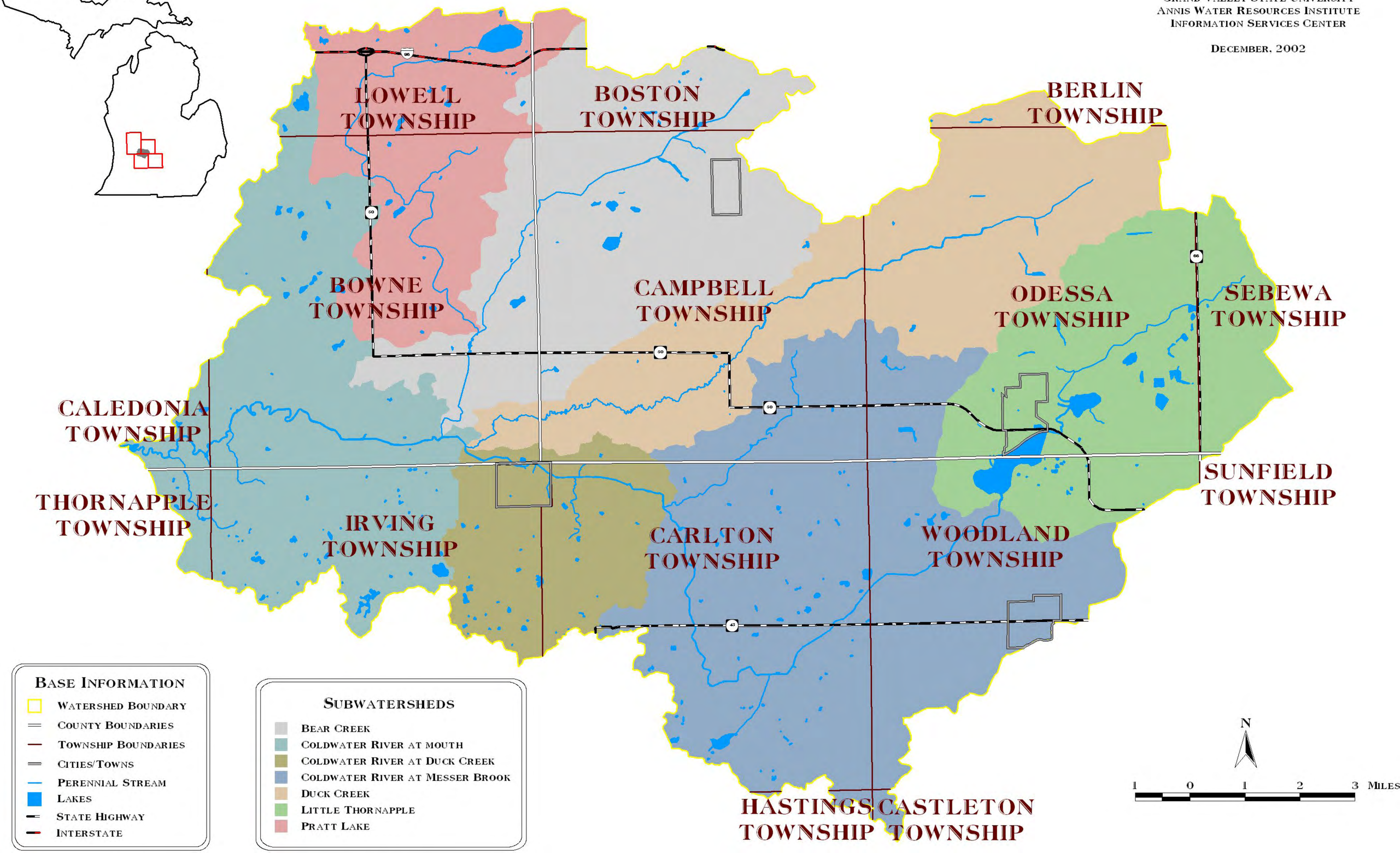
Appendix R

Coldwater River Watershed Subwatersheds

Base Information
Michigan Center For Geographic Information
Michigan Geographic Data Library

Grand Valley State University
Annis Water Resources Institute
Information Services Center

December, 2002



Coldwater River Watershed Subwatersheds

Appendix S

Temperature Comparison Table

Temperatures Collected and Compared to VSEC Classification System				
	Data Collection Source	**Weakly Mean Temperature**	**Degrees of Variation (weekly)**	**VSEC Classified As:**
Coldwater	DNR Data	18.48°	6.27°	Cold Mean with Moderate Variation
	AWRI Data	20.31°	8.77°	Cool Mean With Moderate Variation
Duck	DNR Data	N/A	N/A	N/A
	AWRI Data	19.55°	5.42°	Cool Mean with Low Variation
Tyler	DNR Data	N/A	N/A	N/A
	AWRI Data	17.64°	5.97°	Cold Mean with Low Variation

Temperature data shown in table is from the following two sources:

Jim Dexter. Department of Natural Resources, Fisheries Division. Temperature Recordings for Coldwater River, July 1997.

Annis Water Resources Institute. Temperature Recordings for Coldwater River, July 2002.

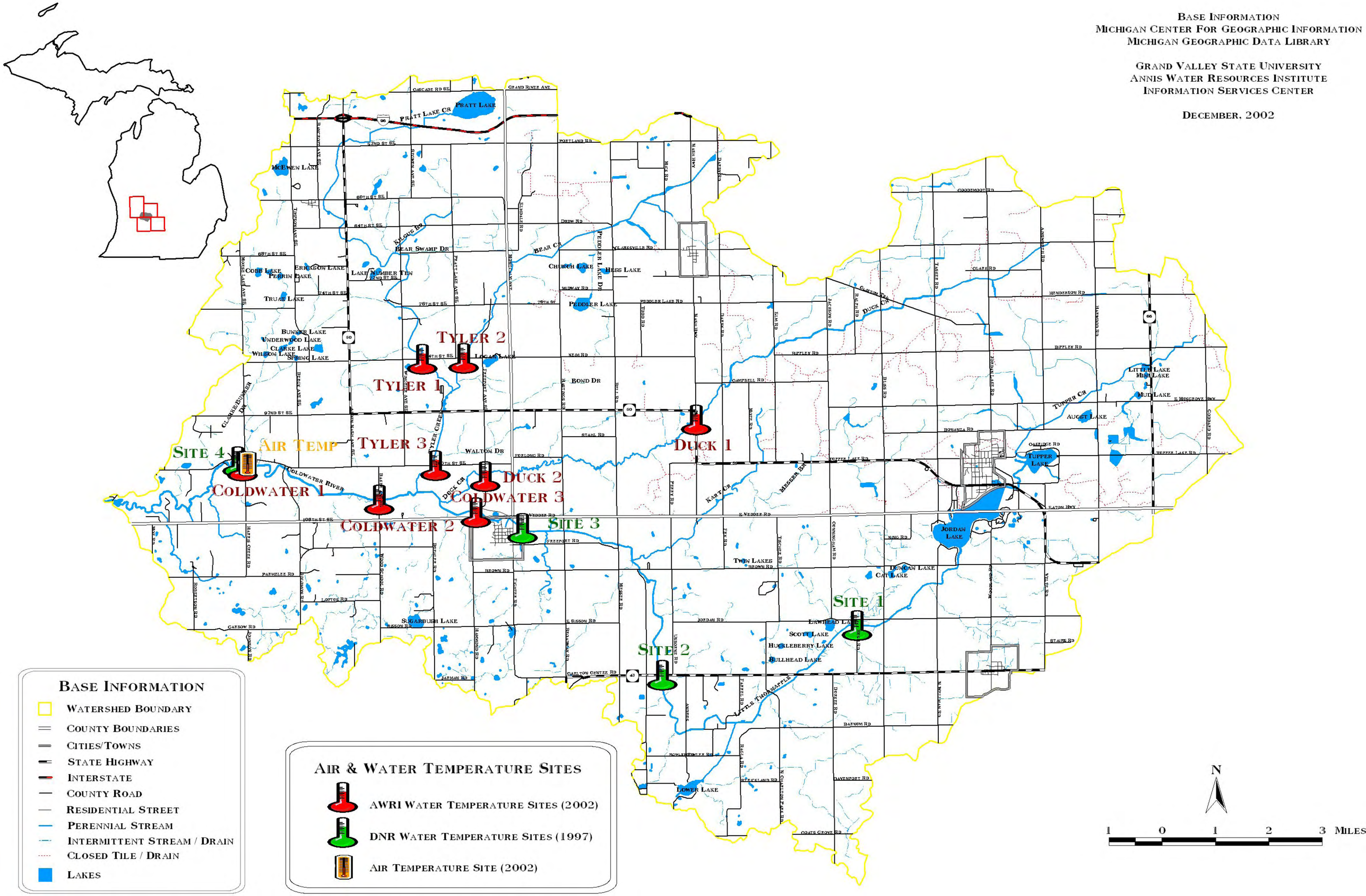
Appendix T

Water Temperature Sampling Sites

Base Information
Michigan Center For Geographic Information
Michigan Geographic Data Library

Grand Valley State University
Annis Water Resources Institute
Information Services Center

December, 2002



Coldwater River Watershed
Air and Water Temperature Sites

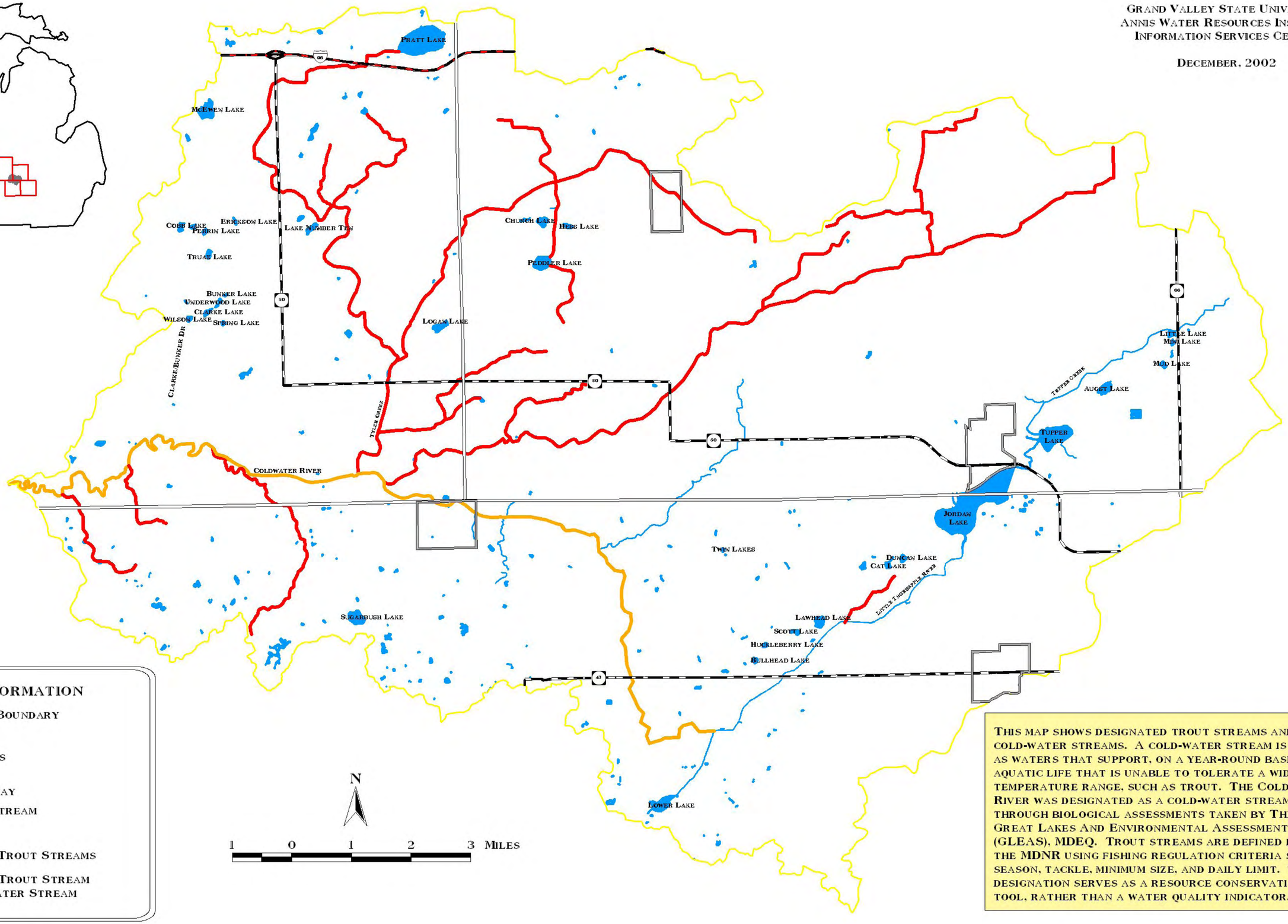
Appendix U

Cold-water Fishery Designated Area for the Coldwater River

Base Information
Michigan Center For Geographic Information
Michigan Geographic Data Library

Grand Valley State University
Annis Water Resources Institute
Information Services Center

December, 2002



Base Information

- Watershed Boundary
- City/Town
- County Lines
- Interstate
- State Highway
- Perennial Stream
- Lakes
- Designated Trout Streams
- Designated Trout Stream and Cold-Water Stream

This map shows designated trout streams and cold-water streams. A cold-water stream is defined as waters that support, on a year-round basis, aquatic life that is unable to tolerate a wide temperature range, such as trout. The Coldwater River was designated as a cold-water stream through biological assessments taken by The Great Lakes And Environmental Assessment (GLEAS), MDEQ. Trout streams are defined by the MDNR using fishing regulation criteria such as season, tackle, minimum size, and daily limit. The designation serves as a resource conservation tool, rather than a water quality indicator.

