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SAMPLING AND ANALYSIS OF THE GENESEE RIVER TO ASSESS WATER QUALITY IMPACTS OF THE FORMER SINCLAIR REFINERY SITE

June 1999

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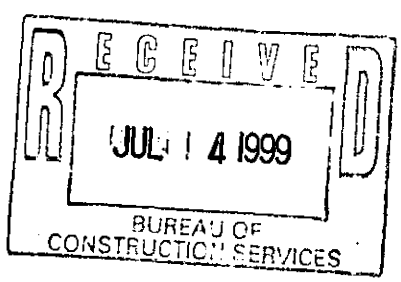

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EXECUTIVE SUMMARY

The former Sinclair Refinery site, which is located along the Genesee River in Wellsville, NY, has an active groundwater system in operation. One of the primary objectives of this system is to minimize any effects to the Genesse River. The objective of the study was to assess the water quality of the river by sampling the river upstream and downstream of the site at low water conditions.

Five surveys were performed between 4 August 1998 and 6 October 1998, when flow in the river was low according to data provided by the U.S. Geological Survey (USGS) for the gaging station at Wellsville. River flow at the USGS Wellsville gage generally decreased through the sampling period to approximately 20 cfs, which is equivalent to the 30-day, 10-year recurrence low flow (30Q10) that is appropriate for assessing compliance with water quality standards set to protect human health (NYSDEC 1998). The water surface of the river adjacent to the site was gaged routinely, along with groundwater elevation in monitoring wells adjacent to the river.

Two transects were used for sampling and flow (velocity, depth) measurements: one was near the upstream edge of the site and the other was near the downstream edge of the site. The two transects were approximately 5250 ft from each other. Five sampling points were spaced evenly along each transect to collect river water at fixed distances away from the site. In addition, the river was sampled from its bank at the former water intake pipe, which is approximately 2000 ft downstream of the downstream transect. Previous site monitoring has identified the following eleven contaminants of interest (COI) in groundwater adjacent to the Genese River:

- Benzene
- Toluene
- Ethylbenzene
- 1,2-xlyene
- 1,3- and 1,4-xylene
- 1,1-dichloroethane
- cis-1,2 dichloroethene
- 1,1,1-trichloroethane
- Vinyl chloride
- Nitrobenzene
- Arsenic

Sampling and analytical procedures conformed to the requirements of the site Quality Assurance Project Plan and included field duplicate and spiked samples for quality control.

Groundwater elevations in the site monitoring wells generally declined through the sampling period, except for a temporary increase in level at several wells located downgradient of the groundwater extraction field in the Northern area of the site. This increase occurred after the first survey when pumping from the extraction wells stopped because of a treatment problem. Pumping did not resume until after the fifth survey was completed.

All 11 COIs and other EPA Method 8260 analytes were reported as below their practical quantitation limits (PQL) for samples collected at the transect upstream of the site. Only three COIs were measured at concentrations above their PQL in samples collected at the transect downstream of the site:

- Ethylbenzene
- 1,3- and 1,4 Xylene
- Nitrobenzene

Samples having greater-than-PQL concentrations were collected at either the first and/or the second sampling point from the west bank (i.e., site) of the river at the downstream transect. Only one COI, nitrobenzene, was found above the PQL (0.20 µg/L) in samples taken at the former water intake. All other EPA Method 8260 analytes were below PQL in all samples downstream of the site.

The maximum concentrations of ethylbenzene, 1,3- and 1,4-xylene and nitrobenzene were compared to NYSDEC's water quality standards. Only nitrobenzene was found in concentrations greater than the State's standard (0.4µg/l).

During the fifth survey three additional river samples were collected between the upstream and downstream transects at 10% of the total river width from the west bank for analysis of nitrobenzene. Two of these three samples had measurable concentrations of nitrobenzene: one was immediately upstream of the lower dam, just downstream of the drainage swale; the other was downstream of the lower dam and adjacent to the groundwater extraction wells.

The flow-weighted average and measured nitrobenzene concentrations at the downstream transect were analyzed for relationships with river flow and groundwater elevation. A slight inverse relationship was found between nitrobenzene concentrations at DS-B and

WI and river flow; that is, as flow decreased, nitrobenzene concentration increased. There is no apparent correlation between river flow and flow-weighted average nitrobenzene concentration or nitrobenzene concentration at DS-A. The third survey had a relatively high nitrobenzene concentration (54 µg/l) in one sample that resulted in a flow-weighted average concentration of 12.87 µg/l for the transect. The nitrobenzene loading for this survey was greater than six times that of the next highest (fifth) survey.

Groundwater has been sampled from monitoring wells on the site between May 1993 and December 1998 and analyzed for nitrobenzene and other COIs. Nitrobenzene concentration of monitoring well (MW-70) adjacent to the river, varied from less than 50 µg/l (in December 1998) to 62,000 µg/L (in April 1998). Nitrobenzene concentrations in groundwater are approximately 1,000 to 10,000 times the concentrations found in the river adjacent to the site. Therefore, groundwater discharge to the river adjacent to the site at very low flow rates is diluted enormously before passing the downstream transect at mid-depth.

CHAPTER 1

INTRODUCTION

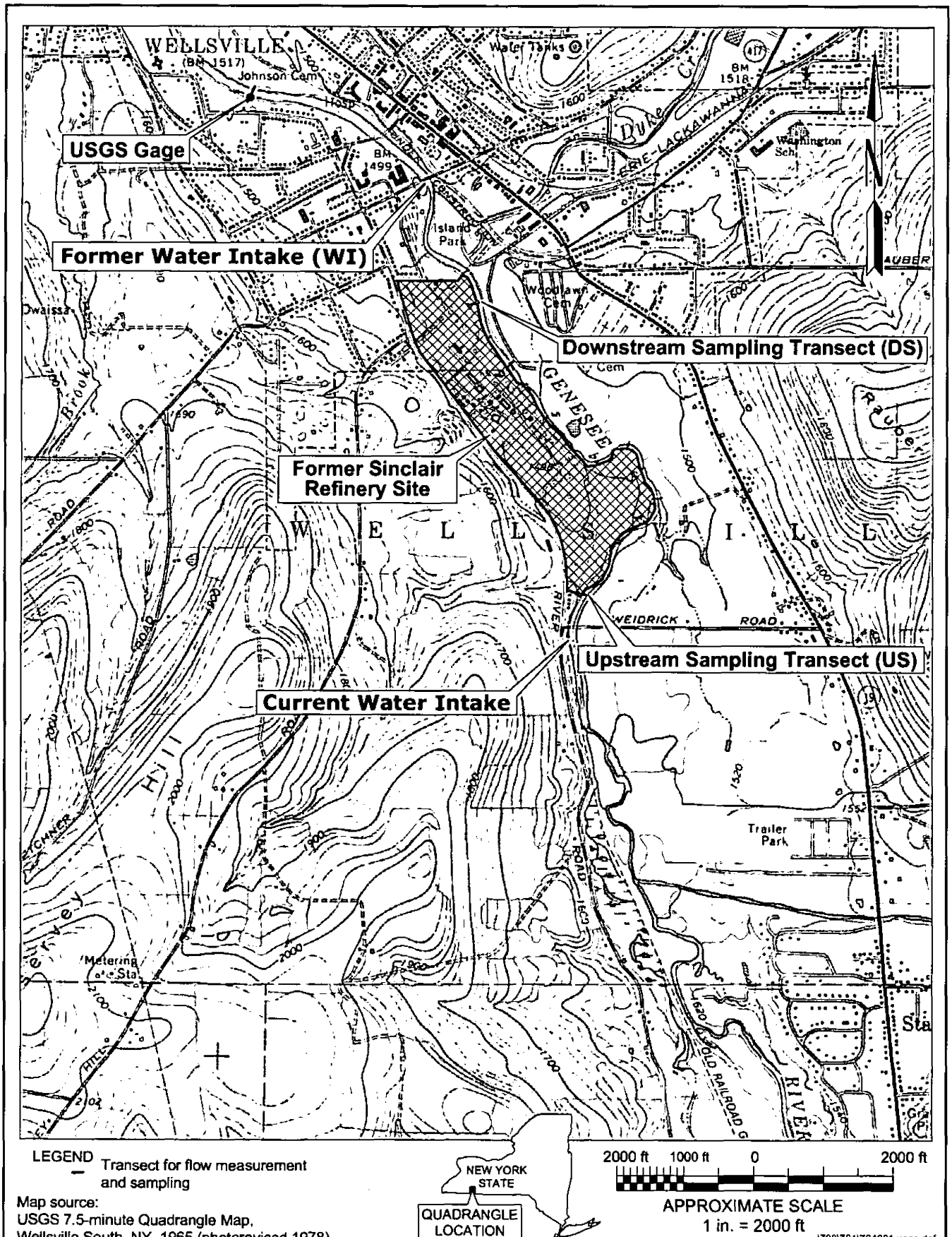
1.1 OVERVIEW

The former Sinclair Refinery site is has an active groundwater remediation system in operation. One of the primary objectives of the system is to minimize effects to the Genesse River. Sampling and analysis of the Genesee River is relevant to assess the current and future water quality impacts of the groundwater flow from the site to the river. The primary contaminants of interest (COIs)* identified in site groundwater are: benzene, toluene, ethylbenzene, xylene (1,2-, 1,3-, and 1,4-xylene) (BTEX), nitrobenzene, 1,1-dichloroethane, cis-1,2-dichloroethene, 1,1,1-trichloroethane, vinyl chloride, and arsenic.

The primary bases for the assessment are the water quality standards promulgated by the New York State Department of Environmental Conservation (NYSDEC). The Genesee River adjacent to the site is classified as Class A, which has an intended use as drinking water. The Class A designation of the Genesee River extends from the mouth of Dyke Creek to Stannard Road bridge, which is south of the mapped area in Figure 1-1. NYSDEC's standards for ten of the COIs are summarized in Table 1-1 There is no surface water standard for vinyl chloride.

As the water quality standards for the 10 organic substances and the controlling standard for arsenic are set to protect human health via a drinking water source, the 30-day, 10-year recurrence low flow (30Q10) is the appropriate flow for the assessment according to NYSDEC's Division of Water Technical and Operational Guidance Series (TOGS) 1.3.1. Total Maximum Daily Loads and Water Quality-Based Effluent Limits (NYSDEC 1998). The U.S. Geological Survey (USGS) operates a flow measurement gage of the Genesee River, which is located downstream of the site and downstream of the confluence with Dyke Creek. These data were analyzed as part of this study to estimate the 30Q10 flow and to set a target flow for sampling the river.

* As the laboratory analytical method used in this study measured the sum of 1,3- and 1,4-xylene, the combination of these two isomers is referred to as one COI. Thus, there are 11 COIs.



Map source:
USGS 7.5-minute Quadrangle Map,
Wellsville South, NY, 1965 (photorevised 1978).

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Lawler, Matusky & Skelly Engineers LLP One Blue Hill Plaza • Pearl River, New York 10965 ENVIRONMENTAL SCIENCE & ENGINEERING CONSULTANTS	**Genesee River Study Area** **Former Sinclair Refinery Site at Wellsville, NY**	**Figure 1-1**

TABLE 1-1

NYSDEC WATER QUALITY STANDARDS FOR CLASS A WATERS - CONTAMINANTS OF INTEREST FOR FORMER SINCLAIR REFINERY SITE AT WELLSVILLE, NEW YORK

SUBSTANCE	CRITERION (µg/l)	TYPE[a]
Benzene	1.0	H(WS)
Ethylbenzene	5.0	H(WS)
Toluene	5.0	H(WS)
1,2-, 1, 3-, and 1,4- xylene (each isomer)	5.0	H(WS)
1,1-Dichloroethane	5.0	H(WS)
cis 1,2-Dichloroethene	5.0	H(WS)
1,1,1-Trichloroethane	5.0	H(WS)
Vinyl chloride	-	
Arsenic (dissolved)	50	H(WS)
Arsenic (dissolved)	150	A(C)
Arsenic (dissolved)	340	A(A)
Nitrobenzene	0.4	H(WS)

[a]Type:
H(WS) = Health (Water Source)
A(C) = Aquatic (Chronic)
A(A) = Aquatic (Acute)

1.2 PREVIOUS RIVER WATER SAMPLING

The Genesee River adjacent to the site was previously sampled several times between May 1984 and July 1994 for analysis of one or more of the COIs. The data from these surveys indicated that concentrations of the COIs adjacent to the site were generally greater under low-flow (23 cfs at USGS gage) than high-flow (106 cfs) conditions. Since the groundwater at the site has undergone remediation subsequent to the earlier sampling, additional river sampling was required in 1998 to obtain data on present levels of COIs. The sampling was performed during low-flow conditions to assess compliance with water quality standards at critical low-flow conditions.

1.3 OBJECTIVES

The objectives of this study were to:

- Obtain data necessary to assess the impacts of the site on concentrations of COIs in the Genesee River.
- Assess compliance with respect to the New York State Department of Environmental Conservation (NYSDECs) water quality standards for COIs under 30Q10 conditions.

1.4 PROJECT ORGANIZATION

This report fully describes the water quality study, which was performed primarily by Lawler, Matusky & Skelly Engineers LLP (LMS), under subcontract to Envirogen, Inc. Most of the field data were collected by On-Site Health & Safety Services, Inc. (later referred to as On-Site), of Wellsville, New York. The analytical laboratory was Columbia Analytical Services of Rochester, New York.

1.5 REPORT ORGANIZATION

The rationale and approach to the sampling and measurements are described in Chapter 2, Sampling and Measurement Plan. The sampling protocols and analytical laboratory methods are provided in Chapter 3. River survey results and the analysis of the data are presented in Chapters 4 and 5, respectively. The conclusions are put forth in Chapter 6.

CHAPTER 2

SAMPLING AND MEASUREMENT PLAN

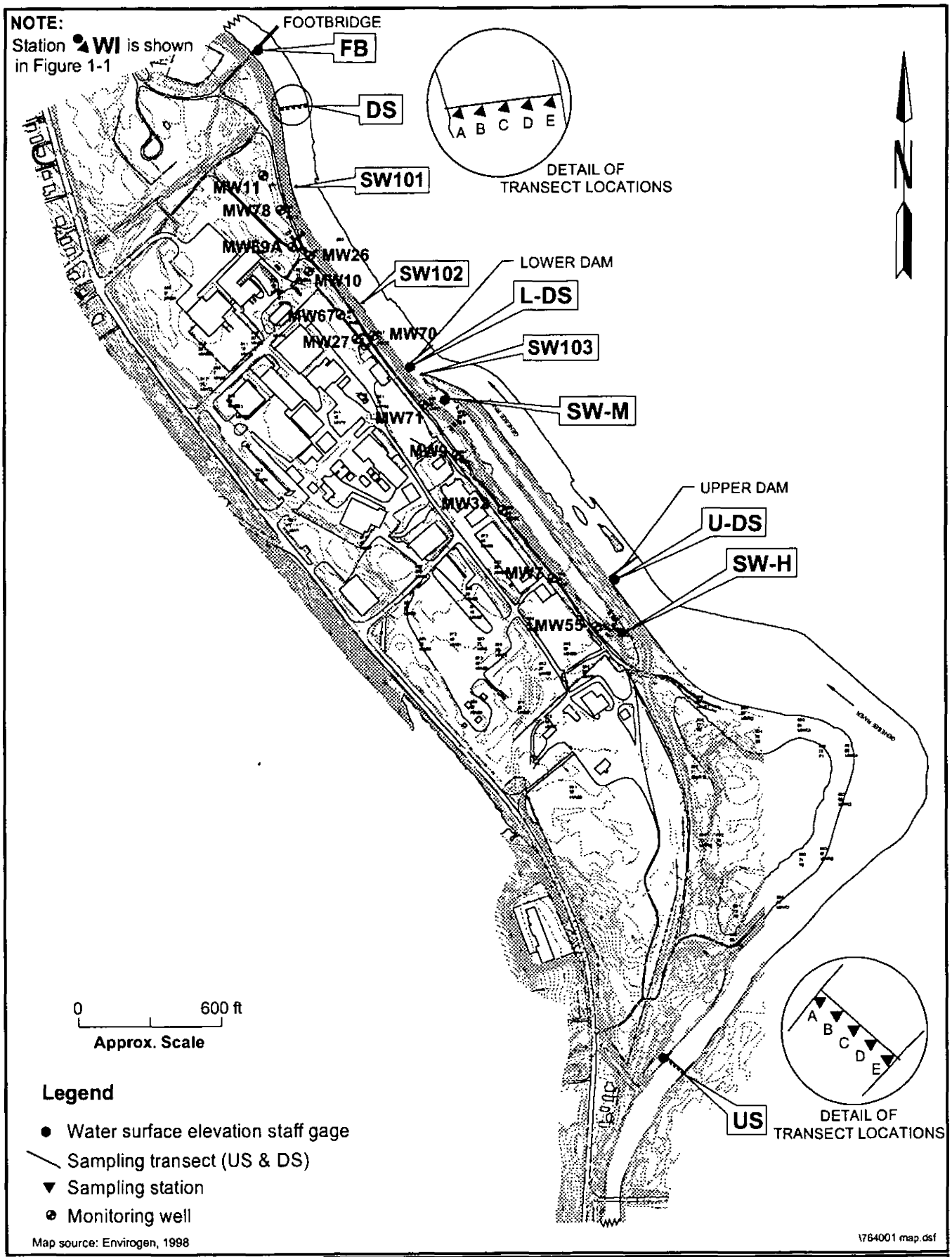
2.1 GENERAL APPROACH

Two sampling transects were used to measure the site's loading of COIs to the river: one near the upstream edge and the other near the downstream edge of the site boundary. The purpose of the upstream transect was to define the levels of COIs where the site has no impact and thereby have a control point. The purpose of the downstream transect was to monitor the river for contaminants near the downstream edge of the site. Sampling and measuring flow (velocity and depth) along these two transects was performed under low-flow conditions by wading in the river. The river was sampled from the bank at station WI to assess water quality at the downstream intake. The design of the sampling and measurement plan and the procedures for identifying appropriate low-flow conditions are described in the following sections.

2.2 RECONNAISSANCE SURVEY

A reconnaissance survey was made on 29 and 30 June 1998 by LMS, Envirogen, and On-Site personnel to locate the two transects at suitable positions in the river where wading is practicable. The upstream transect, US, is located approximately 600 ft downstream of the Weidrick Road Bridge in relatively shallow water (Figure 2-1). The downstream transect, DS is located approximately 400 ft upstream of a footbridge in slightly deeper water. Transect DS is located approximately 5250 ft downstream of transect US (measured along the western bank of the river).

The distance from the downstream transect (DS) to the former water intake station (WI) is approximately 2000 ft and the incremental drainage area is minimal. A major tributary, Dyke Creek, which has a drainage area of 71.4 miles^2 (25% of drainage area of Genesee River at the USGS Wellsville gage), joins the Genesee River immediately downstream of the water supply intake. The USGS flow gaging station, Genesee River at Wellsville (Station 04221000), is located approximately 3200 ft downstream of the confluence of Dyke Creek (see Figure 1-1).



LMS Lawler, Matusky & Skelly Engineers LLP One Blue Hill Plaza • Pearl River, New York 10965 ENVIRONMENTAL SCIENCE & ENGINEERING CONSULTANTS	**Site Map and River Sampling and Measurement Locations** **FORMER SINCLAIR REFINERY SITE, WELLSVILLE, NY**	**Figure 2-1**

Flow in the Genesee River passes over two low-head dams (drop structures) adjacent to the site, labeled "upper dam" and "lower dam" on Figure 2-1. The stage or depth of flow along reaches of the river between US and WI is relevant to tracking temporal hydrological trends during the period of study. The water surface elevations of the river and the adjacent drainage swale were measured during the sampling period by installing staff gages that were surveyed to a common datum (i.e., mean sea level). The locations of the seven staff gaging stations installed during the reconnaissance survey are shown in Figure 2-1 and listed as follows:

1. Upstream transect (US)
2. Head of swale (SW-H)
3. Mouth of swale (SW-M)
4. Upper dam (U-DS)
5. Lower dam (L-DS)
6. Footbridge (FB)
7. Water Intake (WI)

2.3 SAMPLING STRATEGY

The strategy for sampling the Genesee River was to sample at five stations spaced evenly along each transect. Analyses of separate samples along each transect provide data to assess the probable source of COIs. Depth and river velocity were measured every 5 ft across the transects to provide data for evaluating the river flow associated with each subwidth sample. A total of eleven river water samples were collected: five each at the US and DS transects and one at WI.

