NEMADJI RIVER BASIN PROJECT
PHASE II
WORK PLAN

2000-2001-2002

PROJECT SPONSOR:

Carlton County Water Plan Advisory Committee
P.O. Box 220
Carlton, Minnesota 55718

CONTRIBUTING SPONSORS:

Local Contributing Sponsors:
Carlton County Soil and Water Conservation District
Carlton County Highway Department
EQIP Cost Share Match (Private Landowners)
Carlton County Land and Timber Department

STATE AND FEDERAL CONTRIBUTING SPONSORS:

Minnesota Pollution Control Agency
Natural Resources Conservation Service
Forestry Technical Committee (mostly state and federal representatives)
Minnesota Department of Natural Resources Division of Fisheries
Minnesota Department of Natural Resources Division of Forestry
United States Department of Agriculture
United States Army Corp of Engineers
EPA Section 319 Grant Funds
University of Minnesota
University of Minnesota Extension Carlton County

Work Plan Developed by:
Joanne Rosberg, NRBP Coordinator
Rian Reed, DNR Watershed Technical Coordinator
Brian Hayden, Project Representative, Carlton County Water Plan Coordinator

TABLE OF CONTENTS **Page**

LIST OF TABLES Page

STATEMENT OF PROBLEMS AND EXISTING CONDITIONS

The Nemadji River flows into Superior Bay, which was designated as an "area of concern" by the Great Lakes Water Quality Agreement (WQA) between The United States and Canada in 1972. Five impaired uses were recognized at that time: 1) Fish Consumption Advisories, 2) Degradation of Benthos, 3) Restrictions on Dredging, 4) Degradation of Aesthetics, and 5) Loss of Fish and Wildlife Habitat. In 1987, Remedial Action Plans (RAPs) were developed for implementing provisions of the WQA and restoring beneficial uses of this area.

In 1993, the Citizen's Advisory Committee of the RAP requested the Natural Resources Conservation Service (NRCS) to identify methods for reducing sedimentation in the Nemadji River. Under the authority of Public Law-566 Watershed Protection and Flood Prevention Act, the NRCS began work on the Nemadji River Basin Project in January 1994. The Carlton County Board of Commissioners, several Wisconsin agencies and the Metropolitan Interstate Committee served as sponsors to provide local support and input. The mission of the Nemadji River Basin Project at that time was to recommend remedial actions and treatments to implement restoration to beneficial uses to the Nemadji River Basin.

The Nemadji River Basin has approximately 433 square miles (277,400 acres) of drainage area and is located south of Duluth, Minnesota, straddling the Minnesota-Wisconsin border. The Nemadji River flows into Superior Bay at Superior, Wisconsin. The basin area includes southeastern Carlton County and northeastern Pine County in Minnesota and Northwestern Douglas County in Wisconsin. The land cover is 69 percent forest, 18 percent cropland and pasture, 11 percent wetlands and lakes, and two percent other categories. The majority of land ownership is non-industrial private land (55percent). The remainder is county (22 percent), state (16 percent), railroad and industrial (6 percent), and Tribal, City, and Township (1 percent). Approximately 80% of the Minnesota portion of the Nemadji River basin is located within Carlton County including all of the clay-erosion prone areas and most of the headwater tributaries.

Approximately one third of the basin is comprised of glacial till and glacial lake-laid clay soils. These soils are commonly referred to as "red-clay" and were formed during the last glaciation of the area some 10,000 years ago. Red-clay is considered highly erodable and is prone to extensive mass wasting or "slumping" along streams and tributaries. The upland two-thirds of the basin is sandy and loamy tills and glacial outwash. These soils are generally sandier and much less erodable than the red clay.

A sediment budget developed for this project during Phase I found that 89 percent of the fines (silt- and clay- sized particles) eroded come from streambank and bluff erosion along streams. The remaining 11 percent of fines originate from roadside erosion and sheet and rill erosion. The vast majority (about 92 percent) of all streambank and bluff erosion occurs in the red-clay portion of the basin. Fourteen percent (19,000 tons) of all the silt and clay is trapped in Superior

Bay. The remaining 74 percent (98,000 tons) is carried out into Lake Superior.

This sediment budget shows less sediment yield from the Nemadji River Basin than was previously thought. An EPA report published in 1979 estimated suspended sediment yield at 562,000 tons per year, about four times higher than the Nemadji River Basin Project estimate of 127,000 tons per year. The reason for the vast difference is that several more years of stream-flow and suspended sediment data were available for use in the above stated estimate than were available in 1979.

The high sediment yield of the Nemadji River Basin is largely a result of changes in the hydrologic system. Hydrologic changes caused by human activities have resulted in increased volumes and rates of runoff and stream-flow. These changes have resulted in higher stream-flow energies that, in turn, have increased streambank and bluff erosion and slumping. The major human activities that have had a significant impact on the hydrology of the basin are the early logging practices dating back to the mid 1800's. Logging and clearing of the land lead to the conversion of forest to permanent agriculture, creating more efficient hydrologic pathways by building roads, railroads, and logging roads, and clearing of existing streams and tributaries for efficient transport of logs to the sawmills.

On-site damage due to the instability of red-clay results in frequent and expensive maintenance schedules for road cut and embankment situations. Property damage from slumping is relatively small due to the low population density in the watershed.
Off-site damages include ecosystem damages and sedimentation in Superior Bay. The most extensive study of damage to the ecosystem was done during the Red-Clay Project in the 1970's. Sediment deposited in watercourses can interfere with feeding and reproduction of fish and aquatic insects.

Sediment carried into the Nemadji River from converging streams and rivers then down the Nemadji River into Superior Harbor and out into Lake Superior is the major concern. Approximately 33,000 tons of Nemadji River sediment is dredged annually by the U.S. Army Corps of Engineers to maintain adequate depth for shipping traffic in Superior Bay. The annual cost for this portion of the total dredging within the Duluth-Superior Harbor area is approximately $260,000.

Transport of pollutants attached to settled bottom material has created a "storehouse" of toxins in the lower reaches of the harbor. Pollutants include mercury, dioxins, and PCB's. Re-suspension and/or dredging of this material can lead to elevated toxin levels in the biota.

Increased sedimentation also decreases river's fisheries. The Minnesota portion of the Nemadji Watershed contributes 40% of Lake Superior's migratory trout and salmon spawning habitat in Minnesota. Fine-grained sedimentation degrades the quality of the spawning bed habitat. The

loss of riparian vegetation cover that acts as protective shading also increases the river's average temperature. Warm water conditions are extremely detrimental to trout habitat.

The most recent livestock concentration inventory was completed in 1997 and showed 85 sites in Minnesota and 42 sites in Wisconsin. Of the 127 total sites, 51 sites were rated as high hazard for surface or groundwater pollution potential.

Livestock have two major impacts on watershed condition: 1) Pastures in clay soils are compacted by mismanaged livestock. The compaction decreases infiltration rates and increases runoff. The impact of increased water yield from compaction is an increase in channel forming flows, which accelerates streambank erosion; 2) Unrestricted livestock access to streams removes vegetation and root systems from stream-banks. This removal of vegetation reduces the resistance of the steam-bank to erosion. As a result of compaction and removal of vegetation by livestock, the stream channel becomes wider and shallower.

Clear-cut and new growth forests (0-15years old) will have increased channel-forming flows (the peak flow that occurs about every one and a half years). The process of removing forest products from a harvest area can accelerate erosion. Logging roads, skid trails, and log landings are sources of soil erosion from a timber harvest.

The long-term goal, as stated in the Nemadji River Basin Project Summary Report (see attachment), is to restore beneficial uses to the Nemadji River Basin. Specific hydrologic processes requiring restoration include stabilizing runoff volumes and peak discharges through coordination of land use activities, “de-channelizing” runoff paths from uplands to main channels, and re-establishing healthy riparian corridors. Effecting hydrologic change on a watershed scale with land treatment is long term and best measured in terms of decades.

Short-term goals include prevention of further degradation of the hydrologic condition, maintaining the economic viability of the land for land owners, expanding partnerships and coordination to address watershed problems, and establishing an educational program to ensure land owner awareness of land management and sedimentation interactions.

Short-term goals are subject to change and expansion as sub-watersheds are prioritized and specific restoration sites are identified and studied. All short-term goals and objectives will ultimately enhance and support the main long-term objective of reducing sediment in the waterways of the Nemadji River Basin and maintaining the percentage of open land and young forest to 40% or less within each sub-watershed.

Phase I of the Nemadji Project defined five priority management areas in the *Erosion and Sedimentation in the Nemadji River Basin* Final Report. These priority areas include: (1) forest management; (2) agriculture management; (3) riparian zone management; (4) fisheries and wildlife habitat management; and (5) urban/infrastructure management. The Phase I report defined several broad areas of implementation actions that are being addressed in this Phase II effort based upon prioritization of 11 sub-watersheds of concern within the Minnesota portion of the basin. Phase I of the Nemadji Project did not create specific implementation goals for the sub-watersheds of concern. Recommendations are stated in the Nemadji River Basin Project Report "*Erosion and Sedimentation in the Nemadji River Basin*". With this document, specific implementation goals will be created while keeping the work process flexible to insure efforts fit into existing schedules of agencies and persons involved in any/all projects.

The Carlton County portion of the Nemadji River Watershed is the focus or target for this work plan.

WATERSHED WORKPLAN

I. OVERALL GOALS:

A. Water Quality

Goals can be configured over short and long-term basis. For the long-term basis (e.g. 10 to 20 years) it is the stated objective of Carlton County to reduce sedimentation and turbidity to the Nemadji River and its tributaries by reducing frequency of bankfull flow by as much as **2.5** times (e.g. about **25%** reduction in maximum flow events) and sediment loads by as much as 50%in headwater tributaries. from watersheds as small as one square mile in the Nemadji River Watershed. (From Faith Fitzpatrick North Fish Creek Study, June 1999**).**

Bruce, I Need to talk with you about this…….

