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APPENDICES

Grand Traverse Bay Watershed Protection Plan

APPENDIX A: PLAN DEVELOPMENT PROCESS

This Appendix includes information regarding the project steering committee; the initial project's planning process; use of a website to disseminate information; and the public information and education strategy used during project. In addition, a summary of the second project to update the protection plan is provided at the end.

INITIAL PLANNING PROJECT (DECEMBER 2001-2003)

Many tasks were conducted to develop the Grand Traverse Bay Watershed Protection Plan. Developing a protection plan for the 976-mi^2 watershed required a large amount of planning and cooperation among organizations, as well as compiling a large amount information into a single document. The following bulleted list highlights some of the key components of the plan development process.

- Steering Committee
  - A steering committee, comprised of local and statewide experts and interested citizens, was formed at the beginning of the project. This committee guided the project to completion and made key decision regarding findings and reporting information.
  - The committee met approximately every other month.
  - List of steering committee members (project vendors in bold):

    Sarah U'Ren, Anne Brasie, John Nelson, and Anne Hansen: The Watershed Center Grand Traverse Bay
    Greg Goudy: Michigan Department of Environmental Quality
    Jim Muratzki: Land Information Access Association
    Matt Heiman: Leelanau Conservancy
    Jim Haveman, Laura Keuhn: Conservation Resource Alliance
    Megan Olds, Viet Doan: Northwest Michigan Council of Governments
    Tom Wessels: Grand Traverse Regional Math, Science, and Technology Center
    Matt McDonough: Grand Traverse Regional Land Conservancy
    Gordon Hayward: Peninsula Twp. Planner
    Russ Adams: Silver Lake Association
    Mary Wilson, Patty O'Donnell: Grand Traverse Band of Ottawa and Chippewa Indians
    Steve Largent, Lew Coulter: Grand Traverse Conservation District
    Maureen Templeton: Grand Traverse County Drain Commissioner
    Tom Buss: Grand Traverse County Health Department
    Russ LaRowe: Kalkaska Conservation District
    Natasha Lapinski, Chris Grobbel: Ball Environmental Associates
    Tom Emling: MSU-North
    Barbara Nelson-Jameson: National Park Service
    Bob Cole: City of Traverse City, Department of Public Works
    Tom Kelly: Inland Seas Education Association
    Gerry Harsch: Garfield Township Planner
    John McKinney: MSU Sea Grant
    Bruce Knapp, Tom Adams, Buzz Long, Pepper Bromelmeier: Natural Resources Conservation Service
    Bryan Pijanowski: Purdue University (formerly of MSU)

- Project Website
  - As part of this project, the Watershed Center's website (www.gtbay.org) was extensively revamped in January 2003. It contains updated general information

on The Watershed Center, as well as detailed information and data on the watershed as it was gathered and compiled for the project.
    - The website also serves as a data repository for steering committee members; meeting notes and agendas, and project documents were posted for review by steering committee members.
    - A calendar of events was also available for visitors to the website.

- Public Information and Education (I/E) Strategy
  To get the word out about the project and to generate public awareness regarding the Grand Traverse Bay watershed, an extensive information and education strategy was implemented throughout the project. The following items were used as either educational tools or as ways to gather information regarding stakeholders' opinions of threats to water quality, watershed goals, and desired uses.
    - Newsletters – a quarterly newsletter was printed and distributed to approximately 1,200 individuals outlining progress and projects pertaining to the plan.
    - Press Kit – A press kit containing general project and watershed information fact sheets was created.
    - Project Brochure – A simple brochure about The Watershed Center and the project was created. In addition, a simple flyer was created as a take-home piece for use at stakeholder meetings.
    - Bay Day – We hosted Bay Day in both June 2002 and June 2003, providing attendees with fun, interesting opportunities to learn about the watershed and the protection plan.
    - Regional Watershed Conference – We co-hosted a two-day conference in August 2003 to help educate regional government officials and others about watershed protection planning and other related issues, such as, water quality monitoring.
    - "Freshwater Focus: The State of the Watershed" – We produced a 16-page insert to the Record Eagle (c. 42,000) to educate area citizens about the plan and key issues that the plan will address including nutrients, sedimentation, land use and growth, etc. An additional 5,000 copies were printed for further distribution.
    - Household Survey – A survey was conducted by M-TEC Business Research Services, a division of Northwestern Michigan College, to determine what water quality issues area residents were concerned about, their level of knowledge on watershed issues and basic demographics.
    - Focus Groups – Conducted series of six business focus groups: agriculture, manufacturing, Grand Traverse County, Leelanau County, Antrim County, and Kalkaska County. Objective was to explore area business people/owners water quality concerns and ideas for protection, as well as perceived obstacles to natural resource protection. Report compiled by M-TEC Business Research Services of Northwestern Michigan College.
    - Friday Night Live – Had booth with project information at 3 downtown Traverse City "Friday Night Live" events (7/25, 8/1, 8/29)

- Stakeholder meetings

What	Where	When
Governmental and Public Stakeholder Meetings Meetings included: • presentation about the 319 Project • time for participants to share their water quality and pollutant concerns • handouts for participants to take back regarding general project information. *A partial summary of results of these meetings is in the Spring 2003 newsletter.*	Antrim County	Gov: 2/25/03 Pub: 4/10/03
	Grand Traverse County	Gov: 2/27/03 Pub: 4/28/03
	Kalkaska County	Gov: 3/4/03 Pub: 4/8/03
	Leelanau County	Gov: 3/6/03 Pub: 4/22/03
Other Stakeholder Meetings Meetings included a presentation explaining The Watershed Center and the Planning Project. Since the presentations were made at regular meetings of these organizations they were under time constraints and kept short.	TC Rotary Club	1/7/03
	TC Sunshine Rotary Club	1/8/03
	Three Lakes Association	5/12/03
	Elk Rapids Historical Society	4/24/03
	Northport Lions	6/11/03

TRANSITION GRANT – PLAN UPDATE PROJECT (JULY 2003 - DECEMBER 2005)

The initial Grand Traverse Bay watershed plan was completed in December 2003 and approved by the DEQ under the Clean Michigan Initiative bond criteria. The following year, the plan needed to be updated to meet new EPA criteria for the Section 319 funding program. The Watershed Center Grand Traverse Bay was awarded an additional Section 319 grant (called the 'Transition Grant') to complete the plan update. The 2005 revisions include additional information on pollutant sources and concentrations, load reduction estimates of various BMPs, measurable milestones to guide implementation progress, and a set of criteria to evaluate the effectiveness of implementation efforts.

