STORMWATER CHARACTERIZATION STUDY

STATE OF NEW HAMPSHIRE
DEPARTMENT OF ENVIRONMENTAL SERVICES
6 HAZEN DRIVE
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EXECUTIVE SUMMARY

Purpose

The purpose of this study was to:

* *Characterize urban stormwater which would be indicative of stormwater runoff from New Hampshire communities.*

* *Provide information necessary to develop a stormwater strategy for New Hampshire.*

* *Determine the quality of rain and its relative contribution to stormwater concentrations.*

* *Show the effects of urbanization on stormwater quality.*

Study Description

Stormwater samples from an urban and residential site were analyzed for 26 parameters.

Two closed (piped) storm drain systems were sampled in Concord, New Hampshire; one from an urban site and one from a residential site. The urban site drained a 225 acre area that included a mix of relatively high density commercial, business and residential land uses. The drainage area of the residential site was approximately 72 acres, of which approximately 60 percent was developed with light to medium density single family homes.

Seven storms were sampled at each site in June, September and October 1996. Stormwater samples were analyzed for the 26 parameters listed in Table ES-1. In most cases, four grab samples of stormwater were taken for each parameter. Samples were generally taken about every 15 to 30 minutes in an attempt to capture the first flush (the highest concentrations and loadings of pollutants). The quality and quantity of rain was also measured and stormwater flows were estimated at each site.

4.5 RAIN QUALITY

Rain samples were collected at the urban site for storms 5, 6 and 7. The rain samples give an idea of potential atmospheric sources and of what the concentration of stormwater should approach after the majority of pollutants on land have been washed off. A summary of the results is shown in Table 4-1. Results for each storm are presented in Appendix E. In the calculations for the average and median values, the detection limit was used where results were recorded as below the detection limit (BDL). In Table 4-6, the average and median values are reported to be less than the value shown when 50 percent or more of the samples used to calculate the average or mean were BDL.

As shown in Table 4-1, the results of most rain samples were below the detection level. However, 75 percent or more of the samples taken for NO3&NO2-N, TP and Total Zn were above the detection level and 25 to 50 percent of the samples for TKN, NH3-N, Total Al, Cu, and Fe were above the detection level. A discussion regarding the relative contribution of rain on overall stormwater quality is provided in Section 4.6.1.

Table 4-1
Summary of Rain Quality Results

Parameter	# of Samples	# of Samples BDL	Concentrations (mg/L unless otherwise noted)			
			Average [1]	Median [1]	Range Low	Range High
pH	1	0	4.8	4.8	4.8	4.8
TKN [2]	4	2	<0.235	<0.100	<0.100	0.640
NH3-N [2]	4	3	<0.208	<0.100	<0.100	0.530
NO3&NO2-N [2]	4	0	0.113	0.120	0.090	0.130
TP [2]	4	0	0.005	0.004	0.002	0.01
Chlorides	4	4	<2.00	<2.00	<2.00	<2.00
Hardness	4	4	<1.45	<1.45	<1.45	<1.45
Total Al [2]	4	3	<0.0398	<0.0250	<0.0250	0.0840
Total Cd	4	4	<0.0005	<0.0050	<0.0005	<0.0005
Total Cr	4	4	<0.0050	<0.0050	<0.0050	<0.0050
Total Cu [2]	4	3	<0.0026	<0.0025	<0.0025	0.0028
Total Fe [2]	4	3	<0.0418	<0.0250	<0.0250	0.0920
Total Pb	4	4	<0.0025	<0.0025	<0.0025	<0.0025
Total Ni	4	4	<0.0100	<0.0100	<0.0100	<0.0100
Total Zn [2]	4	1	0.1068	0.0670	<0.0250	0.2680

(1) Values with a < sign mean the value is probably lower than value shown because 50% or more of the samples used to calculate the value were below the detection level (BDL).

(2) Shaded areas indicate parameters where one or more readings were above the detection limit.

4.6 STORMWATER QUALITY

4.6.1 Concentrations

Concentrations of each sample for the urban and residential sites may be found in Appendices F and G respectively.   Graphs showing the results for each storm and parameter for the urban and residential sites are provided in Appendices H and I. Summary statistics for all storms for the urban and residential sites are presented in Table 4-2. These include the average, median (i.e. the middle-most value, half the samples are greater than the median and half are less), minimum, and maximum concentrations as well as the standard deviation and the concentration that should not be exceeded 95 percent of the time, (i.e., the 95 percent confidence level). In calculating the average, median and 95 percent confidence level, the detection limit was used where results indicated a value below the detection level (BDL). Consequently some of the statistics may be somewhat conservative for this reason. Where 50 percent or more of samples for a particular parameter were BDL, the average, median and 95 percent confidence level concentrations are reported as less than (<) the value shown in Table 4-2. The actual number of samples that were BDL for each parameter and storm may be determined from the spreadsheets in Appendices F and G. Detection limits may be found in Tables 3-2 and 3-3.

Between 20 and 29 samples were collected for most parameters. However, in reviewing Table 4-2, one should be cautioned that the samples for oil and grease and the polynuclear aromatic hydrocarbons (PAH) were only based on two to four samples. Because only a few samples were taken, the 95 percent confidence level for these parameters were not computed.