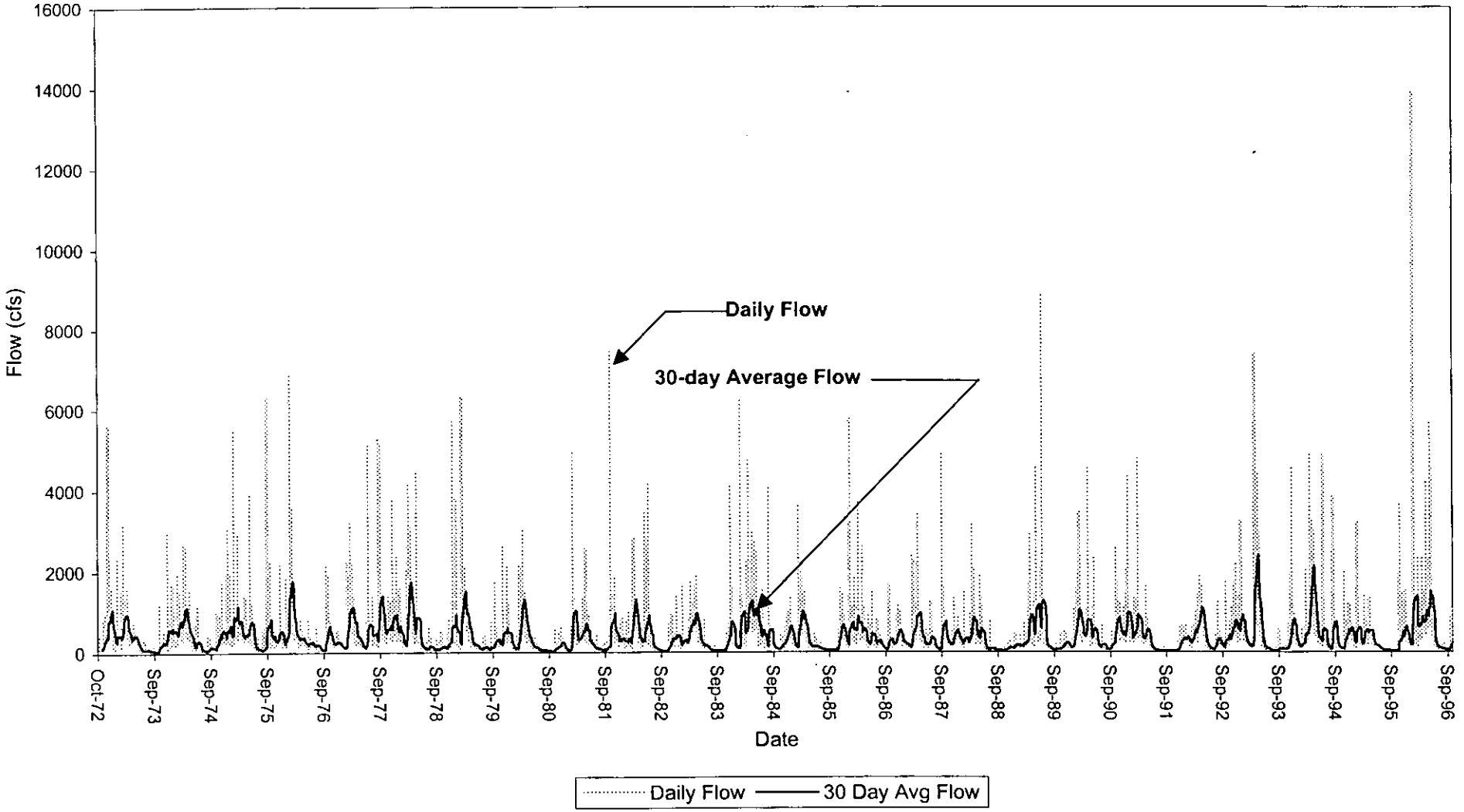
2.4 TARGETED FLOW FOR SAMPLING

Five water quality surveys were planned to sample the river during low river flows. In order to determine target flows for the five sampling events, historical streamflow data from the USGS gage (number 04221000) located on the Genesee River at Wellsville, New York, were analyzed to compute the 30Q10 flow. Figure 2-2 shows the daily flow and the 30-day running average flow for the Genesee River at Wellsville from October 1972 to September 1996.

Figure 2-2

Daily and 30-Day Average Flows

Genesee River, USGS Gaging Station at Wellsville, NY, October 1972 - September 1996



The yearly minimum 30-day average flows were calculated and a histogram was developed to show the recurrence interval for each year of flow (Thomann and Mueller 1987). Figure 2-3 shows the results of the 30Q10 analysis; the 30Q10 flow for the Genesee River at USGS Wellsville Station was calculated at approximately 20 cfs.

Historical flow data were reviewed to set a target flow for performing the water quality surveys. Figure 2-4, illustrates that the daily flow has not consistently fallen below 20 cfs in the past 24 years. Periods when flows were below 20 cfs were very brief. However, flows of 80 cfs generally occur each year and often remain lower than 80 cfs for extended periods. Therefore, an assumed flow of 80 cfs at the USGS gage was used as a target to begin sampling.

Data from the USGS rating table for the Wellsville gage were used to produce a rating curve (Figure 2-5). At the target flow of 80 cfs the stage at the USGS gage is approximately 4.49 ft. As the gage reports the stage in tenth of a foot increments, a river stage of 4.5 ft or lower indicated appropriate sampling conditions.

2.5 MONITORING RIVER FLOW AND RAINFALL

River flow, precipitation in the watershed, and precipitation at the site were monitored to confine the sampling to dry-weather conditions. The Internet was used to monitor river flow (stage) and precipitation through the following web sites:

- U.S. National Water Information Survey (NWIS) operated by USGS, which provides real-time river stage data at USGS' Wellsville gage
- National Weather Service, operated by Cornell University, provides forecast for Allegany County, including City of Wellsville
- National Precipitation Image, operated by WSI Corporation, which provides estimated precipitation for 24-hr period preceeding 0700 hr eastern standard time

These web sites were accessed daily starting on 27 July 1998 to check for appropriate flow and rainfall conditions. Rainfall at the site is read and recorded each workday morning (generally Monday through Friday). When appropriate flow conditions appeared, On-Site was requested to check on rainfall during the preceeding 48 hrs. If

Figure 2-3

30Q10 Analysis

Genesee River, USGS Gaging Station at Wellsville, NY, October 1972 - September 1996

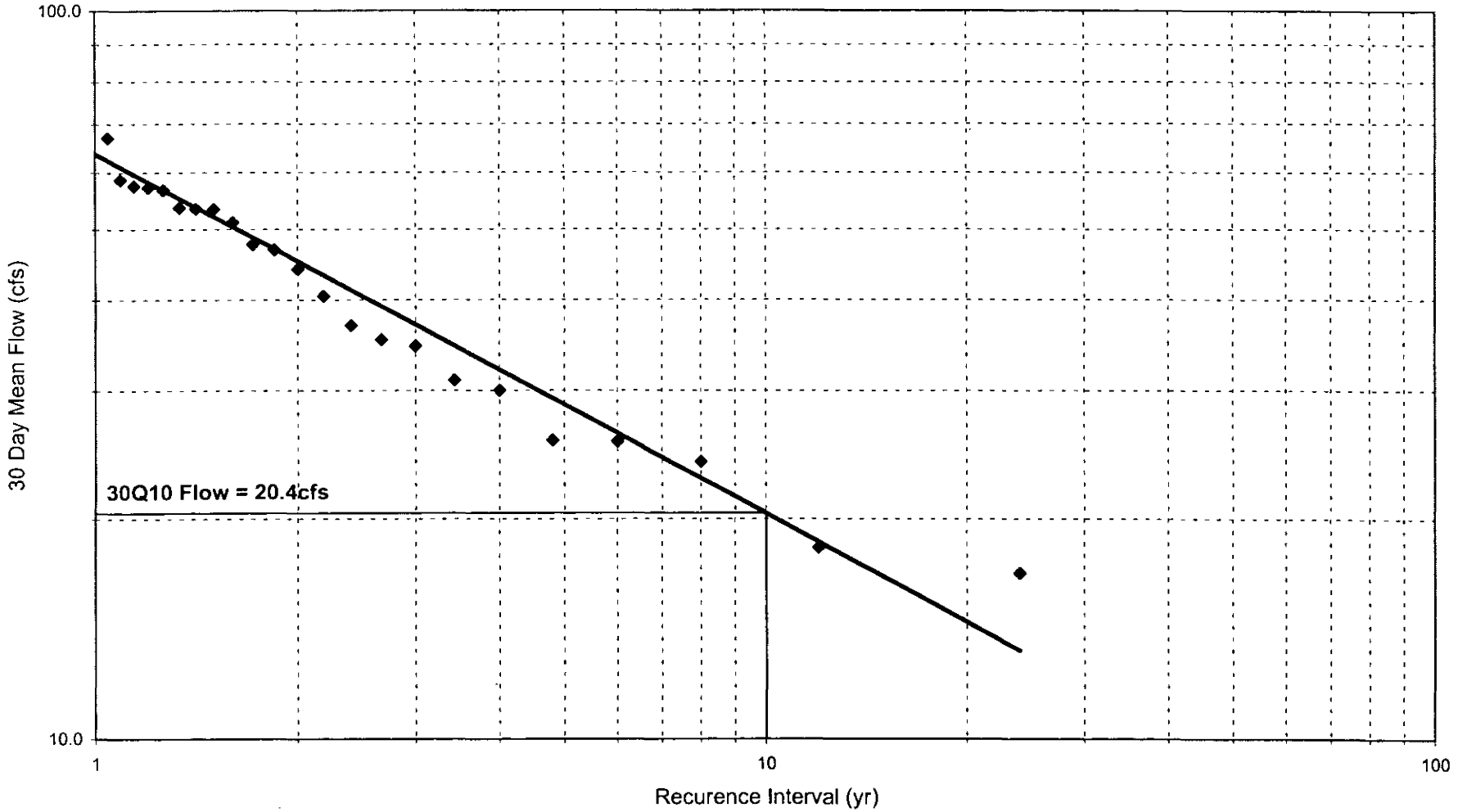


Figure 2-4

Target Flow and 30Q10 Flow

Genesee River, USGS Gaging Station at Wellsville, NY, October 1972 - September 1996

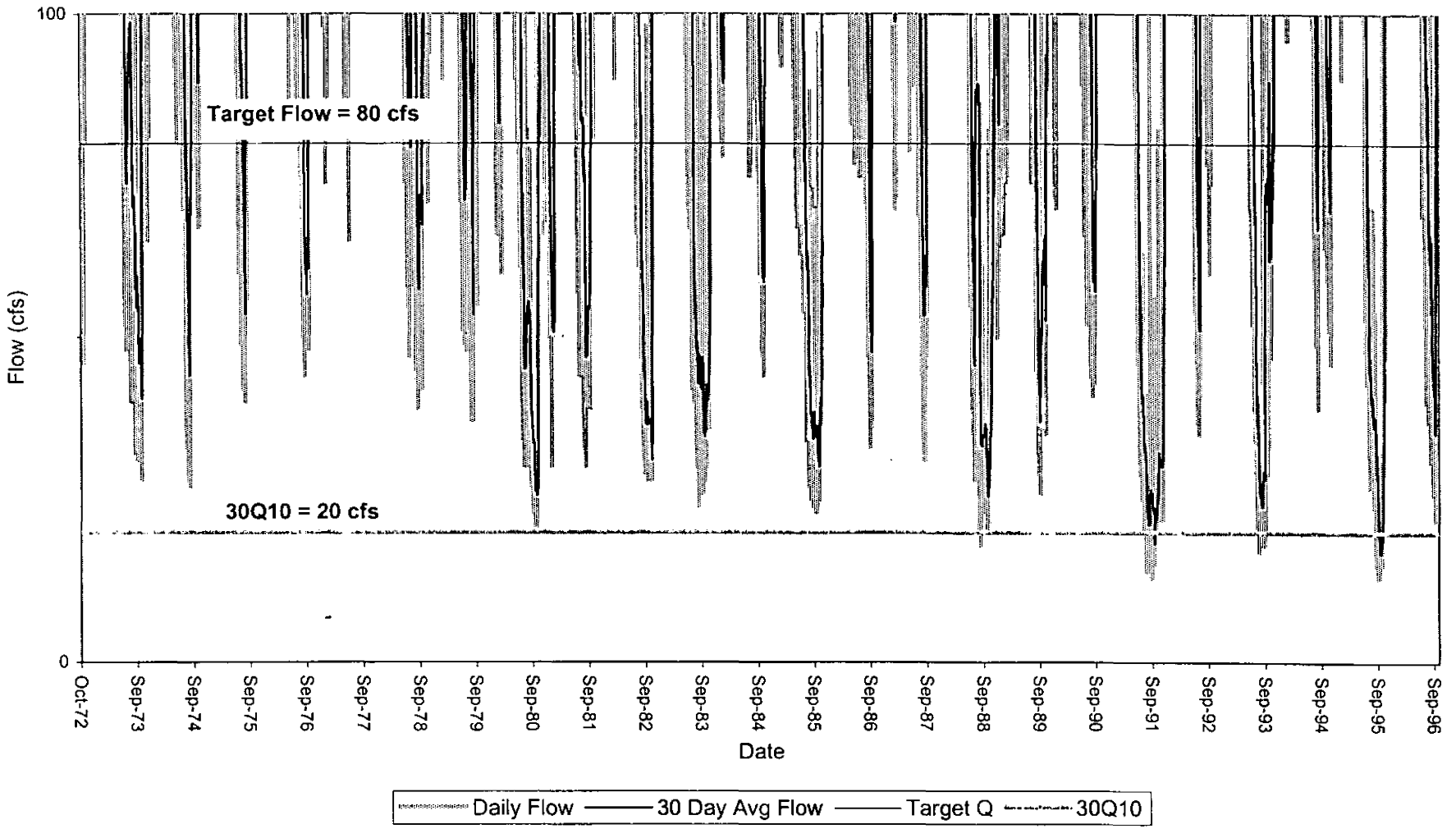
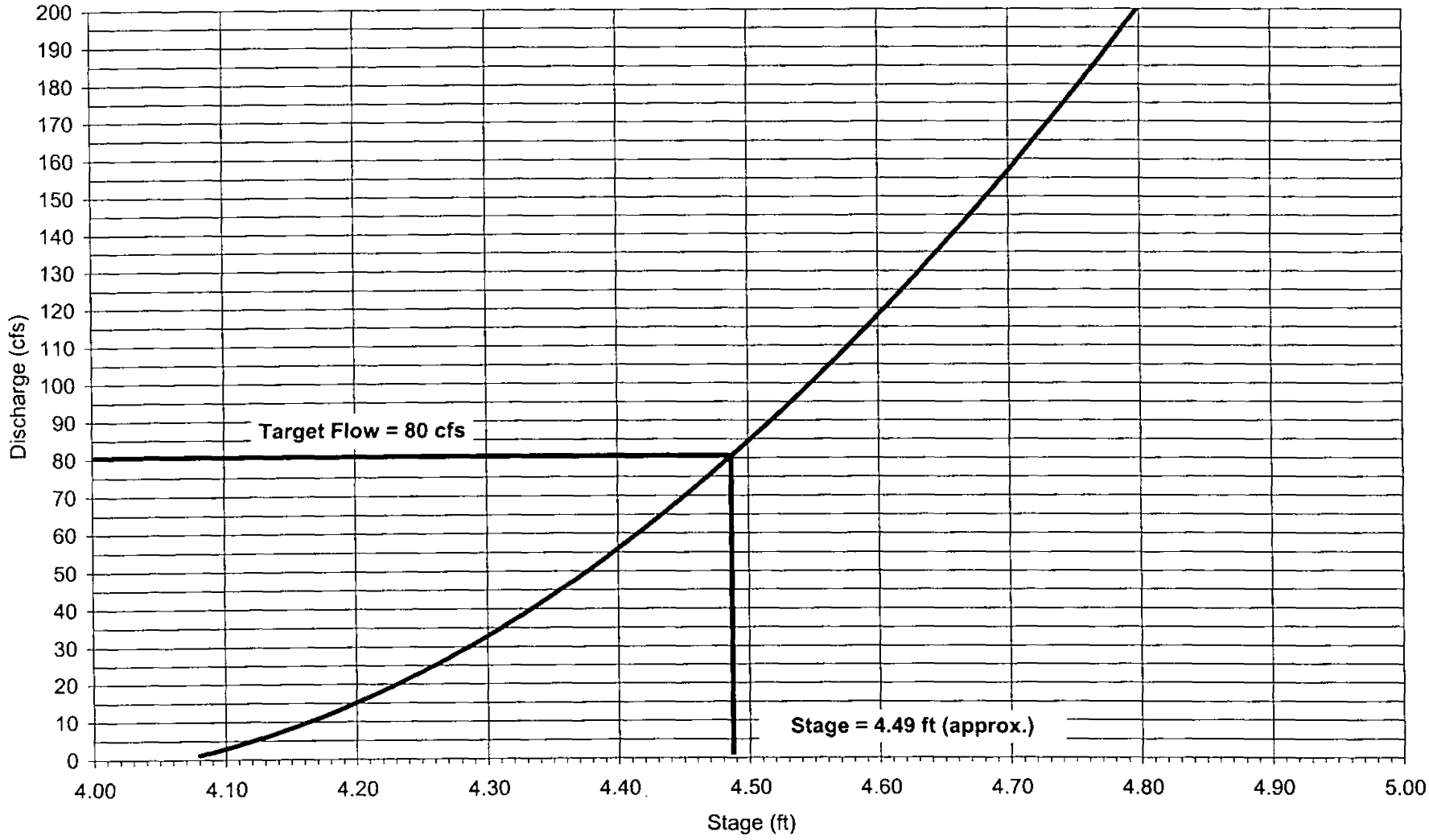


Figure 2-5

Rating Curve, 0 - 200 cfs

Genesee River, USGS Gaging Station at Wellsville, NY, October 1972 - September 1996



rainfall at the site and in the watershed did not exceed 0.1 in. during the preceeding 48 hrs and river flow was within the targeted range, a survey was initiated.

LMS, Envirogen, and On-Site coordinated the scheduling of surveys to allow approximately seven days or more between surveys so that Columbia Analytical Services (CAS) could complete their work on the previous survey's samples.

CHAPTER 3

MATERIALS AND METHODS

The methods employed for the sampling and field measurements are presented first, followed by the analytical laboratory methods.

3.1 FIELD SURVEY ACTIVITIES

The sequence of sampling was from downstream to upstream (i.e., WI, DS, and US). At transects DS and US, sampling preceded the measurements of depth and velocity. An LMS field technician served as crew chief for the first field survey to instruct On-Site field technicians in the protocols. The remaining four surveys were conducted by On-Site.

3.1.1 Sampling

River water was sampled at middepth by immersing the sample container and slowly filling it through the partially opened cap. Care was taken to minimize turbulence and formation of bubbles. All sample containers were provided with preservatives, as required, by Columbia Laboratory. The pH of the sample was measured using an Oakton pH Testr 3 with Automatic Temperature Compensation (ATC) and the temperature was measured using a Corning Checkmate 90. An aliquot of each sample was filtered (0.45 micron pore diameter) in the field for subsequent laboratory analysis of dissolved organic carbon. Sampling personnel recorded the following on field data sheets:

- Date/time (start and end of sampling at transect)
- Transect/station number
- Depth of station
- Bottle number
- pH
- Temperature
- Gage height (start and end of sampling at transect)

The total width of the river was estimated at transects US and DS. Samples were collected at five equally spaced positions, 10, 30, 50, 70, and 90% of the total width. The

five sample containers were labeled "A" (adjacent to site) through "E" (opposite side). For example, the sample labels at the transect US and percent of river width are:

US-A	10%
US-B	30%
US-C	50%
US-D	70%
US-E	90%

A mid-depth sample of the river was collected from the former intake structure at Station WI. One of the 11 sampling stations was sampled in duplicate (i.e., field duplicate) as required by the site Quality Assurance Project Plan*. The station was designated by LMS/Envirogen prior to the survey. The duplicate sample was taken within five minutes of the original sampling. All sample containers were packed in coolers with chain of custody forms and sent by an overnight carrier to Columbia Analytical Services in Rochester, New York. Three additional samples collected between the two transects (US and DS) during the fifth survey were labeled SW 101, SW 102 and SW 103 (see Figure 2-1) and are described in Sections 4.4.1 and 5.2.

3.1.2 **Flow Measurements**

Flow velocity and depth were measured at 5-ft intervals across transects US and DS. A "tag line" perpendicular to the direction of flow was set between the banks of the river. A hand-held, battery-powered velocity meter, Marsh-McBurney Flo-Mate™ Model 2000, which has an electromagnetic velocity sensor, was used. The manufacturer states that the meter is accurate to ±2% of the reading in the range from –0.5 to 20.0 fps. The meter was mounted on a Topset™ wading rod. The water depth at each point of measurement was measured by the meter and the velocity probe was moved to a point on the rod that was at 60% of the water depth below the water surface. The velocity probe was positioned perpendicular to the tag line; any deviation between the probe position and the perpendicular was noted in terms of the angle. Depth and velocity measurements were automatically logged by the meter and the data were subsequently transcribed to data sheets. All field data sheets were sent to LMS for review and analysis of flow, as described in Section 4.2.

*Operations and Maintenance Quality Assurance Project Plan, Groundwater Treatment System, Remediation Technologies, Inc. (November 1994).

3.2 LABORATORY ANALYSES

Each sample was analyzed for the following constituents using analytical methods that attain these practicable quantition limits (PQL):

ANALYTE	PQL
Benzene	0.5 µg/L
Toluene	0.5 µg/L
Ethylbenzene	0.5 µg/L
1,2-Xylene	0.5 µg/L
1,3-Xylene and 1,4-xylene	0.5 µg/L
1,1-Dichloroethane	0.5 µg/L
cis-1,2-Dichloroethene	0.5 µg/L
1,1,1-Trichloroethane	0.5 µg/L
Vinyl chloride	0.5 µg/L
Nitrobenzene	0.2 µg/L
Arsenic	10 µg/L
Total organic carbon (TOC)	1.0 mg/L
Dissolved organic carbon (DOC)	1.0 mg/L
Total suspended solids (TSS)	1.0 mg/L
Total volatile suspended solids (TVSS)	1.0 mg/L

PQLs for BTEX compounds, 1,1-dichloroethane, cis-1,2-dichloroethene, 1,1,1-trichloroethane, vinyl chloride, and nitrobenzene are set equal to or less than one-half of NYSDEC's water quality criteria. While these PQLs are lower than standard laboratory limits, they were required to obtain data that will satisfy the objective of evaluating compliance with water quality standards.

The EPA methods of analysis used by the laboratory for analytes or groups of analytes, in the same order as above, are:

METHOD No.	ANALYTE
EPA 8260	Volatile organic compounds (benzene through vinyl chloride)
EPA 8270	Semivolatile organic compounds – Selective Ion Monitoring (SIM) mode (nitrobenzene only)
EPA 206.2	Total arsenic
EPA 415.2	Organic carbon (unfiltered/filtered samples)
EPA 160	Total suspended solids/volatile suspended solids

A complete list of all EPA Method 8260 analytes and their PQLs is provided in Attachment A. The Selective Ion Monitoring (SIM) mode of analysis that utilizes gas chromatography and mass spectrotography (GC/MS) was used specifically to attain the PQL of 0.2 µg/l for nitrobenzene. The analysis of total organic carbon (TOC) and dissolved organic carbon (DOC), along with TSS, provides data to quantify the organic carbon concentration of the suspended solids, which is relevant to analyzing the partitioning of organic compounds.

