Stony/Paint Creek Subwatershed Management Plan

Addison Township ~ City of Auburn Hills ~ Brandon Township ~ Bruce Township ~ Independence Township ~ Village of Lake Orion ~ Oakland Township ~ Orion Township ~ Oxford Schools ~ Oxford Township ~ Oxford Village ~ City of Rochester ~ City of Rochester Hills ~ Rochester Schools ~ Shelby Township ~ Washington Township ~ Macomb County ~ Oakland County ~ Clinton River Watershed Council ~ SEMCOG

November 2005

CLINTON RIVER WATERSHED COUNCIL

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DEQ

Stony/Paint Creek Subwatershed Management Plan
TABLE OF CONTENTS

Appendices

Figures.. see Maps tab

Tables

Illustrations

Acknowledgements

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This plan was prepared by the Stony/Paint Creek Project Team:

Clinton River Watershed Council

Jessica Pitelka Opfer, Executive Director
Tracie Beasely, Stewardship Director
Heather Van Den Berg, Education Director
Claudette Wizniuk, Administrative Assistant

Environmental Consulting & Technology, Inc.

Kelly C. Karll
Chip Thomas
Pete Hill
Calvin Creech
Jane Tesner Kleiner
Donald Tilton, Ph.D.
Sanjiv Sinha, Ph.D.

Carlisle/Wortman Associates, Inc.

Sally Elmiger
Richard Carlisle

Applied Science, Inc.

Kurt Spieles

This plan was prepared with guidance from the Stony/Paint Creek Subwatershed Group:

Bruce Austin, City of Rochester
Roger Bajorek, Stony Creek Metropark Nature Center
Don Brown, Macomb County Board of Commissioners
Deanna Burns, Oxford Township
Shirley Clancy, Oxford Township
Jim Creech, Oakland Township
John Crumm, Macomb County Planning & Economic Development
Bill Devine, Planning Commissioner, Addison Township
Lance DeVoe, City of Rochester Hills Environmental Education Center
David Dortman, Michigan Department of Environmental Quality
Sue Ann Douglas, Oakland County Board of Commissioners
Joe Figa, Oakland County Parks & Recreation
Donna Folland, Oakland Land Conservancy
Kathy Fraser, Oakland County Drain Commissioner's Office
Megan Greening, City of Rochester
Mike Hartner, City of Rochester Hills Parks & Forestry
Marty Hendges, Michigan Department of Environmental Quality
Seth Hopkins, Macomb Conservation District
Nina Ignaczak, Oakland County Planning & Economic Development Services
Ken Johnson, City of Rochester
Gary Kirsh, Washington Township
Robert Koski, Supervisor, Addison Township
Elaine Leven, Oakland Township
Susan Malone, Road Commission for Oakland County
Amy Mangus, SEMCOG
Roger Moore, City of Rochester Hills Department of Public Services
Paul Muelle, Huron-Clinton Metropolitan Authority
Amy Ploof, Oakland County Drain Commissioner's Office
Tim Pollizzi, City of Rochester Hills Department of Public Services
Cheri Pozzi, Addison Township
Ann Purdy, Addison Township Parks & Recreation
Mark Richardson, Macomb County Prosecutor's Office
Terri Rose, Oakland County Health Division
Gerard Santoro, Macomb County Department of Planning and Economic Development
Gary Schocke, Bruce Township
Lynne Seymour, Macomb County Public Works Office
Lara Sucharski, Macomb County Public Works Office
Karen Tauriainen, Oakland County Drain Commissioner's Office
JoAnn Van Tassel, Village of Lake Orion
Gary White, Macomb County Health Department
Ellen Witz, Oakland Township
Robert Zbiciak, Michigan Department of Environmental Quality

With assistance from these dedicated Stony/Paint Creek residents and volunteers:

Tony Bonini, Mac Deuparo, John Eberline, Todd & Barbi Johnston, Bruce Kezlarian, Alexis Martin, Marie Masters, Doug Moran, and William Poland.

Stonefly Search Volunteers, January 2003

APPENDIX A: PUBLIC PARTICIPATION & EDUCATION

As an important component of the development of the Stony/Paint Creek Subwatershed Management Plan, the Clinton River Watershed Council and the Stony Creek Stewardship Committee initiated a number of education efforts and hosted a series of meetings to engage the public in the development of the plan. These various activities are listed below and described in detail on the following pages.

1. Initial Public Meeting
2. Stony Creek Watershed Display and River Day Events
3. Stony Creek Project Website
4. Riparian Landowner Survey
5. Landowner Stewardship Workshop
6. Stonefly Search
7. Visioning Session
8. Frog & Toad Walk
9. Stone Wall Pumpkin Festival
10. Second Riparian Landowner Survey
11. Newsletter Articles & Media Coverage

Activity 1 – Initial Public Meeting, November 2000

On November 9, 2000, the Clinton River Watershed Council kicked off the Stony Creek subwatershed planning process with a public visioning session held at Addison Oaks County Park in Addison Township. The purpose of the meeting was to present the results of the completed Stony Creek Wetlands Assessment Project, and to introduce the audience to the Stony Creek subwatershed planning project. Attendees were asked to provide input regarding both high quality natural features and areas of concern in the Stony Creek watershed. A summary of their comments is provided below.

High Quality Natural Features:

- Mink and muskrat have been observed on west branch ½ mile south of Buell Rd.
- Freshwater clams and protected wildflowers have been observed on west branch.
- No zebra mussels have invaded west branch.
- There are several cedar bogs north of Inwood in the undeveloped area of Stony Creek Metropark.
- Consult CRWC aquatic habitat records, Michigan Natural Features Inventory, Michigan Chapter of The Nature Conservancy, Michigan Nature Association for information about high quality areas and how these organizations might assist.
- Document priority wetlands in Bald Mountain State Park (Graham Lakes, Clear Creek areas). Consult Michigan Natural Areas Council. Consult Tony Hough at Wayne State University regarding his research in Bald Mountain.
- Create map of all existing private, local, county, regional, and state protected areas in the watershed.
- Consult Trout Unlimited, DNR Fisheries Division, and HCMA for available fisheries data.
- Investigate area on north side of Snell Road, west side of Sheldon, north of Stony Creek Metropark. Beech-maple climax forest, west branch Stony Creek (photos available).
- Note relationship of Stony Creek to North American migratory bird flyways.

Areas of Concern:

- Treatment of aquatic nuisance plants on Cranberry Lake – concerned about application of herbicides.
- Five dams on west branch – should they be removed, lowered or dredged?
- Follow Remedial Action Plan recommendations for removing upstream dams.
- Maintain/upgrade septic systems.
- Explore mitigation for sand and gravel mines – there are currently 16 operating in Washington Township alone.
- Identify background arsenic levels.
- Main branch of Stony Creek from Van Hoosen Farm to confluence with Clinton River is threatened; poor road crossing and development are contributing to sedimentation.
- **Dams –** Produce a map of all dams, compile information from inspection reports on status of each dam, and assess benefits vs. adverse impacts of each dam, including dam failure / sediment release potential. Huron River Comprehensive Fisheries Management Plan might be useful. CRWC worked with DNR at one time to establish minimum flow release agreement for the Stony Creek Lake dam to avoid fish kills below the dam (impact on lake level calculated to be inconsequential).
- **Mining Operations –** Compile information about existing mining sites and any stipulated water quality protection practices. Use maps to estimate extent of future potential mining; assess post-mining practices for adequate environmental protection; identify whether better local ordinances are needed to govern mining practices.

- **Septic System Failures –** Many concerns exist regarding bacteria levels in Lakeville Lake. Consult report of meeting with Lake Board (part of CRWC's onsite sewage disposal project). Failing septics in Leonard flowing into north end of Lakeville Lake may be contributing. Work with county health departments and local governments to create watershed map of known septic failures. Oakland Township has seen high incidence of failures due to subdivision development in lowland soils unsuitable for septics. Identify such areas and overlay land use to identify potential problem sites. Continue working with Oakland and Macomb counties to adopt septic inspection program (see success of Washtenaw / Wayne county programs).
- **Landfills –** Concerns about potential contamination upstream of Stony Creek Metropark. Check DEQ records to assure that no offsite migration is occurring.
- **Agriculture –** What data is available for phosphate, nitrogen, and pesticides in Stony Creek? To what extent have there been changes in historical practices? Are there any remaining agricultural concerns?
- **Pipeline Construction –** Survey results of last year's Vector Pipeline construction, which involved many stream crossings. Were BMPs employed? Are lingering impacts visible?
- **Wetlands –** What is the history of wetlands permit applications in the Stony Creek watershed over the past 5 years? What conclusions can be drawn regarding continuing loss of wetlands? Use ADID project results to identify critical wetlands for protection based on the seven functions identified. Use this information to encourage local governments to pursue wetlands acquisition (purchase or conservation easements) targeting priority sites.
- **Stormwater –** Promote local stormwater management ordinances with the objective of no increase in runoff in new developments.

Activity 2 – Stony Creek Watershed Display & River Day Events, Summer 2002-3

A Stony Creek watershed display was developed highlighting the wetlands of Stony Creek and the steps in the watershed planning process. This display was taken to a number of events in 2002 and 2003, including River Day, Sarah's Sundae Sunday, Free Fridays, and the Stone Wall Pumpkin Festival.

One of the River Day 2002 events was "Knee Deep in Stony Creek" at Stony Creek Nature Center, pictured at right.

Activity 3 – Stony Creek Project Website, Summer 2002

The Stony Creek project webpage was launched on CRWC's website in summer 2002. The website outlines the steps in the watershed planning process and will eventually house the stream inventory survey maps and photographs, as well as the final management plan. Most of the website was developed by CRWC interns. An excerpt from the project webpage follows this document.

Activity 4 – Riparian Landowner Survey, Summer 2002

To get a better understanding of the current water quality conditions and land use concerns in the Stony Creek subwatershed, and to engage the public in the development of the management plan, CRWC distributed an informational letter and survey to approximately 2,200 riparian property owners in August 2002. CRWC received approximately 60 responses (3% response rate). By far the greatest concerns were related to excess nutrients and resulting algae growth (from fertilizers, failing septic systems, etc.) and the consequences of urban development, particularly soil erosion and increased stormwater flows. A number of respondents also reported on the high quality of Stony Creek and their concerns about keeping it that way. CRWC invited responders to subsequent events such as the landowner stewardship workshop, the stonefly search, frog walk, and public meetings in the watershed planning process. Here are some excerpts from the surveys:

High Quality Areas:

- Stream/pond off Parkdale w/beaver mounds and woods full of woodland wildflowers.
- Winkler Mill Pond – blue and green heron, king fishers, beaver lodge.
- Lived in Stony Creek Village for 54 years – Stony Creek is a treasure.
- Streams, shallow ponds, showy and yellow ladyslipper, marvel mushrooms, indian pipe, bloodroot, trout lilly, turtlehead, Joe Pye weed, red striped & blue spotted salamanders.
- Lots of wetlands with wildflowers, blueherons daily, deer, wild turkeys, ducks, chipmunks, squirrels,etc.
- Live on Clam Lake – water supports generous aquatic life; water seems clean and of good quality. Very concerned about future of lake due to building of new middle school – septic field, parking lot, etc. drain towards lake and wetlands.
- Knowledge of methane gas bubble on Lakeville Lake.
- Seen whooping crane, turtles, ducks, geese behind home, concerned about construction in area.
- Cardinal flowers, christmas ivy, crayfish, snapping turtles.
- Trillium, fox, mink, deer.

Concerns:

- Low flow
- Stagnant water dam at Addison Oaks causing minimal flow.
- Sedimentation
- Poor road-stream crossings
- Invasive plants
- Clearcutting of vegetation down to stream's edge
- Overuse of fertilizers
- Poor erosion control by developers
- Need more landowner education
- Excessive nutrients
- Wetlands violations - draining, filling, installing culverts without permits
- Chemical weed control
- How to control deer population – eat trillium
- Disturbance of stream flow by neighbors
- Algae blooms in pond adjacent to McClure Drain – seems more pronounced since Millers Crossing Subdivision went in on Snell Road.
- Erosion from Rochester Road is causing sedimentation in Round Lake.
- Siltation from Twin Lakes development – have talked to them with friendly response, but only temporary relief.
- "Foam" in West Branch especially after rainfall.

- Golf course runoff
- Erosion off gravel roads
- Concerned about dam at golf course at Buell and Rochester Road – affects fish coming up the stream in the spring.
- In 2000, Oakland County Road Commission blocked flow of water at Mead Road between Sheldon and 1200 Mead – lake level went down, wildlife left, OCRC cut trillium, ,jack-in-the-pulpit, bloodroot.
- Road grading - calcium chloride and ditching along county dirt roads.
- Excessive development near Tienken Road.
- Enormous number of ducks and geese on Long Lake.
- Areas of stream seem overgrown & clogged up, could organize church youth group to help with clean-up.
- Buell Road east of Rochester Road – severe erosion, dam at erosion area restricts stream flow in summer.
- Herbicides that are dumped into Indian Lake by the other people on the lake that flow downriver to Stony Creek.
- Lakeville Lake residents dump vegetation in lake.
- Hay barriers and flooding problems at Ravines subdivision.
- Stony Creek behind our home, turns brown with extensive stormwater runoff after it rains. This started when the developer removed all natural vegetation to build homes in subdivision located upstream on other side of creek. Began 2 years ago & continues since construction began.
- Winkler Pond septic system failure.

Activity 5 – Landowner Stewardship Workshop, October 2002

On October 26, 2002, twenty area residents attended the Stony Creek Landowner Stewardship workshop at the Rochester Hills Museum at Van Hoosen Farm. This was an Adopt-A-Stream training workshop that educated participants on the knowledge, skills, and methods to assess their riparian corridor. The participants were encouraged to conduct monitoring on their own properties or at sites identified by CRWC. Three sites were evaluated and the results are summarized in the following table.

Volunteer Stream Survey Results.

Site	Physical Results	Biological	Overall	Comments
Unnamed tributary to West Branch of Stony Creek	No channelization, little disturbance; dominant substrate: sand; shaded stream; herbaceous vegetated riparian corridor; surrounding land use wetlands.	Not applicable – monitored in December	Excellent	Private residence
West Branch of Stony Creek (Rabbit Apple Lane)	Meandering stream, little disturbance; dominant substrate: sand; dominant vegetation: shrubs; woody debris is common; pollutant source farms & septic systems.	Not applicable – monitored in December	Good	
Main Branch of Stony Creek at Stony Creek Village	No channelization; clear color; dominant substrate: gravel; little siltation; herbaceous riparian vegetation; woody debris abundant; surrounding land use residential.	Not applicable – monitored in December	Good	Private residence in Historic Stony Creek Village

Workshop participants use a kick net to collect aquatic organisms (left), then inspect the net to remove and identify the macroinvertebrates (right).

Activity 6 – Stony Creek Stonefly Search, January 2003

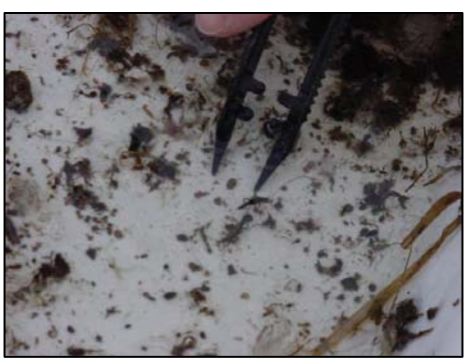
More than 25 area residents of all ages braved the cold temperatures on a Saturday morning in January to search for open water and stonefly larvae. Two sites within the Stony Creek subwatershed were sampled. The first site, just downstream of the Stony Creek Lake dam (QAPP-09), did not produce any stonefly larvae. However, mayfly and caddisfly larvae were found at this site (they too are in the same pollution-sensitive category). The absence of the stonefly larvae at this location is most likely due to the even distribution of sediment across the creek bottom and the low water flow, which lowers the amount of dissolved oxygen in the water. (Stonefly larvae need high levels of DO.)

The second site sampled was the Main Branch of Stony Creek at the bridge crossing on 31 Mile Road (QAPP-04). This location is approximately 5 miles upstream of the first sampling location. Stonefly larvae were found in abundance at this site. Mayfly and caddisfly larvae were also found at this location. The stream composition was much different than the first location. The fast moving water with a good gravel bottom had little sedimentation, which made for optimum habitat for the stonefly larvae.

CRWC Education Director Heather Van Den Berg demonstrates use of a D-net to collect aquatic organisms.

Volunteers search for stoneflies.

CRWC received excellent media coverage following the event. The Oakland Press did a spread in the Sunday paper on the day following the event. The article highlighted the significance of Stony Creek, the Stonefly Search, and the current threats to the tributary (sedimentation and other non-point source pollutants carried by stormwater).



A stonefly is visible just below the right prong of the tweezer.

The crew is pleased with their find at the northern survey site.

Activity 7 – Visioning Session, February 2003

A second public meeting was held in February 2003 at Oakland Township Hall. Presentations were made on the stream survey results, planning analysis, and imperviousness and build-out analysis. Approximately 40 individuals attended the meeting and submitted valuable input on their values, concerns, and recommended actions to protect Stony Creek.

Attendance

- Stony Creek watershed residents from: Oakland Township (7), Oxford Township, Lake Orion, Lakeville, Rochester
- Also residents from Clarkston, Metamora, Bloomfield Hills, Chesterfield, Harrison Township, Plymouth, Rochester Hills
- Variety of Macomb and Oakland county staff, local government officials, and representatives from planning, engineering, parks & recreation, education

Citizens, local officials and other stakeholders participated in breakout sessions during the visioning session.

Individual Responses to Visioning Session Questionnaire:

Individual Values:

What do you value about Stony Creek for you and/or your community? *(i.e. wildlife viewing, recreation, fishing, water quality, wetlands)*

Individual Value	Responses
Wildlife: Attractions, corridor, habitat, viewing (birds, herons, waterfowl, mammals)	13
Water quality	8
Wetlands & wetlands preservation; wetlands associated with Cranberry Lake	7
Recreation (e.g. passive use trail for observations)	5
Natural beauty, undeveloped environment, open space, viewshed	4
Historic aspects of Stony Creek (museums, structures, mills, etc.)	1
Intact riparian habitat for stormwater absorption and to decrease downstream flows	1
Lakeville Village Center & MNA Preserve	1
Landscape diversity	1
Proper position within the water cycle	1
Stony Creek Metropark	1

Individual Concerns:

What concerns do you have about Stony Creek and its effects it may have on you and/or your community? (i.e. protecting high quality sites, wetlands protection, improving degraded sites)

Individual Concern	**Responses**
Protecting high quality sites from: sewage, siltation from roads, invasive plants, matching land use and zoning to capabilities of land	7
Development: build-out, over-building, future degradation, future development without adequate stormwater management which includes wetlands protection and erosion control	7
Improving degraded sites	4
Wetlands protection	4
Erosion & sedimentation	3
Creating connection between high quality sites by restoring landowner education	1
Destruction of sensitive slopes, floodplains, wetlands	1
High flows, runoff	1
Keep it clean! Teach residents	1
Protect current wild sites before they are bought up and developed	1
Protect designated natural areas	1
Public access to stream	1
Septic management	1
Water quality	1

Actions:

What would you like to know about Stony Creek? What can you do to protect Stony Creek? What would you like your local governments to do to protect Stony Creek?

Individual Action
Build-out analysis - what it suggests about future extent of impervious surfacing.
Buy up adjoining land still available.
Control development as much as possible.
Create a plan that takes into consideration the health of the watershed - prime consideration.
Create buffers.
Create mosaic of recreational use, good homeowner practices, and protection of sensitive habitat.
Education concerning using native vegetation plantings.
Examine and change necessary master plan and zoning ordinances (i.e. rationalize master plan).
Help residents to eliminate individual septic areas near water bodies.
Identifying the watershed.
Inventory and protect key sensitive features.
Learn if we are doing anything to damage the quality of our property.
Look at new ways to do cool detention basins.
Look at road development and maintenance standards.
Macomb County communities master plan.
Make all riparian areas natural areas that cannot be built on and used solely for recreation and/or natural preserve.

Make sure township constantly uses BMPs.
Minimize impacts of development.
Monitor water quality.
Parks purchase natural areas for passive use.
Preserve open space.
Prevent industry, golf courses, and landowners from dumping harmful substances.
Promote stewardship.
SEMCOG has discovered that local master plans expect far more population than some area forecasts project - will these be recommended for Stony Creek watershed.
Stormwater ordinance.

Additional Comments

Determine what BMPs can be employed at road crossings – direct road runoff from discharge directly to creek.
Develop lakeshed plan for Lakeville Lake in headwaters. It has a small watershed (6 miles?) and overlay zoning could specify measures not needed in rest of township.
Also pursue community septic fields and small flow pressured sewers for correction of failing septics which are old and on small lots.
Develop wetlands protection plan.
Great job!
The Macomb Land Conservancy is now working with the County Commissioners to develop trail systems connecting West and East (big & little).
Stony Creek can serve as a model for the whole Clinton River.

Group Results from Break-Out Sessions:

Top Group Values:

- Uniqueness / headwaters
- Landscape diversity / environmental features / views
- Intact riparian corridor
- Wildlife
- Recreation – Metropark, passive recreation, nature observation
- Water quality
- Historic aspects of Stony Creek
- Open space preservation (Lakeville Village & MNA Preserve)
- Wetlands areas

Top Group Concerns:

- Degradation due to development
- Development of natural areas/views
- Erosion/sedimentation
- Homeowner practices
- Improving degraded sites
- Lack of vision
- No enforcement of existing laws
- Protecting high quality sites

- Riparian education for landowners
- Septic failure/human impact
- Stormwater runoff
- Water quality degradation (due to build out)

Top Group Actions:

- Examine and rationalize master plans and ordinances
- Buy parks/natural areas and create buffers
- Community education, specifically for riparian landowners
- Better road maintenance/planning
- Enforce current laws
- Entice communities to use BMPs
- Government to monitor water quality
- Inventory and protect very sensitive features
- Land use
- Person / place for citizens to go to for environmental questions
- Preserve open space
- Replace buck thorn/riparian education
- Stormwater ordinance (also to cool detention pond water)

Activity 8 – Spring Frog & Toad Walk, April 2003

Staged in the headwaters of the West Branch of Stony Creek, approximately 40 residents and watershed enthusiasts gathered near Heart Lake in the Bald Mountain Recreation Area for the Spring Frog and Toad Walk. A local frog expert and CRWC volunteer led the crowd in search of amphibians. The true signs of spring emerged from the wetlands of Stony Creek as the flashlights beamed around the lake, evidence that everyone was enjoying the search for the western chorus frog and the northern spring peeper. Joined by the naturalist from the HCMA Stony Creek Nature Center, this educational activity connected the headwaters of Stony Creek in Bald Mountain State Recreation Area to the well-known HCMA Stony Creek Metropark where the Main Branch and West Branch of Stony Creek converge at Stony Creek Lake.

Activity 9 – Stone Wall Pumpkin Festival, October 2003

CRWC provided a presentation, display, and kids' activities at the Stone Wall Pumpkin Festival at Van Hoosen Farm in Rochester Hills on October 11, 2003. This activity took the place of a final public meeting because several thousand people were expected to attend the festival. Attendees were able to view a PowerPoint presentation about the subwatershed plan, large maps, and a draft of the plan were on display. Families participated in can casting games and fish printing down by the water's edge.

Families enjoyed the fish printing (left) and can casting (right) activities at the Stone Wall Pumpkin Festival.

Activity 10 – Second Riparian Landowner Mailing, November 2003

A second riparian landowner mailing was mailed in November 2003 to coincide with the release of the final management plan. This mailing included a summary of the project, a map of the watershed, and information about ways to get involved in protection Stony Creek. Recipients were also given the opportunity to be added to CRWC's mailing list.

Activity 11 – Newsletter Articles and Media Coverage

CRWC covered the planning process and outreach events in its quarterly newsletter and received coverage in the local media. Examples of these stories follow.

Following submittal of the November 2003 Stony Creek Subwatershed Management Plan, the Stony/Paint Subwatershed Management Group developed an updated Public Participation Process to include Paint Creek Subwatershed. It's important to note that the activities completed during the development of the Stony Creek Subwatershed Management Plan had participation from residents in both the Stony/Paint subwatersheds. The expanded process built upon these past efforts and utilized mechanisms that were found to be the most successful.

The various activities utilized during the update of the Stony/Paint subwatershed plan are listed here and are further described on the following pages.

1. Websites
2. Newsletters
3. Email distribution lists
4. Workshops / public meetings
5. Major events
6. Presentations to specific groups
7. Cable television – government & community access channels
8. Press releases
9. Questionnaires
10. Public comment period

Activity 1 – Websites

Websites provide a valuable source of information. The Clinton River Watershed Council website was updated to include individual subwatershed activities and information. Information that described ongoing activities of the Stony/Paint group was provided on www.crwc.org. Communities that provided individual links to this website further enhanced opportunities for involvement in the Stony/Paint planning process.

Activity 2 – Newsletters

Newsletters were utilized by both the CRWC and individual Stony/Paint communities. The CRWC River News is mailed to CRWC members and includes information about what is going on in the Clinton River Watershed. The following River News issues provided information about watershed activities:

Spring 2004 & Annual Report (Cover Story: Coldwater Conservation Volunteers Gear Up for Second Season)
Summer 2004 (Cover Story: "Dockwalking" for a Cleaner Lake St. Clair)
Fall 2004 (Cover Story: A Season of Exploration on the "Big River")
Winter 2004 (Cover Story: Watershed Planning in Action)
Spring 2005 & Annual Report (Cover Story: CRWC Launches Stormwater Education Program)
Summer 2005 (Cover Story: Creating Healthier Habitat for Fish & Wildlife)

In addition to these newsletters, individual communities printed a variety of newsletters which are detailed in their respective PEP annual reports.

Activity 3 – Email Distribution Lists

The Clinton River Watershed Council has proven to be a valuable source of information for residents and other interested in participating in various stakeholder activities. The CRWC listserve has numerous stakeholders that actively participate in ongoing Stony/Paint activities. The CRWC listserve was utilized throughout the planning process to inform people about the status of Stony/Paint activities, opportunities for involvement and notification of workshops and open houses.

Activity 4 – Workshops / Public Meetings

The Stony/Paint Subwatershed Management Group organized, planned, advertised and conducted a Stony/Paint watershed-wide open house on June 29, 2005. Lake Orion High School hosted the open house. The purpose of the Open House was to inform and educate the citizens of the Stony/Paint Subwatershed on the conditions and opportunities within their subwatershed. The open house was chosen as a workshop method as opposed to a public meeting so that residents could visit and talk with experts of the subwatershed on a one-on-one informal basis. Public meetings do not typically solicit constructive information and do not always give ample opportunities for the public to learn about various topics.

A presentation was developed to summarize the state of the subwatershed then residents were given the chance to visit various "booths" within the open house. Four categories of booths/displays were presented at the open house. Booth topics consisted of Recreational Opportunities, Stewardship Opportunities, Existing Conditions and Land Use Planning issues. Guests had an opportunity to walk around the many different displays, collect brochures and ask questions from community, county, state subwatershed representatives.

The following stakeholders and representatives provided displays:

Recreational Opportunities

- Oakland County Parks
- Friends of the Clinton River Trail
- Bald Mountain State Recreation Area
- Stony Creek Metropark
- Community Parks and Trails
- REI
- Hank's Flyfishing Unlimited

Land Use Planning

- Oakland County Planning & Road Commision
- Community Land Use & Storm Water Plans
- Rochester Hills Natural Features Inventory
- Macomb County Planning & Road Comminsion
- Streambank Stabilization Projects

Existing Conditions

- Clinton River Field Surveys
- CRWC Stream Leaders
- Woody Debris Management

Stewardship and Volunteer Opportunities

- Clinton River Watershed Council

- Southeast Michigan Council of Governments (SEMCOG)
- Oakland Land Conservancy
- Clinton River Cold Water Conservation Project
- Rochester Hills Environmental Education Center
- Upland Hills Ecological Awareness Center
- Department of Natural Resources
- Fish & Wildlife Service

A total of thirty-five (35) guests attended the event. Surveys were also provided to each guest. The purpose of the survey was to set priority to the goals that the subwatershed group put together for the subwatershed management plan. Twenty-five of the thirty-five guests returned their surveys. Results of the compiled surveys are provided in Activity 10 – Questionnaires.

Activity 5 – Major Events

Major Clinton River Watershed events primarily include River Day and Clinton Clean-Up. River Day is in June of each year, while Clinton Clean-Up is held in September of each year. The Clinton River Watershed hosts over 1500 volunteers at over 20 different locations. In 2005, over 550 participants participated at ten (10) sites within the Stony/Paint Subwatershed. Clinton Clean-Up was held at one site in the Stony/Paint Subwatershed with over 25 participants in 2005.

Other annual events are conducted throughout the subwatershed by all representative communities. These annual events are also included in most public education programs and are reported on within those plans. These annual events often receive participation from those people most interested in watershed protection and restoration activities and have proven to be a useful tool in gaining participation.

Activity 6 – Presentations to Specific Groups

Presentations can prove to be a useful public participation tool, but more effectively when targeted towards groups with a specific interest in watershed protection. Two types of presentations were conducted throughout this planning process, including a presentation at the Stony/Paint Open House geared towards the general public and presentations to City Councils and Township Boards.

The Stony/Paint Open House presentation was conducted twice during the day and consisted of a summary of the state of the Stony/Paint water resources along with a description of the high quality attributes of the subwatershed. The presentation also included information on the opportunities for participation, recreation and monitoring throughout the subwatershed.

During the public comment period, various permittees also conducted a presentation to their respective governing bodies (as necessary) in order to obtain general support for implementation of the Stony/Paint Subwatershed Management Plan. Although, it is clear that participation in the monthly subwatershed management group meetings by individual permittees represents support by those governing bodies, many representatives chose to also present specific portions of the plan and upcoming requirements to their councils/boards. Permittees who conducted this activity will include this information in their respective annual reports.

Activity 7 – Cable television

Cable television did not prove to be a cost- and time-efficient activity for soliciting participation in the watershed planning process. The Clinton River Watershed has numerous opportunities –

beyond utilizing cable television - for involvement that result in increased hands-on participation in watershed activities. The subwatershed management group observed, throughout the planning process, activities requiring volunteers resulted in a high level of participation, and that utilizing cable television was not necessary.

Many communities do have cable television and/or bulletin boards in which various activities are posted or discussed. These actions are reported in those annual reports.

Activity 8 – Press Releases (& Media Coverage)

The Clinton River Watershed Council has been the primary contact for many watershed-wide activities and thus a primary contact for media coverage for these activities. CRWC has issued a number of press releases during this planning process, some of which are listed as follows:

2004 – 2005 Press Releases

- October 26, 2004 - Students Present Water Quality Results
- October 4, 2004 - MDNR Director to Keynote Clinton River Watershed Council's 6th Annual Preservation Celebration
- October 4, 2004 - Thousands of Area Students Go "Knee Deep in the Creek" to Study Water Quality in Clinton River
- June 26, 2004 - Behr America Celebrates Local Waterway and Practices Environmental Stewardship at Big Beaver CreekFest
- June 9, 2004 - Citizens, Civic Groups and Communities Join Hands to Celebrate Local Water Resources on River Day 2004
- May 2, 2005 - Stream Leaders Spring Monitoring
- February 25, 2005 - 2nd Annual Lake St. Clair Clean Boating Campaign
- February 21, 2005 - Citizens "Gear Up" for Adopt-A-Stream
- June 2, 2005 – River Day 2005

2004 – 2005 Media Coverage

- November 24, 2004 - Detroit News: Clinton River council aims to guard watershed
- October 29, 2004 - Macomb Daily: Celebrating knowledge of the river
- October 29, 2004 - Oakland Press: Grant will help with Clinton River erosion
- October 29, 2004 - Oakland Press: Discoveries about watershed shared
- October 22, 2004 - Oakland Press: New DNR director looks at restored Clinton with pride
- October 21, 2004 - Oakland Press: River's health to be discussed
- October 13, 2004 - Detroit News: EPA, kids gauge river's health
- October 7, 2004 - Macomb Daily: Students spend quality time in depths of river
- October 7, 2004 - Oakland Press: Students put water to test
- August 19, 2004 - Oakland Press: DNR award recognizes Clinton River comeback
- August 11, 2004 - Detroit News: Urban fishery plan hatched: Improved water quality spurs Clinton River project
- August 5, 2004 - Detroit Free Press: Open-space advocates stump for tax
- August 5, 2004 - Macomb Daily: Parade of Lights festival ranges from political messages to whimsical designs
- July 25, 2005 - Oakland Press: Departing watershed director keeps busy
- July 10, 2005 - Oakland Press: Volunteers work to build fish habitat
- June 15, 2005 - Spinal Column Newsweekly: Watershed Council director leaving
- June 11, 2005 - Macomb Daily: Clinton River gets its day today

- June 1, 2005 - Oakland Lakefront: DNR stocking helps local fisheries
- June 1, 2005 - Oakland Lakefront: The final word with Jessica Pitelka Opfer
- May 11, 2005 Spinal Column Newsweekly: Students check Clinton River sites
- May 5, 2005 - Macomb Daily: Students explore state of river environment
- April 27, 2005 - Spinal Column Newsweekly: Tips for boaters to protect water
- April 15, 2005 - Macomb Daily: Clinton River spawns spring steelhead
- April 13, 2005 - Macomb Daily: Macomb pinpoints polluters
- April 7, 2005 - Oakland Press: Group needs bird watchers for Clinton River watershed
- March 31, 2005 - Oakland Press: Work begins on bridge over Clinton River
- March 9, 2005 - Detroit News: Volunteers help monitor water: St. Clair Shores sets up Adopt-a-Stream program to enlist help in identifying environmental problems
- March 8, 2005 - Detroit News: Residents monitor waterways: Program trains volunteers to check health of watershed along Clinton River
- March 7, 2005 - Oakland Press: Volunteers sought to protect our lakes, rivers
- March 4, 2005 - Oakland Press: Jump right in for watershed study
- February 1, 2005 - Detroit News: Corps keeps river healthy - Sediment removal and computer studies have an impact on the Clinton's vitality
- January 30, 2005 - Oakland Press: DNR ups steelhead allotment
- January 30, 2005 - Oakland Press: Region's biodiversity is on display in atlas
- January 24, 2005 - Oakland Press: Study to assist in erosion prevention

Activity 9 – Questionnaires

As part of the Stony/Paint Open House, River Day and Clinton Clean-Up, the communities & CRWC distributed the Stony/Paint surveys to residents, volunteers, participants and community staff. These questionnaires proved to be a useful tool when utilized at a variety of events as opposed to just the Stony/Paint Open House.

Surveys subsequently distributed to the community members at various events after the open house produced an additional 45 surveys. A copy of the survey is provided at the end of this Appendix. The results of the survey are described as follows:

Live Near Waters Edge		**Total Completed Surveys**
Yes	26	25 – at open house
No	44	45 – post open house

Number of Surveys Completed by Community					
Oakland Township	7	Orion Township	4	Addison	1
Lake Orion	22	Rochester Hills	10	Harper Woods	1
Rochester	9	Clarkston	1	Misc	4
Brandon Township	9	Oxford	2		

Rank	**Goal**
1	Reduce soil erosion.
2	Protection of waterfront land & natural areas (riparian corridors/ wetlands/woodlands/wildlife habitat/unique ecosystems)
3	Increase the public's understanding of their role in protecting Paint Creek
4	Establish and sustain a Paint Creek Subwatershed Plan
5	Improve recreational access and opportunities

Rank	Goal
6	Protect and restore Paint Creek fishery
7	Protect farmland and reduce agricultural impacts on water quality
8	Protect and interpret the historic character of Paint Creek

Additional Comments:
Encourage school participation through ecoliteracy programs
Should have explained what a subwatershed is
Great fishing!
Prevent large buildings from being built near the creek

Activity 10 – Public Comment Period

Public comment period was available September through October 21, 2005. Comments were received from Addison Township in reference to updating the description of their current land use information. This information has been included in Chapter 4. No additional comments were received in reference to updating the plan.

The following schedule outlines the timeframe for soliciting participation in the watershed planning process, including the timing and frequency of each activity identified. This timeline is a general schedule of activities and includes those activities that were completed as a subwatershed. Community specific activities are also outlined in the respective Public Education Plans.

Subwatershed Specific Public Participation Activities

Activity	2004				2005			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Public Participation Activities								
1. Website			X	X	X	X	X	X
2. Newsletters			X	X	X	X	X	
3. Email distribution lists				X	X	X	X	X
4. Workshops / public meetings							X	
5. Major events		X	X			X	X	
6. Presentations				X			X	X
7. Cable television								
8. Press releases		X	X	X		X	X	X
9. Public questionnaires		X	X	X	X	X	X	X
10. Public comment period							X	X
Watershed Plan Development								
1. Data collection & analysis			X	X	X			
2. Prioritize goals and objectives				X	X			
3. Develop action plan					X	X		
4. Prepare draft plan						X	X	
5. Submit final plan								X

STONY CREEK & PAINT CREEK GOALS SURVEY

CLINTON RIVER WATERSHED COUNCIL

Thank you for visiting our Open House today. We would appreciate you filling out this brief survey in order to help focus efforts on enhancing the Stony & Paint Creeks resources.

1. Please identify which community you live in.______________________________

2. Do you live on or near the water's edge? (i.e. Are you a riparian corridor property owner?
   Yes No

3. The following GOALS have been identified for Stony Creek. Please read through the list and rank (1-7: 1 being the highest) these goals for Paint Creek.

_____Establish and sustain a Paint Creek Subwatershed plan.

_____Increase the public's understanding of their role in protecting Paint Creek.

_____Protection of Waterfront Land & Natural Areas.
(riparian corridors/wetlands/woodlands/wildlife habitat/unique ecosystems)

_____Improve Recreational Access & Opportunities (Circle all that apply).
hiking boating parks fishing picnicking
swimming

_____Protect and restore Paint Creek fishery.

_____Protect and interpret the historic character of Paint Creek.

_____Protect farmland and reduce agricultural impacts on water quality.

Please Use Back of Survey for Any Additional Comments

APPENDIX B: STONY/PAINT SUBWATERSHED EXISTING AND POTENTIAL FUTURE IMPERVIOUS COVER ANALYSIS

Table of Contents

Table of Tables

Table of Figures

Executive Summary

Impervious Cover (IC) can be defined as having two components: "the rooftops under which we live work, and shop, and the transport system (roads, driveways, and parking lots) that get us from place to place" (Schueler, 1994). IC impacts stream ecosystems by increasing the proportion of stormwater runoff discharged from the watershed directly to the stream as compared with the proportion that infiltrates back into the ground or is detained in wetland systems. Negative effects of increased runoff to streams include hydrologic, structural habitat, and water quality impacts. The Center for Watershed Protection has developed an "Impervious Cover Model" (ICM) which predicts the quality and character of a stream based on the percentage of IC in the watershed. The ICM contains three categories: (0-11% IC= Sensitive; 11-25% = Impacted; 25+% = Degraded) (Schueler, 1994).

As part of the development of a watershed management plan for Phase 2 stormwater regulations, an analysis was conducted to estimate the existing and potential future percentage of IC in the Paint Creek and Stony Creek subwatersheds. Four tasks were undertaken: (1) catchments within the Paint Creek subwatershed were delineated to provide a closer look at the impact of IC on small watershed areas (2)the existing IC was estimated using Color Infrared Photography from the year 2000, (3) the potential future IC was estimated using community land use plans and estimated imperviousness coefficients associated with planned land uses, and (4) an alternative potential future IC was estimated, using IC reduction factors that may be gained by implementing "Better Site Design" practices.

The existing IC in the Paint Creek in 2000 was estimated to be 6%, and in Stony Creek 7.25%, placing both in the "Sensitive" category of the ICM. The IC was unevenly distributed within the subwatersheds, tending to concentrate along the commercial corridors and in more densely developed areas. Catchments within Paint Creek had imperviousness values as low as 3% in the less developed areas and as high as 9% in more developed areas.

The potential future IC of the Paint Creek was estimated to be 12% under conventional development techniques, pushing the watershed into the "Impacted" category of the ICM. The potential future IC of the Stony Creek was estimated to be 11% under conventional development techniques, pushing the watershed into the "Impacted" category of the ICM. The analysis demonstrated that "Better Site Design" measures could lower the potential future watershed IC to by 2-3%, with significant savings in some areas and catchments.

The following conclusions may be made based on this analysis:

1. Overall, the Paint and Stony Creek Subwatersheds were “Sensitive” stream systems based on the ICM in the year 2000 (6% IC and 7.25% IC, respectively).

2. Because of the uneven development pattern across the subwatersheds, some areas will remain “Sensitive” while others will become “Impacted”. It is not expected that any areas will become “Non-supporting”.

3. “Better Site Design” measures, while not significantly reducing IC for either subwatershed as a whole, have the potential to make significant reductions in IC in catchments and local areas.

Overview of Impervious Cover

Impervious Cover (IC) derives from human development and has a variety of damaging effects on streams. The Center for Watershed Protection has developed an "IC Model" (ICM) that can serve as a framework for watershed managers to use in evaluating the existing and potential future extent of stream degradation due to IC in the watershed.

What is Impervious Cover?

The following definition (Schueler, 1994) succinctly characterizes IC:

> *"Impervious Cover represents the imprint of land development on the landscape. It is composed of two primary components: the rooftops under which we live, work and shop, and the transport system (roads, driveways, and parking lots) that we use to get from one roof to another."*

How Does Impervious Cover Impact Stream Ecosystems?

A preponderance of evidence has shown that the amount of IC in a watershed has a direct influence on the integrity of the hydrology, physical structure, water quality, and biology of the streams and rivers in that watershed (Center for Watershed Protection, 2003). IC impacts stream ecosystems by increasing the volume of stormwater runoff discharged from the watershed to the stream. ***Hydrologic impacts*** including disruption of natural water balance, increased flood peaks**,** increased stormwater runoff**,** more frequent flooding, increased bank full flows, and lower dry weather flow. ***Structural habitat impacts*** include stream widening & erosion, reduced fish passage, degradation of habitat structure, decreased channel stability, loss of pool-riffle structure, fragmentation of riparian tree canopy, and decreased substrate quality. ***Water quality impacts*** include increased stream temperature, pollutants, and risk of beach closure.

The Impervious Cover Model (ICM)

The IC Model (ICM) creates a framework that classifies the quality of streams and rivers based on the percentage of IC in their watersheds (Schueler, 1994). The framework classifies streams as sensitive (0-11% IC), impacted (11-25% IC), and non-supporting (>25%) (Figure 1). Each of these classifications represents a gradient tending toward increasing levels of degradation as more IC is added to the watershed. Specific signs of degradation are offered for each IC category (Table 1).

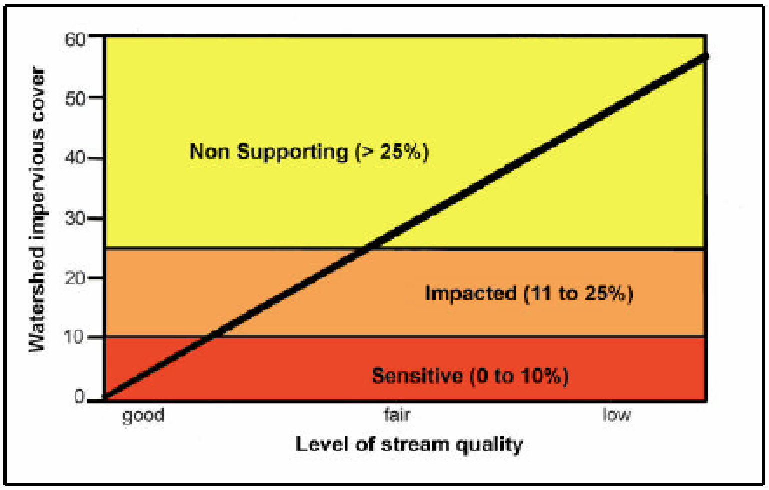


Figure 1. The IC Model (Schueler, 1994)

Table 1. Stream attributes according to the IC Model (Schueler, 1994)

Sensitive Stream	Impacted Stream	Non-Supporting Stream
0-10%	**11-25%**	**>25%**
High quality, stable flow regime	Signs of degradation, flow regime destabilizes	Low quality; stream is essentially a conduit for conveying stormwater
Stable channels are in stable equilibrium	Altered stream geometry	Severely eroded and incised stream channel
Excellent habitat structure	Degraded physical habitat in the stream	Structure needed to sustain fish is diminished or eliminated
Excellent water quality	Water quality degraded; contact recreation becomes an issue	Water contact recreation is no longer possible
Diverse communities of both fish and aquatic insects	Many sensitive fish and aquatic insects disappearing from the stream	Stream cannot support any but the most tolerant of life forms
Do not experience frequent flooding	Flooding becomes a more serious problem	Flooding becomes a serious problem requiring drastic engineering solutions

Tasks of Analysis

This analysis was conducted as a part of the development of a subwatershed management plan for the Stony and Paint Creek subwatersheds, both tributary to the Clinton River in Oakland County. The purpose of the analysis was to evaluate the existing and potential future IC in the subwatershed in order to understand existing conditions and potential future conditions as a basis for goal-setting.

Four tasks were undertaken:

Delineate catchments

- This was accomplished within the Paint Creek Subwatershed (only a subwatershed-wide analysis was conducted for Stony Creek).

Estimate Impervious Cover or the watersheds for year 2000

- This was accomplished using Color-Infrared photography for the year 2000. A land use estimate method was used to estimate IC for areas of the Stony creek watershed in Macomb County.

Estimate potential future Impervious Cover at "buildout"

- This was accomplished using community master plans and a buildout assessment methodology.

Estimate the extent of potential reductions in Impervious Cover

- This was accomplished using strategies through implementation of "Better Site Design" (Center for Watershed Protection, 1998).

Methods

Combinations of automated and manual GIS functions were used to delineate catchments and to develop estimates of existing and future IC.

Catchment Delineation

In order to report IC conditions with a level of detail useful for watershed planning, a sub-drainage area delineation was undertaken for Paint Creek using ESRI ArcHydro tools (Maidment, 2002) and a 20-foot resolution topography model. This delineation resulted in the identification of 12 sub-drainage areas, or catchments, within the Paint Creek subwatershed. A detailed technical instruction of the methodology utilized to create the delineation is available on the CD-ROM accompanying the *Arc Hydro: GIS for Water Resources* manual.

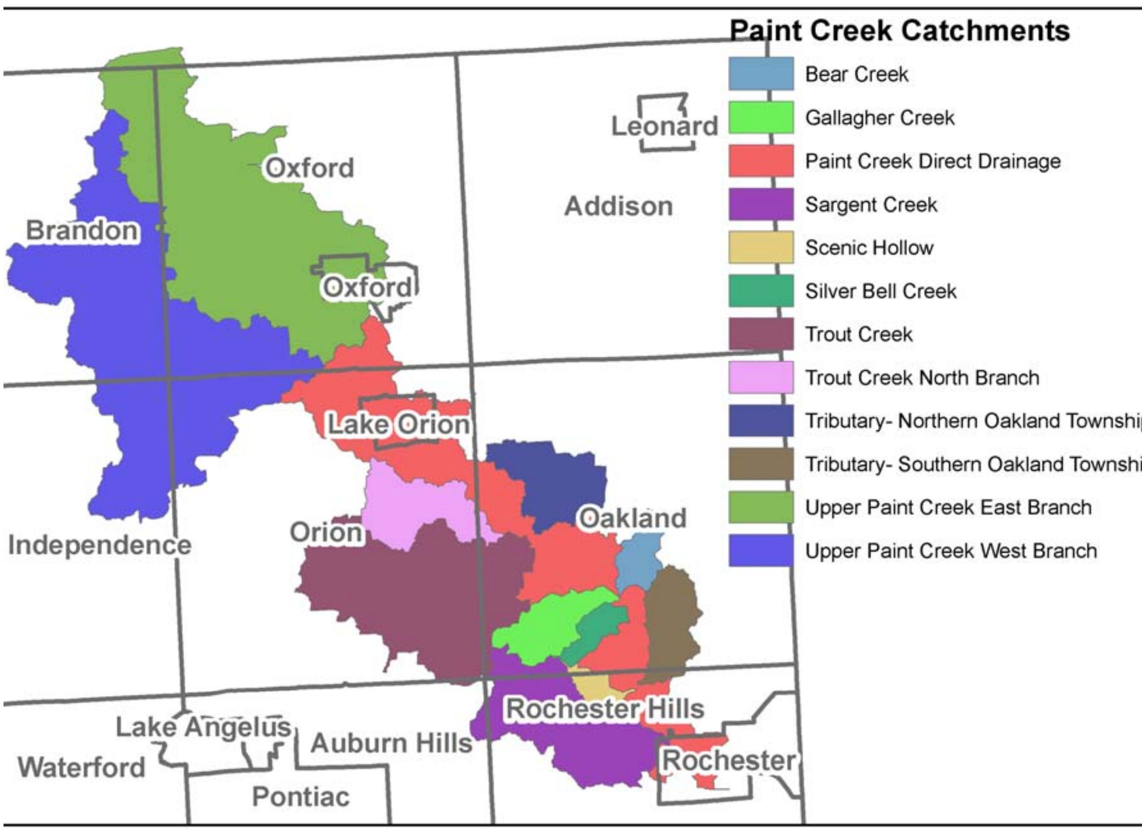


Figure 2. Catchments in the Paint Creek Subwatershed.

Existing Impervious Cover

Existing IC was estimated using a semi-automated analysis of 2000 color-infrared photography. An algorithm was developed using ERDAS software to classify the photography into 4 categories: vegetative cover, nonvegetative cover, wetlands, and water. Wetlands and water were derived directly from stereo-compiled Oakland County GIS coverages. In addition, buffered Oakland county road centerlines were used to "burn in" all roads. The nonvegetative class was then manually interpreted to segregate IC from bare soil. Bare soil classes consisted of development sites, cultivated lands, and gravel pits. IC areas consisted of paved areas and rooftops. Gravel roads were included in the IC class. Pixel class summaries were generated for each catchment, and total acres of IC as well as percent of IC were generated.

Because the CIR photography did not extend into Macomb County, SEMCOG 2000 land use was used to estimate IC in these communities. Estimates of percent IC for these land use classes were used to generate IC acres for each community.

Potential Future Impervious Cover

In order to generate estimates of IC percentages for Oakland County's parcel-based land use model, pixel summaries for each land use classification over the entire geographic area were calculated. These numbers were then used to calculate potential IC (Table 2).

Table 2. 2001 Oakland County land use classes and associated % IC values

Land Use Classification	Estimated % IC
Water	0
Agricultural	1.1
Vacant	2
Recreation and Conservation	2.9
Single Family, 10 acres or greater	3
Single Family, 5 to 9.9 acres	5.4
Single Family, 2.5 to 4.9 acres	7.9
Extractive	9.6
Transportation, Utility, and Communication	10.7
Single Family, 1 to 2.4 acres	12.5
Single Family, 14,000 to 43,559 sq. ft	23.6
Public/Institutional	28
Railroad ROW	30
Single Family Units w/ one parent parcel	31.8
Industrial	32.5
Single Family, 8,000 to 13,999 sq. ft.	35
Single Family, Less than 8,000 sq. ft.	41.6
Multiple Family	42.8
Mobile Home	46.1
Road ROW	47.8
Commercial/Office	52.2

Potential future land use was estimated by combining several datasets into one. The datasets used for the Oakland County portion included Oakland County 2002 Land Use, Oakland County Composite Master Plan, and Oakland County Hydrography. The datasets used for the Macomb portion included SEMCOG 2000 Land Use, Macomb County Composite Master Plan, and the National Wetlands Inventory. Each polygon in this combined dataset contained the following attributes:

- Existing Land Use (based on Oakland/Macomb 2000/2001land use)
- Future Land Use (the planned land use based on Oakland/Macomb Composite Master Plan)
- Municipality (the community name)
- Area (geographic area in square feet)
- Buildable (a state denoting whether the land represented by the polygon can be built on

The "Buildable" field contained the following possible values:

1. **Buildable** – A*reas that are not any of the below; developable areas*
2. **Water** – *Land area classified as water by the OC Hydrography*
3. **Wetland** – *Land area classified as "swamp/marsh" by the OC Hydrography*
4. **Committed Land Use** – *Land areas in a use other than Single Family or Vacant, Agricultural, or Extractive**
5. **Built-out** – *Single family parcels that are developed to their fullest potential***

* Land areas that were in any use other than single family or vacant were assumed to remain in that use.

** The "Built-out" areas were determined by manually selecting parcels by comparing the planned and existing parcel-size and by visually identifying parcels that almost certainly will not be split.

To estimate total potential future IC, the future additional IC acres and the year 2000 IC acres were totaled for each catchment and the watershed.

Incorporating Better Site Design Reduction Factors

Potential reductions in IC were estimated by using reduction factors. These factors can be achieved through the use of "Better Site Design" techniques (Better Site Design Handbook (1998). The following reduction factors were used (Huron River Watershed Council, 1999):

- Reduction of 20% for utilizing residential *open-space development* (attributed to reduced road length)
- Reduction of 14% for utilizing *road width reduction* in residential development
- Reduction of 20% for *reduced parking* in commercial and industrial development

Results

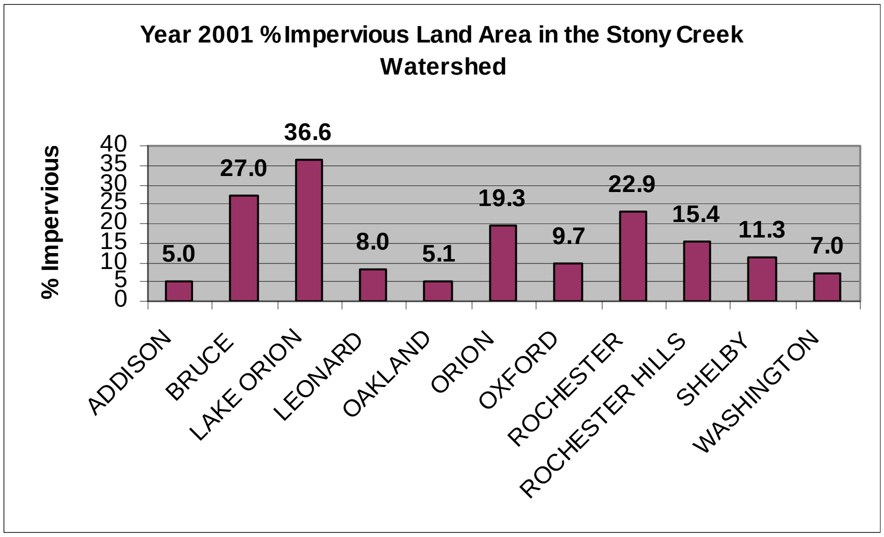
Year 2000 Impervious Cover - Stony Creek

The total watershed estimated IC for 2000 was **7.25%,** which places the Stony Creek watershed within the "Sensitive" category of the ICM. Individual community estimates were also made ().

Table 3. Year 2001 IC Estimates for Stony Creek Watershed Communities

NAME	Acres	Year 2001 % IC	Year 2001 IC Acres
ADDISON TOWNSHIP	16570.1	5.0	835.5
BRUCE TOWNSHIP	1308.1	27.0	353.2
VILLAGE OF LAKE ORION	8.0	36.6	2.9
VILLAGE OF LEONARD	455.5	8.0	36.3
OAKLAND TOWNSHIP	13677.6	5.1	700.4
ORION TOWNSHIP	742.9	19.3	143.5
OXFORD TOWNSHIP	4461.7	9.7	433.5
CITY OF ROCHESTER	621.5	22.9	142.5
CITY OF ROCHESTER HILLS	1425.1	15.4	218.8
SHELBY TOWNSHIP	26.6	11.3	3.0
WASHINGTON TOWNSHIP	7916.3	7.0	554.1
TOTAL FOR WATERSHED	47213.5	**7.3**	3423.8

The highest individual community percentages of IC in the Stony Creek watershed were attributed to the Village of Lake Orion (36.6%), Bruce Township (27%), the City of Rochester (22.9%), and the City of Rochester Hills (15.4%). The lowest percentages of IC were attributed to Addison Township (5%) and Oakland Township (5.1 %), however these two communities also had the greatest amount of IC acreage, a byproduct of having the largest land area in the watershed. Addison Township comprises 35 % of the watershed and had 835.5 acres of IC in 2001, while Oakland Township comprises 29% of the watershed and had 700.4 acres of IC in 2001.



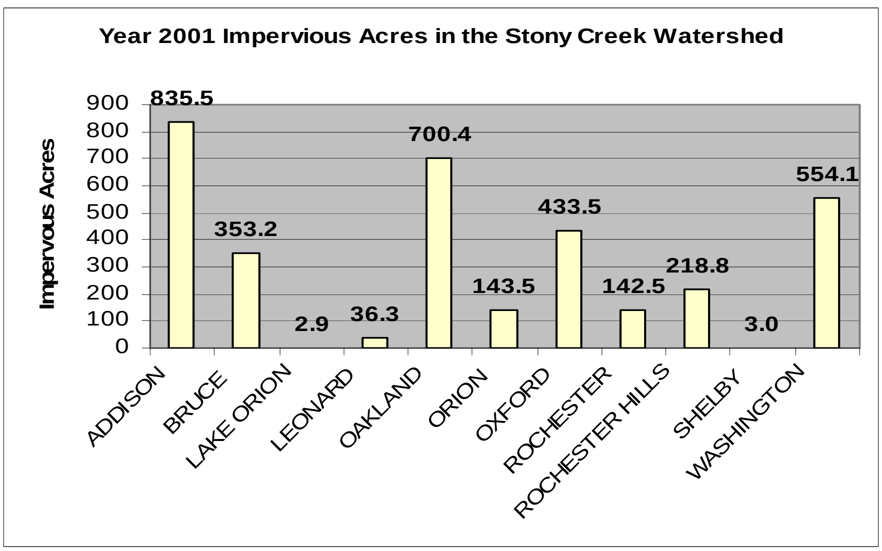


Figure 3. % IC and IC Acres by Community for Stony Creek Watershed

Year 2000 Impervious Cover - Paint Creek

The total watershed estimated IC for Paint Creek in the year 2000 was **6%,** which places it within the "Sensitive" category of the ICM. Individual catchment estimates were also made (Figure 3, Table 3).

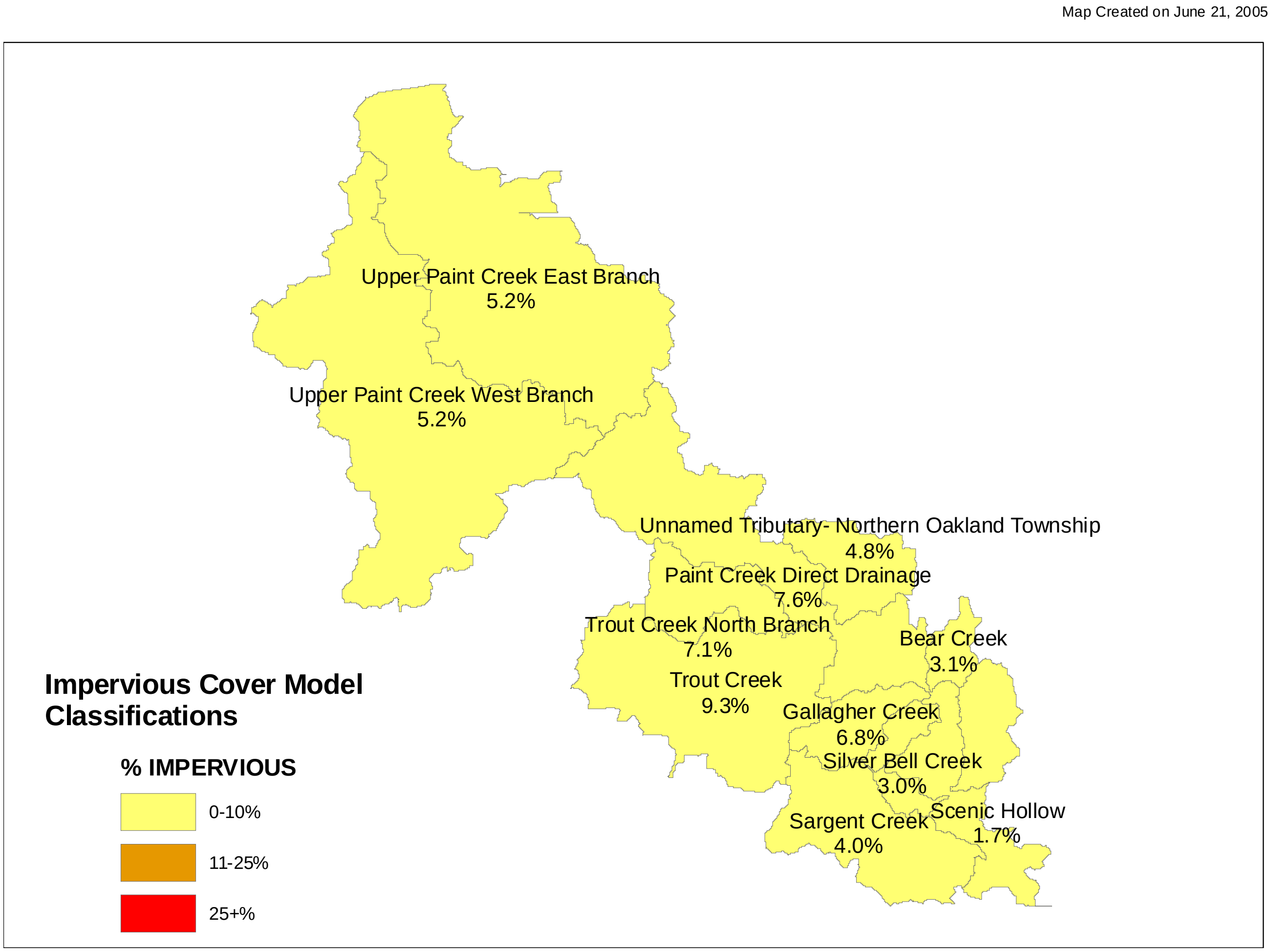


Figure 4. Paint Creek Subwatershed Catchment IC- Year 2000

Table 4. Year 2000 Landcover Estimates for Paint Creek Subwatershed Catchments

Catchment Name	% Impervious
Upper Paint Creek West Branch	5.2
Paint Creek Direct Drainage	7.6
Sargent Creek	4.0
Scenic Hollow	1.7
Unnamed Tributary- Southern Oakland Township	6.0
Bear Creek	3.1
Silver Bell Creek	3.0
Gallagher Creek	6.8
Trout Creek	9.3
Unnamed Tributary- Northern Oakland Township	4.8
Trout Creek North Branch	7.1
Upper Paint Creek East Branch	5.2

Catchment IC ranged from 3% to 9.3%. Of the 12 catchments, all were classified as "Sensitive". Impervious surfaces are largely concentrated along road corridors and in higher density residential areas. Trout Creek had the highest IC measured, and Silver Bell creek had he lowest.

Potential Future Development- Stony Creek

Based on existing land use planning policy, the potential future IC percentage of the entire Stony Creek watershed was estimated to be 12.5%, which places Stony Creek Watershed in the lower end of the "Impacted" category of the ICM. Oakland Township has the greatest potential to add IC acres within the watershed, potentially adding 1,781 additional acres of IC and bringing the Stony Creek watershed area of the township from 5.1% IC to 13.1% IC. Other large estimated potential increases include Addison Township (adding 1,417 IC acres to bring the percentage from 5% to 8.6 %), Washington Township (adding 353 IC acres to bring the percentage from 7% to 11.5%), and the City of Rochester Hills (adding 139 IC acres to bring the percentage from 15.4 to 25.1).

Estimated potential reductions in IC using "Better Site Design" methods did not drive the overall watershed percentage below 11%. A savings of only 1 % watershed wide was attained, reducing the watershed-wide IC from 12.4% to 11.4%.

Table 5. Year 2000 and Potential Future IC Estimates of Communities in the Stony Creek Watershed

NAME	Acres	Year 2000 % IC	Year 2000 IC Acres	Potential Additional IC Acres (CD)	Potential Future IC Acres (CD)	Potential % IC Acres (CD)	Potential Additional IC Acres (BSD)	Potential Total IC Acres (BSD)	Potential % IC (BSD)
ADDISON TOWNSHIP	16570.1	5.0	835.5	581.7	1417.2	8.6	477.9	1313.5	7.9
BRUCE TOWNSHIP	1308.1	27.0	353.2	58.7	411.9	31.5	47.0	400.2	30.6
VILLAGE OF LAKE ORION	8.0	36.6	2.9	0.6	3.6	44.7	0.5	3.4	43.1
VILLAGE OF LEONARD	455.5	8.0	36.3	52.7	89.0	19.5	42.2	78.5	17.2
OAKLAND TOWNSHIP	13677.6	5.1	700.4	1086.8	1787.1	13.1	869.4	1569.8	11.5
ORION TOWNSHIP	742.9	19.3	143.5	23.8	167.2	22.5	19.0	162.5	21.9
OXFORD TOWNSHIP	4461.7	9.7	433.5	134.1	567.6	12.7	107.5	540.9	12.1
CITY OF ROCHESTER	621.5	22.9	142.5	13.0	155.5	25.0	10.4	152.9	24.6
CITY OF ROCHESTER HILLS	1425.1	15.4	218.8	139.2	358.0	25.1	111.5	330.3	23.2
SHELBY TOWNSHIP	26.6	11.3	3.0	0.7	3.7	13.9	0.5	3.6	13.4
WASHINGTON TOWNSHIP	7916.3	7.0	554.1	353.3	907.5	11.5	282.7	836.8	10.6
TOTAL	**47213.5**	**7.3**	**3423.8**	**2444.5**	**5868.4**	**12.4**	**1968.6**	**5392.4**	**11.4**

CD = Conventional Development
BSD = Better Site Design

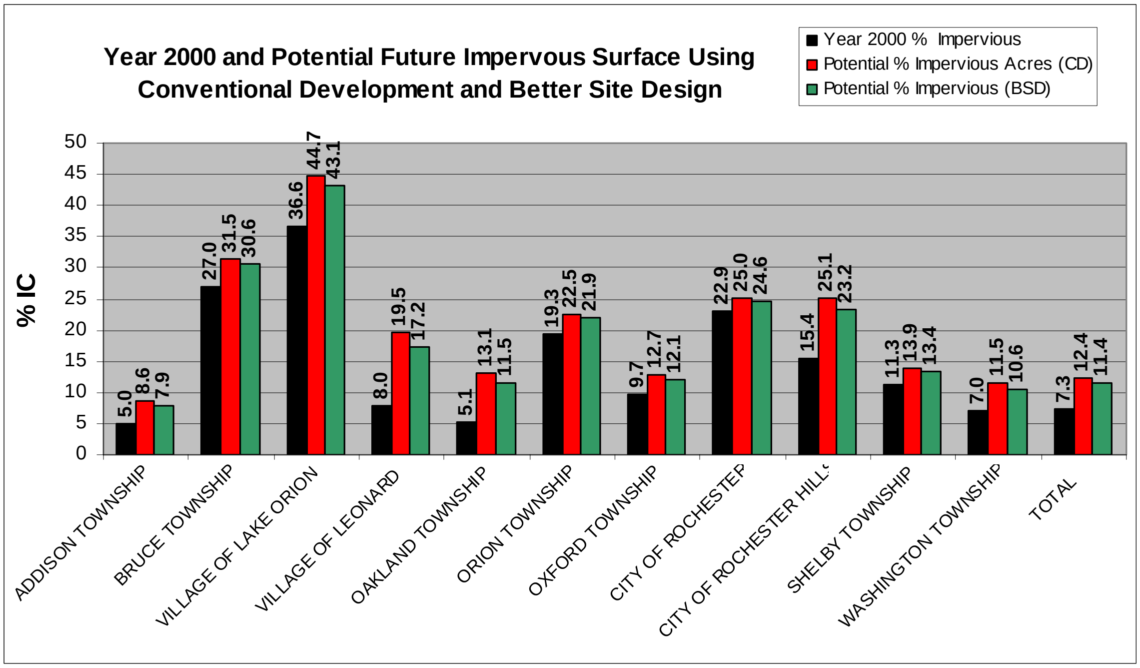


Figure 5. Year 2000 and Potential Future % IC Estimates of Communities in the Stony Creek Watershed

Potential Future Development- Paint Creek

Based on the existing development status of land and community master plans, the potential future IC at buildout was mapped and summarized for each catchment and for the entire subwatershed for conventional site development and using Better Site Design, Figure 6. Using conventional design, we expect the total subwatershed IC at buildout to reach 12%; with Better Site Design that may be reduced to 11%; placing the subwatershed in the lower end of the "Impacted: category of the ICM.

Only 2 of the 12 catchments will remain in the "Sensitive" category of the ICM under either conventional or better site design scenarios; all others will enter the "Impacted" category to varying degrees.

The highest % IC at buildout expected is in an unnamed tributary in northern Oakland Township (17.2%), Gallagher Creek (15.3%), and Trout Creek (14.7%). Potentially the greatest impacts of using Better Site Design will be in the unnamed tributary in northern Oakland Township (a reduction of 2.5%), in Bear Creek (a reduction of 2.1%), in Silver Bell Creek (a reduction of 1.9%),, and in Gallagher Creek(a reduction of 1.7%).

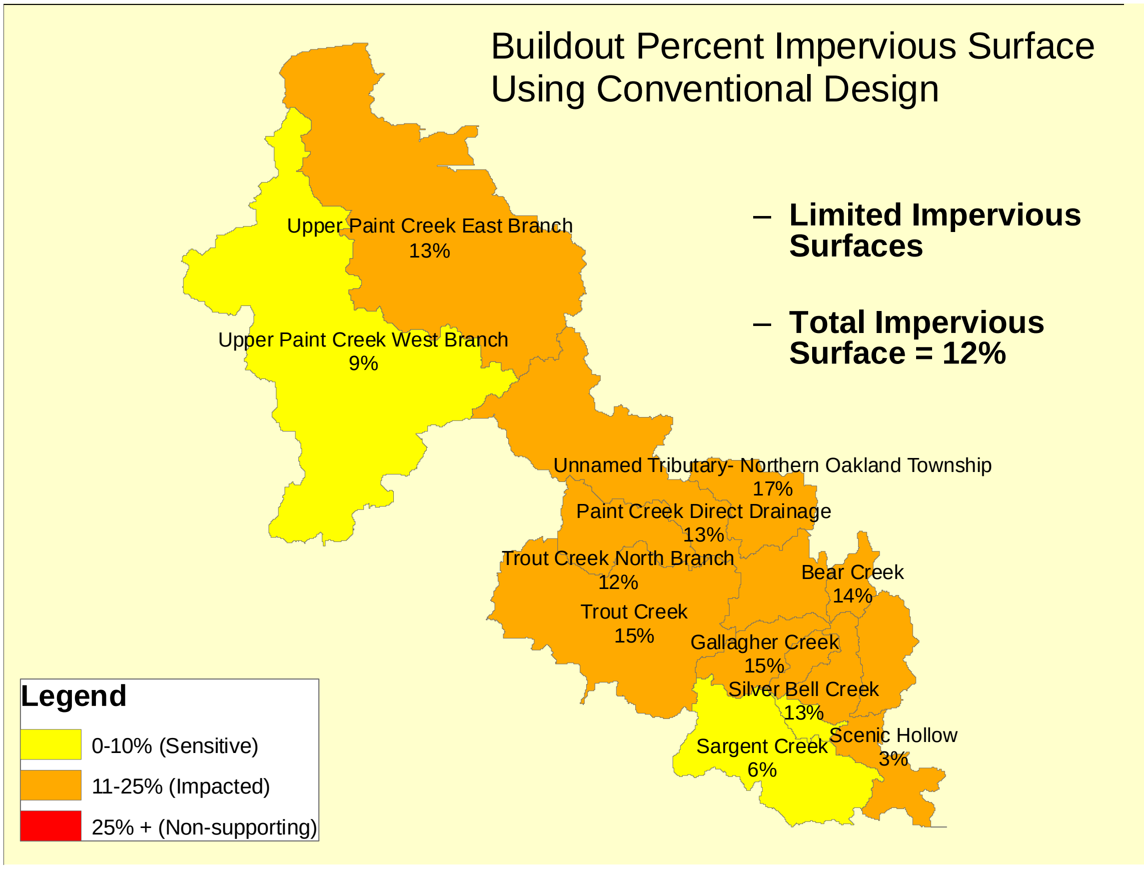


Figure 6. Future IC the Paint Creek Subwatershed (Conventional Development)

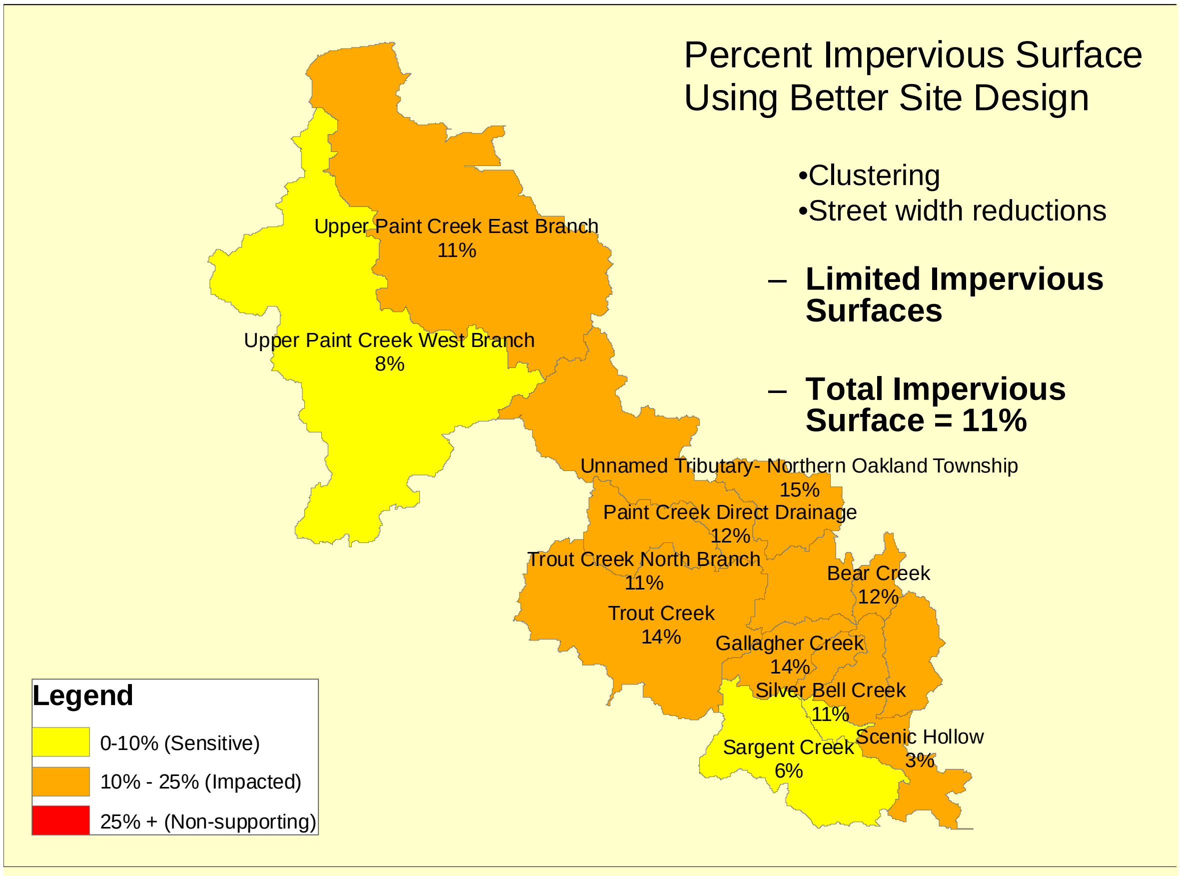


Figure 7. Future IC the Paint Creek Subwatershed (Better Site Design)

Table 6. Year 2000 and Future IC in the Paint Creek Subwatershed

Catchment Name	% Impervious	Buildout % Impervious (Conventional Development)	Buildout % Impervious (Better Site Design)	Change (Conventional Development)	Change (Better Site Design)	BSD Savings
Upper Paint Creek West Branch	5.2	8.8	8.1	3.6	2.9	0.7
Paint Creek Direct Drainage	7.6	13.2	12.1	5.6	4.5	1.1
Sargent Creek	4	6.3	5.8	2.3	1.8	0.5
Scenic Hollow	1.7	3.5	3.1	1.8	1.4	0.4
Unnamed Tributary-Southern Oakland Township	6	11.2	10.2	5.2	4.2	1
Bear Creek	3.1	13.9	11.8	10.8	8.7	2.1
Silver Bell Creek	3	12.9	11	9.9	8	1.9
Gallagher Creek	6.8	15.3	13.6	8.5	6.8	1.7
Trout Creek	9.3	14.7	13.6	5.4	4.3	1.1
Unnamed Tributary-Northern Oakland Township	4.8	17.2	14.7	12.4	9.9	2.5
Trout Creek North Branch	7.1	11.6	10.7	4.5	3.6	0.9
Upper Paint Creek East Branch	5.2	13	11.5	7.8	6.3	1.5

Potential Errors in the Analysis

The accuracy of the future IC estimates depends upon two factors; the accuracy of the IC estimates for each land class (discussed in the next section) and the accuracy of the methodology in estimating potential development areas.

Potential Development Methodology

Community master plan data was combined with wetlands and water features to remove "unbuildable" land areas. The remaining land was then evaluated to determine if the land was in a "committed use" using GIS data sources. Committed uses were generally parks and schools. Finally, the remaining land was evaluated to determine whether it was "built-out" to its fullest potential, thereby not likely to be developed. Any error in the databases or manual or automated processing could affect the outcome of the analysis. Redevelopment was not considered in the analysis.

Error in Estimating IC for Land Use Classes

Because the master plan data was parcel specific, IC estimates were generated for each land use classification by generating average pixel summaries of imperviousness for each parcel in Oakland County's parcel-specific 2001 land use data. The actual percentage of IC on any particular parcel within a land use classification may vary widely from the average value. This variation likely introduced error into the potential IC analysis; therefore the future imperviousness values represent average imperviousness conditions and should only be used as a general guide for projecting future conditions. **This analysis does not purport to make a highly accurate forecast of future conditions, but rather provides an indication of future trends.**

Conclusions

The following conclusions may be made based on this analysis:

4. Overall, the Paint and Stony Creek Subwatersheds were "Sensitive" stream systems based on the ICM in the year 2000 (6% IC and 7.25% IC, respectively).

5. Because of the uneven development pattern across the subwatersheds, some areas will remain "Sensitive" while others will become "Impacted". It is not expected that any areas will become "Non-supporting".

6. "Better Site Design" measures, while not significantly reducing IC for either subwatershed as a whole, have the potential to make significant reductions in IC in catchments and local areas.

Literature Cited

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APPENDIX C: RECOMMENDED ACTIONS & CRITERIA FOR SUBCRITICAL AREAS

Summary

The purpose of this appendix is to further characterize and categorize the recommended watershed actions that should be implemented within each of the associated subbasin and subcritical areas.

Table C.1 Recommended Stony/Paint Subwatershed Actions contains a chronological list of the actions listed in Chapter 5. Each action was assigned a number and these numbers have been transferred to Tables C.2 and C.3.

Tables C.2 and C.3 compile all the actions, survey results and priorities into a list of recommended actions by BMP Phasing. Each table lists subbasin ID along with each of the field survey site IDs. Permittees having jurisdictional area within each subbasin is listed followed by the assigned preservation category that was described in Chapter 5.

Three columns then list the associated recommended actions for implementation by subbasin and site. The recommended actions are categorized by BMP Phase (i.e., I, II, or III). These actions may be cross-referenced with Tables 5.3, 5.4 and 5.4b in which the Level of Effort and Evaluation Methods are described. Furthermore, as various actions are implemented, Appendix E, combined with Tables 5.3 and 5.4, provides an overall subwatershed approach to monitoring long-term improvements.

The following two tables summarize the actions by subbasin:

Table C.1. Stony Creek Recommended Actions by Subbasin; and
Table C.2. Paint Creek Recommended Actions by Subbasin.

Table C.2. Stony Creek Recommended Actions by Subbasin

Subbasin ID (Field Survey Site IDs in Subbasin)	Subwatershed Representatives	Figure 3.15 &Table 3.44 Preservation Category	Recommended Actions (Table 5.3, 5.4 & 5.4b) (BMP Phase 1)	Recommended Actions (Table 5.3, 5.4 & 5.4b) (BMP Phase II)	Recommended Actions (Table 5.3, 5.4 & 5.4b) (BMP Phase III)
Stony Creek Subwatershed					
SC A (QAPP10; QAPP09; MS02; MS02A; MS02B; MS03)	Rochester; Rochester Hills; Oakland Township; Washington Township; Oakland County; Macomb County	3	7-9, 11, 19, 21, 23, 41, 46, 58	10, 15, 16, 17, 18, 22a, 23, 25, 28, 29, 30, 32a, 42, 54, 56, 57	30b, 32b, 39, 43, 46b, 59
SC B (QAPP04; MS04)	Washington Township; Macomb County	2	7-9, 11, 19, 21, 23, 41, 46, 58	10, 13, 15, 18, 22a, 28, 29, 36, 42, 54, 56, 57	30b, 32b, 39, 43, 46b, 59
SC C (QAPP05)	Washington Township; Oakland Township; Oakland County; Macomb County	3	7-9, 11, 19, 21, 23, 26, 33, 41, 46, 58	10, 15, 16, 17, 18, 22a, 25, 28, 29, 30, 32a, 36, 42	32b, 39, 43, 46b, 59
SC D (QAPP06)	Washington Township; Oakland Township; Oakland County; Macomb County	3	7-9, 11, 19, 23, 24, 26, 31, 33, 41,46, 58	10, 15, 16, 17, 18, 22a, 25, 28, 29, 31, 32a, 36, 42, 56, 57	17, 30b, 32b, 43, 46b, 59
SC E (QAPP08; WS01; WS02; WS06; WS07; WS09; WS13; WS15; WS17)	Oakland Township; Oakland County	3	7-9, 11, 19, 23, 24, 26, 31, 33, 41, 46, 58	10, 15, 16, 18, 22a, 25, 28, 29, 32a, 33, 36, 42, 58, 59a	17, 39, 30b, 32b, 43, 46b, 59
SC F (QAPP03; MS06; MS07; MS08)	Washington Township; Bruce Township; Addison Township; Oakland County; Macomb County	3	7-9, 11, 19, 23, 41	10, 15, 18, 22a, 28, 29, 30, 30, 32a, 42, 58, 59a	30b, 32b, 39, 43, 59b
SC G (MS05)	Washington Township; Oakland Township; Addison Township; Oakland County; Macomb County	1	7-9, 11, 19	10, 12, 13, 15, 18, 22a, 29, 58	22b, 39
SC H (QAPP02)	Oakland Township; Addison Township; Oakland County	2	7-9, 11, 19, 23, 41	10, 15-18, 22a, 25, 28, 32a, 42, 56, 57, 59a	22b, 32b, 39, 43, 59b
SC I (WS18)	Oakland Township; Addison Township; Oxford Township; Oakland County	1	7-9, 11, 19, 23, 41,	11, 12, 13, 15, 18, 22a, 29, 42, 47-50, 59a	22b, 32, 39, 43, 59b
SC J (QAPP07; WS19; WS20; WS21; WS22)	Oakland Township; Addison Township; Oxford Township; Orion Township; Oakland County	1	7-9, 11, 19, 21, 23, 46	10, 18, 22a, 28, 36	22b, 39, 46b

Table C.2. Stony Creek Recommended Actions by Subbasin

Subbasin ID (Field Survey Site IDs in Subbasin)	Subwatershed Representatives	Figure 3.15 &Table 3.44 Preservation Category	Recommended Actions (Table 5.3, 5.4 & 5.4b) (BMP Phase 1)	Recommended Actions (Table 5.3, 5.4 & 5.4b) (BMP Phase II)	Recommended Actions (Table 5.3, 5.4 & 5.4b) (BMP Phase III)
Stony Creek Subwatershed					
SC K (QAPP01; MS09)	Addison Township; Bruce Township; Oakland County; Macomb County	2	7-9, 11, 19, 21, 23, 41	10, 12, 13, 15, 18, 22a, 28, 29, 30a, 32a, 42, 47-50, 58, 59a	22b, 30b, 32a, 39, 43, 59b
SC L (NA)	Addison Township; Oakland County	1	7-9, 11, 19, 21, 23, 42	10, 12, 13, 15, 18, 22a, 28, 29, 30a, 32a, 42, 47-50, 58, 59a	22b, 30b, 32a, 39, 43, 59b
SC M (MS10; MS11; MS12)	Addison Township; Oakland County	1	7-9, 11, 19, 21, 23, 43	10, 12, 13, 15, 18, 22a, 28, 29, 30a, 32a, 42, 47-50, 58, 59a	22b, 30b, 32a, 39, 43, 59b
SC N (NA)	Addison Township; Oakland County	1	7-9, 11, 19, 21, 23, 44	10, 12, 13, 15, 18, 22a, 28, 29, 30a, 32a, 42, 47-50, 58, 59a	22b, 30b, 32a, 39, 43, 59b
SC O (NA)	Oxford Township; Oakland County	3	7-9, 11, 19, 21, 23, 45	10, 12, 13, 15, 18, 22a, 28, 29, 30a, 32a, 42, 47-50, 58, 59a	22b, 30b, 32a, 39, 43, 59b

APPENDIX D:
TOOLS AND TECHNIQUES FOR PROTECTION OF THE STONY/PAINT CREEK CORRIDORS

Introduction

As described in Chapter 4 of the Stony/Paint Creek Subwatershed Management Plan, the following material describes potential tools that could be used to improve protection of Stony & Paint Creeks and its water quality. It describes planning tools that work to improve water resource protection, as well as provides some example language for goals, policies and guidelines.

