STORMWATER MONITORING AND MANAGEMENT PLAN

Antigo Lake Protection and Rehabilitation District

Antigo, Wisconsin

May 2, 2000

Robert E. Lee & Associates, Inc.
Engineering • Surveying • Laboratory Service
2825 South Webster Avenue, Post Office Box 2100
Green Bay, WI 54306 (920) 336-6338

TABLE OF CONTENTS

INTRODUCTION

The Antigo Lake Protection and Rehabilitation District initiated a stormwater sampling and management planning project in 1998 to evaluate the stormwater pollutant loading to Antigo Lake and the Spring Brook watershed, and management alternatives for reduction in pollutant loading, if feasible.

The project includes sampling of actual stormwater pollutant discharges from the City of Antigo stormwater collection system, development of the stormwater drainage basins and estimation of the stormwater flows which result, and recommendation of stormwater treatment alternatives to reduce the pollutant loadings where appropriate.

The project was conducted over a sufficient time period to enable collecting the stormwater samples from the major basins in the stormwater collection system.

This report presents the stormwater monitoring data and the recommendations resulting from evaluation of the existing stormwater system flows.

PROJECT METHODOLOGY

The project methodology defines the overall approach to the sampling program and the calculation of the stormwater discharges to Antigo Lake and the drainage basin. The key elements of the project methodology include the following:

- Stormwater discharge samples were collected from the major drainage basin discharges to Antigo Lake by use of composite water sampling equipment. The Langlade County Land Conservation Dept provided the day-to-day monitoring and Robert E. Lee & Associates provided the sampling equipment.
- The State of Wisconsin Department of Hygiene provided analyses of the stormwater samples.
- The U.S. Weather Service reported rainfall data was used to calculate the pollutant loadings, based on the sampling data obtained. These calculations

result in a pollutant loading from the stormwater drainage basins based on the observed rainfall intensity and the estimated flow. The rainfall intensity during many of the sampling events was low, with only one or two sampling events at high rainfall levels. The amount of monitoring was limited by budget limitations.

- The stormwater drainage basin areas were estimated based on the general contour map of the City of Antigo superimposed over the City stormwater collection system.
- The 10-year design rainfall intensity was used for calculation of the storm flow volumes from the drainage basins for sizing stormwater detention basins.
- The estimated pollutant loadings and the estimated stormwater flow volumes were used to identify the most significant stormwater drainage basins. These basins were selected for further evaluation of stormwater treatment to reduce peak flow rates and/or pollutant discharges to Antigo Lake and the watershed basin.

EXISTING CONDITIONS

The City of Antigo stormwater drainage basins were developed based on estimation of the each basin configuration using the stormwater collection system map and the City contour elevation map. The map as developed is enclosed as Figure 1. The base maps were provided by the City of Antigo.

The location of the stormwater discharge points was provided by the City of Antigo. The discharge points are listed in Table 1.

The rainfall data used for the calculation of the pollutant loadings is based on the U.S. Weather Service data and is included in Appendix A. Useful actual measured stormwater flow data at the sampling points was not obtained because the readings were not routinely taken and the stormwater flow rates were sometimes below the trip points for initiation of the flow meters. Flow initiated sampling was used for the sampling sites. Thus, climatological rainfall data was used to calculate flows in the

absence of actual site stormwater flow data. This is reasonable for purposes of this study.

DESIGN CRITERIA

The basic design criteria for sizing the stormwater detention improvements was selected as follows:

- Utilize "Urban Hydrology for Small Watersheds" SCS TR-55 methods for computing peak runoff.
- SCS Type II storm.
- Storm Frequencies – 2-year/24-hour and 10-year/24-hour storms.
- Utilize Eaglepoint Watershed Modeling Software for sizing the detention ponds.
- Detention – Provide detention volumes necessary to limit the peak discharges to levels approximately at background levels prior to installation of the stormwater collection system.

SAMPLING PROGRAM

Robert E. Lee & Associates, Inc. supplied sampling equipment for use by the Lake Protection District. Training in operation of the sampling equipment and sample collection and preservation was provided.

Four portable ISCO 6700 samplers were used to obtain stormwater samples. These samplers were initiated based on rainfall using ISCO 674 rain gauges. The rain gauges connect to the samplers and use a tipping bucket design to record rainfall. The samplers were programmed to start after a 0.10-inch rainfall was recorded. This resulted in obtaining a sample of the initial flush of stormwater from each drainage basin.

Personnel for the Spring Brook Priority Watershed (Langlade Land Conservation Office) collected the samples after the rainfall events and installed the sampling equipment at the various locations monitored.

Samples were packed on ice and shipped to the State Laboratory of Hygiene for analysis. Stormwater parameters analyzed were lead, zinc, phosphorus, and suspended solids.

The results of the sampling and analyses are shown in Table 1.

