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INVESTIGATION OF STORMWATER DISCHARGES TO WHEELER OSGOOD WATERWAY

by

Margaret Stinson
Dale Norton

Washington State Department of Ecology
Water Quality Investigations Section
Olympia, Washington 98504-6811

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ABSTRACT

Six discharges to Wheeler Osgood Waterway were sampled to determine if they are current sources of copper, lead, arsenic, zinc, 4-methylphenol, and dichlorobenzenes. Metals concentrations were similar to those typically seen in urban runoff. 4-Methylphenol was detected at 2.3 ug/L in the Western Steel Fabricators Drain sample; 1,2-dichlorobenzene was detected at an estimated concentration of 0.7 ug/L in Wheeler Osgood Storm Drain. Based on a single sampling, it cannot be determined if these data are typical of discharges to the waterway, or are sufficient sources of 4-methylphenol and 1,2-dichlorobenzene to be responsible for contamination found in earlier studies in Wheeler Osgood Waterway sediments.

INTRODUCTION

Wheeler Osgood Waterway is a remnant of the old west channel of the Puyallup River opening into the east side of City Waterway (Figure 1). The waterway was historically the site of a number of industries, largest of which was the old St. Regis Door Mill. The waterway is now encircled by abandoned buildings and warehouses interspersed with a few small industries. A few blocks east of the waterway is Hygrade Foods (formerly Carsten's Packing Company). This meat-packing plant was a major contributor of organic material to the waterway prior to diversion of process wastes to the sanitary sewer system in the 1970s (Tetra Tech, 1985). Hygrade now discharges only non-contact cooling water and surface runoff to the waterway via Wheeler Osgood Storm Drain. Other industries include J.D. English Steel Company, Cascade Drywall, General Beer Distributors, Western Steel Fabricators, and a number of small industries that rent space from the Wattles Company in the old St. Regis Door Mill building. None of these companies currently discharge process effluents to the waterway.

Elevated concentrations of a number of toxicants were found in Wheeler Osgood Waterway sediments during the Commencement Bay Nearshore/Tideflats Remedial Investigation (Tetra Tech, 1985). Contaminants recommended by Tetra Tech for additional source investigation include copper, lead, arsenic, zinc, 4-methylphenol, and dichlorobenzenes.

Although much of the sediment contamination in Wheeler Osgood Waterway had been assumed to be historical, cores indicated that diversion of waste streams from the waterway has apparently not resulted in a decrease in contamination of surficial sediments. It is uncertain if current sources exist, or if contaminated sediments have simply not been covered with more recent material. This issue must be resolved before remedial action can begin. Therefore, the objective of this investigation was to determine if storm drains discharging to Wheeler Osgood Waterway are current sources of the contaminants of concern.

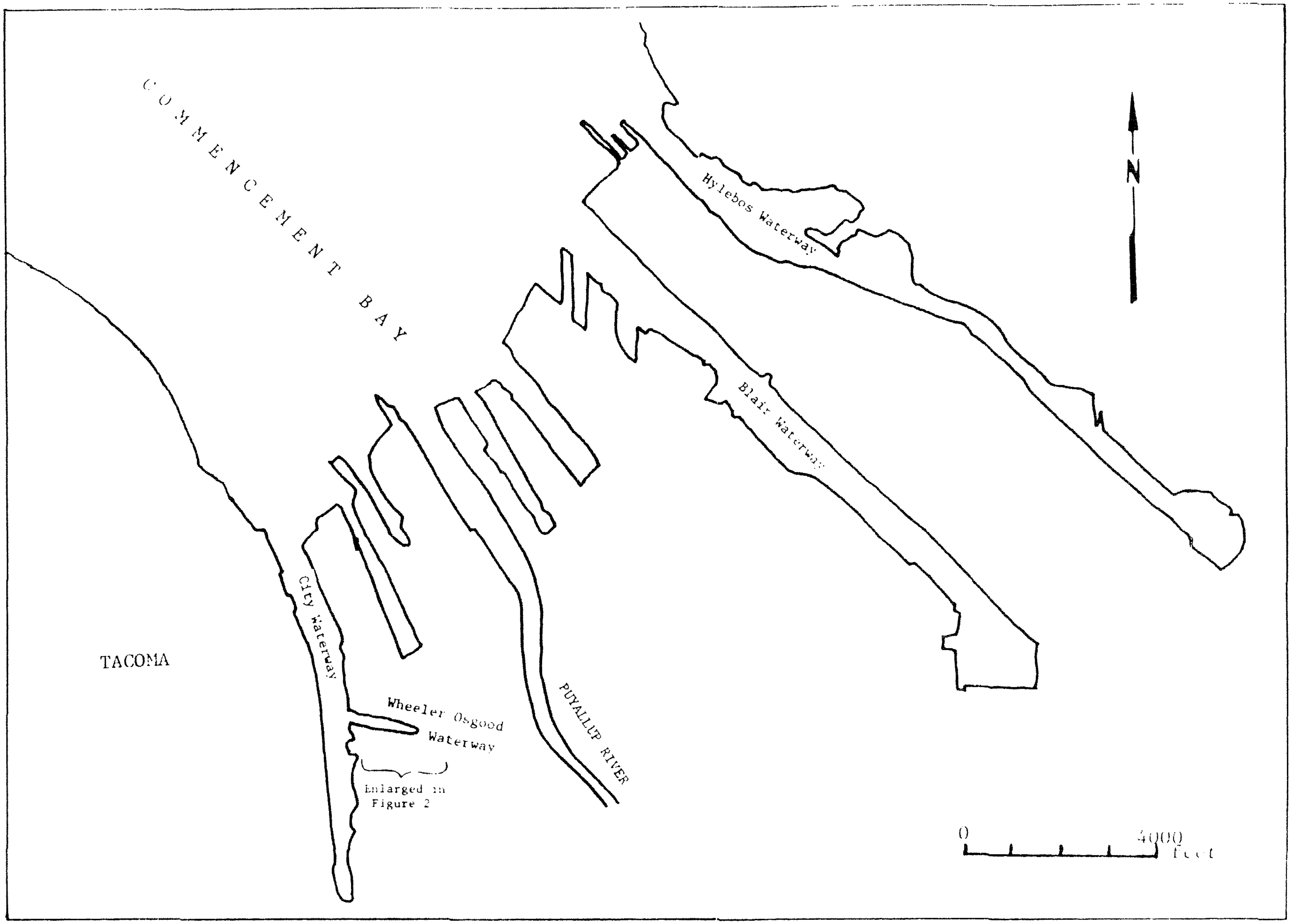

Figure 1. Location of Wheeler Osgood Waterway

METHODS

Sampling Plan

A reconnaissance survey of Wheeler Osgood Waterway was performed during dry weather on August 5, 1986, with the assistance of Ray Hanowell and Roy Young of the Tacoma-Pierce County Public Health Department. With the exception of Wheeler Osgood Drain, no drains were flowing at that time. Nine drains were tentatively selected for wet weather sampling. This included all drains known by the Health Department officials to flow during wet weather. Locations of sample collection sites are shown in Figure 2; physical descriptions are in Appendix I.

