FIVE-YEAR PROJECT REPORT

City of Des Moines Water Quality Monitoring Program

Prepared for

City of Des Moines Surface Water Management Utility

February 2001

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Prepared for

City of Des Moines Surface Water Management Utility 805 South 219th Street Des Moines, Washington 98198-6317

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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

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NORMANDY CREEK DES MOINES CREEK GREEN RIVER MASSEY CREEK DIRECT OUTFLOW TO PUGET SOUND MC SORLEY CREEK WOODMONT CREEK REDONDO/COLD CREEK AR 025301 2. STORMWATER MANAGEMENT FACILITIES IN THE CITY OF DES MOINES.

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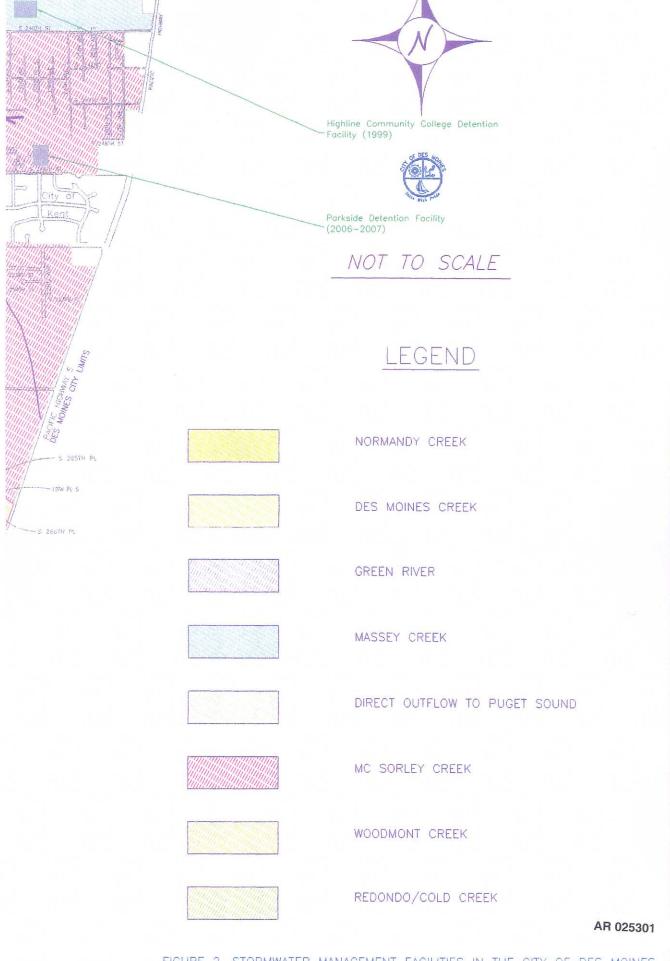


FIGURE 2. STORMWATER MANAGEMENT FACILITIES IN THE CITY OF DES MOINES.

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 Mo	nitoring	Base Flov	v 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
		2 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.

	Sample Type/An	alysis Location
Parameter	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.
РН	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. milliliters.	mg/L milligrams per liter. NTU nephelometric turbidity units.
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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).

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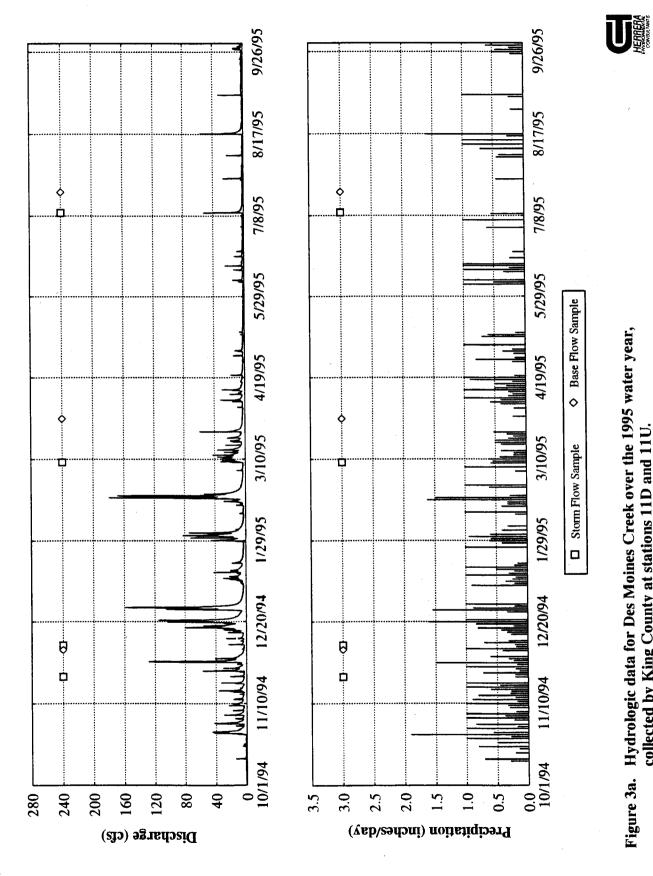
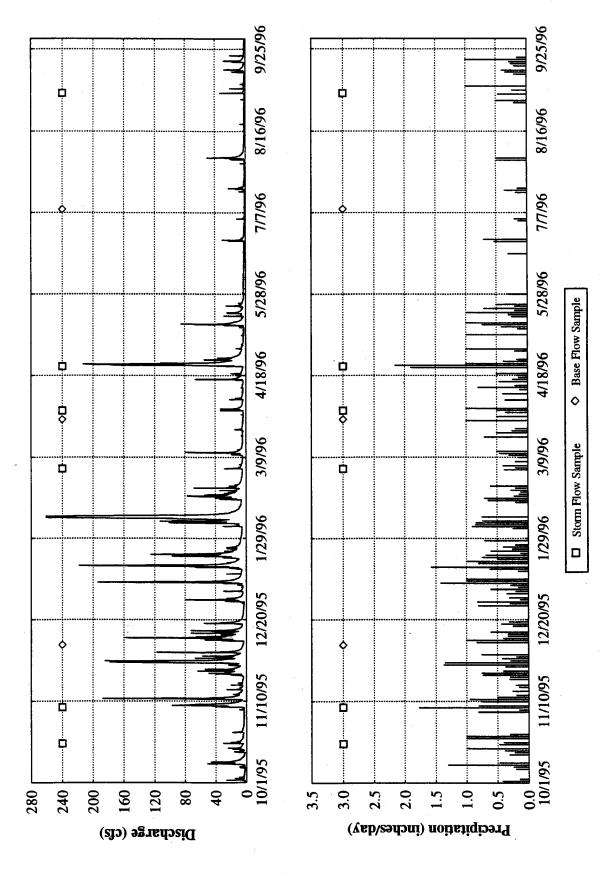


Figure 3a. Hydrologic data for Des Moines Creek over the 1995 water year, collected by King County at stations 11D and 11U.



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

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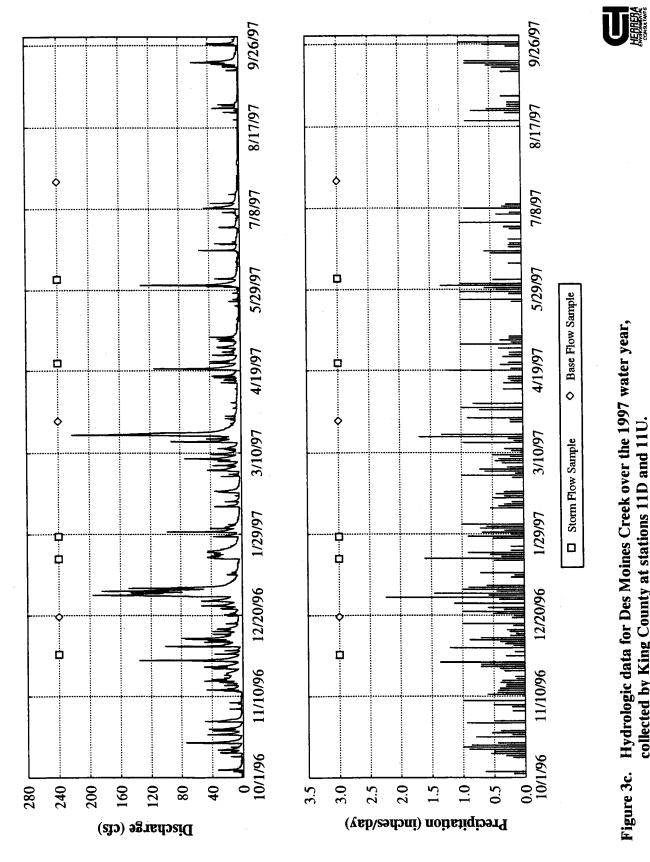


Figure 3c. Hydrologic data for Des Moines Creek over the 1997 water year, collected by King County at stations 11D and 11U.



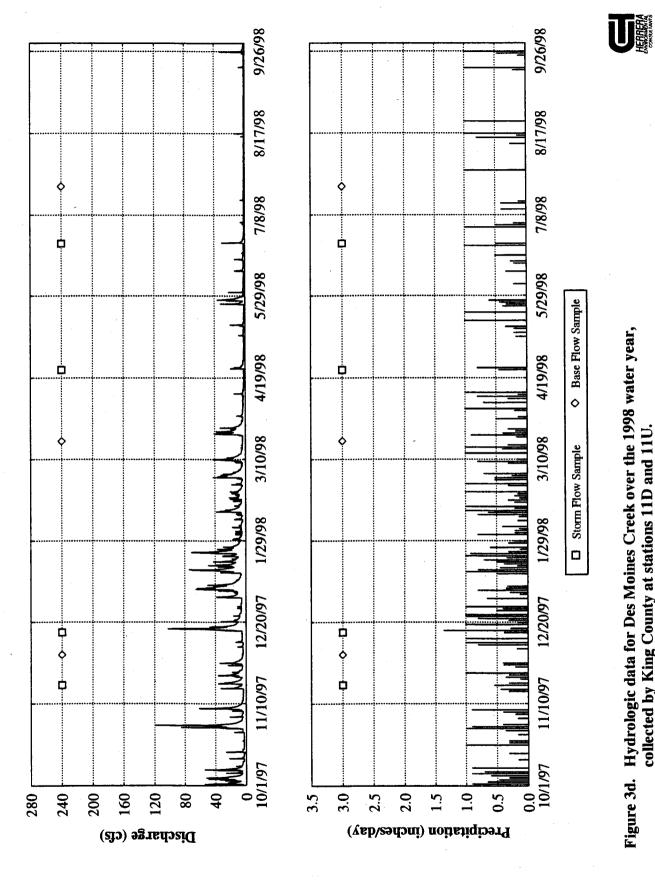
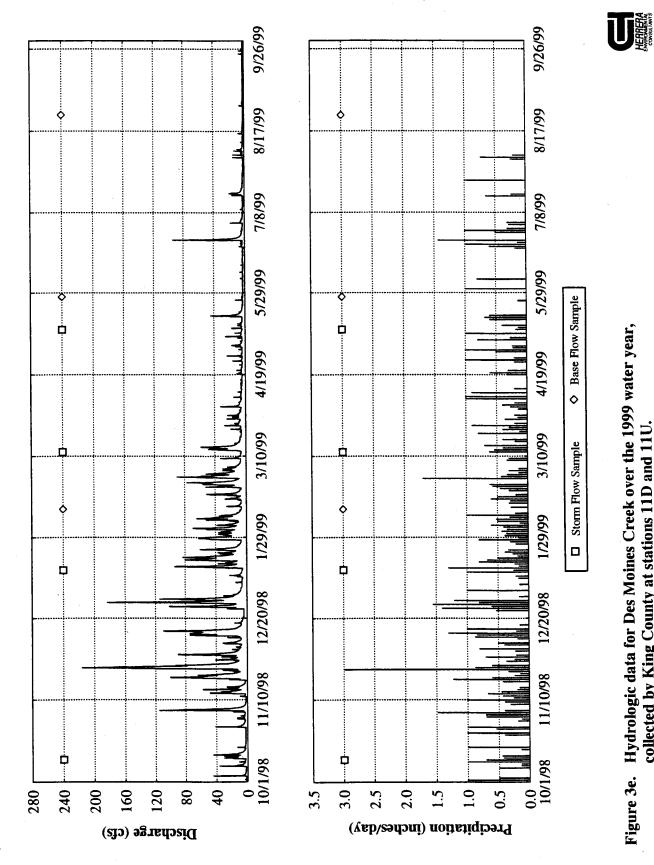
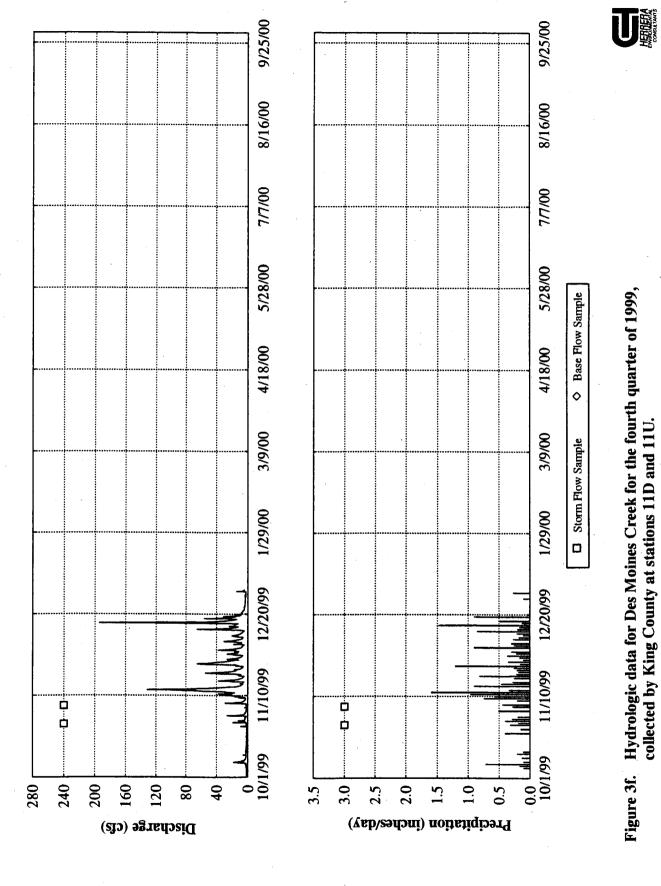


Figure 3d. Hydrologic data for Des Moines Creek over the 1998 water year, collected by King County at stations 11D and 11U.



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



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

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.

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

Water Year	Range of Monthly Average Discharge ^a (cfs)	Range of Monthly Peak Discharge (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

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

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

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.

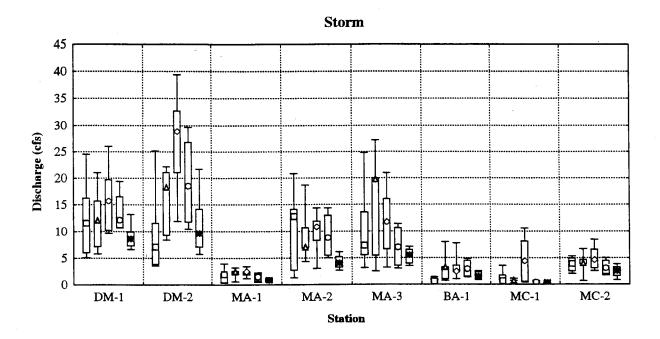
Hydrology of Sampled Events

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.



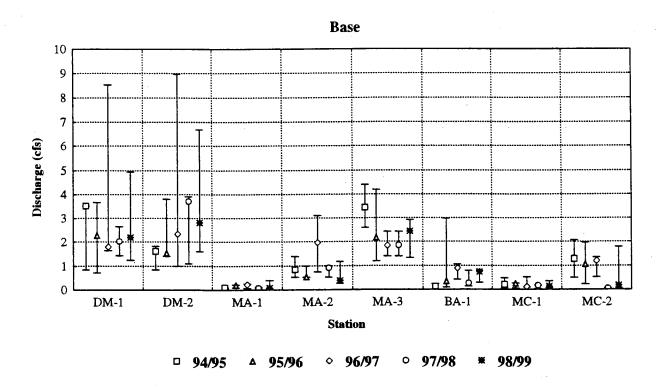


Figure 4. Discharge of Des Moines streams during storm and base flow sampling events.



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,

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

streams.

Table 5.

	DM-1	DM-2	MA-1	MA-2	MA-3	BA-1	MC-1	MC-2
Temperature (°C)	9.1	9.1	9.5	8.6	9.2	9.6	8.2	6.7
H	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 (umhos/cm)	91.0	127	95.1	72.1	0.86	126	138	107
Hardness (mg/L as CaCO ₁)	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	99	98	16	25
Total phosphorus (ug/L)	134	134	74.0	110	164	233	147	127
Nitrate+nitrite nitrogen (ug/L)	432	209	531	498	609	803	279	433
Ammonia nitrogen (µg/L)	70	48	89	43	36	43	36	57
Dissolved copper (ug/L)	5.9	4.2	3.9	3.3	3.1	3.6	3.1	9.9
Dissolved lead (ug/L)	0.7	< 0.5	1.3	< 0.5	< 0.5	< 0.5	8.0	< 0.5
Dissolved zinc (µg/L)	20	12	37	=	∞	9	7	13
Total copper (ug/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)	.09	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	290	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)	ns per centimeter)		·	·		DM-1 DM-2 MA-1 MA-3 MA-3 BA-1 MC-1	upper Des Moines Creek lower Des Moines Creek upper Massey Creek middle Massey Creek lower Massey Creek lower Barnes Creek upper McSorley Creek lower McSorley Creek	nes Creek nes Creek Creek Creek Creek Jreek y Creek

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February 21, 2001

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

	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
Hd	7.53	7.65	7.28	7.75	1.67	7.76	7.03	7.61
Dissolved oxygen (mg/L)	11.2	6.6	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 CaCO3)	86.3	87.7	109	94.1	0.86	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	8.0	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	19	=	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)	2	< 3	4	< 3	< 3	< 3	< 3	4
Fecal coliform bacteria (organisms/100 mL)	42	09	91	88	86	200	153	78
°C degree Celsius mg/L milligrams per liter μg/L micromhos per liter CaCO ₃ calcium carbonate NTU nephelometric turbidity units mL milliliters μmhos/cm micromhos per centimeter (= microsiemens per centimeter)	s per centimeter)	·				DM-1 DM-2 MA-1 MA-3 MA-3 MA-1 MC-1 MC-1	upper Des Moines Creek lower Des Moines Creek upper Massey Creek middle Massey Creek lower Massey Creek lower Barnes Creek upper McSorley Creek lower McSorley Creek	ines Creek ines Creek Creek Creek Creek Y Creek

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

			Stor	Storm Flow					Bas	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	8.0	7.7	14.1	20.2	903
Hu	7.3	2,6	7.1	7.5	8.3	246	7.4	6.1	7.2	1.7	11.2	763
Discolved oxvgen (mg/L.)	10.7	5.4	8.6	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	2.79	126	200	507	855
Turkidit. (NTI)	Ξ	80	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 abosahoms (114/1)	109	21	99	178	1,570	277	58	2	42	82	519	878
Ammonio nitrogen (1971)	3,6	<u> </u>	61	55	343	274	27	10	Ξ	43	1,940	877
Nitrate+nitrite nitrogen (µg/L)	742	10	548	1,110	3,520	274	947	70	989	1,350	3,830	877
Conner total (110/1)	3.5	0.5	2.4	5.2	27.9	103	2.4	1.1	1.7	3.4	9.1	54
Copper, total (hg/L)	97	0.2	0.7	3.2	58.9	103	1.0	0.2	8.0	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
Total coliform backeria () may (100 ml)	800	0	290	2.475	28.000	274	180	7	71	400	20,000	907
recal collicial packetia (vig., 100 mill)		, 1010)	0460	, doi	21) Inamita (0)	AK) Valen	THI T (PAPE)	Bear (0478)	Longellow ((C370), May	45. Learning (0631) Limits (0446) Kelsey (0444) Little Rear (0478) Longellow (C370), May (0444), Newaukum (0322)	kum (0322),

Streams (station): Big Bear (C484), Big Soos (A320), Evans (B484), Forbes (0456), Issaquah (0631), Juanita (0446), I 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.

upper Des Moines Creek Iower Des Moines Creek

upper Massey Creek middle Massey Creek lower Massey Creek lower Barnes Creek

upper McSorley Creek lower McSorley Creek

MA-1 MA-3 MA-3 BA-1 MC-1

milligrams per liter micrograms per liter nephelometric turbidity units degree Celsius umhos/cm °C mg/L µg/L NTU AR 025323

milliliters micromhos per centimeter (= microsiemens per centimeter)

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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+	В
Nitrate+nitrite nitrogen	S+			S+
Ammonia nitrogen	S-	В-	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 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
upper Massey Creek
upper Massey Creek
MC-1 upper McSorley Creek
MC-2 lower 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

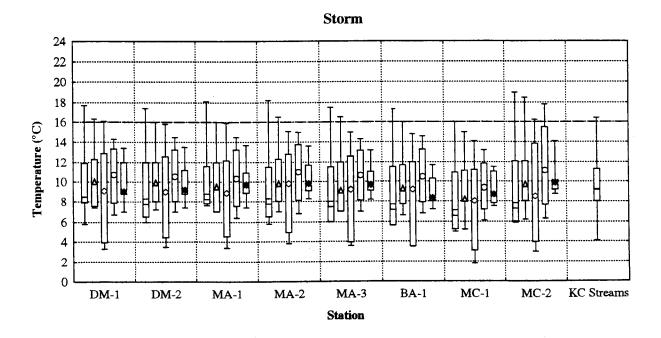
the biodegradation of organic matter present in waters and sediments, resulting in increased demands on the dissolved oxygen resources of a system. In addition, increased water temperatures decrease the solubility of oxygen, which exacerbates dissolved problems. For example, surface waters that are saturated 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 ($\alpha = 0.05$) 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+			16
Hardness	S+	S+						
Turbidity								
Total suspended solids				•				
Total phosphorus			S+					
Nitrate+nitrite nitrogen			B				B	S-
Ammonia nitrogen				В-	B			В
Dissolved copper	В–						В-	В-
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 s. DM-1 upper Des Moines Creek DM-2 lower Des Moines Creek MA-1 upper Massey Creek MA-2 middle Massey Creek	amples on	ly.		- 1	MA-3 BA-1 MC-1 MC-2	lower upper	Massey Cre Barnes Cre McSorley (McSorley (ek 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



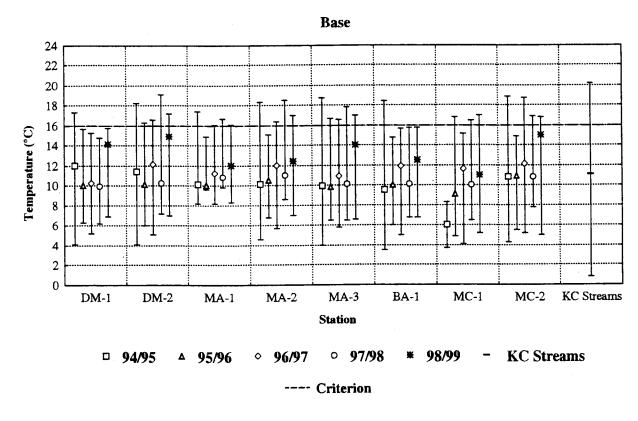


Figure 5. Temperatures during storm and base flow sampling events in Des Moines streams and in other King County (KC) streams.



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.

Flow Samples 33.3 0.0 33.3 33.3 33.3 33.3 0.0 33.3 33.3 33.3 33.3 0.0 33.3 33.3 33.3 33.3 0.0 33.3		DM-1	DM-2	MA-1	MA-2	MA-3	BA-1	MC-1	MC-2	All Stations
33.3 33.3 33.3 33.3 33.3 33.3 0.0 0.0 0.0 33.3 33.3 33.3 33.3 0.0 0.0 0.0 33.3 33.3 33.3 0.0 0.0 0.0 33.3 33.3 33.3 0.0 0.0 0.0 33.3 33.3 33.3 0.0 33.3 0.0 33.3 33.3 33.3 0.0 33.3 0.0 33.3 26.7 26.7 20.0 0.0 20 20.0 20.0 20.0 0.0 0.0 20 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	Base Flow Samples			*						
0.0 33.3 0.0 0.0 33.3 33.3 0.0 33.3 33.3 33.3 33.3 0.0 0.0 0.0 33.3 33.3 33.3 33.3 0.0 0.0 0.0 33.3 33.3 33.3 33.3 0.0 0.0 0.0 33.3 26.7 26.7 33.3 6.7 21.4 20 20 20 20 20 0.0 0.0 20 0 0 0 0 0 0 0 20 0 0 0 0 0 0 0 0 20 0 0 0 0 0 0 0 0 20 0 0 0 0 0 0 0 0 20 0 0 0 0 0 0 0 0 0 20 0 0 0 0 0 0 0 0 0 12.5 12.5 12.5 25.0 25.0 25.0 0 0 12.5 12.5 12.5 12.5 25.0 0 0 10.0	94/95	33.3	33.3	33.3	33.3	33.3	33.3	0.0	33.3	30.4
0.0 33.3 33.3 33.3 33.3 0.0 0.0 0.0 33.3 33.3 33.3 33.3 0.0 33.3 0.0 33.3 33.3 33.3 33.3 0.0 33.3 0.0 33.3 33.3 33.3 0.0 33.3 6.7 33.3 26.7 26.7 33.3 6.7 21.4 5.0 20 20 20 0.0 21.4 20 20 20 20 0.0	96/56	0.0	33.3	0.0	0.0	33.3	0.0	33.3	0.0	12.5
0.0 33.3 30.0 33.3 33.3 33.3 30.0 33.3 33.3 33.3 33.3 30.0 33.3 33.3 30.0 33.3 30.0 31.3 30.0 31.3 30.0 31.3 30.3 30.0 31.3 30.0	16/96	0.0	33.3	33.3	33.3	33.3	0.0	0.0	33.3	20.8
6.7 33.3 33.3 33.3 33.3 33.3 33.3 33.3 33.3 6.7 21.4 6.7 33.3 26.7 26.7 33.3 6.7 21.4 20 0 20 0 20 0 20.0 20.0 20.0 20.0 20 0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 12.0 4.0 4.0 8.0 8.0 4.0 0.0 12.0 25.0 25.0 25.0 25.0 0.0 12.5 12.5 12.5 12.5 0.0 0.0 12.5 12.5 12.5 25.0 0.0 0.0 10.0 14.3 14.3 14.3 0.0 14.3 10.0 15.0 12.5 15.0 25.0 0.0 0.0 10.0 11.1 11.1 11.1 11.1 11.1 11.1 11.1 10.0 15.0 12.5 15.0	86/26	0.0	33.3	33.3	33.3	33.3	0.0	33.3	33.3	25.0
6.7 33.3 26.7 26.7 33.3 6.7 21.4 20 0 20 0 20.0 20.0 20.0 0.0 0.0 20 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	66/86	0.0	33.3	33.3	33.3	33.3	0.0	33.3	33.3	25.0
20 0 20 0 20 0 20 0 20 0 0.0 20 0 0 0 0 0 20 0 20 0 0.0 20 0 0 0 0 0 0 0 0 0 0.0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 <td>All Years</td> <td><i>L</i>.9</td> <td>33.3</td> <td>26.7</td> <td>26.7</td> <td>33.3</td> <td>6.7</td> <td>21.4</td> <td>26.7</td> <td>22.7</td>	All Years	<i>L</i> .9	33.3	26.7	26.7	33.3	6.7	21.4	26.7	22.7
20 0 20 0 20 0 20 0 0 0 0 0 20 0 0.0 0.0 20 0 0 0 0 0 0 0 20 0 0.0 0.0 0.0 0.0 0 0 0 0 0 0 0.0 0.0 0.0 0.0 0.0 0.0 0 0 0 0 0 0 12.0 4.0 4.0 8.0 8.0 4.0 0.0 0 0 <td>Storm Flow Samples</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	Storm Flow Samples									
5/96 20 th 0.0 0.0 20.0 0.0	94/95	200	20.0	20.0	20.0	20.0	20.0	0.0	20.0	17.5
6/97 20.0 0.0 </td <td>96/56</td> <td>20.0</td> <td>0.0</td> <td>0.0</td> <td>20.0</td> <td>20.0</td> <td>0.0</td> <td>0.0</td> <td>20.0</td> <td>10.0</td>	96/56	20.0	0.0	0.0	20.0	20.0	0.0	0.0	20.0	10.0
7/98 0.0 <td>16/96</td> <td>20.0</td> <td>0.0</td> <td>0.0</td> <td>0.0</td> <td>0.0</td> <td>0.0</td> <td>0.0</td> <td>20.0</td> <td>5.0</td>	16/96	20.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	5.0
amples	86/L6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0	3.1
All Years 12.0 4.0 4.0 8.0 8.0 4.0 0.0 amples 25.0 25.0 25.0 25.0 25.0 25.0 0.0 4/95 12.5 25.0 25.0 25.0 0.0 12.5 5/96 12.5 12.5 12.5 25.0 0.0 12.5 6/97 12.5 12.5 12.5 12.5 0.0 0.0 7/98 0.0 14.3 14.3 14.3 0.0 14.3 8/99 0.0 11.1 11.1 11.1 0.0 11.1 All Years 10.0 15.0 12.5 15.0 17.5 5.0 7.7 upper Des Moines Creek 10.0 15.0 12.5 15.0 17.5 5.0 7.7 upper Massey Creek 10.0 15.0 12.5 15.0 17.5 17.7	66/86	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
amples 25.0 25.0 25.0 25.0 25.0 25.0 25.0 0.0 5/96 12.5 12.5 0.0 12.5 0.0 12.5 6/97 12.5 12.5 12.5 0.0 0.0 7/98 0.0 14.3 14.3 14.3 0.0 14.3 8/99 0.0 11.1 11.1 11.1 0.0 11.1 All Years 10.0 15.0 12.5 15.0 17.5 5.0 7.7 upper Des Moines Creek 10.0 15.0 12.5 15.0 17.5 5.0 7.7 upper Massey Creek 10.0 15.0 12.5 15.0 17.5 5.0 7.7	All Years	12.0	4.0	4.0	8.0	8.0	4.0	0.0	16.0	7.0
4/95 25.0 25.0 25.0 25.0 25.0 0.0 0.0 5/96 12.5 12.5 0.0 12.5 25.0 0.0 12.5 6/97 12.5 12.5 12.5 12.5 0.0 12.5 7/98 0.0 14.3 14.3 14.3 0.0 14.3 8/99 0.0 11.1 11.1 11.1 0.0 11.1 All Years 10.0 15.0 12.5 15.0 7.7 upper Des Moines Creek 12.5 15.0 17.5 5.0 7.7 upper Massey Creek 12.5 15.0 17.5 8A-1 17.5	All Samples									
5/96 12.5 12.5 0.0 12.5 25.0 0.0 12.5 6/97 12.5 12.5 12.5 0.0 0.0 12.5 7/98 0.0 14.3 14.3 14.3 0.0 14.3 8/99 0.0 11.1 11.1 11.1 0.0 11.1 All Years 10.0 15.0 12.5 15.0 17.5 5.0 7.7 upper Des Moines Creek 10.0 15.0 12.5 15.0 17.5 5.0 7.7 upper Massey Creek 10.0 </td <td>94/95</td> <td>25.0</td> <td>25.0</td> <td>25.0</td> <td>25.0</td> <td>25.0</td> <td>25.0</td> <td>0.0</td> <td>25.0</td> <td>22.2</td>	94/95	25.0	25.0	25.0	25.0	25.0	25.0	0.0	25.0	22.2
6/97 12.5 12.5 12.5 12.5 0.0 0.0 7/98 0.0 14.3 14.3 14.3 0.0 14.3 8/99 0.0 11.1 11.1 11.1 0.0 11.1 All Years 10.0 15.0 12.5 15.0 7.7 upper Des Moines Creek 10.0 15.0 12.5 15.0 17.5 5.0 7.7 upper Des Moines Creek 10.0 15.0 12.5 15.0 17.5 17.5 17.7	96/56	12.5	12.5	0.0	12.5	25.0	0.0	12.5	12.5	10.9
7/98 0.0 14.3 14.3 14.3 0.0 14.3 8/99 0.0 11.1 11.1 11.1 0.0 11.1 All Years 10.0 15.0 12.5 15.0 17.5 5.0 7.7 upper Des Moines Creek 10.0 15.0 17.5 5.0 7.7 upper Des Moines Creek 10.0 15.0 17.5 15.0 17.5 15.0	<i>16/96</i>	12.5	12.5	12.5	12.5	12.5	0.0	0.0	25.0	10.9
8/99 0.0 11.1 11.1 11.1 0.0 11.1 All Years 10.0 15.0 12.5 15.0 17.5 5.0 7.7 upper Des Moines Creek Indeed Des Moin	86/L6	0.0	14.3	14.3	14.3	14.3	0.0	14.3	28.6	12.5
All Years 10.0 15.0 12.5 15.0 17.7 upper Des Moines Creek MA-3 IPPA-3 IPPA-	66/86	0.0	11.1	11.1	Ξ	11.1	0.0	11.1	11.1	8.3
upper Des Moines Creek lower Des Moines Creek upper Massey Creek	All Years	10.0	15.0	12.5	15.0	17.5	5.0	7.7	20.0	12.9
middle Massey Creek					-			MA-3 BA-1 MC-1 MC-2	lower Ma lower Bar upper Mc lower Mc	lower Massey Creek lower Barnes Creek upper McSorley Creek 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.

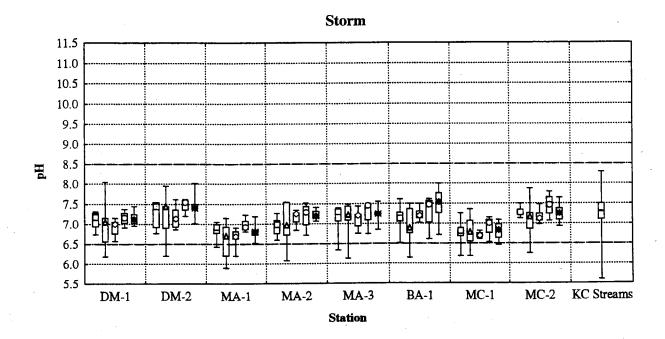
There were no significant differences in temperature between monitoring years at any of the stations for storm flow or base flow (see Appendix C). Nor did the analysis for temporal trends throughout the entire 5-year monitoring program show any significant increasing or decreasing trends for temperature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

рH

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.



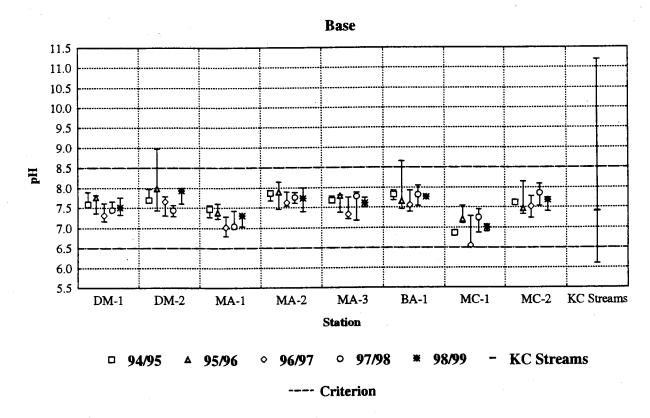


Figure 6. Measurements of pH during storm and base flow sampling events in Des Moines streams and in other King County (KC) streams.



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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
96/56	0.0	33.3	0.0	0.0	0.0	33.3	0.0	0.0	8.3
26/96	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6/26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
66/86	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
96/56	20.0	20.0	40.0	20.0	20.0	20.0	20.0	20.0	22.5
26/96	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	2.5
80/26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
66/86	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
96/56	12.5	25.0	25.0	12.5	12.5	25.0	12.5	12.5	17.2
26/96	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0	1.6
07/08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
66/80	0.0	0.0	0.0	0.0	0.0	0.0	11.1	0.0	1.4
All Vears	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 BA-1 MC-1 MC-2	lower B lower Ba upper M lower M	lower Massey Creek lower Barnes Creek upper McSorley Creek 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

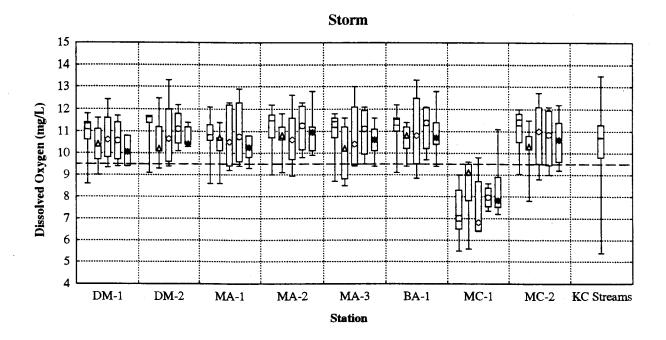
Dissolved oxygen is significant for the protection of aesthetic qualities of water as well as for the maintenance of fish and other aquatic life (U.S. EPA 1976). To allow for differences among requirements by affected species of fish and other aquatic organisms, dissolved oxygen standards are based on 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

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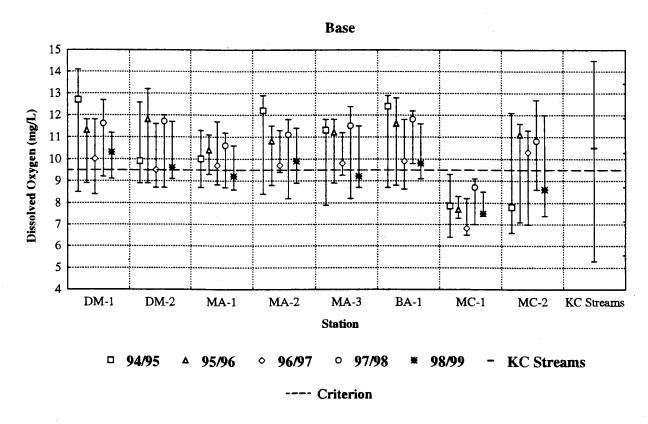


Figure 7. Dissolved oxygen concentrations during storm and base flow sampling events in Des Moines streams and in other King County (KC) streams.



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	DM-1	DM-2	MA-1	MA-2	MA-3	BA-I	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	2.99	43.5
96/56	33.3	33.3	33.3	33.3	33.3	33.3	100.0	33.3	41.7
26/96	33.3	66.7	33.3	33.3	33.3	33.3	100.0	33.3	45.8
86/26	33.3	33.3	33.3	33.3	33.3	0.0	100.0	33.3	37.5
66/86	33.3	33.3	2.99	33.3	2.99	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
96/56	20.0	20.0	20.0	20.0	40.0	20.0	80.0	20.0	30.0
26/96	20.0	20.0	40.0	20.0	40.0	40.0	80.0	40.0	37.5
86/26	25.0	0.0	25.0	0.0	25.0	0.0	100.0	25.0	25.0
66/86	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
96/56	25.0	25.0	25.0	25.0	37.5	25.0	87.5	25.0	34.4
26/96	25.0	37.5	37.5	25.0	37.5	37.5	87.5	37.5	40.6
86/26	28.6	14.3	28.6	14.3	28.6	0.0	100.0	28.6	30.4
66/86	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 lowe BA-1 lowe MC-1 uppe MC-2 lowe	lower Massey Creek lower Barnes Creek upper McSorley Creek lower McSorley Creek
					,				

February 21, 2001

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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).

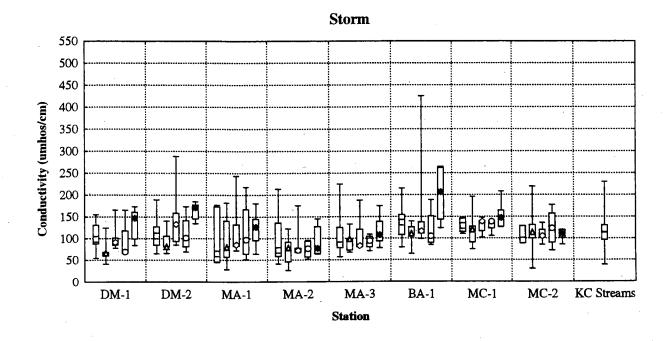
Conductivity

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



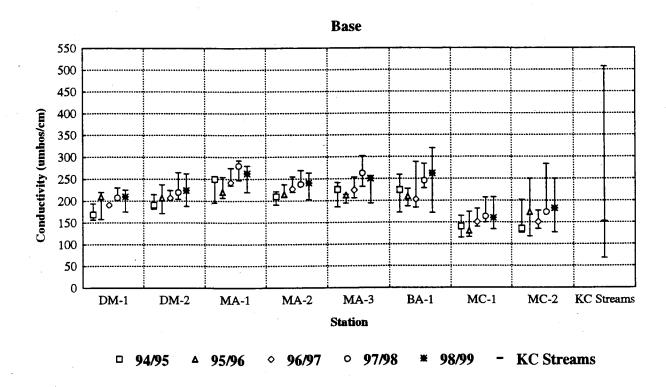


Figure 8. Conductivity levels during storm and base flow sampling events in Des Moines streams and in other King County (KC) streams.



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.

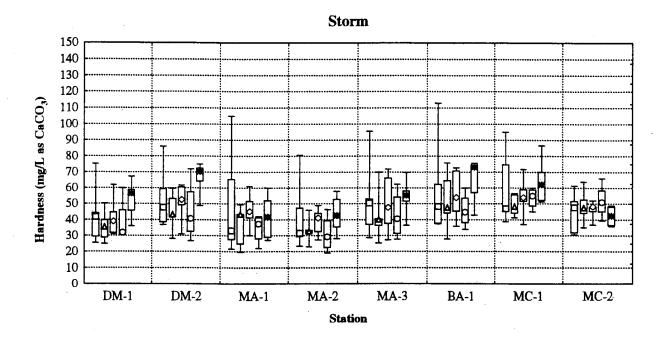
Hardness measurements over the 5-year monitoring program ranged from 19.1 to 139 mg/L (as calcium carbonate) (Figure 9). The median hardness concentration ranged from 33.3 to 53.8 mg/L among the stations during storm flow and from 67.2 to 109 mg/L during base flow.

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).



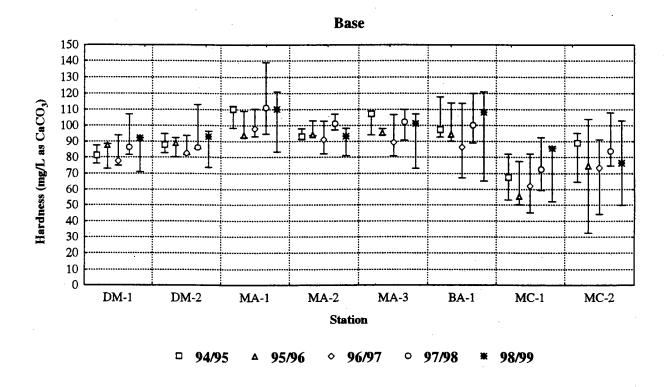


Figure 9. Hardness during storm and base flow sampling events in Des Moines streams.



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.

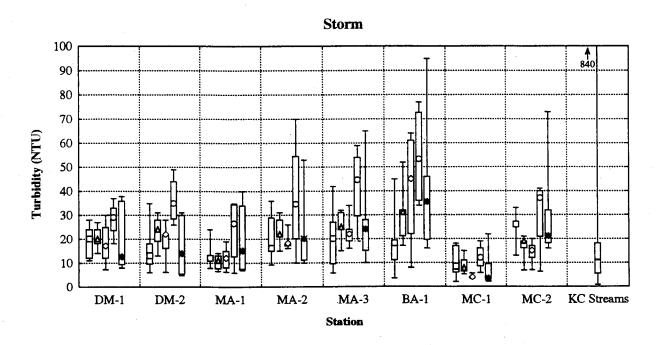
The analysis for spatial trends showed no significant longitudinal (downstream) trends in turbidity within the Des Moines Creek basin during either storm flow or base flow (Table 8 and Appendix C). Turbidity was significantly lower in the upper reaches of Massey Creek (station MA-1) during storm flow 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).



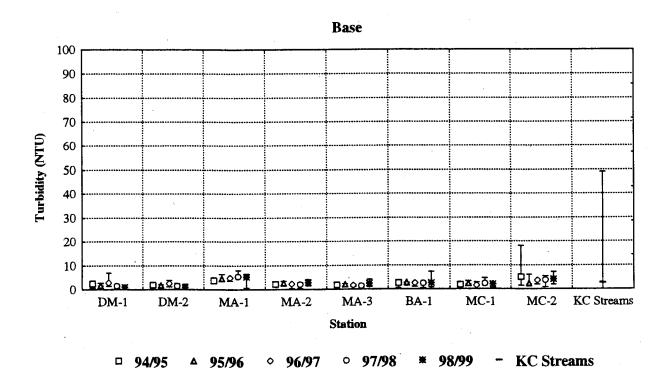


Figure 10. Turbidity values during storm and base flow sampling events in Des Moines streams and in other King County (KC) streams.



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

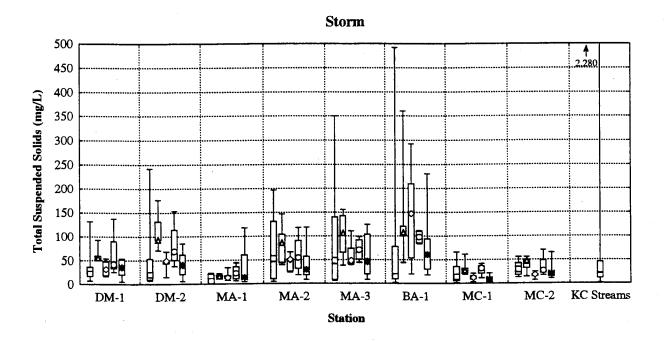
MA-3 lower Massey Creek

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).



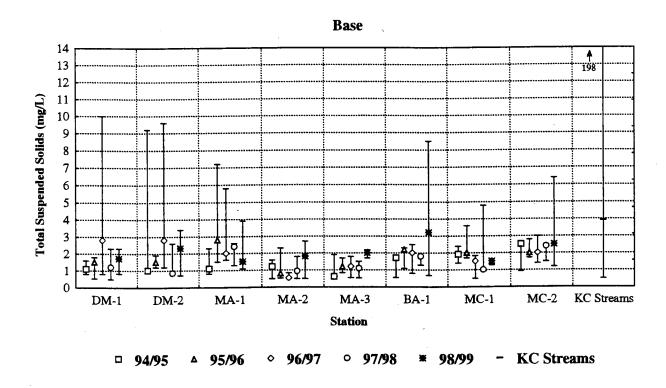


Figure 11. Total suspended solids concentrations during storm and base flow sampling events in Des Moines streams and in other King County (KC) streams.



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

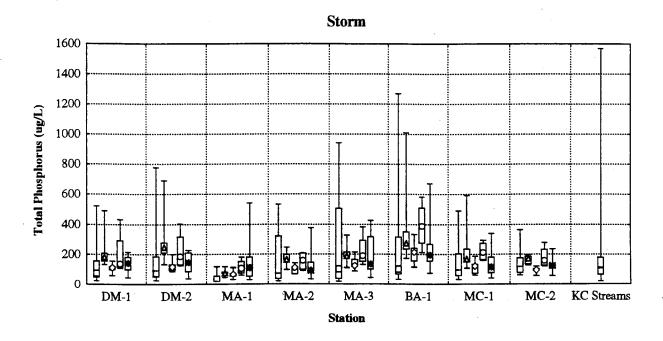
Total phosphorus concentrations over the 5-year monitoring program ranged from 15.0 to 1,270 micrograms per liter (μ g/L) (Figure 12). The median total phosphorus concentration ranged from 74 to 233 μ g/L among the stream stations during storm flow and from 21 to 82 μ g/L during base flow. Storm flow 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 μ g/L (Figure 13). The median ammonia nitrogen concentration ranged from 36 to 70 μ g/L among the stations during storm flow and from less than 10 to 61 μ g/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).



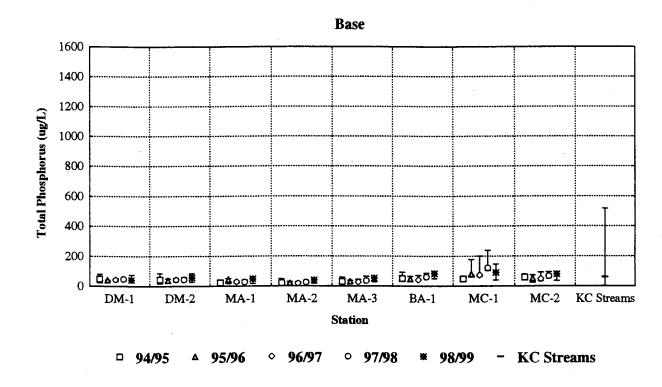
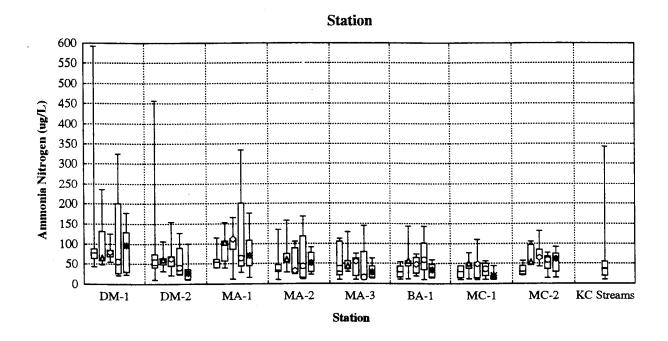


Figure 12. Total phosphorus concentrations during storm and base flow sampling events in Des Moines streams and in other King County (KC) streams.





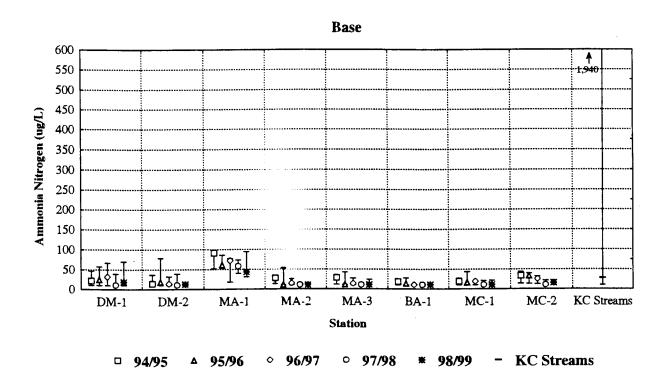


Figure 13. Ammonia nitrogen concentrations during storm and base flow sampling events in Des Moines streams and in other King County (KC) streams.



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.

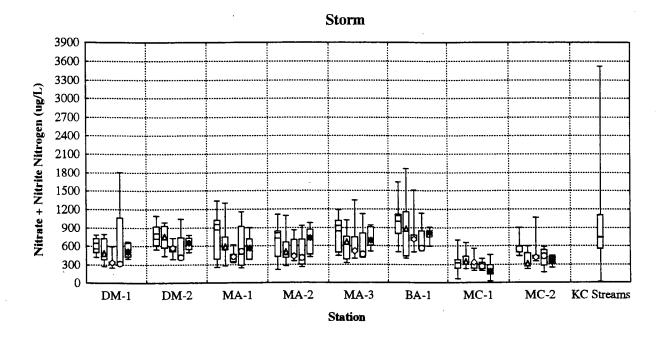
There were no significant differences in ammonia nitrogen concentrations between monitoring years at any of the stations for storm or base flow (Appendix C). The analysis for temporal trends over the entire 5-year monitoring program showed significant decreasing trends for base flow ammonia nitrogen 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).



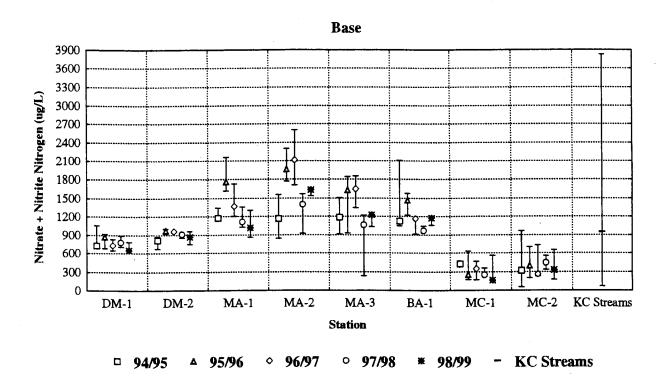


Figure 14. Nitrate + Nitrite nitrogen concentrations during storm and base flow sampling events in Des Moines streams and in other King County (KC) streams.



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.

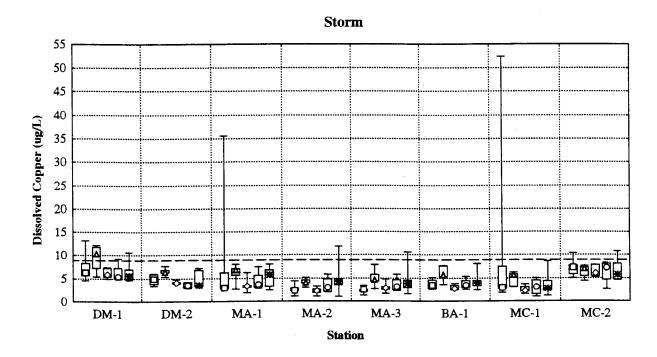
Dissolved and total metals results are discussed below for copper, lead, and zinc. The graphs of the dissolved metals results during storm flow include acute toxicity criteria from the Washington state surface water quality standards that are based on a hardness concentration of 50 mg/L (as calcium carbonate), 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 μ g/L (Figure 15). The median dissolved copper concentration ranged from 3.1 to 6.6 μ g/L among the stations during storm flow and from less than 1.0 to 2.4 μ g/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.



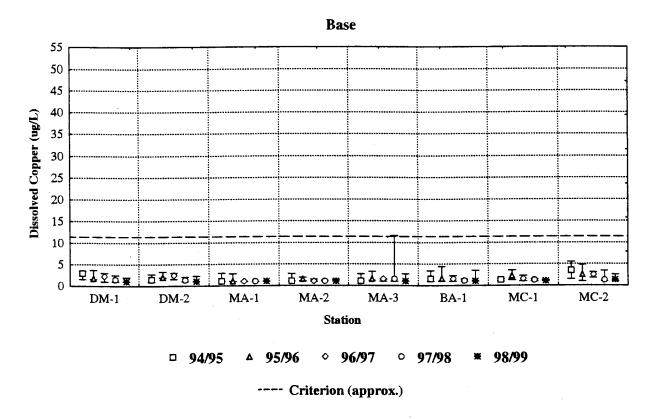


Figure 15. Dissolved copper concentrations during storm and base flow sampling events in Des Moines streams.



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.

Base Flow Samples 0		DM-1	DM-2	MA-1	MA-2	MA-3	BA-1	MC-1	MC-2	All Stations
94/95 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	Base Flow Samples									
95/96 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	94/95	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 0.	96/56	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	4.2
94/98 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	16/96	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 0.	86/L6	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 0.	66/86	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 Flow Samples 60.0 0.0 40.0 0.0 0.0 20.0 94/95 60.0 0.0 40.0 0.0 0.0 20.0 94/95 100.0 20.0 20.0 0.0 0.0 0.0 95/96 20.0 0.0 0.0 0.0 0.0 0.0 98/99 16.7 0.0 16.7 16.7 0.0 0.0 All Years 40.0 4.0 16.7 16.7 0.0 0.0 All Years 40.0 4.0 25.0 0.0 0.0 0.0 95/96 62.5 12.5 0.0 25.0 0.0 0.0 0.0 96/97 12.5 12.5 0.0 25.0 0.0 0.0 0.0 98/99 11.1 0.0 11.1 11.1 0.0 0.0 0.0 0.0 98/99 11.1 0.0 11.1 11.1 0.0 0.0 0.0 0.0 0.0 <td< td=""><td>All Years</td><td>0.0</td><td>0.0</td><td>0.0</td><td>0.0</td><td>0.0</td><td>0.0</td><td>0.0</td><td>6.7</td><td>0.8</td></td<>	All Years	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.8
94/95 60.0 0.0 40.0 0.0 0.0 2	storm Flow Samples					•				
95/96 100.0 20.0 20.0 0.0 40.0 20.0 0.0 96/97 20.0 0.0 <t< td=""><td>94/95</td><td>0.09</td><td>0.0</td><td>40.0</td><td>0.0</td><td>0.0</td><td>0.0</td><td>20.0</td><td>40.0</td><td>20.0</td></t<>	94/95	0.09	0.0	40.0	0.0	0.0	0.0	20.0	40.0	20.0
96/97 20.0 0.0<	96/56	100.0	20.0	20.0	0.0	40.0	20.0	0.0	0.0	25.0
97/98 0.0 </td <td>26/96</td> <td>20.0</td> <td>0.0</td> <td>0.0</td> <td>0.0</td> <td>0.0</td> <td>0.0</td> <td>0.0</td> <td>0.0</td> <td>2.5</td>	26/96	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5
98/99 16.7 0.0 16.7 16.7 16.7 0.0 0.0 All Years 40.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 amples 20.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 94/95 37.5 0.0 25.0 0.0 0.0 14.3 0.0 14.3 0.0 14.3 0.0	86/26	0.0	0.0	25.0	0.0	0.0	0.0	0.0	25.0	6.3
All Years 40.0 4.0 20.0 4.0 12.0 4.0 4.0 amples 94/95 37.5 0.0 25.0 0.0 0.0 14.3 95/96 62.5 12.5 12.5 0.0 0.0 14.3 0.0 96/97 12.5 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 98/99 11.1 0.0 11.1 11.1 11.1 0.0 0.0 All Years 25.0 2.5 12.5 2.5 2.5 2.5 windfle Massey Creek middle Massey Creek All Years All Years All Mc-1	66/86	16.7	0.0	16.7	16.7	16.7	0.0	0.0	16.7	10.4
upper Des Moines Creek upper Das Moines Creek unique A sasey Creek 37.5 0.0 25.0 0.0 0.0 14.3 94/95 37.5 0.0 25.0 0.0 12.5 0.0 95/96 62.5 12.5 12.5 0.0 0.0 0.0 0.0 96/97 12.5 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 98/99 11.1 0.0 11.1 11.1 0.0 0.0 0.0 All Years 25.0 2.5 12.5 2.5 2.5 2.5 3.6	All Years	40.0	4.0	20.0	4.0	12.0	4.0	4.0	16.0	13.0
94/95 37.5 0.0 25.0 0.0 0.0 14.3 95/96 62.5 12.5 12.5 0.0 0.0 12.5 0.0 96/97 12.5 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 98/99 11.1 0.0 11.1 11.1 0.0 0.0 All Years 25.0 2.5 12.5 2.5 2.5 2.5 upper Das Moines Creek lungs Creek lungdle Massey	All Samples									
95/96 62.5 12.5 12.5 0.0 25.0 12.5 0.0 96/97 12.5 0.0 <td< td=""><td>94/95</td><td>37.5</td><td>0.0</td><td>25.0</td><td>0.0</td><td>0.0</td><td>0.0</td><td>14.3</td><td>25.0</td><td>12.7</td></td<>	94/95	37.5	0.0	25.0	0.0	0.0	0.0	14.3	25.0	12.7
96/97 12.5 0.0<	96/56	62.5	12.5	12.5	0.0	25.0	12.5	0.0	12.5	17.2
99/98 98/99 11.1 0.0 0.0 0.0 0.0 0.0 0.0 0.0 98/99 11.1 0.0 11.1 11.1 0.0 0.0 11.1 11.1 0.0 0.0 All Years Lyse Des Moines Creek lower lower Des Moines Creek lower low	16/96	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6
98/99 All Years 25.0 2.5 12.5 2.5 7.5 2.5 2.6 upper Des Moines Creek upper Massey Creek upper Massey Creek middle Massey Creek middle Massey Creek MC-1 MC-2	86/L6	0.0	0.0	14.3	0.0	0.0	0.0	0.0	14.3	3.6
All Years 25.0 2.5 12.5 2.5 2.5 2.6 upper Des Moines Creek	66/86	11.1	0.0	11.1	11.1	11.1	0.0	0.0	11.1	6.9
upper Des Moines Creek lower Des Moines Creek upper Massey Creek middle Massey Creek	All Years	25.0	2.5	12.5	2.5	7.5	2.5	2.6	12.5	8.5
								MA-3 BA-1 MC-1 MC-2		assey Creek unes Creek cSorley Creek

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rp3 /00-00836-000 5-wear projectreport.doc February 21, 2001 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 μ g/L (Figure 16). The median total copper concentration ranged from 5.5 to 13.7 μ g/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 μ g/L (Figure 17). The median dissolved lead concentration ranged from less than 0.5 to 1.3 μ g/L among the stream stations during storm flow. The median dissolved lead concentration during base flow was less than 0.5 μ g/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).

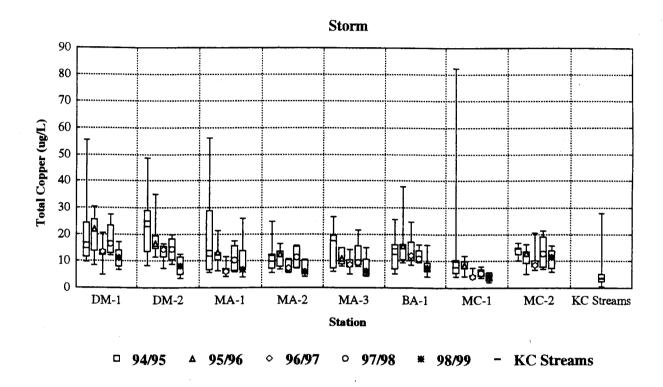
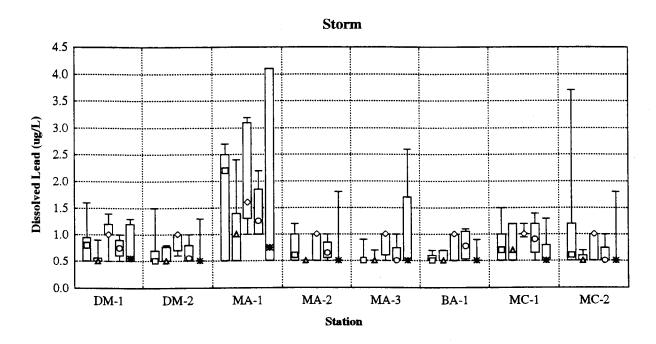


Figure 16. Total copper concentrations during storm flow sampling events in Des Moines streams and in other King County (KC) streams.





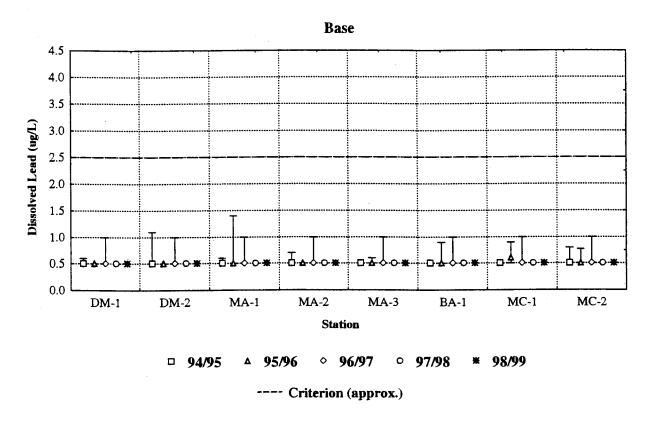


Figure 17. Dissolved lead concentrations during storm and base flow sampling events in Des Moines streams.



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.

Base Flow Samples 0.0 0.0 94/95 0.0 0.0 95/96 0.0 0.0 96/97 0.0 0.0 98/99 0.0 0.0 All Years 0.0 0.0 94/95 0.0 0.0 95/96 0.0 0.0 96/97 0.0 0.0 98/99 0.0 0.0 98/99 0.0 0.0 98/99 0.0 0.0 All Years 0.0 0.0 90 0.0 0.0 97 0.0 0.0 98/99 0.0 0.0 98/99 0.0 0.0 98/99 0.0 0.0 98/99 0.0 0.0 98/99 0.0 0.0 98/90 0.0 0.0 98/90 0.0 0.0 98/90 0.0 0.0 98/90 0.0 0.0 98/90 0.0 0.0 98/90 0.0 0.0	0.0 0.0 0.0 0.0	0.0 0.0 0.0 0.0	0.0	0.0	, (
0.0 0.0 0.0 0.0 0.0 0.0 0.0	0.0	0.0	0.0	0.0	(0	
0.0 0.0 0.0 0.0 0.0 0.0 0.0	0.0	0.0	0);	0.0	U.U	0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0	0.0	0.0	>:>	0.0	0.0	33.3	4.2
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0		0.0	0.0	0.0	6.7	8.0
0.0 0.0 0.0 0.0 0.0	0.0						
0.0 0.0 0.0 ears 0.0	00	0.0	0.0	0.0	0.0	0.0	0.0
0.0 0.0 0.0 ars 0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 0.0 ars 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
o.0 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	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
0.0 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 66/86	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 BA-1 MC-1 MC-2		lower Massey Creek lower Barnes Creek upper McSorley Creek 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 $\mu g/L$ (Figure 18). The median total lead concentration ranged from 2.3 to 10.5 $\mu g/L$ 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 μ g/L (Figure 19). The median dissolved zinc concentration ranged from 6 to 37μ g/L among the stream stations during storm flow and from less than 3 to 5 μ g/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).

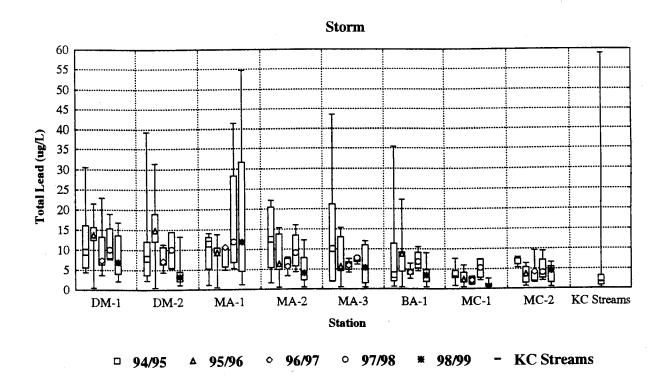
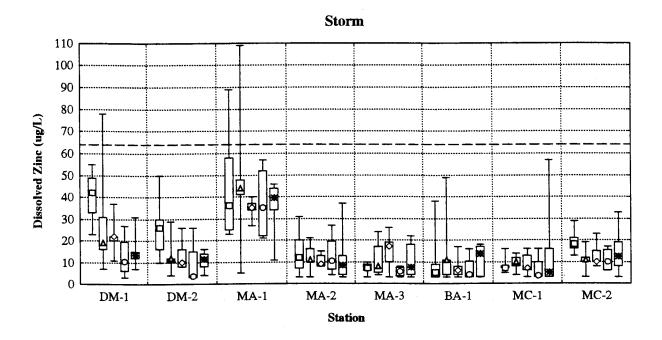


Figure 18. Total lead concentrations during storm flow sampling events in Des Moines streams and in other King County (KC) streams.





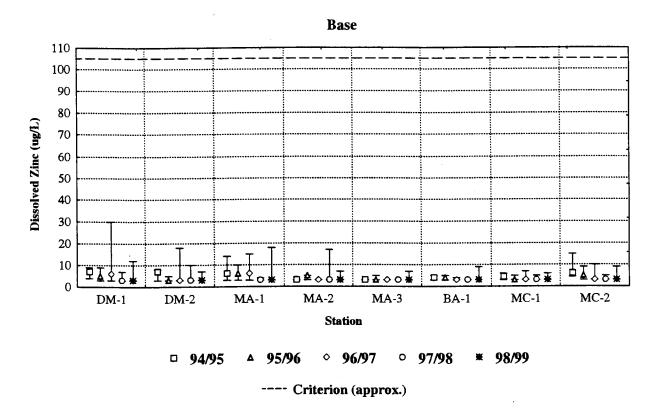


Figure 19. Dissolved zinc concentrations during storm and base flow sampling events in Des Moines streams.



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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		7							
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
26/96	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
86/L6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
66/86	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
96/56	20.0	0.0	40.0	0.0	0.0	0.0	0.0	0.0	7.5
26/96	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
86/26	0.0	0.0	25.0	0.0	0.0	0.0	0.0	0.0	3.1
66/86	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
96/56	12.5	0.0	25.0	0.0	0.0	0.0	0.0	0.0	4.7
16/96	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
86/26	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	1.8
66/86	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 BA-1 MC-1 MC-2		lower Massey Creek lower Barnes Creek upper McSorley Creek 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 μ g/L (Figure 20). The median total zinc concentration ranged from 12 to 61 μ g/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

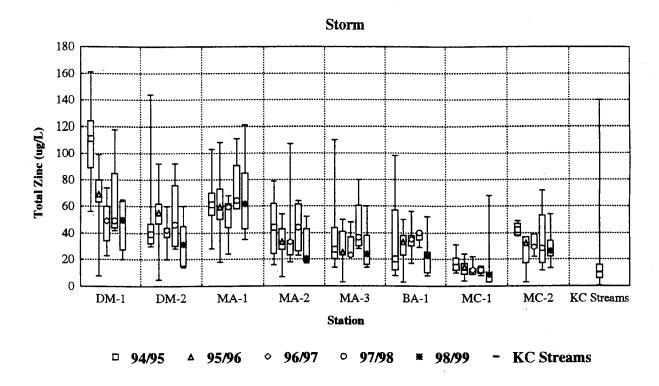


Figure 20. Total zinc concentrations during storm flow sampling events in Des Moines streams and in other King County (KC) streams.



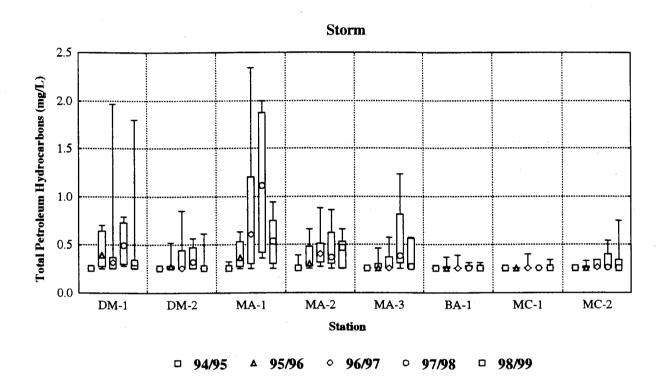


Figure 21. Total petroleum hydrocarbon concentrations during storm and base flow sampling events in Des Moines streams.



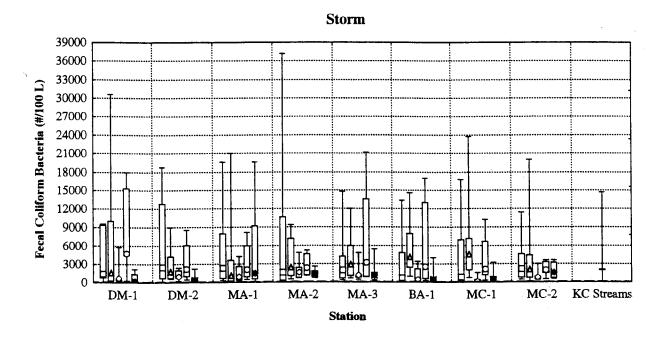
wildlife (birds and mammals). The simple presence of these bacteria does not necessarily indicate a threat to public health because only a small proportion, if any, are likely to be pathogenic to humans. However their use as an "indicator" of potential fecal contamination is considered important in the 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).



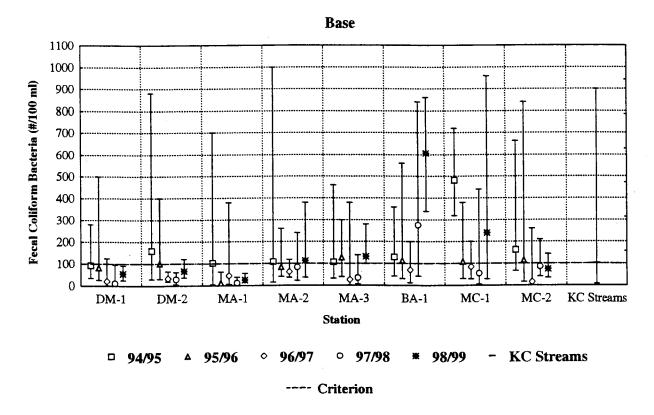


Figure 22. Fecal coliform bacteria concentrations during storm and base flow sampling events in Des Moines streams and in other King County (KC) streams.



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	2.99	2.99	2.99	2.99	2.99	100.0	100.0	73.9
96/56	33.3	66.7	33.3	2.99	2.99	2.99	2.99	2.99	58.3
26/96	33.3	33.3	33.3	33.3	33.3	66.7	2.99	33.3	41.7
86/L6	33.3	2.99	0.0	2.99	33.3	2.99	2.99	2.99	50.0
66/86	66.7	2.99	33.3	2.99	100.0	100.0	2.99	2.99	70.8
All Years	46.7	0.09	33.3	0.09	0.09	73.3	71.4	2.99	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
96/56	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
16/96	100.0	100.0	100.0	100.0	100.0	80.0	80.0	100.0	95.0
86/L6	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
66/86	66.7	83.3	83.3	100.0	100.0	83.3	83.3	100.0	87.5
All Years	92.0	0.96	0.96	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
96/56	75.0	87.5	75.0	87.5	87.5	87.5	87.5	87.5	84.4
26/96	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0
86/26	71.4	85.7	57.1	85.7	71.4	85.7	85.7	85.7	78.6
66/86	66.7	77.8	2.99	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 BA-1 MC-1 MC-2	lower Massey Creek lower Barnes Creek upper McSorley Cre lower McSorley Cre	lower Massey Creek lower Barnes Creek upper McSorley Creek lower McSorley Creek

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

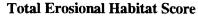
Benthic macroinvertebrate monitoring results for all three sampling years (autumn 1994, 1996, and 1998) are presented in the bioassessment report (Appendix G). This report includes a discussion of the methods and results, and a comparative summary of bioassessment scores and selected metrics for all 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).

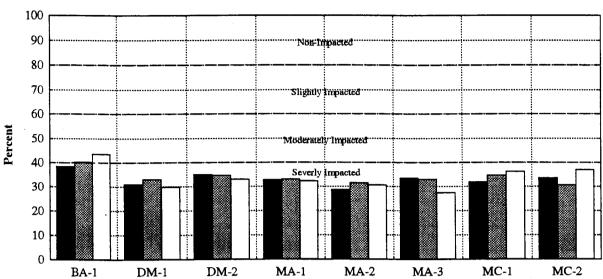
Data for the total erosional habitat indices and scores for its three main components (i.e., primary metrics, positive indicators, and negative indicators) are presented graphically in Figures 23 and 24 for the benthic invertebrate samples in the Des Moines streams. These scoring results are discussed 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 midorder, 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).

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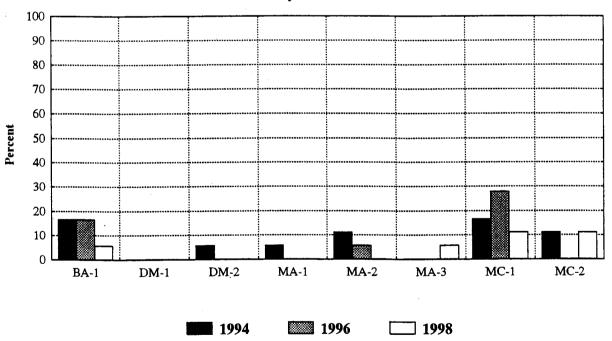
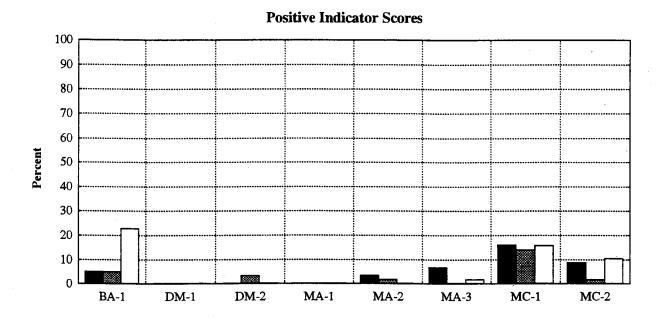


Figure 23. Total erosional habitat indices and primary metrics scores for benthic invertebrate monitoring of Des Moines streams.





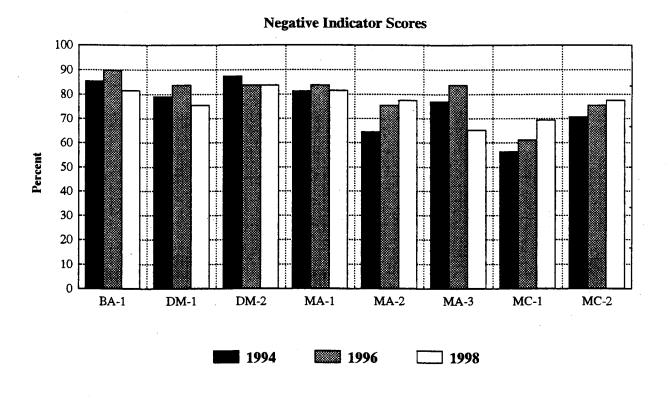


Figure 24. Positive and negative indicator scores for benthic invertebrate monitoring of Des Moines streams.



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

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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.

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

		Storm Flow	Flow	•		Base Flow	low	
	Des Moines	Massey	Barnes	McSorley	Des Moines	Massey	Barnes	McSorley
Townstatute		l		4,5	1,5	1	1	1
Temperature	4.5	4	60	4	4	4	2,5	4
pri Dischad causes	<u>}</u> 1	. —	1	_	1,5	—	-	_
Dissolved oxygen	345	4	ۍ	ı	2,4,5	2,3	2,5	ı
Conductivity	345	4	٠ ٧	i	4,5	ı	5	I
Turbidity	2, ,,2	1,2,4	2,5	1,2,4	1	1	I	S
Total encounded colide	2.4	4,4	2,4,5	4	J	ı	1	2
Total absence somes	· Î I	4	2.5	1	I	4	ı	5
Total phosphorus	٧	٠ ١	· •	4	1	5	5	ı
Nitrate+munic minogen	F	ı)	2.4.5	- 1	ı	1	
Ammonia ninogen	1			÷ (I	1	4.5
Dissolved copper	1	1	ı	4,	l	l	l	<u>,</u> -
Dissolved lead	I	I	1		1	ŀ	I	4
Dissolved zinc	ı	i	1	4,5	i	1	ļ	1
Total conner	2.5	74	7	2,4	NA	NA	NA	٧X
Total land	2.5	7	7	2,4	N A	NA	NA	Ϋ́
Total lead) s		7	2.4	NA	NA	NA	NA
Total zinc	•	1	ı İ	₹ ₹	Y X	NA V	NA	NA
Total petroleum nydrocardons	ı •	٠,			-	-	1.35	-
Fecal coliform bacteria	·	c,I	-	1	T	·	atak v	

*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 75th percentile of other King County streams, where available (dissolved oxygen < 25th 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).

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 o	juality	analyses.
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	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).

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

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

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 (μ mhos/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

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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

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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.

	В	ase Flow Sam	oles	Sto	orm Flow Sam	ples
Parameter	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
pН	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.

