STORMWATER-RUNOFF DATA, MADISON, WISCONSIN, 1993–94

By R.J. Waschbusch

U.S. GEOLOGICAL SURVEY
Open-File Report 95-733

Prepared in cooperation with the
CITY OF MADISON, WISCONSIN

Madison, Wisconsin
1996

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY
Gordon P. Eaton, Director

For additional information write to:

District Chief
U.S. Geological Survey
6417 Normandy Lane
Madison, WI 53719

Copies of this report can be purchased from:

U.S. Geological Survey
Earth Science Information Center
Open-File Reports Section
Box 25286, MS 517
Denver Federal Center
Denver, CO 80225

CONTENTS

FIGURE

TABLES

CONVERSION FACTORS AND ABBREVIATED WATER-QUALITY UNITS

Multiply	By	To Obtain
inch (in.)	25.4	millimeter
acre	0.4048	hectare
foot (ft)	0.3048	meter
foot per second squared (ft/s^2)	0.3048	meter per second squared
gallon per minute (gal/min)	0.06309	cubic meter per second
square foot	0.09290	square meters
square mile (mi^2)	2.590	square kilometer
cubic foot	0.02832	cubic meters
cubic foot per second (ft^3/s)	0.02832	cubic meter per second

Temperature, in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) using the following equation:

$°F = 1.8°C + 32.$

Abbreviated water-quality units used in this report: Chemical concentration and water temperature are given in metric units. Chemical concentration is given in milligrams per liter (mg/L) or micrograms per liter (µg/L). Milligrams per liter is a unit expressing the concentration of chemical constituents in solution as weight (milligrams) of solute per unit volume (liter) of water. One thousand micrograms per liter is equivalent to one milligram per liter. For concentrations less than 7,000 mg/L, the numerical value is the same as for concentrations in parts per million. Volume of samples is given in milliliters (mL).

Stormwater-Runoff Data, Madison, Wisconsin, 1993–94

By R.J. Waschbusch

Abstract

Section 402(P) of the Water Quality Control Act of 1987 requires that municipalities with a population of 100,000 or more obtain permits to discharge stormwater runoff and to control its quality. Monitoring and sampling of stormwater runoff from seven drainage basins in Madison, Wis., was performed from April 1993 through November 1994 by the U.S. Geological Survey and the city of Madison to (1) characterize the quantity and quality of wet-weather discharge, (2) determine storm and annual loadings of selected constituents, and (3) characterize rainfall and runoff conditions. The seven basins were selected for monitoring rainfall and runoff on the basis of land-use characteristics, dry-weather flow conditions, and monitorability.

As required by Section 402(P) of the Water Quality Control Act of 1987, stormwater-runoff samples collected during storms that met three criteria (rainfall depths 50 to 150 percent of average depth range, rainfall durations 50 to 150 percent of average duration, and antecedent dry-weather period of at least 72 hours) were analyzed for semivolatile organic chemicals, total metals, pesticides, polychlorinated biphenyls, inorganic constituents, bacteria, oil and grease, pH, and water temperature. Two of the seven sites also had samples analyzed for volatile organic chemicals. In addition to the required sampling, additional runoff samples that did not necessarily meet the three rainfall criteria, were analyzed for total metals and inorganic constituents. Storm loads of selected constituents were computed.

INTRODUCTION

Section 402 (P) of the Water Quality Control Act of 1987 requires that municipalities with a population of 100,000 or more obtain permits to discharge stormwater runoff and to control its quality. In Wisconsin, the Wisconsin Department of Natural Resources (WDNR) has been granted permitting authority by the U.S. Environmental Protection Agency (USEPA). Some of the permit requirements are the following:

1. Characterization of the quantity and quality of wet-weather discharge from representative stormwater channels during three or more representative storm events.

2. Determination of storm and annual pollutant loadings from each stormwater channel characterized in item 1.

3. Characterization of rainfall and runoff conditions.

USEPA rules specify that municipalities must sample a minimum of three storm events that meet the following criteria:

1. The rainfall depth must be in the 50 to 150 percent of average depth range.

2. The rainfall duration must be in the 50 to 150 percent of average duration range.

3. The rainfall must be preceded by at least a 72 hour dry-weather period, where dry weather is defined to mean the total rainfall during the period is less than 50 percent of the average storm depth.

Storm events that meet these three criteria are referred to as "representative" events. USEPA rules further specify that samples from the three storms meeting the above three criteria, representative events, are to be analyzed for specific volatile and semi-volatile organic chemicals, total metals, pesticides, polychlorinated biphenyls (PCB's), inorganic constituents, bacteria, oil and grease, pH, and water temperature. These constituents are specified in tables 1-3. Since it was judged that volatile organic chemicals (VOC's) were unlikely to be present at most of the monitoring sites and with WDNR approval, VOC sampling was performed at only the two sites judged to be most likely to have VOC's present in their runoff water.

In addition to these required samples, a minimum of three additional samples were collected at each

site to enable more complete characterization of stormwater runoff. These three additional samples were not necessarily representative events. These samples were analyzed at the City of Madison Department of Public Health Laboratory for a smaller list of constituents. These constituents are listed in table 3.

Before 1993, storm-runoff quantity and quality data for Madison, Wis., were unavailable in sufficient detail for the above-mentioned characterizations. In April 1993, the city of Madison and the U.S. Geological Survey (USGS) began a study to collect storm-runoff data in the Madison area. The data, collected from April 1993 through November 1994, are representative of various urban land uses.

This report summarizes the data collection methods and presents the basic data. Rain, runoff, constituent concentration, water-quality properties, and selected constituent storm load data are presented.

METHODS OF INVESTIGATION

Seven sites were selected by the city of Madison, WDNR, and the USGS for monitoring of rainfall and stormwater runoff. The sites were selected on the basis of land-use characteristics in the basins, dry-weather flow characteristics, and monitorability. The seven land uses selected were commercial, medium-density residential, high-density residential, university, light industrial, highway, and shopping center; together, they represent the range of land uses in Madison. Site locations are shown in figure 1. Descriptions of the basins and sites representing each of these land uses follow. These descriptions are in the order the data for them will appear in the data tables.

Commercial. This land use was represented by the 67.8 acre Annamark Road Basin (USGS station no. 05428630), 50 percent of which is classified as commercial and 30 percent as highway; 20 percent is grassy, undeveloped area. The stormwater from the basin drains into a 36-in.-diameter round concrete storm sewer.

Medium-density residential. This land use was represented by the 58.2-acre Harper Road Basin (USGS station no. 05427980), 96 percent of which is classified as medium-density residential and the remaining 4 percent as high-density residential. The stormwater from the basin drains into a 36-in.-diameter round concrete storm sewer.

High-density residential. This land use was represented by the 73.7-acre Lakeland Avenue Basin (USGS station no. 05428540), 15 percent of which is classified as high-density residential. 73 percent as medium-density residential, 3 percent as commercial, 6 percent as institutional, and 3 percent as parks. The stormwater from the basin drains into a 36-in.-square concrete box culvert storm sewer.

University. This land use was represented by the 23.0-acre Observatory Drive Basin (USGS station no. 05427973), 100 percent of which is classified as university. The stormwater from the basin drains into a 36-in.-diameter round concrete storm sewer. This site was established despite dry-weather flow because a suitable alternative could not be found.

Light industrial. This land use was represented by the 114.6-acre Syene Road Basin (USGS station no. 05429268), 100 percent of which is classified as light industrial. The stormwater from the basin drains into a 54-in.-diameter round concrete storm sewer.

Highway. This land use was represented by the 83.2-acre Todd Drive Basin (USGS station no. 05429073), 25 percent of which is classified as highway, 29 percent as commercial, 27 percent as high-density residential, and 19 percent as medium-density residential. The stormwater from the basin drains into a 48-in.-diameter round concrete storm sewer.

Shopping center. This land use was represented by the 73.5-acre West Towne Basin (USGS station no. 05427960), 100 percent of which is classified as shopping center or shopping center parking lot. The stormwater from the basin drains into a 42-in.-diameter round concrete storm sewer.

Rainfall, stormwater-runoff volume, and water-quality data were collected at all of the sites. Rainfall was measured using a tipping bucket rain gage and recorded by a digital data logger. Three methods were used to compute storm-runoff volumes.

For the Syene Road site, storm-runoff volumes were computed using the Manning equation,

$$Q = \frac{Cm}{n} A R^{2/3} S^{1/2} \quad , \qquad (1)$$

where

Q is discharge, in cubic feet per second;
C_m is a constant (1.49 for inch-pound units);
n is roughness coefficient, (dimensionless);
A is cross-sectional flow area, in square feet;
R is hydraulic radius, in feet; and
S is slope of energy grade line.

EXPLANATION

- Sampling locations and land use
  1. Annamark Road — *Commercial*
  2. Harper Road — *Medium-density residential*
  3. Lakeland Avenue — *High-density residential*
  4. Observatory Drive — *University*
  5. Syene Road — *Light industrial*
  6. Todd Drive — *Highway*
  7. West Towne — *Shopping center*

