FIVE-YEAR PROJECT REPORT

City of Des Moines Water Quality Monitoring Program

Prepared for

City of Des Moines
Surface Water Management Utility

February 2001

AR 025289

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Water Quality Monitoring Program

Prepared for

City of Des Moines
Surface Water Management Utility
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Acknowledgments

The habitat surveys for this monitoring program were performed by Joy P. Michaud of Envirovision. In addition, Envirovision collected the benthic invertebrate samples and conducted the public involvement workshops. Aquatic Biology Associates analyzed the benthic invertebrate samples. Aquatic Research, Inc. analyzed the water samples. Stream gauges were read by Wayne Matthews (city of Des Moines) and by the following volunteers: Iva Hays, Peggy McClusky, Joe Dusenberry, and Sandy Kline.

Introduction

This document is the final project report for the city of Des Moines water quality monitoring program. Methods and results are presented for the entire 5-year monitoring program, which was conducted from October 1994 through November 1999. Monitoring has been conducted in accordance with the *Water Quality Monitoring and Quality Assurance Project Plan* (Herrera 1994). Methods and results for the first three years of monitoring have been presented in annual reports (Herrera 1995, 1996, 1998).

The primary objective of this 5-year monitoring program has been to collect a comprehensive set of data for evaluating trends in water quality in three stream basins within the city of Des Moines. Water quality and biological monitoring were conducted over a 5-year period at upstream and downstream locations in each of the stream basins. Water quality data were collected to assess the effects of a program of stormwater management and nonpoint source pollution control being implemented under the *City of Des Moines Comprehensive Stormwater Management Plan* (Parametrix 1991). Biological monitoring data were collected to evaluate the ways in which water quality and stormwater management affect benthic invertebrates and aquatic habitat. The data set from this monitoring program were also used to identify and prioritize water quality problems, by comparing monitoring results to data for other streams in the region and to Washington state surface water quality standards for Class AA streams (WAC 173-201A).

The purpose of this final project report is to describe methods of data collection and analysis, present analytical results for the fourth and fifth years of the monitoring program, and provide a comprehensive analysis of the results for the entire monitoring program.

This report begins with a brief site description, and then describes methods and results of the following monitoring program components:

- Water quality monitoring
- Pollutant source tracking
- Benthic invertebrate monitoring
- Habitat surveys
- Public involvement program.

Finally, conclusions from the monitoring program and recommendations for continued monitoring are presented.

Site Description

The study area for the city of Des Moines water quality monitoring program comprises three stream basins: Des Moines Creek, Massey Creek, and the north fork of McSorley Creek (Figure 1). Each of these basins is described in the drainage area characterization and water quality assessment sections of the *City of Des Moines Comprehensive Stormwater Management Plan* (Parametrix 1991). The drainage area characterization describes physical characteristics (i.e., topography, soil types, climate, land use, and drainage facilities), sensitive areas (i.e., wetlands, stream corridors, erosion hazard areas, and flood hazard areas), and beneficial uses (i.e., fisheries, wildlife, and recreation). The water quality assessment describes water quality, habitat quality, and potential sources of pollution.

Basin characteristics and stormwater management facilities are summarized below for each of the three basins along with historical observations of water and habitat quality. Additional information will be provided in a current update of the city's stormwater management plan (in preparation by RW Beck).

In 1999, the city of Des Moines annexed additional property that includes residential areas located in other stream basins that also discharge to Puget Sound (Figure 2). Annexed property located south of the previous city limits includes most of the land draining to the south fork of McSorley Creek and Woodmont Creek, as well as the lower reaches of Redondo Creek and Cold Creek. Annexed property located north of the previous city limits includes a portion of the Normandy Creek basin. Monitoring was not conducted in these basins for this water quality monitoring program.

Des Moines Creek Basin

Des Moines Creek is the largest stream flowing through the city of Des Moines. Des Moines Creek originates on a plateau that has a fairly low gradient, until it descends steeply through a ravine before entering Puget Sound. Des Moines Creek is approximately 3.5 miles long and flows from an elevation of about 350 feet to its mouth within the Des Moines Beach Park on Puget Sound, located just north of the Des Moines marina (see Figure 2). Only the lower portion of the stream basin is located within the city limits, comprising approximately 500 acres (14 percent) of the entire 3,700-acre Des Moines Creek basin. Basin land use within the city of Des Moines is primarily open space and single-family residences, with some commercial development near Pacific Highway South (SR 99). Areas of the basin outside (upstream of) Des Moines include Seattle-Tacoma International Airport, the Tyee Golf Course, and substantial commercial and residential development.

In 1986, a multi-agency management team (including the Municipality of Metropolitan Seattle [Metro], King County, Trout Unlimited, and the Washington Department of Ecology) began discussing the restoration of Des Moines Creek. The *Des Moines Creek Restoration Project* (Herrera and Hall 1989) presents the outcome of those discussions and a plan for controlling and

LEGEND

NORMANDY CREEK

DES MOINES CREEK

GREEN RIVER

MASSEY CREEK

DIRECT OUTFLOW TO PUGET SOUND

MC SORLEY CREEK

WOODMONT CREEK

REDONDO/COLD CREEK

2. STORMWATER MANAGEMENT FACILITIES IN THE CITY OF DES MOINES.

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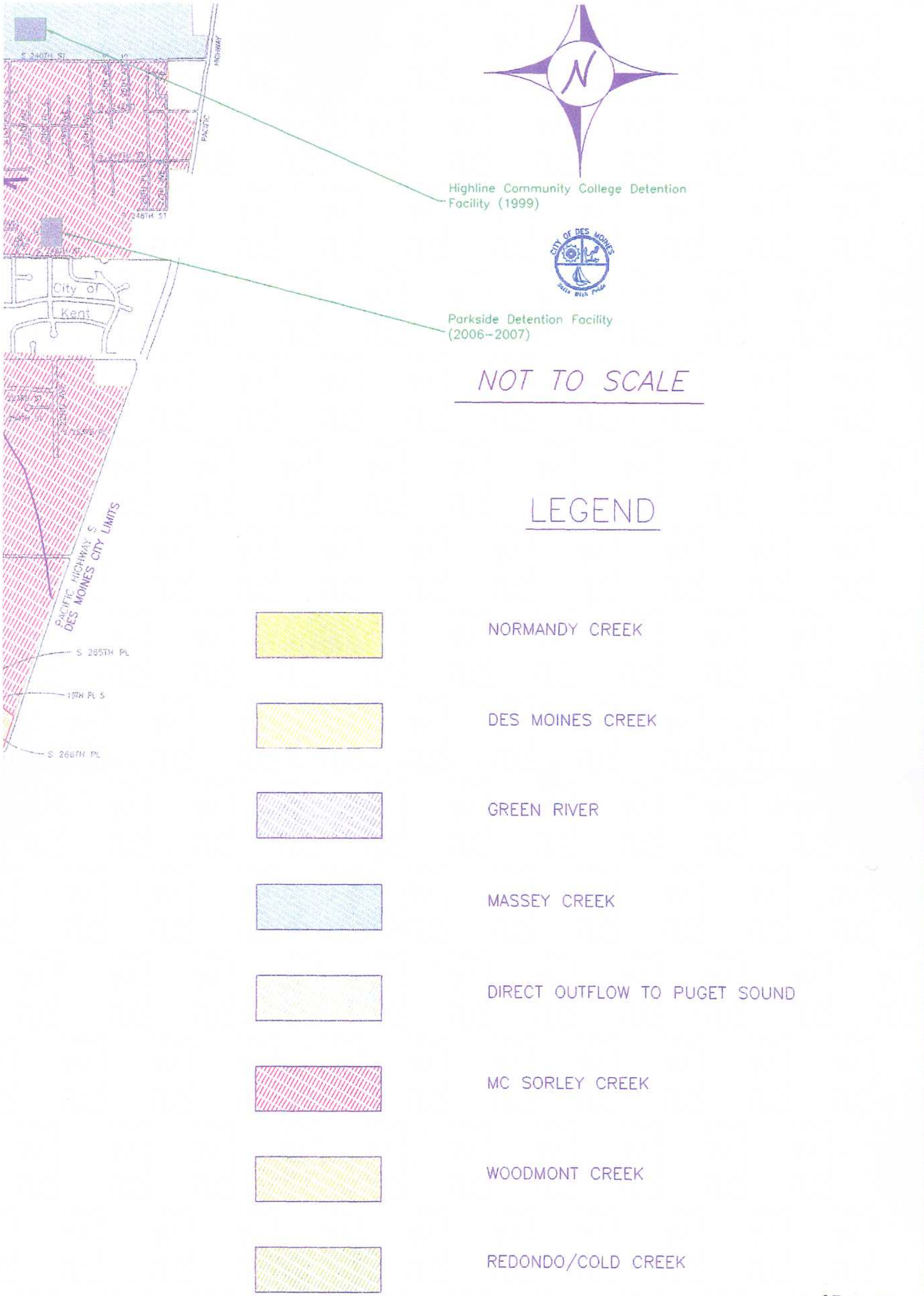

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FIGURE 2. STORMWATER MANAGEMENT FACILITIES IN THE CITY OF DES MOINES.

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maintaining water quality in the creek and restoring salmon and trout populations. This restoration report identifies problems and suggests solutions for restoring water quality and fisheries in Des Moines Creek.

In 1997, a multi-agency management team (including the city of SeaTac, city of Des Moines, Port of Seattle, and King County) prepared the *Des Moines Creek Basin Plan* (Des Moines Creek Basin Committee 1997). Primary goals of this plan include addressing interjurisdictional issues regarding water quality and quantity, and recommending capital improvement projects. The primary recommendation involves construction of a regional (in-stream) detention facility in Tyee Golf Course, combined with the use of an abandoned sewer pipe as a bypass for excess streamflow. Replacement of the culvert under Marine View Drive with a bridge is recommended to improve fish passage. Additional recommendations include a low-flow augmentation facility near South 200th Street, a series of habitat improvement projects in the city of Des Moines, and initiation of a program to reduce fecal contamination from onsite wastewater treatment (septic) systems.

Improvement projects completed since 1997 include stabilizing stream banks upstream of the Des Moines Creek wastewater treatment plant, and planting riparian vegetation in Des Moines Beach Park. It is anticipated that the recommended regional detention facility will be constructed in 2002 and 2003, and the bridge will be constructed in 2001 or 2002.

Historical information on water and habitat quality in Des Moines Creek is provided in the water quality monitoring plan (Herrera 1994) and is summarized below. More recent information, not summarized here, was collected for the basin plan (Des Moines Creek Basin Committee 1997), and current information is being collected by the Port of Seattle.

Water Quality

A comprehensive study of water quality was conducted for Des Moines Creek in 1973 and 1974 (Stevens, Thompson, and Runyan 1974; data reported by Herrera and Hall 1989). During this study, several field parameters were measured (including temperature, turbidity, and dissolved oxygen), and samples were submitted for analysis of nutrients, fecal coliform bacteria, metals, pesticides, and herbicides. Samples were collected monthly at several sampling stations. Biological characteristics and stream hydrology are described in the restoration report (Herrera and Hall 1989).

Numerous violations of Washington state water quality standards for Class AA streams (WAC 173-201A) were reported by Herrera and Hall (1989). Exceedances were observed for fecal coliform bacteria, metals, and turbidity. Turbidity measurements and concentrations of lead, copper, and zinc were particularly high in samples collected during storm events, indicating surface runoff as the source of contamination. High temperature and low dissolved oxygen concentrations were observed in measurements made during the summer months. Pesticides and herbicides (including DDT; aldrin; dieldrin; 2,4-D; and 2,4,5-T) were also detected at elevated concentrations in samples collected from the creek.

Between 1985 and 1986, there were two major spills of highly toxic jet fuel into the creek. These spills eliminated nearly all aquatic life throughout most of the stream (RW Beck 1990). The creek appeared to recover from the spills, and the Des Moines chapter of Trout Unlimited has implemented projects to restore fishery resources in the creek (Stafford 1990 personal communication).

Habitat Quality

Historical habitat surveys of Des Moines Creek suggest that the creek had suitable spawning and rearing habitat for several salmon and trout species (Herrera and Hall 1989). However, physical modifications to the creek had reduced the available fishery habitat. From the mouth of the creek to Marine View Drive, the creek had been channelized and the banks had been stabilized using large riprap. The remainder of the stream within Des Moines city limits was in a relatively natural condition, except for fish passage weirs near the Des Moines Creek wastewater treatment plant. The substrate was primarily gravel, and the vegetated canopy provided unbroken shade for the creek. The pool/riffle ratio was nearly 1 to 1. This reach of the creek was considered some of the best fish habitat in Des Moines Creek. However, high stormwater flow and lack of refuge for small fish limited the suitability of this habitat for fish production (Johnson 1989 personal communication).

Examination of benthic invertebrate communities provides another measure of the biological health of a creek. In Des Moines Creek, characteristics observed in these benthic communities indicate that the creek had been moderately polluted (Herrera and Hall 1989). Many species were observed in low abundances, including those sensitive species that are typically found in clean waters.

Massey Creek Basin

The Massey Creek basin is the largest drainage basin in the city of Des Moines, covering approximately 1,700 acres. Massey Creek flows for 1.9 miles parallel to the Kent–Des Moines Road (SR 516), and discharges to Puget Sound just south of the Des Moines marina (see Figure 2). Barnes Creek is a major tributary to Massey Creek, joining the main stem of Massey Creek near 14th Avenue South. Approximately 90 percent of the Massey Creek basin is located within the city limits; only the southeastern portion is located in the city of Kent. The Massey Creek basin is primarily in residential use or undeveloped, with a small amount of commercial development along SR 99 (Parametrix 1991). A flood control plan was prepared in 1990 (R.W. Beck 1990).

The primary drainage network in the Massey Creek basin consists of storm sewer pipes (12 to 48 inches in diameter), open channels, and onsite detention systems. Roadside ditches and smaller storm sewers form the secondary drainage system. The 25-acre City Park detention facility was built in 1996 and the Highline Community College detention facility was built in 1999 (see Figure 2). Construction of three detention facilities is planned for 2002 as part of the Pacific Highway Improvement Project. Construction of the Barnes Creek detention facility is planned for 2003. A stream the culvert was replaced at Marine View Drive in 1993. Stream culvert replacements are planned at 16th Avenue in 2001, at 10th Avenue in 2002, at 223rd Street (Barnes Creek) in 2003, at Kent-Des Moines Road (Barnes Creek) in 2005, and at 20th Avenue in 2007 (see Figure 2).

Water Quality

Although water quality data were not previously collected in Massey Creek, RW Beck (1990) observed high turbidity, channel scour, and bed erosion during high-flow periods, as well as evidence of oil dumping and spills. Water quality in Barnes Creek was judged to be "moderately good" and horse access to the upper reaches of Barnes Creek was identified as a possible source of fecal coliform bacteria (RW Beck 1990).

Habitat Quality

Massey Creek once provided habitat for coho and possibly chum salmon (Washington Department of Fisheries 1975). A spawning survey was conducted in 1988 that reported the presence three adult coho salmon and three spawning redds in lower Massey Creek (RW Beck 1990).

A habitat survey of Massey Creek was also performed in 1988 (RW Beck 1990). Approximately half of the stream channel had been altered by adjacent construction. Massey Creek provided poor fish habitat near the mouth of the creek, where the gravel substrate was interspersed with sand and silt and the vegetated canopy was sparse. However, upstream of 10th Avenue South, the creek passed through a forested ravine with a heavy canopy and good habitat characteristics, including deep pools. This 0.3-mile reach had excellent spawning and rearing habitat for salmonids.

Channel erosion was evident in some sections of Massey Creek upstream of 16th Avenue South. These middle reaches of the creek were highly channelized in culverts or ditch-like channels, and the stream banks included riprap and steep earthen banks. However, these channelized reaches were interspersed with areas providing good resident trout habitat, where numerous trout were caught by electrofishing (RW Beck 1990).

Barnes Creek provided relatively undisturbed habitat at the time of the 1988 survey. The tree canopy was mature, and stream banks were stable and did not exhibit extensive high-flow damage. The substrate was gravel interspersed with a few cobbles and boulders. This creek provided good habitat for cuthroat trout, which were caught by electrofishing (RW Beck 1990). No salmon (or bull trout) were observed in Barnes Creek, perhaps due to blockage by the trash rack located near the mouth or due to insufficient flow during certain times of the year (RW Beck 1990).

North Fork McSorley Creek Basin

The southern portion of the city of Des Moines (within the former city limits, prior to the 1999 annexation) drains to the north fork of McSorley Creek (which has also been called Smith

Creek). The north fork of McSorley Creek originates in the Parkside Wetland, flowing west and south to Saltwater State Park where it joins the south fork of McSorley Creek before discharging to Puget Sound (see Figure 2). A portion of the 300-acre north fork basin also lies within the city of Kent. In addition, stormwater runoff from the Midway landfill (located east of the basin between SR 99 and Interstate 5) is discharged to the lower reaches of the north fork at South 250th Street. The north fork McSorley Creek basin is primarily zoned single-family residential, with small areas of medium-density residential development and commercial property. A basin plan was completed in 1987 (RW Beck 1987).

Stormwater management facilities in the north fork basin are limited to small onsite detention systems. Detention of runoff from the Midway landfill is provided by a wetpond system. Some in-stream detention may be provided by a private pond located upstream of where the landfill detention system discharges to the north fork of McSorley Creek at South 250th Street. Construction of the Parkside detention facility is planned for 2007(see Figure 2).

Water Quality

Because the north fork of McSorley Creek receives stormwater runoff from the Midway landfill, several water quality studies have been conducted to investigate and monitor potential landfill impacts on the creek and the Parkside Wetland (Parametrix 1988, 1989). Runoff from the landfill is treated by a wetpond system before it is discharged to McSorley Creek from an outfall located within South 250th Street, just east of 16th Avenue South. Parametrix (1988) reported on the quality of stormwater runoff, standing water near the Parkside Wetland, and the north fork of McSorley Creek. Parametrix (1989) presented results of monthly water quality sampling by Green River Community College that included two stations on the north fork of McSorley Creek. In addition, King County monitored water quality in McSorley Creek during both base and storm flow conditions, and collected samples in the north fork of the creek (King County 1990).

During base flow conditions, water quality in the north fork of McSorley Creek was generally good. However, during storm flow, high concentrations of suspended solids were observed, and fecal coliform bacteria concentrations frequently exceeded state standards for Class AA streams (WAC 173-201A) (Parametrix 1988, 1989; King County 1990). Low levels of dissolved oxygen were occasionally recorded in late summer. Phosphorus concentrations also exceeded recommended guidelines (King County 1990).

Measurable levels of several metals were detected in samples collected from the creek. Copper and zinc were detected at concentrations exceeding acute toxicity criteria (Parametrix 1989; King County 1990). Elevated metals concentrations were most frequently detected in samples collected during the winter months (Parametrix 1989). Water samples collected from the north fork of McSorley Creek were not analyzed for organic compounds.

Samples collected from the Parkside Wetland and from stormwater runoff had moderate to high conductivity and fecal coliform bacteria levels (RW Beck 1987; Parametrix 1988). Metals (copper, zinc, and lead) were also detected in both wetland and stormwater samples (RW Beck 1987; Parametrix 1988). Samples collected in a culvert receiving runoff from SR 99 and surrounding areas exceeded acute toxicity criteria for zinc. No pesticides or polychlorinated biphenyls (PCBs) were detected in wetland or stormwater samples (Parametrix 1988).

Volatile organic compounds were detected in two water samples from the Parkside Wetland. Toluene and styrene were detected in samples collected by the Washington Department of Ecology (Ecology 1986). A single sample collected by Parametrix (1988) contained low levels of trichlorethene, benzene, toluene, chlorobenzene, and 1,1,1-trichlorethane. These compounds are ingredients in automotive products and household cleaners and are some of the most frequently detected organic compounds in urban runoff (Metro 1982). However, it should be noted that although organic compounds were detected at one wetland station, they were not detected in stormwater runoff draining to the wetland or in samples collected from other areas of the wetland. These results indicate that the Parkside Wetland was contaminated by an isolated source, such as an illicit discharge, illegal dumping, or landfill seepage.

Habitat Quality

A habitat survey of the north fork of McSorley Creek was conducted by King County (1987). As with Des Moines Creek and Massey Creek, McSorley Creek exhibited widely varying habitat quality along various reaches. Channelization, loss of channel diversity, and sedimentation were typical problems associated with the varying habitat quality. However, much of the stream still provided good fish habitat, and many areas were suitable for restoration. Currently, South 250th Street is a fish passage barrier due to the extreme elevation change below the culvert outfall.

Results of benthic invertebrate communities evaluated at two stations on the north fork of McSorley Creek indicate that the water quality was degraded (Parametrix 1989). High numbers of pollution-tolerant groups such as oligochaetes and chironomids (58 to 67 percent) were present, although a few pollution-sensitive species were also present in low numbers. These biological effects were likely the result of pollutants present in runoff from the surrounding urban areas.

Water Quality Monitoring

Water quality monitoring was conducted within the three stream basins during storm and base flow conditions in accordance with the monitoring plan established for this program (Herrera 1994). Hydrologic data were also collected from these streams to support the water quality evaluation. Monitoring methods and results are summarized below. Hydrologic results are discussed separately for data collected continuously at lower Des Moines Creek during the five year study, and for measurements taken at all sites during each water quality sampling event. Water quality results are discussed separately for each analytical parameter.

Methods

Water quality monitoring was conducted for a period of 5 years at eight stations to evaluate temporal and spatial trends in water quality during both storm and base flow conditions. Monitoring stations were positioned at upstream and downstream locations in the three stream basins to evaluate impacts of stormwater runoff from the city of Des Moines (see Figure 1). Water quality and streamflow were monitored at the following eight stations:

- DM-1: Des Moines Creek upstream, located near the city limits (accessed via the Des Moines Creek wastewater treatment plant)
- DM-2: Des Moines Creek downstream, located at the King County stream gauge near the creek mouth in Des Moines Beach Park
- MA-1: Massey Creek upstream, located immediately downstream of 24th Place South
- MA-2: Massey Creek midstream, located immediately downstream of 16th Avenue South
- MA-3: Massey Creek downstream, located near the creek mouth and upstream of Marine View Drive
- BA-1: Barnes Creek downstream, located near the creek mouth and upstream of Kent–Des Moines Road
- MC-1: McSorley Creek upstream, located immediately downstream of Parkside Wetland
- MC-2: McSorley Creek downstream, located downstream of 16th Avenue South (accessed via the Midway Sewer District pump station).

Monitoring was conducted during five storm events per year for a total of 25 storm events, and during three base flow events per year for a total of 15 base flow events (Table 1). During each storm event, three to four grab samples were collected at each station at an approximate rate of one sample per hour. Storm sampling generally began during the rising limb of the stream hydrograph of a storm event measuring at least 0.25 inches that occurred at least 48 hours after the previous storm event. The grab samples from each station were flow-proportionately composited into one sample by the laboratory prior to analysis.

Table 1. Water quality monitoring events in the Des Moines five-year program.

		Storm Flow Monitoring			Base Flow Monitoring	
Study Year	Water Year	Event Number	Sampling Date	Storm Size (inches of rain)	Event Number	Sampling Date
1	94/95	1	11/23/94	0.22	1	12/6/94
		2	12/8/94	0.21	2	3/29/95
		3	3/8/95	0.67	3	7/19/95
		4	7/9/95	0.93		
		5	10/20/95	0.34		
2	95/96	6	11/7/95	2.63	4	12/7/95
		7	3/3/96	0.38	5	3/27/96
		8	3/31/96	0.76	6	7/8/96
		9	4/22/96	2.89		
		10	9/3/96	0.46		
3	96/97	11	11/30/96	0.28	7	12/19/96
		12	1/16/97	1.46	8	3/25/97
		13	1/27/97	0.49	9	7/21/97
		14	4/22/97	0.45		
		15	6/3/97	0.46		
4	97/98	16	11/19/97	0.57	10	12/4/97
		17	12/15/97	2.01	11	3/19/98
		18	4/23/98	0.45	12	7/22/98
		19	6/24/98	0.49		
5	98/99	20	10/12/98	1.56	13	2/12/99
		21	1/13/99	1.27	14	5/27/99
		22	3/12/99	1.47	15	8/25/99
		23	5/11/99	0.17		
		24	10/27/99	0.49		
		25	11/5/99	0.71		

To evaluate the potential effects of nonpoint source pollution during low-flow periods throughout each year, base flow monitoring was conducted by collecting a single grab sample at each station following at least 3 days of dry weather in midwinter, late spring, and late summer. During the first two years of the monitoring program, base flow monitoring was also conducted at four upstream stations on Des Moines Creek located within the city of SeaTac for basin planning purposes. Locations and results for these four stations are presented in the two previous annual reports (Herrera 1995, 1996) and are not included in this report.

Samples of storm flow and base flow were analyzed in the field and laboratory for various parameters (Table 2). These water quality parameters were used to assess relative impacts on the instream aquatic ecosystems arising from various urban activities. Where appropriate, Washington state surface water quality standards for Class AA freshwaters (i.e., tributaries to Class AA marine waters in Puget Sound) were used for comparative purposes and are listed in Table 3. Specific field and laboratory analytical methods are described in the quality assurance report (Appendix A).

Table 2. Water quality monitoring parameters used in the Des Moines five-year program.

Parameter	Sample Type/Analysis Location	
	Storm Flow	Base Flow
Temperature	Grab/Field	Grab/Field
pH	Grab/Field	Grab/Field
Dissolved oxygen	Grab/Field	Grab/Field
Conductivity	Grab/Field	Grab/Field
Hardness	Composite/Lab	Grab/Lab
Turbidity	Composite/Lab	Grab/Lab
Total suspended solids	Composite/Lab	Grab/Lab
Total phosphorus	Composite/Lab	Grab/Lab
Ammonia nitrogen	Composite/Lab	Grab/Lab
Nitrate+nitrite nitrogen	Composite/Lab	Grab/Lab
Copper, dissolved	Composite/Lab	Grab/Lab
Lead, dissolved	Composite/Lab	Grab/Lab
Zinc, dissolved	Composite/Lab	Grab/Lab
Copper, total	Composite/Lab	None
Lead, total	Composite/Lab	None
Zinc, total	Composite/Lab	None
Total petroleum hydrocarbons	Grab/Lab	None
Fecal coliform bacteria	Grab/Lab	Grab/Lab

Table 3. Washington state surface water quality standards for Class AA freshwaters.

Parameter	Standard
Temperature	Shall not exceed 16.0°C due to human activities. When natural conditions exceed 16°C, no temperature increase will be allowed that raises the receiving water temperature by greater than 0.3°C. Incremental temperature increases from nonpoint source activities shall not exceed 2.8°C.
PH	Shall be within the range of 6.5 to 8.5 with a human-caused variation within a range of less than 0.5 units.
Dissolved oxygen	Shall exceed 9.5 mg/L.
Total dissolved gas	Shall not exceed 110 percent saturation at any point of sample collection.
Turbidity	Shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.
Fecal coliform bacteria	Shall not exceed a geometric mean value of 50 organisms/100 mL, with not more than 10 percent of samples exceeding 100 organisms/100 mL.
Toxic, radioactive, or deleterious material concentrations	Shall be below concentrations that have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent on those waters, or adversely affect public health, as determined by Ecology.
Aesthetic values	Shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.
Characteristic uses	Shall include, but not be limited to, the following uses: domestic, industrial, and agricultural water supply; stock watering; salmonid and other fish migration, rearing, spawning, and harvesting; shellfish rearing, spawning, and harvesting; wildlife habitat; general recreation and aesthetic enjoyment; and commerce and navigation.

Source: WAC 173-201A.
mL milliliters.
mg/L milligrams per liter.
NTU nephelometric turbidity units.

Rainfall conditions were documented with two sets of hourly rainfall data from 1) the National Weather Station at Seattle-Tacoma (Sea-Tac) International Airport, and 2) the King County rain gauge 11U at Tyee Golf Course. Daily rainfall data were also compiled from the Midway Sewer District rain gauge at the Des Moines Creek treatment plant.

Stream stage was measured following the collection of each grab sample. Staff and crest gauges were installed at each station to measure water stage during sampling and peak water stage prior to sampling. Discharge was estimated from water stage using Manning's equation or rating curves developed from discharge measurements collected over a range of water stages. Local citizen volunteers and Des Moines city staff also measured stream stage and crest gauge heights (see Public Involvement Program section).

Continuous measurements of stream stage at station DM-2 on lower Des Moines Creek were collected by King County (the county identifies this station as 11D). King County then converted these stage measurements to discharge using a rating curve based on discharge measurements collected over a range of water stages.

Hydrologic Results

Results are presented and discussed below for precipitation and stream discharge. These results include a 5-year summary of continuous rainfall and discharge data collected by King County for Des Moines Creek, and stream discharge data collected for each monitoring station during sampling events.

Five-Year Summary

Continuous records of precipitation and discharge for the Des Moines Creek watershed were collected by King County over the entire monitoring period, and these are presented in Figures 3a through 3f. Base and storm flow sampling events are identified in these figures for reference.

Precipitation

Summary statistics for precipitation measured at Sea-Tac Airport are presented by water year in Table 4 for the 5-year period of study (i.e., beginning with water year 1995, which begins in October 1994, and ending with water year 1999, which ends in September 1999). Monthly statistics for the rain gauge at Sea-Tac Airport and two other gauges located in the Des Moines vicinity are presented in Appendix D.

Annual precipitation at Sea-Tac Airport ranged from 32.3 inches in water year 1998 to 51.8 inches in water year 1997. Based on averages from a 30-year precipitation record at Sea-Tac Airport, normal precipitation totals were exceeded by at least 32 percent in water years 1996, 1997, and 1999. Water year 1995 exhibited near-normal precipitation (+6 percent) and water year 1998 exhibited below-normal precipitation (-13 percent).

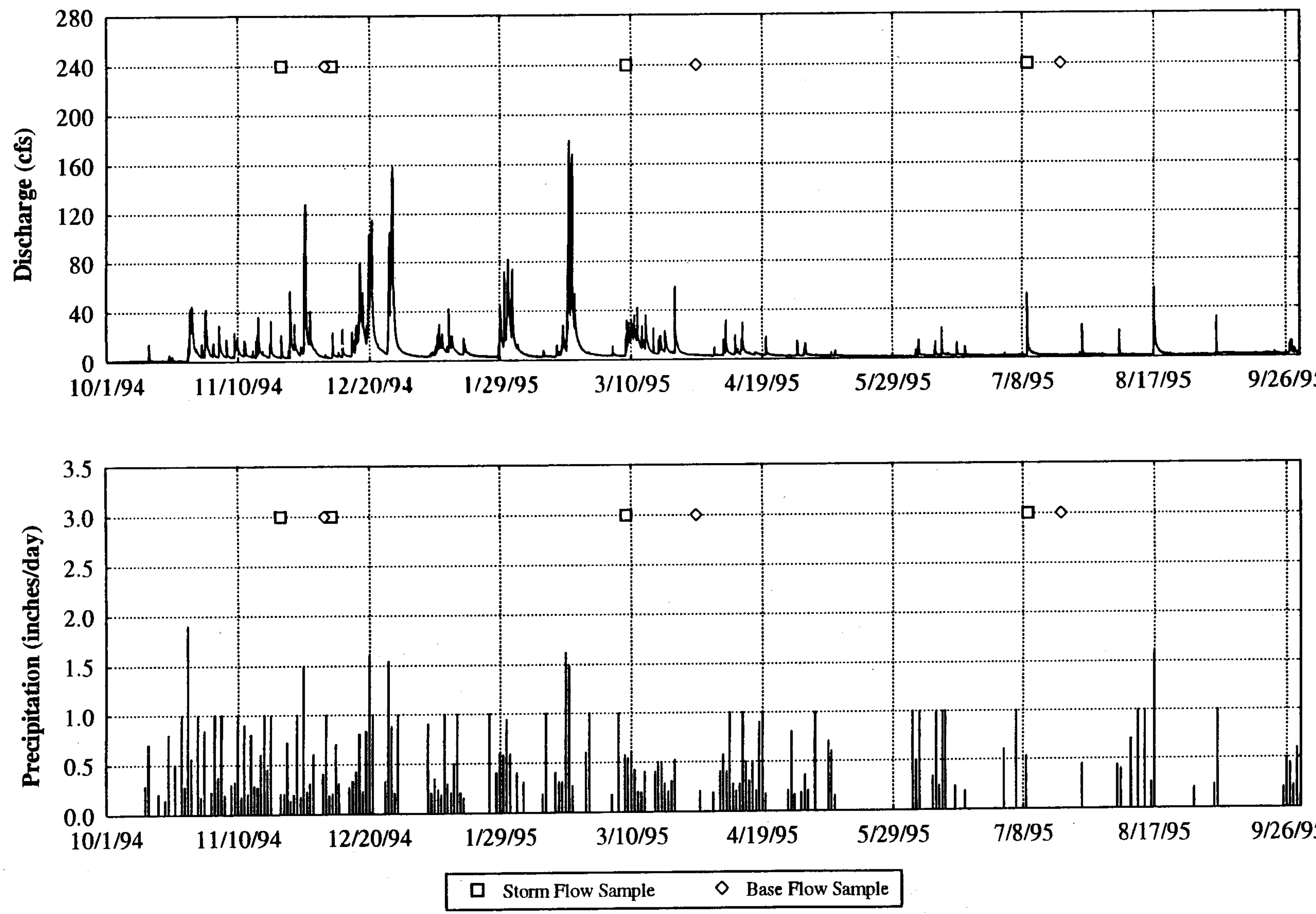

Figure 3a. Hydrologic data for Des Moines Creek over the 1995 water year, collected by King County at stations 11D and 11U.

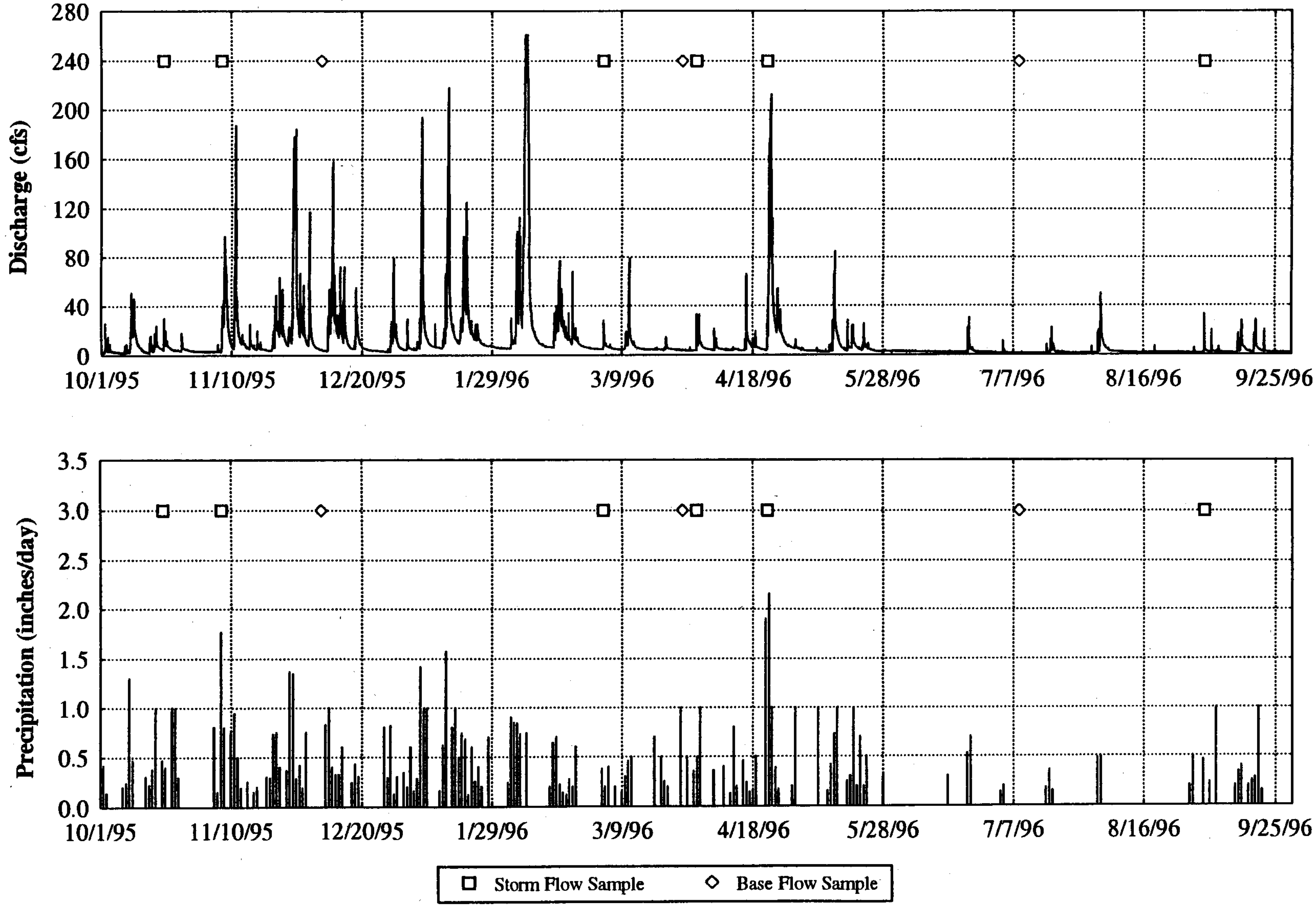

Figure 3b. **Hydrologic data for Des Moines Creek over the 1996 water year, collected by King County at stations 11D and 11U.**

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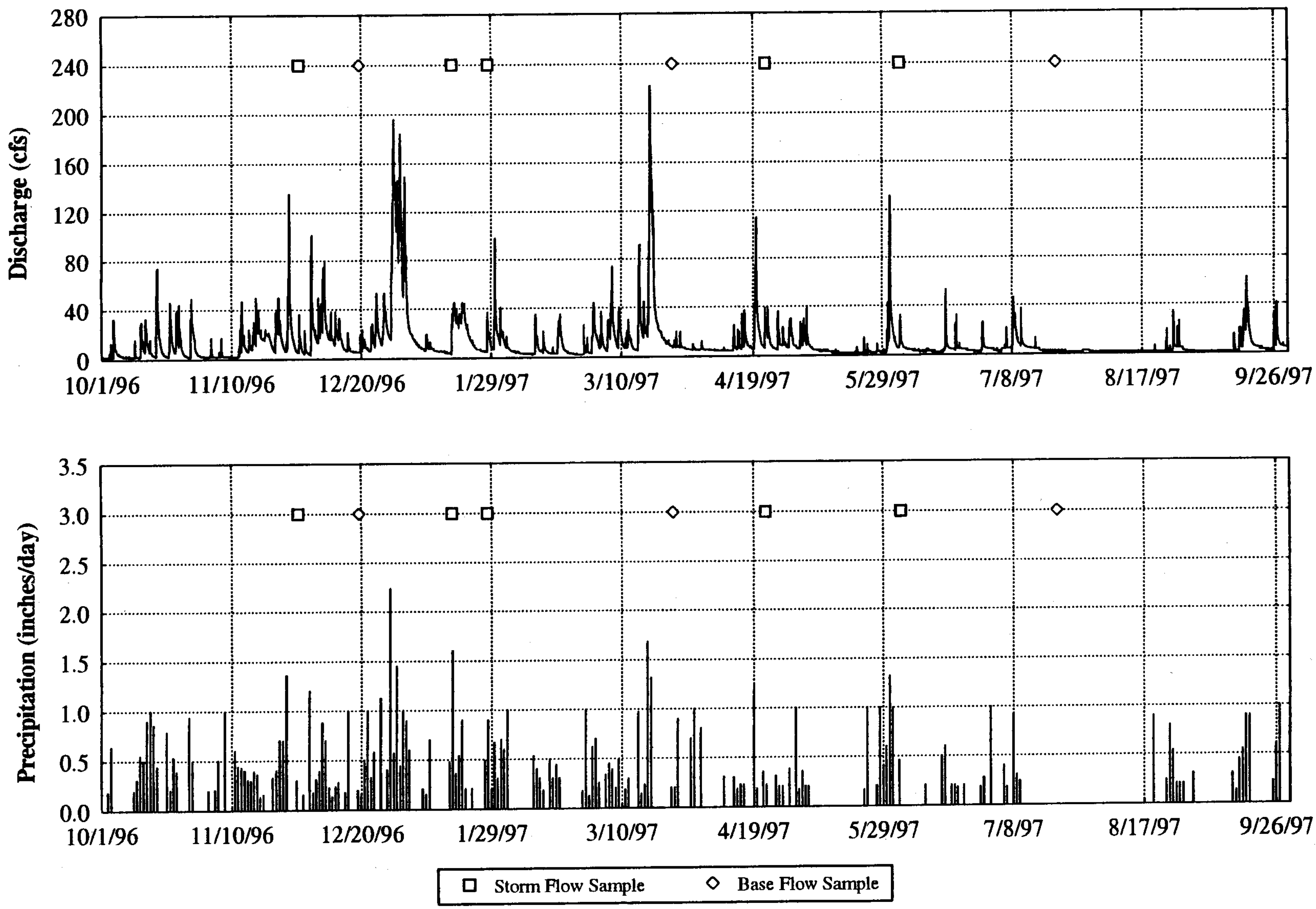

Figure 3c. **Hydrologic data for Des Moines Creek over the 1997 water year, collected by King County at stations 11D and 11U.**

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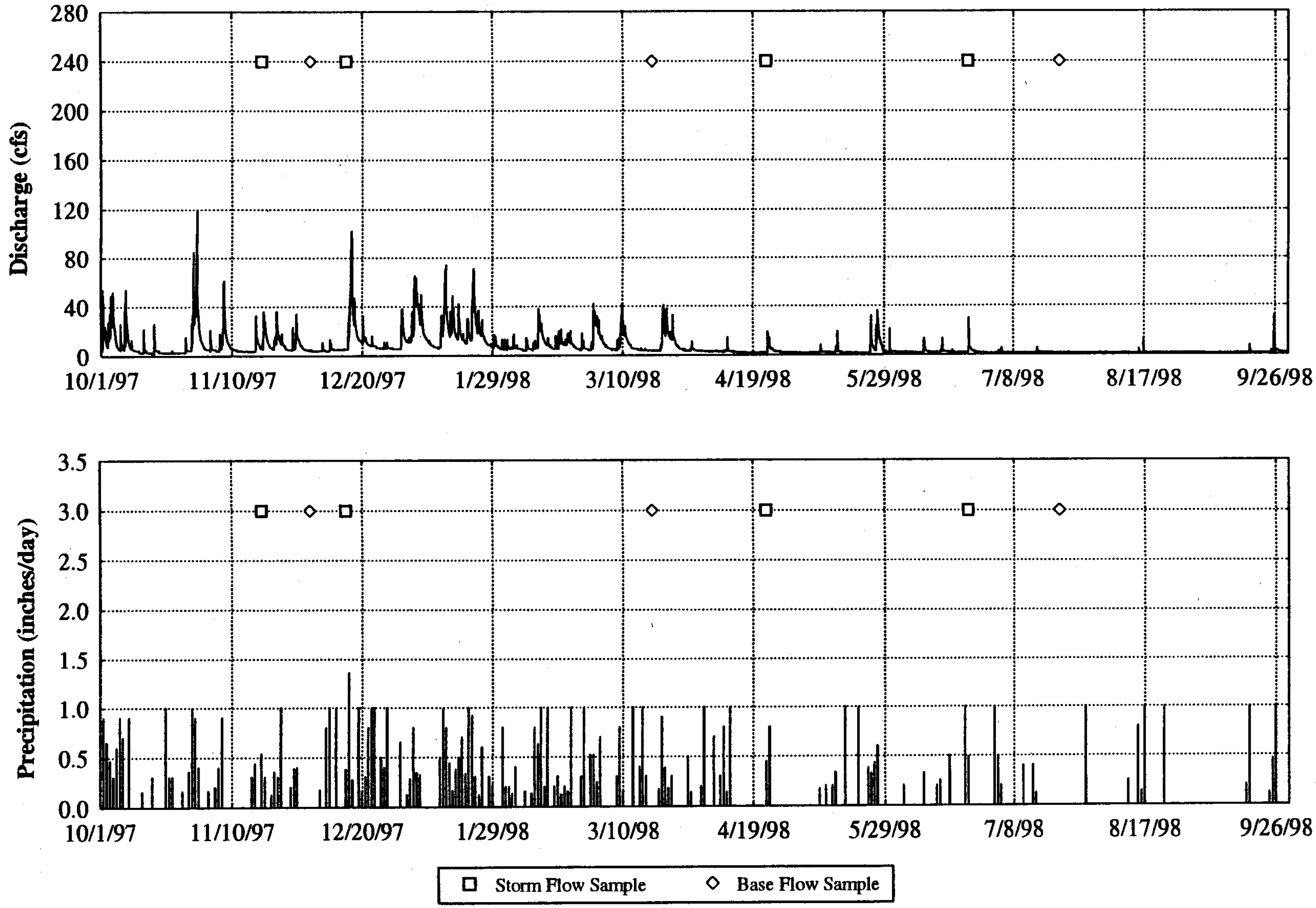

Figure 3d. Hydrologic data for Des Moines Creek over the 1998 water year, collected by King County at stations 11D and 11U.

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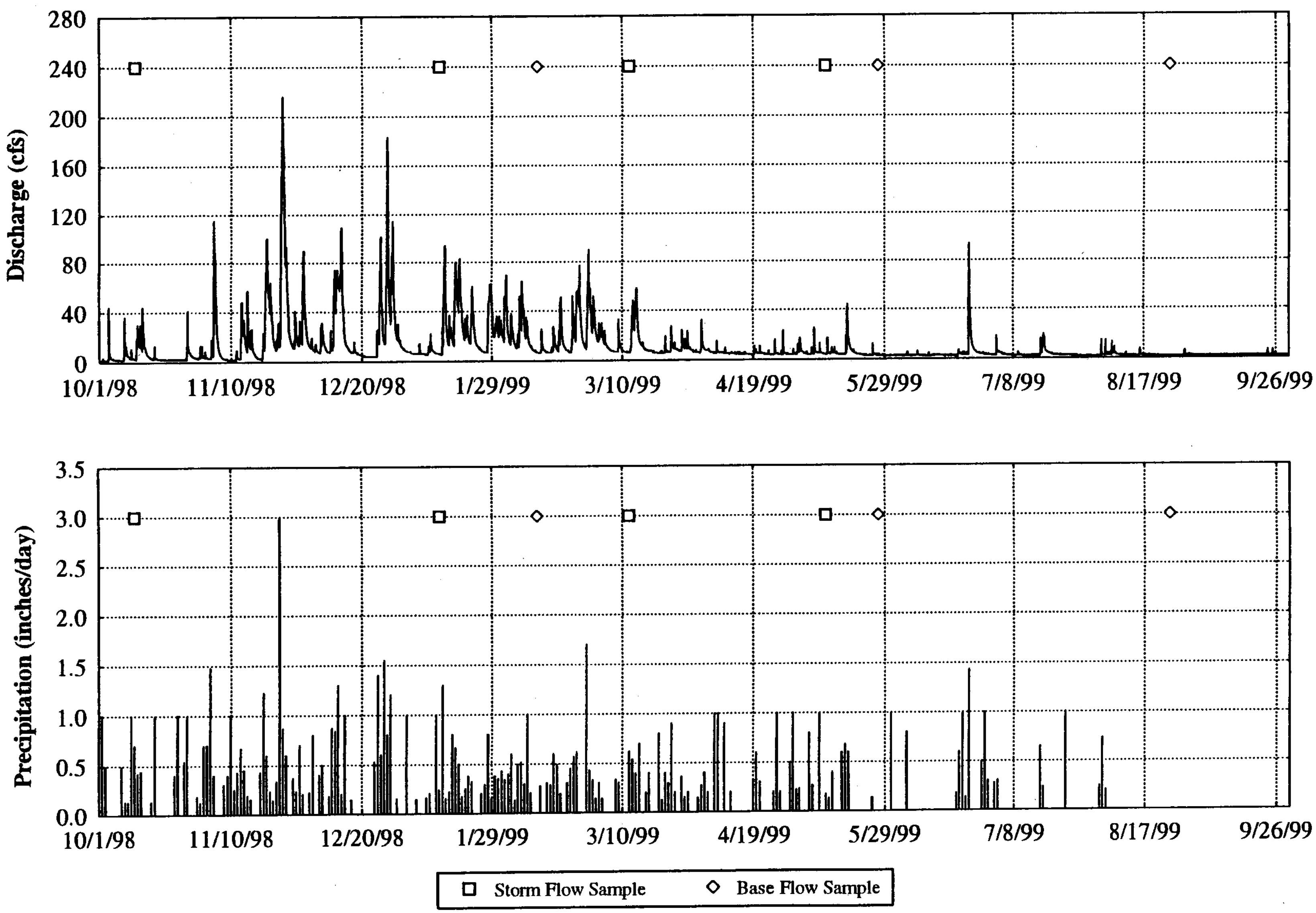

Figure 3e. **Hydrologic data for Des Moines Creek over the 1999 water year, collected by King County at stations 11D and 11U.**

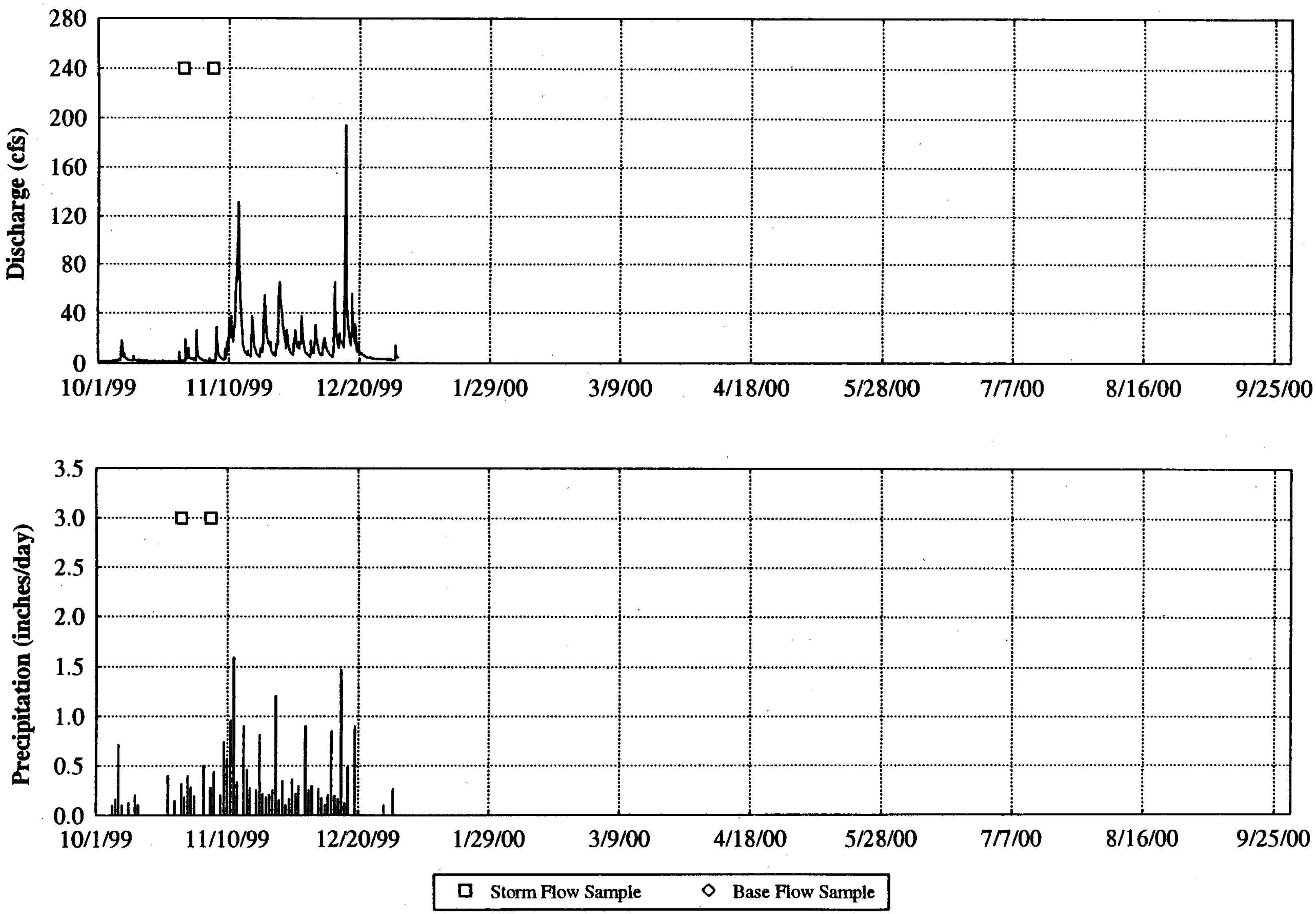

Figure 3f. **Hydrologic data for Des Moines Creek for the fourth quarter of 1999, collected by King County at stations 11D and 11U.**

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Comparisons of the rainfall totals presented among three rain gauges in the Des Moines Creek basin indicate that the Midway Sewer District treatment plant receives approximately 16 percent more precipitation than Sea-Tac Airport in any given month (see Appendix D). This difference in precipitation totals likely results from a precipitation gradient between the airport and surrounding locations, as evidenced by the results from other King County rain gauges (King County 1995).

The higher than normal precipitation totals measured during the 5-year monitoring period may have influenced the monitoring results presented in this report. Numerous large storms occurring in rapid succession can stress stormwater and erosion control facilities. If these systems become compromised or fail due to extreme climatic conditions, natural resources that are directly influenced by stormwater runoff are adversely affected (e.g., surface water quality and hydrology).

Discharge

Summary statistics for discharge measured in lower Des Moines Creek (station DM-2) are presented in Table 4 by water year for the 5-year period of study (i.e., water years 1995 through 1999). Monthly flow statistics for lower Des Moines Creek are presented in Appendix D. Discharge statistics are not available for the seven other monitoring stations because continuous water level recorders were only installed at lower Des Moines Creek. Differences in discharge rates among the eight monitoring stations are presented for sampled events in the following section.

Table 4. Hydrologic characteristics of Des Moines Creek at station DM-2 compared with precipitation statistics measured at the Sea-Tac Airport rain gauge.

Water Year	Range of Monthly Average Discharge [a] (cfs)	Range of Monthly Peak Discharge [a] (cfs)	Total Discharge Volume [a] (acre-feet)	Total Precipitation [b] (inches)	Precipitation as Percent of Normal [c] (%)
1995	2.09 – 19.5	12.0 - 179	4,786	39.35	5.8
1996	1.71 – 28.3	22.0 - 261	7,509	50.42	35.6
1997	2.20 – 26.1	34.0 - 222	8,047	51.84	39.4
1998	1.16 – 19.2	5.10 - 119	4,430	32.29	-13.2
1999	1.64 – 25.9	6.30 – 216	7,966	49.16	32.2

[a] Data collected by King County Department of Natural Resources.
[b] Data collected at Sea-Tac Airport by National Oceanic and Atmospheric Administration (NOAA).
[c] Based on mean of 37.19 inches for a 30-year record (1961–1990) collected at Sea-Tac Airport by NOAA.

Monthly average discharge rates for Des Moines Creek ranged from 1.16 to 28.3 cubic feet per second (cfs) during the 5-year study period. Monthly peak discharge rates ranged from 5.10 to 222 cfs over the same period. Discharge volumes ranged from 4,430 acre-feet in the 1998 water year to 8,047 acre-feet in the 1997 water year. Discharge rates and volumes for a given water year were highly correlated with the amount total precipitation that fell over the same period. For example, the peak discharge rate in the water year with the highest precipitation total (i.e., 1997) was roughly twice as high as the peak discharge rate measured in the water year with the lowest precipitation total (i.e., 1998). In general, relatively high discharge rates and volumes occurred in the 1996, 1997, and 1999 water years in response to high precipitation totals. Conversely, the 1995 and 1998 water years had lower discharge rates and volumes due to lower measured precipitation totals.

Discharge rates in Des Moines Creek showed distinct differences during wet and dry seasons (see Figures 3a through 3f). The dry season typically extended from April through August, with average discharge rates ranging from 2.26 cfs in the 1998 water year to 5.89 cfs in the 1997 water year. As a result of increased ground water recharge, dry season discharge rates in water years with high precipitation totals (e.g., 1996 and 1997) were nearly double those measured in water years with relatively low precipitation totals (e.g., 1998). The wet season in Des Moines typically began in September, when daily mean flow rates increased to approximately 8 cfs, and continued through March.

Hydrology of Sampled Events

Average stream discharge rates during sampled storm and base flow events are presented as box and whisker plots in Figure 4 for comparison to similar presentations of water quality data. Graphs of storm discharge rates present the minimum and maximum, the 25th and 75th percentiles, and the median for each stream station. Graphs of base flow discharge rates present only the minimum, maximum and median for each stream station, because the number of samples is not sufficient to calculate 25th and 75th percentiles. Stream discharge rates measured during each storm and base flow event are presented in Appendix B with the water quality database. Continuous records of stream discharge and precipitation during each sampled storm event are presented in Appendix D for Des Moines Creek (King County stream gauge 11D and rain gauge 11U).

Precipitation

Precipitation totals for sampled storm events are presented in Appendix B and summarized in Table 1. Rainfall data are based on King County records from rain gauge 11U at the Tyee Golf Course. Rainfall totals during all sampled storm events ranged from 0.17 inches for event 23 (May 11, 1999) to 2.89 inches for event 9 (April 22, 1996). The goal of 2 days (48 hours) of dry weather preceding sampled storm events was met for all sampled storm events during the 5-year monitoring program.

Antecedent dry periods for base flow sampling events were calculated as: the time elapsed since the end of a preceding 24-hour period in which 0.10 or more inches of precipitation had fallen. Dry periods over the 5-year monitoring program ranged from approximately 54 hours for base flow event 14 (May 27, 1999) to 488 hours for base flow event 15 (August 25, 1999). The goal of at least 3 days (72 hours) of dry weather preceding base flow sampling was met for all base flow events except events 1 and 14, which had antecedent dry periods of approximately 61 and 54 hours, respectively.

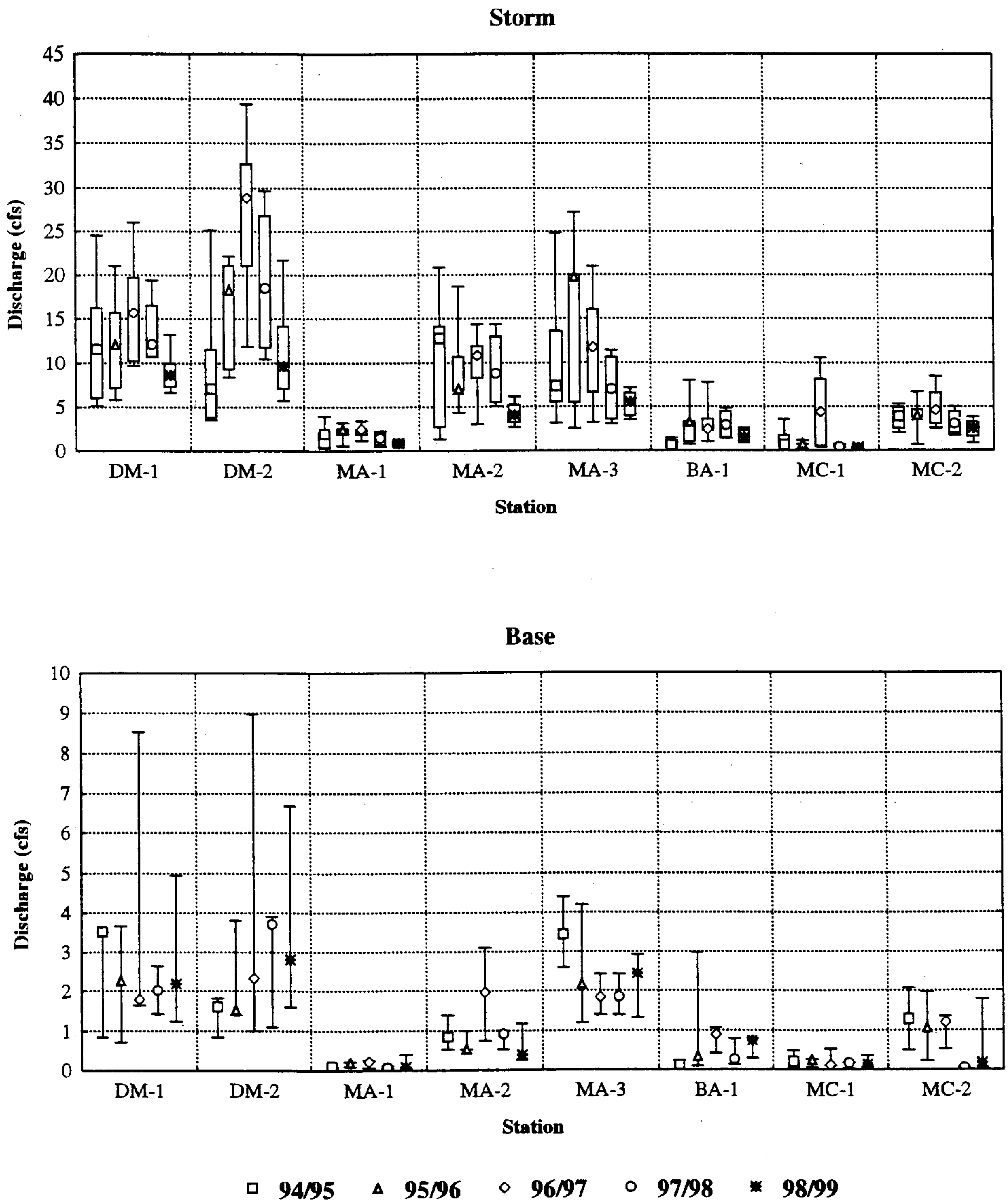

Figure 4. Discharge of Des Moines streams during storm and base flow sampling events.

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Discharge Rates

Mean discharge rates during storm sampling ranged from a minimum of 0.18 cfs at station MC-1 during storm event 10 (September 3, 1996) to a maximum of 39 cfs at station DM-2 during storm event 13 (January 27, 1997). Discharge rates during sampled storm events were generally highest in the second, third, and fourth years of monitoring and lowest in the fifth year (see Figure 4). These differences do not appear to be related to the measured precipitation totals for each of these monitoring years (see Table 4). The highest discharge rates during storm sampling were consistently measured in Des Moines Creek (stations DM-1 and DM-2) and lower Massey Creek (stations MA-2 and MA3), while the lowest discharge rates were measured in upper McSorley Creek (station MC-1).

Discharge rates during base flow sampling ranged from less than 0.1 cfs at stations BA-1 and MC-1 during summer base flow events to 9 cfs at station DM-2 during base flow event 8 (March 25, 1997). There were no substantial differences between monitoring years in discharge rates during base flow sampling (see Figure 4).

Storm Flow Sampling Temporal Coverage

Storm flow sampling typically began within a few hours from the onset of rainfall and captured both the ascending and descending limbs of the hydrograph (see Appendix D).

Water Quality Results

Appendix B presents water quality results separately for storm flow and base flow samples from each stream station. These results are presented as a database that includes sample collection data, hydrologic data, analyte values, and data flags (i.e., qualifiers) for the entire study. Values qualified as estimates are used in the evaluation, and none of the analytical test result values were rejected (see the quality assurance report in Appendix A). Laboratory results, chain-of-custody records, and data quality assurance worksheets for the fourth and fifth monitoring years are presented in Appendix E.

Water quality results for the eight stream monitoring stations shown in Figure 1 are discussed below for each parameter measured or analyzed. Median parameter values are presented for each station in Table 5 (storm flow) and Table 6 (base flow). These values are also compared to water quality statistics for streams in other developed areas of King County (Table 7).

The water quality results are presented in a series of "box and whisker" plots for comparisons of storm and base flows, comparisons of stations within and between basins, and comparisons of monitoring years. Where applicable, these graphs also provide data for comparisons to streams in other developed areas of King County (see Table 7), as well as Washington state surface water quality standards (see Table 3).

Graphs of storm flow results present the minimum and maximum, the 25th and 75th percentiles, and the median for each station. Graphs of base flow results present only the minimum,

Table 5. Median water quality values by monitoring station for samples collected during storm flow events in Des Moines streams.

	DM-1	DM-2	MA-1	MA-2	MA-3	BA-1	MC-1	MC-2
Temperature (°C)	9.1	9.1	9.5	9.8	9.2	9.0	8.2	9.7
pH	7.05	7.43	6.81	7.17	7.23	7.28	6.77	7.25
Dissolved oxygen (mg/L)	10.6	10.8	10.6	10.9	10.7	10.8	7.8	10.8
Conductivity (µmhos/cm)	91.0	127	95.1	72.1	98.0	126	138	107
Hardness (mg/L as $CaCO_3$)	39.7	52.5	41.1	33.3	47.5	53.8	53.8	47.6
Turbidity (NTU)	20	22	12	20	24	32	6.1	20
Total suspended solids (mg/L)	43	55	14	50	56	86	16	25
Total phosphorus (µg/L)	134	134	74.0	110	164	233	147	127
Nitrate+nitrite nitrogen (µg/L)	432	607	531	498	609	803	279	433
Ammonia nitrogen (µg/L)	70	48	68	43	36	43	36	57
Dissolved copper (µg/L)	5.9	4.2	3.9	3.3	3.1	3.6	3.1	6.6
Dissolved lead (µg/L)	0.7	< 0.5	1.3	< 0.5	< 0.5	< 0.5	0.8	< 0.5
Dissolved zinc (µg/L)	20	12	37	11	8	6	7	13
Total copper (µg/L)	13.7	13.4	7.1	7.8	9.0	10.4	5.5	12.4
Total lead (µg/L)	9.4	7.1	10.5	6.3	6.2	4.8	2.3	4.9
Total zinc (µg/L)	60	42	61	33	27	30	12	34
Total petroleum hydrocarbons (mg/L)	0.31	< 0.25	0.36	0.35	< 0.25	< 0.25	< 0.25	< 0.25
Fecal coliform bacteria (organisms/100 mL)	720	800	1,240	1,800	1,160	790	800	2,100

°C degree Celsius
mg/L milligrams per liter
µg/L micrograms per liter
$CaCO_3$ calcium carbonate
NTU nephelometric turbidity units
mL milliliters
µmhos/cm micromhos per centimeter (= microsiemens per centimeter)

DM-1 upper Des Moines Creek
DM-2 lower Des Moines Creek
MA-1 upper Massey Creek
MA-2 middle Massey Creek
MA-3 lower Massey Creek
BA-1 lower Barnes Creek
MC-1 upper McSorley Creek
MC-2 lower McSorley Creek

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Table 6. Median water quality values by monitoring station for samples collected during base flow events in Des Moines streams.

	DM-1	DM-2	MA-1	MA-2	MA-3	BA-1	MC-1	MC-2
Temperature (°C)	10.2	11.4	10.8	11.0	10.1	10.1	9.6	10.9
pH	7.53	7.65	7.28	7.75	7.67	7.76	7.03	7.61
Dissolved oxygen (mg/L)	11.2	9.9	10.0	10.8	11.2	11.6	7.6	10.3
Conductivity (µmhos/cm)	193	206	249	226	225	227	155	173
Hardness (mg/L as $CaCO_3$)	86.3	87.7	109	94.1	98.0	97.2	67.2	76.3
Turbidity (NTU)	1.6	1.7	4.9	2.2	1.7	2.5	2.0	3.6
Total suspended solids (mg/L)	1.5	1.5	2.0	0.8	1.2	1.8	1.5	2.4
Total phosphorus (µg/L)	41	41	27	21	31	53	82	56
Nitrate+nitrite nitrogen (µg/L)	731	912	1,300	1,630	1,220	1,160	299	333
Ammonia nitrogen (µg/L)	21	13	61	11	11	10	13	22
Dissolved copper (µg/L)	1.7	1.9	< 1.0	< 1.0	1.5	1.5	1.3	2.4
Dissolved lead (µg/L)	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Dissolved zinc (µg/L)	5	< 3	4	< 3	< 3	< 3	< 3	4
Fecal coliform bacteria (organisms/100 mL)	42	60	16	88	98	200	153	78

°C degree Celsius
mg/L milligrams per liter
µg/L micrograms per liter
$CaCO_3$ calcium carbonate
NTU nephelometric turbidity units
mL milliliters
µmhos/cm micromhos per centimeter (= microsiemens per centimeter)

DM-1 upper Des Moines Creek
DM-2 lower Des Moines Creek
MA-1 upper Massey Creek
MA-2 middle Massey Creek
MA-3 lower Massey Creek
BA-1 lower Barnes Creek
MC-1 upper McSorley Creek
MC-2 lower McSorley Creek

Table 7. Water quality statistics for stations located at the mouth of selected King County streams[a] (1995 through 1999) for comparison to Des Moines streams.

	Storm Flow						Base Flow					
	Median	Minimum	25th %	75th %	Maximum	Samples	Median	Minimum	25th %	75th %	Maximum	Samples
Temperature (°C)	9.2	4.1	8.0	11.3	16.4	273	11.1	0.8	7.7	14.1	20.2	902
pH	7.3	5.6	7.1	7.5	8.3	246	7.4	6.1	7.2	7.7	11.2	763
Dissolved oxygen (mg/L)	10.7	5.4	9.8	11.3	13.5	263	10.5	5.3	9.6	11.5	14.5	865
Conductivity (µmhos/cm)	113	38.5	95.5	130	230	227	151	67.7	126	200	507	855
Turbidity (NTU)	11	0.8	5.6	18	840	277	2.6	0.05	1.8	4.0	49	877
Total suspended solids (mg/L)	22.2	1.1	11.2	45.5	2,280	277	3.9	0.5	2.5	7.1	198	872
Total phosphorus (µg/L)	109	21	66	178	1,570	277	58	2	42	82	519	878
Ammonia nitrogen (µg/L)	36	10	19	55	343	274	27	10	11	43	1,940	877
Nitrate+nitrite nitrogen (µg/L)	742	10	548	1,110	3,520	274	947	70	686	1,350	3,830	877
Copper, total (µg/L)	3.5	0.5	2.4	5.2	27.9	103	2.4	1.1	1.7	3.4	9.1	54
Lead, total (µg/L)	1.6	0.2	0.7	3.2	58.9	103	1.0	0.2	0.8	1.8	9.4	54
Zinc, total (µg/L)	10.4	0.5	5.8	16.0	140	103	6.2	2.1	4.1	10.8	33.5	52
Fecal coliform bacteria (org./100 mL)	800	9	290	2,475	28,000	274	180	7	71	400	20,000	907

[a] Streams (station): Big Bear (C484), Big Soos (A320), Evans (B484), Forbes (0456), Issaquah (0631), Juanita (0446), Kelsey (0444), Little Bear (0478), Longellow (C370), May (0444), Newaukum (0322), North (0474), Pipers (R210), Swamp (0470), Thornton (0434), Tibbetts (A630/X630).

Note: Base flow samples may include samples collected during rain events.

Source: King County (2000) unpublished data.

°C	degree Celsius
mg/L	milligrams per liter
µg/L	micrograms per liter
NTU	nephelometric turbidity units
mL	milliliters
µmhos/cm	micromhos per centimeter (= microsiemens per centimeter)

DM-1	upper Des Moines Creek
DM-2	lower Des Moines Creek
MA-1	upper Massey Creek
MA-2	middle Massey Creek
MA-3	lower Massey Creek
BA-1	lower Barnes Creek
MC-1	upper McSorley Creek
MC-2	lower McSorley Creek

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maximum, and median for each station, because the number of samples is not sufficient to calculate 25th and 75th percentiles for each year of study. In addition, graphs of fecal coliform bacteria data present the minimum, maximum, and geometric mean, because the water quality standard is based on geometric means (see Table 3).

The water quality results were also analyzed for spatial and temporal trends using various statistical procedures. Spatial trends in the water quality data were analyzed using one of two approaches, depending on the number of monitoring stations in the stream basin. For basins with only two monitoring stations (i.e., the Des Moines Creek and McSorley Creek basins), a signed-rank test was used to determine whether one station had significantly higher pollutant concentrations than the other (Helsel and Hirsch 1992). For basins with more than one monitoring station (i.e., the Massey Creek basin), a Friedman test was used to determine whether there were significant differences in pollutant concentrations among any of the basin's monitoring stations. If significant differences were detected using the Friedman test, a follow-up nonparametric multiple comparison test was conducted to determine which stations were significantly different from others in the basin (Zar 1984). All of the statistical tests described above are paired or blocked analyses that eliminate the variability or noise associated with temporal factors (e.g., the sampling of different sized storms over time), so that spatial trends can be more readily detected.

A Kruskal-Wallis analysis of variance (ANOVA) was used to evaluate whether there were significant differences in analyte concentrations between any of the monitoring years at a given site. If significant differences were detected using the Kruskal-Wallis ANOVA, a follow-up nonparametric multiple comparison test was conducted to determine which monitoring years were significantly different from others (Zar 1984).

To determine whether analyte concentrations have generally increased or decreased over the entire 5-year monitoring program, a temporal trend analysis was performed by computing the Kendall's tau (τ) correlation coefficient for analyte concentrations versus sampling dates. The resultant correlation coefficient was then evaluated to determine its statistical significance (i.e., $\tau \neq 0$; $\alpha = 0.05$). Significant positive and negative correlation coefficients indicate a significant increasing or decreasing trend, respectively, in analyte concentrations.

To increase the likelihood of detecting temporal trends, noise in the water quality data that stems from sampling over a range of storm sizes was removed whenever possible using a method described by Helsel and Hirsch (1992). The following provides a brief summary of this procedure:

1. Linear regression was employed to determine whether there was a significant relationship (i.e., $\beta \neq 0$, $\alpha = 0.05$; $r^2 > 0.15$) between mean discharge at the time of sample collection and the concentration of a given analyte.

2. Residuals from the regression analysis were then extracted for those analytes showing a significant relationship with mean discharge. The residuals represent analyte concentrations that have been flow-corrected by removing noise stemming from variations in mean discharge.

3. A temporal trend analysis was performed, as described above, using the residuals or flow-corrected data in order to reveal temporal trends that would otherwise be undetectable due to the confounding influence of discharge on analyte concentrations. Significant positive and negative correlation coefficients indicate a significant increasing or decreasing trend, respectively, in analyte concentrations.

All of the statistical analyses described above were evaluated at a significance level of $\alpha = 0.05$. Results of spatial and temporal trend analyses are presented in Appendix C and summarized in Tables 8 and 9, respectively.

Table 8. Summary of significant ($\alpha = 0.05$) of positive (+) and negative (–) downstream trends [a] in storm (S) and base (B) flow water quality data for Des Moines stream stations.

	DM-1 to DM-2	MA-1 to MA-2	MA-2 to MA-3	MC-1 to MC-2
Temperature			S–	S+
pH	S+, B+	S+, B+		S+, B+
Dissolved oxygen	S+	S+		S+, B+
Conductivity	S+, B+	S–, B–	S+	S–
Hardness	S+, B+	B–	S+	S–
Turbidity		S+, B–		S+
Total suspended solids	S+	S+, B–		S+
Total phosphorus			S+, B+	B–
Nitrate+nitrite nitrogen	S+			S+
Ammonia nitrogen	S–	B–	S–	S+
Dissolved copper	S–			S+, B+
Dissolved lead		S–		
Dissolved zinc	S–	S–		S+
Total copper [b]				S+
Total lead [b]	S–			S+
Total zinc [b]	S–	S–		S+
Total petroleum hydrocarbons [b]	S–			S+
Fecal coliform bacteria				

[a] A plus sign (+) indicates an increasing trend downstream, whereas a minus sign (–) indicates a decreasing trend downstream.
[b] Parameter analyzed in storm flow samples only.

DM-1 upper Des Moines Creek
DM-2 lower Des Moines Creek
MA-1 upper Massey Creek
MA-1 middle Massey Creek
MA-3 lower Massey Creek
MC-1 upper McSorley Creek
MC-2 lower McSorley Creek

Temperature

The species composition and activity of aquatic organisms are regulated by temperature. Because essentially all aquatic organisms are cold-blooded, water temperature regulates their metabolism and ability to survive and reproduce effectively. Temperature also affects the natural self-purification processes that occur in water bodies. Thus, increased temperatures accelerate the biodegradation of organic matter present in waters and sediments, resulting in increased demands on the dissolved oxygen resources of a system. In addition, increased water temperatures decrease the solubility of oxygen, which exacerbates dissolved problems. For example, surface waters that are saturated with dissolved oxygen at temperatures in excess of 18°C would not meet the minimum dissolved oxygen criterion (9.5 milligrams per liter) for Class AA freshwaters (see Table 3).

Table 9. Summary of significant (α = 0.05) positive (+) and negative (–) temporal trends in storm (S) and base (B) flow water quality data for Des Moines stream stations.

	DM-1	DM-2	MA-1	MA-2	MA-3	BA-1	MC-1	MC-2
Temperature								
pH						S+		
Dissolved oxygen								
Conductivity	B+	S+	B+	B+	B+			
Hardness	S+	S+						
Turbidity								
Total suspended solids								
Total phosphorus			S+					
Nitrate+nitrite nitrogen			B–				B–	S–
Ammonia nitrogen				B–	B–			B–
Dissolved copper	B–						B–	B–
Dissolved lead								
Dissolved zinc	S–							B–
Total copper [a]		S–					S–	
Total lead [a]								
Total zinc [a]	S–							
Total petroleum hydrocarbons [a]			S+					
Fecal coliform bacteria						B+		

[a] Parameter analyzed in storm flow samples only.
DM-1 upper Des Moines Creek
DM-2 lower Des Moines Creek
MA-1 upper Massey Creek
MA-2 middle Massey Creek
MA-3 lower Massey Creek
BA-1 lower Barnes Creek
MC-1 upper McSorley Creek
MC-2 lower McSorley Creek

Temperature measurements over the 5-year monitoring program ranged from 1.8 to 19.1°C (Figure 5). The median temperature ranged from 8.2 to 9.8°C among the sampling stations during storm flow and from 9.6 to 11.7°C among the stations during base flow. All three basins in this study exhibited similar median temperatures in their downstream reaches relative to other King County streams during base flow and storm flow (see Tables 5, 6, and 7).

The Washington state Class AA criterion for temperature (16°C) was exceeded at least once at every monitoring station during the 5-year monitoring period (Table 10). The percentage of samples exceeding the state criterion during storm flow sampling ranged from zero percent

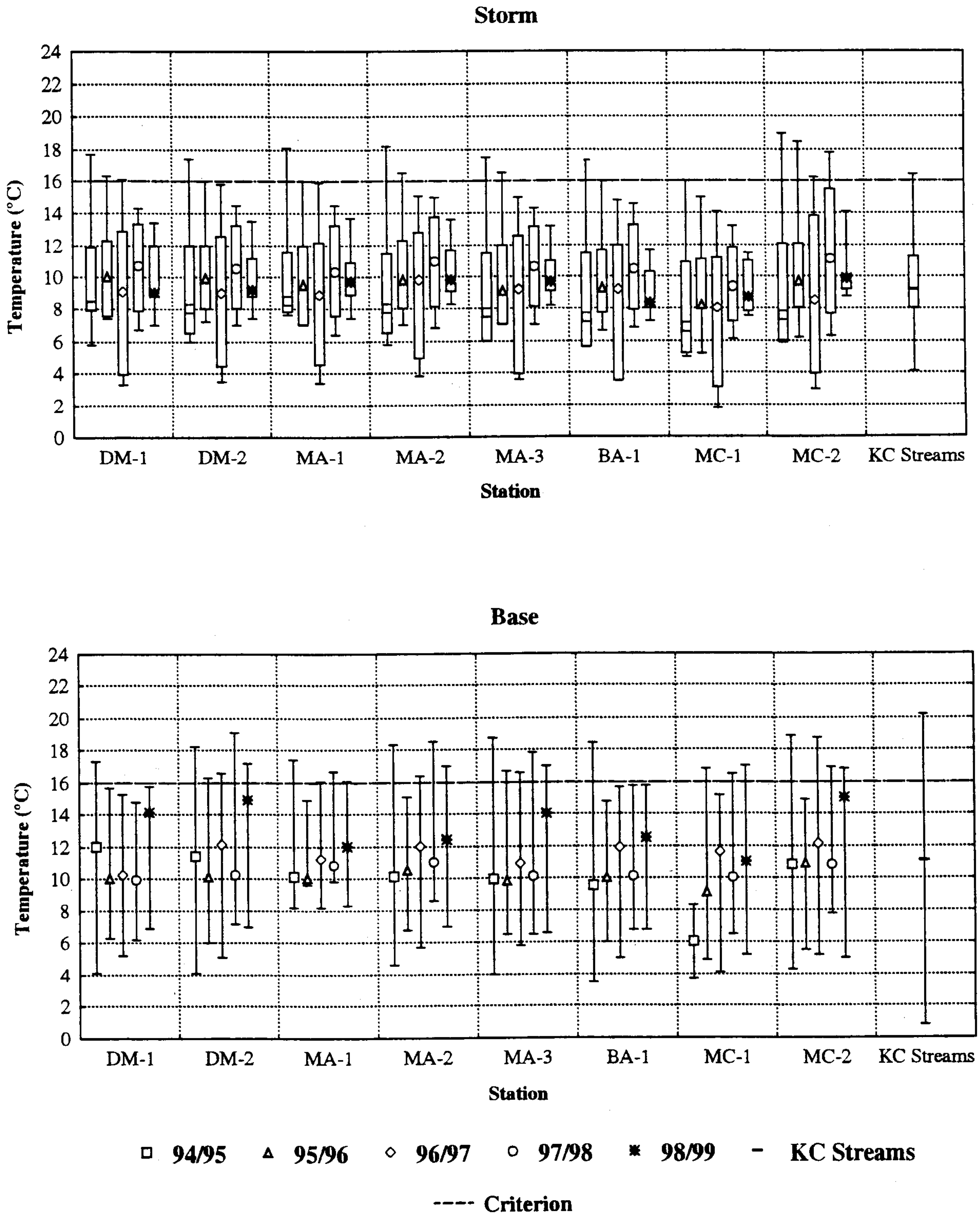

Figure 5. **Temperatures during storm and base flow sampling events in Des Moines streams and in other King County (KC) streams.**

Table 10. Percentages of samples from Des Moines streams exceeding the Washington state Class AA water quality criterion for temperature by monitoring station and year.

	DM-1	DM-2	MA-1	MA-2	MA-3	BA-1	MC-1	MC-2	All Stations
Base Flow Samples									
94/95	33.3	33.3	33.3	33.3	33.3	33.3	0.0	33.3	30.4
95/96	0.0	33.3	0.0	0.0	33.3	0.0	33.3	0.0	12.5
96/97	0.0	33.3	33.3	33.3	33.3	0.0	0.0	33.3	20.8
97/98	0.0	33.3	33.3	33.3	33.3	0.0	33.3	33.3	25.0
98/99	0.0	33.3	33.3	33.3	33.3	0.0	33.3	33.3	25.0
All Years	6.7	33.3	26.7	26.7	33.3	6.7	21.4	26.7	22.7
Storm Flow Samples									
94/95	20.0	20.0	20.0	20.0	20.0	20.0	0.0	20.0	17.5
95/96	20.0	0.0	0.0	20.0	20.0	0.0	0.0	20.0	10.0
96/97	20.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	5.0
97/98	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0	3.1
98/99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All Years	12.0	4.0	4.0	8.0	8.0	4.0	0.0	16.0	7.0
All Samples									
94/95	25.0	25.0	25.0	25.0	25.0	25.0	0.0	25.0	22.2
95/96	12.5	12.5	0.0	12.5	25.0	0.0	12.5	12.5	10.9
96/97	12.5	12.5	12.5	12.5	12.5	0.0	0.0	25.0	10.9
97/98	0.0	14.3	14.3	14.3	14.3	0.0	14.3	28.6	12.5
98/99	0.0	11.1	11.1	11.1	11.1	0.0	11.1	11.1	8.3
All Years	10.0	15.0	12.5	15.0	17.5	5.0	7.7	20.0	12.9

DM-1 upper Des Moines Creek
DM-2 lower Des Moines Creek
MA-1 upper Massey Creek
MA-2 middle Massey Creek
MA-3 lower Massey Creek
BA-1 lower Barnes Creek
MC-1 upper McSorley Creek
MC-2 lower McSorley Creek

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(station MC-1) to 16 percent (station MC-2). The percentage of samples exceeding the state criterion during base flow sampling ranged from 7 percent (stations DM-1 and BA-1) to 33 percent (stations DM-2 and MA-3). Overall, 13 percent of the samples collected during the 5-year monitoring program exceeded the state criterion for temperature. Samples collected during summer base flow conditions consistently exceeded the state criterion for temperature at all stations except DM-1 and BA-1.

The analysis for spatial trends showed that there were no significant differences in temperature between monitoring stations in the Des Moines Creek basin during either storm flow or base flow (see Table 8 and Appendix C). Temperatures were significantly lower in Barnes Creek (station BA-1) relative to the other monitoring stations in the Massey Creek basin during storm flow. Colder water entering Massey Creek from Barnes Creek most likely contributed to a significant decrease in temperatures from station MA-2 to station MA-3 during storm flow. Base flow temperatures in the Massey Creek basin were significantly different only at stations BA-1 and MA-2. Temperatures in McSorley Creek significantly increased downstream during storm flow but not during base flow. This trend is most likely related to the presence of the Parkside Wetland at the headwaters of McSorley Creek. Relatively cool water that enters the Parkside Wetland from ground water may provide a buffer against temperature increases in the upper reaches of McSorley Creek during storm events.

There were no significant differences in temperature between monitoring years at any of the stations for storm flow or base flow (see Appendix C). Nor did the analysis for temporal trends throughout the entire 5-year monitoring program show any significant increasing or decreasing trends for temperature at any of the monitoring stations (see Table 9 and Appendix C).

pH

pH is a measure of the hydrogen ion activity in water, which can have a direct effect on aquatic organisms, or an indirect effect by virtue of the fact that the toxicity of several common pollutants are markedly affected by changes in pH. Waters that exhibit a pH in the range of 0.0 to 7.0 are considered acidic, while waters with pH ranging from 7.0 to 14.0 are considered alkaline. Washington state standards indicate that acceptable pH values range from 6.5 to 8.5 for Class AA freshwater (see Table 3).

Measurements of pH over the 5-year monitoring program ranged from 5.90 to 8.98 (Figure 6). The median pH ranged from 6.77 to 7.43 among the stream stations during storm flow and from 7.04 to 7.75 during base flow. All three basins in this study exhibited similar median pH levels in their downstream reaches similar to median levels measured in other King County streams during base and storm flow (see Tables 5, 6, and 7).

The Washington state Class AA criterion for pH was exceeded at least once at every monitoring station during the 5-year monitoring period (Table 11). The percentage of storm flow samples exceeding the state criterion for pH ranged from 4 percent (stations DM-1, DM-2, MA-2, BA-1, and MC-2) to 16 percent (station MA-1). The percentage of base flow samples exceeding the state criterion ranged from zero percent (stations DM-1, MA-1, MA-2, MA-3, MC-1, and MC-2) to 7 percent (stations DM-2 and BA-1). Overall, 5 percent of the samples collected during the 5-year monitoring program exceeded the state criterion for pH. Instrument problems may have affected the accuracy of monitoring results for pH during storm event 7 (March 3, 1996) because all eight of the samples collected during this event exhibited pH levels below the state criterion.

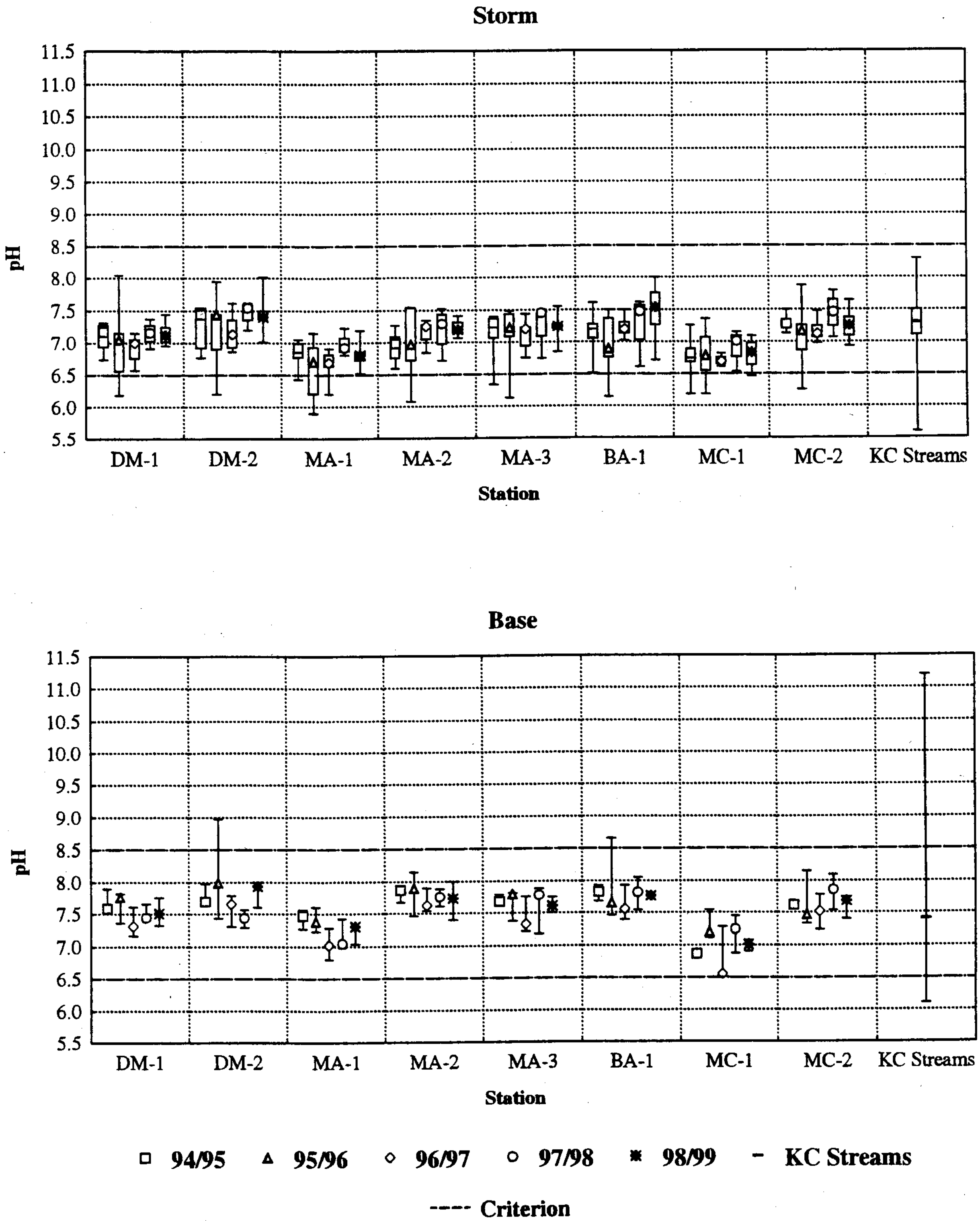

Figure 6. **Measurements of pH during storm and base flow sampling events in Des Moines streams and in other King County (KC) streams.**

Table 11. Percentages of samples from Des Moines stream exceeding the Washington state Class AA water quality criterion for pH by monitoring station and year.

	DM-1	DM-2	MA-1	MA-2	MA-3	BA-1	MC-1	MC-2	All Stations
Base Flow Samples									
94/95	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
95/96	0.0	33.3	0.0	0.0	0.0	33.3	0.0	0.0	8.3
96/97	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
97/98	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
98/99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All Years	0.0	6.7	0.0	0.0	0.0	6.7	0.0	0.0	1.7
Storm Flow Samples									
94/95	0.0	0.0	20.0	0.0	20.0	0.0	20.0	0.0	7.5
95/96	20.0	20.0	40.0	20.0	20.0	20.0	20.0	20.0	22.5
96/97	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	2.5
97/98	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
98/99	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	2.1
All Years	4.0	4.0	16.0	4.0	8.0	4.0	12.0	4.0	7.0
All Samples									
94/95	0.0	0.0	12.5	0.0	12.5	0.0	14.3	0.0	4.8
95/96	12.5	25.0	25.0	12.5	12.5	25.0	12.5	12.5	17.2
96/97	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0	1.6
97/98	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
98/99	0.0	0.0	0.0	0.0	0.0	0.0	11.1	0.0	1.4
All Years	2.5	5.0	10.0	2.5	5.0	5.0	7.7	2.5	5.0

DM-1 upper Des Moines Creek
DM-2 lower Des Moines Creek
MA-1 upper Massey Creek
MA-2 middle Massey Creek
MA-3 lower Massey Creek
BA-1 lower Barnes Creek
MC-1 upper McSorley Creek
MC-2 lower McSorley Creek

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However, these pH results were not qualified as estimates because no problems with instrument calibration or operation were noted by the technician.

The analysis for spatial trends showed that pH values generally increased downstream in all three basins in the study. For example, pH values in both Des Moines Creek and McSorley Creek increased significantly downstream during storm and base flow (see Table 8 and Appendix C). Storm and base flow pH values were also significantly lower in the upper reaches of Massey Creek (station MA-1) relative to all other monitoring stations in the basin (MA-2, MA-3, and BA-1). Natural or human-induced nutrient enrichment in the downstream reaches of these streams may be stimulating primary productivity by attached algae that increases pH levels. There were no significant differences in pH values between monitoring years at any of the stations for storm flow or base flow (see Appendix C). The analysis for temporal trends throughout the entire 5-year monitoring program showed only a significant increasing trend for storm flow pH levels in Barnes Creek (station BA-1) (see Table 9 and Appendix C).

Dissolved Oxygen

Dissolved oxygen is significant for the protection of aesthetic qualities of water as well as for the maintenance of fish and other aquatic life (U.S. EPA 1976). To allow for differences among requirements by affected species of fish and other aquatic organisms, dissolved oxygen standards are based on concentrations that supports a well-rounded population of fish. The Washington state standard for Class AA freshwaters requires that dissolved oxygen shall exceed 9.5 milligrams per liter (mg/L) (see Table 3).

Dissolved oxygen concentrations over the 5-year monitoring program ranged from 5.5 to 14.1 mg/L (Figure 7). The median dissolved oxygen concentration ranged from 7.8 to 10.9 mg/L among the stream stations during storm flow and from 7.6 to 11.6 mg/L during base flow. All three basins in this study exhibited median dissolved oxygen concentrations in their downstream reaches similar to other streams in developed areas of King County during base flow and storm flow (see Tables 5, 6, and 7).

The Washington state Class AA criterion for dissolved oxygen was exceeded at least once at every monitoring station during the 5-year monitoring period (Table 12). The percentage of storm flow samples exceeding the state criterion for dissolved oxygen ranged from 12 percent (stations DM-2 and BA-1) to 88 percent (station MC-1). The percentage of base flow samples exceeding the state criterion ranged from 27 percent (station BA-1) to 100 percent (station MC-1). Overall, 35 percent of the samples collected during the 5-year monitoring program exceeded the state criterion. Dissolved oxygen concentrations in samples collected during summer base flow conditions were in chronic violation of the state criterion for dissolved oxygen. Low dissolved oxygen concentrations in these streams most likely result from a combination of factors, including 1) water temperature increases resulting from the removal of shade providing canopy cover in the riparian zone, and 2) high nutrient concentrations that stimulate excessive microbial decomposition.

The analysis for spatial trends showed that dissolved oxygen concentrations in Des Moines Creek significantly increased downstream during storm flow but not during base flow (see

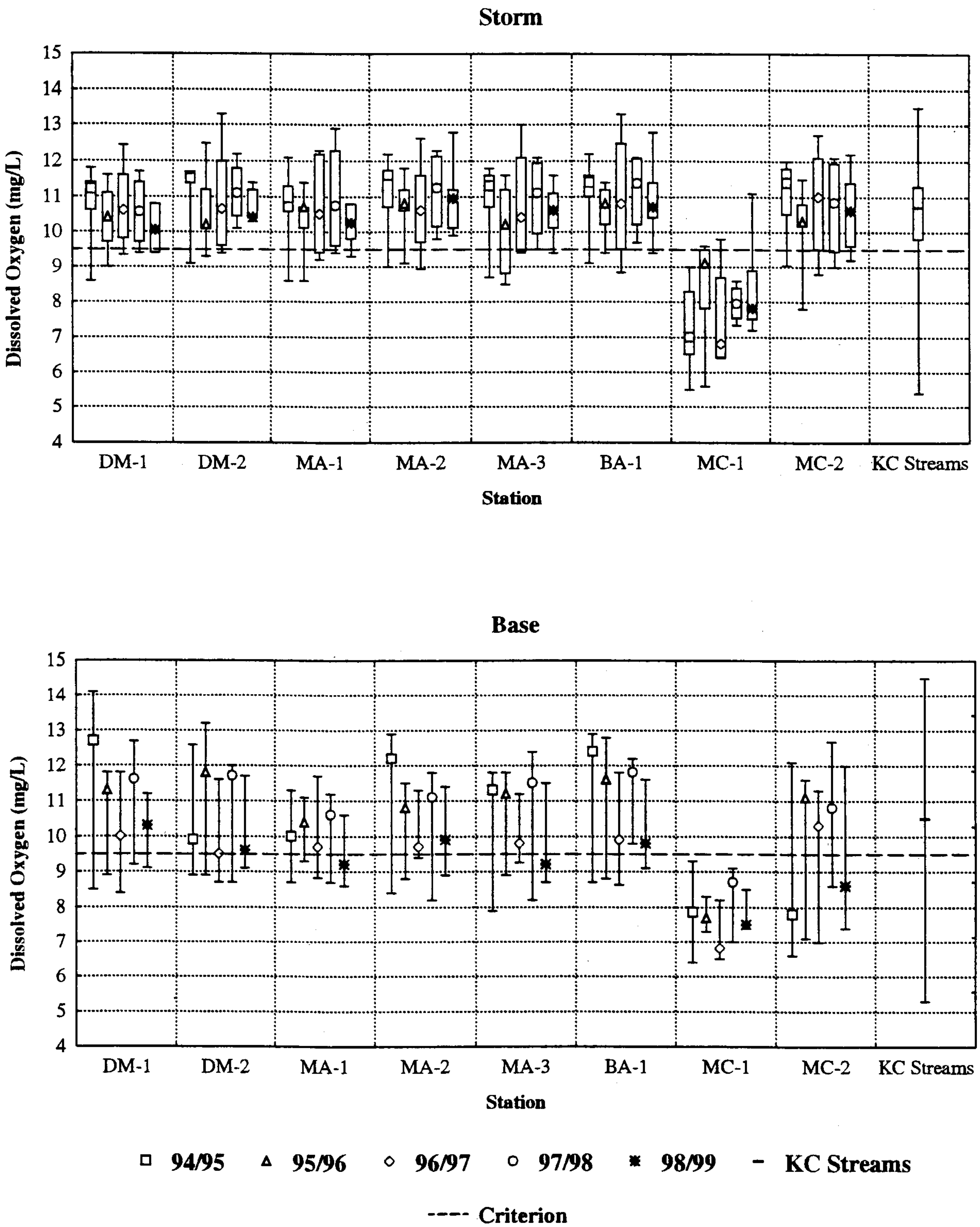

Figure 7. Dissolved oxygen concentrations during storm and base flow sampling events in Des Moines streams and in other King County (KC) streams.

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Table 12. Percentages of samples from Des Moines streams exceeding the Washington state Class AA water quality criterion for dissolved oxygen by monitoring station and year.

	DM-1	DM-2	MA-1	MA-2	MA-3	BA-1	MC-1	MC-2	All Stations
Base Flow Samples									
94/95	33.3	33.3	33.3	33.3	33.3	33.3	100.0	66.7	43.5
95/96	33.3	33.3	33.3	33.3	33.3	33.3	100.0	33.3	41.7
96/97	33.3	66.7	33.3	33.3	33.3	33.3	100.0	33.3	45.8
97/98	33.3	33.3	33.3	33.3	33.3	0.0	100.0	33.3	37.5
98/99	33.3	33.3	66.7	33.3	66.7	33.3	100.0	66.7	54.2
All Years	33.3	40.0	40.0	33.3	40.0	26.7	100.0	46.7	44.5
Storm Flow Samples									
94/95	20.0	20.0	20.0	20.0	20.0	20.0	100.0	20.0	30.0
95/96	20.0	20.0	20.0	20.0	40.0	20.0	80.0	20.0	30.0
96/97	20.0	20.0	40.0	20.0	40.0	40.0	80.0	40.0	37.5
97/98	25.0	0.0	25.0	0.0	25.0	0.0	100.0	25.0	25.0
98/99	33.3	0.0	16.7	0.0	16.7	16.7	83.3	16.7	22.9
All Years	24.0	12.0	24.0	12.0	28.0	20.0	88.0	24.0	29.0
All Samples									
94/95	25.0	25.0	25.0	25.0	25.0	25.0	100.0	37.5	34.9
95/96	25.0	25.0	25.0	25.0	37.5	25.0	87.5	25.0	34.4
96/97	25.0	37.5	37.5	25.0	37.5	37.5	87.5	37.5	40.6
97/98	28.6	14.3	28.6	14.3	28.6	0.0	100.0	28.6	30.4
98/99	33.3	11.1	33.3	11.1	33.3	22.2	88.9	33.3	33.3
All Years	27.5	22.5	30.0	20.0	32.5	22.5	92.3	32.5	34.8

DM-1 upper Des Moines Creek
DM-2 lower Des Moines Creek
MA-1 upper Massey Creek
MA-2 middle Massey Creek
MA-3 lower Massey Creek
BA-1 lower Barnes Creek
MC-1 upper McSorley Creek
MC-2 lower McSorley Creek

Table 8 and Appendix C). There were no clear longitudinal (downstream) trends for storm flow dissolved oxygen concentrations in the Massey Creek basin. Base flow dissolved oxygen concentrations in the Massey Creek basin were significantly different only at stations MA-1 and BA-1, with higher concentrations at station MA-1. Natural conditions that reduce dissolved oxygen concentrations in drainage from the Parkside Wetland (e.g., low aeration and high levels of oxygen-demanding substances) caused dissolved oxygen concentrations to be significantly lower in upper McSorley Creek (station MC-1) during both storm and base flow.

There were no significant differences in dissolved oxygen concentrations between monitoring years at any of the stations for storm and base flow (see Appendix C). Nor did the analysis for temporal trends over the entire 5-year monitoring program show any significant increasing or decreasing trends for dissolved oxygen at any of the monitoring stations (see Table 9 and Appendix C).

Conductivity

Specific conductance or conductivity is a measure of the ability of a water to conduct an electrical current, which is directly related to the content of dissolved ions (solids) in the water. While there is no water quality standard established for conductivity, this measurement is useful for identifying sources of dissolved pollutants and for determining relative contributions of ground water, because conductivity is typically higher in ground water than in surface waters.

Conductivity levels over the 5-year monitoring program ranged from 27.0 to 425 micromhos per centimeter (µmhos/cm) (Figure 8). The median conductivity level ranged from 72.1 to 138 µmhos/cm among the stream stations during storm flow and from 155 to 249 µmhos/cm during base flow. Conductivity levels are generally lower during storm flow than base flow, because surface runoff dilutes stream waters originating from seepage that typically has high dissolved ion concentrations. During base flow, median conductivity levels were highest in the Massey Creek basin and lowest in the McSorley Creek basin. Median conductivity levels in the downstream reaches of all three basins were higher than the median levels for other streams located in developed areas of King County during base flow, but not during storm flow (see Tables 5, 6, and 7).

The analysis for spatial trends showed that conductivity levels in Des Moines Creek and McSorley Creek significantly increased downstream during both storm flow and base flow (see Table 8 and Appendix C). Conductivity levels were significantly lower in the middle reaches of Massey Creek (station MA-2) during storm flow compared to all other monitoring stations in the basin. During base flow, conductivity levels were significantly higher in the upper reaches of the Massey Creek basin (station MA-1).

There were no significant differences in conductivity between monitoring years at any of the stations for storm and base flow (Appendix C). The analysis for temporal trends over the entire 5-year monitoring program showed a significant increasing trend for storm flow conductivity levels in lower Des Moines Creek (station DM-2). There were also significant increasing trends for base flow conductivity levels in upper Des Moines Creek (station DM-1) and all of Massey Creek (stations MA-1, MA-2, and MA-3) (see Table 9 and Appendix C). The trend of increasing

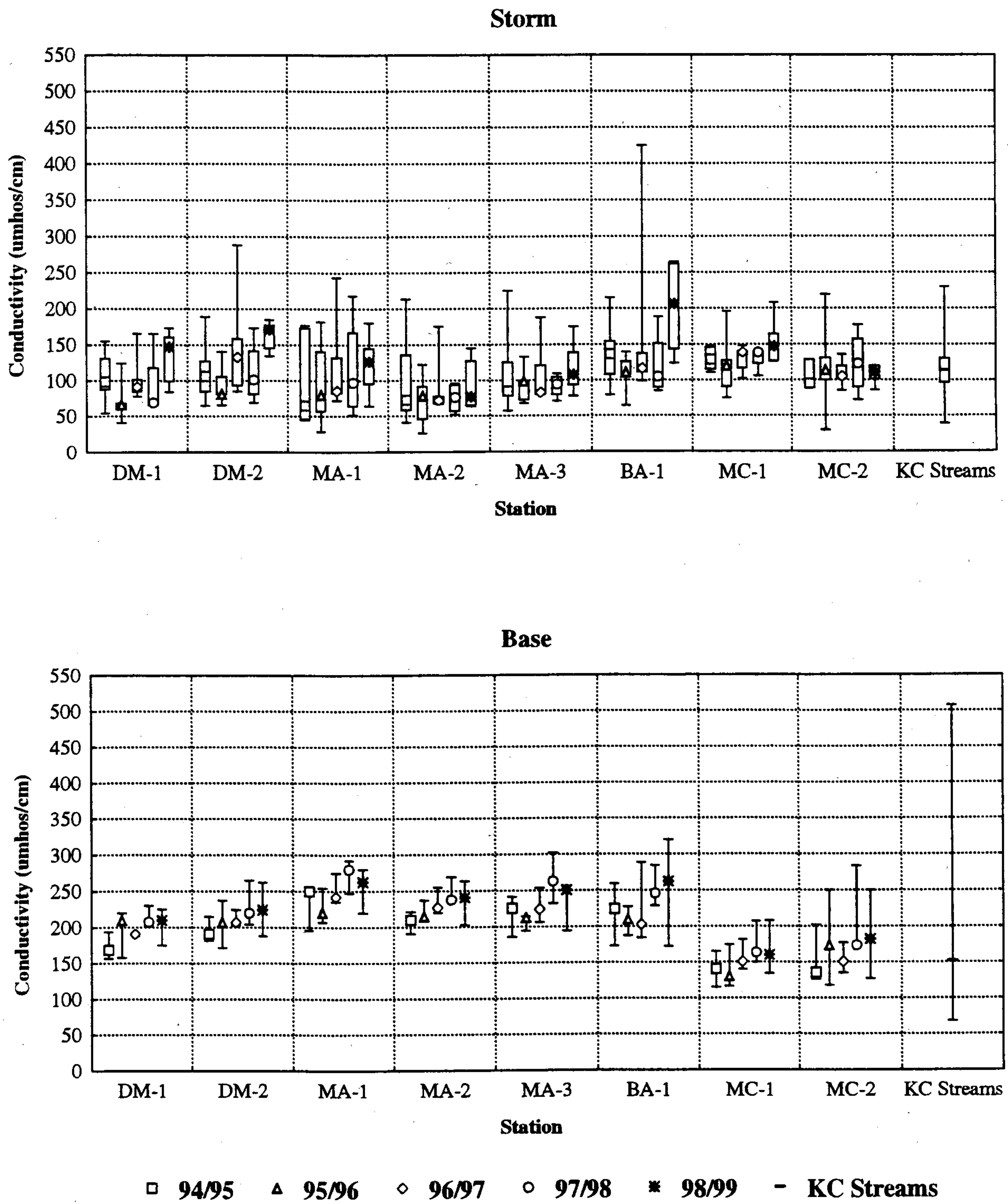

Figure 8. **Conductivity levels during storm and base flow sampling events in Des Moines streams and in other King County (KC) streams.**

base flow conductivity at all three of the Massey Creek monitoring stations suggests that ground water discharging to the stream contained increasing concentrations of major cations (i.e., calcium and magnesium) throughout the study period. Increasing cation concentrations in ground water are not necessarily indicative of pollution, but have been associated with lower amounts of rainfall infiltration during dry years (King County 1994). However, the cause for increasing base flow conductivity in Massey Creek is unclear because rainfall amounts did not consistently decrease, basin development (which reduces infiltration) did not substantially increase, and base flow hardness (cation) concentrations did not significantly decrease during the study period (see below).

Hardness

Hardness measurements are based on the concentrations of calcium and magnesium, which directly affect the toxicity of some heavy metals (i.e., metals are more toxic at lower levels of hardness). Hardness measurements are necessary for determining compliance with state water quality standards for dissolved copper, lead, and zinc.

Hardness measurements over the 5-year monitoring program ranged from 19.1 to 139 mg/L (as calcium carbonate) (Figure 9). The median hardness concentration ranged from 33.3 to 53.8 mg/L among the stations during storm flow and from 67.2 to 109 mg/L during base flow.

The analysis for spatial trends showed that hardness in Des Moines Creek significantly increased downstream during both storm flow and base flow (see Table 8 and Appendix C). Hardness concentrations were significantly higher in Barnes Creek (station BA-1) than in upper and middle Massey Creek (stations MA-1 and MA-2, respectively) during storm flow. Water entering Massey Creek from Barnes Creek most likely contributed to a significant increase in hardness from station MA-2 to station MA-3 during storm flow. There were no clear longitudinal trends for hardness measurements in the Massey Creek basin during base flow. Hardness in McSorley Creek increased significantly downstream during storm flow but not during base flow.

There were no significant differences in hardness measurements between monitoring years at any of the stations for storm or base flow (Appendix C). The analysis for temporal trends over the entire 5-year monitoring program showed a significant increasing trend for storm flow hardness in Des Moines Creek (stations DM-1 and DM-2) (see Table 9 and Appendix C). The cause of this apparent trend is unclear because there was no concurrent trend of decreasing discharged rates (and less dilution of high base flow hardness concentrations) during storm flow sampling of Des Moines Creek.

Turbidity

Turbidity is a measure of particulate matter in water that reduces water transparency or clarity. Measurements of turbidity in nephelometric turbidity units (NTU) are used to determine whether state standards have been exceeded (see Table 3).

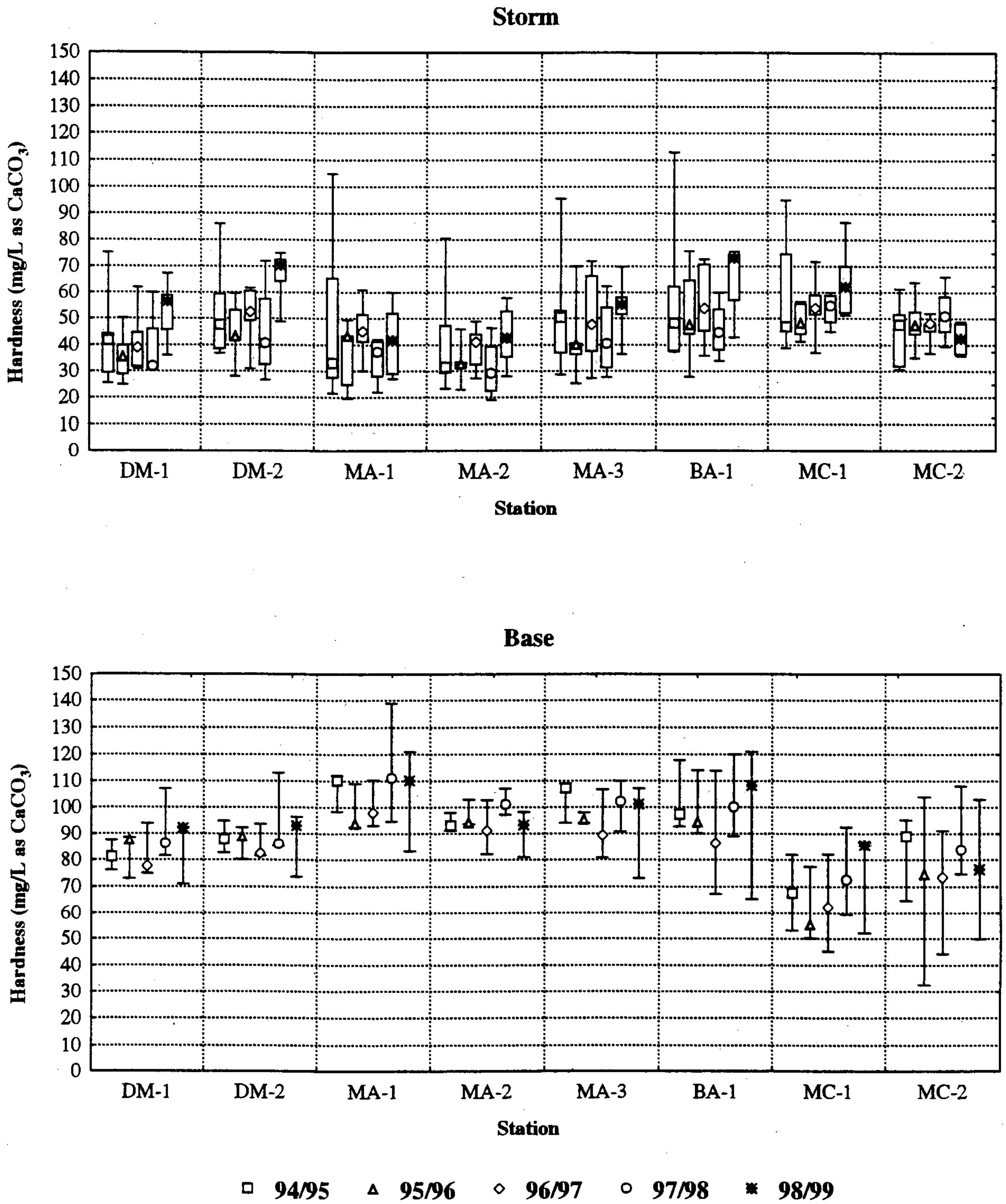

Figure 9. **Hardness during storm and base flow sampling events in Des Moines streams.**

Turbidity levels over the 5-year monitoring program ranged from 2.1 to 95 NTU (Figure 10). The median turbidity level ranged from 6.1 to 32 NTU among the stream stations during storm flow and from 1.6 to 4.9 NTU during base flow. Storm flow turbidity levels were generally highest in Barnes Creek (station BA-1). Storm flow median turbidity levels in the downstream reaches of all three basins were roughly twice as high as the median level for other streams located in developed areas of King County (see Tables 5, 6, and 7).

During the 5-year monitoring period, the Washington state Class AA criterion for turbidity (i.e., shall not exceed a 5 NTU or 10 percent increase over background) was exceeded at least once at every monitoring station having a suitable upstream station for assessing background turbidity (Table 13). The percentage of samples exceeding the state criterion for turbidity during storm flow sampling ranged from 20 percent (station DM-2) to 84 percent (station MC-2). The percentage of samples exceeding the state criterion for turbidity during base flow sampling ranged from zero percent (stations DM-2, MA-2, and MA-3) to 7 percent (station MC-2). Overall, 36 percent of the samples collected during the 5-year monitoring program exceeded the state criterion for turbidity. Potential sources of turbidity that contribute to these water quality violations include 1) fine sediment entering the water via surface water runoff, 2) bank erosion, and 3) resuspension of previously deposited particles in the streambed.

The analysis for spatial trends showed no significant longitudinal (downstream) trends in turbidity within the Des Moines Creek basin during either storm flow or base flow (Table 8 and Appendix C). Turbidity was significantly lower in the upper reaches of Massey Creek (station MA-1) during storm flow and significantly higher in the upper reaches during base flow. Turbidity in McSorley Creek increased significantly downstream during storm flow but not during base flow.

There were no significant differences in turbidity between monitoring years at any of the stream stations for storm or base flow (Appendix C). Nor did the analysis for temporal trends over the entire 5-year monitoring program show any significant increasing or decreasing trends in turbidity for any of the monitoring stations (Table 9 and Appendix C).

Total Suspended Solids

Total suspended solids in urban runoff are the most widespread pollutant entering surface waters. Solids, especially the finer fractions, reduce light penetration in water and can have a smothering effect on fish spawning and benthic biota. Suspended solids are also closely associated with other pollutants such as nutrients, bacteria, metals, and organic compounds. These pollutants tend to adsorb onto the solids particles and are consequently transported in surface runoff to receiving waters if no onsite controls are implemented for solids removal. Thus, the presence of suspended solids is used to evaluate the overall pollutant loading within a basin. No state standards have been established for suspended solids.

Total suspended solids concentrations over the 5-year monitoring program ranged from less than 0.5 to 490 mg/L (Figure 11). The median total suspended solids concentration ranged from 14 to 86 mg/L among the stations during storm flow and from 0.8 to 2.4 mg/L during base flow. Storm flow total suspended solids concentrations were highest in Barnes Creek (station BA-1).

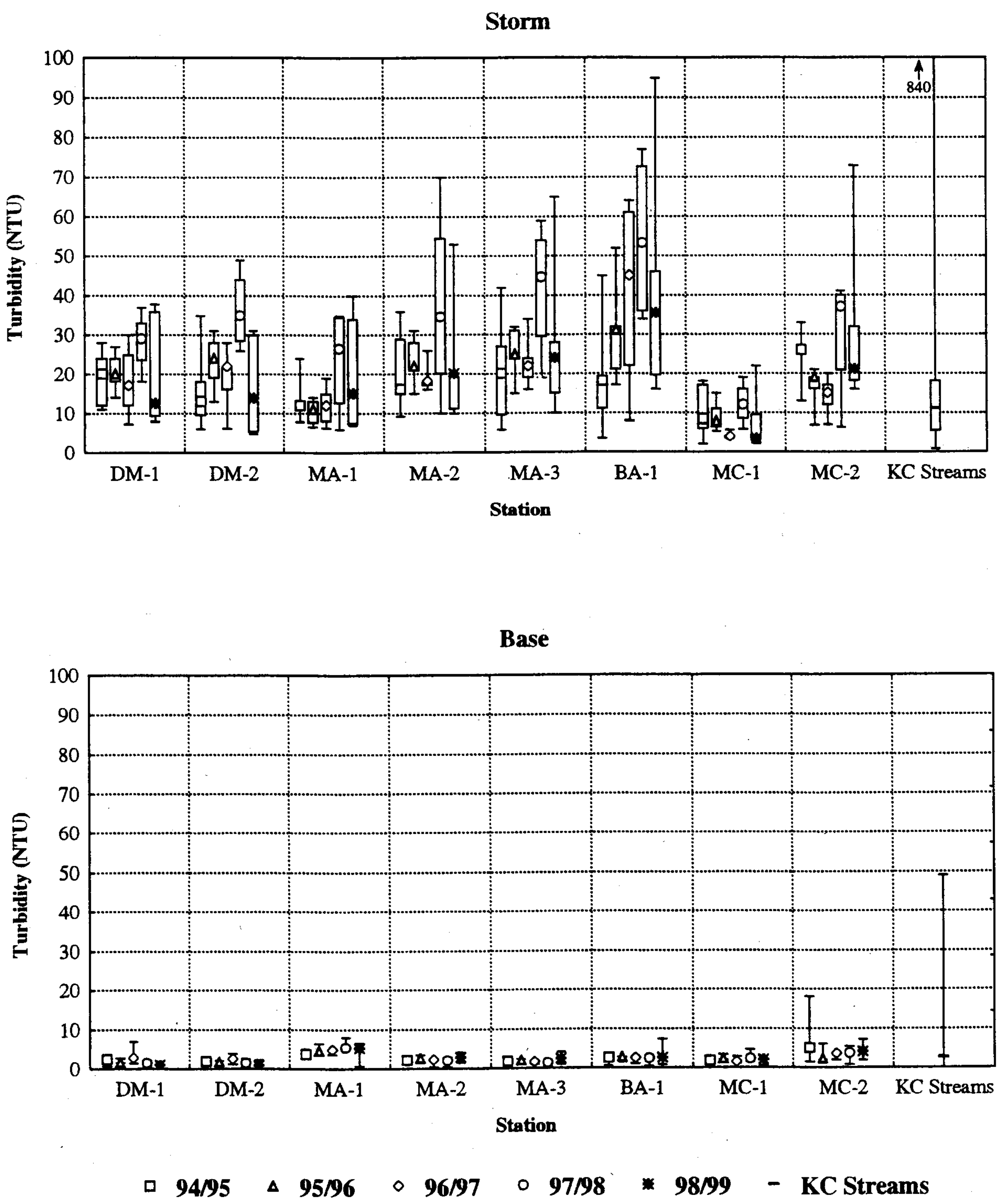

Figure 10. Turbidity values during storm and base flow sampling events in Des Moines streams and in other King County (KC) streams.

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Table 13. Percentages of samples from Des Moines streams exceeding the Washington state Class AA water quality criterion for turbidity by monitoring station and year.

	DM-2	MA-2	MA-3	MC-2	All Stations
Base Flow Samples					
94/95	0.0	0.0	0.0	33.3	8.3
95/96	0.0	0.0	0.0	0.0	0.0
96/97	0.0	0.0	0.0	0.0	0.0
97/98	0.0	0.0	0.0	0.0	0.0
98/99	0.0	0.0	0.0	0.0	0.0
All Years	0.0	0.0	0.0	6.7	1.7
Storm Flow Samples					
94/95	20.0	40.0	40.0	80.0	45.0
95/96	20.0	100.0	80.0	80.0	70.0
96/97	0.0	80.0	60.0	80.0	55.0
97/98	50.0	50.0	75.0	75.0	62.5
98/99	16.7	33.3	66.7	100.0	54.2
All Years	20.0	60.0	64.0	84.0	57.0
All Samples					
94/95	12.5	25.0	25.0	62.5	31.3
95/96	12.5	62.5	50.0	50.0	43.8
96/97	0.0	50.0	37.5	50.0	34.4
97/98	28.6	28.6	42.9	42.9	35.7
98/99	11.1	22.2	44.4	66.7	36.1
All Years	12.5	37.5	40.0	55.0	36.3

The turbidity criterion is based on an increase over background where an upstream location is used for background. Therefore, the turbidity criterion applies only to the following downstream locations:
DM-2 lower Des Moines Creek
MA-2 middle Massey Creek
MA-3 lower Massey Creek
MC-2 lower McSorley Creek

Storm flow median total suspended solids concentrations in the downstream reaches of the Des Moines and Massey Creek basins were 2.5 times higher than the median level for other King County streams (see Tables 5, 6, and 7).

The analysis for spatial trends showed that total suspended solids concentrations in all three study basins significantly increased downstream during storm flow (Table 8 and Appendix C). Barnes Creek appeared to be the primary source of total suspended solids in the lower reaches of the Massey Creek basin. There were no clear longitudinal trends for total suspended solids during base flow in any of the study basins.

There were no significant differences in total suspended solids concentrations between monitoring years at any of the stations for storm or base flow (Appendix C). Nor did the analysis for temporal trends over the entire 5-year monitoring program show any significant increasing or decreasing trends for total suspended solids at any of the monitoring stations (Table 9 and Appendix C).

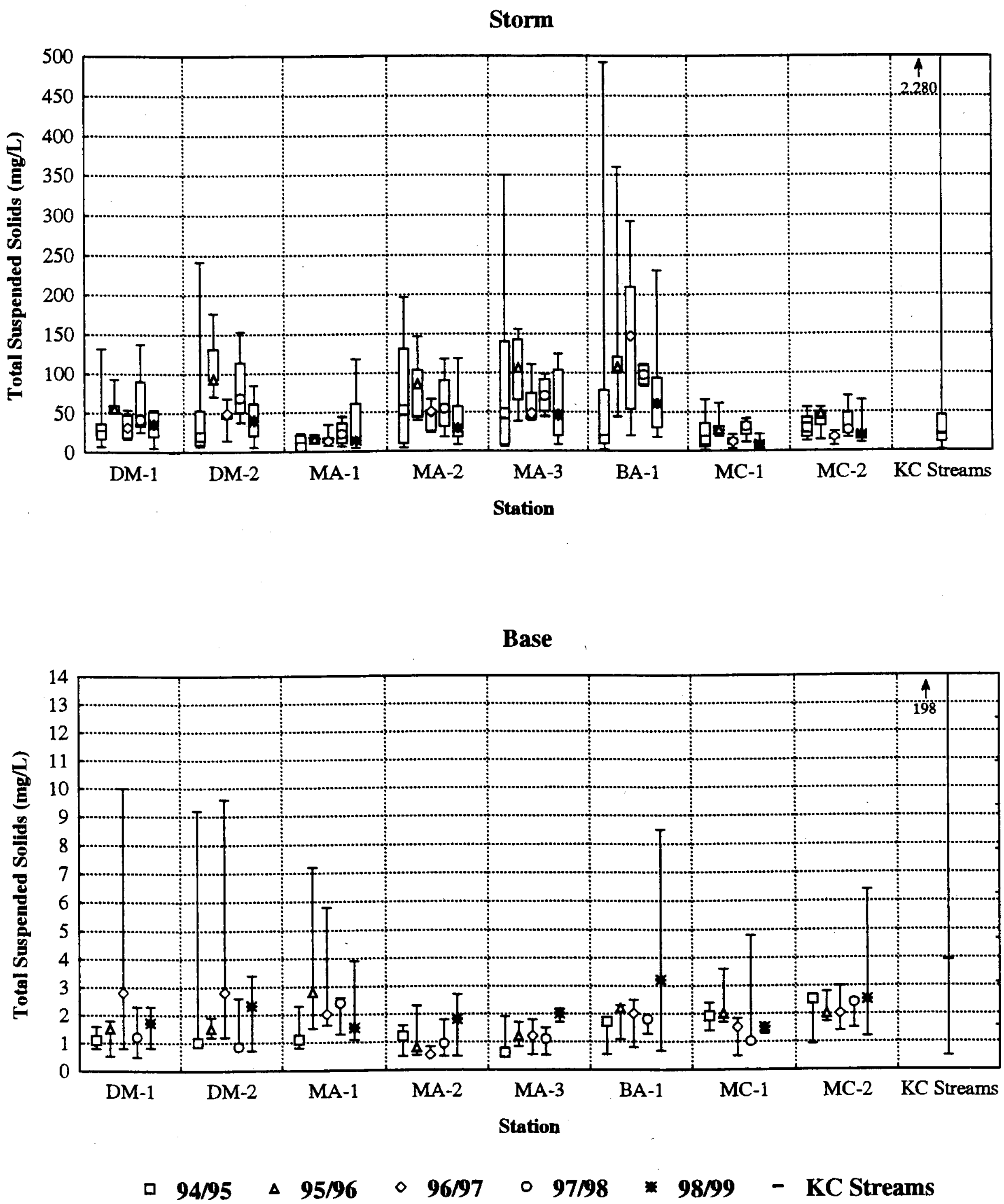

Figure 11. Total suspended solids concentrations during storm and base flow sampling events in Des Moines streams and in other King County (KC) streams.

Nutrients

The nutrients of general concern in urban runoff are nitrogen and phosphorus. These elements are primary nutrients for algae and other plants in freshwater ecosystems including wetlands, streams, and lakes. Inputs of large quantities of nitrogen and phosphorus can cause excessive algal growth and a general decline in the quality of receiving waters. Common sources of nitrogen and phosphorus are fertilizers and nutrient-containing soils that have been eroded and washed into the stream. No state standards have been established for nutrients in streams.

Total Phosphorus

Total phosphorus concentrations over the 5-year monitoring program ranged from 15.0 to 1,270 micrograms per liter (µg/L) (Figure 12). The median total phosphorus concentration ranged from 74 to 233 µg/L among the stream stations during storm flow and from 21 to 82 µg/L during base flow. Storm flow total phosphorus concentrations were highest in Barnes Creek (station BA-1). Storm flow median total phosphorus concentrations in the downstream reaches of all three basins were slightly higher than the median level for other King County streams (see Tables 5, 6, and 7).

The analysis for spatial trends showed no significant longitudinal (downstream) trends in total phosphorus concentrations in the Des Moines Creek basin during either storm or base flow (Table 8 and Appendix C). Significant increases in total phosphorus concentrations in the downstream reaches of the Massey Creek basin during both storm and base flow appeared to be related to high total phosphorus concentrations in Barnes Creek (station BA-1). Total phosphorus concentrations in McSorley Creek decreased significantly downstream during base flow.

There were no significant differences in total phosphorus concentrations between monitoring years at any of the stations for storm or base flow (Appendix C). The analysis for temporal trends over the entire 5-year monitoring program showed only a significant increasing trend for storm flow total phosphorus concentrations in upper Massey Creek (station MA-1) (Table 9 and Appendix C).

Ammonia Nitrogen

Ammonia nitrogen concentrations over the 5-year monitoring program ranged from less than 10 to 592 µg/L (Figure 13). The median ammonia nitrogen concentration ranged from 36 to 70 µg/L among the stations during storm flow and from less than 10 to 61 µg/L during base flow. Storm flow ammonia nitrogen concentrations were highest in upper Des Moines Creek (station DM-1) and upper Massey Creek (station MA-1). Base flow ammonia nitrogen concentrations were highest in upper Massey Creek (station MA-1). Storm flow median ammonia nitrogen concentrations in the downstream reaches of the Des Moines and McSorley Creek basins were approximately 50 percent higher than the median level for other King County streams (see Tables 5, 6, and 7).

