contaminated sediments were not addressed.



The cleanup proceeded using clamshell dredging technology which allowed at least 1-2% (estimated) material to spill back into the river. This technology and substandard operators resulted in the spread of PCB-contaminated sediment in the river outside of the cleanup area. Post-cleanup monitoring showed that 9 out of 12 monitoring sites now have PCBs at levels higher than before the cleanup and above the state cleanup standards. Corrective actions for recovering the spilled PCB-contaminated sediments have not yet been determined.

Reports published for Duwamish/Diagonal from 1994 through spring 2004 include a cleanup study plan, cleanup study report, source control summary, cleanup action decision, and a cleanup monitoring summary. A project closure report is expected in July 2004.

Consultants Hired for this Site.

Anchor Environmental, LLC; EcoChem Inc.

Contaminants

Contaminants of concern that drove cleanup:

The contaminants of concern for the Duwamish/Diagonal site that were used to define the cleanup boundary were PCBs, bis(2-ethylhexyl) phthalate, butyl benzyl phthalate, and mercury.

Secondary contaminants that were (or may still be at) the site:

- *North Inshore area:* Phthalates dominated the contamination plume off of the Duwamish/Diagonal outfalls with a hot spot greater than 4 times CSL. Other constituents which exceeded standards in this area were PCBs, mercury, zinc, total HPAH, total LPAH, phenol, 1,4-dichlorobenzene, and 1,2-dichlorobenzene, and 4-methylphenol in the surface samples and additionally in subsurface samples: cadmium, copper, and lead.
- *South Inshore area:* PCBs, phthalates, and chlorinated benzenes were the primary contaminants at the area offsite of the cement plant dock and old treatment plant site. Other constituents which exceeded standards in this area were mercury, cadmium, chromium, lead, silver, zinc, total HPAHs, 4-methylphenol, and 2-methyl naphthalene.
- *The dredged river channel offshore* of these two inshore areas was dominated by PCB contamination. Other constituents that exceeded standards in this area were phthalates, hexachlorobenzene, mercury, arsenic, and zinc.
- *Contaminants that exceeded SQS* (from all combined data through 1998): PCBs, 6 metals, chlorobenzenes, 2 phenols, bis(2-ethylhexyl) and butyl benzyl phthalates, total LPAHs, total HPAHs
- *Distribution:* Bis(2-ethylhexyl) phthalates were highest near the CSO outfall and second highest near the old treatment pump station outfall.
- The highest surface concentrations of PCBs were at the outfall of the Former Diagonal Avenue Treatment Plant. The highest overall concentrations were found in buried sediments under less

contaminated top layer of sediments, near the CSO outfall. High levels of PCBs were already in the river when siphons were constructed in 1966/67.

- *Other contaminants referenced in reports:* Tributyltin

Sediment contaminants listed in 2003 Early Action Report showing maximum exceedence factors (EF) relative to sediment standards:

Chemical	SQS* EF	CSL** EF	Chemical	SQS* EF	CSL** EF
1,4-Dichlorobenzene	1.0	0.35	Chrysene	1.1	0.24
2,4-Dimethylphenol	10	10	DDTs (total-calc'd)	33	3.3
1,2,4-Trichlorobenzene	2.7	1.2	Fluoranthene	2.3	0.31
1,2-Dichlorobenzene	4.8	4.8	Hexachlorobenzene	3.6	0.60
1,4-Dichlorobenzene	6.9	2.4	Phenol	2.1	0.73
4-Methylphenol	6.9	6.9	Total HPAH (calc'd)	1.1	0.20
Benzoic acid	2.1	2.1	PCBs (total-calc'd)	53	9.7
Bis(2-ethylhexyl)phthalate	8.2	5.0	Arsenic	1.5	0.91
Butyl benzyl phthalate	16	1.2	Cadmium	2.3	1.7

*SQS - Washington State Marine Sediment Quality Standards
**CSL - Puget Sound Marine Sediment Cleanup Screening Levels

Potential Sources

Outfalls

Diagonal Avenue South Combined Sewer Overflow/storm drain outfall (CSO/SD) (City of Seattle)(12-foot pipe that ends at two 11 by 9 feet rectangular openings to the river) (1966/67). Located at the end of the unimproved South Oregon Street right of way, this 12-foot pipe discharges to the river at a large concrete structure which is only totally exposed when the tide is at –3 feet (MLLW); a 12-inch pipe is attached. The Diagonal CSO/SD is the City's largest storm water outfall. The outfall discharges both combined (65 million gallons per year) and separated storm water (1230 million gallons per year). These two flow streams are described in more detail below.

Separated storm water comes from the Diagonal basin (estimated 1,328 acres) downstream of the Hanford tunnel and the Hanford basin (estimated 1,315 acres) that total 2,585 acres with a calculated average flow volume of 1230 million gallons per year. Stormwater flows to the system from residential, commercial, and industrial areas, including Central District, Rainier Valley, the Duwamish Industrial area, and Beacon Hill, and 3.6 miles of I-5 freeway (between mile post 156 and 163). The drainage also includes the Sixth Avenue South landfill, which operated from about 1925 to 1955 and accepted dredge materials from the Duwamish. The Diagonal system drains the area east of the Duwamish. The Hanford system drains Rainier Valley - the system carries stormwater flows to the Duwamish through the Hanford tunnel. Port of Seattle T106 stormwater is piped to the Diagonal outfall pipe.

Combined Sewer Overflows (CSOs): The system collects flows from eight city CSO locations (Diagonal 111A through 111H) draining 624 acres and one county CSO location (Hanford #1) draining 4,900 acres. The total Diagonal drainage area is 4,900 acres and the 624 acres of combined drainage is a subset of that total. Much of this sewage drainage area overlaps the stormwater drainage area described above.

Current Diagonal Avenue CSO overflow frequency and volume for these two CSO systems are:

CSO Name	Ave. Annual volume (Mgal.yr)	Ave. Annual Frequency
Hanford #1	65 (model estimate)	11
Diagonal 111A-H	2.2	32

From 1998 through 2002 total discharge from the city's Diagonal 111A-H drains ranged from 0.58 to 5.21 million gallons per year with a frequency ranging from 21 to 40 overflow events per year. Most of the overflows occurred at one location, Diagonal 111D.

Overflow events are reduced by separation of stormwater from sewage flow and construction of storage structures and/or retention facilities. The City of Seattle built a storage structure on one Diagonal drain in 1994. The problem drain, 111D, drains about 40 acres and has had an average overflow volume of about 1 million gallons per year. In July 2004, the city replaced an undersized pipe on 111D to allow more flow to the King County interceptor. The drain will be monitored to determine if more improvements are necessary.

The King County CSO drainage system has been modified by separation and storage improvements so that the overflows are reduced by roughly 75% according to county staff. King County has estimated that historically about 300 million gallons per year of combined sewer and stormwater flows were discharged at the Hanford #1 CSO. . A sewage pipe was installed inside the Hanford tunnel in 1987 in order to separate the sewage from the stormwater. The sewage is transported to the Elliott Bay Interceptor. Studies in 1999, however, showed that the Hanford #1 CSO is still discharging to the Diagonal Avenue S outfall at a calculated rate of about 65 million gallons per year. This remaining flow is from three upstream connections that were discovered after a 1992 construction upgrade project: Bayview North, Bayview South, and Hanford at Rainer. These remaining flows, now reported as Hanford # 1, are schedule to have a capital improvement project completed in 2026. In general, it is difficult to model the flows from Hanford accurately and so the flow is an estimated value. The Duwamish Pump Station has a peak flow of 63 million gallons per day and a maximum pumping capacity of 100 million gallons per day. Also, under normal dry weather conditions (23 million gallons per day), the station has two hours of storage time from shutdown to overflow. In big storms the system does overflow to the Duwamish, although at a much reduced rate than historically. The planned capital improvements to the system will be implemented 22 years *after* the cleanup at the site.

Sediment problem/Contaminants

Sediment accumulates in the drain from two sources, overflows and tidal inputs. There is no tide gate in the CSO/SD outfall so the long flat pipe regularly fills with Duwamish River water at high tide. Studies of sediment contamination in the drains includes a 1985 EPA (TetraTech) study which found many contaminants that exceeded SQS or CSL, including LPAHS, mercury, dibenzofuran, and PCBs. More recent studies (2002) of sediment sampled in the pipe and tributaries had elevated levels of total petroleum hydrocarbons (TPH) as motor oil, TPH as diesel fuel, PAHs, bis(2-ethyl hexyl)phthalate,

butyl benzyl phthalate, benzo(a)pyrene, PCBs, cadmium, chromium, and zinc. King County has not proposed treatment at the outfall for phthalates or other contaminants that are currently being detected in sediment traps within the drainage basin.

Additional connections: One small storm drain on the south end of T106 once discharged to the small cove on the downstream side of the Diagonal CSO/SD and now has been directly connected to the Diagonal CSO/SD pipe.

Duwamish combined sewer outfall (CSO) outfall (King Co) (36-inch). The submerged Duwamish CSO outfall is located about 30 meters south (upriver) of the Diagonal CSO/SD outfall. The Duwamish CSO outfall is an emergency relief point for the Duwamish Pump Station, which receives water from the Duwamish siphon and from the Elliott Bay Interceptor. ***The Duwamish Siphon*** is connected to the Delridge Trunk Sewer and the Chelan Avenue Regulator (west side of Duwamish River) and serves combined drainage of 1,169 acres. ***The Elliott Bay Interceptor*** draws from basins upstream and downstream of the East Marginal Way Pump Station and serves two drainage areas: the East Marginal PS located upstream (907 acres) and an area located between the East Marginal PS and the Duwamish PS (128 acres). No overflows have occurred since 1989 because this outfall will only overflow if there is a serious emergency.

Former Diagonal Avenue Treatment Plant outfall (18?-inch). Upstream of the main Duwamish/Diagonal Outfall, a small concrete, broken pipe remains exposed at low tide that was the outfall associated with the Diagonal Avenue Treatment Plant. This treatment plant was operated from 1940 to 1961 by the City of Seattle and from 1961 to 1969 by Metro and provided primary treatment for combined sewage/storm water from the city's industrial core. It was considered one of the worst quality outfalls in the Seattle area and frequently discharged untreated sewage to the river. Plant capacity was 7-8 mgd. The Cleanup Report indicates that discharge from this location was discontinued in 1969 when flows were diverted to the West Point sewage treatment plant. Duwamish/Diagonal Cleanup "Area B" addressed the contaminant hot spot off of this outfall.

Diagonal Avenue South Storm Drain (12-inch). The Diagonal Avenue South drain is located about 1000 feet south of the Diagonal CSO outfall. The drain is attached to a concrete slab in the upper intertidal on a sloping bank. It drains a 12-acre area, from the river along Diagonal Avenue to East Marginal Way, which is mostly paved and used for storage. As stated in the Source Control Summary, "No effort was made to determine the volume of storm water that discharges out the Diagonal Ave. SD, because the volume would be small compared to the 1,200 million gallons per year of storm water discharged out the Diagonal CSO/SD (located about 1,000 feet down stream)."

Contaminants: Sediment sample collected from the pipe in 1985 showed three of the detected chemicals exceeded the SQS (zinc, indeno(1,2,3-c, d)pyrene, and di-n-octyl phthalate) and chromium exceeded the CSL value. Additionally, seven of the undetected chemicals were above the sediment management standards. Four of these seven chemicals exceeded the CSL values (1, 2- dichlorobenzene, 1,4-dichlorobenzene, hexachlorobenzene, and benzyl alcohol) and three exceeded the SQS values (1,2, 4-trichlorobenzene, butyl benzyl phthalate, and total PCBs). For these seven chemicals, it is not possible to know whether the concentrations present in the sample would have exceeded the state sediment management standards.

No samples were collected from the storm drain sediment in the 1994-96 assessment. Three sediment samples collected offshore from this outfall showed only phthalates with increased

values near the storm drain. King County concluded that "The lack of any elevated chemicals, besides phthalates, in these three sediment samples collected in front of the small SD outfall suggests there are no problem discharges to this small pipe that could be a potential recontamination source to Area B."

South Nevada Street Stormdrain drains a portion of the Port of Seattle T106 property that is used for warehousing and for a shipping container repair facility. This outfall was not found during a May 2003 city outfall survey because it was not visible at that time.

Small, abandoned Storm Drain outfall off of Port property (near Nevada Street drain). This drain was not found during the May 2003 city outfall survey. Port of Seattle property records do not indicate that stormwater flows to this location.

Adjacent or nearby properties:

Diagonal Avenue sewage treatment plant property. This site, described above, housed the sewage treatment plant that was removed in 1977. Soils at this site may have been contaminated by the use of sewage sludge drying ponds (1940-1969) which were covered with a layer of fill, dredge settling ponds for PCBs (1976), and fill material made up of contaminated sediment dredged from near the old treatment plant outfall (1977) when the shoreline was moved east about 30 feet. The plant was removed and the sludge ponds were filled in or eliminated during a 1977 reconfiguration of the shoreline by Chiyoda. Potentially surface drainage, groundwater discharge, or bank erosion from the old treatment property could pose a potential source of recontamination to the Duwamish/Diagonal cleanup project. Chiyoda formerly owned part of the site. It was sold to the Port of Seattle in 1980 that in turn sold the inland portion to Chevron. The southern area of the site was leased to LaFarge Cement Company who used the site from 1989-1999 for loading cement at a barge facility on the shoreline. The southern part of the site is currently part of the Port of Seattle's Terminal 108 and is used for container storage.

1974 PCB spill fill material: In 1976, approximately 10 million gallons of PCB-contaminated dredge spoils from a 1974 transformer fluid spill in Slip 1 (260 gallons of near pure PCB) were disposed on the site by the Army Corps in two excavated sludge beds. Water pumped from the disposal lagoons was treated by particulate, sand, and charcoal filters prior to discharge to the Duwamish Waterway. The recovery of the removal operations was about 92% according to EPA August 1977 report (as communicated by Doug Hotchkiss of the Port of Seattle, September 13, 2004). The sludge beds were back-filled with material from the excavation and additional sediment dredged from the shoreline. The contamination status of these beds is unknown.

Contaminated soil storage: Chevron stockpiled soil contaminated with petroleum hydrocarbons in the vicinity of the former disposal lagoons. This soil was treated to meet a cleanup level of 200 mg/kg.

T106 and T108 T106 is located downstream of the Duwamish/Diagonal site and T108 is immediately upstream. These properties are leased to Container Car International Ltd. Most of each of these terminals is paved except near the shore. Backfilling and/or dredge material disposal has occurred at both sites. The quality of the material used to backfill the T106 property is not known at this time. At T108, at various times, contaminated sediment has been deposited on the site. At present, runoff from these two properties flows through a local drainage system and discharges at one of three locations: Nevada St. Stormdrain, the Diagonal CSO/SD, or the

Diagonal Ave. S. In 1994, a stormwater sample at T106 found halogenated organic compounds and petroleum products. The Port of Seattle is preparing property reports for these two properties for EPA as part of the Superfund process. The Port's study includes 1) analysis of samples from existing wells and assessment of groundwater flow direction, 2) the installation and analysis of samples from additional groundwater wells as well as assessment of tidal fluctuations; and 3) preparation of a summary report.

Washington State Liquor Control Board Warehouse. This warehouse is located about 90 meters from the site.

Federal Center South. Floor drains and drain lines, including those from the FBI maintenance and dye test areas, may drain to the Diagonal Avenue South stormdrain or to the sanitary system. The Department of Ecology and the City of Seattle have requested diagrams of the stormwater drainage system for the site.

Groundwater/Seeps

Depth of ground water ranges from 2 to 12 feet below ground surface. In a 1985 survey, as noted in the Cleanup Study Report, potential groundwater sources to the Duwamish/Diagonal site were identified: Ash Grove Cement, Seattle City Light Substation, ChemPro, Liquid Carbonic Corporation, and several dump sites.

Port of Seattle groundwater samples from 14 wells (1991/1992) at the Chiyoda/Chevron property (old treatment plant) found PAHs, PCBs (0.3 ug/l in one duplicate sample), cadmium (max. 38 ug/l), copper (200 ug/l), lead (260 ug/l), mercury (0.3 ug/l), nickel (380 ug/l) and zinc (6,200ug/l) exceeded ten times the marine chronic Water Quality Criteria. Diesel fuel and gasoline were measured in nine of the 14 wells (30 to 490 ug/l). The Port should include this information in the data they provide to EPA and the Department of Ecology.

