Memory Lake Management Plan

Grantsburg, Wisconsin

SEH No. A-GRANT0602.00

January 2008

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January 4, 2008

RE: Memory Lake Management Plan
Grantsburg, Wisconsin
SEH No. A-GRANT0602.00

Ms. Jennifer Zeiler, Clerk
Village of Grantsburg
316 S. Brad Street
Grantsburg, WI 54840

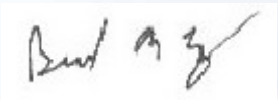
Dear Jennifer:

Short Elliott Hendrickson Inc. (SEH®) is pleased to be sending you a copy of the Memory Lake Management Plan. This report was completed for the Village of Grantsburg with financial assistance from the Wisconsin Department of Natural Resource Lakes Grant Program. It addresses the in-filling and aquatic plant issues in Memory Lake.

This Lake Management Plan looks at a holistic set of management alternatives for Memory Lake and can be used to assist local decision making to enhance and maintain the quality of Memory Lake and the Wood River. The Management Plan includes analysis, discussion of management alternative and implications, recommendations, and an implementation roadmap. The Plan will serve to guide decision makers in implementing long term solutions that are good for the lake or the community.

SEH would like to thank the Village for using our services in developing this plan.

Sincerely,



Bernard N. Lenz, PE
Project Manager

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Memory Lake Management Plan

Grantsburg, Wisconsin

Prepared for:
Village of Grantsburg
Grantsburg, Wisconsin

Prepared by:
Short Elliott Hendrickson Inc.
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Memory Lake Management Plan

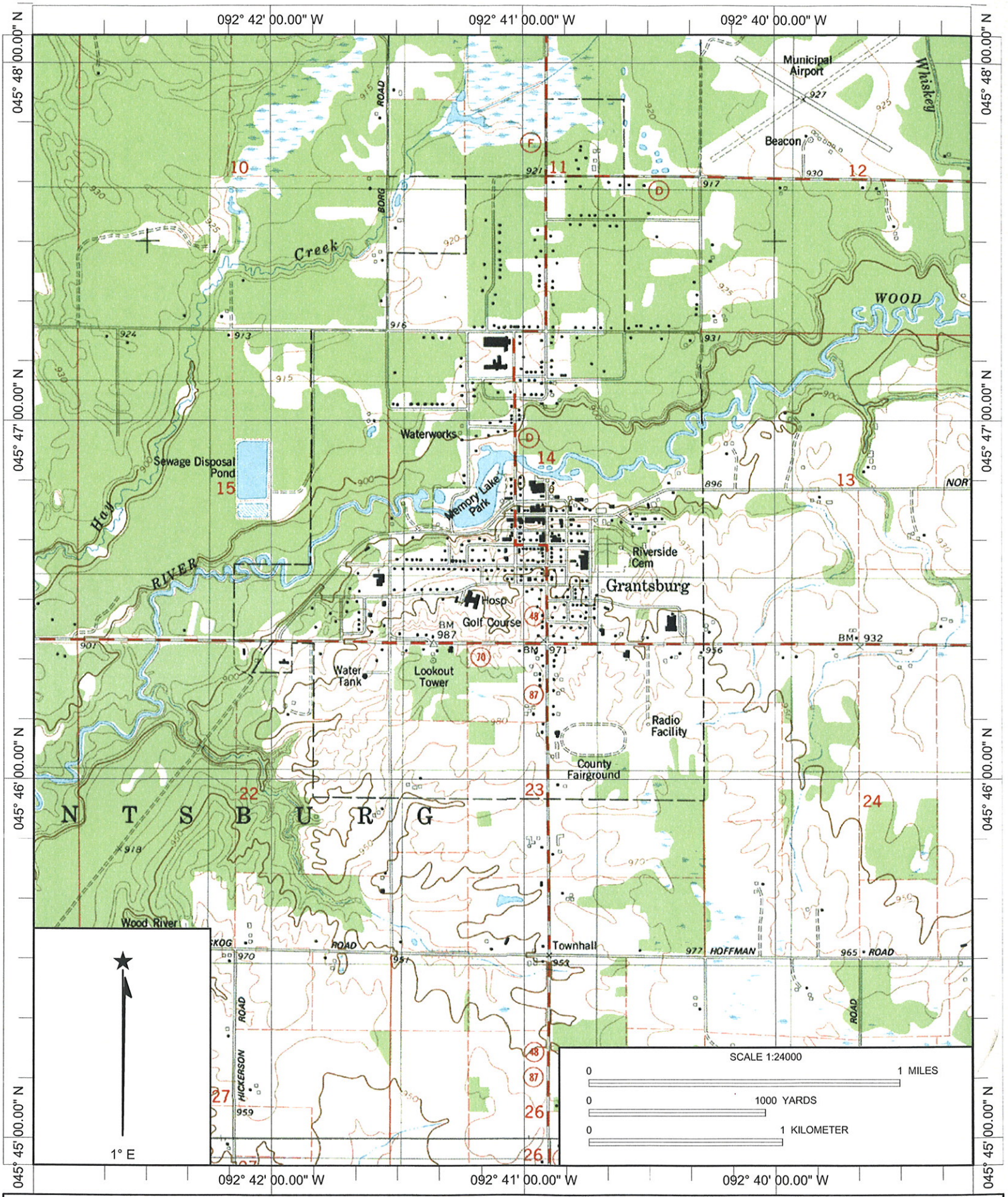
Prepared for the Village of Grantsburg

1.0 Introduction and Background

Memory Lake is a 10.2 acre drainage impoundment on the Wood River located in the Village of Grantsburg, Wisconsin (Figure 1). The dam was first constructed in 1864. In 1936 the dam failed and between 1936 and 1951 the dam was inoperable. The Village rebuilt the dam in 1951 and has been the owner of the dam since. (Johannes and Ryan, 1984) The dam was most recently rebuilt in 1994. It is the first dam upstream from the confluence of the St Croix River. The only other dam on the Wood River forms Wood Lake approximately 7 miles upstream. The North Fork of the Wood River branches below Wood Lake and has no dams.

The Village of Grantsburg owns the entire Memory Lake shoreline that consists of park and natural area. The lake is heavily used for recreation and aesthetics by the citizens of Grantsburg and the surrounding area. Kids are seen fishing in the lake. Occasional swimming and limited boat use do occur but are the exception more than the rule. Grantsburg holds an annual World Championship Snowmobile Watercross on the impoundment annually, drawing thousands of spectators and raising nearly $200,000 for charities in the area. Waterfowl use the impoundment heavily as a resting sanctuary and wild rice beds are found in the upper portion of the impoundment.

In the past, the impoundment has struggled with excessive aquatic vegetation and sedimentation. A common practice to control weeds in the impoundment from 1977 to 1994 was to draw down the lake during the summer to expose and kill aquatic vegetation. The detrimental impacts of this practice to the lakes fish community and the Wood River ecosystem down stream of the dam is provided in a Wisconsin Department of Natural Resources (WDNR) report “Investigation of Memory Lake and the Wood River Including Management Recommendations” by Stan Johannes and Dan Ryan (1984) (Appendix A). This practice was terminated in 1994 at the request of the WDNR. Aquatic weed harvest on the lake now occurs annually under an Aquatic Vegetation Permit; typically just prior to the World Championship Snowmobile Watercross.



Name: GRANTSBURG
Date: 7/19/2007
Scale: 1 inch equals 2000 feet

Location: 045° 46' 30.06" N 092° 41' 05.03" W
Caption: Figure 1. Memory Lake Location Map

Sedimentation of the impoundment has been a continuous problem. A report by the USGS (Lenz and others, 2001) estimated the annual suspended sediment load of the Wood River, just upstream of the impoundment, to be 227,000 to 1,170,000 kg/yr. The impoundment slows water allowing some of this sediment to accumulate, impacting the usability of the impoundment for recreation, fisheries, aquatic vegetation, and wildlife. Additionally, four stormwater pipes from the Village of Grantsburg empty into the basin.

An acute reflection of this sedimentation problem is the Snowmobile Watercross which is impacted by a decrease in the water depth due to in-filling, the increased aquatic plant growth due to shallower water depths, and the accumulated sediments affecting the ability to retrieve machines that sink during the event. These acute affects reflect the overall problem: loss of substrate, lower retention time resulting in poor nutrient cycling, degradation of aquatic vegetation, overall decrease in the quality of the fishery, and reduced recreational value of the lake. Without an adequate lake management plan, the lake will continue to fill with sediment, already excessive aquatic plant growth will continue to expand, the limited fishery will disappear, and the usefulness of the lake and it's benefits to the Village and surrounding communities will continue to be diminished.

2.0 Past Lake Management Activities

Management activities have occurred or been suggested for the lake in the past, but few were based on a solid understanding of the lake as a whole. The predominant user of the lake, the citizens of the Village of Grantsburg, had limited involvement in past recommendations. First, in 1984 after a 5.31" rain event caused shoreline erosion, sedimentation, and threatened the dam some limited dredging and bank stabilization/restoration occurred in the lake. Then prior to redoing the dam in 1994, suggestions were made by the WDNR that the dam could be abandoned allowing the river to be restored and flow thru the park; though concern for carp movement resulted in the need for a fish barrier as an associated management recommendation to dam removal. Winter draw downs to control aquatic plants were suggested. The idea of dredging has come up more than once. Weed harvesting is the currently the only ongoing management activity for Memory Lake.

Depths in the impoundment have notably decreased since 1994. Most notably, a rain event of 8" to 10" occurred in early October of 2005 and exacerbated the sediment issue by in-filling some locations in the impoundment with as much as 3 to 4 feet of sediment in the single event. Native plants, including portions of the wild rice beds, and most of the benthic community within the lake were inundated to some degree. A significant percent of the total water storage volume of the reservoir was lost in that single event. Dredging was immediately contemplated because of the fear of the impact on the Snowmobile Watercross. However, due the cost, the potential detrimental impacts of dredging, and the fear of dredging being only a short term fix, the Village has decided they would like to come up with a long-term solution to the issue with Memory Lake and acquired financial assistance from the WDNR Lake Management Planning Grant Program to study the lake and determine a management plan that balances the desires of the community and the sustainability of the resource.

3.0 Study Components

3.1 Aquatic Vegetation

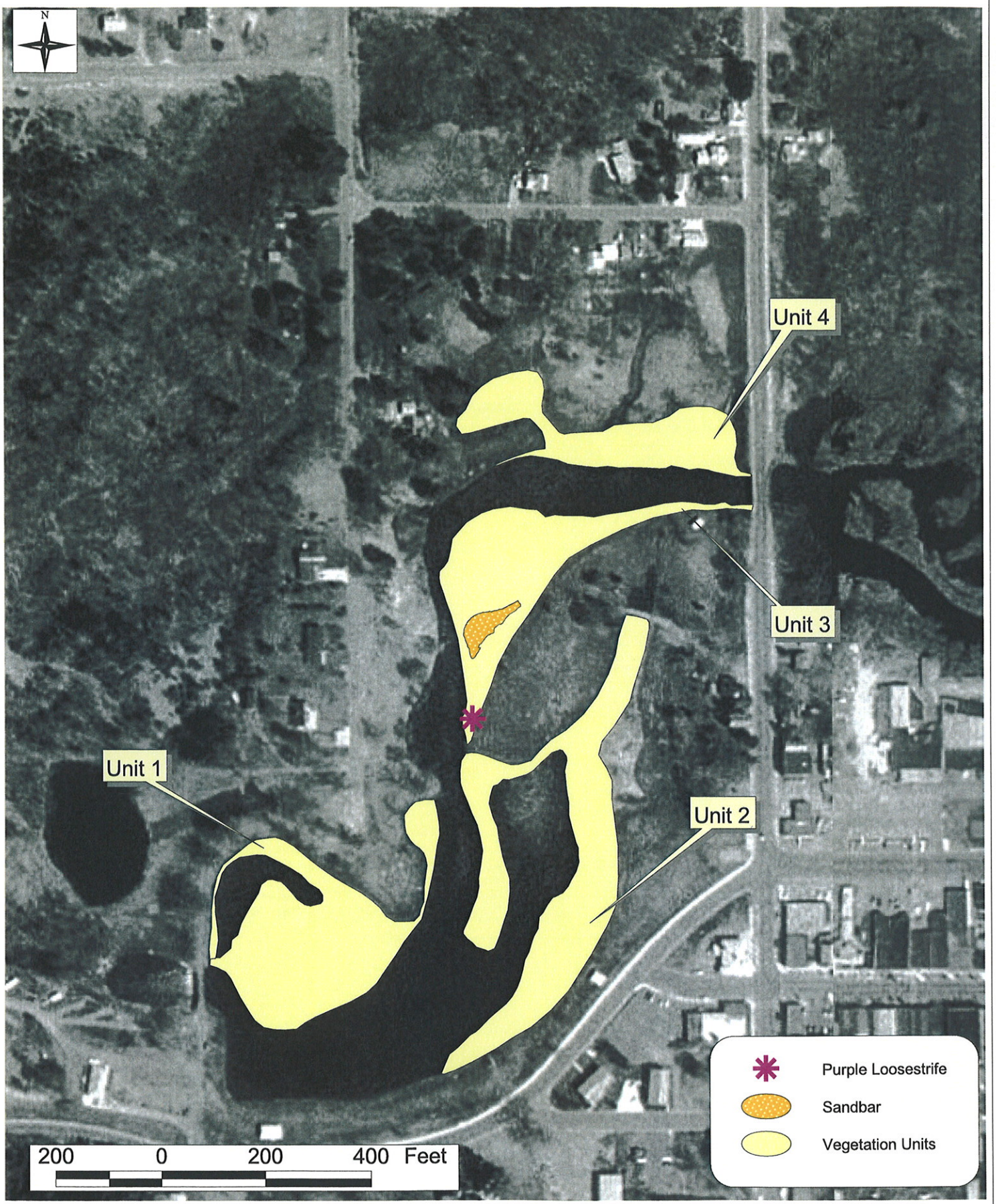
A historical aquatic plant survey was not found for Memory Lake. An aquatic plant survey was done that included detailed mapping of wild rice and a qualitative look at the rest of the aquatic plant community in the lake. Rice bed locations and four aquatic plant community groups were mapped using GIS (Figures 2 and 3). Table 1 contains the aquatic plants species identified and their relative abundances by community group. The pond is relatively productive and dominated by pond weeds, water lilies, and wild rice with relatively low abundance of cattails, loosestrife, or reed canary grass. Wild rice density was highest in community groups 1 and 4 and least in group 2. Several purple loosestrife plants were located and their locations identified on the maps.

3.1.1 Management Discussion

Aquatic plant life in Memory Lake is healthy under current management which includes an annual pre-Watercross harvest. The majority of people surveyed feel the aquatic plants have no or a limited negative impact on their use of the lake and only 14% feel the wild rice in the lake is a significant natural resource. However, 2/3 of the people surveyed feel aquatic plants should be harvested periodically. Current management appears necessary but adequate.

3.1.2 Management Recommendations

- Continue current annual weed harvest, obtaining WDNR aquatic plant harvest permit annually.
- Work with Watercross sponsors to design track course that limits the extent of annual weed harvest and thus impacts on wild rice.
- Remove purple loosestrife manually before the infestation becomes too large. A large infestation would require assistance from the County Land and Water Department to develop a beetle release program.
- The Wood River has the potential to be a conveyor belt of exotic aquatic plant species from upstream lakes. Memory Lake should be inspected annually for invasive aquatic plant species. Grantsburg should also support the County and other lake associations or municipalities in their effort to limit the spread of exotic species.



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Grantsburg Memory Pond
Aquatic Vegetation Survey Locations

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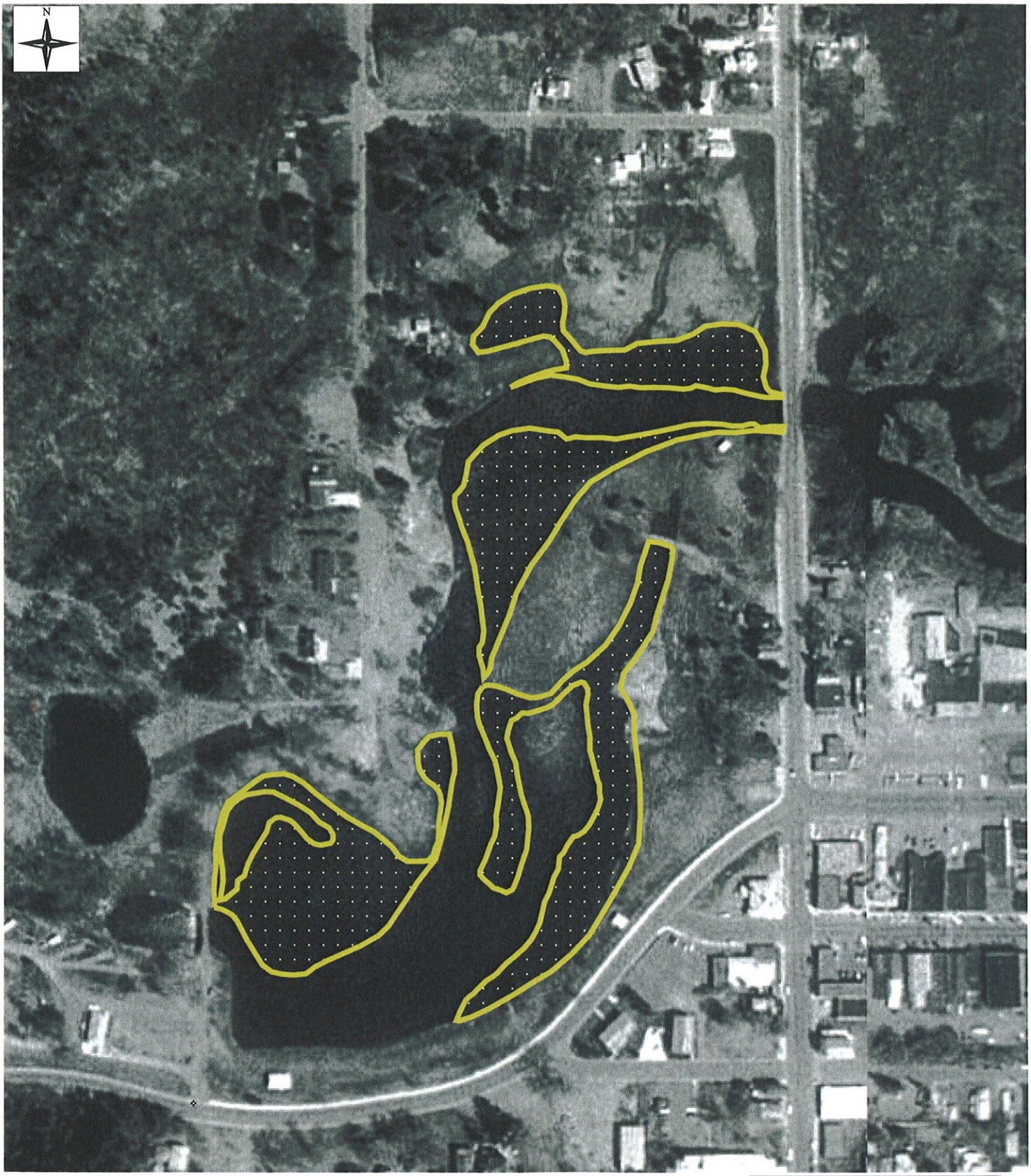
Figure 2



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Grantsburg Memory Pond
Extent of Wild Rice

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Figure 3

Table 1
List of Aquatic Vegetation by Species Presences and Abundance

Scientific Name	Common Name	Unit 1	Unit 2	Unit 3	Unit 4
Asclepias incarnata	Swamp Milkweed	R	R		R
Bidens sp.	Begger-tick		R	R	R
Calamagrostis canadensis	Canada bluejoint grass		O		R
Carex lacustris	Lake sedge		O		
Carex scoparia	Broom Sedge				R
Ceratophyllum demersum	Coontail	O	O		R
Chara vulgaris	Muskgrass	R	R		
Cyperus diandras	Umbrella flatsedge		R		
Cyperus strigosus	Yellow nut-sedge			R	
Eleocharis palustris	Creeping spikerush		R	O	R
Elodea canadensis	Canada Waterweed	F	F	A	
Eupatoriadelphus maculatus	Spotted Joe-pye-weed		R		R
Impatiens capensis	Spotted touch-me-not		O		
Lemna sp.	Duckweed	F		R	O
Lythrum salicaria	Purple Loosestrife			R	
Mentha arvensis	Field Mint	R			
Myriophyllum exalbescens	Northren Watermilfoil	R	R		
Najas guadalupensis	Slender Naiad	R	O	O	
Nuphar variegatum	Spatterdock	O	O	R	
Nymphaea odorata	White Water Lily	O	F	O	F
Phalaris arundinacea	Reed Canary Grass		R		O
Polygonum amphibium	Water Smartweed	R	R		
Polygonum persicaria	Lady's Thumb			R	
Potamogeton amplifolius	Large-leaf Pondweed	O	O		
Potamogeton crispus	Curly-leaf pondweed	A	F	O	O
Potamogeton natans	Floating-leaf Pondweed		O		R
Potamogeton nodosus	Long-leaf Pondweed			R	
Potamogeton pusilis	Small Pondweed	R			
Potamogeton zosteriformes	Flat-stemmed Pondweed	A	F	R	O
Potendaria cordata	Pickerelweed		R		
Ranunculus aquatilis	White Water Buttercup	R			R
Sagittaria latifolia	Broad-leaved arrowhead	O	R		
Sagittaria rigida	Stiff arrowhead		O	R	O
Scirpus fluviatilis	River Bulrush		R		
Scirpus validus	Softstem bulrush		O		R
Sparganium eurycarpum	Giant burreed	O		R	
Typha latifolia	Broad-leaved Cattail		R		
Vallisneria Americana	Wild Celery	R			
Verbena hastata	Blue Vervain				R
Zizania aquatica	Wild Rice	A	A	A	A
	Total Number of Species	**20**	**28**	**16**	**18**
	Number of Unique Species	**3**	**6**	**4**	**2**

A = Abundant	Very Common, found in all areas of the Unit
F = Frequent	Common, found throughout in low density, or isolated high density areas
O = Occasional	Uncommon, but found in multiple low density locations
R = Rare	Rare, represented by a few plants

3.2 Fisheries

The fishery in Memory Lake is primarily a low quality still water fishery with game fish consisting of small sunfish, bass and northern pike. The density and diversity of the fishery increases in the Wood River below Memory Lake and is similar upstream as in the lake. The dam is irrelevant as a carp barrier because carp populations are well established above and below the dam. The dam is not an effective fish barrier during high flows, thus it is not expected to prevent upstream movement of any future mobile exotic species that may enter the St Croix River system. Historically, sturgeon were present in the Wood Lakes upstream of the Memory Lake dam and likely migrated from the St Croix River in search of food. The Wood River above Memory Lake is not large enough to be considered prime sturgeon spawning habitat.

