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Appendix Categories

Maps, Equipment and Facilities, Information and Education,
Anna River System, Furnace Creek System, Munising Falls Creek, St. Martins Hill,
Sweats Creek, Soil Maps and Type Descriptions

Funded by the Michigan Department of Environmental Quality
Nonpoint Source Program, Section 319

Introduction

The Munising Bay Watershed Restoration Project is located in north central Alger County, Michigan, and consists of the Anna River system with it's many tributaries, Furnace, Hanson, Gangeau, Munising Falls, and Sweats Creeks, and the numerous drains, wetlands, and upland recharge areas that contribute water (and sediment) to the Munising Bay area. The total surface area encompasses ~30,350 acres including the City of Munising and portions of Munising and AuTrain Townships. The year-round population of the Munising Bay area is about 4000 residents. Numbers climb tremendously as summer residents and large numbers of tourists enjoy the area's recreational, historical, and natural attractions. Tourism, hunting and fishing, and water and snow sport recreation are vital to the economy of the area. According to the U.S. Bureau of Census we can expect a substantial increase in population and development by the year 2020. Since 1998, the Munising area has been one of the fastest growing communities in the Upper Peninsula. We have forged a broad community-based partnership of local stakeholders, area schools, and landowners, to educate and to help identify and resolve existing degradations and help guide new responsible development. Thanks go out to the Alger County Health Department, Alger County Road Commission, Alger County Board of Commissioners, the City of Munising, Munising and AuTrain Townships, Pictured Rocks National Park, Hiawatha National Forest, Lake Superior State Forest, NRCS (Natural Resource Conservation Service) and Michigan State University-Extension. All had the foresight to support the concept and vision of a comprehensive Watershed Restoration Plan. That support enabled the Alger Conservation District to obtain Michigan Department of Environmental Quality, Nonpoint Source Program- Section 319 grant monies. This allowed us to begin planning the Munising Bay Watershed Restoration Project (MBWRP). As other wise communities across the nation organize to monitor, protect, and restore their water resources, our community has recognized that a healthy watershed is vital to long-term economic and environmental health. The community depends on this watershed for drinking water, flood protection, hunting, fishing, boating, swimming, wildlife, and aesthetic values that greatly enhance our quality of life.

Historically, the Munising Bay Watershed has paid a heavy price for enhancing man's condition. From the time when horse roads and narrow gauge railroads were pushed through the wilderness and timber was floated down our streams and rivers to fuel the great American expansion, miners, loggers, farmers, ranchers, and fur traders settled and cleared the land. As the new residents developed the land and built new communities, they took the abundant water resources for granted. It is high time now, to protect and restore those aquifers, rivers, and streams by closing abandoned wells, repairing, replacing, or stabilizing erosion sites and bad road or rail stream crossings, and planting forested buffer zones, wildlife corridors, and filter strips. These efforts, combined with in-stream fisheries enhancements can restore, create, and improve lost fish and wildlife habitat and help rid streams of tons of accumulated sediments, while sustaining the local economy, environmental health, and enhancing recreational opportunities. The Munising Bay Watershed Restoration Project (MBWRP) seeks to accomplish these goals by inventory of the watershed, and through voluntary, non-regulatory action and input of the local community and our watershed partners, community education, and identification and prioritization of water resource problems. With the continued support of our local partners, and through application to the Clean Michigan Initiative Fund, we hope to implement best management practices and physical improvements that will restore designated use of prioritized critical areas. To achieve our goals, we have performed inventories and assessments of stream fish, aquatic insects, hydrology, erosion, sedimentation, and runoff

impacts that we hope will make the watershed eligible for grants to fund a range of improvement projects.

Munising Bay Watershed- Demographics - Stakeholders: Whom Do We Serve?

Population Demography: Alger County had 9,862 people according to the 2000 census, making it the 77th most populous county (of 83 counties total). The population increased by 890 people or 9.9% since the 1990 census. Of the total population, about 16.2% are adults over the age of 65, 60.3% are adults between 18-64 years of age, 18.4% are youth ages 5-17, and 5% are under age 5. The fastest growing age group is 45-64 year-olds, growing by 466 people or 25.3 percent since the 1990 census. Males made up 53.8% of the population, females made up 46.2%. Of 3,337 households in Alger County, 2,671 or 80% owned their own homes, and 666 or 20% rented. On average, one out of every five Michigan citizens experience a disability.

Multiculturism: Cultural statistics for Alger County show the inhabitants are 87.5% Caucasian, 6% black, 3.1% Native American, 1% Hispanic, 1.9% biracial, 0.3% Asian, and 0.2% "other". Two major historic Native American trails and one minor trail were known to converge on the Munising Bay Watershed area during the historic era (1760's), but archaeological site density is listed as "very light" for the area. The watershed area lacks any reservation lands, being a portion of that area ceded to the U.S. Government in the Washington Treaty of 1836. There is one Native American casino operation on the watershed, located in Christmas, Michigan. The Native Americans in Alger County are of the Ojibwa (Chippewa) Tribe.

Education: High School graduation rates in Alger County increased 9.8% since 1980, with 11.5% of the adult population holding a college degree. Alger ranks 36th among the 83 counties for persons with college degrees.

Labor Force: The Alger County labor force has grown from 3,800 to 4,475 from 1990 to 1999. The number of women with school-aged children in the work force increased by 13%. Total average unemployment rate for Alger County was 5.9% in 1999.

Employment: Full and part-time jobs increased 21% from 1990 to 1998 to 3,992 jobs in Alger County. Manufacturing (paper & wood products) led employment with 24.7% of the jobs, Services had 22.3%, Retail/Wholesale had 19.8%, Government had 15.6%, Finance, Insurance, and Real Estate had 5.8%, Construction had 5.4%, Transportation had 3.7%, Farm Employment had 1.8%, and Agricultural Services had 0.8% of the jobs. These statistics highlight the area's economic dependence on recreational tourism, services and related

How Do We Serve? Public Input: Interested citizens were invited to join in formation of a Watershed Committee, and each locally elected government within the watershed boundary was asked to provide a designated representative to serve on the committee. This consisted of the City of Munising, and Munising and AuTrain Townships. The same was asked of each state or federal agency, and these were; Michigan State Univ. Extension, LMAS Health Dept., Hiawatha National Forest, and Pictured Rocks National Lakeshore Park. Some Department of Natural Resource and State Parks personnel also served to provide permission, technical advice, and instruction for fisheries inventories. Citizen resource concerns were taken by mailing out survey forms in two newsletters, in which we asked for natural resource concerns, and natural resource related recreation, and fishing preferences. In addition to watershed committee meetings, citizen input was gained by attending and making presentations and updates at county, township, and city board meetings. We received 160 completed surveys, about 1.6 % of the 9,862 estimated adult population ages 18-85+ in Alger County. This was short of our goal of a minimum of 5%. However, through the survey, we did receive 62 offers of volunteer help for in-stream or erosion control work, a single $50 cash donation, and overwhelming support for the goals of the district and the watershed plan.

History and Current Condition of The Watershed

Overall, the Munising Bay Watershed has 76 public and private, road or railroad crossings on its streams. We are very fortunate that of those, only 10 have been identified as critically eroding sites currently in need of replacement or other mitigation. The relatively small stream scale, and high quality year round flow, makes the watershed a prime candidate, and economically feasible for restoration. The largest of the stream systems, the Anna River system is about 6 miles long, with about 18 miles of tributaries draining an area of about 20 square miles. The Anna was formerly renowned as one of the better Brook trout streams in the area, and at one time provided excellent spawning habitat for salmonids. The Anna system also contributed to recruitment of Rainbow and Brown Trout, and Coho and Chinook Salmon once these species were introduced.

In 1960-61 a State highway project on M-28 caused heavy sand erosion into the lower part of the Anna River from the Wagner Creek tributary to the mouth. Today, because of the low gradient, flat nature of the lower river and floodplain, the lower 2 miles still has a heavy sand streambed load, that covers about 90% of the former spawning gravels. The only existing gravel/cobble spawning area left on the lower Anna, exists intermittently (depending on time of year) at and below the junction of Horseshoe Falls Creek where the extra flow is able to flush the annual deposition of sand from a small area. The streambed sand loading of 12”- 24” in depth, has caused instability in the form of increased meander, channel widening, bank erosion, and has reduced the overall river depth. Many local residents and officials blame this reduced depth for the unprecedented flooding that occurred in the spring of 1978, and flooded many homes near the lower Anna. Since the highway sediment event, the river goes over the bankfull stage, inundating the floodplain much more frequently.

In the mid 1980’s a private artesian well blew out, eroding significant sand deposits into the middle section of the upper Anna, and in the early 1990’s two railroad crossings failed causing two large sediment events. All three of these events added to the prior bed loading on the lower two miles and solidly choked the middle to upper reaches as well. Wisconsin Central Railroad was litigated by the State of Michigan, and forced to stabilize both crossings and improve others, and put in two 300’ sediment trap areas on the middle Anna River below the failed crossings. They also had to install 6 gravel-spawning riffles to replace natural ones that were inundated with sand. The landowner that had the well blow out, hosted one of the sand traps on his property and allows access for cleanouts. The sand traps are scheduled for 2 more years of cleanouts by the railroad (5 yrs total). Generally, the sand traps continue to fill up 3-4 months before their annual cleanouts, allowing further downstream movements of sediments to the lower section. They also are eroding and widening the river channel slightly at the trap locations due to the mechanical removals.