In the Source Control summary Report, King County downplays groundwater as a significant concern for source control and states that: "In the cleanup area, mercury is the only metal that exceeds the sediment standard, and this tends to be in deeper water farther from the property or in one area inshore at T108 north of the Diagonal SCO/SD." The Department of Ecology and EPA, however, did request that newer groundwater data be made available.

In the 2004 Seeps Survey, no seeps in the vicinity of the Duwamish/Diagonal site have been proposed for sampling and analysis. DRCC recommends that at least one seep linked to former contaminated groundwater test results be sampled and analyzed fro all contaminants of concern.

Bank Erosion

The shoreline in the area of the cleanup is primarily covered with riprap, much at a 45-degree angle above a cobble and sandy lower beach. A pocket beach is located near the Diagonal Ave South storm drain outfall.

Known Problem Properties/Illegal Dumping In Contributing Drainage

Janco-United, 4412 Fourth Avenue South. In 1984, EPA acted against Janco-United, because they installed an illegal drain-pipe in the summer of 1992 that led to the Diagonal CSO/SD. Janco was a janitorial chemical supply company that formulated and repackaged a variety of commercial grade cleaners from concentrate. For about 27 months from September 1982 to November 1984, chemicals were illegally discharged. EPA found high concentrations of

phthalates, chlorinated benzenes, and volatile organic compounds in soils and drains. Criminal charges were filed and two executives eventually pleaded guilty to illegal dumping.

Union Pacific recovery operation. In July 2000, an oil sheen was observed in ground water and traced back to this location. An estimated 38,000 gallons of diesel product was removed. An active cleanup is underway and reports are submitted annually to the Department of Ecology.

Unknown Source. In 2000, Seattle Public Utilities crews removed about 6,500 gallons of oil-contaminated material from a storm drain at 7th Avenue S and S. Charlestown Street.

Old PCB Spills/Resuspension Potential

As mentioned above, in 1974, a major "PCB spill occurred at Slip # 1, which is located about 3,300 feet (1,000 meters) upstream of the Duwamish/Diagonal outfalls. About 255 gallons of near pure PCB (Aroclor 1242) was spilled on September 13, 1974, when an electric transformer being loaded onto a barge was dropped and broken on the north pier of Slip 1. The majority of the PCBs were recovered during two separate dredging actions. In 1974, an initial cleanup was attempted using several hand dredges, which recovered approximately 80 gallons of PCB. Subsequent sampling determined that the remaining fluid had spread throughout the slip and into the river channel, requiring a second dredging. Prior to that second project, a "20-year flood" occurred during the winter of 1975/1976 and may have contributed to further spreading of contaminated sediments in the river channel. In 1976, the U.S. Army Corps of Engineers (USACE) conducted a second dredging of PCBs at the northwest corner of Slip 1 using hydraulic dredging piping the slurry overland to settling ponds on the Chiyoda Corporation property (former Diagonal Avenue Sewage Treatment Plant property). …A report prepared by the USACE in 1978 estimated that the dredging removed another 170 gallons of the 255-gallon spill of Aroclor 1242 resulting in a total recovery of about 98 percent. Post-spill sediment concentrations of Aroclor 1242 ranged from 0.06 to 2400 ppm in the vicinity of the spill. The highest concentrations were at the immediate location of the spill. Post-dredge (5/4/76) sediment concentrations ranged from 0.03 to 140 ppm…. The report concluded that based on these monitoring results, the spill did not contribute a significant PCB loading to the Duwamish River. However, sediment samples taken by EPA in 1998 showed measurable levels of PCBs remain in the sediment in the dredged channel both upstream and down stream of Slip 1."

Source Control

Between 1994 and 1996, King County did three rounds of sediment sampling at the Duwamish/Diagonal site, characterized contaminants of concern, and evaluated source control measures within the drainage area.

In addition, 1995, King County collected stormwater samples from a drain at 8th Ave South and Hind street (3 samples) and a drain at 13th Avenue and South Horton Street:

Parameter	Detection Frequency	Concentration (ug/L)
Arsenic (total)	10/10	2-4
Cadmium (total)	10/10	0.4-1.3
Chromium (total)	10/10	2-22
Copper (total)	10/10	2-119
Lead (total)	10/10	9-68
Mercury (total)	1/10	0.3
Zinc (total)	10/10	50-225

Bis(2-ethylhexyl)phthalate	9/10	0.9-14.7
Butyl benzyl phthalate	5/10	0.79-1
Dimethyl phthalate	1/10	0.825
Di-n-butyl phthalate	1/10	9.13
Fluoranthene	1/10	0.84
PCBs	0/10	<0.26-<0.5
Pyrene	1/10	0.998

King County also developed a computer model to assess the potential for recontamination of the site after cleanup. All of the sampling and modeling information was compiled and summarized in a 2001 Cleanup Study. Some of the major findings of this analysis are:

- In an effort to look at the potential for recontamination, the County created a METSED computer model in 1997 and a second mass balance model in 1999 (West). Both models showed the potential for phthalate recontamination near the outfalls. Soon after, King County and the City of Seattle began a program to look for phthalate sources in the drainage area.
    - In 1994, a King County stormwater sample from the Diagonal Avenue storm drain found a maximum average bis(2-ethylhexyl)phthalate concentration of 7.15 mg/L and butyl benzyl phthalate of 0.59 mg/L.

- "Current discharge pipes are not a significant source of PCBs."

- A threat to this site is resuspension and recontamination by dredging activities in the river, particularly for PCBs.

- In addition to business inspections discussed below, a sediment removal program was considered for drain inlets into the system. King County estimated that there are between 1,200 and 1,300 storm sewer inlets in the Diagonal and Hanford basin. Maintenance records indicate that these inlets are checked yearly for sediment depth and are pumped out, as needed, every other year. [Note: King County and City of Seattle staff have more recently indicated (2004) that there are about 3,700 catch basins in the Diagonal basin, both in the public right of way and on private property, mapped in the city database. This estimate is probably low because many private drains are not completely mapped in the database. In 2004 (as of July) the City has inspected about 2,400 catch basins and cleaned out about 300 catch basins in the Diagonal basin.]

A *Duwamish/Diagonal Source Control Summary Report* was produced by King County in April 2002, at the request of The Department of Ecology and EPA. An update to this information was provided in the *King County and Seattle Public Utilities Source Control Program for the Lower Duwamish Waterway June 2004 Progress Report* and in a comment letter (dated September 7, 2004) to the draft of this report. The major activities that King County and the City are doing to address source control are:

- *Pretreatment Program*. King County implemented an industrial pretreatment program for discharges to the sewer system including inspections, permitting, monitoring, technical assistance and enforcement. This program focuses on inputs and problems at the sewage treatment plant and not on discharge loads at CSOs. At the end of 1999, King County listed 145 Significant Industrial Users and 279 discharge authorizations. The report doesn't mention how the search for exceedences specifically relates to contaminants of concern at the Duwamish/Diagonal (i.e., if there is an explicit connection between the two efforts).

- *Sewage Treatment Plant Sampling*. Samples of influent are analyzed by King County at West Point and South Plant in an effort to find rogue industrial discharges.

- *Hazardous Waste Program*. City of Seattle and King County source control efforts also include business inspections, public education, and response to citizen complaints, under the Regional Hazardous Waste Management Program. Over 3000 businesses were inspected citywide in 2000. A multi-agency hazardous waste program inspects businesses to reduce the use of and promote the proper disposal of chemicals, with one goal being to reduce chemical input into the drainage system.

- *Catch Basin Cleaning*. City of Seattle cleans street catch basins on a regular basis.

- *Cleanout of Contaminated Sediment.* As part of the agreement with the Elliott Bay Duwamish Restoration Panel to eliminate potential sources, the City of Seattle began to clean out contaminated sediment from Diagonal CSO/storm drain and two tributary pipes in summer 2002. The drain is about 1 mile long. River water can enter the drain during high tides because of its low elevation. In 1992, the City conducted a pipe inspection and sampled accumulated sediments. The pipe cleaning was assigned a projected cost of $500,000. The maximum depth of accumulated sediment was about 12 inches in the main (estimated volume of 434 cubic yards) and about 8 inches in one tributary line (64 cubic yards). The total projected volume of sediment was about 498 cubic yards.

In 2002, sediment was cleaned out of 2,800 lineal feet of the two lateral drains located below 4th Avenue South (Denver Avenue South and 1st Avenue South) 2 by city crews. In 2003, contractors cleaned out part of the main drain and the South Dakota lateral. The drain had to be taken out of service and a shear gate installed at the downstream end of the drain to block the tides. At the upper end of the main pipe, a diversion pump bypass was installed to send flows to the sanitary sewer. In the summer, before the wet season, crews were able to clean out 2,500 linear feet of the main drain the Dakota tributary. The sediment was taken to a nearby cement plant for use in the process. From July to October 2004, the remaining 600 feet of the South Dakota drain was planned to be cleaned out. After the mainline was cleaned, four sediment samples were taken in February 2004. These data have not yet been published.

- *Spill/Illicit Discharge Follow-up.* City has made a focused effort to locate the source of recurrent oil sheen at the Diagonal CSO/SD outfall. 4-methyl phenol is a component of oil and concentrations of 4-methyl phenol have been found in Duwamish/Diagonal sediments in some years, but not all, of sampling data and appear to correlate with oil spills. Documented oil sheens/spills have occurred and been investigated in 1997, 1999, and 2000. 4-methyl phenol might also come from wood waste, or it might be a seasonal contaminant (proposed at Elliott Bay waterfront site).

- *Shared Data*. City, King County, and state planned to share data, mapping and other source control information. To date, this effort is incomplete and agencies do not have compatible data systems or hardware.

- *Focused Duwamish/Diagonal Business Inspections.* King County and the City of Seattle are co-leads in a program to inspect businesses in areas that discharge to the Duwamish. The intent of the program is to control ongoing sources of pollution to reduce the potential for waterway sediments to be recontaminated after cleanup. As stated in the City and King County's 2004

source control progress update report, "the goal is to complete the business inspections before sediment cleanup begins."

In the Duwamish/Diagonal system, businesses in the separated system (i.e., stormwater only) system were given higher priority for inspections because their runoff flows during most rainstorms to the river whereas the CSO flows are often diverted to the sewage treatment plant. The goal of the program is to minimize potential for river recontamination by preventing accidental or deliberate discharge of concentrated wastes to the CSO or storm drains. Four agencies were jointly involved in the inspection program are:

King County Industrial Waste, Wastewater Treatment Division
Seattle Public Utilities
King County Local Hazardous Waste Management, Land and Resources Division
King County Local Hazardous Waste Management, Seattle-King Co. Public Health

Activities under this joint effort have been:

Cross training: Thirty inspectors from the four agencies attended a joint training event. A training manual and field forms were created that were tailored to the Duwamish drainage area. Inspectors are trained to look for contaminants of concern for the waterbody, including phthalates and PCBs.

Business Inspection Process: A preliminary screening to determine which businesses need a "full inspection" involves a drive-by observation (or a visit to the inside of the business) to ensure that the business conducts operations entirely inside and does not use hazardous materials. For the businesses that are determined to be "high-risk," teams of 1-2 inspectors do the following:

Industrial wastewater – Determine if business generates wastewater and what contaminants would be discharged and inspects any pretreatment systems.
Wastes/materials disposal – Review chemical and waste storage, handling and disposal practices.
Spill prevention – Evaluate spill prevention and cleanup practices.
Stormwater – Examine activities that have high potential for polluting stormwater such as fueling, maintenance, and construction. Examine onsite catchbasins and stormwater structures.

The inspectors mail business with violations or problems letters that require corrective action within 30 days. If action is not taken, then the problem business is referred to the appropriate jurisdiction.

History of Inspections

- In 1996 and 1997, the City conducted focused business inspections in the Diagonal storm water drainage basin (Diagonal plus Hanford). The City used standard industrial classification codes to identify about 1,000 businesses in the drainage area. They focused on businesses with outdoor activities that could impact stormwater runoff, such as manufacturing, scrap yards, transportation, or automotive repair. More than 700 businesses were deleted from the list because they do not conduct outdoor activities. About 264 businesses received a drive-by inspection or an actual site visit inspection

during 1996/1997. A series of information bulletins promoting best management practices were mailed to area businesses.

- A second round of source inspections in the basin began in 2001. 200 businesses were inspected in the western portion of the Diagonal basin: 109 drive-by inspections and 91 complete onsite inspections. 81 of the businesses inspected were not in compliance with City stormwater source control requirements, mostly related to inadequate maintenance of onsite storm drainage systems (33 percent) and inadequate spill response programs (47 percent); by March 2002, 90% of these businesses were brought into compliance. Business owners were informed of ways to improve their stormwater pollution prevention practices. More businesses were inspected in 2003.

- In late 2000 through 2001, the City also conducted an intense business inspection program in the Diagonal drainage basin in an attempt to locate the source of a sticky white material (water-soluble acrylic resin that has a verity of uses including coatings for paper, textiles, and wood products, in adhesives, and in ion exchange resins) that fouled fish nets on September 25, 2000. They did not find the source but used the opportunity to look for stormwater issues at each business visited.

- During 2002 and 2003, the City surface water quality team continued conducting source control activities in the Diagonal drainage basin. An additional inspector was hired in 2002 to work on the City's Duwamish source control effort and the effort was expanded to the eastern portion of the drainage. In addition, focused inspections were to be conducted at select businesses to determine whether these facilities are sources of the contaminants of concern found in the sediment offshore of the Diagonal outfall.

- Between March 1, 2003 and May 31, 2004, inspectors screened 249 businesses and conducted an additional 531 full inspections. 65% of the businesses that were fully inspected required corrective actions for problems such as clogged or broken stormdrain structures, improper chemical storage, lack of spill prevention plan, illicit connections and poor outdoor housekeeping.

- As of July 2003, 16 dental offices had been visited to ensure that mercury amalgam separators had been installed or proper permits filed in order to meet requirements to reduce mercury in their wastestreams.

- *CSO Reductions:* King County has reduced the discharge at the Diagonal Avenue S CSO/SD outfall to roughly 75% of the original CSO flow from 300 to less than 65 million gallons per year. The City has reduced its CSO overflows to less than 1 per year. In 2002/2003, the Duwamish pump station near the CSO outfall had no overflows. 2003/2004 water year data are still being tabulated.

- *Computer modeling and storage to reduce CSO overflows:* King County uses a "Computer Augmented Treatment and Discharge" system that uses pipe storage to reduce the volume of CSO flow that is discharged with the use of computer controlled regulator gates.

- *Source Tracing:* In 2003, a new focus by King County and City of Seattle on sampling for contaminants of concern in the drainage, especially phthalate sampling and research, was

initiated. This effort builds on previous and ongoing phthalate assessment in the Thea Foss Waterway drainage area.
King County and City of Seattle staffs are analyzing contaminants of concern, in sediments and/or water samples in the drainage system. Samples are collected in the following locations:

- **Key Manhole Samples:** King County staff collects 24-hour composite wastewater samples at key locations over seven days twice a year, once during wet weather and once during dry weather. Normally only metals were analyzed but starting in 2003, five sites were analyzed for semi-volatile organic compounds in order to determine phthalate levels. Bis(2-ethylhexyl) phthalate (BEHP) at East Marginal and Duwamish locations (2-14 ug/L) was detected at concentrations that have been found elsewhere in Seattle and Tacoma in stormwater and treatment plant influent (5-37 ug/L). Samples at West Marginal were higher and ranged from 21-148 ug/L**.**

- **In-Line Sediment Traps:** In-line sediment traps, wide mouth sample bottles mounted on the side of a collection pipe, were installed at seven sites in the Diagonal drainage. The sampling stations were selected to represent different land uses and subbasins. In place for four to six months, the samplers collect suspended particulate matter from flowing stormwater. Three sampling events have occurred – February-August 2003, October 2003-March 2004, and February-August 2004. The traps will be used for the next three to four years. Results from the first two rounds of sampling include:

  - PCBs are infrequently detected and at low levels
  - Metals are low except for zinc. Zinc exceeded standards at four locations.
  - BEHP exceeded standards at five out of seven stations. The lowest concentrations were found at the residential and mixed residential/industrial stations.
  - PAHs were below standards at all stations.