The actual stormwater collection system drainage basin suspended solids and total phosphorus discharges were calculated based on the recorded rainfall data for Antigo for the sampling dates and the analytical data obtained. The recorded rainfall data, included in Appendix A, was used as the estimate of the precipitation. The drainage basin area, rainfall runoff coefficent, the rainfall intensity, and the rainfall which is actual runoff all used calculate the basin stormwater flow. This calculation estimates the stormwater drainage basin TSS and total P discharges for the observed rainfall events by calculating the pounds of pollutants discharged as the product of the flow and concentration.

This data was used to select the drainage basins of significant total P and suspended solids discharges. Based on the suspended solids discharges, the most significant discharges are from basin 14 (at Bridge Street), from basin 1 (at Graham Street) and basin 8 (at Gowan Street). These basins experienced a stormwater discharge of 5,000 lbs suspended solids or greater, and a phosphorus discharge of 10 lbs or greater. Basins 2 and 5 also experience TSS discharges, though at levels of about 500 lbs/day. The other basin discharges are considerably lower and perhaps considered negligible compared to the larger basin discharges.

The results indicate Basin 14 contributed a high flow and suspended solids discharge to the drainage basin. The reported rainfall on July 8, 1999 approximated a 7-year frequency of occurrence, and the TSS discharge exceeded 12,000 lbs.

Basins 8 and 1 discharges of suspended solids were at rainfall less than the 2-year rainfall intensity.

Basin 14 is a residential area of curb and gutter streets in the southeastern portion of the City. It is a discrete area with only one point of discharge. The discharge is downstream of Antigo Lake. Basin 14 experienced a suspended solids discharge of 12,700 lbs during the estimated 3.5-inch rainfall on July 8, 1999. The estimated stormwater discharge volume was approximately 10 million gallons. This data indicates that Basin 14 is a significant stormwater runoff basin. The July 8 event is not the spring runoff event, therefore, an early spring storm event may result in a higher TSS discharge.

Basin 1 is a commercial area with primarily curb and gutter streets. Basin 1 discharges at Graham Street and enters the Antigo Lake area of the drainage basin. Basin 1 is only approximately 35 acres but the observed discharge suspended solids loading was high at approximately 4,700 lbs at the 0.29-inch rainfall. The total runoff volume during May 5-6, 1999 was only 190,000 gallons over the two-day period. The results may indicate a first flush from the basin because the second day discharge TSS was considerably lower. The high TSS discharge should be further investigated because of the high TSS discharge for this smaller basin.

Basin 8 is approximately 800 acres of drainage area, and is mainly residential development with curb and gutter streets. The basin discharge sampling was conducted during two rainfall events; May 17 at 0.60-inches rainfall and June 28 at 0.64-inches rainfall. The suspended solids discharge exceeded 6,000 lbs/day during these events. The TSS discharge from this basin appears low given the large drainage area, and rainfall events prior to May 17 may have flushed significant TSS prior to this sampling (May 7 at 1.96-inch rainfall).

The monitored events for Basin 8 result in a discharge TSS per unit of basin area at approximately 7.5 lbs TSS per acre for both the May 17 and June 28 rainfall events.

Basin 8 discharges at the south end of the City downstream of Antigo Lake and may not have a direct impact on lake water quality

Compare Basin 14 at 48 lbs TSS/acre on July 8 and 9 lbs TSS/acre on July 15, 1999; and Basin 1 at 135 lbs TSS/acre on May 5 and 35 lbs TSS/acre on May 6. It is likely that Basin 8 discharges a higher suspended solids loading than observed in this July sampling. The Basin 14 stormwater discharge should be treated due to the probable volume and TSS levels.

Drainage Basins 2 and 5 discharge into or upstream of Antigo Lake and TSS discharges were observed. Basin 2 is approximately 33 acres and at a 0.29-inch rainfall discharged approximately 700 lbs/day TSS. This is a TSS level higher than the many small stormwater drainage basins elsewhere in the City. The TSS discharge on May 6, 1999, was at 28 lbs TSS/acre at a 0.29-inch rainfall. This basin probably discharges higher TSS levels at higher rainfall intensities.

Drainage Basin 5 is approximately 262 acres and experienced TSS discharges at 700 lbs TSS/day on May 6 and 7, 1999. Given the size of this basin and the commercial development, Basin 5 probably experiences TSS discharges to be considered for treatment.

Basin 18 is a larger basin at approximately 234 acres, but is not as developed as other areas of the City. The storm sewer is a 60-inch diameter pipe, which provides significant hydraulic capacity. This stormwater drainage basin could be a significant discharge point in the future. This discharge is into Antigo Lake and should be considered for future stormwater treatment.

STORMWATER DRAINAGE

The of Antigo stormwater collection system was divided into individual stormwater drainage basins based on a contour map of the City and the estimated drainage basin boundaries. This map was presented as Figure 1.