Historical fish survey data of the flowage and river, both upstream and downstream, as well as discussion by the WDNR Fisheries Manger of impacts of the Memory Lake dam can be found in Appendix B.

3.2.1 Management Discussion

The current fishery is of low quality and has very little usage. A 1984 WDNR report states “Memory Lake will never be capable of supporting a very high quality fish community” due to short retention time and lack of nutrient cycling.

Allowing fish passage from the St Croix River to the upstream lakes and headwaters of the North Fork of the Wood River would likely raise the diversity of the fisheries in and upstream of Memory Lake without adding significant additional risk of the spread of exotic species. Increasing the flow rates thru the Memory Lake could impact the existing still water fishery, however, the likely increase in diversity, the presence of other game fish, and the potential benefit to sturgeon outweigh the loss of the current marginal fishery.

Only 14% of the people surveyed feel the fishery in Memory Lake is good and 76% say the fishery has no impact on their usage of the lake. Over half of those surveyed said they have no preference in regard to the fishery; of those with a preference, 71% would like to see a more river-like fishery.

3.2.2 Management Recommendations

- Current ecological philosophy is that a connected ecosystem is better than one physically separated. Free fish passage should be a goal. Allow easier fish passage thru Memory Lake to connect the St Croix River with the upper reaches of the Wood River.
- Conversion of the fishery from a low quality still water fishery to a more river-like fishery would likely create a higher quality fishing usage and is thus recommended.

3.3 Hydrology, Water Quality, and Sediments

3.3.1 Hydrology and Water Quality

Flow characteristics of various flow regimes were determined, including low flow, average flow, and the Q2, Q10, Q25, and Q100 flood flows (Appendix C). Retention time was calculated for each and it was determined that at daily average flows, the retention time of Memory Lake is 1/3 of a day. This means the volume of the lake flushes 3 times a day at average flow. At extreme low flow conditions (Q7,10) retention time is 2 days. At peak flow the retention time is minutes and the lake flushes hundreds of times per day. In essence, the water quality in Memory Lake equals the river water quality in all conditions. Thus, nutrient loading is of limited concern for Memory Lake as low retention time equates to an inability for nutrient cycling to occur. Water quality in Memory Lake will essentially reflect that of the Wood River in all flow conditions.

3.3.2 Sediment Loading

Water quality and sediment loading data from a USGS study on the St Croix Tributaries was used to define loading for the Wood River upstream of the USGS site at N. Williams Road. Below N. Williams Road, watershed boundaries were delineated to define overland runoff to the Wood River between N. Williams Road and Memory Lake, overland runoff to Memory Lake, and runoff from each of the 4 storm sewer drainages from the Village of Grantsburg (Figure 4). Drainage areas were calculated in GIS. Village and Township zoning maps and urban loading coefficients were used to calculate sediment loading rates. Sediment moving along the bottom of the Wood River (bed load) was calculated using an empirical relation between the Wood River basins physical characteristics and the USGS measured annual suspended sediment load.

The annual sediment load to Memory Lake is 1,537,000 kg/yr. The majority of this sediment is coming down the Wood River. The 1999 sediment yield for the Wood River was 4,350 kg/km^2/yr. Other St. Croix River tributaries had 1999 yields of 1,800 to 8,400 kg/km^2/yr. Results of the analysis by source is shown in Figure 5.

3.3.3 Sediment Survey

Sediment coring on the flowage was done via canoe using a hand probe to determine the type, depth, and extent of sediments in the flowage. Additionally, a potential depth map (based on probe refusal depth) and a water depth map were drawn. Maps from the sediment survey are shown in Figures 6-9. Sediment in Memory Lake consists of mostly silts and sands. The sands were found in thick layers with more sand in upper part of basin and more silt in the lower.

We assumed the bottom of the sediment determined in the survey represents the extents of the Memory Lake dredging that occurred in 1966, the last year the lake has been dredged. Sediment accumulation rate (assuming a 1966 dredge) is 32,136 cubic feet per year or about 2.33 ft over the entire lake in the 41 year time period. That's about 0.7 inches per year of sediment accumulation on average.

Legend

- Watersheds
- Storm Sewer

0 1,000 2,000 4,000 Feet

N

Source:
Burnett County,
NAIP
and the Village of Grantsburg.
Projection:
Burnett County
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MEMORY LAKE

Village of Grantsburg

Watershed Map

Figure 4

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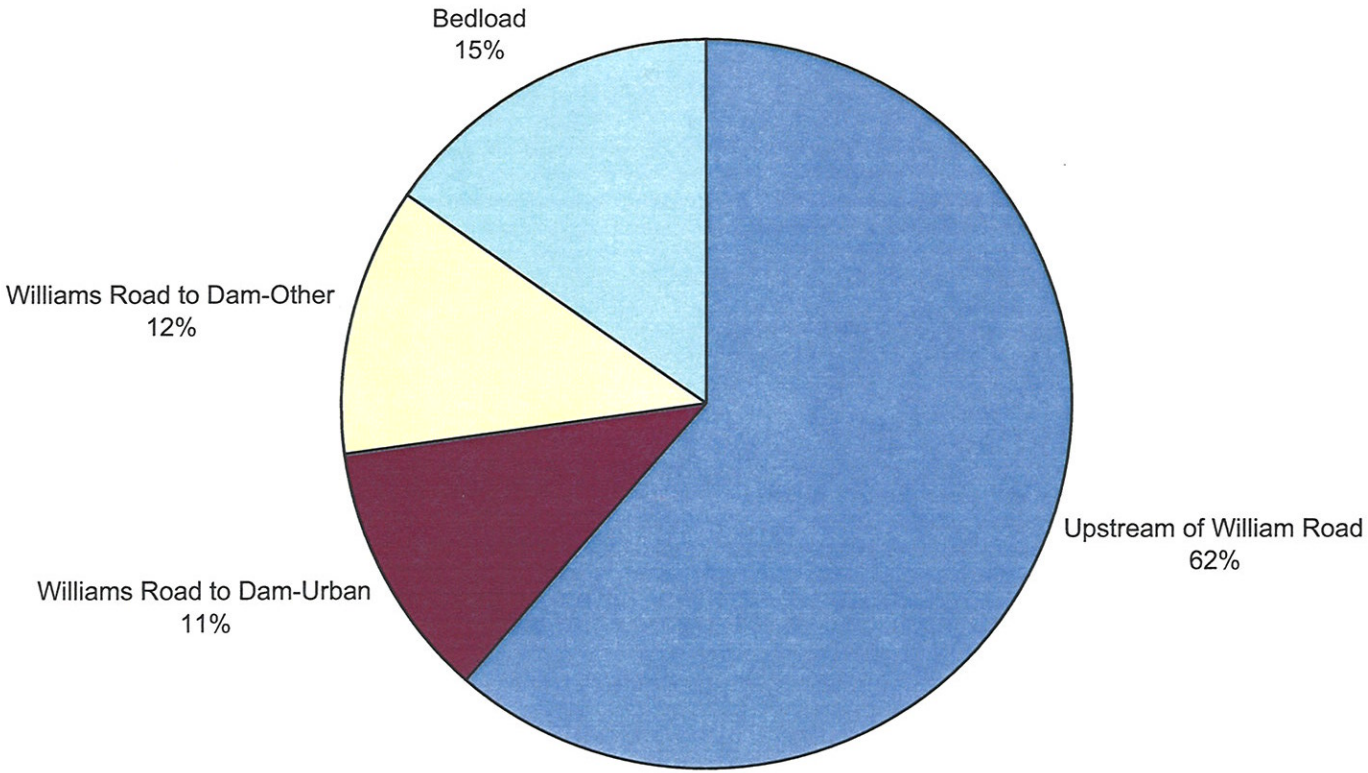
Figure 5. Memory Lake Annual Sediment Load



Legend

Transect Points
- <all other values>

Benthic_co
- cobble
- gravel
- muck
- mud
- sand
- silt

Lake Edge

Sediment Depth Contours
- <all other values>

Sed_Contou
- 1
- 2
- 3
- 4
- 5
- 6
- 7

N

0 100 200 400 Feet

Source:
Burnett County,
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MEMORY LAKE
Village of Grantsburg

Sediment Types

Figure 6

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Legend

- Transect Points
- Lake Edge

Sediment Depth Contours

- <all other values>

CONTOUR

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

0 100 200 400 Feet

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MEMORY LAKE
Village of Grantsburg

Sediment Depth Contours

Figure
7

Map Document: (P:\fjg\GRANT\060200\GIS\Water_Depth_Map.mxd)
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Legend

- Transect Points
- Lake Edge

Potential Depth Contours

- <all other values>

CONTOUR

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10

0 100 200 400 Feet

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Potential Water Depth Contours

Figure 8

Map Document: (P:\fig\GRANT\060200\GIS\Water_Depth_Map.mxd)
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Legend

- Transect Points
- Lake Edge

Water Depth Contours

<all other values>

CONTOUR

- 1
- 2
- 3
- 4
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- 6
- 7
- 8

0 100 200 400 Feet

Source:
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Existing Water Depth Contours

Figure 9

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Using accumulated sediment volume from the sediment survey and estimated annual load; the trapping efficiency of Memory Lake is 94%, meaning nearly all the suspended sediment load would be trapped in Memory Lake. We know this isn't possible. This discrepancy is discussed in the Management Discussion section that follows.

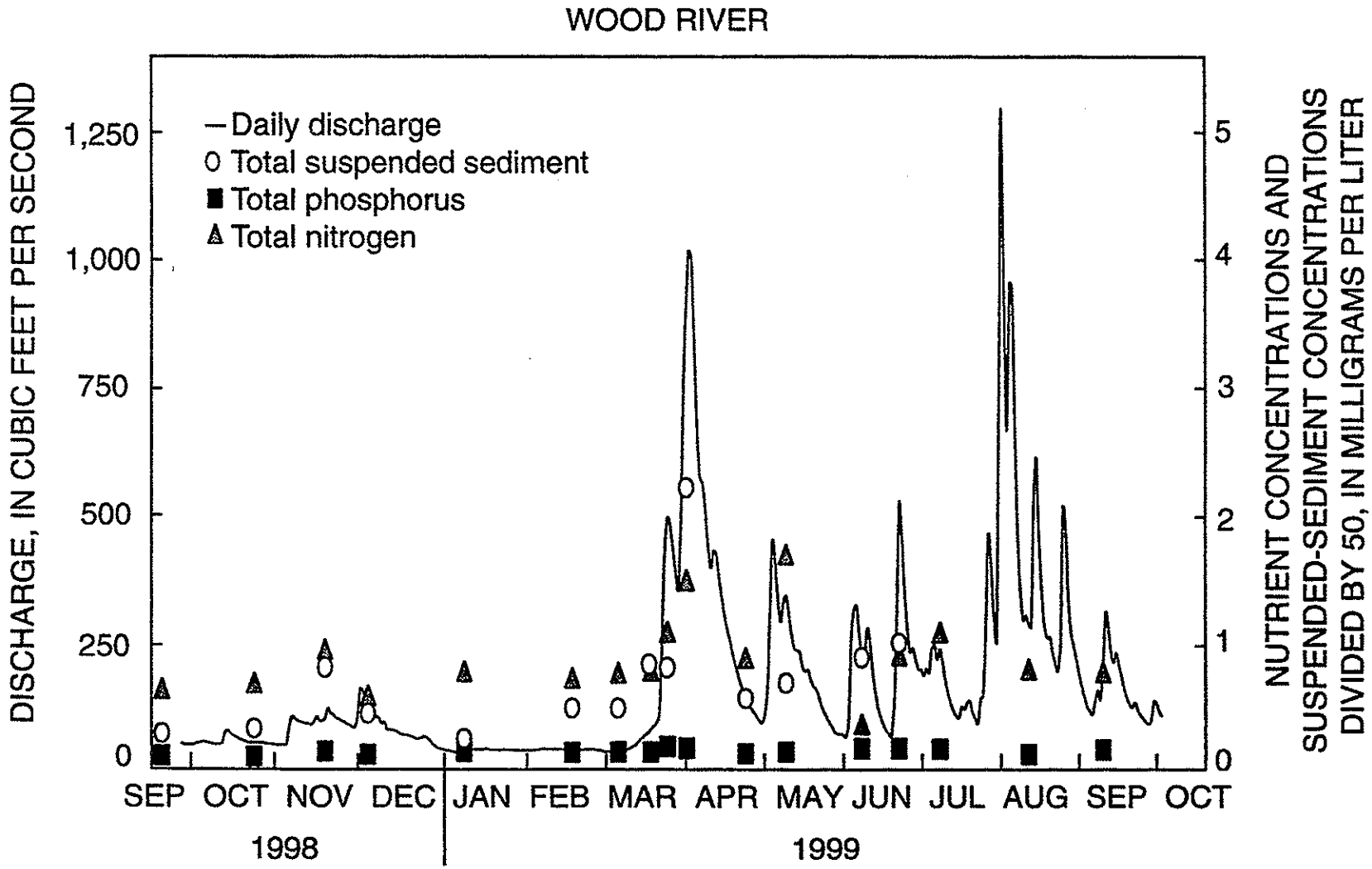
No likely contaminate sources were identified upstream. Regardless, three samples were composited and sent to the SLOH for the dredge screen suite of chemicals. No elevated level of contamination was found. The sediment sample analysis results are in Appendix D.

3.3.3.1 Management Discussion

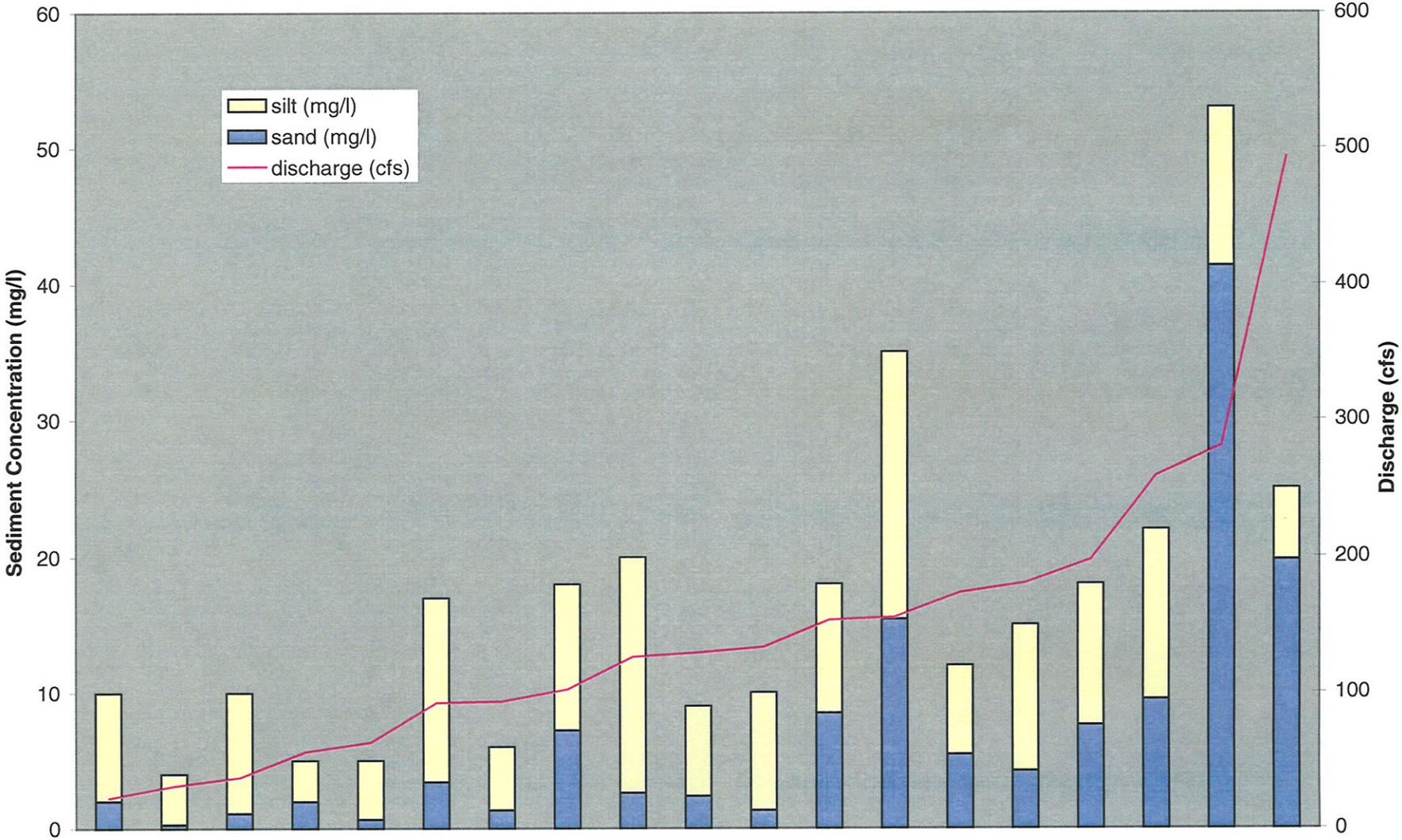
Sedimentation within the basin is controlled by a combination of retention time, flow velocity, sediment settling rates, and scouring. The flow regime within the reservoir is highly variable due to the small volume and variability of the flow in the Wood River. Determining the impacts of hydrology on sedimentation accumulation rates was an important part of the Lake Management Plan. Flow velocity, particle settling rates, and retention time were modeled using a spreadsheet model to determined theoretical sedimentation rates using various flows. Calculations are shown in Appendix E. The settling velocities of sediment types compared to retention time and surface area/flow show that mostly sand and some silts are trapped but clay would be passed.

The USGS data from 1999 show that the amount and type of sediment coming down the Wood River changes with flow. There is an exponential increase in sediment volume and a shift toward coarser material during larger events. (Figures 10 and 11). Additionally, with the increased suspended sediment load during these events, a significant increase in bed load is expected. Flow rates in 1999 were about 1/2 the predicted 100 year flow rate, Figures 10 and 11 show only the effects of moderate events. In streams similar to the Wood River, past studies have shown that it is not uncommon for single large events to have a daily sediment load that exceeds the average annual load.

Part of what instigated this Lake Management Plan was a large -nearly 100 year event, that occurred in October of 2005. The amount of sediment delivered to Memory Lake in that one single event far exceeded the annual average accumulation of 0.7 inches and was an example of the amount of sediment that can be produced by the Wood River in a single event. The WDNR gave permission to leave the Memory Lake drawn down after the event. Prior to it being refilled, SEH examined the sediment and saw locations in the lake with several feet of new sand accumulation. Pictures can be found in Appendix F.


WOOD RIVER
DISCHARGE, IN CUBIC FEET PER SECOND
NUTRIENT CONCENTRATIONS AND SUSPENDED-SEDIMENT CONCENTRATIONS DIVIDED BY 50, IN MILLIGRAMS PER LITER
Daily discharge
Total suspended sediment
Total phosphorus
Total nitrogen
1,250
1,000
750
500
250
0
5
4
3
2
1
0
SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT
1998
1999

Wood River Sediment Composition
(based on 1999 USGS sampling)



The discrepancies in the calculated annual load, theoretical particle settling rates, estimated trapping efficiencies, and accumulated sediment volume since 1966 as well as the documented increase in sediment loading with flow events all indicate that episodic loading events are typical for this system. The in-filling of Memory Lake is related to discrete, extreme events with suspended sediment particles of a larger size or bed load, rather than a continued steady accumulation of sediment over time. The sediment core survey results confirm this as thick layers of sand between thin layers of silt are common.