- **Catch Basin Samples:**
  - **Contaminated sediment in onsite catch basins**: From March 1, 2003 to May 31, 2004, King County and City of Seattle sampled sediment from catch basins at 36 sites. Many of these basins had significantly elevated concentrations of contaminants including (all in mg/Kg): lead (10-2,010), copper (30-1,520), mercury (<0.06-1.82), zinc (55-2,720), TPH-oil (52-71,000), TPH-diesel (15—34,000), PCBs (<0.11-267 mg/Kg OC), 1,4-dichlorobenzene (43,000 OC), and DEHP (10-2,700). These basins have been cleaned out or were in process by June 2004. The high concentrations of bis(2-ethylhexyl)phthalate were found at catch basins onsite at targeted business/commercial types including:

    Business Type Concentration Range (mg/Kg TOC)

Auto repair	81-824
Grocery store	225
Transportation	34-226
Manufacturing	12-100
Restaurant	76-596
Miscellaneous retail	99-990

- **Right of Way Samples**: Samples taken from catch basins in roadways had the following ranges of concentrations (mg/Kg): zinc (84.7-851), copper (38.4-229), lead (25-1,370), mercury (<0.06-0.87), TPH-oil (480-11,000), PCBs (0.18-6.70), BEHP (15-460 OC). BEHPs were generally higher in low-median traffic roadways compared to higher traffic roadways.

The contaminant concentrations from the onsite samples overall were higher than from those in the right-of-way catch basins. PCBs and PAHs were lower than sediment standards in all samples but BEHP did exceed standards in 82% of onsite catch basins, 65% of right-of-way catch basins, and 80% of inline sediment traps.

Phthalate Source Study: Along with the City of Tacoma, King County and City of Seattle are conducting research into the concentrations of phthalates in household and automotive products. Products sampled ranged from carwash soap, cigarette butts, break pad dust, tire dressing, to packaging peanuts. Tacoma staff developed a method to test atmospheric dust from the roof of the Tacoma Dome. Air sampling is planned for the Duwamish/Diagonal drainage as well. To date, no conclusive evidence points to any specific products at any specific locations.

Duwamish/Diagonal Source Control Comments and Recommendations

1. ***Quantification.*** Source control for the Duwamish/Diagonal site is primarily directed towards reducing the contaminants entering the drainage system and flowing to the outfalls. Key to both understanding these sources as well as determining the success of source control efforts is quantification of the problem.

   - *Pipe sampling*. Sampling is needed to quantify exactly what is in the outfall discharges post-cleanout of the Diagonal combined sewer drain. The sampling in 2002, which showed exceedences for a number of constituents, was rightly pointed out to be an analysis of years of sediment accumulation. After the cleanout of the pipe and the cleanup of the Diagonal/Diagonal site are complete, new sampling should be performed in the pipe to test the contaminant load of new material that accumulates on an annual or periodic basis. A loading estimate for key constituents should be made.

   - *Sampling to support model*. The King County models of the CSO flow are useful for predictions, but given the large number of assumptions that had to be made in order to run the models, the site-specific recontamination potential needs to be evaluated by actual data in the drainage system. Sediment contamination patterns did not match the modeling – zinc being one example.

   - *Additional drain sampling.* The source detection sampling that King County and the City are conducting should be given more resources so that additional locations can be sampled.

2. ***Phthalate Action.*** Cleanup at the Duwamish/Diagonal site has been completed prior to achieving source control for phthalates and other contaminants. Given that it will cost another number of millions to re-cleanup the site for phthalate recontamination, if it should occur down the line, the elimination and reduction of potential sources to the drainage system should occur swiftly. King County and the City are conducting a sampling and research program and more funding should be directed towards this effort.

3. ***Treatment for Phthalates at end of pipe.*** If phthalate sources cannot be eliminated in a timely fashion from the Duwamish/Diagonal drainage, then treatment options should be investigated.

4. ***Phthalates should be a concern at all sites.*** From the Source Control Summary: "The lack of any elevated chemicals, besides phthalates, in these three sediment samples collected in front of the small SD outfall suggests there are no problem discharges to this small pipe that could be a potential recontamination source to Area B." Phthalates need to be addressed at this outfall and potentially at all outfalls.

5. ***Need for Coordination with Other Cleanup and Dredging Actions.*** The biggest threat for major PCB recontamination is dredging of PCB-contaminated sediment in the river. These locations need to be assessed so that dredging can be carefully planned. Further, the partial cleanup conducted at this site did spread PCBs outside of the site during dredging and leaves open the potential for PCB recontamination. The spilled PCBs should be captured immediately before they can spread to the clean cap and other river sediments. Cleanup of adjacent PCB hotspots should be carefully coordinated to minimize recontamination.

6. ***Status of actions that have occurred.*** It would be helpful for the Department of Ecology to produce, on a quarterly basis, a summary of source control actions and results of those actions that are listed in the source control and cleanup plans. An easily updated webpage could also serve this communication function. King County and the City are devoting considerable resources towards source control efforts. Examples of actions that were planned and the outcome is unknown are:

    - *Pretreatment Results.* King County's industrial pretreatment program for discharges to the sewer system provides information that could address source control. What success has the County had in determining levels of contaminants to the system?

    - *Influent testing*. West Point and South Plant influent is tested in an effort to find rogue industrial discharges. What chemicals that have been found?

    - *Modeling.* What is the current status of King County's CSO modeling?

7. ***Effectiveness of restricting dredging to top 3 feet.*** PCBs contamination concentrations exceed SQS or CSL criteria values down to depths of 6-9 feet, or possibly greater than 9 feet in depth, and yet the site was only dredged to an average depth of 5 feet. Will follow-up monitoring examine the effectiveness of leaving material in place at depth?

8. ***Examples of potential source issues that need further assessment:***

    - *Groundwater Assessment*: What is the current water quality of the groundwater at T108? Ecology should request that the Port conduct a sampling and report the data. Groundwater data from 1992 should also be provided. This data would be useful to determine whether groundwater is a source control problem.

    - *T106 and T108 reports.* The Port of Seattle is preparing property reports for these two properties for EPA. "When the Port was contacted by the County about obtaining property reports on T106 and T108, the Port said that they were assembling the information to send to

EPA as part of the Superfund potentially responsible party search and will be providing that data to EPA soon." Has this occurred and when will this information be available?: The Port's T106 was backfilled with material in the 1970's. What was the quality of that material?

9. ***Clarification about interpretation of core data.*** The Source Control Summary Report concludes that at CSO outfalls, sediment concentration patterns show reduction over time due to recent source control actions. "This reduction can be seen in the core data [in Section 5 of the Cleanup Study Report], where the older, deeper sediments have higher concentrations. The reduction of concentrations towards the surface demonstrates the reduction in loading being discharged. This reduction of loading is a direct measure of the success of source control activities to date." This statement may be related to source control activities or may due to the historic nature of the contaminants. No tie-in to the sedimentation rates is reflected in the report to indicate that the source control efforts are working.

10. ***Shared Data.*** The City, King County, and the state planned to share data, mapping and other source control information. Based on DRCC's discussions with the Department of Ecology, it appears that there are some ongoing technology constraints that are preventing the sharing of data electronically.

11. ***Fill Material.*** There is a concern that material that was planned to be used as the engineered fill cap was to be from the Turning Basin, which is dredged on a periodic basis as part of the Army Corp's regular navigational maintenance activities. This material was not used in the recent cleanup at Duwamish/Diagonal because it was not available – but it might be used in the future. Fish biologists have raised the concern that this dredging has occurred during sensitive times for river aquatic species. This concern should be investigated. In addition, this material may be contaminated. How often is it tested?

References and Studies

Duwamish/Diagonal CSO/SD Cleanup Study Report, Draft 2001 (December), by KCDNR

Source Control Summary for the Duwamish/Diagonal Cleanup Project Addendum, April 2002, by KCDNR

Report to DRCC on Duwamish/Diagonal, 2003 (June 27), Dr. P.L. de Fur

Sediment Management Standards Cleanup Action Decision: Duwamish/Diagonal CSO/SD, 2002 July 25), by Ecology

Duwamish/Diagonal CSO/Storm Drain Sediment Cleanup Project, Cleanup Action Decision Memo, Public Comment Responsiveness Summary, 2002 (July 25), by Ecology

Duwamish/Diagonal Sediment Remediation Project Summary Package, 2004 (June 7), by King Co.

Comment Letter from Beth Schmoyer (City of Seattle) and Elsie Hulsizer (King County), September 7, 2004.

Lower Duwamish Waterway Source Control Action Plan for the Duwamish/Diagonal Way Early Action Cleanup, 2004 (September), by Ecology

Slip 4 (Early Action Area 3)

Slip 4 Summary
Major Contaminants of Concern: PCBs, phthalates, PAHs (plus many less widespread contaminants)
Project Coordinators: King County and City of Seattle
Current Status: Sampling to determine boundary conditions
Main potential sources: Historic and current outfalls, adjacent properties (multiple pathways)

Action.

Slip 4 is one of seven sites within the Lower Duwamish Waterway Superfund site chosen for early cleanup actions because of its potential for higher levels of risk based on PCB levels. Cleanup plans are being developed under the existing Administrative Order on Consent between the City of Seattle, King County, the Port of Seattle (Port), and The Boeing Company—called the Lower Duwamish Waterway Group (LDWG)—and EPA and the Department of Ecology. The leads for this site are King County and the City of Seattle (City Light).

Location and Cleanup

Arc-shaped Slip 4 is located approximately 2.8 from the tip of Harbor Island on the east bank of the Duwamish River. It is approximately 1,400 feet long, with an average width of 200 feet totaling about 5.7 acres and represents a remnant of the original river before it was channelized. The adjacent major properties include Boeing Plant #2 and First South Properties to the south and Crowley Marine to the north. Crowley Maritime Corporation and Boeing own the slip. Five public outfalls are located at the slip head. A dock and berth extend over the water off of the Crowley property. Under Superfund, the sediments in the slip will be addressed. Sampling in order to determine the boundary of cleanup for early action is underway. Of interest is the distribution of fine material in the slip. Several dredging events have occurred in the slip, complicating the use of some of the historic sampling data. From fall 2003 through May 2004, a workplan, data gaps report, and a field sampling plan were published.

Consultants Hired for this Site

Integral Consulting (formerly Striplin Environmental Associates).

Contaminants

Contaminants of Concern that drive cleanup: Total PCBs exceed CSLs over large area, and are especially concentrated in the inner area (head) of the slip near outfalls. Bis(2-ethylhexyl)phthalate also occur at elevated levels in hot spots that do not consistently overlap with PCB hotspots. EPA initially identified PCBs and PAHs as contaminants of concern for Slip 4. PAHs are mostly localized in a hot spot off of Crowley Marine.

Additional contaminants of concern:

- *Distribution:* Greater than 80% of sediment samples considered in the Data Gaps Report had detections of LPAH, HPAH, bis(2-ethylhexyl)phthalate, dibenzofuran, carbazole, and PCBs.
- *Surface* sediment detected SQS exceedences include PCBs, bis(2-ethylhexyl)phthalate, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, chrysene, mercury, fluoranthene, butyl benzyl phthalate, total HPAH, zinc, lead, benzo(a)anthracene, benzofluoranthenes (total), di-n-octyl phthalate, phenanthrene, cadmium, n-nitrosodiphenylamine, benzo(a)pyrene, benzo(g,h,i)perylene
- *Non SMS contaminants:* DDT (total), alpha-chlordane and dieldrin
- *Subsurface* detected SQS exceedences: PCBs, acenaphthene, benzo(a)anthracene, Benzofluoranthenes (total-calc'd), bis(2-ethylhexyl)phthalate, butyl benzyl phthalate, cadmium,

chrysene, dibenzo(a,h)anthracene, di-n-octyl phthalate, fluoranthene, indeno(1,2,3-cd)pyrene, lead, mercury, silver, total HPAH

- *East of Crowley Marine* LPAHs and HPAHs exceeded SQS values and phenanthrene, fluorene, and total LPAH exceeded CSL.
- *Porewater* (one sample): cadmium exceeded chronic marine water quality criteria.
- *Butyltins and dioxin/furans* were detected in the few samples analyzed: butyltins (40 ug/Kg tributyltin [TBT]), Total tetrachlorodibenzo-p-dioxin (TCDD) (10 pg/g) and tetrachlorodibenzofuran (TCDF) (63 pg/g)
- *Slip 4 surface water quality.* In August 2002, NOAA collected and analyzed two surface water samples for PCBs and PAHs. PCBs were undetected. Total PAHs were 0.1 and 0.72 ug/L.
- *Other.* A number of contaminants in sediments were undetected at levels that exceeded standards because concentrations above standards are not detectable using current laboratory methods.

Sediment contaminants listed in 2003 Early Action Report showing maximum exceedence factors (EF) relative to sediment standards:

Chemical	SQS* EF	CSL** EF	Chemical	SQS* EF	CSL** EF
alpha-Chlordane	2.6	na	DDTs (total-calc'd)	417	41.7
Benzo(a)pyrene	1.0	0.5	Dibenzo(a,h)anthracene	1.6	0.6
Benzo(g,h,i)perylene	2.0	0.8	Dieldrin	28	na
Benzofluoranthenes (total-calc'd)	1.0	0.5	Indeno(1,2,3-cd)pyrene	2.0	0.8
Bis(2-ethylhexyl)phthalate	3.2	1.9	Mercury	2.7	1.9
Butyl benzyl phthalate	1.6	0.1	Total HPAH (calc'd)	1.0	0.2
Chrysene	1.0	0.2	PCBs (total-calc'd)	150	27.8

*SQS - Washington State Marine Sediment Quality Standards
**CSL - Puget Sound Marine Sediment Cleanup Screening Levels

Potential Sources

[Note, groundwater data is noted at each site, rather than being pulled out for a separate groundwater section so that one can compare soil and groundwater contamination]

Outfalls

Eleven outfalls discharge to the slip. Among these are five public outfalls, including storm drains and emergency sewer overflows, which are located at the slip head. The exact location and drainage area of all of the outfalls is a data gap. For most of the outfalls no monitoring data has been provided.

Georgetown Steam Plant (GTSP) Flume outfall (constructed in 1917) (60 inch diameter). In 1917, a pumphouse was built to the northwest of Slip 4 to supply cooling water to the Georgetown Steam Plant, and a 0.4 mile long flume measuring 7 feet wide and 5 feet deep was constructed to return the cooling water to Slip 4. The flume is made up of both concrete and wooden sections and over the years has been covered over to facilitate industrial development on top – 1,240 feet remains open to the air and receives sheet stormwater flow from adjacent properties. Many legal and illegal hookups to the flume occurred over the decades. Some discharges included 700 gallons per minute Boeing cooling water, 6-inch iron pipe from Boeing oil yard drain pit, storm drain from Boeing (with soil samples of up to 520 ppm PCBs described in 1984 and cleaned up), containment area for 10,000 gallon methylene chloride tank, compressor cooling water discharge, and a 1986 spill of lubricating oil (estimated at 10 gallons). In 1985, 29 undocumented drains into the flume were found and closed. The Steam Plant quit regular operations in 1964, was maintained on "cold standby" starting in 1971, and was officially retired in 1977.

Boeing sampled sediments in their stormwater collection system discharging to the head of the flume in the mid-1980s; PCB concentrations ranged up to 520 mg/Kg. Other Boeing buildings and properties discharged to the flume and are only partially described in the Data Gaps Report. Further work is needed to ensure no connections discharge to the flume at this time.

Contaminated soils and sediments were discovered in the flume and adjacent site in the early 1980's. The flume was cleaned in 1985, the site was given closure in 1987 and the sediment continued to be monitored quarterly from 1989 through 1991. Before cleaning, PCB concentrations were as high as 2,521 mg/Kg. Samples taken after the cleaning were only as high as 14.26 mg/Kg. Post closure samples had PCB concentrations up to 103 mg/Kg. A 1998 sampling of the flume sediment found PCB concentrations ranging up to 3.9 mg/Kg.

I-5 Storm drain (constructed in 1965) (72" diameter): Washington Department of Transportation owns this outfall which drains approximately 1.5 miles of I-5 and40 acres of primarily residential land located east of I-5. The I-5 Storm drain outfall has an approximate discharge of 10 million gallons per year. A sediment analysis in 1985 by Tetra Tech found only lead as a problem contaminant in this drain (maximum 714 mg/kg).