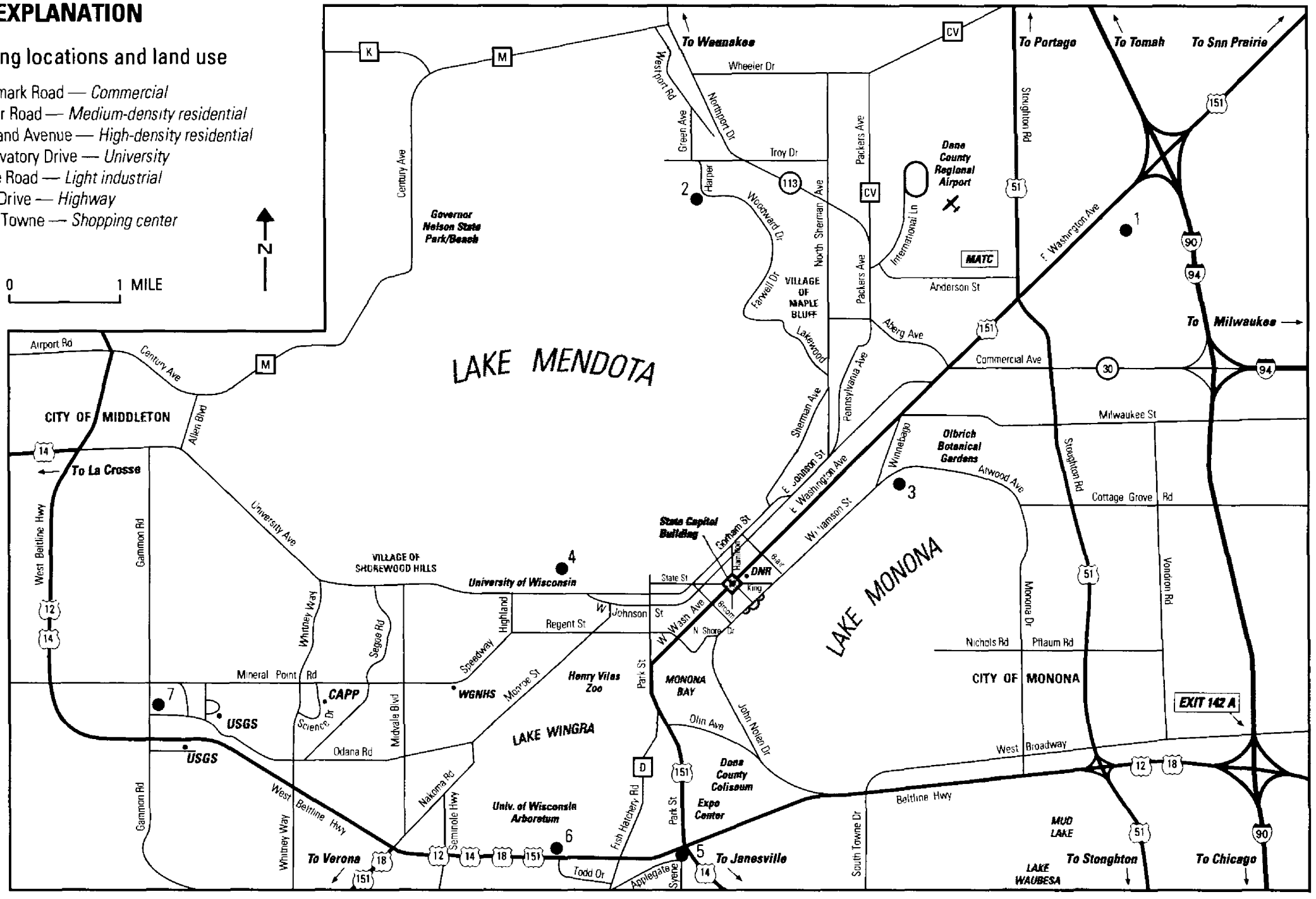

Figure 1. City of Madison sampling locations.

Pipe stage was determined using acoustic stage sensors mounted on the top of the pipe. The pipe stage was used to calculate the flow area (A) and hydraulic radius (R). The pipe roughness coefficient (n) was estimated to be 0.013, which is between published values for finished concrete and unfinished concrete (Streeter and Wylie, 1985, p. 211). The slope of the energy grade line (S) was assumed to be approximately equal to the slope of the pipe, which is 2 ft per 1,000 ft.

At the Lakeland Avenue site, stormwater-runoff volumes were computed using a 120°V-notch weir placed in the box culvert. Stage was read 3 ft upstream from the weir using a Campbell Scientific Stormwater Monitoring System[1]. The stage was then substituted for upstream head (H) in the following weir equation to compute discharge (Grant, 1989, p. 139-141):

$$Q = 4.33H^{2.5}, \qquad (2)$$

where

Q is discharge, in cubic feet per second;

4.33 is a constant for 120°V-notch weirs;

H is upstream head above the weir crest, in feet; and

2.5 is a constant for all V-notch weirs.

This discharge was corrected for approach velocity by multiplying by a correction coefficient (C) (U.S. Department of the Interior, Bureau of Reclamation, 1975, p. 25-26). The correction coefficient was computed as follows:

1. First, an approximate velocity (v) was calculated by dividing the above discharge by the flow area.

2. Next, a head due to the velocity of approach (h), in feet, was calculated using the following equation:

$$h = \frac{v^2}{2g}, \qquad (3)$$

where g is acceleration of gravity, or 32.2 ft/s^2.

3. The effective head on the weir (D) was then computed from the velocity head (h) and the measured head (H) as follows:

$$D = [(H+h)^{3/2} - h^{3/2}]^{2/3}. \qquad (4)$$

4. The measured head and the effective head were then used to compute a correction coefficient (C) with the following equation:

$$C = \frac{D^{3/2}}{H^{3/2}}, \qquad (5)$$

5. The corrected discharge (Q') was computed by multiplying the initial discharge (Q) by the correction coefficient (C).

6. This new discharge (Q') was used to recompute the velocity (v) as in step 1. Steps 2-6 were reiterated until the increase in (Q') became insignificant.

At all of the remaining sites, stormwater-runoff volumes were computed using a Palmer-Bowlus flume design that was tested and rated by the USGS in Mississippi (Kilpatrick and others, 1985). For each of these sites, the stage was read one pipe diameter upstream from the entrance lip to the flumes using a Campbell Scientific Stormwater Monitoring System. This stage was used in the following equation to calculate the total discharge through the flume:

$$Q = a\left[\frac{Ha}{D}\right]^b D^{2.5}, \qquad (6)$$

where

Q is discharge, in cubic feet per second;

a is a constant, 3.685;

b is a constant, 1.868;

Ha is the head above the upstream lip of the flume, at a distance of one pipe diameter upstream from the flume entrance, in feet;

D is pipe diameter, in feet; and

2.5 is a constant.

For the Observatory Drive monitoring site, the dry-weather-flow volume was subtracted from the total flow volume to determine the stormwater-runoff volume. The dry-weather-flow volume was computed using the Palmer-Bowlus flume discharge equation and a stage interpolated between the stage before the storm event began and the stage after the storm event was over.

Water-quality samples also were collected at all seven sites. Programmable ISCO automatic samplers with 3/8-in.-diameter teflon-lined sampling tubing were used to collect automatic flow-composite samples. Refrigerated samplers were installed at five sites, and unrefrigerated samplers were installed at the Lakeland Avenue and West Towne sites. For representative

[1]Use of brand names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

Table 1. Organic constituents for which concentrations in stormwater-runoff samples from monitoring sites in Madison, Wisconsin, were determined by a private laboratory, 1993–94

Semivolatile organic chemicals		
1,2,4-Trichlorobenzene	4-Nitrophenol	Dimethylphthalate
1,2-Dichlorobenzene	Acenaphthene	Fluoranthene
1,2-Diphenylhydrazine (2)	Acenaphthylene	Fluorene
1,3-Dichlorobenzene	Anthracene	Hexachlorobenzene
1,4-Dichlorobenzene	Benzidine	Hexachlorobutadiene
2,2'-Oxybis(1-chloropropane)	Benzo(*a*)anthracene	Hexachlorocyclopentadiene
2,4,6-Trichlorophenol	Benzo(*a*)pyrene	Hexachloroethane
2,4-Dichlorophenol	Benzo(*b*)fluoranthene	Indeno(1,2,3-*cd*)pyrene
2,4-Dimethylphenol	Benzo(*g,h,i*)perylene	Isophorone
2,4-Dinitrophenol	Benzo(*k*)fluoranthene	*N*-Nitrosodi-*n*-propylamine
2,4-Dinitrotoluene	Bis(2-chloroethoxy)methane	*N*-Nitrosodimethylamine
2,6-Dinitrotoluene	Bis(2-chloroethyl)ether	*N*-Nitrosodiphenylamine (1)
2-Chloronaphthalene	Bis(2-chloroisopropyl)ether	Naphthalene
2-Chlorophenol	Bis(2-ethylhexyl)phthalate	Nitrobenzene
2-Nitrophenol	Butylbenzylphthalate	Pentachlorophenol
3,3'-Dichlorobenzidine	Chrysene	Phenanthrene
4,6-Dinitro-2-methylphenol	Di-*n*-butyl phthalate	Phenol
4-Bromophenyl phenyl ether	Di-*n*-octyl phthalate	Pyrene
4-Chloro-3-methylphenol	Dibenz(*a,h*)anthracene	
4-Chlorophenyl phenyl ether	Diethylphthalate	

Volstile orgsnic chemicals		
1,1,1-Trichloroethane	Acrylonitrile	Chloromethane
1,1,2,2-Tetrachloroethane	Benzene	*cis*-1,3-Dichloropropene
1,1,2-Trichloroethane	Bromodichloromethane	Ethylbenzene
1,1-Dichloroethane	Bromoform	Fluorotrichloromethane
1,1-Dichloroethene	Bromomethane	Methylene chloride
1,2-Dichloroethane	Carbon tetrachloride	Tetrachloroethene
1,2-Dichloroethene, total	Chlorobenzene	Toluene
1,2-Dichloropropane	Chlorodibromomethane	*trans*-1,3-Dichloropropene
2-Chloroethylvinyl ether	Chloroethane	Trichloroethene
Acrolein	Chloroform	Vinyl chloride

Pesticides and polychlorinated biphenyls		
4,4'-DDD	Aroclor-1248	Endrin
4,4'-DDE	Aroclor-1254	Endrin aldehyde
4,4'-DDT	Aroclor-1260	Endrin ketone
Aldrin	Beta-BHC	Gamma-BHC (lindane)
Alpha-BHC	Chlordane	Gamma-chlordane
Alpha-chlordane	Delta-BHC	Heptachlor
Aroclor-1016	Dieldrin	Heptachlor epoxide
Aroclor-1221	Endosulfan I	Methoxychlor
Aroclor-1232	Endosulfan II	Toxaphene
Aroclor-1242	Endosulfan sulfate	

Table 2. Metals and grab-sampled constituents for which concentrations in stormwater-runoff samples from monitoring sites in Madison, Wisconsin, were determined by a private laboratory, 1993–94

Metals	Grab-sampled constituents
Antimony, total	Cyanide, total
Beryllium, total	Oil and grease, total recoverable
Mercury, total	Phenolics, total recoverable
Thallium, total	

Table 3. Metals, inorganic chemicals, and bacteria for which concentrations in stormwater-runoff samples from monitoring sites in Madison, Wisconsin, were determined by the City of Madison Department of Public Health Laboratory, 1993–94

Metals	Inorganic chemical constituents	Bacteria
Aluminum, total	Chemical oxygen demand	Fecal coliform
Arsenic, total	Biochemical oxygen demand	Fecal streptococcus
Cadmium, total	Suspended solids	
Chromium, total	Dissolved solids	
Copper, total	Nitrogen, ammonia	
Lead, total	Nitrogen, nitrate	
Manganese, total	Nitrogen, nitrite	
Nickel, total	Nitrogen, $NO_2 + NO_3$	
Selenium, total	Nitrogen, total kjeldahl	
Silver, total	Nitrogen, organic	
Zinc, total	Nitrogen, total	
	Phosphorus, total	
	Phosphorus, dissolved	

events, automatic flow-composite samples were analyzed for semi-volatile organic constituents, pesticides, PCB's, total metals, and inorganic chemical constituents. These specific constituents are listed in tables 1-3. For the additional, not necessarily representative samples, the automatic flow-composite samples were analyzed for the metals and inorganic chemical constituents listed in table 3. Constituents for which concentrations were determined by a private laboratory are listed in tables 1 and 2; constituents for which concentrations were determined by the City of Madison Department of Public Health Laboratory are listed in table 3.

Grab samples were collected using a D-77 sampler with a 1/4-in.-diameter teflon nozzle and a 1-quart glass sample bottle. Grab samples from representative events were analyzed for cyanide, residual chlorine, oil and grease, total phenols, fecal coliform, and fecal streptococcus. While grab samples were being collected, the pH, the temperature, and the presence of residual chlorine in the water also were determined. The City of Madison Department of Public Health Laboratory determined the bacteria concentrations and the private laboratory determined the remainder of the grab sampled constituent concentrations.