3.3.3.2 Management Recommendation

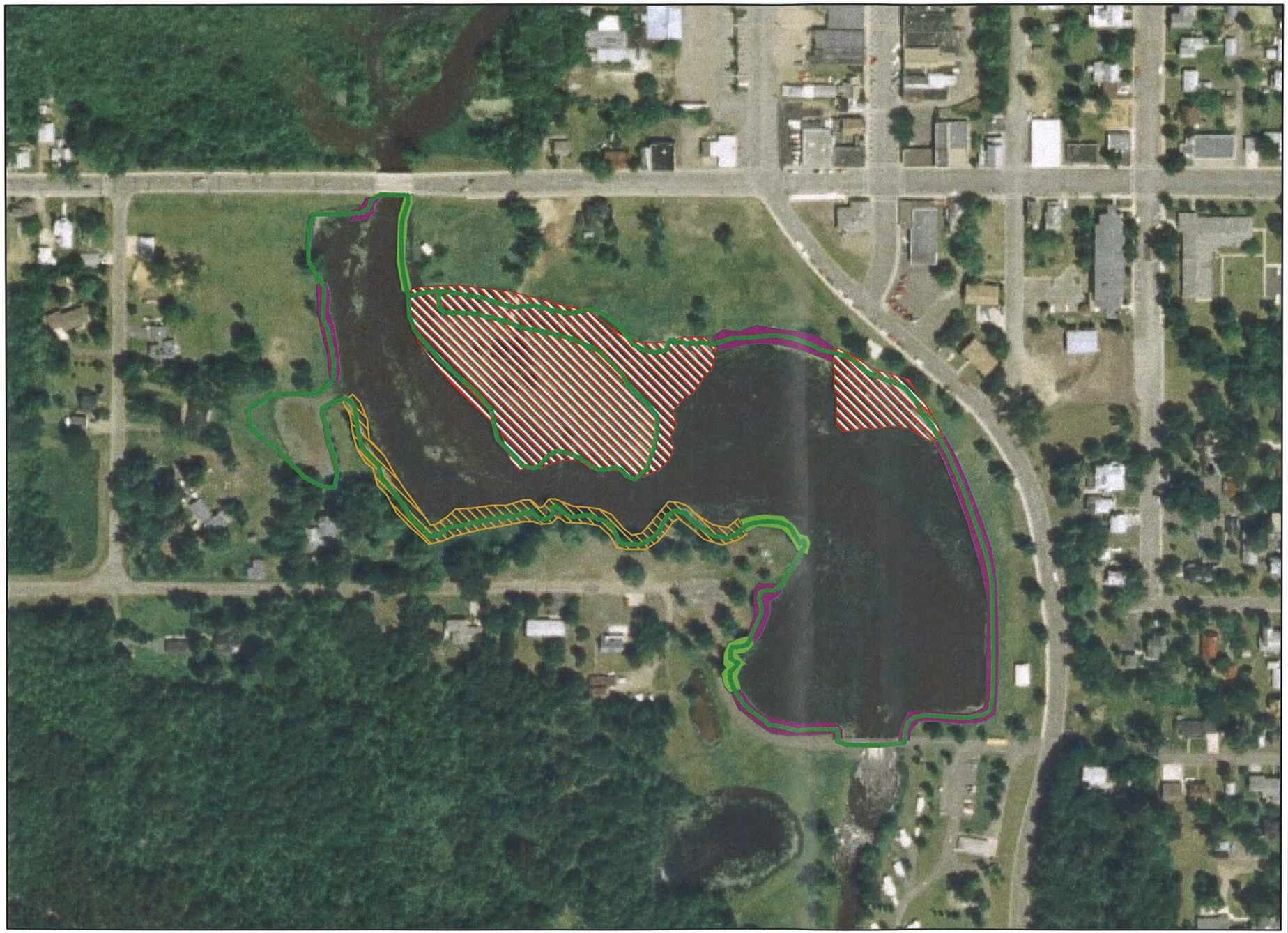
- Consider loading related to the in-fill of Memory Lake natural
  - Episodic events likely causing most of sedimentation
  - Significant in-fill is related to extreme events, not a steady accumulation over time
  - Future in-fill is likely to reoccur with current dam operation, when is difficult to predict (a factor of statistical reoccurrence interval)
- Focus sediment reduction need on upstream basin load and bed load.
- To maintain pond without changing current dam operation, an active sediment trap is needed.
  - If dredging occurs you will want to make a fore bay type hole in upper portion
- To reduce in-fill rate, sediments should be passed, including bed load
  - Without dam the sediments would pass
  - With dam in place, more sediments could pass if flood flow were routed under gate, eliminating energy loss. This may even allow bed load to pass. (1984 is a good example of this)
  - With current dam operation, in-fill will continue
- Small, on going sediment removal in upper basin after episodic loading event would be more successful than periodic dredging of entire basin at wider spaced intervals.

3.4 Shoreline Survey

A qualitative shoreline survey was completed by SEH biologists to identify ecologically sensitive areas. Erosion potential and restoration needs are mapped, prioritized based on bank steepness and vegetation present, and shown in Figure 12.

3.4.1 Management Discussion

There are few vegetative buffers around the lake, and areas of mowed grass attract geese to the uplands around Memory Lake making many of the mowed areas of the park unusable. Vegetated buffers serve as a deterrent to geese as well as protect the shoreline, serve to remove pollution from overland flow, and provide habitat. Only 6% of those surveyed think there should be more mowed area, 70% think the current mix of natural and mowed is about right. Slightly more than 1/2 of the people surveyed take concern with the geese.



Legend

- Lake Edge
- **Ecologically Sensitive Area**
  - Heavy Depositional Area
  - High Erosion Potential
  - Moderate Erosion Potential
  - Well Protected Bank

0 100 200 400 Feet

Source:
Burnett County,
NAIP
and the Village of Grantsburg.
Projection:
Burnett County
Map by:
SEH

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PROJECT: AGRANT0602.00

DATE: 11/22/2006

MEMORY LAKE
Village of Grantsburg

Ecologically Sensitive Areas

Figure 1

Map Document: (P:\lj\g\GRANT\060200\GIS\Water_Depth_Map.mxd)
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3.4.2 Management Recommendation

- The northern west portion of lake's shoreline is currently protected with dense vegetation. This bank needs to stay protected as this is an energy dissipation area for inflows during flooding events.
- The point located on west shore-central part of lake is eroding due to foot traffic and needs restoration. This point should be revegetated, with access limited until the bank has been stabilized. Access to this erodable bank could even be permanently limited by the installation of a defined trail and lookout platform of sorts on the point, surrounded by a vegetation restoration to stabilize the bank.
- More vegetative buffer is needed to reduce the attractiveness of the lake to geese and to protect the areas on the north shore that have a higher potential for erosion. A portion of the north shoreline should be restored with vegetative buffer measuring a minimum distance of 10 feet from the waters edge. This area extends from the north edge of the dam to the eroding point discussed above. This area also has the potential for the worst overland run-off water quality from the street and parking area which a buffer would help mitigate. Soils in these areas will have seed banks of native plants. These areas, if left unmowed, will revert back to a shoreline habitat less attractive to geese while becoming more usable for other types of wildlife.
- Those shoreline areas to the south of the dam should be maintained as mowed grass, as the south shore has the pavilion and picnic tables and sees the most use. An alternative is to keep the lawn but implement rain gardens at key areas around roofs and other hard surfaces.

3.5 Community Survey

A community survey was preformed to gather input from residents of the Village of Grantsburg using the Village utilities mailing. Questions regarding the use of Memory Lake, the perceived value to the community, and the level of acceptance of possible management alternatives were included and results are in Appendix G. The survey was sent to approximately 550 Grantsburg residents. Approximately 100 responses were received. Results are used in the management discussions throughout this Plan.

3.6 Regulatory Considerations

Pertinent State regulations impacting the management alternatives considered include the following:

- **NR 109: Aquatic Plant: Introduction, Manual Removal, and Mechanical Control Regulations:** This regulates the removal or disturbance of aquatic plants and details permitting requirements.
- **NR 345: Dredging Navigable Waterways:** This regulates the removal of material from the bed of lakes and rivers and details the permitting requirements.

- **NR 347: Sediment Sampling and Analysis, Monitoring Protocol, and Disposal Criteria for Dredging Products:** This regulates the removal of material from the bed of lakes and rivers and details the dredging needs and requirements.
- **Village Stormwater Control Ordinance:** This regulates the discharge of stormwater into the Village storm sewer system and details construction and post construction stormwater control requirements.

4.0 Management Alternative Evaluation

Management alternatives evaluated below have come from discussions with the Village, stakeholders, and WDNR personnel as well as historic reference. Each option is discussed, with reference to the ecological and sociological implications. Final recommendations are given in Section 5.0.

4.1 Dredging

The effectiveness of dredging to restore volume and control aquatic plants in Memory Lake ends up being somewhat of a gamble. Since in-fill of Memory Lake is not caused by continual loading, but rather by episodic events driven by large events which are random in nature, the in-filling associated with these events is also somewhat random in nature. It is possible that if Memory Lake were dredged, years would go by without a significant event to produce significant in-fill. Conversely, one large event could come the year after dredging and substantially negate the benefits of the dredging. Due to the cost of dredging, this is a gamble not worth taking. Dredging should not be undertaken if the Memory Lake Dam operation continued as it is currently. Dredging is a viable option if management of future sediment load is also planned.

4.1.1 Ecological Consideration

An evaluation of the industries upstream of Memory Lake and a composite sample taken from thee points in Memory Lake indicate the sediments in the lake are not contaminated and would not pose an environmental threat to dredge. Dredging could improve the fishery, but not significantly due to the low retention time. The impact on wild rice beds in the lake is an ecological concern with dredging since water depths would be increased and the area of the lakebed suitable for rice growth reduced.

4.1.2 Sociological Consideration

The Village a Grantsburg is well known for the Watercross it hosts on Memory Lake every year. The Watercross is an internationally attended event that brings an influx of money into the small community. Additionally, many of the civic groups make a large portion of their annual income during this event. The depth of the lake is about as shallow as is possible for the event to occur safely. Consideration was given to abandoning the event in 2007 due to this and other issues, but due to the importance of the event to the Village it has continued. The importance of the event to Grantsburg residents can be seen in the survey results. Although 62% of respondents have said that the in-filling has not impacted their personal use of the lake, 77% say it has impacted the community's use of Memory Lake, and about 1/2 would support an additional assessment to fund maintenance of Memory Lake's sediments.

Indian treaty rights associated with wild rice mandate that tribal considerations to the impact on wild rice be considered. Only 14% of survey respondents consider Memory Lake a significant resource, probably because of the lack of production of the crop. Typically the rice does not produce a crop that can be harvested.

4.2 Sediment Loading Control

The majority of sedimentation in Memory Lake is comprised of the coarse sediments that settle out first and appears to be associated with large events. Due to the large size of the watershed, controls that would impact this basin wide event load are not feasible for the Village to undertake alone. Partnership with the county would be critical. Even with extensive controls in place, a portion of the loading from the watershed is natural and would remain.

The fact that Memory Lake is a small impoundment relative to the size of the sediment load produced by the Wood River means source control in the upper basin would have limited success as a long term fix to the in-filling of Memory Lake.

Deltas at the mouths of the urban storm sewer point discharges indicate that these are a source of sediment to Memory Lake. Urban sediments typically are coarser and have higher concentrations of pollutions, including toxins such as lead and metals. Watershed controls by the Village should focus first on the Village's storm sewer system, and second on support of the County's Land and Water Conservation Departments' efforts in the rest of the basin.

The Village currently has storm water control ordinances and a storm water utility in place that encourages and funds storm water controls within the Village. The utility currently encourages these practices on business parcels but could be used to fund rain barrels or rain gardens in residential parcels. A master stormwater planning effort that would coordinate and prioritize Village stormwater management efforts needs to be undertaken.

4.2.1 Ecological Consideration

Effort to reduce loading from the watershed is a sound management strategy to reducing the sediment load in the Wood River and would have positive benefits to the Wood River, and thus to Memory Lake. Those improvements would also be passed down stream to the St Croix River, and as far as the Gulf of Mexico. Reduction in overall loading would reduce the in-fill of Memory Lake. However, the scale of these changes would need to be very large to be effective.

4.2.2 Sociological Consideration

The Village of Grantsburg is a relatively small Village with limited operating budget. The sheer size of the Wood River Basin and the scale of the work that would be required to get the loading reduction required to have a significant impact to the lake far exceed what Grantsburg could accomplish financially on Memory Lake.

4.3 Restoration to Channel Flow

Two alternatives of this approach have been suggested, complete removal of the dam or running the current dam with the gates opened. Under both scenarios, the impoundment would no longer exist and the park would operate as a riverine corridor, rather than a reservoir. This would significantly alter the look and use of the park. This is significant since the park is a central focal point in this community. Temporarily restoring a pond (for events such as the World Championship Snowmobile Watercross) is possible if gates are left in place, however, there is enough concern over the ecological and structural impacts that doing so is not recommended. This is likely a low cost option for the Village, as it would not require dredging. Additionally, current ecological thinking favors dam removal, and thus grant funding sources for dam abandonment and/or removal are available.

An important consideration of this option is that the dam was completely restored in 1994 and by all signs is in relatively good condition. Had the dam been in ill repair abandonment would have been a more attractive option for the Village. However, the sociological implications associated with changing Memory Lake into a riverine park are very intertwined in the Village's sense of community; due in a big part by the need for the continued existence of Memory Lake to sustain the Watercross. The event is of such importance to the Village that this option is only viable if some form of dredging and/or operational change is not financially feasible for the Village.

4.3.1 Ecological Consideration

Hydraulically, Memory Lake and any management option for the lake considered in this report have next to no impact on the Wood River's flows. The impoundment is simply too small to impact the hydrology of a river this size.

The release of sediments immediately downstream and eventually to the St. Croix River with this alternative would be of concern only initially, as the accumulated sediment is first moved. After a relative short period of time the river would have incorporated and distributed the sediments into it's natural sediment load and transport mechanics. However, directly downstream of the dam is a mussel bed that contains state endangered mussels. This bed was studied in July 2005 and the results are included as Appendix I. The impacts of that initial flush of sediment on this mussel bed would need to be considered and potentially, the bed relocated prior to removal or opening of the dam.

The impacts on fish movement are positive both in opening more area up for spawning runs and restoring access to the upper watershed and upstream lakes. Since the dam currently is not an effective barrier to exotics and not necessary for carp, the only negative impact on fisheries would be the likely loss of the marginal still water fishery (bass, sunfish, and pike). This is outweighed by the improvement associated with the free fish movement.

The option of restoring water to the lake only during the Watercross would require a slow process in both filling and drawdown. Problems with downstream flows and the phreatic surface thru the dike, earthen dam, and pond embankments would need to be considered. Loading on the dam in a

dynamic saturation situation or the wetted perimeter of the lake remaining saturated if water is drained quickly could lead to failure. An extended fill and drain period before and after an event would be needed and result in extended inundation in the summer period surrounding the Watercross. In nature, seasonal inundation during the summer is not typical; therefore, there would not be a native plant community suited to this type of environment. Any plants established in the spring or fall drawdown period would be subject to the stress of inundation and either die or become susceptible to quick growing invasives. The option of filling the pond on an "as needed" basis is a poor management alternative.

4.3.2 Sociological Consideration

When asked what consideration should be given the most weight when choosing a management alternative for Memory Lake, "The continued existence of Memory Lake" was the overwhelming choice of survey respondents, followed by the overall cost/benefit of the lake and park. Although 62% of the people surveyed say the in-filling has not impacted their personal use of Memory Lake, 70% say in has impacted the community's use. Nearly half of those responding say they'd support additional assessments of some form or another to fix it.

Memory Lake and City Park – the well used urban park that surrounds the lake – are very intertwined in the Village of Grantsburg's sense of community and are a focal point of the Village. This area is used year round: for fireworks, observation of resting local and migrating waterfowl and other wildlife, as a backdrop to "Music in the Park", and for many other such nature and community activities. The lake/river is also an important draw to users of the municipal campground located at the dam (many seasonal residents). The campground is a source of revenue to the Village (in camping fees) as well as a source of customers to Village businesses.

The highest profile use of Memory Lake is the World Championship Watercross. Continued existence of Memory Lake is required to sustain the Watercross, an event of much importance to the Village; financially and as a showcase for the community. It is also considered by others to be environmentally degrading. The Watercross is likely the factor causing the polarizing survey results seen when residents were asked about removing the dam and restoring the area to a riverine park with "likely" cost share. Of the respondents to this question, 30 ranked removal of the dam first and 36 ranked it last as a management option. Only 21 ranked it in the middle. Whereas, when asked to rank an altered gate operation plan to allow flushing with "possible" grant funding 28 ranked this option first, 36 ranked it second, and only 4 ranked it last as a management option.

Additionally, the Village considered removing the dam in 1994 and instead made a financial investment in the lake by redoing the dam and gates. There is cost associated with the loss of this investment if the dam were to be removed and is also a factor in why this option of removal of the dam is polarizing. If the dam or gates had not been recently repaired this option would likely not be as polarizing.

It is our opinion that removing the dam and converting Memory Lake to a riverine park would be less polarizing and more sociologically viable if it were financially unpractical to deal with the in-fill issue and maintain the lake depth required for the Watercross or if the Watercross were to be abandoned due to an unrelated issue (such as cost of insuring the event). The Village made a decision in 1994 to invest in the dam and it was somewhat polarizing then. With the importance of the Watercross to so many individuals in the Village and surrounding area, and conversely the negative environmental connotations of the event, this will continue to be a polarizing issue for years to come.

4.4 Change Dam Operation Plan

Summer drawdowns to control aquatic plants and operating gates to promote sediment passage rather than accumulation were operational plans considered (as well as opening the gates year round discussed in Section 4.3). The negative ecologic impacts of summer drawdown were considered by the WDNR when the operation plan for the lake was changed in 1994. Additionally, summer drawdowns do not promote the passage of sediment thru the reservoir. In fact, exposing the sediment in the bottom of the lake probably made the sedimentation accumulation worse, as sediment exposed to the air for long periods actually compacts, and become less susceptible to re-entrainment. Keeping water in the reservoir over much of the year and opening gates in the spring during higher flows associated with snowmelt run-off to allow these sediments to be washed thru the reservoir may be a better option.

Since fine to medium sediments do not have time to settle the majority of the in-fill of Memory Lake is coarse material that is carried into the lake during episodic run-off events. The operation of the dam gates should mimic these episodic events in an effort to pass these coarser sediments and bed load thru the system, rather than capture them in the lake. Opening the gates from the bottom up and allowing theses larger flows to run unobstructed thru Memory Lake would create a conveyor belt type of affect. These sediments would be moved during period of high flow and naturally high sediment concentrations, mimicking nature and limiting negative downstream impacts.

Historically, the yearly high flows in Wisconsin's larger streams occur during spring snowmelt. Under a revised operation plan, the timing for opening of the Memory Lake gates would occur concurrently with spring run-off, and gates would remain open until after the spring spawning run was complete, at which time Memory Lake would be filled and remain a normal pool elevation until the following spring. Consideration would be given to opening the gates during large events at other times of the year on a case by case basis. Extreme events such as the October 2005 event would likely need the gates open for flood control purposes. In 2005, gates were allowed to remain open and even the average flows removed sediments in the main channel during this period. Large sand deposits were observed downstream of the dam, but eventually were flushed downstream. This Plan would mimic that process on a less extreme, but more frequent annual basis.

If the ecologic benefits outweigh the cost, or if accumulated sediments have been compacted to the point that they can not be re-entrained in this new operation plan, dredging concurrent with this new plan should also be considered. Village stormwater controls and best management practices must be in place before such operation could occur. Otherwise this operation change could simply transfer the Village's urban runoff somewhere downstream, burdening another community.

4.4.1 Ecological Consideration

Lakebed would not be exposed in the summer or to winters extreme conditions, limiting impacts on aquatic plants. Impacts of extreme lake elevation changes in the summer months and winter freeze-out would be avoided.

Any accumulated sediment from the previous year would be carried downstream during this spring flush. As our study has shown, the majority of this would be sand sized sediments. Unless a significant event had occurred the previous year, the amount of sediment flushed from Memory Lake would be insignificant compared the average Wood River spring load. If a significant event had occurred the previous year, the river would have been geomorphicly altered from that extreme event (that's why Memory Lake would have accumulated sediment) and the river would still be in transition. The spring flush for Memory Lake would thus be ecologically insignificant.

As discussed in Section 4.3.1, the impacts of the initial release of historic sediments downstream may be of concern, as directly downstream of the dam is a mussel bed that contains state endangered mussels. There was a significant study of the mussel beds below Memory Lake performed prior to the October 2005 event. After the event the beds were observed completely covered by a substantial sand layer. Subsequently, erosion has exposed these beds. A study that looks at the impacts of that 2005 event on those endangered mussels should be the starting point or determine how to limit ecological impacts to this important mussel bed. If impacted, translocation of those beds would be necessary prior to implementation of the new dam operation plan.

An operation plan to perform drawdowns/refilling while limiting impacts of a changing phreatic surface thru the dike, earthen dam, and pond embankments would need to be developed for refill of the lake.

A final ecological consideration is that Memory Lake currently acts as a sediment basin for urban run-off from a significant portion of the Village. This sediment is chemically different from that in the Wood River, and this option would increase the flushing of these urban sediments downstream. To reduce the impacts on the downstream watershed that contains endangered mussels and the wild and scenic St Croix River, urban stormwater planning and the implementation of stormwater controls and best management practices would be needed concurrently to changing the operation plan of the dam. The Village currently has a stormwater utility and stormwater ordinances in place to promote and fund these practices.

4.4.2 Sociological Consideration

The proposed dam operation plan would require a much more active approach to the operation of the dam. Continued existence of Memory Lake in a sustainable manor would be the tradeoff. Of the survey respondents, 2/3 picked an alternative that included keeping Memory Lake as their first choice, and 70% picked this option as their first or second choice.

Asking the community to pay for the expense of dredging without changing the dam operation plan to assure that in-filling from a large event will be limited to the highest degree possible seems inappropriate.