A summary of the calculated peak stormwater runoff at 2-year and 10-year storms is presented in Table 3. The calculations of the storm runoff are included in Appendix B. The runoff calculation procedures are also included in Appendix B.

The runoff data is listed in Table 3 in priority of highest storm flow to lowest. The highest flow basins are likely the highest priority for stormwater treatment. Table 3 also estimates the required stormwater detention basin volume to reduce the TSS discharge to a low level. The basin volumes are provided for only the larger flow basins.

TABLE 1
STORM WATER SAMPLING RESULTS FOR THE CITY OF ANTIGO STORM WATER MANAGEMENT PLAN

FIELD #	COLLECTION LOCATION	COLLECTION DATE	PRECIP. (IN)	LEAD (UG/L)	TOTAL PHOSPHORUS (MG/L)	SUSPENDED SOLIDS (MG/L)	ZINC (UG/L)
1	MANHOLE AT E END OF GRAHAM ST	5/5/99	0.29*	ND (LOD=0.8)	1.88	5960	150
1	MANHOLE AT E END OF GRAHAM ST	5/6/99	0.29	48	0.836	1550	190
2	STORM DRAIN ON 3RD AVE E OF RETIREMENT HOME	5/5/99	0.29*	46	1.35	276	520
2	STORM DRAIN ON 3RD AVE E OF RETIREMENT HOME	5/6/99	0.29	96	1.46	985	530
4	STORM DRAIN S END EDISON ST & 10TH AVE	5/5/99	0.29*	31	0.809	264	280
4	STORM DRAIN S END EDISON ST & 10TH AVE	5/6/99	0.29	5.8	0.116**	29	70
5	STORM DRAIN BY LANGLADE CO HWY SHOP ARTIC ST	5/6/99	0.29	16.5**	0.900**	112	100**
5	STORM DRAIN BY LANGLADE CO HWY SHOP ARTIC ST	5/7/99	1.96	6.5	0.391	20	52
6	ANTIGO LAKE DAM - OUTLET TO ANTIGO LAKE	5/17/99	0.60	26	0.345	198	58
7	MANHOLE ON 4TH AVE BY HUNTERS FEED MILL	5/7/99	1.96	5.4	0.222	159	22
7	MANHOLE ON 4TH AVE BY HUNTERS FEED MILL	5/7/99	1.96	27	0.705	146	130

*Precipitation data estimated from closest 24 hr rainfall event
** Wrong bottle used, result approximate
ND = NO DETECT
LOD = LEVEL OF DETECTION

FIELD #	COLLECTION LOCATION	COLLECTION DATE	PRECIP. (IN)	LEAD (UG/L)	TOTAL PHOSPHORUS (MG/L)	SUSPENDED SOLIDS (MG/L)	ZINC (UG/L)
8	STORM DRAIN OUTLET ON WEST SIDE OF GOWAN ST & N SIDE OF SPRING BROOK	5/17/99	0.60	22	0.452	156	110
8A	STORM DRAIN OUTLET ON WEST SIDE OF GOWAN ST & N SIDE OF SPRING BROOK	6/28/99	0.64	16	0.273	178	57
8B	STORM DRAIN OUTLET ON WEST SIDE OF GOWAN ST & N SIDE OF SPRING BROOK	6/28/99	0.64	ND (LOD=13)	0.216	231	36
9	WHITE PLASTIC STORM DRAIN OUTLET ON WEST SIDE OF MILTON AND NORTH SIDE OF SPRING BROOK	5/17/99	0.60	ND (LOD=13)	0.887	128	73
9	WHITE PLASTIC STORM DRAIN OUTLET ON WEST SIDE OF MILTON AND NORTH SIDE OF SPRING BROOK	5/24/99	0.43*	ND (LOD=13)	0.200	27	25
10A	STORM OUTLET UNDER 6TH AVE BRIDGE ON WEST SIDE OF SPRING BROOK	6/28/99	0.64	20	0.135	92	87
10B	STORM OUTLET UNDER 6TH AVE BRIDGE ON WEST SIDE OF SPRING BROOK	6/28/99	0.64	19	0.281	47	59

*Precipitation data estimated from closest 24 hr rainfall event
** Wrong bottle used, result approximate
ND = NO DETECT
LOD = LEVEL OF DETECTION