Based on discussions with WDNR it was decided that volatile organic chemicals (VOC's) were unlikely to be present in the runoff from the monitoring sites; therefore with WDNR approval, VOC sampling was performed at only the two sites most likely to have VOC's present in their stormwater-runoff. Todd Drive and West Towne were chosen for this sampling because

land-use in the basins was thought to be most likely to yield VOC's. Samples to be analyzed for VOC's were collected in the following manner:

1. Every 20 minutes, during the first three hours of stormwater-runoff, a 1-quart glass jar was dipped into the flow stream and the time of collection was recorded.

2. Immediately after collection, a sub-sample was poured from the 1-quart glass jar into a 20 mL glass vial containing 0.5 mL of 18 percent hydrochloric acid. The vial was then capped and checked to be certain there was no head-space. In other words, no bubbles were present in the vial.

3. Steps 1 and 2 were repeated for 3 hours until nine sub-samples were collected.

4. The flow data from the event were then used to calculate the volume of water required to withdraw from each of the nine vials to create a flow-composite sample. These withdrawals, performed at the private laboratory, were made using a syringe, to prevent head-space from being introduced. Analyses of this flow-composite sample, yields an event-mean-concentration (EMC), which is the average constituent concentration during the storm event.

Specific VOC's for which concentrations were determined are listed in table 1. All VOC concentrations were determined at a private laboratory.

Runoff from a minimum of six storms was sampled at each site. Three of the storms met the USEPA rainfall criteria, so runoff samples for these storms were analyzed for all constituents designated by the USEPA. These constituents are listed in tables 1-3. The remaining storms did not necessarily meet the criteria, but these runoff samples were analyzed by the City of Madison Department of Public Health Laboratory for those constituents listed in table 3. Storm loads for selected composite sampled constituents were computed by multiplying stormwater-runoff volume sampled by the storm event mean concentration. Samples collected in a flow proportional manner result in samples that represent the average constituent concentrations during a storm event and are referred to as event mean concentrations (EMC).

PRESENTATION OF DATA

The data collected during the study are listed in tables 4 through 20 (at back of report).

REFERENCES CITED

Kilpatrick, F.A.; Kaehrle, W.R.; Hardee, Jack; Cordes, E.H.; and Landers, M.N., 1985, Development and testing of highway storm-sewer flow measurement and recording system: U.S. Geological Survey Water-Resources Investigations Report 85-4111, 98 p.

Grant, D.M., 1989, ISCO open channel flow measurement handbook (3d ed.): Lincoln, Neb., ISCO, Inc., 356 p.

Streeter, V.L., and Wylie, E.B., 1985, Fluid mechanics (8th ed.): New York, McGraw-Hill, 586 p

U.S. Department of the Interior, Bureau of Reclamation, 1975, Water measurement manual: Washington, D.C., U.S. Government Printing Office, 327 p.

Table 4. Rainfall and runoff amounts at monitoring sites in Madison, Wisconsin

[Time is given in 24-hour (military) time; --, runoff volume not determined]

Site	Rain start Date and time		Rain end Date and time		Rainfall duration, in hours:minutes	Total rainfall, in inches	Rain volume, in cubic feet	Total runoff volume, in cubic feet	Percentage of rain that ran off	Runoff volume sampled, in cubic feet	Percentage of runoff sampled
Annamark Road	05/22/93	1738	05/22/93	2219	04:41	0.13	31,995	--	--	--	--
	06/24/93	1919	06/25/93	0032	05:13	.53	130,440	36,046	28	--	--
	07/24/93	2256	07/25/93	0442	05:46	1.07	263,342	77,427	29	--	--
	10/08/93	2103	10/09/93	0411	07:08	.37	91,062	16,053	18	15,396	96
	10/20/93	1707	10/21/93	0348	10:41	.23	56,606	9,703	17	8,450	87
	11/12/93	1744	11/13/93	0029	06:45	.33	81,218	14,213	17	12,407	87
	03/20/94	2359	03/21/94	0331	03:32	.19	46,762	8,001	18	6,895	86
	04/12/94	0810	04/12/94	2110	13:00	.56	137,824	28,452	21	27,467	97
	05/11/94	0445	05/11/94	0945	05:00	.17	41,839	9,444	23	8,199	87
	05/14/94	1311	05/15/94	0311	14:00	.30	73,834	16,563	22	15,941	96
Harper Road	05/22/93	1744	05/23/93	0349	10:05	.13	27,645	--	--	--	--
	06/17/93	1035	06/17/93	1212	01:37	.20	42,253	6,834	16	6,083	89
	06/24/93	1934	06/25/93	0027	04:53	.52	109,858	17,893	16	17,358	97
	07/24/93	2300	07/25/93	0437	05:37	1.18	249,294	52,756	21	49,524	94
	08/09/93	1010	08/09/93	1125	01:15	.62	130,985	29,791	23	25,436	85
	10/08/93	2038	10/09/93	0410	07:32	.37	78,168	8,623	11	7,966	92
	10/20/93	1657	10/20/93	2306	06:09	.25	52,817	4,061	8	3,231	80
	11/12/93	1805	11/12/93	2245	04:40	.29	61,267	6,938	11	5,996	86
	08/30/94	1047	08/30/94	1521	04:34	.29	61,267	12,960	21	11,871	92
	09/14/94	0456	09/14/94	1020	05:24	.80	169,013	39,718	23	39,018	98
	09/22/94	0747	09/22/94	1138	03:51	.21	44,366	9,806	22	9,348	95
Lakeland Avenue	05/22/93	1740	05/22/93	2210	04:30	.11	29,428	--	--	--	--
	06/17/93	1039	06/17/93	1100	00:21	.57	152,493	14,205	9	14,079	99
	06/24/93	1912	06/25/93	0023	05:11	.60	160,519	14,742	9	--	--
	07/25/93	0219	07/25/93	0519	03:00	1.27	339,734	39,583	12	38,870	98
	08/09/93	1027	08/09/93	1133	01:06	.39	104,337	7,902	8	7,346	93
	11/12/93	1802	11/12/93	2242	04:40	.27	72,233	4,142	6	4,025	97
	03/20/94	1728	03/21/94	0337	10:09	.23	61,532	13,313	22	12,786	96
	04/12/94	0834	04/12/94	1739	09:05	.50	133,766	10,260	8	9,772	95
	05/11/94	0445	05/11/94	0936	04:51	.19	50,831	4,049	8	3,644	90
	08/03/94	1348	08/04/94	0233	12:45	.78	208,674	17,707	8	17,397	98

Table 4. Rainfall and runoff amounts at monitoring sites in Madison, Wisconsin—Continued

Site	Rain start Date and time		Rain end Date and time		Rainfall duration, in hours:minutes	Total rainfall, in inches	Rain volume, in cubic feet	Total runoff volume, in cubic feet	Percentage of rain that ran off	Runoff volume sampled, in cubic feet	Percentage of runoff sampled
Observatory Drive	05/22/93	1743	05/23/93	0536	11:53	.18	15,028	--	--	--	--
	06/17/93	1034	06/17/93	1224	01:50	.50	41,745	20,967	50	20,665	99
	06/24/93	1907	06/25/93	0046	05:39	.62	51,764	30,432	59	29,700	98
	07/25/93	0229	07/25/93	0544	03:15	1.25	104,363	75,774	73	66,986	88
	08/09/93	1029	08/09/93	1309	02:40	.44	36,736	21,464	58	21,179	99
	10/08/93	2134	10/09/93	0447	07:13	.29	24,212	10,019	41	9,784	98
	10/20/93	1702	10/20/93	2303	06:01	.18	15,028	6,051	40	4,335	72
	11/12/93	1749	11/13/93	0015	06:26	.33	27,552	13,513	49	12,065	89
	08/03/94	1338	08/04/94	0337	13:59	.78	65,122	39,627	61	30,722	78
	08/12/94	1432	08/13/94	0106	10:34	.18	15,028	7,101	47	7,088	100
Syene Road	05/22/93	1615	05/23/93	0308	10:53	.27	112,319	74,753	67	--	--
	06/17/93	1038	06/17/93	1234	01:56	.49	203,839	104,293	51	97,684	94
	06/24/93	1854	06/25/93	0048	05:54	.74	307,839	228,822	74	216,156	94
	07/25/93	0219	07/25/93	0502	02:43	1.91	794,556	560,701	71	495,426	88
	08/09/93	1025	08/09/93	1136	01:11	.82	341,118	194,556	57	183,548	94
	10/08/93	2100	10/09/93	0321	06:21	.23	95,680	60,731	63	54,328	89
	11/12/93	1800	11/13/93	0325	09:25	.35	145,599	85,406	59	78,987	92
	04/12/94	0821	04/12/94	1700	08:39	.47	195,519	129,125	66	121,902	94
Todd Drive	05/22/93	1717	05/23/93	0408	10:51	.24	72,484	35,467	49	32,573	92
	06/17/93	1036	06/17/93	1224	01:48	.39	117,786	57,154	49	54,933	96
	06/24/93	1851	06/25/93	0042	05:51	.68	205,371	112,182	55	84,024	75
	08/09/93	1000	08/09/93	1106	01:06	.73	220,472	112,476	51	105,520	94
	10/08/93	2101	10/09/93	0449	07:48	.28	84,564	30,093	36	26,430	88
	10/20/93	1720	10/20/93	2255	05:35	.17	51,343	19,742	38	17,574	89
	11/12/93	1737	11/13/93	0027	06:50	.38	114,766	82,452	72	81,423	99
	03/20/94	2348	03/21/94	0320	03:32	.23	69,464	40,694	59	38,465	95
	04/12/94	0823	04/12/94	1749	09:26	.56	169,129	89,951	53	84,897	94
	08/03/94	1534	08/04/94	0155	10:21	1.56	471,145	239,172	51	234,377	98
	08/12/94	1342	08/13/94	0230	12:48	.26	78,524	43,165	55	41,204	95
	09/22/94	0645	09/22/94	1152	05:07	.23	69,464	28,054	40	26,594	95

Table 4. Rainfall and runoff amounts at monitoring sites in Madison, Wisconsin—Continued

Sita	Rain start Data and time		Rain end Date and time		Rainfall duration, in hours:minutes	Total rainfall, in inches	Rain volume, in cubic feet	Totai runoff volume, in cubic feet	Percentage of rain that ran off	Runoff volume sampled, in cubic feet	Percentage of runoff sampled
West Towne	04/27/93	1654	04/28/93	0108	08:14	.29	77,373	21,548	28	--	--
	05/22/93	1708	05/23/93	0416	11:08	.22	58,697	13,141	22	--	--
	06/17/93	1027	06/17/93	1222	01:55	.39	104,054	30,974	30	30,508	98
	06/24/93	1843	06/25/93	0048	06:05	1.13	301,490	88,923	29	--	--
	07/25/93	0146	07/25/93	0427	02:41	1.54	410,880	158,206	39	72,213	46
	08/09/93	1022	08/09/93	1126	01:04	.49	130,734	44,211	34	43,615	99
	10/08/93	2111	10/09/93	0430	07:19	.48	128,066	25,220	20	25,194	100
	10/20/93	1514	10/20/93	2302	07:48	.25	66,701	13,548	20	13,349	99
	11/12/93	1741	11/13/93	2336	05:55	.33	88,046	20,485	23	19,699	96
	04/12/94	0814	04/12/94	1726	09:12	.72	192,100	50,086	26	--	--
	05/14/94	1344	05/15/94	0140	11:56	.26	69,369	17,868	26	17,436	98
	09/09/94	1206	09/09/94	1222	00:16	.76	202,772	49,740	25	49,732	100
	09/22/94	1856	09/23/94	0635	11:39	.35	93,382	28,780	31	28,296	98
	11/05/94	0847	11/05/94	1750	09:03	.29	77,373	23,665	31	23,553	100