Coldwater River Watershed
Designated Trout/Cold-Water Streams

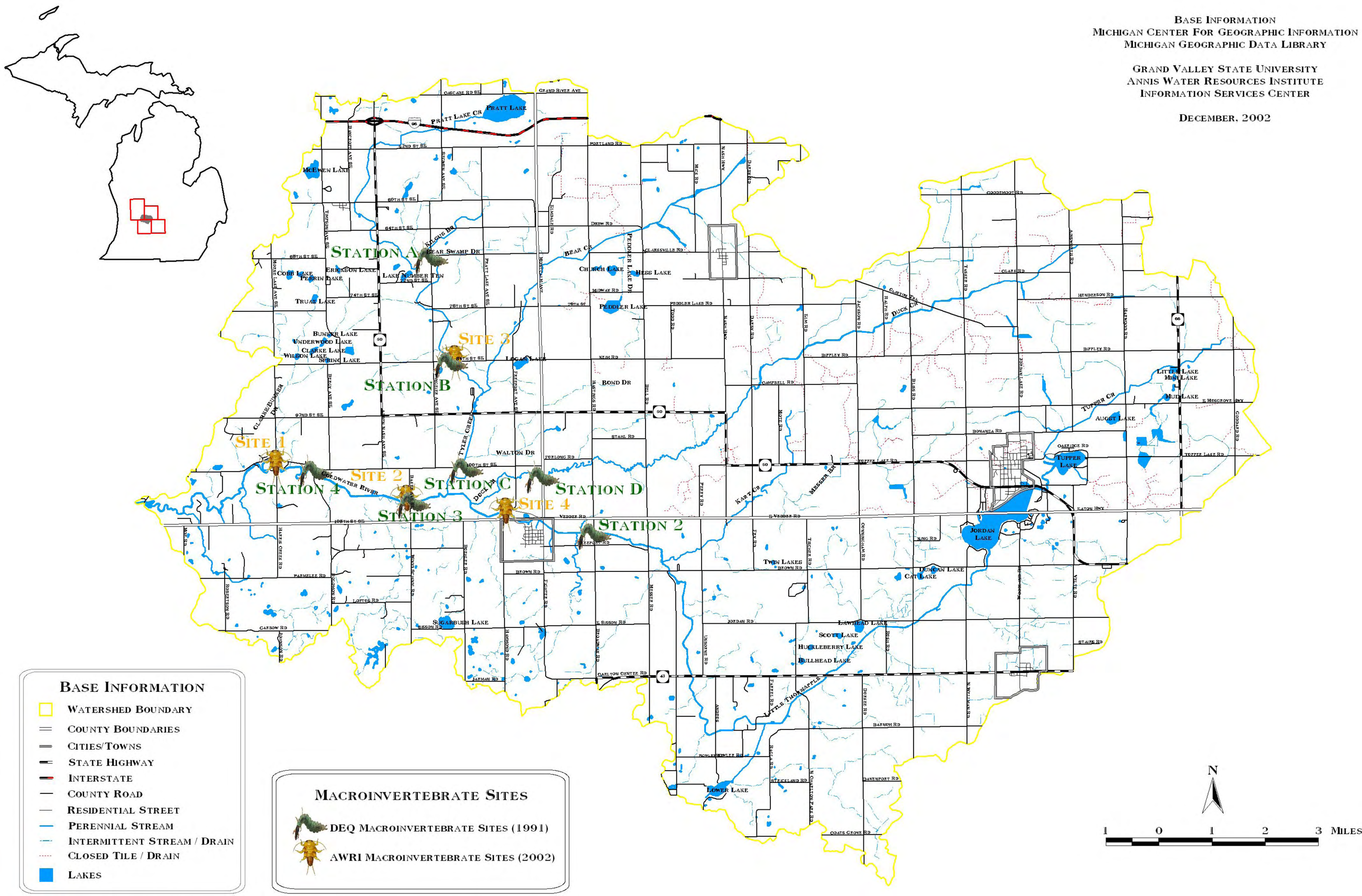
Appendix V

Macroinvertebrate Sampling Sites

Base Information
Michigan Center For Geographic Information
Michigan Geographic Data Library

Grand Valley State University
Annis Water Resources Institute
Information Services Center

December, 2002



Coldwater River Watershed Macroinvertebrate Sites

Appendix V

Volunteer Stream Survey

Single Site Watershed Survey Data Sheet

Date: | Time:
Waterbody Name: | County: | Station #:
Location: | Township: | Sec T R ¼ ¼
Investigator: | Lat: | Long:

Coordinate Determination Method (check the one that applies):
___ GPS ___ GPS w/ DBR ___ Digital mapping software ___ Topographic map ___ Other (describe _____)
Map Scale (if known _____)

Upstream Side/Downstream Side

PHYSICAL HABITAT

BACKGROUND INFORMATION - pg. 18

Event Conditions noted at site	None	Light	Moderate	Heavy	
Days since Rain	≤ 1	2	3	Unknown	
Water Temp./D.O./pH *					
Water Color	Clear	Gray	Brown	Black	Green
Waterbody Type-u/s	Stream	Lake	Impound	Wetland	
Waterbody Type-d/s	Stream	Lake	Impound	Wetland	
Stream Width (ft.)	<10	10-25	25-50	>50	
Avg. Stream Depth (ft.)	<1	1-3	>3	Unknown	
Water Velocity (ft./sec) *					
Stream Flow Type	Dry	Stagnant	L	M	H

PHYSICAL APPEARANCE - pg. 20
(Check all that apply)

Aquatic Plants	Present	Abundant
Floating Algae	Present	Abundant
Filamentous Algae	Present	Abundant
Bacterial Sheen/Slimes	Present	Abundant
Turbidity	Present	Abundant
Oil Sheen	Present	Abundant
Foam	Present	Abundant
Trash	Present	Abundant

SUBSTRATE (%) - pg. 22
(add to 100%)

Boulder – 10 in. diam.	
Cobble/Gravel –10 to .08 in. diam.	
Sand – coarse grain	
Silt/Detritus/Muck - fine grain/organic matter	
Hardpan/Bedrock – solid clay/rock surface	
Artificial – manmade	
Unknown	

INSTREAM COVER – pg. 23
(check all that apply)

Undercut Banks	
Overhanging Vegetation	
Deep Pools	
Boulders	
Aquatic Plants	
Logs or Woody Debris	

RIVER MORPHOLOGY – pg. 23

Riffle	Present		Abundant
Pool	Present		Abundant
Channel	Natural	Recovering	Maintained
Designated Drain	?	Y	N

Highest Water Mark (ft.)	?	<1	1-3	3-5	5-10	>10

STREAM CORRIDOR – pg. 26

Riparian Veg. Width ft.(L)	<10	10-30	30-100	>100
Riparian Veg. Width ft.(R)	<10	10-30	30-100	>100
Bank-Erosion	0	L	M	H
Streamside Land Cover	Bare	Grass	Shr	Trees
Stream Canopy %	<25	25-50		>50

Stream Cross Section

Adjacent Land Uses

Wetlands	L	R
Shrub or Old Field	L	R
Forest	L	R
Pasture	L	R
Crop Residue	L	R
Rowcrop	L	R
Residential Lawns, Parks	L	R
Impervious Surfaces	L	R
Disturbed Ground	L	R
No Vegetation	L	R

* Optional Data Item

Single Site Watershed Survey Data Sheet (page 2)

Date: Station #:

Upstream Side/Downstream Side

POTENTIAL SOURCES (Severity: S – slight; M – moderate; H – high) – pg. 28							
Crop Related Sources	S	M	H	Land Disposal	S	M	H
Grazing Related Sources	S	M	H	On-site Wastewater Systems	S	M	H
Intensive Animal Feeding Operations	S	M	H	Silviculture (Forestry NPS)	S	M	H
Highway/Road/Bridge Maintenance and Runoff (Transportation NPS)	S	M	H	Resource Extraction (Mining NPS)	S	M	H
Channelization	S	M	H	Recreational/Tourism Activities (general)	S	M	H
Dredging	S	M	H	• Golf Courses	S	M	H
Removal of Riparian Vegetation	S	M	H	• Marinas/Recr. Boating (water releases)	S	M	H
Bank and Shoreline Erosion/ Modification/Destruction	S	M	H	• Marinas/Recr. Boating (bank or shoreline erosion)	S	M	H
Flow Regulation/ Modification (Hydrology)	S	M	H	Debris in Water	S	M	H
Upstream Impoundment	S	M	H	Industrial Point Source	S	M	H
Construction: Highway/Road /Bridge/Culvert	S	M	H	Municipal Point Source	S	M	H
Construction: Land Development	S	M	H	Natural Sources	S	M	H
Urban Runoff (Residential/ Urban NPS)	S	M	H	Source(s) Unknown	S	M	H

SITE SUMMARY INFORMATION – pg. 33			
SURVEY DIRECTION	N/A	U/S	D/S
SITE SIMILARITY	?	Y	N
OVERALL SITE RANKING	L	M	H
SITE FOLLOW-UP RANK	L	M	H

COMMENTS:

Section 4: Benthic Macroinvertebrates

4.1 Spend approximately 30 minutes collecting invertebrates, then identify and fill out the sheet below.
4.2 Try to sample from all of the habitats listed below.

Check the types of habitats and substrates from which invertebrates were collected.

_____Riffles	_____Runs	_____Pools
_____Cobbles	_____Margins	_____Undercut Banks / Over-hanging Vegetation
_____Aquatic Plants	_____ Leaf Packs	_____Submerged Wood

_____Other (Please Describe) _____

4.3 Use letter codes **R** and **C** (Rare = 1-10, & Common = 11 or more) to record the approximate numbers of organisms in each taxa found in the stream reach.