	EVCIN	Monitoring	Sample	Sample	Antecedent Dry	FIUW NAIC	тетр.			-	3	Conductivity	ו חומותול	667	recal Contorm		= ;
Station	Number	Year	Date	Time	Period (hours)	(cfs)	(၁ (၁		Hd	(mg/L)	/L)	(nmhos/cm)	(NTU)	(mg/L)	(CFU/100 mL)		(mg/L)
1	-	_	12/6/94	10:40	6.89	0.23	3.5	7	7.82		12.4	223	2.5	0.55	42		0.047
RA-1	. ~	-	3/29/95	19:50	75.8	0.12	9.5	7	89.7	=	12.9	173	2.5	1.70	140 J	ပ	0.034
BA-1	۳ (_	2/19/95	15:30	242.0	0.005	18.4	C 7	7.93	ىد	8.7 C	259	0.47	1.70	360 J	ပ	0.092
RA-1	4		12/7/95	15:00	87.0	0.33	0.9	7	7.46	Ξ	9'11	187	2.7	2.20	30 J		0.046
RA-1	٠.		3/27/96	13:50	109.8	3.0	10.0	80	8.65 C		2.8	209	2.8	1.10	98	ပ	0.064
BA-1	, ,	, 0	7/8/96	18:00	114.0	060.0	14.8	7	7.65	ىد	8.8 C	; 227	1.4	2.30	260	ပ	0.031
EA.1	, ,	 1 m	96/61/61	11:00	84.0	0.41	5.0	7	7.39	-	8.1	202	2.7	2.00	12 J		0.037
BA-1	· ox	. 67	7/25/97	15:00	135.8	0.89	11.9	7	7.55	5	6.6	184	2.5	2.50	134	ပ	0.039
1 V D	• •	. ~	701107	12:51	256.8	1.1	15.7	7.	7.93	تعد	8.6 C	288	-	0.80	200 J	ပ	0.072
1-VG	` <u>c</u>	.4	12/4/97	12:00	95.8	0.80	6.8	7.	7.54	-	11.8	245	2.4	1.3	42		0.058
1-1/0	1	•	30/01/2	17.35	1 161	0.25	101	7	7.81	12	12.2	228	2.7	1.80	840	ပ	0.053
Į.	: :	•	20/07/	13.10	149.7	0.13	28	00	8.05	٠,	8.6	284	0.41	1.80	280	ပ	0.086
BA-1	7 :	. 4	00/17/0	12.00	87.0	080	8 9	7	7.76	=	911	172	7.4	8.50	160	ບ	0.049
DA-1	2 :	n 4	607773	13:30	545	0.30	17.5	7	7.81	, ,	80	261	2.5	3.20	340 J	ပ	0.082
BA-1	<u>+</u> -	n 4	972500	13:30	4803	0.73	15.8	7	7.75		0		80	0.67	860	C	0.081
BA-1	2 •	n -	6615710	07.61	707		7.7		7 00	- =			3.5	1 60	80.1	۲	0.046
I-WC	- (P6/C/71	14:20	16.0	J. 6	- C		2.5			891	2.3	080	1 76)	0.03
DM-I	7	-	3/29/95	00.61	0.67	0.5	0.71			-			6.7	9:-	1 080	ز	
DM-I	m	-	7/19/95	14:25	740.9	0.85	. ;	، نہ د	7.38	- :			0.04	2	007	י כ	0.000
DM-I	4	2	12/7/95	13:50	82.8	3.7	6.3	7	7.36	_	1.3	158	7.8	05.1	200	ن	0.036
DM-i	S	2	3/27/96	12:05	108.1	0.71	10.0	7	7.82	-			1.6	1.80	Z6 J		0.040
DM-1	9	2	96/8//	13:15	109.3	2.3	15.7	7	7.76	~	8.9 C		1.6	0.53	42		0.041
DM-I	7	E	12/19/96	15:30	88.5	1.8	5.2	7	7.17	=	11.8	190	2.7	2.80	2 J		0.031
DM-I	o c	3	3/25/97	11:15	132.0	8.5	10.2	7	7.31		10	188	7	10.00	126	ပ	0.053
DM-I	6	E	7011217	10:20	254.3	1.6	15.3	7	7.61	~	8.4 C		1.5	0.80	32 J		0.041
DM-1	10	4	12/4/97	9:50	93.6	2.6	6.2	7	7.41	:1	2.7	201	1.5	0.50 U	2 J		0.047
DM-1	=	4	3/19/98	11:25	189.9	2.0	6.6	7	99'.	Ξ	9.1	207	2.1	2.30	6 J		0.037
DM-1	17	4	7/22/98	10:00	146.5	1.4	14.8	7	7.44	υ	9.2 C	•	0.5	1.20	96	ပ	0.046
DW.	! ==	v	2/12/99	13:30	89.3	4.9	6.9	7	7.32	=	1.2	175	0.83	2.30	24 J		0.029
	1	· •	5/27/99	15:00	96.0	2.2	14.1	7	7.76	5	9.1 C	209	2.0	1.70	89	ပ	0.075
	. <u>~</u>	· •	8/25/99	9:30	485.5	1.24	15.8	7	7.50	=	10.3	225	6.0	0.82	92	ပ	0.040
, CMC	-		12/5/94	13:40	47.9	8:	4.1	7	7.65	7	2.6	190	2.5	1.00	160 J	ပ	0.041
2 MG	٠,	-	30/075	18:15	74.2	1.6	11.4 M		7.98 M	5	9.9 M	181 M	1.7	1.00	28 J		0.017
		-	2/19/95	14:00	240.5	0.85	18.2	ပ	69.	-	8.9 C	215	1.8	9.20	880	ပ	0.085
	. 4		12/7/95	14:20	86.3	1.5	6.0	7	7.43	Ξ	∞ .	171	2.1	1.20	400	ပ	0.038
7.100	- v		90/2012	13.00	109.0	3,00	10.1	œ	8.98 C	_	3.2	206	1.7	1.50	30 J		0.028
7-WC	n v	4 (70/8/2	14.40	110.7	4	16.3	C 7	7.98	J	8.9 C	237	1.1	1.90	84	ပ	0.049
7-WG	7 0	, r	90/01/21	16.25	89.4	0.1	5.1		7.31	Ξ	1.6	224	3.9	9.60	18 1		0.041
7-MC	- 0	. "	20/20/2	16:30	137.3	0.6	12.1	7	7.65	٠,	9.5 C	203	2.5	2.80	64	ပ	0.029
7-MC	۰ د) (70/10/	11.45	255.8	23	16.6	C 7	7.79	نب	Ī		1.2	1.20	26 J		0.053
7-MI-7	` 5	· •	12/4/07	16.10	6 66	3.9	7.2	7	7.43	Ξ	1.7	204	1.4	0.80	54	ပ	0.042
7-IM	2 :	•	2/10/08	13.00	190 5	3.7	10.2	7	7.29		12	219	2.6	2.60	6 J		0.037
DM-2	= :	÷ •	3/17/176	12.00	1636		101	ָ ע	7 56	G	٠, ۲		0.35	0.83	09	C	0.061
DM-2	77	4 ,	86/77/1	00:91	5.251	1.10	13.1		7.03	- =	_		890	2.30	36.1)	0.027
DM-2	13	2	2/12/99	13:00	88.7	0.70	0.7	- (6.73	- '	1.7	166	0.00	2.00	74 141	(0.000
										•							

0.027 0.017 M 0.042 0.050 0.018

0.031 0.028 0.026

6 J 61 380 J 34 J

0.040 M

0.017

14 J 16 J

5.35 M 0.64 5.2 6.6 2.1 2.5 1.5 3.5

8.6 12.9 12.2 8.4 11.5

0.6

8.7 10.6 9.2

15:00

MA-I

11:50 11:05

13:55

7011217 12/4/97 3/19/98

MA-1 MA-I MA-1 0.015

2.60 3.00 2.00 2.80 1.30 1.30 1.10 0.80 0.80 0.80 0.80 0.80 1.10 1.50 M 1.50 M 1.50 M 1.10 1.50 M 1.10 1.10 1.10 M (mg/L) 0.71 4.00 5.30 1.70 1.80 2.00 0.80 6.83 5.1 3.2 3.6 M 6.5 Turbidity ONTO Conductivity 262 148 160 197 197 198 203 215 215 216 276 (umhos/cm) DO (mg/L) 10.6 7.6 11.3 10 8.7 10.4 11.1 9.3 9.7 Table B1. Base flow data for the Des Moines Water Quality Monitoring Program. 11.0 3.9 12.7 21.6 6.3 10.5 8.2 0.0 14.9 0.0 11.2 Flow Rate (cfs) 1.60 2.5 2.3 2.3 0.38 0.013 0.035 0.11 0.93 0.95 0.34 0.69 0.091 0.089 0.089 0.014 0.18 0.089 0.25 0.21 0.068 0.07 0.05 0.05 Antecedent Dry 491.0 49.1 73.7 239.0 84.4 107.7 108.2 49.8 Period (hours) 238.2 107.5 107.6 49.9 71.7 238.1 84.1 107.2 107.3 51.3 72.9 72.9 85.2 106.7 106.3 75.5 88.7 111.7 113.5 87.7 136.7 257.5 99.3 192.4 151.5 87.6 52.1 76.3 242.4 87.4 Sample 11:35 11:35 12:05 11:10 11:20 17:05 16:55 13:00 13:10 10:15 18:40 19:30 16:40 11:40 15:35 11:30 10:40 15:40 14:40 16:00 13:28 15:30 1:40 1:55 5:45 7/8/96 12/5/94 3/29/95 7/19/95 2/19/95 12/7/95 36/12/8 96/8// 729/95 7/19/95 2/5/94 3/27/96 96/8/ 12/5/94 3/27/96 3/29/95 7/19/95 12/7/95 3/27/96 12/7/95 3/29/95 7/19/95 12/7/95 3/27/96 96/8/ 2/19/96 3/25/97 Monitoring Year Event Number DM-3 DM-3 DM-3 DM-3 DM-3 DM-5 DM-5 DM-S DM-5 DM-5 DM-5 9-WQ 9-MQ 9-WQ 9-WQ DM-6 DM-6 DM-3 DM4 DM4 DM-4 MA-1 MA-I MA-1 MA-I MA-I MA-1 MA-1

(mg/L)

Fecal Coliform (CFU/100 mL)

0.039

0.032

0.044 0.051

300 J 16

0.039

140 J 180 J

0.037 0.042

52 12 J 12 J

0.040 0.033 0.065 0.044 0.033

0.092 0.043 1.940 0.064

440 16 J 2 U 2 U 48 88 88 220 J 220 J 98 28 J 540

0.435 0.080 0.020

0.017

700 J 380 J

Fable B1-2

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

5	Number 5		Date	Lime	Period (hours)	(July)	2	7		•		-				
A-2 A-2 A-2 A-2 A-2 A-2 A-2 A-2	5				ו הווה היות לויהיים	(613)	ربر مر) در	Пď	(mg/L)	(mm)	(umhos/cm)	(NTU)	(mg/L)	(CFU/100 mL)		(mg/L)
A-2 A-2 A-2 A-2 A-2 A-2 A-2 A-2		7	3/27/96	14:20	110.3	0.52	10.5	8.15	10.8		214	2.6	0.80	36	ပ	0.016
A-2 A-2 A-2 A-2 A-2 A-2 A-2	9	7	96/8/1	15:55	111.9	1.0	13.1	7.89	8.8	C	237	1.4	0.53	260 J	ပ	0.030
A-2 A-2 A-2 A-2 A-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
A-2 A-2 A-2 A-2 A-2	∞	ω.	3/25/97	15:30	136.3	1.9	12.0	7.62	9.7		220	2.2	0.83	50		0.017
A-2 A-2 A-2 A-2 A-2	6	m	7/21/97	13:56	257.9	0.74	16.4	C 7.90	9.4	C	255	0.45	0.53	118	ပ	0.027
A-2 A-2 A-2 A-2	10	4	12/4/97	14:50	9.86	16.0	9.8	7.61	11.8		237	7	0.93	22 J		0.021
A-2 A-2 A-2	11	4	3/19/98	13:35	192.1	1.0	11.0	7.88	11.1		236	2.9	1.80	100	U	0.024
A-2 A-2	12	4	7/22/98	14:40	151.2	0.52	18.5	C 7.75	8.2	C	569	0.37	0.50 U	240 J	ပ	0.036
A-2 A-2	13	'n	2/12/99	11:00	8.98	1.2	7.0	7.73	11.4		203	4.1	0.50	36 J		0.016
A-2	14	5.	5/27/99	11:45	52.8	0.37	12.4	8.00	6.6		240	2.7	2.70	102	ပ	0.038
	15	2	8/25/99	11:30	487.5	0.26	17.0	C 7.40	8.9	ပ	263	1.5	1.80	380	၁	0.038
MA-3	_	_	12/5/94	17:50	52.1	2.6	4.0	7.79	8.1.		225	1.7	09:0	32 J		0.028
MA-3	7	-	3/29/95	20:40	7.97	4.4	6.6	7.62	11.3		185	1.9	1.90	80 J	ပ	0.024
MA-3	3	_	7/19/95	15:00	241.5	3.4	18.7	C 7.67	7.9	S	241	0.52	0.50 U	460	ن	0.058
MA-3	4	7	12/7/95	14:40	86.7	4.2	6.5	7.38	11.2		194	2.4	1.20	38.1	ı	0.030
MA-3	5	2	3/27/96	13:25	109.4	1.2	8.6	7.81	11.8		212	1.9	0.83	300 F	Ü	0.024
MA-3	9	7	96/8/L	15:30	111.5	2.2	16.7	C 7.79		ນ	214	1.3	1.70	180 1	י ני	0.038
MA-3	7	3 15	2/19/96	11:40	84.7	1.8	5.8	7.22	11.2		223	2	1.20	380 J	י נ	0.025
MA-3	0 0	m	3/25/97	12:35	133.3	2.4	10.9	7.32	8.6		206	1.6	1.80	2)	0.03
MA-3	6	٠. ٣	7/21/97	12:03	256.0	1.4	9.91	C 7.76	9.3	S	253	_	0.56	- 18 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	=	4	3/16/68	12:20	190.8	2.4	10.1	7.88	12.4		232	2.1	1.10	6 9		0.031
MA-3	12	4	7/22/98	14:00	150.5	8 .T	17.8	C 7.77	8.2	ပ	302	0.56	1.50	140	Ç	0.064
MA-3	13	.,	2/12/99	9:30	85.3	2.9	9.9	7.60	11.5		194	4.1	2.20	132	ပ	0.027
MA-3	4	S	5/27/99	13:50	54.8	1.33	14.0	7.75	9.5	ن ن	250	2.3	1.70	86	ပ	0.051
MA-3	13	S	8/25/99	13:50	489.8	2.42	17.0	C 7.51	8.7	ပ	256	0.93	2.00	280	ပ	190.0
MC-1	_	_	12/5/94	19:35	53.8	0.49	3.7	6.81	9.3	U	165	1.4	1.40	320 J	ပ	0.040
MC-1	7	_ 	3/29/95	21:10	77.2	0.19	8.3	6.91	6.4	ບ	115	1.9	2.40	720 J	U	0.051
MC-1	٣	1 7	7/19/95	16:15	242.8	0.048										
MC-1	4	2 1	12/7/95	15:55	87.9	0.24	4.9	7.11	7.3	U	911	2.0	1.70	30 J		0.076
MC-1		2 3	3/27/96	14:40	110.7	0.27	9.1	7.54	8.3	t)	130	2.2	2.00	380 J	ပ	0.071
MC-1	9	7	96/8//	16:45	112.7	0.048	16.8	C 7.20	7.7	O	174	3.4	3.60	901	ပ	0.177
MC-1	7	3 12	5/16/96	14:00	87.0	0.52	4.1	6.54	8.2 (O	150	1.1	0.50 U	28 J		0.070
MC-1	∞	33	3/25/97	14:10	134.9	0.090	9.11	6.54	6.8	O	140	1.4	1.50	104	ပ	0.064
MC-1	6	3 7	7/21/97	15:08	259.1	0.10	15.2	7.28	6.5	()	181	2.9	1.83	200 J	ပ	0.200
MC-1	10	4	12/4/97	14:10	6.76	0.15	6.5	6.88	9.1	C)	163	1.5	0.93	54	ပ	0.118
MC-1	=	4 .	3/19/98	13:20	191.8	0.17	10.0	7.24	8.7	<i>(</i>)	150	2.2	4.80	6 9		0.102
MC-1	12	4 7	7/22/98	12:40	149.2	0.03	16.5	C 7.45	7 (ບ	207	4.7	1.00	440	ပ	0.238
MC-1	13	5 2	2/12/99	11:20	87.1	0.35	5.2	6.91	8.5	ບ	134	0.57	1.30	28 J		0.039
MC-1	14	5 5.	5/27/99	12:15	53.3	0.12	11.0	7.07	7.4 (, r v	159	2.0	1.50	096	ပ	0.088
MC-1	15	ν •×	8/25/99	10:20	486.3	0.07	17.0	C 7.00	7.5 (ບ	208	2.2	1.50	200	ပ	0.146
MC-2	_	-	12/5/94	19:20	53.6	2.1	4.3	7.63	12.1		126	18 C	2.50	99	ပ	0.056
MC-2	7	1.3	3/29/95	21:35	77.6	<u>13</u>	10.8	19.7	7.8	ບ	135	5.0	2.50	1 96 J	ပ	0.046
MC-2	,	1 7	7/19/95	16.35	243.1	0.50	M 6 %1	C 760 M	CMAA	,	202 M	14 M	0 04 M	WI 299	ر	M 070 M

																4
	T. Care	Cyent Monitoring	Sample		Sample Antecedent Dry	Flow Rate	Temp.		2	Condt	onductivity	Turbidity	ISS	recal Colitoria		<u>-</u>
Cration	Number	Year			Period (hours)	(cfs)	(O C)	Hd	(mg/L)	hmu)	umhos/cm)	(NTU)	(mg/L)	(CFU/100 mL)		(mg/L)
Station	1		15	16.15	88.3	2.0	5.5	7.33	11.6		118	6.1	2.80	110	ပ	0.051
MC-2	† '	7 (201501		111.2	=	100	8.15	11.1		173	2.2	2.00	16 J		0.023
MC-7	o,	7	06/17/6	01.01	111.2	27.0	140	7.46	7.1	Ü	250	1.9	1.73	840	ပ	0.073
MC-2	9	7	96/8//	16:20	5.71	1.1		7.74	11.3)	17.1	9.6	2.00	260 J	ပ	0.045
MC-2	7	.n	96/61/7	04:71	93.7	7.1	4. 5	27.6	5.01		135	£.	3.00	6 9		0.033
MC-2	00	3	3/25/97	13:25	134.2	C: 1	1.2.1		i t	C	0.4		1 40	1 (0 000
C-2M	6	6	7/21/97	14:21	258.3	0.52	18.7	7.51	0.7	ر	00.		04.1			1/0.0
	. 5	•	12/4/07	12.45	2 %6	90.0	7.8	7.53	10.8		173	5.5	2.40	40		0.065
MC-2	2 ;	· •	16/4/71	17.66	101	•	80	8 00	12.7		172	3.6	2.50	7.7	ပ	0.054
MC-2	=	4 .	3/13/96	66.21	1707	0 0	14.0	7 85	8	C	283	0.75	1.50	210 J	ပ	0.094
MC-2	12	4	1/22/98	17:00	146.3	60.0			?: :)	117	7.3	2.50	14.1		0.036
MC-2	13	2	2/12/99	10:50	9.98	1.78	2.0	/0/	71	{	/71	9	97.7	144	C	0 00
77	14		5/27/99	12:45	53.8	0.16	15.0	7.74	9.0	ပ	181	4.0	0.40	:	ו נ	0.070
MC-2	15	, vo	8/25/99	10:50	486.8	0.07	16.8	C 7.40	7.4	ပ	250	1.9	1.20	78	ပ	0.077
1)															

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

Station	Number	(mg/L)	(mg/L)	(mg/L as CaCO3)	(mg/L)	(mg/L)	(mg/L)
BA-I	-	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	9	0.024	1.05	118.0	0.0034	0.0005 U	0.005
BA-1	4	0.028	1.58	90.3	0.0044	0.000	0.005
BA-1	40	0.013	1.22	94.3	0.0016	0.0005 U	0.004
BA-1	9	0.010 U	1.46	114.0	0.0010 U	0.0005 U	0.003 U
BA-I	7	0.010 U	1.160	86.3	0.0023	0.0010 U	0.004
BA-1	∞	0.010 U	0.918	67.4	0.0015	0.0005 U	0.003 U
BA-I	6	0.010 U	1.162	113.8	0.0010 U	0.0005 U	0.003 U
BA-1	01	0.01 U	1.04	100	0.0015	0.0005 U	0.003 U
BA-1	=	0.010 U	0.957	1.68	0.0011	0.0005 UJ	0.003 U
BA-1	12	0.010 U	1960	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	0.00
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	-	0.047	0.725	16.0	0.0034	0.0005 U	0.007
DM-1	2	0.010	0.705	80.9	9100.0	0.0005 U	0.00
DM-1	e	0.021	1.06	87.5	0.0029	90000	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	0.00
DM-1	9	0.010	0.870	88.5	0.0017	0.0005 U	0.003 U
DM-1	7	0.067	0.731	. 17.5	0.0030	0.0010 U	0.03
DM-1	∞	0.031	0.650	75.0	0.0022	0.0005 U	9000
DM-I	6	0.010 U	0.837	93.9	0.0010 U	0.0005 U	0.003 U
DM-I	10	0.010 U	0.779	81.5	0.0025	0.0005 U	0.003 U
DM-I	=	0.039	0.70	86.3	0.0014	0.0005 UJ	0.00
DM-I	12	0.010 U	0.892	107.0	0.0010 U	0.0005 U	0.003 U
DM-1	<u>::</u>	0.070	0.646	71.1	0.0020	0.0005 U	0.012
DM-I	14	0.010 U	0.644	92.5	0.0010 U	0.0005 U	0.003 U
DM-I	15	0.018	0.789	92.1	0.0010 U	0.0005 U	0.003 U
DM-2	-	0.037	0.808	87.8	0.0027	0.0005 U	0.003 U
DM-2	7	0.010	0.674	87.7	0.0010 UM	0.0005 UM	0.008 M
DM-2	m	0.013	0.877	94.9	0.0014	0.0011 J	0.00
DM-2	4	0.079	0.974	80.2	0.0033	0.0005 U	0.005
DM-2	\$	0.018	0.919	0.68	0.0019	0.0005 U	0.003
DM-2	9	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	00	0.013	0.953	81.6	0.0016	0.0005 U	0.003 U
DM-2	6	0.010 U	996.0	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	=	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	10:0
DM-2	13	0.016	0.964	73.7	0.0023	0.0005 U	0.00

Station	Number	(11)						
	,	(mg/L)	(mg/L)	(mg/L as CaCO3)	(mg/L)	(mg/L)		(mg/L)
7-WO	SI	0.012	0.749	96.5	0.0010 U	0.0005 U		0.003 U
DM-3	-	0.064	0.705	0.89	0.0041	0.0005 U		0.008
DM-3	2	0.023	0.774	81.7	0.0016	0.0005 U		900'0
DM-3		0.037	1.13	91.8	0.0026	0.0011		0.009
DM-3	4	0.119	0.940	7.07	0.0048	0.0005 U		0.01
DM-3	S	0.034	0.974	90.4	0.0022	0.0005 U		0.004
DM-3	9	0.026	0.924	91.3	0.0025	0.0005 U		0.004
DM-4	-	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	9900'0	0.0005 U		0.003
DM-4	.	0.107	0.727	159.0	0.0021	0.0005 U		0.003 U
DM4	9	0.093	0.782	149.0	0.0045	0.0005 U		0.00
DM-5	-	0.090	0.332	103.0	0.0061	0.0005 U		0.004
DM-5	7	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	~	0.067	0.232	105.0	0.0032	0.0005 U		0.003 U
DM-5	9	0.020	0.0300	98.4	0.0015	0.0005 U		0.003
9-MQ	-	0.117	0.284	11.6	0.0026	0.0019	ပ	0.008
9-WQ	2	0.082	0.319	43.8	0.0014			0.013
9-WQ	3	0.218	0.0180	64.7	0.0148		ပ	990.0
9-WQ	4	0.136	0.675	33.1	0.0053	C 0.0007		0.013
9-WQ	5	0.962	3.47	49.2	0.0065		ပ	0.003 U
9-МО	9	0.097	0.275	58.4	0.0030	0.0005 U		0.004
MA-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		90.0
MA-1	ю	0.090	1.34	112.0	0.0029	90000		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	\$	0.053	1.76	92.7	0.0010 U	0.0005 U		0.006
MA-1	9	980.0	1.62	0.601	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	œ	0.018	1.360	93.3	0.0010 U	0.0005 U		0.006
MA-1	6	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	Σ	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	-	0.033	1.56	0.86	0.0010 U	0.0005 U		0.003 U
MA-2	7	0.013	1.16	91.3	0.0010 U	0.0005 U		0.003 U
MA-2	m	0.027	0.847	93.1	0.0028	0.0007		0.003 U
N. A. J.	, •				0100.0	11 3000 0		200

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

	FACIL						
Station	Number	(mg/L)	(mg/L)	(mg/L as CaCO3)	(mg/L),	(mg/L)	(mg/L)
MA-2	~	U 0100	1.96	94.1	0.0011	0.0005 U	0.005
MA-2	9	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	œ	0.014	1.710	82.2	0.0010	0.0005 U	0.003 U
MA-2	6	0.010 U	2.604	102.7	0.0010 U	0.0005 U	0.003 U
MA-2	01	0.007	1.390	101.0	0.0012	0.0005 U	0.003 U
MA-2	=	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	4	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	_	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	m	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	9000'0	0.005
MA-3	S	0.011	1.63	94.1	0.0015	0.0005 U	0.003 U
MA-3	9	0.011	0.931	0.86	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	∞	0.013	1.340	80.8	0.0015	0.0005 U	0.003 U
MA-3	6	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	=	U 010.0	0.237	8.06	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	<u>4</u>	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	-	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	900'0
MC-1	3						
MC-1	4	0.044	0.634	50.3	0.0036	0.000	0.003 U
MC-1	3	0.010 U	0.252	55.2	0.0013	0.0005 U	0.005
MC-1	9	0.016	0.178	2.77	0.0022	90000	0.003
MC-1	7	0.019	0.465	62.0	0.0023	0.0010 U	0.007
MC-1	∞	0.020	0.347	45.4	0.0015	0.0005 U	0.003 U
MC-1	6	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	=	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	9000
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	8.98	0.0010 U	0.0005 U	0.003 U
MC-2	-	0.044	0.968	89.0	0.0055	0.0005 U	0.015
MC-2		0.014	0.054	64.8	0.0015	0.0005 U	9000
1							

	Event	Event Ammonia	Nitrate+Nitrite	Hardness	Copper, Dis.	Lead, Dis.		Zinc, Dis.
Station	Number	(mg/L)	(mg/L)	(mg/L as CaCO3)	(mg/L)	(mg/L)		(mg/L)
MC-2	4	0.033	0.702	32.5	0.0048	C 0.0008	ပ	0.00
MC-2	S	0.040	0.202	74.6	0.0010 U	0.0005 U		0.005
MC-2	9	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	••	0.025	0.232	44.4	0.0024	0.0005 U		0.003 U
MC-2	6	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	=	0.022	0.440	74.8	0.0010 U	0.0005 UJ		0.005
MC-2	12	0.010 U	0.333	0.801	0.0012	0.0005 U		0.003 U
MC-2	13	0.015	0.655	49.8	0.0026	0.0005 U		0.00
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.

1 11/2394 17:15 12/894 17:15 12/894 17:15 17/2394 17:15 12/894 17:15 12/894 17:15 12/894 17:15 12/894 17:15 12/894 17:15 12/894 17:15 12/894 17:15 12/894 17:15 17/2394 17/239	ILS) (INCHES)				
1 11/2394 7.20 11/2394 4.20 3 11/2394 0.45 3 1 12/8394 7.20 11/2394 16.0 3 11/2394 16.4 4 1 12/895 19.45 3/895 16.10 4 12/895 5.30 5 1 10/2005 13.36 10/2005 8.00 3 10/2005 4.95 10/2005 4.90 10/2005 4.90 10/2005 4.90 10/2005 4.90 10/2005 4.90 10/2005 4.90 10/2005 4.90 10/2005 4.90 10/2005 4.90 10/2005 4.90 10/2005 4.90 10/2005 4.90 10/2005 10/200		(cra)	(crs)	ر اع	H
2 1 12894 17.15 12.894 21.00 4 12.894 1645 4 1 38955 13.30 7995 16.35 4.30 4.30 4.30 4 1 7995 13.30 7995 16.35 4.30		<u> </u>	9.1	9.6	6.51
3 1 38955 945 3/895 1215 3/895 530 4 1 102095 1336 11795 1635 4 77995 1615 5 1 107095 1336 117795 163 4 77995 1915 6 2 117795 139 117795 1445 117695 1915 9 2 247206 1330 472296 1615 3 47209 1130 10 2 374706 1335 117096 1764 1770 1130 11 3 1173096 1335 117096 1764 1769 1770 12 3 1173096 1335 117099 1770 1770 1770 13 4 472797 1346 17697 1770 1770 1770 14 3 472797 1345 1770 1770 1770 1770 1770 1770 1770 177	8.0 0.21	0.3	0.4	9.6	7.61
4 1 71995 1330 77995 1635 4 71995 1045 5 1 102093 5.33 1072095 4.30 471995 4.30 6 2 117796 15.30 117795 4.43 4 117695 19.30 9 2 472196 19.30 472296 16.15 3 34796 17.50 10 2 37396 12.25 17396 17.50 17.50 17.50 11 3 117096 12.25 17.50 17.50 17.50 17.50 12 3 117697 12.45 3 117696 17.50 17.50 12 3 117697 12.50 17.79 17.50 <td< td=""><td></td><td>1.4</td><td>1.8 8.1</td><td>7.4</td><td>7.04</td></td<>		1.4	1.8 8.1	7.4	7.04
5 1 1002095 \$35 1070095 \$8.00 3 1002095 \$43 6 2 311796 19.30 31796 12.05 3 37196 810 9 2 317196 19.30 37196 15.05 3 37196 1715 10 2 37196 19.30 37196 15.05 3 37196 1710 10 2 37196 19.30 472296 11.30 97196 11.30 11 3 117097 19.43 117096 17.00 3 117096 17.00 13 3 117097 11.0597 22.55 3 17097 17.00 2 14 3 402297 11.0697 11.0697 11.00 17.00 17.00 17.00 17.00 17.00 17.00 17.00 17.00 17.00 17.00 17.00 17.00 17.00 17.00 17.00 17.00 17.00 17.00	2.8 0.93	9.0	1.2	17.3 C	7.28
6 2 11/795 1:30 11/795 445 4 11/695 19:15 8 2 3/3/96 1:39 11/795 2 3/3/96 15:20 3 3/3/96 15:10 3 3/3/96 15:10 3 3/3/96 15:10 3 3/3/96 15:10 3 3/3/96 15:10 3 3/3/96 15:10 3 3/3/96 15:10 3 3/3/96 15:10 3 3/3/96 15:10 3 3/3/96 15:10 3 3/3/96 15:10 3 3/3/96 15:10 3 3/3/96 15:10 3 3/3/96 15:10 3 3/3/96 15:10 3 3/3/96 15:10 3 3/3/96 15:10 3 3/3/96 15:10 3 3/3/96 15:10 17:10 3 3/3/96 15:10 17:10 3 3/3/96 15:10 17:10 3 3 3 3 3 3 3 3 3 3		0.3	0.5	11.5	7.12
7 2 31396 1045 31396 12:50 3 1396 8:0 8 2 313196 19:30 313196 15:05 3 343196 17:15 10 2 472366 15:05 3 343196 17:15 11 3 11/3096 12:25 93:36 15:05 3 343196 17:15 11 3 11/3096 13:35 11/3096 15:05 3 343196 17:10 12 3 11/3097 19:35 47297 25:06 17:04 3 11/3096 12:00 14 3 4/2297 19:03 11/1099 22:05 3 472397 17:30 15 4 11/1397 11:10 11/1399 13:00 3 14:00 14:00 16 4 11/1397 11/1399 13:10 3 14:00 14:00 14:00 14:00 14:00 14:00 14:00 14:00 14:00 <td></td> <td>6.0</td> <td>1.2</td> <td>7.7</td> <td>6.75</td>		6.0	1.2	7.7	6.75
8 2 3/31/96 19:30 3/31/96 12:05 3/31/96 17:15 9 2 4/22/96 13:30 4/22/96 16:15 3 4/22/96 11:30 10 2 4/32/96 13:35 11/30/96 15:36 3 9/39/96 11:30 11 3 11/30/96 13:35 11/30/96 17:04 3 11/30/96 17:00 12 3 11/30/97 10:31 12/20/97 21:35 3 11/30/96 17:00 14 3 11/30/97 10:15 4/22/97 21:05 3 4/22/97 17:00 16 4 11/19/97 10:15 4/22/97 12:05 3 11/30/97 17:00 17 4 12/15/97 10:17 11/19/97 11:18 4 4/22/97 14:00 18 4 4/22/98 10:07 11:18 3 11/19/97 11:18 3 11/19/97 11:08 3 <td< td=""><td></td><td>8.0</td><td>10.0</td><td>9.9</td><td>6.15</td></td<>		8.0	10.0	9.9	6.15
9 2 47296 1330 47296 1615 3 47296 1130 10 2 91796 1225 93496 1565 3 94796 1130 11 3 11697 1223 14799 1760 1700 12 3 11697 1940 11697 2144 3 11697 1700 13 3 162797 1945 11697 11797 166 4 117097 166 4 117097 166 4 117097 166 4 117097 166 4 117097 166 16797 1710 1710997 1170 1170997 1170 1170997 1170 1170997 1170 1170997 1170 1170997 1170 1170997 1170 1170997 1170 1170 1170997 1170 1170 1170 1170 1170 1170 1170 1170 1170 1170 1170 1170 1170		3.2	3.9	9.3	88.9
10 2 9/396 12.25 9/396 15.05 3 9/396 12.00 11 3 11/697 11/697 17:04 3 11/3096 12.00 12 3 11/697 21:35 11/3096 17:04 3 11/3096 17:00 13 3 1/27/97 21:03 17/797 21:45 3 11/3096 17:00 14 3 4/22/97 21:03 17/797 12:20 3 4/22/97 17:30 15 3 4/22/97 10:15 3 17/1997 11:00 11/1997 11:00 11/1997 11:00 11/1997 11:00 11/1997 11:00 11/1997 11:00 11/1997 11:00 11/1997 11:00 11/1997 11:00 11/1997 11:00 11/1997 11:00 11/1997 11:00 11/1997 11:00 11/1997 11:00 11/1997 11:00 11/1997 11:00 11/1997 11:00 11:00 11:00 </td <td></td> <td>3.2</td> <td>4.4</td> <td>11.7</td> <td>7.37</td>		3.2	4.4	11.7	7.37
11 3 11/3096 13.35 11/3096 17.04 3 11/3096 12.00 12 3 1/17/97 12.03 11/3097 12.03 11/3097 17.00 13 3 1/17/97 12.03 1/27/97 22.65 3 1/17/97 17.00 16 4 1/27/97 10.15 6/3/97 22.65 3 4/22/97 16.45 16 4 1/17/97 10.15 6/3/97 12.20 3 4/22/97 16.45 17 4 1/17/97 10.15 6/3/97 11.00 11.00 11.00 11.00 11.00 11.00 11.00 11.00 11.00 11.10		0.7	1.2	16.0	7.50
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Begin End End End Sample Time	10/12/98	1/13/99			14:34 10/27/99	66/6/11 11/23/94	12/8/94	3/8/95		_	11/7/95	3/3/96	3/31/96	4/22/96	9/3/96		1/28/97	4/22/97	16/2/9	11/19/97	_	0.50 6/24/08	10/12/98	1/13/99	3/12/99	5/11/99	14:55 10/2//99	103/99	12/8/94	3/8/95	26/6/2			10:35 3/3/96		13:20 4/22/96	12:15 9/3/96	13:18 11/30/96	19:30 1/16/97
End No. of Time Samples		23:40 3	14:10 3	5:27	17:06 3	4:50	21:50 4	12:45 3	16:20 4	8:25 ' 3	5:05 4	13:25 3	22:40 3	17:05 3	15:25 3	72-70 3	0:30	22:30 3	12:55 3	14:05 3	1:38 3	32:21	12:20 3	23:58 3	14:00 3	15:42 3	33:50	4:05	21:00 4	12:15 3	14:55 4	7:50 3	4:35 4	12:40 3	21:50 3	16:05 3	14:55 3	16:48 3	21:35 3
Precipitation Precipitation Begin Date Begin Time	ı	1/13/99 19:00		_ ,	10/2//99 13:00	•		3/8/95 5:30	_		-	•			9/3/96 9:30			4/22/97 16:45			12/15/97 14:00			_		5/11/99 11:00	11/5/00 18:00	•	-		7/9/95 10:45	10/20/95 4:30	11/6/95 19:15	3/3/96 8:00	-	_	06:6 96/6/6	11/30/96 12:00	1/16/97 17:00
Precip. Dur. (hours)	00 57.0	00 21.0			26.0			_			, -				2.3			_	-		51				•,	0.0 4.0				_		30 2.3	15 13.0				30 2.3		00 22.5
Precip. Amt. (inches)	1.56	1.27	1.47	0.17	0.49	0.22	0.21	0.67	0.93	0.34	2.63	0.38	0.76	2.89	0.46	1.46	0.49	0.45	0.46	0.57	2.01	0.49	1.56	1.27	1.47	0.17	0.71	0.22	0.21	0.67	0.93	0.34	2.63	0.38	92.0	2.89	0.46	0.28	1.46
Mean Flow Peak (cfs)	10.0	13.3	7.3	9.3	0.0 8 7	7.0	3.7	3.5	25.2	11.6	22.2	æ. c	9.2	18.3	17.1	21.0	28.8	39.4	32.8	23.9	29.7	13.2	14.2	21.7	9.0	0.7	5.7	1.9	0.4	0.4	3.9	2.1	3.2	2.4	1.8	2.5	9.0	1.2	2.4
reak riow iemp. (cfs) (o C)	11.6 13.4	17.3 7.0			9.4 9.2					_		_			767 0.0				_		32.4 7.0					9.4 11.2				0.6 8.5	5.0 18.1	3.8 11.6					_		3.8 3.4
	7.45	6.95	7.04	7.01	C7.7	6.91	7.55		C 7.44	7.55	6.89	6.20	7.95	7.45	7 13	7.36	6.92	98.9	7.62	7.58	7.62	7.51	8.02	7.38	7.50	10.7	7.37	6.91	7.05	6.43 J	C 6.76	6.93	5.90	6.20	69.9	7.15	6.93	6.20	89.9

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Table B2. Story
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Year Sample Date Sample 3		Event	Monitoring	Begin	Begin	End	End	No. of	Precipitation	Precipitation	Precip. Dur.	Precip. Amt.	Mean Flow	Peak Flow	Temp.		
14 3 47279 1900 472797 2159 242297 1454 145 145 244 245 244 245 24	Station	Number		Sample Date	Sample		Sample Time	Samples	Begin Date	Begin Time	(hours)	(inches)	(cls)	(cts)	(O C)		₌l
1	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	9.9	25
1,	MA-1	15	3	6/3/97	10:00	16/2/97	12:05	3	6/3/97	4:45	15.3	0.46	1.8	2.1	15.9	36	31
1	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	3.9	20
18 4 6/22/498 12-41 6/42/498 11-10 3 6/42/498 500 14 0.65 0.84 17 10 20 5 1/11/299 25.5 6/10/298 11-10 3 10/12/98 500 14 0.64 0.8 15.1 10 0.6 15.0 11.0 0.6 0.6 0.6 0.6 15.0 0.6 0.6 0.6 0.6 0.6 15.0 0.6	MA-I	17	4	12/16/97	90:0	12/16/97	1:08	E.	12/15/97	14:00	51	2.01	2.2	3.2	6.4	9.9	=
19 4 674708 8.5 604408 5.0 14 6.0 </td <td>MA-1</td> <td><u>«</u></td> <td>4</td> <td>4/23/98</td> <td>12:41</td> <td>4/23/98</td> <td>13:31</td> <td>3</td> <td>4/23/98</td> <td>10:00</td> <td>14</td> <td>0.45</td> <td>0.8</td> <td>1.7</td> <td>12.0</td> <td>7.7</td> <td>ξi.</td>	MA-1	<u>«</u>	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	7.7	ξi.
20 5 1/10/299 9423 11/13/99 11/13/99 11/13/99 10/12/99 11/13/99 11/13/99 10/13/99 <td>MA-I</td> <td>19</td> <td>4</td> <td>6/24/98</td> <td>8:56</td> <td>6/24/98</td> <td>11:10</td> <td>3</td> <td>6/24/98</td> <td>2:00</td> <td>14</td> <td>0.49</td> <td>0.5</td> <td>0.8</td> <td>14.5</td> <td>9</td> <td>Z</td>	MA-I	19	4	6/24/98	8:56	6/24/98	11:10	3	6/24/98	2:00	14	0.49	0.5	0.8	14.5	9	Z
21 5 J11399 12440 11399 11399 11399 11399 11399 11399 11399 11399 11399 11399 11439	MA-1	20	5	10/12/98	9:25	10/12/98	11:40	9	10/12/98	9:00	57.0	1.56	0.4	9.0	13.7	7.	6
23 5 51/1299 116.30 3 171299 16.50 3 171299 16.50 3 171299 16.50 3 171299 16.50 3 171299 16.00 4.00 0.17 0.05 15.0 3 17.00 15.0 15.00 17.00 15.0 15.0 15.0 17.0 <td< td=""><td>MA-I</td><td>21</td><td>5</td><td>1/13/99</td><td>20:40</td><td>1/13/99</td><td>23:10</td><td>3</td><td>1/13/99</td><td>19:00</td><td>21.0</td><td>1.27</td><td>1.1</td><td>1.9</td><td>7.4</td><td>6.3</td><td>2</td></td<>	MA-I	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	6.3	2
23 5 51109 13.08 51109 15.41 3 571199 11.00 4.0 0.17 0.9 13 10 24 5 1027299 13.48 1027299 15.41 3 571199 11.00 4.0 0.17 0.9 13 10 9.5 25 1 11.00 2.0 11.00 4.0 0.1 12 2.9 9.5 2 1 1.00 1.0 1.0 0.0 1.0 0.0 1.0 0.0 1.0 0.0 1.0 0.0 1.0 0.0 1.0 0.0 <t< td=""><td>4A-1</td><td>22</td><td>ς.</td><td>3/12/99</td><td>10:50</td><td>3/12/99</td><td>14:30</td><td>3</td><td>3/12/99</td><td>9:00</td><td>20.0</td><td>1.47</td><td>9.0</td><td>6.0</td><td>8.0</td><td>9.9</td><td><u>ب</u></td></t<>	4A-1	22	ς.	3/12/99	10:50	3/12/99	14:30	3	3/12/99	9:00	20.0	1.47	9.0	6.0	8 .0	9.9	<u>ب</u>
24 5 1167299 11644 3 113799 13.00 0.49 1.1 2.0 9.5 1.1 2.0 9.5 1.1 9.5 1.1	AA-1	23	\$	5/11/99	13:08	5/11/99	15:01	9	5/11/99	11:00	4.0	0.17	6.0	1.5	10.9	6.7	∞
15 1 (1559) 733 1 (1559) 23:10 4 1 (1559) 64 0.7 0.7 1 24 1 1 24 1 24 1 24 3 1 24 3 4 3 4 3 4 3 4 3 4 3 4 4 4 4	/A-1	24	· v o	10/27/99	13:48	10/27/99	16:44		10/27/99	13:00	26.0	0.49	1.3	2.0	9.5	6.7	2
1 1173944 255 1173044 4:10 1173944 6:10 0.22 12.8 9:2 5:4 5:8 2 1 178944 1730 128944 12894 12894 6:4 5:0 0.22 12.8 5:4 5:8 4 1 107095 5:15 3:0 3:4 5:0 0.23 13 18 5 3:1 8:0 2 18 6 12.8 18 5:0 18 8:0 2 18 8:0 2 18 8:0 2 18 8:0 2 18 8:0 2 18 8:0 2 3:0 8:0 18 9:0 18 8:0 9:0 18 8:0 9:0 18 9:0 18 18 9:0 9:0 9:0 9:0 9:0 9:0 9:0 9:0 9:0 9:0 9:0 9:0 9:0 9:0 9:0 9:0 9:0 9:0 9:0 <td< td=""><td>/A-1</td><td>25</td><td>· v</td><td>11/5/99</td><td>20:35</td><td>11/5/99</td><td>23:10</td><td>4</td><td>11/5/99</td><td>18:00</td><td>12.0</td><td>0.71</td><td>0.7</td><td>1.2</td><td>6.6</td><td>8.9</td><td>=</td></td<>	/A-1	25	· v	11/5/99	20:35	11/5/99	23:10	4	11/5/99	18:00	12.0	0.71	0.7	1.2	6.6	8.9	=
2 1 12894 173894 15454 8.6 62 13 18 65 4 1 13894 1239 1239 12894 1645 8.0 0.2 13 18 65 4 1 18 1220 1995 1531 4 17995 28 0.9 20 21 18 6 5 1 102095 153 1400 3 1020 20 22 18 2 18 6 2 1110 3 18 6 3 18 6 3 18 6 3 18 6 3 6 18 6 3 18 6 3 18 6 3 18 6 3 18 6 3 18 6 3 18 6 3 18 6 3 18 6 3 18 6 3 18 6 3 18 <td>AA-2</td> <td>-</td> <td>-</td> <td>11/23/94</td> <td>2:55</td> <td>11/23/94</td> <td>4:10</td> <td>3</td> <td>11/23/94</td> <td>0:45</td> <td>5.0</td> <td>0.22</td> <td>12.8</td> <td>24.2</td> <td>5.8</td> <td>6.9</td> <td>7</td>	AA-2	-	-	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	6.9	7
3 1 38985 12.30 38895 12.30 14.5 0.67 27 3.1 8.0 4 1 79995 11.20 3.8995 12.30 3.8995 12.30 3.89 12.30 3.89 12.31 8.0 22.1 18.0 2.2 18.0 2.2 18.0 2.2 18.0 2.2 18.0 2.2 18.0 2.2 18.0 2.2 18.0 2.2 18.0 2.2 18.0 2.2 18.0 2.2 18.0 2.2 3.0	4A-2	2	-	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	7.2	7
4 1 70995 12.51 4 70995 10.45 2.1 2.2 1.00 2.2 2.10 2.2 3.10 3.10 3.10 3.10 3.10 3.10 3.10 3.10 3.10 3.10 3.10 3.10 3.10 3.10 3.10 3.10 3.10	4A-2	m	-	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
5 1 10,2005 5.15 11,2009 5.34 10,2009 5.34 10,2009 5.16 11.5 11,70 5.15 11,70 5.15 11,70 5.15 11,70 5.15 11,70 5.15 11,70 5.2 11,70 5.2 11,70 5.2 11,70 5.2 11,70 5.2 11,70 5.2 11,70 5.2 11,70 5.2 5.3 4.3 5.0 6.8 11.0 9.8 9 2 3,13,96 11,20 3,13,96 11,20 4.2 7.0 1.6 7.0 1.0 9.8 1.0 1.0 9.8 1.0 1.0 9.8 1.0 1.0 1.0 9.8 1.0	4A-2	4	-	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		6
6 2 117795 1:55 117795 5:30 4 116995 1:51 117795 5:30 4 116995 1:10 3:1396 1:10 3:1396 1:10 3:1396 1:10 3:1396 1:10 3:1396 1:10 3:1396 1:10 3:1396 1:10 3:1396 1:10 3:1396 1:10 3:1396 1:10 3:1396 1:10 3:1396 1:10 3:1396 1:10 3:1396 1:10 3:1396 1:10 3:10 1:10 3:10	4A-2	S	-	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	6.7	S.
7 2 31396 11:00 31396 31396 31396 31396 31396 </td <td>AA-2</td> <td>9</td> <td>2</td> <td>11/7/95</td> <td>1:55</td> <td>11/7/95</td> <td>5:30</td> <td>4</td> <td>11/6/95</td> <td>19:15</td> <td>13.0</td> <td>2.63</td> <td>18.7</td> <td>25.9</td> <td>0.8 8</td> <td>6.7</td> <td>=</td>	AA-2	9	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	0.8 8	6.7	=
8 2 34196 20.05 34196 12.50 34196 17:15 4 0.76 6.8 11.0 9.8 9 2 43196 12.0 34196 12.5 3 44296 11:3 4 0.76 6.8 11.0 9.8 10 2 97366 13.20 97366 15.5 3 9296 12.0 0.76 6.8 11.0 9.8 11 3 114306 13.20 10736 12.3 3 114309 12.0 11.0 9.9 0.4 4.3 15.3 9.8 13 3 112787 12.0 117.097 12.0 117.097 12.0 17.0 3 11.0 9.9 0.4 4.4 4.5 1.8 9.3 6.7 9.9 1.0 1.8 9.3 1.1 9.0 9.0 9.0 9.4 9.0 1.1 9.3 9.8 1.0 9.0 9.0 9.0 9.0 9.0 9.0 9.0 9.0<	1A-2	7	2	3/3/96	11:00	3/3/96	11:00	3	3/3/36	8:00	5.0	0.38	7.0	11.0	7.0	9.0	∞
9 2 472296 14:06 472296 16:45 3 472296 11:30 48 28 10.7 15:5 12.3 10 2 91396 13:5 11/697 7:1 3 11/3096 12.3 40.4 48 3.9 10.4 16:5 12.3 11/3096 13:5 11/3097 7:1 11/3097<	1A-2	•	2	3/31/96	20:05	3/31/96	22:50	3	3/31/96	17:15	4.0	0.76	9.9	11.0	8.	6.9	9
10 2 91796 13.20 97966 13.53 97966 13.53 97966 13.54 97966 4.3 7.0 16.5 C 11 3 11/6976 13.55 11/1697 17.10 3 11/1697 17.10 17.10 2.2 1.6 4.4 16.5 4.9 13 11/1697 12.0 17.79 22.20 3 11/1697 17.0 2.8 9.8 17.0 18.8 9 8 9.8 17.0 3.8 17.0 18.8 9 17.0 18.8 9 17.0 18.8 9 17.0 18.8 9 18.8 9 18.8 9 18.8 9 18.8 9 18.8 9 18.8 9 18.8 9 18.8 9 18.8 9 18.8 9 18.8 9 18.8 9 18.8 9 18.8 9 18.8 9 18.8 9 18.8 9 18.8	1A-2	6	2	4/22/96	14:06	4/22/96	16:45	m	4/22/96	11:30	4.8	2.89	10.7	15.5	12.3		寸 :
11 3 11/3096 13.55 11/3097 17.10 3 11/3096 12.50 9.0 0.22 1.46 14.3 3.3 9.8 12 3 11/3097 12.30 11/3097 12.30 3 11/3097 17.00 22.5 1.48 0.45 14.0 15.3 9.8 13 11/3797 21.20 11/3097 22.30 3 11/3097 16.4 14.8 0.45 10.8 19.5 12.8 14 3 4/2297 22.30 3 11/3997 16.6 0.49 12.0 11.0 17.3 3 11/3997 16.6 0.49 12.0 11.0 3 11.1 3 11.1 11.2 11.1 11.2 11.1 11.2 11.1 11.2 11.2 3 11.1 11.2 11.1 11.2 3 11.1 11.2 3 11.1 11.2 3 11.1 11.1 11.2 3 11.1 11.1 <td< td=""><td>4A-2</td><td>10</td><td>7</td><td>9/3/96</td><td>13:20</td><td>96/2/6</td><td>15:35</td><td>m</td><td>96/2/6</td><td>9:30</td><td>2.3</td><td>0.46</td><td>4.3</td><td>7.0</td><td>16.5</td><td></td><td><u>بر ب</u></td></td<>	4A-2	10	7	9/3/96	13:20	96/2/6	15:35	m	96/2/6	9:30	2.3	0.46	4.3	7.0	16.5		<u>بر ب</u>
12 3 11/697 19:50 11/697 22:30 3 11/697 17:00 22:5 146 144 10:5 49 13 3 472797 22:30 3 17/797 17:30 60 9 120 17:09 3 17:09 120 17:09 3 17:09 120 10 3 17:30 66 10 8 120 17:09 3 17:09 120 10 3 17:09 14 8 120 120 120 17:09 3 127:09 14 8 0.45 120 11:09 120 14 9 120 120 120 14 9 120 120 120 120 120 120 120 120 17:09 14 9 120 14 9 120 14 9 120 120 120 120 120 120 120 120 120 120 120 120	1A-2	=======================================	3	11/30/96	13:55	11/30/97	17:10		11/30/96	12:00	9.0	0.28	3.0	5.3	9.6	7.3	<u> </u>
13 3 1/27/97 21:20 1/27/97 <td>4A-2</td> <td>12</td> <td>3</td> <td>1/16/97</td> <td>19:50</td> <td>1/16/97</td> <td>22:30</td> <td>m,</td> <td>1/16/97</td> <td>17:00</td> <td>22.5</td> <td>1.46</td> <td>14.4</td> <td>16.5</td> <td>2. d</td> <td>æ. c</td> <td></td>	4A-2	12	3	1/16/97	19:50	1/16/97	22:30	m,	1/16/97	17:00	22.5	1.46	14.4	16.5	2. d	æ. c	
14 3 472297 20:10 472997 12:10 3 472297 16:45 16:46 </td <td>IA-2</td> <td>13</td> <td>æ</td> <td>1/27/97</td> <td>21:20</td> <td>16/12/1</td> <td>23:20</td> <td>3</td> <td>16/12/1</td> <td>17:30</td> <td>0.9</td> <td>0.49</td> <td>12.0</td> <td>17.0</td> <td>3.8</td> <td>7.7</td> <td><u> </u></td>	IA-2	13	æ	1/27/97	21:20	16/12/1	23:20	3	16/12/1	17:30	0.9	0.49	12.0	17.0	3.8	7.7	<u> </u>
15 3 6/3/97 10:30 6/3/97 12:30 3 6/3/97 4:45 15:3 0.46 82 9:3 15:1 16 4 11/19/97 11:30 11/19/97 12/15/97 3 11/19/97 14:40 21:6 9:4 0.5 9:4 0.5 14:40 21:6 9:4 11/19/97 14:40 21:6 9:4 0.5 14:40 21:6 9:4 14:40 21:6 9:4 14:40 21:6 9:4 14:40 21:6 9:4 14:40 21:6 9:4 14:40 21:6 14:1 6:4 8:2 15:1 8:3 15:0 14:0 3:4 15:0 14:0 3:4 14:0 15:0 3:4 6:74/98 15:0 14:0 15:0 14:0 14:0 14:0 14:0 14:0 14:0 14:0 14:0 14:0 14:0 14:0 14:0 15:0 14:0 14:0 14:0 14:0 14:0 14:0 14:0 <t< td=""><td>1A-2</td><td>14</td><td>E</td><td>4/22/97</td><td>20:10</td><td>4/22/97</td><td>22:10</td><td>3</td><td>4/22/97</td><td>16:45</td><td>14.8</td><td>0.45</td><td>10.8</td><td>19.5</td><td>12.8</td><td>7.0</td><td>4</td></t<>	1A-2	14	E	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	7.0	4
16 4 11/1997 113-50 11/1997 13-50 3 11/1997 11-6 3 11/1997 11-6 3 11/1997 11-6 3 11/1997 11-0 34 0.57 14-40 21-6 94 17 4 12/1597 23:50 12/1697 15:50 3 12/1597 14:00 34 0.57 14-16 88 12.5 19 4 6/2498 11:35 3 4/2398 100 14 0.49 5.05 66 15.0 20 5 10/1298 10:15 10/1298 12:40 3 10/1298 6:00 57.0 14 0.49 5.05 66 15.0 21 5 10/1298 10-1299 12:40 3 10/1298 6:00 57.0 14 0.49 5.05 6.14 8.2 13.6 22 5 11/399 13:20 3 11/1399 13:00 4 11/29 13.	1A-2	15	3	6/3/97	10:30	16/2/91	12:30	3	6/3/97	4:45	15.3	0.46	8.7	9.3	15.1	7.7	.
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 18 4 4/24/98 13:05 4/23/98 14:20 3 4/23/98 10:00 14 0.45 5.81 8.9 19 4 6/24/98 9:38 6/24/98 11:35 3 4/23/98 10:00 14 0.45 5.81 8.9 20 5 1/13/99 10:15 10/12/98 12:40 3 1/13/99 15:0 14 0.45 5.0 6.14 8.2 13.6 21 5 1/13/99 12:40 3 1/13/99 15:30 3 1/13/99 15:30 3 1/13/99 15:30 3 1/13/99 15:30 3 1/13/99 15:30 3 1/13/99 15:30 3 1/13/99 15:30 3 1/13/99 15:30 3 1/13/99 15:30 10:30 10:30	4A-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	7.2	2
18 4 4/23/98 13:05 4/23/98 14:20 3 4/23/98 10:00 14 0.45 5.81 89 12.5 19 4 6/24/98 9:38 6/24/98 11:35 3 6/24/98 5:00 14 0.45 5.81 89 12.5 20 5 10/12/98 10:15 10/12/98 12.40 3 10/12/98 6:00 5:00 14 0.49 5:05 6:0 13.6	(A-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	8 .9	7.3	יט
19 4 6/24/98 9:38 6/24/98 11:35 3 6/24/98 5:00 14 0.49 5:05 66 15:0 20 5 10/12/98 10:15 10/12/98 12:40 3 10/12/98 6:00 57.0 1.56 6:14 82 13:6 21 5 1/13/99 21:25 1/13/99 12:40 3 1/13/99 16:00 57.0 1.56 6:14 82 13:6 22 5 1/13/99 21:25 1/13/99 14:00 3 1/13/99 16:00 50.0 1.47 2.62 37 1.83 24 5 10/27/99 14:40 17:15 3 10/12/99 11:00 4.0 0.17 3.18 5.5 11.7 24 5 10/27/99 17:15 3 11/15/99 11:00 4 11/5/99 11:0 4 11/5/99 11:0 0.71 40 45 9.1 2	(A-2	90	4	4/23/98	13:05	4/23/98	14:20	3	4/23/98	10:00	4	0.45	5.81	8.9	12.5	6.7	_
20 5 10/12/98 10/12/98 12:40 3 10/12/98 6:00 57.0 1.56 6.14 8.2 13.6 21 5 1/13/99 21:25 1/13/99 23:40 3 1/13/99 19:00 21:0 1.27 8.3 22 5 3/12/99 11:20 3/12/99 14:00 3 3/12/99 6:00 50.0 147 2.62 3.7 9.1 23 5 11/299 13:45 5/11/99 15:30 3 3/12/99 6:00 50.0 147 2.62 3.7 9.1 24 5 10/27/99 13:45 5/11/99 17:15 3 11/5/99 11:0 4.0 0.17 3.18 5.5 11.7 25 5 11/5/99 17:15 3 11/5/99 18:00 12.0 0.71 4.0 0.71 4.0 4.2 9.8 25 1 11/28/94 11/5/99 18:00 11/5/99 <td>(A-2</td> <td>16</td> <td>4</td> <td>6/24/98</td> <td>9:38</td> <td>6/24/98</td> <td>11:35</td> <td>6</td> <td>6/24/98</td> <td>2:00</td> <td>14</td> <td>0.49</td> <td>5.05</td> <td>9.9</td> <td>15.0</td> <td>7.5</td> <td>ii) i</td>	(A-2	16	4	6/24/98	9:38	6/24/98	11:35	6	6/24/98	2:00	14	0.49	5.05	9.9	15.0	7.5	ii) i
21 5 1/13/99 21:25 1/13/99 23:40 3 1/13/99 19:00 21:0 1.27 8:3 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 23 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 24 5 5/11/99 13:45 5/11/99 17:15 3 3/12/99 6:00 6:00 6.0 1.47 2.62 3.7 9.1 24 5 10/27/99 14:40 10/27/99 17:15 3 10/27/99 13:00 4 11/5/99 13:00 6.0 6.0 6.0 6.0 9.8 5.2 11.7 9.8 5.0 12.0 9.8 9.8 9.1 11.7 9.8 9.8 9.2 6.0 9.8 9.8 9.8 9.8	(A-7	20	8	10/12/98	10:15	10/12/98	12:40	æ	10/12/98	9:00	57.0	1.56	6.14	8.2	13.6	7.4	7
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 23 5 5/11/99 15:30 3 5/11/99 11:00 4.0 0.17 3.18 5.5 11.7 24 5 10/27/99 14:40 10/27/99 17:15 3 10/27/99 11:00 4.0 0.17 3.18 5.5 11.7 24 5 11/5/99 17:15 3 10/27/99 13:00 26.0 0.49 5.2 6.2 9.8 25 11/5/99 12/240 4 11/5/99 18:00 12.0 0.71 4.0 4.5 9.8 2 1 12/8/94 17:45 12/8/94 21:00 4 12/8/94 16:45 8.0 0.21 3.1 6.0 2 1 12/8/94 12:50 3 3/8/95 5:30 14:5 0.67 5:5 5.7 <	4A-2	21	40	1/13/99	21:25	1/13/99	23:40	ش	1/13/99	19:00	21.0	1.27			∞	7.1	7
23 5 /11/99 13:45 5/11/99 15:30 3 /11/99 11:00 4.0 0.17 3.18 5.5 11.7 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 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 2 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 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 3 1 3/8/95 12:40 1/9/95 15:40 4 19/995 16:45 8:0 0.21 3:1 7:7 4 17:5 2 4:4 17:45 17:45 17:45 17:45 17:45 17:40 4<	C-47	22	. •	3/12/99	11:20	3/12/99	14:00	m	3/12/99	9:00	20.0	1.47	2.62	3.7	9.1	7.3	7
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 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 25 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 2 1 12/804 17:45 12/804 21:00 4 12/804 16:45 8.0 0.21 3.1 3.4 6.0 3 1 12/804 17:45 12:40 1/9/95 12:40 4 1/9/95 16:45 8.0 0.21 3.1 3.4 6.0 4 1 7/9/95 12:40 4 7/9/95 10:45 2.8 0.93 24.8 35.4 17.5 C 5 1 10/20/95 2:40 4<	7.V.	7 1	, v.	5/11/99	13:45	5/11/99	15:30	33	5/11/99	11:00	4.0	0.17	3.18	5.5	11.7	7.0	7
25 5 11/5/99 23:40 4 11/5/99 18:00 12.0 0.71 4.0 4.5 9.8 25 5 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 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 3 1 12/8/94 10:50 3/8/95 12:50 3 3/8/95 5:30 14:5 0.67 5:5 5:7 7.7 4 1 7/9/95 12:40 4 7/9/95 10:45 2.8 0.93 24:8 35:4 17:5 7.7 5 1 10/20/95 5:43 10/20/95 7:55 3 10/20/95 13:15 3 3/3/96 13:15 3 3/3/96 13:15 3 3/3/96 5:0 0.23 0.38 5:4 7.3	7 V Z	74	٠,	10/27/99	14:40	10/27/99	17:15	æ	10/27/99	13:00	26.0	0.49	5.2	6.2	8.6	7.1	4
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 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 2 1 12/8/94 17:45 12:60 4 12/8/94 16:45 8:0 0:21 3:1 3:4 6:0 4 1 7/9/95 12:40 7/9/95 12:40 4 7/9/95 10:45 2:8 0.93 24:8 35:4 17:5 C 5 1 10/20/95 5:40 4 11/6/95 19:15 13:0 2:63 19:7 24:3 7:0 6 2 11/7/95 5:40 4 11/6/95 8:00 5:0 0:38 5:4 7:3 7:0 7 2 3/3/96 11:10 3/3/96 13:15 3 3/3/96 8:00	4A.5	25	·	11/5/99	20:00	11/8/99	23:40	4	11/5/99	18:00	12.0	0.71	4.0	4.5	8.6	7.2	7
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 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 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 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 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 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	4A-3	-		11/23/94	2:05	11/23/94	4:20	3	11/23/94	0:45	5.0	0.22	7.2	9.5	0.9	7.2	6
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 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 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 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 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	C-V1			12/8/94	17:45	12/8/94	21:00	4	12/8/94	16:45	8.0	0.21	3.1	3.4	0.9	7.4	0
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 4 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 5 1 1/7/95 2:10 11/7/95 5:40 4 11/6/95 19:15 13.0 2.63 19.7 24.3 7.0 6 2 11:10 3/3/96 13:15 3 3/3/96 8:00 5:0 0.38 5:4 7.3 7.0	C-VI	1 11	4 5	3/8/95	10:50	3/8/95	12:50	3	3/8/95	5:30	14.5	19.0	5.5	5.7	1.7	6.3	4
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 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 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	2 4	· <		7/9/05	12:40	1/9/95	15:40	4	719195	10:45	2.8	0.93	24.8	35.4	17.5		4
6 2 117795 2:10 117795 5:40 4 117695 19:15 13:0 2.63 19.7 24.3 7.0 6 2 3/3796 11:10 3/3796 13:15 3 3/3796 8:00 5.0 0.38 5.4 7.3 7.0	- 	۷ ۱	-	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	7.0	9
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	C-Y	· •		50/2/11	2:10	11/7/95	5:40	4	11/6/95	19:15	13.0	2.63	19.7	24.3	7.0	7.0	∞
OCICIO 7	MA-3	0 1	٦ ٢	90/2/2	11:10	96/1/1	13:15	· (r)	3/3/96	8:00	5.0	0.38	5.4	7.3	7.0	6.1	3
	MA-3	•	4	טלונונ	>	5	; }	ı									

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	Event	Monitoring	Begin	Begin	End	End	No of	Precipitation	Precinitation Precin Dur	Precin Dur	Precin Amt	Mean Flow	Peak Clow	Tenin		- 1
Station	Number		Sample Date	Sample Time	Sample	Sample Time	Samples .	Begin Date	Begin Time	(hours)	(inches)	(cfs)	cfs)	(0 C)	Hd	
MA-3	∞	2	3/31/96	20:25	3/31/96	23:05	3	3/31/96	17:15	4.0	97.0	19.9	24.3	9.1	7.22	1
MA-3	6	2	4/22/96	14:20	4/22/96	17:00	£.	4/22/96	11:30	4.8	2.89	27.2	31.6	12.0	7.44	
MA-3	10	2	96/8/6	13:35	9/3/96	15:50	33	96/2/6	9:30	2.3	0.46	2.5	2.8	16.5	C 7.49	
MA-3	Ξ	3	11/30/96	14:05	11/30/96	17:50	m	11/30/96	12:00	9.0	0.28	3.2	4.4	9.2		
MA-3	12	3	1/16/97	20:05	1/16/97	22:45	æ	1/16/97	17:00	22.5	1.46	20.9	26.5	3.9	6.75	
MA-3	13	æ	1/27/97	21:30	1/27/97	23:45	33	1/27/97	17:30	0.9	0.49	16.1	23.4	3.6	7.20	
MA-3	14	ю	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	16/2/9	10:40	6/3/97	12:40	33	16/2/9	4:45	15.3	0.46	9.9	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	11	4	12/15/97	0:05	12/16/97	2:05	· 3	12/15/97	14:00	51	2.01	6.6	12.4	7.0	7.42	
MA-3	8 2	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	16	4	6/24/98	9:55	6/24/98	11:45	3	6/24/98	5:00	4	0.49	3.0	4.0	14.3	7.50	
MA-3	70	5	10/12/98	10:30	10/12/98	12:50	3	10/12/98	00:9	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	9:00	50.0	1.47	3.9	4.9	9.1	7.26	
MA-3	23	5	5/11/99	13:45	8/11/99	15:45	33	5/11/99	11:00	4.0	0.17	4.5	5.3	11.0	6.84	
MA-3	24	3 0	10/27/99	14:55	10/27/99	17:30	e	10/27/99	13:00	26.0	0.49	7.1	8.7	8.6	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	-		11/23/94	1:20	11/23/94	3:30	6	11/23/94	0:45	5.0	0.22	1.7	2.0	5.2	6.80	
MC-1	7	-	12/8/94	16:55	12/8/94	20:05	4	12/8/94	16:45	8.0	0.21	9.0	9.0	5.0	6.19	_
MC-1	m	-	3/8/95	10:05	3/8/95	12:00	6	3/8/62	5:30	14.5	0.67	0.4	0.5	8 .9	7.26	
MC-1	4	-	7/9/95	12:35	26/6/1	15:25	4	7/9/95	10:45	2.8	0.93	3.5	4.3	16.0	6.84	
MC-1	. 5	-	10/20/95	5:30	10/20/95	8:15	33	10/20/95	4:30	2.3	0.34	0.5	9.0	10.9	6.67	
MC-I	9	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	3/3/6	8:00	5.0	0.38	0.7	8.0	5.2	6119	_
MC-1	∞	2	3/31/96	19:25	3/31/96	21:55	m	3/31/96	17:15	4.0	0.76	0.7	0.7	8.2	7.36 J	
MC-1	6	2	4/22/96	13:30	4/22/96	16:10		4/22/96	11:30	4.8	2.89	0.7	0.7	11.1	6.77	
MC-1	10	2	96/8/6	12:35	9/3/96	15:35	æ	96/8/6	9:30	2.3	0.46	0.2	0.2	15.0	7.07	
MC-1	=	m	11/30/96	13:30	11/30/96	16:50	m	11/30/96	12:00	0.6	0.28	0.5	9.0	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	89.9	
MC-1	13	က	1/27/97	20:40	1/27/97	22:45	3	107701	17:30	0.9	0.49	10.6	9.01	8 .	6.81	
MC-1	14	3	4/22/97	19:45	4/22/97	21:45	c.	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	m	16/2/91	4:45	15.3	0.46	0.4	0.5	14.1	6.75	
MC-1	91	4	11/19/97	10:55	11/19/97	13:30	æ	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	٣	12/15/97	14:00	51	2.01	0.7	0.7	6.1	96'9	
MC-1	<u>∞</u>	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	е	6/24/98	2:00	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	33	10/12/98	9:00	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	· E	1/13/99	19:00	21.0	1.27	9.0	0.7	11.0	6.62	
MC-1	22		3/12/99	10:50	3/12/99	13:35	3	3/12/99	9:00	50.0	1.47	0.4	0.4	7.5	6.46	0
MC-1	23	5	66/11/5	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	S	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	\$	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	-	=	11/23/94	1:30	11/23/94	3:50	£,	11/23/94	0:45	5.0	0.22	60 60	4.5	5.9	727	
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Table B2. Storm flow data for the Des Moines Water Quality Monitoring Program.

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	hd	7.23	7.13	C 7.51 M	7.32	7.16	97.9	6.85	7.26	C 7.87	7.06	6.97	7.48	7.11	C 7.25	7.41	7.51	7.07	C 7.79	7.64	7.38	7.32 M	6.93	7.08	7.17
Temp.	(o C)	0.9	7.5	19.0	17.1	8.0	6.2	6.7	12.1	18.5	8.5	3.9	3.0	13.8	16.2	0.6	6.3	13.2	17.8	14.1	90	9.2 M	10.1	10.0	9.7
Peak Flow	(cfs)	2.2	2.5	6.3	6.1	7.8	4.4	4.7	5.6	0.7	3.2	8.0	9.1	5.2	3.1	5.2	9.6	2.8	1.9	1.2	4.1		0.0	3.1	3.4
Mean Flow	(cfs)	2.0	2.4	5.3	4.9	9.9	3.7	3.9	4.6	9.0	2.5	6.5	8 .4	4.5	3.0	3.9	5.0	2.1	1.7	1.2	3.8		0.2	2.6	2.2
Precip. Amt. N	(inches)	0.21	19:0	0.93	0.34	2.63	0.38	97.0	2.89	0.46	0.28	1.46	0.49	0.45	0.46	0.57	2.01	0.45	0.49	1.56	1.27	1.47	0.17	0.49	0.71
Precip. Dur.	(hours)	8.0	14.5	2.8	2.3	13.0	5.0	4.0	4.8	2.3	0.6	22.5	6.0	14.8	15.3	34	51	14	14	57.0	21.0	50.0	4.0	26.0	12.0
Precipitation P	Begin Time	16:45	5:30	10:45	4:30	19:15	8:00	17:15	11:30	9:30	12:00	17:00	17:30	16:45	4:45	1:00	14:00	10:00	5:00	9:00	19:00	00:9	11:00	13:00	18:00
Precipitation	Begin Date	12/8/94	3/8/95	7/9/95	10/20/95	11/6/95	3/3/96	3/31/96	4/22/96	96/2/6	11/30/96	1/16/97	1/27/97	4/22/97	16/3/97	11/19/97	12/15/97	4/23/98	6/24/98	10/12/98	1/13/99	3/12/99	8/11/99	10/27/99	11/5/99
No. of	Samples	4	3	4	3	4	33	33	33	3	3	3	3	e	9	3	۳,	C	3	٣	٣	3	3	æ	4
End	Sample Time	20:25	12:20	15:45	8:25	5:20	12:55	22:30	16:30	15:20	17:10	22:20	23:05	21:55	12:15	13:40	1:40	14:10	11:25	12:00	23:25	13:50	15:20	17:05	23:35
End		12/8/94	3/8/95	7/9/95	10/20/95	11/7/95	3/3/96	3/31/96	4/22/96	96/8/6	11/30/96	1/16/97	1/27/97	4/22/97	16/3/97	11/19/97	12/16/97	473798	6/24/98	10/12/98	1/13/99	3/12/99	8/11/9	10/27/99	11/5/99
Begin	Sample Time	17:15	10:20	12:50	6:15	1:40	10:45	19:50	13:50	12:50	13:45	19:35	21:05	19:55	10:10	11:15	23:40	12:25	9.25	0 6	21 05	11:05	13:20	14:25	19:45
Begin		12/8/94	3/8/95	7/9/95	10/20/95	11/7/95	3/3/96	3/31/96	4/22/96	9/3/6	11/30/96	1/16/97	1/27/97	4/22/97	6/3/97	11/19/97	12/15/97	4/23/98	6/24/98	10/12/98	1/13/99	3/12/99	8/11/99	10/27/99	11/5/99
Monitoring		-	_	_	_	2	7	7	7	7	60			- (**)	m	4	4	4	4	\$	√	5	\$	5	5
Event Mc		2	ım	4	٠,	9	1	- 00	6	01	=	: 2	: =	<u> 7</u>	<u>.</u>	9 9	21		61	20	21	22	23	24	25
	Station	MC-2	MC-2	MC-2	MC-2	MC-2	MC-2	MC-2	MC-2	MC-2	MC-2	MC.2	MC-2	MC-2	7 C-2 MC-2	MC-2	7-5-W	MC-2	MC-2	MC-2	MC-2	MC-2	MC-2	MC-2	MC-2

Station Nun	Number ((mg/L)		(nmhos/cm)	(NTU)	(mg/L)	(mg/L)	(CFU/100 mL)		(mg/L)	(mg/L)	(mg/L)	(mg/L as CaCO3)
BA-1	-	11.4		154	18	15	0.25 U	280	၁	0.071	0.043	0.803	62.3
BA-1	7	11.6		215	3.7	8 .1	0.25 U	6 J		0.033	0.016	1.640	113
BA-1	٣	11.0		136	=	9.2	0.25 U	089	ပ	0.101	0.035	1.050	48.2
BA-1	4	9.1	၁	79.5	45	492	0.25 U	13,400	ပ	1.270	0.054	1.120	37.7
BA-1	'n	12.2		107 M	MI 91	78 M	0.25 UM	4,800 M	ပ	0.317 M	0.011 M	0.502 M	37.4 M
BA-1	9	11.2		64.0	31	100	0.25 U	8,000	ပ	0.351	0.056	0.407	27.9
BA-1	7	11.4		140	32	121	0.25 U	096	ပ	0.233	0.056	0.882	64.8
BA-1	•	10.8		126	17	45	0.37	2,400 J	C	0.173	0.012	1.870	47.6
BA-1	0	10.7		011	21	107	0.25 U	4.200	ပ	0.272	0.043	0.437	75.8
BA-1	. 2	0.4	ت	107	22	360	0.27	14,600	ပ	1.010	0.143	1.160	44
1-70	2 =	201)	\$67	! 5	210	0.25 11	42		0.213	0.019	1.51	707
, -	: :	10.0			. 3	262	0.25 111	1 070	C	0 335	0.074	0 705	53.8
DA-1	7 [13.3		086	; ;	53	0.25 11	1 081	٠ ر	0.155	0.047	9890	35.8
BA-I	2 :	5.5	(70.0	77		0.62.0	1001	י נ		0.00	0000	9.5.0
BA-I	7	∞ 0	ပ	911	5 5	147	0.39	7,200 5	، ر	0.241	0.065	0.503	45.2
BA-1	15	9.5		137	œ. 	21	0.25 U	3,400 J	ပ	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	ပ	0.212 M	0.060 M	0.558 M	60.05 M
BA-1	11	12.1		88	11	84	0.25 U	160	ပ	0.336	0.010 U	0.562	42
BA-1	18	10.7		115	38	109	0.25 U	17,000 J	ပ	0.438	0.143	1.140	47.1
BA-1	19	1.6		94.2	34	112	0.31	0006	ပ	0.581	0.057	0.522	33.9
BA-1	20	9.4	ပ	216 M	19.5 M	50.5 M	0.25 UM	790 M	ပ	0.197 M	0.048 M	0.808 M	75.7 M
BA-1	21	11.4		124	46	94	0.31	4,000	ပ	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		961	32	71	0.25 U	092	ပ	0.189	0.014	0.918	74.4
BA-I	24	9.01		262	95 M	231 M	0.25 UM	320 JM	ပ	0.673 M	0.016 M	0.745 M	72.7 M
BA-1	25	8.01		265	16 M	31 M	0.25 UM	220 JM	ပ	0.154 M	0.039 M	0.592 M	73.2 M
DM-1	-	11.2		0.86	20	22	0.25 U	160	ပ	0.077	0.068	0.499	41.6
DM-1	7	11.4		155	28	23	0.25 U	64	ပ	0.025	0.592	0.786	75.2
DM-1	Э	10.6		131	12	7.4	0.25 U	1,080	ပ	0.051	0.088	0.600	44.2
DM-1	4	9.6	ပ	54.6	24	132	0.25 U	6,400	ပ	0.521	0.070	0.725	25.5
DM-I	5	8.1		87.3	111 J	38	0.25 U	009'6	ပ	0.156	0.043	0.424	29.3
DM-1	9	11.1		40.5	20	55	0.25 U	10,000	ပ	0.181	0.058	0.274	25.0
DM-1	7	11.6		125	24	09	0.64	260 J	ပ	0.208	0.131	0.727	50.3
DM-1	90	9.7		60.7	<u>8</u>	21	0.70	280 J	ပ	0.134	0.065	0.480	35.2
DM-1	6	10.4		68.7	14	20	0.27	410	ပ	0.153	0.048	0.384	39.7
DM-I	10	0.6	ပ	99	27	93	0.39	30,600	ပ	0.491	0.236	0.797	28.6
DM-1	=	9.01		166	25	48	0.25 U	280 J	ပ	0.118	0.085	0.356	44.6
DM-1	12	911		101.3	30	54	1.97 J	400	ပ	0.156	0.125	0.314	38.8
DM-1	13	12.5		84.1	12	61	0.31	360 J	ပ	0.063	0.079	0.249	31
DM-1	7	8.6		. 78	17	32.8	0.37	640	ပ	0.100	0.068	0.334	31.6
DM-1	15	9.4	ပ	91	7.4	17	0.25 U	2,800	ပ	0.112 J	0.055	0.594	62
DM-1	91	11.1		64.9	37	27	0.28	12,600 J	ပ	0.116	0.078	0.325	30.4
DM-1	17	11.7		19	29	43	0.67	240 J	ပ	0.111	0.031	0.303	32.1
DM-1	81	10.0		166	29	138	0.31	18,000 J	ပ	0.433	0.324	1.810	09
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Table B2. Sto	
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Station Number (m DM-1 20 DM-1 21 DM-1 22 DM-1 23 DM-1 24 DM-1 25 DM-2 1 DM-2 2 DM-2 3 DM-2 2 DM-2 2 DM-2 2 DM-2 2 DM-2 2 DM-2 2 DM-2 2 DM-2 3 DM-2 2 DM-2 2 DM-2 2 DM-2 2 DM-2 2 DM-2 2 DM-2 2 DM-2 3 DM-2 2 DM-2 2 DM-2 2 DM-2 3 DM-2 3 DM-2 3 DM-2 6 DM-2	(mg/L) 9.4 ((umhos/	(NTU)	(mg/L)	(Dam)	() () () () () ()		(// // //	(//		
20 22 23 23 24 25 1 1 2 2 3					(1116/27)	(CFU/100 mL)		(mg/L)	(mg/L)	(mg/L)	(mg/L as CaCU3)
22 22 23 25 24 25 25 2 2 2 2 2 2 2 2 2 2 2 2 2 2		ე ჯ	13	22	0.31	2,200 J	၁	0.110	0.127	0.432	45.6
222222222222222222222222222222222222222		6	38	54	8.	1,380	၁	0.168	0.129	0.431	36
22 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	×	141	9.4	5.2	0.31	20 J		0.047	0.029	.0.579	58.8
745 745 745 75 75 75 75 75 75 75 75 75 75 75 75 75		191	12	51	0.33	720	ပ	0.182	0.065	0.647	67.3
		-	36	52	0.25 U	89	ပ	0.214	0.023	0.670	58.4
<u> </u> - 4 4 4 4 6 6	101	174	8.	20	0.25 U	22 J		0.100	0.178	0.403	54.3
- ИМ 4 И Ф 1		840	<u>~</u>	20	0.25 U	5,400	ပ	0.074	0.456	0.607	59.5
1 4 4 60 6 7		081	63	7.2	0.25 U	104	ပ	0.027	0.074	0.927	86.2
N 4 N D F		101	50	0	0.25 11	640	၁	0.052	0.053	0.758	41.6
, ;; ;; ; , ; ; ; ; ; ; ; ; ; ; ; ; ; ;		(3)	35	C 242	0.25 11	18.800	Ü	7777	0.040	1.100	38.3
, ; ; v 0 r			111	747	0.25.11	12,800	ر	0.186	0.010 1	0.544	36.9
2. 6	11.5	9 ;	L C I		0.25.0	4 300	י כ	0.100	0.050	0.041	180
,	11.2	1.00	87	76	0.23 0	007'4	י כ	0.240	0.00	14t-0	7.07
	12.5	141	24	93	0.27	079	ا ر	0.208	0.004	0.930	39.0
DM-2 8	10.2	80.8	19	17	0.52	096	ပ	0.134	0.031	0.751	43.0
DM-2 9	10.1	80.7	13 M	132 M	0.28	W 029	ပ	0.278 M	0.048 M	0.568 M	53.2 M
01 Z WU		901	31	177	0.25 U	6,000	ပ	0.693	0.106	0.995	41.5
			22	20	0.25 U	220 J	ပ	0.117	0.069	0.595	52.5
: : :		051	, C	. ×	0.85.1	2 000 1	Ü	0.199	0.154	0.561	8.19
JM-2 12	0.21	60.0	97	8 5		780 1	, د	080	290 0	0 393	==
	13.3	6.76	9 5	64	1.00	. 004) נ	0.007	700.0	0.514	101
DM-2 14			77	44	0.22.0	000	، ر	0.132	0.04	913.1	1.64
DM-2 15		C 132	6.4	13	0.25 U	2,400 J	ر ر	0.095	0.021	0.731	00.7
DM-2 16	11.4	97.6	39	39	0.38	440	ပ	0.125	0.054	0.434	43.1
11	12.2	109	49	C 61	0.25 U	1,520	ပ	0.133	0.023	0.401	37.8
8	10.8	174	31	153	0.25 U	3,600 J	ပ	0.403	0.126	1.050	72
61	10.1	1.69	56	92 O	0.56	8,600	ပ	0.235	0.024	0.393	26.8
20	10.4	175	8.5	56	0.25 U	2,220 J	ပ	0.117	0.034	0.499	75
5	11.4	134	30	62	0.61	780	ပ	0.171	0.100	609.0	49
	11.2	166	5.5	5.8	0.25 U	40		0.039	0.010 U	0.781	64.2
	7 7	185	61	C 85	0.25 U	. 240	ပ	0.226	0.011	0.728	71.17
	70.	144.8	==		0.25 U	300 J	ပ	0.210	0.018	0.682	72.5
	10.4	177	, ,	2.5	0.25 U	190	ပ	0.088	0.036	0.541	69.2
C7 7-WO	4.01	7/1	. ב	i 7	0.37	0000	۲	0.037	0.045	0.252	33.0
MA-1	5.1.3	45.0	7 -		11 50 0	065	ט פ	0.043	0.045	0.910	105
7	10.7	* /-	= •	9 6	11 50 0	300 1	ر ر	5000	0.061	1 340	65.4
m		•	× •	7.7	0.22.0	007 01	ر	0000	0.00	1 030	216
MA-1 4		C 44.2	17	57	0.22 0	19,000	, ر	0.020	0.00	1.030	27.5
MA-1 S	12.1	64.0	24 J	22	0.25 U	8,000	، د	0.119	0.046	0.392	C.12
MA-1 6	11.4	29.3	8.9	11.3	0.25 U	3,600	ပ	0.049	0.039	0.531	19.7
MA-1 7	10.7	141	14	23	0.63	116	ပ	0.085	0.153	0.582	43.2
MA.1	10.7	79.1	1.7	16	0.36	220 J	ပ	0.074	0.107	0.750	43.4
MA-1 0		56.5	11	19.5	0.53	800 J	ပ	0.078	950'0	0.281	24.7
. 5		182	13	14	0.27	21,000	ပ	0.118	0.103	1.300	49.5
- •			<u>:</u>	: 1	0.25 11	1008	ی	0.057	0.012	0.617	51.6
	10.5	744	<u>.</u>	2 2	1 14 5	400	، ر	0.113	0 166	PPE 0	41.1
MA-1 12	12.2	72.5	61	96	2.34 J	00+) נ	0.113	0.100	*C* 0	30.7
MA-1 13	12.3	82.4	6.5	7.8	6.3	186	ر	0.034	0.113	0.424	7.00

