METHODS
Water Quality

Field Methods

Eleven baseline samples were collected from June 25, 1984 to October 25, 1984 and six baseline samples were collected from June 10, 1985 to September 15, 1985. Samples were horizontally and vertically integrated the entire width of the stream using a Federal Interagency Sedimentation Laboratory model US DH75A, with a two liter integrating water sampler when water levels permitted. A separate two liter sample was taken for suspended sediment using the same method. If water levels did not permit the collection of an integrated sample, a grab sample was taken at mid depth, as far out from the bank as one could safely wade.

Samples were collected for three peak power generation (peak-event) periods, along with an immediate pre-event sample. Samples were collected on August 9th, August 26th and August 30th, 1985. All samples were collected at midstream and integrated vertically, but sampling water at the air-water and sediment-water interfaces were avoided. Water depth was monitored at a fixed metal post driver into the substrate with a meter stick attached. Parameters analyzed, both baseline and peaks, are shown in Table I.

Washing of bottles and preparation and transportation of samples followed EPA protocol.

Peak-Event Sampling of August 9th

The ascending leg (up leg) and peak plateau of this peak-event were intensely sampled. Water samples were collected during a two hour and twenty-four minute period at S3, 6.5 river km (4.0 river mi) upstream, and S5 0.6 river km (0.4 river mi) downstream of the dam.

The initial sampling plan consisted of collecting water samples at two subsites along a transect at each site. One subsite (B) was located at midstream on the transect, while the other subsite (A) was located approximately one quarter of the width of the stream out from the near bank. It was determined that there were no significant differences in water chemistry between the two subsites, and that mixing was occurring throughout the stream during peak-events. During the remaining peak-event samplings, water samples were only collected at subsite B at all sites involved.

Peak-Event Sampling of August 26th

The entire peak-event, consisting of the ascending leg, peak plateau, and descending leg (down leg) was sampled. Water samples were collected during a six hour period at Sites S3, S5, and in addition S6, which was located 13.1 river km (8.1 river mi) downstream of the reservoir. Site S6 was added to the sampling scheme to determine the distance the peak water-surge traveled downstream, and to observe whether effects on water quality were present farther downstream.

Peak-Event Sampling of August 30th

The entire peak-event was sampled during a nine hour period at S3, S5, S6, and in addition S8, which was located 16.0 river km (9.9 river mi) downstream of the reservoir. Site S8 was added to further test the distance traveled by the peak water-surge and magnification of effects on water quality.

Laboratory Methods

Chemical analyses were conducted within a 24-72 hour time period, depending on the parameter being analyzed. All analyses were accomplished using Standard Methods (APHA, 15th edition, 1980), unless otherwise noted. Confidence in laboratory results was established with the following methods:

1. Analyses were run in triplicate. Some analyses were run in duplicate after comparisons between triplicate samples showed consistency.
2. Additional sample bottles were collected at several sites, chosen randomly, during each sampling date. The different sample bottles from the same site were analyzed for the same parameter, and the results compared for consistency.
3. Quality control samples for the water quality parameters of concern in this study, were obtained from the U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio. The quality control samples were analyzed every third to fourth sampling date using identical procedures as the study samples. Concentrations obtained from the analysis of the EPA samples were compared to the actual concentrations provided by the EPA.

Table I: Baseline and peak water parameters analyzed.

		Baseline 1984-85	Peaks 1985	EPA Method
Hydrological	Water Depth	_____*	X	
Water Quality	Ammonia Nitrogen ($N\text{-}NH_3$)	_____**	X	350.1
	Organic Nitrogen	X	X	353.2
	Nitrate Nitrogen ($N\text{-}NO_3$)	X	X	353.2
	Nitrite Nitrogen ($N\text{-}NO_2$)	X	X	353.2
	Total Phosphorus (TP)	X	X	365.1
	Filterable Phosphorus ($P\text{-}PO_4$)	_____**	X	365.1
	Total Non-Filterable Residue (TNFR)	X	X	160.2
	Total Volatile Non-Filterable Residue (TVNFR)	X	X	160.4
	Conductivity	X	X	120.1
	pH	X	X	150.1
	Water Temperature	X	X	170.1
Organic Matter	Coarse Particulate Organic Matter (CPOM)	X	X	
	Fine Particulate Organic Matter (FPOM)	X	X	
	Very Fine Particulate Organic Matter (VPOM)	X	X	
	Dissolved Organic Carbon (DOC)	X	X	