The Steering Committee met twice during the 18 month project and helped to guide the plan update. During the transition grant period a number of outreach activities were conducted to get the word out about results from the protection plan and to generate public awareness regarding the Grand Traverse Bay watershed. The activities included: an updated project display, a stormdrain stenciling event, newsletters, two editions of Freshwater Focus, updated project website, and a reprinting of The Watershed Center's Great Lakes Shoreline Property Owners Guide.

APPENDIX B: PROJECT EVALUATION

(DECEMBER 2001-2003)

Note: This is an evaluation of the initial planning project conducted by the Conservation Resource Alliance. It does not include an evaluation of the additional project (Transition Grant) from July 2004-December 2005 to update the protection plan to meet the newly implemented EPA criteria.

An evaluation of the watershed protection planning process was completed by the Conservation Resource Alliance (CRA) during the mid- and final-project phases. CRA was subcontracted by The Watershed Center to conduct the evaluation using the "Seeking Signs of Success: A guided approach to more effective watershed programs" guidebook (Beyer et al. 2001).

The evaluation process involved tracking the progress and success of each of the project tasks outlined in the project work plan. CRA worked with the project steering committee to establish a task force to aid in the development of the evaluation process for the project. It was determined that goals and activities that needed to be completed to accomplish those goals should be developed for each task. The party accountable for each task was responsible for working with CRA to develop the goals and activities. CRA developed forms for evaluating progress towards reaching the goals and for retrieving general feedback (i.e.: project success and frustrations) from subcontractors and the steering committee at large. CRA worked with the steering committee to conduct an evaluation of the planning process at the mid-project point in November of 2002 and near project completion in November of 2003. The feedback was summarized, compiled into a report and presented to the steering committee by CRA.

The mid-project and final project evaluation reports and evaluation feedback questionnaire responses are available for review at The Watershed Center. The general findings from the mid-project evaluation indicated that progress was being made on all tasks, however complications with staff transition and the project contract at the start of the project resulted in some deviations from the project schedule. The Watershed Center worked closely with MDEQ to revise the project work plan and timetable to include an extension of one quarter. Participants felt that future proposals would benefit from inclusion of an advanced communications task to allow for set up prior to the first quarter of project activity. It was also decided that an evaluation strategy for the upcoming implementation phase of the watershed protection plan would be beneficial.

The final project evaluation indicated that all project tasks would be successfully completed and within schedule. A couple of project activities were dropped or revised due to change in the scope of a task. The biggest struggle in the final phase of the project was obtaining participation from the full steering committee for reviewing the draft portions of the watershed plan.

During the second year of the project, CRA worked with the steering committee to draft an evaluation strategy for the implementation phase of the watershed protection plan. The strategy discussed methods for tracking and evaluating the success of plan implementation. That plan has been revised and updated to include newly implemented EPA criteria for watershed protection plans and is found in Section 7.5.

APPENDIX C

FIELD ASSESSMENT OF THE GRAND TRAVERSE BAY SHORELINE

Click Here to View the Grand
Traverse Bay Shoreline Report

APPENDIX D

SUMMARY OF EXISTING WATERSHED PLANS AND OTHER RESEARCH STUDIES

Summary of Existing Watershed Plans and Other Research Studies

Subwatershed	Existing Studies	General Findings	Environmental Stressors/ Pollutants	Sources
Elk River – Chain of Lakes	1. Watershed Master Plan July 1989 – NWMCOG 2. Watershed Management Plan July 2001 – CRA	1. WQ threats and concerns = planning/zoning for development, septic tanks, loss of wetlands/natural areas/open space, use conflicts, stormwater runoff, erosion/sedimentation, industrial pollution, oil/gas/brine wells and LUSTs, low and fluctuating water levels in upper Chain of Lakes area Conclusions: *headwaters just as impt. as more visible lakes/streams *economics based on maintaining high quality resources for recreation and quality of life *maintaining natural vegetation and wetlands is key *reduce man-made inputs from septic/stormwater/chemicals/other 2. Lists 5 specific watershed Goals with corresponding Objectives, and Strategies: *protect/improve quality of water resources *protect integrity of system *preserve the distinctive character and aesthetic qualities *establish land management practices which conserve natural res. *establish and support educational programs *utilize steering committee as coordinating body <u>General facts:</u> 491 mi^2, 23% water, 200^+streams, 138 miles of Desig Trout Stream	Sedimentation Toxins Nutrients Hydrological Flow Thermal Poll?	Rd. Str. Cross Bank erosion Construction Wells Indus.Poll Stormh20 LUSTs Septics Stormh2o H2O levels Dams Stormh2o Lack canopy