Table 5. Temperature, pH, and presence of residual chlorine from selected stormwater-runoff samples from monitoring sites in Madison, Wisconsin

[Time is given in 24-hour (military) time; --, no data; ND, not detected]

Site	Date	Time	Temperature, in degrees Celsius	pH	Residual chlorine
Annamark Road	06/24/93	2040	23.9	7.6	ND
	07/25/93	0405	23.4	7.9	ND
	08/09/93	1150	18.8	8.2	ND
	11/12/93	2021	6.8	6.5	ND
Harper Road	05/22/93	1756	11.5	7.5	ND
	06/24/93	2115	22.4	7.4	ND
	07/25/93	0450	21.4	7.6	ND
	08/09/93	1245	19.0	7.7	ND
	11/12/93	2102	7.2	7.0	ND
Lakeland Avenue	05/22/93	2101	14.2	7.5	ND
	06/24/93	2005	22.4	7.2	ND
	07/25/93	0315	23.4	7.2	ND
	08/09/93	1110	20.2	7.4	Detected
	11/12/93	1950	7.2	6.8	ND
Observatory Drive	05/22/93	2131	19.3	7.8	ND
	06/07/93	1315	17.8	7.3	ND
	06/24/93	2145	--	7.6	ND
	07/25/93	0500	2.0	7.3	ND
	08/09/93	1230	21.7	7.7	ND
	11/12/93	2130	12.6	7.6	ND
Syene Road	05/22/93	1730	14.3	7.4	ND
	06/07/93	1230	16.6	7.2	ND
	06/24/93	2115	26.5	6.8	ND
	07/25/93	0415	22.1	6.7	ND
	08/09/93	1150	19.1	7.0	ND
	11/12/93	2100	6.9	6.3	ND
	04/12/94	0945	6.8	7.8	ND
Todd Drive	05/22/93	1800	18.3	7.4	ND
	06/07/93	1210	16.6	6.8	ND
	06/24/93	2045	25.5	6.6	ND
	07/25/93	0345	21.8	6.1	ND
	08/09/93	1130	19.1	6.3	ND
	11/12/93	2030	6.9	6.4	ND
West Towne	05/22/93	2020	15.7	7.3	ND
	06/07/93	1120	16.8	6.4	ND
	06/24/93	1955	25.5	7.1	ND
	07/25/93	0315	22.3	5.6	ND
	08/09/93	1045	19.7	6.2	ND
	11/12/93	2000	7.0	6.1	ND

Table 6. Concentrations of fecal coliform and fecal streptococcus determined in stormwater-runoff samples from monitoring sites in Madison, Wisconsin

[Time is given in 24-hour (military) time; concentrations, are in colony-forming units per 100 milliliters; --, no data]

Site	Date	Time	Fecal coliform	Fecal strep
Annamark Road	06/07/93	--	1,200	7,500
	06/24/93	2040	23,000	48,000
	07/25/93	0405	8,000	23,000
	11/12/93	2021	100	1,900
Harper Road	05/22/93	1756	--	200,000
	06/07/93	--	9,500	31,000
	06/24/93	2115	12,000	25,000
	07/25/93	0450	30,000	88,000
	11/12/93	2102	82,000	55,000
Lakeland Avenue	05/22/93	2101	--	58,000[1]
	05/22/93	2101	--	49,000[1]
	06/07/93	--	9,400	35,000
	06/24/93	2005	21,000	130,000
	07/25/93	0315	29,000	48,000
	11/12/93	1950	740,000	680,000
Observatory Drive	05/22/93	2131	--	9,100
	06/07/93	1315	2,700	9,000
	06/24/93	2145	3,400	2,400
	07/25/93	0500	4,300	65,000
	11/12/93	2130	1,600	1,600
Syene Road	05/22/93	1730	--	7,800
	06/07/93	1230	2,700	26,000
	06/24/93	2115	4,500	33,000
	11/12/93	2100	1,300	36,000
	04/12/94	0945	500	1,400
Todd Drive	05/22/93	1800	--	10,000
	06/07/93	1210	3,200	19,000
	06/24/93	2045	12,000	54,000
	11/12/93	2030	--	--
West Towne	05/22/93	2020	--	980
	06/07/93	1120	260	2,000
	06/24/93	1955	500	3,700
	11/12/93	2000	2,500	3,100
	04/12/94	0900	<1	200

[1]Duplicate sample for quality assurance.

Table 7. Concentration of selected inorganic chemical constituents determined in stormwater-runoff samples from monitoring sites in Madison, Wisconsin, by the City of Madison Department of Public Health Laboratory

[Time is given in 24-hour (military) time; --, concentration not determined]

Site and constituent	Concentration, in milligrams per liter, for given date and time						
	10/09/93 0315	10/20/93 2249	11/12/93 2150	03/21/94 0300	04/12/94 1342	05/11/94 0930	05/14/94 2304
Annamark Road							
Chemical oxygen demand	40.0	47.0	37.0	34.2	9.8	45.9	29.7
Biochemical oxygen demand	8.0	--	10.0	8.1	5.2	16.0	10.0
Suspended solids	63	45	124	216	245	174	195
Dissolved solids	75	114	54	300	82	98	101
Nitrogen, ammonia	<.10	1.10	.70	1.00	<.10	1.25	.30
Nitrogen, nitrate	.63	2.35	1.12	1.00	.51	.78	.59
Nitrogen, nitrite	<.05	<.05	<.05	<.05	<.05	.67	<.05
Nitrogen, NO_2+NO_3	.63	2.35	1.12	1.00	.51	1.45	.59
Nitrogen, total kjeldahl	.60	2.45	1.45	2.50	<.10	--	1.10
Nitrogen, organic	.60	1.35	.75	1.50	<.10	--	.80
Nitrogen, total	1.23	4.80	2.57	3.50	.51	--	1.69
Phosphorus, total	.31	.28	.55	.62	.49	.24	.31
Phosphorus, dissolved	.21	--	.24	.16	.032	.06	.06

	06/17/93 1104	06/25/93 0032	07/25/93 0438	08/09/93 1122	10/09/93 0203	10/20/93 2005	11/12/93 2117	08/30/94 1607	09/14/94 0956	09/22/94 1209
Harper Road										
Chemical oxygen demand	60.7	52.5	39.0	49.0	43.0	65.6	41.0	--	--	--
Biochemical oxygen demand	7.0	9.5	6.2	4.0	13.0	--	9.0	--	--	--
Suspended solids	110	113	83	118	50	11	58	27	21	--
Dissolved solids	78	46	22	--	34	69	75	--	--	--
Nitrogen, ammonia	<.10	<.10	<.10	<.10	<.10	.95	.65	--	--	--
Nitrogen, nitrate	.45	.98	.54	.43	.49	2.02	1.04	--	--	--
Nitrogen, nitrite	<.05	<.05	<.05	<.05	<.05	<.05	<.05	--	--	--
Nitrogen, NO_2+NO_3	.45	.98	.54	.43	.49	2.02	1.04	--	--	--
Nitrogen, total kjeldahl	1.95	2.45	.80	.40	1.05	.70	1.35	--	--	--
Nitrogen, organic	1.95	2.45	.80	.40	1.05	<.10	.70	--	--	--
Nitrogen, total	2.40	3.43	1.34	.47	1.54	2.72	2.39	--	--	--
Phosphorus, total	.40	.34	.32	.32	.51	1.11	.58	--	--	--
Phosphorus, dissolved	--	--	.11	--	.36	--	.39	.30	.12	.92

Table 7. Concentration of selected inorganic chemical constituents determined in stormwater-runoff samples from monitoring sites in Madison, Wisconsin, by the City of Madison Department of Public Health Laboratory—Continued

	Concentration, in milligrams per liter, for given date and time								
	06/17/93 1135	07/25/93 0451	08/09/93 1144	11/12/93 2155	03/21/94 0421	04/12/94 1327	05/11/94 1002	08/03/94 2106	
Lakeland Avenue									
Chemical oxygen demand	38.1	43.0	75.0	221.0	49.2	29.1	--	--	
Biochemical oxygen demand	8.6	5.3	7.0	20.0	7.7	--	--	6.0	
Suspended solids	92	103	132	62	165	252	--	--	
Dissolved solids	61	27	--	183	162	78	119	--	
Nitrogen, ammonia	<.10	<.10	<.10	.80	1.20	.80	--	--	
Nitrogen, nitrate	<.10	.55	.55	<.10	1.01	.56	--	--	
Nitrogen, nitrite	<.05	<.05	<.05	<.05	<.05	<.05	--	--	
Nitrogen, NO_2+NO_3	--	.55	.55	--	1.01	.56	--	--	
Nitrogen, total kjeldahl	2.00	.85	2.40	4.25	3.10	1.60	--	--	
Nitrogen, organic	2.00	.85	2.40	3.50	1.90	.85	--	--	
Nitrogen, total	2.00	1.40	2.95	4.25	4.11	2.16	--	--	
Phosphorus, total	.44	.37	.53	2.38	.64	.71	--	--	
Phosphorus, dissolved	--	.10	--	1.40	.20	.06	.04	.15	

	06/17/93 1138	06/25/93 0103	07/25/93 0428	08/09/93 1214	10/09/93 0251	10/20/93 2012	11/12/93 2138	08/03/94 1723	08/13/94 0158
Observatory Drive									
Chemical oxygen demand	35.0	22.7	47.0	48.0	21.0	30.0	16.1	--	--
Biochemical oxygen demand	4.4	3.6	5.3	4.0	6.0	--	3.5	--	--
Suspended solids	126	163	126	76	13	14	169	--	44
Dissolved solids	100	105	49	--	165	235	172	--	--
Nitrogen, ammonia	<.10	<.10	<.10	<.10	<.10	.60	<.10	--	--
Nitrogen, nitrate	.43	1.08	.64	.80	.83	1.63	.99	--	--
Nitrogen, nitrite	<.05	<.05	<.05	<.05	<.05	<.05	.59	--	--
Nitrogen, NO_2+NO_3	.43	1.08	.64	.80	.83	1.63	1.58	--	--
Nitrogen, total kjeldahl	1.80	<.10	.50	.60	<.10	.75	.30	--	--
Nitrogen, organic	1.80	<.10	.50	.60	<.10	.15	.30	--	--
Nitrogen, total	2.23	1.08	1.14	1.40	.83	2.38	1.88	--	--
Phosphorus, total	.37	.15	.25	.15	.18	.24	.23	--	.08
Phosphorus, dissolved	--	--	.06	--	.10	--	.02	.07	.02