5.0 Recommendations

We recommend option 4.4 - operating the dam with a new operation plan to pass sediments down stream during the annual spring snowmelt run-off flush. If the ecologic benefits outweigh the cost, dredging (option 4.1) prior to starting this new operation plan should also be considered. Translocation of the bed is another option to consider. Dredging may also need to be considered if sediments prove to be too compacted to become re-entrained with the new operation plan. Dredging should be avoided initially due to the cost and potential impact to wild rice. If after trying the new operation plan, historic sedimentation is found to be too compact to be re-entrained and transported out of the lake, dredging would be needed. If so, it should be planned in a manner that has the least impact on wild rice in Memory Lake. Since Memory Lake currently traps the urban stormwater from the Village, this option requires stormwater controls and best management practices be in place and implemented as part of this recommendation.

Finally, recommendation made previously in this report in Section 3.1.2 in regard to aquatic plants and Section 3.4.2 in regard to shoreline restoration should also be implemented. The Village also needs to be a leader in showing the need to reduce sediment loading to Memory Lake. In addition to implementing the urban stormwater controls and best management practices, the Village should take the opportunity to educate citizen as to why these practices are being implemented and how they help reduce sedimentation in the lake. The Village may want to help cost share in high profile sediment reduction projects in the watershed and show support of County efforts to do the same. This would be especially effective on those projects that are close to the village limits and where it can clearly be seen that sedimentation is reduced.

Applying this new operation plan will more closely mimic nature, allowing for the ecological connection of the Wood River, including the sediments. Sediments have been shown to be a necessary component in the river processes that create habitat necessary for the aquatic plants and animals in a river. These recommendations address concerns about both the sedimentation and aquatic plants in Memory Lake. Additionally, it allows passage of fish to improve the overall watershed fishery.

6.0 Implementation Roadmap

A roadmap for the community to follow in implementing the Management Plan is an important component to a success plan. Steps and possible funding alternatives to implement the management recommendation are included below.

- Release of the Lake Management Plan
- Seek stakeholder comment on the Management Plan
- Implement recommended shoreline restoration efforts (County Cost Share)
- Educate Watercross leadership on the aquatic plant recommendations
- Investigate the impacts of the sedimentation accumulation that occurred on the mussel beds downstream of Memory Lake (Lake Management Planning Grant)
- Pursue mussel bed translocation or dredging planning and permitting if necessary
- Implement activities to reduce Village's stormwater inputs to Memory Lake
- Develop new dam operation plan to promote spring flushing (Lake Management Planning Grant)
- Apply with WDNR to change the dam operation plan
- Implement new operation plan
- Determine effectiveness of sediment re-entrainment under new operation plan within 2 years of implementation. (Lake Management Planning Grant)
- Pursue dredging planning and permitting if necessary

7.0 Conclusion

This Lake Management Plan developed for the Village of Grantsburg looks holistically at a set of management alternatives for Memory Lake. This Plan will assist local decision making and provide a roadmap to enhance and maintain the quality of Memory Lake and the Wood River. This sound Management Plan and implementation roadmap can be used as a guide to the decision makers in implementing long term solutions that are good for the lake and the community. SEH would like to thank the Village, the stakeholder involved in the process, and the WDNR for their assistance in developing this Plan.

Appendix A

WDNR Report: Investigation of Memory Lake and the Wood River including Municipal Recommendations

INVESTIGATION OF MEMORY LAKE AND THE WOOD RIVER INCLUDING MANAGEMENT RECOMMENDATIONS

by

Stan Johannes, Fish Manager
Dan Ryan, Water Resources Specialist

I. History of the Village of Grantsburg Dam (Memory Lake) on the Wood River

According to the Wisconsin Public Service Commission (P.S.C.) and more recently the Wisconsin Department of Natural Resources Regulation Files, the Village of Grantsburg Dam on the Wood River was first constructed in 1864 for logging purposes. Later it was franchised by the Laws of 1895 for a 15-year period (purpose of the franchise is unknown). This franchise apparently was not renewed or extended. After 1910, the dam was maintained under the Milldam Act and as such was licensed by the 1915 Water Power Laws, Section 31.33(2).

In 1936 the dam failed and did not hold a head of water between 1936 and 1951. Because the dam was not rebuilt and maintained by the original owner during this time, it was felt that the owner lost all rights to the structure. In 1951, the engineer for the Village of Grantsburg submitted plans for a new dam (Hickerson Roller Mill structure with 8 ft. head). The Village of Grantsburg did construct a new dam in 1951 according to these plans and is presently assumed to own and maintain the Memory Lake structure.

Although plans for the Memory Lake Dam were submitted to the state back in 1951, no plan approval for the structure was given and no structure permit issued. Later in March of 1952 an after the fact approval of the dam plan was issued by the Wisconsin P.S.C. The Village of Grantsburg has been operating and maintaining the dam since 1951 although no operation or level limits have been in effect during this time.

II. Recent Manipulation or Operation of Memory Lake Dam. 1951-1984

The Village of Grantsburg has been maintaining the Memory Lake Dam at full pool since the dam was rebuilt in 1951. With the passage of time, the flowage developed rather dense beds of aquatic vegetation in the shallows. Then in 1977 the Grantsburg Lions Club initiated sponsorship of the Worlds Championship Snowmobile Water-Cross Competition on Memory Lake. In an effort to minimize interference from aquatic vegetation, the Village of Grantsburg cooperated with the Lions Club to reduce the stands of aquatic vegetation through a brief summer drawdown of Memory Lake. The drawdown of Memory Lake was designed to expose the bed of the flowage during the hot summer, thus killing the nuisance aquatic vegetation plants. The results of these short summer drawdowns were successful in reducing the nuisance beds of aquatic vegetation for the competing snowmobiles. Since 1977, the Village has continued to draw Memory Lake down during the summer (some years more than once) to help minimize the interference from aquatic vegetation for the annual Snowmobile Water-Cross.

In 1984, above normal spring precipitation followed by a 5.31" rainfall on June 12, 1984, resulted in very high flows, severe pressure, stress and erosion at the Memory Lake Dam. All the splash boards from all eight gates were removed to save the dam

from washing out. High flows down the Wood River continued for several weeks causing severe erosion to several banks within the flowage basin. A drag line was hired by the village to slope some of this eroded shoreline plus fill and rip-rap the dike immediately south of the Memory Lake Dam. Memory Lake was then refilled during the week of July 15-21 in anticipation of the 8th Annual World Championship Snowmobile Water-Cross.

III. Description of Memory Lake

Memory Lake is a 10.2 acre hard water, drainage impoundment on the Wood River located in the Village of Grantsburg. Its water is hard (MPA-88ppm) alkaline (pH 7.2) and usually quite turbid. It has an 8-foot Hickerson Roller Mill Structure at its outlet and its normal discharge is estimated at 83 cubic feet per second. Fish species present include northern pike, largemouth bass, white sucker, bluegill, yellow perch, golden shiner minnows, and carp. The lakeshore is almost entirely upland and the only waterfowl use is by migrant puddle ducks, diving ducks, and a few geese from Crex Meadows. Private development consists of four homes along with the north shore of the flowage.

The Village of Grantsburg's storm sewers (four large pipes) all drain into the south side of the flowage. The Village Park, Memory Lake Park and campground surround the flowage on the north and south sides of the dam. This Village Park offers access to the flowage, picnicing, camping, swimming, and fishing to the campground residents of Grantsburg and the surrounding area. A total of 0.74 miles of frontage is owned by the Village of Grantsburg around Memory Lake.

IV. Memory Lake Management Recommendations

A. Fish

Memory Lake is a very small flowage (10.2 acres, 40.8 acres feet of water). For all practical purposes, it is nothing more than a wide spot along the Wood River. With the Wood having a normal flow of 83 cubic feet per second, Memory Lake has an exchange rate of 6 hours, i.e. all the water in Memory Lake is exchanged with new water every six hours under normal flow conditions. A six hour exchange rate means that nutrients being carried into Memory Lake are not being allowed adequate time to cycle through the flowage ecosystem but instead are being rapidly flushed through the flowage. This means that Memory Lake will never be capable of supporting a very high quality fish community. The following practices will help establish a stable fishery: (1) Keep the flowate at or near full pool to allow maximum time for the nutrients to be cycled through the flowage. (2) Eliminate or reduce the drawdowns for vegetation control because the drawdowns flush most of the resident fish population down the river. Studies have shown that it takes three to four years to restore a flowage's fish population following a complete drawdown.

The Department will work with the village to make the small urban flowage as good a fishing lake as possible. However, because of the small size and rapid nutrient exchange rate even at full pool level, a high density fish population will be difficult to establish.

In August and September of 1982, the Department carried out some electroshocker sampling of Memory Lake, three stations on the Wood River, Whiskey Creek, and North Branch of Wood Creek. All samples were qualitative in nature. All samples showed fairly good species diversity, although overall relative abundance was rather low. These survey results are presented in Table 1 attached at the back of this report with sampling stations shown in Figure 1.

Carp are present in the Wood River System both above and below the Memory Lake Dam. They are not present at nuisance levels in the waters above Memory Lake at this time, but could be if their movement out of the St. Croix River isn't blocked. For this reason, we would urge the village to always maintain at least a three-foot head of water at the dam during drawdowns. In addition, if the village were to decide to maintain the Wood River as a natural stream channel through town, the Department would like to discuss with the village the possibility of incorporating a warm water fish barrier into their existing dam design to block upstream migration of carp.

It has come to the Department's attention that some years following a drawdown almost all of the Wood River water was blocked from passing through the dam by placing plastic or canvas on the face of the dam during the refilling process. This was having an adverse environmental effect on the stream biota below the dam. As the water is shut off and the flow ceases, fish and aquatic organisms are either stranded in pools or on the exposed stream bed substrates. Here they either die, are eaten by birds or other vertebrates, or become severely stressed from the heat and lack of fresh water. According to State Statute 31.34 at least 25% of the normal base flow shall continue to be passed through the dam structure during the refilling process. In the case of the Wood River at Grantsburg with a normal base flow of 83 cfs, 25% would be a flow of around 21 cfs should continue to be passed during the refilling process.

B. Aquatic Vegetation

Most forms of submersed rooted aquatic plants are not greatly affected by water level fluctuations, especially if water level fluctuations are relatively short term and of a small magnitude. As a rule, the greater the fluctuation and the longer the impoundment bottom remains exposed to the atmosphere and sunlight, the greater the impact on aquatic vegetation species diversity and abundance. Time of year is also important with over-winter drawdowns being more effective in

reducing aquatic vegetation abundance than summer drawdowns. There are certain species of aquatic vegetation that are more resistant to water fluctuations than others. Memory Lake with its past history of summer drawdowns probably is inhabited in the littoral zone with the more resistant species such as thin-leaved pondweeds, floating-leaf pondweeds, and bushy pondweeds, water marigold and common elodea. If Memory Lake were to be managed with stable water levels, one of the obvious results would be a gradual increase in aquatic vegetation abundance in the basin. More aquatic vegetation would provide more cover and food producing areas for fish, and would help to reduce the turbidity of the water through reduced velocity and a filtering action. Besides being more aesthetically pleasing, clearer water would of course have a positive impact on all forms of aquatic life within the flowage.

If the village desires to control aquatic vegetation abundance for the Lions-sponsored World Championship Snowmobile Water-Cross, there are vegetation control methods available which are less drastic than the present practice of complete summer drawdown. (1) Mechanical control of the plants in the high-use area by cutting and harvesting would be the most environmentally sound control method. Only those plants causing the problem would be treated and the rest of the flowage would remain stable. (2) Chemical treatment of the problem area may or may not be feasible due to the fast flow-through time. This procedure would also require an annual permit and the practice of applying chemical herbicides to the aquatic community is questioned by many environmentalists. (3) It is possible that a winter drawdown of at least one-month duration every three to five years may provide the desired control while at the same time not having nearly as severe an impact on the fish community. Probably the best time for a winter drawdown is during the months of November and December before significant amounts of snow have built up.

C. Water Quality

The water quality of Memory Lake will essentially reflect that of the Wood River. The small size, fast flow-through time, and low head of the impoundment will preclude the development of significant stratification and other lake-like characteristics associated with large flowages.

During normal flow the drop in velocity at the head end of the flowage will result in some deposition of sediment load of the Wood River. However, during high flows when the dam gates are opened this sediment will be resuspended and the material moved somewhere downstream.

The "turbid" appearance of the flowage is, at least in part and under certain conditions, influenced by the presence of iron floc. Figures 3 and 4, and Tables 2 and 3 document the

locations and results of water sampling done within this watershed. The amount of iron in the water of this stream system is very high and in many places violates the recommended standard of 1.0 mg/l (Quality Criteria for Water, U.S.E.P.A., Washington, D.C., July 1976).

In general, the concentrations of iron increases downstream on the Wood River and each of the tributaries. The highest iron concentrations are found on the streams which drain from the extensive wetlands and flowage areas located across the northern portion of this watershed. The iron in this watershed is of natural origin and comes from the soils of the region. The factors which determine the amount of iron entering surface waters are unknown at this time. Because of the long history of water level manipulation on the Crex Meadows area, it is impossible at this time to know what the characteristics of "normal" drainage water through this area was. It is probable that the "natural" characteristics of streams draining this area have always been high in iron. (Note the named stream "Iron Creek" flowing north to the St. Croix River.)

The impact of the high iron concentrations on the water quality of the Wood River and Memory Lake is difficult to assess. Under certain flow conditions the "floc" will be visually apparent and considered by some to be aesthetically unpleasing. However, the occurrence of "red waters" is prevalent around the Grantsburg area and may be a somewhat natural phenomenon.

High iron concentrations can be expected to have an impact on the fish and aquatic life. However, the toxicity of iron in the water will be influenced by many other characteristics of the aquatic environment (i.e. pH, dissolved oxygen, alkalinity, and natural complexing agents).

The Wood River and its tributaries do support a rather diverse fish population and benthic community. This suggests that certain environmental factors are mitigating the effects of the high iron concentrations. The Wood River fishery and aquatic community is also being limited by the shifting sand bottom substrate. It can be expected that the fishery and aquatic community of Memory Lake will also be limited by its small size and rapid exchange rate as mentioned earlier.

The Village of Grantsburg's storm sewers (four large pipes) all drain into the south side of Memory Lake. The main types of pollution that wash into the flowage during precipitation events are salt, metals, oils, sand, sediment, and debris. According to DNR Engineer, Pete Prusak, these storm sewers are probably not having a real serious impact on the overall water quality of Memory Lake. Probably the most important thing the Village of Grantsburg can do to minimize pollution from storm sewer draining would be for the village to clean their streets

with a street cleaner on a regular basis. A more costly correction to this problem would be for the village to intercept, combine, and then outfall storm sewer drainage into the river below the Memory Lake Dam.

D. Swimming Area

If water quality conditions do improve it might be desirable for the village to consider developing a small swimming area along the shoreline of Memory Lake. It would be a rather simple process to grade a small area along the shoreline for a swimming beach for village residents and campers. There are several nice sandy areas around the flowage that could be developed as a swimming beach.

As a precaustion, water samples should be collected from the storm sewer outfalls after a rainfall event. Problems with bacteria contamination of beaches has occurred in the past under similar conditions.

E. Management of Memory Lake in a Drawdown State, i.e. a Natural Stream Channel Rather than as a Flowage

The idea has been suggested to leave Memory Lake drawn down and to expand and develop Memory Lake Park around the natural Wood River stream channel. This suggestion surely has merit although this plan would involve the expenditure of some village dollars to stabilize critical erosion sites along the stream and to convert the flowage bottom into a manicured park. To significantly expand the size of the Memory Lake Park would also result in increased maintenance obligations for the village. With the heavy run off experienced this spring, four critical erosion sites developed which would have to be stabilized through shaping and grading, placement of filter cloth, and large rock rip-rap. (See Figure 2 attached). If the village were prepared to make these commitments, the size of the park could almost be doubled and the improvements that could be made would only be limited by the village's imagination.

V. Summary of Management Recommendations

1. For Memory Lake to support the best fish population possible, the flowage must be maintained at full pool the year around. A complete drawdown anytime of the year for whatever purpose will flush the resident fish population downstream thus reducing the flowage's fishery to a river population.

2. Maintaining Memory Lake at full pool would help to keep the water as clear as possible. In addition, cleaning Grantsburg's streets with a street cleaner on a regular basis would also help in this regard.

3. Maintaining Memory Lake at full pool to enhance the growth and abundance of rooted aquatic vegetation would benefit all forms of aquatic life and water clarity of the flowage.

4. The recommended aquatic vegetation control method would be by mechanical cutting and harvesting. A controlled winter drawdown is another possible control technique.

5. At the present time we are not aware of anything feasible that can be done to alleviate or reduce the iron floc turbidity problem. It is highly possible that the occurrence of the red iron floc in the Wood River system may be a natural phenomena.

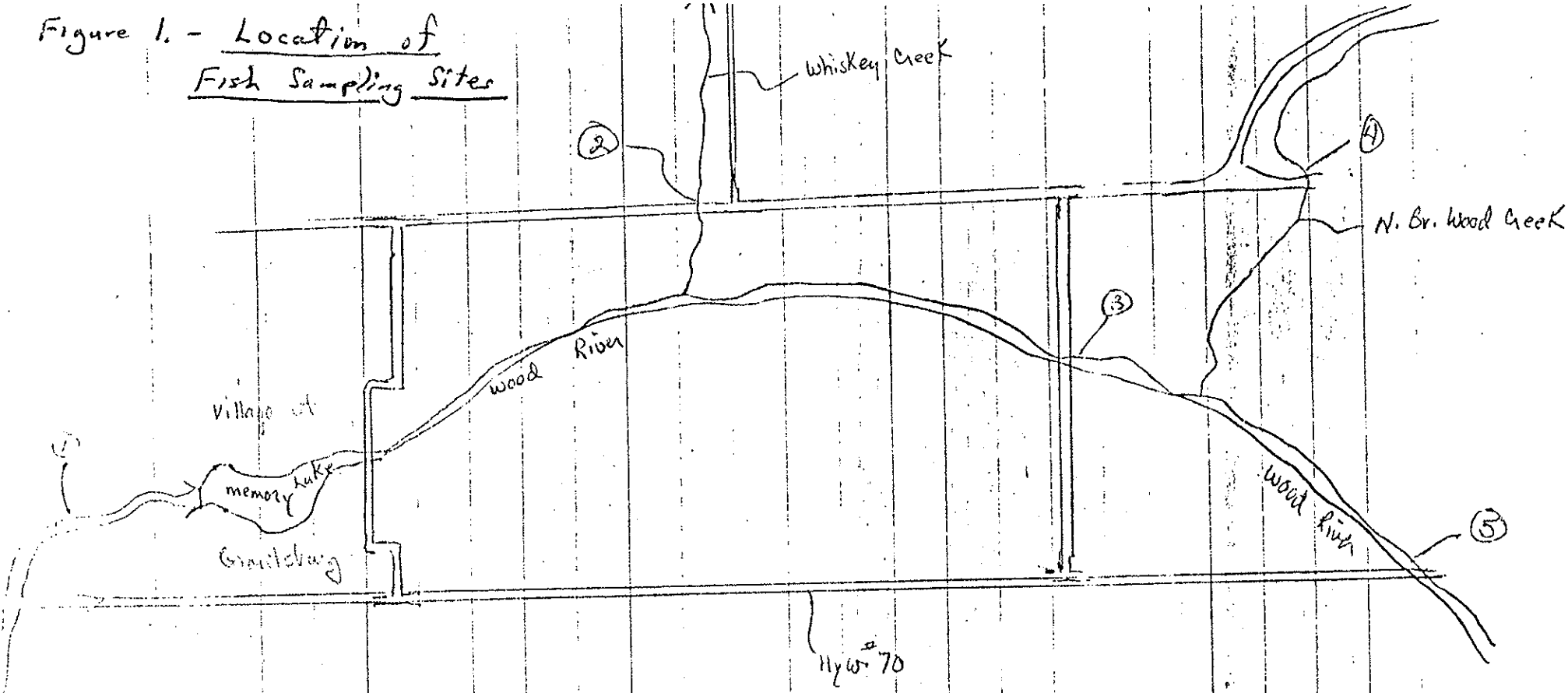
6. The idea to leave Memory Lake drawndown, and to expand and develop the Memory Lake Park around the natural Wood River stream channel surely has merit. In order for this idea to become a reality, four critical erosion sites within the old bed of the flowage along the Wood River would have to be stabilized and the old bed of the flowage developed into a manicured park. If the village were prepared to make these commitments, the size of the park could almost be doubled and the improvements that could be made would only be limited by the village's imagination.

7. If the village were to decide to maintain the Wood River as a natural stream channel through town, the Department would like to see a warm water fish barrier incorporated into the existing dam design to block upstream migration of carp. Funding through the Burnett County Conservation Aid Program would be available to cover costs.