In our estimation the sediment bed loading on the upper portion of the river will have diminished only about 50-60% by the time scheduled trap maintenance ends. One exception is the portion just south of the second sand trap, where the placed spawning riffles remain clear and channel deepening (down cutting) is also occurring in other areas between spawning beds, uncovering more spawning substrates and creating deep holes. On the upper Anna River headwaters, at the Perch Lake Road crossings of the north and south branches, two inadequate and partly deformed culverts exist. These two crossings allow considerable sediment to erode directly from the dirt road surface, and the road ditching during flashy rain events and high flow times. The inadequate culvert diameter also causes ponding upstream of the road crossings, eroding around and under the culverts. Both culverts are also the same width as the roadbed (too short) and the roadside lacks any slope for good effect with riprap.

Above this point the river is undeveloped except for one stable railroad crossing on the South Branch. Although the upper reaches beyond the road crossings are well wooded again, and the stream appears fairly pristine for a post-logging era stream, some sand bed loading (61-77%) remains from the early days of timber harvesting. Though the entire river corridor was cutover at one time, this is unlikely to pose a problem in the future due to the nature of private and vacation home development on the river corridor in the years since.

The lower Anna has some other problems that add to sedimentation, exacerbate instability, and add to the flooding and tendency to meander. At the Wagner Creek junction, a large hole has developed that functions through the low flow times of the year as a natural sediment trap, but is flushed downstream periodically during winter and spring high flow times. This natural "sand trap" has easy road access directly to the streambank, and acts to intercept sediment moving down from the midsection and would allow clean out of annual deposits without digging a trap. About a mile below the Wagner tributary, DNR-Fisheries (George Madison), landowner Bruce Cromell, and other members of the local "Fishing Committee" placed a electric salmon exclusion weir just above a private bridge crossing on the Cromell property. This was meant to block salmon access to the upper Anna in an attempt to improve the Brook Trout population and decrease competition for forage fish, insects, and spawning areas. Though this was abandoned after several years, it remains in place, and has caused significant erosion and instability at the site. The orientation of the weir narrows the river channel, increasing velocities, and directs the flow at the eastern end of the bridge abutment. This has caused over 6 feet of undercutting and partial subsidence of the wooden bridge structure. The bridge now blocks flows at high flow times, and causes further bank erosion. Near the mouth area of the Anna River, just below the county highway H58 crossing, there is an old abandoned wooden bridge structure that blocks ice during spring breakup. This restricts flow and causes ice and water damming and increases the likelihood of flooding upstream. At the mouth itself, bank erosion on the west side of the river, along the Kimberly-Clark sediment basin is another chronic but lower priority problem. The sandy beachhead across from it contributes as much, if not more sediment to the river and Munising Bay. Wagner Creek from below the falls to the Anna, is high quality salmonid habitat, with a rocky substrate and abundant aquatic insects. Above the falls, Wagner Creek is bisected by an eroding road crossing and forms two large ponds known as "Cox Ponds". The Cox Ponds are the central element of Munising Township's Robert McQuisten Recreation Area development.

In the city of Munising, we have the critically eroding slope known as St. Martin's Hill, as the major sediment problem in the city. This large, steeply sloping hill, has a slope nearly 2650' long. This site chronically erodes with every rain event, and sediment is carried downslope to overwhelm the city storm water system and carry fines all the way into the Munising Bay of Lake Superior. Previous attempts to stabilize the hill with rip rap and erosion fabric have been unsuccessful, though the fabric placement and amount of riprap was insufficient and improperly installed. Sediment plumes are visible in the lake with every rain event. The sediment negatively impacts benthic fisheries resources on the floor of the bay.

On the west side of the watershed, Furnace Creek (about ½ mile in length) has a few problems other than the contaminants from road and highway M-28 runoff. There is also a remnant Lamprey Weir, which causes some sediment deposition and scouring, and the inadequate culvert diameter at its source, the outlet of Furnace/Carr Lake. The U.S. Fish and Wildlife Service (USFWS) has long wanted to place a Sea Lamprey barrier in the outlet of Furnace/Carr Lake to deny access to the rich sediments associated with the wetland soils of the lake basin. The USFWS has offered $10,000 toward the replacement of the culvert outlet and construction of a removable lamprey barrier. The culvert diameter at this site is inadequate for the seasonal high flows, and flows overtop the culvert and road occasionally,

by as much as 6”. The Furnace Creek drainage system consists of two streams, the Gangeau Creek with an east and west branch, and Hanson Creek. The Gangeau is the most pristine of the two, and has three critically eroding road stream crossings, due to short and undersized culverts that can’t handle storm flows. Two improperly installed, and undersized culverts are located on the east and west branches of the Gangeau at the Carr Lake development road. One other critically eroding road stream crossing of the Gangeau is located at the county-owned Ridge Road upstream of the Carr lake development. Hanson creek has numerous well-established private crossings upstream of Carr Lake, including only one severely eroding site on the Jurmu property known as Hanson Estates. This is the site of a poorly designed road crossing a riparian floodplain, lacks ditching or vegetation on the new roadsides, and is made of a cut in half old steel tank. According to DEQ storm flow calculations, the homemade culvert is of inadequate width for the streambed, by several feet. Another undersized culvert is in place on Hanson Creek downstream from Hanson Estates, on the Carr Development road.

These are all critical crossings because of the current erosion and high continuous use, and the expected increase in traffic and development. A Native American casino is now located in Christmas, Michigan, and is driving explosive home and business development in the area. All of the Carr development stream crossing sites are located on an access road to a sand and gravel pit operation used as a material source by private developers and occasionally by the county road commission, as well as serving as a logging access road to interior forestland. One new problem with the Furnace System has arisen with the impact of sudden snowmelt and heavy rains in the last week of April 2002. A 29 acre site owned by Mr. Kevin Kolbus, and developed as a dirt racetrack, experienced major slope failures, gullying and rills, and resulted in sediment inundation of a small wetland on adjacent property owned by Shelter Bay Forests. Because of the high clay content of the soil, clay-laden water flowed downslope along an intermittent but well vegetated topographic drainage channel to the headwaters of the west branch of Gangeau Creek. Most of the heavy sediment was intercepted by vegetation and trapped by the roadside ditches and the adjacent wetland area, so did not make it to the permanent stream channel. Suspended fines transported as clay-laden water did flow through the channel directly into Carr/Furnace Lake, and then on into Lake Superior for a period of about 2 days. Subsequent rains washed evidence of the fine silt from the vegetation but flow patterns were clearly evident. Lake Residents were alarmed by the entire lake turning pink and quickly alerted DEQ, the soil erosion permit office and the watershed manager. The Alger County Road Commission has recently installed a culvert where this intermittent flowage crossed Perch Lake Road and dug sediment trap basins at either end as an emergency stopgap measure. I toured and photographed the site on 5/1/02, with the DEQ and Alger County Soil Erosion Agent.

Methods

General: Watershed maps were created by the watershed manager using ArcView 3.2a software. The software and digital air photos were provided by the NRCS, after attending two training sessions. Reports were done in Microsoft Word & Excel. Newsletters and photo pages were created using Microsoft Publisher. All available written material on the Munising Bay Watershed was gathered and studied for analysis. Historic Flow measures came from USGS and USFWS-Lamprey Control, and DEQ reports. Over 900 runs of historic fisheries survey data also came from Lamprey Control. Sediment suspension was measured when possible, with a "Lawrence Enterprises" 60 cm Secchi-tube, and new flow measurements were made by the float method using a variant of the Emdahl, 1927 method, provided on formatted data forms by DNR-Fisheries. Streams were watched carefully and flows were taken when "channel-forming" or "bankfull" conditions occurred, to facilitate hydrological analysis, as well as during insect/fish inventory. Use of a 3 foot length float distance, a digital stopwatch, careful choice of location (for uniformity) and measurement of the 3' wide stream cross section assured accurate flow assessment. Temperatures were taken using digital thermometers accurate to 0.1 degree F or C. PH was taken with wide range PH paper strips, of O.5 PH units 0-14 PH range. The readings were confirmed or refined by drop titration using a Hach Model 17-N PH test colorimetric kit. Dissolved Oxygen was taken using a Hach model OX-2-P DO, "reagent powder pillow" kit. All supplies for the aforementioned testing, except the secchi tube and digital stopwatches, were loaned to the watershed by "Turtle Springs Research" of Marquette, Michigan. PH testing by school students was performed hands-on with the "PH-Hydrion" strips, and under adult supervision when using the PH and DO chemical test kits. A LaMott's "Pondwater Tour" water analysis kit was furnished to the Mather Middle School, for use in student analysis of nitrates/nitrites, oxygen, and PH.

