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MEMORANDUM
December 13, 1984

To: Jim Krull

From: Art Johnson and Dale Norton, Water Quality Investigations Section

Subject: Completion Report on WQIS Project 5 (Part 1) for the Commencement Bay Nearshore/Tideflats Remedial Investigation: Priority Pollutants and Other Contaminants in City Waterway Storm Drains, September-November 1983

ABSTRACT

Twenty-two samples of discharge collected from ten storm drains to City Waterway between September and November of 1983 were analyzed for EPA priority pollutants/hazardous substances. Twenty organic priority pollutants and three compounds on the hazardous substances list were detected. The most frequently detected organic compounds were chloroform and toluene, which were detected in 41 percent and 32 percent, respectively, of the samples collected. The remaining compounds, primarily phthalates, chlorinated ethylenes and ethanes, polyaromatic hydrocarbons, and pesticides were detected only once or twice.

Concentrations of organics and metals were low and generally within FPA receiving water criteria for protection of marine life. Maximum loads to the waterway were calculated to be 0.37 pound/day of organics and 1.5 pounds/day of metals. The pollutant input detected in storm drain discharges during this survey did not appear sufficient to bring about the level of sediment contamination currently existing in City Waterway.

INTRODUCTION

The Water Quality Investigations Section (WQIS) had responsibility for five projects† in the Commencement Bay Nearshore/Tideflats Remedial Investigation. Project 5 involved investigating sources of contaminants to City Waterway. This memorandum reports the results of dry- and wet-weather sampling of the ten major storm drains to the waterway--one part of the Project 5 effort.

†WQIS projects:
- No. 1 - Assessment of Log Sort Yards as Metals Sources to Commencement Bay Waterways
- No. 2 - Metals in Hylebos Creek Drainage
- No. 3 - Point Source Monitoring
- No. 4 - Source Evaluation for Metals in Sitcum Waterway Sediments
- No. 5.1 - Priority Pollutants - City Waterway Storm Drains
- No. 5.2 - Metals in City Waterway Sediments
- No. 5.3 - Petroleum Compounds in D Street Groundwater and Adjacent City Waterway Sediment

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The objective of the storm drain survey was to measure flow and contaminant concentrations (primarily the EPA priority pollutants) in this runoff in order to determine if any of the drains were active sources of the toxicants known to be present at elevated levels in City Waterway sediments. These data were also needed in the overall source assessment for the Commencement Bay project, and have been entered in the project data base maintained by Tetra Tech, Inc., Bellevue.

METHODS

Sampling and Analysis

The approximate locations of the ten storm drains monitored are shown in Figure 1. Photographs and physical descriptions for each drain are at the end of the report.

Two sets of water samples and flow measurements were taken at each drain--the first during dry weather September 6-7, 1983, and the second during wet weather November 21-22, 1983. Additional samples were taken September 19 and October 26, 1983, from the west 96-inch drain at the head of the waterway (serving Nalley Valley) as part of another Commencement Bay project.

All samples were manual composites of three or four grabs of one quart each taken over the sampling period indicated, usually two to three hours. Sampling was done during minus tides to gain access to certain of the drains and minimize saltwater influence.

Organic priority pollutant samples were collected in one-gallon glass jars which had teflon-lined lids. After compositing was completed, two 40 mL septum-capped glass vials were filled from each gallon jar for volatiles analyses. Organics containers were cleaned with sequential rinses of detergent, HCl, HNO_3, distilled water, nanograde acetone, and nanograde methylene chloride, then dried at 350°F for twenty-four hours.

Priority pollutant metals samples were collected in new one-gallon polyethylene cubitainers previously rinsed with de-ionized water. Water samples for conventional parameters--pH, specific conductivity, and total suspended solids--were determined on subsamples split out of the metals composites prior to their being acidified to pH <2 with HNO_3.

Flows were measured with a Marsh-McBirney magnetic flow meter and top-setting rod or with bucket and stopwatch.

All samples were kept on ice from the time of collection to analysis. Chain-of-custody procedures were followed.

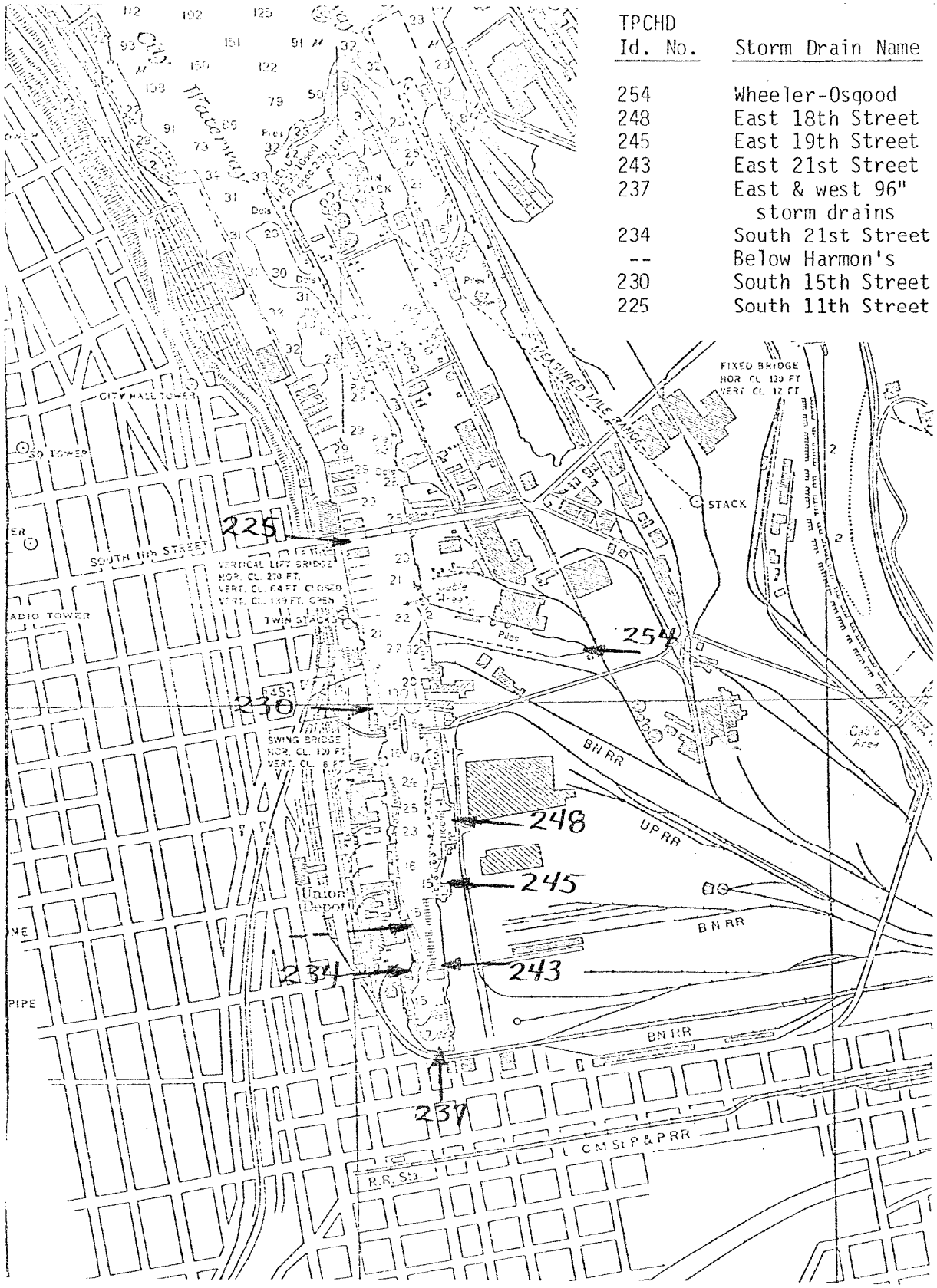

Figure 1. City Waterway storm drains sampled by WDOE September-November 1983. (TPCHD = Tacoma-Pierce County Health Department; drainage map of July 1, 1983.)