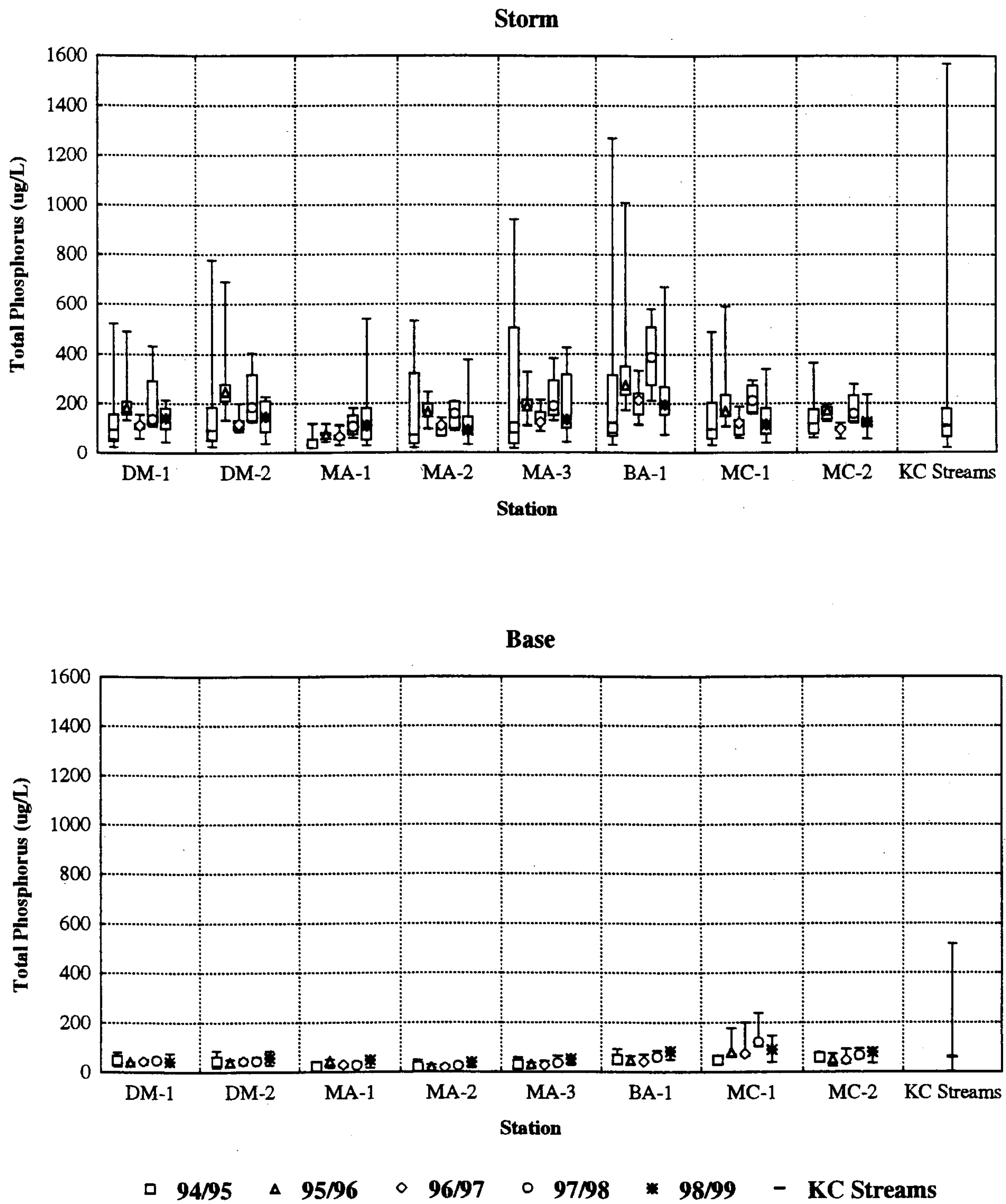

Figure 12. **Total phosphorus concentrations during storm and base flow sampling events in Des Moines streams and in other King County (KC) streams.**

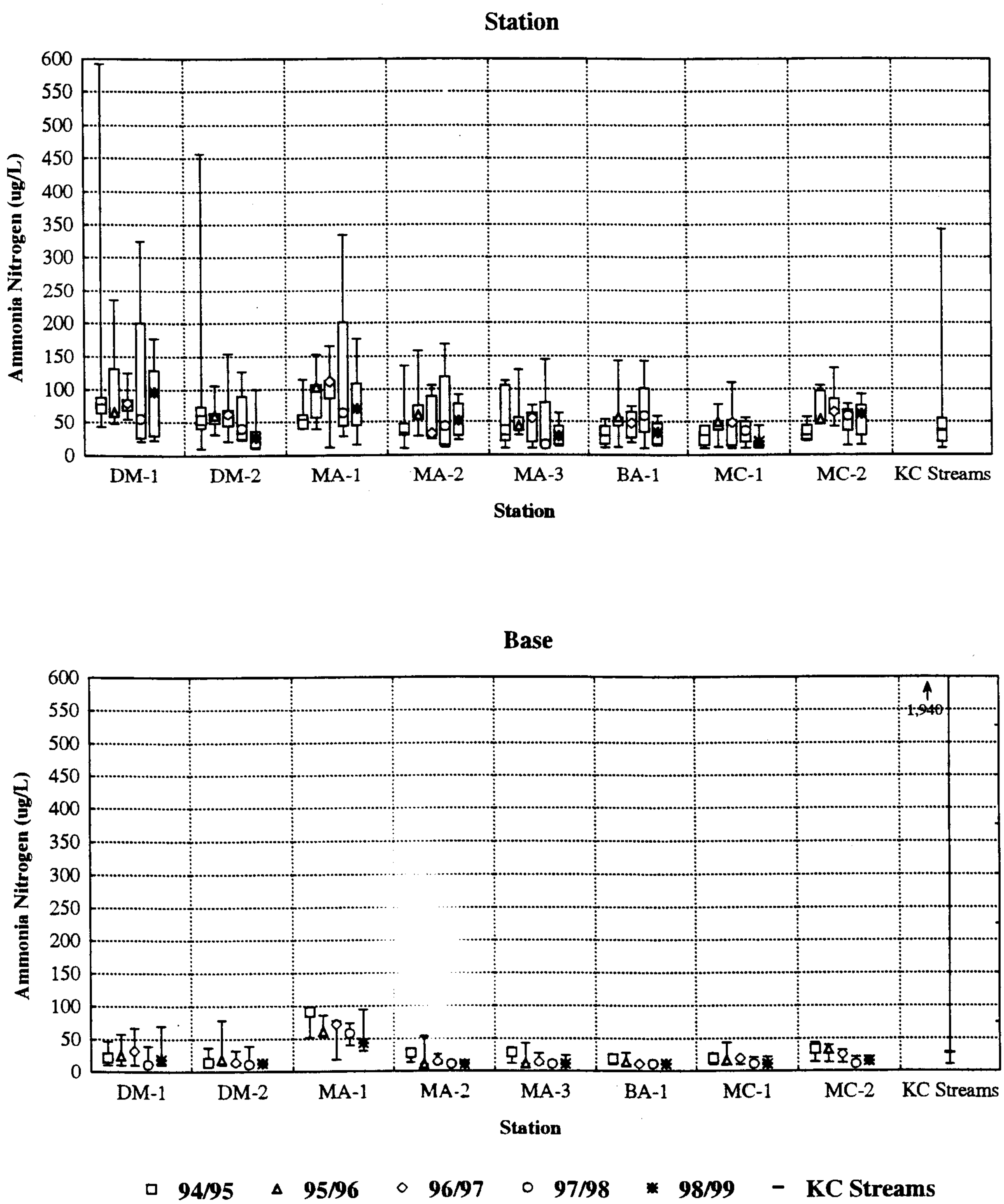

Figure 13. Ammonia nitrogen concentrations during storm and base flow sampling events in Des Moines streams and in other King County (KC) streams.

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During the 5-year monitoring period, the Washington state criterion for ammonia toxicity was never exceeded.

The analysis for spatial trends showed that ammonia nitrogen concentrations in Des Moines Creek significantly decreased downstream during storm flow (Table 8 and Appendix C). Similarly, ammonia nitrogen decreased significantly downstream in the Massey Creek basin during both storm and base flow. In contrast to the other two basins in the study, ammonia nitrogen concentrations in the McSorley Creek basin significantly increased downstream during storm flow. This observation suggests that runoff from the Midway landfill may be a significant source of ammonia nitrogen to McSorley Creek.

There were no significant differences in ammonia nitrogen concentrations between monitoring years at any of the stations for storm or base flow (Appendix C). The analysis for temporal trends over the entire 5-year monitoring program showed significant decreasing trends for base flow ammonia nitrogen concentrations in middle and lower Massey Creek (stations MA-2 and MA-3, respectively) and in lower McSorley Creek (station MC-2) (Table 9 and Appendix C).

Nitrate+Nitrite Nitrogen

Nitrate+nitrite nitrogen concentrations over the 5-year monitoring program ranged from 27 to 1,870 μg/L (Figure 14). The median nitrate+nitrite nitrogen concentration ranged from 279 to 803 μg/L among the stream stations during storm flow and from 333 to 1,630 μg/L during base flow. Storm flow nitrate+nitrite nitrogen concentrations were highest in Barnes Creek (station BA-1). Base flow nitrate+nitrite nitrogen concentrations were highest in Massey Creek (stations MA-1, MA-2, and MA-3) and Barnes Creek (station BA-1). Storm flow median nitrate+nitrite nitrogen concentrations in the downstream reaches of all three study basins were slightly lower than the median level for other King County streams (see Tables 5, 6, and 7).

The analysis for spatial trends showed that nitrate+nitrite nitrogen concentrations in Des Moines Creek and McSorley Creek significantly increased downstream during storm flow (Table 8 and Appendix C). Nitrate+nitrite concentrations were significantly higher in Barnes Creek (station BA-1) than in upper and middle Massey Creek (stations MA-1 and MA-2, respectively) during storm flow. There were no clear longitudinal trends in nitrate+nitrite nitrogen concentrations in the Massey Creek basin during base flow.

The statistical analysis for trends by monitoring year showed that nitrate+nitrogen concentrations during base flow were significantly higher at upper and middle Massey Creek (stations MA-1 and MA-2, respectively) in the second and third years of monitoring (i.e., 1995/96 and 1996/97, respectively) compared to the other three years. The analysis for temporal trends over the entire 5-year monitoring program showed significant decreasing trends for base flow nitrate+nitrite nitrogen concentrations in upper Massey Creek (stations MA-1) and in upper McSorley Creek (station MC-1) (Table 9 and Appendix C). There was also a significant decreasing trend for storm flow nitrate+nitrite nitrogen concentrations in lower McSorley Creek (station MC-2).

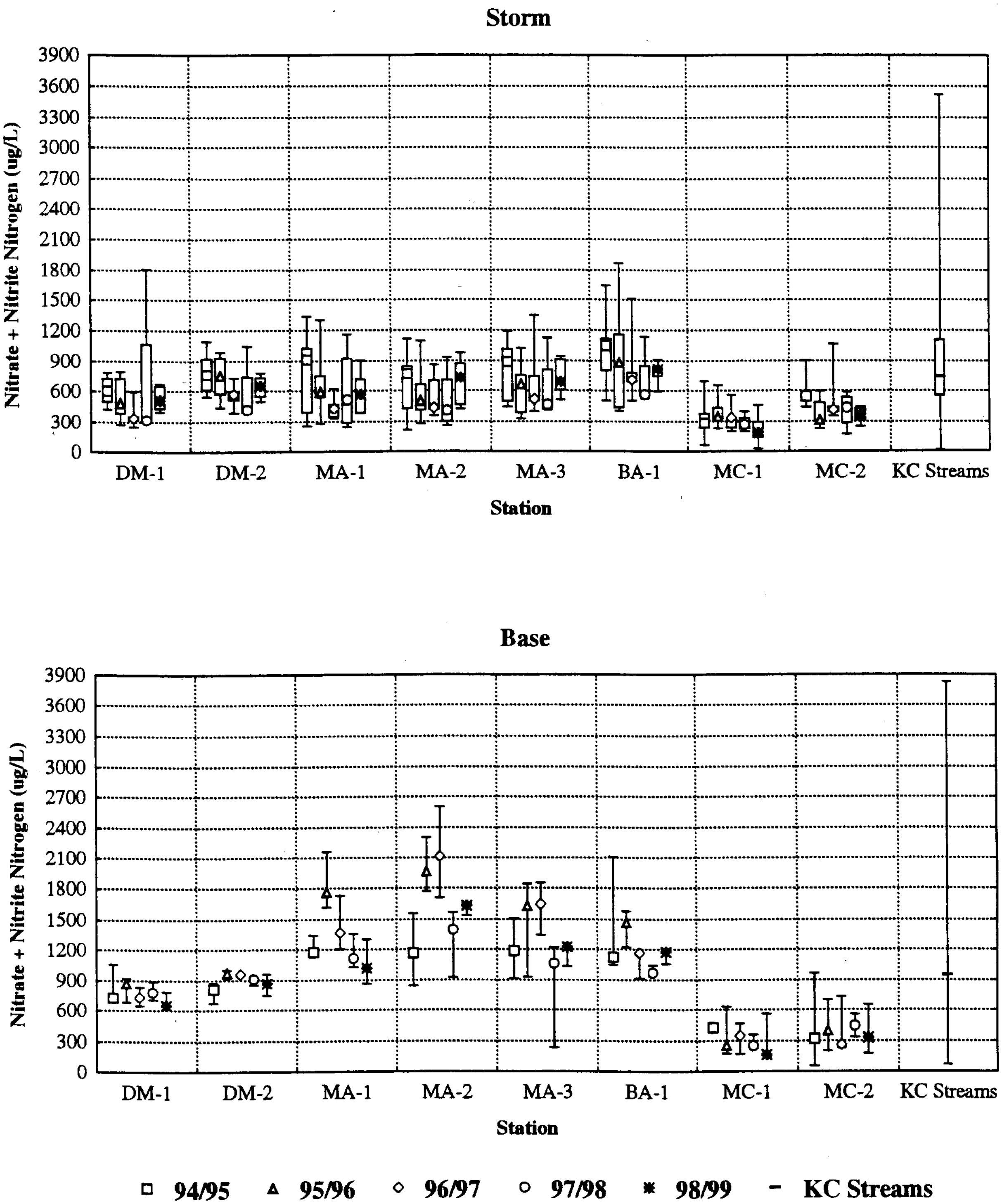

Figure 14. Nitrate + Nitrite nitrogen concentrations during storm and base flow sampling events in Des Moines streams and in other King County (KC) streams.

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Metals

Metals are among the most common toxicants found in urban runoff. The form of metals that is most toxic to aquatic biota is the free ionic or dissolved state. Water hardness directly influences the toxic effects on aquatic biota of a given metal concentration. Washington state surface water quality standards have been established for various dissolved metals based on water hardness (WAC 173-201A). Total recoverable metals, which include both particulate and dissolved fractions, are used by Ecology for calculating pollutant loads and effluent limits.

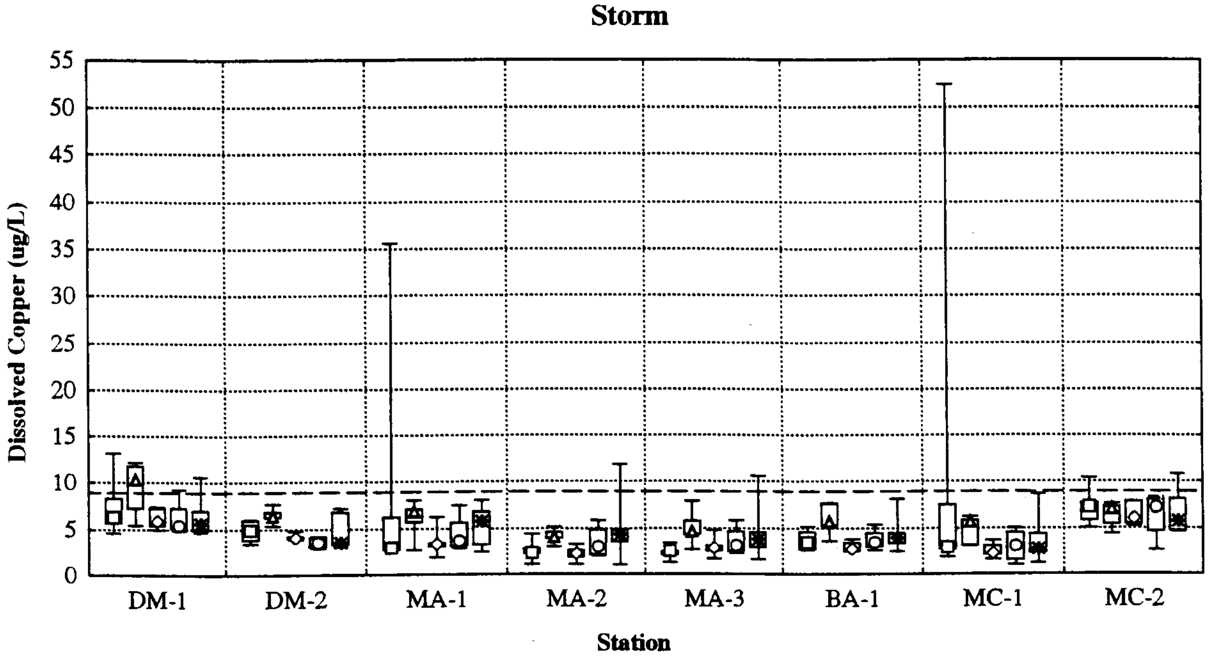
Dissolved and total metals results are discussed below for copper, lead, and zinc. The graphs of the dissolved metals results during storm flow include acute toxicity criteria from the Washington state surface water quality standards that are based on a hardness concentration of 50 mg/L (as calcium carbonate), which approximates an average hardness measurement among all of the monitoring stations during storm flow. The graphs of dissolved metals results during base flow include chronic toxicity criteria that are based on an approximate average hardness measurement of 100 mg/L (as calcium carbonate). Measured hardness concentrations were used for determining the exceedance of metals criteria for each sample, using acute criteria for storm flow samples and chronic criteria for base flow samples.

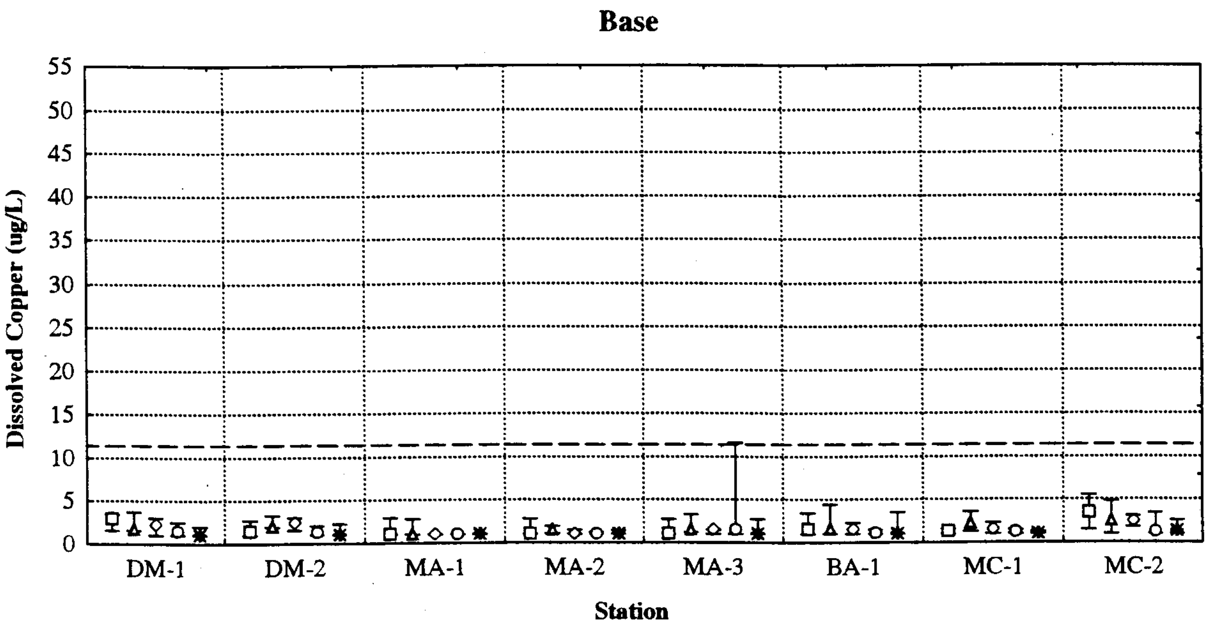
Dissolved Copper

Dissolved copper concentrations over the 5-year monitoring program ranged from less than 1.0 to 52.4 µg/L (Figure 15). The median dissolved copper concentration ranged from 3.1 to 6.6 µg/L among the stations during storm flow and from less than 1.0 to 2.4 µg/L during base flow. Storm and base flow dissolved copper concentrations were highest in upper Des Moines Creek (station DM-1) and in lower McSorley Creek (station MC-2).

During the 5-year monitoring period, Washington state Class AA criteria for dissolved copper were exceeded at least once at every monitoring station (Table 14). The percentage of samples exceeding the acute criterion for dissolved copper during storm flow sampling ranged from 4 percent (stations DM-2, MA-2, BA-1, and MC-1) to 40 percent (station DM-1). The percentage of samples exceeding the chronic criterion for dissolved copper during base flow sampling ranged from zero percent (stations DM-1, DM-2, MA-1, MA-2, MA-3, and MC-1) to 7 percent (station MC-2). Overall, 9 percent of the samples collected during the 5-year monitoring program exceeded dissolved copper criteria.

The analysis for spatial trends showed that dissolved copper concentrations in Des Moines Creek significantly decreased downstream during storm flow (Table 8 and Appendix C). Dissolved copper concentrations were significantly higher in Barnes Creek (station BA-1) than in upper and middle Massey Creek (stations MA-1 and MA-2, respectively) during storm flow. There were no clear longitudinal trends in dissolved copper concentrations in the Massey Creek basin during base flow. Dissolved copper concentrations in McSorley Creek significantly increased downstream during both storm and base flow. Runoff carrying pollutants from the Midway landfill (which is located between the upper and lower McSorley Creek monitoring stations) may be contributing to this trend. Similarly, runoff carrying pollutants from SeaTac airport (which is located upstream of station DM-1) maybe responsible for higher dissolved copper concentrations in upper Des Moines Creek.





□ 94/95 △ 95/96 ◇ 96/97 ○ 97/98 ✱ 98/99

---- Criterion (approx.)

Figure 15. Dissolved copper concentrations during storm and base flow sampling events in Des Moines streams.

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Table 14. Percentages of samples from Des Moines streams exceeding the Washington state Class AA water quality criterion for dissolved copper by monitoring station and year.

	DM-1	DM-2	MA-1	MA-2	MA-3	BA-1	MC-1	MC-2	All Stations
Base Flow Samples									
94/95	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
95/96	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	4.2
96/97	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
97/98	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
98/99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All Years	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.8
Storm Flow Samples									
94/95	60.0	0.0	40.0	0.0	0.0	0.0	20.0	40.0	20.0
95/96	100.0	20.0	20.0	0.0	40.0	20.0	0.0	0.0	25.0
96/97	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5
97/98	0.0	0.0	25.0	0.0	0.0	0.0	0.0	25.0	6.3
98/99	16.7	0.0	16.7	16.7	16.7	0.0	0.0	16.7	10.4
All Years	40.0	4.0	20.0	4.0	12.0	4.0	4.0	16.0	13.0
All Samples									
94/95	37.5	0.0	25.0	0.0	0.0	0.0	14.3	25.0	12.7
95/96	62.5	12.5	12.5	0.0	25.0	12.5	0.0	12.5	17.2
96/97	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6
97/98	0.0	0.0	14.3	0.0	0.0	0.0	0.0	14.3	3.6
98/99	11.1	0.0	11.1	11.1	11.1	0.0	0.0	11.1	6.9
All Years	25.0	2.5	12.5	2.5	7.5	2.5	2.6	12.5	8.5

DM-1 upper Des Moines Creek
DM-2 lower Des Moines Creek
MA-1 upper Massey Creek
MA-2 middle Massey Creek
MA-3 lower Massey Creek
BA-1 lower Barnes Creek
MC-1 upper McSorley Creek
MC-2 lower McSorley Creek

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The statistical analysis for trends by monitoring year showed that storm flow dissolved copper concentrations at station DM-2 were significantly higher in the second monitoring year and lower in the fourth year compared to the other three years (Appendix C). The analysis for temporal trends over the entire 5-year monitoring program showed significant decreasing trends for base flow dissolved copper concentrations in upper Des Moines Creek (station DM-1) and upper and lower McSorley Creek (stations MC-1 and MC-2) (Table 9 and Appendix C).

Total Copper

Total copper concentrations over the 5-year monitoring program ranged from 2.1 to 82.3 μg/L (Figure 16). The median total copper concentration ranged from 5.5 to 13.7 μg/L among the stream stations, with the highest total copper concentrations occurring in upper and lower Des Moines Creek (stations DM-1 and DM-2). Storm flow median total copper concentrations in the downstream reaches of all three study basins were three to four times higher than the median level for other King County streams (see Tables 5, 6, and 7).

The analysis for spatial trends showed that storm flow total copper concentrations increased significantly downstream in McSorley Creek (Table 8 and Appendix C). There were no clear longitudinal trends for total copper in the Des Moines Creek and Massey Creek basins.

There were no significant differences in total copper concentrations between monitoring years at any of the stations (Appendix C). The analysis for temporal trends over the entire 5-year monitoring program showed a significant decreasing trend for storm flow total copper concentrations in lower Des Moines Creek (station DM-2) and in upper McSorley Creek (station MC-1) (Table 9 and Appendix C).

Dissolved Lead

Dissolved lead concentrations over the 5-year monitoring program ranged from less than 0.5 to 4.1 μg/L (Figure 17). The median dissolved lead concentration ranged from less than 0.5 to 1.3 μg/L among the stream stations during storm flow. The median dissolved lead concentration during base flow was less than 0.5 μg/L at all stations. Storm flow dissolved lead concentrations were highest in upper Massey Creek (station MA-1).

During the 5-year monitoring period, Washington state Class AA criteria for dissolved lead were exceeded in only one collected sample (station MC-2 for base flow event 4) (Table 15).

The analysis for spatial trends showed that storm flow dissolved lead concentrations were significantly higher in upper Massey Creek than at the other monitoring stations in the basin (Table 8 and Appendix C). There were no significant longitudinal trends for dissolved lead in the Des Moines Creek and McSorley Creek basins.

There were no significant differences in dissolved lead concentrations between monitoring years at any of the stations for storm or base flow (Appendix C). Nor did the analysis for temporal trends over the entire 5-year monitoring program show any significant increasing or decreasing trends in dissolved lead concentrations for any of the monitoring stations (Table 9 and Appendix C).

JL/Total Cu Box Plot.stg

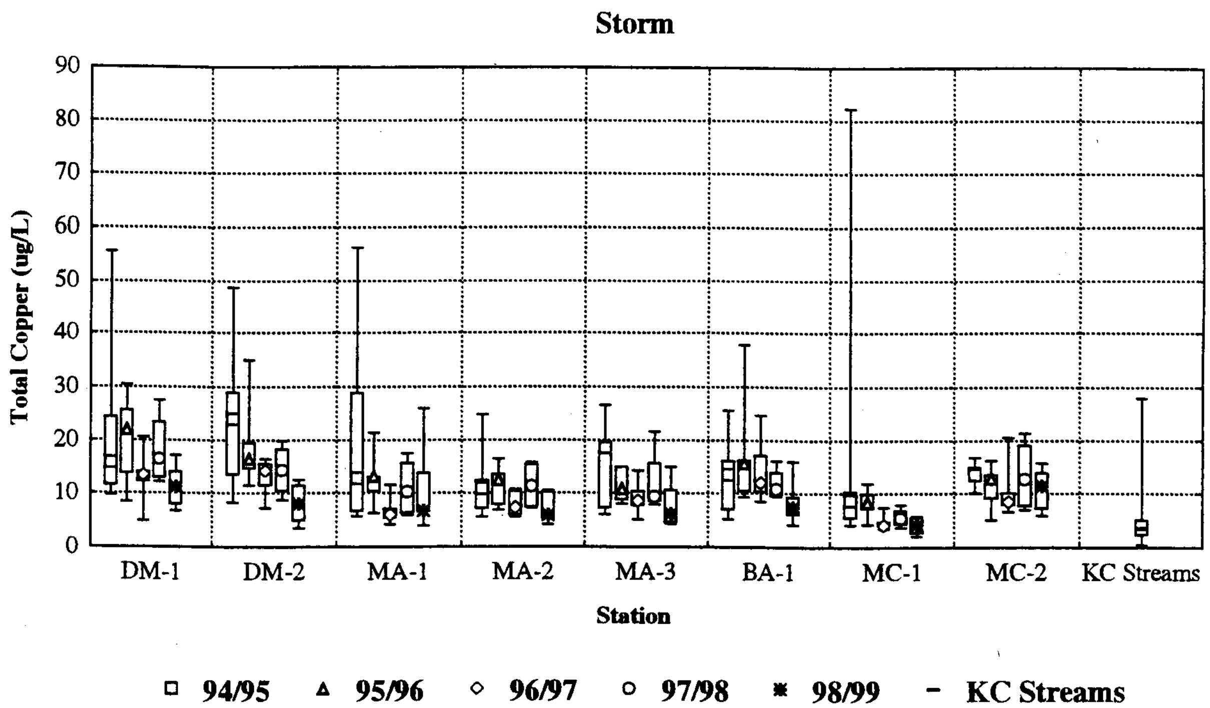

Figure 16. Total copper concentrations during storm flow sampling events in Des Moines streams and in other King County (KC) streams.

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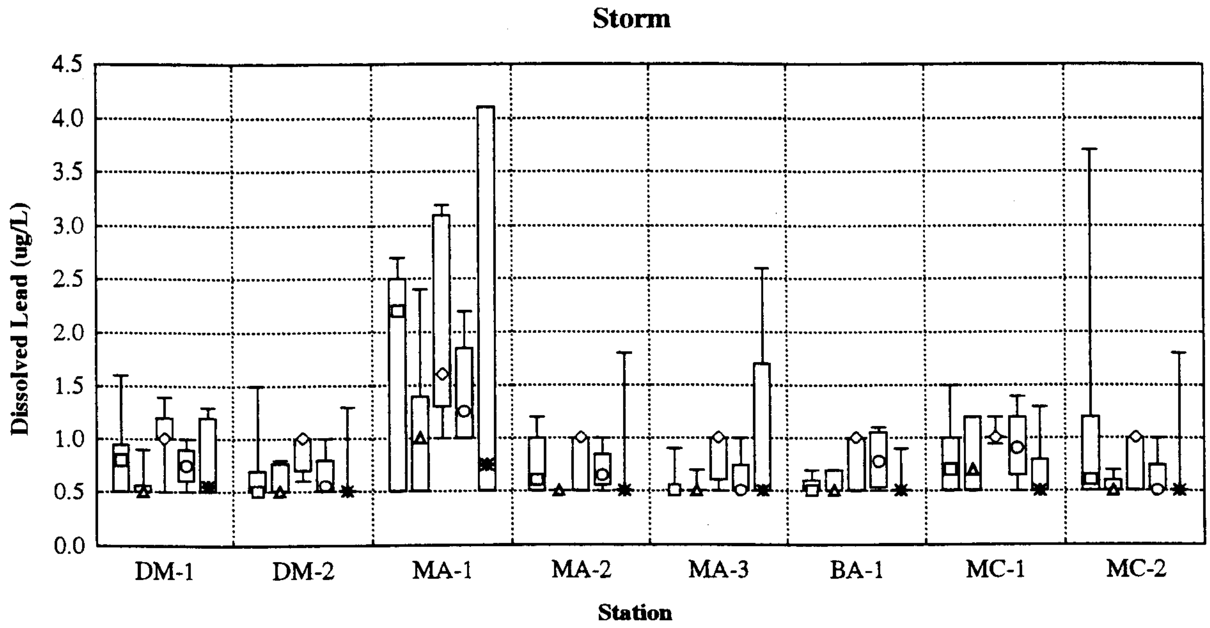

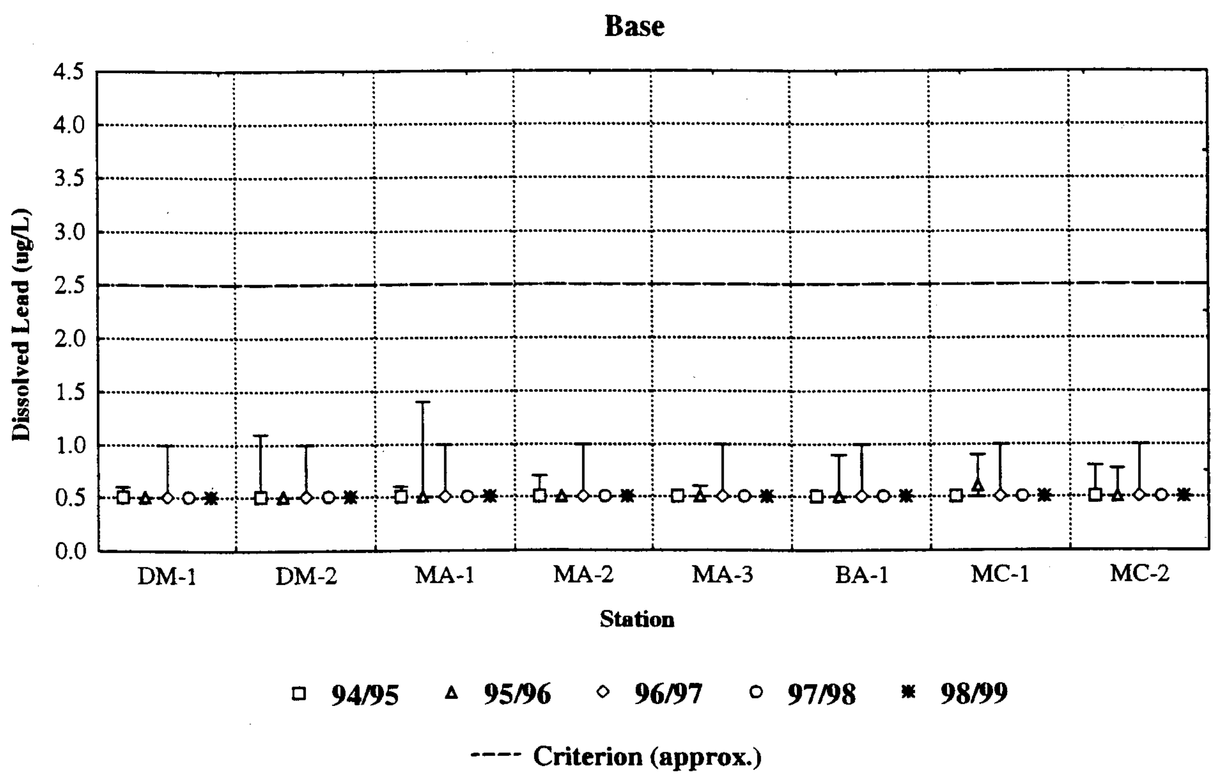

Figure 17. Dissolved lead concentrations during storm and base flow sampling events in Des Moines streams.

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Table 15. Percentages of samples from Des Moines streams exceeding the Washington state Class AA water quality criterion for dissolved lead by monitoring station and year.

	DM-1	DM-2	MA-1	MA-2	MA-3	BA-1	MC-1	MC-2	All Stations
Base Flow Samples									
94/95	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
95/96	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	4.2
96/97	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
97/98	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
98/99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All Years	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.8
Storm Flow Samples									
94/95	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
95/96	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
96/97	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
97/98	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
98/99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All Years	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All Samples									
94/95	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
95/96	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.5	1.6
96/97	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
97/98	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
98/99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All Years	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.3

DM-1 upper Des Moines Creek
DM-2 lower Des Moines Creek
MA-1 upper Massey Creek
MA-2 middle Massey Creek
MA-3 lower Massey Creek
BA-1 lower Barnes Creek
MC-1 upper McSorley Creek
MC-2 lower McSorley Creek

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Total Lead

Total lead concentrations over the 5-year monitoring program ranged from less than 0.5 to 54.7 μg/L (Figure 18). The median total lead concentration ranged from 2.3 to 10.5 μg/L among the stream stations during storm flow, with the highest total lead concentrations occurring in upper Massey Creek (station MA-1). Storm flow median total lead concentrations in the downstream reaches of all three study basins were three to four times higher than the median level for other King County streams (see Tables 5, 6, and 7).

The analysis for spatial trends showed that total lead concentrations were significantly lower downstream in the Des Moines Creek basin and significantly higher downstream in the McSorley Creek basin (Table 8 and Appendix C). There were no clear longitudinal trends for total lead in the Massey Creek basin.The statistical analysis for trends by monitoring year showed that storm flow total lead concentrations at station MC-1 were significantly lower in the fifth year of monitoring than in the other four monitoring years (Appendix C). The analysis for temporal trends over the entire 5-year monitoring program did not show any significant increasing or decreasing trends in total lead concentrations at any of the stream monitoring stations (Table 9 and Appendix C).

Dissolved Zinc

Dissolved zinc concentrations over the 5-year monitoring program ranged from less than 3 to 109 μg/L (Figure 19). The median dissolved zinc concentration ranged from 6 to 37μg/L among the stream stations during storm flow and from less than 3 to 5 μg/L during base flow. Storm flow dissolved zinc concentrations were highest in upper Massey Creek (station MA-1) and in upper Des Moines Creek (station DM-1).

During the 5-year monitoring period, the Washington state Class AA criterion for dissolved zinc was exceeded only in storm samples collected from upper Des Moines Creek (station DM-1) and upper Massey Creek (station MA-1) (Table 16). Water quality violations for dissolved zinc in the upper reaches of these basins may be related to runoff from high traffic areas (e.g., SeaTac airport and parking areas in the Des Moines Creek basin and SR 99 in the Massey Creek basin).

The analysis for spatial trends showed that storm flow dissolved zinc concentrations were significantly lower downstream in the Des Moines Creek and Massey Creek basins and significantly higher downstream in the McSorley Creek basin (Table 8 and Appendix C). There were no clear longitudinal trends for dissolved zinc during base flow in any of the study basins.

The statistical analysis for trends by monitoring year showed that storm flow dissolved zinc concentrations at station DM-1 were highest in the first year of monitoring and lowest in the fourth and fifth years (Appendix C). The analysis for temporal trends over the entire 5-year monitoring program showed significant decreasing trends for storm flow dissolved zinc concentrations in upper Des Moines Creek (station DM-1) and for base flow dissolved zinc concentrations in lower McSorley Creek (station MC-2) (Table 9 and Appendix C).

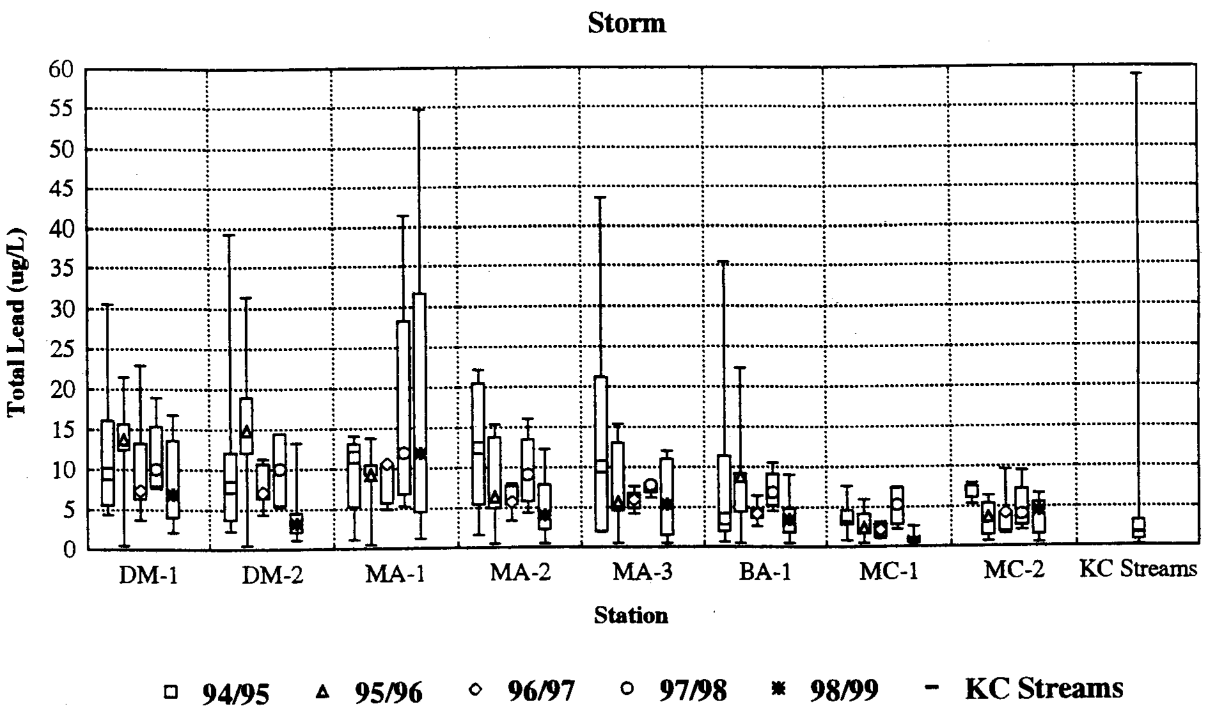

Figure 18. **Total lead concentrations during storm flow sampling events in Des Moines streams and in other King County (KC) streams.**

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JL/Dissolved Zn Box Plot.stg

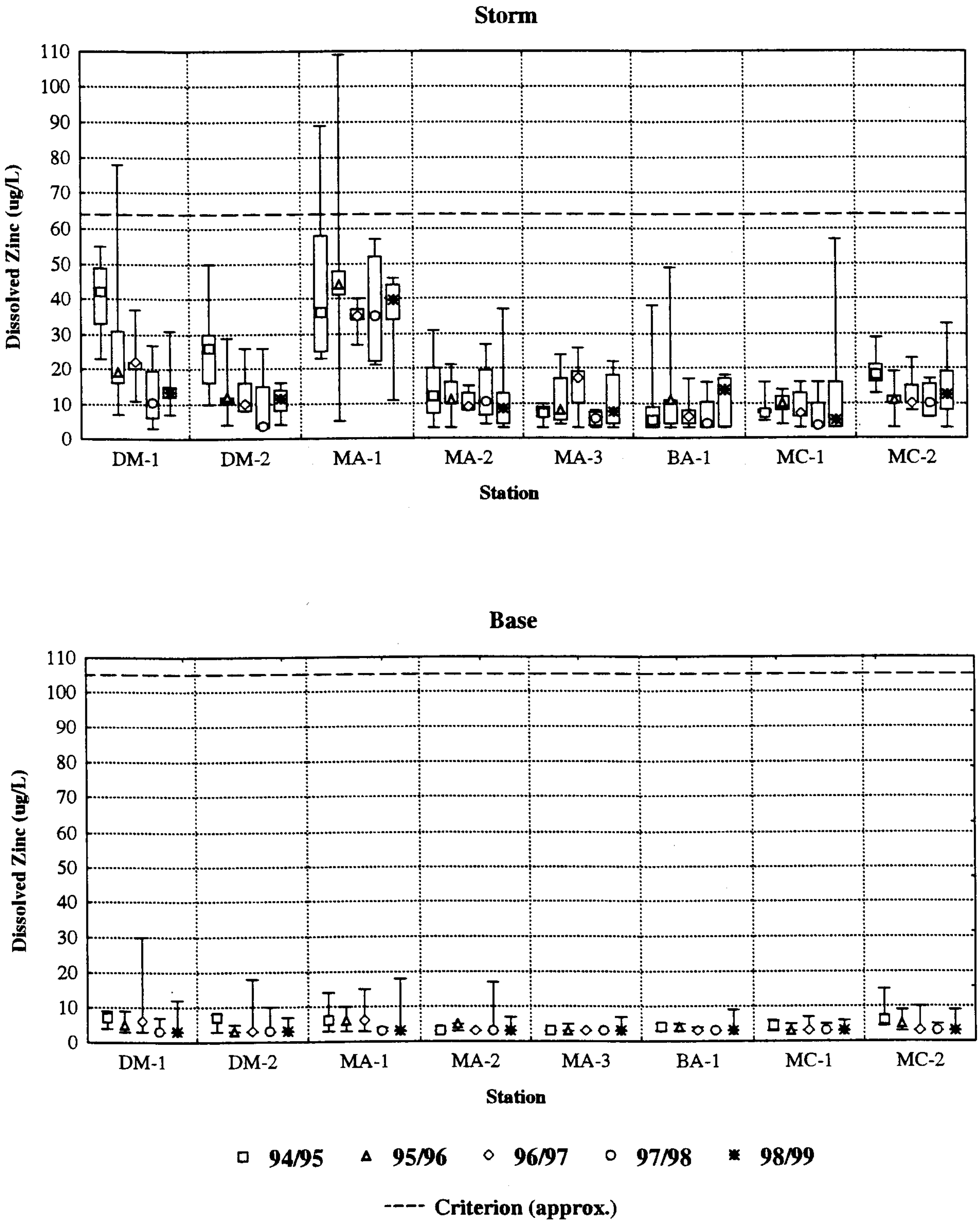

Figure 19. Dissolved zinc concentrations during storm and base flow sampling events in Des Moines streams.

Table 16. Percentages of samples from Des Moines streams exceeding the Washington state Class AA water quality criterion for dissolved zinc by monitoring station and year.

	DM-1	DM-2	MA-1	MA-2	MA-3	BA-1	MC-1	MC-2	All Stations
Base Flow Samples									
94/95	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
95/96	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
96/97	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
97/98	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
98/99	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All Years	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Storm Flow Samples									
94/95	20.0	0.0	40.0	0.0	0.0	0.0	0.0	0.0	7.5
95/96	20.0	0.0	40.0	0.0	0.0	0.0	0.0	0.0	7.5
96/97	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
97/98	0.0	0.0	25.0	0.0	0.0	0.0	0.0	0.0	3.1
98/99	0.0	0.0	33.3	0.0	0.0	0.0	0.0	0.0	4.2
All Years	8.0	0.0	28.0	0.0	0.0	0.0	0.0	0.0	4.5
All Samples									
94/95	12.5	0.0	25.0	0.0	0.0	0.0	0.0	0.0	4.8
95/96	12.5	0.0	25.0	0.0	0.0	0.0	0.0	0.0	4.7
96/97	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
97/98	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	1.8
98/99	0.0	0.0	22.2	0.0	0.0	0.0	0.0	0.0	2.8
All Years	5.0	0.0	17.5	0.0	0.0	0.0	0.0	0.0	2.8

DM-1 upper Des Moines Creek
DM-2 lower Des Moines Creek
MA-1 upper Massey Creek
MA-2 middle Massey Creek
MA-3 lower Massey Creek
BA-1 lower Barnes Creek
MC-1 upper McSorley Creek
MC-2 lower McSorley Creek

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Total Zinc

Total zinc concentrations over the 5-year monitoring program ranged from less than 3 to 161 µg/L (Figure 20). The median total zinc concentration ranged from 12 to 61 µg/L among the stream stations during storm flow, with the highest total zinc concentrations occurring in upper Des Moines Creek (station DM-1) and in upper McSorley Creek (station MC-1). Storm flow median total zinc concentrations in the downstream reaches of all three basins were two to three times higher than the median level for other King County streams (see Tables 5, 6, and 7).

As with dissolved zinc, the analysis for spatial trends showed that storm flow total zinc concentrations were significantly lower downstream in the Des Moines Creek and Massey Creek basins and significantly higher downstream in the McSorley Creek basin (Table 8 and Appendix C). The statistical analysis for trends by monitoring year showed no significant differences in total zinc concentrations between monitoring years at any of the stations (Appendix C). The analysis for temporal trends over the entire 5-year monitoring program showed a significant decreasing trend for total zinc concentrations in upper Des Moines Creek (Table 9 and Appendix C).

Total Petroleum Hydrocarbons

Measurements of total petroleum hydrocarbons (TPH) in water are used to assess the amount of contamination present from petroleum-based products such as oil, grease, gasoline, and diesel fuel, which are commonly present in urban runoff. No state surface water quality standard has been established for total petroleum hydrocarbons. Base flow samples were not analyzed for total petroleum hydrocarbons.

Total petroleum hydrocarbon concentrations over the 5-year monitoring program ranged from less than 0.25 to 2.34 mg/L (Figure 21). The median total petroleum hydrocarbon concentration ranged from less than 0.25 to 0.36 mg/L among the stream stations, with the highest total petroleum hydrocarbon concentrations occurring in upper Des Moines Creek (station DM-1) and in upper and middle Massey Creek (stations MA-1 and MA-2).

Total petroleum hydrocarbon concentrations were significantly lower downstream in the Des Moines Creek basin and significantly higher downstream in the McSorley Creek basin (Table 8 and Appendix C).

The statistical analysis for trends by monitoring year showed no significant differences in total petroleum hydrocarbon concentrations between monitoring years at any of the stations (Appendix C). The analysis for temporal trends over the entire 5-year monitoring program showed a significant decreasing trend for total petroleum hydrocarbon concentrations in upper Massey Creek (station MA-1) (Table 9 and Appendix C).

Fecal Coliform Bacteria

Urban runoff characteristically contains high levels of fecal coliform bacteria. These organisms are used as indicators of fecal contamination from humans and other warm-blooded animals. Human sources include failing septic systems, municipal wastewater discharges, and cross-connections with municipal wastewater systems. Animal sources include pets, livestock, and

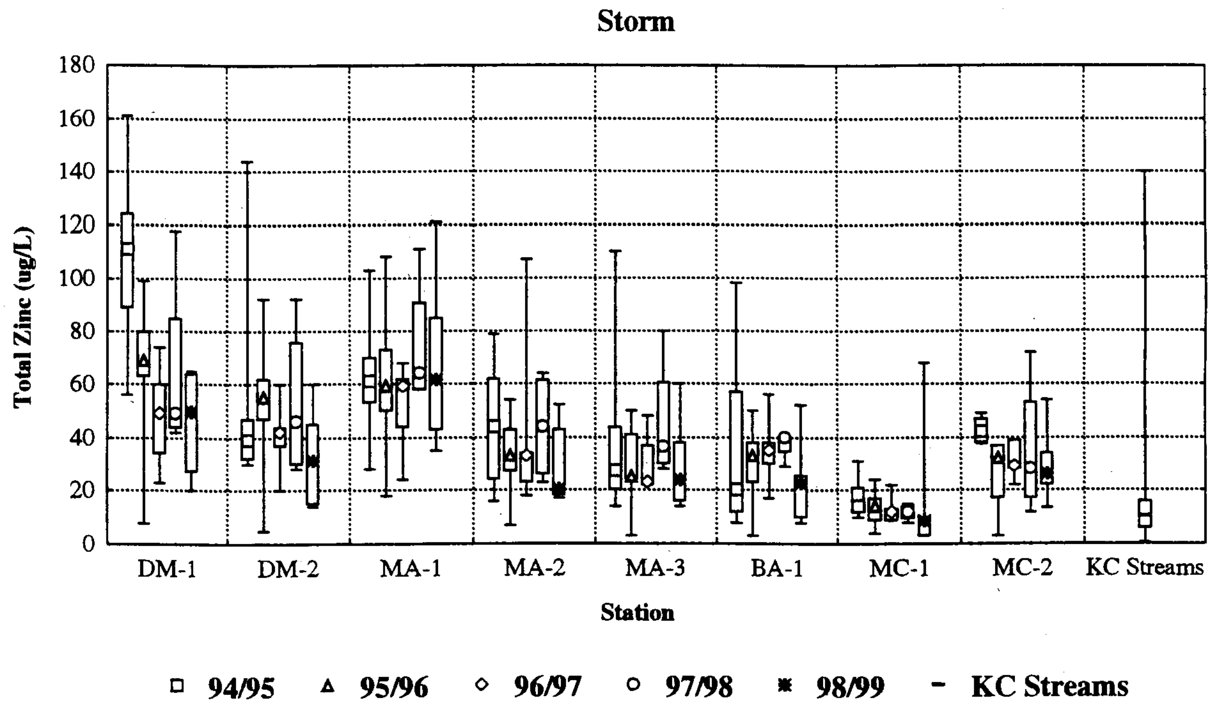

Figure 20. Total zinc concentrations during storm flow sampling events in Des Moines streams and in other King County (KC) streams.

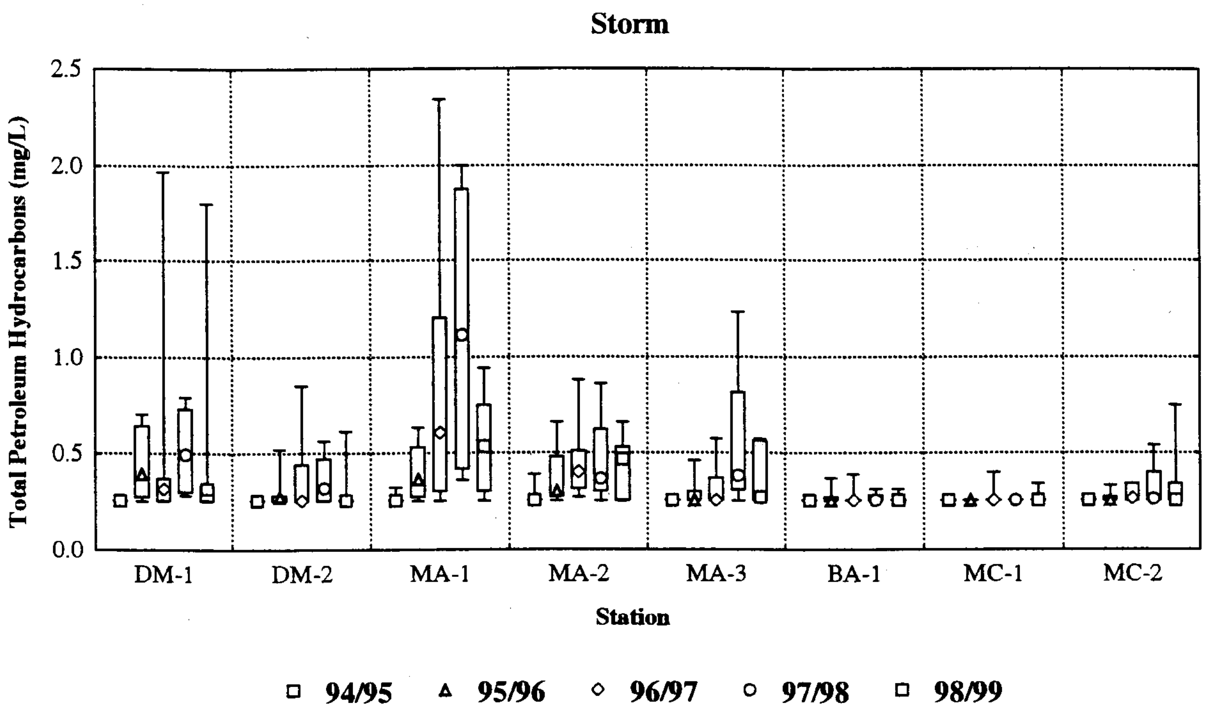

Figure 21. Total petroleum hydrocarbon concentrations during storm and base flow sampling events in Des Moines streams.

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wildlife (birds and mammals). The simple presence of these bacteria does not necessarily indicate a threat to public health because only a small proportion, if any, are likely to be pathogenic to humans. However their use as an "indicator" of potential fecal contamination is considered important in the early detection of problems that could lead to public health problems. Water quality standards established for fecal coliform bacteria in Class AA freshwaters are identified in Table 3.

Fecal coliform bacteria concentrations over the 5-year monitoring program ranged from less than 2 to 37,200 organisms per 100 milliliters (mL) (Figure 22). The fecal coliform bacteria concentration ranged from 720 to 2,100 organisms/100 mL among the stream stations during storm flow and from 16 to 200 organisms/100 mL during base flow. Storm flow fecal coliform bacteria concentrations were highest in middle Massey Creek (station MA-2) and in lower McSorley Creek (station MC-2). Storm flow median fecal coliform bacteria concentrations in the downstream reaches of all three study basins were similar to the median level for other King County streams (see Tables 5, 6, and 7).

During the 5-year monitoring period, the Washington state Class AA criterion for fecal coliform bacteria was exceeded at least once at every monitoring station (Table 17), with exceedances commonly occurring at all stations during storm flow. The percentage of samples exceeding the state criterion for fecal coliform bacteria during storm flow sampling ranged from 88 percent (stations BA-1 and MC-1) to 100 percent (stations MA-2, MA-3, and MC-2). The percentage of samples exceeding the state criterion for fecal coliform bacteria during base flow sampling ranged from 33 percent (station MA-1) to 67 percent (station MC-2). Overall, 82 percent of the samples collected during the 5-year monitoring program exceeded the state criterion for fecal coliform bacteria.

Due to high variability in the data, no significant spatial trends were detected for fecal coliform bacteria concentrations in any of the monitoring basins during storm or base flow.

The statistical analysis for trends by monitoring year showed no significant differences in fecal coliform bacteria concentrations between monitoring years at any of the stations (Appendix C). The analysis for temporal trends over the entire 5-year monitoring program showed a significant increasing trend for fecal coliform bacteria concentrations in Barnes Creek (station BA-1) (Table 9 and Appendix C).

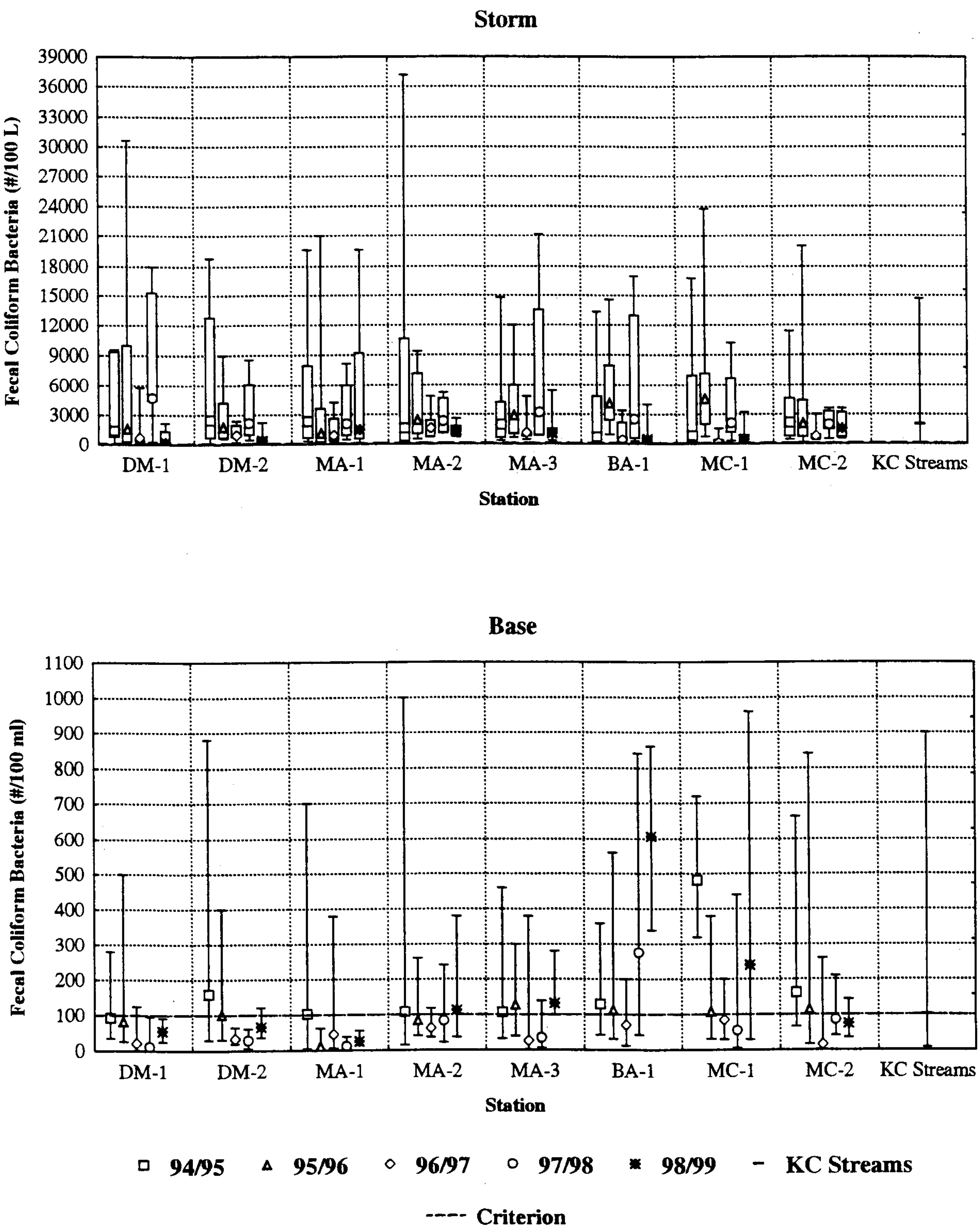

Figure 22. Fecal coliform bacteria concentrations during storm and base flow sampling events in Des Moines streams and in other King County (KC) streams.

Table 17. Percentages of samples from Des Moines streams exceeding the Washington state Class AA water quality criterion for fecal coliform bacteria by monitoring station and year.

	DM-1	DM-2	MA-1	MA-2	MA-3	BA-1	MC-1	MC-2	All Stations
Base Flow Samples									
94/95	66.7	66.7	66.7	66.7	66.7	66.7	100.0	100.0	73.9
95/96	33.3	66.7	33.3	66.7	66.7	66.7	66.7	66.7	58.3
96/97	33.3	33.3	33.3	33.3	33.3	66.7	66.7	33.3	41.7
97/98	33.3	66.7	0.0	66.7	33.3	66.7	66.7	66.7	50.0
98/99	66.7	66.7	33.3	66.7	100.0	100.0	66.7	66.7	70.8
All Years	46.7	60.0	33.3	60.0	60.0	73.3	71.4	66.7	58.8
Storm Flow Samples									
94/95	100.0	100.0	100.0	100.0	100.0	80.0	80.0	100.0	95.0
95/96	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
96/97	100.0	100.0	100.0	100.0	100.0	80.0	80.0	100.0	95.0
97/98	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
98/99	66.7	83.3	83.3	100.0	100.0	83.3	83.3	100.0	87.5
All Years	92.0	96.0	96.0	100.0	100.0	88.0	88.0	100.0	95.0
All Samples									
94/95	87.5	87.5	87.5	87.5	87.5	75.0	85.7	100.0	87.3
95/96	75.0	87.5	75.0	87.5	87.5	87.5	87.5	87.5	84.4
96/97	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0
97/98	71.4	85.7	57.1	85.7	71.4	85.7	85.7	85.7	78.6
98/99	66.7	77.8	66.7	88.9	100.0	88.9	77.8	88.9	81.9
All Years	75.0	82.5	72.5	85.0	85.0	82.5	82.1	87.5	81.5

DM-1 upper Des Moines Creek
DM-2 lower Des Moines Creek
MA-1 upper Massey Creek
MA-2 middle Massey Creek
MA-3 lower Massey Creek
BA-1 lower Barnes Creek
MC-1 upper McSorley Creek
MC-2 lower McSorley Creek

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Pollutant Source Tracking

The city of Des Moines stormwater drainage system was inspected during dry weather on October 12 and 24, 1994. A total of 40 storm drain outfalls were examined for obvious signs of pollutant sources or cross-connections with the sanitary sewer system. Locations and results of this inspection are presented in Appendix F.

Approximately two-thirds of the outfalls to Des Moines, Massey, and McSorley creeks were flowing, while only one of seven outfalls to Barnes Creek was flowing. Unusually high discharge rates were not observed at any of the outfalls, indicating that there were no major illicit discharges of water into the stormwater drainage system during the inspection.

Of the 23 outfalls that were flowing, two outfalls exhibited odors indicating possible sewage contamination. However, water samples collected from these two outfalls exhibited relatively low fecal coliform bacteria concentrations (22 organisms/100 mL and 180 organisms/100 mL) that are not indicative of sewage contamination. The absence of high turbidities and oily sheens in any of the outfall flows further suggests that wastewaters were not being discharged into the stormwater drainage system during the inspection.

Benthic Invertebrate Monitoring

Benthic invertebrate monitoring was conducted in the beginning of the first, third, and fifth years of the Des Moines water quality monitoring program to provide data for a bioassessment of the study streams. As described below, benthic invertebrate samples were collected and analyzed according to procedures developed by Aquatic Biology Associates, Inc. The bioassessment method used is based on a model of invertebrate taxa and community structure that are expected to be present in an undisturbed, mid-order western montane (i.e., mountain) stream having high water quality and habitat complexity.

This assessment uses fixed scoring criteria that are based on optimal stream conditions without comparison to reference stations. It is important to recognize that even under optimal conditions, most Puget Sound lowland streams are not expected to exhibit high bioassessment scores (i.e., greater than 80 percent) because of the physical characteristics associated with their typically lower gradients and warmer temperatures.

Methods

Benthic invertebrate samples were collected by Envirovison on the following three occasions:

- October 23, 1994 at the beginning of the first year of study
- November 2, 1996 at the beginning of the third year of study
- October 30 and 31, 1998 at the beginning of the fifth year of study.

Sampling was conducted at approximately the same time in each fall season for comparison between years. The fall season was selected for sampling rather than the spring season because the varied timing of insect emergence in the spring can affect bioassessment results. Late October was selected for sampling because benthic invertebrates are typically most abundant and diverse when streamflow is relatively high but has not been subjected to large storms.

Benthic invertebrate samples were collected in erosional habitats (i.e., riffles and runs) near each of the eight water quality monitoring stations (see Figure 1). Benthic invertebrate monitoring stations for upper Massey Creek (station MA-1) and upper McSorley Creek (station MC-1) were located downstream of their respective water quality monitoring locations because erosional habitats were not present at these water quality monitoring stations.

Five grab samples were collected at each station employing a kick net having a 500-micron mesh. The five samples were combined (i.e., composited) into one sample, preserved with alcohol, processed to remove excess debris, and sent to the Aquatic Biology Associates laboratory for analysis. Using this procedure, the total sample area at each station was equivalent to 1 square meter.

The composite samples were analyzed according to a method developed by Aquatic Biology Associates (Appendix G). This method meets or exceeds U.S. Environmental Protection Agency (U.S. EPA) guidelines for the analysis of benthic invertebrate samples. The analysis includes the following information:

- Identification to class for oligochaetes and microcrustaceans, and to genus for other macroinvertebrates
- Abundance data
- Calculations of community metrics
- Bioassessment using key metrics and an index (single rating) of biological integrity for each sample.

Metric scores calculated from the sample results were then used to characterize the level of habitat impairment at each sampling location. The single rating of biological integrity (or total erosional habitat bioassessment score) is reported as a percentage of a total possible score of 122. The total score is based on 47 components, which include the abundance of taxa that are sensitive or tolerant to stress, and community characteristics such as taxa richness.

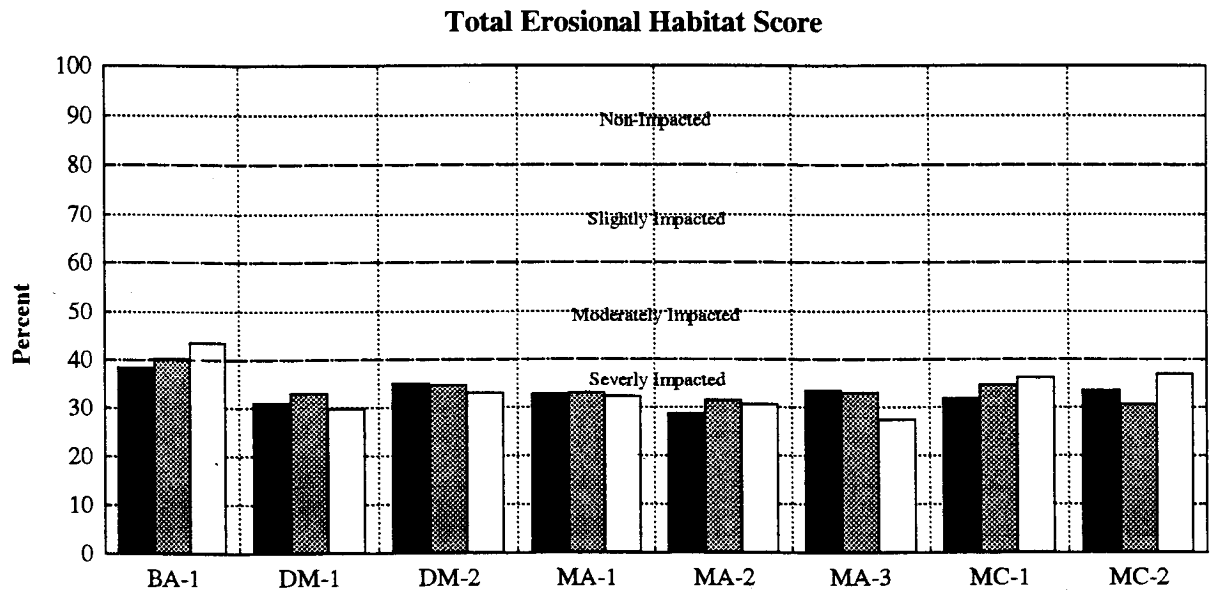
Results

Benthic macroinvertebrate monitoring results for all three sampling years (autumn 1994, 1996, and 1998) are presented in the bioassessment report (Appendix G). This report includes a discussion of the methods and results, and a comparative summary of bioassessment scores and selected metrics for all three sampling years. Also included are tabular summaries and statistics of taxa encountered at each site in 1998. Data for 1994 and 1996 are presented in annual reports (Herrera 1995, 1998).

Data for the total erosional habitat indices and scores for its three main components (i.e., primary metrics, positive indicators, and negative indicators) are presented graphically in Figures 23 and 24 for the benthic invertebrate samples in the Des Moines streams. These scoring results are discussed below, followed by observations of selected taxa and a comparison to other streams in King County.

Total Erosional Habitat Index

The Aquatic Biology Associates bioassessment format is based on a model of undisturbed mid-order, forested, higher-gradient, cool/cold montane streams with high water quality and habitat complexity. The streams monitored in this study are low-gradient Puget Sound lowland streams. These streams are not expected to exhibit the same macroinvertebrate assemblages as the streams used to calibrate the index. The full potential of a Puget Sound lowland stream in a pristine condition is estimated to be a score of 60 to 80 percent for the total erosional habitat index (Appendix G).



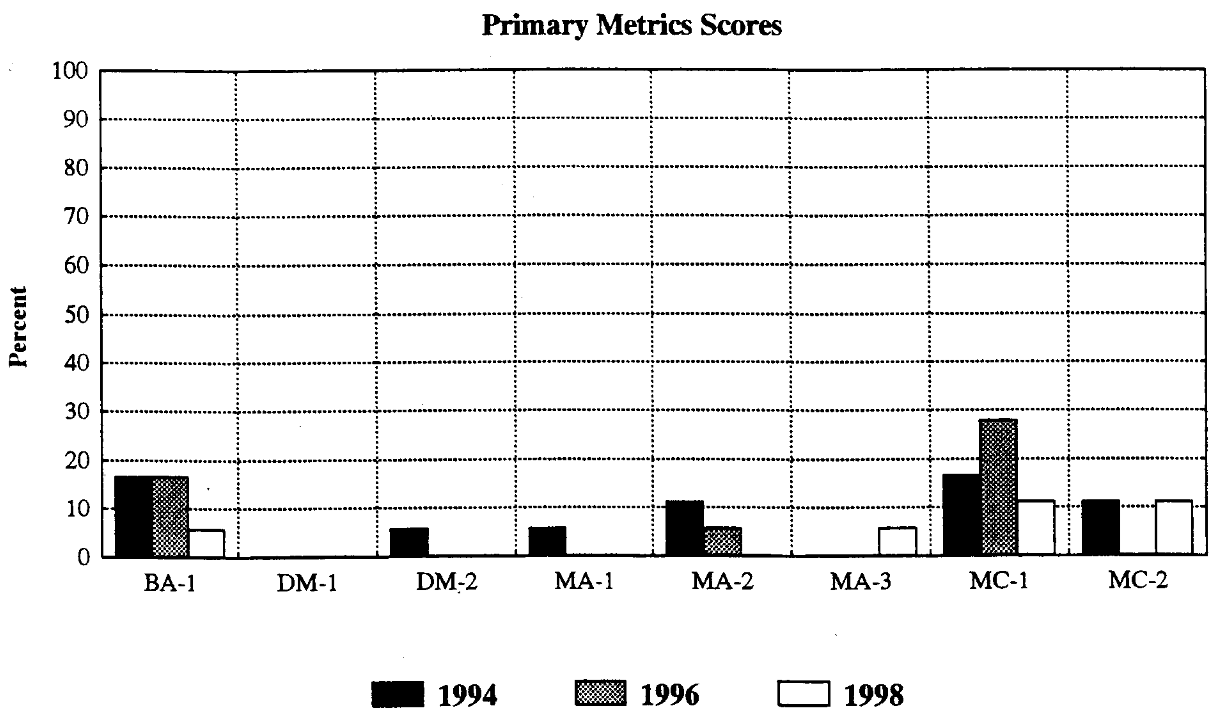


Figure 23. Total erosional habitat indices and primary metrics scores for benthic invertebrate monitoring of Des Moines streams.

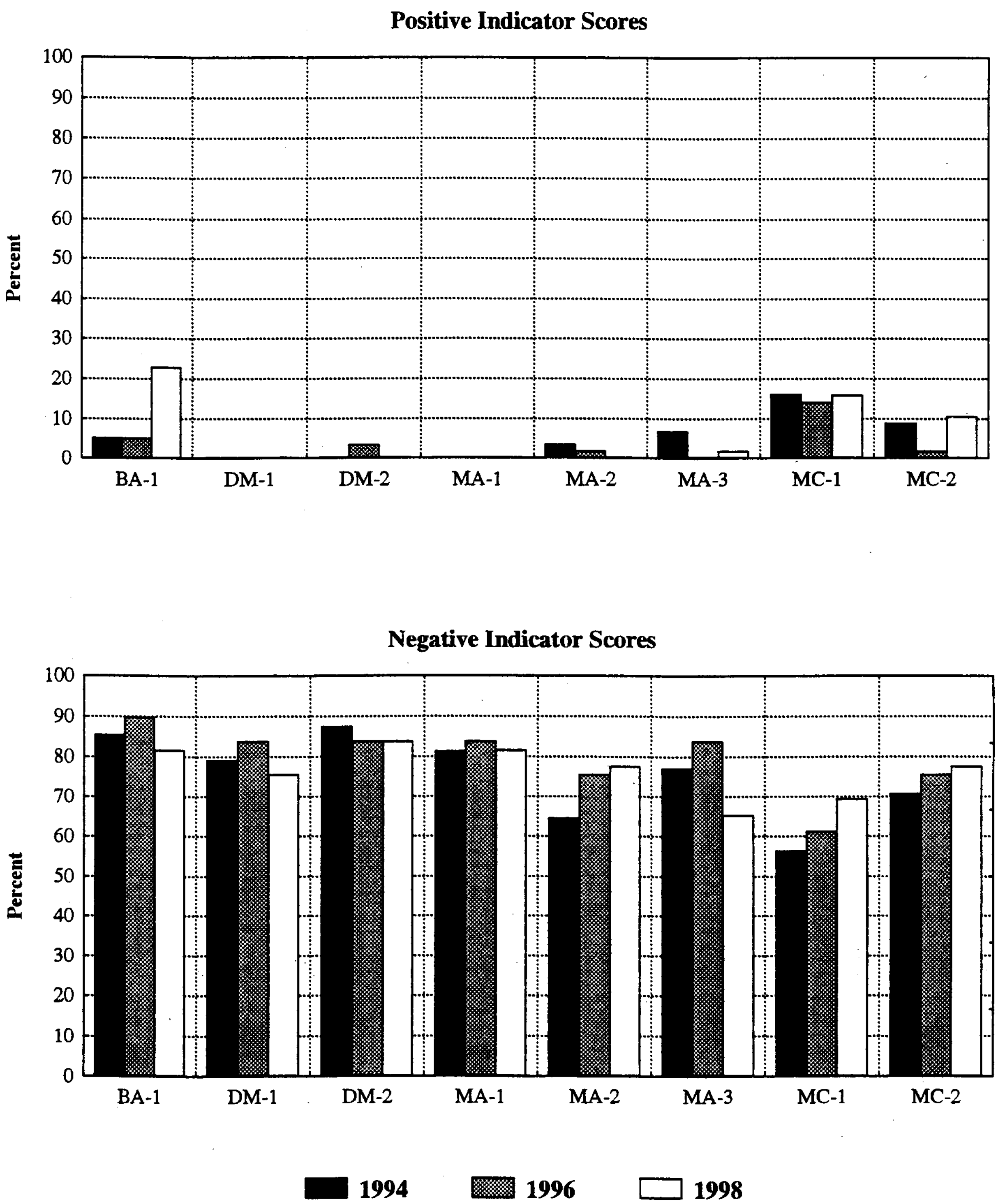


Figure 24. Positive and negative indicator scores for benthic invertebrate monitoring of Des Moines streams.

Total erosional habitat indices were low for all stations and study years in the Des Moines streams (see Figure 23). These indices ranged from 27.4 to 43.5 percent, indicating that there have been moderate to severe water and habitat quality limitations for macroinvertebrate communities in Des Moines streams.

Total erosional habitat indices varied less then 10 percent between monitoring stations and years. Although the Aquatic Biology Associates bioassessment does not lend itself to statistical testing, this level of variation indicates that there were no significant differences between monitoring stations or years (Appendix G).

Primary Metrics

The primary metrics score is calculated from the following five measurements of macroinvertebrate community composition:

- Total abundance of individuals
- Total taxa richness
- Percentage dominance of the most abundant taxa
- Emphemoptera, plecoptera, and trichoptera (EPT) taxa richness
- Community tolerance.

The primary metrics scores for benthic invertebrate samples from the Des Moines streams were extremely low, ranging from zero to 28 percent, indicating that severely stressed communities were present at all sampling sites. Des Moines and Massey creeks exhibited the lowest (zero) primary metrics scores. The highest primary metrics score was observed at upper McSorley Creek in 1996.

Total invertebrate abundance (i.e., density) ranged from very low (less than 500 individuals per square meter) to low (between 500 and 1,000 individuals per square meter) at all stations in the Des Moines streams. Total invertebrate densities ranged from a low of 23 individuals per square meter at station MA-1 in 1998, to a high of 952 individuals per square meter at station MC-2 in 1994. Nineteen of the 24 samples exhibited less than 500 individuals per square meter, which is considered very low or depauperate. Total invertebrate densities can be as high as 100,000 per square meter in North American streams, and densities often exceed 10,000 per square meter in streams that have slight to moderate levels of nutrient enrichment and are not totally shaded.

Total invertebrate densities in the Des Moines streams varied somewhat from year to year, but were generally higher in 1994 (following a drought year), and lower in 1996 (following a normal rainfall year) and 1998 (following a wet year). These results suggest that depauperate invertebrate densities may be related to severe scour and resorting of substrate during large storm events.

Total taxa richness was very low, ranging from six taxa at upper Massey Creek (station MA-1) in 1998 to 33 taxa at upper McSorley Creek (station MC-1) in 1996. A total richness of 40 to 50 taxa would be expected in a relatively undisturbed Puget Sound lowland stream.

Emphemoptera, plecoptera, and trichoptera (EPT) taxa richness was extremely low in the Des Moines streams, ranging from one to eight EPT taxa. The lowest value occurred repeatedly at all stations on Des Moines and Massey creeks. The highest value was observed at upper McSorley Creek (station MC-1) in 1994. A similar undisturbed stream would be expected to have greater than 20 EPT taxa.

The percentage of dominant taxa metric refers to the proportion of the total abundance of individuals that comes from the most frequently occurring taxa. Extremely disturbed invertebrate communities not only tend to have fewer taxa but also tend to be dominated by a few tolerant weedy taxa. The percentage dominance of the most numerous taxa at each site was typically high, ranging from 16 percent at upper McSorley Creek (station MC-1) in 1994 to 79 percent at middle Massey Creek (station MA-2) in 1996. Undisturbed streams would be expected to have less than 20 percent dominant taxa.

Positive Indicators

The positive indicator score is based on particular taxa, taxa assemblages, or feeding groups whose presence or increased abundance is a sign of low stress on invertebrate communities. A high positive indicator score corresponds to high abundance of such taxa and a habitat exerting low stress. The positive indicator score is an average of 21 metrics (see Appendix G).

Positive indicator scores for the Des Moines streams were extremely low, ranging from zero to 22.8 percent. Invertebrate taxa indicative of high water and habitat quality were virtually absent. The lowest score (zero) occurred at least once at each of the Des Moines and Massey creek sampling sites. The highest value of 22.8 percent was observed at Barnes Creek (station BA-1) in 1998.

Negative Indicators

The negative indicator score is based on taxa or feeding groups whose presence or increased abundance is a sign of high stress on the invertebrate community. A high negative indicator score corresponds to a low abundance of weedy and pollution-tolerant taxa, and suggests that the habitat exerts low stress on the benthic invertebrate community. Negative indicator scores for samples from the Des Moines streams were high, ranging from 56.3 to 89.8 percent.

The high negative indicator scores observed are contradictory to the low positive indicator and primary metrics scores. These observations indicate that water or habitat quality is so degraded that colonization by negative indicator (weedy and pollution-tolerant) taxa is severely impaired. If stream impacts were limited to moderate nutrient enrichment, loss of riparian vegetation, and siltation, then the stream would be expected to have a greater abundance of weedy and pollution-tolerant taxa (and a lower negative indicator score). The low abundance of both negative indicator taxa and positive indicator taxa suggests that Des Moines streams are severely affected by channelization and high flow or extreme toxicity.

Observations on Selected Taxa

Observations on the following selected taxa provide qualitative information on stream habitat quality and can be used to supplement the quantitative results of the scoring system:

- Insect taxa richness was generally very low in Des Moines streams. Based on comparison with other Puget Sound lowland streams, many more taxa would be expected to occur (Plotnikoff 1992). Their absence may not be explained solely by poor habitat quality, considering that these streams are perennial, and the sampled substrates consist of cobble and coarse gravel, which provide good insect habitat. The paucity of insect taxa indicates exposure to toxins or extreme flow conditions.

- The dominant insect taxa observed in Des Moines streams are more tolerant taxa that are capable of rapid colonization and have multiple generations during the year (e.g., *Baetis tricaudatus,* blackflies, and midges). High proportions of these taxa are often associated with communities that are subjected to episodic disturbance, such as intermittent pulses of toxins or high water velocities. These taxa are able to recolonize and regenerate rapidly after such disturbances.

- Collector feeding group taxa dominated the benthic invertebrate communities at all sites, comprising 24 to 100 percent of the taxa observed in the samples. Although the collector feeding group taxa are normal components of erosional habitat communities, dominance by this group in excess of about 50 percent generally indicates moderate to severe stress.

- Non-insect taxa, such as worms, mollusks, crustaceans, and mites, comprised between 6.8 and 95.7 percent of the taxa in the sampled benthic invertebrate communities. The particular non-insect taxa present at the Des Moines sites were all moderately to highly tolerant forms.

- Although the mollusk taxa that were encountered in the samples are moderately to highly tolerant of nutrient enrichment, warmer temperatures, fine sediments, low dissolved oxygen levels, and filamentous algae, they are sensitive to certain toxins, such as heavy metals, and to frequent disturbance of stream substrates. Snails were low in abundance or absent from the Barnes, Des Moines, and Massey creek sites where they would be expected in greater abundance.

- Long-lived invertebrate taxa (i.e., semi-voltine, or those requiring more than 1 year to complete their life cycle) were absent at most sites and were limited to several highly tolerant snails at other sites. Long-lived taxa such as crayfish, mussels, some stoneflies, some caddis flies, and snails other than those observed in samples would be expected in streams of the type found in Des Moines. In 1998, more long-lived taxa were found at some sites, including the caddis fly *Parapsyche almota* and the beetle *Lara avara.*

Comparison to Other Indices

A protocol for interpreting macroinvertebrate data specifically from the Puget Sound lowland region, known as the Puget lowland benthic index of biotic integrity (B-IBI), has recently been developed (Kleindl 1995). The Des Moines invertebrate data are not directly comparable to the B-IBI metrics because the sampling protocols differ (i.e., the B-IBI is based on three replicate samples versus one composite sample). However, the B-IBI is based on a maximum score of 50 that can be compared to the total habitat erosional score, which is based on a maximum score of 100.

In developing the B-IBI, Des Moines Creek was sampled in 1995 at a location near station DM-2. Des Moines Creek scored a 16 out of 50 (32 percent) on the B-IBI, which is interpreted as having very poor habitat quality (Karr 1999 personal communication). Similarly low B-IBI scores were reported for other King County streams located in developed basins having approximately 50 percent impervious surfaces. In 1994 and 1996, the total erosional habitat index score for station DM-2 was 35 percent, which is interpreted as being severely affected. These results suggest that there is general agreement between the two indices and conclusions.

Habitat Surveys

Two separate habitat surveys were conducted during the monitoring program by Envirovision. These surveys occurred during low-flow periods in late September to early October of 1994 and during similar low-flow periods in 1999. The habitat surveys were conducted along selected riparian corridors within the three major stream basins in the city of Des Moines. The main purpose of the surveys was to identify apparent impacts to the stream from urbanization. Detailed results of the habitat surveys are presented in Appendix H. A summary of the survey methods is presented below, followed by an overview of findings for each stream basin that includes existing habitat quality, changes observed between the 1994 and 1998 habitat surveys, and habitat rehabilitation opportunities.

Wherever the channel was accessible, streams were walked and notes were recorded on vegetation, wildlife, sediments, presence of trash, stream condition, large woody debris or potential for large woody debris, and evidence of stormwater inputs. Stream reaches chosen for more detailed habitat surveys were selected based on their accessibility and representativeness of overall stream conditions. Six sites were assessed on Massey Creek and three sites were assessed on each of Des Moines, Barnes, and McSorley creeks (see Figure 1).

The habitat surveys were conducted according to the Washington Department of Ecology's *Guidance for Conducting Water Quality Assessments* (Ecology 1989). The following information was documented for each survey reach using Ecology's riparian corridor assessment form:

- Fish habitat
- Channel capacity
- Stream bank stability and erosion
- Riparian vegetation
- Substrate condition

Des Moines Creek Basin

Habitat Quality

Fish habitat was observed during both surveys to be moderately impaired in Des Moines Creek due to low habitat diversity, dense periphyton growth, and possible barriers to fish migration during low flow. Habitat diversity was particularly low downstream of the Des Moines Creek wastewater treatment due to the predominance of riffles, which was also noted during a fish habitat survey of Des Moines Creek that was conducted in the winter of 1994 by Resource Planning Associates et al. (1994). The primary cause of dense periphyton growth observed in the stream appeared to be nutrient inputs from sources upstream of the city limits. Possible barriers to fish migration were present between the Des Moines Creek wastewater treatment plant and Marine View Drive from an accumulation of debris at several locations in this stream reach. Dense periphyton growth and fish migration barriers were not identified as habitat problems by Resource Planning Associates et al. (1994).

Upstream of the Des Moines Creek wastewater treatment plant, the stream flows through a deep ravine where steep banks prohibit development and provide a vegetated buffer. Vegetation in the ravine varied throughout the stream course but generally consisted of an open overstory of birch, alder, and maple, and an understory of mixed shrubs and herbaceous plants (e.g., salmonberry, Indian plum, Himalayan blackberry, and grasses). Stream banks were typically stable throughout the stream course, but eroded banks and sediment deposition areas were occasionally observed.

Changes Observed Between the 1994 and 1999 Habitat Surveys

Changes observed in the Des Moines Creek riparian corridor over the past 5 years have been related to construction activities. The wastewater pipeline maintenance road, which extends along the north bank of the stream between Marine View Drive and the city limits, had been paved and sections upstream of the wastewater treatment plant were open for use as a pedestrian trail. A pedestrian access trail, a bridge across the stream, and a parking lot had been constructed near the corner of 13th Avenue South and South 211th Street. Between Marine View Drive and the Des Moines Creek wastewater treatment plant, the maintenance road was expanded and riprap was used to stabilize the stream bank at road corners and stormwater outfalls.

Habitat Rehabilitation Opportunities

Des Moines Creek presents opportunities for both public education and fish habitat rehabilitation. The paved pedestrian trail would be an excellent location to install information boards that describe stream ecology, protection, and rehabilitation. Fish habitat could be improved downstream of Marine View Drive (in Des Moines Beach Park) by placing structures such as boulders and logs in the stream to create pools and increase habitat diversity.

Massey Creek Basin

Habitat Quality

Fish habitat in Massey Creek was observed during both surveys to be limited by impacts from urbanization that included poor stream substrate quality, a lack of pools, and barriers to fish migration. In many sections of the creek, stream substrates consisted primarily of sand and silt. This predominance of fines affects macroinvertebrates, which are an important source of food for fish rearing, and inhibits fish spawning. Little pool habitat was present and was typically limited to exposed root, accumulated debris, stream bank vegetation, and a few undercut banks. There was a severe lack of large woody debris present in the stream. Stream culverts at South 234th Street and 16th Avenue South were identified as potential barriers to fish migration.

Approximately 75 percent of the stream flows either through a steep, wooded ravine or along a steep bank adjacent to Kent-Des Moines Road which restricts development and provides a vegetated buffer. The buffer areas within the ravine were well vegetated with trees and understory shrubs. However, the dominant vegetation along the stream banks consisted of Himalayan blackberry, which is an invasive, non-native plant with leaves that are a poor source of food for macroinvertebrates and roots that do not form a fibrous mat to stabilize stream banks. Channelization was also noted in Massey Creek and was particularly severe below 20th Avenue South where a 5-foot deep channel was observed.

Changes Observed Between the 1994 and 1999 Habitat Surveys

Changes observed in the intervening years between surveys of Massey Creek include the spread of invasive vegetation and some construction. Himalayan blackberries increased in dominance throughout the survey areas, and were most prevalent in the reaches above 20th Avenue South and below 10th Avenue South. The downstream end of the stream culvert that extends underneath 16th Avenue South had collapsed since the 1994 survey, resulting in a mass wasting of overlying material to the stream. Ecology blocks were used to temporarily stabilize the steep embankment along 16th Avenue South until the culvert is replaced.

Habitat Rehabilitation Opportunities

Massey Creek provides several opportunities for habitat rehabilitation, but would be most effective in the reaches below 10th Avenue South and 20th Avenue South. Himalayan blackberries could be removed and replaced with native vegetation. Boulders, logs, and root wads could be placed in the stream to create pools and enhance channel meandering. Reduction of peak flows would reduce channelization problems.

Barnes Creek Basin

Habitat Quality

The majority of Barnes Creek flows though low-density development that consists primarily of single-family residences. Throughout the upper stream reaches, Himalayan blackberries were the dominant riparian vegetation. Habitat quality concerns associated with upper Barnes Creek also included eroded stream banks and poor substrate quality. Substrates located below the erosion areas consisted of fine silt and organic muck, potentially interfering with fish spawning and rearing activities. Habitat characteristics improved downstream as the stream flows through a ravine that was well vegetated with trees and shrubs, and contained relatively coarse substrates and a variety of instream habitat structures.

Changes Observed Between the 1994 and 1999 Habitat Surveys

Between the 1994 and 1999 surveys, Himalayan blackberries had generally become more dominant along the stream channel. Also, additional stormwater outfalls were observed in the vicinity of 13th Avenue South, and the largest outfall appeared to have caused more erosion and sedimentation of the stream channel than was previously noted in 1994.

Habitat Rehabilitation Opportunities

Himalayan blackberries could be removed from selected areas of upper Barnes Creek and replaced with native vegetation. The extent of sedimentation and erosion impacts from the large stormwater outfall located in the vicinity of 13th Avenue South could be further investigated, and mitigation could be designed to rehabilitate this area of the stream.

McSorley Creek Basin

Habitat Quality

Habitat quality concerns observed during both surveys of the north fork of McSorley Creek included stream bank erosion, sedimentation, and possible barriers to fish migration. Evidence of erosion included the exposure of tree roots in the stream channel and the presence of eroded banks where residential yards border the upper stream reaches. Erosion of trails entering the stream near the Parkside Elementary School contributed to sedimentation problems. Lower reaches of the stream exhibited a diverse habitat that included pools and riffles, logs and boulders for fish cover, and riparian vegetation. This area provides good fish habitat, but the stream is highly channelized and contains debris barriers near its confluence with the south fork of McSorley Creek.

Changes Observed Between the 1994 and 1999 Habitat Surveys

In comparison to the 1994 survey, Himalayan blackberries became even more dominant in 1999 along all reaches of the stream.

Habitat Rehabilitation Opportunities

McSorely Creek presents various opportunities for both habitat rehabilitation and public education projects. An inspection program could be put in place to periodically check the lowermost reach for fish barriers and ensure their removal when they form, thus allowing fish passage to the high-quality habitat upstream.

Because McSorley Creek flows through many residential yards, community involvement and education could be beneficial for rehabilitating and protecting the stream. Educational efforts could focus on implementing general lawn and garden best management practices (BMPs), planting native vegetation along the stream banks, and maintaining a buffer of native grasses and shrubs between lawns and the stream channel.

Public Involvement Program

A public involvement program was initiated to educate local citizens and to gain advocates of the water quality monitoring program. The public involvement program consisted of two water quality workshops and the enlistment of citizen volunteers to record stream gauge readings. Workshop activities and steam gauge monitoring procedures are summarize below.

Water Quality Workshops

A workshop to familiarize the public with benthic macroinvertebrate sampling and identification, as well as to gain advocates of the Des Moines water quality monitoring program, was held on October 22, 1994 at the Founders Lodge in Des Moines Beach Park. The agenda for the workshop and a critique form completed by the participants were presented in the first annual report (Herrera 1995). The workshop began with an introduction by Loren Reinhold (city of Des Moines). Joy Michaud (Envirovision) then provided a slide presentation of stream ecology, including information about habitat and feeding requirements of benthic invertebrates. Ms. Michaud then guided participants in the collection and examination of benthic invertebrate samples from Des Moines Creek. The workshop also included a presentation about stream habitat improvements by John Muramatsu (Trout Unlimited) and a summary of the Des Moines water quality monitoring program by Rob Zisette (Herrera Environmental Consultants).

Eight people attended the workshop, three of whom volunteered to take part in stream gauge monitoring, described below. Their critiques of the workshop were generally positive, with all eight participants responding that they enjoyed the workshop and learned something new. Six participants thought that the level of information was about right, while one participant felt that there was too much detail and another that there was not enough detail. Seven participants thought that the ideas were presented clearly, the presenters were well prepared, and the workshop was well organized. Comments from the participants indicated that the activity they enjoyed most was the collection and examination of the invertebrates, and that they would have preferred to spend more time with that activity and less time on presentations.

A second workshop to educate the public and gain advocates of the monitoring program was held on September 10, 1997 at the Founders Lodge in Des Moines Beach Park. This workshop was integrated with a Des Moines University class studying Des Moines Creek, and was attended by approximately eight local citizens. The workshop began with an introduction by Loren Reinhold (city of Des Moines). Joy Michaud (Envirovision) then provided a slide presentation on stream ecology, including information about habitat and feeding requirements of benthic invertebrates. The class was led on a walk along lower Des Moines Creek, where participants were shown different types of stream habitat, monitoring station DM-2, and the stream culvert under Marine View Drive.

Steve Worthy (Worthy and Associates) presented a summary of the Des Moines Creek trail project, which is planned to improve hydrologic conditions in the stream by replacing the existing culvert at Marine View Drive with a bridge. Rob Zisette (Herrera Environmental

Consultants) concluded the workshop with a summary of the Des Moines water quality monitoring program objectives, methods, and results.

Stream Gauge Monitoring

The public involvement program included monitoring of stream gauges by citizen volunteers. Simple staff and crest gauges were installed at each monitoring station in October 1994 for the water quality monitoring program. The primary objective of stream gauge monitoring was to provide data for evaluating potential trends in stream discharge over the 5-year monitoring period.

Three local citizens volunteered at the initial water quality workshop in October 1994 to participate in stream gauge monitoring. These citizens were assigned to monitoring stations in locations that were convenient for them to read the gauges at weekly intervals: station DM-1 (Peggy McCluskey), station MA-3 (Joe Dusenberry), and station BA-1 (Iva Hays). In addition, Parkside Elementary School was contacted, and a third grade teacher (Sandy Klein) volunteered her class to monitor the gauge at station MC-1. An employee of the Des Moines Stormwater Management Utility (Wayne Matthews) monitored stations MA-1 and MC-2.

Each volunteer was instructed how to read the staff gauge and crest gauge, and how to reset the crest gauge. Forms were provided to record observations. Completed forms and a summary of gauge observations are presented in Appendix I.

During each of the first two monitoring years, the volunteers recorded between seven and 45 observations for each of the six gauges. Observations were few to none during subsequent years, with the exception of station BA-1, which was monitored by Iva Hays on at least 18 occasions during each of the 5 years. No concerted effort was made to gain new volunteers, primarily because the data gathered had limited usefulness, due to inconsistencies in the frequency of observations and inaccuracies of measured stage/discharge relationships. Stream channels changed and stream gauges were replaced throughout the monitoring period, making it difficult to develop rating curves that would consistently predict an accurate discharge from the crest gauge readings. Therefore, the stream gauge data collected by the volunteers were not converted into discharge rates and evaluated for hydrologic trends.

Annual water level fluctuations were calculated for each stream station by subtracting the minimum staff gauge height from the maximum crest gauge height (see Appendix H). Station BA-1, located near the mouth of Barnes Creek, was the only station that exhibited an apparent change in water level fluctuation during the monitoring period. Water levels fluctuated 3 feet during the first two monitoring years and only 0.8 feet during subsequent years. According to notes recorded by the volunteer, the high water levels were caused by an accumulation of debris on the trash rack, which was located approximately 20 feet downstream of the staff gauge during the first two years of monitoring. Because of this problem, the staff gauge was moved approximately 35 feet upstream, where it remained for the last three years of monitoring. Thus, the apparent reduction in water level fluctuation was likely due in part to the new staff gauge location.

Study Conclusions

The Des Moines water quality monitoring program collected a comprehensive set of data that were successfully used to evaluate water quality and habitat conditions in the three stream basins located within the city of Des Moines. Conclusions are presented below for the three primary monitoring components: water quality monitoring, benthic invertebrate monitoring, and habitat surveys.

Water Quality Monitoring

A summary of water quality observations and concerns is presented for each stream basin in Table 18. This summary tables identifies the following observations for each parameter during storm and base flow conditions:

1. Water quality criteria (where applicable) were exceeded in more than 20 percent of samples collected from stations located at stream mouths.
2. Median value for the steam mouth exceeds the 75th percentile value for other streams in developed areas of King County.
3. There is a significant temporal trend of increasing values at the stream mouth during the 5-year study period.
4. There is a significant spatial trend of increasing values from the upstream to the downstream stream station.
5. The stream mouth exhibits the highest median value among all Des Moines streams.

Observations 1, 2, or 3 are considered to be a water quality concern and are presented as bold values in Table 18. These concerns are summarized below for each stream basin.

Des Moines Creek:

- High temperatures and low dissolved oxygen concentrations during base flow
- High turbidity and total suspended solids concentrations during storm flow
- High total metals concentrations during storm flow
- High fecal coliform bacteria concentrations during storm and base flow.

Table 18. Summary of water quality observations and concerns[a] in Des Moines streams.

	Storm Flow				Base Flow			
	Des Moines	Massey	Barnes	McSorley	Des Moines	Massey	Barnes	McSorley
Temperature	–	–	–	4,5	1,5	**1**	–	**1**
pH	4,5	4	**3**	4	4	4	2,5	4
Dissolved oxygen	–	**1**	–	**1**	1,5	**1**	**1**	**1**
Conductivity	3,4,5	4	5	–	2,4,5	**2,3**	2,5	–
Hardness	3,4,5	4	5	–	4,5	–	5	–
Turbidity	**2**	**1,2,4**	2,5	**1,2,4**	–	–	–	5
Total suspended solids	2,4	2,4	2,4,5	4	–	–	–	5
Total phosphorus	–	4	2,5	–	–	4	–	5
Nitrate+nitrite nitrogen	4	–	5	4	–	5	5	–
Ammonia nitrogen	–	–	–	2,4,5	–	–	–	5
Dissolved copper	–	–	–	4,5	–	–	–	4,5
Dissolved lead	–	–	–	–	–	–	–	4
Dissolved zinc	–	–	–	4,5	–	–	–	–
Total copper	2,5	**2**	**2**	2,4	NA	NA	NA	NA
Total lead	2,5	**2**	**2**	2,4	NA	NA	NA	NA
Total zinc	2,5	**2**	**2**	2,4	NA	NA	NA	NA
Total petroleum hydrocarbons	–	–	–	4	NA	NA	NA	NA
Fecal coliform bacteria	**1**	1,5	**1**	**1**	**1**	**1**	**1,3,5**	**1**

[a]Bold numbers are considered to be water quality concerns due to the occurrence of observations 1, 2, or 3.
1. Water quality criteria (where applicable) exceeded in more than 20 percent of the samples collected from stations located at stream mouths.
2. Median value for stream mouth exceeds 75[th] percentile of other King County streams, where available (dissolved oxygen < 25[th] percentile).
3. Significant temporal trend of increasing values at the stream mouth during the 5-year study period (decreasing dissolved oxygen).
4. Significant spatial trend of increasing values from the upstream to the downstream stations, excluding Barnes Creek (decreasing dissolved oxygen).
5. Highest median value among stations located at stream mouths (lowest dissolved oxygen).

NA = Not analyzed

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Massey Creek:

- High temperatures during base flow, and low dissolved oxygen concentrations during storm and base flow
- High turbidity and total suspended solids during storm flow
- High total metals concentrations during storm flow
- High fecal coliform bacteria concentrations during storm and base flow.

Barnes Creek:

- High pH during storm and base flow
- Low dissolved oxygen concentrations during base flow
- High turbidity and total suspended solids concentrations during storm flow
- High total phosphorus concentrations during storm flow
- High total metals concentrations during storm flow
- High fecal coliform bacteria concentrations during storm and base flow.

North Fork of McSorley Creek:

- High temperatures during base flow, and low dissolved oxygen concentrations during storm and base flow
- High turbidity during storm flow
- High ammonia nitrogen concentrations during storm flow
- High total metals concentrations during storm flow
- High fecal coliform concentrations during storm and base flow.

High water temperatures and low dissolved oxygen concentrations were observed in each of the study stream basins during summer months. Prolonged periods of high temperatures and low dissolved oxygen can stress invertebrates and fish, and can eventually lead to a complete loss of sensitive organisms from the streams. Increased water temperature decreases the solubility of oxygen, which exacerbates dissolved oxygen problems. Water temperatures exceeded the state criterion for Class AA waters (16.0°C) in 67 percent of the base flow samples collected from the stream stations in July or August. Similarly, dissolved oxygen concentrations were below the allowable limits established for Class AA waters (9.5 mg/L) in 95 percent of the base flow samples collected from the stream stations in July or August. These conditions could be improved by increasing shading of the streams by planting trees, increasing ground water contributions to summer base flow by infiltrating stormwater runoff, and decreasing nutrient enrichment of the streams by treating stormwater runoff.

Fecal coliform bacteria contamination is a significant concern in each of the study stream basins, particularly during storm flow. Pathogens associated with fecal coliform bacteria can potentially affect the health of humans who come in contact with stream waters. Over the entire 5-year monitoring period, fecal coliform bacteria concentrations exceeded the Washington state Class AA criterion (50 organisms/100 mL) in 59 percent of collected base flow samples and in 95 percent of collected storm flow samples. However, median values of fecal coliform bacteria did not exceed 75th percentile values for other King County streams which have not been closed to public access due to health concerns for contact recreation. Sources of fecal coliform bacteria likely include domestic animals, urban wildlife, and failing septic systems in the Des Moines stream basins.

Pollutant concentrations were much higher during storm flow than during base flow for all measured parameters expect nitrate + nitrite nitrogen. Median storm flow turbidity and total suspended solids concentrations solids concentrations were highest in Barnes Creek, increased downstream in each of the three major study basins, and were typically twice those observed for other developed stream basins in King County. Median nutrient concentrations were similar to those observed for other developed stream basins in King County, with the exception of high storm flow total phosphorus concentrations in Barnes Creek and high storm flow ammonia nitrogen concentrations in McSorley Creek.

Median dissolved copper concentrations were highest at lower McSorely Creek, but the acute criterion for dissolved copper was exceeded most often (40 percent) at upper Des Moines Creek during storm flow. Criteria for dissolved lead and zinc were rarely exceeded at all stream monitoring stations. Median storm flow concentrations of total copper, lead, and zinc were typically three times higher than those observed for other developed stream basins in King County.

The analysis of spatial trends in water quality indicates several important sources of pollution in the study basins. Metals concentrations often decreased significantly downstream in the Des Moines Creek and Massey Creek basins during storm flow, suggesting that runoff from high traffic areas (e.g., SeaTac airport and SR 99) is an important source of heavy metals in the upper reaches of these basins. In contrast, metals concentrations in the McSorley Creek basin frequently increased significantly downstream, suggesting that runoff from the Midway landfill may be contaminating McSorley Creek with heavy metals. This analysis also showed that Barnes Creek is an important source of turbidity, total suspended solids, and total phosphorus in the Massey Creek basin.

Concentrations of some pollutants appear to have declined over the 5-year monitoring period. For example, copper and zinc concentrations significantly decreased in the Des Moines Creek and McSorley Creek basins during storm and base flow. Similarly, base flow concentrations of nitrate+nitrite nitrogen and ammonia nitrogen significantly decreased at some of the Massey Creek and McSorley Creek monitoring stations.

Conversely, concentrations of total phosphorus and total petroleum hydrocarbons increased significantly over the 5-year monitoring period in upper Massey Creek (station MA-1), and fecal coliform bacteria concentrations increased significantly in Barnes Creek. Significant increases in conductivity were observed at every monitoring station in the Des Moines Creek and Massey Creek basins, which is generally indicative of increasing basin development.

Benthic Invertebrate Monitoring

Benthic invertebrate monitoring results indicate that the benthic invertebrate communities were severely stressed at all stream sampling stations throughout the 5-year monitoring program. These communities may have been subjected to severe periodic disturbances as indicated by low taxa richness, low densities, lack of long-lived taxa, and dominance by a few rapid-generation weedy taxa. The community profiles suggest that these disturbances were caused by pulses of toxins or severe scouring and resorting of stream substrates, which are common problems in urban streams. The results further suggest that even if habitat and nutrient conditions were to improve, other factors may still limit the biotic integrity of these urban streams.

Severe flood events during the first two years of monitoring appear to have affected benthic invertebrate communities at many of the stream monitoring stations, as evidenced by the following differences between the 1994 and 1996 results:

- Total invertebrate density decreased at seven of the eight stations, with a substantial decrease in density (greater than 50 percent) at three of the stream stations.
- Total taxa richness decreased at six of the eight stations, with a substantial decrease in richness (greater than 40 percent) at five of the stream stations.
- Dominance by a single tolerant and rapidly recolonizing or regenerating taxon increased at six of the eight stream stations, with a substantial increase in percentage of dominant taxa (greater than 50 percent) at four of the stream stations.

Comparison of the 1996 and 1998 results indicates that total invertebrate densities and total taxa richness increased at five of the eight stream stations. However, total erosional habitat indices did not vary substantially between monitoring years at any of the stream stations.

The total erosional habitat index for lower Des Moines Creek compared well with an independently determined benthic index of biotic integrity (B-IBI) for the same location.

Agreement between the two indices provides further support for the conclusion that benthic communities in all of Des Moines streams studied are severely disturbed.

Habitat Surveys

Steep ravines provide natural buffers throughout much of the length of the Des Moines streams. These buffers deter direct access to the streams and provide overhead canopy, forest litter inputs, and large woody debris where banks are properly vegetated. However, blackberry brambles that enshroud large portions of the streams are increasingly encroaching upon many of these areas in Massey and McSorley creeks. The blackberry brambles reduce the quality of litter inputs (and macroinvertebrate diet), and have poor bank stabilization properties due to their low root mass. A program to remove the brambles from potentially high-quality habitat and replace them with a stratified community (i.e., herbs, shrubs, and trees) of native plants would benefit stream ecology.

There is little habitat diversity and low abundance of pools in Massey and McSorley creeks. Encouraging meander formation by placing rootwads and boulders in the streams would enhance pool formation. Habitat in deeply cut and channelized areas of Massey and McSorley creeks could also be improved by reducing peak flows, which would allow the streams to return to a more natural morphology.

Monitoring Recommendations

Recommendations for future monitoring of Des Moines streams are provided below for routine water quality and hydrologic monitoring, additional water quality studies, benthic invertebrate monitoring, and public involvement. Based on initial observations from the 5-year water quality monitoring program, pollutant source tracking is not recommended because isolated sources of pollution in the stream basins do not appear to be the primary causes of water quality impairment. Additional habitat surveys are not recommended unless stream rehabilitation projects are initiated as recommended below for public involvement. Recommendations for stormwater management will be provided in the update of the city's stormwater management program (RW Beck in preparation).

Water Quality and Hydrologic Monitoring

It is recommended that the city of Des Moines continue monitoring the water quality of streams within the city to track long-term effects of basin development and stormwater management measures. Due to annual variability, water quality changes should be assessed by comparing results for an entire 5-year period (i.e., water years 2001 through 2005) to conditions presented in this report (i.e., water years 1995 through 1999). Results for water years 1995 through 1999 indicate that the same sampling frequency would be sufficient to detect significant changes during a future 5-year period. Therefore, sampling should be conducted during five storm events and three base flow events each year for another period of 5 years.

Results for water years 1995 through 1999 are useful for detecting spatial trends within the stream basins. To assess overall changes in each stream basin, it is recommended that future monitoring be conducted only at the mouths of streams. An additional monitoring station should be located near the mouth of the south fork of McSorley Creek, because most of its basin is now located within the Des Moines city limits. Monitoring of Woodmont Creek is not recommended due to its small size and limited fish habitat potential. Monitoring of Normandy, Redondo, and Cold creeks is only recommended if monitoring costs are shared with adjacent jurisdictions, because only a small portion of their basins are located within the city limits. Therefore, it is recommended that water quality monitoring be performed at the following five stations:

- DM-2: existing station located in Des Moines Beach Park near the mouth of Des Moines Creek
- MA-3: existing station located upstream of Marine View Drive near the mouth of Massey Creek
- BA-1: existing station located upstream of Kent–Des Moines Road near the mouth of Barnes Creek
- MC-2: existing station located downstream of 16th Avenue South near the mouth of the north fork of McSorley Creek

- MC-3: new station located at 16th Avenue South near the mouth of the south fork of McSorley Creek.

Sample collection and analytical procedures should generally follow methods presented in this report. However, a more cost-effective approach should be employed, eliminating some of the monitoring parameters. Based on monitoring results from the first 5-year program, it is recommended that collected water samples be analyzed for the following parameters:

- Temperature (grab samples of storm and base flow)
- pH (grab samples of storm and base flow)
- Dissolved oxygen (grab samples of storm and base flow)
- Conductivity (grab samples of storm and base flow)
- Hardness (composite samples of storm flow and grab samples of base flow)
- Turbidity (composite samples of storm flow and grab samples of base flow)
- Total suspended solids (composite samples of storm flow and grab samples of base flow)
- Total phosphorus (composite samples of storm flow and grab samples of base flow)
- Dissolved copper (composite samples of storm flow and grab samples of base flow)
- Total copper (composite samples of storm flow only)
- Fecal coliform bacteria (grab samples of storm and base flow).

Analysis for ammonia and nitrate+nitrite nitrogen is not recommended, because total phosphorus is considered an adequate measure of nutrient conditions in these streams for the purpose of evaluating long-term trends. Lead and zinc analyses are not needed, because copper is considered an adequate measure of heavy metal contamination for the purpose of evaluating long-term trends, and because water quality criteria for lead and zinc were rarely exceeded at the monitoring stations. Total petroleum hydrocarbon analyses are not recommended, because effects of observed concentrations are not well known, and the water quality monitoring design does not allow for assessment of the occurrence and extent of isolated petroleum spills.

Ecology (2000) has recently proposed new standards for the bacteriological quality of surface waters that include criteria for Enterococci in freshwaters and marine waters. Ecology also recommends simultaneous analysis of fecal coliform bacteria and Enterococci for a 3-year period. Therefore, future water quality monitoring of Des Moines streams should consider analysis of Enterococci for comparison to the state's revised bacteriological standards.

Hydrologic monitoring should be improved by collecting continuous discharge data at each of the five monitoring stations. Continuous discharge data can be used with existing rainfall data to better evaluate hydrologic conditions and impacts on the Des Moines streams, and to calculate total maximum daily loads. Continuous discharge monitoring would require installation and operation of equipment at only four stations, because discharge is being continuously monitored now by King County at station DM-2 on Des Moines Creek. Staff gauges and water level meters can be installed and operated at a relatively low cost. Costs for rating curve development would be similar to the amount expended in water years 1995 through 1999. Additional costs would be incurred for data management and evaluation.

Water Quality Studies

It is recommended that monitoring be conducted to evaluate the pollutant removal effectiveness of existing and future stormwater detention facilities. Inflow and outflow samples should be collected and analyzed concurrent with routine water quality monitoring. These results should be compared to those expected for similar types of detention facilities and used to evaluate the potential for enhancement of the pollutant removal effectiveness of the city's facilities.

Ecology (2000) has recently proposed new temperature and dissolved oxygen criteria for surface waters that require measurement of 7-day-average maximum temperature and minimum dissolved oxygen values throughout the year for salmon-bearing streams. Therefore, a water quality study is recommended to better assess water temperature and dissolved oxygen conditions in the streams. Multiparameter meters that continuously record water temperature and dissolved oxygen should be installed at each of the five stations and operated for a minimum of one entire monitoring year. If funds are limited, temperature data loggers could be installed at each station to record continuous water temperatures at a very low cost.

Another water quality study is recommended to better assess the sources of fecal coliform bacteria contamination in Massey and McSorley creeks. This study should employ a genetic fingerprinting technique recommended by Ecology (1999), which is presently being used by the Port of Seattle for upper Des Moines Creek (Herrera 2000), and has been successfully used to identify fecal sources in other urban watersheds (e.g., Herrera 1993, 1999; Des Moines Creek Basin Committee 1997; and Samadpour and Chechowitz 1995). This study should be designed to incorporate hydrologic data for determining the total maximum daily load of fecal coliform bacteria.

Benthic Invertebrate Monitoring

Benthic invertebrate monitoring is recommended in order to continue the evaluation of water quality and habitat conditions in the Des Moines streams. Benthic invertebrate samples should be collected in late October of every second year (i.e., 2001, 2003, and 2005) at each of the five monitoring stations. Sample collection and analysis procedures should follow the Aquatic Biology Associates method used for the first 5-year monitoring program (see Appendix G). In addition, a simple measure of substrate conditions (e.g., pebble counts) should be performed during sample collection, to better assess potential changes in habitat conditions.

Public Involvement

It is recommended that future public involvement efforts be focused on the rehabilitation of stream habitat in the Massey and McSorley creek basins. Organizing a "stream team" and enlisting interested citizens for projects designed to improve habitat conditions has been successful in other urban streams in the Puget Sound region. Stream rehabilitation projects should be developed that include removal of trash and blackberry brambles, and planting and maintenance of native vegetation at locations identified by the habitat surveys. If public involvement continues to be successful, additional rehabilitation efforts should include placement of structures such as rootwads and boulders in the streams to enhance pool formation and channel meandering.

Funding for this type of public involvement activity is available from several county and state programs, which recognize the benefits of promoting stream stewardship and improving stream habitat. King County offers grants through the Public Works Grant Program, Watershed Action Grants Program, and the Urban Reforestation and Habitat Restoration Grant Fund. The Washington Department of Ecology offers grants or loans through the Centennial Clean Water Fund, the State Revolving Loan Fund, and the Washington Conservation Corps Fund. The Washington State Interagency Committee for Outdoor Recreation offers grants through the Salmon Recovery Funding Board. The National Fish and Wildlife Foundation also funds a variety of public education and habitat rehabilitation projects.

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APPENDIX A

Quality Assurance Report

Quality Assurance Report

This report describes sampling, analytical, and quality control procedures used for the Des Moines water quality monitoring program, as set forth in the *Water Quality Monitoring and Quality Assurance Project Plan* (Herrera 1994). In addition, data validation results are presented for the fourth and fifth year of monitoring from November 1997 through November 1999. Data validation results for the first three years of monitoring were presented in annual reports (Herrera 1995, 1996, 1998).

Sampling Procedures

Sampling procedures generally followed *Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound* (U.S. EPA 1991) and *National Pollutant Discharge Elimination System (NPDES) Stormwater Sampling Guidance Document* (U.S. EPA 1992). Prior to each sampling event, the project field coordinator reviewed sampling procedures and equipment needs with the field technicians.

Water Sample Collection

Grab samples were collected from the center of the stream channel by submerging laboratory-cleaned, pre-labeled sample containers below the water surface at mid-depth. When appropriate (i.e., when collecting water for analyses other than oil and grease or fecal coliform bacteria), the sample bottles were rinsed once with sample water prior to filling. Sample containers were sealed and immediately placed on ice in a cooler.

Measurements of field parameters (e.g., pH, dissolved oxygen, temperature, and conductivity) were performed by submerging the portable meter probes into the flowing water or a sample withdrawn from the stream. Flow-proportioned composite samples for each of the eight stations were prepared at the laboratory from separate grab samples of storm flow using clean technique.

Field Notes

At each sampling station, the following information was recorded in a waterproof field notebook:

- Sampling date
- Name of sampler
- Time of sample collection, measurement, or observation
- Station location
- Weather and flow conditions
- Calibration results for field instruments
- Field measurements
- Number and type of samples collected
- Unusual conditions (e.g., oily sheen, odor, color, turbidity, discharges and land disturbances, fish kill, aquatic and riparian vegetation).

Upon return to the office, field notes were copied and inspected by the project quality assurance officer.

Sample Containers and Preservation

Pre-cleaned sample containers were obtained from the analytical laboratory for the required analyses. Spare sample containers were carried by the sampling team in case of breakage or possible contamination. Sample containers and preservation techniques were in accordance with analytical methods and USEPA (1992) guidelines.

Sample Identification and Labeling

Each sample was identified by a unique station number and the date of collection. Prior to filling, sample containers were labeled with the following information using indelible ink:

- Station number
- Date of collection (day/month/year)
- Time of collection (military format)
- Project name (Des Moines)
- Company/sampler initials.

Labels on glass containers were secured with clear adhesive tape.

Sample Transport and Custody

Samples were transported at 4° C in a cooler to the laboratory within 12 hours of collection. A chain-of-custody record accompanied the samples. Upon return to the office, a signed copy of the chain-of-custody record was inspected by the quality assurance officer.

Analytical Procedures

Field measurements of temperature, pH, dissolved oxygen, and conductivity were conducted using portable meters operated according to the manufacturer's directions and following standard procedures (American Public Health Association [APHA] et al. 1992).

Laboratory analytical procedures followed U.S. EPA approved methods (APHA et al. 1992; U.S. EPA 1983, 1984). These methods provide detection limits that are below the state and federal regulatory criteria or guidelines, and enable direct comparison of analytical results with these criteria. Detection limits and analytical methods are presented in Table A1.

Table A1. Methods and detection limits for water quality analyses.

	Method	Method Number [a]	Detection Limit/Unit
Temperature	Electrode	SM 2550B	0.1 degrees C
pH	Electrometric	SM 4500-H and B	None
Dissolved oxygen	Electrode or Winkler	SM 4500-OG or C	0.1 mg/L
Conductivity	Wheatstone bridge	SM 2520B	1 μmhos/cm
Hardness	Calculation or titrimetric	SM 2340B or C	2 mg/L as CaCO3
Turbidity	Nephelometric	SM 2130B	0.1 NTU
Total suspended solids	Gravimetric, 103 degrees C	EPA 160.2	0.5 mg/L
Total phosphorus	Automated ascorbic acid	EPA 365.1	0.002 mg/L
Ammonia nitrogen	Automated phenate	EPA 350.1	0.010 mg/L
Nitrate+nitrite nitrogen	Automated cadmium reduction	EPA 353.2	0.010 mg/L
Copper, dissolved and total	Graphite furnace atomic absorption	EPA 220.2	0.001 mg/L
Lead, dissolved and total	Graphite furnace atomic absorption	EPA 239.2	0.0005 mg/L[b]
Zinc, dissolved and total	Inductively coupled plasma	EPA 200.7	0.003 mg/L
Total petroleum hydrocarbons	Infrared spectrophotometric	EPA 418.1	0.25 mg/L
Fecal coliform bacteria	Membrane filter	SM 9222D	2 CFU/100 mL

[a] SM method numbers are from APHA et al. (1992), EPA method numbers are from U.S. EPA (1983, 1984).

[b] Because analytical interferences are common in urban stream samples, the lowest achievable detection limit for lead may be 0.001 mg/L.

The laboratory reported the analytical results within 30 days of receipt of the samples. Sample and quality control data were reported in a standard format. The reports also include a case narrative summarizing any problems encountered in the analyses.

Quality Control Objectives and Procedures

The overall quality assurance objective was to ensure that data of known and acceptable quality are provided. All measurements were performed to yield consistent results that are representative of the media and conditions measured. Specific quality control objectives and procedures for laboratory analyses and data management are described in the following sections.

Chain-of-Custody Record

A chain-of-custody record was maintained for each sample batch listing sampling date and time, sample identification numbers, quantities analyzed, number of containers, persons relinquishing and receiving custody, and dates and times of custody transfer.

Holding Times

Immediately upon receipt of samples, the laboratory filtered, preserved, and refrigerated the samples at 4°C. The samples were analyzed within the maximum holding time established by the U.S. Environmental Protection Agency (U.S. EPA 1992). Analysis dates were reported with the analytical results. Holding times were calculated in days from the sampling date to the analysis date. Results associated with holding times that exceed the U.S. EPA maximum were qualified as estimates (J). Extended holding times were allowed for fecal coliform bacteria analyses (one day allowed versus 6 hours allowed by U.S. EPA).

Standard Laboratory Procedures

In compliance with the state laboratory certification program, the Washington Department of Ecology (Ecology) routinely evaluated the laboratory's standard operating procedures. As part of the program, performance evaluation samples were analyzed for at least once every 6 months. Throughout the monitoring period, the laboratory (Aquatic Research, Inc.) has maintained its certification and results of the performance evaluation sample analyses have met the acceptable criteria.

Water used for preparation of reagents was equivalent to Type 1 water having a conductivity less that 0.1 micromhos per centimeter (μmhos/cm) (APHA et al. 1992). All reagents and solvents used in analyses were analytical reagent grade.

Instrument Maintenance and Calibration

Records of maintenance of instruments used for the analyses were provided upon request. Calibration was conducted each time an instrument is set up for an analytical run. Calibration standards for the analyses were within the same concentration range as the samples, and a blank was included. Following calibration, verification was conducted using an independent standard (from a different source) in the same range; results must be within 10 percent of the true value. Verification was repeated after every nine samples, or every 2 hours, and at the completion of the analysis. A calibration blank was run after each verification standard. The absolute value of the blank cannot exceed the specified detection limit. If any of the stated conditions were violated, affected samples were reanalyzed. Verification standard results from quality control check samples were reported with the analytical results. Results associated with quality control check sample recoveries outside the range 90 to 110 percent were qualified as estimates (J).

Preparation Blanks

A preparation blank was processed through each sample preparation procedure after every nineteenth sample or with each batch. The blank concentration must be either less than 2 times the detection limit or less that 20 percent of the concentration of the least concentrated sample in the batch. If the stated condition was violated, affected samples were reanalyzed. Preparation blank results were reported with the analytical results. Results associated with preparation blank concentrations in violation of the stated condition were qualified as estimates (J).

Field Transfer Blanks

For metals analyses, field transfer blanks were analyzed approximately twice per year to check for contamination during the sampling procedure. Reagent water was poured into appropriate laboratory sample bottles under normal sampling conditions in the field. Transfer blank samples were submitted to the laboratory as separate (blind) samples. Sampling procedures were revised if analyte concentrations in the field transfer blank exceeded two times the detection limit.

Matrix Spikes

Matrix spikes were added to a randomly selected sample in each batch of samples. Spiking levels were generally between 0.25 and 10 times the sample values. Results of spike recoveries were reported with the analytical results. Results associated with spike recoveries outside the range of 75 to 125 percent were qualified as estimates (J) by the quality assurance officer.

Laboratory Duplicates

A laboratory duplicate sample was analyzed for a randomly selected sample with every sample batch. The results of duplicate analyses were reported with the analytical results. If the duplicate sample concentrations differed more than 25 percent (for sample values greater than or equal to five times the detection limit), or two times the detection limit (for sample values less than five times the detection limit), all results associated with the duplicate analysis were qualified as estimates (J) by the quality assurance officer.

Field Duplicates

Field duplicate samples were analyzed for randomly selected samples at a frequency of at least 5 percent of all project samples. Duplicate samples were submitted to the laboratory and labeled as separate (blind) samples. If the duplicate sample concentrations differed more than 25 percent (for sample values greater than or equal to five times the detection limit), or two times the detection limit (for sample values less than five times the detection limit), all results associated with the duplicate analysis were qualified as estimates (J) at the discretion of the quality assurance officer.

Data Management

Field notes and chain-of-custody records were inspected by the quality assurance officer following collection of the water samples. Laboratory reports were received by the quality assurance officer, usually within 30 days of sample collection, and inspected for completeness and severe quality control problems. Field and laboratory data were validated on a regular basis, and all problems and actions (e.g., data qualifiers) were noted on worksheets. Water quality data and associated qualifiers were entered in spreadsheets, and the spreadsheets were checked for data entry errors.

Data Validation Results

There were no severe problems associated with the analysis of water quality samples collected from November 1997 through November 1999 for the fourth and fifth monitoring years. Therefore, none of the reported values were rejected. Minor quality control problems that required qualification of data as estimates (J) include the following analyses:

- Total copper values for samples of storm flow collected on December 15, 1997 and June 24 1998 were qualified as estimates (J) because the relative percent difference between laboratory duplicates was high (43 and 27 percent, respectively).
- Dissolved lead values for samples of storm flow collected on November 5, 1999 were qualified as estimates (J) because the percent recovery of the matrix spike was high (127 percent) and, therefore, only included values reported at or above the detection limit.
- Total lead values for samples of storm flow collected on October 12, 1998 were qualified as estimates (J) because the percent recovery of the matrix spike was low (70 percent).
- Fecal coliform bacteria values for samples of base and storm flow were qualified as estimates by the laboratory because the number of colonies per plate was less than 20.

Field duplicate samples were analyzed for all parameters on eight occasions (three base flow events and five storm events) during the last two years of the monitoring program. Precision of the field duplicate analyses exceeded the objective of 25 percent difference or ± 2 times the detection limit for some parameters. However, no data were qualified because the analytical precision was acceptable (based on laboratory duplicate results) and the field duplicate results were generally considered to be within the range of the natural variation. Precision objectives were exceeded for the following field duplicate analyses:

- Total phosphorus for samples of base flow collected on July 22, 1998 (45 percent difference).
- Dissolved zinc for samples of storm flow collected on October 12, 1998 (± 2.3 times the detection limit).
- Total zinc for samples of storm flow collected on October 12, 1998 (35 percent difference).
- Dissolved copper for samples of storm flow collected on March 12, 1999 (± 2.2 times the detection limit).
- Fecal coliform bacteria for samples of storm flow collected on March 12, 1999 (67 percent difference).

Transfer blank samples were analyzed for dissolved metals on seven occasions (three base flow events and four storm events) during the last two years of the monitoring program. Only one of the samples contained a detectable quantity of a dissolved metal. The transfer blank sample collected during base flow on May 27, 1999 exhibited a dissolved zinc concentration of 0.010 mg/L, which is 3.3 times the detection limit of 0.003 mg/L. However, zinc was only detected in one of the stream water samples (0.004 mg/L in sample DM-2) and was not detected in the field duplicate of the same sample. Therefore, the undetected zinc value for the field duplicate was used in the data analysis and contamination of the field transfer blank with zinc did not appear to be associated with sample collection procedures.

Minor quality control problems were also noted for some analyses conducted during the first three years of the monitoring program (see Herrera 1995, 1996, and 1998). All analyte values that were qualified as estimates (J) were used in the data analysis. Detection limits for undetected values (U or UJ) were also used in the data analysis. Relative frequencies of estimated and undetected values are summarized in Table A2 for the 5-year water quality monitoring program.

Table A2. Percentages of analyte values that were qualified as estimates (J or UJ) and less than the detection limit (U and UJ) for the Des Moines water quality monitoring program.

Parameter	Base Flow Samples			Storm Flow Samples		
	Estimated Detected Values (J)	Estimated Undetected Values (UJ)	Undetected Values (U + UJ)	Estimated Detected Values (J)	Estimated Undetected Values (UJ)	Undetected Values (U + UJ)
Temperature	0	0	0	0	0	0
pH	0	0	0	1	0	0
Dissolved oxygen	0	0	0	0	0	0
Conductivity	0	0	0	0	0	0
Hardness	0	0	0	0	0	0
Turbidity	0	0	0	4	0	0
Total suspended solids	0	0	5	0	0	0
Total phosphorus	0	0	0	5	0	0
Nitrate+nitrite nitrogen	0	0	0	0	0	0
Ammonia nitrogen	0	0	28	0	0	10
Dissolved copper	0	0	33	1	0	1
Dissolved lead	1	6	85	2	0	62
Dissolved zinc	1	0	48	4	0	9
Total copper	NA	NA	NA	17	0	0
Total lead	NA	NA	NA	11	1	8
Total zinc	NA	NA	NA	0	0	2
Total petroleum hydrocarbons	NA	NA	NA	3	1	57
Fecal coliform bacteria	57	0	1	37	0	1

NA = not analyzed

The frequency of estimated suspended solids, nutrient, and dissolved metals values was low (less than 5 percent). The frequency of estimated storm flow total metals values was relatively high for detected values of copper (17 percent) and lead (11 percent). The frequency of estimated fecal coliform bacteria values was high (57 percent of base flow values and 37 percent of storm flow values), primarily due to qualification by the laboratory for a low number (less than 20) of enumerated colonies. Therefore, evaluation of the water quality data should consider the reduced accuracy or precision of storm flow total copper and lead values, and base and storm flow fecal coliform bacteria values.

