August 14, 1997

RECEIVED
AUG 19 1997
LMD SOLID WASTE

Ms. Jennifer Huffman
Wisconsin Department of Natural Resources
1125 North Military Avenue
P.O. Box 10448
Green Bay, Wisconsin 54307-0448

Re: Final Report, Kewaunee Marsh Arsenic Site, Kewaunee, Wisconsin -- STS Project No. 20716XA

Dear Ms. Huffman:

STS Consultants, Ltd., (STS) is submitting this report to document work conducted to meet the requirements of Consent Order No. 96-LMEE-006. Based on the terms of the Consent Order, the work required of the Railroad has been completed. Submittal of this report, including monitoring results, groundwater modeling, and revisions to the surface water model requested by the Department, fulfills our client's obligations. We appreciate your review of this project. If you have any questions or comments, please contact Mike Berger or Mark Bergeon at 414-468-1978.

Sincerely,

STS CONSULTANTS LTD.

Michael T. Berger, CHMM
Environmental Scientist

Mark A. Bergeon, P.G.
Associate

MTB/ljs.wd

STS Consultants Ltd.
Consulting Engineers

1035 Kepler Drive
Green Bay, Wisconsin 54311
414.468.1978/Fax 414.468.3312

Copy to: Mr. Thomas P. McElligott
Quarles & Brady
411 East Wisconsin Avenue
Milwaukee, Wisconsin 53202-4497

Mr. Robert E. Dowdy
Anixter International
10422 Elderberry Lane
Orland Park, Illinois 60462

Ms. Janet Gilbert
Fox Valley & Western Ltd.
P.O. Box 5062
Rosemont, Illinois 60017-5062

(c416a017)

FINAL REPORT
KEWAUNEE MARSH ARSENIC SITE
KEWAUNEE, WI
STS PROJECT NO. 20716 KA - July 1997

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FINAL REPORT
KEWAUNEE MARSH ARSENIC SITE
KEWAUNEE, WISCONSIN
STS PROJECT NO. 20716XA -- JULY 1997

1.0 REMEDIAL ACTION

The action chosen for the site included placement of a geotextile and wood chip cover, and installation of a security fence. Fence and cover placement was conducted to prevent direct contact exposure to arsenic-impacted sediments.

Cover placement was conducted during the first quarter of 1996. Work was conducted in substantial accordance with the Wisconsin Department of Natural Resources (WDNR) approved STS Consultants, Ltd., (STS) "Work Plan" dated July 26, 1995, and the STS "Work Plan Addendum" dated December 29, 1995. Installation of the fence and cover system was documented in the STS "Construction Documentation Report" dated June 11, 1996. Copies of as-built drawings of the cover system are included in this report as Sheet Nos. 20716XA-AB1 and 20716XA-AB2.

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KEWAUNEE, WISCONSIN
STS PROJECT NO. 20716XA -- JULY 1997

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2.0 SITE MONITORING

2.1 Cover Monitoring

Cover and surrounding marsh elevations were surveyed immediately following cover placement during March 1996, and again during August 1996. Cover surveys are illustrated on Sheet No. 20716XA-AB3. Comparison of the two surveys indicates that no significant settling (greater than 1 foot) has occurred. In addition, gross differential settling has not been observed. Based on observed performance, STS anticipates that the cover will continue to function as designed.

2.2 Groundwater and Surface Water Monitoring

Six monitoring points and a staff gauge were installed to monitor marsh groundwater and river elevations, respectively. Locations for monitoring point and staff gauge placement were reviewed with the WDNR prior to installation and are indicated on Sheet No. 20716XA-AB1. Monitoring Points MP-1, MP-2, MP-3, and MP-4 were installed immediately downgradient of the cover. Monitoring point MP-6 was installed in the marsh upgradient of the cover and Monitoring Point MP-5 was installed in the marsh south of the railroad tracks adjacent to the cover. The staff gauge was installed in the Kewaunee River on the railroad trestle.

Groundwater elevation measurements and staff gauge readings were taken monthly from April through November, 1996. From December 1996 through March 1997, the Kewaunee River and groundwater in the monitoring points were frozen. Monitoring point elevations were surveyed by STS during March, June, and August 1996.

Groundwater samples were collected from the monitoring points during April, July, and October 1996. Both filtered and unfiltered groundwater samples were collected for arsenic analyses.

In-field measurements of groundwater included temperature and specific conductance. Groundwater color, odor, and sample turbidity were also noted in the field.

Unfiltered surface water samples were collected from the right downstream bank of the Kewaunee River, directly east of the cover. In-field measurements of the surface water included temperature and conductivity. Both groundwater and river water samples were submitted to HES, Inc., of Madison, Wisconsin, for arsenic analyses. Results of groundwater and surface water monitoring are included in Tables 1 and 2, respectively. Laboratory analytical reports are included in Appendix A.

Laboratory analyses indicated that the highest recorded arsenic concentrations were observed in groundwater samples collected from Monitoring Points MP-1, MP-2, MP-3 and MP-4. Arsenic concentrations were recorded above the Wisconsin Administrative Code NR 140 arsenic enforcement standard (ES) of 50 micrograms per liter (µg/l). These monitoring points are located immediately downgradient of the cover and within the security fence.

Arsenic concentrations recorded in samples recovered from Monitoring Point MP-5 were above the NR 140 arsenic preventive action limit of 5 µg/l. No arsenic ES exceedances were recorded at this monitoring point. Arsenic concentrations recorded in samples recovered from Monitoring Point MP-6 were typically just over the NR 140 arsenic ES. Monitoring Points MP-5 and MP-6 are outside of the security fence.

Results of site monitoring indicate that the most heavily impacted groundwater is found within the fenced area. The fence functions to limit access to areas of highest impact.

Results of river water analyses indicate that elevated arsenic concentrations (118 µg/l, 108 µg/l and 50 µg/l) were recorded during April, May, and June of 1996, respectively. These recorded concentrations were above the Wisconsin Administrative Code NR 105 Table 9 Arsenic Human

Cancer Criteria of 50 μg/l. Arsenic concentrations were not recorded above the NR 105 Table 1 Arsenic Acute Toxicity Criteria of 363.8 μg/l or above the NR 105 Arsenic Chronic Toxicity Criteria of 153 μg/l.

From February to June 1996, the area of marsh immediately south of the cover was still unvegetated and disturbed from cover construction. It is likely that elevated arsenic concentrations recorded in the Kewaunee River in April, May, and June were due to increased surface water transport of arsenic-impacted sediment from this unvegetated area.

Arsenic concentrations recorded in surface water samples declined in July and October, 1996. Recorded concentrations were 3.7 μg/l and 3.2 μg/l, respectively. The decline in recorded surface water arsenic concentrations coincided with the revegetation of the area immediately south of the cover.

Arsenic concentrations were not detected above the method detection limit in a surface water sample collected during June 1997. This indicates that the revegetated marsh is not impacting the surface water quality of the Kewaunee River above NR 105 standards.

3.0 GROUNDWATER MODELING

Groundwater modeling was conducted by HSI GeoTrans, Inc., (GeoTrans) of Boulder, Colorado, to determine fate and transport of arsenic in groundwater. GeoTrans conducted modeling using the BIO1D model. The BIO1D code was developed by GeoTrans for simulating the transport of organic, inorganic, metals, and radioactive contaminants. The BIO1D code is a proprietary, but publicly available code that has been benchmarked and verified against analytical and other numerical models. The main advantage in using the BIO1D code is that it can simulate the one-dimensional transport of arsenic from the marsh to the river and accurately account for the adsorption/desorption of arsenic as a function of time.

A copy of the GeoTrans report is included in Appendix B. Monitoring data collected by both the WDNR and STS were used to conduct modeling. Results of groundwater modeling indicate that the maximum concentration that may discharge to the river will be about 200 milligrams per liter in approximately 2,700 years.

4.0 SURFACE WATER MODELING

Surface water modeling was conducted by STS using the HYDROCAD stormwater modeling system. This model is based on the Soil Conservation Service Technical Release 20 Methodology and generates synthetic flood hydrographs identical to the U.S. Army Corps of Engineers HEC-1 computer model.

Monitoring data collected by both the WDNR and STS were used to conduct the modeling. In addition, results from groundwater modeling were used in conjunction with surface water modeling results to determine the total load of arsenic which could enter the Kewaunee River. Based on the maximum marsh arsenic concentration from surface water data and the modeled maximum groundwater discharge concentrations, the potential maximum downstream arsenic concentration in the Kewaunee River was calculated to be 28.3 μg/l. Calculated concentrations are comparable to concentrations measured in water samples collected from the Kewaunee River adjacent to the cover area. Results of STS surface water modeling are included in Appendix C.

5.0 CONCLUSIONS

A cover system has been installed that, in conjunction with the security fence, limits direct contact exposure to arsenic within the marsh. One year of site monitoring has also been completed as specified in the Consent Order. Based on the data collected, the areas with the highest arsenic concentrations are either covered or enclosed within the security fence. Results of site monitoring indicate that arsenic in the marsh is not impacting the Kewaunee River above NR 105 standards. Modeling results indicate that arsenic in the marsh will not impact the Kewaunee River above NR 105 standards in the foreseeable future. Based on the foregoing, the railroad has satisfied its obligations under the Consent Order.

6.0 GENERAL QUALIFICATIONS

The scope of this report is limited to the specific project and locations described herein. Conclusions presented are based on site conditions as revealed through sample collection, surface conditions noted at the time of the study, subcontractor laboratory analysis, and our professional interpretation of this information. Our interpretation of results and conclusions represents our professional judgment based on the available information; no other warranties are expressed or implied.

LIST OF TABLES

Table 1
Kewaunee Marsh Monitoring Results
Monitoring Point Data

Monitoring Point	Date	TPVC Elevation	Water Level	Groundwater Elevation	Arsenic (ug/L) Filtered Sample	Conductivity	Temperature (Celcius)	Color	Turbidity	Odor
MP-1	19-MAR-96	583.26	2.72	580.54	-	frozen	frozen	frozen	frozen	frozen
	23-APR-96	583.26	2.44	580.82	763	282	8.7	none	slight	swampy
	20-MAY-96	583.26	2.55	580.71	-	-	-	-	-	-
	18-JUN-96	583.29	2.4	580.89	-	-	-	-	-	-
	12-JUL-96	583.29	2.42	580.87	733	-	-	-	-	-
	20-AUG-96	unable to locate								
	20-SEP-96	583.29	2.41	580.88	-	-	-	-	-	-
	23-OCT-96	583.29	2.19	581.1	318	595	10.4	brown	turbid	swampy
	19-NOV-96	583.29	2.5	580.79	-	-	-	-	-	-
	24-DEC-96	583.29	2.37	580.92	-	frozen	frozen	frozen	frozen	frozen
	20-JAN-97	583.29	2.41	580.88	-	frozen	frozen	frozen	frozen	frozen
MP-2	19-MAR-96	583.12	2.82	580.3	-	frozen	frozen	frozen	frozen	frozen
	23-APR-96	583.12	2.43	580.69	877	527	10.1	brown	turbid	swampy
	20-MAY-96	583.12	2.28	580.84	-	-	-	-	-	-
	18-JUN-96	583.19	2.28	580.91	-	-	-	-	-	-
	12-JUL-96	583.19	2.32	580.87	436	-	-	-	-	-
	20-AUG-96	583.22	2.32	580.9	-	-	-	-	-	-
	20-SEP-96	583.22	2.35	580.87	-	-	-	-	-	-
	23-OCT-96	583.22	2.22	581	65.8	927	10.2	brown	turbid	swampy
	19-NOV-96	583.22	2.33	580.89	-	-	-	-	-	-
	24-DEC-96	583.22	2.31	580.91	-	frozen	frozen	frozen	frozen	frozen
	20-JAN-97	583.22	2.34	580.88	-	frozen	frozen	frozen	frozen	frozen
MP-3	19-MAR-96	583.19	2.28	580.91	-	frozen	frozen	frozen	frozen	frozen
	23-APR-96	583.19	2.28	580.91	333	640	10.6	none	slight	swampy
	20-MAY-96	583.19	2.28	580.91	-	-	-	-	-	-
	18-JUN-96	583.12	2.28	580.84	-	-	-	-	-	-
	12-JUL-96	583.12	2.35	580.77	136	-	-	-	-	-
	20-AUG-96	583.23	2.82	580.41	-	-	-	-	-	-
	20-SEP-96	583.23	2.37	580.86	-	-	-	-	-	-
	23-OCT-96	583.23	2.09	581.14	156	856	10.5	brown	turbid	swampy
	19-NOV-96	583.23	2.32	580.91	-	-	-	-	-	-
	24-DEC-96	583.23	2.25	580.98	-	frozen	frozen	frozen	frozen	frozen
	20-JAN-97	583.23	2.27	580.96	-	frozen	frozen	frozen	frozen	frozen

Notes:

TPVC = top of pvc

= exceeds NR 140 arsenic Enforcement Standard of 50 ug/l

ug/l = micrograms per liter

mg/l = milligrams per liter

Table 1
Kewaunee Marsh Monitoring Results
Monitoring Point Data

Monitoring Point	Date	TPVC Elevation	Water Level	Groundwater Elevation	Arsenic (ug/L) Filtered Sample	Conductivity	Temperature (Celcius)	Color	Turbidity	Odor
MP-4	19-MAR-96	583.46	2.92	580.54	-	frozen	frozen	frozen	frozen	frozen
	23-APR-96	583.46	2.78	580.68	-	frozen	frozen	frozen	frozen	frozen
	20-MAY-96	583.46	2.6	580.86	-	-	-	-	-	-
	18-JUN-96	583.5	2.56	580.94	-	-	-	-	-	-
	12-JUL-96	583.5	2.7	580.8	358	-	-	-	-	-
	20-AUG-96	583.51	2.6	580.91	-	-	-	-	-	-
	20-SEP-96	583.51	2.63	580.88	-	-	-	-	-	-
	23-OCT-96	583.51	2.32	581.19	311	707	11.4	brown	turbid	swampy
	19-NOV-96	583.51	2.54	580.97	-	-	-	-	-	-
	24-DEC-96	583.51	2.51	581	-	frozen	frozen	frozen	frozen	frozen
	20-JAN-97	583.51	2.54	580.97	-	frozen	frozen	frozen	frozen	frozen
MP-5	19-MAR-96	583.69	2.22	581.47	-	frozen	frozen	frozen	frozen	frozen
	23-APR-96	583.69	2.29	581.4	<16	751	9.4	none	slight	swampy
	20-MAY-96	583.69	2.36	581.33	-	-	-	-	-	-
	18-JUN-96	583.71	2.32	581.39	-	-	-	-	-	-
	12-JUL-96	583.71	2.44	581.27	9.9	-	-	-	-	-
	20-AUG-96	583.71	2.61	581.1	-	-	-	-	-	-
	20-SEP-96	583.71	3.01	580.7	-	-	-	-	-	-
	23-OCT-96	583.67	2.53	581.14	5.7	800	10.6	brown	turbid	swampy
	19-NOV-96	583.67	2.47	581.2	-	-	-	-	-	-
	24-DEC-96	583.67	2.34	581.33	-	frozen	frozen	frozen	frozen	frozen
	20-JAN-97	583.67	2.36	581.31	-	frozen	frozen	frozen	frozen	frozen
MP-6	19-MAR-96	583.58	2.05	581.53	-	frozen	frozen	frozen	frozen	frozen
	23-APR-96	583.58	2.22	581.36	46	912	7.1	brown	turbid	swampy
	20-MAY-96	583.58	2.32	581.26	-	-	-	-	-	-
	18-JUN-96	583.67	2.34	581.33	-	-	-	-	-	-
	12-JUL-96	583.67	2.31	581.36	415	-	-	-	-	-
	20-AUG-96	583.62	2.47	581.15	-	-	-	-	-	-
	20-SEP-96	583.62	2.99	580.63	-	-	-	-	-	-
	23-OCT-96	583.62	2.37	581.25	19	902	10.9	brown	turbid	swampy
	19-NOV-96	583.62	2.4	581.22	-	-	-	-	-	-
	24-DEC-96	583.62	2.17	581.45	-	frozen	frozen	frozen	frozen	frozen
	20-JAN-97	583.62	2.2	581.42	-	frozen	frozen	frozen	frozen	frozen

Notes:
TPVC = top of pvc
= exceeds NR 140 arsenic Enforcement Standard of 50 ug/l
ug/l = micrograms per liter
mg/l = milligrams per liter

Table 2
Kewaunee Marsh Monitoring Results
Kewaunee River Data

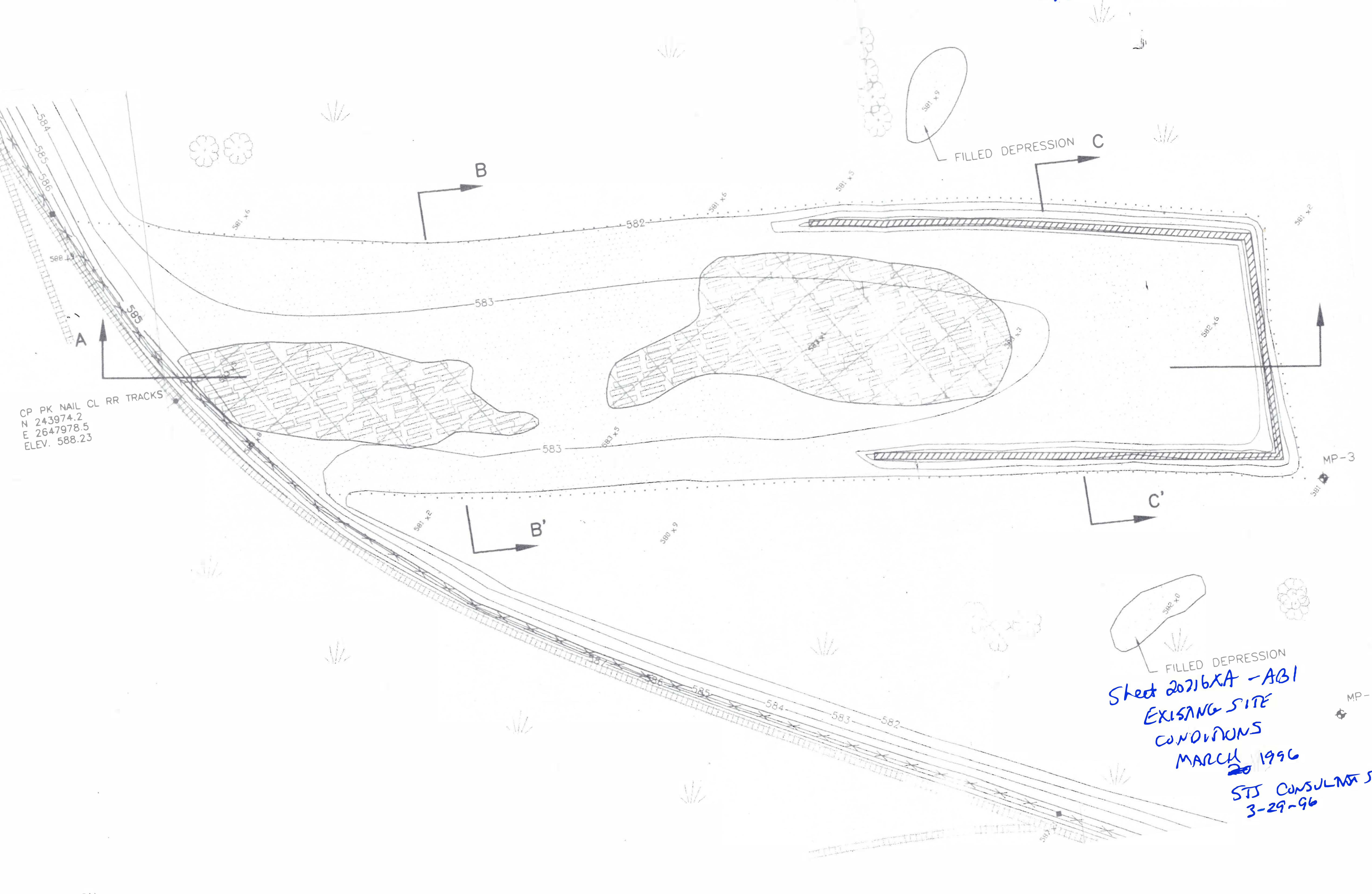
Date	Staff Gauge Reading	River Elevation	Arsenic (ug/l) Unfiltered
19-Mar-96	2.00	579.34	-
23-APR-96	2.40	579.74	118.0
20-MAY-96	2.90	580.24	108.0
18-JUN-96	3.55	580.89	50.0
12-JUL-96	3.50	580.84	3.7
20-AUG-96	3.57	580.91	-
20-SEP-96	3.58	580.92	-
23-OCT-96	3.77	581.11	3.2
19-NOV-96	3.27	580.61	-
24-DEC-96	3.47	580.81	-
20-JAN-97	3.47	580.81	-
6-JUN-97	4.45	581.79	<2.0

Notes:

ug/l = micrograms per liter

[boxed] = exceeds NR 105 arsenic Human Cancer Criteria

LIST OF FIGURES



FILLED DEPRESSION
C
B
582
583
A
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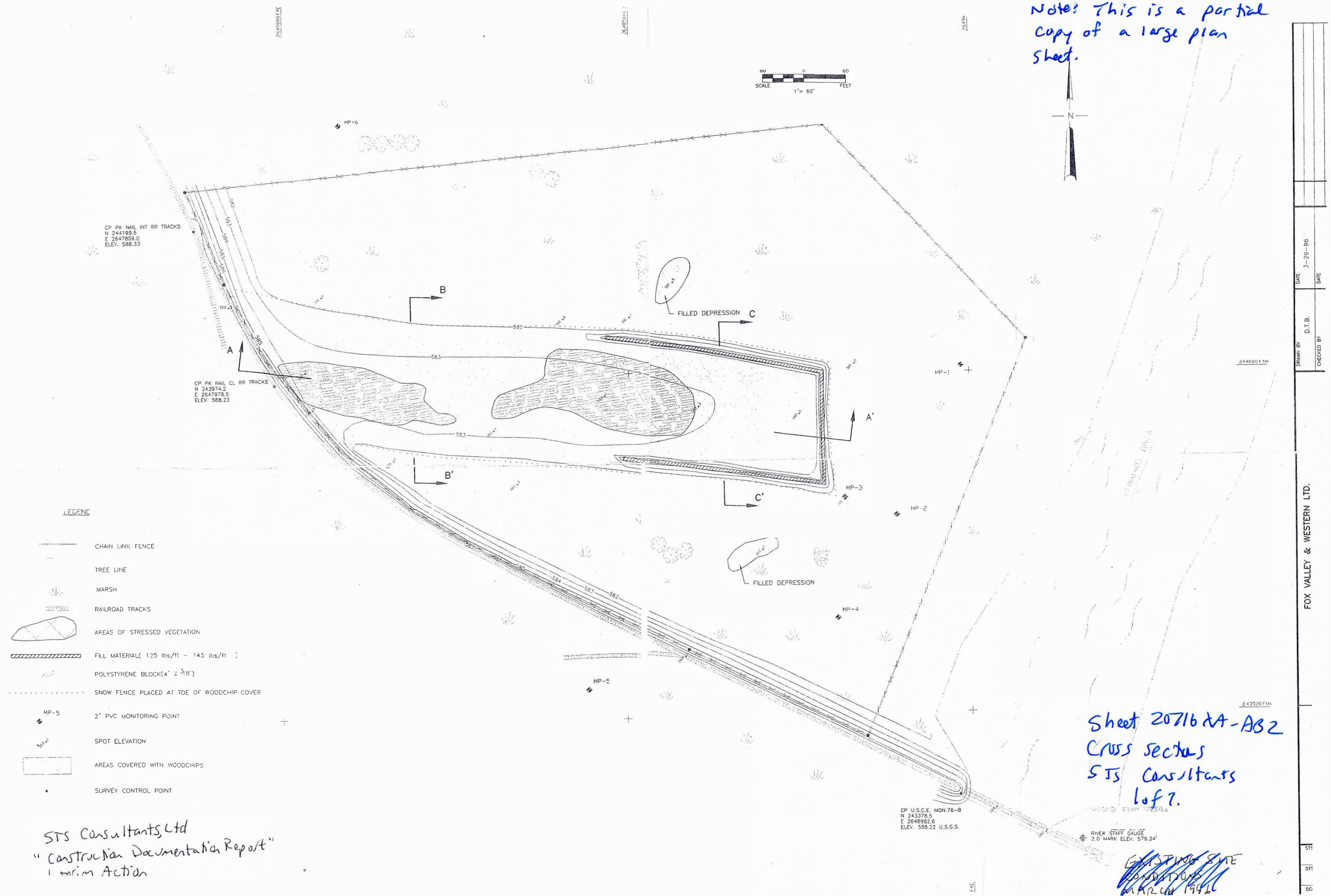
N 243974.2
E 2647978.5
ELEV. 588.23
MP-3
C'
B'
FILLED DEPRESSION
Sheet 20216XA -AB1
EXISTING SITE
CONDITIONS
MARCH 20 1996
STJ CONSULTANTS
3-29-96

Note: This is a partial copy of a large plan sheet.

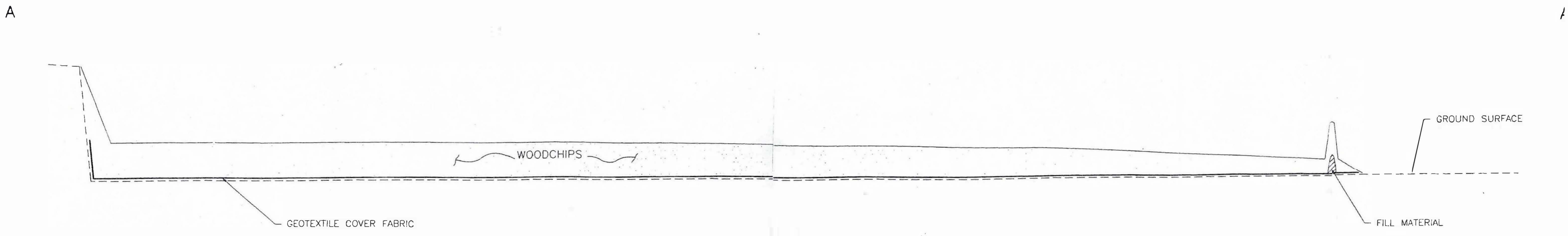


Sheet 20716 XA-AB2
Cross sections
STS Consultants
1 of 7.

STS Consultants, Ltd
"Construction Documentation Report"
Interim Action

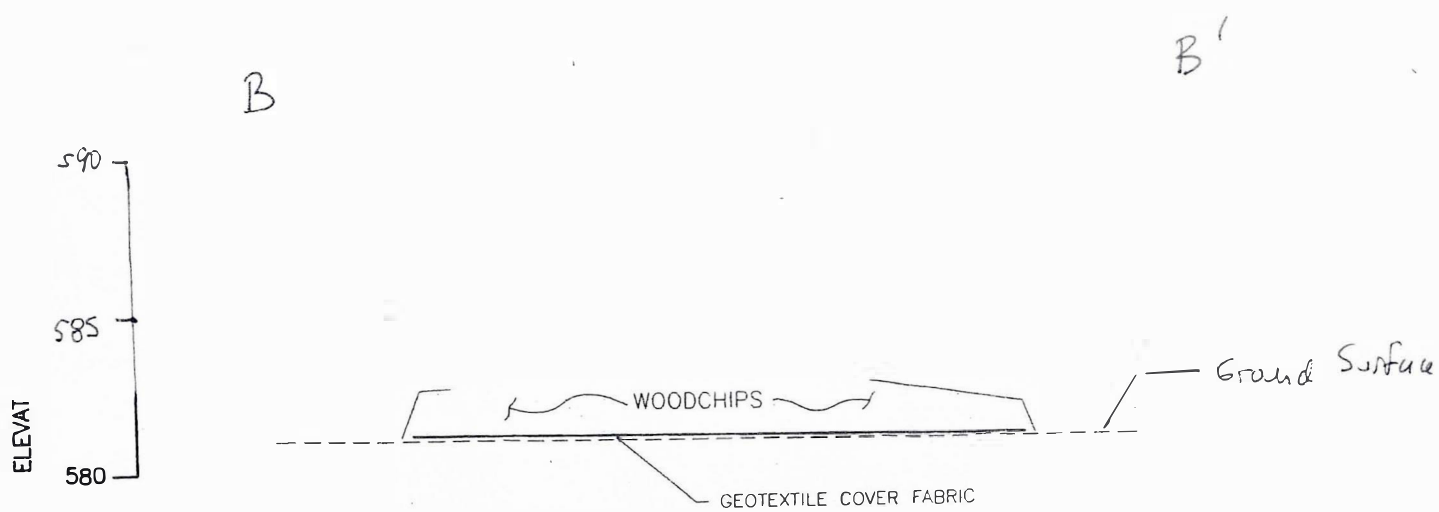
EXISTING SITE CONDITIONS
MARCH 1996

Note: this is a partial Copy of a large plan sheet



CROSS-SECTION A-A'

SCALE: 1"= 40' HORIZ.
1"= 4' VERT.



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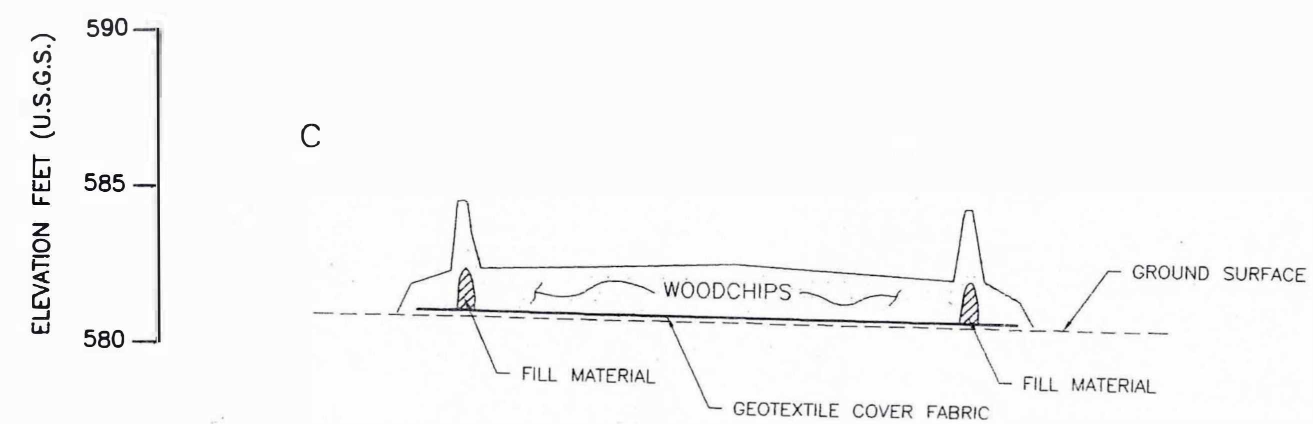


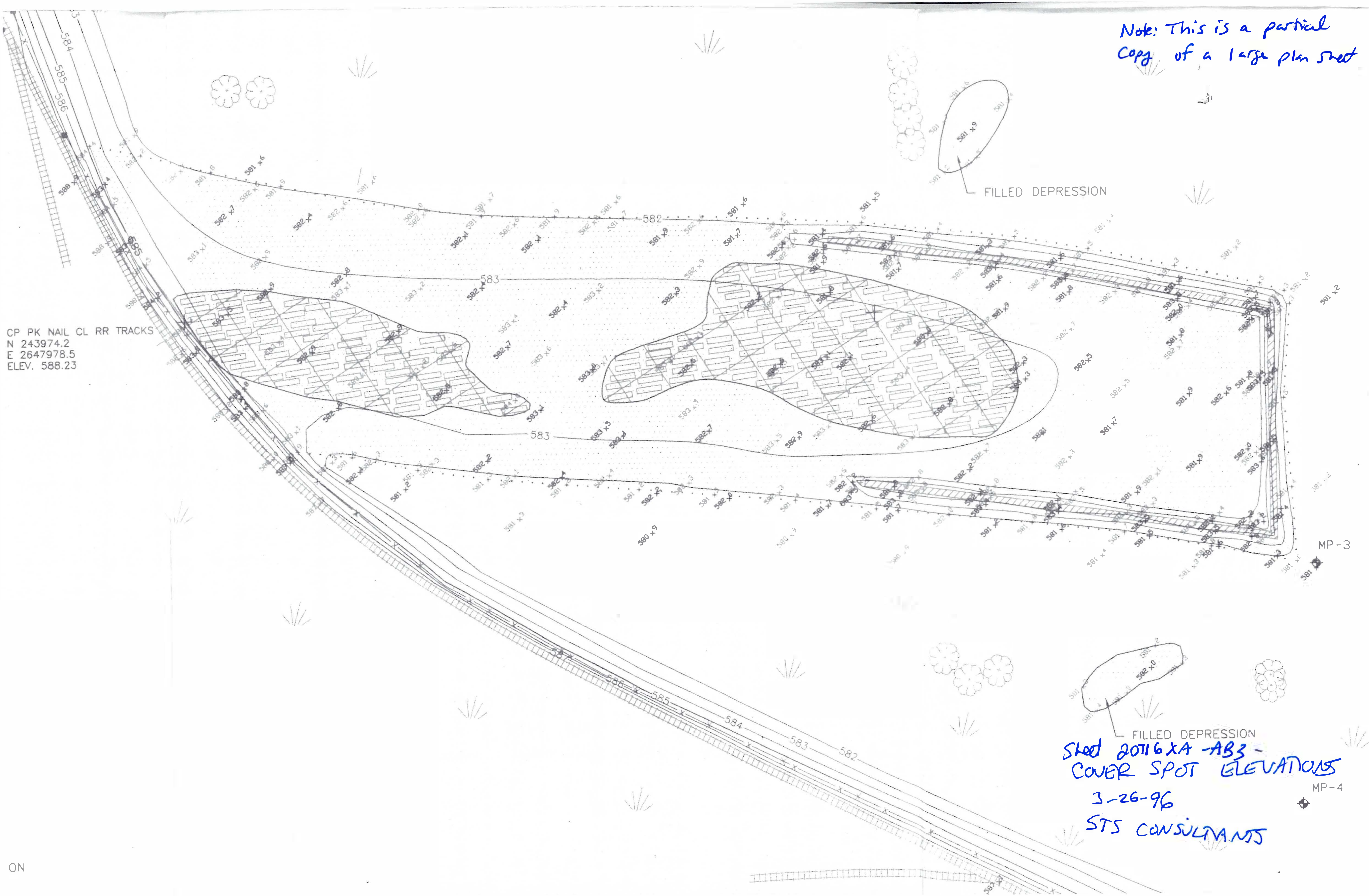
CROSS-SECTION C-C'

SCALE: 1"= 40' HORIZ.
1"= 4' VERT.

Cross Sections
STS Consultants Ltd.
"Construction Documentation Report Interim Action" 6/11/96

Sheet 20716X A-A B2
CROSS SECTIONS
STS CONSULTANTS
2 of 2.

LEGEND
WOODCHIPS
FILL MATERIAL
GROUND SURFA
GEOTEXTILE COV



Note: This is a partial copy of a large plan sheet
FILLED DEPRESSION
CP PK NAIL CL RR TRACKS
N 243974.2
E 2647978.5
ELEV. 588.23
582
583
MP-3
FILLED DEPRESSION
Sheet 20116XA-AB3-
COVER SPOT ELEVATIONS
3-26-96
STS CONSULTANTS
MP-4
ON

APPENDIX A

Analytical Laboratory Data

Hazleton Environmental Services, Inc.

525 SCIENCE DRIVE MADISON, WISCONSIN 53711

HES, Inc.

5/13/96

Mike Berger
STS Consultants Ltd.
1035 Kepler Drive
Green Bay, WI 54311

Re: STS Consultants Ltd. Project Kewaunee Marsh
HES Batch Number 60400751

Dear Mr. Berger:

Enclosed are the analytical results for the water samples received by HES, Inc. on 4/24/96 (HES sample numbers 60400751-60400761). The original chain of custody form for these samples is included with this report.

If you need any additional information, please contact Peggy Popp at (608) 232-3335, or myself at (608)232-3332.

Sincerely,

Tina Shipley
Client Service Representative

Wisconsin Laboratory Certification Number 113172950

enclosure

cc: Central File

Hazleton
Environmental
Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 6040071

DATE ENTERED: 04/24/96

REPORT PRINTED: 05/13/96

WATER,MP-1,4/23,TOTAL
PROJECT NAME:KEWAUNEE MARSH/20716XA

PURCHASE ORDER NUMBER: 20716XA

ICP SPECTROSCOPY

	LOD MG/L	LOQ MG/L	RESULTS MG/L	FLAGS
ARSENIC	0.016	0.049	0.771	N/A

DATE DIGESTED 05/01/96
DATE ANALYZED 05/08/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ____________________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ICP SPECTROSCOPY
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/ 4-79-020, METHOD 200.7, U.S. EPA, CINCINNATI, OH (ADDED DECEMBER 1982)
TEST METHODS FOR EVALUATING SOLID WASTE, SW-846, SECOND EDITION, METHOD 6010, EDITION, METHOD 6010, U.S. EPA, WASHINGTON DC (REVISED APRIL 1984)

EDIT MNEMONIC-INORGANICS
SIGNATURE BLOCK FOR INORGANIC ANALYSIS

Hazleton Environmental Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 60400752

DATE ENTERED: 04/24/96

REPORT PRINTED: 05/13/96

WATER,MP-1,4/23,FILTERED
PROJECT NAME:KEWAUNEE MARSH/20716XA

PURCHASE ORDER NUMBER: 20716XA

ICP SPECTROSCOPY

	LOD MG/L	LOQ MG/L	RESULTS MG/L	FLAGS
ARSENIC	0.016	0.049	0.763	N/A

DATE DIGESTED 05/01/96
DATE ANALYZED 05/08/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ______________________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ICP SPECTROSCOPY
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/4-79-020, METHOD 200.7, U.S. EPA, CINCINNATI, OH (ADDED DECEMBER 1982)
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EDIT MNEMONIC-INORGANICS
SIGNATURE BLOCK FOR INORGANIC ANALYSIS

Hazleton
Environmental
Services, Inc.