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Organic priority pollutant samples were sent to an EPA contract laboratory, Cal Analytical in Sacramento, California, by air freight on the day of collection and extracted within five days. Analysis was by GC/MS according to IFB contract no. WA-83-A093 and by EPA methods 608 and 612 for the polychlorinated butadienes (PCBDs), polychlorinated biphenyls (PCBs), and pesticides. Target compounds included all the EPA priority pollutants (except cyanide), tri- and tetrachlorobutadiene isomers, and the twenty compounds on EPA's "non-priority pollutant hazardous substances" list. Additional compounds were tentatively identified by computer match for twenty of the largest remaining peaks in each sample.

Metals samples were acidified at the WDOE Tumwater, Washington, laboratory within twenty-four hours of collection and transported to the EPA/WDOE laboratory in Manchester, Washington, for analysis. These samples were analyzed by atomic adsorption spectrometry following EPA (1979) Methods for Chemical Analysis of Water and Wastes. Mercury was done by the cold vapor method.

The WDOE Tumwater laboratory did the conventional analyses. pH was measured with a Corning "pH/ion meter 135." Specific conductivity was determined on a Beckman "Conductivity Bridge." Total suspended solids analysis employed Method 160.2 in the above EPA manual.

Quality Assurance

These surveys were done in accordance with a quality assurance program (WDOE, 1983) developed following requirements and guidelines set down in Final QA Program Plan for Commencement Bay Nearshore/Tideflats Investigations (Tetra Tech, 1983).

QA review of the organics data was done by James Farr of Ecology and Environment, Inc., Seattle, Washington, who made corrections for concentrations of compounds found in laboratory blanks. Internal standards and surrogate/matrix spikes were determined to be within EPA-accepted limits in all cases except for low recoveries in the pesticide fraction. Appendices I - V contain the complete data set as received from the reviewer, and show all compounds included in the analysis and their respective detection limits.

Field blanks, transport blanks, and duplicates were analyzed for each field collection. These data are in the above-mentioned appendices. Bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, heptachlor, endrin, benzoic acid, and several tentatively identified compounds were detected in both storm drain samples and blanks for some surveys. Except for benzoic acid, blank concentrations were 24 to 190 percent of corresponding sample concentrations for these compounds and, therefore, are reported in the text as "detected but also detected in blank" rather than quantified. Benzoic acid was detected

in one storm drain sample at 110 ug/L, while the field blank for that survey had 9.2 ug/L. Benzoic acid is reported in the text as quantified in the sample with a note indicating the concentration measured in the corresponding blank. Methylene chloride and acetone were detected in one drain sample each, but are not reported in the text because these solvents were used to clean the sample containers. Analyses of three pairs of duplicate samples, prepared in the field, were in good agreement except for phthalates which were detected in one sample only of one duplicate pair. The average difference between values in duplicates was 0.3 ± 0.2 ug/L for volatiles (six compounds) and 0.6 ug/L for polyaromatic hydrocarbons (two compounds)--the only compounds other than phthalates detected in duplicate samples.

The EPA Manchester labaoratory achieved ± 3 percent accuracy on EPA performance evaluation metals samples (EMSL, Cincinnati, Ohio) run as internal standards and spike recoveries of 85 to 110 percent (Arp, 1984). Laboratory blanks analyzed separately from field samples as a check against metals contamination arising from sample containers, HNO_3 preservative, or analytical procedures consistently had metals concentrations at or below the limits of detection. Field blanks were also below detection limits except for the dry-weather survey of September 6-7 which had elevated copper, zinc, and lead (Appendix VI). Since blank concentrations were substantial (i.e., >20 percent) relative to concentrations measured in the majority of storm drain samples (all copper, 60 percent of zinc, and 90 percent of lead concentrations), data for these metals are not reported for the dry-weather survey. The average relative range of two pairs of duplicates split in the field for metals analysis was: copper - 11 ug/L; zinc - 8 ug/L; chromium - 0.5 ug/L; cadmium - 0.1 ug/L; lead - 2 ug/L; and arsenic - 19 ug/L. Nickel, mercury, and antimony were not detected in the duplicates; selenium, silver, beryllium , and thallium were not run in duplicate.

RESULTS

The results of City Waterway storm drain sample analyses and flow measurement are summarized in Table 1 and discussed below.

Flow

Flow in individual storm drains ranged from 0.01 to 3.6 MGD. The pair of 96-inch storm drains at the head of the waterway were contributing about 85 percent of the runoff during both sampling periods.

In spite of the large difference in rainfall preceeding the dry- and wet-weather collections, as illustrated in Table 2, a few drains, including the 96-inch storm drains, had similar flows during both surveys. As a result, combined flow to the waterway was 7.0 MGD and 7.6 MGD, respectively, for the dry and wet collections. This is partly because of a short delay in sampling

Table 1. Concentrations of priority pollutants measured[a] in City Waterway storm drain samples collected by WDOE September, October, and November 1983 (ug/L).

Drain	Wheeler-Osgood			East 18th Street		East 19th Street		East 21st Street		East 96" Drain	
TPCHD Identification No.[b]	254			248		245		243		237	
Date Sampled	9/06	11/07-08	11/07-08	9/07	11/21-22	9/07	11/21-22	9/07	11/21-22	9/07	11/21-22
Time Sampled	1045-1315	2310-0135	2310-0135 (duplicate)	1125-1345	2330-0120	1115-1355	2335-0130	1107-1255	2220-0045	1055-1420	2225-0135
Flow (MGD)	0.15	0.23		0.01	0.03	0.05	0.09	0.21	0.52	2.7	2.8
pH (S.U.)	N/A	7.1	N/A	N/A	7.8	N/A	7.4	N/A	6.9	N/A	7.4
Sp. Conductivity (umhos/cm)	8,870	7,000		19,000	16,800	25,600	20,400	22,100	17,100	257	242
Total Susp. Solids (mg/L)	4	6		<1	<1	8	7	3	4	1	<1
Volatiles (ug/L)											
chloroform	1u	/1.0m/	/1.0m/	1u	1u	1u	1u	/5m/	/5.2/	1u	1u
dichlorobromomethane	1u	1u	1u	1u	1u	1u	1u	1u	1u	1u	1u
chloroethane	1u	1u	1u	1u	1u	1u	1u	1u	1u	1u	1u
1,1-dichloroethane	1u	1u	1u	1u	1u	1u	1u	1u	1u	1u	1u
1,2-trans-dichloroethylene	1u	1u	1u	1u	1u	1u	1u	1u	1u	1u	1u
1,1,1-trichloroethane	1u	1u	1u	1u	1u	1u	1u	1u	1u	1u	1u
trichloroethylene	1u	1u	1u	1u	1u	1u	1u	1u	1u	1u	1u
benzene	1u	1u	1u	1u	1u	1u	1u	1u	1u	1u	1u
toluene	1u	/1.0m/	1u	1u	/1.1m/	1u	/2.0m/	1u	/3.7m/	1u	1u
Base/Neutrals (ug/L)											
naphthalene	1.0u	/4.0m/	/3.0m/	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
phenanthrene	0.1u	/0.5/	/0.4m/	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	/0.4m/	0.1u
fluoranthene	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u
pyrene	0.1u	0.1u	0.1u	0.1u	0.1u	/0.2m/	0.1u	0.1u	0.1u	0.1u	0.1u
benzo(g,h,i)perylene	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u
di-n-butylphthalate	1.0u	/14/	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
bis(2-ethylhexyl)phthalate	1.0u	/18/	1.0u	1.0u	/7.4m/	1.0u	/4.6m/	1.0u†	/6.4/	1.0u	1.0u
Pesticides (ug/L)											
endrin	0.05u	0.05u†	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u
heptachlor	0.05u	0.05u	0.05u	0.05u†	0.05u	0.05u†	/0.05m/	0.05u†	/0.05m/	0.05u†	0.05u
alpha-BHC	/0.06m/	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u
beta-BHC	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u
gamma-BHC	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	/0.05m/	0.05u
Metals (ug/L)											
copper		12	31		10		1u		1u		1u
zinc		34	50		35		10		54		5
nickel	2	1u	1u	1u	3	1	2	1u	1u	2	1u
chromium	2	1	1u	1	7	1	7	1	4	1	3
cadmium	0.1	0.1	0.2	0.1	0.1u	1.8	0.1u	0.2	0.1u	0.1	0.1u
lead		26	29		3		2		2		1
mercury	0.06u	0.05	0.05	0.06u	0.055	0.06u	0.055	0.06u	0.055u	0.06u	0.055u
arsenic	3	1u	28	2	1u	3	1u	1	1u	1u	1u
antimony	1u	1u	1u	1u	1u	1u	1u	1u	1u	1u	1u
selenium	N/A	N/A	N/A	N/A	6	N/A	9	N/A	7	N/A	1u
silver	N/A	N/A	N/A	N/A	0.2u	N/A	0.2u	N/A	0.2u	N/A	0.2u
beryllium	N/A	N/A	N/A	N/A	0.5u	N/A	0.5u	N/A	0.5u	N/A	0.5u
thallium	N/A	N/A	N/A	N/A	1	N/A	2	N/A	1	N/A	1u