- Fish Sampling Summary - Wood River, Burnett County

Sampling Stations	Species deversity #Species sampled/500' stream thread.	No. Individuals sampled per 500' of stream thread.	No. individuals/ft. / No. individuals/acre.		
Memory Lake including about 1/8 mile of Wood River	7	37	.07/ft. / 3.7/acre		
1. Wood River Below Memory Lake	15	50	0.10/ft. / 122/acre		
2. Whiskey Creek Co. Hwy. 'D' crossing	7	17	0.15/ft. / 213/acre		
3. Wood River n-s Twp. road crossing	6	36	0.07/ft. / 78/acre		
4. N. Branch Wood Creek	5	31	0.06/ft. / 172/acre.		
5. Wood River State Highway #70	7	133	0.27/ft. / 459/acre		

Figure 1. - Location of Fish Sampling Sites



Proposed sample sites for fish (each station to be 500' in length)

(1) Below Memory Lake (Wood River)

(2) Whiskey Creek

(3) Wood River

(4) N. Branch Wood Creek

(5) Wood River at Hwy. #70

Plus - Memory Lake

Figure 2 Location of Critical Erosion Sites

SCALE 4" = 1 MILE

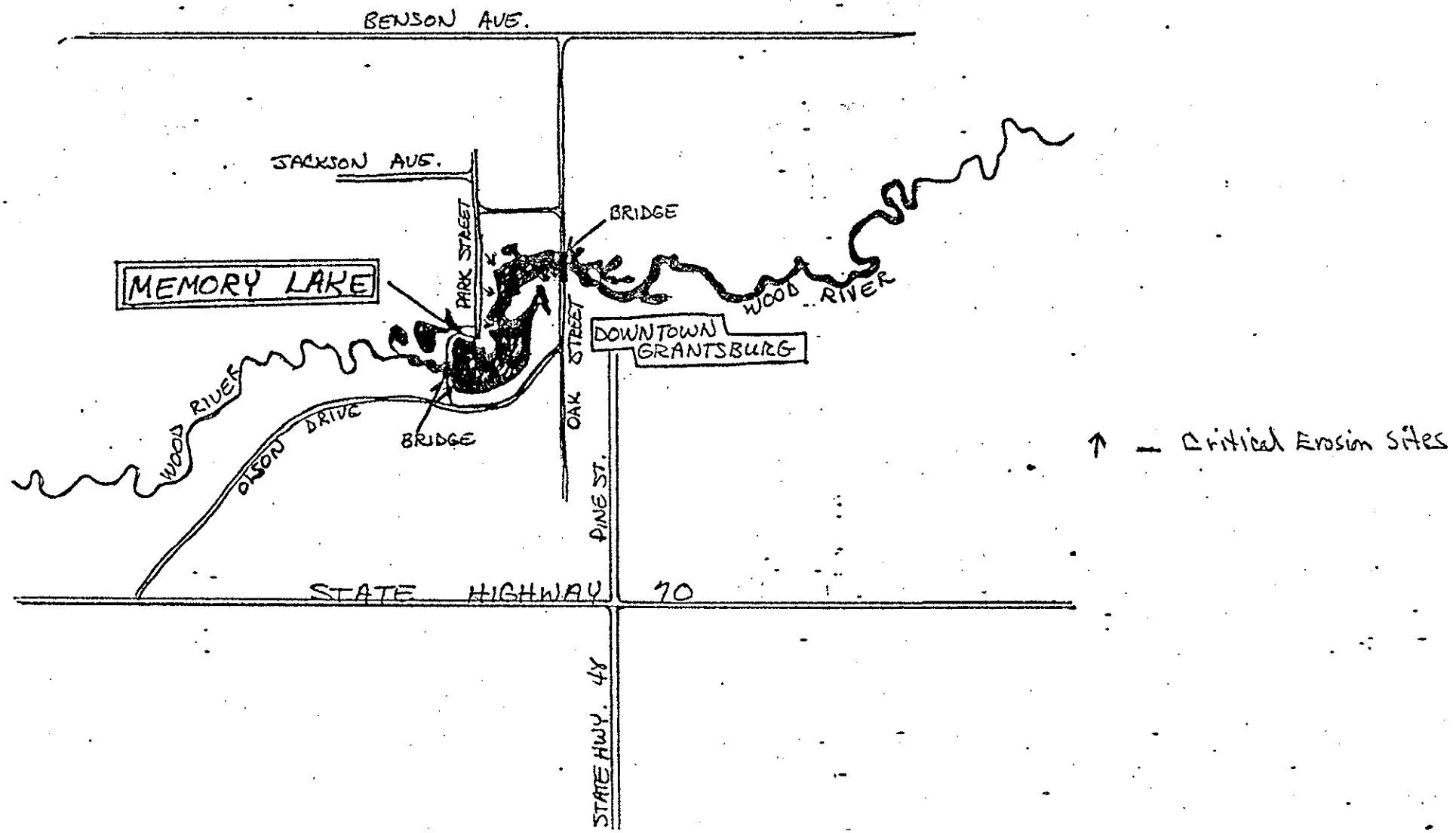


Table No. 2 – Water Sampling Results, 3 Aug. 1982

Water Quality Analyses

All analyses reported in mg/L unless otherwise specified.

Location	Description	DO Field	Temp (°C) Field	Tot. Solids	Vol. Tot. Solids	Susp. Solids	Vol. Susp. Solids	Color (su)	Turbidity (FTU)	Iron, Tot.
(A)	Wood River	8.8	26	134	38	2	2	20	6.6	1.0
(B)	Memory Lake	7.5	25	128	36	6	4	50	8.7	2.5
(C)	No. Fk Wood Cr.	7.6	22	126	40	3	2	80	24.0	4.2
(D)	Whisky Creek	6.9	25	100	42	26	9	160	31.0	12.0

Table No. 3 - Water Sampling Results, 15 June 1983

Water Quality Analyses

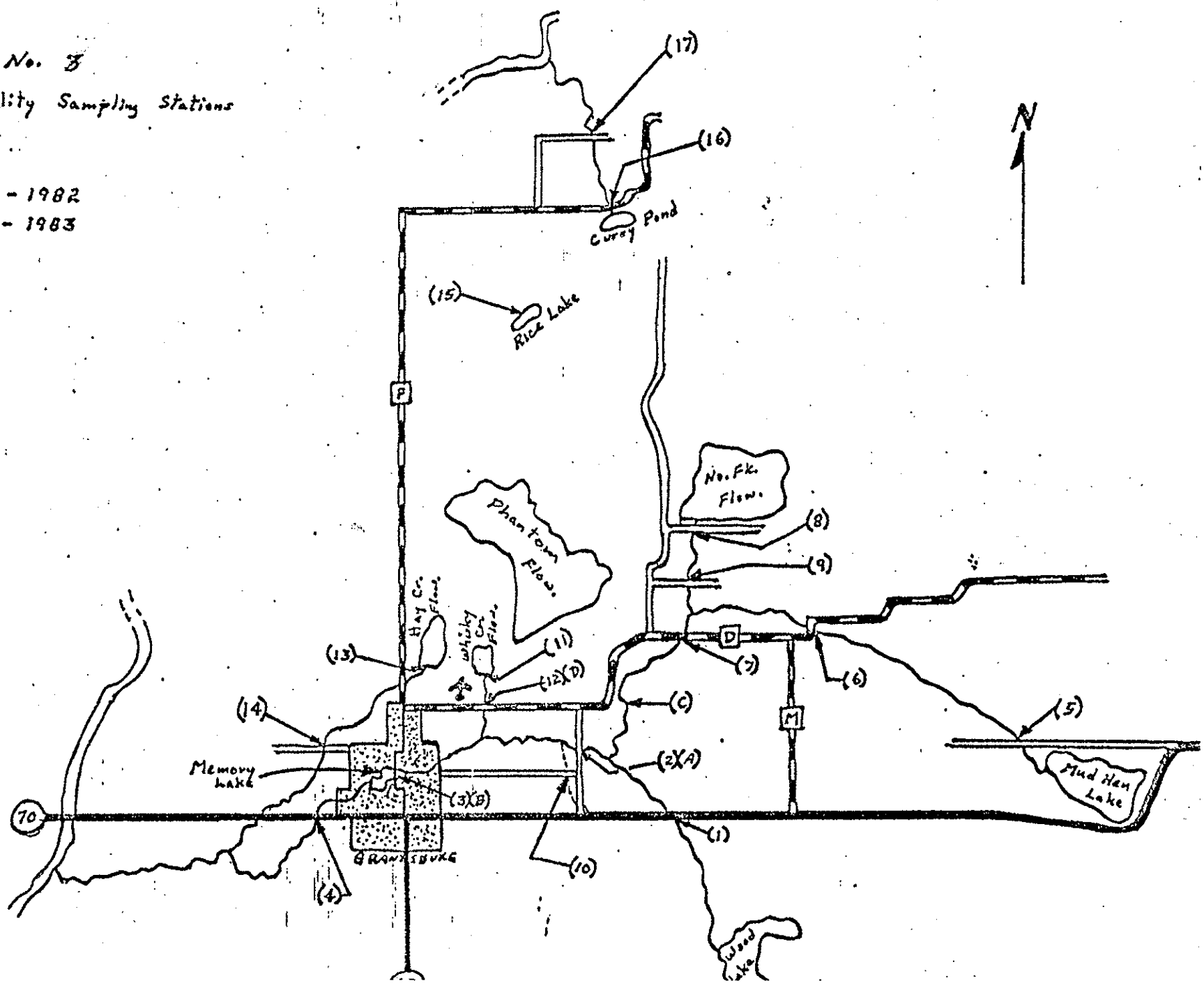
All analyses reported in mg/L unless otherwise specified.

Location	Description	Temp (°C) Field	DO Field	ph (su) Field	Tot. Solids	Susp. Solids	Tot. Alkalinity (as $CaCO_3$)	Color (su)	Conductivity (µmhos)	Hardness (as $CaCO_3$)	Turbidity (FTU)	Iron, Tot.	Iron, Dissolv.
(1)	Wood River	22.6	8.8	8.2	154	16	108	30	200	108	3.6	0.4	0.1
(2)	Wood River	17.2	8.1	7.6	152	15	104	50	200	108	6.5	1.4	0.6
(3)	Wood Riv. @ Mem. L.	17.8	8.1	7.5	158	9	98	60	170	100	6.2	1.8	0.8
(4)	Wood River	18.8	8.7	7.5								1.9	0.8
(5)	No. Fk. Wood Creek	22.3	8.4	7.6	126	2	92	10	180	92	2.2	0.1	<0.1
(6)	No. Fk. Wood Creek	21.0	9.0	7.1	148	4	104	70	180	106	1.8	0.7	0.4
(7)	No. Fk. Wood Creek	19.9	8.6	7.6								2.8	1.3
(8)	No. Fk. Flow. Outlet	20.5	8.1	7.0	70	11	16	120	37	18	5.6	2.3	1.5
(9)	No. Fk. Flow. Creek	19.0	3.2	6.5								14.0	2.5
(10)	Wood R. Trib. (South)	15.5	5.5	7.6	174	20	62	120	150	74	6.4	0.8	0.4
(11)	Whisky Cr. Flow. Outlet	19.0	7.7	7.8	126	6	44	>140	79	44	15.0	7.6	4.0
(12)	Whisky Creek	16.1	7.6	7.3	128	23	40	>140	77	40	23.0	12.0	2.8
(13)	Hay Cr. Flow. Outlet	21.0	9.4	7.2	76	8	28	60	57	28	2.8	1.4	0.6
(14)	Hay Creek	17.5	7.7	6.9								8.7	3.0
(15)	Rice Lake	21.5	9.2	6.7	116	18	20	>140	19	10	3.3	3.6	0.6
(16)	Curry Flow. Outlet	21.5	5.8	6.2	94	17	10	110	22	10	2.5	2.4	0.5
(17)	Iron Creek	20.1	3.9	6.1								21.0	8.8

GRANTSBURG – WOOD RIVER – CREX MEADOWS AREA

Figure No. 8
Water Quality Sampling Stations

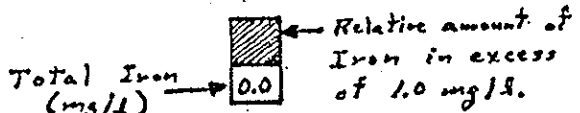
(A) - 1982
(1) - 1983



GRANTSBURG - WOOD RIVER - CREX MEADOWS AREA

Figure No. 4

Iron Concentrations in Surface Waters - 15 June 88



Appendix B

WDNR Letter Dated 11/27/2006 Discussing Memory Lake Fishery and Historic Fish Survey Data

CORRESPONDENCE/MEMORANDUM

State of Wisconsin

DATE: 11-27-2006 FILE REF: 3600

TO: Pamela Toshner

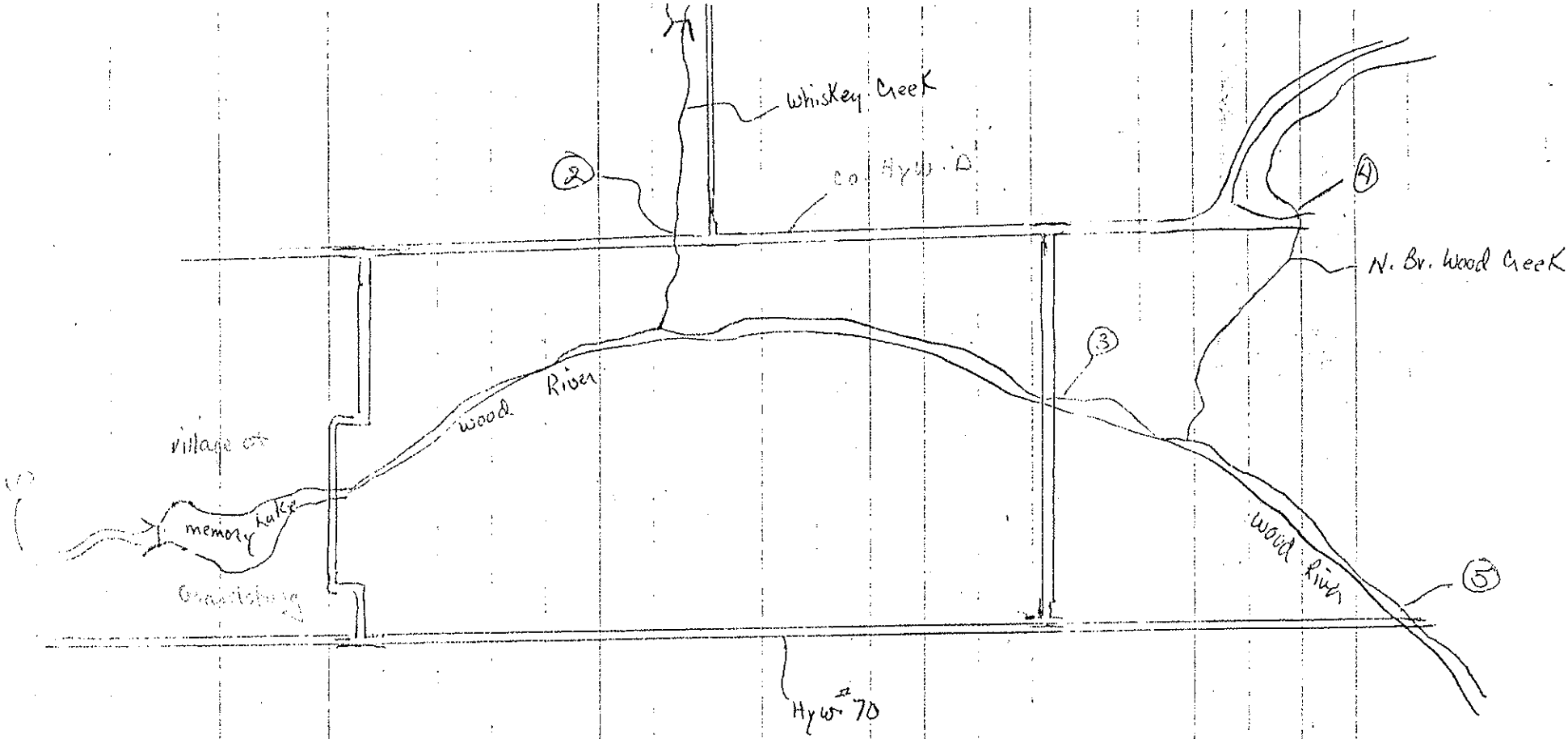
FROM: Larry Damman LD

SUBJECT: Memory Lake Discussion Comments

Attached are the only DNR fish surveys of Memory Lake and nearby stations of the Wood River and tributaries. I doubt much has changed since. Sport fish potential here is low, with or without the dam.

The concept of having a bottom opening (mud) gate is intriguing and might be effective to minimize sediment accumulation even without any dredging. However, if effectively designed and operated, it would also probably result in elimination of still water adapted fish like bass, bluegill and pumpkinseed sunfish. It would likely change the plant community too. Note also that the downstream channel and banks have been mined out of sediment because of being deprived of bed load. Restoring sediment flow will be ecologically desirable downstream in long run, but may not appear so when sand bars form and holes fill initially.

I favor the free fish passage goal. Removing the dam seems to make the best ecological and economical sense but goal could probably be done here with a bypass channel without actually removing the dam. Free fish passage includes exotics already present or whatever may come in the future. The dam is biologically irrelevant as a carp barrier since carp populations are well established upstream. I suspect the net movement of carp on this system is downstream, not upstream. The dam is not an effective barrier to fish migration during periods of high flow so can not be expected to prevent upstream movement of any future exotic fish that might enter the St Croix basin. Historically lake sturgeon were present in the Wood Lakes upstream. I suspect this was not a population that spawned in Wood River, but rather fish that moved up from the St Croix. Sturgeon may migrate to headwater lakes to take advantage of richer feeding opportunities and migrate downstream to find rivers large enough for spawning. Free passage could benefit the sturgeon.



Proposed sample sites for fish (each station to be 500' in length)

(1) Below Memory Lake (Wood River)

(2) Whiskey Creek

(3) Wood River

(4) N. Branch Wood Creek

(5) Wood River at Hwy. #70

Plus - mummy lake

Fish Sampling Summary - Wood River, Burnett County

Sampling Stations	Species deversity #Species sampled/500' stream thread.	No. Individuals sampled per 500' of stream thread.	No. individuals/ft. / No. individuals/acre.		
Memory Lake including about 1/8 mile of Wood River	7	37	.07/ft. / 3.7/acre		
1. Wood River Below Memory Lake	15	50	0.10/ft. / 122/acre		
2. Whiskey Creek Co. Hwy. 'D' crossing	7	17	0.15/ft. / 213/acre		
3. Wood River n-s Twp. road crossing	6	36	0.07/ft. / 78/acre		
4. N. Branch Wood Creek	5	31	0.06/ft. / 172/acre.		
5. Wood River State Highway #70	7	133	0.27/ft. / 459/acre		

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Water Temp - 24°C (76°F)
Dissolved Oxygen 7.5 p.m.

Air Temp. - 92° F

GAME FISH LENGTH FREQUENCY

FORM 3600-65 REV. 5-78

Five kids swimming out in front of dam.