HES, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 604007
DATE ENTERED: 04/24/96
REPORT PRINTED: 05/13/96

WATER,MP-2,4/23,TOTAL
PROJECT NAME:KEWAUNEE MARSH/20716XA

PURCHASE ORDER NUMBER: 20716XA

ICP SPECTROSCOPY

	LOD MG/L	LOQ MG/L	RESULTS MG/L	FLAGS
ARSENIC	0.016	0.049	0.837	N/A

DATE DIGESTED 05/01/96
DATE ANALYZED 05/08/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ______________________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ICP SPECTROSCOPY
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/4-79-020, METHOD 200.7, U.S. EPA, CINCINNATI, OH (ADDED DECEMBER 1982)
TEST METHODS FOR EVALUATING SOLID WASTE, SW-846, SECOND EDITION, METHOD 6010, EDITION, METHOD 6010, U.S. EPA, WASHINGTON DC (REVISED APRIL 1984)

EDIT MNEMONIC-INORGANICS
SIGNATURE BLOCK FOR INORGANIC ANALYSIS

Hazleton Environmental Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 60400754

DATE ENTERED: 04/24/96

REPORT PRINTED: 05/13/96

WATER,MP-2,4/23,FILTERED
PROJECT NAME:KEWAUNEE MARSH/20716XA

PURCHASE ORDER NUMBER: 20716XA

ICP SPECTROSCOPY

	LOD MG/L	LOQ MG/L	RESULTS MG/L	FLAGS
ARSENIC	0.016	0.049	0.877	N/A

DATE DIGESTED 05/01/96
DATE ANALYZED 05/08/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED [signature]
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ICP SPECTROSCOPY
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/4-79-020, METHOD 200.7, U.S. EPA, CINCINNATI, OH (ADDED DECEMBER 1982)
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EDIT MNEMONIC-INORGANICS
SIGNATURE BLOCK FOR INORGANIC ANALYSIS

Hazleton
Environmental
Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 604007 5
DATE ENTERED: 04/24/96
REPORT PRINTED: 05/13/96

WATER,MP-3,4/23,TOTAL
PROJECT NAME:KEWAUNEE MARSH/20716XA

PURCHASE ORDER NUMBER: 20716XA

ICP SPECTROSCOPY

	LOD MG/L	LOQ MG/L	RESULTS MG/L	FLAGS
ARSENIC	0.016	0.049	0.282	N/A

DATE DIGESTED 05/01/96
DATE ANALYZED 05/08/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED John C Walton
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ICP SPECTROSCOPY
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/4-79-020, METHOD 200.7, U.S. EPA, CINCINNATI, OH (ADDED DECEMBER 1982)
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SIGNATURE BLOCK FOR INORGANIC ANALYSIS

525 SCIENCE DRIVE • MADISON, WISCONSIN 53711 Phone 608-232-3300 Fax 608-233-0502

Hazleton Environmental Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SA LE NUMBER: 60400756

DATE ENTERED: 04/24/96

REPORT PRINTED: 05/13/96

WATER,MP-3,4/23,FILTERED
PROJECT NAME:KEWAUNEE MARSH/20716XA

PURCHASE ORDER NUMBER: 20716XA

ICP SPECTROSCOPY

	LOD MG/L	LOQ MG/L	RESULTS MG/L	FLAGS
ARSENIC	0.016	0.049	0.333	N/A

DATE DIGESTED 05/01/96
DATE ANALYZED 05/08/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED [signature]
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ICP SPECTROSCOPY
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/4-79-020, METHOD 200.7, U.S. EPA, CINCINNATI, OH (ADDED DECEMBER 1982)
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EDIT MNEMONIC-INORGANICS
SIGNATURE BLOCK FOR INORGANIC ANALYSIS

Hazleton
Environmental
Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 604007
DATE ENTERED: 04/24/96
REPORT PRINTED: 05/13/

WATER,MP-5,4/23,TOTAL
PROJECT NAME:KEWAUNEE MARSH/20716XA

PURCHASE ORDER NUMBER: 20716XA

ICP SPECTROSCOPY

	LOD MG/L	LOQ MG/L	RESULTS MG/L	FLAGS
ARSENIC	0.016	0.049	<0.016	N/A

DATE DIGESTED 05/01/96
DATE ANALYZED 05/08/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ______________________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ICP SPECTROSCOPY
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/ 4-79-020, METHOD 200.7, U.S. EPA, CINCINNATI, OH (ADDED DECEMBER 1982)
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Hazleton Environmental Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SA LE NUMBER: 60400758

DATE ENTERED: 04/24/96

REPORT PRINTED: 05/13/96

WATER,MP-5,4/23,FILTERED
PROJECT NAME:KEWAUNEE MARSH/20716XA

PURCHASE ORDER NUMBER: 20716XA

ICP SPECTROSCOPY

	LOD MG/L	LOQ MG/L	RESULTS MG/L	FLAGS
ARSENIC	0.016	0.049	<0.016	N/A

DATE DIGESTED 05/01/96
DATE ANALYZED 05/08/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ____________________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ICP SPECTROSCOPY
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/ 4-79-020, METHOD 200.7, U.S. EPA, CINCINNATI, OH (ADDED DECEMBER 1982)
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Hazleton
Environmental
Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 604007
DATE ENTERED: 04/24/96
REPORT PRINTED: 05/13/96

WATER,MP-6,4/23,TOTAL
PROJECT NAME:KEWAUNEE MARSH/20716XA

PURCHASE ORDER NUMBER: 20716XA

ICP SPECTROSCOPY

	LOD MG/L	LOQ MG/L	RESULTS MG/L	FLAGS
ARSENIC	0.016	0.049	0.067	N/A

DATE DIGESTED 05/01/96
DATE ANALYZED 05/08/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ______________________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ICP SPECTROSCOPY
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/ 4-79-020, METHOD 200.7, U.S. EPA, CINCINNATI, OH (ADDED DECEMBER 1982)
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Hazleton
Environmental
Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 60400760

DATE ENTERED: 04/24/96

REPORT PRINTED: 05/13/96

WATER,MP-6,4/23,FILTERED
PROJECT NAME:KEWAUNEE MARSH/20716XA

PURCHASE ORDER NUMBER: 20716XA

ICP SPECTROSCOPY

	LOD MG/L	LOQ MG/L	RESULTS MG/L	FLAGS
ARSENIC	0.016	0.049	0.046	Y

Y=ANALYTE CONCENTRATION IS BETWEEN THE LOD AND THE LOQ.

DATE DIGESTED 05/01/96
DATE ANALYZED 05/08/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ______________________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ICP SPECTROSCOPY
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/4-79-020, METHOD 200.7, U.S. EPA, CINCINNATI, OH (ADDED DECEMBER 1982)
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525 SCIENCE DRIVE • MADISON, WISCONSIN 53711 Phone 608-232-3300 Fax 608-233-0502

Hazleton Environmental Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 604007[redacted]

DATE ENTERED: 04/24/96

REPORT PRINTED: 05/13/[redacted]6

WATER,RIVER SAMPLE,4/23,TOTAL
PROJECT NAME:KEWAUNEE MARSH/20716XA

PURCHASE ORDER NUMBER: 20716XA

ICP SPECTROSCOPY

	LOD MG/L	LOQ MG/L	RESULTS MG/L	FLAGS
ARSENIC	0.016	0.049	0.118	N/A

DATE DIGESTED 05/01/96
DATE ANALYZED 05/08/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ______________________
JOHN C. WALTON
SUPERVISOR, INORGANICS

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Terms and Conditions

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3. Samples submitted to HES for routine analysis will be retained for a minimum of sixty (60) days after the report of analysis is issued. Extended storage requirements must be brought to the attention of HES prior to or at the time of sample submission. HES, at its discretion, may charge for such extended storage. Records and specimens from all government regulated studies will be maintained in accordance with federal regulations.

4. Analytical Method Summaries will be supplied to the client upon request. Detailed copies of in-house laboratory procedures may be reviewed by the client or his agent during a site visit, but may not be copied without the expressed consent of HES.

5. All work performed by HES will be conducted in accordance with the HES Quality Assurance Program. Specific documentation requirements of the client for work performed by HES must be made known to HES prior to the start of the requested work.

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9. Routine inquiry concerning work performed by HES should be made to the Client Service Center. The client is also encouraged to bring any concerns or questions to the attention of management, technical staff, or the facility Quality Assurance Unit.

CHAIN OF CUSTODY RECORD

№ 22496

RECORD NUMBER 1 THROUGH 1

Contact Person MIKE BERGER
Phone No. 414 468-1978 Office G.B.
Project No. 207164 XA PO No.
Project Name KEWAUNEE MARSH (ARSENIC PARK)

Special Handling Request
- ☐ Rush
- ☐ Verbal
- ☐ Other

Laboratory HES
Contact Person ~~Condition~~ Cold ~~Storage~~ W1-R-2
Phone No. ~~Acct. #~~ 1161 ~~Abbrev.~~ ~~STGWE~~ STSG
Results Due LMD
Smpl Rec'd APR 24 1996 Init. LMD
Date Entered 4-24-96
LIMS # 60400751-761
@PM 4/25/96

Sample I.D.	Date	Time	Grab	Composite	No. of Containers	Sample Type (Water, soil, air, sludge, etc.)	Preservation Y	Preservation N	Field Data PID/FID Ambient	Field Data PID/FID Sample	PH	Special Cond.	Analysis Request	Comments on Sample (Include Major Contaminants)
mp-1	4/23		X		2	WATER	X						60400751, 60400752	
mp-2	↓		↓		2	↓	↓						60400753, 60400754	~~WAS~~ BOTTLED FIELD FILTERED
mp-3	↓		↓		2	↓	↓						60400755, 60400756 ARSENIC (METALS)	AND MARKED (FILTERED)
mp-5	↓		↓		2	↓	↓						60400757, 60400758	COPY
mp-6	↓		↓		2	↓	↓						60400759, 60400760	
RIVER SAMPLE	↓		↓		1	↓	↓						60400761	

Collected by: Dan Braatz	Date 4/23/96	Time 4:00pm	Delivery by: UPS NEXT DAY AIR	Date 4/23/96	Time ~5:00pm
Received by:	Date	Time	Relinquished by:	Date	Time
Received by:	Date	Time	Relinquished by:	Date	Time
Received by:	Date	Time	Relinquished by:	Date	Time
Received for lab by: Lynn Derry	Date 4-24-96	Time 930 A	Relinquished by:	Date	Time

Laboratory Comments Only: Seals Intact Upon Receipt? ☐ Yes ☐ No ☐ N/A

Final Disposition:

Comments (Weather Conditions, Precautions, Hazards): Rec'd with ice - LMD

Distribution: Original and Green - Laboratory Yellow - As needed Pink - Transporter Goldenrod - STS Project File
Instructions to Laboratory: Forward completed original to STS with analytical results. Retain green copy.

9/94cp10k

Hazleton
Environmental
Services, Inc.

525 SCIENCE DRIVE MADISON, WISCONSIN 53711

HES, Inc.

6/3/96

Mike Berger
STS Consultants Ltd.
1035 Kepler Drive
Green Bay, WI 54311

Re: STS Project #20716XA (Kewaunee Marsh)
HES Batch Number 60501217

Dear Mr. Berger:

Enclosed are the analytical results for the water sample received by HES, Inc. on 5/23/96 (HES sample number 60501217). A copy of the original chain of custody form is included with this report.

If I can be of assistance, or provide additional information, please call me at (608) 232-3335.

Sincerely,

Peggy

Peggy Popp
Project Manager

Wisconsin Laboratory Certification Number 113172950

Enc.: Laboratory Analytical Report

c: Central File

Phone 608-232-3300 Fax 608-233-0502

Hazleton Environmental Services, Inc.

HES, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 605012[redacted]

DATE ENTERED: 05/24/96

REPORT PRINTED: 06/03/[redacted]

WATER,RIVER(5-20-96),5/20/96,2P
PROJECT NAME: ARSENIC PARK/20716XA

PURCHASE ORDER NUMBER: 20716XA

ICP SPECTROSCOPY

	LOD MG/L	LOQ MG/L	RESULTS MG/L	FLAGS
ARSENIC	0.016	0.049	0.108	N/A

DATE DIGESTED 05/29/96
DATE ANALYZED 05/29/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ____________________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ICP SPECTROSCOPY
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/4-79-020, METHOD 200.7, U.S. EPA, CINCINNATI, OH (ADDED DECEMBER 1982)
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EDIT MNEMONIC-INORGANICS
SIGNATURE BLOCK FOR INORGANIC ANALYSIS

525 SCIENCE DRIVE • MADISON, WISCONSIN 53711 Phone 608-232-3300 Fax 608-233-0502

Terms and Conditions

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2. The term "Less Than" or the symbol (<) is used to signify the lower limit of quantitation of the procedure under the conditions employed. The use of the term "Less Than" or (<) does not imply that traces of analyte were present.

   The term "None Detected" is used to report assay results where detection limits have been established for the method but acceptable residue levels have not been defined by the industry or by federal law or when the method does not define detection limits. The term will specify the fixed amount of sample employed in the analysis and does not imply that traces of the analyte were present.

3. Samples submitted to HES for routine analysis will be retained for a minimum of sixty (60) days after the report of analysis is issued. Extended storage requirements must be brought to the attention of HES prior to or at the time of sample submission. HES, at its discretion, may charge for such extended storage. Records and specimens from all government regulated studies will be maintained in accordance with federal regulations.

4. Analytical Method Summaries will be supplied to the client upon request. Detailed copies of in-house laboratory procedures may be reviewed by the client or his agent during a site visit, but may not be copied without the expressed consent of HES.

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6. Records of the raw data, reports, etc., will be maintained by HES in its data archives for a minimum of five (5) years unless otherwise specified by government regulations after the completion of the requested work. One (1) duplicate report will be made available free of charge for a period of one (1) year. HES reserves the right to charge for copies made after one (1) year and to charge for any and all copies of raw data requested.

7. Raw data, chromatograms, calibration data, etc., are the sole property of HES. Copies will be made available upon request when the quality of the original document is such that duplication is possible.

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9. Routine inquiry concerning work performed by HES should be made to the Client Service Center. The client is also encouraged to bring any concerns or questions to the attention of management, technical staff, or the facility Quality Assurance Unit.

CHAIN OF CUSTODY RECORD

COPY № 21439

RECORD NUMBER ______ THROUGH ______

Contact Person Mike Berger
Phone No. (414) 465-1978 Office GB
Project No. 20716XA PO No. ______
Project Name Arsenic Park

Special Handling Request
- [x] Rush
- [ ] Verbal
- [ ] Other

Laboratory HES
Contact Person Peggy Popp
Phone No. ______
Results Due Please Fax As Soon As Ready

Sample I.D.	Date	Time	Grab	Composite	No. of Containers	Sample Type (Water, soil, air, sludge, etc.)	Preservation Y	Preservation N	Field Data PID/FID Ambient	Field Data PID/FID Sample	Field Data PH	Field Data Special Cond.	Analysis Request	Comments on Sample (Include Major Contaminants)
River (5-20-96)	5/20	2p	X		1	water	X				60501217		As - ICP/GFAA	Possible Arsenic Impac
														Condition cold Storage WR-2
														Acct. # 4320 Abbrev. STSG
														Smpl Rec'd MAY 23 1996 Init. WAG WAG
														Date Entered 5-23-96
														LIMS # 60501217

Collected by: MTB	Date 5/20	Time	Delivery by:	Date	Time
Received by:	Date	Time	Relinquished by:	Date	Time
Received by:	Date	Time	Relinquished by:	Date	Time
Received by:	Date	Time	Relinquished by:	Date	Time
Received for lab by: Wilma Gruenewald	Date 5/23/96	Time 1004	Relinquished by:	Date	Time

Laboratory Comments Only: Seals Intact Upon Receipt? ☐ Yes ☐ No ☐ N/A

Final Disposition:

Comments (Weather Conditions, Precautions, Hazards):

Distribution: Original and Green - Laboratory Yellow - As needed Pink - Transporter Goldenrod - STS Project File
Instructions to Laboratory: Forward completed original to STS with analytical results. Retain green copy.

9/94cp10k

STS Consultants Ltd.
ons[redacted] Eng

Hazleton
Environmental
Services, Inc.

525 SCIENCE DRIVE MADISON, WISCONSIN 53711

7/9/96

Mike Berger
STS Consultants Ltd.
1035 Kepler Drive
Green Bay, WI 54311

Re: Project #20716XA (Kewaunee Marsh)
HES Batch Number 60600611

Dear Mr. Berger:

Enclosed are the analytical results for the water samples received by HES, Inc. on 6/21/96 (HES sample numbers 60600611 - 60600612). A copy of the original chain of custody form is included with this report.

If I can be of assistance, or provide additional information, please call me at (608) 232-3335.

Sincerely,

Peggy

Peggy Popp
Project Manager

Wisconsin Laboratory Certification Number 113172950

Enc.: Laboratory Analytical Report

c: Central File

Hazleton Environmental Services, Inc.

HES, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 606006
DATE ENTERED: 06/22/96
REPORT PRINTED: 07/09/

WATER,RIVER,6/18,1:00
PROJECT NAME:KEWAUNEE MARSH

PURCHASE ORDER NUMBER: 20716XA

ICP SPECTROSCOPY

	LOD MG/L	LOQ MG/L	RESULTS MG/L	FLAGS
ARSENIC	0.016	0.049	<0.016	N/A

DATE DIGESTED 06/26/96
DATE ANALYZED 06/27/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ____________________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ICP SPECTROSCOPY
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/ 4-79-020, METHOD 200.7, U.S. EPA, CINCINNATI, OH (ADDED DECEMBER 1982)
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EDIT MNEMONIC-INORGANICS
SIGNATURE BLOCK FOR INORGANIC ANALYSIS

Hazleton Environmental Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 60600612

DATE ENTERED: 06/22/96

REPORT PRINTED: 07/09/96

WATER,R BANK,6/18,1:00
PROJECT NAME:KEWAUNEE MARSH

PURCHASE ORDER NUMBER: 20716XA

ICP SPECTROSCOPY

	LOD MG/L	LOQ MG/L	RESULTS MG/L	FLAGS
ARSENIC	0.016	0.049	0.050	N/A

DATE DIGESTED 06/26/96
DATE ANALYZED 06/27/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED [signature]
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ICP SPECTROSCOPY
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1. Reports are submitted to clients on a confidential basis. No reference to the work, the results, or HES, Inc., in any form of advertising, news release, or other public announcements may be made without written authorization from HES.

2. The term "Less Than" or the symbol (<) is used to signify the lower limit of quantitation of the procedure under the conditions employed. The use of the term "Less Than" or (<) does not imply that traces of analyte were present.

   The term "None Detected" is used to report assay results where detection limits have been established for the method but acceptable residue levels have not been defined by the industry or by federal law or when the method does not define detection limits. The term will specify the fixed amount of sample employed in the analysis and does not imply that traces of the analyte were present.

3. Samples submitted to HES for routine analysis will be retained for a minimum of sixty (60) days after the report of analysis is issued. Extended storage requirements must be brought to the attention of HES prior to or at the time of sample submission. HES, at its discretion, may charge for such extended storage. Records and specimens from all government regulated studies will be maintained in accordance with federal regulations.

4. Analytical Method Summaries will be supplied to the client upon request. Detailed copies of in-house laboratory procedures may be reviewed by the client or his agent during a site visit, but may not be copied without the expressed consent of HES.

5. All work performed by HES will be conducted in accordance with the HES Quality Assurance Program. Specific documentation requirements of the client for work performed by HES must be made known to HES prior to the start of the requested work.

6. Records of the raw data, reports, etc., will be maintained by HES in its data archives for a minimum of five (5) years unless otherwise specified by government regulations after the completion of the requested work. One (1) duplicate report will be made available free of charge for a period of one (1) year. HES reserves the right to charge for copies made after one (1) year and to charge for any and all copies of raw data requested.

7. Raw data, chromatograms, calibration data, etc., are the sole property of HES. Copies will be made available upon request when the quality of the original document is such that duplication is possible.

8. Clients and/or their agents may, with prior notice, inspect/audit the records, facilities, etc., of HES pertinent to their study. All data not pertinent to the specific study is confidential and will not be made available.

9. Routine inquiry concerning work performed by HES should be made to the Client Service Center. The client is also encouraged to bring any concerns or questions to the attention of management, technical staff, or the facility Quality Assurance Unit.

Hazleton Environmental Services, Inc.
525 SCIENCE DRIVE MADISON, WISCONSIN 53711

HES, Inc.

8/12/96

Mike Berger
STS Consultants Ltd.
1035 Kepler Drive
Green Bay, WI 54311

Re: Project #20716XA (Kewaunee Marsh)
HES Batch Number 60700352

Dear Mr. Berger:

Enclosed are the analytical results for the water samples received by HES, Inc. on 7/16/96 (HES sample numbers 60700352 - 60700365). A copy of the original chain of custody form is included with this report.

If I can be of assistance, or provide additional information, please call me at (608) 232-3335.

Sincerely,

Peggy

Peggy Popp
Project Manager

Wisconsin Laboratory Certification Number 113172950

Enc.: Laboratory Analytical Report

c: Central File

Phone 608-232-3300 Fax 608-233-0502

CHAIN OF CUSTODY RECORD

№ 21619

STS

RECORD NUMBER ______ THROUGH ______

Contact Person: Mike Berger
Phone No: (414) 468-1978 Office: Green Bay
Project No.: 20716XA PO No.:
Project Name: Kewaunee Marsh

Special Handling Request

☐ Rush
☐ Verbal
☐ Other

Laboratory: HES
Contact Person: Peggy Papp
Phone No.:
Results Due: Std.

COPY

Sample I.D.	Date	Time	Grab	Composite	No. of Containers	Sample Type (Water, soil, air, sludge, etc.)	Preservation Y	Preservation N	Field Data PID/FID Ambient	Field Data PID/FID Sample	PH	Special Cond.	Analysis Request	Comments on Sample (Include Major Contaminants)
River	6/18	1:00	X		1	Water	X						As - ICP/GFAA	60600611 Possible Arsenic
RBank	6/18	1:00	X		1	Water	X						As - ICP/GFAA	60600612 Impacts
														Condition: Good Storage: WIR-1
														Acct.#: 4320 Abbrev.: STSG
														LMD
														Smpl Rec'd: JUN 21 1996 Init.: LMD
														Date Entered: 6-22-96

LIMS #: 60600611-12

Collected by: MTB	Date 6/18/96	Time 1P		Delivery by:	Date	Time
Received by:	Date	Time		Relinquished by:	Date	Time
Received by:	Date	Time		Relinquished by:	Date	Time
Received by:	Date	Time		Relinquished by:	Date	Time
Received for lab by: Lynn Derry	Date 6-21-96	Time 1050		Relinquished by:	Date	Time

Laboratory Comments Only: Seals Intact Upon Receipt? ☐ Yes ☐ No ☐ N/A

Final Disposition:

Comments (Weather Conditions, Precautions, Hazards): Cooler was opened and placed ~~in~~ in[1] the WIR-1, no temp was taken upon arrival. Samples packed with St packing peanuts.

Distribution: Original and Green - Laboratory Yellow - As needed Pink - Transporter Goldenrod - STS Project File
Instructions to Laboratory: Forward completed original to STS with analytical results. Retain green copy.

(1) Cross out script error - LMD 6-22-96

9/94cp10k

STS Consultants Ltd
Consulting Engineers

Hazleton
Environmental
Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 60700352

DATE ENTERED: 07/17/96

REPORT PRINTED: 08/12/96

WATER,MP-1 FILTERED,7-12-1996
PROJECT NO.20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

	LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
ARSENIC	1.0	3.5	733.	N/A

DATE DIGESTED 07/26/96
DATE ANALYZED 07/31/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED [signature]
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ARSENIC
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/4-79-020, METALS 1-19 AND METHOD 206.2, U.S. EPA, CINCINNATI, OH
TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION NO. SW-846, SECOND EDITION, METHODS 3020 AND 7060, U.S. EPA, WASHINGTON, DC (REVISED APRIL 1984)

EDIT MNEMONIC-INORGANICS
SIGNATURE BLOCK FOR INORGANIC ANALYSIS

525 SCIENCE DRIVE • MADISON, WISCONSIN 53711 Phone 608-232-3300 Fax 608-233-0502

Hazleton
Environmental
Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 607003[illegible]

DATE ENTERED: 07/17/96

REPORT PRINTED: 08/12/[illegible]

WATER,MP-1 UNFILTERED,7-12-1996
PROJECT NO.20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
1.0	3.5	983.	N/A

DATE DIGESTED 07/26/96
DATE ANALYZED 07/31/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED [signature]
JOHN C. WALTON
SUPERVISOR, INORGANICS

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SIGNATURE BLOCK FOR INORGANIC ANALYSIS

Hazleton
Environmental
Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 60700354

DATE ENTERED: 07/17/96

REPORT PRINTED: 08/12/96

WATER,MP-2 FILTERED,7-12-1996
PROJECT NO.20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
1.0	3.5	436.	N/A

DATE DIGESTED 07/26/96
DATE ANALYZED 07/31/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED [signature]
JOHN C. WALTON
SUPERVISOR, INORGANICS

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Hazleton Environmental Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 607003-
DATE ENTERED: 07/17/96
REPORT PRINTED: 08/12/-

WATER,MP-2 UNFILTERED,7-12-1996
PROJECT NO.20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

	LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
	1.0	3.5	643.	N/A

DATE DIGESTED 07/26/96
DATE ANALYZED 07/31/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ______________________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

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SIGNATURE BLOCK FOR INORGANIC ANALYSIS

525 SCIENCE DRIVE • MADISON, WISCONSIN 53711 Phone 608-232-3300 Fax 608-233-0502

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 60700356

DATE ENTERED: 07/17/96

REPORT PRINTED: 08/12/96

WATER,MP-3 FILTERED,7-12-1996
PROJECT NO.20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

	LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
	1.0	3.5	136.	N/A

DATE DIGESTED 07/26/96
DATE ANALYZED 07/31/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED [signature]
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

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Hazleton Environmental Services, Inc.

HES, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 6070035
DATE ENTERED: 07/17/96
REPORT PRINTED: 08/12/9?

WATER,MP-3 UNFILTERED,7-12-1996
PROJECT NO.20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

	LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
	1.0	3.5	167.	N/A

DATE DIGESTED 07/26/96
DATE ANALYZED 07/31/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ______________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ARSENIC
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/ 4-79-020, METALS 1-19 AND METHOD 206.2, U.S. EPA, CINCINNATI, OH
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Hazleton
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Services, Inc.

HES, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 60700358

DATE ENTERED: 07/17/96

REPORT PRINTED: 08/12/96

WATER,MP-4 FILTERED,7-12-1996
PROJECT NO.20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
1.0	3.5	358.	N/A

DATE DIGESTED 07/26/96
DATE ANALYZED 07/31/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ____________________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ARSENIC
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/4-79-020, METALS 1-19 AND METHOD 206.2, U.S. EPA, CINCINNATI, OH
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Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 6070035
DATE ENTERED: 07/17/96
REPORT PRINTED: 08/12/96

WATER,MP-4 UNFILTERED,7-12-1996
PROJECT NO.20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

	LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
	1.0	3.5	454.	N/A

DATE DIGESTED 07/26/96
DATE ANALYZED 07/31/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED [signature]
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ARSENIC
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/4-79-020, METALS 1-19 AND METHOD 206.2, U.S. EPA, CINCINNATI, OH
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Hazleton
Environmental
Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 60700360

DATE ENTERED: 07/17/96

REPORT PRINTED: 08/12/96

WATER,MP-5 FILTERED,7-12-1996
PROJECT NO.20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
1.0	3.5	9.9	N/A

DATE DIGESTED 07/26/96
DATE ANALYZED 07/31/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ____________________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ARSENIC
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/4-79-020, METALS 1-19 AND METHOD 206.2, U.S. EPA, CINCINNATI, OH
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Hazleton
Environmental
Services, Inc.

HES, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 6070036[redacted]

DATE ENTERED: 07/17/96

REPORT PRINTED: 08/12/9

WATER,MP-5 UNFILTERED,7-12-1996
PROJECT NO.20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

	LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
	1.0	3.5	12.2	N/A

DATE DIGESTED   07/26/96
DATE ANALYZED   07/31/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ______________________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

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METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/4-79-020, METALS 1-19 AND METHOD 206.2, U.S. EPA, CINCINNATI, OH
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Hazleton
Environmental
Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 60700362

DATE ENTERED: 07/17/96

REPORT PRINTED: 08/12/96

WATER,MP-6 FILTERED,7-12-1996
PROJECT NO.20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

	LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
	1.0	3.5	415.	N/A

DATE DIGESTED 07/26/96
DATE ANALYZED 07/31/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED [signature]
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ARSENIC
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/ 4-79-020, METALS 1-19 AND METHOD 206.2, U.S. EPA, CINCINNATI, OH
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EDIT MNEMONIC-INORGANICS
SIGNATURE BLOCK FOR INORGANIC ANALYSIS

Hazleton Environmental Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 6070036
DATE ENTERED: 07/17/96
REPORT PRINTED: 08/12/96

WATER,MP-6 UNFILTERED,7-12-1996
PROJECT NO.20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

	LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
	1.0	3.5	393.	N/A

DATE DIGESTED 07/26/96
DATE ANALYZED 07/31/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ARSENIC
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/4-79-020, METALS 1-19 AND METHOD 206.2, U.S. EPA, CINCINNATI, OH
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EDIT MNEMONIC-INORGANICS
SIGNATURE BLOCK FOR INORGANIC ANALYSIS

Hazleton
Environmental
Services, Inc.

HES, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 60700364

DATE ENTERED: 07/17/96

REPORT PRINTED: 08/12/96

WATER, R.R. BRIDGE, 7-12-1996
PROJECT NO.20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
1.0	3.5	6.4	N/A

DATE DIGESTED 07/26/96
DATE ANALYZED 07/31/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ______________________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

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EDIT MNEMONIC-INORGANICS
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Hazleton Environmental Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 607003€
DATE ENTERED: 07/17/96
REPORT PRINTED: 08/12/9

WATER,RIVER EMBANKMENT,7/12/1996
PROJECT NO.20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

	LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
	1.0	3.5	3.7	N/A

DATE DIGESTED 07/26/96
DATE ANALYZED 07/31/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED [signature]
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ARSENIC
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EDIT MNEMONIC-INORGANICS
SIGNATURE BLOCK FOR INORGANIC ANALYSIS

Terms and Conditions

1. Reports are submitted to clients on a confidential basis. No reference to the work, the results, or HES, Inc., in any form of advertising, news release, or other public announcements may be made without written authorization from HES.

2. The term "Less Than" or the symbol (<) is used to signify the lower limit of quantitation of the procedure under the conditions employed. The use of the term "Less Than" or (<) does not imply that traces of analyte were present.

   The term "None Detected" is used to report assay results where detection limits have been established for the method but acceptable residue levels have not been defined by the industry or by federal law or when the method does not define detection limits. The term will specify the fixed amount of sample employed in the analysis and does not imply that traces of the analyte were present.

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CHAIN OF CUSTODY RECORD

№ 21659

STS

RECORD NUMBER ______ THROUGH ______

Contact Person Mike Berger
Phone No. 468-1978 Office GB
Project No. 20716XA PO No.
Project Name

Special Handling Request
☐ Rush
☐ Verbal
☐ Other

Laboratory HES
Contact Person Peggy Papp
Phone No.
Condition Cold Storage WIK 2
Acct. # 4320 Abbrev. STSG

COPY

(14)
Smpl Rec'd JUL 16 1996
Init. LMD
Date Entered 7-17-96
LIMS # 60700352-365

Sample I.D.	Date	Time	Grab	Composite	No. of Containers	Sample Type (Water, soil, air, sludge, etc.)	Preservation Y	Preservation N	Field Data PID/FID Ambient	Field Data PID/FID Sample	PH	Special Cond.	Analysis Requested		Comments on Sample (Include Major Contaminants)
	1996														
MP-1 filtered	7-12				1	water	X						As	60700352	Possible Arsenic Impact
MP-1 unfiltered	↓				1	↓	↓						↓	60700353	
MP-2 filtered	↓				1	↓	↓						↓	60700354	
MP-2 unfiltered	↓				1	↓	↓						↓	60700355	
MP-3 filtered	↓				1	↓	↓						↓	60700356	
MP-3 unfiltered	↓				1	↓	↓						↓	60700357	
MP-4 filtered	↓				1	↓	↓						↓	60700358	
MP-4 unfiltered	↓				1	↓	↓						↓	60700359	

Collected by: Jim Calaway	Date 7/12/96	Time	Delivery by:	Date	Time
Received by:	Date	Time	Relinquished by:	Date	Time
Received by:	Date	Time	Relinquished by:	Date	Time
Received by:	Date	Time	Relinquished by:	Date	Time
Received for lab by: Linn Derry	Date 7-16-96	Time 955	Relinquished by:	Date	Time

Laboratory Comments Only: Seals Intact Upon Receipt? ☐ Yes ☐ No ☐ N/A

Final Disposition:

Comments (Weather Conditions, Precautions, Hazards): Rec'd with ice - LMD

Distribution: Original and Green - Laboratory Yellow - As needed Pink - Transporter Goldenrod - STS Project File
Instructions to Laboratory: Forward completed original to STS with analytical results. Retain green copy.

9/94cp10k

STS Consultants Ltd.
Consulting Engineers

[redacted]

CHAIN OF CUSTODY RECORD

№ 21658

STS

Contact Person: Mike Berger	RECORD NUMBER ______ THROUGH ______
Phone No.: 468-1978 Office: GB	Laboratory: HES
Project No.: 20716XA PO No.:	Contact Person: Peggy Popp
Project Name:	Phone No.:
	Results Due:

Special Handling Request

- ☐ Rush
- ☐ Verbal
- ☐ Other

COPY

Sample I.D.	Date 1996	Time	Grab	Composite	No. of Containers	Sample Type (Water, soil, air, sludge, etc.)	Preservation Y	Preservation N	Field Data PID/FID Ambient	Field Data PID/FID Sample	Field Data PH	Field Data Special Cond.	Analysis Request		Comments on Sample (Include Major Contaminants)
MP-5 Filtered	7/12				1	Water	X						As	607003360	Possible Arsenic Impact
MP-5 unfiltered	↓				1	↓	↓						↓	607003361	
MP-6 Filtered	↓				1	↓	↓						↓	607003362	
MP-6 unfiltered	↓				1	↓	↓						↓	607003363	
R.R. Bridge	↓				1	↓	↓						↓	607003364	
River Embankment	↓				1	↓	↓						↓	607003365	

	Date	Time		Date	Time
Collected by: Jim Calaway	7/12/96		Delivery by:		
Received by:			Relinquished by:		
Received by:			Relinquished by:		
Received by:			Relinquished by:		
Received for lab by: Lynn Derry	7-16-96	955	Relinquished by:		

Laboratory Comments Only: Seals Intact Upon Receipt? ☐ Yes ☐ No ☐ N/A

Final Disposition:

Comments (Weather Conditions, Precautions, Hazards): Rec'd with ice - LMD

Hazleton Environmental Services, Inc.
525 SCIENCE DRIVE MADISON, WISCONSIN 53711

HES, Inc.

11/26/96

Mike Berger
STS Consultants Ltd.
1035 Kepler Drive
Green Bay, WI 54311

Re: Project #20716XA (Kewaunee Marsh)
HES Batch Number 61001196

Dear Mr. Berger:

Enclosed are the analytical results for the water samples received by HES, Inc. on 10/24/96 (HES sample numbers 61001196 - 61001208). A copy of the original chain of custody form is included with this report.

If I can be of assistance, or provide additional information, please call me at (608) 232-3335.

Sincerely,

Peggy

Peggy Popp
Project Manager

Wisconsin Laboratory Certification Number 113172950

Enc.: Laboratory Analytical Report

c: Central File

Phone 608-232-3300 Fax 608-233-050■

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 61001196

DATE ENTERED: 10/24/96

REPORT PRINTED: 11/26/96

WATER,MP-1,10/23,UNFILTERED
PROJECT NAME: KEWAUNEE MARSH/20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
1.0	3.5	486.	N/A

DATE DIGESTED 11/19/96
DATE ANALYZED 11/21/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ______________________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ARSENIC
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/4-79-020, METALS 1-19 AND METHOD 206.2, U.S. EPA, CINCINNATI, OH
TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION NO. SW-846, SECOND EDITION, METHODS 3020 AND 7060, U.S. EPA, WASHINGTON, DC (REVISED APRIL 1984)

EDIT MNEMONIC-INORGANICS
SIGNATURE BLOCK FOR INORGANIC ANALYSIS

Hazleton Environmental Services, Inc.