	Event	2		Conductivity	Turbidity		TSS	TPH	Fecal Coliform		II.	Ammonia	Nitrate+Nitrite	Hardness
Station N		(mg/L)		(nmhos/cm)	(NTU)		(mg/L)	(mg/L)	(CFU/100 mL)		(mg/L)	(mg/L)	(mg/L)	(mg/L as CaCO3)
MA-1	4	9.4	ပ	132	12		18	1.2	4,200	ပ	890.0	0.086	0.337	19
MA-1	15	9.2	ပ	85	8.1		13	9.0	2,600 J	ပ	0.074 J	0.111	0.469	45.1
MA-1	91	12.9		51.8	35		31	0.47	1,240 J	ပ	0.124	0.068	0.245	22
MA-1	11	11.7		9/	61		4	2	460	ບ	0.065	0.028	0.328	33.8
MA	× ×	80		218	34		45	1.75	3,800 J	ပ	0.181	0.334	1.160	40.5
1-770	2 2	0.0	ر	1117	1.9		6.4	0.36	8,200	ပ	0.088	0.028	169'0	42
- VIV	2 2	. 0	י כ	13	7.5		9.5	0.3	19,600 J	ပ	0.108	0.061	0.384	51.3
	3 5	. a cl)	1 50	91		17	0.94	520	ပ	0.055	0.108	0.514	31.7
MA-I	17 (10.6		181	7.1		4.7	0.25 U	12 J		0.031	0.044	0.908	60.1
MA-I	7 6	0.0		101	7		: 5	0.75	1.200	ပ	0.181	0.177	0.599	52
MA-I	3 3	y .		143	ξ 🤄		7 2	0 66	9.200	Ú	0.540	0.016	0.717	27
MA-1	74	10.8		1.38	? :		911	80.5	5 800	ر	0.113	8200	0.387	28.9
MA-1	52	6.6		138	14.0	{	2 :	+ 6	000.) (2300	0.030	7170	31.4
MA-2	-	9.11		58.0	29	ن	77	0.39	1,008,1	، ر	0.030	0.039	7.70	708
MA-2	7	11.7		214	91		0	0.25 U	Ş e	ی	0.021	0.029	071.1	0.00
MA-2	657	10.7		136	9.2		4.7	0.25 U	240 3	ပ	0.055	0.043	0.845	47.4
MA-2	4	0.6	U	40.7	36	ပ	197	0.25 U	10,600	ပ	0.533	0.135	0.766	29.3
MA		12.2)	72.1	16 J		131	0.25 U	37,200 J	ပ	0.322	0.010 U	0.424	23.4
7.VW	۰ ۷	11.7		27.0	31	၁	147	0.48	7,200	ပ	0.246	0.055	0.412	23.0
2-VIV	,	201		77.9	28 M	ပ	104 M	0.66 M	510 M	ပ	0.198 M	0.075 M	0.498 M	46.0 M
7-V	- 0	10.6		610	. 51	U	41	0.27	1,000	ပ	0.100	0.059	0.657	32.5
7-WW		2 -		45.3	22	C	82	0.30	2,200 J	ပ	0.162	0.028	0.281	30.9
7-VM	` 5	-	۲	122	21	ပ	44	0.25 U	9,400	ပ	0.156	0.158	1.100	33.3
7-VIV	2 =	10,6)	176	80		22	0.27	1,800 J	ပ	0.071	0.024	0.861	44
MA-2	: :	11.6		71.4	26	ပ	99	0.88 J	200	ပ	0.141	0.105	0.430	32.3
MA-2	1 =	12.7		67.5	11	ပ	27	0.31	700 J	ပ	0.071	0.089	0.417	27.3
3-VIM	1 7	0	٢	89	80	ပ	52	0.51	2,400 J	ပ	0.116	0.031	0.358	48.9
MA-2	<u>.</u>)	2,8	91	Ç	20	0.40	4,800	ပ	0.110 J	0.027	0.697	4
MA-2	2 2	12.2		\$7.5	92	Ú	8 27	0.25 U	1,100	Ç	0.205	0.068	0.260	1.61
7 5	2 5	2		5	36	Ü	46	0.38	1,160	U	0.106	0.012	0.342	32.3
MA-2	<u>:</u> :	10.5	-	36	£	•	. 29	0.86	4,000	ပ	0.207	0.168	0.939	46.3
MA-2	9 5	500		914	2		61	0.35	5,200	ပ	0.093	0.016	0.474	25.9
MA-2	<u>.</u>	0.0		89	Ξ		38	0.5	1,820 J	ပ	0.079	0.077	0.426	52.9
7-Y	3 7	12.0		846	20		32	99.0	100	ပ	0.079	0.074	0.463	28.1
MA-2	ן נ	11.3		145	6.6		8.7	0.25 U	800 J	ပ	0.035	0.028	0.982	57.8
7-VW	3 6	7 - 1		107	70		57	0.53	1,000	ပ	0.145	0.023	0.870	46.8
14-7 14-7	3 7			63.4	23	၁	119	0.43	2,600 J	ပ	0.376	0.028	0.862	35.2
MA-2	7 7	100		64	70	ပ	78	0.25 U	1,180	ပ	0.104	0.091	0.588	38.1
MA-2	7 -	11.6		82.0	27	ပ	4 8	0.25 U	009	ပ	0.101	0.036	0.494	53.1
MA-5		11.0		225	0.9		5.7	0.25 U	360	ပ	0.019	0.112	1.190	95.4
MA-5	4 ~	10.7		125	9.5		7.8	0.25 U	2,000 J	ပ	0.037	0.020	0.886	50.2
MA-5	· -		ر	57.2	42	ပ	350	0.25 U	14,800	ပ	0.941	0.105	1.020	36.9
-VI	t v	1 6)	84.3	20 J		140	0.25 U	4,200	ပ	0.506	0.010 U	0.446	28.7
MA-3	. 4	911		17.3	31	ت	156	0.25 U	9000'9	ပ	0.328	0.043	0.384	25.4
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Table B2. Storm flow data for the Des Moines W	
low data fo	
82. Storm f	
Table	

Station MA-3				()	E		(Dame)	(1/2/2)	(CE11/100 ml)		([/ow/	(I/ow)	(I/om)	(FO) 25 (20)
1A-3	iaminoci	(mg/L)		(umnos/cm)	(N10)		(mg/L)	(mg/L)	(CI 0/100 IIIE)		(116/11)	(~,SII)	(7,6)	(coord on a Am)
	0 0	10.2		99.5	15	ပ	40	0:30	1,000	ပ	0.112	0.035	0.754	36.2
MA-3	6	œ œ	ပ	6.79	24	၁	106	0.25	4,000	ပ	0.187	0.030	0.330	40.6
MA-3	10	8.5	ပ	133	25		65	0.25 U	12,000	ပ	0.182	0.129	1.030	40
MA-3	=	10.4		188	22		42	0.25 U	086	ပ	0.092	0.010 U	1.35	66.3
MA-3	12	12.1		82	34	ပ	Ξ	0.57 J	092	ပ	0.214	0.076	0.514	37.4
MA-3	13	13.0		79.9	19		41	0.25 U	440 J	ပ	0.118	0.063	0.495	27.3
MA-3	14	9.5	ပ	80	24	ပ	74	0.37	1,160	ပ	0.164		0.402	71.9
MA-3	15	9.4	ပ	121	91	ပ	48	0.25 U	4,800	ပ	0.122 J		0.744	47.5
MA-3	16	12.1		87.1	89		84	0.25 U	920	ပ	0.168	0.015	0.431	34.7
MA-3	17	~		17	49	ပ	26	0.36	098	ပ	0.132	0.010 U	0.414	27.7
MA-3	: <u>«</u>	10.4		109	40	ပ	66	1.23	21,200 J	ပ	0.382	0.144	1.130	62.3
NA S	2 2	0	٢	001	19	ပ	45	0.4	000'9	ပ	0.206	0.015	0.496	46.1
C-VIV	; c	0.4) C	63	10		20	0.25 U	1,600 J	Ç	0.102	0.037	0.604	51.5
7 VIV	21	- 11)	i 61	26	ပ	41	0.57	740	ပ	0.115	0.063	609.0	36.4
7 V 7	; ;	? =		139	15	U	90	0.56	380 J	ပ	0.045	0.013	0.948	58
NA 3	77	=======================================		175 M		<u>ں</u>	104 M	0.28 M	870 M	ပ _	0.318 M	M 0.015 M	0.918 M	W 8.69
MA.3	3 %	10.1		78.1			125	0.25 U	5,400	ပ	0.427	0.018	0.756	55.1
NA 2	25.	10.5		114	22		51	0.25 U	1,180	ပ	0.150	0.043	0.512	55.3
MC	} -	00	ر	146	17		14	0.25 U	099	ပ	0.080	0.041	0.061	94.9
ָ עַרָּי		. 00	ن د	148	2.1		1.4	0.25 U	40		0.033	0.010	0.380	74.6
MC		6.5	υ U	111	6.1		5.2	0.25 U	120 J	ပ	090.0	0.036	0.268	46.8
MC-1	4	5.5	ပ	114	<u>ec</u>		99	0.25 U	16,800	ပ	0.491	0.037	0.695	38.7
MC-1	v	7.0	ပ	128	8.5 J		37	0.25 U	1,000	ပ	0.204	0.014	0.279	45.0
MC-1	9	9.5	ပ	75.0	15		62	0.25 U	7,000	ပ	0.234	0.051	0.320	44.0
MC-1	7	9.6		127	5.5		19.5	0.25 U	780	ပ	0.111	0.037	0.344	56.6
MC-1	•	7.8	ပ	90.3	6.5		28	0.25 U	2,000 J	ပ	0.147	0.012	0.437	41.4
MC-1	6	9.1	ပ	119	7.8		33	0.25 U	7,200	ပ	0.166	0.049	0.228	48.2
MC-1	2	5.6	ပ	961	=		25	0.25 U	23,800	ပ	0.593	0.077	0.653	55.8
MC-1	=	6.4	ပ	140	3.5		3.2	0.25 U	98	ပ	0.076	0.010 U	0.560	51.4
MC-1	12	8.7	ບ	116	4.2		12	0.25 JU	300 J	ပ	0.134	0.110	0.341	53.8
ZC-I	13	8.6		101.9	4.1		8.3	0.25 U	1,580 J	ပ	0.064	0.052	0.334	37
W.	14	6.4	ပ	148	5.9		22	0.4	2 U		0.120	0.013	0.197	59
MC-1	15	8.9	ပ	138	3.6		91	0.25 U	420	ပ	0.188	J 0.048	0.232	71.8
M C	91	8.2	ပ	138	11		12	0.25 U	300 J	ပ	0.159	0.027	0.198	51.9
ر د د	17	9	ပ	106	19		31	0.25 U	2,000 J	ပ	0.166	0.010 U	0.253	45
	. <u>e</u>	7.4	Ú	138	. 13		42	0.25 U	3,200 J	Ç	0.253	0.044	0.400	09
Z Z	2 6	7.7	ပ	140.1	9		34	0.25 U	10,200	ပ	0.296	0.056	0.270	57.6
Z Z	20	7.2	Ç	208	3.5		3.2	0.25 U	3,200 J	ပ	0.182	0.019	0.178	86.7
Z.	21	11.1		126	9.5		13	0.34	920	C	0.079	0.044	0.461	52
MC-I	22	8.9	ပ	126	2.2		1.6	0.25 U	26 J		0.043	0.010 U	0.295	51.3
NC-1	23	7.8	ပ	153	3.5		9.4	0.25 U	420	ပ	0.087	0.011	0.184	8.09
	24	7	ن	140.2	22		23	0.25 U	800	ပ	0.341	0.019	0.131	63.3
ı U	2,5	7.5	Ü	164	3.1		9	0.25 U	162	ပ	0.143	0.018	0.027	70
	; -)	040	33	ن	30	0.26	2.200 J	Ö	0.091	0.057	0.535	47.6

	Event	DQ	Conductivity	Turbidity		TSS	TPH	Fecal Coliform		d.L	Ammonia	Nitratc+Nitrite	Hardness
Station	Number (mg/L)	(mg/L)	(nmhos/cm)	(NTU)		(mg/L)	(mg/L)	(CFU/100 mL)		(mg/L)	(mg/L)	(mg/L)	(mg/L as CaCO3)
MC-2	2	11.8	129		C	14	0.25 U	750 J	ပ	0.064	0.042	0.908	61.4
MC-2	E 0	10.5	129		ပ	<u>e</u>	0.25 U	480	ပ	860.0	0.036	0.526	51.6
MC-2	4	9.1 M C	91.2	25.5 M) 	26 M	0.25 U	11,400 M	ပ	0.363 JM	0.022 M	0.558 M	31.8
MC-2	ν.	12.0	92.3			43	0.25 U	4,600	ပ	0.175	0.022	0.442	30.7
MC-2	9	11.5	30.0		ပ	47	0.25 U	4,400	ပ	0.185	0.051	0.30	35.0
MC-2	7	8.01	131		ပ	20	0.33	180 J	Ŋ	0.127	0.105	0.482	44.0
MC-2	•	10.2	113		ပ	33	0.25 U	200	ပ	0.134	0.051	0.223	52.7
MC-2	6	10.3	99.2		ပ	99	0.27	3,200 J	ပ	0.168	0.052	0.298	47.4
MC-2	10	7.8 C	219			15	0.25 U	20,000	၁	0.195	0.097	0.594	64
MC-2	=	11.0	136		ပ	6.9	0.25 U	400	ပ	0.061	0.042	1.07	52
MC-2	12	12.1	82		ပ	76	0.34 J	520	ပ	0.105	0.131	0.393	45.2
MC-2	13	12.8	104.4		ပ	20	0.34	440 J	ပ	0.094	0.064	0.442	36.8
MC-2	7	9.5 C	119		ပ	18	0.25 U	086	ပ	0.095	0.061	0.355	48.1
MC-2	15		101			15	0.26	3,000 J	ပ	0.121 J	0.085	0.412	48.1
MC-2	16	12.1	72.4		ပ	27	0.25 U	220	ပ	0.121	0.077	0.386	39.3
MC-2	17	11.8	101		ပ	28	0.26	2,400 J	ပ	0.127	0.014	0.476	. 51
MC-2	28	6.6	137		U	70	0.54	3,000 J	ပ	0.278	0.059	0.584	50.8
MC-2	61	9.0 C	177.3			18	0.25 U	3,600 J	Ö	0.184	0.057	0.168	99
MC-2	70		101		ပ	15	0.25	3,200 J	ပ	0.131	0.075	0.346	36.8
MC-2	21	12.2	8 =		ပ	8 1	0.75	260	ပ	0.106	0.075	0.445	49
MC-2	22	11.4 M	102 M		ບ _	Z Z	0.25 UM	2,100 JM	ပ	0.062 M	0.028 M	0.433 M	48.1 M
MC-2	23	9.6	120		ပ	24	0.25 U	099	ပ	0.114	0.015	0.251	47.6
MC-2	24	10.4	119		ပ	65	0.34	1,320	ပ	0.234	0.047	0.389	36.4
MC-2	25	8.01	98		ပ	25	0.25 U	3,600 J	ပ	0.136	0.092	0.312	35.8

0.026 M 0.021 0.057 M 0.052 M 0.008 M 0.003 U 0.010 0.056 0.020 0.040 0.008 960.0 0.056 0.029 0.040 .038 0.023 0.050 0.038 0.030 0.035 0.017 0.041 0.111 0.161 0.124 0.008 0.069 0.063 0.060 0.034 0.049 0.023 0.046 Zinc, Total ML 6100.0 0.0017 M 0.0044 0.0005 U D.0090 M 0.0114 M 0.0005 U 0.0162 J 0.0006 J 0.0005 U 0.0048 J 0.0019 0.0048 0.0354 0.0045 0.0078 0.0094 0.0055 0.0305 0.0157 (mg/L)3.0092 0.0044 0.0065 0.0026 0.0215 0.0087 0.0036 0.0048 0.0041 0.0058 0.0124 0.0137 0.0229 Lead, Total 0.0223 0.0132 0.0037 0.0073 0.0063 0.0076 0.0082 Table B2. Storm flow data for the Des Moines Water Quality Monitoring Program. 0.0160 M 0.0042 M 0.0114 0.0555 M 1910' 0.0074 M 0.0095 J 0.0097 J 0.0122 J 0.0246 J 0.0103 J 0.0133 J 0.0136 J 0.0093 0.0074 0.0256 0.0119 0.0161 0.0061 0.0097 0.0140 0.0134 0.0053 0.0093 0.0155 0.0104 0.0378 0.0172 0.0085 0.0117 0.0243 0.0219 0.0137 0.0256 0.0206 0.0049 0.0274 0.0162 0.0084 0.0305 0.0121 Copper, Total 0.003 UM 0.00S M 0 0 14 M 0.003 U 0.018 M 0.009 M 0.003 U 11 100 0 0.004 J 0.003 U 9100 0.017 000 0.014 (mg/L) 0.003 0.049 0.017 0.042 0.055 0.023 0.049 910.0 0.037 0.003 0.004 0.011 0.00 900'0 0.033 0.007 0.031 0.019 0.009 Zinc, Dis. 0.0005 UM 0.000S UM 0.0005 UM 0.0005 U U 0100.0 0.0006 M 0.0005 U 0.0005 U D.0006 M 0.0005 U 0.0005 U 0.0005 U 0.0010 U 0.0005 U 0.0005 U 0.0005 U 0.0010 U 0.0010 U 0.0010 U 0.0005 U 0.0010 U 0.0005 U 0.0005 U 0.0009 0.0016 0.0014 (mg/L) 0.0007 0.0008 0.000 9000.0 0.000 0.0012 0.0008 0.0007 0.0011 Lead, Dis. 0.0044 0.0081 M 0.0045 M 0.0057 0.0046 M 0.0033 M 0.0033 M 0.0025 0.0054 0.0026 0.0034 0.0046 (mg/L) 0.0026 0.0034 0.0052 0.0057 0.0076 0.0027 0.0038 0.0036 0.0132 0.0053 0.0036 0.0077 0.0025 0.0025 0.0034 0.0063 0.0083 0.0055 0.0118 0.0103 0.0072 0.0122 0.0074 0.0054 0.0050 0.0059 0.0073 0.0054 0.0054 Event Copper, Dis. Number DM-I BA-1 BA-1 BA-1 DM-I DM-1 DM-1 DM-1 DM-1 DM-1 DM-I DM-I DM-1 DM-I DM-I DM-I BA-1 BA-1 BA-1 BA-1 BA-I BA-1 BA-1 BA-1 BA-1 BA-I BA-1 BA-1 BA-1 BA-1 BA-I

	Event	Conner Die		l ead	Lead Die	Zinc Dis	Copper, Total	Lead. Total	Zinc, Total	4
Station	Number	(mg/L)		ت	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	1
DM-I	2	0.0057		0	0.0005 U	0.015	90100	0.0040 J	0.043	
DM-1	21	0.0047		0	0.0005 U	0.014	0.0172	0.0169 J	0.064	
DM-1	22	0.0055		O	90000	0.007	0.0068	0.0021	0.027	
DW-I	. 23	0.0049		0	0.0012	0.012	0.0117	0.0136	0.056	
DM-1	24	0.0106	၁		0.0005 U	0.031	0.0140	0.0081	0.065	
DW-I	25	0.0070		0	0.0013 J	0.013	0.0080	0.0056	0.020	
DM-2	-	0.0038		0	0.0015	0.026	0.0238	0.0078	0.047	
DM-2	2	0.0061		0	0.0005 U	0.030	0.0487	0.0023 J	0:030	
DM-2	3	0.0034		0	0.0005 U	0.010	0.0083	0.0037	0.032	
DM-2	4	09000		0	0.0005 U	0.050	0.0290	0.0394	0.144	
DM-2	S	0.0049		0	0.0007	0.016	0.0134	0.0121	0.039	
DM-2	9	0.0054	ပ		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	•	0.0069		0	0.0005 U	0.010	0.0195	0.0148	0.047	
DM-2	6	0.0077 M	_	0	0.0008 M	0.012 M	0.0164 M	0.0190 M	0.062 M	
DM-2	10	0.0064		0	0.0005 U	0.029	0.0350	0.0314	0.092	
DM-2	=	0.0040		0	0.0010 U	0.008	0.0165	0.0113	0.037	
DM-2	12	0.0040		0	0.0010 U	0.026	0.0141	0.0107	090.0	
DM-2	2	0.0039		0	0.0010 U	0.010	0.0073	0.0064	0.042	
DM-2	14	0.0042		0	0.0007	0.016	0.0115 J	0.0071	0.044	
DM-2	15	0.0048		0	9000'0	0.008 J	0.0155 J	0.0044	0.020	
DM-2	16	0.0031		0	90000	0.004	0.0119	0.0056	0.032	
DM-2	17	0.0039		0	0.0005 U	0.003	0.0088 J	0.0053	0.028	
DM-2	8 2	0.0029		0	0.0005 U	0.003 U	0.0199	0.0145	0.092	
DM-2	61	0.0042		0	0.0010 U	0.026	0.0167 J	0.0144	090'0	
DM-2	20	0.0033		0	0.0005 U	0.013	0.0068	0.0023 J	0.034	
DM-2	21	0.0031		0	0.0005 U	0.010	0.0115	0.0040 J	0.045	
DM-2	22	0.0035		0	0.0005 U	0.004	0.0049	0.0011	0.015	
DM-2	23	0.0068		0	0.0013	0.014	0.0125	0.0132	090'0	
DM-2	24	0.0072		0	0.0005 U	0.016	0.0092	0.0045	0.028	
DM-2	25	0.0034		0	0.0005 U			0.0020	0.014	
MA-1		0.0356	Ö		0.0027	0.089 C		0.0131	0.103	
MA-1	7	0.0029		0	0.0005 U	0.025	0.0289	0.0011 J	0.028	
MA-1		0.0027		0	0.0022	0.036	0.0057	0.0052	0.053	
MA-I	4	0.0063	Ü		0.0025	0.058 C	29000	0.0114	0.070	
MA-1	1	0.0027		0	0.0005 U	0.023	0.0127	0.0141	0.061	
MA-1	· · c	0.0027		0	0.0005 U	0.005	0.0063	0.0005 U	0.018	
MA-1	7	0.0071		0	0.0010	0.048	0.0131	0.0092	0.073	
MA-1	- 00	0.0068		0	0.0014	0.044	0.0214	0.0092	0.050	
MA-1	6	0.0057	ပ		0.0024	0.041 C	0.0103	0.0138	0.059	
MA-1	9	0.0080		0	0.0005 U	0.109 C	0.0131	0.0104	0.108	
MA-1	=	0.0033		0	0.0032	0.040	0.0054	0.0106	0.062	
MA-1	12	0.0019		0	0.0010 U	0.034	0.0042	0.0057	0.059	
MA-1	13	0.0034		0	0.0013	0.027	0.0071	0.0049	0.024	

0.054 M 0.035 0.024 0.016 0.062 0.079 0.007 0.027 0.043 0.033 0.023 Zinc, Total 0.058 0.085 0.044 0.033 0.034 0.064 0.029 0.059 0.023 0.058 3.062 0.121 0.061 0.017 0.018 0.018 0.052 0.027043 0.043 0.022 0.0005 U 0.0138 M 0.0054 J 0.0005 U 0.0045 J 0.0116 J 0.0022 J 0.0050 J 0.0019 J 0.0414 0.0083 0.0012 0.0016 0.0205 0.0153 0.0547 0.0317 0.0119 0.0124 0.0221 0.0063 0.0049 0.0054 0.0034 0.0057 0.0077 0.0080 0.0161 0.0072 0.0109 0.0122 0.0079 0.0030 0.0100 0.0019 Lead, Total 0.0154 0.0435 0.0212 Table B2. Storm flow data for the Des Moines Water Quality Monitoring Program. 0.0136 M 0.0056 0.0107 0.0060 0.0073 J 0.0108 0.0073 J 0.0150 0.0060 0900' 0.0067 0.0068 6900.0 0.0078 Copper, Total 0.0056 0.0248 0.0124 0.0165 9900.0 0.0040 0.0138 0.0259 9900.0 0.0108 0.0057 0.0060 0.0042 0.0103 0.0105 0.0124 0.0071 0.0073 0.0265 0.0053 0.0061 0.0184 0.0192 0.003 U 0.016 M 0.003 U 0.006 0.003 U 0.013 0.037 J 0.015 J (mg/L) 0.035 Zinc, Dis. 0.012 0.020 0.010 0.013 0.000 0.004 0.012 0.009 0.027 0.031 0.011 0.008 0.00 0.004 0.057 0.042 0.021 0.037 0.046 900.0 0.021 0.0005 UM 0.0005 U 0.0006 0.0005 U 0.0010 U 0.0010 U 0.0010 U 0.0010 U 0.0005 U 0.0005 U 0.0005 U 0.0010 U 0.0005 U 0.0005 U 0.0005 U 0.0005 U 0.0005 U 0.0041 J 0.0005 J 0.0005 U 0.0005 U 0.0010 9000.0 0.000 0.0006 0.0016 0.0015 0.0022 0.0041 0.000 0.0012 Lead, Dis. 0.0018 0.0009 0.0046 M 0.0010 U 0.0033 J Event Copper, Dis. 0.00390.0022 0.0052 0.0039 0.0040 0.0018 0.0026 0.0038).0035 0.0025 0.0011 0.0028 0.0044 0.0033 0.0038 0.0059 0.0049 9110.0 0.0065 0.0023 0.0011 0.0022 0.0020 0.0021 0.0047 0.0013 0.0080 0.0058 0.0021 0.0025 0.0034 Number MA-2 MA-2 MA-2 **MA-2** MA-2 MA-2 ₩¥-I MA-I MA-I MA-1 MA-I MA-1 MA-1 MA-1 MA-2 MA-2 MA-2 MA-2 MA-2 MA-2 MA-2 MA-2 **MA-2** MA-2 MA-3 MA-1 **MA-3 MA-3** MA-3

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Ctation	Event	Copper, Dis		Lead, Dis. (mg/L)	Zinc, Dis. (mg/L)	Copper, 1 otal (mg/L)	Lead, 10tal (mg/L)	Linc, 1 otal (mg/L)
MA-2	~	0.0079	ت	0.0005 17	0.008	0.0150	0.0045	0.024
MA-3		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	=	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	610.0	0.0085 J	0.0059	0.037
MA-3	15	0.0048		90000	0.017 J	0.0104 J	0.0076	0.022
MA-3	16	0.0026		0.0005 U	0.004	0.0000	0.0080	0.028
MA-3	17	0.0035		0.0005 U	0.003	0.0080 J	0.0062	0.032
MA-3	2	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	70	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	Ų,	0.0026	0.022	0.0150	0.0110	090'0
MA-3	25	0.0039		0.0005 U	0.008	0.0057	0.0059	0.025
MC-1	-	0.0524	ပ	0.0010	0.016	0.0823	0.0038	0.031
MC-1	7	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	9.000	0.021
MC-1	9	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	∞	0.0057		0.0012	0.012	0.0119	0.0060	0.024
MC-1	6	0.0031		0.0012	0.014	0.0083	0.0041	0.017
MC-1	9	0.0031		0.0005 U	0.010	0.0043	0.0023	0.009
MC-I	=	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		0.000	0.013	0.0041 J	0.0028	0.012
MC-I	15	0.0037		0.0012	0.006 J	0.0048 J	0.0031	270.0
MC-1	16	0.0040		0.0008	0.004	0.0079	0.0032	0.013
MC-1	11	0.0051		0.0005	0.003	0.0037 J	0.0022	0.008
MC-1	22	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	
MC-1	20	0.0023		0.0005 U	0.057	0.0027	0.0005 JU	
MC-1	7	0.0026		0.0005 U	0.007	0.0059	0.0005 JU	
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	_	0.0051		9000'0	0.016	0.0134	0.0074	0.038

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

11.11.6		CODIC: CO.	Coac, Dis.	CIII', DIS.	Copper, 10th		
Station	Number	umber (mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
MC.2	1	0 0104	0.0037	0.029	0.0149	0.0068 J	0.047
MC-2	, (*	0.0058	0.0005 U	0.018	0.0131	0.0054	0.049
7 C-2 M	. 4	0.0077 M C	0.0012 M	0.021 M	0.0102 JM	0.0080 M	0.038 M
NC.2		0 0072 C	0.0005 U	0.013	0.0168	0.0068	0.042
MC.2	٠ ٧	0.0044	0.0006	0.003 U	0.0051	9000'0	0.003 U
7 C-7 MC-2	, ,	92000	0.0005 U	0.010	0.0162	0.0064	0.037
TOWN	· •	0.0073	0.0005 U	0.011	0.0136	0.0036	0.032
Z OM		0.0070	0.0007	0.012	0.0127	0.0054	0.037
Z CZ	` =	0.0054	0.0005 U	0.019	0.0091	0.0013	0.017
Z CZ	? =	0.0078	0.0010 U	0.015	0.0080	0.0016	0.029
100	: :	09000	O.0010 U	0.023	0.0067	9600'0	0.039
7-0W	1 [0.0053	0.0010 U	0.010	0.0102	0.0041	0.039
7-27 10-7	3 3	0.0055	0.0005 13	0.010	0.0084 J	0.0018	0.022
7-7V	<u> </u>	0.0038	0 0005 13	0.008 J	0.0206 J	0.0041	0.028
7-7 10-7	C1 71	7 2200	0.0005 11	0.00	0.0168	0.0049	0.034
MC-2	2 2	0.0066	0.0005	0.014	0.0085 J	0.0031	0.012
MC-2	<u> </u>	0.0000	0.0000	9000	0.0214	0.0094	0.072
MC-2	9 2	0.0000	0.000.0	0.017	0.0070 J	0.0020	0.022
7-2M	, ,	0.0061	0.0005	0.019	0.0139	0.0014 J	0.022
7-2 1-2 1-2 1-2 1-2 1-2 1-2 1-2 1-2 1-2 1	7 7	0.0001	0 0005 11	0.008	0.0103	0.0055 J	0.028
7-2M	7 (0.0013 0.0047 M	0.0005 UM	0.003 UM	0.0073 M	0.0005 UM	0.014 M
MC-2	7 5	0.0081	0.0018	0.009	0.0124	0.0051	0.034
MC.2	7 7	0.0108 C	0.0005 U	0.033	0.0158	9900'0	0.054
TOWN	25	0.0053	0.0008 J	910.0	0900'0	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

Values in bold indicate significant differences exist between stations DM-1 and DM-2 at a significance level of α = 0.05. 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		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	$0.00~\mathrm{mg/L}$		
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		

Values in bold indicate significant differences exist between stations DM-1 and DM-2 at a significance level of α = 0.05. 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		
pН	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		

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

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

C-4

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.

			Stat	ion ^b	
Parameter	p-Value*	Low Mean Rank			High Mean Rank
Temperature	< 0.0001	BA-1	MA-3	MA-1	MA-2
pН	< 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 $\alpha = 0.05$.

 $^{^{\}text{b}}$ 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.

		Station ^b						
Parameter	p-Value ^a	Low Mean Rank			High Mean Rank			
Temperature	0.0138	BA-1	MA-3	MA-1	MA-2			
рН	< 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 $\alpha = 0.05$.

 $^{^{\}text{b}}$ 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.

			Year ^b						
	N	p-Value*	Low Mean	Rank		High	Mean Rank		
Temperature	25	0.9825	97/98	96/97	94/95	95/96	98/99		
рН	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		

² Values in bold indicate significant differences exist between monitoring years at a significance level of $\alpha = 0.05$.

 $^{^{\}text{b}}$ 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
pН	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.

			Year ^b						
	N	p-Value*	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 α = 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.

					Year ^b		
	N	p-Value ^a	Low Mean	Rank		High	Mean Rank
Temperature	25	0.9472	94/95	97/98	96/97	95/96	98/99
pН	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 $\alpha = 0.05$.

 $^{^{\}text{b}}$ Years connected by a single unbroken line are not significantly different at α = 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.

					Year ^b		
	N	p-Value ^a	Low Mean	Rank		High	Mean Rank
Temperature	25	0.9393	94/95	96/97	97/98	95/96	98/99
pН	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	Low Mean	Rank		High	Mean Ran
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.

					Year ^b		
	N	p-Value*	Low Mean I	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

 $^{^{\}alpha}$ 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 25 25 25 25 25 25 25	p-Value ^a 0.8695 0.4902 0.9052 0.9355 0.6028	96/97 96/97 95/96 94/95	94/95 95/96 97/98 97/98	97/98 97/98 96/97 96/97	High 95/96 94/95 94/95	98/99 98/99 98/99
25 25 25 25	0.4902 0.9052 0.9355	96/97 95/96 94/95	95/96 97/98 97/98	97/98	94/95 94/95	98/99
25 25 25	0.9052 0.9355	95/96	97/98 97/98	96/97	94/95	····
25 25	0.9355	94/95	97/98			98/99
25			· -	96/97	95/96	
	0.6028	94/95				98/99
25			98/99	96/97	95/96	97/98
	0.1216	96/97	95/96	97/98	94/95	98/99
25	0.2386	96/97	97/98	98/99	94/95	95/96
25	0.0888	96/97	94/95	. 97/98	98/99	95/96
25	0.1881	94/95	97/98	98/99	95/96	96/97
25	0.1616	97/98	95/96	98/99	96/97	94/95
25	0.9622	97/98	95/96	98/99	96/97	94/95
25	0.6527	97/98	95/96	98/99	96/97	94/95
25	0.3410	96/97	97/98	95/96	98/99	94/95
25	0.6510	95/96	97/98	96/97	98/99	94/95
25	0.1520	95/96	97/98	96/97	98/99	94/95
25	0.1576	97/98	95/96	98/99	96/97	94/95
25	0.7247	94/95	97/98	95/96	96/97	98/99
25	0.4604	96/97	97/98	94/95	95/96	98/99
	25 25 25 25 25 25 25 25 25 25	25 0.0888 25 0.1881 25 0.1616 25 0.9622 25 0.6527 25 0.3410 25 0.6510 25 0.1520 25 0.1576 25 0.7247	25 0.0888 96/97 25 0.1881 94/95 25 0.1616 97/98 25 0.9622 97/98 25 0.6527 97/98 25 0.3410 96/97 25 0.6510 95/96 25 0.1520 95/96 25 0.1576 97/98 25 0.7247 94/95	25 0.2386 96/97 97/98 25 0.0888 96/97 94/95 25 0.1881 94/95 97/98 25 0.1616 97/98 95/96 25 0.9622 97/98 95/96 25 0.6527 97/98 95/96 25 0.3410 96/97 97/98 25 0.6510 95/96 97/98 25 0.1520 95/96 97/98 25 0.1576 97/98 95/96 25 0.7247 94/95 97/98	25 0.2386 96/97 97/98 98/99 25 0.0888 96/97 94/95 97/98 25 0.1881 94/95 97/98 98/99 25 0.1616 97/98 95/96 98/99 25 0.9622 97/98 95/96 98/99 25 0.6527 97/98 95/96 98/99 25 0.3410 96/97 97/98 95/96 25 0.6510 95/96 97/98 96/97 25 0.1520 95/96 97/98 96/97 25 0.1576 97/98 95/96 98/99 25 0.7247 94/95 97/98 95/96 25 0.7247 94/95 97/98 95/96	25 0.2386 96/97 97/98 98/99 94/95 25 0.0888 96/97 94/95 97/98 98/99 25 0.1881 94/95 97/98 98/99 95/96 25 0.1616 97/98 95/96 98/99 96/97 25 0.9622 97/98 95/96 98/99 96/97 25 0.6527 97/98 95/96 98/99 96/97 25 0.3410 96/97 97/98 95/96 98/99 25 0.6510 95/96 97/98 96/97 98/99 25 0.1520 95/96 97/98 96/97 98/99 25 0.1576 97/98 95/96 98/99 96/97 25 0.1576 97/98 95/96 98/99 96/97 25 0.7247 94/95 97/98 95/96 98/99 96/97 25 0.7247 94/95 97/98 95/96 98/99 96/97

^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.

					Year ^b		
	N	p-Value ^a	Low Mean	Rank		High	Mean Rank
Temperature	15	0.9429	97/98	96/97	95/96	94/95	98/99
pН	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
Fecal Coliform Bacteria	15	0.6937	97/98 ———	96/97	98/99	95/96	94

^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 α = 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
рН	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.

	•				Year ^b		
	N	p-Value*	Low Mean Rank			High	Mean Ranl
Temperature	15	0.9856	95/96	96/97	94/95	98/99	97/98
рН	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 $\alpha = 0.05$.

 $^{^{\}text{b}}$ Years connected by a single unbroken line are not significantly different at α = 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.

					Year ^b		
	N	p-Value*	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 $\alpha = 0.05$.

 $^{^{\}text{b}}$ 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.

	٠.				Year ^b		
	N	p-Value ^a	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.

					Year ^b		
	N	p-Value ^a	Low Mean	Rank		High	Mean Rank
Temperature	15	0.9665	95/96	94/95	96/97	97/98	98/99
рН	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 Ran	
Temperature	14	0.6730	94/95	95/96	96/97	97/98	98/99
рН	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 $\alpha = 0.05$.

 $^{^{\}text{b}}$ Years connected by a single unbroken line are not significantly different at α = 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.

					Year ^b		
	N	p-Value ^a	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.

	With	out Flow Cor	rrection	With	Flow Corre	ection ^b
Parameter	N	tau	p-Value ^a	N	tau.	p-Value*
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.

-	With	out Flow Con	rrection	With	Flow Corre	ection ^b
Parameter	N	tau	p-Value ^a	N	tau	p-Value*
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.

	With	out Flow Cor	rection	With	Flow Corre	ection ^b
Parameter	N	tau	p-Value ^a	N	tau	p-Value*
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			1
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			

 $^{^{\}text{a}}$ 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.

	With	out Flow Cor	rrection	With	n Flow Corre	ection ^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			

 $^{^{\}text{a}}$ 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.

	With	out Flow Cor	rection	With	Flow Corre	ection ^b
Parameter	N	tau	p-Value ^a	. N	tau	p-Value*
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.

	With	out Flow Cor	rection	With Flow Correction ^b			
Parameter	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.

	With	out Flow Co	rrection	With	Flow Corr	ection ^b
Parameter	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			

 $^{^{\}text{a}}$ 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.

	Witho	out Flow Cor	rection	With	Flow Corr	ection ^b
Parameter	N	tau	p-Value*	· 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			·

 $^{^{\}text{a}}$ 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

 $^{^{\}text{a}}$ 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*
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

 $^{^{\}text{a}}$ 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*
Temperture	15	0.249	0.1961
pН	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*
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

^{*} p-values in bold indicate a significant trend exists at $\alpha = 0.05$

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	······································	Pre	cipitation	Totals (inch	es)
•			Flow Volume				Normal
Month/Year	Average	Peak	(acre-feet/Month)	MSDTP ^a	Tyee ^b	Sea-Tac ^c	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).

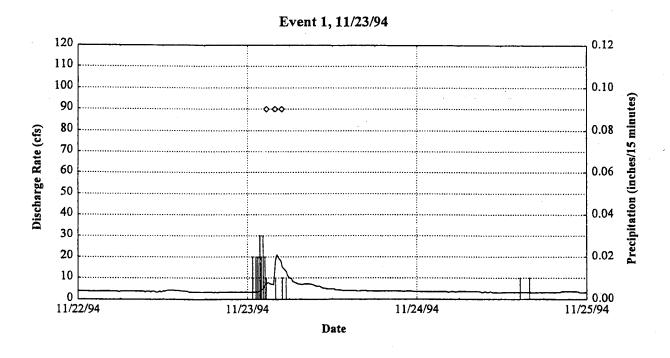
	Flow	Rate		Pre	cipitation	Totals (inch	es)
			Flow Volume				Normal
Month/Year	Average	Peak	(acre-feet/Month)	MSDTP ^a	Tyee ^b	Sea-Tacc	Sea-Tac ^d
Apr-98	2.98	19.0	179	1.49	0.89	0.99	2.33
May-98	3.39	36.0	211	2.60	2.29	1.98	1.70
Jun-98	2.37	30.0	143	1.28	1.16	1.11	1.50
Jul-98	1.39	5.10	86	0.37	0.38	0.41	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.



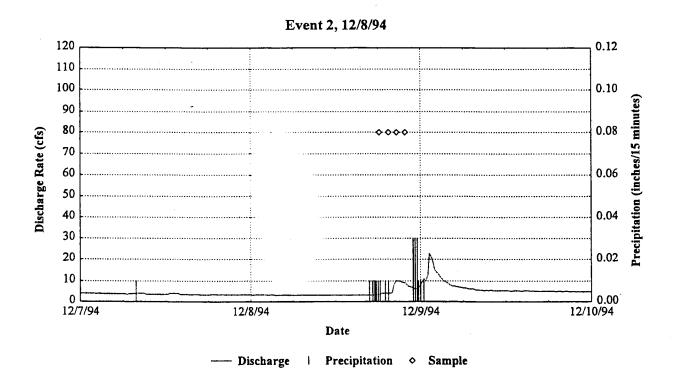
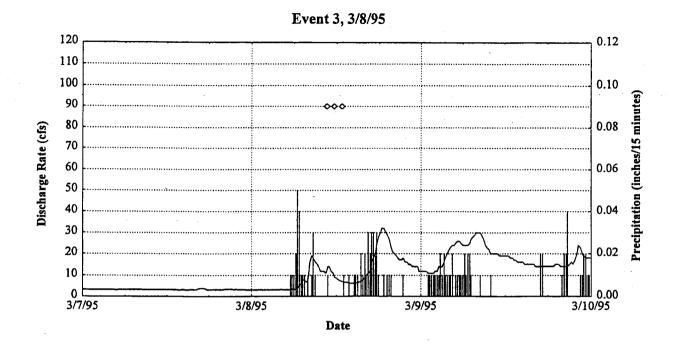


Figure D1. Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.





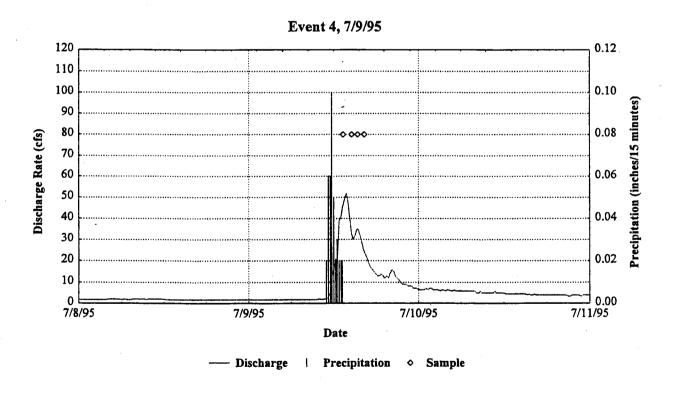
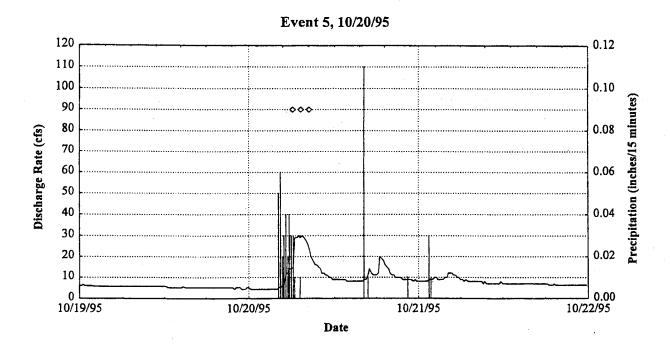


Figure D2. Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.





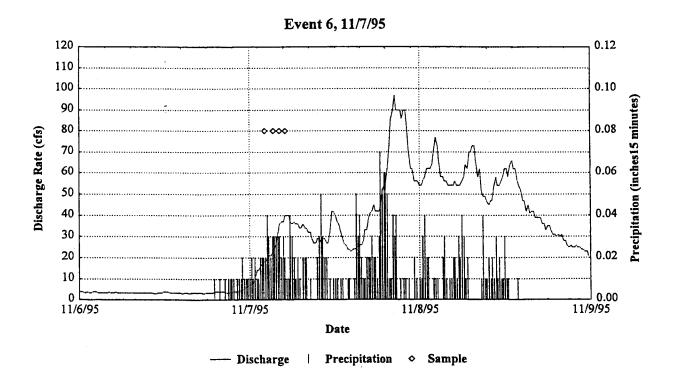
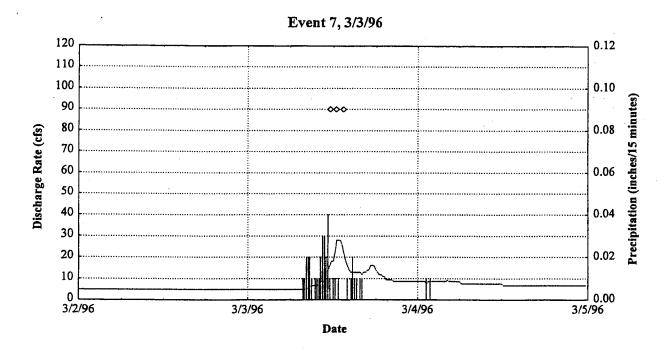


Figure D3. Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.





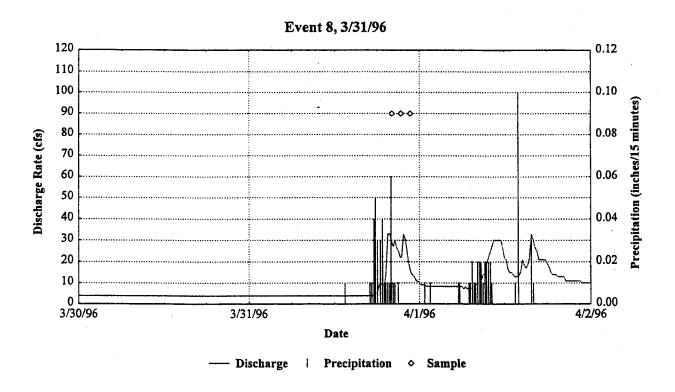
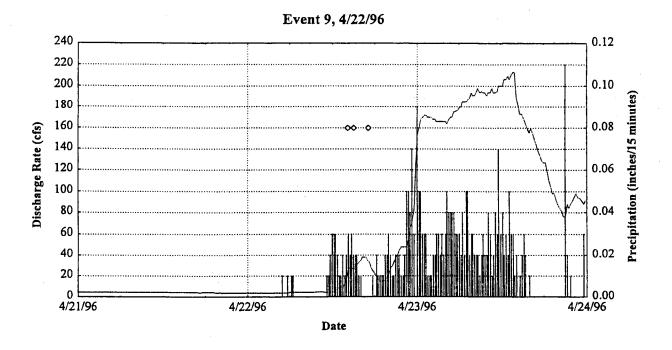


Figure D4. Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.





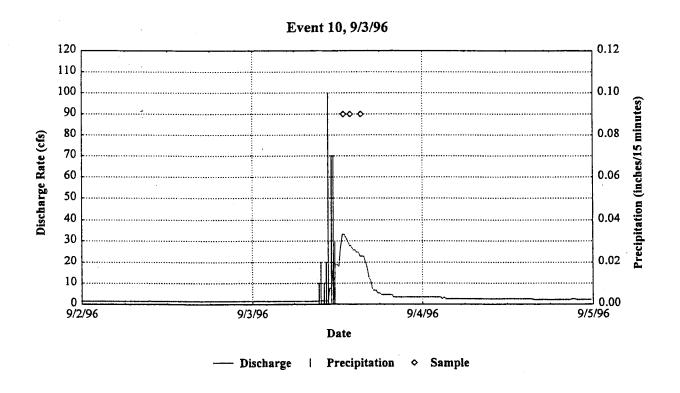
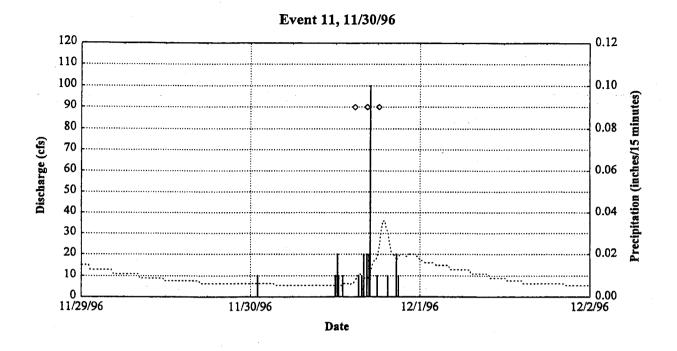


Figure D5. Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.





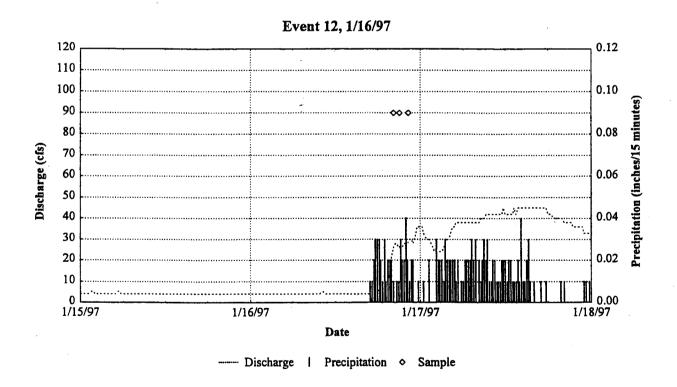
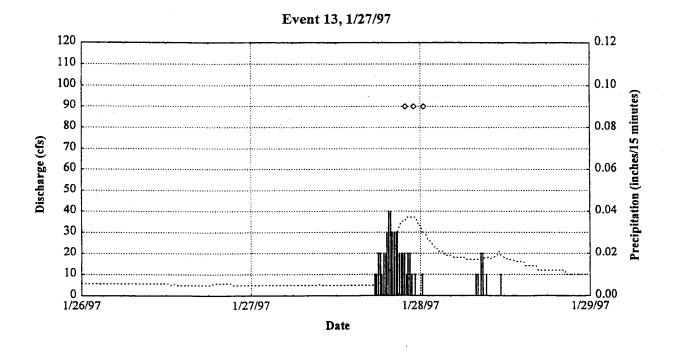


Figure D6. Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.





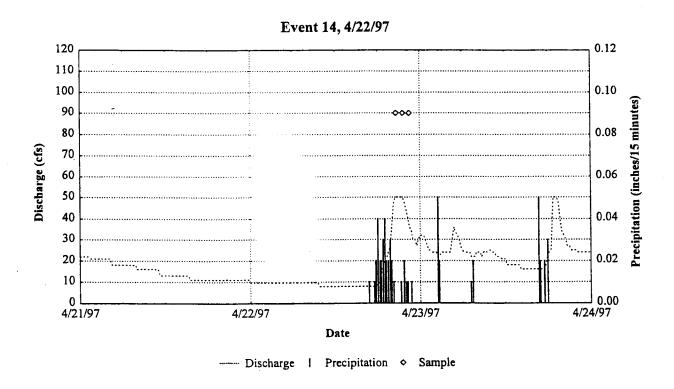
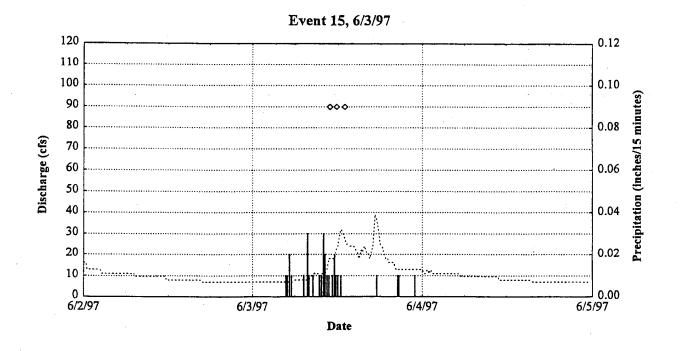


Figure D7. Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.





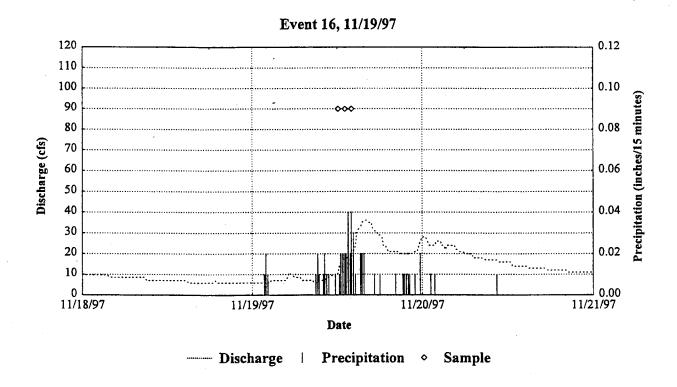
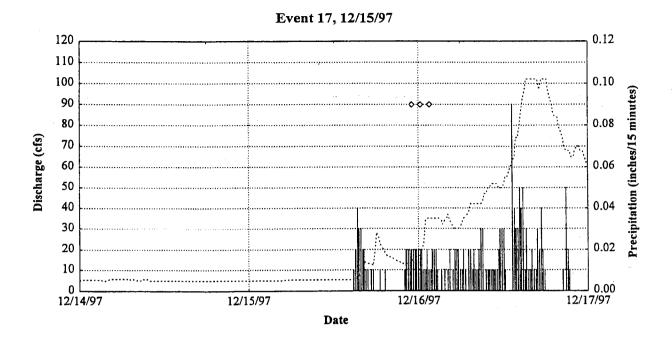


Figure D8. Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.





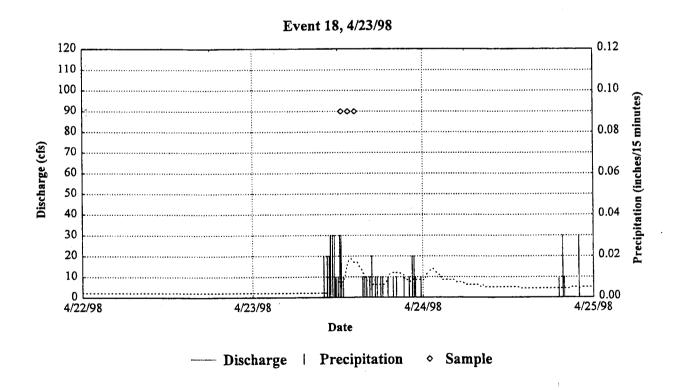
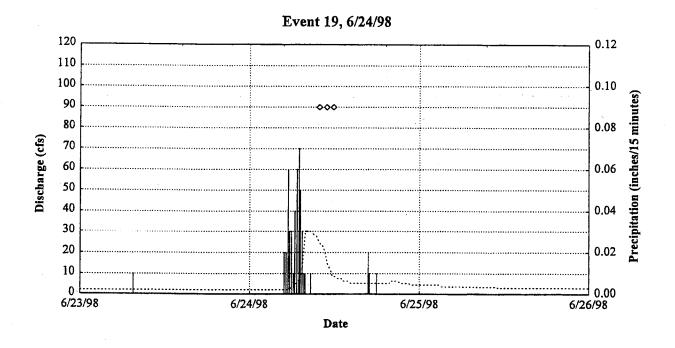


Figure D9. Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.





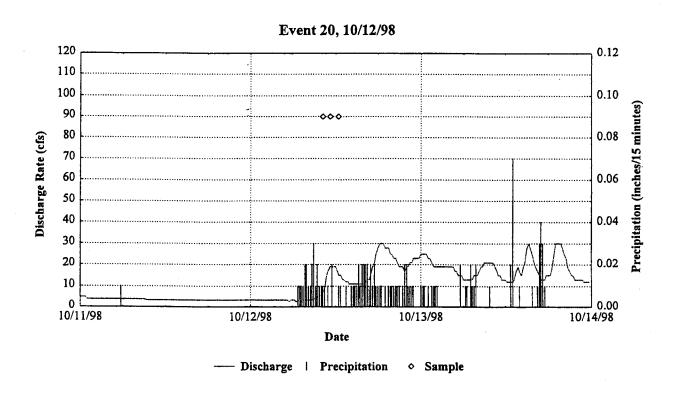
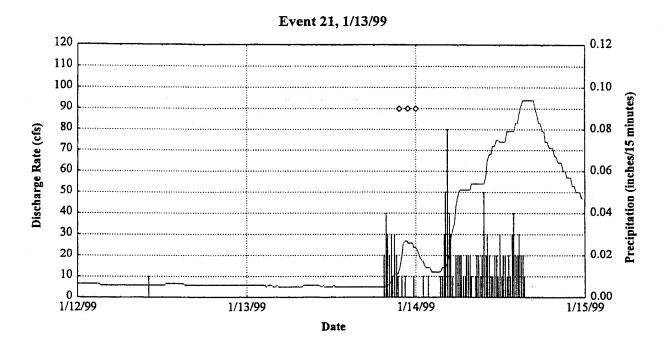


Figure D10. Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.





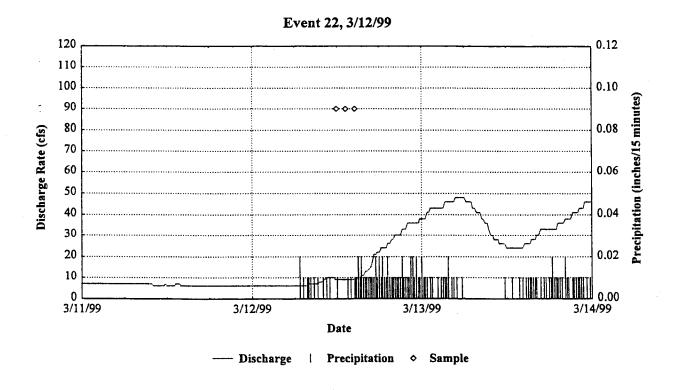
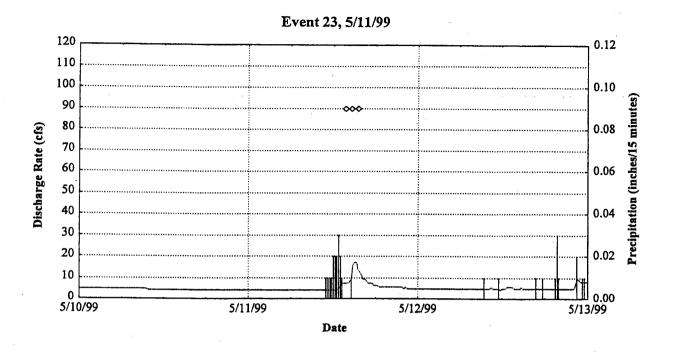


Figure D11. Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.





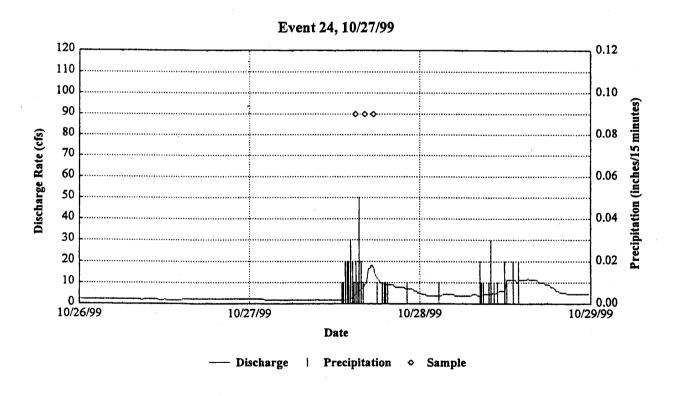


Figure D12. Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.



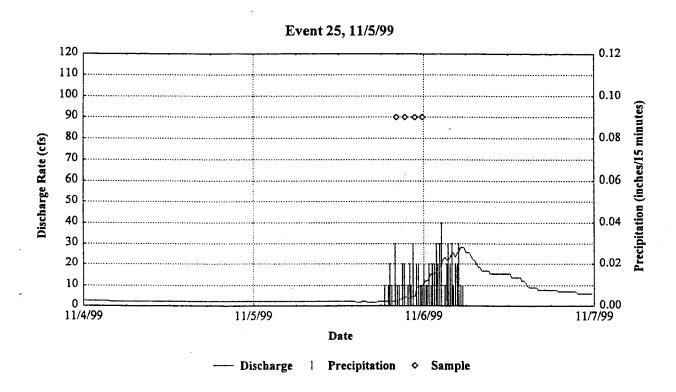


Figure D13. Hydrologic data for Des Moines Creek during sampled storm events, collected by King County at Stations 11D and 11U.



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



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:
ATE SAMPLED:

01/08/98

12/04/97

DATE RECEIVED:

12/04/97

FINAL REPORT, LABORATORY / NALYSIS 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 successive descending to EPA procedures. Sample data follows while QA/QC data is contained on subsequent pages.

Base 10

	TURBIDITY	TSS	FECALS	TOTAL-P	AMMONIA	NO3+NO2	ТРН
SAMPLE ID	(NTU)	(mg/l)	(#/100ml)	(mg/l)	(mg/l)	(mg/l)	(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

	Γ	DISS	OLVED META	LS
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



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CASE FILE NUMBER:

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PAGE 2

REPORT DATE: DATE SAMPLED: 01/09/98

12/04/97

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12/04/97

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER

SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

9A/9C DATA WATER

QC PARAMETER	TURBIDITY	TSS	FECALS	TOTAL-P	AMMONIA	NO3+NO2	TPH
	(NTU)	(mg/l)	(#/100ml)	(mg/l)	(mg/l)	(mg/l)	(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	I
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
Ос снеск							
FOUND	8.5	9.5		0.081	0.858	0.426	33.8
TRUE	8.0	10	1 .	0.078	0.915	0.424	33.9
% RECOVERY	106.25%	95.00%	NA	103.85%	93.81%	100.57%	99.71%
BLANK	NA NA	<0.50	< 2	<0.002	<0.010	<0.010	< 0.25
DIVIAU	L NA	₹0.50	1 4	₹0.002	40.010	1 10.010	1 (0.20

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.



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

CASE FILE NUMBER:

HER042-28

PAGE 3

REPORT DATE:
ATE SAMPLED:

01/09/98

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

	Ī	DIS	SOLVED MET	ALS
QC PARAMETER	HARDNESS	COPPER	LEAD	ZINC
	(mgCaCO3/1)	(mg/l)	(mg/l)	(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	МА-З
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%
OC 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%
		<u> </u>		
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.

SUBMITTED BY:

even Lazoff

Laboratory Director

⁻ 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.

CHAIN OF CUSTODY RECORD



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	Completeness/	Holding	Blanks/ Detection	Matrix Spikes/ Surrogate		d	Lab Control	Instrument Calibration/ Performance	NOIHU
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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:

HER042-30

PAGE 1

REPORT DATE:

DATE SAMPLED:

04/22/98

03/19/98

DATE RECEIVED:

03/19/98

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. 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 AMPLEDATA

	TURBIDITY	TSS	FECALS	TOTAL-P	TPH	AMMONIA	NO3+NO2
SAMPLE ID	(NTU)	(mg/l) ⁻	(#/100ml)	(mg/l)	(mg/l)	(mg/l)	(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
МА-З	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

		DISS	OLVED META	LS .
	HARDNESS	COPPER	LEAD	ZINC
SAMPLE ID	(mgCaCO3/l)	(mg/l)	(mg/l)	(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



LABORATORY & CONSULTING SERVICES

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

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PAGE 2

REPORT DATE: DATE SAMPLED: 04/22/98

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	TSS	FECALS	TOTAL-P	TPH	AMMONIA	NO3+NO2
	(UTU)	(mg/l)	(#/100ml)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
METHOD	SM182130B	EPA 160.2	SM180222D	EPA 365.1	EPA 418.1	EPA 350.1	EPA 953.2
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	I	MC-2	MC-2
ORIGINAL	3.6	2.5	72	0.054		0.022	0.440
DUPLICATE	3.6	2.5	74	0.053	İ	0.025	0.438
RPD	0.00%	0.00%	2.74%	0.56%	NA	14.35%	12.40%
					,		
SPIKE SAMPLE	·						
				MC-2	T	MC-2	MC-2
SAMPLE ID				0.054	•	0.022	0.440
ORIGINAL	4			0.054	j	0.022	0.626
SPIKED SAMPLE	,			0.107		0.200	0.200
SPIKE ADDED			NA	105.80%	NA.	106.20%	93.00%
% RECOVERY	NA NA	NA .	NA NA	105.80%	NA.	100.20%	30.00%
OO OUROW							
OC CHECK							
FOUND	8.0	10		0.081	36.8	0.923	0.437
TRUE	8.0	10	1.	0.077	33.9	0.915	0.424
% RECOVERY	100.00%	100.00%	NA.	105.19%	108.55%	100.86%	102.97%
A LUCO I DICI	100.00%	1 200.00	L	1	· ····································		
BLANK	NA NA	<0.50	< 2	<0.002	<0.25	<0.010	<0.010

RPD = RELATIVE PERCENT DIFFERENCE.

IN = 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.



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

CASE FILE NUMBER:

HER042-30

PAGE 3

REPORT DATE:

OATE SAMPLED:

04/22/98

03/19/98

DATE RECEIVED:

03/19/98

INAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER

SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

A/QC DATA WATER

, 0				
		DIS	SOLVED MET	ALS
QC PARAMETER	HARDNESS	COPPER	LEAD	ZINC
	(mgCaCO3/1)	(mg/l)	(mg/l)	(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%
OC 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
				

D - RELATIVE PERCENT DIFFERENCE.

SUBMITTED BY:

teven Lazoff

aboratory Director

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.

CHAIN OF CUSTODY RECORD

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CONSULTANTS	Project Name/No./Client: Laboratory/Parameters: Sample Date/Sample ID:	Parameter	Turbidity 155	Facil Colhorm	Total P	TAP	NHa. N	NO3+ NO2. N	Hardness		Disselved	50	22	Field Mens.	Covo

file: DATAQA3.XLS



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: DATE SAMPLED: 08/12/98

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

	TURBIDITY	TSS	FECALS	TOTAL-P	AMMONIA	NO3+NO2
SAMPLE ID	(NTU)	(mg/l)	(#/100ml)	(mg/l)	(mg/l)	(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

	Γ	DISS	OLVED META	LS
	HARDNESS	COPPER	LEAD	ZINC
SAMPLE ID	(mgCaCO3/l)	(mg/l)	(mg/l)	(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



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

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PAGE 2

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FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER

SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

JA/QC DATA WATER

QC PARAMETER	TURBIDITY	TSS	FECALS	TOTAL-P	AMMONIA	NO3+NO2
	(NTU)	(mg/l)	(#/100ml)	(mg/l)	(mg/l)	(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
DUDIECAMO						
DUPLICATE						
SAMPLE ID	МА-З	МА-З	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					v	
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
OC 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.

A = NOT APPLICABLE OR NOT AVAILABLE.

C = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.

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



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

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PAGE 3

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07/22/98

Final report, laboratory analysis of selected parameters on water

SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

_			
	DIS	SOLVED MET	ALS
HARDNESS	COPPER	LEAD	ZINC
(mgCaCO3/1)	(mg/l)	(mg/l)	(mg/l)
SM18 2340B	EPA 220.2	EPA 239.2	EPA 200.7
08/04/98	08/10/98	08/10/98	08/10/98
2.00	0.0010	0.0005	0.003
			,
SAMPLE X	SAMPLE X	SAMPLE X	SAMPLE X
135	<0.0010	<0.0005	<0.003
136	<0.0010	<0.0005	<0.003
0.55%	NC	NC	NC
SAMPLE X	SAMPLE X	SAMPLE X	SAMPLE X
135	<0.0010	<0.0005	<0.003
155	0.0135	0.0130	1.07
20.0	0.0125	0.0125	1.00
100.31%	108.00%	104.00%	107.00%
,			
40.1	0.0269	0.0261	0.981
40.0	0.0250	0.0250	1.00
100.25%	107.60%	104.40%	98.10%
<2.00	<0.0010	<0.0005	<0.003
	SM18 2340B 08/04/98 2.00 SAMPLE X 135 136 0.55% SAMPLE X 135 155 20.0 100.31%	HARDNESS COPPER (mg/l)	SM18 2340B EPA 220.2 EPA 239.2

RPD = RELATIVE PERCENT DIFFERENCE.

SUBMITTED BY:

Laboratory Director

RPD = RELATIVE PERCENT DUFFRENCE.

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

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file: DATAQA3.XLS

Notes:



LABORATORY & CONSULTING SERVICES 3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715

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CASE FILE NUMBER:

HER042-36

PAGE 1

REPORT DATE: DATE SAMPLED:

03/02/99

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

	TURBIDITY	CONDUCTIVITY	TSS	FECALS	TOTAL-P	AMMONIA	NO3+NO2
SAMPLE ID	(NTU)	(umhos/cm)	(mg/l)	(#/100ml)	(mg/l)	(mg/l)	(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
МА-З	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

		DISS	OLVED META	LS
.	HARDNESS	COPPER	LEAD	ZINC
SAMPLE ID	(mgCaCO3/1)	(mg/l)	(mg/l)	(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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PAGE 2

REPORT DATE: DATE SAMPLED: 03/02/99 02/12/99

DATE RECEIVED:

02/12/99

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER

SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

9A/9C DATA WATER

QC PARAMETER	TURBIDITY	CONDUCTIVITY	TSS	FECALS	TOTAL-P	AMMONIA	NO3+NO2
_	(NTU)	(umhos/cm)	(mg/l)	(#/100ml)	(mg/l)	(mg/l)	(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%
		<u> </u>	7.4970		2.82%	ZIDL	0.31%
SPIKE SAMPLE					<u> </u>		
,	-			•			
SAMPLE ID					MC-2	MC-2	MC-2
ORIGINAL					0.036	0.015	0.655
SPIKED SAMPLE			ŀ	Ì	0.091	0.214	0.826
SPIKE ADDED	İ		ļ		0.050	0.200	0.200
% RECOVERY	NA	NA	NA	NA.	108.40%	99.35%	85.40%
		L,,	·	<u> </u>	110.0090	99.50%	85,5%
QC CHECK					•	• • •	
9							
FOUND	0.78	748	9.8	I	0.094	0.524	0.913
TRUE	0.80	718	10	1 .	0.093	0.499	0.933
% RECOVERY	97.50%	104.18%	98.00%	NA	100.54%	105.01%	97.83%
7. 1.000 VB1(1	07.00%			<u> </u>	101.08%		97.862
BLANK	NA NA	NA	<0.50	< 2	<0.002	<0.010	<0.010
		<u> </u>				^ 	

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.



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

CASE FILE NUMBER:

HER042-36

PAGE 3

PEPORT DATE:
ATE SAMPLED:

03/02/99

02/12/99

DATE RECEIVED:

02/12/99

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER

AMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

A/QC DATA WATER

	Γ	DISS	SOLVED MET	ALS
QC PARAMETER	HARDNESS	COPPER	LEAD	ZINC
	(mgCaCO3/1)	(mg/l)	(mg/l)	(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%
SPIKE SAMPLE	1.997,	ZIPL	·	
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%
OC CHECK	104.50%	104.80%	Du 80%	
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

RPD - RELATIVE PERCENT DIFFERENCE.

"4 - NOT APPLICABLE OR NOT AVAILABLE.

C = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.

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

SUBMITTED BY:

Laboratory Director

1	RERA WENTAL
L	HERR

ENVIRONMENTAL CONSULTANTS							ğ	to the	70/
Project Name/No./Client: Laboratory/Parameters: Sample Date/Sample ID:	./Client: neters: nple ID:	ACT/Con ACT/Con Base 13	10387/GI	387/GHyo Besmoines 14 My 1918 2/12/99 Botations	usó ions	1.1.1	Date Checked	3/8/00 Page	Page 1 of (
	Completeness/	Holding	Blanks/ Detection	Matrix Spikes/ Surrogate	Lab	Field	Lab Control	Instrument Calibration/	NO!TO
Tameter	Methodology	o C	ok ok	NA	2.76.70	Dupincaics	97.50%	イン	None
Conductivity		********	-	V.	0.00.7		154.18%	. ·	
13			`	VN VN	7.69%		98.00%		
Feats				NA	2		せて		
d d t				110.00%	231%		101.00%	· .	
NHY-N				99,50%	7017		%10'601		
NO2+NO2-N				85,50%	0 0.31%		94.86%		
Hardness				104.507	104.50% 1.9970		98,50%	0	
				-					
Dissolved	·		-	104-80%	7017 0		92.20%		
కెడ్డి				425.03	NC (both W)	oft U)	92.00%		
Teld			that along residence had a residence	X Z	¥2		2		
000	>	\	->					>	P
								-	

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

Notes:



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

EPORT 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

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

Base 14

	TURBIDITY	TSS	FECALS	TOTAL-P	AMMONIA	NO3+NO2
SAMPLE ID	(NTU)	(mg/l)	(#/100ml)	(mg/l)	(mg/l)	(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
МА-З	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

		DISS	OLVED META	LS
	HARDNESS	COPPER	LEAD	ZINC
SAMPLE ID	(mgCaCO3/l)	(mg/l)	(mg/l)	(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		<0.0010	<0.0005	0.010

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



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

CASE FILE NUMBER:

HER042-39

PAGE 2

REPORT DATE: DATE SAMPLED: 06/21/99

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	TSS	FECALS	TOTAL-P	AMMONIA	NO3+NO2
	(NTU)	(mg/l)	(#/100ml)	(mg/l)	(mg/l)	(mg/l)
METHOD	SM152130B	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%
		22.2170		2.17%		ZIDL
SPIKE SAMPLE				2-11-1-12	:	
•					 	
SAMPLE ID				MC-2	BATCH	BATCH
ORIGINAL				0.093	f <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%
				100.0070	95.50%	, 91.007d
QC CHECK					13.007	
			· · · · · · · · · · · · · · · · · · ·			
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%
					104,074	105.35%
BLANK	NA	<0.50	< 2	<0.002	<0.010	<0.010
	·					

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.



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: DATE SAMPLED:

06/21/99

05/27/99

DATE RECEIVED:

05/27/99

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER

SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

3A/9C DATA WATER

		DISSOLVED METALS			
QC PARAMETER	HARDNESS	COPPER	LEAD	ZINC	
	(mgCaCO3/1)	(mg/l)	(mg/l)	(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	1,4590			LIDL	
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 7	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%	107.70	108.002	05570	
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%	107.4020		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.

Laboratory Director

CHAIN OF CUSTODY RECORD

PROJECT NUMBER		CLIENT / M						A	ANAL YSEŞ REQUESTED	REQUE	STED				
او		coeyto: 1/1911 /	82	-	-		- //-		1445 SW	W-	4.				
		DELIYERY METHOD:		5:	-		- E 01),[<u>}</u>	المورا	19)上	•			
REQU	QUESTE	REQUESTED COMPLETION DATE: TOTAL # OF CON-	ż	524 524	י ק וקנד		<u>√</u>	1 - S	0/055	برورا	ودا -			•	
		# OF	F 3	ورو	5 <u>J</u>	Į	777 <u>.</u> 801	11/	2000 101	059	0162.	 ,			
1 1	TIME	SAMPLE DESCRIPTION TAI	TAINERS	T	- 7	<u> </u>	<u>7</u>] V	7	7	2				
5/27/99 15:1	15:00	ethen Water	4	X	X	>	X		×	X	>	-		1	
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13.6	13:50				-		E	F				-		_	
12:15	<u>5</u>							F				_			
12.7	12:12	Φ (₽	Þ	1	6	0	D	6					
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keals should	7 	1,000/100ml	ť						,		,				
SIGNATU	SIGNATURE	LOB ZIXTHE STATING	625	RECEIVE	RECEIVED BY DAMEICO.)	WESO.)	MATES	\ <u>s</u>	SIGNATURE	1 4			DATE/TIME	2	425
SIGNA	SIGNATURE	DATE/TIME	<u> </u>	ECEIVE	RECEIVED BY (NAME/CO.)	ME/CO.)		SIG	SIGNATURE				DATE/TIME]	
								\dashv						.	

<u> </u>	Page Lof L	RZ	2/1400				ACTION	> Lost						-			→ 1	fonly sample DM-2)	14 USE UM-3 4.803 (Field dup)			
<i>t</i> ,	1/6/00 Page	nitials	date		Instrument	Calibration/	Performance	くて	· 		·							~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~	<i></i>	- PK	-	
1	By Date	Checked		in		Lab Control	Samples	16.6210	96,0090	7 4	95.76%	104.67%	105,3370	98.00%	107,40%		NCLLARY 108.80%	96.70%		A N	3	
			Ducicate	ant +1 Field Mansferblant	DM7-DM-3			8,550	5,28%	0,000,0	3,14%	NC FORM	1.58%	3.24%	NChka			(0.004 and	€ 0°,003	T)	<u>.</u>	
			5 + [Field.	+ I Field			Duplicates I	} 5	27.22 %	5.117	2.17%	KC both li	ムルト	1.45%	NCboka		NC bohu	7017		V V	<u></u>	
	Des Maines	3		whom	Matrix Spikes/		Recoveries D	2	ΥN	せる	100.001	95.38%	91.0050	95,00%	107.20%		100,00%	105,00%		VIV	<u> </u>	
•	Jun 10/4 26	Conv 4 Meta	5/27/99	1 2 Bold botters	Blanks/ Matrix Spik	Detection	Limits	ا 2 -			·							0.010 blank		6	X 2	
	14%) CHANGE	NET "	Pax 14)		Holding	Times	رل	<i></i>					· · · · · ·		-					→	
	/Client:	reters:	ple ID:			Completeness/	Methodology	<u>7</u> -				-								•	->	
HEHHEHA EWIROMEN'AL CONSULTANTS	Project Name/No./Client:	Laboratory/Parameters:	Sample Date/Sample ID:	·		1	Parameter / / /	Tarbian ry	755	Fials	4	NH4-N	NO3+NON	Hardruss	Dissolved	ر اد	ЬÞ	3	Field	tho	_8	

Notes: NC: Not calculable due to one or more values being below the detection limit file: DATAQA3.XLS



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: DATE SAMPLED:

09/10/99

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

	TURBIDITY	TSS	FECALS	TOTAL-P	AMMONIA	NO3+NO2
SAMPLE ID	(NTU)	(mg/l)	(#/100ml)	(mg/l)	(mg/l)	(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
МА-З	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

		DIS	SOLVED META	LS
	HARDNESS	COPPER	LEAD	ZINC
SAMPLE ID	(mgCaCO3/l)	(mg/l)	(mg/l)	(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		<0.0010	<0.0005	<0.003

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



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

CASE FILE NUMBER:

HER042-40

PAGE 2

EPORT DATE: JATE SAMPLED: 09/10/99 08/25/99

DATE RECEIVED:

08/25/99

final report, laboratory analysis of selected parameters on water

AMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

QC PARAMETER	TURBIDITY	TSS	FECALS	TOTAL-P	AMMONIA	NO3+NO2
	(NTU)	(mg/l)	(#/100ml)	(mg/l)	(mg/l)	(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%
		9.842		0,00%	ZIOL	0.93%
SPIKE SAMPLE						
SAMPLE ID				MC-2	MC-2	MC-2
ORIGINAL				0.077	0.022	0.322
SPIKED SAMPLE				0.129	0.022	0.505
SPIKE ADDED				0.129	0.200	0.200
% RECOVERY	NA	NA	NA	103.08%	104.60%	91.25%
% RECOVERT	IVA	INA	INA			
QC CHECK				104,001	0 104,50%	91.50%
ge criben	·				•	
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%
					103.47/2	102.00%
BLANK	NA	<0.50	< 2	<0.002	<0.010	<0.010

D = RELATIVE PERCENT DIFFERENCE.

<sup>NOT APPLICABLE OR NOT AVAILABLE.