FIELD #	COLLECTION LOCATION	COLLECTION DATE	PRECIP (IN)	LEAD (UG/L)	TOTAL PHOSPHORUS (MG/L)	SUSPENDED SOLIDS (MG/L)	ZINC (UG/L)
11A	STORM DRAIN OUTLET UNDER 6TH AVE BRIDGE ON EAST SIDE OF SPRING BROOK	6/28/99	0.64	14	0.157	59	64
11B	STORM DRAIN OUTLET UNDER 6TH AVE BRIDGE ON EAST SIDE OF SPRING BROOK	7/23/99	0.26	ND (LOD=13)	0.232	61	34
12A	STORM DRAIN OUTLET UNDER 7TH AVE BRIDGE ON WEST SIDE OF SPRING BROOK	6/28/99	0.64	ND (LOD=13)	0.307	94	50
12B	STORM DRAIN OUTLET UNDER 7TH AVE BRIDGE ON WEST SIDE OF SPRING BROOK	6/28/99	0.64	ND (LOD=13)	0.173	54	66
13A	STORM DRAIN OUTLET UNDER 7TH AVE BRIDGE ON EAST SIDE OF SPRING BROOK	6/28/99	0.64	ND (LOD=13)	0.174	51	50
13B	STORM DRAIN OUTLET UNDER 7TH AVE BRIDGE ON EAST SIDE OF SPRING BROOK	6/28/99	0.64	15	0.178	55	50
14A	SOUTH SIDE 8TH ST BRIDGE - EAST SIDE OF SPRING BROOK	7/8/99	3.54*	ND (LOD=13)	0.226	151	36
14B	SOUTH SIDE 8TH ST BRIDGE - EAST SIDE OF SPRING BROOK	7/15/99	0.30*	38	0.252	394	110
15A	STORM DRAIN OUTLET AT THE DEAD END ON WEST SIDE OF MAPLE ST	7/5/99	0.52	ND (LOD=13)	0.164	30	39

*Precipitation data estimated from closest 24 hr rainfall event
** Wrong bottle used, result approximate
ND = NO DETECT
LOD = LEVEL OF DETECTION

FIELD #	COLLECTION LOCATION	COLLECTION DATE	PRECIP. (IN)	LEAD (UG/L)	TOTAL PHOSPHORUS (MG/L)	SUSPENDED SOLIDS (MG/L)	ZINC (UG/L)
16A	STORM DRAIN OUTLET UNDER 5TH AVE ON WEST SIDE OF SPRING BROOK	7/23/99	0.26	ND (LOD=13)	0.199	71	ND (LOD=19)
16B	STORM DRAIN OUTLET UNDER 5TH AVE ON WEST SIDE OF SPRING BROOK	7/23/99	0.26	13	0.110	27	58
17A	STORM DRAIN OUTLET UNDER 4TH AVE BRIDGE ON WEST SIDE OF SPRING BROOK	7/23/99	0.26	ND (LOD=13)	0.080	12	ND (LOD=19)
17B	STORM DRAIN OUTLET UNDER 4TH AVE BRIDGE ON WEST SIDE OF SPRING BROOK	7/23/99	0.26	ND (LOD=13)	0.098	12	ND (LOD=19)
18A	STORM DRAIN OUTLET EAST OF LANGLADE CO RACETRACK & HIGHWAY SHOP	7/23/99	0.26	14	0.270	69	150
18B	STORM DRAIN OUTLET EAST OF LANGLADE CO RACETRACK & HIGHWAY SHOP	7/23/99	0.26	ND (LOD=13)	2.92	73	35

*Precipitation data estimated from closest 24 hr rainfall event
** Wrong bottle used, result approximate
ND = NO DETECT
LOD = LEVEL OF DETECTION

TABLE 2
STORM WATER SAMPLING RESULTS FOR THE CITY OF ANTIGO LAKE DISTRICT STORM WATER MANAGEMENT PLAN

FIELD #	COLLECTION LOCATION	COLLECTION DATE	PRECIP. (IN)	RUNOFF (IN)	TOTAL RUNOFF VOLUME (GAL)	TOTAL PHOSPHORUS (MG/L)	TOTAL PHOSPHORUS (LBS/RAIN EVENT)	SUSPENDED SOLIDS (MG/L)	SUSPENDED SOLIDS (LBS/RAIN EVENT)
1	MANHOLE AT E END OF GRAHAM ST	5/5/99	0.29**	0.10	95,033	1.88	1.49	5,960	4,724
1	MANHOLE AT E END OF GRAHAM ST	5/6/99	0.29	0.10	95,033	0.836	0.66	1,550	1,228
2	STORM DRAIN ON 3RD AVE E OF RETIREMENT HOME	5/5/99	0.29**	0.10	89,602	1.35	1.01	276	206
2	STORM DRAIN ON 3RD AVE E OF RETIREMENT HOME	5/6/99	0.29	0.10	89,602	1.46	1.09	985	736
4	STORM DRAIN S END OF EDISON ST & 10TH AVE	5/5/99	0.29**	0.10	70,596	0.809	0.48	264	155
4	STORM DRAIN S END OF EDISON ST & 10TH AVE	5/6/99	0.29	0.10	70,596	0.116***	0.07	29	17
5	STORM DRAIN BY LANGLADE CO HWY SHOP ARTIC ST	5/6/99	0.29	0.10	867,898	0.900***	6.51	112	811
5	STORM DRAIN BY LANGLADE CO HWY SHOP ARTIC ST	5/7/99	1.96	0.59	5,120,606	0.391	16.70	20	854
6	ANTIGO LAKE DAM - OUTLET FROM ANTIGO LAKE	5/17/99	0.60	0.18	27,247	0.345	0.08	198	45
7*	MANHOLE ON 4TH AVE BY HUNTERS FEED MILL	5/7/99	1.96	0.59	59,337	0.464	0.23	153	75
8	STORM DRAIN OUTLET ON WEST SIDE OF GOWAN ST & N SIDE OF SPRING BROOK	5/17/99	0.60	0.18	3,909,946	0.452	14.74	156	5,087