HES, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 610011 7

DATE ENTERED: 10/24/96

REPORT PRINTED: 11/26/ 5

WATER,MP-1,10/23,FILTERED
PROJECT NAME: KEWAUNEE MARSH/20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
1.0	3.5	318.	N/A

DATE DIGESTED 11/19/96
DATE ANALYZED 11/21/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED [signature]
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ARSENIC
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/4-79-020, METALS 1-19 AND METHOD 206.2, U.S. EPA, CINCINNATI, OH
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SIGNATURE BLOCK FOR INORGANIC ANALYSIS

Hazleton Environmental Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 61001198

DATE ENTERED: 10/24/96

REPORT PRINTED: 11/26/96

WATER,MP-2,10/23,UNFILTERED
PROJECT NAME: KEWAUNEE MARSH/20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

	LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
	1.0	3.5	170.	N/A

DATE DIGESTED 11/19/96
DATE ANALYZED 11/21/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ____________________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ARSENIC
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/4-79-020, METALS 1-19 AND METHOD 206.2, U.S. EPA, CINCINNATI, OH
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Hazleton
Environmental
Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 610011[redacted]

DATE ENTERED: 10/24/96

REPORT PRINTED: 11/26/[redacted]

WATER,MP-2,10/23,FILTERED
PROJECT NAME: KEWAUNEE MARSH/20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
1.0	3.5	65.8	N/A

DATE DIGESTED 11/19/96
DATE ANALYZED 11/21/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ____________________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ARSENIC
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/4-79-020, METALS 1-19 AND METHOD 206.2, U.S. EPA, CINCINNATI, OH
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Hazleton Environmental Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 61001200

DATE ENTERED: 10/24/96

REPORT PRINTED: 11/26/96

WATER,MP-3,10/23,UNFILTERED
PROJECT NAME: KEWAUNEE MARSH/20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

	LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
	1.0	3.5	175.	N/A

DATE DIGESTED 11/19/96
DATE ANALYZED 11/21/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

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SIGNATURE BLOCK FOR INORGANIC ANALYSIS

525 SCIENCE DRIVE • MADISON, WISCONSIN 53711 Phone 608-232-3300 Fax 608-233-0502

Hazleton
Environmental
Services, Inc.

HES, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 610012
DATE ENTERED: 10/24/96
REPORT PRINTED: 11/26/96

WATER,MP-3,10/23,FILTERED
PROJECT NAME: KEWAUNEE MARSH/20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

	LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
	1.0	3.5	156.	N/A

DATE DIGESTED 11/19/96
DATE ANALYZED 11/21/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ______________________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

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METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/4-79-020, METALS 1-19 AND METHOD 206.2, U.S. EPA, CINCINNATI, OH
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Hazleton
Environmental
Services, Inc.

HES, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 61001202

DATE ENTERED: 10/24/96

REPORT PRINTED: 11/26/96

WATER,MP-4,10/23,UNFILTERED
PROJECT NAME: KEWAUNEE MARSH/20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

	LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
	1.0	3.5	391.	N/A

DATE DIGESTED 11/19/96
DATE ANALYZED 11/21/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ____________________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ARSENIC
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/4-79-020, METALS 1-19 AND METHOD 206.2, U.S. EPA, CINCINNATI, OH
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Hazleton
Environmental
Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 610012 3

DATE ENTERED: 10/24/96

REPORT PRINTED: 11/26/96

WATER,MP-4,10/23,FILTERED
PROJECT NAME: KEWAUNEE MARSH/20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

	LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
	1.0	3.5	311.	N/A

DATE DIGESTED 11/19/96
DATE ANALYZED 11/21/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ______________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ARSENIC
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/4-79-020, METALS 1-19 AND METHOD 206.2, U.S. EPA, CINCINNATI, OH
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SIGNATURE BLOCK FOR INORGANIC ANALYSIS

Hazleton Environmental Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 61001204

DATE ENTERED: 10/24/96

REPORT PRINTED: 11/26/96

WATER,MP-5,10/23,UNFILTERED
PROJECT NAME: KEWAUNEE MARSH/20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
1.0	3.5	5.1	N/A

DATE DIGESTED 11/19/96
DATE ANALYZED 11/21/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ____________________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ARSENIC
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/4-79-020, METALS 1-19 AND METHOD 206.2, U.S. EPA, CINCINNATI, OH
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Hazleton Environmental Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 610012 5

DATE ENTERED: 10/24/96

REPORT PRINTED: 11/26/ 5

WATER,MP-5,10/23,FILTERED
PROJECT NAME: KEWAUNEE MARSH/20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

	LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
	1.0	3.5	5.7	N/A

DATE DIGESTED 11/19/96
DATE ANALYZED 11/21/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ______________________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ARSENIC
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/4-79-020, METALS 1-19 AND METHOD 206.2, U.S. EPA, CINCINNATI, OH
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Hazleton
Environmental
Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 61001206

DATE ENTERED: 10/24/96

REPORT PRINTED: 11/26/96

WATER,MP-6,10/23,UNFILTERED
PROJECT NAME: KEWAUNEE MARSH/20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

	LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
	1.0	3.5	48.1	N/A

DATE DIGESTED 11/19/96
DATE ANALYZED 11/21/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ______________________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ARSENIC
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/4-79-020, METALS 1-19 AND METHOD 206.2, U.S. EPA, CINCINNATI, OH
TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION NO. SW-846, SECOND EDITION, METHODS 3020 AND 7060, U.S. EPA, WASHINGTON, DC (REVISED APRIL 1984)

EDIT MNEMONIC-INORGANICS
SIGNATURE BLOCK FOR INORGANIC ANALYSIS

Hazleton Environmental Services, Inc.

HES, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 610012▪

DATE ENTERED: 10/24/96

REPORT PRINTED: 11/26/[illegible]

WATER,MP-6,10/23,FILTERED
PROJECT NAME: KEWAUNEE MARSH/20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

	LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
	1.0	3.5	19.0	N/A

DATE DIGESTED 11/19/96
DATE ANALYZED 11/21/96

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED [signature]
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ARSENIC
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/4-79-020, METALS 1-19 AND METHOD 206.2, U.S. EPA, CINCINNATI, OH
TEST METHODS FOR EVALUATING SOLID WASTE, EPA PUBLICATION NO. SW-846, SECOND EDITION, METHODS 3020 AND 7060, U.S. EPA, WASHINGTON, DC (REVISED APRIL 1984)

EDIT MNEMONIC-INORGANICS
SIGNATURE BLOCK FOR INORGANIC ANALYSIS

Hazleton
Environmental
Services, Inc.

REPORT OF ANALYSIS

MIKE BERGER
STS CONSULTANTS, LTD
1035 KEPLER DRIVE
GREEN BAY, WI 54311

SAMPLE NUMBER: 61001208

DATE ENTERED: 10/24/96

REPORT PRINTED: 11/26/96

WATER,RIVER,10/23,UNFILTERED
PROJECT NAME: KEWAUNEE MARSH/20716XA

PURCHASE ORDER NUMBER: 20716XA

ARSENIC

	LOD UG/L	LOQ UG/L	RESULTS UG/L	FLAGS
	1.0	3.5	3.2	Y

DATE DIGESTED 11/19/96
DATE ANALYZED 11/21/96
Y: ANALYTE CONCENTRATION IS BETWEEN THE LOD AND THE LOQ

EDIT MNEMONIC-INORGANICS

WISCONSIN DNR CERTIFICATION NUMBER: 113172950

SIGNED ______________________
JOHN C. WALTON
SUPERVISOR, INORGANICS

METHOD REFERENCES

ARSENIC
METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, EPA PUBLICATION NO. 600/4-79-020, METALS 1-19 AND METHOD 206.2, U.S. EPA, CINCINNATI, OH
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EDIT MNEMONIC-INORGANICS
SIGNATURE BLOCK FOR INORGANIC ANALYSIS

525 SCIENCE DRIVE • MADISON, WISCONSIN 53711 Phone 608-232-3300 Fax 608-233-0502

Terms and Conditions

1. Reports are submitted to clients on a confidential basis. No reference to the work, the results, or HES, Inc., in any form of advertising, news release, or other public announcements may be made without written authorization from HES.

2. The term "Less Than" or the symbol (<) is used to signify the lower limit of quantitation of the procedure under the conditions employed. The use of the term "Less Than" or (<) does not imply that traces of analyte were present.

   The term "None Detected" is used to report assay results where detection limits have been established for the method but acceptable residue levels have not been defined by the industry or by federal law or when the method does not define detection limits. The term will specify the fixed amount of sample employed in the analysis and does not imply that traces of the analyte were present.

3. Samples submitted to HES for routine analysis will be retained for a minimum of sixty (60) days after the report of analysis is issued. Extended storage requirements must be brought to the attention of HES prior to or at the time of sample submission. HES, at its discretion, may charge for such extended storage. Records and specimens from all government regulated studies will be maintained in accordance with federal regulations.

4. Analytical Method Summaries will be supplied to the client upon request. Detailed copies of in-house laboratory procedures may be reviewed by the client or his agent during a site visit, but may not be copied without the expressed consent of HES.

5. All work performed by HES will be conducted in accordance with the HES Quality Assurance Program. Specific documentation requirements of the client for work performed by HES must be made known to HES prior to the start of the requested work.

6. Records of the raw data, reports, etc., will be maintained by HES in its data archives for a minimum of five (5) years unless otherwise specified by government regulations after the completion of the requested work. One (1) duplicate report will be made available free of charge for a period of one (1) year. HES reserves the right to charge for copies made after one (1) year and to charge for any and all copies of raw data requested.

7. Raw data, chromatograms, calibration data, etc., are the sole property of HES. Copies will be made available upon request when the quality of the original document is such that duplication is possible.

8. Clients and/or their agents may, with prior notice, inspect/audit the records, facilities, etc., of HES pertinent to their study. All data not pertinent to the specific study is confidential and will not be made available.

9. Routine inquiry concerning work performed by HES should be made to the Client Service Center. The client is also encouraged to bring any concerns or questions to the attention of management, technical staff, or the facility Quality Assurance Unit.

Hazleton Environmental Services, Inc.
525 Science Drive
Madison, Wisconsin 53711
Telephone 608-232-3300
Facsimile 608-233-0502

Chain of Custody Record and Analysis Request

Enclose with samples and send to:
HES, Inc.
Attn: Sample Entry
515 Science Drive, Madison, Wisconsin 53711

For HES use only
Condition: Cold Storage: WIR-1
Acct. #: 4320 Abbrev.: STSG
Smpl Rec'd: OCT 24 1996 LMD Init. LMD
Date Entered: 10-24-96
LIMS #: 61001196-1208

Company Name and Address (Please Type or Print): STS CONSULTANTS LTD, 1035 KEPLER DR, GREEN BAY WI 54311

Project No.: 20716XA
Project Name: KEWAUNEE MARSH
Sampler(s) (Signature): Jim Calaway

Name of Submitter: JIM CALAWAY
Phone No.: 414-468-1978
Send Reports To: MIKE BERGER
Send Invoice To: SAME
Date Sent: 10-22-96
Purchase Order No.:

Analysis Requested: GF-ICP FOR ARSENIC

Sample Code	Date 1996	Time	Matrix[1]	Sample Description[2]	Number of Containers	Remarks
	10/23			MP-1 61001196, 1197	2	*ONE FIELD FILTERED, ONE NOT FILTERED
	↓			MP-2 61001198, 1199	↓	↓
	↓			MP-3 61001200, 1201	↓	↓
	↓			MP-4 61001202, 1203	↓	↓
	↓			MP-5 61001204, 1205	↓	↓
	↓			MP-6 61001206, 1207	↓	↓
	↓			RIVER 61001208	1	*NOT FILTERED

*ALL SAMPLES CONTAIN PRESERVE

COPY

I hereby certify that I received, properly handled, and disposed of these samples as noted above:

Relinquished By (Signature)	Date/Time	Received By (Signature)
	10-24-96 940	Lynn Derry

Remarks (HES use only): Rec'd with ice - LMD

1 Specify groundwater, surface water, soil, leachate, sludge, etc.
2 Sample description must clearly correlate the sample ID to the sampling location.

WHITE - Executed Copy YELLOW - HES Copy PINK Client Original

10/93

U.S. Oil Co., Inc.

Analytical Laboratory
1090 Kennedy Ave. Kimberly, WI 54136
414-735-8295

WI DNR Certified Lab #445027660

MIKE BERGER
S T S CONSULTANTS LTD
1035 KEPLER DRIVE
GREEN BAY WI 54311

Report Date: 20-Jun-97

Project #: 20716XF
Project : Kewaunee Marsh
Sample ID: River
Lab Code: 5017224A
Sample Type: Water
Sample Date: 06-Jun-97

Test	Result	LOD	LOQ	Unit	pH	Date Ext/Digested	Date Analyzed:	Analyzed By:	QC Code
ARSENIC **SW846 7060**	< 2	2	7	UG/L	1.4	1	19-Jun-97	S. Forster	1

LOD = Limit of Detection

LOQ = Limit of Quantitation

QC SUMMARY

CODE:

1 All laboratory QC requirements were met for this sample.

Authorized Signature Katherine A. Brahmstead t

RECEIVED
JUN 30 1997

CHAIN OF CUSTODY RECORD 5017224 № 22098

Contact Person MIKE BERGER
Phone No. 914-468-1978 Office G.B.
Project No. 20716XF PO No.
Project Name ~~ASSE~~ KEWAUNEE MARSH

Special Handling Request
☐ Rush
☐ Verbal
☐ Other

RECORD NUMBER 1 THROUGH 1
Laboratory U.S. OIL
Contact Person CHRIS ZABEL
Phone No.
Results Due

Sample I.D.	Date	Time	Grab	Composite	No. of Containers	Sample Type (Water, soil, air, sludge, etc.)	Preservation Y	Preservation N	Field Data PID/FID Ambient	Field Data PID/FID Sample	Field Data PH	Field Data Special Cond.	Analysis Request	Comments on Sample (Include Major Contaminants)
	1997													
RIVER	6/6		X		2	WATER	6						ARSENIC	5017224 A

Collected by: [signature]	Date 6-6-97	Time 10:50A	Delivery by: [signature]	Date 6-6-97	Time 12:19P
Received by:	Date	Time	Relinquished by: [signature]	Date	Time
Received by:	Date	Time	Relinquished by:	Date	Time
Received by:	Date	Time	Relinquished by:	Date	Time
Received for lab by: Kelly Schroeder	Date 6/10/97	Time 12:30pm	Relinquished by:	Date	Time

Laboratory Comments Only: Seals Intact Upon Receipt? ☐ Yes ☒ No ☐ N/A on ice. Client

Final Disposition:

Comments (Weather Conditions, Precautions, Hazards):

Distribution: Original and Green - Laboratory Yellow - As needed Pink - Transporter Goldenrod - STS Project File
Instructions to Laboratory: Forward completed original to STS with analytical results. Retain green copy.

9/94cp10k

STS Consultants Ltd.
Consulting Engineers

APPENDIX B

HSI GeoTrans, Inc., Report, "Fate and Transport Modeling of Arsenic at the Kewaunee Marsh," dated May 1997

FATE AND TRANSPORT MODELING OF ARSENIC AT THE KEWAUNEE MARSH

PREPARED FOR:

STS CONSULTANTS LTD.
1035 KEPLER DRIVE
GREEN BAY, WISCONSIN 54311

PREPARED BY:

HSI GEOTRANS, INC.
4888 PEARL EAST CIRCLE
SUITE 300-E
BOULDER, COLORADO 80301
(303) 440-4556

May 21, 1997

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1.0 INTRODUCTION

In 1994, an area of arsenic impact was discovered by the Wisconsin Department of National Resources (DNR) in the C.D. Besadny Wildlife Area. Arsenic concentrations in the soil and groundwater exceeded 10,000 mg/kg and 900 mg/l, respectively. The DNR was concerned that arsenic-contaminated groundwater and surface water would seep into an adjacent major river system, which discharges into Lake Michigan. The proposed remediation at the site consisted of the installation of a floating HDL cap, which was covered with an organic substrata to promote wetlands vegetation growth. The installation of the cap effectively eliminated the potential for humans and wildlife coming in contact with the more highly contaminated areas. In addition, the cap reduced the potential for the migration of arsenic contaminated sediments through surface-water transport. A secondary concern of the DNR was the potential for groundwater transport of dissolved arsenic compounds.

HSI GeoTrans was subcontracted to perform a geochemical analysis of the arsenic contamination, and to perform fate and transport modeling. HSI GeoTrans reviewed the data-collection program, performed an extensive geochemical literature search on arsenic contamination in wetlands, and develop nonlinear sorption parameter values for the predictive transport model simulations. Given the uniform groundwater flow system and the limited historical data available for the site, HSI GeoTrans proposed the use of a one-dimensional fate and transport code, BIO1D. The use of a one-dimensional model provided reasonable estimates of travel times and concentration breakthroughs at the river.

2.0 SITE HYDROGEOLOGY AND GEOCHEMISTRY

2.1 REGIONAL SETTING

The site is located in the flood plain of the Kewaunee River approximately 1.5 miles upstream from where it discharges into Lake Michigan. The marsh area is on the inside of a broad river meander (approximately 0.5 miles across), with the river to the east, west and north of the marsh. Regional groundwater flow in the alluvial deposits is most likely from the northwest to the southeast, following the approximate orientation of the valley in this area; however, water-level fluctuations within the peat/clay deposits in the marsh are probably dominated by changes in river stage. The permeability of the upper peat/clay deposit is high and readily transmits changes in river stage back into the marsh.

2.2 SITE HYDROGEOLOGY

The marsh was formed by the deposition of alluvial sediments and the formation of peat through the decay of organic matter. The upper 8 feet of deposits at the site are predominantly peat, and alluvial silts and muds. The amount of fine-grained alluvial sediments interbedded with peat deposits increases with depth. Deposits beneath the peat consist of interbedded alluvial deposits of clay, silty clay, gravelly-silty sand, and coarse sand. Based on borings through the peat at the site, the predominant alluvial material beneath the peat is clay to silty clay.

Shallow piezometers were installed by both the DNR and STS Consultants to monitor shallow water levels and to collect water samples for analysis. Aquifer slug tests were performed in the STS piezometers to estimate the horizontal permeability of the peat deposits. Results of these six tests indicated that the permeability of the peat/clay deposits ranged from 6.7×10^{-5} to 1.5×10^{-3} cm/sec, with a geometric mean value of 2.1×10^{-4} cm/sec. Removing the highest and lowest measured value of hydraulic conductivity from the data set results in a geometric mean value of 1.7×10^{-4} cm/sec.

Potentiometric surface contours were developed based on monthly water-level data collected by the DNR from May to November 1996. The location of monitoring wells and piezometers at the site are shown in Figure 1. The shallow potentiometric surface for the months of May, August and November are shown in Figures 2, 3 and 4. The September water-level data contained measurement errors and were not used in the analysis. Temporal changes in the potentiometric surface are minimal for the period May to November 1996. The potentiometric surface contours for the marsh approximately parallel the river indicating that the direction of groundwater flow is perpendicular to the river and that the river is a discharge point for shallow groundwater. The shape of the potentiometric surface contours have remained approximately constant for the period of record, with the exception of small shifts in the contours near the river.

A potentiometric surface valley is centered on the approximate location of the HDL cap. This low point in the potentiometric surface may be due to the cap diverting a portion of the shallow groundwater flow around this area.

The groundwater flow directions do not appear to be impacted by the presence of the railroad track fill material. Previous conceptual models for the shallow flow in this area were based on the railroad track fill material acting as a drain to shallow groundwater flow. Based on the water-level data for 1996, it does not appear that the fill material is acting as a drain.

2.3 ARSENIC TRANSPORT PROPERTIES

The transport of arsenic in groundwater systems is strongly retarded by surface adsorption reactions, resulting in arsenic transport rates that are significantly slower than the groundwater velocities. Both arsenite and arsenate are strongly sorbed to oxyhydroxides (especially iron and aluminum) in the pH range of 5 to 7. Sorption occurs very quickly and the surface complexation appears to form very stable complexes. Laboratory experiments using iron oxyhydroxides indicate that the process is reversible; however, weathered oxyhydroxides have much greater surface area and a significant fraction of arsenic may bond irreversibly to the oxides (oral communication, Dr. James Leckie, at Stanford University, 8/29/96).

Both Freundlich and Langmuir isotherms have been successfully used to model arsenic adsorption data from field and laboratory experiments (Luo and others, 1991; Jiang, 1983; Elkhatib and others, 1984; Olsen and others, 1991; Rai and Zachara, 1984). The Freundlich isotherm will tend to predict greater arsenic adsorption than the Langmuir isotherm at higher concentrations. The Freundlich isotherm predicts that adsorption continues with increasing solute concentrations, whereas the Langmuir isotherm approaches an asymptotic value as solute concentrations increase. The equations that define the Freundlich and Langmuir isotherms are the following:

Freundlich Isotherm:

$$\frac{X}{M} = K_d C^n \qquad \textbf{(1)}$$

Langmuir Isotherm:

$$\frac{X}{M} = \frac{K_L A_m C}{1 + K_L C} \qquad \textbf{(2)}$$

3.0 TRANSPORT MODEL

3.1 APPROACH

A one-dimensional transport model was chosen to model fate and transport at this site. This approach is sufficient to establish the approximate arrival time of the arsenic plume at the river, the shape of the concentration breakthrough curve as a function of time, and the time required for the majority of the arsenic to be naturally flushed from the marsh. Neither the decisions dependent on this model nor the data that currently exist for the site justify the development of a more complex model. While the data indicate that the flow field is approximately one dimensional, the approach will tend to overestimate concentrations at the river because lateral dispersion is ignored.

3.2 MODEL CODE DESCRIPTION

HSI GeoTrans proposed the use of a one-dimensional transport code entitled "BIO1D". The BIO1D code was developed by HSI GeoTrans for simulating the transport of organic, inorganic, metals and radioactive contaminants. The BIO1D code is capable of simulating the biodegradation of organic contaminants, and the radioactive decay of radionuclides. BIO1D is a proprietary, but publicly available code that has been bench marked and verified against analytical and other numerical models. It is widely used by government agencies, universities, and private industry.

The BIO1D code uses a finite-difference solution scheme to solves the one-dimensional solute transport equation:

$$D_x \frac{\partial^2 C}{\partial x^2} - v_x \frac{\partial C}{\partial x} = \frac{\partial C}{\partial t} R_f \qquad (3)$$

Freundlich Isotherm:

$$R_f = 1 + \frac{\rho_b K_d n C^{n-1}}{\theta_e} \qquad (4)$$

Where:

X	is the mass of analyte adsorbed, M;
M	is the mass of sorbent,M;
C	is the dissolved concentration of analyte, M/L^3;
K_d	is the distribution coefficient, L^3/M;
K_L	is the Langmuir distribution coefficient, L^3/M;
n	is the Freundlich isotherm exponent, dimensionless; and
A_m	is a Langmuir constant; dimensionless.

The parameters used to define the Freundlich and Langmuir isotherms were determined by manually adjusting the parameter values to obtain the best fit to the arsenic concentration data for the site. The arsenic concentration data for the site were obtained from soil samples and surface-water samples collected in November 1994 and from pore-water samples collected in February 1995 by STS Consultants. Paired soil and water-sample arsenic concentration data do not exists for the site. Hence, the soil-sample concentrations were extrapolated to the water sampling locations based on isoconcentration contours developed by STS Consultants. The soil concentration data were based on a total analysis of the soil and water contained in the sample. Therefore, the soil concentration data need to be corrected for the dissolved arsenic contained in the residual water in the soil samples. The water sample arsenic concentration data and the extrapolated soil concentration points are presented in Table 1.

A plot of arsenic concentration data, and the calculated Freundlich and Langmuir isotherms are presented in Figure 5. Both the Freundlich and Langmuir isotherms fit the data equally well in the concentration range of 0 to 175 mg/l. For concentrations above approximately 175 mg/l, the Freundlich and Langmuir isotherms deviate significantly. The Langmuir isotherm predicts that arsenic adsorption ceases above a solute concentration of about 200 mg/l, whereas, the Freundlich isotherm predicts that the arsenic adsorption continues to increase as solute concentrations increase. Therefore, the use of a Langmuir isotherm will tend to predict higher arsenic concentrations at the river than the Freundlich isotherm, since a smaller percentage of the arsenic will be absorbed in the marsh areas with arsenic concentrations above 200 mg/l.

Langmuir Isotherm:

$$R_f = 1 + \frac{\rho_b K_L A_m}{\theta_e (1 + K_L C)^2} \tag{5}$$

Where:

θ_e	effective porosity, dimensionless;
ρ_b	aquifer bulk density M/L^3;
D_x	longitudinal dispersion, L^2/t; and
V_x	groundwater velocity in the x direction, L/t.

3.3 MODEL DESIGN

The one-dimensional BIO1D model does not explicitly solve the groundwater flow equation. The groundwater velocity is specified by the user, and is assumed to be constant and uniform along a chosen flow path. The groundwater velocity for the Kewaunee marsh was calculated from the Darcy equation:

$$V_x = \frac{(k * i)}{\theta_e} \tag{6}$$

Where:

k	is the hydraulic conductivity, L/t;
I	is the hydraulic gradient, L/L.

The geometric mean hydraulic-conductivity value was obtained from the aquifer tests performed at the site and the hydraulic gradient was obtained from the May 1996 potentiometric surface map (Figure 2). The highest and lowest measured hydraulic-conductivity values were eliminated from the hydraulic-conductivity data set, so that the calculated value is more representative of the mean value for the site. The parameter values used to calculate the average groundwater velocity are the following:

Hydraulic conductivity	1.7×10^{-4} cm/sec ($1.76 \times 10^{+2}$ ft/yr)
Hydraulic gradient	8.45×10^{-4} ft/ft
Effective Porosity	0.40

and yield an estimate of the average groundwater pore velocity of 0.37 ft/yr. This fairly low groundwater velocity is due to the small hydraulic gradient for the marsh and high effective porosity of the peat deposit.

The arsenic transport was simulated with a Langmuir isotherm. Either the Langmuir or Freundlich isotherms could have been used to simulate the transport of the arsenic plume; however, the Langmuir isotherm is the more conservative of the two. The parameter values used to simulate the Langmuir isotherm are the following:

K_L	0.15 l/mg
A_m	8.3 mg/g

supposed to be dimensionless

The longitudinal-dispersivity value was estimated based on the scale of the transport problem and the model grid dimensions. The longitudinal-dispersivity value was set equal to 20.0 feet for all transport simulations.

Two flow paths were chosen for simulation of the groundwater transport of arsenic at the Kewaunee marsh. The flow paths were based on the May 1996 potentiometric surface and were chosen to represent the highest arsenic concentrations through the center of the plume and the lower concentrations along the northern edge of the plume. The central flow path and northern flow path are shown in Figure 6.

The objective of the model simulations was to calculate the arsenic concentration in the groundwater discharging to the river. Therefore, it is important that the downstream model boundary does not artificially impact the calculated arsenic concentrations at the river. A common modeling technique for minimizing the impacts of the boundary is to place it sufficiently far away so that the plume does not reach it during the simulation period. The upgradient boundary was located approximately 60 feet west of the railroad track where arsenic contamination was 0 mg/l and the downgradient boundary was specified at an arbitrary large distance away from the river. The grid spacing was adjusted during the initial model simulations to ensure that the arsenic plume did not encounter the downgradient boundary.

Both the upgradient and downgradient concentration boundaries were set to a specified value (Dirichlet boundary) of 0. The upgradient boundary condition is based on the assumption that arsenic is not entering the model from the upgradient boundary. The flow paths were simulated with the maximum number of grid nodes (201).

The central flow path grid spacing was set to 20 feet and the northern flow path grid spacing was set to 10 feet. The central flow path's larger grid spacing was required because a longer simulation period was needed to model the peak arsenic concentration breakthrough at the river. The longer simulation time (8000 years) required for the central flow path also required that the downstream boundary be moved farther away to prevent the plume from hitting it. Hence, the grid spacing was doubled to move the boundary twice as far away. The simulation time (3000 years) for the northern flow path was less and therefore, a smaller grid spacing was appropriate for modeling arsenic transport along this flow path.

The initial starting groundwater concentrations for arsenic is based on the current distribution of arsenic in the marsh (Figure 7). In general, the maximum arsenic concentration detected in the groundwater and surface water, during the period of record at the marsh, was extrapolated to the central and northern flow paths. The maximum arsenic concentration for the central flow path is 920,000 μg/l near the area of stressed vegetation and the maximum arsenic concentration for the northern flow path is 3000 μg/l near the center of the marsh (Figure 7).

3.5 RESULTS

The results of the model simulations indicate that the arsenic is not very mobile in the groundwater system. It will take approximately 400 years for the central flow path groundwater arsenic concentration to increase to a value of 0.05 mg/l at the river (Figure 8). The arsenic concentration will peak after about 2800 years at 200 mg/l and then slowly decline. The model predicts that the groundwater arsenic concentration will decrease to about 4 mg/l at the river after 8000 years. The distribution of the arsenic concentrations along the central flow path at 8000 years is shown in Figure 9. The majority of the arsenic contaminants have been flushed from the system by this time.

It will take about 450 years for the groundwater concentration along the northern flow path to increase to 0.05 mg/l (Figure 10). The groundwater arsenic concentration along the northern flow path will gradually increase to a value of 0.5 mg/l at the river after about 1700 years and will remain at this value for about the next 1000 years. The model was not run for a long enough time period to predict the actual peak concentration at the river for this flow path; however, based on the arsenic distribution at 3000 years (Figure 11) the arsenic concentration will peak at less than 2 mg/l after 3000 years.

A one-dimensional transport model will overestimate the arsenic concentration at the river because it does not account for lateral dispersion. Therefore, the arsenic concentrations calculated by the model at the river are higher than the concentrations that would be calculated by a more complex model.

4.0 CONCLUSION

The results of the transport simulations indicate that arsenic transport via the groundwater system is extremely slow. The accuracy of the model predictions decrease as the simulation time increases. One reason for the decrease in the accuracy of the model is that the assumptions implicit in the development of the model may change with time. Future changes to the hydrologic system upgradient of the marsh can change the present day groundwater velocities calculated at the site. If the groundwater velocities increase by a factor of two, the arsenic transport rate will also approximately increase by a factor of two. Given the current conditions at the site and the assumptions used to develop the model, the arsenic transport rate is extremely slow and groundwater concentrations at the river will not peak for 1000s of years into the future.

Based on the model results, it appears that the current distribution of arsenic at the site is not due to groundwater transport. The groundwater transport rates are much too low to explain the current distribution. One potential explanation for the current distribution of arsenic is that surface-water and sediment transport during river flooding are responsible for the distribution of arsenic. With the HDL cap currently in place at the site, the potential for the surface-water transport of arsenic has been significantly reduced.

5.0 REFERENCES

Elkhatib, E.A., Bennett, O.L., and Wright, R.J. (1984). Arsenite sorption and desorption in soils. *Soil Sci. Soc. Am. J.* 48, 1025-1030; in Jerome O. Nriagu (1994) Arsenic in the environment, Part I: cycling and characterization, John Wiley, Inc.

Jiang, Y.G. (1983). Adsorption of arsenate by different soils. *Turang Xuebao* 20(4), 394-405.; in Jerome O. Nriagu (1994) Arsenic in the environment, Part I: cycling and characterization, John Wiley, Inc.

Luo, J.F., Xia, Z.L., and Li, S.Z. (1991). Chemical behavior of As in purple soils and their effects on crop. *Acta Sci. Circumstantiae* 11(3), 269-275.; in Jerome O. Nriagu (1994) Arsenic in the environment, Part I: cycling and characterization, John Wiley, Inc.

Olsen, R.L., J.J. Eisenbeis, and M.C. Gemperline. Fate, Transport and Cleanup of Arsenic in Groundwater at a Superfund Site. In: Proceedings of the 1991 FOCUS Conference on Eastern Regional Ground Water Issues, Ground Water Management Book 7 of the Series, National Ground Water Association.

Rai, D. And J.M. Zachara, 1984. Chemical Attenuation Rates, Coefficients, and Constants in Leachate Migration, Volume I: A Critical Review. Prepared for Electric Power Research Institute by Battelle, Pacific Northwest Laboratories, EPRI EA-3356.

Table 1. STS--Arsenic concentrations in paired sediment and water samples.
(Sediment samples adjusted for mass of As in water of dried sample.)

Porosity	0.4
Peat Density	1.44 (g/cm^3)
Bulk Density	0.86 (g/cm^3)

Water Sample ID	As Concentration Water (mg/l) C	Sediment and Water (mg/kg)	As Mass in Water per kg of Sediment (mg)	Sediment As Concentration (mg/kg) X/M
H-4	920.0	10700	425.9	10274.1
H-3	148.0	8000	68.5	7931.5
H-5	24.8	8000	11.5	7988.5
P-2	800.0	7000	370.4	6629.6
P-1	17.2	5500	8.0	5492.0
H-2	5.7	2200	2.6	2197.4
H-1	19.3	3100	8.9	3091.1
P-3	21.0	4200	9.7	4190.3
H-6	19.1	2440	8.8	2431.2

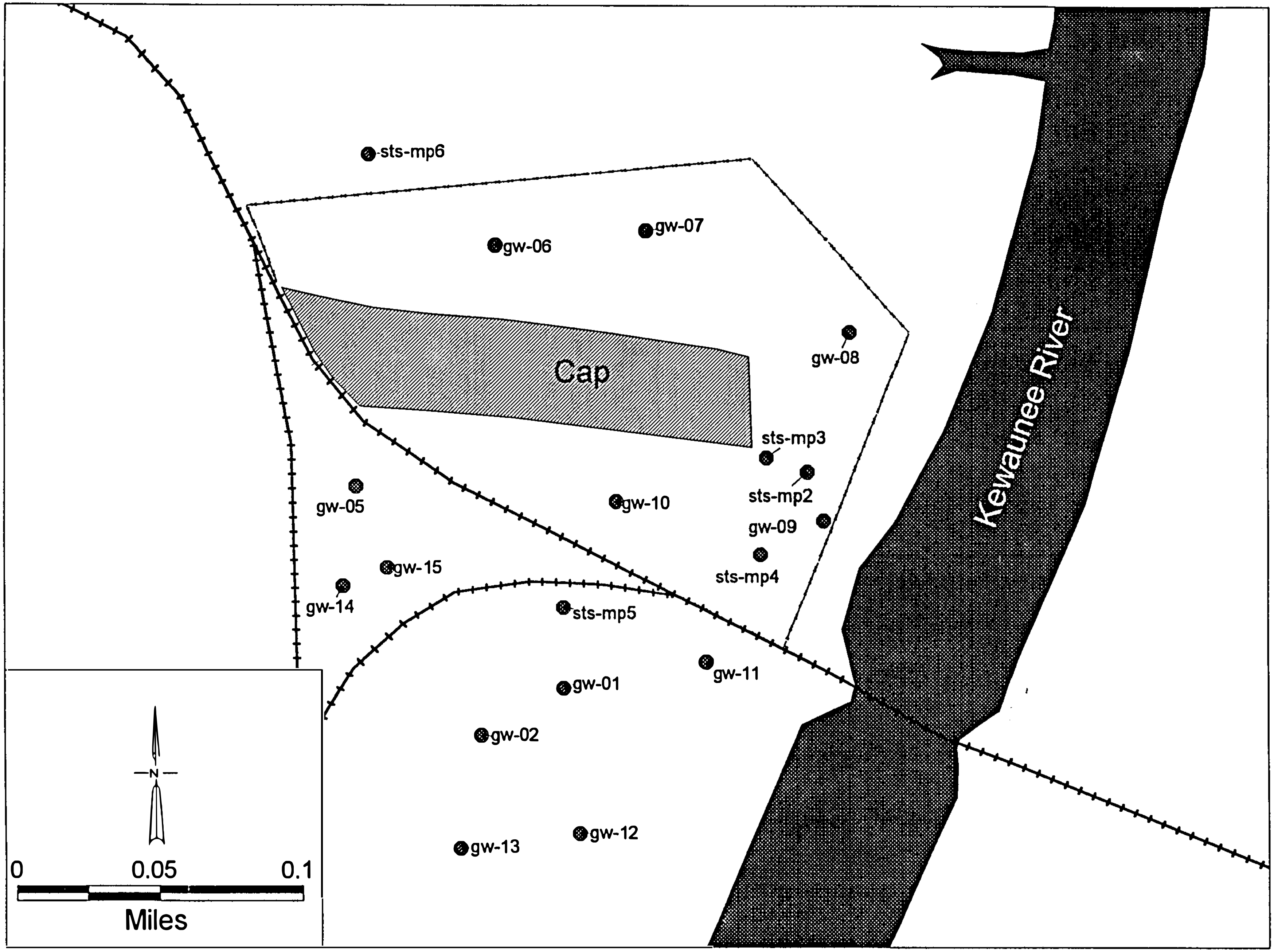


Figure 1. Location of monitoring wells and piezometers at the Kewaunee marsh.