Samples were collected November 13, 1986. No rainfall had been recorded during the preceding week. Rain began falling at about noon the day sampling took place. Sample collection was timed around low tide to allow access to the drains and to minimize saltwater influence. Lower low water was at 2123 hours (+0.7 feet). About 0.15 inch of rain fell before and during sampling (data obtained from Ray Redding, Tacoma Public Works Department, Sewer Utility Division).

Five of the nine drains were not sampled because of negligible flows. Two seeps discovered on the north shore of the waterway were included among the discharges sampled. Samples from drains number 3 and 5 were collected in two grabs; the remainder were single grabs.

Sample Collection

Water samples for organics analysis were collected as grabs in one-quart jars, and composited into one-gallon jars. Sample containers were priority pollutant-cleaned, glass with teflon-lined screw closures (I-Chem^{R}, Hayward, California). Aliquots were split into 75 mL glass bottles and preserved with sulfuric acid for total organic carbon (TOC) analysis.

Samples for metals analysis were collected in one-quart, acid-cleaned, Nalgene^{R} bottles provided by Battelle Marine Research Laboratory, Sequim, Washington. Samples for metals analysis were preserved within three hours of collection by adding 1 mL hydrochloric acid (Baker Insta-Analyzed for Trace Metal Analysis) per liter. Samples for pH, specific conductance, and total suspended solids (TSS), were collected in 500 mL Nalgene^{R} bottles.

Samples were kept on ice in the field, and transported to the Ecology/EPA Environmental Laboratory at Manchester, Washington, the day after collection. Organics and metals samples were held at 4^{o}C until transferred to contract laboratories for analysis.

Flow was measured with a Marsh-McBirney magnetic flow meter, or alternatively with a bucket and stopwatch, depending on the drain configuration.

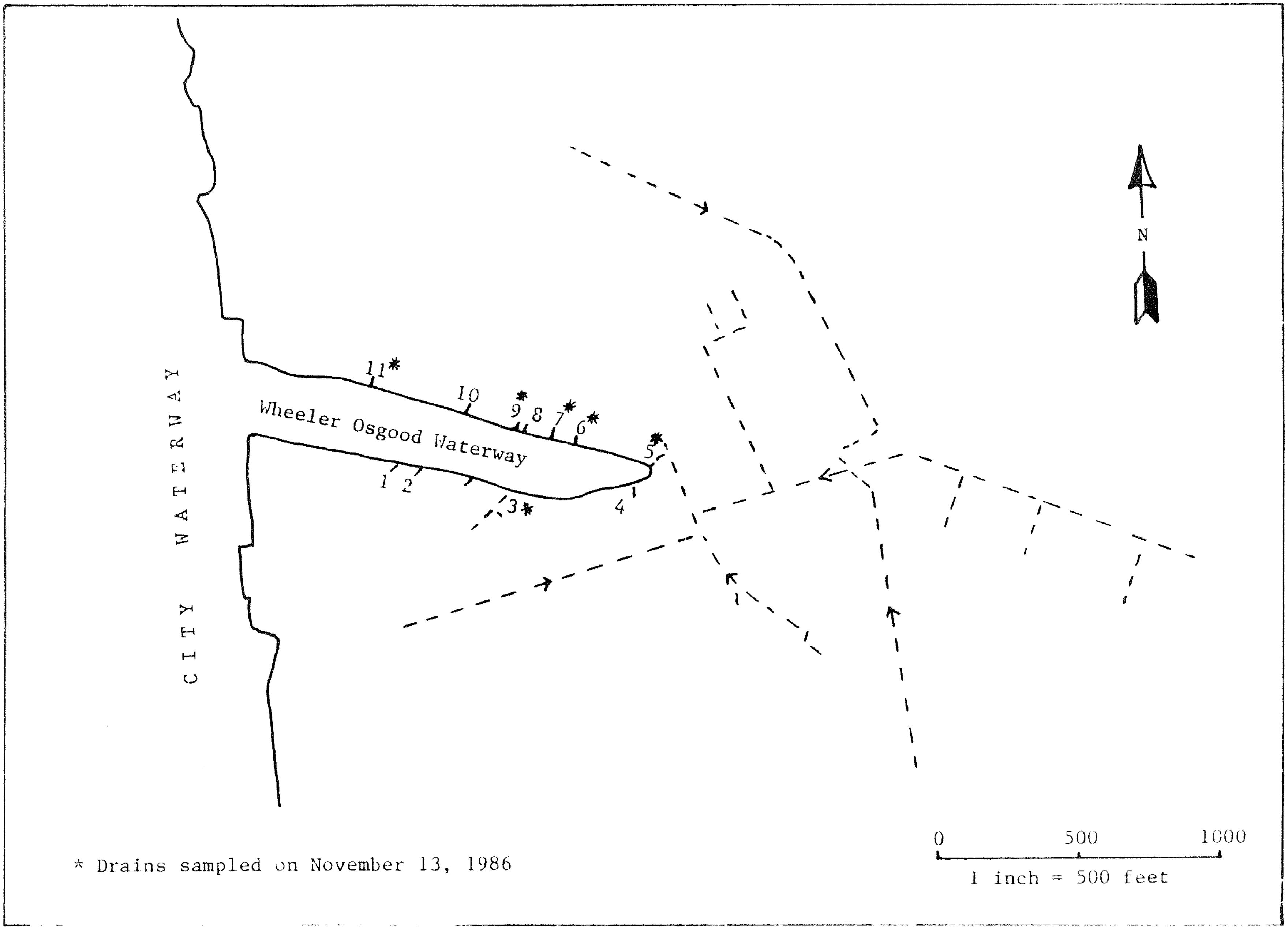

Figure 2. Locations of discharges to Wheeler Osgood Waterway, including drainage of Wheeler Osgood Storm Drain (#5).