INCHES Once around lake - Daytime

UNTY	WATERS	DATE	GEAR
Burnett County	Memory Lake	8-3-82	230 Volt AC Boom Shocker

Size Range	SPECIES					Size Range	SPECIES	
	W. Sucker	N. Pike	LMB					
3.0- 3.4			1111			27.0-27.4		
3.5- 3.9						27.5-27.9		
4.0- 4.4						28.0-28.4		
4.5- 4.9						28.5-28.9		
5.0- 5.4						29.0-29.4		
5.5- 5.9						29.5-29.9		
6.0- 6.4		1		Bluegill		30.0-30.4		
6.5- 6.9				7.0''		30.5-30.9		
7.0- 7.4				6.0''		31.0-31.4		
7.5- 7.9						31.5-31.9		
8.0- 8.4						32.0-32.4		
8.5- 8.9						32.5-32.9		
9.0- 9.4				Goldon		33.0-33.4		
9.5- 9.9				Shiner		33.5-33.9		
10.0-10.4				2.0"&3.0"		34.0-34.4		
10.5-10.9		1				34.5-34.9		
11.0-11.4		1				35.0-35.4		
11.5-11.9						35.5-35.9		
12.0-12.4	1					36.0-36.4		
12.5-12.9				YellowPerch		36.5-36.9		
13.0-13.4	11			2.5"		37.0-37.4		
13.5-13.9				2.0"		37.5-37.9		
14.0-14.4	11			2.5"		38.0-38.4		
14.5-14.9				3.0"		38.5-38.9		
15.0-15.4	5					39.0-39.4		
15.5-15.9						39.5-39.9		
16.0-16.4	11					40.0-40.4		
16.5-16.9						40.5-40.9		
17.0-17.4	4	1				41.0-41.4		
17.5-17.9						41.5-41.9		
18.0-18.4	11					42.0-42.4		
18.5-18.9						42.5-42.9		
19.0-19.4		1		Carp -		43.0-43.4		
19.5-19.9				27."		43.5-43.9		
20.0-20.4						44.0-44.4		
20.5-20.9						44.5-44.9		
21.0-21.4	1					45.0-45.4		
21.5-21.9						45.5-45.9		
22.0-22.4						46.0-46.4		
22.5-22.9						46.5-46.9		
23.0-23.4						47.0-47.4		
23.5-23.9						47.5-47.9		
24.0-24.4						48.0-48.4		
24.5-24.9						48.5-48.9		
25.0-25.4						49.0-49.4		
25.5-25.9						49.5-49.9		
26.0-26.4								
26.5-26.9								
Total	19	5	4					

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STATION FISH SAMPLING SUMMARY
Form 3600-57

STREAM: Wood River (Below Memory Lake) Below Rock Rifle

INVESTIGATOR: Lund, Nelson, Johannes

Area Sampled:	LENGTH	WIDTH	AREA (ACRES)	STATION NO.	NO. PER ACRE	DATE
	500'	36'	0.41	1		9/29/82

SIZE RANGE	SPECIES: N. Pike	Walleye	White Sucker	Silver Red Horse	Burbot	Hog Sucker	BLBH	R. Bass	Pumpkin-seed	Gr. S.F	Y.BH	SMB
1												
1.0 - 1.4												
1.5 - 1.9												
2.0 - 2.4												
2.5 - 2.9												
3.0 - 3.4								1				
3.5 - 3.9								1		1		
4.0 - 4.4							5					
4.5 - 4.9							2	1	1			
5.0 - 5.4							7					
5.5 - 5.9							8					
6.0 - 6.4							2	1				
6.5 - 6.9												
7.0 - 7.4							1				1	1
7.5 - 7.9					2	1						
8.0 - 8.4				1								
8.5 - 8.9					1							
9.0 - 9.4						1						
9.5 - 9.9												
10.0 - 10.4					1							
10.5 - 10.9					1							
11.0 - 11.4						1						
11.5 - 11.9	1											
12.0 - 12.4				1		1						
12.5 - 12.9												
13.0 - 13.4												
13.5 - 13.9												
14.0 - 14.4		1		1								
14.5 - 14.9												
15.0 - 15.4												
15.5 - 15.9												
16.0 - 16.4												
16.5 - 16.9												
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20.5 - 20.9												
21.0 - 21.4												
21.5 - 21.9												
22.0 - 22.4												
22.5 - 22.9												
23.0 - 23.4												
23.5 - 23.9												
24.0 - 24.4												
24.5 - 24.9												
25 + (give actual size)												
TOTAL	1	1	0	3	5	4	25	4	1	1	1	1

Common Shiner - 3"

Bluegill - 4-2"

Yellow Perch - 2.5"

Rev. 3-75

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STATION FISH SAMPLING SUMMAR
Form 3600-57

ter level down considerably from level on August 3, 1982. Water did not appear rusted as it did on 8-

STREAM				INVESTIGATOR		
Whiskey Creek (Co. Hyw. D) Burnett County				Lund, Nelson, Johannes		
Area Sampled:	LENGTH	WIDTH	AREA (ACRES)	STATION NO.	NO. PER ACRE	DATE
	500'	7'	.08	2		9-29-82

SIZE RANGE	Common SPECIES						
	Mudminnow	N. Pike	Shiner	W. Sucker	Johney Darter	Black BH	Finescale
1							
1.0 - 1.4							
1.5 - 1.9							
2.0 - 2.4	6				1		4
2.5 - 2.9			1				1
3.0 - 3.4							
3.5 - 3.9							
4.0 - 4.4							
4.5 - 4.9							
5.0 - 5.4	1						
5.5 - 5.9						1	
6.0 - 6.4							
6.5 - 6.9							
7.0 - 7.4							
7.5 - 7.9							
8.0 - 8.4				1			
8.5 - 8.9							
9.0 - 9.4							
9.5 - 9.9							
10.0 - 10.4							
10.5 - 10.9		1					
11.0 - 11.4							
11.5 - 11.9							
12.0 - 12.4							
12.5 - 12.9							
13.0 - 13.4							
13.5 - 13.9							
14.0 - 14.4							
14.5 - 14.9							
15.0 - 15.4							
15.5 - 15.9							
16.0 - 16.4							
16.5 - 16.9							
17.0 - 17.4							
17.5 - 17.9							
18.0 - 18.4							
18.5 - 18.9							
19.0 - 19.4							
19.5 - 19.9							
20.0 - 20.4							
20.5 - 20.9							
21.0 - 21.4							
21.5 - 21.9							
22.0 - 22.4							
22.5 - 22.9							
23.0 - 23.4							
23.5 - 23.9							
24.0 - 24.4							
24.5 - 24.9							
25 + (give actual size)							
TOTAL	7	1	1	1	1	1	5

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STATION FISH SAMPLING SUMMARY
Form 3600-57

STREAM		INVESTIGATOR				
Wood River (N-S Twp. Rd.)		Lund, Nelson, Hohannes				
Area Sampled:	LENGTH 500'	WIDTH 40'	AREA (ACRES) 0.46	STATION NO. 3	NO. PER ACRE	DATE 9-28-82

SIZE RANGE	SPECIES							
	Rock Bass	Johney Darter	Mudminnow	C. Shiner	N Pike	Lamprey	Tadpole	Crayfish
1								
1.0 - 1.4								
1.5 - 1.9	1			5			2	2
2.0 - 2.4		12		5				
2.5 - 2.9		4	1					
3.0 - 3.4			2					
3.5 - 3.9	2		1					
4.0 - 4.4			1					
4.5 - 4.9	1							
5.0 - 5.4						3		
5.5 - 5.9								
6.0 - 6.4					1			
6.5 - 6.9								
7.0 - 7.4								
7.5 - 7.9								
8.0 - 8.4								
8.5 - 8.9								
9.0 - 9.4								
9.5 - 9.9								
10.0 - 10.4								
10.5 - 10.9								
11.0 - 11.4								
11.5 - 11.9								
12.0 - 12.4								
12.5 - 12.9								
13.0 - 13.4								
13.5 - 13.9								
14.0 - 14.4								
14.5 - 14.9								
15.0 - 15.4								
15.5 - 15.9								
16.0 - 16.4								
16.5 - 16.9								
17.0 - 17.4								
17.5 - 17.9								
18.0 - 18.4								
18.5 - 18.9								
19.0 - 19.4								
19.5 - 19.9								
20.0 - 20.4								
20.5 - 20.9								
21.0 - 21.4								
21.5 - 21.9								
22.0 - 22.4								
22.5 - 22.9								
23.0 - 23.4								
23.5 - 23.9								
24.0 - 24.4								
24.5 - 24.9								
25 + (give actual size)								
TOTAL	4	16	5	10	1	3	2	2

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STATION FISH SAMPLING SUMMARY
Form 3600-57

AM

N. Branch of Wood Creek

INVESTIGATOR: Lund, Nelson, Johannes

Area Sampled:	LENGTH	WIDTH	AREA (ACRES)	STATION NO.	NO. PER ACRE	DATE
	500'	16'	0.18	4		9-28-82

SIZE RANGE	SPECIES							
	Mudminnow	Johney Darter	Sculpin	Lamprey	N. Pike			
1								
1.0 - 1.4								
1.5 - 1.9		5	2					
2.0 - 2.4	1	10						
2.5 - 2.9	1	3						
3.0 - 3.4	1		1	Present				
3.5 - 3.9	2		1					
4.0 - 4.4								
4.5 - 4.9								
5.0 - 5.4								
5.5 - 5.9								
6.0 - 6.4								
6.5 - 6.9								
7.0 - 7.4								
7.5 - 7.9								
8.0 - 8.4								
8.5 - 8.9								
9.0 - 9.4								
9.5 - 9.9					1			
10.0 - 10.4								
10.5 - 10.9								
11.0 - 11.4								
11.5 - 11.9								
12.0 - 12.4								
12.5 - 12.9					1			
13.0 - 13.4								
13.5 - 13.9								
14.0 - 14.4								
14.5 - 14.9								
15.0 - 15.4								
15.5 - 15.9								
16.0 - 16.4								
16.5 - 16.9								
17.0 - 17.4								
17.5 - 17.9								
18.0 - 18.4								
18.5 - 18.9								
19.0 - 19.4								
19.5 - 19.9								
20.0 - 20.4								
20.5 - 20.9								
21.0 - 21.4								
21.5 - 21.9								
22.0 - 22.4								
22.5 - 22.9								
23.0 - 23.4								
23.5 - 23.9								
24.0 - 24.4								
24.5 - 24.9								
+ (give actual size)								
TOTAL	5	18	4	2				

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.rtment of Natural Resources

STATION FISH SAMPLING SUMMARY
Form 3600-57

STREAM				INVESTIGATOR		
Wood River (Highway #70)				Lund, Nelson, Johannes		
Area Sampled:	LENGTH	WIDTH	AREA (ACRES)	STATION NO.	NO. PER ACRE	DATE
	500	25'	0.29	5		9-28-82

SIZE RANGE	SPECIES Common Shiner	Johney Darter	Mudminnow	G.Chub	Brook LMB Silver sides	Rk.Bass	Giant Walking Stick	Tadpole	Cray fis
1									
1.0 - 1.4	2						No.-11		
1.5 - 1.9	3	4		1				11	Pres
2.0 - 2.4	16	7	2			1			
2.5 - 2.9	24	13	5						
3.0 - 3.4	34	3	6			2			
3.5 - 3.9	3			1	1 1	1			Leac
4.0 - 4.4						2			Pres
4.5 - 4.9									
5.0 - 5.4						1			
5.5 - 5.9									
6.0 - 6.4									
6.5 - 6.9						1		Fingernail	
7.0 - 7.4								Clams	
7.5 - 7.9								Present	
8.0 - 8.4									
8.5 - 8.9									
9.0 - 9.4									
9.5 - 9.9									
10.0 - 10.4									
10.5 - 10.9									
11.0 - 11.4									
11.5 - 11.9									
12.0 - 12.4									
12.5 - 12.9									
13.0 - 13.4									
13.5 - 13.9									
14.0 - 14.4									
14.5 - 14.9									
15.0 - 15.4									
15.5 - 15.9									
16.0 - 16.4									
16.5 - 16.9									
17.0 - 17.4									
17.5 - 17.9									
18.0 - 18.4									
18.5 - 18.9									
19.0 - 19.4									
19.5 - 19.9									
20.0 - 20.4									
20.5 - 20.9									
21.0 - 21.4									
21.5 - 21.9									
22.0 - 22.4									
22.5 - 22.9									
23.0 - 23.4									
23.5 - 23.9									
24.0 - 24.4									
24.5 - 24.9									
25 + (give actual size)									
TOTAL	81	27	13	2	1 1	8			

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Appendix C

Flow Frequency Analysis

Appendix D

Lab Result of Sediment Composite Sample Dredge Screen

Wisconsin Department of Natural Resources
Laboratory Report

Laboratory: **Wisconsin State Laboratory of Hygiene** DNR ID **113133790**
2601 Agriculture Dr
Madison **WI** **537077996**
Phone : **800-442-4618** *Fax Phone :* **608-224-6276**

Sample:

Field #:	**SITE 1-3**	*Sample #:*	**IR010829**
Collection Start:	**09/29/2006 09:00 am**	*Collection End:*	**09/29/2006 02:00 pm**
Collected by:	**LENZ**	*Waterbody/Outfall Id:*	**2642900**
ID #:		*ID Point #:*	
County:	**Burnett**	*Account #:*	**PP009**
Sample Location:	**MEMORY LAKE IN VILLAGE OF GRANTSBURG**		
Sample Description:	**SEDIMENT CORE WITH STAINLESS STEEL PUSH PROBE**		
Sample Source:	**SE**	*Sample Depth:*	**F1-4**
Date Reported:	**12/29/2006**	*Sample Status:*	**COMPLETE**
Project No:			

Analyses and Results:

Analysis Method	*Analysis Date*	*Lab Comment*
ARSENIC, ICP, DRY WT (SW846 6010B)	**11/21/2006**	

Code	*Description*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
1003	**ARSENIC**	**3.**	MG/KG	1		3

Analysis Method	*Analysis Date*	*Lab Comment*
BARIUM, ICP, DRY WT (SW846 6010B)	**11/21/2006**	

Code	*Description*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
1008	**BARIUM**	**35.3**	MG/KG	0.5		1.6

Analysis Method	*Analysis Date*	*Lab Comment*
CADMIUM, ICP, DRY WT (SW846 6010B)	**11/21/2006**	

Code	*Description*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
1028	**CADMIUM**	**0.1**	MG/KG	0.1		0.3

Analysis Method	*Analysis Date*	*Lab Comment*
CHROMIUM, ICP, DRY WT (SW846 6010B)	**11/21/2006**	

Code	*Description*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
1029	**CHROMIUM**	**9.5**	MG/KG	0.5		1.6

Analysis Method	*Analysis Date*	*Lab Comment*
COPPER, ICP, DRY WT (SW846 6010B)	**11/21/2006**	

Code	*Description*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
1043	**COPPER**	**3.9**	MG/KG	0.5		1.6

Analysis Method	*Analysis Date*	*Lab Comment*

DIG 750.1, ICP, SOLIDS (SW846 3050B) 11/08/2006

Code	Description	Result	Units	LOD	Report Limit	LOQ
99393	PREP DIG SOLIDS 750.1 SW846 3050B	COMPLETE				

Analysis Method	Analysis Date	Lab Comment
LEAD, ICP, DRY WT (SW846 6010B)	11/21/2006	

Code	Description	Result	Units	LOD	Report Limit	LOQ
1052	LEAD	4.	MG/KG	1		3

Analysis Method	Analysis Date	Lab Comment
MERCURY, @60 DEG C, AA VAPOR, DRY WT	11/09/2006	HOLDING TIME EXCEEDED BY 13 DAYS

Code	Description	Result	Units	LOD	Report Limit	LOQ
71921	MERCURY	*ND LOD=0.015	MG/KG	0.015		0.045

Analysis Method	Analysis Date	Lab Comment
TOT KJELDAHL NITROGEN,DRY WT (LACH	11/17/2006	SAMPLE RECEIVED WITH ICE MELTED

Code	Description	Result	Units	LOD	Report Limit	LOQ
627	NITROGEN KJELDAHL TOTAL	*569	MG/KG		230	

Analysis Method	Analysis Date	Lab Comment
NICKEL, ICP, DRY WT (SW846 6010B)	11/21/2006	

Code	Description	Result	Units	LOD	Report Limit	LOQ
1068	NICKEL	5.	MG/KG	0.5		1.6

Analysis Method	Analysis Date	Lab Comment
TOTAL PHOSPHORUS, DRY WT (USGS I-6600		SAMPLE RECEIVED WITH ICE MELTED

Code	Description	Result	Units	LOD	Report Limit	LOQ
668	PHOSPHORUS	*238	MG/KG	9.9		29.7

Analysis Method	Analysis Date	Lab Comment
SELENIUM, ICP, DRY WT (SW846 6010B)	11/21/2006	

Code	Description	Result	Units	LOD	Report Limit	LOQ
1148	SELENIUM	ND	MG/KG	2		6

Analysis Method	Analysis Date	Lab Comment
SILVER, ICP, DRY WT (SW846 6010B)	11/21/2006	

Code	Description	Result	Units	LOD	Report Limit	LOQ
1078	SILVER	1.6	MG/KG	1		3

Analysis Method	*Analysis Date*	*Lab Comment*
PERCENT SOLIDS (SM 2540G)	**12/05/2006**	**SAMPLE RECEIVED WITH ICE MELTED**

Code	*Description*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
70318	**SOLIDS PERCENT**	***65.3**	%		0.1	

Analysis Method	*Analysis Date*	*Lab Comment*
ZINC, ICP, DRY WT (SW846 6010B)	**11/21/2006**	

Code	*Description*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
61509	**ZINC**	**20.**	MG/KG	0.5		1.6

Analysis Method	*Analysis Date*	*Lab Comment*
TEMPERATURE ON RECEIPT	**11/03/2006**	

Code	*Description*	*Result*	*Units*	*LOD*	*Report Limit*	*LOQ*
136	**TEMPERATURE AT LAB**	**10.**	C		0	

Appendix E

Memory Lake Particle Settling Calculation

Memory Lake Particle Settling Calculations

Surface Area Method

Vc=Qout/Asurface

Vc	critical settle velocity
Qout	flow
Asurface	surface area

Data

Asurface (ft) =	565580	
Vc clay; 5 micron (ft/s) =	0.00013	*WDNR criteria
Vc silt; micron (ft/s) =	0.0095	
Vc sand; 200 micron (ft/s) =	0.069	

Discharge			Particle size trapped		
return period	flow - cfs	Vc	clay	silt	sand
Q7,2	2.2	3.89E-06	YES	YES	YES
Q7,10	3.9	6.9E-06	YES	YES	YES
Daily Ave	63.4	0.000112	YES	YES	YES
Q2	313	0.000553	NO	YES	YES
Q5	525	0.000928	NO	YES	YES
Q10	666	0.001178	NO	YES	YES
Q25	839	0.001483	NO	YES	YES
Q50	964	0.001704	NO	YES	YES
Q100	1086	0.00192	NO	YES	YES

Memory Lake Particle Settling Calculations (cont.)

Volume/Detention Time Method

Tdet=Vol/Qout

Tdet	Detention time
Vol	Lake Volume
Qout	flow

Calculation using current depth and volume

Depth = 5 volume= 1645320

Discharge		Detention time	Settling time in min			Particle size trapped		
return period	flow - cfs	min	clay	silt	sand	clay	silt	sand
Q7,2	2.2	12465	38462	526	72	NO	YES	YES
Q7,10	3.9	7031	38462	526	72	NO	YES	YES
Daily Ave	63.4	433	38462	526	72	NO	NO	YES
Q2	313	88	38462	526	72	NO	NO	YES
Q5	525	52	38462	526	72	NO	NO	NO
Q10	666	41	38462	526	72	NO	NO	NO
Q25	839	33	38462	526	72	NO	NO	NO
Q50	964	28	38462	526	72	NO	NO	NO
Q100	1086	25	38462	526	72	NO	NO	NO

Calculation using potential depth and volume

Depth = 8 volume= 2962910

Discharge		Detention time	Settling time in min			Particle size trapped		
return period	flow - cfs	min	clay	silt	sand	clay	silt	sand
Q7,2	2.2	12465	38462	526	72	NO	YES	YES
Q7,10	3.9	7031	38462	526	72	NO	YES	YES
Daily Ave	63.4	433	38462	526	72	NO	NO	YES
Q2	313	88	38462	526	72	NO	NO	YES
Q5	525	52	38462	526	72	NO	NO	NO
Q10	666	41	38462	526	72	NO	NO	NO
Q25	839	33	38462	526	72	NO	NO	NO
Q50	964	28	38462	526	72	NO	NO	NO
Q100	1086	25	38462	526	72	NO	NO	NO

Appendix F

Photo Log of Memory Lake, October 2005

Appendix G

Memory Lake Community Survey Results

2007 MEMORY LAKE MANAGEMENT PLAN SURVEY

Question #1 Do you feel the lake has been adequately managed?

	MORE				ADEQUATE			LESS
	1	1	1	1	1	1	1	1
	1	1	1	1	1	1		1
	1	1	1	1	1	1		1
	1	1	1	1	1	1		1
	1	1	1	1	1	1		1
	1	1	1	1	1	1		1
	1	1	1	1	1	1		1
	1	1	1	1	1	1		1
	1	1	1	1	1	1		1
	1	1	1		1	1		1
	1	1	1		1	1		1
	1	1	1		1	1		1
	1	1	1		1	1		1
	1	1	1		1	1		1
	1	1	1		1	1		
	1	1	1		1	1		
Column totals	15	15	15	9	15	15	1	13
Grand totals	54				31			13

54 people feel the lake needs more management.
32 people feel the lake is adequately managed.
13 people feel the lake needs less management.

QUESTION #2 HAS THE IN-FILLING OF MEMORY LAKE IMPACTED YOUR INDIVIDUAL USE OF MEMORY LAKE?

	NO IMPACT				LIMITED IMPACT		GREAT IMPACT
	1	1	1	1	1	1	1
	1	1	1	1	1	1	1
	1	1	1	1	1	1	1
	1	1	1	1	1	1	1
	1	1	1	1	1	1	1
	1	1	1		1	1	1
	1	1	1		1	1	1
	1	1	1		1	1	1
	1	1	1		1	1	1
	1	1	1		1	1	1
	1	1	1		1		1
	1	1	1		1		1
	1	1	1		1		1
	1	1	1		1		1
	1	1	1				
	1	1	1				
	1	1	1				
	1	1	1				
	1	1	1				
Column totals	19	19	19	5	14	10	14
Grand totals	62				24		14

62 people feel the in-filling of the lake has had no impact on their use of the lake.
24 people feel the in-filling of the lake has had a limited impact on their use of the lake.
14 people feel the in-filling of the lake has had a great impact on their use of the lake.

QUESTION #3 HAS THE IN-FILLING OF MEMORY LAKE IMPACTED THE VILLAGE OF GRANTSBURG'S USE OF MEMORY LAKE?

	NO IMPACT		LIMITED IMPACT				GREAT IMPACT		
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
	1	1.	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1			
			1	1	1				
Column totals	11	11	12	12	12	11	10	10	10
Grand totals	22		47				30		

22 people feel the in-filling has had no impact on the community's use of the lake.
47 people feel the in-filling has has limited impact on the community's use of the lake.
30 people feel the in-filling has had a great impact on the community's use of the lake.

99

QUESTION #4 WOULD YOU BE WILLING TO HAVE AN ADDITIONAL ASSESSMENT ON YOUR TAX BILL TO FUND MAINTENANCE OF MEMORY LAKE SEDIMENTS (INCLUDING DREDGING)?

	NOT SUPPORT ANY TAX				
	1	1	1	1	1
	1	1	1	1	1
	1	1	1	1	1
	1	1	1	1	1
	1	1	1	1	1
	1	1	1	1	
	1	1	1	1	
	1	1	1	1	
	1	1	1	1	
	1	1	1	1	
	1	1	1	1	
	1	1	1	1	
Column totals	12	12	12	12	5
Grand total	53				

	SMALL ANNUAL TAX							
	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	
	1	1	1	1	1	1	1	
	1	1	1	1	1	1	1	
	1	1	1	1	1	1	1	
Column totals	6	6	6	6	6	6	6	2
Grand total	44							

	LARGER, ONE TIME TAX	
	1	1
	1	1
	1	
	1	
	1	
	1	
Column totals	6	2
Grand total	8	

53 people would NOT support a tax assessment .
44 people WOULD support a small, annual tax assessment.
8 people said they would support LARGER, ONE TIME tax assessment.