For long term water quality monitoring plans, inventory, and future information and education endeavors and (some items) inclusion in our two school loan boxes, several water test meters, supplies and kits were purchased, as well as a refill kit for the "Pondwater Tour" water analysis kit. Water monitoring equipment purchased included; ISO 9001 certified-Oakton "rough duty" double junction, waterproof PH tester with replacement electrode, Oakton waterproof electrical conductivity tester with replacement electrode (PH & EC meters, and DO chem kit is not included in the school loan boxes); LaMotte Dissolved Oxygen test kit model EDO #7414 with refill chemicals; Coralife "Deep Six" hydrometers for salinity testing; and pHydrion "brilliant" (PH 0.0-13) paper strip dispensers; "Accurite" Mercury-free digital thermometers (2); and "Athletic Works" digital stopwatches (2) for stream flow determinations. Rounding out our "loan boxes", each also contains minnow traps (3) with labeled floats, small animal live trap (1), 100 count box of latex gloves, insect sorting tray, flexible, and floating foam yardsticks. Accessories to the loan boxes include; D-ring aquatic insect nets (1 each), D-ring fish capture nets (3 each), watershed map displays, stream ecology posters, aquatic insect ecology and stream rating guide displays with PH guide. Schools (or the watershed manager) furnish the "floats" for stream gauging (medium oranges!) and the watershed furnishes a 100' open reel fiberglass tape for measuring cross sections and transects.

Sedimentation/Pollution Inventory: Each stream in the watershed was walked where possible, using waders, from headwater areas to their junctions with larger streams, lakes, or their mouths at Lake Superior. Because of the forested nature of the upper reaches of the streams, little was found in terms of erosion sites other than natural undercut banks, and sediment deposition in beaver ponds, or in stream beds below blown out beaver dams such as

occurs on the Valley Spur tributary to the Anna River, and the west branch of Gangeau Creek. The most severe erosion sites found were at a few of the many road-stream crossings, below which sediment bed loading had increased, and also below some of the already mitigated railroad-stream crossings. Much of the upper and middle of the Anna River system was formerly "hardened" and straightened or channelized by construction of the Wisconsin-Central Railroad. Due to large amounts of coarse woody debris and small stream size, little of the watershed is navigable, even by canoe or kayak. The navigable areas include; Furnace/Carr Lake and Furnace Creek below highway M-28 to the mouth, and the Anna River from below the Bruce Cromell property to the mouth at Lake Superior. No livestock access, irrigation withdrawal, or industrial inputs were found. The primary impairments seem to be sedimentation from road and rail crossings, and possibly runoff from parking areas, a snowmobile trail, roads, and highways. Just above highway H-58, on the lower Anna, is Munising's municipal sewage treatment plant, which contributes traces of heavy metals, and treated wastewater, but conforms to current regulatory requirements. Some increase in algal growth occurs below this point, but seems to have little effect on the overall riverine ecology because of the cold water, high flow scouring action, and heavy sand bed loading in this area.

Fisheries Inventory: A MI-DNR Fisheries Biologist, George Madison, who was familiar with the streams of this watershed, set forth general requirements for inventory of fish and aquatic invertebrates. Because of the small size of the streams on the watershed, the directions included establishing two or more 300' survey transect areas on each major stream or river system within the project area. Yellow plastic, numbered, "pig-sized" animal ear tags were lag screwed to a tree to mark the beginning point of each transect. Each transect was marked out by measuring distance along the waterway with a "Hip Chain" and flagging at each 50' interval. At each interval marker, a 3' wide cross-section of the stream bottom was to be measured and sampled for embedment (sediment) and for aquatic insects using a standard EPA-certified rapid-bioassay kick net, and two D-ring aquatic insect nets. In addition, any small to medium rocks, sticks, logs, or removable items found on each 3' wide cross section, were to be immersed and scrubbed with a brush in a bucket of water, to detach and collect invertebrate colonizers. Invertebrates were to be collected, identified, counted, and representative samples of each species were to be preserved. Most collected invertebrates were returned to the transect area immediately after identification and counting. Some invertebrates to be preserved, or needing further sorting or identification, were taken to the Turtle Springs Research Lab in Marquette for processing. The loan of this facility was necessary because we are prohibited from using alcohols or solvents (insect preservatives) in our office at the Health Dept. Turtle Springs Research provided a ventilated work area, sorting tables with illuminated magnifiers, dissecting and regular microscopes, and storage, mixing, and use of insect preservative.

Each transect was subjected to a single pass electro-fishing survey to identify native fishes present before other data was taken. Students helped capture stunned fish and helped the manager measure, record species and total length, and release them. Due to the watershed manager's prior qualifications, training, and work experience (including operation of fish shocker units and teaching native fish and insect identification in a university setting) the manager was able to borrow a Fish-Shocker from the U.S. Fish and Wildlife Service, Lamprey Control, at the Marquette, Michigan Biological Station. By agreement with the USFWS, No students were allowed to use the fish shocker.

Public Input- Interested citizens were invited to join in formation of a Watershed Committee, and each locally elected government within the watershed boundary was asked to provide designated representatives to serve on the committee. This consisted of the City of Munising, and Munising and AuTrain Townships. The same was asked of each state or federal agency, and these were; Michigan State Univ. Extension, LMAS Health Dept., Hiawatha National Forest, and Pictured Rocks National Lakeshore Park. Some Department of Natural Resource and State Parks personnel also served to provide permission, technical advice, and instruction for fisheries inventories. Citizen resource concerns were taken by mailing survey forms in two issues of newsletters, asking for natural resource concerns, recreation, and fishing preferences. In addition to watershed committee meetings, updates and citizen input was gained by attending and making presentations at county, township, and city board meetings, as well as by attending several meetings of the Munising Bay Fishing Committee. Though we mailed out approximately 8700 newsletters to the entire county, we only received 160 completed surveys, approximately 1.6 % of the estimated 9,862 adults (ages 18-85+) in Alger County, short of our goal of a minimum of 5%. However, we did receive 62 offers of volunteer help for in-stream or erosion control work, and overwhelming support for the goals of the district and the watershed plan from those who responded. The Resource, Recreation, and Fishing Preferences survey form and all results are included in the Information and Education appendix section.

Methods for Determining Stream Hydrology:

To determine the stability or changes in stability of any stream or river system, it is necessary to perform measurements that allow derivation of several important ratios. The most useful measurements are stream channel flow, depth, and channel width at "**Bankfull**" stage and flood stages. Stream flow at Bankfull stage is defined as the "channel-forming flow" or a flood stage occurring at 1.5 year intervals or sooner (67% probability of occurrence any year), and is characterized as the stage when the flow just begins to overtop its normal banks. Another description is when the stream level reaches the first depositional floodplain zone, or the level of lower limit of terrestrial plant growth along the banks on streams lacking layered floodplains. We were able to take bankfull measurements on all streams of the watershed as they were receding from flood stages of several days duration, at well over the bankfull stage. Changes in the Following Ratios Determine Stability State.

Width to Depth Ratio- Bankfull width (ft) divided by bankfull depth (ft)

Entrenchment Ratio- Flood Prone width (ft) divided by bankfull depth (ft). Flood Prone width is derived by finding the width at the hypothetical stream surface level at 2 times the bankfull depth.

Meander Width Ratio- Meander width (ft) divided by Bankfull width (ft)

Sinuosity Ratio- Channel Length (ft) divided by Valley Length (ft)

Stream Balance Equation- Q_W multiplied by S = Q_S multiplied by D_{10}

Q_W = Stream Flow (at Bankfull) **Q_S** = Sediment Load

S = Stream Slope **D_{50}** = Sediment Particle Size

Methods-Educational Innovations:

My strategy was to combine inventory with information and education efforts to enhance our long-term management strategy and visibility, and to build community support. I didn't want to hire contractors for the inventory work, a single use expenditure with a one time yield, since I was told DNR-Fisheries couldn't do it within our 2-yr time frame. For assistance with stream inventory, electro-fishing, and middle school presentations, we utilized an "at-risk" high school volunteer assistant, who received release time from classes and school credit. We also hired a watershed-experienced college student the during the first

year inventory. Our high school student then qualified for the Michigan Works Program after graduating, and served as a part-time, subsidized watershed intern for 12 weeks of the second summer.

To accomplish the surveys, we purchased survey equipment (detailed above in the general and inventory portions of Methods) for long-term and continued supervised use by youth participating in stream inventories. This also provides the means for long term monitoring efforts. Preparatory presentations, field excursions, and follow-up presentations as "courses" were designed to meet requirements of the Michigan Science Model for middle and elementary schools. The courses served an introduction to watershed concepts, cycles, and ecology, the scientific method, and included hands-on survey experience. We fostered teamwork, critical and analytical thinking, and guided the development of conclusions based on our experiences. In this way we hoped to also instill a sense of community ownership, responsibility, and stewardship ethic for watershed resources, while entertaining and teaching youth in a creative learning project. I am proud of the fact that during the 2 years of the planning project we provided exciting hands-on, 3-hour, watershed related field experiences for over **1,720** youth! Photos from some of the field trips are shown in the information and education and stream system appendixes following the body of this document.