Laboratory Analysis

Organics samples were analyzed for acid/base-neutrals (and Hazardous Substance List compounds) by Analytical Resources, Inc., Seattle, Washington, using Isotope Dilution Gas Chromatography/Mass Spectroscopy, EPA Method 1625(B) (U.S. EPA, 1984).

Metals were analyzed by the Battelle Sequim Laboratory. Copper and lead were preconcentrated from seawater by APDC coprecipitation before analysis using atomic absorption spectrophotometry (AAS) with Zeeman graphite furnace (Bloom and Crecelius, 1984). Zinc was analyzed by direct injection along with a matrix modifier. Arsenic was analyzed by hydride generation with a quartz burner AAS detector (Bertine and Lee, 1983; Crecelius, 1978).

pH, specific conductance, TOC, and TSS were analyzed at the Manchester laboratory. pH was measured using a Corning 155 pH meter. Specific conductance was measured with a Beckman RC20 conductivity meter. Samples were analyzed for TOC and TSS by EPA Methods 415.1 and 160.2, respectively (U.S. EPA, 1979).

Quality Assurance

This investigation followed the procedures and guidelines specified in Tetra-Tech, Inc. (1986) Quality Assurance Project Plan for Field Investigations to Support Commencement Bay Nearshore/Tideflats Feasibility Study.

Quality assurance (QA) review of the organics data was done by Marsha Meredith of Tetra Tech, Inc., Bellevue, Washington. The data were generally considered acceptable in terms of compound identification, precision, spike recovery, and detection limits. Two exceptions were noted.

- Isotope recoveries greater than 10 percent were considered acceptable. Four compounds had recoveries consistently below 10 percent: Hexachlorobutadiene, pentachlorophenol, benzidine, and 3,3'-dichlorobenzidine. None of these, however, were objects of this source investigation. Pentachlorophenol was detected in three samples, in spite of poor isotope recovery.

- It was recommended that several reported data values be used with caution because they were reported as estimated concentrations below the detection limit. These values (and results of calculations using these values) are qualified with a "j" in tables and figures in this report.

QA review of the metals data was done by Deborah Coffey, also of Tetra Tech. The data were considered acceptable in terms of precision, accuracy, spike recovery, and detection limits.

National Research Council of Canada standard seawater reference materials were analyzed by Battelle to assess the accuracy and precision of the metals measurements. Battelle results were generally in good agreement with certified values (Table 1).

Table 1. Results of Battelle analyses of National Research Council of Canada standard seawater reference materials (NASS - Seawater Reference Material for Trace Metals; CASS - Nearshore Seawater Reference Material for Trace Metals).

Reference Material	Metal	Certified Value (ug/L)	Battelle Value (ug/L)
CASS-1	Copper	0.291 ± 0.027	0.33
CASS-1	Lead	0.251 ± 0.027	0.23
CASS-1	Zinc	0.980 ± 0.099	1.01 ± 0.10 sd(n=7)
NASS-1	Arsenic	1.65 ± 0.19	1.55 ± 0.09 sd(n=7)

Results of transfer and transport blank analyses are in Appendix II. Concentrations of copper and lead were at or near detection limits. Zinc was detected at concentrations that were insignificant relative to field samples. No organic compounds were detected in transport or transfer blanks.

In accordance with the QA plan, one sample was split in the field for triplicate analyses. Table 2 summarizes these results. Precision estimates, expressed as Relative Standard Deviation (RSD), met specifications of the QA plan for all parameters except TSS, TOC, copper, zinc, and bis(2-ethylhexyl)phthalate. Since precision estimates for laboratory analyses met QA objectives listed in Table 2, lack of sample homogeneity in field triplicates may be responsible.

RESULTS

Table 3 is a summary of the results of analyses of water samples from Wheeler Osgood drains. Complete results are reported in Appendix II.

Wheeler Osgood Storm Drain was the major discharge to the waterway at 250,000 gallons per day (GPD). This accounted for 97 percent of the flow to the waterway measured at the time of sample collection. Flows in the remainder of the discharges ranged from 770 to 3700 GPD.

pH was not substantially different among drains, ranging from 6.9 to 7.3. Specific conductance varied widely (136 to 18,580 umhos/cm), higher conductivity probably being due to saltwater influence. TSS

Table 2. Results of triplicate analyses of a water sample from Wheeler Osgood Drain, November 13, 1986 (ug/L, unless otherwise stated).

Parameter	Wheeler Osgood Storm Drain Sample Number 46-8254	46-8255	46-8256	Mean	RSD (%)	Objectives for Precision
pH	6.9	6.9	7.0	--	--	NS
Spec. Cond. (umhos/cm)	5620	5600	5660	5630	0.5	NS
TSS (mg/L)	5	4.6	25	11.5	101	±10%
TOC (mg/L)	5	4	4	4	13.3	±5%
Copper	6.46	5.38	9.15	7.00	27.7	±20%
Lead	6.82	6.41	7.22	6.82	5.94	±20%
Arsenic	1.51	1.42	1.49	1.47	3.21	±20%
Zinc	80.0	40.0	55.0	58.3	34.6	±20%
1,2-Dichlorobenzene	0.6j	0.8j	0.7j	0.7j	14.3	±30%
Naphthalene	0.2j	0.2j	0.2j	0.2j	0	±30%
Phenanthrene	0.2j	0.3j	0.3j	0.3j	21.7	±30%
bis(2-Ethylhexyl)-phthalate	1.0	1.7	0.8	1.2	40.5	±30%

j = Estimated value, below detection limits
NS = Objective for precision not specified for this parameter

Table 3. Concentrations of metals and acid/base-neutrals detected in water samples collected November 13, 1986, from discharges to Wheeler Osgood Waterway (ug/L).