Slip 4 Storm drain (constructed in 1940's) (60" diameter). King County owns this drain that drains approximately 290 acres from the north end of the King County Airport/Boeing Field. Estimated discharge is 150 million gallons per year. A sediment analysis in 1985 by Tetra Tech found the following problem contaminants: cadmium lead, mercury, silver and zinc.

Slip 4 Emergency Overflow/Storm drain (EOF/SD #117) (constructed in 1940's) (24" diameter). [Note: Previous reports (e.g., Tetra Tech 1988) identified this drain as the Slip 4 CSO/SD (117). Similarly, the East Marginal Way Emergency Overflow (W034) was identified in previous reports as the East Marginal Pump Station CSO (W034). Both discharges are emergency pump station overflows rather than actual combined sewer overflows]. This drain is a City of Seattle emergency overflow for pump station #44 (located on Airport Way South) and currently drains small area on north end of King County airport/Boeing Field. Drainage area for the Emergency Overflow is 75 acres and for the storm drain is 3 acres. Prior to 1976, this drain was a raw sewage outfall for the far north end of the King County Airport/Boeing Field and the area to the north of the field. The storm system was separated from the sewage system in 1976 and this drain was converted to a storm drain as well as an emergency overflow for City sewer pump station #44. Between 1985 and 1987, the drainage from the overflow system was diverted to the Slip 4 Storm Drain. The drain was identified by Metro in 1984 as a source of PCBs (103 mg/kg in drain sediment sample) as well as a number of metals to Slip 4. In 1985, Tetra Tech collected sediment samples and identified 16 problem chemicals in EOF/SD (#117): cadmium (33.9 mg/kg), lead (745 mg/kg), mercury (9.02 estimated mg/kg), silver (19.1 estimated mg/kg), naphthalene (3,000 ug/kg), fluorine (4,900 mg/kg), phenanthrene (7,200 mg/kg), fluoranthrene (9,00 mg/kg), indeno(1,2,3-c)pyrene (2,100 estimated mg/kg), LPAH (16,000 estimated mg/kg), HPAH 40,000 estimated mg/kg), 2-methyl-naphthalene (6,200 mg/kg), 4-methylphenol (1,400 estimated mg/kg), p,p'-DDE (3,400 mg/kg with low internal standard recovery), p,p'-DDT (4,300 mg/kg with low internal standard recovery), and PCBs (260,000 estimated mg/kg). The pump station did not overflow in four years prior to 2004. Historic connections as well as problems are noted below. It is unclear if all of these locations continue to discharge to the system.

Connections to this drain and known contamination problems:

- 1954: parts of Boeing Plant 2 were permitted to connect to the drain.
- 1985: inspection found oil/water separators at North Boeing Field discharging to the storm drain, including various fuels, oils, solvents, and electrical transformer/capacitor station runoff.
- 1986: inspection found uncontained storm and wash runoff from Famco Transport oil tanks and truck wash areas.
- 1994: industrial water discharge survey found North Boeing Field process water, condensate water and floor discharging to the storm drain.

East Marginal Way Pump Station Emergency Overflow (W034) (constructed in 1970): This King County/Metro emergency sewer overflow pump station has auxiliary power and will function only in an extreme emergency. There has not been a recorded overflow from this pump station since at least the 1970s.

Private Drains:

- Two Boeing Plant 2 drains (approximately 24-inch), located on the south side of Slip 4, approximately 170 feet from the mouth of the slip, drain about 17.5 acres of the Boeing property (under the NPDES industrial stormwater program). In 1992, sediment samples from the Boeing storm drain collection system discharging to the Slip 4 storm drains had PCB concentrations as high as 426 mg/Kg. Boeing then conducted a cleanout that included removing sediment from drainage system manholes, catch basins, and piping.

- Five First South Properties (4- to 6-inch) drains located on the southeast side of Slip 4 (3 are under an industrial stormwater permit.

- Six outfalls (8-inch) are located on the north side of Slip 4 draining an unknown location at or near the Crowley property. The ownership and source status of the drains is unknown although one was flowing during a May 2003 field survey.

NPDES permits for stormwater (The first monitoring reports were due to the Department of Ecology in August 2003):

- Boeing Plant 2
- Cedar Grove Composting – Webster Yard (Former occupant of property currently owned by First South Properties)
- King County Airport Maintenance Shop (via Slip 4 storm drain)
- North Boeing Field (via Slip 4 storm drain)
- Northland Services 8th Avenue Terminal (Crowley property)

Adjacent or nearby properties

Boeing Plant 2 (South side of Slip 4, 755 East Marginal Way South): Since the 1930's, this 107-acre upland site is used for storage and manufacture of airplane parts, including those made of aluminum alloy, steel alloy, and titanium alloy. The site has confirmed releases of metals, petroleum products, halogenated and non-halogenated organic compounds, PCBs, and PAHs to groundwater, surface water, air, and/or soil, and sediment (suspected) and has the highest rank on the Washington Ranking Method (WARM) scale due to the risk to human health and the environment. The only unpaved areas at Boeing Plant 2 are the park and landscaped areas. Under a Resource Conservation and Recovery Act (RCRA) Administrative Order investigative and remedial work is underway.

On site at Boeing Plant 2 were a chemistry laboratory and a structure that housed solvents. A reinforced concrete, dangerous waste sump was constructed in 1980 in the center of the north end of Building 2-01 and was used to collect fluids used during cleaning and repair of landing gear assemblies, including hydraulic fluid. The sump handled waste materials containing acetone, 2-butanone, toluene, and petroleum hydrocarbons. The sump was removed and concrete and underlying soils were then sampled for comparison to closure performance standards. *PCBs were not analyzed during closure activities*. Later, an additional 270 tons of soil in the vicinity of the sump were excavated. Prior to closure, maximum soil concentrations were 700 ug/Kg for acetone, 31 ug/Kg for 2-butanone, 8.3 ug/Kg for toluene, and 100 mg/Kg for TPH which, after excavation were reduced below 100 ug/Kg for acetone, 100 ug/Kg for 2-butanone, 5 ug/Kg for toluene, and 25 mg/Kg for TPH.
Eighteen underground tanks appear on the Department of Ecology database records for Plant 2; three are operational, seven have been removed, and eight are apparently waste oil tanks used for heating.

Additional Contamination Investigations at northern end of Boeing Plant 2 (1990 – 1994):

- *Known soil contamination at the site* (near Slip 4): PCBs (up to 14 mg/Kg), PAHs (up to 28,000 ug/Kg), acetone (up to 190 ug/Kg), 2-butanone (up to 34 ug/Kg), 111-trichloroethane (up to 6 ug/Kg), trichloroethene (up to 9 ug/Kg), Hs (71 to 28,000 g/Kg), di-n-octylphthalate (up to 200 ug/Kg), naphthalene (28,000 ug/Kg) and methylnaphthalene (8,800 ug/Kg), TPHs (103 mg/Kg), copper (310 mg/Kg), lead (160 mg/Kg), and zinc (220 mg/Kg), and cadmium.
- *Groundwater at site*: Vinyl chloride (up to 2.0 ug/L), oil and grease (up to 12 mg/L), arsenic (up to 30 g/L) and chromium (up to 60 mg/L), copper (up to 2.7 mg/L), lead (0.7 mg/L), nickel (3.8 mg/L), and zinc (2.4 mg/L). Additional known groundwater data from this site has not been reported in the Slip 4 documents.

The Boeing Plant 2 RCRA corrective action upland investigation work is all located south of Building 2-122 and does not include the north end of Plant 2 adjacent to Slip 4 or sediments in Slip 4.

Crowley Marine Services - Parcel D (North side of Slip 4, 7400 8th Ave S?): Currently leased to Alaska Logistics, this upland terminal has been used for cargo container storage from the 1980's. The site is mostly paved. The adjacent berthing area, located on Slip 4, is made of concrete pilings with a concrete platform that extends over the water. Site has been investigated for contamination at least as early as 1988.
Historic uses of this site: Hydraulic Supply Manufacturing Company used southern end of property, a manufacturer of pipes, tanks, chains, and perhaps hydraulic parts or equipment, including pipe-dipping vat (1929-1970's); Pankrantz Lumber Company occupied the northern half of site and included a large lumberyard, sawmill, refuse burner, boiler, and planar (1929?-1946?); Lumber site was mostly used for storage and probably dipping of lumber poles with rafting and bundling of logs in Slip 4 (1946-1960).
Investigated contaminants (1988-1990):

- *Soil* samples had elevated arsenic (up to 2,800 mg/Kg), TPH (maximum 29,000 mg/Kg), carcinogenic PAHs (cPAHs, maximum 1,396 mg/Kg) and PCBs (maximum 2.5 mg/Kg) as well as copper and zinc. Extensive arsenic contamination was found in the vicinity of the former pipe-dipping facility as well as at an upland sediment disposal area near well D-MW-6. PAH contamination was more widespread. Hart Crowser (in 1990) estimated that approximately 9,000 cubic yards (cy) of soil at the site exceeded MTCA criteria.

- *Groundwater* samples had elevated metals: arsenic (up to 0.098 mg/L), copper (up to 0.003 mg/L) which were above marine standards, as well as zinc (up to 0.044 mg/L); and organic chemicals: methylene chloride (up to an estimated 1.4 ug/L), acetone (7.0 ug/L), cis-1,2-dichloroethene (1.5 ug/L), chrysene (1.4 ug/L in D-MW-6), and cPAHs (totaling from an estimated concentration of 0.7 ug/L up to 22.6 ug/L), ethylbenzene (at an estimated 0.6 ug/L), and total xylenes (at an estimated 0.6 ug/L). Additional metals and a total of 12 SOVs were detected. Arsenic appeared to occur in four hotspots, which might have been near old pole dipping locations. Bis(2-ethylhexyl)phthalate in groundwater sample was attributed to sample contamination. Elsewhere in the river, phthalates that are tagged as laboratory errors have been called into question recently.

No records of soil or groundwater remediation activities resulting from these investigations have been found.

Crowley Marine Services - Parcel F (head of Slip 4): Historically this site was used as a log storage site and production of manufacture excelsior, or fine wood shavings used as packing material (1920's?-1950's?) and later was occupied by Washington Excelsior and Manufacturing Company for the manufacture of aluminum windows and sashes (1950's – 1980's?) and more recently used for shipping container storage. Two underground storage tanks were removed in 1988: 8,000-gallon diesel and 2,000-gallon gasoline.

Investigated contaminants (1988-1990):

- *Soil* samples had elevated zinc, selenium, cadmium, total chromium (up to 21.4 mg/Kg), methylene chloride (8 ug/Kg), ethylbenzene (up to 96 ug/Kg), toluene (up to 120 ug/Kg), total xylenes, TPH (up to 280,000 mg/Kg), endosulfan I (up to 17.7 ug/Kg), PCBs (up to 890 mg/Kg) and acetone (attributed to laboratory contamination). In a 1990 assessment, "Several VOCs (up to 240 ug/Kg), SVOCs (up to 63,000 ug/Kg), and metals (up to 106 mg/Kg) were detected in the samples."
- *Groundwater* samples had detections of pentachlorophenol, bis(2- ethylhexyl)phthalate (up to 29 ug/L) and methylene chloride (up to 1.1 ug/L) but were qualified as possible sample contamination. Detected metals included arsenic (up to 0.002 mg/L), chromium (up to 0.011 mg/L), copper (up to 0.007 mg/L), and zinc (up to 0.017 mg/L).

No record of remedial activities performed to address the TPH-contaminated soil or the possible remaining underground storage tanks at Parcel F has been found.

Crowley Marine Services - East Marginal Way South (northeastern end of Slip 4): This small site is the location of a billboard and has several outfalls

First South Property – Parcel E (Northeast of Slip 4, 7343 E Marginal Way S): This partially paved upland property is used by Emerald Services to store portable toilets, storage tanks and containers, and large construction hauling/recycling containers and dumpsters. The site has a hazardous waste permit and is considered a medium quantity waste generator.

Site History: Washington Machinery and Storage Company machine shop and railroad spur (1920's- 1980's?); J.A. Jack and Son lime plant (1940's-1960's); Northwest Precote, Inc. asphalt plant, with four tanks (1940's-1980's); Cedar Grove Composting and Evergreen Marine Leasing (1990's)

Investigated contaminants (1988-1996):

- *Soil* samples had elevated TPH (up to 25,000 mg/Kg), cadmium (up to 2.7 mg/Kg), lead (up to 1,190 mg/Kg), and total chromium (up to 20.7 mg/Kg).
- *Groundwater* samples had elevated arsenic (up to 0.093 mg/L), copper (up to 0.132 mg/L), zinc (up to 0.211 mg/L), 2-methylnapthalene, TPH, and LPAHs. Hart Crowser (1991)

compared all groundwater concentrations to calculated worst-case criteria based on MTCA surface water protection criteria and sediment quality criteria (did not include attenuation, dispersion, or dilution during transport) and concluded that TPH and 2-methylnaphthalene concentrations in groundwater did exceed the worst-case criteria.

A number of cleanup actions included removal of five tanks (8,000 gallon diesel, 12,500 gallon buried railroad tank car with heavy oil, 1,000 gallon possible stove oil, 2,500 gallon diesel, and 1,000 gallons soil/oil mixture) and associated 1,500 cubic yards of TPH contaminated soil and rubble as well as follow-up groundwater monitoring. No further action determination was granted by the Department of Ecology in 1998.

King County, East Marginal Way Pump Station property (East side of Slip 4, on E Marginal Way S). The pump station was constructed in 1966 and is associated with the Elliott Bay Interceptor. The pump station has an emergency overflow outfall into Slip 4.

Seattle City Light Georgetown Steam Plant and Flume Property. The Georgetown Steam Plant constructed in 1906 was originally located on the Duwamish but when the river was channelized in 1917 the steam plant was no longer on the river and a pump station was built at Slip 4 to bring cooling water to the plant. A return flume (see outfalls) was built to return water to the slip. The flume property is owned by the City of Seattle and varies between 20 and 45 feet in width. Starting in 1952, Boeing leased portions of the land where the flume is located, built buildings including a fuel laboratory and storage tanks, and began discharging stormwater and cooling water through the flume to Slip 4, including the end of Boeing Field (the "fire training pit"). Broken floor pipes in a Boeing building and other problems were found in environmental investigations. The soils of the plant and flume property contain elevated contaminants and were excavated in the late 1990's to levels below 11 mg/Kg but the Data Gaps Report indicates that the it is unclear if other contaminated areas were completely cleaned up.

Investigated contaminants (1984-2002):

Soil samples from drainage ditch, the plant and flume property, and North Boeing Field had elevated PCBs (up to 91,000 mg/kg) as well as a broken pipe with an oily fluid with 25,300 mg/kg PCBs and 25,500 mg/kg TPH (in a Boeing building). The soils in these areas were excavated and removed.

Groundwater/Seeps

Groundwater depth is generally 6 to 10 feet below ground surface in properties around Slip 4. Tidal influence has been observed in the vicinity, estimated to extend at least 500 feet inland from the river. A seep was observed on the southeastern shoreline during a site visit in 2003. During the seep reconnaissance for Phase II/RI work in May 2004, at least 3 seeps were observed in Slip 4: two on the south side and one off of the Crowley Marine property at the mouth of the slip. An additional seep (or set or seeps) was observed under the pumphouse inlet gates. The Crowley and one of the south slip seeps was scheduled to be sampled in July 2004 as part of the riverwide Phase II/RI Seep Survey.

Studies at Boeing Plant 2 showed discharge from groundwater into the river at a rate of 15 gallons per minute in upper zones and 11 gallons per minute from lower zones. As noted in the Data Gaps Report, contaminants have been found in concentrations above marine standards at properties adjacent to the slip: arsenic, copper, zinc, bis(2-ethylhexyl)phthalate and PAHs.

Bank Erosion

Over two-thirds of the Slip 4 bank is covered with riprap or bulkhead. The banks are armored by a sheet-piling wall, wooden or cinderblock bulkheads, and pavement debris along the Crowley, First South parcels and by riprap along the Boeing facility shoreline. Evidence of erosion is seen by relatively recent fill placement observed along the First South property and minor eroded vegetation along the Crowley shoreline. Bank erosion problems (i.e. soil chemistry) have not been investigated.