The Quality Assurance and Quality Control (QA/QC) methods for the five surveys consisted of:

- Trip Blanks – one per VOC sample shipping case.
- Field Blank – one per survey; container filled at transect DS with analyte-free water and analyzed for VOCs only.
- Field Duplicate – one sample per survey; one of the stations with high probability of one or more COIs was designated (e.g., DS-A, DS-B, DS-C, and WI).

In addition, samples spiked with known concentrations of benzene, ethylbenzene, toluene, m-, o-, and p-xylene**, nitrobenzene and arsenic were prepared by Environmental Resource Associates (ERA) of Arvada, CO. These whole-volume performance evaluation samples were sent to On-Site at Wellsville and shipped to CAS with the samples collected during the second survey (27 August 1998). The results of these laboratory analyses are presented in Section 4.3.

3.2.1 **Routine Monitoring**

Elevation of the river water surface and the elevation of groundwater adjacent to the river were monitored daily to provide hydrogeological data during the sampling period. River water levels at the seven staff gages described in Section 2.2 were measured and recorded daily. Groundwater depth at monitoring wells adjacent to the river and the drainage swale (shown in Figure 2-1) was measured and recorded weekly. These data were converted to elevations above MSL to illustrate the differences in surface water and groundwater over the course of the study.

**Numerical equivalents of these xylene forms are: m=1,3; o=1,2, and p=1,4

CHAPTER 4

DATA AND RESULTS

4.1 OVERVIEW OF SAMPLING PERIOD

Hydrological conditions during the field sampling period in August through October 1998 were consistent with the intended low-flow sampling. Daily flow at the USGS gage was generally lower than the target flow for each day of the sampling period. According to historical daily flow data, the flows encountered were normally exceeded in 80% of the years.

The Genesee River flow at the USGS Wellsville, New York gage from 1 August through 7 October 1998 is shown on Figure 4-1. Flow data through 1 September are reported by USGS as hourly flow; subsequent data, which are stage measurements that were converted by LMS to flows using USGS' rating table, are reported as provisional. River flow generally declined through the sampling period and the flow during late September and early October was frequently only 20 cfs. This is equivalent to the 30Q10 flow that is used to assess compliance with NYSDEC water quality standards (NYSDEC 1998). The flows measured at the US and DS transects during the five surveys, which will be explained in Section 4.2, are also shown in Figure 4-1. It is important to note that the fourth and fifth surveys occurred when river flow was practically at 30Q10 conditions (Figure 4-1).

Rainfall during the sampling period was also below normal, with September and early October were particularly dry (Figure 4-2). The rainfall data collected Tuesday through Friday at the site are an accumulation for the proceeding 24 hrs. Readings on Monday of each week are an accumulation for the preceding 72 hrs. The total rainfall between 1 September and 6 October 1998, (date of the last survey) was 0.82 in., which is substantially below normal. The normal September precipitation in the Western Plateau region of New York is 3.66 in., according to Cornell University.

4.2 FLOW AT SAMPLING TRANSECTS

The measurements of velocity and depth at each transect were used to compute the river flow. The river cross section at each transect is separated into 5 ft segments between measurement points. The velocity for each segment is the average of the two

Figure 4-1

Genesee River Flow During 1998 Survey Period
USGS Gaging Station at Wellsville, NY and Survey Transects

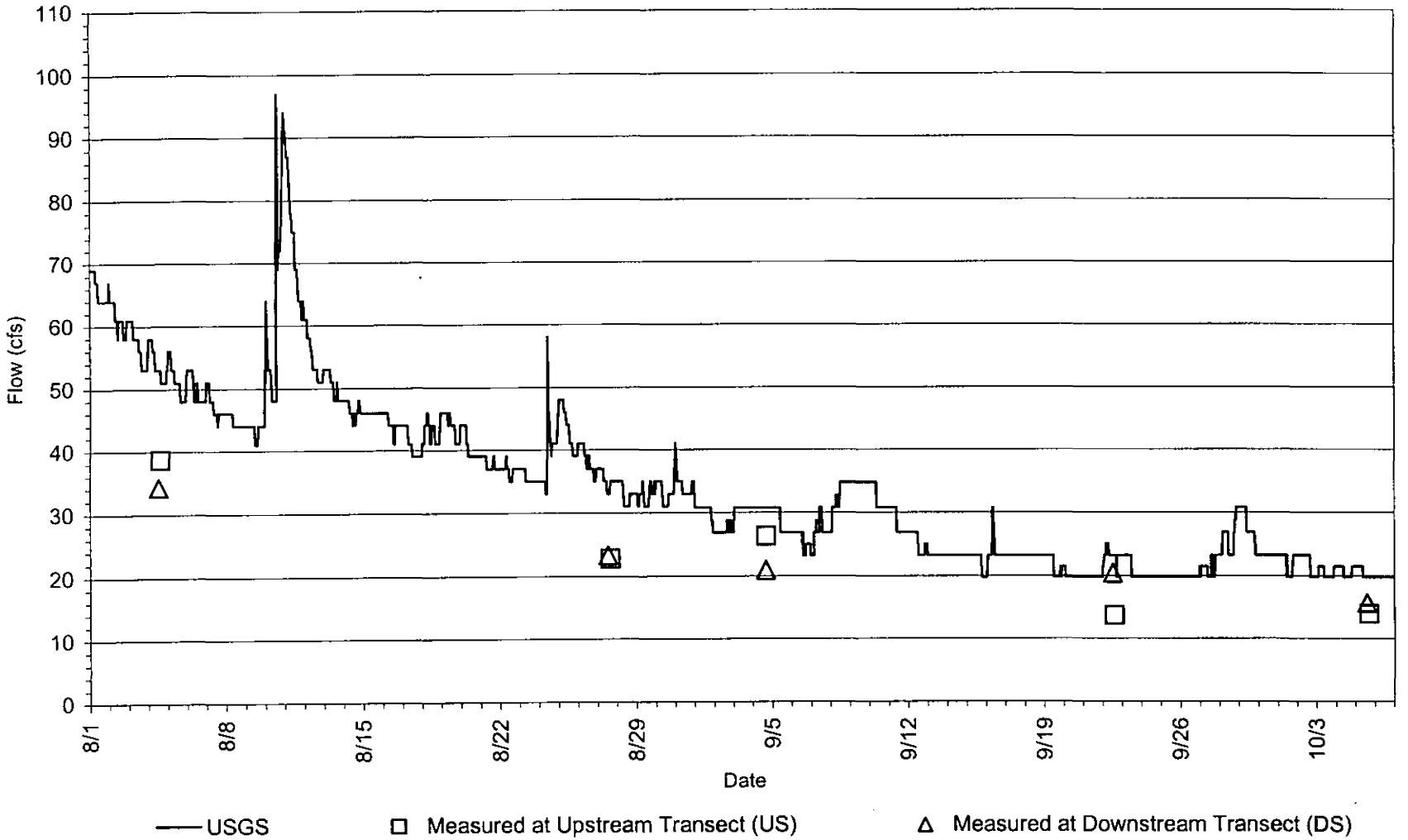
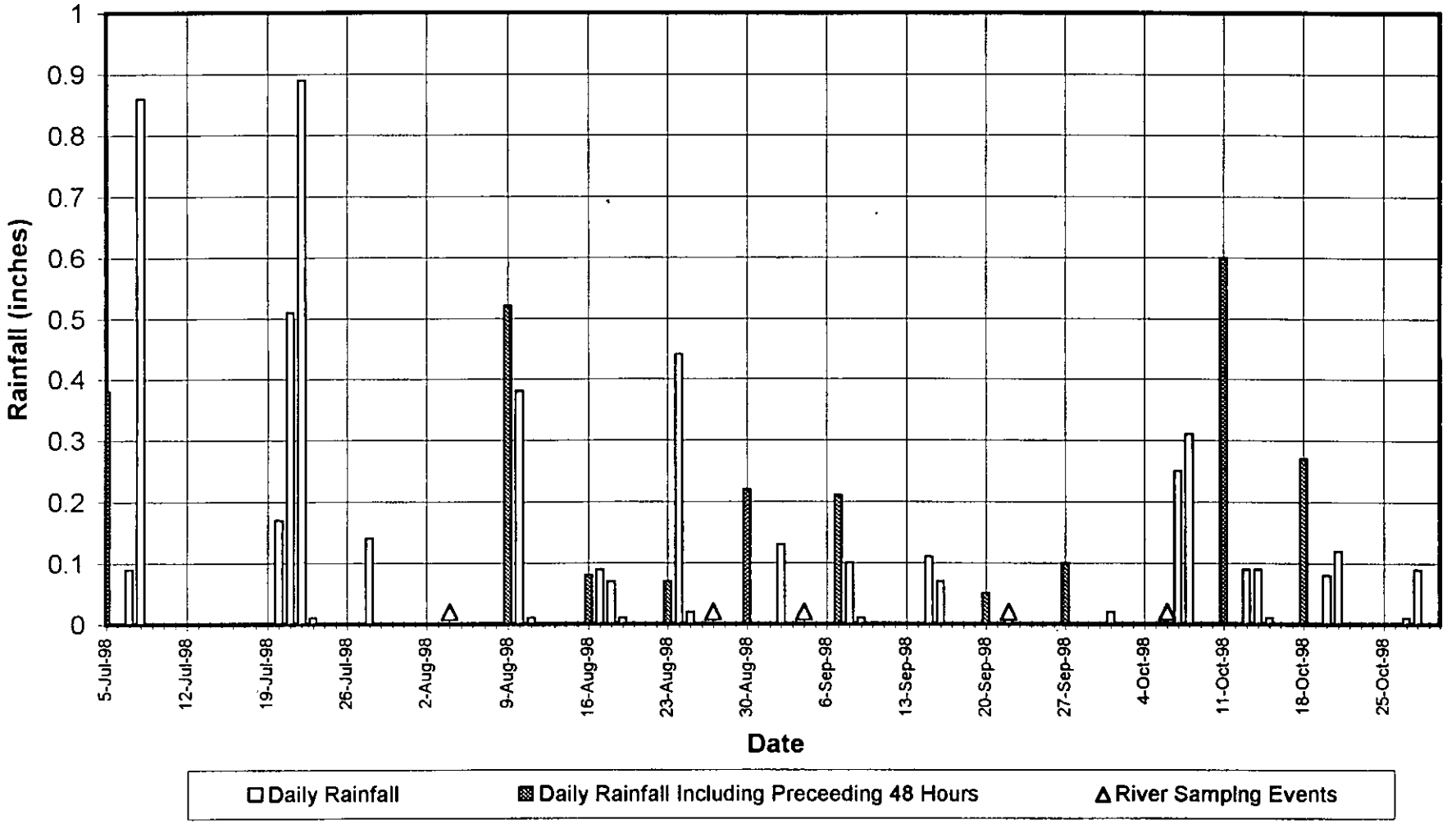


Figure 4-2
Rainfall at the Wellsville Site



measurements at its boundaries. The velocities of the first and last segment along each transect are the single measurement 5 ft from the water's edge. The flow in each segment is the product of the segment velocity and cross-sectional area. The river flow or discharge is calculated as the sum of the flows at all segments along a given transect. The spreadsheet tables showing the computation of flow and figures showing the cross-sectional depth profile for the five surveys are included in Appendix A.

The stage, average velocity, total cross-sectional area, and river discharge results for the five surveys are summarized in Table 4-1. The flows measured during the surveys show a general decline through the sampling period that is similar to the temporal trend shown by USGS data. The difference in flow between transect DS and US varies from -5.4 cfs (4 September 1998 survey) to 6.7 cfs (22 September 1998 survey). Although river flow is expected to increase from the upstream to the downstream transect, there are complicating factors that may explain the negative incremental flows found, including: temporal variations between two sets of measurements (see Figure 4-1 for variation in hourly flow), wind gust effects, outflows due to evaporation and recharge of groundwater, and measurement error. The flow in the river is generally expected to increase from transect US to DS, however, increases were less than the errors involved in measuring flow. The flows measured adjacent to the site are, as expected, less than the flows gaged farther downstream by USGS, where Dyke Creek is tributary to the Genesee River. Thus the measured flow data are sufficiently accurate to use in analyzing contaminant concentration data, as described in Section 5.2.

4.3 GROUNDWATER WELL AND RIVER WATER SURFACE ELEVATION

Groundwater elevations were monitored at a series of groundwater monitoring wells (MW) adjacent to the river from the head of the swale to approximately 300 ft upstream of transect DS (Figure 2-1). The weekly groundwater elevations are plotted along with the daily river surface elevations in the adjacent reach of the river. The elevation in MWs located between the lower and upper dams (MW-7, MW-9, MW-32, and MW-71) are shown (Figure 4-3) along with the water surface levels at the mouth of the swale (SW M) and the lower dam (L-DS). In general, the groundwater elevations decreased more rapidly than the river water surface, particularly during late July and early August. MWs that are located downstream of the lower dam (MW-10, MW-11, MW-26, MW-27, MW-67, MW-69A, MW-70) are plotted with the river water surface near the footbridge (FB) in Figure 4-4. A steep decline in the groundwater elevation at MW-10, MW-11, MW-26,

Table 4-1

Genesse River Survey Flow Data Summary

Upstream Transect

Survey	Date	Stage (ft)	Avg. Vel. (fps)	Total Area (ft^2)	Discharge (cfs)	Avg Wind (mph)	Max Gusts (mph)
1	8/4/98	1.10	0.74	50	38.7	0	8
2	8/27/98	1.10	0.49	40	22.8	1	14
3	9/4/98	0.88	0.56	43	26.3	1	18
4	9/22/98	0.86	0.36	33	13.7	NA	NA
5	10/5/98	0.86	0.40	28	13.9	NA	NA

Downstream Transect

Survey	Date	Stage (ft)	Avg. Vel. (fps)	Total Area (ft^2)	Discharge (cfs)	Avg Wind (mph)	Max Gusts (mph)
1	8/4/98	2.36	0.12	259	34.3	0	8
2	8/27/98	2.31	0.09	246	23.3	1	14
3	9/4/98	2.31	0.08	238	20.9	1	18
4	9/22/98	2.28	0.09	218	20.4	NA	NA
5	10/5/98	2.28	0.06	251.5	15.7	NA	NA

USGS Gaging Station

Survey	Date	Discharge (cfs)
1	8/4/98	53.8
2	8/27/98	35.3
3	9/4/98	30.7
4	9/22/98	23.2
5	10/5/98	20.4

NA - Not Available

Figure 4-3

River & Groundwater Elevations Between Lower & Upper Dams

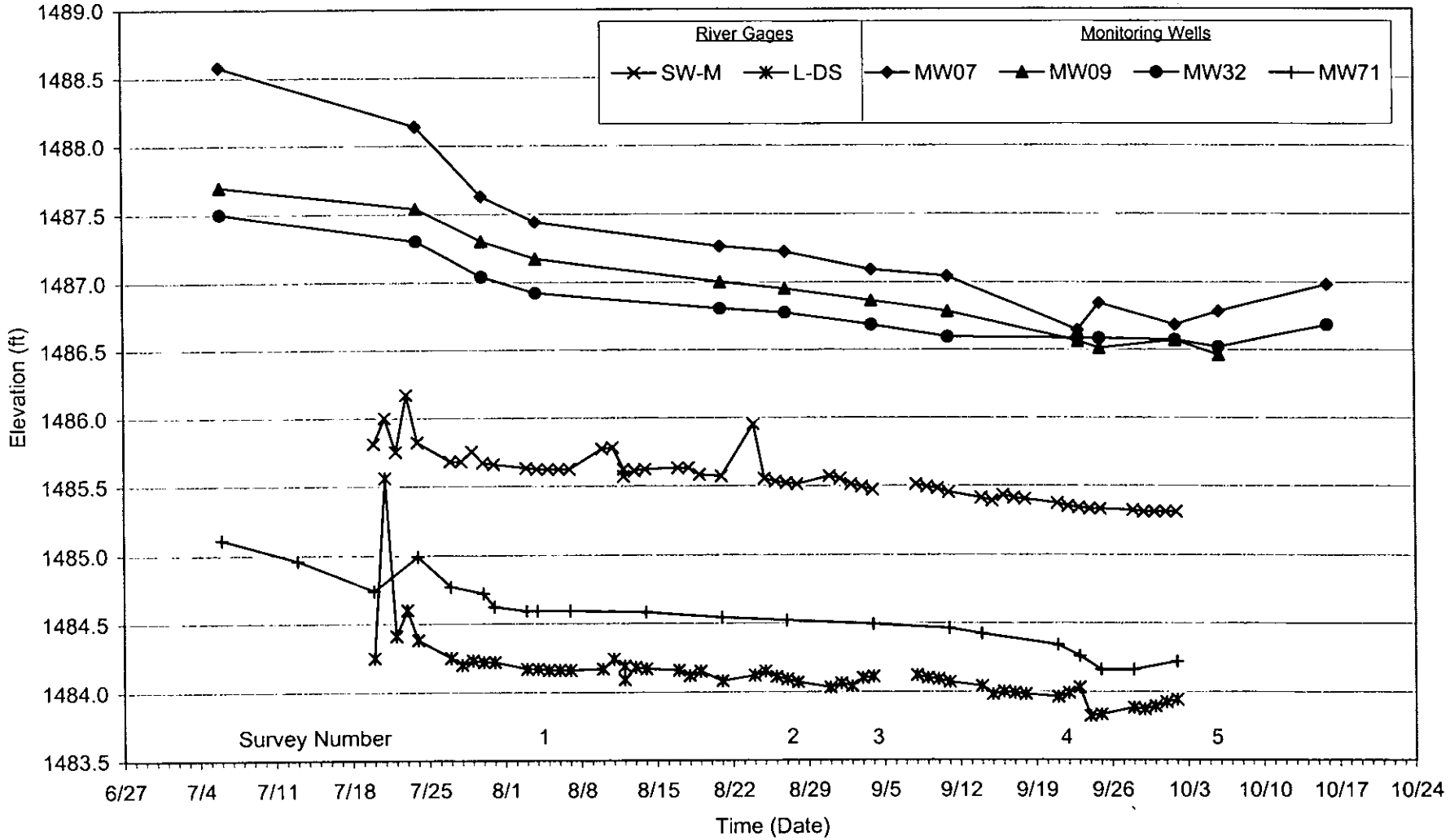
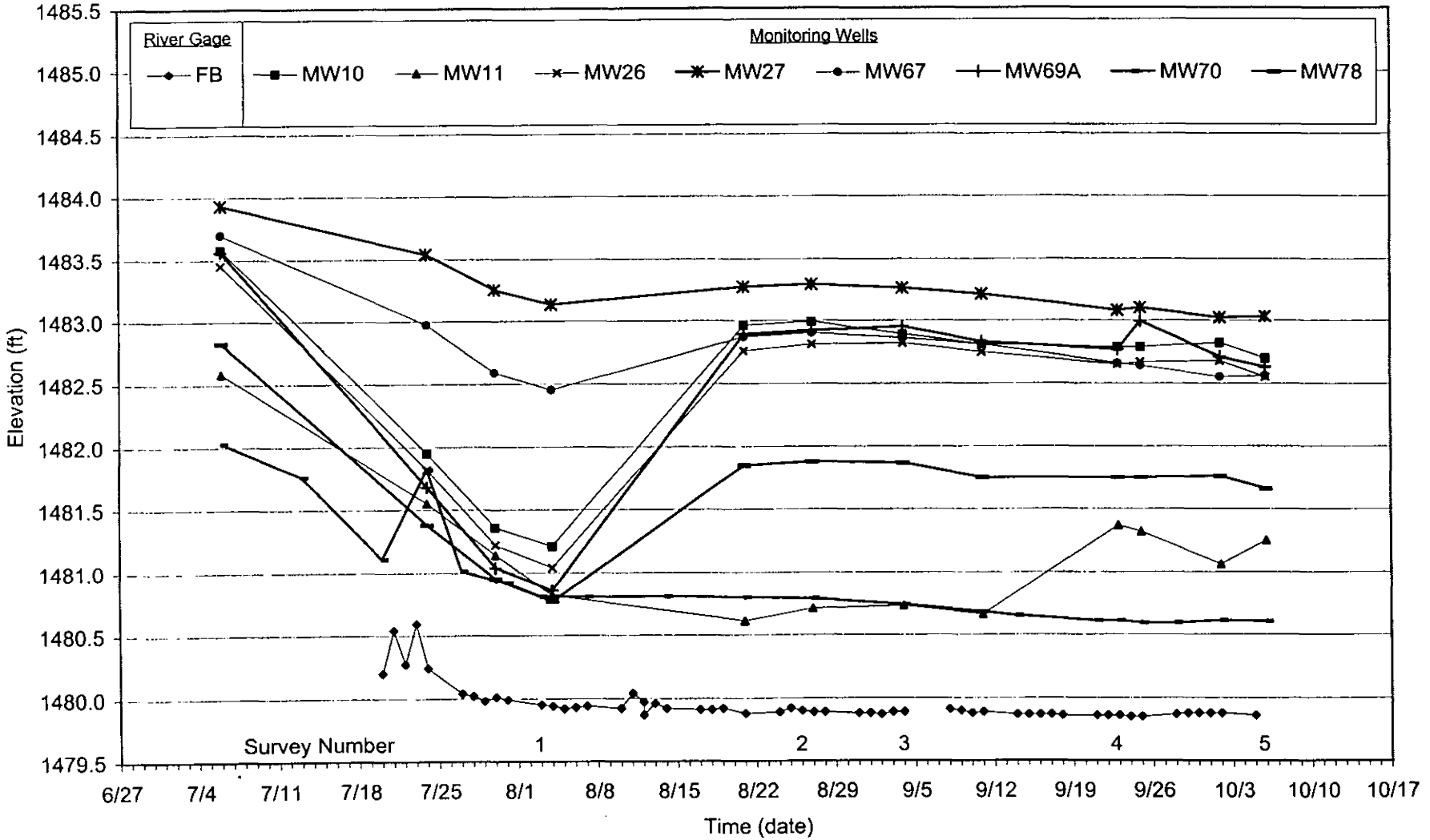


Figure 4-4

River & Groundwater Elevations Downstream of Lower Dam



MW-27, MW-69A, and MW-78 throughout July is followed by an abrupt rise in level at MW-10, MW-26, MW-69A, and MW-78. These monitoring wells are immediately downgradient of three groundwater extraction wells in the northern area of the site. The observed rise in groundwater elevations was probably caused by an interruption in the groundwater extraction system operation between 10 August and 7 October 1998.