I don't see this much improvement, even 25-50 percent over the 10-20 year period. For these statements 2.5 and 5 times, I am referring to longer term beyond twenty years, based on information from the North fish Creek Study. (if you don't have a copy let me know)

B. Fisheries

- Improve the essential habitats for salmonid species by reducing turbidity and sedimentation and restore fish migratory access to previously inaccessible areas.
- Measure success by habitat assessments and invertebrate counts.

II. HOW TO ACHIEVE GOALS

A. Reduce Bankfull Flow Discharge Rates
B. Reduce Channel Downcutting
C. Reduce Streambank Erosion
(See *Erosion and Sediment in the Nemadji River Basin* Final Report)

III. SPECIFIC PROGRAM ELEMENTS TO ACHIEVE GOALS

Goals to be accomplished within the framework of this work plan time are:

A. CREATE A FRAMEWORK FOR PROJECT MANAGEMENT

1. Carlton County Water Plan Citizen Advisory Committee
2. Technical Committee
3. Nemadji River Forestry Committee
4. Technical Support Team

B. NATURAL RESOURCE INVENTORIES

1. Forest Cover Inventory (GIS)
2. Erosion Inventory
3. Army Corps of Engineers Sediment Model
4. Refine priority management areas.

C. PROJECTS

1. Prioritization of Sensitive Areas
    a. Priority Management Areas
        - Forest Management
        - Agriculture management
        - Riparian Management
        - Fish and Wildlife Habitat Management
        - Urban/infrastructure Management
2. Restoration Projects
    a. Land Use Management
    b. Spring Creek/County Hwy. #6
    c. Pauly Tree Planting
    d. Black Hoof Stream Bank Stabilization
    e. Agriculture Waste Removal
    f. Other

D. MONITORING

1. Monitoring Plan
2. Quality Assurance Project Plan
3. Hydrologic Monitoring
4. Water Quality Monitoring
5. Fishery or Biological Monitoring
6. Data Analysis and Assessment

E. ESTABLISH EDUCATION AND COMMUNICATION SYSTEMS

1. Township and Community Meetings
2. Schools
3. Private and commercial landowner contacts
4. Pasture Walks
5. Agricultural Tours
6. Forestry Field Tours
7. Newsletters and newspaper articles.

A. PROJECT MANAGEMENT

Project management will be directed by Carlton County Water Plan Citizen Advisory Committee with recommendations provided by its Nemadji River Basin Project Technical Committee. Brian Hayden of the Carlton County Planning and Zoning Office is the Project Representative and directs Joanne Rosberg, the Nemadji River Basin Project Coordinator. Assisting the cooperative effort is Kelly Smith of the Carlton County Soil and Water Conservation District and Rian Reed of the Minnesota Department of Natural Resources. Rian Reed assists the Project Representative as the Nemadji River Basin Technical Coordinator and is responsible for also coordinating all of the Minnesota Department of Natural Resources related efforts within the watershed.

1. Carlton County Water Plan Citizen Advisory Committee

This is the decision making body within the structure of the Carlton County portion of the Nemadji Basin. The people on this committee represent the towns and townships within the Nemadji Basin. They will provide input from local landowners that may have concerns about the proposed projects within the Nemadji Basin or have suggestions for projects. The Water Plan Citizen Advisory Committee meets quarterly. The Nemadji River Basin Technical Committee provides background information and recommendations to the Citizen Advisory Committee for action.

Representatives:

Merrill Loy: Supervisor, Carlton County Soil and Water Conservation District
Ron Venier: Carlton
Paul Davidson: Moose Lake
Jim Mosack: Esko
Dennis Lampi: Cloquet
Sandy Wentkeiwicz: Barnum, Lake Association Representative
Al Behrens: Cloquet

2. Technical Committee and Responsibilities

The Technical Committee has been selected by the Project Coordinator and Water Planning Coordinator because of their knowledge of the Nemadji River Basin due to past experiences in projects pertaining to the Nemadji Basin and the problems it presents. The Technical Committee will be responsible for prioritizing the sub-watersheds and specific project sites within each sub-watershed in the Nemadji River Basin. The Technical Committee will also be involved in implementing the work involved on selected project sites. Coordination of this group is the responsibility of the NRBP Coordinator and the DNR Watershed Coordinator.

Nemadji River Basin Project Technical Committee:

*Brian Hayden: Carlton County Water Plan Coordinator
*Rian Reed: DNR Watershed Technical Coordinator
*Joanne Rosberg: NRBP Coordinator
*Kelly Smith: Conservation Technician Carlton County SWCD
Tony Kroska: GIS Consultant, *Community GIS*
Sandy Verry: Technical Consultant, US Forest Service, Grand Rapids, MN
Paul Sandstrom: District Conservationist, Natural Resources Conservation Service
John Spurrier: Area Supervisor, DNR Fisheries, Duluth
Mark Ebbers: State of Minnesota Trout and Salmon Coordinator, DNR Fisheries, St. Paul
Don Schleip: Area Manager, DNR Fisheries, Duluth
Marty Wiley: Forester, Department of Natural Resources, Moose Lake
Eli Sagor: University of Minnesota Extension Educator, Forestland Ecology and Management, Cloquet Forestry Center
Mike Reichenbach: University of Minnesota Extension Forest Educator, Forest Economic Development, Cloquet Forestry Center
Gene Knudson: Citizen, Carlton County SWCD Supervisor
Gene Lindquist: Superintendent, Carlton County Highway Department
Wayne Olson: County Engineer, Carlton County Highway Department
Milo Rasmussen: Land Commissioner, Carlton County Land Department
Brad Matlack: District Manager, Carlton County Soil and Water District
Representatives from: Arrowhead Fly Fishers Club, Cloquet, (Dr. John Connolly, President); Trout Unlimited, Gitche Gumme Chapter, Duluth, (John P. Lenczewski, President); Lake Superior Steelhead Association, Duluth, (Kevin Bovee, Co-Editor, Lake Superior Angler)
Fred Strand: Forester, Wisconsin DNR
Mike Peloquin: Area Hydrologist, DNR Waters, Two Harbors
Rich Staffon: Area Wild Life Manager, DNR Wildlife, Cloquet
Dick Noyes: Water Plan Coordinator, Hinckley, Pine County SWCD
Julie McDonnell: Minnesota Pollution Control Agency Project Manager
Bruce Wilson: Minnesota Pollution Control Agency, St. Paul

The Technical Committee meets quarterly or as needed.
* Indicates core administration: meets bi-weekly during work plan development and as needed.

a. Technical Support Team

The Technical Support Team was selected because of their expertise in watershed activities, their past experience with the Nemadji River Basin, their connection with the University of Minnesota and the need to continue their research of the Nemadji Basin.
The Technical Support Team will be notified of all Technical Committee meetings.

Technical Support Team :

Dr. Sandy Verry: Hydrology, US Forest Service, Grand Rapids, MN.
Dr. Ken Brooks: Hydrology, University of Minnesota
Ian Chisholm: DNR Ecological Services

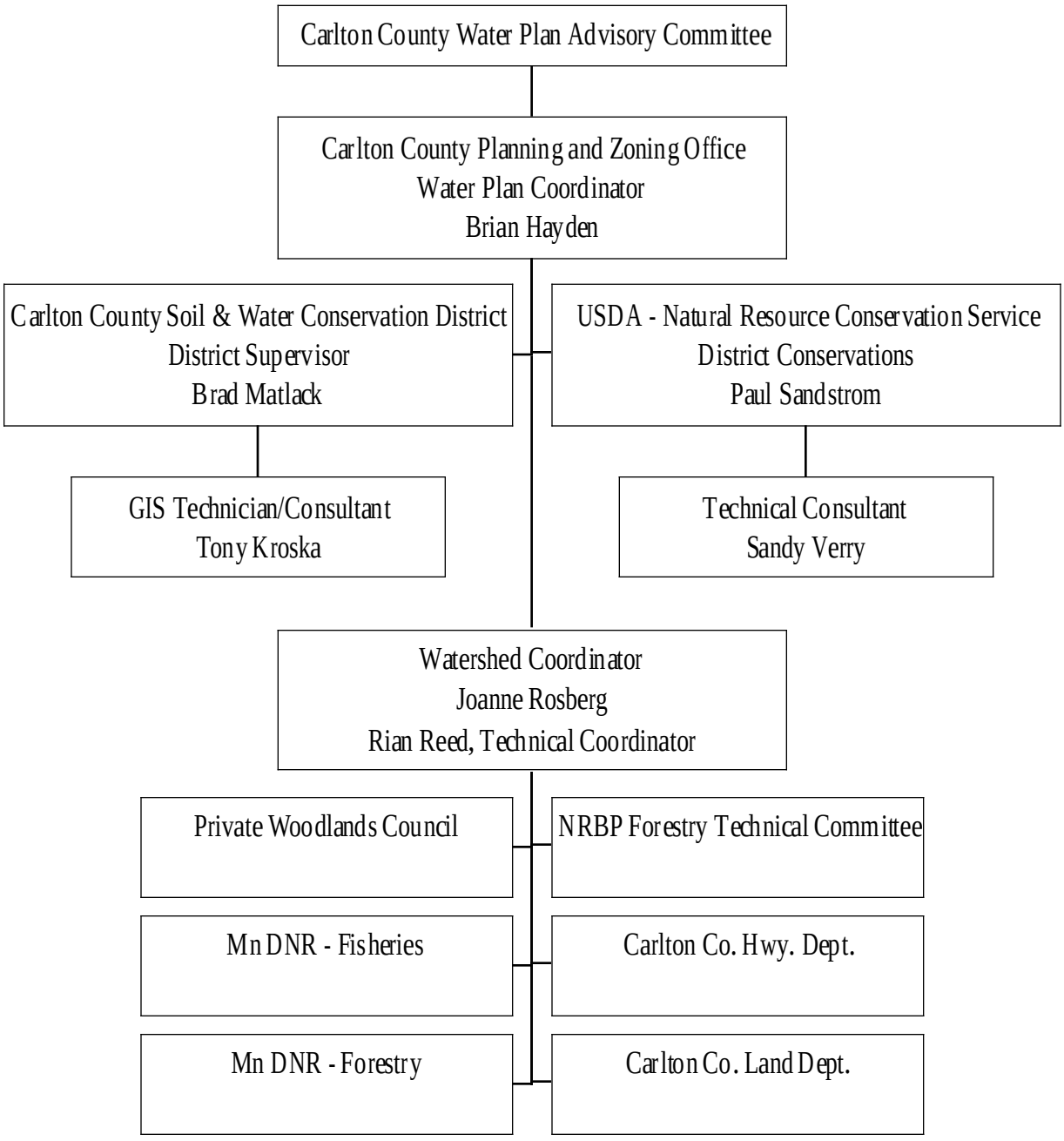
b. Nemadji River Forestry Committee

The Forestry Committee will meet two times a year to review land-sat comparisons to the previous year. If, at any time during the year a need arises, the Forestry Committee will be called to meet and determine the urgency and solution to that need.