Orb Snail

Gilled Snail

Group 1 Sensitive	**Group 2** Somewhat-Sensitive	**Group 3** Tolerant
_____ Beetle adults (Coleoptera)	_____ Alderfly larvae (Megaloptera)	_____ Aquatic worms (Oligochaeta)
_____ Blackfly larvae (Diptera)	_____ Beetle larvae (Coleoptera)	_____ Leeches (Hirudina)
_____ Caddisfly larvae(Trichoptera)	_____ Clams (Pelecypoda)	_____ Midge larvae (Diptera)
_____ Gilled Snails (Gastropoda)	_____ Crane Fly larvae (Diptera)	_____ Pouch snails (Gastropoda)
_____ Hellgrammites (Megaloptera)	_____ Crayfish (Decapoda)	_____ Sowbugs (Isopoda)
_____ Mayfly nymphs (Ephemeroptera)	_____ Damselfly nymphs (Odonata)	_____ True Bugs (Hemiptera)
_____ Stonefly nymphs (Plecoptera)	_____ Dragonfly nymphs (Odonata)	_____ Other Diptera
_____ Water penny (Coleoptera)	_____ Scuds (Amphipoda)	

Pouch Snail

Group 1	**Group 2**	**Group 3**
____# of R's X 5.0 =____	____# of R's X 3.0 =____	____# of R's X 1.1 = ____
____# of C's X 5.3 =____	____# of C's X 3.2 =____	____# of C's X 1.0 = ____
Group 1 Total =____	**Group 2 Total =**____	**Group 3 Total =** ____

Total Stream Quality Score (sum of totals for Groups 1-3) = _____

____Excellent (>48) ____Good (34-48) ____Fair (19-33) ____Poor (<19)

4.4 During the sampling and evaluation, did you observe any fish or wildlife? ( ) Yes ( ) No

If yes, please describe (if possible):

Appendix X

Results of AWRI Macroinvertebrate Survey

Table of Macroinvertebrate Survey 2002				
Insect	**Coldwater Park**	**Coldwater at Baker**	**Tyler at 8h**	**Coldwater at Freeport**
Group 1				
Coleoptera	R	C	R	-
Diptera	-	-	C	-
Ephemeroptera	C	C	C	C
Megaloptera	-	R	-	-
Plecoptera	C	C	R	C
Trichoptera	C	C	C	C
Group 1 total score:	20.9	26.2	25.9	15.9
Group 2				
Amphipoda	C	R	C	C
Coleoptera	R	-	-	R
Decapoda	-	-	C	-
Diptera	R	-	-	-
Pelecypoda	-	R	R	-
Group 2 total score:	9.2	6	9.4	6.2
Group 3				
Diptera (midge)	C	C	C	C
Diptera (other)	-	-	-	C
Hemiptera	-	C	-	C
Isopoda	R	-	-	C
Group 3 total score:	2.1	2	1	4
Total Stream Quality Score:	32.2	34.2	36.3	26.1
	Fair	Good	Good	Fair

Appendix Y

Michigan Department of Environmental Quality, Biological Assessment, 1998

Dex ✓ Coldwater River
Bly ✓ Barry Co

AUG 05 1998

MI/DEQ/SWQ-97/085

RECEIVED

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
SURFACE WATER QUALITY DIVISION
JULY 1998

Fisheries-Plainwell

STAFF REPORT

A BIOLOGICAL ASSESSMENT OF STREAMS IN THE COLDWATER RIVER WATERSHED BARRY, KENT, AND IONIA COUNTIES, MICHIGAN JUNE 23, 1992 AND JULY 2, 1992

Staff of the Great Lakes and Environmental Assessment Section (GLEAS) conducted biological assessments at eight sites on streams in the Coldwater River watershed (Figure 1) on June 23, 1992 and July 2,1992. The objective of the surveys was to document the streams' biological communities, habitat and water quality.

The Coldwater River is designated by Michigan Water Quality Standards as a coldwater stream. The specific coldwater designated reach is from the confluence with the Thornapple River upstream to Route 43 (Carlton Center Road). Fish and aquatic macroinvertebrate communities and habitat were surveyed using GLEAS Procedure #51 (MDNR, 1991) at four sites on the Coldwater River, two sites on Pratt Lake Creek and one site each on Bear (Tyler) Creek and Duck Creek. The results were evaluated and scored using an updated GLEAS Procedure #51 (MDEQ, 1997).

At all stations, the streams are protected as coldwater designated streams. The Coldwater River watershed is tributary to the Thornapple River, a warmwater designated stream, and located in the Southern Michigan Northern Indiana Till Plains ecoregion (Omernik and Gallant, 1988).

SUMMARY

1. Biological sampling locations are provided in Figure 1. Location descriptions are given in Table 3.

2. Fish and aquatic macroinvertebrate community evaluations are listed in Table 1 and Table 2, respectively. Physical habitat metric scores are given in Table 3. Length frequencies for selected fish species are given in Tables 4A-4G. A summary of fish, invertebrate and habitat metric scores is provided in Table 5.

3. **Biological Communities and Habitat**

   Coldwater River
   The absence of trout at all four Coldwater River sites indicated that the coldwater designated use was not supported despite good or excellent habitat ratings (reported below).

   Macroinvertebrate communities were not assessed at Station 1 because of a thunderstorm and continuous rainfall during the day of the site inspection. The

stream banks leading to excessive sedimentation of stream habitat. The headwaters of Duck Creek have been dredged between upper Lake Odessa Road downstream to Darby Road. These headwaters then meander through numerous modified, channelized stream channels to the main stem of Duck Creek.

REFERENCES

MDNR. 1991. Procedure 51 - Qualitative Biological and Habitat Survey Protocols for Wadable Streams and Rivers. Great Lakes & Environmental Assessment Section, Surface Water Quality Division.

MDEQ. 1997. Procedure 51 - Qualitative Biological and Habitat Survey Protocols for Wadable Streams and Rivers. Great Lakes & Environmental Assessment Section, Surface Water Quality Division.

Omernik, J. M. and A. L. Gallant. 1988. Ecoregions of the Upper Midwest States. United States Environmental Protection Agency, Environmental Research Laboratory, EPA/600/3-88/037.

Walterhouse, M. 1997. A biological survey of Pratt Lake Creek, Kent County, Michigan, August 31, 1995. Michigan Department of Environmental Quality, Surface Water Quality Division, Report No. MI/DEQ/SWQ-97/048.

Field Survey: Roger Jones, Aquatic Biologist
Jim Rossio, Environmental Quality Analyst
John Wuycheck, Aquatic Biologist
Surface Water Quality Division

Report By: John Wuycheck, Aquatic Biologist
Sara Synnestvedt, Aquatic Biologist
Surface Water Quality Division
Water Quality Appraisal Unit South

Table 1A. Qualitative fish sampling results for Coldwater River (Kent/Barry Counties, Michigan), a second and third order, coldwater designated stream located in the S. Michigan/N. Indiana Till Plains ecoregion, 23 June and 2 July 92.

TAXA	STATION 1 u/s Brown Rd.	STATION 2 u/s Broadway Rd.	STATION 3 u/s Baker Rd.	STATION 4 u/s Coldwater Rd.
Cyprinidae (minnows and carps)				
Nocomis biguttatus (Horneyhead)		1		
Semotilus atromaculatus (Creek)	10	11	21	13
Luxilus cornutus (Common shiner)			3	1
Rhinichthys atratulus (Blacknose d.)	125	177	17	15
Cottidae (sculpins)				
Cottus bairdii (Mottled sculpin)			56	61
Catostomidae (suckers)				
Catostomus commersoni (W. sucker)		5	2	4
Centrarchidae (sunfish)				
Lepomis cyanellus (Green sunfish)				1
Micropterus salmoides (Lm. bass)				2
Percidae (perch)				
Etheostoma nigrum (Johnny darter)	5	3	5	1
Percina maculata (Blackside d.)		1	2	4
TOTAL INDIVIDUALS	140	198	106	102
TOTAL NUMBER OF TAXA	3	6	7	9
Number of hybrid sunfish	0	0	0	0
Number of anomalies	0	0	0	0
Percent anomalies	0.000	0.000	0.000	0.000
Percent salmonids	0.000	0.000	0.000	0.000
Reach sampled	150	300	500	300
Area sampled (sq ft)	4,500	6,000	22,500	9,000
Density (# fish/sq ft)	0.031	0.033	0.005	0.011
Gear				
FISH COMMUNITY CATEGORY	Not Meeting Designated Uses	Not Meeting Designated Uses	Not Meeting Designated Uses	Not Meeting Designated Uses

Table 2A. Qualitative macroinvertebrate sampling results for the Coldwater River (Kent/Barry Counties, Michigan), a second and third order, coldwater designated stream located in the S. Michigan/N. Indiana Till Plains ecoregion, 23 June 92 and

TAXA	STATION 2 u/s Broadway Rd.	STATION 3 u/s Baker Rd.	STATION 4 u/s Coldwater Rd.
PLATYHELMINTHES (flatworms)			
Turbellaria	1		
BRYOZOA (moss animals)		1	
ANNELIDA (segmented worms)			
Oligochaeta (worms)			2
ARTHROPODA			
Crustacea			
Amphipoda (scuds)	12	4	10
Decapoda (crayfish)		8	8
Isopoda (sowbugs)			2
Insecta			
Ephemeroptera (mayflies)			
Baetidae	8	8	4
Ephemerellidae	5		2
Heptageniidae	8	10	8
Siphlonuridae			1
Odonata			
Anisoptera (dragonflies)			
Gomphidae		2	
Zygoptera (damselflies)			
Calopterygidae			2
Plecoptera (stoneflies)			
Perlidae		2	2
Perlodidae	10	12	14
Pteronarcyidae			1
Hemiptera (true bugs)			
Corixidae	2	4	4
Gerridae	2	2	2
Veliidae			1
Trichoptera (caddisflies)			
Brachycentridae			1
Glossosomatidae	15		
Helicopsychidae	4	2	
Hydropsychidae	6	12	3
Leptoceridae			3
Limnephilidae	12	14	8
Philopotamidae	1		
Coleoptera (beetles)			
Gyrinidae (adults)			3
Hydrophilidae (total)	3		3
Elmidae		5	3
Diptera (flies)			
Chironomidae	8	8	8
Simuliidae	2		8
MOLLUSCA			
Gastropoda (snails)			
Ancylidae (limpets)			
Lymnaeidae	1		
Physidae			8
Pelecypoda (bivalves)			
Sphaeriidae (clams)	1		2
TOTAL INDIVIDUALS	101	94	113

Table 2A. Qualitative macroinvertebrate sampling results for Coldwater River tributaries, Bear Creek and Duck Creek (Kent/Ionia Counties, Michigan), second order, coldwater designated streams located in the S. Michigan/N. Indiana Till Plains ecoregion, 2 July 92.

TAXA	STATION A Pratt Lk. Cr. Wingeier Rd.	STATION B Pratt Lk. Cr. 84th St.	STATION C Bear Creek (Tyler) 100th St.	STATION D Duck Creek Montcalm Rd.
PLATYHELMINTHES (flatworms)				
Turbellaria		3		
BRYOZOA (moss animals)		1		
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	15	15	14	10
Decapoda (crayfish)		5	8	5
Isopoda (sowbugs)			2	
Insecta				
Ephemeroptera (mayflies)				
Baetidae	15	10	10	5
Heptageniidae		8	5	8
Odonata				
Anisoptera (dragonflies)				
Aeshnidae				8
Gomphidae				2
Zygoptera (damselflies)				
Calopterygidae			2	
Plecoptera (stoneflies)				
Perlodidae				6
Hemiptera (true bugs)				
Corixidae		8	3	
Gelastocoridae	1			
Gerridae	1	2	2	2
Mesoveliidae				4
Naucoridae			1	
Trichoptera (caddisflies)				
Helicopsychidae			1	
Hydropsychidae		8	5	5
Limnephilidae		8	6	2
Coleoptera (beetles)				
Dytiscidae (total)	8	5	1	
Haliplidae (adults)			1	
Hydrophilidae (total)	1		1	
Elmidae			1	
Diptera (flies)				
Chironomidae	4	5	8	15
Simuliidae	5		8	
Tabanidae		3		
MOLLUSCA				
Gastropoda (snails)				
Ancylidae (limpets)				
Physidae			1	3
Pelecypoda (bivalves)				
Sphaeriidae (clams)				4
TOTAL INDIVIDUALS	50	81	80	79

Table 3. Habitat evaluation for Coldwater River (Kent/Barry Counties, Michigan), a second and third order, coldwater designated stream located in the S. Michigan/N. Indiana Till Plains ecoregion, 23 June 92 or 2 July 92.