Table 7. Concentration of selected inorganic chemical constituents determined in stormwater-runoff samples from monitoring sites in Madison, Wisconsin, by the City of Madison Department of Public Health Laboratory—Continued

	Concentration, in milligrams per liter, for given dete and time						
	06/17/93 1431	06/25/93 0210	07/25/93 0534	08/09/93 1438	10/09/93 0344	11/13/93 0036	04/12/94 1444
Syene Road							
Chemical oxygen demand	65.6	26.0	34.0	38.0	55.0	42.0	10.5
Biochemical oxygen demand	5.0	3.2	7.1	4.0	13.0	9.0	7.2
Suspended solids	226	216	146	240	37	78	249
Dissolved solids	83	55	39	--	54	47	64
Nitrogen, ammonia	<.10	<.10	<.10	<.10	<.10	.30	.35
Nitrogen, nitrate	--	<.10	.55	.42	.76	1.00	.55
Nitrogen, nitrite	--	<.05	<.05	<.05	<.05	<.05	<.05
Nitrogen, NO_2+NO_3	--	--	.55	.42	.76	1.00	.55
Nitrogen, total kjeldahl	2.15	1.55	.25	<.10	.95	.90	.90
Nitrogen, organic	2.15	1.55	.25	<.10	.95	.65	.55
Nitrogen, total	--	1.55	.80	.42	1.71	1.90	1.45
Phosphorus, total	.44	.26	.38	.38	.37	.32	.54
Phosphorus, dissolved	--	--	.10	--	.20	.14	.03

	05/22/93 2242	06/17/93 1238	06/24/93 2308	08/09/93 1111	10/09/93 0309	10/20/93 2257	03/21/94 0329	04/12/94 1539	08/03/94 2013	08/13/94 0008	09/22/94 1142
Todd Drive											
Chemical oxygen demand	131.0	55.2	34.2	47.0	50.0	67.0	--	--	--	--	48.2
Biochemical oxygen demand	<20.0	10.0	5.5	5.0	16.0	--	8.0	--	--	--	4.5
Suspended solids	--	93	113	180	23	31	--	--	--	217	23
Dissolved solids	45	78	31	--	67	117	392	--	--	--	140
Nitrogen, ammonia	--	<.10	<.10	<.10	<.10	1.20	--	--	--	--	<.10
Nitrogen, nitrate	--	.58	.95	.44	.56	1.75	--	.56	--	--	.68
Nitrogen, nitrite	--	<.05	<.05	<.05	<.05	<.05	--	<.05	--	--	<.05
Nitrogen, NO_2+NO_3	--	.58	.95	.44	.56	1.75	--	.56	--	--	.68
Nitrogen, total kjeldahl	--	1.95	1.00	.20	.75	1.65	--	--	--	--	1.05
Nitrogen, organic	--	1.95	1.00	.20	.75	.45	--	--	--	--	1.05
Nitrogen, total	--	2.53	1.95	.64	1.31	3.40	--	--	--	--	1.73
Phosphorus, total	.31	.44	.22	.29	.38	.63	--	--	--	.10	.25
Phosphorus, dissolved	--	--	--	--	.26	--	.11	.07	.09	.03	.14

Table 7. Concentration of selected inorganic chemical constituents determined in stormwater-runoff samples from monitoring sites in Madison, Wisconsin, by the City of Madison Department of Public Health Laboratory—Continued

	Concentration, in milligrams per liter, for given dete and time									
	06/17/93 1115	07/25/93 0407	08/09/93 1151	10/09/93 0454	10/20/93 2345	11/12/93 2311	05/15/94 0156	09/09/94 1354	09/23/94 0720	11/05/94 1850
West Towne										
Chemical oxygen demand	20.0	28.0	29.0	18.0	34.0	56.0	33.9	--	--	--
Biochemical oxygen demand	3.2	5.2	3.0	4.0	--	10.0	8.1	--	--	--
Suspended solids	14	15	31	16	21	22	212	--	--	--
Dissolved solids	59	37	--	40	61	49	61	--	--	--
Nitrogen, ammonia	<.10	<.10	<.10	<.10	1.30	.50	.50	--	--	--
Nitrogen, nitrate	--	.61	.41	<.10	2.07	1.05	.68	--	--	--
Nitrogen, nitrite	--	<.05	<.05	<.05	<.05	<.05	<.05	--	--	--
Nitrogen, NO_2+NO_3	--	.61	.41	--	2.07	1.05	.68	--	--	--
Nitrogen, total kjeldahl	1.20	.70	1.40	.70	1.15	.60	.55	--	--	--
Nitrogen, organic	1.20	.70	1.40	.70	<.10	.15	.05	--	--	--
Nitrogen, total	--	1.31	1.81	.70	3.22	1.65	1.23	--	--	--
Phosphorus, total	.08	.05	.07	.06	.10	.12	.17	--	--	--
Phosphorus, dissolved	--	<.01	--	.03	--	.04	.04	.11	.01	.14

Table 8. Concentration of selected metals determined in stormwater-runoff samples from monitoring sites in Madison, Wisconsin, by the City of Madison Department of Public Health Laboratory

[Time is given in 24-hour (military) time; --, concentration not determined; concentration results designated by a "D" mean the constituent was detected between the limit of detection (LOD) and the limit of quantitation (LOQ) but no concentration estimate was obtained; concentrations followed by a * mean that the concentration is between the LOD and the LOQ

Site and constituent	Concentration, in micrograms per liter, for given dete and time						
	10/09/93 0315	10/20/93 2249	11/12/93 2150	03/21/94 0300	04/12/94 1342	05/11/94 0930	05/14/94 2304
Annamark Road							
Arsenic, total	2	--	3	--	4	--	1*
Cadmium, total	.6	.5	.7	1.4	2.1	1.4	1.1
Chromium, total	5	--	7	26	29	10	14
Copper, total	12	16	27	51	46	33	24
Lead, total	25	16	30	100	85	49	30
Nickel, total	<2	--	--	--	32*	--	44*
Selenium, total	<.8	--	1.0	--	<.8	--	<.8
Silver, total	<.1	--	0.1	--	.6	--	.2
Zinc, total	189	134	--	356	328	245	192
	06/17/93 1104	**06/25/93 0032**	**07/25/93 0438**	**08/09/93 1122**	**10/09/93 0203**	**10/20/93 2005**	**11/12/93 2117**
Harper Road							
Arsenic, total	--	D	D	--	<1	--	<1
Cadmium, total	D	.82	.8	--	1.1	.5	.4
Chromium, total	--	13	10	--	3	--	4
Copper, total	16	18	39	23	10	--	18
Lead, total	19	26	69	30	19	--	30
Nickel, total	--	24	<2	--	<2	--	<2
Selenium, total	--	3.0	1.7	--	<.8	--	.8
Silver, total	--	<.1	--	--	<.1	--	<.1
Zinc, total	182	146	160	D	97	105	131
	06/17/93 1135	**07/25/93 0451**	**08/09/93 1144**	**11/12/93 2155**	**03/21/94 0421**	**04/12/94 1327**	
Lakeland Avenue							
Arsenic, total	--	D	--	2	4	4	
Cadmium, total	1.0	.9	.8	.7	1.1	1.6	
Chromium, total	--	16	--	4	15	19	
Copper, total	23	34	466	22	31	37	
Lead, total	28	92	109	26	78	105	
Nickel, total	--	<2	--	<2	32*	44*	
Selenium, total	--	<.8	--	<.8	<.8	<.8	
Silver, total	--	--	--	.5	.3	.5	
Zinc, total	140	160	152	163	267	342	

Table 8. Concentration of selected metals determined in stormwater-runoff samples from monitoring sites in Madison, Wisconsin, by the City of Madison Department of Public Health Laboratory—Continued

	Concentration, in micrograms per liter, for given date and time						
	06/17/93 1138	**06/25/93 0103**	**07/25/93 0428**	**08/09/93 1214**	**10/09/93 0251**	**10/20/93 2012**	**11/12/93 2138**
Observatory Drive							
Arsenic, total	--	D	D	--	2	--	1
Cadmium, total	D	.34	.5	.6	.3	.1	.3
Chromium, total	--	4	7	--	5	--	5
Copper, total	57	23	31	41	20	24	35
Lead, total	27	15	23	--	12	1.9	51
Nickel, total	--	51	<2	--	<2	--	<2
Selenium, total	--	2	<.8	--	<.8	--	.8
Silver, total	--	D	--	--	<.1	--	.5
Zinc, total	179	180	220	138	125	125	216
	06/17/93 1431	**06/25/93 0210**	**07/25/93 0534**	**08/09/93 1438**	**10/09/93 0344**	**11/13/93 0036**	**04/12/94 1444**
Syene Road							
Arsenic, total	--	D	--	--	2	3	6
Cadmium, total	D	.46	1.2	.5	.6	.5	2.2
Chromium, total	--	6	--	--	5	5	22
Copper, total	35	17	21	44	13	19	38
Lead, total	17	13	27	32	11	16	57
Nickel, total	--	31	--	--	<2	--	55*
Selenium, total	--	4.0	--	--	<.8	<.8	<.8
Silver, total	--	<.1	--	--	<.1	<.1	.4
Zinc, total	215	168	190	180	152	223	392
	05/22/93 2242	**06/17/93 1238**	**06/24/93 2308**	**08/09/93 1111**	**10/09/93 0309**	**10/20/93 2257**	**09/22/94 1142**
Todd Drive							
Arsenic, total	--	--	D	--	<1	--	--
Cadmium, total	--	D	0.46	1.0	0.6	0.4	0.8
Chromium, total	--	--	7	--	8	--	8
Copper, total	--	44	55	42	14	D	22
Lead, total	--	54	23	42	14	6	17
Nickel, total	--	--	22	--	<2	--	<16
Selenium, total	--	--	2.0	--	<.8	--	<2
Silver, total	--	--	D	--	<.1	--	--
Zinc, total	--	220	210	243	149	205	--

Table 8. Concentration of selected metals determined in stormwater-runoff samples from monitoring sites in Madison, Wisconsin, by the City of Madison Department of Public Health Laboratory—Continued

	Concentration, in micrograms per liter, for given date and time							
	06/17/93 1115	07/25/93 0407	08/09/93 1151	10/09/93 0454	10/20/93 2345	11/12/93 2311	05/15/94 0156	11/05/94 1850
West Towne								
Arsenic, total	--	--	--	<1	--	<1	<1	--
Cadmium, total	1.0	.6	.7	.2	.5	.8	.8	--
Chromium, total	--	--	--	3	--	6	12	--
Copper, total	21	18	31	8	24	18	26	--
Lead, total	20	17	--	8	53	34	24	--
Nickel, total	--	--	--	<2	--	--	32*	16*
Selenium, total	--	--	--	.8	--	<.8	<.8	--
Silver, total	--	--	--	<.1	--	.4	<.1	--
Zinc, total	108	160	144	149	216	236	261	--