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APPENDIX B

Water Quality Database

LIST OF DEFINITIONS

Data qualifiers included in the water quality database:

U	analyte not detected at specified detection limit
J	estimated value from quality assurance review
C	exceeds water quality criteria for Class AA freshwaters
M	mean of field duplicate values

Table B1. Base flow data for the Des Moines Water Quality Monitoring Program.

Station	Event Number	Monitoring Year	Sample Date	Sample Time	Antecedent Dry Period (hours)	Flow Rate (cfs)	Temp. (o C)	pH	DO (mg/L)	Conductivity (umhos/cm)	Turbidity (NTU)	TSS (mg/L)	Fecal Coliform (CFU/100 mL)	TP (mg/L)
BA-1	1	1	12/6/94	10:40	68.9	0.23	3.5	7.82	12.4	223	2.5	0.55	42	0.047
BA-1	2	1	3/29/95	19:50	75.8	0.12	9.5	7.68	12.9	173	2.5	1.70	140 J C	0.034
BA-1	3	1	7/19/95	15:30	242.0	0.005	18.4 C	7.93	8.7 C	259	0.47	1.70	360 J C	0.092
BA-1	4	2	12/7/95	15:00	87.0	0.33	6.0	7.46	11.6	187	2.7	2.20	30 J	0.046
BA-1	5	2	3/27/96	13:50	109.8	3.0	10.0	8.65 C	12.8	209	2.8	1.10	86 C	0.064
BA-1	6	2	7/8/96	18:00	114.0	0.090	14.8	7.65	8.8 C	227	1.4	2.30	560 C	0.031
BA-1	7	3	12/19/96	11:00	84.0	0.41	5.0	7.39	11.8	202	2.7	2.00	12 J	0.037
BA-1	8	3	3/25/97	15:00	135.8	0.89	11.9	7.55	9.9	184	2.5	2.50	134 C	0.039
BA-1	9	3	7/21/97	12:51	256.8	1.1	15.7	7.93	8.6 C	288	1	0.80	200 J C	0.072
BA-1	10	4	12/4/97	12:00	95.8	0.80	6.8	7.54	11.8	245	2.4	1.3	42	0.058
BA-1	11	4	3/19/98	12:35	191.1	0.25	10.1	7.81	12.2	228	2.7	1.80	840 C	0.053
BA-1	12	4	7/22/98	13:10	149.7	0.13	15.8	8.05	9.8	284	0.41	1.80	580 C	0.086
BA-1	13	5	2/12/99	12:09	87.9	0.80	6.8	7.76	11.6	172	7.4	8.50	760 C	0.049
BA-1	14	5	5/27/99	13:30	54.5	0.29	12.5	7.81	9.8	261	2.5	3.20	340 J C	0.082
BA-1	15	5	8/25/99	13:20	489.3	0.73	15.8	7.75	9.1 C	320	0.8	0.67	860 C	0.081
DM-1	1	1	12/5/94	14:20	48.6	3.5	4.1	7.90	12.7	156	3.5	1.60	80 J C	0.046
DM-1	2	1	3/29/95	19:00	75.0	3.5	12.0	7.53	14.1	168	2.3	0.80	34 J	0.023
DM-1	3	1	7/19/95	14:25	240.9	0.85	17.3 C	7.58	8.5 C	193	0.64	1.10	280 J C	0.080
DM-1	4	2	12/7/95	13:50	85.8	3.7	6.3	7.36	11.3	158	2.8	1.50	500 C	0.036
DM-1	5	2	3/27/96	12:05	108.1	0.71	10.0	7.82	11.8	209	1.6	1.80	26 J	0.040
DM-1	6	2	7/8/96	13:15	109.3	2.3	15.7	7.76	8.9 C	220	1.6	0.53	42	0.041
DM-1	7	3	12/19/96	15:30	88.5	1.8	5.2	7.17	11.8	190	2.7	2.80	2 J	0.031
DM-1	8	3	3/25/97	11:15	132.0	8.5	10.2	7.31	10	188	7	10.00	126 C	0.053
DM-1	9	3	7/21/97	10:20	254.3	1.6	15.3	7.61	8.4 C	193	1.5	0.80	32 J	0.041
DM-1	10	4	12/4/97	9:50	93.6	2.6	6.2	7.41	12.7	201	1.5	0.50 U	2 J	0.047
DM-1	11	4	3/19/98	11:25	189.9	2.0	9.9	7.66	11.6	207	2.1	2.30	6 J	0.037
DM-1	12	4	7/22/98	10:00	146.5	1.4	14.8	7.44	9.2 C	230	0.5	1.20	96 C	0.046
DM-1	13	5	2/12/99	13:30	89.3	4.9	6.9	7.32	11.2	175	0.83	2.30	24 J	0.029
DM-1	14	5	5/27/99	15:00	56.0	2.2	14.1	7.76	9.1 C	209	2.0	1.70	68 C	0.075
DM-1	15	5	8/25/99	9:30	485.5	1.24	15.8	7.50	10.3	225	0.9	0.82	92 C	0.040
DM-2	1	1	12/5/94	13:40	47.9	1.8	4.1	7.65	12.6	190	2.5	1.00	160 J C	0.041
DM-2	2	1	3/29/95	18:15	74.2	1.6	11.4 M	7.98 M	9.9 M	181 M	1.7	1.00	28 J	0.017
DM-2	3	1	7/19/95	14:00	240.5	0.85	18.2 C	7.69	8.9 C	215	1.8	9.20	880 C	0.085
DM-2	4	2	12/7/95	14:20	86.3	1.5	6.0	7.43	11.8	171	2.1	1.20	400 C	0.038
DM-2	5	2	3/27/96	13:00	109.0	3.8	10.1	8.98 C	13.2	206	1.7	1.50	30 J	0.028
DM-2	6	2	7/8/96	14:40	110.7	1.4	16.3 C	7.98	8.9 C	237	1.1	1.90	84 C	0.049
DM-2	7	3	12/19/96	16:25	89.4	1.0	5.1	7.31	11.6	224	3.9	9.60	18 J	0.041
DM-2	8	3	3/25/97	16:30	137.3	9.0	12.1	7.65	9.5 C	203	2.5	2.80	64 C	0.029
DM-2	9	3	7/21/97	11:45	255.8	2.3	16.6 C	7.79	8.7 C	206	1.2	1.20	26 J	0.053
DM-2	10	4	12/4/97	16:10	99.9	3.9	7.2	7.43	11.7	204	1.4	0.80	54 C	0.042
DM-2	11	4	3/19/98	12:00	190.5	3.7	10.2	7.29	12	219	2.6	2.60	6 J	0.037
DM-2	12	4	7/22/98	16:00	152.5	1.10	19.1 C	7.56	8.7 C	265	0.35	0.83	60 C	0.061
DM-2	13	5	2/12/99	13:00	88.7	6.70	7.0	7.93	11.7	188	0.68	2.30	36 J	0.027
DM-2	14	5	5/27/99	14:25	55.4	2.80	14.9	8.00	9.6	223	2.4 M	3.40 M	122 M C	0.084 M

Table B1. Base flow data for the Des Moines Water Quality Monitoring Program.

Station	Event Number	Monitoring Year	Sample Date	Sample Time	Antecedent Dry Period (hours)	Flow Rate (cfs)	Temp. (o C)	pH	DO (mg/L)	Conductivity (umhos/cm)	Turbidity (NTU)	TSS (mg/L)	Fecal Coliform (CFU/100 mL)	TP (mg/L)
DM-2	15	5	8/25/99	15:00	491.0	1.60	17.2	C 7.60	9.1 C	262	0.8	0.71	60 C	0.054
DM-3	1	1	12/5/94	14:50	49.1	2.5	5.1	7.23	11.2	148	5.0	4.00	62 C	0.054
DM-3	2	1	3/29/95	17:40	73.7	2.3	13.4	7.28	8.9 C	160	3.4	5.30	16 J	0.039
DM-3	3	1	7/19/95	12:30	239.0	0.38	18.0	C 7.38	7.1 C	197	1.1	1.70	300 J C	0.118
DM-3	4	2	12/7/95	12:25	84.4	3.7	5.8	7.13	10.7	148	3.1	1.80	480 C	0.044
DM-3	5	2	3/27/96	11:40	107.7		10.0	7.40	11.8	203	2.4	2.00	18 J	0.032
DM-3	6	2	7/8/96	12:15	108.2	0.26	16.1	C 7.46	8.6 C	215	1.4	0.80	140 J C	0.051
DM-4	1	1	12/5/94	15:35	49.8	0.013	7.7	7.99	11.3	288	2.3	5.60	180 J C	0.039
DM-4	2	1	3/29/95	15:50	71.8	0.074	11.5	7.40	9.7	276	2.2	0.83	16 J	0.031
DM-4	3	1	7/19/95	11:40	238.2	0								
DM-4	4	2	12/7/95	11:55	83.9		8.0	7.24	11.1	224	1.6	0.67	4 J	0.037
DM-4	5	2	3/27/96	11:30	107.5	0.014	9.5	7.31	10.8	300	3.0	2.60	52 C	0.053
DM-4	6	2	7/8/96	11:35	107.6	0.015	15.5	6.73	5.7 C	398	5.0	3.00	12 J	0.042
DM-5	1	1	12/5/94	15:40	49.9	1.1	4.2	7.06	13.2	131	6.8	2.00	12 J	0.040
DM-5	2	1	3/29/95	15:45	71.7	1.0	15.0	7.10	10.4	161	6.1	2.80	600 J C	0.033
DM-5	3	1	7/19/95	11:35	238.1	0.57	20.6	C 7.24	2.7 C	168	0.7	1.30	440 C	0.065
DM-5	4	2	12/7/95	12:05	84.1		4.8	7.12	4.6 C	146	3.5	1.00	16 J	0.044
DM-5	5	2	3/27/96	11:10	107.2	0.035	11.0	7.27	8.4 C	206	2.5	0.80	2 U	0.033
DM-5	6	2	7/8/96	11:20	107.3	0.11	20.1	C 7.19	4.2 C	226	1.1	0.50 U	48	0.040
DM-6	1	1	12/5/94	17:05	51.3	0.93	3.9	7.43	12.8	79.5	3.2	3.60	88 C	0.092
DM-6	2	1	3/29/95	16:55	72.9	0.95	12.7	7.24	8.6 C	83.5	2.4	2.40	220 J C	0.043
DM-6	3	1	7/19/95	13:00	239.5	0.34	21.6	C 7.18	2.5 C	135	5.9	11.00	200 J C	1.940
DM-6	4	2	12/7/95	13:10	85.2	0.69	6.3	7.38	11	148	4.5	3.40	98 C	0.064
DM-6	5	2	3/27/96	10:40	106.7	0.19	10.5	7.45	10.6	178	76	3.60	28 J	0.435
DM-6	6	2	7/8/96	10:15	106.3	0.091	20.2	C 6.98	7.6 C	130	2.2	2.20	540 C	0.080
MA-1	1	1	12/5/94	18:40	52.9	0.089	8.2	7.46	11.3	250	3.7	0.80	4 J	0.020
MA-1	2	1	3/29/95	19:30	75.5	0.089	10.1	7.27	10	196	5.1	2.30	700 J C	0.017
MA-1	3	1	7/19/95	17:15	243.8	0.050 J	17.4	C 7.56	8.7 C	249	3.2	1.10	380 J C	0.027
MA-1	4	2	12/7/95	16:40	88.7	0.21	9.6	7.23	10.4	207	3.6 M	1.50 M	3 JM	0.017 M
MA-1	5	2	3/27/96	15:40	111.7	0.18	10.0	7.60	11.1	220	6.5	7.20	6 J	0.042
MA-1	6	2	7/8/96	17:30	113.5	0.089	14.9	7.38	9.3 C	254	4.5	2.80	61 C	0.050
MA-1	7	3	12/19/96	14:40	87.7	0.25	8.2	7.02	11.7	241	3.6	2.00	380 J C	0.018
MA-1	8	3	3/25/97	16:00	136.7	0.21	11.2	6.80	9.7	235	4.8	5.80	34 J	0.031
MA-1	9	3	7/21/97	13:28	257.5	0.068	16.1	C 7.28	8.8 C	275	5	1.63	6 J	0.028
MA-1	10	4	12/4/97	15:30	99.3	0.07	9.8	6.99	10.6	279	8.1	2.40	4 J	0.026
MA-1	11	4	3/19/98	13:55	192.4	0.12	10.8	7.42	11.2	247	4.9	2.60	6 J	0.024
MA-1	12	4	7/22/98	15:00	151.5	0.05	16.7	C 7.04	8.7 C	292	5.35 M	1.30 M	37 JM	0.040 M
MA-1	13	5	2/12/99	11:50	87.6	0.39	8.3	7.04	10.6	220	0.64	1.50	14 J	0.017
MA-1	14	5	5/27/99	11:05	52.1	0.07	12.0	7.31	9.2 C	262	5.2	1.10	16 J	0.046
MA-1	15	5	8/25/99	12:15	488.3	0.05	16.1	C 7.30	8.6 C	280	6.6	3.90	54 C	0.052
MA-2	1	1	12/5/94	18:20	52.6	0.83	4.6	7.89	12.9	221	2.1	1.20	14 J	0.018
MA-2	2	1	3/29/95	20:20	76.3	1.4	10.1	7.67	12.2	191	2.5	1.60	88 J C	0.015
MA-2	3	1	7/19/95	15:55	242.4	0.52	18.3	C 7.86	8.4 C	209	1.5	0.50 U	1000 J C	0.048
MA-2	4	2	12/7/95	15:25	87.4	0.52	6.8	7.46	11.5	210	3.5	2.30	40	0.019

Table B1. Base flow data for the Des Moines Water Quality Monitoring Program.

Station	Event Number	Monitoring Year	Sample Date	Sample Time	Antecedent Dry Period (hours)	Flow Rate (cfs)	Temp. (o C)		pH	DO (mg/L)		Conductivity (umhos/cm)	Turbidity (NTU)		TSS (mg/L)	Fecal Coliform (CFU/100 mL)		TP (mg/L)
MA-2	5	2	3/27/96	14:20	110.3	0.52	10.5		8.15	10.8		214	2.6		0.80	56	C	0.016
MA-2	6	2	7/8/96	15:55	111.9	1.0	15.1		7.89	8.8	C	237	1.4		0.53	260 J	C	0.030
MA-2	7	3	12/19/96	10:25	83.4	3.1	5.7		7.54	11.3		226	2.5		0.50 U	36 J		0.015
MA-2	8	3	3/25/97	15:30	136.3	1.9	12.0		7.62	9.7		220	2.2		0.83	50		0.017
MA-2	9	3	7/21/97	13:56	257.9	0.74	16.4	C	7.90	9.4	C	255	0.45		0.53	118	C	0.027
MA-2	10	4	12/4/97	14:50	98.6	0.91	8.6		7.61	11.8		237	2		0.93	22 J		0.021
MA-2	11	4	3/19/98	13:35	192.1	1.0	11.0		7.88	11.1		236	2.9		1.80	100	C	0.024
MA-2	12	4	7/22/98	14:40	151.2	0.52	18.5	C	7.75	8.2	C	269	0.37		0.50 U	240 J	C	0.036
MA-2	13	5	2/12/99	11:00	86.8	1.2	7.0		7.73	11.4		203	4.1		0.50	36 J		0.016
MA-2	14	5	5/27/99	11:45	52.8	0.37	12.4		8.00	9.9		240	2.7		2.70	102	C	0.038
MA-2	15	5	8/25/99	11:30	487.5	0.26	17.0	C	7.40	8.9	C	263	1.5		1.80	380	C	0.038
MA-3	1	1	12/5/94	17:50	52.1	2.6	4.0		7.79	11.8		225	1.7		0.60	32 J		0.028
MA-3	2	1	3/29/95	20:40	76.7	4.4	9.9		7.62	11.3		185	1.9		1.90	80 J	C	0.024
MA-3	3	1	7/19/95	15:00	241.5	3.4	18.7	C	7.67	7.9	C	241	0.52		0.50 U	460	C	0.058
MA-3	4	2	12/7/95	14:40	86.7	4.2	6.5		7.38	11.2		194	2.4		1.20	38 J		0.030
MA-3	5	2	3/27/96	13:25	109.4	1.2	9.8		7.81	11.8		212	1.9		0.83	300 J	C	0.024
MA-3	6	2	7/8/96	15:30	111.5	2.2	16.7	C	7.79	8.9	C	214	1.3		1.70	180 J	C	0.038
MA-3	7	3	12/19/96	11:40	84.7	1.8	5.8		7.22	11.2		223	2		1.20	380 J	C	0.025
MA-3	8	3	3/25/97	12:35	133.3	2.4	10.9		7.32	9.8		206	1.6		1.80	2		0.023
MA-3	9	3	7/21/97	12:03	256.0	1.4	16.6	C	7.76	9.3	C	253	1		0.56	18 J		0.043
MA-3	10	4	12/4/97	11:15	95.0	1.39	6.5		7.18	11.5		262	1.3		0.53	42		0.034
MA-3	11	4	3/19/98	12:20	190.8	2.4	10.1		7.88	12.4		232	2.1		1.10	6 J		0.031
MA-3	12	4	7/22/98	14:00	150.5	1.8	17.8	C	7.77	8.2	C	302	0.56		1.50	140	C	0.064
MA-3	13	5	2/12/99	9:30	85.3	2.9	6.6		7.60	11.5		194	4.1		2.20	132	C	0.027
MA-3	14	5	5/27/99	13:50	54.8	1.33	14.0		7.75	9.2	C	250	2.3		1.70	98	C	0.051
MA-3	15	5	8/25/99	13:50	489.8	2.42	17.0	C	7.51	8.7	C	256	0.93		2.00	280	C	0.061
MC-1	1	1	12/5/94	19:35	53.8	0.49	3.7		6.81	9.3	C	165	1.4		1.40	320 J	C	0.040
MC-1	2	1	3/29/95	21:10	77.2	0.19	8.3		6.91	6.4	C	115	1.9		2.40	720 J	C	0.051
MC-1	3	1	7/19/95	16:15	242.8	0.048												
MC-1	4	2	12/7/95	15:55	87.9	0.24	4.9		7.11	7.3	C	116	2.0		1.70	30 J		0.076
MC-1	5	2	3/27/96	14:40	110.7	0.27	9.1		7.54	8.3	C	130	2.2		2.00	380 J	C	0.071
MC-1	6	2	7/8/96	16:45	112.7	0.048	16.8	C	7.20	7.7	C	174	3.4		3.60	106	C	0.177
MC-1	7	3	12/19/96	14:00	87.0	0.52	4.1		6.54	8.2	C	150	1.1		0.50 U	28 J		0.070
MC-1	8	3	3/25/97	14:10	134.9	0.090	11.6		6.54	6.8	C	140	1.4		1.50	104	C	0.064
MC-1	9	3	7/21/97	15:08	259.1	0.10	15.2		7.28	6.5	C	181	2.9		1.83	200 J	C	0.200
MC-1	10	4	12/4/97	14:10	97.9	0.15	6.5		6.88	9.1	C	163	1.5		0.93	54	C	0.118
MC-1	11	4	3/19/98	13:20	191.8	0.17	10.0		7.24	8.7	C	150	2.2		4.80	6 J		0.102
MC-1	12	4	7/22/98	12:40	149.2	0.03	16.5	C	7.45	7	C	207	4.7		1.00	440	C	0.238
MC-1	13	5	2/12/99	11:20	87.1	0.35	5.2		6.91	8.5	C	134	0.57		1.30	28 J		0.039
MC-1	14	5	5/27/99	12:15	53.3	0.12	11.0		7.07	7.4	C	159	2.0		1.50	960	C	0.088
MC-1	15	5	8/25/99	10:20	486.3	0.07	17.0	C	7.00	7.5	C	208	2.2		1.50	500	C	0.146
MC-2	1	1	12/5/94	19:20	53.6	2.1	4.3		7.63	12.1		126	18	C	2.50	66	C	0.056
MC-2	2	1	3/29/95	21:35	77.6	1.3	10.8		7.61	7.8	C	135	5.0		2.50	96 J	C	0.046
MC-2	3	1	7/19/95	16:35	243.1	0.50	18.9 M	C	7.60 M	6.6 M	C	202 M	1.4 M		0.94 M	663 JM	C	0.079 M

Table B1. Base flow data for the Des Moines Water Quality Monitoring Program.

Station	Event Number	Monitoring Year	Sample Date	Sample Time	Antecedent Dry Period (hours)	Flow Rate (cfs)	Temp. (o C)		pH	DO (mg/L)		Conductivity (umhos/cm)	Turbidity (NTU)	TSS (mg/L)	Fecal Coliform (CFU/100 mL)		TP (mg/L)
MC-2	4	2	12/7/95	16:15	88.3	2.0	5.5		7.33	11.6		118	6.1	2.80	110	C	0.051
MC-2	5	2	3/27/96	15:10	111.2	1.1	10.9		8.15	11.1		173	2.2	2.00	16 J		0.023
MC-2	6	2	7/8/96	16:20	112.3	0.22	14.9		7.46	7.1	C	250	1.9	1.73	840	C	0.073
MC-2	7	3	12/19/96	12:40	85.7	1.2	5.2		7.24	11.3		177	3.6	2.00	260 J	C	0.045
MC-2	8	3	3/25/97	13:25	134.2	1.3	12.1		7.78	10.3		135	3.5	3.00	6 J		0.033
MC-2	9	3	7/21/97	14:21	258.3	0.52	18.7	C	7.51	7.0	C	150	1.9	1.40	2 J		0.092
MC-2	10	4	12/4/97	12:45	96.5	0.06	7.8		7.53	10.8		173	5.5	2.40	40		0.065
MC-2	11	4	3/19/98	12:55	191.4		10.8		8.09	12.7		172	3.6	2.50	72	C	0.054
MC-2	12	4	7/22/98	12:00	148.5	0.03	16.9	C	7.85	8.6	C	283	0.75	1.50	210 J	C	0.094
MC-2	13	5	2/12/99	10:50	86.6	1.78	5.0		7.67	12		127	7.3	2.50	34 J		0.036
MC-2	14	5	5/27/99	12:45	53.8	0.16	15.0		7.74	8.6	C	181	4.0	6.40	144	C	0.093
MC-2	15	5	8/25/99	10:50	486.8	0.07	16.8	C	7.40	7.4	C	250	1.9	1.20	78	C	0.077

Table B1. Base flow data for the Des Moines Water Quality Monitoring Program.

Station	Event Number	Ammonia (mg/L)	Nitrate+Nitrite (mg/L)	Hardness (mg/L as CaCO3)	Copper, Dis. (mg/L)	Lead, Dis. (mg/L)	Zinc, Dis. (mg/L)
BA-1	1	0.018	2.11	97.2	0.0015	0.0005 U	0.003 U
BA-1	2	0.010 U	1.12	92.9	0.0010 U	0.0005 U	0.004
BA-1	3	0.024	1.05	118.0	0.0034	0.0005 U	0.005
BA-1	4	0.028	1.58	90.3	0.0044	0.0009	0.005
BA-1	5	0.013	1.22	94.3	0.0016	0.0005 U	0.004
BA-1	6	0.010 U	1.46	114.0	0.0010 U	0.0005 U	0.003 U
BA-1	7	0.010 U	1.160	86.3	0.0023	0.0010 U	0.004
BA-1	8	0.010 U	0.918	67.4	0.0015	0.0005 U	0.003 U
BA-1	9	0.010 U	1.162	113.8	0.0010 U	0.0005 U	0.003 U
BA-1	10	0.01 U	1.04	100	0.0015	0.0005 U	0.003 U
BA-1	11	0.010 U	0.957	89.1	0.0011	0.0005 UJ	0.003 U
BA-1	12	0.010 U	0.967	120.0	0.0010 U	0.0005 U	0.003 U
BA-1	13	0.010 U	1.190	65.3	0.0035	0.0005 U	0.009
BA-1	14	0.010 U	1.170	108.0	0.0010 U	0.0005 U	0.003 U
BA-1	15	0.012	1.060	121.0	0.0010 U	0.0005	0.003 U
DM-1	1	0.047	0.725	76.0	0.0034	0.0005 U	0.007
DM-1	2	0.010	0.705	80.9	0.0016	0.0005 U	0.009
DM-1	3	0.021	1.06	87.5	0.0029	0.0006	0.004 J
DM-1	4	0.058	0.923	72.9	0.0037	0.0005	0.005
DM-1	5	0.024	0.685	87.5	0.0016	0.0005 U	0.009
DM-1	6	0.010	0.870	88.5	0.0017	0.0005 U	0.003 U
DM-1	7	0.067	0.731	77.5	0.0030	0.0010 U	0.03
DM-1	8	0.031	0.650	75.0	0.0022	0.0005 U	0.006
DM-1	9	0.010 U	0.837	93.9	0.0010 U	0.0005 U	0.003 U
DM-1	10	0.010 U	0.779	81.5	0.0025	0.0005 U	0.003 U
DM-1	11	0.039	0.709	86.3	0.0014	0.0005 UJ	0.007
DM-1	12	0.010 U	0.892	107.0	0.0010 U	0.0005 U	0.003 U
DM-1	13	0.070	0.646	71.1	0.0020	0.0005 U	0.012
DM-1	14	0.010 U	0.644	92.5	0.0010 U	0.0005 U	0.003 U
DM-1	15	0.018	0.789	92.1	0.0010 U	0.0005 U	0.003 U
DM-2	1	0.037	0.808	82.8	0.0027	0.0005 U	0.003 U
DM-2	2	0.010	0.674	87.7	0.0010 UM	0.0005 UM	0.008 M
DM-2	3	0.013	0.877	94.9	0.0014	0.0011 J	0.007
DM-2	4	0.079	0.974	80.2	0.0033	0.0005 U	0.005
DM-2	5	0.018	0.919	89.0	0.0019	0.0005 U	0.003
DM-2	6	0.010 U	1.00	92.5	0.0020	0.0005 U	0.003 U
DM-2	7	0.032	0.958	82.4	0.0024	0.0010 U	0.018
DM-2	8	0.013	0.953	81.6	0.0016	0.0005 U	0.003 U
DM-2	9	0.010 U	0.966	93.7	0.0030	0.0005 U	0.003 U
DM-2	10	0.010 U	0.909	85.5	0.0021	0.0005 U	0.003 U
DM-2	11	0.039	0.912	86.1	0.0010 U	0.0005 UJ	0.003 U
DM-2	12	0.010 U	0.854	113.0	0.0013	0.0005 U	0.01
DM-2	13	0.016	0.964	73.7	0.0023	0.0005 U	0.007
DM-2	14	0.010 UM	0.868 M	92.5 M	0.0010 UM	0.0030 U C	0.004 M

Table B1. Base flow data for the Des Moines Water Quality Monitoring Program.

Station	Event Number	Ammonia (mg/L)	Nitrate+Nitrite (mg/L)	Hardness (mg/L as CaCO3)	Copper, Dis. (mg/L)	Lead, Dis. (mg/L)	Zinc, Dis. (mg/L)
DM-2	15	0.012	0.749	96.5	0.0010 U	0.0005 U	0.003 U
DM-3	1	0.064	0.705	68.0	0.0041	0.0005 U	0.008
DM-3	2	0.023	0.774	81.7	0.0016	0.0005 U	0.006
DM-3	3	0.037	1.13	91.8	0.0026	0.0011	0.009
DM-3	4	0.119	0.940	70.7	0.0048	0.0005 U	0.01
DM-3	5	0.034	0.974	90.4	0.0022	0.0005 U	0.004
DM-3	6	0.026	0.924	91.3	0.0025	0.0005 U	0.004
DM-4	1	0.039	1.00	157.0	0.0087	0.0005 U	0.005
DM-4	2	0.010 U	1.32	148.0	0.0017	0.0005 U	0.005
DM-4	3						
DM-4	4	0.070	0.862	119.0	0.0066	0.0005 U	0.003
DM-4	5	0.107	0.727	159.0	0.0021	0.0005 U	0.003 U
DM-4	6	0.093	0.782	149.0	0.0045	0.0005 U	0.009
DM-5	1	0.090	0.332	103.0	0.0061	0.0005 U	0.004
DM-5	2	0.029	0.445	83.9	0.0023	0.0005 U	0.005
DM-5	3	0.029	0.0390	81.4	0.0038	0.0005 UJ	0.003 U
DM-5	4	0.217	0.552	72.3	0.0062	0.0006	0.011
DM-5	5	0.067	0.232	105.0	0.0032	0.0005 U	0.003 U
DM-5	6	0.020	0.0300	98.4	0.0015	0.0005 U	0.003
DM-6	1	0.117	0.284	71.6	0.0026	0.0019 C	0.008
DM-6	2	0.082	0.319	43.8	0.0014	0.0005 U	0.013
DM-6	3	0.218	0.0180	64.7	0.0148 C	0.0030 C	0.066
DM-6	4	0.136	0.675	33.1	0.0053 C	0.0007	0.013
DM-6	5	0.962	3.47	49.2	0.0065 C	0.0016 C	0.003 U
DM-6	6	0.097	0.275	58.4	0.0030	0.0005 U	0.004
MA-1	1	0.097	1.17	110.0	0.0010 U	0.0005 U	0.003
MA-1	2	0.052	1.15	98.5	0.0010 U	0.0005 U	0.006
MA-1	3	0.090	1.34	112.0	0.0029	0.0006	0.014
MA-1	4	0.061 M	2.16 M	93.8 M	0.0028 M	0.0014 M	0.01 M
MA-1	5	0.053	1.76	92.7	0.0010 U	0.0005 U	0.006
MA-1	6	0.086	1.62	109.0	0.0010 U	0.0005 U	0.003 U
MA-1	7	0.072	1.730	97.8	0.0010 U	0.0010 U	0.015
MA-1	8	0.018	1.360	93.3	0.0010 U	0.0005 U	0.006
MA-1	9	0.077	1.204	110.3	0.0010 U	0.0005 U	0.003 U
MA-1	10	0.040	1.110	111.0	0.0010 U	0.0005 U	0.003 U
MA-1	11	0.058	1.354	94.7	0.0010 U	0.0005 UJ	0.004
MA-1	12	0.074 M	1.029 M	139.0 M	0.0010 UM	0.0005 UM	0.003 UM
MA-1	13	0.031	1.300	83.2	0.0010 U	0.0005 U	0.018
MA-1	14	0.043	1.010	110.0	0.0010 U	0.0005	0.003 U
MA-1	15	0.094	0.863	121.0	0.0010 U	0.0005	0.003 U
MA-2	1	0.033	1.56	98.0	0.0010 U	0.0005 U	0.003 U
MA-2	2	0.013	1.16	91.3	0.0010 U	0.0005 U	0.003 U
MA-2	3	0.027	0.847	93.1	0.0028	0.0007	0.003 U
MA-2	4	0.054	1.77	93.7	0.0019	0.0005 U	0.005

Table B1. Base flow data for the Des Moines Water Quality Monitoring Program.

Station	Event Number	Ammonia (mg/L)	Nitrate+Nitrite (mg/L)	Hardness (mg/L as CaCO3)	Copper, Dis. (mg/L)	Lead, Dis. (mg/L)	Zinc, Dis. (mg/L)
MA-2	5	0.010 U	1.96	94.1	0.0011	0.0005 U	0.005
MA-2	6	0.010	2.30	103.0	0.0015	0.0005 U	0.003 U
MA-2	7	0.026	2.110	91.0	0.0015	0.0010 U	0.003 U
MA-2	8	0.014	1.710	82.2	0.0010	0.0005 U	0.003 U
MA-2	9	0.010 U	2.604	102.7	0.0010 U	0.0005 U	0.003 U
MA-2	10	0.007	1.390	101.0	0.0012	0.0005 U	0.003 U
MA-2	11	0.011	1.570	97.3	0.0010 U	0.0005 UJ	0.017
MA-2	12	0.010 U	0.928	107.0	0.0010 U	0.0005 U	0.003 U
MA-2	13	0.010 U	1.660	81.0	0.0014	0.0005 U	0.007
MA-2	14	0.010 U	1.630	98.3	0.0010 U	0.0005 U	0.003 U
MA-2	15	0.013	1.540	93.2	0.0010 U	0.0005 U	0.003 U
MA-3	1	0.031	1.51	107.0	0.0010 U	0.0005 U	0.003 U
MA-3	2	0.012	1.18	94.1	0.0010 U	0.0005 U	0.003
MA-3	3	0.028	0.917	109.0	0.0027	0.0005 U	0.003 U
MA-3	4	0.043	1.84	95.3	0.0033	0.0006	0.005
MA-3	5	0.011	1.63	94.1	0.0015	0.0005 U	0.003 U
MA-3	6	0.011	0.931	98.0	0.0012	0.0005 U	0.003 U
MA-3	7	0.027	1.850	89.4	0.0015	0.0010 U	0.003
MA-3	8	0.013	1.340	80.8	0.0015	0.0005 U	0.003 U
MA-3	9	0.010 U	1.642	106.7	0.0010 U	0.0005 U	0.003 U
MA-3	10	0.010 U	1.220	102.0	0.0015	0.0005 U	0.003 U
MA-3	11	0.010 U	0.237	90.8	0.0010 U	0.0005 UJ	0.003 U
MA-3	12	0.010 U	1.060	110.0	0.0116	0.0005 U	0.003 U
MA-3	13	0.010 U	1.220	73.1	0.0027	0.0005 U	0.007
MA-3	14	0.010 U	1.260	101.0	0.0010 U	0.0005 U	0.003 U
MA-3	15	0.024	1.030	107.0	0.0010 U	0.0005 U	0.003 U
MC-1	1	0.027	0.446	82.0	0.0016	0.0005 U	0.003
MC-1	2	0.010	0.397	53.2	0.0010 U	0.0005 U	0.006
MC-1	3						
MC-1	4	0.044	0.634	50.3	0.0036	0.0009	0.003 U
MC-1	5	0.010 U	0.252	55.2	0.0013	0.0005 U	0.005
MC-1	6	0.016	0.178	77.5	0.0022	0.0006	0.003
MC-1	7	0.019	0.465	62.0	0.0023	0.0010 U	0.007
MC-1	8	0.020	0.347	45.4	0.0015	0.0005 U	0.003 U
MC-1	9	0.010 U	0.173	82.1	0.0010	0.0005 U	0.003 U
MC-1	10	0.010 U	0.248	72.3	0.0015	0.0005 U	0.005
MC-1	11	0.021	0.359	59.3	0.0010 U	0.0005 UJ	0.003 U
MC-1	12	0.010 U	0.227	92.6	0.0012	0.0005 U	0.003 U
MC-1	13	0.010 U	0.560	52.2	0.0013	0.0005 U	0.006
MC-1	14	0.010 U	0.163	85.4	0.0010 U	0.0005 U	0.003 U
MC-1	15	0.022	0.152	86.8	0.0010 U	0.0005 U	0.003 U
MC-2	1	0.044	0.968	89.0	0.0055	0.0005 U	0.015
MC-2	2	0.014	0.054	64.8	0.0015	0.0005 U	0.006
MC-2	3	0.033 M	0.315 M	95.4 M	0.0034 M	0.0008 M	0.0045 M

Table B1. Base flow data for the Des Moines Water Quality Monitoring Program.

Station	Event Number	Ammonia (mg/L)	Nitrate+Nitrite (mg/L)	Hardness (mg/L as CaCO3)	Copper, Dis. (mg/L)		Lead, Dis. (mg/L)		Zinc, Dis. (mg/L)
MC-2	4	0.033	0.702	32.5	0.0048	C	0.0008	C	0.009
MC-2	5	0.040	0.202	74.6	0.0010 U		0.0005 U		0.005
MC-2	6	0.013	0.397	104.0	0.0025		0.0005 U		0.003 U
MC-2	7	0.032	0.734	73.3	0.0031		0.0010 U		0.01
MC-2	8	0.025	0.232	44.4	0.0024		0.0005 U		0.003 U
MC-2	9	0.013	0.257	91.2	0.0018		0.0005 U		0.003 U
MC-2	10	0.010 U	0.559	83.6	0.0034		0.0005 U		0.003 U
MC-2	11	0.022	0.440	74.8	0.0010 U		0.0005 UJ		0.005
MC-2	12	0.010 U	0.333	108.0	0.0012		0.0005 U		0.003 U
MC-2	13	0.015	0.655	49.8	0.0026		0.0005 U		0.009
MC-2	14	0.010 U	0.176	76.3	0.0013		0.0005 U		0.003 U
MC-2	15	0.022	0.322	103.0	0.0010 U		0.0005 U		0.003 U

Table B2. Storm flow data for the Des Moines Water Quality Monitoring Program.

Station	Event Number	Monitoring Year	Begin Sample Date	Begin Sample Time	End Sample Date	End Sample Time	No. of Samples	Precipitation Begin Date	Precipitation Begin Time	Precip. Dur. (hours)	Precip. Amt. (inches)	Mean Flow (cfs)	Peak Flow (cfs)	Temp. (o C)	pH
BA-1	1	1	11/23/94	2:00	11/23/94	4:20	3	11/23/94	0:45	5.0	0.22	1.1	1.6	5.6	6.51
BA-1	2	1	12/8/94	17:15	12/8/94	21:00	4	12/8/94	16:45	8.0	0.21	0.3	0.4	5.6	7.61
BA-1	3	1	3/8/95	9:45	3/8/95	12:15	3	3/8/95	5:30	14.5	0.67	1.4	1.8	7.4	7.04
BA-1	4	1	7/9/95	13:30	7/9/95	16:35	4	7/9/95	10:45	2.8	0.93	0.6	1.2	17.3 C	7.28
BA-1	5	1	10/20/95	5:35	10/20/95	8:00	3	10/20/95	4:30	2.3	0.34	0.3	0.5	11.5	7.12
BA-1	6	2	11/7/95	1:30	11/7/95	4:45	4	11/6/95	19:15	13.0	2.63	0.9	1.2	7.7	6.75
BA-1	7	2	3/3/96	10:45	3/3/96	12:50	3	3/3/96	8:00	5.0	0.38	8.0	10.0	6.6	6.15 C
BA-1	8	2	3/31/96	19:30	3/31/96	22:05	3	3/31/96	17:15	4.0	0.76	3.2	3.9	9.3	6.88
BA-1	9	2	4/22/96	13:30	4/22/96	16:15	3	4/22/96	11:30	4.8	2.89	3.2	4.4	11.7	7.37
BA-1	10	2	9/3/96	12:25	9/3/96	15:05	3	9/3/96	9:30	2.3	0.46	0.7	1.2	16.0	7.50
BA-1	11	3	11/30/96	13:35	11/30/96	17:04	3	11/30/96	12:00	9.0	0.28	2.2	3.4	9.2	7.13
BA-1	12	3	1/16/97	19:40	1/16/97	21:45	3	1/16/97	17:00	22.5	1.46	2.4	4.2	3.5	7.31
BA-1	13	3	1/27/97	21:03	1/27/97	23:55	3	1/27/97	17:30	6.0	0.49	3.5	4.3	3.5	7.19
BA-1	14	3	4/22/97	19:55	4/22/97	22:05	3	4/22/97	16:45	14.8	0.45	7.7	14.1	12.0	7.02
BA-1	15	3	6/3/97	10:15	6/3/97	12:20	3	6/3/97	4:45	15.3	0.46	1.0	2.4	14.8	7.50
BA-1	16	4	11/19/97	11:07	11/19/97	13:19	3	11/19/97	1:00	34	0.57	4.2	6.8	9.0 M	7.62 M
BA-1	17	4	12/15/97	23:06	12/16/97	1:15	3	12/15/97	14:00	51	2.01	4.8	5.2	6.8	7.52
BA-1	18	4	4/23/98	12:50	4/23/98	13:40	3	4/23/98	10:00	14	0.45	1.5	1.8	11.9	6.61
BA-1	19	4	6/24/98	9:06	6/24/98	11:17	3	6/24/98	5:00	14	0.49	1.4	2.0	14.6	7.43
BA-1	20	5	10/12/98	9:35	10/12/98	11:45	3	10/12/98	6:00	57.0	1.56	0.8	1.2	11.7	8.01 M
BA-1	21	5	1/13/99	20:50	1/13/99	23:20	3	1/13/99	19:00	21.0	1.27	2.5	3.0	7.2	7.37
BA-1	22	5	3/12/99	11:00	3/12/99	13:55	3	3/12/99	6:00	50.0	1.47	1.1	1.2	8.4	7.70
BA-1	23	5	5/11/99	13:21	5/11/99	15:10	3	5/11/99	11:00	4.0	0.17	0.8	1.1	10.3	6.71
BA-1	24	5	10/27/99	14:00	10/27/99	16:52	3	10/27/99	13:00	26.0	0.49	2.3	3.4	8.3	7.76
BA-1	25	5	11/5/99	19:30	11/5/99	23:20	4	11/5/99	18:00	12.0	0.71	1.7	2.8	8.0	7.26
DM-1	1	1	11/23/94	2:20	11/23/94	4:35	3	11/23/94	0:45	5.0	0.22	11.6	16.5	8.2	6.73
DM-1	2	1	12/8/94	17:50	12/8/94	21:30	4	12/8/94	16:45	8.0	0.21	5.1	6.6	5.8	7.32
DM-1	3	1	3/8/95	10:20	3/8/95	12:35	3	3/8/95	5:30	14.5	0.67	6.0	6.6	7.9	6.93
DM-1	4	1	7/9/95	13:00	7/9/95	16:00	4	7/9/95	10:45	2.8	0.93	24.5	36.3	17.7 C	7.17
DM-1	5	1	10/20/95	5:55	10/20/95	8:10	3	10/20/95	4:30	2.3	0.34	16.2	20.6	11.9	7.28
DM-1	6	2	11/7/95	1:50	11/7/95	4:55	4	11/6/95	19:15	13.0	2.63	21.0	24.8	7.5	6.55
DM-1	7	2	3/3/96	11:10	3/3/96	13:05	3	3/3/96	8:00	5.0	0.38	7.1	10.9	7.4	6.19 C
DM-1	8	2	3/31/96	19:45	3/31/96	22:25	3	3/31/96	17:15	4.0	0.76	5.8	7.6	10.0	8.05
DM-1	9	2	4/22/96	13:45	4/22/96	16:45	3	4/22/96	11:30	4.8	2.89	12.1	14.6	12.3	7.15
DM-1	10	2	9/3/96	12:45	9/3/96	15:15	3	9/3/96	9:30	2.3	0.46	15.7	17.8	16.3 C	7.04
DM-1	11	3	11/30/96	14:17	11/30/96	17:38	3	11/30/96	12:00	9.0	0.28	9.7	18.7	9.1	6.57
DM-1	12	3	1/16/97	19:55	1/16/97	20:50	3	1/16/97	17:00	22.5	1.46	15.7	17.9	3.9	6.99
DM-1	13	3	1/27/97	21:27	1/28/97	0:10	3	1/27/97	17:30	6.0	0.49	19.7	21.4	3.3	7.05
DM-1	14	3	4/22/97	20:15	4/22/97	22:15	3	4/22/97	16:45	14.8	0.45	26.0	35.4	12.9	6.75
DM-1	15	3	6/3/97	10:30	6/3/97	12:35	3	6/3/97	4:45	15.3	0.46	10.2	12.8	16.1 C	7.15
DM-1	16	4	11/19/97	11:49	11/19/97	13:59	3	11/19/97	1:00	34	0.57	13.6	22.0	9.0	7.17
DM-1	17	4	12/15/97	23:29	12/16/97	1:29	3	12/15/97	14:00	51	2.01	19.4	20.7	6.7	7.38
DM-1	18	4	4/23/98	12:10	4/23/98	13:08	3	4/23/98	10:00	14	0.45	10.7	11.3	12.4	6.90
DM-1	19	4	6/24/98	9:28	6/24/98	11:30	3	6/24/98	5:00	14	0.49	10.7	18.5	14.3	7.14

Table B2. Storm flow data for the Des Moines Water Quality Monitoring Program.

Station	Event Number	Monitoring Year	Begin Sample Date	Begin Sample Time	End Sample Date	End Sample Time	No. of Samples	Precipitation Begin Date	Precipitation Begin Time	Precip. Dur. (hours)	Precip. Amt. (inches)	Mean Flow (cfs)	Peak Flow (cfs)	Temp. (o C)	pH
DM-1	20	5	10/12/98	10:00	10/12/98	12:10	3	10/12/98	6:00	57.0	1.56	10.0	11.6	13.4	7.45
DM-1	21	5	1/13/99	21:20	1/13/99	23:40	3	1/13/99	19:00	21.0	1.27	13.3	17.3	7.0	6.95
DM-1	22	5	3/12/99	11:25	3/12/99	14:10	3	3/12/99	6:00	50.0	1.47	7.3	7.5	8.9	7.04
DM-1	23	5	5/11/99	13:40	5/11/99	15:27	3	5/11/99	11:00	4.0	0.17	9.3	12.1	12.0	7.01
DM-1	24	5	10/27/99	14:34	10/27/99	17:06	3	10/27/99	13:00	26.0	0.49	6.6	9.4	9.2	7.25
DM-1	25	5	11/5/99	19:50	11/5/99	23:35	4	11/5/99	18:00	12.0	0.71	7.8	12.5	8.8	7.19
DM-2	1	1	11/23/94	2:45	11/23/94	4:50	3	11/23/94	0:45	5.0	0.22	7.0	10.4	6.0	6.91
DM-2	2	1	12/8/94	18:10	12/8/94	21:50	4	12/8/94	16:45	8.0	0.21	3.7	5.2	6.5	7.55
DM-2	3	1	3/8/95	10:35	3/8/95	12:45	3	3/8/95	5:30	14.5	0.67	3.5	4.6	8.0	6.76
DM-2	4	1	7/9/95	13:20	7/9/95	16:20	4	7/9/95	10:45	2.8	0.93	25.2	29.9	17.4	C 7.44
DM-2	5	1	10/20/95	6:10	10/20/95	8:25	3	10/20/95	4:30	2.3	0.34	11.6	17.5	12.0	7.55
DM-2	6	2	11/7/95	2:10	11/7/95	5:05	4	11/6/95	19:15	13.0	2.63	22.2	26.3	8.0	6.89
DM-2	7	2	3/3/96	11:30	3/3/96	13:25	3	3/3/96	8:00	5.0	0.38	8.4	15.4	7.2	6.20 C
DM-2	8	2	3/31/96	20:05	3/31/96	22:40	3	3/31/96	17:15	4.0	0.76	9.2	14.1	9.9	7.95
DM-2	9	2	4/22/96	14:10	4/22/96	17:05	3	4/22/96	11:30	4.8	2.89	18.3	19.3	12.0	7.45
DM-2	10	2	9/3/96	12:55	9/3/96	15:25	3	9/3/96	9:30	2.3	0.46	21.1	25.0	16.0	7.44
DM-2	11	3	11/30/96	14:42	11/30/96	18:14	3	11/30/96	12:00	9.0	0.28	12.0	26.7	9.0	7.13
DM-2	12	3	1/16/97	20:15	1/16/97	22:20	3	1/16/97	17:00	22.5	1.46	21.0	25.3	4.4	7.36
DM-2	13	3	1/27/97	21:48	1/28/97	0:30	3	1/27/97	17:30	6.0	0.49	28.8	32.4	3.5	6.92
DM-2	14	3	4/22/97	20:35	4/22/97	22:30	3	4/22/97	16:45	14.8	0.45	39.4	51.2	12.6	6.86
DM-2	15	3	6/3/97	10:50	6/3/97	12:55	3	6/3/97	4:45	15.3	0.46	32.8	38.9	15.8	7.62
DM-2	16	4	11/19/97	12:08	11/19/97	14:05	3	11/19/97	1:00	34	0.57	23.9	37.9	9.0	7.58
DM-2	17	4	12/15/97	23:46	12/16/97	1:38	3	12/15/97	14:00	51	2.01	29.7	32.4	7.0	7.62
DM-2	18	4	4/23/98	12:26	4/23/98	13:22	3	4/23/98	10:00	14	0.45	10.4	15.8	12.0	7.20
DM-2	19	4	6/24/98	9:50	6/24/98	11:47	3	6/24/98	5:00	14	0.49	13.2	23.9	14.5	7.51
DM-2	20	5	10/12/98	10:15	10/12/98	12:20	3	10/12/98	6:00	57.0	1.56	14.2	19.0	13.5	8.02
DM-2	21	5	1/13/99	21:40	1/13/99	23:58	3	1/13/99	19:00	21.0	1.27	21.7	27.0	7.4	7.38
DM-2	22	5	3/12/99	11:55	3/12/99	14:00	3	3/12/99	6:00	50.0	1.47	9.0	9.0	9.1	7.50
DM-2	23	5	5/11/99	13:58	5/11/99	15:42	3	5/11/99	11:00	4.0	0.17	7.0	9.4	11.2	7.01
DM-2	24	5	10/27/99	14:55	10/27/99	17:25	3	10/27/99	13:00	26.0	0.49	10.2	16.6	9.3	7.43
DM-2	25	5	11/5/99	20:10	11/5/99	23:50	4	11/5/99	18:00	12.0	0.71	5.7	11.2	8.8	7.37
MA-1	1	1	11/23/94	1:45	11/23/94	4:05	3	11/23/94	0:45	5.0	0.22	1.9	3.3	7.6	6.91
MA-1	2	1	12/8/94	17:15	12/8/94	21:00	4	12/8/94	16:45	8.0	0.21	0.4	0.4	7.8	7.05
MA-1	3	1	3/8/95	9:45	3/8/95	12:15	3	3/8/95	5:30	14.5	0.67	0.4	0.6	8.5	6.43 J C
MA-1	4	1	7/9/95	12:05	7/9/95	14:55	4	7/9/95	10:45	2.8	0.93	3.9	5.0	18.1	C 6.76
MA-1	5	1	10/20/95	5:20	10/20/95	7:50	3	10/20/95	4:30	2.3	0.34	2.1	3.8	11.6	6.93
MA-1	6	2	11/7/95	1:15	11/7/95	4:35	4	11/6/95	19:15	13.0	2.63	3.2	3.8	7.0	5.90 C
MA-1	7	2	3/3/96	10:35	3/3/96	12:40	3	3/3/96	8:00	5.0	0.38	2.4	3.6	7.0	6.20 C
MA-1	8	2	3/31/96	19:20	3/31/96	21:50	3	3/31/96	17:15	4.0	0.76	1.8	2.1	9.5	6.69
MA-1	9	2	4/22/96	13:20	4/22/96	16:05	3	4/22/96	11:30	4.8	2.89	2.5	2.6	12.0	7.15
MA-1	10	2	9/3/96	12:15	9/3/96	14:55	3	9/3/96	9:30	2.3	0.46	0.6	1.3	16.0	6.93
MA-1	11	3	11/30/96	13:18	11/30/96	16:48	3	11/30/96	12:00	9.0	0.28	1.2	2.1	8.9	6.20 C
MA-1	12	3	1/16/97	19:30	1/16/97	21:35	3	1/16/97	17:00	22.5	1.46	2.4	3.8	3.4	6.68
MA-1	13	3	1/27/97	20:49	1/27/97	23:45	3	1/27/97	17:30	6.0	0.49	3.4	4.6	4.5	6.90

Table B2. Storm flow data for the Des Moines Water Quality Monitoring Program.

Station	Event Number	Monitoring Year	Begin Sample Date	Begin Sample Time	End Sample Date	End Sample Time	No. of Samples	Precipitation Begin Date	Precipitation Begin Time	Precip. Dur. (hours)	Precip. Amt. (inches)	Mean Flow (cfs)	Peak Flow (cfs)	Temp. (o C)	pH
MA-1	14	3	4/22/97	19:40	4/22/97	21:50	3	4/22/97	16:45	14.8	0.45	2.4	3.2	12.2	6.62
MA-1	15	3	6/3/97	10:00	6/3/97	12:05	3	6/3/97	4:45	15.3	0.46	1.8	2.1	15.9	6.81
MA-1	16	4	11/19/97	10:50	11/19/97	13:20	3	11/19/97	1:00	34	0.57	2.0	3.2	8.6	6.80
MA-1	17	4	12/16/97	0:06	12/16/97	1:08	3	12/15/97	14:00	51	2.01	2.2	3.2	6.4	6.91
MA-1	18	4	4/23/98	12:41	4/23/98	13:31	3	4/23/98	10:00	14	0.45	0.8	1.7	12.0	7.23
MA-1	19	4	6/24/98	8:56	6/24/98	11:10	3	6/24/98	5:00	14	0.49	0.5	0.8	14.5	6.92
MA-1	20	5	10/12/98	9:25	10/12/98	11:40	3	10/12/98	6:00	57.0	1.56	0.4	0.6	13.7	7.19
MA-1	21	5	1/13/99	20:40	1/13/99	23:10	3	1/13/99	19:00	21.0	1.27	1.1	1.9	7.4	6.52
MA-1	22	5	3/12/99	10:50	3/12/99	14:30	3	3/12/99	6:00	50.0	1.47	0.6	0.9	8.9	6.85
MA-1	23	5	5/11/99	13:08	5/11/99	15:01	3	5/11/99	11:00	4.0	0.17	0.9	1.5	10.9	6.78
MA-1	24	5	10/27/99	13:48	10/27/99	16:44	3	10/27/99	13:00	26.0	0.49	1.3	2.0	9.5	6.72
MA-1	25	5	11/5/99	20:35	11/5/99	23:10	4	11/5/99	18:00	12.0	0.71	0.7	1.2	9.9	6.81
MA-2	1	1	11/23/94	2:55	11/23/94	4:10	3	11/23/94	0:45	5.0	0.22	12.8	24.2	5.8	6.97
MA-2	2	1	12/8/94	17:30	12/8/94	20:35	4	12/8/94	16:45	8.0	0.21	1.3	1.8	6.5	7.27
MA-2	3	1	3/8/95	10:35	3/8/95	12:30	3	3/8/95	5:30	14.5	0.67	2.7	3.1	8.0	6.59
MA-2	4	1	7/9/95	12:20	7/9/95	15:15	4	7/9/95	10:45	2.8	0.93	20.8	22.1	18.2	C 7.09
MA-2	5	1	10/20/95	5:15	10/20/95	7:40	3	10/20/95	4:30	2.3	0.34	14.2	21.6	11.5	6.75
MA-2	6	2	11/7/95	1:55	11/7/95	5:30	4	11/6/95	19:15	13.0	2.63	18.7	25.9	8.0	6.71
MA-2	7	2	3/3/96	11:00	3/3/96	11:00	3	3/3/96	8:00	5.0	0.38	7.0	11.0	7.0	6.08 C
MA-2	8	2	3/31/96	20:05	3/31/96	22:50	3	3/31/96	17:15	4.0	0.76	6.8	11.0	9.8	6.96
MA-2	9	2	4/22/96	14:06	4/22/96	16:45	3	4/22/96	11:30	4.8	2.89	10.7	15.5	12.3	7.54
MA-2	10	2	9/3/96	13:20	9/3/96	15:35	3	9/3/96	9:30	2.3	0.46	4.3	7.0	16.5	C 7.55
MA-2	11	3	11/30/96	13:55	11/30/97	17:10	3	11/30/96	12:00	9.0	0.28	3.0	5.3	9.8	7.35
MA-2	12	3	1/16/97	19:50	1/16/97	22:30	3	1/16/97	17:00	22.5	1.46	14.4	16.5	4.9	6.83
MA-2	13	3	1/27/97	21:20	1/27/97	23:20	3	1/27/97	17:30	6.0	0.49	12.0	17.0	3.8	7.25
MA-2	14	3	4/22/97	20:10	4/22/97	22:10	3	4/22/97	16:45	14.8	0.45	10.8	19.5	12.8	7.04
MA-2	15	3	6/3/97	10:30	6/3/97	12:30	3	6/3/97	4:45	15.3	0.46	8.2	9.3	15.1	7.28
MA-2	16	4	11/19/97	11:30	11/19/97	13:50	3	11/19/97	1:00	34	0.57	14.40	21.6	9.4	7.22
MA-2	17	4	12/15/97	23:50	12/16/97	1:50	3	12/15/97	14:00	51	2.01	11.62	14.1	6.8	7.35
MA-2	18	4	4/23/98	13:05	4/23/98	14:20	3	4/23/98	10:00	14	0.45	5.81	8.9	12.5	6.71
MA-2	19	4	6/24/98	9:38	6/24/98	11:35	3	6/24/98	5:00	14	0.49	5.05	6.6	15.0	7.53
MA-2	20	5	10/12/98	10:15	10/12/98	12:40	3	10/12/98	6:00	57.0	1.56	6.14	8.2	13.6	7.42
MA-2	21	5	1/13/99	21:25	1/13/99	23:40	3	1/13/99	19:00	21.0	1.27			8.3	7.17
MA-2	22	5	3/12/99	11:20	3/12/99	14:00	3	3/12/99	6:00	50.0	1.47	2.62	3.7	9.1	7.32
MA-2	23	5	5/11/99	13:45	5/11/99	15:30	3	5/11/99	11:00	4.0	0.17	3.18	5.5	11.7	7.07
MA-2	24	5	10/27/99	14:40	10/27/99	17:15	3	10/27/99	13:00	26.0	0.49	5.2	6.2	9.8	7.14
MA-2	25	5	11/5/99	20:00	11/5/99	23:40	4	11/5/99	18:00	12.0	0.71	4.0	4.5	9.8	7.22
MA-3	1	1	11/23/94	2:05	11/23/94	4:20	3	11/23/94	0:45	5.0	0.22	7.2	9.2	6.0	7.29
MA-3	2	1	12/8/94	17:45	12/8/94	21:00	4	12/8/94	16:45	8.0	0.21	3.1	3.4	6.0	7.40
MA-3	3	1	3/8/95	10:50	3/8/95	12:50	3	3/8/95	5:30	14.5	0.67	5.5	5.7	7.7	6.34 C
MA-3	4	1	7/9/95	12:40	7/9/95	15:40	4	7/9/95	10:45	2.8	0.93	24.8	35.4	17.5	C 7.34
MA-3	5	1	10/20/95	5:43	10/20/95	7:55	3	10/20/95	4:30	2.3	0.34	13.6	17.7	11.5	7.06
MA-3	6	2	11/7/95	2:10	11/7/95	5:40	4	11/6/95	19:15	13.0	2.63	19.7	24.3	7.0	7.08
MA-3	7	2	3/3/96	11:10	3/3/96	13:15	3	3/3/96	8:00	5.0	0.38	5.4	7.3	7.0	6.13 C

Table B2. Storm flow data for the Des Moines Water Quality Monitoring Program.

Station	Event Number	Monitoring Year	Begin Sample Date	Begin Sample Time	End Sample Date	End Sample Time	No. of Samples	Precipitation Begin Date	Precipitation Begin Time	Precip. Dur. (hours)	Precip. Amt. (inches)	Mean Flow (cfs)	Peak Flow (cfs)	Temp. (o C)	pH
MA-3	8	2	3/31/96	20:25	3/31/96	23:05	3	3/31/96	17:15	4.0	0.76	19.9	24.3	9.1	7.22
MA-3	9	2	4/22/96	14:20	4/22/96	17:00	3	4/22/96	11:30	4.8	2.89	27.2	31.6	12.0	7.44
MA-3	10	2	9/3/96	13:35	9/3/96	15:50	3	9/3/96	9:30	2.3	0.46	2.5	2.8	16.5	C 7.49
MA-3	11	3	11/30/96	14:05	11/30/96	17:50	3	11/30/96	12:00	9.0	0.28	3.2	4.4	9.2	7.44
MA-3	12	3	1/16/97	20:05	1/16/97	22:45	3	1/16/97	17:00	22.5	1.46	20.9	26.5	3.9	6.75
MA-3	13	3	1/27/97	21:30	1/27/97	23:45	3	1/27/97	17:30	6.0	0.49	16.1	23.4	3.6	7.20
MA-3	14	3	4/22/97	20:30	4/22/97	22:30	3	4/22/97	16:45	14.8	0.45	11.8	18.4	12.6	6.93
MA-3	15	3	6/3/97	10:40	6/3/97	12:40	3	6/3/97	4:45	15.3	0.46	6.6	8.3	15.0	7.23
MA-3	16	4	11/19/97	11:40	11/19/97	13:55	3	11/19/97	1:00	34	0.57	11.5	19.1	9.2	7.48
MA-3	17	4	12/15/97	0:05	12/16/97	2:05	3	12/15/97	14:00	51	2.01	9.9	12.4	7.0	7.42
MA-3	18	4	4/23/98	13:15	4/23/98	14:35	3	4/23/98	10:00	14	0.45	3.9	5.3	12.0	6.74
MA-3	19	4	6/24/98	9:55	6/24/98	11:45	3	6/24/98	5:00	14	0.49	3.0	4.0	14.3	7.50
MA-3	20	5	10/12/98	10:30	10/12/98	12:50	3	10/12/98	6:00	57.0	1.56	3.5	3.6	13.2	7.56
MA-3	21	5	1/13/99	21:40	1/13/99	23:50	3	1/13/99	19:00	21.0	1.27	6.5	8.3	8.2	7.28
MA-3	22	5	3/12/99	11:35	3/12/99	14:10	3	3/12/99	6:00	50.0	1.47	3.9	4.9	9.1	7.26
MA-3	23	5	5/11/99	13:45	5/11/99	15:45	3	5/11/99	11:00	4.0	0.17	4.5	5.3	11.0	6.84
MA-3	24	5	10/27/99	14:55	10/27/99	17:30	3	10/27/99	13:00	26.0	0.49	7.1	8.7	9.8	7.22
MA-3	25	5	11/5/99	20:10	11/5/99	23:45	4	11/5/99	18:00	12.0	0.71	6.4	7.9	9.5	7.21
MC-1	1	1	11/23/94	1:20	11/23/94	3:30	3	11/23/94	0:45	5.0	0.22	1.7	2.0	5.2	6.80
MC-1	2	1	12/8/94	16:55	12/8/94	20:05	4	12/8/94	16:45	8.0	0.21	0.6	0.6	5.0	6.19 C
MC-1	3	1	3/8/95	10:05	3/8/95	12:00	3	3/8/95	5:30	14.5	0.67	0.4	0.5	6.8	7.26
MC-1	4	1	7/9/95	12:35	7/9/95	15:25	4	7/9/95	10:45	2.8	0.93	3.5	4.3	16.0	6.84
MC-1	5	1	10/20/95	5:30	10/20/95	8:15	3	10/20/95	4:30	2.3	0.34	0.5	0.6	10.9	6.67
MC-1	6	2	11/7/95	1:20	11/7/95	5:10	4	11/6/95	19:15	13.0	2.63	1.1	1.7	8.0	6.54
MC-1	7	2	3/3/96	10:30	3/3/96	12:45	3	3/3/96	8:00	5.0	0.38	0.7	0.8	5.2	6.19 C
MC-1	8	2	3/31/96	19:25	3/31/96	21:55	3	3/31/96	17:15	4.0	0.76	0.7	0.7	8.2	7.36 J
MC-1	9	2	4/22/96	13:30	4/22/96	16:10	3	4/22/96	11:30	4.8	2.89	0.7	0.7	11.1	6.77
MC-1	10	2	9/3/96	12:35	9/3/96	15:35	3	9/3/96	9:30	2.3	0.46	0.2	0.2	15.0	7.07
MC-1	11	3	11/30/96	13:30	11/30/96	16:50	3	11/30/96	12:00	9.0	0.28	0.5	0.6	8.0	6.64
MC-1	12	3	1/16/97	19:20	1/16/97	22:05	3	1/16/97	17:00	22.5	1.46	8.1	9.5	3.1	6.68
MC-1	13	3	1/27/97	20:40	1/27/97	22:45	3	1/27/97	17:30	6.0	0.49	10.6	10.6	1.8	6.81
MC-1	14	3	4/22/97	19:45	4/22/97	21:45	3	4/22/97	16:45	14.8	0.45	4.4	4.8	11.2	6.61
MC-1	15	3	6/3/97	9:50	6/3/97	12:05	3	6/3/97	4:45	15.3	0.46	0.4	0.5	14.1	6.75
MC-1	16	4	11/19/97	10:55	11/19/97	13:30	3	11/19/97	1:00	34	0.57	0.3	0.5	8.2	7.03
MC-1	17	4	12/15/97	23:20	12/16/97	1:20	3	12/15/97	14:00	51	2.01	0.7	0.7	6.1	6.96
MC-1	18	4	4/23/98	12:15	4/23/98	14:05	3	4/23/98	10:00	14	0.45	0.4	0.5	10.5	6.53
MC-1	19	4	6/24/98	9:00	6/24/98	11:15	3	6/24/98	5:00	14	0.49	0.4	0.4	13.2	7.15
MC-1	20	5	10/12/98	9:30	10/12/98	11:45	3	10/12/98	6:00	57.0	1.56	0.2	0.2	11.5	7.09
MC-1	21	5	1/13/99	20:45	1/13/99	23:15	3	1/13/99	19:00	21.0	1.27	0.6	0.7	11.0	6.62
MC-1	22	5	3/12/99	10:50	3/12/99	13:35	3	3/12/99	6:00	50.0	1.47	0.4	0.4	7.5	6.46 C
MC-1	23	5	5/11/99	13:10	5/11/99	15:10	3	5/11/99	11:00	4.0	0.17	0.3	0.3	8.9	6.75
MC-1	24	5	10/27/99	13:55	10/27/99	16:55	3	10/27/99	13:00	26.0	0.49	0.2	0.4	8.5	6.88
MC-1	25	5	11/5/99	20:20	11/5/99	23:15	4	11/5/99	18:00	12.0	0.71	0.3	0.5	7.8	6.97
MC-2	1	1	11/23/94	1:30	11/23/94	3:50	3	11/23/94	0:45	5.0	0.22	3.8	4.5	5.9	7.27

Table B2. Storm flow data for the Des Moines Water Quality Monitoring Program.

Station	Event Number	Monitoring Year	Begin Sample Date	Begin Sample Time	End Sample Date	End Sample Time	No. of Samples	Precipitation Begin Date	Precipitation Begin Time	Precip. Dur. (hours)	Precip. Amt. (inches)	Mean Flow (cfs)	Peak Flow (cfs)	Temp. (o C)	pH
MC-2	2	1	12/8/94	17:15	12/8/94	20:25	4	12/8/94	16:45	8.0	0.21	2.0	2.2	6.0	7.23
MC-2	3	1	3/8/95	10:20	3/8/95	12:20	3	3/8/95	5:30	14.5	0.67	2.4	2.5	7.5	7.13
MC-2	4	1	7/9/95	12:50	7/9/95	15:45	4	7/9/95	10:45	2.8	0.93	5.3	6.3	19.0	C 7.51 M
MC-2	5	1	10/20/95	6:15	10/20/95	8:25	3	10/20/95	4:30	2.3	0.34	4.9	6.1	12.1	7.32
MC-2	6	2	11/7/95	1:40	11/7/95	5:20	4	11/6/95	19:15	13.0	2.63	6.6	7.8	8.0	7.16
MC-2	7	2	3/3/96	10:45	3/3/96	12:55	3	3/3/96	8:00	5.0	0.38	3.7	4.4	6.2	6.26 C
MC-2	8	2	3/31/96	19:50	3/31/96	22:30	3	3/31/96	17:15	4.0	0.76	3.9	4.7	9.7	6.85
MC-2	9	2	4/22/96	13:50	4/22/96	16:30	3	4/22/96	11:30	4.8	2.89	4.6	5.6	12.1	7.26
MC-2	10	2	9/3/96	12:50	9/3/96	15:20	3	9/3/96	9:30	2.3	0.46	0.6	0.7	18.5	C 7.87
MC-2	11	3	11/30/96	13:45	11/30/96	17:10	3	11/30/96	12:00	9.0	0.28	2.5	3.2	8.5	7.06
MC-2	12	3	1/16/97	19:35	1/16/97	22:20	3	1/16/97	17:00	22.5	1.46	6.5	8.0	3.9	6.97
MC-2	13	3	1/27/97	21:05	1/27/97	23:05	3	1/27/97	17:30	6.0	0.49	8.4	9.1	3.0	7.48
MC-2	14	3	4/22/97	19:55	4/22/97	21:55	3	4/22/97	16:45	14.8	0.45	4.5	5.2	13.8	7.11
MC-2	15	3	6/3/97	10:10	6/3/97	12:15	3	6/3/97	4:45	15.3	0.46	3.0	3.1	16.2	C 7.25
MC-2	16	4	11/19/97	11:15	11/19/97	13:40	3	11/19/97	1:00	34	0.57	3.9	5.2	9.0	7.41
MC-2	17	4	12/15/97	23:40	12/16/97	1:40	3	12/15/97	14:00	51	2.01	5.0	5.6	6.3	7.51
MC-2	18	4	4/23/98	12:25	4/23/98	14:10	3	4/23/98	10:00	14	0.45	2.1	2.8	13.2	7.07
MC-2	19	4	6/24/98	9:25	6/24/98	11:25	3	6/24/98	5:00	14	0.49	1.7	1.9	17.8	C 7.79
MC-2	20	5	10/12/98	9:50	10/12/98	12:00	3	10/12/98	6:00	57.0	1.56	1.2	1.2	14.1	7.64
MC-2	21	5	1/13/99	21:05	1/13/99	23:25	3	1/13/99	19:00	21.0	1.27	3.8	4.1	8.8	7.38
MC-2	22	5	3/12/99	11:05	3/12/99	13:50	3	3/12/99	6:00	50.0	1.47			9.2 M	7.32 M
MC-2	23	5	5/11/99	13:20	5/11/99	15:20	3	5/11/99	11:00	4.0	0.17	0.2	0.0	10.1	6.93
MC-2	24	5	10/27/99	14:25	10/27/99	17:05	3	10/27/99	13:00	26.0	0.49	2.6	3.1	10.0	7.08
MC-2	25	5	11/5/99	19:45	11/5/99	23:35	4	11/5/99	18:00	12.0	0.71	2.2	3.4	9.7	7.17

Table B2. Storm flow data for the Des Moines Water Quality Monitoring Program.

Station	Event Number	DO (mg/L)		Conductivity (umhos/cm)	Turbidity (NTU)	TSS (mg/L)	TPH (mg/L)	Fecal Coliform (CFU/100 mL)		TP (mg/L)	Ammonia (mg/L)	Nitrate+Nitrite (mg/L)	Hardness (mg/L as CaCO3)
BA-1	1	11.4		154	18	15	0.25 U	580	C	0.071	0.043	0.803	62.3
BA-1	2	11.6		215	3.7	1.8	0.25 U	6 J		0.033	0.016	1.640	113
BA-1	3	11.0		136	11	9.2	0.25 U	680	C	0.101	0.035	1.050	48.2
BA-1	4	9.1	C	79.5	45	492	0.25 U	13,400	C	1.270	0.054	1.120	37.7
BA-1	5	12.2		107 M	19 JM	78 M	0.25 UM	4,800 M	C	0.317 M	0.011 M	0.502 M	37.4 M
BA-1	6	11.2		64.0	31	100	0.25 U	8,000	C	0.351	0.056	0.407	27.9
BA-1	7	11.4		140	32	121	0.25 U	960	C	0.233	0.056	0.882	64.8
BA-1	8	10.8		126	17	45	0.37	2,400 J	C	0.173	0.012	1.870	47.6
BA-1	9	10.2		110	21	107	0.25 U	4,200	C	0.272	0.043	0.437	75.8
BA-1	10	9.4	C	107	52	360	0.27	14,600	C	1.010	0.143	1.160	44
BA-1	11	10.8		425	61	210	0.25 U	42		0.213	0.019	1.51	70.7
BA-1	12	12.5		111.1	64	292	0.25 JU	240 J	C	0.335	0.074	0.705	53.8
BA-1	13	13.3		98.6	22	53	0.25 U	180 J	C	0.155	0.047	0.686	35.8
BA-1	14	8.8	C	116	45	147	0.39	2,200 J	C	0.241	0.065	0.503	45.2
BA-1	15	9.5	C	137	8.1	21	0.25 U	3,400 J	C	0.116 J	0.025	0.781	72.7
BA-1	16	12.1 M		188.5 M	68.5 M	86 M	0.25 UM	330 JM	C	0.212 M	0.060 M	0.558 M	60.05 M
BA-1	17	12.1		85	77	84	0.25 U	760	C	0.336	0.010 U	0.562	42
BA-1	18	10.7		115	38	109	0.25 U	17,000 J	C	0.438	0.143	1.140	47.1
BA-1	19	9.7		94.2	34	112	0.31	9,000	C	0.581	0.057	0.522	33.9
BA-1	20	9.4	C	216 M	19.5 M	50.5 M	0.25 UM	790 M	C	0.197 M	0.048 M	0.808 M	75.7 M
BA-1	21	11.4		124	46	94	0.31	4,000	C	0.269	0.059	0.842	42.8
BA-1	22	12.8		143	39	19	0.25 U	48		0.079	0.026	0.828	56.9
BA-1	23	10.4		196	32	71	0.25 U	760	C	0.189	0.014	0.918	74.4
BA-1	24	10.6		262	95 M	231 M	0.25 UM	320 JM	C	0.673 M	0.016 M	0.745 M	72.7 M
BA-1	25	10.8		265	16 M	31 M	0.25 UM	220 JM	C	0.154 M	0.039 M	0.592 M	73.2 M
DM-1	1	11.2		98.0	20	22	0.25 U	760	C	0.077	0.068	0.499	41.6
DM-1	2	11.4		155	28	23	0.25 U	64	C	0.025	0.592	0.786	75.2
DM-1	3	10.6		131	12	7.4	0.25 U	1,080	C	0.051	0.088	0.600	44.2
DM-1	4	8.6	C	54.6	24	132	0.25 U	9,400	C	0.521	0.070	0.725	25.5
DM-1	5	11.8		87.3	11 J	38	0.25 U	9,600	C	0.156	0.043	0.424	29.3
DM-1	6	11.1		40.5	20	55	0.25 U	10,000	C	0.181	0.058	0.274	25.0
DM-1	7	11.6		125	24	60	0.64	260 J	C	0.208	0.131	0.727	50.3
DM-1	8	9.7		60.7	18	51	0.70	280 J	C	0.134	0.065	0.480	35.2
DM-1	9	10.4		68.7	14	50	0.27	410	C	0.153	0.048	0.384	39.7
DM-1	10	9.0	C	66	27	93	0.39	30,600	C	0.491	0.236	0.797	28.6
DM-1	11	10.6		166	25	48	0.25 U	280 J	C	0.118	0.085	0.356	44.6
DM-1	12	11.6		101.3	30	54	1.97 J	400	C	0.156	0.125	0.314	38.8
DM-1	13	12.5		84.1	12	19	0.31	360 J	C	0.063	0.079	0.249	31
DM-1	14	9.8		78	17	32.8	0.37	640	C	0.100	0.068	0.334	31.6
DM-1	15	9.4	C	91	7.4	17	0.25 U	5,800	C	0.112 J	0.055	0.594	62
DM-1	16	11.1		64.9	37	27	0.28	12,600 J	C	0.116	0.078	0.325	30.4
DM-1	17	11.7		67	29	43	0.67	240 J	C	0.111	0.031	0.303	32.1
DM-1	18	10.0		166	29	138	0.31	18,000 J	C	0.433	0.324	1.810	60
DM-1	19	9.4	C	70.5	18	42	0.79	8,600	C	0.154	0.021	0.306	31.3

Table B2. Storm flow data for the Des Moines Water Quality Monitoring Program.

Station	Event Number	DO (mg/L)		Conductivity (umhos/cm)	Turbidity (NTU)		TSS (mg/L)	TPH (mg/L)	Fecal Coliform (CFU/100 mL)		TP (mg/L)	Ammonia (mg/L)	Nitrate+Nitrite (mg/L)	Hardness (mg/L as CaCO3)
DM-1	20	9.4	C	84	13		22	0.31	2,200 J	C	0.110	0.127	0.432	45.6
DM-1	21	10.8		98.7	38		54	1.8	1,380	C	0.168	0.129	0.431	36
DM-1	22	10.8		141	9.4		5.2	0.31	20 J		0.047	0.029	0.579	58.8
DM-1	23	9.4	C	161	12		51	0.33	720	C	0.182	0.065	0.647	67.3
DM-1	24	10.0		151.8	36		52	0.25 U	68	C	0.214	0.023	0.670	58.4
DM-1	25	10.1		174	8.1		20	0.25 U	22 J		0.100	0.178	0.403	54.3
DM-2	1	11.5		84.0	18		20	0.25 U	5,400	C	0.074	0.456	0.607	59.5
DM-2	2	11.7		189	6.2		7.2	0.25 U	104	C	0.027	0.074	0.927	86.2
DM-2	3	11.7		127	9.5		9	0.25 U	640	C	0.052	0.053	0.758	47.6
DM-2	4	9.1	C	65.0	35	C	242	0.25 U	18,800	C	0.777	0.040	1.100	38.3
DM-2	5	11.5		106	13 J		53	0.25 U	12,800	C	0.186	0.010 U	0.544	36.9
DM-2	6	11.2		66.1	28	C	92	0.25 U	4,200	C	0.246	0.059	0.441	28.1
DM-2	7	12.5		141	24		93	0.27	620	C	0.208	0.064	0.936	59.6
DM-2	8	10.2		80.8	19		71	0.52	960	C	0.134	0.031	0.751	43.0
DM-2	9	10.1		80.7	13 M		132 M	0.28	670 M	C	0.278 M	0.048 M	0.568 M	53.2 M
DM-2	10	9.3	C	106	31		177	0.25 U	9,000	C	0.693	0.106	0.995	41.5
DM-2	11	10.7		289	22		50	0.25 U	220 J	C	0.117	0.069	0.595	52.5
DM-2	12	12.0		159	28		68	0.85 J	2,000 J	C	0.199	0.154	0.561	61.8
DM-2	13	13.3		92.9	16		49	0.44	780 J	C	0.089	0.062	0.393	31
DM-2	14	9.6		85	22		44	0.25 U	800	C	0.132	0.044	0.514	49.1
DM-2	15	9.4	C	132	6.4		15	0.25 U	2,400 J	C	0.095 J	0.021	0.731	60.7
DM-2	16	11.4		92.6	39		39	0.38	440	C	0.125	0.054	0.434	43.1
DM-2	17	12.2		109	49	C	61	0.25 U	1,520	C	0.133	0.023	0.401	37.8
DM-2	18	10.8		174	31		153	0.25 U	3,600 J	C	0.403	0.126	1.050	72
DM-2	19	10.1		69.1	26	C	76	0.56	8,600	C	0.235	0.024	0.393	26.8
DM-2	20	10.4		175	8.5		26	0.25 U	2,220 J	C	0.117	0.034	0.499	75
DM-2	21	11.4		134	30		62	0.61	780	C	0.171	0.100	0.609	49
DM-2	22	11.2		166	5.5		5.8	0.25 U	40		0.039	0.010 U	0.781	64.2
DM-2	23	10.3		185	19	C	85	0.25 U	540	C	0.226	0.011	0.728	71.1
DM-2	24	10.4		144.8	31		55	0.25 U	300 J	C	0.210	0.018	0.682	72.5
DM-2	25	10.4		177	5		21	0.25 U	160	C	0.088	0.036	0.541	69.2
MA-1	1	11.3		45.0	12		5.1	0.32	2,200	C	0.037	0.045	0.252	33.0
MA-1	2	10.7		174	11		5.8	0.25 U	590	C	0.043	0.045	0.910	105
MA-1	3	10.6		177	8		2.2	0.25 U	300 J	C	0.025	0.061	1.340	65.4
MA-1	4	8.6	C	44.2	12		24	0.25 U	19,600	C	0.020	0.115	1.030	21.6
MA-1	5	12.1		64.0	24 J		22	0.25 U	8,000	C	0.119	0.046	0.392	27.5
MA-1	6	11.4		29.3	6.8		11.3	0.25 U	3,600	C	0.049	0.039	0.531	19.7
MA-1	7	10.7		141	14		23	0.63	116	C	0.085	0.153	0.582	43.2
MA-1	8	10.7		79.1	7.7		16	0.36	220 J	C	0.074	0.107	0.750	43.4
MA-1	9	10.1		56.5	11		19.5	0.53	800 J	C	0.078	0.056	0.281	24.7
MA-1	10	8.6	C	182	13		14	0.27	21,000	C	0.118	0.103	1.300	49.5
MA-1	11	10.5		244	15		13	0.25 U	320 J	C	0.057	0.012	0.617	51.6
MA-1	12	12.2		72.5	19		36	2.34 J	400	C	0.113	0.166	0.344	41.1
MA-1	13	12.3		82.4	6.5		7.8	0.3	380 J	C	0.034	0.113	0.424	30.2

Table B2. Storm flow data for the Des Moines Water Quality Monitoring Program.

Station	Event Number	DO (mg/L)		Conductivity (umhos/cm)	Turbidity (NTU)		TSS (mg/L)	TPH (mg/L)	Fecal Coliform (CFU/100 mL)		TP (mg/L)	Ammonia (mg/L)	Nitrate+Nitrite (mg/L)	Hardness (mg/L as CaCO3)
MA-1	14	9.4	C	132	12		18	1.2	4,200	C	0.068	0.086	0.337	61
MA-1	15	9.2	C	85	8.1		12	0.6	2,600 J	C	0.074 J	0.111	0.469	45.1
MA-1	16	12.9		51.8	35		31	0.47	1,240 J	C	0.124	0.068	0.245	22
MA-1	17	11.7		76	19		14	2	460	C	0.065	0.058	0.328	33.8
MA-1	18	9.8		218	34		45	1.75	3,800 J	C	0.181	0.334	1.160	40.5
MA-1	19	9.4	C	117	6.1		6.4	0.36	8,200	C	0.088	0.028	0.691	42
MA-1	20	9.3	C	113	7.5		9.5	0.3	19,600 J	C	0.108	0.061	0.384	51.3
MA-1	21	10.8		95.1	16		12	0.94	520	C	0.055	0.108	0.514	31.7
MA-1	22	10.6		181	7.1		4.7	0.25 U	12 J		0.031	0.044	0.908	60.1
MA-1	23	9.8		145	34		61	0.75	1,200	C	0.181	0.177	0.599	52
MA-1	24	10.8		64.1	40		118	0.66	9,200	C	0.540	0.016	0.717	27
MA-1	25	9.9		138	14.0		16	0.4	5,800	C	0.113	0.078	0.387	28.9
MA-2	1	11.6		58.0	29	C	52	0.39	1,800 J	C	0.056	0.039	0.214	31.4
MA-2	2	11.7		214	16		10	0.25 U	56	C	0.021	0.029	1.120	80.6
MA-2	3	10.7		136	9.2		4.7	0.25 U	240 J	C	0.055	0.043	0.845	47.4
MA-2	4	9.0	C	40.7	36	C	197	0.25 U	10,600	C	0.533	0.135	0.766	29.3
MA-2	5	12.2		72.1	16 J		131	0.25 U	37,200 J	C	0.322	0.010 U	0.424	23.4
MA-2	6	11.2		27.0	31	C	147	0.48	7,200	C	0.246	0.055	0.412	23.0
MA-2	7	10.8		77.9	28 M	C	104 M	0.66 M	510 M	C	0.198 M	0.075 M	0.498 M	46.0 M
MA-2	8	10.6		91.2	15	C	41	0.27	1,000	C	0.100	0.059	0.657	32.5
MA-2	9	11.8		45.3	22	C	85	0.30	2,200 J	C	0.162	0.028	0.281	30.9
MA-2	10	9.1	C	122	21	C	44	0.25 U	9,400	C	0.156	0.158	1.100	33.3
MA-2	11	10.6		176	18		25	0.27	1,800 J	C	0.071	0.024	0.861	44
MA-2	12	11.6		71.4	26	C	66	0.88 J	700	C	0.141	0.105	0.430	32.3
MA-2	13	12.7		67.5	17	C	27	0.31	700 J	C	0.071	0.089	0.417	27.3
MA-2	14	9.0	C	68	18	C	52	0.51	2,400 J	C	0.116	0.031	0.358	48.9
MA-2	15	9.7		78	16	C	50	0.40	4,800	C	0.110 J	0.027	0.697	41
MA-2	16	12.3		52.5	70	C	118	0.25 U	1,100	C	0.205	0.068	0.260	19.1
MA-2	17	12.0		60	39	C	46	0.38	1,160	C	0.106	0.012	0.342	32.3
MA-2	18	10.5		96	30		62	0.86	4,000	C	0.207	0.168	0.939	46.3
MA-2	19	9.8		91.4	10		19	0.35	5,200	C	0.093	0.016	0.474	25.9
MA-2	20	9.9		68	11		18	0.5	1,820 J	C	0.079	0.077	0.426	52.9
MA-2	21	12.8		84.6	20		32	0.66	700	C	0.079	0.074	0.463	28.1
MA-2	22	11.2		145	9.9		8.7	0.25 U	800 J	C	0.035	0.028	0.982	57.8
MA-2	23	10.1		127	20		57	0.53	1,000	C	0.145	0.023	0.870	46.8
MA-2	24	11.0		63.4	53	C	119	0.43	2,600 J	C	0.376	0.028	0.862	35.2
MA-2	25	10.9		64	20	C	28	0.25 U	1,180	C	0.104	0.091	0.588	38.1
MA-3	1	11.6		82.0	27	C	48	0.25 U	600	C	0.101	0.036	0.494	53.1
MA-3	2	11.3		225	6.0		5.7	0.25 U	360	C	0.019	0.112	1.190	95.4
MA-3	3	10.7		125	9.5		7.8	0.25 U	2,000 J	C	0.037	0.020	0.886	50.2
MA-3	4	8.7	C	57.2	42	C	350	0.25 U	14,800	C	0.941	0.105	1.020	36.9
MA-3	5	11.8		84.3	20 J		140	0.25 U	4,200	C	0.506	0.010 U	0.446	28.7
MA-3	6	11.6		72.3	31	C	156	0.25 U	6,000	C	0.328	0.043	0.384	25.4
MA-3	7	11.2		98.0	32	C	143	0.46	660	C	0.214	0.056	0.659	69.9

Table B2. Storm flow data for the Des Moines Water Quality Monitoring Program.

Station	Event Number	DO (mg/L)		Conductivity (umhos/cm)	Turbidity (NTU)		TSS (mg/L)	TPH (mg/L)	Fecal Coliform (CFU/100 mL)		TP (mg/L)	Ammonia (mg/L)	Nitrate+Nitrite (mg/L)	Hardness (mg/L as CaCO3)
MA-3	8	10.2		99.5	15	C	40	0.30	1,000	C	0.112	0.035	0.754	36.2
MA-3	9	8.8	C	67.9	24	C	106	0.25	4,000	C	0.187	0.030	0.330	40.6
MA-3	10	8.5	C	133	25		65	0.25 U	12,000	C	0.182	0.129	1.030	40
MA-3	11	10.4		188	22		42	0.25 U	980	C	0.092	0.010 U	1.35	66.3
MA-3	12	12.1		82	34	C	111	0.57 J	760	C	0.214	0.076	0.514	37.4
MA-3	13	13.0		79.9	19		41	0.25 U	440 J	C	0.118	0.063	0.495	27.3
MA-3	14	9.5	C	80	24	C	74	0.37	1,160	C	0.164	0.055	0.402	71.9
MA-3	15	9.4	C	121	16	C	48	0.25 U	4,800	C	0.122 J	0.019	0.744	47.5
MA-3	16	12.1		87.1	59		84	0.25 U	920	C	0.168	0.015	0.431	34.7
MA-3	17	11.8		71	49	C	56	0.36	860	C	0.132	0.010 U	0.414	27.7
MA-3	18	10.4		109	40	C	99	1.23	21,200 J	C	0.382	0.144	1.130	62.3
MA-3	19	9.5	C	100	19	C	45	0.4	6,000	C	0.206	0.015	0.496	46.1
MA-3	20	9.4	C	93	10		20	0.25 U	1,600 J	C	0.102	0.037	0.604	51.5
MA-3	21	11.6		101	26	C	41	0.57	740	C	0.115	0.063	0.609	36.4
MA-3	22	11.1		139	15	C	8.8	0.56	380 J	C	0.045	0.013	0.948	58
MA-3	23	10.1		175 M	28 M	C	104 M	0.28 M	870 M	C	0.318 M	0.015 M	0.918 M	69.8 M
MA-3	24	10.7		78.1	65	C	125	0.25 U	5,400	C	0.427	0.018	0.756	55.1
MA-3	25	10.5		114	22		51	0.25 U	1,180	C	0.150	0.043	0.512	55.3
MC-1	1	9.0	C	146	17		14	0.25 U	660	C	0.080	0.041	0.061	94.9
MC-1	2	8.3	C	148	2.1		1.4	0.25 U	40		0.033	0.010	0.380	74.6
MC-1	3	6.5	C	111	6.1		5.2	0.25 U	120 J	C	0.060	0.036	0.268	46.8
MC-1	4	5.5	C	114	18		66	0.25 U	16,800	C	0.491	0.037	0.695	38.7
MC-1	5	7.0	C	128	8.5 J		37	0.25 U	7,000	C	0.204	0.014	0.279	45.0
MC-1	6	9.5	C	75.0	15		62	0.25 U	7,000	C	0.234	0.051	0.320	44.0
MC-1	7	9.6		127	5.5		19.5	0.25 U	780	C	0.111	0.037	0.344	56.6
MC-1	8	7.8	C	90.3	6.5		28	0.25 U	2,000 J	C	0.147	0.012	0.437	41.4
MC-1	9	9.1	C	119	7.8		33	0.25 U	7,200	C	0.166	0.049	0.228	48.2
MC-1	10	5.6	C	196	11		25	0.25 U	23,800	C	0.593	0.077	0.653	55.8
MC-1	11	6.4	C	140	3.5		3.2	0.25 U	56	C	0.076	0.010 U	0.560	51.4
MC-1	12	8.7	C	116	4.2		12	0.25 JU	300 J	C	0.134	0.110	0.341	53.8
MC-1	13	9.8		101.9	4.1		8.3	0.25 U	1,580 J	C	0.064	0.052	0.334	37
MC-1	14	6.4	C	148	5.9		22	0.4	2 U		0.120	0.013	0.197	59
MC-1	15	6.8	C	138	3.6		16	0.25 U	420	C	0.188 J	0.048	0.232	71.8
MC-1	16	8.2	C	138	11		12	0.25 U	300 J	C	0.159	0.027	0.198	51.9
MC-1	17	8.6	C	106	19		31	0.25 U	2,000 J	C	0.166	0.010 U	0.253	45
MC-1	18	7.4	C	138	13		42	0.25 U	3,200 J	C	0.253	0.044	0.400	60
MC-1	19	7.7	C	140.1	6		34	0.25 U	10,200	C	0.296	0.056	0.270	57.6
MC-1	20	7.2	C	208	3.5		3.2	0.25 U	3,200 J	C	0.182	0.019	0.178	86.7
MC-1	21	11.1		126	9.5		13	0.34	920	C	0.079	0.044	0.461	52
MC-1	22	8.9	C	126	2.2		1.6	0.25 U	26 J		0.043	0.010 U	0.295	51.3
MC-1	23	7.8	C	153	3.5		9.4	0.25 U	420	C	0.087	0.011	0.184	60.8
MC-1	24	7.8	C	140.2	22		23	0.25 U	800	C	0.341	0.019	0.131	63.3
MC-1	25	7.5	C	164	3.1		6	0.25 U	162	C	0.143	0.018	0.027	70
MC-2	1	11.4		94.0	33	C	30	0.26	2,200 J	C	0.091	0.057	0.535	47.6

Table B2. Storm flow data for the Des Moines Water Quality Monitoring Program.

Station	Event Number	DO (mg/L)		Conductivity (umhos/cm)	Turbidity (NTU)		TSS (mg/L)	TPH (mg/L)	Fecal Coliform (CFU/100 mL)		TP (mg/L)	Ammonia (mg/L)	Nitrate+Nitrite (mg/L)	Hardness (mg/L as CaCO3)
MC-2	2	11.8		129	26	C	14	0.25 U	750 J	C	0.064	0.042	0.908	61.4
MC-2	3	10.5		129	26	C	18	0.25 U	480	C	0.098	0.036	0.526	51.6
MC-2	4	9.1 M	C	91.2	25.5 M	C	56 M	0.25 U	11,400 M	C	0.363 JM	0.022 M	0.558 M	31.8
MC-2	5	12.0		92.3	13 J		43	0.25 U	4,600	C	0.175	0.022	0.442	30.7
MC-2	6	11.5		30.0	21	C	47	0.25 U	4,400	C	0.185	0.051	0.309	35.0
MC-2	7	10.8		131	19	C	50	0.33	180 J	C	0.127	0.105	0.482	44.0
MC-2	8	10.2		113	16	C	33	0.25 U	700	C	0.134	0.051	0.223	52.7
MC-2	9	10.3		99.2	19	C	56	0.27	3,200 J	C	0.168	0.052	0.298	47.4
MC-2	10	7.8	C	219	7		15	0.25 U	20,000	C	0.195	0.097	0.594	64
MC-2	11	11.0		136	12	C	6.9	0.25 U	400	C	0.061	0.042	1.07	52
MC-2	12	12.1		85	20	C	26	0.34 J	520	C	0.105	0.131	0.393	45.2
MC-2	13	12.8		104.4	17	C	20	0.34	440 J	C	0.094	0.064	0.442	36.8
MC-2	14	9.5	C	119	15	C	18	0.25 U	980	C	0.095	0.061	0.355	48.1
MC-2	15	8.8	C	101	7.1		15	0.26	3,000 J	C	0.121 J	0.085	0.412	48.1
MC-2	16	12.1		72.4	41	C	27	0.25 U	520	C	0.121	0.077	0.386	39.3
MC-2	17	11.8		107	39	C	28	0.26	2,400 J	C	0.127	0.014	0.476	51
MC-2	18	9.9		137	35	C	70	0.54	3,000 J	C	0.278	0.059	0.584	50.8
MC-2	19	9.0	C	177.3	6.5		18	0.25 U	3,600 J	C	0.184	0.057	0.168	66
MC-2	20	9.2	C	101	20	C	15	0.25	3,200 J	C	0.131	0.075	0.346	36.8
MC-2	21	12.2		118	22	C	18	0.75	560	C	0.106	0.075	0.445	49
MC-2	22	11.4 M		102 M	18 M	C	11 M	0.25 UM	2,100 JM	C	0.062 M	0.028 M	0.433 M	48.1 M
MC-2	23	9.6		120	16	C	24	0.25 U	660	C	0.114	0.015	0.251	47.6
MC-2	24	10.4		119	73	C	65	0.34	1,320	C	0.234	0.047	0.389	36.4
MC-2	25	10.8		86	32	C	25	0.25 U	3,600 J	C	0.136	0.092	0.312	35.8

Table B2. Storm flow data for the Des Moines Water Quality Monitoring Program.

Station	Event Number	Copper, Dis. (mg/L)	Lead, Dis. (mg/L)	Zinc, Dis. (mg/L)	Copper, Total (mg/L)	Lead, Total (mg/L)	Zinc, Total (mg/L)
BA-1	1	0.0027	0.0007	0.005	0.0070	0.0034	0.012
BA-1	2	0.0026	0.0005 U	0.003	0.0134	0.0006 J	0.008
BA-1	3	0.0034	0.0005 U	0.003	0.0053	0.0019	0.020
BA-1	4	0.0052	0.0005 U	0.038	0.0256	0.0354	0.098
BA-1	5	0.0046 M	0.0006 M	0.009 M	0.0161 M	0.0114 M	0.057 M
BA-1	6	0.0057 C	0.0007	0.003 U	0.0093	0.0005 U	0.003 U
BA-1	7	0.0053	0.0005 U	0.011	0.0162	0.0092	0.038
BA-1	8	0.0076	0.0005 U	0.004	0.0155	0.0044	0.023
BA-1	9	0.0036	0.0007	0.011	0.0104	0.0087	0.033
BA-1	10	0.0077	0.0005 U	0.049	0.0378	0.0223	0.050
BA-1	11	0.0025	0.0010 U	0.003 U	0.0172	0.0036	0.038
BA-1	12	0.0025	0.0010 U	0.008	0.0119	0.0048	0.030
BA-1	13	0.0034	0.0010 U	0.006	0.0085	0.0041	0.035
BA-1	14	0.0027	0.0005 U	0.017	0.0246 J	0.0065	0.056
BA-1	15	0.0038	0.0005 U	0.004 J	0.0103 J	0.0026	0.017
BA-1	16	0.0033 M	0.0006 M	0.005 M	0.0117	0.0058	0.029
BA-1	17	0.0036	0.0011	0.003	0.0095 J	0.0045	0.041
BA-1	18	0.0054	0.0005 U	0.003 U	0.0161	0.0078	0.040
BA-1	19	0.0026	0.0010 U	0.016	0.0097 J	0.0105	0.040
BA-1	20	0.0033 M	0.0005 UM	0.014 M	0.0074 M	0.0019 JM	0.026 M
BA-1	21	0.0025	0.0005 U	0.014	0.0093	0.0048 J	0.021
BA-1	22	0.0034	0.0005 U	0.003 U	0.0061	0.0005 U	0.010
BA-1	23	0.0044	0.0009	0.017	0.0074	0.0048	0.024
BA-1	24	0.0081 M	0.0005 UM	0.018 M	0.0160 M	0.0090 M	0.052 M
BA-1	25	0.0045 M	0.0005 UM	0.003 UM	0.0042 M	0.0017 M	0.008 M
DM-1	1	0.0057	0.0016	0.042	0.0114	0.0094	0.056
DM-1	2	0.0132 C	0.0008	0.055	0.0555	0.0162 J	0.089
DM-1	3	0.0046	0.0005 U	0.023	0.0097	0.0055	0.111
DM-1	4	0.0063 C	0.0005 U	0.049 C	0.0243	0.0305	0.161
DM-1	5	0.0083 C	0.0010	0.033	0.0156	0.0044	0.124
DM-1	6	0.0055 C	0.0006	0.007	0.0084	0.0005 U	0.008
DM-1	7	0.0118 C	0.0005 U	0.031	0.0219	0.0157	0.080
DM-1	8	0.0103 C	0.0005 U	0.016	0.0305	0.0215	0.069
DM-1	9	0.0072 C	0.0009	0.019	0.0137	0.0124	0.063
DM-1	10	0.0122 C	0.0005 U	0.078 C	0.0256	0.0137	0.099
DM-1	11	0.0074	0.0012	0.022	0.0206	0.0229	0.060
DM-1	12	0.0054	0.0010 U	0.037	0.0140	0.0132	0.074
DM-1	13	0.0050	0.0010 U	0.020	0.0049	0.0037	0.034
DM-1	14	0.0059 C	0.0005 U	0.022	0.0122 J	0.0073	0.049
DM-1	15	0.0073	0.0014	0.011 J	0.0133 J	0.0063	0.023
DM-1	16	0.0054	0.0008	0.009	0.0121	0.0076	0.042
DM-1	17	0.0054	0.0005 U	0.003	0.0136 J	0.0082	0.046
DM-1	18	0.0092	0.0007	0.012	0.0274	0.0190	0.118
DM-1	19	0.0049	0.0010 U	0.027	0.0192 J	0.0118	0.052

Table B2. Storm flow data for the Des Moines Water Quality Monitoring Program.

Station	Event Number	Copper, Dis. (mg/L)	Lead, Dis. (mg/L)	Zinc, Dis. (mg/L)	Copper, Total (mg/L)	Lead, Total (mg/L)	Zinc, Total (mg/L)
DM-1	20	0.0057	0.0005 U	0.015	0.0106	0.0040 J	0.043
DM-1	21	0.0047	0.0005 U	0.014	0.0172	0.0169 J	0.064
DM-1	22	0.0055	0.0006	0.007	0.0068	0.0021	0.027
DM-1	23	0.0049	0.0012	0.012	0.0117	0.0136	0.056
DM-1	24	0.0106 C	0.0005 U	0.031	0.0140	0.0081	0.065
DM-1	25	0.0070	0.0013 J	0.013	0.0080	0.0056	0.020
DM-2	1	0.0038	0.0015	0.026	0.0238	0.0078	0.047
DM-2	2	0.0061	0.0005 U	0.030	0.0487	0.0023 J	0.030
DM-2	3	0.0034	0.0005 U	0.010	0.0083	0.0037	0.032
DM-2	4	0.0060	0.0005 U	0.050	0.0290	0.0394	0.144
DM-2	5	0.0049	0.0007	0.016	0.0134	0.0121	0.039
DM-2	6	0.0054 C	0.0008	0.004	0.0114	0.0005 U	0.005
DM-2	7	0.0063	0.0005 U	0.012	0.0146	0.0120	0.055
DM-2	8	0.0069	0.0005 U	0.010	0.0195	0.0148	0.047
DM-2	9	0.0077 M	0.0008 M	0.012 M	0.0164 M	0.0190 M	0.062 M
DM-2	10	0.0064	0.0005 U	0.029	0.0350	0.0314	0.092
DM-2	11	0.0040	0.0010 U	0.008	0.0165	0.0113	0.037
DM-2	12	0.0040	0.0010 U	0.026	0.0141	0.0107	0.060
DM-2	13	0.0039	0.0010 U	0.010	0.0073	0.0064	0.042
DM-2	14	0.0042	0.0007	0.016	0.0115 J	0.0071	0.044
DM-2	15	0.0048	0.0006	0.008 J	0.0155 J	0.0044	0.020
DM-2	16	0.0031	0.0006	0.004	0.0119	0.0056	0.032
DM-2	17	0.0039	0.0005 U	0.003	0.0088 J	0.0053	0.028
DM-2	18	0.0029	0.0005 U	0.003 U	0.0199	0.0145	0.092
DM-2	19	0.0042	0.0010 U	0.026	0.0167 J	0.0144	0.060
DM-2	20	0.0033	0.0005 U	0.013	0.0068	0.0023 J	0.034
DM-2	21	0.0031	0.0005 U	0.010	0.0115	0.0040 J	0.045
DM-2	22	0.0035	0.0005 U	0.004	0.0049	0.0011	0.015
DM-2	23	0.0068	0.0013	0.014	0.0125	0.0132	0.060
DM-2	24	0.0072	0.0005 U	0.016	0.0092	0.0045	0.028
DM-2	25	0.0034	0.0005 U	0.008	0.0035	0.0020	0.014
MA-1	1	0.0356 C	0.0027	0.089 C	0.0562	0.0131	0.103
MA-1	2	0.0029	0.0005 U	0.025	0.0289	0.0011 J	0.028
MA-1	3	0.0027	0.0022	0.036	0.0057	0.0052	0.053
MA-1	4	0.0063 C	0.0025	0.058 C	0.0067	0.0114	0.070
MA-1	5	0.0027	0.0005 U	0.023	0.0127	0.0141	0.061
MA-1	6	0.0027	0.0005 U	0.005	0.0063	0.0005 U	0.018
MA-1	7	0.0071	0.0010	0.048	0.0131	0.0092	0.073
MA-1	8	0.0068	0.0014	0.044	0.0214	0.0092	0.050
MA-1	9	0.0057 C	0.0024	0.041 C	0.0103	0.0138	0.059
MA-1	10	0.0080	0.0005 U	0.109 C	0.0131	0.0104	0.108
MA-1	11	0.0033	0.0032	0.040	0.0054	0.0106	0.062
MA-1	12	0.0019	0.0010 U	0.034	0.0042	0.0057	0.059
MA-1	13	0.0034	0.0013	0.027	0.0071	0.0049	0.024

Table B2. Storm flow data for the Des Moines Water Quality Monitoring Program.

Station	Event Number	Copper, Dis. (mg/L)		Lead, Dis. (mg/L)	Zinc, Dis. (mg/L)		Copper, Total (mg/L)	Lead, Total (mg/L)	Zinc, Total (mg/L)
MA-1	14	0.0030		0.0016	0.035		0.0060 J	0.0107	0.068
MA-1	15	0.0063		0.0031	0.037 J		0.0116 J	0.0105	0.044
MA-1	16	0.0029		0.0015	0.023		0.0137	0.0153	0.070
MA-1	17	0.0033 J		0.0010	0.021		0.0060 J	0.0083	0.058
MA-1	18	0.0075	C	0.0022	0.057	C	0.0175	0.0414	0.111
MA-1	19	0.0039		0.0010 U	0.047		0.0067 J	0.0053	0.058
MA-1	20	0.0050		0.0006	0.034		0.0068	0.0045 J	0.043
MA-1	21	0.0025		0.0005 U	0.044	C	0.0066	0.0116 J	0.062
MA-1	22	0.0032		0.0005 U	0.011		0.0040	0.0012	0.035
MA-1	23	0.0068		0.0041	0.037		0.0138	0.0547	0.085
MA-1	24	0.0080	C	0.0009	0.046	C	0.0259	0.0317	0.121
MA-1	25	0.0065	C	0.0041 J	0.042	C	0.0066	0.0119	0.061
MA-2	1	0.0023		0.0010	0.012		0.0124	0.0124	0.044
MA-2	2	0.0011		0.0012	0.020		0.0071	0.0054 J	0.024
MA-2	3	0.0028		0.0005 U	0.007		0.0056	0.0016	0.016
MA-2	4	0.0044		0.0006	0.031		0.0108	0.0221	0.062
MA-2	5	0.0022		0.0005 U	0.003 U		0.0248	0.0205	0.079
MA-2	6	0.0030		0.0005 U	0.003 U		0.0069	0.0005 U	0.007
MA-2	7	0.0046 M		0.0005 UM	0.016 M		0.0136 M	0.0138 M	0.054 M
MA-2	8	0.0052		0.0005 U	0.011		0.0124	0.0063	0.027
MA-2	9	0.0039		0.0005 U	0.010		0.0165	0.0154	0.043
MA-2	10	0.0040		0.0005 U	0.021		0.0078	0.0049	0.033
MA-2	11	0.0018		0.0010 U	0.008		0.0056	0.0054	0.023
MA-2	12	0.0011		0.0010 U	0.008		0.0107	0.0034	0.033
MA-2	13	0.0026		0.0010 U	0.013		0.0060	0.0057	0.107
MA-2	14	0.0022		0.0005 U	0.009		0.0073 J	0.0077	0.034
MA-2	15	0.0033		0.0005 U	0.015 J		0.0104 J	0.0080	0.018
MA-2	16	0.0020		0.0006	0.004		0.0158	0.0161	0.064
MA-2	17	0.0038		0.0007	0.012		0.0073 J	0.0072	0.029
MA-2	18	0.0059		0.0005 U	0.009		0.0150	0.0109	0.059
MA-2	19	0.0021		0.0010 U	0.027		0.0074 J	0.0044	0.023
MA-2	20	0.0038		0.0005 U	0.004		0.0057	0.0022 J	0.017
MA-2	21	0.0010 U		0.0005 U	0.006		0.0060	0.0050 J	0.018
MA-2	22	0.0035		0.0005 U	0.003 U		0.0042	0.0005 U	0.018
MA-2	23	0.0049		0.0018	0.013		0.0103	0.0122	0.043
MA-2	24	0.0119	C	0.0005 U	0.037		0.0105	0.0079	0.052
MA-2	25	0.0047		0.0005 J	0.011		0.0053	0.0030	0.022
MA-3	1	0.0013		0.0009	0.006		0.0073	0.0100	0.027
MA-3	2	0.0021		0.0005 U	0.009		0.0265	0.0019 J	0.020
MA-3	3	0.0025		0.0005 U	0.003		0.0061	0.0019	0.014
MA-3	4	0.0034		0.0005 U	0.010		0.0184	0.0435	0.110
MA-3	5	0.0025		0.0005 U	0.007		0.0192	0.0212	0.044
MA-3	6	0.0058	C	0.0005	0.004		0.0088	0.0005 U	0.003
MA-3	7	0.0043		0.0005 U	0.005		0.0150	0.0154	0.050

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Table B2. Storm flow data for the Des Moines Water Quality Monitoring Program.

Station	Event Number	Copper, Dis.. (mg/L)	Lead, Dis. (mg/L)	Zinc, Dis. (mg/L)	Copper, Total (mg/L)	Lead, Total (mg/L)	Zinc, Total (mg/L)
MA-3	8	0.0079 C	0.0005 U	0.008	0.0150	0.0045	0.024
MA-3	9	0.0027	0.0007	0.017	0.0108	0.0130	0.041
MA-3	10	0.0046	0.0005 U	0.024	0.0081	0.0056	0.025
MA-3	11	0.0017	0.0010 U	0.003 U	0.0077	0.0042	0.022
MA-3	12	0.0025	0.0010 U	0.026	0.0142	0.0068	0.048
MA-3	13	0.0028	0.0010 U	0.010	0.0051	0.0048	0.023
MA-3	14	0.0031	0.0005 U	0.019	0.0085 J	0.0059	0.037
MA-3	15	0.0048	0.0006	0.017 J	0.0104 J	0.0076	0.022
MA-3	16	0.0026	0.0005 U	0.004	0.0090	0.0080	0.028
MA-3	17	0.0035	0.0005 U	0.003	0.0080 J	0.0062	0.032
MA-3	18	0.0059	0.0005 U	0.007	0.0216	0.0081	0.080
MA-3	19	0.0023	0.0010 U	0.008	0.0096 J	0.0075	0.041
MA-3	20	0.0031	0.0005 U	0.004	0.0046	0.0014 J	0.022
MA-3	21	0.0016	0.0005 U	0.007	0.0065	0.0047 J	0.014
MA-3	22	0.0029	0.0005 U	0.003 U	0.0043	0.0005 U	0.016
MA-3	23	0.0046 M	0.0017 M	0.018 M	0.0106 M	0.0120 M	0.038 M
MA-3	24	0.0106 C	0.0026	0.022	0.0150	0.0110	0.060
MA-3	25	0.0039	0.0005 U	0.008	0.0057	0.0059	0.025
MC-1	1	0.0524 C	0.0010	0.016	0.0823	0.0038	0.031
MC-1	2	0.0019	0.0005 U	0.008	0.0055	0.0008 J	0.010
MC-1	3	0.0029	0.0007	0.005	0.0086	0.0027	0.014
MC-1	4	0.0027	0.0005 U	0.007	0.0042	0.0040	0.012
MC-1	5	0.0075	0.0015	0.007	0.0104	0.0076	0.021
MC-1	6	0.0063	0.0007	0.004	0.0073	0.0005 U	0.004
MC-1	7	0.0059	0.0005 U	0.008	0.0099	0.0017	0.014
MC-1	8	0.0057	0.0012	0.012	0.0119	0.0060	0.024
MC-1	9	0.0031	0.0012	0.014	0.0083	0.0041	0.017
MC-1	10	0.0031	0.0005 U	0.010	0.0043	0.0023	0.009
MC-1	11	0.0022	0.0010 U	0.003 U	0.0035	0.0012	0.009
MC-1	12	0.0031	0.0010 U	0.016	0.0075	0.0010 U	0.013
MC-1	13	0.0021	0.0010 U	0.007	0.0041	0.0020	0.009
MC-1	14	0.0016	0.0009	0.013	0.0041 J	0.0028	0.012
MC-1	15	0.0037	0.0012	0.006 J	0.0048 J	0.0031	0.022
MC-1	16	0.0040	0.0008	0.004	0.0079	0.0032	0.013
MC-1	17	0.0051	0.0005	0.003	0.0037 J	0.0022	0.008
MC-1	18	0.0020	0.0014	0.003 U	0.0058	0.0075	0.011
MC-1	19	0.0010 U	0.0010 U	0.016	0.0050 J	0.0073	0.015
MC-1	20	0.0023	0.0005 U	0.057	0.0027	0.0005 JU	0.068
MC-1	21	0.0026	0.0005 U	0.007	0.0059	0.0005 JU	0.003
MC-1	22	0.0012	0.0005 U	0.003 U	0.0021	0.0005 U	0.003 U
MC-1	23	0.0028	0.0013	0.003 U	0.0030	0.0026	0.007
MC-1	24	0.0086	0.0005 U	0.003 U	0.0053	0.0011	0.010
MC-1	25	0.0044	0.0005 U	0.016	0.0056	0.0005 U	0.010
MC-2	1	0.0051	0.0006	0.016	0.0134	0.0074	0.038

Table B2. Storm flow data for the Des Moines Water Quality Monitoring Program.

Station	Event Number	Copper, Dis. (mg/L)		Lead, Dis. (mg/L)	Zinc, Dis. (mg/L)	Copper, Total (mg/L)	Lead, Total (mg/L)	Zinc, Total (mg/L)
MC-2	2	0.0104		0.0037	0.029	0.0149	0.0068 J	0.047
MC-2	3	0.0058		0.0005 U	0.018	0.0131	0.0054	0.049
MC-2	4	0.0077 M	C	0.0012 M	0.021 M	0.0102 JM	0.0080 M	0.038 M
MC-2	5	0.0072	C	0.0005 U	0.013	0.0168	0.0068	0.042
MC-2	6	0.0044		0.0006	0.003 U	0.0051	0.0006	0.003 U
MC-2	7	0.0076		0.0005 U	0.010	0.0162	0.0064	0.037
MC-2	8	0.0073		0.0005 U	0.011	0.0136	0.0036	0.032
MC-2	9	0.0070		0.0007	0.012	0.0127	0.0054	0.037
MC-2	10	0.0054		0.0005 U	0.019	0.0091	0.0013	0.017
MC-2	11	0.0078		0.0010 U	0.015	0.0080	0.0016	0.029
MC-2	12	0.0060		0.0010 U	0.023	0.0067	0.0096	0.039
MC-2	13	0.0053		0.0010 U	0.010	0.0102	0.0041	0.039
MC-2	14	0.0055		0.0005 U	0.010	0.0084 J	0.0018	0.022
MC-2	15	0.0078		0.0005 U	0.008 J	0.0206 J	0.0041	0.028
MC-2	16	0.0077	C	0.0005 U	0.006	0.0168	0.0049	0.034
MC-2	17	0.0066		0.0005 U	0.014	0.0085 J	0.0031	0.012
MC-2	18	0.0083		0.0005 U	0.006	0.0214	0.0094	0.072
MC-2	19	0.0026		0.0010 U	0.017	0.0070 J	0.0020	0.022
MC-2	20	0.0061		0.0005 U	0.019	0.0139	0.0014 J	0.022
MC-2	21	0.0046		0.0005 U	0.008	0.0103	0.0055 J	0.028
MC-2	22	0.0047 M		0.0005 UM	0.003 UM	0.0073 M	0.0005 UM	0.014 M
MC-2	23	0.0081		0.0018	0.009	0.0124	0.0051	0.034
MC-2	24	0.0108	C	0.0005 U	0.033	0.0158	0.0066	0.054
MC-2	25	0.0053		0.0008 J	0.016	0.0060	0.0038	0.024

APPENDIX C

Water Quality Data Trend Analysis Results

Table C1. Analysis of spatial trends in storm flow samples collected from stations DM-1 and DM-2 based on the results from a signed-rank test.

Parameter	N	p-Value[a]	Median Difference (DM-2 – DM-1)[b]
Temperature	25	1.0000	0.0° C
pH	25	**0.0005**	0.27
Dissolved Oxygen	25	**0.0003**	0.40 mg/L
Conductivity	25	**0.0014**	20.1 µmhos/cm
Hardness	25	**0.0001**	11.0 mg $CaCO_3$/L
Turbidity	25	0.8383	0.0 NTU
Total Suspended Solids	25	**0.0003**	14.0 mg/L
Total Phosphorus	25	0.0953	7 µg/L
Ammonia Nitrogen	25	**0.0022**	-29 µg/L
Nitrate + Nitrite Nitrogen	25	**< 0.0001**	144 µg/L
Dissolved Copper	25	**0.0001**	-2.0 µg/L
Dissolved Lead	25	0.0961	0 µg/L
Dissolved Zinc	25	**0.0001**	-6.0 µg/L
Total Copper	25	0.2301	-1.9 µg/L
Total Lead	25	**0.0247**	-2 µg/L
Total Zinc	25	**0.0003**	-12 µg/L
Total Petroleum Hydrocarbons	25	**0.0389**	0.00 mg/L
Fecal Coliform Bacteria	25	0.3074	40/100 ml

[a] Values in bold indicate significant differences exist between stations DM-1 and DM-2 at a significance level of $\alpha = 0.05$.
[b] Median difference between stations (i.e., DM-2 - DM-1) across samples paired by sample date.

Table C2. Analysis of spatial trends in base flow samples collected from stations DM-1 and DM-2 based on the results from a signed-rank test.

Parameter	N	p-Value[a]	Median Difference (DM-2 – DM-1)[b]
Temperature	16	0.0614	0.6° C
pH	16	**0.0098**	0.14
Dissolved Oxygen	16	0.7893	0.00 mg/L
Conductivity	16	**0.0019**	14.0 µmhos/cm
Hardness	16	**0.0162**	4.4 mg $CaCO_3$/L
Turbidity	16	0.3017	-0.2 NTU
Total Suspended Solids	16	0.7893	0.20 mg/L
Total Phosphorus	16	0.7893	2 µg/L
Ammonia Nitrogen	16	0.0771	0 µg/L
Nitrate + Nitrite Nitrogen	16	0.1214	130 µg/L
Dissolved Copper	16	0.5791	-0.4 µg/L
Dissolved Lead	16	1.0000	0 µg/L
Dissolved Zinc	16	0.1824	0.0 µg/L
Fecal Coliform Bacteria	16	0.7893	4/100 ml

[a] Values in bold indicate significant differences exist between stations DM-1 and DM-2 at a significance level of $\alpha = 0.05$.

[b] Median difference between stations (i.e., DM-2 - DM-1) across samples paired by sample date.

Table C3. Analysis of spatial trends in base flow samples collected from stations MC-1 and MC-2 based on the results from a signed-rank test.

Parameter	N	p-Value[a]	Median Difference (MC-2 – MC-1)[b]
Temperature	14	0.0614	0.7° C
pH	14	**0.0005**	0.66
Dissolved Oxygen	14	**0.0162**	2.25 mg/L
Conductivity	14	0.1814	21.0 µmhos/cm
Hardness	14	0.1814	11.3 mg $CaCO_3$/L
Turbidity	14	0.2673	2.1 NTU
Total Suspended Solids	14	0.2673	0.80 mg/L
Total Phosphorus	14	**0.0162**	-40 µg/L
Ammonia Nitrogen	14	0.1138	2 µg/L
Nitrate + Nitrite Nitrogen	14	0.0614	90 µg/L
Dissolved Copper	14	**0.0149**	0.7 µg/L
Dissolved Lead	14	0.4795	0 µg/L
Dissolved Zinc	14	0.2207	0.0 µg/L
Fecal Coliform Bacteria	14	0.4227	-148/100 ml

a Values in bold indicate significant differences exist between stations MC-1 and MC-2 at a significance level of $\alpha = 0.05$.
b Median difference between stations (i.e., MC-2 - MC-1) across samples paired by sample date.

Table C4. Analysis of spatial trends in storm flow samples collected from stations MC-1 and MC-2 based on the results from a signed-rank test.

Parameter	N	p-Value[a]	Median Difference (MC-2 – MC-1)[b]
Temperature	25	**< 0.0001**	1.2 °C
pH	25	**0.0001**	0.50
Dissolved Oxygen	25	**< 0.0001**	2.55 mg/L
Conductivity	25	**0.0455**	-21.2 µmhos/cm
Hardness	25	**0.0164**	-9.00 mg $CaCO_3$/L
Turbidity	25	**< 0.0001**	12.9 NTU
Total Suspended Solids	25	**0.0455**	11.7 mg/L
Total Phosphorus	25	0.4237	-15 µg/L
Ammonia Nitrogen	25	**< 0.0001**	20 µg/L
Nitrate + Nitrite Nitrogen	25	**0.0164**	158 µg/L
Dissolved Copper	25	**0.0003**	2.9 µg/L
Dissolved Lead	25	0.1814	0 µg/L
Dissolved Zinc	25	**0.0190**	2.0 µg/L
Total Copper	25	**0.0003**	4.8 µg/L
Total Lead	25	**0.0080**	2 µg/L
Total Zinc	25	**0.0001**	20.0 µg/L
Total Petroleum Hydrocarbons	25	**0.0159**	0.00 mg/L
Fecal Coliform Bacteria	25	0.8383	220/100 ml

[a] Values in bold indicate significant differences exist between stations MC-1 and MC-2 at a significance level of $\alpha = 0.05$.

[b] Median difference between stations (i.e., MC-2 - MC-1) across samples paired by sample date.

Table C5. Analysis for spatial trends in storm flow samples collected at stations MA-1, MA-2, MA-3, and BA-1 based on results from a Freidman test and a nonparametric multiple comparison test.

		Station[b]			
Parameter	p-Value[a]	Low Mean Rank			High Mean Rank
Temperature	**< 0.0001**	BA-1	MA-3	MA-1	MA-2
pH	**< 0.0001**	MA-1	MA-3	MA-2	BA-1
Dissolved Oxygen	**0.0001**	MA-1	MA-3	MA-2	BA-1
Conductivity	**< 0.0001**	MA-2	MA-1	MA-3	BA-1
Hardness	**< 0.0001**	MA-2	MA-1	MA-3	BA-1
Turbidity	**< 0.0001**	MA-1	MA-2	MA-3	BA-1
Total Suspended Solids	**< 0.0001**	MA-1	MA-2	MA-3	BA-1
Total Phosphorus	**< 0.0001**	MA-1	MA-2	MA-3	BA-1
Ammonia Nitrogen	**< 0.0001**	MA-3	BA-1	MA-2	MA-1
Nitrate + Nitrite	**< 0.0001**	MA-2	MA-1	MA-3	BA-1
Dissolved Copper	**0.0022**	MA-2	MA-1	MA-3	BA-1
Dissolved Lead	**< 0.0001**	MA-3	BA-1	MA-2	MA-1
Dissolved Zinc	**< 0.0001**	BA-1	MA-3	MA-2	MA-1
Total Copper	0.1313	MA-2	MA-1	MA-3	BA-1
Total Lead	**0.0001**	BA-1	MA-3	MA-2	MA-1
Total Zinc	**< 0.0001**	BA-1	MA-3	MA-2	MA-1
Total Petroleum Hydrocarbons	**< 0.0001**	BA-1	MA-3	MA-2	MA-1
Fecal Coliform Bacteria	0.5766	BA-1	MA-1	MA-2	MA-3

[a] Values in bold indicate significant differences exist between monitoring stations at a significance level of $\alpha = 0.05$.
[b] Stations connected by a single unbroken line are not significantly different at $\alpha = 0.05$.

Table C6. **Analysis for spatial trends in base flow samples collected at stations MA-1, MA-2, MA-3, and BA-1 based on results from a Freidman test and a nonparametric multiple comparison test.**

Parameter	p-Value[a]	Station[b] Low Mean Rank			High Mean Rank
Temperature	**0.0138**	BA-1	MA-3	MA-1	MA-2
pH	**< 0.0001**	MA-1	MA-3	MA-2	BA-1
Dissolved Oxygen	**0.0121**	BA-1	MA-3	MA-2	MA-1
Conductivity	**0.0008**	BA-1	MA-3	MA-2	MA-1
Hardness	**0.0104**	MA-2	BA-1	MA-3	MA-1
Turbidity	**< 0.0001**	MA-3	MA-2	BA-1	MA-1
Total Suspended Solids	**0.0043**	MA-2	MA-3	BA-1	MA-1
Total Phosphorus	**< 0.0001**	MA-2	MA-1	MA-3	BA-1
Ammonia Nitrogen	**< 0.0001**	BA-1	MA-2	MA-3	MA-1
Nitrate + Nitrite	**0.0091**	BA-1	MA-1	MA-3	MA-2
Dissolved Copper	**0.0014**	MA-1	MA-2	MA-3	BA-1
Dissolved Lead	0.5616	MA-3	BA-1	MA-2	MA-1
Dissolved Zinc	**0.0008**	MA-3	MA-2	BA-1	MA-1
Fecal Coliform Bacteria	**0.0018**	MA-1	MA-3	MA-2	BA-1

[a] Values in bold indicate significant differences exist between monitoring stations at a significance level of $\alpha = 0.05$.

[b] Stations connected by a single unbroken line are not significantly different at $\alpha = 0.05$.

Table C7. Analysis for temporal trends in storm flow samples collected from station DM-1 based on the results from a Kruskal-Wallis ANOVA and nonparametric multiple comparison test.

	N	p-Value[a]	Year[b] Low Mean Rank				High Mean Rank
Temperature	25	0.9825	97/98	96/97	94/95	95/96	98/99
pH	25	0.5725	96/97	95/96	97/98	94/95	98/99
Dissolved Oxygen	25	0.7810	97/98	95/96	98/99	96/97	94/95
Conductivity	25	0.0966	95/96	97/98	94/95	96/97	98/99
Hardness	25	0.2398	97/98	95/96	94/95	96/97	98/99
Turbidity	25	0.2398	96/97	94/95	98/99	95/96	97/98
Total Suspended Solids	25	0.2000	96/97	94/95	97/98	98/99	95/96
Total Phosphorus	25	0.3553	96/97	94/95	97/98	98/99	95/96
Ammonia Nitrogen	25	0.9635	97/98	95/96	96/97	94/95	98/99
Nitrate + Nitrite Nitrogen	25	0.1900	96/97	97/98	95/96	94/95	98/99
Dissolved Copper	25	0.3214	97/98	96/97	98/99	94/95	95/96
Dissolved Lead	25	0.3783	95/96	97/98	94/95	98/99	96/97
Dissolved Zinc	25	**0.0362**	97/98	98/99	96/97	95/96	94/95
Total Copper	25	0.3287	98/99	96/97	97/98	94/95	95/96
Total Lead	25	0.8174	97/98	96/97	98/99	94/95	95/96
Total Zinc	25	0.8174	97/98	96/97	98/99	95/96	94/95
Total Petroleum Hydrocarbons	25	0.0932	94/95	96/97	97/98	95/96	98/99
Fecal Coliform Bacteria	25	0.3733	98/99	96/97	97/98	95/96	94/95

[a] Values in bold indicate significant differences exist between monitoring years at a significance level of $\alpha = 0.05$.

[b] Years connected by a single unbroken line are not significantly different at $\alpha = 0.05$.

Table C8. **Analysis for temporal trends in storm flow samples collected from station DM-2 based on the results from a Kruskal-Wallis ANOVA and nonparametric multiple comparison test.**

			Year[b]				
	N	p-Value[a]	Low Mean Rank				High Mean Rank
Temperature	25	0.9582	97/98	96/97	94/95	95/96	98/99
pH	25	0.5906	96/97	95/96	94/95	97/98	98/99
Dissolved Oxygen	25	0.7943	95/96	97/98	96/97	98/99	94/95
Conductivity	25	0.0751	95/96	97/98	94/95	96/97	98/99
Hardness	25	0.1226	97/98	95/96	94/95	96/97	98/99
Turbidity	25	0.1026	94/95	96/97	98/99	95/96	97/98
Total Suspended Solids	25	0.0589	94/95	96/97	98/99	97/98	95/96
Total Phosphorus	25	0.1337	94/95	96/97	97/98	98/99	95/96
Ammonia Nitrogen	25	0.4193	98/99	97/98	94/95	95/96	96/97
Nitrate + Nitrite Nitrogen	25	0.2485	97/98	96/97	95/96	98/99	94/95
Dissolved Copper	25	**0.0437**	97/98	96/97	94/95	98/99	95/96
Dissolved Lead	25	0.2333	97/98	95/96	98/99	94/95	96/97
Dissolved Zinc	25	0.1328	97/98	96/97	95/96	98/99	94/95
Total Copper	25	0.0547	98/99	97/98	96/97	95/96	94/95
Total Lead	25	0.2202	98/99	97/98	96/97	94/95	95/96
Total Zinc	25	0.6017	98/99	97/98	96/97	94/95	95/96
Total Petroleum Hydrocarbons	25	0.3822	94/95	97/98	98/99	96/97	95/96
Fecal Coliform Bacteria	25	0.2622	98/99	97/98	96/97	95/96	94/95

[a] Values in bold indicate significant differences exist between monitoring years at a significance level of $\alpha = 0.05$.

[b] Years connected by a single unbroken line are not significantly different at $\alpha = 0.05$.

Table C9. Analysis for temporal trends in storm flow samples collected from station MA-1 based on the results from a Kruskal-Wallis ANOVA and nonparametric multiple comparison test.

	N	p-Value[a]	Year[b] Low Mean Rank				High Mean Rank
Temperature	25	0.9899	97/98	96/97	95/96	94/95	98/99
pH	25	0.3687	96/97	95/96	97/98	94/95	98/99
Dissolved Oxygen	25	0.9535	97/98	95/96	96/97	98/99	94/95
Conductivity	25	0.8008	94/95	97/98	95/96	96/97	98/99
Hardness	25	0.7085	97/98	95/96	94/95	96/97	98/99
Turbidity	25	0.5991	95/96	96/97	94/95	97/98	98/99
Total Suspended Solids	25	0.7478	94/95	97/98	96/97	95/96	98/99
Total Phosphorus	25	0.1719	94/95	96/97	95/96	97/98	98/99
Ammonia Nitrogen	25	0.8799	97/98	94/95	95/96	98/99	96/97
Nitrate + Nitrite Nitrogen	25	0.6871	97/98	96/97	95/96	94/95	98/99
Dissolved Copper	25	0.5972	96/97	97/98	94/95	98/99	95/96
Dissolved Lead	25	0.6653	95/96	97/98	94/95	98/99	96/97
Dissolved Zinc	25	0.8274	97/98	96/97	98/99	94/95	95/96
Total Copper	25	0.3861	96/97	97/98	98/99	95/96	94/95
Total Lead	25	0.7862	95/96	96/97	97/98	94/95	98/99
Total Zinc	25	0.8819	96/97	97/98	95/96	94/95	98/99
Total Petroleum Hydrocarbons	25	0.0643	94/95	95/96	97/98	96/97	98/99
Fecal Coliform Bacteria	25	0.8151	96/97	95/96	97/98	94/95	98/99

[a] Values in bold indicate significant differences exist between monitoring years at a significance level of $\alpha = 0.05$.