For Graphic presentation, I produced several compact, accordion-folding display boards with topographic and GIS-ArcView derived map displays, watershed concepts, and graphics on fish and aquatic insect ecology and Stream BMP's. I also created a dual carousel regular slide show tour of the watershed for Township, Watershed Committee, and other meetings. Some of the slides were later digitized for inclusion in power point presentations.

Equipment for inventory and school volunteer use was low tech and included; a single EPA-certified Rapid Bio-Assay Kicknet, 2-Dframe insect nets, 6- fish dip nets, 6 minnow traps, assorted sizes of rubber knee boots, waders, an all-important wader dryer, digital thermometers, turbidity tube, water test kits, digital thermometers, and a stopwatch. We borrowed a GPS unit, food-grade plastic pails with lids (for collecting buckets), meter sticks, 100m reel tape, marking ribbon, and rubber gloves from Turtle Springs Research, and were given glass insect sample vials (discarded Health dept water sample mailer kits). Through competitive grant writing to the Michigan Association of Conservation Districts (MACD), the watershed manager was able to purchase a digital camera and GPS unit for watershed and district use in the future.

The Pictured Rocks National Lakeshore's, Educational Officer and watershed partner, Dave Kronk, helped supervise teams for most of the field and classroom presentations and brought extra nets and waders. The Mather Middle School provided bus transportation and drivers. We worked with the teachers to forge each 6 or 7th grade science class into sets of teams each assigned specific tasks during field inventory, then shared in the findings. Each class received an entertaining presentation of conceptual and practical use, before the inventory excursion, then a follow up presentation to present findings, ask students to analyze results, and help lead them to the proper conclusions. We finish with a fun aquatic ecology game played in a gym or outside. Each class rated the inventory site they worked on by various parameters described above, including the Isaac Walton league stream quality guide.

Our educational outreach included high school journalism and science students who accompanied and "reported" on the Middle school watershed activities, and who later participated in storm drain stenciling in Munising during the summer "Watershed Appreciation Day" sponsored by the Central Lake Superior Watershed Partnership. This event was one part of the week-long "Life of Lake Superior Youth Program" created by our watershed partner, MSU-Extension of Alger County. I created a "Watershed's and Wildlife" presentation as another part of their Youth Program, and presented out on Grand Island in

Lake Superior! Later we used this same presentation and a field excursion as an activity for area Seniors, sponsored by NMU- Center For Lifelong Learning, Manistique Middle School, Munising's Central Elementary and Mather Middle Schools, Marquette Conservation District's Annual Conservation Festival, and the Marquette-Alger Intermediate School District's "Young Authors Program". See the photos in the information and education appendix.

Munising Bay Watershed: Physical Description

Physiographic Region: The Munising Bay Watershed area contains about 30,000 acres around the communities of Munising and Christmas in Alger County, Michigan. This entire area is contained within the general Michigan Landform type 6a, the Schoolcraft Plain.

Elevation: A narrow region of the watershed along Lake Superior, and most of Grand Island is located at less than 600 feet above mean sea level. About 75% of the watershed lies at 600-800 feet above mean sea level, and a tiny portion 2-5% lies at 1000-1200 feet above mean sea level.

Glaciation: The watershed area was completely covered by ice at 11,000 years before present. Final deglaciation took place between then and 9,500 years ago.

Geologic Age of Bedrock: Most of the watershed (~70%) lies on Cambrian Period bedrock of about 600 million years of age. Some (~30%) of the watershed (southeastern portion) lies on Ordovician Bedrock of about 500 million years of age.

Surface Formations: Most (~75%) of the watershed is composed of glacial moraine, while some (~25%), mostly located along Lake Superior is composed of lacustrine plain.

Bedrock Surface Altitude: Grand Island, the northwest corner of the watershed, and the shoreline from the Anna River to Sand Point lie at 600-800 feet above mean sea level. A small part of the watershed that is within the eastern part lies at 400-600 feet above mean sea level, and the rest (majority) lies at 200-400 feet above mean sea level.

Suitability For Farming: Less than 5% of the watershed is currently composed of farmland, with ~40% being poorly suited for farming, ~30% well suited, ~10% unsuited, and about ~20% moderately suited.

Presettlement Forest: All of the watershed area was originally composed of the Northern Hardwoods type known as Maple-Beech-Birch-Hemlock complex association.
Present Forest Type: Most of the watershed area (~70%) remains the Maple-Beech-Birch-Hemlock complex association. About 30% is now composed of Pine-Oak-Aspen and Spruce-Fir complex associations.

Mean Annual Temperature: All of the watershed falls within 42-44 degrees fahrenheit mean annual average.

Soil & Slope Associations:

Soils, Slopes, and Hydrology are intimately related and interact to affect each other. The hydrological effect is discussed in the Hydrology section below. Each of the soil types listed has management or activity limitations imposed by engineering considerations, its structure, and prevailing permitting requirements. Current (Apr. 2002) soil maps and type/limitation description lists are included in an attached appendix. In general terms, the majority (~85%) of the watershed is overlain with Haplorthod and Fragiorthod soils of the **H2** (Keweenaw, Kalkaska, Gogebic), **H3** (Emmet, Trenary, Leelenau), and **H6** (Munising, Skanee, Keweenaw) types. A small portion of the watershed is overlain with Histosols (Roscommon, AuGres, organic soil). All of these soils are easily eroded if not stabilized with vegetation or tree cover or are exposed by activity or construction. Most of the lower reaches of the Furnace Creek and Anna River systems are of zero to little slope, making historic and chronic sediment deposits hard to flush out of stream beds and contributing to continued stream instabilities. Some of the high elevation sandy deposits have a high clay content. Detailed soil type, from mouth to headwater, for the two main stream systems on the watershed are reported with their slope category below:

Anna River System Soils/Slopes:

The first 400m (1300') upstream of the mouth to just above the County Road H58 bridge, the river cuts through soil "type 232b"; Shelldrake sand (0% slope). From that point, 900m (2,095') upstream to just upstream of the State Highway M94 bridge, the soil is "type 93"; Tawas-Deford Mucks (0-1% slope). From that point, 1275m (4,144') upstream to Alger Falls Creek tributary, soils are of "type 57"; Carbondale, Lupton, and Tawas Mucks (0% slope). From that point upstream 3,450m (11,212') to the Pasineault property is soil "type 93"; Tawas-Deford Mucks (0-1% slopes**).** From that point upstream 160m (520') the Anna crosses a soil "type 76c"; Garlic-BlueLake-Okeefe Complex (1-12% slope, dissected). From there upstream another 1180m (3,835') past the tiny Mud Lake tributary to the Schumaker property, the soil is of "type 71b"; Evart-Pelkie-Sturgeon Complex (0-4% slope). From the Schumaker property upstream 870m (2,827') to the power line corridor the soil is "type 76e"; Garlic-BlueLake-Okeefe Complex (8-35% slopes, dissected). From that point upstream 550m (1,787') is the North Branch tributary, past and including the **Perch Lake Road crossing #1, and is of soil "type 76c"; Garlic-BlueLake-Okeefe Complex (1-12% slopes, dissected)**. From that point upstream 670m (2,177') and including the entire South Branch tributary and **Perch Lake Road crossing #2, is of soil "type 76e";Garlic-BlueLake-Okeefe Complex (8-35% slopes, dissected)**. From there upstream about 1430m (4,647') to point of origin at Anna Marsh, is of soil "type 57"; Carbondale, Lupton, and Tawas Mucks (0% slope).

Furnace Creek System Soils/Slopes:

Hanson Creek: From the mouth of Hanson Creek, upstream 250m (812') is of soil "type 60"; Histosols & Aquents, Ponded (0% slope). From there upstream 400m (1300') including the **Hanson Creek Road crossing on Carr Road is of soil "type 57"; Carbondale, Lupton, and Tawas Mucks (0% slope)**. From that point upstream 1600m (5,200') is of "type 72e"; Deerton-Trout Bay Complex (8-35% slopes, dissected). From there upstream 300m (975') is soil "type 72c"; Deerton-Trout Bay Complex (1-12% slopes, dissected). From that point upstream 2500m (8,125'), including **Hanson Creek crossing at Hanson Estates is soil "type 57"; Carbondale, Lupton and Tawas Mucks (0% slope)**. The next 200m (650') is of soil "type 221b"; Jeske-AuTrain-

Gangeau Complex (1-12% slopes). The next 675m (2194') upstream which crosses State highway M-28 at about 250m, is of soil "type 196e"; Frohling-Tokiahok-Onota Complex (8-35% slopes, dissected). North of the highway, the next 400m (1300') upstream is of soil "type 17a"; AuGres Sand (0-3% slope). The last 850m (2,762') upstream to the headwater source is of soil "type 57"; Carbondale, Lupton, and Tawas Mucks (0% slope).
Gangeau Creek: The first 600m upstream from Furnace/Carr lake of the **east branch tributary road crossing is in soil "type 57"; Carbondale, Lupton, and Tawas Mucks (0% slope)**. At that point due Southwest of Furnace Lake, and including the **west branch road crossing, there is a small soil lens that runs 400m (1300') of soil "type 60; Histosols and Aquents, Ponded (0% slope)**. From there upstream 1700m (5,525') soils are "type 196F"; Frohling-Tokiahok-Onota (15-65% slopes, dissected).
From that point upstream 700m (2,275') soils are "type 158c"; Munising-Onota-Yalmer Complex (1-12% slopes, dissected, stony). From that point upstream 350m (1137') including the **Ridge Road crossing, is of soil "type 241"; Cathro-Gay Complex (0% slope)**. From there upstream 1750m (5687') to the point of origin is soil "type 57"; Carbondale, Lupton, and Tawas Mucks (0% slope).