[a]Appendices I - III show all organic priority pollutants included in these analyses and their respective detection limits. No acid extractables, PCBs, or dioxins were detected.

[b]Tacoma-Pierce County Health Department drainage map, July 1,1983.

N/A = Not analyzed.
u = Not detected at detection limit shown.
m = Detected but below quantification limit shown.
† = Detected but also detected in blank.

Table 1. (priority pollutants concentrations[a] continued).

Drain	West 96" drain (Nalley Valley)					South 21st Street		Below Harmon's	
TPCHD Identification No.[b]			237			234		--	
Date Sampled	9/07	9/07	9/19	10/26	11/21-22	9/07	11/21-22	9/07	11/21-22
Time Sampled	1055-1417	1055-1417 (duplicate)	1025-1310	0325-0445	2225-0135	1046-1409	2235-0050	1040-1230	2225-0005
Flow (MGD)	3.6		2.7	1.9	3.4	0.04	0.03	0.06	0.09
pH (S.U.)	N/A	N/A	N/A	7.4	7.4	N/A	7.5	N/A	7.8
Sp. Conductivity (umhos/cm)	370	N/A	228	272	264	1,310	1,240	35,300	35,000
Total Susp. Solids (mg/L)	2	N/A	<1	<1	<1	1	59	10	3
Volatiles (ug/L)									
chloroform	1u	1u	/2.9m/	/1.4m/	/5.5/	1u	1u	1u	1u
dichlorobromomethane	1u	1u	1u	1u	1u	1u	1u	1u	1u
chloroethane	1u	1u	1u	1u	1u	1u	1u	/4m/	/5.3/
1,1-dichloroethane	1u	1u	1u	1u	1u	1u	1u	/30/	/26/
1,2-trans-dichloroethylene	1u	1u	1u	1u	1u	1u	1u	/3m/	/2.2m/
1,1,1-trichloroethane	1u	1u	1u	1u	1u	1u	1u	/14/	/13/
trichloroethylene	1u	1u	/1m/	1u	1u	1u	1u	1u	1u
benzene	1u	1u	1u	1u	1u	1u	1u	1u	1u
toluene	1u	1u	1u	1u	1u	1u	1u	1u	1u
Base/Neutrals (ug/L)									
naphthalene	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
phenanthrene	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u
fluoranthene	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u
pyrene	0.1u	0.1u	0.1u	0.1u	0.1u	/0.2m/	0.1u	0.1u	0.1u
benzo(g,h,i)perylene	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u
di-n-butylphthalate	/1.2m/	1.0u	1.0u	1.0u†	1.0u	1.0u	1.0u	1.0u	1.0u
bis(2-ethylhexyl)phthalate	1.0u†	1.0u†	1.0u†	1.0u†	1.0u	1.0u†	1.0u	1.0u†	1.0u
Pesticides (ug/L)									
endrin	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u
heptachlor	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u†	0.05u	0.05u†	0.05u
alpha-BHC	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u
beta-BHC	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u
gamma-BHC	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u	0.05u
Metals (ug/L)									
copper		N/A	13	19	1u		34		1u
zinc		N/A	12	8	14		25		9
nickel	1	N/A	3	3	1u	1u	8	1	1u
chromium	1	N/A	1u	1	2	1	9	1	2
cadmium	0.2	N/A	0.1	0.1u	0.1u	0.2	0.1u	0.1	0.1u
lead		N/A	9	16	4		38		1u
mercury	0.06u	N/A	0.06u	0.05u	0.055u	0.06u	0.055u	0.06u	0.055u
arsenic	1u	N/A	1u	12	1u	1	1u	4	1u
antimony	1u	N/A	1u	1u	1u	1u	1u	3	1u
selenium	N/A	N/A	N/A	N/A	1u	N/A	1u	N/A	22
silver	N/A	N/A	N/A	N/A	0.2u	N/A	0.2u	N/A	0.2u
beryllium	N/A	N/A	N/A	N/A	0.5u	N/A	0.5u	N/A	0.5u
thallium	N/A	N/A	N/A	N/A	1u	N/A	1u	N/A	7

[a]Appendices I - III show all organic priority pollutants included in these analyses and their respective detection limits. No acic extractables, PCBs, or dioxins were detected.

[b]Tacoma-Pierce County Health Department drainage map, July 1, 1983.

N/A = Not analyzed.
u = Not detected at detection limit shown.
m = Detected but below quantification limit shown.
† = Detected but also detected in blank.

Table 1. (priority pollutants concentrations[a] cortinued).

Drain	South 15th Street			South 11th Street	
TPCHD Identification No.[b]	230			225	
Date Sampled	9/07	11/21-22	11/21-22	9/07	11/21-22
Time Sampled	1035-1337	2315-0105	2315-0105 (duplicate)	1028-1327	2320-0110
Flow (MGD)	0.16	0.22		0.03	0.07
pH (S.U.)	N/A	7.6	N/A	N/A	7.8
Sp. Conductivity (umhos/cm)	845	1,150	N/A	342	2,460
Total Susp. Solids (mg/L)	20	<1	N/A	1	<1
Volatiles (ug/L)					
chloroform	/6/	/9.3/	/9.1/	/2m/	1u
dichlorobromomethane	1u	/1.0m/	/1.3m/	1u	1u
chloroethane	1u	1u	1u	1u	1u
1,1-dicnloroethane	1u	1u	1u	1u	1u
1,2-trans-dichloroethylene	1u	1u	1u	1u	1u
1,1,1-trichloroethane	1u	1u	1u	1u	1u
trichloroethylene	1u	1u	1u	1u	1u
benzene	1u	/1.9/	/1.5m/	1u	1u
tpluene	/15/	/1.1m/	/1.1m/	1u	/1.5m/
Base/Neutrals (ug/L)					
naphthalene	1.0u	1.0u	1.0u	1.0u	1.0u
phenanthrene	/0.4m/	0.1u	0.1u	0.1u	0.1u
fluoranthene	/0.2m/	0.1u	0.1u	0.1u	0.1u
pyrene	/0.2m/	0.1u	0.1u	0.1u	0.1u
benzo(g,h,i)perylene	/0.2m/	0.1u	0.1u	0.1u	0.1u
di-n-butylphthalate	1.0u	1.0u	1.0u	1.0u	1.0u
bis(2-ethylhexyl)phthalate	1.0ut	1.0u	1.0u	1.0ut	1.0u
Pesticides (ug/L)					
endrin	0.05u	0.05u	0.05u	0.05u	0.05u
heptachlor	0.05u	0.05u	0.05u	0.05u	0.05u
alpha-BHC	0.05u	0.05u	0.05u	0.05u	0.05u
beta-BHC	/0.05m/	0.05u	0.05u	0.05u	0.05u
gamma-BHC	0.05u	0.05u	0.05u	0.05u	0.05u
Metals (ug/L)					
copper		6	8		1u
zinc		38	38		9
nickel	1u	1u	1u	1u	1u
chromium	49	4	4	16	4
cadmium	0.5	0.1u	0.1u	0.1	0.1u
lead		4	5		1
mercury	0.06u	0.055u	0.055u	0.06u	0.055u
arsenic	2	1u	1u	1u	1u
antimony	1u	1u	1u	1u	1u
selenium	N/A	1u	1u	N/A	1u
silver	N/A	0.2u	0.2u	N/A	0.2u
beryllium	N/A	0.5u	0.5u	N/A	0.5u
thallium	N/A	1u	1u	N/A	1u

[a]Appendices I - III show all organic priority pollutants included in these analyses and their respective detection limits. No acid extractables, PCBs, or dioxins were detected.