HABITAT METRIC	STATION 1 u/s Brown Rd.	STATION 2 u/s Broadway Rd.	STATION 3 u/s Baker Rd.	STATION 4 u/s Coldwater Rd.
Bottom Substrate Avail. Cover (20):	15	15	20	20
Embeddedness (20):	6	20	16	11
Velocity:Depth (20):	16	6	6	20
Flow Stability (15):	12	15	15	15
Bottom Depos. (15):	9	15	15	14
Pools-Riffles-Runs-Bends (15):	11	3	3	14
Bank Stability (10):	3	10	6	10
Bank Vegetative Stability (10):	6	9	9	10
Stream Cover (10):	9	8	8	8
TOTAL SCORE (135):	87	101	98	122
HABITAT RATING:	GOOD (SLIGHTLY IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)	EXCELLENT (NON-IMPAIRED)
Date:	23 June 92	02 July 92	02 July 92	02 July 92
Weather:	Cloudy		Sunny	Cloudy
Air Temperature:	66 Deg. F.	85 Deg. F.	74 Deg. F.	68 Deg. F.
Water Temperature:	59 Deg. F.	65 Deg. F.	60 Deg. F.	60 Deg. F.
Ave. Stream Width:	30 Feet	20 Feet	45 Feet	30 Feet
Ave. Stream Depth:	1 Feet	1.5 Feet	1.5 Feet	1.5 Feet
Surface Velocity:	0.5 Ft./Sec.	1 Ft./Sec.	0.5 Ft./Sec.	1 Ft./Sec.
Estimated Flow:	15 CFS	30 CFS	33.75 CFS	45 CFS
Stream Modifications:				
Nuisance Plants (Y/N):	N	N	N	N
Report Number:	97/085	97/085	97/085	97/085
STORET No.:				
Stream Name:	Coldwater River	Coldwater River	Coldwater River	Coldwater River
Road Crossing/Location:	u/s Brown Rd.	u/s Broadway Rd.	u/s Baker Rd.	u/s Coldwater Rd.
County Code:	08	08	41	41
TRS:	T4NR8WS9	T4NR8WS5	T5NR9WS34	T5NR9WS32
Latitude (dd):	42.7547	42.7658	42.7747	42.7836
Longitude (dd):	85.2631	85.2903	85.3583	85.3928
Ecoregion:	SMNITP	SMNITP	SMNITP	SMNITP
Stream Type:	Coldwater	Coldwater	Coldwater	Coldwater
USGS Basin Code:	04050007	04050007	04050007	04050007

COMMENTS:

Table 4A. Length frequencies for selected fish species collected at Station 1 on the Coldwater River, Barry County, 23 June 1992.

Species / Length (inches)	Creek Chub
1	2
2	3
3	5
Total	**10**

Table 4B. Length frequencies for selected fish species collected at Station 2 on the Coldwater River, Barry County, 2 July 1992.

Species / Length (inches)	Creek Chub	White Sucker	Hornyhead Chub
1			
2	8	1	
3	2	1	
4	1	3	1
Total	**11**	**5**	**1**

Table 4C. Length frequencies for selected fish species collected at Station 3 on the Coldwater River, Kent County, 2 July 1992.

Species / Length (inches)	Creek Chub	White Sucker	Common Shiner
1	1		
2	4		
3	7	1	1
4	3	1	
5	6		2
6			
Total	**21**	**2**	**3**

Table 4F. Length frequencies for selected fish species collected at Station C on Bear (Tyler) Creek; Kent County, 2 July 1992.

Species / Length (inches)	Creek Chub	White Sucker	Brown Trout
1			
2	1	2	1
3	3		
4	4	3	
5			
6	1	2	
7			
8		1	
9			
10			
11			
12		1	
13			
14		5	
Total	**9**	**14**	**1**

Table 4G. Length frequencies for selected fish species collected at Station D on Duck Creek, Ionia County, 2 July 1992.

Species / Length (inches)	Creek Chub	White Sucker	Northern Hogsucker	Comm on Shiner	Brown Trout
1					
2	8			1	
3	6	1		1	
4	1			1	
5	3	4			
6	3	2	1		1
7	1	1			
8		1	1		
Total	**22**	**9**	**2**	**3**	**1**

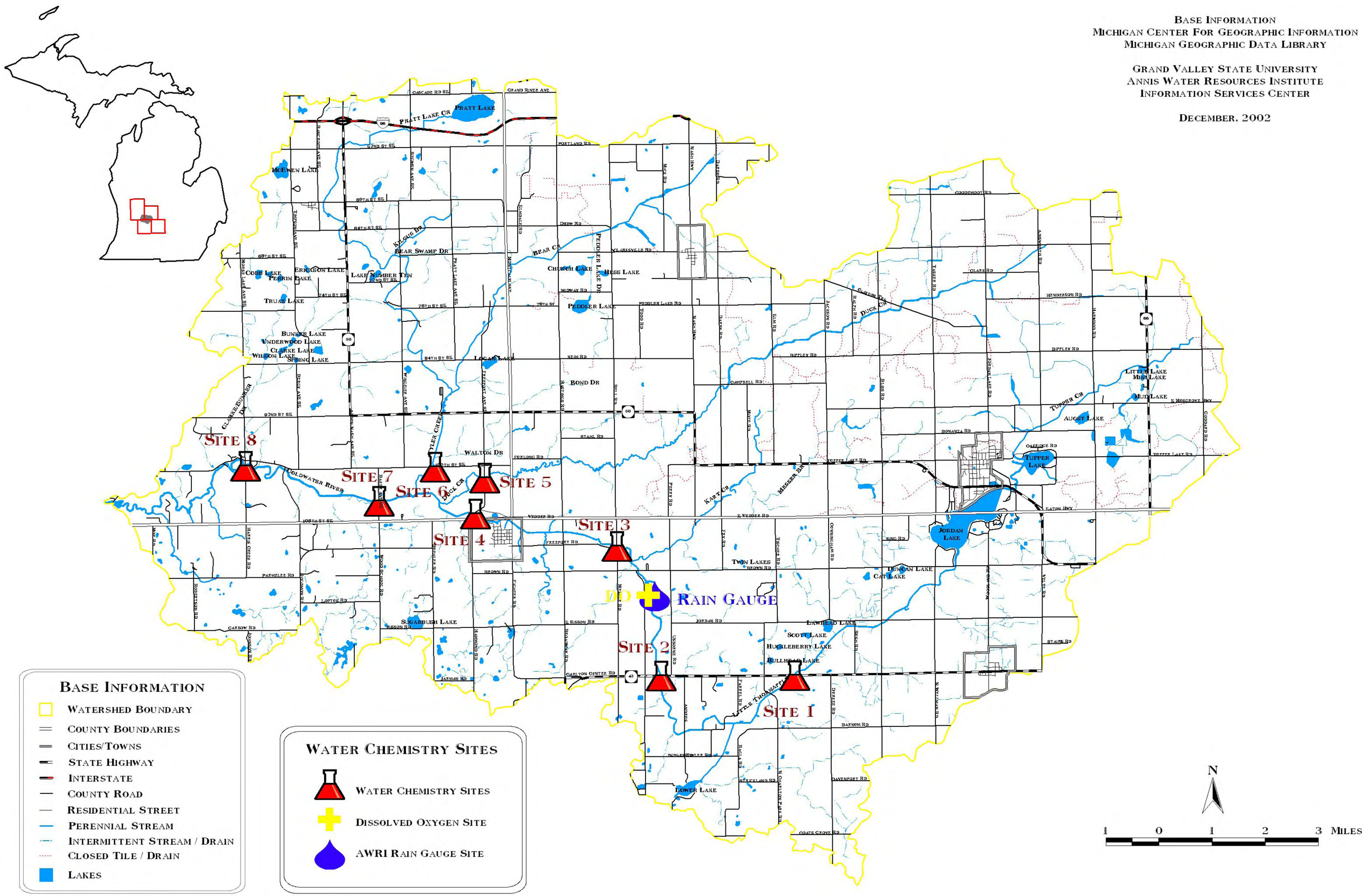
Appendix Z

Water Chemistry Sampling Sites

Base Information
Michigan Center For Geographic Information
Michigan Geographic Data Library

Grand Valley State University
Annis Water Resources Institute
Information Services Center

December, 2002



Coldwater River Watershed
Water Chemistry Sites

Appendix AA

Complete Set of Water Chemistry Results

Complete Set of Total Suspended Solids (TSS) Results for the Coldwater River Watershed								
TSS (mg/L)	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8
2/27/2001	14	8	10	11	10	17	14	28
3/13/2001	3	2	2	1	4	4	1	5
3/27/2001	4	3	2	2	1	1	2	2
4/10/2001	6	6	6	5	3	5	6	7
4/24/2001	7	12	12	17	7	7	16	23
5/8/2001	3	3	1	3	3	2	3	8
5/22/2001	16	7	11	14	27	29	23	32
6/26/2001	27	16	13	12	21	10	27	10
7/10/2001	11	6	5	5	4	1	3	4
7/24/2001	12	9	8	5	12	3	7	10
8/14/2001	15	6	5	5	5	2	3	6
8/28/2001	10	8	8	7	11	3	5	8
9/11/2001	8	8	10	7	4	5	5	5
9/25/2001	11	9	7	9	4	4	5	7
10/9/2001	5	2	2	2	2	1	1	3
10/23/2001	5	5	2	9	1	4	3	3
11/13/2001	4	3	4	3	1	2	1	2
11/27/2001	3	4	4	3	1	2	2	3
12/4/2001	4	7	7	7	5	6	6	9
12/18/2001	7	13	17	17	19	13	16	18
1/8/2002	9	9	7	6	4	7	5	5
1/22/2002	10	10	7	8	6	5	6	7
2/12/2002	5	3	9	7	11	3	8	7
2/26/2002	7	6	8	8	8	3	7	8
3/12/2002	15	25	32	35	14	11	27	30
3/26/2002	5	5	5	5	1	1	3	2
4/9/2002	31	39	53	53	72	140	110	110
4/23/2002	4	4	3	2	1	1	2	3
5/14/2002	12	12	17	18	20	22	25	24
5/28/2002	5	7	6	6	3	3	4	10
6/12/2002	4	4	6	6	4	4	7	5
6/25/2002	8	5	5	7	4	4	5	8
7/9/2002	30	1	3	11	3	6	8	6
8/13/2002								
8/27/2002	7	8	22	11	5	7	26	16

"Rule 50 of the Michigan Water Quality Standards (Part 4 of Act 451) states that waters of the state shall not have any of the following unnatural physical properties in quantities which are or may become injurious to any designated use: turbidity, color, oil films, floating solids, foam, settleable solids, suspended solids, and deposits. This kind of rule, which does not establish a numerical level, is known as a "narrative standard."