Subwatershed	Existing Studies	General Findings	Environmental Stressors/ Pollutants	Sources
Acme Creek (including a study with Yuba Creek)	1. Acme Creek Watershed Planning Project June 1995 – GT County Drain Commission 2. Acme/Yuba Creek NPS Implementation Project April 2000 – GT County Drain Commission	1. WQ concerns: sedimentation, nutrient loading (golf courses), res. and ag. lands, and stormwater runoff (from inc. imperv surfaces) *Developed watershed database (wetlands, parcel lines, slopes, land cover, twnp zoning, potentially sensitive areas) *Existing ordinances weak and not targeted to protect creek/fish hab *Specific streambank erosion sites/inadequate culverts noted *Public concerns: golf course practices, road construction, and protection of headwater areas *DEQ bio 1994 bio survey: macros slightly impaired <u>General facts:</u> 12.6 mi^2, drains to East Bay; Acme, East Bay, Whitewater Twp., 62%forest, 12%urban, 10%open, 9%wetlands 2. Land Protection: Deepwater Point Natural Preserve, Frost property, Spindrift property I/E: watershed landowner's handbook, road signage BMPs: corrected all severe runoff erosion sites (prevented 73 and 70 tons of sed/year from entering Acme and Yuba Creeks)	Sediment Nutrients Toxins? Thermal Poll?	Rd St Cross Bank erosion Construction? Stormh2o Golf Course Ag. Runoff Stormh2o Stormh2o Lack canopy
Acme/Yuba/ Mitchell Creeks	Mapping Impervious Surface Coverage for Watershed Monitoring and Land Use Planning GT Co. Drain Commissioner's Office and GIS Dept – ####	Defined as any surface in urban landscape that can't effectively absorb or infiltrate rainfall (road, sidewalk, parking lot, roof) Impervious surface important WQ indicator; stream degradation occurs at % impervious levels bt/n 10% - 20% Mitchell Creek: 8.9% impervious; 7 of 29 subbasins > 10% Acme Creek: 4.2% impervious; 2 of 11 subbasins > 10% Yuba Creek: 2.4% impervious Efforts to control impervious areas could be an effective approach for protecting WQ and quantity; Land use planning; impacts of zoning buildout…	<u>Imperv. Areas</u> Stormwater Nutrients Thermal Pollution Toxins Hydrology Sediment Red. Infilt.	

Subwatershed	Existing Studies	General Findings	Environmental Stressors/ Pollutants	Sources
Mitchell Creek	1. NPS Pollution Study 1991 – Gosling Czubak Associates and Battelle Gr. Lks. Env. Center 2. Implementation Project Final Report 1995 – GT Co. Drain Comm. 3. Watershed Protection Strategy 1995 – GT Co. Drain Comm.	1. Critical areas = wetlands & gh2o recharge areas General recommendations: GT County Soil Erosion and Stormwater Runoff Control Ordinance, preserve wetlands, install riparian buffer zones, create/preserve forest cover, protect gh2o recharge Specific recommendation: install agricultural, golf course, and urban stormwater BMPs 2. Outputs: * Watershed protection plan; * BMPs (246 acres in ag. management program & 1200 ft. streambank stabilized); * Land Protection: land owner database, land owner's handbook, 158 acres protected; * Organizational structure/ intergovernmental support; *GIS database; * I/E: cleanups, tree plantings, signage, video "Beyond Boundaries, A Community Approach" 3. Contains recommendations relating to the amt, type, and location of development, size of stream setbacks and wildlife corridors, viewshed opportunities, and other components <u>Assessment of Natural Systems:</u> Aquatic Resources: fisheries quality fair-excellent, numerous stream segments have excessive sediment deposits Wildlife Resources: lower portion has good diversity Wetlands: 4 critical wetland areas, development pressure Aquifer Recharge Area: located in headwaters, higher elevations <u>WQ Problems:</u> excessive sediment, elevated nutrients, urbanization threatening gh2o recharge, drinking h2o threats WQ and aquatic diversity are good in spite of obvious degradation – recommended to control erosion/sedimentation and thermal poll <u>General facts:</u> 14.7 mi^2; drains to East Bay; Blair, East Bay, Garfield Twp and City of Traverse City; headwater area = steep slopes, middle/lower = flatter w/ wetlands; 16 miles of high quality trout stream; significant gh2o contrib. (gaining stream); land use shifting from agriculture and forest to urban (13%)	Sedimentation Nutrients Hydrological Flow Thermal Poll Urbanization?	Stormh2o Rd St Cross Bank erosion Construction Stormh2o Reduc. of Wetlands Reduction of gh2o recharge Lack canopy Stormh2o

Subwatershed		Existing Studies	General Findings	Environmental Stressors/ Pollutants	Sources
Boardman River	Boardman River (entire)	1. Section 319 Success Stories 1997 – EPA 2. Restoration and Protection Project 1999 – GTCD	1. Stabilized 96 sites on River, Prevented 1200 tons sed/yr, Used bioengineering practices (native plants, whole tree revetments, log cribbing, vegetation to water's edge, veg. w/ rock rip rap, fish lunkers, composted leaves), Installed 4 sand traps, Educational materials (brochures, display, t-shirts, video-"Currents of the Boardman", three 30-second PSAs), GT Reg.Land Conservancy protected 600+ acres and established endowment fund 2. No *impaired* designated uses: ch2o fishery and total body contact threatened, has list of pollutants and sources with paragraphs detailing information DNR P51('93-'96) = 54% index stations good, 46% fair; occasional health advisories (sewage); 600+ erosion sites neg. impacting aq. habitat; DNR ('86) lack of adequate trout cover and spawning gravel, ('94) improving, need for continuous erosion control work and sand trap maintenance Steering committee prioritizations: road/stream crossings, streambank erosion, recreational activity, urban stormwater runoff, and land fragmentation Six project goals: Implement BMPs to reduce sedimentation… Permanently protect critical riparian areas thru conserv. easements Evaluation effectiveness thru WQ/bio monitoring & public comment Monitor & maintain all past and future restoration activities Education Involve citizens, public agencies, user groups and landowners W/in 5 years, develop Boardman R. Restoration & Protection Fund <u>General facts:</u> 295 mi^2, GT and Kalkaska Counties, Blue Ribbon Trout Stream and Natural River, 50+% forested-12% urban	Sedimentation Thermal Poll. Nutrients Pathogens	Rd St Cross Bank Erosion Rec activities Stormh20 High flow Velocity Ag activities Impv surface Hydro prod Timber harv Animal waste Stormh2o Septic Riparian graz Sewage Trt. Stormh2o Riparian graz Animal waste