Source Control

The SAP indicates that current investigative work at the site by the consultants will focus solely on characterizing the sediments. Source control is not described in the workplan – and the only aspects of potential sources described in the Data Gaps Report are the adjacent properties and the locations of the outfalls. Much more information is needed to determine the potential sources, including adjacent properties and drainage systems that contribute to the outfalls for this site.

King County and Seattle Public Utilities Source Control Program for the Lower Duwamish Waterway, June 2004 Progress Report and a comment letter for this report (Dated September 7, 2004) indicate that joint inspections, similar to those performed in the Duwamish/Diagonal drainage area, were initiated at the potential stormwater discharging businesses at King County Airport in July 2004. 22 businesses were inspected by September 2004. Ten sediment traps were installed and additional traps will be installed after access negotiations are complete with Boeing. King County Airport managers were planning to send informational letters to all of their tenants. The inspection program will cover the 35 acre combined sewage area (City of Seattle pump station) which overlaps with the storm drain system but not the 6,200 acre combined sewer overflow drainage system that discharges to Slip 4 via the emergency overflow at the King County pump station because it has not overflowed in the past 20 years.

At the November 2, 2004 Source Control Working Group meeting, the Department of Ecology staff summarized ongoing work.

- A joint Department/City of Seattle inspection of the Crowley Marine property revealed that they have no stormwater permit. The catch basins and drain lines are cleaned once a year.

- Six shorebank samples were taken earlier in 2004 and a PCB hotspot was found at the junction between the First South and the Boeing properties at the end of what appears to be an old stormdrain. No shorebank samples were taken on the Boeing bank.

- The City and County had also taken samples of stormdrains that drain into Slip 4, except those on the Boeing Property. A consultant has been hired to survey and video the inside of the Flume to determine if all connections have been closed off and take sediment samples.

- The City and County had conducted inspections at about 70 businesses at the King County Airport, including taking samples in some catch basins at those sites.

Slip 4 Source Control Comments and Recommendations

1. ***Good Potential for Success.*** Most of the drains and the flume that have current discharges to Slip 4 have limited drainage areas. If the immediate sources (i.e., the public and private outfalls) are determined to be clean and all potential inputs to larger drainage systems and the flume, as well as adjacent properties, are cleared, then Slip 4 has a good potential to avoid recontamination. There is no certainty at this point, however, that the potential sources for this site are being identified and addressed. Phthalates and other urban runoff issues must be thoroughly investigated and controlled to avoid recontamination.

2. ***Lack of Source Identification in Published Documents***. In the Slip 4 workplan, the stated goals are: "to implement tasks to characterize sediment quality in the Slip 4 Early Action Area, *evaluate potential sources to the slip*, and support EPA's associated public involvement activities." [italics added] At this time, however, no source identification actions are proposed. This site has a high potential for success if handled in a systematic and comprehensive manner.

3. ***Reduction in Scope of Consultant's work.*** In the Workplan , source control data to be included in the Data Gaps Report were: "potential ongoing and historical sources of contamination to the Slip 4 Early Action Area to the extent they can be determined, and, for each source, a description of the types of information that would support the EPA/Washington State Department of Ecology Baseline Source Control Matrix for the Lower Duwamish Waterway Superfund Site." In the Data Gaps Report, however, this goal was inexplicably reduced to: "The major objective of this report is to fully document existing environmental conditions in and adjacent to Slip 4. Data compiled in this report are limited to Slip 4, adjoining properties, and discharges to the slip." Source control data was removed from the scope. The workplan documents still need to be produced.

4. ***Lack of clarity on timeframe.*** The Workplan also states: "Generally, significant continuing sources should be controlled to the greatest extent possible before or concurrent with cleanup of sediment." The timing and implementation of source control efforts is not clear. The sediment characterization is proceeding on a tight schedule, but the needed parallel effort on source control is not clearly articulated and may lag behind cleanup plans as has occurred at the Duwamish/Diagonal early action area.

5. Examples of potential source areas that need assessment:

- A major concern is the cleanliness of the flume and the potential continuing sources of PCBs in its drainage area. What was/is the source of PCBs? What is the current condition of the Boeing Field fire drill area? This is a substantial data gap.

- Extensive soil and groundwater contamination have been found at Crowley Marine, but no cleanup action has been documented. The PAH plume may still be in the groundwater and may be contributing to the observed PAH hotspot that is found in the sediment off the Crowley parcel. This potential source needs to be investigated.

- Extremely high levels of arsenic at some of the adjacent parcels, notably Crowley Marine, have been described in the Data Gaps Report. Follow-up sampling should determine if this is a continuing source.

- Similarly, no follow-up has been indicated to check groundwater quality at Parcel F-First South Property. For example, TPH and 2-methylnaphthalene concentrations in groundwater exceeded the worst-case criteria for impacts to slip 4 in 1990.

- Sketchy and incomplete information has been published in the Slip 4 documents about contaminants in groundwater, soils and storm drains at Boeing Plant 2, as well as historic or continuing sources of pollutants. Furthermore, the RCRA corrective action upland investigation work for Boeing Plant 2 is all located south of Building 2-122 and does not include the north end of Plant 2 adjacent to Slip 4 or sediments in Slip 4.

- Outfall locations, status, ownership and drainage area are not fully described or depicted (or known). This is another major unknown identified in the Data Gaps Report. All of these outfalls, as well as key locations such as catch basins, should be sampled during dry and wet weather conditions.

- Sites that are not immediately adjacent to the slip, but may be potential sources, need to be assessed.

- Closure has not been documented for the contaminated sites around Slip 4. These reports should be located or follow-up action initiated by the Department of Ecology.

- Phthalate contamination in groundwater was attributed to laboratory errors at several sites. Follow-up sampling should occur.

- Review is needed of the NPDES permits for stormwater inputs to Slip 4. The first monitoring reports were due to the Department of Ecology in August 2003.

6. ***More Information about Site Characterization:***

    - Much more specific data about sources should have been provided as part of the Data Gaps Report, such as amount of area that is paved for each site, condition of pavement, what chemicals are stored at adjacent sites under permits (or not) and NPDES stormwater data. This type of information *was* provided in the T-117 Data Gaps Report and should be added to the Slip 4 documentation for thoroughness and consistency.

    - How much of the sediment, particularly fine sediment, in the slip enters from the outfalls versus from the river. This question is unanswered in the Data Gaps Report.

    - Overall, what is the relationship of contamination in the slip to contamination in the river?

    - What is the chemistry of the banks? The six samples taken to date do not adequately characterize bank contamination.

7. ***Significance of groundwater.*** The Data Gaps Report states that, "all site-specific investigations concluded that groundwater contaminant migration, with respect to surface water quality, was deemed not significant." This assertion has not yet been substantiated. Groundwater and seep information is needed to provide a basis for this determination for Slip 4.

Studies and References Reviewed:

Phase II/RI Work Plan, 2004 (Feb 6) (Draft Final) by LDWG
Proposed Dredging of Slip No. 4, Duwamish River, Seattle, WA 1996, by PTI for Crowley Marine Services
Slip 4 Workplan for Investigation Tasks, 2003 (October 16), by City of Seattle and King Co.
Slip 4 Summary of Existing Information and Identification of Data Gaps, 2004 (January 15), by City of Seattle and King Co.
Slip 4 Sampling and Analysis Plan for Boundary Definition, Final, 2004 (March 4), by City of Seattle and King Co.
King County and Seattle Public Utilities Source Control Program for the Lower Duwamish Waterway, June 2004 Progress Report

Terminal 117 (Early Action Area 5)

Action.

The Terminal 117 (T-117) Early Action Area is one of seven sites within the Lower Duwamish Waterway (LDW) Superfund site chosen for early cleanup actions because of its potential for higher levels of risk due to elevated PCB levels. Investigations for the cleanup are being done under the existing Administrative Order on Consent between the City of Seattle, King County, the Port of Seattle (Port), and The Boeing Company—called the Lower Duwamish Waterway Group (LDWG)—and EPA and the Department of Ecology. The lead for this site is the Port of Seattle. The City of Seattle is a partner.

T-117 Summary
Major Contaminants of Concern: PCBs and PAHs
Project Coordinator: Port of Seattle and City of Seattle
Current Status: Sampling to determine sources and cleanup boundary
Main potential sources: Historic asphalt manufacturing operations and handling of PCB-contaminated waste oils at the Malarkey plant site.
Secondary potential sources: Upland sites that are contributing through stormwater discharges, adjacent properties, and upriver sources

Location and Cleanup

The Terminal 117 Early Action Area is on the west side of the Lower Duwamish Waterway, about 3.5 miles from the southern tip of Harbor Island. The 5.5 acre upland portion of the site includes the former Malarkey Asphalt Company location and other property owned by the Port of Seattle. The site includes a Port-owned 50-ft-wide section of land adjacent to the shoreline that is successor to the Duwamish commercial waterway district. In 2000, EPA oversaw excavation of the top layer of PCB-contaminated soil at the upland Malarkey Asphalt property area. The site was paved over. Under Superfund, the sediments in the adjacent river will be addressed. Sampling in order to determine the boundary of cleanup is underway. Some of the historical sediment data is unusable for the current cleanup because the river has been dredged twice in the past three decades. From 2003 through May 2004, a workplan, data gaps report, sampling plan and addendum, upland sources data report (draft), supplemental sediment and soil data report (draft), and preliminary boundary (i.e., limits of contamination cleanup area) report (draft) were published. The proposed cleanup plan and associated public hearing are planned for the early 2005.

Consultants Hired for this Site

Windward Environmental; Dalton, Olmsted and Fuglevand; and Onsite Enterprises

Contaminants

Contaminants of Concern that drive cleanup: PCBs are used in the draft Boundary Report to define the extent of contamination in the river. Concentrations of PCBs are highest in sediments closest to T-117. Downstream extent of contamination is not known and is to be determined from new sampling.

Secondary contaminants that were (or may still be at) the site: Chemicals that exceeded SQS or CSL include mercury and phenol and hexachlorobenzene in surface sediment samples.
In subsurface samples, Bis(2-ethylhexyl)phthalate, Butyl benzyl phthalate, and DDTs (total) exceeded SQS standards.
Dioxins and furans (no standards) were detected.
Tributyltin (TBT) and pentachlorophenol are of concern in the river (NOAA).

Other contaminants mentioned in reports: In the Data Gaps Report: Several surface sediment chemicals exceeded SQS but were less than the detection limit: 1,2-dichlorobenzene, 1,2-dichlorobenzene, 1, 2,4- trichlorobenzene, hexachlorobenzene, butyl benzyl phthalate, DDTs (total calculated), and dieldrin.
Boundary Report (2004): Contaminants that were found in T-117 source area include: PCBs, PAHs, bis(2-ethylhexyl)phthalate, benzoic acid, benzyl alcohol, butyl benzyl phthalate, pentachlorophenol, silver, and zinc

Past T-117 upland soil and/or groundwater contaminants at significant levels (1984-1999): PCBs, zinc, arsenic, lead, TPH, PAHs, free product (1/8 inch), total chlorine, and asbestos

Sediment contaminants listed in 2003 Early Action Report showing maximum exceedence factors (EF) relative to sediment standards:

Chemical	SQS* EF	CSL** EF
Phenol	5.0	1.8
PCBs (total-calc'd)	69.9	12.9
Hexachlorobenzene	2.0	0.3

*SQS - Washington State Marine Sediment Quality Standards
**CSL - Puget Sound Marine Sediment Cleanup Screening Levels

Potential Sources

[Note, outfalls are described after adjacent properties at this site for clarity in describing the outfalls]

Dredge Materials

It is possible that dredge materials were deposited in the vicinity of the T-117 upland area in the period from the 1940's to 1970's.

Adjacent or nearby properties

Port of Seattle's T-117 property (formerly Malarkey plant until 1999, 8700 Dallas Avenue S): This 5.5 acre site is contaminated due to roofing asphalt manufacturing operations and handling of PCB-contaminated waste oils. The site was used as the asphalt plant by Duwamish Manufacturing Company from about 1937 to 1978 and then Malarkey Asphalt Company from 1978-1993. In the early 1970's, approximately 1000 gallons of waste PCB-containing oils per month, from Seattle City Light, were used by Malarkey at the site. The site was used as a drain field to a partially buried railcar tank apparently used as a crude oil-water separator as well as three waste oil storage tanks. In the 1990's the site was used as an unpaved roadway and by Evergreen Lumber for untreated lumber storage and loading.

Contamination: In 1992, metals, PCBs, pesticides and volatile organic compounds were found in soil and metals, PCBs, pesticides and SVOCs were detected in groundwater. On-site drainage ditch sediment samples in 1985/86 had elevated lead (1,666 ppm), arsenic (2,027 ppm) and zinc (5,416 ppm). Twenty-three aboveground tanks were cleaned and removed from the site. Results indicated that PCBs were present in shallow soil throughout the ponding "roadway" area on the Port property. PCB concentrations ranged up to 531 mg/kg. The Malarkey drain field and surrounding soil were eventually removed and excavated to a depth of 3-5 feet during an EPA Superfund emergency PCB soil removal action in 1999 (PCBs, zinc, and PAHs), filled with quarry spalls (large angular rocks) and then the site was paved over. Over 2,000 tons of PCB-contaminated soil were excavated and disposed with a goal of achieving concentrations at or below 25 mg/kg from the roadway area of the site. Outlier areas with unknown concentrations of PCBs were left in place and soil at depth is known to have concentrations as high as 22.2 mg/kg which meets EPA's approved cleanup level of 25 mg/Kg as well as the current TSCA remediation levels for limited access industrial sites. In the T-117 documents reviewed, it is not reported if the entire extent of contamination (laterally and vertically) was determined, either before or after cleanup. Significantly higher concentrations of PCBs, for example, have been found in soils, catch basins and drainage ditches at the site during the 2004 investigations. The Port plans to remediate soils in contact or in pathways impacting or potentially impacting adjacent river sediment to lower levels than 25 mg/Kg (according to Doug Hotchkiss, September 13, 2004).

Except for the unpaved shoreline berm area and south drainage ditch (between T-117 and Boeing), soil at the T-117 has been covered over with or asphalt or concrete pavement (gravel sub-grade and bituminous pavement). Asphalt material has been observed in the subsurface. Post-cleanup groundwater monitoring in 2003 showed concentrations of diesel-range TPH, lube oil-range TPH and six PAHs.

Basin Oil use of site: Basin Oil continued to use part of this site to separate oil until March 2004 when they vacated the property. There have been several complaints against Basin Oil related to their operations (and are noted below). Any unchecked spills or oil flowing to the exterior of the building could enter the T-117 storm drain catch basins.
Additional businesses located at T-117 are: International Inspection (office), Port of Seattle's Construction Services Division (office, storage shed, and outdoor equipment and material storage, included treated lumber), and, until March 2004, Basin Oil Company (a portion of the large metal building – see Basin Oil Below).

Seattle Chocolate Company (8620 16th Avenue S and 8619 17th Avenue S). This site currently houses a chocolate confectionary manufacturing company. **Allied Bolt Company and Fasteners, Inc**. formally occupied the site and might have discharged VOCs and metals into the storm drain. This is unknown. Records from show that the site used waste combustible liquid "not otherwise specified," mineral spirits and waste flammable liquid not otherwise specified" aliphatic and aromatic hydrocarbons. A sump pump currently at the site discharges to the city's combined sewer system.

Port Construction Services (occupied this site until 2004?): At this site, storage of treated lumber may be a source of TPH and PAH in runoff.

Unoccupied (formerly Basin Oil – until March 2004 - and Northwest Antifreeze Service) (located adjacent to T-117, 8661 Dallas Avenue). Basin Oil Company was a collector, transporter, and marketer of used oil. This site may be a source to the T-117 cleanup site due to spills, releases of oil materials from oil/water separator, dismantled tanks and equipment potentially entering stormdrains or leaked to the soil. As of 2000, these operations handled materials such as lubricating oil, Bunker C heating oil, diesel fuel, crude oil, jet fuel and gasoline in an aboveground storage tank farm consisting of approximately 22 tanks with a total capacity of approximately 150,000 gallons. In the past, Northwest Antifreeze Service also stored used and new antifreeze in two tanks at the site. Basin Tank and Environmental Service also used the site until January 2002.