105

QUESTION #5 HAVE AQUATIC PLANTS IMPACTED YOUR USE OF MEMORY LAKE?

	LARGE NEGATIVE IMPACT		
	1	1	1
	1	1	
	1	1	
	1	1	
Column totals	4	4	1
Grand total	9		

	LIMITED NEGATIVE IMPACT					
	1	1	1	1	1	1
	1	1	1	1	1	1
	1	1	1	1	1	1
	1	1	1	1	1	1
Column totals	4	4	4	4	4	4
Grand total	24					

	NO IMPACT									
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	
Column totals	6	6	6	6	6	6	6	6	6	5
Grand total	59									

	POSITIVE IMPACT	
	1	1
	1	1
	1	1
	1	
	1	
Column totals	5	3
Grand total	8	

9 people feel aquatic plants have had a large negative impact on their usage of the lake.
24 people feel aquatic plants have had a limited negative impact on their usage of the lake.
59 people feel aquatic plants have had no impact on their usage of the lake.
8 people feel aquatic plants have positively impacted their usage of the lake.

100

QUESTION #6 ARE YOU CONCERNED ABOUT IMPACTS TO WILD RICE (FROM EITHER MANAGEMENT OR LACK OF MANAGEMENT) IN MEMORY LAKE?

	YES, THE WILD RICE IN MEMORY LAKE IS A SIGNIFICANT NATURAL RESOURCE FOR THE AREA.	
	1	1
	1	1
	1	1
	1	1
	1	1
	1	1
	1	
	1	
Column totals	8	6
Grand total	14	

	I HAVE NO OPINION ON WILD RICE IN MEMORY LAKE					
	1	1	1	1	1	1
	1	1	1	1	1	1
	1	1	1	1	1	1
	1	1	1	1	1	
	1	1	1	1	1	
	1	1	1	1	1	
	1	1	1	1	1	
Column totals	7	7	7	7	7	3
Grand total	38					

	MINOR SIGNIFICANCE OF RESOURCE FOR THE AREA.					
	1	1	1	1	1	1
	1	1	1	1	1	1
	1	1	1	1	1	1
	1	1	1	1	1	1
	1	1	1	1	1	1
	1	1	1	1	1	
	1	1	1	1	1	
	1	1	1	1	1	
	1	1	1	1	1	
Column totals	9	9	9	9	9	5
Grand total	50					

14 people feel the wild rice is a significant natural resource for the area.
38 people have no opinion on the wild rice.
50 people feel the wild rice is a minor significance of resource for the area.

102

QUESTION #7 DO YOU SUPPORT HARVESTING WEEDS IN MEMORY LAKE?

	YES, WE NEED TO HARVEST WEEDS PERIODICALLY									
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	
	1	1	1	1	1	1	1	1	1	
	1	1	1	1	1	1	1	1	1	
	1	1	1	1	1	1	1	1	1	
Column totals	7	7	7	7	7	7	7	7	7	3
Grand total	66									

	I HAVE NO OPINION ON WEED HARVESTING		
	1	1	1
	1	1	
	1	1	
	1	1	
	1	1	
	1	1	
	1	1	
Column totals	7	7	1
Grand total	15		

	NO, WE SHOULD NOT BE HARVESTING WEEDS		
	1	1	1
	1	1	1
	1	1	1
	1	1	1
	1	1	
	1	1	
	1	1	
Column totals	7	7	4
Grand total	18		

66 people feel we need to harvest weeds periodically.
15 people have no opinion on whether or not we should harvest weeds in the lake.
18 people feel we should not be harvesting weeds.

99

QUESTION #8 DO YOU THINK MEMORY LAKE HAS THE RIGHT PROPORTION OF MANAGED SHORELINE (MOWED GRASS VS. NATURAL VEGETATION)?

	WE NEED MORE MOWED OR MAINTAINED PARK AREAS BORDERING MEMORY LAKE
	1
	1
	1
	1
	1
	1
Column totals	6
Grand total	6

	WE HAVE THE RIGHT MIX OF NATURAL AND MAINTAINED SHORELINE								
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	
	1	1	1	1	1	1	1	1	
Column totals	8	8	8	8	8	8	8	8	6
Grand total	70								

	WE NEED MORE NATURAL SHORELINE ON MEMORY LAKE		
	1	1	1
	1	1	1
	1	1	1
	1	1	1
	1	1	1
	1	1	1
	1	1	
	1	1	
	1	1	
Column totals	9	9	6
Grand total	24		

6 people feel we need to have more mowed/maintained shoreline at Memory Lake.
70 people feel we have the right mix of natural and maintained shoreline.
24 people feel we need more natural shoreline at Memory Lake.

QUESTION #9 DOES THE PRESENT FISHERY IN MEMORY LAKE IMPACT YOUR USE OF MEMORY LAKE?

	NEGATIVE IMPACT	NO IMPACT			LIMITED POSITIVE IMPACT	LARGE POSITIVE IMPACT
	1	1	1	1	1	1
	1	1	1	1	1	1
	1	1	1	1	1	1
	1	1	1	1	1	1
	1	1	1	1	1	
	1	1	1	1	1	
	1	1	1	1	1	
	1	1	1	1	1	
	1	1	1	1	1	
		1	1	1		
		1	1	1		
		1	1	1		
		1	1	1		
		1	1	1		
		1	1	1		
		1	1	1		
		1	1	1		
		1	1	1		
		1	1	1		
		1	1	1		
		1	1	1		
		1	1	1		
		1	1	1		
		1	1	1		
		1	1	1		
		1	1	1		
		1	1	1		
		1	1	1		
Column totals	9	26	26	26	9	4
Grand totals	9	78			9	4

9 people feel the present fishery has a negative impact on their usage of Memory Lake.
78 people feel the fishery has had NO impact on their usage of Memory Lake.
9 people feel the fishery has had a limited positive impact on their usage of the lake.
7 people feel the fishery has had a large positive impact on their usage of the lake.

103

QUESTION #10 WHAT TYPE OF FISHERY WOULD YOU PREFER IN MEMORY LAKE?

	THE CURRENT FISHERY IN MEMORY LAKE IS GOOD.			
	1	1	1	
	1	1	1	
	1	1		
	1	1		
	1	1		
	1	1		
Column totals	6	6	2	
Grand total	14			

	I WOULD PREFER TO SEE A FISHERY MORE RIVER-LIKE WITH FREE PASSAGE OF FISH THROUGH THE LAKE/DAM.				
	1	1	1	1	1
	1	1	1	1	1
	1	1	1	1	1
	1	1	1	1	1
	1	1	1	1	1
	1	1	1	1	1
	1	1	1	1	
Column totals	7	7	7	7	6
Grand total	34				

	I HAVE NO PREFERENCES IN REGARD TO THE MEMORY LAKE FISHER.				
	1	1	1	1	1
	1	1	1	1	1
	1	1	1	1	1
	1	1	1	1	1
	1	1	1	1	1
	1	1	1	1	1
	1	1	1	1	1
	1	1	1	1	1
	1	1	1	1	
	1	1	1	1	
	1	1	1	1	
Column totals	11	11	11	11	8
Grand total	52				

14 people feel the current fishery is good in Memory Lake.
34 people would like to see a fishery more river-like with free passage of fish through the dam.
52 people have no preference in regard to the fishery.

100

QUESTION #11 HOW DO YOU FEEL ABOUT THE AMOUNT OF USE MEMORY LAKE RECEIVES FROM LOCAL GEESE (NOT DURING THE MIGRATION)?

	I WISH NO GEESE WOULD USE MEMORY LAKE.			
	1	1	1	1
	1	1	1	
	1	1	1	
	1	1	1	
Column totals	4	4	4	1
Grand total	13			

	I WISH FEWER GEESE WOULD USE MEMORY LAKE.									
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	
	1	1	1	1	1	1	1	1	1	
Column totals	5	5	5	5	5	5	5	5	5	3
Grand total	48									

	ABOUT THE RIGHT NUMBERS OF GEESE USE MEMORY LAKE.							
	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	
	1	1	1	1	1	1	1	
	1	1	1	1	1	1	1	
Column totals	5	5	5	5	5	5	5	2
Grand total	37							

	I WISH MORE GEESE WOULD USE MEMORY LAKE.
	1
	1
Column totals	2
Grand total	2

13 people wish NO geese would use Memory Lake.
48 people wish FEWER geese would use Memory Lake.
37 people feel about the RIGHT number of geese use the lake.
2 people wish MORE geese would use Memory Lake.

QUESTION #12 HAS THE PRESENCE OF GEESE IMPACTED YOUR USE OF MEMORY LAKE?

	LARGE NEGATIVE IMPACT			LIMITED NEGATIVE IMPACT			NO IMPACT				
	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1
	1	1		1	1	1	1	1	1	1	1
	1	1		1	1	1	1	1	1	1	
	1	1		1	1	1	1	1	1	1	
	1	1		1	1	1	1	1	1	1	
	1	1		1	1		1	1	1	1	
	1	1		1	1		1	1	1	1	
							1	1	1	1	
Column totals	10	10	4	10	10	8	11	11	11	11	5
Grand totals	24			28			49				

24 people feel the presence of geese at Memory Lake has a LARGE NEGATIVE impact on their usage of the lake.

28 people feel the presence of geese at Memory Lake has a LIMITED NEGATIVE impact on their usage of the lake.

49 people feel the presence of geese at Memory Lake has NO IMPACT on their usage of the lake.

QUESTION #13 PLEASE RANK THE CONSIDERATIONS THAT SHOULD HAVE THE MOST WEIGHT WHEN CHOOSING THE MANAGEMENT ALTERNATIVE FOR MEMORY LAKE (1 BEING THE MOST IMPORTANT CONSIDERATION AND 5 BEING THE LEAST).

OPTIONS:

Continued existence of Memory Lake.

	Rated 1st					2nd	3rd	4th	5th	
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1
	1	1	1	1		1	1	1	1	1
	1	1	1	1		1	1	1	1	1
	1	1	1	1		1		1	1	1
	1	1	1	1				1	1	1
	1	1	1	1				1	1	1
	1	1	1	1				1	1	
	1	1	1	1				1	1	
	1	1	1	1						
Column totals	12	12	12	12	4	7	6	11	11	9
Grand totals	52					7	6	11	20	

Impacts on natural resources.

	Rated 1st	2nd		3rd			4th		5th		
	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1
	1	1		1	1	1	1		1	1	1
		1		1	1	1	1		1	1	1
				1	1	1	1		1	1	1
				1	1	1	1		1		
				1	1	1	1				
Column totals	7	8	6	10	10	10	10	5	9	8	8
Grand totals	7	14		30			15		25		

Future out of pocket costs.

	Rated 1st			2nd		3rd		4th			5th		
	1	1	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1	1	
	1	1	1	1	1	1	1	1	1	1	1	1	
	1	1	1	1	1	1	1	1	1	1	1	1	
	1	1	1	1	1	1	1	1	1	1	1	1	
	1	1	1	1	1	1	1	1	1		1	1	
	1	1	1	1	1	1	1	1	1		1	1	
	1	1	1	1	1			1	1		1	1	
Column totals	8	8	8	8	8	7	7	8	8	5	8	8	1
Grand totals	24			16		14		21			17		

Overall cost/benefit analysis of the Lake and Park (including investment to date).

	Rated 1st			2nd			3rd		4th		5th
	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1
	1	1	1		1	1	1	1	1	1	1
	1	1	1		1	1	1	1	1	1	
	1	1	1		1	1	1	1	1	1	
	1	1	1		1	1	1	1	1	1	
	1	1	1		1				1		
Column totals	10	10	10	5	10	9	9	9	10	9	6
Grand totals	35				19		18		19		6

Impacts on the community.

	Rated 1st		2nd			3rd			4th		5th	
	1		1	1	1	1	1	1	1	1	1	1
	1		1	1	1	1	1	1	1	1	1	1
	1		1	1	1	1	1	1	1	1	1	1
	1		1	1	1	1	1	1	1	1	1	1
	1		1	1		1	1	1	1	1	1	1
	1		1	1		1	1	1	1	1	1	
	1		1	1		1	1	1	1	1	1	
	1		1	1		1	1	1	1	1	1	
	1		1	1		1	1		1	1	1	
	1		1	1		1	1		1			
Column totals	10		10	10	4	10	10	8	10	9	9	5
Grand totals	10		24			28			19		14	

QUESTION #13 PLEASE RANK THE CONSIDERATIONS THAT SHOULD HAVE THE MOST WEIGHT WHEN CHOOSING THE MANAGEMENT ALTERNATIVE FOR MEMORY LAKE.

QUESTION #13 SUMMARY PAGE:

	Rated	1st	2nd	3rd	4th	5th
Continued existence of Memory Lake:		52	7	6	11	20
Impacts on natural resources:		7	14	30	15	25
Future out of pocket costs:		24	16	14	21	17
Overall cost/benefit analysis of the Lake and Park (including investment to date):		35	19	18	19	6
Impacts on the community:		10	24	28	19	14

Above numbers reflect the number of people that rated that information in order of importance.

QUESTION #14 PLEASE RANK THE FOLLOWING ALTERNATIVES FOR MEMORY LAKE (1 BEING THE MOST IMPORTANT CONSIDERATION AND 5 BEING THE LEAST).

OPTIONS:

Continued operation of the dam and doing nothing to the sediments.

	Rated 1st		2nd			3rd				4th		
	1	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1	1
	1		1	1	1	1	1	1	1	1	1	1
	1		1	1	1	1	1	1	1	1	1	
	1		1	1	1	1	1	1		1	1	
	1		1	1	1	1	1	1		1	1	
	1		1	1	1	1	1	1		1	1	
	1		1	1		1	1	1		1	1	
Column totals	8	2	8	8	7	8	8	8	4	8	8	3
Grand totals	10		23			28				19		

Dredging of the lake. (likely no grant funding available)

	Rated 1st			2nd		3rd			4th			
	1	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1		1	1	1	
	1	1	1	1		1	1		1	1	1	
	1	1	1									
Column totals	8	8	8	7	6	7	7	5	7	7	7	5
Grand totals	24			13		19			26			

Removal of the dam and restoration of the lake bed to a river and park. (likely grant funding available with 50% cost match)

	Rated 1st				2nd	3rd		4th				
	1	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1	1
	1	1	1			1	1	1	1	1	1	1
	1	1	1			1		1				
Column totals	8	8	8	6	6	8	7	8	7	7	7	7
Grand totals	30				6	15		36				

	Altered operation of the gates to allow "flushing" of sediments through Memory Lake. (possible permitting and/or associated dredging costs. Possible grant funding available with cost match).										
	Rated 1st				2nd				3rd		4th
	1	1	1	1	1	1	1	1	1	1	1
	1	1	1		1	1	1	1	1	1	1
	1	1	1		1	1	1	1	1	1	1
	1	1	1		1	1	1	1	1	1	1
	1	1	1		1	1	1	1	1	1	
	1	1	1		1	1	1	1	1	1	
	1	1	1		1	1	1		1	1	
	1	1	1		1	1	1		1	1	
	1	1	1		1	1	1		1		
					1	1	1				
Column totals	9	9	9	1	10	10	10	6	9	8	4
Grand totals	28				36				17		4

QUESTION #14 PLEASE RANK THE FOLLOWING ALTERNATIVES FOR MEMORY LAKE.

QUESTION #14 SUMMARY PAGE:

Rated:	1st	2nd	3rd	4th
Continued operation of the dam and doing nothing to the sediments:	10	23	28	19
Dredging of the lake (likely no grant funding available):	24	13	19	26
Removal of the dam and restoration of the lake bed to a river and park (likely grant funding available with 50% cost match):	30	6	15	36
Altered operation of the gates to allow "flushing" of sediments through Memory Lake (possible permitting and/or associated dredging costs. Possible grant funding available with cost match):	28	36	17	4

92

Above numbers reflect the number of people that rated that information in order of importance.

ANY WRITTEN COMMENTS OR QUESTIONS:

1. Response written after question #14 (named Removal of dam #5) and said "You didn't give 5 options-nice."
2. "Let the Water Skip foot the bill."
3. Did not answer either question # 13 or 14. Wrote "As long as my taxes are not affected, I am not concerned."
4. RE Question #1-"Need more active management also from Wood Lake and further up; also as to what is flowing into Memory Lake." RE Question #2- "1st the Airport-2nd the Golf Course-3rd Memory Lake. What next?"
5. Multiple comments throughout survey-"Less geese" and RE Question #1 "No, due to DNR Regulations."
6. "Waterskip organization should fund this."
7. RE Question #2- "I think the use of Memory Lake comes from people outside of Grantsburg."
8. RE Question #1- "Return it to a river."
9. "I avoid the park in the fall when so many geese are present. Their waste is disgusting."
10. "Geese have no impact on my use of Memory Lake other than to walk around the droppings."
11. "It is not wild rice. It was recently planted."
12. "Remove dam."
13. "We would support some form of tax assessment."
14. "I thought we were already approved for a grant."
15. RE Question #3- "Only for the watercross (a few days annually)."
16. RE Question #11-"Migrant (non-local) goose numbers could be reduced."
17. RE Question #14-"Where is the 5th alternative?"
18. "How can you make a silk purse out of a sow's ear? In my 33 years in Grantsburg, I have seen very little use of Memory Lake by typical "park" users (swimming, fishing, picnicing-except in shelters-sunning, etc). Water quality is too poor (due largely to a watershed problem w/agricultural runoff, Wood Lake development, etc.) to support water-based recreation. The value of Memory Lake is mostly aesthetic (green space) and I hope the park continues in the future. However, if the dam was removed and the river course restored and the "urban" park management continued (grass mowing, etc), Memory Lake Park (or more aptly renamed Wood River Park) would continue to serve Grantsburg as a valued public green space. In my opinion, dredging Memory Lake would benefit only the Watercross crowd. Using Memory Lake to race snowmobiles on water is a form of environmental prostitution. Watercross sponsors have claimed to donate funds to local charities, but that is misleading in that the various volunteers have to work at the event at low or below minimum wages. I personally leave Grantsburg during the Watercross. If Memory Lake is dredged, the costs should be paid by the Watercross sponsors, not the Village of Grantsburg tax payers. Remove the dam, restore the river, maintain the park."
19. "Take the headers out of the dam, drain the lake, get rid of the goose problem and leave the walk bridge the way it is."
20. "Dredge the lake so it doesn't look like a swamp. It is a man-made lake after all. Remove, kill, trap-whatever-but get rid of the geese. The geese are horrible! There are plenty of geese to see at Crex Meadows."
21. "Doesn't the Village get enough taxes from us to take care of the lake?"
22. "Stop weedwacking to the water and control purple loose strife. You should consider giving tax break incentives to property owners living along the shoreline who are willing to leave an unmowed (natural) 25' border with the lake. Continue the waterskip."