[b]Thomas-Pierce County Health Department drainage map, July 1, 1983

N/A = Not analyzed.
u = Not detected at detection limit shown.
m = Detected but below quantification limit shown.
t = Detected but also detected in blank.

after the steady rain of November 15-20, but also due to differences in time of collection dictated by tide; the wet-weather samples being taken in the late-evening-to-early-morning hours when human activity is at a minimum.

It should be noted that because the wet-weather collection was done after an extended period of rainfall, it would not have caught the initial flush of particulates and associated contaminants accumulated during dry weather.

Table 2. Rainfall* preceeding WDOE City Waterway storm drain sample collections of September, October, and November 1983 (collection days underlined).

Dry-weather Collection		West 96-inch Storm Drain (Nalley Valley) collection only				Wet-weather Collection	
Date	Rainfall (inches)	Date	Rainfall (inches)	Date	Rainfall (inches)	Date	Rainfall (inches)
8/31	0	9/12	0	10/19	--	11/15	0.46
9/01	0.42	9/13	0	10/20	0.16	11/16	0.33
9/02	0.13	9/14	0	10/21	0.01	11/17	0.31
9/03	0	9/15	Trace	10/22	0.28	11/18	0.38
9/04	0	9/16	0	10/23	--	11/19	0.22
9/05	0	9/17	0	10/24	Trace	11/20	0.30
9/06	0.01	9/18	0.66	10/25	0.01	11/21	0.01
9/07	0	9/19	0	10/26	--	11/22	0.05

*Data provided by Raymond Redding, Tacoma Central STP.

Conventionals

pH ranged from 6.9 to 7.8. Some drains had high specific conductivities due to their depth in the intertidal zone and resulting saltwater influence. Suspended solids concentrations were low in all discharges except one sample from the South 21st Street drain. Heavy equipment was operating upstream when this sample was being collected.

Organic Compounds

Twenty organic priority pollutants, including haloforms, chlorinated ethylenes and ethanes, aromatics, phthalates, and pesticides, were detected. It should be noted that both the phthalates and the pesticide heptachlor, although reported as quantified, were also detected in field and transport blanks for samples collected on other dates. Volatiles were much more abundant than base/neutrals and pesticides. No acid compounds (i.e., phenols and cresols), PCBs, or dioxins were detected.

As shown in Table 3, most compounds were detected only once or twice except chloroform and toluene which were routinely detectable.

Table 3. Detection frequency[a] of organic priority pollutants in City Waterway storm drain samples collected by WDOE September, October, and November, 1983.

chloroform	41%	(9 of 22)
toluene	32%	(7 of 22)
bis(2-ethylhexyl) phthalate	18%	(4 of 22)
phenanthrene	14%	(3 of 22)
pyrene	14%	(3 of 22)
1,1,1-trichloroethane	9%	(2 of 22)
1,1-dichloroethane	9%	(2 of 22)
chloroethane	9%	(2 of 22)
1,2-trans-dichloroethylene	9%	(2 of 22)
di-n-butyl phthalate	9%	(2 of 22)
heptachlor	9%	(2 of 22)
benzene	5%	(1 of 22)
dichlorobromomethane	5%	(1 of 22)
trichloroethylene	5%	(1 of 22)
fluoranthene	5%	(1 of 22)
naphthalene	5%	(1 of 22)
benzo(g,h,i)perylene	5%	(1 of 22)
alpha-BHC	5%	(1 of 22)
beta-BHC	5%	(1 of 22)
gamma-BHC	5%	(1 of 22)

[a]Percent of samples (22 total) in which compound was detected.

The majority of compounds were present in concentrations at or below the limits of quantification (5 ug/L or less depending on the compound in question). The maximum concentration measured for an individual compound was 30 ug/L of 1,1-dichloroethane. Heptachlor was detected at <0.05 ug/L once each in two drains which, given the detection limit for this compound, would exceed EPA's 24-hour average receiving water criterion of 0.0038 ug/L for protection of marine life, but meets the 0.053 ug/L "not to exceed at any time" criterion (EPA 1980). All other compounds were well within EPA criteria without further dilution in the receiving waters.

The South 15th Street and Wheeler-Osgood discharges contained the widest variety of compounds. A suite of four chlorinated solvents--chloroethane, 1,1-dichloroethane, 1,2-trans-dichloroethylene, and 1,1,1-trichloroethane-- was detected at similar concentrations in both samples from the drain below Harmons, suggesting that this drain may be a chronic source of these compounds. 1,1-dichloroethane and 1,1,1-trichloroethane were measured at 14 to 30 ug/L here, high concentrations relative to compounds found in the other drains. These solvents were not identified in other discharges.

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Three drains contained compounds on EPA's list of hazardous substances, as noted in Table 4. Benzoic acid and 4-methyl-2-pentanone were present at higher concentrations than the organic priority pollutants discussed above. Low concentrations of xylene in each of the South 15th Street samples are consistent with the co-detection of toluene noted above.

Table 4. EPA "non-priority pollutant hazardous substances" compounds found in City Waterway storm drain samples collected by WDOE September, October, and November 1983 (ug/L).

Drain	Date	Compound Name	Concentration
Wheeler-Osgood	11/07-08	benzoic acid	38
W. 96" drain (Nalley Valley)	10/26	" "	110*
S. 15th Street	9/07	4-methyl-2-pentanone	34
" " "	"	xylenes	3m
" " "	11/21-22	"	2.9m
" " "	" (dup.)	"	2.6m

* = Also detected at 9.2 ug/L in field blank for this date.
m = Detected but below limit of quantification shown.

The concentrations measured for these compounds are below known toxicity thresholds (Lewis, 1982). Benzoic acid (benzene carboxylic acid) is used in plasticizers, antifungal agents, and as a food preservative. No data were found on aquatic toxicity, but the rat oral LC_{50} is 9750 mg/Kg. 4-methyl-pentanone (methylisobutylketone) a paint solvent and denaturant for alcohol, has an aquatic toxicity of 1000 ppm. Xylene has an aquatic toxicity of 100 - 10 ppm.

An additional eight organic compounds, excluding those also identified in blanks, were tentatively identified at concentrations estimated to range from 5 to 47 ug/L, as shown in Table 5.

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Table 5. Compounds tentatively identified in City Waterway storm drain samples collected by WDOE September, October, and November, 1983.