* See Flow Tables

** Insufficient number of Data Points (Many were below detection)

EPA quality control samples of the Mineral Series, WP882, were used to test the accuracy of the laboratory technique for determining the following parameters: pH and conductivity. The Nutrient Series, WP 481, was used for the following parameters: Ammonia-Nitrogen, Organic-Nitrogen, and Filterable and Total Phosphorus. The Volatile Residue and Non-Filterable Residue quality control samples, WP184, were used for the following parameters: Total Volatile Non-Filterable Residue and Total Non-Filterable Residue (TVNFR) respectively. EPA quality control samples were not available for the following parameters: Water Temperature, Nitrite-Nitrogen, CPOM, FPOM, and VPOM. However, the procedures to determine the last three parameters mentioned were similar to the procedure for TVNFR.

Water Temperature was taken at mid depth using a standard laboratory, mercury-filled, centigrade thermometer. Specific conductance (conductivity) was measured in the field using a portable, battery operated meter (Lab-Line Instruments, model MC-3) and recorded in umhos/cm. The pH of the samples was determined using a Beckman Expandomatic pH meter in the laboratory.

Total non-filterable residue and total volatile non-filterable residue were determined by using standard procedures including a well mixed 100.0 ml sample, pre-washed and pre-ignited Whatman glass fiber filters, a 105° C drying temperature, and a 550-600° C igniting temperature.

Organic material (OM) size analysis was accomplished by dividing the OM into four size classifications. To facilitate comparison with other studies, we defined coarse particulate organic material (CPOM) as particles >1mm in diameter; fine particulate organic material (FPOM) as >0.53 um<1 mm; very fine particulate organic material (VPOM) as >0.45 um<0.53 um; dissolved organic carbon (DOC), the carbon component of OM <0.45 um (Boling et al., 1975). The water from a well-mixed, two liter integrated sample was filtered through nested 1 mm and 0.53 um sieves. The non-filterable residue in each sieve was rinsed onto a pre-weighed and pre-ignited (600°C, 30 minutes) Whatman glass fiber filter with activated charcoal filtered, deionized, glass distilled water. The filtrate was evenly filtered through two, pre-washed and pre-ignited, 0.45 um Whatman glass fiber filters. All filters were dried for 24 hours at 105°C and weighed to obtain the dry weight of the residue. The total organic material was obtained by igniting the filters at 600°C for 30 minutes. The organic material in the remaining filtrate was determined by wet oxidation with a 0.025 N solution of potassium dichromate (Maciolek, 1962). The dissolved organic material was assumed to be fifty percent dissolved organic carbon (Fisher, 1977).

Statistical Methods

Descriptive statistics, Pearson product-moment correlations, and one-way analysis of variance determinations were generated for the entire sampling periods of 1984 and 1985 as well as an early/late sampling period.

Statistical inference was not carried out on the peak-event data gathered. A sufficient number of cases did not exist for the generation of meaningful, interpretable, statistics.

The statistical analysis results are not presented in this report because of their more academic interest. One is referred to Ruff, Greg, 1987 thesis for coverage of this component.

Sediments

Suspended Sediments

Field

Suspended sediments were collected at the eight baseline sites (Figure 2) during the ice free season, twelve times in 1984 and seven in 1985. The three previously described peak events of 1985 were also sampled to correlate with the chemistry. All collecting utilized one gallon glass jugs mounted in a Paul Fasching designed heavy harness sampler (Figure 5). The sampler was moved up and down in the water column in order to achieve vertical integration. The design of the sampler prevented bottom sediment, even if disturbed, from entering the jugs. Duplicates as well as other vertical transects across the river were taken to determine reproducibility and consistency.

Laboratory

The gallon samples were treated to the following process in the sediment laboratory.

1. Decanted down to 1000 ml.
2. Split with the second half to be used for disaggregated, non-flocculated, determinations. .
3. Put through a 230 sieve screen for use in determining weight of coarse and organic content if sufficient material existed.
4. Brought up to 1000 ml in a graduated cylinder.
5. Pipetted to 50 ml beakers for grain size analysis of fines following Table IV.
6. Pipetted to crucibles for determination of percent organic
7. Grain size samples dried and weighted.
8. Percent organic dried at 105° and then burned at 525° for three hours in a muffle furnace.
9. The other half of the original split followed the above procedures 3-7 except that 10 ml of calgon was added, utilizing a calculating factor, to obtain grain-size distribution of the disaggregated sediment.

