Quality of Storm Water Runoff from Urbanized Houston Metropolitan Area

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During the years 1992 and 1993, the City of Houston, Harris County, Harris County Flood Control District, and the City of Pasadena conducted representative storm water sampling from a total of 15 sites located in the urbanized Houston metropolitan area. The storm water sampling effort was in response to the U. S. Environmental Protection Agency (EPA) storm water NPDES permitting requirements. EPA stipulated that the storm water sampling should be representative of commercial, residential, and industrial land-use activities of the drainage area contributing to the municipal storm sewer system. In response to EPA requirements, storm water representative sampling was conducted for the following four land-use categories:

- single-family residential
- multi-family residential
- commercial
- industrial

Three different sites from each land-use category were chosen for representative sampling purposes. Three additional sites where drainage areas were primarily undeveloped also were selected to establish baseline water quality conditions. As a result, representative sampling was conducted for 5 different types of land uses and from a total of 15 sampling sites. These locations are shown on Figure 1. The drainage areas contributing to the storm sewer systems ranged from 7 to 872 acres, with an average area of 140 acres.

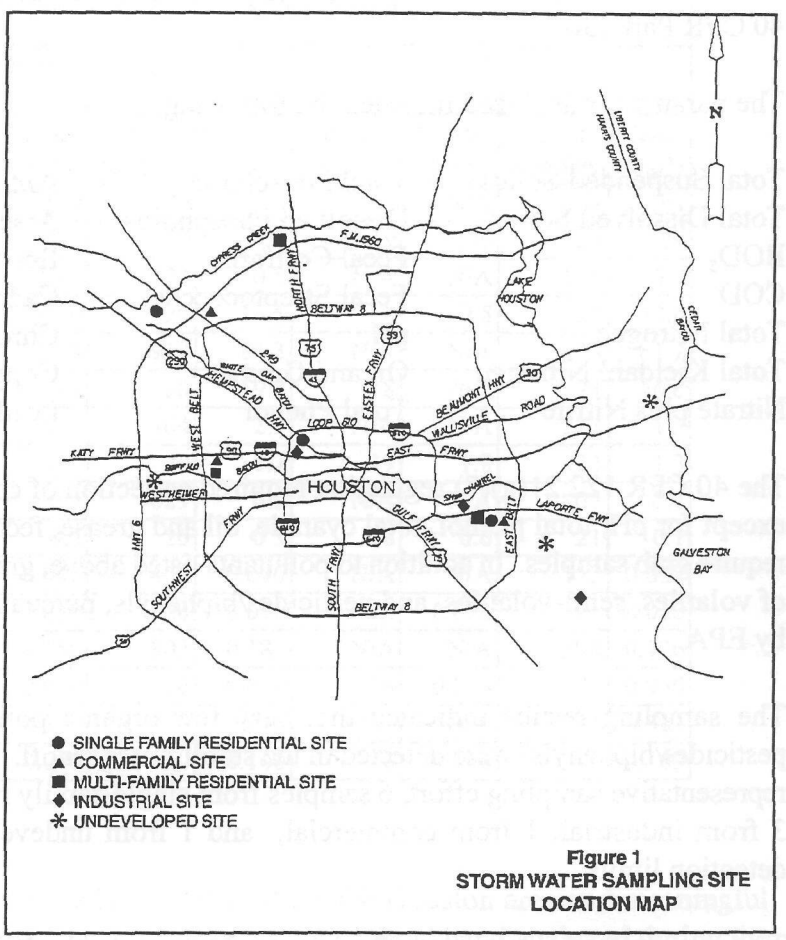

Figure 1
STORM WATER SAMPLING SITE LOCATION MAP

The primary purpose of the sampling was to determine the event mean concentrations (EMC) of storm water runoff from each of the five unique land-use categories. The EMCs were subsequently used to estimate annual pollutant loads from each major watershed.

Manual sampling procedures were utilized to collect samples. Sampling was initiated approximately 20 minutes after the first runoff discharge, and grab samples were collected at 20 minute intervals. Storm runoff flow rates were measured each time an individual sample was taken. Composite samples were flow-weighted.

A representative storm is a storm that is typical for the area in terms of duration, volume, and intensity. For representative sampling, the storm should have a volume greater than 0.1 inch, should be preceded by at least 72 hours of dry weather, and should not vary by more than 50 percent from the average rainfall volume and duration, where feasible. The annual average rainfall duration, volume, and intensity for Houston were determined to be 8 hours (duration), 0.78 inch (volume), and 0.14 inch/hour (intensity). Six representative storm events were sampled at each site.

All samples were handled under chain-of-custody procedures. A Qualify Assurance/Quality Control plan was prepared and implemented for sampling and analytical work. Sample collection was conducted in accordance with procedures specified in 40 CFR 122.21(g)(7), while analytical methods were based on 40 CFR Part 136.