Station Description	Cascade Drywall S.D.	Wheeler Osgood S.D.	#1 Seep E. Wattles Bldg	East Wattles Drain	#2 Seep Wood Bulkhead	Western Steel Fabricators
Station Number	3	5	6	7	9	11
Sample Number	46-8252	46-8254-6	46-8263	46-8257	46-8264	46-8260
Flow (Gallons per Day)	2,100	250,000	920	1,300	3,700	770
pH	7.1	6.9	7.3	7.0	7.0	7.3
Specific Conductance (uhmos/cm)	274	5,630	464	18,580	4,350	136
Total Suspended Solids (mg/L)	29	4.3	80	14	14	4
Total Organic Carbon (mg/L)	26	11.5	40	10	12	6.8
*Copper	22.6	7.00	72.0	122	8.61	57
*Lead	14.6	6.82	42.8	16.4	6.08	6.30
*Arsenic	2.30	1.47	4.51	4.50	12.9	0.19
*Zinc	150	58	130	130	60.0	365
Phenolic Compounds						
Phenol	2.5u	2.5u	2.5u	2.7u	2.5u	6.3
2-Methylphenol	1.0u	1.0u	1.0u	1.0u	1.0u	1.1
*4-Methylphenol	1.0u	1.0u	1.0u	1.0u	1.0u	2.3
Substituted Phenols						
Pentachlorophenol[b]	12.0	2.5u	1.4j	2.5u	2.5u	16.0
Low Molecular Weight Aromatic Hydrocarbons						
Naphthalene	3.0	0.2j	0.4u	0.2j	0.4u	3.6
2-Methylnaphthalene	9.0	1.0u	1.0u	1.0u	1.0u	1.9
Acenaphthene	1.4	0.6u	0.3j	0.6u	0.6u	0.6u
Fluorene	3.4	0.6u	0.6u	0.6u	0.6u	0.6u
Phenanthrene	3.2	0.3j	0.2j	0.4u	0.4u	0.3j
Anthracene	0.4u	0.4u	0.5	0.4u	0.4u	0.4u
Dibenzofuran	1.4	0.5u	0.5u	0.5u	0.5u	0.5u
High Molecular Weight Aromatic Hydrocarbons						
Fluoranthene	0.3j	0.4u	0.7	0.4u	0.4u	0.4u
Pyrene	0.5u	0.4u	1.1	0.4u	0.4u	0.4u
Benzo(a)Anthracene	0.5u	0.5u	0.1j	0.5u	0.5u	0.5u
Chrysene	0.5u	0.5u	0.5	0.5u	0.5u	0.5u
Benzo(b)Fluoranthene	0.5u	0.5u	0.2j	0.5u	0.5u	0.5u
Benzo(k)Fluoranthene	0.5u	0.5u	0.3j	0.5u	0.5u	0.5u
Benzo(a)Pyrene	0.5u	0.5u	Trace	0.5u	0.5u	0.5u
Chlorinated Aromatic Hydrocarbons						
*1,2-Dichlorobenzene	1.0u	0.7j	1.0u	1.0u	1.0u	1.0u
Phthalates						
Dimethyl Phthalate	0.6u	0.5u	0.5u	0.5u	0.5u	0.9
Di-n-Butylphthalate	1.7	0.4u	1.6	1.7	1.3	2.1
bis(2-Ethylhexyl)Phthalate	1.6	1.2	0.3j	1.5	0.9	1.2

* = Object of present source investigation
b = Pentachlorophenol results may be underestimated, based on low isotope recovery.
j = Estimated value, below method detection limits
u = Not detected at detection limit shown
Trace = Not quantifiable
Underscore indicates organic compounds detected

and TOC values were elevated in samples from Cascade Drywall (29 and 26 mg/L, respectively) and #1 Seep (80 and 40 mg/L, respectively). The remaining TSS and TOC concentrations were 14 mg/L or less.

Metals concentrations were detected in all drains. Highest concentrations were: copper - 122 ug/L (East Wattles Drain); lead - 42.8 ug/L (#1 Seep); arsenic - 12.9 ug/L (#2 Seep); and zinc - 365 ug/L (Western Steel Fabricators).

Twenty-two acid/base-neutral compounds were detected in drains to Wheeler Osgood. Most commonly detected compounds were bis(2-ethylhexyl)-phthalate (detected in all discharges), di-n-Butylphthalate (five of six discharges), naphthalene and phenanthrene (four of six discharges), and pentachlorophenol (three of six discharges). The highest concentration of any organic compound detected was 16 ug/L pentachlorophenol. Approximately one-third of the concentrations reported were estimated values below quantification limits.

Two objects of this investigation, 4-methylphenol and 1,2-dichlorobenzene, were detected at one site each. 4-Methylphenol was detected at 2.3 ug/L in the sample from Western Steel Fabricators Drain. 1,2-Dichlorobenzene was detected at an estimated concentration of 0.7 ug/L from Wheeler Osgood Drain; its presence was verified in replicate samples.

Estimated loads for the contaminants of concern in discharges to Wheeler Osgood Waterway are in Table 4. Total metals loading to the waterway for the day of sample collection was 0.17 lb/day, with zinc accounting for 76 percent of this total. Estimated loads for 4-methylphenol and 1,2-dichlorobenzene were 0.00002 lb/day and 0.002j lb/day, respectively. For the remainder of the organic compounds detected, estimated total loading was less than 0.004 lb/day. It was assumed that contaminants in discharges were from land-based sources. If contamination results from intrusion of saltwater, it would be expected to be found in all other tidally influenced drains. This was not the case.

Table 4. Loading estimates for contaminants of concern in discharges to Wheeler Osgood Waterway, November 13, 1986 (lb/day).

	Total Load	Predominant Source	Percent Contribution
Flow (GPD)	259,000	Wheeler Osgood Drain	97
Copper	0.018	Wheeler Osgood Drain	84
Lead	0.015	Wheeler Osgood Drain	93
Arsenic	0.0036	Wheeler Osgood Drain	86
Zinc	0.13	Wheeler Osgood Drain	93
4-Methylphenol	0.00002	Western Steel Fab.	100
1,2-Dichlorobenzene	0.002j	Wheeler Osgood Drain	100

j =Estimated

DISCUSSION

Historical data on Wheeler Osgood Drains from Ecology (Johnson and Norton, 1984) and Tacoma Pierce County Health Department (Rogers, et al., 1983) are summarized in Table 5. Metals and conventional measures of water quality in this investigation were within the range of results seen in earlier studies. Metals concentrations in previous investigations of City Waterway discharges have also been similar to those seen in the present study.