In addition, Basin Oil used a site at 8617 17th Avenue South for excess drum storage, and Basin Oil also used a portion of the interior of the south building on T-117 property for storage and oil filter processing. Site has been inspected several times in1995, 2000, and 2002 but no samples were taken. The integrity of the oil separating system and the lack of secondary containment prompted complaints (at Term 117 site). "A sump pump with a float valve automatically pumped water from the oil/water separator and discharged it out the fence to the west side of Dallas Avenue South… Ecology also noted that the plan did not address maintenance, testing, and monitoring of the separator. Finally Ecology was concerned about activities conducted on the gravel and dirt areas predominately located along the southern portion of the facility. These activities included used UST and AST storage and decommissioning, miscellaneous vehicle and equipment storage, and storage of crushed oil filters. Basin Oil's SPCC Plan (Basin Oil 1995) listed lubricating oil, Bunker C heating oil, diesel fuel, crude oil, jet fuel and gasoline as petroleum-based products routinely handled at the facility…. According to Ecology records, Basin Oil routinely checked its oil using Chlor-D-Tect® test kits and used additional means to assure incoming products do not contain PCBs. Used antifreeze is generally known to contain certain metals such as lead and cadmium."
This site was previously occupied by Frontwater Service and Vintage Oil Inc., whose operations included handling of used oil or antifreeze products.

In August 2004 the Department of Ecology and the City of Seattle inspected the former Basin Oil site. The Department of Ecology will place this property on the state list of contaminated sites – which will trigger further investigations and potential cleanup.

A&B Barrel Company (8604 Dallas Avenue South – same address as South Park Marina below). A barrel refurbishing and cleaning operation was located at this site in the 1950s. Liquid waste, including oils, grease and sodium hydroxide (as high as 940 mg/L) were discharged into a small pond that discharged directly into the river.

South Park Marina and mobile home park (8604 Dallas Avenue South, located directly north of T-117, on the river): Since 1970, this site has been used for boat maintenance and transport, and engineering operations, upland boat storage, boat haul-out services, a boat launching ramp, and moorage slips, including 18 live-aboard vessels. This site is overlain by mixed fill material. South Park Marina has a closed-loop boat washing facility and a stormwater discharge (oil/water separator) covered under Washington State's general boatyard NPDES permit. Regulated parameters for the separator outfall include oil and grease, total recoverable copper, and total suspended solids. There are four or five additional catch basins located throughout the boatyard that discharge to undetermined locations. The marina appears to enforce good stormwater Best Management Practices. According to the owner, the offices and catch basins are connected to

the City of Seattle's combined sewer system, although no records were available from the city to verify this.

The marina stores additional boats at parcels at southwest corner of the intersection of 16th Avenue South and Dallas Avenue South.

Boeing South Park (located directly south of T-117, on the river): Relatively little information is available for this facility which has been used by Boeing for training of commercial aircraft customer flight crews and maintenance personnel. A fact sheet mentioned that various research projects were being conducted in the Radiation Effects Laboratory and in the Electron Laser Facility. At this site, 50 gallons of hydraulic oil was released to soil (1997).

Outfalls and Catch Basins

In May 2003, the City of Seattle surveyed the Lower Duwamish Waterway to identify locations of pipes, ditches, creeks and major seeps. The following drainages were found between the 1st Avenue South Bridge an the south end of T-117:

- Four piped outfalls owned by Port of Seattle and serving the T-117 property
- Two piped outfalls of unknown origin
- One piped outfall that appears to be abandoned
- One seep
- One ditch

T-117: Outfalls and overflow areas drained Malarkey Asphalt site and likely contributed PCBs, TPH, and PAHs to the river. All known existing catch basins on T-117 include sumps for retaining settled solids:

- Catch basin 1 collects water in the northern portion of the property and discharges to a 6 inch PVC pipe in the riprap.
- Catch basin 2 collects from the central area and discharges through a 3_-inch iron pipe onto the paved area and flows overland to catch basin 3.
- Catch basin 3 discharges through a 6-in. underground pipe to catch basin 4.
- Catch basin 4 collects from the southern "roadway" area and discharges to catch basin 5.
- Catch basin 5 collects from the southern area of the property as well as from Dallas Avenue, Basin Oil, the east terminus of Donovan Street, and catch basin 6. This catch basin is surrounded with hay bales and is equipped with an insert to retain solids in potentially turbid runoff. It discharges through a 6-inch pipe through the riprap.

South Park Marina*:* Discharge from the oil/water separator discharges to the southern-most outfall at this property. Other catch basins either discharge to the sewer or unmapped outfalls.

Boeing South Park**:** Outfalls have not yet been identified but one drain, an 8-inch concrete pipe near South Concord Street, is likely the drain that received noncontact cooling water from the Boeing South Park Plant under an NPDES permit until 1993.

Groundwater/Seeps

Groundwater and seeps were considered as part of source control for this site. Depth to groundwater is 5-15 ft below ground surface and tidal influence is documented in groundwater wells at T-117. Two significant seeps have been observed as well as additional minor seeps. In 1992, metals, PCBs, pesticides and SVOCs were detected in groundwater well samples. In 2003, groundwater samples showed diesel-range TPH (0.70 mg/L), lube oil-range TPH (1.4 mg/L) and six PAH compounds at concentrations ranging from 0.013 to 1.6 µg/L. Floating product and metals were been detected in

upland groundwater wells in samples taken in the 1990's, although some past sampling may have been suspect. No groundwater data is available from adjacent properties: Basin Oil, South Park Marina, or Boeing to assess additional groundwater problems or upgradient sources.

2004 sampling event: No chemicals were detected nor floating product observed in shoreline wells sampled in 2004. It is unclear if the inland wells were observed at this time. Three seeps were recently sampled. The seep samples were initially analyzed as direct samples. The samples were re-analyzed after being centrifuged. The pre-centrifuged samples had higher levels PCBS and metals than the analyses after centrifuge. Copper in groundwater was above standards, although the Boundary Report states that the copper concentration was below river ambient values.

Bank Erosion

The T-117 site currently has an erodable shoreline which includes a gently sloping intertidal habitat topped by a steep vegetated rip-rap bank as well as a large, flat sandy silt beach with debris and remnant asphalt wastes from the upland asphalt plant, including waste drums and hardened and semi-soft product. In addition to potential contaminated soil sluffed or washed off of T-117, materials dumped at the shoreline includes hardened asphalt and may include river dredge spoils (1940s-1970s). "Small sheens 1–2 in. (2- 5 cm) in diameter can also be observed on the mudflats directly offshore of hardened asphalt masses in the river bank, further indication that these materials are decomposing and serve as a potential source of chemicals in river sediment"

Source Control

In the site Workplan (May 29, 2003), the concept of source control before remediation is described: "Additionally, once this general understanding of the T-117 Early Action Area is achieved, Windward will continue to work with the Department of Ecology and EPA on source control efforts related to the T-117 Early Action Area, which may include source identification, prioritization, documentation and tracking of source control plans and completed source control actions, evaluating and documenting effectiveness of source control measures, and providing input to EPA and the Department of Ecology's decision regarding whether source control is adequate to move forward with the early action. Generally, significant continuing sources should be controlled to the greatest extent possible before or concurrent with cleanup of sediment."

The Data Gaps Report lists a number of Source Control "needs" which are listed below:

1. *Discharge points for the four catch basins observed at South Park Marina. The* discharge point for the fifth (southeast) catch basin is documented in the facility's NPDES permit for the oil/water separator. Discharge points should be determined by the relevant property owner or appropriate government agency through direct inspection of the catch basins and piping, flow observations, and, if necessary, dye testing.

2. *The surveyed location and elevation of stormwater outfalls from T-117 catch basins 1 and 5 to the LDW*. Outfalls were recently located by the City of Seattle Public Utility surveyors and will be surveyed in the near future. Flow from catch basin 1 versus potential surrounding seeps may be clarified.

3. *Quality of sediment contained in drainage area catch basins*. Sediment from the six catch basins located on T-117 and the catch basins at South Park Marina that discharge to the LDW should be

sampled and analyzed for selected chemicals of interest. [Note, these samples were collected by the Port of Seattle in 2003]

4. *Quality of seeps* observed at the base of the riprap shoreline at the center of the T-117 shoreline and (if located within the study area) southeast of the South Park Marina boat ramp. Water from these seeps should be sampled and analyzed for selected chemicals of interest and conventional field parameters. [Note, the seeps have been sampled at T-117 and according to Doug Hotchkiss (September 7, 2004), "based on the data we have so far, only the south end of end of South Park Marina will be within the T-117 boundary, unless something very different is found."]

5. *Specific locations and estimated quantities of waste materials* (solidified asphalt and asphalt roofing materials) located within the shoreline riprap and in the drainage ditch at the south side of T-117 (between the terminal and the Boeing South Park property). [Note: According to Doug Hotchkiss (September 7, 2004), "In many instances, the volumes of these materials could not be reliably estimated because they are not fully exposed."]

6. *Presence and size of any buried or partially buried asphalt* masses located within the sediment of the intertidal mudflats.

7. *Quality of soil on the shoreline berm* surface, including the heavily vegetated crest of the berm, in the vicinity of catch basin outfalls and historical upland overflow points. Surface soil in the berm face should be sampled and analyzed for selected chemicals of interest.

8. *Quality of groundwater in the shoreline berm*. Monitoring wells will be installed in upland soil boring locations and analyzed for selected chemicals of interest. Existing shoreline berm monitoring wells will also be analyzed. All wells will be sampled when the tide is below MLLW to ensure that LDW water does not dilute the groundwater sample. Tide cycle monitoring will also be performed on all sampled wells. *Should not groundwater inland of the berm be sampled too?*

In the Quality Assurance Plan, implications of source control results are discussed: "…Characterize sources of recontamination to sediments of the T-117 EAA. It is understood that if a significant recontamination issue is found, its source will have to be delineated and addressed ***before*** moving forward with any removal action." [Italics added]

Several types of sampling actions, many of which relate to source control, were proposed in the Quality Assurance Plan and were conducted from December 2003 through spring 2004. In addition, more sampling was proposed by the Port to better characterize the northern subtidal area in late May. The results of these sampling events are shown in the table below.

Sampling Action	**Reason**	**Results (**Uplands Report (April 8, 2004))
T-117 Catch basin soil chemistry	Determine soils contain PCBs and other SMS analytes of interest as a continuing source and/or if upland sources are contributing to the drains.	Soil concentrations were: Catch basin 1 PCB: 52 and 70 mg/kg-OC Additional contaminants that exceeded standards: butyl benzyl phthalate, pentachlorophenol, silver, and benzyl alcohol Catch basin 4 PCB: 620 and 890 ug/kg dw Catch basin 5 and adjacent sample PCB: 33 and 1,200 mg/kg-OC Additional contaminants that exceeded standards: butyl benzyl phthalate, bis(2-ethylhexyl)phthalate, benzyl alcohol and zinc
Seep chemistry	Determine if seeps are a source of contaminants.	When wells were developed for the groundwater assessment, it was observed that turbidity remained in the wells likely due to the extremely fine silts in the surrounding soils. A major and two minor seeps were sampled using a tube and the following were detected: copper (above standards), bis(2-ethylhexyl)phthalate, total PCBs (0.89 ug/L). These samples were not centrifuged – and the levels of metals were reported at higher levels in the Upland Report compared to the later Boundary report where they were reported as total because "long period of time that elapsed before the samples analyzed for dissolved metals were filtered.
Soil boring chemistry and physical properties	Determine if shoreline is source of contaminants, concentrations of PAHs (historic practices and hotspots), and engineering characteristics of soils for remediation actions.	Soil borings showed significant contamination with PCB concentrations above standards at all shoreline locations ranging up to a maximum of 10,000 mg/kg OC (estimated). Two borings had PAHs at concentrations that exceeded standards.
Sediment chemistry: 36 subsurface (0-10 ft) samples and surface (0-10 cm)	Determine extent of contamination, remediation boundary, release of upland contaminants to sediment, and engineering characteristics of sediment for remediation actions.	Maximum surface sediment in new sampling event was 2,200 mg/kg OC. This compares with the historical maximum detection of 840 mg/kg OC. In addition, multiple PAHs exceeded standards at two sampling locations. Of the surface samples analyzed for metals or volatile organic compounds, only hexachlorobenzene exceeded SQS. Maximum PCB concentration in subsurface samples was 2,600 mg/kg OC (in the top interval of this sample).
Drainage ditch soil chemistry (ditch between the T-117 south building and the Boeing South Park Property to south)	Determine if ditch is source of contaminants.	Soil concentrations were: Sample 1 PCB: 1,600 and 2,200 µG/KG DW Also above standards: benzoic acid, benzyl alcohol, and zinc. Sample 2: PCB: 4600 µG/KG DW Also above standards: benzoic acid and benzyl

		alcohol
Groundwater chemistry (two new and two existing wells at top of bank)	Determine if PCBs, PAHs, and VOCs are in groundwater and whether groundwater is a source of contamination to sediments.	No chemicals detected. [Note: Windward believes that the four monitoring wells located along the edge of T-117 should be viewed as "sentry wells," that will be the best indicator of contaminants moving towards the river.]
24-hour tidal study (in the four wells as well as inland well (MW-03))	Determine groundwater gradient, influence of tides, and assess total suspended solids (TSS) and free product.	Not provided.
Roadway samples near entrance to T-117	Determine if roadway samples are source of contamination to catch basin 5.	Soil samples detected PCBS ranging from 320 to 660 ug/kg dw.

OC: average OC normalized value using TOC
DW: dry weight basis

Future potential sampling, if needed, would include:

- Sampling additional catch basins
- Analyzing for additional seep and groundwater analytes as indicated by sediment analyses
- Sediment sampling outside the identified PCB "boundary" to check for additional SMS contaminants in areas not likely to be remediated for PCBs
- Analysis of archived sediment for additional analytes
- Sediment toxicity testing and/or bioavailability studies
- Fate and transport
- Sampling surface water for dissolved organic carbon

Port of Seattle Removal of contaminated material

In September 2004, the Port of Seattle removed an underground vault and piping that contained asphalt material from the T-117 property. There had previously been reports of asphalt bubbling to the surface but the Port decided to wait until the weather was cooler to do the cleanup. The removal area was filled back in and covered with pavement. Soil samples were taken but these data are not published yet.

City Of Seattle/King County Investigation of PCBs In Nearby Streets

As a step in source control action for the T-117 site, City of Seattle and King County staff took samples of dirt in the roadways in the neighborhood near the site in August 2004. Elevated levels of PCBs were found by the City of Seattle. Followup sampling, in September, in the right of way (grassy area adjacent to the street, across from Basin Oil site) detected PCBs at concentrations over 90 mg/kg. Samples from yards of adjacent residences taken by King County on October 10, 2004, detected PCBs at concentrations up to 46.0 mg/kg. Planned follow-up activities include additional soil sampling, indoor dust sampling (homes), and cleaning up the PCBs in the roadway. Along Dallas Avenue, South Donovan Street and 17th Avenue, the City will scrape dirt off and replace with geotextile and clean gravel. High-powered vacuum trucks will sweep the roadways.

T-117 Source Control Comments and Recommendations

Compared to the other early action sites, source control at T-117 could occur in an expedited manner because the site is more easily defined and does not have a large drainage/stormdrain system providing runoff to the area. Major sources for the contaminants of concern for site are located near and adjacent

to the river. The pathways for sources to enter the river at this site include stormwater runoff, seep flow, and erosion carrying contaminated materials from adjacent properties,

1. ***Removal of upland area as part of cleanup.*** Significant levels of PCBs were found in the shoreline bank soil boring samples. Catch basin data, drainage ditch, and preliminary seep data provide supporting evidence that the upland area is highly contaminated and continues to contribute contaminants to the river. The high level of PCBs in the drainage ditch provides evidence that the site, even though it is paved, continues to shed material, perhaps by being undermined or through groundwater flow. Over the long-term, this site will continue to contribute contamination through soil erosion, stormwater runoff, and/or by being undermined. The entire contaminated land area should be cleaned up. The project should be considered either as one contiguous cleanup site or, if as two sites, the source area (the uplands) should be cleaned up first and the sediments second. If this site were an underground contamination plume, by comparison, it would be imprudent, as well as more costly, to clean up the plume without first addressing the source of the plume. Further, if a large flood occurred in the Duwamish, this highly contaminated parcel would be a significant threat to the river. It is unlikely that a layer of riprap will protect the river from an upland area that has such high levels of PCBs.