General Hydrology

The Munising Bay Watershed stream systems developed, and draw their clear, cold waters, from the same type of rugged upland recharge areas. These are composed of permeable deposits of sand and gravel known as the Munising Moraine. In natural low areas during glacial dewatering, fines settled out in some areas, depositing clay lenses, fragipans, mucks, or other organic soils, as found around Furnace, Perch, and Mud Lakes, as well as other scattered low wetland areas. Clean gravelly sand and cobble was deposited on the barely sloping outwash plains such as the lower Anna River. Other organic soil complexes and mucks developed within the outwash plains as Lake Superior levels varied over long periods creating successive beachheads and changing stream meander near the mouth. These stream drainages were well incised into the rocky outwash or organic substrate 3' to 6' and have been slowly, actively meandering in response to hydrological (snowmelt & rain) and biological events (beaver) for thousands of years. The rate of stream meander has varied with the degree of tree cover, beaver activity, and bank stabilization that existed.

We know this historic meander would have continued to decline as a mature forest and well stabilized banks developed from the original post-glacial condition. When man denuded this watershed, had log drives, and constructed primitive road and rail crossings in the early part of the 19th century, we can expect that both the erosion and meander rate increased considerably and continues to this day. We now have a forest in middle age, and much of the upper reaches of the watershed is well wooded once again, with stable banks. If we can stabilize banks on the lower stretches through bioengineering and recover the gravel spawning areas on the lower Anna, heal the hydrological limitations at a few critically eroding stream crossings, and stabilize other eroding areas that could affect future changes in hydrology, we have a chance to restore the quality streams of the watershed to their full potential.

Minimum Infiltration Rates: About 90% of the 30,000 acre watershed has soil properties that allow 4-8 inches per hour of water infiltration, while the rest of the area allows 1-2 inches per hour.

Water Holding Capacity: This is the water capacity of the upper 3 feet of soil, and represents water available to trees and plants. About 85% of the watershed is of the 6.5-9.0 inches of water holding capacity, while 15% is of the 3.75-6.5 inch capacity.

Water Availability from Bedrock: About 50% of the watershed is of bedrock that will make 10-100 gallons per minute, the other half is of bedrock that will make less than 10 gallons a minute.

Water Availability from Glacial Deposits: About 70% of the watershed area is of glacial deposits that will make 10-100 gallons per minute, with 30% of glacial deposits that will make less than 10 gallons per minute.

Mean Annual Precipitation: About 30% of the watershed gets an estimated 34-36 inches of rain per annum average, and about 70% gets 32-34 inches of rain per annum on average. Average number of Thunderstorm days (Flash events) is 28-32 days per year.

Total Annual Runoff: About 85% of the watershed has an estimated 15-18 inches per year of runoff, with about 15% of the watershed having 12-15 inches per year on average.

Average Annual Snowfall: All of the watershed area usually receives 100-120 inches of snow per year with an average of 120-140 days with 1" of snow or more. Some exceptional years (the winter of 2001-2002 for instance) can exceed 300 inches of snow.

Watershed: All 30,00 acres of the watershed falls within the Great Lakes Drainage Basin and is of the general type considered to be "short drainages directly to the Great Lakes (Lake Superior). The watershed restoration project focuses mainly on two main high quality stream systems, the Anna River and tributaries, and the Furnace Creek and tributaries. Another small stream, Sweat's Creek, another small tributary to Munising Bay, and once renowned for Smelt runs, is also under consideration for improvements. Munising Falls Creek is another Munising Bay source we are monitoring for educational purposes, and have transects above the fall on Pictured Rocks National Lakeshore property, and below the falls within the City of Munising, on the Hospital grounds.

The Munising Bay Watershed Restoration Plan

Our watershed restoration plan has brought together local residents, their community, and local government, over the common issues of watersheds degraded by erosion and sedimentation, impaired fisheries and potential threats to groundwater supplies. The watershed restoration plan is based on a planning process that educated the public through newsletters, information and education activities with the public schools, and gathering local input on watershed, natural resources, and resource-related recreational concerns from as many of the county's citizens as could be coerced into coming to a meeting, and filling and mailing in a resource concern survey. Additional input was received through personal landowner site visits, phone contacts, attending local Fish Committee, township, city, and county board meetings, and consulting with NRCS, MI-DNR, and MI-DEQ. The watershed plan drove investigation and identification of the causes, extent, sources, and degree of degradation or impairment, and herein recommends actions necessary to mitigate, restore, and protect impacted areas through direct mechanical, physical, and bioengineering techniques or protective covenants, conservation easements, or planning and zoning changes. Our watershed plan also seeks to create a network of interested stakeholders and volunteers who will continue to support the watershed goals and maintain installed practices into the future. Our Stakeholders include numerous interested local citizens and volunteers, representatives of a local sport fishing group, landowners, industries, city-township-county boards, road commissions, schools, civic groups, Boy & Girl Scouts, USDA-Forest Service, USDI-National Park Service, MSU-Extension, LMAS-District Health Dept., MDNR, USDA-NRCS, and the Alger Conservation District.

What are the Munising Bay Watershed Restoration Goals and How Were They Prioritized With Local Input?

The goals of the Watershed Restoration Project as evinced by it's project partners, landowners, the Conservation District board, and other local input, are to **restore** and repair, impaired designated uses of the watershed. The desire is to mitigate and protect identified critical areas of the rivers, streams, drainages, and groundwater recharge areas of the watershed, and remove, reduce or minimize impacts or threats to the designated uses of surface flows and groundwater. This Project also seeks to establish long-term local watershed support, monitoring, and cooperative conservation and maintenance of implemented best management practices by volunteers and watershed partners, while furnishing educational opportunities for the local schools. Another desire expressed in words and actions of local units of government and citizens responding to our resource concern surveys, was to enhance recreational opportunities for all citizens while protecting the resources that recreation impacts. The degree of impairments to designated and (and desired) use of water resources were considered by a Watershed Committee. All surface water in Michigan is automatically designated by the State of Michigan and protected for the following designated uses with the exception of #5 below.

1. Agriculture- not impaired, historic use, but none currently or likely, less than 5% agricultural land on the watershed.
2. Industrial Water Supply- not impaired, historic logging use, none currently or likely
3. Public Water Supply- not impaired, historic use, none currently
4. **Navigation- impaired by woody debris, but 90% of the watershed streams are too small for practicable navigation.**

5. Coldwater Fishery (Special Category)- Streams in the watershed are State Designated, Regulated Trout Waters and are severely IMPAIRED by sedimentation
6. Warm water Fishery- Not applicable
7. Indigenous Aquatic Life and Wildlife- IMPAIRED natural food chain affecting all trophic levels, by sedimentation of stream bottom or "benthic" habitat.
8. Partial Body Contact Recreation- not impaired, wading by sport fishers is common on this watershed.
9. Total Body Contact (May 1- Oct. 31)- not impaired, but not used here due to year-round cold water temps.

Interested citizen stakeholders and some agency representatives serve on the watershed committee. Each agency listed above also has a designated watershed committee member who is either a partner or signatory on the planning grant. The committee and county and township boards are presented with regular updates and findings of the watershed inventory, assessment, and recommended actions. The committee helped guide the prioritization process and helped in choosing cost-effective long-term solutions acceptable to landowners. The main prioritization process was by representatives of the 3 main fiscal partners, AuTrain Township (Supervisor-George Lucier), the City of Munising (Commissioner- Charles Steinhoff), and Munising Township (Twp. Supervisor- Jim "Curly" Wrosch). These three people indicated their approval of the developing plan after reviewing resource concern survey returns, site plans and preliminary proposals and provided financial commitments for further support. The Anna River, being the largest of the stream systems within the watershed, and having portions of which fall within each partners' geopolitical boundary, was prioritized as the primary focus. A great deal of effort at improving the upper reaches of the Anna, has been expended by local landowners, the Boy Scouts, and MI-DNR Fisheries going back to the 1930's. Each of the three main partners then selected critical areas within their respective boundaries that occurred inside the designated topographic watershed boundary as a secondary focus. AuTrain Township agreed with our findings on the Furnace Creek system as a secondary focus due to the rapid development occurring there and the atrocious nature of the road-stream crossings (the only other large stream system within both the designated watershed boundary and theirs). The City of Munising rightly chose St. Martin's Hill erosion site as the major secondary focus of watershed efforts within their boundary, and Munising Township chose their McQuisten Recreation Area development that is a part of the Anna River system. All three entities acknowledge worries about runaway development, perceived coldwater fisheries degradation, and their tourism-dependent economies, fire protection, and a desire for enhanced public recreation and handicap access, and mitigation of known erosion sites. For wholistic and logical analysis, the watershed manager decided stream systems should be "worked" from headwaters to mouth to find problem areas. Problem or "Critical" areas discovered where then presented in a slide show format at township or city board meetings, to take comment both public and official. Findings and proposed critical sites were published in a second newsletter to garner further public comment.