4.4 LABORATORY RESULTS

4.4.1 Analyte Concentrations

Laboratory results for the five surveys are presented in Tables 4-2 through 4-6. All 11 COIs and all other EPA Method 8260 analytes were reported as below the PQL for samples collected at transect US during the five surveys. Eight COIs were reported as below PQL for all samples collected at transect DS and 10 COIs were reported below the PQL for samples taken at WI. All other EPA Method 8260 analytes were reported as below PQL for all samples collected at transect DS and at WI. The individual survey results are summarized by focusing on the following analytes (COIs) measured at concentrations above their PQLs:

- Ethylbenzene
- 1,3- and 1,4-Xylene
- Nitrobenzene

Only nitrobenzene was detected during the first survey (4 August 1998) in two samples (DS-A and WI). The concentration at WI (2.3 µg/l) was slightly lower than at DS-A (4.0 µg/l).

1,3-and 1,4-Xylene were found slightly above the PQL at DS-A during the second survey (27 August 1998). Nitrobenzene was measured at three sampling stations, DS-A, DS-B, and WI during the second survey.

The same two COIs were detected at the same respective stations during the third survey (4 September 1998). However, the nitrobenzene concentration at DS-A (54 µg/l) was substantially greater than the concentrations measured during the previous two surveys.

Table 4-2

Laboratory Results of Genesee River Sampling - 04 August 1998

Analyte	Units	Detection Limit	Transect - US A	B	C	D	E	Transect - DS A	B	C	D	E	Water Intake	FD *
benzene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
toluene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
ethylbenzene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
1,2-xylene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
1;3-xylene & 1,4-xylene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
1,1-dichloroethane	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
cis-1,2-dichloroethene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
1,1,1-trichloroethane	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
vinyl chloride	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
nitrobenzene	ug/L	0.20	U a	U	U	U b	U	4.0	U	U	U	U	2.3	
arsenic	mg/L	0.01	U	U	U	U	U	U	U	U	U	U	U	U
TOC	mg/L	1.00	2.30	2.20	2.30	2.20	2.20	2.90	2.80	2.40	2.40	2.40	2.60	2.50
DOC	mg/L	1.00	2.24	2.16	2.17	2.13	2.18	2.1	2.27	2.18	2.15	2.15	2.39	2.14
TSS	mg/L	1.00	2.42	2.54	2.60	3.02	3.42	2.09	2.67	2.36	17.90	2.59	5.26	2.04
TVSS	mg/L	1.00	U	U	U	U	U	U	U	U	2.50	U	U	U

* FD (field duplicate): DS - C

a detection limit for this sample is 0.26 {ug/L}

b detection limit for this sample is 0.22 {ug/L}

TOC Total Organic Carbon

DOC Dissolved Organic Carbon

TSS Total Suspended Solids

TVSS Total Volatile Suspended Solids

Table 4-3

Laboratory Results of Genesee River Sampling - 27 August 1998

Analyte	Units	Detection Limit	Transect - US A	B	C	D	E	Transect - DS A	B	C	D	E	Water Intake	FD *
benzene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
toluene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
ethylbenzene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
1,2-xylene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
1,3-xylene & 1,4-xylene	ug/L	0.50	U	U	U	U	U	0.52	U	U	U	U	U	0.5
1,1-dichloroethane	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
cis-1,2-dichloroethene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
1,1,1-trichloroethane	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
vinyl chloride	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
nitrobenzene	ug/L	0.20	U	U	U	U	U a	3.9	0.25	U	U	U	2.1	6.8
arsenic	mg/L	0.003	U	U	U	U	U	U	U	U	U	U	U	U
TOC	mg/L	1.00	2.08	1.97	1.91	2.16	1.99	2.52	2.18	1.99	2.24	2.10	2.86	2.30
DOC	mg/L	1.00	1.77	1.85	1.87	1.89	2.05	2.2	1.91	1.96	1.97	1.95	2.02	2.09
TSS	mg/L	1.00	2.30	2.60	2.90	2.70	2.80	5.20	2.10	2.40	1.90	2.20	12.00	4.70
TVSS	mg/L	1.00	U	U	U	U	U	1.30	U	U	U	U	2.1	1.20

* FD (field duplicate): DS - A

a detection limit for this sample is 0.22 (ug/L)

TOC Total Organic Carbon

DOC Dissolved Organic Carbon

TSS Total Suspended Solids

TVSS Total Volatile Suspended Solids

NOTE: Survey included spike sample (SP1); results presented in a separate table

Table 4-4

Laboratory Results of Genesee River Sampling - 04 September 1998

Analyte	Units	Detection Limit	Transect - US A	B	C	D	E	Transect - DS A	B	C	D	E	Water Intake	FD
benzene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
toluene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
ethylbenzene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
1,2-xylene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
1,3-xylene & 1,4-xylene	ug/L	0.50	U	U	U	U	U	0.74	U	U	U	U	U	U
1,1-dichloroethane	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
cis-1,2-dichloroethene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
1,1,1-trichloroethane	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
vinyl chloride	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
nitrobenzene	ug/L	0.20	U	U	U	U	U	54 a	2.2	U	U	U	5.1	6.0
arsenic	mg/L	0.003	U	U	U	U	U	U	U	U	U	U	U	U
TOC	mg/L	1.00	1.90	1.99	1.83	1.80	1.80	2.26	2.06	2.00	2.02	1.99	2.17	2.01
DOC	mg/L	1.00	1.75	1.75	1.78	1.72	2.37	2.09	1.96	1.95	1.90	1.95	1.80	1.92
TSS	mg/L	1.00	2.40	2.80	3.10	2.70	3.10	2.80	1.80	2.50	2.70	2.80	6.00	6.10
TVSS	mg/L	1.00	U	U	U	U	U	U	U	U	U	U	U	1.00

* FD (field duplicate): WI

a detection limit for this sample is 2.0 {ug/L}

TOC Total Organic Carbon

DOC Dissolved Organic Carbon

TSS Total Suspended Solids

TVSS Total Volatile Suspended Solids

Table 4-5

Laboratory Results of Genesee River Sampling - 22 September 1998

Analyte	Units	Detection Limit	Transect - US A	B	C	D	E	Transect - DS A	B	C	D	E	Water Intake	FD
benzene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
toluene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
ethylbenzene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
1,2-xylene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
1,3-xylene & 1,4-xylene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
1,1-dichloroethane	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
cis-1,2-dichloroethene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
1,1,1-trichloroethane	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
vinyl chloride	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
nitrobenzene	ug/L	0.20	U a	U	U b	U	U	U	0.58	U	U	U	2.2	U
arsenic	mg/L	0.003	U	U	U	U	U	U	U	U	U	U	U	U
TOC	mg/L	1.00	1.78	1.71	2.13	2.14	1.74	2.21	2.18	2.03	2.05	2.54	2.64	2.23
DOC	mg/L	1.00	1.84	1.76	2.14	2.09	1.95	2.17	1.92	2.09	2.1	2	2.5	2.17
TSS	mg/L	1.00	11.00	22.30	27.00	25.80	23.50	7.60	2.20	2.46	6.80	1.70	12.50	5.00
TVSS	mg/L	1.00	1.40	2.02	2.67	2.50	3.00	1.20	U	U	U	U	U	U

* FD (field duplicate): DS - A

a detection limit for this sample is 0.21 {ug/L}

b detection limit for this sample is 0.24 {ug/L}

TOC Total Organic Carbon

DOC Dissolved Organic Carbon

TSS Total Suspended Solids

TVSS Total Volatile Suspended Solids

Table 4-6

Laboratory Results of Genesee River Sampling - 06 October 1998

Analyte	Units	Detection Limit	Transect - US A	B	C	D	E	Transect - DS A	B	C	D	E	Water Intake	FD
benzene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
toluene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
ethylbenzene	ug/L	0.50	U	U	U	U	U	0.57	U	U	U	U	U	0.56
1,2-xylene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
1,3-xylene & 1,4-xylene	ug/L	0.50	U	U	U	U	U	0.91	U	U	U	U	U	0.89
1,1-dichloroethane	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
cis-1,2-dichloroethene	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
1,1,1-trichloroethane	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
vinyl chloride	ug/L	0.50	U	U	U	U	U	U	U	U	U	U	U	U
nitrobenzene	ug/L	0.20	U a	U	U	U b	U	0.3	9	U	U	U c	8.2	3.5
arsenic	mg/L	0.00	U	U	U	U	U	U	U	U	U	U	U	U
TOC	mg/L	1.00	2.64	1.85	1.95	1.95	1.87	2.30	1.95	2.02	2.02	2.10	2.62	2.31
DOC	mg/L	1.00	2.23	1.92	1.83	1.86	1.92	2	1.8	1.82	1.76	1.87	2.09	2.05
TSS	mg/L	1.00	10.60	1.50	1.90	2.60	1.40	2.50	1.60	1.30	45.90	7.10	4.10	2.50
TVSS	mg/L	1.00	1.10	U	U	U	U	U	U	U	4.44	U	N/A	U

Additional samples analyzed for nitrobenzene only:

Station	Nitrobenzene (ug/L)
SW101	U
SW102	26 d
SW103	4.8

* FD (field duplicate):	DS - A
a	detection limit for this sample is 0.22 {ug/L}
b	detection limit for this sample is 0.26 {ug/L}
c	detection limit for this sample is 0.21 {ug/L}
d	detection limit for this sample is 2.0 {ug/L}
TOC	Total Organic Carbon
DOC	Dissolved Organic Carbon
TSS	Total Suspended Solids
TVSS	Total Volatile Suspended Solids

Nitrobenzene was detected in only two samples (WI and DSB) collected during the fourth survey (22 September 1998). No other COIs were detected.

The fifth survey (6 October 1998) resulted in the three contaminants exceeding their PQLs at DS-A and one at WI. The only other station/sample along the DS transect that had a quantifiable concentration was DS-B, with 9.0 µg/l of nitrobenzene.

Two (SW 102 and SW 103) of the three additional samples taken during the fifth survey for analysis of nitrobenzene were greater than the PQL.

Conventional water quality constituents (TOC, DOC, TSS, and TVSS) were relatively constant throughout the river during the five surveys except for abnormally high TSS and TVSS concentrations found at DS-D during the first and fifth surveys (4 August and 6 October 1998, respectively) and at US-A through US-E during the fourth survey (22 September 1998). Construction (pile driving) at the Weidrick Road Bridge, which is approximately 700 ft upstream of transect US, took place on 22 September and probably explain the elevated TSS and TVSS concentration at the upstream transect (Table 4-5). A patch of aquatic weeds around the DS-D location may have been disturbed during the first and fifth surveys and consequently increased the TSS and TVSS concentrations (Tables 4-2 and 4-6).

4.4.2 **Quality Control/Quality Assurance Results**

All field blanks analyzed during the five surveys resulted in undetected analytes. All trip blanks, which were analyzed for VOCs and undetected analytes. This confirms the lack of contamination from nonriver (atmospheric) sources.

The performance evaluation (spike) sample results shown in Table 4-7 show that each concentration reported by the laboratory was well within the acceptance limits. The difference in nitrobenzene concentration between the laboratory and certified values is 5.6%.

The concentrations for the field duplicate samples are compared to the original sample for all analytes detected in either sample (Table 4-8). The percent difference is calculated relative to the average of the two reported values. The percent differences for 1,3- and 1,4-xylene and ethylbenzene were less than 4%. The percent difference in nitrobenzene

Table 4-7

Laboratory Results of Genesee River Spike Sample* - 27 August 1998

Analyte	Units	Detection Limit	CAS (spike)	certified value	performance acceptance limits
benzene	ug/L	0.50	1.3	1.24	0.956 - 1.54
toluene	ug/L	0.50	2.1	2.11	1.63 - 2.55
ethylbenzene	ug/L	0.50	2.2	2.64	1.98 - 3.08
1,2-xylene	ug/L	0.50	2.5	2.70	1.74 - 3.39
1,3-xylene	ug/L	---	---	1.26	0.815 - 1.59
1,4-xylene	ug/L	---	---	1.54	0.999 - 1.94
1,3-xylene & 1,4-xylene	ug/L	0.50	2.5	2.80	1.814 - 3.53
1,1-dichloroethane	ug/L	0.50	U		
cis-1,2-dichloroethene	ug/L	0.50	U		
1,1,1-trichloroethane	ug/L	0.50	U		
vinyl chloride	ug/L	0.50	U		
nitrobenzene	ug/L	0.21	0.69	0.730	0.362 -0.860
arsenic	ug/L	3.0	41.4	42.0	31.5 - 49.6

Spike Sample prepared by Environmental Resource Associates of Arvada, CO
CAS is Columbia Analytical Services Laboratory

Table 4-8

Comparison of Field Duplicate and Sample Results for Quantifiable Concentrations

Survey	Date	Field Dup Station	Analyte Detected	Concentration (ug/l) Sample	Concentration (ug/l) Field Dup	% Difference
1	08/04/98	DS-C	None			
2	08/27/98	DS-A	Nitrobenzene	3.9	6.8	54.21
			1,3-&1,4-xylene	0.52	0.5	3.92
3	09/04/98	WI	Nitrobenzene	5.10	6	16.22
4	09/22/98	DS-A	None			
5	10/06/98	DS-A	Ethylbenzene	0.57	0.56	1.77
			1,3-&1,4-xylene	0.91	0.89	2.22
			Nitrobenzene	0.26	3.5	172.34

duplicates is notably higher and may be a result of spatial and temporal variation in the river and/or analytical error.

CHAPTER 5

ANALYSIS OF DATA

5.1 COMPARISON OF COI CONCENTRATIONS TO NYSDEC STANDARDS

The numerical concentration criteria set in NYSDEC's water quality standards are limits that must not be exceeded at any time and in any sample. (See paragraphs 700.2 and 703.5(d) of Chapter X Division of Water Resources in New York State's Codes, Rules, and Regulations.) The flow conditions applied by NYSDEC in setting discharge permit limits under its State Pollutant Discharge Elimination System (SPDES) program imply that the criteria should be met when river flow is greater than or equal to the 30Q10 flow. As the five surveys of the Genesee River were conducted at flows that were nearly at the 30Q10 flow, the concentrations of the three measurable COIs are compared to NYSDECs criteria.

	SAMPLE WITH MAXIMUM CONCENTRATION				
QUANTIFIABLE COI	SURVEY	STATION	CONCENTRATION (µg/l)	NYSDEC STANDARD (µg/l)	COMPLIANCE?
Ethylbenzene	6 Oct 1998	DS-A	0.57	5.0	Yes
1,3- and 1,4-Xylene	6 Oct 1998	DS-A	0.91	5.0*	Yes
Nitrobenzene	4 Sep 1998	DS-A	54.0	0.4	No

*Standard for each compound is 5.0 µg/l.

As the maximum concentration of ethylbenzene and 1,3- plus 1,4-xylene was measured during the fifth survey (6 October 1998) when the Genesee River flow was equivalent to the 30Q10 flow, the sampling data clearly show compliance with NYSDEC's standards for these VOCs. Nitrobenzene, which was measured in at least one sample from each survey at a concentration exceeding NYSDEC's standard, is the only COI that is not in compliance. Concentrations of nitrobenzene found in groundwater in the vicinity of MW-70 are approximately 1000 to 10,000 times the concentrations found in the river water sampled adjacent to the site (DS-A and DS-B) and the former water intake (see Attachment B). Therefore, groundwater seepage that enters through the banks and bed of the river adjacent to the site at very low flow rates is diluted enormously before passing transect DS at middepth.

5.2 ANALYSIS OF NITROBENZENE

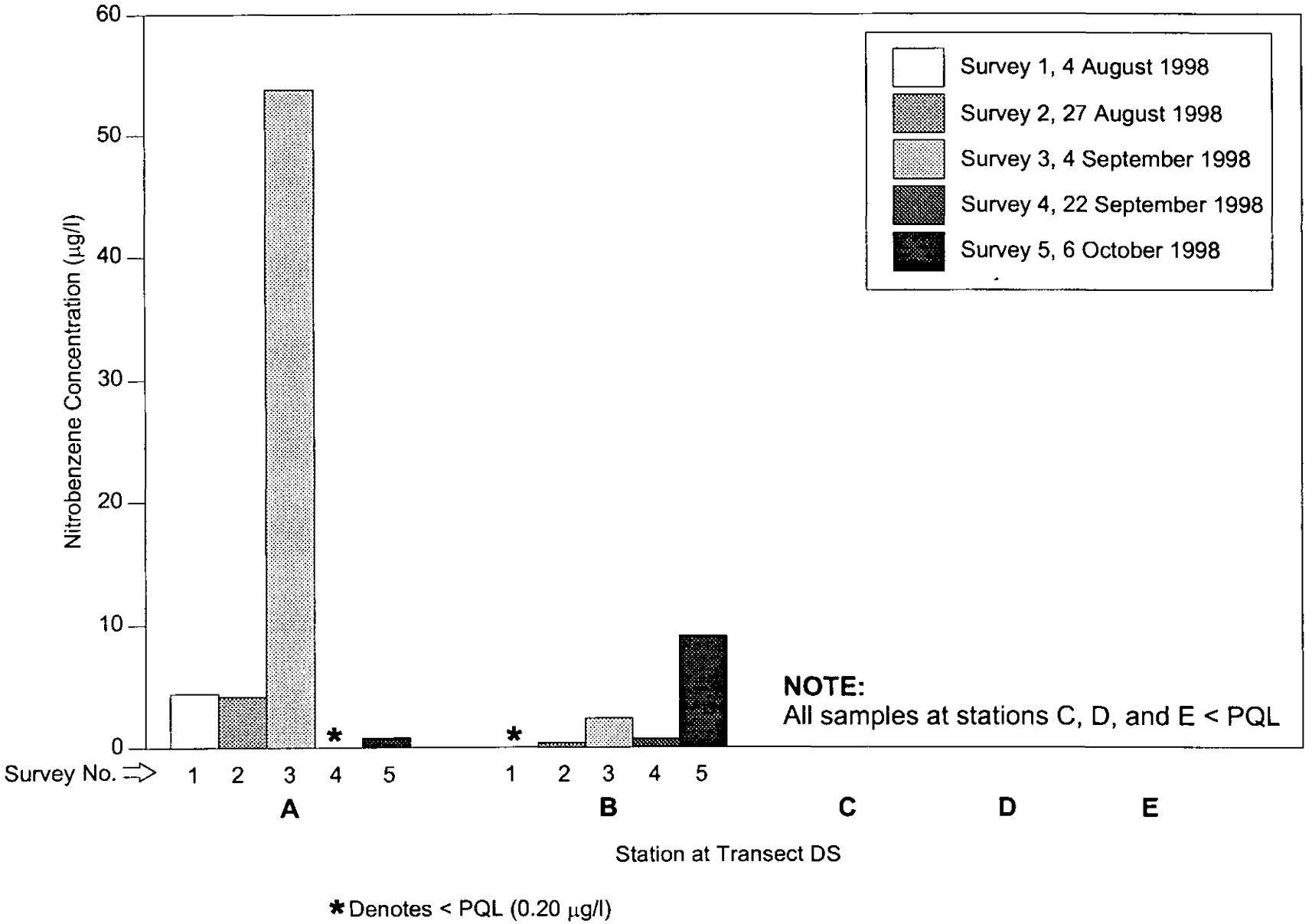
5.2.1 Lateral Distribution

The lateral distribution of nitrobenzene concentrations at transect DS showed higher concentrations on the west side of the river adjacent to the site than on the east side. Nitrobenzene concentrations at transect DS varied substantially among the five surveys (Figure 5-1). In addition, concentrations at DS-A, DS-B, and WI varied temporally through the sampling period.

5.2.2 Relationship to Genesee River Flow

The relationship of measured and flow-weighted nitrobenzene concentrations to river flow is plotted in Figure 5-2. Flow-weighted average nitrobenzene concentrations are calculated using depth and velocity measurements at 24 or 25 equally spaced points along transect DS (see Appendix A). The nitrobenzene load or flux associated with each of the five samples collected was calculated using the total flow for the five lateral segments associated with each sample. (When only 24 points were measured, the sum of the flow in the last four segments was used for DS-E.) A concentration of zero was assumed for samples with nitrobenzene below the PQL. The resulting flow-weighted average concentration at DS would not change significantly if the concentration of these samples were assumed to be 0.2 µg/l (i.e., PQL). The spreadsheets showing the flow-weighted average nitrobenzene concentration for each survey are provided in Appendix B and the results are summarized in Table 5-1.

Analysis of the flow-weighted average and measured nitrobenzene concentrations at DS vs flow indicates that in general, nitrobenzene concentrations at DS-B and WI appear to increase as river flow decreases. There is no apparent correlation between river flow and flow-weighted average nitrobenzene concentration or nitrobenzene concentration at DS-A. Nitrobenzene loading and concentration at DS were highest during the third survey. The nitrobenzene loading for this survey was greater than six times that of the next highest (fifth) survey. During the fourth survey the nitrobenzene concentration at WI was suprisingly greater than that in any sample at transect DS. These data indicate that the groundwater source and/or the river dilution are temporally and spatially variable.