2. ***Extent of upland contamination.*** As shown in the Boundary Report, the maximum PCB concentration in the recent shoreline soil (2003/2004) samples is 10,000 mg/kg OC which is more than four times higher than the maximum PCB concentration in the adjacent river (2,200 mg/kg OC), supporting the argument that the upland area is a significant threat to the river. Further, most of the PCB contamination in the river is near the surface, again indicating recent deposition. The Port proposes cleaning up this shoreline area to the edge of the pavement. The inland T-117 area (to the west) of these borings, however, has not been characterized as part of the recent assessments, although older data indicate that high levels of PCBs are still in place, especially at depths of greater than 3 feet. Sampling must be done west (inland) of the shore borings to characterize the extent of this highly contaminated area. Given the seep, ditch, catchment basin and other upland data, this inland area is likely a major threat.

3. ***Other contaminants must be addressed as well.*** Although the stated driver for cleanup at T-117 is PCB contamination, a number of other contaminants are found at elevated levels at the site and in upland source areas and must be considered for source control, including PAHs, which exceeded standards at two shoreline borings, and phthalates, which were found in catch basin and seep samples. Tributyltin (TBT) and pentachlorophenol contamination must also be addressed.

4. ***Contaminated soil in T-117 basins and ditch***. The determination of the source of contaminated soil to the catch basins and drainage ditch should be a high priority action. Significant levels of PCBs are still being found at these surface locations, as well as metals and other pollutants. If the PCB levels in catch basin 5 are higher than those from the reported source area – the roadway – then additional sources to that drain must be investigated. Further, why is it necessary for protective devices (bails of hay) to be placed around catch basin 5 – what contaminants are flowing on the surface in that area? What are impacts to neighbors?

5. ***Seeps.*** Seeps appear to be a source of contaminants to the river. A more comprehensive seep survey and sampling is needed for T-117. Both filtered and unfiltered results should be presented because of the problem that particles of soil from the upland area may be entrained in the seep flows and therefore may be a major source of continuing deposition of contaminated

sediment in the river. Fine particulate matter was observed by DRCC in numerous seeps in the vicinity and could be coming from the easily erodable underlying soils (as opposed to being entrained surface material). The draft Boundary Report (on page 21) supports the argument that seeps cause erosion of the underlying capped contaminated soils: "..seeps may be eliminated, while others (especially if found to like to a stormwater drainage system) may be redirected to prevent erosion of the underlying capped materials." In addition, the owner of the adjacent South Park Marina reports that the marina property "sinks" 1–2 inches or more a year, indicating potential erosion (possibly subsurface) of upland and underlying soils.

6. ***Groundwater.*** The Port of Seattle eliminated groundwater as a concern for this site because no chemicals were detected in groundwater in the most recent sampling. It was noted, however, in the Uplands Report, that when the wells were developed for the groundwater assessment, it was observed that turbidity remained in the wells likely due to the extremely fine silts in the surrounding soils. Further, the groundwater samples were filtered. Therefore, given the PCBs in the uncentrifuged seep results, it is not clear that upland material is not being moved by groundwater.

7. ***Adjacent properties***. Incomplete analysis of potential sources from adjacent properties is problematic. No soil samples were taken across the T-117 boundary with the South Park Marina. This was justified in the Boundary Report because historic aerial photos and site histories indicate that the Malarkey activities did not extend to adjacent parcels. Given that DRCC members observed leaking barrels of PCB-contaminated oil onsite as recently as 2003, there is no certainty that past practices did not include dumping or dispersion of material outside of their property boundary. It is standard practice when determining soil cleanup boundaries to establish the clean parameter by sampling. This has not been done for this site. To date, a clean boundary for the site in the river has not been established.

8. ***Northern drainage ditch***. The drainage ditch between T-117 and the South Park Marina has not been sampled. Given the high levels of PCBs and other contaminants at the drainage ditch to the south, it is surprising that the northern ditch is not being sampled as well.

9. ***Further sampling is needed.*** PCBs are the driver for the site cleanup, but the Quality Assurance Plan states: "The full suite of SMS analytes will also be analyzed at selected locations for source control evaluation."…page 26: "The Data Gaps Analysis Report indicated that PCBs were the likely risk driver for the remediation at the T-117 shoreline. Therefore, the first tier of the sampling design focuses primarily on PCBs, with secondary data generated to support the evaluation of the site. The secondary data will include analyses of sediment and soil samples for the complete list of analytes to evaluate potential contamination from upland sources. If analytical results of full SMS for soil or sediment samples indicate that other chemicals of concern are present, archived samples collected during the first tier will be analyzed or additional media will be sampled and analyzed for these chemicals as part of a second tier. Initially, PCB results will be used to delineate the remediation boundary. In subsequent tiers, additional site data may be gathered and analyses of other chemicals of concern may be performed outside of the PCB delineated boundary and used to assist in cleanup decisions or provide additional data for the LDW RI." Other contaminants were detected in the samples and should be considered in source control.

10. ***Timing of source control investigation.*** Significant source control questions were brought forward in the Data Gaps Report and yet the Quality Assurance Plan only addressed specific

sampling efforts. When and who will address these other questions? Is the Department of Ecology expected to take the lead on source control or will the Port continue these investigations? Who will be responsible for each task?

The Quality Assurance Plan states: "Following review of results from the initial field effort, additional field effort(s) will be initiated to accomplish the following: Characterize sources of recontamination to sediments of the T-117 EAA. It is understood that if a significant recontamination issue is found, its source will have to be delineated and addressed before moving forward with any removal action. In the broader context of source control, it is also understood that Ecology will develop an action plan for the T-117 EAA according to the Lower Duwamish Source Control Strategy. Data generated from the field studies identified in this QAPP will be provided to Ecology."

11. ***Stormdrain problems.*** From Data Gaps Report, page 67: "Stormwater from the west side of the Basin Oil Plant and the vicinity of 17th Avenue South historically drained to one of two catch basins located at the west side of 17th Avenue. Based on location and design, it is believed that these basins are City of Seattle catch basins and, when operative, discharged to the same combined storm/sanitary system serving the catch basins located further west. These catch basins were observed to be completely filled with soil and inoperative (field reconnaissance, June 11, 2003). Without proper drainage, stormwater pools in 17th Avenue South and, under heavy rainfall conditions, begins to discharge around the north end of the Basin Oil plant onto Dallas Avenue South. This condition has been observed in the vicinity for at least the past 10 years. Eventually, this runoff combines with the other overland flows to catch basin 5. The pavement on 17th Avenue and the southern portion of Dallas Avenue South has not been maintained, contributing to the high suspended solids in the runoff from these areas." In 2003, the City of Seattle cleaned the catch basin across from 8607 17th Avenue South. The other catch basins along 17th will be addressed as part of the joint King County/City of Seattle business inspection program.

12. ***Examples of additional or incomplete source control work that is still needed***:

- The catch basins at South Park Marina should be examined to determine if they are connected to the City of Seattle's combined sewer system or discharge directly to the river. In addition, the boatyard NPDES monitoring reports for this site should be reviewed.

- Stormwater discharges over the land surface of adjacent properties are believed to be the most significant threat to this site. The adjacent properties can be relatively easily assessed and this effort is moving forward. The documents for this site are much more thorough than the reports were for Duwamish/Diagonal or Norfolk in identifying the condition of local properties.

- Many of the adjacent property sites have been visited by inspectors in past five years, and even though concerns were raised about the various contaminants of concern, no samples were taken. This work should occur now.

- Recent findings of significant levels of PCBs in South Park neighborhood street dust should be thoroughly investigated in order to determine the source. Possible sources include historic dust-control oiling of the street, spilled material from trucks going to and from Basin Oil, or aerial deposition.

Studies and References Reviewed

Superfund Fact Sheet: Malarkey Asphalt Company, 2000 (March), by EPA
Lower Duwamish Waterway Remedial Investigation Task 5: Identification Of Candidate Sites For Early Action, 2003, by LDWG
Terminal 117 Early Action Area Gaps Report, Final, 2003 (September 26), by Port
T-117 Quality Assurance Project Plan, 2003 (Dec, 3), By Port
T-117 Quality Assurance Project Plan Addendum - Sediment And Soil, 2004 (March 9), by Port
T-117 Work Plan For Investigation Tasks Final, 2003 (May 29), By Port
T-117 Upland Sources Data Report, Draft, 2004 (April 8), by Port
T-117 Sediment and Soil Supplemental Data Report, Draft, 2004 (April 14), by Port
T-117 Preliminary Boundary Technical Memorandum Draft, 2004 (April 28), by Port

Norfolk Combined Sewer Overflow (CSO) (Early Action Area 7)

Action

The Norfolk Combined Sewer Overflow Area is one of seven sites within the Lower Duwamish Waterway (LDW) Superfund site chosen for early cleanup actions because of its potential for higher levels of risk due to elevated PCB levels. A 1991 consent decree settling a lawsuit by NOAA and the Washington Department of Ecology against Seattle and King County for damages due to combined sewer overflow and stormdrain discharges created the Elliott Bay/Duwamish Restoration Panel. The parties provided $12 million for sediment cleanup at outfalls, $5 million for nearshore habitat restoration, up to $5 million for real estate, and $2 million for source control at habitat and cleanup sites. The Norfolk site was selected for inclusion in the Panel's projects. The lead for the Norfolk CSO site is King County.

Norfolk CSO Summary
Major Contaminants of Concern: PCBs, bis(2-ehtylehexyl)phthalate, 1,4-dichlorobenzene, and mercury
Project Coordinators: (1) King County; (2) Boeing
Current Status: Post cleanup monitoring (may be incomplete)
Main potential sources: CSO and Boeing outfalls.

Location and Cleanup

The Norfolk Combined Sewage Overflow (CSO) site is located on the east bank of the Duwamish River 0.3 miles north of the Turning Basin, in the City of Tukwila. The Norfolk CSO drain was associated with a sediment plume contaminated by PCBs, bis(2-ehtylehexyl)phthalate, 1,4-dichlorobenzene, and mercury. The Norfolk site is included in the Superfund project boundary limits but the main cleanup activity occurred prior to the formal listing of the river as a Superfund Site in September 2001. The later cleanup by Boeing (described below) occurred after the listing.

Cleanup at the Norfolk site involved dredging 5,190 cubic yards of sediment, to depths of three to nine feet, and backfilling with 6,700 cubic yards of clean sediment obtained from the Turning Basin, from February through March 1999. Three rounds of dredging and confirmation sampling resulted in the final determination to leave high PCBs in place (all surface samples exceeded CSL and two samples exceeded TSCA) because of a concern for bank stability near Boeing Outfall (adjacent to locations where dredging occurred to depths of 9 feet). In September 2003, as a result of additional sampling that

indicated significant recontamination by PCBs, Boeing conducted a cleanup of 60 cubic yards of sediment in the vicinity of their stormdrain. Reports published for Norfolk CSO site from 1994 through spring 2001 include a cleanup workplan, cleanup study, site closure report, follow-up monitoring reports and a phase I sediment cap recontamination investigation.

Consultants Hired for this Site

EcoChem Inc., West Consultants Inc., Black and Veatch Special Projects, Harman Associates Inc., Striplin Environmental Associates, Pentec Environmental Inc. and ERDA Environmental Services.

Contaminants

Contaminants of Concern that drive cleanup: In cleanup documents, the listed chemicals that drove cleanup and were used to define the aerial extent of contamination were: PCBs, bis(2-ehtylehexyl)phthalate, 1,4-dichlorobenzene, and mercury. PCBs were found in several hot spots, not all considered to be related to the Norfolk CSO.

Secondary contaminants that were (or may still be at) the site: Benzoic acid (downstream site – next to treated wood barge and thus eliminated from cleanup related to the CSO), phenanthrene, and HPAHs (including indio(1,2,3cd)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene). PAHs were high at only one core sample near the outfall and thus were not considered to drive cleanup. They were also found at one station upstream of the outfall.

Other contaminants mentioned in reports: Hexachlorobutadiene. Contaminants detected in CSO discharge were benzylbutylphthalate, diethylphthalate, acetone, and tetrachloroethylene

Sediment contaminants listed in 2003 Early Action Report showing maximum exceedence factors (EF) relative to sediment standards:

Chemical	SQS* EF	CSL** EF	Chemical	SQS* EF	CSL** EF
Bis(2-ethylhexyl)phthalate	1.9	1.2	Phenanthrene	1.4	0.3
Dibenzo(a,h)anthracene	1.4	0.5	PCBs (total-calc'd)	883	163
Indeno(1,2,3-cd)pyrene	1.2	0.5	Butyl benzyl phthalate	1.4	0.1

*SQS - Washington State Marine Sediment Quality Standards
**CSL - Puget Sound Marine Sediment Cleanup Screening Levels

Potential Sources

Outfalls

- **Norfolk Street Regulator Station Combined Sewer Overflow/Storm Drain (Norfolk CSO/SD) Outfall** (S 102nd St and East Marginal Way) (84-inch). King County operates the CSO system at this location. The Norfolk CSO/SD outfall, located in Tukwila, has a flap gate over an 84" diameter pipe, which is exposed at low tides. A regulator controls the CSO flows. In addition, five storm drains connect to the system. The drainage area covers about 800 acres and includes residential areas in south Seattle and Tukwila east of I-5 and commercial/industrial properties in Seattle along Martin Luther King Jr. Way South and in Seattle and Tukwila along East Marginal Way South, including the south end of King County Airport and the Boeing Military Flight Center as well as South Norfolk Street. King County estimates that the Norfolk CSO discharged on average between 70 and 80 million gallons per year in the late 1980's and early 1990's. In 1990/91, 25 overflow events occurred at the Norfolk CSO, totaling about 169 million gallons of stormwater and untreated sewage while in 1991/92, there were 5 overflows with a combined flow of about 8 million gallons per year. In 2002/2003, the Norfolk CSO had one overflow of roughly 0.71 million gallons. The 2003/2004 water year data are still being tabulated.

Contamination:

The following chemicals exceeded standards in sediment samples located in the river adjacent to the outfall: PCBs, bis(2-ehtylehexyl)phthalate, 1,4-dichlorobenzene, benzoic acid, and mercury. A CSO sample collected in 1993 found phthalates, acetone, and tetrachloroethylene.
In 1997, King County collected stormwater samples at four locations in the Norfolk drainage basin, from four Boeing drainage ditches in the vicinity of the Norfolk CSO/SD and from three CSOs that will discharge to the Norfolk outfall after King County makes intended changes to the county interceptor system to reduce overflows to Lake Washington [note: need to see data].

Boeing Outfalls. There are five Boeing storm drains located downstream of the Norfolk CSO outfall. These drains collect runoff from the Boeing Development Center between E. Marginal Way and the Duwamish River. A storm drain next to Boeing was considered the main source of PCBs to the site.

Contamination:

In 1996, Boeing sampled the sediment at the base of each of the five outfalls. PCBs (0.19 mg/kg) were detected at one location. Previous sampling had found elevated PCBs in the mudflats in front of these drains. As part of the Norfolk cleanup planning sampling, sediment samples in the river showed two PCB hotspots downstream of the Norfolk CSO. One hotspot was located off of Boeing outfall #1 with PCBs as high as 19,000 mg/kg OC (as well as elevated levels of phthalate, 1,4-dichlorobenzene and mercury) and a smaller hotspot was off of Boeing #4. [See *Post-Cleanup Monitoring and Sediment Removal* section below for information about the 2003 cleanup of sediment associated with Boeing Drain #1]

Ryan Street I-5 Outfall (60-inch) (WSDOT**).** The Ryan Street outfall is 0.4 miles upstream from the Norfolk CSO. Washington Department of Transportation owns the Ryan Street I-5 stormdrain, which drains I-5 between the Boeing Access Road (Ryan Street extension) and Myrtle Street and as well as some other areas (unreported). This drain was not considered a historic source of contaminants to the Norfolk site because the sediment contaminant levels in the river upstream of Norfolk were below standards.

Adjacent or nearby properties

The major property near the site is the Boeing Development Center. Additional nearby properties include Boeing Field and a residential neighborhood. Known nearby contaminated sites include Yellow Freight Terminal and Northwest Auto Wrecking.

Groundwater/Seeps

Not investigated by King County as part of their assessment. Although seeps in the area were noted in the river-wide Phase II/RI reconnaissance study, these seeps will not be sampled as part of the Seep Assessment.