	Kid's Creek	Stormwater Management Plan 1991 – FTC&H (for Garfield Twnshp and TC)	Project Goals: protect nat. resources, existing residential units adjacent to stream, and to control potential detrimental impacts resulting from stormh2o runoff <u>Specific Problems in Kid's Creek:</u> Flooding – due to inc. stormwater runoff, Soil Erosion and Sedimentation, Streambank Erosion, and Water Quality – potential thermal pollution included Contains both structural and non-structural recommendations <u>General facts:</u> 4.3 miles long, trib to Boardman, designated trout stream, heavy and rapid urbanization	Sedimentation Thermal Poll Hydrologic Flow	Rd St Cross Stormh2o Bank erosion Stormh2o Lack canopy Flooding (stormh2o)
	Miller & Jack's Creeks	NPS Pollution & Stream Habitat Report March 1998 – GT Conservation District	Major Resource Concerns: 1. Perched Culverts – 4 of concern (2 in each), greatest threat to biological health 2. Sediment – Miller = 22 sites, Jack's = 8 sites 3. Nutrient Loading – buffalo farms in hw of both 4. Trash – esp. Miller behind GT Crossings u/s to US 31 5. Stream Habitat – Miller u/s Cass Rd = sandy, d/s = good hab; Jack's u/s Cass Rd = lacks wdy debris and cover, d/s = good 6. Riparian Land Use – steep slopes and gh2o seeps impt. (developers must strictly adhere to soil erosion and sed. control ordinances) <u>General facts:</u> 14.7 mi^2; subwatersheds/tribs to Boardman, located entirely w/in Garfield Twnshp	Sedimentation Nutrients	Rd St Cross Bank Erosion Ag farms Stormh2o
	Boardman Lake/ River	The Collection and Analysis of Sediment Samples from the Boardman LakeRiver GLEC – 2002	Report done for DEQ: *July 1997 – sediment core sampling to det if lake sediments had been impacted by the Q of contam from pt and nonpt sources – current report reanalyzes toxicity of sediments from 3 spots *Results indicate that there are elevated conc of contam in the sediments in B Lake and River at sampled locations, in some areas are toxic and have potential to neg affect benthic organisms (measured = PAH's, metals, toxicity to zooplankton)		

	Silver Lake	1. Silver Lake Summary & Issues 2002 – S.L.Assoc. 2. Fish Collect. Data 1994 – MDNR 3. Silver Lake WQ Trend Analysis 2000 – GLEC	1. Runoff and spring fed; Land use from ag to residential, GT County pop increased 272% from 1950-2000; 300 properties year round residences w/ approx 100ft of shoreline; ¼ mile of 8mi perimeter is undeveloped; Overflow drain completed in 1987, max of 862 ft above sea level (to Beitner Crk, trib to Boardman), sporadic flow, turned off when temp is 68^{o}F+; Development has eliminated small wetland pockets; 53 erosion sites identified; WQ testing spring and fall since 1993 – TP/secchi disk/chlorophyll a/temp/DO Designated uses threatened: Navigation, other indigenous aquatic life, warmwater fishery, total/partial body contact 2. Lack of bluegill and yellow perch special concern, which were abundant in 1982; walleye/smallmouth bass/ largemouth bass growing below state average 3. Water quality data collected from 1993-99 P is primary algal growth limiting nutrient; Bottom-water has low DO in north end, demonstrates potential for WQ degradation; Elevated near bottom phosphorus levels- WQ has been compromised; further deterioration of WQ will likely result if P and sediment loading are increased <u>General facts:</u> 10 mi^2, 600 acre surface area, 2-4 mi SW of TC, Garfield and Blair Twp,	Sediment Nutrients Invasive aq. species	Bank erosion Stormh2o High P Eurasian Milfoil

Summaries of Studies Done on the Grand Traverse Bay and Watershed

Name of Study/ Subwatershed	General Findings
Assessment of the Lake Michigan Monitoring Inventory: A report of the Lake MI tributary monitoring project Great Lakes Commission – August 2000 Full Report at: www.glc.org/monitoring	Part of the GLC and EPA's Lake Michigan Lakewide Management Plan. Purpose: assess existing monitoring efforts in LMI basin and subwatersheds; comprehensive review of monitoring programs at the federal, state, and local levels; analysis of gaps, inconsistencies and unmet needs; assessment of the adequacy of existing efforts to support critical ecosystem indicators, and recommendations for addressing major monitoring needs. Done by: surveying potential local monitoring organizations and follow-up interviews; survey of state and federal monitoring; all compiled into database Summary of Grand Traverse Bay Watershed: Watershed protection plans for five sub-basins: Mitchell, Acme, Yuba, Elk River/Chain of Lakes, Boardman – includes short summary of pollutants and sources for each subbasin. Pollutants of Concern and Synopsis of monitoring efforts for each of the following: Aquatic, Pollutant Release, Nutrients and Bacteria, Meteorological and Flow Monitoring, Sediments, Fish Contaminants/Fish Health/Aquatic Nuisance Spp, Benthos, Air, Wildlife and Land Use