To help communities incorporate these ideas into their existing planting documents, the tools have been organized into three main categories:

- Master Plan
- Zoning and other ordinances
- Standards, guidelines, and overlay districts

The recommendations presented here are organized in the same way as the evaluations are organized: Plans and Policies, Development/Redevelopment Regulations, and Design Standards. This organization was used to enable easy integration of the recommendations into each document. It also allows the community to see how the recommendations could be combined, and how they might impact each other as well as existing policies and/or regulations.

Model language for some recommendations is also provided. This language is intended to be a sample that can guide the community's work in customizing it to best fit into their existing goals, plans and regulations. They do not provide a legal opinion and should not be relied upon for a complete description of required language.

Plans and Policies

The most influential tools that a community has for protecting water resources are its plans and policies. These documents lay out a community's future vision of the character of its landscapes, the goals of its citizens, and the policies it has adopted to achieve this vision.

This section discusses a few options available for communities to create a policy basis for planning decisions that can help to protect water resources. It describes information that can be added to the community's Master Plan or be stand-alone plans themselves. Regardless of how the information is organized, this section provides guidance to the ideas that could be included in a planning document that communicates a community's vision for the future of its water resources.

As part of this discussion, we have provided sample language that communities can use as a basis for developing goals, policies and ordinances. ***We strongly recommend that any sample language used in this way be carefully considered and modified as necessary so that it is consistent with and compliments goals, policies and requirements in the community's current documents*.**

Master Plan as a Basis

Planning is a process that involves the conscious selection of policy choices to guide land use, growth, and development in the community. The Master Plan is the official document that sets forth policies to guide future land use and development of the community.

The Plan serves many functions and is to be used in a variety of ways:

1) The Plan is a general state of the community's goals and policies and provides a single, comprehensive view of the community's desires for the future.

2) The Plan serves as an aid in daily decision-making. The goals and policies outlined in the Plan guide the Planning Commission and elected officials in their deliberations on zoning, subdivision, capital improvements and other matters relating to land use and development.

   The policy orientation of this Plan provides decision-makers with a framework and basis for decisions while recognizing the dynamic character of the community. The variables upon which this Plan is based will likely change over time. However, adherence to the goals and policies will provide a stable, long-term basis for decision-making.

3) The Plan provides the statutory basis upon which zoning decisions are based. Both the Township Rural Zoning Act (P.A. 184 of 1943, as amended), and the City and Village Zoning Act (P.A. 207 of 1921) require that the zoning ordinance be based upon a plan designed to promote the public health, safety, and general welfare.

4) The Plan is an educational tool and gives citizens, property owners, developers, and adjacent communities a clear indication of the community's direction for the future.

In summation, the Master Land Use Plan is the only officially adopted document that sets forth an agenda for the achievement of goals and policies for the entire community. It is a long-range statement of general goals and policies aimed at the unified and coordinated development of the community. As such, it provides the basis upon which zoning and land use decisions are made.

A community's Master Plan sets out to establish the basis for protection of water resources and justification for the direction of the ordinances adopted to achieve both natural feature preservation and ecologically-aware development. Both the Municipal Planning Act (P.A. 285 of 1931) and the Township Planning Act (P.A. 168 of 1959) give broad authority for the consideration of natural resource protection and development rules and guidelines in the formulation of the Plan. One tool that can be incorporated into the Master Plan to achieve these goals is a Natural Areas Plan.

1) Natural Areas Plan

The purpose of a Natural Areas Plan is to identify environmentally significant areas of the community that should be preserved in their natural state and those that can be compatibly integrated with development. Furthermore, the Natural Areas Plan can work toward creating a system of open spaces that are linked to one another through naturally-occurring or human-made corridors. It can be included as a Chapter of the Master Plan, or can be a stand-alone plan. If stand-alone, the natural features inventory and background data should be included as part of the plan.

The Natural Areas Plan represents an ecosystem approach to open space planning that will help preserve both the natural areas themselves, but also the *functioning* of the systems these areas represent. It is an "ecosystem" approach to land preservation, which takes into account not only the natural feature identified as significant, but also the other adjacent land elements that allow that natural feature to be sustained.

Development of the Plan

A Natural Areas Plan can be developed using the following steps:

*Step 1: Combining the Data***.**
Available natural features data is combined on a map that identifies important natural and human-made features. This data can include:

a) Any natural feature inventories conducted for parcels within the community, such as wetlands, woodlands, high quality wildlife habitat, etc.

b) Wetland Riparian Systems. This data includes rivers, streams, floodplains, lakes and wetlands. These landscape features are important because, with their plant and animal communities, they filter out pollutants and protect water quality for all the organisms that use surface waters and protect the physical health of citizens through clean groundwater.

c) Upland Landscape Fabric. This data includes woodlands, tree rows and severe slopes. These elements offer an opportunity for establishing a network of natural landscape corridors linking patches, and larger natural areas establishing habitat corridors.

Linkages provide continuity between various areas of the landscape fabric, offering more and varied landscape types for wildlife.

d) Publicly-Owned Properties and Recreational Lands. All publicly-owned recreational lands, including state, county, and locally-owned parcels are identified.

e) Other Corridors. This data includes human-made corridors such as Natural Beauty Roads and utility corridors. Also included are existing and planned bicycle paths and trail systems.

Step 2: Analyzing the Data.
Once the data is combined on a map, it is possible to see where several data elements overlap, signifying the environmentally-important areas. Areas should be identified as "ecosystems," or combinations of natural features that impact one another.

Step 3: Identifying Connections.
The next step is to connect the environmentally-significant sites to create an interrelated network of natural areas. The connecting corridors, such as rivers, existing tree rows, natural beauty roads, and utility lines, help preserve the natural functioning of these systems. If kept in their natural state, these corridors preserve the hydrologic connections between the river and its wetlands, between wetlands, and between adjacent uplands and wetlands. The corridors also provide spaces for wildlife to move between the natural areas and allow them to play their role in the functioning of the entire system.

Step 4: Prioritizing Areas and Identifying Protective Tools.
The last step in the process is to prioritize the natural areas based on their quality. This can be done by assessing the areas size, intactness (level of fragmentation), riparian corridor, wetlands, restorability, and known occurrence of rare plant communities or species. Some of this information, such as "restorability" and "rare plant communities or species" can be assessed on a case-by-case basis as land is being developed through the site plan review process.

Another method of prioritizing areas is to assess the role they play in surface and groundwater storage and filtering, habitat, community character, or other values that the community places on its natural resources. Once areas are prioritized, their fitness for development can be assessed, and tools can be identified to protect natural features, restore degraded features, and guide development.

Example tools:

- *Preserve open space through fee simple purchase and/or conservation easements.*
- *Continue to use land conservation and clustering tools to preserve existing natural features and their functioning.*
- *Protect non-regulated wetlands from development and water quality degradation. Best management practices should be implemented for the capture and filtering of storm water and storm water infiltration to treat water before it reaches any existing wetland.*
- *Use low impact road crossing techniques to protect the riparian corridor and existing hydrology of rivers and streams.*

2) Storm Water Master Plan

A comprehensive Storm Water Master Plan addresses development, implementation, and enforcement of controls to protect designated uses in all receiving waters. It requires the development of ordinances or other regulatory measures to address post-construction storm water runoff from new development and re-development projects. Tools that would be included are:

1) Ordinances or other mechanisms that will regulate storm water runoff from developed sites. This ordinance should address storm water quality, and limit the rate of runoff to pre-development rates.

2) Requirements for the use of structural and non-structural Best Management Practices (BMPs).

3) Requirements for the long-term maintenance of BMPs.

4) Site plan review requirements for storm water management facilities.

5) Requirements that will minimize illicit discharges and spills into the community's storm water system by commercial operations.

In addition to appropriate tools, the Storm Water Master Plan will also include measurable goals that could be accomplished by using BMPs, such as reduction in pollutant levels.

3) Greenway Plan

A Greenway Plan can achieve several purposes: natural features preservation, facilities for alternate modes of transportation, and recreation opportunities. Greenway Plans are particularly relevant to water resource protection because of their linear character. Rivers and streams provide ideal corridors upon which to build a greenway.

As in most planning documents, a Greenway Plan requires goals and objectives. These principles guide the development of the plan, and assist in decision-making. Oftentimes, communities solicit public input on the development of a Greenway Plan, which helps to identify corridors, destinations, and points of interest along the way.

Example goals and objectives:

Goal:	*Develop a greenway system that helps protect cultural and sensitive environmental areas.*
Objective:	*Acquire property or conservation easements (or the like) along environmentally-sensitive corridors such as rivers, streams, wetlands, woodlands, and wildlife habitat corridors to protect and integrate these areas as part of the greenway system.*
Goal:	*Develop the greenway system through cooperation and coordination with private land owners, land conservancies, developers, recreation and environmental groups, and other public agencies.*
Objective:	*Build on existing relationships between the community and public and private groups to plan, finance, and implement the greenway system.*

Other important goals would discuss the approach to funding and maintaining the greenway trail.

Development of the Plan

A Greenway Plan can be created by combining layers of information about the community, its natural resources, and cultural assets.

Step 1: Determine Greenway Elements.
Determine the important destinations within the community that should be connected by a non-motorized path system. These elements could include existing parks, schools, and historic and cultural points of interest.

Step 2: Determine Natural Features.
Identify natural features that should be preserved, particularly natural river and stream corridors.

Step 3: Determine Human-Made Features.
Identify human-made corridors such as roads, abandoned railroad rights-of-way, tree-rows, Natural Beauty Roads, and utility line corridors. Other amenities to identify are existing and planned trail systems offered through other state, county or local agencies.

Step 4: Create and Map the Greenway
When all this information is combined on a map, the potential routes and destinations present themselves by the pattern of overlapping data. The actual trail and points of interest can be considered and finalized, culminating in a Greenway Plan Map.

It is important to connect your community's greenway with trails that travel through other communities. This will significantly increase the value of the greenway for alternative transportation and recreation purposes. For example, the "Greenways Initiative" has developed a concept greenway plan for Southeast Michigan. This large-scale plan connects the seven counties of the region, and was developed by working with residents in these counties to connect 4.5 million people through the non-motorized path system.

A Greenway Plan can be a stand-alone document, or can be a chapter in the community's Recreation Master Plan. If a stand-alone document, descriptions of the community's relevant features, such as streams and rivers, other natural resources and cultural destination points, needs to be included as background information for the Greenway Plan itself.

Development/Redevelopment Regulations:

Zoning and Other Ordinances

Other effective tools a community possess are their ordinances. These local laws can provide detailed direction on the approach a community wants a landowner to take in developing or redeveloping land. Ordinances can provide standards that address natural features and their preservation and help the land developer, and the public servants reviewing the site plans, design and assess a site's potential for development and protection of water resources.

1) Storm Water Management Ordinance

A Storm Water Management Ordinance can be used to communicate to developers how storm water quality and quantity are viewed by the community, and can give them guidance to how they should approach storm water management on site through their designs. Storm water runoff is one of the major sources of pollution degrading our water resources. This is due, in part, because we have become very efficient at collecting runoff, and carrying it off site through underground pipes. These pipes, however, do not filter the storm water of pollutants before it reaches a stream or wetland.

Therefore, the main emphasis of a Storm Water Management Ordinance should be to prevent storm water runoff, and treat the runoff that does occur before it reaches a natural water body. (Please see the next section, "Impervious Surface Reduction/Infiltration Enhancement Ordinance," for more information and sample language on preventing storm water runoff.)

General standards to include in a Storm Water Management Ordinance are topics such as:

- Encourage open space design subdivisions that use smaller lot sizes. This minimizes impervious surface by clustering developing in one area of the site, reducing total construction costs (shorter roads, utilities), and provides recreational space. The open space allows storm water to infiltrate into the ground, filtering out pollutants and recharging groundwater.

- Limiting land disturbance and grading.

- Maintaining the natural drainage patterns on site.

- Leave as much open space as possible in its natural condition. This provides storm water infiltration and has minimal maintenance costs.

- Link open space to existing wetlands, river systems, and other open space areas. This provides a buffer to these sensitive areas, allows scenic recreational opportunities for residents, provides a wildlife corridor, and cold provide a location for non-motorized transportation (bicycles, roller bladers, hikers, walkers, etc.)

- Maintaining vegetated buffer strips other native vegetation along natural features to remain on site to improve infiltration of storm water.

- Minimizing impervious surfaces to reduce the amount of runoff and improve infiltration.

- Using Best Management Practices (BMPs) whenever possible. Using above-ground BMPs instead of below ground storm water conveyance systems (Please refer to the section titled "Best Management Practices" in this booklet for more information.) Above-ground BMPs include facilities such as vegetated swales planted with native species, terraces, contoured landscapes and runoff spreaders.

- Using infiltration devices.

- Require that soils be aerated/decompacted after construction is complete. The activity of heavy construction equipment can make soils almost as impervious as asphalt or concrete. Compacted soils reduce infiltration and can cause storm water management practices to be ineffective. In addition, storm water BMPs should be clearly labeled on grading plans and flagged in the field to ensure heavy construction equipment avoids these areas.

Other requirements in the ordinance should cover the use of wetlands, streams, rivers or other water bodies for storm water retention and/or conveyance. These standards would prohibit directly discharging storm water into a natural water body to the greatest extent possible and require that runoff be pre-treated to remove pollutants and sediments as well as slow the water's velocity before it enters the water body.

Regulations for erosion control before, during and after construction could also be addressed in this ordinance. Other topics could include maintenance of the existing water body in its current state and function, private restrictions (i.e. through Master Deed and Bylaws) to insure that the water body is not disturbed in the future, and that all drainage systems are visually attractive with naturally contoured ponds planted with native plants.

Lastly, if some water bodies, such as wetlands, have been identified as high quality, the community may want to protect them more stringently. For example, a wooded wetland is particularly sensitive to hydrological changes, and discharging any storm water into it may dramatically change the plant mix from trees to a cattail marsh. Each community may want to single out particularly sensitive or high-quality water bodies and develop special standards for protecting these places.

An important element of the Storm Water Management ordinance is that it calls for regular inspection and maintenance of the storm water structures and facilities, and could require that the landowner enter into a maintenance agreement with the community to ensure these facilities are maintained for maximum efficiency.

2) Impervious Surface Reduction/Infiltration Enhancement Ordinance

Storm water runoff is one of the major sources of pollution degrading our water resources. This is due, in part, to the growing amount of impervious surfaces such as roads, parking lots, and buildings. Impervious surfaces add to the amount and rate of storm water entering our surface waters. This runoff carries a variety of pollutants such as fertilizers, pesticides, oil, bacteria from animal waste, and increased flow into the system. This results in degradation to our water resources, increases in the magnitude and frequency of flood events, reductions in fish and other aquatic species diversity, increases in stream bank erosion, and decreases in infiltration into the groundwater.

There are many ways to reduce the amount of impervious surfaces in a development. An Impervious Surface Ordinance could be used to communicate site development standards that guide developers and individuals doing site plan review to find opportunities for water infiltration. These standards can be included in a stand alone ordinance, as a set of site design standards, or included in other ordinances dealing with storm water or natural features/wetland protection. The following example language incorporates impervious surface reduction with language regulating storm water management.

Storm Water Management/Impervious Surface Mitigation Ordinance

1. *It is the intent of this Ordinance to encourage the use of structural, vegetative, or managerial practices, commonly referred to as best management practices (BMP's), designed to treat, prevent, or reduce degradation of water quality due to storm water runoff. All development projects subject to review under the requirements of this Ordinance shall be designed, constructed, and maintained using best management practices (BMP's) to prevent flooding, protect water quality, reduce soil erosion, maintain and improve wildlife habitat, and contribute to the aesthetic values of the project. The particular facilities and measures required on-site shall reflect and incorporate existing grade, natural features, wetlands, and watercourses on the site to the maximum extent feasible.*

2. *Storm Water Drainage/Erosion Control. All storm water drainage and erosion control plans shall meet the standards adopted by the Community for design and construction and shall, to the maximum extent feasible, utilize nonstructural control techniques, including but not limited to:*

    a. *limitation of land disturbance and grading;*

    b. *maintenance of vegetated buffers and natural vegetation;*

    c. *minimization of impervious surfaces;*

    d. *use of terraces, contoured landscapes, runoff spreaders, grass or rock-lined swales;*

    e. *use of infiltration devices.*

3. *General Standards.*

a. Storm water management systems shall be designed to prevent flooding and the degradation of water quality related to storm water runoff and soil erosion from proposed development.

b. All properties which are subject to this ordinance shall provide for on-site storage of storm water. Facilities shall be designed to provide a volume of storage and discharge rate which meets the standards of the community.

c. Priority shall be placed on site design which maintains natural drainage patterns and watercourses. Alterations to natural drainage patterns shall not create flooding or degradation in water quality for adjacent or downstream property owners.

d. The use of swales and buffer strips vegetated with desirable native materials is encouraged as a method of storm water conveyance so as to decrease runoff velocity, allow for biofiltration, allow suspended sediment particles to settle, and to remove pollutants. Tolerance for water saturation, sunlight, pesticides, metals, and salts shall be required in determining appropriate plantings in these areas.

e. Drainage systems shall be designed to be visually attractive. The integration of storm water conveyance systems and retention and detention ponds in the overall landscape concept is recommended. Ponds with a naturally contoured, rather than square or rectangular, design and appearance shall be encouraged.

f. Where large amounts of grease and oil may accumulate, as in the case of commercial/industrial developments and large areas of impervious surfaces for parking, oil separators shall be required.

g. For sites that store or use chemicals, a spill response plan shall be submitted and approved by the community.

4. Use of Wetlands. Wetlands may be used for storm water management if all the following conditions are met:

a. Wetlands shall be protected from impairment due to the discharges of storm water. Measures shall be taken reduce erosive velocities of storm water and to remove sediment and other pollutants prior to discharge to a wetland.

b. Wildlife, fish or other beneficial aquatic organisms and their habitat within the wetland will not be impaired

c. The wetland has sufficient holding capacity for storm water, based upon calculations prepared by the proprietor and reviewed and approved by the community.

d. On-site erosion control shall be provided to protect the natural functioning of the wetland.

e. Provisions approved by the community shall be established so as to insure that the wetland is not disturbed or impaired in the future relative to the needed storage capacity.

f. Applicable permits from the Michigan Department of Environmental Quality are obtained.

5. Impervious Surface Reduction/Infiltration Enhancement. The community recognizes that, due to the specific requirements of any given development, inflexible application of the design standards may result in development with excessive paving and storm water runoff and a waste of space which could be left as open space.

Either through procedures prescribed by Ordinance or creative land development techniques permitted by Ordinance, the community may permit deviations from requirements allowing for reduction in impervious surfaces whenever it finds that such deviations are more likely to meet the intent and standards of this Ordinance and accommodate the specific characteristics of the use in question.

The community may attach conditions to the approval of a deviation that bind such approval to the specific use in question. Measures that reduce impervious surface and increase infiltration may include, but are not limited to, the following:

a. Streets and Access.

(1) Design residential streets with the minimum required pavement width needed to support travel lanes, on-street parking, and emergency, maintenance, and service vehicle access and function based on traffic volumes.

(2) Reduce the total length of residential streets by examining alternative street layouts to determine the best option for increasing the number of homes per unit length.

(3) Design street right-of-way widths/private road easements to reflect the minimum required to accommodate the travel-way, the sidewalk, and vegetated open channels.

(4) Minimize the number of street cul-de-sacs and reduce the radius of cul-de-sacs to the minimum required to accommodate emergency and maintenance vehicles. Alternative turnarounds shall be considered, including the use of mountable curbing and grass shoulders for the occasional event of access by fire trucks and other large commercial trucks. Where cul-de-sacs do exist, provide landscape center islands.

(5) Where density, topography, soils, and slope permit, use vegetated open channels in the street right-of-way/private road easements to convey and treat storm water runoff.

(6) Use alternative driveway surfaces and shared driveways that connect two or more sites.

(7) Promote more flexible design standards for residential subdivision sidewalks. Where practical, consider locating sidewalks on only one side of the street and providing common walkways linking pedestrian areas.

b. Parking

(1) Base parking requirements on the specific characteristics of the use, landbanking in open space parking required to satisfy Ordinance requirements.

(2) Reduce the overall imperviousness associated with parking lots by providing compact car spaces, minimizing stall dimensions, incorporating efficient parking lanes, and using pervious materials in the spillover parking areas where possible.

(3) Encourage shared parking between compatible users.

c. Site Design

(1) Direct rooftop runoff to pervious areas such as yards, open channels, or vegetated areas and avoid routing rooftop runoff to the roadway and the storm water conveyance system.

(2) Create a naturally vegetated buffer system which may vary in width as determined by the community along all drainage ways. Critical environmental features such as the 100-year floodplain, steep slopes, and wetlands shall be considered.

(3) Minimize clearing and grading of woodlands and native vegetation to the minimum amount needed to build lots, allow access, and provide fire protection.

(4) Conserve trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native plants.

6. Maintenance. Whenever a landowner is required to provide on site storm water retention and/or surface drainage to a wetland, or whenever other protective environmental measures including monitoring devices are required, such measures or facilities shall be provided and maintained at the landowner's expense. The landowner shall provide assurance to the Community by written agreement that the landowner will bear the responsibility for providing and maintaining such methods or facilities. A maintenance plan shall be provided including notation and description of maintenance requirements and timelines.

3) Wetland Protection Ordinance

Federal and state wetland regulations generally protect wetland areas of more than five acres and wetlands of any size that are contiguous with other water bodies, such as rivers and lakes. Local wetland regulations can build on these laws and provide protection for smaller, or isolated wetlands that could otherwise be threatened by development. It is important that before adopting any wetlands ordinance, a community work with the Michigan Department of Environmental Quality (MDEQ) to ensure that the new ordinance coordinates with the state and federal regulations.

Basic Wetland Ordinance Components

There are generally six basic components to a wetlands ordinance:

1) **A statement of wetland protection goals** that validate wetland regulations as a way to carry out mandated state statutes, such as controlling water pollution or reducing flooding. Ties between wetland protection and protecting citizens' health, safety and general welfare should also be made by stating the values that wetlands bring each community and the problems that can arise if wetlands are not properly protected.

2) **A definition of a wetland**. Michigan's wetland protection laws require that local governments define wetlands in the same way as they are defined under the state statute.

3) **Wetland inventory map**. Communities must adopt a wetlands map that inventories wetlands throughout the community. This map, used in conjunction with aerial photographs and field inventories on a case-by-case basis, are used to administer the wetland ordinance.

4) **Permitted uses, prohibited uses, standards for protection and use**. A list of prohibited and permitted uses and performance standards. Many of these items are listed within the state statute.

5) **Permit application, review and administration**. If a community has a wetland's ordinance, they become responsible for reviewing and issuing permits for wetlands covered by the ordinance. The local unit of government is responsible for keeping MDEQ informed of wetland permit applications and the results of a wetland permit application review.

   Penalties. Most ordinances include penalties for violations of the wetlands ordinance. Penalties can include fines and/or a requirement that the affected wetland area be restored or mitigated in some way.

6) Lastly, **<u>enforcement is the key to wetland protection</u>**. Field inspections need to be made to ensure wetlands are properly protected during construction and, if a mitigation project, that the new wetland is functioning properly. Field visits to confirm that required actions have been taken will also help monitor wetlands over time, providing the community with information that indicates whether the wetland's ability to function is improving, getting worse or being maintained.

4) Natural Features Setback Ordinance

A natural features setback establishes a minimum setback from natural features to prevent physical harm or destruction of the feature. This ordinance recognizes the relationship that adjacent ecosystem types have to one another. An example ordinance follows this description.

The natural features setback creates a naturally vegetated strip of land adjacent to the natural feature that is left intact during and after construction. The size of the vegetated strip is up to the community, but should be a minimum of 25 feet wide.

Because there is broad authority in the Zoning Enabling legislation for natural feature protection, this ordinance would be a provision of the Zoning Ordinance.

Example Natural Features Setback Ordinance

The language utilized below presumes that a separate article of the zoning ordinance would be adopted. Modifications would be required for application in a separate ordinance.

1. <u>Intent</u>

It is the intent of this article to require a minimum setback from natural features [Note: If the community defines "natural feature" in its ordinance for other purposes, a different term should be considered for purposes of this regulation.], and to regulate property within such setback in order to prevent physical harm, impairment and/or destruction of or to a natural feature. It has been determined that, in the absence of such a minimum setback, intrusions in or on to natural features would occur, resulting in harm, impairment and/or destruction of natural features contrary to the public health, safety and general welfare. This regulation is based on the police power, for the protection of the public health, safety and welfare, including the authority granted in the ____________ Zoning Enabling Act.

2. <u>Regulation</u>

A natural feature setback shall be maintained in relation to all areas defined in this ordinance as being a "natural feature," unless, and to the extent, it is determined to be in the public interest not to maintain such a setback.

3. <u>Definition of "Natural Feature"</u>

A "natural feature" shall mean a wetland, and shall mean a watercourse. [Note: The definition may be expanded to include floodplain, fragile land (as identified, defined and/or mapped), geologic feature (as identified, defined and/or mapped), steep slopes, areas of highly erodible or highly permeable soils, woodlands, or other appropriate feature.

4. <u>Authorization and Prohibition</u>

(a) The natural feature setback shall be an area or feature with boundaries and limitations determined in accordance with the standards and provisions in this article in relation to respective types of natural features.

(b) In conjunction with the review of plans submitted for authorization to develop property or otherwise undertake an operation in or on, or adjacent to, a natural feature, applicable natural feature setbacks shall be determined, and authorizations and prohibitions established, by the body undertaking the plan review.

(c) Within an established natural feature setback, unless and only to the extent determined to be in the public interest by the body undertaking plan review, there shall be no: Deposit of any material, including structures; removal of any soils, minerals and/or vegetation; dredging, filling or land balancing; and/or constructing or undertaking seasonal or permanent operations. This prohibition shall not apply with regard to those activities exempted from this prohibition, below.

(d) In determining whether proposed construction or operations are in the public interest, the benefit which would reasonably be expected to accrue from the proposal shall be balanced against the reasonably foreseeable detriments of the construction or other operation, taking into consideration the local, state and national concern for the protection and preservation of he natural feature in question. If, as a result of such a balancing, there remains a debatable question whether the proposed project and/or operation is clearly in the public interest, authorization for the construction and/or operation within the natural feature setback shall not be granted. The following general criteria shall be applied in undertaking this balancing test:

(1) The relative extent of the public and private need for the proposed activity.

(2) The availability of feasible and prudent alternative locations and methods to accomplish the expected benefits from the activity.

(3) The extent and permanence of the beneficial or detrimental effects which the proposed activity may have on the public and private use to which the area is suited, including the benefits the natural feature and/or natural feature setback provides.

(4) The probable impact of the proposed construction and/or operation in relation to the cumulative effect created by other existing and anticipated activities in the natural feature to be protected.

(5) The probable impact on recognized historic, cultural, scenic, ecological, or recreational values, and on fish, wildlife and the public health.

(6) The size and quantity of the natural feature setback being considered.

(7) The amount and quantity of the remaining natural feature setback.

(8) Proximity of the proposed construction and/or operation in relation to the natural feature, taking into consideration the degree of slope, soil type and the nature of the natural feature to be protected.

(9) Economic value, both public and private, of the proposed construction and/or operation, and economic value, both public and private, if the proposed construction and/or operation were not permitted.

(10)The necessity for the proposed construction and/or operation.

5. <u>Exemptions</u>

If and to the extent the municipality is prohibited by its ordinance and/or law from regulating the proposed activity in or on the respective natural feature, regulation under this article shall be exempted.

6. <u>Application Form</u>

(APPLICATION FORM DEVELOPED BY COMMUNITY).

7. <u>Setback Standards</u>

Unless otherwise determined by the body undertaking the plan review, the following setbacks shall apply:

(a) A 25 foot setback from the boundary or edge of a wetland, as defined and regulated in Ordinance No _______ [If the municipality does not have a wetlands ordinance, the following phrase may be inserted: "from a wetland, as defined by Act 203 of the Public Acts of 1979, as amended]. "*

(b) A 25 foot setback from the ordinary high water mark of a watercourse, i.e., from a natural or artificial lake, pond or impoundment, river, stream or creek which may or may not be serving as a drain as defined by Act 40 of the Public Acts of 1956, as amended, or any other body of water which has definite banks, a bed and visible evidence of a continued flow or continued occurrence of water. [*Note: The use of a 25 foot standard in these provisions is not intended to alter the standard used or decided upon by any municipality.]*

[BELOW IS OPTIONAL FOR COMMUNITIES REGULATING OTHER NATURAL FEATURES]

A setback distance determined during plan review to be reasonably required in order to prevent probable and unreasonable physical intrusion in or on to a protected natural feature, taking into consideration degree of slope, soil type, the nature and type of activities anticipated to impact upon the natural feature, and the nature and type of the natural feature to be protected, provided, in all events, the setback shall not be greater than XX feet. For purposes of this provision, unreasonable physical intrusion shall be deemed to be a physical intrusion which would be damaging, impairing and/or undermining to the usefulness and/or function of the natural feature.

5) Tree/Woodlands Protection Ordinance

Tree preservation ordinances acknowledge that trees are an important community resource for both environmental and aesthetic reasons. Trees in wetlands and around other water bodies play an important role of taking up large amounts of water, thus aiding in flood control and nutrient absorption.

The goal of tree and woodlands preservation ordinances is to encourage creative design and construction techniques that will preserve as many trees, both as individuals and as woodland areas, as possible. This tool sets up a permit process if taking trees is unavoidable, a replacement scheme, a permit fee schedule, and penalties for illegally removing trees. It also identifies specific sizes for “Landmark Trees,” which are particularly large trees for the given species.

The following provide a general guideline to the development of such an ordinance:

1) **Conduct an assessment of the community’s tree and woodland resources.** This can be accomplished as a community project, or as properties are developed. The assessment should note the type and location of plant communities, including tree species and sizes, the presence of any unique ecosystems, and the location of large “landmark” trees.

2) **Establish priorities for preservation.** Once the assessment is completed, areas with significant trees or woodlands can be prioritized for preservation.

3) **Set goals for tree and woodland preservation.** This should address the different types of resources (such as woodland trees and understory plants, tree rows, landmark trees) that the community wants to preserve. Goals could include a maintenance program for existing trees, reducing tree loss during and after development, and providing for replacement trees.

4) **Provisions for pre-construction, on-site monitoring, and post-construction maintenance.** Ordinance requirements for pre-construction meetings to discuss tree protection, and on-site monitoring during construction ensure that existing trees are protected as planned. Post-construction monitoring also ensures that trees impacted by construction receive the appropriate care.

5) **Enforcement.** The ordinance should include an enforcement process with penalties for violations.

6) Private Road Ordinance

Growing communities experience a significant number of site plans that include construction of a roadway. If not carefully designed and built, roads can become a significant source of storm water pollution. One way to reduce the amount of clearing, grading and impervious surface in roadways is to allow for some flexibility in constructing them in residential developments. A private road ordinance can allow small developments to construct roadways in narrower road easements than public road regulations allow. This minimizes the amount of clearing required thus potentially preserving existing mature trees, reduces grading by allowing steeper grades and the ability to follow existing topography more closely, and allowing for less impervious surface through narrower pavement widths.

Problems with the maintenance of private roads have led many communities to prohibit them altogether. In some instances, residents of private roads petition to have the roadway become private to release them from the maintenance burden. This means either the City or the County (for Townships) has to accept these roads as part of their roadway network.

If a community decides to allow private roads, it should adopt standards that guide the design and construction of roads that will provide access for residents as well as emergency, delivery and maintenance vehicles. The April, 1997 issue of *Planning and Zoning News* suggests the following minimum standards be adopted in a separate private road ordinance, the zoning ordinance, or as a part of the land division ordinance:

- Right-of-way width (either 66 feet, or smaller. If smaller, the right-of-way is usually tied to the number of parcels served)
- Maximum road length ending in a cul-de-sac (usually 600 – 800 feet in urbanizing areas)
- Maximum number of parcels served on a private road with a single connection to a public road (usually 25 units).
- Circumstances under which the private road must be connected to other existing or proposed public or private roads.
- Clear vision area at intersections and driveways (usually at least 20 feet)
- Minimum turning radii in the cul-de-sac (usually tied to the needs of firefighting equipment and school buses)
- Subsurface materials and construction standards
- Drainage requirements
- Grade requirements and pavement slope standards
- Pavement type
- Shoulder width and surface requirements
- Requirements related to physical connections with public or other private roads
- Driveway width requirement for driveways created along the private road
- Engineering review requirements
- Inspection requirements
- Maintenance requirements (including recording with the Register of Deeds)

7) Parking Ordinance

Inflexible application of the requirements in a parking ordinance can generate a significant amount of storm water runoff through unnecessary and unused parking. Some ways to minimize or reduce impervious surfaces are discussed in the "Impervious Surface Reduction/Infiltration Enhancement Ordinance" section of this document. However, a community can also add language to their existing parking ordinance that will allow them more flexibility in applying the requirements they currently have.

In addition to the following language, provisions for allowing "banked" parking can also be included that will reserve room on a site for future parking if needed.

Example Language for Flexible Application of Parking Ordinance

Flexibility in Application. The community recognizes that, due to the specific requirements of any given development, inflexible application of the parking standards set forth in Section X may result in development with inadequate parking or parking far in excess of that which is needed. The former situation may lead to traffic congestion or unauthorized parking on adjacent streets of neighboring sites. The latter situation may result in excessive paving and storm water runoff and a waste of space which could be left as open space.

The body responsible for approving a site plan may permit deviations from the requirements of Section X and shall require more or less parking based upon a finding that such deviations are more likely to provide a sufficient number of parking spaces to accommodate the specific characteristics of the use in question.

The body responsible for approving a site plan may attach conditions to the approval of a deviation from the requirement of Section X that binds such approval to the specific use in question. Where a deviation results in a reduction of parking, the body responsible for approving a site plan may further impose conditions which ensure that adequate useable reserve area is set aside for future parking, if needed. Where area is set aside for reserve parking, it shall be easily developed, not devoted to a use other than open space, and shall be designed to accommodate attendant facilities such as maneuvering lanes and drainage.

A valuable resource to review current parking standards is the American Planners Association's *Planner's Advisory Report No. 432*,*"Off-Street Parking Requirements*." The editor surveyed 127 Zoning Ordinances from communities around the country and compiled standards for more than 165 land uses.

8) Fertilizer Ordinance

Studies have shown that significant amounts of nutrients (phosphorus, nitrogen, and other chemicals) found in waterways come from fertilization practices by homeowners and other land managers. Communities have the ability to regulate the application of fertilizers within their jurisdiction as long as the regulations do not attempt to preempt requirements that are the responsibility of the Michigan Department of Agriculture (MDA). The MDA has the responsibility for regulating fertilizers to ensure that the product meets legal standards, that the labels accurately describe what is in the package, and that the manufacturers and distributors are licensed properly, among other activities. Farms generally cannot be regulated under a fertilizer ordinance unless they have proven adverse impacts to the environment or public health even with conformance with the Generally Accepted Agricultural Management Practices (GAAMPs).

At the local level, most communities have fertilizer ordinances that either regulate commercial applicators, local land owners, or both. It may be easier to only regulate commercial applicators at first, and then once educational activities can have some impact on citizens, implement an ordinance that also regulates land owners within the community.

The basic considerations and components of a fertilizer ordinance should include the following:

- First assess whether or not nutrients from fertilizers are a problem for waterways within your community.
- Determine if regulation is the appropriate mechanism to reduce nutrient inputs, or if other methods, such as public education, could be as effective.
- A fertilizer ordinance should address the following topics:
  - Licensing process for applicators in the community
  - Months of the year that fertilizers can be applied
  - Number of applications allowed per year
  - Allowable rate of application for phosphorous, nitrogen, and potassium. Language that helps applicators determine how many pounds of fertilizer for different sized lawns should be included.
  - Prohibit application of fertilizers within a certain distance from a waterbed wetland, or floodplain
  - Match fertilizer application with necessity through encouraging the use of soil testing by homeowners and commercial applicators.
  - Enforcement procedures and penalties for non-compliance
- Communities should include an educational component for residents and commercial applicators that explain the connection between fertilizer use, storm water runoff, and nutrient impacts on water bodies.

For communities with a significant agricultural industry, the following topics should also be considered in managing fertilizers:

- Develop a working relationship with the Michigan Department of Environmental Quality (MDEQ) and the MDA. These agencies assist farmers, through the Michigan Right to Farm Law, by developing Generally Accepted Agricultural Management Practices (GAAMPs), which if voluntarily followed, help to protect a farmer from nuisance lawsuits.
- There is an opportunity for communities to participate in the development of GAAMPs, and also a public input component to this process. The community should participate either of these for nutrient (fertilizer) use on farms, specifically commenting on

appropriateness of application rates, prohibitions on application during frost conditions, linking application rates to soil tests, and prohibiting application within a certain distance of water bodies, wetlands, or floodplains.

For a model fertilizer ordinance and more information about regulating fertilizer use in Michigan, please go to SEMCOG's website (www.SEMCOG.org), and type in "Fertilizer" in the "Search" box. This will get you to their publication *Managing Fertilizer to Protect our Water Resources*.

Design Standards:

Standards, Guidelines and Overlay Districts

In addition to modifications to the Master Plan and ordinances, there are other standards and tools that a community can adopt that promote and enhance stewardship of water resources. These tools focus on sustainable design and construction methods.

1) Best Management Practices (BMPs)

Communities should have policies and standards in place that encourage the use of Best Management Practices (BMPs) whenever possible to minimize, collect and treat storm water. Storm water BMPs consist of methods or a combination of methods that prevent or reduce water pollution generated from non-point sources. In general, BMP's can be structural, or they can be non-structural policies that help protect water resources. Structural BMPs are most often described in a community's Engineering Design Standards, which provides minimum standards on how each type of facility is to be built. BMPs should function together as a system to ensure that the volume, rate, timing, and pollutant load of runoff remains similar to that which occurred under natural conditions.

Structural Best Management Practices (BMPs)

Structural BMPs are physical means of accomplishing the above goals and can be divided into four categories:

1) **Detention structures**. Structures that "detain" water, and let it out slowly until the pond is dry.

2) **Retention structures**. Structures that "retain" water, holding it until it infiltrates into the ground or evaporates.

3) **Vegetated swales and strips**.

4) **Other practices** to reduce accumulated pollutants picked up by runoff, regulate the amount of impervious areas, and eliminate inappropriate discharges to drains and storm sewers.

Examples of various structural BMPs are listed below. Please note that some examples may fall under more than one category.

Detention Structures

- Detention Ponds
- Wet Ponds
- Storm water Wetlands
- Multiple Pond Systems

Retention Structures

- Wet Ponds
- Infiltration Trenches
- Infiltration Basins
- Storm water Wetlands
- Multiple Pond Systems
- Rain Gardens

Vegetated swales and strips

- Grassed Swales
- Filter Strips

Other practices

- Porous Pavement
- Grass Pavers
- Water Quality Inlets (e.g. Oil/Grit Separators)

Where each of these structural BMPs can be used is site specific and dependent on soil type, infiltration rate of soil, the level of the water table at the particular location, amount of sediment at the site, thermal impacts, space constraints, drainage area, and cost. Therefore, a particular BMP should be selected based on the water quality needs as well as cost, drainage area, land use, soil and topography. Consideration should also be given to addressing maintenance and inspection of BMPs to ensure that they are functioning properly.

Policy (Non-Structural) Best Management Practices (BMPs) Prevention and/or reduction of pollution generated from non-point sources can also be accomplished through the use of a community's policy BMPs, standards or programs. These tools can be described in the community's Property/Facilities Management Manual, Master Plan, and/or Zoning Ordinance. Examples of policy BMPs are as follows:

Storm water System Maintenance

- Street Sweeping
- Catch Basin Cleaning
- Outfall Inventory/Inspection
- Woody Debris Management
- Stream Bank Stabilization
- Floodplain/Wetland Management
- Household Hazardous Waste Disposal
- Equipment/Storage Area Maintenance

- Fertilizer Management

Site Development
- Cluster Housing
- Minimization of Street Parking
- Minimum/Maximum Parking Space Criteria
- Lot Coverage Requirements
- Open Space Requirements
- Require Use of Structural BMPs
- Enforce Soil Erosion and Sedimentation Control (SESC) Practices
- Development and Maintenance Agreements

Public Education /Outreach
- Display Boards
- Cable Programming
- Fliers/Brochures/Newsletters
- Public Meetings/Workshops
- Volunteer Opportunities
- Website
- River/Creek Signage

BMP Selection

Selecting the BMP for a site is an important step in meeting your community's storm water goals. The Center for Watershed Protection (CWP) has developed a Web site called Storm Water Manager's Resource Center (www.stormwatercenter.net) to assist communities in this process. CWP provides a series of matrices that can be used as a screening process for selecting the correct BMP for a development site. As selection of BMPs should be done on a site-by-site basis, these factors can be included in Engineering Design Standards to help assess proposed storm water BMPs. Screening factors include:

- Land use (practices best suited for the proposed land use at a site),
- Physical feasibility (physical constraints that may restrict or preclude a BMP),
- Climate/regional factors (regional characteristics that restrict or modify the use of certain BMPs),
- Watershed factors (which BMP helps meet watershed protection goals),
- Storm water management capability (which BMP or combination of BMPs are needed to meet storm water sizing criteria),
- Pollutant removal (how does each BMP compare in terms of pollutant removal), and
- Community and environmental factors (decide if the BMPs have any important community or environmental benefits or drawbacks that might influence the selection).

The table below lists BMPs to consider when implementing storm water management techniques.

Planning Criteria for Best Management Practices

BMP	Description	Function	Application
Extended Wet Detention Pond	Small constructed lake or basin with emergent wetland vegetation around the bank. Designed to detain runoff from storm events until it is displaced by subsequent events.	Reduction of storm water peak discharge. Removal of suspended solids. Removal of metals and nutrients.	Generally used for drainage areas in excess of five acres.
Extended Dry Detention Pond	A pond or basin that is usually dry between storms that captures runoff and releases it slowly enough to allow most sediment to settle. Less effective than wet retention pond at removing pollutants.	Reduction of storm water peak discharge. Removal of suspended solids.	Used for tributary watersheds 10 acres and larger to remove particulates.
Constructed Wetlands	Constructed basin with a significant percentage covered by wetland vegetation.	Reduction of storm water peak discharge. Removal of suspended solids. Removal of metals and nutrients. Removal of pathogens.	
Vegetated Swales	Channels or flat surfaces lined with vegetation that filters flow.	Removal of nutrients. Removal of suspended solids.	
Storm Water Filters	System that uses a filter medium (sand, gravel, peat or compost) or surface vegetation to remove a fraction of the polluting constituents in runoff. Limitations in cold climates because of freezing of medium. No affect on storm water flow attenuation.	Removal of nutrients. Removal of suspended solids. Removal of pesticides.	Used for reducing sediment, fertilizers, pesticides, etc. from drainage areas up to five acres with slopes up to two percent (e.g., along roads, around parking lots). Used mostly for particulate removal of runoff from large paved areas.
Oil and Grease Separators	A device that removes abnormally high concentrations of petroleum compounds, grease, and grit.	Removal of petroleum or grease. Removal of suspended solids.	At commercial/industrial facilities that generate high levels of oil products or grease. In medium to large parking or motor vehicle storage areas.

Source: *Planning and Cost Estimating Criteria for Best Management Practices*, Rouge River National Weather Demonstration Project, April 2001

BMP Combinations

Incorporating the use of several structural and/or policy BMPs can yield additional water quality benefits as opposed to simply relying on a single practice such as constructing a regional detention basin. Possible examples are as follows:

- Directing runoff from downspouts or parking lots to vegetative swales or grass filter strips instead of discharging directly to a stream
- Instituting a policy of regular storm water system maintenance, including street sweeping, cleaning catch basins, and detecting and eliminating inappropriate connections to storm drains (i.e. illicit discharges).
- Instituting and enforcing soil erosion policies, such as requiring a vegetated strip between cultivated land and a watercourse.
- Public education on the use and disposal of fertilizers, herbicides, and pesticides, including information regarding proper disposal.

2) Native Vegetation Guidelines

One goal of water resource protection is to develop and implement appropriate and effective tools to protect your community's natural resources. Important components of these natural resources are the plants that live within them. The plants that occur in your community naturally are very important because they uniquely perform environmental functions that keep our natural environment working. Plants native to Southeast Michigan clean our surface waters through absorption of pollutants and filtration of sediments, clean our air, provide familiar food sources to native wildlife, and are part of a sustainable system that is self-perpetuating within a scheme of checks and balances.

What are native plants? Native plants are the trees, shrubs, flowers, grasses and ferns that have evolved in a particular area, such as Southeast Michigan, over thousands of years, and existed in the area before European settlement. Over this long period of time, these plants have adapted to the particular growing conditions present here, including temperature, rainfall, winds, soils, slopes and fauna. A native plant *community* is a combination of different plant species that have evolved together, and share the same site conditions, including soils, climate and hydrology. An example of a plant community native to Southeast Michigan is an Oak-Hickory woodland, which occurs in upland areas on dry, well-drained soils, and where drought is a major habitat characteristic.

To impact water quality, communities can encourage the use of native plants in two basic ways:
1) Preservation and restoration of native plant communities in open space, buffer zones, and community-owned land, such as parks and municipal building properties.
2) Landscaping with native plant species on municipally-owned and privately-owned lands.

Preservation and Restoration of Native Plant Communities

Preserving existing native plants or restoring the plant community on a development site or within a community park can have significant impacts on the quantity and quality of storm water runoff coming from that site. The benefits of native plant preservation/restoration include:

- *Improved storm water infiltration and absorption*. Native trees, shrubs and ground layer plants, such as prairie grasses, can absorb a great deal of storm water. The plant's deep root systems also create a maze of cavities that storm water can penetrate, enhancing the ground's infiltration. Improving infiltration of storm water can help to restore ground water supplies. Reducing the amount of storm water that goes into a stream can protect the stream bed from "flashy flows" where a lot of water reaches the stream at the same time, eroding the banks, depositing this soil into the water, and degrading wildlife habitat.

- *Improved storm water filtration*. By preserving the existing vegetation along a water body, such as a river or lake, any runoff from the adjacent land will have to make its way through the stems of the buffer plants before it reaches the water body. This slows the water's progress, making it more likely that the water will be absorbed by the ground or the plants themselves, as well as allowing sediments and heavy substances to settle out of the water before it reaches the river or lake. This improves water quality. In contrast, turf grasses' fine stems do not slow the water as much, and the ground that the turf is planted on is generally compacted, not allowing much water absorption.

Preserving native vegetation along undeveloped reaches of stream or river banks is an easy and cost effective way of protecting water quality from polluted runoff. "Restoration" of native plant communities differs from landscaping in that the plants are chosen to mimic the plant community being restored, and they are arranged as they would be in nature, rather than in a "garden" arrangement.

Language that discusses the benefits of preservation of native vegetation can be added to the community's Master Plan, in conjunction with goals and policies for natural feature preservation. It can also be added to a native plant ordinance that provides guidelines on preserving native vegetation.

Example Language for Preservation of Native Vegetation

This (Master Plan/ordinance) works to maximize the use of native plants in the landscapes of all development projects including the preservation of existing vegetation on a site. The following suggestions are guidelines that describe different ways of preserving native vegetation during the site development process.

Standards:

- *Protect and conserve existing native plant communities by locating development in areas of the site, if any, that have been previously disturbed. Priority for preservation should be given to native plant communities that are contiguous with other tracts of existing natural areas or designated open space, and /or for native plant communities that are made up of a rich variety of species that indicates a site of high ecological significance.*

- *Maintain the existing hydrology of the site so as not to significantly increase or decrease the amount of water flowing to existing native plant communities to be conserved*

- *Designate a natural features setback of xxx' between the existing native plant community and proposed development, or private property lines in case of a residential development. Locate the edge of natural features setbacks with permanent markers.*

- *Provide language in Master Deed and Bylaws that specifically protects the existing native plant communities to remain on site from alteration, removal or destruction, except for annual maintenance requirements, such as mowing or prescribed burning.*

The following standards provide important information regarding site work.

Standards:

- *All topsoil that is stripped from the areas to be developed shall be stockpiled on site. Topsoil shall be stockpiled based on soil type and shall be replaced in areas of similar soil types on site. Bringing in new topsoil to the site should be avoided, as this brings in weed seeds and other exotic plant species from off site.*

- *If infiltration areas are to be seeded with a prairie grass or other grass mix, all soils to be seeded are to be broken up to a minimum of 6" deep if heavy equipment has compacted the soil during construction. This scarification will create air pockets and the start of a route for storm water to enter the soil.*

- *Where degraded ecosystems exist on a site, appropriate native plant species should be used to restore the landscape. This can be accomplished to improve storm water infiltration and water quality, habitat for wildlife and community character.*

Landscaping with Native Plants

Native plants can be used in landscaping to create a "natural-looking" environment, or they can be used in traditional arrangements in urban landscaped areas. Many possess ornamental qualities that contribute to an attractive planting.

Using native plants in landscaping will provide many benefits, including the following:

- Native plants are well-adapted to local conditions, therefore requiring little maintenance once established. They eliminate or significantly reduce the need for fertilizers, pesticides, water and lawn maintenance equipment. They also often attract beneficial insects, which prey upon pests, decreasing the need for pesticides.

- Native plants reduce air pollution, improve water quality and reduce soil erosion. Using native vegetation, unlike cultivated landscapes, does not require the use of lawn maintenance equipment, a major contributor to air pollution. They improve water quality by filtering contaminated storm water, and reduce soil erosion by stabilizing soils with their deep root systems.

- Most native species are perennial, or self-seeding biennial plants.

- Native plants attract our native songbirds and butterflies. Just as the plants have evolved and adapted to our area over time, the local wildlife has evolved along side them, depending on these plants for food and shelter.

- Using native plants promotes biodiversity. Planting a small meadow that once was lawn replaces one plant species with many, increasing the opportunities for beneficial wildlife and insects to live. We are also learning that genetic diversity is an increasingly important resource for our planet. Native plants carry a part of this rich, complex, and continually evolving genetic heritage. In contrast, non-native plants, sold mostly as cultivars, tend to represent a very limited pool of genetic material, bred for uniformity and consistency.

- Native plants maintain our natural heritage and our community's character.

- Native plants are less expensive to maintain. U.S. EPA reports that a prairie or wetland costs approximately $150 a year per acre to maintain, while the same amount of lawn costs $1,000 per year per acre to maintain.

Local communities can modify ordinances and municipal procedures to accommodate using native species in either a traditional planting or a more natural arrangement. Note that many local "weed" ordinances prohibit plants or grasses to be maintained above a certain height (usually 18" – 24"). Therefore, existing regulations may need to be modified to permit "natural landscaping."

The following language provides guidelines to developers, designers, and residents about acceptable native plant installation and maintenance.

Many native species are available from commercial nurseries within the region. A helpful listing of these plants is available from Springfield Township (Oakland County) in the form of a computer CD. They have developed this CD to assist residents in choosing native plants for their landscapes. It has also been given to interested developers, engineers, and site designers. To request a CD, call the Clerk's office at (248) 846-6510.

Example Language for Landscaping With Native Vegetation

The following definitions provide a common understanding of terminology used in the native plant provisions.

Definitions:

- *Cultivar – A certain variant of a species that is propagated for ornamental use. The cultivar name is always enclosed in single quotation marks or designated "cv."; it is not italicized. Example: Acer rubrum '*Sunset*'.*

- *Environmentally-Sound Landscape Management Practices – Landscape management practices that use appropriate native plant species for the site conditions, reduces the need for irrigation, eliminates the use of chemical pesticides and fertilizers, and significantly reduces or eliminates the use of gasoline-powered landscaping equipment.*

- *Exotic Plant Species – A plant species that has evolved in a country or region other than Oakland County and has been introduced by human activity.*

- *Exotic Invasive Plant Species – An exotic invasive plant species is an exotic plant species that has no natural controls and is able to out-compete and gradually displace native plants. A list of prohibited exotic invasive plant species is included in this ordinance.*

- *Floristic Quality Assessment – A Floristic Quality Assessment is a method for evaluating the relative significance of tracts of land in terms of their native floristic composition. This method was developed by the Michigan Department of Natural Resources. The plant list that results from this process provides information about the ecosystems on the site, the condition of those systems, and gives guidance to what native plant species would be appropriate to use in landscaping the site after development has occurred.*

- *Native Plant Species – A native plant species is one that has naturally evolved in a certain area over thousands of years under certain soil, hydrologic, and other site conditions. Where "native plant species" is used in the text, this means a straight species, not a cultivar of a species.*

- *Native Plant Community – A collection of plant species native to _________ County that have evolved together under similar site conditions.*

- *Natural Landscaping – A property that is landscaped so as to exhibit the deliberate and conscious decision to plant, cultivate and maintain those native species identified as wildflower, grass, shrub, or tree in commonly accepted publications, including "Michigan Flora" by Edward Voss, all volumes. This landscaping tries to capture the character and spirit of nature in a designed landscape by arranging plants in a community context, similar to their arrangement in nature.*

Language that could be included in the "intent" portion of a landscaping ordinance includes the following:

It is the intent of this ordinance to maximize the use of native plant species in landscaping all areas of a site, including but not limited to foundation plantings, lawn areas, screening and greenbelt areas, and surface storm water conveyance features.

The community encourages the use of native plants in this ordinance is based on the following:

- *Native plants are a necessary part of the proper functioning of natural ecosystems within (community name) and perform tasks including, but not limited to, storm water attenuation, uptake and purification, air purification, wildlife food and habitat, and community character and aesthetics; and*

- *Landscaping with native plants encourages environmentally-sound maintenance practices by requiring little or no pesticide or fertilizer use, and minimal watering to get plants established, which, in turn, reduces the threat of environmental degradation; and*

- *The community has stated in its Master Plan the goal to preserve the natural features and character of the community lands and protect the quality of vital air, land and water resources; and*

- *Encourage the use of desirable native species of vegetation. The community recognizes that species native to the local area are generally hardier, offer more wildlife benefit, filter pollutants, are an effective component in storm water management, and support and complement local ecosystems. Additionally, native species require less maintenance, water and chemicals (including fertilizers and pesticides), and are drought resistant. It is the intent of this ordinance to encourage the use of desirable native species of plants for all landscaping.*

The following elements could be incorporated as separate items throughout a landscaping ordinance:

1. Noxious Weeds.

Noxious weeds are those defined per the Michigan Seed Law, P.A. 329 of 1965, as amended, Regulation No. 715, Rule 7. The noxious weeds are not native plants. They are introduced species. These plants are also prohibited from being used in any natural landscaping.

It shall be the responsibility of the owners of all subdivided lots to adequat4ely control the growth of noxious weeds on their lot. The control of such weeds shall be by cutting said weed on a regular basis during the growing season so as to limit the height of said weeds to not more than six (6) inches. In the event the lot owner does not comply with this section of the ordinance, the (City, Township, etc.) shall, after written notice to the owner of record on the latest assessment roll, have the right to enter upon said lot or lots and cut said weeds in compliance with this ordinance. The cost of such action by the (City, Township, etc.) shall only apply to lots in subdivision and not to any other land within the (City, Township, etc.).

2. Private Naturally Landscaped Lots

A private, "naturally landscaped" lot is a privately-owned lot where the landscaping exhibits the deliberate and conscious decision to plant, cultivate and maintain native plant species. A naturally landscaped lot often has a significantly different character than a traditionally landscaped lot, as it generally does not include much mown lawn, but is made up of relatively tall plants, often in an arrangement that emulates nature.

Naturally landscaped lots must be maintained so that herbaceous plants are mown or cut to 18" or less at least once prior to June 1 of each calendar year.

Natural landscaping on private lots shall not be located within two (2) feet of the front property line or at corner side property lines of lots having a public sidewalk, or within four (4) feet of any other property line; provided, however, no rear or side yard setback shall be required where the natural landscaping material is separated from adjacent lots by fencing or bushes, or where the natural landscaping material abuts permitted natural landscaping material on an adjacent lot. An intervening path or sidewalk shall not be deemed to prevent natural landscape materials from "abutting" for purposes of this section.

3. Prohibited Plant Species

*The following plants are prohibited for use in landscaping activities. Most of these plants are not native to the area, reproduce profusely and have potentially harmful effects on natural ecosystems. They are known as "**exotic invasive species***

Common Name (Botanic Name):

Trees:

Norway Maple (Acer platanoides)
Amur Maple (Acer ginnala)
Tree of Heaven (Ailanthus altissima)
European Alder (Alnus glutinosa)
Goldenraintree (Koelruteria paniculata)
Amur Cork Tree (Phellodendron amurense)
White Poplar (Populus alba)
Siberian Elm (Ulmus pumila)

Shrubs and Vines:

Porcelainberry (Ampelopsis brevipendunculata)
Japanese barberry (Berberis thunbergii)
Common barberry (Berberis vulgaris)
Butterfly Bush (Budlia davidii)
Oriental Bittersweet (Celastrus orbiculatus)
Cotoneaster (Cononeaster microphyllus)
Cotoneaster (Cotoneaster pannosus)
Cotoneaster (Cotoneaster lacteus)
Autumn Olive (Eleagnus umbellata)
Russian Olive (Eleagnus angustifolia)

Burningbush (Euonymus alatus)
Wintercreeper (Euonymus fortunei)
English Ivy (Hedra helix)
Privet (Ligustrum vulgare)
Japanese Honeysuckle (Lonicera japonica)

Amur Honeysuckle (Lonicera maackii)
Morrow Honeysuckle (Lonicera morrowi)
Tartarian Honeysuckle (Lonicera tatarica)
White Mulberry (Morus alba)
Common Buckthorn (Rhamnus cathartica)
Glossy Buckthorn (Rhamnus frangula)
Multiflora Rose (Rosa multiflora)
Japanese Spiraea (Spiraea japonica)
Japanese Yew (Taxus cuspidata)
Guelder Rose (Viburnum opulus var. opulus)

Grasses and Grass-Like Plants:
Pampas Grass (Cortaderia selloana, C. jubata)
Chinese Silver Grass (Miscanthus sinensis)
Giant Reed (Phragmites communis)
Reed Canary Grass (Phalaris arundinacea)
Ribbon Grass (Phalaris picata)

Flowers and Groundcovers:
Creeping Bugleweed (Ajuga reptans)
Garlic Mustard (Alliaria officinalis)
Spotted Knapweed (Centaurea maculosa)
Crown Vetch (Coronilla varia)
Foxglove (Digitalis purpurea)
Japanese Knotweed (Fallopia japonica)
Dame's Rocket (Hesperis matronalis)
Purple Loosestrife (Lythrum salicaria)
Pachysandra (Pachysandra terminalis)
Myrtle, or Periwinkle (Vinca minor)

4. Plant Rescue and Transplantation

In the development of many sites, there are appropriate native plant species that exist on the site that will be destroyed by development, but could be transplanted to other areas on a site. If this is the case, the following suggested guidelines should be followed:

<u>Standards</u>*:*

- *Where native plant species are being displaced by development, herbaceous and woody plants should be rescued to the extent possible before all land clearing operations begin. Plants that can be successfully transplanted should be designated by a qualified botanist during the site plan review process. These plants should be protected from construction activity and maintained in a healthy condition on site until they can be transplanted to other areas of the site.*

- *Woody native plant species that are rescued from developed areas of a site may be used to fulfill landscaping requirements. Plants of a size smaller than the sizes outlined in this landscape ordinance are allowed as long as the plants are no less than one-half the required size, and that the total number of plants used adds up to the size requirements for a single species. For example, two, rescued 1-1/4" caliper Oaks can be used instead of one, 2-1/2" caliper Oak.*

- *Native plant species should not be removed for transplanting or for other purposed from undisturbed areas of the site, or areas designated as preservation or conservation areas. Federal and state laws protecting native plant species designated as endangered, threatened or of special concern must be adhered to and under no circumstances shall these plants be damaged, destroyed or removed from the site.*

- *Plants that will otherwise be destroyed through construction activities can be rescued from one site for transplanting to another site as long as permission for removing the plants is granted, in writing, by the land owner, and that the plants are inspected by the Michigan Department of Agriculture Pesticide and Plant Pest Division. Inspection is also necessary if the plants are moved across a public road, even if the road is on the same property as the plant's original location.*

5. Exotic Invasive Species Removal

Recommended standards for removing exotic invasive species are described below:

Standards:

Where possible, exotic invasive plant species should be removed where they exist within native plant communities to remain after development is complete. Tested methods for removal of specific species should be employed to ensure that the invasive species do not return in the same or increased numbers.

6. Native Plants in Landscaping

If native species are to be used in landscaping and plantings, the following guidelines should be considered:

Standards:

- *Native plant species chosen for a site should be based on the existing vegetation and site conditions. The woodland, wetland or meadow species that currently grow on a site indicate the native species to be used in landscaping the site.*

- *For traditional landscaping arrangements, it is recommended that native plant species rated a 0 through 7 in the Michigan Floristic Quality Assessment Plant Database be used. Rational for this recommendation is that the rarest plants (rated 8 – 10) are not readily available from local genetic stock and that common species (rated 0 – 2) are readily available through local nurseries. Endangered, threatened or special concern plants should be avoided altogether. Listing of these plants are available from the (City, Township, etc.)*

- *For natural landscaping arrangements, such as open spaces or storm water systems, it is recommended that native plant species rated 3 through 7 in the Michigan Floristic Quality Assessment Plant Database be used. Rationale for this recommendation is that the rarest plants (rated 8 – 10) are not readily available from local genetic stock, and the most common plants (rated 0 – 2) will most likely be in the seed bank in existing topsoil or come in on their own. Endangered, threatened or special concern plants should be avoided altogether. Listings of these plants are available from the (City, Township, etc.)*

- *In entryways or other areas where aesthetics is of primary importance, cultivars of native plant species may be considered to ensure, to a certain degree, the plant's appearance.*

- *Plantings installed in areas of storm water conveyance, infiltration, or retention/detention should be planted with native species that specifically perform the necessary runoff attenuation, filtration, water uptake and purification functions needed in such areas. Both herbaceous and woody species should be incorporated into the plant mix, where the desired function dictates.*

- *The arrangement of native species can be designed in both conventional arrangements, or more "natural" arrangements. Natural arrangements emulate the arrangements found in nature within the particular plant community being used for landscaping purposes. Natural arrangements should be used for landscaping open space, such as surface storm water systems, street tree plantings, and/or parks. If natural arrangements are used, plant spacing requirements can be relaxed as long as the function the plants are to serve is accomplished.*

- *The number of native species used in a natural arrangement should be more complex, and somewhat representative of the plant community being emulated, than would be used in a conventional planting arrangement.*

7. Maintenance

One purpose of using native vegetation is to reduce the amount of maintenance and watering required, eliminate the use of chemical fertilizers and pesticides, and reduce emissions from gasoline-powered landscaping equipment. These guidelines provide suggestions about how this can be accomplished.

Standards:

- *All ecosystem types should be maintained using environmentally-sound practices that will keep the plants in a healthy and thriving condition without the use of toxic chemicals. Maintenance program should be based on the ecosystem type. For instance, prairie plantings require annual or biannual mowing or burning to encourage new, vigorous growth.*

- *If a native planting is installed in a landscape bed that would otherwise require irrigation, the Planning Commission may waive this requirement if the plants selected are drought-tolerant species, and that the planting will be regularly watered for the first full growing season so that the plants are well established.*

- *Residential landscapes that use native plants in a natural arrangement must be maintained to keep a mown edge three (3) feet wide and not higher than six (6) inches along all public sidewalks, and a strip not less than three (3) feet wide adjacent to neighboring property lines unless waived by the abutting property owner on the side affected. Vegetation must not interfere with site distances from driveways and roads.*

Local communities can also encourage landscaping with native vegetation through the following:

- Provide leadership by increasing the use of natural landscaping on public properties.
- Provide information to residents, businesses, developers and design professionals (through site plan review process) on the benefits of landscaping with native vegetation.
- Develop a multi-year plan for retrofitting native vegetation into existing sites.
- As mentioned above, amend or replace the local weed ordinance so that it encourages natural landscaping.
- As mentioned above, ensure that storm water management program uses native vegetation in design of storm water BMPs.

3) Resource Protection Overlay District

Overlay districts are one approach to applying special restrictions to areas with unique conditions. Properties included within these districts retain their underlying zoning classification but are subject to additional requirements specified in the overlay district ordinance. In preparing an overlay district, it is first necessary to identify the geographic limits of the areas to be included. This involves clearly stating the purpose for creating a district as well as reflecting established local preservation policies.

The adoption of an overlay district accomplishes three objectives:

1) Requires all parcels within the district to be inventoried, although this may be done one parcel at a time. Potential development of the site is what generally triggers the required inventory.

2) Alerts a developer of the site's potentially significant resources and that it would be subject to special restrictions; and

3) Allows the community to identify those priority protection areas on a site that a developer must refrain from developing or develop with minimal site disturbance.

With an overlay zone, sites will get inventoried either lot by lot, or through a comprehensive survey initiated by the community. In the inventory process, it is important to determine the full ecological significance of a parcel in relationship to its surroundings. If a lot-by-lot inventory process is adopted, it is better to have sites prioritized for inventory, so as money is made available for a full ecological field study, priorities will have been established and permission granted by property owners for site access.

Example Resource Protection Overlay District.

1. *Purpose. The purpose of this Section is to ensure that property is developed in a manner consistent with its zoning designation, and the proposed physical elements are designed and arranged to protect the priority resource protection areas both on the site, and in the vicinity of the site, as identified by the Community as Resource Conservation areas, Land Use Plan, and Valuable Natural Areas, Natural Features, within the Community Master Plan. The Overlay District establishes procedures to enable the applicant and the Community to achieve the mutually compatible objectives of reasonable use of land and protection of vital natural resources.*

2. *Applicability. To the maximum extent feasible, any development plan (i.e. site plan, subdivision plat and site condominium plan) shall be designed and arranged to ensure that disturbance to any priority resource protection area as a result of the development, and that impacts and disturbance to such areas and the plants and wildlife inhabiting those areas, shall be minimized through the use of natural area buffers, conservation easements and creative land development techniques. To that end, the Community has established that this Section shall apply to lands that meet both of the following criteria:*

   a. *The property is indicated on the Community Zoning Map, entirely or in part, as AGRE, Agricultural Residential or RE, Rural Estate, or SR, Suburban Residential, and;*

   b. *The property is designated entirely or partially as Resource Conservation on Map x, Land Use Plan, of the Community Master Plan.*

3. *Ecological Characterization. It is intended that these Ordinance requirements be applied based upon reliable and factual data. Applicants are encouraged to consult the Michigan Natural Features data base. In addition, information contained in [any available natural features inventory] is useful to determine important natural areas of the Community, of which x valuable natural areas have been identified within the Community. These areas have significant value to the community and are indicated on Map x, Natural Features, of the Community Master Plan.*

   If a development site is determined by the Community, based on additional information or from inspection, that the site likely includes areas with wildlife, plant life and/or other natural characteristics in need of protection, and if the Community does not then possess the information required to apply review standards, then the developer shall provide to the Community a report prepared by a professional qualified in the areas of ecology, botany, wildlife biology or other relevant discipline that describes, without limitation, the following:

   a. *the wildlife use and habitat showing the species of wildlife using the area, the times or seasons that the area is used by those species and the "value" (meaning feeding, watering, cover, nesting, roosting, perching) that the area provides for such wildlife species;*

   b. *the boundary of wetlands in the area and a description of the ecological functions and characteristics provided by those wetlands;*

   c. *any prominent views from or across the site;*

   d. *the pattern, species and location of any significant native trees and other native site vegetation;*

   e. *the bank, shoreline and high water mark of any stream or body of water on the site;*

   f. *wildlife movement corridors; and*

   g. *the general ecological functions provided by the site and its features.*

   The Community may employ their own consultants with the relevant expertise to review materials submitted by the applicant. The applicant shall be required to provide and *present the credentials for all qualified professionals hired for the purpose of fulfillment of Section (C). The credentials and qualifications of these individuals shall be sufficient, in the opinion of the Community, to demonstrate competence in the area in which the expertise will be provided.*

4. *Establishment of Priority Protection. For every development subject to this Ordinance, the applicant shall propose areas of priority protection. The Community shall review these areas for appropriateness. If acceptable, the Community shall accept and establish on the*

   project development plan, areas of priority protection. The development plan shall establish the development capability of the site and indicate the specific area(s) of a site within which the developed project may be constructed and within which the development activity shall be contained. In establishing the development capability of a site, the Community shall consider and apply the following criteria:

   a. *The actual boundary of development capability designation to be shown on a development plan shall be proposed by the applicant, and established by the Community through site evaluations and reconnaissance, and shall be based on the ecological characterization of the area.*

   b. *In establishing the development capability of the site, the following shall be taken into account, as evaluated by qualified professional(s) and/or certified consultant(s):*

      (1) *visual impacts, including but not limited to ridgeline protection areas and protection of scenic views.*

      (2) *erosion prevention and control, including but not limited to protection of natural drainage channels and compliance with an approved storm water drainage management plan.*

      (3) *preservation of significant native trees and other native site vegetation, including protection of natural area buffers zones.*

      (4) *conservation of water, including but not limited to preservation of existing native vegetation, reduction in amounts of irrigated areas and similar considerations.*

      (5) *stream corridor and wetland protection and buffering.*

      (6) *site topography, including but not limited to such characteristics as steepness of slopes, existing drainage features, rock outcroppings, river and stream terraces, valley walls, ridgelines and scenic topographic features.*

      (7) *floodplains and floodways.*

      (8) *wildlife movement corridors.*

      (9) *natural area buffer zones as delineated below.*

      (10) *the practical needs of approved construction activity in terms of ingress and egress to the developed project and necessary staging and operational areas.*

(11) hydrology and groundwater flow.

5. Development Standards and Guidelines.

a. To the maximum extent feasible, no construction activity, including, without limitation, grading, excavation or stockpiling of fill material, shall be permitted within priority protection areas whether to provide for a building site, on-site utilities or services, or for any roads or driveways except as provided for below.

(1) mitigation of development activities;

(2) restoration of previously disturbed or degraded areas;

(3) emergency public safety activities and utility installations, installed with the utmost sensitivity to natural features, when such activities and installations cannot reasonably be contained to areas outside of those identified as significant;

(4) construction of trails or pedestrian walkways that will provide access in an environmentally appropriate manner;

(5) the enhancement of the habitat values and/or other natural resource values of a natural area.

b. Establishment of Buffer-Zones. Buffer zones shall be established adjacent to areas of priority protection. Such buffers shall be up to one hundred (100) feet in width. The Community may reduce the perimeter setback and buffer zones in cases where the density of the proposed use is compatible with adjacent uses and/or natural features, such as woodlands and topographical features. In establishing the buffer zone(s), the Community shall consider and apply the following criteria:

(1) the foreseeable impacts of development on the wildlife usage or ecological character or function of the natural area.

(2) the ecological and wildlife use characterization of the natural area.

(3) the existence of wildlife movement corridors.

(4) the extent of floodplains and floodways.

(5) the type, amount and extent of existing vegetation on the site.

(6) the existence of special wildlife habitat features.

(7) the character of the proposed development in terms of use, density, traffic generation, quality of runoff water, noise, lighting and similar potential development impacts.

(8) site topography, including but not limited to such characteristics as steepness of slopes, existing drainage features, ridgelines and scenic topographic features.

c. Mitigation of Disturbance. While development is anticipated outside of priority protection areas, the applicant shall avoid disturbance to priority protection areas and undertake mitigation measures to restore any damaged or lost natural resource. Any such mitigation or restoration shall be roughly equivalent to the loss suffered by the Community because of the disturbance, and shall be based on such mitigation and restoration plans and reports as have been requested, reviewed and approved by the Community. The mitigation plan shall include a timeline for restoration and mitigation of disturbed areas, which must be acceptable to the Community. The Community may require performance guarantees pursuant to Section x of the Zoning Ordinance

insuring fulfillment of, and compliance with, the mitigation plan. In addition, the Community may issue a cease and desist order of the site development activities if determined to be in violation of the approved mitigation plan.

d. Connections. If the development site contains priority protection areas that connect to other off-site areas of a similar nature, to the maximum extent feasible, the development plan shall preserve such connections. If priority protection areas lie adjacent to the development site, but such areas are not presently connected across the development site, then the development plan shall, to the extent reasonably feasible, provide such connection. Such connections shall be designed and constructed to allow for the continuance of existing wildlife movement between natural areas and to enhance the opportunity for the establishment of new connections between areas for the movement of wildlife.

e. Lakes, Reservoirs and Ponds. If the development site contains a lake, reservoir or pond, the development plan shall include such enhancements and restoration as are necessary to provide reasonable wildlife habitat and improve aesthetic quality in areas of shoreline transition and areas subject to wave erosion. The development plan shall also include a design that requires uniform and ecologically and aesthetically compatible treatment among the lots or tracts surrounding a lake, reservoir or pond with regard to the establishment of erosion control protection and shoreline landscaping on or adjacent to such lots or tracts.

f. Design and Aesthetics. Projects located within the Overlay District, shall be designed to complement the visual context of the natural area. Techniques such as architectural design, site design, the use of native landscaping and choice of colors and building materials shall be utilized in such manner that scenic views across or through the site are protected, and manmade facilities are screened from off-site observers and blend with the natural visual character of the area.

g. Storm water Drainage/Erosion Control. All storm water drainage and erosion control plans shall meet the standards adopted by the Community for design and construction and shall, to the maximum extent feasible, utilize nonstructural control techniques, including but not limited to:

(1) limitation of land disturbance and grading;

(2) maintenance of vegetated buffers and natural vegetation;

(3) minimization of impervious surfaces;

(4) use of terraces, contoured landscapes, runoff spreaders, grass or rock-lined swales;

(5) use of infiltration devices.

APPENDIX E: MONITORING AND EVALUATION

Introduction

The Stony/Paint Subwatershed Management Group agrees that a well-planned evaluation process will provide measures of the effectiveness of implementing this Subwatershed Management Plan. Measurement and evaluation is an important part of planning because it can indicate whether or not efforts are successful and provide a feedback loop for improving project implementation as new information is gathered over time. Also, if the subwatershed group is able to show results because of an evaluation program, the plan will likely gain more support from the partnering communities and agencies, as well as local decision makers, and increase the likelihood of project sustainability and success.

Monitoring and measuring progress in the subwatershed will be two-tiered. First, individual agencies and communities will monitor certain community and agency projects and programs on the community, watershed council and agency levels to establish effectiveness. For example, a lawn fertilizer education workshop will be assessed and evaluated by that community and the Clinton River Watershed Council. Also, with the implementation of a community project such as establishment of riparian buffers, the individual community responsible for the implementation of that task would monitor water quality/quantity parameters before and after the retrofit to establish the improvements. Secondly, there will be a need to monitor progress and effectiveness on a regional – subwatershed or watershed – level in order to assess the ecological affects of the collective community and agency actions on the health of the river and its tributaries. In continuing to work as a subwatershed toward collective goals for the Clinton River, the Stony/Paint Group recognizes the importance of a long-term monitoring program to determine where resources are focused as they progress toward meeting those collective long-term goals.

As part of the development of the Stony/Paint Subwatershed Plan, a series of field surveys were conducted (which are described in Chapter 3) in order to establish a baseline set of data, characteristics and indicators of water quality in both the Stony and Paint tributaries. This baseline data and incorporation of these procedures and sites into the well-established Clinton River Watershed Council volunteer monitoring programs will serve as the basis for long-term monitoring. The ultimate goal is to have enough volunteers to conduct similar monitoring at all sites used in the development of this plan. As grant funding becomes available, the group will explore opportunities for conducting water quality sampling and water quantity monitoring/modeling to support the volunteer data and further demonstrate effectiveness of the actions identified in this subwatershed plan.

Qualitative Program Evaluation Techniques: Tier 1

Qualitative Program Evaluation Techniques

As seen in the Action Matrix (Table 5.4 and 5.4b), there are and will be many programs and projects implemented to improve water quality, water quantity and habitat in the Stony/Paint Subwatershed over the short and long term through many different types of programs – from physical in-stream improvements to public education programs. It is anticipated that most of these actions will be incorporated into individual Storm Water Pollution Prevention Initiatives within the next six (6) months.

Finding creative ways to measure the effectiveness of each of these individual and often unique programs will be recorded for each task under the individual SWPPIs. However, a summary (Tables 5.3, 5.4 and 5.4b) of the methods that are proposed will provide and indication of how these programs might be measured and monitored to evaluate success in both the short and the long term.

Some of these evaluations may be implemented on a subwatershed or watershed basis, such as a public awareness survey to evaluate long-term public education efforts, but most of these activities will be measured at the local, community level. By evaluating the effectiveness of these programs, communities, agencies and the Clinton River Watershed Council will be better informed about public response and success of the programs, how to improve the programs and which programs to continue. Although these methods of measuring progress are not directly tied to measurements in the river, it is assumed that the success of these actions/programs, collectively and over time, will have a positive impact on the in-stream conditions and measurements of the river that are investigated concurrently as described in Tier 2 below. Whereas evaluating these programs and projects on a more qualitative basis is to determine short-term programmatic successes, it is this success that will result in long term, quantitative impacts in the river.

Table 1. Stony/Paint Summary of Qualitative Program Evaluation Techniques

Evaluation Methods	Types of programs/projects	What is Measured	Pros and Cons	Implementation
Public Surveys	Any public education or involvement program or project	Knowledge Behaviors Attitudes Awareness Concerns	Moderate cost. Often low response rate.	Pre and post surveys recommended. Mail, telephone, group setting. Could be done on either a local or watershed-wide basis. Repeating same survey on regular basis can show long-term trends.
Written Evaluations	Any public meeting or group education or involvement activity.	Benefit of activity based on increased knowledge and participant feedback.	Good response rate. Low cost. Improves continuing activities.	After an event, meeting, workshop, ask participants to fill out brief evaluation. Ask what was learned, what was missing, what could be done better. Participants return evaluations at site.
Stream surveys/walks	Identifying riparian and aquatic improvements. Identifying recreational opportunities and needs.	Aesthetics Log jams Erosion Habitat Recreation potential	Best information from field Investigation. Time consuming.	Identify parameters of interest. Create form for recording observations. Surveyor training for consistency. Compile findings geographically to identify sites of interest and concern.

Evaluation Methods	Types of programs/projects	What is Measured	Pros and Cons	Implementation
BMP monitoring	Riparian buffers. Detention basin retrofits. Wetland restoration. Rain barrels. Street sweeping.	Water quality, water quantity improvements from specific BMP.	Site-specific. Quantitative.	Set up isolated BMP area pre and post BMP installation. Record parameters of storm water discharge before and after installation to measure improvements.
Photographic documentation	BMP installations, detention pond retrofits, aesthetic alterations (native landscaping, etc.).	Aesthetic changes. Before and after results.	Implementation easy, low cost. Good visual communication, documentation. Limited to visual description.	Visual evidence with photographs. Use photographs in educational pieces, website, etc.
Phone call/complaint records	Education efforts, advertising of contact numbers for complaints/concerns	Number and types of concerns voiced by public. Location of problem areas.	Limited to opinions, input from members of public willing or motivated to contact you.	Persons answering phone, letters, emails track nature of related calls concerns on an ongoing log sheet.
Quantification of participation	Public involvement and participation events.	Amount of people reached. Amount of waste collected.	Easy to calculate. Provides numerical measurement that is easy to understand and track.	Track participation with sign in sheets, registration lists, counts of people, counts of materials collected.
Focus Groups	Behavior change, education programs.	Perceptions, viewpoints, concerns, barriers, behaviors.	Fast method for identifying motivators and barriers to behavior change. Can introduce new ideas.	Widely solicit for diverse participants, or handpick certain interested people. Could advertise opportunity in newsletter. Should be no more than 6-8 people per group. Plan questions, facilitate. Tape and transcribe discussion.

In-stream Monitoring Program: Tier 2

In-Stream Monitoring Program

In addition to measuring the effectiveness of certain specific programs and projects within communities or agencies, there would be a benefit to measuring the long-term progress and effectiveness of the cumulative subwatershed efforts in terms of a water quality, quantity and biological monitoring. Presently the Clinton River Watershed Council conducts volunteer monitoring training and has an extensive monitoring program. *Through previous discussions with MDEQ staff in the update of the Stony Creek Plan, it was considered that the Clinton River Watershed Council Adopt-A-Stream monitoring program could be utilized to provide indicators of the quality and progress of both Stony and Paint Creek activities.* The Clinton River Watershed Council Adopt-A-Stream program will form the basis of the In-Stream Monitoring Program

A description of this program (as described at www.crwc.org) is provided as follows:

Adopt-a-Stream is a volunteer-based program that empowers community members to protect local streams and rivers by monitoring their health. Volunteers are teamed up in Stream Teams, are assigned sites, given equipment, data sheets and protocols, and are sent out to gather information on streamside habitat and macroinvertebrate populations.

Twice a year (in May and October), Stream Teams visit their adopted sites and collect data, including physical information (such as extent of stream bank erosion and surrounding land use) and chemical information (such as water temperature and pH). They collect and identify macroinvertebrates (commonly known as "bugs") that live in the streambed and surrounding vegetation. Different bugs need specific conditions in which to survive and reproduce. Some are very pollution sensitive while others can tolerate highly polluted water. A stream's health can be determined by the number and types of bugs that live in it. The data are used by CRWC, municipalities and the state to assess the health of our streams and rivers and make decisions regarding their protection and restoration.