Drain	Date	Compound Name	CAS* No.	Estimated Concentration (ug/L)
Wheeler-Osgood	11/07-08	2-chloro-trans-cyclohexanol	6628-80-4	†
East 18th Street	11/21-22	2-methylpropanoic acid	97-85-8	12
East 19th Street	9/07	2,7-diethylbenzo(B)thiophene	16587-45-4	5.0
East 21st Street	9/07	1,1-dichloro-2,2-cyclopropane	694-16-6	7.0
East 96" Drain	11/21-22	2-butoxyethanol	111-76-2	47
" " "	"	4-hydroxy-4 methyl-2-pentanone	123-42-2	†
West 96" Drain (Nalley Valley)	9/07	1,3,5-cycloheptatriene	544-25-2	20
" " " " "	9/19	"	"	7.0
" " " " "	"	1,1-dichloro-2,2-cyclopropane	694-16-6	†
" " " " "	10/26	N-propylbenzamide	10546-70-0	17
" " " " "	11/21-22	2-methylpropylester-propanoic acid	540-42-1	19
" " " " "	"	4-hydroxy-4-methyl-2-pentanone	123-42-2	†
South 21st Street	11/21-22	"	"	†
" " "	"	2-methylpropylester-propanoic acid	540-42-1	30
Below Harmon's	9/07	1,1-dichloro-2,2-cyclopropane	694-16-6	5.0
" "	11/21-22	4-hydroxy-4-methyl-2-pentanone	123-42-2	†
" "	"	2-methyl-2,3-dichlorobutane	507-45-9	†
" "	"	cyclohexanone	108-94-1	†
" "	"	4-butoxy-1-butene	34061-76-2	†
South 15th Street	9/07	1,1-dichloro-2,2-cyclopropane	694-16-6	6.0
" " "	"	heptadecane	629-78-7	5.0
" " "	11/21-22	4-hydroxy-4-methyl-2-pentanone	123-42-2	†
" " "	"	2-methylpropylester-propanoic acid	540-42-1	14†
" " "	"	cyclohexanone	108-94-1	†
South 11th Street	9/07	1,1-dichloro-2,2-cyclopropane	694-16-6	7.0
" " "	11/21-22	dipropanoate-1,2-ethanediol	123-30-8	20
" " "	"	4-hydroxy-4-methyl-2-pentanone	123-42-2	†
" " "	"	cyclohexanone	108-94-1	†

*Chemical Abstracts Registry.
†Detected but also detected in blank.

The following information was found on these chemicals in standard reference works (Hawley, 1981; Lewis and Tatken, 1982; Windholz, et al., 1983): 2-methylpropionic acid (isobutyric acid) uses include manufacture of solvents, disinfectants, varnish, and tanning agents. It is a strong irritant and has a rat oral LD_{50} of 1280 mg/Kg. Benzothiophenes are sulfur containing polyaromatic hydrocarbons. 2-butoxyethanol (ethylene glycol monobutylether) is found in enamels, lacquers, dry cleaning compounds, and soaps. It has an aquatic toxicity of 1000 - 100 ppm. The rat oral LD_{50} for 1,2,5-cycloheptatrine (tropilidene) is 57 mg/Kg. 2-methylproplyester propionic acid (propionic acid, isobutyl ether) has a rat oral LD_{50} of 5599 mg/Kg. Heptadecane is a 17-carbon paraffin. No information was found on 1,1-dichloro-2,2-cyclopropane or dipropanoate-1,2-ethanediol.

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Metals

The storm drain discharges had low metals concentrations, being within levels considered protective of marine life in most cases. Some drains had copper and lead concentrations above the EPA saltwater chronic exposure criteria of 4 ug/L copper and 25 ug/L lead Two- to four-fold dilution would bring the higher of these concentrations within the EPA criteria, except for copper in the South 21st Street drain where eight-fold dilution would be required. The dry-weather data for copper, lead, and zinc, although deleted because of elevated field blanks, were within a range of concentrations similar to that reported for the wet-weather collection.

DISCUSSION

Historical Data on City Waterway Drains

WDOE data from 1981 and 1982 are available on priority pollutants and conventional water quality parameters in four of the City Waterway storm drains --Wheeler-Osgood, east and west 96-inch drains, and South 15th Street. These data are summarized in Table 6,and show a range of organic and metallic pollutant types and concentrations generally similar to findings from the present survey; an exception being that no pesticides were detected. Detection limits for volatiles, base/neutrals, and acid extractables in some of the older data are higher than those employed in this survey.

The historical data on conventionals show wet-weather flows and suspended solids concentrations can be much greater than was observed in the present survey. Also noteworthy are the high COD concentrations in the Wheeler-Osgood and South 15th Street drains, and the high nutrient concentrations common to all four drains. Cross-connections of domestic sewage lines with the west 96-inch storm drain, known to exist at that time, are the probable cause of high fecal coliform counts. No bacteria samples were taken in the 1983 surveys, but the odor and color of this discharge suggest that sewage was present.

Pollutant Loads to City Waterway and Comparison with Sediment Contaminants

Loads of priority pollutant organics and metals were calculated in pounds per day using data from the September-November 1983 survey, and are presented in Table 7. These data should be used with caution because of the very low concentrations and detection frequencies of most constituents and the limited number of samples and flow measurements taken at each drain. Where a compound was present in concentrations too low to measure, the quantification limit for that compound was used in the load calculation and the value flagged.

Table 6. WDOE historical water quality data on City Waterway storm drains.

Drain	Wheeler-Osgood		East 96" Drain		West 96" Drain (Nalley Valley)		S. 15th St.
TPCHD Identification Number[a]	254		237		237		230
Date Sampled	7/28/81	3/29/82	7/28/81	2/16/82	7/28/81	2/16/82	4/28/82
Time Sampled	0830 - 1200	1300 - 1530	0850 - 1115	1420 - 1800	0850 - 1115	1435 - 1800	1300 - 1445
Flow (MGD)	0.13	0.62	2.6	11.0	1.5	10.7	0.14
pH (S.U.)	7.3	7.1	7.4	7.5	7.4	7.2	5.0
Turbidity (NTU)	7	12	2	68	3	160	210
Sp. Conductivity (umhos/cm)	10,780	6,840	260	128	277	342	2,820
COD (mg/L)	490	170	4	33	18	4	190
F. Coli.[b] (col/100 mL)	140-240	250-560	8* - 15*	360-840	>240->600	1,800-14,000*	<1-900*
NO_3-N (mg/L)	0.65	0.44	2.9	1.1	1.0	0.55	0.85
NO_2-N (mg/L)	0.02	0.01	<0.01	0.01	0.02	0.01	<0.05
NH_3-N (mg/L)	0.56	0.43	0.02	0.10	0.23	0.18	0.45
O-PO_4-P (mg/L)	0.59	N/A	0.05	0.10	0.11	0.12	N/A
T-PO4-p (mg/L)	0.64	0.26	0.05	0.11	0.19	0.20	0.05
Total Solids (mg/L)	8,200	4,600	210	180	200	480	1,900
Total Non-Vol. Solids (mg/L)	6,700	4,000	160	110	140	380	1,500
Total Susp. Solids (mg/L)	6	17	<1	74	5	320	280
Total Non-Vol. Susp. Solids (mg/L)	3	7	<1	59	<1	260	210
Recoverable Oil & Grease (mg/L)	6	8	4	<1	4	2	<1
Recoverable Phenolics as Phenol (mg/L)	0.038	N/A	0.021	0.003	0.016	0.004	N/A
Volatiles[c] (ug/L)							
chloroform	1u	10u	1u	10u	/4.5/	10u	/10m/
trichloroethylene	1u	10u	/1m/	10u	/1m/	10u	10u
tetrachloroethylene	1u	10u	1u	10u	/1m/	10u	10u
toluene	1u	10u	1u	10u	/1/	10u	10u
Base/Neutrals[c] (ug/L)							
naphthalene	10u	10u	10u	10u	/0.4/	10u	/10m/
anthracene/phenanthrene	10u	/15/	10u	10u	10u	10u	10u
butylbenzyl phthalate	10u	10u	10u	10u	/6.1/	10u	10u
Acid Extractables[c] (ug/L)							
phenol	10u	10u	10u	10u	10u	10u	/10m/
Miscellaneous (ug/L)							
cyanide	N/A	/5/	N/A	/<5/	N/A	/5/	/5/
Metals[d] (ug/L)							
copper	40	10	1u	50	6	60	420
zinc	140	80	12	80	34	180	370
nickel	24	20u	1u	5u	1u	9	20u
chromium	4	10u	2u	20u	2u	20u	20
cadmium	0.6	2u	10u	5u	10	5u	6
lead	75	80	100u	59	100u	360	650
mercury	0.24	0.20u	0.20u	0.20u	0.20u	0.20u	0.39
arsenic	20	18	1u	25	1u	16	150

[a]Tacoma-Pierce County Health Department drainage map, July 1, 1983.