\764 NitroBenzDist at DS.dsf

LMS Lawler, Matusky & Skelly Engineers LLP One Blue Hill Plaza • Pearl River, New York 10965 ENVIRONMENTAL SCIENCE & ENGINEERING CONSULTANTS	**Nitrobenzene Distribution at DS** **FORMER SINCLAIR REFINERY SITE, WELLSVILLE, NY**	**Figure 5-1**

Figure 5-2

Flow-Weighted Average and Measured Nitrobenzene Concentrations as a Function of River Flow

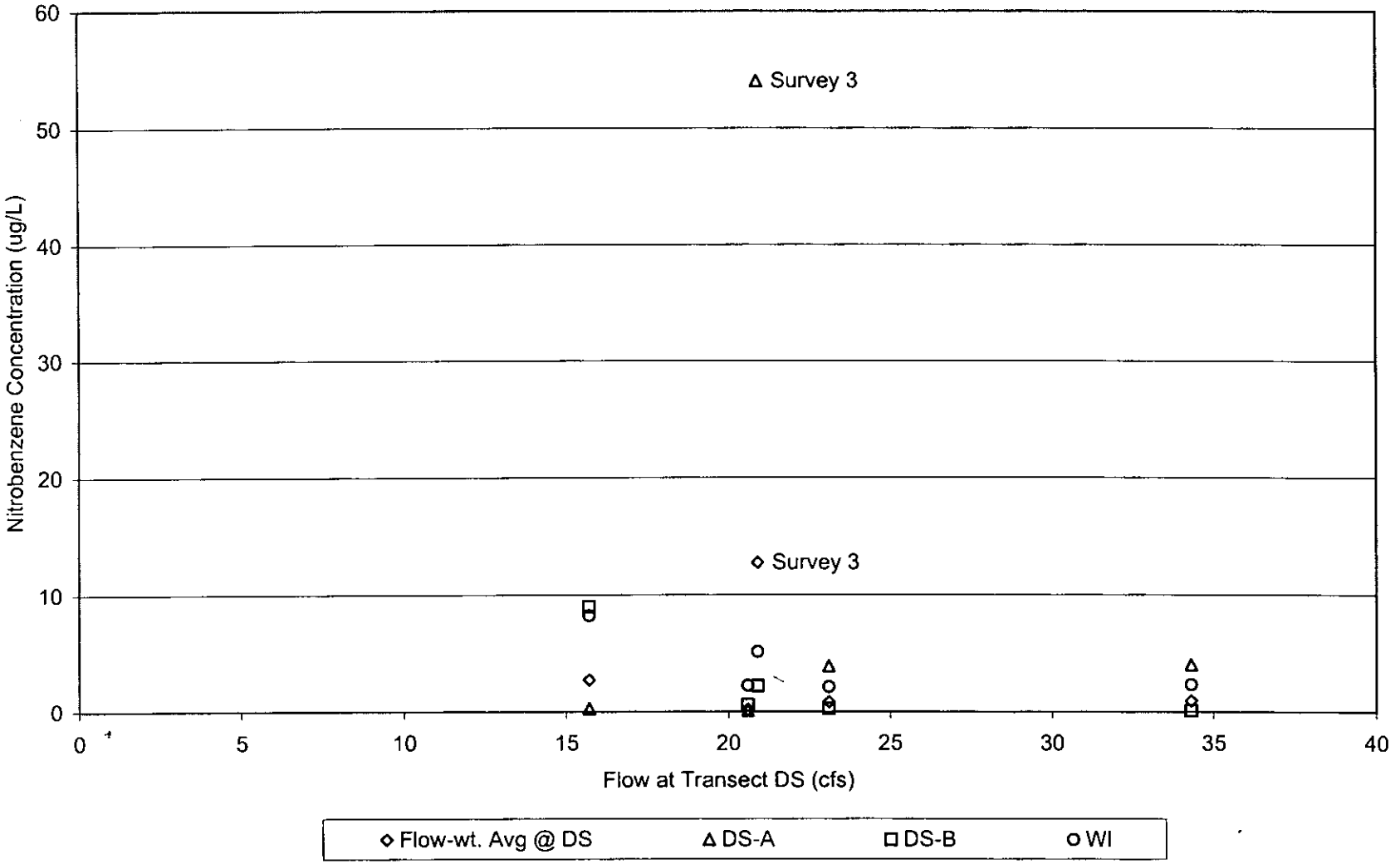


Table 5-1

Summary of Nitrobenzene Data for Five Surveys of the Genesee River

Survey No.	Date	DS-A	DS-B	Transect DS			Water Intake
		Nitrobenzene Conc. (ug/L)	Nitrobenzene Conc. (ug/L)	Flow (cfs)	Nitrobenzene Load (g/day)	Nitrobenzene Flow-weighted Avg. Conc. (ug/L)	Nitrobenzene Conc. (ug/L)
1	8/4/98	4.0	0.10	34.3	75.94	0.91	2.3
2	8/27/98	3.9	0.25	23.1	44.58	0.79	2.1
3	9/4/98	54	2.2	20.9	651.7	12.8	5.1
4	9/22/98	0.10	0.58	20.6	7.36	0.15	2.2
5	10/6/98	0.26	9.0	15.7	103.0	2.69	8.2

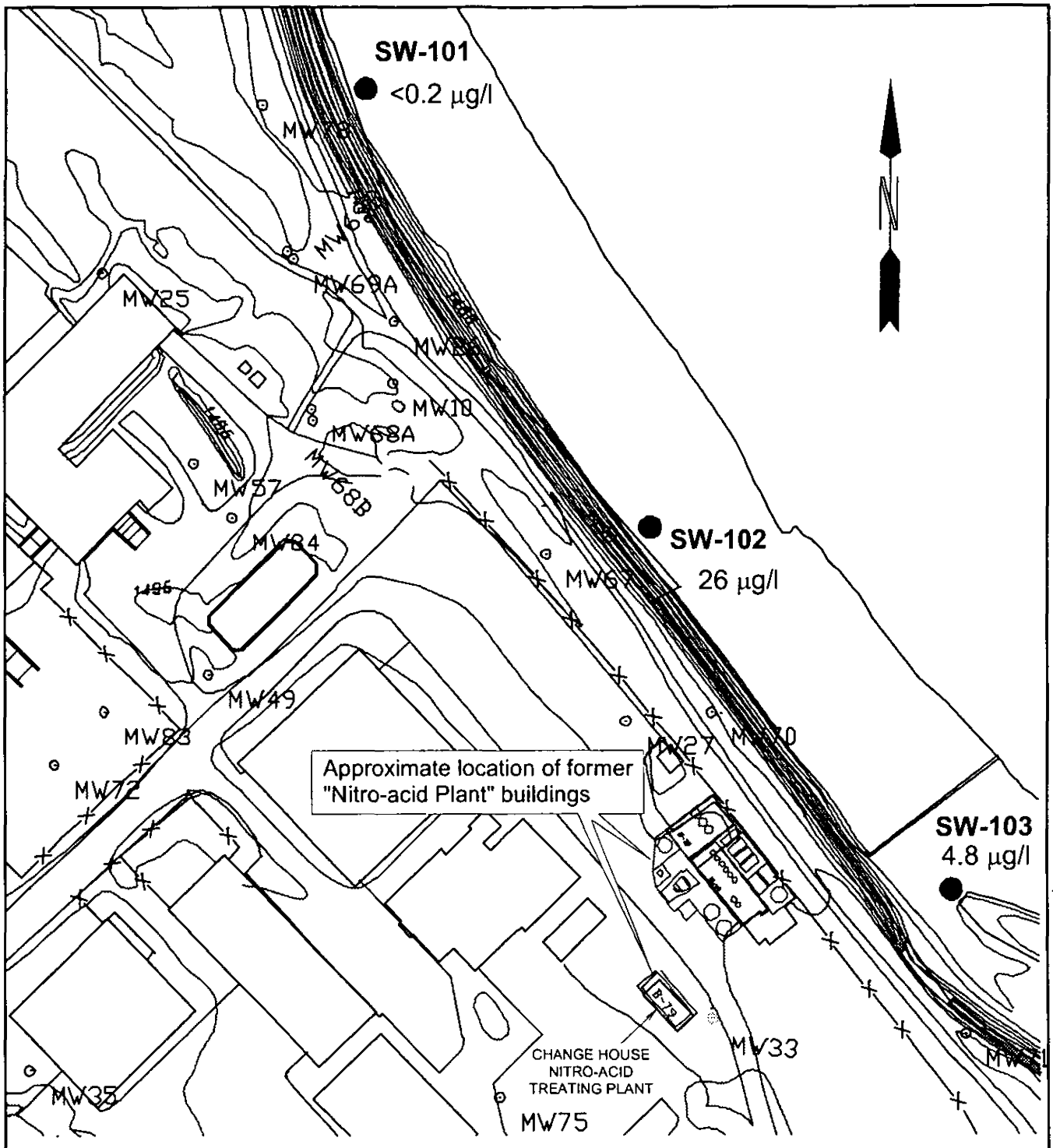
5.2.3 **Longitudinal Extent**

The fifth survey, which included additional samples between US and DS, provides data to look for the source of nitrobenzene along the site. Three additional samples (SW 101, SW 102 and SW 103), which were taken at a distance of 10% of the river width from the west bank, had the following nitrobenzene concentrations:

STATION	DISTANCE DOWNSTREAM OF TRANSECT US (ft)	NITROBENZENE CONCENTRATION (µg/l)
US-A	0	nondetectable (PQL = 0.2 µg/l)
SW 103	3,940	4.8
SW 102	4,380	26.0
SW 101	4,810	nondetectable (PQL = 0.2 µg/l)
DS-A, DS-B*	5,250	0.26, 9.0
WI	7,250	8.2

*All stations were located at 10% of river width except DS-B, which is 30% and WI, which was along the intake structure on the west bank.

The data for stations SW 101, SW 102, and SW 103 are plotted on a map of the site in Figure 5-3. These sampling locations are shown in relation to the approximate location of former nitro-acid plant buildings at the former refinery. The sample taken between the drainage swale mouth and the lower dam (SW 103) indicates that nitrobenzene contaminated groundwater is entering the river between the lower dam and transect US. The next downstream sample (SW 102) had the maximum nitrobenzene concentration found during this survey (26.0 µg/l). This station is just downstream of MW-70, which had the highest nitrobenzene concentration found in seven monitoring wells in this area. Nitrobenzene was below 0.2 µg/l (PQL) at SW 101, which is reasonably consistent with the concentration found at DS-A, a station that is at the same distance from the bank as SW 101.



LEGEND

SW-103 — Station number

4.8 µg/l — Nitrobenzene concentration

\700\764\764001 addt samp locs.dsf

LMS Lawler, Matusky & Skelly Engineers LLP One Blue Hill Plaza • Pearl River, New York 10965 ENVIRONMENTAL SCIENCE & ENGINEERING CONSULTANTS	**Additional River Sampling Locations and Nitrobenzene Concentrations During the Fifth Survey** **Former Sinclair Refinery Site at Wellsville, NY**	**Figure 5-3**

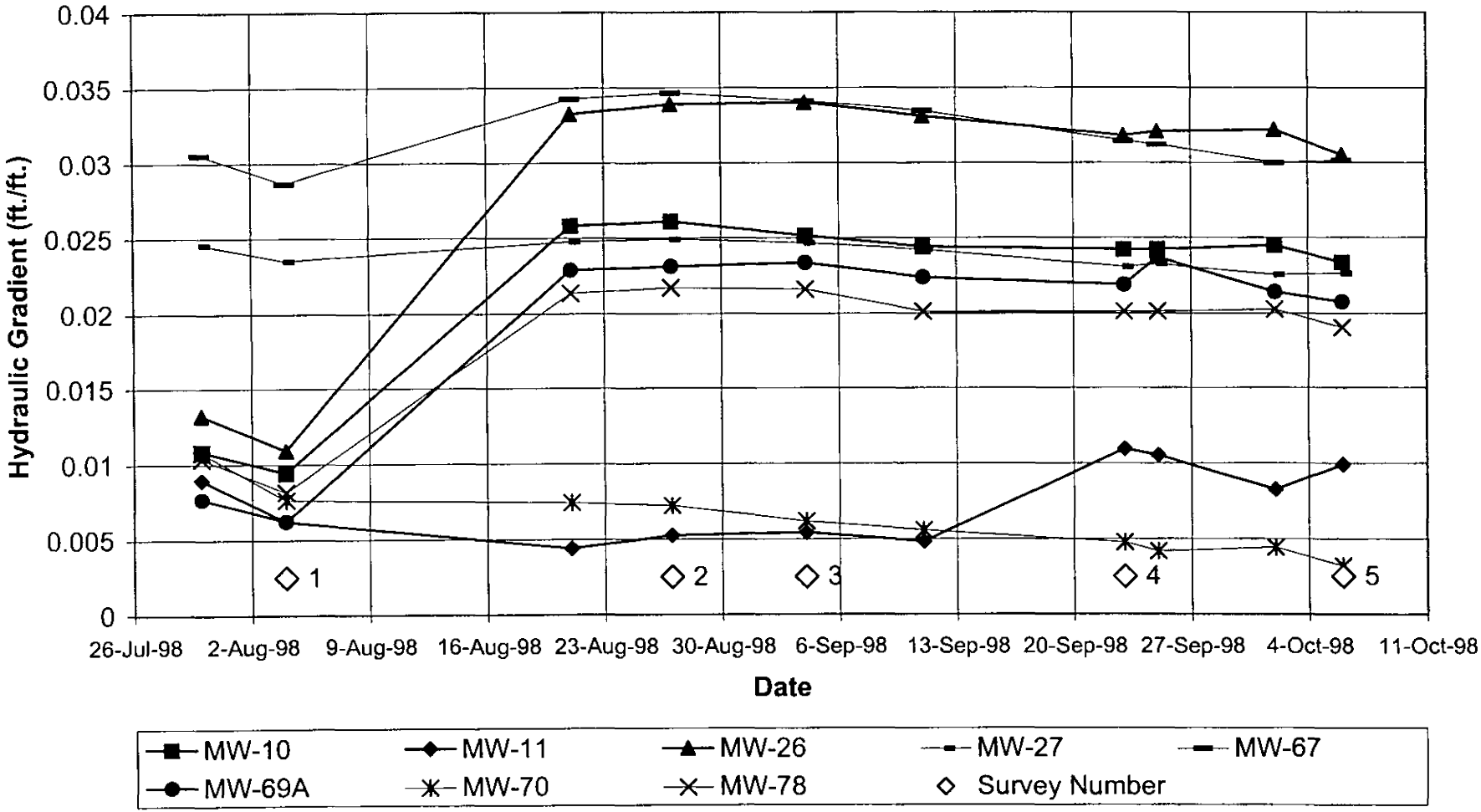
5.2.4 **Relationship to Groundwater Gradient**

The nitrobenzene load during the third survey greatly exceeds the other four surveys. Changes in groundwater hydraulic gradients below the lower dam were analyzed to evaluate potential effects on nitrobenzene load. The average groundwater hydraulic gradient observed at monitoring wells adjacent to the river reach downstream of the lower dam are plotted in Figure 5-4.

An attempt was made to correlate nitrobenzene loading at DS with hydraulic gradients in wells adjacent to the river bank. Average groundwater hydraulic gradients between each monitoring well and the closest point on the river were calculated by dividing the approximate difference in hydraulic head by the distance between the monitoring well and the river. Hydraulic gradients for monitoring wells in the vicinity of the Northern Groundwater Extraction System increased after the first sampling event due to a shut down of that system (Figures 4-3 and 4-4). Monitor wells MW-10, MW-26, MW-69a and MW-78 show significantly higher hydraulic gradients after the first sampling event. Although the steeper hydraulic gradients appeared prior to the second survey, the nitrobenzene loading at DS was lower for the second survey than the first survey. The third survey, which occurred eight days after the second survey, is characterized by hydraulic gradients similar to those of the prior survey; however, the nitrobenzene loading substantially increased. No clear correlation was found between nitrobenzene loading or concentrations in the river and groundwater hydraulic gradients adjacent to the river in this area of the site or operation of the Northern Groundwater Extraction System.

As groundwater nitrobenzene has been at high concentrations at some monitoring wells along this reach of the river, very low groundwater flows from the site may be capable of producing the loadings found in the river during the five surveys. Overall, it appears that seepage of groundwater from the site varied while river flow declined, resulting in sporadic nitrobenzene levels in the river.

Figure 5-4
Average Hydraulic Gradients Between Site Monitoring Wells and the Genesee River



CHAPTER 6

CONCLUSIONS

Water quality surveys of the Genesee River were conducted during August through October 1998 at low river flows. River flow generally decreased through the sampling period and reached approximately 20 cfs at the USGS Wellsville gage during the fifth (and final) survey. As the 30Q10 flow of 20 cfs occurred during this survey, the measured concentrations of COIs were compared to NYSDEC's standards for an assessment of compliance.

The three COIs found above their PQLs at the downstream transect were collected along the side of the river adjacent to the site (i.e., within 30% of total width at this transect). They are:

1) Ethylbenzene,
2) 1,3- and 1,4-Xylene, and
3) Nitrobenzene.

Only nitrobenzene was found above the PQL at the water intake. The only NYSDEC water quality standard that was exceeded in any sample was the criterion of 0.4 µg/l for nitrobenzene. The flow-weighted average nitrobenzene concentration at the downstream transect DS exceeded this criterion in four of five surveys, and at least one sample along the transect exceeded the criterion in all five surveys. Samples at the water intake (WI) exceeded NYSDEC's standard during all five surveys. Additional samples collected during the fifth survey at stations SW 102 and SW 103, which were at 10% of the total width from the site's embankment, showed measurable concentrations of nitrobenzene upstream and downstream of the lower dam.

The relationships among nitrobenzene concentrations at DS and WI, river flow, river/ groundwater elevation, and groundwater hydraulic gradient adjacent to the river were investigated. However, no clear correlation could be found given the high levels of dilution and the observed variability in river flows and groundwater seepage rates during the study.

REFERENCES

New York State Department of Environmental Conservation. 1998. Division of Water Technical and Operational Guidance Series (1.3.1) Total Maximum Daily Loads and Water Quality – Based Effluent Limits (reissued 26 February 1998).

State of New York Official Compilation of Codes, Rules, and Regulations. Chapter X Division of Water Resources. Article 2 Classifications and Standards of Quality (revised 1998).

Thomann, R.V., and J.A. Mueller. 1987. Principles of surface water quality modeling and control. New York: Harper and Row, Publishers.

APPENDIX A

VELOCITY, DEPTH, AND FLOW AT SAMPLING TRANSECTS

Genesee River Velocity Survey
Survey: 1 8/4/98
Transect: US
Transect Width 85ft
Start Time: 13:35 Gage Height 1.1
Start Time: 1:53 Gage Height 1.1

Avg Velocity = 0.74 fps
Total Area = 49.5 ft^2

Total Dicharge = 38.7 cfs

Segment	Station	Time	Distance From Bank (ft)	Depth (ft)	Reading Depth (ft)	Velocity (ft/sec)	Segment Area ft^2	Segment Velocity (ft/sec)	Segment Flow cfs
			0	0	0				
1	1	13:35	5	0.3	0.18	0.61	0.75	0.61	0.4575
2	2	13:30	10	0.6	0.36	1.18	2.25	0.895	2.01375
3	3	13:37	15	0.5	0.3	1.13	2.75	1.155	3.17625
4	4	13:39	20	0.6	0.36	1.05	2.75	1.09	2.9975
5	5	13:40	25	0.8	0.48	0.95	3.5	1	3.5
6	6	13:41	30	1.1	0.66	1.16	4.75	1.055	5.01125
7	7	13:42	35	0.9	0.54	0.73	5	0.945	4.725
8	8	13:43	40	0.9	0.54	0.68	4.5	0.705	3.1725
9	9	13:45	45	0.6	0.36	0.09	3.75	0.385	1.44375
10	10	13:46	50	0.4	0.24	0.2	2.5	0.145	0.3625
11	11	13:47	55	0.6	0.36	0.94	2.5	0.57	1.425
12	12	13:48	60	0.7	0.42	0.59	3.25	0.765	2.48625
13	13	13:50	65	0.7	0.42	1.06	3.5	0.825	2.8875
14	14	13:51	70	0.5	0.3	0.95	3	1.005	3.015
15	15	13:52	75	0.4	0.24	0.36	2.25	0.655	1.47375
16	16	13:53	80	0.3	0.18	0.16	1.75	0.26	0.455
17			85	0	0		0.75	0.16	0.12

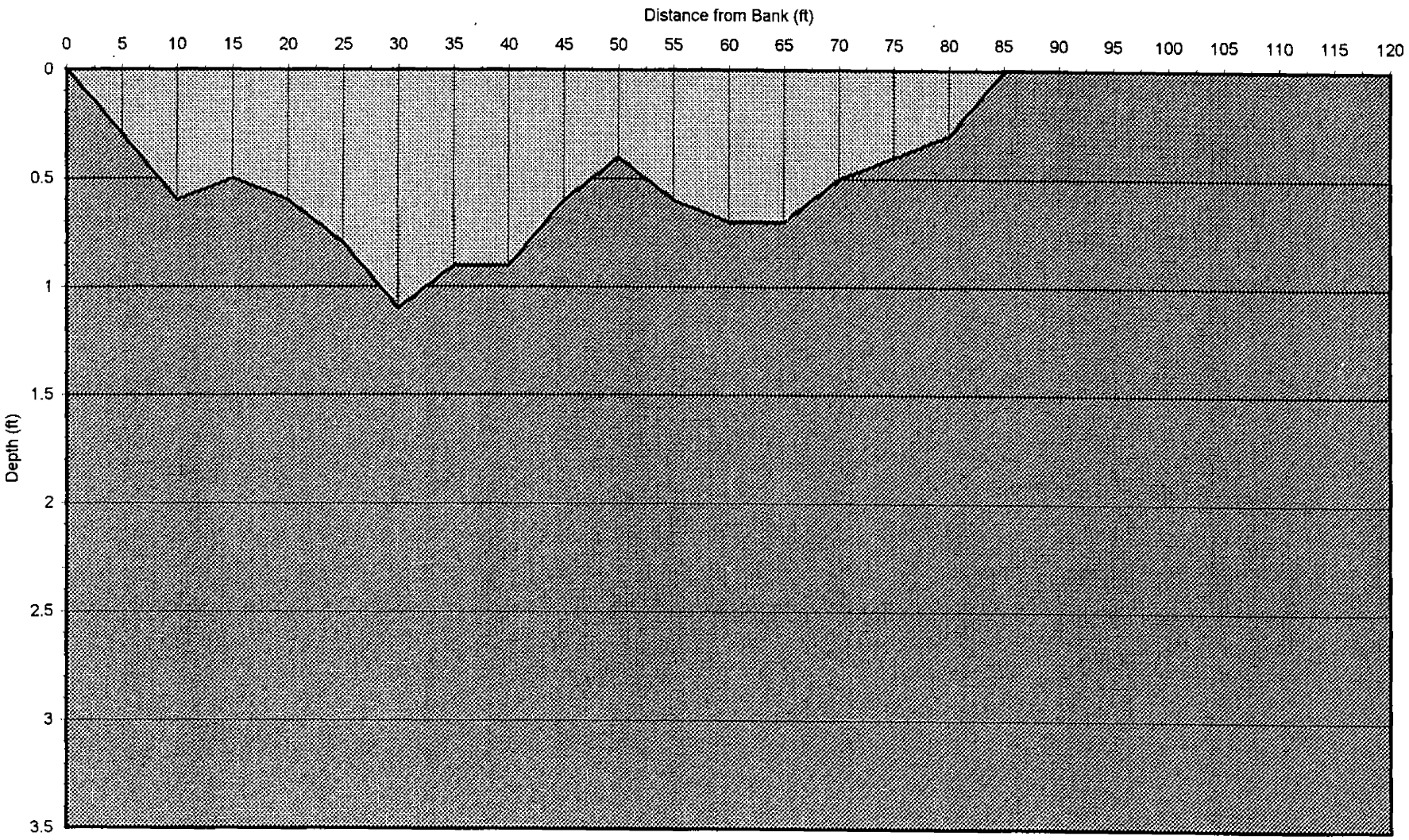
Genesee River Velocity Survey
Survey: 1 8/4/98
Transect: DS
Transect Width 120ft
Start Time 11:20 Gage Height 2.36
Start Time 11:52 Gage Height 2.36