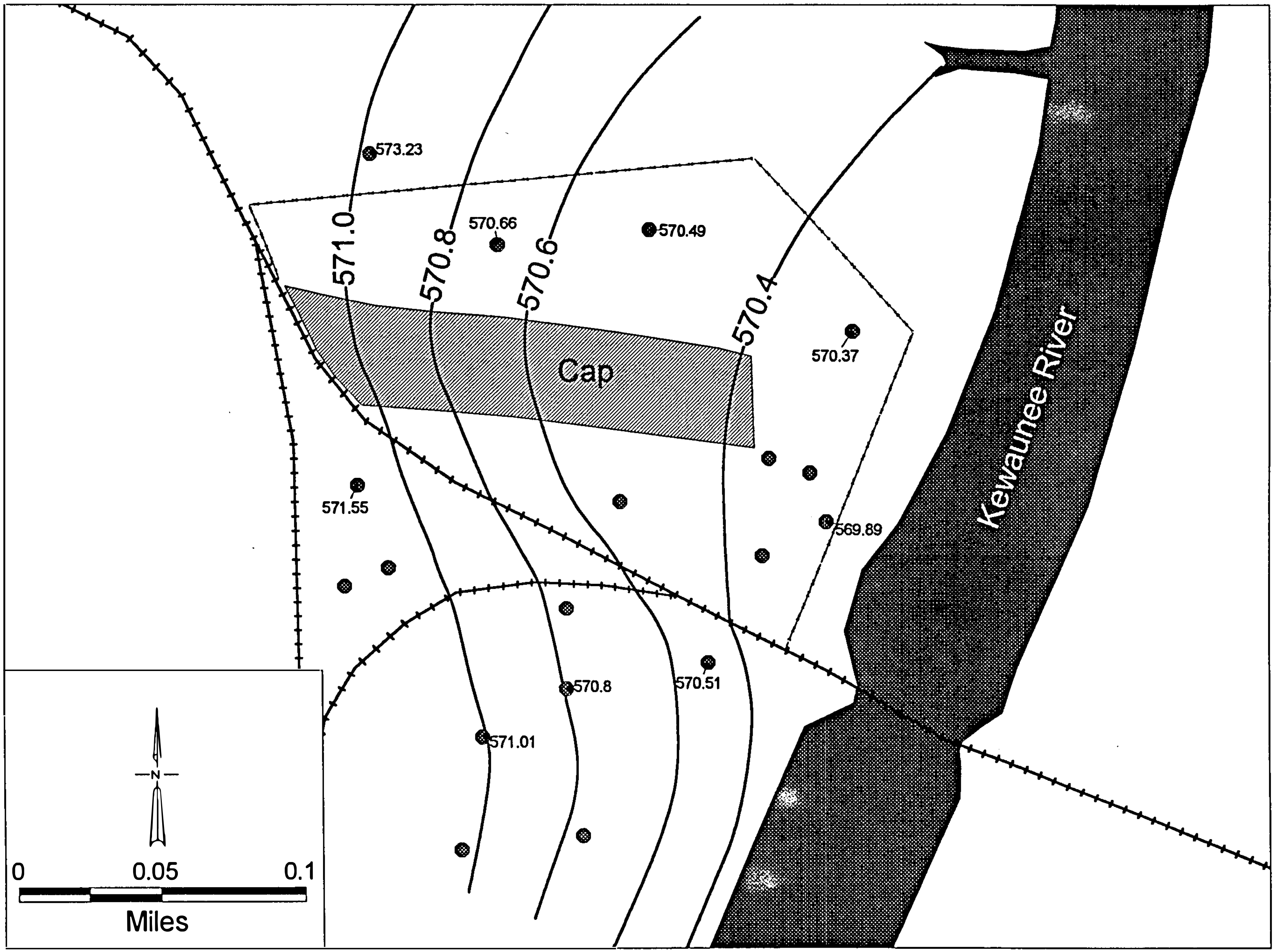


Figure 2. Potentiometric surface for the Kewaunee marsh, May 1996.

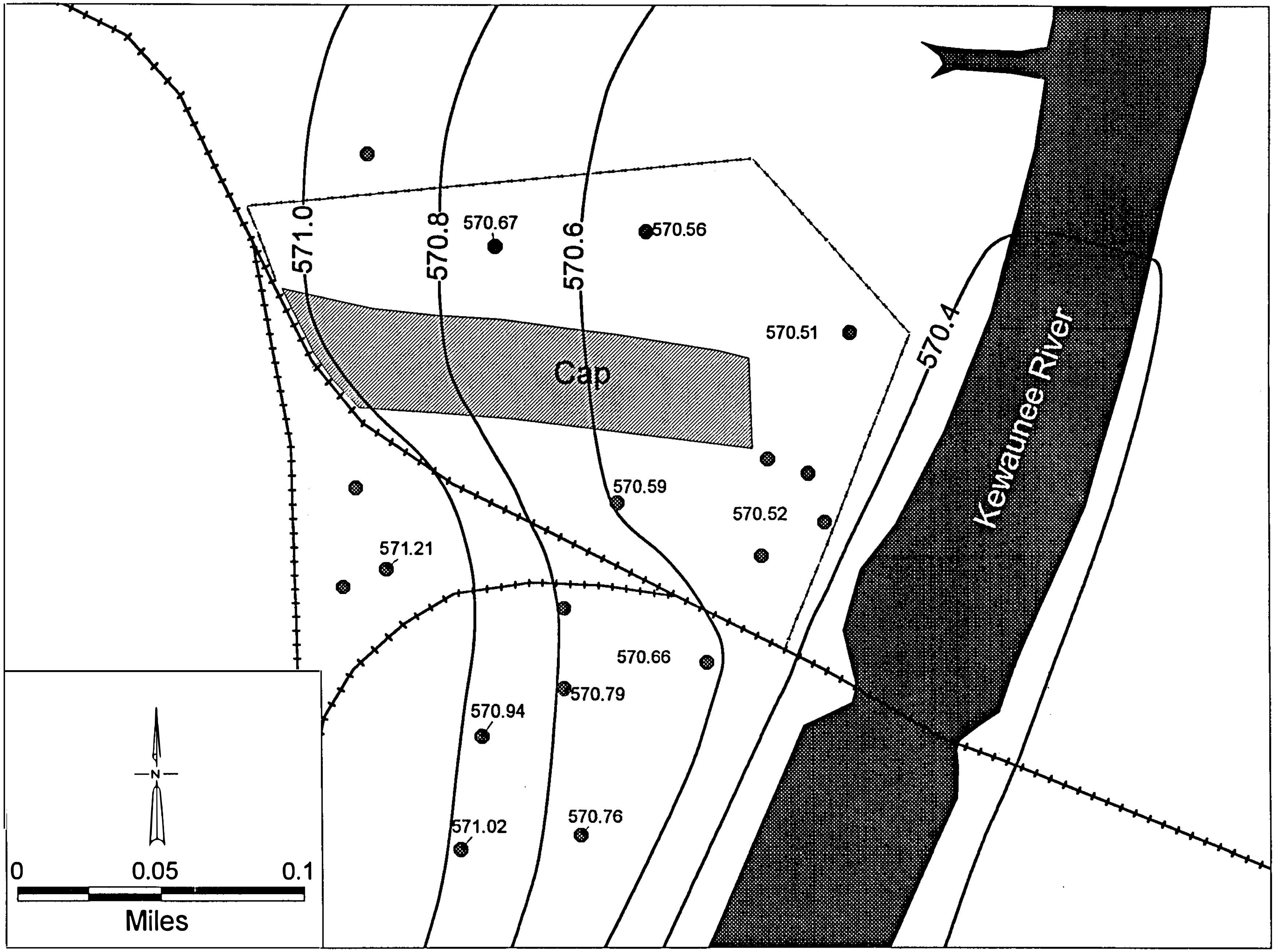


Figure 3. Potentiometric surface for the Kewaunee marsh, August 1996.

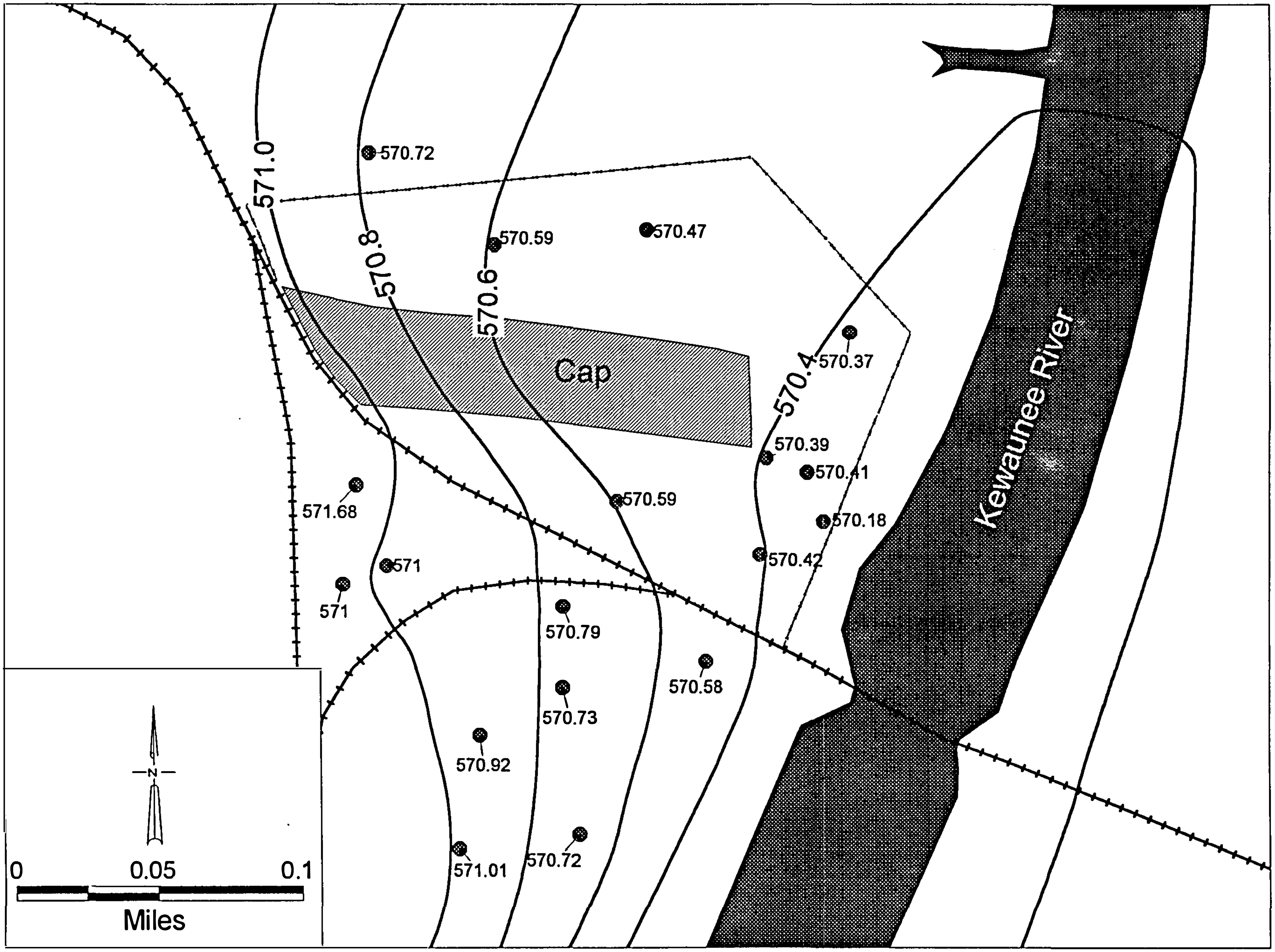
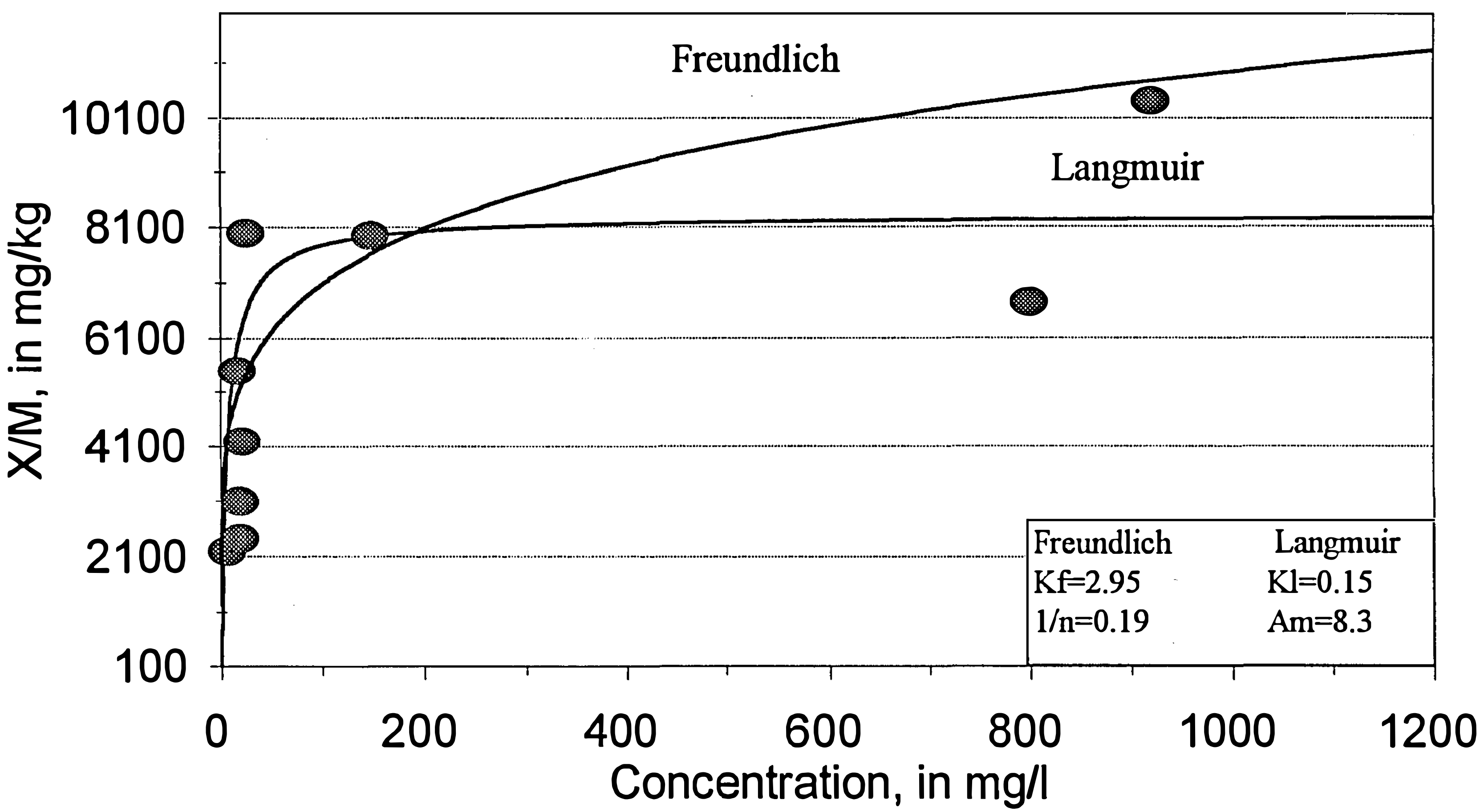


Figure 4. Potentiometric surface for the Kewaunee marsh, November 1996.

Figure 5. Measured arsenic concentration data for sediments and water, and fitted Langmuir and Freundlich isotherms.



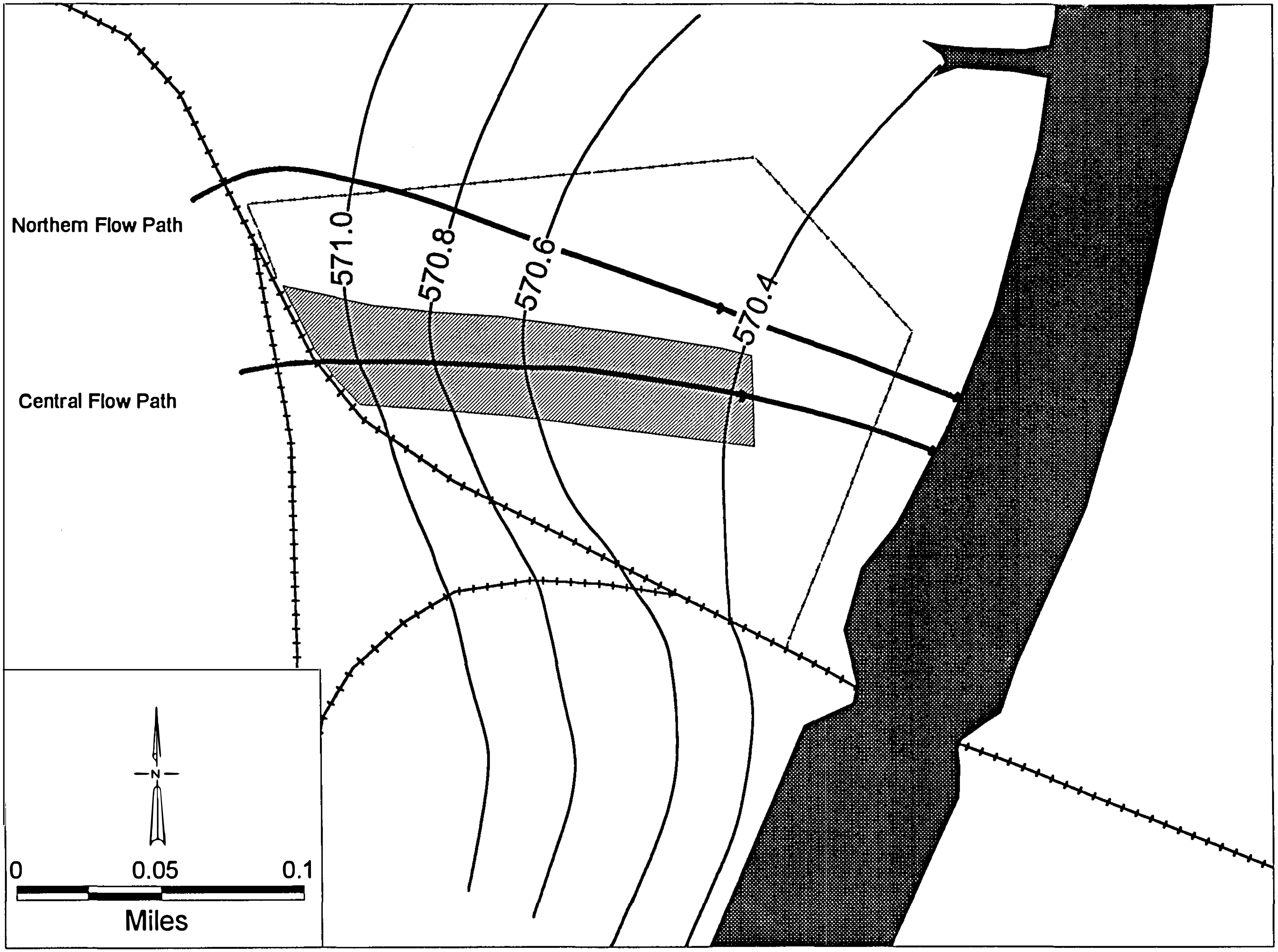


Figure 6. BIO1D flow paths for arsenic transport simulations at the Kewaunee Marsh.

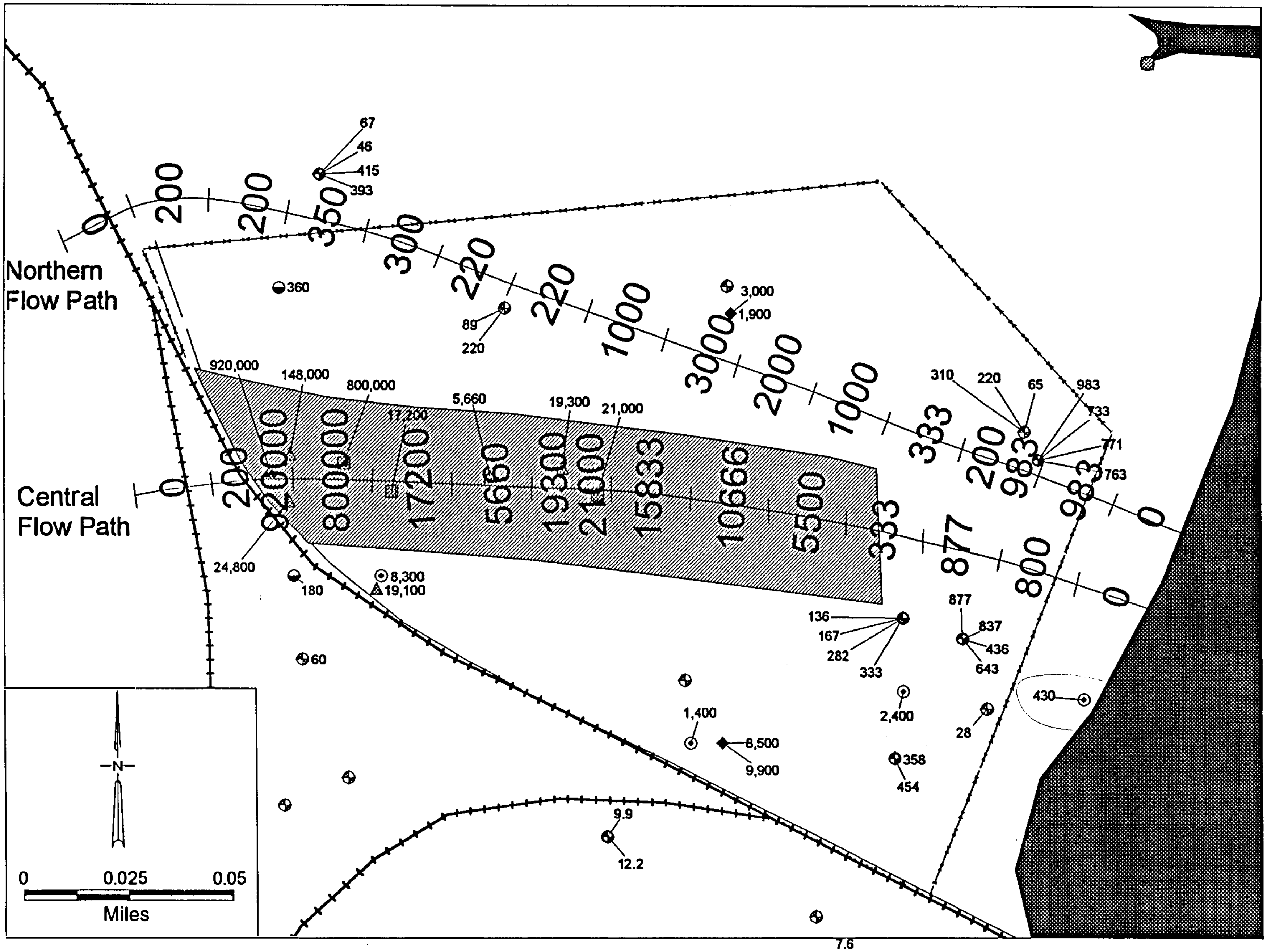


Figure 7. BIO1D initial arsenic concentrations for the Kewaunee Marsh.

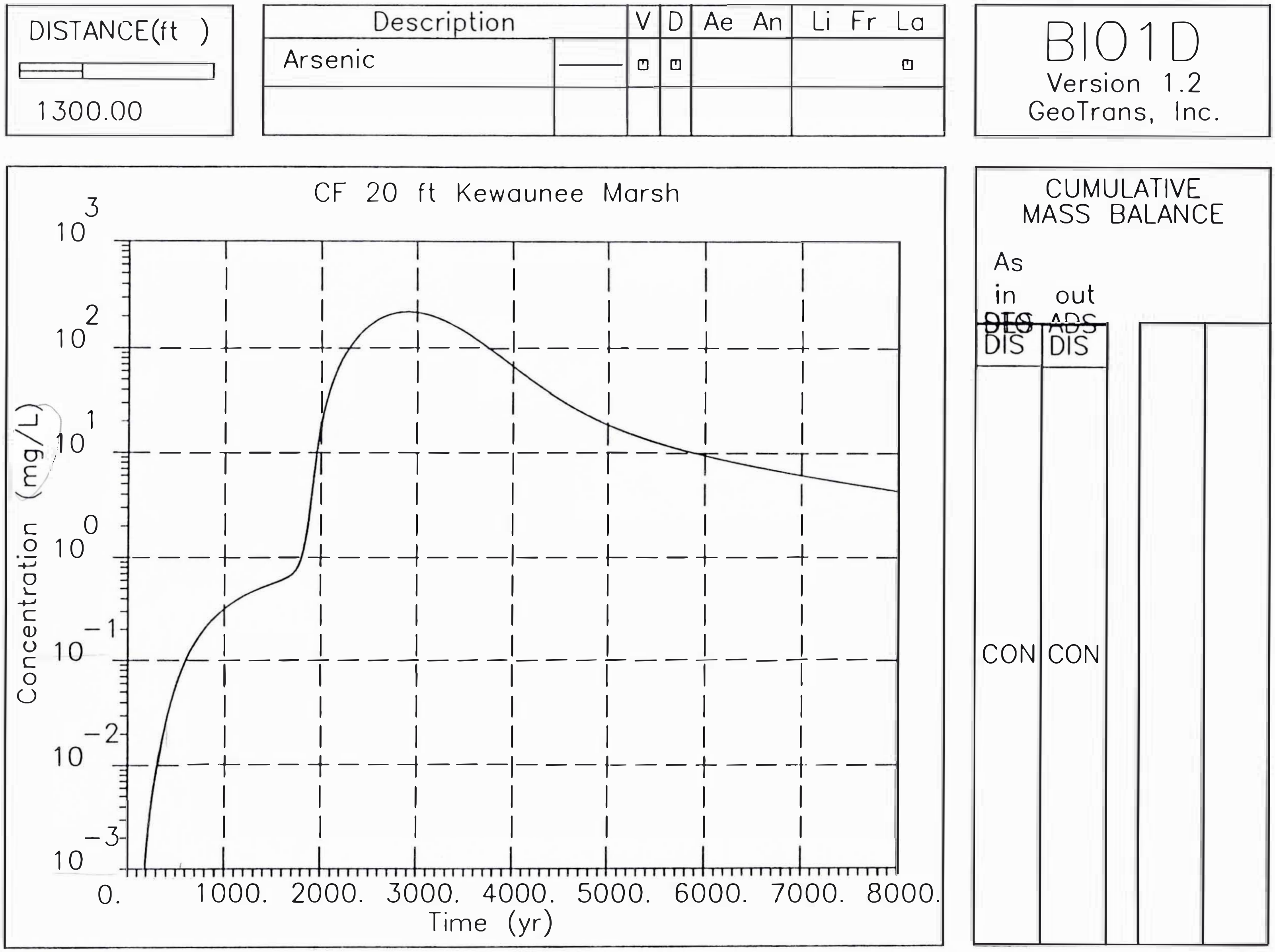


Figure 8. Groundwater arsenic concentrations discharging to river as a function of time for the Central Flow Path

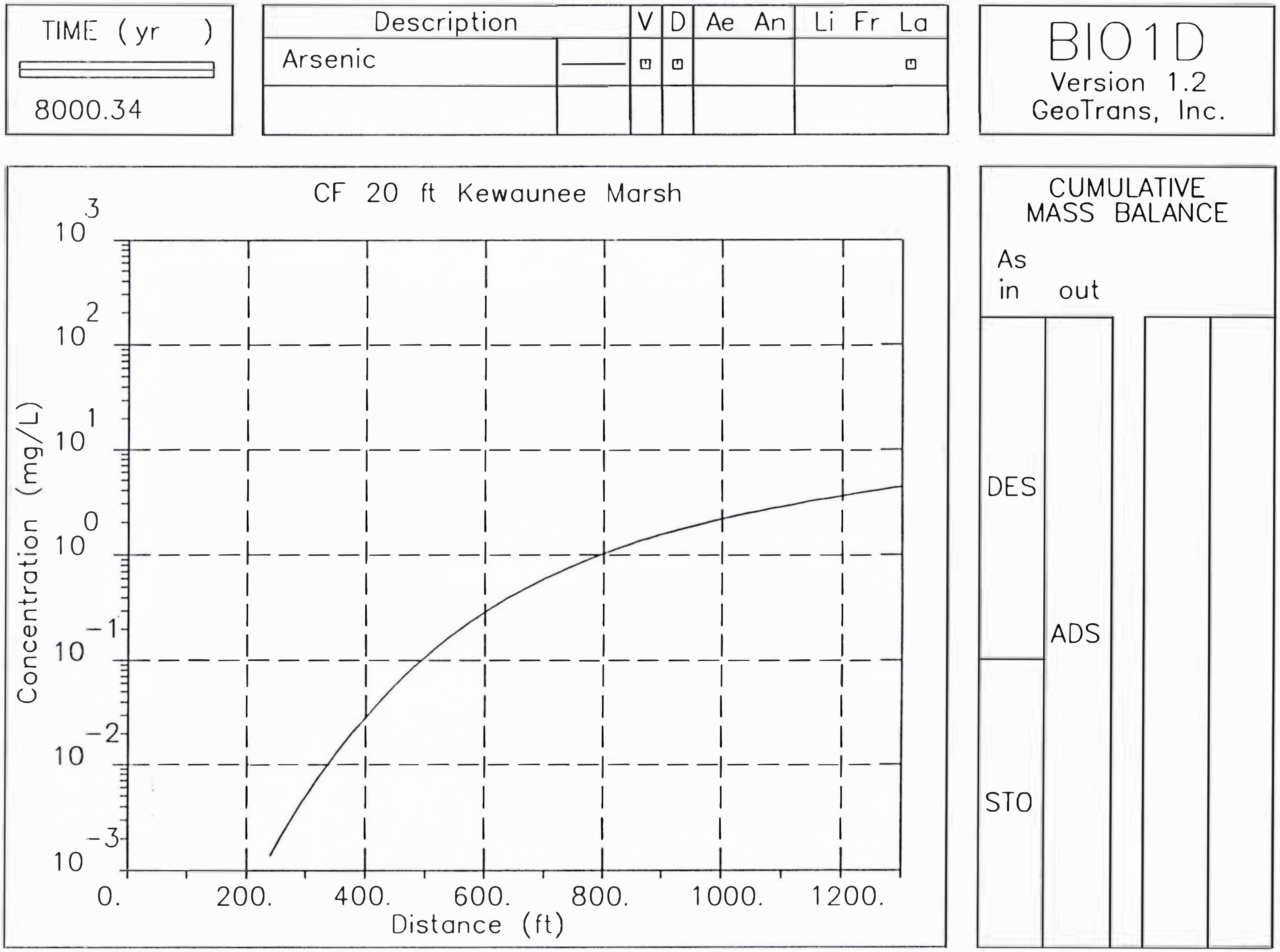


Figure 9. Groundwater arsenic concentrations as a function of distance for the Central Flow Path.

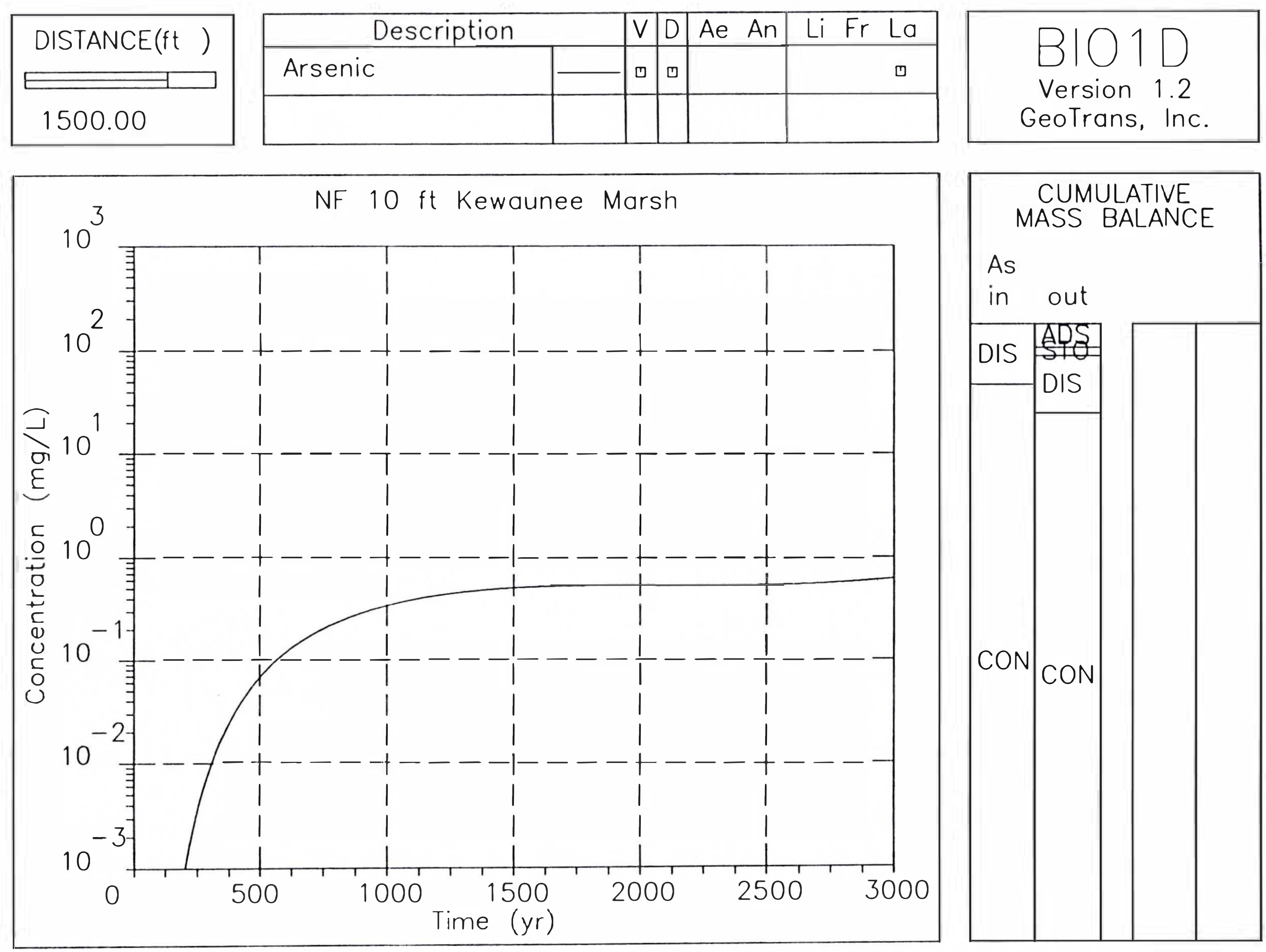


Figure 10. Groundwater arsenic concentrations discharging to the river as a function of time for the Northern Flow Path.

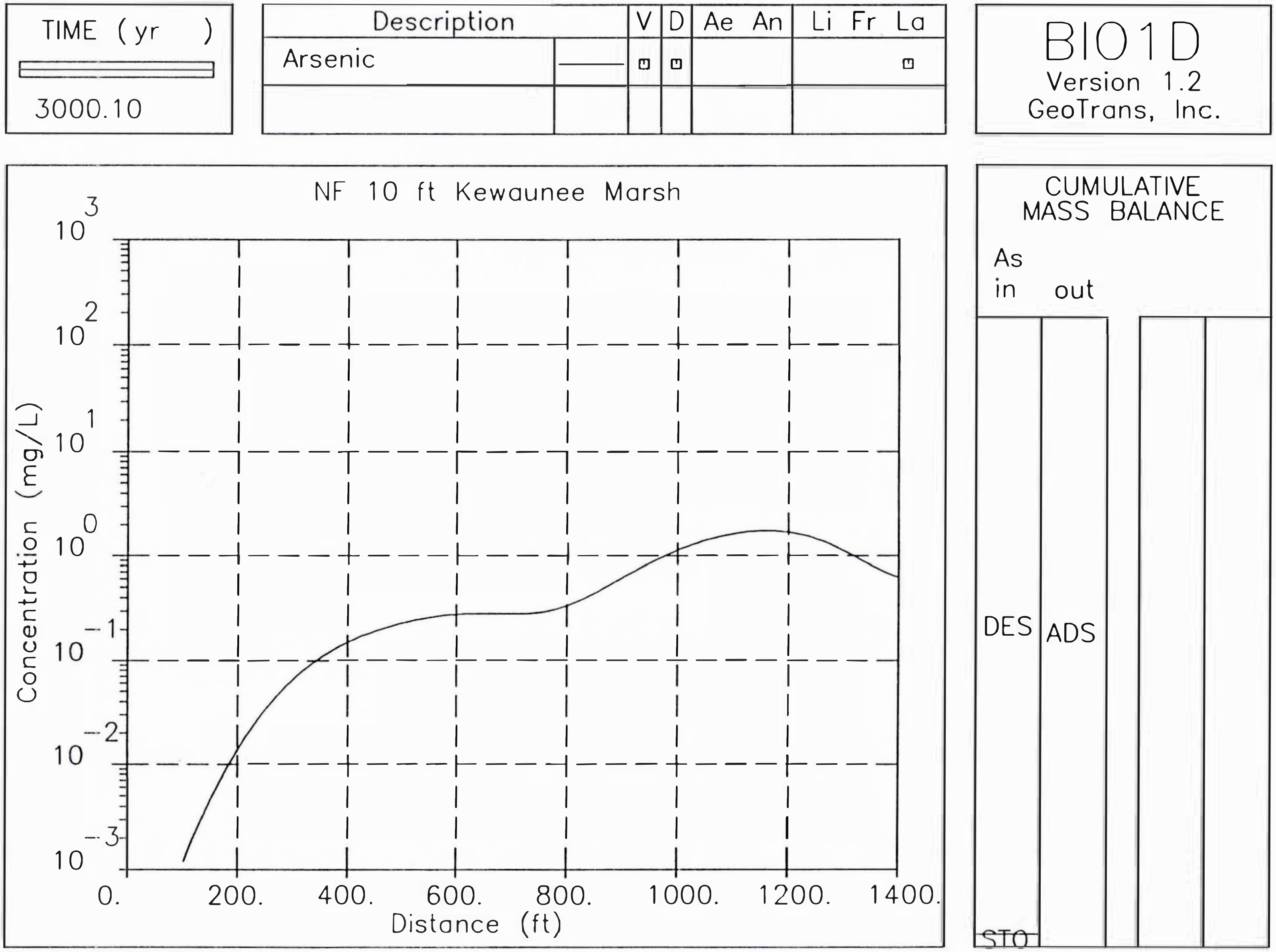


Figure 11. Groundwater arsenic concentrations as a function of distance between the marsh and river for the Northern Flow Path.

APPENDIX C

STS Report, "Surface Water Modeling Report," dated May 1997

R E P O R T

Quarles & Brady

411 East Wisconsin Avenue

Milwaukee, Wisconsin 53202-4497

Surface Water Modeling Report

(Revision #1)

Quarles & Brady

C.D. Besadny Wildlife Area

Kewaunee, Wisconsin

20716XA

May 1997

May 29, 1997

Mr. James R. Reyburn
Wisconsin Department of Natural Resources
1125 North Military Avenue
P.O. Box 10448
Green Bay, Wisconsin 54307-0448

Re: Revision No. 1 to Surface Water Modeling Report for the C.D. Besadny Wildlife Area, Kewaunee, Wisconsin -- STS Project No. 20716XA

Dear Jim,

Enclosed are the results of our revised surface water model for the above-referenced site. Modeling was revised to address comments in the Wisconsin Department of Natural Resources (WDNR) review letter dated March 20, 1997.