[b] Years connected by a single unbroken line are not significantly different at $\alpha = 0.05$.

Table C10. Analysis for temporal trends in storm flow samples collected from station MA-2 based on the results from a Kruskal-Wallis ANOVA and nonparametric multiple comparison test.

	N	p-Value[a]	Year[b] Low Mean Rank				High Mean Rank
Temperature	25	0.9472	94/95	97/98	96/97	95/96	98/99
pH	25	0.5854	94/95	95/96	97/98	96/97	98/99
Dissolved Oxygen	25	0.9534	96/97	97/98	95/96	94/95	98/99
Conductivity	25	0.9405	97/98	95/96	94/95	96/97	98/99
Hardness	25	0.4294	97/98	95/96	94/95	96/97	98/99
Turbidity	25	0.5510	96/97	94/95	98/99	97/98	95/96
Total Suspended Solids	25	0.6574	97/98	96/97	98/99	94/95	95/96
Total Phosphorus	25	0.5200	96/97	94/95	97/98	98/99	95/96
Ammonia Nitrogen	25	0.9050	97/98	94/95	96/97	98/99	95/96
Nitrate + Nitrite Nitrogen	25	0.6899	97/98	96/97	95/96	94/95	98/99
Dissolved Copper	25	0.1135	96/97	94/95	97/98	95/96	98/99
Dissolved Lead	25	0.1917	95/96	97/98	98/99	94/95	96/97
Dissolved Zinc	25	0.9788	97/98	98/99	96/97	94/95	95/96
Total Copper	25	0.1322	98/99	96/97	97/98	94/95	95/96
Total Lead	25	0.489	98/99	96/97	97/98	95/96	94/95
Total Zinc	25	0.5951	98/99	95/96	97/98	96/97	94/95
Total Petroleum Hydrocarbons	25	0.2406	94/95	97/98	95/96	96/97	98/99
Fecal Coliform Bacteria	25	0.8878	96/97	97/98	94/95	98/99	95/96

[a] Values in bold indicate significant differences exist between monitoring years at a significance level of $\alpha = 0.05$.

[b] Years connected by a single unbroken line are not significantly different at $\alpha = 0.05$.

Table C11. Analysis for temporal trends in storm flow samples collected from station MA-3 based on the results from a Kruskal-Wallis ANOVA and nonparametric multiple comparison test.

	N	p-Value[a]	Year[b] Low Mean Rank				High Mean Rank
Temperature	25	0.9393	94/95	96/97	97/98	95/96	98/99
pH	25	0.7587	96/97	94/95	95/96	97/98	98/99
Dissolved Oxygen	25	0.7349	95/96	97/98	96/97	98/99	94/95
Conductivity	25	0.8066	97/98	95/96	94/95	96/97	98/99
Hardness	25	0.6105	97/98	95/96	94/95	96/97	98/99
Turbidity	25	0.4462	94/95	96/97	95/96	98/99	97/98
Total Suspended Solids	25	0.6902	97/98	96/97	94/95	98/99	95/96
Total Phosphorus	25	0.7364	96/97	94/95	97/98	98/99	95/96
Ammonia Nitrogen	25	0.6970	97/98	98/99	96/97	94/95	95/96
Nitrate + Nitrite Nitrogen	25	0.7491	97/98	95/96	96/97	94/95	98/99
Dissolved Copper	25	0.1288	94/95	97/98	96/97	98/99	95/96
Dissolved Lead	25	0.2898	97/98	95/96	94/95	98/99	96/97
Dissolved Zinc	25	0.4370	97/98	94/95	95/96	98/99	96/97
Total Copper	25	0.2821	98/99	96/97	97/98	95/96	94/95
Total Lead	25	0.7565	96/97	97/98	95/96	98/99	94/95
Total Zinc	25	0.6645	96/97	95/96	98/99	94/95	97/98
Total Petroleum Hydrocarbons	25	0.2541	94/95	95/96	96/97	97/98	98/99
Fecal Coliform Bacteria	25	0.6654	96/97	94/95	97/98	98/99	95/96

[a] Values in bold indicate significant differences exist between monitoring years at a significance level of $\alpha = 0.05$.
[b] Years connected by a single unbroken line are not significantly different at $\alpha = 0.05$.

Table C12. Analysis for temporal trends in storm flow samples collected from station BA-1 based on the results from a Kruskal-Wallis ANOVA and nonparametric multiple comparison test.

	N	p-Value[a]	Year[b] Low Mean Rank				High Mean Rank
Temperature	25	0.9297	94/95	96/97	97/98	95/96	98/99
pH	25	0.3540	95/96	94/95	96/97	97/98	98/99
Dissolved Oxygen	25	0.9259	95/96	97/98	96/97	98/99	94/95
Conductivity	25	0.1031	97/98	95/96	94/95	96/97	98/99
Hardness	25	0.3692	97/98	95/96	94/95	96/97	98/99
Turbidity	25	0.1560	94/95	95/96	96/97	97/98	98/99
Total Suspended Solids	25	0.3520	94/95	97/98	98/99	96/97	95/96
Total Phosphorus	25	0.3231	94/95	96/97	98/99	97/98	95/96
Ammonia Nitrogen	25	0.4920	94/95	98/99	97/98	96/97	95/96
Nitrate + Nitrite Nitrogen	25	0.7819	97/98	96/97	95/96	94/95	98/99
Dissolved Copper	25	0.0760	96/97	97/98	94/95	98/99	95/96
Dissolved Lead	25	0.2581	94/95	98/99	95/96	97/98	96/97
Dissolved Zinc	25	0.8344	97/98	94/95	96/97	95/96	98/99
Total Copper	25	0.1803	98/99	97/98	94/95	96/97	95/96
Total Lead	25	0.5537	96/97	98/99	94/95	97/98	95/96
Total Zinc	25	0.5661	98/99	95/96	94/95	97/98	96/97
Total Petroleum Hydrocarbons	25	0.6794	94/95	97/98	96/97	98/99	95/96
Fecal Coliform Bacteria	25	0.1352	96/97	98/99	94/95	97/98	95/96

[a] Values in bold indicate significant differences exist between monitoring years at a significance level of $\alpha = 0.05$.

[b] Years connected by a single unbroken line are not significantly different at $\alpha = 0.05$.

Table C13. Analysis for temporal trends in storm flow samples collected from station MC-1 based on the results from a Kruskal-Wallis ANOVA and nonparametric multiple comparison test.

	N	p-Value[a]	Year[b] Low Mean Rank				High Mean Rank
Temperature	25	0.9259	94/95	96/97	97/98	95/96	98/99
pH	25	0.8148	96/97	94/95	97/98	95/96	98/99
Dissolved Oxygen	25	0.6319	94/95	97/98	96/97	95/96	98/99
Conductivity	25	0.3967	95/96	97/98	96/97	94/95	98/99
Hardness	25	0.4168	95/96	97/98	94/95	96/97	98/99
Turbidity	25	0.1329	96/97	98/99	97/98	94/95	95/96
Total Suspended Solids	25	0.0621	98/99	96/97	94/95	97/98	95/96
Total Phosphorus	25	0.2984	96/97	94/95	98/99	97/98	95/96
Ammonia Nitrogen	25	0.3933	94/95	97/98	98/99	96/97	95/96
Nitrate + Nitrite Nitrogen	25	0.3446	97/98	98/99	94/95	96/97	95/96
Dissolved Copper	25	0.3187	97/98	96/97	98/99	94/95	95/96
Dissolved Lead	25	0.3368	98/99	97/98	94/95	95/96	96/97
Dissolved Zinc	25	0.7201	97/98	96/97	98/99	94/95	95/96
Total Copper	25	0.0548	96/97	98/99	97/98	94/95	95/96
Total Lead	25	**0.0321**	98/99	96/97	95/96	97/98	94/95
Total Zinc	25	0.4283	97/98	98/99	96/97	95/96	94/95
Total Petroleum Hydrocarbons	25	0.6034	97/98	94/95	95/96	96/97	98/99
Fecal Coliform Bacteria	25	0.0916	96/97	98/99	94/95	97/98	95/96

[a] Values in bold indicate significant differences exist between monitoring years at a significance level of $\alpha = 0.05$.

[b] Years connected by a single unbroken line are not significantly different at $\alpha = 0.05$.

Table C14. **Analysis for temporal trends in storm flow samples collected from station MC-2 based on the results from a Kruskal-Wallis ANOVA and nonparametric multiple comparison test.**

	N	p-Value[a]	Year[b] Low Mean Rank				High Mean Rank
Temperature	25	0.8695	96/97	94/95	97/98	95/96	98/99
pH	25	0.4902	96/97	95/96	97/98	94/95	98/99
Dissolved Oxygen	25	0.9052	95/96	97/98	96/97	94/95	98/99
Conductivity	25	0.9355	94/95	97/98	96/97	95/96	98/99
Hardness	25	0.6028	94/95	98/99	96/97	95/96	97/98
Turbidity	25	0.1216	96/97	95/96	97/98	94/95	98/99
Total Suspended Solids	25	0.2386	96/97	97/98	98/99	94/95	95/96
Total Phosphorus	25	0.0888	96/97	94/95	97/98	98/99	95/96
Ammonia Nitrogen	25	0.1881	94/95	97/98	98/99	95/96	96/97
Nitrate + Nitrite Nitrogen	25	0.1616	97/98	95/96	98/99	96/97	94/95
Dissolved Copper	25	0.9622	97/98	95/96	98/99	96/97	94/95
Dissolved Lead	25	0.6527	97/98	95/96	98/99	96/97	94/95
Dissolved Zinc	25	0.3410	96/97	97/98	95/96	98/99	94/95
Total Copper	25	0.6510	95/96	97/98	96/97	98/99	94/95
Total Lead	25	0.1520	95/96	97/98	96/97	98/99	94/95
Total Zinc	25	0.1576	97/98	95/96	98/99	96/97	94/95
Total Petroleum Hydrocarbons	25	0.7247	94/95	97/98	95/96	96/97	98/99
Fecal Coliform Bacteria	25	0.4604	96/97	97/98	94/95	95/96	98/99

[a] Values in bold indicate significant differences exist between monitoring years at a significance level of $\alpha = 0.05$.
[b] Years connected by a single unbroken line are not significantly different at $\alpha = 0.05$.

Table C15. Analysis for temporal trends in base flow samples collected from station DM-1 based on the results from a Kruskal-Wallis ANOVA and nonparametric multiple comparison test.

	N	p-Value[a]	Year[b] Low Mean Rank				High Mean Rank
Temperature	15	0.9429	97/98	96/97	95/96	94/95	98/99
pH	15	0.4199	96/97	97/98	98/99	95/96	94/95
Dissolved Oxygen	15	0.7409	96/97	98/99	95/96	97/98	94/95
Conductivity	15	0.2594	94/95	96/97	95/96	98/99	97/98
Hardness	15	0.8926	94/95	96/97	95/96	98/99	97/98
Turbidity	15	0.4572	98/99	97/98	94/95	95/96	96/97
Total Suspended Solids	15	0.6854	94/95	97/98	95/96	98/99	96/97
Total Phosphorus	15	0.9289	95/96	98/99	96/97	94/95	97/98
Ammonia Nitrogen	15	0.9184	97/98	94/95	95/96	98/99	96/97
Nitrate + Nitrite Nitrogen	15	0.5412	98/99	96/97	94/95	97/98	95/96
Dissolved Copper	15	0 4067	98/99	97/98	96/97	95/96	94/95
Dissolved Lead	15	0.5188	95/96	97/98	98/99	94/95	96/97
Dissolved Zinc	15	0.7769	97/98	98/99	95/96	96/97	94/95
Fecal Coliform Bacteria	15	0.6937	97/98	96/97	98/99	95/96	94/95

[a] Values in bold indicate significant differences exist between monitoring years at a significance level of $\alpha = 0.05$.

[b] Years connected by a single unbroken line are not significantly different at $\alpha = 0.05$.

Table C16. Analysis for temporal trends in base flow samples collected from station DM-2 based on the results from a Kruskal-Wallis ANOVA and nonparametric multiple comparison test.

			Year[b]				
	N	p-Value[a]	Low Mean Rank				High Mean Rank
Temperature	15	0.9631	95/96	94/95	96/97	97/98	98/99
pH	15	0.2026	97/98	96/97	94/95	98/99	95/96
Dissolved Oxygen	15	0.7830	96/97	98/99	97/98	94/95	95/96
Conductivity	15	0.6364	94/95	95/96	96/97	98/99	97/98
Hardness	15	0.9255	96/97	95/96	94/95	98/99	97/98
Turbidity	15	0.5659	98/99	97/98	95/96	94/95	96/97
Total Suspended Solids	15	0.6267	97/98	94/95	95/96	98/99	96/97
Total Phosphorus	15	0.9279	95/96	96/97	94/95	97/98	98/99
Ammonia Nitrogen	15	0.9195	98/99	97/98	96/97	94/95	95/96
Nitrate + Nitrite Nitrogen	15	0.0603	94/95	97/98	98/99	96/97	95/96
Dissolved Copper	15	0.3583	98/99	97/98	94/95	95/96	96/97
Dissolved Lead	15	0.5188	95/96	97/98	98/99	96/97	94/95
Dissolved Zinc	15	0.8883	95/96	97/98	96/97	98/99	94/95
Fecal Coliform Bacteria	15	0.3972	96/97	97/98	98/99	95/96	94/95

[a] Values in bold indicate significant differences exist between monitoring years at a significance level of $\alpha = 0.05$.

[b] Years connected by a single unbroken line are not significantly different at $\alpha = 0.05$.

Table C17. Analysis for temporal trends in base flow samples collected from station MA-1 based on the results from a Kruskal-Wallis ANOVA and nonparametric multiple comparison test.

	N	p-Value[a]	Year[b] Low Mean Rank				High Mean Rank
Temperature	15	0.9856	95/96	96/97	94/95	98/99	97/98
pH	15	0.2267	96/97	97/98	98/99	95/96	94/95
Dissolved Oxygen	15	0.8732	98/99	94/95	96/97	97/98	95/96
Conductivity	15	0.3819	95/96	94/95	96/97	98/99	97/98
Hardness	15	0.4757	95/96	96/97	98/99	94/95	97/98
Turbidity	15	0.5120	94/95	96/97	95/96	98/99	97/98
Total Suspended Solids	15	0.4052	94/95	98/99	97/98	96/97	95/96
Total Phosphorus	15	0.6900	94/95	96/97	97/98	95/96	98/99
Ammonia Nitrogen	15	0.7174	97/98	98/99	96/97	95/96	94/95
Nitrate + Nitrite Nitrogen	15	**0.0491**	98/99	97/98	94/95	96/97	95/96
Dissolved Copper	15	0.5188	96/97	97/98	98/99	95/96	94/95
Dissolved Lead	15	0.6685	97/98	98/99	94/95	96/97	95/96
Dissolved Zinc	15	0.7808	97/98	98/99	95/96	94/95	96/97
Fecal Coliform Bacteria	15	0.6595	97/98	95/96	98/99	96/97	94/95

[a] Values in bold indicate significant differences exist between monitoring years at a significance level of $\alpha = 0.05$.

[b] Years connected by a single unbroken line are not significantly different at $\alpha = 0.05$.

Table C18. **Analysis for temporal trends in base flow samples collected from station MA-2 based on the results from a Kruskal-Wallis ANOVA and nonparametric multiple comparison test.**

	N	p-Value[a]	Year[b] Low Mean Rank				High Mean Rank
Temperature	15	0.9472	94/95	95/96	96/97	98/99	97/98
pH	15	0.9480	96/97	97/98	98/99	94/95	95/96
Dissolved Oxygen	15	0.8995	96/97	98/99	95/96	97/98	94/95
Conductivity	15	0.2471	94/95	95/96	96/97	98/99	97/98
Hardness	15	0.3505	96/97	98/99	94/95	95/96	97/98
Turbidity	15	0.7421	96/97	97/98	94/95	95/96	98/99
Total Suspended Solids	15	0.8015	96/97	94/95	97/98	95/96	98/99
Total Phosphorus	15	0.6969	96/97	95/96	94/95	97/98	98/99
Ammonia Nitrogen	15	0.2394	97/98	98/99	95/96	96/97	94/95
Nitrate + Nitrite Nitrogen	15	**0.0221**	94/95	97/98	98/99	95/96	96/97
Dissolved Copper	15	0.4738	97/98	98/99	96/97	94/95	95/96
Dissolved Lead	15	0.5188	95/96	97/98	98/99	94/95	96/97
Dissolved Zinc	15	0.4497	94/95	96/97	98/99	97/98	95/96
Fecal Coliform Bacteria	15	0.9789	96/97	97/98	94/95	95/96	98/99

[a] Values in bold indicate significant differences exist between monitoring years at a significance level of $\alpha = 0.05$.

[b] Years connected by a single unbroken line are not significantly different at $\alpha = 0.05$.

Table C19. Analysis for temporal trends in base flow samples collected from station MA-3 based on the results from a Kruskal-Wallis ANOVA and nonparametric multiple comparison test.

	N	p-Value[a]	Year[b]				
			Low Mean Rank				High Mean Rank
Temperature	15	0.9742	95/96	96/97	94/95	97/98	98/99
pH	15	0.6128	96/97	98/99	97/98	94/95	95/96
Dissolved Oxygen	15	0.9310	98/99	96/97	94/95	95/96	97/98
Conductivity	15	0.2267	95/96	94/95	96/97	98/99	97/98
Hardness	15	0.5916	96/97	95/96	98/99	97/98	94/95
Turbidity	15	0.7083	94/95	97/98	96/97	95/96	98/99
Total Suspended Solids	15	0.2402	97/98	94/95	96/97	95/96	98/99
Total Phosphorus	15	0.4936	96/97	95/96	94/95	98/99	97/98
Ammonia Nitrogen	15	0.1290	97/98	98/99	96/97	95/96	94/95
Nitrate + Nitrite Nitrogen	15	0.1881	97/98	94/95	98/99	95/96	96/97
Dissolved Copper	15	0.7663	94/95	98/99	96/97	97/98	95/96
Dissolved Lead	15	0.5188	94/95	97/98	98/99	95/96	96/97
Dissolved Zinc	15	0.5188	94/95	96/97	97/98	95/96	98/99
Fecal Coliform Bacteria	15	0.7174	96/97	97/98	94/95	98/99	95/96

[a] Values in bold indicate significant differences exist between monitoring years at a significance level of $\alpha = 0.05$.
[b] Years connected by a single unbroken line are not significantly different at $\alpha = 0.05$.

Table C20. **Analysis for temporal trends in base flow samples collected from station BA-1 based on the results from a Kruskal-Wallis ANOVA and nonparametric multiple comparison test.**

	N	p-Value[a]	Year[b]				
			Low Mean Rank				High Mean Rank
Temperature	15	0.9665	95/96	94/95	96/97	97/98	98/99
pH	15	0.8462	96/97	95/96	98/99	97/98	94/95
Dissolved Oxygen	15	0.7322	98/99	96/97	95/96	97/98	94/95
Conductivity	15	0.6868	95/96	94/95	96/97	98/99	97/98
Hardness	15	0.8384	96/97	95/96	98/99	94/95	97/98
Turbidity	15	0.7719	94/95	97/98	96/97	98/99	95/96
Total Suspended Solids	15	0.5959	94/95	97/98	96/97	95/96	98/99
Total Phosphorus	15	0.4678	95/96	96/97	94/95	97/98	98/99
Ammonia Nitrogen	15	0.1870	96/97	97/98	98/99	94/95	95/96
Nitrate + Nitrite Nitrogen	15	0.0780	97/98	96/97	94/95	98/99	95/96
Dissolved Copper	15	0.8926	97/98	98/99	96/97	94/95	95/96
Dissolved Lead	15	0.5188	94/95	97/98	98/99	95/96	96/97
Dissolved Zinc	15	0.5168	97/98	96/97	98/99	94/95	95/96
Fecal Coliform Bacteria	15	0.2411	96/97	95/96	94/95	97/98	98/99

[a] Values in bold indicate significant differences exist between monitoring years at a significance level of $\alpha = 0.05$.

[b] Years connected by a single unbroken line are not significantly different at $\alpha = 0.05$.

Table C21. Analysis for temporal trends in base flow samples collected from station MC-1 based on the results from a Kruskal-Wallis ANOVA and nonparametric multiple comparison test.

			Year[b]				
	N	p-Value[a]	Low Mean Rank				High Mean Rank
Temperature	14	0.6730	94/95	95/96	96/97	97/98	98/99
pH	14	0.2819	94/95	96/97	98/99	97/98	95/96
Dissolved Oxygen	14	0.6938	96/97	94/95	95/96	98/99	97/98
Conductivity	14	0.6981	94/95	95/96	96/97	98/99	97/98
Hardness	14	0.6955	94/95	95/96	96/97	97/98	98/99
Turbidity	14	0.4455	94/95	96/97	98/99	97/98	95/96
Total Suspended Solids	14	0.5173	94/95	96/97	98/99	97/98	95/96
Total Phosphorus	14	0.2674	94/95	98/99	96/97	95/96	97/98
Ammonia Nitrogen	14	0.9380	94/95	97/98	98/99	96/97	95/96
Nitrate + Nitrite Nitrogen	14	0.7271	98/99	97/98	94/95	96/97	95/96
Dissolved Copper	14	0.3339	98/99	94/95	97/98	96/97	95/96
Dissolved Lead	14	0.2764	94/95	97/98	98/99	96/97	95/96
Dissolved Zinc	14	0.9724	94/95	95/96	97/98	98/99	96/97
Fecal Coliform Bacteria	14	0.4936	96/97	97/98	95/96	94/95	98/99

[a] Values in bold indicate significant differences exist between monitoring years at a significance level of $\alpha = 0.05$.

[b] Years connected by a single unbroken line are not significantly different at $\alpha = 0.05$.

Table C22. Analysis for temporal trends in base flow samples collected from station MC-2 based on the results from a Kruskal-Wallis ANOVA and nonparametric multiple comparison test.

	N	p-Value[a]	Year[b] Low Mean Rank				High Mean Rank
Temperature	15	0.9957	95/96	94/95	97/98	98/99	96/97
pH	15	0.7174	96/97	95/96	94/95	98/99	97/98
Dissolved Oxygen	15	0.8873	94/95	96/97	98/99	95/96	97/98
Conductivity	15	0.8012	94/95	96/97	95/96	98/99	97/98
Hardness	15	0.8028	96/97	95/96	98/99	94/95	97/98
Turbidity	15	0.9097	96/97	97/98	95/96	94/95	98/99
Total Suspended Solids	15	0.9883	94/95	97/98	96/97	95/96	98/99
Total Phosphorus	15	0.6747	95/96	96/97	94/95	98/99	97/98
Ammonia Nitrogen	15	0.2464	97/98	98/99	96/97	95/96	94/95
Nitrate + Nitrite Nitrogen	15	0.9554	98/99	94/95	96/97	95/96	97/98
Dissolved Copper	15	0.5688	98/99	97/98	95/96	96/97	94/95
Dissolved Lead	15	0.6685	97/98	98/99	95/96	94/95	96/97
Dissolved Zinc	15	0.5543	97/98	96/97	98/99	95/96	94/95
Fecal Coliform Bacteria	15	0.7786	96/97	98/99	97/98	95/96	94/95

[a] Values in bold indicate significant differences exist between monitoring years at a significance level of $\alpha = 0.05$.

[b] Years connected by a single unbroken line are not significantly different at $\alpha = 0.05$.

Table C23. Analysis for temporal trends at station DM-1 based on correlations between analyte concentrations in storm flow samples and sampling dates.

Parameter	Without Flow Correction			With Flow Correction[b]		
	N	tau	p-Value[a]	N	tau.	p-Value[a]
Temperture	25	0.053	0.7086			
pH	25	0.137	0.3359			
Dissolve Oxygen	25	-0.165	0.2469			
Conductivity	25	0.237	0.0967	25	0.220	0.1232
Hardness	25	0.227	0.1123	25	0.287	**0.0446**
Turbidity	25	-0.017	0.9059			
Total Suspend Solids	25	-0.070	0.6221			
Total Phosphorus	25	0.020	0.8882			
Ammonia Nitrogen	25	-0.120	0.3989			
Nitrate + Nitrite Nitrogen	25	-0.080	0.5751	25	-0.107	0.4548
Dissolved Copper	25	-0.192	0.1794			
Dissolved Lead	25	0.037	0.7981			
Dissolved Zinc	25	-0.383	**0.0074**			
Total Copper	25	-0.224	0.1170			
Total Lead	25	-0.133	0.3502			
Total Zinc	25	-0.324	**0.0233**			
Total Petroleum Hydrocarbons	25	0.238	0.0957			
Fecal Coliform Bacteria	25	-0.104	0.4683	25	-0.180	0.2072

[a] p-values in bold indicate a significant trend exists at $\alpha = 0.05$

[b] Trend analysis of flow-corrected data was only performed for parameters that exhibit a significant relationship between stream discharge and analyte concentration.

Table C24. Analysis for temporal trends at station DM-2 based on correlations between analyte concentrations in storm flow samples and sampling dates.

	Without Flow Correction			With Flow Correction[b]		
Parameter	N	tau	p-Value[a]	N	tau	p-Value[a]
Temperture	25	0.104	0.4653			
pH	25	0.111	0.4386			
Dissolve Oxygen	25	-0.128	0.3684			
Conductivity	25	0.310	**0.0296**	25	0.313	**0.0281**
Hardness	25	0.220	0.1232	25	0.293	**0.0399**
Turbidity	25	0.044	0.7587	25	0.040	0.7793
Total Suspend Solids	25	-0.080	0.5751	25	-0.053	0.7086
Total Phosphorus	25	-0.003	0.9813	25	-0.013	0.9256
Ammonia Nitrogen	25	-0.277	0.0522			
Nitrate + Nitrite Nitrogen	25	-0.184	0.1982			
Dissolved Copper	25	-0.198	0.1647			
Dissolved Lead	25	-0.103	0.4722			
Dissolved Zinc	25	-0.262	0.0662			
Total Copper	25	-0.384	**0.0071**			
Total Lead	25	-0.230	0.1065			
Total Zinc	25	-0.152	0.2876			
Total Petroleum Hydrocarbons	25	0.063	0.6583			
Fecal Coliform Bacteria	25	-0.237	0.0967			

[a] p-values in bold indicate a significant trend exists at $\alpha = 0.05$

[b] Trend analysis of flow-corrected data was only performed for parameters that exhibit a significant relationship between stream discharge and analyte concentration.

Table C25. Analysis for temporal trends at station MA-1 based on correlations between analyte concentrations in storm flow samples and sampling dates.

Parameter	Without Flow Correction			With Flow Correction[b]		
	N	tau	p-Value[a]	N	tau	p-Value[a]
Temperture	25	0.101	0.4806			
pH	25	0.067	0.6382			
Dissolve Oxygen	25	-0.101	0.4776			
Conductivity	25	0.187	0.1909	25	0.093	0.5132
Hardness	25	0.013	0.9256			
Turbidity	25	0.179	0.2104			
Total Suspend Solids	25	0.151	0.2908			
Total Phosphorus	25	0.338	**0.0178**			
Ammonia Nitrogen	25	0.047	0.7429			
Nitrate + Nitrite Nitrogen	25	-0.060	0.6742	25	-0.180	0.2072
Dissolved Copper	25	0.088	0.5382			
Dissolved Lead	25	0.010	0.9419			
Dissolved Zinc	25	-0.067	0.6382			
Total Copper	25	-0.107	0.4518			
Total Lead	25	0.157	0.2715			
Total Zinc	25	0.084	0.5560			
Total Petroleum Hydrocarbons	25	0.316	**0.0270**			
Fecal Coliform Bacteria	25	0.130	0.3616			

[a] p-values in bold indicate a significant trend exists at $\alpha = 0.05$

[b] Trend analysis of flow-corrected data was only performed for parameters that exhibit a significant relationship between stream discharge and analyte concentration.

Table C26. Analysis for temporal trends at station MA-2 based on correlations between analyte concentrations in storm flow samples and sampling dates.

	Without Flow Correction			With Flow Correction[b]		
Parameter	N	tau	p-Value[a]	N	tau	p-Value[a]
Temperture	25	0.145	0.3095			
pH	25	0.198	0.1661			
Dissolve Oxygen	25	-0.037	0.7963			
Conductivity	25	0.050	0.7257	24	-0.203	0.1648
Hardness	25	0.104	0.4683	24	-0.087	0.5516
Turbidity	25	-0.024	0.8686	24	0.051	0.7284
Total Suspend Solids	25	-0.164	0.2517	24	0.174	0.2338
Total Phosphorus	25	-0.054	0.7077	24	0.072	0.6198
Ammonia Nitrogen	25	-0.023	0.8695	24	-0.007	0.9304
Nitrate + Nitrite Nitrogen	25	0.073	0.6074			
Dissolved Copper	25	0.178	0.2135			
Dissolved Lead	25	-0.094	0.5118			
Dissolved Zinc	25	-0.030	0.8310			
Total Copper	25	-0.215	0.1324	24	-0.152	0.2975
Total Lead	25	-0.154	0.2811			
Total Zinc	25	-0.114	0.4225			
Total Petroleum Hydrocarbons	25	0.218	0.1269			
Fecal Coliform Bacteria	25	0.010	0.9437			

[a] p-values in bold indicate a significant trend exists at $\alpha = 0.05$

[b] Trend analysis of flow-corrected data was only performed for parameters that exhibit a significant relationship between stream discharge and analyte concentration.

Table C27. Analysis for temporal trends at station MA-3 based on correlations between analyte concentrations in storm flow samples and sampling dates.

	Without Flow Correction			With Flow Correction[b]		
Parameter	N	tau	p-Value[a]	N	tau	p-Value[a]
Temperture	25	0.165	0.2469			
pH	25	0.074	0.6062			
Dissolve Oxygen	25	-0.068	0.6359			
Conductivity	25	0.137	0.3375	25	-0.113	0.4272
Hardness	25	0.093	0.5132	25	-0.040	0.7793
Turbidity	25	0.107	0.4518			
Total Suspend Solids	25	-0.087	0.5423	25	0.047	0.7437
Total Phosphorus	25	0.030	0.8332	25	0.173	0.2246
Ammonia Nitrogen	25	-0.155	0.2778			
Nitrate + Nitrite Nitrogen	25	0.020	0.8886	25	-0.153	0.2827
Dissolved Copper	25	0.232	0.1041			
Dissolved Lead	25	0.166	0.2439			
Dissolved Zinc	25	0.072	0.6136			
Total Copper	25	-0.245	0.0866			
Total Lead	25	-0.023	0.8695			
Total Zinc	25	0.020	0.8874			
Total Petroleum Hydrocarbons	25	0.257	0.0718			
Fecal Coliform Bacteria	25	0.003	0.9813			

[a] p-values in bold indicate a significant trend exists at $\alpha = 0.05$

[b] Trend analysis of flow-corrected data was only performed for parameters that exhibit a significant relationship between stream discharge and analyte concentration.

Table C28. Analysis for temporal trends at station BA-1 based on correlations between analyte concentrations in storm flow samples and sampling dates.

Parameter	Without Flow Correction			With Flow Correction[b]		
	N	tau	p-Value[a]	N	tau	p-Value[a]
Temperture	25	0.070	0.6221			
pH	25	0.294	**0.0392**			
Dissolve Oxygen	25	-0.078	0.5868			
Conductivity	25	0.224	0.1170			
Hardness	25	0.104	0.4683			
Turbidity	25	0.274	0.0547	25	0.187	0.1909
Total Suspend Solids	25	0.027	0.8518			
Total Phosphorus	25	0.053	0.7086			
Ammonia Nitrogen	25	0.027	0.8508			
Nitrate + Nitrite Nitrogen	25	-0.087	0.5437			
Dissolved Copper	25	0.034	0.8122			
Dissolved Lead	25	-0.016	0.9089			
Dissolved Zinc	25	0.099	0.4890			
Total Copper	25	-0.251	0.0783			
Total Lead	25	-0.037	0.7956			
Total Zinc	25	-0.030	0.8327			
Total Petroleum Hydrocarbons	25	0.072	0.6145			
Fecal Coliform Bacteria	25	-0.083	0.5586			

[a] p-values in bold indicate a significant trend exists at $\alpha = 0.05$

[b] Trend analysis of flow-corrected data was only performed for parameters that exhibit a significant relationship between stream discharge and analyte concentration.

Table C29. **Analysis for temporal trends at station MC-1 based on correlations between analyte concentrations in storm flow samples and sampling dates.**

Parameter	Without Flow Correction			With Flow Correction[b]		
	N	tau	p-Value[a]	N	tau	p-Value[a]
Temperture	25	0.111	0.4386	25	0.187	0.1909
pH	25	0.067	0.6393			
Dissolve Oxygen	25	0.050	0.7248			
Conductivity	25	0.245	0.0856	25	0.047	0.7437
Hardness	25	0.244	0.0877			
Turbidity	25	-0.161	0.2591			
Total Suspend Solids	25	-0.154	0.2811			
Total Phosphorus	25	0.090	0.5276			
Ammonia Nitrogen	25	-0.091	0.5220			
Nitrate + Nitrite Nitrogen	25	-0.273	0.0555			
Dissolved Copper	25	-0.184	0.1967			
Dissolved Lead	25	-0.115	0.4192			
Dissolved Zinc	25	-0.151	0.2907			
Total Copper	25	-0.371	**0.0094**			
Total Lead	25	-0.197	0.1683			
Total Zinc	25	-0.244	0.0872			
Total Petroleum Hydrocarbons	25	0.143	0.3158			
Fecal Coliform Bacteria	25	-0.084	0.5560			

[a] p-values in bold indicate a significant trend exists at $\alpha = 0.05$

[b] Trend analysis of flow-corrected data was only performed for parameters that exhibit a significant relationship between stream discharge and analyte concentration.

Table C30. Analysis for temporal trends at station MC-2 based on correlations between analyte concentrations in storm flow samples and sampling dates.

Parameter	Without Flow Correction			With Flow Correction[b]		
	N	tau	p-Value[a]	N	tau	p-Value[a]
Temperture	25	0.181	0.2057			
pH	25	0.040	0.7793			
Dissolve Oxygen	25	-0.067	0.6382			
Conductivity	25	0.070	0.6221			
Hardness	25	-0.050	0.7239			
Turbidity	25	-0.027	0.8508			
Total Suspend Solids	25	-0.095	0.5060			
Total Phosphorus	25	0.080	0.5738			
Ammonia Nitrogen	25	0.101	0.4806			
Nitrate + Nitrite Nitrogen	25	-0.297	**0.0373**			
Dissolved Copper	25	-0.020	0.8882			
Dissolved Lead	25	-0.122	0.3932			
Dissolved Zinc	25	-0.169	0.2366			
Total Copper	25	-0.120	0.3989			
Total Lead	25	-0.198	0.1661			
Total Zinc	25	-0.239	0.0934			
Total Petroleum Hydrocarbons	25	0.130	0.3617			
Fecal Coliform Bacteria	25	0.027	0.8508			

[a] p-values in bold indicate a significant trend exists at $\alpha = 0.05$

[b] Trend analysis of flow-corrected data was only performed for parameters that exhibit a significant relationship between stream discharge and analyte concentration.

Table C31. Analysis for temporal trends at station DM-1 based on correlations between analyte concentrations in base flow samples and sampling dates.

Parameter	N	tau	p-Value[a]
Temperture	15	0.162	0.4002
pH	15	-0.134	0.4863
Dissolve Oxygen	15	-0.240	0.2116
Conductivity	15	0.459	**0.0170**
Hardness	15	0.268	0.1638
Turbidity	15	-0.337	0.0803
Total Suspend Solids	15	0.067	0.7265
Total Phosphorus	15	0.067	0.7265
Ammonia Nitrogen	15	-0.082	0.6689
Nitrate + Nitrite Nitrogen	15	-0.219	0.2550
Dissolved Copper	15	-0.473	**0.0139**
Dissolved Lead	15	-0.207	0.2831
Dissolved Zinc	15	-0.270	0.1599
Fecal Coliform Bacteria	15	-0.134	0.4863

[a] p-values in bold indicate a significant trend exists at $\alpha = 0.05$

Table C32. Analysis for temporal trends at station DM-2 based on correlations between analyte concentrations in base flow samples and sampling dates.

Parameter	N	tau	p-Value[a]
Temperture	15	0.257	0.1815
pH	15	-0.067	0.7265
Dissolve Oxygen	15	-0.193	0.3153
Conductivity	15	0.345	0.0734
Hardness	15	0.172	0.3708
Turbidity	15	-0.260	0.1773
Total Suspend Solids	15	-0.010	0.9601
Total Phosphorus	15	0.211	0.2740
Ammonia Nitrogen	15	-0.217	0.2590
Nitrate + Nitrite Nitrogen	15	-0.067	0.7290
Dissolved Copper	15	-0.245	0.2026
Dissolved Lead	15	-0.244	0.2046
Dissolved Zinc	15	-0.166	0.3893
Fecal Coliform Bacteria	15	-0.172	0.3708

[a] p-values in bold indicate a significant trend exists at $\alpha = 0.05$

Table C33. Analysis for temporal trends at station MA-1 based on correlations between analyte concentrations in base flow samples and sampling dates.

Parameter	N	tau	p-Value[a]
Temperture	15	0.221	0.2505
pH	15	-0.191	0.3200
Dissolve Oxygen	15	-0.240	0.2116
Conductivity	15	0.402	**0.0368**
Hardness	15	0.115	0.5507
Turbidity	15	0.306	0.1116
Total Suspend Solids	15	0.067	0.7265
Total Phosphorus	15	0.290	0.1320
Ammonia Nitrogen	15	-0.181	0.3471
Nitrate + Nitrite Nitrogen	15	-0.429	**0.0260**
Dissolved Copper	15	-0.357	0.0637
Dissolved Lead	15	-0.297	0.1229
Dissolved Zinc	15	-0.228	0.2367
Fecal Coliform Bacteria	15	0.000	1.0000

[a] p-values in bold indicate a significant trend exists at $\alpha = 0.05$

Table C34. Analysis for temporal trends at station MA-2 based on correlations between analyte concentrations in base flow samples and sampling dates.

Parameter	N	tau	p-Value[a]
Temperture	15	0.295	0.1250
pH	15	-0.077	0.6908
Dissolve Oxygen	15	-0.276	0.1513
Conductivity	15	0.498	**0.0097**
Hardness	15	0.067	0.7290
Turbidity	15	-0.029	0.8808
Total Suspend Solids	15	0.059	0.7586
Total Phosphorus	15	0.309	0.1081
Ammonia Nitrogen	15	-0.403	**0.0361**
Nitrate + Nitrite Nitrogen	15	-0.029	0.8820
Dissolved Copper	15	-0.291	0.1304
Dissolved Lead	15	-0.207	0.2831
Dissolved Zinc	15	0.070	0.7172
Fecal Coliform Bacteria	15	0.172	0.3708

[a] p-values in bold indicate a significant trend exists at $\alpha = 0.05$

Table C35. **Analysis for temporal trends at station MA-3 based on correlations between analyte concentrations in base flow samples and sampling dates.**

Parameter	N	tau	p-Value[a]
Temperture	15	0.249	0.1961
pH	15	-0.115	0.5507
Dissolve Oxygen	15	-0.174	0.3661
Conductivity	15	0.383	**0.0467**
Hardness	15	-0.029	0.8808
Turbidity	15	0.010	0.9601
Total Suspend Solids	15	0.298	0.1214
Total Phosphorus	15	0.306	0.1116
Ammonia Nitrogen	15	-0.507	**0.0084**
Nitrate + Nitrite Nitrogen	15	-0.172	0.3708
Dissolved Copper	15	-0.054	0.7808
Dissolved Lead	15	-0.169	0.3798
Dissolved Zinc	15	0.056	0.7697
Fecal Coliform Bacteria	15	0.010	0.9605

[a] p-values in bold indicate a significant trend exists at $\alpha = 0.05$

Table C36. Analysis for temporal trends at station BA-1 based on correlations between analyte concentrations in base flow samples and sampling dates.

Parameter	N	tau	p-Value[a]
Temperture	15	0.298	0.1214
pH	15	0.010	0.9601
Dissolve Oxygen	15	-0.271	0.1598
Conductivity	15	0.314	0.1025
Hardness	15	0.067	0.7290
Turbidity	15	-0.080	0.6788
Total Suspend Solids	15	0.221	0.2505
Total Phosphorus	15	0.295	0.1250
Ammonia Nitrogen	15	-0.353	0.0668
Nitrate + Nitrite Nitrogen	15	-0.276	0.1513
Dissolved Copper	15	-0.282	0.1421
Dissolved Lead	15	-0.169	0.3798
Dissolved Zinc	15	-0.303	0.1159
Fecal Coliform Bacteria	15	0.440	**0.0222**

[a] p-values in bold indicate a significant trend exists at $\alpha = 0.05$

Table C37. Analysis for temporal trends at station MC-1 based on correlations between analyte concentrations in base flow samples and sampling dates.

Parameter	N	tau	p-Value[a]
Temperture	14	0.385	0.0554
pH	14	0.122	0.5426
Dissolve Oxygen	14	0.011	0.9563
Conductivity	14	0.376	0.0613
Hardness	14	0.297	0.1394
Turbidity	14	0.158	0.4305
Total Suspend Solids	14	-0.112	0.5777
Total Phosphorus	14	0.297	0.1394
Ammonia Nitrogen	14	-0.150	0.4538
Nitrate + Nitrite Nitrogen	14	-0.407	**0.0428**
Dissolved Copper	14	-0.413	**0.0397**
Dissolved Lead	14	-0.280	0.1637
Dissolved Zinc	14	-0.130	0.5185
Fecal Coliform Bacteria	14	0.000	1.0000

[a] p-values in bold indicate a significant trend exists at $\alpha = 0.05$

Table C38. Analysis for temporal trends at station MC-2 based on correlations between analyte concentrations in base flow samples and sampling dates.

Parameter	N	tau	p-Value[a]
Temperture	15	0.191	0.3200
pH	15	0.048	0.8046
Dissolve Oxygen	15	-0.057	0.7654
Conductivity	15	0.290	0.1320
Hardness	15	0.143	0.4579
Turbidity	15	-0.126	0.5119
Total Suspend Solids	15	0.000	1.0000
Total Phosphorus	15	0.200	0.2987
Ammonia Nitrogen	15	-0.488	**0.0112**
Nitrate + Nitrite Nitrogen	15	-0.048	0.8046
Dissolved Copper	15	-0.398	**0.0386**
Dissolved Lead	15	-0.297	0.1229
Dissolved Zinc	15	-0.410	**0.0333**
Fecal Coliform Bacteria	15	-0.067	0.7290

[a] p-values in bold indicate a significant trend exists at $\alpha = 0.05$

APPENDIX D

Hydrologic Data for Sampled Storm Events at King County Stations 11D and 11U

Table D1. Monthly hydrologic characteristics of Des Moines Creek at station DM-2 and three rain gauge stations.

	Flow Rate			Precipitation Totals (inches)			
Month/Year	Average	Peak	Flow Volume (acre-feet/Month)	MSDTP[a]	Tyee[b]	Sea-Tac[c]	Normal Sea-Tac[d]
Oct-94	3.94	45.0	244	4.05	3.60	3.51	3.23
Nov-94	9.50	128	571	6.65	5.87	5.79	5.83
Dec-94	19.5	158	1208	9.37	7.53	8.15	5.91
Jan-95	8.98	82.0	557	5.28	4.30	4.48	5.38
Feb-95	13.6	179	766	5.55	5.10	4.97	3.99
Mar-95	8.33	59.0	517	5.14	4.28	4.07	3.54
Apr-95	4.13	31.0	249	2.48	2.27	2.05	2.33
May-95	2.09	12.0	130	0.94	0.85	0.81	1.70
Jun-95	2.21	24.0	133	1.92	1.62	1.46	1.50
Jul-95	2.28	52.0	141	1.10	1.05	1.34	0.76
Aug-95	2.23	56.0	138	1.90	1.91	1.81	1.14
Sep-95	2.15	32.0	130	0.98	1.16	0.91	1.88
Oct-95	6.13	51.0	381	5.07	4.33	3.93	3.23
Nov-95	19.4	187	1164	11.56	10.64	10.40	5.83
Dec-95	14.0	158	875	7.07	6.70	6.37	5.91
Jan-96	20.0	218	1240	7.96	7.21	7.34	5.38
Feb-96	28.3	261	1645	9.53	9.21	8.35	3.99
Mar-96	5.82	79.0	362	2.62	2.21	2.06	3.54
Apr-96	14.4	213	864	7.10	6.13	5.37	2.33
May-96	5.88	85.0	365	2.50	2.26	2.07	1.70
Jun-96	2.53	30.0	152	0.65	0.63	0.59	1.50
Jul-96	1.71	22.0	106	0.96	0.85	0.77	0.76
Aug-96	2.73	50.0	169	1.05	1.04	1.32	1.14
Sep-96	3.09	33.0	186	2.44	2.35	1.85	1.88
Oct-96	8.61	74.0	536	6.81	6.12	5.54	3.23
Nov-96	12.0	135	721	6.61	5.87	5.23	5.83
Dec-96	26.1	196	1623	11.60	11.01	10.20	5.91
Jan-97	21.4	184	1328	6.90	7.03	7.02	5.38
Feb-97	6.43	41.0	361	2.23	2.04	1.99	3.99
Mar-97	21.9	222	1364	7.24	7.72	8.15	3.54
Apr-97	10.7	114	642	4.05	3.91	4.32	2.33
May-97	6.51	131	404	3.17	3.00	1.87	1.70
Jun-97	5.40	53.0	324	1.89	1.92	1.64	1.50
Jul-97	4.66	46.0	290	1.41	1.41	1.20	0.76
Aug-97	2.20	34.0	135	1.68	1.27	1.27	1.14
Sep-97	5.32	62.0	321	3.43	3.18	3.41	1.88
Oct-97	10.6	119	658	6.47	5.52	5.83	3.23
Nov-97	9.05	61.0	544	4.21	3.58	3.93	5.83
Dec-97	9.45	102	587	3.55	2.77	2.63	5.91
Jan-98	19.2	74.0	1189	7.68	7.18	7.15	5.38
Feb-98	8.12	38.0	456	3.80	3.13	3.31	3.99
Mar-98	9.95	42.0	618	4.00	3.94	3.96	3.54

Table D1 Monthly hydrologic characteristics of Des Moines Creek at station DM-2 and three rain gauge stations (continued).

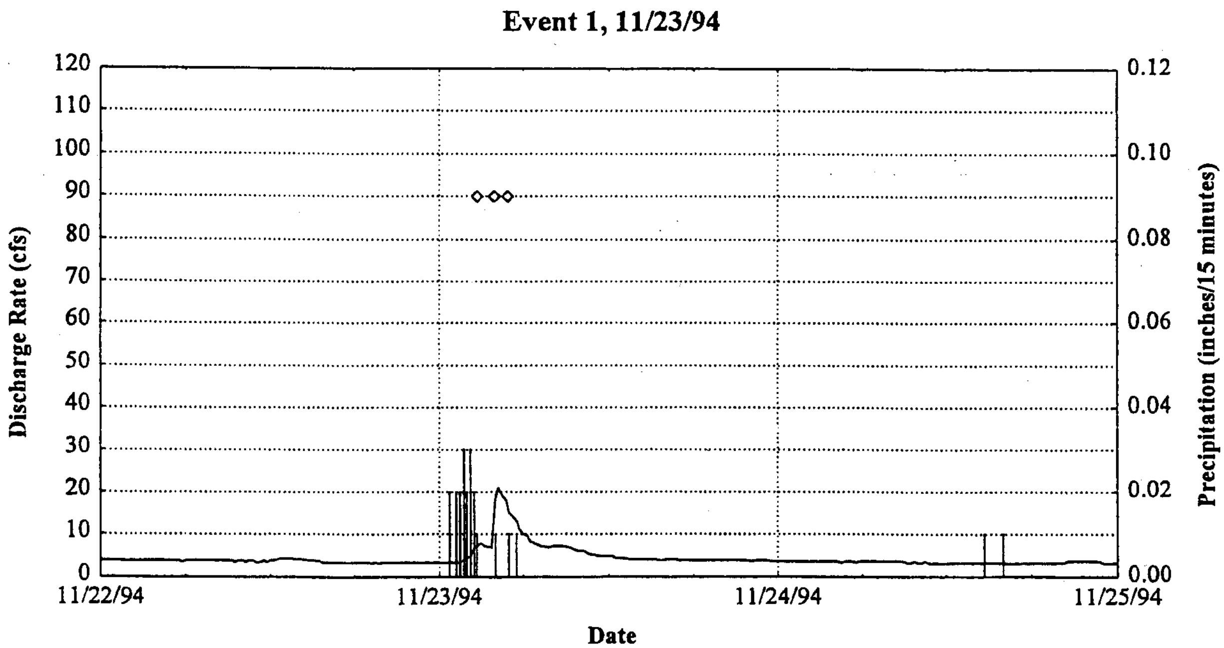
	Flow Rate			Precipitation Totals (inches)			
Month/Year	Average	Peak	Flow Volume (acre-feet/Month)	MSDTP[a]	Tyee[b]	Sea-Tac[c]	Normal Sea-Tac[d]
Apr-98	2.98	19.0	179	1.49	0.89	0.99	2.33
May-98	3.39	36.0	211	2.60	2.29	1.98	1.70
Jun-98	2.37	30.0	143	1.28	1.16	1.11	1.50
Jul-98	1.39	5.10	86	0.37	0.38	0.41	0.76
Aug-98	1.16	13.0	72	0.31	0.24	0.27	1.14
Sep-98	1.45	31.0	87	0.73	0.71	0.72	1.88
Oct-98	5.34	44.0	328	4.71	3.80	3.47	3.23
Nov-98	24.6	216	1463	12.71	11.73	11.62	5.83
Dec-98	25.9	183	1594	10.02	9.17	8.98	5.91
Jan-99	20.3	94.0	1247	7.54	7.15	6.84	5.38
Feb-99	22.0	90.0	1195	8.02	7.10	6.95	3.99
Mar-99	11.8	58.0	785	4.79	3.95	3.66	3.54
Apr-99	5.63	32.0	338	1.70	1.45	1.38	2.33
May-99	5.04	44.0	314	2.79	2.27	2.12	1.70
Jun-99	4.67	94.0	278	2.06	2.06	1.86	1.50
Jul-99	3.03	19.0	189	1.29	1.19	1.18	0.76
Aug-99	2.24	14.0	138	1.40	1.28	0.93	1.14
Sep-99	1.64	6.30	98	0.24	0.17	0.17	1.88
Oct-99	2.79	25.8	171	2.50	0.71	2.26	3.23
Nov-99	18.0	131	1069	10.43	1.59	9.60	5.83

[a] Data collected at Midway Sewer District treatment plant by plant personnel.

[b] Data collected at Tyee Golf Course by King County Department of Natural Resources.

[c] Data collected at Sea-Tac Airport by National Oceanic and Atmospheric Administration (NOAA).

[d] Mean of 30 -year record (1961 - 1990) collected at Sea-Tac Airport by NOAA.



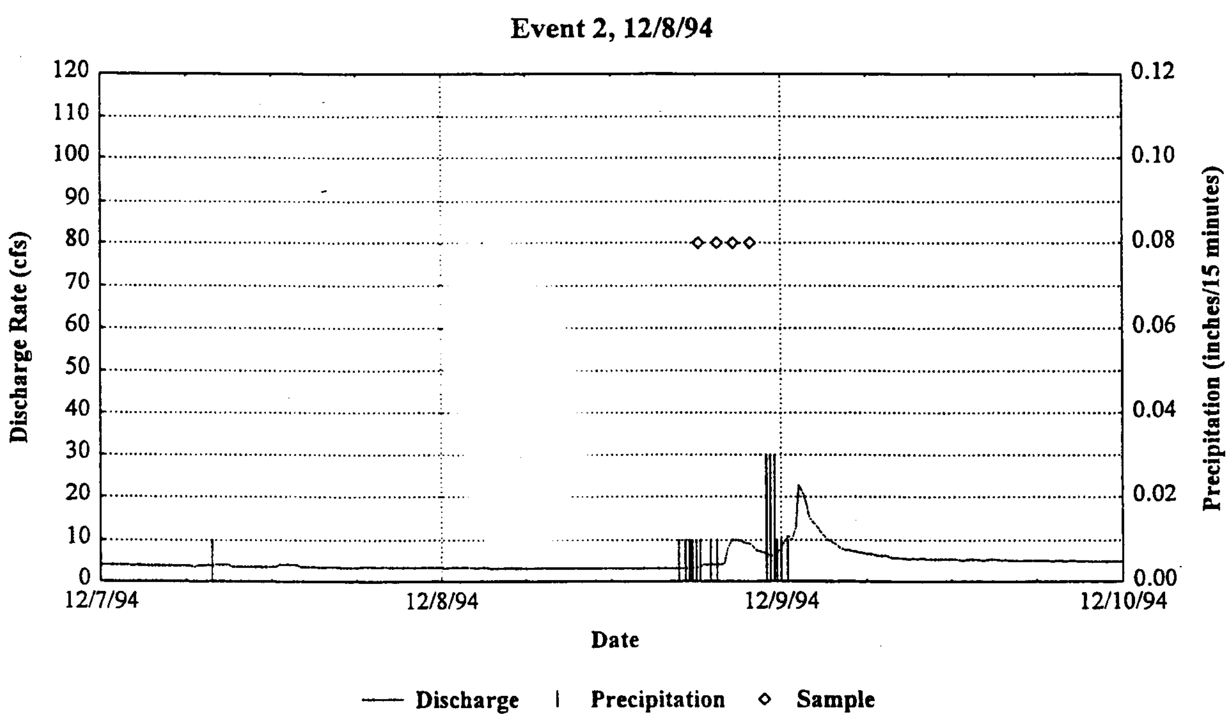
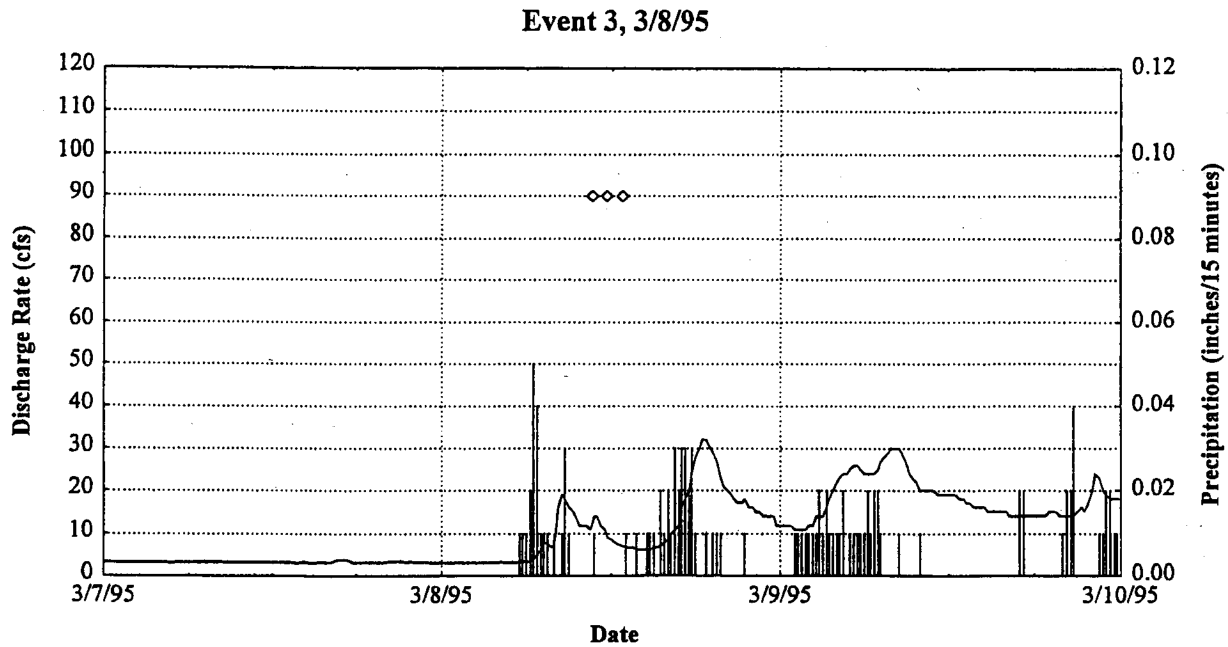


Figure D1. Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.



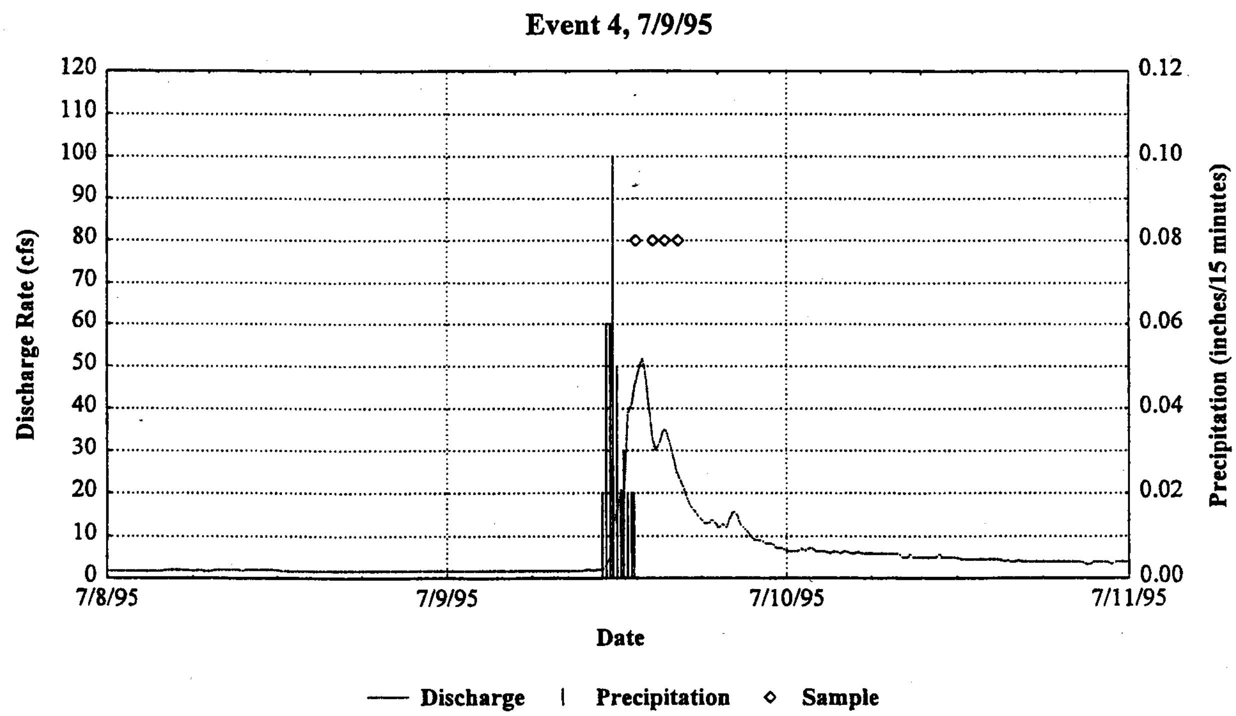


Figure D2. **Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.**

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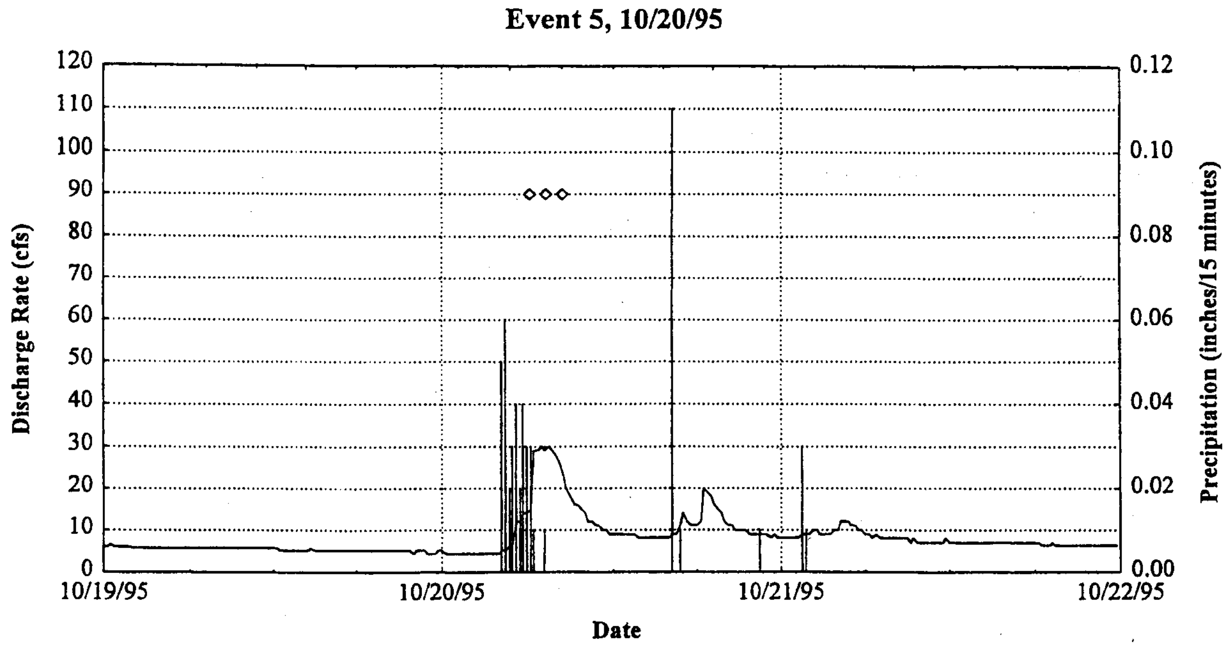


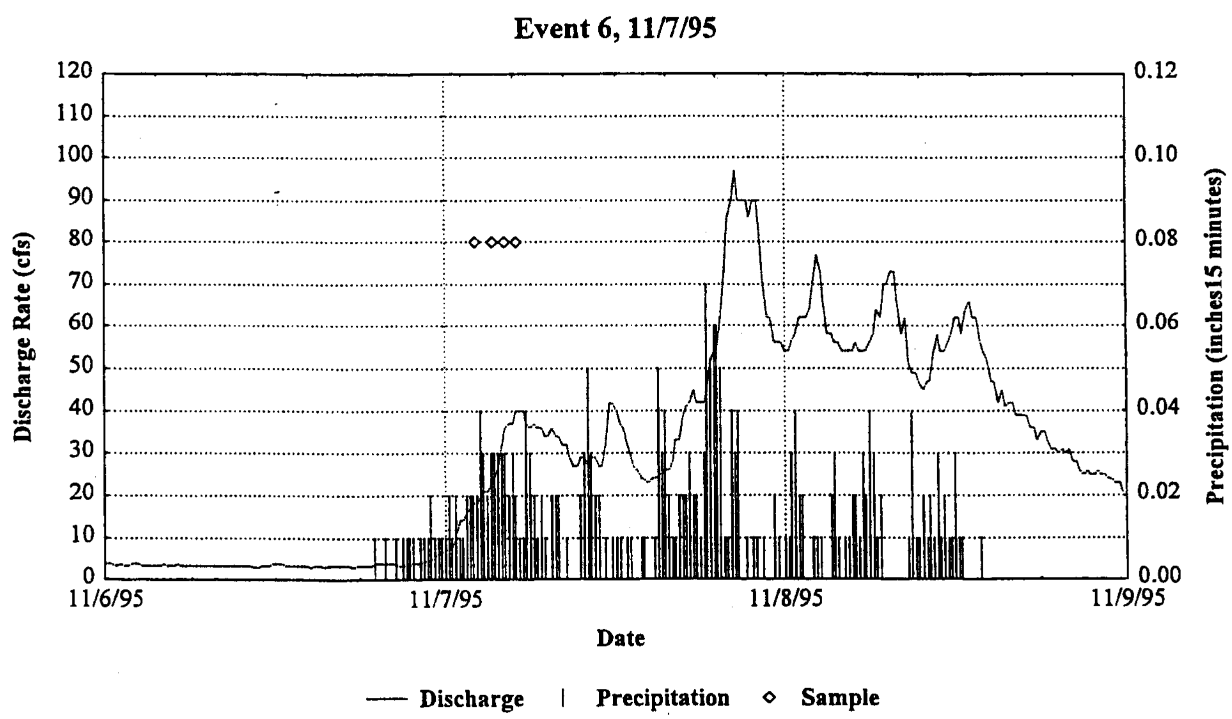
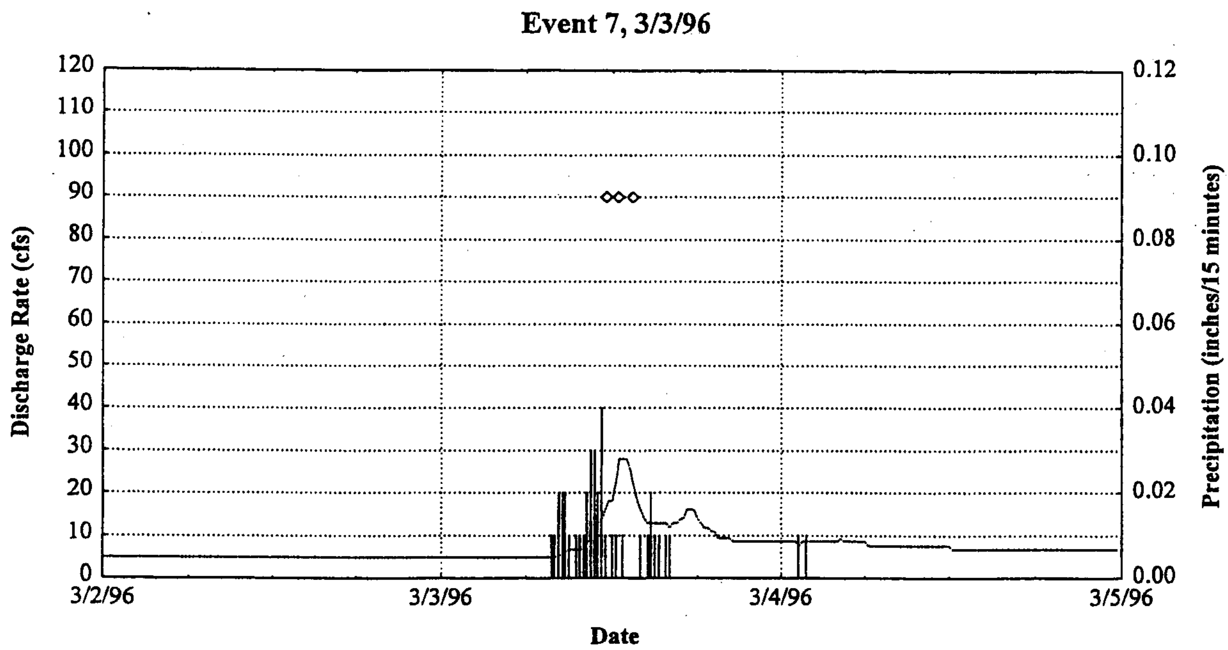


Figure D3. Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.



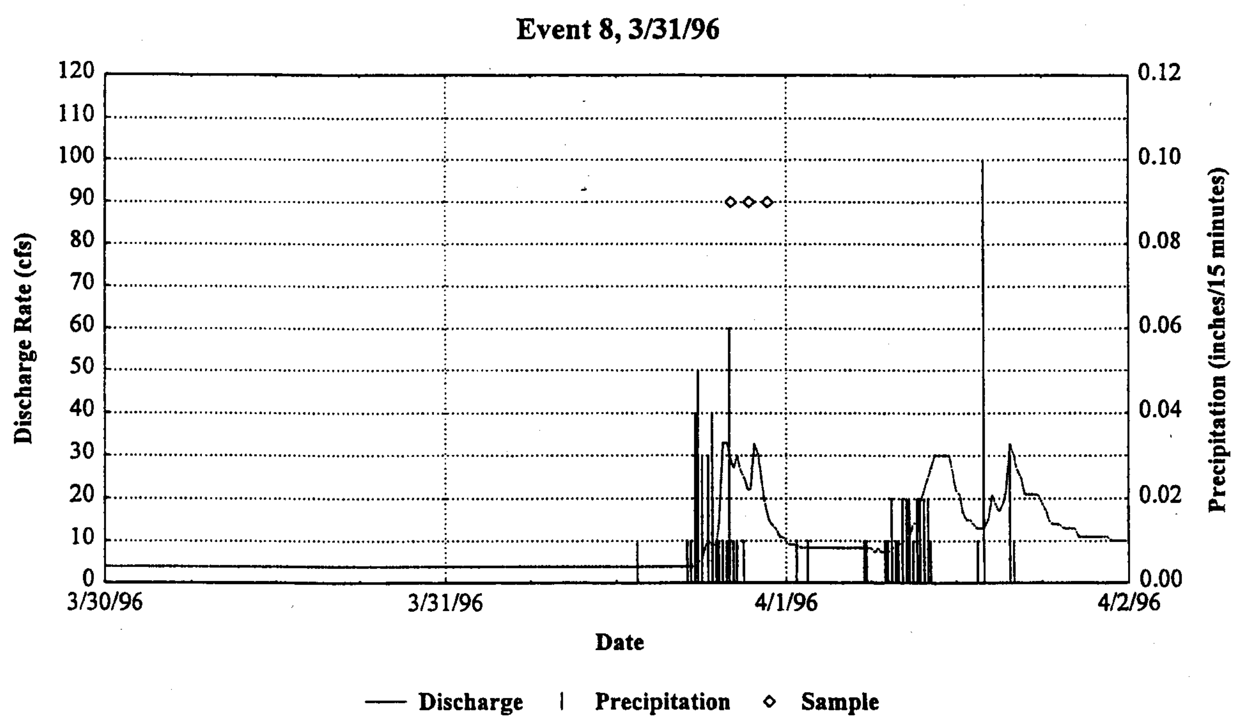
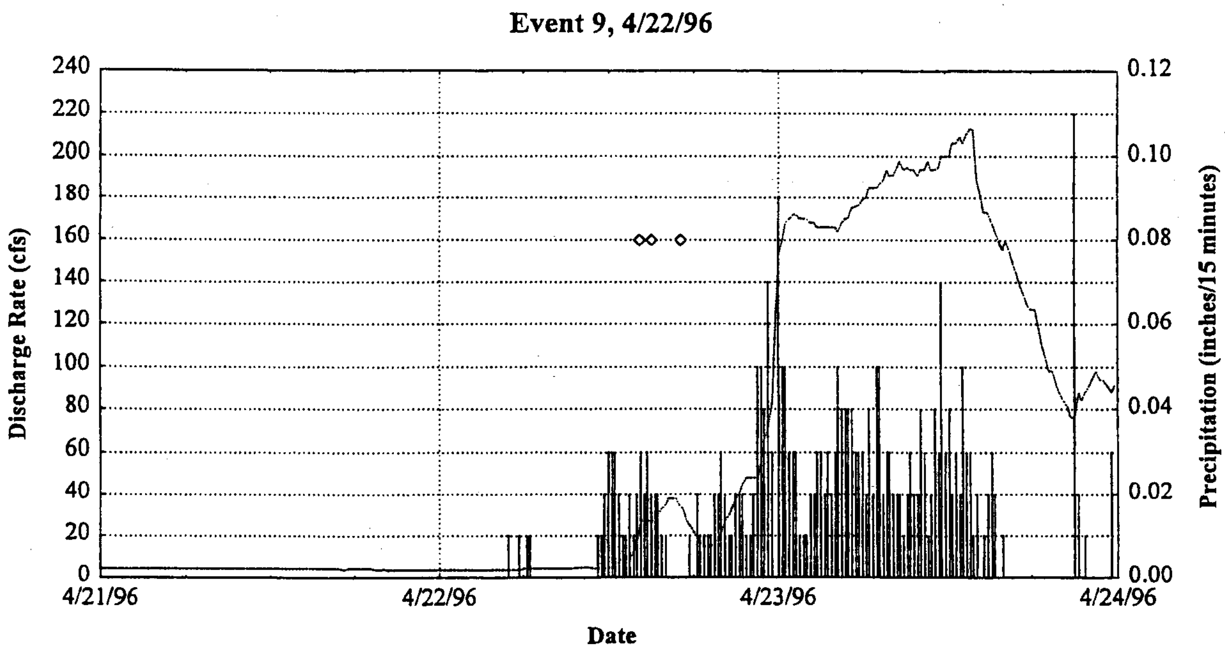


Figure D4. Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.



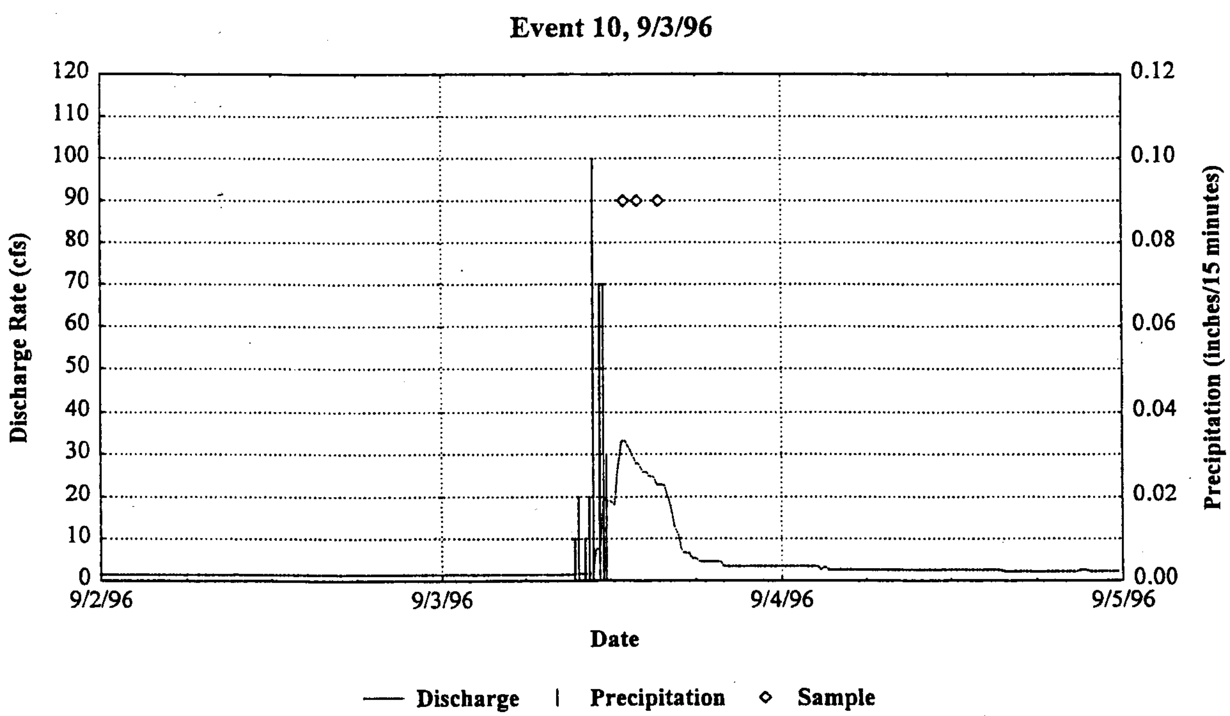


Figure D5. **Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.**

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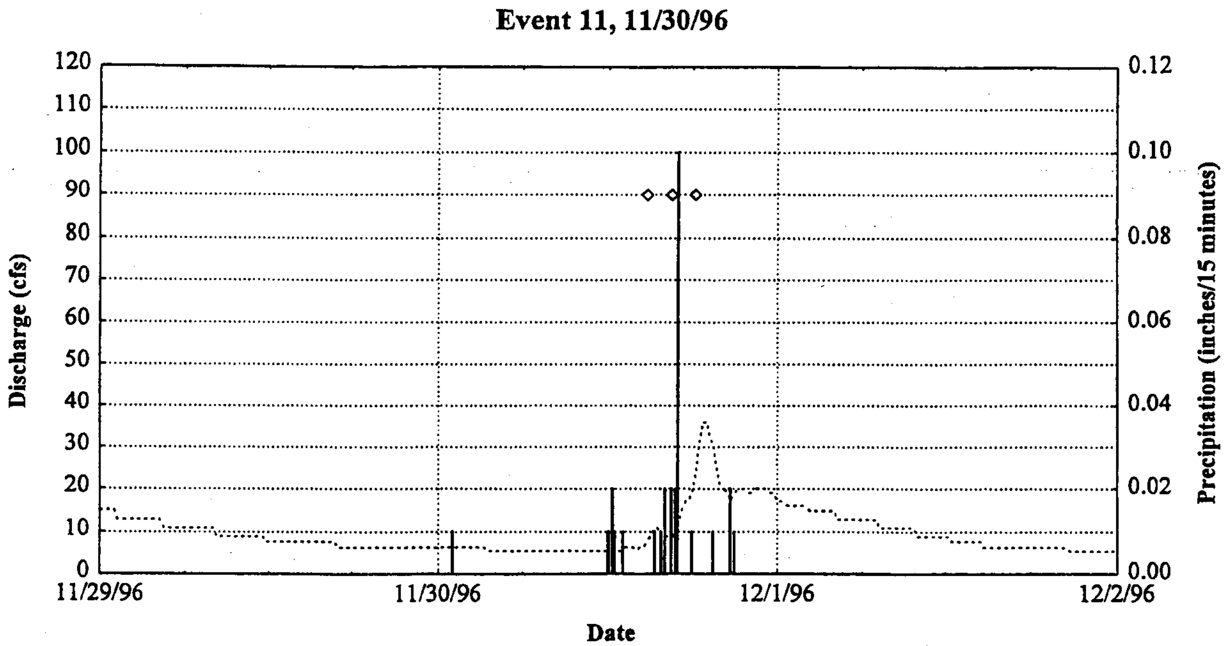


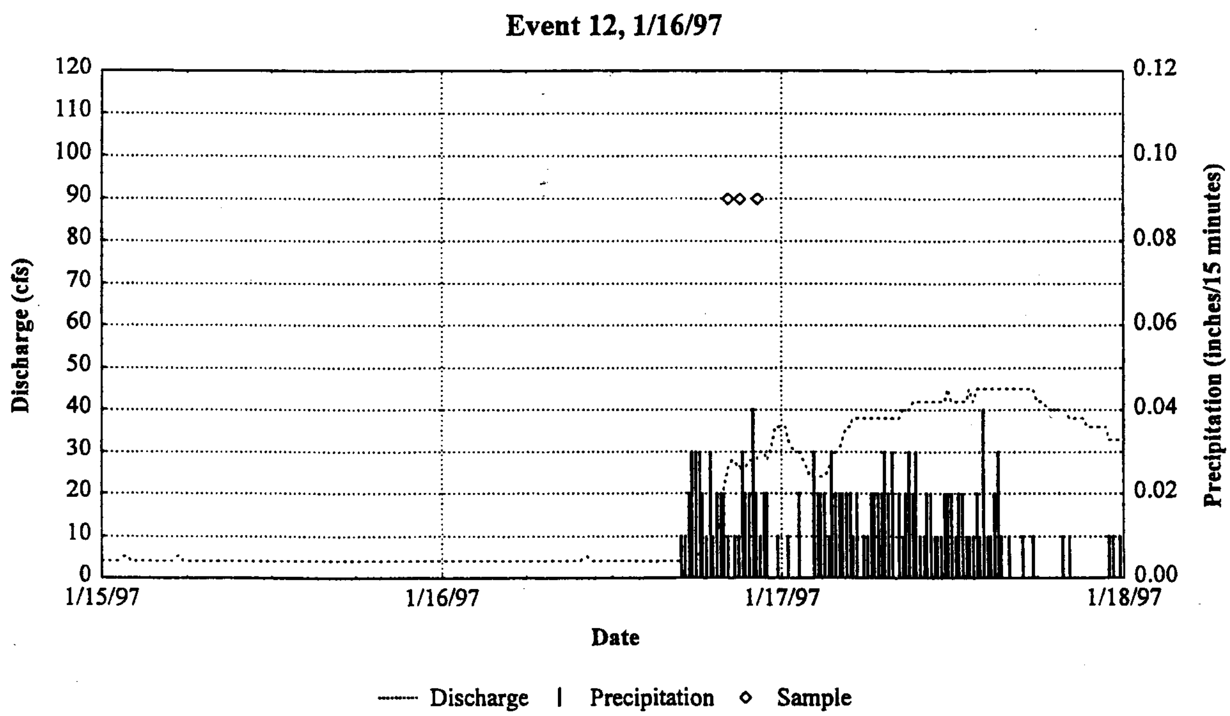
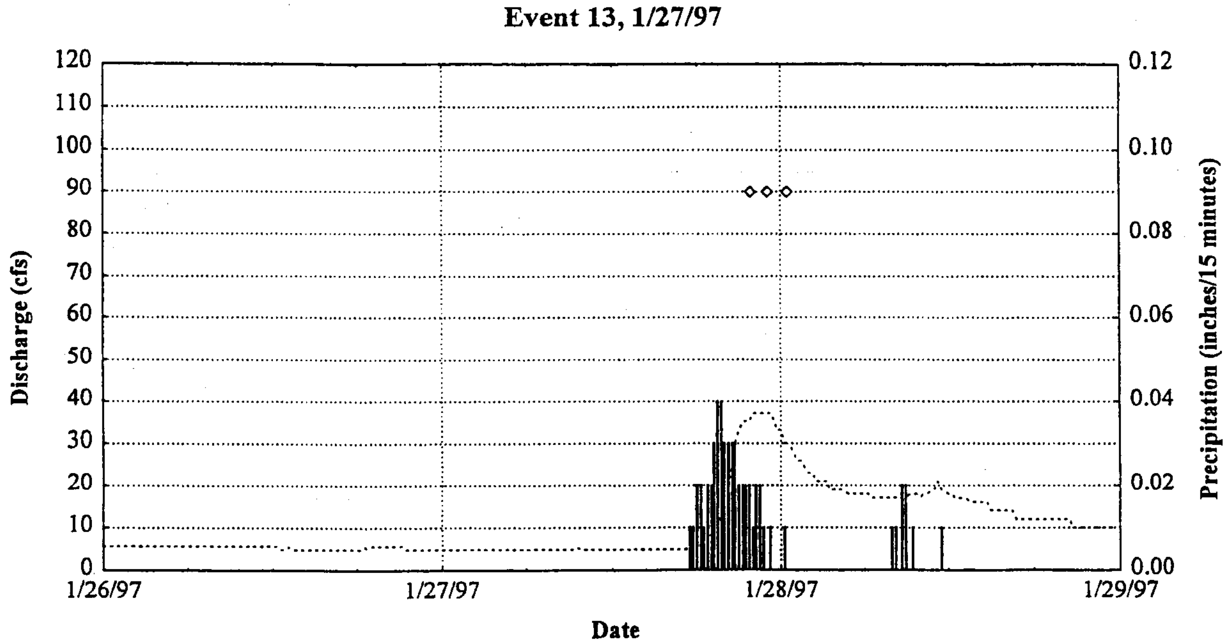


Figure D6. **Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.**



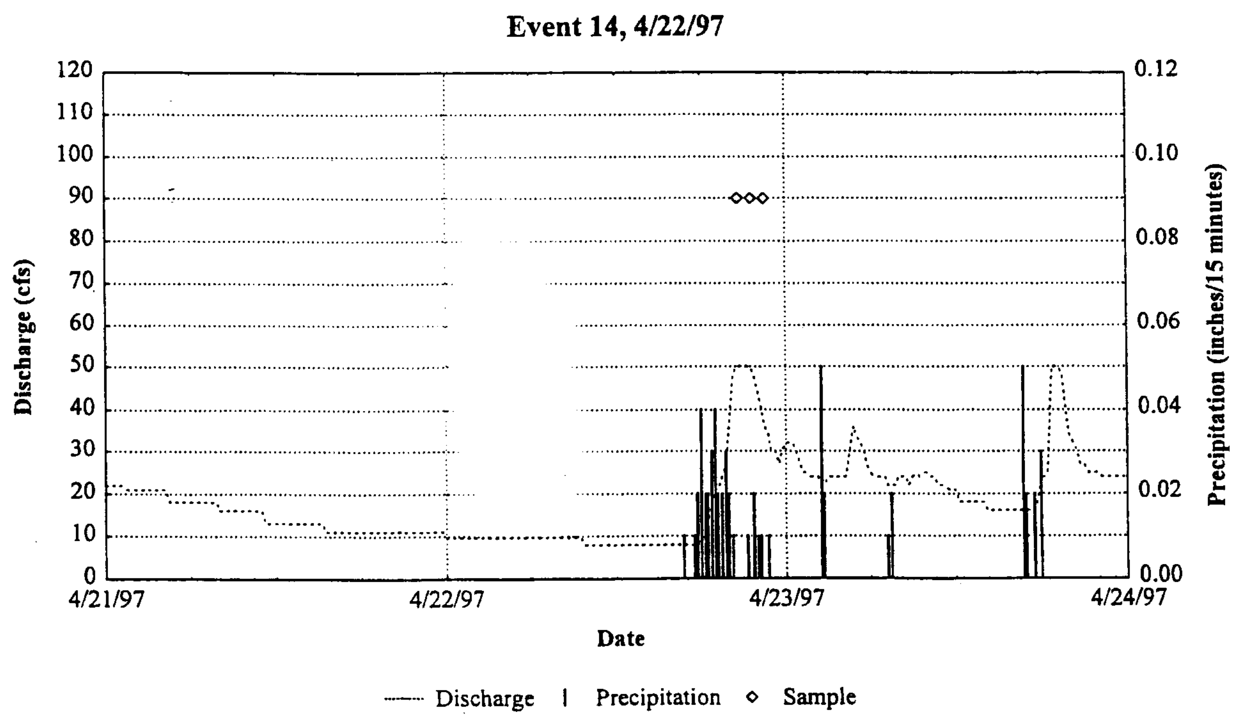
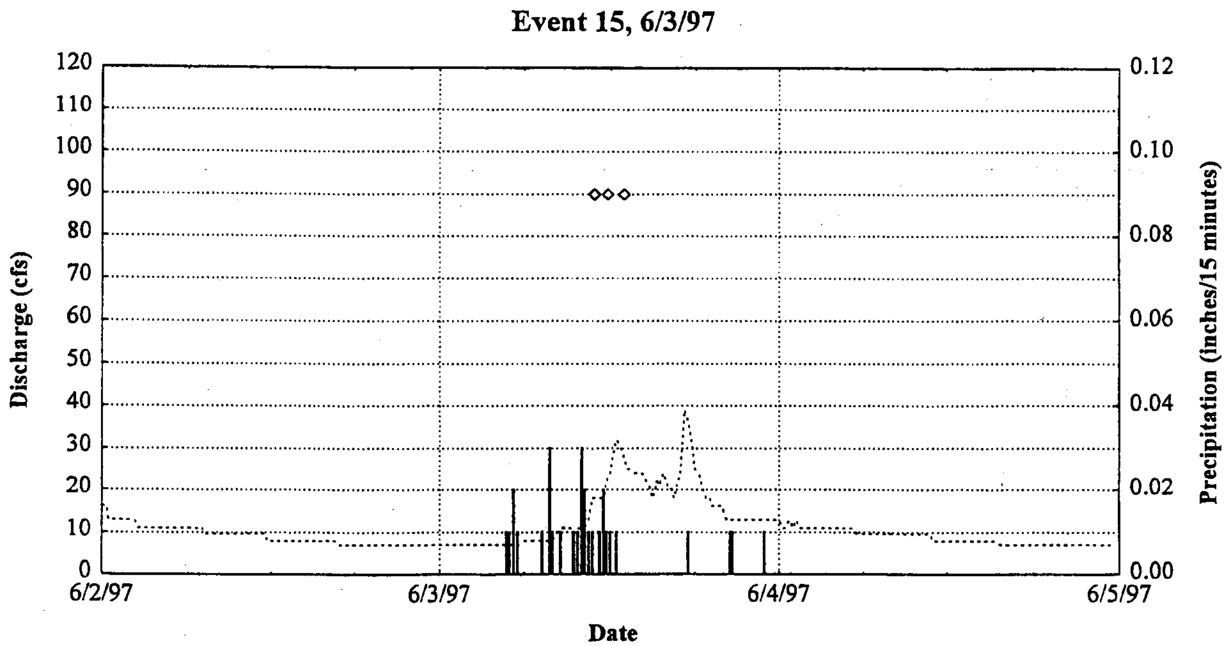


Figure D7. **Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.**



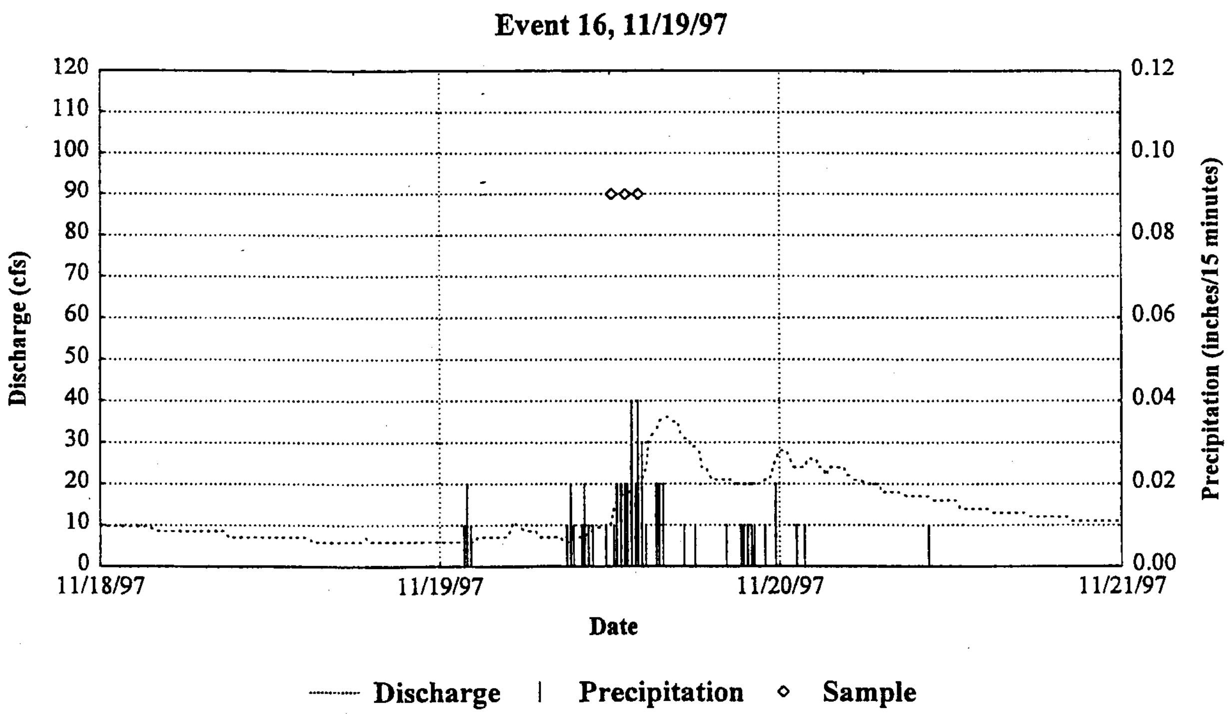


Figure D8. Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.

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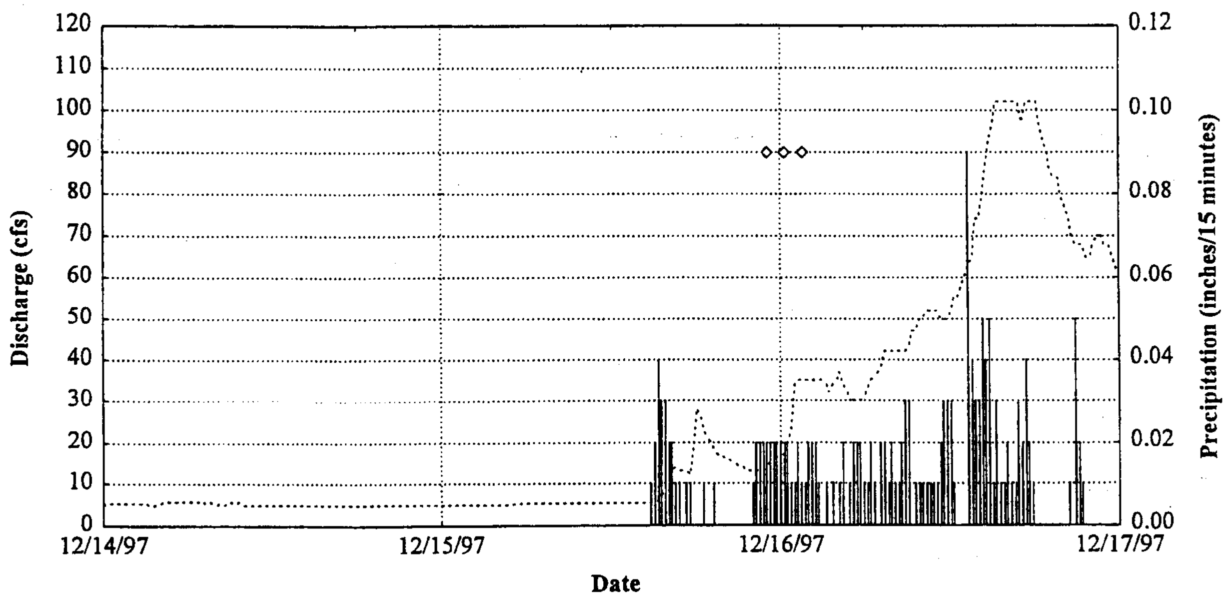
Event 17, 12/15/97



Event 18, 4/23/98

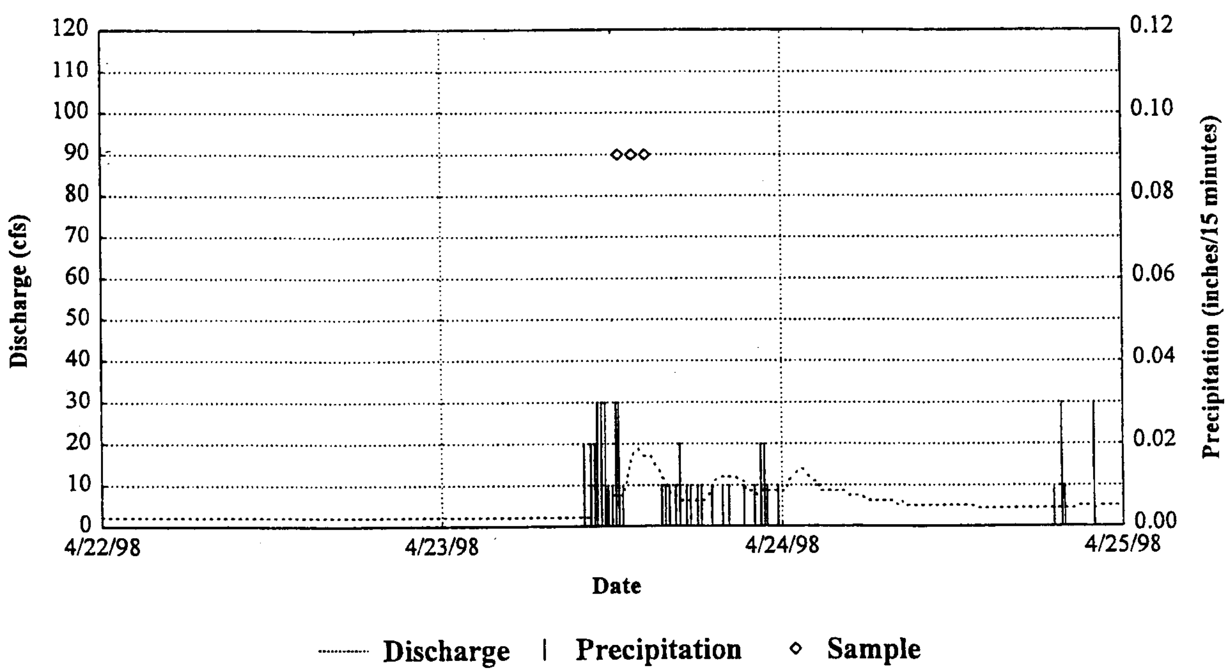


Figure D9. Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.

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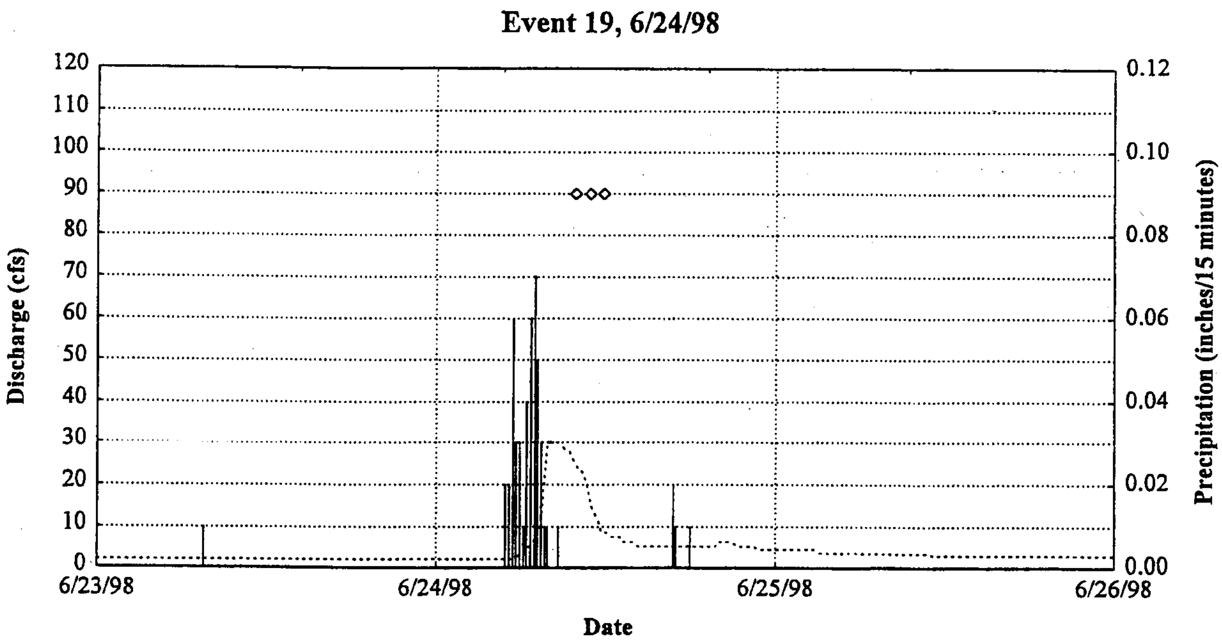

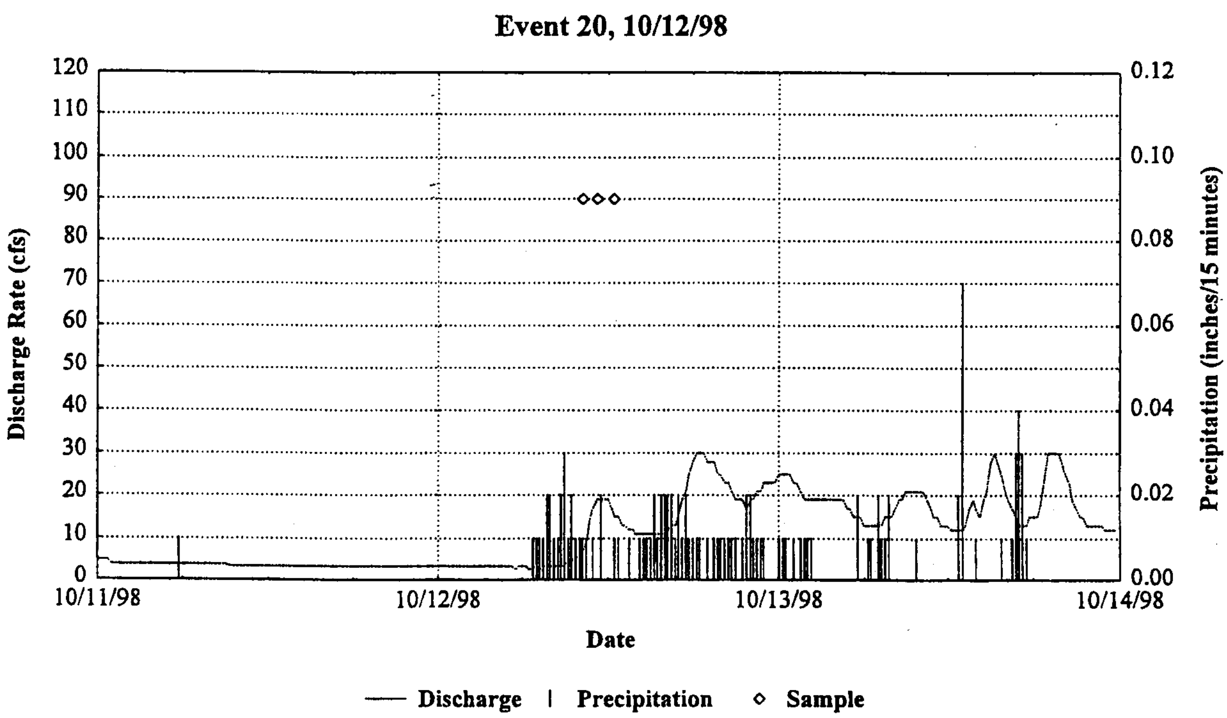

Figure D10. Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.

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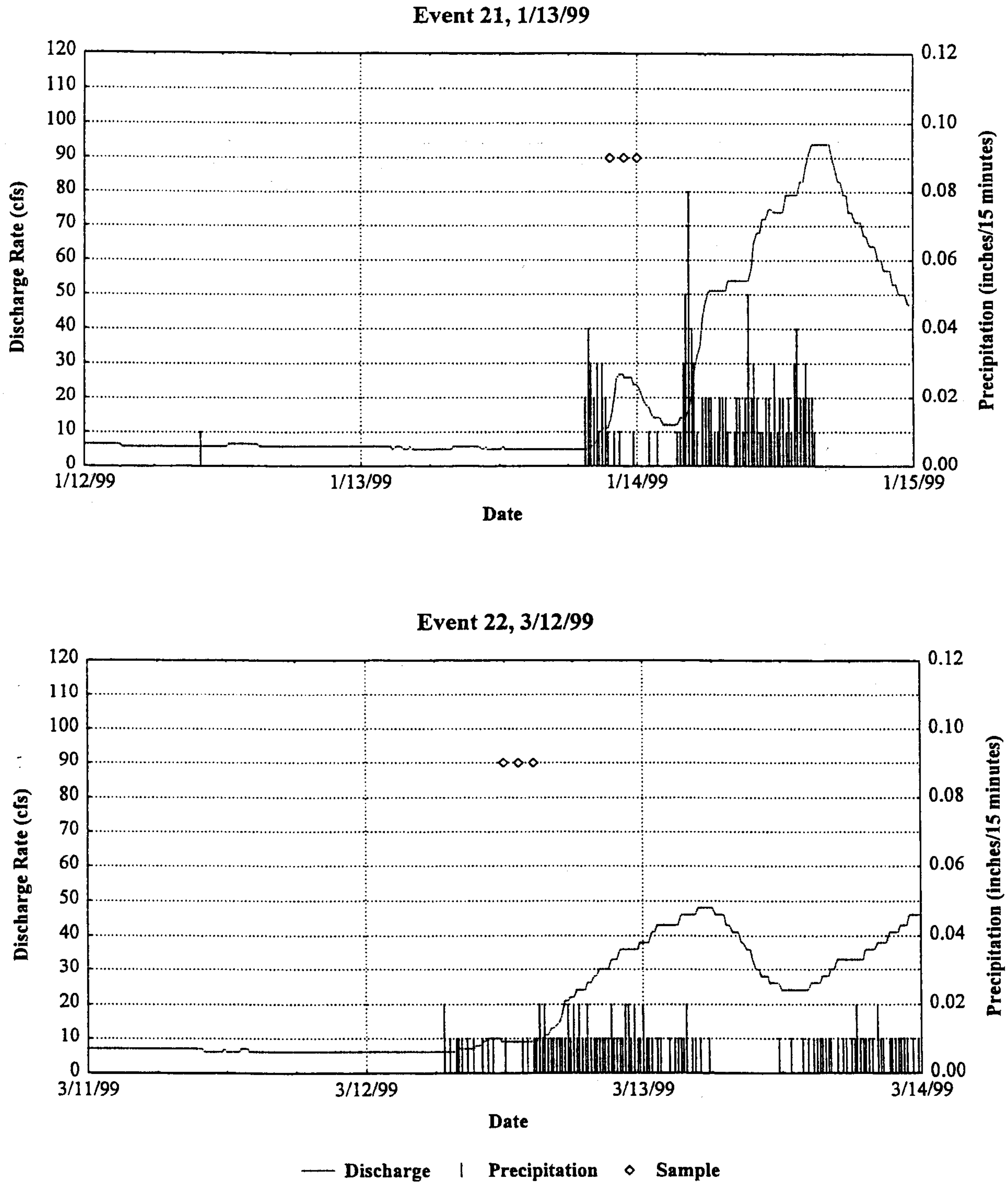
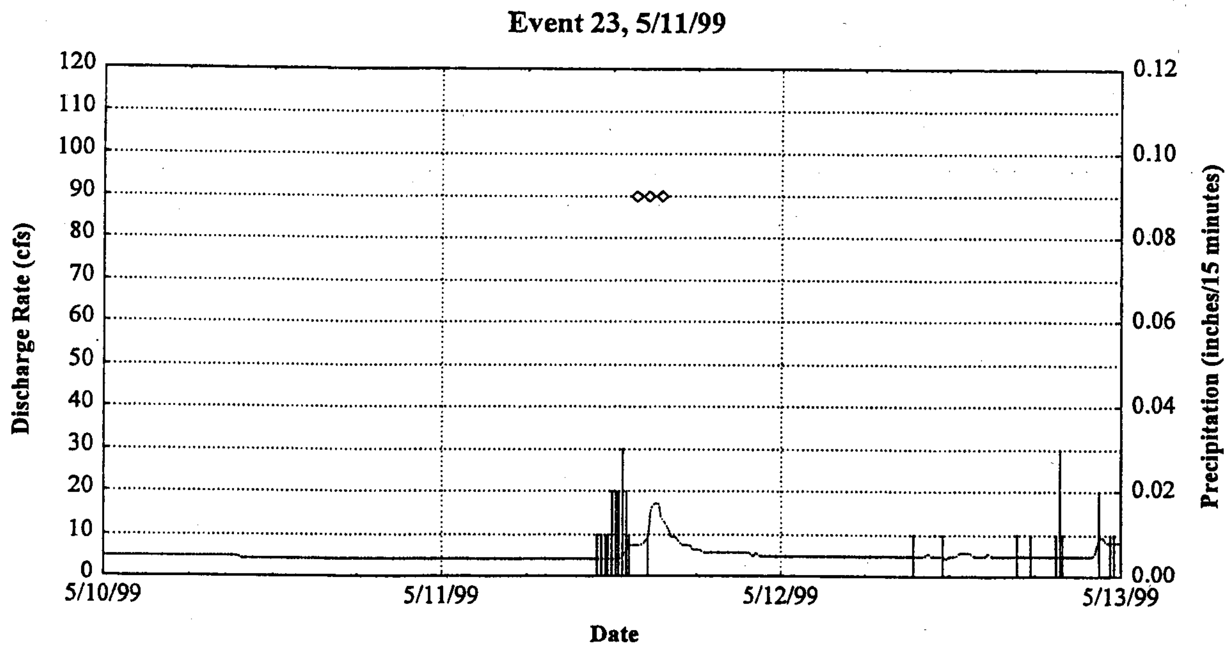


Figure D11. Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.



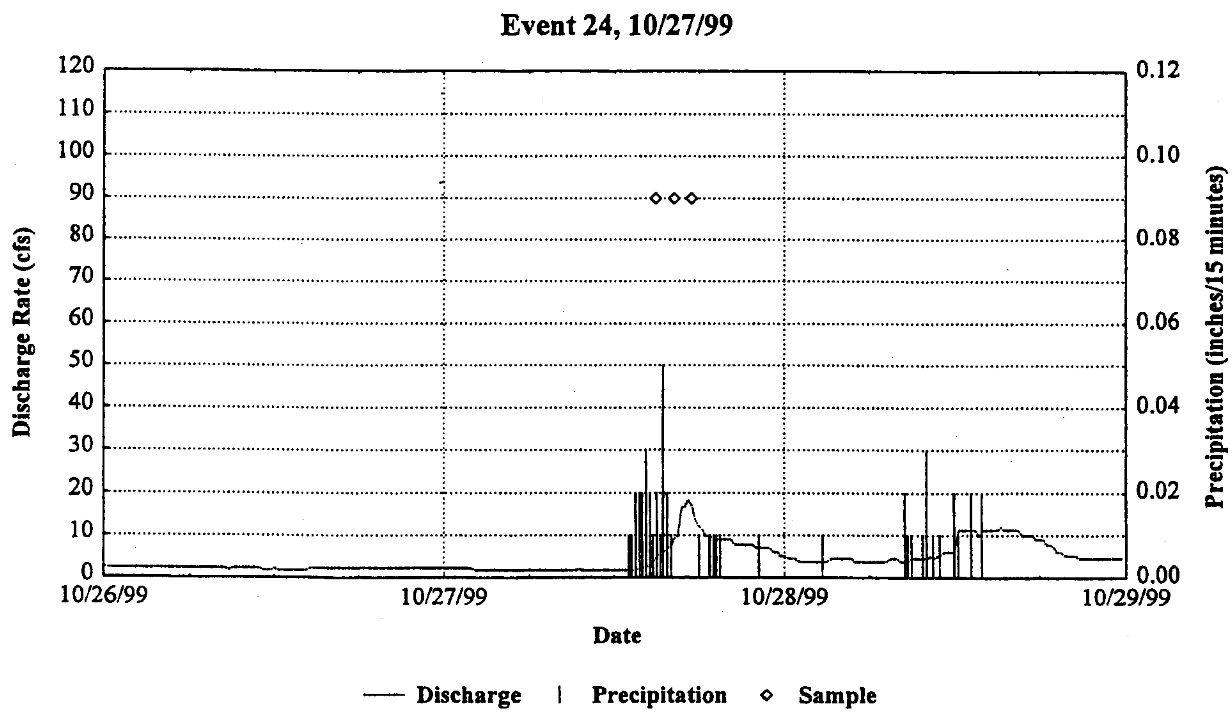


Figure D12. **Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.**

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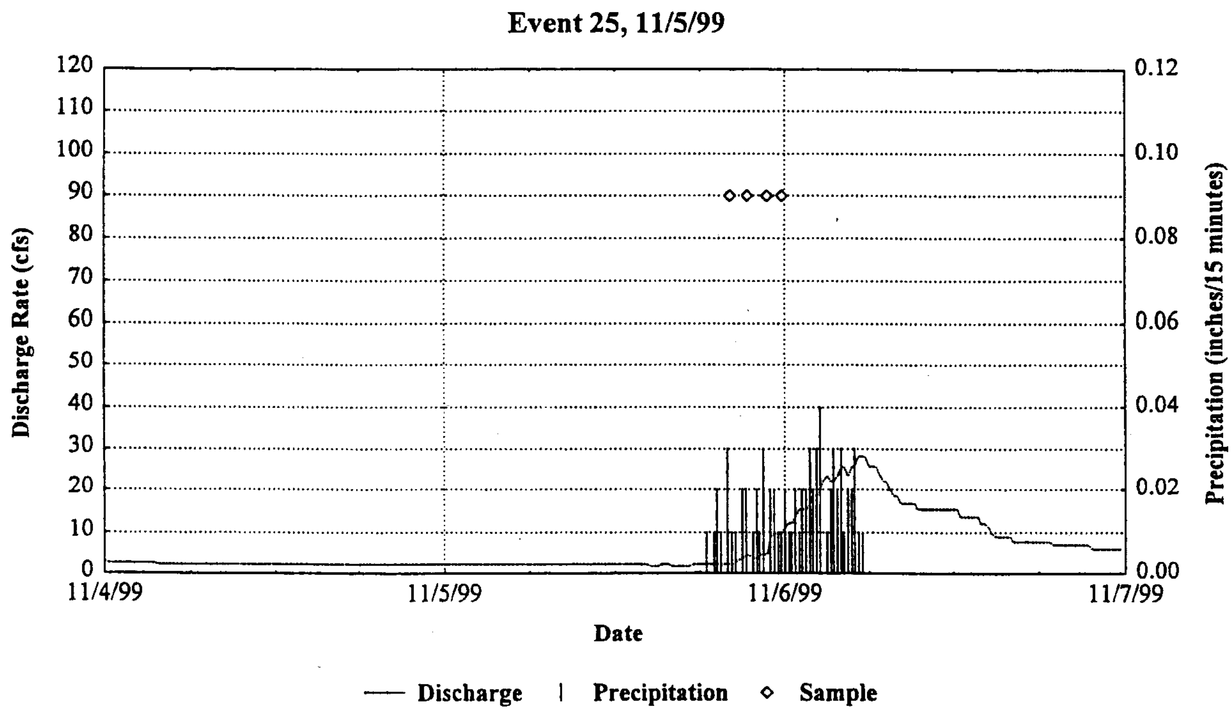

Figure D13. Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.

APPENDIX E

Laboratory Reports, Chain-of-Custody Records, and Data Quality Assurance Worksheets for Monitoring Years Four and Five

AQUATIC RESEARCH INCORPORATED

LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER: HER042-28 PAGE 1

EPORT DATE: 01/08/98

ATE SAMPLED: 12/04/97 DATE RECEIVED: 12/04/97

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER AMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

CASE NARRATIVE

ght water samples were delivered to the laboratory in good condition. The samples were analyzed according to the chain of custody. Samples for total metals were digested according to EPA procedures. Sample data follows while QA/QC data is contained on subsequent pages.

Base 10

AMPLE DATA

SAMPLE ID	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)	TPH (mg/l)
DM-1	1.5	<0.50	est 2	0.047	<0.010	0.779	< 0.25
DM-2	1.4	0.80	54	0.042	<0.010	0.909	< 0.25
BA-1	2.4	1.3	42	0.058	<0.010	1.04	< 0.25
MA-1	8.1	2.4	est 4	0.026	0.040	1.11	< 0.25
MA-2	2.0	0.93	est 22	0.021	0.007	1.39	< 0.25
MA-3	1.3	0.53	42	0.034	<0.010	1.22	< 0.25
MC-1	1.5	0.93	54	0.118	<0.010	0.248	< 0.25
MC-2	5.5	2.4	40	0.065	<0.010	0.559	< 0.25

		DISSOLVED METALS		
SAMPLE ID	HARDNESS (mgCaCO3/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)
DM-1	81.5	0.0025	<0.0005	<0.003
DM-2	85.5	0.0021	<0.0005	<0.003
BA-1	100	0.0015	<0.0005	<0.003
MA-1	111	<0.0010	<0.0005	<0.003
MA-2	101	0.0012	<0.0005	<0.003
MA-3	102	0.0015	<0.0005	<0.003
MC-1	72.3	0.0015	<0.0005	0.005
MC-2	83.6	0.0034	<0.0005	<0.003

AQUATIC RESEARCH INCORPORATED
LABORATORY & CONSULTING SERVICES
3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	HER042-28		PAGE 2
REPORT DATE:	01/09/98		
DATE SAMPLED:	12/04/97	DATE RECEIVED:	12/04/97

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

QC PARAMETER	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)	TPH (mg/l)
METHOD	SM182130B	EPA 160.2	SM189222D	EPA 365.1	EPA 350.1	EPA 353.2	EPA 418.1
DATE ANALYZED	12/05/97	12/09/97	12/04/97	12/10/97	12/31/97	12/31/97	12/29/97
DETECTION LIMIT	0.10	0.50	2	0.002	0.010	0.010	0.25
DUPLICATE							
SAMPLE ID	MC-2	MC-2	MC-2	MC-2	MC-1	MC-1	
ORIGINAL	5.5	2.4	40	0.065	<0.010	0.248	
DUPLICATE	5.5	2.4	est 28	0.066	<0.010	0.254	
RPD	0.00%	0.00%	NC	0.92%	NC	0.92%	NA
SPIKE SAMPLE							
SAMPLE ID				MC-2	MC-1	MC-1	
ORIGINAL				0.065	<0.010	0.248	
SPIKED SAMPLE				0.126	0.188	0.448	
SPIKE ADDED				0.050	0.200	0.200	
% RECOVERY	NA	NA	NA	122.20%	93.75%	100.25%	NA
QC CHECK							
FOUND	8.5	9.5		0.081	0.858	0.426	33.8
TRUE	8.0	10		0.078	0.915	0.424	33.9
% RECOVERY	106.25%	95.00%	NA	103.85%	93.81%	100.57%	99.71%
BLANK	NA	<0.50	< 2	<0.002	<0.010	<0.010	< 0.25

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

AQUATIC RESEARCH INCORPORATED
LABORATORY & CONSULTING SERVICES
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CASE FILE NUMBER: HER042-28 PAGE 3
REPORT DATE: 01/09/98
ATE SAMPLED: 12/04/97 DATE RECEIVED: 12/04/97
INAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER
SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

A/QC DATA WATER

QC PARAMETER	HARDNESS (mgCaCO3/l)	DISSOLVED METALS COPPER (mg/l)	DISSOLVED METALS LEAD (mg/l)	DISSOLVED METALS ZINC (mg/l)
METHOD	SM18 2340B	EPA 220.2	EPA 239.2	EPA 200.7
DATE ANALYZED	12/17/98	12/11/97	12/11/97	01/07/98
DETECTION LIMIT	2.00	0.0010	0.0005	0.003
DUPLICATE				
SAMPLE ID	MA-1	DM-1	DM-1	MA-3
ORIGINAL	111	0.0025	<0.0005	<0.003
DUPLICATE	114	0.0024	<0.0005	<0.003
RPD	2.21%	4.08%	NC	NC
SPIKE SAMPLE				
SAMPLE ID	MA-1	DM-1	DM-1	MA-3
ORIGINAL	111	0.0025	<0.0005	<0.003
SPIKED SAMPLE	131	0.0149	0.0118	0.925
SPIKE ADDED	20.0	0.0125	0.0125	1.00
% RECOVERY	98.58%	99.20%	94.40%	92.50%
QC CHECK				
FOUND	40.9	0.0245	0.0251	0.974
TRUE	40.0	0.0250	0.0250	1.00
% RECOVERY	102.25%	98.00%	100.40%	97.40%
BLANK	<2.00	<0.0010	<0.0005	<0.003
BLANK SPIKE %	NA	102.08%	105.16%	108.30%

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
= NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
= RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:
:even Lazoff
Laboratory Director

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue, Suite 601
Seattle, Washington 98121
(206)441-9080
FAX 441-9108

HER042-28

CHAIN OF CUSTODY RECORD

PROJECT NAME	Desmon 2
PROJECT NUMBER	C836
CLIENT	City of Des Moines
REPORT TO:	Rob Zisette
COPY TO:	—
SAMPLED BY:	Kent Easthouse
DELIVERY METHOD	Hand
LABORATORY:	Aquatic Research
REQUESTED COMPLETION DATE:	< 30 days
TOTAL # OF CONTAINERS:	32
LAB USE:	

ANALYSES REQUESTED

SAMPLE ID	DATE	TIME	SAMPLE DESCRIPTION	# OF CONTAINERS	Hardness	Turb	TSS	TP	NO_2+NO_3-N	NH_3-N	Fecal Coliform	Cu (Dissolved) GFAA	Pb (Dissolved) GFAA	Zn (Dissolved) ICP	TPH
DM-1	12/4/97	0950	Baseflow Water	4	X	X	X	X	X	X	X	X	X	X	X
DM-2	↓	1610	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
BA-1	↓	1200	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
MA-1	↓	1115	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
MA-2	↓	1450	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
MA-3	↓	1530	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
MC-1	↓	1410	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
MC-2	↓	1245	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓

REMARKS: Dissolved metals need filtering

TPH pres. wjb 12.4.97
met. filt. & pres. wjb 12.5.97

RELINQUISHED BY (NAME/CO.)	SIGNATURE	DATE/TIME	RECEIVED BY (NAME/CO.)	SIGNATURE	DATE/TIME
Kent Easthouse Herrera	[signature]	12/4/97 1710	W.J. Bruton (Aquatic)	W.J. Bruton	12.4.97 17:10
RELINQUISHED BY (NAME/CO.)	SIGNATURE	DATE/TIME	RECEIVED BY (NAME/CO.)	SIGNATURE	DATE/TIME

Data Quality Assurance Worksheet

HERRERA ENVIRONMENTAL CONSULTANTS

Project Name/No./Client: Desmon 2
Laboratory/Parameters: Aquatic Research / Conv. + Metals
Sample Date/Sample ID: Base 10, 12/4/97

By: J. Lenth
Date: 9/24/99
Page 1 of 1
Checked initials: RZ
Checked date: 7/10/00

Parameter	Completeness/ Methodology	Holding Times	Blanks/ Detection Limits	Matrix Spikes/ Surrogate Recoveries	Lab Duplicates	Field Duplicates	Lab Control Samples	Instrument Calibration/ Performance	ACTION
Turbidity	OK	O.K.	NA	NA	0.00%	NA	100.25%	O.K.	None
TSS			<0.50	NA	<IDL 0%		95.00%		
Fecal Coli.			<2	NA	NC	35% est.	NA		None
Total P			<0.002	122.20%	1.53%		103.45%		
NH_3-N			<0.010	93.81%	NC		93.81%		None
NO_3+NO_2-N			<0.010	100.25%	2.39%		100.57%		
TPH			<0.25	NA	NA		99.71%		None
Hardness			NA	98.58%	2.67%		102.25%		
Dissolved Cu			<0.0010	99.20%	<IDL		98.00%		None
Pb			<0.0005	94.40%	NC		100.40%		
Zn			<0.003	92.50%	NC		97.40%		
Field Meas. Temp, DO, pH, Cond.			NA	NA	NA		NA	OK.	None

Notes:

file: DATAQA3.XLS

AR 025487

AQUATIC RESEARCH INCORPORATED

LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER: HER042-30 PAGE 1

REPORT DATE: 04/22/98

DATE SAMPLED: 03/19/98 DATE RECEIVED: 03/19/98

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

CASE NARRATIVE

Eight water samples were delivered to the laboratory in good condition. The samples were analyzed according to the chain of custody. Samples for total metals were digested according to EPA procedures. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows while QA/QC data is contained on subsequent pages.

BASE 14

SAMPLE DATA

SAMPLE ID	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	TPH (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
DM-1	2.1	2.3	est. 6	0.037	<0.25	0.039	0.709
DM-2	2.6	2.6	est. 6	0.037	<0.25	0.013	0.912
BA-1	2.7	1.8	840	0.053	<0.25	<0.010	0.957
MA-1	4.9	2.6	est. 6	0.024	<0.25	0.058	1.35
MA-2	2.9	1.8	100	0.024	<0.25	0.011	1.57
MA-3	2.1	1.1	est. 6	0.031	<0.25	<0.010	0.327
MC-1	2.2	4.8	est. 6	0.102	<0.25	0.021	0.359
MC-2	3.6	2.5	72	0.054	<0.25	0.022	0.440

		DISSOLVED METALS		
SAMPLE ID	HARDNESS (mgCaCO3/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)
DM-1	86.3	0.0014	<0.0005	0.007
DM-2	86.1	<0.0010	<0.0005	<0.003
BA-1	89.1	0.0011	<0.0005	<0.003
MA-1	94.7	<0.0010	<0.0005	0.004
MA-2	97.3	<0.0010	<0.0005	0.017
MA-3	90.8	<0.0010	<0.0005	<0.003
MC-1	59.3	<0.0010	<0.0005	<0.003
MC-2	74.8	<0.0010	<0.0005	0.005

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CASE FILE NUMBER:	HER042-30		PAGE 2
REPORT DATE:	04/22/98		
DATE SAMPLED:	03/19/98	DATE RECEIVED:	03/19/98

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

QC PARAMETER	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	TPH (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
METHOD	SM182130B	EPA 160.2	SM189222D	EPA 365.1	EPA 418.1	EPA 350.1	EPA 353.2
DATE ANALYZED	03/20/98	03/20/98	03/19/98	03/25/98	04/14/98	04/02/98	04/02/98
DETECTION LIMIT	0.10	0.50	2	0.002	0.25	0.010	0.010
DUPLICATE							
SAMPLE ID	MC-2	MC-2	MC-2	MC-2		MC-2	MC-2
ORIGINAL	3.6	2.5	72	0.054		0.022	0.440
DUPLICATE	3.6	2.5	74	0.053		0.025	0.438
RPD	0.00%	0.00%	2.74%	0.56%	NA	14.35%	12.40%
SPIKE SAMPLE							
SAMPLE ID				MC-2		MC-2	MC-2
ORIGINAL				0.054		0.022	0.440
SPIKED SAMPLE				0.107		0.234	0.626
SPIKE ADDED				0.050		0.200	0.200
% RECOVERY	NA	NA	NA	105.80%	NA	106.20%	93.00%
QC CHECK							
FOUND	8.0	10		0.081	36.8	0.923	0.437
TRUE	8.0	10		0.077	33.9	0.915	0.424
% RECOVERY	100.00%	100.00%	NA	105.19%	108.55%	100.86%	102.97%
BLANK	NA	<0.50	< 2	<0.002	<0.25	<0.010	<0.010

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

AQUATIC RESEARCH INCORPORATED
LABORATORY & CONSULTING SERVICES
3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
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CASE FILE NUMBER: HER042-30 PAGE 3
REPORT DATE: 04/22/98
DATE SAMPLED: 03/19/98 DATE RECEIVED: 03/19/98
FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

QC PARAMETER	HARDNESS (mgCaCO3/l)	DISSOLVED METALS COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)
METHOD	SM18 2340B	EPA 220.2	EPA 239.2	EPA 200.7
DATE ANALYZED	04/02/98	04/01/98	04/01/98	04/22/98
DETECTION LIMIT	2.00	0.0010	0.0005	0.003
DUPLICATE				
SAMPLE ID	MC-2	BA-1	BA-1	MA-3
ORIGINAL	74.8	0.0011	<0.0005	<0.003
DUPLICATE	75.2	0.0012	<0.0005	<0.003
RPD	0.53%	8.70%	NC	#DIV/0!
SPIKE SAMPLE				
SAMPLE ID	MC-2	BA-1	BA-1	MA-3
ORIGINAL	74.8	0.0011	<0.0005	<0.003
SPIKED SAMPLE	93.6	0.0107	0.0087	1.19
SPIKE ADDED	20.0	0.0125	0.0125	1.00
% RECOVERY	94.00%	76.80%	69.60%	119.00%
QC CHECK				
FOUND	40.1	0.0244	0.0244	1.02
TRUE	40.0	0.0250	0.0250	1.00
% RECOVERY	100.25%	97.60%	97.60%	102.00%
BLANK	<2.00	<0.0010	<0.0005	<0.003

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
NR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Steven Lazoff
Laboratory Director

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue, Suite 601
Seattle, Washington 98121
(206)441-9080
FAX 441-9180

CHAIN OF CUSTODY RECORD

PROJECT NAME	DESMON 2
PROJECT NUMBER	C836
CLIENT	City of Des Moines
REPORT TO:	Rob Zisette
COPY TO:	—
SAMPLED BY:	John Osborne
DELIVERY METHOD:	HEC vehicle
LABORATORY:	AQR
REQUESTED COMPLETION DATE:	≤ 30 days
TOTAL # OF CONTAINERS:	32
LAB USE:	

SAMPLE ID	DATE	TIME	SAMPLE DESCRIPTION	# OF CONTAINERS	Hardness	Turb	TSS	TP	NO2+NO3-N	NH3-N	Fecal Coliform	Cu (dissolved) GFAA	Pb (") GFAA	Zn (") ICP	TPH
Dm-1	3/19/98	1105	Baseflow water	4	X	X	X	X	X	X	X	X	X	X	X
Dm-2		1200													
BA-1		1235													
MA-1		1355													
MA-2		1335													
MA-3		1220													
MC-1		1320													
MC-2		1255													

REMARKS: Dissolved metals need filtering.

RELINQUISHED BY (NAME/CO.)	SIGNATURE	DATE/TIME	RECEIVED BY (NAME/CO.)	SIGNATURE	DATE/TIME
John Osborne / HEC	[signature]	3/19/98/1609	AARON CROTT / Sheres	[signature]	3-19-98/1605
RELINQUISHED BY (NAME/CO.)	SIGNATURE	DATE/TIME	RECEIVED BY (NAME/CO.)	SIGNATURE	DATE/TIME

HERRERA ENVIRONMENTAL CONSULTANTS

Data Quality Assurance Worksheet

Project Name/No./Client: Desmon 2
Laboratory/Parameters: Aquatic Research / Conv. + Metals
Sample Date/Sample ID: Base 11, 3/19/98

By John Lenth
Date 9/24/99 Page 1 of 1
Checked initials ~~[illegible]~~ RZ
date 7/10/00

Parameter	Completeness/ Methodology	Holding Times	Blanks/ ~~Detection Limits~~	Matrix Spikes/ Surrogate Recoveries	Lab Duplicates	Field Duplicates	Lab Control Samples	Instrument Calibration/ Performance	ACTION
Turbidity	O.K. ↓	O.K. ↓	NA	NA	0.00%	NA ↓	100.00%	O.K. ↓	
TSS			<0.50	NA	0.00%		100.00%		None
Fecal Coliform			<2	NA	2.74%		NA		
Total P			<0.002	105.80%	1.87%		105.19%		
TPH			<0.25	NA	NA		108.55%		None
NH4-N			<0.010	106.20%	<IDL		100.86%		
NO3+NO2-N			<0.010	93.00%	0.46%		102.97%		None
Hardness			<2.00	94.00%	0.53%		100.25%		
Dissolved Cu			<0.0010	76.80%	<IDL		97.60%		None
Pb			<0.0005	69.60% (boxed)	NC		97.60%		✓ Data qualified as estimate(s)
Zn			<0.003	119.00%	NC		102.00%		None
Field Meas. Temp DO pH Cond			NA	NA	NA		NA	~~No Notes~~ ~~[illegible]~~ O.K.	None

Notes:

file: DATAQA3.XLS

AR 025492

AQUATIC RESEARCH INCORPORATED

LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	HER042-33	PAGE 1	
REPORT DATE:	08/12/98		
DATE SAMPLED:	07/22/98	DATE RECEIVED:	07/22/98

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

CASE NARRATIVE

Ten water samples were delivered to the laboratory in good condition. The samples were analyzed according to the chain of custody. Samples for total metals were digested according to EPA procedures. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows while QA/QC data is contained on subsequent pages.