Avg Velocity = 0.12 fps
Total Area = 258.75 ft^2

Total Dicharge = 34.3 cfs

Segment	Station	Time	Distance From Bank (ft)	Depth (ft)	Reading Depth (ft)	Velocity (ft/sec)	Segment Area ft^2	Segment Velocity (ft/sec)	Segment Flow cfs
			0	0	0				
1	1	11:23	5	1.8	1.08	-0.02	4.5	-0.02	-0.09
2	2	11:26	10	2.2	1.32	0.14	10	0.06	0.6
3	3	11:27	15	2	1.2	0.21	10.5	0.175	1.8375
4	4	11:28	20	2.2	1.32	0.25	10.5	0.23	2.415
5	5	11:29	25	2.5	1.5	0.26	11.75	0.255	2.99625
6	6	11:30	30	2.7	1.62	0.26	13	0.26	3.38
7	7	11:31	35	2.8	1.68	0.17	13.75	0.215	2.95625
8	8	11:33	40	2.5	1.5	0.17	13.25	0.17	2.2525
9	9	11:34	45	2.6	1.56	0.24	12.75	0.205	2.61375
10	10	11:35	50	2.8	1.68	0.22	13.5	0.23	3.105
11	11	11:37	55	3	1.8	0.14	14.5	0.18	2.61
12	12	11:39	60	3	1.8	0.12	15	0.13	1.95
13	13	11:41	65	2.95	1.77	0.06	14.875	0.09	1.33875
14	14	11:43	70	2.9	1.74	0.04	14.625	0.05	0.73125
15	15	11:44	75	2.6	1.56	0.06	13.75	0.05	0.6875
16	16	11:45	80	1.1	0.66	-0.03	9.25	0.015	0.13875
17	17	11:46	85	1	0.6	0.14	5.25	0.055	0.28875
18	18	11:47	90	2	1.2	0.15	7.5	0.145	1.0875
19	19	11:48	95	1.9	1.14	0.04	9.75	0.095	0.92625
20	20	11:49	100	2	1.2	0.12	9.75	0.08	0.78
21	21	11:50	105	1.7	1.02	0.05	9.25	0.085	0.78625
22	22	11:51	110	1.8	1.08	0.01	8.75	0.03	0.2625
23	23	11:52	115	1.7	1.02	0.07	8.75	0.04	0.35
24			120	0	0		4.25	0.07	0.2975

Survey 1
US Cross Sectional Area



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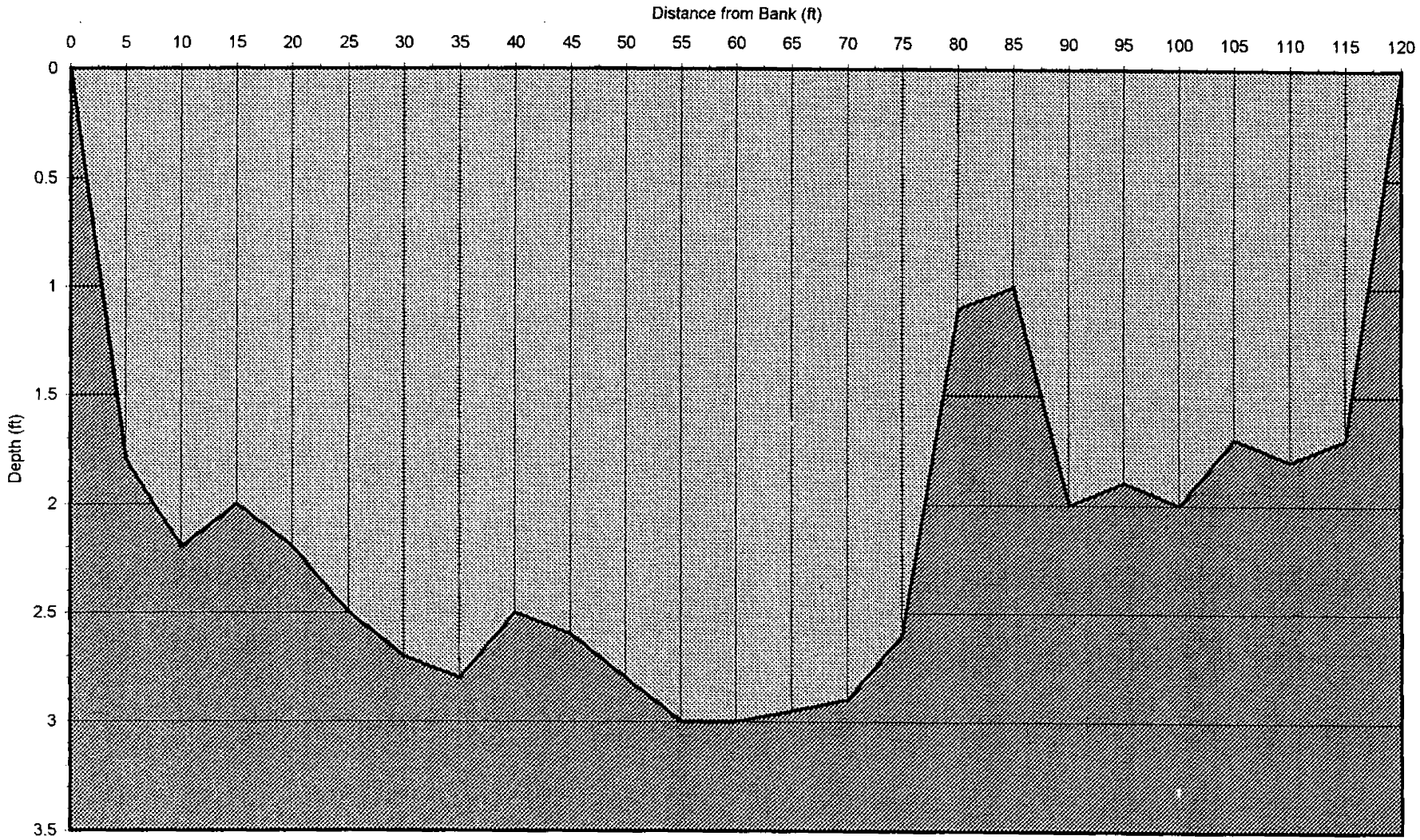
Survey 1
DS Cross Sectional Area



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Genesee River Velocity Survey
Survey: 2 8/27/98
Transect: US
Transect Width 80ft
Start Time: 15:15 Gage Height 1.1
Start Time: 16:05 Gage Height 1.1

Avg Velocity = 0.49 fps
Total Area = 40.00 ft^2

Total Dicharge = 22.8 cfs

Segment	Station	Time	Distance From Bank (ft)	Depth (ft)	Reading Depth (ft)	Velocity (ft/sec)	Segment Area ft^2	Segment Velocity (ft/sec)	Segment Flow cfs
			0	0	0				
1	1	15:15	5	0.2	0.12	0.44	0.5	0.44	0.22
2	2	15:17	10	0.5	0.3	0.36	1.75	0.4	0.7
3	3	15:20	15	0.4	0.24	0.91	2.25	0.635	1.42875
4	4	15:23	20	0.5	0.3	0.72	2.25	0.815	1.83375
5	5	15:26	25	0.6	0.36	0.92	2.75	0.82	2.255
6	6	15:30	30	0.7	0.42	1.17	3.25	1.045	3.39625
7	7	15:32	35	0.9	0.54	0.88	4	1.025	4.1
8	8	15:35	40	0.6	0.36	0.62	3.75	0.75	2.8125
9	9	15:40	45	0.5	0.3	0.35	2.75	0.485	1.33375
10	10	15:43	50	0	0	0	1.25	0.175	0.21875
11	11	15:46	55	0.5	0.3	-0.05	1.25	-0.025	-0.03125
12	12	15:50	60	0.6	0.36	0.32	2.75	0.135	0.37125
13	13	15:53	65	0.7	0.42	0.81	3.25	0.565	1.83625
14	14	15:56	70	0.8	0.48	0.16	3.75	0.485	1.81875
15	15	15:59	75	0.4	0.24	0.09	3	0.125	0.375
16	16	16:05	80	0.2	0.12	0.08	1.5	0.085	0.1275
			85	0					

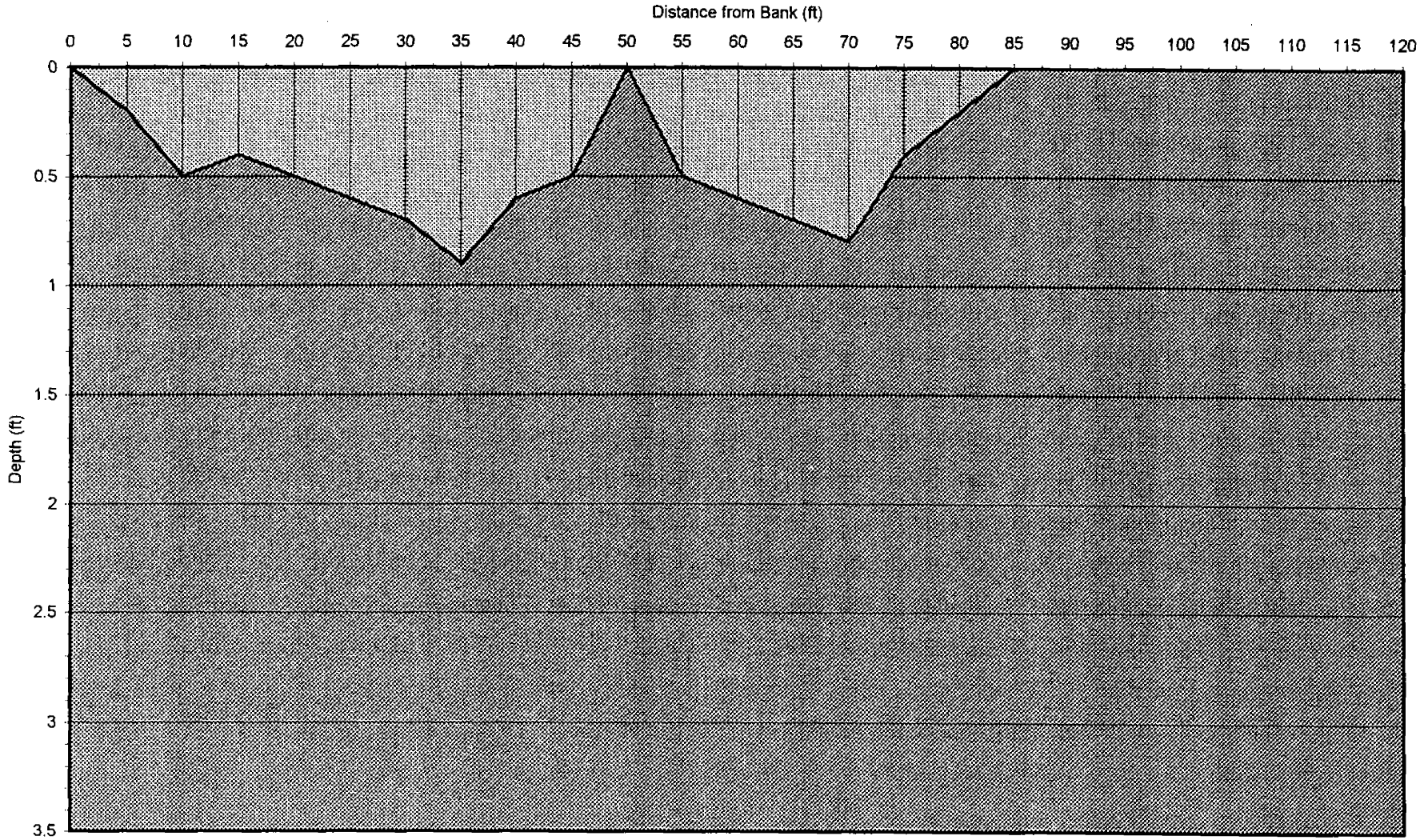
Genesee River Velocity Survey
Survey: 2 8/27/98
Transect: DS
Transect Width 125ft
Start Time 12:05 Gage Height 2.31
Start Time 13:25 Gage Height 2.31

Avg Velocity = 0.09 fps
Total Area = 246.00 ft^2

Total Dicharge = 23.1 cfs

Segment	Station	Time	Distance From Bank (ft)	Depth (ft)	Reading Depth (ft)	Velocity (ft/sec)	Segment Area ft^2	Segment Velocity (ft/sec)	Segment Flow cfs
			0	0	0				
1	1	12:05	5	2.8	1.7	0.03	7.00	0.03	0.21
2	2	12:08	10	2.1	1.3	-0.04	12.25	-0.01	-0.06
3	3	12:10	15	1.8	1.1	0.12	9.75	0.04	0.39
4	4	12:12	20	2.0	1.2	0.20	9.50	0.16	1.52
5	5	12:15	25	2.1	1.3	0.22	10.25	0.21	2.15
6	6	12:17	30	2.1	1.3	0.13	10.50	0.18	1.84
7	7	12:21	35	1.9	1.1	0.14	10.00	0.14	1.35
8	8	12:25	40	1.9	1.1	0.10	9.50	0.12	1.14
9	9	12:30	45	1.9	1.1	0.20	9.50	0.15	1.43
10	10	12:32	50	1.9	1.1	0.10	9.50	0.15	1.43
11	11	12:35	55	2.1	1.3	0.09	10.00	0.10	0.95
12	12	12:39	60	2.2	1.3	0.09	10.75	0.09	0.97
13	13	12:42	65	2.4	1.4	0.03	11.50	0.06	0.69
14	14	12:45	70	2.8	1.7	0.01	13.00	0.02	0.26
15	15	12:50	75	2.2	1.3	-0.06	12.50	-0.03	-0.31
16	16	12:52	80	1.7	1.0	0.03	9.75	-0.02	-0.15
17	17	12:55	85	1.1	0.7	0.04	7.00	0.04	0.25
18	18	13:00	90	2.0	1.2	0.12	7.75	0.08	0.62
19	19	13:03	95	2.2	1.3	0.22	10.50	0.17	1.79
20	20	13:06	100	2.2	1.3	0.21	11.00	0.22	2.37
21	21	13:10	105	2.1	1.3	0.15	10.75	0.18	1.94
22	22	13:13	110	2.0	1.2	0.05	10.25	0.10	1.03
23	23	13:16	115	2.0	1.2	0.10	10.00	0.08	0.75
24	24	13:18	120	1.3	0.8	-0.05	8.25	0.10	0.83
25	25	13:25	125	0.8	0.5	0.02	5.25	-0.05	-0.26

Survey 2
US Cross Sectional Area



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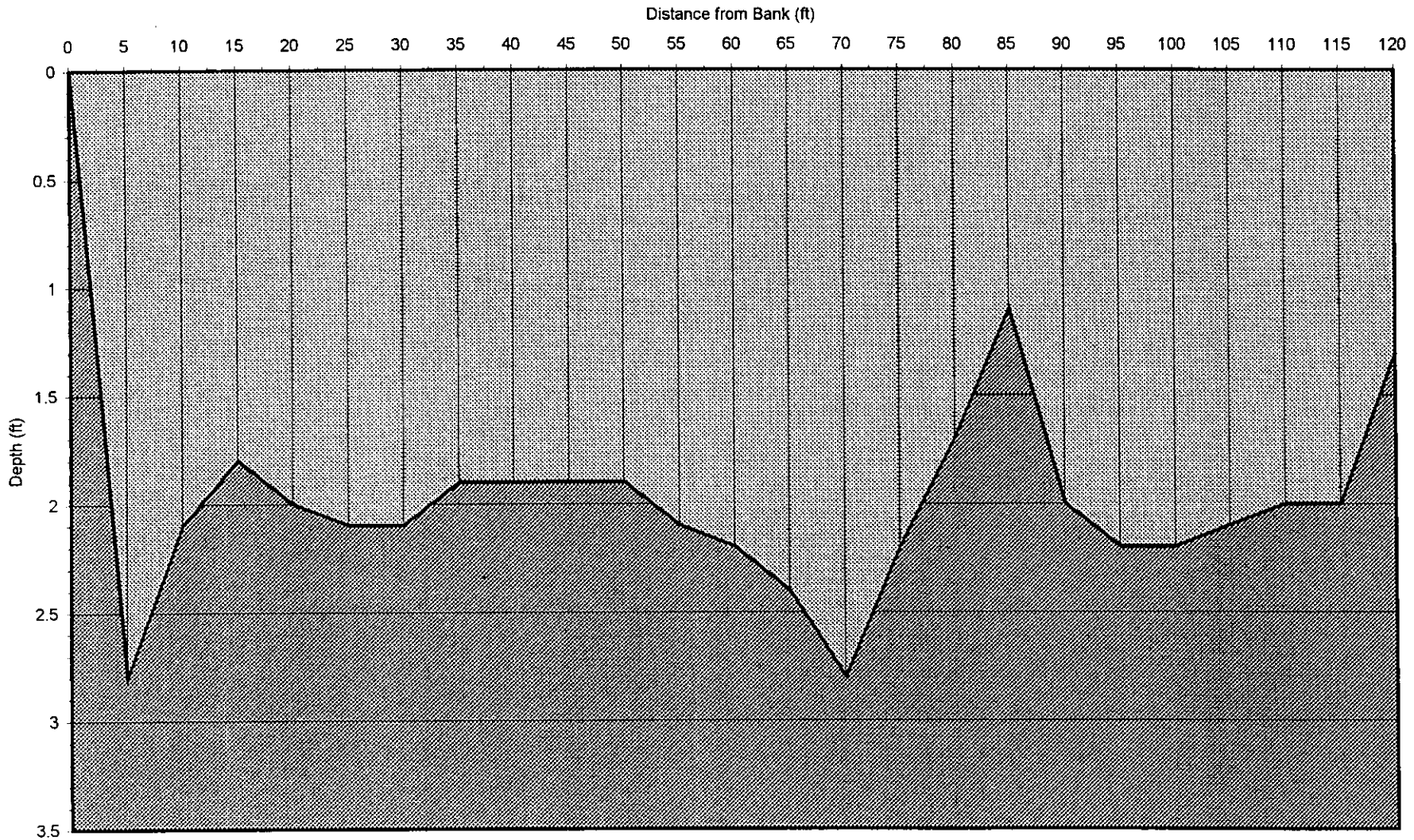
Survey 2
DS Cross Sectional Area



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Genesee River Velocity Survey
Survey: 3 9/4/98
Transect: US
Transect Width 80ft
Start Time: 16:15 Gage Height 0.88
Start Time: 16:55 Gage Height 0.88

Avg Velocity = 0.56 fps
Total Area = 43.25 ft^2

Total Dicharge = 26.3 cfs

Segment	Station	Time	Distance From Bank (ft)	Depth (ft)	Reading Depth (ft)	Velocity (ft/sec)	Segment Area ft^2	Segment Velocity (ft/sec)	Segment Flow cfs	
			0	0	0					
1	1	16:15	5	0.4	0.24	0.30	1	0.3	0.3	
2	2	16:18	10	0.5	0.30	0.52	2.25	0.409808	0.922067	30 Deg West
3	3	16:20	15	0.4	0.24	0.82	2.25	0.669808	1.507067	
4	4	16:22	20	0.6	0.36	1.02	2.5	0.92	2.3	
5	5	16:25	25	0.7	0.42	1.06	3.25	1.04	3.38	
6	6	16:28	30	0.7	0.42	0.96	3.5	1.01	3.535	
7	7	16:31	35	0.9	0.54	0.80	4	0.88	3.52	
8	8	16:34	40	0.6	0.36	0.72	3.75	0.76	2.85	
9	9	16:37	45	0.3	0.18	0.57	2.25	0.645	1.45125	
10	10	16:40	50	0.3	0.18	0.31	1.5	0.44	0.66	
11	11	16:42	55	0.6	0.36	0.58	2.25	0.445	1.00125	
12	12	16:45	60	0.8	0.48	0.44	3.5	0.51	1.785	
13	13	16:48	65	0.5	0.30	0.04	3.25	0.24	0.78	Below large rock
14	14	16:50	70	0.8	0.48	0.43	3.25	0.235	0.76375	
15	15	16:52	75	0.4	0.24	0.39	3	0.41	1.23	
16	16	16:55	80	0.3	0.18	0.01	1.75	0.2	0.35	Along rocky shore
			85	0						