*Results are a daily average
**Precipitation data estimated from closest 24 hour rainfall event
***Wrong bottle used, result approximate
ND=No Detect
LOD=Level of Detection

FIELD #	COLLECTION LOCATION	COLLECTION DATE	PRECIP. (IN)	RUNOFF (IN)	TOTAL RUNOFF VOLUME (GAL)	TOTAL PHOSPHORUS (MG/L)	TOTAL PHOSPHORUS (LBS/RAIN EVENT)	SUSPENDED SOLIDS (MG/L)	SUSPENDED SOLIDS (LBS/RAIN EVENT)
8*	STORM DRAIN OUTLET ON WEST SIDE OF GOWAN ST & N SIDE OF SPRING BROOK	6/28/99	0.64	0.19	4,127,165	0.245	8.42	205	7,039
9	WHITE PLASTIC STORM DRAIN OUTLET ON WEST SIDE OF MILTON AND NORTH SIDE OF SPRING BROOK	5/17/99	0.60	0.18	54,494	0.887	0.40	128	58
9	WHITE PLASTIC STORM DRAIN OUTLET ON WEST SIDE OF MILTON AND NORTH SIDE OF SPRING BROOK	5/24/99	0.43**	0.12	36,329	0.200	0.06	27	8
10*	STORM DRAIN OUTLET UNDER 6TH AVE WEST SIDE OF ROAD UNDER BRIDGE	6/28/99	0.64	0.19	113,497	0.208	0.20	70	66
11	STORM DRAIN OUTLET UNDER 6TH AVE BRIDGE ON EAST SIDE OF SPRING BROOK	6/28/99	0.64	0.19	276,101	0.157	0.36	59	136
11	STORM DRAIN OUTLET UNDER 6TH AVE BRIDGE ON EAST SIDE OF SPRING BROOK	7/23/99	0.26	0.10	145,316	0.232	0.28	61	74
12*	STORM DRAIN OUTLET UNDER 7TH AVE BRIDGE ON WEST SIDE OF SPRING BROOK	6/28/99	0.64	0.19	72,225	0.240	0.14	74	45

*Results are a daily average
**Precipitation data estimated from closest 24 hour rainfall event
***Wrong bottle used, result approximate
ND=No Detect
LOD=Level of Detection

FIELD #	COLLECTION LOCATION	COLLECTION DATE	PRECIP (IN)	RUNOFF (IN)	TOTAL RUNOFF VOLUME (GAL)	TOTAL PHOSPHORUS (MG/L)	TOTAL PHOSPHORUS (LBS/RAIN EVENT)	SUSPENDED SOLIDS (MG/L)	SUSPENDED SOLIDS (LBS/RAIN EVENT)
13*	STORM DRAIN OUTLET UNDER 7TH AVE BRIDGE ON EAST SIDE OF SPRING BROOK	6/28/99	0.64	0.19	224,332	0.176	0.00	53	0
14	SOUTH SIDE 8TH ST BRIDGE - EAST SIDE OF SPRING BROOK	7/8/99	3.54**	0.19	7,441,386	0.226	14.03	151	9,371
14	SOUTH SIDE 8TH ST BRIDGE - EAST SIDE OF SPRING BROOK	7/15/99	0.30**	1.42	524,041	0.252	1.10	394	1,722
15	STORM DRAIN OUTLET AT THE DEAD END ON WEST SIDE OF MAPLE ST	7/5/99	0.52	0.10	82,543	0.164	0.11	30	21
16*	STORM DRAIN OUTLET UNDER 5TH AVE ON WEST SIDE OF SPRING BROOK	7/23/99	0.26	0.10	46,159	0.155	0.06	49	19
17*	STORM DRAIN OUTLET UNDER 4TH AVE BRIDGE ON WEST SIDE OF SPRING BROOK	7/23/99	0.26	0.10	105,894	0.089	0.08	12	11
18*	STORM DRAIN OUTLET EAST OF LANGLADE CO RACETRACK & HIGHWAY SHOP	7/23/99	0.26	0.10	635,366	1.60	8.45	71	376