State of the Bay 2000 The Watershed Center	Summary: • Average water clarity increased 20% from 1990-2000 in W. Arm of Bay • Sediment quality very good at nearshore sites – typical substrate is coarse sand with numerous nearshore areas of cobble and gravel; 100+ft depth, bottom is silt/clay • Total Phosphorus: - Sig. differences in TP bt/n offshore surface and bottom samples for Omena Bay - TP higher at nearshore than offshore - TP continued to decline since 1970 - Sig. higher levels of TP at mouth of Boardman River and Acme Creek • Urban tribs and stormwater drains are a sig source of nutrients to the Bay; elevated levels of bacteria may pose health risk after large rain events • Weed bed numbers have nearly doubled from 64 (1991) to 124 (1998) • Seiche events (large scale periodic movements of water) can resuspend sediments in deeper portions of the Bay. If carried into the water column, they can release contaminants deposited decades ago. • Sig changes in dates of freeze-up and break-up bt/n 1851-1993 in Bay - Av. freeze-up date is 12 days later - Av. break-up date is 19 days earlier - Did not freeze over in 2001, marking the 5th consecutive year of not freezing over in past hundred years of record • Five federally listed endangered or threatened species (+1 candidate): Bald Eagle, Kirtland's Warbler, Piping Plover, Pitcher's Thistle, MI Monkey Flower, Eastern Massasauga Rattlesnake • Two new exotic species found in Bay since 1999: Fishhook Water Flea and Rusty Crayfish (since 2000, the Spiney Water Flea has been discovered) Additional Info: EPA recommends measuring recreational WQ by the abundance of *Escherichia Coli*: Water is unsafe for swimming if – 130+colonies/100mL in 5 samples over 30-day period or 300+colonies/100mL in any 1 sample • *E.Coli* is common intestinal organism – presence indicates Fecal Pollution, the kinds measured in water don't generally cause disease; those that cause disease are **pathogens** (i.e., other bacteria, viruses, protozoa, small worms) • EPA studies indicate when *E.Coli* exceeds set standards, increased risk of gastroenteritis from pathogens in Fecal Pollution Sources: urban runoff, inadequately treated wastewater, ag runoff, illegal sewage discharge from boats, animals, etc.

Cont'd… State of the Bay 2000 The Watershed Center	*Parameters summarized in State of the Bay and not GLEC Habitat Study:* Water and Habitat Quality – Most common nearshore bottom feature is sand or combo of sand, gravel, and cobble Increase in silt and organic detritus along nearshore bottom 39 spp. of native and non-native fish live in Bay; diverse assortment of other insect and inverts Minerals – Levels of Ca, Mg, Sulfates, and Chlorides are all consistent among sample sites and years Concentrations are typical of high quality freshwater lakes, no suggestion of WQ degradation Toxic Metals Data – Cd, Cr, Pb, Zn, Ni: all relatively low, consistent with other lakes Cu decreased by 60% => 1ug/L (1975), 0.4ug/L (1998) Hg levels low => 0.26ng/L, slightly higher at South end of W.Arm and North end of E.Arm; b/c of loadings from Boardman and Elk River Report comes with informational CD containing the following sections: • History of Land Use • Bay Ecology and Natural Processes • Impacts on the Bay • Efforts to Protect the Bay • Regional Maps • Virtual Flight over the Bay

Integrated Habitat and Water Quality Inventory for the Grand Traverse Bay GLEC – April 2000 **With historical references to:** 1. The Limnology of Grand Traverse Bay, Lake Michigan, Auer et al., 1975 2. Some Aspects of the physical Limnology of Grand Traverse Bay, Lauff, 1957 3. Final Report for the GTBWI: PartII, Water Quality of the Bay and Tributaries, Shuey et al., 1992 4. The Acme Creek Ecological Project: Natural Features Inventory and Land Management Plan, GLEC, 1994 5. Peshawbestown and Omena Bay Baseline Water and Sediment Quality Study, GLEC, 1998	Study designed to compliment past and ongoing studies – make it comparable Purpose: Characterize the state of the GTBay regarding chemical and bio indicators, by conducting habitat and WQ inventories of near-shore waters. *Links near/off-shore WQ to nearshore habitat **Findings:** Typical of other oligotrophic embayments in Gr.Lakes; deep, clear, cold, DO/temp indicate little stratification, DO at or near saturation most of year, h2o transparency exceeded 7-8m, nutrients and chlorophyll a were relatively low (continually declined), overall productivity low Sediment – Quality is good, typically coarse sand w/ numerous areas of cobble and gravel Isolated areas relatively rich in inorganic matter (Omena Bay); does not contribute significant concentrations of nutrients to water column; few rooted macrophyte beds (b/c of lack of suitable substrate?); most of sediment Phosphorus is organically bound Macrophyte Beds – Weed bed numbers have nearly doubled from 64 growth areas (in 1991) to 124 areas (in 1998) Most concentrated at S end of W.Bay (where higher amts of P enter) highly influenced by rapid development Nutrient inputs and the amount of water flushing an area were most important determinants for locations of beds Total Phosphorus – Growth limiting nutrient for the GT Bay *Sig differences bt/n offshore surface and bottom samples in Omena Bay (sediment quality, incomplete mixing of Omena Bay w/ GTBay): Spring'99- 2ug/L at surface; 64ug/L at 80ft *Nearshore TP concentrations higher than offshore: near av = 4.6ug/L, off av = 2.8ug/L * Continued decline since early '70's: 1975 - 7.8ug/L, 1992 – 5.4ug/L, 1994 – 4.9ug/L, 1998 – 3.8ug/L, 1999 – 3.0ug/L Nitrate – Not a growth limiting nutrient for the GT Bay, sufficient quantities for growth Generally higher in offshore near bottom than surface samples (except Omena Bay) 1998 – 0.2mg/L (0.25mg/L in Wbay), measurements similar to historical (Auer, Shuey, GlEC) Silica – Found in colloidal/suspended matter or in biomass (diatoms) Declined dramatically in past 40yrs: 1957 - 3.6mg/L, 1976 - 0.423mg/L, 1992 - 0.410mg/L, 1998/9 - 1.06mg/L

Cont'd…

Integrated Habitat and Water Quality Inventory for the Grand Traverse Bay
GLEC – April 2000

With historical references to:

1. The Limnology of Grand Traverse Bay, Lake Michigan, Auer et al., 1975
2. Some Aspects of the physical Limnology of Grand Traverse Bay, Lauff, 1957
3. Final Report for the GTBWI: PartII, Water Quality of the Bay and Tributaries, Shuey et al., 1992
4. The Acme Creek Ecological Project: Natural Features Inventory and Land Management Plan, GLEC, 1994
5. Peshawbestown and Omena Bay Baseline Water and Sediment Quality Study, GLEC, 1998