BASE 12

SAMPLE DATA

SAMPLE ID	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
DM-1	0.50	1.2	96	0.046	<0.010	0.892
DM-2	0.35	0.83	60	0.061	<0.010	0.854
MC-1	4.7	1.0	440	0.238	<0.010	0.227
MC-2	0.75	1.5	> 210	0.094	<0.010	0.333
BA-1	0.41	1.8	580	0.086	<0.010	0.967
MA-1	5.4	1.3	est 36	0.049	0.074	1.06
MA-2	0.37	<0.50	est 240	0.036	<0.010	0.928
MA-3	0.56	1.5	140	0.064	<0.010	1.06
SAMPLE X	5.3	1.3	est 38	0.031	0.074	0.999

		DISSOLVED METALS		
SAMPLE ID	HARDNESS (mgCaCO3/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)
DM-1	107	<0.0010	<0.0005	<0.003
DM-2	113	0.0013	<0.0005	0.010
MC-1	92.6	0.0012	<0.0005	<0.003
MC-2	108	0.0012	<0.0005	<0.003
BA-1	120	<0.0010	<0.0005	<0.003
MA-1	143	<0.0010	<0.0005	<0.003
MA-2	107	<0.0010	<0.0005	<0.003
MA-3	110	0.0116	<0.0005	<0.003
SAMPLE X	135	<0.0010	<0.0005	<0.003
TRANSFER BLANK		<0.0010	<0.0005	<0.003

Sample X = field duplicate of MA-1

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LABORATORY & CONSULTING SERVICES
3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER: HER042-33
REPORT DATE: 08/12/98
DATE SAMPLED: 07/22/98 DATE RECEIVED: 07/22/98
FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

QC PARAMETER	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
METHOD	SM182130B	EPA 160.2	SM189222D	EPA 365.1	EPA 350.1	EPA 353.2
DATE ANALYZED	07/23/98	07/23/98	07/22/98	07/29/98	07/29/98	07/29/98
DETECTION LIMIT	0.10	0.50	2	0.002	0.010	0.010
DUPLICATE						
SAMPLE ID	MA-3	MA-3	MC-2	SAMPLE X	MA-3	MA-3
ORIGINAL	0.56	1.5	>210	0.031	<0.010	1.06
DUPLICATE	0.56	1.4	>170	0.031	<0.010	1.02
RPD	0.00%	4.65%	NC	0.33%	NC	12.40%
SPIKE SAMPLE						
SAMPLE ID				SAMPLE X	MA-3	MA-3
ORIGINAL				0.031	<0.010	
SPIKED SAMPLE				0.085	0.171	
SPIKE ADDED				0.050	0.200	
% RECOVERY	NA	NA	NA	109.60%	85.50%	OR
QC CHECK						
FOUND	8.3	9.7		0.099	0.523	0.922
TRUE	8.0	10		0.093	0.499	0.933
% RECOVERY	103.75%	97.00%	NA	106.45%	104.81%	98.82%
BLANK	NA	<0.50	< 2	<0.002	<0.010	<0.010

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

AQUATIC RESEARCH INCORPORATED

LABORATORY & CONSULTING SERVICES
3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	HER042-33		PAGE 3
REPORT DATE:	08/12/98		
DATE SAMPLED:	07/22/98	DATE RECEIVED:	07/22/98

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

		DISSOLVED METALS		
QC PARAMETER	HARDNESS (mgCaCO3/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)
METHOD	SM18 2340B	EPA 220.2	EPA 239.2	EPA 200.7
DATE ANALYZED	08/04/98	08/10/98	08/10/98	08/10/98
DETECTION LIMIT	2.00	0.0010	0.0005	0.003
DUPLICATE				
SAMPLE ID	SAMPLE X	SAMPLE X	SAMPLE X	SAMPLE X
ORIGINAL	135	<0.0010	<0.0005	<0.003
DUPLICATE	136	<0.0010	<0.0005	<0.003
RPD	0.55%	NC	NC	NC
SPIKE SAMPLE				
SAMPLE ID	SAMPLE X	SAMPLE X	SAMPLE X	SAMPLE X
ORIGINAL	135	<0.0010	<0.0005	<0.003
SPIKED SAMPLE	155	0.0135	0.0130	1.07
SPIKE ADDED	20.0	0.0125	0.0125	1.00
% RECOVERY	100.31%	108.00%	104.00%	107.00%
QC CHECK				
FOUND	40.1	0.0269	0.0261	0.981
TRUE	40.0	0.0250	0.0250	1.00
% RECOVERY	100.25%	107.60%	104.40%	98.10%
BLANK	<2.00	<0.0010	<0.0005	<0.003

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Steven Lazoff
Laboratory Director

Aquatic Research Incorporated

3927 Aurora Ave. N / Seattle, WA 98103 / (206) 632-2715

IAIN-OF-CUSTODY RECORD

CLIENT: Herrera Consultants

S MPLING DATE: 7/22/98

S MPLERS: Kent E

SHEET 1 OF 1

PROJECT ID: Des Moines

CASE FILE NO.:

DATA RECORDED BY:

SAMPLE INFORMATION

PARAMETERS

SAMPLE ID	DATE/TIME COLLECTED		Hardness	Turbidity	TSS	TP	NO_2+NO_3	NH_3	Cu (Dissolved)	Pb (Dissolved)	Zn (Dissolved)	Fecals	BOTT #	NOTES
DM-1	7/22/98	1000	X	X	X	X	X	X	X	X	X	X		
DM-2	↓	1600	X	↓	↓	↓	↓	↓	↓	↓	↓	X		
MC-1	↓	1240	X	↓	↓	↓	↓	↓	↓	↓	↓	X		
MC-2	↓	1200	X	↓	↓	↓	↓	↓	↓	↓	↓	X		
BA-1	↓	1310	X	↓	↓	↓	↓	↓	↓	↓	↓	X		
MA-1	↓	1500	X	↓	↓	↓	↓	↓	↓	↓	↓	X		
MA-2	↓	1440	X	↓	↓	↓	↓	↓	↓	↓	↓	X		
MA-3	↓	1400	X	↓	↓	↓	↓	↓	↓	↓	↓	X		
Sample X	↓	0800	X	X	X	X	X	X	X	X	X	X		
Transfer Blank	↓	1700							X	X	X			

	Relinquished By	Date/Time	Received By	Date/Time
inted Name	Kent Easthouse	7/22/98 1720	Tom Meadowc	7/22/98 17:30
gnature	[signature]		[signature]	
Affiliation	Herrera		ARI	

	Relinquished By	Date/Time	Received By	Date/Time
Printed Name				
Signature				
Affiliation				

Miscellaneous Notes (Hazardous Materials, Quick turn-around time, etc.): Dissolved Metals need to be filtere

AR 025496

HERRERA ENVIRONMENTAL CONSULTANTS

Data Quality Assurance Worksheet

By: J. Lentl
Date: 9/24/99 Page 1 of 1
Checked initials: ~~JL~~ RZ
date: 7/19/00

Project Name/No./Client: Desmon 2
Laboratory/Parameters: Aquatic Research / Conv. + Metals
Sample Date/Sample ID: Base 12, 7/22/98

Parameter	Completeness/ Methodology	Holding Times	Blanks/ ~~Detection~~ Limits	Matrix Spikes/ Surrogate Recoveries	Lab Duplicates	Field Duplicates	Lab Control Samples	Instrument Calibration/ Performance	ACTION
Turbidity	O.K. ↓	O.K. ↓	NA	NA	0.00%	1.87%	103.75%	O.K. ↓	
TSS			<0.50	NA	< IDL	< IDL	97.00%		None
Fecals			< 2	NA	NC	5.41%	NA		
Total P			<0.002	109.60%	0.00%	45.00% (boxed)	106.45%		note TP None
NH4-N			<0.010	85.50%	NC	0.00%	104.81%		
NO3+NO2-N			<0.010	Recovery out of Range	3.85%	5.93%	98.82%		
Hardness			<2.00	100.31%	0.74%	5.76%	100.25%		None
Dissolved Cu			<0.0010	108.00%	NC both U	NC both U	107.60%		None
Pb			<0.005	104.00%	NC ↓	NC ↓	104.40%		
Zn			<0.003	107.00%	NC	NC	98.10%		
Field Meas. Temp DO pH Cond.	↓	↓	NA	NA	NA	NA	NA	~~No Notes~~ ~~Data Notes~~ O.K.	None

file: DATAQA3.XLS

Notes:

AR 025497

AQUATIC RESEARCH INCORPORATED

LABORATORY & CONSULTING SERVICES
3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER: HER042-36 PAGE 1
REPORT DATE: 03/02/99
DATE SAMPLED: 02/12/99 DATE RECEIVED: 02/12/99
FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER AMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

CASE NARRATIVE

ight water samples were delivered to the laboratory in good condition. The samples were analyzed according to the chain of custody. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows while QA/QC data is contained on subsequent pages.

BASE 13

AMPLE DATA

SAMPLE ID	TURBIDITY (NTU)	CONDUCTIVITY (umhos/cm)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
DM-1	0.83	175	2.3	est 24	0.029	0.070	0.646
DM-2	0.68	188	2.3	est 36	0.027	0.016	0.964
MA-1	0.64	220	1.5	est 14	0.017	0.031	1.73
MA-2	4.1	203	0.50	est 36	0.016	<0.010	1.66
MA-3	4.1	194	2.2	132	0.027	<0.010	1.22
BA-1	7.4	172	8.5	760	0.049	<0.010	1.19
MC-1	0.57	134	1.3	est 28	0.039	<0.010	0.560
MC-2	7.3	127	2.5	est 34	0.036	0.015	0.655

		DISSOLVED METALS		
SAMPLE ID	HARDNESS (mgCaCO3/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)
DM-1	71.1	0.0020	<0.0005	0.012
DM-2	73.7	0.0023	<0.0005	0.007
MA-1	83.2	<0.0010	<0.0005	0.018
MA-2	81.0	0.0014	<0.0005	0.007
MA-3	73.1	0.0027	<0.0005	0.007
BA-1	65.3	0.0035	<0.0005	0.009
MC-1	52.2	0.0013	<0.0005	0.006
MC-2	49.8	0.0026	<0.0005	0.009

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3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	HER042-36		PAGE 2
REPORT DATE:	03/02/99		
DATE SAMPLED:	02/12/99	DATE RECEIVED:	02/12/99

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

QC PARAMETER	TURBIDITY (NTU)	CONDUCTIVITY (umhos/cm)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
METHOD	SM182130B	EPA 120.1	EPA 160.2	SM189222D	EPA 365.1	EPA 350.1	EPA 353.2
DATE ANALYZED	02/12/99	02/23/99	02/18/99	02/12/99	02/16/99	02/24/99	02/24/99
DETECTION LIMIT	0.10	0.10	0.50	2	0.002	0.010	0.010
DUPLICATE							
SAMPLE ID	MC-2	MC-2	MC-2	MA-1	MC-2	MC-2	MC-2
ORIGINAL	7.3	127	2.5	est 14	0.036	0.015	0.655
DUPLICATE	7.5	127	2.7	est 6	0.035	0.022	0.653
RPD	2.70%	0.00%	9.52%	NC	3.07%	37.84%	0.38%
			7.49%		2.82%	<IDL	0.31%
SPIKE SAMPLE							
SAMPLE ID					MC-2	MC-2	MC-2
ORIGINAL					0.036	0.015	0.655
SPIKED SAMPLE					0.091	0.214	0.826
SPIKE ADDED					0.050	0.200	0.200
% RECOVERY	NA	NA	NA	NA	108.40%	99.35%	85.40%
					110.00%	99.50%	85.50%
QC CHECK							
FOUND	0.78	748	9.8		0.094	0.524	0.913
TRUE	0.80	718	10		0.093	0.499	0.933
% RECOVERY	97.50%	104.18%	98.00%	NA	100.54%	105.01%	97.83%
					101.08%		97.86%
BLANK	NA	NA	<0.50	< 2	<0.002	<0.010	<0.010

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OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

AQUATIC RESEARCH INCORPORATED

LABORATORY & CONSULTING SERVICES
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CASE FILE NUMBER:	HER042-36		PAGE 3
REPORT DATE:	03/02/99		
DATE SAMPLED:	02/12/99	DATE RECEIVED:	02/12/99

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

		DISSOLVED METALS		
QC PARAMETER	HARDNESS (mgCaCO3/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)
METHOD	SM18 2340B	EPA 220.2	EPA 239.2	EPA 200.7
DATE ANALYZED	02/22/99	02/22/99	02/22/99	02/22/99
DETECTION LIMIT	2.00	0.0010	0.0005	0.003
DUPLICATE				
SAMPLE ID	MC-2	DM-1	DM-1	MA-1
ORIGINAL	49.8	0.0020	<0.0005	0.018
DUPLICATE	50.8	0.0021	<0.0005	0.018
RPD	2.00%	5.88%	NC	0.00%
	1.99%	<IDL		
SPIKE SAMPLE				
SAMPLE ID	MC-2	DM-1	DM-1	MA-1
ORIGINAL	49.8	0.0020	<0.0005	0.018
SPIKED SAMPLE	70.7	0.0151	0.0222	1.01
SPIKE ADDED	20.0	0.0125	0.0250	1.00
% RECOVERY	104.46%	104.96%	88.80%	99.20%
	104.50%	104.80%	86.80%	
QC CHECK				
FOUND	39.4	0.0232	0.0230	1.01
TRUE	40.0	0.0250	0.0250	1.00
% RECOVERY	98.50%	92.80%	92.00%	101.40%
				101.00%
BLANK	<2.00	<0.0010	<0.0005	<0.003

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NR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Steven Lazoff
Laboratory Director

Data Quality Assurance Worksheet

HERRERA ENVIRONMENTAL CONSULTANTS

Project Name/No./Client: Desimon/C387/City of Des Moines
Laboratory/Parameters: ARI/Conv+Metals
Sample Date/Sample ID: Base 13 2/12/99 8 stations

By: R. Janacek
Date: 3/8/00 Page 1 of 1
Checked initials: RZ
date: 7/10/00

Parameter	Completeness/ Methodology	Holding Times	Blanks/ Detection Limits	Matrix Spikes/ Surrogate Recoveries	Lab Duplicates	Field Duplicates	Lab Control Samples	Instrument Calibration/ Performance	ACTION
Turbidity	OK	OK	OK	NA	2.70%		97.50%	NA	None
Conductivity				NA	0.00%		104.18%		
TSS				NA	7.69%		98.00%		
Fecals				NA	NC		NA		
TP				110.00%	2.82%		101.08%		
NH_4-N				99.50%	<IDL		105.01%		
NO_3+NO_2-N				85.50%	0.31%		97.86%		
Hardness				104.50%	1.99%		98.50%		
Dissolved									
Cu				104.80%	<IDL		92.80%		
Pb				86.80%	NC (both U)		92.00%		
Zn				99.20%	0.00%		101.00%		
Field				NA	NA		NA	OK	
temp									
pH									
DO									

Notes: NC: Not calculable due to one or more values being below the detection limit.

file: DATAQA3.XLS

AQUATIC RESEARCH INCORPORATED

LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	HER042-39	PAGE 1	
ιEPORT DATE:	06/21/99		
)ATE SAMPLED:	05/27/99	DATE RECEIVED:	05/27/99

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER AMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

CASE NARRATIVE

ɜn water samples were delivered to the laboratory in good condition. The samples were analyzed according to the chain of custody. No difficulties were ɩɔcountered in the preparation or analysis of these samples. Sample data follows while QA/QC data is contained on subsequent pages.

Base 14

ˉAMPLE DATA

SAMPLE ID	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
DM-1	2.0	1.7	68	0.075	<0.010	0.644
DM-2	2.3	3.3	122	0.087	<0.010	0.861
DM-3	2.5	3.5	122	0.081	<0.010	0.874
BA-1	2.5	3.2	est 340	0.082	<0.010	1.17
MA-1	5.2	1.1	est 16	0.046	0.043	1.01
MA-2	2.7	2.7	102	0.038	<0.010	1.63
MA-3	2.3	1.7	98	0.051	<0.010	1.26
MC-1	2.0	1.5	960	0.088	<0.010	0.163
MC-2	4.0	6.4	144	0.093	<0.010	0.176

		DISSOLVED METALS		
SAMPLE ID	HARDNESS (mgCaCO3/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)
DM-1	92.5	<0.0010	<0.0005	<0.003
DM-2	94.0	<0.0010	<0.0005	0.004
DM-3	91.0	<0.0010	<0.0005	<0.003
BA-1	108	<0.0010	<0.0005	<0.003
MA-1	110	<0.0010	0.0005	<0.003
MA-2	98.3	<0.0010	<0.0005	<0.003
MA-3	101	<0.0010	<0.0005	<0.003
MC-1	85.4	<0.0010	<0.0005	<0.003
MC-2	76.3	0.0013	<0.0005	<0.003
MC-3	[redacted]	<0.0010	<0.0005	0.010

DM3 = Field duplicate of DM-2
MC-3 = Field transfer blank

AQUATIC RESEARCH INCORPORATED
LABORATORY & CONSULTING SERVICES
3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER: HER042-39
REPORT DATE: 06/21/99
DATE SAMPLED: 05/27/99 DATE RECEIVED: 05/27/99
FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

QC PARAMETER	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
METHOD	SM182130B	EPA 160.2	SM189222D	EPA 365.1	EPA 350.1	EPA 353.2
DATE ANALYZED	05/28/99	05/27/99	05/27/99	06/01/99	06/07/99	06/07/99
DETECTION LIMIT	0.10	0.50	2	0.002	0.010	0.010
DUPLICATE						
SAMPLE ID	BATCH	BA-1	DM-1	MC-2	BATCH	BATCH
ORIGINAL	6.4	3.2	68	0.093	<0.010	0.012
DUPLICATE	6.4	4.0	72	0.091	<0.010	0.011
RPD	0.00%	23.26%	5.71%	2.56%	NC	3.54%
		22.22%		2.17%		<1 DL
SPIKE SAMPLE						
SAMPLE ID				MC-2	BATCH	BATCH
ORIGINAL				0.093	<0.010	0.012
SPIKED SAMPLE				0.143	0.201	0.194
SPIKE ADDED				0.050	0.200	0.200
% RECOVERY	NA	NA	NA	100.20%	100.50%	91.25%
				100.00%	95.50%	91.00%
QC CHECK						
FOUND	7.7	9.6		0.089	0.785	0.632
TRUE	8.0	10		0.093	0.750	0.600
% RECOVERY	96.25%	96.00%	NA	95.70%	104.68%	105.40%
					104.67%	105.33%
BLANK	NA	<0.50	< 2	<0.002	<0.010	<0.010

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AQUATIC RESEARCH INCORPORATED
LABORATORY & CONSULTING SERVICES
3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	HER042-39		PAGE 3
REPORT DATE:	06/21/99		
DATE SAMPLED:	05/27/99	DATE RECEIVED:	05/27/99

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

		DISSOLVED METALS		
QC PARAMETER	HARDNESS (mgCaCO3/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)
METHOD	SM18 2340B	EPA 220.2	EPA 239.2	EPA 200.7
DATE ANALYZED	06/14/99	06/23/99	06/23/99	06/22/99
DETECTION LIMIT	2.00	0.0010	0.0005	0.003
DUPLICATE				
SAMPLE ID	MC-2	MA-2	MA-2	MC-3
ORIGINAL	76.3	<0.0010	<0.0005	0.010
DUPLICATE	75.2	<0.0010	<0.0005	0.011
RPD	1.48%	NC	NC	9.52%
SPIKE SAMPLE	1.45%			<DL
SAMPLE ID	MC-2	MA-2	MA-2	MC-3
ORIGINAL	76.3	<0.0010	<0.0005	0.010
SPIKED SAMPLE	95.3	0.0144	0.0140	1.06
SPIKE ADDED	20.0	0.0125	0.0125	1.00
% RECOVERY	95.13%	115.20%	111.92%	104.60%
QC CHECK	95.00%	107.20	108.00%	105%
FOUND	39.2	0.0269	0.0272	0.967
TRUE	40.0	0.0250	0.0250	1.00
% RECOVERY	97.93%	107.44%	108.80%	96.65%
	98.00%	107.60%		96.70%
BLANK	<2.00	<0.0010	<0.0005	<0.003

RPD = RELATIVE PERCENT DIFFERENCE.
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OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Steven Lazoff
Laboratory Director

HER042-39

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue, Suite 601
Seattle, Washington 98121
(206)441-9080
FAX 441-9108

CHAIN OF CUSTODY RECORD

PROJECT NAME	PROJECT NUMBER	CLIENT
Desmon 2	836	City of Des Moines

REPORT TO: Rob Zisette
COPY TO: –
SAMPLED BY: Rob Zisette
DELIVERY METHOD: hand
LABORATORY: Aquatic Research
REQUESTED COMPLETION DATE: Std.
TOTAL # OF CONTAINERS:
LAB USE:

ANALYSES REQUESTED

SAMPLE ID	DATE	TIME	SAMPLE DESCRIPTION	# OF CONTAINERS	Hardness	Turbidity	TSS	TP	NO2+NO3-N	NH3-N	Fecal Coliforms	Dissolved Copper GFAA	Dissolved Lead GFAA	Dissolved Zinc ICP
DM-1	5/27/99	15:00	Stream Baseflow Water	4	X	X	X	X	X	X	X	X	X	X
DM-2	↓	14:25	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
DM-3	↓	14:35	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
BA-1	↓	13:30	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
MA-1	↓	11:05	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
MA-2	↓	11:45	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
MA-3	↓	13:50	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
MC-1	↓	12:15	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
MC-2	↓	12:45	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
MC-3	↓	1400	↓	1								X	X	X

REMARKS: fecals should be < 1,000/100 ml

RELINQUISHED BY (NAME/CO.)	SIGNATURE	DATE/TIME	RECEIVED BY (NAME/CO.)	SIGNATURE	DATE/TIME
Rob Zisette Herrera	Rob Zisette	5/27/99 1625	Aaron Crotts / ARI	Aaron	5/27/99 1625

HERRERA ENVIRONMENTAL CONSULTANTS

Data Quality Assurance Worksheet

Project Name/No./Client: Desmon / C387 / City of Des Moines
Laboratory/Parameters: AVI / Conv 4 metals
Sample Date/Sample ID: Base 14 5/27/99 8 stations + 1 Field Duplicate + 1 Field Transfer blank

By: R. Janacek
Date: 3/8/00 Page 1 of 1
Checked: initials RZ
date: 7/6/00

MC-3 - field transfer blank
DM-2 = DM-3

Parameter	Completeness/ Methodology	Holding Times	Blanks/ Detection Limits	Matrix Spikes/ Surrogate Recoveries	Lab Duplicates	Field Duplicates	Lab Control Samples	Instrument Calibration/ Performance	ACTION
Turbidity	OK	OK	OK	NA	0.00%	8.33%	96.25%	NA	None
TSS	↓	↓	↓	NA	22.22%	5.28%	96.00%	↓	↓
Fecals				NA	5.71%	0.00%	NA		
TP				100.00%	2.17%	7.14%	95.70%		
NH_4-N				95.50%	NC both U	NC both U	104.67%		
NO_3+NO_2-N				91.00%	<IDL	1.50%	105.33%		
Hardness				95.00%	1.45%	3.24%	98.00%		
Dissolved Cu				107.20%	NC both U	NC both U	107.60%		
Pb			↓	103.00%	NC both U	NC both U	108.80%		pos. Zn value (only sample DM-2) ⇒ use DM-3 <.003 (field dup)
Zn			0.010 transfer blank	105.00%	<IDL	NC (0.004 and <0.003)	96.70%	↓	
Field temp								OK	
pH			NA	NA	NA	NA	NA	↓	
DO	↓	↓							

Notes: NC: Not calculable due to one or more values being below the detection limit.

file: DATAQA3.XLS

AR 025506

AQUATIC RESEARCH INCORPORATED
LABORATORY & CONSULTING SERVICES
3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	HER042-40		PAGE 1
REPORT DATE:	09/10/99		
DATE SAMPLED:	08/25/99	DATE RECEIVED:	08/25/99
FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES			

CASE NARRATIVE

Ten water samples were delivered to the laboratory in good condition. The samples were analyzed according to the chain of custody. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows while QA/QC data is contained on subsequent pages.

Base 15

SAMPLE DATA

SAMPLE ID	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
DM-1	0.86	0.82	92	0.040	0.012	0.789
DM-2	0.75	0.71	60	0.054	0.018	0.749
BA-1	0.78	0.67	860	0.081	0.012	1.06
MA-1	6.6	3.9	54	0.052	0.094	0.863
MA-2	1.5	1.8	est 380	0.038	0.013	1.54
MA-3	0.92	2.0	est 280	0.061	0.024	1.03
MA-4	7.0	3.2	56	0.056	0.084	0.870
MC-1	2.2	1.5	500	0.146	0.022	0.152
MC-2	1.9	1.2	78	0.077	0.022	0.322

		DISSOLVED METALS		
SAMPLE ID	HARDNESS (mgCaCO3/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)
DM-1	92.1	<0.0010	<0.0005	<0.003
DM-2	96.5	<0.0010	<0.0005	<0.003
BA-1	121	<0.0010	0.0005	<0.003
MA-1	121	<0.0010	0.0005	<0.003
MA-2	93.2	<0.0010	<0.0005	<0.003
MA-3	107	<0.0010	<0.0005	<0.003
MA-4	116	<0.0010	<0.0005	<0.003
MC-1	86.8	<0.0010	<0.0005	<0.003
MC-2	103	<0.0010	<0.0005	<0.003
MC-3	[redacted]	<0.0010	<0.0005	<0.003

MA-4 = MA-1 : Field duplicate (collected 4 hrs apart)
MC-3 = Field transfer blank

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LABORATORY & CONSULTING SERVICES
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PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER: HER042-40 PAGE 2
REPORT DATE: 09/10/99
DATE SAMPLED: 08/25/99 DATE RECEIVED: 08/25/99
FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

QC PARAMETER	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
METHOD	SM182130B	EPA 160.2	SM189222D	EPA 365.1	EPA 350.1	EPA 353.2
DATE ANALYZED	08/27/99	08/30/99	08/25/99	09/07/99	09/09/99	09/09/99
DETECTION LIMIT	0.10	0.50	2	0.002	0.010	0.010
DUPLICATE						
SAMPLE ID	MC-2	MA-4	MA-3	MC-2	MC-2	MC-2
ORIGINAL	1.9	3.2	est 280	0.077	0.022	0.322
DUPLICATE	1.9	2.9	est 360	0.077	0.023	0.325
RPD	0.00%	8.79%	NC	0.22%	4.84%	0.86%
		9.84%		0.00%	<IDL	0.93%
SPIKE SAMPLE						
SAMPLE ID				MC-2	MC-2	MC-2
ORIGINAL				0.077	0.022	0.322
SPIKED SAMPLE				0.129	0.231	0.505
SPIKE ADDED				0.050	0.200	0.200
% RECOVERY	NA	NA	NA	103.08%	104.60%	91.25%
				104.00%	104.50%	91.50%
QC CHECK						
FOUND	8.0	10		0.092	0.776	0.612
TRUE	8.0	10		0.093	0.750	0.600
% RECOVERY	100.00%	100.00%	NA	98.92%	103.44%	101.95%
					103.47%	102.00%
BLANK	NA	<0.50	< 2	<0.002	<0.010	<0.010

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
NR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

AQUATIC RESEARCH INCORPORATED

LABORATORY & CONSULTING SERVICES
3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	HER042-40		PAGE 3
REPORT DATE:	09/10/99		
DATE SAMPLED:	08/25/99	DATE RECEIVED:	08/25/99

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

		DISSOLVED METALS		
QC PARAMETER	HARDNESS (mgCaCO3/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)
METHOD	SM18 2340B	EPA 220.2	EPA 239.2	EPA 200.7
DATE ANALYZED	09/07/99	08/30,31/99	08/30,31/99	09/02/99
DETECTION LIMIT	2.00	0.0010	0.0005	0.003
DUPLICATE				
SAMPLE ID	MC-2	MC-3	MC-3	MC-3
ORIGINAL	103	<0.0010	<0.0005	<0.003
DUPLICATE	103	<0.0010	<0.0005	<0.003
RPD	0.19%	NC	NC	NC
SPIKE SAMPLE				
SAMPLE ID	MC-2	MC-3	MC-3	MC-3
ORIGINAL	103	<0.0010	<0.0005	<0.003
SPIKED SAMPLE	123	0.0119	0.0117	1.00
SPIKE ADDED	20.0	0.0125	0.0125	1.00
% RECOVERY	99.67%	95.20%	93.60%	100.30%
QC CHECK				
FOUND	40.3	0.0245	0.0267	1.03
TRUE	40.0	0.0250	0.0250	1.00
% RECOVERY	100.75%	98.00%	106.68%	103.30%
BLANK	<2.00	<0.0010	<0.0005	<0.003

RPD = RELATIVE PERCENT DIFFERENCE.
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NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Steven Lazoff
Laboratory Director

HERR...

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue, Suite 601
Seattle, Washington 98121
(206)441-9080
FAX 441-9108

CHAIN OF CUSTODY RECORD

PROJECT NAME	PROJECT NUMBER	CLIENT
Desmon 2	836	City of Des Moines

REPORT TO:	COPY TO:
Rob Zisette	O

SAMPLED BY:	DELIVERY METHOD:
Kent Easthouse/Sara Martin	Hand

LABORATORY:	REQUESTED COMPLETION DATE:	TOTAL # OF CONTAINERS:
	Std	

LAB USE:

ANALYSIS REQUESTED

SAMPLE ID	DATE	TIME	SAMPLE DESCRIPTION	# OF CONTAINERS	Hardness	Turbidity	TSS	TP	NO_2+NO_3-N	NH_3-N	Fecals	Dissolved Cu (GF)	Dissolved Pb (GF)	Dissolved Zn (I)
DM-1	8/25/99		Stream Base flow	4	X	X	X	X	X	X	X	X	X	X
DM-2	↓		↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
BA-1	↓		↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
MA-1	↓		↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
MA2	↓		↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
MA-3	↓		↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
MA-4	↓		↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
ML-1	↓		↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
ML-2	↓		↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
ML-3	↓		↓	1								X	X	X

REMARKS: Metals need to be filtered. Fecals should be <1000/100mL

RELINQUISHED BY (NAME/CO.)	SIGNATURE	DATE/TIME	RECEIVED BY (NAME/CO.)	SIGNATURE	DATE/TIME
[signature] KENT EASTHOUSE	[signature]	8/25/99 1700	A CLOTTS / AQRES	[signature]	8/25/99 1700
RELINQUISHED BY (NAME/CO.)	SIGNATURE	DATE/TIME	RECEIVED BY (NAME/CO.)	SIGNATURE	DATE/TIME

HERRERA ENVIRONMENTAL CONSULTANTS

Data Quality Assurance Worksheet

Project Name/No./Client: Desmon / C307 / City of Des Moines
Laboratory/Parameters: ACI / conv + Metals
Sample Date/Sample ID: Base 15 8/25/99 8 stations + 1 Field duplicate + 1 field transfer blank

By: R Janacek
Date: 3/9/00 Page 1 of 1
Checked initials: RZ
date: 7/10/00

MC-3 = transfer blank

* MA-4 = MA-1

Parameter	Completeness/ Methodology	Holding Times	Blanks/ Detection Limits	Matrix Spikes/ Surrogate Recoveries	Lab Duplicates	Field Duplicates	Lab Control Samples	Instrument Calibration/ Performance	ACTION
Turbidity	ok	ok	ok	NA	0.00%	6%	100.00%	NA	None
TSS				NA	9.84%	19.7%	100.00%		
Fecals				NA	NC (25% est)	4%	NA		
TP				104.00%	0.00%	7%	98.92%		
NH_4-N				104.50%	<IDL	4%	103.47%		
NO_3+NO_2-N				91.50%	0.93%	0.8%	102.00%		
Hardness				100.00%	0.00%	4%	100.75%		
Dissolved Cu				~~87.20%~~ 95.2%	NC both	NC both	98.00%		
Pb			No hits on transfer blank	~~89.~~ 93.6%	NC	NC <.0005 0.0005	106.80%		
Zn				99.70%	NC	NC both	100.00%		
Field temp pH DO			NA	NA	NA	NA	NA	ok	

Notes: NC: Not calculable due to one or more values being below the detection limit.

file: DATAQA3.XLS

* MA-4 collected at MA-1 3 hrs 45 min after collecting MA-1

AQUATIC RESEARCH INCORPORATED

LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	HER042-27		PAGE 1
REPORT DATE:	12/17/97		
DATE SAMPLED:	11/19/97	DATE RECEIVED:	11/19/97

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

CASE NARRATIVE

'en water samples were delivered to the laboratory in good condition. The samples were analyzed according to the chain of custody. Samples for total metals were digested according to EPA procedures. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows while QA/QC data is contained on subsequent pages.

Storm 16

SAMPLE DATA

SAMPLE ID	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	TPH (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
DM-1	37	27	>12600	0.116	0.28	0.078	0.325
DM-2	39	39	440	0.125	0.38	0.054	0.434
BA-1	65	84	est. 320	0.210	<0.25	0.057	0.559
BA-2	72	88	est. 340	0.214	<0.25	0.063	0.557
MA-1	35	31	>1240	0.124	0.47	0.068	0.245
MA-2	70	118	1,100	0.205	<0.25	0.068	0.260
MA-3	59	84	920	0.168	<0.25	0.046	0.431
MC-1	11	12	est. 300	0.159	<0.25	0.027	0.198
MC-2	41	27	520	0.121	<0.25	0.077	0.386

		DISSOLVED METALS			TOTAL METALS		
SAMPLE ID	HARDNESS (mgCaCO3/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)
DM-1	30.4	0.0054	0.0008	0.009	0.0121	0.0076	0.042
DM-2	43.1	0.0031	0.0006	0.004	0.0119	0.0056	0.032
BA-1	55.0	0.0034	<0.0005	0.006	0.0117	0.0058	0.029
BA-2	65.1	0.0031	0.0006	0.004	0.0138	0.0060	0.034
MA-1	22.0	0.0029	0.0015	0.023	0.0137	0.0153	0.070
MA-2	19.1	0.0020	0.0006	0.004	0.0158	0.0161	0.064
MA-3	34.7	0.0026	0.0005	0.004	0.0090	0.0080	0.028
MC-1	51.9	0.0040	0.0008	0.004	0.0079	0.0032	0.013
MC-2	39.3	0.0077	<0.0005	0.006	0.0168	0.0049	0.034
MA-4		<0.0010	<0.0005	<0.003			

BA-2 = Field Duplicate of BA-1
MA-4 = Transfer Blank

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LABORATORY & CONSULTING SERVICES
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CASE FILE NUMBER:	HER042-27		PAGE 2
REPORT DATE:	12/17/97		
DATE SAMPLED:	11/19/97	DATE RECEIVED:	11/19/97

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

QC PARAMETER	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	TPH (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
METHOD	SM182130B	EPA 160.2	SM189222D	EPA 365.1	EPA 418.1	EPA 350.1	EPA 353.2
DATE ANALYZED	11/20/97	11/20/97	11/19/97	11/28/97	12/05/97 12/17/97	12/11/97	12/11/97
DETECTION LIMIT	0.10	0.50	2	0.002	0.25	0.010	0.010
DUPLICATE							
SAMPLE ID	MC-2	MC-2	MC-2	MC-2		DM-1	DM-1
ORIGINAL	41	27.0	520	0.121		0.078	0.325
DUPLICATE	41	28.0	520	0.128		0.088	0.348
RPD	0.00%	3.64%	NC	5.62%	NA	12.40%	12.40%
SPIKE SAMPLE							
SAMPLE ID				MC-2		DM-1	DM-1
ORIGINAL				0.121		0.078	0.325
SPIKED SAMPLE				0.168		0.259	0.544
SPIKE ADDED				0.050		0.200	0.200
% RECOVERY	NA	NA	NA	94.00%	NA	90.30%	109.50%
QC CHECK							
FOUND	78	9.9		0.084	35.5	0.861	0.432
TRUE	80	10		0.078	32.9	0.915	0.424
% RECOVERY	97.50%	99.00%	NA	108.08%	107.90%	94.07%	101.79%
BLANK	NA	<0.50	< 2	<0.002	<0.25	<0.010	<0.010

RPD = RELATIVE PERCENT DIFFERENCE.
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NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

AQUATIC RESEARCH INCORPORATED
LABORATORY & CONSULTING SERVICES
3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
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CASE FILE NUMBER: HER042-27 PAGE 3
REPORT DATE: 12/17/97
DATE SAMPLED: 11/19/97 DATE RECEIVED: 11/19/97
FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

		DISSOLVED METALS			TOTAL METALS		
QC PARAMETER	HARDNESS (mgCaCO3/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)
METHOD	SM18 2340B	EPA 220.2	EPA 239.2	EPA 200.7	EPA 220.2	EPA 239.2	EPA 200.7
DATE ANALYZED	11/21/97	12/12/97	11/26/97	11/28/97	12/12/97	11/26/97	11/28/97
DETECTION LIMIT	2.00	0.0010	0.0005	0.003	0.0010	0.0005	0.003
DUPLICATE							
SAMPLE ID	MC-2	MA-1	MC-2	MC-2	MA-1	MC-2	MC-2
ORIGINAL	39.3	0.0029	<0.0005	0.006	0.0137	0.0049	0.034
DUPLICATE	38.0	0.0030	<0.0005	0.008	0.0134	0.0052	0.037
RPD	3.36%	3.39%	NC	28.57%	2.21%	5.94%	8.45%
SPIKE SAMPLE							
SAMPLE ID	MC-2	MA-1	MA-1	MC-2	MA-1	MC-2	MC-2
ORIGINAL	39.3	0.0029	<0.0005	0.006	0.0137	0.0049	0.034
SPIKED SAMPLE	58.8	0.0163	0.0122	1.23	0.0270	0.0175	0.916
SPIKE ADDED	20.0	0.0125	0.0125	1.00	0.0125	0.0125	1.00
% RECOVERY	97.50%	107.20%	97.60%	122.40%	106.40%	100.80%	88.20%
QC CHECK							
FOUND	38.9	0.0225	0.0251	0.906	0.0225	0.0256	1.08
TRUE	40.0	0.0250	0.0250	1.00	0.0250	0.0250	1.00
% RECOVERY	97.25%	90.00%	100.40%	90.60%	90.00%	102.40%	108.00%
BLANK	<2.00	<0.0010	<0.0005	<0.003	0.0015	<0.0005	<0.003
BLANK SPIKE %					113.00%	84.20%	124.00%

RPD = RELATIVE PERCENT DIFFERENCE.
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NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
NR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Steven Lazoff
Laboratory Director

HER042-27
login the 11/19

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue, Suite 601
Seattle, Washington 98121
(206)441-9080
FAX 441-9108

CHAIN OF CUSTODY RECORD

PROJECT NAME: Desmon 2	PROJECT NUMBER: C836/2	CLIENT: City of Des Moines
REPORT TO: Rob Zisette		COPY TO: –
SAMPLED BY: R. Zisette, J. Leuth		DELIVERY METHOD: Hand
LABORATORY: Aquatic Research	REQUESTED COMPLETION DATE: Std.	TOTAL # OF CONTAINERS: 45
LAB USE:		

ANALYSES REQUESTED

SAMPLE ID	DATE	TIME	SAMPLE DESCRIPTION	# OF CONTAINERS	Hardness OA 11/21/97	Turbidity OA 11/20	TSS	TP	NO_2+NO_3-N	NH_3-N	TPH	Fecal Coliform	Copper-total (GFAA)	Copper-diss. (GFAA)	Lead-total (GFAA)	Lead-diss. (GFAA)	Zinc-total (ICP)	Zinc-diss. (ICP)	Note: metal samples preserved by [initials] 11-20-97
DM-1	11/19/97	1149	Stream Stormwater	5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
DM-2	↓	1208	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
BA-1	↓	1115	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
BA-2	↓	1117	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
MA-1	↓	1050	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
MA-2	↓	1130	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
MA-3	↓	1140	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
MC-1	↓	1655	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
MC-2	↓	1115	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
MA-4	11/19/97	1600	↓	1										X		X		X	

REMARKS: Please composite as per attached sheets
Dissolved metals require filtering

RELINQUISHED BY (NAME/CO.)	SIGNATURE	DATE/TIME	RECEIVED BY (NAME/CO.)	SIGNATURE	DATE/TIME
Rob Zisette (Herrera)	R. Zisette	11/19/97 1600	Rebecca Janacek / Herrera	Rebecca Janacek	11/19/97 4:31 16:31
Rebecca Janacek / Herrera	Rebecca Janacek	11/19/97 1659	W. J. Brixton / Aquatic	W. J. Brixton	11/19/97 4:59

AR 025515

Composite storm sample data form

HERRERA ENVIRONMENTAL CONSULTANTS

Project: Des Moines Monitoring Program

Date: 11/19/97

Sampling location: Des Moines Storm 16

Personnel: R. Zisette, J. Leavitt

	Sample ID	Time	Depth (ft)		Flow (cfs)			Compositing proportions (%)	Compositing proportions (mL)
1	MC-1-1	1055	0.10		0.27			22.0	
2	-2	1240	0.14		0.39			31.7	
3	-3	1330	0.19		0.57			46.3	
4									
5	MC-2-1	1115	0.48		1.86			16.1	
6	-2	1250	0.69		4.53			39.1	
7	-3	1340	0.73		5.20			44.8	
8									
9	MA-1-1	1050	0.28		0.76			12.9	
10	-2	1225	0.44		2.00			33.6	
11	-3	1320	0.56		3.18			53.5	
12									
13	MA-2-1	1130	0.20		3.67			8.5	
14	-2	1300	0.55		17.97			41.6	
15	-3	1350	0.62		21.55			49.9	
16									
17	MA-3-1	1140	0.85		8.73			23.9	
18	-2	1310	1.21		12.42			34.0	
19	-3	1355	1.50		15.40			42.1	
20									
21	BA-1-1	1115	10.06		1.35			19.1	
22	-2	1222	10.09		1.47			20.8	
23	-3	1319	10.32		4.26			60.1	
24									

Comments:

form COMPFM.wq1

AR 025516

Herrera Environmental Consultants

Composite storm sample data form

Project: Des Moines Monitoring Program

Date: 11/19/97

Sampling location: Des Moines Storm 16

Personnel: RZ, JL

	Sample ID	Time	Depth (ft)		Flow (cfs)			Compositing proportions (%)	(mL)
1	BA-2-1	–	–					19.1	
2	-2	–	–					20.8	
3	-3	–	–					60.1	
4									
5	DM-1-1	1149	1.31		7.65			19.2	
6	-2	1250	1.49		10.19			25.5	
7	-3		1.72		22.08			55.3	
8				+2.16		-offset			
9	DM-2-1	1208	1.44	3.60	14.82	1.40		15.8	
10	-2	1302	1.48	3.64	18.85	1.44		20.0	
11	-3	1359	1.91	4.07	60.38	~~[illegible]~~ 1.87		64.2	
12				↑KC gauge					
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									

Comments:

form COMPFM.wq1

Data Quality Assurance Worksheet

HERRERA ENVIRONMENTAL CONSULTANTS

Project Name/No./Client: Desmon 2
Laboratory/Parameters: Aquatic Research / Conv. + Metals
Sample Date/Sample ID: Storm 16, 11/19/97 11/19/97

By: J. Lenth
Date: 9/24/99 Page 1 of 1
Checked: initials ~~[struck out]~~ RZ
date 7/10/00

Parameter	Completeness/ Methodology	Holding Times	Blanks/ ~~Detection Limits~~	Matrix Spikes/ Surrogate Recoveries	Lab Duplicates	Field Duplicates	Lab Control Samples	Instrument Calibration/ Performance	ACTION
Turbidity	O.K.	O.K.	NA	NA	0.00%	10.22%	97.50%	O.K.	
TSS	↓	↓	<0.50	NA	3.64%	4.65%	99.00%	↓	None
Hardness	↓	↓	<2.00	97.50%	3.36%	16.82%	97.25%	↓	
Fecal Coliform	↓	↓	<2	NA	~~NC~~ 0%	6.06%	NA	↓	None
TPH	↓	↓	<0.25	NA	NA	NC	107.90%	↓	
TP	↓	↓	<0.002	94.00%	5.62%	1.89%	108.08%	↓	
NH4-N	↓	↓	<0.010	90.30%	12.40%	10.00%	94.07%	↓	None
NO3+NO2-N	↓	↓	<0.010	109.50%	12.40%	0.36%	101.79%	↓	
Dissolved									
Cu	↓	↓	<0.0010	107.20%	3.39%	9.23%	90.00%	↓	
Pb	↓	↓	<0.0005	97.60%	NC	<IDL	100.40%	↓	None
Zn	↓	↓	<0.003	122.40%	<IDL	<IDL	90.60%	↓	
Total									
Cu	↓	↓	<2xDL, [0.0015]	106.40%	2.21%	1.69%	90.00%	↓	
Pb	↓	↓	<0.0005	100.90%	5.94%	3.51%	102.40%	↓	None
Zn	↓	↓	<0.003	88.20%	8.45%	9.84%	108.00%	↓	
Field Meas.									
Temp	↓	↓	NA	NA	NA	NC	NA	O.K.	None
DO	↓	↓				0.53%			
pH	↓	↓				0.13%			
Cond	↓	↓				2.53%			

Notes:

file: DATAQA3.XLS

AQUATIC RESEARCH INCORPORATED

LABORATORY & CONSULTING SERVICES
3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	HER042-29		PAGE 1
REPORT DATE:	01/08/98		
DATE SAMPLED:	12/15/97	DATE RECEIVED:	12/16/97

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

CASE NARRATIVE

Eight water samples were delivered to the laboratory in good condition. The samples were analyzed according to the chain of custody. No difficulties were encountered in the preparation or analysis of these samples. Samples for total metals were digested according Sample data follows while QA/QC data is contained on subsequent pages.

Storm #17

SAMPLE DATA

SAMPLE ID	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)	TPH (mg/l)
DM-1	29	43	est 240	0.111	0.031	0.303	0.67
DM-2	49	61	1,520	0.133	0.023	0.401	<0.25
BA-1	77	84	760	0.336	<0.010	0.562	<0.25
MA-1	19	14	460	0.065	0.058	0.328	2.0
MA-2	39	46	1,160	0.106	0.012	0.342	0.38
MA-3	49	56	860	0.132	<0.010	0.414	0.36
MC-1	19	31	est 2000	0.166	<0.010	0.253	<0.25
MC-2	39	28	est 2400	0.127	0.014	0.476	0.26

		DISSOLVED METALS			TOTAL METALS		
SAMPLE ID	HARDNESS (mgCaCO3/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)
DM-1	32.1	0.0054	< 0.0005	<0.003	0.0136	0.0082	0.046
DM-2	37.8	0.0039	< 0.0005	<0.003	0.0088	0.0053	0.028
BA-1	42.0	0.0036	0.0011	<0.003	0.0095	0.0045	0.041
MA-1	33.8	0.0033	0.0010	0.021	0.0060	0.0083	0.058
MA-2	32.3	0.0038	0.0007	0.012	0.0073	0.0072	0.029
MA-3	27.7	0.0035	< 0.0005	<0.003	0.0080	0.0062	0.032
MC-1	45.0	0.0051	0.0005	<0.003	0.0037	0.0022	0.008
MC-2	51.0	0.0066	< 0.0005	0.014	0.0085	0.0031	0.012

AQUATIC RESEARCH INCORPORATED

LABORATORY & CONSULTING SERVICES
3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER: HER042-29 PAGE 2
REPORT DATE: 01/13/98
DATE SAMPLED: 12/15/97 DATE RECEIVED: 12/16/97
FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

QC PARAMETER	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)	TPH (mg/l)
METHOD	SM182130B	EPA 160.2	SM189222D	EPA 365.1	EPA 350.1	EPA 353.2	EPA 418.1
DATE ANALYZED	12/17/97	12/17/97	12/16/97	12/19/97	12/30/97	12/30/97	01/12/98
DETECTION LIMIT	0.10	0.50	2	0.002	0.010	0.010	0.25
DUPLICATE							
SAMPLE ID	MC-2	MC-2	MC-2	MC-2	DM-2	DM-2	
ORIGINAL	39	28	est 2400	0.127	0.023	0.401	
DUPLICATE	39	28	est 2600	0.132	0.024	0.409	
RPD	0.00%	0.00%	NC	3.79%	2.99%	1.90%	NA
SPIKE SAMPLE							
SAMPLE ID				MC-2	DM-2	DM-2	
ORIGINAL				0.127	0.023	0.401	
SPIKED SAMPLE				0.173	0.201	0.582	
SPIKE ADDED				0.050	0.200	0.200	
% RECOVERY	NA	NA	NA	91.60%	89.05%	90.25%	NA
QC CHECK							
FOUND	78	9.8		0.080	0.872	0.449	35.1
TRUE	80	10		0.077	0.915	0.424	33.9
% RECOVERY	97.50%	98.00%	NA	103.90%	95.34%	105.94%	103.54%
BLANK	<0.10	<0.50	< 2	<0.002	<0.010	<0.010	< 0.25

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

AQUATIC RESEARCH INCORPORATED
LABORATORY & CONSULTING SERVICES
3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	HER042-29		PAGE 3
REPORT DATE:	01/13/98		
DATE SAMPLED:	12/15/97	DATE RECEIVED:	12/16/97

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

		DISSOLVED METALS			TOTAL METALS		
QC PARAMETER	HARDNESS (mgCaCO3/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)
METHOD	SM18 2340B	EPA 220.2	EPA 239.2	EPA 200.7	EPA 220.2	EPA 239.2	EPA 200.7
DATE ANALYZED	12/22/97	12/29/97	12/29/97	01/08/98	12/26/97	12/26/97	01/08/98
DETECTION LIMIT	2.00	0.0010	0.0005	0.003	0.0010	0.0005	0.003
DUPLICATE							
SAMPLE ID	DM-2	BA-1	BA-1	MA3	BATCH	BATCH	MA-3
ORIGINAL	37.8	0.0036	<0.0005	<0.003	0.0042	<0.0005	0.032
DUPLICATE	38.9	0.0035	<0.0005	<0.003	0.0065	0.0005	0.032
RPD	2.99%	2.82%	NC	NC	42.99%	NC	0.00%
SPIKE SAMPLE							
SAMPLE ID	DM-2	BA-1	BA-1	MA3	BATCH	BATCH	MA-3
ORIGINAL	37.8	0.0036	<0.0005	<0.003	0.0042	<0.0005	0.032
SPIKED SAMPLE	57.8	0.0156	0.0097	1.00	0.0168	0.0124	0.940
SPIKE ADDED	20.0	0.0125	0.0125	1.00	0.0125	0.0125	1.00
% RECOVERY	100.21%	96.00%	77.60%	100.40%	100.80%	99.20%	90.80%
QC CHECK							
FOUND	39.7	0.0237	0.0236	0.891	0.0234	0.0231	0.999
TRUE	40.0	0.0250	0.0250	1.00	0.0250	0.0250	1.00
% RECOVERY	99.25%	94.80%	94.40%	89.10%	93.60%	92.40%	99.90%
BLANK	<2.00	<0.0010	<0.0005	<0.003	<0.0010	<0.0005	<0.003
BLANK SPIKE %	NA	103.00%	101.00%	NA	108.00%	92.00%	112.10%

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:
Steven Lazoff
Laboratory Director

HERRERA ENVIRONMENTAL CONSULTANTS

Data Quality Assurance Worksheet

Project Name/No./Client: Desmen 2
Laboratory/Parameters: Aquatic Research / Conv. + Metals
Sample Date/Sample ID: Storm 17, 12/15/97

By: J. Leuth
Date: 9/24/99 Page 1 of 1
Checked initials: ~~Et~~ RZ
date: 7/10/00

Parameter	Completeness/ Methodology	Holding Times	Blanks/ ~~Detection~~ ~~Limits~~	Matrix Spikes/ Surrogate Recoveries	Lab Duplicates	Field Duplicates	Lab Control Samples	Instrument Calibration/ Performance	ACTION
Turbidity	O.K.	O.K.	<0.10	NA	0.00%		97.50%	O.K.	
TSS	↓	↓	<0.50	NA	0.00%	NA	98.00%	↓	None
Hardness			NA	100.21%	2.99%		99.25%		
Fecal Coliform			<2	NA	NC 8% est		NA		
TPH			<0.25	NA	NA	NA	103.54%		None
TP			<0.002	91.60%	3.79%		103.90%		
NH4-N			<0.010	89.05%	2.99%	NA	95.34%		None
NO3+NO2-N			<0.010	90.25%	1.90%		105.94%		
Dissolved									
Cu			<0.0010	96.00%			94.80%		
Pb			<0.0005	77.60%	NC both U	NA	94.40%		None
Zn			<0.003	100.40%	NC both U		89.10%		
Total									Data qualified as est. (J)
Cu			<0.0010	100.80%	± 2.3 X DL ~~42.99%~~ – batch sample		93.60%		None
Pb			<0.0005	99.20%	NC <DL @DL	NA	92.40%		
Zn			<0.003	90.80%	0.00%		99.90%	↓	None
Field Meas. Temp DO pH Cond	↓	↓	NA	NA	NA	NA	NA	No Notes Appears O.K.	None

Notes:

file: DATAQA3.XLS

AR 025522

HEK042-29
login wjb 12/16/97

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue, Suite 601
Seattle, Washington 98121
(206)441-9080
FAX 441-9108

CHAIN OF CUSTODY RECORD

PROJECT NAME: Desmar 2	PROJECT NUMBER: C836/2	CLIENT: City of Des Moines
REPORT TO: Rob Zisette		COPY TO:
SAMPLED BY: J. Lenth, R. Harrison		DELIVERY METHOD: Hand
LABORATORY: Aquatic Research	REQUESTED COMPLETION DATE: Std.	TOTAL # OF CONTAINERS:
LAB USE:		

ANALYSES REQUESTED

SAMPLE ID	DATE	TIME	SAMPLE DESCRIPTION	# OF CONTAINERS	Hardness	Turbidity	TSS	TP	NO_2+NO_3-N	NH_3-N	TPH	Fecal Coliform	Copper-total (GFAA)	Copper-diss. (GFAA)	Lead-total (GFAA)	Lead-diss. (GFAA)	Zinc-total (ICP)	Zinc-diss. (ICP)		
DM-1	12/15/97	2329	Stream Stormwater	5	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
DM-2		2346																		
BA-1		2306																		
MA-1		2254																		
MA-2		2350																		
MA-3		0005																		
MC-1		2320																		
MC-2		2340																		

REMARKS: Please composite as per attached sheets. Dissolved metals have not been filtered
Metals filtered & pres. wjb 12/16/97
TPH pres. wjb 12/16/97

RELINQUISHED BY (NAME/CO.)	SIGNATURE	DATE/TIME	RECEIVED BY (NAME/CO.)	SIGNATURE	DATE/TIME
John Lenth/HEC	[signature]	12/16/97 13:21	W. J. Bruton	W. J. Bruton	12-16-97
RELINQUISHED BY (NAME/CO.)	SIGNATURE	DATE/TIME	RECEIVED BY (NAME/CO.)	SIGNATURE	DATE/TIME

HERRERA ENVIRONMENTAL CONSULTANTS

Composite storm sample data form

Project: Des Moines Water Quality Monitoring

Date: 12/15/97-12/16/97

Sampling location: Des Moines Storm 17

Personnel: J. Lenth, R. Harrison

	Sample ID	Time	Depth (ft)		Flow (cfs)		Compositing proportions		
								(%)	(mL)
1	DM-1-1	2329	1.69		20.62		35.7	~~51.7~~	
2	-2	0032	1.67		19.68		34.1	~~49.3~~	
3	-3	0129	1.62		17.49		30.3	~~43.8~~	
4									
5	DM-2-1	2346	1.58		25.98		29.2		
6	-2	0046	1.66		32.37		36.4		
7	-3	0138	1.64		30.67		34.5		
8									
9	BA-1-1	2306	10.19		2.40		29.1%		
10	-2	0015	10.22		2.79		33.8%		
11	-3	0115	10.24		3.07		37.1%		
12									
13	MA-1-1	2254	0.56		3.18		47.3%	~~[illegible]~~	
14	-2	0006	0.43		1.89		28.0%	~~[illegible]~~	
15	-3	0108	0.40		1.67		24.7%	~~[illegible]~~	
16									
17	MA-2-1	2350	0.47		14.13		40.5%	~~[illegible]~~	
18	-2	0050	0.38		10.16		29.1%	~~[illegible]~~	
19	-3	0150	0.39		10.58		30.3%	~~[illegible]~~	
20									
21	MA-3-1	0005	1.27		13.04		36.5		
22	-2	0105	1.12		11.50		32.2		
23	-3	0205	1.09		11.19		31.3		
24									

Comments:

form COMPFM.wq1

HERRERA ENVIRONMENTAL CONSULTANTS

Composite storm sample data form

Project: Des Moines Water Quality

Date: 12/15/97-12/16/97

Sampling location: Des Moines Storm 17

Personnel: JL/RH

	Sample ID	Time	Depth (ft)		Flow (cfs)			Compositing proportions (%)	Compositing proportions (mL)
1	MC-1-1	2320	5.25		0.83			33.4	
2	-2	0020	5.25		0.83			33.3	
3	-3	0120	5.25		0.83			33.3	
4									
5	MC-2-1	2340	0.70		4.69			31.1	
6	-2	0040	0.71		4.85			32.2	
7	-3	0140	0.75		5.55			36.8	
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									

Comments:

form COMPFM.wq1

AQUATIC RESEARCH INCORPORATED

LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	HER042-31	PAGE 1	
EPORT DATE:	05/14/98		
ATE SAMPLED:	04/23/98	DATE RECEIVED:	04/24/98

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER
AMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

CASE NARRATIVE

ght water samples were delivered to the laboratory in good condition. The samples were analyzed according to the chain of custody. Samples for total tals were digested according to EPA procedures. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows while QA/QC data is contained on subsequent pages.

STORM 18

SAMPLE DATA

SAMPLE ID	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	TPH (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
DM-1	29	138	est. 1800	0.433	0.31	0.324	1.81
DM-2	31	153	est. 3600	0.403	<0.25	0.126	1.05
MA-1	34	45	est. 3800	0.181	1.75	0.334	1.16
MA-2	30	62	4,000	0.207	0.86	0.168	0.939
MA-3	40	99	est. 21200	0.382	1.23	0.144	1.13
BA-1	38	109	est. 17000	0.438	<0.25	0.143	1.14
MC-1	13	42	est. 3200	0.253	<0.25	0.044	0.400
MC-2	35	70	est. 3000	0.278	0.54	0.059	0.584

		DISSOLVED METALS			TOTAL METALS		
SAMPLE ID	HARDNESS (mgCaCO3/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)
DM-1	60.0	0.0092	0.0007	0.012	0.0274	0.0190	0.118
DM-2	72.0	0.0029	<0.0005	<0.003	0.0199	0.0145	0.092
BA-1	47.1	0.0054	<0.0005	<0.003	0.0161	0.0078	0.040
MA-1	40.5	0.0075	0.0022	0.057	0.0175	0.0414	0.111
MA-2	46.3	0.0059	<0.0005	0.009	0.0150	0.0109	0.059
MA-3	62.3	0.0059	<0.0005	0.007	0.0216	0.0081	0.080
MC-1	60.0	0.0020	0.0014	<0.003	0.0058	0.0075	0.011
MC-2	50.8	0.0083	<0.0005	0.006	0.0214	0.0094	0.072

AQUATIC RESEARCH INCORPORATED
LABORATORY & CONSULTING SERVICES
3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	HER042-31		PAGE 2
REPORT DATE:	05/14/98		
DATE SAMPLED:	04/23/98	DATE RECEIVED:	04/24/98

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

QC PARAMETER	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	TPH (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
METHOD	SM182130B	EPA 160.2	SM189222D	EPA 365.1	EPA 418.1	EPA 350.1	EPA 353.2
DATE ANALYZED	04/24/98	04/27/98	04/24/98	04/28/98	04/29/98	04/29/98	04/29/98
DETECTION LIMIT	0.10	0.50	2	0.002	0.25	0.010	0.010
DUPLICATE							
SAMPLE ID	BATCH	MA-3	MC-2	MC-2		MC-2	MC-2
ORIGINAL	16	99	est. 3000	0.278		0.059	0.584
DUPLICATE	16	94	est. 2800	0.278		0.059	0.576
RPD	0.00%	5.18%	NC	0.00%	NA	0.00%	12.40%
SPIKE SAMPLE							
SAMPLE ID						MC-2	MC-2
ORIGINAL						0.059	0.584
SPIKED SAMPLE						0.256	0.752
SPIKE ADDED						0.200	0.200
% RECOVERY	NA	NA	NA	OR	NA	98.45%	84.10%
QC CHECK							
FOUND	7.8	9.7		0.098	34.1	0.914	0.463
TRUE	8.0	10		0.093	32.9	0.915	0.424
% RECOVERY	97.50%	97.00%	NA	105.38%	103.65%	99.89%	109.25%
BLANK	NA	<0.50	< 2	<0.002	<0.25	<0.010	<0.010

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

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CASE FILE NUMBER:	HER042-31		PAGE 3
'EPORT DATE:	05/14/98		
'ATE SAMPLED:	04/23/98	DATE RECEIVED:	04/24/98

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

A/QC DATA WATER

QC PARAMETER	HARDNESS	DISSOLVED METALS			TOTAL METALS		
	HARDNESS (mgCaCO3/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)
METHOD	SM18 2340B	EPA 220.2	EPA 239.2	EPA 200.7	EPA 220.2	EPA 239.2	EPA 200.7
DATE ANALYZED	04/27/98	05/01/98	05/01/98	04/28/98 05/04/98	05/01/98 05/04/98	05/01/98 05/04/98	04/28/98
DETECTION LIMIT	2.00	0.0010	0.0005	0.003	0.0010	0.0005	0.003
DUPLICATE							
SAMPLE ID	MC-2	MA-2	MA-2	MA-3	BA-1	BA-1	BA-1
ORIGINAL	50.8	0.0059	<0.0005	0.007	0.0161	0.0078	0.040
DUPLICATE	50.4	0.0060	<0.0005	0.007	0.0196	0.0093	0.043
RPD	0.79%	1.68%	NC	0.00%	19.61%	17.54%	7.23%
SPIKE SAMPLE							
SAMPLE ID	MC-2	MA-2	MA-2	MA-3	BA-1	BA-1	BA-1
ORIGINAL	50.8	0.0059	<0.0005	0.007	0.0161	0.0078	0.040
SPIKED SAMPLE	70.3	0.0186	0.0122	0.873	0.0301	0.0181	0.933
SPIKE ADDED	20.0	0.0125	0.0125	1.00	0.0125	0.0125	1.00
% RECOVERY	97.56%	101.60%	97.60%	86.60%	112.00%	82.40%	89.30%
QC CHECK							
FOUND	40.5	0.0255	0.0256	0.967	0.0255	0.0256	0.967
TRUE	40.0	0.0250	0.0250	1.00	0.0250	0.0250	1.00
% RECOVERY	101.25%	102.00%	102.40%	96.70%	102.00%	102.40%	96.70%
BLANK	<2.00	<0.0010	<0.0005	<0.003	<0.0010	<0.0005	<0.003

RPD = RELATIVE PERCENT DIFFERENCE.
= NOT APPLICABLE OR NOT AVAILABLE.
= NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
= RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Steven Lazoff
Laboratory Director

4ER042-31

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue, Suite 601
Seattle, Washington 98121
(206)441-9080
FAX 441-9108

CHAIN OF CUSTODY RECORD

page 1 of 1

PROJECT NAME: Desmon 2
PROJECT NUMBER: C836/2
CLIENT: City of Des Moines
REPORT TO: Rob Zisette
COPY TO:
SAMPLED BY: J. Leath, R. Harrison
DELIVERY METHOD: hand
LABORATORY:
REQUESTED COMPLETION DATE: Std.
TOTAL # OF CONTAINERS: 40
LAB USE:

ANALYSES REQUESTED

SAMPLE ID	DATE	TIME	SAMPLE DESCRIPTION	# OF CONTAINERS	Turbidity	TSS	TP	NO_2+NO_3-N	NH_3-N	TPH	Fecal Coliform	Hardness	Copper-total (GFAA)	Copper-diss. (GFAA)	Lead-total (GFAA)	Lead-diss. (GFAA)	Zinc-total (ICP)	Zinc-diss. (ICP)
DM-1	4/23/98	12:10	Stream stormwater	5	X	X	X	X	X	X	X	X	X	X	X	X	X	X
DM-2		12:26																
MA-1		12:41																
MA-2		1:05																
MA-3		1:15																
~~[illegible]~~																		
BA-1		12:50																
MC-1		12:15																
MC-2		12:25																
~~[illegible]~~		~~12:15~~																

REMARKS: Please composite according to percentages in ~~attached~~ accompanying sheet (except for TPH and fecal coliform). Dissolved metals require lab filtering. Lead detection limit = 0.0005 mg/L! ~~Flow composite sheet will be faxed by 9:00 am 4/24/98~~ RC

RELINQUISHED BY (NAME/CO.)	SIGNATURE	DATE/TIME	RECEIVED BY (NAME/CO.)	SIGNATURE	DATE/TIME
John Leath/HEC	[signature]	4/24/98 8:03	Rebecca Janacek/HEC	[signature]	4/24/98 8:03
John Leath/HEC	[signature]	4/24/98 9:58	Aaron Clotts/AQ RES	[signature]	4/24/98 0955

TPH ... 4-24-98

AR 025529

HERRERA ENVIRONMENTAL CONSULTANTS

Composite Storm Sample Data Form

Page 1 of 2

Project Des Moines Monitoring C836 Date 4/23/98

Sampling Location Des Moines ; Storm 19 Personnel J. Lenth, R. Harrison

Sample ID	Time	Depth (ft)		Flow (cfs)			Composting Proportions (%)	Composting Proportions (mL)
DM-1-1	12:10	1.39		9.64			~~16.7~~ 3	31.5 %
-2	13:08	1.43		2L ~~1.43~~ 10.76			~~18.6~~ 3L	35.2 %
-3	14:04	1.41		3L ~~1.41~~ 10.19			~~17.6~~ 3L	33.3%
DM-2-1	12:26	1.24		3.27			10.4	
-2	13:26	1.45		15.75			50.3	
-3	14:22	1.41		12.31			39.3	
MA-1-1	12:41	0.41		1.67			~~24.7~~ 3L	66.0%
-2	13:38	0.24		0.56			~~8.4~~ 3L	22.3%
-3	14:31	0.18		0.29			~~4.4~~ 3L	11.7%
		gauge						
MA-2-1	1305	0.35		8.94			51.3	
-2	1345	0.27		5.93			34.0	
-3	1420	0.16		2.56			14.7	
MA-3-1	1315	0.92		9.45			37.9	
-2	1350	0.82		8.42			33.7	
-3	1435	0.69		7.08			28.4	

Comments:

Composite Storm Sample Data Form

HERRERA ENVIRONMENTAL CONSULTANTS

Project Des Moines Water Mon. C836 Date 4/23/98

Sampling Location Des Moines ; Storm 19 Personnel J. Lenth, R. Harrison

Sample ID	Time	Depth (ft)		Flow (cfs)			Composting Proportions (%)	Composting Proportions (mL)
BA-1-1	12:50	10.12		1.8			41.1	
-2	13:48	10.10		1.6			36.2	
-3	14:40	10.04		1.0			22.7	
		gauge						
MC-1-1	1215	5.14		0.39			30.5	
-2	1325	5.13		0.36			28.0	
-3	1405	5.18 ?		0.53			41.5	
		wier(d)	Gauge (ft)					
MC-2-1	1225	0.19	0.83			based on	46.3	
-2	1335	0.11	0.75			wier depth	26.8	
-3	1410	0.11	0.75				26.8	

Comments:

AR 025531

HERRERA ENVIRONMENTAL CONSULTANTS

Data Quality Assurance Worksheet

Project Name/No./Client: Desmen 2
Laboratory/Parameters: Aquatic Research / Conv. + Metals
Sample Date/Sample ID: Storm 18, 4/23/98

By: J. Leuth
Date: 9/24/99 Page 1 of 1
Checked initials: RZ
date: 7/10/00

Parameter	Completeness/ Methodology	Holding Times	Blanks/ Detection Limits	Matrix Spikes/ Surrogate Recoveries	Lab Duplicates	Field Duplicates	Lab Control Samples	Instrument Calibration/ Performance	ACTION
Turbidity	O.K.	O.K.	NA	NA	0.00%	NA	97.50%	O.K.	
TSS			<0.50	NA	5.18%		97.00%		None
Hardness			<2.00	97.56%	0.79%		101.25%		
Fecal Coliform			<2	NA	NC 7% est		NA		None
TPH			<0.25	NA	NA		103.65%		
TP			<0.002	Recovery Out of Range	0.00%		105.38%		
NH_4-N			<0.010	98.45%	0.00%		99.89%		None
NO_3+NO_2-N			<0.010	84.10%	12.40%		109.25%		
Dissolved									
Cu			<0.0010	101.60%	1.68%		102.00%		
Pb			<0.0005	97.60%	NC both U		102.40%		None
Zn			<0.003	86.60%	<IDL		96.70%		
Total									
Cu			<0.0010	112.00%	19.61%		102.00%		
Pb			<0.0005	82.40%	17.54%		102.40%		None
Zn			<0.003	89.30%	7.23%		96.40%		
Field Meas. Temp DO pH Cond			NA	NA	NA		NA	Adjusted calibration of Cond Meter. ~~Otherwise~~ O.K.	None

Notes:

file: DATAQA3.XLS

AR 025532

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CASE FILE NUMBER:	HER042-32		PAGE 1
REPORT DATE:	07/13/98		
DATE SAMPLED:	06/24/98	DATE RECEIVED:	06/24/98

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

CASE NARRATIVE

Eight water samples were delivered to the laboratory in good condition. The samples were analyzed according to the chain of custody. Samples for total metals were digested according to EPA procedures. The RPD for total copper in sample DM-1 was larger than the 20% criterion at 26.6%. The sample and duplicate were reanalyzed with similar results. No further action was taken. No other difficulties were encountered in the preparation or analysis of these samples. Sample data follows while QA/QC data is contained on subsequent pages.

STORM 19

SAMPLE DATA

SAMPLE ID	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	TPH (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
DM-1	18	42	8,600	0.154	0.79	0.021	0.306
DM-2	26	76	8,600	0.235	0.56	0.024	0.393
BA-1	34	112	9,000	0.581	0.31	0.057	0.522
MA-1	6.1	6.4	8,200	0.088	0.36	0.028	0.691
MA-2	10	19	5,200	0.093	0.35	0.016	0.474
MA-3	19	45	6,000	0.206	0.40	0.015	0.496
MC-1	6.0	34	10,200	0.296	<0.25	0.056	0.270
MC-2	6.5	18	est. 3,600	0.184	<0.25	0.057	0.168

		DISSOLVED METALS			TOTAL METALS		
SAMPLE ID	HARDNESS (mgCaCO3/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)
DM-1	31.3	0.0049	<0.0010	0.027	0.0192	0.0118	0.052
DM-2	26.8	0.0042	<0.0010	0.026	0.0167	0.0144	0.060
BA-1	33.9	0.0026	<0.0010	0.016	0.0097	0.0105	0.040
MA-1	42.0	0.0039	<0.0010	0.047	0.0067	0.0053	0.058
MA-2	25.9	0.0021	<0.0010	0.027	0.0074	0.0044	0.023
MA-3	46.1	0.0023	<0.0010	0.008	0.0096	0.0075	0.041
MC-1	57.6	<0.0010	<0.0010	0.016	0.0050	0.0073	0.015
MC-2	66.0	0.0026	<0.0010	0.017	0.0070	0.0020	0.022

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CASE FILE NUMBER:	HER042-32		PAGE 2	
REPORT DATE:	07/13/98			
DATE SAMPLED:	06/24/98	DATE RECEIVED:	06/24/98	

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

QC PARAMETER	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	TPH (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
METHOD	SM182130B	EPA 160.2	SM189222D	EPA 365.1	EPA 418.1	EPA 350.1	EPA 353.2
DATE ANALYZED	06/24/98	10/26/98	06/24/98	06/30/98	07/13/98	06/29/98	06/29/98
DETECTION LIMIT	0.10	0.50	2	0.002	0.25	0.010	0.010
DUPLICATE							
SAMPLE ID	MC-2	MC-2	MC-2	MC-2		MC-2	MC-2
ORIGINAL	6.5	18	est. 3,600	0.184		0.057	0.168
DUPLICATE	6.5	17	est. 3,200	0.181		0.059	0.159
RPD	0.00%	5.71%	11.76%	1.64%	NA	3.45%	5.50%
SPIKE SAMPLE							
SAMPLE ID						MC-2	MC-2
ORIGINAL						0.057	0.168
SPIKED SAMPLE						0.250	0.329
SPIKE ADDED						0.200	0.200
% RECOVERY	NA	NA	NA	OR	NA	96.50%	80.50%
QC CHECK							
FOUND	8.0	10		0.096	34.6	0.513	0.908
TRUE	8.0	10		0.093	32.9	0.499	0.933
% RECOVERY	100.00%	100.00%	NA	103.23%	105.17%	102.73%	97.32%
BLANK	NA	<0.50	< 2	<0.002	<0.25	<0.010	<0.010

RPD = RELATIVE PERCENT DIFFERENCE.
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= RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

AQUATIC RESEARCH INCORPORATED

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CASE FILE NUMBER:	HER042-32	PAGE 3	
REPORT DATE:	07/13/98		
DATE SAMPLED:	06/24/98	DATE RECEIVED:	06/24/98

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

QC PARAMETER	HARDNESS (mgCaCO3/l)	DISSOLVED METALS COPPER (mg/l)	DISSOLVED METALS LEAD (mg/l)	DISSOLVED METALS ZINC (mg/l)	TOTAL METALS COPPER (mg/l)	TOTAL METALS LEAD (mg/l)	TOTAL METALS ZINC (mg/l)
METHOD	SM18 2340B	EPA 220.2	EPA 239.2	EPA 200.7	EPA 220.2	EPA 239.2	EPA 200.7
DATE ANALYZED	07/06/98	06/29/98	06/29/98	07/07/98	07/07/98	07/07/98	07/07/98
DETECTION LIMIT	2.00	0.0010	0.0005	0.003	0.0010	0.0005	0.003
DUPLICATE							
SAMPLE ID	MC-2	DM-1	DM-1	BATCH	DM-1	DM-1	BATCH
ORIGINAL	66.0	0.0049	<0.0010	0.007	0.0192	0.0118	0.019
DUPLICATE	67.3	0.0049	<0.0010	0.005	0.0147	0.0113	0.018
RPD	1.95%	0.00%	NC	33.33%	26.55%	4.33%	5.41%
SPIKE SAMPLE							
SAMPLE ID	MC-2	DM-1	DM-1	BATCH	DM-1	DM-1	BATCH
ORIGINAL	66.0	0.0049	<0.0010	0.007	0.0192	0.0118	0.019
SPIKED SAMPLE	85.9	0.0173	0.0126	0.939	0.0304	0.0238	1.11
SPIKE ADDED	20.0	0.0125	0.0125	1.00	0.0125	0.0125	1.00
% RECOVERY	99.50%	99.20%	100.80%	93.20%	89.60%	96.00%	109.10%
QC CHECK							
FOUND	39.8	0.0255	0.0255	1.03	0.0253	0.0246	0.928
TRUE	40.0	0.0250	0.0250	1.00	0.0250	0.0250	1.00
% RECOVERY	99.50%	102.00%	102.00%	103.00%	101.20%	98.40%	92.80%
BLANK	<2.00	<0.0010	<0.0005	<0.003	<0.0010	<0.0005	<0.003

RPD = RELATIVE PERCENT DIFFERENCE.
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NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Steven Lazoff
Laboratory Director

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue, Suite 601
Seattle, Washington 98121
(206)441-9080
FAX 441-9108

CHAIN OF CUSTODY RECORD

page 1 of 1

PROJECT NAME	PROJECT NUMBER	CLIENT
Desmun 2	C836	City of Des Moines

REPORT TO: Rob Zisette	COPY TO:
SAMPLED BY: J. Lenth, K Easthouse	DELIVERY METHOD: hand
LABORATORY: Aquatic Research	REQUESTED COMPLETION DATE: Standard
LAB USE:	TOTAL # OF CONTAINERS:

ANALYSES REQUESTED

SAMPLE ID	DATE	TIME	SAMPLE DESCRIPTION	# OF CONTAINERS	Hardness	Turbidity	TSS	TP	NO_3+NO_2-N	NH_3-N	TPH	Fecal Coliform	Copper - total (GFAA)	Copper - dissolved (GFAA)	Lead - total (GFAA)	Lead - dissolved (GFAA)	Zinc - total (ICP)	Zinc - dissolved (ICP)
DM-1	6/24/98	9:28	Stream Stormwater	5	X	X	X	X	X	X	X	X	X	X	X	X	X	X
DM-2	↓	9:50	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
BA-1	↓	9:06	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
MA-1	↓	8:56	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
MA-2	↓	9:38	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
MA-3	↓	9:55	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
MC-1	↓	9:00	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
MC-2	↓	9:25	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓

REMARKS: For each analysis except fecals and TPH, please composite 3 one liter bottles for each sample in percentages on attached composite form. Dissolved metals require filtering immediately after compositing.

RELINQUISHED BY (NAME/CO.)	SIGNATURE	DATE/TIME	RECEIVED BY (NAME/CO.)	SIGNATURE	DATE/TIME
John Lenth	[signature]	6/24/98 1615	Allan Clotts [illegible]	[signature]	6/24/98 1615

THIS PRESERVED [illegible] AC

AR 025536

HERRERA ENVIRONMENTAL CONSULTANTS

Composite storm sample data form

Project Des Moines Water Quality Monitoring   Date 6/24/98

Sampling location Des Moines   Personnel KE, JL

	Sample ID	Time	Depth (ft)		Flow (cfs)			Compositing proportions (%)	(mL)
1	DM-1-1	9:28	1.64		18.34			59.6	
2	-2	10:38	1.28		6.99			22.7	
3	-3	11:30	1.20		5.44			17.7	
4									
5	DM-2-1	9:50	1.55		23.85			60.2	
6	-2	10:53	1.39		10.86			27.4	
7	-3	11:47	1.27		4.90			12.4	
8									
9	BA-1-1	9:06	10.14		2.05			51.4	
10	-2	10:17	10.06		1.20			30.2	
11	-3	11:17	10.01		0.73			18.4	
12									
13	MA-1-1	8:56	0.29		0.84			56.9	
14	-2	10:07	0.19		0.34			23.1	
15	-3	11:10	0.18		0.29			20.0	
16									
17	MA-2-1	9:38	0.29		6.64			43.9	
18	-2	10:15	0.27		5.93			39.2	
19	-3	11:35	0.16		2.56			16.9	
20									
21	MA-3-1	9:55	0.82		8.42			37.4	
22	-2	10:20	0.76		7.80			34.7	
23	-3	11:45	0.61		6.26			27.9	
24									

Comments:

form COMPFM.wq1

HERRERA ENVIRONMENTAL CONSULTANTS

Composite storm sample data form

Project: Des Moines Water Quality Monitoring — Date: 6/24/98

Sampling location: Des Moines — Personnel: KE, JL

	Sample ID	Time	Depth (ft)		Flow (cfs)			Compositing proportions (%)	(mL)
1	MC-1-1	9:00	5.17		0.49			35.8	
2	-2	10:00	5.17		0.49			35.8	
3	-3	11:15	5.14		0.39			28.3	
4									
5	MC-2-1	9:25	0.77		~~5.92~~	~~1.66~~ JL		34.4	
6	-2	10:10	0.75		~~5.55~~	~~1.62~~ JL		33.5	
7	-3	11:25	0.72		~~5.02~~	~~1.56~~ JL		32.1	
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									

Comments:

form COMPFM.wq1

Data Quality Assurance Worksheet

HERRERA ENVIRONMENTAL CONSULTANTS

Project Name/No./Client: Desmoin 2
Laboratory/Parameters: Aquatic Research / Conv. + Metals
Sample Date/Sample ID: Storm 19, 6/24/98

By: J. Lenth
Date: 9/24/99 Page 1 of 1
Checked initials: RZ
date: 7/10/00

Parameter	Completeness/ Methodology	Holding Times	Blanks/ ~~Detection Limits~~	Matrix Spikes/ Surrogate Recoveries	Lab Duplicates	Field Duplicates	Lab Control Samples	Instrument Calibration/ Performance	ACTION
Turbidity	O.K. ↓	O.K. ↓	NA	NA	0.00%	NA ↓	100.00%	O.K. ↓	
TSS			<0.50	NA	5.71%		100.00%		None
Hardness			<2.00	99.50%	1.95%		94.50%		
Fecal Coliform			<2	NA	11.76% est.		NA		None
TPH			<0.25	NA	NA		105.17%		
TP			<0.002	Recovery Out of Range	1.64%		103.23%		
NH4-N			<0.010	96.50%	3.45%		102.73%		None
NO3+NO2-N			<0.010	80.50%	5.50%		97.32%		
Dissolved Cu			<0.0010	99.20%	< IDL		102.00 %		
Pb			< 0.005	100.40%	NC Both U		102.00 %		None
Zn			<0.003	93.20%	< IDL		103.00 %		
Total Cu			<0.0010	89.60%	26.55%		101.20 %		All total Cu values estimated (J) cause lab dup
Pb			<0.0005	96.00%	4.35%		98.40 %		None
Zn			<0.003	109.10%	5.41%		92.80 %		
Field Meas. Temp DO pH Cond			NA	NA	NA		NA	O.K. after some initial problem w/ the corning Cond. Meter	None

Notes:

file: DATAQA3.XLS

AR 025539

AQUATIC RESEARCH INCORPORATED

LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER: HER042-34 PAGE 1

EPORT DATE: 10/30/98

ATE SAMPLED: 10/12/98 DATE RECEIVED: 10/12/98

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER
AMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

CASE NARRATIVE

a water samples were delivered to the laboratory in good condition. The samples were analyzed according to the chain of custody. Samples for total metals
w.re digested according to EPA procedures. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows while
QA/QC data is contained on subsequent pages.

Storm 20

MPLE DATA

SAMPLE ID	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	TPH (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
DM-1	13	22	est 2200	0.110	0.31	0.127	0.432
DM-2	8.5	26	>2220	0.117	<0.25	0.034	0.499
BA-1	20	52	740	0.198	<0.25	0.048	0.803
BA-2	19	49	840	0.195	<0.25	0.047	0.812
MA-1	7.5	9.5	>19600	0.108	0.30	0.061	0.384
MA-2	11	18	>1820	0.079	0.50	0.077	0.426
MA-3	10	20	>1600	0.102	<0.25	0.037	0.604
MC-1	3.5	3.2	est 3200	0.182	<0.25	0.019	0.178
MC-2	20	15	est 3200	0.131	0.25	0.075	0.346

SAMPLE ID	HARDNESS (mgCaCO3/l)	DISSOLVED METALS COPPER (mg/l)	DISSOLVED METALS LEAD (mg/l)	DISSOLVED METALS ZINC (mg/l)	TOTAL METALS COPPER (mg/l)	TOTAL METALS LEAD (mg/l)	TOTAL METALS ZINC (mg/l)
DM-1	45.6	0.0057	<0.0005	0.015	0.0106	0.0040	0.043
DM-2	75.0	0.0033	<0.0005	0.013	0.0068	0.0023	0.034
BA-1	76.4	0.0032	<0.0005	0.017	0.0066	0.0018	0.021
BA-2	75.0	0.0033	<0.0005	0.010	0.0082	0.0020	0.030
MA-1	51.3	0.0050	0.0006	0.034	0.0068	0.0045	0.043
MA-2	52.9	0.0038	<0.0005	0.004	0.0057	0.0022	0.017
MA-3	51.5	0.0031	<0.0005	0.004	0.0046	0.0014	0.022
MC-1	86.7	0.0023	<0.0005	0.057	0.0027	<0.0005	0.068
MC-2	36.8	0.0061	<0.0005	0.019	0.0139	0.0014	0.022
MA-4		<0.0010	<0.0005	<0.003			

A-2 = Field duplicate of BA-1
MA-4 = Field transfer blank

AQUATIC RESEARCH INCORPORATED

LABORATORY & CONSULTING SERVICES
3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	HER042-34		PAGE 2
REPORT DATE:	10/30/98		
DATE SAMPLED:	10/12/98	DATE RECEIVED:	10/12/98

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

QC PARAMETER	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	TPH (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
METHOD	SM182130B	EPA 160.2	SM189222D	EPA 365.1	EPA 418.1	EPA 350.1	EPA 353.2
DATE ANALYZED	10/13/98	10/14/98	10/12/98	10/19/98	10/27/98	10/13/98	10/13/98
DETECTION LIMIT	0.10	0.50	2	0.002	0.25	0.010	0.010
DUPLICATE							
SAMPLE ID	MC-2	MC-2	MC-2	DM-2		MC-2	MC-2
ORIGINAL	20	15	est 3200	0.117		0.075	0.346
DUPLICATE	21	15	est 3400	0.122		0.079	0.350
RPD	4.88%	4.44%	NC	4.18%	NA	5.30%	12.40%
		0	6.06			5.19	1.15%
SPIKE SAMPLE							
SAMPLE ID				DM-2		MC-2	MC-2
ORIGINAL				0.117		0.075	0.346
SPIKED SAMPLE				0.167		0.270	0.529
SPIKE ADDED				0.050		0.200	0.200
% RECOVERY	NA	NA	NA	~~99.00%~~	NA	97.15%	91.60%
				100%		97.5	91.5
QC CHECK							
FOUND	8.5	11		0.094	34.7	0.914	0.463
TRUE	8.0	10		0.093	32.9	0.915	0.424
% RECOVERY	106.25%	106.00%	NA	101.08%	105.47%	99.89%	109.25%
		110%					109.20
BLANK	NA	<0.50	< 2	<0.002	<0.25	<0.010	<0.010

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

AQUATIC RESEARCH INCORPORATED

LABORATORY & CONSULTING SERVICES
3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
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CASE FILE NUMBER:	HER042-34		PAGE 3
REPORT DATE:	10/30/98		
DATE SAMPLED:	10/12/98	DATE RECEIVED:	10/12/98

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

QC PARAMETER		DISSOLVED METALS			TOTAL METALS		
	HARDNESS (mgCaCO3/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)
METHOD	SM18 2340B	EPA 220.2	EPA 239.2	EPA 200.7	EPA 220.2	EPA 239.2	EPA 200.7
DATE ANALYZED	10/15/98	10/21,22/98	10/21,22/98	10/22/98	10/21,22/98	10/21,22/98	10/22/98
DETECTION LIMIT	2.00	0.0010	0.0005	0.003	0.0010	0.0005	0.003
DUPLICATE							
SAMPLE ID	MC-2	MA-4	MA-4	MA-4	DM-1	DM-1	DM-1
ORIGINAL	36.8	<0.0010	<0.0005	<0.003	0.0106	0.0040	0.043
DUPLICATE	37.0	<0.0010	<0.0005	<0.003	0.0102	0.0043	0.048
RPD	0.52%	NC	NC	NC	3.85%	7.23%	10.99%
SPIKE SAMPLE	0.4						
SAMPLE ID	MC-2	MA-4	MA-4	MA-4	DM-1	DM-1	DM-1
ORIGINAL	36.8	<0.0010	<0.0005	<0.003	0.0106	0.0040	0.043
SPIKED SAMPLE	56.7	0.0128	0.0124	1.039	0.0213	0.0127	1.04
SPIKE ADDED	20.0	0.0125	0.0125	1.00	0.0125	0.0125	1.00
% RECOVERY	99.26%	102.40%	99.52%	103.90%	85.60%	~~69.60%~~	99.60%
QC CHECK	99.5	94.4	95.2	103.4			99.7
FOUND	40.8	0.0236	0.0252	1.04	0.0236	0.0242	1.04
TRUE	40.0	0.0250	0.0250	1.00	0.0250	0.0250	1.00
% RECOVERY	102.00%	94.40%	100.68%	103.50%	94.40%	96.80%	103.50%
			100.80	104%			104%
BLANK	<2.00	<0.0010	<0.0005	<0.003	<0.0010	<0.0005	<0.003

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
* = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Steven Lazoff
Laboratory Director

HER042-34

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue, Suite 601
Seattle, Washington 98121
(206)441-9080
FAX 441-9108

CHAIN OF CUSTODY RECORD

PROJECT NAME	PROJECT NUMBER	CLIENT
Desmon 2	C836/2	City of Des Moines

REPORT TO: Rob Zisette
COPY TO: —
SAMPLED BY: R. Zisette, M. Brennan
DELIVERY METHOD: hand
LABORATORY: Aquatic Research
REQUESTED COMPLETION DATE: Std.
TOTAL # OF CONTAINERS: 46
LAB USE:

ANALYSES REQUESTED

SAMPLE ID	DATE	TIME	SAMPLE DESCRIPTION	# OF CONTAINERS	Hardness	Turbidity	TSS	TP	NO_2+NO_3-N	NH_4-N	TPH	Fecal Coliforms	Copper-total (GFAA)	Copper-diss. (GFAA)	Lead-total (GFAA) ✱	Lead-diss. (GFAA) ✱	Zinc-total (ICP)	Zinc-diss. (ICP)		
DM-1	10/12/98	1000	Stream Stormwater	5	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
DM-2		1015																		
BA-1		0935																		
BA-2		0945																		
MA-1		0925																		
MA-2		1015																		
MA-3		1030																		
MC-1		0930																		
MC-2		0950																		
MA-4		1600		1										X		X		X		

REMARKS: Please Composite as per attached sheets. Dissolved metals require filtering. ✱ Pb detection limit = 0.5 µg/L if possible

RELINQUISHED BY (NAME/CO.)	SIGNATURE	DATE/TIME	RECEIVED BY (NAME/CO.)	SIGNATURE	DATE/TIME
Matt Brennan/Herrera	Matt Brennan	10/12/98 1700	Aaron Crotts/ARL	Aaron C.	10/12/98 1700

AR 025543

Composite Storm Sample Data Form

HERRERA ENVIRONMENTAL CONSULTANTS

Project: Des Moines Water Quality Monitoring   Date: 10/12/98
Sampling Location: Des Moines, storm 20   Personnel: RZ, MB

Sample ID	Time	Depth (ft)		Flow (cfs)			Composting Proportions (%)	(mL)
BA-1-1	9:35	9.89		0.19			7.9	
-2	10:45	10.06		1.26			52.9	
-3	11:49	10.02		0.94			39.2	
BA-2-1	9:45	9.89		0.19			7.9	
-2	10:55	10.06		1.26			52.9	
-3	11:55	10.02		0.94			39.2	
DM-1-1	10:00	1.38		9.32			33.1	
-2	11:05	1.44		10.92			38.8	
-3	12:10	1.32		7.89			28.0	
DM-2-1	10:15	1.18		2.32			5.9	
-2	11:15	1.39		12.94			35.2	
-3	12:20	1.34		10.19			25.7	
MA-1-1	9:25	0.2		0.39			29.8	
-2	10:35	0.18		0.29			22.5	
-3	11:40	0.25		0.63			47.7	
MA-2-1	10:15	0.33		8.15			44.3	
-2	11:10	0.28		6.29			34.2	
-3	12:40	0.21		3.97			21.6	

Comments:

HERRERA ENVIRONMENTAL CONSULTANTS

Composite Storm Sample Data Form

Project Des Moines Water Quality Monitoring Date 10/12/98
Sampling Location Des Moines, Storm 20 Personnel RZ, MB

Sample ID	Time	Depth (ft)		Flow (cfs)			Composting Proportions (%)	(mL)
MA-3-1	10:30	0.78		7.91			33.3	
-2	11:25	0.77		7.81			32.9	
-3	12:50	0.79		8.01			33.8	
MC-1-1	9:30	5.05		0.15			21.1	
-2	10:40	5.10		0.27			37.5	
-3	11:45	5.11		0.30			41.4	
MC-2-1	9:50	0.69		use depth			33.5	
-2	10:50	0.69		proportions			33.5	
-3	12:00	0.68					33.0	

Comments:

HERRERA ENVIRONMENTAL CONSULTANTS

Data Quality Assurance Worksheet

Project Name/No./Client: Desmon/C387/City of Des Moines
Laboratory/Parameters: ARI/Conv. & Metals
Sample Date/Sample ID: Storm 20 10/12/98 8 stations + Field Duplicate + Transfer Blank

By: B. Janacek
Date: 3/7/00 Page 1 of 1
Checked initials: RZ
date: 7/11/00

Parameter	Completeness/ Methodology	Holding Times	Blanks/ Detection Limits (Metals transfer blank MA-4)	Matrix Spikes/ Surrogate Recoveries	Lab Duplicates	Field Duplicates (BA1 = BA-2)	Lab Control Samples	Instrument Calibration/ Performance	ACTION
Turbidity	OK	OK	OK	NA	4.88%	5.13%	106.25%	NA	None
TSS	↓	↓	↓	NA	0.00%	5.94%	110.00%	↓	↓
Fecals	↓	↓	↓	NA	NC 6% est.	12.66%	NA	↓	↓
TP	↓	↓	↓	100%	4.18%	1.53%	10 08%	↓	↓
TPH	↓	↓	↓	NA	NA	0%	105.47%	↓	↓
NH_4-N	↓	↓	↓	97.5%	5.19%	<IDL	99.39%	↓	↓
NO_3+NO_2-N	↓	↓	↓	91.5%	1.15%	1.11%	109.20%	↓	↓
Hardness	↓	↓	↓	99.5%	0.54%	1.85%	102.00%	↓	↓
Dissolved									
Pb	↓	↓	↓	95.2%	NC both U	NC Both U	100.80%	↓	None
Cu	↓	↓	↓	94.4%	NC	<IDL	94.40%	↓	
Zn	↓	↓	↓	103.6%	NC	51.85% ±2DL	101.00%	↓	but Note ±2.3×DL diss Zn in field dup
Total									
Pb	↓	↓	No hits on transfer blank	69.6%	7.23%	<IDL%	96.80%	↓	All total Pb values underestimated Flag J
Cu	↓	↓	↓	85.6%	3.85%	21.62%	94.40%	↓	None
Zn	↓	↓	↓	99.7%	10.99%	35.29%	104.00%	↓	but Note 35% total Zn in field dup
Field									
Temp	↓	↓	NA	NA	NA	NA	NA	OK	
pH	↓	↓						↓	
DO	↓	↓							

Notes: NC: Not calculable due to one or more values being below the detection limit

file: DATAQA3.XLS

AQUATIC RESEARCH INCORPORATED

LABORATORY & CONSULTING SERVICES
3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	HER042-35	PAGE 1	
REPORT DATE:	01/27/99		
DATE SAMPLED:	01/13/99	DATE RECEIVED:	01/14/99
FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES			

CASE NARRATIVE

Eight water samples were delivered to the laboratory in good condition. The samples were analyzed according to the chain of custody. Samples for total metals were digested according to EPA procedures. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows while QA/QC data is contained on subsequent pages.

Storm 21

SAMPLE DATA

SAMPLE ID	TURBIDITY (NTU)	CONDUCTIVITY (umhos/cm)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	TPH (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
DM-1	38	98.7	54	1380	0.168	1.8	0.129	0.431
DM-2	30	134	62	780	0.171	0.61	0.100	0.609
BA-1	46	124	94	4000	0.269	0.31	0.059	0.842
MA-1	16	95.1	12	520	0.055	0.94	0.108	0.514
MA-2	20	84.6	32	700	0.079	0.66	0.074	0.463
MA-3	26	101	41	740	0.115	0.57	0.063	0.609
MC-1	9.5	126	13	920	0.079	0.34	0.044	0.461
MC-2	22	118	18	560	0.106	0.75	0.075	0.445

		DISSOLVED METALS			TOTAL METALS		
SAMPLE ID	HARDNESS (mgCaCO3/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)
DM-1	36.0	0.0047	<0.0005	0.014	0.0172	0.0169	0.064
DM-2	49.0	0.0031	<0.0005	0.010	0.0115	0.0040	0.045
BA-1	42.8	0.0025	<0.0005	0.014	0.0093	0.0048	0.021
MA-1	31.7	0.0025	<0.0005	0.044	0.0066	0.0116	0.062
MA-2	28.1	<0.0010	<0.0005	0.006	0.0060	0.0050	0.018
MA-3	36.4	0.0016	<0.0005	0.007	0.0065	0.0047	0.014
MC-1	52.0	0.0026	<0.0005	0.007	0.0059	<0.0005	0.003
MC-2	49.0	0.0046	<0.0005	0.008	0.0103	0.0055	0.028

AQUATIC RESEARCH INCORPORATED

LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

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ASE FILE NUMBER:	HER042-35	PAGE 2	
REPORT DATE:	01/27/99		
DATE SAMPLED:	01/13/99	DATE RECEIVED:	01/14/99

INAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER AMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

A/QC DATA WATER

QC PARAMETER	TURBIDITY (NTU)	CONDUCTIVITY (umhos/cm)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	TPH (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
METHOD	SM182130B	SM182510B	EPA 160.2	SM189222D	EPA 365.1	EPA 418.1	EPA 350.1	EPA 353.2
DATE ANALYZED	01/15/99	01/21/99	01/20/99	01/14/99	01/18/99	01/24/99	01/15/99	01/15/99
DETECTION LIMIT	0.10	0.10	0.50	2	0.002	0.25	0.010	0.010
DUPLICATE								
SAMPLE ID	MC-2	MC-2	MC-2	MC-2	MC-2		MC-2	MC-2
ORIGINAL	22	118	18	560	0.106		0.075	0.445
DUPLICATE	24	118	17	est 340	0.099		0.079	0.446
RPD	8.70%	0.00%	5.71%	NC	6.56%	NA	5.70%	12.40%
SPIKE SAMPLE					6.03%		5.19%	0.22%
SAMPLE ID					MC-2		MC-2	MC-2
ORIGINAL					0.106		0.075	0.445
SPIKED SAMPLE					0.157		0.297	0.641
SPIKE ADDED					0.050		0.200	0.200
% RECOVERY	NA		NA	NA	103.00%	NA	111.20%	97.75%
QC CHECK					102.00%		111.00%	98.00%
FOUND	85	752	9.8		0.090	33.8	0.529	0.976
TRUE	80	718	10		0.093	33.9	0.499	0.933
% RECOVERY	106.25%	104.74%	98.00%	NA	96.77%	99.71%	106.05%	104.61%
							106.01%	
BLANK	NA	NA	<0.50	< 2	<0.002	<0.25	<0.010	<0.010

RPD - RELATIVE PERCENT DIFFERENCE.
NA - NOT APPLICABLE OR NOT AVAILABLE.
NC - NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
: RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

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LABORATORY & CONSULTING SERVICES
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CASE FILE NUMBER:	HER042-35	PAGE 3	
REPORT DATE:	01/27/99		
DATE SAMPLED:	01/13/99	DATE RECEIVED:	01/14/99

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

QC PARAMETER	HARDNESS (mgCaCO3/l)	DISSOLVED METALS COPPER (mg/l)	DISSOLVED METALS LEAD (mg/l)	DISSOLVED METALS ZINC (mg/l)	TOTAL METALS COPPER (mg/l)	TOTAL METALS LEAD (mg/l)	TOTAL METALS ZINC (mg/l)
METHOD	SM18 2340B	EPA 220.2	EPA 239.2	EPA 200.7	EPA 220.2	EPA 239.2	EPA 200.7
DATE ANALYZED	01/29/99	01/28/99	01/28/99	01/29/99	01/21/99	01/26/99	01/26/99
DETECTION LIMIT	2.00	0.0010	0.0005	0.003	0.0010	0.0005	0.003
DUPLICATE							
SAMPLE ID	MC-2	DM-2	DM-2	BATCH	BA-1	BA-1	BA-1
ORIGINAL	49.0	0.0031	<0.0005	<0.003	0.0093	0.0048	0.021
DUPLICATE	48.2	0.0029	<0.0005	<0.003	0.0099	0.0035	0.021
RPD	1.65%	6.67%	NC	NC	6.25%	31.33%	0.00%
SPIKE SAMPLE							
SAMPLE ID	MC-2	DM-2	DM-2	BATCH	BA-1	BA-1	BA-1
ORIGINAL	49.0	0.0031	<0.0005	<0.003	0.0093	0.0048	0.021
SPIKED SAMPLE	68.5	0.0149	0.0096	0.920	0.0227	0.0189	1.16
SPIKE ADDED	20.0	0.0125	0.0125	1.00	0.0125	0.0125	1.00
% RECOVERY	97.43%	94.40%	76.80%	91.95%	107.20%	112.80%	114.30%
QC CHECK							
FOUND	40.2	0.0246	0.0249	1.01	0.0252	0.0258	1.03
TRUE	40.0	0.0250	0.0250	1.00	0.0250	0.0250	1.00
% RECOVERY	100.50%	98.40%	99.60%	100.90%	100.80%	103.20%	102.70%
BLANK	<2.00	<0.0010	<0.0005	<0.003	<0.0010	<0.0005	<0.003

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Steven Lazoff
Laboratory Director

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue, Suite 601
Seattle, Washington 98121
(206)441-9080
FAX 441-9108

CHAIN OF CUSTODY RECORD

STEVE [illegible] 1/14/99

PROJECT NAME	Desmon2
PROJECT NUMBER	C836/2
CLIENT	City of Des Moines
REPORT TO:	Rob Zisette
COPY TO:	
SAMPLED BY:	R. Zisette M. Brennan
DELIVERY METHOD:	hand
LABORATORY:	Aquatic Research
REQUESTED COMPLETION DATE:	ST
TOTAL # OF CONTAINERS:	46
LAB USE:	

ANALYSES REQUESTED: Conductivity; Turbidity; TSS; TP; NO_2+NO_3-N; NH_4-N; TPH; Fecal Coliforms; Copper, total (GFAA); Copper, dissolved (GFAA); Lead, total (GFAA); Lead, diss. (GFAA); Zinc, total (GFAA); Zinc, diss. (GFAA); Hardness

SAMPLE ID	DATE	TIME	SAMPLE DESCRIPTION	# OF CONTAINERS	Conductivity	Turbidity	TSS	TP	NO_2+NO_3-N	NH_4-N	TPH	Fecal Coliforms	Copper, total (GFAA)	Copper, dissolved (GFAA)	Lead, total (GFAA)	Lead, diss. (GFAA)	Zinc, total (GFAA)	Zinc, diss. (GFAA)	Hardness
DM-1	1/13/99	2120	Stream Storm Water	5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
DM-2	↓	2140		↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
BA-1	↓	2050		↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
MA-1	↓	2040		↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
MA-2	↓	2125		↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
MA-3	↓	2140		↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
MC-1	↓	2045		↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
MC-2	↓	2105		↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	

Per R.Z. by phone

REMARKS: Please composite as per attached sheets. Dissolved metals need to be filtered. Note: BA1 TPH in poly bottle. ☆Pb detection limit = 0.5 ppb if possible

RELINQUISHED BY (NAME/CO.)	SIGNATURE	DATE/TIME	RECEIVED BY (NAME/CO.)	SIGNATURE	DATE/TIME
Rob Zisette (Herrera)	[signature]	1/14/99 1100	Aaron Chatts AQRES	[signature]	1/14/99 1100

TPH's PRES 1/14/99 AC

AR 025550

Composite Storm Sample Data Form

HERRERA ENVIRONMENTAL CONSULTANTS

C836

Project Des Moines Water Quality Date 1/13/99 Page 1 of 2

Sampling Location Des Moines Streams Personnel RZ and MB

Sample ID	Time	Depth (ft)		Flow (cfs)			Composting Proportions (%)	(mL)
DM-1-1	2120	1.61		16.6			44	
-2	2230	1.52		13.4			35	
-3	2340	1.32		7.9			21	
DM-2-1	2140	1.64		34.14			39	
-2	2250	1.59		29.85			35	
-3	2358	1.48		21.86			26	
BA-1-1	2050	10.24		3.24			41	
-2	2210	10.20		2.73			35	
-3	2320	10.13		1.93			24	
MA-1-1	2040	0.43		1.89			58	
-2	2200	0.28		0.76			23	
-3	2310	0.26		0.63			19	
MA-2-1	2125	–		–			37	
-2	2225	–		–			33	
-3	2340	–		–			30	
MA-3-1	2140	1.09		11.05			37	
-2	2235	0.98		9.94			33	
-3	2350	0.89		9.02			30	

Comments:

Composite Storm Sample Data Form

HERRERA ENVIRONMENTAL CONSULTANTS

C836

Project Des Moines Water Quality Date 1/14/99

Sampling Location Des Moines Streams Personnel RZ and MB

Sample ID	Time	Depth (ft)		Flow (cfs)			Composting Proportions (%)	Composting Proportions (mL)
MC-1-1	2045	5.22		0.69			31	
-2	2200	5.24		0.78			35	
-3	2315	5.23		0.74			33	
MC-2-1	2105	0.90					33	
-2	2210	0.92					34	
-3	2325	0.89					33	

Comments:

wp/ c:\documen\forms\cnstorm\compssd.doc

AR 025552

HERRERA ENVIRONMENTAL CONSULTANTS

Data Quality Assurance Worksheet

Project Name/No./Client: Desmon/C387/City of Des Moines
Laboratory/Parameters: ARI/Conv. + Metals
Sample Date/Sample ID: Storm 21 1/13/99 8 stations

By R. Janacek
Date 3/8/00 Page 1 of 1
Checked initials RZ
date 7/11/00

Parameter	Completeness/ Methodology	Holding Times	Blanks/ Detection Limits	Matrix Spikes/ Surrogate Recoveries	Lab Duplicates	Field Duplicates	Lab Control Samples	Instrument Calibration/ Performance	ACTION
Turbidity	OK	OK	OK	NA	8.70%		106.25%	NA	None
Conductivity	↓	↓	↓	NA	0.00%		104.74%	↓	↓
TSS				NA	5.71%		98.00%		
Fecals				NA	NC 49% est dup only		NA		~~note poor precision of est. values~~
TP				102.00%	6.83%		96.77%		
TPH				NA	NA		99.71%		
NH_4-N				111.00%	5.19%		106.01%		
NO_3+NO_2				98.00%	0.22%		104.61%		
Hardness				97.50%	1.65%		100.50%		
Dissolved									
Cu				94.40%	6.67%		98.40%		
Pb				77% ~~72.80%~~	<DL Both u		99.60%		
Zn				91.70%	<DL Both u		101.00%		↓
Total				107.20%	6.25%		100.80%		None
Cu				112.80%	31.33%		103.20%		Flag all total Pb values J as estimated for lab dup
Pb				113.90%	0.00%		103.00%	↓	None
Zn			↓						
Field								OK	None
Temp			NA	NA	NA		NA	↓	↓
pH	↓								
DO		↓							

Notes: NC: not calculable due to one or more values being below the detection limit

file: DATAQA3.XLS

AR 025553

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CASE FILE NUMBER:	HER042-37	PAGE 1	
REPORT DATE:	03/29/99		
DATE SAMPLED:	03/12/99	DATE RECEIVED:	03/12/99

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

CASE NARRATIVE

Ten water samples were delivered to the laboratory in good condition. The samples were analyzed according to the chain of custody. Samples for total metals were digested according to EPA procedures. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows while QA/QC data is contained on subsequent pages.

Storm 22

SAMPLE DATA

SAMPLE ID	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	TPH (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
BA 1	39	19	48	0.079	<0.25	0.026	0.828
DM 1	9.4	5.2	est 20	0.047	0.31	0.029	0.579
DM 2	5.5	5.8	40	0.039	<0.25	0.003	0.781
MA 1	7.1	4.7	est 12	0.031	<0.25	0.044	0.908
MC 1	2.2	1.6	est 26	0.043	<0.25	<0.010	0.295
MC 2	18	11	est 2800	0.061	<0.25	0.029	0.434
MC 3	18	11	est 1400	0.062	<0.25	0.027	0.431
MA 2	9.9	8.7	est 800	0.035	<0.25	0.028	0.982
MA 3	15	8.8	est 380	0.045	0.56	0.013	0.948

		DISSOLVED METALS			TOTAL METALS		
SAMPLE ID	HARDNESS (mgCaCO3/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)
BA 1	56.9	0.0034	<0.0005	<0.003	0.0061	<0.0005	0.010
DM 1	58.8	0.0055	0.0006	0.007	0.0068	0.0021	0.027
DM 2	64.2	0.0035	<0.0005	0.004	0.0049	0.0011	0.015
MA 1	60.1	0.0032	<0.0005	0.011	0.0040	0.0012	0.035
MC 1	51.3	0.0012	<0.0005	<0.003	0.0021	<0.0005	<0.003
MC 2	49.8	0.0058	<0.0005	<0.003	0.0072	<0.0005	0.014
MC 3	46.4	0.0036	<0.0005	<0.003	0.0074	<0.0005	0.013
MA 2	57.8	0.0035	<0.0005	<0.003	0.0042	<0.0005	0.018
MA 3	58.0	0.0029	<0.0005	<0.003	0.0043	<0.0005	0.016
MC-4		<0.0010	<0.0005	<0.003			

MC-3 = Field duplicate of MC-2
MC-4 = Field transfer blank

AQUATIC RESEARCH INCORPORATED

LABORATORY & CONSULTING SERVICES

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CASE FILE NUMBER:	HER042-37		PAGE 2
REPORT DATE:	03/29/99		
DATE SAMPLED:	03/12/99	DATE RECEIVED:	03/12/99

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

QC PARAMETER	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	TPH (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
METHOD	SM182130B	EPA 160.2	SM189222D	EPA 365.1	EPA 418.1	EPA 350.1	EPA 353.2
DATE ANALYZED	03/13/99	03/18/99	03/12/99	03/16/99	03/23/99	03/15/99	03/15/99
DETECTION LIMIT	0.10	0.50	2	0.002	0.25	0.010	0.010
DUPLICATE							
SAMPLE ID	MA-3	BA-1	MC-2	MC 1		MA 3	MA 3
ORIGINAL	15	19	est 2800	0.043		0.013	0.948
DUPLICATE	15	20	est 3800	0.042		0.017	0.949
RPD	0.00%	4.17%	NC	2.60%	NA	25.26%	12.40%
		5.13%		2.35%		< 1DL	0.11%
SPIKE SAMPLE							
SAMPLE ID				MC 1		MA 3	MA 3
ORIGINAL				0.043		0.013	0.948
SPIKED SAMPLE				0.095		0.219	1.13
SPIKE ADDED				0.050		0.200	0.200
% RECOVERY	NA	NA	NA	104.80%	NA	103.30%	90.30%
				104.00%		103.00%	91.00%
QC CHECK							
FOUND	7.9	9.6		0.092	41.7	0.526	0.945
TRUE	8.0	10		0.093	42.4	0.499	0.933
% RECOVERY	98.75%	96.00%	NA	98.92%	98.35%	105.37%	101.33%
						105.41%	101.29%
BLANK	NA	<0.50	< 2	<0.002	<0.25	<0.010	<0.010

RPD = RELATIVE PERCENT DIFFERENCE.
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NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

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CASE FILE NUMBER:	HER042-37	PAGE 3	
REPORT DATE:	03/29/99		
DATE SAMPLED:	03/12/99	DATE RECEIVED:	03/12/99

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

QC PARAMETER		DISSOLVED METALS			TOTAL METALS		
	HARDNESS (mgCaCO3/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)
METHOD	SM18 2340B	EPA 220.2	EPA 239.2	EPA 200.7	EPA 220.2	EPA 239.2	EPA 200.7
DATE ANALYZED	03/15/99	03/15/99	03/29/99	03/19/99	03/15/99	03/29/99	03/19/99
DETECTION LIMIT	2.00	0.0010	0.0005	0.003	0.0010	0.0005	0.003
DUPLICATE							
SAMPLE ID	MA 3	MA 2	MA-2	MA 3	BATCH	MC-3	BATCH
ORIGINAL	58.0	0.0035	<0.0005	<0.003	0.0037	<0.0005	0.006
DUPLICATE	58.0	0.0032	<0.0005	<0.003	0.0035	<0.0005	0.006
RPD	0.00%	8.96%	NC	NC	5.56%	NC	0.00%
		< 1 DL			< 1 DL		
SPIKE SAMPLE							
SAMPLE ID	MA 3	MA 2	MA-2	MA 3	BATCH	MC-3	BATCH
ORIGINAL	58.0	0.0035	<0.0005	<0.003	0.0037	<0.0005	0.006
SPIKED SAMPLE	77.2	0.0152	0.0129	0.943	0.0314	0.0131	1.06
SPIKE ADDED	20.0	0.0125	0.0125	1.00	0.0250	0.0125	1.00
% RECOVERY	96.06%	93.60%	103.52%	94.30%	110.80%	104.48%	105.40%
QC CHECK							
FOUND	39.5	0.0257	0 0237	0.991	0.0257	0.0237	0.949
TRUE	40.0	0.0250	0 0250	1.00	0.0250	0.0250	1.00
% RECOVERY	98.75%	102.80%	94 80%	99.10%	102.80%	94.80%	94.90%
BLANK	<2.00	<0.0010	<0.0005	<0.003	<0.0010	<0.0005	<0.003

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
NOR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Steven Lazoff
Laboratory Director

HERRERA ENVIRONMENTAL CONSULTANTS
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Seattle, Washington 98121
(206)441-9080
FAX 441-9108

CHAIN OF CUSTODY RECORD

PROJECT NAME: Desmon 2
PROJECT NUMBER: C836/2
CLIENT: City of Des Moines
REPORT TO: Rob Zisette
COPY TO: –
SAMPLED BY: M. Brennan/K. Easthouse
DELIVERY METHOD: hand
LABORATORY: Aq. Research
REQUESTED COMPLETION DATE: Std
TOTAL # OF CONTAINERS: 46
LAB USE:

ANALYSES REQUESTED

SAMPLE ID	DATE	TIME	SAMPLE DESCRIPTION	# OF CONTAINERS	Hardness	Turbidity	TSS	TP	NO_2+NO_3-N	NH_3-N	TPH	Fecal Coliform	Copper-Total (GFAA)	Copper-Diss (GFAA)	Lead-Total (GFAA)*	Lead-Diss (GFAA)*	Zinc-Total (ICP)	Zinc-Diss (ICP)		
BA1	3/12/99	11:00	Stream Stormwater	5	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		
DM1	↓	11:20	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		
DM2	↓	11:55	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		
MA1	↓	10:50	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		
MC1	↓	10:50	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		
MC2	↓	11:05	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		
MC3	↓	11:05	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		
MA2	↓	11:20	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		
MA3	↓	11:35	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓		
MC4	↓	15:40	↓	1										↓		↓		↓		

REMARKS: Please composite per sheets to be faxed to lab. Dissolved metals require filtering

* Pb detection limit = 0.5 µg/L if possible

RELINQUISHED BY (NAME/CO.)	SIGNATURE	DATE/TIME	RECEIVED BY (NAME/CO.)	SIGNATURE	DATE/TIME
Matt Brennan/Herrera	Matt Brennan	3/12/99 16:10	AARON CRUTTS	Aaron Crutts	3/12/99 1610

HERRERA ENVIRONMENTAL CONSULTANTS

Composite Storm Sample Data Form

Page 1 of 2

Project Des Moines   Date 3/12/99

Sampling Location Des Moines   Personnel Kent Easthouse, Matt Brennan

Sample ID	Time	Depth (ft)		Flow (cfs)			Composting Proportions (%)	(mL)
DM-1-1	1125	1.27		6.83			33.6	
DM-1-2	1250	1.25		6.44			31.7	
DM-1-3	1410	1.28		7.03			34.6	
DM-2-1	1155	1.40		11.57			31.6	
DM-2-2	1315	1.38		10.19			27.9	
DM-2-3	1430	1.44		14.82			40.5	
MA-1-1	1050	0.20		0.39			23.0	
MA-1-2	1215	0.20		0.39			23.0	
MA-1-3	1350	0.30		0.92			54.0	
MA-2-1	1120	14.01		1.72			32.2	
MA-2-2	1210	13.98		1.64			30.7	
MA-2-3	1400	14.10		1.98			37.1	
MA-3-1	1135	0.78		7.91			32.1	
MA-3-2	1240	0.76		7.71			31.3	
MA-3-3	1410	0.89		9.02			36.6	
BA-1-1	1100	10.05		1.18			34.9	
BA-1-2	1230	10.03		1.01			30.1	
BA-1-3	1355	10.05		1.18			34.9	

Comments:

Composite Storm Sample Data Form

HERRERA ENVIRONMENTAL CONSULTANTS

Page 2 of 3

Project: Des Moines — Date: 3/12/99

Sampling Location: Des Moines — Personnel: Kent Easthouse, Matt Brennan

Sample ID	Time	Depth (ft)		Flow (cfs)			Composting Proportions (%)	(mL)
ML-1-1	1050	5.16		0.46			33.33	
ML-1-2	1145	5.16		0.46			33.33	
ML-1-3	1335	5.16		0.46			33.33	
ML-2-1	1105			~~0.7 est~~		30%	~~[illegible]~~	
ML-2-2	1155			~~0.7 est~~		30%	~~[illegible]~~	
ML-2-3	1350					40%	~~[illegible]~~	
ML-3-1						30%	~~[illegible]~~	
ML-3-2						30%	~~[illegible]~~	
ML-3-3						40%	~~[illegible]~~	

Comments:

HERRERA ENVIRONMENTAL CONSULTANTS

Data Quality Assurance Worksheet

Project Name/No./Client:	Desmon/C387/City of Des Moines	By	R. Janacek
Laboratory/Parameters:	ARI/Conv + Metals	Date	3/8/00 Page 1 of 1
Sample Date/Sample ID:	Storm 22 3/12/99 8 stations + 1 field duplicate + 1 Field transfer blank	Checked	initials RZ
			date 7/11/00

MC-4 = field transfer blank

MC-2 = MC-3

Parameter	Completeness/ Methodology	Holding Times	Blanks/ Detection Limits	Matrix Spikes/ Surrogate Recoveries	Lab Duplicates	Field Duplicates	Lab Control Samples	Instrument Calibration/ Performance	ACTION
Turbidity	OK	OK	OK	NA	0.00%	0.00%	98.75%	NA	None
TSS	↓	↓	↓	NA	5.13%	0.00%	96.00%	↓	↓
Fecals	↓	↓	↓	NA	NC	66.67% est.	NA	↓	None but note precision of est. values
TP	↓	↓	↓	104.00%	2.35%	1.63%	98.92%	↓	None
TPH	↓	↓	↓	NA	NA	0.00% both U	98.35%	↓	↓
NH_4-N	↓	↓	↓	103.00%	<IDL	<IDL	105.41%	↓	↓
NO_3+NO_2-N	↓	↓	↓	91.00%	0.11%	0.69%	101.29%	↓	↓
Hardness	↓	↓	↓	96.00%	0.00%	7.07%	98.75%	↓	↓
Dissolved Cu	↓	↓	No hits on transfer blank	93.60%	<IDL	16.81% ±2.2 DL	102.80%	↓	None but note precision of est. values
Pb	↓	↓	↓	99.20%	NC	0.00%	94.80%	↓	None
Zn	↓	↓	↓	94.00%	NC	0.00%	99.10%	↓	↓
Total Cu	↓	↓	↓	110.80%	<IDL	2.74%	102.80%	↓	↓
Pb	↓	↓	↓	100.80%	NC	0.00%	94.80%	↓	↓
Zn	↓	↓	↓	105.40%	0.00%	<IDL	94.90%	↓	↓
Field Temp pH DO	↓	↓	NA	NA	NA	NA	NA	OK ↓	↓

Notes: NC: not calculable due to one or more values being below the detection limit

file: DATAQA3.XLS

AR 025560

AQUATIC RESEARCH INCORPORATED
LABORATORY & CONSULTING SERVICES
3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	HER042-38	PAGE 1	
REPORT DATE:	06/01/99		
DATE SAMPLED:	05/11/99	DATE RECEIVED:	05/11/99

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

CASE NARRATIVE

Nine water samples were delivered to the laboratory in good condition. The samples were analyzed according to the chain of custody. Samples for total metals were digested according to EPA procedures. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows while QA/QC data is contained on subsequent pages.

Storm 23

SAMPLE DATA

SAMPLE ID	TURBIDITY (NTU)	CONDUCTIVITY (umhos/cm)	pH	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
DM-1	12	161	7.01	51	720	0.182	0.065	0.647
DM-2	19	185	7.01	85	540	0.226	0.011	0.728
BA-1	32	196	6.71	71	760	0.189	0.014	0.918
MA-1	34	145	6.78	61	1200	0.181	0.177	0.599
MA-2	20	127	7.07	57	1000	0.145	0.023	0.870
MA-3	28	175	6.92	104	900	0.323	0.015	0.911
MA-4	27	175	6.75	104	840	0.314	0.015	0.924
MC-1	3.5	153	6.75	9.4	420	0.087	0.011	0.184
MC-2	16	120	6.93	24	660	0.114	0.015	0.251

		DISSOLVED METALS			TOTAL METALS			
SAMPLE ID	HARDNESS (mgCaCO3/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)	TPH (mg/l)
DM-1	67.3	0.0049	0.0012	0.012	0.0117	0.0136	0.056	0.33
DM-2	71.1	0.0068	0.0013	0.014	0.0125	0.0132	0.060	<0.25
BA-1	74.4	0.0044	0.0009	0.017	0.0074	0.0048	0.024	<0.25
MA-1	52.0	0.0068	0.0041	0.037	0.0138	0.0547	0.085	0.75
MA-2	46.8	0.0049	0.0018	0.013	0.0103	0.0122	0.043	0.53
MA-3	72.9	0.0051	0.0013	0.018	0.0108	0.0120	0.039	<0.25
MA-4	66.6	0.0042	0.0021	0.017	0.0103	0.0121	0.037	0.31
MC-1	60.8	0.0028	0.0013	<0.003	0.0030	0.0026	0.007	<0.25
MC-2	47.6	0.0081	0.0018	0.009	0.0124	0.0051	0.034	<0.25

MA-4 = Field duplicate of MA-3

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LABORATORY & CONSULTING SERVICES
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ASE FILE NUMBER:	HER042-38	PAGE 2	
REPORT DATE:	06/01/99		
DATE SAMPLED:	05/11/99	DATE RECEIVED:	05/11/99

INAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER
SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

A/QC DATA WATER

QC PARAMETER	TURBIDITY (NTU)	CONDUCTIVITY (umhos/cm)	pH	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
METHOD	SM182130B	EPA 120.1	EPA 150.1	EPA 160.2	SM189222D	EPA 365.1	EPA 350.1	EPA 353.2
DATE ANALYZED	05/13/99	06/03/99	05/11/99	05/18/99	05/11/99	05/18/99	05/18/99	05/18/99
DETECTION LIMIT	0.10	0.10		0.50	2	0.002	0.010	0.010
DUPLICATE								
SAMPLE ID	MC-2	MC-2		MC-2	MC-2	MA-1	MC-2	MC-2
ORIGINAL	16	120		24	660	0.181	0.015	0.251
DUPLICATE	16	120		25	620	0.177	0.013	0.246
RPD	0.00%	0.00%	NA	2.06%	6.25%	2.56%	17.52%	12.40%
				4.08%		2.23%	<DL	2.01%
SPIKE SAMPLE								
SAMPLE ID						MA-1	MC-2	MC-2
ORIGINAL							0.015	0.251
SPIKED SAMPLE							0.203	0.428
SPIKE ADDED							0.200	0.200
% RECOVERY	NA	NA	NA	NA	NA	OR	94.20%	88.85%
QC CHECK								
FOUND	79	740		9.4		0.096	0.532	0.918
TRUE	80	718		10		0.093	0.499	0.933
% RECOVERY	98.75%	103.06%	NA	94.00%	NA	103.43%	106.57%	98.44%
						103.23%	106.61%	98.39%
BLANK	NA	NA	NA	<0.50	< 2	<0.002	<0.010	<0.010

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
= RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

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CASE FILE NUMBER: HER042-38 PAGE 3
REPORT DATE: 06/01/99
DATE SAMPLED: 05/11/99 DATE RECEIVED: 05/11/99
FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

QC PARAMETER	HARDNESS (mgCaCO3/l)	DISSOLVED METALS COPPER (mg/l)	DISSOLVED METALS LEAD (mg/l)	DISSOLVED METALS ZINC (mg/l)	TOTAL METALS COPPER (mg/l)	TOTAL METALS LEAD (mg/l)	TOTAL METALS ZINC (mg/l)	TPH (mg/l)
METHOD	SM18 2340B	EPA 220.2	EPA 239.2	EPA 200.7	EPA 220.2	EPA 239.2	EPA 200.7	EPA 418.1
DATE ANALYZED	05/20/99	06/08/99	06/08/99	06/14/99	06/08/99	06/08/99	06/14/99	06/01/99
DETECTION LIMIT	2.00	0.0010	0.0005	0.003	0.0010	0.0005	0.003	0.25
DUPLICATE								
SAMPLE ID	MC-2	MC-1	MC-1	MC-1	MC-1	MC-1	MC-1	
ORIGINAL	47.6	0.0028	0.0013	<0.003	0.0030	0.0026	0.007	
DUPLICATE	46.6	0.0029	0.0014	<0.003	0.0028	0.0027	0.008	
RPD	1.98%	1.75%	0.74%	NC	6.90%	3.77%	13.33%	NA
	2.12%	<IDL	<IDL	DL	<IDL		<IDL	
SPIKE SAMPLE								
SAMPLE ID	MC-2	MC-1	MC-1	MC-1	MC-1	MC-1	MC-1	
ORIGINAL	47.6	0.0028	0.0013	<0.003	0.0030	0.0026	0.007	
SPIKED SAMPLE	66.6	0.0139	0.0151	0.891	0.0147	0.0168	1.01	
SPIKE ADDED	20.0	0.0125	0.0125	1.00	0.0125	0.0125	1.00	
% RECOVERY	95.13%	88.48%	109 68%	89.10%	93.60%	113.60%	100.20%	NA
QC CHECK								
FOUND	40.3	0.0260	0.0270	0.967	0.0260	0.0270	0.967	40.2
TRUE	40.0	0.0250	0.0250	1.00	0.0250	0.0250	1.00	42.4
% RECOVERY	100.73%	103.92%	108.00%	96.72%	103.92%	108.00%	96.72%	94.81%
	100.75%	104.00%		96.70%	104.00%		96.70%	
BLANK	<2.00	<0.0010	<0.0005	<0.003	<0.0010	<0.0005	<0.003	<0.25

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Steven Lazoff
Laboratory Director

11

HER042-58

HERRERA ENVIRONMENTAL CONSULTANTS
1414 Dexter Avenue North, Suite 200
Seattle, Washington 98109
(206)281-7604
FAX 281-7651

CHAIN OF CUSTODY RECORD

PROJECT NAME: Desmon 2
PROJECT NUMBER: 836/2
CLIENT: City of Des Moines
REPORT TO: Rob Zisette
COPY TO: —
SAMPLED BY: Rob Zisette / John Leuth
DELIVERY METHOD: hand
LABORATORY: Aquatic Research
REQUESTED COMPLETION DATE: Std.
TOTAL # OF CONTAINERS: 45
LAB USE:

ANALYSES REQUESTED: pH, Conductivity, Hardness, Turbidity, TSS, TP, NH4-N, NO_2+NO3-N, TPH, fecal coliform, Dissolved Copper (GFAA), Dissolved Lead (GFAA), Dissolved Zinc (ICP), Total Cu, " Pb, " Zn

SAMPLE ID	DATE	TIME	SAMPLE DESCRIPTION	# OF CONTAINERS	AC 5/11/99 pH
DM-1	5/11/99	1340	Stream Stormwater	5	7.01
DM-2	↓	1358	↓	↓	7.01
BA-1	↓	1321	↓	↓	6.71
MA-1	↓	1308	↓	↓	6.78
MA-2	↓	1335	↓	↓	7.07
MA-3	↓	1345	↓	↓	6.92
MA-4	↓	1315	↓	↓	6.75
MC-1	↓	1310	↓	↓	6.75
MC-2	↓	1320	↓	↓	6.93

REMARKS: Analyze pH ~~and conductivity~~ on third sample (Sample #-3). Analyze TPH and fecal on first sample (Sample-1). Analyze remaining samples on composite of 3 samples. Compositing proportions will be faxed ~~tomorrow~~ tomorrow AM. Dissolved metals require filtering after compositing. Lead DL = 0.5ppb

RELINQUISHED BY (SIGNATURE, NAME, COMPANY)	DATE/TIME	RECEIVED BY (SIGNATURE, NAME, COMPANY)	DATE/TIME
[signature] Rob Zisette, Herrera	5/11/99 1700	[signature] ARI	5/11/99 1700

RELINQUISHED BY (SIGNATURE, NAME, COMPANY)	DATE/TIME	RECEIVED BY LAB (SIGNATURE, NAME)	DATE/TIME
/			

TPH PRES 5/11/99 w HCl AC

HERRERA ENVIRONMENTAL CONSULTANTS

Composite Storm Sample Data Form

Desmon 2, C836/2

Project Des Moines Water Quality Monitoring Date 5/11/99

Sampling Location Des Moines Personnel RZ, JL

Sample ID	Time	Depth (ft)		Flow (cfs)			Composting Proportions	
							(%)	(mL)
DM-1-1	1340	1.33		8.12			31	
-2	1431	1.46		11.5			44	
-3	1527	1.26		6.63			25	
DM-2-1	1358	1.34		10.14			19	
-2	1442	1.49		22.51			43	
-3	1542	1.45		20.00			38	
BA-1-1	1321	9.94		0.42			17	
-2	1414	10.04		1.09			45	
-3	1510	10.02		0.94			38	
MA-1-1	1308	0.38		1.46			52	
-2	1408	0.30		0.92			32	
-3	1501	0.22		0.44			16	
MA-2-1	1335	14.19		2.33			41	
-2	1440	14.03		1.78			31	
-3	1530	13.95		1.55			28	
MA-3-1	1345	0.92		9.33			36	
-2	1450	0.86		8.72			33	
-3	1545	0.89		8.01			31	

Comments:

HERRERA ENVIRONMENTAL CONSULTANTS

Composite Storm Sample Data Form

Project: Desmon 2, C836/2 Date: 5/11/99

Sampling Location: Des Moines Personnel: AZ, JL

Sample ID	Time	Depth (ft)		Flow (cfs)			Composting Proportions (%)	Composting Proportions (mL)
MA-4-1	1350	–					36	
-2	1455	–					33	
-3	1550	–					31	
MC-1-1	1310	5.12		0.33			35	
-2	1400	5.12		0.33			34	
-3	1510	5.11		0.30			31	
MC-2-1	1320	0.10		1.00 E			39	
-2	1410	0.06		0.83			32	
-3	1520	0.04		0.73 E			29	

Comments:

Data Quality Assurance Worksheet

HERRERA ENVIRONMENTAL CONSULTANTS

Project Name/No./Client: Desmon / C387 / City of Des Moines
Laboratory/Parameters: AEI / conv + metals
Sample Date/Sample ID: 5/11/99 Storm 23 8 station + 1 Field Duplicate

By: R. Janacek
Date: 3/8/00
Page 1 of 1
Checked initials: RZ
date: 7/11/00

MA·3 = MA·4

Parameter	Completeness/ Methodology	Holding Times	Blanks/ Detection Limits	Matrix Spikes/ Surrogate Recoveries	Lab Duplicates	Field Duplicates	Lab Control Samples	Instrument Calibration/ Performance	ACTION
Turbidity	OK	OK	OK	NA	0.00%	3.64%	98.75%	NA	None
Conductivity	↓	↓	↓	NA	0.00%	0.00%	103.06%	↓	↓
pH				NA	NA	NA	NA		
TSS				NA	4.08%	0.00%	94.00%		
Fecals				NA	6.25%	6.90%	NA		
TP				OR	2.23%	2.83%	103.23%		
NH_4-N				94.20%	<IDL	0.00%	106.61%		
NO_3+NO_2-N				88.85%	2.01%	1.24%	98.39%		
Hardness				95.13%	2.12%	9.03%	100.75%		
Dissolved Cu				88.48%	<IDL	± 0.9 DL 19.35%	104.00%		
Pb				109.68%	<IDL	1.6×DL OK ~~<DL~~	108.00%		
Zn				89.10%	NC	5.71%	96.70%		
Total Cu				93.60%	<IDL	4.74%	104.00%		
Pb				113.60%	3.77%	0.83%	108.00%		
Zn				100.20%	<IDL	5.26%	96.70%		
TPH			↓	NA	NA	~~NA~~ ± .25 DL	94.81%	↓ OK	
Field temp DO	↓	↓	NA	NA	NA	NA	NA	↓	↓

Notes: OR: Recovery not calculable due to spike sample out of range or spike too low relative to sample concentration

file: DATAQA3.XLS

AR 025567

AQUATIC RESEARCH INCORPORATED

LABORATORY & CONSULTING SERVICES
3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER: HER042-41 **PAGE 1**
REPORT DATE: 11/15/99
DATE SAMPLED: 10/27/99 **DATE RECEIVED:** 10/28/99
FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

CASE NARRATIVE

Eight water samples were delivered to the laboratory in good condition. The samples were analyzed according to the chain of custody. Samples for total metals were digested according to EPA procedures. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows while QA/QC data is contained on subsequent pages.