*Results are a daily average
**Precipitation data estimated from closest 24 hour rainfall event
***Wrong bottle used, result approximate
ND=No Detect
LOD=Level of Detection

TABLE 3
STORM WATER MANAGEMENT PLAN
ANTIGO LAKE PROTECTION AND REHABILITATION DISTRICT
CITY OF ANTIGO, LANGLADE COUNTY, WI

CALCULATED STORM WATER RUNOFF AND DETENTION VOLUMES

DRAINAGE BASIN NUMBER	DRAINAGE BASIN AREA (ACRES)	TIME OF CONCENTRATION (HOURS)	RUNOFF CURVE NUMBER	PEAK FLOW 2 YEAR STORM (CFS)	PEAK FLOW 10 YEAR STORM (CFS)	STORAGE REQ'D (ACRE-FEET)
8	800	1.31	68	101	352	28.2
20 A	540	1.20	68	72	251	-
5	320	0.87	68	42	149	11.5
14	193	0.60	70	50	154	9.2
18	234	0.84	67	34	127	7.8
19	175	0.75	68	31	109	
30	68	0.45	68	21	64	
11	48	0.30	70	18	55	
29	45	0.32	70	16	50	
13	39	0.30	70	15	45	
25	37	0.30	70	14	42	
1	35	0.34	70	12	38	
2	33	0.34	70	12	36	
17	34	0.40	70	11	34	
22	27	0.25	70	11	34	
4	26	0.30	70	10	30	
10	22	0.30	70	8	25	
23	19	0.22	70	8	25	
15	19	0.30	70	7	22	
16	17	0.30	70	6	19	
26	16	0.28	70	6	19	
21	13	0.21	70	6	18	
20B	35	1.30	70	6	18	
27	13	0.20	70	6	18	
12	14	0.28	70	5	17	
9	10	0.20	70	5	14	
24	8	0.17	70	4	12	
28	7	0.18	70	3	10	
6	5	0.15	70	3	8	
7	1	0.13	70	1	2	-

FIELD OBSERVATIONS

Drainage Basin 8 – This area is extensive residential development. The 30" discharge piping is probably undersized for the extensive residential development in Basin 8. The existing 30" discharges directly to the creek, with a small lowland area adjacent to the pipeline. This could be a site for a small detention pond if the property is owned by the City.

An additional discharge point could be established by diverting a portion of the Basin 8 flow, via a new pipeline, to a location along Wausau Road. Land area is available between Wausau Road and the creek. If property ownership permits, a detention pond could be located along Wausau Road.

Drainage Basin 5 – Extensive erosion has been observed down stream of the Basin 5 outlet, and high flow rates observed. The discharge is into a wooded wetland area. Sufficient area is available for a detention pond, depending on property ownership.

A high suspended discharge was noted during the sampled storm event. This indicates a problem source in the drainage basin. The county highway facility, including stockpiles of sand, is located near the discharge outlet and adjacent to the wetland. It is probable that site surface run-off occurs from the stockpile area, and also from sand in the local street areas. Site protection to control site runoff should be implemented and the street areas should be kept clean.

County Fairgrounds – The Langlade County Fairgrounds is located in Drainage Basins 5 and 18. Some storm flow no doubt leaves the site via surface flow into the wetlands. Reported suspended solids discharges from the fairgrounds, particularly from the clay track during heavy rainfall, have been observed. The discharge is through a storm sewer from the south end of the track which flows into the wetland and via overland flow to the creek. Photos of this discharge are enclosed. These were provided by the Antigo Land Conservation Office.

Drainage Basin 18 – This large drainage basin is on area of potential long-term future commercial and residential development. The storm sewer hydraulic capacity is high due to the 60" pipeline. The storm sewer discharges to a basin constructed for wetland seepage. Channeling of the discharge has been reported, with direct flow to the creek. This basin would benefit from improvements to the seepage pond, possibly enlargement of the pond.

The undeveloped portions of Basin 18 should incorporate on-site stormwater management for the larger sites or areas when commercial development occurs. This will attenuate the future peak flows and provide suspended solids treatment.

Basin 1 – This basin experienced a very high suspended solids discharge, and during the sampling, milky white suspended solids were observed in the settling basin. The sampling was conducted in the manhole ahead of the basin. The milky white discharge may be due to the City water plant located adjacent to the storm sewer. Further investigation of this basin and discharge is warranted. The existing settling basin may be adequate but should be verified.

Basin 2 – This basin discharges to Antigo Lake. Two additional storm sewers also discharge in the same general area. These are smaller drainage basins, with the TSS discharge from Basin 2 reported on 5/6/99. Park area may be available for construction of a detention pond to serve all three stormwater discharges. This should be considered.