Paul Sandstrom: District Conservationist, Natural Resources Conservation Service, Duluth
Paul Flynn: Minnesota Forester, Natural Resources Conservation Service
Tom Cogger: District Conservationist, Natural Resources Conservation Service, Douglas County, Wisconsin
Milo Rasmussen: Land Commissioner, Carlton County Land Department
Sandy Verry: Forest Hydrologist, North Central Research Station
Dave Eggen: Forestry Consultant, Woodland Stewardship Consulting
Brian Hayden: Carlton County Water Plan and Zoning
Tony Kroska: Consultant, Community GIS
Dick Moore: Land Commissioner, Douglas County Forestry Service Wisconsin
Kelly Smith: Conservation Technician, Carlton County Soil and Water Conservation District
Lew Castle: Forester, Potlatch, Cloquet
Marty Wiley: Forester, Department of Natural Resources, Moose Lake
Pete Cooper: State of Minnesota Hydrologist, Natural Resources Conservation Service, St. Paul, Minnesota
Eli Sagor: University of Minnesota Extension Educator, Forestland Ecology and Management, Cloquet Forestry Center
Mike Reichenbach: University of Minnesota Extension Forest Educator, Forest Economic Development, Cloquet Forestry Center.
Rian Reed: DNR Watershed Technical Coordinator
Joanne Rosberg: NRBP Coordinator

Additional Advisory and Interested Persons include those listed in the *Nemadji River Basin Project Report*

NEMADJI RIVER BASIN PROJECT



3. Nemadji River Basin Project Coordinator Responsibilities (Joanne Rosberg)

Facilitates and coordinates project planning meetings, education and communication, coordinates forest management efforts, and riparian restoration efforts within the watershed.

Specific Duties:

1. Disseminate the NRBP information, which includes the NRBP Executive Summary and Report, to essential stakeholders including nine township boards, two municipalities, the Carlton County Board, and civic organizations such as Trout Unlimited and Arrowhead Fly Fisherman Association, Lake Superior Steelhead Association, Conservation Classes in all Carlton County schools, High-school libraries and community libraries, private and corporate landowners.

    Accomplishment: To increase project awareness throughout the public and private community and insure participation through the Citizen and Technical Committees.

2. Present educational information to each of the above list of organizations as an effort to educate and involve the public in the project.

    Accomplishment: To conduct at least seven public presentations per year.

3. Edit and distribute press news releases pertaining to NRBP activities and project status six times a year. To be disseminated to five local news papers (Moose Lake Star Gazette, Arrowhead Leader, Cloquet Journal, Cloquet Pine Knot, and the Duluth News and Tribune).

    Accomplishment: On-going public education through local news media pertaining to the project's status, progress and successes.

4. Facilitate meetings with NRBP Forestry Technical Committee. The purpose of these meetings is to facilitate the dissemination of the identified areas of concern (sub-watersheds with percent open space approaching or exceeding the recommended 40% open land use) to resource managers. Areas of concern will be identified by utilizing the Land SAT photo imagery (see GIS tasks for details.)

    Accomplishment: Conduct two meetings per year with the Forestry Technical Committee.

    Responsible Party: NRBP Coordinator, DNR Forester, University of Minnesota Forest Ecologist

5. Coordinate riparian zone management (as defined in the NRBP report) to maintain the physical continuity of the zones. The riparian zone management recommendations in the NRBP Report will be used as guidelines for the task. Tasks include encouraging voluntary landowner participation with livestock management and timber management. Management tasks include establishing livestock exclusion fencing, re-vegetation and erosion control activities. Contacts with local landowners will be established through educational programs and materials (as outlined in this plan) and one on one contact with individual property owners by the NRBP coordinator and the SWCD soil conservationist. Target goal of contacting at a one-on-one level at least 60 landowners per

year.

Accomplishment: Contacting at least 60 landowners per year to pursue riparian area management.

Responsible Party: NRBP Coordinator, Carlton County SWCD

6. Discuss future timber management road construction needs with major landowners, State, County and Potlatch Corp., to determine if shared or jointly maintained management roads could be established. The Coordinator would compare the future road needs of the listed parties and determine if any shared or jointly maintained roads could be established.

Accomplishment: Establish a dialog between the listed landowners to optimize future logging and timber management road construction needs.

7. Review the timber sale contract specific to red clay soil areas with DNR Foresters who are responsible for developing state and private timber sales within the Nemadji Watershed. After reviewing the contract, modifications and or additions will be recommended to the DNR. Distribute "Sustaining Minnesota Forest Resources: Voluntary site-Level Forest Management Guidelines" which contains the DNR BMPs for logging in "Red Clay" areas and other watershed specific BMPs.

Accomplishment: A timber sales contract to be utilized for timber sales within the watershed that incorporates watershed specific BMPs and concerns to minimize erosion and peak flow conditions.

Responsible Party's: DNR Forestry, NRBP Coordinator, University of Minnesota Extension Education Programs in Forest Economic Development and Forestland Ecology and Management, University of Minnesota Department of Forestry and Carlton County SWCD.

8. The successfulness of the watershed restoration project is a long-term process requiring continued funding for coordination and restoration activities. Seeking and preparing grant/funding requests for proposals will provide financial assistance for the continuation of this project.

Accomplishment: A minimal of two proposals per year will be prepared and submitted to the appropriate organizations for continued funding for the project.

9. To disseminate (via bulk mailing) bi-annual NRBP Watershed newsletter to all stakeholders including private landowners, forestry industries, state, federal and local agencies and civic organizations. Articles will include current watershed activities, status of ongoing projects, and other issues involving the watershed project. Development of the newsletter will be accomplished in cooperation with Northshore Communications and will include editing, printing and distribution of the publication twice a year.

Accomplishment: Distribution of approximately 800 copies per issue of the newsletter to increased project awareness and support.

10. A Technical Committee will meet quarterly to advise and provide direction to the NRBP Coordinator. The Technical Committee will also review and prioritize prospective restoration projects based on the technical merits of the project in achieving the goals listed in the NRBP Report. The Technical Committee is listed elsewhere in this work-plan.

Accomplishments: Provide technical oversight and guidance for the project.

4**. Nemadji River Basin DNR Watershed Technical Coordinator Responsibilities: (Rian Reed)**

Coordinates project activities as they relate to the technical portions of the work plan, under the guidance of project committees and technical support personnel. The Technical Coordinator will provide a 20%-30% of full time commitment through the first year of the work plan and include at least 500 hours of commitment. Specific duties are outlined in the work-plan action items. The Technical Coordinator will assume an increased role as site-specific projects are established.

Duties Include:

1. Works directly with Project Coordinator (Joanne) to assure projects are completed within the framework of the work-plan and within budget.
2. Applies for project grant funds and assists Project Coordinator and others in grant applications.
3. Works with Technical Support Personnel to assure success of restoration and management projects.
4. Reports project implementation activities to the Technical Committee for their review.
5. Reports and provides information to the Forestry Committee to assist in watershed timber management goals.
6. Works with GIS Consultant to adequately assess timber and erosion inventories.
7. Uses GIS inventories to assist in future management projects and timber harvest levels.
8. Conducts water quality and biological monitoring.
9. Works with local SWCD, Water Plan Coordinator Forest Stewardship Program Coordinator and NRCS to assist in private lands management.
10. Assists with fishery stream surveys and erosion inventories.
11. Works with area fishery managers to determine the most appropriate management or restoration at specific fishery protection sites.
12. Works with Public and Private Industrial land managers to maintain timber harvest levels within goals of project.
13. Coordinates communication and technical aspects of project restoration activities.

B. NATURAL RESOURCE INVENTORIES

An inventory of potential causes of erosion and a prioritized list of projects are necessary to address the soil erosion in the Nemadji Watershed in a manner that will achieve our goals in the most efficient manner. A main focus of these inventories will be to look at areas on a smaller subwatershed scale (i.e. areas within sub-watersheds as small as 1 square mile) and to identify priority areas based on the percent of open land, severity of erosion and impacts to natural resources or existing roads, bridges, culverts and highways. The intention of the inventories is to provide information to make decisions as to the causes of hydrologic change, identify erosion areas and to provide a means for determining where to focus management efforts.

1. FOREST COVER INVENTORY (%OPEN)

The main cause of increased bankfull flow discharge rates and associated channel downcutting, erosion, sedimentation and turbidity are because of past (since European Settlement) land use changes. The old growth coniferous forest conversion of evergreen to poplar forest causes greatly increased water yield. This includes clear-cut logging and agricultural activity that creates a hydrological response similar to that of open lands. Impacts can occur in watersheds as small as one (1) square mile if more than 40% of its land is in an open (pasture or young forest) condition (S. Verry personal comm.1999).

Open can be referred to lands that have been clear cut and are less than 15 years old, open agricultural lands, lawns, parks, or older agricultural lands that have been partially reforested through natural succession.