Citizen involvement in water quality monitoring activities has resulted in positive change across the nation, the state, and right here in the Clinton River watershed. For example, water quality data collected by volunteers for the Clinton River Coldwater Conservation Project has been used to select locations for trout habitat restoration, and students in our Stream Leaders program have helped identify and resolve soil erosion problems.

Presently, the Adopt-A-Stream program monitors the locations identified at the end of this Appendix. The field survey data collected for this subwatershed plan by ECT, Inc. and which is described in Chapter 3 encompasses a number of these sites. This data will be used as a baseline set of data for monitoring and evaluation of progress. The subcritical areas were categorized and prioritized based on the following information:

- MDEQ Road Stream Crossing Survey
- Bank Erosion Hazard Index
- Macroinvertebrate Survey
- Nonpoint Source Pollutant Loading Modeling

As described in Chapter 3, a qualitative ranking was assigned to each of the field survey sites. As volunteers are further included in the CRWC Adopt-A-Stream program, the sites described in Chapter 3 will be added to the Adopt-A-Stream program. In addition, as BMPs are implemented, it will be possible to model reductions in nonpoint source pollutant loading utilizing the baseline data presented in Chapter 3.

This physical sampling and monitoring program may be supplemented by a long-term sampling and monitoring program that may include water quality sampling and water quantity monitoring/modeling. The subwatershed management group has indicated this type of monitoring as a “wish list” item and will pursue potential grant funding if available. The Adopt-a-Stream volunteer monitoring program provides an excellent source of data that will certainly demonstrate achievements in meeting watershed objectives as well as long term goals; however, conducting more detailed sampling, monitoring and modeling will further demonstrate that the subwatershed is meeting state water quality standards.

Establishing Targets

When measuring parameters to assess whether or not a goal is being achieved, it is useful to establish targets against which observed measurements are compared. Targets do define either Water Quality Standards, as set forth by the State of Michigan, or scientifically supported numbers that suggest measurements for achieving water quality, quantity and biological parameters to support state designated uses such as partial or total body contact, and fisheries and wildlife. Using these long term, scientifically based targets as goals for success will assist the subwatershed in deciding how to improve programs to reach preservation goals and know when these goals have been achieved. These targets are described below.

Dissolved oxygen (DO) has standards established by the Michigan Department of Environmental Quality (MDEQ) as state standards. For DO, the state has established a requirement of no less than 5.0 mg/l for all warm water fisheries. The DO can drop to no less than 7.0 mg/l in both Stony & Paint Creeks as they are coldwater streams. The Administrative Rules state:

> *“for waters of the state designated for use for warmwater fish and other aquatic life, except for inland lakes as prescribed in R 323.1065, the dissolved oxygen shall not be lowered below a minimum of 4 milligrams per liter, or below 5 milligrams per liter as a daily average, at the design flow during the warm weather season in accordance with R 323.1090(3) and (4). At the design flows during other seasonal periods as provided in R 323.1090(4), a minimum of 5 milligrams per liter shall be maintained. At flows greater than the design flows, dissolved oxygen shall be higher than the respective minimum values specified in this subdivision. For waters of the state designated for use for coldwater fish, except for inland lakes as prescribed in R 323.1065, the dissolved oxygen shall not be lowered below a minimum of 6 milligrams per liter at the design flow during the warm weather season in accordance with R 323.1090(3) and (4). At the design flows during other seasonal periods, as provided in R 323.1090(4), a minimum of 7 milligrams per liter shall be maintained. At flows greater than the design flows, dissolved oxygen shall be higher than the respective minimum values specified in this subdivision.”*

Bacteria (E. coli) has standards established by the MDEQ as state standards. For the designated use of total body contact (swimming), the state requires measurements of no more than 130 E. coli per 100 milliliters as a 30 day geometric mean during 5 or more sampling events representatively spread over a 30 day period. Recreational activities requiring total body contact, such as swimming, and partial body contact, such as wading, fishing, and canoeing apply to this subwatershed. The state requires measurements of no more than 1000 E. coli per 100 milliliters based on the geometric mean of 3 or more samples, taken during the same sampling event for partial body contact.

Phosphorus (TP) for surface waters does not have a numerical standard set by the state. The state requires, however, that “nutrients shall be limited to the extent necessary to prevent stimulation of growths of aquatic rooted, attached, suspended, and floating plants, fungi or bacteria which are or may become injurious to the designated uses of the waters of the state.”

Therefore, based on scientific research, we rely on suggested or recommended targets and continue to study this question on a national and regional level. As described in Chapter 3, phosphorus levels remain consistently good at 1 ppm.

Total suspended solids (TSS) for surface waters does not have a numerical standard set by the state. However, the state requires that "the addition of any dissolved solids shall not exceed concentrations which are or may become injurious to any designated use." To protect the designated uses of fisheries and wildlife habitat, as well as the desired recreational and aesthetic uses of the surface waters in the subwatershed, there are recommended targets established on a scientific basis. From an aesthetics standpoint, it is recommended that TSS less than 25 mg/l is "good", TSS 25-80 mg/l is "fair" and TSS greater than 80 mg/l is "poor". The TSS target, therefore, will be to maintain TSS below 80 mg/l in dry weather conditions.

Another measurement that can be used to determine sediment load is to determine the extent of embeddedness of the substrate (how much of the stream bottom is covered with fine silts) and the bottom deposition (what percentage of the bottom is covered with soft muck, indicating deposition of fine silts). These are measurements included in the field surveys described in Chapter 3. The baseline data rated this category are from "poor" to "excellent". The target for this measurement is to maintain the current ratings and improve ratings where possible.

Flow Rates (cfs) for surface waters do not have a numerical standard set by the state. Although this sections attempts to define a peak flow target for certain points in the river and tributaries, it is most effective to use the health of the fish and macroinvertebrate communities (process described below) as the ultimate indicators of stream and river health. The Clinton River Geomorphology Project described in Chapter 3 demonstrates that the Stony Creek flow rates have remained fairly stable while the Paint Creek flow rates show a slightly increasing trend. Targets will be to maintain the current flow rates and reduce to the maximum extent possible any increase in flow.

Macroinvertebrates Macroinvertebrates are small aquatic insects and animals whose presence can indicate certain long term water quality trends. The state has developed and the GLEAS 51 protocol for assessing macroinvertebrate communities. The macroinvertebrate sampling results for the Stony/Paint Subwatershed range from "poor" to "excellent". Targets will be to improve macroinvertebrate survey results above a "poor" designation and maintain those that currently have "good" or "excellent designations.

Temperature State standard R 323.1075 only lists temperature standards for point source discharges and mixing zones – not ambient water temperatures in surface water. However, recommendations for water temperature can be generated by assessing fish species' tolerance to temperature change and this guidance is recorded in the statute. There are two different kinds of streams with regard to classification of temperature regimes, coldwater and warmwater streams. The state standards recommend that temperatures for coldwater fisheries not exceed temperatures greater than the monthly maximum temperatures listed in the table below.

Recommended Maximum Water Temperatures (°F; Rule 323.1075)

	J	F	M	A	M	J	J	A	S	O	N	D
Cold Water Streams	38	38	43	54	65	68	68	68	63	56	48	40
Warm Water Streams	41	40	50	63	76	84	85	85	79	68	55	43

The temperature difference between the upstream and downstream locations at the Stony Creek sampling site is consistently excellent (<2 ^{o}C). The temperature difference between the upstream and downstream locations at the Paint Creek sampling sites is consistently excellent (<2 ^{o}C), however, one site registered a poor rating (>10 ^{o}C) in 2001 (Gallagher and Orion Roads). The target will be to maintain temperatures below 20°C and maintain the temperature difference of <2°C.

<u>Aesthetics and recreation potential:</u> There is no state standard for measuring aesthetics or recreation potential. However, the subwatershed believes that an area with high aesthetic qualities will add, in either a passive or active context, recreational opportunities for the public and a greater appreciation or awareness of the subwatershed's natural resources. That is the purpose for looking at these two parameters over time.

> *<u>Aesthetics:</u>* Measuring aesthetics of an area is inherently a qualitative effort. However, progress toward attaining aesthetically pleasing places can be measured and evaluated effectively using a standard tool, such as a survey, at regular intervals in time. Aesthetics are inherently included in the Adopt-A-Stream program and can be noted during the volunteer surveys. Measurements in the survey, dependent upon community and subwatershed priorities, should include assessing water clarity, ambient odors, vegetative diversity, wildlife use, streambank erosion, debris, evidence of public use, and other parameters that indicate positive or negative aesthetic qualities.
>
> *<u>Recreation potential:</u>* Measuring and mapping areas with recreation potential should be a community and a subwatershed effort and should be done by or closely with local or county parks departments and staff. Oakland County is currently preparing a Greenways Infrastructure Plan as described in Action 36 and here as follows:
>
> *Greenway Infrastructure Plans can serve multiple purposes, including natural features protection, alternative transportation, and recreation opportunities. Oakland County is currently working with communities to prepare a map that identifies connections throughout the county utilizing trails, tree corridors, utility corridors and riparian corridors. Organizations such as the Oakland Land Conservancy have an established structure for reaching out to riparian landowners to promote corridor protection measures, such as conservation easements and stewardship projects. Such an effort is underway along the Clinton River corridor in the Rochester area. Based upon the critical area identified in the subwatershed plan, a similar corridor protection effort would be very beneficial to achieving the long-term goals for protecting Stony /Paint Creek. Community participation may include attending a visioning session and input to the county.*
>
> The goal is to identify areas in the subwatershed, both along the riparian corridor and on the landscape, that can provide passive recreation (such as photography, resting, bird watching), or active recreation (such as hiking, canoeing, fishing). Within the subwatershed, these areas should be linked where possible to provide linear corridors

that connect, or greenways, for both people (hiking, biking trails) and wildlife. This effort could be easily combined with the aesthetics survey effort described above.

Site Code	Community	County	Subwatershed	Water Body	Location	Notes
AA	Warren	Macomb	Red Run	Bear Creek *(drain)*	S of 12 mile; E of Mound	park at Speedway gas station & walk towards drain; PHYSICAL/HABITAT ONLY DUE TO HIGH COLIFORM AND CONTAMINANTS
A-edit	Independence Twp	Oakland	Upper Clinton	Clinton River-Headwaters	Ortonvill Rd/Main St. Clarkston; upstream side of bridge	Clinton River between Deer and Park Lake; received permission from home owner
B	Orion Twp	Oakland	Stony/Paint	Paint Creek	N of Indianwood; W of Newman Rd	
BB	Clinton Twp	Macomb	LSC	Cottrell Drain	W of Jefferson @ Union Lake Rd	park on Union Lake Rd; wide grassy shoulder
C	Village of Orion	Oakland	Stony/Paint	Paint Creek	Childrens Park; 160 Anderson Street	
D	Orion Twp	Oakland	Stony/Paint	Paint Creek	Kern and Clarkston	Bald Mountain;at wooden footbridge; reference site for program
DD	St Clair Shores	Macomb	LSC	Rhorbeck Drain	St. Clair Shores Country Club;	E of Gratiot; off of Masonic
E	Washington Twp	Macomb	Stony/Paint	Stony Creek	31 mile and E of Mt. Vernon	
EE	Shelby Twp	Macomb	CREW	Middle Branch-Clinton	25 Mile and Van Dyke	upstream
F	Washington Twp	Macomb	Stony/Paint	Stony Creek	Nature Center Rd. inside Stony Creek Metro Park	drive to parking lot and carpool to site to minimize roadside parking
FF	Waterford	Oakland	Clinton Main	Clinton River	Clinton River at Cookely Lake Rd.	if downstream habitat is more variable and more accessible, monitor downstream
G	Oakland Twp	Oakland	Stony/Paint	West Branch Stony Creek	Park Rd inside Stony Creek Metro Park; last waterbody before entrance to West Branch Picnic area	three water bodies crossing Park Road after intersection with Nature Center Rd.; appx.4.1 miles from toll; drive to parking lot and carpool to site to minimize roadside parking
H	Pontiac	Oakland	Clinton Main	Galloway Creek	N of 75; W side of Giddings	
J	Auburn Hills	Oakland	Clinton Main	Clinton River	Riverside Park on Auburn Rd	
K	Rochester Hills	Oakland	Clinton Main	Clinton River	W of Livernois on Avon Rd	park in Veterans Park; potentially dangerous rapids under bridge-use caution; possible flashy flow-use caution
L	Rochester Hills	Oakland	Stony/Paint	Paint Creek	Tienken Rd; E of Livernois Rd	
M	Rochester	Oakland	Stony/Paint	Paint Creek	University Dr E of Rochester Rd	
N	Rochester Hills	Oakland	Clinton Main	Clinton River	Yates Mill Park; N side of Avon at Dequindre	Rochester Hills staff may be collecting fees; tell them you are with this program on behalf of R. Hills; should waive fees
O	Shelby Twp	Macomb	CREW	Middle Branch-Clinton	Schoenherr N. of 25 mile	

Q	Clinton Twp	Macomb	CREW	Utica Drain	Macomb Community College; bridge near entrance; near Garfield and Hall Rd.	closest parking is back of library lot N of bridge
R	Macomb Twp	Macomb	CREW	Middle Branch-Clinton	Waldenburg Park; 21 Mile E of Romeo Plank Rd	flashy flows likely; use caution regarding depth and speed of water
S	Troy	Oakland	Red Run	Sturgis Drain	W side of Rochester Rd; N of Big Beaver @ Life Christian Church	park at church; riffles!; permisson received for monitoring
T	Troy	Oakland	Red Run	Gibson Drain/ Nelson Drain	E of Dequindre @ Hill Dr; S of Long Lake	park on Hill D; access via South side of bridge; caution-slope to water edge; okay at water level
V	Warren	Macomb	Red Run	Big Beaver Creek *(drain)*	James Nelson Park; 15 mile E of Dequindre	N side of 15 mile; park in lot by bathrooms near entrance and walk E towards "creek". Monitor just before it crosses under 15 mile
Y	Sterling Heights	Macomb	Red Run	Clinton River	Clinton River Rd; W of Schoenherr inside of Dodge Park	walk straight back from parking lot to footbridge; monitor upstream side of footbridge
Z	Warren	Macomb	Red Run	Big Beaver Creek *(drain)*	S of 14 mile; E of 53	Subway across street; large "GOLF" sign in parking lot

Stony Creek Metropark, Washington Township

EXECUTIVE SUMMARY

The Clinton River Watershed

The Clinton River basin is the most populous watershed in Michigan, with over 1.4 million residents inhabiting over 760 square miles, portions of four counties (Lapeer, Macomb, Oakland, and St. Clair), and more than 60 communities. The Main Branch of the Clinton River itself runs over 80 miles, dropping more than 500 feet from its headwaters in Brandon, Independence, and Springfield townships to its mouth at Lake St. Clair in Harrison Township.

The Clinton River Watershed includes seven (7) subwatersheds, three (3) of which are subwatersheds of the main Clinton River, the other four (4) of which are subwatersheds of the major tributaries entering the Clinton River. These subwatersheds are smaller areas with similar features, land uses and drainage patterns that help to facilitate effective watershed planning activities.

Stony Creek Subwatershed

Stony Creek is a high-quality coldwater tributary of the Clinton River, with headwaters in the primarily rural communities of Oxford and Addison townships in northeastern Oakland County. The creek has two main branches, the West and Main, which flow through Bruce, Oakland, and Washington townships before entering the Stony Creek Lake impoundment in Stony Creek Metropark. Stony Creek then flows through a portion of Rochester Hills before reaching its confluence with the Clinton River near downtown Rochester. Stony Creek's subwatershed spans over 74 square miles in 12 communities and is inhabited by roughly 17,500 people. The creek follows a broad glacial outwash channel and its riparian corridor and surrounding uplands feature a variety of ecosystem types, from northern hardwood forests and prairies to cedar swamps and emergent marshes.

Stony Creek is home to a wealth of unique natural areas that are already protected in both the public and private domains, including Bald Mountain State Recreation Area, Stony Creek Metropark, Addison Oaks County Park, the Michigan Nature Association's Lakeville Swamp Sanctuary, and a number of local parks and easements. The bulk of the subwatershed, however, is in private ownership, with much of the creek running unseen and relatively unknown through individual parcels in low-density residential and rural areas.

Paint Creek Subwatershed

Paint Creek is a high-quality coldwater tributary of the Clinton River, with headwaters in Brandon and Oxford Townships upstream of Lake Orion. The creek then flows through Lake Orion, Orion Township followed by Oakland Township, Rochester Hills and Rochester before reaching its confluence with the Clinton River near downtown Rochester. Paint Creek's subwatershed spans over 70 square miles in 10 communities and is inhabited by roughly 68,000 people. The creek follows a broad glacial outwash channel and through end moraines in its middle section. Much of this stream is bordered by public land and recreational trails and the riparian corridor is of high quality. It is managed as a trout stream from Lake Orion to its confluence with the Clinton River. Land uses are characterized primarily by residential, recreation/conservation and commercial uses. Similar to the Stony Creek, surrounding uplands feature a variety of ecosystem types, from northern hardwood forests and prairies to cedar swamps and emergent marshes.

Purpose of the Stony/Paint Creek Subwatershed Management Plan

In 1997, seven communities, two counties, and a variety of other local stakeholder groups came together to form the Stony Creek Stewardship Committee to guide a wetlands assessment project initiated by the Clinton River Watershed Council. Upon completion of that project, the Stewardship Committee turned its attention to the development of an overall management plan for the Stony Creek subwatershed. This effort was also initiated by the Clinton River Watershed Council, which received a Clean Water Act Section 604(b) non-point source pollution planning grant from the Michigan Department of Environmental Quality to fund the development of the plan.

In 2002, the Stony Creek group was joined by communities from the Paint Creek subwatershed, which is located to the immediate west of Stony Creek subwatershed and exhibits many similar land uses and stream characteristics. This was done so that a combined Stony/Paint Subwatershed Plan could be developed to fulfill the watershed management plan requirements of the U.S. Environmental Protection Agency's National Pollutant Discharge Elimination System (NPDES) Phase II stormwater regulations. (For more information on these regulations, visit the Southeast Michigan Phase II Information Clearinghouse at www.crwc.org/phase2/phase2home.html.) In addition, the Clinton River Watershed Council was awarded an additional grant to update the Stony Creek Subwatershed Plan and include specific components that would make the stakeholders eligible for future grant funding.

This plan is part of an effort to create management plans for all seven of the major subwatersheds of the Clinton River basin. ***This plan creates a vision for the long-term protection of Stony/Paint Creeks as unique natural, recreational, and cultural resources for the communities through which they flow.*** The purpose of this plan is thus two-fold:

(1) to identify current sources and causes of impairments in order to determine actions necessary to restore the streams to stable conditions; and
(2) to recommend actions that will prevent further degradation of Stony and Creeks and their watershed resources as development advances on the landscape.

The fourteen communities, two counties and two school districts that were involved in the development of this plan are committed to protecting the high-quality natural areas of the Stony/Paint Creek subwatershed, mitigating the impacts of increasing stormwater discharges, and restoring areas that have been degraded. Another recurring theme in this plan is the importance of maintaining the rural character and natural "viewsheds" that make the Stony/Paint Creek subwatershed such an attractive place to live. Protection of the subwatershed's water resources and natural features are a critical component in maintaining the high quality of life enjoyed by Stony and Paint Creek residents.

Current Conditions in Stony & Paint Creeks

A stream is quite literally a reflection of the land through which it flows. The current condition of Stony and Paint Creeks is reflected by the subwatersheds' relatively low-impact land uses. Undeveloped, conservation, and recreation lands comprise nearly 70% of the Stony Creek subwatershed's land area, while agriculture and low- and medium-density residential development dominate the remaining 30%. Only a small proportion of the subwatershed is intensely developed (commercial, office, industrial, high density residential, etc.); these uses are clustered primarily in the southern end of the subwatershed.

A comprehensive assessment of Stony Creek, including a physical stream inventory, macro-invertebrate sampling, and hydrologic survey, were completed in mid-2003 to assess the overall condition of the stream and riparian corridor. Additional field assessments were conducted in 2004 & 2005 in conjunction with the Paint Creek assessment described below. These assessments, along with analysis of historic data, indicate that Stony Creek retains many high-quality characteristics, but is experiencing isolated water quality impairments as a result of increasing development, particularly in the southern end of the subwatershed.

Paint Creek is more densely developed in areas with primarily residential areas in the headwaters and increasing developed areas consisting of residential and commercial downstream of Lake Orion. There are numerous recreational opportunities and this stream has very high potential for sport fishing and there is an ongoing very active cold-water fish management program. Similar to Stony Creek, a comprehensive assessment was completed for Paint Creek, including a physical stream inventory, macroinvertebrate sampling, a geomorphology evaluation and bank erosion survey. This work was completed in 2004 & 2005. At the same time the geomorphology and bank erosion survey were also completed in areas along Stony Creek.

As the Stony and Paint Creek communities continue to develop (as trends indicate they will), the potential for negative environmental effects on Stony and Paint Creeks will increase, including water quality impacts resulting from erosion, sedimentation, and increased inputs of storm water pollutants, as well as water quantity impacts resulting from loss of wetlands, woodlands, and riparian vegetation and increased impervious surfaces. ***The main focus for these two subwatersheds is to minimize these potential impacts by focusing on creek preservation efforts.***

Water Quality Impairments

Current water quality impairments in Stony & Paint Creeks are, for the most part, limited to isolated areas, but these areas are widespread across the subwatershed. Both creeks' water quality impairments can be summarized in the following categories:

- **Hydrology –** Stony Creek is not yet experiencing the damaging high velocity flows during wet weather events that are typical of more urban streams. However, isolated changes to the natural flow characteristics of Stony Creek are already noticeable, particularly in the lower portion of the subwatershed. This is where development has historically been concentrated and where impervious surface coverage is highest and streambank alteration is most pronounced. As development continues to advance northward, hydrologic alteration of Stony Creek will continue unless steps are taken to protect the natural ability of the land to absorb precipitation.

The two USGS gages located within the Stony Creek subwatershed show stable values of both annual mean stream flow and peak stream flow. The two USGS gages located within the Paint Creek subwatershed are fairly typical of most USGS gages within the Clinton River watershed, in that most of the flow trends have been increasing. It is evident that development has not had a drastic effect on the bankfull discharge within the Stony Creek subwatershed and only a moderate effect on the bankfull discharge within the Paint Creek subwatershed.

- **Sediment –** Sediment is one of the primary pollutants of concern in Stony and Paint Creeks, as it appears to be impairing the macroinvertebrate community in a number of locations. Sediment-laden runoff from construction sites, gravel roads, roadside ditches, and poorly maintained bridges enters the stream channel. There, sediments remain suspended in the water column or settle out onto the streambed. Both suspended sediments and sediment deposits can have a negative impact on aquatic organisms and impair aesthetics. Sedimentation is increasing as storm water flows increase, scouring the banks and depositing sediments downstream.

- **Nutrients –** Phosphorus is the primary nutrient of concern in the Stony/Paint Creek subwatershed. Sources of phosphorus include fertilizers from lawns, golf courses, and croplands; failing septic systems; pet, waterfowl, and livestock wastes; and illicit connections between sanitary sewers and storm drains. When excessive amounts of phosphorus are present, aquatic plants can grow out of control and algae blooms are common – problems that have been documented both instream and in lakes and ponds in the Stony/Paint Creek subwatershed.

- **Bacteria –** Excessive levels of bacteria can impair both the aquatic community and threaten public health. Although the extent of bacterial contamination in Stony and Paint Creek is not well documented outside of Stony Creek Metropark, the existence of failing septic systems in the region is well known and therefore is considered to be a fairly certain source of bacteria in Stony and Paint Creeks. Congregating waterfowl, particularly Canada geese, and livestock that have free access to the stream are also potential contributors to elevated bacteria levels.

- **Elevated Temperature –** The Michigan Department of Natural Resources considers Stony and Paint Creeks to be coldwater streams, although only Paint Creek downstream of Lake Orion is managed as a recreational trout fishery. Observations from the stream survey indicate that coldwater fish species are present; however, low flows below impoundments, removal of streambank vegetation, and inputs of storm water runoff (which are typically warmer than base flows) are all likely to be elevating temperatures in Stony and parts of Paint Creek, which could affect sensitive species that cannot tolerate warmer waters.

- **Organic Compounds & Heavy Metals –** Organic compounds and heavy metals can cause adverse impacts on river ecosystems. The Stony Creek Lake impoundment is identified as a Section 303(d) non-attainment water body for FCA - PCBs and mercury under the Clean Water Act. Section 303(d) provides authority for restoring polluted waters, requiring states to work with interested parties to develop Total Maximum Daily Loads (TMDLs). TMDLs are pollutant loading “budgets” designed to restore the health of the waterbody in question. TMDLs must be established for Stony Creek Lake by 2009 for FCA - PCBs and 2011 for mercury. Within the Paint Creek subwatershed, TMDL implementation for Lake Orion is scheduled for 2010 and 2011 for FCA-PCBs, chlordane and mercury. TMDL implementation for Lakeville Lake is scheduled for 2011 for mercury.

- **Salt –** The effects of salt application on roadside vegetation and the aquatic life in Stony and Paint Creeks are a concern. In areas where runoff from paved roads enters roadside ditches that flow into Stony Creek, salt may also impact surface waters, where it can negatively impact both macroinvertebrates and coldwater fish species.

Goals & Objectives

The Stony/Paint Creek Subwatershed Group used a variety of information to develop goals and objectives for the long-term protection of both creeks. These information sources included the stream assessments, an analysis of impervious cover and land use build-out, reviews of each participating community's master plan, ordinances, and development standards, and the input of local officials, organizations, and Stony & Paint Creek residents.

Goal 1. Establish and sustain a community-based mechanism to administer and implement the Stony/Paint Creek subwatershed plan.

Objective 1-A. Continue operation of the Stony/Paint Subwatershed Group as an advisory and decision-making body to guide implementation of the subwatershed plan.

Objective 1-B. Identify and develop creative financing programs to support implementation of the subwatershed plan.

Objective 1-C. Collaborate with the Clinton River Watershed Council, the Clinton River Public Advisory Council, SEMCOG, and other regional groups on watershed-wide activities.

Goal 2. Increase the public's understanding of their role in protecting Stony/Paint Creek.

Objective 2-A. Develop and/or promote existing and future public education and outreach programs.

Objective 2-B. Identify, promote, and encourage participation in educational opportunities for land use decision-makers (e.g. planning commissions, local boards and councils, developers, chambers of commerce, realtors, etc.).

Goal 3. Protect and restore the Stony/Paint Creek subwatershed's water quality, stream channels, riparian corridors, natural areas, wetlands, and unique ecosystems.

Objective 3-A. Reduce storm water and other point and non-point source pollution impacts and stabilize stream flow.

Objective 3-B. Reduce nutrient loading contributing to excessive aquatic plant growth.

Objective 3-C. Reduce sources of bacteria contributing to beneficial use impairments.

Objective 3-D. Identify, prioritize, and establish mechanisms for preserving, restoring, and/or enhancing stream channels, riparian corridors, natural areas, wetlands, and unique ecosystems.

Objective 3-E. Promote and participate in local land and water stewardship efforts.

Objective 3-F. Participate in local and regional efforts to promote natural corridors and greenways.

Objective 3-G. Reduce inputs of hazardous materials, organic compounds, and heavy metals and restore affected areas.

Goal 4. Protect and restore the Stony/Paint Creek fishery.

Objective 4-A. Develop and implement a fisheries restoration and enhancement plan.

Goal 5. Improve recreational access and opportunities.

Objective 5-A. Develop and implement a recreation enhancement plan.

Goal 6. Protect farmland and reduce agricultural impacts on water quality.

Objective 6-A. Support farmland preservation efforts.

Objective 6-B. Encourage agricultural practices that protect water quality.

Goal 7. Protect and interpret the historic character of Stony/Paint Creek.

Objective 7-A. Develop and implement a historic preservation and interpretation plan.

Goal 8. Reduce Soil Erosion and Sedimentation.

Objective 8-A. Develop or revise ordinances to prevent, minimize and reduce soil erosion and sedimentation, especially for construction sites.

Objective 8-B. Implement BMP's for effective soil erosion and sedimentation prevention and mitigation, addressing both upland sources as well as sources from streambank erosion.

Objective 8-C. Improve soil erosion and sedimentation control inspection and enforcement, as well as education, for parties responsible.

Objective 8-D. Reduce sediment deposition into stream channels and wetlands.

Stony/Paint Creek Action Plan

A variety of land management agencies exist in the Stony/Paint Creek subwatershed, including municipalities, county and state agencies, and school districts. Each entity is unique and must determine what practices will be most effective in achieving the goals and objectives of this plan. The following four categories of management recommendations were developed, from which each entity can choose from an array of best management practices for water resource and natural features protection:

- **Plans & policies,** such as master plans, natural features inventories, sewer infrastructure plans, storm water master plans, and greenway plans.
- **Development / redevelopment regulations,** such as Low Impact Development plans, storm water ordinances, private road ordinances, natural features setbacks, and wetland ordinances.
- **Design standards & maintenance practices,** such as detention basin maintenance programs, street sweeping, golf course management programs, streambank stabilization projects, and road maintenance practices.
- **Education & stewardship,** such as lawn care and pet waste education programs, volunteer monitoring programs, and stewardship projects.

The recommended actions are outlined in Chapter 5, which includes a detailed Action Matrix. In addition to the main Action Matrix that identifies the responsible parties and approximate timeline completion of each suggested action, additional tables are provided that refine both subwatersheds into subbasins and outline recommended actions in these areas.

Successful implementation of this plan will depend upon the continued commitment of the Stony & Paint Creek communities, Macomb and Oakland county agencies, school districts and residents to protect and improve the water resources and other natural features of the Stony/Paint Creek subwatershed. One of the most important aspects of watershed management is monitoring activities and evaluating progress. Monitoring can be either quantitative or qualitative; because financial resources for quantitative water quality monitoring is so limited, the use of qualitative evaluation methods will be critical in following the progress of this plan. In addition, the active involvement of residents in monitoring and stewardship will be critical to protecting Stony and Paint Creeks over the long term.

Watershed planning is, just like the water cycle itself, an ever-renewing process. Each community participating in this plan will develop a Storm Water Pollution Prevention Initiative (SWPPI), which outlines their specific actions and timelines to achieve the long-term goals of the plan. The SWPPIs and the subwatershed plan will be reviewed and revised on a regular basis to assess progress and make any necessary changes based upon new information or technologies.

For More Information

For additional copies of the Stony/Paint Creek Subwatershed Management Plan, data sources referenced in this plan, or other information, contact the Clinton River Watershed Council at 248-601-0606, email contact@crwc.org, or visit CRWC's website at www.crwc.org. Complete contact information for the project team members is also listed below.

Clinton River Watershed Council
101 Main Street, Suite 100
Rochester, MI 48307
Phone 248-601-0606
Fax 248-601-1280
Email contact@crwc.org
Web www.crwc.org

Environmental Consulting & Technology, Inc.
501 Avis Drive, Suite 5C
Ann Arbor, MI 48108
Phone 734-769-3004
Web www.ectinc.com
(fka Tilton & Associates, Inc.)

Carlisle/Wortman Associates Inc.
605 S. Main Street, Suite 1
Ann Arbor, MI 48104
Phone 734-662-2200
Web www.CWAplan.com

Applied Science, Inc.
300 River Place, Suite 5400
Detroit, MI 48207
Phone 313-567-3990
Web www.asi-detroit.com


Stony Creek at Van Hoosen Farm, Rochester Hills

CHAPTER 2: INTRODUCTION

2.1 THE STONY/PAINT CREEK SUBWATERSHED

Stony Creek is a high-quality tributary of the Clinton River located in northeastern Oakland County and northwestern Macomb County. Stony Creek's watershed encompasses over 74 square miles, representing approximately 10% of the 760-square-mile Clinton River basin (Figure 2.1). The subwatershed includes a large portion of Addison Township, the southeast portion of Oxford Township, the southwest corner of Bruce Township, the eastern half of Oakland Township, the western third of Washington Township, and northern portions of the cities of Rochester and Rochester Hills (Figure 2.2). The subwatershed also includes small areas of the villages of Lake Orion, Leonard, and Oxford, and the townships of Orion and Shelby. The roughly 17,500 residents of the Stony Creek subwatershed inhabit an area that ranges from rural agricultural and low-density residential areas in the north to rapidly developing and dense suburban and commercial areas in the south. The subwatershed contains a number of protected natural areas, including the North Unit of Bald Mountain State Recreation Area, Stony Creek Metropark, Addison Oaks County Park, the Michigan Nature Association's Lakeville Swamp Preserve, and a number of local parks. One of Stony Creek's distinctive features is that the majority of the creek and its tributaries flow through privately owned lands, presenting unique challenges for riparian landowner stewardship and watershed management.

Stony Creek has two major branches: the West Branch, which is 13.4 miles long, and the Main Branch, which is 21.2 miles long. The Main Branch begins north of Lakeville Lake in Addison Township, and the headwaters of the West Branch are located in a cluster of lakes in southeast Oxford Township. The two branches both flow into Stony Creek Lake, an impoundment in Stony Creek Metropark, which is part of the Huron-Clinton Metropolitan Authority. Stony Creek flows into the Clinton River near downtown Rochester, just downstream of Paint Creek.

Stony Creek is still considered a coldwater fishery by the Michigan Department of Natural Resources, but stocking of brown trout ceased in 1991 due to limited access to the creek, a history of low survivorship, and the presence of better access opportunities nearby in Paint Creek. Nevertheless, the fact that Stony Creek still supports coldwater fish species is an indicator of its high quality.

Paint Creek is a high-quality coldwater tributary of the Clinton River, with headwaters in Brandon and Oxford Townships upstream of Lake Orion. The creek then flows through Lake Orion, Orion Township followed by Oakland Township, Rochester Hills and Rochester before reaching its confluence with the Clinton River near downtown Rochester. Paint Creek's subwatershed spans over 70 square miles in 10 communities and is inhabited by roughly 68,000 people. Paint Creek below Lake Orion to the confluence with the Clinton River is a cold water tributary that is designated trout stream. Sampling by MDNR in 2001 found mottled sculpins, creek chubs, white suckers, and brown trout as the predominant species. Brown trout reproduce in Paint Creek but are supplemented with an annual stocking by MDNR, Fisheries Division.

In recent years, the effects of suburban development have started to become visible along the stream channel and riparian corridor. The removal of riparian vegetation, poor road crossings, increased storm water runoff from roadside ditches and storm drain systems, inadequate soil erosion controls, and elevated nutrients result in flashy flows, erosion, sedimentation, algae blooms, and excessive aquatic plant growth. These impacts are still relatively isolated, and Stony Creek remains one of the highest quality waterways in the Clinton River system.

2.2 PURPOSE OF THE STONY/PAINT CREEK SUBWATERSHED MANAGEMENT PLAN

The Stony/Paint Creek Subwatershed Management Plan is part of an effort to create management plans for all of the major subwatersheds of the Clinton River basin.

This plan creates a vision for the long-term protection of Stony & Paint Creeks as unique natural, recreational, and cultural resource for the communities through which they flow.

The purpose of this plan is two-fold: (1) to identify current sources and causes of impairments in order to determine actions necessary to restore the stream to stable conditions; and (2) to recommend actions that will prevent further degradation of Stony & Paint Creeks and their watershed resources as development advances on the landscape.

This plan also serves to fulfill the watershed management plan requirements of the U.S. Environmental Protection Agency's National Pollutant Discharge Elimination System (NPDES) Phase II storm water regulations. (For more information on these regulations, visit the Southeast Michigan Phase II Information Clearinghouse at www.crwc.org/phase2/phase2home.html.)

The fourteen communities, two counties and two school districts that were involved in the development of this plan are committed to protecting the unique natural areas of the Stony/Paint Creek subwatershed, mitigating the impacts of increasing storm water discharges, and restoring areas that have been degraded.

2.3 STONY/PAINT CREEK SUBWATERSHED GROUP

In 1997, the Clinton River Watershed Council (CRWC) received a grant from the U.S. Environmental Protection Agency to conduct a wetlands assessment project in the Stony Creek subwatershed. CRWC formed the Stony Creek Stewardship Committee to guide the project. The committee was composed of representatives from each of the communities containing land area in the Stony Creek subwatershed, as well as other local, county, and regional stakeholders. In 2000, CRWC received a Clean Water Act Section 604(b) non-point source pollution planning grant from the Michigan Department of Environmental Quality to develop a watershed management plan for the Stony Creek subwatershed. The existing Stony Creek Stewardship Committee, which was wrapping up work on the wetlands assessment, was naturally well-suited to continue the oversight of this new project. The committee has thus been meeting continuously since 1997 to guide water resource protection and restoration efforts in the Stony Creek subwatershed.

In 2002, the Stony Creek group was joined by communities from the Paint Creek subwatershed, which is located to the immediate west of Stony Creek subwatershed and exhibits many similar land uses and stream characteristics. This was done so that a combined Stony/Paint Subwatershed Plan could be developed to fulfill the watershed management plan requirements of the U.S. Environmental Protection Agency's National Pollutant Discharge Elimination System (NPDES) Phase II stormwater regulations. In addition, the Clinton River Watershed Council was awarded an additional grant to update the Stony Creek Subwatershed Plan and include specific components that would make the stakeholders eligible for future grant funding. The Stony/Paint Creek Subwatershed Group includes representatives from the following communities, agencies, and other stakeholder groups:

- Addison Township
- City of Auburn Hills
- Brandon Township
- Bruce Township
- Huron-Clinton Metropolitan Authority
- Independence Township
- Village of Lake Orion
- Macomb and Oakland County Boards of Commissioners
- Macomb and Oakland Conservation Districts
- Macomb County Health Department
- Macomb County Planning & Economic Development
- Macomb County Prosecutor's Office
- Macomb County Public Works Office
- Michigan Department of Environmental Quality
- Oakland County Drain Commissioner's Office
- Oakland County Parks & Recreation
- Oakland County Planning & Economic Development Services
- Oakland Land Conservancy
- Oakland Township
- Orion Township
- Oxford Township
- Oxford Village
- City of Rochester
- City of Rochester Hills
- Shelby Township
- Southeast Michigan Council of Governments
- Washington Township

It should be noted that several communities that have land area in the Stony/Paint Creek subwatershed did not actively participate in the development of this plan because they are focusing their efforts in other subwatersheds where they have more land area. These communities and their respective subwatersheds include Lake Orion (Paint Creek), Orion Township (Upper Clinton / Paint Creek), Shelby Township (Clinton River East), and the Village of Oxford (Paint Creek). The Village of Leonard was also not actively involved in the development of this plan.

In addition to the Clinton River Watershed Council, the core Project Team also included three consultants: Environmental Consulting & Technology, Inc. which completed the field surveys and updated the original plan; Carlisle/Wortman Associates, Inc., which assisted with the planning analysis; and previously Tilton & Associates, Inc., which conducted the initial Stony Creek stream assessment, and Applied Science, Inc., which conducted the initial Stony Creek flow gauging.

2.4 THE SUBWATERSHED PLANNING PROCESS

The development of this plan followed a process that has been used by the Michigan Department of Environmental Quality's (MDEQ) Nonpoint Source Program since 1995. This process is outlined in the document, *Developing a Watershed Management Plan for Water Quality: An Introductory Guide*, which was jointly developed by Michigan State University, MSU Extension, and MDEQ and published in February 2000. The Stony/Paint Creek Project Team and Stewardship Committee followed the basic steps outlined in the guide (note that developing the plan is an iterative process, and many of these steps took place simultaneously):

1. **Identify and network with local agencies and citizens** to identify water quality concerns, define the geographic scope of the watershed, form a steering committee, and begin to develop a resource library. Many of these initial tasks were conducted as part of the Stony Creek wetlands assessment project described previously.
2. **Get to know your watershed** to identify designated and desired uses, determine pollutants of concern and their sources and causes, and develop initial goals for your watershed. This information was obtained in the process of the stream assessment outlined in Chapter 3 and is summarized in Chapter 5.
3. **Define a critical area** that geographically narrows the scope of your watershed project by focusing attention on the parts of the watershed that contribute the greatest pollution to the waterbody. The critical area for the Stony/Paint Creek subwatershed is defined in Chapter 3.
4. **Survey the watershed and inventory your critical area** to clarify the list of pollutants, sources, and causes. The inventory of the Stony/Paint Creek subwatershed is summarized in Chapter 3.
5. **Prioritize pollutants, sources, and causes** based on the designated and desired uses. The pollutants of Stony & Paint Creeks and their sources and causes were prioritized based on the results of the stream inventory, analysis of historic data, and observations of the Project Team and riparian landowners. They are outlined in Chapter 5.
6. **Determine objectives for your watershed goals.** A visioning session was held in July 2003 to finalize the Stony Creek subwatershed goals and establish objectives; these are outlined in Chapter 5. An additional visioning session was held in July 2005 to revisit the Stony Creek goals and update the goals and objectives to be representative for both Stony and Paint Creeks. In addition, Chapter 5 outlines specific actions, such as modifications to existing policies and ordinances, structural improvements, and education and outreach activities to meet the watershed goals and objectives.

7. **Identify systems of best management practices needed** for each source or cause of pollution, including estimated costs. This information is described in Chapter 5.
8. **Identify and analyze projects, programs, and ordinances** that currently impact water quality, evaluate them for consistency with the watershed goals, and identify opportunities to coordinate with or improve upon existing programs. This evaluation was conducted for each of the Stony/Paint Creek communities and is outlined in Chapter 4 and summarized in Chapter 5.
9. **Inform and involve the public** in the watershed planning process and develop an education strategy for delivering watershed information to the public. Public participation and education was a critical component of the Stony/Paint Creek subwatershed planning process. Continued education efforts have been defined in each community's Public Education Plan.
10. **Develop an evaluation process** based on the goals, objectives, and tasks of the watershed plan to determine if your efforts are successful. An evaluation component is included in the Action Matrix in Chapter 5.

2.5 COORDINATION WITH THE NPDES PHASE II STORM WATER PERMIT

The development of a subwatershed management plan is a requirement of Michigan's watershed-based permit, one of two permit options available to communities in Michigan that must comply with the National Pollutant Discharge Elimination System (NPDES) Phase II storm water regulations under the Clean Water Act. Phase II of the NPDES requires communities that fall within the U.S. Census Bureau's urbanized area to obtain storm water discharge permits. Virtually all of the communities in the Clinton River watershed must comply with these regulations as of March 2003.

The watershed-based permit is an innovative approach developed in the mid-1990s by the State of Michigan for the Rouge River National Wet Weather Demonstration Project. This approach requires the formation of subwatershed areas where communities and other public agencies responsible for the management of storm water discharges work cooperatively to develop and implement plans to address storm water pollution. The U.S. Environmental Protection Agency has endorsed the use of the watershed-based permit in place of the traditional jurisdictional permit that would otherwise be required under the NPDES Phase II regulations.

To date, the vast majority of the communities in the Clinton River watershed have adopted the watershed approach and have joined one of six subwatershed planning groups (Upper Clinton, Stony/Paint, Clinton Main, Clinton River East, North Branch, and Red Run). A seventh group has also formed in the Lake St. Clair direct drainage area immediately south of the Clinton River.

As the initial Stony Creek plan was being developed and which was completed in November 2003, the communities in the Stony and Paint creek subwatersheds agreed to combine their efforts due to the similarities between the two creeks and the fact that many of the communities had land area in both subwatersheds. Thus this subwatershed management plan covering both creeks has been developed and includes all of the stakeholders identified in the initial document, with the addition of the Paint Creek communities of Brandon Township, Orion Township, and the villages of Lake Orion and Oxford.

Under the watershed permit, communities and agencies are required to complete a series of plans to address storm water pollution. These plans include a strategy to educate the public about their role in preventing storm water pollution (Public Education Plan) and a plan that identifies the steps each community will take to find and eliminate illicit discharges entering their storm water system (Illicit Discharge Elimination Plan). Communities in each subwatershed must work collaboratively to develop a Subwatershed Management Plan and a Public Participation Plan, which outlines how the public will be involved in the development of the management plan. Finally, each permit holder must develop a Storm Water Pollution Prevention Initiative (SWPPI) after the Subwatershed Management Plan is adopted. The SWPPI identifies the specific actions that will be taken in order to achieve the goals and objectives of the Subwatershed Management Plan. Communities will report annually to the Michigan Department of Environmental Quality on the status of their SWPPIs over the five-year term of the permit.

2.6 COORDINATION WITH THE CLINTON RIVER REMEDIAL ACTION PLAN

In 1972, the United States and Canada signed the *Great Lakes Water Quality Agreement,* which identified 42 pollution "hot spots," or Areas of Concern, in the Great Lakes basin. The main branch of the Clinton River and the spillway downstream of Red Run was initially designated as the Clinton River Area of Concern (AOC), primarily due to concerns over contaminated sediments deposited near the mouth of the river. The first Clinton River Remedial Action Plan (RAP) was developed in 1988 to define a strategy for restoring and protecting the river. At the request of the Clinton River RAP Public Advisory Council (the organization overseeing the RAP process, representing public and private stakeholders in the watershed), the Area of Concern designation was expanded in the early 1990s to include the entire Clinton River watershed in an effort to a provide a more holistic, watershed approach to managing water quality concerns and to more adequately address the impacts from sources upstream from the designated AOC. These sources included historical sediment contamination within the watershed, agricultural impacts, and wet weather impacts including CSOs, SSOs, and increasing impacts of storm water pollution due to land use changes and increased impervious surfaces within the watershed. The RAP was updated in 1995 and again in 1998. The most recent RAP update identifies the primary pollutants of concern in the watershed as storm water runoff and its associated pollutants, contaminated sediments, and bacterial contamination, largely from sewer overflows and failing on-site sewage disposal systems.

In 2004, the Clinton River Public Advisory Council (PAC) received a $32,000 grant from the Great Lakes Commission to develop restoration criteria for the eight Beneficial Use Impairments (BUIs) within the Clinton River Area of Concern. These criteria define "how-clean-is-clean" and are the end goals that will be used to determine when the Clinton River has recovered to the point that it can be delisted as an Area of Concern. The PAC convened a technical committee of local and regional experts and stakeholders to help guide this process. The Clinton River Watershed Council served as the grant administrator and Environmental Consulting & Technology, Inc. (ECT) provided technical support. The technical committee convened in January 2005 to review MDEQ's draft delisting criteria and begin discussing the application of these guidelines to criteria for the Clinton River. Draft restoration criteria have been proposed and the technical committee is currently receiving comments on the criteria. The committee and the PAC have met several times to review and refine the initial proposed criteria. In addition the criteria have been presented to each SWAG within the Clinton AOC combined with a discussion regarding the applicability of the criteria to each of the sub-watersheds within the AOC. On

September 15th, 2005, the draft restoration criteria was reviewed by the PAC and unanimously accepted as the final restoration criteria for the Clinton AOC.

The Stony/Paint Creek Subwatershed Management Plan has been developed with the priorities of the Clinton River RAP process in mind.

Lakeville Swamp, Addison Township

CHAPTER 3: CURRENT CONDITIONS IN THE STONY/PAINT CREEK SUBWATERSHED

3.1 COMMUNITY PROFILES, LAND USE ANALYSIS AND GROWTH TRENDS

The Stony/Paint Creek subwatershed spans over 96,000 acres, or just over 150 square miles, encompassing portions of fifteen communities and two counties. Thirteen of these communities participated in the creation of this subwatershed plan and will be analyzed in further detail throughout this document. Table 3.1 identifies the participating communities and their respective populations and land areas within the subwatershed. Two communities are contained entirely within the Stony/Paint Creek subwatershed, including the villages of Oxford and Lake Orion. The communities with the greatest land area in the subwatershed are Addison and Oakland townships.

Table 3.1. Community Area and Population Within the Stony/Paint Creek Subwatershed.

Community	Acres in Subwatershed	Population in Subwatershed	% of Community in Subwatershed
Addison Township	16,551	5,330	73.0%
Auburn Hills	148	6	1.3%
Brandon Township	7,028	5,725	30.0%
Bruce Township	1,271	329	5.5%
Independence Township	2,258	3,123	9.7%
Village of Lake Orion	828	2,715	100%
Oakland Township	23,454	13,071	99.8%
Orion Township	12,507	14,633	56.5%
Village of Oxford	922	3,540	100%
Oxford Township	14,168	11,095	65.5%
Rochester	2,248	6,897	91.0%
Rochester Hills	7,019	19,998	33.2%
Washington Township	7,909	1,995	35.0%
Total	**96,311***	**88,457**	

Community	Acres in Subwatershed	Population in Subwatershed	% of Community in Subwatershed
Macomb County	9,180	2,324	
Oakland County	87,131	86,133	

**Areas in the communities of Leonard, and Shelby comprise the remaining 599 acres, for a total of 96,910 acres. Source: SEMCOG*

The Stony/Paint Creek subwatershed contains a wide range of existing land uses, from rural, low-density residential and agricultural lands in Oakland and Addison townships to dense suburban development in the villages of Oxford and Lake Orion, and the cities of Rochester and Rochester Hills. Oakland County assigns twelve land use types to properties within the subwatershed while Macomb County assigns six land uses. For ease in analysis, the land uses were condensed and the following categories were created:

Macomb County Land Use Categories:
Upland Open Space
Agricultural
Water / Wetlands
Residential
Commercial / Office / Industrial
Recreation

Oakland County Land Use Categories:
Vacant
Agricultural
Water / Wetlands
Medium / Low Density Residential
Commercial / Office
Recreation / Conservation

To understand land use change in the Stony/Paint Creek subwatershed, it is useful to look at growth trends across the five-county southeast Michigan region. The Southeast Michigan Council of Governments (SEMCOG) looked at land use in relationship to the 2000 census results and analyzed changes that have occurred since the 1990 census. SEMCOG's key findings include the following:

- In the past 10 years, developed land in the region has increased by 17% (159,300 acres). Thirty-seven percent of Southeast Michigan is now considered developed.
- The region's population grew by 5% (243,000 people), which is a major driver in land use change.
- Recent residential development is lower in density. For all housing in the region in 1990, average density was 2.84 units per acre. The new housing added between 1990 and 2000 was built at an average density of 1.26 units per acre.
- Average household size has decreased and average home size has increased.
- In summary, the average home in Southeast Michigan is larger in size, on a larger piece of land, and has fewer people living in it than in 1990. These trends have serious implications in terms of infrastructure costs and environmental impacts.

The trends identified by SEMCOG are reflected in the Stony/Paint Creek subwatershed, which is located on the northern fringe of the rapidly growing metropolitan Detroit region. SEMCOG projects that the combined populations of the thirteen Stony/Paint Creek communities will grow by over 43% by 2030. At the same time, average household size is predicted to decline from 2.68 to 2.40. The predominant housing type in these communities is single family, detached homes. The vast majority of building permits in recent years have been issued for this housing type, with townhomes and attached condominiums running a distant second. Table 3.2 illustrates the population and housing profiles for each of the thirteen communities. Note that these data are for the entire communities, not just their area within the Stony/Paint Creek subwatershed. Table 3.3 and Figure 3.1 illustrate the distribution of current land uses by community within the Stony/Paint Creek subwatershed.

Table 3.2a. Population and Housing Profiles for Stony Creek Communities. (SEMCOG, 2003)

	Addison Township	Bruce Township	Oakland Township	Oxford Township	Rochester	Rochester Hills	Washington Township
Population							
1990 Population	4,785	4,193	8,226	9,004	7,130	61,766	11,386
2000 Population	6,107	6,395	13,071	12,485	10,467	68,825	17,122
2030 Forecast	9,440	12,362	26,063	25,884	11,126	72,585	33,187
2000 Stony Creek Population	5,330	329	4,541	1,650	1,802	1,757	1,995
Households							
2000 Total Households	2,050	2,114	4,341	4,385	4,667	26,315	6,155
2000 Housing Units	2,161	2,188	4,529	4,675	5,056	27,263	6,443
2000 Ave. Household Size	2.91	3.01	3.01	2.83	2.22	2.59	2.77
2030 Ave. Household Size	2.52	2.45	2.77	2.51	2.22	2.31	2.36
2000 Median Household Income	$71,017	$72,102	$102,034	$66,725	$65,179	$74,912	$71,823
2000 Median House Value	$237,400	$238,500	$315,700	$182,400	$260,700	$226,200	$226,200
2000 Educational Attainment							
No High School	12%	11%	5%	10%	6%	7%	12%
High School	27%	27%	18%	29%	15%	18%	28%
Some College	25%	29%	21%	24%	20%	20%	28%
Associate's	8%	9%	8%	10%	7%	7%	10%
Bachelor's	18%	14%	29%	19%	32%	28%	15%
Graduate	11%	11%	19%	8%	20%	19%	8%
2000 Housing Types							
One-Family Detached	1832	1753	4160	3483	2592	18052	4579
One-Family Attached	4	21	8	39	458	2508	482
Two-Family / Duplex	9	0	0	19	214	70	84
Multi-Unit Apartments	31	68	8	273	1792	5208	531
Mobile Homes	284	346	353	858	0	1425	767
Other	0	0	0	0	0	9	0
Total	2161	2188	4529	4675	5056	27263	6443
2002 Residential Building Permits							
Single Family	42	49	260	150	58	227	190
Townhouse / Attached Condo	0	0	124	0	0	10	0
Two-Family / Duplex	0	0	44	0	0	16	2

	Addison Township	Bruce Township	Oakland Township	Oxford Township	Rochester	Rochester Hills	Washington Township
Multi-Family	0	0	168	0	78	0	154
Total New Units	42	49	596	150	136	253	346

Table 3.2b. Population and Housing Profiles for Paint Creek Communities (Cont.). (SEMCOG, 2003)

	Auburn Hills	Brandon Township	Independence Township	Lake Orion	Orion Township	Oxford Village
Population						
1990 Population	17,076	10,799	23,717	3,057	21,019	2,929
2000 Population	19,837	13,230	32,581	2,715	30,748	3,540
2030 Forecast	21,013	18,509	38,103	2,916	40,948	3,546
2000 Stony Creek Population	6	5,725	3,123	2,715	14,633	3,540
Households						
2000 Total Households	8,064	3,535	11,765	1,198	11,048	1,402
2000 Housing Units	8,822	3,694	12,375	1,320	11,517	1,476
2000 Ave. Household Size	2.25	3.04	2.75	2.17	2.77	2.51
2030 Ave. Household Size	1.97	2.73	2.45	2.01	2.54	2.31
2000 Median Household Income	$51,376	$66,895	$74,993	$51,311	$73,755	$53,885
2000 Median House Value	$137,200	$195,000	$203,600	$164,600	$199,100	$165,200
2000 Educational Attainment						
No High School	12%	10%	8%	11%	8%	11%
High School	26%	31%	22%	18%	22%	24%
Some College	21%	29%	26%	34%	24%	27%
Associate's	8%	10%	7%	7%	9%	9%
Bachelor's	23%	15%	24%	19%	25%	19%
Graduate	10%	5%	13%	11%	12%	10%
2000 Housing Types						
One-Family Detached	3,447	3,659	9,447	931	9,047	914
One-Family Attached	544	19	362	29	530	76
Two-Family / Duplex	64	0	59	41	38	59
Multi-Unit Apartments	3,912	23	1,899	318	1,448	329
Mobile Homes	888	1,011	584	0	456	101
Other	0	0	6	0	0	0
Total	8,855	4,718	4,718	1,320	11,517	1,476
2002 Residential Building Permits						
Single Family	64	92	166	15	164	10
Townhouse / Attached Condo	134	0	43	1	16	2

	Auburn Hills	Brandon Township	Independence Township	Lake Orion	Orion Township	Oxford Village
Two-Family / Duplex	0	0	0	2	4	0
Multi-Family	4	0	0	0	0	0
Total New Units	202	92	209	18	184	12

Table 3.3 placeholder (11x17 sheet)

The top three land uses in the Stony/Paint Creek subwatershed are low- and medium-density residential development (38%), vacant land (20%), and recreation and conservation lands (13%), which combined represent over 70% of the total subwatershed land area. These land uses are most highly represented in Oakland, Addison, Oxford and Orion townships, in the upper reaches of the subwatershed. The current high water quality and stream corridor conditions throughout much of this area are a reflection of these relatively low impact land uses. The subwatershed features extensive vegetative cover – ranging from marshes and swamps to upland forests and prairies (Figure 3.2). More than 6% of the subwatershed encompasses water bodies and wetlands, including the large Lakeville Lake, Stony Creek Lake, and Lake Orion impoundments, dozens of small lakes and ponds, and hundreds of wetlands (Figure 3.3).

Over 6%, or almost 6,000 acres, of the subwatershed is still actively farmed – primarily in Addison, Oakland, and Washington townships. Approximately 15% of the subwatershed is intensely developed (commercial, office, industrial, high density residential, etc.). These uses are concentrated in the southern portion of the subwatershed, although there is some significant industrial development in Oxford Township.

As the Stony/Paint Creek communities develop, the potential for negative environmental impacts increases, including water *quality* impacts resulting from erosion, sedimentation, and increased inputs of stormwater pollutants, as well as water *quantity* impacts resulting from loss of wetlands, woodlands, and riparian vegetation and increased impervious surfaces. Following are brief profiles of each of the thirteen Stony Creek communities, highlighting their existing land use and growth trends. The communities are generally listed from north to south and from west to east to reflect the changes in land use as one moves from the headwaters to the lower reaches of the creek.

In addition to each community's general land use features and trends, reference is also made to the results of the recent Michigan Natural Features Inventory study, which assessed the quality and extent of natural areas in Oakland County (Figure 3.4).

Brandon Township

At the very northwestern boundary, Brandon Township contains the headwaters of Paint Creek and several of its tributaries. This subwatershed spans over 7,000 acres in the Township, more than half of which are used for low and medium-density residential development. Another 1,400 acres are vacant, indicating the transition that is happening in this area of the County from agricultural production to residential housing. The Township still has some agricultural uses in the subwatershed (419 acres), but also has similar acreages in road rights-of-way and high-density residential land uses. The Township's population is projected to rise by 40% as of 2030, which is near the average for the subwatershed.

While the Township doesn't have any large water bodies in the subwatershed, it does have a considerable number of ponds and drainageways, many included in MNFI designations.

Oxford Township

Oxford Township has land area in both Paint and Stony Creek subwatersheds. It contains 14,168 acres within the subwatershed, which encompasses the headwaters of both branches of Stony Creek and is a community of many land uses. Natural and recreation areas in Oxford Township that fall within the Stony Creek subwatershed include Crossroads for Youth (formerly Camp Oakland) – an alternative education facility featuring a large track of mostly undeveloped land – and Boulder Point and Oxford Hills golf courses. There are also several state parks within the Paint Creek portion of the subwatershed. The Michigan Natural Features Inventory identifies several large areas of the township as Priority One, Two, or Three natural areas.

Of the township acreage in the Stony/Paint Creek subwatershed, approximately 40% is in low- and medium-density residential development, which is primarily clustered around the Village of Oxford and to the south and west. Just under one-quarter of the subwatershed acreage is vacant. About 11% is in commercial and industrial use, primarily along the M-24 corridor, which spans the township from southeast to northwest and forms part of the northwest border of the Stony Creek subwatershed. More than half of the industrial land in the Stony Creek subwatershed is located in Oxford Township. The township has experienced a population increase of nearly 40% in the last ten years and the population is projected to more than double by 2030.

Village of Oxford

Oxford Village is bisected by the Paint/Stony Creek boundary line. About half of the community is in the Paint Creek subwatershed, and the other half is in the Stony/Creek subwatershed, making the community only one of two municipalities wholly within the Stony/Paint subwatershed. Covering about 1.4 square miles, the Village includes a number of different land uses within its jurisdiction. The largest area is used for medium and low-density residential land uses, representing 28% of the community. The next largest land use is water, made up of Oxford Lake and several smaller surrounding lakes and ponds. While generally considered built-out, the Village has 110 acres (12%) of vacant land available for development or preservation. It also has significant lands devoted to roadways (11%), Industrial (10%), public/institutional (8%), and high-density residential (6%) land uses. In the past 10 years, the population of the Village increased by 21%. However, this trend is not projected to continue, and the number of residents will most likely stay the same by 2030.

Addison Township

The entire lower 75% of the Township is within the Stony/Paint subwatershed. It represents about 17% of the entire subwatershed's land area, and more than one-third of the Stony Creek subwatershed's total land area. It is a rural community of woodlands, farmland, wetlands, and lakes, and is home to the headwaters of both Stony Creek and the North Branch of the Clinton River. Nearly 90% of its population is contained within the Stony/Paint Creek subwatershed. Unique natural areas include the Michigan Nature Association's Lakeville Swamp Nature Sanctuary (located just south of Lakeville Swamp, to the east and west of Rochester Road), Addison Oaks County Park (along the southern border of the township between Lake George and Walker roads), Upland Hills Farm and Ecological Awareness Center (across from Addison Oaks on Lake George Road), and the Salvation Army's Echo Grove Campground (along the northwest shore of Lakeville Lake). Addison also features a significant stretch of the Polly Ann Trail, a rail-trail that traverses the headwaters of the Main Branch of Stony Creek, to the west and north of Lakeville Lake. The trail begins in Lake Orion, passes through the Village of Oxford, Oxford Township, and Leonard, and continues on into Lapeer County. Addison Township contains a large number of high-quality natural areas identified by the Michigan Natural Features Inventory. The majority of these areas include land adjacent to tributaries of Stony Creek.

Small areas of dense residential and commercial development are centered around the Village of Leonard and the hamlet of Lakeville, where the Addison Township offices are located. More than 7,000 acres of the subwatershed in Addison Township are already in low- and medium-density residential use, but other areas are beginning to experience growth pressures as farmland (1,600 acres) and other vacant lands (4,050 acres) are targeted for conversion to residential uses. The township has seen a population increase of more than 25% in the last ten years and is expected to grow by another 50% by 2030.

Bruce Township

Bruce Township is Addison's neighbor to the east in Macomb County, and shares many similar land use characteristics. The portion of Bruce Township contained within the Stony/Paint Creek subwatershed is quite small, encompassing about 1,300 acres, or less than 6% of the Township. A small tributary and short stretch of the Main Branch of Stony Creek flow through primarily large lot residential, vacant, and agricultural parcels in the southwest corner of the township, south of 34 Mile Road and west of Fisher Road. Bruce Township also contains significant land area in the North Branch subwatershed and a small area in the Middle Branch subwatershed of the Clinton River.

Bruce Township has experienced a population increase of more than 50% in the past ten years and is projected to nearly double in population by 2030. It is likely that the vacant lands (450 acres) and agricultural lands (430 acres) in the Stony/Paint Creek subwatershed will be targeted for residential development in the next few decades.

Independence Township

This community has a relatively small area within this subwatershed (approximately 10% or 2,200 acres). It is also within the Upper Clinton subwatershed, and Flint River watershed. Like many other communities within the Stony/Paint, the Township's largest land use is medium and low-density residential development (53%), followed by vacant lands (18%). It does contribute significant recreation land area through the Clarkston Golf Course (235 acres), and water features (149 acres). The population of the Township is projected to increase by 17% as of 2030. Past population increases is also reflected in the relatively large number of single-family building permits issued in the recent past.

Orion Township

The majority of Orion Township within this subwatershed is in the Paint Creek subwatershed, although it has a very small area (744 acres) in the Stony Creek subwatershed as well. The Township is also located within the Upper Clinton and Clinton-Main subwatersheds. Unlike most other communities in the Stony/Paint, this Township has almost as much recreation lands as medium and low-density housing. Thirty-two percent of the Township's subwatershed area is devoted to medium-density residential development, while 28% is covered by recreational lands, due in large part to the Bald Mountain State Recreation Area. The Township also has a number of lakes and other water resources, covering over 900 acres in the subwatershed.

Orion is a developing community that has a considerable roadway network (933 acres) industrial development (603 acres), commercial office development (354 acres), and high-density residential development (282 acres). The majority of commercial development is clustered along M-24 (Lapeer Road). However, in this subwatershed, it still has over 1,400 acres of vacant land, providing significant opportunities to protect natural areas and water features. The population in Orion has historically grown at relatively fast pace (46% over the last 10 years) and it is projected to continue this trend with a population growth of 33% by 2030. The number of building permits also reflects this trend.

Village of Lake Orion

The other community wholly located within the Stony/Paint subwatershed is the Village of Lake Orion. This 800-acre community began as a vacation get-away for Detroit residents, and grew around the Lake into a year-round community. The largest land use is the lake itself, covering over 350 acres or 40% of the community. Medium and low-density residential development covers 21% of the Village, while roadways cover an additional 10%. The remaining 29% is used for high-density residential, commercial/office, vacant (39 acres), and public/institutional uses. The community also has 17 acres of parkland. The population in the Village grew considerably in the past 10 years by 37%. The future projected growth is slower, estimated to be about 7% by 2030.

Oakland Township

Oakland Township, located directly south of Addison Township, has successfully retained its rural character despite significant development activities over the past several decades. The northeastern side of the township contains the majority of the West Branch of Stony Creek and several tributaries to the Main Branch. The southwestern portion of the township falls within the Paint Creek subwatershed and contains the main branch of Paint Creek.

Oakland Township features the most acreage in the subwatershed (23,454 acres or 24% of the subwatershed), and as a result, contains the most residential, vacant and recreation and conservation lands in the Stony/Paint Creek subwatershed (nearly 19,000 acres), including the North Unit of Bald Mountain State Recreation Area in the northwest corner of the township, a portion of Stony Creek Metropark in the southeast corner of the township, several passive use township parks (Cranberry Lake Park, Charles Ilsley Park, and Blue Heron Environmental Area), and several private golf courses (Beaver Creek, Twin Lakes, and Blackheath). Most of these areas are expected to be preserved as open space and recreation lands in the future. The Michigan Natural Features Inventory has identified many natural areas in Oakland Township as either Priority One or Two. Many of the Priority One areas are already protected by either the state, Huron-Clinton Metropolitan Authority, or the township.

More than 9,000 acres of the Stony Creek subwatershed in Oakland Township are already in low- and medium-density residential use. The Adams Road corridor and southern portions of the township (both in the Paint Creek subwatershed) have been targeted for much of the township's future residential development, but over 3,000 acres in the Stony Creek subwatershed and 2,000 acres in the Paint Creek subwatershed are still vacant. Only 1,600 acres are still actively farmed. Oakland Township contains several major roads including Orion Road which runs at a diagonal from northwest to southeast, and Rochester Road, which runs the length of the township from north to south. The township has seen a nearly 60% increase in population in the last ten years and the population is expected to double in size between 2000 and 2030.

Washington Township

Washington Township contains a long stretch of the Main Branch of Stony Creek, much of it within Stony Creek Metropark. Washington Township has the largest land area remaining in agricultural use in the subwatershed (1,800 acres), as well as the largest acreage of water and wetlands (1,500 acres), primarily due to the presence of the large Stony Creek Lake impoundment and its associated wetland systems in the Metropark. A total of 7,900 acres (34%) of the township are contained within the Stony Creek subwatershed; most of the rest of the township is in the Middle Branch subwatershed. Although the Michigan Natural Features Inventory has not yet completed a survey of natural areas in Macomb County, MNFI has evaluated Stony Creek Metropark and has identified a variety of high-quality sites in the park.

Much of Washington's remaining farmland is expected to be targeted for residential development, leading to a growing interest in farmland preservation. Washington also has the most land area in commercial and office use in the subwatershed, due to the Mound Road corridor extending north from M-59 in Shelby Township. Only 1,000 acres of the township in the Stony Creek subwatershed are currently in low- and medium-density residential use; nearly 2,300 acres are vacant. There are several gravel mines that have either been closed or are nearing the end of their operating lives along the western edge of the township. These gravel mines do not utilize any surface waters for their operations; however they do utilize groundwater resources. The township's population has grown by 50% in the past ten years and is expected to nearly double by 2030.

City of Auburn Hills

A very small portion of Auburn Hills is located in the Stony/Paint Creek subwatershed (1.3%) and represents less than 1% of the subwatershed land area. Its main land uses in the subwatershed include recreation/conservation (30%), medium and low-density residential (28%), and an equal amount of vacant land and lands devoted to transportation/utility/ communication uses (both 17%). The population throughout the community has increased by 16% in the past 10 years, and is expected to increase by 6% as of 2030. It is likely the population of the City could increase in the Stony/Paint given that 11 acres are dedicated to high-density residential uses, and that this type of housing has been increasing with in the City in the recent past.

City of Rochester Hills

The City of Rochester Hills stands out as the community with the largest population in the group, but only a relatively small portion of the city actually falls within the Stony Creek subwatershed (7,000 acres out of a total land area of 96,000; 19,900 people out of a total population of 69,000). The City is a largely residential suburban community, with significant land areas in the Paint Creek, Main Branch, and Red Run subwatersheds in addition to Stony Creek. Rochester Hills has the largest acreage of public and institutional lands in the Stony/Paint Creek subwatershed, due to the presence of Stony Creek High School, Hart Middle School, and the Rochester Hills Museum at Van Hoosen Farm, all located along Tienken Road in the northeast corner of the City. Van Hoosen Farm is part of Stony Creek Village, a historic district that runs right along the creek. The Michigan Natural Features Inventory has identified the Stony Creek corridor in the City of Rochester Hills as a Priority Two natural area.

Of the 7,000 acres of Rochester Hills in the subwatershed, half is in low- and medium-density residential use and appoximately 11% is vacant. Rochester Hills is close to build-out, having experienced only an 11% increase in population over the past ten years. The City's population is expected to grow by just over 5% by 2030.

City of Rochester

The City of Rochester is one of the oldest communities in Oakland County. The subwatershed includes both historic and more recently developed portions of the City. Rochester also contains areas in the Clinton River Main Branch subwatershed. Along Stony Creek, there are no protected natural areas, although the riparian corridor is still relatively intact and runs through medium-density residential subdivisions and some commercial and industrial properties. The Michigan Natural Features Inventory has ranked this corridor as Priority Two. Paint Creek runs through City parks and older residential areas.

Not surprisingly, Rochester has the largest land area in high-density residential use in the subwatershed (18% or 406 acres). Its low- and medium-density residential development covers 26% of the City's subwatershed area, roadways cover 15%, and recreation/conservation follows with 12%, or 265 acres. Most of the land area within the subwatershed has been developed, with only 195 acres remaining vacant. As other historic villages within the subwatershed, Rochester is also close to build-out; although the city's population has grown by nearly 50% in the past ten years due to the annexation of land from neighboring Rochester Hills. It is only projected to grow by another 6% by 2030.

3.2 SANITARY SEWER SYSTEM & ON-SITE SEWAGE DISPOSAL SYSTEMS

Two primary mechanisms exist to deal with wastewater, or sewage, disposal in the Stony/Paint Creek subwatershed: sanitary sewers, which ultimately lead to a wastewater treatment plant, or on-site sewage disposal systems (OSDS). OSDS consist of a septic tank and an absorption field; some systems also employ a pretreatment device such as a sand filter. OSDS are most commonly used for single residences but can also be employed at apartment complexes, strip malls, and other locations where a single system may serve multiple units.

As illustrated in Figure 3.5, the use of OSDS to infiltrate wastewater into the soil is the predominant form of sewage treatment in the Stony/Paint Creek subwatershed. This map illustrates currently sewered areas, areas proposed for future sewer system construction, and areas whose sewer status is currently unknown. The majority of the subwatershed is listed as "No Sewer Planned," but for the most part these areas are considered either vacant land or are served by OSDS. Table 3.4 illustrates the percentage of land in the subwatershed by community that is currently sewered, will be sewered in the future, or whose status falls in the unknown category (note that the percentages do not necessarily add up to 100% due to some categories not included here. Also note that water is included in the "Will Not Be Sewered" category.).

Table 3.4. Status of Sewer Systems in Stony/Paint Creek Communities.

	Currently Sewered	**Future Sewered**	**Will Not Be Sewered**	**No Sewer Planned**
Subwatershed				
Addison Township	0%	0%	5%	95%
Auburn Hills	86%	14%	0%	<1%
Brandon Township	0%	0%	99%	<1%
Bruce Township	0%	0%	3%	97%
Independence Township	5%	0%	<1%	94%
Lake Orion	16%	0%	0%	84%
Oakland Township	5%	1%	0%	94%
Orion Township	39%	2%	24%	35%
Oxford Village	84%	0%	16%	0%
Oxford Township	23%	17%	17%	43%
Rochester	95%	0%	0%	5%
Rochester Hills	76%	13%	0%	11%
Washington Township	2%	1%	0%	80%

Source: SEMCOG and community correspondence.

Pockets of the subwatershed that are more urbanized, such as in Oxford Township and Village, Lake Orion, and the cities of Rochester and Rochester Hills, contain areas that are serviced by sanitary sewers. Both OSDS and sanitary sewer systems can effectively treat sewage when properly designed and maintained. If either type of system is not sited, constructed, or maintained properly, however, they can become sources of pollution to surface and ground waters, posing threats to both the aquatic ecosystem and human health. Sewage can contain harmful bacteria that can cause severe illness in humans. Nutrients in sewage can accelerate aquatic plant and bacteria growth, leading to depleted oxygen levels (which can affect fish communities), restricted water-related recreation, and degraded aesthetics.

OSDS can malfunction if they are sited improperly, particularly in clay soils that do not percolate, or infiltrate, into the soil. Systems can function in certain clay soil types if they are properly designed and maintained; otherwise they may fail prematurely. (Additional information on soil types and their infiltration ability can be found in section 3.4.1 Landscape Context – Geology, Soils & Vegetation.) Fortunately today, efforts have been made to improve our understanding of the maintenance required to keep these systems operating at their peak performance. However, owner education about septic system maintenance is an ongoing issue, particularly as more people move from urban areas with sanitary sewers to rural areas served by septics. This is especially true in the Stony/Paint Creek subwatershed, as only 37% of the land area is now or is planned to be served by sanitary sewers.

Both the Oakland and Macomb county health departments regulate the installation and maintenance of septic systems in order to reduce the risks of failure. In August 2002, Macomb County implemented an ordinance that requires time-of-sale inspections of septic systems. Additionally, the Macomb County Health Department obtained a Clean Michigan Initiative grant to transfer historical hard copy records of existing on-site sewage disposal systems into an electronic GIS database. The database will include locations of OSDS, type and sizing of systems, date installed, and date replaced, if applicable. Washington Township, a large portion of which is within the Stony/Paint Creek subwatershed, was chosen as the pilot community for this project. Over 3,500 records have been entered to date. The long-term goal is to expand the project to cover all Macomb County communities that utilize OSDS.

Sanitary sewer systems can also fail if they are improperly constructed or poorly maintained. In some instances sanitary sewer pipes leading from a residence or commercial structure may be accidentally or purposefully connected to a storm drain, creating what is known as an “illicit connection.” In this case, untreated sewage directly enters the storm drain and empties into the nearest stream, river, or lake. Sanitary sewer pipes can also crack and leak into the ground or nearby storm drains if they are not properly maintained; or they can be overloaded beyond the capacity they were designed to carry and overflow. Both of these circumstances can also result in the release of untreated sewage into our waterways. Under the NPDES Phase II stormwater regulations, communities are required to inspect their sanitary sewer systems and correct any discharges of sewage into our waterways. These detection and correction processes are outlined in each community’s Illicit Discharge Elimination Plan (IDEP).

3.3 BASELINE INSTREAM AND RIPARIAN CONDITIONS

Instream and riparian corridor conditions can be assessed by monitoring and analyzing chemical, biological, and physical parameters. CRWC identified several sources of data to assess instream and riparian conditions in Stony/Paint Creek Subwatersheds, including CRWC’s volunteer water quality monitoring program and CRWC’s *1997 Aquatic Habitat Survey of the Clinton River Watershed with Recommended Management Actions*. In addition, CRWC contracted with Tilton & Associates, Inc. (TAI) and subsequently Environmental Consulting & Technology, Inc. (ECT) to conduct an assessment of instream and riparian conditions in the Stony/Paint Creek Subwatersheds. The field surveys consisted of MDEQ’s Stream Crossing

Watershed Survey, Bank Erosion Hazard Index and Macroinvertebrate Surveys. Table 3.5a and Table 3.5b list the locations of the surveys (Figure 3.8). The data collection methods and results are discussed in detail below.

Table 3.5a Stony Creek Subwatershed Survey Locations

STONY CREEK SUBWATERSHED SURVEY SITES		
Name	**Road Crossing**	**Community**
QAPP01	Brewer west of Townsend	Addison
QAPP02	Rochester Road south of Brewer	Addison
QAPP03	31 Mile Road east of Mt. Vernon	Washington
QAPP04	Inwood Road east of Mt. Vernon	Washington
QAPP05	Stony Creek Metro Park (SCMP) Park Road east of County Line	Washington
QAPP06	Stony Creek Metro Park (SCMP) Park Road west of Mt. Vernon	Oakland Twp
QAPP07	Harmon in Bald Mountain Recreation Area	Oakland Twp
QAPP08	Stony Creek Metro Park (SCMP) Park Road	Oakland Twp
QAPP09	USGS Station-Mt. Vernon Court	Washington
QAPP10	Parkdale east of Romeo	Rochester

Table 3.5b Paint Creek Survey Locations

PAINT CREEK SUBWATERSHED SURVEY SITES		
Name	**Road Crossing**	**Community**
PC01	University at Paint Creek	Rochester
PC02	Tienken at Paint Creek	Rochester Hills
PC03	Dutton at Paint Creek	Rochester Hills
PC04	Gunn west of Orion Road	Oakland Twp
PC05	Kern and Clarkston	Orion Twp
PC06	Atwater at Paint Creek	Lake Orion
PC07	Stanton at Paint Creek	Oxford
PC08	Baldwin at Paint Creek	Oxford

Furthermore, ECT conducted a nonpoint source pollutant loading analysis for both the Stony and Paint Creek subwatersheds based on existing land use characteristics.

Data Sources:

Volunteer Water Quality Monitoring Data

CRWC has coordinated *Stream Leaders,* a school-based volunteer water quality monitoring program, for the past eleven years. Students at many local schools have conducted monitoring at several sites along the Stony/Paint Creeks. CRWC provides teachers with training in the use of monitoring equipment, sampling and safety protocols, field data sheets, stream habitat assessment, and identification of benthic macroinvertebrates. Teachers who have been through CRWC's training program then take their students out into the field twice annually, in the fall and spring, to collect and analyze biological, chemical, and physical parameters at their adopted stream site. The data is collected and summarized by CRWC in an annual "scorecard" for the Clinton River.

1997 Aquatic Habitat Survey

In 1996-7, CRWC conducted a survey of aquatic and riparian habitat in the Clinton River watershed with funding from the Michigan Department of Natural Resources. The purpose of this project was to evaluate current habitat conditions and make prioritized management recommendations for habitat protection and restoration. The survey included 16 sites in the Stony Creek subwatershed (10 on the Main Branch and 7 on the West Branch). Sites were evaluated using two methods – the first method was developed by CRWC staff and the second was the Michigan Department of Environmental Quality's (MDEQ) *Qualitative Biological and Habitat Survey Protocols for Wadable Stream and Rivers*, which was developed by the Great Lakes and Environmental Assessment Section (GLEAS) of MDEQ's Surface Water Quality Division. This procedure is known as GLEAS-51. The results of the survey were summarized in the *1997 Aquatic Habitat Survey of the Clinton River Watershed with Recommended Management Actions.*

2002 Stony Creek Instream and Riparian Corridor Assessment

CRWC contracted with Tilton & Associates, Inc., an Ann Arbor-based environmental consulting firm, to conduct an instream and riparian corridor assessment of the Stony Creek subwatershed. The purpose of this inventory was to establish a baseline for current instream and riparian conditions, identify possible sources of nonpoint source pollution, and locate areas for potential protection or restoration. The assessment included three components: a physical (visual) inventory of instream and riparian conditions, macroinvertebrate sampling, and flow gauging. MDEQ's Stream Crossing Watershed Survey and Macroinvertebrate Surveys were used for these assessments. Over thirty (30) sites were analyzed using the MDEQ's Stream Crossing Watershed Survey. The ten (10) initial QAPP sites were used for the purpose of the subwatershed assessment and preparation of the Action Matrix described in Chapter 5.

2004/2005 Paint/Stony Creek Assessment

CRWC contracted with Environmental Consulting & Technology, Inc., an environmental consulting firm, to conduct additional surveys of Stony Creek along with identical surveys of Paint Creek. These additional field assessments were completed at a total of eight (8) sites within the Paint Creek subwatershed. Similar to the Stony Creek assessment, the purpose of this inventory was to establish a baseline for current instream and riparian conditions, identify possible sources of nonpoint source pollution, and locate areas for potential protection or restoration. The assessment included four components: a physical (visual) inventory of instream and riparian conditions using the MDEQ's Stream Crossing Watershed Survey, evaluation for bank erosion potential and macroinvertebrate sampling at two sites (PC07 and PC08) that were not sampled by CRWC Volunteer Sampling or the Clinton River Cold Water Conservation Project. In addition, computer modeling was employed to estimate existing nonpoint source pollutant loading to both creeks.

2004/2005 Stony/Paint Creek Subwatershed Nonpoint Source Pollutant Loading Assessment

Environmental Consulting & Technology, Inc. conducted a pollutant loading model within the Stony/Paint Creek Subwatersheds based on landuse data. The program first delineates subbasins within the subwatershed in order to understand where potential problem areas may be located. This model calculates approximate levels of nonpoint source pollutants within subbasins of the subwatersheds. Understanding the potential levels of specific pollutant loading helps create possible actions that could be taken to improve water quality. The subbasins were given a unique ID number which is listed in Table 3.6 and shown on Figure 3.6. This computer modeling procedure is described in more detail in Section 3.3.6.

Table 3.6. Stony and Paint Creek Subwatershed Subbasin ID and Survey Site ID

Stony Creek Subbasin ID	Survey Site ID	Stony Creek Subbasin ID	Survey Site ID	Paint Creek Subbasin ID	Survey Site ID	Paint Creek Subbasin ID	Survey Site ID
SC A	QAPP10 QAPP09 MS02 MS02A MS02B MS03	**SC H**	QAPP02	**PC A**	PC01	**PC I**	NA
SC B	QAPP04 MS04	**SC I**	WS18	**PC B**	PC02 PC03 PC04	**PC J**	PC07
SC C	QAPP05	**SC J**	QAPP07 WS19 WS20 WS21 WS22	**PC C**	NA	**PC K**	NA
SC D	QAPP06	**SC K**	QAPP01 MS09	**PC D**	NA	**PC L**	PC08
SC E	QAPP08 WS01 WS02 WS06 WS07 WS09 WS13 WS15 WS17	**SC L**	NA	**PC E**	PC05 PC06	**PC M**	NA
SC F	QAPP03 MS06 MS07 MS08	**SC M**	MS10 MS11 MS12	**PC F**	NA	**PC N**	NA

SC G	MS05	**SC N**	NA	**PC G**	NA	**PC O**	NA
		SC O	NA	**PC H**	NA	**PC P**	NA

NA = No road crossing site was surveyed within this subbasin

2004/2005 Stony/Paint Creek Subwatershed Bank Erosion Hazard Index Assessment

Environmental Consulting & Technology, Inc. also conducted a Bank Erosion Hazard Index (BEHI) survey at the eighteen road crossings in Table 3.5a and Table 3.5b. The BEHI is a procedure developed by Dave Rosgen of Wildland Hydrology for assessing streambank erosion condition and potential. It assigns point values to several aspects of bank condition and provides a scoring mechanism for inventorying streambank conditions over large areas and prioritizing eroding banks for restoration (Rosgen, 2001). This survey is described in more detail in Section 3.3.4.