Most people consider water with a TSS concentration less than 20 mg/l to be clear. Water with TSS levels between 40 and 80 tends to appear cloudy, while water with concentrations over 150 mg/l usually appears dirty. The nature of the particles that comprise the suspended solids may cause these numbers to vary." (DEQ, 1994d)

Complete Set of Total Phosphate Results for the Coldwater River Watershed								
Phosphate (mg/L)	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**
2/27/2001	0.150	0.160	0.190	0.210	0.300	0.410	0.250	0.280
3/13/2001	0.080	0.070	0.060	0.060	0.060	0.080	0.070	0.070
3/27/2001	0.070	0.060	0.060	0.050	0.030	0.040	0.040	0.040
4/10/2001	0.100	0.080	0.060	0.060	0.040	0.070	0.060	0.050
4/24/2001	0.091	0.117	0.133	0.112	0.077	0.086	0.099	0.097
5/8/2001	0.062	0.100	0.093	0.076	0.066	0.058	0.070	0.076
5/22/2001	0.100	0.200	0.200	0.200	0.170	0.250	0.210	0.200
6/26/2001	0.090	0.073	0.065	0.060	0.066	0.048	0.059	0.062
7/10/2001	0.064	0.062	0.036	0.034	0.039	0.023	0.024	0.027
7/24/2001	0.061	0.078	0.059	0.054	0.078	0.077	0.074	0.060
8/14/2001	0.063	0.065	0.048	0.042	0.047	0.026	0.031	0.033
8/28/2001	0.041	0.056	0.045	0.040	0.048	0.030	0.046	0.032
9/11/2001	0.110	0.068	0.075	0.050	0.080	0.030	0.037	0.033
9/25/2001	0.132	0.060	0.041	0.048	0.018	0.010	0.023	0.018
10/9/2001	0.040	0.041	0.024	0.021	0.023	0.014	0.017	0.023
10/23/2001	0.100	0.096	0.082	0.260	0.049	0.040	0.089	0.064
11/13/2001	0.075	0.063	0.049	0.044	0.022	0.023	0.025	0.027
11/27/2001	0.076	0.066	0.043	0.041	0.036	0.042	0.035	0.038
12/4/2001	0.062	0.077	0.074	0.075	0.056	1.100	0.070	0.078
12/18/2001	0.100	0.130	0.130	0.130	0.110	0.110	0.120	0.120
1/8/2002	0.063	0.055	0.046	0.044	0.031	0.038	0.037	0.036
1/22/2002	0.089	0.055	0.045	0.052	0.025	0.020	0.030	0.029
2/12/2002	0.053	0.066	0.060	0.064	0.060	0.062	0.051	0.058
2/26/2002	0.052	0.053	0.052	0.052	0.043	0.045	0.049	0.049
3/12/2002	0.088	0.140	0.140	0.130	0.150	0.100	0.130	0.140
3/26/2002	0.054	0.048	0.042	0.041	0.027	0.027	0.030	0.031
4/9/2002	0.190	0.220	0.260	0.260	0.340	0.430	0.370	0.310
4/23/2002	0.054	0.045	0.030	0.028	0.037	0.024	0.022	0.024
5/14/2002	0.130	0.110	0.120	0.120	0.140	0.220	0.170	0.160
5/28/2002	0.062	0.062	0.049	0.039	0.034	0.044	0.039	0.037
6/12/2002	0.120	0.076	0.066	0.087	0.058	0.058	0.140	0.063
6/25/2002	0.076	0.092	0.070	0.100	0.055	0.055	0.056	0.053
7/9/2002	0.130	0.088	0.076	0.078	0.085	0.110	0.069	0.059
8/13/2002	0.066	0.077	0.053	0.042	0.063	0.031	0.036	0.037
8/27/2002	0.065	0.074	0.057	0.049	0.063	0.045	0.049	0.046

Rule 60 of the Michigan Water Quality Standards (Part 4 of Act 451) limits phosphorus concentrations in rivers and streams to 1 mg/l (DEQ, 1994b). Without having a Total Maximum Daily Load assigned to this water body 1 mg/l of total phosphorus was used for assessment of phosphorus levels.

Complete Set of Fecal Coliform Results for the Coldwater River Watershed								
Fecal Coliform								
(colonies/ 100 ML)	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**
2/27/2001	200	100	200	100	200	100	100	220
3/13/2001	33	50	17	50	117	50	17	50
3/27/2001	17	33	17	33	83	50	33	100
4/10/2001	50	50	67	100	67	67	450	150
4/24/2001	67	200	317	383	67	417	900	483
5/8/2001	267	133	167	133	300	200	183	17
5/22/2001	183	17	33	117	.	.	283	500
6/26/2001	300	100	100	100	500	700	200	100
7/10/2001	250	283	183	567	450	750	350	467
7/24/2001	283	283	383	367	.	.	.	600
8/14/2001	450	417	467	267	433	700	433	317
8/28/2001	417	283	600	467	467	1200	1100	800
9/11/2001	417	217	350	1100	.	834	700	700
9/25/2001	683	500	400	500	1384	700	733	867
10/9/2001	167	67	33	167	167	167	67	67
10/23/2001	175	75	0	5000	200	2250	975	.
11/13/2001	400	50	200	25	225	250	100	625
11/27/2001	125	1100	175	150	225	450	75	150
12/4/2001	50	25	50	250	325	150	325	225
12/18/2001	125	125	50	150	700	1125	225	775
1/8/2002	25	25	50	0	25	50	25	125
1/22/2002	50	25	0	75	50	100	25	0
2/12/2002	0	50	50	100	100	175	0	100
2/26/2002	0	0	25	50	125	50	50	0
3/12/2002	33	50	83	117	383	67	67	133
3/26/2002	17	0	0	33	33	0	100	100
4/9/2002	267	233	400	325	1300	500	1125	600
4/23/2002	0	25	200	50	50	75	150	100
5/14/2002	125	325	175	250	700	375	475	125
5/28/2002	100	25	25	125	225	125	50	75
6/12/2002	5000	50	50	25	300	300	0	200
6/25/2002	400	150	200	350	275	300	325	175
7/9/2002	6450	1250	1575	.	1100	.	3600	1500
8/13/2002	700	375	275	2825	1400	475	150	600
8/27/2002	2300	375	150	300	350	750	300	400

"Rule 62 of the Michigan Water Quality Standard (Part 4 of Act 451 limits the concentration of microorganisms in the surface waters of the state and surface water discharges. Discharges containing treated or untreated human sewage shall not contain more than 200 fecal coliform bacteria per 100 ml water as a monthly average and 400 fecal coliform bacteria per 100 ml water as a 7-day average". (DEQ)

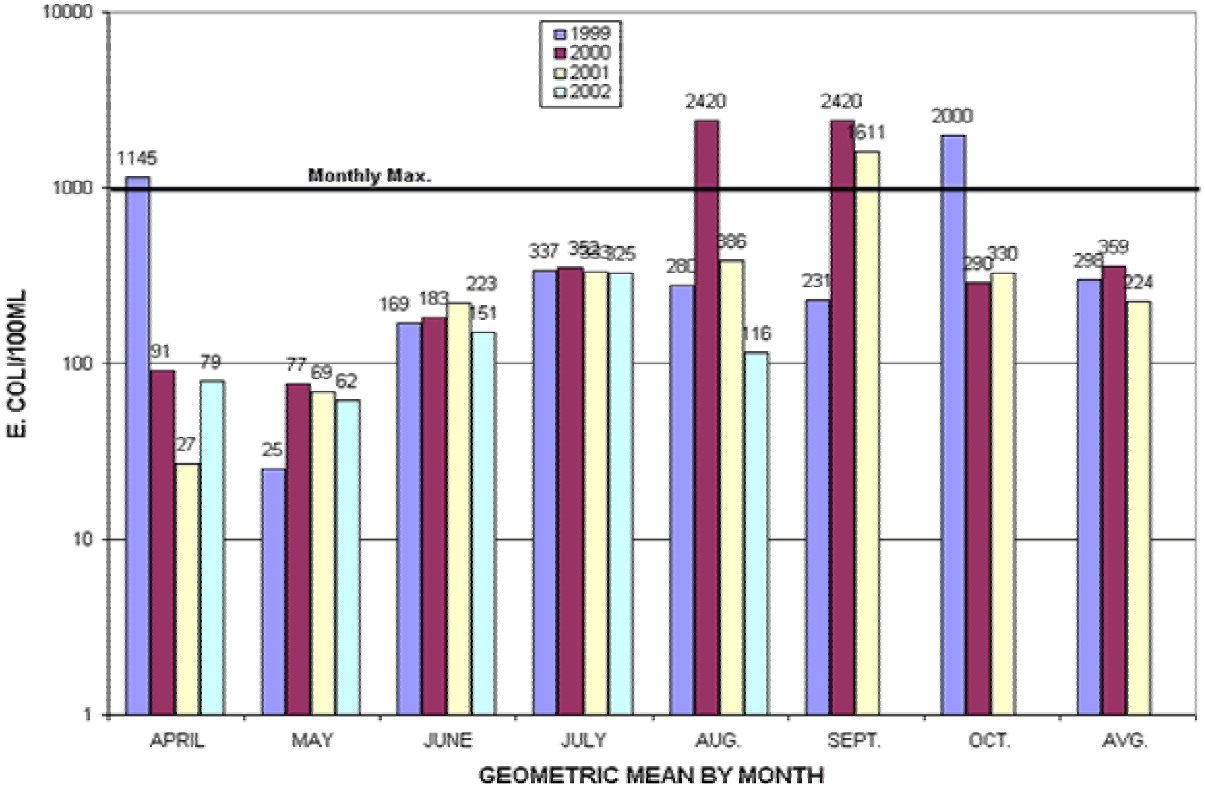
Complete Set of Ammonia (NH3-N) Results for the Coldwater River Watershed								
Ammonia (mg/L)	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**
2/27/2001	0.300	0.400	0.300	0.300	0.300	0.400	0.400	0.300
3/13/2001	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100
3/27/2001	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100
4/10/2001	0.130	0.100	0.100	0.100	0.100	0.100	0.100	0.100
4/24/2001	0.120	0.110	0.110	0.120	0.100	0.100	0.100	0.100
5/8/2001	0.170	0.120	0.100	0.100	0.100	0.100	0.100	0.100
5/22/2001	0.270	0.250	0.250	0.200	0.150	0.270	0.220	0.230
6/26/2001	0.140	0.075	0.051	0.045	0.057	0.043	0.050	0.060
7/10/2001	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100
7/24/2001	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100
8/14/2001	0.080	0.061	0.040	0.025	0.025	0.025	0.025	0.025
8/28/2001	0.067	0.053	0.033	0.018	0.040	0.035	0.021	0.032
9/11/2001	0.120	0.066	0.038	0.020	0.045	0.016	0.010	0.021
9/25/2001	0.091	0.110	0.040	0.017	0.014	0.010	0.010	0.010
10/9/2001	0.061	0.010	0.010	0.010	0.010	0.010	0.010	0.010
10/23/2001	0.012	0.016	0.062	0.040	0.011	0.015	0.024	0.039
11/13/2001	0.200	0.065	0.060	0.051	0.021	0.023	0.025	0.031
11/27/2001	0.090	0.052	0.026	0.029	0.013	0.010	0.010	0.019
12/4/2001	0.015	0.062	0.082	0.010	0.020	0.018	0.049	0.042
12/18/2001	0.560	0.270	0.180	0.160	0.029	0.054	0.081	0.060
1/8/2002	0.180	0.130	0.110	0.084	0.026	0.017	0.048	0.037
1/22/2002	0.170	0.099	0.077	0.066	0.025	0.027	0.034	0.033
2/12/2002	0.076	0.030	0.021	0.016	0.024	0.010	0.011	0.011
2/26/2002	0.100	0.065	0.054	0.053	0.021	0.031	0.040	0.040
3/12/2002	0.063	0.045	0.100	0.037	0.063	0.077	0.037	0.049
3/26/2002	0.045	0.043	0.063	0.061	0.063	0.010	0.040	0.010
4/9/2002	0.140	0.110	0.140	0.180	0.170	0.280	0.230	0.160
4/23/2002	0.170	0.360	0.350	0.140	0.280	0.320	0.430	0.058
5/14/2002	0.120	0.150	0.130	0.110	0.130	0.190	0.150	0.150
5/28/2002	0.030	0.013	0.015	0.019	0.015	0.010	0.014	0.010
6/12/2002	0.120	0.034	0.010	0.029	0.047	0.022	0.120	0.010
6/25/2002	0.120	0.045	0.025	0.013	0.010	0.010	0.010	0.014
7/9/2002	0.100	0.039	0.036	0.034	0.057	0.110	0.044	0.046
8/13/2002	0.140	0.120	0.110	0.090	0.120	0.095	0.094	0.120
8/27/02	0.220	0.160	0.140	0.140	0.140	0.120	0.130	0.150

Ammonia concentrations above 0.3 to 0.4 mg/l are toxic to trout fry (DNR, 1975).