Outcomes of the forest cover inventory will be to provide a historic perspective of subwatershed conditions as they were pre 1970 and to provide a more current assessment of conditions as they relate to the past 15 years. When smaller sub-watersheds are drawn, the inventory will provide a better perspective of how or why impacts are occurring on a smaller scale. Our target is to maintain these smaller sub-watersheds in a 40% or less open condition.

In the future with proper planning within sub-watersheds we will know what areas can be safely harvested based on knowledge from up to date information.

a. Conduct a historic (pre 1970) inventory of all lands.

- Features such as open agricultural fields in the watershed should be identified. Some of these lands have sparse canopies and are considered forested; however the hydrology of these areas is more similar to open lands. Use sources such as county land economic inventories developed around 1928, USGS Quadrangle Maps 1:24000 or old photographs.

Timeline: September-November 2000
Responsibility: DNR Fisheries Area Supervisor
Accomplishments: Inventory of historic open lands that now have a sparse canopy such as low-density brush species or low-density timber stands. Consider them open.
Projected Time Commitment: 80 hours In-kind Fisheries

- Digitize information into Arc View Layer.

Timeline: November 7-15, 2000
Responsibility: GIS Consultant
Accomplishments: Arc View GIS Layer of historic open lands
Projected time commitment: 50 Hours
Cost: @ 30.00/hr = $1500.00

b. Conduct an inventory of more recent (early 1980's to present) public, private industrial and private landowner harvested lands by receiving Land SAT Imagery (1983 - 2002) in one year Intervals.

- Purchase Land Sat Layers
- Geo-reference 19 images using 60 control points
- Use Land SAT and other GIS land use inventories to identify yearly harvested areas, as well as open lands, development or other land use types in the watershed.
- Presentation of maps and other GIS information to Forestry and Technical Committee meetings

Timeline: June 12, 2000 - January 30, 2001
Responsibility: GIS Consultant.
Accomplishments: Purchase images, Geo-reference images, identify open land use areas, and present the information to the NRBP Forestry and Technical Committee
Projected Time Commitment: 19 images @ 3days/image

Cost: Purchase Land Sat Images - 19 images @ $425/image = $8,099.00 (in-kind)
Cost: Geo-reference images - 456 hours (3 days/image) @ 30.00/hr = $10,300.00 ($3,410.00 in-kind)
Cost: Identify yearly harvested areas/open lands and other land use types 2 days/image @ 30.00/hr =$9,120.00
Cost: Presenting data to NRBP Forestry and Technical Committee - 3 meetings @ $120/meeting = $360.00

c. Define watersheds within sub-watersheds as small as one (1) square mile.

Nemadji River Basin Project Prioritization of Sub-Watersheds

The following prioritization of sub-watersheds was determined primarily by Percent Open land Coverage with Sediment Load Rates (estimated load per stream mile), Total Sediment Load for the watershed. Skunk Creek and the Blackhoof River sub-watersheds were ranked higher as a result of the existing model development for Skunk Creek and the importance of the fishery in the Blackhoof.

MN SUBWATERSHED	% OPEN LAND	SEDIMENT LOAD RATE
Skunk Creek	30	Med
Upper Blackhoof River	37.9	Low
Blackhoof River/Sandy Lake	36.5	Low
Blackhoof	23.5	Low
Rock Creek	44.3	Med
Clear Creek 1	42.1	Med
Hunter Creek	40.7	Low
Deer Creek	36.0	Med
Clear Creek 2	35.8	Low
Section 36 Creek	36.7	High
Mud Creek	30.2	Med

- Use available topographic imagery to draw increasingly smaller sub-watersheds down to, in some areas, one (1) square mile.
- Provide dimensional area as well as % percent open condition.
- Start on the outside perimeter of the entire watershed and work inward. The outer portions of the Nemadji watershed are flatter and may allow for larger watershed subdivisions. Also it provides an easier method of assessing cumulative land use changes.

Timeline: September - December 2000
Responsibility: DNR Fisheries Area Supervisor
Accomplishments: Smaller sub-watersheds down to as small as one (1) square mile. Provide information to GIS consultant for use with % open and erosion inventories.
Projected Time Commitment. 120 hours @ $25.00/hr = $3000.00
Cost: In-kind DNR Fisheries

d. Rank areas by percent open, starting with one (1) square mile watersheds from highest percent open to lowest.

Timeline: Yearly, beginning January 2001when Land Sat data is available.
Responsibility: DNR Watershed Technical Coordinator
Accomplishments: Ranking of projects.
Projected Time Commitment. 80 hours @ $25.00/hr = $2000.00
Cost: In-kind

e. Future Inventory Management.

- Observe % open condition in previously drawn smaller sub-watersheds using Land SAT Images or GIS inventories for assessing private landowners and overall watershed condition.
- Meet with Technical and Forestry committees to establish forest management guidelines.

Timeline: After Land SAT Imagery is available from *Community GIS* Consultant
Responsibility: DNR Fisheries Area Supervisor, *Community GIS* Consultant, Technical and Forestry Committee
Accomplishments: maintain < 60% open in smaller sub-watersheds
Projected Time Commitment: 80 hours @ $25.00/hr = $2000.00
Cost: In-kind

2. FISHERY, BLUFF AND STREAMBANK EROSION INVENTORY

Inventories for fisheries habitat will be undertaken to identify erosion areas and potential cold-water habitats that have been degraded or have potential to be degraded near the mainstream of the Nemadji River and other tributaries. The objective of the erosion inventory will be to identify specific erosion sites and rank them from the most severe to the least severe.

a. Bluff erosion areas will be inventoried in the Nemadji and it's tributary streams in Minnesota. Erosion severity will be based on slope, width, height and length. A severity ranking will be developed. Incoming stream tributary locations in relation to main-stem will also be noted such as inside or outside of bend and slope. All sites will be photographed. These data as well as location will be entered into GPS. Data points will be applied to GIS database. Inventory will be done by aerial helicopter flight over watershed stream areas.

Timeline: Leaf off October 2000.
Responsibility: DNR Fisheries Area Supervisor, *Community GIS* Consultant.
Accomplishments: Aerial watershed survey, Identification of erosion sites, and photographs.
Projected Time Commitment. 8 hours @ $30.00 = $240.00
Helicopter fee: 8 hours = $1,920.00
Cost: In-kind DNR Fisheries, French River

b. Ground truth erosion sites from Erosion Inventory. Ground truthing will be done to Determine if nearby erosion threatens any fishery habitat. Areas to ground truth are those that currently provide the most beneficial use to trout. They include:

- Main-stem of the Nemadji River
- Tributaries in the Upper South Fork of the Nemadji River, Stateline, Little Net, Anderson and Silver Creek.
- Blackhoof River
- Several locations near the main-stem of the Nemadji River

Ground truthing will be done by snowmobile in the winter, walking or canoeing in the summer depending on access, etc.

Timeline: October 2000-May 2001
Responsibility: DNR Fisheries Area Supervisor
Accomplishments: Identify site-specific fishery information
Projected Time Commitment: 80 hours @ $30.00 = $2400.00 (2 people-5days)
Cost: In-kind DNR Fisheries, French River and Fisheries Technical Coordinator.

c. Placing data points into GIS Arc View Format with site-specific information of entire watershed (within Minnesota).
Timeline: June 2001
Responsibility: DNR Fisheries Area Supervisor, *Community GIS* Consultant.
Accomplishments: Arc View GIS Points and site-specific information

Cost: $500.00 In-kind

d. Production of necessary maps and data for Technical and Forestry Committee meeting purposes.

Timeline: 2001 after forest inventory complete
Responsibility: DNR Fisheries Area Supervisor, *Community GIS* Consultant.
Accomplishments: Maps
Cost: $200 for 36"x 48" map (8"x10" maps, free) = $4,000.00 In-kind

e. Rank erosion areas by highest severity to lowest. Include a separate ranking for fish habitat. Pay particular attention to the location of the erosion area or slump as it relates to the stream longitudinal profile (i.e. erosion, transition or deposition). The location of the incoming tributary stream in relation to the main-stem should be noted. Incoming streams that are located on the outside of a main-stem bend tend to have more severe active erosion. Erosion within stream transition zones and tributaries that enter on the outside of main-stem bends are also difficult to protect.

Timeline: June 2001
Responsibility: DNR Fisheries Area Supervisor, NRBP Technical Committee with the assistance the Technical Support Team.
Accomplishments: A list of erosion sites ranked by severity from highest to lowest as well as a similar ranking of fish habitat areas with erosion. Database of critical sites that will be added as a GIS Layer.
Projected Time Commitment: 16 hours @$25.00/hr=$400.00
Cost: In-kind

f. Future Inventory Management.

- Conduct the same inventory on restored sites one to two (1-2) years after site-specific implementation of restoration. If significant, restoration up steam could also warrant an inventory to see how slumps or erosion have changed and also after a significant amount of land use improvements have occurred in the watershed.
- Conduct Hill-Slope Hydraulic Studies with the assistance of Technical Support Team. Include possible test-plots to stabilize slopes.

Timeline: 1-2 years after site restoration
Responsibility: DNR Fisheries Area Supervisor, DNR Watershed Technical Coordinator, Technical Support Team
Accomplishments: Inventory to guide management
Projected Time Commitment: 16 hours @ $25.00/hr=$400.00 (In-kind)

3. ARMY CORP OF ENGINEERS SEDIMENT MODEL

This model is being developed for application on the Skunk Creek Subwatershed. This model will be useful for developing an understanding of the Skunk Creek Subwatershed as well as a useful application for the rest of the Nemadji River Sub-watersheds.

Training: DNR Watershed Technical Coordinator
Projected Time Commitment: 120 hrs @ $25.00/hr=$3000.00
Cost: In-Kind

C. PROJECTS AND PRIORITIZATION

Watershed restoration projects are intended to improve the overall condition of the watershed and to provide site-specific benefits for habitat or to reduce erosion and sedimentation. Projects will be prioritized based on severity factors from the previous inventories and projects will be carried out in those areas in need of greatest protection or restoration.