In the original submittal, surface modeling was performed using SCS Curve Numbers from 83 to 86. These curve numbers were thought to most accurately represent the site characteristics. As suggested in the WDNR review letter. the surface water model was revised to take into account the extremes in the assignment of hydrologic soil groups and SCS Runoff Curve Numbers. For one extreme, a curve number of 95 was used. This represents a high groundwater table at the soil surface, and saturated organic soils with little or no storage capacity. This would cause most rainfall to run off. For the other extreme, a curve number of 30 was used. This represents a groundwater table being below the surface and unsaturated organic soils with high intake capacities. This results in very little rainfall runoff.

In addition, the upstream arsenic concentration used in the surface modeling was changed from 0 micrograms per liter (µg/L) to 3 µg/L to adequately reflect sampling data. This upstream arsenic concentration was used in the water balance calculations to determine arsenic loading to the Kewaunee River.

Revisions to the surface water model indicate downstream arsenic concentrations in the Kewaunee River are not likely to exceed the Wisconsin Administrative Code NR 105 Human Cancer Criteria Standard of 50 µg/L.

STS Consultants Ltd.
Consulting Engineers

1035 Kepler Drive
Green Bay, Wisconsin 54311
414.468.1978/Fax 414.468.3312

Please call Mike Berger at 414-468-1978 if you have any questions or comments.

Sincerely,

STS CONSULTANTS LTD.

Mindy E. Reed

Mindy E. Reed
Assistant Project Engineer

Michael T. Berger, CHMM
Environmental Scientist

Mark A. Bergeon, P.G.
Associate

MER/vmv.wd

Copy to: Mr. Thomas McElligott
Quarles & Brady
411 East Wisconsin Avenue
Milwaukee, Wisconsin 53202-4497

(C416A015)

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RESULTS OF SURFACE WATER MODELING
(REVISION #1)
C.D. BESADNY WILDLIFE AREA
KEWAUNEE, WISCONSIN
STS PROJECT NO. 20716XA -- MAY 1997

1.0 INTRODUCTION

To determine potential arsenic loading into the Kewaunee River due to surface water transport, surface water modeling was conducted. In addition, results of groundwater fate and transport modeling conducted by HSI GeoTrans, Inc., were used to determine total potential arsenic loading into the Kewaunee River. Data generated by HSI GeoTrans, Inc., was presented in their report, "Fate and Transport Modeling of Arsenic at the Kewaunee Marsh," dated May 1997.

1.1 Surface Water Modeling

This section explains the methodology and results of modeling completed to estimate peak runoff flow rate from the Kewaunee marsh area to the Kewaunee River.

1.1.1 Methodology

The "HydroCAD Stormwater Modeling System" was used to analyze the Kewaunee Marsh watersheds. This model is based on the Soil Conservation Service (SCS) Technical Release 20 Methodology and generates synthetic flood hydrographs identical to the U.S. Army Corps of Engineers HEC-1 computer model. The HydroCAD model simulates watershed response to precipitation by representing the drainage basins as a system of interconnected hydrologic and hydraulic components. Typical input parameters to the program include basin area, overland flow travel time, soil permeability, soil infiltration relationships, land use characteristics, precipitation amounts, distribution, and base flow.

1.1.2 Hydrologic Parameters

For purposes of surface water modeling, the fenced area at the site was broken into three subareas. See Appendix A for stormwater runoff model site map. The following table summarizes hydrologic parameters used to model surface water runoff from the site. See Appendix A for details of the hydrologic parameters.

TABLE 1

HYDROLOGIC PARAMETERS

Subarea	Area (acres)	Trial #1 SCS Curve Number	Trial #2 SCS Curve Number	Trial #3 SCS Curve Number
1 (north)	6.50	83	95	30
2 (center)	4.57	86	95	30
3 (south)	3.10	83	95	30

Note that three different trials were run to vary the curve numbers used. Trial #1 uses the curve numbers which were thought to most accurately represent the site characteristics. Trials #2 and #3 were run to represent the extremes of the hydrologic soil groups and SCS runoff curve numbers.

Trial #2 (CN = 95) represents a high water table at the soil surface, with water standing in depressions. The organic soils in this situation would be saturated with no storage capacity. Generally, very little rainfall would infiltrate and all would run off from the site.

Trial #3 (CN = 30) represents a groundwater table being below the surface which would result in the upper strata of the organic soils being unsaturated and having a lot of storage capacity. The organic soils would have high intake capacities and subsurface permeability resulting in very little runoff.

It must also be noted that the drainage from the highlands surrounding the marsh were not taken into account when determining the hydrologic parameters. Because this would have caused a higher dilution factor, the downstream Kewaunee River arsenic concentrations computed will be more conservative.

1.1.3 Surface Model Results

The hydrologic parameters described in the previous section were used as input data to the "HydroCAD Stormwater Modeling System." Utilizing this data, the HydroCAD model computed the peak flow from each subarea. The results are shown below in Tables 2A, 2B, and 2C. See Appendix B for HydroCAD model printouts.

TABLES 2A, 2B, and 2C

PEAK FLOWS FROM MARSH SUBAREAS

TABLE 2A

CN = 95

Rainfall Event Return Period (yr)	Type II-24[1] Hour Rainfall (inches)	Subarea 1 Peak Flow (cfs)	Subarea 2 Peak Flow (cfs)	Subarea 3 Peak Flow (cfs)	Total Peak Flow (cfs)
2	2.4	6.46	4.32	3.48	14.3
5	3.2	9.03	6.04	4.86	19.9
10	3.7	10.02	7.11	5.71	22.8
25	4.2	12.21	8.17	6.57	27.0
50	4.7	13.80	9.23	7.42	30.5
100	5.0	14.70	9.87	7.93	32.5

1- A Type II, 24-hour rainfall is a national weather service designation which represents the duration-frequency of rainfall events in the Midwest.

TABLE 2B

CN = 83 to 86

Rainfall Event Return Period (yr)	Type II 24-[1] Hour Rainfall (inches)	Subarea 1 Peak Flow (cfs)	Subarea 2 Peak Flow (cfs)	Subarea 3 Peak Flow (cfs)	Total Peak Flow (cfs)
2	2.4	2.29	2.02	1.25	5.6
5	3.2	3.88	3.23	2.11	9.2
10	3.7	4.93	4.02	2.68	11.6
25	4.2	6.01	4.82	3.26	14.1
50	4.7	7.11	5.63	3.86	16.6
100	5.0	7.77	6.12	4.22	18.1

1- A Type II, 24-hour rainfall is a national weather service designation which represents the duration-frequency of rainfall events in the Midwest.

TABLE 2C

CN = 30

Rainfall Event Return Period (yr)	Type II-24[1] Hour Rainfall (inches)	Subarea 1 Peak Flow (cfs)	Subarea 2 Peak Flow (cfs)	Subarea 3 Peak Flow (cfs)	Total Peak Flow (cfs)
2	2.4	0.00	0.00	0.00	0.00
5	3.2	0.00	0.00	0.00	0.00
10	3.7	0.00	0.00	0.00	0.00
25	4.2	0.00	0.00	0.00	0.00
50	4.7	0.00	0.00	0.00	0.00
100	5.0	0.00	0.00	0.00	0.00

1- A Type II, 24-hour rainfall is a national weather service designation which represents the duration-frequency of rainfall events in the Midwest.

1.2 Arsenic Water Balance

This section explains the methodology and results of modeling completed to estimate the concentration of arsenic which will reach the Kewaunee River just downstream of the marsh.

1.2.1 Methodology

A water balance was conducted using the peak stormwater runoff from the marsh, marsh groundwater flow, recorded flow from the upstream Kewaunee River, and the arsenic concentration found to be present in each of these areas.

Upstream Kewaunee River flow data were obtained from the U. S. Geological Survey (U.S.G.S.) Water Resources Investigations, Open-File Report 91-4128 Flood-Frequency Characteristics of Wisconsin Streams (see Appendix C). Groundwater flow was determined from groundwater fate and transport modeling conducted by HSI GeoTrans, Inc.

1.2.2 Arsenic Concentration in Surface Water Flowing out of Marsh

The arsenic concentration in the surface water flowing out of the marsh was calculated using the arsenic concentration present in each subarea and the peak flow leaving each subarea.

The following table shows the arsenic concentrations found in the samples collected from the marsh.

TABLE 3

ARSENIC CONCENTRATIONS IN MARSH
SURFACE WATER SAMPLES

Subarea	Sample No.	Arsenic Concentration (µg/L)
1 (north)	SW03-01 (WDNR)	360
	SW05-01 (WDNR)	76
	SW06-01 (WDNR)	60
	SW07-01 (WDNR)	110
2 (center)	Impacted area covered with compacted wood chips, assumed arsenic concentration	0 (assumed)
3 (south)	SW08-01 (WDNR)	4.6
	H-6 (STS)	19,100
River	River Water Sample (adjacent to site)	3.5
	Upstream Arsenic Concentration	3 (assumed)

Note: µg/L - micrograms per liter

Two scenarios were used to estimate potential arsenic concentrations. In each scenario, the conservative assumption was made that all surface water runoff which comes in contact with the marsh will transport the total arsenic concentration. The two water balance scenarios included:

1. Surface water runoff concentrations equal to the **maximum** observed marsh surface water arsenic concentration within each subarea

2. Surface water runoff concentrations equal to the **average** observed marsh surface water arsenic concentrations within each subarea

Tables 4A and 4B show the arsenic concentrations in the surface water flowing out of the marsh. See Appendix D for sample calculations.

TABLE 4A

MAXIMUM ARSENIC CONCENTRATIONS FLOWING OUT OF MARSH

Rainfall Event[1] Return Period (yr)	Subarea 1 **Max.** Arsenic Conc. (ug/L)	Subarea 2 **Max.** Arsenic Conc. (ug/L)	Subarea 3 **Max.** Arsenic Conc. (ug/L)	**Max.** Arsenic Conc. In Surface Water* Flowing Out of Marsh (ug/L)		
				CN=95	CN=83 TO 86	CN=30
2	360	0	19,100	4,824.2	4,442.3	0.0
5	360	0	19.100	4,820.7	4,522.5	0.0
10	360	0	19,100	4,932.9	4,554.0	0.0
25	360	0	19,100	4,819.4	4,572.7	0.0
50	360	0	19,100	4,817.4	4,595.5	0.0
100	360	0	19.100	4,823.2	4,605.1	0.0

1- Utilizes a Type II, 24-hour rainfall, which is a national weather service designation which represents the duration-frequency of rainfall events in the Midwest.

$$\text{*Max. Arsenic Conc. In Surf. Water Flowing Out of Marsh} = \frac{(\text{Subarea 1 Max. Arsenic Conc.}) \times (\text{Subarea 1 Peak Flow}) + (\text{Subarea 2 Max. Arsenic Conc.}) \times (\text{Subarea 2 Peak Flow}) + (\text{Subarea 3 Max. Arsenic Conc.}) \times (\text{Subarea 3 Peak Flow})}{\text{Total Peak Flow Out of Marsh}}$$

TABLE 4B

AVERAGE ARSENIC CONCENTRATIONS FLOWING OUT OF MARSH

Rainfall Event[1] Return Period (yr)	Subarea 1 Ave. Arsenic Conc. (ug/L)	Subarea 2 Ave. Arsenic Conc. (ug/L)	Subarea 3 Ave. Arsenic Conc. (ug/L)	Ave. Arsenic Conc. In Surface Water* Flowing Out of Marsh (ug/L)		
				CN=95	CN=83 TO 86	CN=30
2	152	0	9,553	2,400.2	2,210.3	0.0
5	152	0	9,553	2,398.4	2,250.2	0.0
10	152	0	9,553	2,454.9	2,265.8	0.0
25	152	0	9,553	2,397.7	2,275.1	0.0
50	152	0	9,553	2,396.7	2,286.5	0.0
100	152	0	9,553	2,399.7	2,291.3	0.0

1- Utilizes a Type II, 24-hour rainfall, which is a national weather service designation which represents the duration-frequency of rainfall events in the Midwest.

$$\text{*Ave. Arsenic Conc. In Surf. Water Flowing Out of Marsh} = \frac{(\text{Subarea 1 Ave. Arsenic Conc.}) \times (\text{Subarea 1 Peak Flow}) + (\text{Subarea 2 Ave. Arsenic Conc.}) \times (\text{Subarea 2 Peak Flow}) + (\text{Subarea 3 Ave. Arsenic Conc.}) \times (\text{Subarea 3 Peak Flow})}{\text{Total Peak Flow Out of Marsh}}$$

It should be noted that both the average and maximum arsenic concentrations used for each subarea are conservative. This is due to the fact that solubility, adsorption, and dilution were not accounted for. We assumed that the maximum or average arsenic concentrations found in the marsh samples were representative of the entire subarea where each sample was taken from.

1.2.3 Downstream Kewaunee River Flow

The downstream Kewaunee River flow was calculated as a sum of the upstream Kewaunee River flow, the marsh surface water peak flow, and the marsh groundwater flow.

Table 5 shows the calculated downstream Kewaunee River flows. Sample calculations can be found in Appendix D.

The upstream Kewaunee River flow data were obtained from the U.S.G.S. Water Resource Investigations, Open File Report 91-4128 Flood Frequency Characteristics of Wisconsin Streams. A copy can be found in Appendix C.

Groundwater flow was calculated using data from the groundwater fate and transport modeling conducted by HSI GeoTrans, Inc. Marsh groundwater flow calculations can be found in Appendix D.

TABLE 5

KEWAUNEE RIVER DOWNSTREAM FLOWS

Rainfall Event[1] Return Period (yr)	Kewaunee River Upstream Flow (cfs)	Marsh Surface Water Peak Flow (cfs)			Marsh Groundwater Flow (cfs)	* Downstream Kewaunee River Flow (cfs)		
		CN=95	CN=83 to 86	CN=30		CN=95	CN=83 TO 86	CN=30
2	2,700	14.3	5.6	0.0	0.00023	2,714.3	2,705.6	2,700
5	4,370	19.9	9.2	0.0	0.00023	4,389.9	4,379.2	4,370
10	5,490	22.8	11.6	0.0	0.00023	5,512.8	5,501.6	5,490
25	6,880	27.0	14.1	0.0	0.00023	6,907.0	6,894.1	6,880
50	7,870	30.5	16.6	0.0	0.00023	7,920.5	7,906.6	7,870
100	8,810	32.5	18.1	0.0	0.00023	8,902.5	8,888.1	8,810

1- Utilizes a Type II, 24-hour rainfall, which is a national weather service designation which represents the duration-frequency of rainfall events in the Midwest.

* Downstream Kewaunee River Flow = (Upstream Kewaunee River Flow) + (Marsh Surface Water Peak Flow) + (Marsh Groundwater Flow)

1.2.4 Downstream Kewaunee River Arsenic Concentrations

The last step in the arsenic water balancing was to calculate the downstream Kewaunee River Arsenic Concentrations, using the results described in the previous sections.

The following tables summarize the results. The marsh groundwater arsenic concentration was obtained from the groundwater modeling conducted by HSI GeoTrans, Inc. See Appendix D for all other sample calculations.

TABLES 6A, 6B and 6C

CONCENTRATIONS OF ARSENIC DOWNSTREAM IN THE KEWAUNEE RIVER
(USING **MAX**. ARSENIC CONC. FROM EACH SUBAREA)

TABLE 6A
CN = 95

Rainfall Event Return Period (year)	Type II[1] 24-Hour Rainfall (inches)	Upstream Kewaunee River Flow (cfs)	Upstream Kewaunee River As Conc. (μg/l)	Marsh Surface Water Flow (cfs)	Marsh Surface Water As Conc. (μg/l)	Marsh Groundwater Flow (cfs)	Marsh Groundwater As Conc. (μg/l)	Downstream Kewaunee River Flow (cfs)	Downstream Kewaunee River As Conc*. (μg/l)
2	2.4	2,700	3	14.3	4,824.2	0.00023	200,000.0	2,714.3	28.3
5	3.2	4,370	3	19.9	4,820.7	0.00023	200,000.0	4,389.9	24.9
10	3.7	5,490	3	22.8	4,932.9	0.00023	200,000.0	5,512.8	23.4
25	4.2	6,880	3	27.0	4,819.4	0.00023	200,000.0	6,907.0	21.8
50	4.7	7,870	3	30.5	4,817.4	0.00023	200,000.0	7,920.5	21.5
100	5.0	8,870	3	32.5	4,823.2	0.00023	200,000.0	8,902.5	20.6

*Downstream Kewaunee River Arsenic Conc.. = [(Upstream Kewaunee River Flow) x (Upstream Kewaunee River Arsenic Conc.) + (Marsh Surface Water Flow) x (Marsh Surface Water Arsenic Conc.) + (Marsh Groundwater Flow) x (Marsh Groundwater Arsenic Conc.)] / Downstream Kewaunee River Flow

1- A Type II, 24-hour rainfall is a national weather service designation which represents the duration-frequency of rainfall events in the Midwest.

TABLE 6B
CN = 83 TO 86

Rainfall Event Return Period (year)	Type II[1] 24-Hour Rainfall (inches)	Upstream Kewaunee River Flow (cfs)	Upstream Kewaunee River As Conc. (µg/l)	Marsh Surface Water Flow (cfs)	Marsh Surface Water As Conc. (µg/l)	Marsh Groundwater Flow (cfs)	Marsh Groundwater As Conc. (µg/l)	Downstream Kewaunee River Flow (cfs)	Downstream Kewaunee River As Conc.* (µg/l)
2	2.4	2,700	3	5.6	4,442.3	0.00023	200,000.0	2,705.6	12.1
5	3.2	4,370	3	9.2	4,522.5	0.00023	200,000.0	4,379.2	12.5
10	3.7	5,490	3	11.6	4,554.0	0.00023	200,000.0	5,501.6	12.6
25	4.2	6,880	3	14.1	4,572.7	0.00023	200,000.0	6,894.1	12.3
50	4.7	7,870	3	16.6	4,595.5	0.00023	200,000.0	7,906.6	12.6
100	5.0	8,870	3	18.1	4,605.1	0.00023	200,000.0	8,888.1	12.4

*Downstream Kewaunee River Arsenic Conc. = [(Upstream Kewaunee River Flow) x (Upstream Kewaunee River Arsenic Conc.) + (Marsh Surface Water Flow) x (Marsh Surface Water Arsenic Conc.) + (Marsh Groundwater Flow) x (Marsh Groundwater Arsenic Conc.)] / Downstream Kewaunee River Flow

TABLE 6C
CN = 30

Rainfall Event Return Period (year)	Type II[1] 24-Hour Rainfall (inches)	Upstream Kewaunee River Flow (cfs)	Upstream Kewaunee River As Conc. (µg/l)	Marsh Surface Water Flow (cfs)	Marsh Surface Water As Conc. (µg/l)	Marsh Groundwater Flow (cfs)	Marsh Groundwater As Conc. (µg/l)	Downstream Kewaunee River Flow (cfs)	Downstream Kewaunee River As Conc.* (µg/l)
2	2.4	2,700	3	0.0	0.0	0.00023	200,000.0	2,700	3.0
5	3.2	4,370	3	0.0	0.0	0.00023	200,000.0	4,370	3.0
10	3.7	5,490	3	0.0	0.0	0.00023	200,000.0	5,490	3.0
25	4.2	6,880	3	0.0	0.0	0.00023	200,000.0	6,880	3.0
50	4.7	7,870	3	0.0	0.0	0.00023	200,000.0	7,870	3.0
100	5.0	8,870	3	0.0	0.0	0.00023	200,000.0	8,870	3.0

*Downstream Kewaunee River Arsenic Conc. = [(Upstream Kewaunee River Flow) x (Upstream Kewaunee River Arsenic Conc.) + (Marsh Surface Water Flow) x (Marsh Surface Water Arsenic Conc.) + (Marsh Groundwater Flow) x (Marsh Groundwater Arsenic Conc.)] / Downstream Kewaunee River Flow

1- A Type II, 24-hour rainfall is a national weather service designation which represents the duration-frequency of rainfall events in the Midwest.

TABLES 7A, 7B, and 7C
CONCENTRATIONS OF ARSENIC DOWNSTREAM IN THE KEWAUNEE RIVER
(USING **AVE.** ARSENIC CONC. FROM EACH SUBAREA)

TABLE 7A
CN = 95

Rainfall Event Return Period (year)	Type II[1] 24-Hour Rainfall (inches)	Upstream Kewaunee River		Marsh Surface Water		Marsh Groundwater		Downstream Kewaunee River	
		Flow (cfs)	As Conc. (μg/l)	Flow (cfs)	As Conc. (μg/l)	Flow (cfs)	As Conc. (μg/l)	Flow (cfs)	As Conc.* (μg/l)
2	2.4	2,700	3	14.3	2,400.2	0.00023	200,000.0	2,714.3	15.6
5	3.2	4,370	3	19.9	2,398.4	0.00023	200,000.0	4,389.9	13.9
10	3.7	5,490	3	22.8	2,454.9	0.00023	200,000.0	5,512.8	13.2
25	4.2	6,880	3	27.0	2,397.7	0.00023	200,000.0	6,907.0	12.3
50	4.7	7,870	3	30.5	2,396.7	0.00023	200,000.0	7,920.5	12.2
100	5.0	8,870	3	32.5	2,399.7	0.00023	200,000.0	8,902.5	11.7

*Downstream Kewaunee River Arsenic Conc. = [(Upstream Kewaunee River Flow) x (Upstream Kewaunee River Arsenic Conc.) + (Marsh Surface Water Flow) x (Marsh Surface Water Arsenic Conc.) + (Marsh Groundwater Flow) x (Marsh Groundwater Arsenic Conc.)] / Downstream Kewaunee River Flow

1- A Type II, 24-hour rainfall is a national weather service designation which represents the duration-frequency of rainfall events in the Midwest.

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TABLE 7B
CN = 83 TO 86

Rainfall Event Return Period (year)	Type II[1] 24-Hour Rainfall (inches)	Upstream Kewaunee River Flow (cfs)	Upstream Kewaunee River As Conc. (µg/l)	Marsh Surface Water Flow (cfs)	Marsh Surface Water As Conc. (µg/l)	Marsh Groundwater Flow (cfs)	Marsh Groundwater As Conc. (µg/l)	Downstream Kewaunee River Flow (cfs)	Downstream Kewaunee River As Conc.* (µg/l)
2	2.4	2,700	3	5.6	2,210.3	0.00023	200,000.0	2,705.6	7.5
5	3.2	4,370	3	9.2	2,250.2	0.00023	200,000.0	4,379.2	7.7
10	3.7	5,490	3	11.6	2,265.8	0.00023	200,000.0	5,501.6	7.8
25	4.2	6,880	3	14.1	2,275.1	0.00023	200,000.0	6,894.1	7.6
50	4.7	7,870	3	16.6	2,286.5	0.00023	200,000.0	7,906.6	7.8
100	5.0	8,870	3	18.1	2,291.3	0.00023	200,000.0	8,888.1	7.7

*Downstream Kewaunee River Arsenic Conc. = [(Upstream Kewaunee River Flow) x (Upstream Kewaunee River Arsenic Conc.) + (Marsh Surface Water Flow) x (Marsh Surface Water Arsenic Conc.) + (Marsh Groundwater Flow) x (Marsh Groundwater Arsenic Conc.)] / Downstream Kewaunee River Flow

1- A Type II, 24-hour rainfall is a national weather service designation which represents the duration-frequency of rainfall events in the Midwest.

TABLE 7C
CN = 30

Rainfall Event Return Period (year)	Type II[1] 24-Hour Rainfall (inches)	Upstream Kewaunee River Flow (cfs)	Upstream Kewaunee River As Conc. (µg/l)	Marsh Surface Water Flow (cfs)	Marsh Surface Water As Conc. (µg/l)	Marsh Groundwater Flow (cfs)	Marsh Groundwater As Conc. (µg/l)	Downstream Kewaunee River Flow (cfs)	Downstream Kewaunee River As Conc*. (µg/l)
2	2.4	2,700	3	0.0	0.0	0.00023	200,000.0	2,700.0	3.0
5	3.2	4,370	3	0.0	0.0	0.00023	200,000.0	4,370.0	3.0
10	3.7	5,490	3	0.0	0.0	0.00023	200,000.0	5,490.0	3.0
25	4.2	6,880	3	0.0	0.0	0.00023	200,000.0	6,880.0	3.0
50	4.7	7,870	3	0.0	0.0	0.00023	200,000.0	7,890.0	3.0
100	5.0	8,870	3	0.0	0.0	0.00023	200,000.0	8,870.0	3.0

$$\text{*Downstream Kewaunee River Arsenic Conc.} = \frac{(\text{Upstream Kewaunee River Flow}) \times (\text{Upstream Kewaunee River Arsenic Conc.}) + (\text{Marsh Surface Water Flow}) \times (\text{Marsh Surface Water Arsenic Conc.}) + (\text{Marsh Groundwater Flow}) \times (\text{Marsh Groundwater Arsenic Conc.})}{\text{Downstream Kewaunee River Flow}}$$

1- A Type II, 24-hour rainfall is a national weather service designation which represents the duration-frequency of rainfall events in the Midwest.

It should be noted that the marsh groundwater arsenic concentrations used are conservative. This is due to the following reasons:

1. We used the maximum arsenic concentration from the groundwater modeling done by HSI GeoTrans, Inc.
2. The groundwater model forces the arsenic plume to move towards the river. It is possible that the plume may be stable, and the projected arsenic concentrations may not reach the river.

2.0 CONCLUSIONS

Based on **average** marsh arsenic concentrations from each marsh subarea and a runoff rate using a curve number of 95, the potential maximum downstream arsenic concentration in the Kewaunee River was calculated to be **15.6 µg/L.**

Based on **maximum** marsh arsenic concentrations from each marsh subarea and runoff rate using a curve number of 95, the potential maximum downstream arsenic concentration in the Kewaunee River was calculated to be **28.3 µg/L**.

In addition, both the average and maximum arsenic concentrations mentioned above are very conservative due to the following model characteristics:

1. Does not account for solubility, adsorption, or dilution. It assumes that the maximum (or average) arsenic concentrations found in the marsh samples were representative of the entire subarea where each sample was taken from.

2. Does not account for the drainage from the surrounding highlands into the marsh. If this additional drainage was accounted for, there would be a higher dilution factor.

3. Assumes the maximum arsenic concentration from the groundwater model done by HSI GeoTrans, Inc.

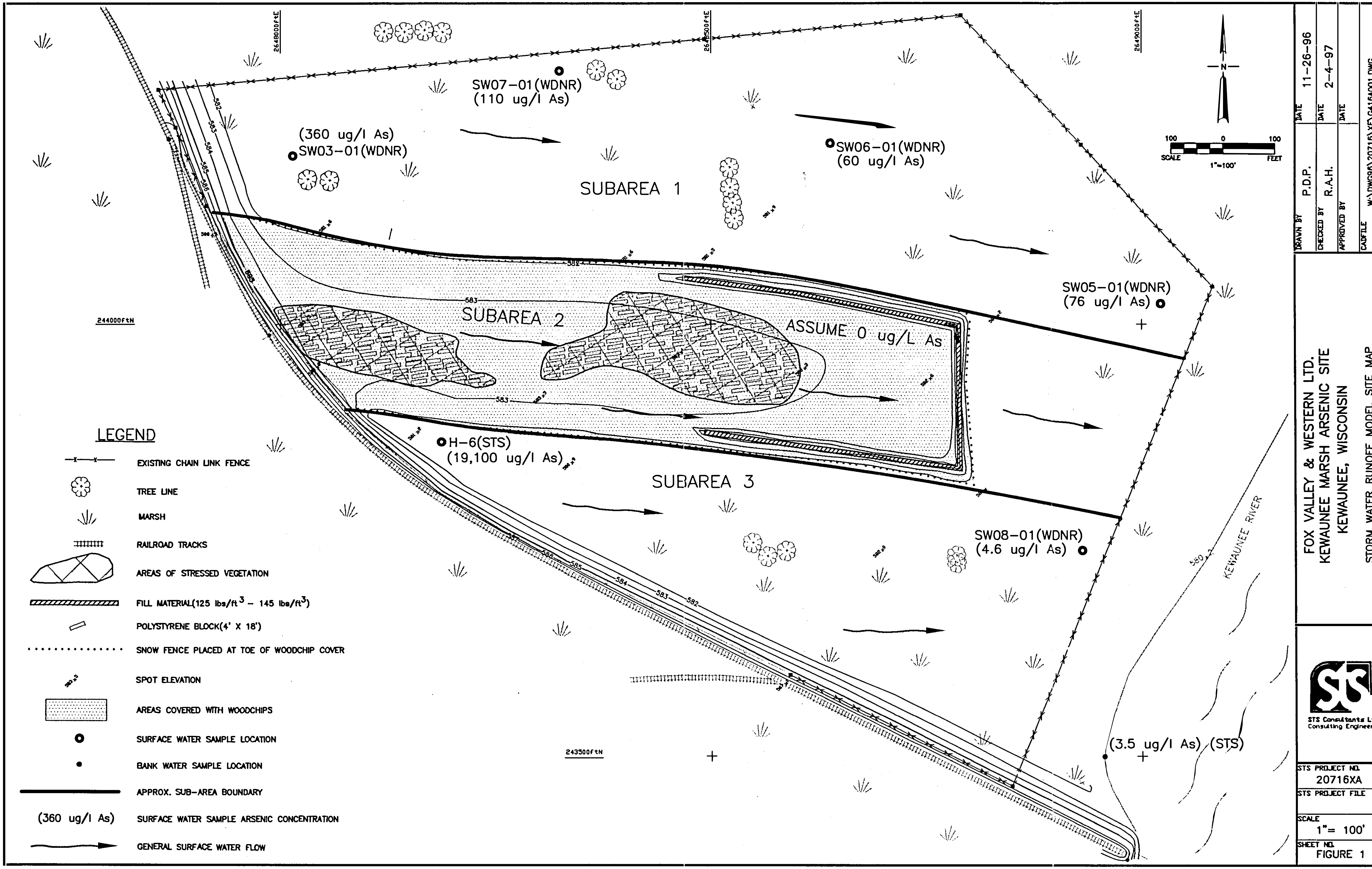
4. The groundwater model forces the arsenic plume to move towards the river. However, it is possible that the plume may be stable, and the projected arsenic concentration may not reach the river.

The Wisconsin Administrative Code NR 105 Human Cancer Criteria Standard for arsenic is 50 μg/L. Therefore, results of surface water and groundwater modeling indicate that arsenic transported to the Kewaunee River should not exceed surface water standards.

APPENDIX A

Stormwater Runoff Model Site Map

Calculation of Hydrologic Parameters



SW07-01(WDNR)
(110 ug/l As)
(360 ug/l As)
SW03-01(WDNR)
SW06-01(WDNR)
(60 ug/l As)
SUBAREA 1
SUBAREA 2
ASSUME 0 ug/L As
SW05-01(WDNR)
(76 ug/l As)
H-6(STS)
(19,100 ug/l As)
SUBAREA 3
SW08-01(WDNR)
(4.6 ug/l As)
(3.5 ug/l As) (STS)
KEWAUNEE RIVER
244000ftN
243500ftN
2648000ftE
2648500ftE
2649000ftE
N
SCALE 1"=100' FEET
LEGEND
EXISTING CHAIN LINK FENCE
TREE LINE
MARSH
RAILROAD TRACKS
AREAS OF STRESSED VEGETATION
FILL MATERIAL(125 lbs/ft3 - 145 lbs/ft3)
POLYSTYRENE BLOCK(4' X 18')
SNOW FENCE PLACED AT TOE OF WOODCHIP COVER
SPOT ELEVATION
AREAS COVERED WITH WOODCHIPS
SURFACE WATER SAMPLE LOCATION
BANK WATER SAMPLE LOCATION
APPROX. SUB-AREA BOUNDARY
(360 ug/l As) SURFACE WATER SAMPLE ARSENIC CONCENTRATION
GENERAL SURFACE WATER FLOW
DRAWN BY P.D.P. DATE 11-26-96
CHECKED BY R.A.H. DATE 2-4-97
APPROVED BY DATE
CADFILE W:\DWG96\20716\XF\G416A001.DWG
FOX VALLEY & WESTERN LTD.
KEWAUNEE MARSH ARSENIC SITE
KEWAUNEE, WISCONSIN
STORM WATER RUNOFF MODEL SITE MAP
STS Consultants Ltd. Consulting Engineers
STS PROJECT NO. 20716XA
STS PROJECT FILE
SCALE 1"= 100'
SHEET NO. FIGURE 1

CALCULATION COVER SHEET

PROJECT Kewaunee River Arsenic Transport JOB NO. 20716XA DIVISION

SUBJECT HYDROLOGIC PARAMETERS FILE NO.

CALC. NO.

ORIGINATOR MER DATE 5/20/97

CHECKER TAP DATE 5/21/97 NO. OF SHEETS 1

RECORD OF ISSUES								
NO.	DESCRIPTION	BY	DATE	CHKD.	DATE	APPRD.		
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△								

PRELIMINARY CALC. ☐

SUPERSEDED CALC. ☒ FINAL CALC. ☐

BRIEF SUMMARY OF CALCULATIONS INCLUDING SCOPE AND RESULTS

SUMMARY OF HOW HYDROLOGIC PARAMETERS WERE DETERMINED

RRS 8251

STS Consultants Ltd.
CALCULATION SHEET

PROJECT	STS JOB NO.
KEWAUNEE RIVER ARSENIC TRANSPORT	20716XA
SUBJECT	CALC. NO.
HYDROLOGIC PARAMETERS	

DATE	BY	CHECKED BY	REV. NO.
5/20/97	MER		1

SUBAREA	AREA	SCS CURVE NO. TRIAL #1	TRIAL #2	TRIAL #3	Length	Slope
1 (NORTH)	6.50 AC	83 ①	95 ③	30 ④	1,000'	0.001 ft/ft
2 (CENTRAL)	4.57 AC	86 ②	95 ③	30 ④	L_1 = 780', L_2 = 225'	S_1 = 0.001 ft/ft, S_2 = 0.001 ft/ft
3 (SOUTH)	3.10 AC	83 ①	95 ③	30 ④	860'	0.001 ft/ft

① Brush/grass mixture - poor curve number = 83

② 79% of area compacted woodchips (CN = 87)
21% of area brush/grass mixture (CN = 83)

③ To model extreme hydrologic condition of high water table. Soils saturated with no storage capacity.

④ To model extreme hydrologic condition of low water table. Soils unsaturated, with high infiltration capability.

(Note: conditions ③ & ④ requested by WDNR)

PRECIP. Values from SCS TR-55

RETURN Period (YR.)	Type II 24-hour Rainfall (inches)
2	2.4
5	3.2
10	3.7
25	4.2
50	4.7
100	5.0

APPENDIX B

HydroCAD Runoff Model Printouts

CN = 95

CN = 95

2 YR. STORM

WATERSHED ROUTING ===

SUBCATCHMENT 1	= North Area (marsh)	->	POND 1
SUBCATCHMENT 2	= Central Area and Cap	->	POND 1
SUBCATCHMENT 3	= South Area	->	POND 1
POND 1	= Kewaunee River	->	

RUNOFF BY SCS TR-20 METHOD: TYPE II 24-HOUR RAINFALL= 2.4 IN, SCS U.H.

RUNOFF SPAN = 10-20 HRS, dt= .10 HRS, 101 POINTS

SUBCAT NUMBER	AREA (ACRE)	Tc (MIN)	--GROUND COVERS (%CN)--				WGT'D CN	C	PEAK (CFS)	Tpeak (HRS)	VOL (AF)
1	6.50	58.9	100%95	-	-	-	95	-	6.46	12.54	.89
2	4.57	63.1	79%95	21%95	-	-	95	-	4.32	12.59	.63
3	3.10	49.8	100%95	-	-	-	95	-	3.48	12.43	.42

REACH ROUTING BY STOR-IND+TRANS METHOD

REACH NO.	DIAM (IN)	BOTTOM WIDTH (FT)	DEPTH (FT)	SIDE SLOPES (FT/FT)	n	LENGTH (FT)	SLOPE (FT/FT)	PEAK VEL. (FPS)	TRAVEL TIME (MIN)	PEAK Qout (CFS)

POND ROUTING BY STOR-IND METHOD

POND NO.	START ELEV. (FT)	FLOOD ELEV. (FT)	PEAK ELEV. (FT)	PEAK STORAGE (AF)	------ PEAK FLOW ------- Qin (CFS)	Qout (CFS)	Qpri (CFS)	Qsec (CFS)	---Qout--- ATTEN. (%)	LAG (MIN)
1	100.0	110.0	100.0	1.94	14.05	.01			100	448.5

LINK NO.	NAME	SOURCE	Qout (CFS)

SUBCATCHMENT 1 **North Area (marsh)**

PEAK= 6.46 CFS @ 12.54 HRS, VOLUME= .89 AF

ACRES	CN	
6.50	95	Marsh

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 2.4 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=1060' s=.001 '/'	**Flow thru marsh**	58.9

SUBCATCHMENT 2 **Central Area and Cap**

PEAK= 4.32 CFS @ 12.59 HRS, VOLUME= .63 AF

ACRES	CN	
3.60	95	Wood Chip Cap
.97	95	Marsh
4.57	95	

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 2.4 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=780' s=.001 '/'	**Wood chips**	46.1
CURVE NUMBER (LAG) METHOD L=225' s=.001 '/'	**Marsh**	17.0
	Total Length= 1005 ft Total Tc=	63.1

SUBCATCHMENT 3 **South Area**

PEAK= 3.48 CFS @ 12.43 HRS, VOLUME= .42 AF

ACRES	CN	
3.10	95	Marsh

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 2.4 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=860' s=.001 '/'	**Marsh**	49.8

POND 1 **Kewaunee River**

Qin = 14.05 CFS @ 12.52 HRS, VOLUME= 1.94 AF
Qout= .01 CFS @ 20.00 HRS, VOLUME= 0.00 AF, ATTEN=100%, LAG= 448.5 MIN

ELEVATION (FT)	AREA (AC)	INC.STOR (AF)	CUM.STOR (AF)
100.0	30.00	0.00	0.00
110.0	100.00	650.00	650.00

STOR-IND METHOD
PEAK STORAGE = 1.94 AF
PEAK ELEVATION= 100.0 FT
FLOOD ELEVATION= 110.0 FT
START ELEVATION= 100.0 FT
SPAN= 10-20 HRS, dt=.1 HRS
Tdet= 387.2 MIN (0 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	100.0'	**100" CULVERT** n=.03 L=100' S=.001'/' Ke=.6 Cc=.9 Cd=.56

CN = 95

5 YR. STORM

WATERSHED ROUTING ==

SUBCATCHMENT 1	= North Area (marsh)	->	POND 1
SUBCATCHMENT 2	= Central Area and Cap	->	POND 1
SUBCATCHMENT 3	= South Area	->	POND 1
POND 1	= Kewaunee River	->	

RUNOFF BY SCS TR-20 METHOD: TYPE II 24-HOUR RAINFALL= 3.2 IN, SCS U.H.