Chlorophyll a –
Pigment found in plants, necessary for photosynthesis – indicates amt of suspended algae
Varies w/ seasons; No significant change since 1975
Overall Bay chlorophyll a average = 1.04ug/L, even though slight increases have been shown for chlorophyll a, the Bay is still oligotrophic w/ overall low productivity

Secchi Disk, Transparency –
Measure of h20 trans. – directly linked to inorganic suspended solids and plankton abundance
Varies throughout year, generally greater in Spring: 1957-10.5m, 1975-7.0m, 1992-5.7m, 1999-8.5m; Spring 2000
Inland Seas – 32ft lower W.Arm, 38ft Suttons Bay
Increase in water clarity correlated to decrease in TP since 1991, suggested that this is strongly linked to proliferation of increased zebra mussels in bay since that time

Phytoplankton –
Greatest abundance in Spring, 21 total spp; dominant ones typical of oligotrophic systems
Historically: Auer 1957 stated W.Arm transitioning towards eutrophication
Current: W.Arm more organisms/L than E.Arm in late summer, *suggests* more nutrients available in W.Arm and higher level of eutrophication
Overall though, typical of oligotrophic and no suggestion of eutrophication

Zooplankton –
Assemblages are similar to those typically found in L. MI and Great Lakes

Benthic Macroinvertebrates –
Spiny water flea observed in Omena Bay
Greilickville abundance of zebra mussels, 58% of population

Fish –
Total of 19 spp. (9 families, 2 invasive: alewife, 3-spined stickleback)

Substrate, Plant Life, and Functional Wetland Assessment –
13 specific substrate/habitat types identified; GIS mapped

Stormwater Source Identification, Sampling and Analysis at Select Storm Drains and Tributaries to GTBay (L.MI) GLEC – 2001	*This report is also summarized in State of the Bay 2000:* Objectives/Purpose: Map the locations of stormdrains that discharge to Bay Quantify the mass loading of nutrients (TP, Nitrates, Fecal Contaminants) via urbanized tribs and direct discharges to Bay *used 1 normal low flow (August) and 1 normal high flow (Nov) *Boardman River, Elk River, Stormdrains: E. 8th St., E. Bay Park, Maple St., Hope St., Bryant Park, Suttons Bay, Northport *Historically*: Shuey et al 1991 – nutrient loadings for 20 tribs and 6 storm sewers; concluded that stormwater outfalls carried the greatest single concentration of nutrients to Bay *(Storage capacity in Elk River is much greater than Boardman River; Elk has lakes to store and buffer water, Boardman has more imperviousness and quicker flow through system)* Total Phosphorus: * TP concentrations mush higher in wet weather samples than for dry weather *Highest concentration of TP are found at stormwater outfalls; however flow is much less, so loading may be less than in Elk or Boardman Rivers; also numerous stormwater outfalls drain directly to Boardman and Elk Rivers… *See Table 2 in State of the Bay 2000* Bacteriological: Combined sewer overflows and Stormwater outfalls are activated during high rainfall events, may result in direct discharge of untreated sewage with Stormwater into waterbody; Sources also include: improp functioning septic tanks, illegal snitary sewer connections, food process plants, animal feeding operations, outdoor pets, and feral animals *Sig potential for fecal contamination following storm events; Extremely high conc of *E.Coli* and enterococci were noted during wet weather sample… *See Table 2 in State of the Bay 2000* *Summer storm even has potential for sig public health risk at local beaches b/c of Stormwater outfalls: At risk= West End, Clinch Park, and Bryant Park Beaches, East Bay Park, Elk Rapids City Park, Northport Beach, Southshore Park Beach (Suttons Bay), and waterfront homes Conclusions: • Implementation of Stormwater retention programs is **critical**: urban and high imperv areas • Stormwater management plans integrated into local land use zoning ordinances

APPENDIX E

AVERAGE RATES FOR COSTS OF INSTALLING STANDARD BMPS
(COMPILED BY: FISHBECK, THOMPSON, CARR & HUBER, INC.)

Information and Education Cost Estimates

Task	Costs	Units	Notes	Source
Promotional				
Flyer	$ 0.28	each	black and white	Grand Valley Community Survey
T-shirts	$ 12.50	each	Three color m,l, and XL	Grand Valley Community Survey
Video Production	$ 6,000.00	each		Grand Valley Community Survey
Telephone book inserts standard	$ 0.07	each	min order of $2500	Verizon Super Pages
Telephone book inserts new resident	$ 0.20	each	min order of $2500	Verizon Super Pages
Bathroom Advertising	$ 75.00	each/month	monthly rate for 11"x 17" plus $95 design and $2 reproduction	Johnny Avertising
Bathroom Advertising	$ 35.00	each/month	monthly rate for 8.5" x 11" plus $95 design and $2 reproduction	
Newspaper Ad	$ 32.00	square inch	Sunday paper full page ad about $4000	Muskegon Chronicle
Newspaper insert	$ 0.05	each	Cost of service only, reproduction is not included (1 sheet max)	Berrien County Drain Commission
Utility bill inserts	$ 0.50	each	Reproduction and distribution	Grand Valley Community Survey
Yellow Pages Ad	$ 5,000.00	each/year	Half Page Add in Yellow Pages	Verizon Super Pages
Watershed Logo Signs	$ 90.00	each	11x17" sign	Grand Valley Community Survey
Operational				
Project Manager/year	$ 29,120.00	$15/hour		Bear Creek Watershed Project
Intern/year	$ 20,800.00	$10/hour		Bear Creek Watershed Project
Vehicle/year	$ 15,000.00	each	does not include maintenance or insurance	Bear Creek Watershed Project
Mileage	$ 3,840.00	$0.32/mile		MDEQ
Fringes (20%)	$ 13,752.00		20 percent of total	MDEQ
Community Development				
Oridinance Development	$ 8,000.00		lawyer fees and meetings	Grand Valley Community Survey
Education				
School Presentation	$ 250.00	each	plus 20 hours preparation	Grand Valley Community Survey
4H Program	$ 39,000.00	annually	Management, Staff, and programs	Bear Creek Watershed Project
Demonstration Sites				
Agriculture	$ 1,350.00	each		Grand Valley Community Survey
demonstration booth	$ 200.00	each		Grand Valley Community Survey
Outreach				
Riparian Club	$ 8,000.00	annually		Grand Valley Community Survey
field trips	$ 16.00	each student		Grand Valley Community Survey
phone hotline	$ 1,142.00		first year startup	Bell South