1. PRIORITIZATION

The GIS person with the assistance of the Technical Committee and Scientific Research Personnel (Technical Support) will use the inventories as a means of identifying a priority list of restoration projects.

Other factors will determine whether specific projects will actually take place such as: landowner cooperation, restoration potential, location or other factors. Specific project site work-plans will be developed once priority sites have been identified and landowner cooperation has been established. Priority projects will be identified from the previous inventories and rankings. The following preliminary initial prioritization method will be used.

a. Use the Percent Open Forest Inventory ranking as a means for maintaining < 40% open in each small subwatershed.

b. Use % open inventory with fish habitat erosion inventory and feedlot inventory as an assessment tool. Determine if any correlation's, or cause and effect situations exist.

Prioritization of project sites will be based on the best professional judgment from the available inventories.

It will be important to begin assessing inventories and conditions beginning on the outer watershed fringe and working inward. It is also important to note that areas within the transition zone (mid gradient region, area of increased slope) of the stream gradient may be more severely eroded because of higher stream velocity and water volume; however, they are the most difficult and expensive to repair. Upstream areas should be managed to reduce erosion on these sites and creating a new channel with a floodplain can be considered if there are threats to infrastructure. The Technical Committee and Technical Support Team will review the inventory information as well as any additional information if available such as the Army Corps Sedimentation Model, (see item #3 above) and will give additional attention to those sites that have the following attributes and fall into the five (5) priority management areas.

- Areas with the greatest percent of open lands.
- Cattle grazing or open agricultural areas being more significant because of increased runoff of up to 50% and the possibility of changing channel structure from cattle use.
- Riparian Zones in need of reforestation or coniferous conversion located in a manageable area of the stream longitudinal profile.
- Stream Trout habitat. (will be a higher priority depending on significance)
- Threatened existing roads, culverts, homes, etc. (can be a higher priority depending on significance).
- Failing existing dams or stream structures previously installed to reduce erosion or provide

hydrologic or biological benefits to stream.

Timeline: July-August 2001
Responsibility: DNR Fisheries Area Supervisor, Technical Committee and Technical Support Team
Accomplishments: Provide a prioritized list of areas to implement water yield reduction activities (timber harvesting, tree planting) erosion control projects, and educational activities.
Projected Time Commitment – 80 hours @ $30.00/hr= $2,400.00
Cost: In-Kind

2. RESTORATION OR LAND USE MANAGEMENT PROJECTS

Restoration and Land Use Management Projects will be undertaken on the above prioritized project areas or sub-watersheds. Some projects may require immediate attention due to their severity or threats to roads, culverts and bridges.

a. Land use management

- Develop watershed timber harvest management guidelines priority areas and to maintain 40% or less open.

Responsibility: Technical Committee. NRBP Coordinator and UMn. Extension Forest Educator
Accomplishments: Maintain watersheds in <40% open condition.
Timeline for prioritization:
Commitment – 80 hours

b. Spring Creek/County Hwy. #6 Project- See attached work-plan developed by Carlton County Hwy. Dept. engineers and Dr. Sandy Verry, Forest Hydrologist, Grand Rapids.

Accomplishment: Habitat improvement and bank stabilization. Restore Spring Creek above the confluence of Spring Creek and Blackhoof River where Spring Creek flows through two four feet in diameter by 66 feet in length culverts. One culvert is corrugated metal and collapsed the other is concrete and deteriorating. Spring Creek is a DNR designated trout stream and at present trout cannot migrate upstream to spawn. Restoration will involve removal of present culverts and replacing them with two (2) culverts measuring 7.5 feet in diameter by 138 feet in length and baffled. Baffles inside the culverts will allow trout to move upstream for spawning.

Permits: Responsibility of the DNR State Fisheries Coordinator, Carlton County Hwy. Department
Timeline: June 30, 2001 Completed
Responsibility: Carlton County Highway Department, Mn DNR Fisheries, Carlton County SWCD.
Cost commitment: $13,000.00 (Balance In-kind)

c. Pauly Tree Planting

Scott and Jeanine Pauly, 844 Sheetz Road, Wrenshall, Mn. 55797

See Attached Pauly Tree Planting Plan of Work
Accomplishments: Tree Planting, Forest Improvement, Upland Wildlife Habitat Improvement and Management.
Hardwood site prep and planting-3.5 Acres
Softwood site prep and planting – 15.5 Acres
Weed control – 19 Acres
Forest Improvement – Release chem/mech – 14 Acres
Upland Wildlife Habitat Management: Site prep, Trees, Weed control – 4 acres
Permits: landowner responsibility
Responsibility: Private land owners with assistance from Carlton County Soil and Water District
Timeline: To be completed by May 15, 2002
Cost: Total Cost: $14,661.00
CWP commitment: 75% = $11,500.00

d. Blackhoof River Stream Bank Stabilization

Lunker structure erosion control
Responsibility: DNR Fisheries
Timeline: Summer 2000
Cost: Total Cost: $30,000.00 (In-kind)
Erosion Control using trees/shrubs
Timeline: Spring 2001
Responsibility: SWCD, Nemadji Coordinators
Cost Commitment: CWP $1,000.00

e. Agriculture (manure) Waste Removal (Silo)

Locate buyer/buyers for the waste material
Pumping and spreading of manure
Permits: Landowner responsibility
Responsibility: Landowner, Carlton County Soil and Water District
Cost: CWP reimbursement $3,000.00
This project is on hold until landowner participation is established.

f. Other important projects will include:

- tree plantings
- reduce grazing in overgrazed areas and riparian areas
- stream bank stabilization/protection
- stream monitoring

See Carlton County Soil and Water District Assignment and Acceptance form “Conservation Practice Technical Approval Authority” for Quality Assurance Plan.

D. MONITORING

1. MONITORING PLAN

Purpose

The purpose of the monitoring plan is to provide a sound approach to understand the non-point source pollution entering the river system and therefore be able to propose realistic implementation strategies.

The monitoring plan will extend over a two year period- the 2000 to 2002 water season.

2. QUALITY ASSURANCE PROJECT PLAN (QAPP)

Data Handling

Protocols for data handling and reporting must be included in a Quality assurance program to gain an accurate understanding of water quality conditions.

The complex nature of the information flow from the Nemadji River system will require the development of large databases. Some of the sources of data include Carlton County landuse data (GIS), Carlton County SWCD, USGS flow data, MPCA flow data, volunteer stream flow monitoring, RiverWatch, the GIS Consultant, Landsat digital imagery. These data include chemical data, quality control samples, hydrologic data, climate data, field data, land-use data, and topographic data.

Programmable field loggers (Campbell CR10) and ISCO Flow Meters are used to collect stream discharge data and control storm event samplers (ISCO 2900). EXCEL spreadsheet package is used for data storage, retrieval, and reduction.The word processing package, WORD PERFECT __ is used to generate reports and documents. Several spreadsheet templates, macros, translating programs and report procedures were also developed to reduce, transfer, and report the data.

Each participant must submit quarterly (every three months) updates of Project activities that have occurred in the Project will be reported to the Project Sponsor. These summaries shall be written in language and presentation suitable for understanding by the general population of the watershed. Progress as to the approved Work Plan milestones shall be noted along with written summaries as to work not completed and problems encountered by the Consultant- in these quarterly updates.

Backup diskettes are dedicated to each subdirectory , or file if large enough, and files are copied when changes are made. A backup of the entire hard disk is made weekly. All sampling sites will be identified according to STORET requirements and the data will be transferred to STORET automatically using a Lotus template. Copies of the STORET output will be edited for accuracy.

Sample Collection and Flow Analysis

River stream sampling and analyses of stream data will be conducted by the Project Sponsor. This primarily relies upon the use of total phosphorus performance standards several times over the sampling seasons. Water flow quality assurance protocols will follow either the USGS or MPCA protocols depending upon the source of the flow data. The following Quality Assurance/Quality Control (QA/QC) Plan supports the general laboratory QA/QC plan and will be amended to specifically support the Jefferson-German Water Quality Improvement Project.

Project Organization and Assignment of Responsibility

The specific project responsibilities are outlined in the Project Work Plan. QA/QC responsibilities are listed in the QA/QC document provided by ERA Laboratory. See Attached ERA Document.

1. Quality Assurance Objectives:

The primary QA objectives for this project are to:

a. collect representative samples
b. produce meaningful data
c. in the event of errors, identify and correct them

From published methods, QA/QC guidelines and previous experience, the objectives for precision, accuracy, and completeness for each analytical parameter is given below.

2. Sampling Procedures

At every sampling period, one in-lake sample site will be sampled in duplicate. All samples will be collected using approved (EPA, USGS,etc.) methods and sampling devices. Samples will be transferred from sample collection device to pre-cleaned polyethylene or glass bottles. Bacteriological samples will be collected in sterile glass, polypropylene or polycarbonate vessels. All water sample containers will be cleaned by washing with a suitable laboratory detergent (Labtone, VWR) and rinsed with distilled deionized water. Distilled water quality will be monitored by conductivity with a quality control objective of <2 megohms. Sample bottles will be fitted with blank labels in the laboratory. Labels will contain a numerical code to coincide with the data transmittal form, sample description, site number, date, time, and where applicable, type of preservative.

3. Analytical Calibration and Standardization Frequency:

Each instrument (spectrophotometers, Ph meters, balances, Gas Chromatographs, etc.) in each laboratory will have calibration, standardization, and maintenance documents. Calibrations and standarizations will be done in a manner and frequency consistent with the manufacturers recommendation and per methods specifications. All thermometers used to

record temperature in refrigerators, incubators, water baths, etc. will be calibrated with a certified thermometer traceable to NBS. A maintenance and calibration log will be maintained on each item.

4. Analytical Methods:

The methods used in this study are derived from method manuals published by the APHA (1985), EPA (1982 and 1986), and/or USGS (1977).