All sediment, suspended and deposited, was classified as to grain-size by the classes given in Table II. Breakdown classes were smaller than seen in the table, but the data was lumped into these tabled categories to make the comparisons manageable.

Table II: Suspended sediment, reservoir and bedload grain size classes.

Class	Diameter
Pebble or larger	Greater than 4mm
Gravel	(4mm-2mm)
Sand (VA Tube)	(2mm-0.062mm)
Very Coarse Sand	(2mm-1mm)
Coarse Sand	(1mm-0.5mm)
Medium Sand	(0.5mm-0.25mm)
Fine and Very Fine Sand	(0.25mm-0.06mm)
Silts and Clays (Pipetting)	(less than 0.062 mm)
Coarse and Medium Silt	(0.062mm-0.016mm)
Fine and Very Fine Silt	(0.016mm-0.004mm)
Clay	(less than 0.004mm)

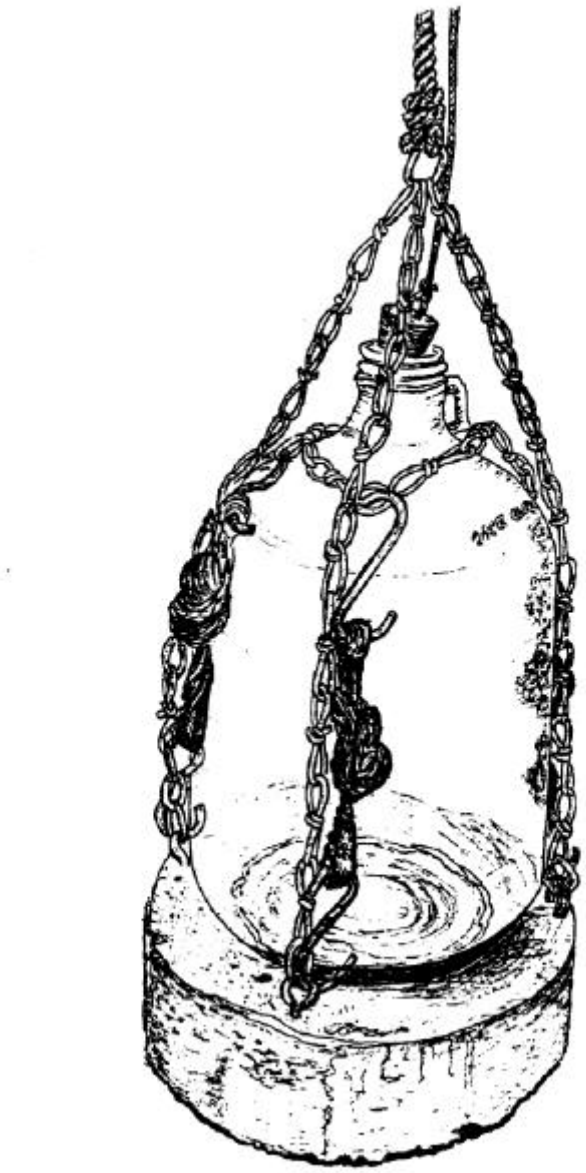

Figure 5. Fasching water sampler.

Reservoir Sediments

Field

Reservoir sediments were collected along 21 transects utilizing a Federal Inter-Agency Sedimentation Project bottom sampler during July of 1985. Representative select sites were again sampled in October. The top two cm's were utilized.

Laboratory

The reservoir sediments were split with a sediment splitter with half used for percent organic determination and half for grain size. The sand fraction of the sediment was analyzed for grain size using a Federal Interagency Visual Apparatus Tube (7 mm) and apparatus. The fines were analyzed by the pipette method as described in the previous section.

Bed Load Sediments

Field

Samples of surface bed material were taken October 12, 1984 (10 samples from the Blue Earth River and 10 samples from the Watonwan River) and measured 2" x 4" x 1". They were taken back to the sediment laboratory and immediately frozen in whirl pacs.

Laboratory

The samples were thawed and the following procedures for analysis were utilized.