RUNOFF SPAN = 10-20 HRS, dt= .10 HRS, 101 POINTS

SUBCAT NUMBER	AREA (ACRE)	Tc (MIN)	--GROUND	COVERS	(%CN)--		WGT'D CN	C	PEAK (CFS)	Tpeak (HRS)	VOL (AF)
1	6.50	58.9	100%95	-	-	-	95	-	9.03	12.54	1.25
2	4.57	63.1	79%95	21%95	-	-	95	-	6.04	12.59	.88
3	3.10	49.8	100%95	-	-	-	95	-	4.86	12.42	.59

REACH ROUTING BY STOR-IND+TRANS METHOD

REACH NO.	DIAM (IN)	BOTTOM WIDTH (FT)	DEPTH (FT)	SIDE SLOPES (FT/FT)	n	LENGTH (FT)	SLOPE (FT/FT)	PEAK VEL. (FPS)	TRAVEL TIME (MIN)	PEAK Qout (CFS)

POND ROUTING BY STOR-IND METHOD

POND NO.	START ELEV. (FT)	FLOOD ELEV. (FT)	PEAK ELEV. (FT)	PEAK STORAGE (AF)	PEAK FLOW Qin (CFS)	PEAK FLOW Qout (CFS)	PEAK FLOW Qpri (CFS)	PEAK FLOW Qsec (CFS)	Qout ATTEN. (%)	Qout LAG (MIN)
1	100.0	110.0	100.0	2.71	19.65	.01			100	448.7

LINK NO.	NAME	SOURCE	Qout (CFS)

SUBCATCHMENT 1 **North Area (marsh)**

PEAK= 9.03 CFS @ 12.54 HRS, VOLUME= 1.25 AF

ACRES	CN		
6.50	95	Marsh	SCS TR-20 METHOD
			TYPE II 24-HOUR
			RAINFALL= 3.2 IN
			SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=1060' s=.001 '/'	**Flow thru marsh**	58.9

SUBCATCHMENT 2 **Central Area and Cap**

PEAK= 6.04 CFS @ 12.59 HRS, VOLUME= .88 AF

ACRES	CN		
3.60	95	Wood Chip Cap	SCS TR-20 METHOD
.97	95	Marsh	TYPE II 24-HOUR
			RAINFALL= 3.2 IN
4.57	95		SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=780' s=.001 '/'	**Wood chips**	46.1
CURVE NUMBER (LAG) METHOD L=225' s=.001 '/'	**Marsh**	17.0
	Total Length= 1005 ft Total Tc=	63.1

SUBCATCHMENT 3 **South Area**

PEAK= 4.86 CFS @ 12.42 HRS, VOLUME= .59 AF

ACRES	CN		
3.10	95	Marsh	SCS TR-20 METHOD
			TYPE II 24-HOUR
			RAINFALL= 3.2 IN
			SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=860' s=.001 '/'	**Marsh**	49.8

POND 1 **Kewaunee River**

Qin = 19.65 CFS @ 12.52 HRS, VOLUME= 2.72 AF
Qout= .01 CFS @ 20.00 HRS, VOLUME= 0.00 AF, ATTEN=100%, LAG= 448.7 MIN

ELEVATION (FT)	AREA (AC)	INC.STOR (AF)	CUM.STOR (AF)
100.0	30.00	0.00	0.00
110.0	100.00	650.00	650.00

STOR-IND METHOD
PEAK STORAGE = 2.71 AF
PEAK ELEVATION= 100.0 FT
FLOOD ELEVATION= 110.0 FT
START ELEVATION= 100.0 FT
SPAN= 10-20 HRS, dt=.1 HRS
Tdet= 388.4 MIN (0 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	100.0'	**100" CULVERT** n=.03 L=100' S=.001'/' Ke=.6 Cc=.9 Cd=.56

CN = 95

10 YR. STORM

WATERSHED ROUTING ==

SUBCATCHMENT 1	= North Area (marsh)	->	POND 1
SUBCATCHMENT 2	= Central Area and Cap	->	POND 1
SUBCATCHMENT 3	= South Area	->	POND 1
POND 1	= Kewaunee River	->	

RUNOFF BY SCS TR-20 METHOD: TYPE II 24-HOUR RAINFALL= 3.7 IN, SCS U.H.

RUNOFF SPAN = 10-20 HRS, dt= .10 HRS, 101 POINTS

SUBCAT NUMBER	AREA (ACRE)	Tc (MIN)	--GROUND	COVERS	(%CN)--		WGT'D CN	C	PEAK (CFS)	Tpeak (HRS)	VOL (AF)
1	6.50	58.9	100%95	-	-	-	95	-	10.62	12.54	1.47
2	4.57	63.1	79%95	21%95	-	-	95	-	7.11	12.59	1.03
3	3.10	49.8	100%95	-	-	-	95	-	5.71	12.42	.70

REACH ROUTING BY STOR-IND+TRANS METHOD

REACH NO.	DIAM (IN)	BOTTOM WIDTH (FT)	DEPTH (FT)	SIDE SLOPES (FT/FT)	n	LENGTH (FT)	SLOPE (FT/FT)	PEAK VEL. (FPS)	TRAVEL TIME (MIN)	PEAK Qout (CFS)

POND ROUTING BY STOR-IND METHOD

POND NO.	START ELEV. (FT)	FLOOD ELEV. (FT)	PEAK ELEV. (FT)	PEAK STORAGE (AF)	PEAK FLOW Qin (CFS)	PEAK FLOW Qout (CFS)	PEAK FLOW Qpri (CFS)	PEAK FLOW Qsec (CFS)	Qout ATTEN. (%)	Qout LAG (MIN)
1	100.0	110.0	100.0	3.19	23.12	.01			100	448.8

LINK NO.	NAME	SOURCE	Qout (CFS)

SUBCATCHMENT 1 **North Area (marsh)**

PEAK= 10.62 CFS @ 12.54 HRS, VOLUME= 1.47 AF

ACRES	CN		
6.50	95	Marsh	SCS TR-20 METHOD
			TYPE II 24-HOUR
			RAINFALL= 3.7 IN
			SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD	**Flow thru marsh**	58.9
L=1060' s=.001 '/'		

SUBCATCHMENT 2 **Central Area and Cap**

PEAK= 7.11 CFS @ 12.59 HRS, VOLUME= 1.03 AF

ACRES	CN		
3.60	95	Wood Chip Cap	SCS TR-20 METHOD
.97	95	Marsh	TYPE II 24-HOUR
			RAINFALL= 3.7 IN
4.57	95		SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD	**Wood chips**	46.1
L=780' s=.001 '/'		
CURVE NUMBER (LAG) METHOD	**Marsh**	17.0
L=225' s=.001 '/'		
	Total Length= 1005 ft Total Tc=	63.1

SUBCATCHMENT 3 **South Area**

PEAK= 5.71 CFS @ 12.42 HRS, VOLUME= .70 AF

ACRES	CN		
3.10	95	Marsh	SCS TR-20 METHOD
			TYPE II 24-HOUR
			RAINFALL= 3.7 IN
			SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD	**Marsh**	49.8
L=860' s=.001 '/'		

POND 1 **Kewaunee River**

Qin = 23.12 CFS @ 12.52 HRS, VOLUME= 3.20 AF
Qout= .01 CFS @ 20.00 HRS, VOLUME= .01 AF, ATTEN=100%, LAG= 448.8 MIN

ELEVATION (FT)	AREA (AC)	INC.STOR (AF)	CUM.STOR (AF)
100.0	30.00	0.00	0.00
110.0	100.00	650.00	650.00

STOR-IND METHOD
PEAK STORAGE = 3.19 AF
PEAK ELEVATION= 100.0 FT
FLOOD ELEVATION= 110.0 FT
START ELEVATION= 100.0 FT
SPAN= 10-20 HRS, dt=.1 HRS
Tdet= 386 MIN (0 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	100.0'	**100" CULVERT** n=.03 L=100' S=.001'/' Ke=.6 Cc=.9 Cd=.56

CN = 95

25 YR. STORM

WATERSHED ROUTING ==

SUBCATCHMENT 1	= North Area (marsh)	->	POND 1
SUBCATCHMENT 2	= Central Area and Cap	->	POND 1
SUBCATCHMENT 3	= South Area	->	POND 1
POND 1	= Kewaunee River	->	

RUNOFF BY SCS TR-20 METHOD: TYPE II 24-HOUR RAINFALL= 4.2 IN, SCS U.H.

RUNOFF SPAN = 10-20 HRS, dt= .10 HRS, 101 POINTS

SUBCAT NUMBER	AREA (ACRE)	Tc (MIN)	--GROUND	COVERS	(%CN)	--	WGT'D CN	C	PEAK (CFS)	Tpeak (HRS)	VOL (AF)
1	6.50	58.9	100%95	-	-	-	95	-	12.21	12.54	1.69
2	4.57	63.1	79%95	21%95	-	-	95	-	8.17	12.59	1.19
3	3.10	49.8	100%95	-	-	-	95	-	6.57	12.42	.80

REACH ROUTING BY STOR-IND+TRANS METHOD

REACH NO.	DIAM (IN)	BOTTOM WIDTH (FT)	DEPTH (FT)	SIDE SLOPES (FT/FT)	n	LENGTH (FT)	SLOPE (FT/FT)	PEAK VEL. (FPS)	TRAVEL TIME (MIN)	PEAK Qout (CFS)

POND ROUTING BY STOR-IND METHOD

POND NO.	START ELEV. (FT)	FLOOD ELEV. (FT)	PEAK ELEV. (FT)	PEAK STORAGE (AF)	PEAK FLOW Qin (CFS)	PEAK FLOW Qout (CFS)	PEAK FLOW Qpri (CFS)	PEAK FLOW Qsec (CFS)	Qout ATTEN. (%)	Qout LAG (MIN)
1	100.0	110.0	100.1	3.67	26.58	.01			100	448.9

LINK NO.	NAME	SOURCE	Qout (CFS)

SUBCATCHMENT 1 **North Area (marsh)**

PEAK= 12.21 CFS @ 12.54 HRS, VOLUME= 1.69 AF

ACRES	CN	
6.50	95	Marsh

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 4.2 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=1060' s=.001 '/'	**Flow thru marsh**	58.9

SUBCATCHMENT 2 **Central Area and Cap**

PEAK= 8.17 CFS @ 12.59 HRS, VOLUME= 1.19 AF

ACRES	CN	
3.60	95	Wood Chip Cap
.97	95	Marsh
4.57	95	

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 4.2 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=780' s=.001 '/'	**Wood chips**	46.1
CURVE NUMBER (LAG) METHOD L=225' s=.001 '/'	**Marsh**	17.0
	Total Length= 1005 ft Total Tc=	63.1

SUBCATCHMENT 3 **South Area**

PEAK= 6.57 CFS @ 12.42 HRS, VOLUME= .80 AF

ACRES	CN	
3.10	95	Marsh

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 4.2 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=860' s=.001 '/'	**Marsh**	49.8

POND 1 **Kewaunee River**

Qin = 26.58 CFS @ 12.52 HRS, VOLUME= 3.68 AF
Qout= .01 CFS @ 20.00 HRS, VOLUME= .01 AF, ATTEN=100%, LAG= 448.9 MIN

ELEVATION (FT)	AREA (AC)	INC.STOR (AF)	CUM.STOR (AF)
100.0	30.00	0.00	0.00
110.0	100.00	650.00	650.00

STOR-IND METHOD
PEAK STORAGE = 3.67 AF
PEAK ELEVATION= 100.1 FT
FLOOD ELEVATION= 110.0 FT
START ELEVATION= 100.0 FT
SPAN= 10-20 HRS, dt=.1 HRS
Tdet= 387.8 MIN (.01 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	100.0'	**100" CULVERT** n=.03 L=100' S=.001'/' Ke=.6 Cc=.9 Cd=.56

CN = 95

50 YR. STORM

WATERSHED ROUTING ==

SUBCATCHMENT 1	= North Area (marsh)	->	POND 1
SUBCATCHMENT 2	= Central Area and Cap	->	POND 1
SUBCATCHMENT 3	= South Area	->	POND 1
POND 1	= Kewaunee River	->	

RUNOFF BY SCS TR-20 METHOD: TYPE II 24-HOUR RAINFALL= 4.7 IN, SCS U.H.

RUNOFF SPAN = 10-20 HRS, dt= .10 HRS, 101 POINTS

SUBCAT NUMBER	AREA (ACRE)	Tc (MIN)	--GROUND COVERS (%CN)--				WGT'D CN	C	PEAK (CFS)	Tpeak (HRS)	VOL (AF)
1	6.50	58.9	100%95	-	-	-	95	-	13.80	12.53	1.91
2	4.57	63.1	79%95	21%95	-	-	95	-	9.23	12.59	1.34
3	3.10	49.8	100%95	-	-	-	95	-	7.42	12.42	.91

REACH ROUTING BY STOR-IND+TRANS METHOD

REACH NO.	DIAM (IN)	BOTTOM WIDTH (FT)	DEPTH (FT)	SIDE SLOPES (FT/FT)	n	LENGTH (FT)	SLOPE (FT/FT)	PEAK VEL. (FPS)	TRAVEL TIME (MIN)	PEAK Qout (CFS)

POND ROUTING BY STOR-IND METHOD

POND NO.	START ELEV. (FT)	FLOOD ELEV. (FT)	PEAK ELEV. (FT)	PEAK STORAGE (AF)	PEAK FLOW Qin (CFS)	PEAK FLOW Qout (CFS)	PEAK FLOW Qpri (CFS)	PEAK FLOW Qsec (CFS)	Qout ATTEN. (%)	Qout LAG (MIN)
1	100.0	110.0	100.1	4.15	30.03	.01			100	449.0

LINK NO.	NAME	SOURCE	Qout (CFS)

SUBCATCHMENT 1 **North Area (marsh)**

PEAK= 13.80 CFS @ 12.53 HRS, VOLUME= 1.91 AF

ACRES	CN		
6.50	95	Marsh	SCS TR-20 METHOD TYPE II 24-HOUR RAINFALL= 4.7 IN SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=1060' s=.001 '/'	**Flow thru marsh**	58.9

SUBCATCHMENT 2 **Central Area and Cap**

PEAK= 9.23 CFS @ 12.59 HRS, VOLUME= 1.34 AF

ACRES	CN		
3.60	95	Wood Chip Cap	SCS TR-20 METHOD
.97	95	Marsh	TYPE II 24-HOUR RAINFALL= 4.7 IN
4.57	95		SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=780' s=.001 '/'	**Wood chips**	46.1
CURVE NUMBER (LAG) METHOD L=225' s=.001 '/'	**Marsh**	17.0
	Total Length= 1005 ft Total Tc=	63.1

SUBCATCHMENT 3 **South Area**

PEAK= 7.42 CFS @ 12.42 HRS, VOLUME= .91 AF

ACRES	CN		
3.10	95	Marsh	SCS TR-20 METHOD TYPE II 24-HOUR RAINFALL= 4.7 IN SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=860' s=.001 '/'	**Marsh**	49.8

POND 1 **Kewaunee River**

Qin = 30.03 CFS @ 12.52 HRS, VOLUME= 4.16 AF
Qout= .01 CFS @ 20.00 HRS, VOLUME= .01 AF, ATTEN=100%, LAG= 449.0 MIN

ELEVATION (FT)	AREA (AC)	INC.STOR (AF)	CUM.STOR (AF)
100.0	30.00	0.00	0.00
110.0	100.00	650.00	650.00

STOR-IND METHOD
PEAK STORAGE = 4.15 AF
PEAK ELEVATION= 100.1 FT
FLOOD ELEVATION= 110.0 FT
START ELEVATION= 100.0 FT
SPAN= 10-20 HRS, dt=.1 HRS
Tdet= 385.5 MIN (.01 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	100.0'	**100" CULVERT** n=.03 L=100' S=.001'/' Ke=.6 Cc=.9 Cd=.56

CN = 95

100 YR. STORM

WATERSHED ROUTING ==

SUBCATCHMENT 1	= North Area (marsh)	->	POND 1
SUBCATCHMENT 2	= Central Area and Cap	->	POND 1
SUBCATCHMENT 3	= South Area	->	POND 1
POND 1	= Kewaunee River	->	

RUNOFF BY SCS TR-20 METHOD: TYPE II 24-HOUR RAINFALL= 5.0 IN, SCS U.H.

RUNOFF SPAN = 10-20 HRS, dt= .10 HRS, 101 POINTS

SUBCAT NUMBER	AREA (ACRE)	Tc (MIN)	--GROUND	COVERS	(%CN)--		WGT'D CN	C	PEAK (CFS)	Tpeak (HRS)	VOL (AF)
1	6.50	58.9	100%95	-	-	-	95	-	14.74	12.53	2.04
2	4.57	63.1	79%95	21%95	-	-	95	-	9.87	12.59	1.44
3	3.10	49.8	100%95	-	-	-	95	-	7.93	12.42	.97

REACH ROUTING BY STOR-IND+TRANS METHOD

REACH NO.	DIAM (IN)	BOTTOM WIDTH (FT)	DEPTH (FT)	SIDE SLOPES (FT/FT)	**n**	LENGTH (FT)	SLOPE (FT/FT)	PEAK VEL. (FPS)	TRAVEL TIME (MIN)	PEAK Qout (CFS)

POND ROUTING BY STOR-IND METHOD

POND NO.	START ELEV. (FT)	FLOOD ELEV. (FT)	PEAK ELEV. (FT)	PEAK STORAGE (AF)	PEAK FLOW Qin (CFS)	PEAK FLOW Qout (CFS)	PEAK FLOW Qpri (CFS)	PEAK FLOW Qsec (CFS)	Qout ATTEN. (%)	Qout LAG (MIN)
1	100.0	110.0	100.1	4.44	32.09	.01			100	449.0

LINK NO.	NAME	SOURCE	Qout (CFS)

SUBCATCHMENT 1 North Area (marsh)

PEAK= 14.74 CFS @ 12.53 HRS, VOLUME= 2.04 AF

ACRES	CN	
6.50	95	Marsh

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 5.0 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=1060' s=.001 '/'	**Flow thru marsh**	58.9

SUBCATCHMENT 2 Central Area and Cap

PEAK= 9.87 CFS @ 12.59 HRS, VOLUME= 1.44 AF

ACRES	CN	
3.60	95	Wood Chip Cap
.97	95	Marsh
4.57	95	

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 5.0 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=780' s=.001 '/'	**Wood chips**	46.1
CURVE NUMBER (LAG) METHOD L=225' s=.001 '/'	**Marsh**	17.0
	Total Length= 1005 ft Total Tc=	63.1

SUBCATCHMENT 3 South Area

PEAK= 7.93 CFS @ 12.42 HRS, VOLUME= .97 AF

ACRES	CN	
3.10	95	Marsh

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 5.0 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=860' s=.001 '/'	**Marsh**	49.8

POND 1 **Kewaunee River**

Qin = 32.09 CFS @ 12.52 HRS, VOLUME= 4.45 AF
Qout= .01 CFS @ 20.00 HRS, VOLUME= .01 AF, ATTEN=100%, LAG= 449.0 MIN

ELEVATION (FT)	AREA (AC)	INC.STOR (AF)	CUM.STOR (AF)
100.0	30.00	0.00	0.00
110.0	100.00	650.00	650.00

STOR-IND METHOD
PEAK STORAGE = 4.44 AF
PEAK ELEVATION= 100.1 FT
FLOOD ELEVATION= 110.0 FT
START ELEVATION= 100.0 FT
SPAN= 10-20 HRS, dt=.1 HRS
Tdet= 385.4 MIN (.01 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	100.0'	**100" CULVERT** n=.03 L=100' S=.001'/' Ke=.6 Cc=.9 Cd=.56

CN = 83 TO 86

CN = 83 TO 86

2 YR. STORM

WATERSHED ROUTING ==

SUBCATCHMENT 1	= North Area (marsh)	->	POND 1
SUBCATCHMENT 2	= Central Area and Cap	->	POND 1
SUBCATCHMENT 3	= South Area	->	POND 1
POND 1	= Kewaunee River	->	

RUNOFF BY SCS TR-20 METHOD: TYPE II 24-HOUR RAINFALL= 2.4 IN, SCS U.H.

RUNOFF SPAN = 10-20 HRS, dt= .10 HRS, 101 POINTS

SUBCAT NUMBER	AREA (ACRE)	Tc (MIN)	--GROUND	COVERS	(%CN)--		WGT'D CN	C	PEAK (CFS)	Tpeak (HRS)	VOL (AF)
1	6.50	95.6	100%83	-	-	-	83	-	2.29	13.08	.47
2	4.57	92.3	79%87	21%83	-	-	86	-	2.02	13.02	.39
3	3.10	80.8	100%83	-	-	-	83	-	1.25	12.89	.22

REACH ROUTING BY STOR-IND+TRANS METHOD

REACH NO.	DIAM (IN)	BOTTOM WIDTH (FT)	DEPTH (FT)	SIDE SLOPES (FT/FT)	n	LENGTH (FT)	SLOPE (FT/FT)	PEAK VEL. (FPS)	TRAVEL TIME (MIN)	PEAK Qout (CFS)

POND ROUTING BY STOR-IND METHOD

POND NO.	START ELEV. (FT)	FLOOD ELEV. (FT)	PEAK ELEV. (FT)	PEAK STORAGE (AF)	------ PEAK FLOW ------- Qin (CFS)	Qout (CFS)	Qpri (CFS)	Qsec (CFS)	---Qout--- ATTEN. (%)	LAG (MIN)
1	100.0	110.0	100.0	1.08	5.52	0.00			100	419.3

LINK NO.	NAME	SOURCE	Qout (CFS)

SUBCATCHMENT 1 **North Area (marsh)**

PEAK= 2.29 CFS @ 13.08 HRS, VOLUME= .47 AF

ACRES	CN	
6.50	83	Marsh

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 2.4 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=1060' s=.001 '/'	Flow thru marsh	95.6

SUBCATCHMENT 2 **Central Area and Cap**

PEAK= 2.02 CFS @ 13.02 HRS, VOLUME= .39 AF

ACRES	CN	
3.60	87	Wood Chip Cap
.97	83	Marsh
4.57	86	

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 2.4 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=780' s=.001 '/'	Wood chips	67.4
CURVE NUMBER (LAG) METHOD L=225' s=.001 '/'	Marsh	24.9
	Total Length= 1005 ft Total Tc=	92.3

SUBCATCHMENT 3 **South Area**

PEAK= 1.25 CFS @ 12.89 HRS, VOLUME= .22 AF

ACRES	CN	
3.10	83	Marsh

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 2.4 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=860' s=.001 '/'	Marsh	80.8

POND 1 **Kewaunee River**

Qin = 5.52 CFS @ 13.01 HRS, VOLUME= 1.08 AF
Qout= 0.00 CFS @ 20.00 HRS, VOLUME= 0.00 AF, ATTEN=100%, LAG= 419.3 MIN

ELEVATION (FT)	AREA (AC)	INC.STOR (AF)	CUM.STOR (AF)
100.0	30.00	0.00	0.00
110.0	100.00	650.00	650.00

STOR-IND METHOD
PEAK STORAGE = 1.08 AF
PEAK ELEVATION= 100.0 FT
FLOOD ELEVATION= 110.0 FT
START ELEVATION= 100.0 FT
SPAN= 10-20 HRS, dt=.1 HRS
Tdet= 378.9 MIN (0 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	100.0'	100" CULVERT n=.03 L=100' S=.001'/' Ke=.6 Cc=.9 Cd=.56

WATERSHED ROUTING ==

SUBCATCHMENT 1	= North Area (marsh)	->	POND 1
SUBCATCHMENT 2	= Central Area and Cap	->	POND 1
SUBCATCHMENT 3	= South Area	->	POND 1
POND 1	= Kewaunee River	->	

CN = 83 TO 86

5 YR. STORM

RUNOFF BY SCS TR-20 METHOD: TYPE II 24-HOUR RAINFALL= 3.2 IN, SCS U.H.

RUNOFF SPAN = 10-20 HRS, dt= .10 HRS, 101 POINTS

SUBCAT NUMBER	AREA (ACRE)	Tc (MIN)	--GROUND	COVERS	(%CN)--		WGT'D CN	C	PEAK (CFS)	Tpeak (HRS)	VOL (AF)
1	6.50	95.6	100%83	-	-	-	83	-	3.88	13.05	.77
2	4.57	92.3	79%87	21%83	-	-	86	-	3.23	13.00	.62
3	3.10	80.8	100%83	-	-	-	83	-	2.11	12.86	.37

REACH ROUTING BY STOR-IND+TRANS METHOD

REACH NO.	DIAM (IN)	BOTTOM WIDTH (FT)	DEPTH (FT)	SIDE SLOPES (FT/FT)	n	LENGTH (FT)	SLOPE (FT/FT)	PEAK VEL. (FPS)	TRAVEL TIME (MIN)	PEAK Qout (CFS)

POND ROUTING BY STOR-IND METHOD

POND NO.	START ELEV. (FT)	FLOOD ELEV. (FT)	PEAK ELEV. (FT)	PEAK STORAGE (AF)	PEAK FLOW Qin (CFS)	PEAK FLOW Qout (CFS)	PEAK FLOW Qpri (CFS)	PEAK FLOW Qsec (CFS)	Qout ATTEN. (%)	Qout LAG (MIN)
1	100.0	110.0	100.0	1.76	9.15	.01			100	420.5

LINK NO.	NAME	SOURCE	Qout (CFS)

SUBCATCHMENT 1 **North Area (marsh)**

PEAK= 3.88 CFS @ 13.05 HRS, VOLUME= .77 AF

ACRES	CN	
6.50	83	Marsh

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 3.2 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=1060' s=.001 '/'	Flow thru marsh	95.6

SUBCATCHMENT 2 **Central Area and Cap**

PEAK= 3.23 CFS @ 13.00 HRS, VOLUME= .62 AF

ACRES	CN	
3.60	87	Wood Chip Cap
.97	83	Marsh
4.57	86	

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 3.2 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=780' s=.001 '/'	Wood chips	67.4
CURVE NUMBER (LAG) METHOD L=225' s=.001 '/'	Marsh	24.9
	Total Length= 1005 ft Total Tc=	92.3

SUBCATCHMENT 3 **South Area**

PEAK= 2.11 CFS @ 12.86 HRS, VOLUME= .37 AF

ACRES	CN	
3.10	83	Marsh

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 3.2 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=860' s=.001 '/'	Marsh	80.8

POND 1   Kewaunee River

Qin = 9.15 CFS @ 12.99 HRS, VOLUME= 1.77 AF
Qout= .01 CFS @ 20.00 HRS, VOLUME= 0.00 AF, ATTEN=100%, LAG= 420.5 MIN

ELEVATION (FT)	AREA (AC)	INC.STOR (AF)	CUM.STOR (AF)
100.0	30.00	0.00	0.00
110.0	100.00	650.00	650.00

STOR-IND METHOD
PEAK STORAGE = 1.76 AF
PEAK ELEVATION= 100.0 FT
FLOOD ELEVATION= 110.0 FT
START ELEVATION= 100.0 FT
SPAN= 10-20 HRS, dt=.1 HRS
Tdet= 399.3 MIN (0 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	100.0'	100" CULVERT n=.03 L=100' S=.001'/' Ke=.6 Cc=.9 Cd=.56

CN = 83 TO 86

10 YR. STORM

WATERSHED ROUTING ==

SUBCATCHMENT 1	= North Area (marsh)	->	POND 1
SUBCATCHMENT 2	= Central Area and Cap	->	POND 1
SUBCATCHMENT 3	= South Area	->	POND 1
POND 1	= Kewaunee River	->	

RUNOFF BY SCS TR-20 METHOD: TYPE II 24-HOUR RAINFALL= 3.7 IN, SCS U.H.

RUNOFF SPAN = 10-20 HRS, dt= .10 HRS, 101 POINTS

SUBCAT NUMBER	AREA (ACRE)	Tc (MIN)	--GROUND	COVERS	(%CN)--		WGT'D CN	C	PEAK (CFS)	Tpeak (HRS)	VOL (AF)
1	6.50	95.6	100%83	-	-	-	83	-	4.93	13.04	.98
2	4.57	92.3	79%87	21%83	-	-	86	-	4.02	12.99	.77
3	3.10	80.8	100%83	-	-	-	83	-	2.68	12.85	.47

REACH ROUTING BY STOR-IND+TRANS METHOD

REACH NO.	DIAM (IN)	BOTTOM WIDTH (FT)	DEPTH (FT)	SIDE SLOPES (FT/FT)	n	LENGTH (FT)	SLOPE (FT/FT)	PEAK VEL. (FPS)	TRAVEL TIME (MIN)	PEAK Qout (CFS)

POND ROUTING BY STOR-IND METHOD

POND NO.	START ELEV. (FT)	FLOOD ELEV. (FT)	PEAK ELEV. (FT)	PEAK STORAGE (AF)	------ PEAK FLOW ------- Qin (CFS)	Qout (CFS)	Qpri (CFS)	Qsec (CFS)	---Qout--- ATTEN. (%)	LAG (MIN)
1	100.0	110.0	100.0	2.22	11.54	.01			100	421.0

LINK NO.	NAME	SOURCE	Qout (CFS)

SUBCATCHMENT 1 North Area (marsh)

PEAK= 4.93 CFS @ 13.04 HRS, VOLUME= .98 AF

ACRES	CN	
6.50	83	Marsh

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 3.7 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=1060' s=.001 '/'	Flow thru marsh	95.6

SUBCATCHMENT 2 Central Area and Cap

PEAK= 4.02 CFS @ 12.99 HRS, VOLUME= .77 AF

ACRES	CN	
3.60	87	Wood Chip Cap
.97	83	Marsh
4.57	86	

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 3.7 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=780' s=.001 '/'	Wood chips	67.4
CURVE NUMBER (LAG) METHOD L=225' s=.001 '/'	Marsh	24.9
	Total Length= 1005 ft Total Tc=	92.3

SUBCATCHMENT 3 South Area

PEAK= 2.68 CFS @ 12.85 HRS, VOLUME= .47 AF

ACRES	CN	
3.10	83	Marsh

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 3.7 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=860' s=.001 '/'	Marsh	80.8

POND 1 Kewaunee River

Qin = 11.54 CFS @ 12.98 HRS, VOLUME= 2.22 AF
Qout= .01 CFS @ 20.00 HRS, VOLUME= 0.00 AF, ATTEN=100%, LAG= 421.0 MIN

ELEVATION (FT)	AREA (AC)	INC.STOR (AF)	CUM.STOR (AF)
100.0	30.00	0.00	0.00
110.0	100.00	650.00	650.00

STOR-IND METHOD
PEAK STORAGE = 2.22 AF
PEAK ELEVATION= 100.0 FT
FLOOD ELEVATION= 110.0 FT
START ELEVATION= 100.0 FT
SPAN= 10-20 HRS, dt=.1 HRS
Tdet= 402.8 MIN (0 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	100.0'	100" CULVERT n=.03 L=100' S=.001'/' Ke=.6 Cc=.9 Cd=.56

WATERSHED ROUTING ==

SUBCATCHMENT 1	= North Area (marsh)	->	POND 1
SUBCATCHMENT 2	= Central Area and Cap	->	POND 1
SUBCATCHMENT 3	= South Area	->	POND 1
POND 1	= Kewaunee River	->	

CN = 83 TO 86

25 YR. STORM

RUNOFF BY SCS TR-20 METHOD: TYPE II 24-HOUR RAINFALL= 4.2 IN, SCS U.H.

RUNOFF SPAN = 10-20 HRS, dt= .10 HRS, 101 POINTS

SUBCAT NUMBER	AREA (ACRE)	Tc (MIN)	--GROUND	COVERS	(%CN)--		WGT'D CN	C	PEAK (CFS)	Tpeak (HRS)	VOL (AF)
1	6.50	95.6	100%83	-	-	-	83	-	6.01	13.03	1.19
2	4.57	92.3	79%87	21%83	-	-	86	-	4.82	12.99	.93
3	3.10	80.8	100%83	-	-	-	83	-	3.26	12.84	.57

REACH ROUTING BY STOR-IND+TRANS METHOD

REACH NO.	DIAM (IN)	BOTTOM WIDTH (FT)	DEPTH (FT)	SIDE SLOPES (FT/FT)	n	LENGTH (FT)	SLOPE (FT/FT)	PEAK VEL. (FPS)	TRAVEL TIME (MIN)	PEAK Qout (CFS)

POND ROUTING BY STOR-IND METHOD

POND NO.	START ELEV. (FT)	FLOOD ELEV. (FT)	PEAK ELEV. (FT)	PEAK STORAGE (AF)	------ PEAK FLOW ------- Qin (CFS)	Qout (CFS)	Qpri (CFS)	Qsec (CFS)	---Qout--- ATTEN. (%)	LAG (MIN)
1	100.0	110.0	100.0	2.68	13.98	.01			100	421.4

LINK NO.	NAME	SOURCE	Qout (CFS)

SUBCATCHMENT 1   North Area (marsh)

PEAK= 6.01 CFS @ 13.03 HRS, VOLUME= 1.19 AF

ACRES	CN	
6.50	83	Marsh

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 4.2 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=1060' s=.001 '/'	Flow thru marsh	95.6

SUBCATCHMENT 2   Central Area and Cap

PEAK= 4.82 CFS @ 12.99 HRS, VOLUME= .93 AF

ACRES	CN	
3.60	87	Wood Chip Cap
.97	83	Marsh
4.57	86	

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 4.2 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=780' s=.001 '/'	Wood chips	67.4
CURVE NUMBER (LAG) METHOD L=225' s=.001 '/'	Marsh	24.9
	Total Length= 1005 ft Total Tc=	92.3

SUBCATCHMENT 3   South Area

PEAK= 3.26 CFS @ 12.84 HRS, VOLUME= .57 AF

ACRES	CN	
3.10	83	Marsh

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 4.2 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=860' s=.001 '/'	Marsh	80.8

POND 1 Kewaunee River

Qin = 13.98 CFS @ 12.98 HRS, VOLUME= 2.69 AF
Qout= .01 CFS @ 20.00 HRS, VOLUME= 0.00 AF, ATTEN=100%, LAG= 421.4 MIN

ELEVATION (FT)	AREA (AC)	INC.STOR (AF)	CUM.STOR (AF)
100.0	30.00	0.00	0.00
110.0	100.00	650.00	650.00

STOR-IND METHOD
PEAK STORAGE = 2.68 AF
PEAK ELEVATION= 100.0 FT
FLOOD ELEVATION= 110.0 FT
START ELEVATION= 100.0 FT
SPAN= 10-20 HRS, dt=.1 HRS
Tdet= 403 MIN (0 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	100.0'	100" CULVERT n=.03 L=100' S=.001'/' Ke=.6 Cc=.9 Cd=.56

CN = 83 TO 86

50 YR. STORM

WATERSHED ROUTING ==

SUBCATCHMENT 1	= North Area (marsh)	->	POND 1
SUBCATCHMENT 2	= Central Area and Cap	->	POND 1
SUBCATCHMENT 3	= South Area	->	POND 1
POND 1	= Kewaunee River	->	

RUNOFF BY SCS TR-20 METHOD: TYPE II 24-HOUR RAINFALL= 4.7 IN, SCS U.H.