Basin 17 – This basin serves a portion of the central area of the City, and discharges into the lake at the dam. A lower suspended solids discharge was observed but this sampling was in July. Limited site area is available for stormwater treatment. A vortex grit removal unit could be utilized for TSS removal from this discharge if the site is owned by the City.

Basin 14 – This basin had a very high TSS discharge during the sampling work. The discharge pipe enters the creek adjacent to Eighth Avenue and no land area is

available for stormwater treatment. The high TSS discharge on July 8, 1999, occurred during a peak rainfall event. It may be possible to provide a grit removal unit at this location but further investigation is needed to determine feasibility.

Mapleview Road Basin – This basin discharges to the creek at Mapleview Road. Area is available in the creek area wetland for a detention basin. Stormwater treatment for this discharge should be a long-term consideration.

CONCLUSIONS

The following conclusions result from evaluation of the stormwater discharges to the Antigo Lake area of the Spring Brook Watershed.

1. The City of Antigo stormwater collection and conveyance system was divided into drainage basins based on the contour map of the City. The drainage basin map is included in this report. There are 30 stormwater discharge points to the Antigo Lake drainage basin. Twenty-one of these basins are small and less than 40 acres in basin size.
2. Eighteen discharge points were sampled from the major drainage basins using flow-initiated samplers. The results of the sampling program indicate that the major suspended solids discharges are from Basins 14, 8, and 1. The Basin 14 discharge occurred during a rainfall event greater than a 5-year storm. Basins 8 and 1 discharges occurred at less than a 2-year rainfall event. This data should be used as a general guide to the significance of the drainage basin discharges.
3. Suspended solids discharge from Basins 5 and 2 may also be significant enough to warrant treatment. These basins discharge into the lake area of the watershed. Basin 18 also discharges upstream of the lake area and is a basin of probable significant future stormwater discharge impact as commercial development continues in this drainage basin.
4. Estimates of the stormwater runoff from the drainage basins at 2-year and 10-year rainfall events were prepared. The calculated peak flow rates for the basins indicate that Basin 8 experiences the highest peak flow at 352 cfs for a 10-year rainfall intensity. Other drainage basins with peak flows over 100 cfs include Basins 14, 5, and 18. These are estimates of the peak flow based on the estimated basin areas and the estimated runoff coefficients, and do not consider hydraulic constraints present in the collection system that may dampen the peak flow.
5. Basin 1 sampling indicated a high suspended solids discharge. This is a relatively small stormwater drainage basin. This should be investigated further to determine if the city water plant or other source contributes to this

discharge. The sampling was conducted ahead of the existing settling pond, and does not represent the actual discharge to the watershed.

6. Basins 1, 2, 5, 17 and 18 discharge to the lake area, while the discharge from Basins 8 and 14 are downstream. This may be considered in the prioritization of implementation of stormwater treatment improvements.
7. The county fairgrounds race track area experiences a suspended solids discharge which enters the creek via flow through the wetland. Visual observation of this discharge has been reported to be significant. Photos are included in the appendix.
8. Sanitary sewer system backups occur in drainage basins 14 and 22 due to deficiencies in the stormwater collection system. Improvements should be made to the sanitary sewer system to eliminate the backups, because this is a health hazard.
9. Basin 8 serves a large portion of the City of Antigo. The stormwater piping is 30 inches diameter at the discharge point. Given large drainage basin area, the storm sewer is hydraulically undersized. As a result, the storm water collection system likely experiences flow restrictions and area flooding during storm events. Drainage basins 8 and 5 are reported by the City of Antigo to experience hydraulic capacity limitations.

RECOMMENDATIONS

The following recommendations are made as a result of this evaluation. These recommendations are prioritized based on reducing the stormwater impact on Antigo Lake, though stormwater discharges downstream of Antigo Lake may be higher in flow and suspended solids. All recommendations should be further evaluated and developed in more detail should engineering work be undertaken to provide stormwater improvements.

1. Drainage Basin 5 (along north HWY 45), which discharges near the county garage to the wetland, should incorporate stormwater detention at the discharge to the wetlands and include discharge channel repairs. A detention basin should also be developed upstream near Center Street to dampen the peak flows. A storm sewer capacity analysis should be conducted for Basin 5 to verify the detention basin design and other possible improvements. The county highway department material stockpiles should incorporate runoff control to minimize stormwater impacts.

2. Basin 18 should incorporate an enlarged detention basin at the existing wetland discharge and an overflow structure to reduce erosion of the wetlands should the basin seepage rate be inadequate.

   In the future, stormwater management improvements should be required for commercial development in this drainage basin. This is intended to reduce the peak flow and the TSS discharge. This should be included in an updated stormwater management plan for new construction in the city.

   Further investigation of upstream stormwater treatment improvements in the city storm sewer system should be conducted in conjunction with Basin 18 improvements.