5. Data Reduction, Validation and Reporting:

All raw data will be transcribed to the data transmittal form and stored in a binder notebook. Where applicable, the data will be organized electronically and filed in the U.S. EPA STORET Database. Statistical analyses on replicate samples will be properly recorded so that the degree of certainty can be estimated.

All data will be reviewed by the faculty supervisor on the project and signed by the analyst. The copies of the data transmittal form and all pertinent records or references to calibration, standardization, and maintenance will be archived.

6. Internal QC Checks and Frequency:

Where applicable, internal reference standards will be analyzed and recorded with each sample run. External reference standards and standard reference material obtained from EPA, NBS or an approved provider will also be used. All stock standard solutions will be properly labeled, stored, and expiration dates visibly recorded on the label. The measured data for the certified standards must fall within the specified range as given by the provider or corrective action will be taken.

7. Performance and System Audits and Frequency:

It is the goal of Environmental Quality Laboratory to apply for state certification, in standard water chemistry, by January 1992. As such, the laboratory will seek performance standards and be open to audit by the MPCA, the MN State Health Department, and the U.S. EPA.

8. Procedures to Assess Data Precision, Accuracy, and Completeness:

Standard statistical procedures, such as analyses of variance, standard deviation and normalcy of data, will be applied to replicate samples and reference standards to define variability and repeatability.

9. Corrective action:

The internal quality assurance unit as described in the standard operating procedures will be performed periodic checks pursuant to item 4 above. Remedial action will be taken whenever quality control samples fall outside of the recommended guidelines. Decision to take remedial action will be mutually decided on between the laboratory manager, faculty supervisor, and the program coordinators.

10. Quality Assurance Reviews:

A quality assurance unit will be assembled to hold periodic reviews of laboratory QA/QC performance and to discuss progress, problems, and recommend remedial action if necessary. The laboratory manager will develop a quality control report format.

QA/QC Responsibility

Task	Responsible Person(s)
Overall Project Decisions	Joanne Rosberg
Overall QA/QC	Rian Reed
Field and Sampling Activity	Rian Reed and Bruce Wilson
Sampling QC	Rian Reed
Laboratory Analyses & Lab. QC	
Environmental Qual. Lab	Lab Manager
Data Processing	Rian Reed
Data Processing QC	Rian Reed
Performance and System Audits	

Quality Assurance Objectives

Water

Parameters	Precision (S.D.)	Accuracy (%)	Completeness (%)	Detection Limit
Total Phosphorous	2.5	>98	>98	20 ug/l
Total Kjeldahl-N	20.0	>98	>95	100 ug/l
Ammonia-N	5.0	>90	>95	10 ug/l
Nitrite + Nitrate-N	20	>90	>95	20 ug/l
Chlorides	5	>92	>95	50 ug/l
TSS	5500	>95	>95	1.0 mg/l
Alkalinity	4.6	>97	>95	1.0 mg/l
Dissolved Oxygen	0.1	>99	>90	0.1 mg/l

Parameters	Precision (S.D.)	Accuracy (%)	Completeness (%)	Detection Limit
Total Phosphorous	2.5	>98	>98	20 ug/l
Conductivity	8.5	>99	>95	5uohm/cm
Chlorophyll-a	8.0	>95	>95	5 ug/l
Ph (s.u.)	0.1	>99	>90	0.05 U
Temperature	1.0	>99	>95	0.5^{o}

In-Flow Storm Event Monitoring

Sample Collection

Disposable sampling bottles are used for all sampling in an effort to reduce systematic error, with the exception of the automated storm event bottles which are cleaned and rinsed after every use. Samplers and sample hoses are rinsed with sample water prior to individual samples taken. All samples are promptly removed from sunlight and kept cool during transport with any preservatives added to specially labeled bottles prior to sampling. Three bottle types are used: 1) white label, unpreserved; 2) yellow label, sulfuric acid preserved (2ml); 3) red label, nitric acid preserved (2ml). The nitric acid preserved bottles are for metal analysis, the sulfuric acid preserved bottles are for total nitrogen and total phosphorus analyses, and the remainder of the analytes are analyzed on the unpreserved samples.

Hydrology

Procedure

The stream ratings were developed by mathematical relationships between water levels (gage) and discharge measurements and are dependent on stable control structures. All control structures are equipped with staff gauges and tied into known bench marks using standard leveling techniques.

Stream height vs discharge ratings are developed by stream measurement methods using current meters and dye dilution. Ratings are derived from log-log regression analysis using stream measurements form each site. The measurements are made using either a pygmy or a standard current meter depending on the magnitude of the flow. Duplicate measurements must agree within 5% and "outlier" data are not used in the rating estimates.

The stream measurements are entered into a Lotus spreadsheet (Discharge.wk1,) and resulting discharges with their corresponding gage readings are saved automatically into site specific ASCII files. The stream rating equations are entered into their prospective field datalogger programs and

composite sheets (Composite.wk1) to compute and store discharges every fifteen minutes and determine compositing volumes, respectively. Automated sampling sequences are initiated by the dataloggers based on a positive change in stream height of 0.05 ft or more within one hour. Once the sampling sequence is initiated, 24 samples will be taken regardless of ensuing rainfall or flow conditions. In determining when to initiate an event sampling sequence, two possible errors are possible: 1) sampling a non-occurring storm, and 2) not sampling an occurring storm. The above methodology reduces the possibility of the latter, more serious, error.
Annual mass loading estimates are derived form substance concentrations, corresponding flows and the average daily flows for the time period using FLUX (Walker, 1984.)

The non-point hydrologic data are downloaded on a monthly basis to the laboratory computer (PC 386). Each datalogger records and stores approximately 3,000 records of information per month and requires a detailed downloading procedure to insure the safety of the data. The data are initially transferred to a storage module (Campbell Scientific) which is read into the laboratory computer using the software package PC208 (Campbell Scientific). The ASCII files are stored in individual subdirectories (subdirectories of PC208 directory) named for each site. The data are then translated into Lotus software and stored in subdirectories also named for each site. Each month the ASCII files in PC208 are replaced with the current data. Using this technique, Lotus translating programs automatically access the specific file for each site. The translated Lotus databases do not replace previous databases in each site directory, however, and are named instead for the current month, stored and merged annually.

When downloading the dataloggers, the task of editing thousands of records by hand is unreasonable. Graphs of the average daily discharge are produced automatically (Graph.wk1) and compared with rainfall records for anomalies. Lake system water balances (Balance.wk1) are performed monthly with each download to estimate the total water balance error. The records of the download periods are kept in a separate ringbinder. Standard operating procedures for data downloading are included as Appendix H

Error in Stream Flow Measurement

Nearly all non-point watershed data are dependent on stream discharge estimates which are used, in conjunction with substance concentrations, to determine annual mass loadings from the local watershed. The multi-step procedure involved in determining discharges and resulting loading estimates illustrates the large number of possible error sources and their composite effect.

Estimating the variability of each step is difficult and certain assumptions have to be made. Stream rating errors are calculated from the regression equations used, but the total error includes the error of the individual flow measurements used to make the rating. Variability in stream estimates are characterized by duplicate measurements, and the accuracy of the current meter is addressed largely by factory recalibration on a biannual basis. For these reasons, much of the error must be assumed to be minimal and addressed largely by assurance documentation. Storm event samples are composited on a flow-weighted basis with site-specific bottle selection schemes that are based on

initial hydrograph characterizations and are repeated with each storm. The sampling schemes are intended to represent the entire storm event. Any error associated with the sample bottle selection would be made on a consistent basis and would represent bias in the event load estimate. The magnitude of the bias would be proportional to the storm event frequency.

Errors in stream measurements, discharge rating regressions, loading calculation methods and analytical measurement can be characterized directly, but the additional components of the total error are more difficult to access. Variability in stream gaging apparatus (floats, potentiometers, etc.), sample collection apparatus, sample bottle selection, sample compositing and data handling, although minimized by a good quality assurance program, are difficult to evaluate.

Components of the total error associated with different collection and measurement activities are thought to be independent of each other and equal in magnitude (Micha, 1988.) Much of the error involved, if normally distributed, would cancel out and the limiting sum of these positive and negative variations would be their mean value. Any cumulative bias involved in the measurement process would become a component of the mass balance error.

3. HYDROLOGIC MONITORING

The hydrology component is extremely important to the project. Precipitation, evaporation, and mainstem Nemadji River flows are necessary to establish long-term water quality trends. Stream flows prepared by the USGS at Deer Creek, and if possible to reactivate the Nemadji River near South Superior, Wi, with the site ID of 04024430. Additionally, the MPCA has reestablished a continuous flow gauging site at the Hwy 23 bridge crossing which was formally operated by the USGS. The MPCA will provide this data to the project.

The general purpose of a monitoring network is to determine the condition of the Nemadji River and it's major tributaries. There are specific reasons to monitor streams.

- Begin long-term monitoring of flows from the North and South Forks and at their confluence prior to discharge into the Superior Bay.
- Identify water, sediment and nutrient loss rates along the Nemadji River basin: Identify river water quality patterns by river segment.
- Begin basin management efforts and understand cause and effect relationships between water volumes, slump/wastage areas and stream sites.

Continuous water quality and or fishery (biological) monitoring sites are also necessary to measure the long term changes in stream quality and to monitor several restoration sites designed to improve localized water quality or fishery (biological) habitat

4. WATER QUALITY MONITORING

a. Limitations on the Monitoring Network

The monitoring work will be limited to a number of stations that can practically be visited on a regular basis. This means using available staff, volunteers and funding.

b. Proposed Approach

There is limited long-term water flow and chemistry data for the Nemadji River. Biological data are very rare. Hence, we need to establish additional stations. The emphasis is upon pooling of resources of several groups that will allow very cost-effective monitoring if all parties complete their tasks.