The parameters analyzed included the following:

Total Suspended Solids	Total Phosphorus	Antimony	Mercury
Total Dissolved Solids	Dissolved Phosphorus	Arsenic	Nickel
BOD_5	Fecal Coliform	Beryllium	Selenium
COD	Fecal Streptococcus	Cadmium	Thallium
Total Nitrogen	pH	Chromium	Silver
Total Kjeldahl Nitrogen	Oil and Grease	Copper	Zinc
Nitrate plus Nitrite	Total Phenol	Lead	Total Cyanide

The 40 CFR 122.21(g)(7) regulation required collection of composite samples for the above parameters except for pH, total phenol, total cyanide, oil and grease, fecal coliform, and fecal streptococcus, which require grab samples. In addition to pollutants listed above, grab samples also were tested for the existence of volatiles, semi-volatiles, and pesticides/biphenyls, pursuant to the sampling requirements established by EPA.

The sampling results indicated that very few organic pollutants (i.e., volatiles, semi-volatiles, and pesticides/biphenyls) were detected in the storm water runoff. Out of the 92 samples collected through the representative sampling effort, 6 samples from single-family residential, 4 from multi-family residential, 3 from industrial, 1 from commercial, and 1 from undeveloped areas had certain parameters above detection limits.

Two samples had levels of ethylbenzene and toluene in the 19 to 50 ug/l range; seven samples had bis (2-ethylhexyl)-phthalate in the 12 to 35 ug/l range; three samples had one of the BHC components slightly above detection limit; one sample indicated 1,1,1-trichloroethane at 6 ug/l; four samples showed methylene chloride in the 15-20 ug/l range; and one sample indicated diethyl phthalate at 17 ug/l.

For certain conventional pollutant parameters, Table 1 presents a comparison of mean concentrations of storm water runoff between the Houston program and the Nationwide Urban Runoff Program (NURP) conducted by EPA in the 1980s. In general, quality of storm water from the Houston area is similar to that of the rest of the nation. However, the Houston results show lower metal concentrations than the NURP results in most land-use categories. Concentrations of 5-day Biochemical Oxygen Demand (BOD_5) in Houston area runoff are slightly higher than the national average while concentrations of Chemical Oxygen Demand (COD) in this region are slightly lower than NURP results except for the undeveloped areas. Because of high variability of Total Suspended Solids (TSS) in the storm water runoff, no meaningful comparison can be made. For commercial areas, the results do show that Houston has lower TSS but higher BOD_5 concentrations than the national average. Nutrient levels are almost identical for both programs. It should be noted that NURP study did not distinguish between single-family and multi-family land uses, and water quality data for industrial land use were unavailable.

TABLE 1 Comparison of Storm Water Runoff Quality - Houston V.S. NURP Results

Parameters and Source of Data		Undeveloped		Single-family Residential		Multi-family Residential		Industrial		Commercial	
		No. of Samples	Mean (mg/l)	No. of Samples	Mean (mg/l)	No. of Samples	Mean (mg/l)	No. of Samples	Mean (mg/l)	No. of Samples	Mean (mg/l)
TSS	NURP	133	216	1102	140	1102	140	N/A	N/A	309	91
	Houston	19	171	19	224	20	102	19	170	21	29
BOD_5	NURP	N/A	N/A	134	10.8	134	10.8	N/A	N/A	171	9.7
	Houston	19	7.1	18	12.6	20	13.1	18	9.8	21	17.4
COD	NURP	40	50.7	913	83.3	913	83.3	N/A	N/A	243	61.2
	Houston	19	57.6	18	50.7	20	59.7	18	76.1	21	56.6
TKN	NURP	120	1.4	904	2.4	904	2.4	N/A	N/A	223	1.3
	Houston	19	1.3	19	2.1	20	1.7	19	1.8	21	1.3
Total P	NURP	144	0.2	1029	0.5	1029	0.5	N/A	N/A	307	0.2
	Houston	19	0.2	18	0.5	20	0.3	18	0.6	21	0.1
Copper	NURP	N/A	N/A	468	0.046	468	0.046	N/A	N/A	152	0.037
	Houston	18	0.030	17	0.030	20	0.070	18	0.030	21	0.020
Lead	NURP	115	0.055	802	0.180	802	0.180	N/A	N/A	298	0.126
	Houston	18	0.060	17	0.070	20	0.070	18	0.070	21	0.050
Zinc	NURP	44	0.234	797	0.176	797	0.176	N/A	N/A	221	0.331
	Houston	18	0.060	17	0.070	20	0.100	18	0.160	20	0.160

NA = Not Available

As shown in Table 1, relatively few samples have been collected for the Houston area and meaningful statistical evaluation is not feasible at this time. As more samples are collected and analyzed during the NPDES storm water permit term, the quality of storm water runoff from the urbanized Houston area can be better defined.