[b]Range of three samples.

[c]Analyses included all EPA priority pollutants; only detected compounds shown. Pesticides, PCBs, and dioxins were not detected.

[d]No blank data available for these samples.

* = Estimated.
N/A = Not analyzed.
u = Not detected at detection limit shown.
m = Detected but below quantification limit shown.

Table 7. Priority pollutant loads from City Waterway storm drains based on WDOE data collected September, October, and November 1983 (pounds/day).

Drain	Wheeler-Osgood		E. 18th Street		E. 19th Street		E. 21st Street		E. 96" Drain		W. 96" Drain			
Date	9/06	11/07-08	9/07	1.721-22	9/07	11/21-22	9/07	11/21-22	9/07	11/21-22	9/07	9/19	10/26	11/21-22
Total Susp. Solids	5	11	--	--	3.3	5.3	5.3	17	23	--	60	--	--	--
Volatiles														
chloroform	--	.002*	--	--	--	--	.009*	.023	--	--	--	.062*	.022*	.16
dichlorobromomethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total haloforms		.002*					.009*	.023				.062*	.022*	.16
chloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,1-dichloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2-trans-dichloroethylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1,1,1-trichloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--
trichloroethylene	--	--	--	--	--	--	--	--	--	--	--	.02*	--	--
Total chlorinated aliphatics												.02*		
benzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--
toluene	--	.002*	--	.0003*	--	.001*	--	.016*	--	--	--	--	--	--
Total aromatics		.002*		.0003*		.001*		.016*						
Base/Neutrals														
naphthalene	--	.008*	--	--	--	--	--	--	--	--	--	--		--
phenanthrene	--	.001	--	--	--	--	--	--	.009*	--	--	--	--	--
fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pyrene	--	--	--	--	.00008*	--	--	--	--	--	--	--	--	--
benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total polyaromatics		.009*			.00008*				.009*					
di-n-butylphthalate	--	.026	--	--	--	--	--	--	--	--	.036*	--	--	--
bis(2-ethylhexyl)phthalate	--	.035	--	.002*	--	.003*	--	.028	--	--	--	--	--	--
Total phthalates		.061		.002*		.003*		.028			.036*			
Pesticides														
heptachlor	--	--	--	--	--	.00004*	--	.0002*	--	--	--	--	--	--
alpha-BHC	.0001*	--	--	--	--	--	--	--	--	--	--	--	--	--
beta-BHC	--	--	--	--	--	--	--	--	--	--	--	--	--	--
gamma-BHC	--	--	--	--	--	--	--	--	.001*	--	--	--	--	--
Total pesticides	.0001*					.00004*		.0002*	.001*					
Metals														
copper		.041		.003		--		--		--		.28	.30	--
zinc		.081	.003	.009		.007		.23		.1		.26	.13	.40
nickel	.003	--	--	.0007	.0004	.001	--	--	.05	--	.03	.07	.05	--
chromium	.003	.001	.00008	.002	.0004	.005	.002	.02	.02	.07	.03	--	.02	.06
cadmium	.0001	.0003	.00001	--	.0007	--	.0003	--	.002	--	.006	.002	--	--
lead		.053	.0008	.0007		.001		.009		.02		.19	.25	.1
mercury	--	.00001	--	.00001	--	.00004	--	--	--	--	--	--	--	--
arsenic	.004	.027	.0002	--	.001	--	.002	--	--	--	--	--	.19	--
antimony	--	--	--	--	--	--	--	--	--	--	--	--	--	--
selenium	N/A	N/A	N/A	.001	N/A	.007	N/A	.03	N/A	--	N/A	N/A	N/A	--
silver	N/A	N/A	N/A	--	N/A	--	N/A	--	N/A	--	N/A	N/A	N/A	--
beryllium	N/A	N/A	N/A	--	N/A	--	N/A	--	N/A	--	N/A	N/A	N/A	--
thallium	N/A	N/A	N/A	.0003	N/A	.001	N/A	.004	N/A	--	N/A	N/A	N/A	--

-- = Not detected.
* = Quantification limit used in load calculation.
N/A = Not analyzed.

Table 7. (priority pollutant loads continued).

Drain	S. 21st Street		Below Harmon's		S. 15th Street		S. 11th Street		Combined Drains	
Date	9/07	11/21-22	9/07	11/21-22	9/07	11/21-22	9/07	11/21-22	9/06-07	11/21-22
Total Susp. Solids	.33	15	5	2.3	27	--	.25	--	129	51
Volatiles										
chloroform	--	--	--	--	.008	.017	.0005*	--	.017*	.20*
dichlorobromomethane	--	--	--	--	--	.002*	--	--	--	.002*
Total haloforms					.008	.019*	.0005*		.017*	.20*
chloroethane	--	--	.002*	.004	--	--	--	--	.002*	.004
1,1-dichloroethane	--	--	.015	.019	--	--	--	--	.015	.019
1,2-trans-dichloroethylene	--	--	.001*	.002*	--	--	--	--	.001*	.002*
1,1,1-trichloroethane	--	--	.007	.010	--	--	--	--	.007	.010
trichloroethylene	--	--	--	--	--	--	--	--	--	--
Total chlorinated aliphatics			.025*	.035*					.025*	.035*
benzene	--	--	--	--	--	.003*	--	--	--	.003*
toluene	--	--	--	--	.020	.002*	--	.0009	.020	.022*
Total aromatics					.020	.005*		.0009	.020	.025*
Base/Neutrals										
naphthalene	--	--	--	--	--	--	--	--	--	.008*
phenanthrene	--	--	--	--	.0005*	--	--	--	.009*	.001
fluoranthene	--	--	--	--	.0003*	--	--	--	.0003*	--
pyrene	.00007*	--	--	--	.0003*	--	--	--	.0005*	--
benzo(g,h,i)perylene	--				.0003*				.0003*	--
Total polyaromatics	.00007*				.001*				.010*	.009*
di-n-butylphthalate	--	--	--	--	--	--	--	--	.036*	.026
bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	--	--	--	.068*
Total phthalates									.036*	.094*
Pesticides										
heptachlor	--	--	--	--	--	--	--	--	--	.0002*
alpha-BHC	--	--	--	--	--	--	--	--	.0001*	--
beta-BHC	--	--	--	--	.00007*	--	--	--	.00007*	--
gamma-BHC	--	--	--	--	--	--	--	--	.001*	--
Total pesticides					.00007*				.001*	.0002*
Metals										
copper		.009		--		.01		--		.063
zinc		.006		.007		.070		.005		.92
nickel	--	.002	.0005	--	--	--	--	--	.084	.004
chromium	.0003	.002	.0005	.001	.065	.007	.004	.002	.083	.17
cadmium	.00007	--	.00005	--	.0007	--	.00003	--	.010	.0003
lead		.009		--		.007		.0006		.20
mercury	--	--	--	--	--	--	--	--	--	.0001
arsenic	.0003	--	.002	--	.003	--	--	--	.013	.027
antimony	--	--	.001	--	--	--	--	--	.001	--
selenium	N/A	--	N/A	.02	N/A	--	N/A	--	N/A	.058
silver	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--
beryllium	N/A	--	N/A	--	N/A	--	N/A	--	N/A	--
thallium	N/A	--	N/A	.005	N/A	--	N/A	--	N/A	.010

-- = Not detected.
* = Quantification limit used in load calculation.
N/A = Not analyzed.