We are proposing a phased approach to this starting simply and getting more complicated as resources allow and needs dictate. The first phase is to design a simple monitoring network using as few stations as possible but tat can still allow us to describe and assess conditions or detect trends. More stations will be added as needed

The basic station refers to (1) a microcomputer that continuously records water levels in the stream that can be converted to flows and (2) the location for obtaining samples of river water (for nutrients, sediments, bacteria, oxygen etc.). Grab sampling of river water will be conducted with an emphasis upon sampling across all seasons and flow patterns. It may be necessary to add more complicated and labor-intensive remote samplers to deal with the "flashy"/complicated flows of the Nemadji River. Grab sampling means getting a sample from a marked location on a bridge along with monitoring of dissolved oxygen and other parameters using computerized multi-parameter sensor devises. It is recommended that telemetry (e.g. a type of cell phone) connection be installed at each of the flow gauging stations in order to dramatically reduce personnel and travel expenses.

c. Scientific Basis for This Approach

A large part of the scientific foundation for watershed management is based on the mass-balance approach. The amounts of water passing a given location (e.g. flow) carry certain amounts of dissolved and particulate materials such as sediments and nutrients (or concentrations). Multiplying flow by concentration give us pounds of pollutants at that monitoring site. The benefit of a mass-balance approach is that we be able to characterize the total pounds of pollutants per year (or season) at any point along a river system. Putting a series of monitoring stations strung together along a river basin allows creation of a large "check book" balance of pollutant quantities, and, by difference the amounts of sediments and pollutants entering the river between stations. The rates of pollutant loading occurring can be compared with other basin areas and to other similar areas of Minnesota to develop short and long- term management goals.

d. Priority Monitoring Stations

This first phase consists of installing or using existing sites to create a simple flow-monitoring network of sites at the mouth of the Nemadji River at Superior and at the Highway 23

site in the Minnesota portion of the main-stem river. The USGS may continue to monitor the Deer Creek site that will be the focus of long-term watershed rehabilitation efforts.

1. Nemadji River, CSAH 23. Characterizes the upper reach of the Nemadji River above Deer Creek. The MPCA has purchased an ultrasonic flow sensor, flow gauging equipment, Campbell Scientific data-logger and automated sampling equipment for this site. The project will need to purchase sampling box (green box) and pay for telemetry. MPCA staff have committed to reduction of the data if telemetry is used on the Highway 23 site.

2. Deer Creek. The USGS station will be relied upon to provide data from this watershed. All flow gauging will be accomplished by the USGS without funding from this project. Sampling will need to be conducted by the project as outlined in the attached spreadsheet.

3. USGS site at Superior. Data is not being collected from the USGS monitoring site at the mouth of the Nemadji River in Superior. $2000.00 per year will be required to reactivate data collection to obtain daily average flows.

e. Macroinvertebrate Monitoring

Macroinvertebrates can be used as indicators of long-term trends in stream conditions. The numbers and types of macroinvertebrates (invertebrate diversity) in a section of stream will be compared to what might be expected in a similar stream that is minimally affected by human activity. This provides a measurement of how well the stream is able to support a variety of life forms, including fish. Since macroinvertebrates respond strongly to oxygen levels in the stream, a period of low oxygen in the stream can change the make-up of the macroinvertebrate community. At the same time, recovery of a stream reach that was damaged by low oxygen can take place rather quickly once conditions return to normal. Using macroinvertebrates can complement chemical monitoring methods because the macroinvertebrate community provides an index of long-term trends in the river and is a direct measurement of the impact of pollution on life in the river.

Macroinvertebrate Sampling Approach

The Minnesota Pollution Control Agency gathered macroinvertebrate data in 1999 from six (6) locations in the Nemadji River watershed as part of a research study of the Lake Superior Basin. The study will develop information to predict changes in the macroinvertebrate community based on the types of land uses in a watershed. More developed watersheds tend to have fewer types and smaller numbers of macroinvertebrates than undeveloped watersheds.

Staff from the MN PCA conducted the data collection effort, which was completed using MPCA standards. In total six (6) macroinvertebrate sampling locations provide a baseline characterization of biological conditions in the Nemadji River watershed. Since the Nemadji main stem is heavily impacted by erosional processes, there are no pristine areas to serve as minimally impacted reference stands. In macroinvertebrate studies, a reference stand is chosen to represent the portion of a river that is least affected by agriculture, human settlement, and other human uses.

Timeline: Monthly, May - October
Responsibility: DNR Watershed Technical Coordinator, MPCA
Accomplishments: Establish baseline conditions for long-term evaluation of the Nemadji River Downstream of Managed areas.
Projected Time Commitment – Sampling 40 hours/yr/site

Stream monitoring before and after projects
Responsibility: NRBP Technical Committee
Accomplishments: Document success or failure of selected projects
CWP commitment: $1000.00

5. FISHERY OR BIOLOGICAL MONITORING

a. Conduct Stream Surveys on 30 miles of streams/year based on Minnesota Stream Survey Manual, Special Publication No. 120, MNDNR Division of Fish and wildlife, Section of Fisheries. Information gained from these surveys include but are not limited to fish species present and numbers, stream invertebrate counts, habitat suitability, etc. The information will be used to determine the relative importance of the stream for trout habitat.

Timeline: May15 to August 31, 2000-2002
Responsibility: DNR Area Fisheries, French River
Accomplishments: Three separate monitoring years to determine fish species present and numbers, stream invertebrate counts, habitat suitability on the following streams.

30 miles of the Blackhoof
22 miles of the Big Net (14) and Little Net (8),
27.5 miles on Stateline (8), Anderson (6), Silver (5), Clear (so. Fork) (5.5), Stony (3).

Projected Time Commitment: Two (2-3) people @ 30 miles of stream/year
Cost: In-Kind - total equipment and personnel $139,360.00

b. Establish Macroinvertabrate ambient monitoring sites.
River Watch Project in cooperation with the St. Louis River Watch Project.
Barnum School: four (4) sites on Blackhoof River, Hardings Hill Sand Banks where DNR plans restoration and lunker structure, up and down stream of future construction site, up and down stream where I-35 crosses a stream that enters the Blackhoof. Fourteen (14) students
River Watch, Carlton, Esko and Wrenshall schools suggested sites - Spring Creek and Blackhoof River, Hwy. #23 at Nemadji River, Deer Creek up stream and down stream from electronic flow meter and Hwy. #23 bridge crossing. Number of students unknown.

Timeline: Monthly, May - October
Responsibility: Technical Coordinator, MPCA, River Watch
Accomplishments: Establish baseline conditions for long-term evaluation of the Nemadji River Downstream of Managed areas.
Projected Time Commitment – Sampling 40 hours/yr/site
Cost: In-kind 6 sites involving approximately 50 students

c. Establish site specific monitoring at project restoration areas

Timeline: Monthly, May - October
Responsibility: Technical Coordinator, MPCA
Accomplishments: Establish baseline conditions for long term evaluation of the Nemadji River Downstream of Managed or restored areas.
Projected Time Commitment – Need project restoration sites

6. DATA ANALYSIS AND ASSESSMENT

Data analysis and assessment for the project will include a review of previous and current data for trend analysis and integration of land-use and water quality data for non-point assessment. To assist in the prediction of future trends and consequences of implementation strategies computer modeling will be used for main-stem Nemadji River data using the USACE software FLUX. Data analysis and assessment will be conducted jointly by the Project Sponsor, DNR, MPCA and contracted consultants.

E. ESTABLISH BASIN-WIDE EDUCATION AND COMMUNICATION

Responsibility: NRBP Coordinator

Goal: Establish Education and Communication methods to best reach the private landowners within the Nemadji Basin.

Goal: Educate and organize the private landowners to assist in the re-vegetation within the Nemadji Basin.

How to achieve those goals:

- Speak at local organization and government meetings.
- Contact local school earth science/conservation classes,(elementary and secondary)
- Work with individual landowners whenever possible.
- Work through the Carlton County Extension Service in the Agriculture related projects
- Work with the Private Woodland Advisors Committee on private forest related projects.
- News Letter to disperse information and updates on projects
- Newspaper releases for community awareness.
- Dissemination of "Erosion and Sedimentation in the Nemadji River Basin"
- Articles in magazines such as the DNR "Volunteer" and Lake Superior Steelhead Associations magazine "The Angler".
- Informational booth at the Carlton County Fair

1. TOWNSHIP and COMMUNITY MEETINGS

Working through the township boards to reach the local landowners will be one way to educate through community meetings.

a. Contact the Township Board in each township within the project area.
Letter of introduction and follow-up phone communication

b. Get citizen comments, questions.
Examples:
Are landowners willing to plant trees on fallow land?
Are landowners willing to practice some of the simple BMPs along waterways?
Are there landowners who would be willing to do monitoring and sampling in the water-ways on their property?
Encourage people to telephone/mail/e-mail with information or questions.

c. Coordinate the volunteer efforts of landowners.

d. Introduce the citizens of the area to the programs and agencies that could possibly help with cost share and plans for their restoration projects

e. Create a working partnership between the agencies involved in the Nemadji Basin Project and the private landowners within the Basin.
Townships within the Nemadji Basin are Atkinson, Barnum, Blackhoof, Holyoke, Mahtowa, Moose Lake, Silver Brook, Twin Lakes, Wrenshall and Clear Creek

f. Carlton County Fair scheduled the 3rd weekend of August each year will be utilized as an educational source. A booth will be set up in the commercial building with informational

materials available, visual information in the form of videos of the Nemadji Basin and subjects pertaining to river water quality, and a person attending to answer questions.

Timeline: Third weekend in August of each year of the NRBP.
Responsibility: Project Coordinator
Accomplishments: Community awareness
Projected Time Commitment: three 11 hour days of years 2000,2001 (gate opens at 10:00 AM and closes at 9:00 PM)

2. SCHOOLS

a. Contact the Earth Science/Natural Resource Instructor in the schools in or near the Nemadji Basin
b. Familiarize the students and instructors with the basin and the dynamics of what is happening there. ("*Erosion and Sedimentation in the Nemadji River Basin* " report)
c. Identify programs or projects students could be involved in.
d. Encourage on-going projects; projects that will continue throughout the year and not end with the school year.
e. Connect students and instructor with agencies and programs such as St. Louis River Watch Program that would work with the students on projects
f. Set up information and instruction sessions with agencies such as DNR Division of Waters, Fisheries and Wildlife, GIS demonstration, etc.
g. Data collected would be shared with the Watershed coordinator to be distributed to the proper agencies to assist in establishing baseline information and keeping data current.
h. Projects and specifics on monitoring and work plans will be added to the reports as this type of education continues throughout the time-period allotted by the granting agency.