In a study of storm runoff in a light industrial area in Seattle, Washington, lead and copper were detected at slightly higher concentrations than in the present study. All metals concentrations in the present investigation were within ranges detected in National Urban Runoff Program studies conducted throughout the United States (Table 6) (Galvin & Moore, 1982, and references therein).

Table 6. A summary of Wheeler Osgood discharges and National Urban Runoff Program (NURP) (Galvin & Moore, 1982) studies metals results.

	Range (ug/L)	
Metal	Wheeler Osgood Discharges	NURP (total metals)
Copper	7 - 122	20 - 520
Lead	6.08 - 42.8	40 - 28,000
Arsenic	0.19 - 4.51	10 - 130
Zinc	58 - 365	10 - 5,750

Because Wheeler Osgood Drain is the major discharge to the waterway, it is the only one that has been sampled previously for the organic compounds targeted in this study. Of the four organic compounds detected in Wheeler Osgood rain in the present investigation, all except 1,2-dichlorobenzene had been detected previously in this drain. 1,2-Dichlorobenzene has occasionally been reported in a few drains in other parts of Commencement Bay, however. Reported concentrations ranged from 2.95 to 30 ug/L (Johnson, et al., 1984). 1,2-Dichlorobenzene is not typical of urban runoff (Galvin & Moore, 1982).

4-Methylphenol has not previously been detected in discharges to Wheeler Osgood Waterway, and has been reported in only one active discharge to Commencement Bay--Surprise Lake Ditch to Hylebos Waterway--(29 ug/L), (Johnson, et al., 1984). Although 4-methylphenol has not commonly been detected in urban runoff (Galvin & Moore, 1982), it should be noted that because 4-methylphenol is not a priority pollutant compound, it is also not commonly analyzed.

Copper, zinc, and lead are common constituents of urban runoff, for the most part related to use of automobiles. Copper and zinc plumbing, and weathering of galvanized metals may be additional sources. ASARCO slag, used extensively for riprap, fill, and sandblasting in the tideflats area, is a possible source of arsenic, copper, and lead to the waterway (Tetra Tech, 1985). Crecelius (1986) has found,

Table 5. Results of Ecology and Tacoma-Pierce County Health Department (TPCHD) sampling of discharges to Wheeler Osgood Waterway (ug/L).

	Wheeler Osgood Drain						East Wattles Drain	Western Steel Fabricators
TPCHD Drain Number	254						256	261
Investigator	Ecology	Ecology	TPCHD	Ecology	Ecology	Ecology	TPCHD	TPCHD
Sampling Date	7/28/81	3/29/82	6/27/83	9/6/83	11/7-8/83	11/7-8/83	5/25/83	5/25/83
Station Number	2039	1388	W-40	34518	6188	6189	W-12	W-14
Flow (MGD)	0.13	0.62	--	0.15	0.23	--	--	--
TSS (mg/L)	6	17	--	4	6	--	--	--
TOC (mg/L)	--	--	5.0	--	--	--	52	14
pH	--	--	--	--	7.1	--	--	--
Specific Conductance (umhos/cm)	10,780	6,840	7,600	8,870	7,000	--	5,600	190
Metals								
Arsenic	20	18	4	3	1u	28	18	2.0u
Copper	40	10	--	--	12	31	--	--
Lead	75	80	8	10z	25z	28z	1	8
Zinc	140	80	--	53z	34	50	--	--
Acid/Base-Neutrals								
Phenolic Compounds								
Phenol	10u	10u	--	1.0u	1.0	1.0u	--	--
2-Methylphenol	--	--	--	--	--	--	--	--
4-Methylphenol	--	--	--	--	--	--	--	--
Substituted Phenols								
Pentachlorophenol	40u	10u	--	1.0u	1.0u	1.0u	--	--
Low Molecular Weight Aromatic Hydrocarbons								
Naphthalene	10u	10u	--	1.0u	4.0m	3.0m	--	--
2-Methylnaphthalene	--	--	--	--	--	--	--	--
Acenaphthene	10u	10u	--	0.1u	0.1u	0.1u	--	--
Fluorene	10u	10u	--	0.1u	0.1u	0.1u	--	--
Phenanthrene	10u	c	--	0.1u	0.5	0.4m	--	--
Anthracene	10u	c	--	0.1u	0.1u	0.1u	--	--
Anthracene/phenanthrene	--	15	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--
High Molecular Weight Aromatic Hydrocarbons								
Fluoranthene	10u	10u	--	0.1u	0.1u	0.1u	--	--
Pyrene	10u	10u	--	0.1u	0.1u	0.1u	--	--
Benzo(a)Anthracene	10u	10u	--	0.1u	0.1u	0.1u	--	--
Chrysene	10u	10u	--	0.1u	0.1u	0.1u	--	--
Benzo(b)Fluoranthene	10u	10u	--	c	c	c	--	--
Benzo(k)Fluoranthene	10u	10u	--	c	c	c	--	--
Benzo(a)Pyrene	10u	10u	--	0.1u	0.1u	0.1u	--	--
Total Benzofluoranthenes	10u	10u	--	0.1u	0.1u	0.1u	--	--
Chlorinated Aromatic Hydrocarbons								
1,2-Dichlorobenzene	10u	10u	--	1.0u	1.0u	1.0u	--	--
Phthalates								
Dimethyl Phthalate	10u	10u	--	1.0u	1.0u	1.0u	--	--
Di-n-Butylphthalate	10u	10u	--	1.0u	14	1.0u	--	--
bis(2-Ethylhexyl)Phthalate	10u	10u	--	1.0u	18	1.0u	--	--

c = Value is included in total for this group
m = Below limit of quantification; quantification limit shown
u = Not detected at detection limit shown
z = Value corrected for blank; resulting value still exceeds the detection limit shown
-- = Analysis not done for this constituent
Underscore indicates organic compounds detected

however, that without wave action or other abrasion, leaching of metals from weathered slag occurs at a very low rate.