Oil recycling container	$	2.79	each	min order of 300 and $750 delivery	GEOPlastics
Adopt-a-Stream Program	$	3,200.00	annually		Grand Valley Community Survey
Evaluation					
Water Quality Monitoring	$	180,000.00	annually		Bear Creek Watershed Project
Stream Monitoring	$	25,000.00	annually		Bear Creek Watershed Project
Fieldwork					
Canoe trip	$	250.00	each		Grand Valley Community Survey
Watershed tours	$	200.00	each		Grand Valley Community Survey
Public Relations					
Public Meetings	$	250.00	each		Grand Valley Community Survey
Workshop	$	500.00	each	plus 40 hours preparation	Grand Valley Community Survey
Committee Meeting	$	25.00	each		Grand Valley Community Survey
Newsletters					
Mailing	$	0.30	each	bulk non-sorted	USPS
	$	0.12	each	presorted bulk mail rate	USPS
	$	600.00	year	application and accounting fees for bulk mailing	USPS
Color glossy	$	2.30	each		Allegan Conservation District
Inserts	$	0.12	each	black and white	Berrien County Drain Commission
Envelopes	$	0.03	each	business envelopes box of 500	Staples.com
Letter	$	0.27	each	envelop, postage, and form letter	

Best Management Practices Cost Estimates*

Task	Costs	Units	Output	Notes	Source
Agriculture					
Conservation Tillage	$ 10.00	acre			NRCS
Fertility Testing	$ 2.75	acre		Lab testing done to MSU standards	MDA Conservation Service 1992 adjusted for inflation
IPM	$ 5.75	acre			MDA Conservation Service 1992 adjusted for inflation
Windbreaks	$ 2.00	foot		4200 feet needed for a square 40 acre field. Protects ten times as trees are high	NRCS
Cover Crop	$ 14.00	acre		sweet clover if using forage for harvest results in gain of $125/acre	NRCS
Critical Area Planting	$ 1,300.00	acre		Includes: grading, planting, herbicides, mulch, and labor.	NRCS
Livestock Exclusion	$ 3.50	foot			NRCS
Agriculture Crossing	$ 1,200.00	crossing	2/day		NRCS
Watering site	$ 5,100.00	site	.5/day	Well, pump, pipe and water facility	NRCS
Rental Rate	$ 58.00	acre		10 year lease $150/acre with grants	NRCS
Riparian Forested Buffer	$ 900.00	acre		Use of herbicides and establishiment and maintenance	NRCS
Riparian Herbaceous Buffer	$ 225.00	acre		On tilled land includes establishment and maintenance	NRCS
Filter Strip	$ 190.00	acre		establishment, herbicides, fertilizer, and lease	NRCS
Zebra Mussel Control	$ 440.00	acre		Irrigation system to control Zebra Mussels for a 1800 acre establishment	American Water Works Association, 1990 adjusted for inflation
Solar Irrigation Pump	$ 2,500.00	unit	3/day	Pump, controller, pipe, and collector	www.solarelectric.com
Waste Storage Lagoon	$ 45,000.00	unit			NRCS
Stream Erosion					
Live crib wall	$ 25.00	square foot	25 ft/day	see habitat restoration	Rogue River National Wet Weather Demonstration Project
Live staking	$ 2.50	stake		with 3 crew and foreman	Rogue River National Wet Weather Demonstration Project
Vegetated geogrid	$ 20.00	square yard		with 3 crew and foreman	Rogue River National Wet Weather Demonstration Project

Live fascine	$	9.00	foot	with 3 crew and foreman	Rogue River National Wet Weather Demonstration Project
Brush layer	$	13.00	foot	with 3 crew and foreman	Rogue River National Wet Weather Demonstration Project
Branch packing	$	25.00	foot	with 3 crew and foreman	Rogue River National Wet Weather Demonstration Project
Coconut roll	$	15.00	foot	with 3 crew and foreman	Gull Lake Shoreline Project
Joint Planting	$	9.00	stake	with 3 crew and foreman	Rogue River National Wet Weather Demonstration Project 4 member crew with foreman
Riprap	$	60.00	square yard	includes geotextile fabric: 2 member crew and foreman using heavy equipment	Means 1996 and adjusted for inflation: Includes heavy equipment rental
Tree revetments	$	12.00	foot	with 3 crew and foreman	Means 1996 and adjusted for inflation
Bank Shaping	$	15.00	cubic yard	With Heavy Equipment	NRCS
Average Bio-Engineering	$	22.00	foot	Using soft methods only	NRCS
Average Streambank Restoration	$	32.00	foot	Using hard methods and bioengineering	NRCS
Hydroseeding and Mulch	$	2,200.00	acre		NRCS
Tile Outlet					
Riprap	$	75.00	square yard	includes geotextile fabric: 2 member crew and foreman using heavy equipment	Means 1996 and adjusted for inflation
Vegetated geogrid	$	20.00	square yard	includes geotextile fabric: 2 member crew and foreman	Means 1996 and adjusted for inflation
Pipe	$	30.00	linear foot	10" pipe steel: 3 member crew, foreman, backhoe	Means 1996 and adjusted for inflation
Inlet/outlet structure		$3,500	each	concrete with riprap splash pool and vegetated geogrid slopes	Means 1996 and adjusted for inflation
Soil Stabilization/Repair		$2.50	square yard	2 member crew and foreman with heavy equipment	Means 1996 and adjusted for inflation
Trash and Debris					
Volunteer Mobilization	$	60.00	day	Includes flyers, meetings, and memberagement	
Tree removal	$	325.00	hour	includes crew, equipment, and removal fees	Means 1996 and adjusted for inflation: Includes heavy equipment rental
Waste hauling fees	$	75.00	load	should include a $2 tip fee for each tire	
Heavy Obstructions	$	890.00	each	includes, crew, equipment, and removal fees	Means 1996 and adjusted for inflation: Includes heavy equipment rental
Rill and Gully					