Appendix H

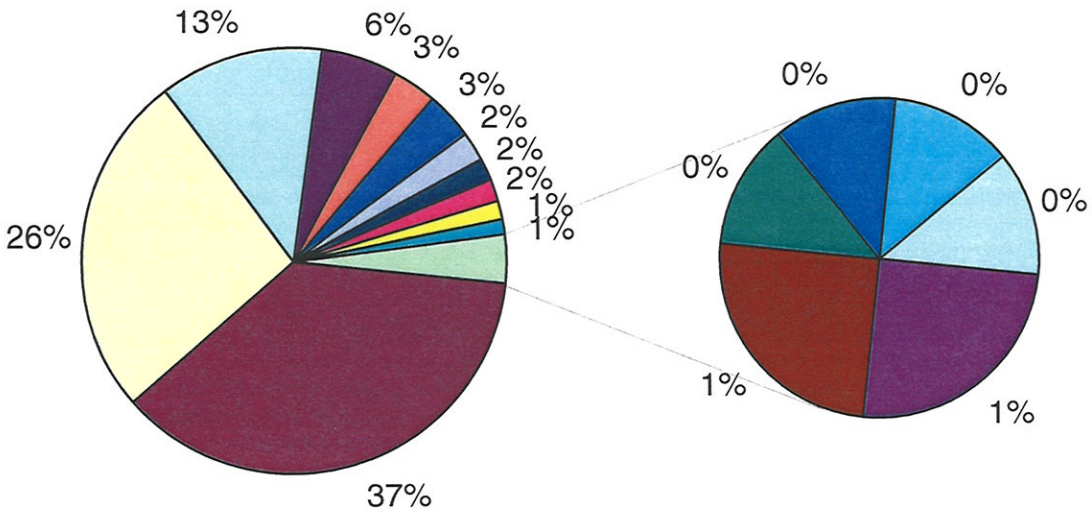
Photo Log of Memory Lake, June 2006


DAM

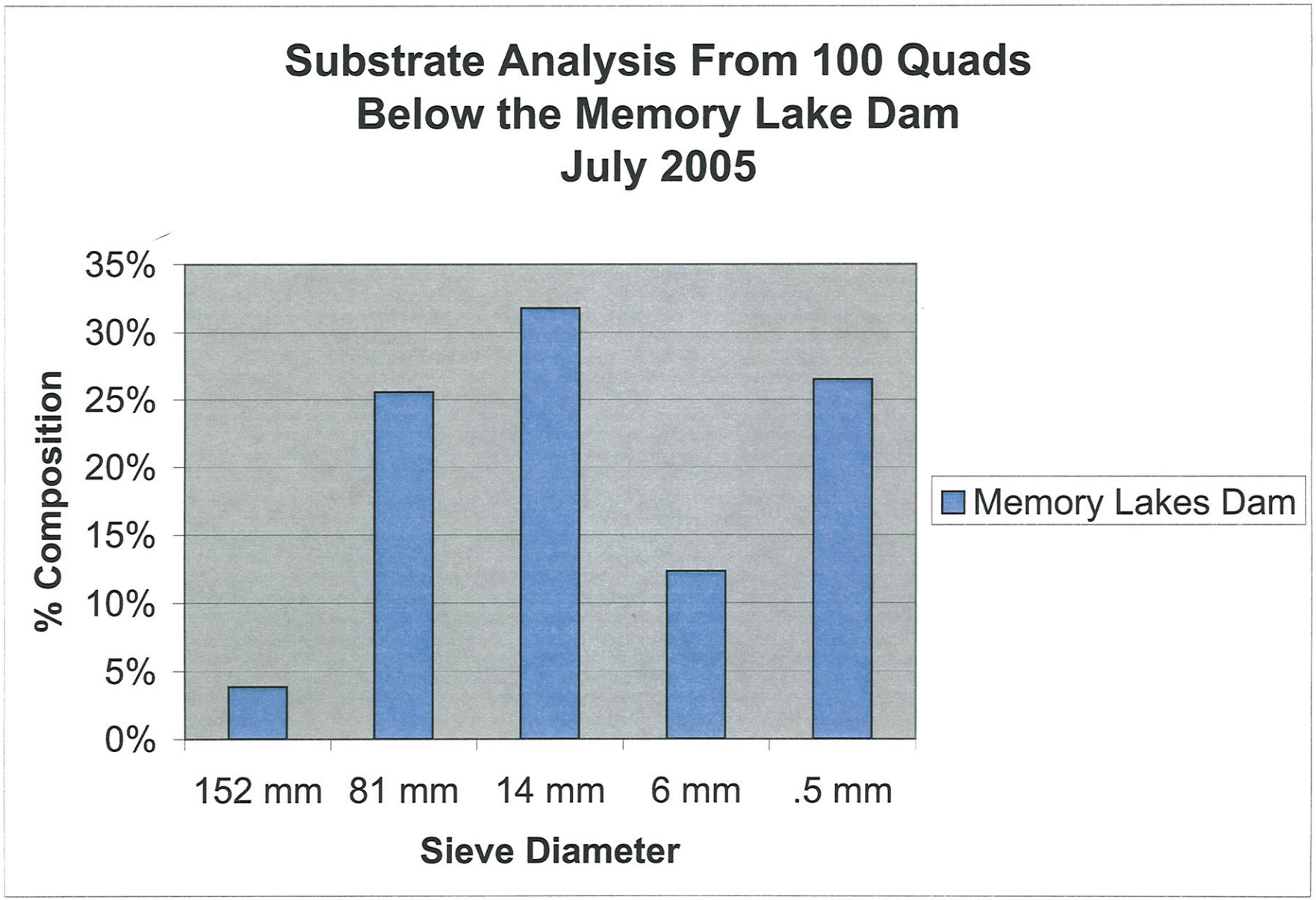
Appendix I

Results of July 2005 Mussel Survey in the Wood River directly below the Memory Lake Dam

Wood River Mussel Community
Below Memory Lake Dam
July 2005



- Species
- Spike
- Mucket
- Threeridge
- Fat Mucket
- Pocketbook
- Wabash Pigtoe
- Fragile Papershell
- Flutedshell
- Strange Floater
- Black Sandshell
- Elktoe
- Cylinder
- Pimpleback
- Creek Heelsplitter
- Hickorynut
- Purple Wartyback
- Pink Heelsplitter


Substrate Analysis From 100 Quads
Below the Memory Lake Dam
July 2005
% Composition
35%
30%
25%
20%
15%
10%
5%
0%
152 mm
81 mm
14 mm
6 mm
.5 mm
Sieve Diameter
Memory Lakes Dam

Mussel Presence and Substate Analysis Data Sheet

Site Number	Site Name	Site Township	Township Range	Section Number	Site Description	GPS N	GPS W
Wood River Memory Lake Dam						upstream 227	
7/11/2005						45.46747 92.41.5	
						downstream 228	
						45.46745	92.41501

Quad #	Species	Length	Width	Height	Age	Tag #	Segment of River Number			Species
1	Spike	99.86	24.92	45.46	14	210	10			Black Sandshell
1	Mucket	93.1	36.47	54.64	13	220	10			Black Sandshell
2	Pocketbook	120.87	56.82	80.34	18	230	10			Black Sandshell
2	Threeridge	110.95	46.89	79.05	22	289	10	227	9.08	Creek Heelsplitte
2	Threeridge	90.48	36.36	64.58	20	354	10			Cylinder
2	Spike	100.45	28.15	47.27	16	355	10			Cylinder
2	Spike	87.28	24.76	41.19	16	356	10			Elk Toe
2	Spike	97.22	29.74	45.28	13	357	10			Elktoe
2	Spike	96.57	31.13	43.57	13	358	10			Elktoe
2	Spike	91.29	24.66	40.23	13	359	10			Fat Mucket
2	Spike	96.81	29.47	44.91	16	360	10			Fat Mucket
2	Spike	96.48	26.06	40.24	16	361	10			Fat Mucket
2	Spike	68.24	18.33	33.33	11	362	10			Fat Mucket
2	Spike	74.84	18.7	33.02	8	363	10			Fat Mucket
3	Black Sandshell	132.08	38.47	58.74	16	364	10			Fat Mucket
3	Pocketbook	106.65	48.59	71.63	14	365	10			Fat Mucket
3	Mucket	101.08	45.03	59.38	13	366	10			Fat Mucket
3	Spike	88.63	25.07	41.02	16	367	10			Fat Mucket
3	Spike	87.26	24.46	41.41	12	368	10			Fat Mucket
3	Spike	52.93	13.57	24.98	5	369	10			Fat Mucket
4	Threeridge	94.67	37.95	69.87	13	370	10			Fat Mucket
4	Spike	94.47	26.13	44.98	14	371	10			Fat Mucket
4	Spike	91.64	22.57	43.26	14	372	10			Fluted Shell
5	Spike	38.55	10.02	18.45	4	373	10			Fluted Shell
5	Spike	61.36	13.74	29.71	6	374	10			Fluted Shell
5	Spike	93.73	25.78	44.64	16	376	10			Flutedshell
5	Spike	97.71	26.16	45.72	13	379	10			Fragile Papershe
5	Wabash Pigtoe	58.55	31.08	47.47	13	380	10			Fragile Papershe
5	Threeridge	88.26	39.97	67.92	15	383	10			Fragile Papershe
5	Threeridge	112.06	53.09	83.32	19	384	10			Fragile Papershe
6	Pimpleback	75.8	40.9	64.8	19	387	10			Fragile Papershe
6	Threeridge	101.01	41.74	75.59	26	388	10			Hickorynut
6	Spike	35.46	8.26	17.81	5	389	10			Mucket
6	Spike	68.04	18.42	32.23	6	390	10			Mucket
6	Spike	70.03	18.4	33.72	7	391	10			Mucket
6	Spike	92.46	25.05	42.36	16	392	10			Mucket
7	Pocketbook	118.62	60.2	80.4	too old		10			Mucket
7	Threeridge	89.6	37.9	65.47	17	100 no tag	10			Mucket
7	Mucket	89.68	31.49	56.08	12	101 no tag	10			Mucket
7	Spike	37.67	9.03	17.75	5	393	10			Mucket
7	Spike	65.47	17.27	30.7	7	395	10			Mucket
7	Spike	89.45	22.99	42.51	14	102 no tag	10			Mucket
7	Spike	97.76	28.47	46.18	10	103 no tag	10			Mucket
8	Fat Mucket	47.67	17.57	28.78	5	396	10			Mucket
8	Spike	90.64	25.85	40.45	11	398	10			Mucket
8	Spike	68.61	16.69	30.46	6	399	10			Mucket
8	Spike	70.74	19.96	34.5	7	439	10			Mucket
8	Spike	98.64	28.52	46.41	12	441	10			Mucket
8	Threeridge	56.77	24.42	43.58	8	442	10			Mucket
8	Threeridge	81.3	36.25	59.8	18	443	10			Mucket
8	Threeridge	94.34	44.79	70.36	17	444	10			Mucket
8	Threeridge	95.72	46.17	71.15	14	445	10			Mucket
9	Elktoe	68.49	27.29	36.04	9	446	10			Mucket
9	Spike	69.48	17.87	32.01	6	447	10			Mucket
9	Spike	68.02	17.88	32.85	7	448	10			Mucket
9	Threeridge	96.82	43.83	70.36	13	104 no tag	10			Mucket
9	Mucket	94.69	39.48	57.47	13	105 no tag	10			Mucket
10	Spike	42.73	9.94	19.27	4	449	10			Mucket
10	Spike	68.71	18.3	33.19	6	450	10			Mucket
10	Spike	67.41	18.64	33.62	7	451	10			Mucket
10	Spike	97.03	26.08	46.79	14	452	10			Mucket
10	Spike	101.1	25.54	49.62	14	453	10			Mucket
10	Mucket	109.88	41.81	61.71	17	106 no tag	10			Mucket
10	Mucket	99.98	44.09	63.93	28	107 no tag	10			Mucket
10	Mucket	101.29	42.25	64.5	22	108 no tag	10			Mucket
1	Spike	43.44	10.01	20.31	4	454	9			Mucket
1	Cylinder	49.72	15.63	25.17	4	455	9			Mucket
2	Fat Mucket	44.68	15.81	25.61	4	456	9			Mucket
2	Threeridge	68.01	32.25	52.74	8	457	9			Mucket
3	Threeridge	25.9	13.18	21.07	4	458	9			Mucket
3	Spike	29.34	6.43	13.41	3	459	9			Mucket
3	Mucket	38.18	12.02	21.7	4	460	9			Mucket
3	Mucket	54.22	19.25	32.04	5	461	9			Mucket
3	Fragile Papershell	74.11	27.19	52.04	5	462	9			Mucket
4	Mucket	50.24	15.88	30.35	5	463	9			Mucket
4	Mucket	36.43	11.03	21.39	4	464	9			Mucket
4	Mucket	31.53	9.94	18.5	4	465	9			Mucket
4	Threeridge	55.49	25.5	42.94	6	466	9			Mucket
4	Spike	79.94	20.11	36.27	7	467	9			Mucket
5	Spike	88.97	27.44	42.05	10	468	9			Mucket
6	Mucket	67.4	24.51	44.11	7	469	9			Mucket
6	Mucket	95.65	34.93	58.44	8	470	9			Mucket
6	Strange Floater	86.28	27.07	44.07	13	471	9			Mucket
6	Strange Floater	76.73	24.7	42.37	8	472	9			Mucket
7	Threeridge	14.5	7.47	11.43	3	473	9			Mucket

Quad #	Species	Length	Width	Height	Age	Tag #	Segment of River Number	Species
7	Fat Mucket	22.35	6.42	12.29	3	474	9	Mucket
7	Hickorynut	52.18	28.5	42.58	6	475	9	Mucket
7	Pocketbook	87.58	38.74	60.21	6	476	9	Mucket
7	Spike	91.04	24.55	41.43	8	477	9	Mucket
7	Mucket	90.56	33.74	55.98	10	478	9	Mucket?
8	Spike	27.81	6.83	13.37	3	479	9	Muckets
8	Mucket	30.52	9.03	18.01	4	481	9	Muckets
9	Pocketbook	50.04	22.72	32.53	4	482	9	Pimpleback
9	Mucket	28.4	8.15	15.46	4	483	9	Pimpleback
9	Mucket	31.36	9.74	17.01	4	484	9	Pocketbook
9	Mucket	75.28	28.43	47.83	7	485	9	Pocketbook
9	Mucket	81.81	31.03	52.31	11	486	9	Pocketbook
10	Spike	24.5	5.01	11.73	3	487	9	Pocketbook
10	Spike	24.01	4.98	11.41	3	488	9	Pocketbook
10	Fat Mucket	29.58	9.54	16.04	3	489	9	Pocketbook
10	Fat Mucket	16.61	4.79	9.59	2	490	9	Pocketbook
10	Fat Mucket	47.09	16.69	26.03	4	491	9	Pocketbook
10	Fat Mucket	40.07	13.74	22.83	4	492	9	Purple Wartybacl
1	Mucket	57.28	19.8	34.79	5	329	8	Spike
2	Purple Wartyback	49.98	24.77	48.47	8	332	8	Spike
2	Threeridge	57.62	25.69	44.63	7	333	8	Spike
3	Spike	78.54	19.53	36.94	6	339	8	Spike
3	Spike	57.55	13.24	26.23	4	340	8	Spike
3	Spike	43.06	10.92	20.88	4	341	8	Spike
3	Fluted Shell	75.66	22.19	43.22	6	342	8	Spike
3	Fat Mucket	75.13	25.13	41.89	7	343	8	Spike
4	Spike	71.46	18.83	33.42	6	347	8	Spike
5	Mucket	67.99	26.24	44.63	6	349	8	Spike
5	Fat Mucket	55.2	17.63	29.96	5	350	8	Spike
5	Spike	45.81	10.17	21.16	5	351	8	Spike
6	Mucket	63.37	22.51	39.77	5	330	8	Spike
6	Mucket	36.97	11.25	21.19	3	331	8	Spike
7	Mucket	83.76	33.77	53.78	9	334	8	Spike
7	Mucket	59.82	20.04	36.73	4	337	8	Spike
7	Mucket	51.79	17.4	32.49	4	338	8	Spike
7	Pocketbook	68.71	31.18	48.49	5	335	8	Spike
7	Threeridge	71.52	33.99	57.03	10	336	8	Spike
8	Pocketbook	66.05	31.59	46.67	5	344	8	Spike
8	Elk Toe	67.5	26.92	37.02	7	345	8	Spike
8	Spike	37.4	9.08	19.37	4	346	8	Spike
9	Spike	42.85	10.66	20.33	4	348	8	Spike
10	Mucket	43.66	14.66	25.31	4	352	8	Spike
10	Spike	40.27	9.19	18.49	5	353	8	Spike
1	Mucket	57.48	20.42	33.63	5	284	7	Spike
1	Mucket	93.28	33.35	60.66	10	290	7	Spike
1	Mucket	43.11	13.44	23.63	5	291	7	Spike
1	Mucket	37.89	12.15	22.71	6	292	7	Spike
1	Threeridge	27.24	12.94	21.28	4	293	7	Spike
1	Spike	36.17	8.49	16.02	4	288	7	Spike
2	Mucket	46.64	16.42	26.01	4	296	7	Spike
2	Mucket	76.39	24.99	44.23	6	297	7	Spike
3	Spike	65.66	16.91	31.41	7	298	7	Spike
3	Spike	47.46	12.92	22.93	4	299	7	Spike
3	Spike	34.83	8.18	16.98	4	300	7	Spike
3	Spike	42.5	10.33	20.39	4	301	7	Spike
3	Spike	36.73	9.33	17.37	4	302	7	Spike
3	Spike	28.51	5.85	13.65	3	303	7	Spike
3	Mucket	28.69	9.29	17.55	4	304	7	Spike
4	Spike	93.79	27.95	40.94	12	305	7	Spike
4	Spike	65.85	16.32	31.5	6	306	7	Spike
4	Spike	65.75	19.71	33.84	8	307	7	Spike
5	Spike	42.18	9.6	19.04	4	309	7	Spike
5	Creek Heelsplitter	48.02	12.02	28.04	5?	310	7	Spike
5	Fragile Papershell	70.4	25.87	41.12	5	311	7	Spike
5	Mucket?	18.33	5.59	1035	3	312	7	Spike
5	Fat Mucket	80.59	35.03	48.88	9	313	7	Spike
8	Spike	66.97	17.47	30.72	8	313	7	Spike
8	Strange Floater	84.52	26.88	44.56	9	314	7	Spike
8	Mucket	70.38	26.58	44.93	7	315	7	Spike
9	Pocketbook	70.49	30.99	46.95	5	216	7	Spike
9	Threeridge	79.05	36.01	56.86	10	217	7	Spike
9	Mucket	47.24	15.41	28.6	5	218	7	Spike
9	Wabash Pigtoe	35.58	20.64	29.47	5	219	7	Spike
10	Fat Mucket	64.55	22.98	36.36	5	320	7	Spike
1	Mucket	54.39	17.99	31.71	5	325	6	Spike
3	Mucket	53.4	17.31	42.59	5	328	6	Spike
4	Black Sandshell	95.72	23.99	41.46	8	326	6	Spike
4	Mucket	50.96	17.35	27.37	4	322	6	Spike
4	Mucket	83.19	30.32	52.16	8	323	6	Spike
4	Mucket	89.43	31.99	53.36	11	324	6	Spike
7	Spike	25.47	5.85	12.02	3	321	6	Spike
10	Threeridge	70.66	28.31	53.21	9	327	6	Spike
1	Spike	58.65	16.73	27.7	6	266	5	Spike
4	Cylinder	55.75	20.42	27.53	10	273	5	Spike
5	Spike	37.2	9.43	18.33	4	283	5	Spike
5	Spike	92.51	27.34	42.53	10	285	5	Spike
5	Spike							Spike
6	Fat Mucket	60.37	21.75	33.09	5	267	5	Spike
8	Fragile Papershell	110.53	36.62	67.8	16	271	5	Spike
8	Threeridge	76.55	39.42	60.24	13	272	5	Spike
10	Spike	92.06	23.5	43.18	14	287	5	Spike
3	Spike	81.97	24.16	41.39	9	269	4	Spike
3	Threeridge	75.63	36.83	61.65	11	270	4	Spike
5	Spike	29.39	7.54	14.28	3	279	4	Spike
5	Strange Floater	81.38	28.25	44.5	10	280	4	Spike

Quad #	Species	Length	Width	Height	Age	Tag #	Segment of River Number	Species
5	Mucket	49.99	18.21	30.37	5	281	4	Spike
5	Mucket	80.87	30.34	51.45	4	282	4	Spike
7	Spike	22.34	4.71	1079	3	259	4	Spike
7	Spike	80.84	20.12	39.07	7	268	4	Spike
9	Wabash Pigtoe	78.24	38.2	58.08	26	274	4	Spike
9	Spike	78.28	18.92	36.9	18	275	4	Spike
9	Mucket	54.87	19.11	33.89	7	276	4	Spike
9	Mucket	49.19	16.95	26.06	5	277	4	Spike
9	Mucket	42.41	13.93	25.76	4	278	4	Strange Floater
10	Flutedshell	78.54	20.62	42.69	8	286	4	Strange Floater
4	Mucket	75.64	24.67	48.06	9	208	3	Strange Floater
5	Spike	71.77	19.17	36.99	7	217	3	Strange Floater
5	Spike	71.2	21.9	35.37	6	213	3	Threeridge
5	Mucket	47.42	15.63	28.46	6	219	3	Threeridge
5	Wabash Pigtoe	48.5	22.56	35.6	6 (deformed)	214	3	Threeridge
5	Wabash Pigtoe	27.79	14.11	21.96	6	216	3	Threeridge
5	Fat Mucket	62.25	21.43	35.54	6	215	3	Threeridge
8	Mucket	74.92	26.12	48.91	10	206	3	Threeridge
8	Mucket	32.02	12.12	19.81	5	207	3	Threeridge
10	Fragile Papershell	76.56	26.96	52.21	5	211	3	Threeridge
1	Black Sandshell	130.1	38.29	58.59	17 (female)	221	2	Threeridge
1	Threeridge	59.12	28.01	44.74	10	222	2	Threeridge
2	Spike	76.09	19.78	37.78	7	225	2	Threeridge
2	Mucket	51.56	16.34	30.66	5	224	2	Threeridge
3	Threeridge	104.21	47.36	81.71	17	251	2	Threeridge
3	Threeridge	71.56	32.92	55.92	9	252	2	Threeridge
3	Wabash Pigtoe	64.94	35.14	54.73	13	250	2	Threeridge
3	Spike	77.84	21.34	36.53	8	212	2	Threeridge
4	Threeridge	24.44	14.41	23.45	5	260	2	Threeridge
4	Pimpleback	44.7	26.38	40.49	7	261	2	Threeridge
5	Fluted Shell	83.74	20.05	44.37	8	256	2	Threeridge
5	Spike	72.55	19.03	35.25	6	257	2	Threeridge
5	Wabash Pigtoe	45.53	24.98	37.47	6	258	2	Threeridge
6	Wabash Pigtoe	50.81	28.13	41.48	7	223	2	Threeridge
7	Elktoe	60.79	22.86	32.49	8	218	2	Threeridge
8	Mucket	43.36	13.27	27.23	4	253	2	Threeridge
8	Mucket	54.25	17.46	32.47	5	254	2	Threeridge
8	Mucket	49.79	17.13	29.98	5	255	2	Threeridge
9	Fluted Shell	35.95	8.12	18.96	4	262	2	Threeridge
10	Spike	83.31	22.69	34.24	7	263	2	Threeridge
10	Spike	72.74	17.85	32.8	7	264	2	Wabash Pigtoe
10	Spike	69.08	19.97	36.24	6	265	2	Wabash Pigtoe
3	Muckets	53.52	17.32	29.36	6	202	1	Wabash Pigtoe
3	Muckets	49.06	17.86	28.48	5	203	1	Wabash Pigtoe
6	Fragile Papershell	58.09	19.87	37.87	na	201	1	Wabash Pigtoe
6	Threeridge	90.03	39.46	69.82	na	200	1	Wabash Pigtoe
8	Mucket	80.72	29.77	52.35	10	204	1	Wabash Pigtoe
9	Mucket	102.43	42.21	63.12	17	205	1	Wabash Pigtoe