Appendix BB

E. coli at Freeport RD, Kent County Health Department

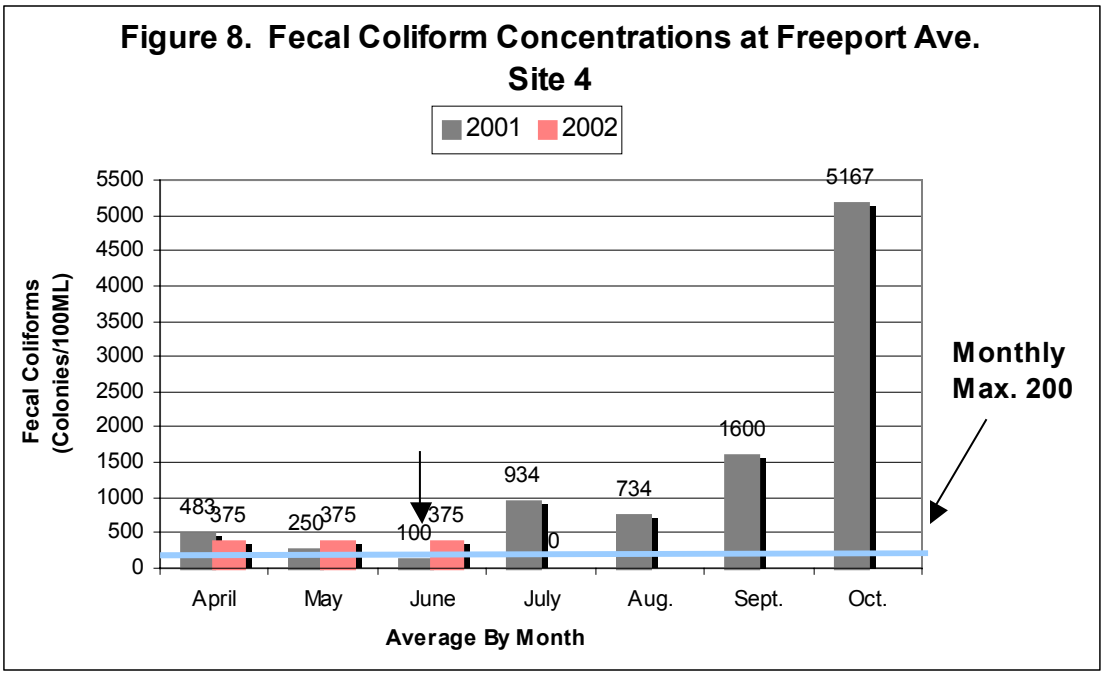
E. COLI at Freeport RD, Kent County Health Department (Access Kent, 2002)



Appendix CC

Fecal Coliform at Freeport RD, AWRI Samples

Fecal Coliform Concentrations at Freeport RD and the Coldwater River



*Arrows indicate bars representing one sampling event. Bars without arrows represent the average of two sampling events.

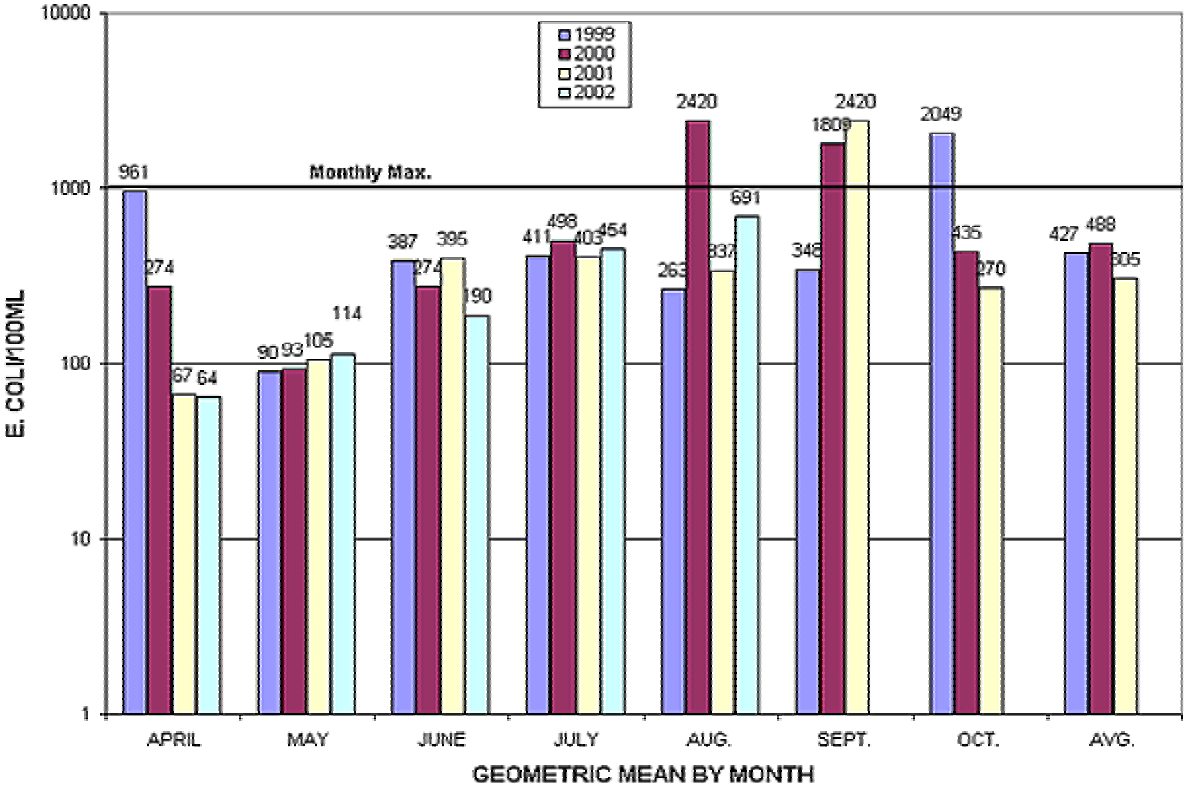
Data collected by the Coldwater River Watershed Council, and analyzed by the Annis Water Resources Institute.

"Rule 62 of the Michigan Water Quality Standard (Part 4 of Act 451) limits the concentration of microorganisms in the surface waters of the state and surface water discharges. Discharges containing treated or untreated human sewage shall not contain more than 200 fecal coliform bacteria per 100 ml water as a monthly average and 400 fecal coliform bacteria per 100 ml water as a 7-day average". (DEQ)

Appendix DD

E. coli at Morse Lake RD, Kent County Health Department

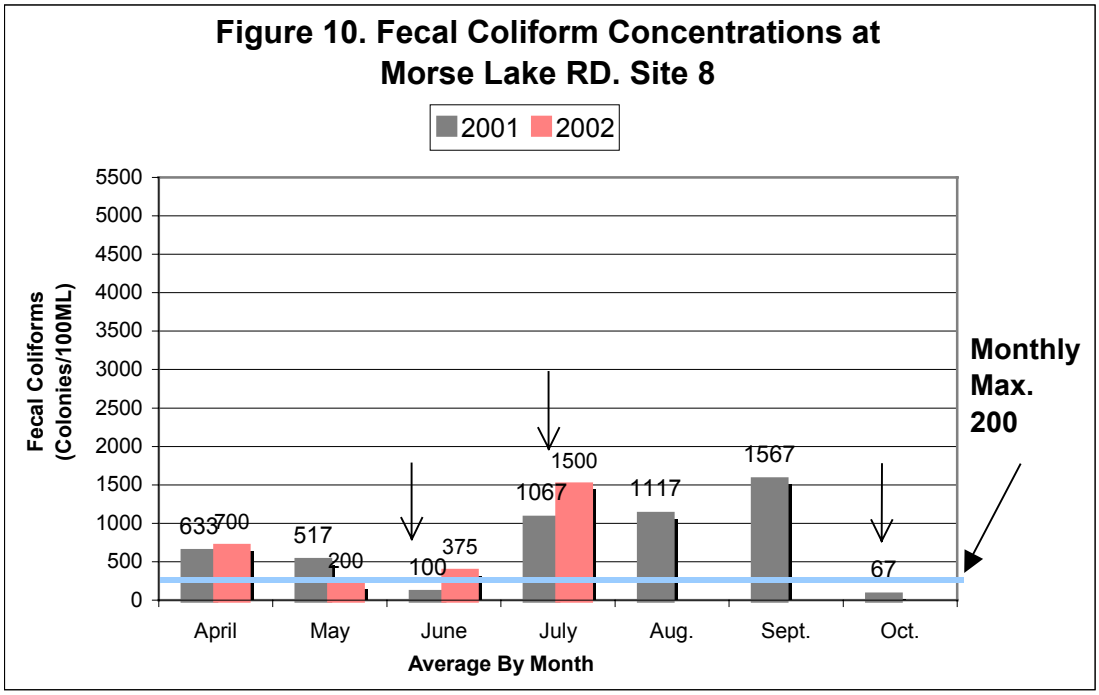
E. Coli at Morse Lake RD, Kent County Health Department (Access Kent, 2002)



Appendix EE

Fecal Coliform at Morse Lake RD, AWRI Samples

Fecal Coliform Concentrations at Morse Lake RD and the Coldwater River



*Arrows indicate bars representing one sampling event. Bars without arrows represent the average of two sampling events.

Data collected by the Coldwater River Watershed Council, and analyzed by the Annis Water Resources Institute.

"Rule 62 of the Michigan Water Quality Standard (Part 4 of Act 451 limits the concentration of microorganisms in the surface waters of the state and surface water discharges. Discharges containing treated or untreated human sewage shall not contain more than 200 fecal coliform bacteria per 100 ml water as a monthly average and 400 fecal coliform bacteria per 100 ml water as a 7-day average". (DEQ)