3.3.1 Water Chemistry

The recent water chemistry data identified for Stony/Paint Creek has been collected as part of CRWC's *Stream Leaders* water quality monitoring program. Students conduct chemical sampling using the GREEN Low Cost Monitoring Kit. This kit uses pre-measured TesTabs, which minimize the chance of error and contain no hazardous materials. Students participating in the program collect multiple water samples and test pH, dissolved oxygen, biochemical oxygen demand, nitrates, phosphates, turbidity, fecal coliform bacteria, and temperature. Each of these parameters is described in detail below. The results for each parameter are scored and a formula is applied to reach an overall Water Quality Index (WQI). The results for Stony Creek over the past 8 years are summarized in Table 3.7a. The results for Paint Creek over the past 5 years are summarized in Table 3.7b. It is apparent from the WQI results that the water quality in Stony/Pain Creek has remained relatively consistent in recent years. Although these results are not quality assured, they provide a good general picture of the water chemistry conditions in Stony/Paint Creek.

Table 3.7a. Summary of Volunteer Monitoring Data for Stony Creek, 1994-2002.

Branch	Year	Season	Macroinvertebrate Rating	Water Quality Index
Main	2002	Fall	Excellent	Good
Main	2002	Spring	Good	Good
West	2002	Fall	Excellent	Good
West	2002	Spring	Good	Good
Main	2001	Fall	Good	Good
West	2001	Fall	Fair	Good
West	2001	Spring	Excellent	Good
Main	1999	Spring	Good	Good
Main	1998	Fall	N/A	Good
Main	1998	Spring	Good	Good
Main	1997	Fall	Good	Good

Branch	Year	Season	Macroinvertebrate Rating	Water Quality Index
Main	1997	Spring	Good	Good
Main	1996	Fall	Good	Good
Main	1995	Fall	Excellent	Good
Main	1995	Spring	Excellent	Good
Main	1994	Spring	Excellent	N/A

Table 3.7b. Summary of Volunteer Monitoring Data for Paint Creek, 1999-2004.

Location	Year	Season	Macroinvertebrate Rating	Water Quality Index
Rochester Road/University (Rochester Park)	2003	Fall	Good	N/A
Rochester Road/University (Rochester Park)	2000	Fall	Good	Good
Rochester Road/University (Rochester Park)	2000	Spring	Good	Good
Rochester Road/University (Rochester Park)	1999	Fall	Fair	Good
Clarkston Rd/Kern (Bald Mountain State Rec. Area)	2004	Fall	Fair	Good
Clarkston Rd/Kern (Bald Mountain State Rec. Area)	2003	Fall	Poor	Good
Clarkston Rd/Kern (Bald Mountain State Rec. Area)	2001	Fall	Fair	Good
Clarkston Rd/Kern (Bald Mountain State Rec. Area)	2000	Fall	Fair	Good
Gallagher/Orion Roads (Paint Creek Cider Mill)	2001	Fall	Fair	Excellent
Gallagher/Orion Roads (Paint Creek Cider Mill)	2000	Fall	Fair	Excellent
Brewster/Dutton (Georgetown Subdivision)	2004	Spring	Good	Good
Brewster/Dutton (Georgetown Subdivision)	2003	Fall	Fair	Good
Brewster/Dutton (Georgetown Subdivision)	2000	Fall	Fair	Good
Anderson Street (Meek's/Children's Park)	2004	Fall	Poor	Good
Anderson Street (Meek's/Children's Park)	2004	Spring	Good	Good

Anderson Street (Meek's/Children's Park)	2003	Fall	Fair	Good
Stanton Lake Road (Paint Creek Country Club)	2004	Spring	Excellent	Good

Dissolved Oxygen

Dissolved oxygen (DO) is essential for fish and is an important component in the respiration of aerobic plants and animals, photosynthesis, oxidation-reduction processes, solubility of minerals, and decomposition of organic matter. The accumulation of organic wastes and accompanying aerobic respiration by microorganisms as they consume the wastes depletes dissolved oxygen in rivers. DO is reported in milligrams of dissolved oxygen per liter of water (which is also referred to as parts per million or ppm). The amount of oxygen an organism requires varies according to species and stage of life. DO levels below 1 or 2 ppm will not support fish. Dissolved oxygen (DO) levels below 3 ppm are stressful to most aquatic organisms. DO levels of 5 to 6 ppm are usually required for growth and activity. Low DO levels encourage the growth of anaerobic organisms and nuisance algae (which usually cause the water to smell bad and are not necessarily a good food supply for fish and other organisms). High levels of bacteria from sewage pollution and high levels of organic matter in the water can lead to low DO levels. Aquatic plants, algae, and phytoplankton produce oxygen as a by-product of photosynthesis. Oxygen also dissolves readily into water from the atmosphere until the water is saturated. Once dissolved in water, oxygen diffuses very slowly and distribution depends on the movement of the aerated water. DO levels naturally fluctuate throughout the day in bodies of water with extensive plant growth. DO levels rise from morning through late afternoon as a result of photosynthesis, reaching a peak in late afternoon. Photosynthesis stops at night, but plants and animals continue to respire and consume oxygen, therefore causing DO levels to fall to a low point just before dawn.

In 1999-2001 Stony Creek was rated lower in the category of dissolved oxygen (good – fair; 51-90% saturation). Prior to 1999 and after 2001 the DO levels in Stony Creek were rated excellent (91 – 100 % saturation). For the monitoring period of 1999 to 2004 the DO levels in Paint Creek were rated fair on average (51 - 70 % saturation).

Bacteria

Bacteria are microorganisms that are found everywhere. Coliform bacteria are a group of bacteria that includes a smaller group known as fecal coliforms which are found in the digestive tract of humans and other warm-blooded animals. Their presence in surface, ground or drinking water serves as an indication that pollution by sewage or wastewater may have occurred and that other harmful microorganisms may be present. Testing to detect the presence and quantity of these bacteria is routinely performed for such purposes. A species of fecal coliform known as *Escherichia coli* or *E. coli* can also be analyzed as a more definitive test for contamination. Bacterial standards for coliforms are as follows:

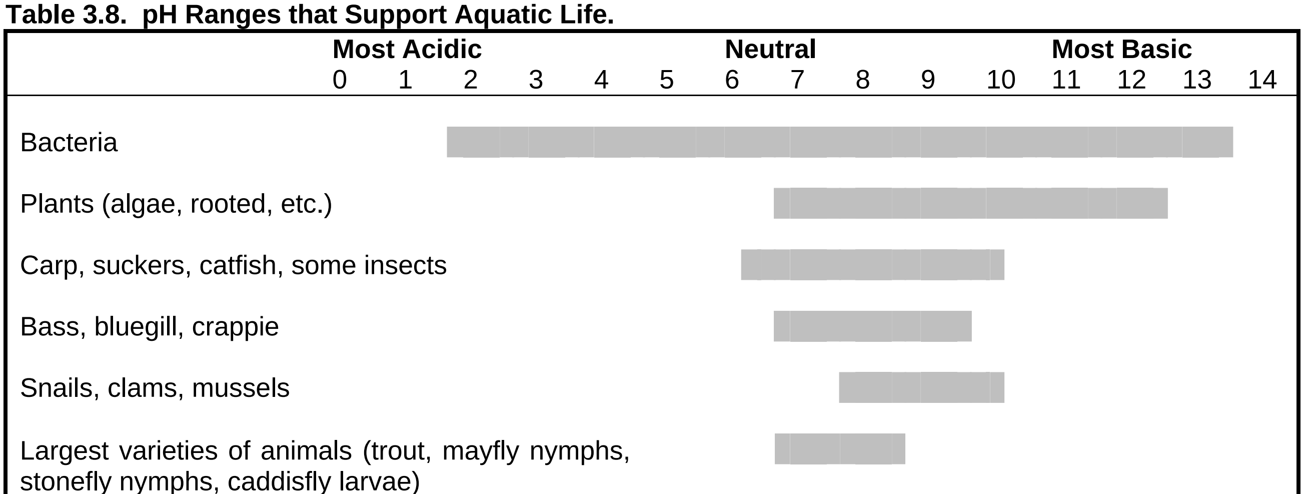
- 0 total coliforms/100 ml for drinking water
- 300 *E. coli*/100 ml (daily geometric mean) or 130 *E. coli*/100 ml (30-day geometric mean) for total body contact (swimming)
- 1000 *E. coli*/100 ml (daily geometric mean) for partial body contact (boating, etc.)
- 200 fecal coliforms/100 ml (30-day geometric mean)or 400 fecal coliforms/100 ml (discharge) for treated or untreated sewage effluent

The *Stream Leaders* program monitors fecal coliform bacteria; levels in Stony Creek remain in the good – excellent range (less than 300 colonies/100 mL). Elevated bacteria levels have been reported periodically at Stony Creek Lake by the Macomb County Health Department. In Paint Creek, the fecal coliform bacteria levels remain in the good range.

pH

pH is a measure of the hydrogen ion activity in a solution, and is important in determining the chemical speciation and solubility of various substances as well as regulating biological processes in rivers. pH is measured on a scale of 0 - 14, with zero indicating acid and 14 indicating base. Pure deionized water is 7 and is considered neutral. Most organisms have adapted to life in water with a specific pH and may die if the pH changes even slightly (Table 3.8). At extremely high or low pH values (>9.6 or <4.5) the water becomes unsuitable for most organisms. A pH range of 6.5 to 8.2 is optimal for most organisms. Most natural waters will have pH values ranging from 5.0 to 8.5. Seawater has a pH value close to 8.0. Rapidly growing algae and vegetation can remove carbon dioxide (CO_2) from the water during photosynthesis, which can result in a significant increase in pH levels. Low pH can cause heavy metals to become more mobile and be released into the water. Acid rain, industrial wastes, agricultural runoff, dredging, etc. can cause fluctuations in pH levels. The pH values for Stony Creek are consistently good (within the range of 6 - 8). The pH values for Paint Creek are consistently good to excellent (within the range of 6 – 8).

Table 3.8. pH Ranges that Support Aquatic Life.



Source: Field Manual for Low Cost Water Quality Monitoring (11th Edition, William Stapp & Mark Mitchell).

Biochemical Oxygen Demand

Biochemical Oxygen Demand (BOD) is the measure of the quantity of dissolved oxygen consumed by bacteria as they break down organic wastes. The difference between the DO result and the BOD result is the amount of oxygen available to other aquatic organisms. In slow moving and polluted rivers, bacteria consume much of the available dissolved oxygen. High levels of BOD indicate increased levels of nutrients, which can result from both natural and human-induced activities. BOD is reported as milligrams of oxygen used per liter (ppm).

In 1999-2001 Stony Creek was rated lower in the category of biochemical oxygen demand (good – fair; 4-8 ppm). Prior to 1999 and after 2001 the BOD levels in Stony Creek were rated excellent (0 ppm). The BOD levels in Paint Creek were generally rated as good – excellent; 0-4 ppm. However, in 2001, one of the sampling sites was recorded as poor (>8 ppm) (Gallagher and Orion Roads).

Temperature

Water temperature directly affects many physical, biological, and chemical characteristics of a river. Temperature affects the amount of oxygen than can be dissolved in the water; the rate of photosynthesis by algae and larger aquatic plants; the metabolic rates of aquatic organisms; and the sensitivity of organisms to toxic wastes, parasites, and diseases (Table 3.9). Thermal pollution, which is the discharge of heated water from industrial operations or runoff from impervious surfaces such as roads and parking lots, increases water temperature. Removing tree cover can also lead to increases in water temperature. Changes in water temperature affect the rate of photosynthesis by aquatic plants (higher temperatures = higher rates of photosynthesis, until temperatures become so high that tissue damage or death of the plant occurs) and affects the sensitivity of organisms to toxic wastes, parasites, and disease.

The temperature difference between the upstream and downstream locations at the Stony Creek sampling site is consistently excellent (<2 ^{o}C). The temperature difference between the upstream and downstream locations at the Paint Creek sampling sites is consistently excellent (<2 ^{o}C), however, one site registered a poor rating (>10 ^{o}C) in 2001 (Gallagher and Orion Roads).

Table 3.9. Examples of Life Supported at Various Temperatures.

Temperature	Life Supported
>20° C	much plant life, warm water fish: bass, crappie, bluegill, carp, catfish
13 - 20° C	some plant life, cold water fish; salmon, trout, aquatic insects; stone fly nymphs
<13° C	mayfly nymphs, caddisfly larvae, water beetles, and water striders; cold water fish such as trout

Source: Field Manual for Low Cost Water Quality Monitoring (10th Edition, William Stapp & Mark Mitchell).

Phosphorus

Phosphorous is an essential nutrient required for plant growth that is often in short supply if left to natural availability. Phosphorus occurs in natural waters in the form of phosphates and is measured in CRWC's *Stream Leaders* as milligrams of phosphate per liter of water (ppm). Because phosphorous is often in short supply, algae and larger aquatic vascular plants rapidly take it up as phosphate. Since algae need small amounts of phosphorous to live, excess phosphorus causes accelerated algal growth, which can decrease the amount of oxygen in the water. Increasing phosphate levels by 0.03 ppm through runoff, etc. can increase plant growth and thus eutrophication. Phosphates enter waterbodies from human and animal wastes, industrial pollution, and fertilizers. The general trend in phosphorus levels in Stony Creek remains excellent (estimated at 1 ppm). The general trend in phosphorus levels in Paint Creek remains good - excellent (estimated at 2 - 1 ppm).

Nitrogen

Nitrogen is an essential nutrient required by all plants and animals for building protein. In CRWC's monitoring protocol, nitrates are combined with nitrites and measured in milligrams per liter of water (ppm). Nitrogen is very abundant in river ecosystems and is found in a number of forms including molecular nitrogen, ammonia, nitrates and nitrites. In excess, nitrogen can stimulate rapid algal and aquatic vascular plant growth, which can decrease the amount of oxygen in the water. Unpolluted waters usually have a nitrate level below 4 ppm. Nitrate levels above 10 ppm are considered unsafe for drinking water. Drinking water containing high nitrate levels can affect the ability of our blood to carry oxygen, which is especially true for infants. Nitrate levels above 2.5 - 5 ppm can lead to accelerated plant growth and eutrophication. Sources of nitrates come from decomposition of dead plants and animals, fertilizers, animal waste, and sewage. The general trend in nitrate levels in both Stony and Paint Creeks remains excellent (estimated at 0 ppm).

Turbidity

Turbidity is a measure of the relative clarity of water and should not be confused with color, since darkly colored water can be clear without being turbid. It is the result of suspended solids in the water that reduce the transmission of light. Turbidity is measured in Jackson Turbidity Units in the *Stream Leaders* program but is also often measured in Nephelometric Turbidity Units (NTU). High turbidity is the direct result of soil erosion, urban runoff, algal blooms, and bottom sediment disturbances that can be caused by boat traffic and abundant bottom feeders such as carp. Suspended solids range from clay, silt and plankton to industrial wastes and sewage. When water has a high turbidity it loses its ability to support a diversity of aquatic organisms. Suspended solids can clog fish gills, reduce growth rates and disease resistance, decrease photosynthesis and reduce DO levels, and prevent egg and larval development. Turbid water absorbs heat from the sun, resulting in less oxygen in the water, and warmer water holds less oxygen then cooler water. Settled particles can accumulate on the stream bottom and smother fish eggs and aquatic insects, suffocate newly-hatched insect larvae and make river bottom micro-habitats unsuitable for mayfly nymphs, stonefly nymphs, caddisfly larvae and other benthic macroinvertebrates.

In 1999-2001 Stony Creek was rated lower in the category of turbidity (good – fair; >0 - <100 JTU). Prior to 1999 and after 2001 the turbidity levels in Stony Creek were rated excellent (0 JTU). The changes observed from 1999-2001 to the quality of water in Stony Creek at Van Hoosen Farm could be a result of construction runoff from a residential site just upstream of the sampling location. Students from Hart Middle School observed degradation in Stony Creek and reported violations of soil erosion control requirements to state and local officials, which resulted in a stop work order until the appropriate soil erosion barriers were properly installed. The resulting improvement in DO, BOD, and turbidity are indicators of the stream's natural ability to recover from short-term degradation. The turbidity levels in Paint Creek were generally rated as good – excellent (0 – 40 JTU). In 2003 – 2004, three sites rated as fair (40 – 100 JTU).

3.3.2 Biological Community

Analysis of the macroinvertebrate community (aquatic insects and other invertebrates that are visible to the naked eye) is an excellent way to assess the long-term health of a creek. Because these organisms do not generally travel great distances, they cannot avoid pollution by moving to other areas. In addition, certain groups of macroinvertebrates are more sensitive to water quality impairments than others. The presence or absence, abundance, and diversity of species can thus serve as an excellent indicator of water quality. Observing the change in abundance and diversity of species over time can help to identify long-term changes in water quality.

In a high-quality, unpolluted stream, a variety of species is observed, with no one group of macroinvertebrates dominating the community. Both pollution-sensitive and pollution-tolerant species are found in a natural, healthy stream. In very high-quality streams, sensitive insects such as stoneflies, mayflies, and caddisflies will be found in good numbers. In a degraded or polluted stream, however, few of these pollution-sensitive species will be observed. Instead, there will be a large number of pollution-tolerant species (typically air-breathing organisms such as worms and midges). Macroinvertebrates found in a particular stream reach can be sorted into categories according to their pollution sensitivity. A formula that incorporates both the diversity of species and abundance of each species is then applied to achieve an overall quality rating for the site.

The *Stream Leaders* program for Stony Creek includes macroinvertebrate analysis and the summary data are included in Table 3.7a and Table 3.7b above. These data are not quality assured, they are limited to two sites at the lower end of the subwatershed, and they are subject to greater subjectivity than the water chemistry results. Because of these limitations, CRWC contracted with TAI to conduct a macroinvertebrate survey at ten sites in the Stony Creek subwatershed.

Macroinvertebrate Survey Methods

Tilton & Associates, Inc. (TAI) staff collected macroinvertebrates at the ten QAPP sites for Stony Creek (Figure 3.7) in the spring of 2003. The collection process utilized dip nets and hand-picking of larger substrates such as wood and boulders. Samples were placed in sorting trays and macroinvertebrates were removed and preserved in 99% ethyl alcohol preservative. Macroinvertebrates were sorted in the lab by phylogenetic order, and the Instream Survey Data Sheet from the MDEQ *Stream Crossing Watershed Survey Procedure* was completed for each of the ten sites.

TAI staff also collected unionid (freshwater) mussels, if present, during the macroinvertebrate survey. Occasionally fish were caught in the dip nets; in these instances the species were recorded and released. A seine was used to intentionally collect fish from gravel/cobble riffles at two sites (QAPP3 and QAPP4). Fish captured were recorded and released. Fish species observed, but not captured, were recorded if the species could be determined from visual observation.

Paint Creek macroinvertebrate data was collected by the CRWC volunteer program at 6 of the eight sites while the other two were collected by Environmental Consulting & Technology, Inc (ECT) staff during 2004(Figure 3.7). ECT followed the same MDEQ *Stream Crossing Watershed Survey Procedure* in the Paint Creek as was conducted in the Stony Creek. Samples were placed in sorting trays and macroinvertebrates were removed and preserved in 99% ethyl alcohol preservative. Macroinvertebrates were sorted in the lab by phylogenetic order, and the Instream Survey Data Sheet from the MDEQ *Stream Crossing Watershed Survey Procedure.* The volunteers followed similar procedures in identifying macroinvertebrates and scoring the results.

Macroinvertebrate Survey Results

The results of the macroinvertebrate survey for Stony Creek are detailed in Table 3.10a. Five of the ten QAPP sampling sites scored in the “Excellent” range (sites 1, 4, 7, 8, 10). An additional site at Brewer Road (site 000) was also surveyed and scored in the “Excellent” range. Of the other five sites, two scored in the “Good” range (sites 3 & 6), one in the “Fair” range (site 5), and two in the “Poor” range (sites 2 & 9).

Sites 2 and 9 scored poorly due to low abundance, low diversity, and lack of caddisflies, mayflies, and stoneflies. Site 2 is a channelized reach with a silty bed and site 9 is downstream of Stony Creek Lake. Although the physical habitat at site 9 is good, silt appears to be a problem. There is a surprising lack of filtering caddisflies (hydrosychids) on boulders and large woody debris at this site. Caddisflies of this family are typically abundant below impoundments. Site 5 scored in the fair range, but only five points higher than sites 2 and 9. Site 5 scored poorly due to a silty bed and low flow. On the sampling date, the site resembled more lentic (pond/lake) conditions because high winds were driving water from Stony Creek Lake into the drain. The presence of adult beetles (Coleoptera) and true bugs (Hemiptera) at site 5 elevated the score above the “Poor” range, but these species are typical of lentic habitat. The fish species captured at site 5 were also more typical of lentic habitats (bluegill, yellow perch, spottail shiner). Better stream habitat was observed approximately 300 feet upstream of the crossing; however, the survey was limited to 100 feet upstream and downstream of the crossings.

Site 3 scored in the “Good” range due to the absence of stoneflies, craneflies, damselflies, and dragonflies. Nonetheless, site 3 contained good physical habitat and scored in the upper end of the “Good” range. While also scoring in the “Good” range, site 6 scored much lower than site 3 due to the absence of hellgrammites and gilled snails, lower abundance of caddisflies and mayflies, and presence of more tolerant taxa. The macroinvertebrate community at site 6 was dominated by scuds, which were very abundant in every habitat sampled at the site. Excessive sand bed load could be contributing to the lower scores at site 6.

Table 3.10a. Macroinvertebrate Survey Results for Stony Creek.

Site	Branch	Location	Number of Sensitive Taxa (Score)	Number of Moderately Sensitive Taxa (Score)	NumBer of Tolerant Taxa (Score)	Total Stream Quality Score	Qualitative Ranking
000	Main	Brewer east of Townsend	5 (25.3)	4 (18.2)	5 (5.4)	48.9	Excellent
1	Main	Brewer west of Townsend	7 (35.3)	6 (18)	2 (2.1)	55.4	Excellent
2	Main	Rochester south of Brewer	1 (5)	3 (9)	2 (2.2)	16.2	Poor
3	Main	31 Mile east of Mt. Vernon	6 (30.6)	3 (9)	1 (1)	40.6	Good
4	Main	Inwood east of Mt. Vernon	6 (30.6)	5 (15)	4 (4.3)	49.9	Excellent
5	Main	Stony Creek Metropark Road east of county line	2 (10)	3 (9)	2 (2.2)	21.2	Fair
6	Main	Stony Creek Metropark Road west of Mt. Vernon	4 (20)	4 (12.2)	2 (3.2)	34.3	Good
7	West	Harmon in Bald Mountain Recreation Area	6 (30.6)	6 (18.2)	4 (4.2)	53.0	Excellent
8	West	Stony Creek Metropark Road northeast of Winter Cove	7 (35.3)	6 (18)	1 (1.1)	54.4	Excellent

Site	Branch	Location	Number of Sensitive Taxa (Score)	Number of Moderately Sensitive Taxa (Score)	NumBer of Tolerant Taxa (Score)	Total Stream Quality Score	Qualitative Ranking
9	Main	USGS station at Mt. Vernon Ct.	2 (10)	1 (3)	3 (3.2)	16.2	Poor
10	Main	Parkdale east of Romeo	6 (30.6)	5 (15)	4 (4.3)	49.9	Excellent

Through the efforts of the Clinton River Watershed Council and ECT macroinvertebrate communities have been assessed at nine sites throughout the Paint Creek subwatershed. *The MDEQ Stream Crossing Watershed Survey Procedure* results in a "Stream Quality Score" (SQS) and ranking. Multiple assessments have been conducted at some sites between 1999 and fall of 2004. Table 3.10b presents summary statistics for individual Paint Creek sites where samples were taken (includes assessment data collected between 1999 and fall 2004). Table 3.11 summarizes all of the monitoring by site. The number of events, mean, minimum and maximum scores are presented.

Table 3.10b Macroinvertebrate Survey Results for Paint Creek

Site ID	Stream	Collector	Location Description	Collection Date	Stream Quality Score	Rank
PC05	Paint Creek	Kingsbury School	Clarkston Rd/Kern (Bald Mtn. State Rec Area)	09/18/00	33	Fair
PC05	Paint Creek	Kingsbury School	Kern and Clarkston roads	10/01/01	24	Fair
PC05	Paint Creek	CRCC	Kern and Clarkston	5/2/2003	23	Fair
PC05	Paint Creek	Kingsbury School	Clarkston Rd/Kern (Bald Mtn. State Rec Area)	10/02/03	12	Poor
PC05	Paint Creek	Kingsbury School	Clarkston Rd/Kern (Bald Mtn. State Rec Area)	09/20/04	20	Fair
PC05	Paint Creek	CRCC	Kern and Clarkston	10/01/04	18	Poor
PC03	Paint Creek	CRCC	Dutton Road	spring 03	34	Good
PC03	Paint Creek	CRCC	Dutton Road	10/01/04	30	Fair
PC02/DH	Paint Creek	CRCC	Dinosaur Hill	spring 03	31	Fair
PC02/DH	Paint Creek	CRCC	Dinosaur Hill	10/01/04	17	Poor
PC07	Paint Creek	Scripps Middle	Stanton Lake Road (Paint Creek	05/17/04	51	Excel

Site ID	Stream	Collector	Location Description	Collection Date	Stream Quality Score	Rank
		School	Country Club)			
PC07	Paint Creek	ECT	Stanton/Newman	10/01/04	30	Fair
PC08	Paint Creek	ECT	Baldwin/Stanton	10/01/04	22	Fair
PC06	Paint Creek	Oakview Middle School	Anderson Street (Meek's Park)	10/01/03	10	Poor
PC06	Paint Creek	Oakview Middle School	Anderson Street (Meek's Park)	10/01/03	26	Fair
PC06	Paint Creek	Scripps Middle School	Anderson Street (Meek's Park)	05/13/04	36	Good
PC06	Paint Creek	Oakview Middle School	Anderson Street (Meek's Park)	10/06/04	14	Poor
PC01	Paint Creek	St. John Lutheran School	Rochester Rd/University (Rochester Park)	09/29/99	29	Fair
PC01	Paint Creek	St. John Lutheran School	Rochester Rd/University (Rochester Park)	05/03/00	39	Good
PC01	Paint Creek	Lincoln Middle School	Rochester Rd/University (Rochester Park)	09/29/00	43	Good
PC01	Paint Creek	Lincoln Middle School	Rochester Rd/University (Rochester Park)	09/29/03	36	Good
PC04/GO	Paint Creek	Rochester Adams High School	Gallagher/Orion (Paint Creek Cider Mill)	09/27/00	32	Fair
PC04/GO	Paint Creek	Rochester Adams High School	Gallagher and Orion Roads	10/03/01	23	Fair
BD	Sargent Crk	Van Hoosen Middle School	Brewster/Dutton	09/28/00	29	Fair
BD	Sargent Crk	Van Hoosen Middle School	Brewster/Dutton	10/15/03	24	Fair
BD	Sargent Crk	Van Hoosen Middle School	Brewster/Dutton - Georgetown Sub	05/13/04	36	Good

Table 3.11 summarizes the macroinvertebrate monitoring by site results. Overall, the Paint Creek demonstrates fair to good macroinvertebrate community health. In 2004, none of the 9 sites received a good ranking.

Table 3.11 Macroinvertebrate Summary Stream Quality Scores.

SITE	COUNT	MEAN	Rank	MIN	MAX
PC01	4	37	Good	29	43
PC03	2	32	Fair	30	34
PC05	6	22	Fair	12	33
PC06	4	22	Fair	10	36
PC07	2	41	Good	30	51
PC02/DH	2	24	Fair	17	31
PC04G/O	2	28	Fair	10	32
B/D	3	30	Fair	24	36
ALL	24	28	29	10	51

Table 3.12 summarizes by monitoring time period rather than by site. From the 1999-2001 monitoring period to the 2003 monitoring period the mean score decreased slightly from 33 to 25. However, scores increased slightly from 2003 to 2004 to a score of 27. This demonstrates that despite a dip in score before 2003 a rise was noted again in 2004.

Table 3.12 Summary Stream Quality for Paint Creek Sites by Year.

PERIOD	COUNT	MEAN	MEDIAN	MIN	MAX
99-01 ALL SITES	8	33	31	23	43
2003 ALL SITES	8	25	26	10	36
2004 ALL SITES	10	27	26	14	51

Fish Community

Paint Creek below Lake Orion to the confluence with the Clinton River is a cold water tributary that is designated trout stream. Sampling by MDNR in 2001 found mottled sculpins, creek chubs, white suckers, and brown trout as the predominant species. Brown trout reproduce in Paint Creek but are supplemented with an annual stocking by MDNR, Fisheries Division. From 1997-2000, the total brown trout population estimate in Paint Creek ranged from 80-180 trout/acre or 170 to 393 trout per mile (Braunscheidel 2002). In 1992, Thomas (1993) calculated a population estimate of 5 to 68 legal-sized (8 inches and larger) brown trout per mile. Juvenile rainbow trout were also caught in Paint Creek and are the result of natural reproduction from steelhead that migrate up the Clinton River from Lake St. Clair and above Yates Dam to spawn in Paint Creek (MDNR Clinton River Assessment Final Draft, December 2004, Revision 1, James T. Francis and Robert C. Haas).

The West Branch of Stony Creek outlets into Stony Creek Impoundment and was sampled at two locations in 2001. This is a small stream (average 9 feet wide) with good gravel and cobble bottom throughout. Species richness was good, ranging from 12-19 species between the two sites, with creek chubs, white sucker rainbow darter, and common shiner the most common species present. Some sensitive species were present at each location, but their abundance was low. Over 70% of the total catch was composed of species that are considered pollution tolerant. Both sites fell into the acceptable category under Procedure 51 (MDNR Clinton River Assessment Final Draft, December 2004, Revision 1, James T. Francis and Robert C. Haas).

Stony Creek originates from Lakeville Lake and is impounded at the lower end to form Stony Creek Impoundment. Stony Creek is a good quality stream that was managed for trout from 1987-1991. Sampling did not take place in the 2001-2002 survey, but occurred most recently in the late 1980's. Pumpkinseed sunfish, common shiners, hornyhead chubs and creek chubs were found to be the most common species. However, a variety of species indicative of high water quality including American brook lamprey, northern brook lamprey, and rainbow darters were present (MDNR Clinton River Assessment Final Draft, December 2004, Revision 1, James T. Francis and Robert C. Haas).

Darters are members of the family *Percidae* (perches), which are important indicators of biological integrity. Most darters use gravel and cobble riffles for feeding and spawning habitat and require coldwater conditions. They are sensitive to urban storm water impacts because of their spawning behavior. Most darter species bury their eggs in gravel depressions or under cobbles and provide no parental care. This behavior is known as lithophilic spawning. Eggs deposited in gravels or under cobbles are susceptible to being smothered by sediments. In general, the presence of darters in suitable habitat is an indicator of good water and habitat quality; the opposite is also true.

Fantail, Iowa, greenside, and rainbow darters were all captured in Stony Creek. The sensitive rainbow darter was captured at sites 1 and 4; both sites scored in the "Excellent" range. Rainbow darters may have been present at the other "Excellent" sites, but were not observed or captured. At least two darter species were captured at all of the "Excellent" sites except for site 7 where no darters were captured (but good habitat was observed). Of the two "Good" sites, 3 and 6, one darter species was captured at site 6. Although no darters were captured at site 3, despite intentional riffle seining, habitat at the site was considered quite good for aquatic organisms in general. Darters may be absent or in low abundance at site 3 due to the fact that the habitat conditions are not ideal for darters (large cobbles and fast flows). Furthermore, the riffle habitat was difficult to seine. Darters were not captured at the "Fair" or "Poor" scoring sites.

Fisheries Stocking Records

Both Stony Creek and Paint Creek maintain a coldwater fisheries designation. However, Stony Creek is not currently stocked or managed as a "blue-ribbon" coldwater trout stream. The Michigan Department of Natural Resources (MDNR) maintains records of the stocking history in Stony/Paint Creek (available online at www.michigandnr.com/fish/fishstock.asp) (Table 3.13a and Table 3.13b). MDNR stocking in Stony Creek was stopped in 1991 due to lack of public access, overall poor survival and recruitment, and the availability of better steams with better public access in the Clinton River watershed.

Table 3.13a. MDNR Fisheries Division Stocking History in Stony Creek, 1982-1991.

Stony Creek Site	Species	Date	Quantity
DEQUINDRE ROAD	Brown trout (*Harrietta)*	4/19/1982	450
INWOOD ROAD	Brown trout (*Harrietta)*	4/19/1982	450
31 MILE ROAD	Brown trout (*Harrietta)*	4/19/1982	450
DEQUINDRE ROAD	Brown trout (*Harrietta)*	4/6/1983	1000
31 MILE ROAD	Brown trout (*Harrietta)*	4/6/1983	1000
INWOOD ROAD	Brown trout (*Harrietta)*	4/6/1983	1000
31 MILE ROAD	Brown trout (*Harrietta)*	4/16/1984	1000
INWOOD ROAD	Brown trout (*Harrietta)*	4/16/1984	1000
DEQUINDRE ROAD	Brown trout (*Harrietta)*	4/19/1984	1000

Stony Creek Site	Species	Date	Quantity
DEQUINDRE ROAD	Brown trout (*Harrietta)*	5/22/1985	530
INWOOD ROAD	Brown trout (*Harrietta)*	5/22/1985	530
31 MILE ROAD	Brown trout (*Harrietta)*	5/22/1985	530
DEQUINDRE ROAD	Brown trout (*Plymouth Rock)*	12/2/1986	1500
31 MILE ROAD	Brown trout (*Plymouth Rock)*	12/2/1986	1500
INWOOD ROAD	Brown trout (*Plymouth Rock)*	12/2/1986	1500
STONY CREEK	Brown trout (*Plymouth Rock)*	12/2/1986	1500
DEQUINDRE ROAD	Brown trout (*Plymouth Rock)*	4/30/1987	620
31 MILE ROAD	Brown trout (*Plymouth Rock)*	4/30/1987	620
INWOOD ROAD	Brown trout (*Plymouth Rock)*	4/30/1987	620
STONY CREEK	Brown trout (*Plymouth Rock)*	4/30/1987	620
DEQUINDRE ROAD	Brown trout (*Soda Lake)*	4/28/1988	800
31 MILE ROAD	Brown trout (*Soda Lake)*	4/28/1988	800
INWOOD ROAD	Brown trout (*Soda Lake)*	4/28/1988	800
STONY CREEK	Brown trout (*Soda Lake)*	4/28/1988	800
STONY CREEK	Brown trout (*Soda Lake)*	4/19/1989	800
DEQUINDRE ROAD	Brown trout (*Plymouth Rock)*	4/27/1989	800
31 MILE ROAD	Brown trout (*Plymouth Rock)*	4/27/1989	800
INWOOD ROAD	Brown trout (*Plymouth Rock)*	4/27/1989	800
STONY CREEK	Walleye (*Muskegon)*	7/12/1989	2301
DEQUINDRE ROAD	Brown trout (*Soda Lake)*	5/7/1990	800
31 MILE ROAD	Brown trout (*Soda Lake)*	5/7/1990	800
INWOOD ROAD	Brown trout (*Soda Lake)*	5/7/1990	800
STONY CREEK	Brown trout (*Soda Lake)*	5/7/1990	800
STONY CREEK	Brown trout (*Soda Lake)*	5/8/1991	870
DEQUINDRE ROAD	Brown trout (*Seeforellen)*	5/30/1991	711
31 MILE ROAD	Brown trout (*Seeforellen)*	5/30/1991	711
INWOOD ROAD	Brown trout (*Seeforellen)*	5/30/1991	711

Table 3.13b. MDNR Fisheries Division Stocking History in Paint Creek, 1979-2005.

Paint Creek Site	Species	Date	Quantity
DUTTON ROAD	Brown trout	3/19/1979	2000
CLARKSTON/KERN	Brown trout	3/19/1979	5000
DUTTON ROAD	Brown trout	4/7/1980	2000
CLARKSTON/KERN	Brown trout	4/7/1980	5000
CLARKSTON/KERN	Brown trout (*Harrietta*)	3/31/1981	500
ADAMS ROAD	Brown trout (*Harrietta*)	3/31/1981	500
GUNN ROAD	Brown trout (*Harrietta*)	3/31/1981	500
GALLAGHER ROAD	Brown trout (*Harrietta*)	3/31/1981	500
SILVERBELL ROAD	Brown trout (*Harrietta*)	3/31/1981	500
DUTTON ROAD	Brown trout (*Harrietta*)	3/31/1981	500
TIENKEN ROAD	Brown trout (*Harrietta*)	3/31/1981	500
CLARKSTON/KERN	Brown trout (*Harrietta*)	4/13/1982	850
ADAMS ROAD	Brown trout (*Harrietta*)	4/13/1982	850
DUTTON ROAD	Brown trout (*Harrietta*)	4/13/1982	850

Paint Creek Site	**Species**	**Date**	**Quantity**
GALLAGHER ROAD	Brown trout (*Harrietta*)	4/13/1982	850
GUNN ROAD	Brown trout (*Harrietta*)	4/13/1982	850
SILVERBELL ROAD	Brown trout (*Harrietta*)	4/13/1982	850
TIENKEN ROAD	Brown trout (*Harrietta*)	4/13/1982	850
CLARKSTON/KERN	Brown trout (*Harrietta*)	5/9/1983	1000
ADAMS ROAD	Brown trout (*Harrietta*)	5/9/1983	1000
GUNN ROAD	Brown trout (*Harrietta*)	5/9/1983	1000
GALLAGHER ROAD	Brown trout (*Harrietta*)	5/9/1983	1000
SILVERBELL ROAD	Brown trout (*Harrietta*)	5/9/1983	1000
DUTTON ROAD	Brown trout (*Harrietta*)	5/9/1983	1000
TIENKEN ROAD	Brown trout (*Harrietta*)	5/9/1983	1000
GALLAGHER ROAD	Brown trout (*Harrietta*)	4/16/1984	1000
SILVERBELL ROAD	Brown trout (*Harrietta*)	4/16/1984	1000
DUTTON ROAD	Brown trout (*Harrietta*)	4/16/1984	1000
TIENKEN ROAD	Brown trout (*Harrietta*)	4/16/1984	1000
CLARKSTON/KERN	Brown trout (*Harrietta*)	4/19/1984	1000
ADAMS ROAD	Brown trout (*Harrietta*)	4/19/1984	1000
GUNN ROAD	Brown trout (*Harrietta*)	4/19/1984	1000
CLARKSTON/KERN	Brown trout (*Plymouth Rock*)	9/26/1984	1650
ADAMS	Brown trout (*Plymouth Rock*)	9/26/1984	1650
GUNN	Brown trout (*Plymouth Rock*)	9/26/1984	1650
GALLAGHER	Brown trout (*Plymouth Rock*)	9/26/1984	1650
SIVERBELL	Brown trout (*Plymouth Rock*)	9/26/1984	1650
DUTTON ROAD	Brown trout (*Plymouth Rock*)	9/26/1984	1650
TIENKEN ROAD	Brown trout (*Plymouth Rock*)	9/26/1984	1600
PAINT CREEK	Brown trout (*Plymouth Rock*)	9/26/1984	2000
CLARKSTON/KERN	Brown trout (*Harrietta*)	4/15/1985	520
ADAMS	Brown trout (*Harrietta*)	4/15/1985	520
DUTTON	Brown trout (*Harrietta*)	4/15/1985	520
GALLAGHER	Brown trout (*Harrietta*)	4/15/1985	520
GUNN	Brown trout (*Harrietta*)	4/15/1985	520
SILVERBELL	Brown trout (*Harrietta*)	4/15/1985	520
TIENKEN ROAD	Brown trout (*Harrietta*)	4/15/1985	520
GALLAGHER ROAD	Brown trout	4/9/1986	50
SILVERBELL ROAD	Brown trout	4/9/1986	50
DUTTON ROAD	Brown trout	4/9/1986	50
TIENKEN ROAD	Brown trout	4/9/1986	50
GALLAGHER ROAD	Rainbow trout	4/9/1986	50
SILVERBELL ROAD	Rainbow trout	4/9/1986	50
DUTTON ROAD	Rainbow trout	4/9/1986	50
TIENKEN ROAD	Rainbow trout	4/9/1986	50
CLARKSTON/KERN	Brown trout (*Soda Lake)*	5/15/1986	580
ADAMS ROAD	Brown trout (*Soda Lake)*	5/15/1986	580
GUNN ROAD	Brown trout (*Soda Lake)*	5/15/1986	580
GALLAGHER ROAD	Brown trout (*Soda Lake)*	5/15/1986	580

Paint Creek Site	Species	Date	Quantity
SILVERBELL ROAD	Brown trout (*Soda Lake)*	5/15/1986	580
DUTTON ROAD	Brown trout (*Soda Lake)*	5/15/1986	580
TIENKEN ROAD	Brown trout (*Soda Lake)*	5/15/1986	580
CLARKSTON/KERN	Brown trout (*Plymouth Rock*)	4/30/1987	800
ADAMS ROAD	Brown trout (*Plymouth Rock*)	4/30/1987	800
DUTTON ROAD	Rainbow trout (*Redband)*	6/3/1987	1400
GALLAGHER ROAD	Rainbow trout (*Redband)*	6/3/1987	1400
GUNN ROAD	Rainbow trout (*Redband)*	6/3/1987	1400
SILVERBELL ROAD	Rainbow trout (*Redband)*	6/3/1987	1400
TIENKEN ROAD	Rainbow trout (*Redband)*	6/3/1987	1400
CLARKSTON/KERN	Brown trout (*Soda Lake)*	4/26/1988	800
ADAMS ROAD	Brown trout (*Soda Lake)*	4/26/1988	800
GUNN ROAD	Brown trout (*Soda Lake)*	4/26/1988	800
GALLAGHER ROAD	Brown trout (*Soda Lake)*	4/26/1988	800
SILVERBELL ROAD	Brown trout (*Soda Lake)*	4/26/1988	800
TIENKEN ROAD	Brown trout (*Soda Lake)*	4/26/1988	800
DUTTON ROAD	Brown trout (*Soda Lake)*	4/26/1988	800
CLARKSTON/KERN	Brown trout (*Soda Lake)*	4/19/1989	800
ADMAS ROAD	Brown trout (*Soda Lake)*	4/19/1989	800
GUNN ROAD	Brown trout (*Soda Lake)*	4/19/1989	800
GALLAGHER ROAD	Brown trout (*Soda Lake)*	4/19/1989	800
SILVERBELL	Brown trout (*Soda Lake)*	4/19/1989	800
DUTTON ROAD	Brown trout (*Soda Lake)*	4/19/1989	800
TIENKEN ROAD	Brown trout (*Soda Lake)*	4/19/1989	800
CLARKSTON/KERN	Brown trout (*Soda Lake)*	4/30/1990	800
ADAMS ROAD	Brown trout (*Soda Lake)*	4/30/1990	800
GUNN ROAD	Brown trout (*Soda Lake)*	4/30/1990	800
GALLAGHER ROAD	Brown trout (*Soda Lake)*	4/30/1990	800
SILVERBELL ROAD	Brown trout (*Soda Lake)*	4/30/1990	800
DUTTON ROAD	Brown trout (*Soda Lake)*	4/30/1990	800
TIENKEN ROAD	Brown trout (*Soda Lake)*	4/30/1990	800
CLARKSTON ROAD	Brown trout (*Soda Lake)*	5/8/1991	870
ADAMS ROAD	Brown trout (*Soda Lake)*	5/8/1991	870
GUNN ROAD	Brown trout (*Soda Lake)*	5/8/1991	830
GALLAGHER ROAD	Brown trout (*Soda Lake)*	5/8/1991	830
SILVERBELL ROAD	Brown trout (*Soda Lake)*	5/8/1991	830
DUTTON ROAD	Brown trout (*Soda Lake)*	5/8/1991	830
TIENKEN ROAD	Brown trout (*Soda Lake)*	5/8/1991	830
ADAMS ROAD	Brown trout (*Wild Rose)*	4/27/1992	780
CLARKSTON/KERN	Brown trout (*Wild Rose)*	4/27/1992	780
DUTTON ROAD	Brown trout (*Wild Rose)*	4/27/1992	780
GALLAGHER ROAD	Brown trout (*Wild Rose)*	4/27/1992	780
GUNN ROAD	Brown trout (*Wild Rose)*	5/11/1992	780
SILVERBELL ROAD	Brown trout (*Wild Rose)*	5/11/1992	780
TIENKEN ROAD	Brown trout (*Wild Rose)*	5/11/1992	780

Paint Creek Site	Species	Date	Quantity
VILLAGE PARK	Brown trout (*Wild Rose)*	5/11/1992	500
SILVERBELL ROAD	Mottled sculpin	9/14/1992	84
CLARKSTON/KERN	Mottled sculpin	9/14/1992	83
SILVERBELL ROAD	Mottled sculpin	11/9/1982	172
CLARKSTON/KERN	Mottled sculpin	11/9/1982	175
VILLAGE PARK	Brown trout (*Wild Rose)*	4/5/1993	500
TIENKEN ROAD	Brown trout (*Wild Rose)*	4/5/1993	790
SILVERBELL ROAD	Brown trout (*Wild Rose)*	4/5/1993	790
GUNN ROAD	Brown trout (*Wild Rose)*	4/5/1993	790
GALLAGHER ROAD	Brown trout (*Wild Rose)*	4/5/1993	790
ADAMS ROAD	Brown trout (*Wild Rose)*	4/5/1993	790
CLARKSTON/KERN	Brown trout (*Wild Rose)*	4/5/1993	790
DUTTON ROAD	Brown trout (*Wild Rose)*	4/5/1993	790
ADAMS ROAD	Brown trout (*Wild Rose)*	4/7/1994	800
CLARKSTON/KERN	Brown trout (*Wild Rose)*	4/7/1994	800
DUTTON ROAD	Brown trout (*Wild Rose)*	4/7/1994	800
GALLAGHER ROAD	Brown trout (*Wild Rose)*	4/7/1994	800
GUNN ROAD	Brown trout (*Wild Rose)*	4/7/1994	800
SILVERBELL ROAD	Brown trout (*Wild Rose)*	4/7/1994	800
TIENKEN ROAD	Brown trout (*Wild Rose)*	4/7/1994	800
VILLAGE PARK	Brown trout (*Wild Rose)*	4/7/1994	500
VILLAGE PARK	Brown trout (*Wild Rose)*	4/25/1995	704
ROCHESTER CITY PARK	Brown trout (*Wild Rose)*	4/25/1995	1199
CLARKSTON/KERN	Brown trout (*Wild Rose)*	4/25/1995	1085
ADAMS ROAD	Brown trout (*Wild Rose)*	4/25/1995	1088
TIENKEN ROAD	Brown trout (*Wild Rose)*	4/25/1995	1088
ADAMS ROAD	Brown trout (*Wild Rose)*	4/17/1996	1130
CLARKSTON/KERN	Brown trout (*Wild Rose)*	4/17/1996	1130
TIENKEN ROAD	Brown trout (*Wild Rose)*	4/17/1996	1130
ROCHESTER CITY PARK	Brown trout (*Wild Rose)*	4/17/1996	1200
VILLAGE PARK	Brown trout (*Wild Rose)*	4/17/1996	750
ADAMS ROAD	Brown trout (*Wild Rose)*	4/22/1997	600
CLARKSTON/KERN	Brown trout (*Wild Rose)*	4/22/1997	600
TIENKEN ROAD	Brown trout (*Wild Rose)*	4/22/1997	600
ROCHESTER CITY PARK	Brown trout (*Wild Rose)*	4/22/1997	600
VILLAGE PARK	Brown trout (*Wild Rose)*	4/22/1997	400
ADAMS ROAD	Brown trout (*Gilchrist Creek)*	4/22/1997	600
CLARKSTON/KERN	Brown trout (*Gilchrist Creek)*	4/22/1997	600
TIENKEN ROAD	Brown trout (*Gilchrist Creek)*	4/22/1997	600
ROCHESTER CITY PARK	Brown trout (*Gilchrist Creek)*	4/22/1997	600
VILLAGE PARK	Brown trout (*Gilchrist Creek)*	4/22/1997	400
ADAMS ROAD	Brown trout (*Gilchrist Creek)*	4/2/1998	600

Paint Creek Site	Species	Date	Quantity
CLARKSTON/KERN	Brown trout (*Gilchrist Creek)*	4/2/1998	600
TIENKEN ROAD	Brown trout (*Gilchrist Creek)*	4/2/1998	600
ROCHESTER CITY PARK	Brown trout (*Gilchrist Creek)*	4/2/1998	600
VILLAGE PARK	Brown trout (*Gilchrist Creek)*	4/2/1998	400
ADAMS ROAD	Brown trout (*Wild Rose)*	4/2/1998	600
CLARKSTON/KERN	Brown trout (*Wild Rose)*	4/2/1998	600
TIENKEN ROAD	Brown trout (*Wild Rose)*	4/2/1998	600
ROCHESTER CITY PARK	Brown trout (*Wild Rose)*	4/2/1998	600
VILLAGE PARK	Brown trout (*Wild Rose)*	4/2/1998	400
VILLAGE PARK	Brown trout (*Wild Rose)*	4/14/1999	400
ROCHESTER CITY PARK	Brown trout (*Wild Rose)*	4/14/1999	600
CLARKSTON/KERN	Brown trout (*Wild Rose)*	4/14/1999	600
ADAMS ROAD	Brown trout (*Wild Rose)*	4/14/1999	600
TIENKEN ROAD	Brown trout (*Wild Rose)*	4/14/1999	600
VILLAGE PARK	Brown trout (*Gilchrist Creek)*	4/14/1999	400
ROCHESTER CITY PARK	Brown trout (*Gilchrist Creek)*	4/14/1999	600
CLARKSTON/KERN	Brown trout (*Gilchrist Creek)*	4/14/1999	600
ADAMS ROAD	Brown trout (*Gilchrist Creek)*	4/14/1999	600
TIENKEN ROAD	Brown trout (*Gilchrist Creek)*	4/14/1999	600
VILLAGE PARK	Brown trout (*Gilchrist Creek)*	3/27/2000	400
ROCHESTER CITY PARK	Brown trout (*Gilchrist Creek)*	3/27/2000	600
CLARKSTON/KERN	Brown trout (*Gilchrist Creek)*	3/27/2000	600
ADAMS ROAD	Brown trout (*Gilchrist Creek)*	3/27/2000	600
TIENKEN ROAD	Brown trout (*Gilchrist Creek)*	3/27/2000	600
VILLAGE PARK	Brown trout (*Wild Rose)*	3/27/2000	400
ROCHESTER CITY PARK	Brown trout (*Wild Rose)*	3/27/2000	600
CLARKSTON/KERN	Brown trout (*Wild Rose)*	3/27/2000	600
ADAMS ROAD	Brown trout (*Wild Rose)*	3/27/2000	600
TIENKEN ROAD	Brown trout (*Wild Rose)*	3/27/2000	600
CLARKSTON/KERN	Brown trout (*Gilchrist Creek)*	4/2/2001	600
ADAMS ROAD	Brown trout (*Gilchrist Creek)*	4/2/2001	600
TIENKEN ROAD	Brown trout (*Gilchrist Creek)*	4/2/2001	600
VILLAGE PARK	Brown trout (*Gilchrist Creek)*	4/2/2001	400
ROCHESTER CITY PARK	Brown trout (*Gilchrist Creek)*	4/2/2001	600
VILLAGE PARK	Brown trout (*Wild Rose)*	4/2/2001	400
ROCHESTER CITY PARK	Brown trout (*Wild Rose)*	4/2/2001	600
CLARKSTON/KERN	Brown trout (*Wild Rose)*	4/2/2001	600
ADAMS ROAD	Brown trout (*Wild Rose)*	4/2/2001	600
TIENKEN ROAD	Brown trout (*Wild Rose)*	4/2/2001	600

Paint Creek Site	Species	Date	Quantity
VILLAGE PARK	Brown trout (*Wild Rose)*	4/8/2002	400
ROCHESTER CITY PARK	Brown trout (*Wild Rose)*	4/8/2002	600
CLARKSTON/KERN	Brown trout (*Wild Rose)*	4/8/2002	600
ADAMS ROAD	Brown trout (*Wild Rose)*	4/8/2002	600
TIENKEN ROAD	Brown trout (*Wild Rose)*	4/8/2002	600
VILLAGE PARK	Brown trout (*Gilchrist Creek)*	4/8/2002	400
ROCHESTER CITY PARK	Brown trout (*Gilchrist Creek)*	4/8/2002	600
CLARKSTON/KERN	Brown trout (*Gilchrist Creek)*	4/8/2002	600
ADAMS ROAD	Brown trout (*Gilchrist Creek)*	4/8/2002	600
TIENKEN ROAD	Brown trout (*Gilchrist Creek)*	4/8/2002	600
VILLAGE PARK	Brown trout (*Wild Rose)*	4/30/2003	400
VILLAGE PARK	Brown trout (*Gilchrist Creek)*	4/30/2003	400
CLARKSTON/KERN	Brown trout (*Wild Rose)*	4/30/2003	600
CLARKSTON/KERN	Brown trout (*Gilchrist Creek)*	4/30/2003	600
ADAMS ROAD	Brown trout (*Wild Rose)*	4/30/2003	600
ADAMS ROAD	Brown trout (*Gilchrist Creek)*	4/30/2003	600
TIENKEN ROAD	Brown trout (*Wild Rose)*	4/30/2003	600
TIENKEN ROAD	Brown trout (*Gilchrist Creek)*	4/30/2003	600
ROCHESTER CITY PARK	Brown trout (*Wild Rose)*	4/30/2003	600
ROCHESTER CITY PARK	Brown trout (*Gilchrist Creek)*	4/30/2003	600
VILLAGE PARK	Brown trout (*Gilchrist Creek)*	4/29/2004	800
CLARKSTON/KERN	Brown trout (*Gilchrist Creek)*	4/29/2004	1200
ADAMS ROAD	Brown trout (*Gilchrist Creek)*	4/29/2004	1200
TIENKEN ROAD	Brown trout (*Gilchrist Creek)*	4/29/2004	1200
ROCHESTER CITY PARK	Brown trout (*Gilchrist Creek)*	4/29/2004	1200
VILLAGE PARK	Brown trout (*Gilchrist Creek)*	4/27/2005	800
CLARKSTON/KERN	Brown trout (*Gilchrist Creek)*	4/27/2005	1200
ADAMS ROAD	Brown trout (*Gilchrist Creek)*	4/27/2005	1200
TIENKEN ROAD	Brown trout (*Gilchrist Creek)*	4/27/2005	1200
ROCHESTER CITY PARK	Brown trout (*Gilchrist Creek)*	4/27/2005	1200

Freshwater Mussels

The presence of mussels is also a good indicator of water quality because they filter water as they feed and thus are sensitive to water quality impairments. Unionid mussel valves (family *Unionidae*) were collected at several sites, although this was not a focus of the survey and the species collected are not a complete representation of the Stony Creek mussel community. Mollusk valves were found at every site except site 5 and were most abundant at sites 3, 4, 8, 10, and the additional Brewer Road site east of Townsend Road (site 000). Common names of unionid mussels found in Stony Creek include the spike, giant floater, squawfoot, Wabash pigtoe, and kidneyshell. None of these mussel species is identified as endangered, threatened, or of special concern in Michigan. Sphaerid, or fingernail, clams (family *Sphaeriidae*) were also found at all of the sampling sites.

3.3.3 Physical Conditions

Instream and Riparian Survey Methods

Existing aerial and land use maps obtained from Oakland and Macomb counties were used to identify stream crossing sites. For the Stony Creek a total of 45 stream crossing sites for evaluation, 37 of which were originally surveyed by TAI staff during 2002. While 2005 updates to this subwatershed plan focus on the ten QAPP sites within Stony Creek, this section will illustrate data collected during the previous 2002 surveys. Surveys for Paint Creek were conducted during 2004/2005 at eight sites (Figure 3.8). These sites represented a combination of land use characteristics including undeveloped, agricultural, residential, and highly urbanized. The seven stream crossing sites that were not surveyed were located on private lands. These sites were identified so that future surveys may be conducted for comparison purposes; however, attention was paid to the nearest upstream and downstream sample points to note any drastic changes that may have been initiated in the private areas.

ECT used the Michigan Department of Environmental Quality's *Single Site Watershed Survey Data Sheet* to conduct the site surveys. This is a less intense, more general survey method than the GLEAS-51 procedure used in the 1997 aquatic habitat survey. The intent of the *Single Site Watershed Survey* procedure is to acquire a quick screening of land use, stream characteristics, and riparian corridor conditions at the individual road/stream crossings. The data sheet includes information about physical appearance, substrate, instream cover, river morphology, stream corridor, adjacent land uses, and potential sources of non-point source pollution. Two data sheets were completed for each site, one evaluating the upstream conditions and one for the downstream conditions.

The data from the previous surveys of Stony Creek in 2002 and surveys conducted for Paint Creek in 2005 utilized a scoring method to understand how the sites rank against each other. The data was tabulated and points were assigned to various categories in the survey. A total score was achieved for the Physical Characteristics. Points were awarded depending on width of the stream riparian vegetation buffer and type of vegetation, such as lawn, wetland or forest, along with the diversity of instream cover and substrate. Points were deducted for negative appearance factors such as turbidity or floating algae and if the adjacent land uses consisted of impervious or disturbed ground. Points were also deducted for any potential pollution source recorded based on low, moderate or high severity. Potential sources included but were not limited to urban runoff, site development construction activities and road runoff. The following information describes the data that were collected during the Road Stream Crossing Survey along with the associated points that were allocated based on these data:

Stream Width and Depth and Highest H_2O Mark: Stream depth indicates the average depth over the area observed while the highest watermark is determined from the bridge/culvert crossings. This gives a relative indication of flow variability within the stream.   These data were reviewed from an overall relative perspective and not included in the total scoring of this category due to the fact that more detailed information have been studied and are described in Section 3.3.5 Dry and Wet Weather Flow Conditions.

Stream Flow Type: This describes the general volume of flow in relation to an overall annual average. The various types include Dry, Stagnant, Low, Medium, or High. Dry refers to no standing or flowing water and bottom sediments may be wet. Stagnant refers to water present, but not flowing. Low, Medium and High categories reflect the flow in relation to the average for the stream.

Substrate: This is the material that makes up the bottom of the stream and is a general indication of potential aquatic habitat. This information was compared to the macroinvertebrate results for consistency. This category was included in the overall ranking of the Physical Characteristics. Table 3.14 describes the categories and the ranking methodology are described as follows:

Table 3.14. Road Stream Crossing Substrate Points

Substrate Type	Points Assigned
>50% Boulders	3
>50% Cobble/Gravel	2
>50% Sand	1
>50% Artificial/Clay/Fine Grain	0

River Morphology: This describes the presence of pools and riffles and which gives an indication of potential aquatic habitat. Table 3.15 describes the points were assigned as follows:

Table 3.15. Road Stream Crossing Morphology Points

Morphology Type	Present/Abundant	Points Assigned
Pools	Present	1
	Abundant	2
Riffles	Present	1
	Abundant	2

Instream Cover: This describes the type of cover available for various aquatic habitat species. One point was assigned to each of the following categories if it was observed to be present during the survey:

Undercut banks, overhanging vegetation, deep pools, boulders, aquatic plants and logs or woody debris.

Stream Corridor: This describes the condition, buffer widths, vegetation types and stream canopy of the riparian corridor. Table 3.16 describes the points, which were assigned to each characteristic in this category:

Table 3.16. Road Stream Crossing Stream Corridor Points

Stream Corridor Characteristic	Points Assigned
Riparian Vegetation Width Left	
<10 feet	1
10-30 feet	2
30-100 feet	3
>100 feet	4
Riparian Vegetation Width Right	
<10 feet	1
10-30 feet	2

Stream Corridor Characteristic	Points Assigned
30-100 feet	3
>100 feet	4
Bank Erosion	
No Erosion	3
Low Relative Erosion	2
Moderate Relative Bank Erosion	1
High Relative Bank Erosion	0
Streamside Land Cover	
Bare	0
Grass	1
Shrubs	2
Trees	3
Stream Canopy (%)	
<25%	1
25-50%	2
>50%	3

Physical Appearance: This category identifies various characteristics observed in the stream, a list of which is provided in Table 3.17. One point was deducted if the characteristic was obviously "*present*" while 2 points were deducted from the total score if the characteristic was "*abundant*".

Table 3.17. Road Stream Crossing Physical Appearance Categories.

Aquatic Plants	plants roots/stems/leaves
Floating Algae	suspended algae or floating algae (not observed in fall timeframe)
Filamentous Algae	algae that appear in stringy/ropy strands
Bacterial Sheen/Slimes	Oily sheens from bacterial decomposition; distinguished from petroleum products by breaking into distinct platelets when disturbed.
Turbidity	Water appears cloudy
Oil Sheen	Caused by petroleum products; thin sheen has rainbow of hues
Foam	Natural foam typical in streams when water flows thru rapids or past surface obstructions; distinguished from soapsuds by rubbing it between fingers. If it disintegrates and leaves wet or gritty residue, then it is naturally occurring. If it is slippery/soapy, then it is not natural foam.
Trash	General litter.

Potential Pollution Sources: Adjacent land use types are also noted at each of the selected sites. This observation provides a relative understanding of the types and extent of pollutant loadings entering the river near the site. Finally, points were deducted for the presence of various Potential Pollutant Sources. Pollutant Potential was scored on a Slight, Moderate or High scale. To convert to a point system a Slight score received 1 point, a Moderate score received 2 points and a High score received 3 points. Table 3.18 provides the list of Potential Sources to select from.

Table 3.18 Potential Pollution Source List

POTENTIAL SOURCES	
Crop Related Sources	Land Disposal
Grazing Related Sources	On-site Wastewater Systems
Intensive Animal Feeding Operations	Silviculture (Forestry NPS)
Highway/Road/Bridge Maintenance and Runoff	Resource Extraction (Mining NPS)
Channelization	Recreational/Tourism Activities
Dredging	• Golf Course
Removal of Riparian Vegetation	• Marinas/Recr. Boating (water releases)
Bank and Shoreline Erosion/Modification/Destruction	• Marinas/Recr. Boating (bank or shoreline erosion)
Upstream Impoundment	Debris in Water
Construction: Highway/Road/Bridge/Culvert	Industrial Point Source
Construction: Land Development	Municipal Point Source
Urban Runoff (Residential/Urban NPS)	Natural Sources
	Source(s) Unknown

Digital photographs were also taken to demonstrate the upstream and downstream conditions at each site. Global Positioning System (GPS) coordinates were determined for each site and were imported into an ArcMap Geographic Information System (GIS) for display on the current land use map. Along with each of the data sheets, ECT prepared a unique site evaluation form for each surveyed site, which graphically represent the site location, the upstream and downstream conditions, and site details.

Stony Creek Main Branch Survey Results

These sites showed signs of a healthy stream with few, isolated non-point source pollution impacted areas. The fluctuations of Stony Creek are relatively low, demonstrating that the stream has not experienced significant increases in flows due to increased development. The water clarity is excellent, and the substrate composition along the creek bed is very good. In most cases, the substrate consists of a good composition of boulders, cobble, and gravel, although soil erosion and sedimentation have impacted isolated stream segments. Although an increase in the percentage of silt substrate and water level fluctuations is observed as one travels downstream, overall good instream habitat and riparian vegetation occur along the corridor. Surrounding land uses are most notably residential, agricultural, and undeveloped areas including forested and wetland parcels.

The highest potential for non-point source pollution in the Main Branch is related to urban stormwater runoff, bank erosion, and road maintenance. Many of the primary roads have not been paved and a great deal of dirt and gravel washes into the stream channel during rain events, especially after recent road grading. Impacts in the creek from soil erosion were also observed near construction sites; however, these areas were more isolated. Excellent opportunities exist along the Main Branch of Stony Creek to maintain the riparian corridor, minimize development impacts, and establish maintenance practices that reduce non-point source pollution inputs to the stream.

Stony Creek West Branch Survey Results

As in the case of the Main Branch, the West Branch is an overall healthy stream with some isolated non-point source pollution impacts. The combination of low flow fluctuation and high water clarity, in addition to good substrate composition and riparian corridor vegetation, confirmed the higher quality stream characteristics. Soil erosion and sedimentation were more evident at the survey sites located farther downstream in the subwatershed. These impacts were demonstrated by a decline in the quality of the substrate, with an increase in the percentage of silt in the creek bed.

Surrounding land uses were observed to be more residential in the West Branch subwatershed than in the Main Branch subwatershed. At the same time, a higher percentage of riparian vegetation still exists adjacent to the stream channel. Upstream areas include higher quality wetlands adjacent to the stream, which provide a number of benefits and represent excellent preservation and stewardship opportunities.

Non-point source pollution impacts in the West Branch stem from the removal of riparian vegetation and associated increases in stormwater runoff. These impacts, along with significant algae growth, are more apparent around the headwater areas and near the lakes and impoundments. The increase in algae may be caused by runoff from residential areas combined with an increase in the use of onsite sewage disposal systems. Dirt roads and associated road maintenance are also potential sources of sedimentation throughout the West Branch subwatershed. Overall, the West Branch demonstrated a combination of high quality stream characteristics and isolated impacted areas.

Comparison to 1997 Conditions

The 16 sites inventoried in CRWC's 1997 aquatic habitat survey coincide with 14 of the sites surveyed in 2002 (Table 3.19). Although the survey methods differ, a comparison of the two assessments provides a general picture of how Stony Creek has changed over the past five years. The 1997 survey gave high scores to both the Main and West branches of Stony Creek but noted some areas of concern. Excerpted here are the summary evaluations:

<table>
<tr>
<td>Main Branch:
Of all the streams evaluated…Stony Creek contained the highest-quality bottom substrate: almost entirely cobble and gravel, even in pools. Walterhouse (1995) evaluated the creek at 33 Mile Road (in the vicinity of this study's site ST9) and rated the fish and macroinvertebrate community and the habitat as "good – slightly impaired."
The bank erosion at sites ST2, ST3, and ST5 seemed to be a result of natural processes with the stream traveling through steep banks, with frequent groundwater seeps trickling out. Input of sediment of anthropogenic origin must be avoided. Road crossings were an obvious example.
This creek was in good condition at this time but with the population growth in the surrounding area there is cause for concern.</td>
<td>West Branch:
The habitat of West Branch Stony Creek appears to be in good condition. The main impairments were deposition of fine sediments and medium embeddedness levels at five sites. Input of fine sediments could be lessened somewhat if three road crossings were improved.
Above site WB2, from Stony Creek Road to approximately 2,000 feet northwest of Rochester Road, the creek is used as an Oakland County drain. Stormwater from Gunn Road is directed down a steep embankment into the creek at site WB4, causing some gullying. This creek was shallow and might benefit from enhancement of pool habitat. A golf course upstream from site WB1 contained areas without a riparian buffer bordering the creek.</td>
</tr>
</table>

Stony Creek, from Romeo Road to Parkdale Road in the vicinity of sites ST1 and ST2, has been designated a county drain. There are large construction projects going up around this segment of the creek and the creek was seen running brown and thick with sediment after a strong rain. Stormwater from new developments must be retained on site. Preserving a creek is much easier than trying to restore it once it has been degraded.	A 1994 study which looked at one section of this creek rated habitat as excellent and reasoned that this was due to being situated in an area which has experienced less watershed disturbance (MDNR, 1995). This may change as the area is now being increasingly considered for development.

A comparison of the 1997 and 2002 survey results indicate that the stream conditions have declined somewhat in the southern reaches, which is not surprising given the increase in development in that area. CRWC staff, *Stream Leaders* participants, and residents have noted increased erosion and sedimentation resulting from poor erosion control measures and increased stormwater flows in the lower end of the creek. Two sites on the Main Branch in the more northern reaches of the subwatershed may have actually improved somewhat over the past five years, while two sites on the West Branch may have declined.

Table 3.19. Stony Creek Inventory and Results

Location	1997 Survey Site ID	2002 Survey Site ID	1997 GLEAS-51 Score	2002 Survey Summary Score
Parkdale east of Romeo	ST1	QAPP-10	Excellent	Good
Romeo west of Runyon	ST2	N/A	Good	N/A
Tienken east of Sheldon	ST3	MS-02	Excellent	I
Mead west of Winkler Mill	ST4	MS-02B	Good	Good
North of Stony Creek Lake	ST5	N/A	Good	N/A
Inwood east of Mt. Vernon	ST6	QAPP-04	Good	Good
31 Mile east of Mt. Vernon	ST7	QAPP-03	Excellent	Excellent
Romeo east of Dequindre	ST8	MS-06	Not available	Excellent
Dequindre at Brewer	ST9	MS-07	Good	Excellent
Brewer west of Townsend	ST10	QAPP-01	Good	Excellent
Clarkston west of Rochester	WB1	WS-09	Good	Fair
Rochester north of Buell	WB2	WS-07	Good	Good
Buell east of Rochester	WB3	WS-05	Good	Good
Gunn east of Sheldon	WB4	WS-02	Good	Fair
Snell east of Sheldon	WB5	WS-01	Good	Good
Stony Creek Metropark Road northeast of Winter Cove	WB6	QAPP-08	Good	Good

Stony Creek Survey Results

Of the thirty seven sites visited during the 2002 assessment the ten QAPP sites were used to calculate the results of Stony Creek. Table 3.20a depicts the QAPP sites and how their qualitative ranking.

Table 3.20a. Stony Creek Survey Qualitative Results

Site ID	Subbasin	Road Crossing	Community	Site Rank
QAPP01	SC K	Brewer west of Townsend	Addison	High
QAPP02	SC H	Rochester south of Brewer	Addison	Low
QAPP03	SC F	31 Mile east of Mt. Vernon	Washington	Moderate
QAPP04	SC B	Inwood Rd. east of Mt. Vernon	Washington	Moderate
QAPP05	SC C	SCMP Park Road east of County Line	Washington	Moderate
QAPP06	SC D	SCMP Park Rd. west of Mt. Vernon	Oakland	Moderate
QAPP07	SC J	Harmon in Bald Mtn. Rec. Area	Oakland	High
QAPP08	SC E	SCMP Park Rd.	Oakland	Low
QAPP09	SC A	USGS Station - Mt. Vernon Ct.	Washington	High
QAPP10	SC A	Parkdale east of Romeo	Rochester	Moderate

The maximum points possible was ninety-two with sites ranging from thirty-six to fifty-nine in Stony Creek. After the sites were ranked by score a relative grouping of Low, Moderate and High were assigned at natural breaks in the scoring. The highest quality sites were QAPP 01 and QAPP 09 while the lowest ranking sites were QAPP 02 and QAPP 08. These ranks were based on physical characteristics only. These data were used in the overall scoring methodology that also included macroinvertebrate survey data, bank erosion hazard index and nonpoint source pollutant loading estimates to qualitatively describe critical areas within the subwatershed. Further discussion is presented in the Section 3.3.6.

Paint Creek Survey Results

A total of 8 sites were evaluated along the Paint Creek (Table 3.20b). These sites showed signs of a relatively healthy stream with few, isolated non-point source pollution impacted areas. Most of the substrate at the individual sites is sand and muck with some of the survey sites exhibiting cobble and boulder components. The stream corridors have moderate to larger riparian buffers at most of the sites with the few exceptions being in denser residential/commercial areas. This corresponds with the fact that the bank erosion hazard potential ranked relatively consistent along the corridor.

Lower ranking sites within the Paint Creek generally occur in more dense commercial and residential areas. This may help isolate areas for potential enhancement opportunities. Paint creek has numerous opportunities for natural features preservation and enhancement along its entire corridor.

Table 3.20b. Paint Creek Survey Qualitative Results

Site ID	Subbasin	Road Crossing	Community	Site Rank
PC01	PC A	University at Paint Creek	Rochester	Low
PC02	PC B	Tienken at Paint Creek	Rochester Hills	High
PC03	PC B	Dutton at Paint Creek	Rochester Hills	Moderate
PC04	PC B	Gunn west of Orion Road	Oakland Twp	Moderate
PC05	PC E	Kern and Clarkston	Orion Twp	Moderate
PC06	PC E	Atwater at Paint Creek	Lake Orion	Low
PC07	PC J	Stanton at Paint Creek	Oxford	Low
PC08	PC L	Baldwin at Paint Creek	Oxford	High

The maximum points possible was ninety-two with sites ranging from thirty-six to fifty-nine in Paint Creek. After the sites were scored, a relative grouping of Low, Moderate and High in terms of quality were assigned at natural breaks in the scoring. The highest quality sites were PC 02 and PC 08 while the lowest ranking sites were PC 01 and PC 07. These ranks were based on physical observation characteristics only. These data were used in the overall scoring methodology that also included macroinvertebrate survey data, bank erosion hazard index and nonpoint source pollutant loading estimates to qualitatively describe critical areas within the subwatershed. Further discussion is presented in the Section 3.3.6.

3.4.4 Bank Erosion Hazard Index

The Michigan Department of Environmental Quality developed a Standard Operating Procedure for Assessing Bank Erosion Potential using Rosgen's Bank Erosion Hazard Index (BEHI). This method was utilized at each of the road stream crossings within the Stony/Paint Subwatersheds. Results of the field surveys are provided on Table 3.22. These results are compared with the other field surveys and data in order to categorize critical areas for the subwatershed. The following information highlights the information collected during the survey:

The Modified Bank Erosion Hazard Index (BEHI) is a subjective survey of existing stream bank conditions. It is used to determine the probable likelihood of streambank erosion. Both banks, upstream and downstream, are subject to the survey. There are four observational categories that are evaluated during this survey that include the following:

- Root Depth to Bank Height- This represents the average root depth to the bank height.
- Root Density – This represents the proportion of the streambank surface covered and protected by plant roots.
- Bank Angle – This is the angle of the streambank from the waterline to the top of bank.
- Surface Protection – Similar to root density, but higher ranking if stone is present.

The Bank Score relative to the BEHI Category described in Table 3.21 below indicates the potential for bank erosion to occur on one streambank. Four streambanks were assessed at each Survey Site, the right and left banks looking both upstream and downstream. A point system of zero to five points, based on the Bank Score, was established in order to tally the entire Survey Site in whole numbers.

Table 3.21. Bank Erosion Hazard Index Score

BEHI Category	Bank Score	Points Assigned at for each bank (4 at each site)
Very Low	<=5.8	5
Low	5.8 - 11.8	4
Moderate	11.9 - 19.8	3
High	19.9 - 27.8	2
Very High	27.9 - 34.0	1
Extreme	34.1 - 40	0

A total of 20 points are possible for each survey site, with 20 points representing the best possible score and minimal erosion potential. Table 3.22 depicts the overall Survey Site Score based on this point system. From these scoring results, an overall ranking was applied to each site relative to its subwatershed.

Table 3.22. Bank Erosion Hazard Index Scoring Results

Stony Creek Survey Site	QAPP 01	QAPP 02	QAPP 03	QAP P 04	QAPP 05	QAPP 06	QAPP 07	QAPP 08	QAPP 09	QAPP 10
Total Points	14	14	12	14	13	16	16	15	12	20
Paint Creek Survey Site	PC01	PC02	PC03	PC04	PC05	PC06	PC07	PC08		
Total Points	15	20	14	19	18	14	18	17		

Table 3.23 illustrates the ranking for each of the survey sites within the Stony/Paint Subwatersheds. This ranking scheme is designed to give priority to the surveyed sites on three levels. The ranking of sites with "Low" infer that the bank is relatively stable and of the best quality within the subwatershed. A ranking of "Moderate" means that the erosion potential is average within the subwatershed. While a ranking of "High" may not directly mean that the sites are of truly poor quality, they just ranked lowest within the relative ranking of the subwatershed. In fact, these rankings are consistent with the scoring descriptions of bank erosion potential described in Table 3.21.

Table 3.23. Stony and Paint Creek Bank Erosion Potential

Stony Creek Sites	BEHI Rank
QAPP 01	Moderate
QAPP 02	Moderate
QAPP 03	Low
QAPP 04	Moderate
QAPP 05	Low
QAPP 06	High
QAPP 07	High
QAPP 08	Moderate
QAPP 09	Low
QAPP 10	High

Paint Creek Sites	BEHI Rank
PC01	Low
PC02	High
PC03	Low
PC04	High
PC05	Moderate
PC06	Low
PC07	Moderate
PC08	High

3.3.5 Dry and Wet Weather Flow Conditions

The measurement of water quantity, or how much and at what rate water travels through a surface water system, is one of the measurements used to study the ecological condition of the Stony/Paint Creeks. Certain hydrologic characteristics can indicate the ecological state of a surface water system and provide a good analysis of how the land, developed or undeveloped, is interacting with the nature of the surface water system. In a natural river system, storm water is intercepted by vegetation, stored temporarily on the land in wetlands or infiltrates into groundwater, and then is slowly released into the surface water system, with only a small fraction of water entering the river via surface runoff. This hydrologic scenario will create a stable stream system. In an urban setting, a large percentage of storm water falls onto impervious surfaces and travels directly to the river through storm drains. In this urban setting, a storm event will cause the rate of surface water to increase quickly and dramatically and is referred to as “flashy”. A flashy creek or river will provide unstable habitat - low base flows and high peak flow rates - for fish and aquatic organisms. These urban creeks and rivers become degraded with high sediment loads and scoured stream banks. Measuring flow during both dry and wet weather conditions can provide an indication of current stream dynamics and provide a baseline against which to compare future flow measurements.

This section describes the various flow studies that have been conducted within the Stony/Paint Creek subwatersheds, including: a hydrologic survey of Stony Creek conduced between summer 2002 and summer 2003 by Applied Science, Inc. (ASI) and an ongoing River Watershed Geomorphology Project (ECT’s 2005 Report to Macomb County Office of Public Works) that details flow trend analyses that have been conducted deploying the data collected from several USGS gages within the Clinton River watershed.

Hydrologic Survey

A hydrologic survey of Stony Creek was conducted between summer 2002 and summer 2003 by Applied Science, Inc. (ASI) under contract with TAI. The survey consisted of measuring discharge and water surface levels at six stream crossing sites throughout the watershed – three on the Main Branch, one on the West Branch and two on other tributaries to the Main Branch (Table 3.24). Three measurements were made at each site during baseflow conditions and three measurements were made directly following a wet weather event.

The first location on the Main Branch, site 1, is located near the headwaters at Brewer Road. The second Main Branch location, site 4, is just upstream of Stony Creek Lake on Nature Park Road in Stony Creek Metropark. Site 10 is located at Parkdale Road, just upstream of the confluence with the Clinton River. The tributary sites include Site 5 on Mount Vernon Drain at Snell Road, Site 6 on McClure Drain at Stony Creek Metropark Road, and Site 8 on the West Branch at Stony Creek Metropark Road.

The first set of flow measurements were taken using a Global Flow Probe; however, the device was not accurate at velocities less than 1 foot per second and the measurements made at four sites during the summer 2002 base flow measurements are considered questionable. The remaining measurements were taken using the Marsh-McBirney FloMate 2000. Additionally, the United States Geological Survey (USGS) maintains two gauging stations on the Main Branch of Stony Creek that record continuous flow data and are available via the USGS website. The first station is located on the Main Branch at 32 Mile Road and the second station is located just downstream of Stony Creek Lake at Mount Vernon Court.

Table 3.24. Hydrologic Survey Sites on Stony Creek.

Site Number	Site Name & Location	Reference Location *(marked with orange spray paint)*	Notes
Stony Creek Survey Sites			
1	Main Branch at 33 Mile Road	Top of culvert on upstream side	Use path to culvert on upstream side of road
4	Main Branch at Nature Center Road	Chisel mark in wood bridge rail on downstream side	In Stony Creek Metropark
5	Mount Vernon Drain at Metro Park Road	Top of culvert on upstream side	Just beyond Stony Creek Park; drain inside park is backwater affected by lake
6	McClure Drain at Metro Park Road	Chisel mark in concrete wingwall on upstream side	In Stony Creek Metropark
8	West Branch at Metro Park Road	Chisel mark in concrete wingwall on upstream side	In Stony Creek Metropark
10	Main Branch at Parkdale Road	Chisel mark in east abutment of bridge on downstream side (over guardrail, partially down bank)	Park in French Associates parking lot and use safety precautions when approaching bridge
USGS Stations			
04161790 04161800	Stony Creek Lake	See USGS site description for details regarding reference locations	Level Sensor only located at dam; flow meter (real-time available) located 500 feet downstream of dam
04161760	West Branch at Stony Creek Metro Park		Peak stage and discharge only (crest-stage gage) in Stony Creek Metropark
04161580	Main Branch at Mount Vernon Court		Flow meter (real-time available) located at 32 Mile Road

Rating Curves

As part of the analysis, rating curves were developed for each survey site so that future flow measurements can be made using a simple distance-to-water surface measurement. A rating curve represents the logarithmic relationship of all flow and surface level data collected at a given site. At each site, a reference point was established from which to measure the distance to the water surface, which established a level measurement for the rating curve. Typically, the reference point is a chisel mark in a bridge or the crown of a culvert.

The rating curves were developed and represented by an equation that was used to calculate flow rate based on the measured water surface level, or in this case the distance to water surface from the reference point. Flow rates determined using the Global Flow Probe are shown on the figures but were not used to determine the rating curve.

The rating curves are an approximation of flow rate based on level and the actual measured data points do not always result in a point exactly equal to the determined curve for a number of reasons. The downstream flow control may become altered, for example by a fallen tree or logjam, which can change the water surface level at a given flow rate. The rating curve can also be affected if the shape of the channel changes. Additionally, the accuracy of both level and flow measurements at extremely low flows is not ideal for rating curves, as occurred at the tributary sites (sites 5, 6, and 8).

The rating curves are very useful for measuring an estimated flow rate in a short period of time. At a given site, the distance from the reference point to the water surface should be measured to the hundredths of a foot using a weighted tape. The distance can then be used with the rating curve graphs to determine flow rate or can be used to calculate the flow rate with the rating curve equations.

Hydrologic Survey Results

On the Main Branch, as expected, flow rates increase as one moves downstream (Table 3.25). The flow increase between sites 1 and 4 reflects the increased drainage area, while the flow at Site 10 is partly controlled by the dam at Stony Creek Lake.

The three tributaries to Stony Creek have very low flow rates, especially during dry weather conditions. Of the tributaries, the West Branch has the highest flow, followed by the McClure Drain and Mount Vernon Drain. The West branch has the largest drainage area and Mount Vernon Drain has the smallest drainage area.

Each flow measurement is a "snapshot" of the dynamic flow conditions that are continually occurring during dry weather and especially wet weather conditions. Overall, the results do not indicate a watershed prone to flash flood conditions, due largely to the current low impervious cover in the watershed and limited development along the stream corridor. However, the measured wet weather flow rates are not necessarily peak flow conditions and each wet weather event is unique in size and intensity. In order to make more certain conclusions regarding flow conditions in the subwatershed, further analysis of the continuous USGS flow data with measured rainfall data should be performed. The rating curves developed for each site can also be used to continue to monitor the flow conditions in the Stony Creek subwatershed and supplement the dataset where USGS data does not exist.

Table 3.25. Summary of Stony Creek Stream Flow Measurements.