4-Methylphenol is a coal tar derivative which is used in production of phenolic resins, in ore floatation, in essential oils (e.g., oil of jasmine), and in a synthetic food flavoring (McKee and Wolf, 1963; Lewis and Tatkin, 1980). Possible sources of 4-methylphenol contamination in Wheeler Osgood Waterway sediments include phenolic resins, possibly from the old St. Regis Door Mill, and movement of groundwater from the nearby Tar Pits (Tetra Tech, 1985). In this study, 4-methylphenol was detected in Western Steel Fabricators Storm Drain, which apparently discharges runoff from a single catch basin in the Western Steel Fabricators yard. The yard is regularly used for treating and painting fabricated metal parts. This practice results in paint residues over much of the yard surface. Paint residues may be a source of 4-methylphenol to the waterway. Phenolic compounds are often used in resin based metal coatings and in metal cleaning compounds.

1,2-Dichlorobenzene is used as a solvent for organic materials and oxides of nonferrous metals, as a degreaser for hides and wool, and as a pesticide. It has been suggested that Hygrade may use 1,2-dichlorobenzene as a degreasing agent; however, use of the compound has not been documented (Tetra Tech, 1985).

The data available on Wheeler Osgood Waterway surficial sediments are from two samples collected within 65 feet of each other near the mouth of the waterway (Tetra Tech, 1985). It is therefore not possible to use gradients of sediment contamination to confirm any of the discharges as major sources of toxicants to the waterway.

Water quality criteria have been established for many of the contaminants detected in this study (U.S. EPA, 1986). The concentration of 1,2-dichlorobenzene (0.7j ug/L) detected in Wheeler Osgood Storm Drain was well within criteria for protection of saltwater organisms. Based on toxicity data from McKee and Wolf (1963), it appears that 4-methylphenol (2.3 ug/L) was similarly not a threat to organisms in the receiving water at the concentration detected.

U.S. EPA water quality criteria for metals are based on "acid soluble" metals concentrations. To measure "acid soluble" metals, samples are adjusted to pH 1 and filtered through a 0.45 micron filter. However, EPA has not provided protocols for measuring "acid soluble" metals and recommends that the criteria should be compared to "total recoverable" metals results. Metals data are reported in this study as "total recoverable" (zinc and arsenic) and "total" (copper and lead). "Acid soluble" based criteria may be overly protective when used to evaluate "total" and "total recoverable" data (U.S. EPA, 1986).

Three of the four metals measured in discharge samples exceeded saltwater metals criteria. The "acute" criterion for copper (2.9 ug/L), was exceeded in every discharge. Lead concentrations were within "acute" criteria, but exceeded the "chronic" criterion (5.6 ug/L) in all discharge samples. Arsenic concentrations were all within criteria specifications. All zinc concentrations exceeded the "chronic" criterion of 58 ug/L, but did not exceed the maximum allowable 170 ug/L.

Potential impact of metals concentrations may be exaggerated because of the low volumes discharged at all but Wheeler Osgood Storm Drain. These data may also approximate maximum values because sample collection was associated with "first flush" conditions. In addition, most of the drains discharge only during wet weather.

It should be noted that these criteria were developed for receiving water concentrations, not undiluted discharges. Table 7 shows the dilution factors required to bring copper, lead, and zinc concentrations in line with metals criteria for protection of saltwater organisms. Dilution factors ranging from 19 to 42 are required for copper in #1 Seep, East Wattles Drain and Western Steel Fabricators. Dilution factors are less than 8 for the remainder of the metals concentrations.

While sources of contaminants of concern were identified in this study, conclusions are limited by the fact that they are based on a single sampling. Although concentrations were generally low, it is not possible to determine if concentrations and estimated loads are typical of discharges to Wheeler Osgood Waterway, or if they are sufficient to produce the levels of contamination found in Wheeler Osgood sediments. It is recommended that Western Steel Fabricators Drain and Wheeler Osgood Storm Drain be sampled to confirm these results, and site investigations be conducted to further define sources of 4-methylphenol and 1,2-dichlorobenzene to Wheeler Osgood Waterway.

SUMMARY

Discharges to Wheeler Osgood Waterway were investigated during wet weather to identify ongoing sources of copper, lead, arsenic, zinc, 4-methylphenol, and dichlorobenzenes. These were the major findings:

- At the time of sample collection, Wheeler Osgood Drain was contributing 97 percent of the measured storm runoff to the waterway.

- Copper, lead, arsenic, and zinc were detected in samples from every discharge. Concentrations were typical of urban runoff. Estimated total metals loading to the waterway for the day of sample collection was 0.17 lb.

- 4-Methylphenol and 1,2-dichlorobenzene were detected in samples from one discharge each. 4-Methylphenol (2.3 ug/L) was found in the Western Steel Fabricators Drain sample; 1,2-dichlorobenzene (0.7j ug/L) was found in the Wheeler Osgood Storm Drain sample. Estimated loads to the waterway for the day of sample collection were: 0.00002 lb. 4-methylphenol, and 0.002j lb. 1,2-dichlorobenzene.

Table 7. Metals concentrations in Wheeler Osgood discharges (November 13, 1987) that exceeded U.S. EPA criteria for protection of saltwater organisms, and dilutions required to meet those criteria.

	Copper (ug/L) ("Acute" Criteria = 2.9 ug/L)		Lead (ug/L) ("Chronic" Criteria = 5.6 ug/L)		Zinc (ug/L) ("Chronic" Criteria = 58 ug/L)	
	Discharge Concentration	Dilution Factor	Discharge Concentration	Dilution Factor	Discharge Concentration	Dilution Factor
Cascade Drywall S.D.	22.6	7.8	14.6	2.6	150.0	2.6
Wheeler Osgood S.D.	7.0	2.4	6.82	1.2	58.33	1.0
#1 Seep	72.0	24*	42.8	7.6	130	2.2
East Wattles Drain	122.0	42*	16.4	3.0	130	2.2
#2 Seep	8.61	3.0	6.08	1.1	60.0	1.0
Western Steel Fab.	57	19*	6.3	1.1	365	6.3

* = Concentrations requiring substantial dilution

- Twenty-two organic compounds were detected at very low concentrations. Estimated loads of these toxicants to the waterway the day of sample collection was less than 0.004 lb.