Appendix FF

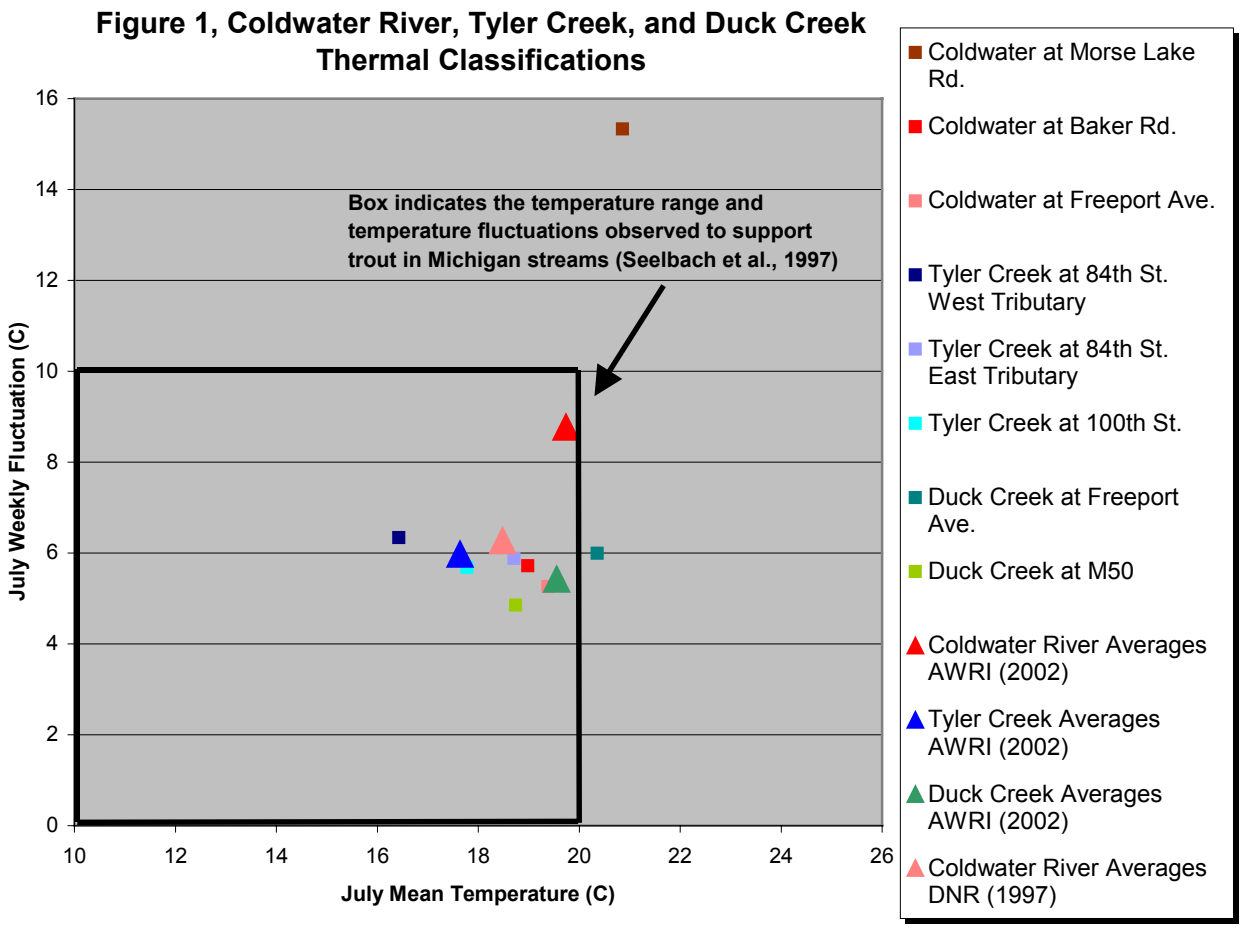
Coldwater Fishery Summary

Coldwater Fishery Summary
As of Summer 2002

The Coldwater River is a valued recreational resource primarily because of the brown trout fishery sustained by stocking. Brown trout, the most robust, fast growing, and most temperature tolerant, were stocked in the Coldwater River as early as 1958. Subsequently, the Michigan Department of Natural Resources (MDNR) has stocked the Coldwater, Duck Creek, and Tyler Creek since 1979. However, in spite of the current stocking program, the Coldwater only supports a modest brown trout fishery and natural reproduction appears to be minimal (MDNR, fish growth analysis, 1999 – 2000). Several factors including, temperature, rough fish, chemical parameter, dissolved oxygen, and habitat may singly or collectively, limit trout survival and ultimately reduce the overall success of the fishery.

Temperature

Based on Michigan Water Quality Standards, the Coldwater River is designated as a coldwater stream from Route 43 (Carlton Center Road) to its confluence with the Thornapple River (MEDQ 1998). Following the model proposed by Seelbach et al. (1997), the geologic and topographic features of the Coldwater River system should supply adequate groundwater flow to maintain cool water temperatures. Water temperature data collected by the MDNR (1997) and AWRI (2002) for the Coldwater River (Site 8, at Morse Lake Rd), Duck Creek (site 1, at Freeport Ave.), and both Tyler Creek sites generally support the conclusion based on the Seelback et al. (1997) model (Figure 1)



Physical and Chemical Parameters

Three parameters including, ammonia, total suspended solids (TSS), and dissolved oxygen (DO) may affect trout survival in the Coldwater system. It should be, however, that other parameters that may stress trout physiologically were not monitored.

Trout fry are the most sensitive to elevated concentrations of ammonia with concentrations of ammonia > 0.3 mg/L can be toxic to trout fry (WMSRDC, 1977). Samples collected from the Coldwater system exceeded this concentration 13 times between February 2001 and July 2002. Ammonia is typically delivered to rivers via stormwater runoff.

Suspended sediment (TSS) also reaches river systems through stormwater runoff. TSS may clog fish gills limiting respiratory capacity and ultimately suffocation. Alternatively, TSS causes physical abrasion to the gill surface resulting in fungal infections and finally death. Sediment also covers spawning gravel. Elevated TSS concentrations were observed in Coldwater samples collected on April 9, 2002.

Base on available data, DO concentrations in the Coldwater River were below minimum standards established for coldwater fisheries over 50% of the time between mid-May and mid-June, 2002. Low dissolved oxygen (DO) concentrations may also limit survival of brown trout in the Coldwater River. Brown trout are affected by low DO during both the egg/larval stage as well as the adult stage (Brown 1985) with impacts being progressively more severe as DO drops below 6.0 mg/L (Table 1). Spawning adults are particularly sensitive, and can tolerate DO < 5.0 mg/L for only brief periods (Reiser and Bjornn, 1979).

Table 2.
Trout Responses to Different Levels of Dissolved Oxygen

		Percent Saturation at Given Temperatures (F)					
Response of trout to three different concentrations of dissolved oxygen	**DO (ppm)**	32°	41°	50°	59°	68°	77°
Function without impairment	7.75	76%	76%	76%	76%	85%	93%
Initial distress symptoms	6.00	57%	57%	57%	59%	65%	72%
Most fish affected by lack of oxygen	4.25	38%	38%	38%	42%	46%	51%

Source: Adapted from Reiser and Bjornn (1979)
Note: Milligram per liter (mg/l) is approximately equal to parts per million (ppm).

Although any one of these parameters may cause stress and death of brown trout, each of these factors does not function in isolation. Indeed, fish may be exposed to stress inducing levels of a few or all of these parameters at any given time. When minimum standards for a parameter are established, the fish are generally exposed to stressful levels of only that one parameter, and other parameters are held at non-stressful levels. Fish may exhibit signs of stress much sooner when exposed to stressful levels of multiple parameters simultaneously. In the Coldwater, a fish may be exposed to low DO, ammonia, and TSS following a rain event. That exposure may result in mortality even though none of the parameters actually reach the minimum levels designated for survival.

Physical Habitat

The brown trout population is affected by four factors of their environment: a lack of habitat; a lack of spawning grounds; excessive sedimentation; and the amount of channelization in the watershed. A lack of habitat in the Coldwater refers to the low amount of large woody debris in the waterway. Woody debris provides living quarters for trout and their food source. Currently, there is a lack of spawning area within the Coldwater River, although Tyler Creek may serve as a nursery stream providing reasonable amounts of spawning area for trout a small trout population. Improving migratory routes between the Coldwater and Tyler Creek may facilitate spawning runs from the Coldwater into Tyler Creek. Spawning grounds are also being affected by the large amount of sediment entering the waterway. Erosion from streambanks is causing the spawning gravel beds to be covered up. Sediment is also affecting the adult trout as mentioned above. The erosion is partially caused by stormwater runoff and high flow

rates. High flow rates are accelerated because of the amount of channelization that has occurred throughout the watershed. As the stream's path has been altered from its natural state drainage has been increased and the watercourse has been straightened making the water flow faster and at higher volumes. This increase in water flow rate and volume pulls at the streambanks increasing sediment.

Conclusion

Ammonia spiking and low DO concentrations have reached levels harmful to trout, they are considered by the AWRI as the main threat to the brown trout population of the Coldwater River. Potential ammonia sources are cattle farms, manure applications, or failing septic systems. Furthermore, excessive nutrients such as fecal matter and fertilizer salts are suspected of lowering DO concentrations through stormwater runoff. Further investigation into elevated temperatures, ammonia spiking, conductivity, dissolved oxygen concentrations, and spates is recommended through the use of river stations and volunteer water sampling.

Appendix GG

Main Causes of Nonpoint Source Pollution
As Determined by Mainstream Resources, 2001

Main Causes for Nonpoint Source Pollution	Erosion Sites Affected
1 vehicle traffic fording river	1
2 bend in river	39
3 bend in river & obstruction in river	17
4 vehicle access & overland runoff	1
5 foot path	1
6 flood flows	24
7 obstruction in river	6
8 bend in river & flood flows	73
9 high water & flood flows	1
10 flood flows & eddying	1
11 obstruction in river & highwater	1
12 obstruction in river & flood flows	11
13 bend in river, bank seepage, & flood flows	6
14 overland runoff from ag. Field	1
15 cattle access	6
16 bend in river, flood flows, access site	1
17 bend in river & flow obstructions	3
18 highwater	1
19 bank seepage & flood flows	12
20 bend in river, animal access, & flood flows	3
21 bend in river & cattle crossing	2
22 bend in river, flood flows, & cattle impacts	1
23 bend in river, cattle crossing, & flood flows	1
24 cattle crossing & flood flows	1
25 bend in river & bank seepage	1
26 obstruction in river, bend in river, & flood flows	18
27 erosion behind wing dam diversion	1
28 bend in river, steep slope, & flood flows	1
29 gullying bank from side channel(overland runoff)	4
30 bank seepage, obstruction in river, & flood flows	1
31 obstruction in river, turbulent flow, & flood flows	2
32 bend in river, flood flows, & pedestrian traffic	1
33 stream ford	1
Total Erosion Sites Affected	**244**

Source: Mainstream Resources, 2001

Appendix HH

Conditions/Problems in the Coldwater River Watershed
As Determined by Mainstream Resources, 2001

Conditions/Problems in the Coldwater River Watershed	Number Of Sites Affected	RC or ES
1 Culvert outlet erosion	2	RC
2 bank erosion beside crossing & outlet erosion	1	RC
3 culvert inlet erosion	3	RC
4 downstream erosion beside crossing	1	RC
5 erosion behind culvert	1	RC
6 embankment erosion	3	RC
7 good	1	RC
8 stagnant water & much erosion	1	RC
9 none	17	RC
10 embankment & culvert outlet erosion	1	RC
11 embankment & stream bank erosion	1	RC
12 toe is stable, upper bank eroding	79	ES
13 toe & upper bank eroding	107	ES
14 toe undercutting	54	ES
15 embankment erosion in all 4 q	1	RC
16 bank erosion @ inlet & outlet	1	RC
17 channel constriction, eroding ditch	1	RC
18 newer pipe-arch	1	RC
19 stream bank erosion	4	RC
20 outlet erosion	1	RC
21 runofff from lawns	1	RC
22 toe is undercutting during flood flows	2	ES
23 toe & bank eroding, flood flows	1	ES
24 embankment erosion, overland ag runoff, shoulder erosion, undercutting of culvert, culvert outlet erosion, undersized culvert	1	RC
25 maintain vegetation	1	RC
26 shoulder/ditch erosion, undercutting bank below culvert, undersized culvert, replace culvert w/ clear span bridge	1	RC
27 stream bank erosion & undersized	1	RC
28 bridge in undersized for peak flow	1	RC
29 culverts are short	1	RC
Total Number of Sites with Conditions/Problems	**291**	
Total number of Road Crossings Affected	**48**	
Total number of Erosion Sites Affected	**244**	

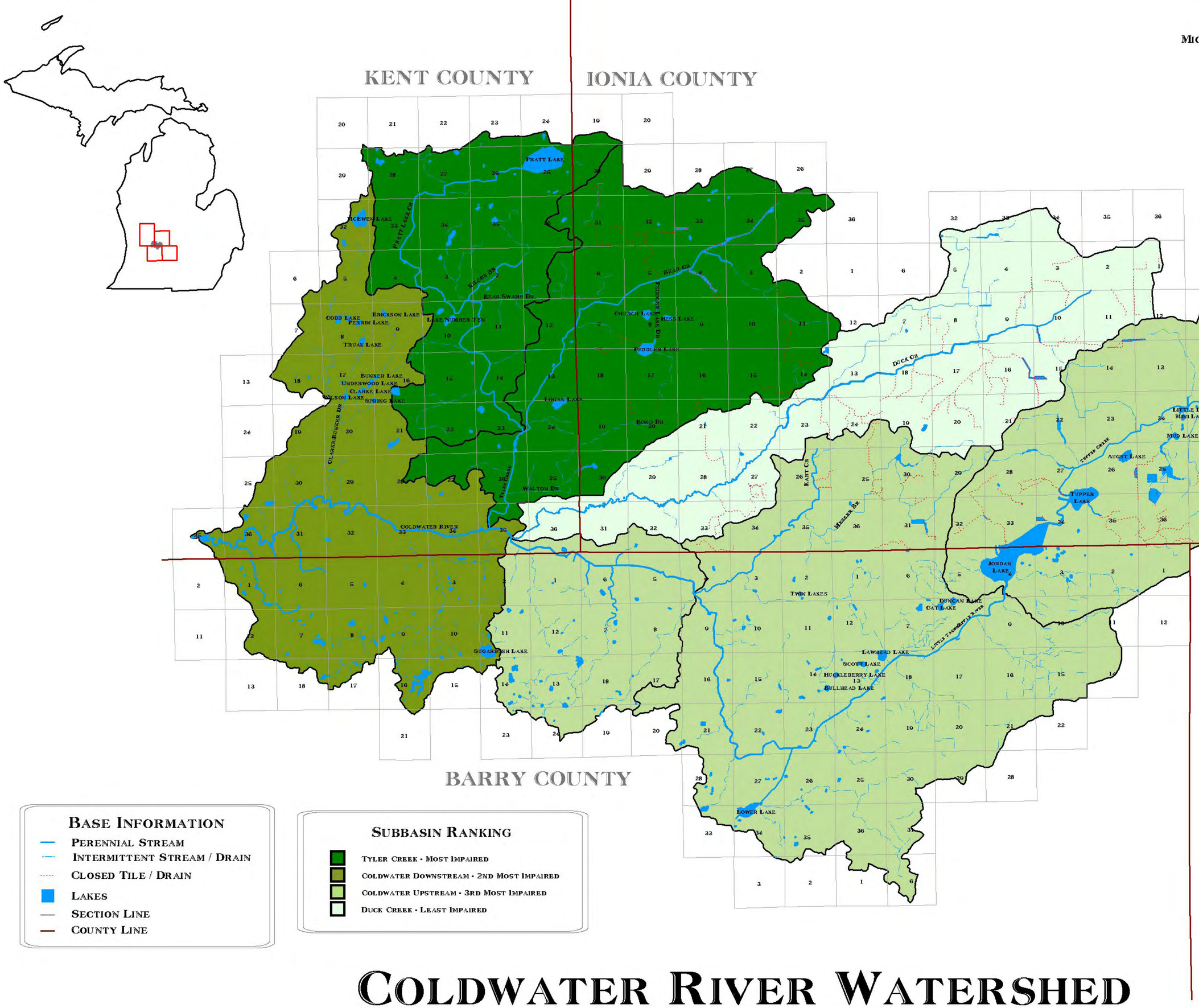
- RC = Road Crossings
- ES = Erosion Sites