3. Investigation of the Basin 1 stormwater discharge and the existing stormwater detention pond performance should be conducted by the City. The basin

sampling was completed at the manhole ahead of the detention pond, and high suspended solids levels were measured. It is likely that the city water plant discharge impacts the detention pond TSS removal. The water plant discharges may be redirected to the sanitary sewer system as a possible control measure.

4. The stormwater discharge from the county fairgrounds should be controlled via construction of a detention basin. At present, a significant visual impact results from this discharge of suspended solids.

5. Basin 2 could incorporate a detention basin for TSS removal prior to discharge to Antigo Lake. There are several stormwater discharges in this area, and all may be combined. However, the detention basin would be located in the park area and adequate safety must be provided. This may be a lower priority improvement.

6. A suspended solids removal process, such as a small centrifugal solids removal unit, should be provided for the Basin 17 stormwater discharge if property ownership allows. While this is a smaller discharge, it is direct into Antigo Lake.

7. Basin 14 was a significant suspended solids discharge to the creek during the rainfall event of July 8, 1999. Due to limited available site area, a stormwater detention basin cannot be used. If sufficient site area is available a centrifugal solids removal process could be considered for TSS removal.

8. Basin 8 is the drainage basin with the highest estimated stormwater flow in the City of Antigo stormwater collection system and is a significant suspended solids discharge to the watershed. A stormwater detention basin of 28 acre/ft of storage volume is required for the 10-year storm event to treat this flow. However, limited land area is available at the existing outfall on Gowan Road.

The Basin 8 stormwater collection system piping is probably undersized for the design peak flow, and therefore, the storm flow is restricted during peak events and localized flooding may result. A capacity study should be performed for this basin to determine improvements required to reduce system constraints.

Handling the peak flow could be accomplished by diversion of part or all of the Basin 8 flow to a new stormwater detention basin constructed along Wausau Road. There may be land area between Wausau Road and the creek which may be used for this purpose. A storm sewer of sufficient hydraulic capacity would be installed along Wausau Road from Tenth Avenue to the detention pond.

A portion of the existing stormwater flow may continue to discharge at Gowan Road with construction of a detention basin in the wetland area adjacent to Gowan Road. Stormwater flow from the areas along Tenth and Ninth Avenue could continue to discharge to this new basin

Basin 8 is a large highly developed residential area. Options are limited within the developed area of the basin for stormwater detention to dampen peak flow rates. One candidate is the Edison Street drainage area. A detention basin could be constructed between McMillan Avenue and First Avenue.

Further study of this drainage basin is recommended to develop stormwater management options in the upstream basin area and to determine the system capacity and hydraulic limitations which may require improvements.

9. The Mapleview Road drainage basin discharge should be a long-term consideration for construction of a detention basin. The discharge is in a wetland area of sufficient size for a detention basin.

10. The stormwater drainage in the north area of Basin 18, east of HWY 45 and north of HWY 64, should be directed to an area along HWY 64 to an open swale. This would alleviate some of the future stormwater flows to the existing basin 18 collection system.

11. Catch basin sumps should be installed, where appropriate, along HWY 45 because the existing storm drains do not have sumps.

12. Sanitary sewer system backups occur in drainage basins 14 and 22, which are likely a result of combined sanitary and storm sewers or cross-connections in the older sanitary sewer system. This should be evaluated and corrective action taken to separate the sewers or replace the sanitary sewer. The sanitary sewer system backups should be alleviated because this is a health problem.

13. The City of Antigo should update its erosion control ordinance, which will result in reduced runoff from future construction sites in the city.

14. The City of Antigo should implement a stormwater management plan that requires good management practices for new commercial and industrial sites. This is important, for example, for basin 18 which is likely to experience significant future development. The stormwater management plan will also be important for new development in other areas of the city.

15. The Antigo Parkway Plan may benefit the Spring Brook Watershed through improved stormwater management practices. For this reason, the Antigo Parkway Plan should be implemented by the responsible governmental agencies.

16. Preliminary project costs have been estimated for the stormwater management alternatives discussed in this evaluation. The summary of the costs is presented below. These costs are based on initial observations of

the treatment improvements and further engineering is required if budget construction costs are desired.

Stormwater Drainage Basin		Range of Construction Cost
5	Detention Basin and Wetland Channel	$85,000 - $130,000
18	Improve Detention basin @ Center Street	$36,000 - $52,000
	County Fairgrounds Racetrack Detention Pond	Cost Not Estimated
17	Centrifugal TSS Removal Unit	$54,000 - $60,000
14	Centrifugal TSS Removal Unit	$105,000 - $120,000
8	Wausau Road Detention Basin/Piping	$300,000 - $425,000
	Gowan Road Detention basin	$100,000 - $125,000

17. Funding for construction of stormwater treatment improvements should be available from the State of Wisconsin through the stormwater management program. This funding source is now being established in the form of low interest loans and should be available in late 2000. This could be used for one or more of the projects.