RECOMMENDATION

- Western Steel Fabricators Drain and Wheeler Osgood Storm Drain should be sampled to confirm the results of this investigation; site investigations should be conducted to further define sources of 4-methylphenol and 1,2-dichlorobenzene to Wheeler Osgood Waterway. Generally low concentrations and loads of contaminants suggest a low priority for follow-up investigation.

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APPENDIX

Appendix I. Locations of discharges to Wheeler Osgood Waterway.

Drain Number	Description	TPCHD[a] Number	Time Sampled
1	J.D. English Ditch Open Ditch to parking lot, roof drain; overgrown	--	No flow; not sampled
2	J.D. English Storm Drain 18-inch concrete pipe; about 40 feet upstream from J.D. English Ditch	250	No flow; not sampled
*3	Cascade Drywall Storm Drain 6-inch PVC pipe outfall; drains parking lot	252	2103 - 2216
4	General Beer Distributors 6-inch concrete pipe; drains parking area	253	Negligible flow, not sampled
*5	Wheeler Osgood Storm Drain 30-inch steel pipe at the head of Wheeler Osgood Waterway	254	2125 - 2200
*6	#1 Seep Midway between Wheeler Osgood Drain and east corner of Wattles Building Lat/Long 47 15'5"/122 25'33"	--	2148
*7	East Wattles Drain 18-inch concrete pipe at east end of buildings	256	2158
8	Wattles Drain Under Building 4-inch concrete pipe at east end of buildings	257	No flow; not sampled
*9	#2 Seep In front of Wattles Building at west corner of wood bulkhead, filled area Lat/Long 47 15'6"/122 25'37"	--	2239
10	Wattles Roof Drain 12-inch PVC roof drain	258	Negligible flow; not sampled
11	Western Steel Fabricators 12-inch metal pipe	261	2216

[a]Tacoma-Pierce County Health Department

* Indicates discharges sampled November 13, 1986

Appendix II. Results of analyses of whole water samples from discharges to Wheeler Osgood Waterway, November 13, 1986 (metals and acid/base-neutrals in ug/L).

Station Description	Cascade Drywall S.D.	Wheeler Osgood S.D.	Wheeler Osgood S.D.	Wheeler Osgood S.D.	#1 Seep E. Wattles Bldg.	East Wattles Drain	#2 Seep Wood Bulkhead	Western Steel Fabricators	Transport Blank	Transfer Blank
Station Number	3	5	5 (Dup)	5 (Trip)	6	7	9	11		
Sample Number	46-8252	46-8254	46-8255	46-8256	46-8263	46-8257	46-8264	46-8260	46-8261	46-8262
Flow (Gallons per Day)	2,100	250,000	N/A	N/A	920	1,300	3,700	770	a	a
pH	7.1	6.9	6.9	7.0	7.3	7.0	7.0	7.3	a	a
Specific Conductance (uhmos/cm)	274	5,620	5,600	5,660	464	18,580	4,350	136	a	a
Total Suspended Solids (mg/L)	29	5	4	4	80	14	14	4	a	a
Total Organic Carbon (mg/L)	26	5	4.6	25	40	10	12	6.8	a	a
*Copper	22.6	6.46	5.38	9.15	72.0	122	8.61	57	0.17	0.13u
*Lead	14.6	6.82	6.41	7.22	42.8	16.4	6.08	6.30	0.01	0.01
*Arsenic	2.30	1.51	1.42	1.49	4.51	4.50	12.9	0.19	0.02u	0.02u
*Zinc	150	80.0	40.0	55.0	130	130	60.0	365	11.5	6.95
Phenolic Compounds										
Phenol	2.5u	2.5u	3.0u	2.5u	2.5u	2.7u	2.5u	6.3	2.5u	2.5u
2-Methylphenol	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.1	1.0u	1.0u
*4-Methylphenol	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	2.3	1.0u	1.0u
2,4-Dimethylphenol	2.5u	2.5u	2.5u	2.5u	2.5u	2.5u	2.5u	3.0u	2.5u	2.5u
Substituted Phenols										
2-Chlorophenol	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
2,4-Dichlorophenol	1.6u	1.6u	1.6u	1.6u	1.6u	1.6u	1.6u	1.6u	1.6u	1.6u
4-Chloro-3-Methylphenol	2.5u	2.5u	2.5u	2.5u	2.5u	2.5u	2.5u	2.5u	2.5u	2.5u
2,4,6-Trichlorophenol	1.8u	1.8u	1.8u	1.8u	1.8u	1.8u	1.8u	1.8u	1.8u	1.8u
2,4,5-Trichlorophenol	1.8u	1.8u	1.8u	1.8u	1.8u	1.8u	1.8u	1.8u	1.8u	1.8u
Pentachlorophenol	12.0	2.5u	2.5u	2.5u	1.4u	2.5u	2.5u	16.0	2.5u	2.5u
2-Nitrophenol	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u
2,4-Dinitrophenol	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u
4-Nitrophenol	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u
4,6-Dinitro-2-Methylphenol	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u
Low Molecular Weight Aromatic Hydrocarbons										
Naphthalene	3.0	0.2j	0.2j	0.2j	0.4u	0.2j	0.4u	3.6	0.4u	0.4u
2-Methylnaphthalene	9.0	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.9	1.0u	1.0u
Acenaphthylene	0.5u	0.5u	0.5u	0.5u	0.5u	0.5u	0.5u	0.5u	0.5u	0.5u
Acenaphthene	1.4	0.6u	0.6u	0.6u	0.3j	0.6u	0.6u	0.6u	0.6u	0.6u
Fluorene	3.4	0.6u	0.6u	0.6u	0.6u	0.6u	0.6u	0.6u	0.6u	0.6u
Phenanthrene	3.2	0.2j	0.3j	0.3j	0.2j	0.4u	0.4u	0.3j	0.4u	0.4u
Anthracene	0.4u	0.4u	0.4u	0.4u	0.5	0.4u	0.4u	0.4u	0.4u	0.4u

Appendix II. Continued.