		Stream Flow Measurements (cubic feet per second, cfs)					
Site No.	Site Name	Summer 2002	Fall 2002		Spring 2003	Summer 2003	
		Base Flow[1]	Base Flow[2]	Wet Weather[3]	Wet Weather[2]	Wet Weather[2]	Wet Weather[2]
1	Main Branch at Brewer	1.7	5.0	11.1	5.2	12.7	5.7
4	Main Branch at Nature Center Road	8.1	9.9	19.2	19.8	35.3	6.5
5	Mount Vernon Drain at Snell	0.04	0.29	0.54	0.86	1.0	0.14
6	McClure Drain at Metro Park Road	0.20	0.39	0.89	1.5	2.2	0.39
8	West Branch at Metro Park Road	0.41	1.4	4.0	5.3	8.8	1.1
10	Main Branch at Parkdale	*	12.3	43.2	38.9	53.3	7.8

[1] Field velocity measurements at sites 4, 5, 6, and 8 in Summer 2002 were made using the Global Flow Probe; these measurements are considered questionable due to the very low instream velocities (<1 cfs), for which the Global Flow Probe is not considered accurate by the manufacturer. The Marsh-McBirney FloMate 2000 was used at Site 1 and no survey was performed at Site 10.

[2] All field velocity measurements were made using the Marsh-McBirney FloMate 2000.

[3] All field velocity measurements were made using the Marsh-McBirney FloMate 2000 except at Site 10. Only level was recorded at Site 10 due to the onset of darkness and the rating curve was used to determine the flow rate.

*Historic Changes in River Flow (*Reference: ECT's 2005 Clinton River Watershed Geomorphology Study Report to Macomb County Office of Public Works*)*

Within the Clinton River watershed, there are a total of 61 USGS gage sites. Of these, sixteen gages contain enough historical data to enable drawing significant statistical trends. Two of these sixteen locations are located directly within the Stony Creek subwatershed. These gages are located on the Stony Creek at Mt. Vernon Court (gage 04161580) and downstream of Stony Creek Lake (gage 04161800). Two of these sixteen locations are located directly within the Paint Creek subwatershed and are located on the Paint Creek at Lake Orion (gage 04161500) and at Rochester (gage 04161540).

As a part of an on-going Clinton River Watershed Geomorphology Project (ECT's 2005 Report to Macomb County Office of Public Works), detailed flow trend analyses have been conducted deploying the data collected from these USGS gages within the Clinton River watershed, including the following:

- Peak Flow Trends – Calculate the trends in the yearly maximum flow for the period of record at the USGS gage;
- Annual Mean Stream Flow Trends – Calculate the trends in the yearly average flowrate for the period of flow record; and
- Bankfull Flow Trends – Calculate the trends in the 1.5-year flow (or "channel-forming flow") over the period of record.

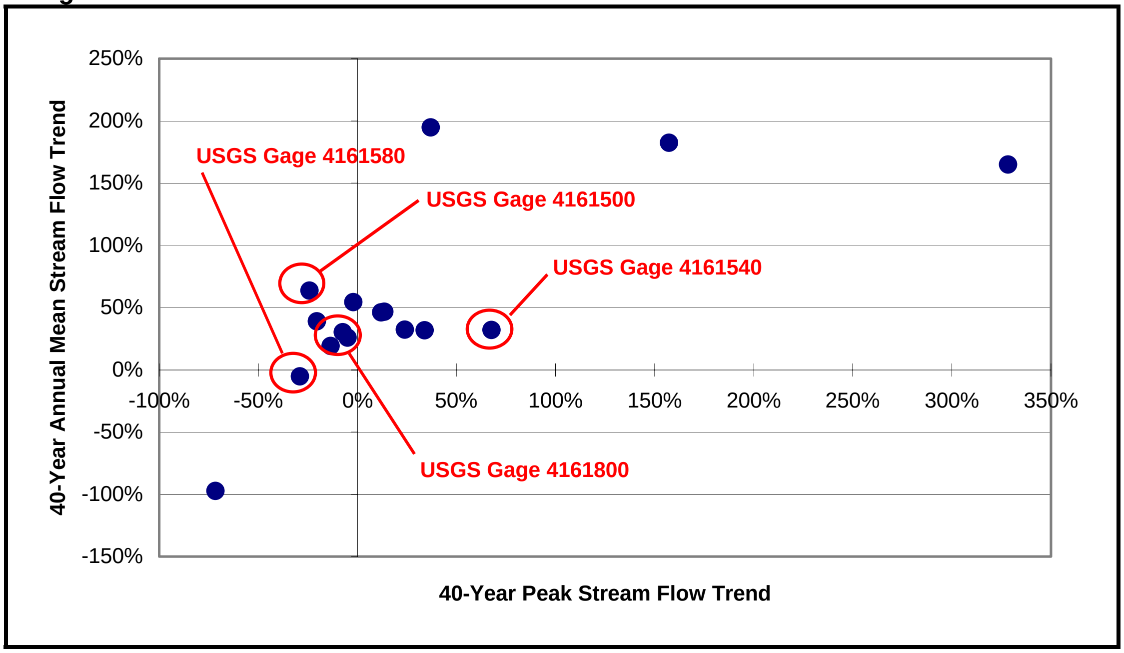
Table 3.26 summarizes the results of the flow trend analysis conducted on each USGS gage within the entire Clinton River watershed. In this table, gages within the Stony Creek subwatershed are highlighted in yellow and those within the Paint Creek subwatershed are highlighted in orange. Table 3.26 shows the relationship between the peak stream flows and the annual mean stream flows for these sixteen USGS gages.

Table 3.26. Changes in flows over a forty-year time period at these sixteen USGS gages within the Clinton River Watershed

USGS Gage	Peak Flow Trend	Annual Mean Trend	Bankfull Flow Trend
4160800	12.00%	46.20%	0.00%
4160900	23.90%	32.20%	0.00%
4161000	328.30%	164.90%	96.60%
4161100	157.30%	182.50%	50.00%
4161500	-24.10%	63.70%	100.00%
4161540	67.70%	32.00%	0.00%
4161580	-29.00%	-5.20%	-27.30%
4161800	-5.00%	25.90%	0.00%

USGS Gage	Peak Flow Trend	Annual Mean Trend	Bankfull Flow Trend
4162900	-71.60%	-97.30%	-91.60%
4163400	13.70%	46.60%	0.00%
4164000	33.90%	31.80%	11.60%
4164100	-7.30%	30.20%	0.00%
4164300	-2.00%	54.30%	0.00%
4164500	-13.50%	19.20%	0.00%
4164800	37.00%	194.70%	126.80%
4165500	-20.40%	38.90%	0.00%

Figure 3.9a Peak Stream Flow vs. Annual Mean Stream Flow Trends

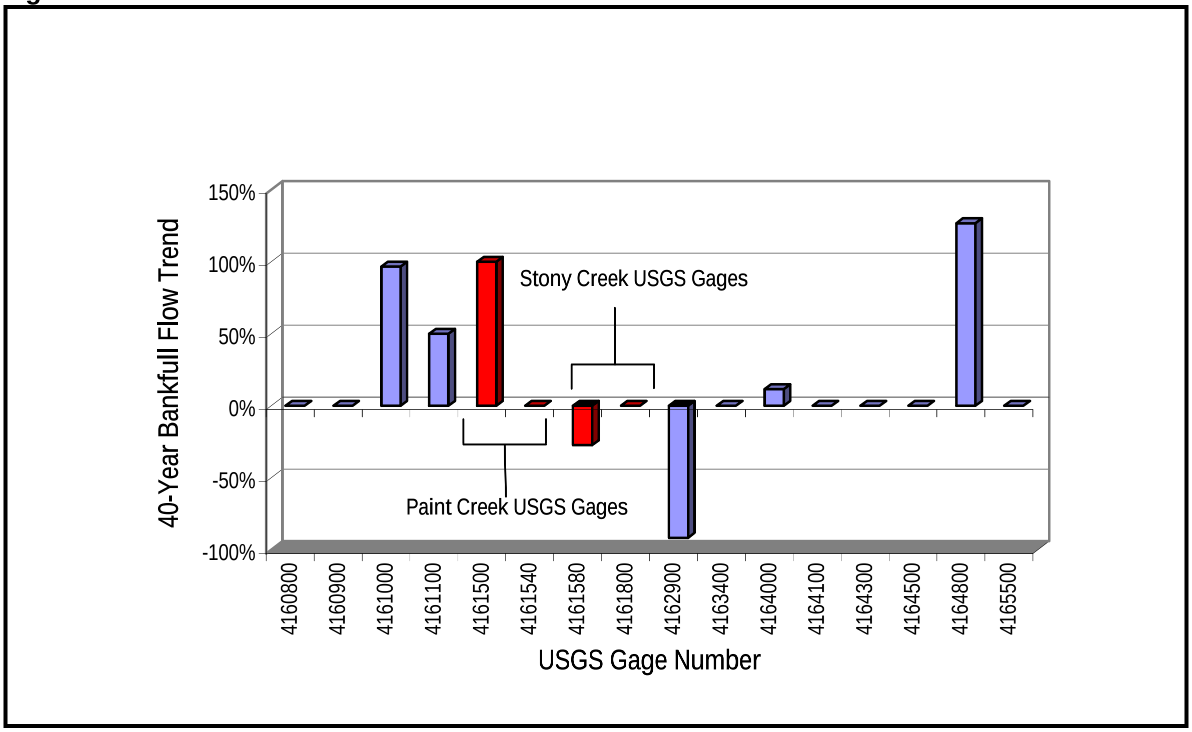


The following conclusions may be drawn from Figure 3.9a:

- Many gages indicate drastic increases in Annual Mean Stream Flow and Peak Stream Flows;
- More gages have larger increases in Annual Mean Stream Flow than Peak Stream Flow; and
- ***The two USGS gages located within the Stony Creek subwatershed show stable values of both annual mean stream flow and peak stream flow.***
- ***The two USGS gages located within the Paint Creek subwatershed are fairly typical of most USGS gages within the Clinton River watershed, in that most of the flow trends have been increasing.***

The bankfull flows, or 1.5-year flows, are significant to analyze for a watershed because these flows are "channel forming flow" due to their frequent occurrence. Therefore, significant increases in the bankfull flows often indicate a stream's instability leading to high amounts of bank erosion. The methodology used for the analysis of the bankfull flows consists of investigating a plot of the cumulative volume curve for each gage. Any noticeable changes in the slope of this plot points towards a change in the average flows over that time period. Secondly, the bankfull flow was calculated based on the general rule that the bankfull flow occurs every 1.5 years. See Figure 3.9b for the relative bankfull flow changes within the Clinton River watershed.

Figure 3.9b 40-Year Bankfull Flow Trends



In many USGS gages within the Clinton River watershed, this bankfull flow increased from the values early in the record when compared to the bankfull late in the record. However, the Stony Creek has experienced stable, or even decreasing occurrences of the bankfull flow. The USGS gage at Lake Orion (4161500) has experienced this large increase in the bankfull flows, however the bankfull flows recorded at the gage located in Rochester (4161540) has been fairly stable. See Figures 3.9c through 3.9j for the plots of this analysis for the Stony and the Paint Creek gage locations. It is evident that development has not had a drastic effect on the bankfull discharge within the Stony Creek subwatershed and only a moderate effect on the bankfull discharge within the Paint Creek subwatershed.

Figure 3.9c. Cumulative Volume for Stony Creek USGS Gage 04161580

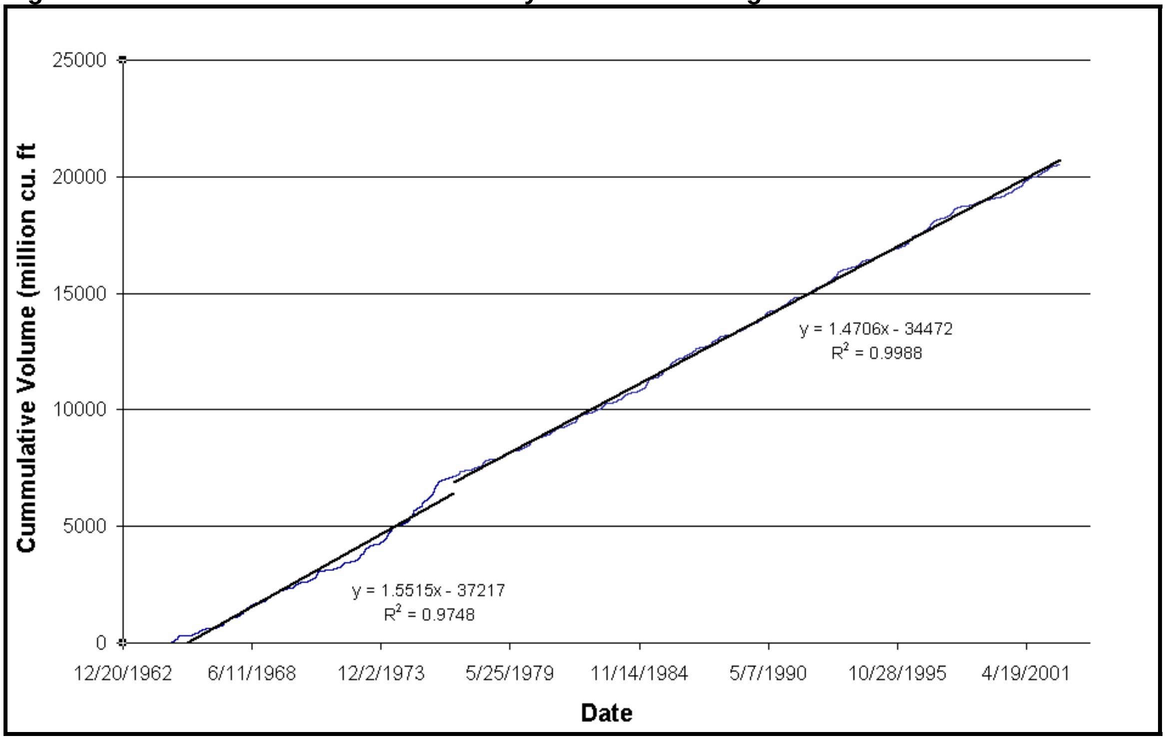


Figure 3.9d. Mean Daily Flow for Stony Creek USGS Gage 04161580

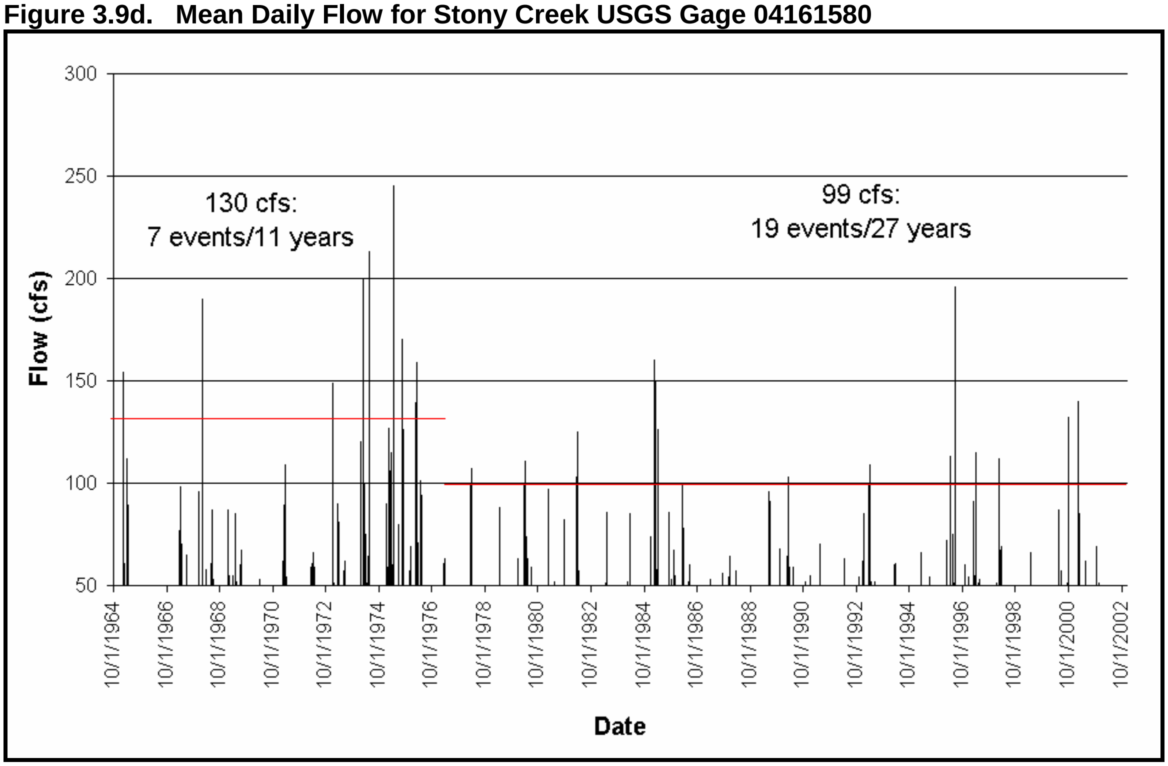


Figure 3.9e. Cumulative Volume for Stony Creek USGS Gage 04161800

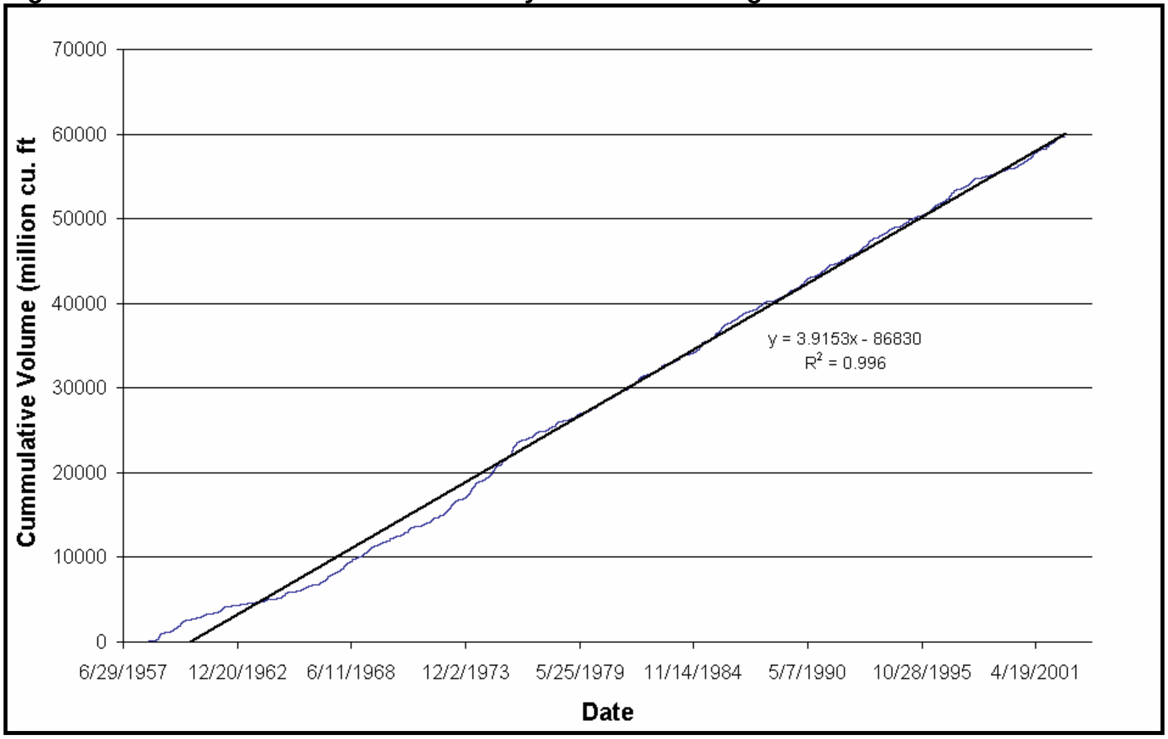


Figure 3.9f. Mean Daily Flows for Stony Creek USGS Gage 04161800

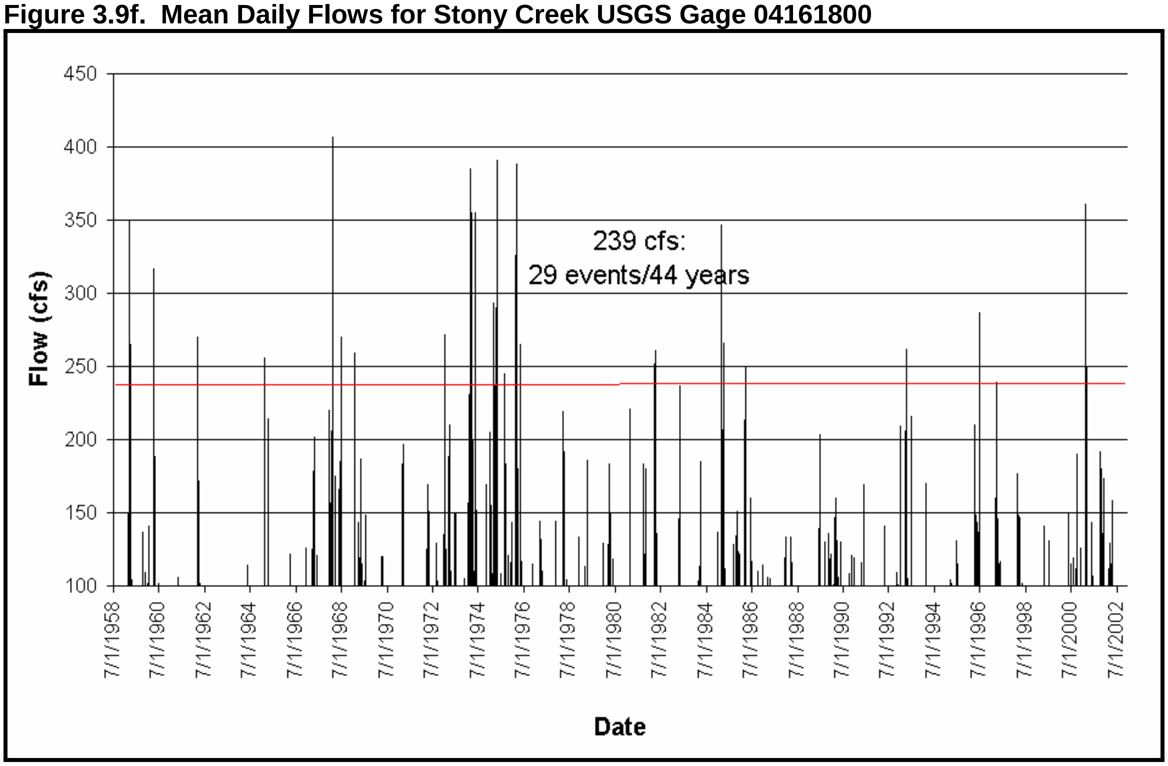


Figure 3.9g. Cumulative Volume for Paint Creek USGS Gage 04161500

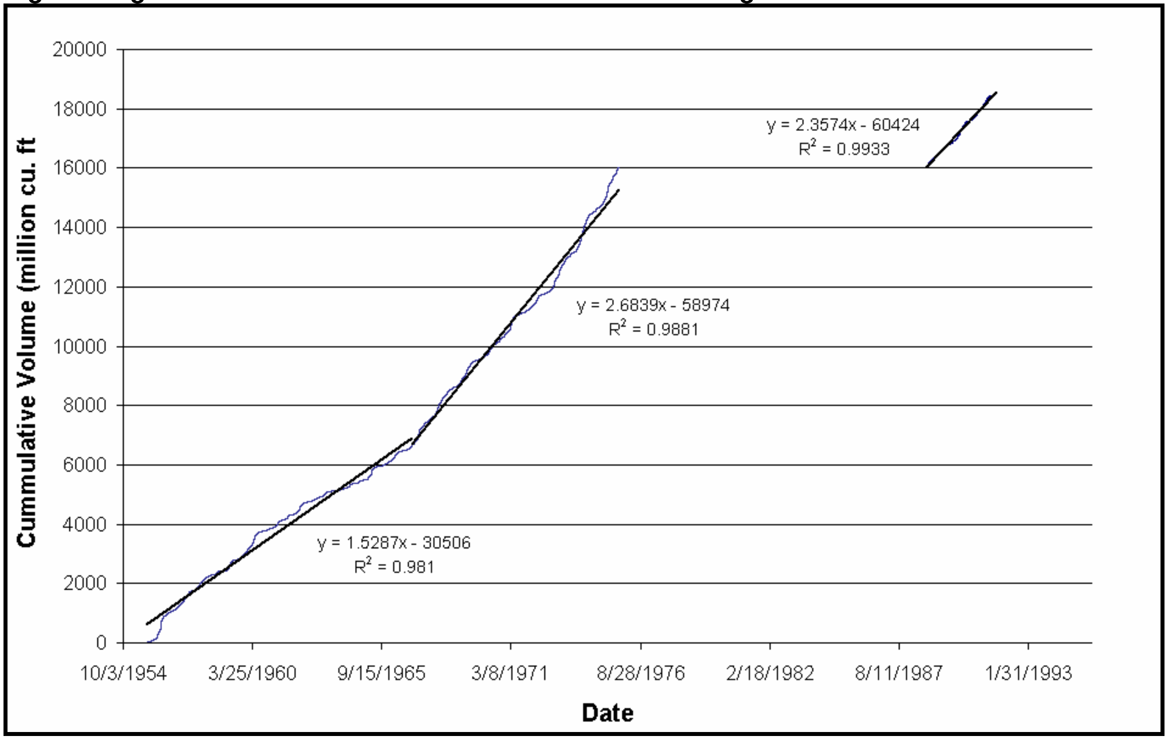


Figure 3.9h. Mean Daily Flow for Paint Creek USGS Gage 04161500

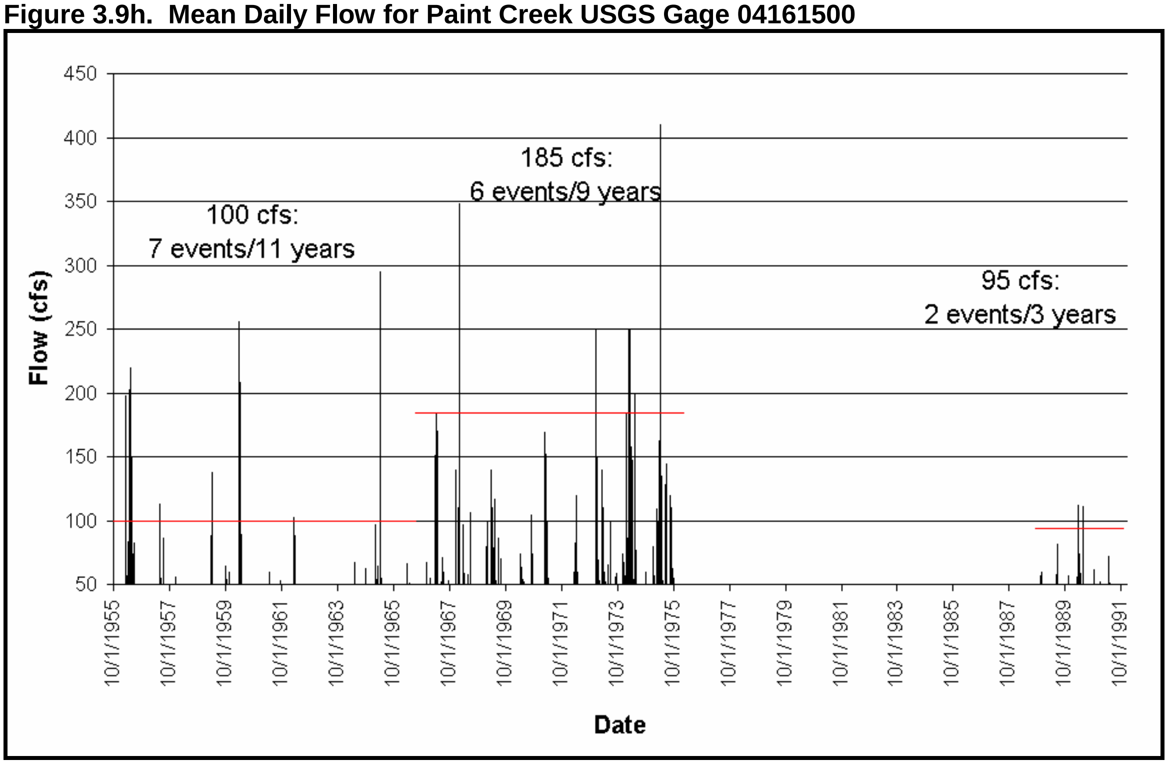


Figure 3.9i. Cumulative Volume for Paint Creek USGS Gage 04161540

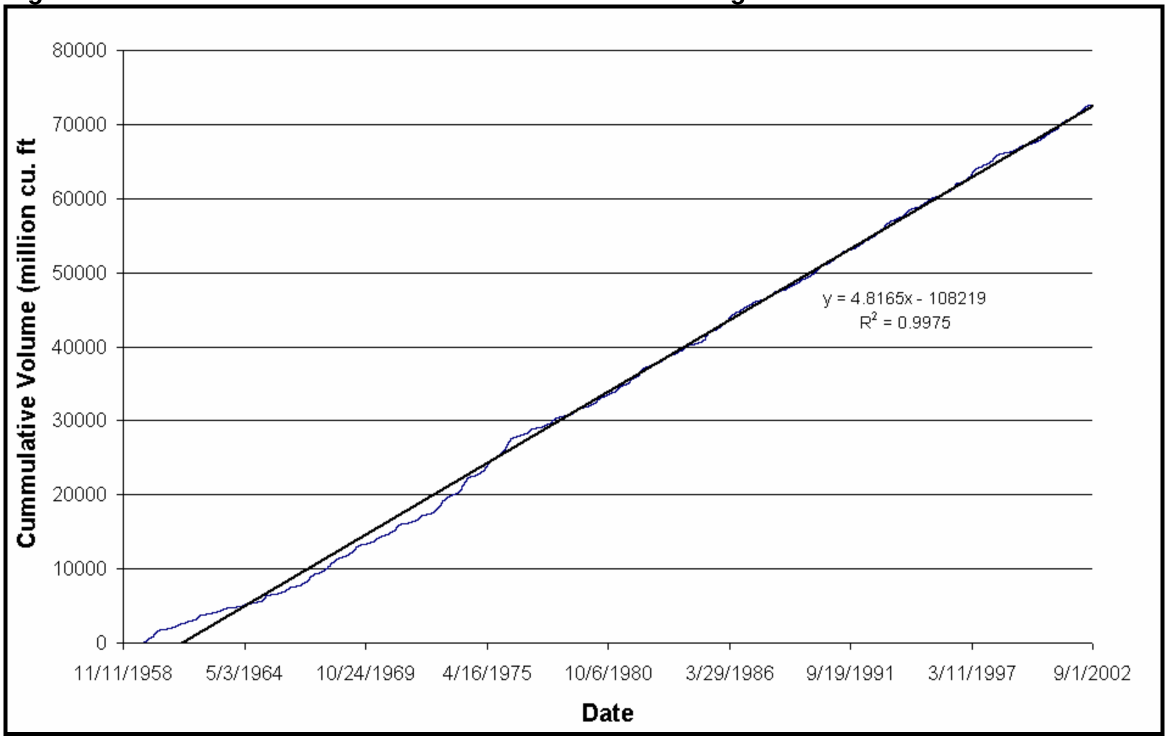
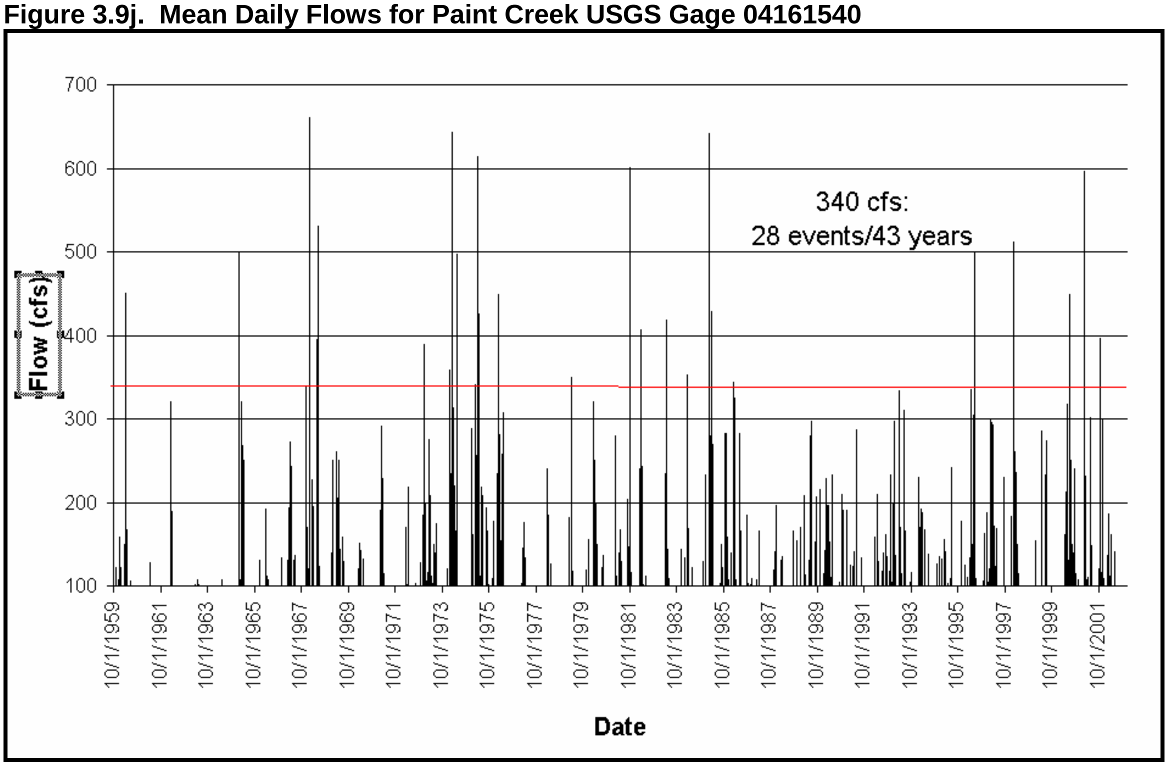


Figure 3.9j. Mean Daily Flows for Paint Creek USGS Gage 04161540



Overall Results

The hydrologic study of Stony Creek conducted by ASI, Inc. (summer 2002 to 2003) confirmed that on the main branch of Stony Creek, as expected, flow rates increase as one moves downstream. In addition, the flow increase between sites 1 and 4 reflects the increased drainage area, while the flow at Site 10 is partly controlled by the dam at Stony Creek Lake. Overall, the results do not indicate a watershed prone to flash flood conditions, due largely to the current low impervious cover in the watershed and limited development along the stream corridor. In order to make more certain conclusions regarding flow conditions in the subwatershed, further analysis of the continuous USGS flow data with measured rainfall data should be performed.

ECT's 2005 Clinton River Watershed Geomorphology Study Report Historic Changes in River Flow illustrates that flows within the Stony Creek Subwatershed have remained fairly stable; however, the overall trend for Paint Creek shows that the flows have been increasing. The bankfull flow modeling results depict that both the Paint Creek and Stony Creek have not been significantly impacted by bankfull flows. This is consistent with the Bank Erosion Hazard Index surveys described in previous sections which concluded that overall bank erosion is not a significant problem. Road crossings do depict erosion issues, but not necessarily due to bankfull flow events.

Water Level Control Structures

Water level control structures or dams, as they are commonly called, are located throughout the Clinton River Watershed. In all, the MDNR Fisheries Division identified 79 dams in the Clinton River Watershed, of which there are six known dams in the Stony/Paint Creek subwatersheds. These water level control structures are located on most of the lakes within the Stony/Paint Creek subwatersheds and are set at a legal level and maintained by the Oakland County Drain Commission.

Although dams have been historically constructed for specific watershed, recreational, and private benefits, there are disadvantages to their presence including blocking fish passage, modifying downstream river flows, increasing water temperature and impacting habitat opportunities. Each dam within the watershed was historically constructed for unique specific benefits. Conversely, each dam also has associated environmental impacts. The purpose of this section report is to provide a historical summary of the existing dams within the Stony/Paint Creek subwatersheds.

The Stony/Paint Creek subwatershed has six dams and Table 3.27 describes the name and location for dams within the Stony/Paint subwatershed. Refer to Figure 3.10 for Lake Level Control Structures within the watershed.

Table 3.27. Lake Level Control Structures

Lake/Structure Name	Community
Indianwood Lake Dam #99-39	Orion Township
Lakeville Lake Dam #90-40	Addison Township
Oxford Multi-Lake #90-32	Oxford Township
Bunny Run Lake #90-10	Orion Township
Stony Creek Lake	Washington Township
Lake Orion	Village of Lake Orion

3.3.6 Nonpoint Source Pollutant Loading

PLOAD Model Background

The GIS Pollutant Loading Application (PLOAD), developed by CH2M HILL, is a simplified, GIS-based model used to calculate pollutant loads for watersheds. PLOAD is an extension of the EPA's Better Assessment Science Integrating Point and Non-point Sources (BASINS) software package.

This model is a useful tool that provides an overall perspective of a watershed's pollutant loadings from storm water runoff. The PLOAD model output is useful in identifying a pollutant's potential origin within a watershed and can also show the relative impact to the watershed based on specific land use changes or implementation of Best Management Practices (BMPs). The PLOAD model does not show the impact of development on a site-specific scale, but rather on a watershed wide scale. Additionally, the model should not be used as a final calculation of exact loadings, but rather should be used to show which sub-basins within a watershed are likely to have relatively higher or lower concentrations of storm water pollutants.

PLOAD Model Assumptions

The PLOAD model was used to estimate non-point source pollutant loadings of typical storm water quality parameters for the Stony/Paint Creek subwatersheds. The Stony Creek subwatershed was delineated into fifteen (15) sub-basins as identified in Figure 3.6 and Table 3.6 for purposes of the evaluation while the Paint Creek subwatershed was delineated into sixteen (16) subbasins as identified the same Figure and Table. The pollutant loadings are based upon nonpoint pollution loading factors that vary by land use and the percent imperviousness associated with each land use type. The land use types and pollutants are linked via an *Event Mean Concentration* value, which defines the concentrations of specific pollutants within each land use type. Nationally, these values vary significantly so regional values were used in the PLOAD model[1]. Table 3.28 summarizes the Event Mean Concentrations for the pollutants analyzed in the Stony/Paint Creek subwatersheds.

Table 3.28. Summary of Event Mean Concentrations for the Stony/Paint Creek Subwatershed (mg/L)

Name	BOD	TSS	TP	DP	TKN	NO23	Pb	Cu	Zn	Cd
Agricultural	3	145	0.37	0.09	1.92	4.06	0	0	0	0
Commercial	21	77	0.33	0.17	1.74	1.23	0.05	0.04	0.16	0.003
Forest/Rural Open	3	51	0.11	0.027	0.94	0.8	0	0	0	0
High Density Residential	14	97	0.24	0.08	1.17	2.12	0.04	0.03	0.22	0.003
Highways	24	141	0.43	0.22	1.82	0.83	0.05	0.04	0.16	0.003
Industrial	24	149	0.32	0.11	2.08	1.89	0.07	0.06	0.67	0.005
Low Density Residential	38	70	0.52	0.27	3.32	1.83	0.06	0.03	0.16	0.004
Medium Density Residential	38	70	0.52	0.27	3.32	1.83	0.06	0.03	0.16	0.004
Urban Open	3	51	0.11	0.03	0.94	0.8	0.01	0	0.04	0.001
Water/Wetlands	4	6	0.08	0.04	0.79	0.59	0.01	0.01	0.03	0.001

[1]*The Rouge River National Wet Weather Demonstration Project – Watershed Management Model, November, 1998*

Definition of Terms:

BOD: Biochemical Oxygen Demand
TSS: Total Suspended Solids
TP: Total Phosphorus
DP: Dissolved Phosphorus
TKN: Total Kjeldahl Nitrogen
NO23: Nitrate + Nitrite
Pb: Lead
Cu: Copper
Zn: Zinc
Cd: Cadmium

Storm water runoff volume is another important parameter in the PLOAD model and is based on the average yearly precipitation and imperviousness associated with each land use type. The average yearly precipitation value for southeast Michigan is approximately 32 inches, and this value was used in the PLOAD model. Table 3.29 provides the corresponding percent impervious value associated with each land use type for both the Stony and Paint Creek Subwatersheds.

Table 3.29 Percent Impervious based on Land Use Type

Land Use Type	Percent Impervious
High Density Residential	50
Medium Density Residential	30
Low Density Residential	10
Urban Open	10
Commercial	90
Industrial	80
Highways	90
Forest/Rural Open	0.5
Agricultural	0.5
Water/Wetlands	100

The PLOAD model allows both point source loadings as well as the implementation of Best Management Practices. Neither of these inputs was added to the PLOAD model of the Stony/Paint Creek subwatersheds due to lack of data available for both of these data inputs.

Results

The Stony Creek Subwatershed is slightly developed. The landuse is a homogeneous mix of a variety of landuses including single-family residential, forests and wetlands, open spaces, and some agriculture. Figure 3.1 outlines the land use information used in the PLOAD model for the Stony Creek Subwatershed. Due to the subwatershed being fairly homogeneous within each catchment, variability in the storm water runoff pollutant loadings between sub-basins is minimal.

The Paint Creek Subwatershed is moderately developed. The majority of the landuses within this subwatershed consist of single-family residential, forests and wetlands, and some agricultural. The highest density of residential landuse occurs in the southern portion of the subwatershed, although is also quite dense in the northern part of the subwatershed as well. There is a large area of forests, wetlands, and open spaces just north of the highest density of residential. Figure 3.1 outlines the land use information used in the PLOAD model for the Paint Creek Subwatershed.

Results of the normalized pollutant loading analysis are shown in Table 3.30. Figure 3.11 also depicts the delineated subbasins with the associated annual loading rates for four key parameters – BOD, TSS, TP and Nitrates/Nitrites, for Stony and Paint Creek, respectively. In order to provide a frame of reference for the results, a comparison to both urban and rural subwatersheds has been provided. A southern portion of the Red Run subwatershed was selected as the nearby urban subwatershed while a northern portion of the North Branch subwatershed was selected as the rural subwatershed.

Table 3.30. Pollutant Loading Results of PLOAD Model Runs

BASIN	BOD	TSS	TP	DP	TKN	NO23	PB	CU	ZN	CD
Stony Creek	15	50	0.3	0.12	1.9	1.5	0.03	0.02	0.09	0.002
Paint Creek	20	55	0.3	0.16	2.4	1.7	0.04	0.02	0.12	0.002
Red Run	63	245	0.9	0.4	5.4	3.7	0.14	0.10	0.73	0.009
North Branch	5	50	0.2	0.1	1.0	1.4	0.01	0.003	0.02	0.000
Clinton Overall	30	112	0.5	0.2	3.0	2.2	0.06	0.04	0.27	0.004

All Values are in lbs of pollutant/acre/year for each Basin

Overall, the delineated basins within the Stony Creek closely resemble a rural subwatershed and those within the Paint Creek subwatershed of the Clinton River are somewhere between a rural and an urban watershed, but more closely resemble a rural subwatershed. The total loading of the Stony and Paint Creek subwatersheds can also be compared to the total loading from the entire Clinton River watershed. This comparison can show the relative loading generated from the Stony and Paint Creek subwatersheds. See Tables 3.31, 3.32 and 3.33 for these results.

Table 3.31. Total Pollutant Loading from the Stony Creek Subwatershed

	Entire Clinton River Watershed	Stony Creek	Percent of Total Loading
BOD	13,668,722	691,083	5.06%
TSS	50,630,319	2,365,523	4.67%
TP	218,453	12,498	5.72%
DP	103,300	5,798	5.61%
TKN	1,378,958	91,672	6.65%
NO23	1,007,742	70,585	7.00%
PB	28,290	1,363	4.82%
CU	18,374	777	4.23%
ZN	123,465	4,410	3.57%
CD	1,740	82	4.73%
Area, Square Miles	760	71.25	9.79%

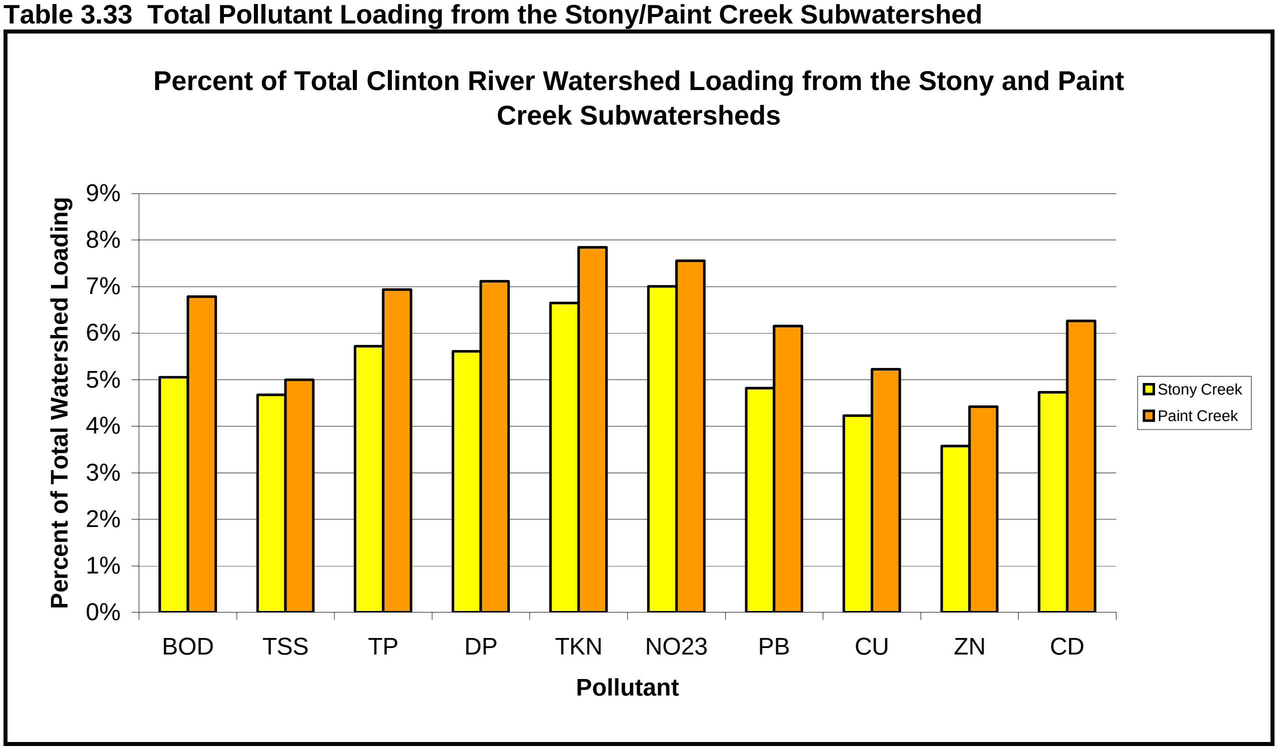
All Pollutant Units are in lbs/year

Table 3.32. Total Pollutant Loading from the Paint Creek Subwatershed

	Entire Clinton River Watershed	Paint Creek	Percent of Total Loading
BOD	13,668,722	928,037	6.79%
TSS	50,630,319	2,530,780	5.00%
TP	218,453	15,152	6.94%
DP	103,300	7,354	7.12%
TKN	1,378,958	108,203	7.85%
NO23	1,007,742	76,117	7.55%
PB	28,290	1,741	6.15%
CU	18,374	960	5.22%
ZN	123,465	5,455	4.42%
CD	1,740	109	6.26%
Area, Square Miles	760	71.25	9.4%

All Pollutant Units are in lbs/year

Table 3.33 Total Pollutant Loading from the Stony/Paint Creek Subwatershed



Therefore, although the Stony Creek subwatershed comprises roughly 10% of the overall area of the Clinton River watershed, this subwatershed contributes only 3.5% to over 7% of the non-point source pollutant loading, and a although the Paint Creek subwatershed comprises roughly 10% of the overall area of the Clinton River watershed, this subwatershed contributes only 4.5% to over 8% of the non-point source pollutant loading.

3.4 OTHER NATURAL & CULTURAL FEATURES

3.4.1 Landscape Context – Geology, Soils & Vegetation

The Michigan Natural Features Inventory (MNFI) conducted surveys for rare plants and exemplary natural communities in four of the Huron-Clinton Metroparks, including Stony Creek, during the summer of 2001. The following information is primarily excerpted from this report; the entire document is available from the Clinton River Watershed Council or the Huron-Clinton Metropolitan Authority.

The Stony Creek and Paint subwatersheds occur within the Washtenaw Subsection Ecoregion of southern lower Michigan, which in turn contains three sub-subsections that differ from each other in their soils, glacial landforms, climate, and vegetation. The Stony/Paint Creek subwatershed is located within the Ann Arbor Moraine and Jackson Interlobate Sub-subsection. Stony Creek flows through a broad, relatively flat, glacial outwash channel.

The Ann Arbor Moraine Sub-subsection contains narrow, parallel bands of fine- and medium-textured end and ground moraines, characterized by loam and sandy loam soils. This region supports a variety of forest types including mesic southern forest, dry-mesic southern forest, oak openings (oak savanna), and oak barrens. In many locations, glacial outwash channels dissect the moraines – these channels contains areas of sandy soils that support oak barrens and prairies, as well as poorly-drained, alluvial sediments and organic deposits that support a variety of wetland types.

The Jackson Interlobate Sub-subsection contains broad glacial outwash sands surrounding sandy and gravelly end and ground moraines. The moraine soils are typically well-drained and support drought-tolerant, fire-dependent communities such as oak barrens, oak forest, and hillside prairie. The outwash soils vary from very well-drained sands supporting oak barrens, oak forests, and prairies to poorly drained organic deposits supporting a variety of wetland types. Soil types in the Stony/Paint Creek subwatershed generally fall into four categories (Figure 3.12):

1) Miami-Marlette-Lapeer
2) Spinks-Houghton-Boyer
3) Marlette-Capac-Parkhill
4) Coloma-Spinks-Oshtemo

These soil associations help to characterize the suitability of different areas of the subwatershed for development and preservation potential. Individual soil series as described in the Oakland and Macomb county soil surveys are provided below:

- **Miami:** Well-drained soils that formed in calcareous loam and silt loam glacial till. These soils are gently sloping to steep. Permeability is moderate to moderately slow. Slopes range from 2 to 25 percent.
- **Marlette:** Nearly level and undulating, moderately well-drained soils on low knolls and ridges. Permeability is moderately slow. Slopes range from 0 to 35 percent.
- **Lapeer:** Well-drained soils form in calcareous sandy loam glacial till on till plains and moraines. The soils are nearly level to steep. Permeability is moderate to moderately rapid. Slopes range from 2 to 25 percent.

- **Spinks:** Very deep, well-drained soils formed in outwash material. They are on dunes, and on foot slopes of moraines, till plains, outwash plains, beach ridges and lake plains. These soils have moderately rapid permeability. Slopes range from 0 to 60 percent.
- **Houghton:** Very poorly-drained soils formed in organic sediments. They are located in bogs or depressions on moraines, till plains, or outwash plains. Permeability is moderately slow to moderately rapid permeable soils. Slopes range from 0 to 1 percent.
- **Boyer:** Well-drained soils on outwash plains, beach ridges, and moraines. These soils formed in sandy and loamy material and in the underlying calcareous gravelly sand. Permeability is moderately rapid in the subsoil and very rapid in the substratum. Slopes range from 0 to 40 percent.
- **Capac:** Nearly level and gently undulating, somewhat poorly-drained soils on broad, flat areas and on low knolls and ridges. Permeability is moderately slow. Slopes range from 0 to 4 percent.
- **Parkhill:** Poorly-drained, level and nearly level soils formed on depressions on the moraines. Permeability is moderately slow. Slopes range from 0 to 2 percent.
- **Coloma:** Very deep, somewhat excessively-drained soils formed in sandy drift on moraines and outwash plains. Permeability is rapid to moderately rapid. Slopes range from 0 to 70 percent.
- **Oshtemo:** Very deep, well-drained soils that formed in stratified, loamy and sandy deposits on outwash plains, valley trains, moraines, and beach ridges. Permeability is moderately rapid in the upper loamy material, and very rapid in the lower sandy material. Slopes range from 0 to 55 percent.

Figure 3.13 shows the hydrologic characteristics of soils in the subwatershed, and how well they infiltrate precipitation. (Note that the hydrologic categories of soils in Macomb County are estimates.)

The extent of vegetated cover in the Stony/Paint Creek subwatershed is illustrated in Figure 3.2 and Table 3.34.

Table 3.34. Extent of Vegetated Cover in the Stony/Paint Subwatershed.

Vegetation Type	Acres	% Cover
Cropland & Fallow Fields	15,794	16.4%
Orchards and Vineyards	458	.5%
Permanent Pasture	811	.8%
Non-Forested Uplands	19,445	20.2%
Non-Coniferous Forest	9,160	9.5%
Coniferous Forest	604	.6%
Forested Wetlands	5,237	5.4%
Non-Forested Wetlands	5,658	5.9%
Total Vegetated Area (excludes fully developed lands)	57,167	59.3%

MNFI's inventory of Stony Creek Metropark highlights the pre-settlement vegetative features of the Stony Creek subwatershed. Fire-dependent black oak barrens, mixed oak forest, mixed conifer swamp, wet prairies, and mixed hardwood swamps all occurred in the area. Many large forested tracts remain in the subwatershed, and a large amount of acreage is occupied by old field. A wide variety of ecosystem types are observed in the metropark at the present time, including cedar swamp, wet-mesic prairie, tamarck fen, wet- and dry-mesic forests, and wet meadows. MNFI identified several rare plants at Stony Creek Metropark, including ginseng *(Panax quinquefolius),* goldenseal *(Hydrastis canadensis),* and potentially a rare species of beardtongue *(Penstemon gracilis* or *Penstemon calycosus).*

High deer densities and invasive species – particularly garlic mustard, glossy buckthorn, multiflora rose, autumn olive, oriental bittersweet, honeysuckle, privet, and purple loosestrife – were cited as management issues in the metropark and are likely to be problems throughout the subwatershed. Management recommendations made by MNFI for Stony Creek include invasive species control, deer control, and prescribed fire; these recommendations are applicable to many areas throughout the subwatershed.

3.4.2 Unique Flora & Fauna

Anecdotal records of unique flora and fauna abound in the Stony/Paint Creek subwatershed. Red fox are seen as far south as the Parkdale Road crossing in Rochester. Mink and muskrat have been observed along the West Branch of Stony Creek south of Buell Road. Great blue herons and other waterfowl, freshwater clams, native fish, and a multitude of native wildflowers populate the streams and riparian corridor. Fortunately, some of the most aggressive invasive species are few and far between – purple loosestrife is not common, and zebra mussels have apparently not invaded at least the West Branch of Stony Creek.

A variety of threatened, endangered, and special concern species, high-quality natural communities, and champion trees have been identified in the Stony/Paint Creek subwatershed (Tables 3.35 - 3.38). The Michigan Natural Features Inventory maintains databases of all known occurrences of these species, as well as high quality natural communities, occurring within the watersheds of Michigan. This list is based on known and verified sightings of threatened, endangered, and special concern species and represents the most complete data set available. It should not be considered a comprehensive listing of every potential species found within a watershed. Because of the inherent difficulties in surveying and inconsistencies of inventory effort across the state, species may be present in a watershed and not appear on this list.

Table 3.35. Threatened, Endangered & Special Concern Plants Occurring in the Stony/Paint Creek Subwatershed. (E = State Endangered; T = State Threatened; SC = State Special Concern)

Scientific Name	Common Name	State Status
Agalinis gattingeri	Gattinger's Gerardia	E
Amorpha canescens	Leadplant	SC
Angelica venenosa	Hairy Angelica	SC
Arabis missouriensis var. deamii	Missouri Rock-cress	SC
Bouteloua curtipendula	Side-oats Grama Grass	T
Calephelis mutica	Swamp Metalmark	SC
Carex richardsonii	Richardson's Sedge	SC
Cirsium hillii	Hill's Thistle	SC
Castanea dentata	American Chestnut	E
Cypripedium candidum	White Lady-Slipper	T
Fuirena squarrosa	Umbrella-Grass	T
Galearis spectabilis	Showy Orchid	T
Gentiana puberulenta	Downy Gentian	E
Gentianella quinquefolia	Stiff Gentian	T
Hieracium paniculatum	Panicled Hawkweed	SC
Hydrastis Canadensis	Goldenseal	T
Linum sulcatum	Furrowed Flax	SC
Linum virginianum	Virginia Flax	T
Panax quinquefolius	Ginseng	T
Platanthera ciliaris	Orange or Yellow Fringed Orchid	T
Psilocarya scirpoides	Bald-Rush	T
Scirpus clintonii	Clinton's Bulrush	SC
Trillium sessile	Toadshade	T
Valeriana edulis var. ciliata	Edible Valerian	T
Viola pendatifida	Prairie Birdfoot Violet	T

Table 3.36. Threatened, Endangered & Special Concern Animals Occurring in the Stony/Paint Creek Subwatershed. (LE = Federal Endangered; C = Federal Concern; E = State Endangered; T = State Threatened; SC = State Special Concern)

Scientific Name	Common Name	Federal Status	State Status
Asio otus	Long-eared Owl		T
Clemmys guttata	Spotted Turtle		T
Emydoidea blandingii	Blanding's Turtle		SC
Nicrophorus americanus	American Burying Beetle	LE	E
Sistrurus catenatus catenatus	Eastern Massasauga	C	SC

Table 3.37. High Quality Natural Communities and Unique Geographical Features in the Stony/Paint Creek Subwatershed.

Name	Type / Description
Bog	Community Type
Coastal Plain Marsh	Infertile pond/marsh, Great Lakes Type
Delta	Geographical Feature
Dry-Mesic Southern Forest	Community Type
Great Blue Heron Rookery	Habitat Type
Hardwood-Conifer Swamp	Community Type
Kame	Geographical Feature
Mesic Southern Forest	Rich Forest, Central Midwest Type
Prairie Fen	Alkaline Shrub/herb Fen, Midwest Type
Relic Conifer Swamp	Forested Bog, Central Midwest Type
Southern Floodplain Forest	Community Type
Southern Swamp	Community Type
Southern Wet Meadow	Wet Meadow, Central Midwest Type

Table 3.38 Champion Trees in the Stony/Paint Creek Subwatershed.*

Scientific Name	Common Name	Tree ID
Acer saccharinum	Silver Maple	Champion Tree 6
Prunus americana	American Plum	Champion Tree 56

**Other champion trees occur in the Stony/Paint Creek subwatershed that are not identified by MNFI.*

3.4.3 Wetlands, Woodlands & Riparian Corridor

The protection of the natural features surrounding Stony/Paint Creek Subwatersheds, such as wetlands, woodlands, and the riparian corridor, are critical to restoring and protecting the high quality of the creeks themselves. In addition, restoration efforts in degraded areas could assist in reducing stormwater impacts on the stream in the future.

Wetlands

According to state law, only wetlands over five acres in size, or that are contiguous to or within 500 feet of a waterbody, are protected by the State. Smaller wetlands, and those further away from or not connected to waterbodies are not given state protection. These wetlands can be filled according to state law, unless there is a local ordinance protecting these wetlands.

Wetlands provide a number of functions that are beneficial to humans. Six benefits provided by wetlands, which are of interest to stakeholders, have been identified as: 1. floral and wildlife habitat, 2. fish and herptile habitat, 3. flood water storage, 4. nonpoint source pollution abatement, 5. shoreline and stream bank protection, and 6. aesthetic and recreational opportunities.

Figure 3.3 is a Potential Wetlands Map for the Stony/Paint Creek Subwatershed. The GIS data set used in Stony/Paint Creek Subwatershed Potential Wetland Map was created by merging several data sources. The Paint Creek Subwatershed area utilized National Wetland Inventory (NWI) data except for wetland data provided by Oakland Township and Rochester Hills. NWI data was prepared by the U.S. Geological Survey (USGS) and the U.S Fish and Wildlife Service, and is also accessible through the MDNR online Geographic Data Library while the

Oakland Township and Rochester Hills data was provided to the respective community through private consultants.

More than 7% of the Stony Creek subwatershed and approximately 18% of Paint Creek subwatershed encompasses wetlands and waterbodies. A variety of pristine wetland systems have been identified in the subwatersheds, including cedar and tamarack bogs in the northern end of the subwatershed. Some of these areas are already protected in local, county, and state preserves, including the Michigan Nature Association's Lakeville Swamp Sanctuary, the northern (undeveloped) portion of Stony Creek Metropark, Bald Mountain Recreation Area, and Oakland Township's passive use parks.

As for the Stony Creek wetland data, in 1998, CRWC completed an assessment of wetland function in the Stony Creek subwatershed (see *Enhancing Community Wetlands Protection and Restoration in Southeast Michigan: Wetlands Assessment in the Stony Creek Watershed).* This assessment utilized a procedure known as the Rapid Assessment Method (RAM), which was developed by Tilton & Associates, Inc. (TAI) to quickly assess wetland functions based on general features and characteristics that can be observed from aerial photographs and a simple on-site evaluation. The assessment evaluated wetlands for seven functions: floral diversity and wildlife habitat, fish and herpetile (reptile / amphibian) habitat, flood and storm water storage, runoff attenuation, water quality protection, shoreline and streambank protection, and aesthetic and recreation opportunities.

CRWC mapped more than 350 wetlands in the Stony Creek subwatershed and field surveyed 138 of them using the RAM during the spring and summer of 1998. The results of this analysis (Table 3.39) indicate that all of the wetlands surveyed fulfilled at least one function: floral diversity and wildlife habitat. Virtually all of the wetlands surveyed also provided water quality protection and aesthetic and recreation opportunities. These results are indicative of the generally high habitat quality and undisturbed nature of many of the wetlands in the Stony Creek subwatershed. Three out of four wetlands surveyed also provided flood and storm water storage, and almost as many provided runoff attenuation.

Table 3.39. Functions of Surveyed Wetlands in the Stony Creek Subwatershed.

Wetland Function	# Wetlands that fulfill function	# Wetlands that do not fulfill function
Floral Diversity & Wildlife Habitat	138	0
Fishery & Herpetile Habitat	31	107
Flood & Stormwater Storage	105	33
Runoff Attenuation	98	40
Water Quality Protection	134	4
Shoreline & Streambank Protection	19	119
Aesthetics & Recreation	136	2

The only functions not well-represented in the Stony Creek subwatershed were fishery and herpetile habitat and shoreline and streambank protection. Many wetlands in the Stony Creek subwatershed occur in low-lying areas that are not immediately adjacent to the creek or other water bodies. This factor eliminates fishery habitat and the presence of shorelines and streambanks from many of the wetlands assessed. That does not mean that these functions are not being fulfilled by wetlands in the subwatershed; it simply means that a majority of the wetlands are not situated in such a way as to serve those functions. Because fishery and herpetile habitat were lumped together in one function, the assessment does not allow for the accurate indication of herpetile habitat alone.

Although the RAM was not designed to delineate wetland size (size was only estimated from existing wetland inventories, aerial photographs, and hydric soils maps), the results clearly indicate that most small wetlands in the Stony Creek subwatershed (less than five acres, which are not protected under state law unless they are adjacent to a water body) perform as many functions as larger wetlands.

The Potential Wetland Map was created to depict areas with a moderate to high likelihood of containing wetlands. To synthesize the Stony/Paint Creek Subwatersheds Potential Wetland Map, NWI, Oakland Township and Rochester Hills wetland themes were joined in the ArcMap Geographical Information System (GIS) software. The areas noted by the polygon overlay identify the potential wetlands.

The Potential Wetland Map gives an overall generalization of wetland areas within the watershed. Wetland area utilizes approximately 25% of the Stony/Paint Creek subwatersheds. A quick glance of the data shows that the areas along the river corridor are primarily the areas of concentration for wetland potential. This is not to say that these are the only locations of wetland within the subwatersheds but it demonstrates the likelihood of these natural wetland areas along the river corridor and in the head waters.

As the Stony/Paint Creek subwatershed develops, it is likely that many wetland areas will come under increasing risk of alteration by filling, draining, and other construction-related activities. The 1998 assessment clearly indicates that the protection of Stony Creek wetlands is critical to preserving the healthy functioning of the stream and its surrounding ecosystems. In addition, Paint Creek subwatershed's surrounding wetlands provide valuable functions, evidenced from the Oakland Township Natural Features Inventory.

Woodlands & Riparian Corridor

Woodlands, particularly those adjacent to the stream in what is known as the riparian corridor, provide many water quality and quantity benefits, as well as wildlife habitat. Woodlands in the Stony/Paint Creek Subwatershed provide food, shelter, and breeding grounds for deer, songbirds, beaver, muskrat, red fox, small rodents, and many other species. Wooded areas adjacent to the stream also shade and cool the water, which is critical for fish survival. Trees help to intercept rainwater as it falls, and promote infiltration of stormwater into the soil, before it reaches the stream. Forests provide aesthetic benefits and both passive and active recreation opportunities for people as well, and is evidenced by the popularity of Bald Mountain Recreation Area and Stony Creek Metropark.

Nearly 60% of the Stony Creek subwatershed and 25% of the Paint Creek subwatershed land area is currently considered woodland and wetland ecosystem types. In many residential areas, the woodlands have been preserved, as they provide aesthetic benefits enjoyed by the subwatershed's human inhabitants. In watersheds that have experienced relatively limited development, woodland and wetland coverage, especially along the riparian corridor, may be the best indicator of overall stream health (even more so than impervious cover – see discussion in Chapter 4). It is therefore imperative that the wealth of woodlands and wetlands that exist in the Stony Creek subwatershed be protected and restored where necessary as the area continues to develop.

3.4.4 Historic Resources

The Stony/Paint Creek subwatershed has a rich cultural history dating back thousands of years. Although the details of early Native American habitation are vague, it is known that the Stony/Paint Creek region supported thriving fish and game populations that would have provided a plentiful food source. Chippewa Indians settled to the south of Stony Creek in the 1780s, opening the gateway for early settlers that had traveled by boat up the Detroit River and Lake St. Clair to head into the wilderness to the north and west.

The Graham family established the first European settlement in the area in 1817, which became the city of Rochester. The waters of Stony and Paint Creeks provided power for mills, which produced cider, wool, and grains through the 1800s. Evidence of the mills remains throughout the region, both in the form of historical sites and as sites of still-thriving businesses. Mill ponds can also still be found scattered throughout the area. The Paint Creek Millrace in Oakland Township was constructed by Needham Hemmingway, who dammed the creek and dug a one-half-mile long millrace and gristmill in 1835. Edward Demerall owned a sawmill just west of the gristmill from 1840 to 1872 when the Detroit and Bay City Railroad laid track that disrupted production. By 1876, William Goodison bought Hemmingway's mill, enlarged it and installed modern machinery. It operated until 1941, and the abandoned railroad became Paint Creek Trail in 1981. The mill is now the Paint Creek Cider Mill.

The Van Hoosens, perhaps Stony Creek's most famous residents, arrived in the 1830s and settled at Stony Creek Village. Sarah and Joshua Van Hoosen established a thriving farm along the banks of Stony Creek. Their daughter, Sarah Van Hoosen Jones, went on to earn masters and PhD degrees from the University of Wisconsin. Sarah eventually willed the 350-acre Van Hoosen estate and various buildings to Michigan State University in 1972. The university donated 3-1/2 acres and the farmhouse to Avon Township, which incorporated as Rochester Hills in 1984. The Rochester Hills Museum at Van Hoosen Farm was established in 1980 and to this day is perhaps one of the best local examples of a bygone era.

Oakland County has recently updated a county-wide historic and cultural features map, which identifies a variety of sites of archaeological and historical significance (Figure 3.14). In addition, CRWC secured the assistance of a volunteer to research the history of the Stony Creek subwatershed. This effort resulted in the creation of a narrative, "Stony Creek: The Hidden Jewel…with a Multi-Faceted History". This is available at www.crwc.org.

3.5 SUMMARY OF WATER QUALITY IMPAIRMENTS, SOURCES & CAUSES

The stream inventory and analysis of historic data indicate that Stony and Paint Creeks are high-quality waterways that have only recently begun to show signs of impairment. Current degradation is, for the most part, limited to isolated areas, but these degraded areas are widespread across the entire subwatershed. This section summarizes the current impairments in Stony and Paint Creeks and identifies sources and causes of those impairments. The impairments have been prioritized based upon the results of the stream inventory, analysis of historical data, Project Team observations, and responses to the riparian landowner survey. The Project Team used this information to prioritize the pollutants from greatest or most immediate threat to least or longest term threat. Then the sources and causes were prioritized from highest to lowest impact. In cases where a source or cause is having an uncertain impact, it was ranked lower than known sources or causes. If additional information is obtained in the future that indicates a lower ranked impairment, source, or cause should be elevated in priority, the ranking should be modified to reflect this new information. The impairments are listed in prioritized order below; the impairments, sources & causes are also summarized in prioritized order in Table 3.40.

3.5.1 Hydrology

Hydrology refers to the study of water quantity and flow characteristics in a water system. How much and at what rate water flows through a river system, and how these factors compare to the system's historic or "pristine" state, are critical in determining the long-term health of the waterway. In a natural river system, precipitation in the form of rain or snow is intercepted by the leaves of plants, absorbed by plant roots, infiltrated into groundwater, soaked up by wetlands, and is slowly released into the surface water system. Very little rainwater and snowmelt flows directly into waterways via surface runoff because there are so many natural barriers in between.

As vegetated areas are replaced by roads, rooftops, sidewalks, and lawns, however, a much larger proportion of rainwater and snowmelt falls onto impervious (hard) surfaces. In a subwatershed like Stony/Paint Creek, this storm water runoff flows either into roadside ditches that drain to the creek, or, in the more densely developed areas, it flows into a system of storm drain pipes that eventually outlet to the creek. During a rain event, this increased runoff causes the flow rate of the creek to increase dramatically over a short period of time, resulting in what is referred to as "flashy flow." In addition to rapidly increasing flows during storm events, the increase in impervious surface also decreases base flows during non-storm conditions because less water infiltrates into the ground and is slowly released into the creek via groundwater seeps. Extreme flashiness can lead to rapid erosion of streambanks (especially in areas where the streambank vegetation has been removed or altered) and sedimentation. These impacts create unstable conditions for the macroinvertebrates and fish that inhabit the creek. (For a more complete analysis of imperviousness, see Appendix B.)

Stony Creek retains many of the hydrologic characteristics of a natural creek system because its watershed is relatively undeveloped. The results of the hydrologic survey indicate that Stony Creek is not yet experiencing the damaging flashy flows during wet weather events that are typical of more urban streams. However, isolated changes to the natural flow characteristics of Stony Creek are already noticeable as a result of advancing development. Most of these changes have been observed in the lower portion of the subwatershed, where development has historically been concentrated. While some storm water detention systems have been constructed in an effort to slow the rate at which storm water runoff enters the creek, a number of respondents to the Stony Creek Riparian Landowner Survey conducted by CRWC in 2002 reported flashy, sediment-laden flows in the lower end of the creek, particularly in the Rochester Hills and Rochester area. In addition, sites higher in the subwatershed are experiencing hydrologic alteration as a result of riparian vegetation removal.

Paint Creek has experienced more development and overall has seen in increase in its peak flow hydrologic conditions as evidenced from the geomorphology study; however, bankfull flow events have been managed because this evaluation demonstrated that these smaller events are not having a significant impact on the channel.

Another hydrologic concern in the Stony/Paint Creek subwatershed is the effect of impoundments on creek flows. The dams located throughout the subwatershed are adjusted to maintain desired lake levels. In some instances, especially during dry periods in the hot summer months, this can result in drastically lowered creek levels below the impoundments, which can have a negative impact on the aquatic community.

As development continues to advance northward, hydrologic alteration of Stony and Paint Creeks will continue unless steps are taken to protect the natural ability of the land to absorb precipitation.

3.5.2 Sediment

Sediment refers to the particles of soil that are picked up by flowing water and deposited on the streambed. Sediments that are suspended in the water column are known as "total suspended solids," or TSS. Elevated TSS can decrease light penetration for aquatic plants, clog gills of aquatic organisms and fish, and impair aesthetics. Sediments that settle out of the water column and are deposited on the streambed can cover up the gravel and cobble substrate where fish and aquatic organisms lay their eggs.

Some sedimentation is natural, as the streambank in one area erodes and the soil is deposited downstream. Increased storm water flows result in increased sediment loadings for a variety of reasons. Soil particles are picked up by storm water as it flows over roads, through ditches, and off of bridges into the creek. In addition, runoff from construction sites can be a major source of sediment if proper soil erosion and sedimentation controls are not in place on bare soil that has been exposed during the construction process.

In Stony and Paint Creeks, sediment is identified as one of the major pollutants of concern, as it appears to be impairing the macroinvertebrate community in a number of locations. Many of the roads in the subwatershed are still gravel, and will likely remain gravel for a long time to come. As a result, sediment enters the stream at bridges as a result of poor construction and maintenance practices, and via road ditches, which convey sediment from gravel roads into the stream. Sedimentation is also increasing as storm water flows increase, scouring the banks and depositing sediments downstream. Finally, in isolated cases, construction sites adjacent to the stream were identified as sources of sediment due to improper erosion and sedimentation controls.

Based on the PLOAD analysis, the subbasins SC-K, SC-O and PC-I within the Stony/Paint Creek subwatershed exhibited the highest levels of sediment load in the subwatershed. These annual sediment load is estimated to be 80-150 lbs/acre. Most of the sediment load for Stony/Paint Subwatershed was modeled to be under 80 lbs/acre per year. Relatively speaking, more urbanized areas exhibit much higher sediment load; however, the Stony/Paint Subwatershed Group has identified sediment as a primary concern throughout the subwatershed in order to continue to preserve these high quality streams.

3.5.3 Nutrients

The primary nutrient of concern in the Stony/Paint Creek subwatershed is phosphorus, which is normally a limiting factor in the growth of aquatic plants. When excessive amounts of phosphorus are present, aquatic plants can grow out of control and algae blooms are common. Sources of phosphorus in the Stony/Paint Creek subwatershed include fertilizers from lawns, golf courses, and croplands, failing septic systems, pet and livestock wastes, and illicit connections between sanitary sewers and storm drains. Aquatic plant growth is a well-documented problem in Lakeville Lake, where the lake association has hired a consultant to address the issue. In addition, numerous homeowners are commonly concerned with their detention ponds and management of the algae. Algae blooms and excessive aquatic plant growth were also observed throughout the subwatershed during the stream inventory. The qualitative observations collected in the inventory indicate that fertilizer use is probably the primary source of phosphorus to Stony and Paint Creeks. It is assumed that failing septic systems are also a major contributor. At this time, it is not clear whether agricultural fertilizer runoff or illicit connections are major sources.

The PLOAD analysis identified subbasin PC-I as the highest contributor of nutrients at approximately 0.6-0.8 lbs/acre annually. PC-C, PC-E, SC-K and SC-O exhibited higher loading rates than the remainder of the subwatershed at 0.4-0.6 lbs/acre annually as opposed to less than 0.4 lbs/acre for the remainder of the subwatershed.

3.5.4 Bacteria

Although bacteria data is not available for the Stony/Paint Creek subwatershed outside of Stony Creek Metropark, the existence of failing septic systems in the region is well known and therefore is considered to be a fairly certain source of bacteria in Stony Creek. In addition, municipal staff and residents alike have observed the presence of large numbers of Canadian geese in areas adjacent to the creek, ponds, and lakes where riparian vegetation has been removed. It is assumed from these observations that waterfowl are also a very likely contributor to elevated bacteria levels. In addition, illicit connections and livestock in the stream are potential contributors, but were not observed in the course of the stream inventory.

3.5.5 Elevated Temperature

Temperature data was not collected as part of the Stony and Paint Creek stream inventory; however, Stony Creek was stocked with brown trout by the Michigan Department of Natural Resources (MDNR) up until 1991 and, according to the MDNR, is still capable of supporting a coldwater fishery. (The stocking was ceased as a result of a combination of problems, including limited access and a series of fish kills.) The observations from the stream inventory indicate that coldwater fish species are still present in the stream. Paint Creek is commonly stocked with brown trout by the Michigan Department of Natural Resources. However, low flows below impoundments, removal of streambank vegetation, and inputs of storm water runoff (which are typically substantially warmer than base stream flows) are all likely to be elevating the temperature in Stony and Paint Creeks.

3.5.6 Organic Compounds & Heavy Metals

Organic compounds (PCBs, PAHs, DDT, etc.) and heavy metals (lead, copper, mercury, zinc, chromium, cadmium, etc.) can potentially cause adverse impacts on river ecosystems. These chemicals and metals can disrupt the physiology of aquatic organisms and can accumulate in their fatty tissues. The contamination of fish tissues with organic chemicals and heavy metals, particularly PCBs and mercury, has resulted in the issuance of fish consumption health advisories in the Clinton River watershed and Lake St. Clair.

Organic chemicals such as PCBs are by-products of manufacturing processes and the combustion of fossil fuels. They are also present in automobile fluids such as gasoline and oils. Other organic chemicals are found in pesticides and herbicides. Heavy metals are also a common by-product of manufacturing, but these contaminants are also common in agricultural and road runoff.

The Stony Creek Lake impoundment is identified as a 303(d) non-attainment water body for FCA - PCBs and mercury under the Clean Water Act (CWA). Section 303(d) of the 1972 CWA provides authority for restoring polluted waters, requiring states to work with interested parties to develop Total Maximum Daily Loads (TMDLs) for these waters. A TMDL is a pollutant loading "budget" designed to restore the health of the waterbody in question by specifying maximum amounts of a pollutant that the waterbody can receive and still meet water quality standards. In Michigan, the Department of Environmental Quality must set dates by which TMDLs must be established for listed waterbodies, as well as set dates by which the waterbody must meet the designated TMDLs. TMDL implementation for Stony Creek Lake is scheduled for 2009 for FCA - PCBs and 2011 for mercury.

Within the Paint Creek subwatershed, TMDL implementation for Lake Orion is scheduled for 2010 and 2011 for FCA-PCBs, chlordane and mercury. TMDL implementation for Lakeville Lake is scheduled for 2011 for mercury.

3.5.7 Salt

The effect of salt application on roadside vegetation and the aquatic life in Stony and Paint Creeks is a concern of municipal staff and residents in the subwatershed. The impacts of salt are not fully understood, but it is generally recognized that salt can negatively affect roadside vegetation. In areas where road runoff enters roadside ditches that flow into Stony and Paint Creeks, there is also the potential for salt to impact surface waters. While the limited number of paved roads in the subwatershed reduces the amount of salt applied, the more densely developed areas of the subwatershed have paved roads, and salt could be a potential issue in those regions.

Following periods of rapid snowmelt in the winter and spring, large amounts of salt can enter Stony and Paint Creeks and literally "shock" the system with elevated sodium chloride levels. This can negatively impact both macroinvertebrates and coldwater fish species, as they must attempt to seek refuge in deeper pools, ponds, and lakes. Anadramous fish species (those that migrate to open waters during the summer months) are less susceptible in the springtime because they are already migrating out to Lake St. Clair.

Table 3.40. Stony Creek Pollutants, Sources & Causes. (s = suspected; k = known)

Pollutants	Sources	Causes
Sediment (k)	Road-stream crossings (k)	Poor road/bridge maintenance (k) Removal of vegetation (k) Improper erosion and sedimentation controls (k)
	Conveyance of sediment from gravel roads via road ditches (k)	Poor road/bridge maintenance (k) Removal of vegetation (k) Improper erosion and sedimentation controls (k)
	Streambanks (k)	Poor road/bridge maintenance (k) Removal of vegetation (k) Poor storm water management practices (k)
	Flow fluctuations (k)	Increase in impervious surfaces (k) Poor storm water management practices (k) Removal of vegetation (k)
	Construction site runoff (k)	Improper erosion and sedimentation controls (k) Removal of vegetation (k) Poor storm water management practices (k) Inadequate enforcement (k)
	Other storm water runoff (k)	Increase in impervious surfaces (k) Poor storm water management practices (k) Removal of vegetation (k)
Nutrients (k)	Residential fertilizer use (k)	Improper design / maintenance (k) Improper or over-application (k) Improper application / lack of buffer (k) Removal of vegetation (k)
	Failing septic systems (k)	Lack of inspections (k) Improper design / maintenance (s)
	Agricultural fertilizer use (k)	Improper or over-application (k) Improper application / lack of buffer (k)
	Illicit connections (s)	Historic cross connections (s)
	Storm water runoff (k)	Increase in impervious surfaces (k) Poor storm water management practices (k) Improper construction / maintenance (s)
Hydrology (k) • **Low Flow (k)** • **Flashiness (k)** • **Dams (k)**	Storm water runoff (k)	Increased impervious surfaces (k) Removal of vegetation (k) Poor storm water management practices (k)

Pollutants	Sources	Causes
	Decreased groundwater recharge (s)	Increased impervious surfaces (k) Removal of vegetation (k) Poor storm water management practices (k)
	Lake/Impoundment Level Control (k)	Lake level management practices (k)
Elevated temperature (k)	Storm water runoff (k)	Increased impervious surfaces (k) Removal of vegetation (k) Poor storm water management practices (k) Impoundments (k)
Salt (k)	Road runoff (k)	Improper or excessive application (k)
Bacteria (k)	Failing septic systems (k)	Improper construction / maintenance (k) Lack of homeowner education on proper maintenance (k) Removal of vegetation (k) Unrestricted access (s)
	Waterfowl (k)	Unrestricted access (s) Removal of vegetation (k)
	Illicit connections (s)	Historic cross connections (s)
	Livestock in stream (s)	Unrestricted access (s)
	Hydrology (k) -low flow (k)	Removal of vegetation (k) Poor storm water management practices (k) Impoundments (k) Lake level management practices (k)
Organic chemicals, heavy metals, pesticides (k)	Lake sediments (s) Agricultural use (s) Residential use (s) Road runoff (s)	Historic contamination (s) Improper or over-application (s) Poor storm water management practices (s)
	Agricultural use (s)	Improper or over-application (s) Poor storm water management practices (s)
	Residential use (s)	Improper or over-application (s) Poor storm water management practices (s)
	Road runoff (s)	Improper or over-application (s) Poor storm water management practices (s)

3.6 IDENTIFICATION OF CRITICAL AREAS

It would be difficult to implement some recommended actions across the entire 140-square mile Stony/Paint Creek subwatershed due to financial constraints and other limited resources. The definition of a critical area helps to prioritize actions in the areas where they will do the most good. Because most of the development in the Stony/Paint Creek subwatershed is relatively low-density residential, most of the sources of impairment and non-point source pollution are associated with the land parcels that are bisected by the stream or are immediately adjacent to the stream, also known as riparian parcels. *For the purposes of this subwatershed management plan, the critical area has thus been defined loosely to include all of the land parcels that either include or are immediately adjacent to the stream and its tributaries* (Figure 3.15). Although not mapped, the critical area is also defined to include road-stream crossings and adjacent roadside ditch systems, as they have been observed to be considerable sources of sediment to the stream.

It is interesting to note that, when overlaid with both wetlands (Figure 3.16) and Michigan Natural Features Inventory priority areas (Figure 3.17), many of the riparian parcels overlap with these critical natural features. These correlations support the definition of the critical area as both the source of pollutants and the region with the greatest potential for protection efforts to prevent further degradation of the stream. Fortunately, a number of large parcels are already protected in parks and other recreation areas (Figure 3.18).

3.6.1 Overall Site Ranking

To begin the overall ranking and scoring process, tabulation of all the individual datasets was conducted. The Single Site Road Crossing Survey, Bank Erosion Hazard Index (BEHI), Macroinvertebrate Survey and Nonpoint Source Pollutant Loading were ranked and scored individually. As discussed in the individual survey method chapters each survey technique had its own scoring system. These scoring systems were converted to a weighted scoring system that was used to determine an overall site score. The scores were then used to rank all sites within the subwatershed on a relative scale.