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As shown in the summary of the organics loading data in Table 8, total storm drain loads for individual organic compounds were typically on the order of hundredths of a pound per day or less. The highest load measured was 0.20 pound per day for chloroform during wet weather. The combined loads for all organic priority pollutant compounds detected were 0.11 pound/day and 0.37 pound/day for dry- and wet weather, respectively. Six of the ten drains monitored in the survey accounted for most of the organics loads to the waterway: Wheeler-Osgood, East 21st Street, east and west 96-inch drains, Harmons, and South 15th Street.

Table 8. Summary of organic priority pollutant loads measured by WDOE in City Waterway storm drains, September 6-7 and November 21-22, 1983.

9/06-07 (Dry Weather)			11/21-22 (Wet Weather)		
Compound	Total load (pounds/ day)	Predominant Source†(s)	Compound	Total Load (pounds/ day)	Predominant Source†(s)
di-n-butylphthalate	.036*	W. 96" Drain (Nalley Valley) (100%)	chloroform	.20*	W. 96" Drain (Nalley Valley) (79%)
toluene	.020	S. 15th Street (100%)	bis(2-ethylhexyl)phthalate	.068*	Wheeler-Osgood (50%) E. 21st Street (40%)
chloroform	.017*	E. 21st Street (49%) S. 15th Street (49%)	di-n-butylphthalate	.026	Wheeler-Osgood (100%)
1,1-dichloroethane	.015	Below Harmon's (100%)	toluene	.022*	E. 21st Street (73%)
phenanthrene	.009*	E. 96" Drain (Nalley Valley) (95%)	1,1-dichloroethane	.019	Below Harmon's (100%)
1,1,1-trichloroethane	.007	Below Harmon's (100%)	1,1,1-trichloroethylene	.010	Below Harmon's (100%)
chloroethane	.002*	Below Harmon's (100%)	naphthalene	.008*	Wheeler-Osgood (100%)
1,2-trans-dichloroethylene	.001*	Below Harmon's (100%)	chloroethane	.004	Below Harmon's (100%)
alpha-BHC	.001*	Wheeler-Osgood (100%)	benzene	.003*	S. 15th Street (100%)
gamma-BHC	.001*	E. 96" Drain (100%)	dichlorobromomethane	.002*	S. 15th Street (100%)
pyrene	.0005*	S. 15th Street (59%)	1,2-trans-dichloroethylene	.002*	S. 15th Street (100%)
fluoranthene	.0003*	S. 15th Street (59%)	phenanthrene	.001	Wheeler-Osgood (100%)
benzo(g,h,i)perylene	.0003*	S. 15th Street (59%)	heptachlor	.0002*	E. 21st Street (83%)
beta-BHC	.00007*	S. 15th Street (100%)	all compounds	.37*	
all compounds	.11*				

*Quantification limit used in calculation.
†≥ 20 percent contribution.

The load summary for metals, Table 9, shows that, although metals constituted about an order of magnitude higher loads than the organics, these loads were also not very large; the maximum total load being 0.92 pound of zinc per day. The six drains named above as predominant organics sources were also contributing most of the metals.

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Table 9. Summary of metals loads measured by WDOE in City Waterway storm drains, September 6-7 and November 21-22, 1983.

9/06-07 (dry weather)				11/21-22 (wet weather)			
Metal	Total Load (pounds/day)	Predominant† Source(s)		Metal	Total Load (pounds/day)	Predominant† Source(s)	
nickel	0.084	E. 96" drain	(57%)	zinc	0.92	W. 96" drain (Nalley Valley)	(40%)
		W. 96" drain (Nalley Valley)	(40%)			E. 21st Street	(24%)
chromium	0.083	S. 15th Street	(52%)	lead	0.20	W. 96" drain (Nalley Valley)	(51%)
		W. 96" drain (Nalley Valley)	(24%)			Wheeler-Osgood	(24%)
arsenic	0.013	Wheeler-Osgood	(36%)	chromium	0.17	W. 96" drain (Nalley Valley)	(39%)
cadmium	0.010	W. 96" drain (Nalley Valley)	(61%)			E. 96" drain	(39%)
		E. 96" drain	(20%)	copper	0.063	Wheeler-Osgood	(65%)
antimony	0.001	Below Harmon's	(100%)	selenium	0.058	E. 21st Street	(48%)
						Below Harmon's	(36%)
mercury		not detected		arsenic	0.027	Wheeler-Osgood	(100%)
copper, zinc, lead		data not usable		nickel	0.004	E. 18th Street	(70%)
selenium, silver, beryllium, thallium		not analyzed		thallium	0.010	E. 21st Street	(42%)
						Below Harmon's	(42%)
				cadmium	0.0003	Wheeler-Osgood	(100%)
				mercury	0.0001	Wheeler-Osgood	(57%)
						E. 19th Street	(29%)
				antimony, silver, beryllium		not detected	
				all metals	1.5		

†≥ 20 percent contribution.

The data presently available on contaminants in City Waterway sediments are summarized in Table 10. Sediment contaminants which were also detected in the storm drains are limited to metals, several polyaromatic hydrocarbons, and phthalates. There are no historical sediment data on the EPA "hazardous substances" and compounds tentatively identified in the storm drains during this survey. Because of high vapor pressure, volatiles such as those present in the storm drain discharges are probably rapidly lost from the water column to the atmosphere. Volatiles have not been detected in the three City Waterway sediment samples analyzed for these compounds. The pesticides heptachlor and BHC found in low concentrations in a few runoff samples, have also not been found in sediment. Phenol has been detected only once each in runoff and sediment and is, therefore, probably not a contaminant of concern in City Waterway. None of the twenty-nine water samples so far collected from City Waterway storm drains have contained detectable concentrations of hexachlorobenzene, hexachlorobutadiene, DDT and metabolites, or PCBs, all of which have been reportd to be elevated in sediment from portions of the waterway.

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Table 10. Summary of City Waterway sediment priority pollutant data collected by NOAA, EPA, and WDOE 1979-1981 (mg/Kg, dry weight).

	Intertidal Sediments (n = 2)		Subtidal Sediments (n = 7)		
	Minimum	Maximum	Minimum	Maximum	Median
Metals					
*Arsenic	36	46	18	63	37
*Cadmium	2.0	3.8	0.28	10.7	4.4
*Chromium	33	34	13.2	59	35
*Copper	220	320	38	280	190
*Mercury	0.21	0.35	0.34	1.03	0.80
*Nickel	36	36	32	33.3	33
*Lead	290	600	25	820	225
*Zinc	270	620	60	740	267
Volatiles	--	--	--	(one sample)	I
Base/Neutrals					
hexachlorobenzene	--	--	--	0.057	(0.003)
hexachlorobutadiene	--	--	--	0.236	(0.0045)
*naphthalene	--	T	--	4.0	0.58
acenaphthene	--	T	0.1	0.71	0.35
acenaphthalene	--	T	--	0.31	(0.2)
*anthracene/phenanthrene	0.63	2.8	0.192	7.0	1.3
fluorene	--	T	T	0.81	0.24
*pyrene	T	4.0	<0.57	10	(2.8)
chrysene/benzo(a)anthracene	--	2.5	0.347	8.5	2.3
*fluoranthene	0.61	4.2	1.2	6.1	3.0
benzo(a)pyrene	--	2.5	0.65	2.6	1.9
benzo(k)fluoranthene/ 3,4-benzofluoranthene	--	2.1	3.0	6.6	1.3
*benzo(g,h,i)perylene	--	T	--	--	I
ideno(1,2,3-cd)pyrene	--	T	--	1.3	(0.35)
dimethyl phthalate	--	--	--	0.063	--
diethyl phthalate	--	--	--	0.085	--
*di-n-butyl phthalate	--	--	T	0.357	0.15
di-n-octyl phthalate	--	--	0.357	1.7	1.3
*bis(2-ethylhexyl) phthalate	3.4	4.9	0.372	25.9	8.4
*butylbenzl phthalate	--	--	0.155	2.3	0.82
Acid Extractables					
*phenol	--	T	--	--	I
Pesticides					
4,4'-DDD	--	--	--	0.030	(0.025)
4,4'-DDE	--	--	--	0.0077	(0.005)
4,4'-DDT	--	--	--	0.020	(0.01)
PCBs					
PCB-1254	--	--	--	T	--
PCB-1260	--	0.15	--	--	--
Total PCBs	--	0.15	T	0.647	0.22

*Also detected in storm drain discharges.