Primary Watershed Concerns	Impaired Designated Uses
1. Eroding Stream Crossings & River Flooding -------	Aquatic life/Wildlife
2. Poor Fishing ----------	Coldwater Fishery

Pollutants	Sources
1. Nutrients (suspected) -------	Livestock in Streams (not found)
	Failing Septic Systems (not found)

Residential Fertilizer Use (not in detectable levels)
2. Sediment (known) ---------- Found extensively in Anna River System and Furnace Creek System, and Sweats Creek, below road crossings; St. Martin's Hill site in Munising. Sources are eroding stream crossings, undercut banks, and stream banks at lower sand trap.
3. E.coli bacteria (suspected)-- Failing Septic Systems (not found)
4. Hydrologic Flow (known)-- Urban Storm Water (road and parking lot runoff, snowmobile trail runoff, road salt (chloride in winter)
5. Pesticides/Herbicides (suspected)-- not found, no agriculture on watershed, minor urban use probable.
6. Oils, Grease, Metals (known)-- not tested for, normally present in trace amounts but regulated in treated sewage wastewater, present in road, parking lot, and snowmobile trail runoff.

Impaired Use	Goals
Aquatic life/Wildlife	Restore fishery by sediment reduction
Coldwater Fishery	Restore fishery by sediment reduction

Desired Uses	Goals
Recreational Trails	Harden high use access areas with trails, boardwalks
Protect River Corridor	Encourage buffer plantings and zoning regulations

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Problem Statement-

To follow the guidelines laid out in numerous DEQ training sessions, and avoid or address previous "band aid" fixes of problem areas, the interim restoration plan will focus on the following priority actions and critical area treatments. These actions are deemed necessary to **restore** the impaired primary designated use as recreational cold water fisheries, of the Anna River and Furnace Creek systems of the Munising Bay Watershed. The lower stretches of both the Anna and Furnace systems are listed in the 2002 DNR- Inland Trout and Salmon Guide as Type #4 designated trout waters, open to Salmonid fishing all year. The upper stretches and all other streams on the watershed are listed as Type # 1 designated trout waters, with April-September seasons. Sedimentation of gravel and rock substrates has seriously impaired spawning of native fishes, and reduced cover and available habitat for aquatic insects and fish forage species. Sedimentation has provided increased habitat for the invasive non-native Sea Lamprey, facilitating reproduction of this species. Sedimentation has also reduced depth, created hydrologic instability, and widened stream channels, creating further erosion, and increased the frequency and potential for flooding and further property damage to homes and road systems.

Priority One: The Anna River System Restoration

Due to catastrophic sediment events caused by a 1960's highway project, a private artesian well blowout, and the erosion from several failed railroad crossings, the DNR-Fisheries Division litigated stream mitigation with Wisconsin-Central Railroad. This resulted in the installation of two sand traps and six spawning beds on the middle section of the Anna River. The responsible well owner provided a location for one sand trap, then the railroad upgraded their crossings, provided a location for the second sand trap, and built both traps. This was a classic "band aid" fix since the action failed to address sediments entering upstream from the two, very bad Perch Lake road crossings, Valley Spur Creek, and the sediments lost downstream and accumulated historically on the low gradient portion of the lower Anna

River at the time of the catastrophic event. At the time of these most recent sediment events, the Anna had not recovered from the 1960's highway project sediment event that covered at least 60% of available spawning substrates present at the time. The Anna River is barely able to keep up in terms of flushing, with the current annual inputs from natural erosion, tributaries, and existing road-stream crossings, and is unlikely to flush the buried cobble and boulders free from the previous catastrophic inundations without physical assistance. The Hiawatha National Forest has acknowledged the high quality and potential of this river system and recently invested in significant fisheries improvements (6 small k-dams) to the major Valley Spur tributary to the Anna, recently cleaning out the large sediment trap pond they have on the stream just upstream of highway M-94. So a reduction in sediments from the Valley Spur Creek source has already been addressed, with a mechanism in place to trap sediments from any future events. On the Anna River, one Wisconsin-Central sand trap is located immediately below the inlet of Valley Spur Creek on the Pasinaeult property, so interception of sediments from Valley Spur Creek, below the Valley Spur sediment trap, is occurring as long as the traps are cleaned annually. This only leaves two bad upstream road-stream crossings at the Perch Lake Road, the Anna River low gradient area sediment and debris accumulation, bank stabilization, rip rap, filter strip plantings, and removal of the defunct bridges and timber obstructions to address for a wholistic restoration. For a wholistic successful restoration, logic dictates working systematically from upstream end of systems to their mouth, addressing each critical area before moving downstream to the next one.

First Proposed Action: Installation of BMP'S and bottomless culverts at the Perch lake road crossings of the headwaters of the Anna River.

Both upper Anna River road-stream crossings (north and south branch) are located on a private access road (Perch lake Road) owned by Shelter Bay Forests, with deeded access to Perch lake property owners and others in the area. The extant crossings were installed years ago, before Shelter Bay ownership, when the road was narrower. They now are squashed and deformed from logging and gravel hauling traffic, too short for the road width, and have zero slope at culvert ends for riprap stabilization. They are undersized to the extent they back up during storm flows and exacerbate erosion occurring from the embankments, around the culverts, and constantly from the road surface. In addition the approaches slope down to the crossings, resulting in some other visible roadside and ditch erosion reaching the river at and immediately over the culvert ends. The site owner, Shelter Bay Forests, has provided a written commitment to cost share BMP's at both crossings.

The proposed BMP's for the Anna River/Perch Lake Road crossings are:

1. Replacement of the short, squashed, undersized round culverts with a wider and longer reinforced aluminum inverted arch culvert. This will answer several needs for restoration of the system. First it will allow enough culvert length to adequately riprap the culvert ends without expensive wingwalls and headwalls, and allow us to raise the road surface at the crossing to slope the immediate approaches away from the crossing. Use of HS-25 (40-140 tons) load-rated culverts will assure continued resource extraction (logging and gravel) and landowner construction activities without future culvert damage. The wider but similar height profile of the proposed culvert will stop the backup of water during high flow times and the associated erosion problems. The bottomless design will return stream bottom to natural, and aid in fish and aquatic insect migration. The multi-plate assembly with metal footing plates of the ConTech brand culverts, facilitates lower site preparation, assembly and installation expense. This allows quick installations of usually less than one day once the site is prepped.

The aluminum arch culverts have the lowest maintenance costs, wider acidity (PH 3-9) resistance than steel culverts, an indefinite life span (+100 years) or more in our water quality) due to their corrosion resistance, and have a proven long-term performance record even in highly abrasive or corrosive situations such as tidal estuaries and salt water environments.

2. Several ditch turnout/diversions consisting of rock-lined channels, would be put in place along the crossing approaches to control down slope erosion of road and ditch surfaces. Rip rapped areas (culvert ends, embankments and turnouts) would be underlain with erosion fabric during installation and staked with native plants or shrubs, and seeded at completion for additional filtering and infiltration capability.

3. We have already had one-half day of engineering measurements taken on these two crossings by an NRCS Watershed Engineer, for site plan development. NRCS Site plans are nearly completed, and we have been informed that the proposed culverts fit the stream profile and road bed perfectly, coming within 3" of current road height, and allowing more road fill.

Second Proposed Action: River Cleanup and Spawning Bed/Habitat Restoration on the lower Anna River. Due to the original native rocky substrate and low gradient on the lower Anna, sediments accumulating on this stretch have proven resistant to flushing. Sediments accumulated suddenly and continued for an extended period before upstream mitigation stopped the main, recent catastrophic sediment sources. This buried much of the native cobble and boulders beyond their ability to flush seasonally to the mouth area. To answer the problem of resistant sediment deposits and restore salmonid spawning and forage insect/fish habitat we would like to initiate the following BMP's.