Storm 24

SAMPLE DATA

SAMPLE ID	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
DM-1	36	52	68	0.214	0.023	0.670
DM-2	31	55	est 300	0.210	0.018	0.682
BA-1	95	231	est 320	0.673	0.016	0.745
MA-1	40	118	9200	0.540	0.016	0.717
MA-2	53	119	est 2600	0.376	0.028	0.862
MA-3	65	125	5400	0.427	0.018	0.756
MC-1	22	23	800	0.341	0.019	0.131
MC-2	73	65	1320	0.234	0.047	0.389

		DISSOLVED METALS			TOTAL METALS			
SAMPLE ID	HARDNESS (mgCaCO3/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)	TPH (mg/l)
DM-1	58.4	0.0106	<0.0005	0.031	0.0140	0.0081	0.065	<0.25
DM-2	72.5	0.0072	<0.0005	0.016	0.0092	0.0045	0.028	<0.25
BA-1	72.7	0.0081	<0.0005	0.018	0.0160	0.0090	0.052	<0.25
MA-1	27.0	0.0080	0.0009	0.046	0.0259	0.0317	0.121	0.66
MA-2	35.2	0.0119	<0.0005	0.037	0.0105	0.0079	0.052	0.43
MA-3	55.1	0.0106	0.0026	0.022	0.0150	0.0110	0.060	<0.25
MC-1	63.3	0.0086	<0.0005	<0.003	0.0053	0.0011	0.010	<0.25
MC-2	36.4	0.0108	<0.0005	0.033	0.0158	0.0066	0.054	0.34

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LABORATORY & CONSULTING SERVICES
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PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	**HER042-41**		**PAGE 2**
REPORT DATE:	**11/15/99**		
DATE SAMPLED:	**10/27/99**	**DATE RECEIVED:**	**10/28/99**

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

QC PARAMETER	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)
METHOD	SM182130B	EPA 160.2	SM189222D	EPA 365.1	EPA 350.1	EPA 353.2
DATE ANALYZED	10/29/99	11/02/99	10/28/99	11/05/99	11/02/99	11/02/99
DETECTION LIMIT	0.10	0.50	2	0.002	0.010	0.010
DUPLICATE						
SAMPLE ID	MC-2	MC-2	MC-2	MC-2	MC-2	MC-2
ORIGINAL	73	65	1,320	0.234	0.047	0.389
DUPLICATE	74	65	1,200	0.240	0.049	0.391
RPD	1.36%	0.00%	9.52%	2.53%	4.18%	12.40%
					4.17%	0.51%
SPIKE SAMPLE						
SAMPLE ID				MC-2	MC-2	MC-2
ORIGINAL					0.047	0.389
SPIKED SAMPLE					0.259	0.574
SPIKE ADDED					0.200	0.200
% RECOVERY	NA	NA	NA	OR	105.95%	92.05%
					104.00%	92.50%
QC CHECK						
FOUND	83	10		0.098	0.752	0.635
TRUE	80	10		0.093	0.750	0.600
% RECOVERY	103.75%	104.00%	NA	105.38%	100.24%	105.78%
		100.00			100.27%	105.83%
BLANK	NA	<0.50	< 2	<0.002	<0.010	<0.010

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

AQUATIC RESEARCH INCORPORATED
LABORATORY & CONSULTING SERVICES
3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	HER042-41		PAGE 3	
REPORT DATE:	11/15/99			
DATE SAMPLED:	10/27/99	DATE RECEIVED:	10/28/99	

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

		DISSOLVED METALS			TOTAL METALS			
QC PARAMETER	HARDNESS (mgCaCO3/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)	TPH (mg/l)
METHOD	SM18 2340B	EPA 220.2	EPA 239.2	EPA 200.7	EPA 220.2	EPA 239.2	EPA 200.7	EPA 418.1
DATE ANALYZED	11/01/99	11/04/99	11/04/99	11/09/99	11/04/99	11/04/99	11/09/99	11/16/99
DETECTION LIMIT	2.00	0.0010	0.0005	0.003	0.0010	0.0005	0.003	0.25
DUPLICATE								
SAMPLE ID	MC-2	MA-1	MA-1	MC-2	MC-2	MC-2	MC-2	
ORIGINAL	36.4	0.0080	0.0009	0.033	0.0158	0.0066	0.054	
DUPLICATE	36.4	0.0092	0.0010	0.037	0.0160	0.0066	0.050	
RPD	0.00%	14.00%	12.77%	NC	1.26%	0.76%	6.95%	NA
		13.95%	<RL	11.43%		0.00%	7.69%	
SPIKE SAMPLE								
SAMPLE ID	MC-2	MA-1	MA-1	MC-2	MC-2	MC-2	MC-2	
ORIGINAL	36.4	0.0080	0.0009	0.033	0.0158	0.0066	0.054	
SPIKED SAMPLE	55.9	0.0209	0.0129	1.23	0.0277	0.0185	0.914	
SPIKE ADDED	20.0	0.0125	0.0125	1.00	0.0125	0.0125	1.00	
% RECOVERY	97.72%	103.44%	96.16%	119.70%	95.20%	95.20%	86.04%	NA
	97.50%	103.20%	96.00%				86.00%	
QC CHECK								
FOUND	40.3	0.0261	0.0235	0.951	0.0261	0.0235	0.951	33.4
TRUE	40.0	0.0250	0.0250	1.00	0.0250	0.0250	1.00	32.9
% RECOVERY	100.73%	104.40%	94.00%	95.10%	104.40%	94.00%	95.10%	101.52%
	100.75%							
BLANK	<2.00	<0.0010	<0.0005	<0.003	<0.0010	<0.0005	<0.003	<0.25

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
NR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Steven Lazoff
Laboratory Director

HER042-411

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue, Suite 601
Seattle, Washington 98121
(206)441-9080
FAX 441-9108

CHAIN OF CUSTODY RECORD

page 1 of 1

PROJECT NAME: Desmon2	PROJECT NUMBER: C836/2	CLIENT: City of Des Moines	
REPORT TO: Rob Zisette		COPY TO:	
SAMPLED BY: J. Lenth, M. Brennan		DELIVERY METHOD: hand	
LABORATORY: Aquatic Research	REQUESTED COMPLETION DATE: Std.		TOTAL # OF CONTAINERS: 40
LAB USE:			

ANALYSES REQUESTED

SAMPLE ID	DATE	TIME	SAMPLE DESCRIPTION	# OF CONTAINERS	Hardness	Turbidity	TSS	TP	NO_2+NO_3-N	NH_3-N	TPH	Fecal Coliform	Copper-total (GFAA)	Copper-dissolved (GFAA)	Lead-total (GFAA)	Lead-dissolved (GFAA)	Zinc-total (ICP)	Zinc-dissolved (ICP)
DM-1	10/27/99	1434	Stream Stormwater	5	X	X	X	X	X	X	X	X	X	X	X	X	X	X
DM-2	↓	1455	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
BA-1	↓	1400	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
MA-1	↓	1348	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
MA-2	↓	1440	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
MA-3	↓	1455	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
MC-1	↓	1355	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
MC-2	↓	1425	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
~~[illegible]~~																		

REMARKS: Please composite 3 grabs per sample according to percentages in attached sheets for all analyses except TPH and fecals. Dissolved metals require filtering. 0.5ug/L detection limit for Lead

RELINQUISHED BY (NAME/CO.)	SIGNATURE	DATE/TIME	RECEIVED BY (NAME/CO.)	SIGNATURE	DATE/TIME
Keith Korabeck	[signature]	10/28 1050	Allen Clotts Aq Res	[signature]	10/28/99 1050
RELINQUISHED BY (NAME/CO.)	SIGNATURE	DATE/TIME	RECEIVED BY (NAME/CO.)	SIGNATURE	DATE/TIME

HERRERA ENVIRONMENTAL CONSULTANTS

Composite Storm Sample Data Form

Project Desmon 2 C836/2 Date 10/27/99 Page 1 of 2

Sampling Location Des Moines Personnel John Leuth & Matt Brenner

Sample ID	Time	Depth (ft)		Flow (cfs)			Composting Proportions (%)	Composting Proportions (mL)
MC-1-1	13:55	5.07		0.19			21.1	
MC-1-2	15:05	5.11		0.29			32.5	
MC-1-3	16:45	5.15		0.41			46.3	
MC-2-1	14:25	0.85		1.92			34.3	
MC2-2	15:15	0.86		1.93			34.7	
MC2 3	17:05	0.77		1.78			31.0	
MA2-1	14:40	14.22		6.31			40.5	
MA2-2	15:30	14.20		5.77			37.0	
MA2-3	17:15	14.10		3.50			22.5	
MA3-1	14:55	0.85		5.34			15.5	
MA3-2	15:40	1.11		15.30			44.5	
MA3-3	17:30	1.08		13.73			39.9	
MA1-1	13:48	0.25		0.63			16.5	
MA1-2	15:22	0.44		2.00			52.7	
MA1-3	16:44	0.34		1.17			30.8	
DM-1-1	14:34	0.84		1.61			8.1	
DM-1-2	15:55	1.34		8.92			44.7	
DM-1-3	17:06	1.36		9.42			47.2	

Comments:

HERRERA ENVIRONMENTAL CONSULTANTS

Composite Storm Sample Data Form

Page 2 of 2

Project Desmon 2 C836/2 Date 10/27/99

Sampling Location Des Moines Personnel John Lenth ; Matt Brennan

Sample ID	Time	Depth (ft)		Flow (cfs)			Composting Proportions (%)	(mL)
DM2-1	14:55	3.52		21.9			24.3	
DM2-2	16:15	3.59		28.8			31.9	
DM2-3	17:25	3.70		39.5			43.8	
BA-1-1	14:00	10.03		0.97			13.6	
BA-1-2	15:38	10.19		2.58			35.9	
BA-13	15:52	10.27		3.64			50.6	

Comments:

wpi c:\document\forms\enviform\compssd.doc

HERRERA ENVIRONMENTAL CONSULTANTS

Data Quality Assurance Worksheet

Project Name/No./Client: Desmon/C387/City of Des Moines
Laboratory/Parameters: ARI/ Conv + Metals
Sample Date/Sample ID: storm 24 10/27/99 8 stations

By: R. Janacek
Date: 3/9/00 Page 1 of 1
Checked initials: R.Z.
date: 7/11/00

Parameter	Completeness/ Methodology	Holding Times	Blanks/ Detection Limits	Matrix Spikes/ Surrogate Recoveries	Lab Duplicates	Field Duplicates	Lab Control Samples	Instrument Calibration/ Performance	ACTION
Turbidity	OK	OK	OK	NA	1.36%		103.75%	NA	None
TSS				NA	0.00%		100.00%		
Fecals				NA	9.52%		NA		
TP				OR	2.53%		105.38%		
NH_4-N				106.00%	4.17%		100.27%		
NO_3+NO_2-N				92.50%	0.51%		105.83%		
Hardness				97.50%	0.00%		100.75%		
Dissolved Cu				103.20%	13.95%		104.40%		
Pb				96.00%	<IDL		94.00%		
Zn				119.70%	11.43%		95.10%		
Total Cu				95.10%	1.24%		104.40%		
Pb				95.20%	0.00%		94.00%		
Zn				86.00%	7.49%		95.10%		
TPH				NA	NA		101.52%		
Field temp pH DO			NA	NA	NA		NA	OK	

Notes:

file: DATAQA3.XLS

AR 025574

AQUATIC RESEARCH INCORPORATED

LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	HER042-42	PAGE 1	
REPORT DATE:	12/04/99		
DATE SAMPLED:	11/05/99	DATE RECEIVED:	11/06/99

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

CASE NARRATIVE

Eleven water samples were delivered to the laboratory in good condition. The samples were analyzed according to the chain of custody. Samples for total metals were digested according to EPA procedures. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows while QA/QC data is contained on subsequent pages.

Storm 25

SAMPLE DATA

SAMPLE ID	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)	NWTPH-DX DIESEL (mg/l)	NWTPH-DX MOTOR OIL (mg/l)
DM-1	8.1	20	est 22	0.100	0.178	0.403		
DM-2	5.0	21	160	0.088	0.036	0.541		
BA-1	16	30	est 240	0.151	0.037	0.591		
BA-2	16	31	est 200	0.156	0.040	0.593		
MA-1	14	16	5800	0.113	0.078	0.387		
MA-2	20	28	1180	0.104	0.091	0.588		
MA-3	22	51	1180	0.150	0.043	0.512		
MC-1	3.1	6.0	162	0.143	0.018	0.027		
MC-2	32	25	est 3600	0.136	0.092	0.312		
DM-1-3							0.74	0.57

SAMPLE ID	HARDNESS (mgCaCO3/l)	DISSOLVED METALS COPPER (mg/l)	DISSOLVED METALS LEAD (mg/l)	DISSOLVED METALS ZINC (mg/l)	TOTAL METALS COPPER (mg/l)	TOTAL METALS LEAD (mg/l)	TOTAL METALS ZINC (mg/l)	TPH (mg/l)
DM-1	54.3	0.0070	0.0013	0.013	0.0080	0.0056	0.020	< 0.25
DM-2	69.2	0.0034	<0.0005	0.008	0.0035	0.0020	0.014	< 0.25
BA-1	73.3	0.0046	<0.0005	<0.003	0.0041	0.0016	0.008	< 0.25
BA-2	73.1	0.0044	<0.0005	<0.003	0.0043	0.0018	0.008	< 0.25
MA-1	28.9	0.0065	0.0041	0.042	0.0066	0.0119	0.061	0.40
MA-2	38.1	0.0047	0.0005	0.011	0.0053	0.0030	0.022	< 0.25
MA-3	55.3	0.0039	<0.0005	0.008	0.0057	0.0059	0.025	< 0.25
MC-1	70.0	0.0044	<0.0005	0.006	0.0056	<0.0005	0.010	< 0.25
MC-2	35.8	0.0053	0.0008	0.016	0.0060	0.0038	0.024	< 0.25
BA-3		<0.0010	<0.0005	<0.003				

BA-1 = BA-2 Field duplicate

BC-3 - Field transfer blank

AQUATIC RESEARCH INCORPORATED

LABORATORY & CONSULTING SERVICES
3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
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CASE FILE NUMBER:	HER042-42		PAGE 2
REPORT DATE:	12/04/99		
DATE SAMPLED:	11/05/99	DATE RECEIVED:	11/06/99

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

QC PARAMETER	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)	DIESEL (mg/l)	MOTOR OIL (mg/l)
METHOD	SM182130B	EPA 160.2	SM189222D	EPA 365.1	EPA 350.1	EPA 353.2	NWTPH-DX	NWTPH-DX
DATE ANALYZED	11/08/99	11/09/99	11/06/99	11/15/99	11/23/99	11/23/99	11/08/99	11/08/99
DETECTION LIMIT	0.10	0.50	2	0.002	0.010	0.010	0.05	0.10
DUPLICATE								
SAMPLE ID	MC-2	MC-2	MC-2	MC-2	MC-2	MC-2	BATCH	BATCH
ORIGINAL	32	25	est 3600	0.136	0.092	0.312	<0.05	1.15
DUPLICATE	33	27	est 3200	0.134	0.097	0.312	<0.05	1.19
RPD	3.08%	5.83%	NC	1.14%	5.61%	12.40%	NC	3.42%
SPIKE SAMPLE		7.69%		1.48%	5.29%	0.00%		
SAMPLE ID				MC-2	MC-2	MC-2		
ORIGINAL				0.136	0.092	0.312		
SPIKED SAMPLE				0.189	0.299	0.494		
SPIKE ADDED				0.050	0.200	0.200		
% RECOVERY	NA	NA	NA	106.56%	103.65%	90.65%	NA	NA
QC CHECK				106%.00	103.50%	91.00%		
FOUND	79	10		0.101	0.745	0.611	0.24	0.53
TRUE	80	10		0.093	0.750	0.600	0.25	0.50
% RECOVERY	98.75%	103.00%	NA	108.60%	99.31%	101.83%	97.60%	105.00%
		100.00%			99.33%	101.83%	96.00%	106.00%
BLANK	NA	<0.50	< 2	<0.002	<0.010	<0.010	<0.05	<0.10

RPD = RELATIVE PERCENT DIFFERENCE.
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NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

AQUATIC RESEARCH INCORPORATED

LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715 FAX: (206) 632-2417

CASE FILE NUMBER:	HER042-42		PAGE 3
REPORT DATE:	12/04/99		
DATE SAMPLED:	11/05/99	DATE RECEIVED:	11/06/99

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

		DISSOLVED METALS			TOTAL METALS			
QC PARAMETER	HARDNESS (mgCaCO3/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)	COPPER (mg/l)	LEAD (mg/l)	ZINC (mg/l)	TPH (mg/l)
METHOD	SM18 2340B	EPA 220.2	EPA 239.2	EPA 200.7	EPA 220.2	EPA 239.2	EPA 200.7	EPA 418.1
DATE ANALYZED	11/12/99	12/02/99	12/02/99	11/30/99	12/03/99	12/03/99	11/30/99	11/26/99
DETECTION LIMIT	2.00	0.0010	0.0005	0.003	0.0010	0.0005	0.003	0.25
DUPLICATE								
SAMPLE ID	MC-2	BA-3	BA-3	BA-3	BATCH	BATCH	BATCH	
ORIGINAL	35.8	<0.0010	<0.0005	<0.003	<0.0010	<0.0005	<0.003	
DUPLICATE	35.6	<0.0010	<0.0005	<0.003	<0.0010	<0.0005	<0.003	
RPD	0.55%	NC	NC	NC	NC	NC	NC	NA
SPIKE SAMPLE								
SAMPLE ID	MC-2	BA-3	BA-3	BA-3	BATCH	BATCH	BATCH	
ORIGINAL	35.8	<0.0010	<0.0005	<0.003	<0.0010	<0.0005	<0.003	
SPIKED SAMPLE	55.3	0.0144	0.0159	1.14	0.0128	0.0128	0.922	
SPIKE ADDED	20.0	0.0125	0.0125	1.00	0.0125	0.0125	1.00	
% RECOVERY	97.72%	115.20%	127.20%	113.80%	102.48%	102.40%	92.20%	NA
QC CHECK								
FOUND	39.5	0.0269	0.0265	1.03	0.0240	0.0247	1.03	32.7
TRUE	40.0	0.0250	0.0250	1.00	0.0250	0.0250	1.00	35.3
% RECOVERY	98.70%	107.60%	106.00%	102.80%	96.00%	98.80%	102.80%	92.63%
BLANK	<2.00	<0.0010	<0.0005	<0.003	<0.0010	<0.0005	<0.003	<0.25

RPD = RELATIVE PERCENT DIFFERENCE.
NA = NOT APPLICABLE OR NOT AVAILABLE.
NC = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
OR = RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Steven Lazoff
Laboratory Director

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue, Suite 601
Seattle, Washington 98121
(206)441-9080
FAX 441-9108

CHAIN OF CUSTODY RECORD

PROJECT NAME: Desmon 2
PROJECT NUMBER: 836
CLIENT: City of Des Moines
REPORT TO: Rob Zisette
COPY TO:
SAMPLED BY: R. Zisette, M. Brennan
DELIVERY METHOD: hand
LABORATORY: Aquatic Research
REQUESTED COMPLETION DATE: Std.
TOTAL # OF CONTAINERS: 56
LAB USE:

ANALYSES REQUESTED

SAMPLE ID	DATE	TIME	SAMPLE DESCRIPTION	# OF CONTAINERS	Hardness	Turbidity	TSS	TP	NO_2+NO_3-N	NH_3-N	Copper, total (GFAA)	Copper, dissolved (GFAA)	Lead, total 0.5 ppb DL (GFAA)	Lead, dissolved 0.5 ppb DL (GFAA)	Zinc, total (ICP)	Zinc, dissolved (ICP)	TPH	Fecal Coliform
DM-1	11/5/99	1950+	Stream Stormwater	6	X	X	X	X	X	X	X	X	X	X	X	X	X	X
DM-2		2010+		6														
BA-1		1930+		6														
BA-2		1935+		6														
MA-1		1915+		6														
MA-2		2000+		6														
MA-3		2010+		6														
MC-1		1930+		6														
MC-2		1945+		6														
[illegible]		2355		1								X		X		X		
DM-1-3		2230		1													X (circled) → NW TPH	

REMARKS: Please composite 4 grabs for each sample as per percentages on attached composite form. Dissolved metals require filtering from composite sample.

RELINQUISHED BY (NAME/CO.)	SIGNATURE	DATE/TIME	RECEIVED BY (NAME/CO.)	SIGNATURE	DATE/TIME
Rob Zisette (Herrera)	[signature]	11/6/99 0200	Keith Koralbach HEC	[signature]	11-6-99 0700
Keith Koralbach HEC	[signature]	11-6-99 0840	Olga Analaryan	[signature]	11-6-99 8:40

TPH's PRES W/ HCl 11/6/99 AC

AR 025578

HERRERA ENVIRONMENTAL CONSULTANTS

Composite Storm Sample Data Form

Project Desmond #836 Date 11/5/99

Sampling Location Des Moines Personnel RZ, MB

Sample ID	Time	Depth (ft)		Flow (cfs)			Composting Proportions (%)	Composting Proportions (mL)
DM-1-1	1950	0.92		2.2			7.2	
-2	2105	1.27		7.3			23.4	
-3	2230	1.35		9.2			29.3	
-4	2335	1.47		12.5			40.1	
DM-2-1	2010	1.33		18.95			16.6	
-2	2125	1.34		19.94			17.5	
-3	2245	1.49		34.64			30.4	
-4	2350	1.55		40.52			35.5	
BA-1-1	1930	10.02		0.90			13.2	
-2	2045	10.04		1.05			15.5	
-3	2210	10.13		1.90			27.9	
-4	2320	10.22		2.96			43.4	
BA-2-1	1935	-						
-2	2050	-						
-3	2215	-						
-4	2325	-						
MA-1-1	1915	0.20		0.39			13.7	
-2	2035	0.16		0.21			7.4	
-3	2205	0.33		1.08			37.9	
-4	2310	0.35		1.07			41.0	

Comments:

HERRERA ENVIRONMENTAL CONSULTANTS

Composite Storm Sample Data Form

Project: Desmon 2 # 836　　Date: 11/5/99

Sampling Location: Des Moines　　Personnel: RZ, MB

Sample ID	Time	Depth (ft)		Flow (cfs)			Composting Proportions (%)	Composting Proportions (mL)
MA-2-1	2000	14.11		3.69			24.2	
-2	2040	14.07		2.96			19.4	
-3	2240	14.14		4.32			28.2	
-4	2340	14.14		4.32			28.2	
MA-3-1	2010	0.83		4.87			12.3	
-2	2050	0.96		8.63			21.4	
-3	2250	1.06		12.76			32.3	
-4	2345	1.07		13.24			33.5	
MC-1-1	1930	5.05		0.14			10.6	
-2	2020	5.10		0.26			19.0	
-3	2215	5.19		0.55			40.5	
-4	2315	5.15		0.41			29.9	
MC-2-1	1945	0.69		1.64			21.9	
-2	2030	0.75		1.74			23.8	
-3	2230	0.83		1.88			26.3	
-4	2325	0.88		1.97			27.9	

Comments:

HERRERA ENVIRONMENTAL CONSULTANTS

Data Quality Assurance Worksheet

Project Name/No./Client:	Desmon/C387/City of Des Moines	By	R. Janacek		Page 1 of 1
Laboratory/Parameters:	ARI/Conv. + metals	Date	3/9/00		
Sample Date/Sample ID:	Storm 25: 11/05/99 8 stations + 1 Field duplicate +1 Field trans. blank	Checked	initials	R.Z.	
			date	7/11/00	

Parameter	Completeness/ Methodology	Holding Times	Blanks/ Detection Limits (BC-3)	Matrix Spikes/ Surrogate Recoveries	Lab Duplicates	Field Duplicates (BA-1=BA-2)	Lab Control Samples	Instrument Calibration/ Performance	ACTION
Turbidity	OK	1 day	OK	NA	3.08%	0.00%	98.75%	NA	None
TSS		OK		NA	7.69%	3.28%	100.00%		
Fecals				NA	NC 12% est.	NC 18% est.	NA		
TP				106.00%	1.48%	3.26%	108.60%		
NH_4-N				103.50%	5.29%	7.79%	99.33%		
NO_3+NO_2-N				91.00%	0.00%	0.34%	101.83%		
Hardness				~~97.50%~~ ok	0.56%	0.27%	98.75%		
Dissolved Cu			no hits on transfer blank	115% ~~107.70%~~	NC Blank! both U	<10L	107.60%		
Pb				127% ~~123.70%~~	NC	NC Both U	106.00%		J detected diss Pb values only as overestimates
Zn				113.70%	NC	NC "	103.00%		NONE
Total Cu				102% ~~91.40%~~	NC Batch both U	<10L	96.00%		
Pb				102% ~~98.40%~~	NC	<10L	98.80%		
Zn				91.90%	NC	0.00%	103.00%		
TPH				NA	NA	NC Both U	92.63%		
~~[illegible]~~ NWTPH				NA	≤3%	NA	98/105%	OK	
Field temp, pH, DO			NA	NA	NA	NA	NA		

Notes: NC: Not calculable due to one or more values being below the detection limit

file: DATAQA3.XLS

APPENDIX F

Pollutant Source Tracking Locations and Results

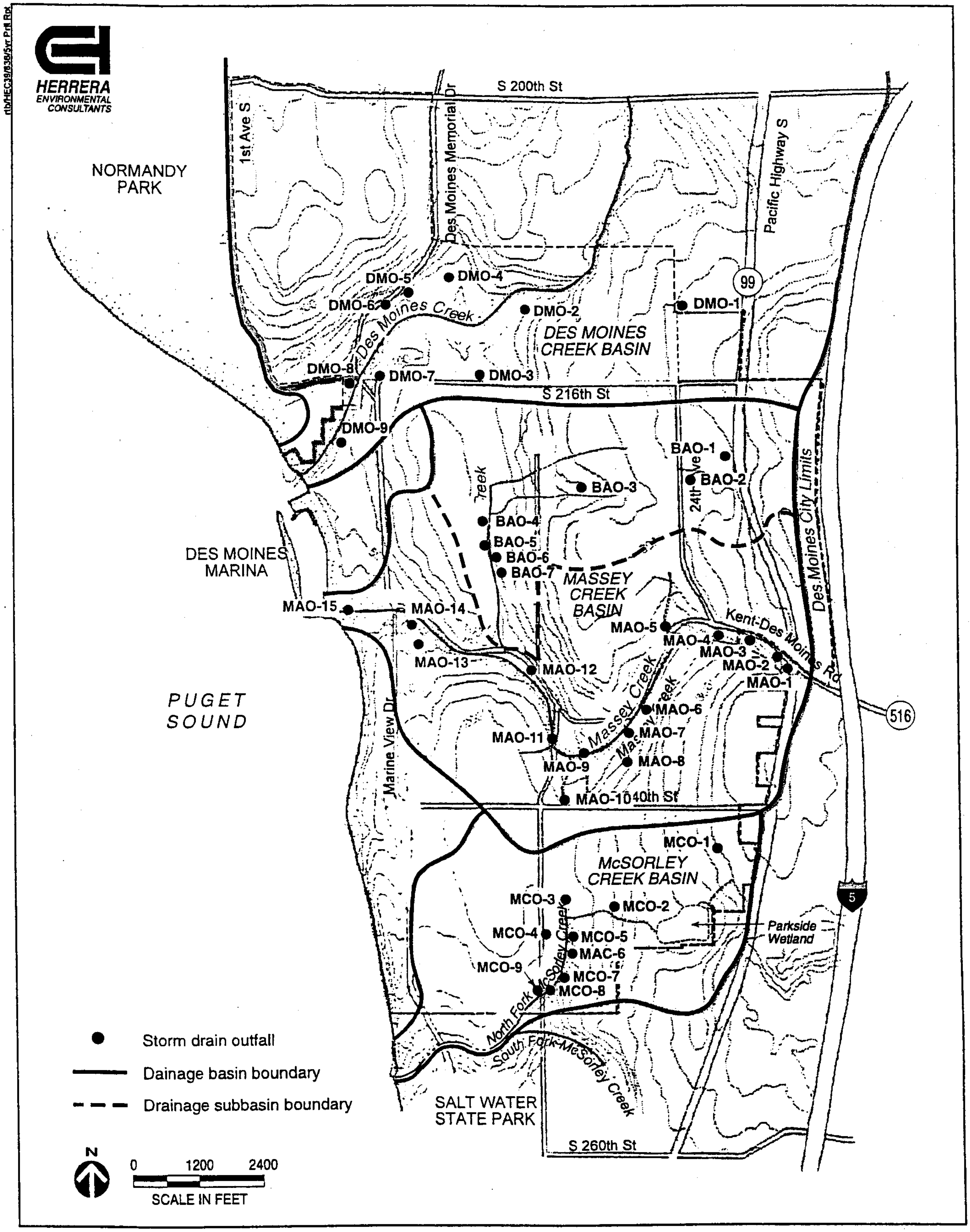

Figure F1. Study area for the Des Moines pollutant source tracking program.

AR 025583

Table F1. Outfall sampling for the Des Moines source tracking and illicit connection investigation conducted in October 1994.

Outfall ID	Location/ Access	Date	Visual observations				Fecal bacteria (No./100 mL)
			Flow present	Sewage odor	High turbidity	Oily sheen	
Des Moines Creek Basin							
DMO-1	24th Ave S at S 212th St/ ditch	10/12/94	Y	N	N	N	
DMO-2	14th Ave S at S 212th St/ manhole	10/12/94	N	--	--	--	
DMO-3	S 216th St at 12th Ave S/ catch basin	10/12/94	Y	Slight	N	N	22 J
DMO-4	S 211th Pl at 12th Ave S/ manhole	10/12/94	Y	N	N	N	
DMO-5	S 211th Pl at 9th block S/ manhole	10/24/94	Y	N	N	N	
DMO-6	S 212th St at 8th block S/ end of pipe	10/12/94	Y	N	N	N	
DMO-7	S 216th St at 7th Pl S/ manhole	10/12/94	N	--	--	--	
DMO-8	Mar. Vw Dr at S 216th St/ end of pipe	10/12/94	Y	N	N	N	
DMO-9	DM Beach Park at bioswale/ end of pipe	10/12/94	Y	N	N	N	
Massey Creek Basin							
BAO-1	S 220th St at 26th block S/ ditch	10/12/94	N	--	--	--	
BAO-2	24th Ave S at S 222nd St/ ditch	10/12/94	N	--	--	--	
BAO-3	19th Ave S at S 223rd St/ stream bed	10/12/94	N	--	--	--	
BAO-4	S 223rd St at 13th Ave S/ culvert	10/12/94	Y	N	N	N	
BAO-5	13th Ave S below S 223rd St/ outfall	10/12/94	N	--	--	--	
BAO-6	15th Ave S at 224th block S/ catch basin	10/12/94	N	--	--	--	
BAO-7	15th Ave S at 225th block S/ ditch	10/12/94	N	--	--	--	
MAO-1	Kent-DM Rd at Hwy 99/ end of pipe: Hwy 99 runoff	10/24/94	N	--	--	--	
MAO-2	Kent-DM Rd at Hwy 99/ catch basin behind mall	10/24/94	N	--	--	--	
MAO-3	Kent-DM Rd at 28th block S/ end of pipe	10/24/94	N	--	--	--	
MAO-4	24th Pl S at apartments/ manhole	10/12/94	Y	N	N	N	

Table F1. Outfall sampling for the Des Moines source tracking and illicit connection investigation conducted in October 1994 (continued).

			Visual observations				
Outfall ID	Location/ Access	Date	Flow present	Sewage odor	High turbidity	Oily sheen	Fecal bacteria (No./100 mL)
Massey Creek Basin (continued)							
MAO-5	City Park at S 230th St/ end of pipe	10/24/94	Y	N	N	N	
MAO-6	S 234th at Kent-DM Rd/ catch basin	10/12/94	Y	N	N	N	
MAO-7	20th Ave S at Kent-DM Rd/ ditch	10/12/94	N	--	--	--	
MAO-8	20th Ave S at HCC entrance/ ditch	10/12/94	N	--	--	--	
MAO-9	20th Ave S at Newport Apts/ end of pipe behind complex	10/12/94	Y	N	N	N	
MAO-10	S 240th St at 17th Ave S/ culvert	10/12/94	N	--	--	--	
MAO-11	16th Ave S at 16th Pl S/ ditch in bottom of ravine	10/12/94	Y	N	N	N	
MAO-12	16th Ave S at Kent-DM Rd/ end of pipe, private driveway	10/12/94	Y	N	N	N	
MAO-13	10th Ave S at S 230th St/ manhole	10/24/94	Y	N	N	N	
MAO-14	Kent-DM Rd at 10th Ave S/ end of pipe, SW corner	10/12/94	Y	N	N	N	
MAO-15	Mar Vw Dr S at S 230th St/ detention pond outfall	10/12/94	Y	N	N	N	
McSorley Creek Basin							
MCO-1	S 242nd St at 26th Pl S/ catch basin	10/24/94	N	--	--	--	
MCO-2	20th Ave S by 244th Pl S/ end of pipe	10/24/94	Y	N	N	N	
MCO-3	S 246th Pl at 16th block S/ catch basin	10/24/94	Y	slight	N	N	180 J
MCO-4	S 245th Pl at 17th block S/ end of pipe from W	10/24/94	Y	N	N	N	
MCO-5	S 245th Pl at 17th block S/ end of pipe from E	10/24/94	N	--	--	--	
MCO-6	S 246th Pl at 17th block S/ catch basin	10/24/94	Y	N	N	N	
MCO-7	S 250th St at 17th block S/ manhole: Midway landfill	10/24/94	N	--	--	--	
MCO-8	S 250th St at 17th block S/ end of pipe	10/24/94	Y	N	N	N	
MCO-9	16th Ave S at S 250th St/ catch basin	10/24/94	Y	N	N	N	

Samples were collected during dry weather, with an antecedent dry period for sampling on 10/12/94 of 28 days and for sampling on 10/24/94 of 2 days.

J = estimated value from quality assurance review

APPENDIX G

Benthic Invertebrate Monitoring Report

BIOASSESSMENT MODEL & TEMPLATE

A bioassessment format developed by ABA for general use in mid-order, western, montane streams was applied to the City of Des Moines 1994, 1996 & 1998 benthic invertebrate data. Forty three community composition metrics are evaluated in this bioassessment. Each metric is evaluated and scored (4,3,2,1,or 0). Subtotal and total scores are then calculated and expressed as a percent of the maximum possible score.

The ABA bioassessment is based on a model of what taxa are expected to be present and how are benthic invertebrate communities expected to be organized in a non-impacted, mid-order, western, montane stream that has very high water quality and habitat complexity. It uses a fixed scoring criteria in place of comparison with reference stations (see table of metrics & scoring criteria).

> e.g. for the metric Total taxa richness; a score of 4 is assigned to sites with >60 taxa present, 3 for 50-59 taxa, 2 for 40-49 taxa, 1 for 30-39 taxa, and 0 for <30 taxa.

The bioassessment is organized hierarchically. Individual metrics are grouped into:

> **Primary Metrics**= General community composition metrics.
>
> **Positive Indicators**= Taxa or assemblages of taxa that generally reflect high water/habitat quality.
>
> **Negative Indicators**= Taxa or assemblages of taxa that are generally tolerant, and indicate poor water/habitat quality.

A score (% of maximum possible score) is provided for each of these three metric sub-groups. The Total Score evaluates all metrics and is expressed as a percentage of the maximum possible total score.

This bioassessment approach is generalized for use over a broad geographic area, and is based on a model for unimpacted, mid-order, forested, higher gradient, cool/cold montane streams with very high habitat complexity & water quality. A particular stream being evaluated may or may not have the potential to develop these conditions, and thus may never achieve high scores.

Most Puget Sound Lowland streams are not expected to have the natural potential to attain a high biotic integrity class of a higher gradient montane stream (i.e. total scores between 80-100% in this model). There is a need to summarize current information on benthic invertebrate communities in streams in the greater Seattle area, and to identify watersheds that can be used as least impacted controls. A more suitable bioassessment model for basin and valley streams in the Pacific Northwest is needed.

The bioassessments provided here are intended to evaluate the current biotic integrity of some of the City of Des Moines streams, and to track trends over a five year period.

1994, 1996 & 1998 BIOASSESSMENTS

Total erosional habitat bioassessment scores for 1994 to 1998 from the 8 sites ranged from 27.4-43.5% (Tables 1 to 4). This is a relatively narrow range, indicating approximate equivalent conditions between the 4 streams and 8 sites.

The Total Erosional Habitat scores are very low (27.4-43.5%), indicating moderate to severe water/habitat quality limitations to the benthic invertebrate community. In their pristine condition, these streams would probably score in the 60-80% range on the ABA bioassessment. There was no substantial change in total scores at any site between 1994 and 1998 (i.e. increases or decreases of more than 10%).

The subtotal scores for **Primary Metrics** were extremely low, and ranged from 0-27.8%. These metrics evaluate total invertebrate densities, taxa richness, diversity and general community tolerance. Scores indicate severely stressed communities at all sites.

Positive Indicator subtotal scores were also extremely low, and ranged from 0-22.8%. Invertebrate taxa indicative of high water/habitat quality were virtually absent.

Negative Indicator subtotal scores were high, ranging from 56.3 to 89.8% (the higher the score the fewer tolerant or negative water/habitat indicator taxa are present). More negative indicator taxa would be expected to occur if impacts to the streams were limited to slight to moderate nutrient enrichment, exposure of stream channels from loss of riparian vegetation, and siltation. Also, channelization and high peak flows during storm events probably limit the ability of both negative and positive indicator taxa to colonize the streams.

Total invertebrate abundance is low, ranging from 23-952 animals per square meter. Invertebrate densities of <1000 per square meter are considered low, and <500 per square meter are very low or depauperate. Streams with slight to moderate nutrient enrichment and open or partial shading can easily exceed 10,000/m2. Densely forested, montane streams, typically have invertebrate densities between 1000 and 10,000 per square meter.

Total invertebrate densities at many of the sites were erratic between years. For example, densities at the Barnes Creek site varied from 27 invertebrates per square meter in 1996 to 832 per square meter in 1994. Densities at most sites were highest in 1994 (a drought year), and substantially lower in 1996 (a major flood year) and 1998 (a wet year). Very low invertebrate densities are probably correlated with severe scour and resorting of substrates during large storm events.

Total taxa richness is very low (6-33). Total richness of 40-50 taxa would be expected in relatively intact Puget Lowland streams. Total taxa richness at most sites was highest in 1994 (a drought year) and lowest in 1996 (a major flood year).

EPT (Ephemeroptera+Plecoptera+Trichoptera insects) richness is extremely low, ranging from 1-8 taxa. Relatively unimpacted streams of this type would be expected to have >20 EPT taxa. EPT taxa richness was highest in 1994 at 5 of the 8 stations.

Benthic communities at all sites were dominated in most cases by one to three tolerant taxa. The **% dominance** of the most numerous taxa at each site ranged from 16-79%. Dominance in well balanced communities is generally <20%.

Collector feeding group taxa dominated the benthic invertebrate communities at all eight biomonitoring stations (24-100%). Though these taxa are normal components of erosional habitat communities, dominance by this group in excess of about 50% generally indicates moderate to severe stress.

Non insect taxa (worms, molluscs, crustaceans, mites) were a substantial component of the benthic invertebrate community at most of the monitoring sites (6.8-95.7%). The particular non insect taxa present at the Des Moines sites were all moderately to highly tolerant forms.

Though the **mollusc taxa** encountered in the October 1994 samples are moderately to highly tolerant of nutrient enrichment, warmer temperatures, fine sediment, lower dissolved oxygen levels, and filamentous algae, they are sensitive to certain toxins (e.g. heavy metals), and to frequent disturbance of stream substrates. Snails were absent or in low numbers at the Barnes, Des Moines and Massey Creek sites, where their abundance would have been expected to be higher.

Insect taxa richness was generally very low. Based on comparison with other Puget Sound Lowland streams, many more taxa would have been expected to occur (Plotnikoff 1992, ABA unpublished data).

Long-lived invertebrate taxa (taxa requiring more than one year to complete their life cycle) are absent at many sites, and limited to several highly tolerant snails at several other sites. Long-lived taxa such as crayfish, mussels, other snails, some stoneflies and some caddisflies would be expected to be routinely present in this stream type. In 1998, more long-lived taxa were found at several sites. These included *Parapsyche almota* (a caddisfly) and *Lara avara* (a wood associated beetle).

Dominant insect taxa present were more tolerant taxa that are capable of rapid colonization and have multiple generations during the year (e.g. *Baetis tricaudatus*, blackflies, midges). High proportions of these taxa are often associated with communities that are subjected to frequent disturbance. These taxa are able to recolonize and regenerate rapidly after disturbances.

CONCLUSIONS

The 1994, 1996 and 1998 bioassessments conducted at the stream biomonitoring stations in the City of Des Moines, indicate that benthic invertebrate communities are severely stressed.

Low taxa richness, low densities, high dominance by a few tolerant, fast generation, "weed" taxa, and lack of more long-lived taxa; indicate that benthic invertebrate communities are subjected to periodic severe disturbance. The community profiles suggest that disturbance may come from either; pulses of toxins, from periodic severe scouring and resorting of stream bottom substrates, or a combination of these two factors. Urban/suburban streams having basins with a high percentage of impervious area, and which receive storm water run-off are likely to be subjected to a combination of toxic inputs and substrate disturbance.

Severe flood events during 1995-96 (particularly from the February 1996 storms), appears to have impacted the benthic invertebrate communities at many of the Des Moines sites. Major indicators of flood impacts are:

> Total invertebrate densities fell at 7 of the 8 sites, with a major drop in densities at 3 of these sites.
>
> Total taxa richness fell at 6 of the 8 sites, with a major drop in richness at 5 of these sites.
>
> Dominance by a single, more tolerant, and fast recolonization/regeneration type taxa, increased at 6 of the 8 sites, with increases being major at 4 of these sites.

In October 1998, total invertebrate densities and total taxa richness were higher at 5 of the 8 stations than in 1996.

REFERENCES

Plotnikoff, R.W., 1992. Timber/Fish/Wildlife Ecoregion Bioassessment Pilot Project. WA: Dept. of Ecology, Watershed Assessments Section, Olympia, WA 98504-7710. TFW-WQ11-92-001.

TABLE 1

Barnes Creek, Site 1

CITY OF DES MOINES, King County, Washington.
October 23, 1994; November 2, 1996 & October 30, 1998.Benthic invertebrate biomonitoring samples.
Determined by ABA, Inc., Corvallis, Oregon for Herrera Environmental Consultants, Inc., Seattle, WA.
Bioassessments are based on a comparison with mid-order, forested, western, montane stream model.

BIOASSESSMENT SCORES (%)	1994 BA1	1996 BA1	1998 BA1
Total Erosional Habitat	38.5	40.3	43.5
Primary Metrics	16.7	16.7	5.6
Positive Indicators	5.4	5.3	22.8
Negative Indicators	85.4	89.8	81.6

Note that the lower the negative indicator score is, the more impacted the site is.
Erosional= riffles, runs, glides, cascades, chutes; or habitats with running water that erode sediments.
Total Scores <40%= severely; 40-59%= moderately; 60-79% slightly; and 80-100% non-impacted sites.
Primary Metrics= General community composition metrics (statistics).
Positive Indicators= Taxa or groups of taxa that are good water/habitat quality indicators.
Negative Indicators= Taxa or groups of taxa that are indicators of poor water/habitat quality.

GENERAL COMMUNITY COMPOSITION METRICS

Total invertebrate abundance (m2)	832	27	144
Total taxa richness	18	10	17
EPT taxa richness	5	6	7
% Dominant taxa	35	33	45.8
% Collectors	70	52	58.3

EPT= The insect orders Ephemeroptera+Plecoptera+Trichoptera

% CONTRIBUTION SELECTED TAXA

% Turbellaria (flatworms)	1.9	0.0	0
% Oligochaeta (segmented worms)	1.4	7.4	2.78
% Tolerant snails	1.0	0.0	0
% Microcrustaceans	0.2	0.0	0
%Tolerant crustacea (scuds&sowbug	5.5	0.0	2.08
TOTAL NON INSECTS	10.1	7.4	4.86

% Baetis tricaudatus (mayfly)	35.1	33.3	45.83
% Ephemeroptera (mayflies)	54.3	37.0	56.94
% Plecoptera (stoneflies)	15.6	25.9	23.61
% Trichoptera (caddisflies)	1.7	14.8	6.25
% Simuliidae (blackfly)	9.4	7.4	0.69
% Chironomidae (midge)	8.4	3.7	6.94

FILE: 98TAB1

TABLE 2

Des Moines Creek, Sites 1 and 2.

CITY OF DES MOINES, King County, Washington.
October 23, 1994; November 2, 1996; & October 30, 1998 Benthic invertebrate biomonitoring samples.
Determined by ABA, Inc., Corvallis, Oregon, for Herrera Environmental Consultants, Inc., Seattle, WA.
Bioassessments are based on a comparison with a mid-order, forested, western, montane stream model.

	1994	1996	1998	1994	1996	1998
	DM1	DM1	DM1	DM2	DM2	DM2
BIOASSESSMENT SCORES (%)						
Total Erosional Habitat	31.1	33.1	29.8	35.2	34.7	33.1
Primary Metrics	0.0	0.0	0	5.6	0.0	0
Positive Indicators	0.0	0.0	0	0.0	3.5	0
Negative Indicators	79.2	83.7	75.5	87.5	83.7	83.7

Note that the lower the negative indicato: score is, the more impacted the site is.
Erosional= riffles, runs, glides, cascades, chutes; or habitats with running water that erode sediments.
Total Scores <40%= severely; 40-59%= moderately; 60-79% slightly; and 80-100% non-impacted sites.
Primary Metrics= General community composition metrics (statistics).
Positive Indicators= Taxa or groups of taxa that are good water/habitat quality indicators.
Negative Indicators= Taxa or groups of taxa that are indicators of poor water/habitat quality.

GENERAL COMMUNITY COMPOSITION METRICS

Total invertebrate abundance (m2)	377	169	161	880	178	306
Total taxa richness	17	9	11	9	12	9
EPT taxa richness	2	1	1	1	2	1
% Dominant taxa	49	54	-46	57	53	76.1
% Collectors	92	92	89.4	100	97	99.4

EPT= The insect orders Ephemeroptera+Plecoptera+Trichoptera

% CONTRIBUTION SELECTED TAXA

% Turbellaria (flatworms)	11.7	0.0	0	14.3	1.7	0
% Oligochaeta (segmented worms)	8.2	0.6	11.8	2.1	13.5	5.56
% Tolerant snails	0.0	0.0	1.86	0.0	0.0	0
% Microcrustaceans	3.5	0.6	0	22.1	0.6	0.33
% Tolerant crustacea(scuds&sowbug	14.3	36.1	27.95	0.9	25.3	15.36
TOTAL NON INSECTS	39.3	37.9	42.86	40.5	41.6	21.57

% Baetis tricaudatus (mayfly)	48.8	53.9	45.96	57.3	52.8	76.14
% Ephemeroptera (mayflies)	48.8	53.9	45.96	57.3	52.8	76.14
% Plecoptera (stoneflies)	0.0	0.0	0	0.0	0.0	0
% Trichoptera (caddisflies)	0.3	0.0	0	0.0	0.6	0
% Simuliidae (blackfly)	1.6	0.0	0	1.8	1.7	0.33
% Chironomidae (midge)	9.3	7.7	9.32	0.5	2.8	1.96

FILE: 98TAB2

TABLE 3

Massey Creek, Sites 1, 2 and 3.

CITY OF DES MOINES, King County, Washington.
October 23, 1994, November 2, 1996 & October 30, 1998. Benthic invertebrate biomonitoring samples.
- Determined by ABA, Inc., Corvallis, Oregon for Herrera Environmental Consultants, Inc., Seattle, WA.
Bioassessments are based on a comparison with mid-order, forested, western, montane stream model.

	1994	1996	1998	1994	1996	1998	1994	1996	1998
	MA1	MA1	MA1	MA2	MA2	MA2	MA3	MA3	MA3
BIOASSESSMENT SCORES (%)									
Total Erosional Habitat	**32.8**	**33.1**	**32.3**	**28.7**	**31.5**	**30.6**	**33.6**	**33.1**	**27.4**
Primary Metrics	5.6	0.0	0.0	11.1	5.6	0.0	0.0	0.0	5.6
Positive Indicators	0.0	0.0	0.0	3.6	1.8	0.0	7.1	0.0	1.8
Negative Indicators	81.3	83.7	81.6	64.6	75.5	77.6	77.1	83.7	65.3

Note that the lower the negative indicator score is, the more impacted the site is.
Erosional= riffles, runs, glides, cascades, chutes; or habitats with running water that erode sediments.
Total Scores <40%= severely; 40-59%= moderately; 60-79% slightly; and 80-100% non-impacted sites.
Primary Metrics= General community composition metrics (statistics).
Positive Indicators= Taxa or groups of taxa that are good water/habitat quality indicators.
Negative Indicators= Taxa or groups of taxa that are indicators of poor water/habitat quality.

GENERAL COMMUNITY COMPOSITION METRICS

Total invertebrate abundance (m2)	430	246	23	185	119	208	128	88	156
Total taxa richness	17	13	6	25	11	12	18	9	15
EPT taxa richness	1	2	1	4	2	1	5	1	2
% Dominant taxa	38	59	74	28	79	76	52	72	38
% Collectors	96	94	87	66	95	90	84	77	88

EPT= The insect orders Ephemeroptera+Plecoptera+Trichoptera

% CONTRIBUTION SELECTED TAXA

% Turbellaria (flatworms)	38.1	3.3	0.0	4.3	0.0	1.4	3.1	0.0	0.0
% Oligochaeta (segmented worms)	19.1	2.0	73.9	28.1	2.5	1.9	51.6	0.0	3.2
% Tolerant snails	0.0	1.6	4.4	1.6	1.7	0.0	3.9	0.0	1.3
% Microcrustaceans	0.2	59.0	8.7	1.6	0.8	0.5	0.0	0.0	0.0
%Tolerant crustacea (scuds&sowbugs	0.0	0.0	0.0	1.1	6.7	0.0	1.6	3.4	23.7
TOTAL NON INSECTS	58.4	69.1	95.7	38.9	11.8	4.8	60.9	6.8	28.9

% Baetis tricaudatus (mayfly)	4.4	28.1	4.4	24.9	79.0	76.4	17.2	71.6	37.8
% Ephemeroptera (mayflies)	4.4	28.1	0.0	25.4	79.0	76.4	22.7	71.6	37.8
% Plecoptera (stoneflies)	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0
% Trichoptera (caddisflies)	0.0	0.4	0.0	1.1	0.8	0.0	2.3	0.0	0.6
% Simuliidae (blackfly)	29.8	0.8	0.0	0.5	0.0	0.0	3.1	1.1	1.9
% Chironomidae (midge)	6.7	1.6	0.0	33.0	5.0	17.3	8.6	17.1	30.8

FILE: 98TAB3

TABLE 4

McSorley Creek, Sites 1 and 2.

CITY OF DES MOINES, King County, Washington.
October 23, 1994; November 2, 1996 & October 30, 1998 Benthic invertebrate biomonitoring samples.
Determined by ABA, Inc., Corvallis, Oregon, for Herrera Environmental Consultants, Inc., Seattle, WA.
Bioassessments are based on a comparison with a mid-order, forested, western, montane stream model.

	1994	1996	1998	1994	1996	1998
	MC1	MC1	MC1	MC2	MC2	MC2
BIOASSESSMENT SCORES (%)						
Total Erosional Habitat	32.0	34.7	36.3	33.6	30.6	37.1
Primary Metrics	16.7	27.8	11.1	11.1	0.0	11.1
Positive Indicators	16.1	14.0	15.8	8.9	1.8	10.5
Negative Indicators	56.3	61.2	69.4	70.8	75.5	77.6

Note that the lower the negative indicator score is, the more impacted the site is.
Erosional= riffles, runs, glides, cascades, chutes; or habitats with running water that erode sediments.
Total Scores <40%= severely; 40-59%= moderately; 60-79% slightly; and 80-100% non-impacted sites.
Primary Metrics= General community composition metrics (statistics).
Positive Indicators= Taxa or groups of taxa that are good water/habitat quality indicators.
Negative Indicators= Taxa or groups of taxa that are indicators of poor water/habitat quality.

GENERAL COMMUNITY COMPOSITION METRICS

Total invertebrate abundance (m2)	153	709	143	952	119	520
Total taxa richness	29	33	23	28	14	26
EPT taxa richness	8	7	5	6	1	5
% Dominant taxa	16	19	29	35	63	34
% Collectors	64	43	55	79	24	89

EPT= The insect orders Ephemeroptera+Plecoptera+Trichoptera

% CONTRIBUTION SELECTED TAXA

% Turbellaria (flatworms)	0.7	0.0	0.0	0.0	0.0	0.0
% Oligochaeta (segmented worms)	10.5	1.3	17.5	7.1	1.7	14.6
% Tolerant snails	16.3	6.1	11.2	3.8	2.5	0.8
% Microcrustaceans	2.6	0.1	0.0	0.2	0.0	0.2
% Tolerant crustacea(scuds&sowbug	11.8	19.2	30.1	4.2	2.5	47.1
TOTAL NON INSECTS	45.1	27.2	60.1	35.1	10.1	64.4

% Baetis tricaudatus (mayfly)	1.3	2.0	0.0	34.9	11.8	24.4
% Ephemeroptera (mayflies)	13.1	2.1	0.0	39.3	11.8	24.6
% Plecoptera (stoneflies)	8.5	12.6	2.1	0.4	0.0	0.4
% Trichoptera (caddisflies)	3.9	7.9	7.0	3.2	0.0	0.6
% Simuliidae (blackfly)	0.7	3.1	1.4	2.3	0.8	0.2
% Chironomidae (midge)	22.9	42.9	19.6	16.8	67.2	7.5

FILE: 98TAB4

Barnes Creek, Site 1, October 30, 1998.

WA: King County, City of Des Moines. For Herrera Environmental Consultants, Inc., Seattle, WA.

BENTHIC INVERTEBRATE BIOASSESSMENT-ABA, January 1995 Version

EROSIONAL/RIFFLE HABITAT

	METRIC	Value	Score
	PRIMARY METRICS		
1	Total abundance (m2)	144	0
2	Total taxa richness	17	0
3	EPT Taxa richness	7	0
4	%Dominant taxa	45.8	0
5	Community Tolerance	4.24	1
	POSITIVE INDICATORS		
1	Predator richness	3	0
2	Scraper richness	2	0
3	Shredder richness	5	1
4	Xylophage richness	1	1
5	%Intolerant mayflies	8.33	4
6	%Intolerant stoneflies	0	0
7	%Intolerant caddisflies	0	0
8	%Intolerant dipterans	0	0
9	Intol. mayfly richness	1	1
10	Intol. stonefly richness	0	0
11	Heptageniidae richness	1	1
12	Ephemerellidae richness	0	0
13	Nemouridae richness	2	1
14	*Pteronarcys*	0	0
15	%Glossosomatidae	0	0
16	%Philopotamidae	0	0
17	%Arctopsychidae	6.25	2
18	*Rhyacophila richness*	0	0
19	%C. *Nostococladius*	0	0
20	Long-lived taxa richness	1	1
21	Class 0 taxa richness	1	1
	NEGATIVE INDICATORS		
1	%Collector	58.3	1
2	%Parasite	0	1
3	%Oligochaeta	2.78	1
4	%Leech	0	1
5	%Tolerant snails	0	4
6	%Tolerant amphipods	2.08	0
7	%Tolerant odonates	0	2
8	%Tolerant mayflies	0	4
9	%Tolerant caddisflies	0	4
10	%Tolerant beetles	0	4
11	%Tolerant dipterans	1.39	2
12	Tol. mayfly richness	0	2
13	Tol caddisfly richness	0	2
14	Tol. beetle richness	0	4
15	Tol. dipteran richness	1	3
16	%Simuliidae	0.69	1
17	%Chironomid (-C.Nostoc	6.94	4

SUMMARY SCORES

	Score	%
EROSIONAL TOTAL	54	43.5
Primary subtotal	1	5.6
Positive Indicators	13	22.8
Negative Indicators	40	81.6

GENERAL BIOTIC INTEGRITY AND IMPACT CATEGORIES

Based on Total Bioassessment Score

Very high biotic/habitat integrity	90-100%
High biotic/habitat integrity	80-89%
Moderate biotic/habitat integrity	60-79%
Low biotic/habitat integrity	40-59%
Severe habitat and/or water quality limitations	<40%

The bioassessment model is based on Pacific Northwest montane watersheds that have experienced minimal human disturbance, and applies to stream sites that are: mid-order, forested, low-mid elevation, and moderate-high gradient. Maximum scores are based on experience with sites that have very high habitat complexity and integrity, and that have a strong, perennial flow of cool/cold water. Potential maximum scores in natural or minimally disturbed systems will vary, depending on watershed parameters and the resultant in-stream habitat characteristics they produce. This bioassessment is not intended to be used on: rivers; large, open streams; basin or valley streams; low gradient sites; alpine/subalpine streams; or small streams.

T&E OR SENSITIVE TAXA IDENTIFIED

None

CLASS 0 TAXA

These are either rare, unusual, or uncommon taxa; or taxa more typically associated with small streams and springs.

Parapsyche almota

COLD WATER BIOTA

Taxa requiring year-round cool/cold water temperatures.

Total percent contribution	8.33
Total taxa richness	1

SAMPLE & ANALYSIS SPECIFICATIONS

Sampler Type: D-frame net, 500 micron.

Number of points: 5 points, 1 square meter.

Subsample size: 500+ organisms

Taxonomy by: ABA standard taxonomic effort.

Data analysis by: ABA BENTHOS program Version 1.0

FILE: 98DM01X

Aquatic Biology Associates, Inc., 3490 NW Deer Run Rd., Corvallis, OR 97330, 541-752-1568 FAX 541-754-9605

Des Moines Creek, Site 1, October 31, 1998.

WA: King County, City of Des Moines. For Herrera Environmental Consultants, Inc., Seattle, WA.

BENTHIC INVERTEBRATE BIOASSESSMENT-ABA, January 1995 Version

EROSIONAL/RIFFLE HABITAT

	METRIC	Value	Score
	PRIMARY METRICS		
1	Total abundance (m2)	161	0
2	Total taxa richness	11	0
3	EPT Taxa richness	1	0
4	%Dominant taxa	46	0
5	Community Tolerance	6.2	0
	POSITIVE INDICATORS		
1	Predator richness	2	0
2	Scraper richness	2	0
3	Shredder richness	2	0
4	Xylophage richness	0	0
5	%Intolerant mayflies	0	0
6	%Intolerant stoneflies	0	0
7	%Intolerant caddisflies	0	0
8	%Intolerant dipterans	0	0
9	Intol. mayfly richness	0	0
10	Intol. stonefly richness	0	0
11	Heptageniidae richness	0	0
12	Ephemerellidae richness	0	0
13	Nemouridae richness	0	0
14	*Pteronarcys*	0	0
15	%Glossosomatidae	0	0
16	%Philopotamidae	0	0
17	%Arctopsychidae	0	0
18	*Rhyacophila richness*	0	0
19	%*C. Nostococladius*	0	0
20	Long-lived taxa richness	0	0
21	Class 0 taxa richness	0	0
	NEGATIVE INDICATORS		
1	%Collector	89.4	0
2	%Parasite	1.24	1
3	%Oligochaeta	11.8	0
4	%Leech	0	1
5	%Tolerant snails	1.86	2
6	%Tolerant amphipods	28	0
7	%Tolerant odonates	0	2
8	%Tolerant mayflies	0	4
9	%Tolerant caddisflies	0	4
10	%Tolerant beetles	0	4
11	%Tolerant dipterans	0.62	3
12	Tol. mayfly richness	0	2
13	Tol caddisfly richness	0	2
14	Tol. beetle richness	0	4
15	Tol. dipteran richness	1	3
16	%Simuliidae	0	1
17	%Chironomid (-C.Nostoc	9.32	4

FILE: 98DM02X

SUMMARY SCORES

	Score	%
EROSIONAL TOTAL	37	29.8
Primary subtotal	0	0.0
Positive Indicators	0	0.0
Negative Indicators	37	75.5

GENERAL BIOTIC INTEGRITY AND IMPACT CATEGORIES
Based on Total Bioassessment Score

Very high biotic/habitat integrity	90-100%
High biotic/habitat integrity	80-89%
Moderate biotic/habitat integrity	60-79%
Low biotic/habitat integrity	40-59%
Severe habitat and/or water quality limitations	<40%

The bioassessment model is based on Pacific Northwest montane watersheds that have experienced minimal human disturbance, and applies to stream sites that are: mid-order, forested, low-mid elevation, and moderate-high gradient. Maximum scores are based on experience with sites that have very high habitat complexity and integrity, and that have a strong, perennial flow of cool/cold water. Potential maximum scores in natural or minimally disturbed systems will vary, depending on watershed parameters and the resultant in-stream habitat characteristics they produce. This bioassessment is not intended to be used on: rivers; large, open streams; basin or valley streams; low gradient sites; alpine/subalpine streams; or small streams.

T&E OR SENSITIVE TAXA IDENTIFIED

None

CLASS 0 TAXA

These are either rare, unusual, or uncommon taxa; or taxa more typically associated with small streams and springs.

None

COLD WATER BIOTA

Taxa requiring year-round cool/cold water temperatures.

Total percent contribution	0
Total taxa richness	0

SAMPLE & ANALYSIS SPECIFICATIONS

Sampler Type: D-frame net, 500 micron.
Number of points: 5 points, 1 square meter.
Subsample size: 500+ organisms
Taxonomy by: ABA standard taxonomic effort.
Data analysis by: ABA BENTHOS program Version 1.0

Aquatic Biology Associates, Inc., 3490 NW Deer Run Rd., Corvallis, OR 97330, 541-752-1568 FAX 541-754-9605

Des Moines Creek, Site 2, October 30, 1998.

WA: King County, City of Des Moines. For Herrera Environmental Consultants, Inc., Seattle, WA.

BENTHIC INVERTEBRATE BIOASSESSMENT-ABA, January 1995 Version

EROSIONAL/RIFFLE HABITAT

	METRIC	Value	Score
	PRIMARY METRICS		
1	Total abundance (m2)	306	0
2	Total taxa richness	9	0
3	EPT Taxa richness	1	0
4	%Dominant taxa	76.1	0
5	Community Tolerance	6.1	0
	POSITIVE INDICATORS		
1	Predator richness	0	0
2	Scraper richness	1	0
3	Shredder richness	1	0
4	Xylophage richness	0	0
5	%Intolerant mayflies	0	0
6	%Intolerant stoneflies	0	0
7	%Intolerant caddisflies	0	0
8	%Intolerant dipterans	0	0
9	Intol. mayfly richness	0	0
10	Intol. stonefly richness	0	0
11	Heptageniidae richness	0	0
12	Ephemerellidae richness	0	0
13	Nemouridae richness	0	0
14	*Pteronarcys*	0	0
15	%Glossosomatidae	0	0
16	%Philopotamidae	0	0
17	%Arctopsychidae	0	0
18	*Rhyacophila richness*	0	0
19	%*C. Nostococladius*	0	0
20	Long-lived taxa richness	0	0
21	Class 0 taxa richness	0	0
	NEGATIVE INDICATORS		
1	%Collector	99.4	0
2	%Parasite	0.33	1
3	%Oligochaeta	5.56	0
4	%Leech	0	1
5	%Tolerant snails	0	4
6	%Tolerant amphipods	15.4	0
7	%Tolerant odonates	0	2
8	%Tolerant mayflies	0	4
9	%Tolerant caddisflies	0	4
10	%Tolerant beetles	0	4
11	%Tolerant dipterans	0	4
12	Tol. mayfly richness	0	2
13	Tol caddisfly richness	0	2
14	Tol. beetle richness	0	4
15	Tol. dipteran richness	0	4
16	%Simuliidae	0.33	1
17	%Chironomid (-C.Nostoc	1.96	4

FILE: 98DM03X

SUMMARY SCORES

	Score	%
EROSIONAL TOTAL	41	33.1
Primary subtotal	0	0.0
Positive Indicators	0	0.0
Negative Indicators	41	83.7

GENERAL BIOTIC INTEGRITY AND IMPACT CATEGORIES
Based on Total Bioassessment Score

Very high biotic/habitat integrity	90-100%
High biotic/habitat integrity	80-89%
Moderate biotic/habitat integrity	60-79%
Low biotic/habitat integrity	40-59%
Severe habitat and/or water quality limitations	<40%

The bioassessment model is based on Pacific Northwest montane watersheds that have experienced minimal human disturbance, and applies to stream sites that are: mid-order, forested, low-mid elevation, and moderate-high gradient. Maximum scores are based on experience with sites that have very high habitat complexity and integrity, and that have a strong, perennial flow of cool/cold water. Potential maximum scores in natural or minimally disturbed systems will vary, depending on watershed parameters and the resultant in-stream habitat characteristics they produce. This bioassessment is not intended to be used on: rivers; large, open streams; basin or valley streams; low gradient sites; alpine/subalpine streams; or small streams.

T&E OR SENSITIVE TAXA IDENTIFIED

None

CLASS 0 TAXA

These are either rare, unusual, or uncommon taxa; or taxa more typically associated with small streams and springs.

None

COLD WATER BIOTA

Taxa requiring year-round cool/cold water temperatures.

Total percent contribution	0
Total taxa richness	0

SAMPLE & ANALYSIS SPECIFICATIONS

Sampler Type: D-frame net, 500 micron.
Number of points: 5 points, 1 square meter.
Subsample size: 500+ organisms
Taxonomy by: ABA standard taxonomic effort.
Data analysis by: ABA BENTHOS program Version 1.0

Aquatic Biology Associates, Inc., 3490 NW Deer Run Rd., Corvallis, OR 97330, 541-752-1568 FAX 541-754-9605

Massey Creek, Site 1, October 30, 1998.

WA: King County, City of Des Moines. For Herrera Environmental Consultants, Inc., Seattle, WA.

BENTHIC INVERTEBRATE BIOASSESSMENT-ABA, January 1995 Version

EROSIONAL/RIFFLE HABITAT

	METRIC	Value	Score
	PRIMARY METRICS		
1	Total abundance (m2)	23	0
2	Total taxa richness	6	0
3	EPT Taxa richness	1	0
4	%Dominant taxa	73.9	0
5	Community Tolerance	7.57	0
	POSITIVE INDICATORS		
1	Predator richness	0	0
2	Scraper richness	2	0
3	Shredder richness	0	0
4	Xylophage richness	0	0
5	%Intolerant mayflies	0	0
6	%Intolerant stoneflies	0	0
7	%Intolerant caddisflies	0	0
8	%Intolerant dipterans	0	0
9	Intol. mayfly richness	0	0
10	Intol. stonefly richness	0	0
11	Heptageniidae richness	0	0
12	Ephemerellidae richness	0	0
13	Nemouridae richness	0	0
14	*Pteronarcys*	0	0
15	%Glossosomatidae	0	0
16	%Philopotamidae	0	0
17	%Arctopsychidae	0	0
18	*Rhyacophila richness*	0	0
19	%C. *Nostococladius*	0	0
20	Long-lived taxa richness	0	0
21	Class 0 taxa richness	0	0
	NEGATIVE INDICATORS		
1	%Collector	87	0
2	%Parasite	8.7	0
3	%Oligochaeta	73.9	0
4	%Leech	0	1
5	%Tolerant snails	4.35	2
6	%Tolerant amphipods	0	2
7	%Tolerant odonates	0	2
8	%Tolerant mayflies	0	4
9	%Tolerant caddisflies	0	4
10	%Tolerant beetles	0	4
11	%Tolerant dipterans	0	4
12	Tol. mayfly richness	0	2
13	Tol caddisfly richness	0	2
14	Tol. beetle richness	0	4
15	Tol. dipteran richness	0	4
16	%Simuliidae	0	1
17	%Chironomid (-C.Nostoc	0	4

FILE: 98DM04X

SUMMARY SCORES

	Score	%
EROSIONAL TOTAL	40	32.3
Primary subtotal	0	0.0
Positive Indicators	0	0.0
Negative Indicators	40	81.6

GENERAL BIOTIC INTEGRITY AND IMPACT CATEGORIES

Based on Total Bioassessment Score

Very high biotic/habitat integrity	90-100%
High biotic/habitat integrity	80-89%
Moderate biotic/habitat integrity	60-79%
Low biotic/habitat integrity	40-59%
Severe habitat and/or water quality limitations	<40%

The bioassessment model is based on Pacific Northwest montane watersheds that have experienced minimal human disturbance, and applies to stream sites that are: mid-order, forested, low-mid elevation, and moderate-high gradient. Maximum scores are based on experience with sites that have very high habitat complexity and integrity, and that have a strong, perennial flow of cool/cold water. Potential maximum scores in natural or minimally disturbed systems will vary, depending on watershed parameters and the resultant in-stream habitat characteristics they produce. This bioassessment is not intended to be used on: rivers; large, open streams; basin or valley streams; low gradient sites; alpine/subalpine streams; or small streams.

T&E OR SENSITIVE TAXA IDENTIFIED

None

CLASS 0 TAXA

These are either rare, unusual, or uncommon taxa; or taxa more typically associated with small streams and springs.

None

COLD WATER BIOTA

Taxa requiring year-round cool/cold water temperatures.

Total percent contribution	0
Total taxa richness	0

SAMPLE & ANALYSIS SPECIFICATIONS

Sampler Type: D-frame net, 500 micron.

Number of points: 5 points, 1 square meter.

Subsample size: 500+ organisms

Taxonomy by: ABA standard taxonomic effort.

Data analysis by: ABA BENTHOS program Version 1.0

Aquatic Biology Associates, Inc., 3490 NW Deer Run Rd., Corvallis, OR 97330, 541-752-1568 FAX 541-754-9605

Massey Creek, Site 2, October 30, 1998.

WA: King County, City of Des Moines. For Herrera Environmental Consultants, Inc., Seattle, WA.

BENTHIC INVERTEBRATE BIOASSESSMENT-ABA, January 1995 Version

EROSIONAL/RIFFLE HABITAT

	METRIC	Value	Score
	PRIMARY METRICS		
1	Total abundance (m2)	208	0
2	Total taxa richness	12	0
3	EPT Taxa richness	1	0
4	%Dominant taxa	76.4	0
5	Community Tolerance	6.26	0
	POSITIVE INDICATORS		
1	Predator richness	4	0
2	Scraper richness	1	0
3	Shredder richness	1	0
4	Xylophage richness	0	0
5	%Intolerant mayflies	0	0
6	%Intolerant stoneflies	0	0
7	%Intolerant caddisflies	0	0
8	%Intolerant dipterans	0	0
9	Intol. mayfly richness	0	0
10	Intol. stonefly richness	0	0
11	Heptageniidae richness	0	0
12	Ephemerellidae richness	0	0
13	Nemouridae richness	0	0
14	*Pteronarcys*	0	0
15	%Glossosomatidae	0	0
16	%Philopotamidae	0	0
17	%Arctopsychidae	0	0
18	*Rhyacophila richness*	0	0
19	%*C. Nostococladius*	0	0
20	Long-lived taxa richness	0	0
21	Class 0 taxa richness	0	0
	NEGATIVE INDICATORS		
1	%Collector	90.4	0
2	%Parasite	0	1
3	%Oligochaeta	1.92	1
4	%Leech	0.96	1
5	%Tolerant snails	0	4
6	%Tolerant amphipods	0	2
7	%Tolerant odonates	0	2
8	%Tolerant mayflies	0	4
9	%Tolerant caddisflies	0	4
10	%Tolerant beetles	0	4
11	%Tolerant dipterans	10.1	0
12	Tol. mayfly richness	0	2
13	Tol caddisfly richness	0	2
14	Tol. beetle richness	0	4
15	Tol. dipteran richness	1	3
16	%Simuliidae	0	1
17	%Chironomid (-C.Nostoc	17.3	3

FILE: 98DM05X

SUMMARY SCORES

	Score	%
EROSIONAL TOTAL	38	30.6
Primary subtotal	0	0.0
Positive Indicators	0	0.0
Negative Indicators	38	77.6

GENERAL BIOTIC INTEGRITY AND IMPACT CATEGORIES
Based on Total Bioassessment Score

Very high biotic/habitat integrity	90-100%
High biotic/habitat integrity	80-89%
Moderate biotic/habitat integrity	60-79%
Low biotic/habitat integrity	40-59%
Severe habitat and/or water quality limitations	<40%

The bioassessment model is based on Pacific Northwest montane watersheds that have experienced minimal human disturbance, and applies to stream sites that are: mid-order, forested, low-mid elevation, and moderate-high gradient. Maximum scores are based on experience with sites that have very high habitat complexity and integrity, and that have a strong, perennial flow of cool/cold water. Potential maximum scores in natural or minimally disturbed systems will vary, depending on watershed parameters and the resultant in-stream habitat characteristics they produce. This bioassessment is not intended to be used on: rivers; large, open streams; basin or valley streams; low gradient sites; alpine/subalpine streams; or small streams.

T&E OR SENSITIVE TAXA IDENTIFIED

None

CLASS 0 TAXA
These are either rare, unusual, or uncommon taxa; or taxa more typically associated with small streams and springs.

None

COLD WATER BIOTA
Taxa requiring year-round cool/cold water temperatures.

Total percent contribution	0
Total taxa richness	0

SAMPLE & ANALYSIS SPECIFICATIONS
Sampler Type: D-frame net, 500 micron.
Number of points: 5 points, 1 square meter.
Subsample size: 500+ organisms
Taxonomy by: ABA standard taxonomic effort.
Data analysis by: ABA BENTHOS program Version 1.0

Aquatic Biology Associates, Inc., 3490 NW Deer Run Rd., Corvallis, OR 97330, 541-752-1568 FAX 541-754-9605

Massey Creek, Site 3, October 30, 1998.

WA: King County, City of Des Moines. For Herrera Environmental Consultants, Inc., Seattle, WA.

BENTHIC INVERTEBRATE BIOASSESSMENT-ABA, January 1995 Version

EROSIONAL/RIFFLE HABITAT

	METRIC	Value	Score
	PRIMARY METRICS		
1	Total abundance (m2)	156	0
2	Total taxa richness	15	0
3	EPT Taxa richness	2	0
4	%Dominant taxa	37.8	1
5	Community Tolerance	6.27	0
	POSITIVE INDICATORS		
1	Predator richness	1	0
2	Scraper richness	2	0
3	Shredder richness	2	0
4	Xylophage richness	0	0
5	%Intolerant mayflies	0	0
6	%Intolerant stoneflies	0	0
7	%Intolerant caddisflies	0	0
8	%Intolerant dipterans	0	0
9	Intol. mayfly richness	0	0
10	Intol. stonefly richness	0	0
11	Heptageniidae richness	0	0
12	Ephemerellidae richness	0	0
13	Nemouridae richness	0	0
14	*Pteronarcys*	0	0
15	%Glossosomatidae	0	0
16	%Philopotamidae	0	0
17	%Arctopsychidae	0	0
18	*Rhyacophila richness*	0	0
19	%*C. Nostococladius*	0	0
20	Long-lived taxa richness	1	1
21	Class 0 taxa richness	0	0
	NEGATIVE INDICATORS		
1	%Collector	87.8	0
2	%Parasite	0.64	1
3	%Oligochaeta	3.21	1
4	%Leech	0	1
5	%Tolerant snails	1.28	2
6	%Tolerant amphipods	23.7	0
7	%Tolerant odonates	0	2
8	%Tolerant mayflies	0	4
9	%Tolerant caddisflies	0	4
10	%Tolerant beetles	0	4
11	%Tolerant dipterans	14.1	0
12	Tol. mayfly richness	0	2
13	Tol caddisfly richness	0	2
14	Tol. beetle richness	0	4
15	Tol. dipteran richness	1	3
16	%Simuliidae	1.92	1
17	%Chironomid (-C.Nostoc	30.8	1

FILE: 98DM06X

SUMMARY SCORES

	Score	%
EROSIONAL TOTAL	34	27.4
Primary subtotal	1	5.6
Positive Indicators	1	1.8
Negative Indicators	32	65.3

GENERAL BIOTIC INTEGRITY AND IMPACT CATEGORIES
Based on Total Bioassessment Score

Very high biotic/habitat integrity	90-100%
High biotic/habitat integrity	80-89%
Moderate biotic/habitat integrity	60-79%
Low biotic/habitat integrity	40-59%
Severe habitat and/or water quality limitations	<40%

The bioassessment model is based on Pacific Northwest montane watersheds that have experienced minimal human disturbance, and applies to stream sites that are: mid-order, forested, low-mid elevation, and moderate-high gradient. Maximum scores are based on experience with sites that have very high habitat complexity and integrity, and that have a strong, perennial flow of cool/cold water. Potential maximum scores in natural or minimally disturbed systems will vary, depending on watershed parameters and the resultant in-stream habitat characteristics they produce. This bioassessment is not intended to be used on: rivers; large, open streams; basin or valley streams; low gradient sites; alpine/subalpine streams; or small streams.

T&E OR SENSITIVE TAXA IDENTIFIED

None

CLASS 0 TAXA

These are either rare, unusual, or uncommon taxa; or taxa more typically associated with small streams and springs.

None

COLD WATER BIOTA

Taxa requiring year-round cool/cold water temperatures.

Total percent contribution	0
Total taxa richness	0

SAMPLE & ANALYSIS SPECIFICATIONS

Sampler Type: D-frame net, 500 micron.
Number of points: 5 points, 1 square meter.
Subsample size: 500+ organisms
Taxonomy by: ABA standard taxonomic effort.
Data analysis by: ABA BENTHOS program Version 1.0

Aquatic Biology Associates, Inc., 3490 NW Deer Run Rd., Corvallis, OR 97330, 541-752-1568 FAX 541-754-9605

McSorley Creek, Site 1, October 31, 1998.

WA: King County, City of Des Moines. For Herrera Environmental Consultants, Inc., Seattle, WA.

BENTHIC INVERTEBRATE BIOASSESSMENT-ABA, January 1995 Version

EROSIONAL/RIFFLE HABITAT

	METRIC	Value	Score
	PRIMARY METRICS		
1	Total abundance (m2)	143	0
2	Total taxa richness	23	0
3	EPT Taxa richness	5	0
4	%Dominant taxa	29.4	2
5	Community Tolerance	5.94	0
	POSITIVE INDICATORS		
1	Predator richness	6	0
2	Scraper richness	2	0
3	Shredder richness	6	1
4	Xylophage richness	1	1
5	%Intolerant mayflies	0	0
6	%Intolerant stoneflies	0	0
7	%Intolerant caddisflies	0	0
8	%Intolerant dipterans	0	0
9	Intol. mayfly richness	0	0
10	Intol. stonefly richness	0	0
11	Heptageniidae richness	0	0
12	Ephemerellidae richness	0	0
13	Nemouridae richness	2	1
14	*Pteronarcys*	0	0
15	%Glossosomatidae	0	0
16	%Philopotamidae	0	0
17	%Arctopsychidae	3.5	2
18	*Rhyacophila richness*	1	0
19	%*C. Nostococladius*	0	0
20	Long-lived taxa richness	4	2
21	Class 0 taxa richness	2	2
	NEGATIVE INDICATORS		
1	%Collector	54.6	1
2	%Parasite	0	1
3	%Oligochaeta	17.5	0
4	%Leech	0.7	1
5	%Tolerant snails	11.2	0
6	%Tolerant crustacea	30.1	0
7	%Tolerant odonates	0	2
8	%Tolerant mayflies	0	4
9	%Tolerant caddisflies	0	4
10	%Tolerant beetles	0	4
11	%Tolerant dipterans	3.5	2
12	Tol. mayfly richness	0	2
13	Tol caddisfly richness	0	2
14	Tol. beetle richness	0	4
15	Tol. dipteran richness	1	3
16	%Simuliidae	1.4	1
17	%Chironomid (-C.Nostoc	19.6	3

FILE: 98DM07X

SUMMARY SCORES

	Score	%
EROSIONAL TOTAL	45	36.3
Primary subtotal	2	11.1
Positive Indicators	9	15.8
Negative Indicators	34	69.4

GENERAL BIOTIC INTEGRITY AND IMPACT CATEGORIES
Based on Total Bioassessment Score

Very high biotic/habitat integrity	90-100%
High biotic/habitat integrity	80-89%
Moderate biotic/habitat integrity	60-79%
Low biotic/habitat integrity	40-59%
Severe habitat and/or water quality limitations	<40%

The bioassessment model is based on Pacific Northwest montane watersheds that have experienced minimal human disturbance, and applies to stream sites that are: mid-order, forested, low-mid elevation, and moderate-high gradient. Maximum scores are based on experience with sites that have very high habitat complexity and integrity, and that have a strong, perennial flow of cool/cold water. Potential maximum scores in natural or minimally disturbed systems will vary, depending on watershed parameters and the resultant in-stream habitat characteristics they produce. This bioassessment is not intended to be used on: rivers; large, open streams; basin or valley streams; low gradient sites; alpine/subalpine streams; or small streams.

T&E OR SENSITIVE TAXA IDENTIFIED

None

CLASS 0 TAXA

These are either rare, unusual, or uncommon taxa; or taxa more typically associated with small streams and springs.

Parapsyche almota, Rhyacophila grandis

COLD WATER BIOTA

Taxa requiring year-round cool/cold water temperatures.

Total percent contribution	0
Total taxa richness	0

SAMPLE & ANALYSIS SPECIFICATIONS

Sampler Type: D-frame net, 500 micron.

Number of points: 5 points, 1 square meter.

Subsample size: 500+ organisms

Taxonomy by: ABA standard taxonomic effort.

Data analysis by: ABA BENTHOS program Version 1.0

Aquatic Biology Associates, Inc., 3490 NW Deer Run Rd., Corvallis, OR 97330, 541-752-1568 FAX 541-754-9605

McSorley Creek, Site 2, October 31, 1998.

WA: King County, City of Des Moines. For Herrera Environmental Consultants, Inc., Seattle, WA.

BENTHIC INVERTEBRATE BIOASSESSMENT-ABA, January 1995 Version

EROSIONAL/RIFFLE HABITAT

	METRIC	Value	Score
	PRIMARY METRICS		
1	Total abundance (m2)	520	1
2	Total taxa richness	26	0
3	EPT Taxa richness	5	0
4	%Dominant taxa	33.7	1
5	Community Tolerance	6.97	0
	POSITIVE INDICATORS		
1	Predator richness	7	0
2	Scraper richness	3	0
3	Shredder richness	4	0
4	Xylophage richness	1	1
5	%Intolerant mayflies	0	0
6	%Intolerant stoneflies	0	0
7	%Intolerant caddisflies	0	0
8	%Intolerant dipterans	0	0
9	Intol. mayfly richness	0	0
10	Intol. stonefly richness	0	0
11	Heptageniidae richness	0	0
12	Ephemerellidae richness	0	0
13	Nemouridae richness	1	0
14	*Pteronarcys*	0	0
15	%Glossosomatidae	0	0
16	%Philopotamidae	0	0
17	%Arctopsychidae	0.38	1
18	*Rhyacophila richness*	1	0
19	%*C. Nostococladius*	0	0
20	Long-lived taxa richness	4	2
21	Class 0 taxa richness	2	2
	NEGATIVE INDICATORS		
1	%Collector	89.2	0
2	%Parasite	0.38	1
3	%Oligochaeta	14.6	0
4	%Leech	0.57	1
5	%Tolerant snails	0.77	3
6	%Tolerant crustacea	47.1	0
7	%Tolerant odonates	0	2
8	%Tolerant mayflies	0	4
9	%Tolerant caddisflies	0	4
10	%Tolerant beetles	0	4
11	%Tolerant dipterans	0.77	3
12	Tol. mayfly richness	0	2
13	Tol caddisfly richness	0	2
14	Tol. beetle richness	0	4
15	Tol. dipteran richness	1	3
16	%Simuliidae	0.19	1
17	%Chironomid (-C.Nostoc	7.5	4

FILE: 98DM08X

SUMMARY SCORES

	Score	%
EROSIONAL TOTAL	46	37.1
Primary subtotal	2	11.1
Positive Indicators	6	10.5
Negative Indicators	38	77.6

GENERAL BIOTIC INTEGRITY AND IMPACT CATEGORIES
Based on Total Bioassessment Score

Very high biotic/habitat integrity	90-100%
High biotic/habitat integrity	80-89%
Moderate biotic/habitat integrity	60-79%
Low biotic/habitat integrity	40-59%
Severe habitat and/or water quality limitations	<40%

The bioassessment model is based on Pacific Northwest montane watersheds that have experienced minimal human disturbance, and applies to stream sites that are: mid-order, forested, low-mid elevation, and moderate-high gradient. Maximum scores are based on experience with sites that have very high habitat complexity and integrity, and that have a strong, perennial flow of cool/cold water. Potential maximum scores in natural or minimally disturbed systems will vary, depending on watershed parameters and the resultant in-stream habitat characteristics they produce. This bioassessment is not intended to be used on: rivers; large, open streams; basin or valley streams; low gradient sites; alpine/subalpine streams; or small streams.

T&E OR SENSITIVE TAXA IDENTIFIED

None

CLASS 0 TAXA

These are either rare, unusual, or uncommon taxa; or taxa more typically associated with small streams and springs.

Parapsyche almota, Rhyacophila grandis

COLD WATER BIOTA

Taxa requiring year-round cool/cold water temperatures.

Total percent contribution	0
Total taxa richness	0

SAMPLE & ANALYSIS SPECIFICATIONS

Sampler Type: D-frame net, 500 micron.
Number of points: 5 points, 1 square meter.
Subsample size: 500+ organisms
Taxonomy by: ABA standard taxonomic effort.
Data analysis by: ABA BENTHOS program Version 1.0

Aquatic Biology Associates, Inc., 3490 NW Deer Run Rd., Corvallis, OR 97330, 541-752-1568 FAX 541-754-9605

Barnes Creek, BA-1, October 30, 1998, Riffle

WA: King County, City of Des Moines. Analysis by ABA, Inc.
Benthic invertebrate biomon. 5 point kick composite, 1 m2, 500 micron.
Abundances (m2). Full or 500+ organism subsample. FILE: 98DM01

IDENTIFICATION CODE	98DM01
CORRECTION FACTOR	1

Taxon	Abundance	%
Oligochaeta	4	2.78
Gammarus	3	2.08
TOTAL: NON INSECTS	7	4.86
Baetis tricaudatus	66	45.83
Cinygma	12	8.33
Paraleptophlebia	4	2.78
TOTAL: EPHEMEROPTERA	82	56.94
Sweltsa	32	22.22
Zapada cinctipes	1	0.69
Zapada Oregonensis Gr.	1	0.69
TOTAL: PLECOPTERA	34	23.61
Parapsyche almota	9	6.25
TOTAL: TRICHOPTERA	9	6.25
Simulium	1	0.69
Dicranota	1	0.69
TOTAL: DIPTERA	2	1.39
Chironomidae-pupae	1	0.69
Brillia	1	0.69
Diplocladius	2	1.39
Eukiefferiella	1	0.69
Rheocricotopus	1	0.69
Tvetenia	4	2.78
TOTAL: CHIRONOMIDAE	10	6.94
GRAND TOTAL	144	100.00

Barnes Creek, BA-1, October 30, 1998, Riffle
WA: King County, City of Des Moines. Analysis by ABA, Inc.
Benthic invertebrate biomon. 5 point kick composite, 1 m2, 500 micron.
Abundances (m2). Full or 500+ organism subsample. FILE: 98DM01

Total invertebrate abundance	= 144.0	EPT abundance	= 125.0
Total number of taxa	= 17	Number EPT taxa	= 7
Hilsenhoff Biotic Index	= 4.24	Brillouin H	= 1.63

TAXONOMIC GROUP	#TAXA	ABUNDANCE	PERCENT
Non-insects	2	7.0	4.86
Odonata	0	0.0	0.00
Ephemeroptera	3	82.0	56.94
Plecoptera	3	34.0	23.60
Hemiptera	0	0.0	0.00
Megaloptera	0	0.0	0.00
Trichoptera	1	9.0	6.25
Lepidoptera	0	0.0	0.00
Coleoptera	0	0.0	0.00
Misc. Diptera	2	2.0	1.38
Chironomidae	6	10.0	6.93

FEEDING GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	3	42.0	29.16
Parasite	0	0.0	0.00
Collector-gatherer	6	83.0	57.64
Collector-filterer	1	1.0	0.69
Macrophyte-herbivore	0	0.0	0.00
Piercer-herbivore	0	0.0	0.00
Scraper	1	12.0	8.33
Shredder	3	3.0	2.07
Xylophage	0	0.0	0.00
Omnivore	2	2.0	1.38
Unknown	1	1.0	0.69

DOMINANT TAXON	ABUNDANCE	PERCENT
Baetis tricaudatus	66.0	45.83
Sweltsa	32.0	22.22
Cinygma	12.0	8.33
Parapsyche almota	9.0	6.25
Oligochaeta	4.0	2.78
SUBTOTAL 5 DOMINANTS	123.0	85.41
Paraleptophlebia	4.0	2.78
Tvetenia	4.0	2.78
Gammarus	3.0	2.08
Diplocladius	2.0	1.39
Zapada cinctipes	1.0	0.69
TOTAL 10 DOMINANTS	137.0	95.13

INDICATOR ASSEMBLAGE	#TAXA	ABUNDANCE	PERCENT
A Tolerant snails	0	0.0	0.00
B Tolerant mayflies	0	0.0	0.00
C Intolerant mayflies	1	12.0	8.33
D Intolerant stoneflies	0	0.0	0.00
E Tolerant caddisflies	0	0.0	0.00
F Intolerant caddisflies	0	0.0	0.00
G Tolerant beetles	0	0.0	0.00
H Intolerant flies	0	0.0	0.00
I Tolerant flies	0	0.0	0.00
J Intolerant midges	0	0.0	0.00
K Tolerant midges	1	2.0	1.39
L	0	0.0	0.00
M	0	0.0	0.00
N	0	0.0	0.00

Barnes Creek, BA-1, October 30, 1998, Riffle
WA: King County, City of Des Moines. Analysis by ABA, Inc.
Benthic invertebrate biomon. 5 point kick composite, 1 m2, 500 micron.
Abundances (m2). Full or 500+ organism subsample. FILE: 98DM01

RATIOS OF TAX. GROUP ABUNDANCES
EPT/Chironomidae = 12.50
Hydropsychidae/Total Trichoptera = 0.00
Baetidae/Total Ephemeroptera = 0.80

RATIOS OF FFG ABUNDANCES
Scraper/Collector-filter = 12.00
Scraper/(Scraper + C.-filterer) = 0.92
Shredder/Total organisms = 0.02

Biotic Condition Index
Community Tolerance Quotient (a) = 70.71
Community Tolerance Quotient (d) = 57.06

DIVERSITY MEASURES
Shannon H (loge) = 1.79
Shannon H (log2) = 2.58
Evenness = 0.63
Simpson D = 0.27

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	57.0	39.58
Univoltine	76.0	52.78
Semivoltine	11.0	7.64

Des Moines Creek, DM-1, October 31, 1998, Riffle

WA: King County, City of Des Moines. Analysis by ABA, Inc.
Benthic invertebrate biomon. 5 point kick composite, 1 m2, 500 micron.
Abundances (m2). Full or 500+ organism subsample. FILE: 98DM02

IDENTIFICATION CODE	98DM02
CORRECTION FACTOR	1

Taxon	Abundance	%
Oligochaeta	19	11.80
Ferrissia	3	1.86
Gammarus	45	27.95
Acari	2	1.24
TOTAL: NON INSECTS	69	42.86
Baetis tricaudatus	74	45.96
TOTAL: EPHEMEROPTERA	74	45.96
Chelifera	3	1.86
TOTAL: DIPTERA	3	1.86
Chironomidae-pupae	2	1.24
Brillia	1	0.62
Diplocladius	1	0.62
Thienemannimyia Gr.	6	3.73
Tvetenia	5	3.11
TOTAL: CHIRONOMIDAE	15	9.32
GRAND TOTAL	161	100.00

Des Moines Creek, DM-1, October 31, 1998, Riffle
WA: King County, City of Des Moines. Analysis by ABA, Inc.
Benthic invertebrate biomon. 5 point kick composite, 1 m2, 500 micron.
Abundances (m2). Full or 500+ organism subsample. FILE: 98DM02

Total invertebrate abundance	= 161.0	EPT abundance	= 74.0
Total number of taxa	= 11	Number EPT taxa	= 1
Hilsenhoff Biotic Index	= 6.20	Brillouin H	= 1.42

TAXONOMIC GROUP	#TAXA	ABUNDANCE	PERCENT
Non-insects	4	69.0	42.85
Odonata	0	0.0	0.00
Ephemeroptera	1	74.0	45.96
Plecoptera	0	0.0	0.00
Hemiptera	0	0.0	0.00
Megaloptera	0	0.0	0.00
Trichoptera	0	0.0	0.00
Lepidoptera	0	0.0	0.00
Coleoptera	0	0.0	0.00
Misc. Diptera	1	3.0	1.86
Chironomidae	5	15.0	9.32

FEEDING GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	2	9.0	5.59
Parasite	1	2.0	1.24
Collector-gatherer	5	144.0	89.44
Collector-filterer	0	0.0	0.00
Macrophyte-herbivore	0	0.0	0.00
Piercer-herbivore	0	0.0	0.00
Scraper	1	3.0	1.86
Shredder	1	1.0	0.62
Xylophage	0	0.0	0.00
Omnivore	0	0.0	0.00
Unknown	1	2.0	1.24

DOMINANT TAXON	ABUNDANCE	PERCENT
Baetis tricaudatus	74.0	45.96
Gammarus	45.0	27.95
Oligochaeta	19.0	11.80
Thienemannimyia Gr.	6.0	3.73
Tvetenia	5.0	3.11
SUBTOTAL 5 DOMINANTS	149.0	92.55
Ferrissia	3.0	1.86
Chelifera	3.0	1.86
Acari	2.0	1.24
Chironomidae-pupae	2.0	1.24
Brillia	1.0	0.62
TOTAL 10 DOMINANTS	160.0	99.37

INDICATOR ASSEMBLAGE	#TAXA	ABUNDANCE	PERCENT
A Tolerant snails	1	3.0	1.86
B Tolerant mayflies	0	0.0	0.00
C Intolerant mayflies	0	0.0	0.00
D Intolerant stoneflies	0	0.0	0.00
E Tolerant caddisflies	0	0.0	0.00
F Intolerant caddisflies	0	0.0	0.00
G Tolerant beetles	0	0.0	0.00
H Intolerant flies	0	0.0	0.00
I Tolerant flies	0	0.0	0.00
J Intolerant midges	0	0.0	0.00
K Tolerant midges	1	1.0	0.62
L	0	0.0	0.00
M	0	0.0	0.00
N	0	0.0	0.00

Des Moines Creek, DM-1, October 31, 1998, Riffle
WA: King County, City of Des Moines. Analysis by ABA, Inc.
Benthic invertebrate biomon. 5 point kick composite, 1 m2, 500 micron.
Abundances (m2). Full or 500+ organism subsample. FILE: 98DM02

RATIOS OF TAX. GROUP ABUNDANCES
EPT/Chironomidae = 4.93
Hyd./Total Tri. undefined. Total Tri.= 0
Baetidae/Total Ephemeroptera = 1.00

RATIOS OF FFG ABUNDANCES
Scraper/Collector-filter undefined - Coll.-Filt.=0
Scraper/(Scraper + C.-filterer) = 1.00
Shredder/Total organisms = 0.01

Biotic Condition Index
Community Tolerance Quotient (a) = 103.55
Community Tolerance Quotient (d) = 98.62

DIVERSITY MEASURES
Shannon H (loge) = 1.52
Shannon H (log2) = 2.19
Evenness = 0.63
Simpson D = 0.30

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	68.8	42.70
Univoltine	82.8	51.40
Semivoltine	9.5	5.90

Des Moines Creek, DM-2, October 30, 1998, Riffle

WA: King County, City of Des Moines. Analysis by ABA, Inc.
Benthic invertebrate biomon. 5 point kick composite, 1 m2, 500 micron.
Abundances (m2). Full or 500+ organism subsample. FILE: 98DM03

IDENTIFICATION CODE	98DM03
CORRECTION FACTOR	1

Taxon	Abundance	%
Oligochaeta	17	5.56
Copepoda	1	0.33
Gammarus	47	15.36
Acari	1	0.33
TOTAL: NON INSECTS	66	21.57
Baetis tricaudatus	233	76.14
TOTAL: EPHEMEROPTERA	233	76.14
Simulium	1	0.33
TOTAL: DIPTERA	1	0.33
Chironomidae-pupae	1	0.33
Rheotanytarsus	1	0.33
Tvetenia	4	1.31
TOTAL: CHIRONOMIDAE	6	1.96
GRAND TOTAL	306	100.00

Des Moines Creek, DM-2, October 30, 1998, Riffle
WA: King County, City of Des Moines. Analysis by ABA, Inc.
Benthic invertebrate biomon. 5 point kick composite, 1 m2, 500 micron.
Abundances (m2). Full or 500+ organism subsample. FILE: 98DM03

Total invertebrate abundance	= 306.0	EPT abundance	= 233.0
Total number of taxa	= 9	Number EPT taxa	= 1
Hilsenhoff Biotic Index	= 6.10	Brillouin H	= 0.77

TAXONOMIC GROUP	#TAXA	ABUNDANCE	PERCENT
Non-insects	4	66.0	21.58
Odonata	0	0.0	0.00
Ephemeroptera	1	233.0	76.14
Plecoptera	0	0.0	0.00
Hemiptera	0	0.0	0.00
Megaloptera	0	0.0	0.00
Trichoptera	0	0.0	0.00
Lepidoptera	0	0.0	0.00
Coleoptera	0	0.0	0.00
Misc. Diptera	1	1.0	0.33
Chironomidae	3	6.0	1.97

FEEDING GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	0	0.0	0.00
Parasite	1	1.0	0.33
Collector-gatherer	5	302.0	98.70
Collector-filterer	2	2.0	0.66
Macrophyte-herbivore	0	0.0	0.00
Piercer-herbivore	0	0.0	0.00
Scraper	0	0.0	0.00
Shredder	0	0.0	0.00
Xylophage	0	0.0	0.00
Omnivore	0	0.0	0.00
Unknown	1	1.0	0.33

DOMINANT TAXON	ABUNDANCE	PERCENT
Baetis tricaudatus	233.0	76.14
Gammarus	47.0	15.36
Oligochaeta	17.0	5.56
Tvetenia	4.0	1.31
Copepoda	1.0	0.33
SUBTOTAL 5 DOMINANTS	302.0	98.70
Acari	1.0	0.33
Simulium	1.0	0.33
Chironomidae-pupae	1.0	0.33
Rheotanytarsus	1.0	0.33
	0.0	0.00
TOTAL 10 DOMINANTS	306.0	100.02

INDICATOR ASSEMBLAGE	#TAXA	ABUNDANCE	PERCENT
A Tolerant snails	0	0.0	0.00
B Tolerant mayflies	0	0.0	0.00
C Intolerant mayflies	0	0.0	0.00
D Intolerant stoneflies	0	0.0	0.00
E Tolerant caddisflies	0	0.0	0.00
F Intolerant caddisflies	0	0.0	0.00
G Tolerant beetles	0	0.0	0.00
H Intolerant flies	0	0.0	0.00
I Tolerant flies	0	0.0	0.00
J Intolerant midges	0	0.0	0.00
K Tolerant midges	0	0.0	0.00
L	0	0.0	0.00
M	0	0.0	0.00
N	0	0.0	0.00

Des Moines Creek, DM-2, October 30, 1998, Riffle
WA: King County, City of Des Moines. Analysis by ABA, Inc.
Benthic invertebrate biomon. 5 point kick composite, 1 m2, 500 micron.
Abundances (m2). Full or 500+ organism subsample. FILE: 98DM03

RATIOS OF TAX. GROUP ABUNDANCES
EPT/Chironomidae = 38.83
Hyd./Total Tri. undefined. Total Tri.= 0
Baetidae/Total Ephemeroptera = 1.00

RATIOS OF FFG ABUNDANCES
Scraper/Collector-filter = 0.00
Scraper/(Scraper + C.-filterer) = 0.00
Shredder/Total organisms = 0.00

Biotic Condition Index
Community Tolerance Quotient (a) = 104.00
Community Tolerance Quotient (d) = 93.49

DIVERSITY MEASURES
Shannon H (loge) = 0.81
Shannon H (log2) = 1.16
Evenness = 0.37
Simpson D = 0.61

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	181.2	59.23
Univoltine	116.2	37.99
Semivoltine	8.5	2.78

Massey Creek, MA-1, October 30, 1998, Riffle

WA: King County, City of Des Moines. Analysis by ABA, Inc.
Benthic invertebrate biomon. 5 point kick composite, 1 m2, 500 micron.
Abundances (m2). Full or 500+ organism subsample. FILE: 98DM04

IDENTIFICATION CODE	98DM04
CORRECTION FACTOR	1

Taxon	Abundance	%
Oligochaeta	17	73.91
Planorbidae	1	4.35
Copepoda	1	4.35
Ostracoda	1	4.35
Acari	2	8.70
TOTAL: NON INSECTS	22	95.65
Baetis tricaudatus	1	4.35
TOTAL: EPHEMEROPTERA	1	4.35
GRAND TOTAL	23	100.00

Massey Creek, MA-1, October 30, 1998, Riffle
WA: King County, City of Des Moines. Analysis by ABA, Inc.
Benthic invertebrate biomon. 5 point kick composite, 1 m2, 500 micron.
Abundances (m2). Full or 500+ organism subsample. FILE: 98DM04

Total invertebrate abundance	= 23.0	EPT abundance	= 1.0
Total number of taxa	= 6	Number EPT taxa	= 1
Hilsenhoff Biotic Index	= 7.57	Brillouin H	= 0.76

TAXONOMIC GROUP	#TAXA	ABUNDANCE	PERCENT
Non-insects	5	22.0	95.66
Odonata	0	0.0	0.00
Ephemeroptera	1	1.0	4.35
Plecoptera	0	0.0	0.00
Hemiptera	0	0.0	0.00
Megaloptera	0	0.0	0.00
Trichoptera	0	0.0	0.00
Lepidoptera	0	0.0	0.00
Coleoptera	0	0.0	0.00
Misc. Diptera	0	0.0	0.00
Chironomidae	0	0.0	0.00

FEEDING GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	0	0.0	0.00
Parasite	1	2.0	8.70
Collector-gatherer	4	20.0	86.96
Collector-filterer	0	0.0	0.00
Macrophyte-herbivore	0	0.0	0.00
Piercer-herbivore	0	0.0	0.00
Scraper	1	1.0	4.35
Shredder	0	0.0	0.00
Xylophage	0	0.0	0.00
Omnivore	0	0.0	0.00
Unknown	0	0.0	0.00

DOMINANT TAXON	ABUNDANCE	PERCENT
Oligochaeta	17.0	73.91
Acari	2.0	8.70
Planorbidae	1.0	4.35
Copepoda	1.0	4.35
Ostracoda	1.0	4.35
SUBTOTAL 5 DOMINANTS	22.0	95.66
Baetis tricaudatus	1.0	4.35
	0.0	0.00
	0.0	0.00
	0.0	0.00
	0.0	0.00
TOTAL 10 DOMINANTS	23.0	100.01

INDICATOR ASSEMBLAGE	#TAXA	ABUNDANCE	PERCENT
A Tolerant snails	1	1.0	4.35
B Tolerant mayflies	0	0.0	0.00
C Intolerant mayflies	0	0.0	0.00
D Intolerant stoneflies	0	0.0	0.00
E Tolerant caddisflies	0	0.0	0.00
F Intolerant caddisflies	0	0.0	0.00
G Tolerant beetles	0	0.0	0.00
H Intolerant flies	0	0.0	0.00
I Tolerant flies	0	0.0	0.00
J Intolerant midges	0	0.0	0.00
K Tolerant midges	0	0.0	0.00
L	0	0.0	0.00
M	0	0.0	0.00
N	0	0.0	0.00

Massey Creek, MA-1, October 30, 1998, Riffle
WA: King County, City of Des Moines. Analysis by ABA, Inc.
Benthic invertebrate biomon. 5 point kick composite, 1 m2, 500 micron.
Abundances (m2). Full or 500+ organism subsample. FILE: 98DM04

RATIOS OF TAX. GROUP ABUNDANCES
EPT/Chironomidae undefined. Chiron.= 0
Hyd./Total Tri. undefined. Total Tri.= 0
Baetidae/Total Ephemeroptera = 1.00

RATIOS OF FFG ABUNDANCES
Scraper/Collector-filter undefined - Coll.-Filt.=0
Scraper/(Scraper + C.-filterer) = 1.00
Shredder/Total organisms = 0.00

Biotic Condition Index
Community Tolerance Quotient (a) = 102.00
Community Tolerance Quotient (d) = 108.00

DIVERSITY MEASURES
Shannon H (loge) = 0.98
Shannon H (log2) = 1.42
Evenness = 0.55
Simpson D = 0.54

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	4.8	20.65
Univoltine	9.8	42.39
Semivoltine	8.5	36.96

Massey Creek, MA-2, October 30, 1998, Riffle

WA: King County, City of Des Moines. Analysis by ABA, Inc.
Benthic invertebrate biomon. 5 point kick composite, 1 m2, 500 micron.
Abundances (m2). Full or 500+ organism subsample. FILE: 98DM05

IDENTIFICATION CODE	98DM05
CORRECTION FACTOR	1

Taxon	Abundance	%
Turbellaria	3	1.44
Oligochaeta	4	1.92
Hirudinea	2	0.96
Copepoda	1	0.48
TOTAL: NON INSECTS	10	4.81
Baetis tricaudatus	159	76.44
TOTAL: EPHEMEROPTERA	159	76.44
Brachycera	2	0.96
Forcipomyiinae	1	0.48
TOTAL: DIPTERA	3	1.44
Brillia	1	0.48
Diplocladius	21	10.10
Paramerina	1	0.48
Rheocricotopus	5	2.40
Thienemannimyia Gr.	8	3.85
TOTAL: CHIRONOMIDAE	36	17.31
GRAND TOTAL	208	100.00

Massey Creek, MA-2, October 30, 1998, Riffle
WA: King County, City of Des Moines. Analysis by ABA, Inc.
Benthic invertebrate biomon. 5 point kick composite, 1 m2, 500 micron.
Abundances (m2). Full or 500+ organism subsample. FILE: 98DM05

Total invertebrate abundance	= 208.0	EPT abundance	= 159.0
Total number of taxa	= 12	Number EPT taxa	= 1
Hilsenhoff Biotic Index	= 6.26	Brillouin H	= 0.91

TAXONOMIC GROUP	#TAXA	ABUNDANCE	PERCENT
Non-insects	4	10.0	4.80
Odonata	0	0.0	0.00
Ephemeroptera	1	159.0	76.44
Plecoptera	0	0.0	0.00
Hemiptera	0	0.0	0.00
Megaloptera	0	0.0	0.00
Trichoptera	0	0.0	0.00
Lepidoptera	0	0.0	0.00
Coleoptera	0	0.0	0.00
Misc. Diptera	2	3.0	1.44
Chironomidae	5	36.0	17.31

FEEDING GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	4	12.0	5.77
Parasite	0	0.0	0.00
Collector-gatherer	5	188.0	90.38
Collector-filterer	0	0.0	0.00
Macrophyte-herbivore	0	0.0	0.00
Piercer-herbivore	0	0.0	0.00
Scraper	0	0.0	0.00
Shredder	1	1.0	0.48
Xylophage	0	0.0	0.00
Omnivore	1	5.0	2.40
Unknown	1	2.0	0.96

DOMINANT TAXON	ABUNDANCE	PERCENT
Baetis tricaudatus	159.0	76.44
Diplocladius	21.0	10.10
Thienemannimyia Gr.	8.0	3.85
Rheocricotopus	5.0	2.40
Oligochaeta	4.0	1.92
SUBTOTAL 5 DOMINANTS	197.0	94.71
Turbellaria	3.0	1.44
Hirudinea	2.0	0.96
Brachycera	2.0	0.96
Copepoda	1.0	0.48
Forcipomyiinae	1.0	0.48
TOTAL 10 DOMINANTS	206.0	99.03

INDICATOR ASSEMBLAGE	#TAXA	ABUNDANCE	PERCENT
A Tolerant snails	0	0.0	0.00
B Tolerant mayflies	0	0.0	0.00
C Intolerant mayflies	0	0.0	0.00
D Intolerant stoneflies	0	0.0	0.00
E Tolerant caddisflies	0	0.0	0.00
F Intolerant caddisflies	0	0.0	0.00
G Tolerant beetles	0	0.0	0.00
H Intolerant flies	0	0.0	0.00
I Tolerant flies	0	0.0	0.00
J Intolerant midges	0	0.0	0.00
K Tolerant midges	1	21.0	10.10
L	0	0.0	0.00
M	0	0.0	0.00
N	0	0.0	0.00

Massey Creek, MA-2, October 30, 1998, Riffle
WA: King County, City of Des Moines. Analysis by ABA, Inc.
Benthic invertebrate biomon. 5 point kick composite, 1 m2, 500 micron.
Abundances (m2). Full or 500+ organism subsample. FILE: 98DM05

RATIOS OF TAX. GROUP ABUNDANCES
EPT/Chironomidae = 4.42
Hyd./Total Tri. undefined. Total Tri.= 0
Baetidae/Total Ephemeroptera = 1.00

RATIOS OF FFG ABUNDANCES
Scraper/Collector-filter undefined - Coll.-Filt.=0
Scraper/(Scraper + C.-filterer) undefined
Shredder/Total organisms = 0.00

Biotic Condition Index
Community Tolerance Quotient (a) = 104.73
Community Tolerance Quotient (d) = 95.82

DIVERSITY MEASURES
Shannon H (loge) = 0.98
Shannon H (log2) = 1.41
Evenness = 0.39
Simpson D = 0.60

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	150.2	72.24
Univoltine	55.8	26.80
Semivoltine	2.0	0.96

Massey Creek, MA-3, October 30, 1998, Riffle

WA: King County, City of Des Moines. Analysis by ABA, Inc.
Benthic invertebrate biomon. 5 point kick composite, 1 m2, 500 micron.
Abundances (m2). Full or 500+ organism subsample. FILE: 98DM06

IDENTIFICATION CODE	98DM06
CORRECTION FACTOR	1

Taxon	Abundance	%
Oligochaeta	5	3.21
Physella	2	1.28
Gammarus	37	23.72
Acari	1	0.64
TOTAL: NON INSECTS	45	28.85
Baetis tricaudatus	59	37.82
TOTAL: EPHEMEROPTERA	59	37.82
Micrasema	1	0.64
TOTAL: TRICHOPTERA	1	0.64
Simulium	3	1.92
TOTAL: DIPTERA	3	1.92
Brillia	5	3.21
Cricotopus	1	0.64
Diplocladius	22	14.10
Eukiefferiella	1	0.64
Paratanytarsus	2	1.28
Rheocricotopus	3	1.92
Thienemannimyia Gr.	6	3.85
Tvetenia	8	5.13
TOTAL: CHIRONOMIDAE	48	30.77
GRAND TOTAL	156	100.00

Massey Creek, MA-3, October 30, 1998, Riffle
WA: King County, City of Des Moines. Analysis by ABA, Inc.
Benthic invertebrate biomon. 5 point kick composite, 1 m2, 500 micron.
Abundances (m2). Full or 500+ organism subsample. FILE: 98DM06

Total invertebrate abundance= 156.0		EPT abundance	= 60.0
Total number of taxa	= 15	Number EPT taxa	= 2
Hilsenhoff Biotic Index	= 6.27	Brillouin H	= 1.74

TAXONOMIC GROUP	#TAXA	ABUNDANCE	PERCENT
Non-insects	4	45.0	28.85
Odonata	0	0.0	0.00
Ephemeroptera	1	59.0	37.82
Plecoptera	0	0.0	0.00
Hemiptera	0	0.0	0.00
Megaloptera	0	0.0	0.00
Trichoptera	1	1.0	0.64
Lepidoptera	0	0.0	0.00
Coleoptera	0	0.0	0.00
Misc. Diptera	1	3.0	1.92
Chironomidae	8	48.0	30.77

FEEDING GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	1	6.0	3.85
Parasite	1	1.0	0.64
Collector-gatherer	7	134.0	85.90
Collector-filterer	1	3.0	1.92
Macrophyte-herbivore	1	1.0	0.64
Piercer-herbivore	0	0.0	0.00
Scraper	0	0.0	0.00
Shredder	1	5.0	3.21
Xylophage	0	0.0	0.00
Omnivore	2	4.0	2.56
Unknown	1	2.0	1.28

DOMINANT TAXON	ABUNDANCE	PERCENT
Baetis tricaudatus	59.0	37.82
Gammarus	37.0	23.72
Diplocladius	22.0	14.10
Tvetenia	8.0	5.13
Thienemannimyia Gr.	6.0	3.85
SUBTOTAL 5 DOMINANTS	132.0	84.62
Oligochaeta	5.0	3.21
Brillia	5.0	3.21
Simulium	3.0	1.92
Rheocricotopus	3.0	1.92
Physella	2.0	1.28
TOTAL 10 DOMINANTS	150.0	96.16

INDICATOR ASSEMBLAGE	#TAXA	ABUNDANCE	PERCENT
A Tolerant snails	1	2.0	1.28
B Tolerant mayflies	0	0.0	0.00
C Intolerant mayflies	0	0.0	0.00
D Intolerant stoneflies	0	0.0	0.00
E Tolerant caddisflies	0	0.0	0.00
F Intolerant caddisflies	0	0.0	0.00
G Tolerant beetles	0	0.0	0.00
H Intolerant flies	0	0.0	0.00
I Tolerant flies	0	0.0	0.00
J Intolerant midges	0	0.0	0.00
K Tolerant midges	1	22.0	14.10
L	0	0.0	0.00
M	0	0.0	0.00
N	0	0.0	0.00

Massey Creek, MA-3, October 30, 1998, Riffle
WA: King County, City of Des Moines. Analysis by ABA, Inc.
Benthic invertebrate biomon. 5 point kick composite, 1 m2, 500 micron.
Abundances (m2). Full or 500+ organism subsample. FILE: 98DM06

RATIOS OF TAX. GROUP ABUNDANCES

EPT/Chironomidae	= 1.25
Hydropsychidae/Total Trichoptera	= 0.00
Baetidae/Total Ephemeroptera	= 1.00

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filter	= 0.00
Scraper/(Scraper + C.-filterer)	= 0.00
Shredder/Total organisms	= 0.03

Biotic Condition Index
Community Tolerance Quotient (a) = 100.00
Community Tolerance Quotient (d) = 101.16

DIVERSITY MEASURES

Shannon H (loge)	= 1.88
Shannon H (log2)	= 2.71
Evenness	= 0.69
Simpson D	= 0.22

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	81.2	52.08
Univoltine	72.2	46.31
Semivoltine	2.5	1.60

McSorley Creek, MC-1, October 31, 1998, Riffle

WA: King County, City of Des Moines. Analysis by ABA, Inc.
Benthic invertebrate biomon. 5 point kick composite, 1 m2, 500 micron.
Abundances (m2). Full or 500+ organism subsample. FILE: 98DM07

IDENTIFICATION CODE	98DM07
CORRECTION FACTOR	1

Taxon	Abundance	%
Oligochaeta	25	17.48
Hirudinea	1	0.70
Sphaeriidae	1	0.70
Physella	1	0.70
Planorbidae	15	10.49
Gammarus	42	29.37
Caecidotea	1	0.70
TOTAL: NON INSECTS	86	60.14
Soyedina	1	0.70
Zapada cinctipes	2	1.40
TOTAL: PLECOPTERA	3	2.10
Parapsyche almota	5	3.50
Limnephilidae	1	0.70
Rhyacophila grandis	4	2.80
TOTAL: TRICHOPTERA	10	6.99
Lara avara	11	7.69
TOTAL: COLEOPTERA	11	7.69
Chelifera	2	1.40
Simulium	2	1.40
Holorusia	1	0.70
TOTAL: DIPTERA	5	3.50
Brillia	2	1.40
Diplocladius	5	3.50
Macropelopia	1	0.70
Orthocladius Complex	1	0.70
Polypedilum	1	0.70
Rheocricotopus	1	0.70
Thienemannimyia Gr.	17	11.89
TOTAL: CHIRONOMIDAE	28	19.58
GRAND TOTAL	143	100.00

McSorley Creek, MC-1, October 31, 1998, Riffle
WA: King County, City of Des Moines. Analysis by ABA, Inc.
Benthic invertebrate biomon. 5 point kick composite, 1 m2, 500 micron.
Abundances (m2). Full or 500+ organism subsample. FILE: 98DM07

Total invertebrate abundance	= 143.0	EPT abundance	= 13.0
Total number of taxa	= 23	Number EPT taxa	= 5
Hilsenhoff Biotic Index	= 5.94	Brillouin H	= 2.10

TAXONOMIC GROUP	#TAXA	ABUNDANCE	PERCENT
Non-insects	7	86.0	60.14
Odonata	0	0.0	0.00
Ephemeroptera	0	0.0	0.00
Plecoptera	2	3.0	2.10
Hemiptera	0	0.0	0.00
Megaloptera	0	0.0	0.00
Trichoptera	3	10.0	7.00
Lepidoptera	0	0.0	0.00
Coleoptera	1	11.0	7.69
Misc. Diptera	3	5.0	3.50
Chironomidae	7	28.0	19.59

FEEDING GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	6	30.0	20.99
Parasite	0	0.0	0.00
Collector-gatherer	7	76.0	53.15
Collector-filterer	1	2.0	1.40
Macrophyte-herbivore	0	0.0	0.00
Piercer-herbivore	0	0.0	0.00
Scraper	1	15.0	10.49
Shredder	5	17.0	11.89
Xylophage	0	0.0	0.00
Omnivore	2	2.0	1.40
Unknown	1	1.0	0.70

DOMINANT TAXON	ABUNDANCE	PERCENT
Gammarus	42.0	29.37
Oligochaeta	25.0	17.48
Thienemannimyia Gr.	17.0	11.89
Planorbidae	15.0	10.49
Lara avara	11.0	7.69
SUBTOTAL 5 DOMINANTS	110.0	76.92
Parapsyche almota	5.0	3.50
Diplocladius	5.0	3.50
Rhyacophila grandis	4.0	2.80
Zapada cinctipes	2.0	1.40
Chelifera	2.0	1.40
TOTAL 10 DOMINANTS	128.0	89.52

INDICATOR ASSEMBLAGE	#TAXA	ABUNDANCE	PERCENT
A Tolerant snails	2	16.0	11.19
B Tolerant mayflies	0	0.0	0.00
C Intolerant mayflies	0	0.0	0.00
D Intolerant stoneflies	0	0.0	0.00
E Tolerant caddisflies	0	0.0	0.00
F Intolerant caddisflies	0	0.0	0.00
G Tolerant beetles	0	0.0	0.00
H Intolerant flies	0	0.0	0.00
I Tolerant flies	0	0.0	0.00
J Intolerant midges	0	0.0	0.00
K Tolerant midges	1	5.0	3.50
L	0	0.0	0.00
M	0	0.0	0.00
N	0	0.0	0.00

McSorley Creek, MC-1, October 31, 1998, Riffle
WA: King County, City of Des Moines. Analysis by ABA, Inc.
Benthic invertebrate biomon. 5 point kick composite, 1 m2, 500 micron.
Abundances (m2). Full or 500+ organism subsample. FILE: 98DM07

RATIOS OF TAX. GROUP ABUNDANCES
EPT/Chironomidae = 0.46
Hydropsychidae/Total Trichoptera = 0.00
Baetidae/Total Ephem. undefined. Total Ephem.=0

RATIOS OF FFG ABUNDANCES
Scraper/Collector-filter = 7.50
Scraper/(Scraper + C.-filterer) = 0.88
Shredder/Total organisms = 0.12

Biotic Condition Index
Community Tolerance Quotient (a) = 90.22
Community Tolerance Quotient (d) = 91.33

DIVERSITY MEASURES
Shannon H (loge) = 2.31
Shannon H (log2) = 3.33
Evenness = 0.74
Simpson D = 0.15

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	21.0	14.69
Univoltine	91.0	63.64
Semivoltine	31.0	21.68

McSorley Creek, MC-2, October 31, 1998, Riffle

WA: King County, City of Des Moines. Analysis by ABA, Inc.
Benthic invertebrate biomon. 5 point kick composite, 1 m2, 500 micron.
Abundances (m2). Full or 500+ organism subsample. FILE: 98DM08

IDENTIFICATION CODE	98DM08
CORRECTION FACTOR	1

Taxon	Abundance	%
Nematoda	2	0.38
Oligochaeta	76	14.62
Hirudinea	1	0.19
Helobdella stagnalis	2	0.38
Sphaeriidae	4	0.77
Physella	3	0.58
Planorbidae	1	0.19
Copepoda	1	0.19
Gammarus	70	13.46
Caecidotea	175	33.65
TOTAL: NON INSECTS	335	64.42
Baetis tricaudatus	127	24.42
Paraleptophlebia	1	0.19
TOTAL: EPHEMEROPTERA	128	24.62
Zapada cinctipes	2	0.38
TOTAL: PLECOPTERA	2	0.38
Parapsyche almota	2	0.38
Rhyacophila grandis	1	0.19
TOTAL: TRICHOPTERA	3	0.58
Lara avara	1	0.19
TOTAL: COLEOPTERA	1	0.19
Brachycera	4	0.77
Ceratopogoninae	6	1.15
Chelifera	1	0.19
Simulium	1	0.19
TOTAL: DIPTERA	12	2.31
Brillia	1	0.19
Diplocladius	4	0.77
Polypedilum	4	0.77
Rheocricotopus	1	0.19
Thienemannimyia Gr.	27	5.19
Tvetenia	2	0.38
TOTAL: CHIRONOMIDAE	39	7.50
GRAND TOTAL	520	100.00

McSorley Creek, MC-2, October 31, 1998, Riffle
WA: King County, City of Des Moines. Analysis by ABA, Inc.
Benthic invertebrate biomon. 5 point kick composite, 1 m2, 500 micron.
Abundances (m2). Full or 500+ organism subsample. FILE: 98DM08

Total invertebrate abundance	= 520.0	EPT abundance	= 133.0
Total number of taxa	= 26	Number EPT taxa	= 5
Hilsenhoff Biotic Index	= 6.97	Brillouin H	= 1.80

TAXONOMIC GROUP	#TAXA	ABUNDANCE	PERCENT
Non-insects	10	335.0	64.41
Odonata	0	0.0	0.00
Ephemeroptera	2	128.0	24.61
Plecoptera	1	2.0	0.38
Hemiptera	0	0.0	0.00
Megaloptera	0	0.0	0.00
Trichoptera	2	3.0	0.57
Lepidoptera	0	0.0	0.00
Coleoptera	1	1.0	0.19
Misc. Diptera	4	12.0	2.30
Chironomidae	6	39.0	7.49

FEEDING GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	7	40.0	7.67
Parasite	1	2.0	0.38
Collector-gatherer	10	463.0	89.03
Collector-filterer	1	1.0	0.19
Macrophyte-herbivore	0	0.0	0.00
Piercer-herbivore	0	0.0	0.00
Scraper	1	1.0	0.19
Shredder	3	4.0	0.76
Xylophage	0	0.0	0.00
Omnivore	2	5.0	0.96
Unknown	1	4.0	0.77

DOMINANT TAXON	ABUNDANCE	PERCENT
Caecidotea	175.0	33.65
Baetis tricaudatus	127.0	24.42
Oligochaeta	76.0	14.62
Gammarus	70.0	13.46
Thienemannimyia Gr.	27.0	5.19
SUBTOTAL 5 DOMINANTS	475.0	91.34
Ceratopogoninae	6.0	1.15
Sphaeriidae	4.0	0.77
Brachycera	4.0	0.77
Diplocladius	4.0	0.77
Polypedilum	4.0	0.77
TOTAL 10 DOMINANTS	497.0	95.57

INDICATOR ASSEMBLAGE	#TAXA	ABUNDANCE	PERCENT
A Tolerant snails	2	4.0	0.77
B Tolerant mayflies	0	0.0	0.00
C Intolerant mayflies	0	0.0	0.00
D Intolerant stoneflies	0	0.0	0.00
E Tolerant caddisflies	0	0.0	0.00
F Intolerant caddisflies	0	0.0	0.00
G Tolerant beetles	0	0.0	0.00
H Intolerant flies	0	0.0	0.00
I Tolerant flies	0	0.0	0.00
J Intolerant midges	0	0.0	0.00
K Tolerant midges	1	4.0	0.77
L	0	0.0	0.00
M	0	0.0	0.00
N	0	0.0	0.00

McSorley Creek, MC-2, October 31, 1998, Riffle
WA: King County, City of Des Moines. Analysis by ABA, Inc.
Benthic invertebrate biomon. 5 point kick composite, 1 m2, 500 micron.
Abundances (m2). Full or 500+ organism subsample. FILE: 98DM08

RATIOS OF TAX. GROUP ABUNDANCES
EPT/Chironomidae = 3.41
Hydropsychidae/Total Trichoptera = 0.00
Baetidae/Total Ephemeroptera = 0.99

RATIOS OF FFG ABUNDANCES
Scraper/Collector-filter = 1.00
Scraper/(Scraper + C.-filterer) = 0.50
Shredder/Total organisms = 0.01

Biotic Condition Index
Community Tolerance Quotient (a) = 91.16
Community Tolerance Quotient (d) = 98.47

DIVERSITY MEASURES
Shannon H (loge) = 1.87
Shannon H (log2) = 2.70
Evenness = 0.57
Simpson D = 0.21

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	127.5	24.52
Univoltine	349.0	67.12
Semivoltine	43.5	8.37

APPENDIX H

1999 Riparian Corridor Assessment Report

1999 Riparian Corridor Assessment
For City Of DesMoines Streams

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Prepared for:
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Date: December 1999

AR 025628

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INTRODUCTION

During the fall of 1994 and 1999 riparian corridor assessment were completed on the three major stream systems in the City of DesMoines. The three streams assessed were; Massey Creek, DesMoines Creek, and McSorley Creek. The main purpose of the assessments was to identify impacts to the streams from urbanization.