RUNOFF SPAN = 10-20 HRS, dt= .10 HRS, 101 POINTS

SUBCAT NUMBER	AREA (ACRE)	Tc (MIN)	--GROUND COVERS (%CN)--				WGT'D CN	C	PEAK (CFS)	Tpeak (HRS)	VOL (AF)
1	6.50	95.6	100%83	-	-	-	83	-	7.11	13.03	1.40
2	4.57	92.3	79%87	21%83	-	-	86	-	5.63	12.98	1.08
3	3.10	80.8	100%83	-	-	-	83	-	3.86	12.84	.67

REACH ROUTING BY STOR-IND+TRANS METHOD

REACH NO.	DIAM (IN)	BOTTOM WIDTH (FT)	DEPTH (FT)	SIDE SLOPES (FT/FT)	n	LENGTH (FT)	SLOPE (FT/FT)	PEAK VEL. (FPS)	TRAVEL TIME (MIN)	PEAK Qout (CFS)

POND ROUTING BY STOR-IND METHOD

POND NO.	START ELEV. (FT)	FLOOD ELEV. (FT)	PEAK ELEV. (FT)	PEAK STORAGE (AF)	------ PEAK FLOW ------- Qin (CFS)	Qout (CFS)	Qpri (CFS)	Qsec (CFS)	---Qout--- ATTEN. (%)	LAG (MIN)
1	100.0	110.0	100.0	3.15	16.46	.01			100	421.7

LINK NO.	NAME	SOURCE	Qout (CFS)

SUBCATCHMENT 1 North Area (marsh)

PEAK= 7.11 CFS @ 13.03 HRS, VOLUME= 1.40 AF

ACRES	CN		
6.50	83	Marsh	SCS TR-20 METHOD TYPE II 24-HOUR RAINFALL= 4.7 IN SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=1060' s=.001 '/'	Flow thru marsh	95.6

SUBCATCHMENT 2 Central Area and Cap

PEAK= 5.63 CFS @ 12.98 HRS, VOLUME= 1.08 AF

ACRES	CN		
3.60	87	Wood Chip Cap	SCS TR-20 METHOD
.97	83	Marsh	TYPE II 24-HOUR
4.57	86		RAINFALL= 4.7 IN SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=780' s=.001 '/'	Wood chips	67.4
CURVE NUMBER (LAG) METHOD L=225' s=.001 '/'	Marsh	24.9
	Total Length= 1005 ft Total Tc=	92.3

SUBCATCHMENT 3 South Area

PEAK= 3.86 CFS @ 12.84 HRS, VOLUME= .67 AF

ACRES	CN		
3.10	83	Marsh	SCS TR-20 METHOD TYPE II 24-HOUR RAINFALL= 4.7 IN SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=860' s=.001 '/'	Marsh	80.8

POND 1 Kewaunee River

Qin = 16.46 CFS @ 12.97 HRS, VOLUME= 3.16 AF
Qout= .01 CFS @ 20.00 HRS, VOLUME= 0.00 AF, ATTEN=100%, LAG= 421.7 MIN

ELEVATION (FT)	AREA (AC)	INC.STOR (AF)	CUM.STOR (AF)
100.0	30.00	0.00	0.00
110.0	100.00	650.00	650.00

STOR-IND METHOD
PEAK STORAGE = 3.15 AF
PEAK ELEVATION= 100.0 FT
FLOOD ELEVATION= 110.0 FT
START ELEVATION= 100.0 FT
SPAN= 10-20 HRS, dt=.1 HRS
Tdet= 400.8 MIN (0 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	100.0'	100" CULVERT n=.03 L=100' S=.001'/' Ke=.6 Cc=.9 Cd=.56

WATERSHED ROUTING ==

SUBCATCHMENT 1	= North Area (marsh)	->	POND 1
SUBCATCHMENT 2	= Central Area and Cap	->	POND 1
SUBCATCHMENT 3	= South Area	->	POND 1
POND 1	= Kewaunee River	->	

CN = 83 TO 86

100 YR. STORM

RUNOFF BY SCS TR-20 METHOD: TYPE II 24-HOUR RAINFALL= 5.0 IN, SCS U.H.

RUNOFF SPAN = 10-20 HRS, dt= .10 HRS, 101 POINTS

SUBCAT NUMBER	AREA (ACRE)	Tc (MIN)	--GROUND	COVERS	(%CN)	--	WGT'D CN	C	PEAK (CFS)	Tpeak (HRS)	VOL (AF)
1	6.50	95.6	100%83	-	-	-	83	-	7.77	13.02	1.53
2	4.57	92.3	79%87	21%83	-	-	86	-	6.12	12.98	1.17
3	3.10	80.8	100%83	-	-	-	83	-	4.22	12.84	.73

REACH ROUTING BY STOR-IND+TRANS METHOD

REACH NO.	DIAM (IN)	BOTTOM WIDTH (FT)	DEPTH (FT)	SIDE SLOPES (FT/FT)	n	LENGTH (FT)	SLOPE (FT/FT)	PEAK VEL. (FPS)	TRAVEL TIME (MIN)	PEAK Qout (CFS)

POND ROUTING BY STOR-IND METHOD

POND NO.	START ELEV. (FT)	FLOOD ELEV. (FT)	PEAK ELEV. (FT)	PEAK STORAGE (AF)	------ PEAK FLOW ------- Qin (CFS)	Qout (CFS)	Qpri (CFS)	Qsec (CFS)	---Qout--- ATTEN. (%)	LAG (MIN)
1	100.0	110.0	100.1	3.43	17.96	.01			100	421.8

LINK NO.	NAME	SOURCE	Qout (CFS)

SUBCATCHMENT 1 North Area (marsh)

PEAK= 7.77 CFS @ 13.02 HRS, VOLUME= 1.53 AF

ACRES	CN	
6.50	83	Marsh

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 5.0 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=1060' s=.001 '/'	Flow thru marsh	95.6

SUBCATCHMENT 2 Central Area and Cap

PEAK= 6.12 CFS @ 12.98 HRS, VOLUME= 1.17 AF

ACRES	CN	
3.60	87	Wood Chip Cap
.97	83	Marsh
4.57	86	

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 5.0 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=780' s=.001 '/'	Wood chips	67.4
CURVE NUMBER (LAG) METHOD L=225' s=.001 '/'	Marsh	24.9
	Total Length= 1005 ft Total Tc=	92.3

SUBCATCHMENT 3 South Area

PEAK= 4.22 CFS @ 12.84 HRS, VOLUME= .73 AF

ACRES	CN	
3.10	83	Marsh

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 5.0 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=860' s=.001 '/'	Marsh	80.8

POND 1 Kewaunee River

Qin = 17.96 CFS @ 12.97 HRS, VOLUME= 3.44 AF
Qout= .01 CFS @ 20.00 HRS, VOLUME= 0.00 AF, ATTEN=100%, LAG= 421.8 MIN

ELEVATION (FT)	AREA (AC)	INC.STOR (AF)	CUM.STOR (AF)
100.0	30.00	0.00	0.00
110.0	100.00	650.00	650.00

STOR-IND METHOD
PEAK STORAGE = 3.43 AF
PEAK ELEVATION= 100.1 FT
FLOOD ELEVATION= 110.0 FT
START ELEVATION= 100.0 FT
SPAN= 10-20 HRS, dt=.1 HRS
Tdet= 402.6 MIN (0 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	100.0'	100" CULVERT n=.03 L=100' S=.001'/' Ke=.6 Cc=.9 Cd=.56

CN = 30

CN = 30

2 YR. STORM

WATERSHED ROUTING ==

SUBCATCHMENT 1 = North Area (marsh) -> POND 1

SUBCATCHMENT 2 = Central Area and Cap -> POND 1

SUBCATCHMENT 3 = South Area -> POND 1

POND 1 = Kewaunee River ->

RUNOFF BY SCS TR-20 METHOD: TYPE II 24-HOUR RAINFALL= 2.4 IN, SCS U.H.

RUNOFF SPAN = 10-20 HRS, dt= .10 HRS, 101 POINTS

SUBCAT NUMBER	AREA (ACRE)	Tc (MIN)	--GROUND	COVERS	(%CN)--		WGT'D CN	C	PEAK (CFS)	Tpeak (HRS)	VOL (AF)
1	6.50	409.1	100%30	-	-	-	30	-	0.00	0.00	0.00
2	4.57	438.5	79%30	21%30	-	-	30	-	0.00	0.00	0.00
3	3.10	346.1	100%30	-	-	-	30	-	0.00	0.00	0.00

REACH ROUTING BY STOR-IND+TRANS METHOD

REACH NO.	DIAM (IN)	BOTTOM WIDTH (FT)	DEPTH (FT)	SIDE SLOPES (FT/FT)	n	LENGTH (FT)	SLOPE (FT/FT)	PEAK VEL. (FPS)	TRAVEL TIME (MIN)	PEAK Qout (CFS)

POND ROUTING BY STOR-IND METHOD

POND NO.	START ELEV. (FT)	FLOOD ELEV. (FT)	PEAK ELEV. (FT)	PEAK STORAGE (AF)	PEAK FLOW Qin (CFS)	PEAK FLOW Qout (CFS)	PEAK FLOW Qpri (CFS)	PEAK FLOW Qsec (CFS)	Qout ATTEN. (%)	Qout LAG (MIN)
1	100.0	110.0	100.0	0.00	0.00	0.00			0	0.0

LINK NO.	NAME	SOURCE	Qout (CFS)

SUBCATCHMENT 1 **North Area (marsh)**

PEAK= 0.00 CFS @ 0.00 HRS, VOLUME= 0.00 AF

ACRES	CN		
6.50	30	Marsh	SCS TR-20 METHOD
			TYPE II 24-HOUR
			RAINFALL= 2.4 IN
			SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD	**Flow thru marsh**	409.1
L=1060' s=.001 '/'		

SUBCATCHMENT 2 **Central Area and Cap**

PEAK= 0.00 CFS @ 0.00 HRS, VOLUME= 0.00 AF

ACRES	CN		
3.60	30	Wood Chip Cap	SCS TR-20 METHOD
.97	30	Marsh	TYPE II 24-HOUR
			RAINFALL= 2.4 IN
4.57	30		SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD	**Wood chips**	320.1
L=780' s=.001 '/'		
CURVE NUMBER (LAG) METHOD	**Marsh**	118.4
L=225' s=.001 '/'		

	Total Length= 1005 ft Total Tc=	438.5

SUBCATCHMENT 3 **South Area**

PEAK= 0.00 CFS @ 0.00 HRS, VOLUME= 0.00 AF

ACRES	CN		
3.10	30	Marsh	SCS TR-20 METHOD
			TYPE II 24-HOUR
			RAINFALL= 2.4 IN
			SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD	**Marsh**	346.1
L=860' s=.001 '/'		

POND 1 **Kewaunee River**

Qin = 0.00 CFS @ 0.00 HRS, VOLUME= 0.00 AF
Qout= 0.00 CFS @ 0.00 HRS, VOLUME= 0.00 AF, ATTEN= 0%, LAG= 0.0 MIN

ELEVATION (FT)	AREA (AC)	INC.STOR (AF)	CUM.STOR (AF)
100.0	30.00	0.00	0.00
110.0	100.00	650.00	650.00

STOR-IND METHOD
PEAK STORAGE = 0.00 AF
PEAK ELEVATION= 100.0 FT
FLOOD ELEVATION= 110.0 FT
START ELEVATION= 100.0 FT
SPAN= 10-20 HRS, dt=.1 HRS

#	ROUTE	INVERT	OUTLET DEVICES
1	P	100.0'	100" **CULVERT** n=.03 L=100' S=.001'/' Ke=.6 Cc=.9 Cd=.56

CN = 30

5 YR. STORM

WATERSHED ROUTING ==

SUBCATCHMENT 1	= North Area (marsh)	->	POND 1
SUBCATCHMENT 2	= Central Area and Cap	->	POND 1
SUBCATCHMENT 3	= South Area	->	POND 1
POND 1	= Kewaunee River	->	

RUNOFF BY SCS TR-20 METHOD: TYPE II 24-HOUR RAINFALL= 3.2 IN, SCS U.H.

RUNOFF SPAN = 10-20 HRS, dt= .10 HRS, 101 POINTS

SUBCAT NUMBER	AREA (ACRE)	Tc (MIN)	--GROUND	COVERS	(%CN)	--	WGT'D CN	C	PEAK (CFS)	Tpeak (HRS)	VOL (AF)
1	6.50	409.1	100%30	-	-	-	30	-	0.00	0.00	0.00
2	4.57	438.5	79%30	21%30	-	-	30	-	0.00	0.00	0.00
3	3.10	346.1	100%30	-	-	-	30	-	0.00	0.00	0.00

REACH ROUTING BY STOR-IND+TRANS METHOD

REACH NO.	DIAM (IN)	BOTTOM WIDTH (FT)	DEPTH (FT)	SIDE SLOPES (FT/FT)	n	LENGTH (FT)	SLOPE (FT/FT)	PEAK VEL. (FPS)	TRAVEL TIME (MIN)	PEAK Qout (CFS)

POND ROUTING BY STOR-IND METHOD

POND NO.	START ELEV. (FT)	FLOOD ELEV. (FT)	PEAK ELEV. (FT)	PEAK STORAGE (AF)	PEAK FLOW Qin (CFS)	PEAK FLOW Qout (CFS)	PEAK FLOW Qpri (CFS)	PEAK FLOW Qsec (CFS)	Qout ATTEN. (%)	Qout LAG (MIN)
1	100.0	110.0	100.0	0.00	0.00	0.00			0	0.0

LINK NO.	NAME	SOURCE	Qout (CFS)

SUBCATCHMENT 1 **North Area (marsh)**

PEAK= 0.00 CFS @ 0.00 HRS, VOLUME= 0.00 AF

ACRES	CN	
6.50	30	Marsh

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 3.2 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD	**Flow thru marsh**	409.1
L=1060' s=.001 '/'		

SUBCATCHMENT 2 **Central Area and Cap**

PEAK= 0.00 CFS @ 0.00 HRS, VOLUME= 0.00 AF

ACRES	CN	
3.60	30	Wood Chip Cap
.97	30	Marsh
4.57	30	

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 3.2 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD	**Wood chips**	320.1
L=780' s=.001 '/'		
CURVE NUMBER (LAG) METHOD	**Marsh**	118.4
L=225' s=.001 '/'		

	Total Length= 1005 ft Total Tc=	438.5

SUBCATCHMENT 3 **South Area**

PEAK= 0.00 CFS @ 0.00 HRS, VOLUME= 0.00 AF

ACRES	CN	
3.10	30	Marsh

SCS TR-20 METHOD
TYPE II 24-HOUR
RAINFALL= 3.2 IN
SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD	**Marsh**	346.1
L=860' s=.001 '/'		

POND 1 **Kewaunee River**

Qin = 0.00 CFS @ 0.00 HRS, VOLUME= 0.00 AF
Qout= 0.00 CFS @ 0.00 HRS, VOLUME= 0.00 AF, ATTEN= 0%, LAG= 0.0 MIN

ELEVATION (FT)	AREA (AC)	INC.STOR (AF)	CUM.STOR (AF)
100.0	30.00	0.00	0.00
110.0	100.00	650.00	650.00

STOR-IND METHOD
PEAK STORAGE = 0.00 AF
PEAK ELEVATION= 100.0 FT
FLOOD ELEVATION= 110.0 FT
START ELEVATION= 100.0 FT
SPAN= 10-20 HRS, dt=.1 HRS

#	ROUTE	INVERT	OUTLET DEVICES
1	P	100.0'	**100" CULVERT** n=.03 L=100' S=.001'/' Ke=.6 Cc=.9 Cd=.56

CN = 30

10 YR. STORM

WATERSHED ROUTING ==

SUBCATCHMENT 1	= North Area (marsh)	->	POND 1
SUBCATCHMENT 2	= Central Area and Cap	->	POND 1
SUBCATCHMENT 3	= South Area	->	POND 1
POND 1	= Kewaunee River	->	

RUNOFF BY SCS TR-20 METHOD: TYPE II 24-HOUR RAINFALL= 3.7 IN, SCS U.H.

RUNOFF SPAN = 10-20 HRS, dt= .10 HRS, 101 POINTS

SUBCAT NUMBER	AREA (ACRE)	Tc (MIN)	--GROUND	COVERS	(%CN)--		WGT'D CN	C	PEAK (CFS)	Tpeak (HRS)	VOL (AF)
1	6.50	409.1	100%30	-	-	-	30	-	0.00	0.00	0.00
2	4.57	438.5	79%30	21%30	-	-	30	-	0.00	0.00	0.00
3	3.10	346.1	100%30	-	-	-	30	-	0.00	0.00	0.00

REACH ROUTING BY STOR-IND+TRANS METHOD

REACH NO.	DIAM (IN)	BOTTOM WIDTH (FT)	DEPTH (FT)	SIDE SLOPES (FT/FT)	n	LENGTH (FT)	SLOPE (FT/FT)	PEAK VEL. (FPS)	TRAVEL TIME (MIN)	PEAK Qout (CFS)

POND ROUTING BY STOR-IND METHOD

POND NO.	START ELEV. (FT)	FLOOD ELEV. (FT)	PEAK ELEV. (FT)	PEAK STORAGE (AF)	PEAK FLOW Qin (CFS)	PEAK FLOW Qout (CFS)	PEAK FLOW Qpri (CFS)	PEAK FLOW Qsec (CFS)	Qout ATTEN. (%)	Qout LAG (MIN)
1	100.0	110.0	100.0	0.00	0.00	0.00			0	0.0

LINK NO.	NAME	SOURCE	Qout (CFS)

SUBCATCHMENT 1 **North Area (marsh)**

PEAK= 0.00 CFS @ 0.00 HRS, VOLUME= 0.00 AF

ACRES	CN		
6.50	30	Marsh	SCS TR-20 METHOD TYPE II 24-HOUR RAINFALL= 3.7 IN SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=1060' s=.001 '/'	**Flow thru marsh**	409.1

SUBCATCHMENT 2 **Central Area and Cap**

PEAK= 0.00 CFS @ 0.00 HRS, VOLUME= 0.00 AF

ACRES	CN		
3.60	30	Wood Chip Cap	SCS TR-20 METHOD TYPE II 24-HOUR
.97	30	Marsh	RAINFALL= 3.7 IN
4.57	30		SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=780' s=.001 '/'	**Wood chips**	320.1
CURVE NUMBER (LAG) METHOD L=225' s=.001 '/'	**Marsh**	118.4
	Total Length= 1005 ft Total Tc=	438.5

SUBCATCHMENT 3 **South Area**

PEAK= 0.00 CFS @ 0.00 HRS, VOLUME= 0.00 AF

ACRES	CN		
3.10	30	Marsh	SCS TR-20 METHOD TYPE II 24-HOUR RAINFALL= 3.7 IN SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD L=860' s=.001 '/'	**Marsh**	346.1

POND 1 **Kewaunee River**

Qin = 0.00 CFS @ 0.00 HRS, VOLUME= 0.00 AF
Qout= 0.00 CFS @ 0.00 HRS, VOLUME= 0.00 AF, ATTEN= 0%, LAG= 0.0 MIN

ELEVATION (FT)	AREA (AC)	INC.STOR (AF)	CUM.STOR (AF)
100.0	30.00	0.00	0.00
110.0	100.00	650.00	650.00

STOR-IND METHOD
PEAK STORAGE = 0.00 AF
PEAK ELEVATION= 100.0 FT
FLOOD ELEVATION= 110.0 FT
START ELEVATION= 100.0 FT
SPAN= 10-20 HRS, dt=.1 HRS

#	ROUTE	INVERT	OUTLET DEVICES
1	P	100.0'	**100" CULVERT** n=.03 L=100' S=.001'/' Ke=.6 Cc=.9 Cd=.56

CN = 30

25 YR. STORM

WATERSHED ROUTING ==

SUBCATCHMENT 1	= North Area (marsh)	->	POND 1
SUBCATCHMENT 2	= Central Area and Cap	->	POND 1
SUBCATCHMENT 3	= South Area	->	POND 1
POND 1	= Kewaunee River	->	

RUNOFF BY SCS TR-20 METHOD: TYPE II 24-HOUR RAINFALL= 4.2 IN, SCS U.H.

RUNOFF SPAN = 10-20 HRS, dt= .10 HRS, 101 POINTS

SUBCAT NUMBER	AREA (ACRE)	Tc (MIN)	--GROUND	COVERS	(%CN)--		WGT'D CN	C	PEAK (CFS)	Tpeak (HRS)	VOL (AF)
1	6.50	409.1	100%30	-	-	-	30	-	0.00	0.00	0.00
2	4.57	438.5	79%30	21%30	-	-	30	-	0.00	0.00	0.00
3	3.10	346.1	100%30	-	-	-	30	-	0.00	0.00	0.00

REACH ROUTING BY STOR-IND+TRANS METHOD

REACH NO.	DIAM (IN)	BOTTOM WIDTH (FT)	DEPTH (FT)	SIDE SLOPES (FT/FT)	n	LENGTH (FT)	SLOPE (FT/FT)	PEAK VEL. (FPS)	TRAVEL TIME (MIN)	PEAK Qout (CFS)

POND ROUTING BY STOR-IND METHOD

POND NO.	START ELEV. (FT)	FLOOD ELEV. (FT)	PEAK ELEV. (FT)	PEAK STORAGE (AF)	PEAK FLOW Qin (CFS)	PEAK FLOW Qout (CFS)	PEAK FLOW Qpri (CFS)	PEAK FLOW Qsec (CFS)	Qout ATTEN. (%)	Qout LAG (MIN)
1	100.0	110.0	100.0	0.00	0.00	0.00			0	0.0

LINK NO.	NAME	SOURCE	Qout (CFS)

SUBCATCHMENT 1 **North Area (marsh)**

PEAK= 0.00 CFS @ 0.00 HRS, VOLUME= 0.00 AF

ACRES	CN		
6.50	30	Marsh	SCS TR-20 METHOD
			TYPE II 24-HOUR
			RAINFALL= 4.2 IN
			SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD	**Flow thru marsh**	409.1
L=1060' s=.001 '/'		

SUBCATCHMENT 2 **Central Area and Cap**

PEAK= 0.00 CFS @ 0.00 HRS, VOLUME= 0.00 AF

ACRES	CN		
3.60	30	Wood Chip Cap	SCS TR-20 METHOD
.97	30	Marsh	TYPE II 24-HOUR
4.57	30		RAINFALL= 4.2 IN
			SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD	**Wood chips**	320.1
L=780' s=.001 '/'		
CURVE NUMBER (LAG) METHOD	**Marsh**	118.4
L=225' s=.001 '/'		

	Total Length= 1005 ft Total Tc=	438.5

SUBCATCHMENT 3 **South Area**

PEAK= 0.00 CFS @ 0.00 HRS, VOLUME= 0.00 AF

ACRES	CN		
3.10	30	Marsh	SCS TR-20 METHOD
			TYPE II 24-HOUR
			RAINFALL= 4.2 IN
			SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD	**Marsh**	346.1
L=860' s=.001 '/'		

POND 1 **Kewaunee River**

Qin = 0.00 CFS @ 0.00 HRS, VOLUME= 0.00 AF
Qout= 0.00 CFS @ 0.00 HRS, VOLUME= 0.00 AF, ATTEN= 0%, LAG= 0.0 MIN

ELEVATION (FT)	AREA (AC)	INC.STOR (AF)	CUM.STOR (AF)
100.0	30.00	0.00	0.00
110.0	100.00	650.00	650.00

STOR-IND METHOD
PEAK STORAGE = 0.00 AF
PEAK ELEVATION= 100.0 FT
FLOOD ELEVATION= 110.0 FT
START ELEVATION= 100.0 FT
SPAN= 10-20 HRS, dt=.1 HRS

#	ROUTE	INVERT	OUTLET DEVICES
1	P	100.0'	**100" CULVERT** n=.03 L=100' S=.001'/' Ke=.6 Cc=.9 Cd=.56

CN = 30

50 YR. STORM

WATERSHED ROUTING ==

SUBCATCHMENT 1	= North Area (marsh)	->	POND 1
SUBCATCHMENT 2	= Central Area and Cap	->	POND 1
SUBCATCHMENT 3	= South Area	->	POND 1
POND 1	= Kewaunee River	->	

RUNOFF BY SCS TR-20 METHOD: TYPE II 24-HOUR RAINFALL= 4.7 IN, SCS U.H.

RUNOFF SPAN = 10-20 HRS, dt= .10 HRS, 101 POINTS

SUBCAT NUMBER	AREA (ACRE)	Tc (MIN)	--GROUND	COVERS	(%CN)--		WGT'D CN	C	PEAK (CFS)	Tpeak (HRS)	VOL (AF)
1	6.50	409.1	100%30	-	-	-	30	-	0.00	0.00	0.00
2	4.57	438.5	79%30	21%30	-	-	30	-	0.00	0.00	0.00
3	3.10	346.1	100%30	-	-	-	30	-	0.00	0.00	0.00

REACH ROUTING BY STOR-IND+TRANS METHOD

REACH NO.	DIAM (IN)	BOTTOM WIDTH (FT)	DEPTH (FT)	SIDE SLOPES (FT/FT)	n	LENGTH (FT)	SLOPE (FT/FT)	PEAK VEL. (FPS)	TRAVEL TIME (MIN)	PEAK Qout (CFS)

POND ROUTING BY STOR-IND METHOD

POND NO.	START ELEV. (FT)	FLOOD ELEV. (FT)	PEAK ELEV. (FT)	PEAK STORAGE (AF)	PEAK FLOW Qin (CFS)	PEAK FLOW Qout (CFS)	PEAK FLOW Qpri (CFS)	PEAK FLOW Qsec (CFS)	Qout ATTEN. (%)	Qout LAG (MIN)
1	100.0	110.0	100.0	0.00	0.00	0.00			0	0.0

LINK NO.	NAME	SOURCE	Qout (CFS)

SUBCATCHMENT 1 **North Area (marsh)**

PEAK= 0.00 CFS @ 0.00 HRS, VOLUME= 0.00 AF

ACRES	CN		
6.50	30	Marsh	SCS TR-20 METHOD
			TYPE II 24-HOUR
			RAINFALL= 4.7 IN
			SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD	**Flow thru marsh**	409.1
L=1060' s=.001 '/'		

SUBCATCHMENT 2 **Central Area and Cap**

PEAK= 0.00 CFS @ 0.00 HRS, VOLUME= 0.00 AF

ACRES	CN		
3.60	30	Wood Chip Cap	SCS TR-20 METHOD
.97	30	Marsh	TYPE II 24-HOUR
			RAINFALL= 4.7 IN
4.57	30		SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD	**Wood chips**	320.1
L=780' s=.001 '/'		
CURVE NUMBER (LAG) METHOD	**Marsh**	118.4
L=225' s=.001 '/'		

	Total Length= 1005 ft Total Tc=	438.5

SUBCATCHMENT 3 **South Area**

PEAK= 0.00 CFS @ 0.00 HRS, VOLUME= 0.00 AF

ACRES	CN		
3.10	30	Marsh	SCS TR-20 METHOD
			TYPE II 24-HOUR
			RAINFALL= 4.7 IN
			SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD	**Marsh**	346.1
L=860' s=.001 '/'		

POND 1 **Kewaunee River**

Qin = 0.00 CFS @ 0.00 HRS, VOLUME= 0.00 AF
Qout= 0.00 CFS @ 0.00 HRS, VOLUME= 0.00 AF, ATTEN= 0%, LAG= 0.0 MIN

ELEVATION (FT)	AREA (AC)	INC.STOR (AF)	CUM.STOR (AF)
100.0	30.00	0.00	0.00
110.0	100.00	650.00	650.00

STOR-IND METHOD
PEAK STORAGE = 0.00 AF
PEAK ELEVATION= 100.0 FT
FLOOD ELEVATION= 110.0 FT
START ELEVATION= 100.0 FT
SPAN= 10-20 HRS, dt=.1 HRS

#	ROUTE	INVERT	OUTLET DEVICES
1	P	100.0'	**100" CULVERT** n=.03 L=100' S=.001'/' Ke=.6 Cc=.9 Cd=.56

CN = 30

100 YR. STORM

WATERSHED ROUTING ==

SUBCATCHMENT 1	= North Area (marsh)	->	POND 1
SUBCATCHMENT 2	= Central Area and Cap	->	POND 1
SUBCATCHMENT 3	= South Area	->	POND 1
POND 1	= Kewaunee River	->	

RUNOFF BY SCS TR-20 METHOD: TYPE II 24-HOUR RAINFALL= 5.0 IN, SCS U.H.

RUNOFF SPAN = 10-20 HRS, dt= .10 HRS, 101 POINTS

SUBCAT NUMBER	AREA (ACRE)	Tc (MIN)	--GROUND	COVERS	(%CN)--		WGT'D CN	C	PEAK (CFS)	Tpeak (HRS)	VOL (AF)
1	6.50	409.1	100%30	-	-	-	30	-	0.00	20.00	0.00
2	4.57	438.5	79%30	21%30	-	-	30	-	0.00	20.00	0.00
3	3.10	346.1	100%30	-	-	-	30	-	0.00	20.00	0.00

REACH ROUTING BY STOR-IND+TRANS METHOD

REACH NO.	DIAM (IN)	BOTTOM WIDTH (FT)	DEPTH (FT)	SIDE SLOPES (FT/FT)	n	LENGTH (FT)	SLOPE (FT/FT)	PEAK VEL. (FPS)	TRAVEL TIME (MIN)	PEAK Qout (CFS)

POND ROUTING BY STOR-IND METHOD

POND NO.	START ELEV. (FT)	FLOOD ELEV. (FT)	PEAK ELEV. (FT)	PEAK STORAGE (AF)	PEAK FLOW Qin (CFS)	PEAK FLOW Qout (CFS)	PEAK FLOW Qpri (CFS)	PEAK FLOW Qsec (CFS)	Qout ATTEN. (%)	Qout LAG (MIN)
1	100.0	110.0	100.0	0.00	0.00	0.00			100	0.0

LINK NO.	NAME	SOURCE	Qout (CFS)

SUBCATCHMENT 1 **North Area (marsh)**

PEAK= 0.00 CFS @ 20.00 HRS, VOLUME= 0.00 AF

ACRES	CN		
6.50	30	Marsh	SCS TR-20 METHOD
			TYPE II 24-HOUR
			RAINFALL= 5.0 IN
			SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD	**Flow thru marsh**	409.1
L=1060' s=.001 '/'		

SUBCATCHMENT 2 **Central Area and Cap**

PEAK= 0.00 CFS @ 20.00 HRS, VOLUME= 0.00 AF

ACRES	CN		
3.60	30	Wood Chip Cap	SCS TR-20 METHOD
.97	30	Marsh	TYPE II 24-HOUR
4.57	30		RAINFALL= 5.0 IN
			SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD	**Wood chips**	320.1
L=780' s=.001 '/'		
CURVE NUMBER (LAG) METHOD	**Marsh**	118.4
L=225' s=.001 '/'		

	Total Length= 1005 ft Total Tc=	438.5

SUBCATCHMENT 3 **South Area**

PEAK= 0.00 CFS @ 20.00 HRS, VOLUME= 0.00 AF

ACRES	CN		
3.10	30	Marsh	SCS TR-20 METHOD
			TYPE II 24-HOUR
			RAINFALL= 5.0 IN
			SPAN= 10-20 HRS, dt=.1 HRS

Method	Comment	Tc (min)
CURVE NUMBER (LAG) METHOD	**Marsh**	346.1
L=860' s=.001 '/'		

POND 1 **Kewaunee River**

Qin = 0.00 CFS @ 20.00 HRS, VOLUME= 0.00 AF
Qout= 0.00 CFS @ 20.00 HRS, VOLUME= 0.00 AF, ATTEN=100%, LAG= 0.0 MIN

ELEVATION (FT)	AREA (AC)	INC.STOR (AF)	CUM.STOR (AF)
100.0	30.00	0.00	0.00
110.0	100.00	650.00	650.00

STOR-IND METHOD
PEAK STORAGE = 0.00 AF
PEAK ELEVATION= 100.0 FT
FLOOD ELEVATION= 110.0 FT
START ELEVATION= 100.0 FT
SPAN= 10-20 HRS, dt=.1 HRS
Tdet= 48.5 MIN (0 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	100.0'	**100" CULVERT** n=.03 L=100' S=.001'/' Ke=.6 Cc=.9 Cd=.56

APPENDIX C

U.S.G.S. Upstream Kewaunee River Flow Data

Table 4. *Flood discharges at selected recurrence intervals and WRC skew for gaging stations in Wisconsin*--Continued

Station number	Station name	WRC skew	Discharge for indicated recurrence interval, Years: 2	5	10	25	50	100	SE_{100}	Remarks[1]
04075200	Evergreen Creek near Langlade, Wis.	0.046	44.5	56.2	63.5	72.6	78.9	85.3	10.1	
04075500	Wolf River above West Branch Wolf River near Keshena, Wis.	.318	1,740	2,120	2,360	2,665	2,890	3,120	6.7	
04077000	Wolf River at Keshena Falls near Keshena, Wis.	.356	2,410	3,070	3,520	4,100	4,545	5,000	7.5	
04078500	Embarrass River near Embarrass, Wis.	-.070	2,340	3,460	4,235	5,240	6,000	6,780	10.8	
04079000	Wolf River at New London, Wis.	-.224	6,720	9,460	11,200	13,400	14,900	16,400	9.1	
04079700	Spaulding Creek near Big Falls, Wis.	.109	52.5	67.7	77.6	90.0	99.2	108	11.2	
04080000	Little Wolf River at Royalton, Wis.	-.522	3,195	4,850	5,880	7,095	7,930	8,715	10.7	
04081000	Waupaca River near Waupaca, Wis.	-.518	1,060	1,540	1,835	2,175	2,405	2,620	9.9	
04081010	Waupaca River tributary near Waupaca, Wis.	-.499	41.4	69.8	89.1	113	130	147	22.5	
04081900	Sawyer Creek at Oshkosh, Wis.	-.001	427	861	1,240	1,840	2,370	2,970	31.7	
		-.243	542	1,020	1,400	1,930	2,360	2,810	25.1	G
04083000	West Branch Fond du Lac River at Fond du Lac, Wis.	-.700	780	1,140	1,370	1,620	1,780	1,930	20.1	
04083400	East Branch Fond du Lac River tributary near Eden, Wis.	-.416	57.6	96.6	123	158	183	207	23.1	
04083500	East Branch Fond du Lac River at Fond du Lac, Wis.	-.710	908	1,550	1,960	2,440	2,760	3,060	26.5	
04084500	Fox River at Rapide Croche Dam, near Wrightstown, Wis.	-.768	12,700	17,000	19,200	21,600	23,000	24,200	6.7	E
04085030	Apple Creek near Kaukauna, Wis.	-.735	787	1,210	1,450	1,730	1,910	2,070	15.6	
04085100	East River tributary at Greenleaf, Wis.	-.162	216	379	504	676	816	965	25.8	
04085200	Kewaunee River near Kewaunee, Wis.	-.417	2,700	4,370	5,490	6,880	7,890	8,870	17.6	
04085281	East Twin River at Mishicot, Wis.	-.163	1,200	2,020	2,620	3,440	4,080	4,750	29.5	
04085300	Neshota River tributary near Denmark, Wis.	-.424	193	326	416	536	622	707	19.6	
04085400	Killsnake River near Chilton, Wis.	-.606	627	1,060	1,340	1,680	1,910	2,130	19.6	
04085427	Manitowoc River at Manitowoc, Wis.	-.154	2,590	4,270	5,510	7,170	8,470	9,820	27.7	
04085700	Sheboygan River tributary near Plymouth, Wis.	-.032	113	163	235	307	365	426	24.4	
04086000	Sheboygan River at Sheboygan, Wis.	-.555	3,140	5,000	6,160	7,480	8,380	9,200	13.6	
04086150	Milwaukee River at Kewaskum, Wis.	-.059	900	1,460	1,860	2,420	2,870	3,330	29.4	
04086200	East Branch Milwaukee River near New Fane, Wis.	-.137	214	352	455	593	702	815	31.1	
04086340	North Branch Milwaukee River near Fillmore, Wis.	-.266	789	1,380	1,820	2,420	2,880	3,360	33.5	
04086360	Milwaukee River at Waubeka, Wis.	-.391	2,110	3,530	4,520	5,770	6,710	7,630	28.6	
04086400	Milwaukee River tributary near Fredonia, Wis.	-.586	55.0	105	141	188	221	254	30.0	
04086500	Cedar Creek near Cedarburg, Wis.	-.189	951	1,860	2,600	3,670	4,570	5,530	20.1	
04087000	Milwaukee River at Milwaukee, Wis.	-.057	4,690	6,990	8,580	10,700	12,300	13,900	10.4	
04087030	Menomonee River at Menomonee Falls, Wis.	.160	539	788	968	1,210	1,400	1,610	27.3	
04087050	Little Menomonee River near Freistadt, Wis.	-.446	182	272	328	395	441	485	14.5	
04087088	Underwood Creek at Wauwatosa, Wis.	-.298	857	1,430	1,840	2,370	2,780	3,180	34.8	
04087100	Honey Creek at Milwaukee, Wis.	-.035	319	488	609	769	894	1,020	17.7	
04087120	Menomonee River at Wauwatosa, Wis.	.023	3,400	5,670	7,430	9,920	12,000	14,100	23.1	
04087200	Oak Creek near South Milwaukee, Wis.	-.117	258	453	604	817	989	1,170.	22.5	
04087204	Oak Creek at South Milwaukee, Wis.	.113	585	767	887	1,040	1,150	1,260	13.1	
04087220	Root River near Franklin, Wis.	.219	1,080	1,860	2,500	3,470	4,310	5,260	27.3	
04087230	West Branch Root River Canal tributary near North Cape, Wis.	-.603	89.4	133	180	190	210	228	15.2	
04087233	Root River Canal near Franklin, Wis.	-.274	709	975	1,140	1,340	1,480	1,610	13.5	
04087240	Root River at Racine, Wis.	-.032	1,940	2,760	3,300	4,000	4,530	5,070	16.0	
04087250	Pike Creek near Kenosha, Wis.	-.308	82.6	135	171	217	252	287	19.0	
04087257	Pike River near Racine, Wis.	-.453	676	1,180	1,350	1,540	1,670	1,790	15.8	
05332500	Namekagon River near Trego, Wis.	.573	1,170	1,620	1,960	2,440	2,830	3,260	12.8	E
05333100	Little Frog Creek near Minong, Wis.	-.345	205	376	508	685	823	964	24.2	

APPENDIX D

Sample Hand Calculations

Calculation Spreadsheets

sts

CALCULATION COVER SHEET

PROJECT Kewaunee River Arsenic Transport JOB NO. 20716XA DIVISION ______

SUBJECT Marsh Groundwater Flow FILE NO. ______

CALC. NO. ______

ORIGINATOR MER DATE 5/20/97

CHECKER TAP DATE 5/21/97 NO. OF SHEETS 1

RECORD OF ISSUES								
NO.	DESCRIPTION	BY	DATE	CHKD.	DATE	APPRD.		
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PRELIMINARY CALC. ☐

SUPERSEDED CALC. ☐ FINAL CALC. ☐

BRIEF SUMMARY OF CALCULATIONS INCLUDING SCOPE AND RESULTS

Calculate Marsh Groundwater Flow using information from GEOTRANS, Inc.