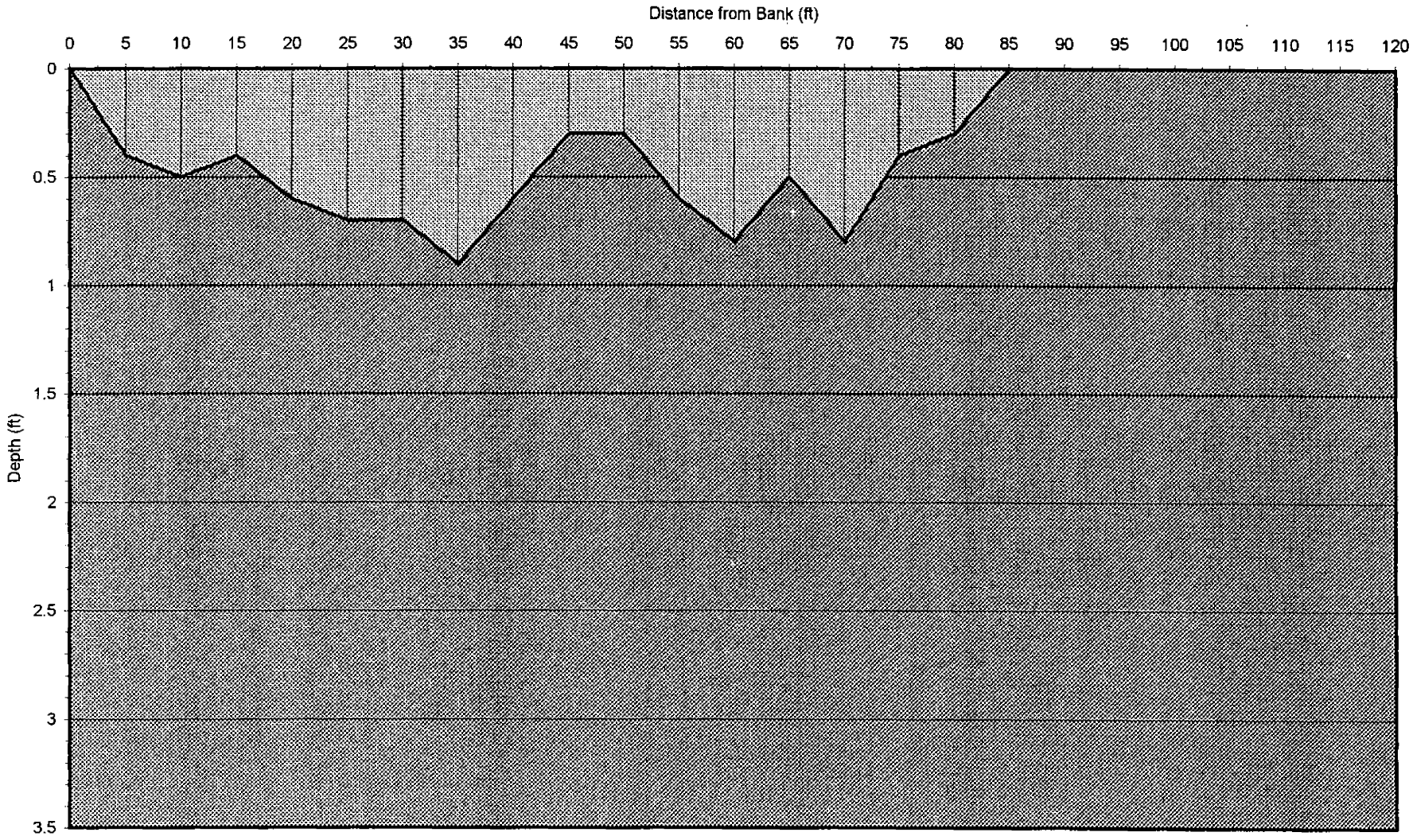
Genesee River Velocity Survey
Survey: 3 9/4/98
Transect: DS
Transect Width 120ft
Start Time 15:25 Gage Height 2.31
Start Time 16:22 Gage Height 2.31

Avg Velocity = 0.08 fps
Total Area = 238.00 ft^2

Total Dicharge = 20.9 cfs

Segment	Station	Time	Distance From Bank (ft)	Depth (ft)	Reading Depth (ft)	Velocity (ft/sec)	Segment Area ft^2	Segment Velocity (ft/sec)	Segment Flow cfs
			0	0	0				
1	1	15:25	5	1.2	0.72	0.03	3.00	0.03	0.09
2	2	15:27	10	2.1	1.26	0.04	8.25	0.04	0.29
3	3	15:30	15	1.9	1.14	0.18	10.00	0.11	1.10
4	4	15:32	20	2.0	1.20	0.16	9.75	0.17	1.66
5	5	15:35	25	2.2	1.32	0.14	10.50	0.15	1.58
6	6	15:38	30	2.0	1.20	0.11	10.50	0.13	1.31
7	7	15:40	35	2.1	1.26	0.13	10.25	0.12	1.23
8	8	15:43	40	2.1	1.26	0.10	10.50	0.12	1.21
9	9	15:34	45	2.1	1.26	0.07	10.50	0.09	0.89
10	10	15:47	50	2.0	1.20	0.08	10.25	0.08	0.77
11	11	15:50	55	2.1	1.26	0.08	10.25	0.08	0.82
12	12	15:52	60	2.3	1.38	0.05	11.00	0.07	0.72
13	13	15:55	65	2.4	1.44	0.03	11.75	0.04	0.47
14	14	15:58	70	2.4	1.44	0.03	12.00	0.03	0.36
15	15	16:00	75	2.5	1.50	0.06	12.25	0.05	0.55
16	16	16:03	80	1.8	1.08	-0.02	10.75	0.02	0.22
17	17	16:05	85	1.4	0.84	0.02	8.00	0.00	0.00
18	18	16:07	90	2.1	1.26	0.09	8.75	0.06	0.48
19	19	16:10	95	2.2	1.32	0.16	10.75	0.13	1.34
20	20	16:12	100	2.1	1.26	0.22	10.75	0.19	2.04
21	21	16:15	105	2.1	1.26	0.11	10.50	0.17	1.73
22	22	16:18	110	2.1	1.26	0.08	10.50	0.10	1.00
23	23	16:20	115	1.8	1.08	0.05	9.75	0.07	0.63
24	24	16:22	120	1.2	0.72	-0.07	7.50	0.05	0.38

Survey 3
US Cross Sectional Area



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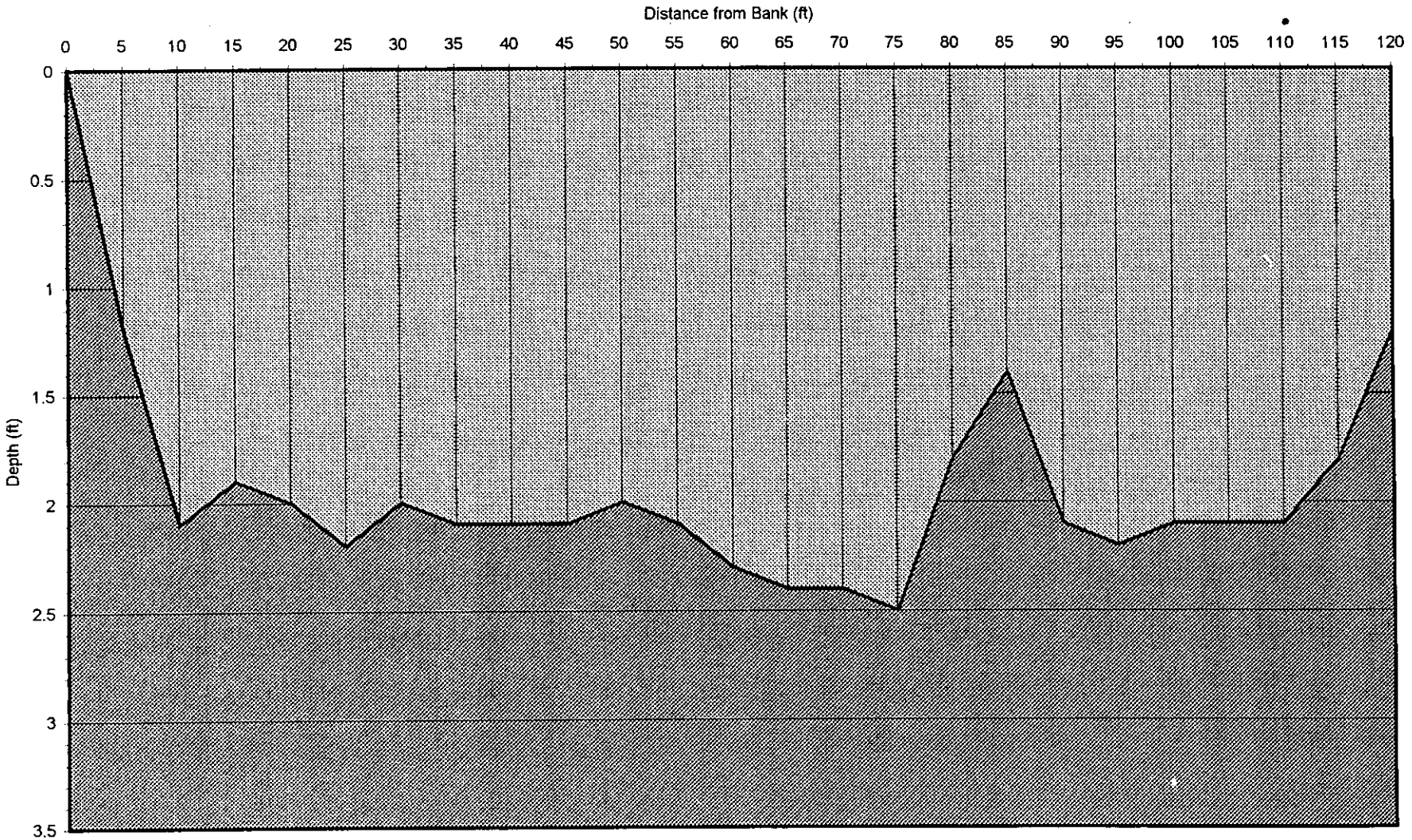
Survey 3
DS Cross Sectional Area



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Genesee River Velocity Survey
Survey: 4 9/22/98
Transect: US
Transect Width 80ft
Start Time: 14:25 Gage Height 0.86
Start Time: 15:30 Gage Height 0.86

Avg Velocity = 0.36 fps
Total Area = 32.5 ft^2

Total Dicharge = 13.7 cfs

Segment	Station	Time	Distance From Bank (ft)	Depth (ft)	Reading Depth (ft)	Velocity (ft/sec)	Segment Area ft^2	Segment Velocity (ft/sec)	Segment Flow cfs	
			0	0	0					
1	1	14:25	5	0.3	0.18	-0.05	0.75	-0.050	-0.038	DS of Large Rock
2	2		10	0.4	0.24	0.18	1.75	0.065	0.114	
3	3		15	0.3	0.18	0.72	1.75	0.450	0.788	
4	4		20	0.4	0.24	0.94	1.75	0.830	1.453	
5	5		25	0.6	0.36	0.70	2.5	0.820	2.050	DS of Large Rock
6	6		30	0.6	0.36	0.17	3	0.435	1.305	@45° angle toward east
7	7		35	0.8	0.48	0.55	3.5	0.358	1.252	@30° angle toward west
8	8		40	0.5	0.30	0.65	3.25	0.598	1.943	
9	9		45	0.4	0.24	0.10	2.25	0.375	0.844	DS of Large Rock
10	10		50	0.4	0.24	0.60	2	0.350	0.700	US of Large Rock
11	11		55	0.7	0.42	0.40	2.75	0.500	1.375	
12	12		60	0	0.00	0.00	1.75	0.200	0.350	NA Large Rock
13	13		65	0.8	0.48	0.41	2	0.205	0.410	
14	14		70	0.3	0.18	0.33	2.75	0.370	1.018	
15	15		75	0	0.00	0.00	0.75	0.165	0.124	NA Shallow
16	16		80	0	0.00	0.00	0	0.000	0.000	
			85	0						

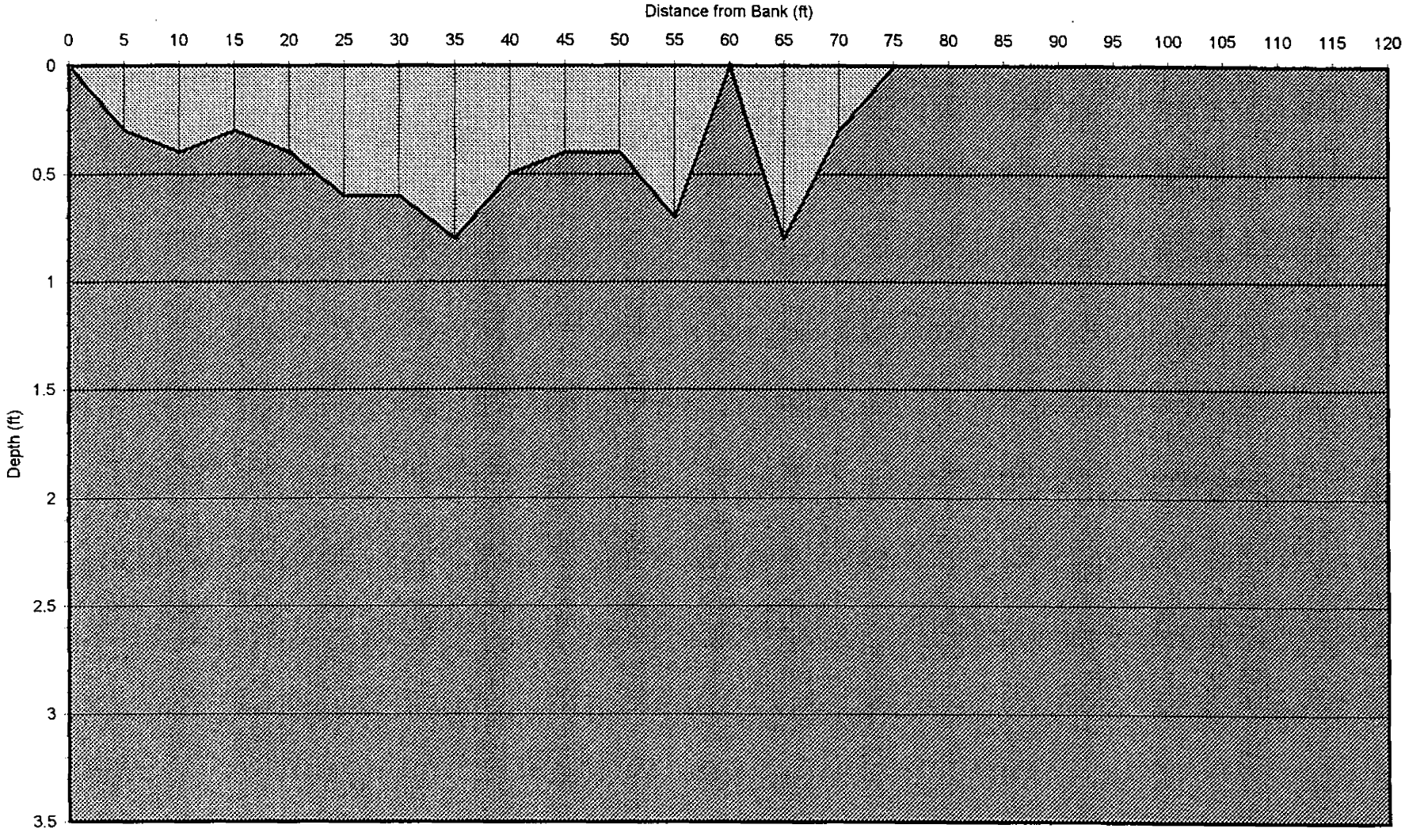
Genesee River Velocity Survey
Survey: 4 9/22/98
Transect: DS
Transect Width 120ft
Start Time 11:10 Gage Height 2.28
Start Time 13:40 Gage Height 2.28

Avg Velocity = 0.09 fps
Total Area = 217.70 ft^2

Total Dicharge = 20.6 cfs

Segment	Station	Time	Distance From Bank (ft)	Depth (ft)	Reading Depth (ft)	Velocity (ft/sec)	Segment Area ft^2	Segment Velocity (ft/sec)	Segment Flow cfs	
			0	0	0					
1	1	12:30	5	1.50	0.90	0.11	3.75	0.11	0.41	
2	2	12:34	10	1.60	0.96	0.14	7.75	0.13	0.97	
3	3	12:36	15	1.80	1.08	0.15	8.50	0.15	1.23	
4	4	12:40	20	2.00	1.20	0.17	9.50	0.16	1.52	
5	5	12:45	25	2.00	1.20	0.14	10.00	0.16	1.55	
6	6	12:47	30	2.10	1.26	0.13	10.25	0.14	1.38	
7	7	12:50	35	2.10	1.26	0.10	10.50	0.12	1.21	
8	8	15:52	40	2.10	1.26	0.10	10.50	0.10	1.05	
9	9	12:55	45	1.80	1.08	0.08	9.75	0.09	0.88	
10	10	12:58	50	2.00	1.20	0.06	9.50	0.07	0.67	
11	11	13:00	55	2.00	1.20	0.08	10.00	0.07	0.70	
12	12	13:05	60	2.10	1.26	0.05	10.25	0.07	0.67	
13	13	13:07	65	2.00	1.20	0.04	10.25	0.05	0.46	
14	14	13:10	70	2.00	1.20	-0.02	10.00	0.01	0.10	Beginning of weed bed
15	15	13:13	75	1.90	1.14	0.01	9.75	-0.01	-0.05	Weed bed
16	16	13:15	80	1.60	0.96	0.04	8.75	0.03	0.22	Weed bed
17	17	13:18	85	1.30	0.78	0.01	7.25	0.03	0.18	End of weed bed
18	18	13:20	90	2.00	1.20	0.18	8.25	0.10	0.78	
19	19	13:22	95	2.10	1.26	0.12	10.25	0.15	1.54	
20	20	13:25	100	2.10	1.26	0.14	10.50	0.13	1.37	
21	21	13:29	105	1.80	1.08	0.10	9.75	0.12	1.17	
22	22	13:32	110	1.70	1.02	0.13	8.75	0.12	1.01	
23	23	13:35	115	1.90	1.14	0.11	9.00	0.12	1.08	
24	24	13:38	120	0.08	0.05	0.01	4.95	0.11	0.54	

Survey 4
US Cross Sectional Area



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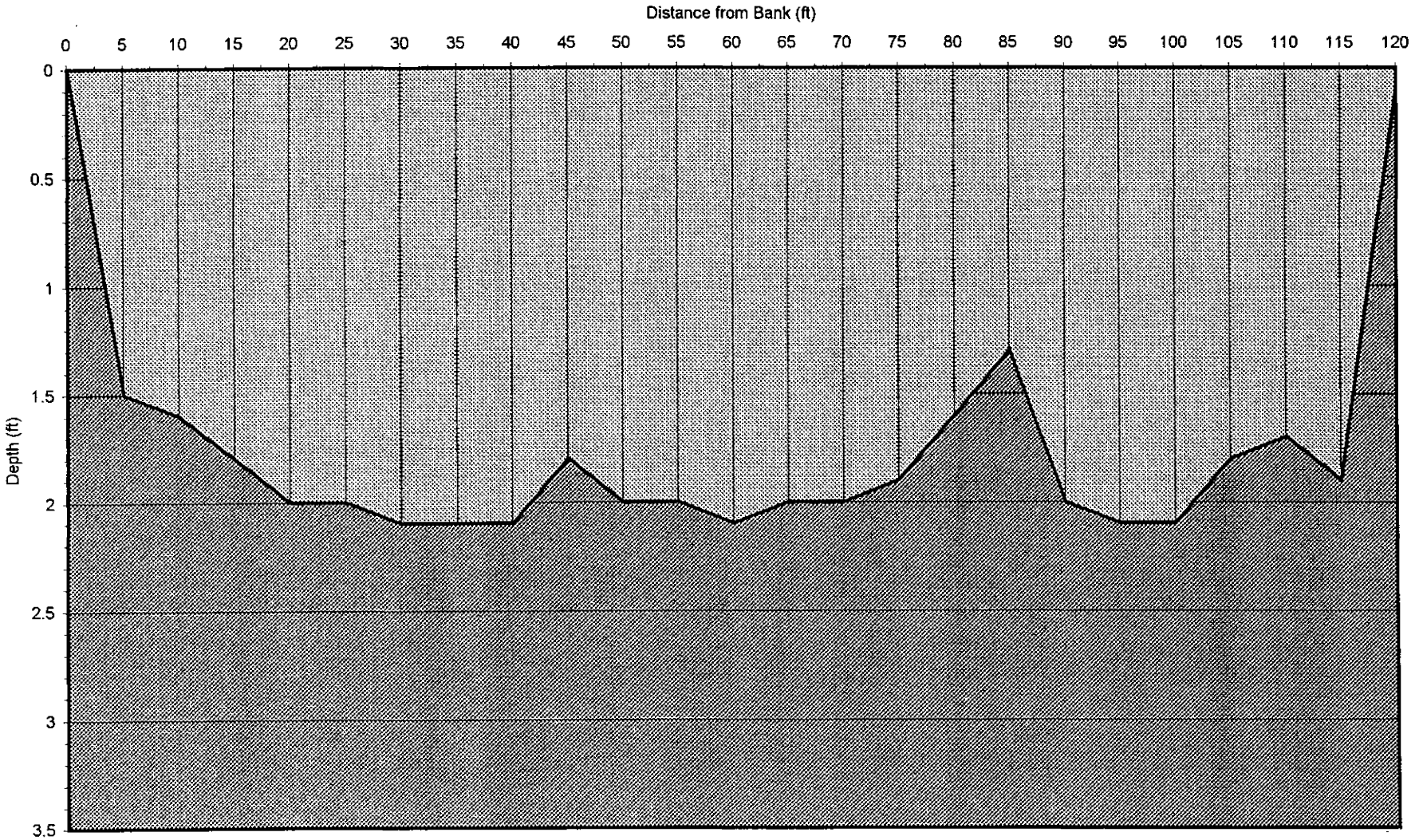
Survey 4
DS Cross Sectional Area