This report presents methods and summarizes the 1999 results for each segment surveyed, as identified by the riparian corridor designation (e.g. MA-1), and compares the 1994 and 1999 results separately for each stream. Completed field data forms, base maps, and representative photos for both survey years are included in appendices. The 1994 survey results were presented in the 1995 Annual Report – City of Des Moines Water Quality Monitoring Program (Herrera, October 1995).

METHODS

In late September to early October (low flow) the three streams within the City of DesMoines were walked and surveyed. To the extent possible the entire stream channel was surveyed. The stream channel was not walked in places where blackberry brambles and other vegetation completely blocked the channel. In these cases, where roadways crossed the channel the stream was surveyed for at least 100' on either side of the roadway to allow assessment of stream condition beyond the road culvert. Riparian corridor assessments were performed at selected sites that represented an appropriate example of the stream segment. The riparian assessment form contained in the Department of Ecology's "Guidance for Conducting Water Quality Assessments" was utilized. The 1999 riparian corridor assessments were performed at the same places as the 1994 assessment.

As the stream was walked notes were taken on vegetation, wildlife, sediments, trash, stream condition, large woody debris (LWD) or LWD potential and evidence of stormwater inputs. Where riparian corridor assessment forms were completed: fish habitat, channel capacity, bank protection and stability, vegetation on the banks, instream and overhead, and substrate were documented. Photographs were also taken to show characteristics of the stream or problem areas.

The riparian corridor assessment of Massey Creek was performed on September 30, 1999. Riparian corridor assessments were completed at six sites on Massey Creek (Figure 1). Sites were located at least 100 feet downstream of the road crossings at; 25th Ave. S. (MA-1), S. 234th Street. (MA-3), 20th Ave. S. (MA-2), 16th Ave. S. (MA-4), 10th Ave. S. (MA-5) and Marine View Drive (MA-6). MA-6 is within the area of strong estuarine influence. Although the assessment form used is not appropriate for estuaries, one was completed and provided in Appendix A.

Barnes Creek a tributary to Massey Creek was surveyed on October 5th, 1999. Riparian corridor assessments were completed at three sites on Barnes Creek (Figure 1). Sites were located at least 100 feet from road crossings at; Kent-DesMoines Road (B1), S. 223rd Street. (B2), and S. 223rd Street (B3).

The riparian corridor assessment of DesMoines Creek occurred on October 5th and 6th, 1999. The stream was surveyed from well east of the city limits to the mouth of the stream (Figure 1). Riparian corridor assessments were completed at three sites; near the junction of 13th Ave. S. and S. 211th Street

(DM-B), below the wastewater treatment plant (WTP) to the bridge at Marine View Drive (DM-C), and along the park/senior citizens center at the mouth of the stream (DM-D).

The riparian corridor assessment of McSorley Creek occurred on October 6th and 14th, 1999. It began at the schoolyard north of 20th Ave. S. and ended at the Saltwater State Park boundary, south and west of 16th Ave. S. (Figure 1). Riparian corridor assessments occurred at three sites; the schoolyard located upstream of 20th Ave. S. (MC-1), below 20th Ave. S. (MC-2), and in the vicinity of the 16th Ave. bridge (MC-3).

MASSEY CREEK

GENERAL DESCRIPTION

The headwaters of Massey Creek originate above a large apartment complex located near the boundary of the Cities of Kent and DesMoines. The stream flows in a westerly direction, its curves mirroring to a large extent the Kent-DesMoines road. It enters Puget Sound, just south of the City of DesMoines marina (Figure 1). Although most of the watershed is developed residential area, much of the stream (approximately 75%) flows through a steep, wooded ravine, or along the Kent-DesMoines road with a steep vegetated left bank. These amenities have protected the stream from direct streamside activity.

The main channel of Massey Creek starts at the culvert under 25th Ave. S. Here the stream daylights through a 36" culvert into a moderate ravine that develops into a deeper and steeper sided ravine with distance. The ravine is substantial and the wide corridor is forested but near stream vegetation consists mainly of blackberry bramble. Apartment buildings and single family residences are located along each side of the stream. Although these residences are located at least 50 feet from the streambank, trails and general impact are affecting the riparian corridor. Below this section the stream enters a culvert and is piped along side the Kent-DesMoines road. It daylights after approximately 500 feet in thick, overhanging blackberry bramble and remains hidden beneath bramble until it crosses under 234th Street (this culvert is a potential fish barrier). Apartment buildings border the stream on the left bank and the Kent-DesMoines road borders the right bank. The stream has room to meander between the buildings and the Kent-DesMoines road (50-100 feet wide). However, the left bank of the stream has minimal vegetation and several stormwater pipes discharging into it; and the right bank is entirely comprised of blackberry bramble. From 234th Street to 20th Ave. S. the stream has fairly natural vegetation along the left bank and is bordered by the Kent-DesMoines road on the right bank. This stretch of the stream has more native vegetation than upstream corridors, although blackberry bramble is still dominant along the stream banks.

Below 20th Ave. S. the stream flows through a large complex of apartments and duplexes. The riparian corridor is narrow and vegetation is fairly sparse. A stormwater pond series is located below the complex. At the time of the survey, no water was in any of the stormwater ponds. The stream flows behind the stormwater ponds through an open, single family development area. This stretch of the stream has a wide natural buffer of grass and shrubs and a tributary entering the stream. The intermittent tributary enters the stream from the south and drains through single family residences. The tributary flows through at least one hobby farm where it appears horses may have had direct access to the stream. No horses were present at the time of the survey.

Below 16th Ave. S. the stream again enters a steep, deep, wooded ravine. Vegetation in the ravine is comprised of a tall overstory of alders and maples and fairly dense understory of shrubs. The streambank continues to be too steep for direct streamside development. A mix of new to moderately aged development and undeveloped properties border the ravine. The streambank is too steep for direct streamside development until below the confluence with Barnes Creek. Where the stream runs parallel to 232nd Street, homes are located closer to the streambank, but the immediate stream corridor remains steep and thus a buffer is maintained. The vegetation within this buffer is comprised of a tall overstory of alders and maples and fairly dense understory of shrubs.

At 10th Ave. S. and Marine view drive the land use is commercial/residential dominated by roadway and other impervious surface. The stream runs through an armored channel, with small buffers adjacent to commercial areas. This area may be within the area of estuarine influence.

RIPARIAN CORRIDOR ASSESSMENTS

MA-1

Site MA-1 is located downstream of 25th Ave. S. where the stream daylights through a 36" culvert. The stream meanders through a steep sided ravine in this segment. Although there are apartment buildings and single family residences adjacent to the stream corridor, the residences are located at least 50 feet from the main channel in most areas. The buffer area along the ravine is well vegetated with trees and understory shrubs. However, blackberry bramble is the most dominant vegetation within the stream corridor. Blackberry bramble is crowding out native vegetation and blocks sunlight from penetrating to the stream it also provides little shoreline root mat. Sands and silts comprised the majority of the substrate. The streambank is in good condition, indicating the sediment source is from upstream inputs. There is trash in the stream and yard debris on the edge of the ravine. A few logs, debris, and bankside vegetation provide instream habitat.

MA-3

Site MA-3 is bordered on the right bank by the Kent-DesMoines road and the left bank by a vegetated hillside. A thick mat of blackberry and other vegetation extends from the right edge of the stream to the Kent-DesMoines road. The vegetated hillside is a buffer consisting of trees, ivy, ferns, laural, and other typical vegetation. Substrate consists of sand and organic muck with a few exposed rocks or cobble. A few logs, debris, and bankside vegetation provide instream habitat.

MA-2

The character and adjacent land use change at MA-2. At this point the stream runs through a large complex of apartments and duplexes, and the streambed is located in a deep (5') confined channel. The channel is located between two chain length fences and the riparian corridor is narrow. Deciduous trees and shrubs make up the overstory and understory, while blackberry and ivy provide streambank vegetation. The vegetation is fairly sparse with little in the way of stabilizing root mat. Old access trails are well packed, and some stretches of the bank have protection material (riprap or silt fencing), usually at culverts or sharp turns. The substrate is comprised of silty sand with some cobble, although cemented clay is exposed in many areas because the channel has been cut down. Instream habitat is minimal and consists of exposed root wads, debris, bankside vegetation and a few undercut banks.

MA-4

Apparently the bridge and road crossing at 16th Ave. S. was washed out, as it has been reconstructed since the 1994 survey. At MA-4 the steep sided left bank is comprised of clay. Some erosion and undercutting is occurring in the stream channel. This has resulted in the loss of some trees and creation of LWD or LWD potential. Some of the resultant debris dams may be potential fish barriers at low flows, but small ponds are developing behind most of them and provide fish habitat. The stream corridor is dominated by gravel/sand substrate where sedimentation hasn't occurred and where the substrate is not hardpan bedrock. Some small boulders also form pool habitat during higher flows. There were a few culverts entering the ravine from an apartment complex on the right bank. Trash is found in the ravine and stream channel along this entire corridor. The bulk of the trash is found behind the apartment complexes below 16th Ave. S.

MA-5

At MA-5 the land use is commercial/residential dominated by roadway and other impervious surface. Upstream of 10th Ave. S., the stream flows alongside the roadway in a confined channel. Willows, blackberry bramble, and grasses form a narrow buffer and a cement wall is located along the left bank at the downstream end. There is no upperstory canopy and in places where there is no willow understory, grasses have overgrown the channel. The substrate is soft, organic muck. No LWD or large boulders exist for fish habitat.

MA-6

Site MA-6 is commercial/residential land use, dominated by roadway and other impervious surface. This is the lower 1/8-mile of the stream and is an estuary with a confined bed. As the stream gets close to entering Puget Sound it goes under a large apartment complex and then is piped through the backyard of a residence. Vegetation is comprised of grass until the stream enters under the apartment complex where it becomes shaded by the building. Once the stream goes under the apartment complex vegetation becomes non-existent. The substrate is a mix of cobble, gravel and sand. No LWD or large bounders exist for fish habitat.

COMPARISON TO 1994

- Blackberry bramble is more dominant throughout the whole stream, especially in the reaches above 20th Ave. S. and below 10th Ave. S.
- The culvert under 234th Street may be a potential fish barrier and was not noted in the 1994 survey.
- The culvert under 16th Ave. S. (a potential fish barrier) was reconstructed since the 1994 survey.

BARNES CREEK

GENERAL DESCRIPTION

Barnes Creek is located in the center of the City of DesMoines. It is the main tributary to Massey Creek. Its confluence with Massey Creek is approximately ½ mile upstream from the mouth of Massey Creek (Figure 1). The headwaters of Barnes Creek are located between S. 220th and S. 22nd Street. From here the stream flows south until its confluence with Massey Creek. The majority of Barnes Creek flows through low-density development mainly comprised of single family residences. The main segment of the stream (downstream of 223rd Street) flows through a wide wooded ravine. This ravine has no immediate streamside development.

The survey of Barnes Creek began where the stream passes under S. 220th Street. This appears to mark the headwaters, although there is no clear view of the streambed because thick blackberry brambles cover the stream corridor. Between S. 220th and S. 22nd Street the stream flows through the back of residential property; large lots that have generally been left un-maintained. Although the immediate riparian zone is not necessarily wide, there are willows and other shrubs along the bank and thick grass or fields adjacent to the buffer. The stream then flows through a grassy swale, parallel to 222nd street until it is piped under the street. An older home and a Substation are located along the south side of 222nd Street. These properties are largely un-maintained; the stream bank is comprised of blackberry bramble and other shrubs and has a well-vegetated buffer. No signs of erosion or sedimentation were observed. However, the stream bed is comprised of organic muck and accumulated silts in this area which could be associated with stormwater. No water was found in the streambed prior to 223rd Street. The only water entering the stream in these upper reaches was from a grassy swale that runs along side 223rd Street. This water was entering the stream via a culvert that is adjacent to the culvert the main channel is piped through under 223rd Street.

Downstream of 223rd Street the stream enters a moderately deep ravine with moderately steep slopes. A stormwater pond is located along the upper bank of the ravine on 13th Ave. S. There are a few small, plastic drains entering the stream just upstream and downstream of the stormwater pond. One of these drains is causing localized erosion in the ravine upstream of the stormwater facility, a poorly placed silt fence is not helping. The immediate riparian corridor is fairly wide and is providing good protection for the stream. However, the stream is becoming entangled with blackberry bramble through this entire corridor.

From 223rd to the Kent-DesMoines Road, the stream moves through an older developed area. The stream corridor develops into another ravine, thus homes are located much further away from the stream leaving a wide, steep, fairly natural corridor. This topography naturally limits streamside activity. However, it also results in a high potential for erosion if steep bank activity were to occur.

RIPARIAN CORRIDOR ASSESSMENTS

B1

At site B1 riparian vegetation consists of grasses or sparse shrubs, and the streambank is broken down in places causing localized erosion problems. The substrate is comprised of accumulated silt. A drainage pipe enters the stream from adjacent property at this site. Upstream of this site the riparian corridor becomes more wooded but has eroding, undercut, and broken down banks. This area has evidence of standing water through much of the year (i.e. water stains on vegetation and exposed sediments with little in the way of living vegetation). No water was present in the stream at the time of the survey.

B2

Site B2 is located close to B1 because the stream channel and riparian corridor changes downstream of 223rd. The stream enters a moderately deep ravine (10-15') with moderately steep slopes at B2. There is a 50-100 foot natural riparian corridor with a tall overstory comprised of maples and alders and a short understory of Indian Plum and other shrubs. The substrate remains primarily organic silts, although there are places where gravel bottom is exposed. Instream habitat is improved with a few rocks and logs present, overhanging vegetation still provides most of the instream cover. Streambanks are fairly stable with adequate natural protection.

B3

At site B3 the stream channel continues to meander through the bottom of the deep, wooded ravine and has a fairly natural, healthy riparian corridor. A tall overstory and understory comprised of maples, alders, Indian Plum, and other shrubs make up the vegetation. Residential housing occurs at the top of both sides of the ravine, however, it is comprised of older, larger lots. Again, direct stream side impacts are minimal because of the ravine. However, the ravine is not as steep as upstream and the bottom is wider allowing greater direct access to the stream. As a consequence there are a few eroded trails, and some trash in the channel. Blackberry is not as prominent in the ravine until the Kent-DesMoines road. The substrate consists of cobble and gravel with logs and rootwads for instream habitat. Sediment accumulation areas do exist; with sandy to silty sands.

COMPARISON TO 1994

- Blackberry bramble has become more dominant along the stream channel since the 1994 survey.
- The large culvert, that enters the stream prior to the stormwater facility off 13th Ave. S., has evidence of causing sedimentation and erosion. This culvert was noted in the 1994 survey but appears to be scoured, eroded and causing more stream impacts then were present when the 1994 survey was conducted.
- Since the 1994 survey more discharge pipes are entering the stream off 13th Ave. S.

DESMOINES CREEK

GENERAL DESCRIPTION

DesMoines Creek is located near the northern boundary of the City of DesMoines (Figure 1). The stream flows west until it discharges into Puget Sound just north of the City of DesMoines marina. Its headwaters are located outside the City of DesMoines and the stream flows past the Seattle-Tacoma International Airport, Tyee Golf Course, and substantial commercial and residential development. DesMoines Creek is the only stream within the City limits that is protected from residential development along both banks because it flows through a steep, deep ravine (presumably owned by the city). Stormwater and nutrient inputs from upstream influences appear to be the primary problem, and the cause of the periphyton growth that was noted throughout the stream. The riprap along the right bank and channel morphology changes (Resources Planning Associates, 1994) provide evidence of past stormwater related problems. Occasional eroded banks (usually along the steeper left bank) and some sediment accumulation areas are signs of existing problems.

A paved public walk/bike trail runs parallel to the stream through most of the city limits. It ends at the upstream edge of the WTP property. Formal trails have been developed to gain access to the walk/bike trail, including one trail that is bridged over the stream. A sewer line runs alongside the stream, under the paved trail, and riprap has been placed along the right bank of the stream to control erosion and stabilize the trail. There are signs of sediment accumulation, usually in places where the stream overflows its banks, or on sharp corners.

Downstream there are houses along the top of the left bank. However, the bank is steep and well vegetated, and there were no signs of access trails. A fence crosses the stream in this area, marking the WTP property. Just downstream of this fence a culvert enters the stream for the left bank and one from the right bank. Neither was discharging at the time of the survey, or appeared to have significant discharges give the morphology of the discharge channel formed in the streambed. The stream channel is highly engineered through the WTP property; concrete dams and log weirs have been placed in the channel. Numerous culverts enter the stream through the WTP property. Two of these culverts were discharging into the stream at the time of the survey. Periphyton grew near these outfalls, and in one case it was highly colored (golden brown), apparently from iron deposits. There was no odor from either. These may be natural springs that have been conveyed underground to allow drainage under the WTP property.

Below the fence that marks the WTP property, the stream channel again becomes boulder strewn and is in a wide, vegetated ravine. The stream has room to meander through this ravine until it is piped under the bridge over Marine View Drive. After exiting the culvert under Marine View Drive the stream is in a broad ravine until it enters Puget Sound near the City marina. A walk trail runs along the right bank of the stream from Marine View Drive all the way to the Sound. The lower portions of the ravine, near the Sound, consist of a senior citizens center and a public park.

A fish habitat survey of this stream (Resource Planning Associates, 1994), indicated that the stream lacked habitat diversity; riffle areas comprised 42% of the total length of the inventoried reach. The 1994 survey concurred with those findings as does this survey.

RIPARIAN CORRIDOR ASSESSMENTS

DM-B

At DM-B a footbridge has been built across the stream, since the 1994 survey, with steps and an access trail to the nearby residential area near 13th Ave. S. and S. 211th Street. Instream activity seems to have declined since the survey in 1994 possible due to the new bridge. However, direct impact continues to occur as evidenced by trash and informal trails.

Vegetation consisted of a fairly open overstory comprised of birch, alder, and maple. The understory is comprised of many different types of shrubs (e.g. salmonberry, Indian plum, and blackberry). Streamside vegetation is mixed forbes and blackberry, although the blackberry is not as dense as what is experienced in the other streams. Moderate periphyton growth occurs on rocks where sunlight penetrates the overstory. The stream channel has an excellent cobbly substrate with rocks to boulders strewn amongst the cobble. The depth ranges from approximately 0.5-1.5', with some pools up to approximately 2' deep formed from LWD or large rocks.

DM-C

Downstream of the WTP property at DM-C, the stream channel is boulder strewn. The ravine is broad from the WTP all the way to the bridge over Marine View Drive. Natural vegetation lines the left bank (e.g. alder, maple, birch, fern, laural, Indian plum, etc.) and the right bank has a maintenance road with natural vegetation beyond it. A few debris jams are located below the WTP property and are causing pooling water and resultant sediment buildup. These could be fish barriers during some flows. However, juvenile and adult fish were seen upstream. The largest debris jam is approximately 300' upstream from the bridge over Marine View Drive.

The entire segment below the WTP is similar in character. Culverts have been placed approximately every 200' under the maintenance road. These culverts are draining directly into the stream but don't seem to be affecting streambed morphology. The substrate consists of cobble with gravel and boulders strewn amongst the cobble. There are a few places with signs of erosion (exposed clay banks and increased sedimentation on the inside curve of the stream). Generally, the stream is 15-20' wide with a few nice pools caused by LWD or boulders, rootwads, and streamside vegetation for instream habitat.

DM-D

The riparian corridor in this lower portion of DesMoines Creek, DM-D, consists of a narrow (5-10') vegetated buffer consisting of shrubs, grasses and blackberry bramble, which lie adjacent to a grassy park like area and roadway. There is some overhead canopy in the lower reaches until the stream exits from under the senior citizen center building. Riffle and glide areas characterize this lower corridor of the stream, within the area of tidal influence. It is 15-20 feet wide, and has a nice (though somewhat embedded) cobbly to stone substrate but no other instream habitat. Riprap has been used in places to define the channel.

COMPARISON TO 1994

- The paved walk/bike trail was a gravel maintenance road during the 1994 survey.
- Prior to the 1994 survey all the access trails entering the ravine were bare soil. There were no formal trails and no bridge allowing access across the stream. Now there is access trails and a parking area at the top of the walk/bike trail.

- Since the 1994 assessment the maintenance road from the WTP property to Marine View Drive has been expanded. Riprap is forming a wall along corners of the maintenance road and where culverts enter the stream (approximately every 200 feet).

MCSORLEY CREEK

GENERAL DESCRIPTION

McSorley Creek is located near the southern boundary of the City of DesMoines (Figure 1). Its headwaters are located in a wetland area above the school near 20th Ave. S. From here the stream flows south and west until it enters Puget Sound at Saltwater State Park. The upper segment of the stream flows through an urban residential area, while the mid-section of the stream has a dam and lake, below this the stream travels through a deep, wooded ravine. The wooded ravine has no immediate streamside development, except a small wastewater treatment plant located below the 16th Ave. Bridge.

The headwaters of McSorley Creek flow through residential backyards above 20th Ave. S. Below 20th Ave. S. the stream discharges through culverts to a heavily armored channel for the first 50 feet and then enters an area where it is bordered on both sides by residential development. As the stream turns south, there is an exposed eroded bank just at the turn and then a berm, apparently built with yard debris. Houses are situated approximately 20 feet from the berm and fences separate the stream from the homes. Stormwater has scoured out the roots of most of the trees along this stretch. The outlet of a small stormwater detention pond discharges directly into the stream approximately 250 feet downstream from where the stream turns south. Evidence of sediment accumulation is present at this outfall. The stream has no overhead canopy and instream vegetation consists almost entirely of grasses through this segment. The substrate consists of silty sands with small areas of gravel.

Once the stream crosses S. 246th Pl., it becomes completely enshrouded in blackberry bramble so that the streambed itself is no longer visible and is difficult to access. Downstream of 246th Pl. the stream enters a steep vegetated ravine. With the exception of where the stream has been dammed to form a small pond, from here to the Sound, the stream flows through this ravine. Houses are located away from the steep banks and slopes are covered with fir, alder, fern, and ivy. Because the slopes are covered with huge old firs and alders there is a high amounts of LWD or LWD potential. However, the stream channel is completely covered by blackberry.

Below the dam and pond the stream again enters a wide, steep ravine. The stream continues through this ravine past a wastewater facility to the city boundaries. Along the wastewater facility the stream is highly channelized (3-5' wide and 2-5' deep) with riprap along the majority of its left bank. A steep hill comprises the right bank. This area has garbage and asphalt/cement chunks in the stream and has potential fish barriers during low flows.

AR 025638

RIPARIAN CORRIDOR ASSESSMENTS

MC-1

Site MC-1 is located at the headwaters of McSorley Creek. The creekbed was dry, at the time of the survey, along the main channel through residential backyards. The stream banks border residential homes with lawns and related activity occurring adjacent to the bank. The yards display the typical range in bankside activity, a few have fairly natural bankside vegetation, most are lawns, and bankside cover varies from thick lawn grass to badly eroded or broken banks. Riprap has been placed along the bank in some places. A tributary to the main channel forms a small ravine, starting below the school playground, and was providing the only water to the stream, at the time of the survey.

Stormwater from the school playground enters the stream via a culvert located at the top of this ravine. In this area there is a fairly wide vegetated buffer, but it is being heavily impacted. The vegetation consisted mainly of blackberry with minimal amounts of ivy, alder and shrubs. A trail enters the ravine from the school playground. This trail is eroded to bare clay, the resultant erosion is the likely cause of sediment accumulation in the stream channel. Another trail parallels the bank to a fence (private property) approximately 10' from where the tributary joins the main stream channel. This trail follows a steep bank and is causing erosion. The stream channel has generally good substrate with cobble, rocks, and large woody debris for habitat and pool development.

MC-2

Site MC-2 is bordered on both sides by residential development. Houses are approximately 10' from the stream banks and yards create a small buffer. Streamside yards have the usual large variation in use; naturally vegetated banks to heavily eroded. In either case, buffer area is narrow and overhead canopy often minimal. There is a great deal of instream vegetation (grasses and ranunculus sp.), probably due to the more open canopy and greater sunlight reaching the stream. The substrate consists of silty sands with small areas of gravel, unless homeowners have altered it.

MC-3

Site MC-3 is located in a wide ravine, resulting in a tall overhead canopy (110'above), with a shrub/bramble streamside canopy. The steep slopes in this entire section are providing plenty of fallen logs. Large boulders and many rocks are found in the streambed. However, sediment accumulation areas have formed and silts cover much of the stream bottom. Logs have been placed across the stream in this area and are causing good pool formation. Stormwater culverts exist where the 16th Ave. bridge crosses the ravine.

COMPARISON TO 1994

- Blackberry bramble more dominant along all reaches of the stream then it was when the 1994 survey was conducted.

PROTECTION/RESTORATION OPPORTUNITIES

Impacts associated with high water flows are evident throughout the city streams. Sections of streams are downcutting, streambanks are eroding, and sediment accumulation areas are prevalent. The streams generally lack the natural sinuosity or meander pattern that is essential for creating more hydrologic diversity (pools, riffles, and glides). This general condition has not changed between survey dates. The following summarize some of the protection or restoration opportunities that exist for each stream system.

MASSEY CREEK

- The fairly wide ravine areas in the upper portion of this stream might be better utilized by enhancing meander formation, or using the floodway for off channel storage, which could reduce flows during the many smaller rainfall events. This area would also be greatly improved through blackberry removal.

- The section between 20th and 16th with its steep confined channel and three 90 degree turns lends itself well to a public involvement and education project since almost the entire section runs between apartment complexes. However, returning the stream to a more natural meander pattern would be difficult in these tight quarters and placement of instream habitat; large boulders or logs, could easily enhance flooding. Restoration of this section would likely require creative engineering and land acquisition.

- The commercial segment below 10th Ave. S. might provide a good City enhancement project. This area is visible to the many people who travel this road. Removal of the blackberry and replacement with native vegetation would not only enhance the ecology of the stream, but could provide a visual amenity to this commercial area. Instream habitat in the form of boulders or anchored logs would enhance fish use.

- With a few exceptions, there are few large boulders or LWD to provide habitat and form the stream channel in Massey Creek. Given the wide naturally wooded ravines located throughout the streams' length, this is surprising. It is possible that LWD is being removed from the stream channel.

BARNES CREEK

- The stormwater discharge pipe at 13th Ave. S. should be examined to discern its contribution to sedimentation and erosion of the stream channel in this area.

DESMOINES CREEK

- The paved walk/bike trail along the stream provides a good opportunity to educate the public about the stream and how to protect it. This could be done with the use of information boards at entrance points to the trail or along the stream.

- Although DesMoines Creek has far more diversity in stream habitat than the other streams assessed, it is still primarily riffle area. This is especially true for the lower stream segment, below Marine

View Drive. This segment of the stream would benefit from additional pool habitat (i.e. large boulders or logs).

MCSORLEY

- The majority of McSorley Creek flows through residential yards, thus community involvement and education programs could be beneficial for restoring and protecting the stream. Emphasis should be on adding streamside plantings of native vegetation, leaving a 5 foot buffer of native grass and shrubs between the maintained lawn and the streambed, and general lawn and garden BMP's.

- The portion of the stream below the pond and dam, which is accessible to salmonids, provides diverse habitat areas (pools and riffles) with good riparian vegetation and many large logs and boulders for cover. However, the streambed along the small wastewater treatment facility is a steep, narrow, tunnel-like channel. Since it may be difficult to re-engineer this channel to allow a more natural meander pattern, an inspection program should be put in place to periodically check this segment for potential fish passage barriers that can easily form from the many available upstream sources. Continual removal of potential barriers should allow fish access to the higher quality upstream habitat.

SUMMARY

Relatively steep ravines are naturally providing protection to much of the stream length for all three streams in the urbanized area. These ravines deter direct access, and when properly vegetated provide good overhead canopy, LWD potential, forest litter and many other requirements for a well functioning stream system. Unfortunately, these areas are increasingly being invaded by blackberry, which enshrouds large portions of each stream. No sunlight can reach the stream bed in these areas, there is little variation in food sources for macroinvertebrates (vegetation material), and the blackberry does not have dense root mass to hold onto soils. A long term program to remove blackberry from select (higher quality) reaches that are well protected from urban impact would greatly benefit the stream ecology.

There is little diversity in habitat in any of the streams. Pool habitat is especially sparse. Where there is adequate space, the streams should be allowed to meander and form their own pools. Placement of small boulders and even root wads would of course also enhance the pool habitat.

There are steep, deeply cut channelized areas in both McSorley and Massey. If possible, off channel flow storage should be considered upstream of these areas to reduce peak flows. Alternatively, these areas could be left as they are but additional efforts be placed at the downstream ends to dissipate flows and enhance the streams ability to return to a more natural morphology.

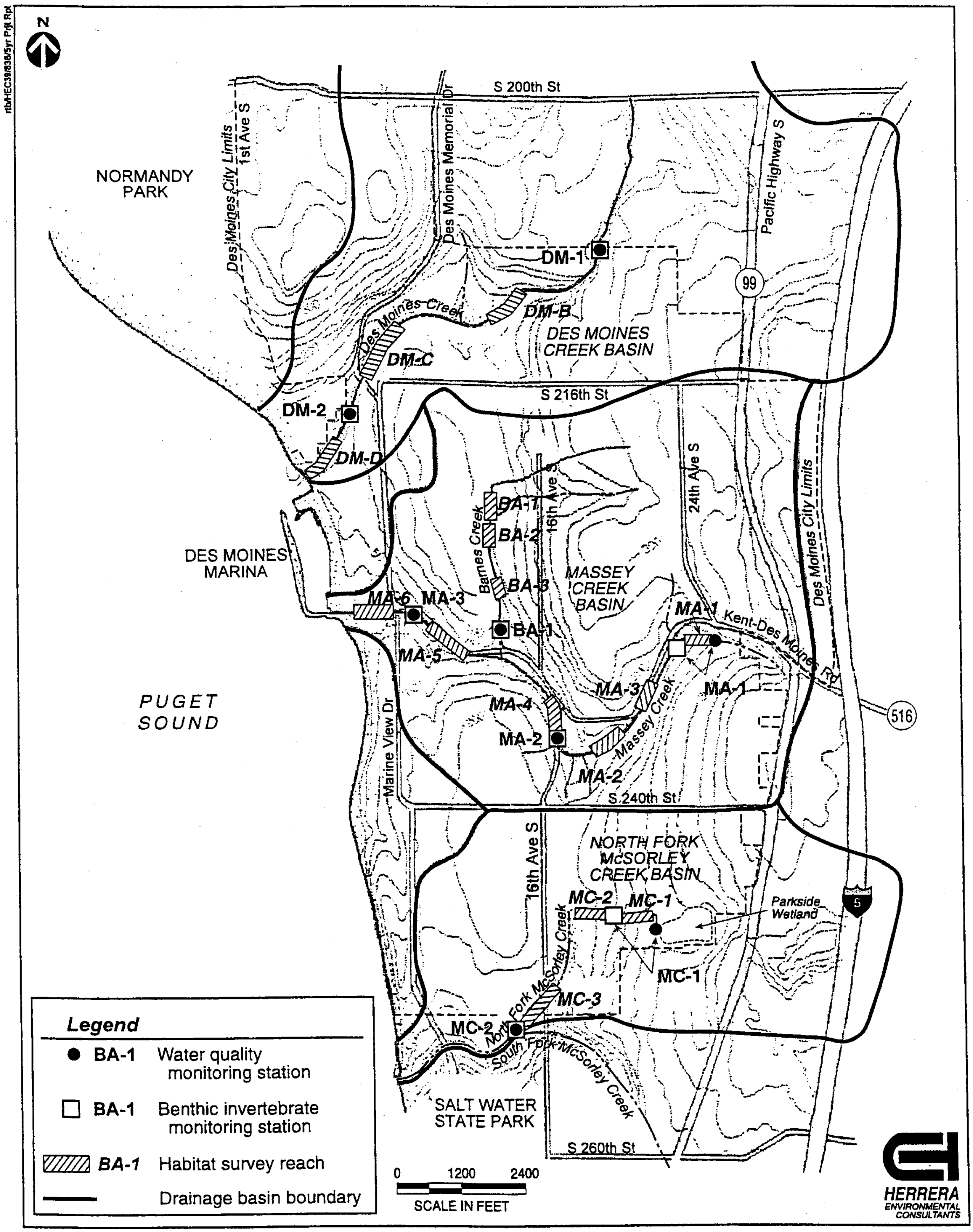
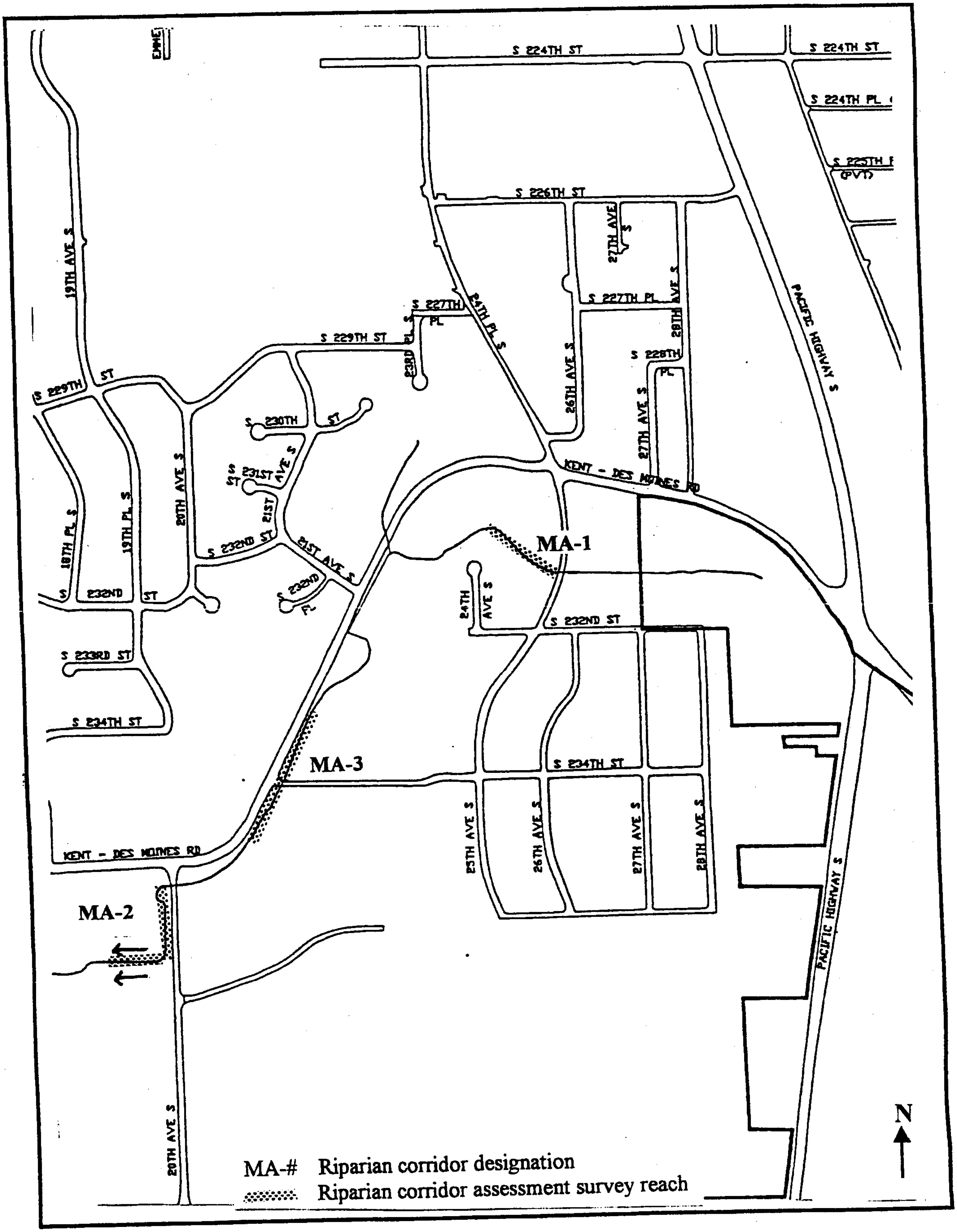


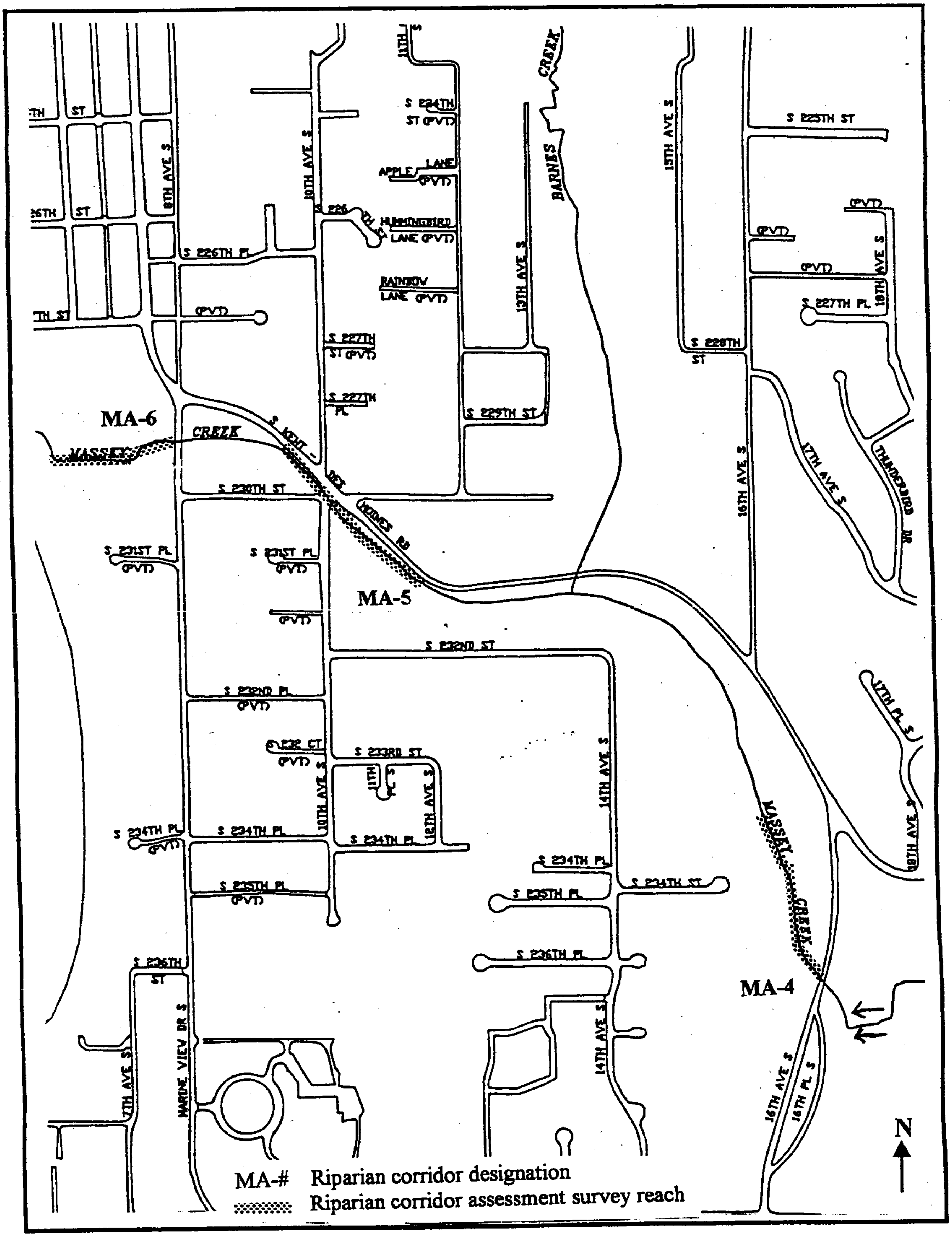
Figure 1. Monitoring locations for the Des Moines water quality monitoring program.

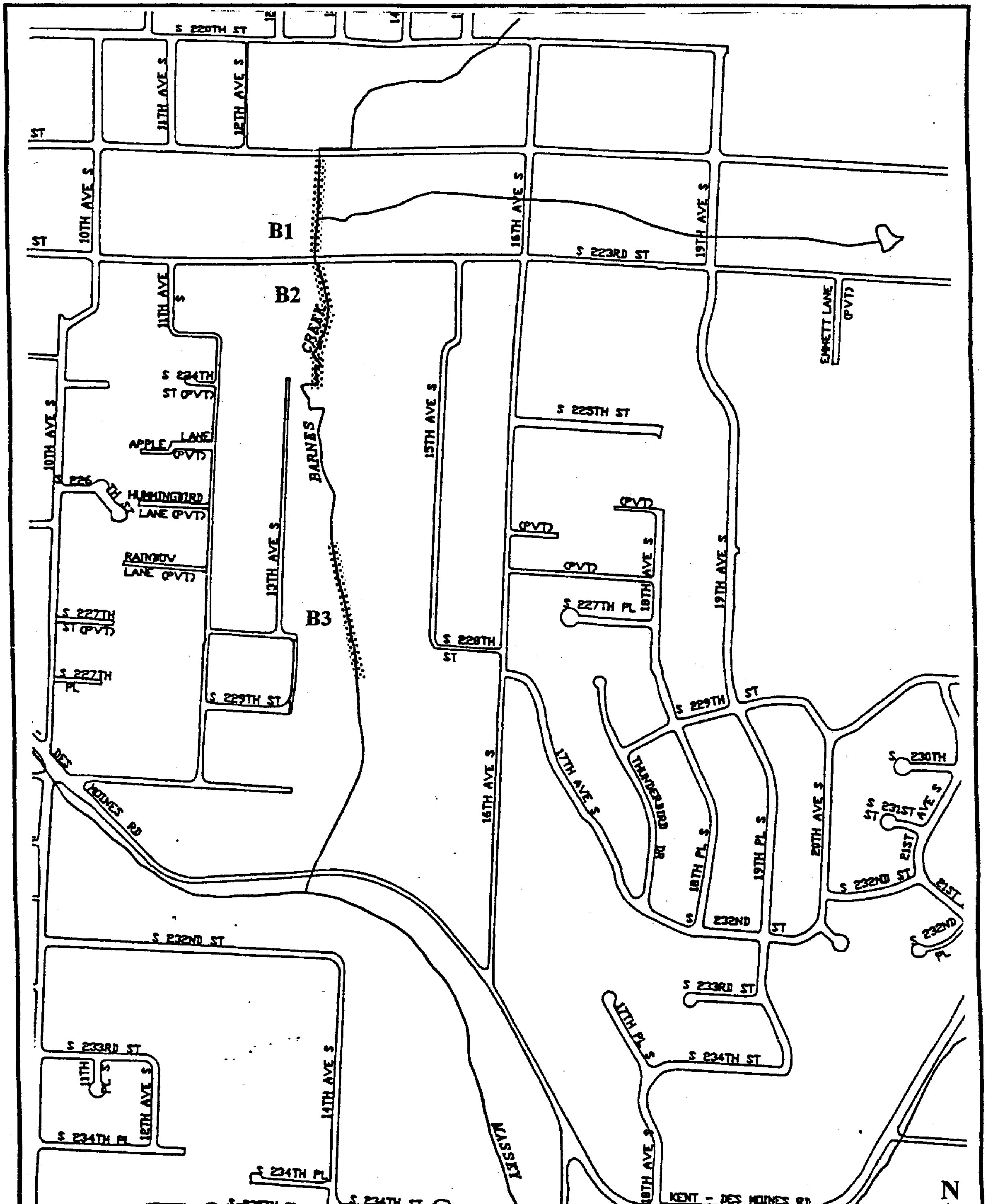
APPENDIX A

1999 RIPARIAN CORRIDOR ASSESSMENT SURVEY FORMS

(Includes base maps used in field surveys.)

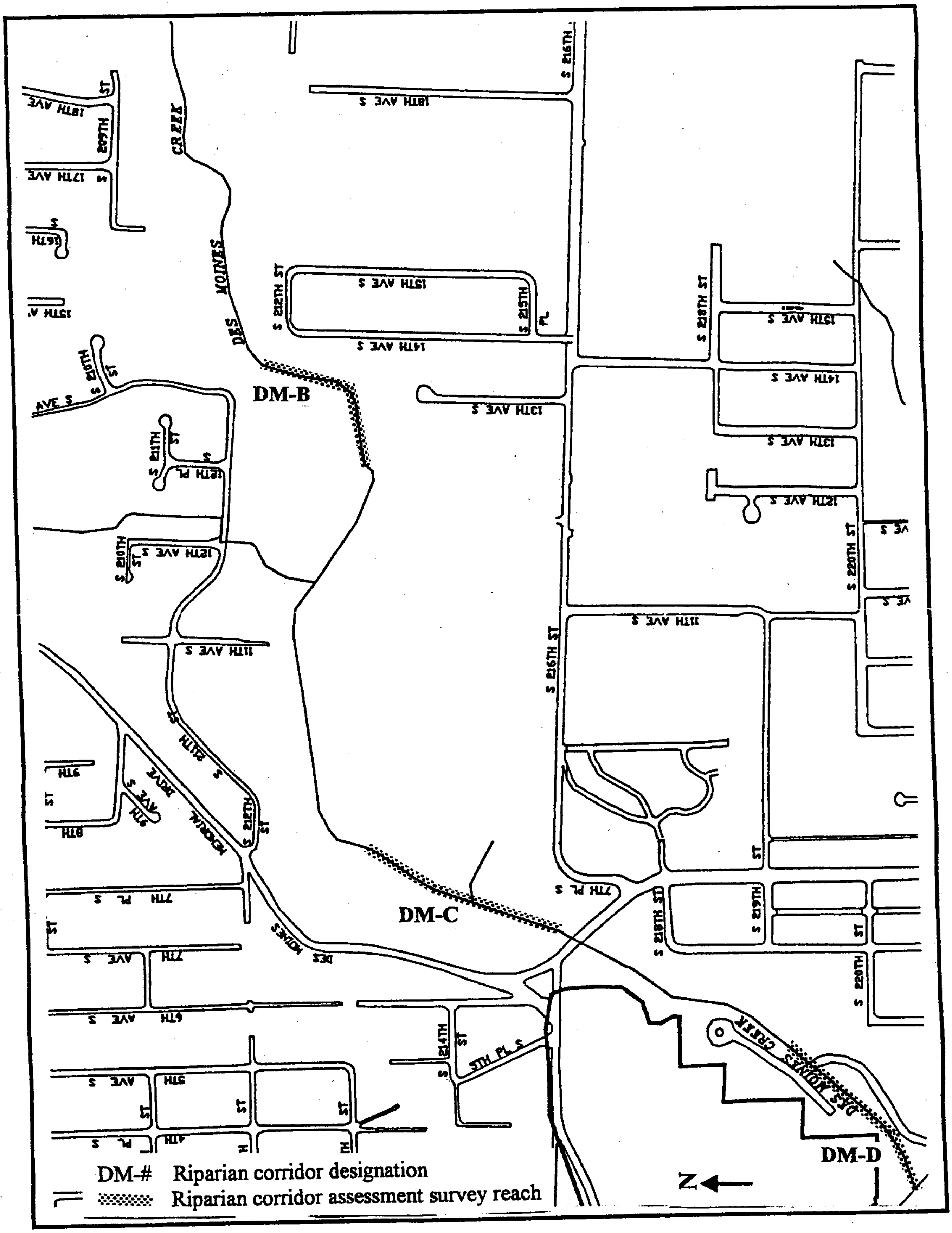

S 224TH ST
S 224TH ST
S 224TH PL
S 225TH PL (PVT)
S 226TH ST
27TH AVE S
S 227TH PL
S 227TH PL
24TH PL S
28TH AVE S
S 229TH ST
23RD PL S
26TH AVE S
S 228TH PL
27TH AVE S
PACIFIC HIGHWAY S
19TH AVE S
S 229TH ST
S 230TH ST
20TH AVE S
S 231ST ST
21ST AVE S
KENT - DES MOINES RD
18TH PL S
19TH PL S
S 232ND ST
21ST AVE S
MA-1
S 232ND ST
S 232ND PL
24TH AVE S
S 232ND ST
S 233RD ST
S 234TH ST
MA-3
S 234TH ST
25TH AVE S
26TH AVE S
27TH AVE S
28TH AVE S
KENT - DES MOINES RD
MA-2
PACIFIC HIGHWAY S
20TH AVE S
N
MA-# Riparian corridor designation
Riparian corridor assessment survey reach

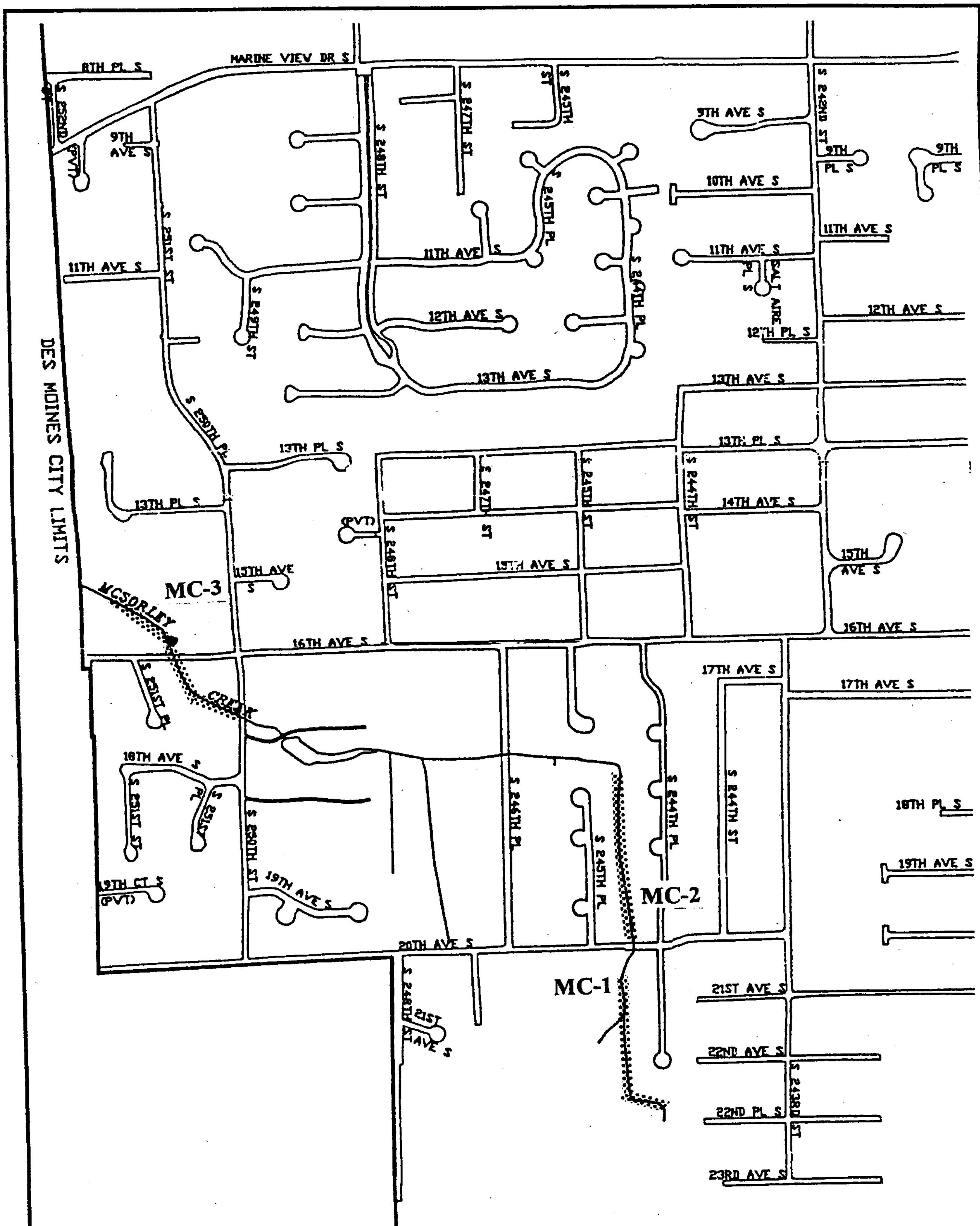

MA-6
MA-5
MA-4
MASSEY CREEK
BARNES CREEK
S 224TH ST (PVT)
APPLE LANE (PVT)
HUMMINGBIRD LANE (PVT)
RAINBOW LANE (PVT)
S 225TH ST
S 226TH PL
S 227TH ST (PVT)
S 227TH PL
S 228TH ST
S 229TH ST
S 230TH ST
S 231ST PL (PVT)
S 232ND ST
S 232ND PL (PVT)
S 232 CT (PVT)
S 233RD ST
S 234TH PL
S 234TH ST
S 235TH PL
S 236TH PL
S 236TH ST
S KENT - DES MOINES RD
8TH AVE S
10TH AVE S
11TH S
12TH AVE S
13TH AVE S
14TH AVE S
15TH AVE S
16TH AVE S
16TH PL S
17TH AVE S
17TH PL S
18TH AVE S
19TH AVE S
7TH AVE S
MARINE VIEW DR S
THUNDERBIRD DR
N
MA-# Riparian corridor designation
Riparian corridor assessment survey reach



B# Riparian corridor designation

::::::: Riparian corridor assessment survey reach


DM-B
DM-C
DM-D
DES MOINES CREEK
S 216TH ST
S 218TH ST
S 219TH ST
S 220TH ST
S 212TH ST
S 215TH PL
18TH AVE S
15TH AVE S
14TH AVE S
13TH AVE S
12TH AVE S
11TH AVE S
7TH PL S
5TH PL S
S 214TH ST
N
DM-# Riparian corridor designation
Riparian corridor assessment survey reach



MC-# Riparian corridor designation

Riparian corridor assessment survey reach

Pictures 3-10

APPENDIX V
RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # MA-1 2. DATE 09/30/99

3. STREAM NAME: Massey 4. SURVEYORS: JPM : SLM

TRIBUTARY TO:__________

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6.___.___ TO 7.___.___

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3	4 ✓
9. SLIMES (Iron bacteria)	1	2	3	4 ✓ (near site)
10. BENTHOS (Bottom Dwelling Animals)	1	2	3	4
11. FISH (JUVENILE/ADULTS):	1	2	3	4 ✓

LAND USE ADJACENT TO STREAM (#; %) DOMINANT 12. # 1 15. 100% %; SUBDOMINANT 13. #___ 16.___%; OTHERS PRESENT 14. #___ 17.___%

This is residential but homes are at least 100' from stream EXCEPT @ condo's

1. Forest or natural vegetation 4. Pasture—unfenced 7. Residential—scattered
2. Park or golf course 5. Pasture—fenced 8. Residential—continuous
3. Roadside (Highway/Street) 6. Cultivated field 9. Industrial/Commercial

18. VEGETATIVE BANK COVER: Bank is predominantly blkberry. 100% cover but little in the way of root mat

- [1] Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion. (No)
- [2] ✓ 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.
- [3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.
- [4] <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: Right Bank 19. >100 feet; Left Bank 20. >100 feet

VEGETATION TYPES: DOMINANT 21. 3 SUBDOMINANT 22. 4 OTHERS PRESENT 23.___
1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER Holly, laurel, Ivy

24. OVERHEAD CANOPY: Blkberry forms solid cover w/75% overstory cover

- [1] ✓ 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).
- [2] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).
- [3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.
- [4] 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT:

- [1] Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.
- [2] Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).
- [3] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.
- [4] ✓ Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. 1 SUBDOMINANT 27.___ OTHERS PRESENT 28.___
1. ROCKS 2. LOGS 3. ROOT WADS 4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG.

29. CHANNEL CAPACITY

- [1] Inadequate. Channel subject to severe erosion—channel may be widening or migrat... extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)
- [2] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)
- [3] ✓ Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).
- [4] Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.
- [5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:

- [1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.
- [2] Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.
- [3] Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.
- [4] ✓ Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state. Lots of activity near condos.

31. STREAMBANK STABILITY:

- [1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.
- [2] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident.
- [3] ✓ 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition. (No Blkberry)
- [4] Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION: Organic bottom w/rocks (occasional)

- [1] ✓ Substrate loose assortment easily moved with boot heel.
- [2] Substrate moderately packed/cemented. Substrate difficult to move with boot heel.
- [3] Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.
- [4] Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR: Very shallow (<2"-5) Colored

- [1] ✓ Transparent, bottom of channel is visible.
- [2] Opaque or white like, bottom of channel may be visible.
- [3] Light to dark brown; visible particulate matter present. Bottom of channel not visible.
- [4] 1. RED (iron) 2. TAN 3. GREEN 4. OIL SHEEN Other colors ______

34. ODOR NA

- [1] Animal waste or manure.
- [2] Septic or human waste.
- [3] Decaying plant matter.
- [4] Other____

1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH

- [1] ✓ Litter in stream: cans, bottles, yard debris, logging or land clearing debris—in or adjacent to channel.
- [2] Tires, cars, appliances, fill material—in or adjacent to channel.
- [3] Dead/decaying animals or fish.
- [4] Concentrated dump site contains _____

1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT NA

- [1] Farm animals in stream at _____.
- [2] Snag pockets found at _____.
- [3] Wetlands at _____
- [4] Water withdrawal (pump/ditch) at _____.
- [5] Floating material _____

1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

AR 025649

MA-1

FISH PASSAGE BARRIERS:

Type:	RM:	Height:	Pool Depth	Length to Negotiate:
Culvert	@ 29th S			
Rockwall	@ Condos Near 21st			

Falls 37_____ Culvert 38_____ Dam 39_____

Debris 40_____ Beaver Dam 41_____

GENERAL COMMENTS:

50. Stream _____ 51. Survey _____

52. Communication with Residents: _____ 53. Other _____

DIRECT DISCHARGE TO STREAM: None

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:
Trib		RB		

Type: Tributary 42_____ Pipe/Culvert 43_____ Seeps/Springs 46_____

Grass-lined Swale 44_____ Ditch 45_____

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:

47. Total _____

A. Clearing/Grading B. Landscaping C. Other Construction Activity

D. Land Use Change

48. Substrate Composition, Percentage of Cover

1 Bedrock _____

2 Boulders (>3') _____

3 ✓ Cobble (3" – 3') 10%

4 Gravel (0.1" – 3") _____

5 Sand (<0.1") & Organic 90%

6 Silt _____

7 Clay _____

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Dept

Channel cross-section:

☑ 3 (majority) ☑ 4 (@ top of spanning) 5 6 7 8

AR 025650

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Pictures 11-15

APPENDIX V
RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # MA-2 2. DATE 09/30/99

3. STREAM NAME: Massey 4. SURVEYORS: JPM / SLM

TRIBUTARY TO:________

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. ___.__ TO 7. ___.__

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3	4 ✓
9. SLIMES	1	2	3 ✓	4
10. BENTHOS (Bottom Dwelling Animals)	1	2	3	4
11. FISH (JUVENILE/ADULTS):	1	2	3	4

LAND USE ADJACENT TO STREAM (#; %)
DOMINANT 12. # 8 15. 80 %
SUBDOMINANT 13. # 3 16. 10 %
OTHERS PRESENT 14. # 4 17. 10 %

1. Forest or natural vegetation
2. Park or golf course
3. Roadside (Highway/Street)
4. Pasture—unfenced
5. Pasture—fenced
6. Cultivated field
7. Residential—scattered
8. Residential—continuous
9. Industrial/Commercial

18. VEGETATIVE BANK COVER: Bramble = Cover & shaded but no real root mat of any kind

[1] Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion.

[2 ✓] 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.

[3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.

[4] <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: Right Bank 19. <10-20 feet; Left Bank 20. <10-20 feet

VEGETATION TYPES: DOMINANT 21. 3 SUBDOMINANT 22. ___ OTHERS PRESENT 23. ___
1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER ________

24. OVERHEAD CANOPY: Minimal tree overstory (trees)

[1] 76-100% of stream surface shaded by trees or overgrowth with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).

[2 ✓] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).

[3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.

[4] 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT:

[1] Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.

[2] Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).

[3 ✓] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.

[4] Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. 1 SUBDOMINANT 27. 4 OTHERS PRESENT 28. ___
1. ROCKS 2. LOGS 3. ROOT WADS 4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG.

CHANNEL CAPACITY

[1] Inadequate. Channel subject to severe erosion—channel may be widening or migrat... extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)

[2 ✓] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)

[3] Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).

[4] Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.

[5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:

[1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.

[2] Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.

[3] Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.

[4 ✓] Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY:

[1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.

[2 ✓] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident.

[3] 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.

[4] Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION:

[1] Substrate loose assortment easily moved with boot heel.

[2 ✓] Substrate moderately packed/cemented. Substrate difficult to move with boot heel.

[3] Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.

[4] Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR:

[1 ✓] Transparent, bottom of channel is visible.

[2] Opaque or white like, bottom of channel may be visible.

[3] Light to dark brown; visible particulate matter present. Bottom of channel not visible.

[4] 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors ________

34. ODOR NA

[1] Animal waste or manure.
[2] Septic or human waste.
[3] Decaying plant matter.
[4] Other _____
1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH

[1 ✓] Litter in stream: cans, bottles, yard debris, logging or land clearing debris—in or adjacent to channel. Not a lot

[2] Tires, cars, appliances, fill material—in or adjacent to channel.

[3] Dead/decaying animals or fish.

[4] Concentrated dump site contains _____
1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT

[1] Farm animals in stream at ________.
[2] Snag pockets found at ________.
[3] Wetlands at ________
[4] Water withdrawal (pump/ditch) at _____.
[5] Floating material ______
1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

MA.2

FISH PASSAGE BARRIERS: None

Type:	RM:	Height:	Pool Depth	Length to Negotiate:

Falls 37________ Culvert 38________ Dam 39________

Debris 40________ Beaver Dam 41________

GENERAL COMMENTS:

50. Stream ________ 51. Survey ________

52. Communication with Residents: ______ 53. Other ________

DIRECT DISCHARGE TO STREAM: None Seen

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:

Type: Tributary 42______ Pipe/Culvert 43______ Seeps/Springs 46______

Grass-lined Swale 44______ Ditch 45______

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:

47. Total ________ A. Clearing/Grading B. Landscaping C. Other Construction Activity D. Land Use Change

48. Substrate Composition, Percentage of Cover

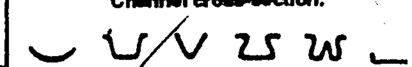
1	Bedrock	______%
2	Boulders (>3')	______%
3 ✓	Cobble (3" – 3')	<20 %
4	Gravel (0.1" – 3")	______%
5 ✓	Sand (<0.1")	Sand Silty Sand 60 %
6 ✓	Silt	______%
7 ✓	Clay Hard Exposed Cemented	20 %

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Dept

Channel cross-section:



3 4 ✓ 5 6 7 8

APPENDIX V

RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # Ma3 2. DATE 09/30/99

3. STREAM NAME: Massey 4. SURVEYORS: JPM SLM

TRIBUTARY TO: ____

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. ___ TO 7. ___

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3	4 ✓
9. SLIMES	1	2	3	4 ✓
10. BENTHOS (Bottom Dwelling Animals)	1	2	3	4
11. FISH (JUVENILE/ADULTS):	1	2	3	4 ✓

LAND USE ADJACENT TO STREAM (#; %) Still blkberry but more diverse canopy

DOMINANT 12. # 1 15. 100 %
SUBDOMINANT 13. # ___ 16. ___ %
OTHERS PRESENT 14. # ___ 17. ___ %

1. Forest or natural vegetation 4. Pasture—unfenced 7. Residential—scattered
2. Park or golf course 5. Pasture—fenced 8. Residential—continuous
3. Roadside (Highway/Street) 6. Cultivated field 9. Industrial/Commercial

18. VEGETATIVE BANK COVER: Sunlite from East means more openings : diversity than md-1

1 ✓ Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion.

2 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.

3 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.

4 <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: Right Bank 19. 20-50' feet; Left Bank 20. >100 feet

VEGETATION TYPES: DOMINANT 21. 3 SUBDOMINANT 22. 2 OTHERS PRESENT 23. Few

1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER Willow, laurel

24. OVERHEAD CANOPY:

1 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).

2 ✓ 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).

3 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.

4 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT:

1 Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.

2 Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).

3 Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.

4 ✓ Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. 1 SUBDOMINANT 27. ___ OTHERS PRESENT 28. 2

1. ROCKS 2. LOGS 3. ROOT WADS 4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG.

CHANNEL CAPACITY

1 Inadequate. Channel subject to severe erosion—channel may be widening or migrat... extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)

2 ✓ Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)

3 Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).

4 Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.

5 Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:

1 Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.

2 ✓ Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered. Above segment entire LB is eroded or has protection Below is none

3 Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.

4 Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY:

1 Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhange and sloughing frequent.

2 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhange and sloughing evident.

3 ✓ 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.

4 Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION:

1 Substrate loose assortment easily moved with boot heel.

2 ✓ Substrate moderately packed/cemented. Substrate difficult to move with boot heel.

3 Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.

4 Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR:

1 ✓ Transparent, bottom of channel is visible.

2 Opaque or white like, bottom of channel may be visible.

3 Light to dark brown; visible particulate matter present. Bottom of channel not visible.

4 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors Brown/Tan

34. ODOR NA

1 Animal waste or manure. 3 Decaying plant matter.

2 Septic or human waste. 4 Other ____

1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH No

1 Litter in stream: cans, bottles, yard debris, logging or land clearing debris—in or adjacent to channel.

2 Tires, cars, appliances, fill material—in or adjacent to channel.

3 Dead/decaying animals or fish.

4 Concentrated dump site contains ____

1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT No

1 Farm animals in stream at ____. 4 Water withdrawal (pump/ditch) at ____.

2 Snag pockets found at ____. 5 Floating material ____

3 Wetlands at ____

1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

AR 025653

MA-3

FISH PASSAGE BARRIERS:

Type:	RM:	Height:	Pool Depth	Length to Negotiate:
RB Raised Bridge	e 234 ft			

Falls 37_____ Culvert 38_____ Dam 39_____

Debris 40_____ Beaver Dam 41_____

GENERAL COMMENTS:

50. Stream _____ 51. Survey _____

52. Communication with Residents: _____ 53. Other _____

DIRECT DISCHARGE TO STREAM:

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:
6" pipe articulated		LB	3-4 new drainage pipes behind ads on LB. Steep eroded banks here.	

Type: Tributary 42_____ Pipe/Culvert 43_____ Seeps/Springs 46_____
Grass-lined Swale 44_____ Ditch 45_____

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:

47. Total _____
A. Clearing/Grading B. Landscaping C. Other Construction Activity
D. Land Use Change

48. Substrate Composition, Percentage of Cover

1	Bedrock	
2	Boulders (>3')	
3	Cobble (3" – 3')	
4 ✓	Gravel (0.1" – 3")	40
5 ✓	Sand (<0.1")	20
6 ✓	Silt	20
7	Clay	

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Dept

Channel cross-section:

3 4 ✓ 5 6 7 8

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AR 025654

Picts 16-20

APPENDIX V

RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # Ma 4   2. DATE 09/30/99

3. STREAM NAME: Massey   4. SURVEYORS: JPM + SLM

TRIBUTARY TO: ____

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. __.__ TO 7. __.__

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3	4 ✓
9. SLIMES (Brown periphyton)	1	2 ✓	3	4
10. BENTHOS (Bottom Dwelling Animals)	1	2 ✓	3	4
11. FISH (JUVENILE/ADULTS):	1	2	3 ✓	4

LAND USE ADJACENT TO STREAM (#; %)

	#	%
DOMINANT	12. # 1	15. 80 %
SUBDOMINANT	13. # 7	16. 20 %
OTHERS PRESENT	14. # ____	17. ____ %

1. Forest or natural vegetation
2. Park or golf course
3. Roadside (Highway/Street)
4. Pasture—unfenced
5. Pasture—fenced
6. Cultivated field
7. Residential—scattered
8. Residential—continuous
9. Industrial/Commercial

18. VEGETATIVE BANK COVER:

[1 ✓] Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion. Except in [illegible]

[2] 75-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.

[3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.

[4] <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: Right Bank 19. 10-200 feet; Left Bank 20. 7 800 feet

VEGETATION TYPES: DOMINANT 21. 2 SUBDOMINANT 22. 4 OTHERS PRESENT 23. 5

1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER ferns, etc

24. OVERHEAD CANOPY: Much more open

[1] 75-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).

[2 ✓] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).

[3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.

[4] 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT:

[1] Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.

[2 ✓] Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).

[3] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.

[4] Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. 2 SUBDOMINANT 27. 4 OTHERS PRESENT 28. 5

1. ROCKS 2. LOGS 3. ROOT WADS 4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG.

CHANNEL CAPACITY

[1] Inadequate. Channel subject to severe erosion—channel may be widening or migrat... extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)

[2] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)

[3 ✓] Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).

[4] Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.

[5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:

[1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.

[2] Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.

[3] Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.

[4 ✓] Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state. In lower end of reach only

31. STREAMBANK STABILITY:

[1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.

[2 ✓] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident.

[3] 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.

[4] Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION:

[1] Substrate loose assortment easily moved with boot heel.

[2] Substrate moderately packed/cemented. Substrate difficult to move with boot heel.

[3 ✓] Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.

[4] Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR:

[1 ✓] Transparent, bottom of channel is visible.

[2] Opaque or white like, bottom of channel may be visible.

[3] Light to dark brown; visible particulate matter present. Bottom of channel not visible.

[4] 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors ____

34. ODOR

[1] Animal waste or manure.

[2] Septic or human waste.

[3 ✓] Decaying plant matter.

[4] Other ____

1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH Lots. Everything & anything

[1 ✓] Litter in stream: cans, bottles, yard debris, logging or land clearing debris—in or adjacent to channel.

[2] Tires, cars, appliances, fill material—in or adjacent to channel.

[3] Dead/decaying animals or fish.

[4] Concentrated dump site contains ____

1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT

[1] Farm animals in stream at ____.

[2] Snag pockets found at ____.

[3] Wetlands at ____

[4] Water withdrawal (pump/ditch) at ____.

[5] Floating material ____

1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

AR 025655

MA-4

FISH PASSAGE BARRIERS:

Type:	RM:	Height:	Pool Depth	Length to Negotiate:
Some of the debris dams may be barriers.				

Falls 37________ Culvert 38________ Dam 39________

Debris 40________ Beaver Dam 41________

GENERAL COMMENTS:

50. Stream ________ 51. Survey ________

52. Communication with Residents: _____ 53. Other ________

DIRECT DISCHARGE TO STREAM:

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:
lg plastic culvert		RB		
Sm 4"		RB		
Sm 4"		RB		

Type: Tributary 42______ Pipe/Culvert 43______ Seeps/Springs 46______

Grass-lined Swale 44______ Ditch 45______

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR: New Culvert @ 16th

RM:	Prox to Stream: <30 >30:	Length	Cause:
			Road wash

47. Total ________

A. Clearing/Grading B. Landscaping C. Other Construction Activity

D. Land Use Change

48. Substrate Composition, Percentage of Cover

- [1] Bedrock Clay/hardpan 70
- [2] Boulders (>3') ______
- [3] Cobble (3" – 3') ______
- [4] Gravel (0.1" – 3") 15
- [5] Sand (<0.1") 15
- [6] Silt ______
- [7] Clay ______

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

[1] Width	[2] Depth	[1] Width	[2] Dept
6-7'	~4" av.	Existing	
10-20'		High Flow	

Channel cross-section:

[3] [4] ✓ [5] [6] [7] [8]

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AR 025656

APPENDIX V
RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # MA-5 2. DATE 09/30/99

3. STREAM NAME: Massey 4. SURVEYORS: JPM + SLM

TRIBUTARY TO: ______

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. __.__ TO 7. __.__

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3	4 ✓
9. SLIMES	1	2 ✓ (algae)	3	4
10. BENTHOS (Bottom Dwelling Animals)	1	2	3	4
11. FISH (JUVENILE/ADULTS) (both circled):	1	2 ✓	3	4

LAND USE ADJACENT TO STREAM (#; %)

	#	%
DOMINANT	12. # 3	15. 50 %
SUBDOMINANT	13. # 9	16. 50 %
OTHERS PRESENT	14. # ___	17. ___ %

1. Forest or natural vegetation
2. Park or golf course
3. Roadside (Highway/Street) (circled)
4. Pasture—unfenced
5. Pasture—fenced
6. Cultivated field
7. Residential—scattered
8. Residential—continuous
9. Industrial/Commercial (circled)

18. VEGETATIVE BANK COVER:

- [1] ✓ Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion.
- [2] 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.
- [3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.
- [4] <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: Right Bank 19. 10 feet; Left Bank 20. 10-20 feet

VEGETATION TYPES: DOMINANT 21. 3 SUBDOMINANT 22. 2 OTHERS PRESENT 23. 1

1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER ______
willows, bamboo, horsetail, nightshade family

24. OVERHEAD CANOPY:

- [1] 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).
- [2] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).
- [3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.
- [4] ✓ 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT:

- [1] Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.
- [2] Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).
- [3] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.
- [4] ✓ Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. 6 SUBDOMINANT 27. 1 OTHERS PRESENT 28. ___

1. ROCKS 2. LOGS 3. ROOT WADS 4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG.

CHANNEL CAPACITY

- [1] Inadequate. Channel subject to severe erosion—channel may be widening or migrat... extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)
- [2] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)
- [3] ✓ Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).
- [4] Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.
- [5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:

- [1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.
- [2] Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.
- [3] Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.
- [4] ✓ Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY:

- [1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhange and sloughing frequent.
- [2] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhange and sloughing evident.
- [3] 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.
- [4] ✓ Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION:

- [1] Substrate loose assortment easily moved with boot heel.
- [2] Substrate moderately packed/cemented. Substrate difficult to move with boot heel.
- [3] ✓ Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.
- [4] ✓ Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR:

- [1] ✓ Transparent, bottom of channel is visible.
- [2] Opaque or white like, bottom of channel may be visible.
- [3] Light to dark brown; visible particulate matter present. Bottom of channel not visible.
- [4] 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors ______

34. ODOR NA

- [1] Animal waste or manure.
- [2] Septic or human waste.
- [3] Decaying plant matter.
- [4] Other ______

1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH minor

- [1] ✓ Litter in stream: cans, bottles, yard debris, logging or land clearing debris—in or adjacent to channel.
- [2] Tires, cars, appliances, fill material—in or adjacent to channel.
- [3] Dead/decaying animals or fish.
- [4] Concentrated dump site contains ______

1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT

- [1] Farm animals in stream at ______.
- [2] Snag pockets found at ______.
- [3] Wetlands at ______
- [4] Water withdrawal (pump/ditch) at ______.
- [5] Floating material ______

1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

AR 025657

MA-5

FISH PASSAGE BARRIERS: NA

Type:	RM:	Height:	Pool Depth	Length to Negotiate:

Falls 37________ Culvert 38________ Dam 39________

Debris 40________ Beaver Dam 41________

GENERAL COMMENTS:

50. Stream ________ 51. Survey ________

52. Communication with Residents: ______ 53. Other ________

DIRECT DISCHARGE TO STREAM: NA

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:

Type: Tributary 42______ Pipe/Culvert 43______ Seeps/Springs 46______

Grass-lined Swale 44______ Ditch 45______

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:

47. Total ____________

A. Clearing/Grading B. Landscaping C. Other Construction Activity

D. Land Use Change

48. Substrate Composition, Percentage of Cover

1	Bedrock	______
2	Boulders (>3')	______
3	Cobble (3" – 3')	______
4 ✓	Gravel (0.1" – 3")	60
5	Sand (<0.1")	40 (Sand and Silt bracketed)
6	Silt	______
7	Clay	______

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Dept
~ 2'	≤ 6"	Existing	

Channel cross-section:

3 4 ✓ (circled) 5 6 7 8

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Lower 1/8 mi, Estuary w/ confined bed. This form is not very appropriate. These are not issues

APPENDIX V
RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # 1MA-6 2. DATE 09/30/99

3. STREAM NAME: Massey 4. SURVEYORS: JPM + SLM

TRIBUTARY TO: ______

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. ___.__ TO 7. ___.__

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3	[✓] 4
9. SLIMES	1	[✓] 2	3	4
10. BENTHOS (Bottom Dwelling Animals)	1	2	3	4
11. FISH (JUVENILE/ADULTS):	1	2	3	4

LAND USE ADJACENT TO STREAM (#; %)
- DOMINANT 12. # 9 15. 80 %
- SUBDOMINANT 13. # 8 16. 20 %
- OTHERS PRESENT 14. # ___ 17. ___ %

1. Forest or natural vegetation
2. Park or golf course
3. Roadside (Highway/Street)
4. Pasture—unfenced
5. Pasture—fenced
6. Cultivated field
7. Residential—scattered
8. Residential—continuous
9. Industrial/Commercial

18. VEGETATIVE BANK COVER:
- [1] Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion.
- [2] 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.
- [✓ 3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.
- [4] <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: Right Bank 19. 0-15 feet; Left Bank 20. 0-15 feet

VEGETATION TYPES: DOMINANT 21. 3 SUBDOMINANT 22. 1 OTHERS PRESENT 23. ___
1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER ______

24. OVERHEAD CANOPY:
- [1] 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).
- [2] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).
- [3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.
- [✓ 4] 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent. 100% covered when under building

25. FISH HABITAT:
- [1] Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.
- [2] Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).
- [3] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.
- [✓ 4] Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. ___ SUBDOMINANT 27. ___ OTHERS PRESENT 28. ___
1. ROCKS 2. LOGS 3. ROOT WADS 4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG.

. CHANNEL CAPACITY
- [1] Inadequate. Channel subject to severe erosion—channel may be widening or migrat... extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)
- [2] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)
- [3] Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).
- [✓ 4] Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.
- [5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:
- [1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.
- [✓ 2] Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.
- [3] Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.
- [4] Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY:
- [1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.
- [✓ 2] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident.
- [3] 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.
- [4] Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION:
- [1] Substrate loose assortment easily moved with boot heel.
- [2] Substrate moderately packed/cemented. Substrate difficult to move with boot heel.
- [3] Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.
- [✓ 4] Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR:
- [✓ 1] Transparent, bottom of channel is visible.
- [2] Opaque or white like, bottom of channel may be visible.
- [3] Light to dark brown; visible particulate matter present. Bottom of channel not visible.
- [4] 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors ______

34. ODOR Salty
- [1] Animal waste or manure.
- [2] Septic or human waste.
- [3] Decaying plant matter.
- [4] Other ____

1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH NA
- [1] Litter in stream: cans, bottles, yard debris, logging or land clearing debris—in or adjacent to channel.
- [2] Tires, cars, appliances, fill material—in or adjacent to channel.
- [3] Dead/decaying animals or fish.
- [4] Concentrated dump site contains ____

1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT
- [1] Farm animals in stream at ______.
- [2] Snag pockets found at ______.
- [3] Wetlands at ______
- [4] Water withdrawal (pump/ditch) at ____.
- [5] Floating material ______

1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

MA-U

FISH PASSAGE BARRIERS: NA

Type:	RM:	Height:	Pool Depth	Length to Negotiate:

Falls 37________ Culvert 38________ Dam 39________

Debris 40________ Beaver Dam 41________

GENERAL COMMENTS:

50. Stream ________ 51. Survey ________

52. Communication with Residents: ______ 53. Other ________

DIRECT DISCHARGE TO STREAM: NA

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:

Type: Tributary 42______ Pipe/Culvert 43______ Seeps/Springs 46______

Grass-lined Swale 44______ Ditch 45______

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:

47. Total ________________

A. Clearing/Grading B. Landscaping C. Other Construction Activity

D. Land Use Change

48. Substrate Composition, Percentage of Cover

- 1 Bedrock ________%
- 2 Boulders (>3') ________%
- 3 ✓ Cobble (3" – 3') 30________%
- 4 ✓ Gravel (0.1" – 3") 30________%
- 5 ✓ Sand (<0.1") 30________%
- 6 Silt ________%
- 7 Clay ________%

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Dept

Channel cross-section:

3 4 (circled) 5 6 7 8

" Much of it is confined

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AR 025660

APPENDIX V
RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # B-1   2. DATE 10/5/99

3. STREAM NAME: Baines   4. SURVEYORS: SLM

TRIBUTARY TO: Massey

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. ___.___ TO 7.___.___

No H2O upstream of culvert all water from street (223rd)

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3 ✓	4
9. SLIMES	1	2	3	4 ✓
10. BENTHOS (Bottom Dwelling Animals)	1	2	3	4 ✓
11. FISH (JUVENILE/ADULTS):	1	2	3	4 ✓ (1 juvenil on downstream side of 223rd)

LAND USE ADJACENT TO STREAM (#; %)
DOMINANT 12. # 7   15. 100 %
SUBDOMINANT 13. # ___   16. ___ %
OTHERS PRESENT 14. # ___   17. ___ %

1. Forest or natural vegetation   4. Pasture—unfenced   7. Residential—scattered
2. Park or golf course   5. Pasture—fenced   8. Residential—continuous
3. Roadside (Highway/Street)   6. Cultivated field   9. Industrial/Commercial

18. VEGETATIVE BANK COVER:

[1] Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion.

[2 ✓] 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible. — grass (lawn) further upstream it turns to muck

[3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.

[4] <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: Right Bank 19. 50 feet; Left Bank 20. 100 feet — Lawn (house bottom ditch)

VEGETATION TYPES: DOMINANT 21. 1 SUBDOMINANT 22. 3 OTHERS PRESENT 23. 4, 2
1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER ___________

24. OVERHEAD CANOPY:

[1 ✓] 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).

[2] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).

[3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.

[4] 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT:

[1] Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.

[2] Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).

[3] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.

[4 ✓] Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. 11 SUBDOMINANT 27.___ OTHERS PRESENT 28.___
1. ROCKS 2. LOGS 3. ROOT WADS 4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG.

29. CHANNEL CAPACITY — Marshy area upstream

[1] Inadequate. Channel subject to severe erosion—channel may be widening or migrat. _ extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)

[2] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)

[3 ✓] Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).

[4] Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.

[5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:

[1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.

[2] Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.

[3] Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.

[4 ✓] Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY:

[1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.

[2] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident.

[3 ✓] 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition. — (not natural but not eroding)

[4] Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION:

[1] Substrate loose assortment easily moved with boot heel.
[2] Substrate moderately packed/cemented. Substrate difficult to move with boot heel.
[3] Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.
[4 ✓] Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR: N/A — No water

[1] Transparent, bottom of channel is visible.
[2] Opaque or white like, bottom of channel may be visible.
[3] Light to dark brown; visible particulate matter present. Bottom of channel not visible.
[4] 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors ___________.

34. ODOR N/A

[1] Animal waste or manure.   [3] Decaying plant matter.
[2] Septic or human waste.   [4] Other_____
1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH

[1 ✓] Litter in stream: cans, bottles, yard debris, logging or land clearing debris—in or adjacent to channel.
[2] Tires, cars, appliances, fill material—in or adjacent to channel.
[3] Dead/decaying animals or fish.
[4] Concentrated dump site contains _______
1. ORGANIC MATERIAL 2. INORGANIC

Marshy area - evidence of normal standing water

36. SPECIAL CASES PRESENT

[1] Farm animals in stream at ___________.   [4] Water withdrawal (pump/ditch) at _______.
[2] Snag pockets found at ___________.   [5] Floating material _________
[3] Wetlands at ___________
1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

AR 025661

8-1

FISH PASSAGE BARRIERS:

Type:	RM:	Height:	Pool Depth	Length to Negotiate:

Falls 37________ Culvert 38__________ Dam 39__________

Debris 40_________ Beaver Dam 41__________

GENERAL COMMENTS:

50. Stream ________ 51. Survey ________

52. Communication with Residents: _____ 53. Other ___________

DIRECT DISCHARGE TO STREAM:

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:

Type: Tributary 42______ Pipe/Culvert 43______ Seeps/Springs 46______

Grass-lined Swale 44_______ Ditch 45_________

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:

47. Total ____________________

A. Clearing/Grading B. Landscaping C. Other Construction Activity

D. Land Use Change

48. Substrate Composition, Percentage of Cover

1 Bedrock __________%

2 Boulders (>3') __________%

3 Cobble (3" – 3') __________%

4 Gravel (0.1" – 3") __________%

5 Sand (<0.1") __________%

6 Silt 100% organic muck %

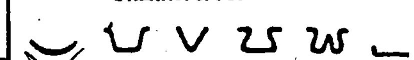
7 Clay __________%

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Dept

Channel cross-section:



3 (crossed out) 4 5 6 7 8

middle

close to 222nd and 223rd

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23-25 pictures

APPENDIX V

RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # B-2
2. DATE 10/5/99
3. STREAM NAME: Balnes
4. SURVEYORS: SLM

TRIBUTARY TO: Massey

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. ___.__ TO 7. ___.__

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3	4 ✓
9. SLIMES	1	2	3 ✓	4
10. BENTHOS (Bottom Dwelling Animals)	1	2	3	4 ✓
11. FISH (JUVENILE/ADULTS):	1	2	3 ✓	4 juvenile

LAND USE ADJACENT TO STREAM (#; %)

	#	%
DOMINANT	12. # 1	15. 100 %
SUBDOMINANT	13. # ___	16. ___ %
OTHERS PRESENT	14. # ___	17. ___ %

Blackberry/ivy/salmonberry

1. Forest or natural vegetation
2. Park or golf course
3. Roadside (Highway/Street)
4. Pasture—unfenced
5. Pasture—fenced
6. Cultivated field
7. Residential—scattered
8. Residential—continuous
9. Industrial/Commercial

18. VEGETATIVE BANK COVER:

[1] Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion.

[2] 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.

[3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.

[4] <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: Right Bank 19. 50 feet; Left Bank 20. >200 feet

VEGETATION TYPES: DOMINANT 21. 2 SUBDOMINANT 22. 3 OTHERS PRESENT 23. 4

1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER ferns, ivy, bramble

24. OVERHEAD CANOPY: lots of blackberries

[X] 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).

[2] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).

[3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.

[4] 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT:

[1] Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.

[X] Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).

[3] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.

[4] Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. 4 SUBDOMINANT 27. 6 OTHERS PRESENT 28. 2,5

1. ROCKS 2. LOGS 3. ROOT WADS 4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG.

29. CHANNEL CAPACITY

[1] Inadequate. Channel subject to severe erosion—channel may be widening or migrat... extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)

[2] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)

[X] Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).

[4] Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.

[5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:

[1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.

[2] Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.

[X] Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state. — in backyards

[4] Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY:

[1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.

[2] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident.

[X] 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.

[4] Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION:

[1] Substrate loose assortment easily moved with boot heel.

[2] Substrate moderately packed/cemented. Substrate difficult to move with boot heel.

[3] Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.

[X] Substrate consists of/covered by sand, clay or organic muck. hardpack areas, sand/clay areas, muck areas

33. TRANSPARENCY/COLOR: very brown

[✓] Transparent, bottom of channel is visible.

[2] Opaque or white like, bottom of channel may be visible.

[3] Light to dark brown; visible particulate matter present. Bottom of channel not visible.

[4] 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors Brown

34. ODOR N/A

[1] Animal waste or manure.

[2] Septic or human waste.

[3] Decaying plant matter.

[4] Other _____

1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH

[✓] Litter in stream: cans, bottles, yard debris, logging or land clearing debris—in or adjacent to channel.

[2] Tires, cars, appliances, fill material—in or adjacent to channel.

[3] Dead/decaying animals or fish.

[4] Concentrated dump site contains _____

1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT

[1] Farm animals in stream at _____.

[2] Snag pockets found at _____.

[3] Wetlands at _____

[4] Water withdrawal (pump/ditch) at _____.

[5] Floating material _____

1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

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8-2

FISH PASSAGE BARRIERS:

Type:	RM:	Height:	Pool Depth	Length to Negotiate:

Falls 37________ Culvert 38__________ Dam 39__________

Debris 40________ Beaver Dam 41__________

GENERAL COMMENTS:

50. Stream ________ 51. Survey ________

52. Communication with Residents: _____ 53. Other ___________

DIRECT DISCHARGE TO STREAM:

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:
Culvert	233rd and 13th	LB	12" (?)	eroded / cut bank
pipe (3)	13th	RB	3" (?)	(none)
pipe	13th	RB	12" (?)	erosion/cut bank bad silt fence

Type: Tributary 42_____ Pipe/Culvert 43_____ Seeps/Springs 46_____

Grass-lined Swale 44______ Ditch 45________

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:

47. Total ____________________

A. Clearing/Grading B. Landscaping C. Other Construction Activity

D. Land Use Change

48. Substrate Composition, Percentage of Cover

1 Bedrock ________

2 Boulders (>3') ________

3 Cobble (3" – 3') ________

4 Gravel (0.1" – 3") 10 %

5 Sand (<0.1") ________ } organic muck 90%

6 Silt ________

7 Clay ________

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Dept

Channel cross-section:

3 4 (X) 5 6 7 8

WASHINGTON STATE DEPARTMENT OF ECOLOGY

APPENDIX V
RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # 3-2 2. DATE 10/8/93
3. STREAM NAME: Baines 4. SURVEYORS: SLM
TRIBUTARY TO: Massey
5. SURVEY ENTRY/EXIT POINTS:
RIVER MILES SURVEYED: 6. ___ TO 7. ___

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3	[X] 4
9. SLIMES	1	2	3	[X] 4
10. BENTHOS (Bottom Dwelling Animals)	1	2	3	[X] 4
11. FISH (JUVENILE/ADULTS):	1	2	3	[X] 4

LAND USE ADJACENT TO STREAM (#; %)
DOMINANT 12. # 1 15. 100 %
SUBDOMINANT 13. # ___ 16. ___ %
OTHERS PRESENT 14. # ___ 17. ___ %

in a ravine so has good natural veg - some blackberries but not too much

1. Forest or natural vegetation 4. Pasture—unfenced 7. Residential—scattered
2. Park or golf course 5. Pasture—fenced 8. Residential—continuous
3. Roadside (Highway/Street) 6. Cultivated field 9. Industrial/Commercial

18. VEGETATIVE BANK COVER:
- [1] Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion.
- [X] 75-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.
- [3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.
- [4] <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: Right Bank 19. 50-100 feet; Left Bank 20. 50-100 feet (to top of ravine)

VEGETATION TYPES: DOMINANT 21. 2 SUBDOMINANT 22. 1 OTHERS PRESENT 23. 4,3
1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER ______

24. OVERHEAD CANOPY:
- [1] 75-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).
- [X] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).
- [3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.
- [4] 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT:
- [1] Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.
- [X] Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).
- [3] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.
- [4] Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. 2 SUBDOMINANT 27. 4 OTHERS PRESENT 28. 5,6,1.
1. ROCKS 2. LOGS 3. ROOT WADS 4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG.

CHANNEL CAPACITY
- [1] Inadequate. Channel subject to severe erosion—channel may be widening or migrat... extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)
- [2] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)
- [3] Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).
- [X] Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration. Creek curves through ravine cutting in some areas
- [5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:
- [1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.
- [2] Bank protection material common (25-50% of bankline) and/or much of natural streambank configuration altered.
- [3] Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.
- [X] Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY:
- [1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.
- [2] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident.
- [3] 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.
- [X] Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION:
- [1] Substrate loose assortment easily moved with boot heel.
- [X] Substrate moderately packed/cemented. Substrate difficult to move with boot heel. ← depends on area but generally
- [3] Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.
- [4] Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR:
- [X] Transparent, bottom of channel is visible.
- [2] Opaque or white like, bottom of channel may be visible.
- [3] Light to dark brown; visible particulate matter present. Bottom of channel not visible.
- [4] 1. RED (2. TAN) 3. GREEN 4. OIL SHEEN Other colors ______

34. ODOR N/A
- [1] Animal waste or manure.
- [2] Septic or human waste.
- [3] Decaying plant matter.
- [4] Other ______

1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH
- [1] Litter in stream: cans, bottles, yard debris, logging or land clearing debris—in or adjacent to channel. some wood cutting
- [2] Tires, cars, appliances, fill material—in or adjacent to channel.
- [3] Dead/decaying animals or fish.
- [4] Concentrated dump site contains ______

1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT
- [1] Farm animals in stream at ______.
- [2] Snag pockets found at ______.
- [3] Wetlands at ______
- [4] Water withdrawal (pump/ditch) at ______.
- [5] Floating material ______

1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

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8.3

FISH PASSAGE BARRIERS: None

Type:	RM:	Height:	Pool Depth	Length to Negotiate:

Falls 37______ Culvert 38______ Dam 39______

Debris 40______ Beaver Dam 41______

GENERAL COMMENTS:

50. Stream ______ 51. Survey ______

52. Communication with Residents: ______ 53. Other ______

DIRECT DISCHARGE TO STREAM: None

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:

Type: Tributary 42______ Pipe/Culvert 43______ Seeps/Springs 46______

Grass-lined Swale 44______ Ditch 45______

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:

47. Total ______

A. Clearing/Grading B. Landscaping C. Other Construction Activity

D. Land Use Change

48. Substrate Composition, Percentage of Cover

1 Bedrock ______

2 Boulders (>3') ______

3 Cobble (3" – 3') 10

4 Gravel (0.1" – 3") 40

5 Sand (<0.1") } 50 majority sand/silt

6 Silt

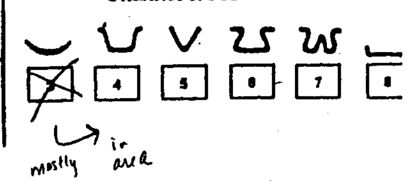
7 Clay ______

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Dept
4.0'	1.5"		

Channel cross-section:



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pictures 1-7

APPENDIX V
RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # Des Moines 2. DATE 10/5/99

3. STREAM NAME: DM-B 4. SURVEYORS: SLM

TRIBUTARY TO: ______

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. ___ TO 7. ___

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3 ✓	4
9. SLIMES	1	2 ✓	3	4
10. BENTHOS (Bottom Dwelling Animals)	1	2	3	4 ✓
11. FISH (JUVENILE/ADULTS):	1	2	3 ✓	4

LAND USE ADJACENT TO STREAM (#; %)
DOMINANT 12. # 1 15. 100 %
SUBDOMINANT 13. # ___ 16. ___ %
OTHERS PRESENT 14. # ___ 17. ___ %
very natural corridor on RB, LB has trail

1. Forest or natural vegetation 4. Pasture—unfenced 7. Residential—scattered
2. Park or golf course 5. Pasture—fenced 8. Residential—continuous
3. Roadside (Highway/Street) 6. Cultivated field 9. Industrial/Commercial

18. VEGETATIVE BANK COVER:

[X] Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion. Some clay banks - mainly on RB

[2] 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.

[3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.

[4] <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: Right Bank 19. 2-5' feet; Left Bank 20. >200 feet
steep bank w/ trail along the side - some places sluffing / silt fences

VEGETATION TYPES: DOMINANT 21. 4,5 SUBDOMINANT 22. 2,3 OTHERS PRESENT 23. 1
1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER Deciduous trees as canopy - blkberries on LB along trail

24. OVERHEAD CANOPY:

[X] 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).

[2] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).

[3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.

[4] 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT:

[X] Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.

[2] Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).

[3] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.

[4] Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. 1 SUBDOMINANT 27. 2,3 OTHERS PRESENT 28. 4,-6
1. ROCKS 2. LOGS 3. ROOT WADS 4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG.

29. CHANNEL CAPACITY

[1] Inadequate. Channel subject to severe erosion—channel may be widening or migrat. extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)

[2] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)

[X] Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).

[4] Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.

[5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:

[1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.

[2] Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.

[X] Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.

[4] Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY:

[1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhange and sloughing frequent.

[2] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhange and sloughing evident.

[X] 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.

[4] Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION: Some areas of clay pack but majority of stream is rocks/cobble/gravel very diverse

[X] Substrate loose assortment easily moved with boot heel.

[2] Substrate moderately packed/cemented. Substrate difficult to move with boot heel.

[3] Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.

[4] Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR:

[X] Transparent, bottom of channel is visible.

[2] Opaque or white like, bottom of channel may be visible.

[3] Light to dark brown; visible particulate matter present. Bottom of channel not visible.

[4] 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors ______

34. ODOR N/A but sewer treatment plant is along stream (Didn't smell today)

[1] Animal waste or manure. [3] Decaying plant matter.
[2] Septic or human waste. [4] Other ______
1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH

[X] Litter in stream; cans, bottles, yard debris, logging or land clearing debris—in or adjacent to channel. tire/wheel

[2] Tires, cars, appliances, fill material—in or adjacent to channel.

[3] Dead/decaying animals or fish.

[4] Concentrated dump site contains ______
1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT

[1] Farm animals in stream at ______. [4] Water withdrawal (pump/ditch) at ______.
[2] Snag pockets found at ______. [5] Floating material ______
[3] Wetlands at ______
1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

DM-B

FISH PASSAGE BARRIERS:

Type:	RM:	Height:	Pool Depth	Length to Negotiate:

Falls 37________ Culvert 38________ Dam 39________

Debris 40________ Beaver Dam 41________

GENERAL COMMENTS:

50. Stream ________ 51. Survey ________

52. Communication with Residents: _____ 53. Other ________

DIRECT DISCHARGE TO STREAM:

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:
Culverts	along/under bike trail from other tribs and steep banks	RB		

Type: Tributary 42______ Pipe/Culvert 43______ Seeps/Springs 46______

Grass-lined Swale 44______ Ditch 45______

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:
	bike/maintenance road along creek RB		

47. Total ________

A. Clearing/Grading B. Landscaping C. Other Construction Activity

D. Land Use Change

48. Substrate Composition, Percentage of Cover

1	Bedrock	________
2	Boulders (>3')	20%
3	Cobble (3" – 3')	50%
4	Gravel (0.1" – 3")	20%
5	Sand (<0.1")	5%
6	Silt	________
7	Clay	5%

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Dept
10' pools/debri	0.5-1.5' very nice		

Channel cross-section: 3, ~~4~~ (X), 5, 6, 7, 8

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pictures 8-10

APPENDIX V
RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # DM-C
2. DATE 10/6/99
3. STREAM NAME: Des Moines
4. SURVEYORS: SLM

TRIBUTARY TO: ____

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. ___ TO 7. ___

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3	4
9. SLIMES	1	[X] 2	3	4
10. BENTHOS (Bottom Dwelling Animals)	1	2	[X] 3	4 crawdads
11. FISH (JUVENILE/ADULTS):	1	2	[X] 3	4

LAND USE ADJACENT TO STREAM (#; %)
DOMINANT 12. # 1 15. 100 %
SUBDOMINANT 13. # ___ 16. ___ %
OTHERS PRESENT 14. # ___ 17. ___ %
(lots of grass fields)

1. Forest or natural vegetation
2. Park or golf course
3. Roadside (Highway/Street)
4. Pasture—unfenced
5. Pasture—fenced
6. Cultivated field
7. Residential—scattered
8. Residential—continuous
9. Industrial/Commercial

18. VEGETATIVE BANK COVER:

[X] 1 Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion.

2 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.

3 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.

4 <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL:
Right Bank 19. 10-20 feet to maintenance road then >200 after
Left Bank 20. >200 feet

VEGETATION TYPES: DOMINANT 21. 4,2 SUBDOMINANT 22. 1,3 OTHERS PRESENT 23. ___
1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER ____

24. OVERHEAD CANOPY:

[X] 1 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).

2 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).

3 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.

4 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT:

1 Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.

[X] 2 Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).

3 Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.

4 Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. 1,2 SUBDOMINANT 27. 3-6 OTHERS PRESENT 28. ___
1. ROCKS 2. LOGS 3. ROOT WADS 4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG.

29. CHANNEL CAPACITY

1 Inadequate. Channel subject to severe erosion—channel may be widening or migrating, extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)

2 Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)

[X] 3 Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).

4 Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.

5 Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:

1 Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.

2 Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.

3 Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.

[X] 4 Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY:

1 Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.

2 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident.

[X] 3 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.

4 Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION:

[X] 1 Substrate loose assortment easily moved with boot heel.

2 Substrate moderately packed/cemented. Substrate difficult to move with boot heel.

3 Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.

4 Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR:

[X] 1 Transparent, bottom of channel is visible.

2 Opaque or white like, bottom of channel may be visible.

3 Light to dark brown; visible particulate matter present. Bottom of channel not visible.

4 1. RED (2. TAN) 3. GREEN 4. OIL SHEEN Other colors ____ (Brown)

34. ODOR Wast treatment plant

1 Animal waste or manure.
[X] 2 Septic or human waste.
3 Decaying plant matter.
4 Other ____
1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH

1 Litter in stream: (cans, bottles) yard debris, logging or land clearing debris—in or adjacent to channel. - very minimal
2 (Tires) cars, appliances, fill material—in or adjacent to channel.
3 Dead/decaying animals or fish.
4 Concentrated dump site contains ____
1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT

1 Farm animals in stream at ____.
2 Snag pockets found at ____.
3 Wetlands at ____
4 Water withdrawal (pump/ditch) at ____.
5 Floating material ____
1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

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DM-C

FISH PASSAGE BARRIERS:

Type:	RM:	Height:	Pool Depth	Length to Negotiate:
Debris jam near des moines road	300' from bridge	4'	None	< 10'

Falls 37________ Culvert 38________ Dam 39________

Debris 40________ Beaver Dam 41________

GENERAL COMMENTS:

50. Stream ________ 51. Survey ________

52. Communication with Residents: _____ 53. Other ________

DIRECT DISCHARGE TO STREAM:

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:
culverts (lots along road)	Above bridge	RB		
metal culverts cement culverts	Below bridge	RB RB LB	18" 36" 6"	

Type: Tributary 42______ Pipe/Culvert 43______ Seeps/Springs 46______
Grass-lined Swale 44______ Ditch 45______
Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:
	maintenance road w/ silt fence 10-20' from creek. RB		

47. Total ________
A. Clearing/Grading B. Landscaping C. Other Construction Activity
D. Land Use Change

48. Substrate Composition, Percentage of Cover

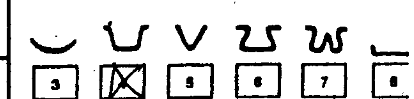
1 Bedrock ______
2 Boulders (>3') 20
3 Cobble (3" – 3') 50
4 Gravel (0.1" – 3") 20
5 Sand (<0.1")
6 Silt } 10%
7 Clay

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Depth
10-20'	1-2'		

Channel cross-section:



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APPENDIX V
RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # DM-D
2. DATE 10/6/99
3. STREAM NAME: Des Moines
4. SURVEYORS: BLM

TRIBUTARY TO: ______

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. __ . __ TO 7. __ . __

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3	4 ✓
9. SLIMES	1	2 ✓	3	4
10. BENTHOS (Bottom Dwelling Animals)	1	2	3 ✓	4 crawdad
11. FISH (JUVENILE/ADULTS):	1	2	3 ✓	4

LAND USE ADJACENT TO STREAM (#; %)

DOMINANT	12. # 2	15. 90 %
SUBDOMINANT	13. # 3	16. 10 %
OTHERS PRESENT	14. # ___	17. ___ %

Senior center

1. Forest or natural vegetation
2. Park or golf course
3. Roadside (Highway/Street)
4. Pasture—unfenced
5. Pasture—fenced
6. Cultivated field
7. Residential—scattered
8. Residential—continuous
9. Industrial/Commercial

18. VEGETATIVE BANK COVER:

[X] Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion. grass

[2] 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.

[3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.

[4] <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: Right Bank 19. 10 feet; Left Bank 20. 10 feet

VEGETATION TYPES: DOMINANT 21. 1 SUBDOMINANT 22. 2, 3 OTHERS PRESENT 23. ___

1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER ______

24. OVERHEAD CANOPY:

[1] 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).

[2] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).

[3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.

[X] 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT:

[1] Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.

[2] Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).

[X] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.

[4] Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. ___ SUBDOMINANT 27. ___ OTHERS PRESENT 28. ___

1. ROCKS 2. LOGS 3. ROOT WADS 4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG.

29. CHANNEL CAPACITY

[1] Inadequate. Channel subject to severe erosion—channel may be widening or migrat... extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)

[2] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)

[3] Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).

[X] Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.

[5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:

[1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.

[2] Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.

[X] Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.

[4] Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY:

[1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.

[2] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident.

[X] 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.

[4] Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION:

[X] Substrate loose assortment easily moved with boot heel.

[2] Substrate moderately packed/cemented. Substrate difficult to move with boot heel.

[3] Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.

[4] Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR:

[X] Transparent, bottom of channel is visible.

[2] Opaque or white like, bottom of channel may be visible.

[3] Light to dark brown; visible particulate matter present. Bottom of channel not visible.

[4] 1. RED (2. TAN) 3. GREEN 4. OIL SHEEN Other colors ______

34. ODOR N/A

[1] Animal waste or manure.

[2] Septic or human waste.

[3] Decaying plant matter.

[4] Other ______

1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH

[✓1] Litter in stream (cans), bottles, yard debris, logging or land clearing debris—in or adjacent to channel.

[2] Tires, cars, appliances, fill material—in or adjacent to channel.

[3] Dead/decaying animals or fish.

[4] Concentrated dump site contains ______

1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT

[1] Farm animals in stream at ______.

[2] Snag pockets found at ______.

[3] Wetlands at ______

[4] Water withdrawal (pump/ditch) at ______.

[5] Floating material ______

1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

DM.D

FISH PASSAGE BARRIERS: (None)

Type:	RM:	Height:	Pool Depth	Length to Negotiate:

Falls 37______ Culvert 38______ Dam 39______

Debris 40______ Beaver Dam 41______

GENERAL COMMENTS:

50. Stream ______ 51. Survey ______

52. Communication with Residents: ____ 53. Other ______

WASHINGTON STATE DEPARTMENT OF ECOLOGY

DIRECT DISCHARGE TO STREAM:

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:
culverts	2 below bridge 2 after building over stream	RB	6-12"	None

Type: Tributary 42______ Pipe/Culvert 43______ Seeps/Springs 46______

Grass-lined Swale 44______ Ditch 45______

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:
	Building over creek even stream channel not much ponding		

47. Total ______

A. Clearing/Grading B. Landscaping C. Other Construction Activity

D. Land Use Change

48. Substrate Composition, Percentage of Cover

1	Bedrock	____
2	Boulders (>3')	____
3	Cobble (3" – 3')	40%
4	Gravel (0.1" – 3")	50%
5	Sand (<0.1")	10%
6	Silt	____
7	Clay	____

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Dept
10.15'	1.2'		

Channel cross-section:

3 4 5 6 7 [X]

pictures 14-23

APPENDIX V

RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # MC-1   2. DATE 10/6/99

3. STREAM NAME: McSorley   4. SURVEYORS: SLM

TRIBUTARY TO: ____

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. ___ TO 7. ___

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3	4 ✓
9. SLIMES	1	2	3	4 ✓
10. BENTHOS (Bottom Dwelling Animals)	1	2	3	4 ✓
11. FISH (JUVENILE/ADULTS):	1	2	3	4 ✓

no water in main stream water from culvert (school?) only source of water to tributary

LAND USE ADJACENT TO STREAM (#; %)
- DOMINANT 12. # 8 50% 15. 9 50% %- school
- SUBDOMINANT 13. # ___ 16. ___ %
- OTHERS PRESENT 14. # ___ 17. ___ %

1. Forest or natural vegetation
2. Park or golf course
3. Roadside (Highway/Street)
4. Pasture—unfenced
5. Pasture—fenced
6. Cultivated field
7. Residential—scattered
8. Residential—continuous
9. Industrial/Commercial

18. VEGETATIVE BANK COVER:

[1 ✓] (tributary @school) Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion.

[2] 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.

[3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.

[4 ✓] (along upper portion school →) <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL:
- Right Bank 19. >10 feet } trib @school   <2 } back-yards
- Left Bank 20. >50 feet   <2

VEGETATION TYPES: DOMINANT 21.___ SUBDOMINANT 22.___ OTHERS PRESENT 23.___

1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER ____

24. OVERHEAD CANOPY:

[1 ✓] (blackberry school trib.) 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).

[2] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).

[3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.

[4 ✓] (yards) 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT:

[1 ✓] (trib.) Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.

[2] Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).

[3] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.

[4] Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. 1 SUBDOMINANT 27. 1 OTHERS PRESENT 28.___

1. ROCKS 2. LOGS 3. ROOT WADS 4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG.

*Not much water

CHANNEL CAPACITY

[1] Inadequate. Channel subject to severe erosion—channel may be widening or migrat... extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)

[2] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)

[3 ✓] Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).

[4] Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.

[5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:

[1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.

[2] Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.

[3 ✓] Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.

[4] Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY: in yards doing stabalization / culvating

[1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhange and sloughing frequent.

[2 ✓] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident.

[3] 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.

[4] Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION:

[1 ✓] Substrate loose assortment easily moved with boot heel.

[2] Substrate moderately packed/cemented. Substrate difficult to move with boot heel.

[3] Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.

[4] Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR:

[1 ✓] Transparent, bottom of channel is visible.

[2] Opaque or white like, bottom of channel may be visible.

[3] Light to dark brown; visible particulate matter present. Bottom of channel not visible.

[4] 1. RED (2. TAN) 3. GREEN 4. OIL SHEEN Other colors ____

34. ODOR N/A

[1] Animal waste or manure.

[2] Septic or human waste.

[3] Decaying plant matter.

[4] Other ____

1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH

[1] Litter in stream (cans), bottles, yard debris, logging or (land clearing debris)—in or adjacent to channel. — backyards - grass to edge

[2] (Tires), cars, appliances, fill material—in or adjacent to channel.

[3] Dead/decaying animals or fish.

[4] Concentrated dump site contains ____

1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT

[1] Farm animals in stream at ____.

[2] Snag pockets found at ____.

[3] Wetlands at ____

[4] Water withdrawal (pump/ditch) at ____.

[5] Floating material ____

1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

AR 025673

MC-1

FISH PASSAGE BARRIERS:

Type:	RM:	Height:	Pool Depth	Length to Negotiate:

Falls 37________ Culvert 38________ Dam 39________

Debris 40________ Beaver Dam 41________

GENERAL COMMENTS:

50. Stream ________ 51. Survey ________

52. Communication with Residents: _____ 53. Other ________

DIRECT DISCHARGE TO STREAM:

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:

Type: Tributary 42______ Pipe/Culvert 43______ Seeps/Springs 46______

Grass-lined Swale 44______ Ditch 45______

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:

47. Total ________

A. Clearing/Grading B. Landscaping C. Other Construction Activity

D. Land Use Change

48. Substrate Composition, Percentage of Cover

1 Bedrock ________

2 Boulders (>3') ________

3 Cobble (3" – 3') 25%

4 Gravel (0.1" – 3") 25%

5 Sand (<0.1") ________

6 Silt 50% (sand/silt/clay bracketed)

7 Clay ________

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Dept
2'	2"		

Channel cross-section:

3 4 5 6 7 8 (5 crossed out)

pictures 24-25

APPENDIX V

RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # MC-2 2. DATE 10/4/99

3. STREAM NAME: McSorley 4. SURVEYORS: SLM

TRIBUTARY TO: ____

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. ___ TO 7. ___

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3	[✓] 4
9. SLIMES	1	2	[✓] 3	4
10. BENTHOS (Bottom Dwelling Animals)	1	2	3	[✓] 4
11. FISH (JUVENILE/ADULTS):	1	2	3	[✓] 4

LAND USE ADJACENT TO STREAM (#; %)
DOMINANT 12. # 8 15. 100 %
SUBDOMINANT 13. # ___ 16. ___ %
OTHERS PRESENT 14. # ___ 17. ___ %

1. Forest or natural vegetation 4. Pasture—unfenced 7. Residential—scattered
2. Park or golf course 5. Pasture—fenced 8. Residential—continuous
3. Roadside (Highway/Street) 6. Cultivated field 9. Industrial/Commercial

18. VEGETATIVE BANK COVER: grass/buttercup

[1] Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion.

[✓ 2] 75-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.

[3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.

[4] <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL:
Right Bank 19. 0-5 feet
Left Bank 20. 0-5 feet

VEGETATION TYPES: DOMINANT 21. 1 SUBDOMINANT 22. 2 OTHERS PRESENT 23. 4
(1.) GRASSES (2.) SHRUBS 3. BLK BRY BUSHES (4.) TREES 5. OTHER ____

24. OVERHEAD CANOPY:

[1] 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).

[2] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).

[✓ 3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.

[4] 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT:

[1] Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.

[2] Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).

[3] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.

[✓ 4] Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. 6 SUBDOMINANT 27. ___ OTHERS PRESENT 28. ___
1. ROCKS 2. LOGS 3. ROOT WADS 4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG.

29. CHANNEL CAPACITY

[1] Inadequate. Channel subject to severe erosion—channel may be widening or migrating. Extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)

[2] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)

[✓ 3] Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).

[4] Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.

[5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:

[1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.

[✓ 2] Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered. in backyds riprap - then nothing but grass

[3] Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.

[4] Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY:

[1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.

[✓ 2] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident. couldn't see all yards

[3] 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.

[4] Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION:

[✓ 1] Substrate loose assortment easily moved with boot heel.

[2] Substrate moderately packed/cemented. Substrate difficult to move with boot heel.

[3] Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.

[4] Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR:

[✓ 1] Transparent, bottom of channel is visible.

[2] Opaque or white like, bottom of channel may be visible.

[3] Light to dark brown; visible particulate matter present. Bottom of channel not visible.

[4] 1. RED (2. TAN) 3. GREEN 4. OIL SHEEN Other colors ____

34. ODOR N/A

[1] Animal waste or manure. [3] Decaying plant matter.
[2] Septic or human waste. [4] Other ____
1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH

[1] Litter in stream: cans, bottles, yard debris, logging or land clearing debris—in or adjacent to channel.
[2] Tires, cars, appliances, fill material—in or adjacent to channel.
[3] Dead/decaying animals or fish.
[4] Concentrated dump site contains ____
1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT

[1] Farm animals in stream at ____. [4] Water withdrawal (pump/ditch) at ____.
[2] Snag pockets found at ____. [5] Floating material ____
[3] Wetlands at ____
1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

AR 025675

MC-2

FISH PASSAGE BARRIERS:

Type:	RM:	Height:	Pool Depth	Length to Negotiate:

Falls 37________ Culvert 38________ Dam 39________

Debris 40________ Beaver Dam 41________

GENERAL COMMENTS:

50. Stream ________ 51. Survey ________

52. Communication with Residents: ______ 53. Other ________

DIRECT DISCHARGE TO STREAM:

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:
culvert			36" frm across 20th	

Type: Tributary 42______ Pipe/Culvert 43______ Seeps/Springs 46______

Grass-lined Swale 44______ Ditch 45______

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:
	residential lawns landscaping -fences		

47. Total ________

A. Clearing/Grading B. Landscaping C. Other Construction Activity

D. Land Use Change

48. Substrate Composition, Percentage of Cover

1	Bedrock	________
2	Boulders (>3')	________
3	Cobble (3" – 3')	5 %
4	Gravel (0.1" – 3")	10 %
5	Sand (<0.1")	} 85%
6	Silt	} 85%
7	Clay	________

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Dept
4-6'	2-4"		

Channel cross-section:

3 ~~4~~ 5 6 7 8

ECOLOGY
WASHINGTON STATE DEPARTMENT OF

AR 025676

pictures 26-27

APPENDIX V
RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # MC-3 2. DATE 10/6/99

3. STREAM NAME: McSorley 4. SURVEYORS: SLM

TRIBUTARY TO: ____

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. ___.__ TO 7.___.__

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3	4 ✓ buttercups
9. SLIMES	1	2	3 ✓	4
10. BENTHOS (Bottom Dwelling Animals)	1	2	3 ✓	4 crawdads
11. FISH (JUVENILE/ADULTS):	1	2	3 ✓	4

LAND USE ADJACENT TO STREAM (#; %)

DOMINANT 12. # 1 15. 100 %
SUBDOMINANT 13. # ___ 16. ___ %
OTHERS PRESENT 14. # ___ 17. ___ %

1. Forest or natural vegetation 4. Pasture—unfenced 7. Residential—scattered
2. Park or golf course 5. Pasture—fenced 8. Residential—continuous
3. Roadside (Highway/Street) 6. Cultivated field 9. Industrial/Commercial

18. VEGETATIVE BANK COVER:

[1] Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion.

[2] ✓ 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.

[3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.

[4] <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: Right Bank 19. >100 feet; Left Bank 20. >100 feet — in ravine

VEGETATION TYPES: DOMINANT 21.___ SUBDOMINANT 22.___ OTHERS PRESENT 23.___
1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER ____

24. OVERHEAD CANOPY: Trees / blkberry / bramble / Shrub

[1] ✓ 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).

[2] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).

[3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.

[4] 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT:

[1] ✓ Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.

[2] Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).

[3] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.

[4] Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. 2 SUBDOMINANT 27. 1,4 OTHERS PRESENT 28.___
1. ROCKS 2. LOGS 3. ROOT WADS 4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG.

CHANNEL CAPACITY

[1] Inadequate. Channel subject to severe erosion—channel may be widening or migrat. _ extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)

[2] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)

[3] Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).

[4] ✓ Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.

[5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION: good above treatment plant, riprap along treatment plant

[1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.

[2] Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.

[3] ✓ Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.

[4] Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY:

[1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.

[2] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident.

[3] 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.

[4] ✓ Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION:

[1] Substrate loose assortment easily moved with boot heel.

[2] ✓ Substrate moderately packed/cemented. Substrate difficult to move with boot heel.

[3] Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.

[4] Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR:

[1] ✓ Transparent, bottom of channel is visible.

[2] Opaque or white like, bottom of channel may be visible.

[3] Light to dark brown; visible particulate matter present. Bottom of channel not visible.

[4] 1. RED (2. TAN) 3. GREEN 4. OIL SHEEN Other colors ____

34. ODOR N/A

[1] Animal waste or manure.
[2] Septic or human waste.
[3] Decaying plant matter.
[4] Other ____
1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH

[1] Litter in stream: (cans) bottles, yard debris, logging or land clearing debris—in or adjacent to channel.
[2] Tires, cars, appliances, fill material—in or adjacent to channel.
[3] Dead/decaying animals or fish.
[4] Concentrated dump site contains ____
1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT

[1] Farm animals in stream at ____.
[2] Snag pockets found at ____.
[3] Wetlands at ____
[4] Water withdrawal (pump/ditch) at ____.
[5] Floating material ____
1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

AR 025677

MC-3

FISH PASSAGE BARRIERS:

Type:	RM:	Height:	Pool Depth	Length to Negotiate:

Falls 37________ Culvert 38________ Dam 39________

Debris 40________ Beaver Dam 41________

GENERAL COMMENTS:

50. Stream ________ 51. Survey ________

52. Communication with Residents: ________ 53. Other ________

DIRECT DISCHARGE TO STREAM:

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:
culverts	@ 110ft	LB	? 36"	
culvert/rock wall	@ 250ft	above channel	16"	

Type: Tributary 42______ Pipe/Culvert 43______ Seeps/Springs 46______

Grass-lined Swale 44______ Ditch 45______

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:

47. Total ________

A. Clearing/Grading B. Landscaping C. Other Construction Activity

D. Land Use Change

48. Substrate Composition, Percentage of Cover

1	Bedrock	________
2	Boulders (>3')	10%
3	Cobble (3" – 3')	40%
4	Gravel (0.1" – 3")	20%
5	Sand (<0.1")	} 30%
6	Silt	
7	Clay	________

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Dept
10'	5-10" pools/nic area		

Channel cross-section:

3 4 5 6 7 8 ✓

APPENDIX B

1994 RIPARIAN CORRIDOR ASSESSMENT SURVEY FORMS

Pictures 10-11

APPENDIX V
RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # MA 1 235 ft S   2. DATE 6 Sept 94

3. STREAM NAME: Masecy   4. SURVEYORS: JPM

TRIBUTARY TO: ____   36' adjunct

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. ___ TO 7. ___

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3	4
9. SLIMES	1	2	3	4
10. BENTHOS (Bottom Dwelling Animals)	1	2	3	4
11. FISH (JUVENILE/ADULTS):	1	2	3	4

LAND USE ADJACENT TO STREAM (#; %)
- DOMINANT 12. # 1 15. 100 % Full buffer 50'
- SUBDOMINANT 13. # ___ 16. ___ %
- OTHERS PRESENT 14. # ___ 17. ___ %

1. Forest or natural vegetation 4. Pasture—unfenced 7. Residential—scattered
2. Park or golf course 5. Pasture—fenced 8. Residential—continuous
3. Roadside (Highway/Street) 6. Cultivated field 9. Industrial/Commercial

18. VEGETATIVE BANK COVER:

[X] Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion.

[2] 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.

[3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.

[4] <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: Right Bank 19. 50 feet; Left Bank 20. 25-51 feet

VEGETATION TYPES: DOMINANT 21. 3 SUBDOMINANT 22. 4 OTHERS PRESENT 23. ___

1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES (4. TREES) 5. OTHER ____ alder, evergreens

24. OVERHEAD CANOPY:

[X] 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).

[2] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).

[3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.

[4] 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT:

[1] Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.

[X] Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities). Brambles overall

[3] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.

[4] Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. ___ SUBDOMINANT 27. ___ OTHERS PRESENT 28. ___

1. ROCKS (2. LOGS) 3. ROOT WADS (4. DEBRIS) 5. UNDERCUT BANK (6. BANK VEG.) 7. OTHER ____

CHANNEL CAPACITY

[1] Inadequate. Channel subject to severe erosion—channel may be widening or migrating, extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)

[2] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)

[3] Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).

[X] Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.

[5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:

[1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.

[2] Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.

[3] Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.

[X] Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY:

[1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.

[2] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident.

[X] 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition. Potential moderate -- pretty thick veg, not too steep

[4] Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION:

[1] Substrate loose assortment easily moved with boot heel.

[2] Substrate moderately packed/cemented. Substrate difficult to move with boot heel.

[3] Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.

[X] Substrate consists of/covered by (sand, clay) or (organic muck).

33. TRANSPARENCY/COLOR:

[X] Transparent, bottom of channel is visible. Brown - evidence of iron

[2] Opaque or white like, bottom of channel may be visible.

[3] Light to dark brown; visible particulate matter present. Bottom of channel not visible.

[4] 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors ____

34. ODOR NA

[1] Animal waste or manure. [3] Decaying plant matter.

[2] Septic or human waste. [4] Other ____

1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH

[X] Litter in stream: (cans, bottles, yard debris), logging or land clearing debris—in or adjacent to channel. 10' berm consisting

[2] Tires, cars, (appliances), fill material—in or adjacent to channel.

[3] Dead/decaying animals or fish.

[4] Concentrated dump site contains ____

1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT

[1] Farm animals in stream at ____. [4] Water withdrawal (pump/ditch) at ____.

[2] Snag pockets found at ____. [5] Floating material ____

[3] Wetlands at ____

1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

AR 025680

FISH PASSAGE BARRIERS:

Type:	RM:	Height:	Pool Depth	Length to Negotiate:

Falls 37______ Culvert 38______ Dam 39______

Debris 40______ Beaver Dam 41______

GENERAL COMMENTS:

50. Stream ______ 51. Survey ______

52. Communication with Residents: _____ 53. Other ______

DIRECT DISCHARGE TO STREAM: None

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:

Type: Tributary 42_____ Pipe/Culvert 43_____ Seeps/Springs 46_____

Grass-lined Swale 44_____ Ditch 45_____

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:

47. Total __________

A. Clearing/Grading B. Landscaping C. Other Construction Activity

D. Land Use Change

48. Substrate Composition, Percentage of Cover

1	Bedrock	____ %
2	Boulders (>3')	____ %
3	Cobble (3" – 3')	5 %
4	Gravel (0.1" – 3")	____ %
5	Sand (<0.1")	50 %
6	Silt	45 %
7	Clay	____ %

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Depth

Channel cross-section:

3 (circled) 4 5 6 7 8

AR 025681

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Menn... 3
2nd ... 3
Down ... corridor 1"

APPENDIX V
RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # MA-2   2. DATE 6 Sept 94

3. STREAM NAME: Massey   4. SURVEYORS: JPM

TRIBUTARY TO: ______   @ 20" ... S. or s. side. ... street ... is ... as at MA-2

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. ____ TO 7. ____

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3	[X]
9. SLIMES	1	2	3	[X]
10. BENTHOS (Bottom Dwelling Animals)	[X]	2	3	4
11. FISH (JUVENILE/ADULTS):	1	2	3	4

LAND USE ADJACENT TO STREAM (#; %)

	#	%
DOMINANT	12. # 8	15. 100 %
SUBDOMINANT	13. # ____	16. ____ %
OTHERS PRESENT	14. # ____	17. ____ %

(100% on other side of street)

1. Forest or natural vegetation
2. Park or golf course
3. Roadside (Highway/Street)
4. Pasture—unfenced
5. Pasture—fenced
6. Cultivated field
7. Residential—scattered
8. (circled) Residential—continuous condos
9. Industrial/Commercial

18. VEGETATIVE BANK COVER:

[1] Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion.

[2] 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.

[3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.

[X] <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: Right Bank 19. 20 feet; Left Bank 20. 10 feet

VEGETATION TYPES: DOMINANT 21. 1 SUBDOMINANT 22. 3 OTHERS PRESENT 23. ____

1. GRASSES 2. SHRUBS (3.) BLK BRY BUSHES (4.) TREES (Alder) 5. OTHER Ivy

24. OVERHEAD CANOPY:

[X] 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual). Deciduous

[2] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).

[3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.

[4] 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT: One nice pool!

[1] Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.

[X] Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).

[3] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.

[4] Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. 3 SUBDOMINANT 27. 4/6 OTHERS PRESENT 28. 5

1. ROCKS 2. LOGS (3.) ROOT WADS (4.) DEBRIS (5.) UNDERCUT BANK (6.) BANK VEG.
7. OTHER ______

4-8' wide ...

. CHANNEL CAPACITY

[1] Inadequate. Channel subject to severe erosion—channel may be widening or migrat... extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)

[2] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)

[3] Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).

[X] Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration. 90° turn could some day present a problem

[5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION: This is probably not the natural channel

[1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.

[2] Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.

[X] Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state. @ Culverts

[4] Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY:

[1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.

[2] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident.

[X] 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in (natural) ? stable condition.

[4] Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION: Gravelly

[1] Substrate loose assortment easily moved with boot heel.

[X] Substrate moderately packed/cemented. Substrate difficult to move with boot heel.

[3] Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.

[4] Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR: Lt Brn

[X] Transparent, bottom of channel is visible.

[2] Opaque or white like, bottom of channel may be visible.

[3] Light to dark brown; visible particulate matter present. Bottom of channel not visible.

[4] 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors ______

Good ... site

34. ODOR n/a

[1] Animal waste or manure.
[2] Septic or human waste.
[3] Decaying plant matter.
[4] Other ____

1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH ... esp. considering adjacent condos

[X] Litter in stream: cans, bottles, yard debris, logging or land clearing debris—in or adjacent to channel.
[2] Tires, cars, appliances, fill material—in or adjacent to channel.
[3] Dead/decaying animals or fish.
[4] Concentrated dump site contains ______

1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT

[1] Farm animals in stream at ______.
[2] Snag pockets found at ______.
[3] Wetlands at ______
[4] Water withdrawal (pump/ditch) at ______.
[5] Floating material ______

1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

AR 025682

#2

FISH PASSAGE BARRIERS:

Type:	RM:	Height:	Pool Depth	Length to Negotiate:

Falls 37________ Culvert 38________ Dam 39________

Debris 40________ Beaver Dam 41________

GENERAL COMMENTS:

50. Stream ________ 51. Survey ________

52. Communication with Residents: _____ 53. Other ________

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DIRECT DISCHARGE TO STREAM:

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:

Type: Tributary 42______ Pipe/Culvert 43______ Seeps/Springs 46______

Grass-lined Swale 44______ Ditch 45______

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:

47. Total ________________

A. Clearing/Grading B. Landscaping C. Other Construction Activity

D. Land Use Change

48. Substrate Composition, Percentage of Cover

1	Bedrock	______%
2	Boulders (>3')	______%
3	Cobble (3" – 3')	______%
4	Gravel (0.1" – 3")	70%
5	Coarse Sand (<0.1")	20%
6	Silt	10%
7	Clay	______%

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Depth
4-8'	5' down		

Channel cross-section:

3 4 5 6 7 8

AR 025683

APPENDIX V
RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # MA-3 2. DATE 6 Sept 94

3. STREAM NAME: Massey 4. SURVEYORS: JPM

TRIBUTARY TO: ______

Finally found creek by sound. Brambles [illegible] w/old dead branches [illegible]

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. ___ TO 7. ___

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3	[X]
9. SLIMES	1	2	3	[X]
10. BENTHOS (Bottom Dwelling Animals)	1	2	3	4
11. FISH (JUVENILE/ADULTS):	1	2	3	4

LAND USE ADJACENT TO STREAM (#; %)

DOMINANT	12. # 1	15. 100 %
SUBDOMINANT	13. # ___	16. ___ %
OTHERS PRESENT	14. # ___	17. ___ %

1. Forest or natural vegetation 4. Pasture—unfenced 7. Residential—scattered
2. Park or golf course 5. Pasture—fenced 8. Residential—continuous
3. Roadside (Highway/Street) 6. Cultivated field 9. Industrial/Commercial

18. VEGETATIVE BANK COVER:

[X] Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion.

[2] 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.

[3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.

[4] <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: Right Bank 19. 30-> feet Left Bank 20. 30-> feet

On other side of 234th just veg. strip 20-30' along road [illegible]

VEGETATION TYPES: DOMINANT 21. 3 SUBDOMINANT 22. 4 OTHERS PRESENT 23. 5

1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER Fern, horsetail [illegible] etc

24. OVERHEAD CANOPY:

[X] 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).

[2] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).

[3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.

[4] 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT:

[1] Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.

[2] Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).

[3] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.