In the majority of cases, urban concentrations were significantly higher than the residential concentrations; specific differences will be discussed further in the subsequent sections. Although increased urbanization is believed to be the main reason, one should be cautioned that the residential results may also be lower because of dilution during the initial parts of the storm. As discussed in Section 2.3, sampling of the residential site occurred in a manhole which usually had about a half to one foot of water in it due to backwater from a downstream wetlands area. Consequently, depending on the stormwater flows into the manhole, the first one or two samples may have been diluted by the backwater. As stormwater flows increased in time and magnitude, the concentrations were more representative of just the stormwater. Consequently, in comparing urban and residential results, the 95th percentile confidence level or the maximum concentrations is probably more representative of the differences between the two sites than the average concentrations.   One should also recognize that the results for the residential site may be somewhat influenced by an illegal sanitary house service connection that was not discovered and corrected until the beginning of the fall sampling period. Comparing the spring to the fall sampling results for bacteria (see Appendix G) however, the bacteria concentrations are not drastically different. Consequently it is not believed that the cross connection had a major impact on the residential stormwater results.

Measurements taken in the field by the hydrolab for the urban and residential sites are shown in Appendices J and K respectively. These include temperature, pH, DO, and percent DO saturation. The relative (uncalibrated) specific conductance is also shown. Though uncalibrated,

Table 4-2
Stormwater Concentrations [2]

Parameter	Urban Site				Residential Site			
	Average [1]	Median [1]	Range	95% Confidence Level [1]	Average [1]	Median [1]	Range	95% Confidence Level [1]
Minimum pH	5.90	5.95	3.93 to 6.05	-	5.93	5.86	5.06 to 6.81	-
Maximum % DO Saturation	90.9	93.8	64.2 to 98.4	-	67.1	63.1	52.3 to 91.3	-
Alkalinity	9.39	4.70	<1.00 to 57.50	13.85	19.42	15.65	1.60 to 45.70	24.01
Hardness	14.15	10.80	3.45 to 38.80	17.07	30.21	27.60	5.08 to 76.60	36.02
E. coli (counts/ 100 ml)	6563	3200	<10 to >50,000	9830	3997	1515	30 to 23,400	5989
Turbidity (NTU)	55	39	14 to 160	67	19	10	3 to 78	26
BOD5	21.4	18.6	6.6 to 65.0	27.3	5.1	3.8	<1.0 to 16.5	6.5
TSS	58.3	47.0	<1.0 to 146.0	72.5	28.0	22.0	5.0 to 70.0	34.6
TKN	3.394	2.290	0.530 to 13.720	4.436	0.800	0.600	0.280 to 1.900	0.953
NH3-N	2.194	0.960	0.010 to 10.400	3.064	0.184	0.105	<0.100 to 0.480	0.223
NO3&NO2-N	1.040	0.765	0.130 to 3.850	1.311	0.518	0.500	0.140 to 1.100	0.595
TP	1.082	0.322	0.108 to 11.200	1.780	0.146	0.093	0.022 to 0.372	0.180
Chloride	14.8	10.0	4.0 to 47.0	18.3	17.1	20.0	<2.0 to 38.0	20.4

Concentrations (mg/L unless otherwise noted)

(1)   Values with a < sign mean the value is probably less than shown because 50% or more of the samples used to calculate the value were below the detection level.

(2)   This table is continued on the next page.

Table 4-2 (continued)
Stormwater Concentrations [3]

Parameter	Urban Site				Residential Site			
	Average [1]	Median [1]	Range	95% Confidence Level [1]	Average [1]	Median [1]	Range	95% Confidence Level [1]
Total Al	1.5152	1.1200	0.4180 to 4.8500	1.8587	0.6023	0.3500	0.1350 to 2.5800	0.7972
Total Cd	0.0009	0.0007	<0.0005 to 0.0046	0.0012	<0.0005	<0.0005	<0.0005 to 0.0005	0.0005
Total Cr	0.0112	0.0090	<0.0050 to 0.0300	0.0136	<0.0051	<0.0050	<0.005 to 0.008	<0.0053
Total Cu	0.0401	0.0350	0.0090 to 0.1100	0.0485	0.0048	0.0038	0.0025 to 0.0095	0.0055
Total Fe	2.6873	2.0800	0.6140 to 9.1300	3.3505	1.7949	0.8620	0.2240 to 9.5300	2.4938
Total Pb	0.0322	0.0238	0.0095 to 0.1020	0.0400	0.0052	0.0033	0.0025 to 0.0280	0.0070
Total Ni	<0.0107	<0.0100	<0.0100 to 0.0185	<0.0114	<0.0100	<0.0100	<0.0100	<0.0100
Total Zn	0.2591	0.2070	0.0670 to 0.6500	0.3091	0.0520	0.0385	0.0250 to 0.1820	0.0645
Dissolved Al [2]	0.0485	0.0372	0.0000 to 0.1707	0.0673	0.0170	0.0000	0.0000 to 0.0770	0.0253
Dissolved Cd	0.0009	<0.0005	<0.0005 to 0.0050	0.0013	<0.0005	<0.0005	<0.0005 to 0.0005	<0.0005
Dissolved Cr	0.0062	<0.0050	<0.0050 to 0.0170	0.0074	<0.0052	<0.0050	<0.0050 to 0.0090	<0.0055
Dissolved Cu [2]	0.0185	0.0157	0.0018 to 0.0562	0.0242	0.0006	0.0000	0.0000 to 0.0040	<0.0010
Dissolved Fe [2]	0.1173	0.0987	0.0087 to 0.3977	0.1519	0.0786	0.0707	0.0000 to 0.1947	0.0958
Dissolved Pb	0.0060	0.0036	<.0025 to 0.0260	0.0084	<0.0025	<0.0025	<0.0025	<0.0025
Dissolved Ni	<0.0100	<0.0100	<0.0100 to 0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100
Dissolved Zn [2]	0.1671	0.1510	0.0220 to 0.3335	0.2006	0.0603	0.0270	0.0000 to 0.2420	0.0867

(1) Values with < sign mean the value is probably less than shown because 50% or more of the samples used to calculate the value were below the detection level.

(2) Dissolved Al, Cu, Fe, and Zn are based on "corrected" values to account for probable filter contamination.

(3) This table is continued on the next page.