SURVEY4.xls 12/22/98 2:36 PM

Genesee River Velocity Survey
Survey: 5 10/05/98
Transect: US
Transect Width 80ft
Start Time: 14:25 Gage Height 0.86
Start Time: 15:30 Gage Height 0.86

Avg Velocity = 0.40 fps
Total Area = 27.65 ft^2

Total Dicharge = 13.9 cfs

Segment	Station	Time	Distance From Bank (ft)	Depth (ft)	Reading Depth (ft)	Velocity (ft/sec)	Segment Area ft^2	Segment Velocity (ft/sec)	Segment Flow cfs	
			0	0	0					
1	1	16:55	5	0.2	0.12	0.70	0.50	0.70	0.35	
2	2	16:55	10	0.3	0.18	0.62	1.25	0.66	0.83	
3	3	16:16	15	0	0.00	0.00	0.75	0.31	0.23	DS of Large Rock
4	4	16:16	20	0.5	0.30	0.59	1.25	0.30	0.37	
5	5	16:16	25	0.6	0.36	1.08	2.75	0.84	2.30	
6	6	16:57	30	0.8	0.48	0.72	3.50	0.90	3.15	
7	7	16:57	35	0.5	0.30	0.46	3.25	0.59	1.92	
8	8	16:58	40	0.4	0.24	0.01	2.25	0.24	0.53	DS of Large Rock
9	9	16:58	45	0	0.00	0.00	1.00	0.01	0.01	NA Shallow
10	10	16:59	50	0.3	0.18	0.39	0.75	0.20	0.15	
11	11	17:00	55	0.7	0.42	0.68	2.50	0.54	1.34	
12	12	17:00	60	0.6	0.36	0.46	3.25	0.57	1.85	
13	13	17:01	65	0.6	0.36	0.02	3.00	0.24	0.72	DS of Large Rock
14	14	17:01	70	0.03	0.02	0.20	1.58	0.11	0.17	
15	15	17:02	75	0	0.00	0.00	0.08	0.10	0.01	NA Shallow
			80	0						
			85	0						

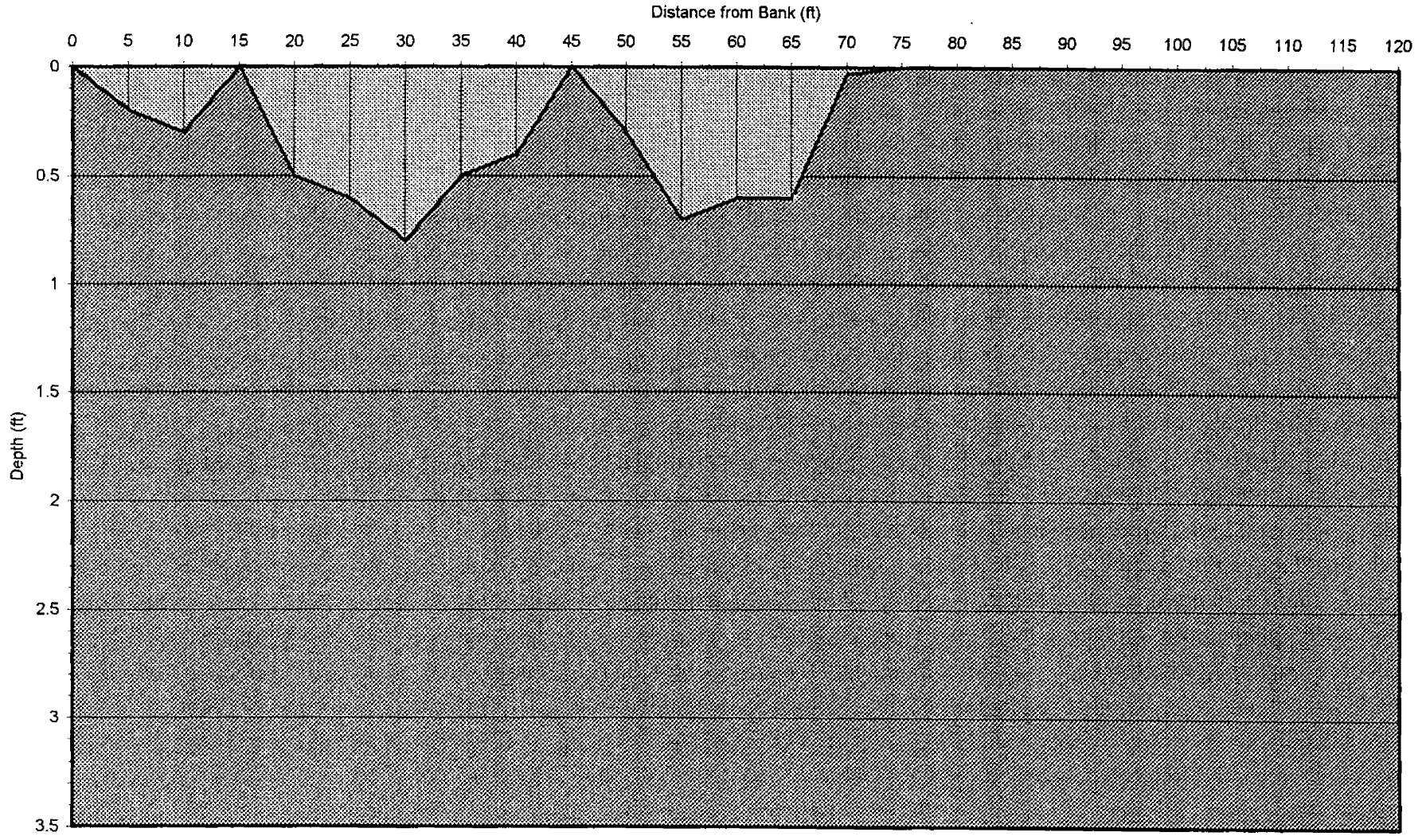
Genesee River Velocity Survey
Survey: 5 10/05/98
Transect: DS
Transect Width 118ft
Start Time 12:00 Gage Height 2.28
Start Time 14:45 Gage Height 2.28

Avg Velocity = 0.06 fps
Total Area = 251.50 ft^2

Total Dicharge = 15.7 cfs

Segment	Station	Time	Distance From Bank (ft)	Depth (ft)	Reading Depth (ft)	Velocity (ft/sec)	Segment Area ft^2	Segment Velocity (ft/sec)	Segment Flow cfs	
			0	0	0					
1	1	14:12	5	2.30	1.38	0.03	5.75	0.03	0.17	DS. Of riprap
2	2	14:14	10	2.30	1.38	0.01	11.50	0.02	0.23	
3	3	14:15	15	1.90	1.14	0.08	10.50	0.05	0.47	
4	4	14:16	20	2.10	1.26	0.08	10.00	0.08	0.80	
5	5	14:17	25	2.40	1.44	0.09	11.25	0.09	0.96	
6	6	14:17	30	2.40	1.44	0.08	12.00	0.09	1.02	
7	7	14:18	35	2.70	1.62	0.04	12.75	0.06	0.77	edge of weed, downstream
8	8	15:18	40	2.70	1.62	0.02	13.50	0.03	0.41	
9	9	14:19	45	2.50	1.50	0.13	13.00	0.08	0.98	
10	10	14:20	50	2.80	1.68	0.09	13.25	0.11	1.44	15° toward east
11	11	14:21	55	2.90	1.74	0.10	14.25	0.09	1.33	
12	12	14:21	60	2.90	1.74	0.12	14.50	0.11	1.60	
13	13	14:22	65	2.90	1.74	0.02	14.50	0.07	1.02	
14	14	14:24	70	2.80	1.68	0.04	14.25	0.03	0.43	In weed bed
15	15	14:25	75	2.50	1.50	0.05	13.25	0.05	0.60	
16	16	14:26	80	1.20	0.72	0.00	9.25	0.03	0.23	Weed bed below rock
17	17	14:27	85	1.30	0.78	0.11	6.25	0.06	0.34	
18	18	14:28	90	1.80	1.08	0.07	7.75	0.09	0.70	
19	19	14:29	95	1.70	1.02	0.08	8.75	0.08	0.66	
20	20	14:30	100	1.70	1.02	0.06	8.50	0.07	0.60	
21	21	14:31	105	1.50	0.90	0.04	8.00	0.05	0.40	
22	22	14:32	110	2.00	1.20	0.03	8.75	0.04	0.31	
23	23	14:33	115	1.00	0.60	0.02	7.50	0.03	0.19	
24	24	14:33	118	0.00	0.00	0.00	2.50	0.02	0.05	

Survey 5
US Cross Sectional Area



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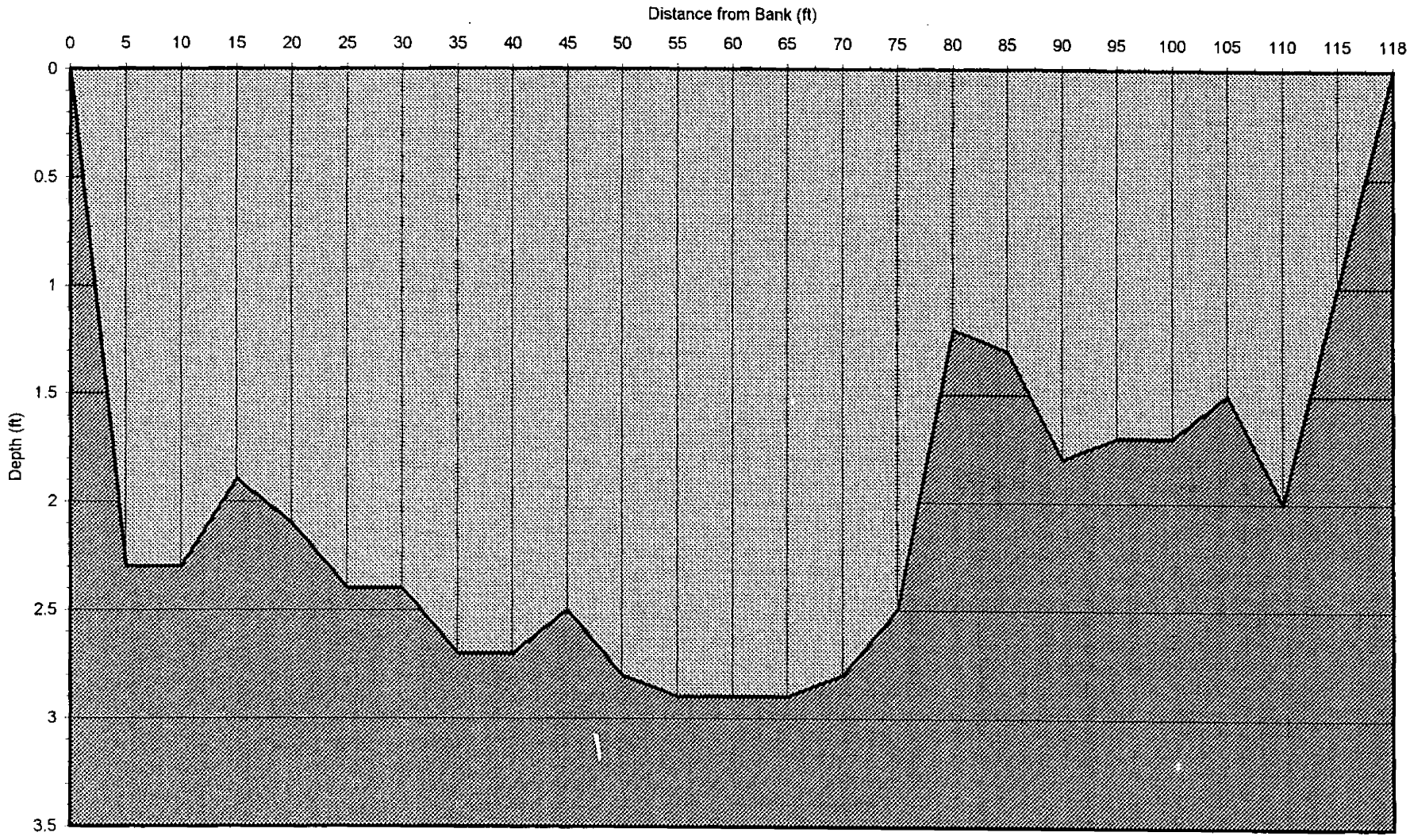
Survey 5
DS Cross Sectional Area



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APPENDIX B

NITROBENZENE FLOW-WEIGHTED AVERAGE CONCENTRATION AT TRANSECT DS

Concentration and Load of Nitrobenzene at Transect DS in Genesee River

4-Aug-98

Lateral Station	Flow (cfs)	Concentration (ug/L)	Load (g/day)
A	7.76	4.00	75.94
B	14.31	0.00	0.00
C	7.32	0.00	0.00
D	3.22	0.00	0.00
E	1.70	0.00	0.00
Total	34.30		75.94
Flow-weighted Average		0.91	

Concentration and Load of Nitrobenzene at Transect DS in Genesee River
27-Aug-98

Lateral Station	Flow (cfs)	Concentration (ug/L)	Load (g/day)
A	4.21	3.90	40.19
B	7.18	0.25	4.39
C	2.56	0.00	0.00
D	4.87	0.00	0.00
E	4.27	0.00	0.00
Total	23.09		44.58
Flow-weighted Average		0.79	

Concentration and Load of Nitrobenzene at Transect DS in Genesee River
04-Sep-98

Lateral Station	Flow (cfs)	Concentration (ug/L)	Load (g/day)
A	4.71	54.00	622.55
B	5.41	2.20	29.13
C	2.92	0.00	0.00
D	4.08	0.00	0.00
E	3.74	0.00	0.00
Total	20.86		651.68
Flow-weighted Average		12.77	

Concentration and Load of Nitrobenzene at Transect DS in Genesee River

22-Sep-98

Lateral Station	Flow (cfs)	Concentration (ug/L)	Load (g/day)
A	5.68	0.00	0.00
B	5.18	0.58	7.36
C	1.88	0.00	0.00
D	4.09	0.00	0.00
E	3.80	0.00	0.00
Total	20.63		7.36
Flow-weighted Average		0.15	

Concentration and Load of Nitrobenzene at Transect DS in Genesee River

6-Oct-98

Lateral Station	Flow (cfs)	Concentration (ug/L)	Load (g/day)
A	2.63	0.26	1.67
B	4.60	9.00	101.36
C	4.97	0.00	0.00
D	2.52	0.00	0.00
E	0.94	0.00	0.00
Total	15.67		103.03
Flow-weighted Average		2.69	

ATTACHMENT A

LIST OF EPA METHOD 8260 ANALYTES AND THEIR RESPECTIVE PRACTICABLE QUANTITATION LIMITS

LIST OF EPA METHOD 8260 ANALYTES AND THEIR RESPECTIVE PQLs

1998 SURFACE WATER SAMPLING, WELLSVILLE, NY

ANALYTE	PQL (µg/L)
1,1,1-Trichloroethane	0.50
1,1,2,2-Tetrachloroethane	0.50
1,1,2-Trichloroethane	0.50
1,1-Dichloroethane	0.50
1,1-Dichloroethylene	0.50
1,2,4-Trimethylbenzene	0.50
1,2-cis-Dichloroethylene	0.50
1,2-Dichlorobenzene	0.50
1,2-Dichloropropane	0.50
1,2-Trans-dichloroethylene	0.50
1,3,5-Trimethylbenzene	0.50
2-Butanone (mek)	5.0
2-Hexanone	5.0
4-Methyl-2-pentanone (mibk)	5.0
Acetone	5.0
Benzene	0.50
Bromoform	0.50
Carbon disulfide	5.0
Carbon tetrachloride	0.50
Chlorobenzene	0.50
Chlorodibromomethane	0.50
Chloroethane	0.50
Chloroform	0.50
cis-1,3-Dichloropropylene	0.50
Dichlorobromomethane	0.50
Ethylbenzene	0.50
Isopropyl Benzene	0.50
m+p-Xylene	0.50
Methyl bromide	0.50
Methyl chloride	0.50
Methylene chloride	0.50
Methyl-Tert-Butyl-Ether	0.50
Naphthalene	0.50
N-Butylbenzene	0.50
N-Propylbenzene	0.50
o-Xylene	0.50
P-Isopropyltoluene	0.50
Sec-Butylbenzene	0.50
Styrene	0.50
Tert-Butylbenzene	0.50
Tetrachloroethene	0.50
Toluene	0.50
trans-1,3-Dichloropropylene	0.50
Trichloroethene	0.50
Vinyl chloride	0.50

ATTACHMENT B

GROUNDWATER SEIMVOLATILE ORGANIC COMPOUND MONITORING DATA SUMMARIZED FROM ENVIROGEN 1998 PROGRESS MONITORING REPORTS

Groundwater Semi-Volatile Organic Compound Concentrations (ppb)

Former Sinclair Refinery Superfund Site (OU2), Wellsville, NY

	Date									
Monitoring Well / Analyte	May-93	Jul-93	Nov-95	Mar-96	Jun-96	Sep-97	Apr-98	Jul-98	Oct-98	Dec-98
MW-10										
2-Methylnaphthalene		4J 4J	11U	10U	11	18	3 J			
Dimethyl Phthalate						5 U	2.6 J			
Naphthalene		10 U 10 U	1.8U	2.3	2.3	5 U	5 U			
Nitrobenzene		10 U 10 U	2.1U	2U	62	8,700	5 U	340	10U	
MW-25										
2-Methylnaphthalene		39								
MW-26										
Naphthalene		12 17								
2-Methylnaphthalene		20 42								
Dibenzofuran		10 U 1J								
Flourine		10 U 1J								
Phenanthrene		10 U 1J								
Nitrobenzene		10 U 10U					25U		10U	
MW-27										
4-Nitrophenol						20 U	10 J	200U		1,000 U
Aniline								2,100		1,400
Azoxybenzene								140		250U
Nitrobenzene	440J	5,200				2,800	1,900	540		2,800
Nitrosobenzene								87		ND
Di-n-butyl phthalate	81J	27J				5 U	5 U	50U		250U
MW-33										
2-Methylnaphthalene	2J	1J				10 U				10U
Di-n-butyl phthalate	1J	10 U				5 U				5U
Unknown TICs										1,248J
Nitrobenzene	11 U	6J				5 U				14
MW-49										
2-Methylnaphthalene		13		10U		100				
Phenanthrene		1J		5.6U		50 U				
1,2-Dichlorobenzene		10 U		2.4		50 U				
Nitrobenzene		10 U		8.6		50 U				
Naphthalene		10 U		1.9		50 U				
bis(2-Ethylhexyl)phthalate		10 U		10 U		370				
MW-54										
Naphthalene		20								
2-Methylnaphthalene		33								
Acenaphthalene		3J								
Phenanthrene		5J								
MW-57										
Naphthalene	18*	29								
2-Methylnaphthalene	15*	19								
Phenanthrene	10 U	1J								
MW-67										
2-Methylnaphthalene		40		10U	11U	10 U				10U
Acenaphthalene		1J		3.6U	2.1U	5 U				5.1U
Flourine		2J		2U	2.1U	5 U				5.1U
Phenanthrene		2J		5.6U	6U	5 U				5.1U
bis(2-Ethylhexyl)phthalate		3J		10U	11U	5 U				5.1U
Nitrobenzene		10 U		92.9	101	5 U	10U	24		5.1U
Cyclo-aliphatic TICs										78 JN
Substituted Aromatic TICs										85 JN
Unknown TICs										33JN

Groundwater Semi-Volatile Organic Compound Concentrations (ppb)

Former Sinclair Refinery Superfund Site (OU2), Wellsville, NY

MW-70										
Aniline										790
4-Nitrophenol						210 U	15 J	20U		200U
2-Methylnaphthalene		27J	10U	10U	10U	10 U	100 U	10 U	10U		100U
Di-n-butyl phthalate		30J	15	10U	10U	10 U	52 U	5 U	5U		50U
bis(2-Ethylhexyl)phthalate		8J	10U	10U	10U	10 U	100	1.4 J	5U		210
Naphthalene		206 U	5.0	3.9	4.4	4.5	52 U	3.1 J	5U		50U
Nitrobenzene		5,300	21,700	26,000	20,700	22,700	4,900	62,000	6,500		50U
Pentachlorophenol							210 U	3.6 J	20U		200U
Cyclo-aliphatic TICs									54 JN		3,010 JND
Substituted Aromatic TICs									245 JN		
Unknown hydrocarbon											13,940JD
Unknown TICs									223J		670JD
MW-71										
Nitrobenzene			2U	153			5 U		120		22
bis(2-Ethylhexyl)phthalate							12				5U
4,4-Dimethyl-2-cyclopenten-1-on											7JN
Unknown TICS											262J
OW-1										
Nitrobenzene											2,900
Aniline											130J
OW-3										
Nitrobenzene											2,200
Aniline											990
OW-4										
Nitrobenzene											16
Cyclo-aliphatic TICs											14 JN
Unknown TICs											50J
OW-6										
Nitrobenzene											61
Aniline											213
Substituted Aromatic TICs											190 JND
Unknown TICs											399 JND
OW-8										
Nitrobenzene											10
Cyclo-aliphatic TICs											21 JN
Substituted Aromatic TICs											52 JN
Unknown TICs											100 J

J - Approximate value, less than the quantitation limit for that analysis, but greater than zero.
ND - Compound was not detected.
U - Compound not detected using detection limit shown.
N - Spiked sample recovery not within control limits.
A - This flag indicates that a TIC is a suspected aldol-condensation product.
D - Spike diluted out.
Blank indicates well was not sampled or parameter not analyzed for..
- Original Analysis; Duplicate Anaylsis

* - Originally reported in Table 3-8B of ReTec's Draft Remedial Design Investigation Report (RDIR), dated October, 1993, as 18 ppb of 1,2,4,-trichlorobenzene, and 15 ppb of hexachlorobutadiene, which are each one text line above napthalene and 2-methylnapthalene, respectively, in Table 3-8B. Based on subsequent analyses, this is believed to be a typographical error.