T = Trace amount I = Insufficient data -- = None detected
( ) = Estimated median

Source: Johnson, A., B. Yake, and D. Norton, 1984. A Summary of Priority Pollutant Data for Point Sources and Sediment in Inner Commencement Bay. WDOE.

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The concentrations of metals, polyaromatic hydrocarbons, and phthalates that have been measured in the storm drains are on the order of parts per million when normalized to suspended solids content. The storm drain discharge observed for these compounds would be sufficient to bring about the level of sediment contamination now existing in City Waterway if the contaminants were associated with particulates, most of which settled out in the waterway without significant dilution from other sources of sediment.

Incoming marine water during flood tide, and bank erosion are probably the other major sediment sources to City Waterway. There are no data on erosion as a source of sediment, but the suspended solids load to the waterway over one full tidal cycle was estimated* to be 2500 pounds/day. Total storm drain loads were measured at 51 pounds/day and 129 pounds/day, insignificant compared to advection. The potential remains that storm drain discharge is (or has been) an important route of sediment contamination as a result of spills or during runoff conditions not covered during this survey.

SUMMARY AND RECOMMENDATIONS

The major findings of WDOE's September-November 1983 City Wateway storm drain survey are as follows:

1. The twin 96-inch drains at the head of the waterway were contributing about 85 percent of the storm drain runoff.

2. The storm drain discharges did not contain high concentrations of organic chemicals or metals during the periods surveyed.

3. The drain below Harmon's appeared to be a chronic low-level source of four chlorinated solvents.

4. Historical data and field observations during the present survey suggested sewage is present in the west 96-inch storm drain.

5. The combined loads of organic priority pollutants to the waterway were calculated to be 0.11 pound/day and 0.37 pound/day for the dry- and wet-weather collections, respectively. A metals load of 1.5 pounds/day was measured during wet weather.

*200 ft (width) x 2500 ft (length) x 8.1 ft (mean tide range) x 2 (cycles/day) x 28.3L/ft^3 x 5 mg/L (TSS) x (2.2×10^{-6}) mg/lb = 2,500 lbs/day (TSS concentration based on data in Riley (1980) and Dames & Moore (1981).

Appendix II. (base/neutrals analyses continued).

Drain	West 96" drain (Valley)					South 21st Street		Below Harmon's	
TPCHD Identification No.[a]			237			234		--	
Date Sampled	9/07	9/07	9/19	10/26	11/21-22	9/07	11/21-22	9/07	11/21-22
Time Sampled	1055-1417	1055-1417	1025-1310	0325-0445	2225-0135	1046-1409	2235-0050	1040-1230	2225-0005
Sample Number	J1562	J1563 (dup)	J1574	J3406	J3422	J1565	J3423	J1566	J3424
acenaphthene	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u
benzidine	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
1,2,4-trichlorobenzene	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
hexachlorobenzene	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
hexachloroethane	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
bis(2-chloroethyl)ether	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
2-chloronaphthalene	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
1,2-dichlorobenzene	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
1,3-dichlorobenzene	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
3,3-dichlorobenzidine	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
2,4-dinitrotoluene	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
2,6-dinitrotoluene	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
1,2-diphenylhydrazine	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
fluoranthene	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u
4-chlorophenylphenylether	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
4-bromophenylphenylether	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
bis(2-chloroisopropyl)ether	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
bis(2-chloroethoxy)methane	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
hexachlorobutadiene	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
hexachlorocyclopentadiene	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
isophorone	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
naphthalene	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
nitrobenzene	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
N-nitrosodimethylamine	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
N-nitrosodiphenylamine	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
N-nitrosodi-n-propylamine	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
bis(2-ethylhexyl)phthalate	/7.4/†	/10/†	/8.2/†	/12/†	1.0u	/6.0/†	1.0u	/4.0m/†	1.0u
butylbenzylphthalate	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
di-n-butylphthalate	/1.2m/	1.0u	1.0u	/11/†	1.0u	1.0u	1.0u	1.0u	1.0u
di-n-octylphthalate	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
di-ethylphthalate	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
di-methylphthalate	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
benzo(a)anthracene	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u
benzo(a)pyrene	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u
3,4-benzofluoranthene and/ or benzo(k)fluoranthene	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u
chrysene	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u
acenaphthylene	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u
anthracene	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u
benzo(q,h,i)perylene	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u
fluorene	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u
phenanthrene	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u
dibenzo(a,h)anthracene	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u
ideno(1,2,3-cd)pyrene	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u	0.1u
pyrene	0.1u	0.1u	0.1u	0.1u	0.1u	/0.2m/	0.1u	0.1u	0.1u
polychlorinated butadienes	1.0u	1.0u	1.0u	1.0	1.0u	1.0u	1.0u	1.0u	1.0u

[a] Tacoma-Pierce County Health Department drainage map, July 1, 1983.

u = Not detected; detection limit shown.
m = Detected but below limit of quantification; quantification limit shown.

† Also detected in field and/or transport blank, no correction applied.

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6. Many compounds of concern in City Waterway sediments including hexachlorobenzene, hexachlorobutadiene, DDT, and PCBs were not detected in storm drain discharges. These discharges were, however, low-level sources for metals, polyaromatic hydrocarbons, and phthalates--all elevated in waterway sediment. The contaminant loads measured during this survey period, however, did not appear sufficient to account for the present level of sediment contamination.

If additional sampling of these drains is done and objectives are similar to the survey reported here, it is recommended that work be concentrated on Wheeler-Osgood drain, east and west 96-inch drains, the drain below Harmon's, and the South 15th Street drain. Because of the low concentrations of most constituents of interest and tendency to adsorb to particulates, suspended solids should be analyzed where practical. Metals samples should be filtered to separate total and dissolved loads. Finally, it may be important to sample during daylight hours because of the drop in flow observed at night in some drains.

AJ:cp

Attachments

ADDENDUM

As part of a separate WDOE project, two additional samples were collected from the west 96-inch storm drain (Nalley Valley) on February 14 and April 17, 1984 after the report for the 1983 WDOE City Waterway storm drain survey was completed. Sampling and analysis were identical to that followed for the 1983 work. The data below were obtained:

Date Sampled Time Sampled	February 14, 1984 1947 - 2314	April 17, 1984 1040 - 1335
Flow (MGD)	3.5	1.2
pH (S.U.)	--	5.8
Sp. Cond. (umhos/cm)	--	5230
Total Susp. Solids (mg/L)	--	15
TOC (mg/L)	8	64
chloroform (ug/L)	/1.6m/	/2.0m/
trichloroethylene (ug/L)	/1.0m/	1.0u
benzyl alcohol (ug/L)	1.0u	/4.8m/
zinc (ug/L)	38	104
nickel (ug/L)	5	1u
cadmium (ug/L)	0.1	0.3
mercury (ug/L)	--	0.052
arsenic (ug/L)	25	2
antimony (ug/L)	1u	1u
selenium (ug/L)	1u	1u
silver (ug/L)	0.2u	0.3
beryllium (ug/L)	0.5	0.2u
thallium (ug/L)	1u	1u

u = Not detected at limit of detection shown.
m = Detected but not quantified at limit of quantification shown.

These results are consistent with the 1983 findings and historical data except that benzyl alcohol, a compound on EPA's list of hazardous substances, was detected for the first time. Benzyl alcohol has an aquatic toxicity rating (TLm96) of 1000-100 ppm (Lewis, 1982).

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