[X] Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. 6 SUBDOMINANT 27. ___ OTHERS PRESENT 28. ___

1. ROCKS 2. LOGS 3. ROOT WADS 4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG. [illegible]
7. OTHER ______

29. CHANNEL CAPACITY

[1] Inadequate. Channel subject to severe erosion—channel may be widening or migrat... extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)

[2] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)

[3] Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).

[X] Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.

[5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:

[1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.

[2] Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.

[3] Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.

[X] Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY:

[1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.

[2] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident.

[3] 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.

[X] Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION:

[1] Substrate loose assortment easily moved with boot heel.

[2] Substrate moderately packed/cemented. Substrate difficult to move with boot heel.

[3] Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.

[X] Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR: ?

[1] Transparent, bottom of channel is visible.

[2] Opaque or white like, bottom of channel may be visible.

[3] Light to dark brown; visible particulate matter present. Bottom of channel not visible.

[4] 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors ______

34. ODOR

[1] Animal waste or manure. [3] Decaying plant matter.

[2] Septic or human waste. [4] Other ___

1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH Not too close -- brambles too thick

[1] Litter in stream: cans, bottles, yard debris, logging or land clearing debris—in or adjacent to channel.

[2] Tires, cars, appliances, fill material—in or adjacent to channel.

[3] Dead/decaying animals or fish.

[4] Concentrated dump site contains ______

1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT

[1] Farm animals in stream at ______. [4] Water withdrawal (pump/ditch) at ______.

[2] Snag pockets found at ______. [5] Floating material ______

[3] Wetlands at ______

1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

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MA-3

FISH PASSAGE BARRIERS:

Type:	RM:	Height:	Pool Depth	Length to Negotiate:

Falls 37______ Culvert 38______ Dam 39______

Debris 40______ Beaver Dam 41______

GENERAL COMMENTS:

50. Stream ______ 51. Survey ______

52. Communication with Residents: ______ 53. Other ______

DIRECT DISCHARGE TO STREAM:

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:

Type: Tributary 42______ Pipe/Culvert 43______ Seeps/Springs 46______

Grass-lined Swale 44______ Ditch 45______

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:

47. Total ______

A. Clearing/Grading B. Landscaping C. Other Construction Activity

D. Land Use Change

48. Substrate Composition, Percentage of Cover

inaccessible

1 Bedrock ______ %

2 Boulders (>3') ______ %

3 Cobble (3" – 3') ______ %

4 Gravel (0.1" – 3") ______ %

5 Sand (<0.1") ______ %

6 Silt ______ %

7 Clay ______ %

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Depth

Channel cross-section:

3 4 5 6 7 8

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AR 025685

APPENDIX V

RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # MA-1L
2. DATE 6 Sep 94
3. STREAM NAME: Massey
4. SURVEYORS: JPM

TRIBUTARY TO: ________

Steep ravine area
3'd 4' wide square concrete culvert

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. ___ TO 7. ___

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3	[X]
9. SLIMES	1	2	[X]	4
10. BENTHOS (Bottom Dwelling Animals)	1	2	3	4
11. FISH (JUVENILE/ADULTS):	1	2	3	4

LAND USE ADJACENT TO STREAM (#; %)

	#	%
DOMINANT	12. # 1	15. 100 %
SUBDOMINANT	13. # ___	16. ___ %
OTHERS PRESENT	14. # ___	17. ___ %

1. Forest or natural vegetation
2. Park or golf course
3. Roadside (Highway/Street)
4. Pasture—unfenced
5. Pasture—fenced
6. Cultivated field
7. Residential—scattered
8. Residential—continuous
9. Industrial/Commercial

18. VEGETATIVE BANK COVER:

[1] Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion.

[X] 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.

[3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.

[4] <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: Right Bank 19. >100 feet; Left Bank 20. >100 feet

VEGETATION TYPES: DOMINANT 21. 2:3 SUBDOMINANT 22. 1:5 OTHERS PRESENT 23. ___

1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER Ferns/Ranunculus
Alder/Maple Upper Story

24. OVERHEAD CANOPY:

[X] 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).

[2] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).

[3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.

[4] 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT:

[1] Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.

[X] Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).

[3] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.

[4] Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. 1 SUBDOMINANT 27. 1:2 OTHERS PRESENT 28. ___

(1.) ROCKS (2.) LOGS 3. ROOT WADS (4.) DEBRIS 5. UNDERCUT BANK 6. BANK VEG.
7. OTHER ________

10 - 30'

CHANNEL CAPACITY Capacity sufficient but signs of erosion & sed. accum.

[1] Inadequate. Channel subject to severe erosion—channel may be widening or migrating, extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)

[2] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)

[X] Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).

[4] Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.

[5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:

[1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.

[2] Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.

[3] Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.

[X] Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY: LB often hardpan bluff

[1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.

[X] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident. Some undercutting

[3] 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.

[4] Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION: Cobble/Gravel w/ interspersed areas of sed. accum.

[1] Substrate loose assortment easily moved with boot heel.

[X] Substrate moderately packed/cemented. Substrate difficult to move with boot heel.

[3] Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.

[4] Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR:

[1] Transparent, bottom of channel is visible.

[X] Opaque or white like, bottom of channel may be visible.

[3] Light to dark brown; visible particulate matter present. Bottom of channel not visible.

[4] 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors ________

34. ODOR

[1] Animal waste or manure.
[2] Septic or human waste.
[3] Decaying plant matter.
[4] Other ___

1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH

[1] Litter in stream: cans, bottles, yard debris, logging or land clearing debris—in or adjacent to channel.
[2] Tires, cars, appliances, fill material—in or adjacent to channel. junk
[3] Dead/decaying animals or fish.
[4] Concentrated dump site contains ______

1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT

[1] Farm animals in stream at ________.
[2] Snag pockets found at ________.
[3] Wetlands at ________
[4] Water withdrawal (pump/ditch) at ______.
[5] Floating material ________

1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

MA-4

FISH PASSAGE BARRIERS: None seen

Type:	RM:	Height:	Pool Depth	Length to Negotiate:
				Fair substrate a few good pools

Falls 37________ Culvert 38________ Dam 39________

Debris 40________ Beaver Dam 41________

GENERAL COMMENTS:

50. Stream ________ 51. Survey ________

52. Communication with Residents: _____ 53. Other ________

DIRECT DISCHARGE TO STREAM:

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:

Type: Tributary 42_____ Pipe/Culvert 43_____ Seeps/Springs 46_____

Grass-lined Swale 44_____ Ditch 45_____

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:
Development: roads far back from stream bank			

47. Total ________

A. Clearing/Grading B. Landscaping C. Other Construction Activity

D. Land Use Change

48. Substrate Composition, Percentage of Cover

1 Bedrock ____%

2 Boulders (>3') ____%

3 Cobble (3" – 3') 20 %

4 Gravel (0.1" – 3") 50 %

5 Sand (<0.1") ____%

6 Silt 30 %

7 Clay ____%

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Depth
10-20'	6"-1'		
adequate capacity			

Channel cross-section:

3 4 5 6 7 8

![Washington State Department of Ecology logo]

WASHINGTON STATE DEPARTMENT OF ECOLOGY

AR 025687

APPENDIX V
RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # MA 5 2. DATE 6 Sept 94

3. STREAM NAME: Massey 4. SURVEYORS: JPM

TRIBUTARY TO: ______

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. ___ TO 7. ___

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	[X]	2	3	4
9. SLIMES	1	2	3	4
10. BENTHOS (Bottom Dwelling Animals)	1	2	3	4
11. FISH (JUVENILE/ADULTS):	1	2	3	4

LAND USE ADJACENT TO STREAM (#; %)
DOMINANT 12. # 1 15. 100 % w/in 15'
SUBDOMINANT 13. # 3 16. 100 % after 15'
OTHERS PRESENT 14. # 7 17. ___ % RB

(1.) Forest or natural vegetation 4. Pasture—unfenced (7.) Residential—scattered LB
2. Park or golf course 5. Pasture—fenced 8. Residential—continuous
(3.) Roadside (Highway/Street) 6. Cultivated field 9. Industrial/Commercial

18. VEGETATIVE BANK COVER:

[X] Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion.

[2] 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.

[3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.

[4] <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: Right Bank 19. 20 feet; Left Bank 20. 5->29 feet (Cement wall 100's LB)

VEGETATION TYPES: DOMINANT 21. 1 SUBDOMINANT 22. 2 OTHERS PRESENT 23. ___
(1.) GRASSES (2.) SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER Horsetail

24. OVERHEAD CANOPY: Open in 1st 50' then 100% shaded (willow)

[1] 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).

[2] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).

[3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.

[4] 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT: None. Grasses w/soft bottom

[1] Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.

[2] Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).

[3] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.

[4] Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. ___ SUBDOMINANT 27. ___ OTHERS PRESENT 28. ___
1. ROCKS 2. LOGS 3. ROOT WADS 4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG.
7. OTHER ______

CHANNEL CAPACITY

[1] Inadequate. Channel subject to severe erosion—channel may be widening or migrat... extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)

[2] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)

[3] Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).

[X] Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.

[5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:

[1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.

[2] Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.

[3] Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.

[X] Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY:

[1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.

[2] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident.

[3] 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.

[4] Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION:

[1] Substrate loose assortment easily moved with boot heel.
[2] Substrate moderately packed/cemented. Substrate difficult to move with boot heel.
[3] Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.
[X] Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR: ?

[1] Transparent, bottom of channel is visible.
[2] Opaque or white like, bottom of channel may be visible.
[3] Light to dark brown; visible particulate matter present. Bottom of channel not visible.
[4] 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors ______

34. ODOR

[1] Animal waste or manure. [3] Decaying plant matter.
[2] Septic or human waste. [4] Other ___
1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH No

[1] Litter in stream: cans, bottles, yard debris, logging or land clearing debris—in or adjacent to channel.
[2] Tires, cars, appliances, fill material—in or adjacent to channel.
[3] Dead/decaying animals or fish.
[4] Concentrated dump site contains ___
1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT

[1] Farm animals in stream at ______. [4] Water withdrawal (pump/ditch) at ______.
[2] Snag pockets found at ______. [5] Floating material ______
[3] Wetlands at ______
1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

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MA-5

FISH PASSAGE BARRIERS: None

Type:	RM:	Height:	Pool Depth	Length to Negotiate:

Falls 37________ Culvert 38________ Dam 39________

Debris 40________ Beaver Dam 41________

GENERAL COMMENTS:

50. Stream ________ 51. Survey ________

52. Communication with Residents: ______ 53. Other ________

DIRECT DISCHARGE TO STREAM:

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:
	None	obvious some	possible hidden beneath vegetation	

Type: Tributary 42______ Pipe/Culvert 43______ Seeps/Springs 46______

Grass-lined Swale 44______ Ditch 45______

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR: No direct impacts

RM:	Prox to Stream: <30 >30:	Length	Cause:

47. Total ________

A. Clearing/Grading B. Landscaping C. Other Construction Activity

D. Land Use Change

48. Substrate Composition, Percentage of Cover

1	Bedrock	______%
2	Boulders (>3')	______%
3	Cobble (3" – 3')	______%
4	Gravel (0.1" – 3")	15 %
5	Sand (<0.1")	______%
6	Silt	85% soft bottom %
7	Clay	______%

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Depth
5'	4'		

Channel cross-section:

3 4 (circled) 5 6 7 8

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Picture 23-24 MA-6 ... 25 MA-6 So. side of road

APPENDIX V
RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # MA-6 2. DATE 6 Sept 94

3. STREAM NAME: Massey 4. SURVEYORS: JPM

TRIBUTARY TO: ______ Storm H2O Facility (?) Adjacent to downstream end of site

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. ___ TO 7. ___

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3	4
9. SLIMES	1	2	3	4
10. BENTHOS (Bottom Dwelling Animals)	1	2	3	4
11. FISH (JUVENILE/ADULTS):	1	2	3	4

Buffer = 2.5 LB, 7.5 RB

LAND USE ADJACENT TO STREAM (#; %) outside of buffer
DOMINANT 12. # 9 15. 100 %
SUBDOMINANT 13. # ___ 16. ___ %
OTHERS PRESENT 14. # ___ 17. ___ %

1. Forest or natural vegetation 4. Pasture—unfenced 7. Residential—scattered
2. Park or golf course 5. Pasture—fenced 8. Residential—continuous
3. Roadside (Highway/Street) 6. Cultivated field (9.) Industrial/Commercial

18. VEGETATIVE BANK COVER:

[X] Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion.

[2] 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.

[3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.

[4] <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: Right Bank 19. >15 feet; Left Bank 20. 3-5 feet

VEGETATION TYPES: DOMINANT 21 (2) SUBDOMINANT 22 (3) OTHERS PRESENT 23 (1)

1. GRASSES 2. SHRUBS (willow) 3. BLK BRY BUSHES 4. TREES 5. OTHER ______

24. OVERHEAD CANOPY: Open in 50' ... overgrown

[1] 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).

[X] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals). Somewhat open

[3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.

[4] 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT: Silty substrate w/ a few cobble. No LOD (large) boulders

[1] Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.

[2] Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).

[3] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.

[4] Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26.___ SUBDOMINANT 27.___ OTHERS PRESENT 28.___

1. ROCKS 2. LOGS 3. ROOT WADS 4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG. 7. OTHER ______

29. CHANNEL CAPACITY 10-20' wide

[1] Inadequate. Channel subject to severe erosion—channel may be widening or migrating, extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)

[2] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)

[3] Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).

[X] Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.

[5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:

[1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.

[X] Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered. Riprap near bridge both sides. Otherwise natural

[3] Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.

[4] Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY:

[1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.

[2] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident.

[X] 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.

[4] Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION:

[1] Substrate loose assortment easily moved with boot heel.

[2] Substrate moderately packed/cemented. Substrate difficult to move with boot heel.

[3] Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.

[4] Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR:

[1] Transparent, bottom of channel is visible.

[2] Opaque or white like, bottom of channel may be visible.

[3] Light to dark brown; visible particulate matter present. Bottom of channel not visible.

[4] 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors ______

34. ODOR

[1] Animal waste or manure. [3] Decaying plant matter.

[2] Septic or human waste. [4] Other ______

1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH (N/A)

[1] Litter in stream: cans, bottles, yard debris, logging or land clearing debris—in or adjacent to channel.

[2] Tires, cars, appliances, fill material—in or adjacent to channel.

[3] Dead/decaying animals or fish.

[4] Concentrated dump site contains ______

1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT

[1] Farm animals in stream at ______. [4] Water withdrawal (pump/ditch) at ______.

[2] Snag pockets found at ______. [5] Floating material ______

[3] Wetlands at ______

1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

MA-6

FISH PASSAGE BARRIERS:

Type:	RM:	Height:	Pool Depth	Length to Negotiate:

Falls 37________ Culvert 38________ Dam 39________

Debris 40________ Beaver Dam 41________

DIRECT DISCHARGE TO STREAM:

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:

Type: Tributary 42______ Pipe/Culvert 43______ Seeps/Springs 46______

Grass-lined Swale 44______ Ditch 45________

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

48. Substrate Composition, Percentage of Cover

inaccessible

1 Bedrock ________%

2 Boulders (>3') ________%

3 Cobble (3" – 3') ________%

4 Gravel (0.1" – 3") ________%

5 Sand (<0.1") ________%

6 Silt ________%

7 Clay ________%

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Depth

Channel cross-section:

3 4 5 6 7 8

GENERAL COMMENTS:

50. Stream ________ 51. Survey ________

52. Communication with Residents: ______ 53. Other ________

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:

47. Total ____________________

A. Clearing/Grading B. Landscaping C. Other Construction Activity

D. Land Use Change

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Pictures #2:3

4' wide x 1.5' deep

APPENDIX V
RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # Sike B1   2. DATE 6 Sept 94

3. STREAM NAME: Barnes   4. SURVEYORS: JFM

TRIBUTARY TO: ____

5. SURVEY ENTRY/EXIT POINTS: @ 223rd X.   36" culvert under road dry

RIVER MILES SURVEYED: 6. ___ TO 7. ___

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3	4
9. SLIMES	1	2	3	4
10. BENTHOS (Bottom Dwelling Animals)	1	2	3	4
11. FISH (JUVENILE/ADULTS):	1	2	3	4

LAND USE ADJACENT TO STREAM (#; %)
DOMINANT 12. # ___ 15. ___ %
SUBDOMINANT 13. # ___ 16. ___ %
OTHERS PRESENT 14. # ___ 17. ___ %

1. Forest or natural vegetation
2. Park or golf course
3. Roadside (Highway/Street)
4. Pasture—unfenced
5. Pasture—fenced
6. Cultivated field
7. Residential—scattered
8. Residential—continuous
9. Industrial/Commercial

18. VEGETATIVE BANK COVER:

[X] Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion.

[2] 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.

[3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.

[4] <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: Right Bank 19. ___ feet; Left Bank 20. ___ feet

VEGETATION TYPES: DOMINANT 21. 1 SUBDOMINANT 22. 4 OTHERS PRESENT 23. 3

1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER ___

24. OVERHEAD CANOPY:

[X] 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).

[2] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).

[3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.

[4] 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT: Dry/Intermittent

[1] Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.

[2] Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).

[X] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous. Plenty but habitat gra!

[4] Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. 6 SUBDOMINANT 27. ___ OTHERS PRESENT 28. 5

1. ROCKS 2. LOGS 3. ROOT WADS 4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG. 7. OTHER ___

29. CHANNEL CAPACITY

[1] Inadequate. Channel subject to severe erosion—channel may be widening or migrating, extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)

[2] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)

[X] Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).

[4] Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.

[5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:

[1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.

[2] Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.

[3] Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.

[X] Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY:

[1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.

[X] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident.

[3] 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.

[4] Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION:

[1] Substrate loose assortment easily moved with boot heel.

[2] Substrate moderately packed/cemented. Substrate difficult to move with boot heel.

[3] Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.

[X] Substrate consists of/covered by sand, clay or organic muck. Silt

33. TRANSPARENCY/COLOR: No H2O

[1] Transparent, bottom of channel is visible.

[2] Opaque or white like, bottom of channel may be visible.

[3] Light to dark brown; visible particulate matter present. Bottom of channel not visible.

[4] 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors ___

34. ODOR n/a

[1] Animal waste or manure.
[2] Septic or human waste.
[3] Decaying plant matter.
[4] Other ___

1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

Site adjacent to maintained yard, then 100' natural wooded - non-impacted - then opens into grass beyond

35. TRASH

[X] Litter in stream: cans, bottles, yard debris, logging or land clearing debris—in or adjacent to channel.

[2] Tires, cars, appliances, fill material—in or adjacent to channel.

[3] Dead/decaying animals or fish.

[4] Concentrated dump site contains ___

1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT

[1] Farm animals in stream at ___.
[2] Snag pockets found at ___.
[3] Wetlands at ___
[4] Water withdrawal (pump/ditch) at ___.
[5] Floating material ___

1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

(81)

FISH PASSAGE BARRIERS:

Type:	RM:	Height:	Pool Depth	Length to Negotiate:

Falls 37________ Culvert 38________ Dam 39________

Debris 40________ Beaver Dam 41________

GENERAL COMMENTS:

50. Stream ________ 51. Survey ________

52. Communication with Residents: _____ 53. Other __________

DIRECT DISCHARGE TO STREAM:

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:
Lawn Drain		RB	6"	Organic accum.

Type: Tributary 42______ Pipe/Culvert 43______ Seeps/Springs 46______

Grass-lined Swale 44______ Ditch 45______

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:
	See Notes		

47. Total __________________
A. Clearing/Grading B. Landscaping C. Other Construction Activity
D. Land Use Change

48. Substrate Composition, Percentage of Cover

- [1] Bedrock ________%
- [2] Boulders (>3') ________%
- [3] Cobble (3" – 3') ________%
- [4] Gravel (0.1" – 3") ________%
- [5] ✓ Sand (<0.1") 15 %
- [6] ✓ Silt 70 %
- [7] ✓ Clay 15 %

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

[1] Width	[2] Depth	[1] Width	[2] Depth
~4'	1 - 1.5'		

Channel cross-section:

[3] [4] [5] [6] [7] [8] (8 circled)

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Pictures #4 : 5

APPENDIX V
RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # B-2
2. DATE 6 Sept 94
3. STREAM NAME: Barnes
4. SURVEYORS: JPM

TRIBUTARY TO: ____

Road culvert @ this site. Poor placement. Cut eroded bank w/ poorly operating silt fence

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. ____ TO 7. ____

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3	4
9. SLIMES	1	2	3	4
10. BENTHOS (Bottom Dwelling Animals)	1	2	3	4
11. FISH (JUVENILE/ADULTS):	1	2	3	4

LAND USE ADJACENT TO STREAM (#; %)
DOMINANT 12. # 1 15. 100 % w/in 50' then roadside or road
SUBDOMINANT 13. # ____ 16. ____ %
OTHERS PRESENT 14. # ____ 17. ____ %

1. Forest or natural vegetation
2. Park or golf course
3. Roadside (Highway/Street)
4. Pasture—unfenced
5. Pasture—fenced
6. Cultivated field
7. Residential—scattered (circled) General land use
8. Residential—continuous
9. Industrial/Commercial

18. VEGETATIVE BANK COVER:

[X] 1 Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion.

[2] 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.

[3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.

[4] <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL:
Right Bank 19. 50 feet
Left Bank 20. >100 feet

VEGETATION TYPES: DOMINANT 21. 2 SUBDOMINANT 22. 4 OTHERS PRESENT 23. 5
1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER Ferns/Bramble

24. OVERHEAD CANOPY:

[X] 1 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).

[2] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).

[3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.

[4] 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT: No habitat (Flow) for most of year

[1] Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.

[X] 2 Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities). Few rocks or logs

[3] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.

[4] Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. 6 SUBDOMINANT 27. 4 OTHERS PRESENT 28. 2
1. ROCKS 2. LOGS 3. ROOT WADS 4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG.
7. OTHER ____

CHANNEL CAPACITY 5'

[1] Inadequate. Channel subject to severe erosion—channel may be widening or migrat... extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)

[2] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)

[3] Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).

[X] 4 Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.

[5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:

[1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.

[2] Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.

[3] Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.

[X] 4 Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY:

[1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.

[2] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident.

[3] 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.

[X] 4 Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION:

[1] Substrate loose assortment easily moved with boot heel.
[2] Substrate moderately packed/cemented. Substrate difficult to move with boot heel.
[3] Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.
[X] 4 Substrate consists of/covered by sand, clay or organic muck (circled) w/ places of gravel bottom

33. TRANSPARENCY/COLOR:

[X] 1 Transparent, bottom of channel is visible. Only 1" H_2O Light brown color. All water here (vol.) appears to be from hillside ditch along 223rd
[2] Opaque or white like, bottom of channel may be visible.
[3] Light to dark brown; visible particulate matter present. Bottom of channel not visible.
[4] 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors ____

34. ODOR NA

[1] Animal waste or manure.
[2] Septic or human waste.
[3] Decaying plant matter.
[4] Other ____
1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH NA

[1] Litter in stream: cans, bottles, yard debris, logging or land clearing debris—in or adjacent to channel.
[2] Tires, cars, appliances, fill material—in or adjacent to channel.
[3] Dead/decaying animals or fish.
[4] Concentrated dump site contains ____
1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT

[1] Farm animals in stream at ____.
[2] Snag pockets found at ____.
[3] Wetlands at ____
[4] Water withdrawal (pump/ditch) at ____.
[5] Floating material ____
1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

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(82)

FISH PASSAGE BARRIERS:

Type:	RM:	Height:	Pool Depth	Length to Negotiate:

Falls 37______ Culvert 38______ Dam 39______

Debris 40______ Beaver Dam 41______

GENERAL COMMENTS:

50. Stream ______ 51. Survey ______

52. Communication with Residents: _____ 53. Other ______

DIRECT DISCHARGE TO STREAM:

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:
		RB	12" ?	Eroded bank

Type: Tributary 42_____ Pipe/Culvert 43_____ Seeps/Springs 46_____

Grass-lined Swale 44_____ Ditch 45_____

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:

47. Total ______

A. Clearing/Grading B. Landscaping C. Other Construction Activity

D. Land Use Change

48. Substrate Composition, Percentage of Cover

1 Bedrock _____ %

2 Boulders (>3') _____ %

3 Cobble (3" – 3') _____ %

4 Gravel (0.1" – 3") 20 %

5 Sand (<0.1") _____ %

6 Silt (sand clay mix) 80 %

7 Clay _____ %

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Depth
5'	Deep Channel to Ravine		

Channel cross-section:

3 4 5 (checked) 6 7 8

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Pictures 7, 8, 9

APPENDIX V
RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # B-3 2. DATE 16 Sep. 94

3. STREAM NAME: Barnes 4. SURVEYORS: JPM

TRIBUTARY TO: ____

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. ____ TO 7. ____

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	[1]	[2]	[3]	[4]
9. SLIMES	[1]	[2]	[3]	[4]
10. BENTHOS (Bottom Dwelling Animals)	[1]	[2]	[3]	[4]
11. FISH (JUVENILE/ADULTS):	[1]	[2]	[3]	[4]

LAND USE ADJACENT TO STREAM (#; %)
DOMINANT 12. # 1 15. 100 %
SUBDOMINANT 13. # ____ 16. ____ %
OTHERS PRESENT 14. # ____ 17. ____ %
(to top of ravine then older (not dense) wooded residen.)

(1) Forest or natural vegetation (circled) 4. Pasture—unfenced 7. Residential—scattered
2. Park or golf course 5. Pasture—fenced 8. Residential—continuous
3. Roadside (Highway/Street) 6. Cultivated field 9. Industrial/Commercial

18. VEGETATIVE BANK COVER:

[X] Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion. Eroded side of meander shows impact -- trail impact

[X] 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.

[3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.

[4] <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: Right Bank 19. 50-75 feet to top ravine; Left Bank 20. 50 feet

VEGETATION TYPES: DOMINANT 21. 2 SUBDOMINANT 22. 1 OTHERS PRESENT 23. ____
1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER ____

24. OVERHEAD CANOPY:

[1] 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).

[X] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).

[3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.

[4] 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT:

[1] Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.

[2] Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).

[3] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.

[4] Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. 2 SUBDOMINANT 27. 6 OTHERS PRESENT 28. 3:4
1. ROCKS 2. LOGS 3. ROOT WADS 4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG. 7. OTHER ____

29. CHANNEL CAPACITY

[1] Inadequate. Channel subject to severe erosion—channel may be widening or migrat... extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)

[2] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)

[3] Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).

[X] Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration. (main channel

[5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common. Natural meandering causing cutting banks

30. ARTIFICIAL BANK PROTECTION:

[1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.

[2] Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.

[3] Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.

[X] Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY:

[1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.

[2] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident.

[3] 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.

[X] Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION:

[1] Substrate loose assortment easily moved with boot heel.
[X] Substrate moderately packed/cemented. Substrate difficult to move with boot heel.
[3] Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.
[4] Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR:

[X] Transparent, bottom of channel is visible. Light Brown
[2] Opaque or white like, bottom of channel may be visible.
[3] Light to dark brown; visible particulate matter present. Bottom of channel not visible.
[4] 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors ____

34. ODOR NA

[1] Animal waste or manure. [3] Decaying plant matter.
[2] Septic or human waste. [4] Other ____
1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH

[X] Litter in stream: cans, bottles, yard debris, logging or land clearing debris—in or adjacent to channel. Lumber for bridges, etc.
[2] Tires, cars, appliances, fill material—in or adjacent to channel.
[3] Dead/decaying animals or fish.
[4] Concentrated dump site contains ____
1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT

[1] Farm animals in stream at ____. [4] Water withdrawal (pump/ditch) at ____.
[2] Snag pockets found at ____. [5] Floating material ____
[3] Wetlands at ____
1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

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B3

FISH PASSAGE BARRIERS: None

Type:	RM:	Height:	Pool Depth	Length to Negotiate:

Falls 37________ Culvert 38________ Dam 39________

Debris 40________ Beaver Dam 41________

GENERAL COMMENTS:

50. Stream ________ 51. Survey ________

52. Communication with Residents: _____ 53. Other ________

DIRECT DISCHARGE TO STREAM: None

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:

Type: Tributary 42______ Pipe/Culvert 43______ Seeps/Springs 46______

Grass-lined Swale 44______ Ditch 45______

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:
	None Trails in stream construction 300' from road becomes dense understory of blkberry, maple etc		

47. Total ____________

A. Clearing/Grading B. Landscaping C. Other Construction Activity

D. Land Use Change

48. Substrate Composition, Percentage of Cover

1 Bedrock ______%

2 Boulders (>3') ______%

3 Cobble (3" – 3') 60%

4 Gravel (0.1" – 3") 20%

5 Sand (<0.1") ______%

6 Silt 20%

7 Clay ______%

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Depth
6'	~1' but lots of meander room @ bottom of ravine		

Channel cross-section: 3 (circled) 4 5 6 7 8

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APPENDIX V

RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # Des Moines 2. DATE 13 - Sept 1994

3. STREAM NAME: DM-B 4. SURVEYORS: JPM

TRIBUTARY TO: ______

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. ___ TO 7. ___

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3	[X] 4
9. SLIMES	1	[X] 2	3	4
10. BENTHOS (Bottom Dwelling Animals)	1	2	3	4
11. FISH (JUVENILE/ADULTS):	1	2	3	4

LAND USE ADJACENT TO STREAM (#; %)
DOMINANT 12. # 1 15. 100 % except gravel road along R.B
SUBDOMINANT 13. # ___ 16. ___ %
OTHERS PRESENT 14. # ___ 17. ___ %

1. Forest or natural vegetation 4. Pasture—unfenced 7. Residential—scattered
2. Park or golf course 5. Pasture—fenced 8. Residential—continuous
3. Roadside (Highway/Street) 6. Cultivated field 9. Industrial/Commercial

18. VEGETATIVE BANK COVER:

[X] Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion. Except for exposed clay banks

[2] 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.

[3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.

[4] <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: Right Bank 19. 2-5' feet then 5' high bank then road, then >200' nat. veg
Left Bank 20. >200 feet

VEGETATION TYPES: DOMINANT 21. 4:5 SUBDOMINANT 22. 3 OTHERS PRESENT 23. ___

1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER ______
Open Canopy Deciduous / Blkberry along bank

24. OVERHEAD CANOPY:

[X] 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual). Lite Shade

[2] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).

[3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.

[4] 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT:

[X] Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.

[X] Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).

[3] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.

[4] Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. 1 SUBDOMINANT 27. 2:3 OTHERS PRESENT 28. 4:6

1. ROCKS 2. LOGS 3. ROOT WADS 4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG.
7. OTHER ______

CHANNEL CAPACITY

[1] Inadequate. Channel subject to severe erosion—channel may be widening or migrat... extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)

[2] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)

[X] Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).

[4] Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.

[5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:

[1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.

[2] Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.

[X] Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.

[4] Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY:

[1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.

[2] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident.

[X] 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.

[4] Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION:

[X] Substrate loose assortment easily moved with boot heel.

[2] Substrate moderately packed/cemented. Substrate difficult to move with boot heel.

[3] Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.

[4] Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR:

[X] Transparent, bottom of channel is visible.

[2] Opaque or white like, bottom of channel may be visible.

[3] Light to dark brown; visible particulate matter present. Bottom of channel not visible.

[4] 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors ______

34. ODOR

[1] Animal waste or manure. [3] Decaying plant matter.

[X] Septic or human waste. Due to sewer line - not stream [4] Other ______

1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH Some cans; plants -- not much considering

[1] Litter in stream: cans, bottles, yard debris, logging or land clearing debris—in or adjacent to channel.

[2] Tires, cars, appliances, fill material—in or adjacent to channel.

[3] Dead/decaying animals or fish.

[4] Concentrated dump site contains ______

1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT

[1] Farm animals in stream at ______. [4] Water withdrawal (pump/ditch) at ______.

[2] Snag pockets found at ______. [5] Floating material ______

[3] Wetlands at ______

1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

DM-13

FISH PASSAGE BARRIERS: None

Type:	RM:	Height:	Pool Depth	Length to Negotiate:

Falls 37________ Culvert 38________ Dam 39________

Debris 40________ Beaver Dam 41________

GENERAL COMMENTS:

50. Stream ________ 51. Survey ________

52. Communication with Residents: _____ 53. Other ________

DIRECT DISCHARGE TO STREAM:

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:

Type: Tributary 42______ Pipe/Culvert 43______ Seeps/Springs 46______

Grass-lined Swale 44______ Ditch 45______

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:
Maintenance road follows 5-10' From R.B			

47. Total ________

A. Clearing/Grading B. Landscaping C. Other Construction Activity

D. Land Use Change

48. Substrate Composition, Percentage of Cover

1	Bedrock	____%
2	Boulders (>3')	15 %
3	Cobble (3" – 3')	70 %
4	Gravel (0.1" – 3")	15 %
5	Sand (<0.1")	____%
6	Silt	____%
7	Clay /Hardpan	Some areas %

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS @ low flow

1 Width	2 Depth	1 Width	2 Depth
10'	3-6" of water		
10-20' channel width			
A few good pools			

Channel cross-section:

3 4 5 6 7 8

WASHINGTON STATE DEPARTMENT OF ECOLOGY

AR 025699

APPENDIX V
RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # DM-C
2. DATE 9-13-94
3. STREAM NAME: Des Moines
4. SURVEYORS: JPM

TRIBUTARY TO: ______

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. ___.__ TO 7. ___.__

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	[1]	[2]	[3]	[X]
9. SLIMES	[1]	[X]	[3]	[4]
10. BENTHOS (Bottom Dwelling Animals)	[1]	[2]	[3]	[4]
11. FISH (JUVENILE/ADULTS):	[1]	[2]	[3]	[4]

LAND USE ADJACENT TO STREAM (#; %)
DOMINANT 12. # 1 15. 100 %
SUBDOMINANT 13. # ___ 16. ___ %
OTHERS PRESENT 14. # ___ 17. ___ %
utility corridor on RB is grass

1. Forest or natural vegetation
2. Park or golf course
3. Roadside (Highway/Street)
4. Pasture—unfenced
5. Pasture—fenced
6. Cultivated field
7. Residential—scattered
8. Residential—continuous
9. Industrial/Commercial

18. VEGETATIVE BANK COVER:

[X] Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion.

[2] 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.

[3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.

[4] <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL:
Right Bank 19. 15-50 feet to path then >100
Left Bank 20. >200 feet

VEGETATION TYPES: DOMINANT 21. 4 SUBDOMINANT 22. 2/3 OTHERS PRESENT 23. ___
1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES (4. TREES) 5. OTHER ______

24. OVERHEAD CANOPY:

[X] 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual). Light shade -- not too dense

[2] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).

[3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.

[4] 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT:

[1] Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.

[X] Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).

[3] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.

[4] Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. 1 SUBDOMINANT 27. 2 OTHERS PRESENT 28. 4/3
(1. ROCKS) (2. LOGS) (3. ROOT WADS) (4. DEBRIS) 5. UNDERCUT BANK 6. BANK VEG.
7. OTHER ______

CHANNEL CAPACITY

[1] Inadequate. Channel subject to severe erosion—channel may be widening or migrat... extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)

[2] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)

[X] Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).

[4] Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.

[5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:

[1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.

[2] Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.

[3] Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.

[X] Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY:

[1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.

[2] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident.

[3] 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.

[X] Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION:

[X] Substrate loose assortment easily moved with boot heel.

[2] Substrate moderately packed/cemented. Substrate difficult to move with boot heel.

[3] Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.

[4] Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR:

[X] Transparent, bottom of channel is visible. Brown

[2] Opaque or white like, bottom of channel may be visible.

[3] Light to dark brown; visible particulate matter present. Bottom of channel not visible.

[4] 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors ______

34. ODOR

[1] Animal waste or manure.
[X] Septic or human waste. WTP nearby
[3] Decaying plant matter.
[4] Other ______
1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH Little

[X] Litter in stream: (cans,) bottles, yard debris, logging or land clearing debris—in or adjacent to channel.

[X] (Tires,) cars, appliances, fill material—in or adjacent to channel.

[3] Dead/decaying animals or fish.

[4] Concentrated dump site contains ______
1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT

[1] Farm animals in stream at ______.
[2] Snag pockets found at ______.
[3] Wetlands at ______
[4] Water withdrawal (pump/ditch) at ______.
[5] Floating material ______
1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

AR 025700

DM-C

FISH PASSAGE BARRIERS:

Type:	RM:	Height:	Pool Depth	Length to Negotiate:
40 Debris Jam	~250' below bridge	3'	None @ low flow	< 10'

Falls 37______ Culvert 38______ Dam 39______

Debris 40______ Beaver Dam 41______

GENERAL COMMENTS:

50. Stream ______ 51. Survey ______

52. Communication with Residents: ______ 53. Other ______

DIRECT DISCHARGE TO STREAM:

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:
metal	~100' below bridge	RB	18"	None (iron deposits)
Metal	~150' below bridge	RB	84"	

Type: Tributary 42______ Pipe/Culvert 43______ Seeps/Springs 46______

Grass-lined Swale 44______ Ditch 45______

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:
Maintenance Road	located 10-20' off RB		

47. Total ______

A. Clearing/Grading B. Landscaping C. Other Construction Activity

D. Land Use Change

48. Substrate Composition, Percentage of Cover

1	Bedrock	____ %
2	Boulders (>3')	10 %
3	Cobble (3" – 3')	60 %
4	Gravel (0.1" – 3")	20 %
5	Sand (<0.1")	____ %
6	Silt	____ %
7	Clay	____ %

Sand, Silt, Clay (bracketed): 10%

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Depth
10-15'			

A few good pools formed by logs & rocks

Channel cross-section: 3 4 5 6 7 8 (4 circled)

WASHINGTON STATE DEPARTMENT OF ECOLOGY

AR 025701

APPENDIX V

RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # DM-D 2. DATE 13 Sept 94

3. STREAM NAME: Des Moines 4. SURVEYORS: JPM

TRIBUTARY TO: ______

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. ___ TO 7. ___

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3	[X] 4
9. SLIMES	1	[X] 2	3	4
10. BENTHOS (Bottom Dwelling Animals)	1	2	3	4
11. FISH (JUVENILE/ADULTS):	1	2	3	4

LAND USE ADJACENT TO STREAM (#; %)
DOMINANT 12. # 2 15. 80 %
SUBDOMINANT 13. # 3 16. 20 %
OTHERS PRESENT 14. # ___ 17. ___ %
(senior ctr)

1. Forest or natural vegetation 4. Pasture—unfenced 7. Residential—scattered
(2.) Park or golf course 5. Pasture—fenced 8. Residential—continuous
(3.) Roadside (Highway/Street) 6. Cultivated field 9. Industrial/Commercial

18. VEGETATIVE BANK COVER:

[X] 1 Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion.

2 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.

3 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.

[crossed out] 4 <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: Right Bank 19. 5-10 feet; Left Bank 20. 5-10 feet

VEGETATION TYPES: DOMINANT 21. 2 SUBDOMINANT 22. 3 OTHERS PRESENT 23. 1
1. GRASSES (2.) SHRUBS (3.) BLK BRY BUSHES 4. TREES 5. OTHER ______

24. OVERHEAD CANOPY:

1 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).

2 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).

3 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.

[X] 4 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT:

1 Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.

2 Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).

[X] 3 Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.

4 Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

(Mouth cobbly shallow glide No LWD for pools etc)

FISH COVER TYPES: DOMINANT 26. ___ SUBDOMINANT 27. ___ OTHERS PRESENT 28. ___
1. ROCKS 2. LOGS 3. ROOT WADS 4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG.
7. OTHER ______

29. CHANNEL CAPACITY

1 Inadequate. Channel subject to severe erosion—channel may be widening or migrat... extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)

2 Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)

3 Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).

[X] 4 Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.

5 Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:

1 Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.

[X] 2 Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.

3 Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.

4 Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY: More rip/rap defined channel here

1 Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.

2 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident.

[X] 3 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.

4 Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION:

[X] 1 Substrate loose assortment easily moved with boot heel.
2 Substrate moderately packed/cemented. Substrate difficult to move with boot heel.
3 Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.
4 Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR:

[X] 1 Transparent, bottom of channel is visible.
[X] 2 Opaque or white like, bottom of channel may be visible.
3 Light to dark brown; visible particulate matter present. Bottom of channel not visible.
4 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors ______

34. ODOR

1 Animal waste or manure. 3 Decaying plant matter.
2 Septic or human waste. 4 Other ______
1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH None seen

1 Litter in stream: cans, bottles, yard debris, logging or land clearing debris—in or adjacent to channel.
2 Tires, cars, appliances, fill material—in or adjacent to channel.
3 Dead/decaying animals or fish.
4 Concentrated dump site contains ______
1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT

1 Farm animals in stream at ______. 4 Water withdrawal (pump/ditch) at ______.
2 Snag pockets found at ______. 5 Floating material ______
3 Wetlands at ______
1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

DM-17 **FISH PASSAGE BARRIERS:** None

Type:	RM:	Height:	Pool Depth	Length to Negotiate:

Falls 37____ Culvert 38____ Dam 39____

Debris 40____ Beaver Dam 41____

GENERAL COMMENTS:

50. Stream ____ 51. Survey ____

52. Communication with Residents: ____ 53. Other ____

DIRECT DISCHARGE TO STREAM: none

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:

Type: Tributary 42____ Pipe/Culvert 43____ Seeps/Springs 46____

Grass-lined Swale 44____ Ditch 45____

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR: No recent disturbance

RM:	Prox to Stream: <30 >30:	Length	Cause:

- Building structures located over and directly adjacent to stream
- For most of the segment there is a vegetated buffer, but it is narrow and adjacent to maintained grass

47. Total ____
A. Clearing/Grading B. Landscaping C. Other Construction Activity
D. Land Use Change

48. Substrate Composition, Percentage of Cover

1	Bedrock	____ %
2	Boulders (>3')	____ %
3	Cobble (3" – 3')	30 %
4	Gravel (0.1" – 3")	60 %
5	Sand (<0.1")	10 %
6	Silt	____ %
7	Clay	____ %

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Depth
10-15'	<5" (pretty consistent, all riffle area)		

Channel cross-section:

3 4 5 6 7 8 (8 circled)

![Washington State Department of Ecology logo]

WASHINGTON STATE DEPARTMENT OF ECOLOGY

#13 - Upstrm of entrance trail by school yd'
- 17 looking thru fence @ ~ 2 hses above rd

APPENDIX V
RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # MC-1
2. DATE 27 Sept 1994
3. STREAM NAME: McSoiley
4. SURVEYORS: JPM

TRIBUTARY TO: ____ 4-6' wide

5. SURVEY ENTRY/EXIT POINTS: Headwaters

RIVER MILES SURVEYED: 6. ___ TO 7. ___

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3	☒ 4
9. SLIMES	1	2	3	☒ 4
10. BENTHOS (Bottom Dwelling Animals)	1	2	3	☒ 4
11. FISH (JUVENILE/ADULTS):	1	2	3	☒ 4

just a trickle of water

LAND USE ADJACENT TO STREAM (#; %)
DOMINANT 12. # 8 50% 15. 9 50% %
SUBDOMINANT 13. # ___ 16. ___ %
OTHERS PRESENT 14. # ___ 17. ___ %
~ good buffer

1. Forest or natural vegetation
2. Park or golf course
3. Roadside (Highway/Street)
4. Pasture—unfenced
5. Pasture—fenced
6. Cultivated field
7. Residential—scattered.
8. Residential—continuous
9. Industrial/~~Commercial~~ school

18. VEGETATIVE BANK COVER:

- ☒ 1 Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion. Eroded/well-used trails .. just a few
- 2 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.
- 3 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.
- 4 <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: Right Bank 19. 2-10 feet; Left Bank 20. 760 feet

VEGETATION TYPES: DOMINANT 21. 2 SUBDOMINANT 22. 4 OTHERS PRESENT 23. 3

1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER ____
Not bare grd, but not thick protective forbes either

24. OVERHEAD CANOPY:

- ☒ 1 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).
- 2 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).
- 3 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.
- 4 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT: Not really fish area

- ☒ 1 Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed. Cut banks logs
- 2 Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).
- 3 Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.
- 4 Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. 2 SUBDOMINANT 27. 5 OTHERS PRESENT 28. ___
(1. ROCKS) (2. LOGS) (3. ROOT WADS) 4. DEBRIS (5. UNDERCUT BANK) 6. BANK VEG. 7. OTHER ____

CHANNEL CAPACITY

- 1 Inadequate. Channel subject to severe erosion—channel may be widening or migrat. Extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)
- 2 Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)
- ☒ 3 Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).
- 4 Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.
- 5 Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION: Potential high for sloughing

- 1 Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.
- 2 Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.
- ☒ 3 Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.
- 4 Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY:

- 1 Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.
- 2 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident.
- ☒ 3 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.
- 4 Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION: Rocks : Cobble

- ☒ 1 Substrate loose assortment easily moved with boot heel.
- 2 Substrate moderately packed/cemented. Substrate difficult to move with boot heel.
- 3 Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.
- 4 Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR: No water

- 1 Transparent, bottom of channel is visible.
- 2 Opaque or white like, bottom of channel may be visible.
- 3 Light to dark brown; visible particulate matter present. Bottom of channel not visible.
- 4 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors ____

34. ODOR None

- 1 Animal waste or manure.
- 2 Septic or human waste.
- 3 Decaying plant matter.
- 4 Other ____

1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH Cyclone fencing in channel

- ☒ 1 Litter in stream: cans, bottles, yard debris, logging or land clearing debris—in or adjacent to channel.
- 2 (Tires), cars, appliances, fill material—in or adjacent to channel.
- 3 Dead/decaying animals or fish.
- 4 Concentrated dump site contains ____

1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT

- 1 Farm animals in stream at ____.
- 2 Snag pockets found at ____.
- 3 Wetlands at ____
- 4 Water withdrawal (pump/ditch) at ____.
- 5 Floating material ____

1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

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MC-1

FISH PASSAGE BARRIERS: None

Type:	RM:	Height:	Pool Depth	Length to Negotiate:
				Very shallow; Narrow. Not really Fish habitat

Falls 37________ Culvert 38________ Dam 39________

Debris 40________ Beaver Dam 41________

DIRECT DISCHARGE TO STREAM:

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:

Type: Tributary 42______ Pipe/Culvert 43______ Seeps/Springs 46______

Grass-lined Swale 44______ Ditch 45______

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:
Trails from schoolyard	Broken vegetation along banks RB		

47. Total ________

A. Clearing/Grading B. Landscaping C. Other Construction Activity

D. Land Use Change

GENERAL COMMENTS:

50. Stream ________ 51. Survey ________

52. Communication with Residents: ______ 53. Other ________

48. Substrate Composition, Percentage of Cover

1	Bedrock	____ %
2	Boulders (>3') (large cobble?)	10 %
3	Cobble (3" – 3')	60 %
4	Gravel (0.1" – 3")	____ %
5	Sand (<0.1")	____ %
6	Silt (organic accumulations)	30% %
7	Clay	____ %

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Depth
2-4'	No water Channel ~1' deep		

Channel cross-section: 3 4 5 (circled) 6 7 8

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APPENDIX V
RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # MC-2 2. DATE 27 Sept 94

3. STREAM NAME: McSorley 4. SURVEYORS: JPM

TRIBUTARY TO: ____ very little H_2O

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. ___ TO 7. ___

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3	4 (X)
9. SLIMES	1	2	3	4 (X)
10. BENTHOS (Bottom Dwelling Animals)	1	2	3	4 (X)
11. FISH (JUVENILE/ADULTS):	1	2	3	4 (X)

LAND USE ADJACENT TO STREAM (#; %)
- DOMINANT 12. # 8 15. 100 %
- SUBDOMINANT 13. # ___ 16. ___ %
- OTHERS PRESENT 14. # ___ 17. ___ %

1. Forest or natural vegetation 4. Pasture—unfenced 7. Residential—scattered
2. Park or golf course 5. Pasture—fenced (8.) Residential—continuous
3. Roadside (Highway/Street) 6. Cultivated field 9. Industrial/Commercial

18. VEGETATIVE BANK COVER:

[1] Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion.

[X] 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.

[3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.

[4] <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: Right Bank 19. 0-5 feet; Left Bank 20. 0-25 feet

VEGETATION TYPES: DOMINANT 21. 2 SUBDOMINANT 22. 1 OTHERS PRESENT 23. 4

(1.) GRASSES (2.) SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER ____

24. OVERHEAD CANOPY:

[1] 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual).

[X] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).

[3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.

[4] 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT:

[1] Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.

[2] Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).

[3] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.

[X] Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26.___ SUBDOMINANT 27.___ OTHERS PRESENT 28.___

1. ROCKS 2. LOGS 3. ROOT WADS 4. DEBRIS (5.) UNDERCUT BANK 6. BANK VEG.
7. OTHER ____

CHANNEL CAPACITY

[1] Inadequate. Channel subject to severe erosion—channel may be widening or migrat... extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)

[2] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)

[X] Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).

[4] Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.

[5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:

[1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.

[X] Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered. Entirely for 1st 50' then none

[3] Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.

[4] Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY:

[1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.

[X] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident. Not bad, but assume I saw best case

[3] 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.

[4] Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION:

[X] Substrate loose assortment easily moved with boot heel. Good stuff!

[2] Substrate moderately packed/cemented. Substrate difficult to move with boot heel.

[3] Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.

[4] Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR:

[1] Transparent, bottom of channel is visible.

[2] Opaque or white like, bottom of channel may be visible.

[3] Light to dark brown; visible particulate matter present. Bottom of channel not visible.

[4] 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors ____

34. ODOR

[1] Animal waste or manure. [3] Decaying plant matter.

[2] Septic or human waste. [4] Other ____

1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH cleaned up of trash; natural debris

[1] Litter in stream: cans, bottles, yard debris, logging or land clearing debris—in or adjacent to channel.

[2] Tires, cars, appliances, fill material—in or adjacent to channel.

[3] Dead/decaying animals or fish.

[4] Concentrated dump site contains ____

1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT

[1] Farm animals in stream at ____. [4] Water withdrawal (pump/ditch) at ____.

[2] Snag pockets found at ____. [5] Floating material ____

[3] Wetlands at ____

1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

MC-2

FISH PASSAGE BARRIERS:

Type:	RM:	Height:	Pool Depth	Length to Negotiate:
				Shallow, narrow weed filled corridor - no fish passage

Falls 37______ Culvert 38______ Dam 39______

Debris 40______ Beaver Dam 41______

GENERAL COMMENTS:

50. Stream ______ 51. Survey ______

52. Communication with Residents: ______ 53. Other ______

DIRECT DISCHARGE TO STREAM:

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:
Segment ~~begins w/~~ as [illegible]" culvert into armored channel				

Type: Tributary 42______ Pipe/Culvert 43______ Seeps/Springs 46______

Grass-lined Swale 44______ Ditch 45______

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR:

RM:	Prox to Stream: <30 >30:	Length	Cause:
Entirely banded by residents; lawn; garden activity to bank; instream activity			

47. Total ______

A. Clearing/Grading B. Landscaping C. Other Construction Activity

D. Land Use Change

48. Substrate Composition, Percentage of Cover

1	Bedrock	______ %
2	Boulders (>3')	______ %
3	Cobble (3" – 3')	5 %
4	Gravel (0.1" – 3")	15 %
5	Sand (<0.1")	}
6	Silt	} 80 %
7	Clay	}

(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Depth
2-6'	little water @ bank full < 1' depth		

Channel cross-section:

3 4 5 6 7 8 (8 circled, ✓)

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APPENDIX V
RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM

1. STREAM # Mc-3 2. DATE 27 Sept 94

3. STREAM NAME: Mc Sorley 4. SURVEYORS: JPM

TRIBUTARY TO: ____

5. SURVEY ENTRY/EXIT POINTS:

RIVER MILES SURVEYED: 6. ___ TO 7. ___

ABUNDANCE OF:	ABUNDANT	COMMON	FEW	NONE OBSERVED
8. INSTREAM PLANTS	1	2	3	[X] 4
9. SLIMES	1	2	3	[X] 4
10. BENTHOS (Bottom Dwelling Animals)	1	2	3	[X] 4
11. FISH (JUVENILE/ADULTS):	1	2	3	[X] 4

Lots of water striders in pools

LAND USE ADJACENT TO STREAM (#; %)

	#	%
DOMINANT	12. # 1	15. 100 %
SUBDOMINANT	13. # ___	16. ___ %
OTHERS PRESENT	14. # ___	17. ___ %

(1.) Forest or natural vegetation — 4. Pasture—unfenced — 7. Residential—scattered
2. Park or golf course — 5. Pasture—fenced — 8. Residential—continuous
3. Roadside (Highway/Street) — 6. Cultivated field — 9. Industrial/Commercial

18. VEGETATIVE BANK COVER:

- [1] Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from erosion.
- [X] 76-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor erosion of streambank surface possible.
- [3] 50-75% of streambank surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited protection from erosion.
- [4] <50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, discontinuous, shallow root mat inferred. Vegetation provides streambank surface little protection from erosion.

WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: Right Bank 19. ___ feet; Left Bank 20. ___ feet

To Top of bluffs on either side >50-100

VEGETATION TYPES: DOMINANT 21. 2 SUBDOMINANT 22. 3 OTHERS PRESENT 23. ___

1. GRASSES (2. SHRUBS) (3. BLK BRY BUSHES) (4. TREES) 5. OTHER ____
Indian Plum

24. OVERHEAD CANOPY:

- [X] 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and small (larger/slightly larger than the space resulting from loss of mature individual). High Canopy (100' above)
- [2] 51-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals).
- [3] 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous.
- [4] 0-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.

25. FISH HABITAT:

- [X] Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.
- [2] Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).
- [3] Little diversity and abundance of instream habitat (only one or two of the habitat types present or predominant). Instream cover and/or low overhanging vegetation sparse and discontinuous.
- [4] Almost no diversity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.

FISH COVER TYPES: DOMINANT 26. 2 SUBDOMINANT 27. ___ OTHERS PRESENT 28. ___

1. ROCKS (2. LOGS) (3. ROOT WADS) (4. DEBRIS) 5. UNDERCUT BANK 6. BANK VEG.
7. OTHER ____

CHANNEL CAPACITY

- [1] Inadequate. Channel subject to severe erosion—channel may be widening or migrat. . extensive deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)
- [2] Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable sediment (esp. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)
- [3] Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down).
- [X] Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.
- [5] Stream flows through or adjacent to marsh/wetland area. Overbank flows natural, common.

30. ARTIFICIAL BANK PROTECTION:

- [1] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank configuration altered.
- [2] Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.
- [X] Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state.
- [4] Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.

31. STREAMBANK STABILITY:

- [1] Streambanks being severely altered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overhangs and sloughing frequent.
- [2] 26-50% streambanks receiving major alterations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident.
- [3] 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition.
- [X] Streambanks stable or only slightly altered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being altered.

32. SUBSTRATE CONSOLIDATION:

- [1] Substrate loose assortment easily moved with boot heel.
- [X] Substrate moderately packed/cemented. Substrate difficult to move with boot heel. Pretty well sedimented in
- [3] Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hardpan.
- [X] Substrate consists of/covered by sand, clay or organic muck.

33. TRANSPARENCY/COLOR:

- [1] Transparent, bottom of channel is visible.
- [2] Opaque or white like, bottom of channel may be visible.
- [X] Light to dark brown; visible particulate matter present. Bottom of channel not visible.
- [4] 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors ____

Much sediment accumulation.

34. ODOR None

- [1] Animal waste or manure.
- [2] Septic or human waste.
- [3] Decaying plant matter.
- [4] Other ____

1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM

35. TRASH

- [X] Litter in stream: cans, bottles, yard debris, logging or land clearing debris—in or adjacent to channel.
- [2] Tires, cars, appliances, fill material—in or adjacent to channel.
- [3] Dead/decaying animals or fish.
- [4] Concentrated dump site contains ____

1. ORGANIC MATERIAL 2. INORGANIC

36. SPECIAL CASES PRESENT

- [1] Farm animals in stream at ____.
- [2] Snag pockets found at ____.
- [3] Wetlands at ____
- [4] Water withdrawal (pump/ditch) at ____.
- [5] Floating material ____

1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

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MC-3

FISH PASSAGE BARRIERS: None

Type:	RM:	Height:	Pool Depth	Length to Negotiate:
Dam above this segment				

Falls 37______ Culvert 38______ Dam 39______

Debris 40______ Beaver Dam 41______

GENERAL COMMENTS:

50. Stream ______ 51. Survey ______

52. Communication with Residents: ______ 53. Other ______

DIRECT DISCHARGE TO STREAM:

Type:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:
Metal Culvert	@ 16th bridge	RB RB	large	

Type: Tributary 42______ Pipe/Culvert 43______ Seeps/Springs 46______
Grass-lined Swale 44______ Ditch 45______

Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted

RECENT IMPACTS TO STREAMSIDE CORRIDOR: None

RM:	Prox to Stream: <30 >30:	Length	Cause:

47. Total ______
A. Clearing/Grading B. Landscaping C. Other Construction Activity
D. Land Use Change

48. Substrate Composition, Percentage of Cover

1	Bedrock	____ %
2	Boulders (>3')	10 %
3	Cobble (3" – 3')	40 %
4	Gravel (0.1" – 3")	10 %
5	Sand (<0.1")	____ %
6	Silt	40 %
7	Clay	____ %

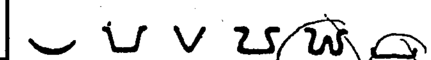
(Measurements at diameter)

49. CHANNEL CHARACTERISTICS

1 Width	2 Depth	1 Width	2 Depth
10-15	6"-1'		

Channel can expand to 25' fairly easily
Some good, deep pools

Channel cross-section:



3 4 5 6 7 8

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Appendix C

Pictures

INTRODUCTION

This appendix contains select pictures from the stream segments surveyed within the City of DesMoines, in 1994 and 1999. These pictures were selected to characterize streamside condition, vegetation, evidence of stormwater impacts and erosion, LWD, etc. Not all of the riparian corridor assessment segments are represented. Photos are identified by photo numbers, riparian corridor assessment survey form site numbers (e.g. MA-1), and the year the photo was taken. Photo numbers correspond to the photo numbers at the top of the riparian corridor assessment survey forms in Appendix A and B.

See Figures 1-5 at the end of this appendix for picture locations. The 1994 picture locations are designated with circles, whereas the 1999 picture locations are designated with squares. Individual picture numbers are located next to the year symbol.

MASSEY CREEK

Photo #10, (MA-1) 1994

Photo #9, (MA-1) 1999

Photo #8, (MA-1) 1999

Photo #11, (MA-2) 1999

Photo #12, (MA-2) 1999

Photo #16, (MA-4) 1999

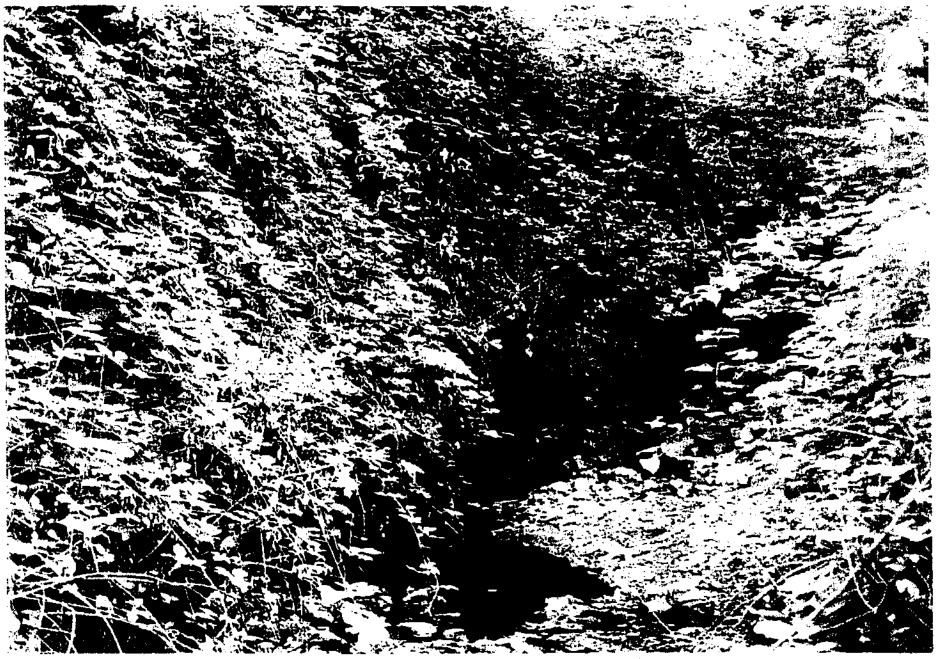


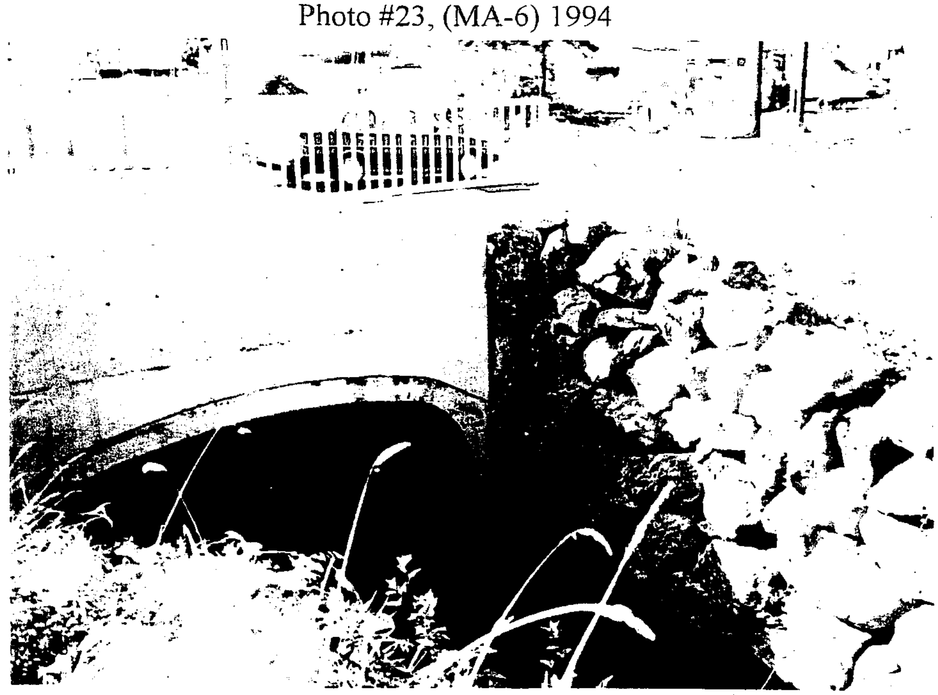
Photo #18, (MA-4) 1999

Photo #20, (MA-4) 1999

Photo #18, (MA-5) 1994

Photo #24, (MA-5) 1994

Photo #23, (MA-6) 1994

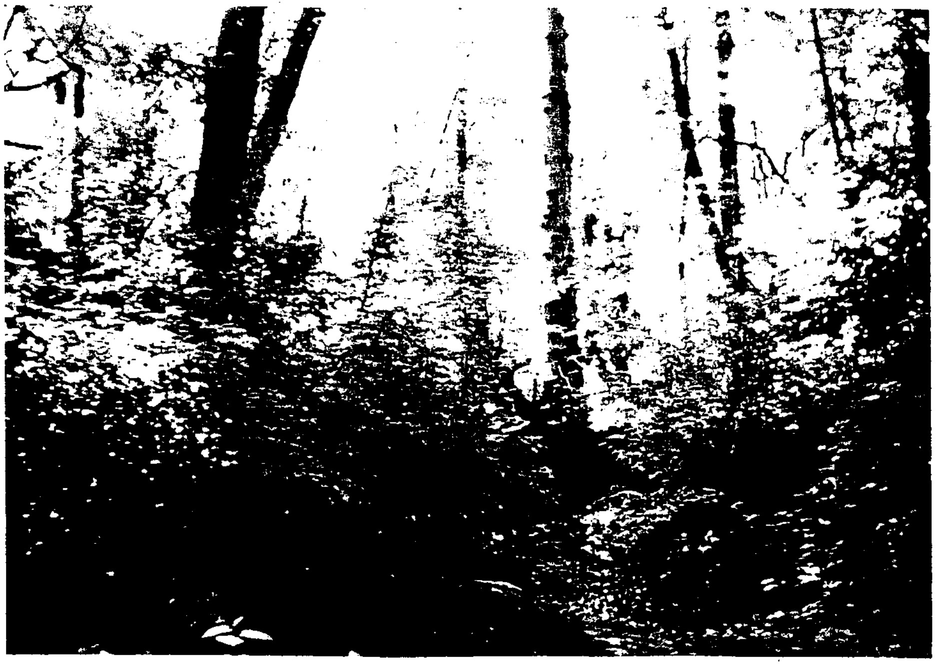


Barnes Creek

Photo #2, (B-2) 1994

Photo #24, (B-2) 1999

Photo #8, (B-3) 1994



DESMOINES CREEK

Photo #2, (DM-B) 1999

Photo #5, (DM-B) 1999

Photo #33, (DM-B) 1994

Photo #7, (DM-B) 1999

Photo #10, (DM-C) 1999

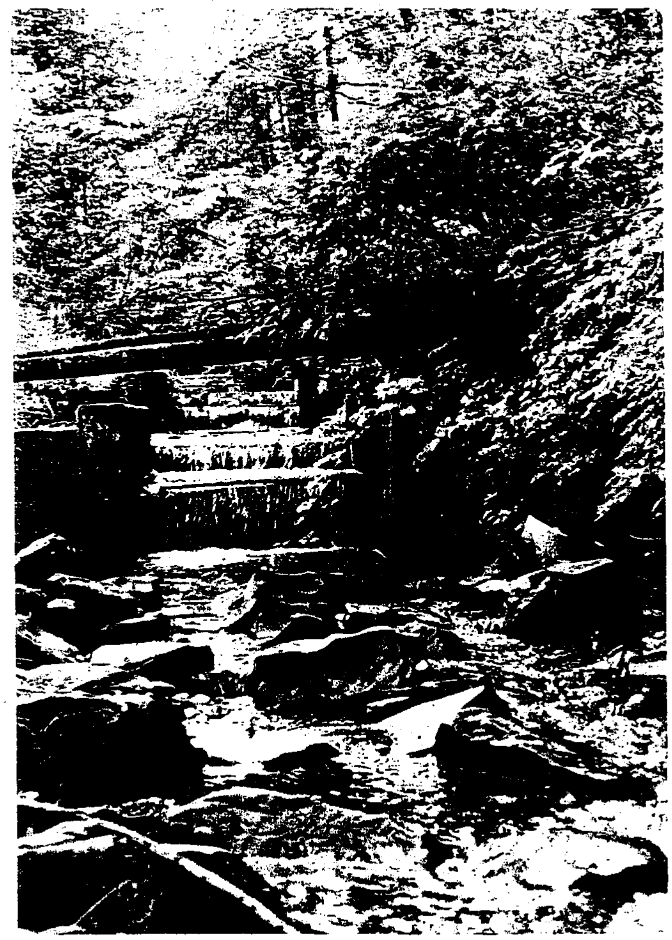


Photo #8, (DM-C) 1999

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Photo #5, (DM-C) 1994

Photo #8, (DM-C) 1994

Photo #11, (DM-D) 1999

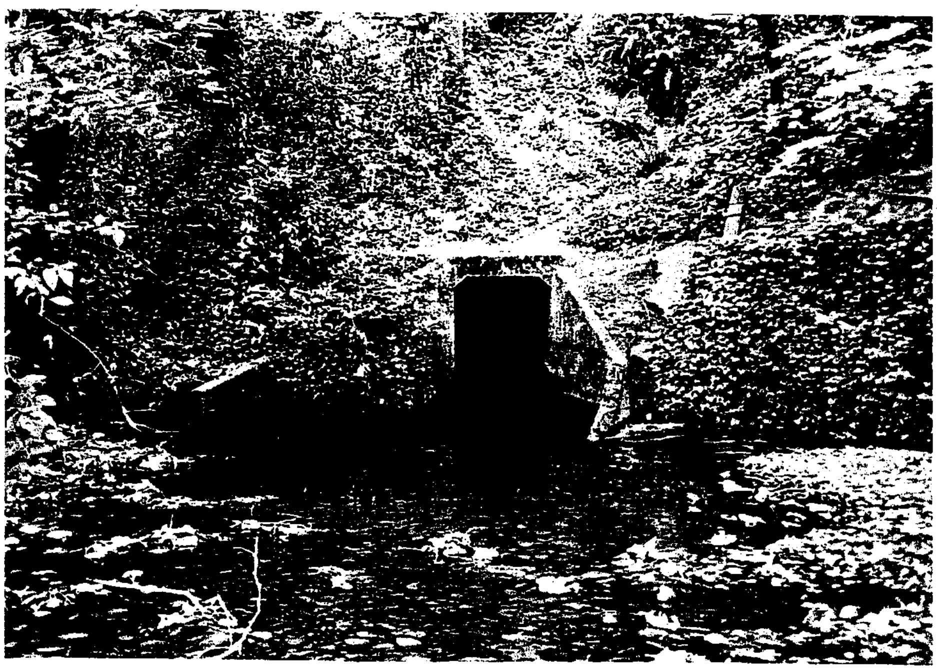

Photo #12, (DM-D) 1999

MCSORLEY CREEK

Photo #16, (MC-1) 1999

Photo #23, (MC-1) 1999

Photo #21, (MC-1) 1999

Photo #20, (MC-2) 1994

Photo #22, (MC-2) 1994

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Photo #23, (MC-2) 1994

Photo #24, (MC-2) 1994

Photo #31, (MC-3) 1994

Photo #36, (MC-3) 1994

FIGURE 1A – MASSEY CREEK

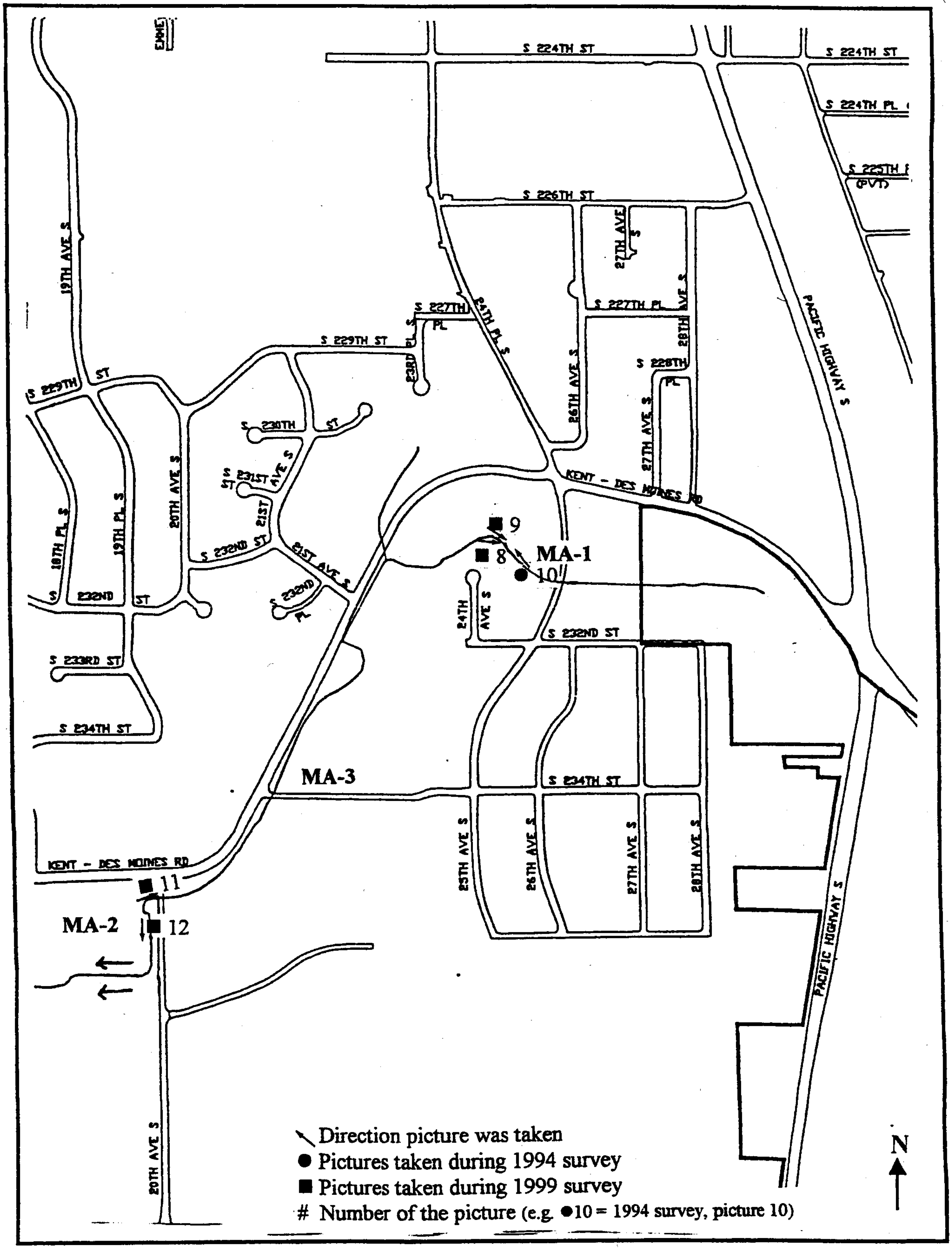
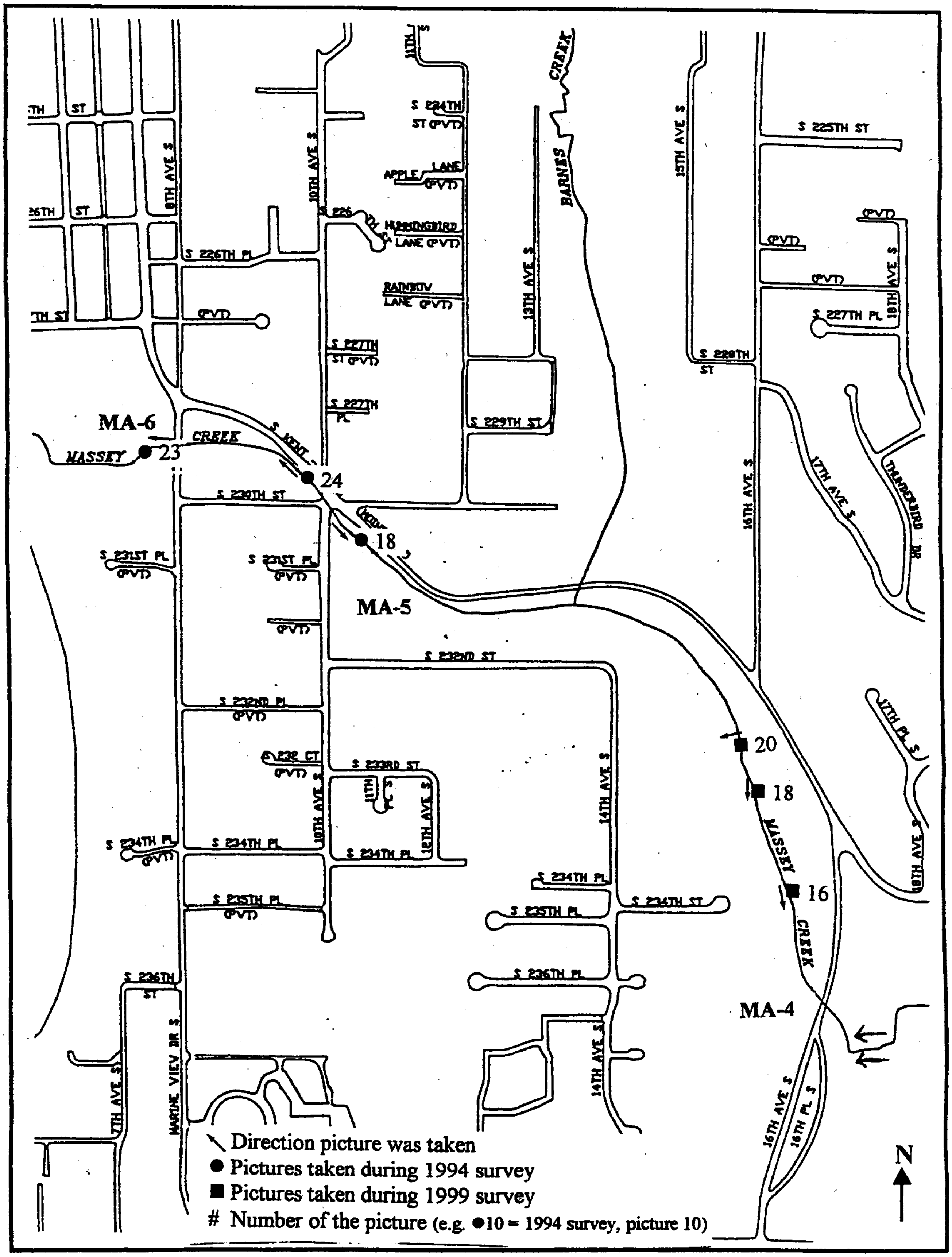
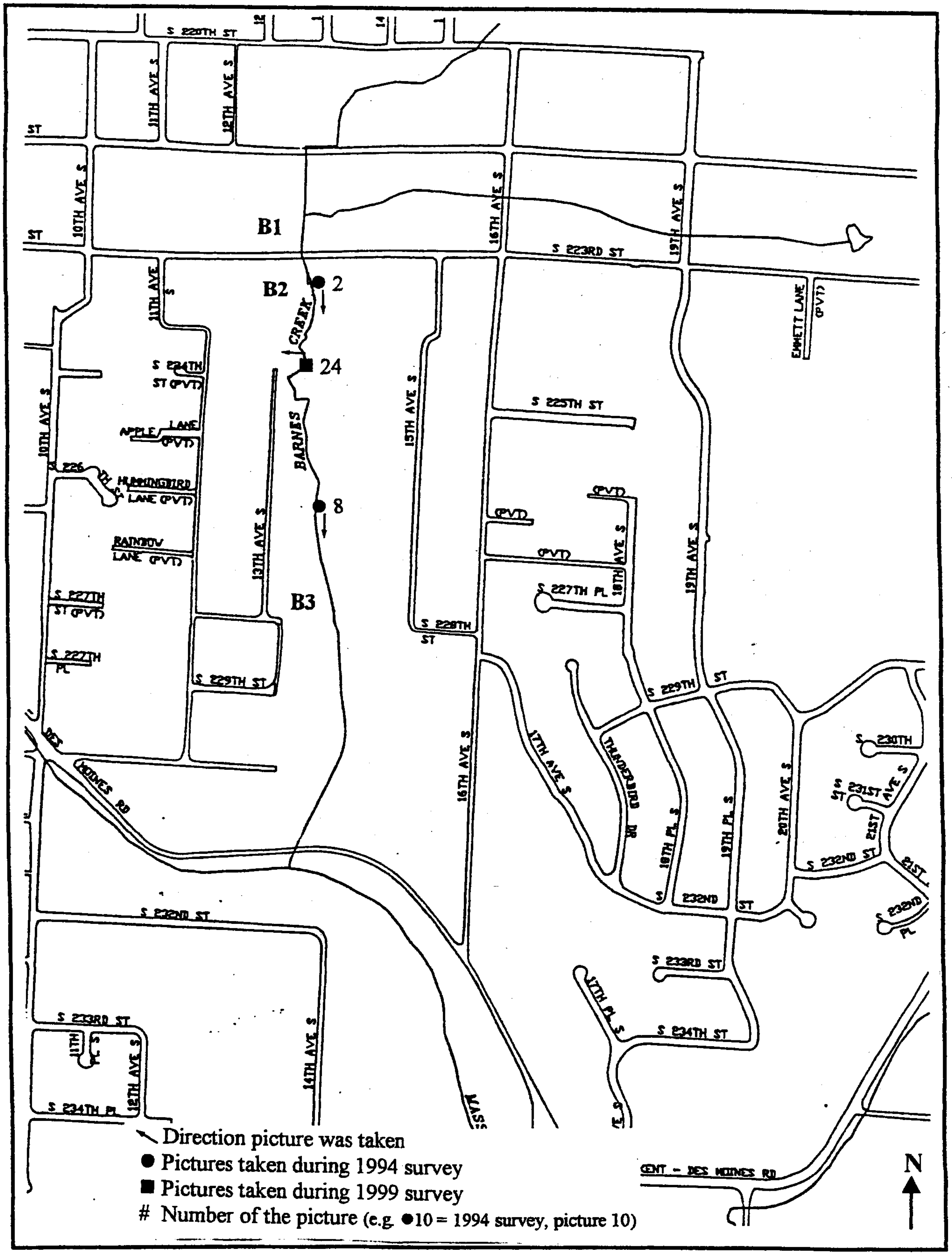


FIGURE 1B – MASSEY CREEK



↖ Direction picture was taken
● Pictures taken during 1994 survey
■ Pictures taken during 1999 survey
\# Number of the picture (e.g. ●10 = 1994 survey, picture 10)

FIGURE 2 – BARNES CREEK



AR 025726

FIGURE 3 – DESMOINES CREEK

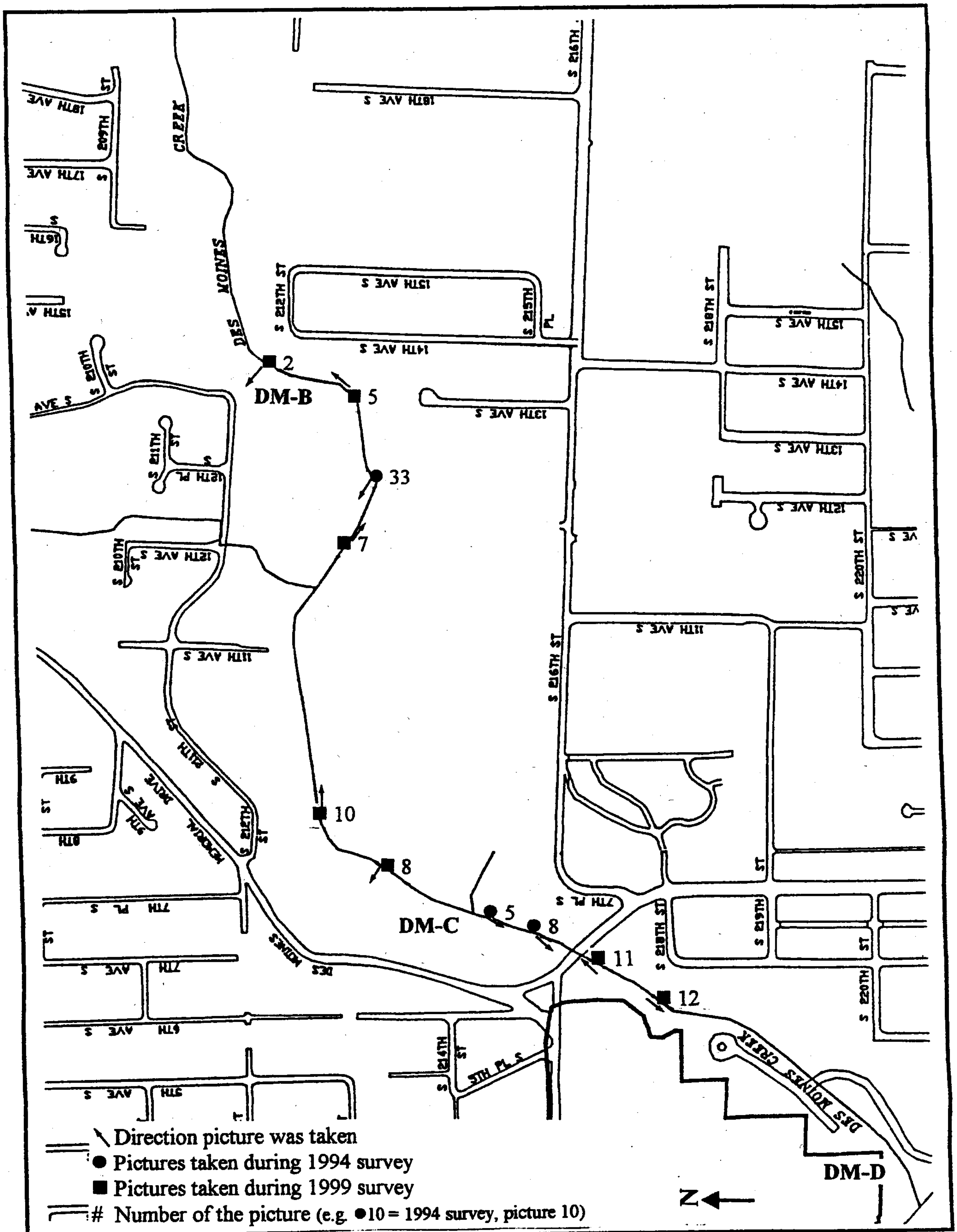
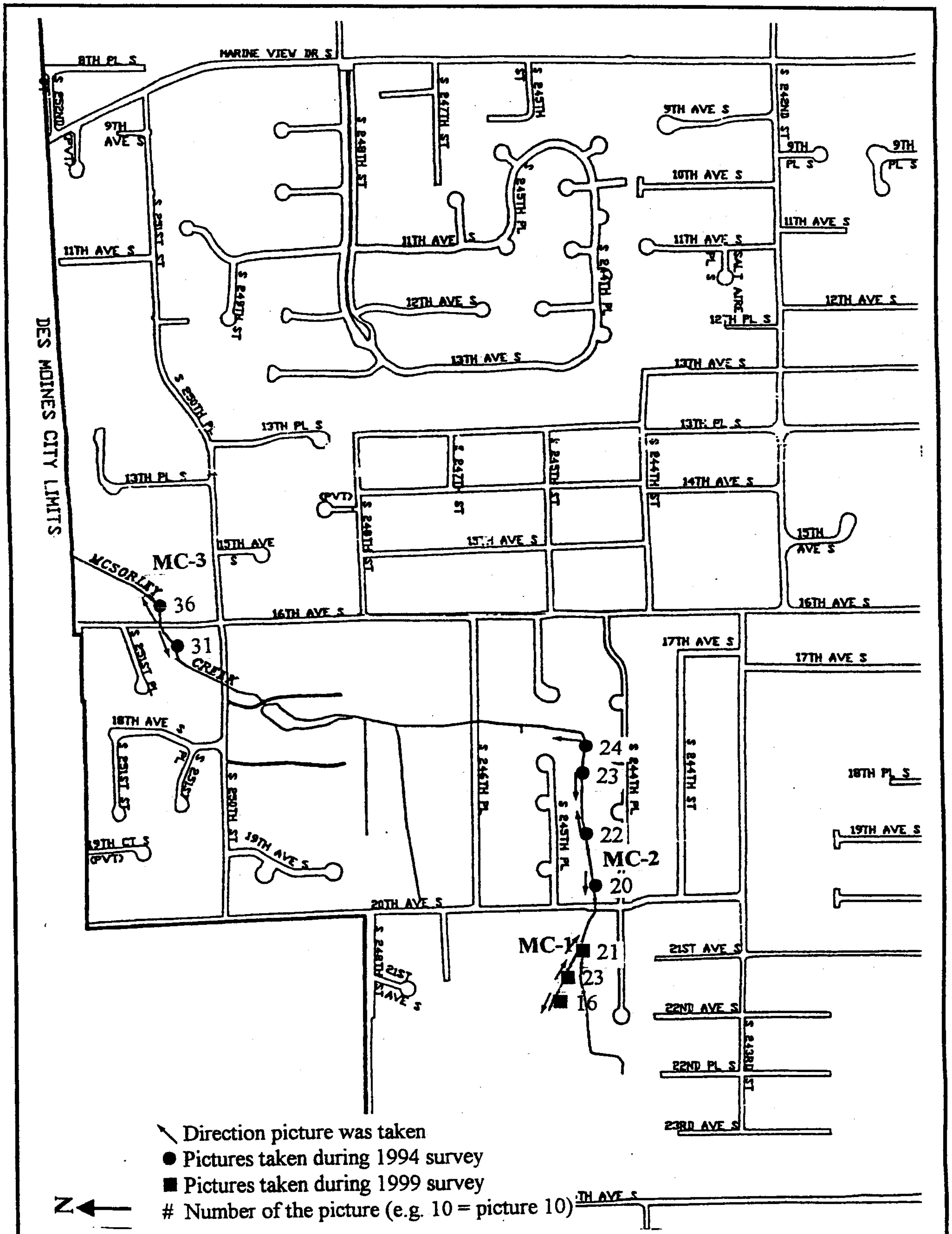


FIGURE 4 – MCSORLEY CREEK



APPENDIX I

Stream Gauge Monitoring Data

Table H1. Summary of stream gauge data collected by volunteers for the Des Moines water quality monitoring program.

Station	Water Year	Begin Date	End Date	Number of Days Observed	Minimum Staff (ft)	Minimum Staff Date	Maximum Crest (ft)	Maximum Crest Date	Fluctuation (ft) (max. crest - min. staff)	Recorder	Comments
DM-1	1995	10/31/94	3/20/95	17	9.46	1/4/95	11.59	12/27/94	2.13	Peggy McCluskey	
DM-1	1995	4/10/95	9/21/95	15	0.27	8/3/95	0.85	6/12/95	0.58	Wayne Matthews	10 ft subtracted from reading?
DM-1	1996	10/2/95	4/26/96	15	0.30	4/11/96	2.50+	1/12/96	> 2.20	Wayne Matthews	New gauge on 2/20/96 (14=1); gauge missing on 5/15/96
DM-1	1997	4/14/97	6/9/97	3	0.62	5/12/97	2.90	6/9/97	2.28	Wayne Matthews	New gauge on 4/14/97
DM-1	1998	4/29/98	4/29/98	1	0.97	4/29/98	None	None	--	Wayne Matthews	Crest tube broken
MA-1	1995	11/7/94	3/27/95	13	0.10	11/7/94	0.92	12/5/94, 3/27/95	0.82	Wayne Matthews	Crest tube missing in 1/95
MA-1	1996	1/26/96	9/3/96	12	0.14	5/2/96, 9/3/96	1.12	4/11/96	0.98	Wayne Matthews	
MA-1	1997	10/10/96	12/17/97	12	0.07	10/10/96	1.18	1/10/97	1.11	Wayne Matthews	
MA-1	1998	4/29/98	4/29/98	1	0.11	4/29/98	None	None	--	Wayne Matthews	Missing cork dust
MA-2	1996	2/5/96	2/20/96	6	0.05	2/7/96	None	None	--	Wayne Matthews	No crest gauge; max. staff = 0.80 ft
MA-2	1997	4/14/97	4/14/97	1	0.23	4/14/97	None	None	--	Wayne Matthews	No crest gauge
MA-2	1998	4/29/98	4/29/98	1	0.10	4/29/98	None	None	--	Wayne Matthews	No crest gauge
MA-3	1995	11/23/94	9/4/95	20	13.72	12/8/94	16.40	12/21/94	2.68	Joe Dusenberry	
MA-3	1996	2/5/96	5/15/96	13	13.58	4/11/96	16.60	4/24/96	3.02	Wayne Matthews	Flood over gauge on 2/8/96 (>16.60 ft)
MA-3	1997	10/10/96	10/25/96	3	13.65	10/10/96	15.48	10/25/96	1.83	Wayne Matthews	
MA-3	1997	12/6/96	8/18/97	9	0.60	8/18/97	4.30	12/31/96	3.70	Wayne Matthews	New gauge = old gauge - 13.08 ft
MA-3	1998	1/14/98	4/29/98	2	0.47	4/29/98	None	None	--	Wayne Matthews	Missing cork dust
BA-1	1995	10/26/94	9/28/95	45	9.00	8/2/95 - 8/30/95	12.01	2/22/95	3.01	Iva Hays	Debris blocked culvert on 2/20/95, cleared by 2/22/95
BA-1	1996	10/5/95	1/26/96	18	9.00	10/5/95	11.97	11/17/95	2.97	Iva Hays	High crest from debris blocked culvert from 11/95 - 1/96
BA-1	1997	1/22/97	9/24/97	35	9.82	1/29/97, 3/5/97	10.56	6/18/97	0.74	Iva Hays	New gauge upstream; Crest overtopped on 3/18/97
BA-1	1998	10/1/97	9/24/98	45	9.87	10/1/97	10.69	12/17/97	0.82	Iva Hays	
BA-1	1999	10/1/98	8/18/99	35	9.89	10/15/98, 5/13/99	10.69	6/24/99	0.80	Iva Hays	Crest overtopped on 1/8/99
MC-1	1995	11/1/94	1/3/95	7	5.00	11/7/94	5.60	11/1/94	0.60	Sandy Klein	
MC-1	1996	10/21/95	4/1/96	13	5.10	11/6/95	5.65	11/13/95	0.55	Sandy Klein	
MC-2	1995	11/4/94	9/21/95	28	0.15	8/3/95	1.60	2/27/95	1.45	Wayne Matthews	
MC-2	1996	10/2/95	9/3/96	21	0.30	9/3/96	2.06	2/8/96	1.76	Wayne Matthews	
MC-2	1997	12/31/96	6/9/97	9	0.33	5/12/97	2.03	12/31/96	1.70	Wayne Matthews	
MC-2	1998	12/16/97	4/29/98	2	0.62	4/29/98	None	12/16/97	--	Wayne Matthews	

Attn: John Osborne
fax 281-7651

Stream Level Record

Des Moines Water Quality Monitoring Program

Monitoring station: Upper Des Moines (DM-1)

Observer(s): Peggy McCluskey

Date	Time	Gauge heights (ft) Staff	Crest	Initials	Date	Time	Gauge heights (ft) Staff	Crest	Initials
10-31-94	12:30pm	10.10	10.20	PM					
11-7-94	12:35pm	9.56	10.08	PM					
11/14/94	12:15pm	9.60	10.03	PM					
11/21/94	12:37pm	9.51	10.22	PM					
12/12/94	12:35pm	9.53	10.01	PM					
12/19/94	12:36pm	10.34	9.92	PM					
12/27/94	12:32pm	11.59	—	PM					
1/4/95	12:38pm	9.46	10.03	PM					
1/9/95	12:45p	9.59	9.59	PM					
1/23/95	12:32p	9.44	9.60	PM					
2/7/95	12:30p	9.51	9.63	PM					
KE 2/14/95	12:32p	9.47	9.60	PM					
2/21/95	12:50p	10.81	10.99	PM					
2/28/95	12:37p	9.57	9.89	PM					
3/6/95	12:40pm	9.56	9.96	PM					
3/13/95	12:30pm	9.50	9.78	PM					
3/20/95	12:32p	9.47	9.60	PM					

END OF RECORD

← THIS STATION TRANSFERRED TO WAYNE MATTHEWS —

AR 025731

Stream Level Record

Des Moines Water Quality Monitoring Program

Monitoring station DM-7

Observer(s) Wayne Matthews

Date	Time	Gauge heights (ft) Staff	Crest	Initials	Date	Time	Gauge heights (ft) Staff	Crest	Initials
4.10.95	10:00	.52	.60	WM					
4.24.95	11:10	.45	.62	WM					
5-1-95	10:00	.43	.47	WM					
5-8.95	1030	.42	.82	WM					
5.15.95	11 45	.39	.48	WM					
5.22.95	945	.34	—	WM					
5.30.95	10 45	.32	—	WM					
6-5-95	11 40	.38	.74	WM					
6-12-95	1030	.38	.85	Periwinkle in crest					
6-27.95	2:10	.30	.84	WM					
7-3.95	10 40	.31	—	ADDED CORK					
7.18.95	1:00	.28	1.50?	Crest not well defined					
8-3.95	2:30	.27	—	ADDED CORK					
9-8.95	130	.38	.42						
9.21.95	1020pm	.30	—	PLUG MISSING					
10.2.95	315pm	.57	1.06						
10.19.95	205am	.52	1.47	SURFACE FOAM					
11-1-95	1105am	.38	1.19	WM					
12-4.95	1130am	.98	1.50	WM					
12.11.95	1020am	1.15	1.80	WM					
12.15.95	11 00 am	.80	1.32	WM					
12.22.95	1100am	.51	1.22	WM					
1.12.96	1115am	.54	2.50±?	WM					
1.22.96	330pm	0.75	1.7±	WM ADDED CORK					

Post-it® Fax Note 7671 Date 1-23-96 # of pages ▶ 2
To John Osborne From Wayne Matthews
Co./Dept. Montgomery Watson Co. City of Des Moines
Phone # Phone #
Fax # 441-9108 Fax #

AR 025732

Stream Level Record

Des Moines Water Quality Monitoring Program

Monitoring station: Des Moines Creek DM-1

Observer(s): Wayne Matthews - City of Des Moines

		Gauge heights (ft)		
Date	Time	Staff	Crest	Initials
1-12-96	1115 A	0.54	2.50+	WM
1-22-96	330 P	0.75	1.70+	WM
2-7-96	345 P	0.22	0.86	WM
2-20-96	1035 A	0.65	1.30	NEW GAUGE 14=1 on scale
3-6-96	240 P	0.35	1.20	WM
4-11-96	930 A	0.30	1.35	WM
4-24-96	1115 A	1.15	(2.9 Gauge pushed over by high flows and plants.	Straightened + cork
4-26-96	1045 A	0.62	1.30	WM
5-15-96			WM	Gauge Missing.
4-14-97	1000 AM	1.29	1.52	WM light rain New Gauge
5-12-97	1130 AM	0.62	1.32	WM clear, sunny
6-9-97	1015 AM	0.91	2.90	WM sunny, dry
4-29-98	10 00 AM	0.97	—	UPPER 4" OF TUBE BROKEN OFF. CAP MISSING CORK ADDED

AR 025733

Stream Level Record

Des Moines Water Quality Monitoring Program

Monitoring station MA1 (Upper Massey at 24th Ave S)

Observer(s) Wayne Matthews

Date	Time	Gauge heights (ft) Staff	Crest	Initials	Date	Time	Gauge heights (ft) Staff	Crest	Initials
11.7.94	8 40	0.10	0.30	WM					
11.14.94	8 50	0.11	0.11	WM					
11.21.94	8 50	0.13	—	WM					
11.29.94	9:30	0.17	0.31	WM					
12.5.94	9:20	0.15	0.92	WM					
12.12.94	9:30	0.15	0.26	WM					
Begin using Engineer ruler in 10ths & 100th									
place on pipe rib peak. WM									
1-23.95	11:00	0.15		WM					
1.31.95	8:40	0.44		WM rain					
Begin using new staff									
2.21.95	11:10	0.21	0.84	WM					
2.27.95	8:30	0.15	0.18	WM					
3-6-95	9:45	0.13	0.39	WM					
3.21.95	10:15	0.15	0.60	WM Pt cloudy					
3.27.95	9:45	0.14	0.92	WM					
END OF RECORD - THIS STATION TRANSFERRED TO PEGGY MCCLUSKEY, WHO THEN DROPPED OUT OF VOLUNTEER NETWORK									
→ no record after 3/95									

Page ____ of ____

AR 025734

Stream Level Record

Des Moines Water Quality Monitoring Program

Monitoring station: Upper Massey Creek at 24th Ave S MA-1

Observer(s): Wayne Matthews - City of Des Moines

Date	Time	Gauge heights (ft) Staff	Gauge heights (ft) Crest	Initials
1-26-96	100 P	0.22	1.05	
2-5-96	415 P	0.65		
2-6-96	920 A	0.70		
2-6-96	1020 A	0.68		
2-6-96	1130 A	0.71		
2-6-96	150 P	0.44	0.75	
2-6-96	350 P	0.43	0.50	
2-6-96	500 P	0.54		
2-6-96	740 P	0.37	0.58	
2-7-96	820 A	0.20	0.40	
2-7-96	1020 A	0.25		
2-7-96	330 P	0.45	0.54	
2-8-96	900 A	1.10		
2-8-96	1200 NOON	0.80	1.05	
2-8-96	300 P	0.48	0.63	
2-12-96	345 P	0.24	0.85	

AR 025735

Stream Level Record

Des Moines Water Quality Monitoring Program

Monitoring station: Upper Massey Creek at 24th Ave S MA-1
Observer(s): Wayne Matthews - City of Des Moines

Date	Time	Gauge heights (ft) Staff	Crest	Initials
4.11.96	1000 A	0.16	1.12	WM
4.24.96	150 P	0.22	0.95	WM
4.25.96	415 P	0.68	—	High Flow
4.26.96	1120 A	0.19	0.66	WM
5.2.96	900 A	0.14	0.32	WM
5.15.96	250 P	0.14	0.23	WM
9-3-96	1040 A	0.45	—	WM Sediment observed
9-3-96	130 P	0.14	0.42 0.65	two crest rings.
10-10-96	1150 A	0.07	—	WM Added cork
10-11-96	845 A	0.10	0.38	WM
10-25.96	418 P	0.15	0.65	WM
12-6-96	1050 A	0.30	0.90	WM (New guage)
12-31-96	1105 A	0.38	1.01	WM
1-10-97	220 PM	0.16	1.18	WM
2-3-97	245 PM	0.15	1.00	WM
2-12-97	900 AM	0.18	0.38	WM
4-14-97	315 PM	0.15	–	WM Added Cork
5-12-97	1045 AM	0.12	–	WM clear, sunny

Stream Level Record

Des Moines Water Quality Monitoring Program

Monitoring station Upper Massey Creek at 24th Ave S MA-1

Observer(s) Wayne Matthews - City of Des Moines

		Gauge heights (ft)		
Date	Time	Staff	Crest	Initials
6-9-97	11 00 AM	0.80	—	WM
12-17-97	315 PM	0.42	1.10	WM
4-29-98	1050 AM	0.11	—	CAP MISSING CORK ADDED

AR 025737

Stream Level Record

Des Moines Water Quality Monitoring Program

Monitoring station: Massey Creek at 16th Ave S   MA-2

Observer(s): Wayne Matthews - City of Des Moines

Date	Time	Gauge heights (ft) Staff	Gauge heights (ft) Crest	Initials
2-5-96	405 P	0.20		
2-6-96	910 A	0.20		
2-6-96	1015 A	0.25		
2-6-96	1120 A	0.35		
2-6-96	140 P	0.10	↑	
2-6-96	340 P	0.05		
2-6-96	450 P	0.10	WATER	
2-7-96	810 A	0.05	BELOW	
2-7-96	1010 A	0.05	SCALE	
2-7-96	310 P	0.05	↓	
2-8-96	1145 A	0.80		
2-8-96	310 P	0.35		
2-12-96	300 P	0.10	WATER BELOW SCALE	
2-20-96	1115 A	0.20		
4-14-97	300 P	0.23	New Scale	[illegible] New Scale
4-29-98	1030 AM	0.10 ±		

AR 025738

Stream Level Record

Des Moines Water Quality Monitoring Program

Monitoring station: MA-3 (Lower Massey)

Observer(s): Joe Dusenberry

Date	Time	Gauge heights (ft) Staff	Crest	Initials	Date	Time	~~Gauge heights (ft)~~ Peaks ~~Staff~~	~~Crest~~	~~Initials~~
11-23-94	0420	13.90	15.28	RZ	11.23	storm	(peaked [illegible] later)		
12-5-94	1240	13.75	—	JD	~~12-2~~	~~0300~~			
12-8-94	0800	13.72	—	JD					
12-9-94	1350	13.76	14.32	J.D	12.2	0300			
12-12-94	1320	13.76	14.38	J.D.	12.12	0000			
12-16-94	1310	14.06	14.38	J.D	12.16	storm	(peaked before)		
12-19-94	1205	14.02	15.16	J.D	12.17	0600			
12-21-94	0830	14.16	16.40	JD	12.20	1800			
12-26.94	1200	14.32	15.76	JD	12.26	storm	(peaked before)		
1/24-95	1200	13.80	14.20	JD	12.26	0600			
1/25 95	1500	13.80	—						
1/30/95	1200	14.46	16.06	JD	1.30	storm	(peaked before)		
2-3-95	1300	14.06	15.66	JD	1.31	1200			
2-9-95	1300	13.96	14.10	JD	2-3	0500			
3-14-95	0645	14.08	14.86	JD	2.19	2100			
3-[illegible]-95	[illegible]	14.06	14.54	JD	3.23	0600			
4-7-95	1515	13.96	14.40	J.D	4.7	storm	(peaked before)		
4-24-95	1300	13.90	14.64	J.D.	4.13	0300			
5-18-95	0800	13.88	14.64	J.D	4.30	0000			
9-4-95	0800	14.10	15.50	JD					

Stream Level Record

Des Moines Water Quality Monitoring Program

Monitoring station: Lower Massey Creek MA-3

Observer(s): Wayne Matthews - City of Des Moines

Date	Time	Gauge heights (ft) Staff	Crest	Initials
2-5-96	400 P	14.98		
2-6-96	900 A	14.70	15.69	
2-6-96	1010 A	15.35		
2-6-96	1110 A	15.35		
2-6-96	130 P	15.30	16.10	
2-6-96	330 P	14.80	15.30	
2-6-96	445 P	14.90		
2-6-96	725 P	14.85	15.25	
2-7-96	800 A	14.30	14.86	
2-7-96	1000 A	14.28	14.30	
2-7-96	300 A	14.70		
2-8-96	FLOODED OVER GAUGE			
2-8-96	250 P	15.60	PULLED GAUGE UPRIGHT	
2-12-96	250 P	13.90	PULLED GAUGE UPRIGHT AGAIN	
2-20-96	1100 A	13.80	14.31	
3-6-96	215 P	13.58	14.65	
4-11-96	950 A	13.58	14.72	
4-24-96	140 P	14.00	16.60*	* CORK AT TOP OF GAUGE

Stream Level Record

Des Moines Water Quality Monitoring Program

Monitoring station: Lower Massey Creek MA-3

Observer(s): Wayne Matthews - City of Des Moines

Date	Time	Gauge heights (ft) Staff	Crest	Initials
4.25.96	425 P	14.56	14.61	WM
4-26.96	1115 A	13.80	14.87	WM
5-2-96	845 A	13.68	14.00	WM
5-15-96	1145 A	13.74	13.88	WM 2" minows observed. (Several)
10-10-96	125 P	13.65	15.05 and 14.54	WM 2-2" Fish observed.
10-11-96	920 A	13.83	13.98	WM
10-25.96	410 P	13.69	15.48	WM
12-6-96	1100 A	0.82 NEW 13.90 OLD	—	WM
12-31-96	1025 A	1.53 NEW	4.30 NEW	WM
1-10-97	210 PM	0.80 NEW	3.90 NEW	WM
2-3-97	250 PM	0.77 "	3.60 "	WM
2-12-97	845 AM	0.77	1.50	WM
3-19-97	240 PM	1.00	2.70 3.50	Two ring in staff tube.
4-29-97	100 PM	0.65	—	5-2" Fish Observed. WM
6-9-97	1045 AM	0.73	1.10	6-2"-3" Fish observed WM
8-18-97	930 AM	0.60	—	Dry weather WM
1-14-98	300 PM	1.20	—	Recent rains. WM
4-29-98	1015 AM	0.47	—	CAP MISSING CORK ADDED 6-2" FISH OBSERVED

AR 025741

Stream Level Record

Des Moines Water Quality Monitoring Program

Monitoring station: Lower Barnes Creek (BA-1)

Observer(s): Iva Hays

	Date	Time	Gauge heights (ft) Staff	Crest	Initials
*	10-26-94	10:29 AM	9.75	9.75	IGH
	10-25-94	11:10 AM	9.55	10.15	IGH
	11-2-94	8:00 AM	9.57	10.16	IGH
	11-9-94	8:20 AM	9.61	9.75	IGH
	11-16-94	8:40 AM	9.72	9.72	IGH
	11-23-94	8:55 AM	9.62	9.75	IGH
*	11-30-94	8:50 AM	10.22	10.54	IGH
	12-2-94	12:25 PM	9.60	10.53	IGH
	12-7-94	10:29 AM	9.52	9.52	IGH
	12-14-94	11:10 AM	9.44	9.49	IGH
End * Flooding Pattern	12-21-94	9:00 AM	9.86	11.75	IGH
	12-28-94	9:00 AM	9.90	11.76	IGH
	1-4-95	10:10 AM	9.74	9.77	IGH
	1-12-95	9:20 AM	9.51	9.86	IGH
	1-19-95	3:50 PM	9.46	9.70	IGH
	1-25-95	10:55 AM	9.42	9.54	IGH
	2-1-95	8:21 AM	9.73	9.85	IGH
	2-8-95	10:29 AM	9.58	9.84	IGH
	2-15-95	10:50 AM	9.61	9.70	IGH
*	2-22-95	8:00 AM	9.66	12.01	IGH
	3-1-95	8:40 AM	9.55	9.64	IGH
	3-9-95	8:35 AM	9.65	9.80	IGH
	3-22-95	12:10 PM	9.32	9.75	IGH
	3-29-95	11:20 AM	9.27	9.30	IGH

* Storm on 2/20
Debris in stream partially caused Crest level to the top of gauge.
Maintenance crew had cleared debris by 2/22.
Good success for ... on muddy bank.
IGH

* Storm

12-21-94 Most of Cork in partial ring at 11.50 - Some up to 11.75

12-28-94
Kids Stuffed Mud + Rocks in Tube
1-12-95 - Still some mud in bottom of Tube but [illegible]

RECEIVED
FEB 1 1996

Stream Level Record

Des Moines Water Quality Monitoring Program

Monitoring station: Lower Barnes Creek (BA-1)

Observer(s): Iva Hays

Date	Time	Gauge heights (ft) Staff	Crest	Initials
10-26-94	10:29 AM	9.75	9.75	IJH
10-28-94	11:10 AM	9.55	10.15	IJH
11-2-94	3:00 AM	9.57	10.16	IJH
11-9-94	8:20 AM	9.64	9.75	IJH
11-16-94	8:40 AM	9.72	9.72	IJH
11-23-94	8:55 AM	9.62	9.75	IJH
* 11-30-94	8:50 AM	10.22	10.54	IJH
12-2-94	12:25 PM.	9.60	10.53	IJH
12-7-94	10:29 AM.	9.52	9.52	IJH
12-14-94	11:10 AM.	9.44	9.49	IJH
[illegible] * 12-21-94	9:00 AM	9.86	11.75	IJH
Flooding, Note Below 12-28-94	9:00 AM	9.90	11.76	IJH
1-4-95	12:10 AM	9.74	9.77	IJH
1-12-95	9:20 AM.	9.51	9.76	IJH
1-19-95	3:50 PM	9.46	9.70	IJH
1-25-95	10:55 AM	9.42	9.54	IJH
2-1-95	8:21 AM.	9.73	9.85	IJH
2-8-95	10:27 AM.	9.58	9.84	IJH
2-15-95	10:50 AM.	9.61	9.70	IJH
* 2-22-95	8:00 AM	9.66	12.01	IJH
3-1-95	8:40 AM	9.55	9.64	IJH
3-7-95	8:35 AM	9.65	9.80	IJH
3-22-95	12:10 PM	9.32	9.75	IJH
3-29-95	11:20 PM	9.29	[illegible]	IJH
4-5-95	8:25 AM	9.25	9.41	IJH
4-12-95	8:30 AM	9.28	9.58	IJH
4-26-95	9:30 AM.	9.22	9.57	IJH
5-3-95	12:20 PM	9.26	9.37	IJH
5-10-95	8:58 AM	9.21	9.40	IJH
5-17-95	9:10 AM	9.19	9.24	IJH
5-24-95	10:28 AM	9.18	9.22	IJH
5-31-95	8:25 AM	9.18	9.18	IJH
6-14-95	8:32 AM	9.18	9.54	IJH
6-21-95	8:37 AM	9.18	9.27	IJH
6-28-95	9:20 AM	9.17	9.18	IJH
7-19-95	9:05 AM	Not in Water	9.62	IJH
7-26-95	8:06 AM	9.20	—	IJH
8-2-95		9.00	9.30	IJH
8-9-95	8:26	9.00	9.18	IJH
8-16-95	10:25	9.00	9.00	IJH

Date	Time	Gauge heights (ft) Staff	Crest	Initials
8/23	Vacation			
8-30-95	8:07 AM	9.00	9.51	IJH
9-6-95	8:12 AM	9.02	9.16	IJH
9-13-95	8:49 AM	9.01	9.01	IJH
9-22-95	8:25 AM	9.00	9.01	IJH
9-28-95	9:50 AM	9.07	9.22	IJH
10-5-95	9:37 AM	9.00	9.32	IJH
10-12-95	10:50 AM	9.01	9.69	IJH
10-19-95	10: AM	9.01	9.34	IJH
10-26-95	8:20 AM	9.16	9.55	IJH
11-2-95	9:40 AM	9.08	9.10	IJH
11-9-95	9:50 AM	9.31	10.94	IJH
* 11-17-95	9:35 AM	9.34	11.97	IJH
11-24-95	11:50 AM	9.36	9.80	IJH
* 11-30-95	8:25 AM	9.70	11.48	IJH
12-8-95	11:30 AM	9.40	10.73	IJH
* 12-14-95	9:05 AM	9.42	11.51	IJH
12-22-95	11:25 AM	9.20	9.73	IJH
12-28-95	8:55 AM	9.34	9.51	IJH
1-4-96	8:42 AM	9.21	9.54	IJH
* 1-11-96	9:50 AM	9.88	11.90 +	IJH
1-16-96	9:10 AM	10.32	11.90 +	IJH
1-18-96	10:25 AM	9.52	10.33	IJH
1-26-96	12:35 PM	10.73	10.27	IJH

AR 025743

* Storm

12-21-94 Most of Cork in partial ring
[illegible]

Note: * Storm Crest readings over 11.90 were over the top of Tube and due to Debris piling up at culvert grid.

Des Moines Water Quality Monitoring Program Stream Level Record

Monitoring Station: BA-1, Lower Barnes Creek at inlet to culvert under Kent - Des Moines Road

Observer(s): Iva Hays

Date	Time	Staff Gauge (feet)	Crest Gauge (feet)	Re-set Crest ? (Y/N)	Rain-ing ? (Y/N)	Notes
1-1-97				N	N	Too much snow
1-8-97	1:30 pm			N	Y	Flooding - removed some branches
1-15-97	12:45 pm			N	N	Still over my boots -
1-22-97	11:20 AM	10.03	No indic.	Y	N	Trees across stream - Not blocking
1-29-97	9:55 AM	9.82	10.01	Y	N	
2-5-97	11:45 AM	9.84	9.85	Y	N	
2-12-97	10:30 AM	9.86	10.03	Y	N	Heavy rain yesterday
2-19-97	1:30 PM	9.89	10.01	Y	Y	
2-26-97	I was	ill	10.01 It rained	all week.		
3-5-97	10:42 AM	9.82	9.90	Y	N	~~Blue Heron wading upstream~~
3-12-97	9:35 AM	9.94	10.33	Y	N	Heavy rain last night
3-18-97	10:20 AM	10.42	Over The Top (N)		Y	Didn't Have Cork Dust with me
3-26-97	9:55 AM	9.98	—	Y	N	
4-3-97	1:30 pm	10.01	10.04	Y	Y	
4-9-97	9:25 A.M	9.94	9.95	Y	N	
4-16-97	9:40 AM	9.99	10.09	Y	Y	
4-25-97	7:45 AM	9.92	10.41	Y	N	
4-30-97	11:10 AM	10.03	10.14	Y	Y	

Des Moines Water Quality Monitoring Program Stream Level Record

Monitoring Station BA-1, Lower Barnes Creek at inlet to culvert under Kent - Des Moines Road

Observer(s) Iva Hays

Date	Time	Staff Gauge (feet)	Crest Gauge (feet)	Re-set Crest ? (Y/N)	Rain-ing ? (Y/N)	Notes
5-9-97	7:40 AM	9.91	9.96	Y	N	
5-14-97	10:50	9.90	9.92	Y	Y	
5-21-97	10:15	9.89	9.90	Y	N	
5-28-97	10:06	9.89	9.97	Y	N	
6-6-97	12:45	9.89	10.02	Y	N	A number of small fish in stream
6-11-97	12:45	9.84	9.86	Y	N	
6-18-97	9:08	9.86	10.56	Y	N	Downpour yesterday afternoon
6-26-97	7:55	9.84	10.06	Y	N	
7-2-97	7:49	9.94	10.04	Y	N	
7-9-97	7:59	9.95	10.24	Y	N	Rain all day yesterday
7-16-97	8:20	9.84	10.03	Y	N	
7-23-97	8:35	9.84	9.85	Y	N	
7-30-97	8:50	9.84	9.84	N	N	
8-8-97	8:13	9.83	9.84	Y	N	
8-13-97	8:05	9.83	9.83	N	N	
8-20-97	8:19	9.83	9.86	Y	N	
8-27-97	8:30	9.84	10.12	Y	Y	
9-3-97	on Vacation					
9-10-97	8:12	9.84	9.84	N	N	
9-17-97	10:10	9.90	9.99	Y	N	
9-24-97	10:12	9.84	9.85	Y	N	
10-1-97	12:32 pm	9.87	9.89?	N	Y	Sawdust gone - too low
10-8-97	8:00 Am	Stream washout	10.24	N	Y	

OCT 14

Des Moines Water Quality Monitoring Program Stream Level Record

Monitoring Station BA-1, Lower Barnes Creek at inlet to culvert under Kent - Des Moines Road

Observer(s) Iva Hays

Date	Time	Staff Gauge (feet)	Crest Gauge (feet)	Re-set Crest ? (Y/N)	Rain-ing ? (Y/N)	Notes
10-15-97	8:13 Am	9.98	10.13	Y	N	New Location
10-22-97	1:30 pm	9.93	10.15	Y	N	
10-28-97	8:08 Am	10.35	10.49	Y	N	
11-5-97	9:40 Am	9.94	11.08	Y	N	
11-13-97	9:50 AM	9.96	10.59	Y	N	
11-19-97	9:08 AM	9.98	10.17	Y	Y	
11-26-97	9:24 AM	9.98	10.36	Y	N	
12-4-97	8:54 AM	9.96	10.28	Y	N	
12-10-97	10:34 AM	10.02	11.04	Y	Y	
12-17-97	8:53 AM	10.06	10.69	Y	N	Downpour yesterday
12-24-97	12:02 pm	9.98	10.20	Y	N	
12-31-97	9:01 AM	9.94	10.01	Y	N	

Des Moines Water Quality Monitoring Program Stream Level Record

Monitoring Station BA-1, Lower Barnes Creek at inlet to culvert under Kent - Des Moines Road

Observer(s) Iva Hays

RECEIVED MAY 26 1998

Date	Time	Staff Gauge (feet)	Crest Gauge (feet)	Re-set Crest ? (Y/N)	Rain-ing ? (Y/N)	Notes
1-7-98	9:06	10.15	10.39	Y	N	
1-14-98	10:12	10.32	10.32	N	Y	
1-21-98	9:40	10.00	10.67	Y	Y	
1-28-98	8:45	9.98	10.57	Y	N	
2-4-98	9:30	10.10	10.10	N	Y	
2-11-98	9:34	9.89	10.13	Y	N	
2-18-98	8:50	10.02	10.29	Y	Y	Rain light so far
2-25-98	9:45	10.00	10.08	Y	N	
3-3-98	8:44	9.98	10.38	Y	N	
3-13-98	8:40	9.97	9.99	Y	N	
3-18-98	7:56	9.92	Can't Read	Y	No	A spider web in Tube I removed it.
3-25-98	8:07	10.06	10.45	Y	Y →	off + on
4-1-98	8:10	9.96	10.31	Y	N	
4-8-98	8:59	9.90	9.94	Y	N	
4-15-98	—	—	—	—	—	I was ill this week
4-22-98	8:12	9.88	9.92	Y	N	
4-29-98	8:04	9.88	9.89	Y	N	
						I am having trouble reading the crest because of algae that formed at the bottom of the tube. How can I clean it out?
						Iva - 824-0157

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Herrera Environmental Consultants

AR 025747

Des Moines Water Quality Monitoring Program Stream Level Record

Monitoring Station: BA-1, Lower Barnes Creek at inlet to culvert under Kent - Des Moines Road

Observer(s): Iva Hays

Date	Time	Staff Gauge (feet)	Crest Gauge (feet)	Re-set Crest ? (Y/N)	Raining ? (Y/N)	Notes
5-13-98	10:00	9.97	9.97	Y	N	
6-2-98	9:05	9.94	Can't Read		N	I Have been Ill - 3 wks
6-17-98	8:10	9.89	Can't Read		N	Spider Web again in Tube
6-24-98	10:20	10.05	10.25	Y	N	I Finally devised a Tube cleaner, Rained All last night.
7-2-98	8:19	9.90	10.04	Y	N	
7-15-98	8:20	9.90	9.91	Y	Y	
7-22-98	9:52	9.89	9.94	Y	N	
7-29-98	8:22	9.88	9.88	N	N	
8-6-98	8:40	9.88	9.88	N	N	
8-13-98	12:35	9.88	9.88	N	N	
8-19-98	9:30	9.88	9.88	N	N	
8-25-98	8:08	9.89	9.89	N	N	Rain yesterday
9-3-98	8:17	9.88	9.88	N	N	
9-17-98	9:50	9.89	9.89	N	N	
9-24-98	8:49	9.90	9.90	N	N	
10-1-98	8:59	9.90	9.92	Y	N	
10-8-98	missed	again				not feeling well
10-15-98	8:58	9.89	10.22	Y	N	
10-29-98	8:04	9.89	10.07	Y	N	
11-6-98	8:40	9.86	10.80	Y	N	The main channel has moved
11-12-98	8:00	9.90	9.94	Y	N	
11-20-98	9:30	10.01	10.01	Y	Y	Added Cork Dust

Des Moines Water Quality Monitoring Program Stream Level Record

Monitoring Station: BA-1, Lower Barnes Creek at inlet to culvert under Kent - Des Moines Road

Observer(s): Iva Hays

Date	Time	Staff Gauge (feet)	Crest Gauge (feet)	Re-set Crest ? (Y/N)	Rain-ing ? (Y/N)	Notes
12-2-98	8:55	10.21	3 in. from Top	Y	N	Above the gauge
12-9-98	8:55	10.00	10.24	Y	N	
12-16-98	10:54	10.01	11.12	Y	N	
12-23-98	9:20	9.92	10.14	Y	N	
						Ill for 2 wks during snow
1-8-99	8:58	9.96	No Dust	Y	N	Flood caused over flow
1-12-99	8:59	9.96	"	Y	Y	Replaced cork dust
1-21-99	9:35	10.09	10.64	Y	Y	
1-27-99	11:29	10.00	10.29	Y	N	
2-4-99	9:07	10.00	10.47	Y	N	
2-12-99	9:05	10.00	10.44	Y	N	
2-24-99	8:36	10.28	10.56	Y	Y	
3-17-99	9:38	10.01	10.51	Y	Y	
3-26-99	9:11	9.98	10.01	Y	N	
4-1-99	8:42	9.98	10.21	Y	N	
4-8-99	8:28	9.98	10.23	Y	N	
4-22-99	8:40	9.93	9.98	Y	N	
4-29-99	8:25	9.94	10.00	Y	N	Added Cork Dust

Des Moines Water Quality Monitoring Program Stream Level Record

Monitoring Station BA-1, Lower Barnes Creek at inlet to culvert under Kent - Des Moines Road

Observer(s) Iva Hays

Date	Time	Staff Gauge (feet)	Crest Gauge (feet)	Re-set Crest ? (Y/N)	Rain-ing ? (Y/N)	Notes
5-6-99	8:46	9.92	10.04	Y	N	
5-13-99	8:15	9.89	10.00	Y	N	
5-19-99	8:10	9.92	10.03	Y	N	
5-26-99	8:16	9.92	10.06	Y	N	
6-9-99	8:20	9.91	9.93	Y	N	
6-24-99	8:25	10.01	10.69	Y	N	Yesterday a record rain
7-7-99	8:00	9.98	9.98	Y	Y	
7-16-99	8:18	10.08	10.22	Y	N	Thunder storm last night
7-21-99	8:50	9.98	9.98	N	N	
7-28-99	9:20	9.98	9.98	N	N	
8-13-99	8:10	9.98	10.21	Y	N	Thunder storm 3,45 PM
8-18-99	8:09	9.98	10.07	Y	N	

Stream Level Record

Des Moines Water Quality Monitoring Program

Monitoring station: Parkside (MC-1)

Observer(s): Klein

Date	Time	Gauge heights (ft) Staff	Crest	Initials	Date	Time	Gauge heights (ft) Staff	Crest	Initials
11/1/94	[illegible]0am	5.4	5.6						
11/7/94	8:45am	5.[illegible]	5.4						
11/14/94	9:33a[illegible]		5.4						
11/22/94	8:[illegible]		5.5						
11/28/94	8:[illegible]		5.5						
12/5/94	8:3[illegible]		[illegible]0						
1/3/94	8:12		5.[illegible]						

AR 025751

Stream Level Record

Des Moines Water Quality Monitoring Program

Monitoring station: ML-1

Observer(s): Parkside Elementary

19-95

96

		Gauge heights (ft)					Gauge heights (ft)		
Date	Time	Staff	Crest	Initials	Date	Time	Staff	Crest	Initials
10/31	10:35	1.4	2.8	T.M.					
11/2	2:10	1.2	1.2	T.M.					
11/6	2:18	1.0	1.6	D.P.					
NOV. 9	2:10	2.0	4.8	D.P.					
11/13	12:00	2.0	5.5	D.P.					
11/16	10:40	1.2	2.0	S.H.					
11/20	11:00	1.6	1.6	S.H.					
11/30	12:20	2.6	—	C.A.					
1/30/96	2:07	2.0	5.0	S.K.					
1/11/96	2:00	1.5	6.0	N.C.					
2/7/96	2:00	3.0	[illegible]	S.H.					
3/8	2:10	2.4	3.4	C.A.					
4/1	2:10	3.0	3.0	J.D.					

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AR 025752

Stream Level Record

JEO

Des Moines Water Quality Monitoring Program

Monitoring station: MC-2 (lower McSorley)

Observer(s): Wayne Matthews

		Gauge heights (ft)					Gauge heights (ft)		
Date	Time	Staff	Crest	Initials	Date	Time	Staff	Crest	Initials
11.4.94	1420	0.68	0.81	WM/JO					
11.7.94	9 15	0.52	0.72	WM					
11.14.94	9 15	0.50	0.69	WM					
11.21.94	9 15	0.42	1.00	WM					
11-29.94	9 45	0.57	0.86	WM					
12-5.94	9:00	0.48	0.50	WM					
12.12.94	9:45	0.46	0.64	WM					
12.19.94	8:50	0.65	0.96	WM					
1.4.95	2:25	0.40	1.53	WM					
1-9-95	10:15	0.51	0.56	WM					
1-17.95	11:00	0.43	0.72	WM					
1.31.95	8:50	0.96	1.05	WM rain					
2.27.95	11:00	0.40	1.60	WM clear					
3-6.95	10:00	0.25	0.50	WM clouds					
3-21.95	9:50	0.45	0.84	WM partly cloudy					
3.27.95	9:30	0.32	0.90	WM cl					
SAND	BAGS	REMOVED							
5-8.95	1045	0.37		WM (2)					
5.15.95	4 00	0.36	0.41	WM abt 56 fish					
5.22.95	1015	0.34	—	WM fish spotted					
5.30.95	11 30	0.38	—	WM SILTY water					
6-5.95	3 00pm	0.35	—	FEW FISH OBSERVED					
6-12.95	10 00	0.35	—						
6.27.95	1:40pm	0.28	0.75	MANY 2-3" FISH					
7.3-95	10 10	0.28	0.49						
7.18.95	11:30	0.29	0.80	MANY FISH!					
8-3.95	2:00pm	0.15	0.65	SOME FISH					
9-8.95	11.30	0.28	0.74	WM					
9.21.95	950	0.27	—	WM					
10.2.95	2 45pm	0.31	0.60	WM					
10.19.95	315pm	0.33	1.18	WM					
10.30.95	11 20 am	0.31	0.62	WM					
11.14.95	11 00 am	0.50	—	TWO SALMON 12-15"					
12.11.95	900am	0.75	1.36						
12.15.95	11 45 am	0.58	1.01						
12.22.95	11 40 am	0.44	0.95						
1-3.96	315pm	0.51	1.05	WM					
1-12.96	200pm	0.46	1.35	WM					
1-22.96	400pm	0.60	1.65	WM					

56 fish ...

AR 025753

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Stream Level Record

Des Moines Water Quality Monitoring Program

Monitoring station: Lower MC Sorley Creek MC-2

Observer(s): Wayne Matthews - City of Des Moines

Date	Time	Gauge heights (ft) Staff	Crest	Initials
1-3-96	315 P	0.51	1.05	WM
1-12-96	200 P	0.46	1.35	WM
1-22-96	400 P	0.60	1.65	WM
2-7-96	1030 A	0.69	1.20	WM
2-8-96	320 P	1.45	2.06	WM
2-12-96	335 P	0.48	1.75	WM
2-20-96	1135 A	0.57	0.92	WM
3-6-96	200 P	0.40	0.85	WM
4-11-96	1015 A	0.40	0.85	WM
4-25-96	200 P	0.72	1.64	WM
4-26-96	1130 A	0.61	1.05	WM
5-15-96	310 P	0.50	(2) 0.70 1.25	Two Crest rings.
9-3-96	1050 A	0.78	—	WM
9-3-96	150 P	0.30	0.74	

Note: Gauge is difficult to read during the low flows—

AR 025754

Stream Level Record

Des Moines Water Quality Monitoring Program

Monitoring station: Lower MC Sorley Creek MC-2

Observer(s): Wayne Matthews - City of Des Moines

Date	Time	Gauge heights (ft) Staff	Crest	Initials
12-31-96	1055 A	1.00	2.03	WM
1-10-97	200 PM	0.55	1.85	WM
2-3-97	300 PM	0.48	1.50	CWM
2-12-97	910 AM	0.60	0.82	WM
3-27-97	1030 AM	0.45	—	WM
4-14-97	245 PM	0.42	0.55	WM
4-29-97	140 PM	0.51	0.70	WM
5-12-97	1030 AM	0.33	0.64	WM 4-6 Fish observed - 2"-3" long
6-9-97	1130 AM	0.34	—	WM 6+ Fish observed 2"-3" long
12-16-97	1145 AM	0.90	—	WM Rain event.
4-29-98	1040 AM	0.62	0.80	CAP MISSING 6-2" FISH OBSERVED