NO - 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.</sup>



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: DATE SAMPLED: 09/10/99

08/25/99

DATE RECEIVED:

08/25/99

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER

SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

9A/9C DATA WATER

er, ac pirra ware pr				
		DIS	SOLVED MET	ALS
QC PARAMETER	HARDNESS	COPPER	LEAD	ZINC
	(mgCaCO3/l)	(mg/l)	(mg/l)	(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	мс-з	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	мс-з
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%
OC CHECK	•		t -	· ,
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%
				. 7
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:

Laboratory Director

TICKO TICKO

CHAIN OF CUSTODY RECORD 1986	1) \(\frac{1}{2}\) \(\frac{1}{	shall be -1020/100me	RECEIVED BY (NAME)CO.) SIGNATURE DATE/TIME G/25/99 [70] RECEIVED BY (NAME/CO.) SIGNATURE DATE/TIME
Seatue, Washington 98121 Seatue, Washington 98121 Seatue, Washington 98121 Seatue, Washington 98121 Seatue, Washington 98121 Seatue, Washington 98121 CHAII	PROJECT NAME PROJECT NAME SAMPLED BY: LABORATORY: LABORATORY: LAB USE: MA-2 MA-2 MA-2 MA-2 MA-2 MA-2 MA-2 MA-2 MA-2 MA-2 MA-2 MA-3 MA-2 MA-3 MA-2 MA-2 MA-3 MA-3 MA-3 MA-3 MA-3 MA-3 MA-3 MA-3 MA-3 MA-3 MA-3 MA-3 MA-3 MA-4 MA-3 MA-4 MA-3 MA-4 MA-3 MA-4 MA-3 MA-4 MA-3 MA-3 MA-3 MA-3 MA-3 MA-4 MA-3 MA-4 MA-3 MA-3 MA-3 MA-3 MA-4 MA-3 MA-3 MA-3 MA-3 MA-3 MA-3 MA-3 MA-3 MA-4 MA-4 MA-4 MA-4 MA-4 MA-5 MA-7 MA-7 MA-7 MA-7 MA-4 MA-7 M	d. Pecals	REI JANOSE STANDERCO) STONDETURE LANT LATE DATE/TIME 12 EVORECEIVED BY (NAME/CO.) STOND LAND STOND ST

RJanaak	(X) Page 1. of 1. R 2.	ι ν ce ACTION	Nowe								D
A Cla	399 initials date	Instrument Calibration/ Performance	AN			6 6	2 2		C3 63		€ →
By	Date Checked Locate	_	2,00.001	100.0070 NA	~~	102.00%	N. 00 70 - 100, 75% NC boky NC LAN 92, 00%		NC 6.0005 106,8070 NC boku 100,0070		NA
	Trienda Historia	X m4-4= m 4-4 Field Duplicates	14 7369		%5+85L)		70 AND SE		NO NO NO NO NO NO NO NO NO NO NO NO NO N		X Z
	SMoines Date Checked Setations + 1 Field durchecte	Lab Duplicates	2,00.0	9,84% C25% 5t	0.00%	210L 0.937	2 de		99.70% NC		NA
	207/City of DSMoines 2NV+Metals 8/25/99 Betations	Matrix Spikes/ Surrogate Recoveries	₹ 2	\$ Z 2 2	104.00%	911.50%	200.601	,			ZY ZY
_	CONV-Metals 15 8/25/99	Blanks/ Detection Limits.	2					NOMB	blank blank	>	芝
	Prsman ALT 13056	Holding Times	٥٢	<u> </u>					·		\longrightarrow
	Client: sters: sle ID:	Completeness/ Methodology	0 K								\rightarrow
CONSULTANTS	Project Name/No./Client: Laboratory/Parameters: Sample Date/Sample ID:	Parameter	Turbidity	Tess / Fecals	TP	NH4-N NO2+NO2-N	Hardness	CK.	28	Liela	D. H. D. C. C. C. C. C. C. C. C. C. C. C. C. C.

Notes: NC: Not calculable due to one or prove values being below the defection and anasons as

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



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:

DATE SAMPLED:

12/17/97

12/17/97

DATE RECEIVED:

11/19/97

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER

AMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

CASE NARRATIVE

en water samples were delivered to the laboratory in good condition. The samples were enalyzed 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

	TURBIDITY	TSS	FECALS	TOTAL-P	ТРН	AMMONIA	NO3+NO2
SAMPLE ID	(NTU)	(mg/l)	(#/100ml)	(mg/l)	(mg/l)	(mg/l)	(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

		DISS	OLVED META	LS		TOTAL METALS	3
	HARDNESS	COPPER	LEAD	ZINC	COPPER	LEAD	ZINC
SAMPLE ID	(mgCaCO3/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(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
МА-З	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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CASE FILE NUMBER:

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PAGE 2

REPORT DATE: DATE SAMPLED: 12/17/97

11/19/97

DATE RECEIVED:

11/19/97

Final report, laboratory analysis of selected parameters on water

SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

9A/9C DATA WATER

QC PARAMETER	TURBIDITY	TSS	FECALS	TOTAL-P	TPH	AMMONIA	NO3+NO2
}	(NTU)	(mg/l)	(#/100ml)	(mg/l)	(mg/l)	(mg/l)	(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	12/11/97	12/11/97
i					12/17/97		1
DETECTION LIMIT	0.10	0.50	2	0.002	0.25	0.010	0.010
	V						
DUPLICATE							ı
SAMPLE ID	MC-2	MC-2	MC-2	MC-2	<u> </u>	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 NA	12.40%	12.40%
	0.00%	0.01.0	· · · · · · · · · · · · · · · · · · ·		<u> </u>		·
SPIKE SAMPLE							
SAMPLE ID		-		MC-2		DM-1	DM-1
ORIGINAL				0.121		0.078	0.325
SPIKED SAMPLE		•	1	0.168	. :	0.259	0.544
SPIKE ADDED			į.	0.050		0.200	0.200
% RECOVERY	NA	NA	NA	94.00%	NA	90.30%	109.50%
OC CHECK							
FOUND	78	9.9	T	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 NA	108.08%	107.90%	94.07%	101.79%
		<u></u>			<u> </u>		
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 BAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.



LABORATORY & CONSULTING SERVICES

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

CASE FILE NUMBER:

HER042-27

PAGE 3

REPORT DATE: DATE SAMPLED:

12/17/97

11/19/97

DATE RECEIVED:

11/19/97

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER

SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

JA/QC DATA WATER

J . J	_						
		DIS	SOLVED MET	'ALS		TOTAL METAL	S
QC PARAMETER	HARDNESS	COPPER	LEAD	ZINC	COPPER	LEAD	ZINC
	(mgCaCO3/1)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(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%
OC 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%
The Above							
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.

teven Lazoff

Laboratory Director

^{\=} NOT APPLICABLE OR NOT AVAILABLE. = NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.

^{1 -} RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

HEROH 2-27 login H- 11/19 page Cof

CHAIN OF CUSTODY RECORD

2200 Sixth Avenue, Suite 601

Scattle, Washington 98121 HERRERA (206)441-9080 Wassaxiams FAX 441-9108

12ton Sundles DIR Ð ANAL YSES REQUESTED EON+ steets 4/8/ TAINERS REQUESTED COMPLETION DATE: TOTAL # OF CON-CON # OF REMARKS: Please composite as per attack Stream Stormweter SAMPLE DESCRIPTION Dissolved metulo require filtains DELIVERY METHOD: CLIENT CLIENT COPY T6: 655 149 208 1050 150 88 TIME (33) 140 PROJECT NUMBER C836, Rizisette, J. Leuth 11/19/57 11/18/87 yquatre Kesearch DATE Sob Zistle 125mon 2 PROJECT NAME ABORATORY: EPORT TO: -W SAMPLE ID Z

RELINQUISHED BY (NAME)CO.)

DATE/TIME

RECEIVED BY (NAMENCO.)
W.J. By Kton/Aguatic

DATE/TIME

DATE/TIME

SIGNATURE

LEL MOUISHED BY (NAME/CO.)

RECEIVED BY (NAME/CO)



Composite storm sample data form

Des Moines Montoring Program
cation Des Moines Storm 16

Date

Sampling location

Personnel R. Zisette J. Lente

			Depth	Flow		Compositing proport	ions
	Sample ID	Time	<u>(ft)</u>	(cfs)	· · · · · · · · · · · · · · · · · · ·	(%) (m)	_)
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		५५.8	
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-21	1130	0-20	3.67		9.5	
14	-2	/300	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	-깇	1310	1.21	12.42		34.0	
19	-3	1355	1.50	(5,40		42.1	
20							
21	BA-1-1	1115	10:06	1.35		19.1	
22	-2	1222	10.09	1.47		70.8	
23	-3	/3/9	10.32	4.26		60.1	
24							

Comments:

form COMPFM.wq1

HE	RRI	ERA	
ENVI	MNOF	ENTAL	

Composite storm sample data form

Des Moines Monitoring Program Des Moines Storm (6

Sampling location

Date /1/19/97
Personnel RZ, JL

			Depth		Flow			Compositing	proportions
,	Sample ID	Time	<u>(ft)</u>		(cfs)			(%)	(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			65.3	
8				+2.16		-offset			
9	DM-2-1	1208	1.44	3.60	14.82	1.40		15.8	
10		1302	1.48	3.64	18.85	1,44		20.0	
11		1359	1.9/	4.07	60.38	# 1.8	7	64.2	
12				Ke gauge					
13									<u> </u>
14				-					
15							··.		
16							· .		·
17						·			
18					<u> </u>				
19									
20						<u> </u>			
2			•						
23					·				
2:							<u> </u>		
2									

Comments:

form COMPFM.wq1

٦,	A A A S S S S S S S S S S S S S S S S S
J	HERREF CONSULTA

ş		* RZ	7/10/00	r.		•	ACTION		None			. . 	News		None	None	None	
7. Lenth	9/24/99	initials	date		Instrument	Calibration/	Performance	0.K.					5 %	9,0	% 0% 0%	%00.801 %00.401 %00.0p	1 OIC.	file: DATAQA3.XLS
By	ဥ	Checked	•			Lab Control		97.50%	9,00.66	97.25%	A A	02.06.501	106.08% 94.07%	101.79%	100.40% 100.40% 90.60970		70 NA	
	I					Field	Duplicates	10.22%	4.65%	16.82.70	04.90.9	20	1.8976	0.36%	4.23%	_ n, e.	NC 0.43% 0.13% 2.53%	
		Metals	26/61/11			Lab F	Duplicates L	0.00%	3,64%	3.36%	30	4 ×	5.62%	12.4076	3.34% NC <10L	2.2192 5.94.92 8.4596	VA	
		Conv. + Metals	11/19/93	•	Matrix Spikes/		Recoveries D	X X	4	97.50%	4 7	A N	94.00%. 90.30%	109.50%	17.60%	106.40 %	A	
	ر بر ده	2.66	11 91	•	Blanks/	Detection	Limits	N.V.	C0.50	< J.00	22	52.0>	<.000>	<0.00	<0.0000 <0.0000 <0.0000 <0.0000	<1×10,0,0015 <0.005 <0.005	۸۸	
	Desman 2	Aguat	Starton	. ,		Holding	Times	0.K.		7				• •		*		
	Client	ters:	le ID:			Completeness/	Methodology	0.16.		<u>.</u>	-						>	
CONSULTANTS	Project Name/No./Client:	Laboratory/Parameters:	Sample Date/Sample ID:				Parameter	Throidity	, 55L	Hardness	Fecal Collean	TOL	VHU. N	N. 201 + 201	0.ssolved Cu Pbo Zv	10-40/V	Field Moss.	Notes:



LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715

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CASE FILE NUMBER:

HER042-29

PAGE 1

REPORT DATE: DATE SAMPLED:

01/08/98

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

	TURBIDITY	TSS	FECALS	TOTAL-P	AMMONIA	NO3+NO2	TPH
SAMPLE ID	(NTU)	(mg/l)	(#/100ml)	(mg/l)	(mg/l)	(mg/l)	(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

	Γ	DIS	SOLVED META	ALS		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



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HER042-29

PAGE 2

REPORT DATE: DATE SAMPLED: 01/13/98

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	TSS	FECALS	TOTAL-P	AMMONIA	NO3+NO2	TPH
	(NTU)	(mg/l)	(#/100 ml)	(mg/l)	(mg/l)	(mg/l)	(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
DUPLIĆATE							
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
SAMPLE ID ORIGINAL SPIKED SAMPLE SPIKE ADDED				MC-2 0.127 0.173 0.050	DM-2 0.023 0.201 0.200	DM-2 0.401 0.582 0.200	
% RECOVERY	NA	NA	NA NA	91.60%	89.05%	90.25%	NA
9с снеск			·	·			
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.



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PAGE 3

REPORT DATE:

01/13/98

DATE RECEIVED:

12/16/97

TOTAL METALO

DATE SAMPLED: FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER

12/15/97

SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

	DIS	SOLVED ME	TALS		TOTAL METALS	
HARDNESS	COPPER	LEAD	ZINC	COPPER	LEAD	ZINC
(mgCaCO3/1)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
SM18 2340B	EPA 220.2	EPA 239.2	EPA 200.7	EPA 220.2	EPA 239.2	EPA 200.7
12/22/97	12/29/97	12/29/97	01/08/98	12/26/97	12/26/97	01/08/98
2.00	0.0010	0.0005	0.003	0.0010	0.0005	0.003
						ļ
			•			
DM-2	BA-1	BA-1	МАЗ	BATCH	BATCH	MA-3
37.8	0.0036	<0.0005	<0.003	0.0042	<0.0005	0.032
38.9	0.0035	<0.0005	<0.003	0.0065	0.0005	0.032
2.99%	2.82%	NC	NC	42.99%	NC	0.00%
DM-2	BA-1	BA-1	MA3	BATCH	BATCH	МА-З
37.8	0.0036	<0.0005	<0.003	0.0042	<0.0005	0.032
57.8	0.0156	0.0097	1.00	0.0168	0.0124	0.940
20.0	0.0125	0.0125	1.00	0.0125	0.0125	1.00
100.21%	96.00%	77.60%	100.40%	100.80%	99.20%	90.80%
39.7	0.0237	0.0236	0.891	0.0234	0.0231	0.999
	0.0250	0.0250	1.00	0.0250	0.0250	1.00
99.25%	94.80%	94.40%	89.10%	93.60%	92.40%	99.90%
			<u> </u>			
<2.00	<0.0010	<0.0005	<0.003	<0.0010	<0.0005	<0.003
NA	103.00%	101.00%	NA	108.00%	92.00%	112.10%
	DM-2 37.8 38.9 2.99% DM-2 37.8 38.9 2.99% DM-2 37.8 57.8 20.0 100.21%	HARDNESS (mg/l) SM18 2340B EPA 220.2 12/22/97 12/29/97 2.00 0.0010 DM-2 BA-1 37.8 0.0036 38.9 0.0035 2.99% 2.82% DM-2 BA-1 37.8 0.0036 57.8 0.0156 20.0 0.0125 100.21% 96.00% 39.7 0.0237 40.0 99.25% 94.80%	HARDNESS COPPER LEAD (mg/l) (mg/l) (mg/l)	HARDNESS COPPER LEAD ZINC (mg/l) (mg/l) (mg/l) (mg/l) (mg/l) (mg/l) (mg/l) (mg/l) (mg/l) (mg/l) SM18 2340B EPA 220.2 EPA 239.2 EPA 200.7 12/22/97 12/29/97 01/08/98 0.0010 0.0005 0.003 0.00	HARDNESS COPPER LEAD ZINC COPPER (mg/l) (mg	HARDNESS COPPER LEAD ZINC COPPER LEAD (mg/l) (mg/l

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

i i	J	HERRERA NVIRONNIENTAL
		T.S.

Project Name/No/Client: Descend County + Metals Coretal initials Project Name/No/Client: Aqueete Bassect County + Metals Coretal initials Profect							-	By	J. Lenth	4	
Secretary Agreete Raisect Cervit, 4 Marks 2 Clecked initials Clecked Initials Clecked Initials Completeness Holding Desertion Surrogate Lab Field Lab Control Calibration ACTION	Project Name/No.	/Client:	Desv	2 con			,	Date	66/22/6	Page (of /	,
Septemble D	Laboratory/Param	eters:	Ag year			+ Metals		Checked	initials	TK RZ	
Completeness Holding Detection Surrogate Lab Field Lab Control Calibration ACTION	Sample Date/Sam	ple ID:	Star	41	17				date	7/100	
Methodology Times Limits Recoveries Duplicales Samples Performance ACTION		Completeness/	Holding	Blanks/ Detection	Matrix Spikes/ Surrogate	Lab	Field	Lab Control	Instrument Calibration/	1	
15. 15. 15. 15. 15. 15. 15. 15.	Parameter	Methodology	Times	Limits	Recoveries	Duplicates	Duplicates	Samples	Performance	ACTION	
CO.50	urbidity	<u>0</u> آخ	Ø.K.	01.07	AM	0.00%		04.500%	<i>و</i> ک		
150	. 551			05.00	ΑN	0.00%	NA	98.0070	-	None	
None NA NA NA None	lardness		_	X X	100,2190	2066-2	•	99.25%	-		
20.05 A1.6076 3,740% 103.540% Wone <0.002 91.6076 2.999% NA 95.349% Wone <0.000 90.359% 1.909% 105.949% Wone <0.000 90.359% 1.909% 105.949% Wone <0.0005 77.609% 10.6444 NA 94.409% None <0.0005 99.209% 105.409% NA 93.669% None <0.0005 99.209% 105.409% NA NA NA NA Appears None <0.0005 99.209% 0.009% 105.409% No No Note <0.0005 99.209% 105.409% NA NA Appears None <0.0005 99.209% 105.409% NA NA Appears None	ecal Colibera			62	AA	28 37	est	A A			
2.0002 91.6076 3,79976 103.9970 Nove <0.000 96.0576 1.9070 1.9070 1.9070 Nove <0.000 96.0070 1.9070 1.9070 105.9470 Nove <0.0005 77.6070 100.4070 10.6414 NA 94.4076 Nove <0.0005 99.2070 100.4	TOP			20.25	V	XX	NA	103,54%		None	
2.90 CO.010 84.05% 2.99% NA 95.34% None (05.94% Co.010 90.35% 1.90% N. 1.90% None CO.000 96.00% N. Lahu NA 94.40% None CO.0010 100.40% N. Lahu NA 94.40% None CO.0010 100.40% N. Lahu NA 94.40% None CO.0010 100.40% N. Lahu NA 94.40% None CO.0010 100.40% NA NA NA NA NA Appears None NA NA NA NA NA NA NA NA NA NA NA Appears None	F			2000>	91.60%	3,790%		103.90%			
2.N (0.010 90.25% 1.90% 1.90% 105.94% Nove (0.00% 7.5% 100.40%	VH4- N	,		010.0>	84.05a%	%6662	ΛA	95.340		None	
CO.000 96.00% 1/2 bith NA 94.80% None CO.0005 77.60% NC bith NA 936.00% CO.0005 100.40% 123×02. NA 936.00% CO.0005 99.20% 123×02. NA 93.40% CO.0005 90.80% 0.00% 90.00% CO.0005 100.80% 0.00% 90.00% NA NA NA NA NA NA Appears None O.xx.	N.201+50			0.0.0 >	90.25%	1.90%		(05.94°	0		
<a>CO.0005 <a>77.60% <a>V.C. bahl V.A. 99.10% <a>CO.0005 <a>100.40% <a>V.C. bahl Sample 93.00% <a>Sol.00% <a>100.40% <a>V.C. bahl Sample 93.00% <a>Sol.00% <a>100.40% <a>V.C. bahl Sample 93.00% <a>O.00% <a>99.20% <a>V.C. bahl Sample 93.00% <a>O.00%	solved			<0.000	96.00%		:	708.4P		1/000	
< 0.003	200			<0.0005	27.60%	グロック	4 N M	44.407)	
 <0.0010 100, 50% (43.00%) <0.0005 99.20% (43.00%) <0.0005 99.20% (43.00%) <0.0007 (40.00%) <li< td=""><td>72</td><td></td><td></td><td><0.003</td><td>100.40%</td><td>UC but</td><td><u>י</u> ל</td><td> </td><td></td><td></td><td>į</td></li<>	72			<0.003	100.40%	UC but	<u>י</u> ל				į
 < 0.0005 < 0.0007 < 0.0007<	نها			0.189 0 /	100 40%	# 2.3 X BY	- 1 - batch say			a quelfind on est	プ
	5.0 J.0			A 0.000%	99 who	NC &	ਮ \ \ \		~0	Ž	
NA NA NA Appears	42			<0.003	90.80%	0.000	•	99.90	%	Love	ı
NA NA Appears	Aleas.					-	٧/٧	· V / -	Do Wates		
	00				VΑ	۲ ۷	<u>.</u>	£ Q	Appears	<u>ک</u> ۲	
	TO.	> >	 <u>-</u> <u>-</u> <u>-</u> -						0.35.		

file: DATAQA3.XL.S

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		Zinc - 42	X -			4			DATE/TIME DATE/TIME
ANALYSES REQUESTED	.2 (GFAA) 2. (GFAA) 2 (GFAA) 2. (GFAA)	Lecal Colo Copper - tots Load - tots Lead - dis	Х —			→→→→→		45/71/22 Alm	SIGNATURE SIGNATURE
ANALYSI		HJL N-EHN 4004 JL	メ メ メ メ ス ー			D D D D D D D D D D	,	Midals filtered & press. who tryllegar	(NAME/CO.) SIGN/
		CO CON Turbidity 255	A X X X X X X X X X X X X X X X X X X X			A A A		haeks.	RECEIVED BY I.O. T. Bru RECEIVED BY
	CLIENT CAN A Des Mones COPY IO: DELIVERY METHOD:	OMPLETION DATE: TOTAL # 0F TAINERS:	SAMPLE DESCRIPTION TO			4		site as per attached s	Amy Harry
	C836/2	Harrison	DATE TIME /2/5/97 23.29	2306	2350	3320			AFECO.) AFECO.)
	PROJECT NAME Desman 2 REPORT TO: ROB ZISEHE SAMPLED BY:	J. Lenth, K. LABORATORY: Heynetic Ness Like USE:	SAMPLE ID N-/	0 M-2 B A-1	MA-3 MA-3	MC-1 MC-2		REMARKS:	RELINQUISHED BY (NAN RELINQUISHED BY (NAN



Composite storm sample data form

Date

Des Moines Water Quality Monitaring cation Des Moines Storm 17

Sampling location

Personnel J. Lenth R. Harrison

			Depth	Flow		Compositing proportions (%) (mL)
	Sample ID	Time	(ft)	(cfs)	No.	
1	DM-1-1	2329	1.69	20.62	35.7	5F7
2	-2	0032	1.67	19.68	34.1	49.3
3		0129	1.62	17.49	30.3	43.8
4						
5	DM-2-1	2346	1.58	25.98	29.2	Ì
6	-2	0046	1.66	32.37	36.4	
7	-3	0/38	1,64	30.67	34.5	
8				,		
9	BA-1-1	2306	10-19	2.40	29.1%	
10	1	0015	10.22	2.79	33.8 %	1
11		0115	10,24	3.07	37.1%	
12						
13	MA-1-1	2254	0.56	3.18	47.3	6555
14		0006	0.43	1,89	28.0	347
15	•	0/08	0.40	1.67	1 1 .	× 200
16		•				
17	MA-2-1	2350	6.47	14.13	40.5	% 357
18		0050	.G. 38	10.16	29.1	i
19	-3	0150	6. 39	10.58	, ,	1,2
20						
21	MA-3-1	0005	1.27	13.04	36.5	
22	ì	0/05	1.12	11.50	32-2	
23	-3	0205	1.09	11.19	31.3	
24						

Comments:

form COMPFM.wq1

 HERRERA

Composite storm sample data form

Project <u>Des Moines Water Quality</u>
Sampling location <u>Des Moines</u> Storm 17

Date

Personnel JL/RH

	Sample TD	Time	Depth (ft)	· · · · · · · · · · · · · · · · · · ·	Flow (cfs)	*		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		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	<u> </u>
7	-3	0140	0.75		5.55			36.8	
8					. :				
9									
10									
11							· · · · · · · · · · · · · · · · · · ·		
12									
13			,					•	
14									
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21		•							
22									
23									
24		<u> </u>	اا	<u></u>	L			<u></u>	

Comments:

form COMPFM.wq1



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

MPLES 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 stals 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 (8

	TURBIDITY	TSS	FECALS	TOTAL-P	TPH	AMMONIA	NO3+NO2
SAMPLE ID	(NTU)	(mg/l)	(#/100ml)	(mg/l)	(mg/l)	(mg/l)	(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

		DISS	SOLVED METAL	LS	TOTAL METALS					
SAMPLE ID	HARDNESS (mgCaCO3/1)	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	(mg/l) 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			



LABORATORY & CONSULTING SERVICES 3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715

REPORT DATE:

HER042-31 05/14/98

04/23/98

PAGE 2

FAX: (206) 632-2417

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

DATE SAMPLED:

CASE FILE NUMBER:

QC PARAMETER	TURBIDITY	TSS	FECALS	TOTAL-P	TPH	AMMONIA	NO3+NO2
	(NTU)	(mg/l)	(#/100ml)	(mg/l)	(mg/1)	(mg/l)	(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							
043 (77) 77 77			350.0	MC-2		MC-2	MC-2
SAMPLE ID	BATCH	MA-3	MC-2			0.059	0.584
ORIGINAL	16	99	est. 3000	0.278			1
DUPLICATE	16	94	est. 2800	0.278		0.059	0.576
RPD	0.00%	5.18%	NC 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%
		<u> </u>					
OC 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.



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

CASE FILE NUMBER:

HER042-31

PAGE 3

EPORT DATE:
ATE SAMPLED:

05/14/98

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

·		DIS	SOLVED MET	ALS	TOTAL METALS				
QC PARAMETER	HARDNESS	COPPER	LEAD	ZINC	COPPER	LEAD	ZINC		
	(mgCaCO3/1)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(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	05/01/98	05/01/98	04/28/98		
				05/04/98	05/04/98	05/04/98			
DETECTION LIMIT	2.00	0.0010	0.0005	0.003	0.0010	0.0005	0.003		
DUDU IO AMP									
DUPLICATE	:								
SAMPLE ID	MC-2	MA-2	MA-2	MA-3	BA-1	BA-1	- DA 1		
ORIGINAL	50.8	0.0059	<0.0005	0.007	0.0161	0.0078	BA-1		
DUPLICATE	50.4	0.0060	<0.0005	0.007	0.0181	0.0078	0.040		
RPD	0.79%	1.68%	NC	0.00%	19.61%	17.54%	0.043		
- · · · ·	0.7370	1.00%	NC .	0.00%	15.01%	17.5476	7.23%		
SPIKE SAMPLE									
							1		
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%		
OC 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.

SUBMITTED BY:

Laboratory Director

⁻ 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.

DIV RECORD	
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Seattle, Washington 98121 7FPA (206)441-9080 ARMS FAX 441-9108

ANALYSES REQUESTED	(101) (CFAA) (CFAA) (CFAA)	HO 1- E 103-	17 / N/4 / N	7N											shap (except for TPH and G	0.0005 mg/L 1 1100 mg 2/24/98	RECEIVED BY GNAMEROW, I M. (*) SIGNATURE SIGNATURE THE SIGNATURE SIGNATURE SIGNATURE	SIGNAT	100	0//
	PROJECT NAME PROJECT NUMBER CLIENT SEMON 2 C 836/2 CT 9 Les Moine REPORT TO: COPY TO:	BY: P. Harrison her Nerthod:	Y: REQUESTED COMPLETION DATE: TOTAL # OF $S \not\leftarrow Q'$. TAINERS:	# OF	DATE TIME SAMPLE DESCRIPTION TA	4/23/98	MA-1 (2.20	7	MA-3 1.15	BA-1 12:50	MC-1 12:15	MC-2 6 12:25 4 4	(1) Barrel Later L		→ ≭ `	of motals require lab filter ing. L'éad de tection l	ED BY (NAMEJCO.) SIGNATURE // DATE/TIME	SURPRIME DATETINE	May Hold Holder	3. 14



Composite Storm Sample Data Form

Project Des Moin	ies Monitoring	<i>C</i> 836	Date	4/23/98	Page / of 2
Sampling Location	Moines; Sto	rm 19	Personnel	J. Lenth, R.	Harrison

	· · · · · · · ·	 	T		·		
Sample ID	T:	Daniel (6)			-	Composting	
	Time	Depth (ft)	Flow (cfs)			(%)`	(mL)
Dm-1-1	15:10	1,39	9,64			473	
-2	13:08	1,43	24 6	76		K8-62	35.2%
	14:04	1.41	36/24/10.	19		17,63	353%
DM-2-1	12:26	1.24	3.27			10.4	
-2	13:26	1.45	15.75			50.3	
	14:22	1.41	18.31			39.3	
MA-1-1	12:41	0,41	1.67		÷	24.78	66.0%
-2	13:38	0.24	0.56			34 TL	22.3%
-3	14:31	0.18	0,29			4436	117%
		gauge		·			11.7
MA-2-1	1305	0.35	4,94			51.3.	
-2	1345	0.27	5.93			34.0	
	1420	0.16	256			14.7	
·							
MA-3-1	1315	0.92	9,45			37.9	
-2	1350	0.82	8.42			33,7	
-3		0.69	7.08			2814	
	لـــــــــــــــــــــــــــــــــــــ			<u> </u>			<u> </u>

Comments:



Composite Storm Sample Data Form

*		•					Page	2 of 2
Project Des	Moines	Water Mon	. C83	Date	_4/	23/98		
Sampling Locat	tion Des	Moines ;	Stor	m 9 Perso	nnel J	Lenth	, R. Han	rison
							Composting ?	Proportions
Sample ID	Time	Depth (ft)		Flow (cfs)			(%)	(mL)
BA-1-1	12:50	10.12		1.8			41.1	
-2	13:48	10.10		l. 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			2810	-
-3	1405	5.18 ?		0153			41.5	
		wier(d)	Gause					
mc-2-1	1225	0.19	0.83			based	46.3	
1	1	0.11	0.75			wier depth	26.8	
-2 -3	1410	0.11	0.75				26.8	
	;							
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Comments:

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Parameters: Aguacate Risearch Count + Match Sample Discourt Count + Match Count + Match Count	Project Name/No.	/Client:	Desv	7,000				Date	9/24/99	Page Cof
Instrument Ins	Laboratory/Param	leters:	Aguer	che Beseered	ackslash	r Metals		Checked	initials	M RZ
Simulation Blanks Matrix Spikes Field Lab Control Calibration AC	Sample Date/Sam	ple ID:	Start						date	7/1900
100.00% 100.25% 100.25% 100.25% 100.25% 100.25% 100.25% 100.25% 100.25% 100.25% 100.25% 100.25% 100.25% 100.00% 100	Parameter	Completeness/ Methodology	Holding Times	Blanks/ Detection Limits	Matrix Spikes/ Surrogate Recoveries	Lab Duplicates	Field Duplicates	Lab Control Samples	Instrument Calibration/ Performance	ACTION
Storm C22 UA ULThest UA (10125% C0.002 Regerry On 6 0.00% C0.001 Regerry On 6 0.00% C0.001 Regerry On 6 0.00% C0.001 Regerry On 6 0.00% C0.001 Regerry On 6 0.00% C0.000 Regerry	Thribidity	۵.۲. ۱۵.۲.	٥ - ۲	A A	*X	0.00°C	\ \ \	97.50%	٥ ۲.	1 hose
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70.25 NA NA 103.65% 60.002 Regently out & 0.00% 60.010 92,455, 0.00% 70.010 84.10% 12.40% 60.000 101.60% 102.00% 60.0005 97.60% 60.0005 97.60% 60.0005 97.60% 60.0005 97.60% 60.0005 97.60% 60.0005 97.60% 70.40%	recal Colibera			27	V.A.	NC 7%	est	AV		11,
7. C0.002 Regenery On & 0.00% 105.3870 C0.010 94.10% 12.40% 100.00% C0.0010 84.10% 12.40% 100.00% C0.0005 97.60% 100.00% C0.003 86.60% 6.10% 90.10 102.00.70 C0.005 82.40% 17.540% 102.00.70 C0.005 82.40% 17.540% 100.00% C0.005 891.30% 7.72% 90.00% C0.005 891.30% 7.72% 7.72% 90.00% C0.005 891.30% 7.70% 7.72% 90.00% C0.005 891.30% 7.70% 7.70% 90.00% C0.005 891.30% 7.70% 7.70% 90.00% C0.005 891.30% 7.70% 7.70% 90.00% C0.005 891.30% 7.70% 90.00% C0.005 891.20% 7.70% 90.00% C0.005 891.20% 7.70% 90.00% C0.005 891.20% 7.70% 90.00% C0.005 891.20% 7.70% 90.00% C0.005 891.20% 7.70% 90.00% C0.005 891.20% 7.70% 90.00% C0.005 891.20% 7.70% 90.00% C0.005 891.20% 7.70% 90.00% C0.005 891.20% 7.70% 90.00% C0.005 891.20% 7.70% 90.00% C0.005 891.20% 7.70% 90.00% C0.005 891.20% 7.70% 90.00% C0.005 891.20% 7.70% 90.00% C0.005 891.20% 7.70% 90.00% C0.005 891.20% 90.00% C0.005 891.20% 90.00% C0.005 891.20% 90.00% C0.005 891.20% 90.00% C0.005 891.20% 90.00% C0.005 891.20% 90.00% C0.005 891.20% 90.00% C0.005 891.20% 90.00% C0.005 891.20% 90.00% C0.005 891.20% 90.00% C0.005 891.20% 90.00% C0.005 891.20% 90.00% C0.005 891.20% 90.0	HOL			50.05	XX	KA V		(03.65%		35,007
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60,0005 46.60% 610L 76.70 70 102.00	solved			0\0000>	161.60%	1.21 A	۲ با	102.00 m		-
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CO.005 82.40 10 (T.37.50) CO.005 89,3070 7.23.00 NA Adjusted NA Colons Meter Office DATAQA3.XLS file: DATAQA3.XLS	رة ا			<0.0000	0400-211	_	ر ا	10 2.00 %	0 2/0	1/400
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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:

HER042-32

PAGE 1

REPORT DATE: DATE SAMPLED:

07/13/98

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

	TURBIDITY	TSS	FECALS	TOTAL-P	TPH	AMMONIA	NO3+NO2
SAMPLE ID	(NTU)	(mg/l)	(#/100ml)	(mg/l)	(mg/l)	(mg/l)	(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	76.0	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

		DISS	OLVED META	LS		TOTAL METALS	3
	HARDNESS	COPPER	LEAD	ZINC	COPPER	LEAD	ZINC
SAMPLE ID	(mgCaCO3/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(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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PAGE 2

REPORT DATE:

OATE SAMPLED:

07/13/98

06/24/98

DATE RECEIVED:

06/24/98

'INAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER

SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

A/QC DATA WATER

1					· · · · · · · · · · · · · · · · · · ·		
QC PARAMETER	TURBIDITY	TSS	FECALS	TOTAL-P	TPH	AMMONIA	NO3+NO2
	(NTU)	(mg/l)	(#/100ml)	(mg/l)	(mg/l)	(mg/l)	(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	10/26/93	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	ı L						
			1 222			·	
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 NA	3.45%	5.50%
SPIKE SAMPLE							
SPIRE SAIVIPLE							
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%
OO OFFICE							
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%
			***************************************			<u> </u>	
BLANK	NA	<0.50	< 2	<0.002	<0.25	<0.010	<0.010

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.



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3927 AURORA AVENUE NORTH, SEATTLE, WA 98103
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REPORT DATE: DATE SAMPLED: 07/13/98

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06/24/98

final report, laboratory analysis of selected parameters on water

SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

QA/QC DATA WATER

		DIS	SOLVED MET	'ALS		TOTAL METALS	
QC PARAMETER	HARDNESS	COPPER	LEAD	ZINC	COPPER	LEAD	ZINC
	(mgCaCO3/1)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(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.

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

2200 Sixth Avenue, Suite 601
Scattle, Washington 98121
HERRERA (206)441-9080
GONSLIMMS FAX 441-9108

CHAIN OF CUSTODY RECORD

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<u> </u>	DM-1	6/24/58	82:6	SATER	Storm	سدور ک		X X	X	<u>/</u>	X X	X	X	X	X X	<u> </u>	X	X	1	Т
1	DM-7	-	9:50							7						$\frac{1}{1}$		7		
1	BA-1		9:06				_			\dashv						1			-	Т
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	RELINQUISHED BY (NAME/CO.)	Y (NAME/CO.)	MGNATURE	E. E.	DAT	E/TIME	<u>E.</u>	RECEIVED BY (NAME/CO.)	BY (N/	ME/CO.)	l	S	SIGNATURE			*	DATE	DATE/TIME		
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HERRERA	

Composite storm sample data form

Project Des Moines Water Quality Monitoring

Date

Sampling location

Personnel ___

	_Sample ID	Time	Depth (ft)		Flow (cfs)			Compositing	Droportions
1	DM-1-1	9:28	1.64	T	18.34			(%)	(mL)
2	-7	[0:3€	1.28		6.99			59.6	
3	-3	111.30	1.20		5,44			17.7	
4					3,74			+ + + + + + + + + + + + + + + + + + + +	
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	1		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	-	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									1
21	MA-3-1	9155	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 CONSTITUTATE	

Composite storm sample data form

Page 2 of 2

Project

Des Moines Water Quality Monitoring

Date

6/24/98

Sampling location

Des Maines &

Personnel KE, 34

	Sample ID	Time	Depth (ft)	 Flow (cfs)	· · · · · · · · · · · · · · · · · · ·	Compositin	g proportions (mL)
1	MC-1-1	9:00	5.17	0,49		35.8	(1110)
2	-2	(0:00	5.17	 0.49		35.8	
3	3	11:15	5,14	0,39		28.3	
4							
5	MC-2-1	9:25	6.77	5.92	1.6632	34.4	
6	-2	10:10	0.75	5.55	7.62	33.5	
7	-3	11:25	0.72	502	1.5634	32.1	
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Comments:

form COMPFM.wq1

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سلام	Page 1 of 1.	ACTION	Nove		-	Nove		ار امران		None		All total Cavalues estimated (3) couse (ab	Nova		interior Nove	Meter	
J. Levelly	ी/24/99 initials date	Instrument Calibration/ Performance	o スー				0		.0.					1	Some inter-	File: DATAQA3.XLS	
By	cked	Lab Control Samples	100.00% 100.0001	2005.46	KN.	105·17%	103.23% 162.73%	07.32.90	102,00 000	102.00 %	103.50 %	101.20-07	0% 97,80	92.80 %	NA		
	1 1 1	Field Duplicates	A A		est.		0 ~	ر م	۲	NC BORK	7,	220	² 0	Ę.		>	
	24 99	Lab Duplicates	6.00% 5.71%	1.95%	11.76%est.	XX	2000 L	5.50%	4101	25	7012	26.55%	4.330%	5,412	NA		
		Matrix Spikes/ Surrogate Recoveries	NA AV	99.50%	NA	VV.	Recovery out of Range	80,50%	9602.66	100.40.70	93.20%	89.60%	96.00%	109.10%	NA		
	Desmond Leperte Asserth	Blanks/ - Detectio n L imit s	NA <0.50	< 2.00	27	50.05		0 0 0 V	10,000	< 0.005	50003	< 0.0000	5000,02	<0.0>	NA N		
	Aguerte Storm	Holding	9			····		 _	-					-		>	
	/Client: leters: ple ID:	Completeness/ Methodology	ソ													->	
CONSULTANTS	Project Name/No./Client: Laboratory/Parameters: Sample Date/Sample ID:	Parameter	Thribidity TSS	Hardyece	Fecal Colibera	HOL	E	101+ 102.N	Dissolved	3 2	, N	10401	32	8 N	Field Meas.	ong ong	Noles:



LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715

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CASE FILE NUMBER:

HER042-34

PAGE 1

EPORT DATE: ATE SAMPLED:

10/30/98 10/12/98

DATE RECEIVED:

10/12/98

final report, laboratory analysis of selected parameters on water

MPLES 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 ware 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

	TURBIDITY	TSS	FECALS				
SAMPLE ID	(NTU)		· — -	TOTAL-P	TPH	AMMONIA	NO3+NO2
DM-1		(mg/l)	(#/100ml)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
DM-2	13	22	est 2200	0.110	0.31	0.127	0.432
BA-1	8.5	26	>2220	0.117	<0.25	0.034	
	20	52	740	0.198	<0.25	0.048	0.499
BA-2	19	49	840	0.195	<0.25		0.803
MA-1	7.5	9.5	>19600	0.108		0.047	0.812
MA-2	11	18	>1820		0.30	0.061	0.384
MA-3	10	20		0.079	0.50	0.077	0.426
MC-1	3.5		>1600	0.102	<0.25	0.037	0.604
MC-2		3.2	est 3200	0.182	<0.25	0.019	0.178
	20	15	est 3200	0.131	0.25	0.075	0.346

		DIS	SOLVED META	ALS	TOTAL METALS				
SAMPLE ID	HARDNESS	COPPER	LEAD	ZINC	COPPER	LEAD	ZINC		
DM-1	(mgCaCO3/1)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)		
DM-2	45.6	0.0057	<0.0005	0.015	0.0106	0.0040	0.043		
BA-1	75.0	0.0033	<0.0005	0.013	0.0068	0.0023	0.034		
BA-2	76.4	0.0032	<0.0005	0.017	0.0066	0.0018	0.021		
MA-1	75.0	0.0033	<0.0005	0.010	0.0082	0.0020	0.030		
MA-2	51.3	0.0050	0.0006	0.034	0.0068	0.0045	0.043		
MA-3	51.5	0.0038	<0.0005	0.004	0.0057	0.0022	0.017		
MC-1	86.7	0.0031	<0.0005	0.004	0.0046	0.0014	0.022		
MC-2	36.8	0.0023	<0.0005	0.057	0.0027	<0.0005	0.068		
MA-4	30.8	0.0061	<0.0005	0.019	0.0139	0.0014	0.022		
		<0.0010	<0.0005	< 0.003					

1 A-2 = Field duplicate of BA-1 MA-4 = Field transfer blank



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

CASE FILE NUMBER:

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PAGE 2

REPORT DATE: DATE SAMPLED: 10/30/98

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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	TSS	FECALS	TOTAL-P	TPH	AMMONIA	NO3+NO2
-	(NTU)	(mg/l)	(#/100ml)	(mg/l)	(mg/l)	(mg/l)	(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	1	0.079	0.350
RPD	4.88%	4.44% _	NC	4.18%	NA	5.30%	12.40%
		6	6.04			5.19	1.15%
SPIKE SAMPLE		U					,
							T
SAMPLE ID				DM-2	ł	MC-2	MC-2
ORIGINAL				0.117	ļ	0.075	0.346
SPIKED SAMPLE				0.167	ŀ	0.270	0.529
SPIKE ADDED	·			0.050		0.200	0.200
% RECOVERY	NA	NA	NA	99.00%	NA 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%
-		110070					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.



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

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. Inal report, laboratory analysis of selected parameters on water

SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

A/QC DATA WATER

		DIS	SOLVED META	ALS		TOTAL METALS	
QC PARAMETER	HARDNESS	COPPER	LEAD	ZINC	COPPER	LEAD	ZINC
	(mgCaCO3/1)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(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	r iA					, -	
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%
OC CHECK	99.5	94,4	95.2	103,14			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%
			100.00	104 %	······································		13475
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.

* 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

CHAIN OF CUSTODY RECORD

PROJECT NAME	PROJECT NUMBER		`				ANAL YSES REQUESTED	S REQUE	X GEL				П
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REPORT TO: Rob Zisette	भ		COPÝTO:					W=19	49)	W19	471	<u>」っ</u> か	
SAMPLED BY: R. ZISEHE	te M. Brenna-	नगवन	DELIVERY METHOD: haned		N-	````) [• 551) X))~		
LABORATORY:	Rosarra	REQUESTE	REQUESTED COMPLETION DATE: TOTAL # OF CON-	14.7 5521	- <u>E</u> 0(N	<u> </u>	74 ⁻	p- -	<u> २५०१</u>	44	5) 10	
	7		FO S	בפנק	H (1)	-741	Hd	مورز	2 2 94:	- Jan - Jan	- 2V)	2VI	
SAMPLEID	DATE	TIME	SAMPLE DESCRIPTION TAINERS	7	V	7	7	ก) อา	<u>'</u>	27 24	2	7	
\[\mu_{M-1} \]	86/21/91	<u> </u>	Streem Stormwider 5	X X	义 义 x	X	Х У	X		X U	사사		Т
DM-2	_		_			3			_				\top
BA-1		2560								1			\top
84-2		5460						-		+		+	\top
4		0925						1		+	-	+	T
MA-2		1015								+		+	-
MA-3		CE0/						+		+			T
Mc-1		06/30						7		+		+	П
Me-2		0500	A	A	→ → →	•	4	7	4	>	→	-	T
i	A	1600	-				-	4	X	X			•
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REMARKS: Please Composite as	se 60	mposí	per attached	sheets	¥	7° ¥		detection	n lim	7.	12.0=	<i>u</i> -	,
1 Dissolved metals reguire	Mete	15 reg	quire filtering.								6055	2/6	T
RELINQUISHED BY (NAME/CO.)	AME/CO.)	SIGNATURE				CO.)	SIGNATURE	RE	()		DATE/TIME	ME 48 1700	Q
RELINQUISHED BY (NAME/CO.)	./1	SIGNATURE	10 Pura	1=-			SIGNATURE	JRE			DATE/TIME	WE.	
			7	2 1	\$	13,	¥			,	1		



Project Der Moines Water Auglity Monitoring Date 10/12/98

Sampling Location Des Moires storm 20 Personnel PET MB

·	1			
				Composting Proportions
Sample ID	Time	Depth (ft)	Flow (cfs)	(%) (mL)
BA-1-1	9:35	9.89	0.19	7.9
-2	10:45	10.06	1.24	529
-3	11:49	10.02	0.19 1.24 0.94	7.9 52.9 39.2
DA O I	0.46	0.00	·	<u> </u>
BA-2-1	7:33	9.89	0.19	7.9
-2 -3	10:35	10.06	1.26	52.9
-3	9:45 10:55 11:45	10.02	0.94	7.9 52.9 39.2
DM-1-1	10:00	1.38	622	33.1
-2	11:05	144	10.97	38.8
-3	12:10	1.44	9.32 10.92 7.89	28.0
	12.13	11,70		20.0
DM-2-1	10:15	1.18	2.32	5.9
- 2	11:15	1.39	13.94	35.2
-3	12:20	1.34	2.32 1 3. 94 10.19	25.7
MA-1-1	9:25	0.2	0.39	29.8
MA-1-1 -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	8.15	34.2
-2 -3	11:10	0.21	3.97	21.6

Comments:

wpl c:\document\forms\enstform\compssd.doc



4 ~1	Page 2 of 2
Project Des Moines Water auglity Montpring Date 10/12/98	
Sampling Location Des Moines, Storm 20 Personnel PZ M	B

						Composting	Proportions
Sample ID	Time	Depth (ft)		Flow (cfs)		(%)	(mL)
MA-3-1	10:30	0.78		7.91		33.3	
-2	11:25	0.77		7.81		32.9	
-2 -3	12:50	0.79		8.01		33.8	
MC L	0:2	r .5	<u> </u>	חוד		7/ 1	
MC-1-1 -2	9:30	5.05		0.15		 21.1 37.5 41.4	
	11:45	5.10 5.11	 			 ALL	
-3	11-45	2.11		0.30		 71.4	
MC-2-1 -2 -3	9:50	0.69		lise de	024	33,5 33.5 33.0	·
-2	10:50	0.19		Use de	2005	33.5	
-3	12:00	0.69 0.68		7.7.		33.0	
		<u></u>	1	·			
							
		÷ ,					

Comments:

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Herrera Environmental Consultants

10,000	Δ Page 1 of 1. R Z 7/11/60	ent ion/ ance ACTION	None								→	None		but Note # 2.3 MD- display	All total Pb values at Flag 5	None	but Note 35% total Enim	greles dep		QA3.XLS
Á	· · · · · · · · · · · · · · · · · · ·	Instrument of Calibration/ Performance	SZ NA			0/2	٠	10	.0	o/		3%) 	04.0870 V	- 6	9	file: DATAQA3.XLS
:	Date Checked t tansferBlan	Lab Control Samples	100.25%	110.00%		10 08 970	10547FE	99.39.0%	109.20%	102.00:10		NC BURY 100.80%	9440%	51.85% 150 101.00 1/2		•		410	-	on Whith
	- Fifte	CA1 = CA -2 Field Duplicates	5,13%		12,6070	0/6251	0%0	7012	1.11%	1,35%			2	51.85%	410L%	21.62%	35.29%	¥ Z		e defecti
	SMoines Date Checked BENTIARS + Duplicate + Themsentials	Lab Duplicates	4.88%	0.00%	NC 6 st.	4.1873	Ϋ́N	6,1973	1.15%	0.54%		AL boku	2		69.67 7.13%	85.6% 3.85%	99.7% 10.99%	AIA	5	below the
	2 0	Matrix Spikes/ Surrogate Recoveries	٨A	NA V	¥	100%	NA NA	94.5%	91.5%	99.5%		95.2%	94,4%	103, Lo%	9.69	9.5%	4.7	NA		Jues being
	17.00 V	Blanks/ Detection Limits	- هٰ ا				<u> </u>				-				No hits	ontrainser) blank)	NA	?	u or more ra
	Deamon/Ci AKI/Cońv. Storm 20	Holding Times	-لا																->	due to or
	o./Client: neters: nple ID:	Completeness/ Methodology	OK.				-				<u>.</u>			·					-}	Nor calculable due to one or more values being below the defection likint
NEMIENTAL EWIROMAENTAL CONSULTANTS	Project Name/No./Client: Laboratory/Parameters: Sample Date/Sample ID:	Parameter	Turbidity	735	recals	TP	HAL	N L'N	NO + ON	Hardness		Disselved	<u>)</u> 3	Zn	Total	2	3,U	Field	FG.	Notes: NC : N



LABORATORY & CONSULTING SERVICES

9927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715

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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

	TURBIDITY	CONDUCTIVITY	TSS	FECALS	TOTAL-P	TPH	AMMONIA	NO3+NO2
SAMPLE ID	(NTU)	(umhos/cm)	(mg/l)	(#/100ml)	(mg/l)	(mg/l)	(mg/l)	(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

		DISS	SOLVED META	LS		TOTAL METALS	
•	HARDNESS	COPPER	LEAD	ZINC	COPPER	LEAD	ZINC
SAMPLE ID	(mgCaCO3/1)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(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
МА-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	0.0045	<0.0005	0.008	0.0103	0.0055	0.028

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LABORATORY & CONSULTING SERVICES

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INAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER

AMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

A/QC DATA WATER

TURBIDITY	CONDUCTIVITY	799	FECALO	TOTAL D			
							NO3+NO2
							(mg/l)
		1				1 1	EPA 353.2
		1				1 ' '	01/15/99
0.10	0.10	0.50	2	0.002	0.25	0.010	0.010
MC-2	MC-2	MC-2	MC-2	MC-2	 	MC-2	MC-2
22	118	18	560	0.106		1	0.445
24	118	17	est 340	0.099		1	0.446
8.70%	0.00%	5.71%	NC	6.56%	NA	1	12.40%
***				70.0370		5.19%	0.22%
						T:	
						1	MC-2
		·	į			1	0.445
				į į		l i	0.641
374		•••				1 1	0.200
NA NA		NA NA	NA	103.00%	NA NA		97.75%
				102.00%		111.00%	98.27.
1				0.090	33.8	0.529	0.976
-	718	10		0.093	33.9	0.499	0.933
106.25%	104.74%	98.00%	NA	96.77%	99.71%	106.05%	104.61%
<u>.</u>						104, DIO10	
NA	NA NA	<0.50	< 2	<0.002	<0.25	<0.010	<0.010
	22 24	(NTU) (umhos/cm) SM182130B SM182510B O1/15/99 O1/21/99 O.10 O.10 MC-2 MC-2 22 118 24 118 8.70% O.00% NA NA 85 752 80 718 106.25% 104.74%	(NTU) (umhos/cm) (mg/l) SM182130B SM182510B EPA 160.2 O1/15/99 O1/21/99 O1/20/99 O.10 O.50 O.50 MC-2 MC-2 MC-2 22 118 18 24 118 17 8.70% 0.00% 5.71% NA NA 85 752 9.8 80 718 10 106.25% 104.74% 98.00%	(NTU) (umhos/cm) (mg/l) (#/100ml) SM182130B SM182510B EPA 160.2 SM18222D O1/15/99 O1/21/99 O1/20/99 O1/14/99 O.10 O.50 2 MC-2 MC-2 MC-2 MC-2 118 18 560 24 118 17 est 340 8.70% O.00% 5.71% NC NC NA NA NA NA NA NA NA NA	(NTU) (umhos/cm) (mg/l) (#/100ml) (mg/l) (mg/l) SM182130B SM182510B EPA 160.2 SM18222D EPA 365.1 O1/15/99 O1/21/99 O1/20/99 O1/14/99 O1/18/99 O.10 O.50 2 O.002 MC-2 MC-2 MC-2 MC-2 MC-2 MC-2 MC-2 22 118 18 18 560 O.106 24 118 17 est 340 O.099 8.70% O.00% 5.71% NC 6.56% Up. つごうつ	(NTU) (umhos/cm) (mg/l) (#/100ml) (mg/l) ((NTU) (umhos/cm) (mg/l) (#/100ml) (mg/l) (mg/l) (mg/l) (mg/l) (mg/l) (mg/l) (mg/l) (mg/l) (mg/l) (mg/l) (mg/l) (mg/l) (mg/l) SM182130B SM182510B (PA 160.2) SM188222D EPA 385.1 EPA 415.1 EPA 350.1 O1/15/99 O1/21/99 O1/20/99 O1/14/99 O1/18/99 O1/24/99 O1/15/99 O1.10 O.10 O.50 2 O.002 O.25 O.010 O.10 O.10 O.50 2 O.002 O.25 O.010 O.002 O.25 O.010 O.002 O.25 O.010 O.003 S.70% O.00% S.71% NC 6.56% NA S.70% O.009 S.70% O.00% S.71% NC 6.56% NA S.70% O.009 O.075 O.297 O.050 O.050 O.297 O.050 O.050 O.297 O.050 O.050 O.297 O.050 O.050 O.297 O.050 O.050 O.200 O.050 O.005 O.200 O.050 O.050 O.200 O.050 O.050 O.200 O.050 O.0

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 SPIRE SAMPLE OUT OF RANGE OR SPIRE TOO LOW RELATIVE TO SAMPLE CONCENTRATION



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PAGE 3

REPORT DATE: DATE SAMPLED:

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01/14/99

final report, laboratory analysis of selected parameters on water

SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

9A/9C DATA WATER

		DIS	SOLVED MET	ALS		TOTAL METALS	3
QC PARAMETER	HARDNESS	COPPER	LEAD	ZINC	COPPER	LEAD	ZINC
	(mgCsCO3/1)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(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%
OC 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
DTC#117	₹2.00	40.0010	<u> </u>	<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:

Laboratory Director

にんっつか

Scattle, Washington 98121



Project Des Moines Water Quality Date 1/13/99

Sampling Location Des Moines Streams Personnel RZ and MB

			<u> </u>	·	
Sample ID	Time	Depth (ft)	The state of the s	Composting P	
DM-1-1		1.61	Flow (cfs) 16.6	(%)	(mL)
	2230			44	
-3	í	1.52	13.4	35	
	2340	1.32	7.9	21	<u> </u>
Dm-2-1	2/40	1/11	24.44	100	
-2		1.64	34.14	39	·
	2250	1119	29.85	35	
	2358	1.48	21.86	26	
BA-1-1	<u> </u>				
	2050	10,24	3.24	4/	
-2 -3	2210	10.20	2.73	35	
-3	2320	10.13	1.93	24	
1111					
MA-1-1	3040	0.43	1.89	58	
-2	2200	0,28	0.76	58	
	2310	0.26	0,63	19	
MA-2-1		_		37	
	2225			37	
-3	2340			30	
	į.				
MA-3-1.	2140	1.09	11.05	37	
-2	2235	0.98	9.94	37	
-3 2	7350	0.89	9.02	30	

Comments:



	C836						ъ.	2.2
Project De	c Mar	nes War Maines	ten Ou	calita Dan	1	/14/	Page	<u>2</u> of 2
Sampling Locat	tion has	Maia	Stran	Date Date		02	- 1	10
	عصد المالة	Mary	STIES	Perso	onnei	<u>KZ</u>	and Ir	140
							Composting	Proportions
Sample ID	Time	Depth (ft)		Flow (cfs)			(%)	(mL)
MC-1-1	2045	5.22		0.69			.31	
-2	2200	5.24		0,78	,		35 33	
-3	2315	5,23		0.74			33	
MC-2-1	2105	0.90					33	
		0.92					34	
		0.89					3.3	
		· -						
		 						
		-						
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Comments:

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101	Page 1 of 1	ACTION	Hone	_		note town			_					A	None	Floy all total Phyalue J	as estimates	None	Ð
the transfer	28/00 initials	Instrument Calibration/ Performance	NA			:	0						· · ·			14	\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	96)
ğ	Date Checked	Lab Control Samples	104.25%	104.7476	98.00%	¥	94.77.90	99.71 %	106. DI 70	S. 50	100.507	98,409 ₆	99.60%	101.00%	100.80%	103.20%	103.00%	NA	
		Field Duplicates				NC 49 % est dup	b						soch a	Bothu	,				
	loines	s/ Lab Duplicates	8.70%	0.00%	5.71%	NC 49:	1283.0	∀ Z	6.19%	0.22%	1.65%	64.17		< DL	6.25%	31.33%	0.00-70	NA	
	Cityo DesMoines Metals 13 99 8 stations	Matrix Spikes/ Surrogate Recoveries	₹ _Z	¥2	NA	¥Z.	102.00%	¥	111.00%	98.00%	97,50%	000 000	77% 198	91.10%	107.20%	112.60%	113.90%	X 1	2
•	387, 111	Blanks/ Detection Limits	9.	·								• • • • • • • • • • • • • • • • • • •	11	•/			->	4	
	RESIDEN/C	Holding)) (,,	· · · · · · · · · · · · · · · · · · ·		· .									· >
	Client: ters: le ID:	Completeness/	٥٢										•	•			- 0	-	∌
CONSULTANTS	Project Name/No./Client: Laboratory/Parameters: Sample Date/Sample ID:	Parameter	Turbidity	conductivity	T55	Fecals	TP	TPH	マーケエフ	NO 3+ NO 2	Hardness	Discolved	3.4 <u>0</u>	B	Total	7.0 1.0	4. C.	Field Temp	H 8



LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715

FAX: (206) 632-2417

CASE FILE NUMBER:

HER042-37

PAGE 1

REPORT DATE:
DATE SAMPLED:

03/29/99

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

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 vere 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

	TURBIDITY	TSS	FECALS	TOTAL-P	TPH	AMMONIA	NO3+NO2
SAMPLE ID	(NTU)	(mg/l)	(#/100ml)	(mg/l)	(mg/l)	(mg/l)	(mg/1)
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

		DISS	SOLVED METAI	LS.		TOTAL METALS	
	HARDNESS	COPPER	LEAD	ZINC	COPPER	LEAD	ZINC
SAMPLE ID	(mgCaCO3/1)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(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	<0.00
MC 2	49.8	0.0058	<0.0005	<0.003	0.0072	<0.0005	0.014
мс з	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
МА З	58.0	0.0029	<0.0005	<0.003	0.0043	<0.0005	0.016
MC-4		<0.0010	<0.0005	<0.003			

mc3 = Field duplicate of MC-2 mc-4 = Field transfer blank



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

CASE FILE NUMBER:

HER042-37

PAGE 2

REPORT DATE: DATE SAMPLED:

03/29/99

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	TSS	FECALS	TOTAL-P	TPH	AMMONIA	NO3+NO2
,	(NTU)	(mg/l)	(#/100ml)	(mg/l)	(mg/l)	(mg/1)	(mg/1)
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 I		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%
SPIKE SAMPLE	-	5.13%		2.357s		< 1DL	0.11%
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%
9с снеск			,	104.00%	-	103.00%	911,00%
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%
						105.4190	101.299
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.



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

CASE FILE NUMBER:

HER042-37

PAGE 3

REPORT DATE: ATE SAMPLED:

03/29/99 03/12/99

DATE RECEIVED:

03/12/99

INAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER

SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

۱A	/QC	DATA	WATER
-		~~~~	WALLIN

		DIS	SOLVED META	ALS		TOTAL METALS	5
QC PARAMETER	HARDNESS	COPPER	LEAD	ZINC	COPPER	LEAD	ZUNC
	(mgCaCO3/1)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(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%
		ZIDL			LIDL	· · · · · · · · · · · · · · · · · · ·	
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%
OC 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

D. RELATIVE PERCENT DIFFERENCE

UBMITTED BY:

Steven Lazoff

* aboratory Director

^{*} NOT APPLICABLE OR NOT AVAILABLE.

<sup>NOT CALCULABLE DIN NOT AVAILABLE.
NOT CALCULABLE DUE TO ONE OF 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.</sup>

CHAIN OF CUSTODY RECORD

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SIGNATURE DATE/TIME RECEIVED BY (NAME/CO.) SIGNATURE	Breiney/He.		Mas	Shennan	3/499		1 / C	Ž	2775	<u> </u>) 		3	3/12/9	7.1	0
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Project Des Moines	3/12/66	Page \underline{I} of $\underline{\underline{\lambda}}$
Project	Date $3/12/99$	
Sampling Location DesMoines	Personnel Kent Ensthase	Matt Brenza

	,	,		
Sample ID	77:	70 (1.45)		Composting Proportions
	Time	Depth (ft)	Flow (cfs)	(%) (mL)
DM-1-1	1125	1,27	6.83	33.6
DM-1-2 DM-1-3	1250	1,25	6.44	367
UM-1-3	1410	1,28	7.03	34.6
DN1-2-1	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 BA-1-3	1230	10.03	1.01	30.1
BA-1-3	1355	10.05	/,/8	34.9
			, , , , , , , , , , , , , , , , , , ,	
	<u> </u>			

Comments:

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Project	e Mai	<i>د</i> ے		Date	. 3	112/9	Page .	<u>Z</u> of <u>Z</u>
Sampling Locat	tion	Les Moin	>	Date Pers	onnel	Kentén	sThorse,	Ust Bren
S 1 TD							Composting	Proportions
Sample ID	Time	Depth (ft)		Flow (cfs)	 		(%)	(mL)
MC-1-1	1050	5.16	 	0.46	ļ		33.33	
MC-1-2 MC-1-3	1195	5.16 5.16		0,46			33,33	
146-1-3	/ 725	5,16		0.46			33.33	
ML-2-1 MC 2-2	1105			0.7 5		30%		
M62-2	1155			0.7		30%	3	
MC-2-3	1350					40%		
11/-2-1			<u> </u>		<u> </u>			
ML-3-2				ļ	 	30%	建	
ML-3-3		· · · · · · · · · · · · · · · · · · ·	 		 	30%	理》	
196 7-3			-			40%	房房	
							·	
				·				
		M			7			
					_			
Comments:	<u> </u>				<u></u>			

Herrera Environmental Consultants

200	Page of	RZ	2/11/00			ACTION	None	**	None but 100 K	None					4	but note procession	None						A	ю.
R. Tangrek	3/8/00	initials	date		Instrument Calibration/	Performance	NA				·					. \$ 		7o	10).7c	> 0.	5).	ile: DATAQA3.XI.
By	Date	Checked	يذ) ~	Lab Control	Samples	93.75%	940,00%	t. NA	426, 978,	0.0070b#4 98,3570	105,41%	101.29%	98,75%		22 VOZ. 8070	94.80%	99,1090	102,00%	94.80%	94.40%	N N		さらまして
			ate + I Red	manger one -	Field 10	Duplicates	0.00%	0.00.0	66.67% cst. NA	1.63%	0.0070b#1	7017	0.6970	7.07%		11.819.122 V	0.00%	0.00%	2.74%	0.0072	701~	4N		r defectio
	S	K			Lab	Duplicates	0.00%	5,1370	گ ا	2.35%	\$ 2	<1DJ	6.1170	0.00%		7017	S S	<u>ج</u>	701>		0.00%	之		below th
	City of Desimones	\ \ \ \	Betations + 1 other	nile Hand	Matrix Spikes/ Surrogate	Recoveries	ΑN	A.	AN	104.00%	ΥZ	103.00%	91.00%	916.00%		93.60%	99.20%	94.00%	110.60%	100.80%	10.5.4070	*Z		Imas from
	_	Conv + metal	3/15	mca-fidhanjerdan	Blanks// Detection	Limits	ه لد									No Mits) plank (,			A	42		one or more values being below the defection linis to managas as
	Desman/C307	102/6	Storm 22		Holding	Times	ž				- <u>-</u>									-				ļ.
	o./Client:	neters:	nple ID:		Completeness/	Methodology	05					<u></u>								•				No: nor calculable due to
CONSULTANTS	Project Name/No./Client:	Laboratory/Parameters:	Sample Date/Sample ID:			Parameter	(urbidin	15.5	Fecals	Ę.	HAL	NHY-N	N-, ON + NN	4 adrils		Dissolved	35	5,6	Total	34	Zn	Field Pemp Lang		



LABORATORY & CONSULTING SERVICES

3927 AURORA AVENUE NORTH, SEATTLE, WA 98103

PHONE: (206) 632-2715 F

FAX: (206) 632-2417

CASE FILE NUMBER:

HER042-38

PAGE 1

REPORT DATE: DATE SAMPLED: 06/01/99

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)	pН	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

		DISS	SOLVED META	LS		TOTAL METALS	3	<u> </u>
	HARDNESS	COPPER	LEAD	ZINC	COPPER	LEAD	ZINC	TPH
SAMPLE ID	(mgCaCO3/1)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(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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PAGE 2

REPORT DATE: ATE SAMPLED: 06/01/99

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INAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER

LAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

A/QC DATA WATER

QC PARAMETER	TURBIDITY	CONDUCTIVITY	pН	TSS	FECALS	TOTAL-P	AMMONIA	NO3+NO2
	(NTU)	(umhos/cm)		(mg/l)	(#/100ml)	(mg/l)	(mg/l)	(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					*			ŀ
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%
SPIKE SAMPLE				4,087.		2.23%	ZIDL	2.0176
OI HE OAM HE								!
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%
				-				
OC 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%
					•	107.27%	106.6110	98.397
BLANK	NA	NA	NA	<0.50	< 2	<0.002	<0.010	<0.010

RPD - RELATIVE PERCENT DIFFERENCE.

NA = NOT APPLICABLE OR NOT AVAILABLE.

N° = 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.



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

CASE FILE NUMBER:

HER042-38

PAGE 3

REPORT DATE: DATE SAMPLED:

06/01/99 05/11/99

DATE RECEIVED:

FAX: (206) 632-2417

05/11/99

Final report, laboratory analysis of selected parameters on water SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

9A/9C DATA WATER

00.00		DIS	SOLVED MET	ALS		TOTAL METAL	S	1
QC PARAMETER	HARDNESS	COPPER	LEAD	ZINC	COPPER	LEAD	ZINC	TPH
) (Tomas o m	(ImgCaCOS/1)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(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	T. 3-5	
ORIGINAL	47.6	0.0028	0.0013	<0.003	0.0030		MC-1	
DUPLICATE	46.6	0.0029	0.0014	<0.003	0.0030	0.0026	0.007	
RPD	1.98%	1.75%	0.74%	NC	6.90%	0.0027	0.008	
	2/1276	ZIDL	LIDL		·	3.77%	13.33%	NA NA
SPIKE SAMPLE	D110 .0	2100	2100	PL	LIDL		2100	
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	i
% RECOVERY	95.13%	88.48%	109 68%	89.10%	93.60%	113.60%	100.20%	NIA
	-					110.00%	100.20%	NA NA
OC 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	40.2 42.4
% RECOVERY	100.73%	103.92%	108.00%	96.72%	103.92%	108.00%	96.72%	
	100,2500	104,0070		14. 1696	104,05 h		96.7673	94.81%
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

TO = DECOMPS 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

1414 Dexter Avenue North, Suite 200

Seattle, Washington 98109

(206)281-7604 FAX 281-7651

HEÄRERA ENVIRONMENTAL CONSULTANTS

CHAIN OF CUSTODY RECORD

Page ____of

6.97 6.75 6.93 6.93 6.78 11.9 7.01 3,0 of 3 samples. Compositing = 0.5ppb A 12 178 on First 11 (Sample #-3). Analyze TP Hand Feral Analyza remaining samples on composite of 3 samples.

Lemorrow AM. Dissolud metals require filtering after compositions.

PANY)

PANY)

PANY)

PANY)

PANY)

RECEIVED BY LAB (SIGNATURE, DAME, COMINANY)

PANY)

PANY) # OF CON TAIN ERS REQUESTED COMPLETION DATE TOTAL # OF CONTAINERS G third sample Shrmwakt SAMPLE DESCRIPTION TO THE OZ DELIVERY METHOD: 12 Ct 9 Stream PROJECT NUMBER CLIEN 1308 1345 1310 1320 1315 1340 (358 1321 TIME Aquatic Research 5/11/20 RENIARKS: Analyze pH Sample (Sample - 1 DATE ROB ZISETTE SAMPRED BY: LABJEATORY; RES. proportions wil Desmon 2 116-2 MA-3 71A-4 QIECT NAME MA-2 BA-1 ーフル アーダク MA-1 DM-1 SAMPLEID

AR 025564

RELINDINSTRED BY (SIGNATURE, NAME, CONTRANY)

TPH PRES 5/11/99 WHCI AC

DATE/TINE



Desmon 2, C836/2

Page / of 2

Project Des Moines Water Que lit	Monitoring Date	5/11/99	
Sampling Location <u>Nes Moines</u>	Personnel	RZ, JL	

				Composting 1	Proportions
Sample ID	Time	Depth (ft)	Flow (cfs)	(%)	(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	12	1 -11	10.19	10	
	1358	1.34	22.51	19	
<u>-2</u>	1442	1.49		43	· · · · · · · · · · · · · · · · · · ·
^3	1542	1.45	20.00	38	
BA-1-1	1321	9.94	0.42	/7	
	1414	10.04	1.09	45	
-2 -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	/335	14.19	2.22	41	
-2	1440	14.03	2.33	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	0.39	8,01	31	

Comments:

Herrera Environmental Consultants



							Page	2 of <u>2</u>
Project Des Sampling Location	mon 2	C836/2		Date	5/1	199		
Sampling Location	on <u>De</u> s	Moines		Perso	nnel	AZ,	TL	
							Composting	Proportions
Sample ID	Time	Depth (ft)		Flow (cfs)			(%)	(mL)
	1350	_					36	
-2 -3	1455						33	
-3	1550			1			31	
		_						
mC-1-1	1310	5.12		0.33			35	
-2	1400	5.12		0.33			34 31	
-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	
							· · · · · · · · · · · · · · · · · · ·	
								
· · · · · · · · · · · · · · · · · · ·								
								
		·						
								ļ
Comments:			l		·			<u> </u>

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CONSULTANTS	-							,	
Project Name/No./Client:	/Client:	DESIMON L	10387/Cih	25 mon / C387/City of Os Maines	77	!	By Date	2/5/00 Page	11
Latotiatory/rataniciers: Sample Date/Sample ID:	ple ID:	5/11/99	1 Storm 23	23 Betati	ion + 1 Med	Bstation + 1 Fled Duplicate	Checked	initials date	7/11/00
			Blanks/	Matrix Spikes/		MA.g.mA.4	4	Instrument	
Parameter	Completeness/ Methodology	Holding Times	Detection Limits	Surrogate Recoveries	Lab Duplicates	Field Duplicates	Lab Control Samples	Calibration/ Performance	ACTION
Mipian	OK	<u>5</u> -	ر د د	芝	0.00%	3,44%	98.75%	¥	None
Conductivity				ž	0.00%	0.00.00	103.06%	-	_
1				NA	≸	\$	47		_
755				NA	4.08%	0,00,0	94.Wh		
Fecals				N.A.	6.25%	10:00%	NA		
7				B	2.23gr	2.83%	103.23%		
NH4-N				94.20%	7017 2	0.00%	106-61%		
N0341007-N				6865%		1.24%	98.39%	-	
Hardruss				95.13%	2.129	9,03%	100.75%		
Dissolved				88.48%	,	19.35.91			
ر د د		·		100.00	2 LIDL	70.97	108.00%	·	
3,5				89.10%) NC	5,717	0 96.70%		
Total	······································		·	43,40%	3 210L	1.74%	104.00%		
	-			113,60%	3.776	0.83%	0.83% 108.00%		
20				100,20%	0 41DL	5.20%	96.70%		· .
TAT.		·	>	NA NA	AN AN	St-1 1	# I-15 or dy, 81%	<u>></u>	
7 2 2 2 2 2 3 3 5 5 5 5 6 7			XZ	4Z	NA	NA	1	;	>
	covery not cal	arlable du	u to soill s	sample out of 1	aryt or sy	ile too Low	relative	file: DATAQA3.XLS	
3	to soundit concentration	soumple o	ionavhation		5	, , ,			



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:

ATE SAMPLED:

11/15/99

10/27/99

DATE RECEIVED:

10/28/99

INAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER

SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

ASE 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 ictals were digested according to EPA procedures. No difficulties were encountered in the preparation or analysis of these samples. Sample data follows while A/QC data is contained on subsequent pages.

Storm 24 AMPLE DATA

	TURBIDITY	TSS	FECALS	TOTAL-P	AINOMMA	NO3+NO2
SAMPLE ID	(NTU)	(mg/l)	(#/100ml)	(mg/l)	(mg/l)	(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

		DIS	SOLVED METAL	S		TOTAL METALS	.	
	HARDNESS	COPPER	LEAD	ZINC	COPPER	LEAD	ZINC	TPH
SAMPLE ID	(mgCaCO3/1)	(mg/l)	(mg/1)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(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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10/27/99

final report, laboratory analysis of selected parameters on water

SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

9A/9C DATA WATER

QC PARAMETER	TURBIDITY	TSS	FECALS	TOTAL-P	AMMONIA	NO3+NO2
	(NTU)	(mg/l)	(#/100ml)	(mg/1)	(mg/l)	(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%
					9,1770	0.51%
SPIKE SAMPLE		-			••	7
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	NA	OR	105.95%	92.05%
	i				104.00%	92,50%
OC 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 NA	105.38%	100.24%	105.78%
		100.00			100.27%	105,23%
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 SPICE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.



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10/27/99

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10/28/99

'INAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER

SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

3A/9C	DATA	WATER

	Γ	DIS	SOLVED META	LS				
QC PARAMETER	HARDNESS	COPPER	LEAD	ZINC	COPPER	LEAD	ZINC	TPH
	(mgCaCO3/1)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(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
SPIKE SAMPLE		13.95%	LIPL	11.439	à	0.00%	716971	
SPIRE 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%	0 103,20%	94,0070				20%	
OC CHECK							200	
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.

A - NOT APPLICABLE OR NOT AVAILABLE.
C - NOT CALCULABLE DUE TO ONE OR MORE VALUES BEING BELOW THE DETECTION LIMIT.
R - RECOVERY NOT CALCULABLE DUE TO SPIKE SAMPLE OUT OF RANGE OR SPIKE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY: teven Lazoff

Laboratory Director

AR 025570

page / of

CHAIN OF CUSTODY RECORD

detection limis DATE/TIME DATE/TIME to percentages in attached filtering. O. Sugli detection ANALYSES REQUESTED P Caron SIGNATURE SIGNATURE **P** 10/28 1050 ALLON CLOTTS AR REMARKS: Please composite 3 aprils per sample ascording all analyses except TPH and feats. Dissolved metals require RECEIVED BY (NAME/CO.) 55 TAINERS REQUESTED COMPLETION DATE: TOTAL # OF CON-5 CON-# OF DATE/TIME TAINERS: Stormwater SAMPLE DESCRIPTION DELIVERY METIJOD: Stream CLIENT COPY TO STOKATURE VELINQUISITED BY (NAME/CO.) SIGNATURE 1434 1455 1455 52% 1,600 1440 33 348 J. Lenth, M. Brennan PROJECT NUMBER 10/27/99 Rombach LE INQUISHED Y (NAME/CO.) Agustic Research DATE Rebort TO: Reb 21 sette Jesmon 2 PROJECT NAME LABORATORY: MA-3 mc - 2 MA-2 DM-2 MC-人のな BA-SAMPLED BY: mA-/W/ SAMPLEID



Project	Desun	onZ	C 836/Z Date		Page	of Z
Sampling Loc	cation	es Moines	S Personnel	710/27	7/99 Leuth d	
	-			SOUL	heuth d	MEH B
Sample ID	Time	Depth (ft)	Flow (cfs)		· · · · · · · · · · · · · · · · · · ·	Proportions
MC-1-1	13:55	5.07	0.19		(%)	(mL)
MC-1-2	15:05	5.11	0.29		32.5	<u> </u>
MC-1-3	16:45	5.15	0.40		 	
					46.3	
MC 2-1	14:25	0.85			ļ	
MCZZ	15:15	0.86	1.92		34.3	
MCZ3		0.77	1,93		347	
	17:05	0.77	1.78		31.0	
MA2-1	141.40					
		14.22	(0.31		40.5	
MA2.2	15:30	14.20	5.77		37.0	
MA 2.3	17:15	14.10	3,50		22.5	
				1 7 7 7		
UA-3-1	14:55	0.85	5.34			
MA3-2	15:40	1.01	15.30	 	15.5	ini mma in a
MA3-3	17:30	1.08	13,73		44.5	-
				-	39.9	
4A1-1	13:48	0.25	0.6.3			
441.2	15:22	0,44			16.5	
M 1 · 3	16:44		Z-00		52.7	
	(40.1-1	0.34	(.14		30.8	
SM-1-1						
) M. 1. 7	14:34	0.84	1.61		8.1	
\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \						

Comments:

17:00

Herrera Environmental Consultants



Project	Desmo	2	C 836/	2 Date		12/22	Page	2 of Z
Sampling Loca	nion De	Marie				10/2-	7/99	:
		3 2 3 3 3		Pers	ionnel	Some	Leuth ;	Wat Br
					11.77.13		Composting	Proportions
Sample ID	Time	Depth (ft)		Flow (cfs)			(%)	(mL)
DM2-1	14:55	3.52		219			243	1
17W5-5	16:15	3.59		28.8			31.9	
DM2-3	17:25	3.70		39.5		T	43.8	
							-5,0	
BA-1-1	14.00	10.03	12.	0.97	1		17 /2	
5-1-AB	15:38	10.19		2.58	 	 	13.6	
BA-13	15:52	10.27		3.64			35.9	
				3-6-3			50.6	
						 		
					 			
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Comments:

Herrera Environmental Consultants

4 Jonas Ch	Date $\frac{3}{9}$ $\frac{9}{9}$ $\frac{1000}{0}$ Page 1 of 1.	Instrument Lab Control Calibration/ Samples Performance ACTION	105,00% NA NONE	*	105,38%	100.27.70	105,8370	100.75%	104,40%		94.00%	95,1070	104,40%	74,00%	95.10%	\sim	NA OK	file: DATAQA3.XLS	-
	Sibility 8 stations	Matrix Spikes/ Surrogate Lab Field Lab (Recoveries Duplicates Samp	NA 1.3670 103 NA 0.00% 100,	22516	02 253% 105			001 200.0 5.007p	103.20% 12,95% 104		ZiDL	119.76% 11.43%	95.10% 1,24% 10	0.00%	36.00% 7.49%	NA NA 10	2 ×2 ×2		
	2000 / CON + MORELLS APT / CON + MORELLS Storm 24 10/27/99	Blanks/ ss/ Holding Detection y Times Limits	4- 8-				-										X Z	ð	
ENVIRONMENTAL CONSULTANTS	Project Name/No./Client: Laboratory/Parameters: Sample Date/Sample ID:	Completeness/ Parameter Methodology	Turbickity of	Frals	d+	2-7-7Z	No.1NoN	Hardness	Dissolved	Cr	2	1. 1. 2. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.	25	Pb	30	TPH	rield trap	Noies N	1000:



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: DATE SAMPLED:

12/04/99 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

							NWT	PH-DX
SAMPLE ID	TURBIDITY (NTU)	TSS (mg/l)	FECALS (#/100ml)	TOTAL-P (mg/l)	AMMONIA (mg/l)	NO3+NO2 (mg/l)	DIESEL (mg/l)	MOTOR OIL
DM-1	8.1	20	est 22	0.100	0.178	0.403	(1112/1)	(m g/l)
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

		DIS	SOLVED META	LS		1		
	HARDNESS	COPPER	LEAD	ZINC	COPPER	LEAD	ZINC	TPH
SAMPLE ID	(mgCaCO3/1)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(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-Z Field duplicate BC-3 - Field transfer blank



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

CASE FILE NUMBER:

HER042-42

PAGE 2

REPORT DATE: DATE SAMPLED:

12/04/99 11/05/99

DATE RECEIVED:

11/06/99

FINAL REPORT, LABORATORY ANALYSIS OF SELECTED PARAMETERS ON WATER

SAMPLES FROM HERRERA ENVIRONMENTAL / CITY OF DESMOINES

9A/9C DATA WATER

TURBIDITY	TSS	FECALS	TOTAL-P	AIMOMIA	NO3+NO2	DIESEL	MOTOR OIL
(NTU)	(mg/l)	(#/100ml)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
SM182130B	EPA 160.2	SM189222D	EPA 365.1	EPA 350.1	EPA 353.2	NWTPH-DX	NWTPH-DX
11/08/99	11/09/99	11/06/99	11/15/99	11/23/99	11/23/99	11/08/99	11/08/99
0.10	0.50	2	0.002	0.010	0.010	0.05	0.10
·	•		-	•			
MC-2	MC-2	MC-2	MC-2	MC-2	MC-2	BATCH	BATCH
32	2 5	est 3600	0.136	0.092	0.312	<0.05	1.15
33	27	est 3200	0.134	0.097	0.312	<0.05	1.19
3.08%	5.83%	NC	1.14%	5.61%	12.40%	NC	3.42%
	7.49%		1.4890	5. 29%	0,0070		
			MC-2	MC-2	MC-2		
			0.136	0.092	0.312		
			0.189	0.299	0.494		
			0.050	0.200	0.200		
NA	NA	NA	106.56%	103.65%	90.65%	NA	. NA
			106.00	103.5092	91.00%		
79	10	<u> </u>	0.101	0.745	0.611	0.24	0.53
80	10		0.093	0.750	0.600	0.25	0.50
98.75%	103.00%	NA	108.60%	99.31%	101.83%	97.60%	105.00%
	100.00%			99,33%0	101.8370	94,00%	104.00%
NA	<0.50	< 2	<0.002	<0.010	<0.010	<0.05	<0.10
	(NTU) SM182130B 11/08/99 0.10 MC-2 32 33 3.08% NA NA 79 80 98.75%	(NTU) (mg/1) SM182130B EPA 160.2 11/08/99 11/09/99 0.10 0.50 MC-2 MC-2 32 25 33 27 3.08% 5.83% Th. 19 77b NA NA NA NA 79 10 80 10 98.75% 103.00% / OD .00%	(NTU) (mg/l) (#/100ml) SM182130B EPA 160.2 SM189222D 11/08/99 11/09/99 11/06/99 0.10 0.50 2 MC-2 MC-2 MC-2 32 25 est 3600 33 27 est 3200 3.08% 5.83% NC T₁ ↓ ♀ ♀ ↑ ↑ ↓ ♀ ♀ ↑ ↑ ↑ ↓ ♀ ♀ ↑ ↑ ↑ ↓ ♀ ♀ ↑ ↑ ↑ ↑	(NTU) (mg/l) (#/100ml) (mg/l) SM182130B EPA 160.2 SM189222D EPA 365.1 11/08/99 11/09/99 11/06/99 11/15/99 0.10 0.50 2 0.002 MC-2 MC-2 MC-2 est 3600 0.136 33 27 est 3200 0.134 3.08% 5.83% NC 1.14%	(NTU) (mg/1) (#/100ml) (mg/1) (mg/1) SM182130B EPA 160.2 SM189222D EPA 385.1 EPA 350.1 11/08/99 11/09/99 11/06/99 11/15/99 11/23/99 0.10 0.50 2 0.002 0.010 MC-2 MC-2 MC-2 MC-2 MC-2 32 25 est 3600 0.136 0.092 33 27 est 3200 0.134 0.097 3.08% 5.83% NC 1.14% 5.61%	(NTU) (mg/1) (#/100ml) (mg/1	(NTU) (mg/1) (#/100ml) (mg/1) (mg/

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:

HERO42-42 12/04/99

PAGE 3

REPORT DATE: 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

9A/9C DATA WATER

		DIS	SOLVED MET	ALS		TOTAL METALS		
QC PARAMETER	HARDNESS	COPPER	LEAD	ZINC	COPPER	LEAD	ZINC	TPH
•	(mgCuCO3/1)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(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						n nov	DAMOU	
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 1.00	
SPIKE ADDED	20.0	0.0125	0.0125	1.00	0.0125	0.0125 102.40%	92.20%	NA NA
% RECOVERY	97.72%	115.20%	127.20%	113.80%	102.48%	102.40%	92.20%	I WA
OC CHECK	}							<i>;</i>
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 <u>%</u>	107.60%	106.00%	102.80%	96.00%	98.80%	102.80%	92.63%
	7							
BLANK	<2.00	<0.0010	<0.0005	<0.003	<0.0010	<0.0005	<0.003	<0.25

RPD - RELATIVE PERCENT DIFFERENCE.
HA - 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 SPIRE SAMPLE OUT OF RANGE OR SPIRE TOO LOW RELATIVE TO SAMPLE CONCENTRATION.

SUBMITTED BY:

Steven Lazoff Laboratory Director CHAIN OF CUSTODY RECORD

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DDO IECT NAME	18 SA	REPORT TO	SAMPLED BY:	LABORATORY:	LAB USE:	SAMPLEID	- W	D.M.	84	BA	MA-	71	7	MC	MC	< .	N.M.					REMARKS: Please	Dissolved metals require filtering	RELINQUISHED BY (NAME/CO.)	RELINQUISHED BY (NAMERCO.) SIGNATURE	
Lè	<u> </u>	띪	8	13 7	<u>12</u>	S	٢		<u> </u>	<u> </u>					L_	<u></u>		<u>L_</u>	L	\Box		₹.		120	1 22	<u>_</u>



Composite Storm Sample Data Form

Project Desmon 2 #836	Date ///	15/99	Page \angle of \angle
Sampling Location Des Moines	Personnel	RZ, MB	

	<u> </u>	<u> </u>		Co-montine P	.
Sample ID	Time	Depth (ft)	Flow (cfs)	Composting P	(mL)
DM-1-1	1950	0.92	2.2	7.2	(IIIL)
	2105	1.27	7.3	23.4	
-2 -3	27 30	1.35	9.2	29.3	
-4	2335	1.47	12.5	40.1	
	0000	70.11	74.5	70,1	• • • • • • • • • • • • • • • • • • • •
DM-2-1	2010	1.33	18.95	16.6	
ス	2125	1.34	19.94		
-3	2125 2245 2350	1.49	34.64	17.5 30.4 35.5	
-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	2050	_			
-4	2325	.=-			
MA-1-1	1915	0-20	0.39	/3.7	
-3	2035	0.16	0:21	7.4	
-2 -3	2205	0.33	1.08	37.9	
-4	2310	0.35	1.07	41.0	

Comments:

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Herrera Environmental Consultants



Composite Storm Sample Data Form

CONSULTANTS								
Project	Desmon	2 #8	36	Date	11	15/9	Page _	<u>ス</u> of <u>ス</u>
Sampling Local	tion <u>De</u>	s Moines		Perso	onnel	RZ,	mB	
							Composting I	Proportions
Sample ID	Time	Depth (ft)		Flow (cfs)			(%)	(mL)
MA-2-1		14.11		3.69			24.2	
-3	2040	14.07		2.96			19.4	
-3 -4	2240	14,14		4.32			28.2	
-4	2340	14.14		4.32			28.2	-
							12.3	
MA-3-1	2010	0.83		4.87			3	
-2		0-96	•	8.63	·		@21.4	•
-2 -3	2250	1006		12.76			32.3	
-4	2345	1.07		13,24		·	33.5	
MC-1-1	1930	5.05		0.14			10.6	
-2 -3	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	
-2 -3	2230			1,88			26.3	
-4	2325	0.88		1.97			27.9	

Comments:

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Herrera Environmental Consultants

CONSULTANTS			`				B,	P. Jan	sect .	
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Laboratory/Parameters:	rs:	MOT/	Conv. An	metals	1 1		Checked	initials	R.Z.	
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	Completeness/	Holding	Detection	Surrogate	Lab	Field	Lab Control	Calibration/		
Parameter]	Methodology	Times	Limits	Recoveries	Duplicates	Duplicates	Samples	Performance	ACTION	
th	J.	hop !	OK	とフ	3,08%	0.00%	98.75%	4Z	None	
755	-	ني .		ź.	2,49%	3.28%	100.00%	_		
Fecals				NA NA	NC 12%	NE 18%	NA			
7				100.00%	1,484,1	3.24%	108.60%			
2-7-12				103.50%	5.29%	7,74%	49.33%			
NO2+NO,-N				91.0070	0.00%	0,34%	101.83%			
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35				48.409.		7 < 10L	98.80%			
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APPENDIX F

Pollutant Source Tracking Locations and Results

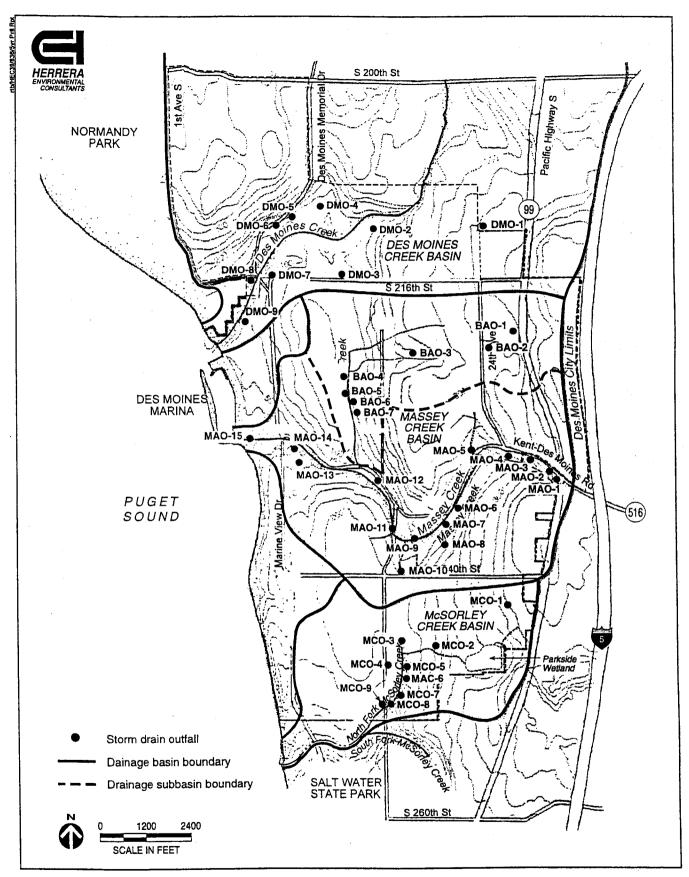


Figure F1. Study area for the Des Moines pollutant source tracking program.

Table F1. Outfall sampling for the Des Moines source tracking and illicit connection investigation conducted in October 1994.

				Visual ob	servations		
Owen ID	Y	Data	Flow	Sewage	High	Oily	Fecal bacteria
Outfall ID	Location/ Access	Date	present	odor	turbidity	sheen	(No./100 mL)
	Creek Basin						
DMO-1	24th Ave S at S 212th St/	10/12/94	Y	N	N	N	
	ditch						
DMO-2	14th Ave S at S 212th St/	10/12/94	N				
D) (0 0	manhole	10/10/04	37	011-1-4	3.7	N	22.1
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/	10/12/94	Y	N	N	N	
DMO-4	manhole	10/12/74	•	14	14	*4	
DMO-5	S 211th Pl at 9th block S/	10/24/94	Y	N	N	N	
21110 3	manhole		-	•			
DMO-6	S 212th St at 8th block S/	10/12/94	Y	N	N	N	
	end of pipe						
DMO-7	S 216th St at 7th Pl S/	10/12/94	N				
	manhole						
DMO-8	Mar. Vw Dr at S 216th St/	10/12/94	Y	N	N	N	
	end of pipe						
DMO-9	DM Beach Park at bioswale/	10/12/94	Y	N	N	N	
	end of pipe						•
Massey Cre	ek Basin		•				
BAO-1	S 220th St at 26th block S/	10/12/94	N				
	ditch						
BAO-2	24th Ave S at S 222nd St/	10/12/94	N				
	ditch						
BAO-3	19th Ave S at S 223rd St/	10/12/94	N				
	stream bed						
BAO-4	S 223rd St at 13th Ave S/	10/12/94	Y	N	N	N	
210.	culvert	10/10/04					
BAO-5	13th Ave S below S 223rd St/	10/12/94	N				
BAO-6	outfall 15th Ave S at 224th block S/	10/12/94	N				
DAU-0	catch basin	_ 10/12/34	14				
BAO-7	15th Ave S at 225th block S/	10/12/94	N			-	
D /10-7	ditch	10/12/51					
MAO-1	Kent-DM Rd at Hwy 99/	10/24/94	N				
	end of pipe: Hwy 99 runoff						
MAO-2	Kent-DM Rd at Hwy 99/	10/24/94	N		•		
	catch basin behind mall						
MAO-3	Kent-DM Rd at 28th block S/	10/24/94	N		-	-	
	end of pipe						
MAO-4	24th Pl S at apartments/	10/12/94	Y	N	N	N	
	manhole						

Table F1. Outfall sampling for the Des Moines source tracking and illicit connection investigation conducted in October 1994 (continued).

				Visual ob	servations	 ·	
		•	Flow	Sewage	High	Oily	Fecal bacteria
Outfall ID	Location/ Access	Date	present	odor	turbidity	sheen	(No./100 mL)
Massey Cree	ek 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	Υ .	N	N	N	
MAO-15	Mar Vw Dr S at S 230th St/ detention pond outfall	10/12/94	Y	N	N	N	
McSorley C	Creek Basin				ı		
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	Ņ	
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.

F-2

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.

Des Moines 1998

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.

Des Moines 1998

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.

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.

	1994	1996	1998
	BA1	BA1	BA1
BIOASSESSMENT SCORES (%)			
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

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 (%)		************		-2		* · . ·
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

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	МАЗ
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	02	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)	44	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

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 (%)						<u> </u>
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

% Chironomidae (midge)	22.9	42.9	19.6	16.8	67.2	7.5
% Simuliidae (blackfly)	0.7	3.1	1.4	2.3	0.8	0.2
% Trichoptera (caddisflies)	3.9	7.9	7.0	3.2	0.0	0.6
% Plecoptera (stoneflies)	8.5	12.6	2.1	0.4	0.0	0.4
% Ephemeroptera (mayflies)	13.1	2.1	0.0	39.3	11.8	24.6
% Baetis tricaudatus (mayfly)	1.3	2.0	0.0	34.9	11.8	24.4

Barnes Creek, Site 1, October 30, 1998.

WA: King County, City of Des Moines. For Herrera Environmental Consultants, Inc., Seattle, WA.

	EROSIONAL/RIFFLE HABITAT		SUMMARY SCORES	%		
	METRIC	Value	Score	EROSIONAL TOTAL	54	43.5
	PRIMARY METRICS			Primary subtotal	1	5.6
1	Total abundance (m2)	144	0	Positive Indicators	13	22.8
2	Total taxa richness	17	0	Negative Indicators	40	81.6
3	EPT Taxa richness	7	0			
4	%Dominant taxa	45.8	0			•
5	Community Tolerance	4.24	1	GENERAL BIOTIC INTEGRITY AND IMPACT	T CATEG	ORIES
	POSITIVE INDICATORS			Based on Total Bioassessment Score		
1	Predator richness	3	0	Very high biotic/habitat integrity		90-100%
2	Scraper richness	2	0	High biotic/habitat integrity		80-89%
3	Shredder richness	5	1	Moderate biotic/habitat integrity		60-79%
4	Xylophage richness	1	1	Low biotic/habitat integrity	`	40-59%
5	%Intolerant mayflies	8.33	4	Severe habitat and/or water quality limitation	ns	<40%
6	%Intolerant stoneflies	0	0		-	
7	%Intolerant caddisflies	0	0	The bioassessment model is based on Pac	ific North	west
8	%Intolerant dipterans	0	0	montane watersheds that have experience	d minimal	human
9	Intol. mayfly richness	1	1	disturbance, and applies to stream sites that	at are: mi	d-order,
10	Intol. stonefly richness	0	0	forested, low-mid elevation, and moderate-	high grac	lient.
11	Heptageniidae richness	1	1	Maximum scores are based on experience	with sites	that
12	Ephemerellidae richness	0	0	have very high habitat complexity and integ	rity, and	that
13	Nemouridae richness	2	1	have a strong, perennial flow of cool/cold w	ater.	
14	Pteronarcys	0	0	Potential maximum scores in natural or minimally disturbed		turbed
15	%Glossosomatidae	0	0	systems will vary, depending on watershed parameters and		ers and
16	%Philopotamidae	0	0	the resultant in-stream habitat characteristic	cs they p	roduce.
17	%Arctopsychidae	6.25	2	This bioassessment is not intended to be used on: rivers;		
18	Rhyacophila richness	0	0	large, open streams; basin or valley streams; low gradient		adient
19	%C. Nostococladius	0	0	sites; alpine/subalpine streams; or small streams.		
20	Long-lived taxa richness	1	.1	1		
21	Class 0 taxa richness	1	1	T&E OR SENSITIVE TAXA IDENTIFIED		
	NEGATIVE INDICATORS			None		
1	%Collector	58.3	1			
2	%Parasite	0	1	CLASS 0 TAXA		
3	%Oligochaeta	2.78	1	These are either rare, unusual, or uncomm	on taxa; c	or taxa
4	%Leech	0	1	more typically associated with small stream	ns and sp	rings.
5	%Tolerant snails	0	4	Parapsyche almota		
6	%Tolerant amphipods	2.08	0			
7	%Tolerant odonates	0	2			
8	%Tolerant mayflies	0	4	COLD WATER BIOTA		
9	%Tolerant caddisflies	0	4	***		ıres.
10	%Tolerant beetles	0	4	Total percent contribution 8.33		8.33
11	%Tolerant dipterans	1.39	2	Total taxa richness 1		1
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	Subsample size: 500+ organisms		
17	%Chironomid (-C.Nostoc	6.94	4	Taxonomy by: ABA standard taxonomic eff	ort.	
	: 98DM01X			Data analysis by: ABA BENTHOS program	Version 1	.0
Aqu	atic Biology Associates, Inc	c., 3490	NW Dee	er Run Rd., Corvallis, OR 97330, 541-752-156		
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Des Moines Creek, Site 1, October 31, 1998.

WA: King County, City of Des Moines. For Herrera Environmental Consultants, Inc., Seattle, WA.

	EROSIONAL/RIFFLE HAB	ITAT		SUMMARY SCORES	Score	%
	METRIC		Score	EROSIONAL TOTAL	37	29.8
	PRIMARY METRICS	Value	000.0	Primary subtotal	0,	
1	Total abundance (m2)	161	0	Positive Indicators	0	0.0
2	Total taxa richness	11	0			0.0
	EPT Taxa richness	1	0	Negative Indicators	37	75.5
4	%Dominant taxa	46	0			
5	Community Tolerance	6.2	0	GENERAL BIOTIC INTEGRITY AND IMPACT	CATEO	00150
3	POSITIVE INDICATORS	0.2	<u> </u>	4	CATEG	OHIES
1	Predator richness	2	0	Based on Total Bioassessment Score Very high biotic/habitat integrity		00 1000/
2	Scraper richness	2	0	High biotic/habitat integrity		90-100% 80-89%
3	Shredder richness	2	0	Moderate biotic/habitat integrity		60-79%
4			0			
5	Xylophage richness	0	0	Low biotic/habitat integrity		40-59%
6	%Intolerant mayflies	0		Severe habitat and/or water quality limitation	IS	<40%
7	%Intolerant stoneflies	0	0	The bisers are a second of the best of the Basic	!- NI4L	
	%Intolerant caddisflies	0	0	The bioassessment model is based on Pacif		
8	%Intolerant dipterans	0	0	montane watersheds that have experienced		
9	Intol. mayfly richness	0	0	disturbance, and applies to stream sites that		
10	Intol. stonefly richness	0	0	forested, low-mid elevation, and moderate-h		
11	Heptageniidae richness	0	0	Maximum scores are based on experience v		
12	Ephemerellidae richness	0	0	have very high habitat complexity and integr		that
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	T&E OR SENSITIVE TAXA IDENTIFIED		
	NEGATIVE INDICATORS			None		
1	%Collector	89.4	0			
2	%Parasite	1.24	1	CLASS 0 TAXA		
3	%Oligochaeta	11.8	0	These are either rare, unusual, or uncommo		
4	%Leech	0	1	more typically associated with small streams	and sp	rings.
5	%Tolerant snails	1.86	2	None		
6	%Tolerant amphipods	28	0			
7	%Tolerant odonates	0	2			
8	%Tolerant mayflies	0	4	COLD WATER BIOTA		
9	%Tolerant caddisflies	0	4			ures.
10	%Tolerant beetles	0	4			
11	%Tolerant dipterans	0.62	3			
12	Tol. mayfly richness	0	2			
	Tol caddisfly richness	0	2	SAMPLE & ANALYSIS SPECIFICATIONS		
	Tol. beetle richness	0	4	·		
	Tol. dipteran richness	1	3			
	%Simuliidae	0	1	Subsample size: 500+ organisms		
	%Chironomid (-C.Nostoc		4	Taxonomy by: ABA standard taxonomic effo	rt.	
	: 98DM02X		· · · · · ·	Data analysis by: ABA BENTHOS program \		1.0
		3400	NW Dec	er Run Rd., Corvallis, OR 97330, 541-752-1568		
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Des Moines Creek, Site 2, October 30, 1998.

WA: King County, City of Des Moines. For Herrera Environmental Consultants, Inc., Seattle, WA.

	EROSIONAL/RIFFLE HAB	TAT		SUMMARY SCORES	Score	%
	METRIC	Value	Score	EROSIONAL TOTAL	41	33.1
	PRIMARY METRICS			Primary subtotal	0	0.0
1	Total abundance (m2)	306	0	Positive Indicators	0	0.0
2	Total taxa richness	9	0	Negative Indicators	41	83.7
3	EPT Taxa richness	1	0			
4	%Dominant taxa	76.1	0			
5	Community Tolerance	6.1	0	GENERAL BIOTIC INTEGRITY AND IMPAC	T CATEG	ORIES
•	POSITIVE INDICATORS			Based on Total Bioassessment Score		
1.	Predator richness	0	0	Very high biotic/habitat integrity		90-100%
2	Scraper richness	1	0	High biotic/habitat integrity		80-89%
3	Shredder richness	1	0	Moderate biotic/habitat integrity		60-79%
4	Xylophage richness	0	0	Low biotic/habitat integrity		40-59%
5	%Intolerant mayflies	0	0	Severe habitat and/or water quality limitation	ons	<40%
6	%Intolerant stoneflies	0	0			
7	%Intolerant caddisflies	0	0	The bioassessment model is based on Pac	ific North	west
- 8	%Intolerant dipterans	0	0	montane watersheds that have experience	d minima	l human
9	Intol. mayfly richness	0	0	disturbance, and applies to stream sites th	at are: mi	d-order,
10	Intol. stonefly richness	0	0	forested, low-mid elevation, and moderate	-high grad	dient.
11	Heptageniidae richness	0	0	Maximum scores are based on experience	with site	s that
12	Ephemerellidae richness	0	0	have very high habitat complexity and integrity, and that		
13	Nemouridae richness	0	0	have a strong, perennial flow of cool/cold water.		
14	Pteronarcys	0	0	Potential maximum scores in natural or minimally disturbed		
15	%Glossosomatidae	0	0	systems will vary, depending on watershed	d paramet	ters and
16	%Philopotamidae	0	0	the resultant in-stream habitat characterist	ics they p	roduce.
17	%Arctopsychidae	0	0	This bioassessment is not intended to be u	used on: r	ivers;
18	Rhyacophila richness	0	0			adient
19	%C. Nostococladius	0	0	sites; alpine/subalpine streams; or small streams.		
20	Long-lived taxa richness	0	0			**
21	Class 0 taxa richness	0	0	T&E OR SENSITIVE TAXA IDENTIFIED		
	NEGATIVE INDICATORS	<u> </u>		None		
1.	%Collector	99.4	0			
2	%Parasite	0.33	1	CLASS 0 TAXA		
3	%Oligochaeta	5.56	0	These are either rare, unusual, or uncomm	non taxa;	or taxa
4	%Leech	0	1	more typically associated with small stream	ns and sp	orings.
5	%Tolerant snails	0	4	None		
6	%Tolerant amphipods	15.4	0			
7	%Tolerant odonates	0	2			
8	%Tolerant mayflies	0	4	COLD WATER BIOTA		-
9	%Tolerant caddisflies	0	4	Taxa requiring year-round cool/cold water	tempera	tures.
10	%Tolerant beetles	0	4	Total percent contribution 0		
11	%Tolerant dipterans	0	4	Total taxa richness	-	0
12	Tol. mayfly richness	0	2			
	Tol caddisfly richness	0	2	SAMPLE & ANALYSIS SPECIFICATIONS		
	Tol. beetle richness	0	4	—		
15	Tol. dipteran richness	0	4	Number of points: 5 points, 1 square meter	er.	
	%Simuliidae	0.33	1	Subsample size: 500+ organisms		
	%Chironomid (-C.Nostoc		4	Taxonomy by: ABA standard taxonomic e		
FILE	: 98DM03X			Data analysis by: ABA BENTHOS progran		
Aqu	atic Biology Associates, In	c., 349	NW De	er Run Rd., Corvallis, OR 97330, 541-752-15	68 FAX 5	41-754-9605
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Massey Creek, Site 1, October 30, 1998.

WA: King County, City of Des Moines. For Herrera Environmental Consultants, Inc., Seattle, WA.

METRIC		EROSIONAL/RIFFLE HAB		_ 5.0,	SUMMARY SCORES	Score	% T
Primary subtotal Primary subtotal O O O O O O O O O		***		Score			
Total abundance (m2) 23 0 0 1 Total taxa richness 6 0 0.0		PRIMARY METRICS	L	L		0	
Total taxa richness 6 0 0 EPT Taxa richness 1 0 0 Scommunity Tolerance 7.57 0 POSITIVE INDICATORS POSITIVE	1	Total abundance (m2)	23	0		0	0.0
PT Taxa richness	2		6	0		40	
Mominant taxa	3	EPT Taxa richness	1	0		1	
Community Tolerance 7.57 0 POSITIVE INDICATORS	4		73.9	0	-		
PCSITIVE INDICATORS Predator richness O Scraper richness O Shredder richness O The bioassessment model is based on Pacific Northwest The bioassessment model is based on Pacific Northwest The bioassessment model requity imitations Alongenidae richness O The bioassessment model is based on Pacific Northwest The bioassessment model is based on Pacific Northwest The bioassessment model is based on Pacific Northwest The bioassessment model is based on Pacific Northwest The bioassessment model is based on Pacific Northwest The bioassessment model is based on Pacific Northwest The bioassessment model is based on Pacific Northwest The bioassessment model is based on Pacific Northwest The bioasses are absed on experience with sites that are: mid-order, forested, low-mid levation, and moderate-high gradient. Maximum scores in natural o	5		7.57	0	GENERAL BIOTIC INTEGRITY AND IMPACT	T CATEG	ORIES
Predator richness 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0			-		Based on Total Bioassessment Score		
Shredder richness 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1		0	0	Very high biotic/habitat integrity		90-100%
Shredder richness 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	2	Scraper richness	2	0	High biotic/habitat integrity		80-89%
Severe habitat and/or water quality limitations <40%	3	Shredder richness	0	0			60-79%
Severe habitat and/or water quality limitations <40%	4	Xylophage richness	0	0	Low biotic/habitat integrity		40-59%
Secondarial Secondaria Secondari	5		0	0		ns	<40%
Solution Solution	6		0	0			
Intol. mayfly richness 0 0 0 0 Intol. stonefly richness 0 0 0 0 Intol. stonefly richness 0 0 0 0 Intol. stonefly richness 0 0 Intol. stonefly richness 0 0 Intol. stone strong representation and integrity, and that have very high habitat completive and integrity, and that have very high habitat completive and integrity, and that have very high habitat completive an	7	%Intolerant caddisflies	.0	0	The bioassessment model is based on Pac	ific North	west
Intol. stonefly richness 0 0 0 Heptageniidae richness 0 0 0 Ephemerellidae richness 0 0 0 Ephemerellidae richness 0 0 0 Heptageniidae richness 0 0 0 Heptageniidae richness 0 0 0 Heptageniidae richness 0 0 0 Heptageniidae richness 0 0 0 Heptageniidae richness 0 0 0 Heptageniidae richness 0 0 0 Heptageniidae richness 0 0 0 Heptageniidae richness 0 0 0 Heptageniidae value very high habitat complexity and integrity, and 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. 1	8	%Intolerant dipterans	0	0	montane watersheds that have experience	d minima	l human
Heptageniidae richness 0 0 0 Ephemerellidae richness 0 0 0 Nemouridae richness 0 0 0 Peronarcys 0 0 0 Selossosomatidae 0 0 0 Selossosomatidae 0 0 0 Selossosomatidae 0 0 0 Selossosomatidae 0 0 0 Selossosomatidae 0 0 0 Selossosomatidae 0 0 0 0 Selossosomatidae 0 0 0 0 0 Selossosomatidae 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	9	Intol. mayfly richness	0	0	disturbance, and applies to stream sites that	at are: mi	d-order,
Ephemerellidae richness 0	10	Intol. stonefly richness	0	0	forested, low-mid elevation, and moderate-	high grad	dient.
Nemouridae richness 0 0 0 have a strong, perennial flow of cool/cold water. Pteronarcys 0 0 0 possible 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. Rhyacophila richness 0 0 1 his 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. NEGATIVE INDICATORS NEGATIVE INDICATORS NEGATIVE INDICATORS NOIlgochaeta 73.9 0 Take 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	11	Heptageniidae richness	0	0	Maximum scores are based on experience	with sites	s that
Peteronarcys 0 0 0 Security Peteronarcys 0 0 0 0 Security Peteronarcys 0 0 0 0 Security Peteronarcys 0 0 0 0 0 0 Security Peteronarcys 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	12	Ephemerellidae richness	0	0	have very high habitat complexity and integ	grity, and	that
systems will vary, depending on watershed parameters and the resultant in-stream habitat characteristics they produce. Whilopotamidae 0 0 0 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. Regative indicator 87 0 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. The or SENSITIVE TAXA IDENTIFIED in the searce either rare, unusual, or uncommon taxa; or taxa more typically associated with small streams and springs. 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	13	Nemouridae richness	0	0			
Mean temperature	14	Pteronarcys	0	0	Potential maximum scores in natural or minimally disturbed		sturbed
Marctopsychidae	15	%Glossosomatidae	0	0			ers and
Rhyacophila richness 0 0 large, open streams; basin or valley streams; low gradient sites; alpine/subalpine streams; or small streams.	16	%Philopotamidae	0	0			
Section Sect	17	%Arctopsychidae	0	0			
Long-lived taxa richness 0 0 0 Class 0 taxa richness 0 0 0 0 NEGATIVE INDICATORS	18		0	1			adient
Class 0 taxa richness 0 0 T&E OR SENSITIVE TAXA IDENTIFIED			0				
NEGATIVE INDICATORS Water			0				
1%Collector8702%Parasite8.703%Oligochaeta73.904%Leech015%Tolerant snails4.3526%Tolerant amphipods027%Tolerant odonates028%Tolerant mayflies049%Tolerant caddisflies0410%Tolerant beetles0410%Tolerant dipterans0411%Tolerant dipterans0412Tol. mayfly richness0213Tol caddisfly richness02SAMPLE & ANALYSIS SPECIFICATIONS	21		0	0	T&E OR SENSITIVE TAXA IDENTIFIED		
2%Parasite8.703%Oligochaeta73.904%Leech015%Tolerant snails4.3526%Tolerant amphipods027%Tolerant odonates028%Tolerant mayflies049%Tolerant caddisflies0410%Tolerant beetles0410%Tolerant dipterans0411%Tolerant dipterans0412Tol. mayfly richness0213Tol caddisfly richness02SAMPLE & ANALYSIS SPECIFICATIONS					None		
3%Oligochaeta73.904%Leech015%Tolerant snails4.3526%Tolerant amphipods027%Tolerant odonates028%Tolerant mayflies049%Tolerant caddisflies0410%Tolerant beetles0411%Tolerant dipterans0412Tol. mayfly richness0213Tol caddisfly richness02SAMPLE & ANALYSIS SPECIFICATIONS							
4%Leech015%Tolerant snails4.3526%Tolerant amphipods027%Tolerant odonates028%Tolerant mayflies049%Tolerant caddisflies0410%Tolerant beetles0411%Tolerant dipterans0412Tol. mayfly richness0213Tol caddisfly richness02SAMPLE & ANALYSIS SPECIFICATIONS	2						
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 SAMPLE & ANALYSIS SPECIFICATIONS SPECIFICATIONS	3			0			
%Tolerant amphipods027%Tolerant odonates028%Tolerant mayflies049%Tolerant caddisflies0410%Tolerant beetles0411%Tolerant dipterans0412Tol. mayfly richness0213Tol caddisfly richness02SAMPLE & ANALYSIS SPECIFICATIONS	-					ns and sp	rings.
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 COLD WATER BIOTA Taxa requiring year-round cool/cold water temperatures. Total percent contribution 0 Total taxa richness 0 SAMPLE & ANALYSIS SPECIFICATIONS					None		
8%Tolerant mayflies04COLD WATER BIOTA9%Tolerant caddisflies04Taxa requiring year-round cool/cold water temperatures.10%Tolerant beetles04Total percent contribution011%Tolerant dipterans04Total taxa richness012Tol. mayfly richness0213Tol caddisfly richness02SAMPLE & ANALYSIS SPECIFICATIONS							
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 Taxa requiring year-round cool/cold water temperatures. 15 Total percent contribution 0 1 16 Total taxa richness 0 1 2 SAMPLE & ANALYSIS SPECIFICATIONS			 				
10 %Tolerant beetles 0 4 Total percent contribution 0 0 11 %Tolerant dipterans 0 4 Total percent contribution 0 12 Tol. mayfly richness 0 2 13 Tol caddisfly richness 0 2 SAMPLE & ANALYSIS SPECIFICATIONS							
11 %Tolerant dipterans 0 4 Total taxa richness 0 12 Tol. mayfly richness 0 2 13 Tol caddisfly richness 0 2 SAMPLE & ANALYSIS SPECIFICATIONS				 		temperat	ures.
12 Tol. mayfly richness 0 2 13 Tol caddisfly richness 0 2 SAMPLE & ANALYSIS SPECIFICATIONS		%Tolerant beetles	0				
13 Tol caddisfly richness 0 2 SAMPLE & ANALYSIS SPECIFICATIONS					Total taxa richness		0
			0				
14 ITal handle richness 0 4 Complex Types D from a not 500 migrap							
		Tol. beetle richness	0	4	Sampler Type: D-frame net, 500 micron.		
15 Tol. dipteran richness 0 4 Number of points: 5 points, 1 square meter.						г.	
16 %Simuliidae 0 1 Subsample size: 500+ organisms				1			
17 Chironomid (-C.Nostoc 0 4 Taxonomy by: ABA standard taxonomic effort.			0	4	4		
FILE: 98DM04X 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 541-754-9609	Aqu	atic Biology Associates, In	c., 3490	NW Dee	er Run Rd., Corvallis, OR 97330, 541-752-156	88 FAX 54	11-754-9605

Massey Creek, Site 2, October 30, 1998.

WA: King County, City of Des Moines. For Herrera Environmental Consultants, Inc., Seattle, WA.

	EROSIONAL/RIFFLE HAB	TAT		SUMMARY SCORES	Score	%
	METRIC	Value	Score	EROSIONAL TOTAL	38	30.6
	PRIMARY METRICS	1.2.20	1	Primary subtotal	0	0.0
1	Total abundance (m2)	208	0	Positive Indicators	0	0.0
2	Total taxa richness	12	0	Negative Indicators	38	77.6
3	EPT Taxa richness	1	0	110gative indicators	00	77.0
4	%Dominant taxa	76.4	0			
5	Community Tolerance	6.26	0	GENERAL BIOTIC INTEGRITY AND IMPACT	CATEG	ORIES
_	POSITIVE INDICATORS	0.20	<u> </u>	Based on Total Bioassessment Score	0/1120	011120
1	Predator richness	4	0	Very high biotic/habitat integrity		90-100%
2	Scraper richness	1	0	High biotic/habitat integrity		80-89%
3	Shredder richness	1	0	Moderate biotic/habitat integrity		60-79%
4	Xylophage richness	Ō	0	Low biotic/habitat integrity		40-59%
5	%Intolerant mayflies	0.	ō	Severe habitat and/or water quality limitation	ns	<40%
6	%Intolerant stoneflies	0	0			1070
7	%Intolerant caddisflies	0	0	The bioassessment model is based on Pacit	fic North	west
8	%Intolerant dipterans	0	0	montane watersheds that have experienced		
9	Intol. mayfly richness	0	0	disturbance, and applies to stream sites that		
10	Intol. stonefly richness	0	0	forested, low-mid elevation, and moderate-h		
11	Heptageniidae richness	0	0	Maximum scores are based on experience		
12	Ephemerellidae richness	0	0	have very high habitat complexity and integ		
13	Nemouridae richness	0	0	have a strong, perennial flow of cool/cold w		
14	Pteronarcys	0	0	Potential maximum scores in natural or minimally disturbed		
15	%Glossosomatidae	0	0	systems will vary, depending on watershed parameters and		
16	%Philopotamidae	0	0	the resultant in-stream habitat characteristics they produce.		
17	%Arctopsychidae	0	0	This bioassessment is not intended to be us	• •	
18	Rhyacophila richness	0	0	large, open streams; basin or valley streams; low gradient		
19	%C. Nostococladius	0	0	sites; alpine/subalpine streams; or small streams.		
20	Long-lived taxa richness	0	0	otoo, dipito/odbaipine streams, of small streams.		
21	Class 0 taxa richness	0	0	T&E OR SENSITIVE TAXA IDENTIFIED	;	
	NEGATIVE INDICATORS			None	·	
- 1	%Collector	90.4	0		· · · · · · · · · · · · · · · · · · ·	
2	%Parasite	0	1	CLASS 0 TAXA		
3	%Oligochaeta	1.92	1	These are either rare, unusual, or uncommo	n taxa; c	or taxa
4	%Leech	0.96	1	more typically associated with small streams		
5	%Tolerant snails	0	4	None		
6	%Tolerant amphipods	0	2			
7	%Tolerant odonates	0	2			
8	%Tolerant mayflies	0	4	COLD WATER BIOTA		
9	%Tolerant caddisflies	0	4	Taxa requiring year-round cool/cold water to	emperati	ıres.
10	%Tolerant beetles	0	4	1		0
11	%Tolerant dipterans	10.1	0	Total taxa richness		0
12	Tol. mayfly richness	0	2			
	Tol caddisfly richness	0	2	SAMPLE & ANALYSIS SPECIFICATIONS		
	Tol. beetle richness	0	4	Sampler Type: D-frame net, 500 micron.		
15	Tol. dipteran richness	1	3	Number of points: 5 points, 1 square meter.		
	%Simuliidae	0	1	Subsample size: 500+ organisms		
	%Chironomid (-C.Nostoc		3	Taxonomy by: ABA standard taxonomic effort	ort.	
	: 98DM05X		•	Data analysis by: ABA BENTHOS program \		.0
		c 3 490	NW Dee	r Run Rd., Corvallis, OR 97330, 541-752-1568		
-1		.,		The second of th		

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 HAB	TAT		SUMMARY SCORES	Score	%
	METRIC	Value	Score	EROSIONAL TOTAL	34	27.4
	PRIMARY METRICS			Primary subtotal	1	5.6
1	Total abundance (m2)	156	0	Positive Indicators	1	1.8
2	Total taxa richness	15	0	Negative Indicators	. 32	65.3
3	EPT Taxa richness	2	0			
4	%Dominant taxa	37.8	1			
5	Community Tolerance	6.27	0	GENERAL BIOTIC INTEGRITY AND IMPAC	T CATEG	ORIES
,	POSITIVE INDICATORS		*************************************	Based on Total Bioassessment Score		
1	Predator richness	1	0	Very high biotic/habitat integrity		90-100%
2	Scraper richness	2	0	High biotic/habitat integrity		80-89%
3	Shredder richness	2	0	Moderate biotic/habitat integrity		60-79%
4	Xylophage richness	0	0	Low biotic/habitat integrity		40-59%
5	%Intolerant mayflies	0	0	Severe habitat and/or water quality limitation	ons	<40%
6	%Intolerant stoneflies	0	0			
7	%Intolerant caddisflies	0	0	The bioassessment model is based on Pac	ific North	west
8	%Intolerant dipterans	0	0	montane watersheds that have experience	d minima	l human
9	Intol. mayfly richness	0	0	disturbance, and applies to stream sites th	at are: mi	d-order,
10	intol. stonefly richness	0	0	forested, low-mid elevation, and moderate	-high grad	dient.
11	Heptageniidae richness	0	0	Maximum scores are based on experience with sites that		s that
12	Ephemerellidae richness	0	0	have very high habitat complexity and integrity, and that		that
13	Nemouridae richness	0	0	have a strong, perennial flow of cool/cold water.		
14	Pteronarcys	0	0	Potential maximum scores in natural or minimally disturbed		sturbed
15	%Glossosomatidae	0	0	systems will vary, depending on watershed parameters and		ters and
16	%Philopotamidae	0	0	the resultant in-stream habitat characteristics they produce.		
17	%Arctopsychidae	0	0	This bioassessment is not intended to be used on: rivers;		
18	Rhyacophila richness	0	0	large, open streams; basin or valley streams; low gradient		adient
	%C. Nostococladius	0	0	sites; alpine/subalpine streams; or small st	reams.	
20	Long-lived taxa richness	1	1			
21	Class 0 taxa richness	0	0	T&E OR SENSITIVE TAXA IDENTIFIED		
	NEGATIVE INDICATORS			None		
1	%Collector	87.8	0			
2	%Parasite	0.64	1	CLASS 0 TAXA		
3	%Oligochaeta	3.21	1	These are either rare, unusual, or uncomm	non taxa;	or taxa
4	%Leech	0	1	more typically associated with small strear	ns and sp	orings.
5	%Tolerant snails	1.28	2	None		
6	%Tolerant amphipods	23.7	0			
7	%Tolerant odonates	0	2			· ·
8	%Tolerant mayflies	0	4	COLD WATER BIOTA		
9	%Tolerant caddisflies	0	4	Taxa requiring year-round cool/cold water	temperat	tures.
10	%Tolerant beetles	0	4			0
11	%Tolerant dipterans	14.1	0	Total taxa richness		0
12	Tol. mayfly richness	0	2			
13	Tol caddisfly richness	0	2	SAMPLE & ANALYSIS SPECIFICATIONS		
14	Tol. beetle richness	0	4	Sampler Type: D-frame net, 500 micron.		
15	Tol. dipteran richness	1	3	Number of points: 5 points, 1 square meter	er.	
16	%Simuliidae	1.92	1	Subsample size: 500+ organisms		
17	%Chironomid (-C.Nostoc	30.8	1	Taxonomy by: ABA standard taxonomic et		
FILE	: 98DM06X			Data analysis by: ABA BENTHOS program	n 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

Heptageniidae richness 0 0 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.		EROSIONAL/RIFFLE HAB	ITAT		SUMMARY SCORES	Score	%
Primary METRICS Total abundance (m2)		METRIC	Value	Score	EROSIONAL TOTAL	45	36.3
Total abundance (m2)		PRIMARY METRICS	• • •			 	
Regative indicators 34 69.4	1		143	0			
September Sept	2						
Secondary Community Tolerance 5.94 0 Community Tolerance 5.95 Community Tolerance 5.95 Community Tolerance 5.95 Community Tolerance 5.95 Community Tolerance 5.95 Community Tolerance 5.95 Community Tolerance 5.95 Community Tolerance 5.94 Community Tolerance 5.95 Community Tolerance 5.95 Community Tolerance 5.95 Community Tolerance 5.95 Community Tolerance 5.95 Community Tolerance 5.95 Community Tolerance 5.95 Community Tolerance 5.95 Community Tolerance 5.95 Community Tolerance 5.95 Community Tolerance 5.95 Community Tolerance 5.95 Community Tolerance 5.95 Community Tolerance 5.95 Community Tolerance 5.95 Community Tolerance 5.95 Community Tolerance 5.95 Community Tolerance 5.95 Community Tolerance 5.	3				Translation of the state of the		03.4
5 Community Tolerance 5.94 0 POSITIVE INIDICATORS 1 Predator richness 6 0 Very high blotic/habitat integrity 90-100% 1 Provinces 6 1 1 Nylophage richness 1 1 1 Nylophage richness 1 1 1 Nylophage richness 1 1 1 Nylophage richness 1 1 1 Nylophage richness 1 1 1 Nylophage richness 1 1 1 Nylophage richness 1 1 1 Nylophage richness 1 1 1 Nylophage richness 1 1 1 Nylophage richness 1 1 1 Nylophage richness 1 1 1 Nylophage richness 1 1 1 Nylophage richness 1 1 Nylophage richness 1 1 Nylophage richness 1 0 Nylotic/habitat integrity 1 Northwest 1 Nylophage richness 2 Nylophage richness 2 Nylophage	4						•
POSITIVE INDICATORS Predator richness 6 0 0 1	5				GENERAL BIOTIC INTEGRITY AND IMPACT	I CATEG	ORIES
Predator richness 6 0 Scraper richness 2 0 O Scraper richness 2 0 O Scraper richness 6 1 Moderate biotic/habitat integrity 80-89% 80-89% Moderate brotic/habitat integrity 40-59% 80-89% Moderate brotic/habitat integrity 40-59% 8 Moderat stoneflies 0 0 Moderate brotic/habitat integrity 40-59% Severe habitat and/or water quality limitations <40% 40-59% Moderate stoneflies 0 0 Moderate brotic/habitat integrity 40-59% Moderate stoneflies 0 0 Moderate brotic/habitat integrity 40-59% Moderate stoneflies 0 0 Moderate brotic/habitat integrity 40-59% Moderate brotic/habitat integrity 40-59% Moderate brotic/habitat integrity 40-59% Moderate brotic/habitat integrity 40-59% Moderate brotic/habitat integrity 40-59% Moderate brotic/habitat integrity 40-59% Moderate brotic/habitat integrity 40-59% Moderate brotic/habitat integrity 40-59% Moderate brotic/habitat integrity 40-59% Moderate brotic/habitat integrity Moderate brotic/habitat integrity 40-59% Moderate brotic/habitat integrity Moderate brotic/habitat integrity 40-59% Moderate brotic/habitat integrity Moderate brotic/hab		POSITIVE INDICATORS		·			0.1.20
2 Scraper richness 2 0 0 Shredder richness 6 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1		6	0	Very high biotic/habitat integrity		90-100%
Shreder richness 6 1 1 Xylophage richness 1 1 1 Xylophage richness 1 1 1 Xylophage richness 0 0 0 0 Xylophage richness 0 0 0 0 Xylophage richness 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	2			0			
4 Xylophage richness 1 1 1	3			1			
Severe habitat and/or water quality limitations 240%	4	Xylophage richness	1	1			
Second collector Second coll	5					ns	
Seminorary Continued Seminorary Continued	6				The state of the s	7.10	140%
Second color of the color of	7				The bioassessment model is based on Pac	ific North	west
Intol. mayfly richness	8						
Intol. stonefly richness 0 0 0 forested, low-mid elevation, and moderate-high gradient. Heptageniidae richness 0 0 0 Ephemerellidae richness 0 0 0 Nemouridae richness 2 1 1 have a strong, perennial flow of cool/cold water. Pteronarcys 0 0 0 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 bioassesment is not intended to be used on: rivers; large, open streams; basin or valley streams; low gradient sites; alpine/subalpine streams. On place are either rare, unusual, or uncommon taxa; or taxa more typically associated with small streams and springs. Parapsyche almota, Rhyacophila grandis 1 %Tolerant snails 11.2 0 WTolerant caddisflies 0 4 Taxa requiring year-round cool/cold water temperatures. Total percent contribution 0 Total taxa richness 0 2 Tol. dipterant richness 0 2 Tol. dipterant richness 0 2 Tol. dipterant richness 0 2 Tol. dipterant richness 1 3 Subsample size: 500+ organisms 1 Taxonomy by: ABA BENTHOS program Version 1.0							
Heptageniidae richness 0 0 0 1 Naximum 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 are based on experience with steal have a strong, perennial flow of coll/cold water. Potential maximum scores are based on experience with steal have a strong, perennial flow of coll/cold water. Potential maximum scores are based on experience with steal have a strong, perennial flow of conlict in the ded to 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. CLASS 0 TAXA The							
Ephemerellidae richness 0 0 0 Namouridae richness 2 1 1 Peteronarcys 0 0 0 0 Sossosmatidae 0 0 Sossosmatidae 0 0 Sossosmatidae 0 0 Sossosmatidae 0 0 Sossosmatidae 0 0 Sossosmatidae 0 0 Sossosmatidae 0 0 Sossosmatidae 0 0 Sossosmatidae 0 0 Sossosmatis incitration of Sossosmatis incitrat	11						
Nemouridae richness 2	12						
Peteronarcys 0 0 0 0	13						LIICIL
## Selossosomatidae							sturbed
## Specific Proposed							
Warctopsychidae 3.5 2 Rhyacophila richness 1 0							
Rhyacophila richness							
Section Sect							
Long-lived taxa richness							acient
Class 0 taxa richness 2 2 2 NEGATIVE INDICATORS **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 addisflies 0 4 7 %Tolerant addisflies 0 4 7 %Tolerant beetles 0 4 7 %Tolerant dipterans 3.5 2 7 Tol. mayfly richness 0 2 7 Tol. daddisfly richness 0 2 7 Tol. dipteran richness 1 3 7 Tol. dipteran richness 1 3 7 Ke OR SENSITIVE TAXA IDENTIFIED None None None None None 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 Tol. daddisfly richness 0 2 Tol. daddisfly richness 0 2 Tol. dipteran richness 1 3 Tol. dipteran richness 1 3 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					sites; alpine/subalpine streams; or small streams.		
NEGATIVE INDICATORS %Collector					TRE OR SENSITIVE TAVA IDENTIFIED		
WCollector	- '						
2 %Parasite 0 1 3 %Oligochaeta 17.5 0 4 %Leech 0.7 1 5 %Tolerant snails 11.2 0 6 %Tolerant doonates 0 2 8 %Tolerant mayflies 0 4 9 %Tolerant caddisflies 0 4 9 %Tolerant beetles 0 4 10 %Tolerant dipterans 3.5 2 10 kmayfly richness 0 2 10 kmayfly richness 0 2 10 loaddisfly richness 0 2 10 loaddisfly richness 0 4 10 loetle richness 0 4 10 kmyfly richness 0 4 11 Tol. beetle richness 0 4 12 Tol. dipteran richness 1 3 13 (Simuliidae 1.4 1 5) 14 %Chironomid (-C.Nostoc 19.6 3) 15 %Chironomid (-C.Nostoc 19.6 3) 16 %Oligochaeta 17.5 0 16 more typically associated with small streams and springs. Parapsyche almota, Rhyacophila grandis COLD WATER BIOTA 1 may a requiring year-round cool/cold water temperatures. Total percent contribution 0 1 Total taxa richness 0 1 SAMPLE & ANALYSIS SPECIFICATIONS 2 Sampler Type: D-frame net, 500 micron. 3 Number of points: 5 points, 1 square meter. 3 Subsample size: 500+ organisms 4 Taxonomy by: ABA standard taxonomic effort. 4 Data analysis by: ABA BENTHOS program Version 1.0	1		54.6	7	TVOILE		
Woligochaeta 17.5 0					CLASS DIAVA		
Weight W							
Parapsyche almota, Rhyacophila grandis STOICH							
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 18 %Tolerant caddisflies 0 4 19 %Tolerant dipterans 3.5 2 10 %Tolerant dipterans 3.5 2 10 %Tolerant dipterans 3.5 2 11 %Tolerant dipterans 0 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 18 %Chironomid (-C.Nostoc 19.6 3) 18 %Tolerant caddisflies 0 4 19 %Total percent contribution 0 10 Total taxa richness 0 10 %AMPLE & ANALYSIS SPECIFICATIONS 10 Sampler Type: D-frame net, 500 micron. 11 Number of points: 5 points, 1 square meter. 12 Subsample size: 500+ organisms 13 Taxonomy by: ABA standard taxonomic effort. 14 Data analysis by: ABA BENTHOS program Version 1.0						s and sp	rings.
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) 18 %Tolerant dipterans 3.5 2 19 Total percent contribution 0 1 10 Total taxa richness 0 1 20 SAMPLE & ANALYSIS SPECIFICATIONS 21 Sampler Type: D-frame net, 500 micron. 22 Number of points: 5 points, 1 square meter. 23 Subsample size: 500+ organisms 24 Taxonomy by: ABA standard taxonomic effort. 25 Data analysis by: ABA BENTHOS program Version 1.0					Parapsyche almota, Hnyacophila grandis		Į.
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) 18 WTolerant mayflies 0 4 19 COLD WATER BIOTA Taxa requiring year-round cool/cold water temperatures. 10 Total percent contribution 0 10 Total taxa richness 0 11 Sampler Type: D-frame net, 500 micron. Number of points: 5 points, 1 square meter. 19 Subsample size: 500+ organisms Taxonomy by: ABA standard taxonomic effort. Data analysis by: ABA BENTHOS program Version 1.0	-						
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 18 WTolerant caddisflies 0 4 19 Taxa requiring year-round cool/cold water temperatures. Total percent contribution 0 10 Total taxa richness 0 20 SAMPLE & ANALYSIS SPECIFICATIONS 21 Sampler Type: D-frame net, 500 micron. 22 Number of points: 5 points, 1 square meter. 23 Subsample size: 500+ organisms 24 Taxa requiring year-round cool/cold water temperatures. Total percent contribution 0 10 Total taxa richness 0 11 Sample Security Specifications 22 Sampler Type: D-frame net, 500 micron. 15 Number of points: 5 points, 1 square meter. 16 %Simuliidae 1.4 1 17 Subsample size: 500+ organisms 17 Taxonomy by: ABA standard taxonomic effort. 17 Data analysis by: ABA BENTHOS program Version 1.0					COLD MATER PIOTA		
Word Word							1
Total taxa richness Total tax						emperati	
Tol. mayfly richness 0 2 Tol caddisfly richness 0 2 SAMPLE & ANALYSIS SPECIFICATIONS Sampler Type: D-frame net, 500 micron. Number of points: 5 points, 1 square meter. Subsample size: 500+ organisms WChironomid (-C.Nostoc 19.6 3) Taxonomy by: ABA standard taxonomic effort. Data analysis by: ABA BENTHOS program Version 1.0							
Tol. beetle richness 0 2 SAMPLE & ANALYSIS SPECIFICATIONS Sampler Type: D-frame net, 500 micron. Number of points: 5 points, 1 square meter. Simuliidae 1.4 1 Subsample size: 500+ organisms Taxonomy by: ABA standard taxonomic effort. Data analysis by: ABA BENTHOS program Version 1.0					l otal taxa richness		0
Tol. beetle richness 0 4 Tol. dipteran richness 1 3 WSimuliidae 1.4 1 WChironomid (-C.Nostoc 19.6 3 LE: 98DM07X 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					0.114m) m. 0. 111111111111111111111111111111111		
Tol. dipteran richness 1 3 Number of points: 5 points, 1 square meter. Subsample size: 500+ organisms Chironomid (-C.Nostoc 19.6 3) Taxonomy by: ABA standard taxonomic effort. Data analysis by: ABA BENTHOS program Version 1.0							
6 %Simuliidae 1.4 1 Subsample size: 500+ organisms Taxonomy by: ABA standard taxonomic effort. Data analysis by: ABA BENTHOS program Version 1.0							
7 %Chironomid (-C.Nostoc 19.6 3 Taxonomy by: ABA standard taxonomic effort. ILE: 98DM07X Data analysis by: ABA BENTHOS program Version 1.0							
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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 HAB	TAT		SUMMARY SCORES	Score	%
	METRIC	Value	Score	EROSIONAL TOTAL	46	37.1
•	PRIMARY METRICS			Primary subtotal	2	11.1
1	Total abundance (m2)	520	1	Positive Indicators	6	10.5
2	Total taxa richness	26	0	Negative Indicators	38	77.6
3	EPT Taxa richness	5	0		 	
	%Dominant taxa	33.7	1			
	Community Tolerance	6.97	0	GENERAL BIOTIC INTEGRITY AND IMPACT	CATEG	ORIES
	POSITIVE INDICATORS		' '	Based on Total Bioassessment Score		
1	Predator richness	7	0	Very high biotic/habitat integrity		90-100%
	Scraper richness	3	0	High biotic/habitat integrity		80-89%
	Shredder richness	4	0	Moderate biotic/habitat integrity		60-79%
4	Xylophage richness	1	1	Low biotic/habitat integrity		40-59%
5	%Intolerant mayflies	0	0	Severe habitat and/or water quality limitation	ns	<40%
6	%Intolerant stoneflies	0	0			
7	%Intolerant caddisflies	0	0	The bioassessment model is based on Pac	ific North	west
8	%Intolerant dipterans	0	0	montane watersheds that have experience		
9	Intol. mayfly richness	0	0	disturbance, and applies to stream sites that		
10	Intol. stonefly richness	0	0	forested, low-mid elevation, and moderate-		
11	Heptageniidae richness	0	0	Maximum scores are based on experience		
	Ephemerellidae richness	0	0	have very high habitat complexity and integrity, and that		
13	Nemouridae richness	1	0			
14	Pteronarcys	0	0			sturbed
15	%Glossosomatidae	0	0	-		
16	%Philopotamidae	ō	0			roduce.
17	%Arctopsychidae	0.38	1	-		
18	Rhyacophila richness	1	0			
19	%C. Nostococladius	Ö	0	sites; alpine/subalpine streams; or small str		
20	Long-lived taxa richness	4	2			
21	Class 0 taxa richness	2	2	T&E OR SENSITIVE TAXA IDENTIFIED		
	NEGATIVE INDICATORS		<u> </u>	None		
1	%Collector	89.2	0			
2	%Parasite	0.38	1	CLASS 0 TAXA		
3	%Oligochaeta	14.6	0	These are either rare, unusual, or uncomm	on taxa;	or taxa
4	%Leech	0.57	1	more typically associated with small stream		
5	%Tolerant snails	0.77	3	Parapsyche almota, Rhyacophila grandis	<u>'</u>	
6	%Tolerant crustacea	47.1	0			ļ
7	%Tolerant odonates	0	2			
8	%Tolerant mayflies	0	4	COLD WATER BIOTA		
9	%Tolerant caddisflies	0	4	Taxa requiring year-round cool/cold water	temperat	ures.
10	%Tolerant beetles	0	4	Total percent contribution		0
11	%Tolerant dipterans	0.77	3	Total taxa richness		0
12	Tol. mayfly richness	0.77	2	Total taxa homicos		
13	Tol caddisfly richness	1 0	2	SAMPLE & ANALYSIS SPECIFICATIONS		
14	Tol. beetle richness	0	4	Sampler Type: D-frame net, 500 micron.		
15		1 1	3	Number of points: 5 points, 1 square mete	r.	
	Tol. dipteran richness			Subsample size: 500+ organisms	••	
16	%Simuliidae	0.19			fort	
17	%Chironomid (-C.Nostoc	7.5	4	Taxonomy by: ABA standard taxonomic ef		1 0
FILL	E: 98DM08X	- 40	- 1 H. (B	Data analysis by: ABA BENTHOS program		1.U 44 7E4 060E

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

IDENTIFICATIO	NCODE	98DM01
CORRECTION	ACTOR	. 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 abund Total number of taxa	= 17		EPT abundance Number EPT taxa	= 7
Hilsenhoff Biotic Index	= 4.	24	Brillouin H	= 1.63
TAXONOMIC GROUP	#TAXA	ABUNDANCI	E 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	ABUNDANC	e percent	
Predator	3	42.0	29.16	
Parasite	Ö	0.0	0.00	
Collector-gatherer	6	83.0	57.64	
Collector-ifilterer	ĭ	1.0	0.69	
Macrophyte-herbivore	ō	0.0	0.00	
Piercer-herbivore	Ö	0.0	0.00	
Scraper	i	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	ARIIN	DANCE	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	ABUNDAN	CE PERCENT	
A Tolerant snails	0	0.0	0.00	
B Tolerant mayflies	Ö	0.0	0.00	
C Intolerant mayflies	1	12.0	8.33	
D Intolerant stoneflies	ō	0.0	0.00	
E Tolerant caddisflies	Ö	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	Alsteinteisinteis	%
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 abund Total number of taxa	ance= 16		EPT abundance Number EPT taxa	= 74.0 = 1
Hilsenhoff Biotic Index			Brillouin H	= 1.42
TAXONOMIC GROUP	#TAXA	ABUNDANCE		
Non-insects Odonata	4 0	69.0 0.0	42.85	
	1	74.0	0.00	
Ephemeroptera Plecoptera	0	0.0	45.96	*
Hemiptera	0	0.0	0.00	
	0	0.0	0.00	
Megaloptera	0	0.0	0.00	
Trichoptera Lepidoptera	0	0.0	0.00	
Coleoptera	0	0.0	0.00	
Misc. Diptera	1	3.0	0.00 1.86	•
Chironomidae	5	15.0	9.32	
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 TAYON	ARTINI	ANCE.	DED (***********************************	at .
DOMINANT TAXON			PERCENT	a
Baetis tricaudatus	74.0		45.96	
Baetis tricaudatus Gammarus	74.0 45.0		45.96 27.95	
Baetis tricaudatus Gammarus Oligochaeta	74.0		45.96 27.95 11.80	
Baetis tricaudatus Gammarus Oligochaeta Thienemannimyia Gr.	74.0 45.0 19.0 6.0		45.96 27.95 11.80 3.73	
Baetis tricaudatus Gammarus Oligochaeta Thienemannimyia Gr. Tvetenia	74.0 45.0 19.0		45.96 27.95 11.80 3.73 3.11	
Baetis tricaudatus Gammarus Oligochaeta Thienemannimyia Gr.	74.0 45.0 19.0 6.0 5.0	0	45.96 27.95 11.80 3.73	
Baetis tricaudatus Gammarus Oligochaeta Thienemannimyia Gr. Tvetenia SUBTOTAL 5 DOMINANTS	74.0 45.0 19.0 6.0 5.0 149.0	o	45.96 27.95 11.80 3.73 3.11 92.55	
Baetis tricaudatus Gammarus Oligochaeta Thienemannimyia Gr. Tvetenia SUBTOTAL 5 DOMINANTS Ferrissia	74.0 45.0 19.0 6.0 5.0 149.0)	45.96 27.95 11.80 3.73 3.11 92.55 1.86	
Baetis tricaudatus Gammarus Oligochaeta Thienemannimyia Gr. Tvetenia SUBTOTAL 5 DOMINANTS Ferrissia Chelifera Acari	74.0 45.0 19.0 6.0 5.0 149.0 3.0)	45.96 27.95 11.80 3.73 3.11 92.55	
Baetis tricaudatus Gammarus Oligochaeta Thienemannimyia Gr. Tvetenia SUBTOTAL 5 DOMINANTS Ferrissia Chelifera	74.0 45.0 19.0 6.0 5.0 149.0 3.0 3.0)	45.96 27.95 11.80 3.73 3.11 92.55 1.86 1.86 1.24	
Baetis tricaudatus Gammarus Oligochaeta Thienemannimyia Gr. Tvetenia SUBTOTAL 5 DOMINANTS Ferrissia Chelifera Acari Chironomidae-pupae	74.0 45.0 19.0 6.0 5.0 149.0 3.0 2.0 2.0)	45.96 27.95 11.80 3.73 3.11 92.55 1.86 1.86 1.24 1.24	
Baetis tricaudatus Gammarus Oligochaeta Thienemannimyia Gr. Tvetenia SUBTOTAL 5 DOMINANTS Ferrissia Chelifera Acari Chironomidae-pupae Brillia TOTAL 10 DOMINANTS	74.0 45.0 19.0 6.0 5.0 149.0 3.0 2.0 2.0 1.0		45.96 27.95 11.80 3.73 3.11 92.55 1.86 1.86 1.24 1.24 0.62 99.37	
Baetis tricaudatus Gammarus Oligochaeta Thienemannimyia Gr. Tvetenia SUBTOTAL 5 DOMINANTS Ferrissia Chelifera Acari Chironomidae-pupae Brillia TOTAL 10 DOMINANTS	74.0 45.0 19.0 6.0 5.0 149.0 3.0 2.0 2.0 1.0 160.0) ABUNDANC	45.96 27.95 11.80 3.73 3.11 92.55 1.86 1.86 1.24 1.24 0.62 99.37 E PERCENT	
Baetis tricaudatus Gammarus Oligochaeta Thienemannimyia Gr. Tvetenia SUBTOTAL 5 DOMINANTS Ferrissia Chelifera Acari Chironomidae-pupae Brillia TOTAL 10 DOMINANTS INDICATOR ASSEMBLAGE A Tolerant snails	74.0 45.0 19.0 6.0 5.0 149.0 3.0 2.0 2.0 1.0 160.0	D ABUNDANC 3.0	45.96 27.95 11.80 3.73 3.11 92.55 1.86 1.86 1.24 1.24 0.62 99.37 E PERCENT 1.86	
Baetis tricaudatus Gammarus Oligochaeta Thienemannimyia Gr. Tvetenia SUBTOTAL 5 DOMINANTS Ferrissia Chelifera Acari Chironomidae-pupae Brillia TOTAL 10 DOMINANTS INDICATOR ASSEMBLAGE A Tolerant snails B Tolerant mayflies	74.0 45.0 19.0 6.0 5.0 149.0 3.0 2.0 2.0 1.0 160.0	ABUNDANC 3.0 0.0	45.96 27.95 11.80 3.73 3.11 92.55 1.86 1.24 1.24 0.62 99.37 E PERCENT 1.86 0.00	
Baetis tricaudatus Gammarus Oligochaeta Thienemannimyia Gr. Tvetenia SUBTOTAL 5 DOMINANTS Ferrissia Chelifera Acari Chironomidae-pupae Brillia TOTAL 10 DOMINANTS INDICATOR ASSEMBLAGE A Tolerant snails B Tolerant mayflies C Intolerant mayflies	74.0 45.0 19.0 6.0 5.0 149.0 2.0 2.0 1.0 160.0 #TAXA 1	ABUNDANC 3.0 0.0 0.0	45.96 27.95 11.80 3.73 3.11 92.55 1.86 1.24 1.24 0.62 99.37 E PERCENT 1.86 0.00 0.00	