Source: Mainstream Resources, 2001

Appendix II

Impaired Area Rankings Map for Method 1

Base Information
Michigan Center For Geographic Information
Michigan Geographic Data Library
Impaired Ranking
GVSU-AWRI, 2002



Base Information

- Perennial Stream
- Intermittent Stream / Drain
- Closed Tile / Drain
- Lakes
- Section Line
- County Line

Subbasin Ranking

- Tyler Creek - Most Impaired
- Coldwater Downstream - 2nd Most Impaired
- Coldwater Upstream - 3rd Most Impaired
- Duck Creek - Least Impaired

N

1 0 1 2 Miles

Coldwater River Watershed

Impaired Area Ranking For Method 1

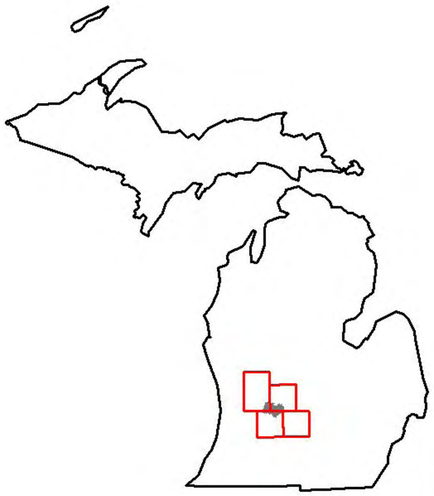
Grand Valley State University
Annis Water Resources Institute
Information Services Center

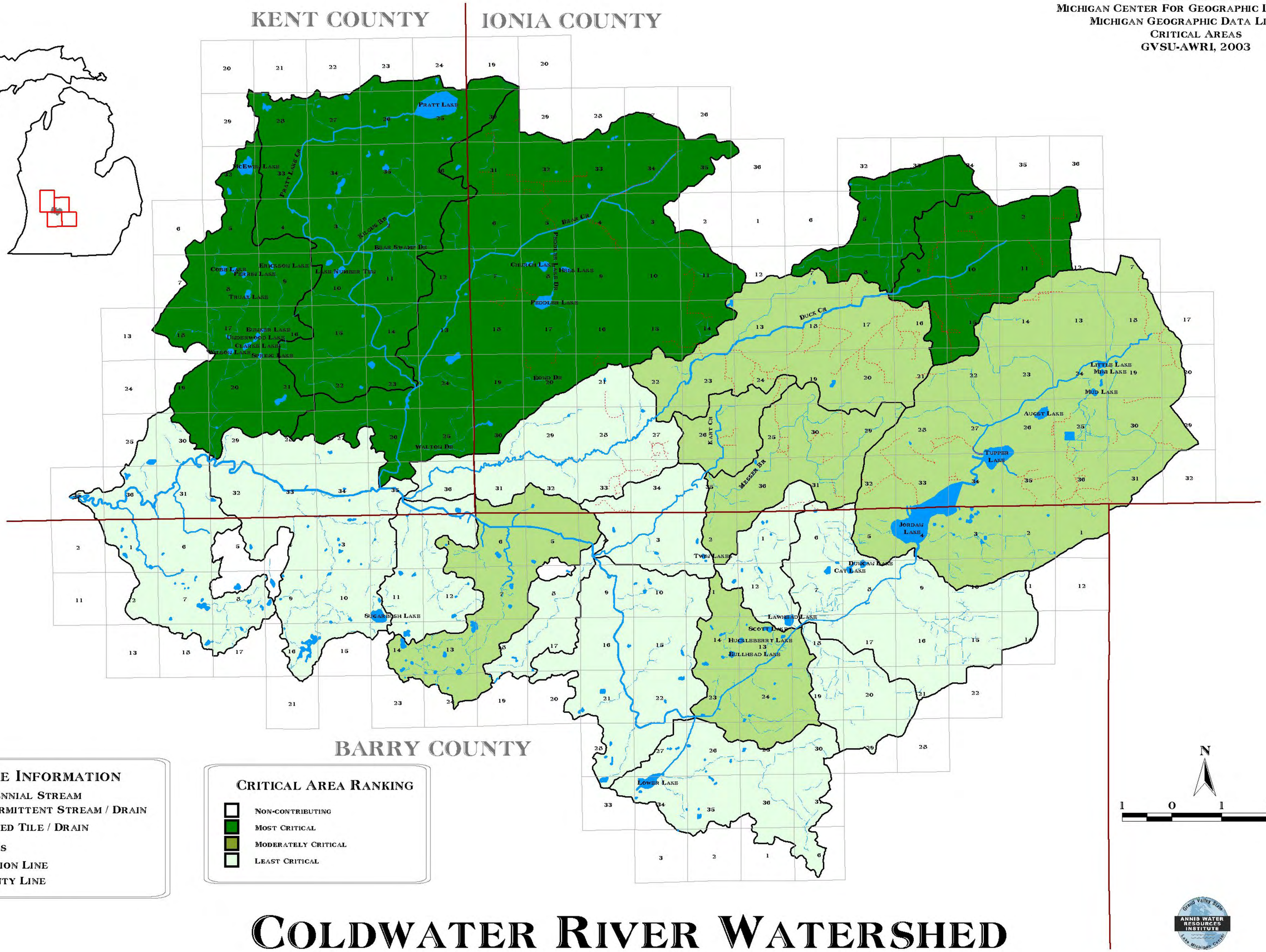
Map Prepared December, 2003

Appendix JJ

Critical Area Map of Coldwater River Watershed

Base Information
Michigan Center For Geographic Information
Michigan Geographic Data Library
Critical Areas
GVSU-AWRI, 2003





Base Information

- Perennial Stream
- Intermittent Stream / Drain
- Closed Tile / Drain
- Lakes
- Section Line
- County Line

Critical Area Ranking

- Non-contributing
- Most Critical
- Moderately Critical
- Least Critical

N

1 0 1 2 Miles

Coldwater River Watershed

Critical Areas

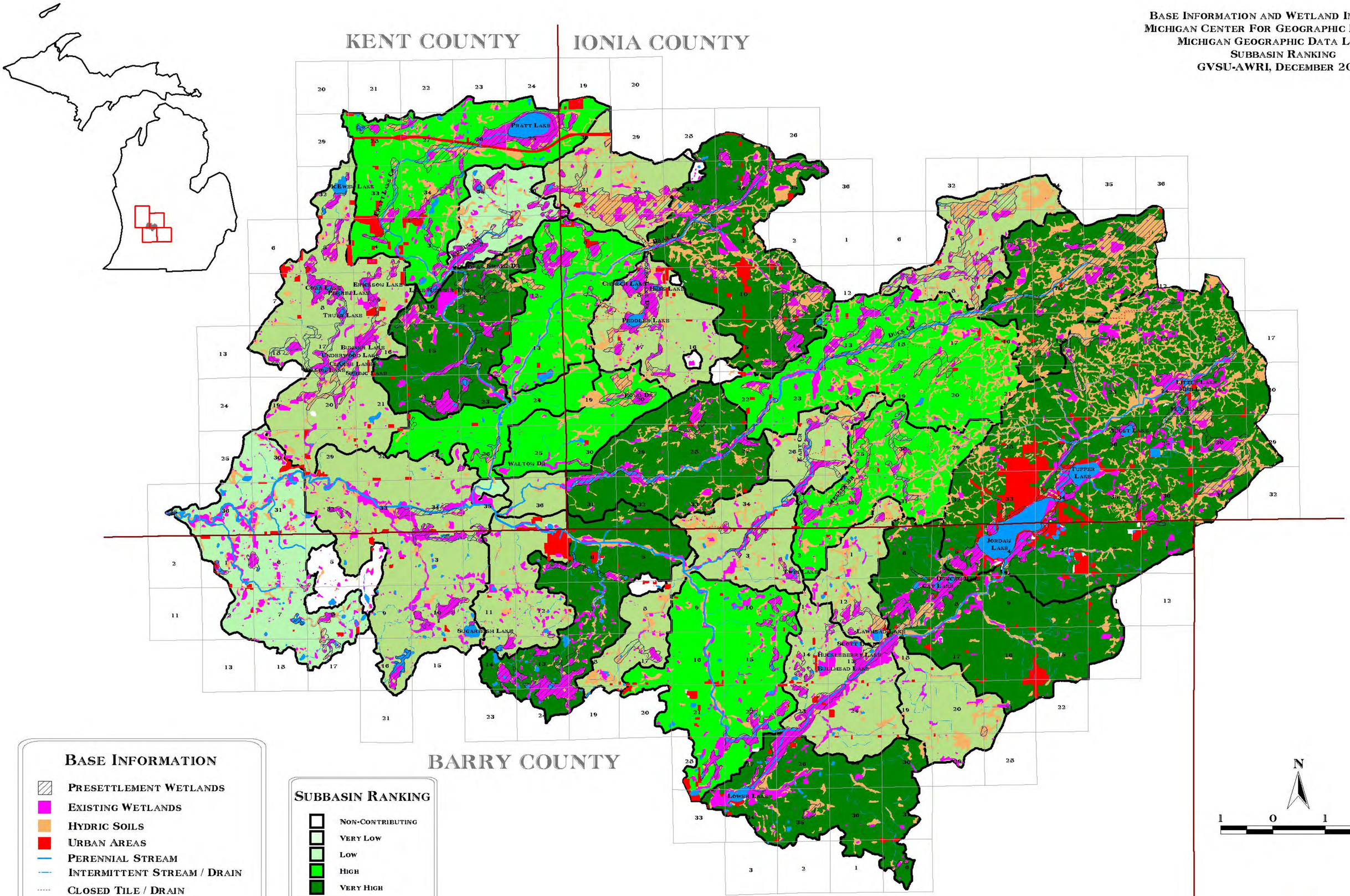
Grand Valley State University
Annis Water Resources Institute
Information Services Center

Map Prepared December, 2003

Appendix KK

Impaired Area Rankings Map for Method 2

Base Information and Wetland Information
Michigan Center For Geographic Information
Michigan Geographic Data Library
Subbasin Ranking
GVSU-AWRI, December 2003



Coldwater River Watershed

Impaired Area Ranking For Method 2

Grand Valley State University
Annis Water Resources Institute
Information Services Center

Map Prepared December, 2003