1. Splitting with a sediment splitter was used to bring the sample to two 7 to 8 gram subsamples.
2. One portion was wet sieved through a sieve stack of #5, #10, and #1230 mesh with the fines collected also.
3. Sieve contents were dried and weighted.
4. Fines were split and utilized for pipette analysis and burned at 550°C for one hour for organic content.
5. Subsample from 1) above was washed through a #10 sieve, organic material oxidized with hydrogen peroxide and processed with 7mm Visual Accumulation Tube Apparatus, Federal Interagency Sedimentology Laboratory equipment and procedures. Procedure given in U.S.G.S. Handbook Laboratory Analysis Book 5, Chapter C1 Laboratory Theory and Methods for Sediment Analysis by Harold P. Guy.

Synthetic Organics

Field

Water samples were collected with two different methods. The first method employed a Federal Interagency Sediment Laboratory model US DH75A integrating water sampler equipped with a glass bottle for nonpeaking events. This method consisted of wading out into the river with the integrator and obtaining a sample of the water column from one side of the riverbank to the other, the amount taken per sample was approximately one litre. The sample was then placed in a clean glass container, and packed in ice prior to shipment to the laboratory.

The second method was the Fasching Method (Figure 5) and was used only during peaking events. Samples were taken from the middle of the river's water column using a boat as a platform. The sample size was approximately one gallon, which was cooled and divided among the various research teams in the lab. The amount of water that was needed for synthetics testing was approximately one litre.

It should be noted that prior to sampling all containers were cleaned at the lab, to prevent contamination, and also upon arrival at the respective sample sites each container was rinsed three times with water from the river.

Laboratory

Samples were extracted using Standard Method 509A. Prior to sample extraction a turbidity reading was obtained using a turbidity meter. The sample was then agitated for 15 seconds by hand, 500 ml of the river water sample was poured into a 2 litre seporatory funnel.

Extraction of each sample was accomplished by pouring 60 ml of a 15 percent diethyl ether and hexane solution into the separatory funnel and shaking it for 3 minutes. The mixture was allowed to stand for 10 minutes. The water phase was then drained back into a 500 ml flask, and the organic phase was poured into a 2 cm x 10 cm column containing sodium sulfate, {for removal of any water within the organic phase}, which drained into a Kuderna-Danish Evaporative Concentrator. The remaining water phase was then poured back into the 2 litre seporatory funnel and the 500 ml flask was rinsed with another 60 ml portion of the 15 percent diethyl ether and hexane solution and poured into the 2 litre separatory funnel, and the extraction process was repeated. The third and final extraction was done with 60 ml of pure hexane. All three of the extractions were poured into the sodium sulfate column that drained into the Kuderna-Danish Evaporative Concentrator. The addition of 60 ml of hexane was also used as a rinse of the sodium sulfate, giving the total liquid volume of 240 ml.

The Kuderna-Danish Evaporative Concentrator was the fitted with a three-ball snyder column and a 10-ml concentrator tube. The organic phase was reduced to 3 ml in a warm water bath (90-95 degrees centigrade). The reduction by distillation removed the diethyl ether and any other low boiling point materials. The concentrator tube was cooled to room temperature and hexane was added to bring the total volume to 5 ml. The 5-ml sample was then poured into a 7-ml glass vial with a trifluoroethylene screw cap, labeled and stored at 4 degrees centigrade.

After each complete sample extraction all glassware was cleaned and rinsed with double distilled deionized water, hexane and air-dried. The sodium sulfate was replaced to prevent contamination for further samples. All samples were extracted within 24 hours of arrival in the lab and stored within a controlled environment of 4 degrees centigrade.

The samples were first run on a Varian G.C. with a Nickel 63 detector using a 5% OV-210 on 100-120 mesh, dimethyl-dichlorosilane treated diatomaceous earth, in a 2 meter column, and a 1.5% OV-17 and 1.95% QF1 column for confirmatory analysis. Running conditions can be checked and cross-referenced by noting Standard Methods procedure 509A. This method included preparation of standards, column conditioning, column flow, temperature, pressures, sample preparation, and injection amounts.

A representative sample was sent to Minnesota Valley Testing for analysis by G.C. Mass Spectrometry. The instrument used was an Extrel ELQ-400 GC/MS operating in the EI mode and tuned according to EPA protocol (Work Order #: M-K-815, 11-11-86).