Baetis tricaudatus Gammarus Oligochaeta Thienemannimyia Gr. Tvetenia SUBTOTAL 5 DOMINANTS Ferrissia Chelifera Acari Chironomidae-pupae Brillia TOTAL 10 DOMINANTS INDICATOR ASSEMBLAGE A Tolerant snails B Tolerant mayflies C Intolerant mayflies D Intolerant stoneflies	74.0 45.0 19.0 6.0 5.0 149.0 2.0 2.0 1.0 160.0 #TAXA 1	ABUNDANC 3.0 0.0 0.0	45.96 27.95 11.80 3.73 3.11 92.55 1.86 1.86 1.24 1.24 0.62 99.37 E PERCENT 1.86 0.00 0.00 0.00	
Baetis tricaudatus Gammarus Oligochaeta Thienemannimyia Gr. Tvetenia SUBTOTAL 5 DOMINANTS Ferrissia Chelifera Acari Chironomidae-pupae Brillia TOTAL 10 DOMINANTS INDICATOR ASSEMBLAGE A Tolerant snails B Tolerant mayflies C Intolerant mayflies D Intolerant stoneflies E Tolerant caddisflies	74.0 45.0 19.0 6.0 5.0 149.0 2.0 2.0 1.0 160.0 #TAXA 1 0	ABUNDANC 3.0 0.0 0.0 0.0	45.96 27.95 11.80 3.73 3.11 92.55 1.86 1.86 1.24 1.24 0.62 99.37 E PERCENT 1.86 0.00 0.00 0.00 0.00	
Baetis tricaudatus Gammarus Oligochaeta Thienemannimyia Gr. Tvetenia SUBTOTAL 5 DOMINANTS Ferrissia Chelifera Acari Chironomidae-pupae Brillia TOTAL 10 DOMINANTS INDICATOR ASSEMBLAGE A Tolerant snails B Tolerant mayflies C Intolerant mayflies D Intolerant stoneflies E Tolerant caddisflies F Intolerant caddisflies	74.0 45.0 19.0 6.0 5.0 149.0 3.0 2.0 1.0 160.0 #TAXA 1 0 0	ABUNDANC 3.0 0.0 0.0 0.0 0.0	45.96 27.95 11.80 3.73 3.11 92.55 1.86 1.86 1.24 1.24 0.62 99.37 E PERCENT 1.86 0.00 0.00 0.00 0.00 0.00	
Baetis tricaudatus Gammarus Oligochaeta Thienemannimyia Gr. Tvetenia SUBTOTAL 5 DOMINANTS Ferrissia Chelifera Acari Chironomidae-pupae Brillia TOTAL 10 DOMINANTS INDICATOR ASSEMBLAGE A Tolerant snails B Tolerant mayflies C Intolerant mayflies C Intolerant stoneflies E Tolerant caddisflies F Intolerant caddisflies G Tolerant beetles	74.0 45.0 19.0 6.0 5.0 149.0 3.0 2.0 1.0 160.0 #TAXA 1 0 0 0	ABUNDANC 3.0 0.0 0.0 0.0 0.0	45.96 27.95 11.80 3.73 3.11 92.55 1.86 1.86 1.24 1.24 0.62 99.37 E PERCENT 1.86 0.00 0.00 0.00 0.00 0.00 0.00 0.00	
Baetis tricaudatus Gammarus Oligochaeta Thienemannimyia Gr. Tvetenia SUBTOTAL 5 DOMINANTS Ferrissia Chelifera Acari Chironomidae-pupae Brillia TOTAL 10 DOMINANTS INDICATOR ASSEMBLAGE A Tolerant snails B Tolerant mayflies C Intolerant mayflies C Intolerant stoneflies E Tolerant caddisflies F Intolerant caddisflies G Tolerant beetles H Intolerant flies	74.0 45.0 19.0 6.0 5.0 149.0 3.0 2.0 1.0 160.0 #TAXA 1 0 0 0	ABUNDANC 3.0 0.0 0.0 0.0 0.0 0.0	45.96 27.95 11.80 3.73 3.11 92.55 1.86 1.86 1.24 1.24 0.62 99.37 E PERCENT 1.86 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	
Baetis tricaudatus Gammarus Oligochaeta Thienemannimyia Gr. Tvetenia SUBTOTAL 5 DOMINANTS Ferrissia Chelifera Acari Chironomidae-pupae Brillia TOTAL 10 DOMINANTS INDICATOR ASSEMBLAGE A Tolerant snails B Tolerant mayflies C Intolerant mayflies D Intolerant caddisflies F Tolerant caddisflies F Intolerant flies H Intolerant flies I Tolerant flies	74.0 45.0 19.0 6.0 5.0 149.0 3.0 2.0 1.0 160.0 #TAXA 1 0 0 0 0	ABUNDANC 3.0 0.0 0.0 0.0 0.0 0.0 0.0	45.96 27.95 11.80 3.73 3.11 92.55 1.86 1.86 1.24 1.24 0.62 99.37 E PERCENT 1.86 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	
Baetis tricaudatus Gammarus Oligochaeta Thienemannimyia Gr. Tvetenia SUBTOTAL 5 DOMINANTS Ferrissia Chelifera Acari Chironomidae-pupae Brillia TOTAL 10 DOMINANTS INDICATOR ASSEMBLAGE A Tolerant snails B Tolerant mayflies C Intolerant mayflies C Intolerant stoneflies E Tolerant caddisflies F Intolerant caddisflies G Tolerant beetles H Intolerant flies I Tolerant flies I Tolerant flies J Intolerant midges	74.0 45.0 19.0 6.0 5.0 149.0 3.0 2.0 1.0 1.60.0 #TAXA 1 0 0 0 0 0	ABUNDANC 3.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	45.96 27.95 11.80 3.73 3.11 92.55 1.86 1.86 1.24 1.24 0.62 99.37 E PERCENT 1.86 0.00 0.	
Baetis tricaudatus Gammarus Oligochaeta Thienemannimyia Gr. Tvetenia SUBTOTAL 5 DOMINANTS Ferrissia Chelifera Acari Chironomidae-pupae Brillia TOTAL 10 DOMINANTS INDICATOR ASSEMBLAGE A Tolerant snails B Tolerant mayflies C Intolerant stoneflies E Tolerant caddisflies F Intolerant caddisflies F Intolerant flies I Tolerant flies I Tolerant flies I Tolerant flies I Tolerant flies J Intolerant midges K Tolerant midges	74.0 45.0 19.0 6.0 5.0 3.0 2.0 2.0 1.0 160.0 #TAXA 1 0 0 0 0	ABUNDANC 3.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	45.96 27.95 11.80 3.73 3.11 92.55 1.86 1.86 1.24 1.24 0.62 99.37 E PERCENT 1.86 0.00 0.	
Baetis tricaudatus Gammarus Oligochaeta Thienemannimyia Gr. Tvetenia SUBTOTAL 5 DOMINANTS Ferrissia Chelifera Acari Chironomidae-pupae Brillia TOTAL 10 DOMINANTS INDICATOR ASSEMBLAGE A Tolerant snails B Tolerant mayflies C Intolerant mayflies C Intolerant caddisflies F Tolerant caddisflies F Intolerant flies G Tolerant flies I Tolerant flies I Tolerant flies J Intolerant midges K Tolerant midges K Tolerant midges L	74.0 45.0 19.0 6.0 5.0 149.0 3.0 2.0 2.0 1.0 160.0 #TAXA 1 0 0 0 0 0 0	ABUNDANC 3.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	45.96 27.95 11.80 3.73 3.11 92.55 1.86 1.24 1.24 0.62 99.37 E PERCENT 1.86 0.00 0.	
Baetis tricaudatus Gammarus Oligochaeta Thienemannimyia Gr. Tvetenia SUBTOTAL 5 DOMINANTS Ferrissia Chelifera Acari Chironomidae-pupae Brillia TOTAL 10 DOMINANTS INDICATOR ASSEMBLAGE A Tolerant snails B Tolerant mayflies C Intolerant stoneflies E Tolerant caddisflies F Intolerant caddisflies F Intolerant flies I Tolerant flies I Tolerant flies I Tolerant flies I Tolerant flies J Intolerant midges K Tolerant midges	74.0 45.0 19.0 6.0 5.0 3.0 2.0 2.0 1.0 160.0 #TAXA 1 0 0 0 0	ABUNDANC 3.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	45.96 27.95 11.80 3.73 3.11 92.55 1.86 1.86 1.24 1.24 0.62 99.37 E PERCENT 1.86 0.00 0.	

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.

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

DENTIF	ICATION ()ODE	980	DM03
CORRE	CTION FAC	TOR		1

Тахоп	Alejajajelejijos	9,6
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 abund		6.0	EPT abundance	= 233.0
Total number of taxa Hilsenhoff Biotic Index	= 9	י	Number EPT taxa Brillouin H	= 1 = 0.77
	- 0.		PLITIONIN H	= 0.77
TAXONOMIC GROUP	#TAXA	ABUNDANC	E 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 Coleoptera	0	0.0	0.00	
Misc. Diptera	1	1.0	0.00	
Chironomidae	3	6.0	0.33	
CHITOHOMINGE	٥	0.0	1.97	
FEEDING GROUP	#TAXA	ABUNDANCI	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	0.00	•
Unknown	1	1.0	0.33	
DOMINANT TAXON	ABUN	DANCE	PERCENT	
Baetis tricaudatus	233.	Õ	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	
TOTAL 10 DOSCUSTANTO	0.0	•	0.00	
TOTAL 10 DOMINANTS	306.	U	100.02	
INDICATOR ASSEMBLAGE	#TAXA	ABUNDANG	CE 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	0.00	
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 M	0	0.0	0.00	
M N	0	0.0	0.00	
41	U	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

DENTIFICATIO	CODE	98DM04
CORRECTION F	ACTOR	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 Total number of taxa **=** 6 Number EPT taxa = 1 = 0.76Brillouin H = 7.57Hilsenhoff Biotic Index #TAXA ABUNDANCE PERCENT TAXONOMIC GROUP 22.0 95.66 Non-insects 5 0.00 0 0.0 Odonata 1.0 4.35 Ephemeroptera 1 0 0.0 0.00 Plecoptera 0.0 0.00 Hemiptera 0 0.0 0.00 0 Megaloptera 0.0 0.00 0 Trichoptera 0. 0.0 0.00 Lepidoptera 0 0.0 0.00 Coleoptera 0 0.0 0.00 Misc. Diptera 0.0 0.00 0 Chironomidae #TAXA ABUNDANCE PERCENT FEEDING GROUP 0 0.0 0.00 Predator 2.0 8.70 Parasite 1 20.0 86.96 Collector-gatherer 0.00 0 0.0 Collector-filterer 0 0.0 0.00 Macrophyte-herbivore 0 0.0 0.00 Piercer-herbivore 1.0 4.35 Scraper 1 0.0 0.00 0 Shredder 0.00 0.0 Xylophage 0 0.00 0 0.0 Omnivore Unknown 0 0.0 0.00 PERCENT DOMINANT TAXON ABUNDANCE 73.91 17.0 Oligochaeta 2.0 8.70 Acari 1.0 4.35 Planorbidae 1.0 4.35 Copepoda Ostracoda 1.0 4.35 22.0 95.66 SUBTOTAL 5 DOMINANTS 1.0 4.35 Baetis tricaudatus 0.0 0.00 0.0 0.00 0.0 0.00 0.0 0.00 100.01 23.0 TOTAL 10 DOMINANTS **#TAXA ABUNDANCE** PERCENT INDICATOR ASSEMBLAGE 1.0 4.35 A Tolerant snails 1 0 0.0 0.00 B Tolerant mayflies 0.0 0.00 C Intolerant mayflies 0 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 H Intolerant flies 0 0.0 0.00 0 0.0 0.00 I Tolerant flies 0 0.0 0.00 J Intolerant midges 0.00 0 0.0 K Tolerant midges 0 0.0 0.00 L 0 0.0 0.00 M

0

N

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

Тахоп	Alejeinjeisinjeis	9,
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
	12	Number EPT taxa	= 1 ,
Hilsenhoff Biotic Index =	6.26	Brillouin H	= 0.91

Total number of taxa	ance= 20 = 12		EPT abundance	= 15;
Hilsenhoff Biotic Index			Number EPT taxa Brillouin H	= 1 = 0.9
milbemoil Block index	- 0.	20	DITITOUTH H	= 0.3
TAXONOMIC GROUP	#TAXA	ABUNDANCI	E PERCENT	
Non-insects	4	10.0	4.80	
Odonata	ō	0.0	0.00	
Ephemeroptera	i	159.0	76.44	
Plecoptera	Ō	0.0	0.00	
Hemiptera	Ö	0.0	0.00	
Megaloptera	Ö	0.0	0.00	
Trichoptera	Ö	0.0	0.00	
Lepidoptera	Ö	0.0	0.00	
Coleoptera	Ö	0.0	0.00	*
Misc. Diptera	2	3.0	1.44	
Chironomidae	5	36.0	17.31	
FEEDING GROUP	#TAXA	ABUNDANCI	E 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		DANCE	PERCENT	
Baetis tricaudatus	159.		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.	O	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.	U	99.03	
INDICATOR ASSEMBLAGE	# ጥ አሄኦ	ABUNDAN	CE PERCENT	
A Tolerant snails	0	0.0		
B Tolerant mayflies	0	0.0	0.00	
	0	0.0	0.00 0.00	
C Intolerant mayflies	=			
D Intolerant stoneflies	0	0.0	0.00	
E Tolerant caddisflies F Intolerant caddisflies	0	0.0 0.0	0.00	
G Tolerant beetles	0	0.0	0.00 0.00	
H Intolerant flies	0	0.0		
I Tolerant flies	0	0.0	0.00	
J Intolerant midges	0	0.0	0.00	
	. 1	21.0	0.00	
K Tolerant midges L		0.0	10.10	•
W	0	0.0	0.00	
N W	0	0.0	0.00	
74	U	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 = 1.0

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

DENTIFIC	ATION CODE	98DM06
CORRECT	ON FACTOR	1

Тахоп	Abundance	9/6
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

Abundances (m2). Full Of	300+ 01	Saurem so	magmbre. rrnm	ODELO
Total invertebrate abunda	ance= 15	6.0	EPT abundance	= 60.0
Total number of taxa	= 15	,	Number EPT taxa	
Hilsenhoff Biotic Index	= 6.	27	Brillouin H	= 1.74
TAXONOMIC GROUP	#TAXA	ABUNDANC	E 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	ABUNDANC		
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	ABU	NDANCE	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	a.	1.92	
Physella	2.0	_	1.28	
TOTAL 10 DOMINANTS	150	. 0	96.16	
	#TAX	a abunda	NCE PERCENT	
INDICATOR ASSEMBLAGE	#TAA			
A Tolerant snails	Ŏ	0.0	0.00	
B Tolerant mayflies C Intolerant mayflies	Ö	0.0	0.00	
D Intolerant stoneflies	Ö	0.0	0.00	
E Tolerant caddisflies	Ö	0.0	0.00	
F Intolerant caddisflies		0.0	0.00	
G Tolerant beetles	0	0.0	0.00	
H Intolerant flies	ŏ	0.0	0.00	
I Tolerant flies	Ŏ	0.0	0.00	
J Intolerant midges	Ö	0.0	0.00	
K Tolerant midges	í	22.0	14.10	
L L	0	0.0	0.00	
	·			
	0	0.0	0.00	
M N	_			

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

DENTIFICA	ION CC)DE	98DM07
CORRECTIO	N FACT	OR .	1

Digochaeta 25 17.48		o xx-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x	• • • • • • • • • • • • • • • • • • • •
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 <td< td=""><td>Taxon</td><td></td><td>~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~</td></td<>	Taxon		~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
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 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			17.48
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 TOTAL: COLEOPTERA 11 7.69 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		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		1	0.70
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		1	0.70
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	Planorbidae	15	10.49
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	Gammarus	42	29.37
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	Caecidotea	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	TOTAL: NON INSECTS	86	60.14
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	Soyedina	1	0.70
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	Zapada cinctipes	2	1.40
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	TOTAL: PLECOPTERA	3	2.10
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	Parapsyche almota	5	3.50
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	Limnephilidae	1	0.70
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	Rhyacophila grandis	4	2.80
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	TOTAL: TRICHOPTERA	10	6.99
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	Lara avara	11	7.69
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		11	7.69
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	Chelifera	2	1.40
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	Simulium	2	1.40
Brillia 2 1.40 Diplocladius 5 3.50 Macropelopia 1 0.70 Orthocladius Complex 1 0.70 Polypedilum 1 0.70	Holorusia	1	0.70
Diplocladius 5 3.50 Macropelopia 1 0.70 Orthocladius Complex 1 0.70 Polypedilum 1 0.70	TOTAL: DIPTERA	5	3.50
Macropelopia 1 0.70 Orthocladius Complex 1 0.70 Polypedilum 1 0.70	Brillia	2	1.40
Orthocladius Complex 1 0.70 Polypedilum 1 0.70	Diplocladius	5	3.50
Polypedilum 1 0.70	Macropelopia	1	0.70
	Orthocladius Complex	1	0.70
Rheocricotopus 1 0.70	Polypedilum	1	0.70
	Rheocricotopus	1	0.70
Thienemannimyia Gr. 17 11.89	Thienemannimyia Gr.	17	11.89
TOTAL: CHIRONOMIDAE 28 19.58	TOTAL: CHIRONOMIDAE	28	19.58
GRAND TOTAL 143 100.00	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

Abundances (m2). Full or	500+ org	ganism sub	osample.	FILE:	98DM07
Total invertebrate abund	ance= 141	3.0	EPT abund	lance	= 13.0
Total number of taxa	= 23		Number EF		
Hilsenhoff Biotic Index	= 5.9	94	Brillouin	н	= 2.10
TAXONOMIC GROUP	#TAXA	ABUNDANCI			-
Non-insects	7	86.0	60.14		
Odonata Ephemeroptera	0	0.0	0.00		
Plecoptera	2	3.0	0.00 2.10		
Hemiptera	Õ	0.0	0.00		
Megaloptera	Ö	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)	
FEFTING CROWN	#TAXA	ABUNDANCI	. Dance	PATTI	
FEEDING GROUP Predator	#1AAA	30.0	PERCE 20.99		
Parasite	Ö	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 Unknown	2 1	2.0 1.0	1.40		
CHAHOWH	1	1.0	0.70		
DOMINANT TAXON	ABUNI	DANCE	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 Parapsyche almota	110.0 5.0	,	76.92 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		
TIME COMMON ASSESSMENT OF	11m= er=	\$ 50 pp	74		
INDICATOR ASSEMBLAGE	#TAXA	ABUNDANG		RCENT	
A Tolerant snails	2 0	16.0 0.0	11.		
B Tolerant mayflies C Intolerant mayflies	0	0.0	0.0		
D Intolerant stoneflies	Ö	0.0	0.0		
E Tolerant caddisflies	Ö	0.0	0.0		
F Intolerant caddisflies	-	0.0	0.0		
G Tolerant beetles	0	0.0	0.0		
H Intolerant flies	0	0.0	0.0		
I Tolerant flies	0	0.0	0.0	00	
J Intolerant midges	0	0.0	0.0		
K Tolerant midges	1	5.0	3.5		
L	0	0.0	0.0	00	
M	^	0 0			
N	0 0	0.0	0.0		

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

IDENTIFICATI	ON	CODE 98DM08	
CORRECTION		ACTOR	1

Тахоп	Alejungiangse	%
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 abund Total number of taxa Hilsenhoff Biotic Index	= 26			oundance EPT taxa	= 133.0 = 5 = 1.80
mrischholl blotte index	- 0.	• •	22224		- 1.00
TAXONOMIC GROUP	#TAXA	ABUNDANCI	S PE	RCENT	
Non-insects	10	335.0	64	.41	
Odonata	0	0.0	0.	00	
Ephemeroptera	2	128.0	24	.61	
Plecoptera	1	2.0		38	
Hemiptera	0	0.0	0.	00	
Megaloptera	0	0.0	0.	.00	
Trichoptera	2	3.0	0.	.57	
Lepidoptera	0	0.0		.00	
Coleoptera	1	1.0		19	
Misc. Diptera	4	12.0		.30	* 1.
Chironomidae	6	39.0	7.	49	
FEEDING GROUP	#TAXA	ABUNDANCI	7 101	RCENT	
Predator	7	40.0		67	
Parasite	í	2.0		.38	
Collector-gatherer	10	463.0		0.03	
Collector-filterer	1	1.0		19	
Macrophyte-herbivore	Ō	0.0		.00	
Piercer-herbivore	ŏ	0.0		.00	
Scraper	ĭ	1.0	-	.19	
Shredder	3	4.0		76	
Xylophage		0.0		.00	
Omnivore	2	5.0		96	
Unknown	ī	4.0		77	
				- 	
DOMINANT TAXON		DANCE	PERCEN	VI.	
Caecidotea	175.0		33.65		
Baetis tricaudatus	127.0 76.0	U	24.42 14.62		
Oligochaeta Gammarus	70.0		13.46		
	27.0		5.19		
Thienemannimyia Gr. SUBTOTAL 5 DOMINANTS	475.		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	ABUNDAN	CE	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		0.00	
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	
<u>L</u>	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



Prepared by:

Joy P. Michaud Sara Martin Envirovision Corporation 203 4th Avenue East Suite 501 Olympia, WA 98501

Date: December 1999

Prepared for:

City of DesMoines

and

Herrera Environmental Cons.

TABLE OF CONTENTS INTRODUCTION 1 METHODS 1 MASSEY CREEK 2 BARNES CREEK 5 DESMOINES CREEK 6 MCSORLEY CREEK 9 PROTECTION/RESTORATION OPPORTUNITIES 11 SUMMARY 12 FIGURE 1 13 APPENDIX A - 1999 RIPARIAN CORRIDOR ASSESSMENT SURVEY FORMS APPENDIX B - 1994 RIPARIAN CORRIDOR ASSESSMENT SURVEY FORMS APPENDIX C - PICTURES

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.

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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.

<u>MA-2</u>

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

<u>B1</u>

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.

<u>B3</u>

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

ENVIROVISION

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.

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

11

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.

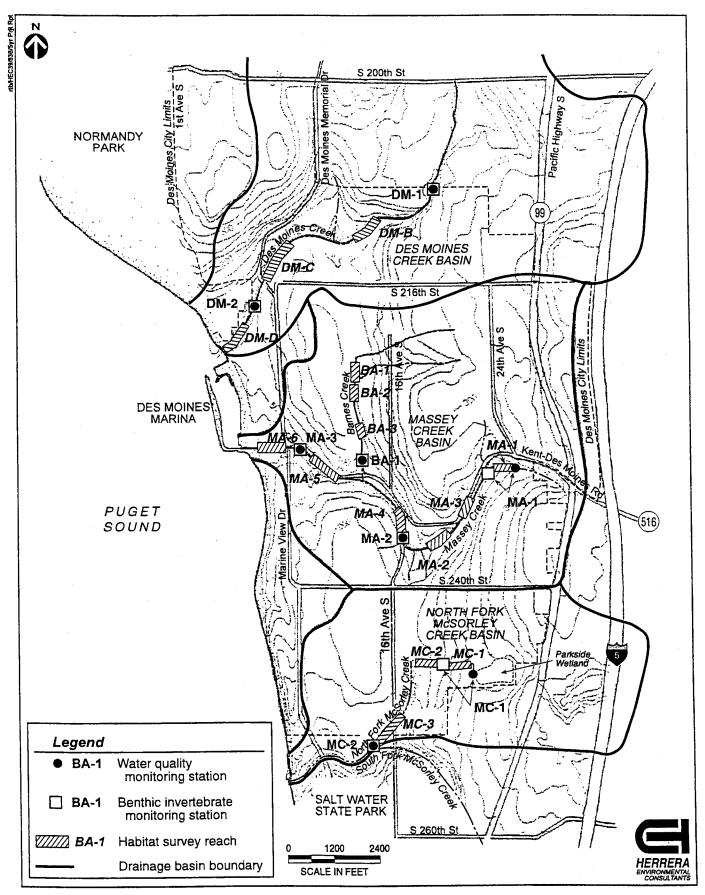
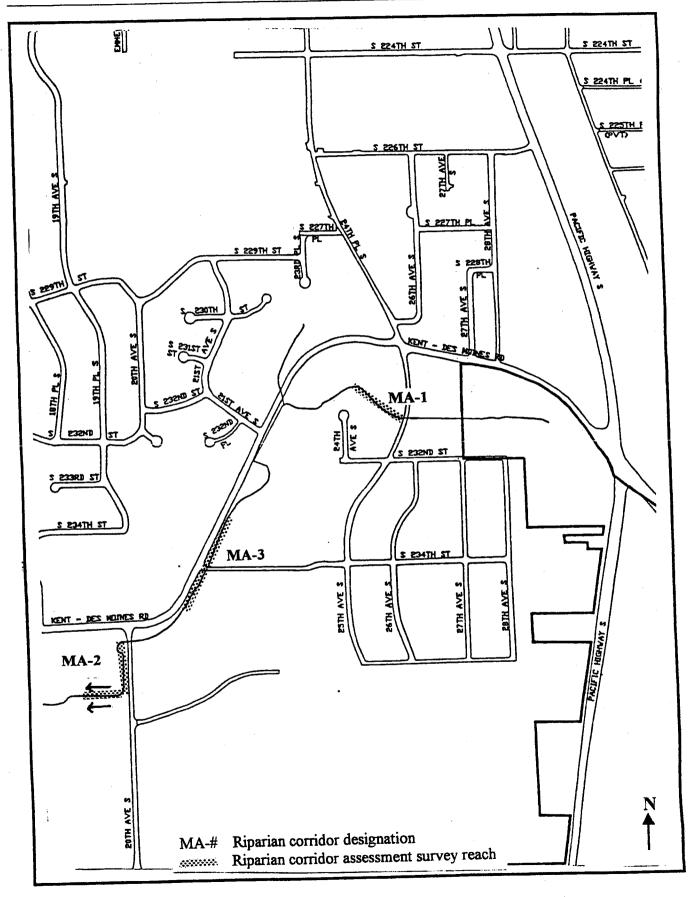


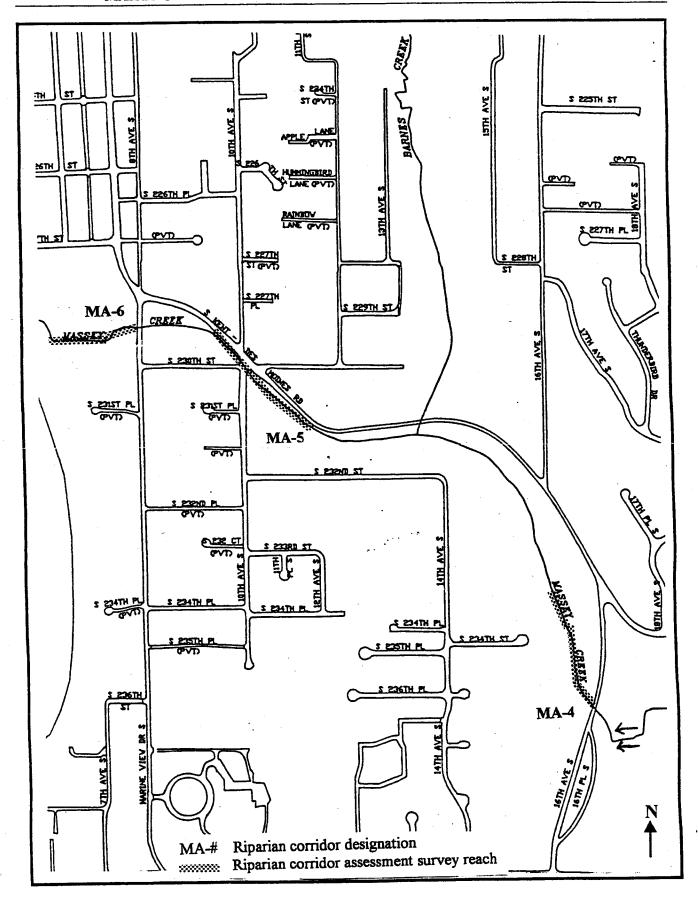
Figure 1. Monitoring locations for the Des Moines water quality monitoring program.

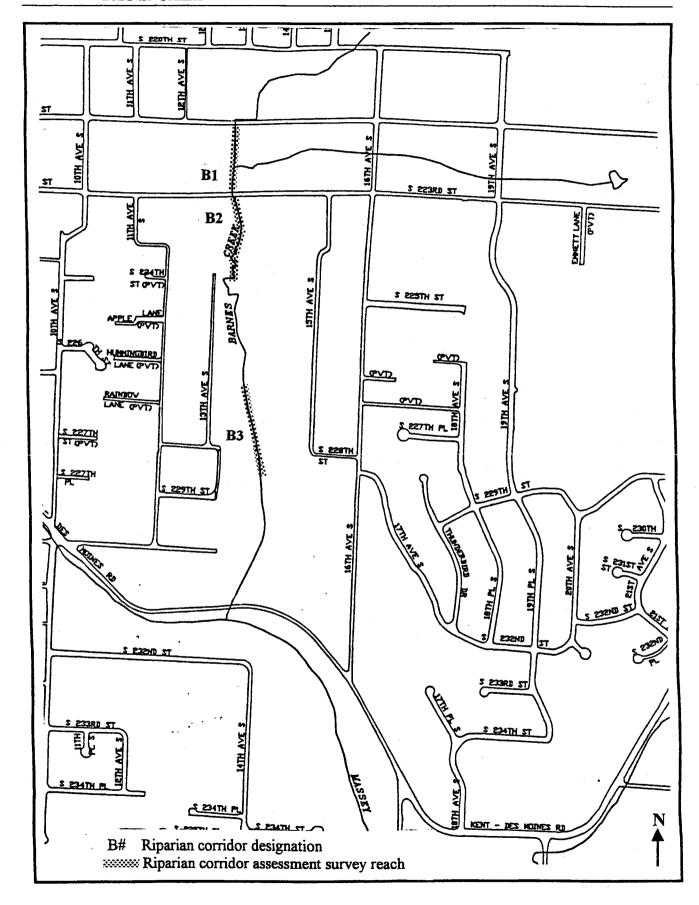
APPENDIX A

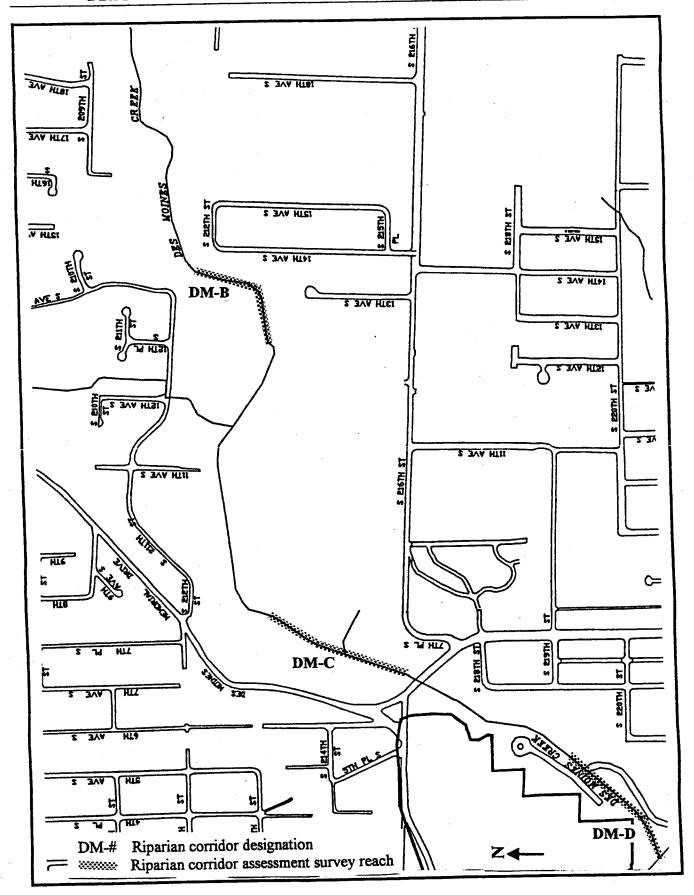
1999 RIPARIAN CORRIDOR ASSESSMENT SURVEY FORMS

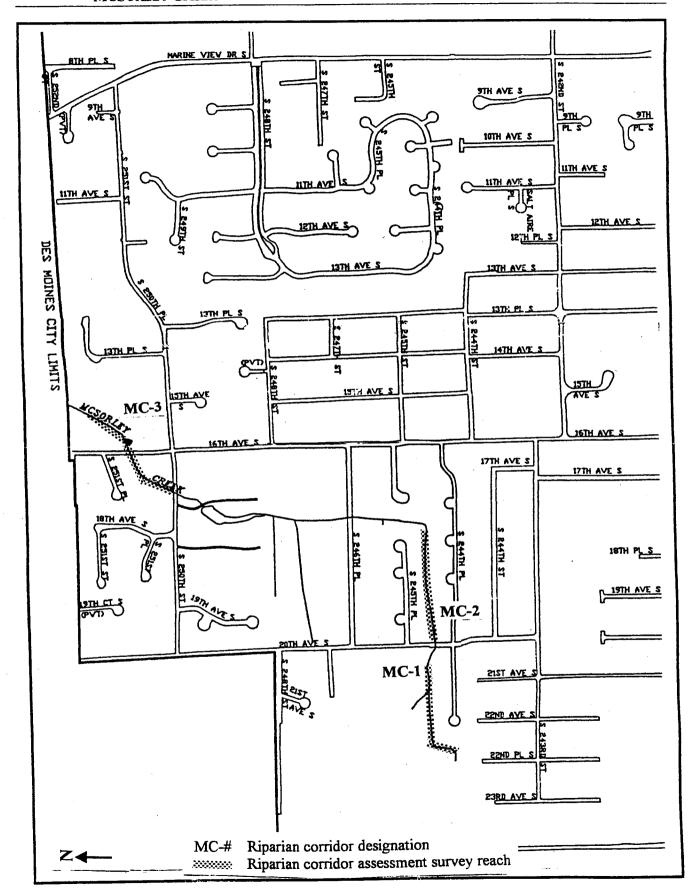
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- 4	16	Colvert M		Dam 30						49. CHANNEL CHARACTERISTICS
0 sta	; 	Beaver	Beaver Dam 41						·	1 Whath 2 Depth 1 Whath 2 Dept
					Type: Tributary 42	242	Proe/C	Pipe/Culvert 43 8	Seepe/Springs 46	
HENERAL COMMENTS:		ä			Grass	Grass-fined Swale 44	2 8	Ditch 46		
. Stream		51. Survey		} 	Effects: A.N.	one 89. C.	harmel/Bank	Erosion C.Sed Do	Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted	
2. Communication with Hestoents:	Bon Wiff	Hespenia			RECENT IMP	ACT8 TO	STREAM	RECENT IMPACTS TO STREAMSIDE CORRIDOR:		
					31.	Prox	Prox to Stream: <30 >30:	Length	Cersos:	34
			٠							
									was 45 and	
								- ·		
				-						
							÷			-
. •							· .			Channel cross-section:
					·					
			v		47. Total A. Clear	Fotal A. Clearing/Grading	11	decaping C. Othe	B. Landecaping C. Other Construction Activity	
	->				D. Land	D. Land Use Change	₽Ĝu			_
י י י	-								٠.	4

. CHANNEL CAPACITY Indequate. Channel subject to severe erosion—channel may be widening or migratcatenative deposits or description of the second service of overbank flows common. (high water mark observed)	outside of chemies.) Cappears to ben's control present peak flows. Flows creating noticeable enceton. Considerable self-ment benevity control present packing behind instream obstruction and/or occasional evidence of self-ment (each fine sediment) accumulating behind instream obstruction and/or occasional evidence of covering flows. (High water mark observed outside of channel.)	Appears adequate to contain most peak flows. Flows may be greating into their and social and a evolution at outcomes and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank vegetation; having matted down). Lank, Debris suspended or deposited on bank vegetation; having vegetation matted down).	Appears able to contain present peak flows. Flows patient with the country. 4 explanes of bank determined. 5 explanes of the selection of the peak o	30. ARTIFICIAL BANK PROTECTION:	Extensive stretches of bank protection material present (>50% of banking) and or import of imports of imports of protection aftered after the protection material portners (20 50% of banking) and/or group of natural streambalities of office of configuration statement. (\$1500% Southern Southe	Occasional stretches of bank protection material present (10-25% of bankine). Streampeans mounty 15- 13 in natural state. 14 Listel, if any bank protection material present (<10% of bankine). Streambank almost endrely in		\		3. Substrate moderately packed-cemented. Substrate difficult to move with boot heel. Substrate lightly packed-cemented. Substrate difficult to dislodge with kicking. May include areas of		33. TRANSPARENCY/COLOR: [27] Transparent, bottom of channel is visible.	2 Opeque or white like, bottom to chemical may be seen. Bottom of chemical not yieldle. 1 Light to deark brown; vieldle perdoulate matter present. Bottom of chemical not yieldle. 4 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors	R N.₩ Animal weeks or menure.	Septic or human waste. 1. Sulfuric 2. OTHER CHEMICAL 3. PETROLEUM	36. TRASH NO. 1. No		COAL CASES PRESENT 1/0 Farm animals in stream of Sona processing found at	2 ABUNDANT SUDS 3.
APPENDIX V RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM	1. STREAM #		MYEN MIES SURVEYED: 6 TO 7	AM PLANTS 1		다 하다고 .	vegetation in vigorous condition. ed. A deep, dense root mat is	surince protection from econom. 78-80% of streambank surface covered by vegetation. Few open areas with unstable vegetation. 8. Addent, Less dense, deep root mart inferred. Minor erosion of streambank surface possible. 8. 78% of streambank surface covered by vegetation. Bare or spersely vegetation graves are evident.	Somewhat shallow and decontinuous root mail inferred. Vegetable cover provides limited protection from erceion.	₹> \$7	WIDTH OF VEGETATIVE COVER Right Bank 10, 20, 20 feet CLTSIDE OF CHANNEL:	VEGETATION TYPES: DOMINANT 21. A SUBDOMINANT 22. A OTHERS PRESENT 22[22] 1. GRASSES 2. SHRUBS 2. BLK BRY BUSHES 4. THEES 8. OTHER 以以如此以此以	24. OVERHEAD CANOPY: 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in 19-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in	individual) 19.179% of stream surface shaded. Trees, other overhead vegetation eventy depensed along 12. streambark (operings in canopy larger than space resulting from the loss of several mature.	Individuals). 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional and compact of stream surface shaded.	0-25% of streem surface shaded. Riparian vegetation, low trees, outer overment vegous	25. FISH HABITAT: Very diverse and complex instream habitat, instream cover and/or low overhanging vegetation Very diverse and evenly dispersed. 1. Submiddent and evenly dispersed instream habitat and/or low overhanging vegetation (at least 3	2 of the habitat types listed below present in moderate quantities). Little diversity and abundance of instream habitat (only one or two of the habitat types present or 1. Little diversity and abundance of instream habitat (only one or two of the habitat types present). predominant), instream cover and/or two overhamping vegatation sparse and discontinuous.	Admost no diversity of abundance of institution essentially absent. Fig. 1. OTHERS PRESENT 28. SUBDOMINANT 27. OTHERS PRESENT 28. SUBDOMINANT 27. OTHERS PRESENT 28. SUBDOMINANT 27. OTHERS PRESENT 28. S. DEBRIS 5. UNDERCUT BANK 6. BANK VEG.

FISH PASSAGE BARRIERS:	BARRIER	<u>:</u>		DIRECT DISCHARGE TO STREAM:	SCHAF	GE TO S	TREAM:		48. Substrate Composition, Percentage of Cover
Type: RM:	Hotght	Pool Depth	Pool Depth Length to Negotiate:	Type:	7. 1.	LB/RB:	State: (Dla/W-D)	Instreem Effects:	1 Bedrock
<u>ق</u>				64 pipe		E	3.4 mary 283		2 Boulders (>3) 5 Cobble (3"-3) 6 Gravel (0.1"-3")
							10 P. B. Co.		Sand (40.17) 20
	,						257,000		7 Clay (Measurements at clameter)
Falls 37	Culvert 36		Dem 39						49. CHANNEL CHARACTERISTICS
Debris 40	Beaver	Beaver Dam 41							A Marin & Longer I waster & Longer
GENERAL COMMENTS: 80. Stream	ITS: 51. Survey			Type: Tributary 42, Grass-lined 6 Effects: A.None B	Tributary 42 Pi Grass-lined Swale 44 I: A.None B. Charnel	Ppe/C ite 44 varme/Bank	Type: Tributary 42 PherCulvert 43 Seepe/Springs 46 Grass-fined Swate 44 Dibth 45 Effects: A.None B, Channel/Bank Eresion C.Sed Deposition D.Polluted	Seepa/Springs 46	
62, Communication with Residents:	in Resident	2	Wild Inches	RECENT MP	ACTS TO	STREAM	RECENT IMPACTS TO STREAMSIDE CORRIDOR:	·	
				3	Pox 1	Prox to Stream: <30 >30:	Length	Cause:	
					·	e2-			
						·			3
X 9 0 7 0 3 3				47. TotalA. Clear	Fotei A. Clearing/Grading D. Land Use Change	1 1	B. Landscaping C. Other	C. Other Construction Activity	

CHANNEL CAPACITY Inadequate, Channel subject to severe erosion—channel may be widening or migratcxtensive 1 deposit of sedimit present and/or evidence of overbank flows common. (high water mark observed	Appears to beneat contain present pask flows. Flows creating noticeable erosion. Considerable sediment geometries and an account strong behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)	Appears adequate to contain most peak flows. Flows may be creating minor bank and superans and evidence of overteask flows rare (e.g., sediment deposited on brank, Debris suspended or deposited on bank vegetation; bank vegetation and additionally.	Appears able to contain present peak flows. Flows pattern with size county, deposition of ourse and evidence of bank determination. Appears alone through on admost it mansh/wetland area. Overbank flows natural, common.	• F	Extensive erretches of bank protection material present (>50% of bankins) and/or majority or recommend are earthcard configuration aftered. Bankins protection material common (26-50% of bankins) and/or much of natural streambank. 2 configuration altered.			~~ ~~ ~~		Substitute against persecutionism. Course and the substitution of	\$ Z	2 Opeque 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	8 -	Septic or human weath. 1. SUIFURIC 2 OTHER CHEMICAL 3. P THASH 10(5), EVELY INTO & CARLY INTO THASH 10(5), EVELY INTO & CARLY INTO EXAMINED THE POSTING OF T	2 Tines, cars, appliances, fill material—in or adjacent to channel. S Dead/decaying animals or fish. Concentrated dump atte contains 1, ORGANIC MATERIAL 2. INORGANIC	6. SPECIAL CASES PRESENT 1 Farm animals in stream et 2 Snag pockets found et 2 Snag pockets found et 3 Wester withdrawal (purrp/ditch) at 5 Floating material 1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER
APPENDIX V RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM	STREAM # 11/4 SELL 4. SURVEYORS VM + 8/17/	THIBUTARY TO:	μ			LAND USE ADJACENT TO STREAM (#; %) DOMINANT 12.# 1 18. 20. % SUBDOMINANT 13. # 7 16. 20. % OTHERS PRESENT 14. # 17	Forest or natural vegetation 4. Pasture—unferced 7. Residential—continuous Park or got course 5. Pasture—fenced 9. Residential—continuous Resid	VEGETATIVE BANK COVER: Over 80% of streambank surface covered by vegetation in vigorous condition, Any bare or speciely I vegetated anses are arms in an eventy dispersed. A deep, dense pool mail is inferred. Streambank anythese brotection from screinfor. For surface of the conditions of the conditions of the conditions of the conditions.	4 2 F	 WIDTH OF VEGETATIVE COVER Right Bank 19, 10 - 300 feet CHANNEL: Left Bank 20, 2, 600 feet	VEGETATION TYPES: DOMINANT 21. A SUBDOMINANT 22 1 OTHERS PRESENT 23. 1. GRASSES 2. SHRUBS 3. BLX BRY BUSHES 4. TREES 8. OTHER 12/115, U.C.	OVERHEAD CANOPY: Much made applied. 78-100% of stream surface shaded by twee or overgrown with grasses, shrubs, brush, Openings in canony yearly depended and small (larger/skiphty larger than the space resulting from loss of mature canonical streams and streams of the space resulting from loss of mature canonical streams.	51-79% of stream surface shaded. Trees, other overhead vegetation eventy dispersed along 2 prosembark (openings in canday larger than space resulting from the loss of several mature participations).	2 50% of stream surface shaded. Trees, other overheed vegetation scattered or in occasional dumps. Overheed canopy thin, discontinuous. 0-25% of stream surface shaded. Riperian vegetation, low trees, other overhead vegetation.	FISH HABITAT: Very diverse and complex instream habitat, Instream cover and/or low overhanging vegetation 1 abstructant and evenly dispersed. Moderate diversity and exundence of instream habitat and/or low overhanging vegetation (at least 3	1 Of the habitat types insect the property present of the habitat types present of the habitat types present of the deveative and abundance of instream habitat (only one or two of the habitat types present). This deveative or abundance of instream habitat (only one of the habitat types present). Amost no diversity or abundance of instream habitat (at most, one of the habitat types present). Amost no diversity or abundance of instream paper instruction of the habitat types present). Amost no diversity or abundance of instream cover and/or low overtaining vogetation essentially about the habitat types present). Fight cover and/or low overtaining vogetation essentially about the habitat types present). Amost no diversity or abundance of instruction of instruction of the habitat types present). Amost no diversity or abundance of instruction or abundance of instruction of instruction or abundance of instruction or abundance of instruction or abundance of instruction or abundance of instruction or abundance of instruction or abundance of instruction or abundance of instruction or abundance of instruction or abundance or abundance of instruction or abundance of instruction or abundance or abundance of instruction or abundance or abunda

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Sin Hill RB Sin Hill Type: Tributary 42 PharCulvert 43 SeeparSprings 46 Type: Tributary 42 Dich 46 Grass-lined Swele 44 Dich 46 Effects: A.None B. Charnel/Bark Ecolon C.8ed Deposition D.Politad RECENT IMPACTS TO STREAMSIDE CORRIDOR: I, guid Cylviller RM: Prox to Stream: Langth @ Cause: RM: Prox to Stream: Langth @ Cause: RM: Prox to Stream: Langth @ Cause:	Sin Hill RB Sin Hill Type: Tributary 42 PharCulvart 43 Scope/Springs 46 Garse-lined Swale 44 Ditch 46 Garse-lined Swale 44 Ditch 46 Garse-lined Swale 44 Ditch 46 Garse-lined Swale 45 G	is may be barriars. In playing the simple si	Type: RM: LB/RB: Stps: (Dla/W-D) Instream Effects:
Type: Tibutary 42. PheCulvert 43 Seepergorings 46. Type: Tibutary 42. PheCulvert 43 Seepergorings 46. Grass-Ened Sivele 44 Dibth 45. Effects: A.None B. Charme/Bank Evolon C.8ed Deposition D.Polktad RECENT IMPACTS TO STREAMSIDE CORRIDOR: I_\text{UL}_\text{CL}_\text{Viget} Risk: Prox to Stream: Langth Cause: And Solo: Risk: Prox to Stream: Langth Cause: And Solo: Doctor 5. No. 10. CL Cause: Doctor 5. No. 10. CL Cause: Doctor 5. No. 10. CL Cause: Doctor 5. No. 10. CL Cause: Doctor 5. No. 10. CL Cause: Doctor 5. No. 10. CL Cause: Doctor 5. No. 10. CL Cause: Doctor 6. No. 10. CL Cause: Doctor 7. No. 10. CL Cause: Doctor 7. No. 10. CL Cause: Doctor 7. No. 10. CL Cause: Doctor 7. No. 10. CL Cause: Doctor 7. No. 10. CL Cause: Doctor 7. No. 10. CL Cause: Doctor 7. No. 10. CL Cause: Doctor 7. No. 10. CL Cause: Doctor 7. No. 10. CL Cause: Doctor 7. No. 10. CL Cause: Doctor 7. No. 10. CL Cause: Doctor 7. No. 10. CL Cause:	Type: Tributary 42. Pre-Culvert 43. Seepa-Springs 46. Grass-lined Swale 44. Ditch 46. Effects: A.None B. Charnel/Barix Erosion C.8ed Deposition D.Polkuted RECENT MAPACTS TO STREAMSIDE CORRIDOR: N.QU.D. C.W.V.Erf. RM: Prox to Stream: Langth C. Cause: A30 >30; Langth C. Cause:	74.0	<u>.</u>
Type: Tributary 42 Praculvert 43 SeeparSprings 46 Grass-lined Swale 44 Ditch 45 Effects: ANone B. Charme/Bank Eroslon C.8ed Deposition D.Polluted RECENT IMPACTS TO STREAMSDE CORRIDOR: New Country RM: Prox to Stream: Langth C. Cause: ANO 200: Deposition D.Polluted Fight: Prox to Stream: Langth C. Cause: Another Country Fight: Prox to Stream: Langth C. Cause: Another Country Fight: Prox to Stream: Langth C. Cause: Another Country Fight: Prox to Stream: Langth C. Cause: Another Country Fight: Prox to Stream: Langth C. Cause: Another Country Fight: Prox to Stream: Langth C. Cause: Another Country Fight: Prox to Stream: Langth C. Cause: Another Country Fight: Prox to Stream: Langth C. Cause: Another Country Fight: Prox to Stream: Langth C. Cause: Another Country Fight: Prox to Stream: Langth C. Cause: Another Country Fight: Prox to Stream: Langth C. Cause: Another Country Fight: Prox to Stream: Langth C. Cause: Another Country Fight: Prox to Stream: Langth C. Cause: Another Country Fight: Prox to Stream: Langth C. Cause: Another Country Fight: Prox to Stream: Langth C. Cause: Another C. Cause: Langth C. Cause: Langt	Type: Tributary 42 Phe-Culvert 43 SeeparSprings 46 Grass-lined Swate 44 Ditch 45 Effects: A.Nora B. Channel/Bank Eroslon C.8ed Deposition D.Polluted RECENT IMPACTS TO STREAMSIDE CORRIDOR: I, QU.) CHANGE PRIME: Prox to Stream: Langth Cause: A30 >30; Langth Cause:		
Type: Tributary 42 Phe-Culvert 43 SeeparSprings 46 Grass-lined Swale 44 Ditch 46 Effects: A.None B. CharnelBank Eroslon C.8ed Deposition D.Politided RECENT IMPACTS TO STREAMSIDE CORRIDOR: New Clause: RM: Prox to Stream: Langth Clause: A30 >30: Prox of Stream: Langth Clause: Apold A	Type: Tributary 42 PracCulvert 43 SeeparSprings 46 Grass-lined Swele 44 Ditch 45 Effects: A.None B. Charme/Barnk Eroelon C.8ed Deposition D.Polluted RECENT MapAGTS TO STREAMSIDE CORRIDOR: I/QUI CHANGE RM: Prox to Stream: Langth Cause: A30 >30: Langth Cause:		
(6-7))[Dum 39	
)[Type	Type: Tributary 42 Phe/Culvert 43 Seeps/Springs 46 Grass-fined Swale 44 Ditch 46 Emants: A None B. Channel/Bank Ension C.Sed Deposition D.Poliuted
	Jeggen Associated the second of the second o	53. Other RECE	RIGHT IMPACTS TO STREAMSIDE CORRIDOR: New CHIVEF
		·	
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7	Appears adoption to contain many fulfilled of overfairly flows rare (e.g., sediment deposited on bank, under a containing constructions. Evidence of overfairly flows rare (e.g., sediment deposited on bank, under a containing contai	_ =	\ \ \ \ \ \ \ \ \ \ \	SUBSTRATE CONSOLIDATION: Substrate consists of better than the consists of streembank being affered. Substrate CONSOLIDATION: Substrate better assortment easily moved with boot heel. Substrate professionentied. Substrate difficult to move with boot heel. Substrate better the street of packed/commented. Substrate difficult to dislocing with licking. May include areas of the best of herchan. Substrate consists of/covered by sand, day or organic muck.	33. TRANSPARENCY/COLOR: Transparent, bottom of channel is visible. Opeque or white like, bottom of channel may be visible. Light to dark brown; visible particulate matter present. Bottom of channel not visible. Light to dark brown; visible particulate matter present. Bottom of channel not visible. 1 Light to dark brown; visible particulate matter.	Supple or Numen weste. 1. SULFURIC 2. OTHER CHEMICAL 3. 1. SULFURIC 2. OTHER CHEMICAL 1. SULFURICAL LIBERARY. Liter in stream: cans, bottles, yard debris, logging of Tires, cars, appliances, fill material—in or adjacent Describerarying snims or fish. Concentrated dump alte contains 1. ORGANIC MATERIAL 2. INORGANIC CIAL CASES PRESENT Farm animals in stream at Sing pockets found at Wetlands at 1. ALGAL MATS 2. ABUNDANT SUDS 3.
1. STHEAM # MID-5 DATE OF 1/30/99 2. STHEAM # MAKE: MASSALY SURVEYORS: JPYM + SLW	SURVEY ENTRY/EXIT POINTS: FIVER MLES SURVEYED: 6 TO 7 NONE ABUINDANT COMMON FEW OBSERVED	TS 1 The Dwelling Animals 1 ADULTS: 1 ACENT TO STREAM (#: %) ADMINANT AND ADMINANT AND ADMINANT AND ADMINANT AND ADMINANT AND ADMINANT AND ADMINANT AND ADMINANT AND ADMINANT AND ADMINANT AND ADMINANT AND ADMINANT AND ADMINANT AND ADMINANT AND ADMINANT AND ADMINIARY	1. Forset or natural vegetation 4. Pasture—unfenced 7. Resides 2. Park or got course 6. Pasture—lenced 7. Resides 3. Roadside (Highwey/Street) 6. Cultivated field 9. Industri GETATIVE BANK COVER: Vegetation from strains and evenity dispersed. A deep, dense root mat is inferred. surface protection from erosion. 7.890% of streambank surface covered by vegetation in vigorous condition. Any b vegetation from erosion.		VEGETATION TYPES: DOMINANT 21	28-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional churps. Overhead canopy thin, discontinuous. 4 0-25% of stream surface shaded. Riparlan vegetation, low brees, other overhead vegetation essentially absent. 29. FISH HABITAT: 1 Very diverse and complex instream habitat. Instream cover and/or low overhanding vegetation is abundant and evenity dispersed. 1 Moderate diversity and abundance of instream habitat equantities). 2 Interdeminantly. Instream cover and/or low overhanding vegetation egenera and discontinuous. 3 predominantly. Instream cover and/or low overhanding vegetation essentially absent. 4 hatteream cover and/or low overhanding vegetation essentially absent. FISH COVER TYPES: DOMINANT 28. C. SUBDOMINANT 27 OTHERS PRESENT 28 FISH COVER TYPES: DOMINANT 28 SUNDERGUT BANK 8. BANK VEG.

ISH PASSAGE BARRIERS: NA	3ARRIEF	is: NA		DIRECT D	SCHAF	GE TO	DIRECT DISCHARGE TO STREAM: NA		48. Substrate Composition, Percentage of Cover	2
100	Holele	Pool Death	Pool Depth Length to Negotiste:	1ype:	ä	LB/RB:	Stor: (Dla/W-D)	Instruem Effects:	1 Bedrock	٠,
i -		L							2 Boulders (>3)	٠,
									3 Cobble (3" - 3)	٠,
			`	_,					4 Gravel (0.1"-3") (4)	• 1
									(a) Sand (<0.17) 1/0	ij
										·i
									1 clay	•1
									(Measurements at diameter)	
	18			•					49. CHANNEL CHARACTERISTICS	
	Demont of	Beauty Dam 41							1 Width 2 Depth 1 Width 2 Dept	¥
COM AND						9		Seeme/Rorings 46	\vdash	1
ENERAL COMMENTS:	ë			Type: Tributary 42,	Tributary 42	1	Ditch 46		Ne Ke	
. Stream	51. Survey	_		Effects: A.N.	9 B. C.	hannel/Bant	Erosion C.Sed De	Effects: A.None B. Charmel/Bank Erosion C.Sed Deposition D.Polluled		
Communication with Residents:	h Resident	83. OB	Diec.	RECENT IN	ACTS TO	STREAM	RECENT MPACTS TO STREAMSIDE CORRIDOR:			
				ä	T S	Prox to Stream: <30 >30:	Length	Cause:		
		ŧ								
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		•								
			·.							
				,	,	,		-,	Channel cross-section:	
•								-	3	
1418				47. Total	Cotal A. Clearing/Grading		B. Landscaping C. Other	C. Other Construction Activity		
Y 0 0 1 0 3						P				

Lower 1/8 mil. Follwary w/ contined bed. Thus form is not very appropriate. Thuse are not issues

CHANNEL CAPACITY Indequate, Channel subject to severe erosion—channel may be widening or migrate	- = =	Streambanks being severely sitered. Less than 50-70 is sized in the control of presentations being severely sitered. Less than 50-70 is sized to the control of severely sized of control of severely sized of sized than 50-70 is sized to the control of severely sized than 50-20 is sized to the control of sized than 50-20 is sized to the control of sized than 50-20 is sized to the control of sized than 50-20 is sized to the control of sized than 50-20 is sized to the control of sized than 50-20 is sized to the control of sized than 50-20 is sized to the control of sized than 50-20 is sized to the control of sized sized than 50-20 is sized to the control of sized sized than 50-20 is sized to the control of sized sized than 50-20 is sized to the control of sized sized than 50-20 is sized to the control of sized sized than 50-20 is sized than 50-20 is sized to the control of sized sized than 50-20 is sized to the control of sized sized than 50-20 is sized th	- 	1 TRASH NEV Little in stream: cars, bottles, yard debris, logging or lend clearing debris—in or adjacent to channel. Little in stream: cars, bottles, yard debris, logging or lend clearing debris—in or adjacent to channel. Little in stream arimals arimals or stream at the contains and stream arimals in stream at the stream arimals in stream at the stream arimals in stream at the stream at
STREAM # 11/1/2-Ce 2. DATE COLLISCO ASSESSMENT SURVEY FORM 1. STREAM WAME: 11/2/2-C/2-C 1. STREAM WAME: 11/2/2-C/2-C 1. STREAM WAME: 11/2/2-C/2-C 1. STREAM WAME: 11/2/2-C/2-C 1. STREAM WAME: 11/2/2-C/2-C 1. SURVEY BNTRY/EXT POINTS: 1. SURVEY BNTRY/EXT POINTS: 1. SURVEY BNTRY/EXT POINTS: 1. SURVEY BNTRY/EXT POINTS: 1. SURVEY BNTRY/EXT POINTS: 1. SURVEY BNTRY/EXT POINTS: 1. ABUNDANT COMMON FEW OBSERVED	m Dwelling Animals) 1 ADULTS): 1 LIACENT TO STREAM (#: %) 0 or natural vegetation 4.	Poetskie (Highway/Street) 6. Cultivation lined TTIVE BANK COVER: or 50% of streambank surface covered by vegetation in vigorous conditions against areas are small and evenity dispersed. A deep, dense root mat is gatised areas are small and evenity dispersed. A deep, dense root mat is seen of streambank surface covered by vegetation. Few open areas with ident. Less dense, deep root mat inferred. Minor evenion of streambank surface covered by vegetation. Bare or sparsely vegetation and discontinuous root mat inferred. Vegetative coverely vegetation than to sparsely only of stream bank surface covered by vegetation. Many bare or sparsely vegetation from evaluation and all of the sparsely vegetation for decontinuous, shallow root mat inferred. Vegetative or sparsely vious. Poor, decontinuous, shallow root mat inferred. Vegetation provide vious. Or CAENATIVE COVER. Paght Bank 19.0—15 femiliar pages.	VEGETATION TYPES: DOMINANT 21 SUBDOMINANT 22 OTHERS PRESENT 22. 1. GRASSES 2 SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER 1. GRASSES 2 SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER 1. GRASSES 2 SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER 1. GRASSES 2 SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER 1. GRASSES 2 SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER 1. GRASSES 2 SHRUBS 3. BLK BRY BUSHES 5. OVERTOWN WITH grasses, shrubs, brish. Openings in canopy lenger/alightly larger than the space resulting from the loss of several mature individuals. 2. Grasses 2. Schrübs 3. BLK BRY BUSHES 5. BLK BRY BUSHES 5. OVERTOWN WITH GRASSES 5. OTHER 5. BLK BRY BUSHES 5. BLK BRY BUSHES 5. BLK BRY BUSHES 5. BLK BRY BUSHES 5. BLK BRY BUSHES 5. BLK BRY BUSHES 5. BLK BRY BUSHES 5. BLK BRY BUSHES 5. BLK BRY BUSHES 5. BLK BRY BUSHES 5. BLK BRY BUSHES 5. BLK BRY BRY BUSHES 5. BLK BRY BUSHES 5. BLK BRY BUSHES 5. BLK BRY BUSHES 5. BLK BRY BUSHES 5. BLK BRY BUSHES 5. BLK BRY BRY BUSHES 5. BLK BRY BUSHES 5. BLK BRY BUSHES 5. BLK BRY BRY BUSHES 5. BLK BRY BUSHES 5. BLK BRY BUSHES 5. BLK BRY BRY BUSHES 5. BLK BRY	25. FISH HABITAT: Very diverse and complex inteream habitat, instream cover and/or low overhanging vegetation (at least 3 blooders) and complex inteream habitat, instream cover and/or low overhanging vegetation (at least 3 blooders) and evenity dispersed. 1 blooders and evenity dispersed. 2 of the habitat types listed below present in moderate quantities). 3 this diversity and abundance of instream habitat end/or low overhanging vegetation sparse and discontinuous. 5 predominant), instream cover and/or low overhanging vegetation sparse and discontinuous. 4 bridge in of diversity or abundance of instream habitat (at most, one of the habitat types present). 7 hear no diversity or abundance of instream habitat (at most, one of the habitat types present). 8 FISH COVER TYPES: DOMINANT 26. SUBDOMINANT 27. OTHERS PRESENT 28. 9 FRANCOVER TYPES: DOMINANT 26. SUBDOMINANT 27. OTHERS PRESENT 28.

FISH PASSAGE BARRIERS: \mathbb{N}^{eta}	SAGE E	ARRIER	is: NA		DIRECTO	ASCHAF	GE TO	DIRECT DISCHARGE TO STREAM: NÀ		48. Substrate Composition, Percentage of Cover
ied (ä	Helght:		Pool Depth Length to Negotiste:	Type:	FR	LB/RB:	Stoe: (Dim/W-D)	Instreem Effects:	1 Bedrock
			<u> </u>					-		2 Boulders (>3')
										\$ Cobbie (3"-3) 20
					•					F Gravel (0.1"-5") 30
		,								Sand (<0.1") 72.
							-			
									•	7 Clay
								,		(Messurements at dismeter)
Fells 37] "	Culvert 38		Dem 36						49. CHANNEL CHARACTERISTICS
Debrie 40		Beaver [Beaver Dam 41			. ,			,	1 Width 2 Depth 1 Width 2 Dept
					Type: Tributary 42.	3,62	Pipe/C	Pipe/Culvert 43 Se	Seepa/Springs 46	
GENERAL COMMENTS: X), Stream	OWNEN	ls: 51. Survey	,		Grass	Grass-lined Swale 44	2 5	Disch 46	- Dollated	
2. Communication with Residents:	ation with	Residents:	SS. Other	Spe	Ellects: A.Y	ore s.		Effects: A.None B. Chame/Bank Erosion C.Seu Deposition O. Foreign	Marinon D.r. Onuted	
					RECENT IN	ACTS TO	STREAM	RECENT MPACTS TO STREAMSIDE CORRIDOR:		
	, F				RIE.	T × ×	Prox to Stream: <30 ×30:	Length	Cause:	
		•								
										•
	ζ.			-						- College and College
•			-							ڀ
	U				47. Total					
10198101					A. Clean D. Land	A. Clearing/Grading D. Land Use Change		B. Landecaping C. Other	C. Other Construction Activity	Which of it is
0 1 0 3	. 9			-						Consined

or o d o d o d o d o d o d o d o d o d o	MATURE OF PORTON	Spander (Wetch
CHANNEL CAPACITY Independent Chemnel subject to servers encelon—channel may be widenfing or migration. Externely deposals of sediment present and/or evidence of overbank flows common. (high water mark observed outsides of channels.) Appears to bereity comfain present peak flows. Flows creating noticeable encelon. Considerable of observed cousts of other marks to be creating minor observed outsides of channel.) Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate of observed outsides of observed outsides of observed. (High water mark observed outsides of observed.) Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate account of the contain present peak flows. Flows pettern with flows rare (a.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation matted down). ARTHOIAL BANK PROTECTION: Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural streambank common sitered. Extensive stretches of bank protection material present (10-25% of bankline). Streambank amount at the configuration altered. Consideration altered. Decadoral stretches of bank protection material present (10-25% of bankline). Streambank amount and material present (10-25% of bankline). Streambank amount of the configuration altered. In the configuration altered. And the configuration of the protection material present (10-25% of bankline). Streambank almost entirely in the configuration altered.	AMEANIK STABILITY: SAMEANIK STABILITY: SAMEANIK STABILITY: Streambank being severally altered. Less than 50% of streambank in stable condition. Over 50% of streambank being severally altered. Less than 50% of streambank incheing major attendions. As much as 60% broken down or enoding. Boot must overlangs and eloughing evident. 26-50% streambank receiving major attendions. As much as 60% broken down or enoding. Boot must overlangs and eloughing evident. The Co. 50% of streambank receiving minor major attendion. At least 75% of stream bank in natural elable condition. Streambanks stable or only slightly altered. Bank protection majorial—natural, artificial or combination of both, infrequent raw banks—less than 10% of streambank being attered. Streambanks stable or only slightly packed/cemented. Substrate difficult to move with boot heel. Substrate loose assortment easily moved with boot heel. Substrate digitity packed/cemented. Substrate difficult to move with boot heel. Substrate consists of/covered by sand, day of organio mych. Substrate consists of/covered by sand, day of organio mych. Transparent, bottom of channel is visible. NSPARENCY/COLOR: W/A	Light to deak brown; visible particulate matter present. Boxon of orienter now reson. 1. RED 2. TAN 3. GREEN 4. Off. SHEEN Other colors Animal wester or manure. Septio or human weste. 1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM 3. Liter in stream: Carrie of the content of
-channel may b f overbank flows lows creating no wind instruction of the drift instruction of the manual of the section; bank we pattern with I and area. Overb ankline) and/or r ankline) and/or r ankline) and/or r	to 50% of stream; ange and slough is. As much as 5 as alteration. At the protection may be be the stream of the st	3. PETROLEI July or land clear Cent to charmel. INC S 3. TRASH
et to severe eroston- nt and/or evidence of resent peak flove. Fi nt) accumulating beh lar most peak flove. In most peak flove. Fiol his most peak flove. Fiol deposited on bank v deposited on bank v deposited on mark- jacent to marsh/welfs k protection material larend. Ammon (26-50% of b or protection material	AMBANK STABILITY: AMBANK STABILITY: Streambants being severally altered. Less than 50% of streambank in stable conditions are associated and severally altered. Less than 50% of streambank being severally altered. Less than 50% of streambank being severally altered. Failure of overhangs and sloughing frequent. 29-50% streambanks receiving major alterations. As much as 50% broken down or met overhangs and sloughing evident. 10-25% of streambanks receiving major alterations. As much as 50% broken down or met overhangs and sloughing evident condition. 10-25% of streambanks at a stable or only slightly altered. Bank protection metarlat—natural, and combination of both. Infrequent raw banks—less than 10% of streambank being alto combinate loose assortment easily moved with boot heel. Substrate loose assortment easily moved with boot heel. Substrate consists of loovered by send, clay of organic mixel. Substrate consists of loovered by send, clay of organic mixel. Substrate consists of loovered by send, clay of organic mixel. Transperent, bottom of channel is visible. Opeque or white fike, bottom of channel may be visible.	1. NED 2. TAN 3. GREEN 4. Of SHEEN Other colors 1. RED 2. TAN 3. GREEN 4. Of SHEEN Other colors 2. Animal waste or manure. 2. Septe or human waste. 3. Decaying plant 4. Other 4. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM 3. Tires, cars, appliances, fill material—in or adjacent to channel. Decaddecaying animals or fish. Concentrated dump site contains 1. ORGANIC MATERIAL 2. INORGANIC
CHANNEL CAPACITY CHANNEL CAPACITY CHANNEL CAPACITY Chicken Channel subject to deposite of aediment present to contain present to brank contain present to contain present to contain present to contain present to contain present to contain present contain present contain present contain present contain present contain present contain present contain present contain present contain present contain present contain present contain present contain present contain present contain present contain present contain present contain contain present contain contain contain at contain at contain contain at contain contain at contain contain at contain contain at contain contain at contain contain contain at contain conta	Atture if any beink procedor inition in press. STREAMBANK STABILITY: Streambank boken or excelling failure of a treambank boken or excelling failure of a treambank boken or excelling evident. 10-29% estreambank receiving major after or excellenge and eloughing evident. 10-29% of streambank receiving minor-minor or 10-29% of streambank receiving minor-minor or stable condition. Streambanks stable or only slightly aftered combination of both. Infrequent raw bening Substrate loose assortment easily moved. Substrate loose assortment easily moved. Substrate both packed/cemented. Substrate or fartifier. Substrate orients of loose assortment easily moved. Substrate both packed/cemented. Substrate both between the fartifier. Thansparent, bottom of channel is vibble.	1. RED 2. TAN 3. GREEN 4. ODOR NOT SHEED 2. TAN 3. GREEN 4. Septic or human waste. 1. SULFURIC 2. OTHER 1. SULFURIC 2. OTHER 1. SULFURIC 2. OTHER 2. Thee, care, applances, fill material 2. Concentrated dump atte contains 1. ORGANIC MATERIAL SPECIAL CASES PRESENT Special Cases PRESENT Them animals in stream of 1. Septicial counts in the series of
W. J. J. J. J. J. J. J. J. J. J. J. J. J.	Source So	3 8 8
25° 56 383 ***	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	
	7. Residential—configures 9. Residential—confinuous 9. Industrial/Commercial 1. Condition, Any bare or sparsely 1. The is inferred. Streambank 1. Supersolve or sparsely 1. Su	see, ehrubs, brush. Opening space resulting from loas of my nevership from loas of my nevership from loas of my necessary despectation on scentrared or in occasional liner overhanging vegetation of the habblat types present; or the habblat types
SSESSMENT SURVEY FORM 4. SURVEYORS: SLM 10 7. SMANN 12 3 14 15 15 15 15 15 15 15 15 15 15 15 15 15	Pasture—unfenced 7. Realdential—codific Pasture—unfenced 7. Realdential—codific Pasture—enced 9. Industrial/Commerced by vegetation in vigorous condition. Any bare or sparagoresed. Almor encelon of streambank surface Streambank and Minor encelon of streambank surface. Streambank surface Streambank surface of sparagores with unstable vegetation and Minor encelon of streambank surface. Streambank surface of mall inferred. Vegetation ence provides imited protection and inferred. Vegetation provides streambank surface of mall inferred. Vegetation provides streambank surface and inferred. Vegetation provides streambank surface of mall inferred provides inferred provides inferred provides inferred provides inferred provides inferred provides inferred provides inferred provides inferred provides inferred provides inferred provides inferred provides inferred provides inferred provides inferred provide	eas or overgrown with greases, shrubs, brush. Denting existingly larger than the space resulting from loss of more overhead vegetation eventy deperated slong than space resulting from the loss of several mature is, other overhead vegetation scattered or in occasional irous. In control of the control of the control of several mature in the control of the control o
A. SURVEYORS: SLM COMMON FEW OBSERVE A. SURVEYORS: SLM A. SURVEYORS	Unal vegetation 4. Parture—unfenced 7 course 6. Cuttiveted field 9 fighings/Street) 6. Cuttiveted field 9 fighings/Street) 6. Cuttiveted field 9 fighings/Street) 6. Cuttiveted field 9 fighings unitace covered by vegetation. Few open eneast, each surface covered by vegetation. Few open eneast, each surface covered by vegetation. Bare or especially and decontinuous root mat inferred. Minor enoising of attreambar and decontinuous root mat inferred. Vegetation of attreambar and decontinuous root mat inferred. Vegetation of attreambar and decontinuous particles. Fight Bank 19. 50. 10.0. ANNEL: Left Bank 20. 10.0. SHRUBS: DOMINANT 21. SUBDOMINANT 22. 2. SHRUBS: 9. BLK BRY BUSHES 4. TREES 5. OTT	OVERHEAD CANOPY: Ye concerned the standard by breas or overgrown with grasses, shrubs, brush. Openings in the concerned standard departs lightly larger than the space resulting from loss of mature high-during and general area of several mature high-during. 81-70% of stream surface shaded. Trees, other overhead vegetation eventy departed along several mature individuals. 81-70% of stream surface shaded. Trees, other overhead vegetation exattered or in occasional profit of several mature. 92-50% of stream surface shaded. Trees, other overhead vegetation exattered or in occasional durings. Overhead camopy thin, discontinuous. 10-25% of stream surface shaded. Riparian vegetation, low trees, other overhead registron. 11-25% of stream surface shaded. Riparian vegetation, low trees, other overheading vegetation. 12-50% of stream surface shaded. Riparian habitat, instream cover and/or low overheading vegetation (at least 3 shoulders) and stundance of histoream habitat equantities. 13-50 And shabitat types listed below present in moderate quantities. 14-50 And read evently and stundance of histoream habitat (only one or two of the habitat types present or the habitat types and stundance of histoream habitat (only one or two of the habitat types present). 25-50 And evently and abundance of histoream habitat (et most, one of the habitat types present). 26-50 And the devently and abundance of histoream habitat (only one or two of the habitat types present). 27-50 And the devently or abundance of histoream habitat (only one or two of the habitat types present). 28-50 And the devently and stundance of histoream habitat (only one or two of the habitat types present). 28-50 And the devently or abundance of histoream habitat (only one or two of the habitat types. DOMINANT 26. 29-50 And And the devently or abundance of histoream habitat (only one or two of the habitat types. 29-50 And And the devently or abundance of histoream habitat (only one or two of the habitat types. 29-50 And And the And And And And And A

48. Substrate Composition, Percentage of Cover	1 Bedrook	2 Boulders (>3')	3 Cobble (3"-3")	4 Gravel (0.1"-3")	8 Sand (<0.17) >	as a sample of the sample of t	7 clay >	(Messurements at dameter)	49. CHANNEL CHARACTERISTICS	1 Width 2 Depth 1 Width 2 Dept			-	-		,						Channel cross-section:	3 2 >)		11 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	277 202	· · ·
	Instream Effects:						,				Seepe/Springs 46		celtion D.Polluted		Cause:				,			-			furnal longing		
TREAM:	Stre: (Dla/M-D)	•									Pipe/Culvert 43 Se	\$	Effects: A.None B. Channel/Bank Erosion C. Bed Deposition D. Politited	IDE CORRIDOR:	Length						٠				B. Landscaping C. Other		_
DIRECT DISCHARGE TO STREAM:	RM: LB/RB:										-	3 2 2	ne B. Channel/Benk	RECENT IMPACTS TO STREAMSIDE CORRIDOR:	Prox to Streem: <30 >30:	-									A. Clearing/Grading B. Lank D. Land Use Change		
DIRECT DIS	Туре:	,	•								Type: Tributary 42	Grass-	Effects: A.Nor	RECENT IMPA	#									47. Total	A. Clearly D. Land U		
٠.	Pool Depth Length to Negotiate:								25 mg				;													. ,	•
HS:						,		·		Dem 41				150 .035													
FISH PASSAGE BARRIERS:	RM: Holght:								1170	Berv		GENERAL COMMENTS:	51. Survey	52. Communication with Residents: .	-			-		,					1. °		•
FISH PAS	ž									Debyte 40		GENERAL C	50. Stream	62, Communi									•				

ALICEDED SINEED	Inadequate. Channel subject to severe enotion—channel may be widening or migratecriterative in deposits of sectioners present and/or evidence of overbank flows common. (high water mark observed deposits of channel.) Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable		Appears sub-in contain present peak flows. Flows pattern with fittle cutting, deposition or other evidence of bank deterioration. Stream flows through or adjacent to mentitywettend errea. Overbank flows natural, common.	30. ARTIFICIAL BANK PROTECTION: Extensive stretches of bank protection material present (>50% of bankine) and/or majority of natural are sembled configuration alread. 9		Streambanks being severely stream. Less uses the sevent and sevent sevent. 2 26-50%, streambank problem croshing relative of overhange and stoughing respect to the sevent seven	X stable condition. Streambanks stable or only slightly aftered. Bank protection material—natural, artificial or Streambanks stable or only slightly attered. Combination of both. Introquent raw banks—less than 10% of streambank being attered. Combination of both. Introquent raw banks—less than 10% of streambank being attered. 22. SUBSTRATE CONSOLIDATION:	Substrate loose assortment easily moved with book need. Substrate moderately packed/commented. Substrate difficult to move with blocking. May include areas of guestrate updaty packed/commented. Substrate difficult to delodge with blocking. May include areas of bedrock or hardpan. Substrate consists of/covered by sand, day or organic mixet. Substrate consists of/covered by sand, day or organic mixet.	TRANSPARENCY(COLOR: Vt. 1/100 fp.v.) Transparent, bottom of channel is visible. Opeque or white like, bottom of channel may be visible. Light to dent brown; visible particulate matter present. Bottom of 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors.	28. TRASH The In stream cultin, bodies and dobris, logging or land dearing debris—in or adjecent to channel. 2 The care, appliances, fill material—in or adjacent to channel. 3 Dead/decaying animals of fish. 4. Orecantrated dump site contains 1. ORGANIC MATERIAL 2. INORGANIC	36. SPECIAL CASES PRESENT 1 Farm snimsts in stream et 2 Snag pockets found et 3 Wedands et 1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER
m. 20 presion	APPENDIX V IAN CORRIDOR ASSESSMENT SURVEY FORM 2. DATE	STREAM NAME: BALMLES . SURVEYORS. JULY THEUTARY TO: MASSEY	r POINTS: TED: 6 TO 7 ABUNDANT CO		LAND USE ADJACENT TO STREAM (#; %) DOMINANT 12. # 18. LOD % BILLOD	Roadside (Highway/Street) e. Curonted lieso ATIVE BANK COVER: ver 90% of streambank surface covered by vegetation in vigorous condition getated grees are small and eventy dispersed. A deep, dense root mat is in	' س لو	arn benk surface covered by vegetation. Many bere or spet r, decontinuous, shallow root mat inferred. Vegetation prov m evolen. F. EGETATINE COVER Flight Bank 18, 50, 500.	K BRY BUSHES 4. TREES 5. O'S to be so or overgrown with grease in larger his grant find and the specific control of the specif	 0-25% of streem surface anaded, riparan vegousion, nor consistent of easentially afternit. H. HABITAT: Very diverse and complex instream habbat. Instream cover and/or known dead overly dispersed. Moderate diversity and abundance of instream habbat and/or low over Moderate diversity and abundance of instream habbat and/or low over the consistent and abundance of instrument habbat and/or low over the consistent and abundance of instrument institutions.	of the habbat types listed below present in moderate yearloads. 1. This diverably and abundance of instream habbat (only one or two of the habbat types present or the deveath and abundance of instream habbat (only one or two of the habbat types present). 2. Dredominant), instream cover and/or loss or instream habbat (at most, one of the habbat types present). 4. Instream cover and/or loss overthanging vegetation essentially absent. 1. Instruction of the present of the present of the habbat types present). 1. Shrock over the present of the habbat types present of the habbat types present. 1. Shrock of the habbat types present of the habbat types present of the habbat types present of the habbat types present.

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FISH PASSAGE BARRIERS:	GE BARR	IERS:		DIRECT DISCHARGE TO STREAM:	И ВСНАЯ	GETOS	TREAM:		48. Substrate Composition, Percentage of Cover
	FAR: Helatri:	ht: Pool Depti	Pool Depth Length to Negotiste:		#	LB/RB:	Stre: (Dla/W-D)	Instruem Effects:	1 Bedrock
_	-				Drg 2022	97	15" (?) 18	enoud/ust bunk	2 Boulders (>3')
					Ę.	87	(2),4	(אטרל)	
		 			Ę.	Z	(2) (1)	trioson/eut bank	4 Gravel (0.1"-3") 10 %
				<u>}</u>				ond wit ance	B Sand (<0.17)
	<u> </u>								o sm (reprice
<u> </u>									7 Clay 00%
· · · · · · · · · · · · · · · · · · ·									(Measurements at dlameter)
	- ;	- ,	- C						49. CHANNEL CHARACTERISTICS
Fels 37		R							The water of party 1 with 12 party
Debris 40	ā 	Beaver Dam 41							
100	and the same of			Type: Tributary 42,	tary 42	PperCt	1	Seeps/Springs 46	
GENERAL COMMENTS:	15 J	81. Survey		Grass	Grass-fined Swale 44	to 44	Grass-fined Swale 44 Ditch 45 Charvel/Bank Eresion C.Sed Deposition D.Politided	 position D.Polluted	
32. Communication with Residents: _	on with Resid		53. Other				9000000		
				RECENT IN	PACTS TO	STREAMS	PECENT MPACTS TO STREAMSIDE COMMIDON:		
				RIM:	Tox.	Prox to Streem: 430 %30:	Longth	Cause:	
			-		• .		-		
							-		
•							•.		
									
<i>.</i>									æ.
				47. Total A. Clea	Total A. Clearing/Grading		secaping C. Other	B. Landscaping C. Other Construction Activity	
90703	-			. C. L. Bar	D. Land Use Change	Š			4

The dequate. Channel subject to server encion—channel may be widening or migrat. Actenable observed consists of sediment present and/or evidence of overtoack flows common. (high wrater mark observed outside of channel.) Appears to berely contain present peak flows. Flows creating noticeable encelon. Considerable of sediment (each fine sediment) accumulating behind instream obstruction and/or occasional evidence of overtoack flows are (e.g. sediment deposited on behavior of overtoack flows are (e.g. sediment deposited on behavior of orderant flows are (e.g. sediment deposited on behavior of orderant flows are (e.g. sediment deposited on behavior of orderant flows are (e.g. sediment deposited on behavior or behavior of other contains flows are of overtoack flows are cution or other sequence of behavior or adjacent to markive tand area. Overtoack flows natural, common. Stream flows through or adjacent to markive tand area. Overtoack flows natural, common. Stream flows through or adjacent to markive tand area. Overtoack flows natural, common. Bark protection material common (28-50% of benkfine). Streambank mostly of natural attention altered. Configuration altered. Bark protection material present (<10% of bankfine). Streambank amostly in natural state. Little, if any bank protection material present (<10% of bankfine). Streambank amostly in natural state.	नार्षे हे नामान है स्वान न है स	13 Light to dark brown; vieble particulate matter present. Bottom of channel not vieble. 24. ODOR N/R 1. RED & TAN 3. GREEN 4. OIL SHEEN Other colors 25. TRASH 26. TRASH 27. TRASH 28. TRASH 29. ODOR N/R 29. ODOR N/R 20. TRASH 20. TRASH 20. Track 20. Track 30. SPECIAL CASES PRESENT 31. Track 32. Track 33. SPECIAL CASES PRESENT 4. Weden'ng matterial 20. Track 34. SPECIAL CASES PRESENT 4. Weden'ng material 5. Shap pockets found at 6. Floating material 7. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER 7. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER
APPENDIX V RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM AN VAME: \$2, DATE 20/27 ANY TO: MALES SURVEYED: \$4. SURVEYORS: \$4	Outside Control of th	24. OVERHEAD CANOPY: 1 75-100% of stream surface shaded by trees or overgrown with grasses, shruba, brush. Openings in canogry evenly dispersed and small (imagerishghtly larger than the space resulting from loss of mature individual). S1-75% of stream surface shaded. Trees, other overhead vagetation evenly dispersed along streaminents (openings in canopy larger than space resulting from the loss of several mature individuals). 26-50% of stream surface shaded. Trees, other overhead vagetation scrattered or in occasional dumps. Overhead canopy thin, discontinuous. 26-50% of stream surface shaded. Ripartan vegetation, low trees, other overhead vegetation essentially absent. FISH HABITA: Very diverse and complex instream habitat instream cover and/or low overhanging vegetation abundant and evenly dispersed. 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). Moderate diversity and abundance of instream habitat (et most, one of the habitat types present). If the charital instream cover and/or low overhanging sugetation sparse and discontinuous. The charital instream cover and/or low overhanging sugetation sesentially size of the habitat types present). FISH COVER TYPES: DOMINANT 26. SUBDOMINANT 37. 1 OTHERS PRESENT 28. S. K. I. RACKS 2 LOCS 3 ROCK WADS 4. DEBRIS 5. LINDERGUT BANK 6. BANK VEG.

FISH PASSAGE BARRIERS: [[m]]	ERS: [/m][DIRECT DISCHARGE TO STREAM:	SCHAF	GE TO S	TREAM: WW	7	48. Substrate Composition, Percentage of Cover	30
Type: Filt: Helgitt:	At: Pool Depth	Pool Depth Length to Negotiste:	Type	ä	LB/RB:	Stas: (Dla/W-D)	Instreem Effects:	1 Bedrock	-
								2 Boulders (>3)	-1
								3 Cobble (3"-3)	-1
						•		4 Gravel (0.1"-3") 40	-1
						-		8 Sand (<0.17)	Ť
							-	HISTORIAN OG \ MS .	<u>=</u>
								7 Clay	i
								(Measurements at diameter)	
2 100		79 mag	·					49. CHANNEL CHARACTERISTICS	92
The state of the s	Dam 41		-					1 Width 2 Depth 1 Width 2 Dept	F
							Rema/Rovince 46	Н	l
GENERAL COMMENTS:			Type: Inbutary 42,	Tributary 42	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Ditch 48		4.0 1.0	
0. Stream 51. 8			Effects: A.N	one B. C	arme/Bank	Erosion C.Sed De	Effects: A.None B. Charme/Bank Erosion C.Sed Deposition D.Polluted		
2. Communication with Residents:		53. Ogier	RÉCENT IM	PACTS TO	STREAM	RÉCENT IMPACTS TO STREAMSIDE CORRIDOR:			
			786	Total Es	Prox to Streem: <30 >30:	Length	Cause:		
						-			
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1									
		,							
						.			
								Channel programmed (m.	1
								5	
		-	47. Total					Ŀ	<u> </u>
2			A. Clea	A. Clearing/Grading D. Land Use Chande	_	decaping C. Other	B. Landscaping C. Other Construction Activity]]]] <u>.</u> :]
X 9 0 7 0 3					,			Mastly and	

CHANNEL CAPACITY Inadequate. Channel subject to severe erosion—channel may be widening or migratscatenative inadequate. Channel subject to severe erosion—channel may be widening or migratscatenative deposed or sediment present and/or evidence of overbank flows common. (high water mark observed outside or drainnel.) Appears to barely contain present peak flows. Flows creating notceable erosion. Considerable Appears to barely contain present peak flows. Flows creating notceable erosion and/or occasional evidence.	Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate evaluation at otherwise and controlled to the substrate of overbank flows rare (e.g., sediment deposited on bank. Debris suspended or deposited on bank vegetation; bank vegetation matted down). Appears able to contain present peak flows. Flows pattern with Ribe cutting, deposition or other evidence of bank defendance.			(5) Wetlands at
STREAM * THE STATE OF THE SURVEY FORM 2. DATE 10/5/19 STREAM * THE STATE OF THE SURVEY FORM 2. DATE 10/5/19 A SURVEYORS: SLM	TO 7. TO ABUNDANT COMMON	M Dwelling Animals) 1 2 3 4 4 3 4 4 3 4 4 3 4 4 4 4 4 4 4 4 4	8. Residential—confinitors 9. Industrial/Commercial 1. Industrial/Comme	HATTERM COVER TYPES: DOMINANT 26. L. SUBDOMNANT 27. 1. OTHERS PRESENT 28. TRSH COVER TYPES: DOMINANT 26. L. SUBDOMNANT 27. 1. OTHERS PRESENT 28. I ROCKS 2. I ROCK WADS 4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG.

FISH PASSAGE BARRIERS:	AGE B	ARRIER	ë		DIRECT	М	DIRECT DISCHARGE TO STREAM:	TREAM:	·.	48. Substrate Composition, Percentage of Cover	.
ě	ä	Holghi	Pool Depth	Pool Depth Length to Negotlete:	Туре:	RNE:	LB/RB:	Stee: (Din/W-D)	Instreem Effects:	1 Bedrock	٦
					Chavats	along/ uncer bitus traul	83			2 Boulders (>3) 20% (6) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1	20,00