Schools within or near the Nemadji Basin in Carlton County include Carlton, Wrenshall, Barnum, Moose Lake and Willow River. (Willow River School is in Pine County.)

No specific inventories relating to macroinvertebrates, substrate embeddedness or aquatic plant populations were made as part of the Nemadji River Basin Project (from the *Erosion and Sedimentation in the Nemadji River* report page 86). Involving the Nemadji Basin schools in the River Watch Projects will give the Nemadji Project baseline data on those inventories.

Timeline: September 1999 thru May 2000 and September 2000 thru May 2001
This will be an ongoing process for schools that are involved in the River Watch Project or choose to continue the process for their own classroom research..
Responsibility: NRBP Coordinator
Accomplishments: Volunteer monitoring for water quality and education for future generations
Projected Time Commitment:5 hours per school per year for 3 years = 75 hours

3. INDIVIDUAL LANDOWNERS

If landowner participation at the township level is not at an acceptable number, the following could be implemented.

a. Obtain a list of landowners by sub-watershed
b. Contact each landowner individually and explain the problems within that sub- watershed
c. Discuss the BMPs any landowner can implement
d. Use BMPs appropriate for each individual landowner
e. The specifics of the BMPs that each landowner would implement would be reported to the granting agency as these contacts are made.
f. Invite private land owners to join a discussion group on Agriculture BMPs.
g. Get involved with the Agriculture Producers Organizations to promote the needs within the Nemadji Basin. This would include such organizations as the Northeast Minnesota Forage and Grassland Association and the Sustainable Farming Association.
h. Promote the use of Shoreland Restoration Master Gardener volunteers among the private landowners. Landowners who contact Master Gardeners to assist in restoration projects on their shoreland agree to public tours for a three-year period after completion of their project.
i. Develop an educational and informational booth at the Carlton County Fair. This is the most important event in the Carlton County area to create a one-on-one discussion with individual private and corporate land owners.
k. Work with the Forest Stewardship Program with individual landowners. The Minnesota Department of Natural Resources sponsors the Forest Stewardship program that has a consultant who is hired to assist individual landowners in creating a forest stewardship plan on their property. Carlton County Soil and Water District works with this program to help encourage county residents to have a forest plan done if they own 20 acres or more. This is a free service to landowners in the Nemadji Basin.
Timeline: On-going program.
Responsibility: NRBP Coordinator, DNR Forestry and SWCD
Accomplishments: Contact approximately 60 individuals per year to create awareness and encourage Best Management Practices
Projected Time Commitment: Monthly contact, Flexible depending on landowner cooperation
Approximate: 25 hours
11. Work with the Woodland Advisors Committee in education efforts. Forest field tours are held yearly throughout Carlton County. Private Woodlands Advisors are trained volunteers who get 48 hours of forest management training through the cooperative efforts of Private, County and State agencies.

4. PASTURE WALK

Pasture walks are an annual public education event in Carlton County organized by the Carlton County Extension Agriculture Educator. A pasture walk demonstrates proper Best Management Practices.

a. A landowner using successful pasture management is be contacted and asked to sponsor a tour of the pasture to share his success with others.

b. This tour is advertised to the general public and/or individuals specifically invited depending on the landowner and his/her circumstances.

c. The tour manager will discuss the advantages of the forbes used, methods of cultivation, livestock watering, fencing, grazing, stream bank/riparian re-vegetation, and any other management used to prevent erosion.

d. This site could become a permanent demonstration site for further educational purposes with the agreement of the landowner.

Timeline: Summer 2000 and Summer 2001
Responsibility: NRBP Coordinator, Carlton County Agriculture Educator
Accomplishment: Education of the general public through demonstration and discussion with agriculture specialists.
Projected Time Commitment: 10 hours per year = 30 hours

5. AGRICULTURAL TOURS

a. Agriculture Tours are organized through the Extension Service by the Carlton County Extension Agriculture Educator. BMPs are incorporated for erosion prevention and feed lot management.

b. Develop at least one agriculture site as a demonstration site to show proper grazing, watering and feedlot management along a waterway. The landowner would be encouraged to agree to periodic public tours

Timeline: Summer 2000-2001
Responsibility: NRBP Coordinator, Carlton County Agriculture Educator
Accomplishments: Public Education and permanent demonstration site for public education
Projected Time Commitment: 10 hours per year = 30 hours
Cost: In-kind – Carlton County Extension Service

6. FORESTRY FIELD TOURS

a. Forestry tours are organized by the Carlton County Private Woodlands Committee and Private Woodlands Advisors for private landowners and others interested in the care of their forests.

b. The tours are educational in focus using forest BMPs.

c. Topics include;

- Forest succession and ecology
- Constructing and maintaining roads to minimize erosion
- Thinning red pine plantations
- Oak management

d. Demonstrations include:

- Pruning trees using a high lift ascender
- Harvesting using ATV's and log arches
- Portable sawmill
- Horse logging

7. NEWSLETTER

a.This newsletter will serve as an update and informational tool as well as for education. The newsletter will include Best Management Practices such as those listed and described in Protecting Minnesota Waters: Shoreland Best Management Practices. That list includes Stabilizing your Shoreline to Prevent Erosion, Minimizing Runoff From Shoreland Property, Managing your Shoreland Wood Lot, Preserving Wetlands, Managing Crops and Animals Near Shorelands, Limiting Impact of Recreation on Water Quality, and more to fit the individual needs of land owners within the Nemadji Basin.

b. A survey will be developed and incorporated into the newsletter to help create a partnership between the working agencies and the landowners within the basin.

c. Photographs of sites in need of restoration and progress being made will be included along with short dialog describing the needs or progress.

d. Information on how to get involved in a volunteer stream monitoring program and measuring rainfall, where to get the equipment, who to report the data to, etc.

e. Contain announcements of financial help possibilities and incentives to encourage landowners to practice BMPs to prevent erosion.

f. Articles introducing agencies involved in the Nemadji Projects will appear in each newsletter.

Timeline: Bi-annual – Spring and Fall
Responsibility: NRBP Coordinator, North Shore Technical Communications
Accomplishments: Communicate with landowners and residents about the goals, current projects, and overall progress of the Nemadji River Basin Project.
Projected Time Commitment: Bi-annually 20 hours
Cost: $1000.00 per issue

8. NEWSPAPER ARTICLES

Newspaper articles will appear in the local newspapers every other month. Carlton County newspapers include the Pine Knot, The Arrowhead Leader, The Star Gazette, and The Cloquet Journal. The Duluth News Tribune will run articles two times a year plus special announcements as needed.

a. Quarterly articles will appear in the Carlton County Extension Connection, and the Carlton County Soil and Water Conservation District newsletter.

b. News articles will serve as information update, and educational tools.

c. New projects can be announced, and a BMP can be included in each release.

d. This method of communication will reach more people and encourage people to attempt Best Management Practices on their own.

e. Volunteer opportunities will be announced in local newspapers.

Timeline: Bi-Monthly
Responsibility: NRBP Coordinator
Accomplishments: Public Education and Awareness
Projected Time Commitment: 5 hours every other month for 3 years = 90 hours

TASK 2000-2001-2002

Months of activity	M	J	J	A	S	O	N	D	J	F	M	A
Watershed Coordinator management of Nemadji River Basin Project	X	X	X	X	X	X	X	X	X	X	X	X
Conduct educational projects	X	X	X	X	X	X	X	X	X	X	X	X
Newsletters	X						X					
Newspaper articles/News Releases		X		X		X		X		X		X
Volunteer Citizens Monitoring	X	X	X	X	X	X						
River-Watch Carlton County Schools	X	X	X	X	X	X						
Township Board Meetings		X		X		X		X		X		X
Technical Committee Meeting		X			X			X			X	
Technical Support Team attends meetings as needed												
Forestry Committee Meeting			X			X			X			X
Water Plan Committee Meeting	X		X		X		X		X		X	
GIS Data Base Management	X	X	X	X	X	X	X	X	X	X	X	X
Stream restoration/habitation restoration 2000			X	X								
Riparian restoration – tree planting		X	X	X	X	X						
Sediment model development	X	X	X	X	X	X	X	X	X	X	X	X
Roadside erosion restoration 2000			X	X	X							
Monitoring at Nemadji Gauging Station	X	X	X	X	X	X						
DNR Fish Survey					X							
DNR Helicopter Flight						X						
Carlton County Fair				X								

Maps: Watershed/Sub-watershed
Feed Lot Inventory

Attachments:

CWP BUDGET

FEED LOT INVENTORY FOR NEMADJI RIVER BASIN
Completed by Carlton County 1997

CARLTON COUNTY HIGHWAY 6, SPRING CREEK, BLACKHOOF RIVER CONFLUENCE
Conditions, Causes, Concerns and Solutions
By: Sandy Verry, January 26, 2000

PAULY TREE PLANTING PLAN OF WORK

References:

EROSION AND SEDIMENTATION
IN THE NEMADJI RIVER BASIN
Final Report

EXECUTIVE SUMMARY REPORT:
EROSION AND SEDIMENTATION
IN THE NEMADJI RIVER BASIN

EROSION AND SEDIMENTATION
IN THE NEMADJI RIVER BASIN
Appendixes A-K

SUSTAINING MINNESOTA FOREST RESOURCES:
Voluntary Site-Level Forest Management Guidelines

MINNESOTA STREAM SURVEY MANUAL, SPECIAL EDITION 120
MNDNR Department of Fish and Wildlife

CONSERVATION PRACTICE TECHNICAL APPROVAL AUTHORITY
Assignment and Acceptance Form