The Road Crossing Survey data was used to tabulate a score for Physical Condition based on the MDEQ Single Site Survey Data Sheet protocol. Points were awarded depending on width of the stream, width of the riparian vegetation, type of vegetation, such as lawn, wetland or forest, and diversity of the instream cover and substrate. The composition of the substrate and the availability of pools and riffles were also factors recorded and scored for river morphology. Points were deducted for negative appearance factors such as turbidity or floating algae and if the adjacent land uses consisted of impervious or disturbed ground. Points were also deducted for any potential pollution source recorded based on low, moderate or high severity. Potential sources included but were not limited to urban runoff, site development construction activities and road runoff

Scoring of the BEHI data sheet was based on the MDEQ Standard Bank Erosion Hazard Index protocol. A total of 20 possible points was possible for a site with minimal erosion potential. The Macroinvertebrate scoring system was also based on the established MDEQ protocol. A total of 60 points possible were awarded to each site dependant on species diversity and totals found.

The Nonpoint Source Pollutant Loading consisted of evaluating four (4) typical nonpoint parameters, including Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), Total

Phosphorus (TP) and Nitrogen (N-as nitrate and nitrite). The sites were assigned points depending on the level of pollutant loading for each parameter within the subbasin. Lower values of pollutant loading received higher scores while sites located in areas of higher pollutant loading received fewer points. A total of five (5) points was possible for each of the four parameters.

A weighted scheme was created in order to provide a relative ranking scheme for all survey sites within the Stony/Paint Creek subwatersheds. This weighted scheme was based on the influence the survey results have on the overall condition of the subwatershed. For example, macroinvertebrate diversity is highly influenced by characteristics evaluated in both the road crossing and behi surveys and in general, a high macroinvertebrate score generally indicates positive subwatershed conditions. It is for this reason that the macroinvertebrate survey was ranked more heavily than the other surveys. The nonpoint source loading was only assigned a 10% ranking due to the fact that it is based on computer modeling and not field data. Table 3.42 highlights the weighted scoring system.

Table 3.41. Weighted Scoring Breakdown

Road Crossing	Macroinvertebrates	BEHI	Nonpoint Loading	Total
25%	40%	25%	10%	100%

3.6.2 Site Ranking Assessment

Table 3.42 and Table 3.43 show the ranking of each site by survey from highest rank down to the lowest rank for each subwatershed. It's important to note that a low ranking does not mean low quality. In relative terms, based on the above described scoring process, the lowest "rank" as shown in the table, had the lowest score; however, all sites within both subwatersheds were similar in quality.

Ranking the sites helped to further categorize the actions that may be implemented within each of the subbasins in the subwatershed. Furthermore, by category provides an indication of the types of future best management practices that may be identified for improvements to the site while the overall rank provides direction for future prioritization of activities. Figure 3.41 shows individual site location and overall ranking.

Table 3.42. Ranking of Survey Sites for Stony Creek

Rank	Overall Rank	Macro Rank	BEHI Rank	Road Xing Rank	NPS Rank
1	QAPP 10	QAPP 01	QAPP 10	QAPP 09	QAPP 04
2	QAPP 07	QAPP 08	QAPP 06	QAPP 01	QAPP 02
3	QAOO 01	QAPP 07	QAPP 07	QAPP 07	QAPP 07
4	QAPP 08	QAPP 04	QAPP 08	QAPP 03	QAPP 08
5	QAPP 04	QAPP 10	QAPP 01	QAPP 05	QAPP 03
6	QAPP 03	QAPP 03	QAPP 02	QAPP 10	QAPP 05
7	QAPP 06	QAPP 06	QAPP 04	QAPP 06	QAPP 06
8	QAPP 05	QAPP 05	QAPP 05	QAPP 04	QAPP 09
9	QAPP 09	QAPP 02	QAPP 03	QAPP 08	QAPP 10
10	QAPP 02	QAPP 09	QAPP 09	QAPP 02	QAPP 01

Table 3.43. Ranking of Survey Sites for Paint Creek

Rank	Overall Rank	Macro Rank	BEHI Rank	Road Xing Rank	NPS Rank
1	**PC 07**	PC 07	PC 02	PC 02	PC 02
2	**PC 02**	PC 01	PC 04	PC 08	PC 03
3	**PC 04**	PC 03	PC 08	PC 03	PC 04
4	**PC 03**	PC 04	PC 05	PC 05	PC 08
5	**PC 08**	PC 02	PC 07	PC 04	PC 01
6	**PC 01**	PC 08	PC 01	PC 06	PC 07
7	**PC 05**	PC 05	PC 06	PC 07	PC 05
8	**PC 06**	PC 06	PC 03	PC 01	PC 06

The following are examples of each category for critical areas:

Marcoinvertebrates

Example sites of the most critical for each subwatershed are QAPP01 and PC07. These sites both scored the highest in terms of macroinvertebrate community. It's interesting that both of the downstream most points in each subwatershed scored the highest in macroinvertebrate community. These sites provide a good habitat in proof of the substrate and riparian corridor at each site.

Bank Erosion Hazard Index (BEHI)

The BEHI is an index used to determine a site's potential for bank erosion. The most critical sites within each subwatershed are QAPP10 and PC02. Overall, sites within the Stony/Paint subwatershed do not have severe bank erosion potential, with the exception of specific site issues at some road/stream crossings. These sites share the same bank conditions as slight slopes and good vegetative cover.

Road Crossing

The sites that are most critical in the Road Crossing category are QAPP09 and PC02. Low density development and larger riparian buffers make these sites unique in terms of preservation opportunities. The less human influence on the road crossing the more the need is to preserve the natural character.

Nonpoint Source Pollutants (NPS)

The nonpoint source analysis (PLOAD) estimated loadings into the creeks within each subbasin. Table 3.6 lists the actual subbasin IDs along with the communities that are located within each subbasin. Figure 3.11 shows the nonpoint source loading results for four main pollutants, including BOD, Phosphorus, Nitrates/Nitrites, and Sediment.

The PLOAD analysis identified subbasin PC-I as the highest contributor of nutrients at approximately 0.6-0.8 lbs/acre annually. PC-C, PC-E, SC-K and SC-O exhibited higher loading rates than the remainder of the subwatershed at 0.4-0.6 lbs/acre annually as opposed to less than 0.4 lbs/acre for the remainder of the subwatershed.

The subbasins SC-K, SC-O and PC-I within the Stony/Paint Creek subwatershed exhibited the highest levels of sediment load in the subwatershed. The annual sediment load is estimated to be 80-150 lbs/acre. Most of the sediment load for Stony/Paint Subwatershed was modeled to be under 80 lbs/acre per year. Relatively speaking, more urbanized areas exhibit much higher sediment load; however, the Stony/Paint Subwatershed Group has identified sediment as a primary concern throughout the subwatershed in order to continue to preserve these high quality streams.

3.6.3 Overall Critical & Subcritical Areas in the Stony/Paint Subwatershed

Due to importance of preservation within this entire subwatershed, it is clear that the critical areas are directly associated and linked to the riparian corridor of these streams and their tributaries. This entire critical area was further refined to prioritize preservation goals and actions. The best means of refining the critical area was by utilizing the subbasins identified and delineated through the nonpoint source loading analysis. The results of the field surveys, volunteer monitoring, nonpoint source pollutant loading and community priorities was the basis for further delineating the riparian corridor into subbasin critical areas.

The Stony Creek subwatershed has fifteen (15) subbasins (SC-A thru SC-O) while the Paint Creek subwatershed has sixteen (16) subbasins (PC-A thru PC-P). Each subbasin was assigned a preservation category (1, 2 or 3) and which is generally consistent with the level of impacts that have been observed in the subbasin. The following description helps to further define these levels of preservation which are equivalent to the subcritical areas within the Stony/Paint Subwatershed:

Preservation Category 1: This category applies to areas that have not experienced a high amount of development. Communities in these subbasins may be experiencing development pressures and may also have significant natural features in which "actions" may include preservation of these natural features. Biological conditions and physical characteristics are high quality and the nonpoint source pollutant loading estimates are low in relative comparison to the remainder of the subwatershed.

Preservation Category 2: This category applies to areas that have experienced development, may have more urbanized land use characteristics and also have some areas that are experiencing development pressures. Survey sites within these subbasins scored in the middle range of most of the analyses. "Actions" that may be implemented within these subbasins consist of a combination of preserving remaining natural features while focusing resources on maintenance of areas that are potentially contributing pollutants to the waterways.

Preservation Category 3: This category applies to areas that are the most urbanized within the Stony/Paint subwatershed as well as areas that are not considered part of the riparian corridor. Impacts to the streams have been observed and/or modeled, but not to the extent that would be expected in the more urbanized areas of the Clinton River Watershed. Therefore, this category does not imply that restoration is the complete focus for the actions in this category; rather, there are a combination of actions that may include some restoration, maintenance and preservation.

Based on the Overall Critical Sites depicted in Tables 3.42 and 3.43 and the overall Pollutant Loading Model Figure 3.11 for the subwatersheds, a ranking based on subbasins was derived. (Table 3.44 and 3.45) The information in these tables was overlain on the riparian parcels and was used to delineate the critical areas within the subwatersheds (Figure 3.15).

In addition, Chapter 5 describes Actions that will be implemented and Appendix C: Recommended Actions & Criteria for Subcritical Areas describes the actions that should be implemented in these subcritical areas.

Table 3.44. Paint Creek Preservation Category by Subbasin and Community

Paint Creek Subbasin ID	Communities within Paint Creek Subbasin	Preservation Category/Subcritical Areas 1, 2, 3
PC-A	Rochester Rochester Hills	2
PC-B	Rochester Rochester Hills	2
PC-C	Rochester Oakland Township Auburn Hills	2
PC-D	Oakland Township	1
PC-E	Oakland Township Orion Township Village of Lake Orion Oxford Township	3
PC-F	Oakland Township	1
PC-G	Oakland Township Orion Township	2
PC-H	Oakland Township Orion Township	2
PC-I	Oxford Township Oxford Village Orion Township	2
PC-J	Oxford Township Orion Township	1
PC-K	Oxford Township Oxford Village Brandon Township	1
PC-L	Oxford Township Oxford Village Brandon Township Orion Township Independence Township	1
PC-M	Orion Township Independence Township	1
PC-N	Brandon Township Independence Township	1
PC-O	Brandon Township	2
PC-P	Brandon Township	1

Table 3.45. Stony Creek Preservation Category by Subbasin and Community

Stony Creek Subbasin ID	Communities within Stony Creek Subbasin	Preservation Category/Subcritical Areas 1, 2, 3
SC-A	Rochester Rochester Hills Oakland Township Washington Township	3
SC-B	Washington Township	2
SC-C	Washington Township Oakland Township	3
SC-D	Washington Township Oakland Township	3
SC-E	Oakland Township	3
SC-F	Washington Township Bruce Township Addison Township	3
SC-G	Washington Township Oakland Township Addison Township	1
SC-H	Oakland Township Addison Township	2
SC-I	Oakland Township Addison Township Oxford Township	1
SC-J	Oakland Township Addison Township Oxford Township Orion Township	1
SC-K	Addison Township Bruce Township	2
SC-L	Addison Township	1
SC-M	Addison Township	1
SC-N	Addison Township	1
SC-O	Oxford Township	3

New homes and prairie off of Rochester Road, Oakland Township

CHAPTER 4: LAND USE PLANNING ANALYSIS

4.1 IMPERVIOUSNESS AND BUILD-OUT ANALYSIS

Impervious cover (IC) can be defined as having two components: “the rooftops under which we live work, and shop, and the transport system (roads, driveways, and parking lots) that get us from place to place” (Schueler, 1994). IC impacts stream ecosystems by increasing the volume of storm water runoff discharged from the watershed to the stream. Damaging effects on streams include hydrologic, structural habitat, and water quality impacts. *Hydrologic impacts* including disruption of natural water balance, increased flood peaks, increased storm water runoff, more frequent flooding, increased bank full flows, and lower dry weather flow. *Structural habitat impacts* include stream widening and erosion, reduced fish passage, degradation of habitat structure, decreased channel stability, loss of pool-riffle structure, fragmentation of riparian tree canopy, and decreased substrate quality. *Water quality impacts* include increased stream temperature, pollutants, and risk of beach closure.

The Center for Watershed Protection (CWP) has developed an “Impervious Cover Model” (ICM) which predicts the quality and character of a stream based on the percentage of IC in the watershed (Table 4.1). The ICM divides imperviousness impacts into three categories (Schueler, 1994):

- 0 - 11% impervious cover = sensitive streams
- 11 - 25% impervious cover = impacted streams
- >25% impervious cover = degraded streams

Table 4.1. Stream Attributes According to the IC Model (Schueler, 1994)

Sensitive Stream	Impacted Stream	Non-Supporting Stream
0-10% IC	**11-25% IC**	**>25% IC**
High quality, stable flow regime	Signs of degradation, flow regime destabilizes	Low quality; stream is essentially a conduit for conveying storm water
Stable channels are in stable equilibrium	Altered stream geometry	Severely eroded and incised stream channel
Excellent habitat structure	Degraded physical habitat in the stream	Structure needed to sustain fish is diminished or eliminated
Excellent water quality	Water quality degraded; contact recreation becomes an issue	Water contact recreation is no longer possible
Diverse communities of both fish and aquatic insects	Many sensitive fish and aquatic insects disappearing from the stream	Stream cannot support any but the most tolerant of life forms
Does not experience frequent flooding	Flooding becomes a more serious problem	Flooding becomes a serious problem requiring drastic engineering solutions

In the summer of 2003, and later in 2005, an analysis was conducted by Oakland County Planning & Economic Development Services to estimate the existing and potential future percentage of impervious cover in the Stony and Paint Creek subwatersheds. This analysis was conducted in an effort to estimate what impact future development might have on the health of both Stony and Paint Creeks. The results of these analyses are summarized below; the complete analyses are included in Appendix B: Impervious Surface Analyses. Four major tasks were undertaken: (1) catchments within the Paint Creek subwatershed were delineated to provide a closer look at the impact of IC on small watershed areas, (2) the existing IC was estimated using Color Infrared Photography from the year 2000, (3) the potential future IC was estimated using community land use plans and estimated imperviousness coefficients associated with planned land uses, and (4) an alternative potential future IC was estimated, using IC reduction factors that may be gained by implementing “Better Site Design” practices.

Results – Year 2000 Impervious Cover

The existing IC in the Paint Creek in 2000 was estimated to be 6%, and in Stony Creek 7.25%, placing both in the “Sensitive” category of the ICM.

In the Paint Creek subwatershed, catchment IC ranged from 3% to 9.3%. of the 12 catchments, all were classified as “Sensitive.” Impervious surfaces are largely concentrated along road corridors and in higher density residential areas. Trout Creek had the highest IC measured, and Silver Bell creek had the lowest. (See the appendix for catchment boundaries.)

The highest individual community percentages of IC in the Stony Creek watershed were attributed to the Village of Lake Orion (36.6%), Bruce Township (27%), the City of Rochester (22.9%), and the City of Rochester Hills (15.4%). The lowest percentages if IC were attributed to Addison Township (5%) and Oakland Township (5.1%); however, these two communities also had the greatest amount of IC acreage, a byproduct of having the largest land area in the watershed. Addison Township comprises 35% of the watershed and had 835.5 acres of IC in 2001, while Oakland Township comprises 29% of the watershed and had 700.4 acres of IC in 2001.

Potential Future Development

Based on existing land use planning policy, the potential future IC percentage of the Stony Creek subwatershed was estimated to be 12.5%, which places Stony Creek in the lower end of the "Impacted" category of the ICM (Table 4.2; Figure 4.2). Oakland Township has the greatest potential to add IC acres within the watershed, potentially adding 1,781 additional acres of IC and bringing the Stony Creek watershed area of the township from 5.1% IC to 13.1% IC. Other large estimated potential increases include Addison Township (adding 1,417 IC acres to bring the percentage from 5% to 8.6 %), Washington Township (adding 353 IC acres to bring the percentage from 7% to 11.5%), and the City of Rochester Hills (adding 139 IC acres to bring the percentage from 15.4 to 25.1).

Estimated potential reductions in IC using "Better Site Design" methods did not drive the overall watershed percentage below 11%. A savings of only 1% watershed wide was attained, reducing the watershed-wide IC from 12.4% to 11.4%

Table 4.2. Year 2000 and Potential Future Impervious Cover Estimates of Communities in the Stony Creek Subwatershed. (CD = Conventional Development; BSD = Better Site Design Practices)

Community	Total Acres	Year 2000 IC Acres	Year 2000 % IC	Potential Additional IC Acres (CD)	Total Future IC Acres (CD)	Potential Future % IC (CD)	Potential Additional IC Acres (BSD)	Total Future IC Acres (BSD)	Potential Future % IC (BSD)
Addison Township	16570.1	835.5	**5.0**	581.7	1417.2	**8.6**	477.9	1313.5	**7.9**
Bruce Township	1308.1	353.2	**27.0**	58.7	411.9	**31.5**	47.0	400.2	**30.6**
Lake Orion	8.0	2.9	**36.6**	0.6	3.6	**44.7**	0.5	3.4	**43.1**
Leonard	455.5	36.3	**8.0**	52.7	89.0	**19.5**	42.2	78.5	**17.2**
Oakland Township	13677.6	700.4	**5.1**	1086.8	1787.1	**13.1**	869.4	1569.8	**11.5**
Orion Township	742.9	143.5	**19.3**	23.8	167.2	**22.5**	19.0	162.5	**21.9**
Oxford Township	4461.7	433.5	**9.7**	134.1	567.6	**12.7**	107.5	540.9	**12.1**
Rochester	621.5	142.5	**22.9**	13.0	155.5	**25.0**	10.4	152.9	**24.6**
Rochester Hills	1425.1	218.8	**15.4**	139.2	358.0	**25.1**	111.5	330.3	**23.2**
Shelby Township	26.6	3.0	**11.3**	0.7	3.7	**13.9**	0.5	3.6	**13.4**
Washington Township	7916.3	554.1	**7.0**	353.3	907.5	**11.5**	282.7	836.8	**10.6**
TOTAL	**47213.5**	**3423.8**	**7.3**	**2444.5**	**5868.4**	**12.4**	**1968.6**	**5392.4**	**11.4**

Based on the existing development status of land and community master plans, the potential future IC at buildout was mapped and summarized for each catchment in the Paint Creek subwatershed, and for the entire subwatershed for conventional site development and using Better Site Design. Using conventional design, we expect the total subwatershed IC at buildout to reach 12%; with Better Site Design that may be reduced to 11%; placing the subwatershed in the lower end of the "Impacted" category of the ICM.

Only 2 of the 12 catchments will remain in the "Sensitive" category of the ICM under either conventional or Better Site Design scenarios; all others will enter the "Impacted" category to varying degrees.

The highest percentage IC at buildout expected is in an unnamed tributary in northern Oakland Township (17.2%), Gallagher Creek (15.3%), and Trout Creek (14.7%). Potentially the greatest impacts of using Better Site Design will be in the unnamed tributary in northern Oakland Township (a reduction of 2.5%), in Bear Creek (a reduction of 2.1%), in Silver Bell Creek (a reduction of 1.9%), and in Gallagher Creek (a reduction of 1.7%).

Table 4.3. Year 2000 and Potential Future Impervious Cover Estimates of Catchments in the Paint Creek Subwatershed. (CD = Conventional Development; BSD = Better Site Design Practices)

Catchment Name	% Impervious-ness	Buldout % Impervious (CD)	Buldout % Impervious (BSD)	Change (CD)	Change (BSD)	Potential BSD Savings
Upper Paint Creek (West Branch)	5.2	8.8	**8.1**	3.6	2.9	**0.7**
Paint Creek Direct Drainage	7.6	13.2	**12.1**	5.6	4.5	**1.1**
Sargent Creek	4	6.3	**5.8**	2.3	1.8	**0.5**
Scenic Hollow	1.7	3.5	**3.1**	1.8	1.4	**0.4**
Unnamed Tributary (Southern Oakland Township)	6	11.2	**10.2**	5.2	4.2	**1**
Bear Creek	3.1	13.9	**11.8**	10.8	8.7	**2.1**
Silver Bell Creek	3	12.9	**11**	9.9	8	**1.9**
Gallagher Creek	6.8	15.3	**13.6**	8.5	6.8	**1.7**
Trout Creek	9.3	14.7	**13.6**	5.4	4.3	**1.1**
Unnamed Tributary (Northern Oakland Township)	4.8	17.2	**14.7**	12.4	9.9	**2.5**
Trout Creek (North Branch)	7.1	11.6	**10.7**	4.5	3.6	**0.9**
Upper Paint Creek (East Branch)	**5.2**	**13**	**11.5**	**7.8**	**6.3**	**1.5**

Potential Errors in the Analysis

The accuracy of the future IC estimates depends upon two factors; the accuracy of the IC estimates for each land class (discussed in the next section) and the accuracy of the methodology in estimating potential development areas.

Potential Development Methodology

Community master plan data was combined with wetlands and water features to remove "unbuildable" land areas. The remaining land was then evaluated to determine if the land was in a "committed use" using GIS data sources. Committed uses were generally parks and schools. Finally, the remaining land was evaluated to determine whether it was "built-out" to its fullest potential, thereby not likely to be developed. Any error in the databases or manual or automated processing could affect the outcome of the analysis. Redevelopment was not considered in the analysis.

Error in Estimating IC for Land Use Classes

Because the master plan data was parcel specific, IC estimates were generated for each land use classification by generating average pixel summaries of imperviousness for each parcel in Oakland County's parcel-specific 2001 land use data. The actual percentage of IC on any particular parcel within a land use classification may vary widely from the average value. This variation likely introduced error into the potential IC analysis; therefore the future imperviousness values represent average imperviousness conditions and should only be used as a general guide for projecting future conditions. **This analysis does not purport to make a highly accurate forecast of future conditions, but rather provides an indication of future trends.**

Conclusions

The following conclusions may be made based on this analysis:

1. Overall, the Paint and Stony Creek Subwatersheds were "Sensitive" stream systems based on the ICM in the year 2000 (6% IC and 7.25% IC, respectively).

2. Because of the uneven development pattern across the subwatersheds, some areas will remain "Sensitive" while others will become "Impacted". It is not expected that any areas will become "Non-supporting".

"Better Site Design" measures, while not significantly reducing IC for either subwatershed as a whole, have the potential to make significant reductions in IC in catchments and local areas.

The Center for Watershed Protection recently completed a review of the scientific literature pertaining to the application of the Impervious Cover Model. This review indicated that the influence of impervious cover in the 1-10% range is relatively weak when compared to other potential factors, such as percent forest cover, riparian continuity, historical land use, soils, and agricultural use (CWP, 2003). The review warned that IC alone should not be used to classify and manage streams in watersheds with less than 10% impervious cover. Overall, it appears that IC is a more reliable indicator of overall stream quality in watersheds that have greater than 10% IC. In addition, CWP found that a number of streams in high-IC watersheds that also had extensive streamside forest cover had unusually high quality biological communities. In these cases, it appeared that forested stream buffers (defined as at least two-thirds of the stream network with at least 100 feet of forest width on either side of the stream) were influential in enhancing stream quality. Riparian forests have many benefits, including shading and cooling, reducing storm water runoff volumes, providing woody debris and leaf litter for instream habitat, and providing bank stability.

These findings have serious implications in the Stony/Paint Creek subwatershed, since its current estimated IC is below 10%, and future predicted IC is still relatively close to the 10% threshold. In the case of Stony and Paint Creeks, while minimizing IC through low-impact development practices is still critical, maintenance of forest cover in general and continuity of the riparian forest corridor along the stream could be the key to protecting the creek over the long term.

4.2 ANALYSIS OF COMMUNITY PLANS, ORDINANCES & STANDARDS

As a component of the Stony/Paint Creek Subwatershed Management Plan, an evaluation of the plans and policies of each participating community was conducted to determine at what level these documents currently protect the Stony and Paint Creek corridors and their water quality. An evaluation check list of development regulations was created from The Center for Watershed Protection's *Better Site Design: A Handbook for Changing Development Rules in Your Community,* (CWP, 1998) and a general analysis was conducted on each community's Master Plan. Draft analyses were presented to each community for input and feedback. The analyses were revised based on the comments gathered and final drafts were provided to the communities for their review. Because the analysis is quite lengthy, only the Master Plan reviews are included in the main text of this document; the code analysis is included as Appendix D.

The recommendations discussed in this document are based on the evaluations of the Master Plan, Zoning Ordinance, and other development documents provided. A draft copy of the recommendations was presented to each community, and modifications were made based on these discussions.

The recommendations have been organized into three main categories:

1. **Plans and Policies**
2. **Development / Redevelopment Regulations**
3. **Programs / Standards / Guidelines**

This organization will enable the community to easily integrate the comments into each document. For example, all the recommendations pertaining to changes to the Master Plan, Recreation Master Plan, or other plans are located within the "Plans and Policies" category. Within each category, recommended ideas or actions are organized by topics.

Each topic also includes a listing of possible tools and techniques that could be used to address storm water quality or quantity issues. The tools are described in more detail in Appendix D, *Tools and Techniques for Protection of the Stony/Paint Creek Corridors*. Some basic tools, such as the Zoning Ordinance, are not described further.

Of course, this list of tools is not an exhaustive list of all possible planning tools that a community could use to protect water quality. However, it is a listing of effective tools that have been used by other communities to meet the goal of water resource protection. Each community must decide how best to integrate these recommendations into its existing planning documents.

4.2.1 Addison Township (prepared and updated by Addison Township, October 2005)

Master Plan Analysis (Adopted July 2002)

General Information

Addison Township can be characterized as a rural residential and agricultural community. As growth in Oakland County has moved further north, Addison Township has maintained a constant rate of growth in new dwelling units of approximately fifty-two unit per year. This growth is comprised of development that is a result of land divisions and small-scale site condominiums.

The most significant change in land use is a modest conversion of vacant land to residential use. Agricultural areas still comprise about 20% of the total land area of the Township, and 58% of the Township is either vacant or agricultural, most of which remain in large acreage parcels.

The township plan states that the top four community land use concerns are to (1) keep the township rural (2) preserve natural areas and wildlife habitat and wildlife corridors (3) protect groundwater and surface waters and (4) preserve large parcel configurations and agricultural uses. The Plan identifies the preservation of natural features as the prevailing objective when considering all future development.

The Master Plan concludes that natural features act to influence the types and intensities of development appropriate for any given area of the Township. The residents value the agricultural and rural nature of the Township. Examining natural features before development occurs will aid in preserving environmentally sensitive areas, woodlands, and wildlife habitat in a most financially reasonable manner.

Physical Features

The Master Plan describes the major natural features of the Township. Lakeville Lake, in the central part of the Township, provides recreation to the dense residential development that surrounds the lake. Because older septic systems were built when the homes were constructed, proactive measures need to be taken to avoid pollution of the lake from these systems.

The Township also has an abundant amount of land with a high water table and large areas classified as poorly drained. There are over 726 acres of wetland-marsh areas in the Township. Those over two acres are protected by wetlands provisions of the township zoning ordinance. The topography is described as sloped and rolling, with approximately 4,750 acres as sloped (10 or more foot vertical change in elevation over 100 feet). There are also significant woodlands within the Township, comprising over 6,000 acres of hardwood, evergreen and lowland brush areas.

The Plan includes a recommended future land use pattern that reflects goals, objectives and policies of the plan. The pattern is a lowered density for many areas of the township compared to the prior plans and reflects an intent to inhibit premature urban sprawl, recognition of the fiscal constraints on the provision of well-maintained roads, inadequate millage structure to keep with unplanned growth from development and a preference for infilling (subject to township goals and objectives) rather than sprawl.

Goals, Objectives and Environmental Guidelines

The Addison Township Master Plan presents planning goals that relate to natural resource preservation, as well as objectives that describe how they could reach these goals:

Goal: Maintain the rural character of the community.

Objectives:

a. Recognize limitations of road agency funding by maintaining low traffic volumes to assure that gravel roads can be maintained in a safe condition.
b. Encourage agricultural land uses and life styles by limiting residential concentrations in close proximity to rural land uses to avoid conflicts.
c. Encourage preservation of rural viewsheds through site plan review conditions to preserve rural character.

d. Maintain large parcels for agricultural and rural land uses and protect such areas form encroachment by incompatible land uses.
e. Promote land uses that preserve wildlife habitat preservation and review site plans for compliance with this objective.
f. Preserve rural tranquility by assuring compatibility of proposed land uses with preexisting land use conditions.
g. Maintain flexible regulations to promote rural land uses.
h. Promote a rural residential density to promote neighborliness, civic involvement and low incidence of crime.

- *Goal: Provide a choice of housing types, location and environments to accommodate individual capabilities and preferences of current and future populations.*

  Objectives:
  a. Provide for growth an development to occur in a controlled and orderly manner which will provide for residential living, yet not over develop lakes or create public safety or public health compromises or result in environmental degradation.
  b. Encourage residential development to occur in a manner that is consistent with the goals, objectives, policies and strategies of township master land use plan.
  c. Encourage residential development to occur at densities according to the recommended future land use pattern of the township master land use plan.
  d. Encourage residential development to occur in a manner which minimizes strip development with driveway access along major transportation routes which compromises public safety an efficient function of roadways.
  e. Encourage single lot residential development to avoid areas of high agricultural activity to prevent land use conflicts.
  f. Encourage residential development to avoid floodprone areas and limit residential densities in sensitive environmental areas which could be significantly damaged.
  g. Encourage the preservation, renovation and maintenance of existing housing and protect existing and future areas from conflicting land uses which would decrease the desirability as residential areas
  h. Higher density development should be discouraged in the absence of adequate sanitary sewage treatment to avoid environmental degradation.

- *Goal: Minimize and mitigate environmental impacts of development in the Township.*

  Objectives:
  a. Reduce the fragmentation of woodlots.
  b. Encourage land use planning that places a commitment to natural resources including farmlands.
  c. Minimize loss of topsoil due to wind erosion.
  d. Protect groundwater quality by reducing potential non-point pollutants.
  e. Minimize challenges to surface water quality.
  f. Protect groundwater quality through reducing non-point source contamination
  g. Maintain and promote corridors for wildlife habitat, protect declining habitat and manage habitat for wildlife.
  h. Preserve wetlands to provide for groundwater recharge, minimize flooding and maximize surface water quality.
  i. Minimize storm water runoff through proper land use locations and development practices.

j. Encourage the use of energy efficient development and use of alternative energy sources.

Additional goals and objectives are contained in the Master Plan under the following categories:

agricultural development, commercial development, industrial development, open space and recreation, transportation and community facilities.

Environmental Guidelines

The Master Plan also has extensive guidelines that describe the benefits of preserving sensitive environmental features such as woodlands, wetlands, lakes, groundwater, topography, and soils. These guidelines also provide policies that can be used to provide for the protection of these resources in order to preserve them.

Existing Land Uses Adjacent to Stony Creek:

- Single-Family Residential
- Semi-Public
- Agricultural
- Vacant

Future Land Uses Adjacent to Stony Creek:

- Rural Residential (1 dwelling unit per five acre density)
- Recreational
- Public
- Lake Area and Village Preservation

(Note: Stony Creek is shown to be within a "Fragile Watercourse Area" for preservation and protection in the Addison Township Land Use Master Plan.)

Recommendations for Addison Township

1. Plans and Policies

Addison has the largest land area within the subwatershed, and therefore activities within the Township will potentially have the greatest impact on Stony Creek. The sensitive wetlands and headwaters of the Stony Creek corridor have significant protection as a result of strengthening the language in the Master Plan in 2002. Further strengthening could occur including steps to add specifics about land development, storm water management, the watershed, the stream itself, and public education. The following ideas could be incorporated:

<u>Land Conservation and Development Techniques:</u>

Provide guidance for community acquisition and/or protection of open space by creating a Natural Areas Plan that identifies important open spaces that should be preserved. This plan could also discuss preferred land conservation techniques, such as conservation easements, protection under subdivision or condominium documents, land conservancy donations, etc.

- Call for the preservation of natural features because of the functional benefits they provide in storm water management (infiltration, filtering, flood control, etc.).

- Call to minimize clearing and grading of sites to retain native vegetation and existing hydrologic patterns.
- Describe agriculture's importance to the community. Map prime and unique agricultural lands, and those agricultural lands that are under development pressure. Provide goals and policies that deal with farmland preservation and coordinate with existing soil capabilities, facilities and infrastructure, transportation, housing and open space.

Storm Water Management Standards:

- Discuss storm water management in the Master Plan, calling for pre-treatment of all storm water before discharge into a natural water body, and maintenance of pre-construction runoff rates.
- Call to reduce impervious surfaces in new construction projects to minimize storm water runoff and improve infiltration.
- Include goals and policies that encourage the use of Best Management Practices (BMPs) to minimize, collect, and treat storm water.
- Include mechanisms to ensure regular inspection and maintenance of BMPs.

Stream Corridors, Floodplains, and Groundwater:

- Connect the community's floodplain protection efforts with adjoining communities' efforts.
- identify groundwater as an important community resource, and map ground water recharge areas in the Master Plan. Make the connection between other environmental features (springs, Stony Creek, etc.) and groundwater recharge areas.

Watershed Issues:

- Identify and map the watershed(s) in the community. Call for protecting watershed resources through development regulations, and sharing in education, pollution prevention, and monitoring. Encourage participation in watershed restoration efforts.

Public Education:

- Amend large lot provisions to include discussion of education efforts to help landowners maintain natural feature buffers and preserve native vegetation.

2. Development / Redevelopment Regulations

Approximately 77% of the community's existing land is in cultivated, grassland and shrub (44%) or woodland and wetland (33%) land use or land cover categories. This gives Addison Township the opportunity to guide future development while preserving natural features. The following offers potential tools to consider. Note that these tools are described in further detail in Appendix D.

Storm Water Management Standards:

- **Storm water Management Ordinance —** This ordinance communicates to developers how storm water quality and quantity are viewed by the community, and can give them guidance as to how they should approach storm water management through their development designs. The main emphasis is to prevent storm water runoff, and treat the runoff that does occur before it reaches a natural water body.
- **Impervious Surface Reduction / Infiltration Enhancement Ordinance —** Impervious surfaces, such as roads, parking lots, and buildings, add to the amount and rate of storm water entering our water bodies. This runoff carries a variety of pollutants. An Impervious

Surface Ordinance can be used to communicate site development standards that guide developers and individuals doing site plan review to find opportunities for less impervious surface and more water infiltration.

- **Best Management Practices —** The zoning ordinance or Engineering Standards can require that all storm water be pre-treated before it is released into a natural water body or wetland. This could be accomplished by the use of Best Management Practices (BMPs) to treat and filter storm water, as well as regulate the rate at which storm water exits a site.

Land Conservation and Development Techniques:

- **Natural Feature Overlay District —** This could be an expansion of the Lake Lot Overlay District. The Natural Feature Overlay district is applied to lands that have been identified as having special environmental features worthy of preservation (through the Natural Areas Plan), but are in various zoning categories. The Overlay District applies additional restrictions to these unique features that "overlay" the underlying zoning classification and rules. The properties retain their original zoning, but the natural features are preserved through the rules in the Overlay District. The areas of protection can be defined as "ecosystems," which would protect the resource itself, and the adjacent lands that contribute to the functioning of the natural resource. For example, a wetland is sustained by the water contributed to it by adjacent uplands. If this water source is cut off by development in the uplands, the wetland will not continue to function. Therefore, through the ecosystem approach, the resource's functions could be preserved, as well as the resource itself.
- **Woodlands Protection Ordinance –** An ordinance that protects trees, tree-rows or entire woodlands (trees, shrubs, and ground layer). This ordinance provides a statement of protection goals, definitions of the features to be conserved, and standards for protection and use. However, these ordinances are generally not written in an "ecosystem" context,

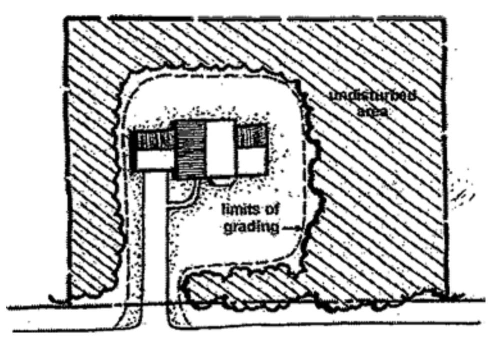


Illustration 4.2. Limit disturbed area using flexible setback provisions.

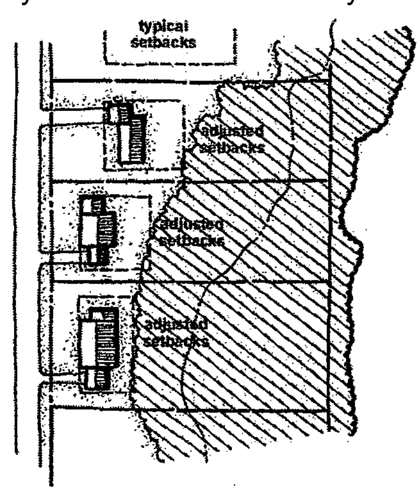


Illustration 4.3. Typical and adjusted setback regulations.

and do not address adjacent lands that contribute to the preservation of the natural resource. (See Natural Feature Overlay District above.)

- **Private Road Ordinance Standards –** Private roads can be safely designed with narrower right-of-ways, which would reduce the amount of clearing and grading necessary to install the roadway.
- **Parking Requirements –** Re-evaluating the community's parking requirements could be a way to reduce the amount of impervious surfaces in a community. One method is to set

parking space maximums instead of minimums. Also, the ordinance could allow the Township body approving site plans to allow for less parking if the situation warrants it. Another method is to permit smaller parking spaces, and shared parking arrangements. Lastly, parking lot islands are an important factor in breaking up the broad expanse of pavement, and allow for infiltration of runoff if designed to capture storm water.

- **Sidewalks –** Currently, the Township does not have sidewalks. However, sidewalks add to impervious surfaces in developments. To balance pedestrian needs with storm water management, pedestrian ways that address imperviousness can be considered.
- **Flexible Setback Provisions –** As part of the development provisions, more flexibility in the setback regulations will help to limit the amount of clearing and grading necessary to build roadways and residential units. The homes can be set closer to the roadway and to each other, using up a smaller building envelope, and enabling the preservation of additional open space.
- **Open Space Management –** Another element of the cluster provisions could discuss how the open space should be maintained after it is set aside for preservation and mechanisms in place to ensure that this happens. Maintenance of natural areas in a natural state may require regular activities to ensure the site retains its functional values.
- **Native Vegetation Guidelines –** That plants that grow naturally in your community perform environmental functions that keep our environment working. The benefits of preserving native plants (woodlands, grasslands, wetland plants, etc.) and landscaping with native plants are many. Native trees, shrubs, and ground layer plants can absorb a great deal of storm water. And improving infiltration of storm water can recharge groundwater resources. Native plants also help filter storm water of its sediments and pollutants, such as through a natural feature buffer. Landscaping with natives requires less fertilizers, pesticides, water and lawn care equipment once the plants are established, reducing the cost of maintenance as well. Natives also provide habitat for beneficial wildlife. Native vegetation guidelines encourage the preservation of native plants, and landscaping with species native to the area. This concept could be expanded to include landscaping adjacent to lakes to help protect water quality and reduce shore line erosion as a component of the Lake Lot Overlay District standards.

3. Programs / Standards / Guidelines

Other actions that can be integrated into a community's day-to-day activities that could positively impact Stony Creek include the following:

- Adopt Design and Engineering Standards. This is a manual available to development professionals that establishes general requirements for the design and construction of subdivisions, site condominiums, commercial sites, and other site improvements under the Township's jurisdiction. This document could be developed to provide, among other things, more detailed information about how to design components of storm water systems that pre-treat runoff, increase infiltration of runoff, or work to maintain pre-construction runoff rates.
- Create a program or coordinate with the County to identify and correct failing septic systems. Prioritize areas for remediation.
- Initiate a community program to regularly clean out, maintain, or inspect structural storm water facilities, such as catch basins, vegetated swales, etc.
- Consider increasing participation in monitoring and enforcing erosion control measures throughout the Township by working with the County.
- Investigate and prioritize clean up of environmental contamination sites, including evaluating state and federal programs for assistance in these efforts.

4.2.2 Auburn Hills

Master Plan Analysis

General Information

The City's Master Plan is expressed on a poster with a future Master Land Use Plan map and text describing the City's vision for its future. The City has plans to update this document within the next few years, and could possibly change the format to allow more space for additional information about Auburn Hills. The current Plan calls for respecting natural areas in its future vision. In addition to discussing natural feature preservation in the Master Plan, the City also discusses this topic in their Recreation Master Plan, and documents created for their Phase II permit through the Rouge Watershed Project (1998). The Recreation plan describes how their existing pathway system connects natural areas together, and the City's paths to greenways in adjacent communities. The Plan also has a goal to build on this pathway system, building new linear parks and trails that connect parks to neighborhoods. The Recreation Plan also provides inventories of important natural features, including wetlands and woodlands, and describes how floodplains are important for storm water infiltration and wetlands are important for storm water storage. An Illicit Discharge Elimination Plan was developed by the City to identify and eliminate illicit discharges to the community drainage system. It also maps the location of all drainage facilities throughout the community.

Environmental Guidelines

Existing Land Uses Adjacent to Paint Creek/tributaries:

- Single-Family Residential

Future Land Uses Adjacent to Paint Creek/tributaries:

- Local Commercial
- Residential/Medium Density (0.5 to 1 ac. min. lot area)
- Residential Multiple Density
- Recreational
- Commercial
- Institutional

Recommendations for Auburn Hills

1. Plans and Policies

If the Master Plan were revised in a more expansive format, this would allow the City to extend each goal into policy statements and more specific objectives of how the goal can be reached. Suggested topics include the following:

Stream Corridors, Floodplains, and Wetlands:

- Indicate the importance of riparian buffers and their role in protecting water quality and the stream channel. State that protecting stream channels promotes the health, safety and welfare of residents through reduced flooding, less erosion, etc. Call for restoration of stream corridors and buffers, and educate the public about the role of buffers on their property.
- Show natural features (including wetlands) and stream protection area on the land use map.

Storm Water Management Standards:

- Discuss storm water management in the Master Plan, calling for pre-treatment of all storm water before discharge into a natural water body, and maintenance of pre-construction runoff rates.
- Call to reduce impervious surfaces in new construction and redevelopment projects to minimize storm water runoff and improve infiltration.
- Include goals and policies that encourage the use of Best Management Practices (BMPs) to minimize, collect, and treat storm water.

Watershed Issues:

- Identify and map the watershed(s) in the community. Call for protecting watershed resources through development regulations, and sharing in education, pollution prevention, and monitoring. Encourage participation in watershed restoration efforts.

2. Development / Redevelopment Regulations

The City's regulations currently provide a broad range of mechanisms that help protect water resources. The following suggestions add to this foundation. Note that these tools are described in further detail in Appendix D.

Storm Water Management Standards:

- **Storm Water Management Ordinance –** This ordinance communicates to developers how storm water quality and quantity are viewed by the community, and can give them guidance as to how they should approach storm water management through their development designs. The main emphasis is to prevent storm water runoff, and treat the runoff that does occur before it reaches a natural water body.
- **Impervious Surface Reduction / Infiltration Enhancement Ordinance –** Impervious surfaces, such as roads, parking lots, and buildings, add to the amount and rate of storm water entering our water bodies. This runoff carries a variety of pollutants. An Impervious Surface Ordinance can be used to communicate site development standards that guide developers and individuals doing site plan review to find opportunities for less impervious surface and more water infiltration.
- **Best Management Practices –** The zoning ordinance or Engineering Standards can require that all storm water be pre-treated before it is released into a natural water body or wetland. It could also limit the amount of clearing and grading for each development proposal. Both could be accomplished by the use of Best Management Practices (BMPs) to treat and filter storm water, as well as regulate the rate at which storm water exits a site.

Land Conservation and Development Techniques:

- **Natural Features Setback/Buffer Guidelines –** The City's current regulations could be enhanced by requiring the buffer for lakes, ponds, and streams in addition to wetlands. The buffer requirement could also be expanded by allowing for a flexible width buffer (larger for more sensitive features, smaller for less sensitive features).
- **Native Vegetation Guidelines –** That plants that grow naturally in your community perform environmental functions that keep our environment working. The benefits of preserving native plants (woodlands, grasslands, wetland plants, etc.) and landscaping with native plants are many. Native trees, shrubs, and ground layer plants can absorb a great deal of storm water, and are particularly useful in storm water conveyance facilities such as swales and retention/detention ponds. And improving infiltration of storm water can recharge groundwater resources. Native plants also help filter storm water of its sediments and pollutants, such as through a natural feature buffer. Landscaping with

natives requires less fertilizers, pesticides, water and lawn care equipment once the plants are established, reducing the cost of maintenance as well. Natives also provide habitat for beneficial wildlife. Native vegetation guidelines encourage the preservation of native plants, and landscaping with species native to the area. This concept could be expanded to include landscaping adjacent to lakes to help protect water quality and reduce shore line erosion as a component of the Lake Lot Overlay District standards.

3. Programs / Standards / Guidelines

Other actions that can be integrated into a community's day-to-day activities that could positively impact Paint Creek include the following:

Consider increasing participation in monitoring and enforcing erosion control measures throughout the Township by working with the County.

4.2.3 Brandon Township

Master Plan Analysis (Adopted March, 2000)

General Information

The main policy approach for Brandon Township's Master Plan (called the *Land Use Plan*) is to address natural feature preservation through an Overlay District, which provides policies for site plan review of properties within the District. These policies include:

1) Areas not suitable for development like lakes, streams, wetlands and flood plains will be classified as preservation and/or conservation areas.
2) Residential density calculations will not be greatly reduced unless there is a significant amount of land area in the project that is unsuitable for development.
3) The developer will be encouraged to minimize physical improvements in natural feature areas of the site that contain woodlands and steep slopes that have ecological and aesthetic value to both the occupants of the development and the community as a whole.
4) The developer will be encouraged to utilize the open areas of the site as much as possible for building sites and active recreational opportunities. Through the use of variable lot sizes, the developer can increase the number of lots in the open areas of the parcel in order to save the trees.
5) The developer will be encouraged to participate in a community-wide Greenway Plan to connect important municipal, cultural, educational and recreational centers in Brandon Township and, where possible, in adjacent Townships.

While the District has supportive maps identifying the Township's various natural features, more detailed information is provided in a separate report called *The Natural Features Report*, which was recently completed. The purpose of this report is to provide the basis for a "Natural Areas Plan," to be included as a chapter in the Township's Land Use Plan.

Physical Features

Brandon Township contains the headwaters to Paint Creek within approximately 7,000 acres of residential, vacant, and agriculturally used properties. A number of tributaries to the Creek also begin in the Township, surrounded in many cases by wetlands and natural areas.

Recommendations for Brandon Township

1. Plans and Policies

The Land Use Plan or Natural Features Report could be augmented to further protect natural features and improve storm water management. It is important to discuss the Township's approach to the following suggested topics in planning documents to create a defendable position for development regulations. Suggested topics include the following:

Storm Water Management Standards:

- Call to reduce impervious surfaces in new construction projects to minimize storm water runoff and improve infiltration.
- Include goals and policies that encourage the use of Best Management Practices (BMPs) to minimize, collect, and treat storm water.

Stream Corridors, Floodplains, and Groundwater:

- Identify groundwater as an important community resource, and map ground water recharge areas in the Master Plan. Make the connection between other environmental features (springs, Paint Creek, etc.) and groundwater recharge areas.

Recreation:

- Develop a Greenways Plan as a stand-along plan or part of the Recreation Master Plan. This plan could identify potential pedestrian and recreation trails through the Township, and help provide preservation of the riparian corridor for the Paint Creek and its tributaries through trail development.

2. Development / Redevelopment Regulations

Approximately 1,400 acres of the community's existing land in the Paint Creek subwatershed is vacant. This gives Brandon Township the opportunity to guide future development while preserving natural features. The following offers potential tools to consider. Note that these tools are described in further detail in Appendix D.

StormWater Management Standards:

- **Storm Water Management Ordinance –** This ordinance communicates to developers how storm water quality and quantity are viewed by the community, and can give them guidance as to how they should approach storm water management through their development designs. The main emphasis is to prevent storm water runoff, and treat the runoff that does occur before it reaches a natural water body.
- **Impervious Surface Reduction / Infiltration Enhancement Ordinance –** Impervious surfaces, such as roads, parking lots, and buildings, add to the amount and rate of storm water entering our water bodies. This runoff carries a variety of pollutants. An Impervious Surface Ordinance can be used to communicate site development standards that guide developers and individuals doing site plan review to find opportunities for less impervious surface and more water infiltration.
- **Best Management Practices –** The zoning ordinance or Engineering Standards can require that all storm water be pre-treated before it is released into a natural water body or wetland. This could be accomplished by the use of Best Management Practices (BMPs) to treat and filter storm water, as well as regulate the rate at which storm water exits a site.
- **Wetlands Protection Ordinances –** Ordinances that protect a specific natural feature, such as a wetland, state protection goals, define the features to be conserved, and provide standards for protection and use. However, these ordinances are generally not written in an "ecosystem" context, and do not address adjacent lands that contribute to the preservation of the natural resource.

Natural Features Setback – An area of native vegetation next to a natural resource that shields or cushions the resource from human activity. The setback or buffer is applied to any natural resource, such as wetlands, streams and rivers, ponds and lakes and even woodlands. Because it is naturally vegetated, it absorbs and filters nutrients and pollutants from storm water before it reaches the water body. It also provides wildlife habitat.

4.2.4 Bruce Township

Master Plan Analysis (Adopted April 2000)

General Information

Bruce Township's Master Plan describes the community's philosophy toward development and natural features preservation. They believe that because the Township is only partially developed, they should carefully examine each opportunity to maximize development in a manner that enhances the community's livability. Planning can best assist in accomplishing this by encouraging designs that respect and work with nature.

Physical Features

The soils in the vicinity of Stony Creek are well-drained, nearly level to hilly soils. Most have severe limitations for use as cropland. Slope is the main limitation for use as residential and recreational areas, and soils adjacent to and just north of Stony Creek have severe limitations for septic systems as well. Boyer soils are a potential source of sand and gravel and of good foundation material for houses, streets, and highways. These particular soils occur only in the southwest corner of the Township.

There are wetlands adjacent to Stony Creek within Bruce Township. The Master Plan describes the important functions of wetlands, and the value they provide the community. These functions include flood attenuation and storage, water filtration, wildlife habitat, and economic and recreational benefits. As for wetlands, the important ecological benefits of woodlands are also described in the Master Plan. Functions such as infiltration and mitigation of the effects of storm water, erosion control, air filtration, and climate and noise control are described. Floodplains, and their valuable functions, are also discussed in the Master Plan, including preventing flood damage, wildlife habitat, scenic resources and recreational activities.

Goals and Objectives

The Master Plan includes goals and objectives that will help protect and restore the natural features within the watershed. The objectives cover many topics. Those that relate to natural area preservation in particular discuss residential development, the natural environment, and recreation and open space. The following are the goals provided throughout the Master Plan:

- To preserve and protect the natural areas found within the Township. These include the topography, woodlots, wetlands, open spaces, farmland and other sensitive areas.
- To promote both residential and commercial developments that focus on the human scale, versus that of the conventional emphasis on the automobile.
- To continue the past growth policy of the Township by limiting the sewer and water availability.
- To preserve and continue to encourage the high quality community facilities, such as schools, parks and open space.

- Develop land use and planning guidelines. These guidelines would be applicable to regional reviews and local land use planning and should encourage the following objectives:
  - Encourage more compact development patterns which conserve land and use infrastructure more efficiently.
  - Protect environmentally sensitive land and valuable farmland.
  - Improve the balance between the location of jobs and housing.
  - Preserve existing infrastructure and encourage the redevelopment of older/urban communities.
- Guide differing intensities of development into areas which are most suitable for that type of development.
- Protect highly sensitive environmental systems currently found within the Township.
- Preserve the rural character that is currently found within the Township.
- Maintain existing and encourage future high quality residential land uses and the preservation of farmland and open space.

Existing Land Uses Adjacent to Stony Creek:
- Vacant
- Residential
- Agricultural

Future Land Uses Adjacent to Stony Creek:
- Rural Estate
- Major and collector thoroughfares (32 Mile, Dequindre, and 33 Mile Road). Traffic counts for 32 Mile Road, west of the Village of Romeo, show a total of nearly 10,500 vehicles per day, while traffic counts on the east side of Romeo show a significant increase in vehicles per day, with a total of 18,700 vehicles. Collector roadways serve internal traffic movements within a limited area of the community, such as a subdivision, and connects this area with the larger arterial system. Collectors do not handle long through-trips and are not, of necessity, continuous for any great length.
- The majority of the southwest corner of the Township is envisioned to be developed as single-family residential homes, at a density consistent with one dwelling unit per two acres. These densities are consistent with those already established by the existing residential developments within this area. These areas are also not intended to be serviced by municipal sewer and water service.
- The current Ford Proving Ground site is shown as a potential planned development area. Should Ford Motor Company close the facility within the time frame of this Plan, it may be in the Township's best interest to provide or help create an overall development plan for the site. The tremendous physical attributes of this site lend very well to a planned open space community. This area is not planned to be serviced by municipal water and sewer.

Recommendations for Bruce Township

1. Plans and Policies

Bruce Township's relatively undeveloped nature is identified in the Master Plan as an opportunity to carefully examine each development proposal and maximize development in a manner that enhances the community's livability by respecting and working with nature. As in most Master Plans, language that preserves natural features tends to be broad. However, protection of Stony Creek in the Master Plan can be strengthened by adding specific language that deals with development, storm water management, water resources within the community and public education. The following ideas could be incorporated:

Land Conservation and Development Techniques:

- Provide guidance for community acquisition and/or protection of open space by creating a Natural Areas Plan that identifies important open spaces that should be preserved. This plan could also discuss preferred land conservation techniques, such as conservation easements, protection under subdivision or condominium documents, land conservancy donations, etc.
- Call for preservation of natural features because of the functional benefits they provide in storm water management (infiltration, filtering, etc.).
- Call to minimize clearing and grading of sites to retain native vegetation and existing hydrologic patterns.

Storm Water Management Standards:

- Discuss storm water management in the Master Plan, calling for pre-treatment of all storm water before discharge into a natural water body, and maintenance of pre-construction runoff rates.
- Call to reduce impervious surfaces in new construction and redevelopment projects to minimize storm water runoff and improve infiltration.
- Include goals and policies that encourage the use of Best Management Practices (BMPs) to minimize, collect, and treat storm water.
- Include mechanisms to ensure regular inspection and maintenance of BMPs.

Stream Corridors, Floodplains, and Groundwater:

- Indicate the importance of riparian buffers and their role in protecting water quality and the stream channel. State that protecting stream channels promotes the health, safety and welfare of residents through reduced flooding, less erosion, etc. Call for restoration of stream corridors and buffers, and educate the public about the role of buffers on their property.
- Show a stream protection area on the land use map.
- Connect the community's floodplain protection efforts with adjoining communities' efforts.
- Identify ground water as an important community resource, and map ground water recharge areas in the Master Plan. Make the connection between other environmental features (springs, Stony Creek, etc.) and groundwater recharge areas.

Illustration 4.4. Importance of a riparian buffer.

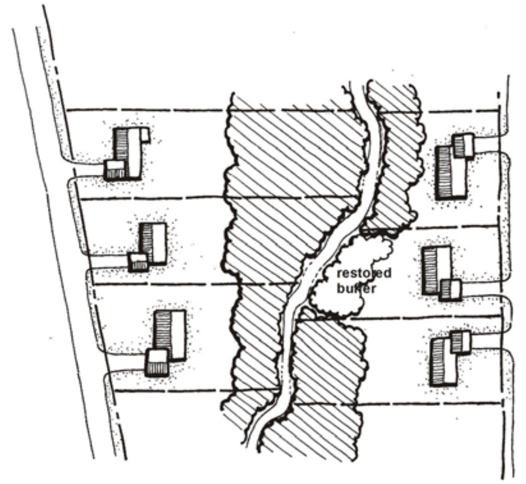


Illustration 4.5. Encourage riparian buffer protection and restoration.

Watershed Issues:

- Identify and map the watershed(s) in the community. Call for protecting watershed resources through development regulations, and sharing in education, pollution prevention and monitoring. Encourage participation in watershed monitoring or restoration efforts.

Public Education:

- Distribute educational materials that describe ways homeowners can limit runoff through rain barrels, rain gardens, reducing the use of fertilizers and pesticides, among other practices.
- Participate in stewardship activities that teach landowners how to preserve and maintain natural features.

2. Development / Redevelopment Regulations

Bruce Township does not contain a relatively large land area within the Stony Creek watershed. However, the area included does have significant amounts of vacant and agricultural lands that could potentially be developed. The following tools outline strategies that could be employed to allow development while preserving natural features at the same time. Note that these tools are described in further detail in Appendix D.

Storm Water Management Standards:

- **Storm Water Management Ordinance –** This ordinance communicates to developers how storm water quality and quantity are viewed by the community, and can give them guidance as to how they should approach storm water management through their development designs. The main emphasis is to prevent storm water runoff, and treat the runoff that does occur before it reaches a natural water body.
- **Impervious Surface Reduction/Infiltration Enhancement Ordinance –** Impervious surfaces, such as roads, parking lots, and buildings, add to the amount and rate of storm water entering our water bodies. This runoff carries a variety of pollutants. An Impervious Surface Ordinance can be used to communicate site development standards that guide

developers and individuals doing site plan review to find opportunities for less impervious surface and more water infiltration.

- **Best Management Practices –** The zoning ordinance or Engineering Standards can require that all storm water be pre-treated before it is released into a natural water body or wetland. This could be accomplished by the use of Best Management Practices (BMPs) to treat and filter storm water, as well as regulate the rate at which storm water exits a site.

Land Conservation and Development Techniques:

- **Natural Feature Overlay District –** This district is applied to lands that have been identified as having special features worthy of preservation (through the Natural Areas Plan), but are in various zoning categories. The Overlay District applies additional restrictions to these unique features that "overlay" the underlying zoning classification and rules. The properties retain their original zoning, but the natural features are preserved through the rules in the Overlay District. The areas of protection can be defined as "ecosystems," which would protect the resource itself, and the adjacent lands that contribute to the functioning of the natural resource. For example, a wetland is sustained by the water contributed to it by adjacent uplands. If this water source is cut off by development in the uplands, the wetland will not continue to function. Therefore, through the ecosystem approach, the resource's functions would be preserved, as well as the resource itself.
- **Wetlands or Woodlands Protection Ordinances –** Ordinances that protect a specific natural feature, such as a wetland or woodland. These ordinances provide a statement of protection goals, definitions of the features to be conserved, and standards for protection and use. However, these ordinances are generally not written in an "ecosystem" context, and do not address adjacent lands that contribute to the preservation of the natural resource. (See Natural Feature Overlay District above.)
- **Natural Features Setback –** An area of native vegetation next to a natural resource that shields or cushions the resource from human activity. The setback or buffer is applied to any natural resource, such as wetlands, streams and rivers, ponds and lakes and even woodlands. Because it is naturally vegetated, it absorbs and filters nutrients and pollutants from storm water before it reaches the water body. It also provides wildlife habitat. Regulations for a natural features setback should include language regarding the purpose of the buffer, and its perpetual maintenance.
- **Private Road Ordinance Standards –** Currently, several elements in the Township's private road standards follow the County's requirements. However, private roads can be safely designed with narrower right-of-ways, narrower pavement widths, and smaller cul-de-sac radii, all of which would reduce the amount of clearing and grading necessary, as well as the amount of impervious surface in a development. Allowing for an infiltration island in the middle of a cul-de-sac also reduces storm water runoff, and pollutants, from the roadway.
- **Parking Requirements –** Other ways of reducing impervious surfaces include re-evaluating the community's parking requirements, and setting parking space maximums versus minimums. Also, the ordinance could allow the Township body approving site plans to allow for less parking if the situation warrants it. Another method is to permit smaller parking spaces, and shared parking arrangements.
- **Flexible Setback Provisions –** As part of the development provisions, more flexibility in the setback regulations will help to limit the amount of clearing and grading necessary to build roadways and residential units. The buildings can be set closer to the roadway and to each other, using up a smaller building envelope, and enabling the preservation of additional open space.

- **Native Vegetation Guidelines –** The plants that grow naturally in your community perform environmental functions that keep our environment working. The benefits of preserving native plants (woodlands, grasslands, wetland plants, etc.) and landscaping with native plants are many. Native trees, shrubs, and ground layer plants can absorb a great deal of storm water. And improving infiltration of storm water can recharge groundwater resources. Native plants also help filter storm water of its sediments and pollutants, such as through a natural feature buffer. Landscaping with natives requires less fertilizers, pesticides, water and lawn care equipment once the plants are established, reducing the cost of maintenance as well. Natives also provide habitat for beneficial wildlife. Native vegetation guidelines encourage the preservation of native plants, and landscaping with species native to the area.

3. Programs / Standards / Guidelines

Other actions that can be integrated into a community's day-to-day activities that could positively impact Stony Creek include the following:

- Create a program or coordinate with the County to identify and correct failing septic systems. This will be particularly important in the Stony Creek subwatershed portion of Bruce Township, as the soils are not well suited for septic systems.
- Initiate a community program to regularly clean out, maintain, or inspect structural storm water facilities, such as catch basins, vegetated swales, etc.
- Include goals to minimize clearing and grading of development sites in Engineering Standards.

Consider increasing participation in monitoring and enforcing erosion control measures throughout the Township by working with the County.

4.2.5 Independence Township

Master Plan Analysis (Adopted November, 1999)

General Information

Independence Township's Master Plan is composed of three documents, the Background Studies document, the Strategic Plan document, and the Master Plan document. One main focus of these three documents is the natural environment and its preservation. The "Historic, Rural, and Open Space Preservation" chapter of the Strategic Plan recognizes the importance of natural features and open space, and has goals and strategies to preserve open space while accommodating development through alternatives to residential land development patterns. The Strategic Plan also talks about coordinating open space between residential developments, and acquiring more public parkland, as well as working with land conservancies and conservation easement.

The Strategic Plan also discusses the importance of storm water management, connects this topic to the health, safety and welfare of residents, and has goals and policies for updating the Township's Storm water Management Plan, and improving water quality. One such effort is the Township's plan for a regional storm water management system that collects, stores, and discharges storm water for 330 acres of the Township. The emphasis of this system is storm water quality and natural feature preservation. Rather than requiring on-site storm water detention, storm water is directed to the regional system through storm sewers and open drains where possible. On its way to discharge points, it is filtered through a constructed six-acre wetland, which doubles as a storage area and wetland mitigation bank. To implement this program, the Township is developing a storm water management plan for this area in addition to a plan detailing the construction of the related infrastructure.

Another chapter of the Plan discusses the important topic of sanitary sewer planning. This chapter covers both septic systems and sanitary sewer systems. The Township has developed a Sewer and Water Master Plan that relates to existing zoning. It states that higher densities should be concentrated closer to public services and utilities. It also identifies areas that are suitable for septic systems, and calls for Township-wide water quality testing program for bodies of water in areas served by septics.

The Township's Plan also discusses the importance of groundwater and calls for its protection. Further protection of groundwater is covered by the Township's Wellhead Protection Plan, which identifies areas that contribute to the community water supply, identifies sources of contamination and includes methods to cooperatively manage the area and minimize threats.

Another planning initiative the Township has undertaken is a Greenway Plan. This plan talks extensively about preserving natural greenways for habitat and natural feature protection, as well as man-made greenways for non-motorized transportation and other recreational opportunities. The Plan looks to connect natural features and community amenities within the Township, as well as to other areas.

In the Background Studies document, the Township has inventories of wetlands, woodlands, and watersheds (drainage areas). The document discusses the importance of wildlife habitat, wetlands, and watershed areas, and calls for their preservation and protection. The watershed discussion provides possible alternatives for protection, two being reduction of impervious surfaces and floodplain protection. Several environmental topics, wildlife habitat and riparian buffers, are related in the Plan to the protection of the community's health, safety and welfare, an important link to justify protective regulation. The Plan also calls for development of a River Conservation Overlay District for the Clinton River, and Sashabaw Creek and other stream resources.

The Strategic Plan calls for development of several additional planning tools. All of these tools could improve the Township's current standard of protecting water quality. These tools include:

- Updating the Storm water Management Plan,
- Developing a program to conduct Township-wide water quality monitoring of water bodies in areas that are served by septic systems, and
- Creating a River Conservation Overlay District.

Recommendations for Independence Township

1. Plans and Policies

While the Township's Master Plan covers a number of important topics, there are several more that could be discussed:

Storm Water Management Standards:

- Call to reduce impervious surfaces in new construction and redevelopment projects to minimize storm water runoff and improve infiltration. (Note that some of these topics are touched upon in the Strategic Plan and/or Greenway Plan, but discussion of them could be expanded.)

- Include goals and policies that encourage the use of Best Management Practices (BMPs) to minimize, collect, and treat storm water.

Stream Corridors, Floodplains, and Groundwater:
- Indicate the importance of riparian buffers and their role in protecting water quality and the stream channel. State that protecting stream channels promote the health, safety and welfare of residents through reduced flooding, less erosion, etc. Call for restoration of stream corridors and buffers, and educate the public about the role of buffers on their property.
- Connect the community's floodplain protection efforts with adjoining communities' efforts.
- Identify groundwater as an important community resource, and map ground water recharge areas in the Master Plan. Make the connection between other environmental features (springs, Paint Creek, etc.) and groundwater recharge areas.

2. Development / Redevelopment Regulations
Independence Township does not contain a relatively large land area within the Paint Creek subwatershed. However, the area included does contain lakes and wetlands, mostly surrounded by single-family residential land uses. The following suggestions should be considered to further protect these water resources. Note that these tools are described in further detail in Appendix D.

Storm Water Management Standards:
- **Impervious Surface Reduction/Infiltration Enhancement Ordinance –** Impervious surfaces, such as roads, parking lots, and buildings, add to the amount and rate of storm water entering our water bodies. This runoff carries a variety of pollutants. An Impervious Surface Ordinance can be used to communicate site development standards that guide developers and individuals doing site plan review to find opportunities for less impervious surface and more water infiltration.
- **Best Management Practices –** The zoning ordinance or Engineering Standards can require that all storm water Best Management Practice (BMP) facilities are inspected and maintained on a regular basis by the property owner or homeowner's association.

Land Conservation and Development Techniques:
- **Natural Features Setback/Buffer Guidelines –** The Township's current regulations could be enhanced by allowing for a flexible width buffer (larger for more sensitive features, smaller for less sensitive features) rather than a standard distance.
- **Woodlands Protection Ordinances –** Ordinances that protect a specific natural feature, such as a woodland usually provide a statement of protection goals, definitions of the features to be conserved, and standards for protection and use. However, these ordinances are generally not written in an "ecosystem" context, and do not address adjacent lands that contribute to the preservation of the natural resource. However, if the Township were to expand its woodlands protections, they could be coordinated with protection of other features on an ecosystem basis.
- **Native Vegetation Guidelines –** The plants that grow naturally in your community perform environmental functions that keep our environment working. The benefits of preserving native plants (woodlands, grasslands, wetland plants, etc.) and landscaping with native plants are many. Native trees, shrubs, and ground layer plants can absorb a great deal of storm water, and perform many functions if planted in storm water facilities such as swales or retention/detention basins. Improving infiltration of storm water can recharge groundwater resources. Native plants also help filter storm water of its sediments and pollutants, such as through a natural feature buffer. Landscaping with

natives requires less fertilizers, pesticides, water and lawn care equipment once the plants are established, reducing the cost of maintenance as well. Natives also provide habitat for beneficial wildlife. Native vegetation guidelines encourage the preservation of native plants, and landscaping with species native to the area. Native Vegetation Guidelines could provide direction to developers and home-owners alike who are interested in creating an environmentally-friendly landscaping approach. While the majority of these provisions would be guidelines only, the Township could include prohibiting "invasive exotic" plants, which take over natural areas and out-compete native species.

3. Programs / Standards / Guidelines

Other actions that can be integrated into a community's day-to-day activities that could positively impact Paint Creek include the following:

- Create a program or coordinate with the County to identify and correct failing septic systems.
- Initiate a community program to regularly clean out, maintain, or inspect structural storm water facilities, such as catch basins, vegetated swales, etc.

4.2.6 Lake Orion

Master Plan Analysis (Adopted January, 2003)

General Information

Lake Orion, named after the lake within its borders, can be characterized as an older (almost 150 years), established community with limited areas for new growth and development. It began as a Victorian summer resort and developed into a small town bedroom community closely linked to the nearby Detroit Metropolitan Area. Over the past decade or so, the community has been experiencing considerable re-development pressures. This has been happening particularly on lake-front lots which contained small cottages that have been renovated into considerably larger homes.

Physical Features

The Master Plan acknowledges the importance of the lake to the Village's quality of life and economic viability. The value the lake contributes to this community is woven throughout the Master Plan. As a water-oriented residential community, the lake offers residents many amenities such as scenic views, valuable waterfront residential properties, fish and wildlife habitat, and recreation. It is considered an "all sports" lake, and is used primarily for recreation. The lake is surrounded by single-family residential land uses, and one-half of Lake Orion's population lives on the lake-front. All residents in the Village have access to the lake through Green's Park.

Paint Creek, and its floodplains and wetlands, are also described in the Master Plan as an important environmental resource worthy of preservation. The creek flows from the dam at the east side of the lake through the central and southeastern portion of the Village. It is bordered almost exclusively by single-family residential land uses. It is know as a high-quality trout stream, and a bottom-draw tube has been inserted near the dam to draw cold water into the creek to improve this habitat. Other projects involving the Clinton River Watershed Council and Trout Unlimited have installed gravel, cobble and natural wood structures to enhance the aquatic habitat.

The Master Plan also describes the surrounding watershed (Clinton River), floodplains, wetlands, and environmental issues important to the Village. The location of floodplains have been mapped. Concerns the Master Plan discusses include:

a. Lake Water Quality. Carrying capacity of the lake and Zebra muscles are two areas needing further study.
b. Storm water management. This section describes the impacts of untreated and unmitigated storm water runoff can have on water resources and the Village's Phase II permit requirements.
c. Lake Use Management. Identifies problems such as algae blooms in early summer, lowering lake levels for cleaning docks and seawalls, and managing recreational access to lakes.
d. Soil Contamination. The Village has five leaking underground storage tanks that pose a threat to groundwater. Since groundwater often feeds into lakes and streams, this is also a potential problem for water resources in the community.

Goals and Objectives

The Master Plan presents a major planning goal that relates to water quality, as well as objectives that describe how they could reach this goal:

- *Goal: Provide for the protection, maintenance, and balanced use of the Village's natural resources and environment for the economic support of local property values, natural beauty and character, ecological needs and historic significance.*

  Objectives: General

  a. Encourage the preservation and enhancement of vegetation and trees and promote street tree planting to help preserve the residential character of the Village. Require Village character landscaping for all developments.
  b. Coordinate planning efforts with the Township to minimize environmental impacts of development on the Lake and other sites which may negatively influence environmental quality in the Village.
  c. Encourage the development of environmentally safe and cost-effective solid waste management systems, which include recycling, composting and other techniques which could reduce the waste stream generated by the Village.

  Objectives: lake

  a. Maintain and enhance the scenic value of the Village's Lakefront by preserving viewsheds and limiting nonresidential development along the Lake.
  b. Maintain and enhance the scenic value of Paint Creek by preserving viewsheds.
  c. Promote the protection of Lake water quality by continuing to work with local community groups, and through review of site development for control of runoff and minimization of erosion. Maintain and improve open space along the Lakefront.
  d. Consider techniques, including keyhole regulations, to reasonably limit the impact and number of boats on Lake Orion to protect is value as a recreational resource and ecological system.
  e. Educate Village residents about the ecology of inland lakes and streams and how various lake uses may affect water environmental quality.
  f. Work with Orion Township and other municipalities to address storm water drainage, runoff, and Lake issues.

A related objective under another goal in the master plan discusses the reduction in parking standards

a. Review and revise off-street parking requirements with the purpose of generally decreasing parking requirements, as appropriate.

Environmental Guidelines

The Master Plan includes suggestions that give guidance for future efforts in protecting the Village's water features:

- Community Facilities Plan: This plan discusses the existing underground facilities in the Village (sewer, water and storm water systems), and calls for several future actions.
  a. Investigate new methods for storing salt to reduce environmental impacts
  b. Sweep streets regularly
  c. Clean catch basins regularly
  d. Reduce the use of pesticides and road salt
  e. Educate the residents about environmental issues

- Neighborhood Plan: For lake island neighborhood, the Plan suggests the following:
  a. Discuss re-development pressures to replace small homes with "big foots."
  b. Review and revise Lakefront Residential Zoning Standards to ensure new development and improvements compliment existing construction.

- Future Land Use Plan: This includes guidelines for lakefront parcels:
  a. All should be used for single-family residential development
  b. Consider reducing or providing flexibility in the required lot area for parcels
  c. Connect building coverage (or impervious surfaces) to the detrimental affects of storm water runoff rates and quality.

- Water and Environment:
  a. Protect the floodplain through a natural greenway (called the Paint Creek Natural Ares)
  b. Protect and expand the Village street tree plantings
  c. Conduct regular water quality testing of the Lake and Paint Creek
  d. Reduce impervious surfaces by incorporating new zoning regulations.

Lastly, the Master Plan calls for potential revisions to the Zoning Ordinance regarding environmental protection, including a keyholing ordinance, Village acquisition of sensitive lands, and the use of conservation easements. It also states that the Village should work with neighboring communities and regulating agencies to protect its natural features, and engage in regular sampling and monitoring of Lake water quality. In the Action Plan section of the Master Plan, it also calls for adopting and implementing a Storm water Management Plan to help ensure water quality.

Recommendations for the Village of Lake Orion

1. Plans and Policies

The Village has included considerable information in their Master Plan regarding water resource protection, particularly because of the Lake's prominence in the City's physical layout and lifestyle. However, additional details of how water resources are protected could be discussed in the Master Plan:

<u>Land Conservation and Redevelopment Techniques</u>:

- Provide guidance for community acquisition and/or protection of open space by creating a Natural Areas Plan that identifies the important natural features within the Village, its parks, and along the streams and river corridors. The plan could provide guidance for redevelopment priorities, as well as strategies for public education regarding management of natural features on private property.
- Expand opportunities for land conservation by discussing other options to the conservation easement, such as land acquisition, donations, land conservancies, etc.

Storm Water Management Standards:

- Discuss storm water management in the Master Plan, calling for pre-treatment of storm water in redevelopment projects, and exploration of retro-fitting storm water structures to filter storm water before it reaches natural water bodies.
- Call to reduce impervious surfaces in redevelopment projects to minimize storm water runoff and improve infiltration.
- Include goals and policies that encourage the use of Best Management Practices (BMPs) to minimize, collect, and treat storm water.
- Include mechanisms to ensure regular inspection and maintenance of BMPs.

Watershed Issues:

- Map the watershed in the community, and the larger watersheds of the region. Encourage participation in watershed monitoring or restoration efforts.

2. Development / Redevelopment Regulations

The Village is not facing extensive new development, but redevelopment proposals are expected. The Village's Master Plan describes several tools, such as a storm water management ordinance (described below), keyhole regulations, and the Paint Creek Natural Areas plan that could be very effective in preserving water quality. The Village could also consider incorporating some of the following tools in the development regulations that will expand treatment and control of storm water, and help to protect the Lake and Paint Creek as a result. Note that these tools are described in further detail in Appendix D.

Storm Water Management Standards:

- **Storm Water Management Ordinance –** This ordinance communicates to developers how storm water quality and quantity are viewed by the community, and can give them guidance as to how they should approach storm water management through their development designs. The main emphasis is to prevent storm water runoff, and treat the runoff that does occur before it reaches a natural water body.
- **Best Management Practices –** The zoning ordinance or Engineering Standards can require that all storm water be pre-treated before it is released into a natural water body or wetland. This could be accomplished by the use of Best Management Practices (BMPs) to treat and filter storm water, as well as regulate the rate at which storm water exits a site.

Land Conservation and Development Techniques:

- **Natural Features Setback Guidelines –** The Village's current regulations could be enhanced by requiring the buffer for any lake or stream, and eliminating the "navigable" requirement. Wetlands could also be included. The buffer requirement could also be expanded by allowing for a flexible width buffer (larger for more sensitive features, smaller for less sensitive features), and that the vegetation be made up of native, woody plant species such as shrubs, trees, and long-rooted perennials vs. turf grass. Residents could also be encouraged to create naturally-vegetated buffers along portions of their own shorelines.

- **Parking Requirements –** One way of reducing impervious surfaces includes re-evaluating the community's parking requirements, and setting parking space maximums versus minimums. Also, the ordinance could allow the Village body approving site plans to allow for less parking if the situation warrants it. Another method is to permit smaller parking spaces and shared parking arrangements, and encourage parking structures.
- **Native Vegetation Guidelines –** The plants that grow naturally in your community perform environmental functions that keep our environment working. The benefits of preserving native plants (woodlands, shoreline, wetland plants, etc.) and landscaping with native plants are many. Native trees, shrubs, and ground layer plants can absorb a great deal of storm water. And improving infiltration of storm water can recharge groundwater resources. Native plants also help filter storm water of its sediments and pollutants, such as through a natural feature buffer. Landscaping with natives requires less fertilizers, pesticides, water and lawn care equipment once the plants are established, reducing the cost of maintenance as well. Less phosphorus in the Lake also helps to control algae blooms. Natives also provide habitat for beneficial wildlife. Native vegetation guidelines encourage the preservation of native plants, and landscaping with species native to your area. This concept could be expanded to include landscaping adjacent to streams and wetlands to help protect water quality and reduce erosion.

3. Programs / Standards / Guidelines

Other actions that can be integrated into a community's day-to-day activities that could positively impact Paint Creek include the following:

- Create a program or coordinate with the County to identify and correct failing septic systems. Prioritize areas for remediation. While the Village only has a few septic systems left, they are most likely very old and not functioning to their highest potential. The Village could also work with MDOT and the County Road Commission to ensure catchbasin cleanout. Lastly, the Village could also work with the County Drain Commissioner's office to assist in erosion control monitoring and enforcement.
- Include goals to minimize clearing and grading of redevelopment sites.

4.2.7 Oakland Township

Master Plan Analysis (Adopted January 1995)

General Information

Oakland Township's philosophy behind natural resource preservation is stated in the introduction of their Master Plan. The position in Oakland Township is not an exclusionary stance, but rather a deep concern for the natural and ecological values inherent in the land and water. There is a general belief that there are reasonable limits on what can be done to the land and water, while still retaining these values. Through planning, policies and ordinances, the Township will guide development to be in harmony with the environment to the greatest extent possible.

Physical Features

The Master Plan includes an Ecological Resource Inventory, which gives brief descriptions of maps that show various natural features within the Township. These maps include topography, existing vegetation, surface soil capability for potential development, hydrology, groundwater resources, and surface and subsurface geology. The community has then taken this information and analyzed it to form conclusions about the development potential throughout the Township.

The Ecological Evaluation Map shows which areas of the Township are most, some or least suitable for development. The Ecological Breakdown Map shows areas that will have severe, moderate or the least impact from development. Each of these categories suggests appropriate levels of density and open space.

This information is combined with a cultural resource map to create a Grid Evaluation Summary Map. A gray tone, representing the areas development potential based on ecological and cultural sensitivity, is assigned for each 10-acre area across the Township. Lastly, this map was used to create the Development Potential Map, which describes areas of existing development, thoroughfare areas, and undeveloped areas and their potential for development.

Goals and Policies

The Oakland Township Master Plan presents general planning goals at the beginning of the document. The following goals relate to natural resource preservation.

- To create an optimum human environment for the present and future residents of Oakland Township by providing an environment that will not only meet their physical needs, but maintains the natural beauty of the Township.
- To relate land use primarily to the natural characteristics of the land and the long-term needs of the community, rather than to short-term private economic gain.
- To preserve aesthetic values of natural environments and historical locations, by means such as parks, scenic open spaces, regulation of development, reforestation ordinances, green belts, and architectural control recommendations.
- Preserve or utilize the natural resources to benefit the whole Township.

The remainder of the document lists policies that, once implemented, will help the Township reach their goals. The statements summarized here pertain to natural resources and open space, housing, controlled growth and planned capital improvement phases, recreation, and amenities. All of these policies can be applied to help reduce the impact development has on natural features, and help to improve surface water quality.

The natural resources and open space policies work to protect and limit development in flood plains, stream buffer zones, wetlands and steep slopes, as well as minimize soil erosion and sedimentation. These policies use the capacity of the land to determine the density of development, based on the site's natural characteristics. They encourage open space development, and preserve unique land features. The policies also address land acquisition as a means for natural resource preservation, require environmental impact statements for intense development, and discuss groundwater monitoring and developing ways to protect the quality of the groundwater.

One policy directly addresses Stony Creek. It states that Stony Creek, its headwaters and its associated wetlands shall be preserved by means of zoning and by application of the Township's wetlands protection ordinance. Development will be monitored to minimize runoff and erosion potentially damaging to Stony Creek; such development as occurs shall be on the lands with less wetlands and tree cover, and the use of clustering shall be encouraged so that the critical wetland and wildlife habitat areas will not be disturbed. The Plan also has similar policies for Cranberry Lake, which is within the Stony Creek watershed.

Policies for housing coordinate with natural resource preservation policies. The Plan states that more density and more intensive developments shall be limited to areas where there will be less of an environmental impact, which are serviced with public water and sewer, and which are served by suitable paved roadways. Lower density will be required where there is an abundance of natural resources to be preserved or where there will be a public benefit from open scenery.

Transportation policies consider the impact road improvements have on natural features, and work to minimize them. For instance, the policy states that when a road is upgraded, existing natural and cultural features along the road are to be retained. Paving width and right-of-way clearing will be the minimum necessary to accomplish the intended purpose of the upgrading. The Plan also supports non-vehicular transportation methods, such as bicycles, and public transportation.

The Plan also includes policies that address growth and planned capital improvements, such as groundwater supplies and storm drainage. The Policies direct developers to use natural best management practices to deal with storm water. They encourage infiltration, filtration of runoff, and reducing velocities to protect streambeds. The Plan also states that the development of a storm water management ordinance will ensure the preservation of natural drainage patterns, minimize increased runoff flows from urbanized areas, and protect sensitive natural features such as surface waters and wetlands from excessive flows and contaminants.

Policies that speak to recreation and other Township amenities also help protect the watershed. The Plan states that the Oakland Township Parks Commission shall actively continue purchasing property for both active and passive recreation facilities. It also discourages overcrowding of recreational bodies of water through appropriate regulations. Policies that focus on amenities include encouraging reforestation, requiring scenic open space along roadways, woodlands, marshes and lakes, and require that building locations complement their natural settings.

Existing Land Uses Adjacent to Stony Creek:

- Recreation and Conservation
- Single Family Residential
- Vacant
- Agricultural

Future Land Uses Adjacent to Stony Creek:

- Recreation and Conservation
- Single Family Residential

Recommendations for Oakland Township

1. Plans and Policies

Oakland Township communicates through its Master Plan that it is deeply committed to preserving, to the greatest extent possible, its natural resources and their functioning. Through its policies, the Master Plan discusses many critical issues that need to be considered while managing growth in their community. Some additional topics that could further expand these protective measures include the following:

<u>Stream Corridors and Floodplains</u>:

- Connect the community's floodplain protection efforts with adjoining communities' efforts.

<u>Recreation</u>:

- Develop a Greenways Plan as a stand-alone plan or part of the Recreation Master Plan. This plan could identify potential pedestrian and recreation trails through the Township, and help provide preservation of the Stony Creek riparian corridor through trail development.