						from thbs oud stap				8 Sand (<0.17) 5% (d .
· · · · · · · · · · · · · · · · · · ·						Strace				surements at den	
Falls 37		Culvert 30	H	Dam 39						19 WINTH 2 Depth 1 WINTH 2 Dept	8 3
							7	Photographed #3	Seans/Snotron 46		
GENERAL COMMENTS: 0. Stream	BINENT .	S: 51. Survey	A		Type: Incurary 44, Grass-fined 8 Effects: A.None B.	Grass-fined Swale 44, R. A.None B. Channel	ale 44 harmel/Bank	C. Sed	cellion D.Polluted	10' 85-19'	
2. Communication with Residents:	tion with	Residents:		55. Odie	RÉCENT IN RM:	PACTS T	TE TO STREAMS Prox to Streem:	RECENT IMPACTS TO STREAMSIDE CORRIDOR: Plox to Stream: Langth 430 >30;	Cause:	אריין (מפאי מיטן מיטן	
,		*				Maint Waint	bailthance Maintenance Voach poo				
		·							·		
. •										> Section:]
9 0 1 0 3		`			47. Total A. Cles D. Lan	Fotel A. Clearing/Grading D. Land Use Change	ng B. Landecaping	1 -	C. Other Construction Activity		Ŀ

				ODOR (NOS) (Nockhold Mr. 40) 1 Animal weate or manure. 1 Septe or human weate. 1 SULFURIC 2 OTHER TRASH 1 Itter in etream: paris, bottles, year. 2 Trees care, applances, fill meterial. 2 Deed/decaying animals or fiet. 2 Concentrated dump also contains.	
SUM SUM NONE OBSERVED	18. OD ** PANA PANA PANA PANA PANA PANA PANA P	n. Any bare or spansely inferred. Streambank unstable vegetation atte of green are evident. ovides limited protection. 32.	and provide streambank surface little 7	attack or evenly dispersed along out the loss of several mature setation scattered or in occasional ee, other overhead vegetation 38, effor low overhanging vegetation (at least 3)	into overnianging regiment of the habitat types present or the habitat types present. It is not of the habitat types present. It is not the habitat types present. It is not the habitat types present. It is not the habitat types present. It is not the habitat types present. It is not the habitat types present.
SURVEY 2. DA NEYORS	1 (4: %) DOMINANT 12.8 OTHERS PRESENT 14.8 PREVINCED 7. 8. PREVINCED 7. 8. PREVINCED 7. 9. PREVINCED 9. 9. PREVINCED 9. 9. PREVINCED 9. 9. PREVINCED 9. 9. PREVINCED 9. 9. PREVINCED 9. 9. PREVINCED 9. 9. PREVINCED 9. 9. PREVINCED 9. 9. PREVINCED 9. 9. PREVINCED 9. 9. PREVINCED 9. 9. PREVINCED 9. 9. PREVINCED 9. 9. PREVINCED 9. 9. PREVINCED 9. 9. PREVINCED	3. Hoazaice (highway/30109) o. Controlled to the CVPE. ETATIVE BANK COVER: Over 90% of streambark surface covered by vegetation in vigorous condition, Any bare or spansaly vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambark surface protection from enoidon. 78-90% of streambark surface covered by vegetation. Few open areas with unstable vegetation. 78-90% of streambark surface protection of streambark surface possible. 50-75% of streambark surface covered by vegetation. Bare or spansaly vegetated ereas are evident. Somewhat shallow and decontinuous root mat inferred. Vegetative cover provides limited protection from enoiden.	2002 × 2000 × 20	Individuals). § 1.75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along \$8.175% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional individuals). § 2.60% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clurys. Overhead canopy thin, discontinuous. § 2.50% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent. HABITAT: Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and evenly dispersed.	Moderate diversity and abundance of instream habitat endor low overnanging regiment in the habitat types listed before present in moderate quantities. If the habitat types listed before present in moderate quantities to the habitat types present or this diversity and abundance of instream habitat (only one or two of the habitat types present) predominant), instream conversandor low overhanging vegetation sparse and discontinuous. Amost no diversity or abundance of instream habitat (at most, one of the habitat types present), instream conversandor low overhanging vegetation essentially about the habitat types present). FISH COVER TYPES: DOMINANT 26.12. SUBDOMINANT 27.21.0THERS PRESENT 28.1 PROCKS 2 LOCS 3.ROXT WADS 4. DEBRIS 5. UNDERGUT BANK 6. BANK VEG.
PIGLULES \mathcal{E} (\mathcal{D} riparam corriestream name: \mathcal{D} \mathcal{L}	EBUTHOS (Bottom Dwelling Animals) 1 FISH (AUVENILE/ADULTS): 1 LAND USE ADJACENT TO STREAM (8; %) 1. Forest or natural vegetation 4. 2. Perk or golf course.	3. Hoodstoe (Highway/Sures) VEGETATIVE BANK COVER: Voors 90% of streambank surface covers are area and even surface protection from erosion. 76-90% of streambank surface covers evident, Less dense, deep root mat 50-75% of streambank surface covers. 3 Somewhat shallow and discontinuor from erosion.	4 Obvious, Poor, decording to the protection from eroding. 4 Obvious, Poor, decording the protection from eroding. 1 Obvious, Poor, decording to the protection from eroding. 1 Obvious, Poor, decording to the protection from eroding. 1 Obvious, Poor, decording to the protection of the prote	redinducing) 21-75% of stream surface shaded. Trees, other overhead veg streamsterik (openings in canopy larger than space resulting hind/yduals). 25-50% of stream surface shaded. Trees, other overhead veg clumps. Overhead canopy thin, discontinuous. 0-25% of stream surface shaded. Riparian vegetation, low tree essentially absent. FISH HABITAT: 1 Sky diverse and complex instream habitat, instream cover at abundant and evenly dispersed.	Moderate diversity and abundance of instream habitat andor for the habitat types listed before present in moderate quantities). Utilis diversity and abundance of instream habitat (only one or in predominant), instream cover and/or low overhanging vegetation. Amost no diversity or abundance of instream habitat (at most, a function of over and/or low overhanging vegetation essentially at histream cover and/or low overhanging vegetation essentially at FISH COVER TYPES: DOMINANT 26, 12—SUBDOMINANT 21, 12—SUBDOMINANT 21, 12—SUBDOMINANT 21, 12—SUBDOMINANT 21, 12—SUBDOMINANT 21, 13—SUBDOMINANT 21, 13
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48. Substrate Composition, Perchitage, of Cover	Instruen Effects:	2 Boulders (>3) 20 3 Cobble (3"-3) 20 4 Gravel (0.1"-37) 20	6 Sit (-0.17)	49. CHANNEL CHARACTERISTICS	Seepa/Springs 46 0.20' 1.2'	Causes		C. Other Construction Activity
DIRECT DISCHARGE TO STREAM:	RM: LB/RB: Stee: (Dts/M-D)	Apare PD	metag Balon RB 32", cultural bridge RB \ 6", cultural bridge RB \ 6",		Type: Tributary 42 PherCulvert 42 Seepa/Springs 48 Grass-lined Swale 44 Ditch 45 Effects: A.None B. Channel/Bank Erecion C.Sed Deposition D.Polluted	RÉCENT IMPACTS TO STREAMSIDE CORRIDOR: RIM: Prox to Streem: Length <30 >30;	maintenance soilt tence 10.20' gran	earing/Grading B. Landecaping
	Pool Depth Langth to Negotiate: Type:	Shows < 10' Chulus soly	metag pulate cenent	Net 36 Dam 39 Dam 30 Dam 41 Da		23. Object		47. Total
FISH PASSAGE BARRIERS:	Type: RM: Height:	Mines 300. 4.		Falls 37 Culvert 38 Debris 40 Bearver	GENERAL COMMENTS: 80, Stream 61, Survey	82, Communication with Residents:		

AR 025670

CHANNEL CAPACITY Inadequate, Channel subject to severe erosion—channel may be widening or migrats,	Appears assequents to content interspectual Evidence of overfamily flows rise (e.g., sediment deposited on exploring at output to content deposited on bank vegetation; bank vegetation matted down). bank, Debris suspended or deposited on bank vegetation; bank vegetation matted down). Appears able to contain present peak flows. Flows patiem with fitte cutting, deposition or other evidence of bank deterioration. Stream flows through or adjacent to marsh/weltend area. Overbank flows natural, common.	ARTIFICIAL BANK PROTECTION: Extensive structured on bank protection material present (>50% of bankline) and/or majority of natural streambank configuration aftered. Bank protection material common (26-50% of bankline) and/or much of natural streambank configuration aftered. Configuration aftered. Apply in natural state.	Little, if any bank protection material present (<10% of bankine). Streambank annual entirely an international annual entirely an international annual entirely and streambank of the server of annual and annual before an entirely altered. Less than 50% of streambank in stable condition. Over 50% of streambank before severely altered. Less than 50% of streambank before or ending. Fallors of overhangs and eloughing frequent. 26-50% streambank receiving mejor alterations. As much as 50% broken down or eroding. Root 27-50% streambank and eloughing evident.	10-29% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, existie condition. Streambanks stable or only slightly altered. Bank protection meterial—natural, entiticial or combination of both, infrequent raw banks—less than 10% of streambank being aftered. SUBSTRATE CONSOLIDATION:	Substitute losse assortment easily mores with book inter- Substitute indicates the packed beamented. Substitute afficially to move with book heet. Substitute signify packed beamented. Substitute afficially to dislocke with kicking. May include areas of the bedrock or handen. Substitute consists of covered by sand, clary or organic muck. A Substitute consists of covered by sand, clary or organic muck.	Transperent, bottom of channel is visible. Opeque or white like, bottom of channel may be visible. Light to derk brown; visible perdoulete matter present. Bottom of channel not visible. 1. RED (LIAM)3. GREEN 4. Oil. SHEEN Other colors	ODOR N/A Septo or human wester. Septo or human wester. Septo or human wester. Septo or human wester. Septo or human wester. A Othe	Tirea, cars, applantica, fill material—In or adjacent to channel. Dead/decaying animals or fish. Concentrated dump alte contains 1. ORGANIC MATERIAL 2. INORGANIC SPECIAL CASES PRESENT E maintenis in stream at 5 Roading material 3. Wetends at 1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER
₹ 5 8 8 8 8 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6		£ \(\bullet \bull				BOOO		
•		8	orange as	벍	Ŕ	I	ನ ಕ	· 8
NT SURVEY FORM 2. DATE 9/4/99 SURVEYORS: 6UM	**************************************	The second of th	7. Residential cost 8. Residential cont 9. Industrial/Comme 2. Industrial/Comme	areas with unstable vegetation sampant surface possible. sersely vegetated areas are evident vs.cover provides limited protection	450% of stream bank surface covered by vegetation. Many bare or spersely vegetated stream authors fittle obvious. Poor, discontinuous, shallow root mat briefly degetation provides streambank authors fittle protection from erosion. WIDTH OF VEGETATIVE COVER Right Bank 20. // feet OUTSIDE OF CHANNEL: Left Bank 20. // feet verseration types: DOMANANT 21. SUBDOMINANT 22. 20THERS PRESENT 23.	1. GRASSES 2 SHRUBS 3. BLK BRY BUSHES 4, TREES 6. OTHER THEAD CANOPY: 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly depensed and smell (largevishightly larger than the space resulting from loss of mature	noviously. 51-75% of stream surface shaded. Trees, other overhead vegetation evenly depensed along stream-cark (stream surface than space nearling from the loss of several mature hidh/duslis). 22-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clumps. Overhead canopy thin, discontinuous. 23-25% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation essentially absent.	HABITAT: Very diverse and complex instream habitat lineraem cover and/or low overhanging vegetation abundant and evenly dispersed. Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 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). (Little diversity and stundance of instream habitat (only one or two of the habitat types present or predominant), instream cover and/or low overhanging vegetation sparse and discontinuous, predominant), instream cover and/or low overhanging vegetation sparse and discontinuous. Amost no diversity or abundance of instream habitat (at most one of the habitat types present). Hattneam cover and/or low overhanging vegetation essentially absent. FISH COVER TYPES: DOMINANT 26. SUBDOMINANT 27. OTHERS PRESENT 28. THOSERCIT BANK 6. BANK VEG.
- (5 appendix v riparian corridor assessment sur rll2	TO 7. —	W.F.*	OTHERS PRESE 4. Pasture—unfence 6. Cultivated field 6. Cultivated field covered by vegetation in vigor	nny dispersed. A deep, cen- sered by vegetation. Few of t inferred. Minor erosion of rered by vegetation. Bare o oue root mail inferred. Vege-	red by vegetation. Many by tow root mat briefland. Veget Public Bank 18 Left Bank 20 NT 21. SUBDOMINAN	KBRY BUSHES 4. TREES d by trees or overgrown with s il (serger/slighty) serger then th	L. Trees, other overhead vei larger than space resulting. Trees, other overhead vei scontinuous. Riparian vegetation, low tr	m habitat, instream cover s e of instream habitat and/ou resent in moderate quantities natream habitat (only one of for low overhanging vegeta of instream habitat (et mot mying vegetadon essentiati nging vegetadon essentiati r ze. SUBDOMINANT r ze. DEBRIS 5. UNIO
CCAL VES (1 - 15 RIPARIAN CORRI THEAM & DIMLID	T POINTS:	ISTREAM PLANTS LIMES ENTHOS (Botton) Dwelling Animals) ISH (ALVENILE/ADULTS): LAND USE ADJACENT TO STREAM (#; %)	1. Forest or natural vegetation 2. Park or golf course 3. Roadside (Highway/Street) EGETATIVE BANK COVER: 7) Over 90% of streambank surface c	Vegetated areas are small and eventy dispensed. A Over, ceres surface protection from encelon. 78-90% of streambank surface covered by vegetation. Few open 2. evident, Less dense, deep root mat inferred. Winor ercelon of after 50-75% of streambank surface covered by vegetation. Bare or st. Somewhat shallow and discontinuous root mat inferred. Vegetation but exerted.	4 dovicus. Poor, decontinuous, shallow root protection from erosion. WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL: L	1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES VERHEAD CANOPY: 76-100% of stream surface shaded by trees or over 1. canopy eventy deperted and small (larger/slightby in	2. Streambasis (openings in canopy larger than space nearliting from the bas of several mature individuals). 28.50% of openings in canopy larger than space nearliting from the bas of several mature individuals). 28.50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasion (28.50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasion of canopy thin, discontinuous.	1 Very diverse and complex instream habitat. Instream cover and/or fow overhanding vegetation abundant and evenly dispersed. Moderate diversity and abundance of instream habitat and/or low overhanding vegetation (at least of the habitat types listed below present in moderate quantities). 2 of the habitat types listed below present in moderate quantities). Little diversity and abundance of instream habitat (only one or two of the habitat types present or the diversity or abundance of instream habitat (only one or two of the habitat types present). Amost no diversity or abundance of instream habitat (at most, one of the habitat types present). Amost no diversity or abundance of instream habitat (at most, one of the habitat types present). Amost no diversity or abundance of instream habitat (at most, one of the habitat types present). FISH COVER TYPES: DOMINANT 26. SUBDOMINANT 27. OTHERS PRESENT 28. FISH COVER TYPES: BANK VEG.

Not much weter	CHANNEL CAPACITY Inadequate. Channel subject to severe erosion—channel may be widening or migratscxtansive i deposits of sediment present and/or evidence of overbank flows common. (high water mark observed	outside of channer.) Appears to benefit youthin present peak flows. Flows creating noticeable entation. Considerable address to benefit while sediment) accumulating behind instream obstruction and/or occasional evidence of overhead flows. (High water mark observed outside of channel.)	P	<u> </u>] 🛊 🗀	Bank protection material common (28-50% of bankline) and/or much of natural streambank configuration alread. Considerations streambanks mostly (Occasions streambanks or bank protection material present (10-25% of bankline). Streambanks mostly In natural streams.		1 green/bank broken or ending. Fallure of overlange and eloughing frequent. 26-50% etreen/banks receiving major attendons. As much as 50% broken down or ending. Root meteory contemps and abunging enders. The contemps and abunging enders.	10-237- of streemberries receiving limited through the control of streemberries and conficient or streemberries stable or only allightly aftered. Bank protection material—natural, artificial or combination of both, infrequent raw banks—less than 10% of streambank being aftered.		3 Societies by present the party of the p	夏团	2 Light to dark bower; visible perdoutate matter present. Bottom of channel not visible. 4. RED & TAM 3. GREEN 4. OIL SHEEN Other colors).	2 Septic or human weath. 1, SULFURIC 2, OTHER CHEMICAL 3, PETROLEUM 1, SULFURIC 2, OTHER CHEMICAL 3, PETROLEUM 1, SULFURIC 2, OTHER CHEMICAL 3, PETROLEUM 1, SULFURIC 2, OTHER CHEMICAL 3, PETROLEUM 1, SULFURIC 2, OTHER CHEMICAL 3, PETROLEUM 1, SULFURIC 2, OTHER CHEMICAL 3, PETROLEUM 1, SULFURIC 2, OTHER CHEMICAL 3, PETROLEUM 1, SULFURIC 2, OTHER CHEMICAL 3, PETROLEUM 1, SULFURIC 3, PETROLEUM 1, SULFURIC 3, PETROLEUM 1, SULFURIC 5, OTHER CHEMICAL 3, PETROLEUM 1, SULFURIC 5, OTHER CHEMICAL 3, PETROLEUM 1, SULFURIC 5, OTHER CHEMICAL 3, PETROLEUM 1, SULFURIC 5, OTHER CHEMICAL 3, PETROLEUM 1, SULFURIC 5, OTHER CHEMICAL 5,	There is stream (gare)-bottles, yard debris, logging or fand dearing debris [1] Liter in stream (gare)-bottles, if it material—in or adjacent to distribute. [2] Deaddecesving enimes or felt.	L 2 INORGANIC	Special CASES PRESENT Water withdrawal (pump/ditch) at Sneg pockets found at Sneg pockets found at	3 2. ABUNDANT SUD9 3.
	APPENDIX V IR ASSESSMENT SURVEY FORM	4. SURVEYORS: J.M.	Con Al Al Al	W OBSERVED	चस्य	DOMINANT 12.8 P. 15.4	CURVER PRESENT 14. 8 Pasture—unferced 7. Pasture—ferrod 8. Curthred field 9.	ETATIVE BANK COVER: Over 90% of streembark surface covered by vegetation in vigorous condition. Any bare or spersely vegetated serves are at and eventy dispersed. A deep, dense not mat is inferred. Streembank	surintes protection from ercelon. 76-90%, of streambank surinte covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep root mat inferred. Minor ercelon of streambank surints possible. evident. Less dense, deep root mat inferred. Minor ercelon of streambank surints evident. Boby, of streambank surints evident.	Somewhat shallow and discontinuous rook mat milerrae, vagerative cover provides interest from entation. S2, from entation. C50% of stream bank surface covered by vagetation. Many bare or sparsely vegetated arrest observed by vagetation and the first provides streambank surface little observed devices. Proof, discontinuous, shallow rook mat inferred, Vagetation provides streambank surface little.	Flight Bank 18_2 10 feet { ynb o } 22 jight Left Bank 20_2 jight jight 22 jight ji	1. SUBDOMINANT 22. OTHERS PRESENT 22. 33.	RHEAD CANOPY: 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in 76-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in 76-100% ovenly dispersed and small (larger/skightly larger than the space resulting from loss of mature		istion acattered or in occasional , other overhead vegetation	Vor low overhanging vegetation	yery diverse and comparation may be a second to the second to the second to the second of the second of the second to the second		instream cover and/or low overhanging vegotation essentially accept 27 OTHERS PRESENT 28 FISH COVER TYPES: DOMINANT 24 SUBDOMINANT 27 OTHERS PRESENT 28 + PROCKS 2 LOGS 3. ROOT WADS 4. DEBRIS 5. UNDERGUT BANK 8. BANK VEG.
Sich 1 18-23	ARIAN CORRIDC 1	STREAM NAME: McStyley	TRIBUTARY TO:		. SLIMES . SLIMES . BENTHOS (Bottom Dwelling Animals)	FISH (JUVENILE/ADULTS): LAND USE ADJACENT TO STREAM (*	1. Forest or natural vegetation 2. Park or golf course 3. Remarked fillothway/Street	LE VEGETATIVE BANK COVER: (A) Over 90% of streembank surface cover (A) J Over 90% of streembank surface cover		from evolution. From evolution. ASON, of stream bank surface covered. Astronomy decontinuous, shallow in evolution from evolution.	WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL.	VEGETATION TYPES: DOMINANT 21 SUBDOMINANT 1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES 4. TREES	24. OVERHEAD CANOPY: (1) 16 100% of streem surface shaded by (2) 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	3: 2 streambark (openings in cartopy large in difficults)		25. FISH HABITAT:			4 Instream cover and/or low overhanging vegetation assertions FISH COVER TYPES: DOMINANT 26. SUBDOMINANT 2: FINCKS 2 LOGS 3 ROOT WADS 4. DEBRIS 5. UNDER

FISH PASSAGE BARRIERS:	SAGE B	ARRIER	ü		DIRECT DISCHARGE TO STREAM:	SCHAF	GE TO S	TREAM:		48. Substrate Composition, Percentage of Cover
Type:	ä	Helghi:	Pool Depth	Pool Depth Length to Negotlate:	Туре:	35	LBARB:	Stee: (Dla/W-D)	Instruer Effects:	1 Bedrock
										Boulders (>3)
			•			,				3 CODDIO (3"-3") 25%
										4 Gravel (0.1"-37) 25%
										B Sand (<0.17)
			- -							
										7 Clay
										(Measurements at dameter)
- 6		Culvert 30		Dam 30						49, CHANNEL CHARACTERISTICS
Debris 40		Beaver Dam 41								1 Width 2 Depth 1 Width 2 Dept
			-		Type: Tributary 42	42	Ploe/C	Pipe/Culvert 43 84	Seepe/Springs 46	
GENERAL COMMENTS:	OMMEN	re: 61. Survey	2		Grass	Grass-fined Swale 44	\$ 9	Offich 45		Cb
and Supering the Booklands.	1	Doublers.	St. Offer		Effects: A.N	one 8. C		Effects: A.None B. Charme/Bank Erosion C.Sed Deposition U.Posuisa	postaon U.Foratisa	
62, Commun	CHICATI WRI	1 nearcenna.			RECENT IM	PACTS TO	STREAM	RECENT IMPACTS TO STREAMSIDE CORRIDOR:		
					R.	Prox t	Prox to Streem: <30 >30:	Length	Cause:	-
						ī		-		
					_		-			
				•	•		4			
								-		
									•	
		-								
		•								
					·					
										Channel cross-section:
•		-								پ
					Total					
111111111111111111111111111111111111111					A Clear	A. Clearing/Grading		B. Landscaping C. Other	C. Other Construction Activity	
0.103	7 9				i i	5	j P			4

. CHANNEL CAPACITY Indequate. Channel subject to severe erosion—channel may be widening or migrate,attensive deposits of sectionent present and/or evidence of overbank flows common. (high water mark observed outside of channel.) Appears to barely contain present pask flows. Flows creating noticeable erosion. Considerable sections (each fine a sectionary) accumulating behind interesm obstruction and/or occasional evidence sections (each fine a sectionary posturulating behind interesm obstruction and/or occasional evidence considerations.	Appears adequate to contain most peak flows. Flows may be creating minor bank and substitute a contain most peak flows. Flows may be creating minor bank and substitute of containt statements of vortically flowers are else, and secure of containt properties of the containt prepared on their vegetation; bank vegetation mailed down). Appears able to contain present peak flows. Flows patient with little cutting, deposition or other evidence of bank deterioration. Stream flows through or adjacent to marsh/weitend area. Overbank flows natural, common.	30. ARTIFICIAL BANK PROTECTION: Extensive atrection of beink protection material present (>50% of bankline) and/or majority of natural agreements of pankline and or majority of natural agreements of material common (26-50% of bankline) and/or much of natural streambank Bank protection material common (26-50% of bankline) and/or much of natural streambank Consistential atractices of bank protection material present (10-25% of bankline). Streambanks mostly	# _	1 spearnbank broken or enoding. Failure of overnary is and eloogining in equality. 26-50% streambanks receiving major alterations. Le much as 50% broken down or enoding. Root 10-20% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, 3 stable condition. Streambanks stable or only slightly attend. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being affered.	22. SUBSTRATE CONSOLIDATION: Substrate lose sesortment easily moved with boot heel. Substrate moderately packed/cernented. Substrate difficult to move with boot heel. Substrate lightly packed/cernented. Substrate difficult to dislodge with kicking. May include areas of bedrock or hindren. Substrate consists of/covered by sand, day or organio muck.	TRANSPARENCY/COLOR: Transperent, bottom of channel is viable. Cheque or white like, bottom of channel may be viable. Light to deak brown; viable perdiculate mather present. Bottom of channel not viable.	34. ODOR NIPA weste or manura. 1 Animal weste or manura. 2 Septic or human weste. 4 Other 1. SULFURIC 2 OTHER CHEMICAL 3. PETROLEUM 38. TRASH	Liter in stream: care, bottee, yand deore, logging or and dearing decining the composition of the care, care, appliances, fill meterial—in or adjacent to channel. 2
PICHURS 24-25 APPENDIX V RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM 2. DATE 1/4/29 THEAM NAME: WICSSYLU 4. SURVEYORS: 2LM	RIBUTARY TO: LIRVEY ENTRY/EXIT POINTS: WER MILES SURVEYED: 6,	TS 1 2 2 1 1 2 2 1 1 1 2 2 1 1 1 2 2 1 1 1 2 2 1	1. Forest or natural vegetation 4. Peature—unfenced 7. Readdential—confinious 2. Park or golf course 5. Peature—fenced 8. Readdential—confinious 3. Roadside (Highway/Street) 6. Cultivated field 9. Industrial/Commercial	FEGETATIVE BANK COVER: (1) Over 60% of streambank surface covered by vegetabon in vigorous condition, Any bare or spensely vegetabed areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank surface protection from evosion. (2) Associated areas are small sand evenly dispersed. A deep, dense root mat is inferred. Streambank and the event of the special contraction of the special contraction of the surface protection from evolution. (3) Associated areas deep root mat inferred. Minor evolution of streambank surface possible.	2 Somewhat shallow and decontituous rook mail inferred. Vegetables cover provides limited protection from erosion. 4 50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated areas obvious. Froof, decontinuous, shallow rook mat inferred. Vegetation provides streambank surface little protection from erosion. WIDTH OF VEGETATIVE COVER Right Bank 18. 0.5 10 feet / 1.5 1000 /	VEGETATION TYPES: DOMINANT 21. SUBDOMINANT 22. Z. OTHERS PRESENT 23. Z. OTHERS PRESENT 23. Z. OTHER SERVINGS 3. BLK BRY BUSHES (4.) THEES 5. OTHER SOVERHEAD CANOPY: 76-100% of streem surface shaded by these or overgrown with grasses, shrubs, brush. Openings in canopy evenly dispersed and armail (larger/shightly larger than the space neartiting from loss of mature.	high-dual). \$1.75% of stream surface shaded. Trees, other overhead vegetation eventy dispersed along \$1.75% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional activities. Overhead camppy thin, discontinuous. \$26.50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional clarified of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation \$4.50% of stream surface shaded. Riparian vegetation, low trees, other overhead vegetation	

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ESH PASSAGE BARRERS:			DIRECT DISCHARGE TO STREAM:	SCHAF	GETOS	TREAM:		48, Substrate Composition, herototage of Cover	1.a
Trace Rife Haldid:	4: Pool Death	Pool Depth Length to Negotiate:	i e	ä	LBARB:	Stree: (Dia/W-D)	Instruem Effects:	1 Bedrock	٠,
						, , , , , , , , , , , , , , , , , , ,		Boulders (>3')	٠,
			CUINCLE			de" from across		3 Cobble (3"-3) 5, %	-1.
						2011		4 Gravel (0.1"-3") 10 %	'n
			***************************************					sand (<0.1")	-
								7/CX \ us •	•ï
						-		7 Olay	·i
·····							,	(Measurements at dlameter)	
St. 50 Calved 38		Dam 39						49. CHANNEL CHARACTERISTICS	90
	Dem 41							1 Width 2 Depth 1 Width 2 Dept	¥
			Trene: Tributery 42	3	PbeA	Pipe/Culvert 43 Se	Seepe/Springs 46	Г	
COMMENTS			Gress	Grass-lined Swale 44	\$ 6	Ottoh 46		4-6 3-4	
O. Street.		Ra Other	Effects: A.N	one B. C	arme/Bank	Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted	position D.Polluted		
Z, Communication with news			RECENT INF	ACTS TO	STREAM	RECENT IMPACTS TO STREAMSIDE CORRIDOR:			
		-	RM:	Prox	Prox to Streem: <30 >30:	Length	Cause:		
		-							
			_	asid	fee sidential				
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								Channel cross-section:	
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			47. Total A. Clea	Fotel A. Clearing/Grading		decaping C. Other	B. Landscaping C. Other Construction Activity		-
Y 9 0 1 0 3			D. Land	D. Land Use Change	egi.			-	

Indequate Channel subject to severe erosion—channel may be widening or migratcaterative classical deposits of seafment present and/or evidence of overtainst flows common. (high water mark observed outside of channel.) Appears to barrely contain present peek flows. Flows creating noticeable erosion. Considerable of overtainst classification and/or occasional evidence of overtainst peek flows. Flows may be creating minor occasional evidence of overtainst flows may be creating minor bank and autostrate and overtainst classifications. Evidence of overtainst flows may be creating minor bank and autostrate and constructions. Evidence of overtainst flows may be creating minor bank and autostrate and constructions. Evidence of overtaint flows may be creating deposited on evidence of bank determination or contain present peak flows. Flows pattern with little cutting, deposition or other series as through or adjacent to marsh/westand area. Overtainst flows natural, common. Stream flows through or adjacent to marsh/westand area. Overtainst flows natural, common.		22. SUBSTRATE CONSOLIDATON: Substrate loces assortment easily moved with boot heel. Substrate increased packed beamented. Substrate difficult to move with boot heel. Substrate and sending packed beamented. Substrate difficult to dislocge with kicking. May include areas of bedrock or hardpen. Substrate consists of covered by send, day or organic muck. Substrate consists of covered by send, day or organic muck. Substrate consists of covered by send, day or organic muck. Transperent, bottom of channel is visible. Transperent, bottom of channel may be visible. Opeque or withis file, bottom of channel may be visible. Ubit to day/braym; visible perfouriste matter present. Sottom of channel not visible. 1. RED	34. ODOR N/A Animal weste or manure. Septeor human weste. 1. SULFURIC 2 OTHER CHEMICAL 3. PETROLEUM 1. SULFURIC 2 OTHER CHEMICAL 3. PETROLEUM 1. SULFURIC 2 OTHER CHEMICAL 3. PETROLEUM 1. SULFURIC 2 OTHER CHEMICAL 3. PETROLEUM 2. Thee, care, appliance, fill material—In or adjacent to channel. 2. Thee, care, appliance, fill material—In or adjacent to channel. 2. Thee, care, appliance, fill material—In or adjacent to channel. 3. Concentrated dump site contains 1. ORGANIC MATERIAL 2. INORGANIC 3. SPECIAL CASES PRESENT 1. Farm antimate in stream et
THEAM & MALES OUT 2 1. STREAM & WALS 2. DATE 10/4 12	LAND USE ADJACENT TO STREAM (6; %) DOMINANT 12.8 12.9 13. (COO %) SUBDOMINANT 13.8 11.8 11.8 11.8 11.8 11.8 11.8 11.8	Somewhat a hallow and decontrollogs from the protection. Many bare or spensely vegetated enses 450% of stream bank surface covered by vegetation. Many bare or spensely vegetated enses 450% of stream bank surface covered by vegetation. Many bare or spensely vegetated enses the devices. Prov. decorptions and surface covered by vegetation. Many bare or spensely vegetated enses the devices. Prov. decorption from ensemble and surface a hallow by these or overgrown with greatest, shruttle, brush. Openings in corroys evenly despensed and small (large-rightly larger than the spense resulting from loss of mature.	21-75% of stream surface shaded. Trees, other overhead vegetation eventy dispersed along streambank (openings in canopy larger than space resulting from the loss of several mature individuals). 25-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional schedules of stream surface shaded. Riperian vegetation, low trees, other overhead vegetation of essentially absent. 4

-3 ISH PASSAGE BARRIERS:	RS:		DIRECT	NSCHAF	DIRECT DISCHARGE TO STREAM:	TREAM:		48. Substrate Composition, Percentage of Cover
Type: RM: Helgitt:	Pool Depth	Pool Depth Length to Negotiste:	1986	33	LB/RB:	Size: (Dia/W-D)	Instruem Effects:	1 Bedrock
	_		Ϋ́	401.0	ā	1 36"		Boulders (>3")
			Calvan	ת ופע י	3	S		3 Cobble (3"-3") 40%
_	,		///01/1	F (70	119"		4 Gravel (0.1°-5") 30%
			Culvoly Const		Channel			8 Serid (<0.17)
				<u></u>				1 3 SW / 30 16
	•	,						7 Clay \
					***			(Messurements at dismeter)
		Dem 30				,		49. CHANNEL CHARACTERISTICS
	Dem 41					,		1 Width 2 Depth 1 Width 2 Dept
			Trene: Tributary 42	12 Val	Ploe/Culvert 43		Seepa/Springs 46	
COMMENTS			Grass	Grass-fined Swale 44	2 2	Dilloh 46		01-0
Stream 51. Survey	A		Effects: A.N.	lone B. Ch	anne/Bank	Erosion C.Sed De	Effects: A.None B. Channel/Bank Eroston C.Sed Deposition D.Polluted	asols/his alla
. Communication with Residents:		par Care	RECENT IN	PACT8 TO	STREAMS	RÉCENT IMPACTS TO STREAMSIDE CORRIDOR:		
			AN.	Prox	Prox to Streem: <30 >30:	Longth	Cause:	
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			47. Total		1 1			
			A C	A. Clearing/Grading D. Land Use Change		B. Landscaping C. Other	C. Other Construction Activity	
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1994 RIPARIAN CORRIDOR ASSESSMENT SURVEY FORMS

5	2. DATE L. SEPT 94	0	He actual		AON FEW OBSERVED		13	7. Residential scattered 8. Residential continuo		ton in vigorous condition, Any bare or sparsely sep, dense not mat is inferred. Streambank	n. Few goen areas with unstable vegetation resion of streambank surface possible. 1. Bare or soursely vegetated areas are evident.	ed. Vegetably e cover provides limited protection 32.	Mary bare or spensely vegetated areas ed. Vegetation provides streenbank suriace little	10, 550 look	MANANT 22.4 OTHERS PRESENT 23.	1) day war	rown with grasses, shrubs, brush. Openings m rger than the space resulting from loss of mature	head vegetation evenly departed along 34, 000R C and the loss of several mature 34, 100 C Animal water or manifes	1	n, low trees, other overhead vegetation 35,	cover and/or low overthanging vegetation	at and/or low overhanging vegetation (at least 3 consmitted). Paranchies, Over 40 t	
ARIAN CORRIDA	FEAM # 104 1 635* 7. S.	į	BUTARY TO:	ĺ	IUNDANCE OF: ABUNDANT STREAM PLANTS	3 Animals)	SH (JUVENILE/ADULTS): LAND USE ADJACENT TO STREAM (#; %) DO SY	1. Forest or natural vegetation 4. Par 2. Park or golf course 6. Par	Roadside (Highway/Street) 6. Cui GETATIVE BANK COVER:	Over 90%, of streambank surface covered by vegetation in vigorous condition. Any bare or sparts by vegetated enses are small and evenity dispersed. A deep, dense noot mat is inferred. Streambank and even overeithe from a residue.	autrace protector interaction execut. 78-90% of streambank surface covered by vegetation. Few open areas with unstable vegetation of streambank surface possible. evident, Less dense, deep not mat inferred. Minor evolun of streambank surface possible. so, 79s., of executivent surface covered by vecetation. Bare or sparsely vegetated areas are evid.	Somewhat shallow and decontinuous root mat Inferred. Vegetable cover provides limited protection from eroelon.	<50% of stream bank surface covered by vegatation. Many bare or spensely vegatated srees obvious. Poor, decontinuous, shellow root mat inferred. Vegetation provides streambank surface fittle protection from erosion.	WIDTH OF VEGETATIVE COVER RIGHT Bank OUTSIDE OF CHANNEL: Left Bank	VEGETATION TYPES: DOMINANT 21. 2 SUBDOMINANT 22. 4	FEHEAD CANOPY:	76-100%, of stream surface shaded by trees or overgrown with grasses, shrubs, brish. Openings in canopy evenly depended and small (larger/skightly larger than the space resulting from loss of mattive individual).	51-75% of stream surface shaded. Trees, other overhead vegetation eventy depented along streambers (openings in canopy larger than space resulting from the loss of several mature that details.	rearrowners	0-25% of stream surface shaded. Riparian vegetation, low breat, other overhead vegetation essentially absent.	SH HABITAT: Very diverse and complex histream habitat. Instream cover and/or low overhanging vegetation	acunosmi and everily disjurace. Moderate diversity and abundance of instreem habitat and/or fow earth habitat endor for earth abundance of instreem habitat and/or fow earth habitat home fisted before present in moderate quantities).	The institute of the state of t

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48. Substrate Composition, Perbindige of Cover	1 Bedrock	2 Boulders (>3)	49. CHANNEL CHARACTERISTICS 1 Width 2 Depth 1 Width 2 Depth) 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3
)	Instreem Effects:			Type: Tributary 42 Pha/Culvert 43 Seeps/Springs 46 Grass-Ined Swale 44 Ditch 45 Effects: A.None B. Channel/Bank Erosion C.8ed Deposition D.Polluted	Course:	B. Landscaping C. Other Construction Activity
DIRECT DISCHARGE TO STREAM: $\bigcup \gamma^{i} \circ \cup$	Stre: (Dla/W-D)			Pipe/Culvert 43 Se 1 Dich 45 ei/Bank Erosion C.8ed De	IDE CORRIDOR: Length	scaping C. Other
CHARGE TO S	RM: LB/RB:			Tributary 42 Phe/Ci Grass-Ined Swale 44 1: A.None B. Channel/Bank	RECENT MPACTS TO STREAMSIDE CORRIDOR: RM: Prox to Stream: Length <30 >30:	
DIRECT DIS	Sedi(I			Type: Tributary 42, Grass-lined 8 Effects: A.None B	RÉCENT IMPAC RM:	47. Total A. Clearing/Grading D. Land Use Change
	Pool Depth Length to Negotiste:		Dem 30	<u>.</u>		
AS:			Dam 41	vey		
FISH PASSAGE BARRIERS:	RM: Height:		Culvert 38	GENERAL COMMENTS: 50. Stream 51. Survey	Technology	
FISH PASS	Type:		Falls 57 Debris 40	GENERAL COMMENTS:		9 0 7 0 3 3



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FISH PASSAGE BARRIERS: Type: RM: Haght: P	BARRIER	18: Pool Depth	i: Pool Depth Langth to Negotiste:	DIRECT DISCHARGE TO STREAM: Type: RM: LB/RB: Stee: (Die	NSCHA!	AGE TO S	TREAM: Stee: (Dle/M-D)	Instreem Effects:	48. Substrate Composition, Percentige of Cover	ericenthige.
_		. L								*
				,					[3] Cobble (3" - 3")	*
									Gravel (0.1" - 3")	× Off
					\				5 Sand (<0.17)	20
-,-,									ats •	× 0/
									7 clay	*
									(Messurements at Gameter)	eter)
Felle 37	Culvert 38		Dem 39				•		49. CHANNEL CHARACTERISTICS	ERISTICS
Debrie 40	Beaver	Beaver Dam 41							1 Width 2 Depth 1 Width 2 Depth	th 2 Depth
				Type: Tributary 42	27 42	P'pe/C	Phe/Culvert 43 S4	Seepa/Springs 46	H. 8' A'L	
GENERAL COMMENTS: 10. Stream	NTS: 51. Survey	6	·,	Grass	Grass-lined Swale 44	4 6	Ditch 46			
2. Communication with Residents:	Ith Residents	: 53, Other	the	Ellects: A.	one B.	verme//Benk	Erosion C.Sed De	Effects: A.None B. Charme/Bank Erosion C.Sed Deposition U.Politied	-	
				RECENT IN	PACTS TO	STREAMS	RECENT IMPACTS TO STREAMSIDE CORRIDOR:		-	
				1	F XOF	Prox to Streem: <30 >30:	Length	Cause:		-42
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				47. Total	Total	- 1	R Landscaping G. Other	C. Other Construction Activity		•
A 9 0 1 0 J				D. Land	D. Land Use Change	_)	

CHANNEL CAPACITY Inadequate, Channel subject to severe excelon—channel may be widening or migrate	Appears to barely contain present peak flows. Flows creating noticeable erosion. Considerable Appears to barely contain present peak flows. Flows creating noticeable and/or occasional evidence of overbank flows. (High water mark observed outside of claimed.) Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate and outside to contain most peak flows. Flows may be creating minor bank and substrate erosion at outside outside of overbank flows may be adement deposited on	bank. Debris suspended or deposited on bank vegetation; bank vegetation matter down.). Appears able to contain present peak flows. Flows pattern with fittle cutting, deposition or other evidence of bank deterioration.	ARTIFICIAL BANK PROTECTION:	Extensive stratches of bank protection material present (>50% or bendune) and/or importy or leaving streambank configuration altered. Benk protection material common (26-50% of bankline) and/or much of natural streambank configuration altered.	Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in natural state. Little, if any bank protection material present (<10% of bankline). Streambank almost entirely in natural state.] 🖁 [streambark broken or erosing. Failure of overnangs and accoping in quant. 28-50% streambarks receiving major alterations. As much as 50% broken down or eroding. Root met overhangs and stoughing evident.	10-25% of streambank receiving minor-moderate streamon. At east, 73% of a sent control of streambanks stable or only alignity aftered. Bank protection material—natural, artificial or Streambanks stable or only alignity aftered. Bank protection material—natural, artificial or combination of both. Infrequent raw banks—less than 10% of streambank being aftered.	٠, ر		2 Upaque or wine ma, bouon or chains may be seen. Bottom of channel not visible. 3 Light to dark brown; visible perticulate matter present. Bottom of channel not visible. 4 1. RED 2. TAN 3. GREEN 4. Of SHEEN Other colors	ODOR 3 Decaying plant matter.	Septic or human waste. 1. SUI-FURIC 2. OTHER CHEMICAL 3. P TRASH No. 100 C.052 - Drove July 100 1	1 Covernment of the Control of the C	SPECIAL CASES PRESENT 1 Farm animals in stream at 2 Sneg pockets found at 3 Wedands at 1. ALGAL MATS 2. ABUN
APPENDIX V RIAN CORRIDOR ASSESSMENT SURVI	DANE DANE	T. NONE		OS (Bottom Dwelling Animals) 1 2 3 UVENILE/ADULTS): 1 2 3	M (#; %) DOMINANT 12.8 SUBDOMINANT 13.8 OTHERS PRESENT 14.8	Forset or natural vegetation 4. Pasture—Unletced / rescuential confinuous 2. Park or golf course 5. Pasture—fenced 8. Residential—confinuous 31. 3. Roadside (Highway/Street) 6. Cultivated field 9. Industrial/Commercial 31.	 VEGETATIVE BANK COVER: Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely expensive areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank 		Somewhat shallow and decontinuous root mat inferred. Vegetative cover provides instead provedures 32. from erosion.	VEGETATION TYPES: DOMINANT 21. Z. SUBDOMINANT 22. Y. OTHERS PRESENT 22. 33. 1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER AND AND AND AND AND AND AND AND AND AND	24. OVERHEAD CANOPY: 76-100% of stream surface shaded by trees or overgrown with grasses, shruke, brush Openings in canopy evenly depended and small (larger/slightly larger tren the space resulting from loss of mature beforeign.)	51-75% of stream surface shaded. Trees, other overhead vegetation evently dispersed along streambank (openings in canopy larger than spece resulting from the loss of several mature influence.	29-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional dumps. Overhead canopy thin, discontinuous. 4 essentially absent. 35.	 FISH HABITAT: Very diverse and complex instream habitat, instream cover and/or low overhanging vegetation abundant and evenly dispersed. Moderate eliversity and abundance of instream habitat and/or low overhanging vegetation (at least 3 	2 of the habbat types listed below present in moderate quantities). Little diversity and sbundance of instream habbat (only one or two of the habbat types present or secondinuous, predominant), instream cover and/or low overhanging vegetation eperse and discontinuous. Amonton to diversity or sbundance of instream habbat (at most, one of the habbat types present). Anoton to of the present of instream thabat (at most, one of the habbat types present). Anoton to of the present of instream thabat (at most, one of the habbat types present). Anoton to of the present of instream thabat (at most, one of the habbat types present). Anoton to of the present of instream thabat (at most, one of the habbat types present). Anoton to of the present of instream thabat (at most, one of the habbat types present). Anoton to of the present of the present of instream thabat types present of the present of instream cover and or instream thabat types present of instream thabat types present of instream thabat types present of instream thabat types present of instream thabat types present of instream thabat types present of instream thabat types present of instream thabat types present of instream thabat types present of instream thabat types present of instream thabat types present of instream thabat types present of instream thabat types present of instream thabat types that the present of instream thabat thabat thabat that the present of instream thabat that the present of instream thabat that the present of instream thabat that the present of instream thabat that the present of instream that the present of instream that the present of instream that the present of instream that the present of instream that the present of instream that the present of instream that the present of instream that the present of instream that the present of instream that the present of instream that the present of instream that the present of instream that the present of instream that the present of instream that the present of instream that the p

b) rish PA	SSAGE	FISH PASSAGE BARRIERS:	3S:			DISCHA	DIRECT DISCHARGE TO STREAM:	TREAM:	.*	48. Substrate Compositon, Percentuge of Cover
Туре:	P.W.:	Helght:	Pool Depth	Pool Depth Length to Negotlate:	Туре:	RX:	LB/RB:	Stze: (Dia/W-D)	Instream Effects:	Bedrock **
							,			2 Boulders (>3') %
										3 Cobble (3" – 3')%
								-		4 Gravel (0.1" - 3") %
										8 is nd (<0.1°)
										%
										7 clay %
								-		(Measurements at diameter)
Falls 37		Culvert 38	ة 	Dam 39				-		49. CHANNEL CHARACTERISTICS
Debris 40	.	Boaver Dam 41	Jam 41							1 Width 2 Depth 1 Width 2 Depth
GENERAL	GENERAL COMMENTS:	TS:			Type: Tributary 42	tary 42	Pipe/Cu	11	Seeps/Springs 46	
50. Stream		51. Survey	\ £		Grass	Grass-lined Swale 44	15 44 1	Ditch 45		
52. Commu	nication with	52. Communication with Residents:	53. Other	her	Effects: A.h	lone B. Cl	hannel/Bank	Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted	osition D.Polluted	-
					RECENT IM	PACTS TO	STREAMS	RECENT IMPACTS TO STREAMSIDE CORRIDOR:		
					RM:	Prox t	Prox to Stream: <30 >30:	Length	Cause:	
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	3.87								-] 3 2 > 2)
# 1 2 H 1 C 1 C 1 C 1 C 1 C 1 C 1 C 1 C 1 C 1				,	47. Total. A. Clear D. Land	Fotal A. Clearing/Grading D. Land Use Change	g B. Landscaping		C. Other Construction Activity	3 4 5 6 7 9
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THE PARIAN CORRIDOR ASSESSMENT SURVEY FORM A SURVEYORS: WALES SURVEYED: THAT TO: T
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48. Substrate Composition, Percentage of Cover	- Bedrock	l	3 Cobble (3'-3') AU **	d(40.17)	C Chay	(Measurements at diameter)	49. CHANNEL CHARACTERISTICS	1 Width 2 Depth 1 Width 2 Depth	11-, 9 , 10e-01	J. dulk te	Sec Proposition of the Propositi				Channel cross-section:		
DIRECT DISCHARGE TO STREAM:	Type: RM: LB/RB: Stori (Dla/W-D) Instream Effects:								pe/Culty	Grass-Ined Swale 44 Ditch 45 Effects: A.None B. Charnel/Bank Erosion C.Sed Deposition D.Polkited	RECENT IMPACTS TO STREAMSIDE CORRIDOR:	RM: Prox to Streem: Length Gause:	Davelopment : Der Hickory			47. Total A. Cleering/Grading B. Landscaping C. Other Construction Activity D. Land Use Change	
FISH PASSAGE BARRIERS: NOV.	ingth to Negotlate:	STANKET!	350	and the second s			Falls 37 Culvert 38 Dam 39	Debris 40 Beaver Dam 41	GENERAL COMMENTS:	St. Survey							

CHANNEL CAPACITY hadequete. Channel subject to severe erosion—channel may be widening or migrat	Appears to berrely contain present peak flows. Flows creating noticeable erosion. Considerable adment (sep. fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)	Appears adequate to contain most peek flows. Flows may be creating minor bank and substrate as erosion at outcurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank upon bank vegetation; bank vegetation matted down).	· /	Streem flows through or adjacent to mersive conditions treating to the conditions that it is continued. APTHICIAN PROTECTION:			<u>کا</u> ڇ [1 streambark broken or eroding. Fallure of overhange and sloughing frequent. 26-50% streambarks receiving major aherations. As much as 50% broken down or eroding. Root mat overhangs and sloughing evident.	10-25%, of streambank receiving minor-moderate enteracts. At least 7.5% of stream own in results, at stable condition. Streambanks stable or only slightly shared. Bank protection meterial—netural, artificial or combination of both, infrequent raw banks—less than 10% of streambank being attend.	SUBSTRATE CONSOLIDATION: Substrate loose sesortment easily moved with boot heel.	Substrate moderately packed/cemented. Substrate difficult to findly with flocking. May include areas of Substrate lightly packed/cemented. Substrate difficult to disloge with kicking. May include areas of bedrock or hardpan. **Experies consists of/covered by send, clay or organic muck.		Cpeque or white like, bottom of channel may be visible. 1 Light to dark brown; visible particulate matter present. Bottom of channel not visible.	Rodo	Animal weste or manure. 3 Decaying plant matter. 4 Other 1. Surf-unic 2. OTHER CHEMICAL 3. PETROLEUM	TRASH NO.	Three, cars, appliances, fill material—in or adjacent to channel. Dead/decaying animals or fish. Concentrated during site contains Concentrated during site contains Concentrated during site contains Concentrated during site contains Concentrated during site contains Concentrate du		_
APPENDIX V RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM ζ DATE $\{b \leq (p)\}$	10.55e./ 4. SURVEYORS:	BUTAHY TO: RVEY ENTRY/EXIT POINTS:	10 7	₹ •	MES NTHOS (Bottom Dwelling Animals) 1 2 3 4 NTHOS (Bottom Dwelling Animals) 1 2 3 4 (JUVENIE/ADULTS): 1 4 (-) (LAND USE ADJACENT TO STREAM (#; %) DOMINANT 12.# 15.100 % A N.C. FO SUBDOMINANT 13.# 2 16.200 % A N.C. FO SUBDOMINANT 14.# 2 17.20 % A N.C. FO SUBDOMINANT 14.# 2 17.20 % A N.C. FO SUBDOMINANT 14.# 2 17.20 % A N.C. FO SUBDOMINANT 14.# 2 17.20 % A N.C. FO SUBJECT 17.20 % A N.C. F	Residential ecent 8. Residential config. 9. Industrial/Commer	GETATIVE BANK COVER: Over 90%, of streambank surface covered by vegetation in vigorous condition, Any bare or spensely vegetated areas are small and evenly dispensed. A deep, dense root mat is inferred. Streambank	 aurince protection from ercelon. 78-90% of streembank surface covered by vegetation. Few open areas with unstable vegetation. evident, Leas dense, deep roof mat inferred. Minor ercelon of streembank surface possible. 50-75% of streembank surface covered by vegetation. 	Somewhates arranged and describing the control of t	protection from encoding. Protection from encod	JBDOMINANT IES 4. TREE	ERHEAD CANOPY: Open in 14 50 han 100% shadlar (UNIVOU) The 100% of streem surface shaded by trees or overgrown with gresses, shrube, brush. Openings in canopy evenly dispersed and small (larger/telights) larger then the space resulting from loss of mature	norvousi). § 1-72% given surface shaded. Trees, other overhead vegetation evenly dispersed along standard in cancoy larger than space resulting from the loss of several mature.	hdv/dusis). 26-50% of streem surface shaded. Trees, other overhead vegetation scattered or in occasional currapa. Overhead canopy thin, discontinuous.	9.25% of streem surface shaded. Riparian vegetation, low trees, other overneau vegetation 38. essentially absent.	H HABITAT: NONE. Groffer (4/9) in the profession over and or low overhanging vegetation. Very diverse and complex instream habitat, instream cover and/or low overhanging vegetation and evenly dispersed. Submident and evenly dispersed.	of the hebtat type's listed before present in moderate quantities). Unde diversity and abundance of instream hebtati (only one or two of the habitat types present or 34, predominant), instream cover and/or low overhanging vegetation sparse and deconfinuous. Amost no diversity or abundance of instream hebtati (at most, one of the habitat types present). Instream cover and/or low overhanging vegetation essentially absent.	FISH COVER TYPES: DOMINANT 26. SUBDOMINANT 37. OTHERS PRESENT 20. 1. ROCKS 2. LOGS 3.ROOT WADS 4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG. 7. OTHER

CHANNEL CAPACITY () -) () () () () () () () () () () () () (Mof-No		22. SUBSTRATE CONSOLIDATION: Substrate locae association and selly moved with boot heed. Substrate index association and selly moved with boot heed. Substrate index produced by substrate difficult to move with boot heed. Substrate tightly peacked beamented. Substrate difficult to delocige with kicking. May include areas of bedrock or hardpan. Substrate tightly peacked beamented. Substrate difficult to delocige with kicking. May include areas of bedrock or hardpan. Substrate consists of/covered by sand, day or organic muck. Substrate consists of connection of channel is visible. Substrate or white like, bottom of channel may be visible. Departure or white like, bottom of channel may be visible. Light to dark brown; visible perfoculate metter present. Bottom of channel ind visible. HEED 2.TAN 3. GREEN 4.OIL SHEEN Other colors	34. ODOR Animal weste or manure. Septic or human waste. 1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM 1. SULFURIC 2. OTHER CHEMICAL 3. PETROLEUM 35. TRASH(\)) 1. Mar In present care boths, locality of lend of deaths debrie.	1 Three, cars, appliances, fill material—in or adjacent to channel. 2 Deed/decaying animals or fielt. 4 Concentrated dump site contains 1. ORGANIC MATERIAL 2. INORGANIC 3. SPECIAL CASES PRESENT 1. Farm animals in stream at Snag pockets found at Snag pockets found at 1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER
CORRIDOR ASSESSMENT SURVEYOR A SURVEYOR A SURVEYOR STATE OF TOO TOO TOO TOO TOO TOO TOO TOO TOO	d of states	Pasture—unfenced 7. Readential—continuous Cultivated field 8. Industrial/Commercial 9. Industrial/Commercial	hom erotion. 450% of stream bank surface covered by vegetation. Many bane or specially vegetated areas e50% of stream bank surface covered by vegetation. Many bane or specially vegetated areas protection from erotion. WIDTH OF VEGETATIVE COVER Right Bank 19 7 5 feet outside CHAINEL. WIDTH OF VEGETATIVE COVER Right Bank 20 3 5 feet outside CHAINEL. VEGETATION TYPES: DOMAINANT 21(2) SUBDOMAINANT 22(2) OTHERS PRESENT 22(1) 1. GRASSES 2 SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER UNIVERSITY OF VEGETATION TYPES OF SUBDOMAINANT 22(2) 1. GRASSES 2 SHRUBS 3. BLK BRY BUSHES 4. TREES 5. OTHER ERHEAD CANOPY: O (4) (4) (4) (4) (4) (4) (4) (4) (4) (4)	ξ.	FISH HABITAT: \$1/(1.1.) \$1/LB (10.2) (1.2) (1.1.) COD(0.2) 0. (1.1.) COD(0.2) 0. (1.1.) COD(0.2) 0. (1.1.) 1. (1.1.)

#

24.

FISH PAS	SAGE	FISH PASSAGE BARRIERS:	i3:		DIRECT	JISCHA	DIRECT DISCHARGE TO STREAM:	STREAM:		48. Substrate Compositon, Percentage of Cover
Type:	RM:	Helght:	Pool Depth	Pool Depth Length to Negotlate:	Туре:	RM:	LB/RB:	Size: (Dia/W-D)	Instream Effects:	inaccessible "Bedrock"
										Boulders (>3')
									•	3 Cobble (3" – 3') %
										4 Gravel (0.1* - 3") %
										[5] s ₂ rd (<0.1°)
					***************************************	,				%
-										7 Clay
	. ,					· · · · · ·				(Measurements at diameter)
Falls 37		Culvert 38	0	Dam 39						49. ÇHANNEL CHARACTERISTICS
Debris 40		Beaver Dam 41)am 41	.						1 Width 2 Depth 1 Width 2 Depth
GENERAL COMMENTS:	DMMENT	Ċ			Type: Tributary 42	ary 42	Pipa/Cu	Pipe/Culvert 43 See	Seeps/Springs 46	
50. Stream		51. Survey			Grass	Grass-lined Swale 44	44 e	Ditch 45		
52. Communication with Residents: _	cation with	Residents:	53. Other	ther	Ellects: A.N	one o. c.	nannevbank	Ellects: Alvone 6. Channe/Bank Erosion C.36d Deposition D.Poliuted	Skilon U.Poliuted	
					RECENT IMF	ACTS TO	STREAMS	RECENT IMPACTS TO STREAMSIDE CORRIDOR:		* * *
					RM:	Prox to	Prox to Stream: <30 >30:	Length	Cause:	
,										
							-			
									à	
					-	:				
·	ris.									
		,								Channel cross-section:
				!		*				· ネコン)
					47. Total		- 1			3 4 5
S # 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	>				A. Cleari D. Land I	A. Clearing/Grading D. Land Use Change	g B. Landscaping ge		C. Other Construction Activity	_]]
נונ	<u>-</u>			•		•	,		•	



4 wide x 1.5 down

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APPEND

out ho	2 Agricult (ago, fine sediment) accumulating behind instream obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.) Appears adequate to contain most peak flows. Flow may be creating thror bank and substrate acciding a customyre and constructions. Evidence of overbank flows may be creating thror bank and substrate acciding the contains the con	\	RYED S. AFTI		-continuous 31. STRE		ب لو	8	Substrate tightity packed/cemented. Substrate difficult to dislocge with licking. May inche bedrock or hardpan. Substrate consists of conversed by sand, clay or argainic muck.	22, 3 31 TRANSPARENCY/COLOR: (b) (12.0)	Opeque or white like, bottom of channel may be visible. 1 Light to dark brown; visible particulate matter present. Bottom of channel not visible. 1. PED 2. TAN 3. GREEN 4. OIL SHEEN Other colors	34. ODOR 11/P.	Septic or human waste. 1. Sulfuric 2. OTHER CHEMICAL 3. PETROLEUM	**		18	TOTAL SELECTION IN THE COLUMN TO THE COLUMN
APPENDIX V RIPARIAN CORRIDOR ASSESSMENT SURVEY FORM STREAM # $(2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times$	4. SURVEYORS:	SURVEY ENTRY/EXT POINTS: (2003) X. TO 7	ANCE OF: ABUNDANT COMMON FEW AM PLANTS 1	LAND USE ADJACENT TO STREAM (#; %) DOMINANT 12.# 13.# 11.# 11.# 11.# 11.# 11.# 11.# 11	 	VEGETATIVE BANK COVER: Over \$0% of streambank surface covered by vegetation in vigorous condition. Any bare or spersely a vegetated areas are small and evently dispersed. A deep, dense root mat is inferred. Streambank	surface protection from erceion. 76-90% of streembank surface covered by vegetation. Few open ansea with unstable vegetation evident. Less dense, deep root mat inferred. Minor evotion of streembank surface possible. 50-75% of streembank surface covered by vegetation. Bare or sparsely vegetated sense are evident.	Somewhat preserve and descriptions for it maintained. Then experted y regelated areas covered by vegetation. Many bare or sparsely vegetated areas obvious. Poor, descriptional, shallow root met inferred. Vegetation provides streambank surface fitties.	WIDTH OF VEGETATIVE COVER Right Bank 19. feet OUTSIDE OF CHANNEL: Left Bank 20. feet	VEGETATION TYPES: DOMINANT 21. [SUBDOMINANT 22. 1] OTHERS PRESENT 1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES 4. TREES 8. OTHER	OVERHEAD CANOPY: 78-100% of stream surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy evenly deperted and small (largerislightly larger than the space resulting from loss of mature	scrivous), 81-75%, of greem guiface shaded. Trees, other overhead vegetation eventy dispensed along streambank (openings in cancry) larger than space nearliting from the lots of several mature	Individuals). 26-50% of stream surface shaded. Trees, other overhead vegetation acattered or in occasional dumps. Overhead canopy thin, discontinuous.	0-25% of stream surface shaded, Riparian vegetation, low treet, other overment vegetation essentially absent.	FISH HABITAT: 1) (U/ (3-19) Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation 1 abundant and evenly dispersed.	Moderate diversity and abundance of instrem national and on continuous series of the habitat types listed below present in moderate quantities). Use diversity and abundance of instrem habitat (only one or two of the habitat types present or the continuous. Our series and discontinuous.	The same transfer that the same and the same transfer that the same

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Lagrand to AV. 2

FISH PASSAGE BARRIERS:	: BARRIEI	. 33:		DIRECT	NSCHAF	DIRECT DISCHARGE TO STREAM:	TREAM:		48. Substrate Composition, Percentige of Cover	settöri, Percentige	-
Type: RM:	Helght:		Pool Depth Langth to Negotlate:	Type:	ROME	LB/RB:	Stre: (Dia/W-D)	instream Effects:	1 Bedrock	*	
		,		Lawn.		RB	د"	ORGANIC OCCUM.	2 Boulders (>3)	*	
				>	r				3 Cobble (3" - 3")	*	
			-						4 Gravel (0.1"-3")	37	
									9 Sand (<0.1")	* 51	
	i		,				-		Sir	\$ QF	
·									A Chay	. 57	
									(Measurements at diameter)	is at diameter)	
Felb 37	Culvert 38		Dem 39						49. CHANNEL CI	49. CHANNEL CHARACTERISTICS	
Debris 40	Beaver	Dem 41	-						1 Width 2 Depth 1 Width 2 Depth	1 Width 2 Depth	
				Type: Tributary 42	ary 42	Ppe/Cu	Pipe/Culvert 43 Se	Seepe/Springs 46	77 1 17		
GENERAL COMMENTS:	NTS:	į		Grass	Grass-fined Swale 44	2 0	Ditch 46		را <u>- ا</u>		
O. Stream 81. Surve	eth Recklants:	vey	Jago	Effects: A.N	lone B. Ch	narmel/Bank	Erosion C.Sed De	Effects: A.None B. Charmel/Bank Erosion C.Sed Deposition D.Polluted			
				RECENT IN	PACTS TO	STREAMS	RECENT IMPACTS TO STREAMSIDE CORRIDOR:			· · ·	
			-	H.	To To	Prox to Streem: <30 >30:	Length	Cause:			
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		•									
	•				K.	CONT					
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									Channel cro	Channel cross-section:	
					,	٠.			> >)	N N N	
				47. Total	[otal	o B Landscapho		C. Other Construction Activity	•		
5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1				D. Lan	D. Land Use Change		-)	١
1 9 0 7 0 J								,			

. CHANNEL CAPACITY 5'	Inadequate, Channel subject to severe eroeion—channel may be widening or migrat	2 sectiment (esp. the sectiment) accumulation behind instrument obstruction and/or occasional evidence of overbank flows. (High water mark observed outside of channel.)	•		Stream flows through or adjacent to merst/wedend area. Overbank nows natural, common.		Benk protection material common (26-50% of bankine) and/or much of natural streambank configuration aliered. 1.90 3.00 3.00 0.00 0.00 0.00 0.00 0.00 0	of the family and the family family protection material present (<10% of bankline). Streambank almost entirely in the family fam		28-50% etreembanis receiving major attentions. As much as 50% broken down or eroding. Root mat overstange and eloughing evident.	10-25% of streambank receiving minor-moderate eiteration. At least 75% of stream bank in natural, a stable condition.	Streambanks stable or only alightly altered. Bank protection material—natural, armost or combination of both, infrequent raw banks—less than 10% of streambank being attered.	¥2		Substitute consists of covered by send, day or organic mich who as or graved to the mich.	NSPARENCY/COLOR: Transparent, bottom of channel is visible. Oh04, 11, 142.0	Opeque or white fike, bottom of chennel may be visible. Light to dark brown; visible perticulate matter present. Bottom of channel not visible.	2 TAN 3. GREEN 4. OIL SHEEN C	34. ODOR NAT. Talmel weste or manure.	OTHER CHEMICAL 3.	36. TRASH WAS	1 Uter in stream: carra, bottlee, yand debra, logging or fand dearing debra- no eujacent to chamine. 2 Thee, carra, applances, fill material—in or adjacent to channel.	Deed/decaying animals or fish. Concentrated church site concentrated church an artistral at 1 NORGANIC	CIAL CASES PRESENT	2 Snag poolest found at 5 Floating metertal 5 Wetlands at	
Pichures # 4: 5 APPENDIX V	ENT SURVEY FORI 2. DATE(<u>r</u>	TEAM NAME: Caches	HOUTARY TO: Read Culvert & Pris Site. Pour Placement Cut erroded touch	NED: 6 TO 7		1 2 3 4 ENTHOS (Bottom Dwelling Animals) 1 2 3 4	12.8 1:30 WA	SUBJOHNMAN 14.8 17	sy/Street) 6. Gulfivered field 9. Industrial/Comitivities	CGETATIVE BANK COVERS: - Cover 100's de treambank suitece covered by vegetation in vigorous condition. Any bare or specially, - Cover 100's de treambank suitece covered by vegetation in vigorous condition. Any bare or specially.	vergence of the projection from erosion. 78,90% of streambank surface covered by vegetalign, few open areas with	 evident, Less dense, deep root mat inferred. Minor érosion of streambank suitable possible. en root no de management en de management per vanatation. Bank or source/vegetated stream set evident. 	DV/3% or suremount advantages of the project of the	-50% of stream bank surface covered by vegetation. Many bare or spensely vegetated sires. Obvious. Poor, discontinuous, shallow not mat inferred. Vegetation provides streambank surface fibe protection from erosion.	WIDTH OF VEGETATIVE COVER FIGHT Benk 19.5(1) feet OUTSIDE OF CHANNEL: Left Benk 20.2./2/2. feet	VEGETATION TYPES: DOMINANT 21.2, SUBDOMINANT 224, OTHERS PRESENT 21.2, 1. GRASSES 2. SHRUBS 3. BLK BRY BUSHES 4. THEES 5. OTHER KULD /G. ALC. D/2	VERHEAD CANOPY:	Centory evenly depended and small (larger/slightly larger than the space resulting from loss of mature individual).	31-75% of stream surface shaded. Trees, other overhead vegetation evenly depend along strigenthemic (openings in canopy larger than space resulting from the loss of several mature brandelists.	28-50% of streem surface shaded. Trees, other overhead vegetation scattered or in occasional dumps. Overhead canopy thin, decontinuous.	O-25% of stream surface shaded, Riparian vegetation, low bees, other overhead vegetation essentially absent.	SH HABITAT: NO holowart (Flow) His most of year	 Yery diversite and complex instream habitat, instream cover and one overnarying regression. abundant and eventy depended. Abundant and eventy and abundance of instream habitat and/or low overhanging vegetation (at least 3 in Moderate diversity and abundance or instream habitat and/or low overhanging vegetation (at least 3. 	c) the habital types listed below present in moderale quantities). Υ (μ.) 1000.5 (01 1000.5) (1000	Amost no diversity or abundance of instream habbar (at most, one of the habbar types present). Amost no diversity or abundance of instream habbar (at most, one of the habbar types present). Instream cover and/or low overhanding vegetation essentially absent. Instrument of the habbar types of the property of the pr	FISH COVER TYPES: DOMINANT 28, Le SUBDOMINANT 27, L. OTHERS PRESENT 24, L.

48. Substrate Composition, Percharige of Cover	Media:	Ţ,	3 Cobble (3" - 3) %	4 Gravel (0.1"-3") 30 %	8 Sand (<0.1") %	Service Servic	Z Clay	(Measurements at diameter)	49, CHANNEL CHARACTERISTICS	1 Width 2 Depth 1 Width 2 Depth	5' Deep Chancel	D Revive										Channel cross section:			•
	Instreem Effects:	Lockson 2)	,							Seepe/Springs 46_	 position D.Pollu			Cause						,			C. Other Construction Activity	
TREAM:	Stee: (Dla/W-D)	12, 2	-								1	Grass-lined Swale 44 Ditch 48 Discher A None B. Charmel/Bank Erosion C. Sed Deposition D. Polluted		RECENT MIPACTS TO STREAMSIDE CORRIDOR:	Length									B. Landscaping C. Other	
DIRECT DISCHARGE TO STREAM:	LB/RB:	8B									Pee/Cu	Grass-lined Swale 44		TO STREAMS	Prox to Streem: <30 >30:		•								
DISCH.	ä										rtary 42	S-Ened S	1	IPACT8	Ğ.						,			Fotes A. Clearing/Grading D. Land Use Change	
DIRECT	Type:										Type: Tributary 42,	Gras Effects: A	-	RÉCENTR	High.			•						47. Total A.Cle D.Lar	- - -
	Pool Depth Length to Negotlate:								Dam 39	i			frer .												
. <u>.</u>	Pool Depth	`							٥	Beaver Dam 41			53. Offe			٠				•	•		-		
ARRIEF	Height								Culvert 38	Beaver	,	51. Survey	Residents												
FISH PASSAGE BARRIERS:	ä		-								Acres of Connecting.	L COMMEN	52. Communication with Residents:									0			V 9 0
FISH P	Ę								Falls 37	Debris 40		50. Stream	52, Comm	<u> </u>	,			-							1033



APPENDIA V AN CORRIDOR ASSESSMENT SURVEY FOI	CHANNEL CAPACITY The dequate, Channel subject to severe erosion—channel may be widening or migrats
STREAM # B 2	_
STREAM NAME: BURNES A. SURVEYORS: JPM	Appears to barrely contrain present peak flows. Flows creating noticeable enterior. Considerable sediment (sep. fine sediment) accumulating behind interest obstruction and/or occasional evidence.
	_
SURVEY ENTRY/EXIT POINTS:	Legislan at autourves and constructions. Existings of overceins from the (e.g., section) bent, Debris suspended or deposited on bank vegetation; bank vegetation; maided down).
PRVER MILES SURVEYED: 6 TO 7 NONE	\boxtimes Appears able to contain present peak flows. Flows pattern with Ritle cutting, deposition or other evidence of bank detectoration. $\bigcup_{n\in L(n)} c_n c_{n,n} c_n$
ABUNDANCE OF: ABUNDANT COMMON FEW OBSERVED INSTREMA PLANTS [2] [3] [4]	Stream flows through or adjacent to meral/westland area. Overbank flows natural, common. L.S. Noture, Noture, reducting Cleusing cutting banks
	Ξ_
Animada)	the strength are accounted to the strength of
	2 Berry protection material continon (20-00% of Centum) and the confidence of th
LAND USE ADJACENT TO STREAM (#: *) DOMINANT 12.# 14. (*) COURT 14.# 17	[
7. Residential scattered 8. Residential confinuos	national state.
sy/Street) 6. Cultivated field 9. Industrial/Commercial	Stretchmodern Street, 1. Streetmonth's being severely aftered, Lees than 50% of streembank in stable condition. Over 50% of
BETATIVE BANK COVEH: Over 90% of streambank auriace covered by vegetation in vigorous condition, Any bare or sparsely	
[2] vegeteted avea are small and evenly dispersed. A deep, dense not mall is limited. Stream think though surface protection from evolun. Etoda & Side of makendlak shows in pact - makendlak shows in pact - makendlak] [
50-75% of streamberk surface covered by vegetation. Bere or spensely vegetated areas are evident., Somewhat shallow and discontinuous root mat inferred. Vegetative cover provides limited profection.	combination of both, infrequent raw banks—less than 10% of streembank being attered.
_	
450% of stream bank surface covered by vagetation. Many bare or specially vagetation areas 4 dovetour. Poor, decordinations, shallow root mat inferred. Vagetation provides streambank surface little protection from erosion.	
WIDTH OF VEGETATIVE COVER FIght Bank 18, 20, 31 feet 10 Rout 10 COUTSIDE OF CHANNEL.	Social and apply provided in the control of the con