The analysis of this sample was performed using a fused silica capillary column (30 meter, 5% phenyl-94% methyl-1% vinyl silicone bonded phase-0.25 um film thickness). The GC conditions were: hold at 30 C for 5 minutes, ramp to 280 C at 8 C/minute and hold for 15 minutes. The splitless injection technique was used for sample introduction into the gas chromatograph.
Because of Minnesota Valley Testing results, a more sensitive detector would be needed for better quantitative results.

A Hewlett Packard HP-5890 with integrator and recorder, and a 5% Phenyl-Methyl Silicone column measuring 25 meters x 0.32 meters x 0.52 micrometers, and a Flame Ionization Detector were used for both qualitative and quantitative analysis. Prior to the runs the machine was calibrated and tested by a representative from Hewlett Packard.

The operating conditions for the HP-5890 were as follows:

1. Total Flow=2.38 ml/min
2. Purge=3.06 ml/min
3. Hydrogen Pressure=28 psi
4. Air=44 psi
5. Auxiliary Gas {Nitrogen}= 40 psi
6. Column Head Pressure=65 Kpa
7. Combined Flow Through Column=75.8 ml/min
8. Injector Temperature=225 degrees Centigrade
9. Detector Temperature=275 degrees Centigrade
10. Ramp Time = Initial temperature at 40 degrees Centigrade, hold 30 seconds, ramp at linear rate of 30 degrees/min to 100 degrees Centigrade, hold for 1 minute, then ramp to 180 degrees at a linear rate of 30 degrees/min
11. Sample injection amount = 2 microlitres

The Run Parameters for the Chart Recorder were as follows:

1. Zero = 10
2. Attenuation 2 = 0.0
3. Chart Speed = 1.0
4. Peak Width 0.01
5. Threshold = 0.0
6. Area Rejected = 0.0
7. No report functions
8. Time table = 3.50 Attenuation 2 = 5, 3.60 Zero = 10, 4.00 Zero = 10, 4.10 Chart Speed= 2.0

Macroinvertebrates

Field

Benthic macroinvertebrates were collected using various sampling methods. The most complete data sets were from Surber samplers and the three-kick sampling and only these data will be presented and discussed.

Surber samplers

The Surber sampler is a quantitative sampler that was used at all sites in triplicate. It was constructed of 80 micron mesh net attached to a brass frame (30 cm x 30 cm). Another brass frame of the same dimensions was attached perpendicular to the net and rested on the substrate when in use. The substrate was disturbed by hand and organisms and finer debris were carried into the net by the current . Samples were preserved in 70% ethanol, labeled, and returned to the laboratory.

Three-kick sampling

The three-kick method involved holding a D-frame dip net firmly against the substrate with the net opening facing upstream. The substrate directly in front of the net was disturbed by kicking it three times. Any dislodged organisms were carried by the current into the net. Sampling was done in triplicate and samples were preserved in 70% ethanol.

Laboratory

Organisms were identified to the Genus level of taxonomy, when possible, or to the Family level when practical. The early instars of various genera of the same Order were pooled and labeled as juveniles.

Due to constraints on time and resources, many of these samples were not used in the analysis. It was decided the artificial substrate samples would not be analyzed at this time due to certain disadvantages as cited by Rosenberg and Resh (1982). Artificial substrates do require relatively long colonization periods during which time fluctuating flows can alter their effectiveness. Changing water levels can expose them to very low flows, to vandalism or loss do to high water levels. These samples are in storage and available for study at another time.

Data Analysis

Data from invertebrate community samples were analyzed in four ways. Total abundance was measured as all macroinvertebrates per sample. Richness was determined by counting all taxa that occurred in a sample. The richness parameter was calculated for insect genera except for the Diptera where families were counted. Diversity of the benthic community was determined using the Shannon-Wiener Diversity Index (Platts, Megahan, and Minshall 1983). Abundance and percent composition of feeding functional groups were calculated after taxa were assigned the functional status defined by Merritt and Cummins (1984). These groups are 1) shredders that use coarse particulate organic material (CPOM) as a food source, 2) collectors that use fine particulate organic material (FPOM) as a food source, 3) scrapers that graze on periphyton and 4) predators that prey on other invertebrates.