Table 9. Number of instances that concentrations of selected grab-sampled constituents were greater than the limits of detection at monitoring sites in Madison, Wisconsin

[LOD, limit of detection; --, no instances greater than the LOD]

Constituent	LOD range, in milligrams per liter	Site						
		Annamark Road	Harper Road	Lakeland Avenue	Observatory Drive	Syene Road	Todd Drive	West Towne
Cyanide, total	0.010	--	--	--	--	1	--	--
Oil and grease, total recoverable	5.1 - 7.1	--	--	--	--	2	--	1
Phenolics, total recoverable	.010	2	1	3	2	2	3	2

Table 10. Grab-sampled constituents found above the limits of detection at monitoring sites in Madison, Wisconsin
[Time is given in 24-hour (military) time]

Site	Constituent	Date	Time	Concentration, in milligrams per liter
Annamark Road	Phenolics, total recoverable	07/25/93	0405	0.01
		11/12/93	2021	.012
Harper Road	Phenolics, total recoverable	07/25/93	0450	.017
Lakeland Avenue	Phenolics, total recoverable	06/24/93	2005	.014
		07/25/93	0315	.013
		11/12/93	1950	.015
Observatory Drive	Phenolics, total recoverable	06/24/93	2145	.013
		07/25/93	0500	.012
Syene Road	Phenolics, total recoverable	06/24/93	2115	.01
		04/12/94	0945	.022
	Cyanide, total	04/12/94	0945	.026
	Oil and grease, total recoverable	11/12/93	2100	5.9
		04/12/94	0945	12
Todd Drive	Phenolics, total recoverable	05/22/93	1800	.024
		06/24/93	2045	.014
		11/12/93	2030	.019
West Towne	Phenolics, total recoverable	11/12/93	2000	.019
		04/12/94	0900	.033
	Oil and grease, total recoverable	04/12/94	0900	18

Table 11. Number of instances that concentrations of selected metals were greater than the limits of detection at monitoring sites in Madison, Wisconsin
[LOD, limit of detection; --, no instances greater than the LOD]

Constituent	LOD range, in micrograms per liter	Site						
		Annsmark Road	Harper Road	Lakeland Avenue	Observatory Drive	Syene Road	Todd Drive	West Towne
Antimony, total	10.0-50.0	--	--	--	--	--	--	--
Beryllium, total	5	--	--	--	--	--	--	--
Mercury, total	.2	--	--	--	--	--	--	--
Thallium, total	3	--	--	--	--	--	--	--

Table 12. Number of instances that selected pesticide or PCB concentrations were greater than the limit of detection at monitoring sites in Madison, Wisconsin

[LOD, limit of detection; --, no concentrations greater than the LOD]

Constituent	LOD range, in micrograms per liter	Site						
		Annsmsrk Road	Harper Road	Lakelsnd Avenue	Observatory Drive	Syene Road	Todd Drive	Wsst Towne
4,4'-DDD	0.10-0.11	--	--	--	--	--	--	--
4,4'-DDE	.10-.11	--	--	--	--	--	--	--
4,4'-DDT	.10-.11	--	--	--	--	--	--	--
Aldrin	.050-.054	--	--	--	--	--	--	--
Alpha-BHC	.050-.054	--	--	--	--	--	--	--
Aroclor-1016	1.0-1.1	--	--	--	--	--	--	--
Aroclor-1221	2.0-2.2	--	--	--	--	--	--	--
Aroclor-1232	1.0-1.1	--	--	--	--	--	--	--
Aroclor-1242	1.0-1.1	--	--	--	--	--	--	--
Aroclor-1248	1.0-1.1	--	--	--	--	--	--	--
Aroclor-1254	1.0-1.1	--	--	--	--	--	--	--
Aroclor-1260	1.0-1.1	--	--	--	--	--	--	--
Beta-BHC	.050-.054	--	--	--	--	--	--	--
Chlordane, technical	.050-.054	--	--	--	--	--	--	--
Delta-BHC	.050-.054	--	--	--	--	--	--	--
Dieldrin	.10-.11	--	--	--	--	--	--	--
Endosulfan I	.050-.054	--	--	--	--	--	--	--
Endosulfan II	.10-.11	--	--	--	--	--	--	--
Endosulfan sulfate	.10-.11	--	--	--	--	--	--	--
Endrin	.10-.11	--	--	--	--	--	--	--
Endrin aldehyde	.10-.11	--	--	--	--	--	--	--
Gamma-BHC (lindane)	.050-.054	--	--	--	--	--	--	--
Heptachlor	.050-.054	--	--	--	--	--	--	--
Heptachlor epoxide	.050-.054	--	--	--	--	--	--	--
Methoxychlor	.50-.54	--	--	--	3	--	--	--
Toxaphene	5.0-5.4	--	--	--	--	--	--	--

Table 13. Methoxychlor concentrations for the Observatory Drive site, Madison, Wisconsin, that were greater than the limit of detection

[Time is given in 24-hour (military) time]

Site	Pesticide	Dste	Time	Concentration, in micrograms per litsr
Observatory Drive	Methoxychlor	06/25/93	0103	3.9
		07/25/93	0428	2.7
		10/09/93	0251	.81

Table 14. Number of instances that selected semivolatile constituent concentrations were greater than the limits of detection at monitoring sites in Madison, Wisconsin

[LOD, limit of detection; --, no concentrations greater than the LOD]

Constituent	LOD range, in micrograms per liter	Site						
		Annamark Road	Herper Road	Lakelend Avenue	Observatory Drive	Syene Road	Todd Drive	West Towne
1,2,4-Trichlorobenzene	10.0-11.0	--	--	--	--	--	--	--
1,2-Dichlorobenzene	10.0-11.0	--	--	--	--	--	--	--
1,2-Diphenylhydrazine (2)	10.0-11.0	--	--	--	--	--	--	--
1,3-Dichlorobenzene	10.0-11.0	--	--	--	--	--	--	--
1,4-Dichlorobenzene	10.0-11.0	--	--	--	--	--	--	--
2,4,6-Trichlorophenol	10.0-11.0	--	--	--	--	--	--	--
2,4-Dichlorophenol	10.0-11.0	--	--	--	--	--	--	--
2,4-Dimethylphenol	10.0-11.0	--	--	--	--	--	--	--
2,4-Dinitrophenol	25-28	--	--	--	--	--	--	--
2,4-Dinitrotoluene	10.0-11.0	--	--	--	--	--	--	--
2,6-Dinitrotoluene	10.0-11.0	--	--	--	--	--	--	--
2-Chloronaphthalene	10.0-11.0	--	--	--	--	--	--	--
2-Chlorophenol	10.0-11.0	--	--	--	--	--	--	--
2-Nitrophenol	10.0-11.0	--	--	--	--	--	--	--
3,3-Dichlorobenzidine	10.0-11.0	--	--	--	--	--	--	--
4,6-Dinitro-2-methylphenol	25-28	--	--	--	--	--	--	--
4-Bromophenyl phenyl ether	10.0-11.0	--	--	--	--	--	--	--
4-Chloro-3-methylphenol	10.0-11.0	--	--	--	--	--	--	--
4-Chlorophenyl phenyl ether	10.0-11.0	--	--	--	--	--	--	--
4-Nitrophenol	25-28	--	--	--	--	--	--	--
Acenaphthene	10.0-11.0	--	--	--	--	--	--	--
Acenaphthylene	10.0-11.0	--	--	--	--	--	--	--
Anthracene	10.0-11.0	--	--	--	--	--	--	--
Benzidine	50-56	--	--	--	--	--	--	--
Benzo(*a*)anthracene	10.0-11.0	--	--	1	--	--	--	--
Benzo(*a*)pyrene	10.0-11.0	1	--	1	--	--	--	--
Benzo(*b*)fluoranthene	10.0-11.0	1	--	1	--	--	--	--
Benzo(*g,h,i*)perylene	10.0-11.0	1	--	1	--	--	--	--
Benzo(*k*)fluoranthene	10.0-11.0	1	--	1	--	--	--	--

Table 14. Number of instances that selected semivolatile constituent concentrations were greater than the limits of detection at monitoring sites in Madison, Wisconsin—Continued

Constituent	LOD range, in micrograms per liter	Site						
		Annamark Road	Harper Road	Lakeland Avenue	Observatory Drive	Syene Road	Todd Drive	West Towne
Bis(2-chloroethoxy)methane	10.0-11.0	--	--	--	--	--	--	--
Bis(2-chloroethyl)ether	10.0-11.0	--	--	--	--	--	--	--
Bis(2-chloroisopropyl)ether	10.0-11.0	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	10.0-11.0	1	--	1	--	--	--	1
Butylbenzylphthalate	10.0-11.0	--	--	--	--	--	--	--
Chrysene	10.0-11.0	1	--	1	--	--	--	--
Di-*n*-butyl phthalate	10.0-11.0	--	--	--	--	--	--	--
Di-*n*-octyl phthalate	10.0-11.0	--	--	--	--	--	--	2
Dibenz(*a*,*h*)anthracene	10.0-11.0	--	--	--	--	--	--	--
Diethylphthalate	10.0-11.0	--	--	--	--	--	--	--
Dimethylphthalate	10.0-11.0	--	--	--	--	--	--	--
Fluoranthene	10.0-11.0	1	--	1	--	--	2	1
Fluorene	10.0-11.0	--	--	--	--	--	--	--
Hexachlorobenzene	10.0-11.0	--	--	--	--	--	--	--
Hexachlorobutadiene	10.0-11.0	--	--	--	--	--	--	--
Hexachlorocyclopentadiene	10.0 - 11.0	--	--	--	--	--	--	--
Hexachloroethane	10.0-11.0	--	--	--	--	--	--	--
Indeno(1,2,3-*cd*)pyrene	10.0-11.0	1	--	--	--	--	--	--
Isophorone	10.0-11.0	--	--	--	--	--	--	--
N-Nitrosodi-*n*-propylamine	10.0-11.0	--	--	--	--	--	--	--
N-Nitrosodimethylamine	10.0-11.0	--	--	--	--	--	--	--
N-Nitrosodiphenylamine (1)	10.0-11.0	--	--	--	--	--	--	--
Naphthalene	10.0-11.0	--	--	--	--	--	--	--
Nitrobenzene	10.0-11.0	--	--	--	--	--	--	--
Pentachlorophenol	25-28	--	--	--	--	--	--	--
Phenanthrene	10.0-11.0	1	--	1	--	--	2	--
Phenol	10.0-11.0	--	--	--	--	--	--	--
Pyrene	10.0-11.0	1	--	1	--	--	2	--

Table 15. *Semivolatile constituent concentrations that were greater than the limits of detection at selected monitoring sites in Madison, Wisconsin*

[Time is given in 24-hour (military) time; *, concentration is between the limit of detection (LOD) and the limit of quantitation (LOQ)]