Station Description	Cascade Drywall S.D.	Wheeler Osgood S.D.	Wheeler Osgood S.D.	Wheeler Osgood S.D.	#1 Seep E. Wattles Bldg.	East Wattles Drain	#2 Seep Wood Bulkhead	Western Steel Fabricators	Transport Blank	Transfer Blank
Station Number	3	5	5 (Dup)	5 (Trip)	6	7	9	11		
Sample Number	46-8252	46-8254	46-8255	46-8256	46-8263	46-8257	46-8264	46-8260	46-8261	46-8262
High Molecular Weight Aromatic Hydrocarbons										
Fluoranthene	0.3u	0.4u	0.4u	0.4u	0.7	0.4u	0.4u	0.4u	0.4u	0.4u
Pyrene	0.5u	0.4u	0.4u	0.4u	1.1	0.4u	0.4u	0.4u	0.4u	0.4u
Benzo(a)Anthracene	0.5u	0.5u	0.5u	0.5u	0.1j	0.5u	0.5u	0.5u	0.5u	0.5u
Chrysene	0.5u	0.5u	0.5u	0.5u	0.5	0.5u	0.5u	0.5u	0.5u	0.4u
Benzo(b)Fluoranthene	0.5u	0.5u	0.5u	0.5u	0.2j	0.5u	0.5u	0.5u	0.5u	0.5u
Benzo(k)Fluoranthene	0.5u	0.5u	0.5u	0.5u	0.3j	0.5u	0.5u	0.5u	0.5u	0.5u
Benzo(a)Pyrene	0.6u	0.6u	0.6u	0.6u	Trace	0.6u	0.6u	0.6u	0.6u	0.6u
Indeno(1,2,3-cd)Pyrene	0.7u	0.7u	0.7u	0.7u	0.7u	0.7u	0.7u	0.7u	0.7u	0.7u
Dibenz(a,h)Anthracene	0.9u	0.9u	0.9u	0.9u	0.9u	0.9u	0.9u	0.9u	0.9u	0.9u
Benzo(ghi)Perylene	0.8u	0.8u	0.8u	0.8u	0.8u	0.8u	0.8u	0.8u	0.8u	0.8u
Chlorinated Aromatic Hydrocarbons										
1,3-Dichlorobenzene	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
1,4-Dichlorobenzene	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
*1,2-Dichlorobenzene	1.0u	0.6j	0.8j	0.7j	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
1,2,4-Trichlorobenzene	1.5u	1.5u	1.5u	1.5u	1.5u	1.5u	1.5u	1.5u	1.5u	1.5u
1,2,3-Trichlorobenzene	1.5u	1.5u	1.5u	1.5u	1.5u	1.5u	1.5u	1.5u	1.5u	1.5u
2-Chloronaphthalene	0.7u	0.7u	0.7u	0.7u	0.7u	0.7u	0.7u	0.7u	0.7u	0.7u
Hexachlorobenzene	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u
Chlorinated Aliphatic Hydrocarbons										
Hexachloroethane	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u
Hexachlorobutadiene	2.5u	2.5u	2.5u	2.5u	2.5u	2.5u	2.5u	2.5u	2.5u	2.5u
Hexachlorocyclopentadiene	2.6u	2.6u	2.6u	2.6u	2.6u	2.6u	2.6u	2.6u	2.6u	2.6u
bis(2-Chloroethyl)Ether	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
bis(2-chloroisopropyl)Ether	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u
bis(2-Chloroethoxy)Methane	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
4-Chlorophenyl-phenylether	1.2u	1.2u	1.2u	1.2u	1.2u	1.2u	1.2u	1.2u	1.2u	1.2u
4-Bromophenyl-phenylether	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u
Phthalates										
Dimethyl Phthalate	0.6u	0.5u	0.5u	0.5u	0.5u	0.5u	0.5u	0.9	0.5u	0.5u
Diethylphthalate	0.7u	0.7u	0.7u	0.7u	0.7u	0.7u	0.7u	0.7u	0.7u	0.7u
Di-n-Butylphthalate	1.7	0.4u	0.4u	0.4u	1.6	1.7	1.3	2.1	0.4u	0.4u
Butylbenzylphthalate	0.5u	0.5u	0.5u	0.7u	0.5u	0.5u	0.5u	0.5u	0.5u	0.5u
bis(2-Ethylhexyl)Phthalate	1.6	1.0	1.7	0.8	0.3j	1.5	0.9	1.2	0.5u	0.5u
Di-n-Octyl Phthalate	0.4u	0.4u	0.4u	0.4u	0.4u	0.4u	0.4u	0.4u	0.4u	0.4u
Miscellaneous Oxygenated Compounds										
Isophorone	0.6u	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6u
Benzyl Alcohol	2.0u	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0u
Benzoic Acid	2.0u	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0u
Dibenzofuran	1.4u	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5u

Appendix II. Continued.

Station Description	Cascade Drywall S.D.	Wheeler Osgood S.D.	Wheeler Osgood S.D.	Wheeler Osgood S.D.	#1 Seep E. Wattles Bldg.	East Wattles Drain	#2 Seep Wood Bulkhead	Western Steel Fabricators	Transport Blank	Transfer Blank
Station Number	3	5	5 (Dup)	5 (Trip)	6	7	9	11		
Sample Number	46-8252	46-8254	46-8255	46-8256	46-8263	46-8257	46-8264	46-8260	46-8261	46-8262
Organonitrogen Compounds										
Nitrobenzene	1.8u	1.8u	1.8u	1.8u	1.8u	1.8u	1.8u	1.8u	1.8u	1.8u
N-Nitroso-Di-n-Propylamine	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u
4-Chloroaniline	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u
2-Nitroaniline	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u
3-Nitroaniline	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u
4-Nitroaniline	4.0u	4.0u	4.0u	4.0u	4.0u	4.0u	4.0u	4.0u	4.0u	4.0u
2,6-Dinitrotoluene	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	1.6u	1.6u
2,4-Dinitrotoluene	1.6u	1.6u	1.6u	1.6u	1.6u	1.6u	1.6u	1.6u	2.0u	2.0u
Diphenylamine	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u
N-Nitrosodiphenylamine(1)	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u
1,2-Diphenylhydrazine	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u
Benzidine	10.0u	10.0u	10.0u	10.0u	10.0u	10.0u	10.0u	10.0u	10.0u	10.0u
3,3'-Dichlorobenzidine	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u
Carbazole	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u

Trace = Not quantifiable
a = Sample not analyzed for this parameter
b = Pentachlorophenol may be underestimated, based on low isotope recovery
j = Estimated value, below method detection limits
u = Not detected at detection limits shown
* = Object of present source investigation
Underscore indicates organic compounds detected