STS Consultants Ltd.
CALCULATION SHEET

PROJECT	STS JOB NO.
Kewaunee River Arsenic Transport	
SUBJECT	**CALC. NO.**
MARSH GROUNDWATER FLOW	

DATE	BY	CHECKED BY	REV. NO.
5-21-97	MER		

FROM HSI GeoTrans final report titled "Fate and Transport Modeling of Arsenic at the Kewaunee Marsh":

FROM HSI GeoTrans:

From Section 3.3 Model Design:

K = Hydraulic conductivity = 1.76×10^2 ft/yr

i = Hydraulic gradient = 8.45×10^{-4} ft/ft

n_e = Effective Porosity = 0.40

$$K = \left(176 \frac{ft}{yr}\right)\left(\frac{1\ yr}{365\ days}\right)\left(\frac{1\ day}{24\ hrs}\right)\left(\frac{1\ hr}{60\ min}\right)\left(\frac{1\ min}{60\ sec}\right) = 5.58 \times 10^{-6}\ ft/s$$

Average groundwater pore velocity (Daily velocity marsh grdwater) $= \dfrac{(k)(i)}{n_e}$

$$= \frac{(0.00000558\ ft/s)(0.000845\ ft/ft)}{0.40}$$

$$= 1.2 \times 10^{-8}\ ft/s \quad (0.378\ ft/yr.)$$

Marsh groundwater flow = (Ave. grdwater pore veloc)(cross-sect. area)

= (Ave. grdwater pore veloc) [(length site along river)(depth river)]

$$= (1.2 \times 10^{-8}\ ft/s)[(960\ ft)(20\ ft)]$$

$$= 2.3 \times 10^{-4}\ cfs$$

$$= \underline{\underline{0.00023\ cfs}}$$

sts

CALCULATION COVER SHEET

PROJECT Kewaunee River Arsenic Transport JOB NO. 20716XA DIVISION

SUBJECT ARSENIC CONCENTRATION CALCULATIONS & Kewaunee River Downstream Flow Calculation FILE NO.

CALC. NO.

ORIGINATOR MER DATE 5/20/97

CHECKER TAP DATE 5/20/97 NO. OF SHEETS 2

RECORD OF ISSUES								
NO.	DESCRIPTION	BY	DATE	CHKD.	DATE	APPRD.		
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PRELIMINARY CALC. ☐

SUPERSEDED CALC. ☐ FINAL CALC. ☐

BRIEF SUMMARY OF CALCULATIONS INCLUDING SCOPE AND RESULTS

Sample calculations of:

1) Arsenic Concentration in Surface Water Flowing out of Marsh
2) Downstream Kewaunee River Flow
3) Downstream Kewaunee River Arsenic Concentration

STS Consultants Ltd. CALCULATION SHEET	PROJECT: Kewaunee River Arsenic Transport	STS JOB NO.: 20716XA
	SUBJECT: Max./Average Arsenic Conc. Flowing from marsh	CALC. NO.:
	DATE: 5/20/97 BY: MER CHECKED BY:	REV. NO.:

EXAMPLE CALCULATIONS USE A 100 YR STORM EVENT AND A CURVE NUMBER OF 95.

(1) MAX. ARSENIC CONC. IN SURFACE WATER FLOWING FROM MARSH

$$= \frac{(\text{Subarea 1 Peak Flow})(\text{Subarea 1 Max Arsen. Conc}) + (\text{Subarea 2 Peak Flow})(\text{Subarea 2 Max. Arsen. Conc}) + (\text{Subarea 3 Peak Flow})(\text{Subarea 3 Max. Ars. Conc.})}{\text{Total Peak Flow from Marsh}}$$

$$= \frac{(14.7 \text{ cfs})(360 \text{ ug/L}) + (9.87 \text{ cfs})(0 \text{ ug/L}) + (7.93 \text{ cfs})(19{,}100 \text{ ug/L})}{32.50 \text{ cfs}}$$

$$= \underline{4{,}823.2 \text{ ug/L}}$$

(2) AVE. ARSENIC CONC. in Surf. water Flowing from Marsh

$$= \frac{(\text{Subarea 1 Peak Flow})(\text{Subarea 1 Ave. Arsen. Conc}) + (\text{Subarea 2 Peak Flow})(\text{Subarea 2 Ave. Arsen. Conc}) + (\text{Subarea 3 Peak Flow})(\text{Subarea 3 Ave. Arsen. Conc.})}{\text{Total Peak Flow from Marsh}}$$

$$= \frac{(14.7 \text{ cfs})(152 \text{ ug/L}) + (9.87 \text{ cfs})(0 \text{ ug/L}) + (7.93 \text{ cfs})(9{,}553 \text{ ug/L})}{32.50 \text{ cfs}}$$

$$= \underline{2{,}399.7 \text{ ug/L}}$$

NOTE: Arsenic concentrations in surface water discharge increases as peak flow increases because the increase of surface water flow from each subarea is not proportional as the year of the event storm increases.

STS Consultants Ltd.
CALCULATION SHEET

PROJECT	STS JOB NO.
Kewaunee River Arsenic Transport	
SUBJECT: Kewaunee River Downstream Flow / Arsenic Conc.	CALC. NO.
DATE: 5-20-97 BY: MER CHECKED BY:	REV. NO.

EXAMPLE CALCULATIONS USE A 100-YR STORM EVENT, MAXIMUM OBSERVED MARSH SURFACE WATER ARSENIC CONCETR, AND A RUNOFF CURVE NUMBER OF 95.

① KEWAUNEE RIVER DOWNSTREAM FLOW = (KEWAUNEE River UPSTREAM FLOW) + (Marsh Surface Water Flow) + (Marsh Grdwater Flow)

= (8,870 cfs) + (32.5 cfs) + (0.00023 cfs)

= **8,902.5 cfs**

② KEWAUNEE RIVER DOWNSTREAM ARSENIC CONC. = [(Kew. River Upstream Flow)(Kew River Upstream Ars. Conc) + (Marsh Surface Water Flow)(Marsh Surf. Water Arsen. Conc) + (Marsh Grdwater Flow)(Marsh Grdwater Arsenic Conc)] / Kewaunee River Downstream Flow

$$= \frac{(8{,}870\ cfs)(3\ ug/L) + (32.5\ cfs)(4{,}823.2\ ug/L) + (0.00023\ cfs)(200{,}000\ ug/L)}{8{,}902.5\ cfs}$$

= **20.6 ug/L**

CALCULATION COVER SHEET

PROJECT Kewaunee River Arsenic Transport JOB NO. ______ DIVISION ______

SUBJECT Excel Spreadsheets - Water Balance Calculations FILE NO. ______

CN = 95 CALC. NO. ______

ORIGINATOR MER DATE 5-21-97

CHECKER ______ DATE ______ NO. OF SHEETS 6

RECORD OF ISSUES								
NO.	DESCRIPTION	BY	DATE	CHKD.	DATE	APPRD.		
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PRELIMINARY CALC. ☐

SUPERSEDED CALC. ☒ FINAL CALC. ☐

BRIEF SUMMARY OF CALCULATIONS INCLUDING SCOPE AND RESULTS

Excel Spreadsheets for Runoff Curve Number = 95

1) Water Balance Using Maximum Observed Surface Water Arsenic Concentrations from Marsh

2) Water Balance using Average Observed Surface Water Arsenic Concentrations from Marsh

Water Balance Using Maximum Observed Surface Water Arsenic Concentrations From Marsh
(CN = 95)

Kewaunee Marsh Flow Calculations												
	Volume (acre-feet)			Volume (gallons)				Peak Discharge (cfs)			
Storm (yr)	Area 1	Area 2	Area 3	Area 1	Area 2	Area 3		Area 1	Area 2	Area 3	Total
2	0.47	0.39	0.22	153,144	127,077	71,684		6.46	4.32	3.48	14.26
5	0.77	0.62	0.37	250,895	202,020	120,560		9.03	6.04	4.86	19.93
10	0.98	0.77	0.47	319,321	250,895	153,144		10.02	7.11	5.71	22.84
25	1.19	0.93	0.57	387,747	303,029	185,728		12.21	8.17	6.57	26.95
50	1.4	1.08	0.67	456,173	351,905	218,311		13.80	9.23	7.42	30.45
100	1.53	1.17	0.73	498,532	381,230	237,862		14.70	9.87	7.93	32.50

Summary

Rainfall Event (year)		Kewaunee River (down stream) Flow (cfs)	As Conc. (ug/l)
2		2,714.3	28.3
5		4,389.9	24.9
10		5,512.8	23.4
25		6,907.0	21.8
50		7,920.5	21.5
100		8,902.5	20.6

Water Balance Using Maximum Observed Surface Water Arsenic Concentrations From Marsh
(CN = 95)

Maximum Surface Water As Conc (ug/l)				As Conc Flowing from Marsh (ug/l)		
Area 1	Area 2	Area 3				
360	0	19,100			4,824.2	
360	0	19,100			4,820.7	
360	0	19,100			4,932.9	
360	0	19,100			4,819.4	
360	0	19,100			4,817.4	
360	0	19,100			4,823.2	

Water Balance Using Maximum Observed Surface Water Arsenic Concentrations From Marsh
(CN = 95)

Rainfall Event (year)	Kewaunee River Upstream Flow (cfs)	Kewaunee River Upstream As Conc. (ug/l)	Kewaunee Marsh Flow (cfs)	Kewaunee Marsh As Conc. (ug/l)	Kewaunee Marsh Ground Water Flow (cfs)	Kewaunee Marsh Ground Water As. Conc. (ug/l)	Kewaunee River (down stream) Flow (cfs)	Kewaunee River (down stream) As Conc. (ug/l)
2	2,700	3	14.3	4,824.2	0.00023	200,000	2,714.3	28.3
5	4,370	3	19.9	4,820.7	0.00023	200,000	4,389.9	24.9
10	5,490	3	22.8	4,932.9	0.00009	200,000	5,512.8	23.4
25	6,880	3	27.0	4,819.4	0.00023	200,000	6,907.0	21.8
50	7,890	3	30.5	4,817.4	0.00023	200,000	7,920.5	21.5
100	8,870	3	32.5	4,823.2	0.00023	200,000	8,902.5	20.6

Water Balance Using Average Observed Surface Water Arsenic Concentrations In Marsh
(CN = 95)

Kewaunee Marsh Flow Calculations

Storm (yr)	Volume (acre-feet) Area 1	Volume (acre-feet) Area 2	Volume (acre-feet) Area 3	Volume (gallons) Area 1	Volume (gallons) Area 2	Volume (gallons) Area 3	Peak Discharge (cfs) Area 1	Peak Discharge (cfs) Area 2	Peak Discharge (cfs) Area 3	Peak Discharge (cfs) Total
2	0.47	0.39	0.22	153,144	127,077	71,684	6.46	4.32	3.48	14.26
5	0.77	0.62	0.37	250,895	202,020	120,560	9.03	6.04	4.86	19.93
10	0.98	0.77	0.47	319,321	250,895	153,144	10.02	7.11	5.71	22.84
25	1.19	0.93	0.57	387,747	303,029	185,728	12.21	8.17	6.57	26.95
50	1.4	1.08	0.67	456,173	351,905	218,311	13.80	9.23	7.42	30.45
100	1.53	1.17	0.73	498,532	381,230	237,862	14.70	9.87	7.93	32.50

Summary

Rainfall Event (years)	Kewaunee River (down stream) Flow (cfs)	Kewaunee River (down stream) As Conc. (ug/l)
2	2,714.3	15.6
5	4,389.9	13.9
10	5,512.8	13.2
25	6,907.0	12.3
50	7,920.5	12.2
100	8,902.5	11.7

Water Balance Using Average Observed Surface Water Arsenic Concentrations In Marsh
(CN = 95)

Average Surface Water As Conc (ug/l)				As Conc Flowing from Marsh (ug/l)		
Area 1	Area 2	Area 3				
152	0	9,553			2,400.2	
152	0	9,553			2,398.4	
152	0	9,553			2,454.9	
152	0	9,553			2,397.7	
152	0	9,553			2,396.7	
152	0	9,553			2,399.7	

Water Balance Using Average Observed Surface Water Arsenic Concentrations In Marsh
(CN = 95)

Rainfall Event (years)		Kewaunee River Upstream Flow (cfs)	Kewaunee River Upstream As Conc. (ug/l)		Kewaunee Marsh Flow (cfs)	Kewaunee Marsh As Conc. (ug/l)		Kewaunee Marsh Ground Water Flow (cfs)	Kewaunee Marsh Ground Water As. Conc. (ug/l)		Kewaunee River (down stream) Flow (cfs)	Kewaunee River (down stream) As Conc. (ug/l)	
2		2,700	3		14.3	2,400.2		0.00023	200,000		2,714.3	15.6	
5		4,370	3		19.9	2,398.4		0.00023	200,000		4,389.9	13.9	
10		5,490	3		22.8	2,454.9		0.00023	200,000		5,512.8	13.2	
25		6,880	3		27.0	2,397.7		0.00023	200,000		6,907.0	12.3	
50		7,890	3		30.5	2,396.7		0.00023	200,000		7,920.5	12.2	
100		8,870	3		32.5	2,399.7		0.00023	200,000		8,902.5	11.7	

sts

CALCULATION COVER SHEET

PROJECT *Kewaunee River Arsenic Transport* JOB NO. ____ DIVISION ____

SUBJECT *Excel Spreadsheets - Water Balance Calculations CN = 83 to 86* FILE NO. ____

CALC. NO. ____

ORIGINATOR *MER* DATE *5-21-97*

CHECKER ____ DATE ____ NO. OF SHEETS *6*

RECORD OF ISSUES

NO.	DESCRIPTION	BY	DATE	CHKD.	DATE	APPRD.		
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PRELIMINARY CALC. ☐

SUPERSEDED CALC. ☒

FINAL CALC. ☐

BRIEF SUMMARY OF CALCULATIONS INCLUDING SCOPE AND RESULTS

Excel Spreadsheets for Runoff Curve Number = 83 to 86

1) Water Balance Using Maximum Observed Surface Water Arsenic Concentrations from Marsh
2) Water Balance Using Average Observed Surface Water Arsenic Concentrations from Marsh

Water Balance Using Maximum Observed Surface Water Arsenic Concentrations From Marsh
CN = 83 TO 86

Kewaunee Marsh Flow Calculations

	Volume (acre-feet)			Volume (gallons)			Peak Discharge (cfs)			
Storm (yr)	Area 1	Area 2	Area 3	Area 1	Area 2	Area 3	Area 1	Area 2	Area 3	Total
2	0.47	0.39	0.22	153,144	127,077	71,684	2.29	2.02	1.25	5.56
5	0.77	0.62	0.37	250,895	202,020	120,560	3.88	3.23	2.11	9.22
10	0.98	0.77	0.47	319,321	250,895	153,144	4.93	4.02	2.68	11.63
25	1.19	0.93	0.57	387,747	303,029	185,728	6.01	4.82	3.26	14.09
50	1.4	1.08	0.67	456,173	351,905	218,311	7.11	5.63	3.86	16.60
100	1.53	1.17	0.73	498,532	381,230	237,862	7.77	6.12	4.22	18.11

Summary

Rainfall Event (year)	Kewaunee River (down stream) Flow (cfs)	As Conc. (ug/l)
2	2,705.6	12.1
5	4,379.2	12.5
10	5,501.6	12.6
25	6,894.1	12.3
50	7,906.6	12.6
100	8,888.1	12.4

Water Balance Using Maximum Observed Surface Water Arsenic Concentrations From Marsh
CN = 83 TO 86

Maximum Surface Water As Conc (ug/l)				As Conc Flowing from Marsh (ug/l)
Area 1	Area 2	Area 3		
360	0	19,100		4,442.3
360	0	19,100		4,522.5
360	0	19,100		4,554.0
360	0	19,100		4,572.7
360	0	19,100		4,595.5
360	0	19,100		4,605.1

Water Balance Using Maximum Observed Surface Water Arsenic Concentrations From Marsh
CN = 83 TO 86

Rainfall Event	Kewaunee River Upstream		Kewaunee Marsh		Kewaunee Marsh Ground Water		Kewaunee River (down stream)	
(year)	Flow (cfs)	As Conc. (ug/l)	Flow (cfs)	As Conc. (ug/l)	Flow (cfs)	As. Conc. (ug/l)	Flow (cfs)	As Conc. (ug/l)
2	2,700	3	5.6	4,442.3	0.00023	200,000	2,705.6	12.1
5	4,370	3	9.2	4,522.5	0.00023	200,000	4,379.2	12.5
10	5,490	3	11.6	4,554.0	0.00023	200,000	5,501.6	12.6
25	6,880	3	14.1	4,572.7	0.00023	200,000	6,894.1	12.3
50	7,890	3	16.6	4,595.5	0.00023	200,000	7,906.6	12.6
100	8,870	3	18.1	4,605.1	0.00023	200,000	8,888.1	12.4

[redacted]

Water Balance Using Average Observed Surface Water Arsenic Concentrations In Marsh
CN = 83 TO 86

Kewaunee Marsh Flow Calculations													
	Volume (acre-feet)				Volume (gallons)				Peak Discharge (cfs)				
Storm (yr)	Area 1	Area 2	Area 3		Area 1	Area 2	Area 3		Area 1	Area 2	Area 3	Total	
2	0.47	0.39	0.22		153,144	127,077	71,684		2.29	2.02	1.25	5.56	
5	0.77	0.62	0.37		250,895	202,020	120,560		3.88	3.23	2.11	9.22	
10	0.98	0.77	0.47		319,321	250,895	153,144		4.93	4.02	2.68	11.63	
25	1.19	0.93	0.57		387,747	303,029	185,728		6.01	4.82	3.26	14.09	
50	1.4	1.08	0.67		456,173	351,905	218,311		7.11	5.63	3.86	16.60	
100	1.53	1.17	0.73		498,532	381,230	237,862		7.77	6.12	4.22	18.11	

Summary

Rainfall Event		Kewaunee River (down stream)	
(years)		Flow	As Conc.
		(cfs)	(ug/l)
2		2,705.6	7.6
5		4,379.2	7.7
10		5,501.6	7.8
25		6,894.1	7.6
50		7,906.6	7.8
100		8,888.1	7.7

Water Balance Using Average Observed Surface Water Arsenic Concentrations In Marsh
CN = 83 TO 86

Average Surface Water As Conc (ug/l)				As Conc Flowing from Marsh (ug/l)		
Area 1	Area 2	Area 3				
152	0	9,553			2,210.3	
152	0	9,553			2,250.2	
152	0	9,553			2,265.8	
152	0	9,553			2,275.1	
152	0	9,553			2,286.5	
152	0	9,553			2,291.3	

Water Balance Using Average Observed Surface Water Arsenic Concentrations In Marsh
CN = 83 TO 86

Rainfall Event (years)	Kewaunee River Upstream Flow (cfs)	Kewaunee River Upstream As Conc. (ug/l)	Kewaunee Marsh Flow (cfs)	Kewaunee Marsh As Conc. (ug/l)	Kewaunee Marsh Ground Water Flow (cfs)	Kewaunee Marsh Ground Water As. Conc. (ug/l)	Kewaunee River (down stream) Flow (cfs)	Kewaunee River (down stream) As Conc. (ug/l)
2	2,700	3	5.6	2,210.3	0.00023	200,000	2,705.6	7.6
5	4,370	3	9.2	2,250.2	0.00023	200,000	4,379.2	7.7
10	5,490	3	11.6	2,265.8	0.00023	200,000	5,501.6	7.8
25	6,880	3	14.1	2,275.1	0.00023	200,000	6,894.1	7.6
50	7,890	3	16.6	2,286.5	0.00023	200,000	7,906.6	7.8
100	8,870	3	18.1	2,291.3	0.00023	200,000	8,888.1	7.7

sts

CALCULATION COVER SHEET

PROJECT Kewaunee River Arsenic Transport JOB NO. ______ DIVISION ______

SUBJECT Excel Spreadsheets - Water Balance Calculations FILE NO. ______

CN = 30 CALC. NO. ______

ORIGINATOR MER DATE 5-21-97

CHECKER ______ DATE ______ NO. OF SHEETS 6

RECORD OF ISSUES

NO.	DESCRIPTION	BY	DATE	CHKD.	DATE	APPRD.		
△								
△								
△								
△								
△								
△								

PRELIMINARY CALC. ☐

SUPERSEDED CALC. ☒ FINAL CALC. ☐

BRIEF SUMMARY OF CALCULATIONS INCLUDING SCOPE AND RESULTS

- Excel Spreadsheets for Runoff Curve Number = 30
  1) Water Balance Using Maximum Observed Surface Water Arsenic Concentrations from Marsh
  2) Water Balance using Average Observed Surface Water Arsenic Concentrations from Marsh

Water Balance Using Maximum Observed Surface Water Arsenic Concentrations From Marsh
(CN = 30)

Kewaunee Marsh Flow Calculations												
	Volume (acre-feet)				Volume (gallons)				Peak Discharge (cfs)			
Storm (yr)	Area 1	Area 2	Area 3		Area 1	Area 2	Area 3		Area 1	Area 2	Area 3	Total
2	0.47	0.39	0.22		153,144	127,077	71,684		0.00	0.00	0.00	0.00
5	0.77	0.62	0.37		250,895	202,020	120,560		0.00	0.00	0.00	0.00
10	0.98	0.77	0.47		319,321	250,895	153,144		0.00	0.00	0.00	0.00
25	1.19	0.93	0.57		387,747	303,029	185,728		0.00	0.00	0.00	0.00
50	1.4	1.08	0.67		456,173	351,905	218,311		0.00	0.00	0.00	0.00
100	1.53	1.17	0.73		498,532	381,230	237,862		0.00	0.00	0.00	0.00

Summary

Rainfall Event		Kewaunee River (down stream)	
(year)		Flow	As Conc.
		(cfs)	(ug/l)
2		2,700.0	3.0
5		4,370.0	3.0
10		5,490.0	3.0
25		6,880.0	3.0
50		7,890.0	3.0
100		8,870.0	3.0

Water Balance Using Maximum Observed Surface Water Arsenic Concentrations From Marsh
(CN = 30)

Maximum Surface Water As Conc				As Conc Flowing from Marsh		
(ug/l)					(ug/l)	
Area 1	Area 2	Area 3				
360	0	19,100			0.00	
360	0	19,100			0.00	
360	0	19,100			0.00	
360	0	19,100			0.00	
360	0	19,100			0.00	
360	0	19,100			0.00	

Water Balance Using Maximum Observed Surface Water Arsenic Concentrations From Marsh
(CN = 30)

Rainfall Event (year)	Kewaunee River Upstream Flow (cfs)	Kewaunee River Upstream As Conc. (ug/l)	Kewaunee Marsh Flow (cfs)	Kewaunee Marsh As Conc. (ug/l)	Kewaunee Marsh Ground Water Flow (cfs)	Kewaunee Marsh Ground Water As. Conc. (ug/l)	Kewaunee River (down stream) Flow (cfs)	Kewaunee River (down stream) As Conc. (ug/l)
2	2,700	3	0.0	0.0	0.00023	200,000	2,700.0	3.0
5	4,370	3	0.0	0.0	0.00023	200,000	4,370.0	3.0
10	5,490	3	0.0	0.0	0.00023	200,000	5,490.0	3.0
25	6,880	3	0.0	0.0	0.00023	200,000	6,880.0	3.0
50	7,890	3	0.0	0.0	0.00023	200,000	7,890.0	3.0
100	8,870	3	0.0	0.0	0.00023	200,000	8,870.0	3.0

Water Balance Using Average Observed Surface Water Arsenic Concentrations In Marsh
(CN = 30)

Kewaunee Marsh Flow Calculations

	Volume (acre-feet)			Volume (gallons)			Peak Discharge (cfs)			
Storm (yr)	Area 1	Area 2	Area 3	Area 1	Area 2	Area 3	Area 1	Area 2	Area 3	Total
2	0.47	0.39	0.22	153,144	127,077	71,684	0.00	0.00	0.00	0.00
5	0.77	0.62	0.37	250,895	202,020	120,560	0.00	0.00	0.00	0.00
10	0.98	0.77	0.47	319,321	250,895	153,144	0.00	0.00	0.00	0.00
25	1.19	0.93	0.57	387,747	303,029	185,728	0.00	0.00	0.00	0.00
50	1.4	1.08	0.67	456,173	351,905	218,311	0.00	0.00	0.00	0.00
100	1.53	1.17	0.73	498,532	381,230	237,862	0.00	0.00	0.00	0.00

Summary

Rainfall Event (years)	Kewaunee River (down stream) Flow (cfs)	As Conc. (ug/l)
2	2,700.0	3.0
5	4,370.0	3.0
10	5,490.0	3.0
25	6,880.0	3.0
50	7,890.0	3.0
100	8,870.0	3.0

Water Balance Using Average Observed Surface Water Arsenic Concentrations In Marsh
(CN = 30)

Average Surface Water As Conc (ug/l)				As Conc Flowing from Marsh (ug/l)										
Area 1	Area 2	Area 3												
152	0	9,553			0.0									
152	0	9,553			0.0									
152	0	9,553			0.0									
152	0	9,553			0.0									
152	0	9,553			0.0									
152	0	9,553			0.0									

Water Balance Using Average Observed Surface Water Arsenic Concentrations In Marsh
(CN = 30)

Rainfall Event	Kewaunee River Upstream		Kewaunee Marsh		Kewaunee Marsh Ground Water		Kewaunee River (down stream)	
(years)	Flow (cfs)	As Conc. (ug/l)	Flow (cfs)	As Conc. (ug/l)	Flow (cfs)	As. Conc. (ug/l)	Flow (cfs)	As Conc. (ug/l)
2	2,700	3	0.0	0.0	0.00023	200,000	2,700.0	3.0
5	4,370	3	0.0	0.0	0.00023	200,000	4,370.0	3.0
10	5,490	3	0.0	0.0	0.00023	200,000	5,490.0	3.0
25	6,880	3	0.0	0.0	0.00023	200,000	6,880.0	3.0
50	7,890	3	0.0	0.0	0.00023	200,000	7,890.0	3.0
100	8,870	3	0.0	0.0	0.00023	200,000	8,870.0	3.0

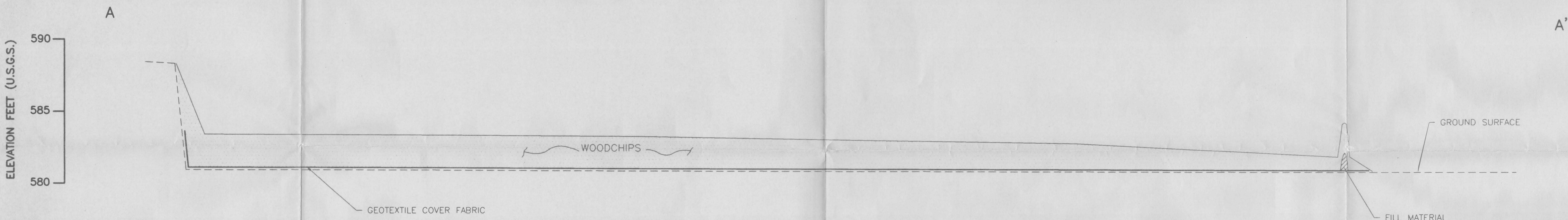
FOX VALLEY & WESTERN LTD.
KEWAUNEE MARSH ARSENIC SITE
KEWAUNEE, WISCONSIN
EXISTING SITE CONDITIONS (MARCH 1996)

DRAWN BY	D.T.B.	DATE	3-29-96
CHECKED BY	M.D.O.	DATE	5-1-96
APPROVED BY	M.T.B.	DATE	5-1-96
CADFILE	C:\DTB\20716XF\SITE96.DWG		

REVISION NO. | DESCRIPTION | DATE | BY

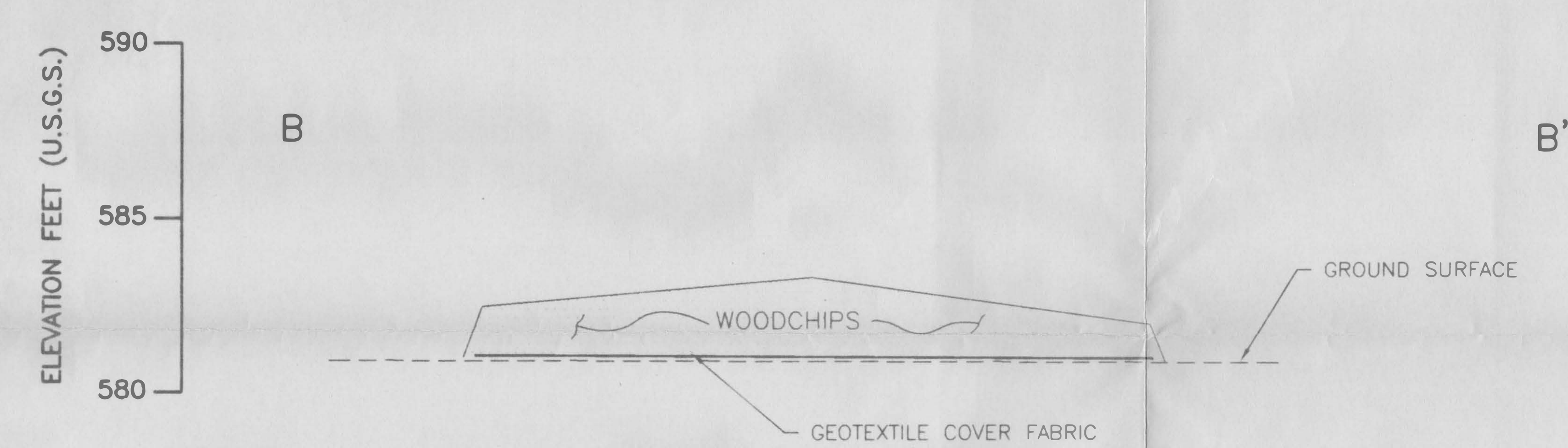
STS Consultants Ltd.
Consulting Engineers

STS PROJECT NUMBER 20716XA
STS PROJECT FILE
SCALE 1"= 60'
SHEET NUMBER 20716XA-AB1



CROSS-SECTION A-A'

SCALE: 1"= 40' HORIZ.
1"= 4' VERT.



CROSS-SECTION B-B'

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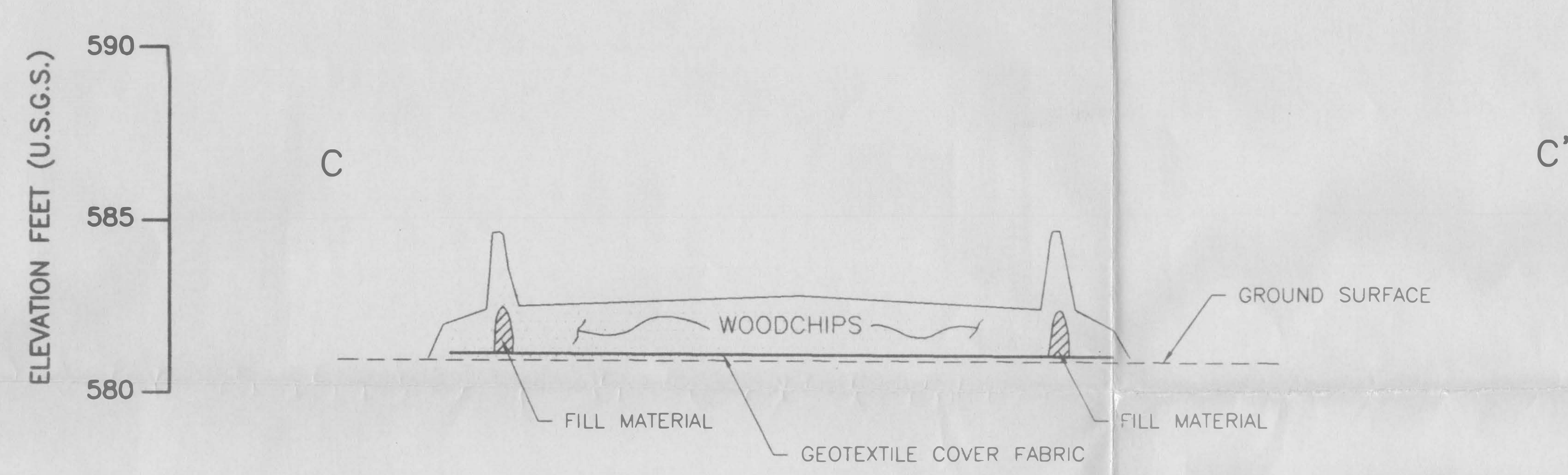
1"= 4' VERT.



CROSS-SECTION C-C'

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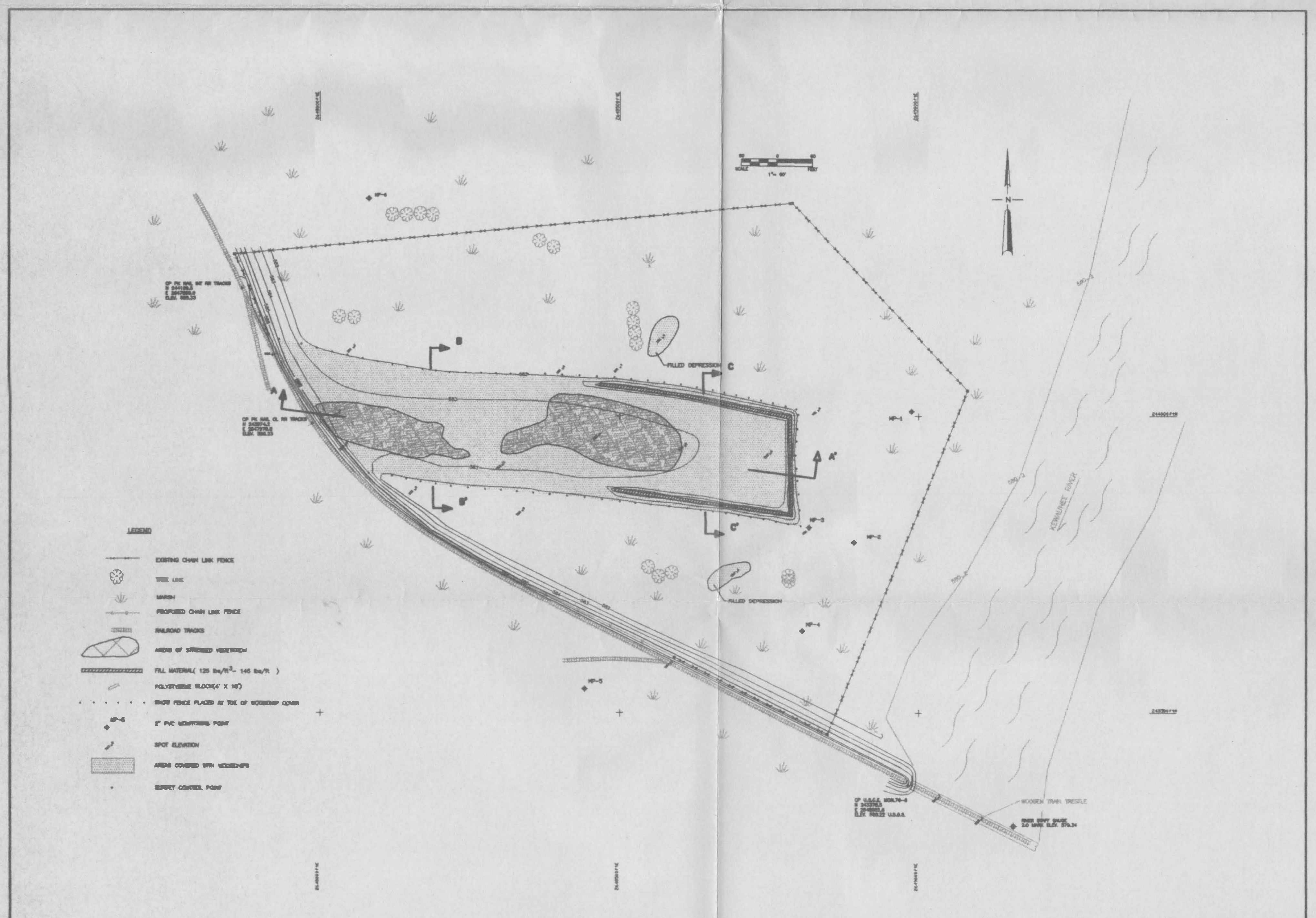
1"= 4' VERT.



CROSS-SECTION INDEX

LEGEND

- WOODCHIPS
- FILL MATERIAL
- GROUND SURFACE
- GEOTEXTILE COVER FABRIC

REVISION NO.	DESCRIPTION	DATE	BY

DRAWN BY	D.T.B.	DATE 3-29-96
CHECKED BY	M.D.O.	DATE 5-1-96
APPROVED BY	M.T.B.	DATE 5-1-96
CADFILE	W:\DWG96\20716XA\AB2.DWG	

FOX VALLEY AND WESTERN LTD.
KEWAUNEE MARSH ARSENIC SITE
KEWAUNEE, WISCONSIN

CROSS-SECTIONS

STS Consultants Ltd.
Consulting Engineers

STS PROJECT NUMBER: 20716XA
STS PROJECT FILE:
SCALE: AS NOTED
SHEET NUMBER: 20716XA-AB2

REVISION NO.	DESCRIPTION	DATE	BY

DRAWN BY D.T.B. DATE 3-29-96

CHECKED BY DATE

APPROVED BY DATE

CADFILE C:\DTB\20716XF\G416A002.DWG

FOX VALLEY & WESTERN LTD.

KEWAUNEE MARSH ARSENIC SITE

KEWAUNEE, WISCONSIN

COVER SPOT ELEVATIONS

STS Consultants Ltd
Consulting Engineers

STS PROJECT NUMBER 20716XA

STS PROJECT FILE

SCALE 1"= 60'

SHEET NUMBER 20716XA-AB3

K:\dwg96\20716\xf\G416A002 Mon May 19 18:21:44 1997 STS Consultants, Ltd., Green Bay, WI