Site	Constituent	Dete	Time	Concentration, in micrograms per liter
Annamark Road	Benzo(*a*)pyrene	04/12/94	1342	4*
	Benzo(*b*)fluoranthene	04/12/94	1342	7*
	Benzo(*g,h,i*)perylene	04/12/94	1342	4*
	Benzo(*k*)fluoranthene	04/12/94	1342	5*
	Bis(2-ethylhexyl)phthalate	04/12/94	1342	8*
	Chrysene	04/12/94	1342	8*
	Fluoranthene	04/12/94	1342	16
	Indeno(1,2,3-*cd*)pyrene	04/12/94	1342	3*
	Phenanthrene	04/12/94	1342	9*
	Pyrene	04/12/94	1342	11
Lakeland Avenue	Benzo(*a*)anthracene	04/12/94	1327	2*
	Benzo(*a*)pyrene	04/12/94	1327	2*
	Benzo(*b*)fluoranthene	04/12/94	1327	4*
	Benzo(*g,h,i*)perylene	04/12/94	1327	2*
	Benzo(*k*)fluoranthene	04/12/94	1327	3*
	Bis(2-ethylhexyl)phthalate	04/12/94	1327	9*
	Chrysene	04/12/94	1327	4*
	Fluoranthene	04/12/94	1327	9*
	Phenanthrene	04/12/94	1327	5*
	Pyrene	04/12/94	1327	6*
Todd Drive	Fluoranthene	05/22/93	2242	13
	Phenanthrene	05/22/93	2242	4*
	Pyrene	05/22/93	2242	10
	Fluoranthene	06/24/93	2308	11
	Phenanthrene	06/24/93	2308	4*
	Pyrene	06/24/93	2308	8*
West Towne	Di-*n*-octyl phthalate	11/12/93	2311	5*
	Fluoranthene	05/15/94	0156	2*
	Bis(2-ethylhexyl)phthalate	05/15/94	0156	6*
	Di-*n*-octyl phthalate	05/15/94	0156	3*

Table 16. Number of instances that volatile organic constituent concentrations were greater than the limits of detection at selected monitoring sites in Madison, Wisconsin

[LOD, limit of detection; --, no concentrations greater than the LOD]

Constituent	LOD, in micrograms per liter	Site	
		Todd Drive	West Towne
1,1,1-Trichloroethane	10	--	--
1,1,2,2-Tetrachloroethane	10	--	--
1,1,2-Trichloroethane	10	--	--
1,1-Dichloroethane	10	--	--
1,1-Dichloroethene	10	--	--
1,2-Dichloroethane	10	--	--
1,2-Dichloroethene, total	10	--	--
1,2-Dichloropropane	10	--	--
2-Chloroethylvinyl ether	10	--	--
Acrolein	20	--	--
Acrylonitrile	20	--	--
Benzene	10	--	--
Bromodichloromethane	10	--	--
Bromoform	10	--	--
Bromomethane	10	--	--
Carbon tetrachloride	10	--	--
Chlorobenzene	10	--	--
Chlorodibromomethane	10	--	--
Chloroethane	10	--	--
Chloroform	10	--	--
Chloromethane	10	--	--
cis-1,3-Dichloropropene	10	--	--
Ethylbenzene	10	--	--
Fluorotrichloromethane	10	--	--
Methylene chloride	10	--	--
Tetrachloroethene	10	--	--
Toluene	10	--	--
trans-1,3-Dichloropropene	10	--	--
Trichloroethene	10	--	--
Vinyl chloride	10	--	--

Table 17. Storm loads of selected inorganic constituents in stormwater-runoff samples from monitoring sites in Madison, Wisconsin

[Time is given in 24-hour (military) time; --, no load calculated]

Site and constituent	Storm load, in kilograms, for given date and time									
	10/09/93 0315	10/20/93 2249	11/12/93 2150	03/21/94 0300	04/12/94 1342	05/11/94 0930	05/14/94 2304			
Annamark Road										
Chemical oxygen demand	17.4	11.2	13.0	6.7	7.6	10.7	13.4			
Biochemical oxygen demand	3.5	--	3.5	1.6	4.0	3.7	4.5			
Suspended solids	27.5	10.8	43.6	42.2	191	40.4	88.0			
Dissolved solids	32.7	27.3	19.0	58.6	63.8	22.8	45.6			
Nitrogen, ammonia	--	.26	.25	.20	--	.29	.14			
Nitrogen, nitrate	.27	.56	.39	.20	.40	.18	.27			
Nitrogen, nitrite	--	--	--	--	--	.16	--			
Nitrogen, NO_2+NO_3	.27	.56	.39	.20	.40	.34	.27			
Nitrogen, total kjeldahl	.26	.59	.51	.49	--	--	.50			
Nitrogen, organic	.26	.32	.26	.29	--	--	.36			
Nitrogen, total	.54	1.2	.90	.68	.40	--	.76			
Phosphorus, total	.14	.07	.19	.12	.38	.06	.14			
Phosphorus, dissolved	.09	--	.08	.03	.02	.01	.03			
	06/17/93 1104	**06/25/93 0032**	**07/25/93 0438**	**08/09/93 1122**	**10/09/93 0203**	**10/20/93 2005**	**11/12/93 2117**	**08/30/94 1607**	**09/14/94 0956**	**09/22/94 1209**
Harper Road										
Chemical oxygen demand	10.5	25.8	54.7	35.3	9.7	6.0	7.0	--	--	--
Biochemical oxygen demand	1.2	4.6	8.6	2.9	2.9	--	1.5	--	--	--
Suspended solids	18.9	55.5	116	85.0	11.3	1.0	9.8	9.1	23.2	--
Dissolved solids	13.4	22.6	30.9	--	7.7	6.3	12.7	--	--	--
Nitrogen, ammonia	--	--	--	--	--	.09	.11	--	--	--
Nitrogen, nitrate	.08	.48	.76	.31	.11	.18	.18	--	--	--
Nitrogen, nitrite	--	--	--	--	--	--	--	--	--	--
Nitrogen, NO_2+NO_3	.08	.48	.76	.31	.11	.18	.18	--	--	--
Nitrogen, total kjeldahl	.34	1.20	1.12	.29	.24	.06	.23	--	--	--
Nitrogen, organic	.34	1.20	1.12	.29	.24	--	.12	--	--	--
Nitrogen, total	.41	1.69	1.88	.34	.35	.25	.41	--	--	--
Phosphorus, total	.07	.17	.45	.23	.12	.10	.10	--	--	--
Phosphorus, dissolved	--	--	.15	--	.08	--	.07	.10	.13	.24

Table 17. Storm loads of selected inorganic constituents in stormwater-runoff samples from monitoring sites in Madison, Wisconsin—Continued

	Storm load, in kilograms, for given date and time							
	06/17/93 1135	07/25/93 0451	08/09/93 1144	11/12/93 2155	03/21/94 0421	04/12/94 1327	05/11/94 1002	08/03/94 2106
Lakeland Avenue								
Chemical oxygen demand	15.2	47.3	15.6	25.2	17.8	8.1	--	--
Biochemical oxygen demand	3.4	5.8	1.5	2.3	2.8	--	--	3.0
Suspended solids	36.7	113	27.5	7.1	59.7	69.7	--	--
Dissolved solids	24.3	29.7	--	20.9	58.7	21.6	12.3	--
Nitrogen, ammonia	--	--	--	.09	.43	.22	--	--
Nitrogen, nitrate	--	.61	.11	--	.37	.15	--	--
Nitrogen, nitrite	--	--	--	--	--	--	--	--
Nitrogen, NO_2+NO_3	--	.61	.11	--	.37	.15	--	--
Nitrogen, total kjeldahl	.80	.94	.50	.48	1.12	.44	--	--
Nitrogen, organic	.80	.94	.50	.40	.69	.24	--	--
Nitrogen, total	.80	1.54	.61	.48	1.49	.60	--	--
Phosphorus, total	.18	.41	.11	.27	.23	.20	--	--
Phosphorus, dissolved	--	.11	--	.16	.07	.02	.0	.07

	06/17/93 1138	06/25/93 0103	07/25/93 0428	08/09/93 1214	10/09/93 0251	10/20/93 2012	11/12/93 2138	08/03/94 1723	08/13/94 0158
Observatory Drive									
Chemical oxygen demand	20.5	19.1	89.2	28.8	5.8	3.7	5.5	--	--
Biochemical oxygen demand	2.6	3.0	10.1	2.4	1.7	--	1.2	--	--
Suspended solids	73.7	137	239	45.6	3.6	1.7	57.7	--	8.8
Dissolved solids	58.5	88.3	92.9	--	45.7	28.8	58.8	--	--
Nitrogen, ammonia	--	--	--	--	--	.07	--	--	--
Nitrogen, nitrate	.25	.91	1.21	.48	.23	.20	.34	--	--
Nitrogen, nitrite	--	--	--	--	--	--	.20	--	--
Nitrogen, NO_2+NO_3	.25	.91	1.21	.48	.23	.20	.54	--	--
Nitrogen, total kjeldahl	1.05	--	.95	.36	--	.09	.10	--	--
Nitrogen, organic	1.05	--	.95	.36	--	.02	.10	--	--
Nitrogen, total	1.30	.91	2.16	.84	.23	.29	.64	--	--
Phosphorus, total	.22	.13	.47	.09	.05	.03	.08	--	.02
Phosphorus, dissolved	--	--	.11	--	.03	--	.01	.06	.0

Table 17. Storm loads of selected inorganic constituents in stormwater-runoff samples from monitoring sites in Madison, Wisconsin—Continued

	Storm load, in kilograms, for given date and time						
	06/17/93 1431	06/25/93 0210	07/25/93 0534	08/09/93 1438	10/09/93 0344	11/13/93 0036	04/12/94 1444
Syene Road							
Chemical oxygen demand	182	159	477	198	84.6	93.9	36.2
Biochemical oxygen demand	13.8	19.6	99.3	20.8	20.0	20.1	24.9
Suspended solids	625	1,320	2,050	1,250	56.9	175	860
Dissolved solids	230	337	547	--	83.1	105	221
Nitrogen, ammonia	--	--	--	--	--	.56	1.21
Nitrogen, nitrate	--	--	7.72	2.18	1.17	2.24	1.90
Nitrogen, nitrite	--	--	--	--	--	--	--
Nitrogen, NO_2+NO_3	--	--	7.72	2.18	1.17	2.24	1.90
Nitrogen, total kjeldahl	5.95	9.49	3.51	--	1.46	2.01	3.11
Nitrogen, organic	5.95	9.49	3.51	--	1.46	1.45	1.90
Nitrogen, total	--	9.49	11.2	2.18	2.63	4.25	5.01
Phosphorus, total	1.22	1.59	5.33	1.98	.57	.72	1.86
Phosphorus, dissolved	--	--	1.40	--	.31	.31	.10