TZ1.2 SUBDOMNANT ZZ.	_ 5
S. OTHER	Transparent bottom of channel is visible, Light Brown
m _	Opeque Light to
 can by a searly dispersed and small (introcribightly larger than the space resulting from loss or mature individual). 	[4] 1. RED Z IAN 3. GREEN 4. OL SREEN CON COM
S1-79% of stream surface shaded. Trees, other overhead vegestion eventy dispensed along streams and streams are streams and streams and streams are streams and streams and streams and streams are streams and streams and streams are streams and streams and streams are streams and streams and streams are streams and streams and streams are streams and streams and streams are streams and streams and streams are streams and streams and streams are streams and streams are streams and streams are streams and streams are streams and streams are streams and st	ODOR 가사 [편] Asimal menta per manura
26-50% stream surface shaded. Trees, other overhead vegetation scattered or in occasional and intermed parameters than discontinuous.	b.
	TRASH TRASH
. =	Liter in streem: care, bottles, yard debris, logging or land dearing debris—in or adjacent to chaminal. y Three, care, appliances, fill material—in or adjacent to channel.
Very diverse and complex instream habitat. Instream cover and or low overnanging vegeration [1] abundant and evenly depended.	Dead/decaying animals or fish. Concentrated climb she contains
2	
Little diversity and abundance of instream habitat (only one or two of the habitat types present or 34. 3 predominant, instream cover landor low overhanging vegetation sparse and decontinuous.	SPECIAL CASES PRESENT [4] Water withdrawal (pump/ditch) at [7] Farm animals in stream at
Ahmost no diversity or abundance of instreem habbar (at most, one of the habbar types present). A instream cover and/or low overhanging to wegetation essentially absent.	Snag pockets found at
HISH COVER LITES: DOMINANI ZB. CL. SUBBOTH ST. U. C. S. S. O. S. S. O. S. S. S. S. S. S. S. S. S. S. S. S. S.	1. ALGAL MATS 2. ABUNDANT SUDS 3. TRASH 4. OTHER

Pidures 7,8,9

FISH PASSAGE BARRIERS: ୪୦୯୨	AGE B	ARRIER	13: No.9	•	DIRECT D	ISCHAR	GE TO S	DIRECT DISCHARGE TO STREAM: $\lambda_{\mathcal{D}^{1}, \alpha}$	7	48. Substrate Composition, Percentage of Cover
ieq(t	ä	Hetght		Pool Depth Length to Negotiate:	Type:	13	LB/RB:	Stre: (Dia/N-D)	hatreem Effects:	1 Bedrock
										2 Boulders (>3) % 5 Cobble (3" - 3') (4/) %
	: .			· · · · · · · · · · · · · · · · · · ·						4 Gravel (0.1"-3") 20 %
										8 Sand (<0.17) %
						<u> </u>				(Messurements at diameter)
Falls 37		Culturat 38		Dem 39						49, CHANNEL CHARACTERISTICS
Debris 40		Beaver	Beever Dam 41							1 Width 2 Depth 1 Width 2 Depth
					Type: Tributary 42,	3 2	Perce		Seepe/Springs 46	1~ 9
GENERAL COMMENTS:	OMNENI	51. Survey			Grass Effects: A.N	Grass-Ined Swale 44, it A.None B. Channel	e 44 anne/Bank	Grass-lined Swale 44 Dich 45 Effects: A.None B. Charme/Bank Erosion C.8ed Deposition D.Polluted	osition D.Polituted	by 10% 100m of meander 100m
2. Communication with Residents:	atton with	Residents			RECENT IM	ACTS TO	STREAMS	RECENT IMPACTS TO STREAMSIDE CORRIDOR:		م المؤوية
			,		RIK.	Prox to	Prox to Streem: <30 >30:	Length	Cause:	
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							" " Land	CONTOGA,		
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						28	5 2 2	<i>i</i> 3	or HUBBINI	
a •								ndow.	L	Channel cross-section:
					47. Total		1 1			
	= >				A. Clean D. Land	A. Clearing/Grading D. Land Use Change	_	B. Landscaping G. Other	C. Other Construction Activity	
	<u>-</u>				,					



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-xternsh.	deposits of sediment present and/or evidence of overbank flows common. (high water mark observed outside of channel.)	Appears to benely contain present peek flows. Flows creating totocheable endelon. Considerable sediment (eap, file sediment) accumulating behind instream obstruction and/or occasional endence of overbank flows. (High water mark observed outside of channel.)	Appears adequate to contain most peak flows. Flows may be creating minor ben't and substitute erosion at outsurves and constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank. Denk. Debnis suspended or deposited on bank vegetation; bank vegetation maited down).	r other	É	-ICIAL BANK PHOTECTION: terasive attentions of bank protection material present (>50% of bankline) and/or majority of natural streambank conflouration affect.	ŧ	Occasional stretches of bank protection material present (10-25% of bankline). Streambanks mostly in returns table. In returns table. I has I any bank protection material present (<10% of bankline). Streambank almost entirely in	2087	communications by a second particle of overheads and aloughing frequent. 26-50% streembanks receiving major alterations. As much as 50% broken down or eroding. Rook	met overhangs and stoughing evident. 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural.										SH 50ND CONS ! DIANKS No! MUCH CONSIGE! IN			£ #		
Thoras.	h water m	n. Consider roccession	ank and a sediment sed down	Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other evidence of bank deterioration.	Stream flows through or adjacent to mareh/weitend area. Overbank flows natural, common	Vor major	Bark protection material common (26-50% of bankline) and/or much of natural streambank configuration aftered.	Occasional stretches of bank protection material present (10-25% of bankine). Streembanks mile in returns state. In the protection material present (<10% of bankine). Streembank almost entirely in	oodston.	m or erod	earn bers	stable condition. Seamberles table or only alightly altered. Bank protection material—natural, artificial or sometiments at table or the infrariant may benke—less than 10% of streambenk being altered.	,		Substrate tightly packed/cemented. Substrate amount to distorge with rooming, way incrows bedrock or hardpan. Substrate consists offcovered by sand, day or organic muck.		4		ter.		S g g			Water withdrawel (pump/ditch) at. Floating materiel		
enhaorn	non. (hlg	ole eroelo on end/o	minor be are (e.g., adon met	utting, de	ows netur	kline) end	of natural	xenkline). ambank a	z elder	equent. aken daw	75% of str	neturel,		rith boot h	the second		1		plant met	1	ider.			Idrawal (F	E	
ev be wid	OWN COTTY	g noticeer coestructi nnet.)	e creating ik flows ra ank veget	E PERSON	erbank fir	% of bend	or much o	-25% of t		ughing fra ss 50% br	At least 7	material X streamt		Substrate kose assortment easily moved with boot heel. Substrate moderately packed/cemented. Substrate difficult to move with boot heel.	ر د مو توء ه سم		1	Light to dark brown; visible perdulate matter present, bought or cleaning may serve. 1. RED 2. TAN 3. GREEN 4. Oil. SHEEN Other colons	Jecaying	Septe or human waste, Dute, (1.75 Super Area or 1. SULFURIC 2 OTHER CHEMICAL 3. PETROLEUM	S/OS/	٠ - <u>ن</u>		Neter with Noeting m	CARRELL MATS 2 ABUNDANT SUDS 3. TRASH 4. OTHER	
A learned	/erbenk fi	re creeting I instrum ide of cha	are may by M overber etation; by	pattern w		sent (>50	ilne) and	resent (10 K of bankl	,	s and sto	ateration.	rotection van 10% o		t heel.	oun to dist		ible.	Other colors	•		Spend P	t to chann			₹	
o miss	6 to 1	ows. Flowing behind ryed outs	Joee Flor Vidence of Denk veg	rs. Flows	h/wetland	Merial pre	% of bank	naterial present (<10)	Ş	overhang srations./	oderate s	d. Berrk p		Substrate	arge of organ		may be vi	HEEN	٠	STREET, STREET	not no	radjacent	2. INORGANIC		Sans	
a evene	d/or evid	nt peak fi ccumulati nark obs	oet peak f uctions. E oetted on l	peak flor	at to mars	tection ma	on (28-50	otection n		Felture of mejor at	vidént. g minor-m	htly altere		illy moved emented.	ned. Sube y sand, d	i vieble	channel	enk brown; visible perficulate matter pre 2. Tan 3. Green 4. Oil Sheen	•	75年 28.28 36.38	AKS	i i			UNDANT	
es training	a tueseuc	diment)	contain m and constra ed or dep	in present rionation.	or adjace	CINON: 'benk po Bonellere	tal comm	of beank pr		eroding.	oughing e k receivin	r only allg	TION:	tment est packed/c	ed/cemen covered b	: Y chennel	bottom of	BEDIO PER GREEN	ě	2 OTH	· Dla	A THE TIME.	ntrated dump site contains 1. ORGANIC MATERIAL	# E E •	2 2 AB	
	annet.)	erely con p. fine se fows. (H)	querie to carriera	to conta	through	(PROTE) retches of configural	fon mater	tretches Ke.	TABILITY	broken or embenka	gs and st reamban	ion. e stable o of both is	Aguos	ose sesor oderately	arther. arther. ansists of	ACOLOR:	this inc.	brown; v	e or ment	men wast	Cars	applance ing anim	d dump a	PRESENTE TO STREET	GAL MA	
CHANNEL CAPACIT	side of ch	peers to b Smerit (ea verbenk)	peers ade sion at ou it. Debris	Appears able to contain present evidence of bank deterioration.	eem flown	ARTHFICIAL BANK PROTECTION: Extensive stretches of bank protect resembank confountion altered.	Bank protection mate configuration eltered.	Occasional stre in natural state.	4 netural state. STREAMBANK STABILITY:	sox stre	toverhan 25% of a	stable condition. Streambanks str combination of b	SUBSTRATE CONSOLIDATION:	Substrate loose assortment easily moved with boot heel. Substrate moderately packed/comented. Substrate diffici	Substrate tightly packed/cemented. Substrate dimout to dest bedrock or hardpan. Substrate consists of/covered by eard, day or organic muck	TRANSPARENCY/COLOR: 17 Tenement bottom of channel is visible.	Opeque or white like, bottom of channel may be visible.	Light to dark 1. RED 2.	R Animal weeks or manure.	pdc or 社	Son	Tines, cars, appliances, fill meterial—in or adjacent to channel. Dead/decaying animals of fielt.	Concentrated dump site contains 1. ORGANIC MATERIAL	SPECIAL CASES PRESENT 1 Farm entmals in stream at	Wedands at	
	-	₽¥ĕ	₹\$B	₹ ₹	& ™		8 %		STREAM			8 8 8 ≥ [-	SUBST	8 8 2	323 -	4	: 8 ∃⊡	3° + •••	900		HASH [გ [⊒		§ ¥ N••	
•						ଞ	٠ -	73 g -2 g	ار الله الله الله الله الله الله الله ال		•		ģ		Par) g			ਲੱ		ĸ			8		
•	335	1			`			*** 1001 1001 1001		*		_	LOH:	2 2	80	1.1	SANK	e in					60 E		. 9	
	Marks 2 20t 194	ļ		SNE SNE	OBSERVED	निर		2	18 E	Car Speri	Vegetated areas are stress covered. A deep, dense roof may be seried. Stress the vegetated areas are stress and series of the series protection from erosion. The ACC 40 CONDUCTATE (1921, 1931, 1931)	78-90%, of streambank surface covered by vegetation. Few open areas with unatable vegetation evident. Less dense, deep not mat inferred, Minor enation of streambank surface possible.	50-75%, of streambank surface covered by vegetation. Sere or sparsely vegetal as a series as a series is somewhat shallow and discontinuous root mai inferred. Vegetative cover provides limited profestion from eneign.	-50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated srees50% of stream bank surface covered by vegetation. Many bare or sparsely vegetated streambank surface fittle devices.	20 > 300 free New 5 1/27 road	1.15 SUBDOMNANT 22, 2 OTHERS PRESENT 23, 3Y BUSHES 4, TREES 5, OTHER	Bilthring along bank	76-100% of stream surface shaded by these or overgrown with prissees, shrubs, brush. Openings in carcay evenly depended and small (larger/slightly larger than the space resulting from loss of mature inchidate). Life, Should.	along	centional		getation	modificant entering responsibilities of instream habitat and/or low overhanging vegetation (at least 3 Moderate diversity and abundance of instream habitat present in moderate quantities).	Little diversity and abundance of instream habbat (only one or two of the habbat types present or predominant), instream cover and/or low overhanging vegetation sparse and decontinuous. Amoust no diversity or abundance of instream habbat (at most, one of the habbat types present).	COTHERS PRESENT 24 (O	; !
2	12	M		2	8 17	خيالت	نــاا		Resident Resident Industrial	7. Agy 54.	S Pales	reteble rince pos	wides Im	vegetated	ξς Υ	ERS PR	ر کر هر	be, brush iding from	dispersed several n	e or	Con Des	v guign	eqeden 61	fact types decontin	S PRESE	i
EV FOR	DATE	8			<u></u>		0	444	てほる	og Go	100 X	The with	cover pr	sparsely provides	(S S	사 의 대표	ななる	see, shru pace ree	n evenly se loss of	n scatter	ner Over	how overhanging vegetation	verhangi	A the had of the had	SOTATE PARTY	1
VALUE	7	SURVEYORS: JPM			COMMON	N N		DOMINANT SUBDOMINANT OTHERS PRESENT	unfenced fenced ffield	vloorous	2	a coor	ogetative	y bere or egetation	6 8 6 V	ANT 22,	/smo	with gree than the s	51-75%, of stream surface shaded. Trees, other overhead vegetation eventy deperted elong streambank (openings in cancry) larger than space resulting from the loss of several mature "Advinces".	28-50% of stream surface shaded. Trees, other overhead vegetation acattered or in occasional clumps. Overhead canopy thin, decontinuous.	0-25% of streem surface shaded. Riparian vegetation, low trees, other overnead vegetation essentially absent.	er eend/or (d'or low o	se or thro petation sy nost, one	If instream cover and/or low overhanging vegetation essentially absent. FISH COVER TYPES: DOMINIANT 28 SUBDOMINANT 270	,
PENDIX V		4		j	8—			MAINANT IBDOMIN THERS P	Pasture—unfence Pasture—fenced Cultivated field	oetetion i	6 3 5 5	tetton. Fe	ration. Sa inferred. V	idon. Mar iferred. V	Bert Fr	VEGETATION TYPES: DOMINANT 21. SUBDOMINANT 22. P. GRASSES 2 SHRUBS 3. BLK BRY BUSHES 4. THEES θ	zcidu z	vergrown thy larger	overhead ace result	overheed	endon, G	HABITAT: Very diverse and complex hetreem habitat. Instream cover and/or	abbitat an erate quer	at (only or enging ver eothet (et :	FISH COVER TYPES: DOWNANT 26. SUBDOMINANT 27.	, 2
APPEN BASSI		1	1	7 2	ABUNDANT][ದೆದ್ ನ	ev ye	4 5 5	A P	d by verification	by vegeta root met i	Right Benk Left Benk	2. පි පි. පු. කු. කු.	A A	trees or c	es, other r than sp	es, other druous.	ey refr	Offset, Inst	netreem! it in mode	an habh w overhu stream h		4.00
October				!	YB4	Î		REAM (#	E ()		77	of met life	e covere	shellow	VER	BLK BI	ર્ષ્ટ ક	amed by	aded. Tre opy large	aded, Tre n, discon	sed. Rips	er meet	sence of 1	of instra and/or k	MANT 26	252
) N V IO	STREAM & DES MOUNT	DM-B	SINTS	9		SUMES BENTHOS (Bottom Dwelling Animals)	3	LAND USE ADJACENT TO STREAM (#; %)	Forest or neitural vegetation Park or golf course Roadside (Highwey/Street)		STREET BETT	ink surfac , deep ro:	nk surfac ind disco	k surface ndnuous,	WIDTH OF VEGETATIVE COVER OUTSIDE OF CHANNEL:	VEGETATION TYPES: DOMINANT 21	ဝ	authore at	uface sha gs in cen	urface sha anopy thi	face she	mplex he	nd abundistad	bundanci am cover or abunda	or fow ow S: DOM	35.5
AGIG	M S	- 1		URVEYE	F. STS		E/ADUL1	NDJACE	et or nett or god o telde (H	ANK CO	reston fr	streembers as dense	etreemb shallows	ream ben bor, disco	VEGET OF CHAI	ON TYP	NOP.	15 P	k (openir	streems remende	treem su sheert.	oo pue es	Swersty set types	sky and a nt). Instru	over and ER TYPE	2 2
	() **	STREAM NAME:	TRIBUTARY TO:	RIVER MILES SURVEYED:	ABUNDANCE OF: INSTREAM PLANTS	S DS	FISH (JUVENILE/ADULTS):	ND USE		VEGETATIVE BANK COVER:	o operation	8-90% of vident. Le	Somewhat at The manufact of The manufact	50% of st bylous. P	ADTH OF CITSIDE	EGETAT GRASS	OVERHEAD CANOPY:	6-100% of	51-75% of a streambank indictuals)	6-50% of lumps. O	-25% of a ceentally	HABITAT: Very dive	the hab	Me diver	National Cov	200
	, STREA	STREA	TRIBU	PEVER	ABUNE	SLIMES	¥	3	∸. બ સ	VEGET	>		 ≅91	V 8	a. ≠0	> +-	Ser Pro		₩. #.	פא : •		E X				-1

48. Substrate Competition, Perbindige of Cover	1 Bedrock	2 Boutders (>3) 15 %	3 Cobble (3"-3) A .*	4 Gravel (0.1"-3") /5 %	s Sand (<0.17)	#S -	7 Chay /Hadpan Some areas x	(Neasurements at dameter)	49. CHANNEL CHARACTERISTICS	1 Width 2 Depth 1 Width 2 Depth	10, 2, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,		7 T 1 1/2 W	TO TO THE	5(000)	o ont					Channel cross-section:) 		
	Instruern Effoots:										Seepa/Springs 46		ceition D.Polluted		Cause:								C. Other Construction Activity	
STREAM:	Stree: (Dla/W-D)										Pipe/Culvert 43 Ser	Ditch 46	Effects: A.None B. Channel/Bank Erosion C.Sed Deposition D.Polluted	SIDE CORRIDOR:	Length		01.5 500						B. Landscaping C. Other	
DIRECT DISCHARGE TO STREAM:	RM: LB/RB:		·.	· · · · · · · · · · · · · · · · · · ·				<u> </u>				Grass-lined Swale 44	one B. Channel/Ban	RECENT IMPACTS TO STREAMSIDE CORRIDOR:	Prox to Stream: <30 >30:		Maintenance road tollows 5.10 From R.B						Total A. Clearing/Grading B. Lan	
DIRECTO	Type:										Type: Tributary 42	Grass-	Elects: A.N.	RECENT IMP	ä		Man lena Fr						47. Total A. Clear	. card
	Pool Depth Length to Negotlate:								Dam 39				1											
FISH PASSAGE BARRIERS: None	Pool Depth								0	Beaver Dam 41		>	S C E						•	•				
BARRIER	Helght:								Culver 36	Beaver		NTS: At Survey	out ordered	RII Descent										
ASSAGE	ä											GENERAL COMMENTS:		Idracalion w									3141	Y 0 0
FISH P	i di								Felb 37	Debris 6		GENERAL (DO. October										113111610	E C O L

CHANNEL CAPACITY Inadequate, Charnel subject to severe erosion—channel may be widening or migrate,cxtensive	_	Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate areason at outsurves and constructions. Evidence of overbank flows rate (e.g., sediment deposited on bank, Debris suspended or deposited on bank vegetation; bank vegetation; and provided flown).	Appears able to contain present peak flows. Flows pattern with fittle criting, deposition or other and evident detectionality and account of the control of	• §	- ~	₹] ह [1 streambank broken or ending. Failure of overhangs and sloughing frequent. 2 26-50% streambanks neceiving major attentions. As much as 50% broken down or eroding. Root and overhangs and sloughing evident.	10-29% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition. Streambanks stable or only slightly shared. Bank protection material—natural, artificial or Streambanks arbitrated or only shared. Bank protection material—natural, artificial or Streambanks have a combination of both, infrection traw between less than 10% of streambank beling attented.	3 \$	Substrate loose assortment easily moved with boot heet. Substrate moderately packed/cemented. Substrate difficult to move with boot heet. Substrate tightly packed/cemented. Substrate difficult to dislodge with kicking. May include areas of bedrock or harden.	33. TRANSPARENCY/COLOR: [X] Transparent, bottom of chennel is viable. Bown.	34, ODOR	OTHER CHEMICAL 3. PI	38. TRASHALING.	Africa) care, appliances, fill material—in or adjacent to channel. Dead/decaying animals or fieth.	Concentrated dump site contains 1. ORGANIC MATERIAL 2. INORGANIC	38. SPECIAL CASES PRESENT 1 Farm animals in stream at		
APPENDIX V N CORRIDOR ASSESSMENT SURVEY FORM	_	™	NONE NOME COMPANY COMP	S S S	SS (Bottom Develling Animals) 1 2 3 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	 1. Forest or natural vegetation 4. Pasture—unfenced 7. Residential—continuous 31. STREAN 2. Park or golf course 6. Pasture—fenced 8. Residential—continuous 31. STREAN 3. Roadside (Highway/Street) 6. Cultivated field 9. Industrial/Commercial 7. Stream 2. Roadside (Highway/Street) 6. Cultivated field 9. Industrial/Commercial 7. Stream 2. Procedure 1. Stream 2. Strea		sea with unstable vegetation 3 bank surface possible.	i i	In bank surface covered by vagebation. Many bare or sparsely vegetated areas of decontinuous, shallow root mat inferred. Vegetation provides streambank surface fittie of experimental and the streambank surface fittie of experimental and the streambank surface fittie of the streambank surface fittie of the surface of the streambank surface fitties of the surface fi	TT 21. H SUBDOMINANT 22. H SUBJOHENS PRESENT 22. 33. TRANK K BRY BUSHES (* TIPEES 6. OTHER TX	 8 8		, other overhead vegetation 35. TRA		₽	# #	F 57	(1) HOCKS (2) LOGS (3) BOOT WADS (4) DEBHIS 5. UNDERFOUR BANK OF BANK

48. Substrate Composition, Percentings of Cover	1 Bedrook	Boulders (>3') // Cobble (3" – 3') //	4 Gravel (0.1"—3")	1 Sir (10%	(Measurements at dismeter)	49. CHANNEL CHARACTERISTICS	1 Whath 2 Depth 1 Whath 2 Depth	151-9		A-fu good pools	Fernen by leps	١٥٥٨			***
DIRECT DISCHARGE TO STREAM:		KB	MADECA 1961 RB 841"					Type: Tributary 42 PherCulvert 43 Seepa/Springs 46 Obch 45	/Bank En	RECENT IMPACTS TO STREAMSIDE CORRIDOR:	Hill: Prox to Streem: Length Ceuse:	Right Hill 1 acut set 30 k		47. Total A. Ciearing/Grading B. Landscaping C. Other Construction Activity D. Land Use Change	
FISH PASSAGE BARRIERS:	Type: RM: Height: Pool Depth Langth to Negotlate:	40 199 3 NOW < 10 1				Falls 37 Culvert 38 Dam 39	Debris 40 Beaver Dam 41	COMMENTS	80. Stream 51. Survey 63. Other					7 J J J J J J J J J J J J J J J J J J J	

. CHANNEL CAPACITY Change subject to severe erosion—channel may be widening or migratecatensive 1 Interpreted to severe erosion—channel flows common, (high water mark observed 1		2	Appears adequate to contain most peak flows. Flows may be creating minor bank and substrate areason at outcurves and constructions. Evidence of eventrank flows rare (e.g., sediment deposited on bank vegetation; bank vegetation maited down).	NONE Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other NONE		30. ARTIFICIAL BANK PROTECTION: [4] Extensive stretches of bank protection material present (>50% of bankline) and/or majority of natural [4] Extensive anti-provident protection material present (>50% of bankline) and/or majority of natural [4]	×	·	Residential ecutions 31. STREAMBANK STABILITY: NOVE (10/100 delined channel to be t	+ 2	:	# Fi	<u> </u>	# [(2) Opeque or white like, bottom of channel may be 13. Light to dark brown; visible particular matter pre	scenedating from loss of mature 4 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Unier colors evenly dispersed along	Alimal waste or menure.	v,	getation (at least 3 Concentrated dump as the combant (at least 3 Laborated dump as the combant of the companies of the compa	1. OHGANIC MATERIAL
APPENDIX V DRRIDOR ASSESSMENT SURVI	STREAM#Z_M	STREAM NAME: Das MOLADS. 4. SURVEYORS:	TRIBUTARY TO:	RIVER MILES SURVEYED: 6 TO 7	ABUNDANCE OF: ABUNDANT COMMON FEW [1] [2] [3] INSTREAM PLANTS][]	LAND USE ADJACENT TO STREAM (#; %) DOMINANT 12.# 3 SUBDOMINANT 13.# 0THERS PRESENT 14.#	₹ €6	VEGETATIVE BANK COVER: VEGETATIVE BANK COVER: VEGETATIVE BANK COVERS:	J. evident, Leas dense, deep root mat merred, winnor enourn or sursern 50-79% of streambenk surface covered by vegetation. Bare or spare Somewhat shallow and decontinuous root mat inferred. Vegetative of	from erosion. 777, 50% of stream bank surface covered by vegetation. Many bare or spansely vegetated srees. 777, 50% of stream bank surface covered by vegetation. Many bare or spansely vegetated srees.	WIDTH OF VEGETATIVE COVER Right Bank 19, 5 - 10 feet OUTSIDE OF CHANNEL Left Bank 20, 5 - 1 Ofest	OMEN.	` □ -] canopy evenly depended and small (largen's lightly larger than the spot individual). 1575% of streem surisce shaded. Trees, other overhead vegetation	j streemtext (openings in canopy larger than abace fresunting from the individuals). individuals of streem surface shaded. Trees, other overhead vegetation	3 dumps. Overheed canopy thin, discontinuous. 0-25%, of stream surface sheded. Riperian vegetation, low trees, other overhee essentially absent.	 abundant and evenly dispersed. Moderate diversity and abundance of instream habitat and/or low overhanging vegetation (at least 3	

48. Subjects Composition, Percentings of Cover	m Effects:	2 Cobbe (3'-3') 30 ** 4 Gravel (0.1'-3') 60 **	Sin City (Measurements at chans	49, CHANNEL CHARACTERSTICS	1 Width 2 Depth 1 Width 1 Depth	10-15 25" (gresty			L D	2 2		19	ion Activity 1		
DIRECT DISCHARGE TO STREAM: No No						Type: Tributury 42 Pipe/Culvert 43 Seeper Springs 46 Grass fined Swale 44 Ditch 45	A.Norie B. Chemielderk Brosi MPACTS TO STREAMSDE	All Prox to Streem: Langth Co.	, Building structures located Ner and directly adjalent to Stream	1 For mos of the segment flave 15 vegethered - butter but it 15 narrow and adjacent to	y grass		47. Total A. Cleuring/Grading B. Landscaping C. Other Construction Activity D. Land Use Change		
AND FISH PASSAGE BARRIERS: None	Type: File: Height: Pool Depth Langth to Megatiste				Falls 37 Culvert 38 Dem 38	Confinerité	90. Stream 81. Communication with Residents: 83. Other			Transfer of the Control of the Contr				х 9 0 7 0 3 3	

Inadequate, Channel subject to savere erosion—channel may be widening or migrath,	4 Appliance of bank distance of the second	4 natural state. STREAMBANK STABILITY: Streambanks being severely aftered. Less than 50% of streambank in stable condition. Over 50% of streambank broken or eroding. Failure of overlarge and eloughing frequent. 2 25-50% streambanks receiving major afterations. As much as 50% broken down or eroding. Root a root overlarge and eloughing evident. 10-25% of streambank receiving minor-moderate alteration. At least 75% of stream bank in natural, stable condition. Streambanks stable or only slightly aftered. Bank protection meterial—natural, artificial or combination of both, infrequent raw banks—less than 10% of streambank being aftered. SUBSTRATE CONSOLIDATION: Root's: 'Cobb.Le.	Substrate loose assortment easity moved with boot heel. Substrate moderately packed/cemented. Substrate difficult to move with boot heel. Substrate againty packed/cemented. Substrate difficult to move with licking. May include areas of substrate admits the decide with licking. May include areas of bedrock or herapen. A Substrate consists of/covered by sand, day or organic muck. Transparent consists of/covered by sand, day or organic muck. Transparent bottom of channel is viable. A Cheegue or white Res, bottom of channel may be viable. Light to dark brown; viable particulate matter present. Bottom of channel not viable. 1. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors	m 512 m _	1. ORGANIC MATERIAL 2. INCHGANIC SPECIAL CASES PRESENT 1. Farm animals in stream of
	S. S. S. S. S. S. S. S. S. S. S. S. S. S	ਲ ਂ ਬੇ		ಕ ಕ	Ŕ
SURVEY FORM 2. DATE & 7. Secol 1994 INVEYORS: JOM H- (' wide	HEW OBSERVED SERVED	1. Forest or natural vegetation 4. Prasture—unfenced 7. Residential—continuous 2. Park or got course 5. Prasture—fenced 8. Residential—continuous 3. Roadside (Highwey/Street) 8. Cultivated field 9. Inchastral/Confinierdial>) ETATIVE BANK COVER: Over 90% of streambark surface covered by vegetation in vigorous condition. Any bare or sparriety vegetated areas are small and eventy dispersed. A deep, dense polymal layered. Sheamfhank vegetated areas are small and eventy dispersed. A deep, dense polymal layered. Sheamfhank 200.5 surface protection from eventy dispersed. A deep, dense polymal layered. Sheamfhank surface covered by vegetation. Few open areas with unstable vegetation evident. Less dense, deep noof mat inferred. Minor eveston of streamfhank surface possible. 80-75% of streambark surface covered by vegetation. Bare or sparsely vegetated areas are evident. Somewhat shallow and discontinuous roof mat inferred. Vegetative cover provides limited protection from ancient.	Software bonk surface covered by vegetation. Many bare or sparsely vegetated street devices obvious, protection from excellen. Fight Bank 18. 3 - 10 feet outside of continuous, shellow root mat inferred. Vegetation provides street-bank surface fittle protection from excellen. Fight Bank 18. 3 - 10 feet outside of channels. Software surface fittle of channels. Vegetation types, downwart 21. 2 suck bank as 2. 4 others present 22. 3 shrubs 3. 8 k bank bushes 4. Thees 8. Others of bank bank and of channels shaded by trees or overgrown with gresses, shrubs, brush. Opinings in 76-100% of streem surface shaded by trees or overgrown with gresses, shrubs, brush. Opinings in compagnersed and small (sarger/likelythy larger than the space resulting from loss of mature can open opinings in compagnersed.	regetation eventy dispersed along girom the loss of serveral mature regetation ecattered or in occasional trees, other overhead vegetation gend/or low overhanging vegetation (at least 3 for low overhanging vegetation (at least 3	of the habitat types present or sparse and discontinuous. of the habitat types present). ent. OTHERS PRESENT 28. LIT BANK 6. BANK VEG.
by shooly 3 hees a Assessment A su	ABUNDANT COMMON ABUNDANT COMMON ABUNDANNANT SUBDOMINANT OTHERS PRESENT	4. Pasture—unfenced S. Pasture—fenced C. Cultivated field Verand by vapatation in vigorous y dispersed. A diego. Genes in pact by vapatation. Few open afferred. Manor erosion of streamed by vapatation. Bare or specific for the proof mail inferred. Vapatation area of the page of the	w root mat inferred. Vegelands w root mat inferred. Vegelands Right Bank 18.20. 19.2. Subdownwart 20.2. 19.2. Subdownwart 20.2. 19.4. Not the ES. 19.4. Not the ES. 19.4. Not the ES. 19.4. Not the ES. 19.4. Not the ES. 19.4. Not the ES.	rees, other overhead vegetal ger than space resulting from rees, other overhead vegetal antituous. UARA PARES Instruent cover and of the seas, of the the seas, of the the seas, of the the seas, of t	ant in moderate quentities). usem habitat (only one or two two overhanding vegetation instream habitat (at most, on ing vegetation essentially state 28, 25 SUBDOMINANT 27. 29, 4. DEBRIS (6. U)
#13- Upsim of extrance tract by shally - 17- locking then tence appendix v RIPARIAN CORRIDOR ASSESSMENT S. STREAM NAME: Mc 20124 THBUTARY TO: S. SURVEY ENTRYREXT POINTS: Headwald S.	RIVER MILES SURVEYED: 6 ABUND ABUNDANCE OF: ABUND INSTREAM PLANTS 1 SLIMES BENTHOS (Bottom Dwelling Animals) 1 FISH (AUVENILE/ADULTS): 1 LAND USE ADJACENT TO STREAM (#: %)	1. Forest or natural vegetation 4. Presture—unferced 7. Residential—confinced 3. Park or gol course 5. Presture—fenced 8. Residential—confinced 3. Residential—confinced 9.	4 devices. Proc. deconfinuous, shelow root mat inferred. Vegetation properties from erosion. WIDTHOF VEGETATIVE COVER Right Bank 18.2-10 OUTSIDE OF CHANNEL. Left Bank 20.2-560 VEGETATION TYPES: DOMINANT 21.2. SUBDOMINANT 22.4 VEGETATION TYPES: DOMINANT 21.2. S	S1-75% of stream surface shaded. Trees, other overhead vegetation evenly dispersed along strandomy dispersed along a strandomy larger than space resulting from the loss of several mature hadvidusis). 26-50% of stream surface shaded. Trees, other overhead vegetation scattered or in occasional a clumps. Overhead canceys this, discontinuous. 4	of the habitat types lated below present in moderate quentities). Unit of which types lated below present in moderate quentities). Unit of which types lated below present in moderate quentities. Unit of which is the habitat types present or before the which types present or be moderate and discontinuous. Amont no ferratity or abundance of instream habitat (at most, one of the habitat types present). Instream cover and/or low overlanging vegetation essentially absent. FISH COVER TYPES: DOMINIANT 28. SUBDOMINANT 27. OTHERS PRESENT 28. FISH COVER TYPES: DOMINIANT 28. SUBDOMINANT 27. OTHERS PRESENT 28. C. PROCES 2. DOSS 3. FROT WADS 4. DEBRISS 6. UNDERFICUT BANK 6. BANK VEG.
STREAM					
# - 4 m	4 4 4 4	#	*	ĸ	

48. Substrate Composition, Perchange of Cover	Instream Effects: 1 Bedrock %	Boulkdorn (>3)	(Measurements at diameter)	49. CHANNEL CHARACTERISTICS	- 3-H	Course:		Channel cross-section:	0
DIRECT DISCHARGE TO STREAM:	Type: RM: LB/RB: Stee: (DM/M-D)				Type: Tributary 42 Pha/Culvert 43 Seepe/Springs 46 Grass-lined Swale 44 Ditch 45 Effects: A.None B. Charmel/Bank Eroston C.Sed Deposition D.Polluted	connider:	Touts on productions of the contractions of th		47. Total A. Cleaning/Grading B. Landscaping C. Other Construction Activity D. Land Use Change
FISH PASSAGE BARRIERS: Name	Type: RM: Height: Pool Depth Length to Negotlate:	7207		Fells 37 Culvert 36 Dam 39 Debris 40 Beaver Dem 41	OENERAL COMMENTS: 50. Stream 61. Survey 73. Other				X 9 0 T 0 3

₩.[DATE 27 Sept 9	•	$U_{\rm CM} \in \mathcal{M}_{\geq Q} = M_{\rm CM}$ Appears edequate to contain most peak flows. Flows may be creating minor bank and substrate $U_{\rm CM} = U_{\rm CM} = U_{\rm CM} = U_{\rm CM}$ and an automate to constructions. Evidence of overbank flows rare (e.g., sediment deposited on bank vegetation; bank vegetation matted down).	Appears able to contain present peak flows. Flows pattern with little cutting, deposition or other NOME evidence of bank deterioration. OBSERVED Stream flows through or adjacent to mansh/wettand area. Overbank flows natural, common.	Bark protection making the Carter of the Car		Reddential continuous 91. STREAMBAUTY: Industrial/Commercial Indus	- ⊠	10-25% of streambank receiving minor-moderate anteracon. At least 10% of stream can be required. 2 stable condition. Streambanks attale or only alignity alwayd. Bank protection material—natural, artificial or streambank being altered.	4	30 5	. 5		34. ODOR	tered or in occasional 2 Septic or human weste. 1. SULFURIC 2 OTHER CHEMICAL 3. PETROLEUM 36. TRASH (JOAN OL) OF ATCAN (LOUN US ALL)	8	#3 Concentrated dump afte contains 1. ORGANIC MATERIAL 2. INORIGANIC	pes present of 34. SPECIAL CASES PRESENT Anthrouse 1 Farm animals in stream at 1 Farm animals in stream at 1 Sneg pockets found at 2 Sneg pockets found at 2 Sneg pockets found at
APPENDIX V	HIPARIAN CONNIDON ASSESSMENT SONTET OF THE $\frac{1}{2}$	Solley 4. SURVEYO	-	ABLIMDANT COMMON FEW	 NN	LAND USE ADJACENT TO STREAM (#; %) DOMINANT 12.# 15.# 15.# 15.# 15.# 15.# 15.# 15.# 15	-69	FEGETATIVE BANK COVER: Over 90% of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely a vegetated areas are small and evenly dispersed. A deep, dense root mat is inferred. Streambank	surface protection from erosion. 78-90% 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. But your Arhannhank surface covered by vegetation and evident.	Somewhat shallow and discontinuous root mail infamed. Vegetative cover provides limited protection from erceion. From erceion. Gors, of stream bank surface covered by vegetation. Many bare or spanish vegetated areas. Bits.	protection from enzulen. protection from enzulen. protection from enzulen. Protection from enzulen. Prof. Bank 182-5 feet OUTSIDE OF CHANNEL. Left Bank 20,2-5 feet	A. TREES 5. OT	VERHEAD CANOPY: 76-100% of streem surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in annow eventy desperad and small (larger/slightly larger than the space resulting from loss of mature.	individual). 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). 26-50% of stream surface shaded, Trees, other overhead vegetation scattered or in occasion churps, Overhead <u>Sancys Min, decontinuous</u> . 6-25% of stream surface shaded. Riparian vegetation, fow trees, other overhead vegetation seasonals in the sanch surface.	HABITAT: Very diverse and complex instream habitat. Instream cover and/or low overhangi	abundant and evenly deperent. Moderate diversity and abundance of instreem habitat and/or low overhanging vegetation (at least 3 of the habitat types listed below present in moderate quantities).	Utile diversity and abundence of instream habitat (only one or two of the habitat types present or predominant), instream cover and/or low overhanging vegetation sparse and discontinuous. Amost no diversity or abundance of instream habitat (at most, one of the habitat types present), histoream cover and/or low overhanging vegetation essentially absent.

FISH PASSAGE BARRIERS:	BARRIER	<u>ö</u>	-	DIRECT D	DIRECT DISCHARGE TO STREAM:	TO STRE	AM:		48. Substrate Composition, Percentage of Cover	h, bercentige
Type: RM:	Helght:	Pool Depth	Pool Depth Length to Negotlate:	Type:	RM: LB/F	LB/RB: Stor	Stre: (Dla/W-D)	Instreem Effects:	1 Bedrock	*
		B JAC	May not mul	Samer	Soment tragins 25 21" culver	F MOFAC	ino armorad challned	. 7	2 Boutders (>3) 5 Cobble (3"-3) 4 Gravel (0.1"-5")	5/
		5 5	and of the same					v	8 Sand (<0.17)	
					<u></u>				(Mesurements at diameter)	
Fells 37	Culvert 38 Berver	rert 36 D Beaver Dami 41	Dem 36						49. CHANNEL CHARACTERISTICS	ACTERISTICS Width a Depth
GENERAL COMMENTS: 80. Streen	ITS: 51. Survey	1 6		Type: Tributary 42, Grass-lined	Tributary 42 Pl Grass-lined Swale 44	Ppe/Culvert 43	Olboh 46	Seeps/Springs 46	2-6 Little	
62. Communication with Residents:	th Residents	. .	bx	RÉCENT MP	RECENT IMPACTS TO STREAMSIDE CORRIDOR: RM: Prox to Stream: Length	EAMSIDE C	CORREDOR:	RECENT MPACTS TO STREAMSIDE CORRIDOR: RM: Prox to Stream: Langth Cause:	1 1 2 1 7 1 7 1 7 1 7 1 7 1 7 1 7 1 7 1	
				Entratig	banded	John Mary	sidents	enterty barnded by residents; lawn ganden activity to bank		
) (1) (1)	an ac	MIN		
•								•		· .
es red sy						· · · · · · · · · · · · · · · · · · ·			- F >	Z Z
				A. Clear D. Land	Fotel A. Clearing/Grading B D. Land Use Change	B. Landscaping		C. Other Construction Activity	• • •	
										4

CHANNEL CAPACITY inadequate. Channel subject to severe erosion—channel may be widening or migrab	Louiside of chainmen. Appears to barely contrain present peak flows. Flows creating noticeable enosion. Considerable sedment to barely contrain present peak flows. Flows may be sedment in each ment observed outside of chainnes.) of overbank flows. (High water mark observed outside of chainnes.) Appears adequate to contrain most peak flows. Flows may casting minor bank and autositate special on at outsurves and contrainations. Evidence of overbank flows may 6-p. sediment deposited on	bank. Debris suspended or deposited on bank vegetation; bank vegetation matted covm.). Appears able to contain present peak flows, Flows patiem with little cutting, deposition or other evidence of bank deterioration.	Streem nows procedured in agreement to make the control of the con	 Occasional etretches of bank protection material present (10-20% of bankine). Sureamberna mostly in the turial state. Little, if any bank protection material present (<10% of bankine). Streambern almost entirely in anturial state.			10-20% of streambanks receiving finite incomes statement. Streambanks stable or only slightly aftered. Bank protection material—natural, artificial or combination of both, infrequent raw banks—less than 10% of streambank being aftered.	₩ ⊡E	10 8	THANSPARENCY/COLOR: Thansperent, bottom of channel is visible.	Opeque or white life, bottom of channel may be visible. Light to dent brown; visible perdeutiste metter present. Bottom of channel not visible. I. RED 2. TAN 3. GREEN 4. OIL SHEEN Other colors.	SR NON-S.	Septic or human waste. 3 Septic or human waste. 1, SULFURIC 2 OTHER CHEMICAL 3. PETROLEUM	38. TRASH [_77] Litter in streem: cens, bottles, yard debris, logging or land clearing debris—in or adjacent to channel.		9	
APPENDIX V RIPARIAN CORRIDOR ASSESSMENT S	2. 2. 4. SURVEYO	EXIT POINTS:		 M(#; %) DOMINANT 12.# SUBDOMINANT 13.# OTHERS PRESENT 14.#	71 Forest or natural vegetation 4. Peature—Unienced 7. reactionities—Confined 2. Park or golf course 5. Peature—Tenced 8. Readential—Confined 3. Readential—Commercial 9. Inclustrial/Commercial	VEGETATIVE BANK COVER: Over 90%, of streambank surface covered by vegetation in vigorous condition. Any bare or sparsely 1 vegetated evest are small and eventy dispersed. A deep, dense not mat is inferred. Streambank	Eutrace protection from enterior. 76-90% of streembark surface covered by vegetation. Few open areas with unstable vegetation 40-75% of streembark surface covered by vegetation. Few open areas with unstable to severe a covered by vegetation. Bare or sparsely vegetated areas are evident.	Softwares in the control of the cont	WIDTH OF VEGETATIVE COVER Right Bank 18. 164 10 10 10 10 10 10 10 10 10 10 10 10 10	VEGETATION TYPES: DOMINANT 21. A SUBDOMINANT 22. Z OTHERS PRESENT 22. 7.7 I. GRASSES 2. BHRUBS A. BAK BRY BUSHES (4. TREES & OTHER.	OVERHEAD CANOPY: 78-100% of streem surface shaded by trees or overgrown with grasses, shrubs, brush. Openings in canopy eventy dispersed and email (imperhightly larger that the space resulting from loss of mature).	19.73%, of streem further shaded. Trees, other overhead vegetation eventy depends along answered making answered making.	Individuals). 26-50% of streem surface shaded. Trees, other overhead vegetation scattered or in occasional and cumps. Overhead canopy thin, discontinuous.	0-25%, of etream surface shaded. Ripartan vegetation, low trees, other overnees vegetation	FISH HABITAT: Very diverse and complex instream habitat. Instream cover and/or low overhanging vegetation abundant and eventy dispersed in the second instream habitat and/or low overhanging vegetation (at least 3	2 of the harblest types listed before present in moderate quentities). Little diversity and abundance of instream harbles (only one or two of the harblest types present or Little diversity and abundance of instream orders or eventuarying vegetation sparse and decontinuous. 3 predominant, instream cover and or two overteamying vegetation sparse and decontinuous.	A modest provided from coverhanging segretation essentially absent. FISH COVER TYPES: DOM/HANT 26.0 SUBDOM/HANT 27. OTHERS PRESENT 28. 1. ROCKS 2 LOGS (3.R)OOT WADS (4. DEBRIS 5. UNDERCUT BANK 6. BANK VEG. 7. OTHER

FISH PASSAGE BARRIERS: None	DIRECT DISCHARGE TO STREAM:	CHARGI	E TO ST	REAM:		48. Substrate Composition, Perchrisige of Cover
Type: RM: Height: Pool Depth Langth to Negotiate:	Type:	FOR: LL	LB/RB:	Stoe: (Dim/W-D)	Instreem Effects:	Pedroak
Dan above this sagment	Mulder House		7. E	(age		2 Boutdons (>3) / / / / / / / / / / / / / / / / / / /
						5 Sand (<0.17)
-alle 37 Curvert 36 Dam 39				-		(Measurements at Caemeter) 49. CHANNEL CHARACTERISTICS
Debris 40 Beaver Dam 41						1 Width 2 Depth 1 Width 2 Depth
	Type: Tributary 42, Grass-lined t Effects: A.None B	Tributary 42 P Grass-lined Swale 44_ is A.None B. Charmel	PiperCulvert 43,	nert 43 Se Ditch 46 Seed Deg	Type: Tributary 42 Pha/Culvert 43 Seepe/Springs 46 Grass-lined Swale 44 Dilch 46 Effects: A.None B. Charnel/Bank Erosion C.Sed Deposition D.Poliuted	1-19 6-1
2. Correction with Readerts: 53. Other	RECENT MPAC	Prox to Streem: <30 >30:	REAMSK reem: 90:	RECENT IMPACTS TO STREAMSHOE CORRIDOR: No. e. Hill: Prox to Streem: Length Co. 430 >30;	1 1	Overned expend to coally
	·					Son 2009, door
		,				Channel goas-arction:
A 9 0 T 0 3	47. Total A. Clearhay/Grading D. Land Use Change		B. Landso	seping C. Other	B. Landscaping C. Other Construction Activity	
						A SERVICE OF THE SERV

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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

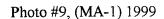






Photo #8, (MA-1) 1999

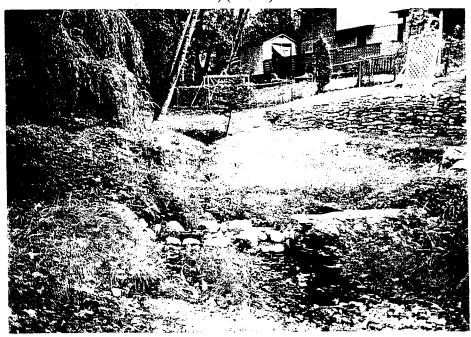


Photo #11, (MA-2) 1999

Photo #12, (MA-2) 1999





Photo #16, (MA-4) 1999

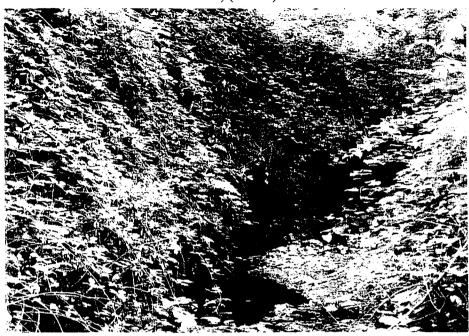


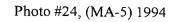
Photo #18, (MA-4) 1999

Photo #20, (MA-4) 1999





Photo #18, (MA-5) 1994





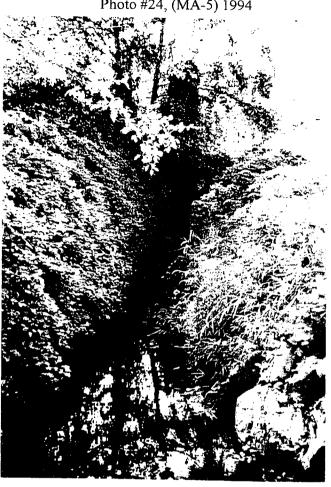


Photo #23, (MA-6) 1994



BARNES CREEK





Photo #8, (B-3) 1994



DESMOINES CREEK

Photo #2, (DM-B) 1999

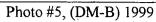


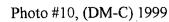


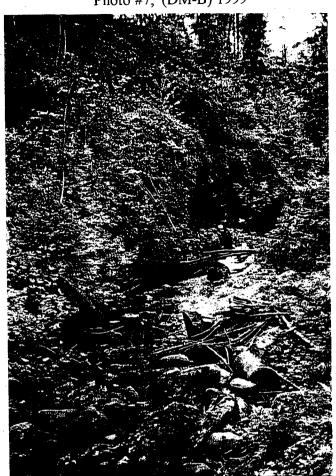


Photo #33, (DM-B) 1994



Photo #7, (DM-B) 1999





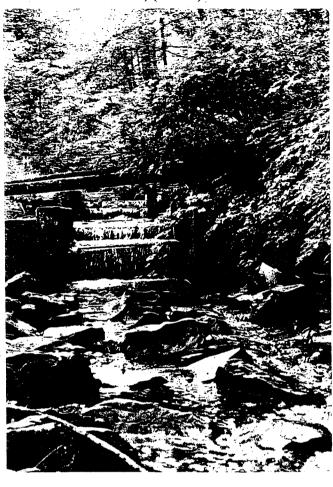


Photo #8, (DM-C) 1999



Photo #5, (DM-C) 1994



Photo #8, (DM-C) 1994



Photo #11, (DM-D) 1999

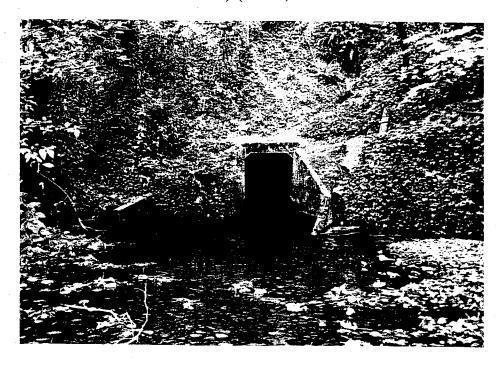


Photo #12, (DM-D) 1999



McSorley Creek

Photo #16, (MC-1) 1999

Photo #23, (MC-1) 1999





Photo #21, (MC-1) 1999



Photo #20, (MC-2) 1994

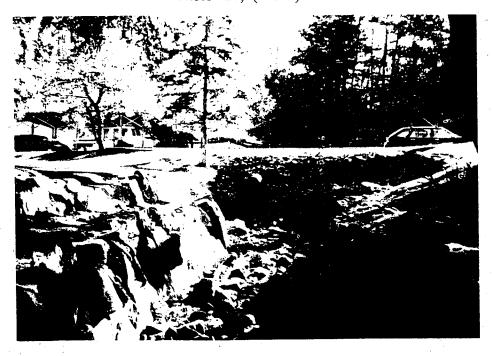


Photo #22, (MC-2) 1994



Photo #23, (MC-2) 1994



Photo #24, (MC-2) 1994

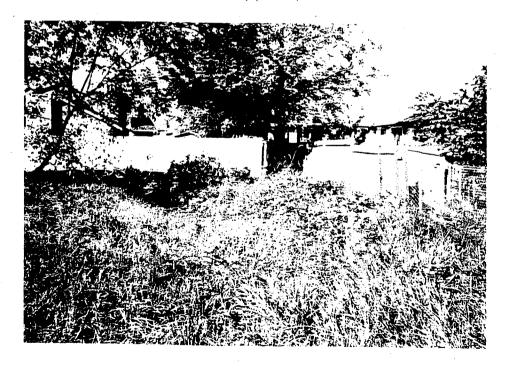
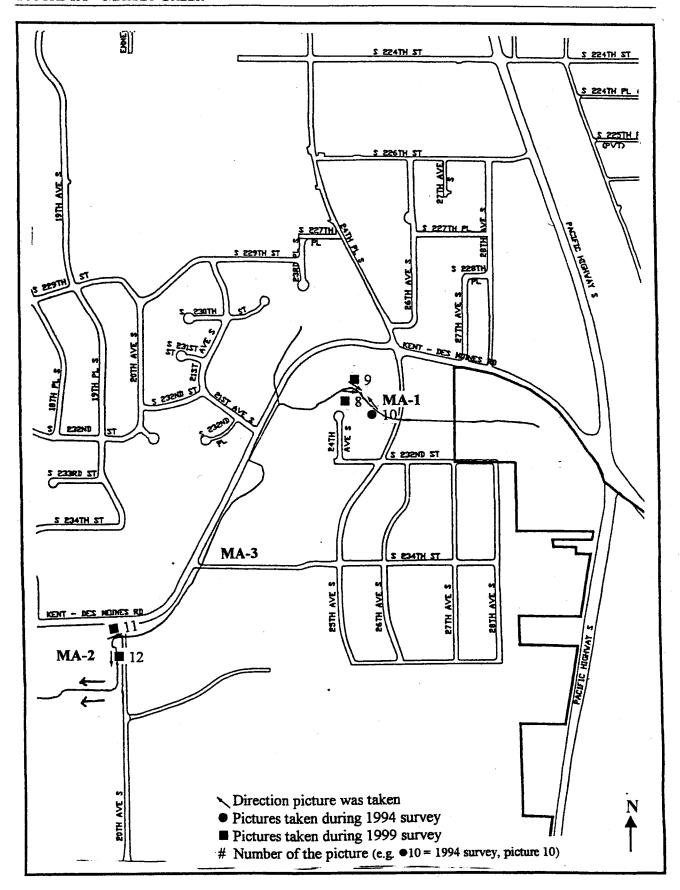


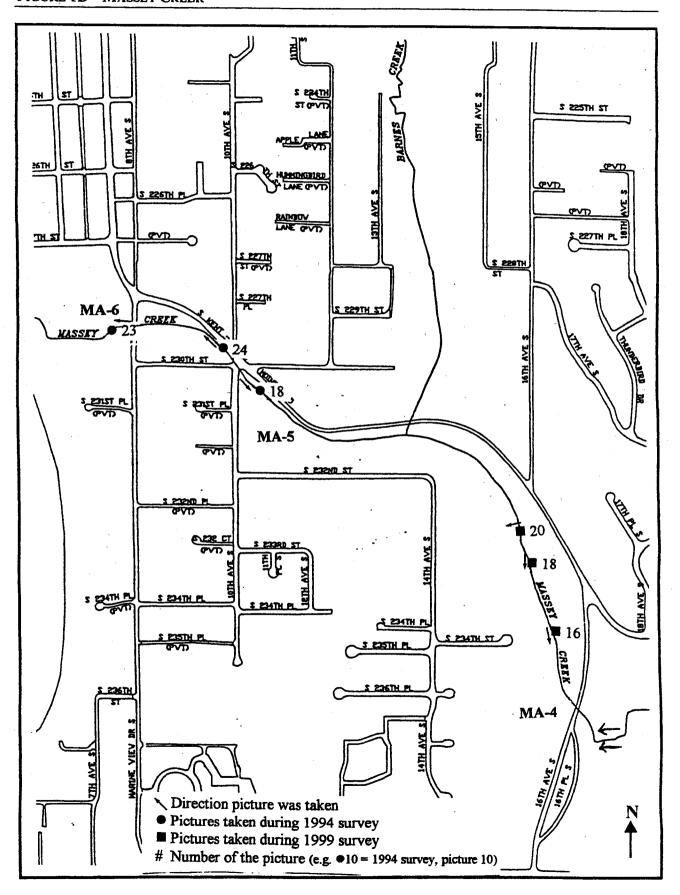
Photo #31, (MC-3) 1994

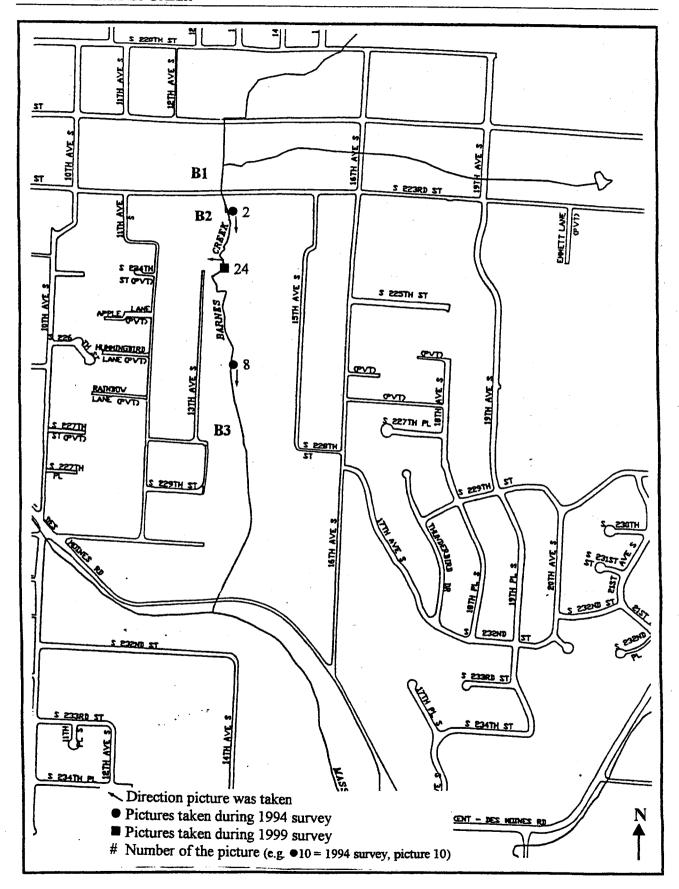


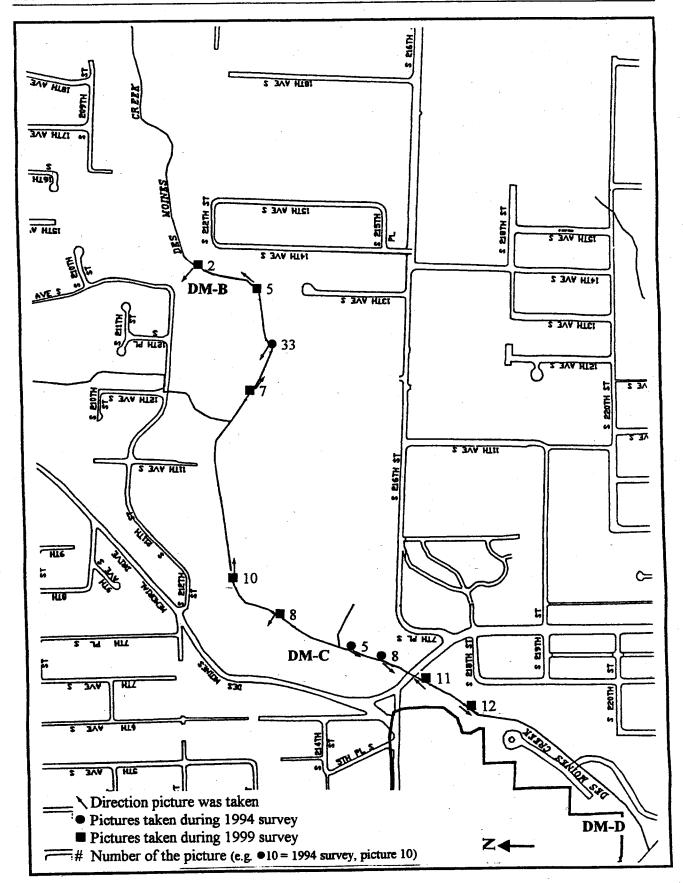
Photo #36, (MC-3) 1994

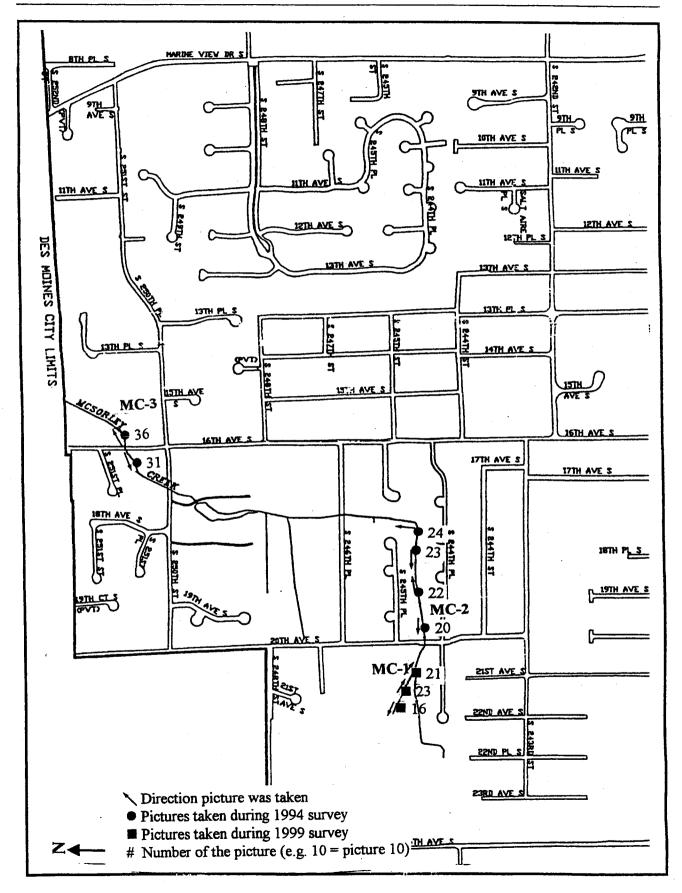












APPENDIX I

Stream Gauge Monitoring Data

Table H1. Summary of stream gauge data collected by volunteers for the Des Moines water quality monitoring program.

		Comments		10 ft subtracted from reading?	New gauge on 2/20/96 (14=1); gauge missing on 5/15/96	New gauge on 4/14/97	Crest tube broken	Crest tube missing in 1/95			Missing cork dust	No crest gauge; max. staff = 0.80 ft	No crest gauge	No crest gauge		Flood over gauge on 2/8/96 (>16.60 ft)		New gauge = old gauge - 13.08 ft	Missing cork dust	Debris blocked culvert on 2/20/95, cleared by 2/22/95	High crest from debris blocked culvert from 11/95 - 1/96	New gauge upstream; Crest overtopped on 3/18/97		Crest overtopped on 1/8/99							
		Recorder	Peggy McCluskey	Wayne Matthews	Wayne Matthews	Wayne Matthews	Wayne Matthews	Wayne Matthews	Wayne Matthews	Wayne Matthews	Wayne Matthews	Wayne Matthews	Wayne Matthews	Wayne Matthews	Joe Dusenberry	Wayne Matthews	Wayne Matthews	Wayne Matthews	Wayne Matthews	Iva Hays	Iva Hays	Iva Hays	Iva Hays	Iva Hays	Sandy Klein	Sandy Klein	Wayne Matthews	Wayne Matthews	Wayne Matthews	Wayne Matthews	
Fluctuation (ft)	(max. crest -	min. staff)	2.13	0.58	> 2.20	2.28	į	0.82	86.0	1.11	. :	i	1	;	2.68	3.02	1.83	3.70	•	3.01	2.97	0.74	0.82	0.80	09.0	0.55	1.45	1.76	1.70	:	
	Maximum	Crest Date	12/27/94	6/12/95	1/12/96	<i>L6/6/9</i>	None	12/5/94, 3/27/95	4/11/96	1/10/97	None	None	None	None	12/21/94	4/24/96	10/25/96	12/31/96	None	2/22/95	11/17/95	6/18/97	12/17/97	6/24/99	11/1/94	11/13/95	2/27/95	7/8/96	12/31/96	12/16/97	
	Maximum	Crest (ft)	11.59	0.85	2.50+	2.90	None	0.92	1.12	1.18	None	None	None	None	16.40	16.60	15.48	4.30	None	12.01	11.97	10.56	10.69	10.69	5.60	5.65	1.60	2.06	2.03	None	
	Minimum	Staff Date	1/4/95	8/3/95	4/11/96	5/12/97	4/29/98	11/7/94	5/2/96, 9/3/96	10/10/96	4/29/98	2/7/96	4/14/97	4/29/98	12/8/94	4/11/96	10/10/96	8/18/97	4/29/98	8/2/95 - 8/30/95	10/5/95	1/29/97, 3/5/97	10/1/97	10/15/98, 5/13/99	11/7/94	11/6/95	8/3/95	9/3/96	5/12/97	4/29/98	
	Minimum	Staff (ft)	9.46	0.27	0.30	0.62	0.97	0.10	0.14	0.07	0.11	0.05	0.23	0.10	13.72	13.58	13.65	09.0	0.47	9.00	00.6	9.82	9.87		5.00	5.10	0.15	0.30	0.33	0.62	
Number of	Days	Observed	17	15	15	m	-	13	12	12	-	9	_	-	20	13	m	6	7	45	18	35	45	35	7	13	78	21	6	, 7	
	End	Date	3/20/95	9/21/95	4/26/96	<i>16/6/9</i>	4/29/98	3/27/95	9/3/96	12/11/97	4/29/98	2/20/96	4/14/97	4/29/98	9/4/95	5/15/96	10/25/96	8/18/97	4/29/98	9/28/95	1/26/96	9/24/97	9/24/98	8/18/99	1/3/95	4/1/96	9/21/95	96/2/6	26/6/9	4/29/98	
	Begin	Date	10/31/94	4/10/95	10/2/95	4/14/97	4/29/98	11/7/94	1/26/96	10/10/96	4/29/98	2/5/96	4/14/97	4/29/98	11/23/94	2/2/96	10/10/96	12/6/96	1/14/98	10/26/94	10/5/95	1/22/97	10/1/97	10/1/98	11/1/94	10/21/95	11/4/94	10/2/95	12/31/96	12/16/97	
	Water	Year	1995	1995	1996	1997	1998	1995	9661	1997	1998	9661	1997	1998	1995	1996	1997	1997	1998	1995	9661	1997	1998	1999	1995	1996	1995	1006	1907	1998	
		Station	DM-1	DM-1	DM-1	DM-1	DM-1	MA-1	MA-1	MA-1	MA-1	MA-2	MA-2	MA-2	MA-3	MA-3	MA-3	MA-3	MA-3	BA-1	BA-1	BA-1	BA-1	BA-I	MC-1	MC-1	MC-2	MC-2	MC.2	MC-2	

attn: John Osborne fax 281-7651

Stream Level Record

Des Moines Water Quality Monitoring Program

4		- J
Monitoring station	LODET Des Moines	(bm-2)
Observer(s)	Peggy McChiskey	
	——————————————————————————————————————	

	Dete	Time	Gauge heig		-			Gauge heig	hts (ft)	
	Date		Staff	Crest		Date	Time	Staff	Crest	Initials
	1031-94	12-1505m	10.10	10.20	<u> </u>	<u> </u>				
	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		9.56	10-08	gn^	 	<u> </u>	J	<u> </u>	
- .	11/2/104	12:1500	9.60	10.03	Sm	}	<u> </u>		<u> </u>	
	12/12/94	1213500	9.51	10.22	RMU					
	12/19/94		9.53	10.01	<u>am</u>	 	-	 	ļ	
	12/27/92	12:32m	11359	739.512	SM	 	<u> </u>		 	
	1/4/94		9.46	10.02		<u> </u>	<u> </u>		 	
	19195	12:455	9.59	10.03	(Pm		 	 		
	1 23/95	12:320	9,44	7.27	GM2		 	 	 	ļ
	27195	12:300	9.51	9.60		ļ	<u> </u>		 	
3000	214195	12:322	9 47	9,63	311	 		 	 	
KL	37.762	12:50	10.81	1100		 -	 	-	ļ	
	23895	12:375	9.57	9.89	Gr.		-	-	-	ļ
		12:40pm			PM Chil		 			
	3 13 195			9,96	m		<u> </u>	1	<u> </u>	
į		12:320	9-47	9.60	m		-	 	 	
	# 5	DOF	RECORD	7.00	777-				 	
	•		COLORS	· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·		 		ļ	}
ناء	- 1475	STATIO	N TRAG	VICEOR	FD 77		 	 	-	
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	WAY	NE M	MITHEWS		•					<u> </u>
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Des Moines Water Quality Monitoring Program

Monitoring station	DM-L	
Observer(s)	Wayne Matthews	

Date	Time	Gange heigh		Initials	Date	Timo :	Gauge heigh		V.421_V _
1.10,95	10:00	152	160	Wan_	erate:	AUMO:	GIALL	CAESI	Initials
24.95	11:10	-45	162	ion			 		
-1-95		.43	.47	Vien/					
5-8.95	1030	.42	182	um					
5. 15.95	11 45	.39	.48	am			,	···	
5.22.95	945	.34		an					
5 30 95	1045	.32		um					
6-3-95	11 40	.38	.74	wm					
5-12-95	1030	.38	-85	Perswinkles					
0-27.95	Z: 10	.30	184	m					
7-3.95	1040	.3/		CURK					
7.18.95	1:00	.28	1.50?	درسول مور		-			
3-3-95	2:30	.27		NODED CHEK					
1-8.95	130	-38	.42						
1.21.95	1020m	-30		PLUS MISSING					
0.2.95	3 15pm	,57	1.06	C 10 74 . C	ļ				
0.19.95	205	.52	1.47	POET CE					
1-1-45	1105	<u>,38</u>	1.19	(2n		· · · · · · · · · · · · · · · · · · ·			
2-4.95	1130an	98	1.50	an.					
2.11.95		1.15	1.80	an					
2.22.95	11 00 Am	_BO							
1.12.96		.51	1.22	en					
	1115 AL	.54	Z.50±?	(AT)					
122.96	330em	0.75	1.7 +	phones					
				 					
									
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		717W Y 21	C# anort			* enort9			
	— 15a	Mess Main	In white	COULTAGE	J WARDER	0/°07			<u> </u>
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		Z 49666 4	76.62.1 ale	7				AL	02573

Des Moines Water Quality Monitoring Program

Monitoring station

Des Moines Creek DM-1

Observer(s)

Wayne Matthours - City of Des Maines

		Gauge heigh	its (ft)	
Date	Time	Staff	Crest	Initials
1-12-96	1115 A	0,54	2,50+	an
1-22-96	330 P	0.75	1.70+	yan
2.7-96	345P	10.22	10,86	1001
2-20.96	1035 A	0.65	1.30	NEW GAUGE
3-6-96	240p	0.35	1,20	1401
4.11-96	930 A	0.30	1.35	m
4.24-96	11 15 A	1.15	(2.9 Guage pushed over by high flows a	straightened + cork and plants.
4.26.96	10 45 A	0.62	1,30	1177
5.15-96			UN	Gauge Missing.
4-14-97	1000 AM	1.29	1.52	New Gauge
5-12-97	11 30 AM	0.62	1.32	eleur, sunny
6-9-97	1015 AM	0.91	2.90	em sunny, dry
4-29.98	10 00 AM	0,97		Upper 4" of TUBC Broken off. Cap Missing cork-dded
			·	
				·

Des Moines Water Quality Monitoring Program

Monitoring station	MAI	(Upper	Massey	at	24th Ave S)	
Observer(s)	Nayne	Matthews				_

		Gauge heigh	its (ft)		Gauge heights (ft)						
Date	Time	Staff	Crest	Initials	Date	Time	Staff	Crest	Initials		
11.7.94	8 40	0.10		wn					- DILLIAIS		
11.14.94		0.11	0.11	WN			-		<u> </u>		
11.21.94	850	0.13		WM							
11-29-94		0.17	0.31	ww		· · · · · · · · · · · · · · · · · · ·		<u> </u>			
12.5-94				um							
12.12.94		0.15		WIN							
	my Engin						 				
place on	pipe rib	peak.	wm								
1-23.95		0.15		w							
1.31.95		0.44		in rain	· · · · · · · · · · · · · · · · · · ·						
Bean wit	n rew st			2000			İ				
Begin 151 - 2 - 21 95	11:10	0.21	0.84	bm							
2.27.95	8:30	0.15	0.18	an							
3-6-95	9:45	0.13	0.39	loon							
3.21.95		0.15	0.60	Wan Petondy			 				
3.27.95	9:45	0.14	0,92	um				İ			
					· · · · · · · · · · · · · · · · · · ·						
END	or re	cono	TIAS	C 77477 CM							
TRAN	SI-GNES	2 72 76	GGY M	courses							
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Sino	record.	Ite 2	105								
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Des Moines Water Quality Monitoring Program

Monitoring station

Upper Massey Creek at 24th Ave 5 MA-1 Wayne Matthews- City of Des Moines

Observer(s)

		Gauge heig	hts (ft)	
Date		Staff	Crest	Initials
1-26-96	100 P	0.22	1,05	
2-5-96	4150	0.65		
2-6.96	920A	0,70		
2-6-96	1020 A	0.68		
2-6-96	1130 A	0.71		·
2-6.96	150P	0.44	0.75	
2-6-96	350 P	0,43	0.50	
2-6-96	500 p	0,54		
2-6-96	740P	0.37	0.58	
2-7-96	820 A	0.20	0.40	
2-7-96	1020 A	6.25		
2-7-96	330+	0.45	0.54	
2-8-96	900A	1,10		
2-8-96	1200 NOON	0.80	1.05	
2-8-96	300 r	0.48	0,63	
2-12-96	3450	0.24	0.85	

Des Moines Water Quality Monitoring Program

Monitoring station

Upper Massey Creek at 24th Ave 5 MA-1

Observer(s)

Wayne Matthews- City of Des Moines

		Gauge heigh	its (ft)	
Date	Time	Staff	Crest	Initials
4.11.96	A 00 01	0.16	1.12	69m
4.24.96	150 p	0.22	0.95	im
4.25.96	4.15 p	0.68		High Flow
4.26.96	1120 A	0.19	0.66	em
5.2.96	900 A	0.14	0.32	un
5.15-96	250 p	0,14	0,23	m
9-3-96	1040 A	0.45		M Sadiment observed
9-3-96	130 p	0.14	0.65	two crest
10-10-96	1150 4	0.07	_	Man Added cork
10-11-96	845 A	0.10	0.38	
10-25.96	4-18 P	0.15	0,65	um
12-6-96.	1050 A	0.30	0.90	Um (New grage)
12-31-96	1105 0	0.38	1.01	im
1-10-97	220 pm	0.16	1,18	m
2-3-97	245 pm	0.15	1.00	war
2-12-97	900 AM	0.18	0.38	m
4.14-97	315 pm	0.15	_	about Cork
5-12-97	1045 AM	0.12	~	clear, sunny

Des Moines Water Quality Monitoring Program

Monitoring station Upper Massey Creek at 24th Ave 5 MA-1
Observer(s) Wayne Matthews- City of Des Moines

		Gauge heigh	its (ft)	
Date	Time		Crest	Initials
6-9-97	1100 AM	0.80		m
12-17-97	315 PM	0.42	1.10	ra
4-29-98	1050 AM	0.11	<u> </u>	CORK ADDED
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Des Moines Water Quality Monitoring Program

Monitoring station

Massey Creek at 16th Ave S MA-Z

Observer(s)

Wayne Matthews - City of Des Moines

		Gauge heigh	hts (ft)	
Date	Time	Staff	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	6,10		
2-6-96	340P	0.05		
2-6-96	450 P	0,10	WATER	
2-7-96	810 A	0.05	BELOW	
2-7-96	10 10 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	11.15 A	0,20	·	
4-14-97	300 P	0.23	New Scale	New Scale
4-29.98	1030 AM	0.10 ±		

Des Moines Water Quality Monitoring Program

Lower Massey) MA-3 Monitoring station Observer(s) Gauge heights (ft) Gauge heights (ft) Date Time Staff Crest Initials Date Time 🦠 Staff- Crost 11.23.94 0420 13.90 15.28 11.23 RZ bealed storm 12-5-94 1240 13.75 J () 0.3-12-8-94 0800 13.72 J 0 12-9-44 1350 12.2 13.76 14.32 7.10 0300 12-12-94 13 20 13.76 14.38 J, p. 0000 12:12 12-16-94 1310 14.06 14.38 7. D 12:16 storm 12-19-94 1205 14.02 15.16 る・ひ 12.17 17-21-94 0830 14.16 16.40 20 1800 12.20 12-26.94 1200 14.32 15.76 12.26 pertil before 20 storm 1/24-95 12:00 13.80 14.20 12.26 0600 J0 125 95 1500 13.80 130/45 1200 14.46 16.06 peaked before 2 D 1.30 Storn 2-3-95 1300 14.06 15.66 JP 1.31 1200 2-9-95 13.96/14.10 1300 2-3 50 0900 3-14-95 0645 14.08 14.86 2100 2.19 20 3-79-85 16 40. 111,06 14.54 0600 プル 3.23 4-7-95 1515 13.96 perhed before 14.40 5.0 storm 4-24-95 1300 13.90 14.64 J.D. 0300 5-18-95 14-64 0800 13.88 2.0 4 20 0000 9-4-85 14.10 0800 15.50 JO

Des Moines Water Quality Monitoring Program

Monitoring station
Observer(s)

Lower Massey Creek MA-3 Wayne Mothews - City of Des Moines

		Gauge heigh	ts (ft)	
Date				Initials
2-5-96	4000	14,98		
2-6-96	900 A	14.70	15.69	
2-6-96	1010 A	15-35		
2-6-96	11 10 A	15.35		
2-6-96	130 P	15.30	16,10	
2-6-96	330P	14.80	15.30	·
2-6-96	445P	14.90		
2-6-96	725P	14.85	15,25	
2-7-96	800A	14.30	14.86	
2-7-96	10 00 A	14.28	14.30	
2-7-96	300 A	14.70		
2-8-96	FLOUDED W	ER GALGE		, e
2-8-96	250 P	15,60	PULLED GAUGE UPRIGHT	1
2-12-96	2500	13.90	PULLED GAUGE UPRIGHT AGAIN	
2-20-96	1100 A	13.80	14.31	
3-6.96	2 15p	13.58	14.65	
4.11.96	950 A	13,58	14.72	
4.24.96	140 p	14.00	16.60*	CURK AT TOP

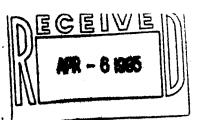
Des Moines Water Quality Monitoring Program

Monitoring station

Lower Massey Creek MA-3 Wayne Matthews - City of Des Moines

Observer(s)

		Gauge heigh	to (ft)	
Doto	Time			Teitiala
Date		Staff	Crest	Initials
4.25.96	425 F	14.56	14-61	war
4-26.96	1115 A	13.80	14.87	JUN-
5-2-96	845 A	13.68	14.00	an
5-15-96	1145 A	13,74	13.88	abserved. (Several)
10-10-96	125 P	13.65	15.05 and 14.54	observed.
10-11-96	920 A	13.83	13,98	ian
10-25.96	410 p	13.69	15.48	am
12-6-96	1100 A	0.82 NEW 13.90 OLD		in
12-31-96	1025 A	1,53 NEW	4.30 NEW	ian
1-10-97	210 pm	0.80 NEW	3,90 xew	mage-
2-3-97	250 PM	0.77 ,	3.60 "	un
2-12-97	845 AM	0.77	1,50	un
3-19-97	240 PM	1.00	2.70 3.50	Two ring in staff type.
4-29-97	100 PM	0.65		5-2" Fish GM Observed.
6-9-97	1045 AM	0.73	1,10	6-2"-3" Fish wom
8-18-97	930 AM	0.60		Dres meather pp
1-14-98	300 PM	1.20		Recent rains.
4-29-98	1015 AM	0.47		CURK ANDERD 6-2" FISH OBSCRED



Des Moines Water Quality Monitoring Program

Monitoring	station
T. TO	omiro.

Lower Barnes Creek (BA-1)

Observer(s)

Iva Hays

		IVA M	V						
		Gauge heig	and the state of t	-			Gauge heigh		
Date	Time	Staff	Crest	Initials	Date	Time	Stall	Crest	Initials
10-25-94	10: 29AM	9.75	7.75	2877					<u> </u>
10-28-79	11:10+00	9.55	19.15	28184					ļ
11-2-94	R: OB AM	7.37	10-16	1894					ļ
11-9-94	8:20 AM	9.611	9.75	MH	<u> </u>		ļ		
11-16-14	7:40 M	9.72	9.72	1994	ļ	<u> </u>	<u> </u>		
11-2377	8:55 811	9.62	9.75	144		<u> </u>	ļ	ļ	
1-30.94	8:50 AAL	10.22	10,54	121			ļ		
	12:25 821.	1	10.53	2714					<u> </u>
	10:29 AM.		9.52	1894	<u> </u>		<u> </u>		
	11:10 AV.		9,49	2894					
	9:00 AM		11.75	201/					
12-25-74	9:00 AM	9.90	11.76	242				<u> </u>	
1-4-95	15:10 AN		9.77	5.444					
1-12-95	9:30 AM		9,76	2.89		041-	1.		
1-19.95	3:50 PM		9.70	244	<i>X</i>	Storm	2/20)	,
1 - 25 - 95			9,54	1914		Debria	4. 4.62	eder 1200	1266
2 - 1 - 95	8:21 AN	9.73	9.85	7887	1	uncertain			7-1-1-
2-8-25	10:27 AM.	7.58	9.89	294		canded	Crest	Minice (los
	10:50 AM.	9.11	9,70	194	1	20 4	/ /	المراكز والمراجون	
	8:00 A.M.	9.66	12.01	101/4	1	the to	T T T	7	·
	T: YO A.M.		7.64	194	 	Mante	, , ,	Z''	$\angle \angle \angle \equiv$
	7: 75 AM	7	7.70	W. K.C.	1	Mante	ستعمده ويمسو	Cition	
	12:10 PM		9.75	14.94		clerred		1 . 2 6 2	/22 -
			9.30	11146	-				
3- 27- 73	11:20 PM	1.21	7 . 30	1 200		J;	1 sace	i Name of the State of the State of the State of the State of the State of the State of the State of the State of	/
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& Storme

12-21-94 Most of Cork in partial ming

Page _____ of ____

11.25-94
11.85 Stuffed Mand - Rocks in Tabe
1-12-95 - Still bound might in hollow to
Tabe that will also the apply

R 025742

Des Moines Water Quality Monitoring Program

Monitoring station

Lower Barnes Creek (BA-1)

Observer(s)

Date	T:	Gauge heig Staff	170000	-	Gauge heights (ft)					
	Time		Crest	Initials	Date	Time	Staff	Crest	Initials	
12-25-94	10: 19AM 11: 10AM		7. 75	2974	¥/25		tron		201.00	
11-2-94	3:60 AM	9.57	10.15	1424	7-30-95	8:07 AM		19.51	244	
11 - 9 - 94	8: 70 AM	9.64	7.75	1.21.74 1.21.74	9-6-94	8:12 AM	9,02	9.16	3.31 97	
11 - 16 114	8:40:M		9.72	1994	9-22-95	9:49 AM		9.01	29 91	
11- 23 77	8:55 AM	9.62	9.75	399	9-28-95	8:25 AM	9-00	9-01	244	
11-30.94.	8:50 AN	10.22	10.54	1214	7	9:40 AM 9:37 AM		9.72	1994	
12-1-74	12:25 P.M.		10.53	STH	10-5-95	10:50 AN	9.00	9.32	2991	
12-7-94	10:29 AM	9.52	9.52	1894	10-11-95		9.01	9.34	2214	
12-14-94	11:10 AM.	9,44	9.49	3.114	10-26-95	10: AM	9.16	9.55	2914	
12-21-94	9:10 AM	9.86	11.75	20%	11-2-95	9: 40 MM			1213/	
12-28-94	9 00 AM		11-76	24 24			9.08	9.10	2996	
1-4-95	12 16 AM	9,14	9 77	5.21 95 ¥	11-9-95	9:35 M		10.94	14 24	
1-12-45	9:30 AM	9.51	9 76	121.1	11 - 17-75	11350 AM	9.34 9.36	11.97	14 7 4 14 1/4	
1-19-98	3.50 PM	9,46	9.70		11-30-95	8:25AM	9,70	11.48	1777 17174	
1 - 25 - 75	10:55 A.M	9.42	9 54	121 %-	12-8-45	1/: 30 AM	9.40	10.73	17.7	
2-1-95	8:21 AM.	9.73	2.85	197 7	13-14.45	9:05 tm	9,42	11.51	12/94	
1 - 8 - 75	16:21 hM	7.58	9 24	24 4	12-22-95	11:25 AM	9,20	9,73	1994	
	10:50 AM	2.61	9.70	3994	12 - 28-95	8:55 AM	9.34	9,51	1.81.84	
	Pich AM	9.66	12.01	المراسل	1-4-96	8:4214	9,21	9.54	2894	
:- 1 - 75	7.40 A.M	9.55	7 64		1-11-96	9:30 AM	9.88	11.90+	1874	
3-4-95	5.35 AM	9.65	780	241/	1-11-91	9: 10 AM	10.32	11.70 +	2724	
	12 416 PM	9.32	1 75		1-18-96	10:25 AM	9,52	10.33	1994	
	11:20 PM	9 29	5.3.		1-26-96	12 × 35- P.M	94737	10,27	2924	
1-5-95	8:25 AM	9.25	9.71	17:74		72 77 17		-20.75.1	N2) //	
4-12-95	7:50 AM	9.28	9.58	المدند					-	
1-26-95	9. 30 A.M.	9.22	9.57	804/ !						
7-3-75	12:20 146	9.26	9.37	2.1						
	EIE AM	9.21	9,40	12:01						
-17-95	9:10 AM	9,19	9.24	144						
	10:28 AM	9:18	9.22	11.71						
	8:25 AM	9 19	9.18	243/						
6-14-25	Z:32 A.M	9.18	2.54	2974						
-21-95		9.18	7,17	18124						
1-28-95			9:18	U194						
				///						
			······································							
7-19-95	9:00 AM	Notin Water	9.62	2424						
7- 16-95		9.20		2424						
7-1-95-	5 - V6 7/11	9.00	7.30	24 %_					7/2	
8-9-96	8:20	9.00	9,18	1994	·			AR 025	743	
7-16-95		9.00	9.00	SA 44						

A Storm 12-21-94 Most of Cork in gestiel ming * Storm Creet readings over 11.90 were over the top of take 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 Staff Crest Re-set Rain-Gauge Gauge Crest? ing? Date Time (feet) (feet) (Y/N) (Y/N) Notes 1-1-97 N Too much Snow 1:30 pm Flooding = removed some - 15-97 12:45 x-N Still over My book across stream - Not blocking No indie - 22-97 11:20 AM N 10.03 9:55 AM 9. 22 10.01 2-5-97 У 11:45 AM 9,84 9.85 N 2-12-97 10:30 AM 9.86 10,03 N Herry rain yesterday 1:30 3M 2-19-97 9.79 10.01 will all wes ill 2-26 97 Swer-3 - 5 - 77 10:42 AM 9.52 9,90 N 10.33 3-12-97 9:357M 9.94 Ń Top NA Over The sida & Have look Dast with me 3-18-97 10:20 AM 10.42 3-26-97 9155 AM 9.97 Ŋ 4-3-97 1:30 pm 10.01 10.04 4-9-97 9:25 A.M 9.95 9.94 4-11-97 9:40 AM 9.79 11.09 4-25-97 7:45 AM 9,92 10.41 N 4-30-97 11:10 AM 10:13 10.14

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 Staff Crest Re-set Rain-Gauge Crest? Gauge ing? Date Time (feet) (Y/N) (Y/N) Notes (feet) 5-9-97 7:40 AM 9.91 9.96 N У 9.90 9,92 5-14-97 10:50 5-21-97 N 10:15 9.89 9.90 10:06 9.89 9.97 A number of small fish is store 10.02 6-6-97 12:45 9.85 9.84 9.86 N 6-11-97 12:45 10.56 (~ 18-97 9:08 9,86 7:55 1 - 26 - 97 9.84 N 10.06 7-2-97 10.04 <u>- 16 - 97</u> 8:20 9, 84 20.03 N H 7 - 23 - 97 7:35 984 9.85 7-30-97 9,84 8:50 9.84 8-8-97 9,83 9.84 Ŋ 8:13 8-13-97 8:05 9.83 9.83 8-20-99 8:19 9.83 9.86 9,84 8-27-97 8:30 10.12 Vacation 9-3-97 Oh 8:12 9.84 9,84 N 9-17-97 10:10 9.90 99 9.84 N 9-24-99 10:12 9.85 Soudust gone - too low 9.87 12:32 0 1 - 97 STreatout 8:00A

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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 Staff Crest Re-set Rain-Gauge Gauge Crest? ing? Date Time (feet) (feet) (Y/N)(Y/N)Notes 8:13 Am 10 - 15 - 97 9.98 10-13 9.93 10-22-97 Ν 1:30 pm 10.15 8:08 Am N 10-28-97 10.35 10.49 9:40 Am - 5-97 9.94 11.08 14 9:50 AAL 9,96 10.59 Y 9,98 10.17 У 9:08 AM 9124 AN 9.98 N 11-26-97 10.36 8:54 AM 9.96 10.28 N -10-97 10:34 AM 10,02 11.04 12-17-97 8153 AM 10.06 10.69 9.98 12:02 pm N 12-24-97 10.20 N 12-31-97 9:01 AM 9,94 10.01

Monitoring Sta	ation	BA-1, Lowe	r Barnes Cre	ek at inle	to culve	ert under Kent - Des Moines Road
Observer(s)	. 	Iva Hays	- 24, 1100 010	CA ME INIC	to curre	Tre ander Ment - Des Mannes Man
, 01 (3)		114 Hays				100 100
Date	Time	Staff Gauge (feet)	Crest Gauge (feet)	Re-set Crest? (Y/N)	Rain- ing? (Y/N)	MAY 2 6 1998 Notes
1-7-98	9:06	10:15	10.39	у у	Н	110223
1-14-98	10:12	10.32	10.32	18	У	
1-21-98	9:40	10,00	10.67	y	<i>y</i>	
1-28-98	8:45	9.98	10.57	y	N	
- 4-97	9:30	10.10	10 - 10	N	У	
2-11-93	9:34	9.89	10, 13	У	N	
2-18-98	7:50	10,02	10.29	y	У	Rain light so far
1.25.98	9:45	10.00	10.08	y	N	
3-3-48	8:44	9.98	10.38	y	Ŋ	
3-13-98	8:40	9.97	9,99	У	Ν	
3 - 18 - 98	7:56	9.92	Can't Read	1/	11/2	A spider well in Tube
3-25-99	<i>פיט:</i>	10.06	10.45	y	у —	<i>U</i>
4-1-98	8:10	9.96	10.31	У	М	
4-8-98	8:59	9.90	9,94	У	N	
4-15-98				-		I was ill this week
4-22-97	8:12	9.88	9.92	У	1/	
4-29-95	7:04	9.88	9.89	У	N	
						I am having trouble
					 	reading the crest belowe
					· · · · · · · · · · · · · · · · · · ·	of algae That formed at the bottom of
						at the bottom of
	· .				· · · · · · · · ·	The Tube . How can I
						chien it out?
				· · · · · ·		
						Iva - 824-0157
	· · · · · · · · · · · · · · · · · · ·					

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 Staff Crest Re-set Rain-Gauge Gauge Crest? ing? Date Time (feet) (feet) (Y/N) (Y/N)Notes 9,97 5-13-98 9.97 10:00 Ŋ 9:05 Can't Read Have been 7.94 Ill - 3 w/s Cant Spider Web again in Tube 17-98 8:10 9.89 Road 1 Finally devised a Tube cleaner, Rained All last night, 10:20 N 10.05 10.25 9.90 8:19 10.04 N 8:20 9,90 9152 7-22-98 9,89 9,94 N 7:22 9.88 9.88 λ/ 6-98 8:40 9.88 9.88 8-13-98 12:35 9.88 9.88 N N 8-19-98 9:30 9.88 N 9.88 Rain yesterday 8:08 8-25-98 9,89 **N** -9.89 8317 9.58 N 9.88 9:50 9-17-98 9.89 Ŋ 9.89 9-24-98 8:49 9.90 9.90 N 9.92 8:59 9,90 Ŋ 10-898 feeling again missed 10-15-98 9,89 8:58 10.22 10-29-98 8:04 9.89 10.07 N The main channel has moved 9,86 8:40 10,80 11-12-98 8:00 9.90 94 Corx Dust Added 11-20-97 9:30 10.01 10.01

			-	_	_	m Stream Level Record
Monitoring Sta	ition		r Barnes Cree	K at iniet	to cuive	ert under Kent - Des Moines Road
Observer(s)		Iva Hays	· · · · · · · · · · · · · · · · · · ·			
		Staff Gauge	Crest Gauge	Re-set Crest?	Rain- ing ?	
Date	Time	(feet)	(feet)	(Y/N)	(Y/N)	Notes
12-2-98	8:55	10.21	3 in fron Top	Y	N	Above the guage
12-9-98	8:55	10.00	10.24	У	N	J ,
12-16-98	10:54	10.01	11,12	У	Ŋ	
12-23-98	9:20	9.92	10.14	У	N	
						Ill for 2 with during snow Flood caused over flow
1-8-99	8:58	9,96	No Dust	У	N	Flood caused over flow
1-12-99	8:59	9.96	11	У	Y	Replaced cork dust
1-21-99	9:35	10.09	10.64	У	À	, and the second
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	У	N	
3 - 24 - 99	8:36	10.28	10.56	У	_y	
3- 17-99	9:38	10.01	10.51	у	У	
3- 26-99	9:11	9,98	10.01	У	N.	
4-1-99	8:42	7.99	10.21	У	N	
4-8-99	8:28	9.98	10,23	У	N	
4-22-99	8:40	9,9,3	9,98	У	Ŋ	
4-29-99	8:25	9.94	10.00	у	Ŋ	Addre Conk Dust
						·
						· ·
						100

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 Staff Crest Re-set Rain-Gauge Gauge Crest? ing? Date Time (feet) (feet) (Y/N) (Y/N)Notes 5-6-99 9,92 8:46 10.04 N 5-13-99 8:15 7.89 10.00 Ŋ 9.92 5-19-99 8:10 Ŋ 10.03 5-26-99 8:16 9,92 Ŋ 10.06 - 9-99 8:20 9,91 9.93 Yesterday a record rain 6 - 24 - 99 8:25 10.01 10,69 8:00 9,98 7-7-99 9.98 y Thunder stom hast night 8:18 10.08 7-16-99 22 N 7-21-99 9.98 8:50 9.98 N N 7-28-99 9:20 9.98 9,98 N \mathcal{N} Thunder Stom 8-13-99 8:10 9.98 10,21 K 8-18-99 8:09 9.98 10.07

Des Moines Water Quality Monitoring Program

Monitoring station

Observer(s)

Parkside (mc-1)

	hradeyn Asansach (is	Gange heid	hts (ft)		reference, week Starte	ى رىدانلىۋىرىلىدىلىدىلىق يېروس	California Latas		
)afé	Time	Staff.	Crock	deitiole	D-10		Currie Derai	ःः (११) था •	
11/1/01/	2	5 A	504 504 504 500 500 500 500	Jiiitta:3	Date @gray	T IMC	<u>्राचार ः ः</u>	Crest	Initials 🐃
Malau	8,450m		50	 					
1111110	8/72/11	 - • • • •	· 2 //	 					
11 190 193	9:33 8:12	•	· } \frac{2}{2}						
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11 30 04	X		<u>515</u>						
B/5/94	8.3		<u></u>						,¥
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Des Moines Water Quality Monitoring Program

	Monitoring station	Μ	L-1						
	Observer(s)	Purk	ide E	e men ta	.~~			· · · · ·	
		Gauge heigh					Gauge heigh	its (ft)	
/	Date Time	Staff	Crest	Initials	Date	Time	Staff	Crest	<u>Initials</u>
	10/3110/35	1.34	2.8	+//		ļ			
19-1	11/6 2:18	1.0	1.6	D, B					
95)	NOV. 9 2:10	2.0	4.8	D.P.					
	11/16 (0:40	7.3	3. 0	44					
	1000 11000	1.10	1,6	5/2				.*	
>	11/30 12:20	3.0	5,0	CIA.					
(1/11/9/2:00	9.5	6.0	7).C.	<u> </u>	<u> </u>			
963	7719 200	3.0		SA					
46)	3/2/1 2:70	7.0	3,4	470					
	7/1 2	-5/0	3.0						·!
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Des Moines Water Quality Monitoring Program

Monitoring station	mc-2	(lower	misorly)	
Observer(s)	Wayne	matthew.	,	

			Gauge beigt	A CONTRACTOR OF THE PROPERTY O				Gauge heigh		
ļ		Time				Date	Time "	Staff	Crest	Initials 🛴
ļ	11.4.94	1420	8.68	0.81	MM /30					
l	11.7.94	9 15	0.52	0.72	WM					
l	11.14.94	915	0.50	0.69	u/el					
l	11.21.94	9 15	0.42	1.00	WM					
l	11-29-94	9 45	0.57	0.86	WM					
I	12-5-94	9:00	0.48	0.50	MM	-1				
l	12.12.94	9:45	0,46	0.64	WM.					
l	12.19.94	8:50	0.65	0.96	WM.					
l	1.4.95	2:25	0.40	1,53	nm					
I	1-9-95	10:15	0.51	0.56	Won					
I	1-17.95	11:00	0.43	0.72	WM.					
ı	1.31.95	8:50	0,96	1.05	WAK rain			١.		
ĺ	2-27-95	11:00	0.40	1.60	WM clogs					
I	3-6.95	10:00	0.25	0.50	MM clods					
ı	3-21-95	9:50	0.45	0.84	Van Park				·	
I	3.27-95	9:30	0.32	0,90	and-					
Į	5AUB	BAGS	REMOVE	D						7.2 00.000
ĺ	5.8.95		0.37		mia					
I	5.15.95	400	0.36	0.41	unter F					
İ	5.22.95	1015	0.34		um France					
į	5.30.95	1130	0.38		60 5127 AGE	-				
Ì	L.K.95	300PA			POU FIRM					
l	6-12.95	10 00	0.35							
Ì	6.2795		0, 2-8	0.75	MANY 2-3"					
ı	7.3-95		0.738	0.49	1					
Ì	7.18.95		0.29	0.80	PSSY					
I	58-3.95			0.65	some FISH					
I	9-8.95		0,28	0.74	(A.Con)					
١	9.21.95	950	0.27		um					
١	10.2.95	24500	0.31	0.60	Yern.					
į	6.19.95	315pm	0.33	1.18	an				<u> </u>	
Ì	10.30A5	11204		0.62	(ma)					
I	11-14-95		A = A		The Salvan				· ·	
ı	12-11-95			136	172414		· · · · · ·		 	
١		11 45 an		1,01	 					
١		11 40 An		0.95		<u> </u>				
١	1201	11 TV AM	251		m	 				
į	1-2-76	3/5Pm	0.01			 	 		 	
1	1-12-76	ZOOPA	0.46	1.35	m	 			 	
ł	1-2296	400 pm	טס,טן	1.65	par	}		ļ 		
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ı								<u> </u>		
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Des Moines Water Quality Monitoring Program

Monitoring station

Wayne Mothews - City of Des Moines

Observer(s)

		hts (ft)		
Date	Time	Staff	Crest	Initials
i- 3-96	315 P	0.51	1.05	Dr
1-12-96	200 p	0,46	(, 35	m
1-22-96	400 7	0,60	1.65	um
2-7-96	1030 A	0,69	1,20	(NI)
2-8-96	320 P	1.45	2.06	(Min
2-12-96	335 p	0,48	1.75	WM
2-20.96	1135 _A	0.57	0,92	WM .
3.6.96	Z00 p	0.40	0.85	9111
4.11.96	1015 A	0,40	0.85	W)
4-25-96	200 p	0.72	1.64	WM .
4-26,96	1130 A	0.61	1.05	m
5-15-96	310 P	0,50	(2) 0.70	Two Creost rings.
9-3-96	1050 A	0.78		ion
9-3-96	150 p	0.30	0.74	
·				

Note: Gauge is difficult to read during -

Des Moines Water Quality Monitoring Program

Monitoring station

Lower Mc Sorley Creek Mc-2 Wayne Matthews - City of Des Moines

Observer(s)

Gauge heights (ft) Staff Crest Date Time Initials wm 12.31.96 1055 A 2.03 1,00 m 1,85 0.55 1-10-97 200 PM com 300 PM 1,50 2-3-97 0.48 2-12-97 910 AM 0.82 0,60 won 3-27-97 0-45 1030 AM 400 0.55 245 PM 0.42 4:14-97 140 pm 0,70 0,51 4-29-97 wan 4-6 Fish 0.64 1030 An 5-12-97 0.33 observed - 2"-3" long um 6+ Fish 1130 AM 6-9-97 0.34 observed 2"-3" long um 12-16.97 1145 AM 0.90 Rain event. CAP MISSING 1040 AM 4-29-98 0.62 0,80 6-2" FISH DESERED