1. Starting at the confluence of Wagner Creek (a sediment pool) and the Anna River, we would like to purchase and use two small, inexpensive, self-powered diaphragm pumps to systemically desilt the 2 mile long, flush-resistant areas of the lower Anna River down to the mouth area. Care would be taken not to deposit sediment into any wetlands. We would pump sand-laden water into reusable, silt-fence corrals to collect sediment and allow water to leak back over plastic sheeting to avoid any erosion from our actions. We have received offers from landowners, 44 individuals that volunteered for in-stream restoration work, and interest from schools, boy scouts, etc., to accomplish this work at a low cost (materials and supplies). The small diaphragm sediment pumps would also serve our long-range plans and would be used to service the Anna River sand traps and the sediment pool at the Wagner Creek tributary, long after the expiration of the railroad maintenance agreement. The resulting increase in stream depth (6"- 24") should increase stream stability, reduce likelihood, extent, and duration of flooding, increase stream channel velocity, reduce widening, meander and bank erosion, and without the current sediment input from the upper river, facilitate the flushing of annual natural sediment loads.

2. Following or accompanying the sediment removal as we work our way downstream, would be the installation of "velocity" rocks or groups of rock in areas lacking boulder-size cobble. These aid in natural sand flushing during high flow times, and serve as "fish loafing stations" during spawning migrations, and provide cover for forage species. DNR-Fisheries Division would guide final placement of such structures.

3. Once sediments are removed and scour zones are created with the aid of the first two BMP's, areas would be designated for restoration and/or creation of spawning areas. George

Madison of MDNR-Fisheries, estimated there would be an opportunity to restore spawning areas from Wagner Creek downstream, with a minimum of 10,000 square feet of spawning bed on the Horseshoe Falls Creek confluence with the lower Anna River area.

4. Volunteers, landowners, and staff would also be used for a Lower Anna River cleanup, to remove a large amount of old tires, vehicle parts, oil drums, metal, and other unnatural debris. Volunteers and staff would also assist with removal of the old electric salmon weir abutments on the Bruce Cromell property, and old bridge timbers located below highway H-58, with the permission of DNR Fisheries, Regional Supervisor, Steve Scott (received) and DEQ permits. Volunteers, landowners, staff, and the City of Munising would also assist with transport and disposal of debris.

5. Improvements should also include the proposed riparian tree and shrub planting for bank stabilization and shade on the Pasinaeult and Cromell properties, and for filter stripping between the Anna River and the City Snow Dump area near Horseshoe Falls Creek.

Third Proposed Action:
1. Landowner and watershed volunteer, Bruce Cromell, has indicated an interest in cost-sharing the replacement of the small (30’ x 9’), subsiding and rotten, wood, access bridge, and stabilizing the associated critically eroding stream banks, undercuts, and the weir sites through native plantings, fascine bundles, and rock rip rap. The bridge is a necessary (and only) access to an occupied rental house. The house has suffered flood damage repeatedly since the sediment deposition of the 1960’s highway project decreased the river depth here about 1-1.5’. Since the 9’ x 30’ bridge is the only access to an occupied building, blocks the river at high flow times, and spring breakup, exacerbating the scour and erosion instability on site, it is a prime candidate for inclusion in our restoration plan.

Fourth Proposed Action:
1. Before we move on downstream on the Anna River system, we should discuss the BMP’s planned for the Wagner Creek tributary, at the eroding culvert on the Cox Pond/Robert McQuisten Recreation Area. Due to lower flows and recreational development plans by Munising Township, this site only needs repair, not replacement, with the aim of hardening a high-use area, mitigating erosion occurring on site, and enhancing recreational access. BMP’s would consist of pulling back the existing improperly placed riprap, and proper placement of erosion fabric, accompanied by redesign and reshaping of the inlet/outlet area. The township has applied to the Fisheries trust fund for a grant to Plant Brook Trout, dredge the upstream side to facilitate habitat improvement, and installation of a fish barrier to keep planted fish from migrating down over the Wagner Falls. The dredging will facilitate and enhance the placement of a Munising Township dry hydrant for fire protection at this site as well. We intend to use the site for at least two erosion control workshops where participants would engage in hands-on placement of materials, including proper sized riprap. Some provision needs to be made to prohibit vehicle access to the streambed at this point. This may be accomplished through connection to the McQuisten handicap-access boardwalk on the upstream (east end) side, and construction of a fishing access or wildlife viewing deck on the downstream (western end). The township has already secured a large Michigan natural resources trust fund grant for the recreation area development.

Eventual Future Action on the Anna River:
1. Below H-58, to the mouth of the Anna River, we have chronic severe erosion occurring along the Kimberly-Clark Paper Mill settling pond. Old dock or walkway timbers protrude

into the river along the west bank at this site, causing bank scour, slumping, and some subsidence. Many old timbers from historic road crossings or other structures, stick up vertically from the river channel contributing to the ice and water damming and erosional processes that occur at ice breakup, snowmelt, and other high flow periods. We believe the old timbers could be easily removed at no great cost, but the bank erosion along the Mill property needs further study as to the best solution, given its proximity to Lake Superior and frequent inundation. Toward this end we have an erosion-control engineer specialist, (scheduled for May 16, 2002), to tour all the problem sites on the watershed and give recommendations for mitigation techniques, cost savings to proposed BMP's, etc.
2. Further study is necessary, to determine whether additional filter stripping, or installation of perforated drain and (buried) vortex/separator boxes are necessary or prudent between the snowmobile/ATV trail and the Anna River. The trail runs parallel to the river for 300-400 yards, directly crossing two small drains, and the river itself (a wooden bridge), all of which may impact the river with oil and fuel contaminated runoff. The parking areas surrounding the lower Anna also allow runoff to flow directly off surfaces into an open ditch storm drain system that empties directly into the river just below the M-28 bridge.
3. A small stand of the invasive exotic plant, Purple Loosestrife is growing on the lower Anna River corridor near the Hardee's Restaurant. Pictured Rocks is working with the watershed manager to develop a plan for hands-on educational workshops to address this problem starting in the spring-summer of 2002. This would involve consultation with the botanists of the local Forest Service, Park Service, and our Forester to develop remediation.

Priority Two- City of Munising – St. Martin's Hill/Varnum St. Extension:
1. This steep and difficult critical erosion site would be re-shaped with heavy equipment, lined with 2 types of Curlex (aspen sandwiched between mesh) erosion fabric "stapled" or pinned to the slope, and receive at least six rock check dams over the fabrics, and at least six rock-lined diversion-turnouts, seeding, and stakes of native, shade-tolerant shrub species. Shade tolerant shrubs will be staked on the check dams as well to hold them in place and provide increased down slope filtering and infiltration effect. This should effect a long, sloping "grassed" waterway for better infiltration and completely "heal" the site. Fabrics would be anchored and buried at roadside, then the final BMP would be paving (2,640') of the road surface. This large-scale critical erosion area has a high potential as a demonstration site for soft engineering practices.

Priority Three- Furnace Creek System
1. Here we depart from the upstream first priorities used for the Anna river restoration rationale. Due to recurring overtopping problems, and the immediate availability of non-CMI funds ($10,000) from USFWS, First proposed action on this system would be engineering of a site plan and the replacement of the outlet culvert of Furnace/Carr Lake with an longer and wider, arched box culvert. This site has also been selected for installation of a dry hydrant for AuTrain Township fire protection, and placement of a lamprey barrier by USFWS-Lamprey Control. The Landowner has made a written cost-share commitment, and proposed providing the heavy equipment, labor, and culvert installation. The USFWS is willing to put $10,000 toward the costs of materials and installation of the removable lamprey barrier in the new culvert. Other associated BMP's would include erosion fabric, riprap, head and wingwalls, and raising the roadbed to slope away from the crossing. The proposed culvert would be a box arch with bottom, and would offer almost three times the current culvert cross-section, alleviating the overtopping and road erosion occurring frequently at this time. Since the materials and installation would be covered by the landowner and the USFWS, we feel it would be a good use of 319 planning money to immediately proceed with the engineering

and site plan. The USFWS has approved release of the funds for this fiscal year, and the culvert replacement would have to take place at low water time in August or September. All parties are anxious to proceed. The sediments confined in the lake lay below the lake outlet and are attractive to spawning Sea Lamprey. The Lake has a viable Northern Pike population, yet is a thoroughfare for migrating Coho Salmon, Rainbow/Steelhead, Coaster and Inland Brook Trout, Whitefish, Walleye, and White Suckers. We found Coho were able to make it as far upstream as the Ridge Road crossing of the Gangeau Creek, and the M-28 crossing of the Hanson Creek. This is a highly desirable project for restoration of the Furnace Creek System. The Old Lamprey Weir downstream in Furnace Creek needs some study in the future to determine whether it should be removed. Several landowners feel it has caused scour and sediment deposition, and should be removed, since it is no longer used.