Bank Erosion

The Norfolk site is located in an area that is primarily riparian natural habitat. A steep bank tops a sloping intertidal mud shoreline. Riprap covers some of the shoreline.

Source Control

From 1994 to 1996, King County conducted site assessment including determination of the extent of contamination (three rounds of sampling) and methods of source control, and evaluation of cleanup

alternatives. The 1996 Cleanup Plan described actions that were considered to be part of source control and were implemented by King County for Norfolk. These are listed below.

1. *Modeling*. Flow and overall water quality of the Norfolk CSO was modeled to assess recontamination potential of the cleanup site.
   - *Flow*: Using models ("Runoff/Transport Model"), King County estimated the volume of flow out of the CSO based on a calculated amount of runoff from the drainage basins.
   - *Water quality:* Beginning in the late 1960's the City began to partially separate storm and sanitary waste. Street and other non-roof runoff was separated into a storm drain system and the roof runoff was still connected to the CSO system. Therefore, King County believed most of the infiltration to the CSO in the Norfolk basin, to be from roof runoff.
   - *Combined model:* King County used sediment recontamination modeling (METSED) to determine if recontamination of the cleanup site would occur. Model results showed that a mixing zone needed to keep various contaminants under the SQS limits had a maximum width of 16 feet for butyl benzyl phthalates, assuming 70 million gallons per year, and the needed width reduced to less than a foot for other contaminants. They modeled arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc, bis(2-ethylhexyl)phthalate, and butyl benzylphthalates. The Model assumed mixing in the river, but low tide or low flow conditions were not taken into account. Modeling did not address PCBs or the five unregulated storm drains in the Norfolk line after the regulator. The reason PCBs were not modeled was because PCBs had not been detected in previous CSO water testing and it was assumed that the PCBs were from historic sources (this later proved to be incorrect). PCBs were concentrated in the deeper 1-2 foot interval in the sediment rather than in the surficial layer.

2. *Combined Sewer Overflow Improvements.*

   - *Henderson/ML King Project*. King County constructed a diversion to eliminate discharges to Lake Washington through the Henderson and MLK CSOs. The diversion to the Norfolk regulator is needed because the Elliott Bay Interceptor did not have enough capacity. At Norfolk the CSO material will be held in a 3105 foot, 14'8" diameter storage/treatment tunnel. This project is scheduled to be completed by roughly mid-2005.

   - *Other Projects*. King County constructed the Southern Transfer Project, Henderson Diversion Project and pipe connections with the planned design of transfer up to 19 million gallons per year via the Allentown Trunk and the Interurban Pump Station.

3. *Reduction of CSO flow.* King County's major source control effort for the Norfolk CSO was to reduce the quantity flow out of the outfall rather than address sources that contributed to the contamination level in the effluent. Modeling results indicated that if these flow reductions occurred the sediment quality in the outfall area would meet standards. Initial flow averaged estimated 70 million gallons per year. The strategy was to reduce the flow by diverting some flow using the Henderson diversion structure, part of the Southern Transfer Project, which would divert 19 million gallons per year to the Renton Treatment Plant. Unfortunately, at the same time as this Norfolk CSO project was being implemented, a CSO that was continuing to discharge into Lake Washington was discovered and the Allentown diversion was created. In order to balance flows, more flow had to be left at the Norfolk CSO. Instead of the initial projected reduction to 7-9 million gallons per year (4 events per year), the target amount

discharge was adjusted to a projected 10-12 million gallons per year. Recent discharges from the Allantown diversion have been lower than was forecast:

1997/1998-199/2000	no overflow events
2000/2001	three events, 0.35 million gallons
2001/2002	three events, 0.61 million gallons
2002/2003	one event, 0.71 million gallons
2003/2004	one event, 0.26 million gallons

4. *Watershed source controls*. In addition to public education, by May 1996, the City of Seattle completed business inspections in which 85 businesses were targeted for drive by or on-site inspections. Inspections included review of business practices, monitoring practices, historical storm system maintenance, and previous investigations.

5. *Sediment removal in storm drains*. The city estimated that approximately 500 storm drain inlets are in the Norfolk basin. Historical maintenance and inspection records inspections documented depth of sediment in the inlets and pump-out history. Pump-outs were scheduled for alternate years. An inspection by the City's Engineering Transportation Department found no sediment in the line in 1995.

6. *WSDOT.* Washington Department of Transportation was to implement improvements to reduce contaminants to their outfall – the Ryan Street drain.

7. *Focused source control at Boeing.* According to Pat Romberg (King County, personal communication), Boeing voluntarily performed extensive source control efforts on their property to remove PCB sources. They power cleaned the stormdrain, looked at roof coverings, and other potential problems.

8. *Recontamination as effectiveness measure.* The effectiveness of the source control was to be measured by whether the sediment cap became recontaminated, which it did. A caveat should be noted, however - that the final post-cleanup monitoring is not complete and the observed levels of contaminants may decrease in the next monitoring event. Also, PCBs were detected in the post-cleanup monitoring and a relatively, quick (compared to other sediment Superfund sites) cleanup *was* conducted by Boeing. None-the-less, results of follow-up sediment cap monitoring by King County shows that lead concentrations dramatically increased (but still less than SQS) in 2003. Arsenic and lead have shown gradually increases in two locations and other metals (chromium, copper and zinc) have shown steady increases at the Boeing sampling station. Phthalates concentrations in samples are moderately high, increasing to a level of 47-70% of SQS (but some data have been attributed to laboratory error). Benzoic acid (2003 sampling event) has increased to 553 ug/kg and approaches the SQS of 650 ug/kg. Phenol and 4-methylphenol were detected for the first time in 2003. PAHs and other contaminants were also detected at low levels. 2004 data will be used to confirm whether these increases were real and not just sampling errors. PCBs have been detected at significant levels (peaked in 2001 at 1330 ppb), often exceeding SQS at the Boeing station. In 2002, PCBs were detected in an upriver reference station. In 2003, PCBs were detected downstream of outfalls but not in upriver reference station, although at levels below SQS. Benzo(g,h,i)perylene and hexochlorbenzene were detected in 1999 (during baseline sampling) at levels above SQS.

Post-Cleanup Monitoring and Sediment Removal

Washington Department of Fish and Wildlife required five years of post-cleanup monitoring of the Norfolk CSO sediment cap. The monitoring (described in more detail, #8 above) showed that a number of contaminants were detected or increased over time in areas that were cleaned up: arsenic, chromium, copper, lead, phthalates, benzoic acid, phenol, 4-methylphenol, LPAHs, HPAHs, 1,4-dichlorobenzene, hexachlorobenzene, and PCBs.

In 2001, Dr. Robert Clarke, Elliott Bay and Duwamish Restoration Project chairman, requested that the Department of Ecology and EPA investigate of the PCB recontamination of the Norfolk sediment cap and adjacent areas near the upstream Boeing outfall. The Department of Ecology undertook the investigation as part of the Duwamish River source control project. The investigation is inconclusive about the actual source of PCBs but did identify the PCB hotspot in front of the Boeing outfall.

PCBs were found at levels up to 8,900 ug/Kg. At least one contaminated station was located upstream of the Boeing outfall but the majority were downstream or adjacent. The PCBs in samples were a mixture of at least Aroclors 1248 and 1254 (one sample also had 1260). The report also noted that stations with higher TOC and silt were mostly in the vicinity of the Norfolk CSO outfall. The study identified an area near the Boeing outfall that needed to be cleaned up in order to eliminate recontamination potential.

The investigation report and King County follow-up monitoring reports provided evidence that led Boeing to do a follow-up excavation of 60 cubic yards of the PCB contaminated soil at their outfall in the fall of 2003. Not all of the PCB-contaminated soil was removed. Post-cleanup monitoring will occur for this second cleanup as well.

Norfolk Source Control Comments and Recommendations

1. ***Lessons learned and continuing questions*** – that can be applied to the next cleanups in the river. Given that the Norfolk CSO was one of the first major cleanups of the sediment in the river, valuable lessons learned can be gleaned:

    - *Phthalates.* Since the Norfolk cleanup, the City and County have pursued testing and research related to phthalates in the drainage systems of the Duwamish – particularly at Duwamish/Diagonal. It would be helpful to for King County to quantify how much recontamination by phthalates has occurred at the Norfolk CSO site. Sampling data gives an indication of amounts at specific sites, but a mass balance calculation could help quantify the problem so that the information could be considered during cleanup of other sites.

    - *Sediment accumulation in the regulated area.* Was the area above the regulator valve investigated for sediment buildup and level of contamination? This area is now used to hold CSO flows during major storms and likely sediment would settle out. The quality of this sediment could provide information about the level of contamination in the drainage system.

    - *Erosion and major flood events.* In the cleanup effort, the County assumed sediment erosion did not need to be factored in because high river discharges or high tidal surges are rare and "therefore the likelihood of sediment erosion and subsequent resettling is

considered to be small." This statement has not been quantified and no evidence is provided to substantiate the claim. The same question of flooding and major erosion applies to other potential cleanup sites in the river.

- *Strengthening the runoff models.* King County has made an effort to model their system and to update their methods and baseline information. The model that was used for the Norfolk system was an early version with some weaknesses such as lack of consideration of tides, absence of PCBs, and use of older data. As newer iterations of this model are developed, it would be helpful to the stakeholders to get a technical update.

- *Turning Basin sediment concern.* Turning Basin sediments should be thoroughly assessed prior to any future use as "clean fill" in river cleanup sites. For the Norfolk CSO site, the Turning Basin sediments were tested and had one SQS bioassay exceedence for larvae. Later, when King County did a composite test of the material on the barge, four contaminants detection limits were above sediment criteria, – despite not being considered contaminants of concern at Norfolk.

- *Significance of PAHs.* PAHs were detected at one upstream station and thus were not considered significant for this site. King County stated that PAHs "were not considered a widespread problem at the study site." PAHs are found throughout the river. What are the sources of these PAHs and what source control actions will apply to them?

- *Business inspection results*. It would be helpful to the stakeholders to see the results of the business inspections and surveys. For example, were any sites contributors of PCBs?

2. ***Boeing property.*** What kind of follow-up source control occurred at Boeing after the recent cleanout? How were the results quantified?

3. ***WSDOT source control.*** WSDOT was to implement improvements to reduce contaminants to their outfall. What actions did they take and how effective were they? Have uncompromised phthalates samples been collected more recently at the Ryan Street outfall (since 2003 report)?

4. ***CSO overflows.*** A major component of the Norfolk source control was the reduction of combined sewer overflow. There was one overflow in the 2002/2003 water year of about 0.71 million gallons. What can be done to speed up the process of reducing these flows?

5. ***More monitoring needed.*** Because the Norfolk CSO cleanup has been shown to have become re-contaminated, follow-up monitoring should continue past 5 years at the initial sediment cap, as well as at the location of the recent Boeing cleanup. This is a particular concern because phthalates (often discounted as lab error) are of interest throughout the river. King County states, in the follow-up monitoring report that phthalates have reached "steady state" for the CSO station. How is this defined? In addition, all of the upriver phthalate data so far are considered compromised. Finally, globules of oil were seen in 2nd round of confirmation samples during dredging of Norfolk. Was this investigated? Are the sources known?

6. ***Metals not at natural levels.*** Metals that are increasing in the sediment cap (levels have doubled) are attributed by King County to "background" because fine sediment and organic carbon concentrations have increased. The metals, however, are increasing at the site and were not found at elevated levels in the Turning Basin sediment, therefore, they are likely not

"background" for the Duwamish. Also, background levels are not equivalent to natural levels in the system and thus are still a source control issue. Another question is how river hydraulic dynamics interact with each site. Does water with contaminants from upstream sources slow and deposit in certain areas, such as the hot spots?. Have river hydraulics been examined for the river?

7. ***Groundwater.*** Groundwater was dismissed as a concern for this site in the 1996 Cleanup Plan because "sediment contaminants of concern are normally associated with a CSO." This statement was not amplified and again, the CSO data is old. The river-wide RI Phase II/RI seep survey does not address this location.

Studies and References

Concept Plan, Elliott Bay/Duwamish Restoration Program, Panel Pub. 7, 1994 (June), by King Co.
Norfolk CSO Sediment Cleanup Study, Panel Pub 13, 1996 (October), by King Co
Norfolk CSO Sediment Remediation Project Closure Report, 1999 (April), by KCDNR
Norfolk CSO Sediment Remediation Project, Five-Year Monitoring Program, 1999 (April), by KCDNR
Norfolk CSO Sediment Remediation Project, Five-Year Monitoring Program, Year 4, 2003 (April), by KCDNR
Norfolk CSO Sediment Cap Recontamination Phase I Investigation, 2003 (February), by Ecology

River-Wide Recommendations

In addition to the site-specific recommendations and follow-up questions, the following recommendations apply to the overall source control program for the Duwamish River Superfund Site:

- **Target and carefully quantify the contaminants of concern for source control.** This may require that added resources be dedicated to the Superfund site and Early Action Areas. This added cost up front, however, will likely save considerable expenses later if recontamination can be avoided.
  - Provide funding for a comprehensive modeling effort to quantify pollutants coming into the river (fate and transport).
  - Provide funding for more sampling of sediments in catch basins, stormdrains, and other input locations as well as stormwater and CSO sampling. The city and county have started an excellent program to search for phthalate contamination sources in the Duwamish/Diagonal basin, contaminants in stormdrains that drain to Slip 4, and street samples upland of T-117. This effort should be expanded. All of the stormdrains that drain directly to Slip 4 have not yet been sampled. Speedier cooperation from Boeing is needed.
  - Provide funding for a more intensive investigation of adjacent properties and coordination of data sharing for business inspection data.
  - Produce ranked lists of contaminants of concern at each area and for the river as a whole to assist with targeting for source control. Pay special attention to contaminants that might be overlooked now because they are not listed as targeted contaminants and/or are considered secondary to PCBs, phthalates and mercury but might be significant for source control in the longer term.

- **Dedicate more resources at the Department of Ecology, including technical staff, to speed up the overall source control effort.** It is critical that a significant source control be implemented prior to cleanups. A similarly sized area, the Commencement Bay Superfund Site, had 6-8

Department of Ecology staff whereas this site has only 3 staff. A dedicated staff person who is working solely on source control for each early action area would significantly improve the effectiveness of source identification. . Alternatively, freeing up existing staff from contract management, database design and management, and authoring reports would help. Ideally, personnel with relevant regulatory experience would be tapped to assist with comprehensive file reviews and summary reporting. Additional resources at the local agency level would be of significant help as well. The city and county staffs are covering a large area.

- **Create regularly published update reports, similar to the Thea Foss "Drain-by-Drain Reports," for the major drains** as a way to report the progress of stormwater source control, including investigation progress for the drain, maps, lists of businesses or sources to the drain, business inspection status and results, follow-up work and visits, as well as results of catch basin or other sampling, inspections of and maintenance work on city- or county-maintained portions of the drainage. Rather than create more paperwork, perhaps an easily updateable and standardized web page could show progress for each site.

- **Don't measure success by failure**. Source control needs must be assessed up front, rather than determining success by whether cleanup areas become recontaminated.

- **Make a more concerted effort to sample outfalls and assess NPDES discharges**. Outfalls and stormwater discharges must be sampled for *all* the drains to all of the sites, especially Slip 4. It should be ensured that PCBs and other contaminants of concern are not continuing to enter the river through permitted discharges.

- **Address arsenic, as well as other river-wide problems**. In Phase I, this issue was delayed for consideration to Phase II/RI. Arsenic could be a major source control problem.

- **Re-assess dredging policy**. Dredge materials from the Duwamish appear to have been recycled through the system for the past 60 years and much appears to ultimately be ending up in the bellies of fish and other wildlife that transport it to the Puget Sound. A new approach to the use, cleanup and disposal of dredge material may be needed. In addition, the cleanliness of the Turning Basin material is in doubt. It is not clear that this material should be reused in the Duwamish due to potential contamination problems. Army Corps dredges 100,000 cubic yards from the Duwamish bi-annually.

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The Duwamish Tribe
The Green-Duwamish Watershed Alliance
The Environmental Coalition of South Seattle
Georgetown Community Council
People For Puget Sound
Puget Soundkeeper Alliance
South Park Neighborhood Association
Washington Toxics Coalition
Waste Action Project