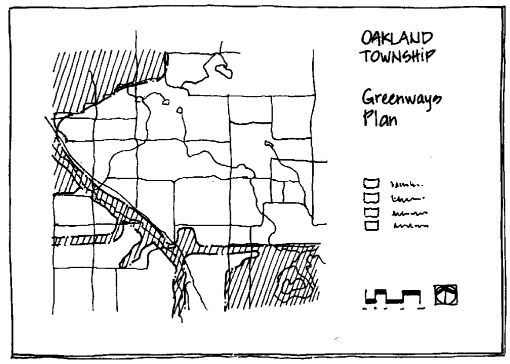


Illustration 4.5. Develop a Greenway Plan.

Watershed Issues:
- Identify and map the watershed(s) in the community. Call for protecting watershed resources through development regulations, and sharing in education and pollution prevention. Encourage participation in watershed monitoring or restoration efforts.

Public Education:
- Distribute educational materials that describe ways homeowners can limit runoff through rain barrels, rain gardens, and reducing the use of fertilizers and pesticides, among other practices.
- Participate in stewardship activities that teach landowners how to preserve and maintain natural features and buffers.

2. Development / Redevelopment Regulations

Oakland Township has some of the largest land area within the Stony Creek watershed. Therefore, their land development practices will have a large impact on the quality of the stream. The Township currently has many beneficial regulations to guide development in a way that protects water quality and regulates storm water flow to the stream. However, the following recommendations could be added that address potential gaps in current rules. Note that these tools are described in further detail in Appendix D.

Storm Water Management Standards:
- **Storm Water Management Ordinance –** The Master Plan discusses development of a Storm water Management Ordinance, and current regulations address many issues that could be addressed under this type of ordinance. A few topics to add include manufactured wetlands (or wet detention/retention basins), requirement of using storm water Best Management Practices (BMPs) (See below), and guidelines to control parking lot runoff.
- **Impervious Surface Reduction/Infiltration Enhancement Ordinance –** Impervious surfaces, such as roads, parking lots, and buildings, add to the amount and rate of storm water entering our water bodies. This runoff carries a variety of pollutants. An Impervious Surface Ordinance can be used to communicate site development standards that guide developers and individuals doing site plan review to find opportunities for less impervious surface and more water infiltration.
- **Best Management Practices –** The zoning ordinance or Engineering Standards can require that all storm water be pre-treated before it is released into a natural water body or wetland. This could be accomplished by the use of Best Management Practices (BMPs) to treat and filter storm water, as well as regulate the rate at which storm water exits a site.

Land Conservation and Development Techniques:
- **Natural Features Setback –** As an extension of the existing regulations for natural feature buffer areas, language could be added that discusses appropriate management of the

buffer area, and using the buffer as a conservation area or as part of a recreational greenway.

- **Private Road Ordinance Standards –** Private roads can be safely designed with narrower right-of-ways, narrower pavement widths, and smaller cul-de-sac radii than current County standards. All of these modifications would reduce the amount of clearing and grading necessary, as well as the amount of impervious surface in a development. Allowing for an infiltration island in the middle of a cul-de-sac would also reduce storm water runoff, and pollutants, from the roadway.
- **Parking Requirements –** Re-evaluating the community's parking requirements could be a way to reduce the amount of impervious surfaces in a community. One method is to set parking space maximums versus minimums. Also, the ordinance could allow the Township body approving site plans to allow for less parking if the situation warrants it. Another method is to permit smaller parking spaces, and shared parking arrangements. Lastly, parking lot islands are an important factor in breaking up the broad expanse of pavement, and allowing for infiltration of runoff if designed to capture storm water.
- **Sidewalks –** Sidewalks add to impervious surfaces in developments. To balance pedestrian needs with storm water management, sidewalks could be permitted on one side of a street only.
- **Flexible Setback Provisions –** As part of the development provisions, more flexibility in the setback regulations will help to limit the amount of clearing and grading necessary to build roadways and residential units. The buildings can be set closer to the roadway and to each other, using up a smaller building envelope, and enabling the preservation of additional open space.
- **Erosion Control Ordinance –** Additional topics that could be addressed in the current Erosion Control Ordinance include stabilization of drainageways, phasing construction to limit soil exposure, protection of steep slopes and cuts, requirement for certified contractors to implement the Erosion and Sedimentation Control (ESC) Plan, and assessment of the ESC practices after a storm event/final inspection.
- **Native Vegetation Guidelines –** That plants that grow naturally in your community perform environmental functions that keep our natural environment working. The benefits of preserving native plants (woodlands, grasslands, wetland plants, etc.) and landscaping with native plants are many. Native trees, shrubs, and ground layer plants can absorb a great deal of storm water. And improving infiltration of storm water can recharge groundwater resources. Native plants also help filter storm water of its sediments and pollutants, such as through a natural feature buffer. Landscaping with natives requires less fertilizers, pesticides, water and lawn care equipment once the plants are established, reducing the cost of maintenance as well. Natives also provide habitat for beneficial wildlife. Native vegetation guidelines encourage the preservation of native plants, and landscaping with species native to the area.

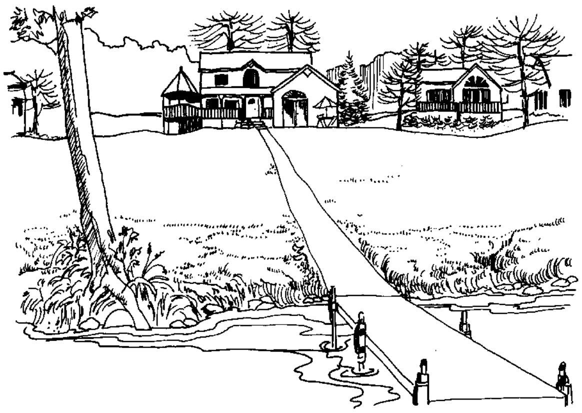


Illustration 4.7. Typical landscaping on a stream or lake lot.

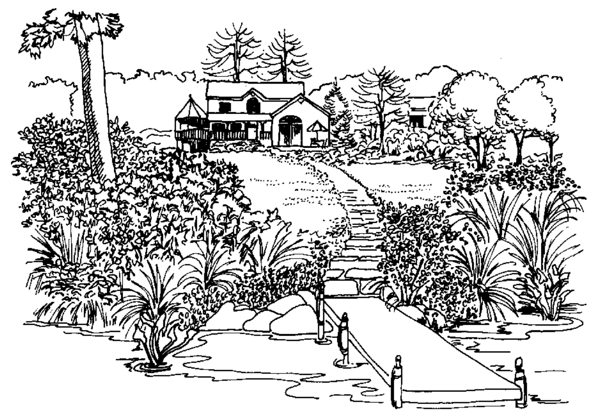


Illustration 4.8. Native landscaping on a stream or lake lot.

3. Programs / Standards / Guidelines

Other actions that can be integrated into a community's day-to-day activities that could positively impact Stony Creek include the following:

- Create a program or coordinate with the County to identify and correct failing septic systems. This is particularly important given the amount of Township land in the watershed that depends on septic systems for sewerage disposal.

4.2.8 Orion Township

Master Plan Analysis (Adopted May, 2003)

General Information

The Orion Township Master Plan is strong in several areas. It discusses the Township's desire to preserve natural features in parks, through new development, and to preserve the character of the Township. It also refers to its Storm water and Erosion Control Ordinance as another way of protecting natural features. The Plan has identified high-priority natural areas, as well as inventoried and mapped Township wetlands and woodlands. Statements that recognize the importance of wetlands and woodlands, and their potential for storm water attenuation and infiltration are also included in the Plan. Another important topic that the Plan addresses is Sanitary Sewer Planning. The Master Plan calls for development of sewer and water service area maps, and for using these maps in zoning decisions. They currently have a Sewer Map showing existing facilities, and have policies to use this information to discourage sprawl.

Recommendations for Orion Township

1. Plans and Policies

Orion Township has a mix of developments, from relatively undeveloped to higher density and intensity developments. As in most Master Plans, language that preserves natural features tends to be broad. However, protection of Paint Creek in the Master Plan can be strengthened by adding specific language that deals with open space preservation, stream corridors and buffers, infiltration of storm water, and greenway development for wildlife habitat. The following ideas could be incorporated:

Land Conservation and Development Techniques:

- The Potential Conservation/Natural Areas map in the Master Plan could be expanded to discuss the benefits of open space as a cohesive unit (ecosystem), and how these units need to be connected by natural corridors.
- Call for preservation of natural features because of the functional benefits they provide in storm water management (infiltration, filtering, etc.).

Storm Water Management Standards:

- Call to reduce impervious surfaces in new construction and redevelopment projects to minimize storm water runoff and improve infiltration.
- Include goals and policies that encourage the use of Best Management Practices (BMPs) to minimize, collect, and treat storm water.
- Include mechanisms to ensure regular inspection and maintenance of BMPs.

Stream Corridors, Floodplains, and Groundwater:

- Indicate the importance of riparian buffers and their role in protecting water quality and the stream channel. State that protecting stream channels promotes the health, safety and welfare of residents through reduced flooding, less erosion, etc. Call for restoration of stream corridors and buffers, and educate the public about the role of buffers on their property.
- Show a stream protection area on the land use map.
- Connect the community's floodplain protection efforts with adjoining communities' efforts.
- Identify ground water as an important community resource, and map ground water recharge areas in the Master Plan. Make the connection between other environmental features (springs, Stony Creek, etc.) and groundwater recharge areas.

Watershed Issues:

- Map the watershed(s) in the community. Call for protecting watershed resources through development regulations, and sharing in education, pollution prevention and monitoring. Encourage participation in watershed monitoring or restoration efforts.

2. Development / Redevelopment Regulations

Storm Water Management Standards:

- **Impervious Surface Reduction/Infiltration Enhancement Ordinance –** Impervious surfaces, such as roads, parking lots, and buildings, add to the amount and rate of storm water entering our water bodies. This runoff carries a variety of pollutants. An Impervious Surface Ordinance can be used to communicate site development standards that guide developers and individuals doing site plan review to find opportunities for less impervious surface and more water infiltration.
- **Best Management Practices –** The zoning ordinance or Engineering Standards can require that all storm water Best Management Practice (BMP) facilities are inspected and maintained on a regular basis by the property owner or homeowner's association.

Land Conservation and Development Techniques:

- **Natural Features Setback/Buffer Guidelines –** The Township's current regulations could be enhanced by allowing for a flexible width buffer (larger for more sensitive features, smaller for less sensitive features) rather than a standard distance to help manage development near stream corridors and provide floodplain protection.
- **Native Vegetation Guidelines –** The plants that grow naturally in your community perform environmental functions that keep our environment working. The benefits of preserving native plants (woodlands, grasslands, wetland plants, etc.) and landscaping with native plants are many. Native trees, shrubs, and ground layer plants can absorb a great deal of storm water, and perform many functions if planted in storm water facilities such as swales or retention/detention basins. Improving infiltration of storm water can recharge groundwater resources. Native plants also help filter storm water of its sediments and pollutants, such as through a natural feature buffer. Landscaping with natives requires less fertilizers, pesticides, water and lawn care equipment once the plants are established, reducing the cost of maintenance as well. Natives also provide habitat for beneficial wildlife. Native vegetation guidelines encourage the preservation of native plants, and landscaping with species native to the area. Native Vegetation Guidelines could provide direction to developers and home-owners alike who are interested in creating an environmentally-friendly landscaping approach. While the majority of these provisions would be guidelines only, the Township could include prohibiting "invasive exotic" plants, which take over natural areas and out-compete native species.

4.2.9 Village of Oxford

Master Plan Analysis (Adopted April, 2005)

General Information

The Village of Oxford was founded in the early 1800's, creating one of the oldest communities within southeastern Michigan. Over the years, it has maintained its small town charm through its various lot sizes and home styles, but has gradually been surrounded by burgeoning development of the Detroit Metropolitan area. A relatively small amount of land remains vacant on scattered lots throughout the Village and in the undeveloped parts of Oxford Lakes Subdivisions. Some of this vacant land also includes some developmentally-constrained land where wetlands or other site limitations impede use of the lots.

The Village supplies drinking water from two municipal wells, and controls sanitary sewers within the community's boundaries. Storm water is directed to enclosed storm drains which discharge into Oxford and Northwest Lake. The Master Plan addresses storm water quality, and suggests that the community require future development and re-development proposals to incorporate pre-treatment of storm water before it is discharged into the lakes.

In the Future Land Use Plan chapter, the document states that the "Recreation" designation and lakes combined make up the second largest land uses in the community. In addition, the Village has recently enhance recreation opportunities by planning for the development of the Polly Ann Trail along the abandoned railroad right-of-way that traverses the north side of the Village. This trail is also slated to be improved with a bridge over M-24, and small park areas adjacent to the trailway.

The reason that there is no natural feature inventory in this Plan may be because this Master Plan document is an update to a previous plan. The Plan does mention that all of the gravel pits in the community have been converted to lakes, but further discussion of the community's natural assets is not included in this document. However, the Recreation Master Plan briefly describes the lakes, soils, vegetation, and wildlife, as well as the watershed that the Village is located within. The Recreation Plan states that the community has three lakes that lie entirely within the Village limits, and a fourth that is partly within Oxford Township. Another important fact is that the Village is near the headwaters of the Clinton River, noting that preservation of open space here will provide environmental benefits for residents of all downstream communities. The plan goes on to discuss vegetation within the Village Parks. Particularly important is the diversity of native flora found in Scripter Park, which had a significant influence on the restoration goals of the Recreation Master Plan.

Goals and Policies

The Master Plan document organizes the Goals and Policies into several land use categories. Categories relevant to this activity include 1) Residential Land Use, and 2) Recreation and Natural Resources Goals:

1) Residential Land Use Goals:
   a) Preserve existing residential neighborhoods through public investment to improve storm drainage, and preservation and improvement of public parks and green spaces.

2) Recreation and Natural Resources Goals:
   a) To improve and enhance the usefulness of parks and natural areas for the residents of the Village.

   Objectives:
   i. Provide facilities at one or more parks for residents to bring their dogs; create a "bark park,"
   ii. Develop "pocket parks" on trails and in the downtown area.

Recommendations for the Village of Oxford

1. Plans and Policies

The Village of Oxford's Master Plan recognizes that this community is essentially built-out, and needs to focus its policies on optimizing the remaining development and re-development opportunities. To accommodate this development while preserving natural features, the following ideas could be incorporated into the Master Plan:

Land Conservation and Development Techniques:

- Provide guidance for community acquisition and/or protection of open space by creating a Natural Areas Plan that identifies important open spaces and natural features (such as wetlands) that should be preserved. This plan could also discuss preferred land conservation techniques, such as conservation easements, protection under subdivision or condominium documents, land conservancy donations, etc.
- Call for the preservation of natural features because of the functional benefits they provide in storm water management (infiltration, filtering, flood control, etc.).

- Call to minimize clearing and grading of sites to retain native vegetation and existing hydrologic patterns.

<u>Storm Water Management Standards:</u>

- Discuss storm water management in the Master Plan further, calling for maintenance of pre-construction runoff rates.
- Explore retro-fitting storm water structures in developed areas of the Village to filter storm water before it reaches natural water bodies.
- Call to reduce impervious surfaces in new construction and redevelopment projects to minimize storm water runoff and improve infiltration.
- Include goals and policies that encourage the use of Best Management Practices (BMPs) to minimize, collect, and treat storm water.
- Include mechanisms to ensure regular inspection and maintenance of BMPs.

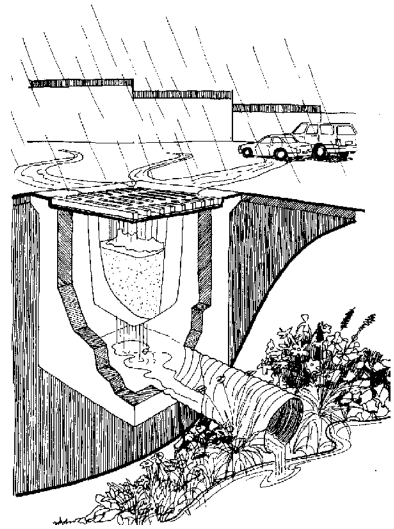


Illustration 4.9. Retrofit storm water structures to filter storm water and remove pollutants.

<u>Recreation</u>:

- Incorporate natural feature preservation or restoration into the Polly Ann Trailway plan. This plan could identify important natural features worthy of preservation/restoration along the corridor, wildlife habitat areas, and wildlife transportation corridors.

<u>Watershed Issues</u>:

- Identify and map the watershed(s) in the community. Call for protecting watershed resources through development regulations, and sharing in education, pollution prevention and monitoring. Encourage participation in watershed monitoring or restoration efforts.

2. Development / Redevelopment Regulations

The Zoning Ordinance was used to evaluate the community's current regulations for water resource protection. The following suggestions could expand on the Village's current regulations, or be added to Engineering and Construction Design Standards. Note that these tools are described in further detail in Appendix D.

<u>Storm Water Management Standards:</u>

- **Storm Water Management Ordinance –** This ordinance communicates to developers how storm water quality and quantity are viewed by the community, and can give them guidance as to how they should approach storm water management through their development designs. The main emphasis is to prevent storm water runoff, and treat the runoff that does occur before it reaches a natural water body. One detail that could be addressed in this ordinance is to prohibit pumping of water into a watercourse from construction sites.
- **Impervious Surface Reduction/Infiltration Enhancement Ordinance –** Impervious surfaces, such as roads, parking lots, and buildings, add to the amount and rate of storm water entering our water bodies. This runoff carries a variety of pollutants. An Impervious Surface Ordinance can be used to communicate site development standards that guide

developers and individuals doing site plan review to find opportunities for less impervious surface and more water infiltration.

- **Best Management Practices –** The zoning ordinance or Engineering Standards can require that all storm water be pre-treated before it is released into a natural water body or wetland. This could be accomplished by the use of Best Management Practices (BMPs) to treat and filter storm water, as well as regulate the rate at which storm water exits a site.

Land Conservation and Development Techniques:

- **Natural Feature Overlay District –** This district is applied to lands that have been identified as having special environmental features worthy of preservation (through the Natural Areas Plan), but are in various zoning categories. The Overlay District applies additional restrictions to these unique features that "overlay" the underlying zoning classification and rules. The properties retain their original zoning, but the natural features are preserved through the rules in the Overlay District. The areas of protection can be defined as "ecosystems," which would protect the resource itself, and the adjacent lands that contribute to the functioning of the natural resource. For example, a wetland is sustained by the water contributed to it by adjacent uplands. If this water source is cut off by development in the uplands, the wetland will not continue to function. Therefore, through the ecosystem approach, the resource's functions could be preserved, as well as the resource itself.
- **Natural Features Setback –** An area of native vegetation next to a natural resource that shields or cushions the resource from human activity. The setback or buffer is applied to any natural resource, such as wetlands, streams and rivers, ponds and lakes and even woodlands. Because it is naturally vegetated with woody plants, it absorbs and filters nutrients and pollutants from storm water before it reaches the water body. The buffer or setback also provides wildlife habitat.
- **Parking Requirements –** Re-evaluating the community's parking requirements could be a way to reduce the amount of impervious surfaces in the Village. One method is to set parking space maximums versus minimums. Also, the ordinance could allow the body approving site plans to allow for less parking if the situation warrants it. Another method is to permit smaller parking spaces, and shared parking arrangements. Lastly, parking lot islands are an important factor in breaking up the broad expanse of pavement, and allowing for infiltration of runoff if designed to capture storm water.
- **Sidewalks –** Currently, the Village requires sidewalks on all residential streets. However, sidewalks add to impervious surfaces in developments. To balance pedestrian needs with storm water management, sidewalks could be permitted on one side of a street only.
- **Flexible Setback Provisions –** As part of the development provisions, more flexibility in the setback regulations will help to limit the amount of clearing and grading necessary to build roadways and residential units. The buildings can be set closer to the roadway and to each other, using up a smaller building envelope, and enabling the preservation of additional open space.
- **Open Space Management –** An element of any of the cluster provisions could discuss how the open space should be maintained after it is set aside for preservation and the mechanisms in place to ensure that this happens. Maintenance of natural areas in a natural state may require regular activities to ensure the area retains its functional values.
- **Native Vegetation Guidelines –** The plants that grow naturally in a community perform environmental functions that keep our environment working. The benefits of preserving native plants (woodlands, grasslands, wetland plants, etc.) and landscaping with native plants are many. Native trees, shrubs, and ground layer plants can absorb a great deal of storm water. And improving infiltration of storm water can recharge groundwater

resources. Native plants also help filter storm water of its sediments and pollutants, such as through a natural feature buffer. Landscaping with natives requires less fertilizer, pesticides, water and lawn care equipment once the plants are established, reducing the cost of maintenance as well. Natives also provide habitat for beneficial wildlife. Native vegetation guidelines encourage the preservation of native plants, and landscaping with species native to the area.

3. Programs / Standards / Guidelines

Other actions that can be integrated into a community's day-to-day activities that could positively impact Paint or Stony Creek include the following:

- Initiate a community program to regularly clean out, maintain, or inspect structural storm water facilities, such as catch basins, vegetated swales, etc.
- Add goals to minimize clearing and grading of development sites in Engineering and Construction Design Standards.
- Consider increasing participation in monitoring and enforcing erosion control measures.

4.2.10 Oxford Township

Master Plan Analysis (Adopted November 1995)

General Information

The Master Plan for Oxford Township characterizes the Township as being the northern edge of a densely populated area. The rural residential and agricultural community has experienced significant growth pressures and has become a highly desirable location due to its proximity to commercial markets such as Auburn Hills and Pontiac. The majority of the recent development activities have occurred within the southern half of the Township due to the lack of sewer service elsewhere in the community. These developments have resulted from the conversion of the vast gravel extraction properties to a mix of residential and commercial uses. Since 1988 the changes in land use have also included increased commercial/office growth along M-24, growth of recreational uses, dramatic increase in land splits, increased reclamation activities and decreased importance of full-time agriculture.

The desire to preserve the Townships remaining natural features has resulted in the draft Open Space and Greenway Plan. This Plan, while not yet adopted, offers an ecosystem based approach to land use, and presents preservation techniques for the natural features so prevalent within the Township. However, the adopted 1995 Master Plan uses the natural carrying capacity of the land to locate areas ideal for higher densities, such as the Central Area. A plan for the Central Area was completed in 1994, and laid out the land use pattern for what has become the largest development within the region, Waterstone. A similar sub-area plan was completed for the East Central Area in 2001 as a result of the potential mining reclamation activities on a parcel equally as large as Waterstone and equally as viable for development.

The Master Plan, Central Area Plan, East Central Area Plan, and draft Greenway Plan each focus on the desire to maintain and enhance the existing natural features. The goals, objectives and policies within these documents promote the viability of development but not at the detriment of these resources. These resources include not only the natural features but also the agricultural environment still prevalent within portions of the Township. The residents of Oxford Township pride themselves on their ability to plan for growth by identifying appropriate locations for development that ensures that the Township maintains its prized natural features.

Physical Features

The Master Plan describes the major natural features of the Township. The most prevalent natural features are prime agricultural land and abundant mineral resources with pockets of woodlands, wetlands and open spaces. Because the majority of the Township does not have access to a municipal water supply, the importance of groundwater is extremely high. As a result, a wellhead protection area was adopted for the majority of the eastern half of the Township.

Goals and Objectives

The Oxford Charter Township Master Plan presents planning goals that relate to natural resource preservation, as well as objectives that describe how they could reach these goals:

- *Goal: Preserve, protect, and enhance the unique community character of Oxford Township.*
  Objectives:
  a. Maintain and promote the rural and resort characteristics of the Oxford Community.
  b. Protect and enhance the Township's environmental assets, including clean air, water, and soils, as well as the woodlands, wetlands, lakes, abundance of wildlife, and viewsheds.
  c. Closely review all types of development proposals – residential, commercial, office, industrial – to insure that future projects will be compatible with Oxford's rural character, and will not detract from its environmental assets.

- *Goal: Recognize and work to improve the condition of environmentally sensitive or damaged areas.*
  Objectives:
  a. Clean up land, air, and water that have been damaged or undesirable uses.

- *Goal: New residential development in Oxford Township should contribute to the variety and complexity of the Township's population while still maintaining and promoting Oxford's unique character.*
  Objectives:
  a. Open spaces, wildlife corridors, and agricultural features should be preserved as a standard proactive of residential development.

- *Goal: The motorized, non-motorized and pedestrian components of Oxford township's transportation system should function as an integrated unit.*
  Objectives:
  a. Establish non-motorized and pedestrian paths that will provide convenient and safe access to businesses, community services, and neighborhoods.

Environmental Guidelines

The Master Plan also identifies an area planned for Urban Infrastructure Area as a means of controlling growth and directing that growth to areas with fewer natural and agricultural features. The boundaries of the Urban Infrastructure Area are the Central Area, the Village of Oxford, portions of the East Central Area, and the land to the west, south and east of the Village. The Open Space Plan for the northern portions of the Township also ensures the maintenance of the rural character while protecting the existing natural features. Various legal arrangements, zoning requirements and development techniques are identified as the means of preserving the open space within the Township.

Existing Land Uses Adjacent to Stony Creek:

- Vacant
- Public & Quasi-Public
- Single Family
- Extraction
- Recreation
- Agriculture

Future Land Uses Adjacent to Stony Creek:

- Recreation and Open Space
- School Sites
- Rural Resort (1 – 1.7 units per acre)
- Resort Residential (2 – 3 units per acre)
- Hunt Country Estates (0.05 – 0.125 units per acre)

Recommendations for Oxford Township

1. Plans and Policies

Protection of natural resources within Oxford Township has been recently enhanced by the development of an Open Space and Greenway Plan, which identifies wetlands, woodlands, tree rows, lakes and rivers/streams/drains within the Stony Creek subwatershed. It also provides a plan for areas of future conservation and land acquisition/dedication. In addition to this Plan, the Master Plan could be amended with the following ideas to further preserve natural features and protect water quality:

Land Conservation and Development Techniques:

- Call for the preservation of natural features because of the functional benefits they provide in storm water management (infiltration, filtering, flood control, etc.).
- Call for minimizing cutting and grading of development sites.

Storm Water Management Standards:

- Discuss storm water management in the Master Plan, calling for pre-treatment of all storm water before discharge into a natural water body, and maintenance of pre-construction runoff rates.
- Explore retro-fitting storm water structures in developed areas of the Township to filter storm water before it reaches natural water bodies.
- Call to reduce impervious surfaces in new construction and redevelopment projects to minimize storm water runoff and improve infiltration.
- Include goals and policies that encourage the use of Best Management Practices (BMPs) to minimize, collect, and treat storm water.
- Include mechanisms to ensure regular inspection and maintenance of BMPs.

Stream Corridors and Floodplains:

- Show stream protection area on the land use map.
- Connect your community's floodplain protection efforts with adjoining communities' efforts.

Watershed Issues:

- Identify and map the watershed(s) in the community. Call for protecting watershed resources through development regulations, and participate in watershed education of the public. Encourage participation in watershed monitoring or restoration efforts.

Public Education:
- Distribute educational materials that describe ways homeowners can limit runoff through rain barrels, rain gardens, reducing the use of fertilizers and pesticides, among other practices.
- Participate in stewardship activities that teach landowners how to preserve and maintain natural features and buffers.

2. Development / Redevelopment Regulations
Twenty-seven percent of the land area within the Township and the Stony Creek subwatershed is vacant. This provides a significant opportunity for the community to institute development regulations that will allow for development, but also preserve environmental features and their functioning. The following offers potential tools to consider. Note that these tools are described in further detail in Appendix D.

Storm Water Management Standards:
- **Storm Water Management Ordinance –** This ordinance communicates to developers how storm water quality and quantity are viewed by the community, and can give them guidance as to how they should approach storm water management through their development designs. The main emphasis is to prevent storm water runoff, and treat the runoff that does occur before it reaches a natural water body.
- **Impervious Surface Reduction/Infiltration Enhancement Ordinance –** Impervious surfaces, such as roads, parking lots, and buildings, add to the amount and rate of storm water entering our water bodies. This runoff carries a variety of pollutants. An Impervious Surface Ordinance can be used to communicate site development standards that guide developers and individuals doing site plan review to find opportunities for less impervious surface and more water infiltration.

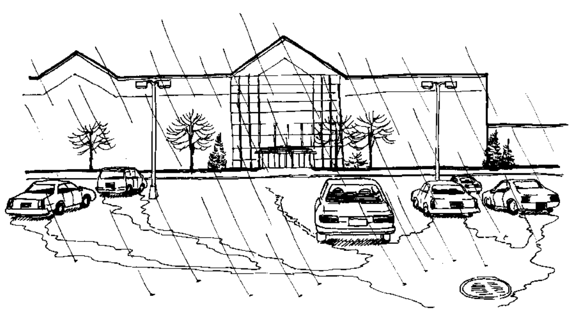


Illustration 4.10. Impervious surfaces such as pavement and rooftops increase storm water runoff.

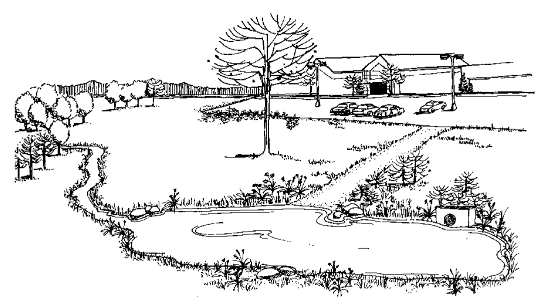


Illustration 4.11. Slow and filter storm water runoff before discharge into natural systems.

- **Best Management Practices –** The zoning ordinance or Engineering Standards can require that all storm water be pre-treated before it is released into a natural water body or wetland. This could be accomplished by the use of Best Management Practices (BMPs) to treat and filter storm water, as well as regulate the rate at which storm water exits a site.

Land Conservation and Development Techniques:
- **Natural Feature Overlay District –** These regulations could pertain to the priority natural areas that were identified in the Open Space and Greenway Plan. This district is applied to lands that have been identified as having special environmental features worthy of

preservation, but are in various zoning categories. The Overlay District applies additional restrictions to these unique features that "overlay" the underlying zoning classification and rules. The properties retain their original zoning, but the natural features are preserved through the rules in the Overlay District. The areas of protection can be defined as "ecosystems," which would protect the resource itself, and the adjacent lands that contribute to the functioning of the natural resource. For example, a wetland is sustained by the water contributed to it by adjacent uplands. If this water source is cut off by development in the uplands, the wetland will not continue to function. Therefore, through the ecosystem approach, the resource's functions could be preserved, as well as the resource itself.

- **Natural Features Setback –** The Open Space and Greenway Plan calls for adoption of an aquatic buffer requirement, and buffers are already required in relationship to floodplains. These regulations could be enhanced by including standards for management of the buffer, and classifying buffers as conservation areas and/or part of a recreational greenway.
- **Private Road Ordinance Standards –** The existing private road requirements could be amended to minimize clearing and grading, and impervious surfaces. Streets can be safely designed with narrower right-of-ways, narrower pavement widths, and smaller cul-de-sac radii than current County standards. Allowing for an infiltration island in the middle of a cul-de-sac would also reduce storm water runoff, and pollutants, from the roadway.
- **Native Vegetation Guidelines –** The plants that grow naturally in a community perform environmental functions that keep our environment working. The benefits of preserving native plants (woodlands, grasslands, wetland plants, etc.) and landscaping with native plants are many. Native trees, shrubs, and ground layer plants can absorb a great deal of storm water. And improving infiltration of storm water can recharge groundwater resources. Native plants also help filter storm water of its sediments and pollutants, such as through a natural feature buffer. Landscaping with natives requires less fertilizers, pesticides, water and lawn care equipment once the plants are established, reducing the cost of maintenance as well. Natives also provide habitat for beneficial wildlife. Native vegetation guidelines encourage the preservation of native plants, and landscaping with species native to your area.

3. Programs / Standards / Guidelines

Other actions that can be integrated into a community's day-to-day activities that could positively impact Stony Creek include the following:

- Create a program or coordinate with the County to identify and correct failing septic systems.
- Initiate a community program to regularly clean out, maintain, or inspect structural storm water facilities, such as catch basins, vegetated swales, etc.
- Consider increasing participation in monitoring and enforcing erosion control measures throughout the Township by working with the County.

4.2.11 City of Rochester

Master Plan Analysis (Adopted June 2000)

General Information

The Master Plan shows that the community is essentially built out, and their main priorities are focused on redeveloping areas of the City. Creating trails and connections throughout the City for non-motorized transportation is also a main priority.

Physical Features
The Master Plan lists the parks, Paint Creek Trailway, and private open spaces in new developments in eastern area

Goals and Objectives
Residential: Continue to require developers to provide pedestrian-friendly streets with sidewalks in new subdivisions, in order to maintain the sense of community in Rochester.

Industrial: Relocate industrial uses away from waterbodies, including the Clinton River, Paint Creek, Stony Creek and wetlands.

Parks and Recreation: Enhance Rochester's facilities by adding additional land for parks and recreation.

Natural Features: Preserve, maintain, and protect sensitive natural features.
- Carefully consider methods to preserve natural features for the enjoyment of the current and future populations.
- Reevaluate zoning ordinance standards to protect woodlands and wetlands.
- Continue requiring tree replacement when existing resources are impacted by development.
- Consider preserving open space, waterbodies, and natural features through a land conservancy or other non-profit organization.
- Protect the City's waterbodies, including rivers, streams, and creeks, from degradation and destruction.
- Enhance the viewsheds of woodlands, wetlands, and other waterbodies.

Vision Statements
Community Character: The Community's appearance is enhanced by the views along the Paint Creek and Clinton River.

Parks and Recreation: Developing a network of multi-purpose trails or a greenways system could provide additional recreation opportunities, while also linking recreation areas both with Rochester and regionally.

Natural Features: The City recognizes the community's natural resources as an important component of quality of life. Efforts to identify and preserve woodlands, wetlands, scenic views, steep slopes, and other natural features should be promoted.
- Preserve, maintain and protect natural resources for the enjoyment of residents.
- Maintain, enhance, increase views of the City's rivers, creeks and other natural resources.
- Promote an image of the City as an "urban forest." Promote or require tree replacement when development impacts existing resources.
- Promote the Clinton River as a community recreation asset. The development of a Clinton River walkway may help to achieve this goal.

Transportation: Continue development of a network of pedestrian and bicycle routes as an alternative means of non-motorized transportation within the community.

Existing Land Uses Adjacent to Stony Creek:
- Single Family Residential (R-5) (Lots abut creek)
- Open Space

- Office

Future Land Uses Adjacent to Stony Creek:
- Single-family residential (R-5)
- Recreation & Open Space
- Research, Office & Technology

Recommendations for City of Rochester

1. Plans and Policies

The City of Rochester is considered essentially built out, with a few vacant parcels or parcels in need of redevelopment. The Master Plan identifies these areas, and provides goals for some redevelopment and natural feature preservation of parcels along streams and the Clinton River. The following ideas for the Master Plan work with these goals to strengthen protection of Stony Creek:

Land Conservation and Redevelopment Techniques:
- Develop a Natural Areas Plan that identifies the important natural features within the City, its parks, and along the streams and river corridors. The plan could provide guidance for redevelopment priorities, as well as strategies for public education regarding management of natural features on private property. Information about existing potential hazards to water quality and goals for improvements to Stony Creek could also be provided.
- Call for preservation and/or restoration of natural features because of the functional benefits they provide in storm water management (infiltration, filtering, etc.).
- Expand opportunities for land conservation by discussing other options to the conservation easement, such as land acquisition, donations, land conservancies, etc.

Storm Water Management Standards:
- Discuss storm water management in the Master Plan, calling for pre-treatment of storm water in redevelopment projects, and exploration of retro-fitting storm water structures to filter storm water before it reaches natural water bodies.
- Call to reduce impervious surfaces in redevelopment projects to minimize storm water runoff and improve infiltration.
- Include goals and policies that encourage the use of Best Management Practices (BMPs) to minimize, collect, and treat storm water.
- Include mechanisms to ensure regular inspection and maintenance of BMPs.

Stream Corridors and Floodplains:
- Indicate the importance of riparian buffers and their role in protecting water quality and the stream channel. State that protecting stream channels promotes the health, safety and welfare of residents through reduced flooding, less erosion, etc. Call for restoration of stream corridors and buffers, and educate the public about the role of buffers on their property.
- Show a stream protection area on the land use map.
- Connect the community's floodplain protection efforts with adjoining communities' efforts.

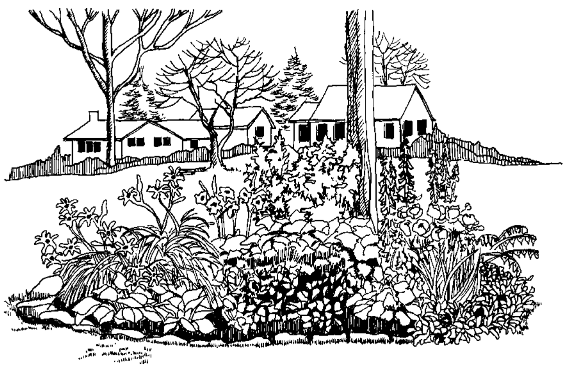
Recreation:
- Develop a Greenways Plan as a stand-alone plan or part of the Recreation Master Plan. This plan could identify potential pedestrian and recreation trails through the City, and help provide preservation of the Stony Creek riparian corridor through trail development.

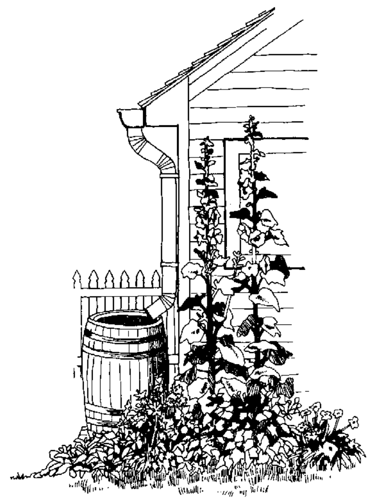
Watershed Issues:

- Identify and map the watershed(s) in the community. Call for protecting watershed resources through development regulations, and sharing in education, pollution prevention and monitoring. Encourage participation in watershed monitoring or restoration efforts.

Public Education:

- Distribute educational materials that describe ways homeowners can limit runoff through rain barrels, rain gardens, reducing the use of fertilizers and pesticides, among other practices.
- Participate in stewardship activities that teach landowners how to preserve and maintain natural features.





Illustrations 4.12. & 4.13. Limit storm water runoff using rain gardens and rain barrels.

2. Development / Redevelopment Regulations

The City is not facing extensive new development, but various redevelopment proposals are expected. The City could incorporate some of the following tools in the development regulations that will expand treatment and control of storm water, and help to protect Stony Creek as a result. Note that these tools are described in further detail in Appendix D.

Storm Water Management Standards:

- **Storm Water Management Ordinance –** This ordinance communicates to developers how storm water quality and quantity are viewed by the community, and can give them guidance as to how they should approach storm water management through their development designs. The main emphasis is to prevent storm water runoff, and treat the runoff that does occur before it reaches a natural water body.
- **Best Management Practices –** The zoning ordinance or Engineering Standards can require that all storm water be pre-treated before it is released into a natural water body or wetland. This could be accomplished by the use of Best Management Practices (BMPs) to treat and filter storm water, as well as regulate the rate at which storm water exits a site.

Land Conservation and Development Techniques:

- **Natural Features Setback Guidelines –** These guidelines (vs. regulations) would be an extension of the City's existing buffer rules, and could be used to educate and encourage private property owners to preserve, restore, and maintain natural feature buffers on their property. The setback or buffer is an area of native vegetation next to a natural resource that shields or cushions the resource from human activity. The setback or buffer is applied to any natural resource, such as wetlands, streams and rivers, ponds and lakes and even woodlands. Because it is naturally vegetated, it absorbs and filters nutrients and pollutants from storm water before it reaches the water body. It also provides wildlife habitat.
- **Parking Requirements –** One way of reducing impervious surfaces includes re-evaluating the community's parking requirements, and setting parking space maximums versus minimums. Also, the ordinance could allow the City body approving site plans to allow for less parking if the situation warrants it. Another method is to permit smaller parking spaces and shared parking arrangements, and encourage parking structures.

Illustration 4.14. Typical parking lot arrangement.

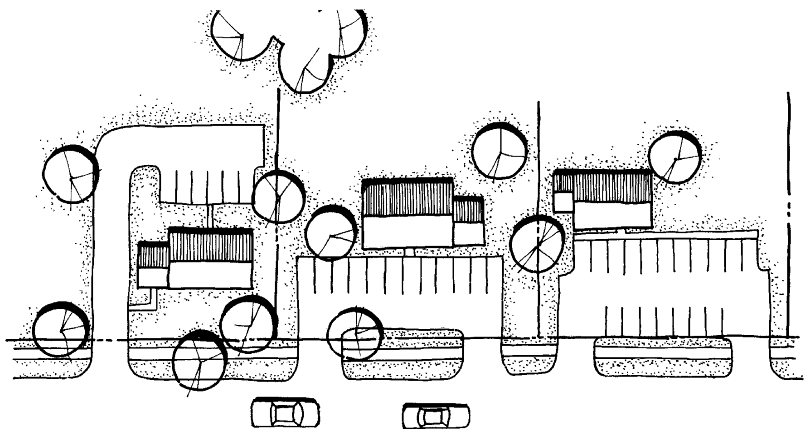
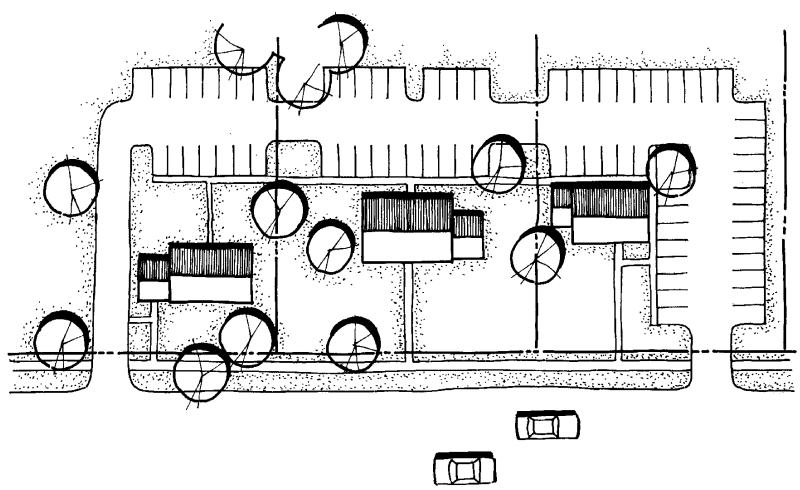


Illustration 4.15. Encourage shared parking lot arrangement.



- **Flexible Setback Provisions –** More flexibility in the setback regulations will help to limit the amount of clearing and grading necessary to build roadways and buildings in redevelopment projects. The buildings can be set closer to the roadway and to each other, using up a smaller building envelope, and enabling the preservation of additional open space.
- **Native Vegetation Guidelines –** That plants that grow naturally in your community perform environmental functions that keep our environment working. The benefits of preserving native plants (woodlands, grasslands, wetland plants, etc.) and landscaping with native plants are many. Native trees, shrubs, and ground layer plants can absorb a great deal of storm water. And improving infiltration of storm water can recharge groundwater resources. Native plants also help filter storm water of its sediments and pollutants, such as through a natural feature buffer. Landscaping with natives requires less fertilizers, pesticides, water and lawn care equipment once the plants are established, reducing the cost of maintenance as well. Natives also provide habitat for beneficial wildlife. Native vegetation guidelines encourage the preservation of native plants, and landscaping with species native to your area. This concept could be expanded to include landscaping adjacent to streams and wetlands to help protect water quality and reduce erosion.

3. Programs / Standards / Guidelines

Other actions that can be integrated into a community's day-to-day activities that could positively impact Stony Creek include the following:

- Initiate a community program to regularly clean out, maintain, or inspect structural storm water facilities, such as catch basins, vegetated swales, etc.
- Include goals to minimize clearing and grading of redevelopment sites.
- Investigate and prioritize clean up of environmental contamination sites, including evaluating state and federal programs for assistance in these efforts.

4.2.12 City of Rochester Hills

Master Plan Analysis (Adopted June 1999)

General Information

In the introduction to the Mater Plan, the Plan states that it recognizes that it is an essentially built-out community, which needs to focus its land use policies on optimizing remaining development and redevelopment while recognizing opportunities for improvement of existing conditions within the City. The Plan also recognizes its relationship to Oakland County and the region. There is a need to coordinate land use, infrastructure, transportation and natural features policies with these communities where impacts extend beyond the City's corporate boundaries. Suburban development patterns have damaged or destroyed many important natural features. Today, it is critical to the sustainability of Rochester Hills' character and desirability that environmental issues are taken seriously in the community's land use planning process.

Physical Features

The Master Plan provides background information describing the community's natural features in relation to Stony Creek.

The quality of the tributary streams in Rochester Hills is still "good" to "excellent" based on a report completed by the Michigan Department of Natural Resources in 1997. Four creeks provide interesting open space linkage opportunities. These creeks vary in character and opportunity. Stony Creek is an integral link with the Metropark system and the historic resources of Rochester Hills.

Stony Creek empties into the Clinton River on the east side of Rochester after flowing through one of the major Metroparks northeast of Rochester Hills. The stream passes through the most historic part of Rochester Hills, which has strong interpretive and recreational links to surrounding communities. Stony Creek has been identified by the Michigan Department of Environmental Quality and Clinton River Watershed Council as the highest quality stream in the City. The upper reaches of Stony Creek are primarily undeveloped, although it is currently under pressure for residential development.

The sensitivity to development of this high quality stream requires careful monitoring of soil erosion and sedimentation control and storm water discharge quality to preserve and protect this stream. A wet meadow along Stony Creek between Bloomer Park and the railroad has been identified as the most diverse and highest quality native habitat in Rochester Hills. A strategy to identify these remnant quality habitats and develop a private/public partnership to acquire these habitats should be considered.

Undisturbed woodland cover continues to be threatened in Rochester Hills as development occurs on the remaining rural or undeveloped sites. Generally, the largest stands of woodlands in the community are visible along the river, creek and wetland corridors, in some of the large open space areas like city parks, Oakland University, and the remaining undeveloped parcels. The loss of the larger stands of woods in the community is significant beyond the loss of the trees for the bird and wildlife habitat they provide. Rochester Hills has a landscaped appearance comprised of many residential properties that enhance community appearance. However, neighborhoods, road corridors and isolated clusters of trees lack the habitat support characteristics of the upland hardwood forest.

Goals and Policies

The Master Plan includes goals and policies that will help protect and restore the natural features within the watershed.

Goals geared toward protecting natural features specifically name the Clinton River and its tributaries as primary elements that should be preserved. Actions that will reduce impacts to the river, such as river edge, woodlands, and wetlands protection, as well as the water quality are discussed. Reduction in impervious pavement, acquisition of sensitive natural features, and a storm water management ordinance are all tools named in the Plan that could be used in preservation efforts.

The Plan also discusses protection of natural features through creating coordinated open spaces. The Clinton River and tributaries provide natural corridors in which to do this, as well as provide opportunities for recreation pathways. In tandem with this idea, the Plan encourages non-motorized modes of transportation through bikeways and greenways, as well as a potential Rails-to-Trails option along the Grand Trunk Railroad.

Other goals related to natural features include cleaning up former landfills and redeveloping them for recreation and open space uses, construction of larger community parks, and providing recreation opportunities further across the City, preserving historic features, and areas of environmental quality.

Existing Land Uses Adjacent to Stony Creek:
- Single Family Residential
- Vacant
- Quasi-Public
- Special Purpose – These are institutional uses that serve an educational, cultural, health, recreational or social purpose in the community. Land uses include hospitals, colleges, and cultural facilities.
- Other Public

Future Land Uses Adjacent to Stony Creek
- Single-family Residential
- Quasi-Public
- Special Purpose
- Public

Recommendations for City of Rochester Hills

1. Plans and Policies
The Rochester Hills Master Plan recognizes that this community is essentially built-out, and needs to focus its policies on optimizing the remaining development and redevelopment opportunities. To incorporate this development while preserving natural features, the following ideas could be incorporated into the Master Plan:

Land Conservation and Development Techniques:
- Provide guidance for community acquisition and/or protection of open space by creating a Natural Areas Plan that identifies important open spaces that should be preserved. This plan could also discuss preferred land conservation techniques, such as conservation easements, protection under subdivision or condominium documents, land conservancy donations, etc.
- Call for the preservation of natural features because of the functional benefits they provide in storm water management (infiltration, filtering, flood control, etc.).
- Call to minimize clearing and grading of sites to retain native vegetation and existing hydrologic patterns.

Storm Water Management Standards:
- Discuss storm water management in the Master Plan, calling for pre-treatment of all storm water before discharge into a natural water body, and maintenance of pre-construction runoff rates.
- Explore retro-fitting storm water structures in developed areas of the City to filter storm water before it reaches natural water bodies.
- Call to reduce impervious surfaces in new construction and redevelopment projects to minimize storm water runoff and improve infiltration.
- Include goals and policies that encourage the use of Best Management Practices (BMPs) to minimize, collect, and treat storm water.
- Include mechanisms to ensure regular inspection and maintenance of BMPs.

Stream Corridors and Floodplains:
- Connect the community's floodplain protection efforts with adjoining communities' efforts.

Recreation:
- Develop a Greenways Plan as a stand-alone plan or part of the Recreation Master Plan. This plan could identify potential pedestrian and recreation trails through the City, and help provide preservation of the Stony Creek riparian corridor through trail development.

Watershed Issues:
- Identify and map the watershed(s) in the community. Call for protecting watershed resources through development regulations, and sharing in education, pollution prevention and monitoring. Encourage participation in watershed monitoring or restoration efforts.

Public Education:
- Distribute educational materials that describe ways homeowners can limit runoff through rain barrels, rain gardens, reducing the use of fertilizers and pesticides, among other practices.
- Participate in stewardship activities that teach landowners how to preserve and maintain natural features and buffers.

2. Development / Redevelopment Regulations

The land within the watershed and the City of Rochester Hills is made up of several different land use types. However, 22% of this land is currently categorized as vacant. Although the community is essentially built-out, there is still potential to incorporate development within the watershed while preserving the properties' natural features. The following offers potential tools to consider. Note that these tools are described in further detail in Appendix D.

Storm Water Management Standards:
- **Storm Water Management Ordinance –** This ordinance communicates to developers how storm water quality and quantity are viewed by the community, and can give them guidance as to how they should approach storm water management through their development designs. The main emphasis is to prevent storm water runoff, and treat the runoff that does occur before it reaches a natural water body. One detail that could be addressed in this ordinance is to prohibit pumping of water into a watercourse from construction sites.
- **Impervious Surface Reduction/Infiltration Enhancement Ordinance –** Impervious surfaces, such as roads, parking lots, and buildings, add to the amount and rate of storm water entering our water bodies. This runoff carries a variety of pollutants. An Impervious Surface Ordinance can be used to communicate site development standards that guide developers and individuals doing site plan review to find opportunities for less impervious surface and more water infiltration.
- **Best Management Practices –** The zoning ordinance or Engineering Standards can require that all storm water be pre-treated before it is released into a natural water body or wetland. This could be accomplished by the use of Best Management Practices (BMPs) to treat and filter storm water, as well as regulate the rate at which storm water exits a site.

Land Conservation and Development Techniques:
- **Natural Feature Overlay District –** This district is applied to lands that have been identified as having special environmental features worthy of preservation (through the

Natural Areas Plan), but are in various zoning categories. The Overlay District applies additional restrictions to these unique features that "overlay" the underlying zoning classification and rules. The properties retain their original zoning, but the natural features are preserved through the rules in the Overlay District. The areas of protection can be defined as "ecosystems," which would protect the resource itself, and the adjacent lands that contribute to the functioning of the natural resource. For example, a wetland is sustained by the water contributed to it by adjacent uplands. If this water source is cut off by development in the uplands, the wetland will not continue to function. Therefore, through the ecosystem approach, the resource's functions could be preserved, as well as the resource itself.

- **Natural Features Setback –** As an extension of the existing regulations for natural feature buffer areas, language could be added that discusses appropriate management of the buffer area, and using the buffer as a conservation area or as part of a recreational greenway.
- **Private Road Ordinance Standards –** Private roads can be safely designed with narrower right-of-ways, narrower pavement widths, and smaller cul-de-sac radii than current County standards. All of these modifications would reduce the amount of clearing and grading necessary, as well as the amount of impervious surface in a development. Allowing for an infiltration island in the middle of a cul-de-sac would also reduce storm water runoff, and pollutants, from the roadway.
- **Parking Requirements –** Re-evaluating the community's parking requirements could be a way to reduce the amount of impervious surfaces in a community. One method is to set parking space maximums versus minimums. Also, the ordinance could allow the body approving site plans to allow for less parking if the situation warrants it. Another method is to permit smaller parking spaces, and shared parking arrangements. Lastly, parking lot islands are an important factor in breaking up the broad expanse of pavement, and allowing for infiltration of runoff if designed to capture storm water.

Illustration 4.16. Implement road standards such as narrower widths, sidewalks on only one side, and roadside swales to minimize impervious surfaces and encourage infiltration.

- **Sidewalks –** Currently, the City requires sidewalks on both sides of residential streets. However, sidewalks add to impervious surfaces in developments. To balance pedestrian needs with storm water management, sidewalks could be permitted on one side of a street only.
- **Flexible Setback Provisions –** As part of the development provisions, more flexibility in the setback regulations will help to limit the amount of clearing and grading necessary to build roadways and residential units. The buildings can be set closer to the roadway and to each other, using up a smaller building envelope, and enabling the preservation of additional open space.

- **Open Space Management –** A element of the cluster provisions could discuss how the open space should be maintained after it is set aside for preservation and the mechanisms in place to ensure that this happens. Maintenance of natural areas in a natural state may require regular activities to ensure the area retains its functional values.
- **Native Vegetation Guidelines –** The plants that grow naturally in a community perform environmental functions that keep our environment working. The benefits of preserving native plants (woodlands, grasslands, wetland plants, etc.) and landscaping with native plants are many. Native trees, shrubs, and ground layer plants can absorb a great deal of storm water. And improving infiltration of storm water can recharge groundwater resources. Native plants also help filter storm water of its sediments and pollutants, such as through a natural feature buffer. Landscaping with natives requires less fertilizer, pesticides, water and lawn care equipment once the plants are established, reducing the cost of maintenance as well. Natives also provide habitat for beneficial wildlife. Native vegetation guidelines encourage the preservation of native plants, and landscaping with species native to the area.

3. Programs / Standards / Guidelines

Other actions that can be integrated into a community's day-to-day activities that could positively impact Stony Creek include the following:

- Initiate a community program to regularly clean out, maintain, or inspect structural storm water facilities, such as catch basins, vegetated swales, etc.
- Consider increasing participation in monitoring and enforcing erosion control measures.

4.2.13 Washington Township

Master Plan Analysis (Adopted April 1993)

General Information

The Stony Creek watershed occupies a significant portion of western Washington Township. The Master Plan describes the Township as being located directly in the path of the housing and population growth trends occurring along the VanDyke/Mound Road growth corridor in Macomb County. Portions of the Township are located within the existing sanitary sewer service areas. In the southern half of the township, and at the eastern edge of the Stony Creek watershed, this service area extends along 26 Mile Road, between Mound and Hayes Roads, and north along Van Dyke to approximately 29 Mile Road.

Adjoining communities influence development within the Township's watershed zone. To the west, the development policies of Oakland Township are reflected in Washington's Zoning designations. Nearly this entire common boundary is zoned for very low residential purposes. South of Snell Road to 26 Mile Road, the common boundary is zoned Regional Park. This designation reflects the extension of Stony Creek Metro Park into the community. Bruce and Washington Townships share a common boundary along 32 Mile Road. West of the Village of Romeo, the 32 Mile Road frontage in Bruce Township is designated for very low density residential purposes. This designation anticipates the development of single-family homes at a density of one dwelling unit for every two acres of land.

The Huron-Clinton Metropolitan Authority also influences activities within the Stony Creek watershed. It operates Stony Creek Metropark, which offers a wide range of recreational opportunities for residents throughout the County and region. The location of this facility in the community has a significant influence on the Township's long-term development patterns, particularly within the Stony Creek watershed.

Physical Features

The Township's most prominent physical feature is the Birmingham Moraine, a range of hills extending from Shelby Township on the south and running in a northeasterly direction through Lockwood hills, Carriage Hills, Indian Hills Elementary School and Eastview Estates, eventually entering Bruce Township near Romeo High School. This moraine serves to define the edge of glacial movement in the Township.

The Stony Creek Valley lies directly to the west of the Birmingham Moraine, including Stony Creek itself and Stony Creek Lake. This valley was once deeper and broader than it is today. Glacial ice and accumulated material restricted the flow of water through this valley. As a result, the valley was filled with fine-grained outwash. Today, Stony Creek occupies a meandering channel through this valley in the western portion of the Township.

The most noticeable changes in topography are found along the Birmingham Moraine and within the Stony Creek Valley. The Master Plan states that proper site planning, good design and proper construction can make the Township's rolling topography an asset for future development. Careful attention should be paid to the development of these hillsides to avoid the problems frequently associated with building on slopes.

The Master Plan identifies soils within the Stony Creek valley as the Oakville-Boyer-Spinks Association. This association is made up of well-drained, nearly level to hilly soils that formed in lake-laid sediments, other sediments, and glacial outwash. The general landscape that these soils are found in is one consisting of hilly areas, numerous narrow outwash plains, and small wet depressions. One of the more practical applications of this soil information is to determine the suitability of the land to support different types of activities and uses. Chief among these is the suitability for on-site sewage disposal systems. The western portion of the Township has only slight limitations for septic systems.

Large wooded areas are distributed throughout Washington Township. Many of these woodlots are located in interior section acreage. These woodlands were measured in 1979. At that time, approximately 2,000 acres of land (eight percent of the total Township area) were covered by trees, excluding existing orchards and land within Stony Creek Park. Most of these wooded areas remain today and, as such, represent a valuable physical resource to be preserved and integrated into the development process.

Most of the existing wetlands in Washington Township are confined to the western portion of the Township within the Stony Creek Valley west of Mound Road. Stony Creek and numerous small lakes are located within this area, which explains the presence of these wetlands.

Goals and Policies

The Master Plan includes goals and policies that will help protect the watershed from degradation in the future. The natural resources goals are to carefully integrate the Township's unique features into the development process thereby preserving these features and enhancing the character and appearance of the built environment. Policies that help meet this goal include preserving the rolling, open topography of the west side of the Township and the Township’s woodlands and water features as well as rehabilitating abandoned mining sites.

Goals for residential development include ways to accommodate the needs and desires of existing and future residents, while preserving environmentally sensitive areas of the Township, increasing the quantity of open space and promoting diversity and quality development. The Township also specifically wants to reserve the rolling western portion of the Township for large lot single-family development.

The Master Plan recognizes the importance of high quality streets and roads, and goals for these facilities create opportunities to address environmental issues at the same time. Goals for road paving, replacing bridges, establishing truck routes, and providing alternative forms of transportation can be linked with projects that address erosion, siltation, and other problems within the watershed. Goals for other public facilities include encouraging large lots and on-site disposal systems where sewer extensions are not foreseeable within the planning period, install sewer and water facilities only where planning and zoning will not be compromised by their use, and develop a master storm water drainage plan that addresses existing and anticipated surface water drainage problems.

Existing Land Uses Adjacent to Stony Creek:

- Industrial: Industrial establishments occupy 73.5 acres of land. The most prominent industrial site is the TRW site, located on 26 Mile Road near the entrance to Stony Creek Metropark. TRW is a more dominant office character, with no production. The site has generous open spaces and architecturally attractive buildings.

- Extractive. Sand and gravel mining sties are included within this category. These uses are confined to the western portion of the Township, along Mound Road north of 29 Mile Road. Nearly 900 acres of land are being used for this purpose, or nearly ten percent of the community's developed land. This total does not include several abandoned mining sites located in the general vicinity of existing operations.

- Public/Semi-Public. Public uses include schools, parks and other Township sites. A substantial quantity of land is being used for this purpose in Washington Township. Public uses alone account for 2,633.5 acres of land, or nearly 30 percent of the Township's developed acreage. Semi-public uses occupy 344.4 acres.

  Lands managed by the Huron-Clinton Metropolitan Authority (HCMA) as part of Stony Creek Metropark account for the largest share of the total quantity of land being used for this purpose. The park boundaries extend from 26 Mile Road as far north as 31 Mile Road.

- Water. More than 600 acres of Washington Township's total area is permanently covered by surface water. this represents nearly three percent of the Township. The single largest body of water is Stony Creek Lake, around which the HCMA Metropark is centered. Several other smaller lakes are located to the north, lying within the Stony Creek Valley.

- Utilities. Other east-west corridors run the full width of the Township north of 29 Mile Road and north of 30 Mile Road between Van Dyke and the Township's western boundary.

Future Land Uses Adjacent to Stony Creek:

- Very Low Density. Approximately 2,200 acres of land are designated for this purpose. Most of this acreage is confined to the northwest corner of the Township, west of Mt. Vernon Road and north of Inwood Road. This designation is consistent with the previously expressed policy of reserving the rolling western portion of the Township for rural residential purposes.

Minimum lot sizes consistent with this classification are two (2) acres or greater. This area of the Township is not intended to be served with public utilities.

- Low Density. The Low Density classification is the most commonly occurring residential classification. A total of 4,100 acres of land are allocated for this purpose. Single-family units, at a density of one (1) unit per acre, are the recommended density of development for this residential classification. Areas designated for this density are generally located outside of any anticipated public utility service areas.

Recommendations for Washington Township

1. Plans and Policies

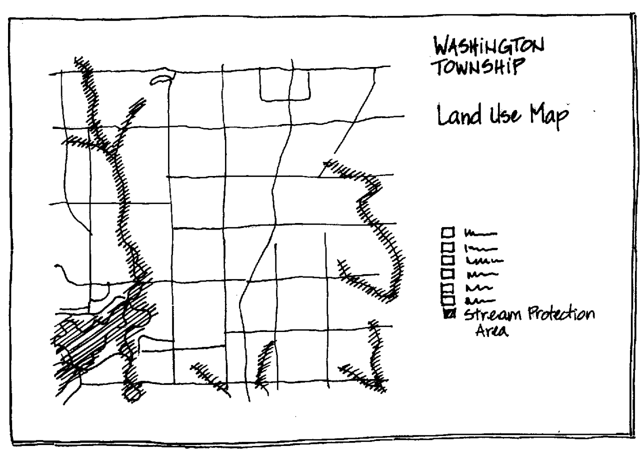
Factors that have influenced Washington Township's Master Planning of the western portion of the Township, and the Stony Creek watershed, include rolling topography, woodlands, and HCMA's Stony Creek Metro Park. The community's goal is to carefully integrate these unique features into the development process thereby preserving these features and enhancing the character of the built environment. Measures that could be integrated into the Master Plan that strengthen the protection of Stony Creek are as follows:

<u>Land Conservation and Development Techniques</u>:

- Preserve natural features because of the functional benefits they provide in storm water management (infiltration, filtering, etc.).
- Provide guidance for community acquisition/protection of open space by creating a Natural Areas Plan that identifies important open spaces that should be preserved.
- Describe agriculture's importance to the community. Map prime and unique agricultural lands, and those agricultural lands that are under development pressure. Provide goals and policies that deal with farmland preservation and coordinate with existing soil capabilities, facilities and infrastructure, transportation, housing and open space.
- Call to reduce impervious surfaces in new construction and redevelopment projects to minimize storm water runoff and improve infiltration.

<u>Storm Water Management Standards:</u>

- Include goals and policies that encourage the use of Best Management Practices (BMPs) to minimize, collect, and treat storm water.
- Include mechanisms to ensure regular inspection and maintenance of BMPs.
- The Township's Master Plan states that it will develop a master storm water drainage plan. Important issues to address in this type of plan could include both quality and quantity of storm water; tying storm water management to the health, safety and welfare of residents; calling for preservation of natural features to alleviate problems associated with storm water runoff; identifying, mapping and prioritizing protection of key areas for hydrologic function (wetlands, ground water



recharge, etc.); and restoring of natural features to improve their capacity for storm water management.

Stream Corridors and Floodplains:

- Indicate the importance of riparian buffers and their role in protecting water quality and the stream channel. State that protecting stream channels promotes the health, safety and welfare of residents through reduced flooding, less erosion, etc. Call for restoration of stream corridors and buffers, and educate the public about the role of buffers on their property.
- Show a stream protection area on the land use map.
- Connect the community's floodplain protection efforts with adjoining communities' efforts.

Illustration 4.17. Show a stream protection area on the land use map.

Watershed Issues:

- Identify and map the watershed(s) in the community. Call for protecting watershed resources through development regulations, and sharing in education and pollution prevention. Encourage participation in watershed monitoring or restoration efforts.

Public Education:

- Distribute educational materials that describe ways homeowners can limit runoff through rain barrels, rain gardens, reducing the use of fertilizers and pesticides, among other practices.
- Amend large lot provisions to include discussion of education efforts to help landowners maintain natural feature buffers and preserve native vegetation.

2. Development / Redevelopment Regulations

Since so much of the Stony Creek corridor has not yet been developed, the Township has an opportunity to guide future development with its goals for natural feature preservation. Some possible tools to consider include the following. Note that these tools are described in further detail in Appendix D.

Storm Water Management Standards:

- **Storm Water Management Ordinance –** This ordinance communicates to developers how storm water quality and quantity are viewed by the community, and can give them guidance as to how they should approach storm water management through their development designs. The main emphasis is to prevent storm water runoff, and treat the runoff that does occur before it reaches a natural water body.

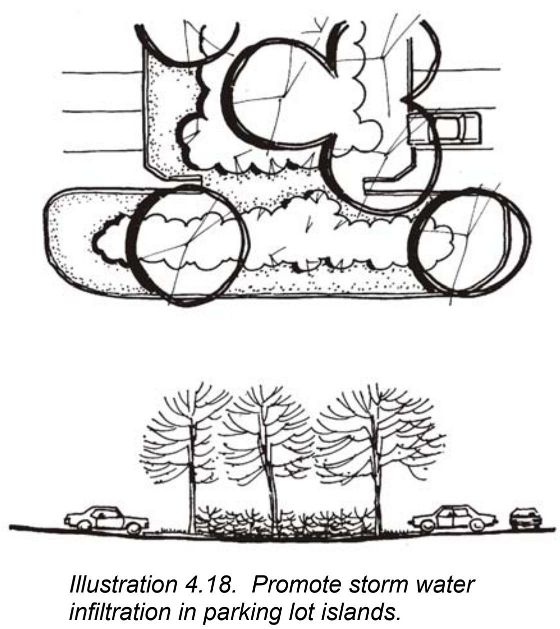


Illustration 4.18. Promote storm water infiltration in parking lot islands.

- **Impervious Surface Reduction/Infiltration Enhancement Ordinance –** Impervious surfaces, such as roads, parking lots, and buildings, add to the amount and rate of storm water entering our water bodies. This runoff carries a variety of pollutants. An Impervious Surface Ordinance can be used to communicate site development standards that guide developers and individuals doing site plan review to find opportunities for water infiltration.
- **Best Management Practices –** The zoning ordinance or Engineering Standards can require that all storm water be pre-treated before it is released into a natural water body or wetland. This could be accomplished by the use of Best Management Practices (BMPs) to treat and filter storm water, as well as regulate the rate at which storm water exits a site.

Land Conservation and Development Techniques:

- **Natural Feature Overlay District –** This district is applied to lands that have been identified as having special features worthy of preservation (through the Natural Areas Plan), but are in various zoning categories. The Overlay District applies additional restrictions to these unique features that "overlay" the underlying zoning classification and rules. The properties retain their original zoning, but the natural features are preserved through the rules in the Overlay District. The areas of protection can be defined as "ecosystems," which would protect the resource itself, and the adjacent lands that contribute to the functioning of the natural resources. For example, a wetland is sustained by the water contributed to it by adjacent uplands. If this water source is cut off by development in the uplands, the wetland will not continue to function. Therefore, through the ecosystem approach, the resource's functions would be preserved, as well as the resource itself.
- **Wetlands or Woodlands Protection Ordinances –** Ordinances that protect a specific natural feature, such as a wetland or woodland. These ordinances provide a statement of protection goals, definitions of the features to be conserved, and standards for protection and use. However, these ordinances are generally not written in an "ecosystem" context, and do not address adjacent lands that contribute to the preservation of the natural resource. (See Natural Feature Overlay District above.)
- **Natural Features Setback –** An area of native vegetation next to a natural resource that shields or cushions the resource from human activity. The setback or buffer is applied to any natural resource, such as wetlands, streams and rivers, ponds and lakes and even woodlands. Because it is naturally vegetated, it absorbs and filters nutrients and pollutants from storm water before it reaches the water body. It also provides wildlife habitat.
- **Private Road Ordinance Standards –** Currently, the Township's private road standards follow the County's requirements. However, private roads can be safely designed with narrower right-of-ways, narrower pavement widths, and smaller cul-de-sac radii, all of which would reduce the amount of clearing and grading necessary, as well as the amount of impervious surface in a development. Allowing for an infiltration island in the middle of a cul-de-sac also reduces storm water runoff, and pollutants, from the roadway.
- **Parking Requirements –** Other ways of reducing impervious surfaces include re-evaluating the community's parking requirements, and setting parking space maximums versus minimums. Also, the ordinance could allow the Township body approving site plans to allow for less parking if the situation warrants it. Another method is to permit smaller parking spaces, and shared parking arrangements. Lastly, sidewalks could be required on only one side of a street to limit impervious surfaces further.
- **Flexible Setback Provisions –** As part of the development provisions, more flexibility in the setback regulations will help to limit the amount of clearing and grading necessary to build roadways and residential units. The buildings can be set closer to the roadway and

to each other, using up a smaller building envelope, and enabling the preservation of additional open space.

- **Native Vegetation Guidelines –** The plants that grow naturally in a community perform environmental functions that keep our environment working. The benefits of preserving native plants (woodlands, grasslands, wetland plants, etc.) and landscaping with native plants are many. Native trees, shrubs, and ground layer plants can absorb a great deal of storm water. And improving infiltration of storm water can recharge groundwater resources. Native plants also help filter storm water of its sediments and pollutants, such as through a natural feature buffer. Landscaping with natives requires less fertilizers, pesticides, water and lawn care equipment once the plants are established, reducing the cost of maintenance as well. Natives also provide habitat for beneficial wildlife. Native vegetation guidelines encourage the preservation of native plants, and landscaping with species native to the area.

3. Programs / Standards / Guidelines

Other actions that can be integrated into a community's day-to-day activities that could positively impact Stony Creek include the following:

- Create a program or coordinate with the County to identify and correct failing septic systems.
- Initiate a community program to regularly clean out, maintain, or inspect structural storm water facilities, such as catch basins, vegetated swales, etc.
- Address goals to minimize clearing and grading of development sites in Engineering Standards.
- Consider increasing participation in monitoring and enforcing erosion control measures throughout the Township by working with the County.

Storm water detention and wetland, Oakland Township

CHAPTER 5: STONY/PAINT CREEK SUBWATERSHED ACTION PLAN

5.1 DESIGNATED & DESIRED USES

Designated Uses of Michigan Waterways

All surface waters of the state of Michigan are designated for and shall be protected for all of the following uses:

1) Agriculture (water supply)
2) Industrial water supply
3) Public water supply at the point of intake
4) Navigation
5) Warmwater fishery
6) Other indigenous aquatic life and wildlife
7) Partial body contact recreation
8) Total body contact recreation between May 1 and October 31
9) Coldwater fishery (designated streams only)

Stony and Paint Creeks are not known to be used as an industrial water supply or public water supply, therefore these uses are not addressed further in this plan.

While the Michigan Department of Natural Resources does not currently manage Stony Creek as a coldwater fishery, the department has indicated that they still consider the stream to support coldwater species.

Desired Uses of the Stony / Paint Creek Subwatersheds

The Stony / Paint Creek Stewardship Committee, with public input, also developed the following desired uses for Stony / Paint Creek in addition to the designated uses defined above. Note that these uses apply generally to the natural features of the subwatersheds, in addition to the waterways themselves:

- Intact riparian corridor for habitat and aesthetics
- Continued agricultural use / maintenance of rural character
- Protection of unique habitats, open space, and endangered / threatened species
- Protection and interpretation of historic character
- Continued active and passive recreational enjoyment

These designated and desired uses were then assessed for impairments, and potential pollutants and threats were identified based upon the results of the stream inventory and analysis of other available data (Table 5.1).

Table 5.1. Stony / Paint Creek Uses, Impairments, and Pollutants / Threats (k = known; s = suspected)

Designated or Desired Use	Impaired or Threatened?	Pollutants / Threats
Agricultural water supply	No impairment identified	
Navigation	Impaired in some areas (e.g. aquatic plants in Lakeville Lake, Stony Creek Lake, Winkler Mill Pond), low flow limits navigation on the stream itself	Nutrients (k) Hydrology (k) • Low Flow (k) • Flashiness (k) • Dams (k) Debris (log jams) (k)
Warmwater / Coldwater fishery	Impaired in some areas	Soil Erosion & Sedimentation (k) Hydrology (k) • Low Flow (k) • Flashiness (k) • Dams (k) Removal of riparian vegetation (k) Temperature (k) Organic compounds, pesticides, and heavy metals (s) Salt (s) Invasive Species (k)
Other indigenous aquatic life and wildlife	Impaired in some areas	Soil Erosion & Sedimentation (k) Hydrology (k) • Low Flow (k) • Flashiness (k) • Dams (k) Removal of riparian vegetation (k) Temperature (k) Organic compounds, pesticides, and heavy metals (s) Salt (s)
Partial body contact recreation	Impaired in some areas	Bacteria (k)
Total body contact recreation	Impaired in some areas (Stony Creek Metropark beach closings)	Bacteria (k)
Intact riparian corridor	Impaired in some areas	Soil Erosion & Sedimentation (k) Removal of riparian vegetation (k) Hydrology (k) • Low Flow (k) • Flashiness (k) • Dams (k)
Continued agricultural use / Maintenance of rural character	Threatened	Conversion to other land uses (k)
Preservation of unique habitats, open space, and	Threatened	Conversion to other land uses (k)

Designated or Desired Use	Impaired or Threatened?	Pollutants / Threats
endangered / threatened species		Hydrology (flashiness) (k) Removal of riparian vegetation (k) Invasive Species (k)
Historic character	Threatened	Conversion to other land uses (k) Lack of public knowledge limits ability to protect and interpret (k)
Recreational Enjoyment (active & passive)	Impaired in Some Areas	Hydrology (k) • Low Flow (k) • Flashiness (k) • Dams (k) Bacteria (k) Nutrients (k) Soil Erosion & Sedimentation (k)

5.2 STONY CREEK GOALS AND OBJECTIVES

Based upon the identification of designated and desired uses, the pollutant / threat assessment, stream inventory results, community planning analyses, and input from the riparian landowner surveys and public visioning sessions, the Stony Creek and Paint Creek Stewardship Committees and Project Team established eight goals and associated objectives for the long-term protection of Stony Creek and Paint Creek as unique natural, recreational, and cultural resources for the communities through which they flow.

The goals are generally defined as long-term goals, in that it will take a number of years to achieve many of them. Progress in achieving these goals will be defined by monitoring the physical and biological conditions of the rivers. The objectives are defined as steps or activities that are recommended for addressing and ultimately achieving the long-term goals. Some of these objectives are already in progress while others need to be implemented.

Goal 1. Establish and sustain a community-based mechanism to administer and implement the Stony/Paint Creek subwatershed plan.

Objective 1-A. Continue operation of the Stony/Paint Subwatershed Group as an advisory and decision-making body to guide implementation of the subwatershed plan.

Objective 1-B. Identify and develop creative financing programs to support implementation of the subwatershed plan.

Objective 1-C. Collaborate with the Clinton River Watershed Council, the Clinton River Public Advisory Council, SEMCOG, and other regional groups on watershed-wide activities.

Goal 2. Increase the public's understanding of their role in protecting Stony/Paint Creek.

Objective 2-A. Develop and/or promote existing and future public education and outreach programs.

Objective 2-B. Identify, promote, and encourage participation in educational opportunities for land use decision-makers (e.g. planning commissions, local boards and councils, developers, chambers of commerce, realtors, etc.).

Goal 3. Protect and restore the Stony/Paint Creek subwatershed's water quality, stream channels, riparian corridors, natural areas, wetlands, and unique ecosystems.

Objective 3-A. Reduce storm water and other point and non-point source pollution impacts and stabilize stream flow.

Objective 3B. Reduce nutrient loading contributing to excessive aquatic plant growth.

Objective 3-C. Reduce sources of bacteria contributing to beneficial use impairments.

Objective 3-D. Identify, prioritize, and establish mechanisms for preserving, restoring, and/or enhancing stream channels, riparian corridors, natural areas, wetlands, and unique ecosystems.

Objective 3-E. Promote and participate in local land and water stewardship efforts.

Objective 3-F. Participate in local and regional efforts to promote natural corridors and greenways.

Objective 3-G. Reduce inputs of hazardous materials, organic compounds, and heavy metals and restore affected areas.

Goal 4. Protect and restore the Stony/Paint Creek fishery.

Objective 4-A. Develop and implement a fisheries restoration and enhancement plan.

Goal 5. Improve recreational access and opportunities.

Objective 5-A. Develop and implement a recreation enhancement plan.

Goal 6. Protect farmland and reduce agricultural impacts on water quality.

Objective 6-A. Support farmland preservation efforts.

Objective 6-B. Encourage agricultural practices that protect water quality.

Goal 7. Protect and interpret the historic character of Stony/Paint Creek.

Objective 7-A. Develop and implement a historic preservation and interpretation plan.

Goal 8. Reduce Soil Erosion and Sedimentation.

Objective 8-A. Develop or revise ordinances to prevent, minimize and reduce soil erosion and sedimentation, especially for construction sites.

Objective 8-B. Implement BMP's for effective soil erosion and sedimentation prevention and mitigation, addressing both upland sources as well as sources from streambank erosion.

Objective 8-C. Improve soil erosion and sedimentation control inspection and enforcement, as well as education, for parties responsible.

Objective 8-D. Reduce sediment deposition into stream channels and wetlands.

These goals correlate to the designated and desired uses of Stony & Paint Creeks (Table 5.2).

Table 5.2. Correlation of Goals and Designated / Desired Uses of Stony & Paint Creeks.

	Designated / Desired Uses										
Goals	**AW**	**NV**	**FI**	**WL**	**PR**	**TR**	**RC**	**AU**	**UH**	**HC**	**RE**
Establish and sustain a community-based mechanism to administer and implement the Stony/Paint Creek subwatershed plan.	X	X	X	X	X	X	X	X	X	X	X
Increase the public's understanding of their role in protecting Stony & Paint Creeks.	X	X	X	X	X	X	X	X	X	X	X
Protect and restore the Stony/Paint Creek subwatershed's water quality, stream channels, riparian corridors, open space, natural areas, wetlands, and unique ecosystems.	X	X	X	X	X	X	X	X	X	X	X
Protect and restore the Stony and Paint Creek fishery.			X								X
Improve recreational access and opportunities.					X	X					X
Protect farmland and reduce agricultural impacts on water quality.	X		X	X	X	X	X	X		X	X
Protect and interpret historic character.										X	
Reduce soil erosion and sedimentation	X	X	X	X			X	X	X	X	X

AW = Agriculture (water supply)
NV = Navigation
FI = Warmwater / Coldwater fishery
WL = Other indigenous aquatic life and wildlife
PR = Partial body contact recreation
TR = Total body contact recreation
RC = Riparian corridor
AU = Agricultural use
UH = Unique habitats, open space, and species
HC = Historic character
RE = Recreation Enjoyment

5.3 SELECTION OF BEST MANAGEMENT PRACTICES

5.3.1 Definition and Performance of Best Management Practices

An understanding of the sources and causes of storm water pollution is necessary to select the best management practices, or BMPs, that will achieve efficient and effective solutions. BMPs cover a broad range of activities and vary greatly in cost, effectiveness, and feasibility. In many cases a series of BMPs should be applied to a site for the best effect; these BMPs will vary from site to site depending on specific conditions, such as whether the site is new construction in a rural community or a redevelopment project in an already urbanized area. In urbanized areas, BMPs focus on pollution prevention and good housekeeping practices along with retrofitting existing storm drainage systems. In a less developed subwatershed like Stony and Paint Creeks, preventative measures such as the implementation of land use planning tools to preserve natural areas, reduce runoff and impervious surfaces, and maintain natural drainage patterns are likely to be the most cost-effective solutions. In both cases, landowner education is also one of the most important components in an effective storm water management strategy.

An excellent body of work conducted by the Rouge River Subwatershed Advisory Groups (SWAGs) in the late-1990s and early 2000s provides subwatershed groups in Southeast Michigan with detailed information on BMP effectiveness, prioritization, and cost estimating guidelines. A great deal of this information is available online, along with a variety of other resources from across the country, including the following:

- **Rouge River National Wet Weather Demonstration Project –** Case studies on BMP pilot projects (www.rougeriver.com)
- **International Storm water Best Management Practices Database –** Storm water BMP documents and standards, developed by the American Society of Civil Engineers and the Environmental Protection Agency (www.bmpdatabase.org)
- **Center for Watershed Protection –** Publications on BMP performance, design, maintenance, watershed planning (www.cwp.org)
- **Storm watercenter.net –** Created by the Center for Watershed Protection, a comprehensive library of articles on BMP performance (www.storm watercenter.net)
- **Environmental Technology Evaluation Center –** Conducts independent evaluations of commercial storm water BMP devices (www.cerf.org/evtec/)

Types of BMPs

BMPs generally fall into two categories: structural and non-structural. *Structural BMPs* are engineered and constructed systems that improve the quality and/or control the quantity of storm water runoff, such as detention and retention ponds, constructed wetlands, infiltration areas, and vegetated swales. *Non-structural BMPs* are institutional arrangements, educational programs, or pollution prevention practices designed to limit the generation of storm water runoff or reduce the amount of pollution contained in that runoff, such as public education workshops, land use planning tools, operation and maintenance practices, or any other technique that does not involve designing and physically building a storm water management system. Each BMP type must be considered based upon a number of site-specific factors, such as drainage area served, available land space, cost, pollutant removal efficiency, soil types, slopes, depth of the water table, etc.

Evaluation of BMPs

The evaluation of BMP effectiveness is a growing field of research that is critical to the watershed planning process. Without data on BMP effectiveness, selecting the right BMPs may seem like an overwhelming task. Choosing BMPs at random based on anecdotal recommendations can be disastrous if the site is not suited to the selected BMP. Structural BMPs can be designed to meet a variety of specific goals, including controlling the quantity of runoff and removing specific pollutants at specific rates. Because the effectiveness of these systems can be quantitatively measured by monitoring inflow and outflow parameters, recent studies have been undertaken to determine pollutant removal efficiencies of a variety of BMPs (Table 5.3). The data presented in Table 5.3 represents the results of nearly 140 monitoring studies evaluating a diverse range of best management practices, including dry and wet ponds, wetlands, filters, and swales.

Table 5.3 The Effectiveness of Storm Water Treatment Practices in Removing Pollutants (Loading Reduction by % Removal Rate).