2. The next priority action would be replacement of the culvert at the Hanson Creek Crossing of Hanson Estates (Jurmu property), and the three culverts at the Hanson Creek crossing, and two Gangeau Creek crossings located on the Carr Road at the back of Furnace/Carr Lake. The Carr property culverts are "atrocious" crossings and are well known to DEQ enforcement personnel (Joan Duncan, personal communication). They are also perched on elevated sandy roadbeds, placed over wetland soils with considerable perched water all around. The BMP's would include placement of rock substrate and bottomless aluminum arch culverts that match the bankfull width of the stream, and prevent the backup and ponding that chronically erodes the road surfaces into these streams. This road system is in a continuous high use area, close to a casino and housing development, as well as being used to access gravel and sand pits. It also provides an important access point for forest management. All of the culverts on these locations are smaller than DEQ storm calculations show would be advisable for smaller flows upstream. BMP's would include longer culverts, providing for proper roadside slopes for rip rap, erosion fabric, staking and seeding native plants, and adding road fill and gravel, elevating the roadbed at the crossing to slope drainage away from the crossing. This would completely restore the road-stream crossing to as close to natural as possible, with a permanent, no maintenance, high load (HS-25: 40-140 ton) solution. The Hanson at Jurmu crossing mitigation would include pulling caved riprap from where it has fallen into and blocks the flow channels at both ends.

4. The final action on the Furnace Creek system, is the replacement of the single culvert at the Ridge Road crossing of Gangeau Creek with a wider, longer, bottomless aluminum culvert with a high load rating (HS-25). It overly constricts flows, and blocks the upstream migration of salmonids, is undersized and too short, and causes ponding and erosion of organic mucks into the creek upstream of the culvert. BMP's would be similar to the other crossings, including erosion fabric, elevating road surface, extra culvert length to allow riprap at roadside at a proper slope, but would also include two sediment logs or fascine bundles, staked across the upstream roadside sediment pools, and placed at either side of the flow channel. This would stop the migration of muck into the stream at this site, catch the sediments, and allow emergent plants and grasses to eventually vegetate the erosion area.

Furnace Creek System: Future Considerations:

During the last week of April, a major sediment event occurred on and adjacent to a 29 acre site just southeast of Furnace Lake, owned by Mr. Kevin Kolbus. The site was developed illegally without permits, and operates as a dirt racetrack for cars, trucks, motorcycles, ATV's and snowmobiles. As a result of unusual warm weather and sudden snowmelt, it experienced major slope failures, gullying and rills, and resulted in sediment inundation of a small wetland on adjacent property owned by watershed cooperator, Shelter

Bay Forests. Because of the high clay content of the soil, clay-laden water flowed downslope along an intermittent but well vegetated topographic drainage channel to the headwaters of the west branch of Gangeau Creek. Most of the heavy sediment was intercepted by vegetation and trapped by the roadside ditches and the adjacent wetland area, so did not make it to the permanent stream channel. Suspended fines transported as clay-laden water did flow through the channel directly into Carr/Furnace Lake, and then on into Lake Superior for a period of about 2 days. Subsequent rains washed evidence of the fine silt from the vegetation but flow patterns in last years' dead vegetation were clearly evident.

This large-scale site will require further study and analysis as to mitigation options, and may be subject to litigation by DEQ, due to apparent violations of the Soil erosion and Sedimentation Act, Inland Lakes and Streams Act, and the Wetlands Act. The landowner is eager and willing to find a solution, or apply for cost-share practices under the watershed restoration plan, but indicates the racetrack enterprise is virtually insolvent.

Pollutant Sources	BMP Reference	Potential BMP Systems
Road-Stream Crossings	Michigan Guidebook for BMP's & DEQ training notes	stream crossings BMP's
Streambanks	Michigan Guidebook for BMP's & DEQ training notes	stabilization BMP's
Failing Septic Systems	Information & Education	referral to Health Dept.
Residential Fertilizer Use	" "	referral to Cons. District
Residential Herbicide Use	" "	referral to Cons. District
Residential Pesticide Use	" "	referral to Cons. District

Watershed Management in Alger County: Successes & Frustrations
Long-Term Planning

Several successes: We have garnered a lot of local support and attention through establishing a popular educational program for the Mather Middle School described in the methods section of this paper. The schools desire to continue involving science students in watershed and water quality monitoring as a component of their science education. We have began to work with the local High School, and have also worked with the Boy Scouts who desire to be involved with fisheries enhancement efforts, as they have done successfully in the past. We have a significant number of volunteers (62), who have indicated a willingness to work on watershed projects. We now have the testing and survey equipment to continue long term educational efforts, monitoring of water quality, sedimentation, and improvements in populations of aquatic life and wildlife on the watershed. We possess the tools for mapping and photo documentation as well as training and equipment to facilitate reporting. We have assembled a considerable list of reference materials, BMP manuals, DEQ training notes, etc. Throughout the watershed planning process, the Alger Conservation District and its watershed manager have advocated the establishment of a county soil erosion control, and permitting program, to bring the county into compliance with state law, further protect county soil and water resources, and exert some control mechanism over runaway development. The district created sample budgets and offered to take on the role for the county as districts have done in other parts of Michigan. The County Board however, recently designated a ½-time erosion control officer and program, to be administered by the County Road Commission and supported by county money and permit proceeds. The watershed manager is already working with the new enforcement officer, conferring on several site mitigations, and to help develop a rapid response plan and a modest list of

materials and equipment desirable for emergency intercession measures for catastrophic flood and sediment events, oil and gas spills, toxic chemicals, or other likely natural resource emergencies not already covered by other agencies. Such materials could consist of erosion fencing and fabrics, staking, absorbent floating booms for aquatic spills of oils, hydrocarbons, caustics, etc., in common use or transported though our area.

Our hopes of establishing riparian and shoreline buffer language in current new county zoning code developments were not so successful, and have been delayed. The County board turned zoning over to the townships, so all programs are starting from scratch this spring. Most townships have not peopled or convened the necessary boards yet. The township of Rock River, responded by a declaration that there will be no zoning! This unforeseen event will make unified county-wide zoning difficult and maybe impossible. Most townships will enforce some sort of local zoning similar to what has been established, and we will still have a chance to educate the new zoning boards on desirable watershed and well head protection buffer language.

Another success, and attempts at enhancing groundwater protection, resulted in the discovery of 3 abandoned wells through presentations and advertising. Though all three were located outside the set watershed boundary, we are facilitating closure by providing guidelines and technical advice to the State Forest, who is closing the only dangerous, open pit well at their cost. The fate (and ownership) of the other two (a steel pipe and concrete boxed pipe) are of lower priority and yet to be determined. We held a dry hydrant workshop, well attended by county fire departments, and provided guest speakers and printed technical guides, and grant assistance information. Later we located water resource locations for 3 new dry hydrants on area streams for 3 township fire departments. A dry hydrant on the watershed we helped engineer previously has been used several times!

Munising Bay Watershed Restoration Plan Summary

The Munising Bay Watershed Restoration Project fostered a unique partnership between a variety of state, federal, and county agencies, and brought together area residents, community, and local and county government over the issues of watersheds degraded by erosion and sedimentation, impaired fisheries and potential threats to groundwater supplies. The local governments involved, unanimously supported a wholistic vision of watershed restoration efforts, to the point of providing the cash match to secure a Section 319 planning grant. The Restoration-Implementation Plan is based on a planning process that educated the public and gathered local input on watershed, natural resource, and resource-related recreational concerns and priorities. The watershed plan investigated and identified the causes, sources, and degree of degradation or impairment, and recommended action to mitigate, restore designated use, and protect impacted areas through direct physical and bioengineering techniques, conservation easements, or planning and zoning changes. The watershed plan created a network of interested stakeholders, partners, and volunteers who will continue to support the watershed goals and maintain installed practices into the future. The Munising Bay Watershed encompasses ~30,000+ acres comprised of 74% forest, 13% wetlands, 10% urban, and 3% agricultural. The primary designated use for streams on the watershed, are as recreational cold-water sport fisheries.

In addition to providing meaningful progress toward Lake Superior LAMP goals (Lakewide Area Management Plan), the implementation of the restoration plan and best management practices identified for each critical priority site, will greatly enhance and restore severely impaired, designated use of coldwater fish and invertebrate prey habitat through sediment input reduction and removal. This will also improve and increase spawning areas available

for whitefish, walleye, smelt, trout and salmon. Filter strips and riparian buffer plantings will stabilize stream banks and reduce runoff of contaminants from lawns, roads, parking areas, and the municipal snow dump. Boardwalks and fishing platforms will harden high use areas, minimize negative impacts to native vegetation and erodable soils, and enhance public access and multiple-use goals identified by project partners. The stabilization of a critically eroding slope in the City of Munising will greatly reduce direct sediment input into the harbor and fishery of Munising Bay of Lake Superior, and would serve as a great demonstration site for modern bioengineering techniques.

Following this summary is a list of Sites, BMP's, and costs. In the Appendixes for each stream system or individual stream site are data sheets, site plans, photographs of sites or problems. Stream station description data sheets contain water quality, flow data, and stream bottom types and sediment embedment information. Issac Walton League Stream Quality Rating guides based on aquatic insect populations and diversity are also included.

The implementation plan was originally scheduled to occur over a three-year time schedule, as submitted in our implementation grant proposal. It was to be performed by the Watershed Manager and the Alger Conservation District.

Measurement of Implementation Project Success: Success of BMP's used in the restoration plan will be measured by the amount of sediment reduction and increases in spawning habitat, increases in populations of fish and aquatic invertebrates; and erosion stabilization achieved.