Berm and Tube	$ 1,500.00	each		with 3 crew, foreman, heavy equipment and materials	NRCS
Water Bars	$ 300.00	each			NRCS Nebraska Cost Estimator
Grassed Waterway	$ 690.00	acre		Best case Scenario with loose soil, no brush, and already tilled ($2245 ave.)	Means 1996 and Rogue River National Wet Weather Demonstration Project
Grassed Waterway	$ 3,800.00	acre		Worst Case Scenario in hard soil, with brush and dense vegetation ($2245 ave.)	Means 1996 and Rogue River National Wet Weather Demonstration Project
Stone Spillway	$ 9.50	square yard		3 member crew, foreman, heavy equipment and material	Means 1996 and adjusted for inflation
Diversions	$ 3.75	linear foot		grassed terrace to divert flow from tilled earth	NRCS and Means 1996
Habitat restoration					
Wetland Restoration	$ 2,350.00	acre		average of $500/acre and up	NRCS and Zbiciak
Channel block	$ 340.00	log structure	3-4/day	single log	Rogue River National Wet Weather Demonstration Project
Channel block	$ 480.00	log structure	2-3/day	triple height log	Rogue River National Wet Weather Demonstration Project
Channel block	$ 1,600.00	log structure	.5-1/day	crib wall: requires heavy equipment	Rogue River National Wet Weather Demonstration Project
Boulder Cluster	$ 59.20	cluster	25/day	varies depending on distance moved: requires heavy equipment	Rogue River National Wet Weather Demonstration Project
Cover logs	$ 290.00	log structure	5-10/day	3 member crew (requires heavy equipment)	Rogue River National Wet Weather Demonstration Project
Root wads	$ 300.00	wad	6-8/day	4 member crew (requires heavy equipment)	Rogue River National Wet Weather Demonstration Project
Tree Covers	$ 172.00	tree	8-12/day	If dropped in place or already in stream (requires heavy equipment)	Rogue River National Wet Weather Demonstration Project
Tree Covers	$ 215.00	tree	4-8/day	If they must me moved to site (requires heavy equipment)	Rogue River National Wet Weather Demonstration Project
Crib wall	$ 9.50	square foot	120+ feet/day	If done with heavy equipment	Rogue River National Wet Weather Demonstration Project
Crib wall	$ 36.50	square foot	20-30 feet/day	If done by hand	Rogue River National Wet Weather Demonstration Project
Log or Bank Shelter	$ 1,080.00	log structure	2/day	use in small streams with a low gradient (requires heavy equipment)	Rogue River National Wet Weather Demonstration Project
Deflectors	$ 390.00	log structure	2 pairs/day	requires highly experienced foreman to correctly size and place the structure	Rogue River National Wet Weather Demonstration Project
Channel Constrictors	$ 2,520.00	structure	1 pair/day	requires highly experienced foreman to correctly size and place the structure	Rogue River National Wet Weather Demonstration Project
Cross log	$ 680.00	structure	1-2/day	requires highly experienced foreman to correctly size and place the structure	Rogue River National Wet Weather Demonstration Project
Wedge and "K" dams	$ 1,360.00	dam	1/day	requires highly experienced foreman to correctly size and place the structure	Rogue River National Wet Weather Demonstration Project

Soil Stabilization				
Mulch	$ 500.00	acre	Using farm equipment	NRCS
Geotextile Fabric	$ 4.50	square yard	3 member crew, foreman, and material	Means 1996 adjusted for inflation
Seeding	$ 450.00	acre	includes site preparation using heavy equipment and 3 member crew	Means 1996 adjusted for inflation
Sodding	$ 13,068.00	acre	includes site preparation using heavy equipment and 3 member crew	Means 1996 adjusted for inflation
Check Dams	$ 15.00	linear foot	includes site preparation using heavy equipment and 3 member crew	Rogue River National Wet Weather Demonstration Project
Silt fence	$ 1.75	linear foot	Done with 3 member crew	Rogue River National Wet Weather Demonstration Project
Sediment Trap	$ 175.00	each	Done with 3 member crew	Rogue River National Wet Weather Demonstration Project
Road Crossing				
Box Culvert	$ 382.00	linear foot	36" culvert: excavation, crew, foreman, transporation, and installation	NPC Inc.
Bridge	$ 1,125.00	linear foot	72" culvert: excavation, crew, foreman, transporation, and installation	Bark River Culvert and Equipment
Cleaning	$ 8.50	cubic yard	Backhoe excavation of sediment	Rogue River National Wet Weather Demonstration Project
Equipment and Operator Rental				
Loader	$ 150.00	hour	includes operator	Rogue River National Wet Weather Demonstration Project
Excavator (backhoe)	$ 175.00	hour	includes operator	Rogue River National Wet Weather Demonstration Project
Dozer	$ 150.00	hour	includes operator	Rogue River National Wet Weather Demonstration Project
Crew	$ 30.00	hour		Rogue River National Wet Weather Demonstration Project
foreman	$ 50.00	hour		Rogue River National Wet Weather Demonstration Project
Design & legal			typically 25% to 30% of construction costs	Rogue River National Wet Weather Demonstration Project
Mobilization			3 to 5% of construction costs	Rogue River National Wet Weather Demonstration Project
Land Clearing	$ 300.00	acre	clearing and grading smooth	NRCS
Excavation	$ 3.50	cubic yard		Means 1996 and NRCS
Backfill	$ 12.00	cubic yard		Means 1996 and NRCS

Grade and Compact	$	2.00	square yard		Means 1996 and NRCS

*** Prices are in 2002 dollars**