	05/22/93 2242	06/17/93 1238	06/24/93 2308	08/09/93 1111	10/09/93 0309	10/20/93 2257	03/21/94 0329	04/12/94 1539	08/03/94 2013	08/13/94 0008	09/22/94 1142
Todd Drive											
Chemical oxygen demand	121	85.9	81.4	140	37.4	33.3	--	--	--	--	36.3
Biochemical oxygen demand	--	15.6	13.0	14.9	12.0	--	8.7	--	--	--	3.4
Suspended solids	--	145	269	538	17.2	15.4	--	--	--	253	17.3
Dissolved solids	41.5	121	73.8	--	50.1	58.2	427	--	--	--	105
Nitrogen, ammonia	--	--	--	--	--	.60	--	--	--	--	--
Nitrogen, nitrate	--	.90	2.26	1.31	.42	.87	--	1.35	--	--	.51
Nitrogen, nitrite	--	--	--	--	--	--	--	--	--	--	--
Nitrogen, NO_2+NO_3	--	.90	2.26	1.31	.42	.87	--	1.35	--	--	.51
Nitrogen, total kjeldahl	--	3.03	2.38	.60	.56	.82	--	--	--	--	.79
Nitrogen, organic	--	3.03	2.38	.60	.56	.22	--	--	--	--	.79
Nitrogen, total	--	3.94	4.64	1.91	.98	1.69	--	--	--	--	1.30
Phosphorus, total	.29	.68	.52	.87	.28	.31	--	--	--	.12	.19
Phosphorus, dissolved	--	--	--	--	.19	--	.12	.17	.60	.04	.11

Table 17. Storm loads of selected inorganic constituents in stormwater-runoff samples from monitoring sites in Madison, Wisconsin—Continued

	Storm load, in kilograms, for given date and time									
	06/17/93 1115	07/25/93 0407	08/09/93 1151	10/09/93 0454	10/20/93 2345	11/12/93 2311	05/15/94 0156	09/09/94 1354	09/23/94 0720	11/04/94 1850
West Towne										
Chemical oxygen demand	17.3	57.3	35.8	12.8	12.9	31.2	16.7	--	--	--
Biochemical oxygen demand	2.8	10.7	3.7	2.9	--	5.6	4.0	--	--	--
Suspended solids	12.1	30.7	38.3	11.4	7.9	12.3	105	--	--	--
Dissolved solids	51.0	75.7	--	28.5	23.1	27.3	30.1	--	--	--
Nitrogen, ammonia	--	--	--	--	.49	.25	.25	--	--	--
Nitrogen, nitrate	--	1.25	.51	--	.78	.59	.34	--	--	--
Nitrogen, nitrite	--	--	--	--	--	--	--	--	--	--
Nitrogen, NO_2+NO_3	--	1.25	.51	--	.78	.59	.34	--	--	--
Nitrogen, total kjeldahl	1.04	1.43	1.73	.50	.43	.33	.27	--	--	--
Nitrogen, organic	1.04	1.43	1.73	.50	--	.08	.02	--	--	--
Nitrogen, total	--	2.68	2.24	.50	1.22	.92	.61	--	--	--
Phosphorus, total	.07	.10	.09	.04	.04	.07	.08	--	--	--
Phosphorus, dissolved	--	--	--	.02	--	.02	.02	.15	.01	.09

Table 18. Storm loads of selected metals in stormwater-runoff samples from monitoring sites in Madison, Wisconsin

[Time is given in 24-hour (military) time; --, no load calculated]

	Storm load, in grams, for given date and time						
	10/09/93 0315	**10/20/93 2249**	**11/12/93 2150**	**03/21/94 0300**	**04/12/94 1342**	**05/11/94 0930**	**05/14/94 2304**
Annamark Road							
Arsenic, total	0.9	--	1.1	--	3.1	--	0.5
Cadmium, total	.3	.1	.3	.3	1.6	.3	.5
Chromium, total	2.2	--	2.5	5.1	23	2.3	6.3
Copper, total	5.2	3.8	9.5	10	36	7.7	11
Lead, total	11	3.8	11	20	66	11	14
Nickel, total	--	--	--	--	25	--	20
Selenium, total	--	--	.4	--	--	--	--
Silver, total	--	--	.0	--	.5	--	.1
Zinc, total	82	32	--	70	260	57	87

	06/17/93 1104	**06/25/93 0032**	**07/25/93 0438**	**08/09/93 1122**	**10/09/93 0203**	**10/20/93 2005**	**11/12/93 2117**
Harper Road							
Arsenic, total	--	--	--	--	--	--	--
Cadmium, total	--	.4	1.1	--	.3	.1	.1
Chromium, total	--	6.4	14	--	.7	--	.7
Copper, total	2.8	8.8	55	17	2.3	--	3.1
Lead, total	3.3	13	97	22	4.3	--	5.1
Nickel, total	--	12	--	--	--	--	--
Selenium, total	--	1.5	2.4	--	--	--	.1
Silver, total	--	--	--	--	--	--	--
Zinc, total	31	72	220	--	22	10	22

	06/17/93 1135	**07/25/93 0451**	**08/09/93 1144**	**11/12/93 2155**	**03/21/94 0421**	**04/12/94 1327**
Lakeland Avenue						
Arsenic, total	--	--	--	.2	1.4	1.1
Cadmium, total	.4	1.0	.2	.1	.4	.4
Chromium, total	--	18	--	.5	5.4	5.3
Copper, total	9.2	37	97	2.5	11	10
Lead, total	11	100	23	3.0	28	29
Nickel, total	--	--	--	--	12	12
Selenium, total	--	--	--	--	--	--
Silver, total	--	--	--	.1	.1	.1
Zinc, total	56	180	32	19	97	95

Table 18. Storm loads of selected metals in stormwater-runoff samples from monitoring sites in Madison, Wisconsin—Continued

	Storm load, in grams, for given date and time						
	06/17/93 1138	**06/25/93 0103**	**07/25/93 0428**	**08/09/93 1214**	**10/09/93 0251**	**10/20/93 2012**	**11/12/93 2138**
Observatory Drive							
Arsenic, total	--	--	--	--	.6	--	.3
Cadmium, total	--	.3	1.0	.4	.1	.0	.1
Chromium, total	--	3.4	13	--	1.4	--	1.7
Copper, total	33	19	59	25	5.5	2.9	12
Lead, total	16	13	44	--	3.3	.2	17
Nickel, total	--	43	--	--	--	--	--
Selenium, total	--	1.7	--	--	--	--	.3
Silver, total	--	--	--	--	--	--	.2
Zinc, total	100	150	420	83	35	15	74
	06/17/93 1431	**06/25/93 0210**	**07/25/93 0534**	**08/09/93 1438**	**10/09/93 0344**	**11/13/93 0036**	**04/12/94 1444**
Syene Road							
Arsenic, total	--	--	--	--	3.1	6.7	21
Cadmium, total	--	2.8	17	2.6	.9	1.1	7.6
Chromium, total	--	37	--	--	7.7	11	76
Copper, total	97	100	290	230	20	42	130
Lead, total	47	80	380	170	17	36	200
Nickel, total	--	190	--	--	--	--	190
Selenium, total	--	24	--	--	--	--	--
Silver, total	--	--	--	--	--	--	1.4
Zinc, total	590	1,030	2,670	940	230	500	1,350
	06/17/93 1238	**06/24/93 2308**	**08/09/93 1111**	**10/09/93 0309**	**10/20/93 2257**	**09/22/94 1142**	
Todd Drive							
Arsenic, total	--	--	--	--	--	--	
Cadmium, total	--	1.1	3.0	.5	.2	.6	
Chromium, total	--	17	--	6.0	--	6.0	
Copper, total	68	130	130	10	--	17	
Lead, total	84	55	130	10	3.0	--	
Nickel, total	--	52	--	--	--	--	
Selenium, total	--	4.8	--	--	--	--	
Silver, total	--	--	--	--	--	--	
Zinc, total	340	500	730	110	100	--	

Table 18. Storm loads of selected metals in stormwater-runoff samples from monitoring sites in Madison, Wisconsin—Continued

	Storm load, in grams, for given date and time							
	06/17/93 1115	07/25/93 0407	08/09/93 1151	10/09/93 0454	10/20/93 2345	11/12/93 2311	05/15/94 0156	11/05/94 1850
West Towne								
Arsenic, total	--	--	--	--	--	--	--	--
Cadmium, total	.9	1.2	.9	.1	.2	.4	.4	--
Chromium, total	--	--	--	2.1	--	3.4	5.9	--
Copper, total	18	37	38	5.7	9.1	10	13	--
Lead, total	17	35	--	5.7	20	19	12	--
Nickel, total	--	--	--	--	--	--	16	11
Selenium, total	--	--	--	.6	--	--	--	--
Silver, total	--	--	--	--	--	.2	--	--
Zinc, total	93	330	180	110	82	140	130	--

Table 19. Storm loads of semivolatile constituents at monitoring sites in Madison, Wisconsin, for all instances where concentrations were greater than the limits of detection

[Time is given in 24-hour (military) time; *, concentration is between the limit of detection (LOD) and the limit of quantitation (LOQ)]

Site	Date	Time	Runoff volume sampled, in cubic feet	Constituent	Concentration, micrograms per liter	Storm load, in grams
Annamark Road	04/12/94	1342	27,467	Benzo(*a*)pyrene	4*	3.1
				Benzo(*b*)fluoranthene	7*	5.4
				Benzo(*g,h,i*)perylene	4*	3.1
				Benzo(*k*)fluoranthene	5*	3.9
				Bis(2-ethylhexyl)phthalate	8*	6.2
				Chrysene	8*	6.2
				Fluoranthene	16	12
				Indeno(1,2,3-*cd*)pyrene	3*	2.3
				Phenanthrene	9*	7.0
				Pyrene	11	8.6
Lakeland Avenue	04/12/94	1327	9,772	Benzo(*a*)anthracene	2*	0.6
				Benzo(*a*)pyrene	2*	.6
				Benzo(*b*)fluoranthene	4*	1.1
				Benzo(*g,h,i*)perylene	2*	.6
				Benzo(*k*)fluoranthene	3*	.8
				Bis(2-ethylhexyl)phthalate	9*	2.5
				Chrysene	4*	1.1
				Fluoranthene	9*	2.5
				Phenanthrene	5*	1.4
				Pyrene	6*	1.7
Todd Drive	05/22/93	2242	32,573	Fluoranthene	13	12
				Phenanthrene	4*	3.7
				Pyrene	10	9.2
	06/24/93	2308	84,024	Fluoranthene	11	26
				Phenanthrene	4*	9.5
				Pyrene	8*	19
West Towne	11/12/93	2311	19,699	Di-*n*-octyl phthalate	5*	2.8
	05/15/94	0156	17,436	Fluoranthene	2*	1.0
				Bis(2-ethylhexyl)phthalate	6*	3.0
				Di-*n*-octyl phthalate	3*	1.5

Table 20. Methoxychlor storm loads for the Observatory Drive site, Madison, Wisconsin, for all instances where concentrations were greater than the limits of detection

[Time is given in 24-hour (military) time]

Site	Date	Time	Concentretion, in micrograms per liter	Runoff volume sampled, in cubic feet	Methoxychlor load, in grams
Observatory Drive	06/25/93	0103	3.9	29,700	3.3
	07/25/93	0428	2.7	66,986	5.1
	10/09/93	0251	.81	9,784	.2

U.S. GOVERNMENT PRINTING OFFICE: 1996 - 747-585