PRACTICE	TSS	Total P	Total N	Cu	Zn	Pb	BOD_5	O / G[1]	Organics	Bact	Criteria for Evaluation
a. Bioretention/Rain Gardens [2]	90	70-83	68-80	93-98	93-98	93-98	ND	ND	90	90	Area of BMP installed, total # of sites implementing BMP; drainage area and calculated pollutant loading reduction
b. Buffer/Vegetated Filter Strips [3]	50-90	50-80	ND	ND	ND	ND	ND	ND	ND	ND	Length of BMP installed, total # of sites implementing BMP; estimated pollutant reduction
c. Catch Basin Cleaning [3]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	# of catch basins cleaned
d. Construction Phasing [3]	42 [4]	ND	ND	ND	ND	ND	ND	ND	ND	ND	Total # of sites implementing BMP
e. Detention Basin (Dry) [5]	50	20	25	26	26	ND	ND	3	ND	44	Area of BMP installed, total # of sites implementing BMP; drainage area and calculated pollutant loading reduction
f. Detention Basin (Extended Dry) [6]	80-90	20-30	10-20	50-60	30-50	70-80	20-30	ND	ND	ND	Area of BMP installed, total # of sites implementing BMP; drainage area and calculated pollutant loading reduction
g. Detention Basin (Wet)A, [6]	80-90	35-70	15-50	60-70	40-50	ND	20-40	78	ND	70	Area of BMP installed, total # of sites implementing BMP; drainage area and calculated pollutant loading reduction
h. Detention Basin (Constructed Wetland) [3,5,7]	75-85	30-65	10-30	40	44	ND	ND	85	ND	78	Area of BMP installed, total # of sites implementing BMP; drainage area and calculated pollutant loading reduction
I. Filtering Practices [2,5]	86	59	38	49	88	ND	ND	84	ND	37	Area/length of BMP installed, total # of sites implementing BMP
j. Filtering Practices (Vertical Sand Filters) [2,5,8]	60-95	45	40-65	ND	ND	ND	ND	15	ND	ND	Area/length of BMP installed, total # of sites implementing BMP
k. Grassed Swales (Ditches/Biofilters/Highway Swales) [3,6,9]	65-90	15-50	30-50	40-60	40-50	ND	20-40	60	ND	ND	Area/length of BMP installed, total # of sites implementing BMP; drainage area and calculated pollutant loading reduction

Table 5.3 The Effectiveness of Storm Water Treatment Practices in Removing Pollutants (Loading Reduction by % Removal Rate).

PRACTICE	TSS	Total P	Total N	Cu	Zn	Pb	BOD_5	O / G[1]	Organics	Bact	Criteria for Evaluation
l. Infiltration [5]	95	80	51	ND	ND	ND	ND	ND	ND	ND	Area/length of BMP installed, total # of sites implementing BMP; drainage area and calculated pollutant loading reduction & %runoff using infiltration
m. Infiltration Basin [3]	50-80	100	ND	ND	ND	ND	ND	ND	ND	ND	Area of BMP installed, total # of sites implementing BMP; drainage area and calculated pollutant loading reduction & %runoff using infiltration
n. Infiltration Trenches/Dry Wells[3,10, 11]	50-90	60-70	60	90	90	90	70-80	ND	ND	90	Length of BMP installed, total # of sites implementing BMP
o. Porous Pavement [8,12]	82-95	65	80-85	ND	ND	ND	ND	ND	ND	ND	Area of BMP installed, total # of sites implementing BMP; estimated volume reduction
p. Riparian Buffers [13]	grass: 63-89	forested: 23-42; grass: 39-78	forested: 85; grass: 17-99	ND	ND	ND	ND	ND	ND	ND	Length of BMP installed, total # of sites implementing BMP.
q. Sand Filters [3,6]	70-90	20-60	40-70	30-60	50-80	ND	30-50	ND	ND	ND	Length of BMP installed, total # of sites implementing BMP
r. Silt Fences (a=If properly installed and maintained [14]; b=If installed at toe of slope [15])[3]	a=75-86; b=36-65	ND	ND	ND	ND	ND	ND	ND	ND	ND	Length of BMP installed, total # of sites implementing BMP.
s. Stabilizing Soils on Construction Sites[3, 16]	80-90	ND	ND	ND	ND	ND	ND	ND	ND	ND	# of new construction sites in municipality, area of BMP installed.
t. Street Sweeping [3,17]	50-90	50-90	ND	ND	ND	ND	ND	ND	ND	ND	Miles of streets sweeped, volume of sediment collected.
u. Swirl Concentrator Unit	60-80	60-80	ND	ND	ND	ND	ND	ND	ND	ND	Total # of sites implementing BMP, # of BMP installed; drainage area and calculated pollutant loading reduction

Table 5.3 The Effectiveness of Storm Water Treatment Practices in Removing Pollutants (Loading Reduction by % Removal Rate).

PRACTICE	TSS	Total P	Total N	Cu	Zn	Pb	BOD_5	O / G[1]	Organics	Bact	Criteria for Evaluation
v. Low-Impact Development	10-30	10-30	ND	ND	ND	ND	ND	ND	ND	ND	# of Low-Impact-Developments built.

ND = No Data

Total P = Total Phosphorus

Total N = Total NO2-3

Cu=Copper; Zn=Zinc; Pb=Lead

Zn = Zinc

O / G = Oil/Grease

[1] Represents Data for Oil/Grease and PAHs

[2] EPA Storm Water Technology Fact Sheet - Bioretention, September 1999.

[3] From Section 6.2 Description and Performance of Stormwater Best Management Practices Considered. Lower One Rouge River Subwatershed Management Plan, April 2001.

[4] Claytor. Watershed Protection Techniques, Technical Note 80.

[5] From Section 5.3.1 Definition and Performance of Best Management Practices, Stony Creek Subwatershed Plan, November, 2003.

[6] From Rouge River National Wet Weather Demonstration Project Pilot Best Management Practices Projects (319 Grant), February 27, 1996.

[7] Urbanization and Water Quality: A Guide to Protecting the Urban Environment. 1994. The Terrene Institute, Washington, D.C.

[8] Erosion and Sediment Control Best Management Practices (BMPs) Research Project; Second Edition December 2002, PBSJ Water Resources Program, MD.

[9] Reeves, E. 1994. Performance and Condition of Biofilters in the Pacific Northwest, Technical Note 30, Watershed Protection Techniques, Vol. 1, No. 3, P. 117-119.

[10] EPA Storm Water Technology Fact Sheet - Infiltration Trench, September 1999.

[11] Horner, Richard. 1994. Fundamentals of Urban Runoff Management, Terrene Institute, Washington, D.C., P. 116.

[12] EPA Storm Water Technology Fact Sheet - Porous Pavement, September 1999.

[13] Mill Creek Subwatershed Management Plan

[14] Goldman, S.J., K. Jackson and T.A. Bursztynsky. 1986. Erosion and Sediment Control Handbook. McGraw-Hill Book Company. New York, NY.

[15] Harding, M.V. 1990. Erosion Control Effectiveness: Comparative Studies of Alternative Mulching Techniques, Environmental Restoration; Science and Strategies for Restoring the Earth, Island Press, Covello, CA, P. 149-156.

[16] Brown, W. and D. Caraco. 1996. Task 2 Technical Memorandum: Innovative and Effective Erosion and Sediment Control Practices for Small Sites. Center for Watershed Protection for the US EPA Office of Wastewater Management. Silver Spring, MD.

[17] Watershed Protection Techniques. 1999. Technical Note: 103. Vol. 3, No. 1, P. 601.

Quantitatively evaluating the success of non-structural BMPs can be much more difficult because there is no physical structure that can be measured. Research demonstrates that these BMPs have a large impact on changing policy, enforcing protection standards, improving operating procedures, increasing public awareness, and changing behaviors to improve water quality and quantity over the long term. Because many of these BMPs are applied over a large land area, it is even more difficult to quantify their collective impact. No controlled monitoring studies have yet been completed at the watershed scale, as this is a very difficult and time-consuming undertaking, and it is very difficult to control actual development and implementation of BMPs over a large area. However, so-called Better Site Design techniques (also known as Low Impact Development, green infrastructure, and a variety of other terms) that minimize impervious cover, conserve natural areas, and distribute storm water treatment across individual development sites could potentially have an enormous impact on storm water runoff control and pollutant removal (Center for Watershed Protection, 2003). These techniques appear to be especially effective in subwatersheds with lower impervious cover (see section 4.1 Impervious Cover and Build-Out Analysis for further discussion).

5.3.2 Selection and Sequencing of Best Management Practices

Determining which BMPs are appropriate for a site, which actions should be implemented at what location in a subwatershed, and which actions should be taken in what order is critical to the effectiveness of the overall storm water management strategy. For example, it is inappropriate and potentially ineffective to address an erosion problem with streambank stabilization if the root of the problem – increasing flows – is left unaddressed further upstream.

A phasing approach has been developed for BMPs that assists in clarifying the BMPs that should be considered at various stages in the watershed management process (Middle One Subwatershed Advisory Group, 2001). This approach is a recommendation only, as specific site conditions may warrant alternative sequencing.

Phase I: BMPs that can be initiated right away, require minimal cost or planning, address the upstream sources / causes of a downstream problem. Usually non-structural BMPs such as source controls, education, good housekeeping activities, etc.

Phase II: BMPs that require significant planning and development or design specifications, require major costs, address sources / causes of a problem. Can be structural or non-structural BMPs, including ordinances, new projects / programs, studies, construction of detention ponds or wetlands, etc.

Phase III: BMPS for which success may depend on the success of a previously implemented BMP. Usually structural, such as in-stream habitat improvements after flow improvements have been made; pond or lake dredging after watershed-wide nutrient or sedimentation reduction efforts are in place, etc.

5.3.3. Examples of Best Management Practice Systems

Storm water BMPs are most effective when they are implemented as a coordinated system; that is, achieving the best water resource protection requires the proper placement and phasing of BMPs from the initial site planning stage all the way to post-construction storm water runoff management. A variety of structural and non-structural BMPs, primarily falling within the Phase II and Phase III categories defined previously, are illustrated on the following pages. These diagrams illustrate how a suite of BMPs can be used to protect water resources and other natural features in both residential and commercial settings.

Illustration 5.1. A residential site plan illustrating best management practices.

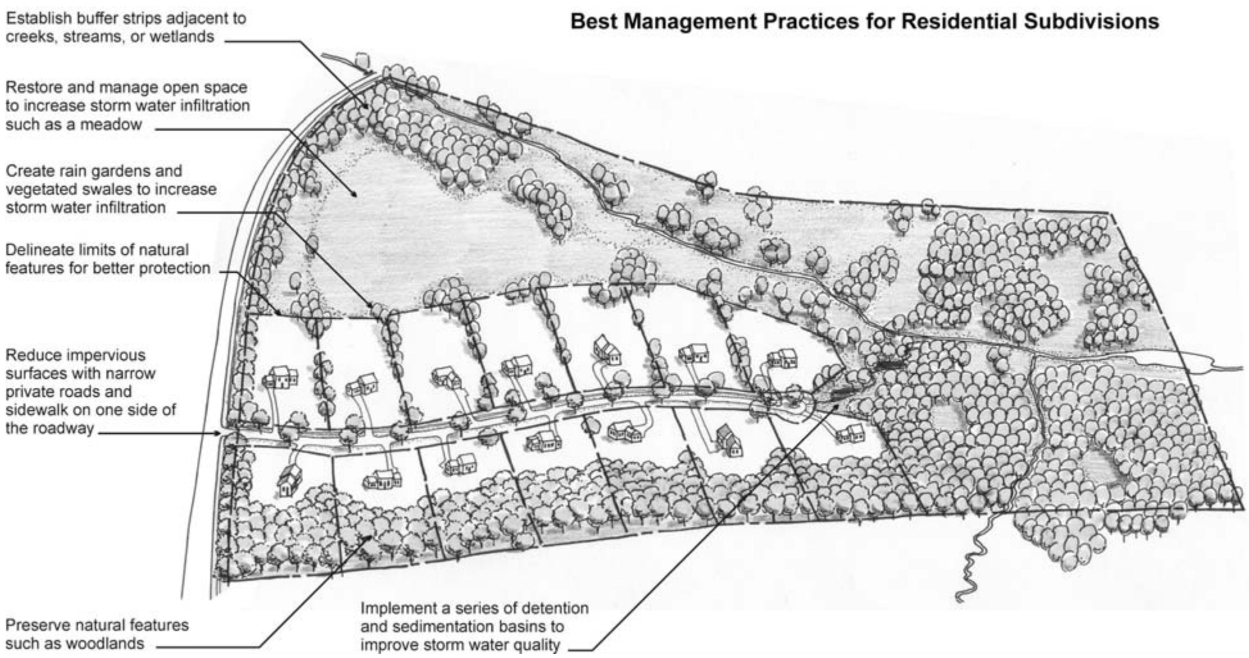


Illustration 5.2. Comparison of conventional and cluster developments.

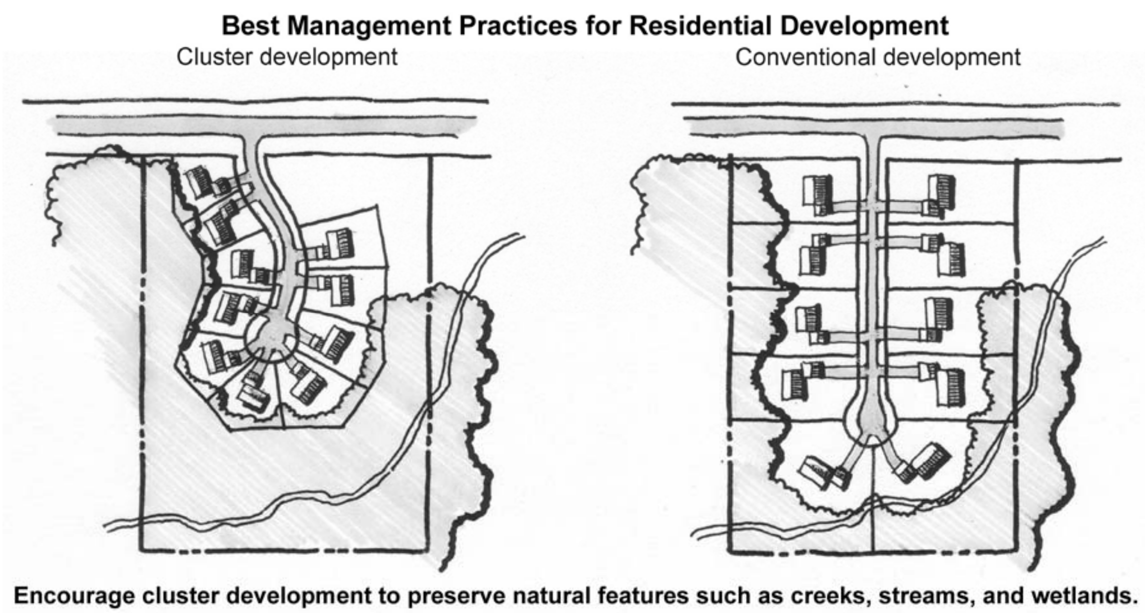


Illustration 5.3. Reduce impacts to natural resources by avoiding mass grading.

Illustration 5.4. A single family home site illustrating best management practices.

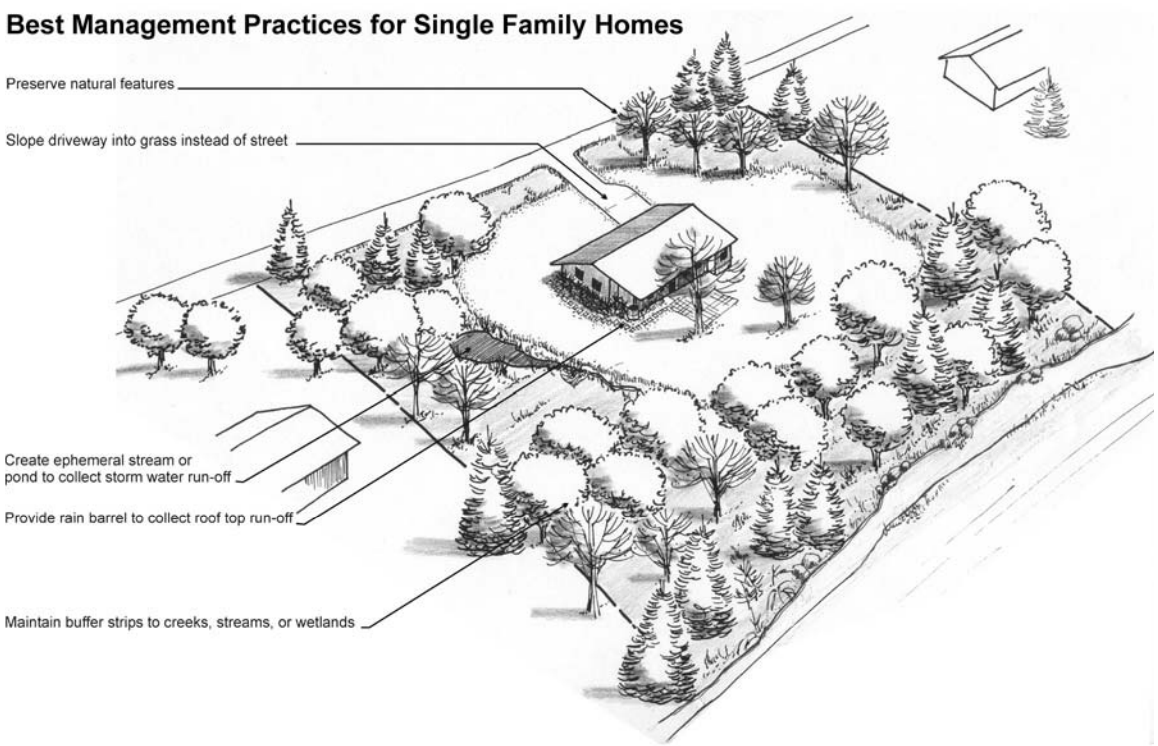
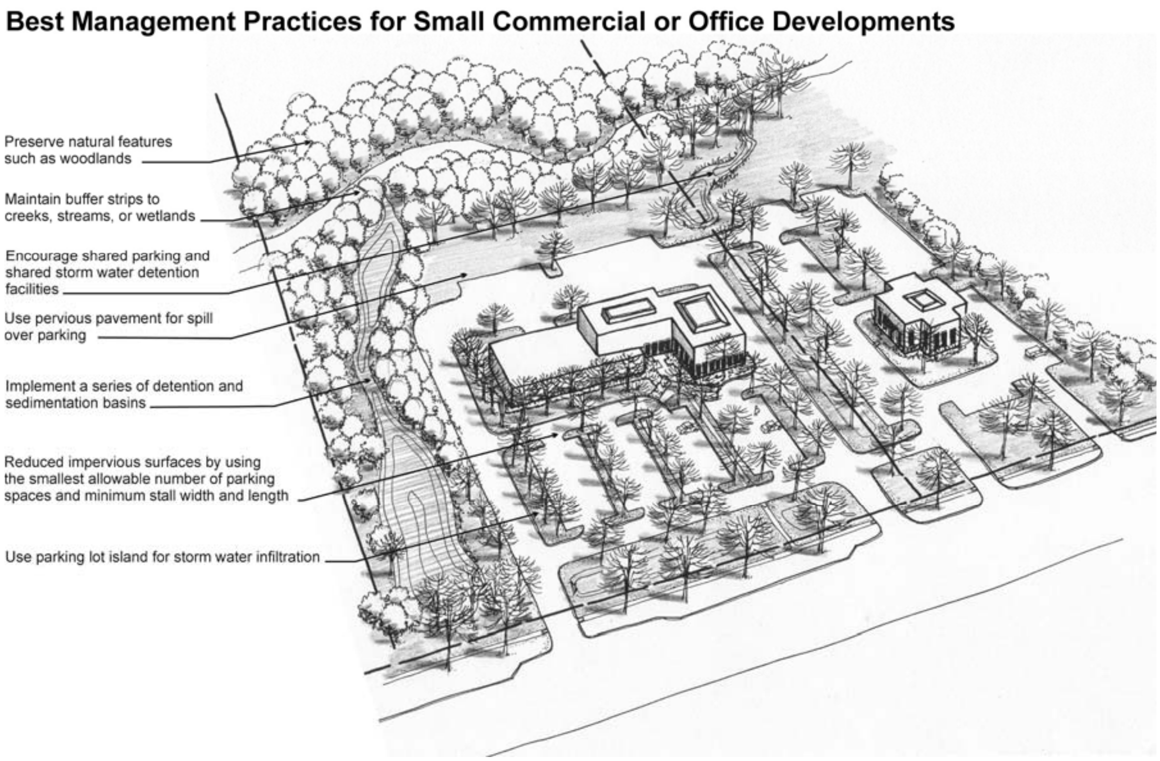


Illustration 5.5. A commercial / office site plan illustrating best management practices.



5.4 STONY CREEK ACTION PLAN

5.4.1. Recommended Actions to Achieve Stony/Paint Creek Subwatershed Goals & Objectives

The following narrative outlines the recommended actions to achieve the goals and objectives of the Stony/Paint Creek subwatershed plan. In addition, this information is further categorized in the subcritical areas in Appendix C: Recommended Actions & Criteria for Subcritical Areas.

Goal 1. Establish and sustain a community-based mechanism to administer and implement the Stony/Paint Creek subwatershed plan.

Objective 1-A. Continue operation of the Stony/Paint Subwatershed Group as an advisory and decision-making body to guide implementation of the subwatershed plan.

Action 1. Identify a facilitating body, organizational structure, and decision-making mechanism for the subwatershed group.

The continued operation of an effective planning body is critical to the successful long-term implementation of the subwatershed plan. The participating communities should determine an organizational structure that will effectively oversee the plan and be able to take action when key decisions are required.

Action 2. Obtain community commitments of support for operation of and participation in the subwatershed group.

Once an organizational structure is finalized, the governing body of each participating community should formally express their commitment to participate in and support the subwatershed group. The group should then endeavor to retain the support and cooperation of all communities within the subwatershed on an ongoing basis.

Objective 1-B. Identify and develop creative financing programs to support implementation of the subwatershed plan.

Action 3. Establish a mechanism for the subwatershed group to research, report on, and pursue financing options in cooperation with other subwatershed groups and regional agencies.

A number of county, regional, and state agencies are exploring options to develop financing mechanisms that could be implemented on a watershed-wide or regional scale. The subwatershed group should stay informed of these developments and take advantage of opportunities to share resources and costs. Staying on top of key legislative decision processes, grant announcements, and other financing options will also be critical in order to take advantage of opportunities quickly. This action can be accomplished through regular updates at the subwatershed group meetings and email correspondence.

Objective 1-C. Collaborate with regional groups on watershed-wide activities.

Action 4. Foster relationships and coordinate efforts with other subwatershed groups.

The Clinton River and its tributaries flow through more than 60 communities on their way to Lake St. Clair. Promoting information sharing and collaborative efforts between these diverse communities via the subwatershed groups could reap both economic and ecological benefits. The Stony/Paint Subwatershed Group should keep informed of the activities of the other subwatershed groups via the Clinton River Watershed Council and the Southeast Michigan Council of Governments, which participate in all of the groups and serve as liaisons for sharing information and resources across the Clinton River basin and southeast Michigan region. The Oakland County Drain Commissioner's Office and Macomb County Public Works Office, which are facilitating the other Clinton River subwatershed groups, can also serve as liaisons across their respective counties.

Action 5. Participate in regional planning efforts facilitated by the Clinton River Watershed Council, county agencies, Southeast Michigan Council of Governments, and other groups.

Participation in regional forums will assist in more rapid information transfer, including successes and lessons learned, and the exploration of opportunities to coordinate on grant requests and other joint projects.

Action 6. Collaborate with the Clinton River Area of Concern Public Advisory Council (PAC) and participate in Remedial Action Plan updates.

The Remedial Action Plan is, in effect, a watershed plan for the entire basin. The subwatershed management plan will be a very important component of future RAP updates and will serve to help break down the RAP into more manageable pieces, with specific goals, objectives, and actions prioritized for each subwatershed. Current PAC representatives include CRWC staff; updates on this process have been presented to each subwatershed, including the Stony/Paint Subwatershed Group. It is through these updates at the regular subwatershed group meetings, that opportunities arise to provide direction and comments to the RAP process.

Goal 2. Increase the public's understanding of their role in protecting Stony Creek.

Objective 2-A. Develop and/or promote existing and future public education and outreach programs.

The actions listed below serve to convey the messages of watershed education and stewardship in a cost-effective and efficient manner. The efforts of existing organizations should be coordinated and cross-promoted in order to take advantage of each group's networking and publicity mechanisms. In most cases there should not be a need to develop completely new materials or programs, as a wealth of information currently exists; however, the subwatershed group can collaborate on such efforts if and when the need arises. For example, the group may wish to target an audience, such as riparian landowners, with Stony Creek-specific materials.

Action 7. Promote and/or participate in existing annual watershed education and outreach events, such as River Day and Clinton Clean-Up.

Action 8. Promote and/or participate in the watershed education and outreach activities of local organizations as outlined in community and county Public Education Plans**.**

These organizations include the Clinton River Watershed Council, Friends of Bald Mountain, MSU Extension, North Oakland Headwaters Land Conservancy, Oakland Land Conservancy, SEMCOG, Stony Creek Nature Center, Wild Ones, etc.

It may be necessary to work with these or other organizations to develop additional mechanisms to supplement existing efforts. As part of the development of each community's Public Education Plan, existing mechanisms were reviewed and coordinated through the Clinton River Watershed Council.

Action 9. Promote and/or participate in the Clinton River Watershed Council's storm water education program, as outlined in community Public Education Plans.

This program is designed to educate the public about the following six topics, as required by the Phase II storm water permit:

- The public's responsibility for stewardship of their watershed.

- The location, function, and potential pollution impacts of separate storm water drainage systems.
- How to identify and report illicit discharges or improper disposal of materials into storm water drainage systems.
- The need to minimize wastes from residential activities washed into storm water drainage systems (including car washing, pesticide and fertilizer use, and lawn and pet waste disposal).
- How to dispose of household hazardous wastes, travel trailer sanitary wastes, yard wastes, and motor vehicle fluids.
- Management of riparian lands to protect water quality.

Action 10. Develop and implement an education strategy targeted at riparian landowners.
The Clinton River Watershed Council and the Oakland Land Conservancy have begun discussing opportunities to engage riparian landowners in watershed stewardship. Because so much of Stony and Paint Creeks flow through private land, an effective riparian landowner education program is critical to the long-term protection of both streams. A number of resources exist for developing this type of program; for instance, riparian technical advisory committees in the Rouge River watershed have developed newsletters and brochures for riparian landowner education.

Objective 2-B. Identify, promote, and/or encourage participation in educational opportunities for land use decision-makers (e.g. planning commissions, local boards and councils, developers, chambers of commerce, realtors, etc.).

Action 11. Promote, encourage, and/or participate in education opportunities for land use decision-makers offered by the organizations listed in Action 8.
Educating land use decision-makers is a critical component to the successful implementation of the subwatershed plan. These individuals are responsible for implementing many of the actions identified for protecting and restoring Stony and Paint Creeks, thus they must stay on top of the most current storm water and watershed management tools and techniques.

Goal 3. Protect and restore the Stony Creek subwatershed's water quality, stream channels, riparian corridors, natural areas, wetlands, and other unique ecosystems.

Objective 3-A. Reduce storm water impacts and stabilize stream flows.

Action 12. Review land use planning and management practices to promote Low Impact Development (LID).
Because many areas within the Stony/Paint Creek subwatershed are still undeveloped, opportunities exist for reviewing the effectiveness of existing land use planning and management practices. Land use planning and management involves a comprehensive planning process to promote LID and control or prevent runoff from certain developed land uses into areas with sensitive water and wetland resources. The land use planning process involves six general steps:

1) determine water quality and quantity goals with respect to human health, aquatic life, and recreation;
2) identify planning area and gather pertinent hydrological, chemical and biological data;
3) determine and prioritize the water quality needs as they relate to land use and the proposed development;
4) develop recommendations for low impact development to address the problems and needs that have been previously determined;
5) present recommendations to a political body for acceptance; and
6) implement adopted recommendations.

Action 13. Minimize directly connected impervious surfaces from new development through the implementation of Low Impact Development Plans.
Utilizing an LID Plan for new developments can minimize directly connected impervious surfaces. LID Plans combine a hydrologically functional site design with pollution prevention measures to compensate for land development impacts on hydrology and water quality. The result will minimize or eliminate impacts of peak discharge, runoff volume, and storm water pollutants as compared to typical development impacts. LID can apply to new residential, commercial and industrial developments. In urban communities, especially older areas, opportunities exist to disconnect impervious areas through downspout and sump pump disconnection and installation of rain gardens and other bioretention areas.

Action 14. Develop comprehensive sanitary sewer infrastructure plans.
The municipalities in the Stony/Paint Creek subwatershed should develop comprehensive sewer plans that are consistent with their zoning and master plans. Local sewer plans identify areas where sanitary sewer service is or will be available, areas where on-site disposal systems will be used for wastewater treatment, and areas where sewers and on-site systems are not appropriate (i.e. environmentally sensitive areas, floodplains, etc.). These service areas should be developed based on the sewer system's capacity to collect, transport, and treat wastewater flows at the density levels allowed in the zoning and master plans and/or the ability of soils to accommodate on-site disposal systems.

Action 15. Develop and implement local Storm Water Master Plans, including storm water management ordinances and maintenance programs.
A comprehensive Storm Water Master Plan addresses development, implementation, and enforcement of controls to protect designated uses in all receiving waters. It includes the development of ordinances and other regulatory measures to address post-construction storm water runoff from new development and redevelopment projects.

Storm water management ordinances outline specific requirements for constructing structural best management practices to minimize the flow and water quality impacts associated with new development. An example of a specific requirement is to modify parking ordinance standards to minimize impervious surfaces. Parking lots contribute a significant amount of impervious surface in commercial areas. As the Stony/Paint Creek subwatershed continues to develop, it will become important to analyze parking standards and identify opportunities to reduce parking lot size and allow for “banked” parking to reserve room for future parking if needed.

Oversight and implementation of storm water standards is often complicated by overlapping jurisdictions and conflicting goals and priorities. Where there are overlapping jurisdictions within individual communities, especially between townships, it is imperative that township and county agencies work cooperatively to understand the goals and unique issues specific to each agency. This will ensure successful implementation of storm water management ordinances.

Action 16. Establish maintenance programs for detention basins and other storm water facilities.
Short-term maintenance of detention basins, swirl concentrators, and other storm water facilities during construction as well as long-term maintenance by the property owner or appropriate jurisdictional agency is as important as implementation of the storm water management ordinance. The ordinance should be set up to require long-term maintenance for these facilities and should also outline minimum maintenance requirements. Without regular inspections and maintenance, these systems will not provide effective pollutant reduction.

Action 17. Establish detention basin retrofit and enhancement programs.
In developed areas where detention basins were originally designed only for flood control, opportunities exist for various enhancements or retrofits to incorporate sediment and nutrient removal capabilities. Outlet structures may be reconfigured to handle the smaller storm events provided adequate volume still exists in the basin for the design storm event. These improvements, combined with native plantings and buffer strips along the basin will reduce nutrient, sediment, and bacteria loadings, discourage geese from congregating, encourage populations of other types of wildlife such as birds, fish, and insects, and ultimately create a more aesthetic environment for the property owner. Such enhancements may also provide passive recreation opportunities.

Action 18. Develop and implement native vegetation guidelines.
The use of native vegetation in landscaping and in conjunction with other storm water best management practices can improve storm water absorption and filtration. Communities should develop guidelines to preserve and restore native plant communities in open space, riparian buffer zones, and parklands, encourage the use of native landscaping on both municipally-owned and private lands, and utilize native plants in constructed wetlands and storm water management systems such as detention and retention ponds. It may also be necessary to revise weed ordinances to accommodate native plantings. Establishing native plants, including prairie and wildflower meadows, within new developments as opposed to grass seed or sod can also greatly enhance storm water infiltration and nutrient uptake.

Action 19. Establish street sweeping and catch basin cleaning programs.

Street sweeping and catch basin cleaning not only reduce sediment loads, but are also effective at reducing nutrient loading because many nutrients bind to soil particles. Because many communities within the Stony/Paint Creek subwatershed do not have paved roads, street sweeping may not be suitable on main roadways; however, encouraging property owners of large parking lots to regularly maintain their paved surfaces without washing debris into the storm sewers will also reduce nutrient and sediment loading. Storm sewer cleaning, especially focusing on catch basin cleaning, can also help reduce pollutant loading. Catch basins typically have sumps to collect sediment and debris. If not properly maintained, the sumps will fill with debris and no longer function effectively.

The installation of catch basin inserts with specialized filters to capture organic compounds and metals can increase the amount and type of pollutants captured by catch basins. These inserts should be considered especially in highly urban areas. Care must be taken to maintain these inserts as directed by the manufacturer to ensure their continued performance.

Street and catch basin maintenance programs may be implemented by the appropriate jurisdictional agency or even by property owners. Homeowners' associations should be encouraged to contract with a company to regularly maintain their streets and catch basins if these areas are not under the jurisdiction of the local community or county.

Action 20. Identify and eliminate illicit discharges.
As a part of their Phase II storm water permits, municipalities and counties in the Stony/Paint Creek subwatershed must develop and implement Illicit Discharge Elimination Plans (IDEP). These plans include conducting a thorough inventory and mapping of outfalls into surface waters, water quality monitoring of outfall discharges, and follow-up when problems are identified. IDEP programs typically identify nutrient and bacteria sources such as cross-connections between sanitary and storm sewers or failing onsite sewage disposal systems, but can also identify hazardous waste discharges.

Action 21. Educate staff and contractors on "good housekeeping" practices, including proper fleet and service yard maintenance and landscaping activities.
These activities are a requirement of the Phase II storm water permit. Not only do good housekeeping practices reduce storm water impacts from municipal properties; they also set an excellent example for residents and can be used as a public education tool.

Action 22. Develop and implement a long-term monitoring strategy.
Continued monitoring of chemical, biological, and physical parameters is critical to evaluating the long-term success of this subwatershed plan. Monitoring is especially critical to identify and respond to illicit discharges such as hazardous waste and sewage discharges. The historical monitoring data and stream inventory results provide a baseline for future assessment. The Macomb and Oakland county health departments, Oakland County Drain Commissioner's Office, Macomb County Public Works Office and the Clinton

River Watershed Council currently engage in various monitoring activities in the Clinton River watershed, including the Stony/Paint Creek subwatershed. The subwatershed group should continue to track monitoring activities by these agencies and entities and pursue additional funding opportunities for monitoring as they arise.

Action 22a. Support, promote and/or participate in the Clinton River Watershed Council volunteer monitoring programs, including the Adopt-a-Stream program and Stream Leaders as applicable, as part of a long-term monitoring strategy. Coordination should exist between the subwatershed group and CRWC with regard to follow-up monitoring at sites that were surveyed in the preparation of this plan. Surveys including the Bank Erosion Hazard Index, the MDEQ Stream Crossing Watershed Survey and Macroinvertebrate Surveys.

Action 22b. Support subwatershed and Clinton River Watershed efforts to procure grant funding and projects for a long-term monitoring program. These efforts will help to facilitate implementation of a long-term water quality/water quantity monitoring program that may include modeling of current and future flow and modeling current and projected nonpoint source load reductions. If grant funding is obtained, the communities will support these efforts by providing comments and input when requested on the monitoring project.

Objective 3-B. Reduce nutrient loading contributing to excessive aquatic plant growth. Nutrients can be successfully managed through a variety of both structural and non-structural BMPs. Structural BMPs include facilities such as detention basins, infiltration basins, vegetated swales, and swirl concentrators. These BMPs can be implemented as part of new developments, by incorporating new BMPs into existing facilities and developments, and by enhancing existing BMPs. Non-structural BMPs include management practices such as implementation of standards, ordinances, and maintenance programs, especially maintenance of structural BMPs. The following actions describe a number of structural and non-structural BMP alternatives that can be implemented across the Stony Creek subwatershed.

Action 23. Implement lawn care education programs for residents and businesses.

Programs that address specific practices on individual properties can have a major impact on nutrient reduction. Lawn care education programs should include information about fertilizer, watering, and mowing practices. In addition, assistance can be provided on reducing turf grass through the establishment of native plant alternatives. Organizations such as the Clinton River Watershed Council, land conservancies, MSU Extension, and Wild Ones currently offer some materials and programs. Lawn care programs should focus on residential and commercial lawns as well as maintenance of common areas and landscaped areas around detention basins. These areas often require different types of maintenance to keep them functioning properly.

Action 24. Encourage golf course management programs that protect water quality.
Encouraging golf courses to develop and implement plans to minimize nutrient loading will help preserve the high quality of the Stony/Paint Creek subwatershed. These efforts may include educating golf course staff about the importance of protecting the water resources located on the golf course. Education may include training appropriate staff on proper fertilizer, watering and mowing techniques to protect water resources. In addition, identifying areas for suitable native plant establishment will also help slow and filter storm water runoff prior to it entering local tributaries. The MSU Extension Turfgrass Stewardship Program is a good source of information for this purpose and offers a certification program for golf courses.

Action 25. Implement local fertilizer ordinances, standards, or guidelines.
Fertilizer ordinances, standards, or guidelines that regulate application of nutrients by both private landowners and/or commercial applicators can minimize nutrient loading, specifically of phosphorus, to waterways. These guidelines can supplement existing public education and involvement programs. Several communities within the Rouge River watershed have adopted or are currently drafting fertilizer ordinances that require licensing and/or permits from the local community prior to any fertilizer application.

Other actions that will address nutrient loading include Actions 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, and 22.

Objective 3-C. Reduce sources of bacteria contributing to beneficial use impairments.

Action 26. Implement animal and pet waste management programs.
Effective pet waste and nuisance waterfowl management programs can reduce bacteria and nutrient sources within the subwatershed. Rural areas should consider working with the Michigan Department of Agriculture and MSU Extension to encourage proper manure and nutrient management on site. In urban and suburban areas, programs to reduce pet and waterfowl waste may include border collie roundup at golf courses and parks, as well as installation of native plantings to replace turfgrass along ponds and lakes. Furthermore, detention basin retrofits that incorporate taller native vegetation can help curtail nuisance waterfowl. Pet waste receptacles and educational signage can be placed in community parks or other pedestrian areas where residents walk their dogs.

Action 27. Implement on-site sewage disposal system ordinances and / or maintenance programs.
An on-site sewage disposal system (OSDS) ordinance that requires time-of-sale inspection along with recommended maintenance guidelines can significantly reduce nutrient loading, especially near lakes and impoundments. Many areas around existing lakes and impoundments do not have access to sanitary sewer systems, so maintenance programs that include regular pumping of septic tanks and evaluation of the septic fields will not only improve the quality of the adjacent water resources, but will also educate home owners about the potential impacts on-site sewage disposal systems, if not functioning properly, have on their water resources. An OSDS

ordinance has been implemented in Macomb County and is being considered in Oakland County.

Other actions that will address bacteria reduction include Actions 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, and 22.

Objective 3-D. ***Identify, prioritize, and establish mechanisms for preserving, restoring, and/or enhancing stream channels, riparian corridors, natural areas, wetlands, and unique ecosystems.***

Action 28. Inventory natural features (e.g. wetlands, floodplains, steep slopes, woodlands, unique ecosystems, etc.) and develop Natural Area Resource Protection Plans.
The first step in protecting a community's natural resources is identifying what resources should be protected, where they are located, and what benefits they provide to the community. After an inventory, it is often helpful to design an assessment of these natural features so that they can be prioritized in terms of their importance to the community and their relative need for preservation.

Communities should consider developing a Natural Area Resource Protection Plan that identifies natural feature areas, including wetlands, woodlands and riparian corridors within their jurisdictional boundaries and also describes their unique functions and opportunities for preservation, enhancement and restoration. This type of plan will identify areas unique for high quality storm water management, habitat enhancement, water quality enhancement, aesthetics and recreational opportunities. It is often not feasible to protect all of the natural features in a community; however, an inventory and assessment can provide scientific rationale to support a local protection ordinance and/or the basis for avoiding the feature during site design and development. Community-wide inventories and assessments can also provide future opportunities to preserve greenways for wildlife as well as recreation. This plan can easily complement land use, water resource and storm water management ordinances.

Action 29. Develop water resource and natural feature protection standards, ordinances, and / or programs.
Protecting existing natural features such as wetlands, woodlands and riparian corridors in the subwatershed is a key goal, especially in less developed communities. These guidance documents can create opportunities to minimize impacts associated with new developments as well as identify opportunities for preservation and enhancement.

29a. Natural Features Setback Ordinance.
By establishing minimum buffers or setbacks from wetlands and watercourses, nonpoint source pollutants will be minimized. In addition, these buffers also enhance and protect habitat areas associated with the natural resources. Buffers or riparian corridors along watercourses also help to slow and filter storm water runoff.

29b. Resource Protection Overlay District.

A Resource Protection Overlay District is a comprehensive natural features protection measure that allows the application of special restrictions to areas with unique conditions, such as riparian corridors, wetlands, steep slopes, and unique habitats. Properties included in the district retain their underlying zoning classification but are subject to additional requirements specified in the overlay district ordinance.

29c. Wetlands Ordinance.
Wetlands provide natural surface water storage and groundwater recharge, allowing water to infiltrate or evaporate instead of running off directly to lakes and streams. While natural wetlands should never be used for direct discharge of storm water, they can help reduce peak flows and pollutants as the last step in a storm water treatment train. Wetlands also provide critical habitat for numerous wildlife species. A wetlands ordinance that is more protective than state or federal regulations may be necessary to protect those wetlands deemed important to a community.

29d. Tree / Woodland Preservation Ordinance.
Tree preservation ordinances acknowledge that trees and woodland areas are an important community resource for both environmental and aesthetic reasons. Trees in wetlands and along riparian corridors play an especially important role in water uptake, aiding in flood control and nutrient absorption. In a low-impervious subwatershed like Stony Creek, preserving the tree canopy is especially important. Preservation of existing trees or new plantings to shade streets, parking lots, streams, and detention ponds can help capture rainfall and moderate water temperatures.

Action 29e. Steep Slope Ordinance. A number of communities within the Stony/Paint subwatershed have very steep slopes that are characteristic of portions of the Clinton River Watershed. To minimize long-term impacts to these unique features, some communities are choosing to develop an ordinance that protects these slopes. The ordinances may include components such as erosion control measures, revegetation requirements and buffer or setback standards.

Action 29f. Weed Ordinance. Local weed ordinances should not conflict with native plant guidelines for storm water management. These ordinances should be updated to reflect the intent that using native plants is actually encouraged and describe the differences in some manner between native plants and noxious weeds.

Action 30a. Identify and prioritize projects to construct, restore, and enhance wetlands.
In addition to preserving existing wetlands through the practices outlined in Action 28 and 29, there are many opportunities to restore and enhance wetlands in the Stony/Paint Creek watershed. Constructed wetlands can also serve as excellent storm water treatment facilities. Identifying areas where wetlands existed historically will provide a good baseline from which to identify potential construction and restoration opportunities. Constructed wetlands are ideal for large, regional tributary areas (10 to 300 acres) where there is a need to achieve high levels of particulate and nutrient removal.

Wetland size and configuration, hydrologic sources, and vegetation selection must be considered during the design phase. Constructed wetlands can provide a suspended solid removal of up to 87%, while nutrient removal ranges widely due to a lack of standard design criteria, but is in the range of 60-90%. Constructed or restored wetlands can also provide fish and wildlife habitat and aesthetic benefits. Wetland restoration and enhancement can be implemented through volunteer monitoring and stewardship projects such as plantings, construction of nesting boxes, educational signage, and other activities.

Action 30b. Implement projects to construct, restore and enhance wetlands. The subwatershed group understands the critical functions that wetlands provide to these water resources. Implementation of these projects will provide numerous benefits; however, funding mechanisms must be identified and secured.

Action 31. Prevent and remove stream obstructions utilizing appropriate management techniques.

This action involves the detection of site-specific stream flow problems that are caused by log jams and sediment islands. Woody debris in the river is not always bad and, if managed appropriately, can actually provide bank protection and enhance habitat. If removal is required to solve a flow, erosion, or flooding problem, it is important to keep habitat disruption to a minimum, recognizing that natural woody debris can be managed within the stream to provide habitat for aquatic organisms. Stream cleanup should always be considered before any drastic measures such as clearing and snagging, channelization or other severe modifications are made. Dam or weir removal to improve fish migration may also fall under this category.

Action 32. Identify, prioritize, and implement projects to restore and enhance instream habitat.

Habitat restoration techniques include instream structures that may be used to correct and/or improve fish and wildlife habitat deficiencies over a broad range of conditions. Examples of these techniques include channel blocks, boulder clusters, covered logs, tree cover, bank cribs, log and bank shelters, channel constrictors, cross logs, and revetment, wedge and "K" dams. The majority of these structures can be installed with hand labor and tools. After construction, a maintenance program must be implemented to ensure long-term success of the habitat structure. It should be noted that in areas that experience high storm water peak flows, instream habitat restoration should be installed after the desired flow target is reached to ensure the success of the habitat improvement project.

Action 32a. Convene discussions between the subwatershed group to identify potential projects involving instream habitat. These projects should be prioritized based on a number of factors including current habitat quality, adjacent land uses, storm water impacts, preservation category and accessibility. These discussions may occur during regular subwatershed group meetings or may occur separately in a subcommittee.

Action 32b. Implement projects to restore and enhance instream habitat.

Action 33. Continue and expand litter and debris cleanup efforts.
Litter and debris cleanup can be achieved through adopt-a-road, adopt-a-park, adopt-a-catch basin, and adopt-a-stream programs. The subwatershed group can coordinate with community organizations, schools, churches, and businesses to collect debris along local, county, and state roads, community parks, and streambanks and riparian corridors. The subwatershed group can also participate in the Clinton River Watershed Council's annual Clinton *Clean-Up* event. Street sweeping can also improve aesthetics by removing litter and pollutants.

Other actions that will address preserving and enhancing stream channels and natural areas include Actions 7, 8, 9, 10, 11, 12, 13, 15, 18, 21, 22, and 28.

Objective 3-E. Promote and participate in local land and water stewardship efforts.

Action 34. Promote and participate in stewardship efforts coordinated by local organizations such as those listed in Action 8.
Many local organizations have already initiated stewardship efforts, such as River Day activities, volunteer water quality monitoring, and restoration and enhancement projects. The subwatershed group should coordinate with these organizations and cross-promote the various activities to take advantage of each organization's networking and publicity mechanisms.

Action 35. Encourage residential storm water management practices.
It is important that individual residents recognize their contributions to storm water management and water quality protection. Communities should encourage homeowners and provide guidance to implement practices such as rain gardens and rain barrels as part of their promotion of stewardship activities.

Other actions that will address land and water stewardship efforts include Actions 7, 8, 9, 10, 16, 21, 22, 28, 29, 30, 31, 32, and 33.

Objective 3-F. Participate in local and regional efforts to promote natural corridors and greenways.

Action 36. Develop a Stony/Paint Green Infrastructure Plan.
Greenway Infrastructure Plans can serve multiple purposes, including natural features protection, alternative transportation, and recreation opportunities. Oakland County is currently working with communities to prepare a map that identifies connections throughout the county utilizing trails, tree corridors, utility corridors and riparian corridors. Organizations such as the Oakland Land Conservancy have an established structure for reaching out to riparian landowners to promote corridor protection measures, such as conservation easements and stewardship projects. Such an effort is underway along the Clinton River corridor in the Rochester area. Based upon the critical area identified in the subwatershed plan, a similar corridor protection effort would be very beneficial to achieving the long-term goals for protecting Stony /Paint

Creek. Community participation may include attending a visioning session and input to the county.

Action 37. Participate in and promote the Southeast Michigan Greenways Network and related county trail and greenway development projects.
A variety of activities are currently underway to promote greenways across Oakland and Macomb counties. The subwatershed group should stay informed of these efforts and be involved as appropriate.

Other actions that will address natural corridors and greenways include Actions 4, 5, 10, 11, 12, 28, 29, 30, and 34.

Objective 3-G. Reduce inputs of hazardous materials, organic compounds, and heavy metals and restore areas impacted by these materials.

Action 38. Develop and implement household hazardous waste collection programs.
The proper disposal of household hazardous waste is an important component in any water quality protection program. The communities of Addison, Oxford, Rochester, and Rochester Hills are members of the recently-established North Oakland Household Hazardous Waste Consortium (NO HAZ), whose goal is to provide regular, reliable, and easily accessible waste collection services to their residents. Oakland Township hosts an annual collection event jointly with Orion Township at the Eagle Valley Recycling Facility. Bruce and Washington townships should take advantage of the Macomb County Health Department's household hazardous waste collection program, and should consider working with the county to expand this program.

Action 39. Work with local and/or county agencies to research and implement BMP road deicing techniques.
A number of strategies, including proper equipment calibration and volume application based on roadway use, can dramatically reduce the detrimental impacts of salt on water resources.

Action 40. Review existing data regarding the presence of PCBs and mercury in Stony Creek Lake, Lake Orion and Lakeville Lake and develop Total Maximum Daily Load (TMDL) plans to restore as required under Clean Water Act Section 303(d).
In the course of developing this subwatershed plan, conflicting information was found regarding the TMDLs proposed for Stony and Paint Creeks. Further research is needed to resolve these conflicts, assess existing data on the presence of PCBs and mercury, and develop an action plan for TMDL implementation.

Other actions that will reduce inputs of hazardous materials, organic compounds, and heavy metals include Actions 7, 9, 16, 17, 18, 19, 20, 21, 22, 24, 28, 31, and 33.

Goal 4. Protect and restore the Stony and Paint Creek fisheries.

Although Stony Creek is not currently managed as a coldwater fishery by the Michigan Department of Natural Resources, it is still considered a coldwater stream and the presence of coldwater species was documented during the stream inventory. The Paint Creek, on the other hand, is managed as a trout stream downstream of Lake Orion. The objectives and actions outlined below are designed to incorporate fisheries restoration and enhancement measures (which are often overlooked in the design and implementation of storm water BMPs) into the subwatershed planning process.

Objective 4-A. Develop and implement a fisheries restoration and enhancement plan.

Action 41. Gather and evaluate current and historic fisheries data and establish fisheries restoration targets.
Historic information from the Michigan Department of Natural Resources and any existing academic studies, as well as planned data collection for the Coldwater Conservation Campaign (a joint project between Trout Unlimited, the Clinton River Watershed Council, and the Michigan Department of Natural Resources), can be used to assess the historic and current fish community characteristics in Stony and Creeks and identify targets for future restoration efforts. Communities will continue to support these ongoing efforts and will review/comment on data that is provided.

Action 42. Encourage communities and county agencies to incorporate fisheries restoration measures into local plans, ordinances, and standards.
Fisheries restoration measures, particularly temperature regulation, in-stream habitat structures, and stream shading, are often overlooked in the selection and design of storm water BMPs. Several studies nationwide have heightened awareness about moderating temperature to protect coldwater species. Maintaining base flows and controlling peak flows is also critical to protecting the fishery. Consideration should be given to fisheries restoration measures in storm water plans, ordinances, and programs.

Action 43. Work with local, regional, and state organizations and agencies to implement fishery restoration projects.
Organizations such as the Clinton River Watershed Council, Trout Unlimited, and the Michigan Department of Environmental Quality are actively involved in fisheries restoration efforts. Restoration projects may include implementing new storm water BMPs, restoring instream habitat, restoring streambank vegetation, and improving access opportunities.

Other actions that will help protect and restore the fishery include Actions 7, 12, 13, 15, 16, 17, 18, 19, 22, 31, 32, 34, 36, 39, 47, 48, 49, 51, and 52.

Goal 5. Improve recreational access and opportunities in the Stony/Paint Creek subwatershed.

Objective 5-A. Develop and implement a recreation enhancement plan.

Action 44. Inventory existing access points and recreation opportunities and identify gaps and needed improvements.

A number of popular recreation areas are located in the Stony Creek subwatershed, including Bald Mountain State Recreation Area and Stony Creek Metropark. Other recreation resources are not as well known, particularly the county and local parks. An inventory of existing recreation resources and an assessment of current needs will serve to establish a baseline for future improvements. Recreation access and amenities are included in recreation master plans.

Action 45. Evaluate opportunities to expand access through acquisition and conservation easements and integrate these opportunities into local recreation plans.
The identification of potential recreation parcels should be included in the proposed Stony Creek corridor stewardship efforts. Acquisition efforts and conservation easements can include consideration of recreation potential in addition to natural features protection.

Action 45b. Implement opportunities identified in Action 45.

Action 46. Enhance recreational opportunities by coordinating with local and regional agencies, offering interpretive and educational programs and events.
Developing and implementing additional public education opportunities can enhance both existing and future recreation areas in the Stony Creek subwatershed. Recreation stakeholders including local, county, regional, and statewide entities along with community organizations already have many programs underway and can continue to coordinate these efforts. These entities may wish to collaborate on grant applications and program development in order to take advantage of limited resources.

Action 46b. Enhance recreational opportunities by developing signage and other needed improvements.

Other actions that will improve recreational access and opportunities include Actions 7, 8, 28, 36, 37, 42, and 43.

Goal 6. Protect farmland and reduce agricultural impacts on water quality.

Objective 6-A. Support farmland preservation efforts.

Action 47. Identify and prioritize prime farmland for protection.
High-quality, economically viable farmland is rapidly disappearing in the Stony Creek subwatershed and throughout the Clinton River watershed. Communities that wish to retain agricultural activities over the long-term should act now to map existing farmland, make contacts with landowners to evaluate their interest, and identify priority areas for protection.

Action 48. Integrate farmland protection priorities into community master plans and ordinances.
Identifying rural character and farmland protection as priorities in community master plans sets the stage for additional protection measures. Communities that still have large areas of agricultural lands should examine their plans and

ordinances and determine whether these documents need to be strengthened.

Action 49. Support farmland preservation programs.
A number of organizations are working locally, statewide, and nationally to encourage farmland preservation programs such as Purchase of Development rights and P.A. 116. Conservation easements are another alternative for preserving farmland that does not require action at the state level.

Objective 6-B. Encourage agricultural practices that protect water quality.

See Action 50. Identify applicable Generally Accepted Agricultural Management Practices (GAAMPs) and develop a dissemination plan to distribute this information to local farmers.
Many communities within the Stony/Paint Creek subwatershed still have active farming operations. The subwatershed group can work with the Michigan Department of Agriculture and the Michigan Department of Environmental Quality to identify GAAMPs and appropriate dissemination mechanisms.

Goal 7. Protect and interpret the historic character of Stony/Paint Creek.

Objective 7-A. Develop and implement a historic preservation and interpretation plan.

Action 51. Create an information clearinghouse and distribute information on historic sites in the subwatershed.
A wealth of resources for historical information exist in the Stony/Paint Creek subwatershed, including local libraries, historical societies, and individual historic sites. These entities should be used as resources to gather and distribute information to the public.

Action 52. Integrate historic preservation goals into community master plans & recreation plans; explore opportunities to develop historic preservation ordinances.
Communities should examine their plans and policies to determine if additional measures are needed to ensure historic preservation goals are addressed.

Action 53. Coordinate with local volunteer organizations to promote preservation and interpretation of historic resources.
A number of historic societies and similar groups already exist in the Stony/Paint Creek subwatershed. Communities should take advantage of this volunteer network to share the history of these streams with their residents.

Goal 8. Reduce Soil Erosion and Sedimentation.

During the Stony/Paint Creek subwatershed field investigations, soil erosion impacts to water resources were evident, especially in areas of active construction. Proper management of soil erosion and sedimentation control is very important in preserving the overall high quality of Stony and Paint Creeks. Because many roads within the subwatershed are unpaved, road maintenance should be addressed regularly and should incorporate water quality management practices. Recommended actions outlined below should be considered for implementation across the Stony/Paint Creek subwatershed.

Objective 8-A. **Develop or revise ordinances to prevent, minimize and reduce soil erosion and sedimentation, especially for construction sites.**

Action 54. Implement soil erosion and sedimentation control (SESC) ordinances or standards.
Within the Stony/Paint Creek subwatershed, statewide soil erosion and sedimentation control (SESC) regulations are managed primarily by county agencies. All SESC plans must meet state requirements. Communities may also consider adopting and overseeing a local SESC ordinance or standards, which must be approved by the Michigan Department of Environmental Quality Water Division. In addition, requiring SESC permits prior to allowing any construction work on a site will help to minimize soil erosion and sedimentation. Soil erosion and sedimentation control plans should also include stabilization measures for construction activities. These plans should show preservation of trees and vegetation along wetlands and streams. Clearing and grading schedules should be identified early in the review and permitting process and should be staged to minimize the amount of exposed earth at any time.

Once mass grading of a site is complete, stabilization of areas should occur as soon as practicable. For example, detention basins should be stabilized once the outlet pipes are installed to minimize sediment from escaping the basin. Road right-of-ways within residential areas can also be stabilized as soon as the roads are complete. Areas where rear yard drainage systems are present should also be stabilized. These measures will minimize the amount of sediment runoff from individual lots before the building process begins.

Action 55. Develop or modify private road ordinances or standards to incorporate impervious surface minimization techniques.
Roads are a significant contributor to sediment loading in Stony and Paint Creeks. A private road ordinance can allow small developments to construct narrower roadways with less clearing, grading, and impervious surface than traditional roads. Opportunities may existing to design and construct a private road with swales as opposed to traditional curb and gutter. The layout of the development can also often be altered to reduce the amount of impervious surface (see also Actions 12 and 13 regarding Low Impact Development Plans).

Objective 8-B. **Implement BMP's for effective soil erosion and sedimentation prevention and mitigation, addressing both upland sources as well as sources from streambank erosion.**

Action 50. Identify applicable Generally Accepted Agricultural Management Practices (GAAMPs) and develop a dissemination plan to distribute this information to local farmers.

Objective 8-C. **Improve soil erosion and sedimentation control inspection and**

enforcement, as well as education, for parties responsible.

Action 56. Implement soil erosion and sedimentation control education programs.
Although many communities do not currently have jurisdiction over soil erosion and sedimentation control, improving municipal staff's understanding of soil erosion impacts will have a positive impact on the overall site plan and engineering plan review process. Communities will support County efforts in their soil erosion education programs.

Action 57. Improve soil erosion inspection and enforcement practices.
County agencies, in most cases, are the jurisdiction responsible for SESC inspection and enforcement in the Stony/Paint Creek subwatershed. These agencies are often understaffed for this purpose, especially given the rate of construction and development in many communities. Communities concerned about the need for more frequent and reliable inspection and enforcement should work with the counties to stress the importance of inspection and enforcement and explore opportunities to improve these services.

Objective 8-D. **Reduce sediment deposition into stream channels and wetlands.**

Action 58. Work with county road commissions to improve maintenance of unpaved roads, particularly at road-stream crossings.
Many roads within the Stony/Paint Creek subwatershed are under the jurisdiction of the county road commissions. Because many roads in the subwatershed are unpaved, it is important that the local communities and counties work cooperatively to implement road maintenance techniques that reduce soil erosion and sedimentation impacts on the water resources. Opportunities that may be evaluated include quickly vegetating roadside ditches to slow and filter storm water runoff, removing accumulated sediment from roadside ditches, and only regrading ditches during dry weather.

Regrading of road surfaces is very important in the overall maintenance of the public roadway system. Some maintenance methods may be considered that will not only meet the goals of keeping the roadway smooth for travelers, but will also minimize sediment loads to the nearby waterways. For example, grading during dry weather and not prior to a rain event, compacting areas where feasible after grading and stockpiling materials away from streams, wetlands and other natural features areas will minimize the amount of sediment entering the nearby watercourses.

Sediment inputs at road crossings are a particular concern in the Stony/Paint Creek subwatershed. A number of areas needing attention were identified in the physical inventory (see Chapter 3). These sites should be reviewed and opportunities to improve maintenance practices and enhance vegetative buffers should be explored in cooperation with the road commissions.

Action 59. Identify, prioritize, and implement streambank stabilization projects.
In some cases streambank erosion can be a direct source of sedimentation within streams. However, streambank erosion is often related to peak storm

flows, therefore it is important to address storm flows upstream of sites to be stabilized if the projects are to succeed over the long-term. Conducting a geomorphology study in advance of stabilization work will assist in understanding the stream's flow dynamics and identifying the highest priority sites. The stream inventory also identified specific road-stream crossings that could benefit from stabilization (see Chapter 3).

Natural channels exist in two or more stages. Restoration to existing channels should explore the opportunity to return the channel to a two-stage cross section. This will help reduce the shear flows at bank-full conditions that lead to high shear stresses and erosion. Streambank stabilization measures work by either reducing the force of flowing water and/or by increasing the resistance of the bank to erosion. Vegetating streambanks can constructing riparian buffers also provides important ecological benefits such as shading water and providing crucial habitat for both terrestrial and aquatic wildlife species.

Three basic types of streambank stabilization methods exist: engineered structures, bioengineering methods, and biotechnical methods. Engineered structures include riprap, gabions, deflectors and other "hard" revetments. Bioengineering refers to the use of live plant materials that are embedded in the ground, where they serve as soil reinforcement, hydraulic drains, and barriers to earth movement. Examples of bioengineering techniques include live stakes, live fascines, brush mattresses, live cribwall and branch packing. Biotechnical measures include the integrated use of plants and inert structural components to stabilize channel slopes, prevent erosion and provide a natural appearance. Examples of biotechnical techniques include joint plantings, vegetated gabion mattresses, vegetated cellular grids, and reinforced grass systems. Whenever possible, bioengineered or biotechnical methods should be implemented in lieu of engineered methods to increase habitat, nutrient uptake, and aesthetic values.

The Stony/Paint Subwatershed Group understands the importance of addressing streambank stabilization issues. The Group has divided this task into three (3) separate actions described as follows:

Action 59a. Prioritize streambank stabilization/riparian buffer projects at road crossings throughout the Stony/Paint subwatershed. ECT conducted both a bank erosion hazard index assessment that summarizes the overall bank erosion potential for areas both upstream and downstream of road/stream crossings as well as conducted the MDEQ Stream Crossing Watershed Survey at the same road crossings. This data which is described in Chapter 3 summarizes the overall ranking of the road crossing sites of which priority road crossings can be identified from the data.

Action 59b. Prioritize streambank stabilization/riparian buffer projects in areas other than road/stream crossings.

Action 59c. Design and construction streambank stabilization/riparian buffer projects at areas identified in Actions 59a & b.

Other actions that will address soil erosion and sedimentation control include Actions 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 21, and 22.

5.4.2 Stony/Paint Creek Action Matrix

A diverse array of communities spanning portions of two counties comprise the land area of the Stony/Paint Creek subwatershed, from very rural and agricultural townships in the north to high-density residential cities in the south. Consequently, a variety of structural and non-structural best management practices should be considered in order to effectively protect Stony/Paint Creek. Each community and county agency must consider their specific needs and individual site characteristics in selecting and choosing appropriate BMPs. The recommended actions listed in Section 5.4.1 were selected because they are most applicable to the current conditions in the Stony/Paint Creek subwatershed. Some of these practices are already being implemented in a number of the communities, while others are being planned and still other have not yet been considered. The recommended actions are summarized in the Stony/Paint Creek Action Matrix (Table 5.4 and 5.4b, see Action Matrix tab) along with the following information:

- **Recommended Actions:** A listing of structural and non-structural best management practices that are most applicable to the Stony/Paint Creek subwatershed as identified through the various inventories and analyses conducted during the development of this plan.
- **Goals & Objectives Addressed:** Identifies which goals and objectives (as outlined in section 5.2) are addressed by each action.
- **Pollutants Addressed:** Identifies which pollutants (as outlined in section 5.1) are addressed by each action.
- **Uses Addressed:** Identifies which designated and desired uses are addressed by each action.
- **Sources Addressed / Causes Addressed:** Identifies which sources and causes of pollution (as outlined in section 5.1) are addressed by each action.
- **Estimated Cost:** A rough estimate of costs for implementing each action. Obviously costs will vary greatly based on a variety of factors.
- **Evaluation Methods & Status:** An explanation of how each action will be evaluated as an indicator of improvement, and a description of the status of each action.
- **Subbasins:** Identifies subbasins to implement the actions.

Table 5.4b provides the following additional information:

- **Responsible Parties:** Identifies which communities or other entities are responsible for each action or may want to consider the action in the future.
- **Timeline & Commitments:** This table identifies whether the action is existing/ongoing; short-term (<5 years); long-term (> 5years); not applicable or wish list item. Each responsible party has identified the appropriate timeline and commitment.

Table 5.4b is specific to identifying permittee commitments and actions. Table 5.4 identifies areas and subbasins for implementation. These areas and subbasins may overlap permittee commitments for some actions and will not overlap for other actions.

CONCLUSION

The fourteen communities, two counties, two school districts and various stakeholders that participated in the development of the Stony/Paint Creek Subwatershed Management Plan share a common purpose: to protect Stony/Paint Creek as a unique natural, recreational, and cultural resource for the communities through which it flows.

The members of the Stony/Paint Creek Subwatershed Group know much more about the waterways flowing through their communities than they did at the outset of this project five years ago, and they now have a good grasp of what needs to be done to achieve their long-term goal of protecting Stony and Paint Creeks. Yet the planning phase is the relatively easy part, and is only the first step in effective watershed management. Now, the various entities that have a responsibility for the stewardship of the Stony/Paint Creek subwatershed – municipal and county governments, businesses, individual residents, non-profit organizations, and other public and private land managers – must follow through on the actions recommended in this plan.

Because Stony and Paint Creeks are such a high quality waterways, we are in the enviable position of being able to plan proactively for the future, rather than having to correct the mistakes of the past. For this reason, many of the recommended actions in this plan take the form of planning tools and educational programs, rather than remediation or redevelopment tasks. Successful implementation of these recommendations over the next decade will lay the foundation for a healthy watershed in the future. Only through the coordinated efforts of land managers and an educated and involved citizenry will be able to achieve our vision for the long-term protection of Stony and Paint Creeks.

Table 5.4 Stony/Paint Creek Action Matrix

	Goals & Objectives Addressed	Pollutants Addressed	Uses Addressed	Sources Addressed	Causes Addressed	Estimated Cost	Evaluation Methods and Status	Level of Effort/Interim Milestones	Stony/Paint Subbasins (See Appendix C)
Plans & Policies									
1. Identify facilitating body, organizational structure, and decision-making mechanism for the subwatershed group.	1-A	All	All	All	All	Minimal; costs to host meetings can be shared by communities; communication can be primarily via email.	Documentation of progress, including formalization of the group, meeting minutes.	Attendance at meetings and participation by Stony/Paint Subwatershded Group	All
2. Obtain community commitments of support for operation of and participation in subwatershed group.	1-A	All	All	All	All	Minimal; costs can be shared by participating entities.	Resolutions of support from governing bodies.	Representatives pass resolutions and/or continue participation	All
3. Establish a mechanism for the subwatershed group to research, report on, and pursue financing options.	1-B	All	All	All	All	Minimal; costs can be shared by participating entities.	Documentation of efforts in meeting minutes, including number of grants pursued.	Staff and CRWC send emails on grant notifications; provide handouts at meetings	All
4. Foster relationships and coordinate efforts with other subwatershed groups.	1-C	All	All	All	All	Minimal; costs can be shared by participating entities.	Documentation of efforts in meeting minutes.	Staff across subwatersheds attend meetings of difference groups	All
5. Participate in regional planning efforts.	1-C	All	All	All	All	Minimal; costs can be shared by participating entities.	Documentation of efforts in meeting minutes.	Attendance at meetings and participation by Stony/Paint Subwatershed Group	All
6. Collaborate with the Clinton River Area of Concern Public Advisory Council (PAC) and participate in Remedial Action Plan updates.	1-C	All	All	All	All	Minimal; costs can be shared by participating entities.	Documentation of efforts in meeting minutes.	Attendance at meetings and participation by Stony/Paint Subwatershded Group	All
14. Develop comprehensive sanitary sewer infrastructure plans.	3-A, 3-B, 3-C	Bacteria, nutrients	Fishery, aquatic life & wildlife, recreation	Failing septic systems, illicit connections	Improper construction / maintenance	$5,000-$20,000 Master Plan	Completed Master Plan	5 subshed representatives have existing plans; 1 community planned in 5 years	All Oakland County subbasins; SC-B; SC-C; SC-F; SC-G
15. Develop and implement local Storm Water Master Plans, including stormwater management ordinances and maintenance programs (see also Action 15 under Development / Redevelopment Regulations and Design Standards & Maintenance Practices).	2-B, 3-A, 3-B, 3-C, 3-D, 3-E, 3-F, 4-A;I 8-A; 8-B; 8-C; 8-D	Hydrology, sediment, nutrients, bacteria	Navigation, fishery, aquatic life & wildlife, recreation, riparian corridor, preservation of habitats / open space / threatened & endangered (T&E) species	Stormwater runoff, decreased groundwater recharge, streambanks, flow fluctuations, construction site runoff, failing septic systems, residential fertilizer use, illicit connections	Increased impervious surfaces, removal of vegetation, poor storm water management practices, improper erosion and sedimentation controls	Using existing templates tailor to individual community needs. $2,000 - $12,000 depending on level of detail.	Completed ordinance / design standards	5 existing/ongoing; 5 planned in 5 years; 2 planned long-term	All

Table 5.4 Stony/Paint Creek Action Matrix

	Goals & Objectives Addressed	Pollutants Addressed	Uses Addressed	Sources Addressed	Causes Addressed	Estimated Cost	Evaluation Methods and Status	Level of Effort/Interim Milestones	Stony/Paint Subbasins (See Appendix C)
22. Develop and implement a long-term monitoring strategy. (2-part program consisting of using volunteer monitoring and long-term sampling programs).	2-A, 2-B, 3-A, 3-B, 3-C, 3-D, 3-E, 3-G, 4-A; 8-A; 8-B;8-C;8-D	All	Navigation, fishery, aquatic life & wildlife, recreation, riparian corridor, preservation of habitats / open space / T&E species	All	All	Volunteer monitoring $15,000 annually; long-term water quality sampling program $200,000; long-term modeling efforts $150,000	Volunteer monitoring ongoing-track progress; long-term dependent on funding availability.	Subwatershed wide~150 sq.miles	Subbasins with tributaries-All SC; PC-A; PC-B; PC-E; PC-J; PC-L
28. Inventory natural features and develop Natural Resource Protection Plans.	2-A, 2-B, 3-A, 3-B, 3-C, 3-D, 3-E, 3-F, 4-A, 5-A, 6-A, 7-A; 8-D	Hydrology, sediment, elevated temperature, nutrients, bacteria	All	Stormwater runoff, decreased groundwater recharge, streambanks, flow fluctuations, construction site runoff, low flow, residential fertilizer use	Increased impervious surfaces, removal of vegetation, lack of buffer	~$15,000-$50,000 per community depending on size and whether field surveys are utilized.	Plan is prepared and utilized during site planning review processes. Oakland Township has completed this process. Rochester has virtually no remaining natural areas that are not already under protection.	Subwatershed wide~150 sq.miles	All
36. Develop a Stony/Paint Green Infrastructure Plan	2-A, 2-B, 3-A, 3-B, 3-C, 3-D, 3-E, 3-F, 4-A, 5-A, 6-A, 7-A; 8-D	Hydrology, sediment, elevated temperature, nutrients, bacteria	All	Stormwater runoff, decreased groundwater recharge, streambanks, flow fluctuations, construction site runoff, low flow, residential fertilizer use	Increased impervious surfaces, removal of vegetation, lack of buffer	Staff time from Oakland County and community participation. $100/hour with approximately 80 hours/community	Overall map is created as a guiding document for long-term planning efforts	8 communities in OC to support OC efforts to prepare map.	All
37. Participate in and promote the Southeast Michigan Greenways Network and related county trail and greenway development projects.	2-A, 2-B, 3-E, 3-F, 5-A, 7-A	Hydrology, sediment, nutrients	Fishery, aquatic life & wildlife, recreation, riparian corridor	Stormwater runoff, streambanks, flow fluctuations, construction site runoff	Increased impervious surfaces, removal of vegetation, poor storm water management practices, removal of vegetation, improper erosion and sedimentation controls	Staff time to attend meetings regarding potential projects.	Documentation of efforts in meeting minutes, including grants pursued.	All communities supporting these efforts by providing comments/input on proposed projects.	All
40. Review existing data regarding the presence of PCBs and mercury in Stony Creek Lake, Lake Orion and Lakeville Lake and develop Total Maxium Daily Load plans to restore as required under Clean Water Act Section 303(d).	3-G	Organic chemicals, heavy metals	Fishery, aquatic life & wildlife, recreation	Lake sediments, atmospheric desposition	Historic contamination	Costs have not been developed.	TMDL plans developed and implemented	Not yet determined	TMDL areas

Table 5.4 Stony/Paint Creek Action Matrix

	Goals & Objectives Addressed	Pollutants Addressed	Uses Addressed	Sources Addressed	Causes Addressed	Estimated Cost	Evaluation Methods and Status	Level of Effort/Interim Milestones	Stony/Paint Subbasins (See Appendix C)
41. Gather and evaluate current and historic fisheries data and establish fisheries restoration targets.	3-A, 3-B, 3-D, 3-E, 4-A; 8-D	Hydrology, sediment, nutrients, elevated temperature, salt	Fishery, aquatic life & wildlife, recreation	Stormwater runoff, decreased groundwater recharge, road-stream crossings, road ditches, streambanks, flow fluctuations, construction site runoff, low flow	Increased impervious surfaces, removal of vegetation, poor stormwater management practices, poor road / bridge maintenance, improper erosion and sedimentation controls, impoundments	Staff time to attend meetings regarding potential projects, commenting on studies and surveys.	Data is collected and restoration targets/potential actions are implemented. Completed MDNR report reviewed	Studies ongoing by MDNR, Trout Unlimited, CRWC. Completed MDNR Report	Critical Area Subbasins
42. Encourage communities and county agencies to incorporate fisheries restoration measures into local plans, ordinances, and standards.	2-B, 4-A	Hydrology, sediment, nutrients, elevated temperature, salt	Fishery, aquatic life & wildlife, recreation	Stormwater runoff, decreased groundwater recharge, road-stream crossings, road ditches, streambanks, flow fluctuations, construction site runoff, low flow	Increased impervious surfaces, removal of vegetation, poor stormwater management practices, poor road / bridge maintenance, improper erosion and sedimentation controls, impoundments	Costs may be included as part of other ordinance development (Action 15, 36)	Reference to fisheries incorporated into other documents	Communities along Critical Area corridor	Critical Area Subbasins
44. Inventory existing access points and recreation opportunities to identify gaps and needed improvements.	2-A, 2-B, 5-A	Hydrology, elevated temperature	Navigation, fishery, aquatic life & wildlife, recreation, riparian corridor, preservation of habitats / open space / T&E species	Stormwater runoff	Conversion to other land uses, increased impervious surfaces	Cost based on preparation of recreation master plan. $10,000-$30,000.	Plan includes recreational opportunities and amenities in master plan.	Communities prepare master plan	Critical Area Subbasins
45. Evaluate opportunities to expand recreation access through acquisition and conservation easements and integrate these opportunities into local recreation plans.	2-A, 2-B, 3-A, 3-B, 3-C, 3-D, 3-E, 3-F, 4-A, 5-A, 7-A;8-A;8-D	All	Navigation, fishery, aquatic life & wildlife, recreation, riparian corridor, preservation of habitats / open space / T&E species	Stormwater runoff	Conversion to other land uses, increased impervious surfaces	Cost associated with time to identify parcels and incorporate on overall subshed map ($10,000-$20,000); property acquisition variable costs.	Communities/counties incorporate into local plans; funding opportunities identified and procured for property acquisition.	2 counties/7 municipalities	Critical Area Subbasins
47. Identify and prioritize prime farmland for protection.	6-A	Hydrology	Agricultural use, historic character	Stormwater runoff	Conversion to other land uses, increased impervious surfaces	Review agricultural lands; draft and finalize recommendations. 80-120 hours @ $100-$150/hour (consultant). Costs are per community, but could be reduced through joint effort.	Communities/counties develop recommendations to protect farmland.	3 communities	SC-B; SC-G; SC-C;SC-F;SC-H;SC-I; SC-J; SC-L; SC-N; SC-O; PC-I; PC-J; PC-K; PC-Q

Table 5.4 Stony/Paint Creek Action Matrix

	Goals & Objectives Addressed	Pollutants Addressed	Uses Addressed	Sources Addressed	Causes Addressed	Estimated Cost	Evaluation Methods and Status	Level of Effort/Interim Milestones	Stony/Paint Subbasins (See Appendix C)
48. Integrate farmland protection priorities into community master plans and ordinances.	6-A, 7-A	Hydrology	Agricultural use, historic character	Stormwater runoff	Conversion to other land uses, increased impervious surfaces	Review agricultural lands; draft and finalize recommendations. 80-120 hours @ $100-$150/hour (consultant). Costs are per community, but could be reduced through joint effort.	Communities/counties develop recommendations to protect farmland.	2 communities within 5 years	SC-B; SC-G; SC-C;SC-F;SC-H;SC-I; SC-J; SC-L; SC-N; SC-O; PC-I; PC-J; PC-K; PC-Q
49. Support farmland preservation programs.	6-A, 7-A	Hydrology	Agricultural use, historic character	Stormwater runoff	Conversion to other land uses, increased impervious surfaces	Cost associated with supporting current preservation programs by providing comment/input.	Communities pass resolutions and/or incorporate support for farmland preservation into local plans.	3 communities	SC-B; SC-G; SC-C;SC-F;SC-H;SC-I; SC-J; SC-L; SC-N; SC-O; PC-I; PC-J; PC-K; PC-Q
52. Integrate historic preservation goals into community master plans.	7-A		Historic character		Conversion to other land uses, lack of public knowledge	Review agricultural lands; draft and finalize recommendations. 80-120 hours @ $100-$150/hour (consultant). Costs are per community, but could be reduced through joint effort.	Communities initiate project and develop recommendations	12 communities total	All
52B. Explore opportunities to develop historic preservation ordinances.	7-A		Historic character		Conversion to other land uses, lack of public knowledge	component of above costs	community develops ordinance	12 communities total	All
Development / Redevelopment Regulations									
12. Review land use planning and management practices to promote Low Impact Development (LID).	3-A, 3-B, 3-C, 3-E, 3-F, 4-A8-A;8-D	Hydrology, sediment, elevated temperature, nutrients, bacteria, heavy metals	Fishery, aquatic life & wildlife, recreation, riparian corridor, agricultural use, preservation of habitats / open space / T&E species, historic character	Stormwater runoff, decreased groundwater recharge, road-stream crossings, flow fluctuations, construction site runoff	Increased impervious surfaces, removal of vegetation, poor stormwater management practices, improper erosion and sedimentation controls, lack of buffer, improper construction / maintenance	Research planning and management practices; review local plans; draft and finalize recommendations. 80-120 hours @ $100-$150/hour. Costs are per community	Communities incorporate LID practices into the site plan planning process; maintain imperviousness	5 permittees currently preparing; 2 within 5 years;	All

Table 5.4 Stony/Paint Creek Action Matrix

	Goals & Objectives Addressed	Pollutants Addressed	Uses Addressed	Sources Addressed	Causes Addressed	Estimated Cost	Evaluation Methods and Status	Level of Effort/Interim Milestones	Stony/Paint Subbasins (See Appendix C)
13. Reduce directly connected impervious surfaces through the implementation of Low Impact Development Plans.	2-B, 3-A, 3-B, 3-C, 3-E, 3-F, 4-A	Hydrology, sediment, elevated temperature, nutrients, bacteria, heavy metals	Fishery, aquatic life & wildlife, recreation, riparian corridor, agricultural use, preservation of habitats / open space / T&E species, historic character	Stormwater runoff, decreased groundwater recharge, road-stream crossings, flow fluctuations, construction site runoff	Increased impervious surfaces, removal of vegetation, poor stormwater management practices, improper erosion and sedimentation controls, lack of buffer, improper construction / maintenance	Costs associated with staff/consultant review of site plans, storm water plans and engineering plans.	Implementation of ordinances that impact directly connected impervious surfaces.	5 permittees currently implementing; 4 communities to implement in 5 years.	All
15. Develop and implement local Storm Water Master Plans, including stormwater management ordinances and maintenance programs (see also Action 15 under Plans/Policies and Design Standards & Maintenance Practices).	2-B, 3-A, 3-B, 3-C, 3-D, 3-E, 3-F, 4-A; 8-A;8-B; 8-C; 8-D	Hydrology, sediment, elevated temperature, nutrients, bacteria, heavy metals	Fishery, aquatic life & wildlife, recreation, riparian corridor, agricultural use, preservation of habitats / open space / T&E species	Stormwater runoff, streambanks, flow fluctuations, construction site runoff	Increased impervious surfaces, removal of vegetation, poor storm water management practices, removal of vegetation, improper erosion and sedimentation controls	Using existing templates tailor to individual community needs. $2,000 - $12,000 depending on level of detail.	Completed ordinance / design standards	5 existing/ongoing; 5 planned in 5 years; 2 planned long-term	All
54. Implement soil erosion and sedimentation control (SESC) ordinances or standards.	2-A, 2-B, 3-A, 3-B, 3-C, 3-E, 3-F, 4-A; 8-D	Sediment, nutrients	Fishery, aquatic life & wildlife, recreation, riparian corridor, preservation of habitats / open space / T&E species	Stormwater runoff, streambanks, construction site runoff, road runoff	Increased impervious surfaces, poor stormwater management practices, removal of vegetation, improper erosion and sedimentation controls	$2,000 - $10,000 cost to review/update/prepare ordinance	Counties and selected communities implementing ordinance	Sufficient staff for enforcement	All
55. Develop or modify private road ordinances or standards to incorporate impervious surface reduction techniques.	2-A, 2-B, 3-A, 3-B, 3-B, 3-C, 3-E, 3-F, 4-A	Hydrology	Fishery, aquatic life & wildlife, recreation, riparian corridor, preservation of habitats / open space / T&E species	Stormwater runoff, road-stream crossings, roadside ditches, construction site runoff	Increased impervious surfaces, poor stormwater management practices, removal of vegetation, improper erosion and sedimentation controls	$2,000 - $10,000 cost to review/update/prepare ordinance	Counties and selected communities implementing ordinance	7 permittees	SC-B; SC-C; SC-F;SC-H;SC-I; SC-J; SC-L; SC-N; SC-O; PC-F; PC-E; PC-H; PC-C; PC-G; PC-I; PC-L; PC-P
25. Implement local fertilizer ordinances, standards, or guidelines.	2-A, 2-B, 3-B, 3-D, 3-E	Nutrients	Fishery, aquatic life & wildlife, recreation	Stormwater runoff, residential fertilizer use	Removal of vegetation, lack of buffer, improper or over-application of fertilizers	$2,000-$5,000 cost to review/draft ordinance	Adoption of ordinance/guidelines	Adoption of ordinance and/or implementation of guidelines by 4 permittees in 5 years	All
27. Implement on-site sewage disposal system ordinances and/or maintenance programs.	2-A, 2-B, 3-A, 3-B, 3-C, 3-D, 3-E, 3-F; 8-A; 8-D	Bacteria, nutrients	Fishery, aquatic life & wildlife, recreation	Failing septic systems, illicit connections	Improperly maintained or failing on-site sewage disposal systems	Research and develop rules and technical guidelines for property owners. 80-120 hours @ $100-$150/hour (consultant). $3,000 legal review and $10,000 per year for coordination of program.	Counties initiate development of the ordinance and adopts. Macomb County has adopted a time-of-sale ordinance.	County to implement ordinance	All with current osds

Table 5.4 Stony/Paint Creek Action Matrix

	Goals & Objectives Addressed	Pollutants Addressed	Uses Addressed	Sources Addressed	Causes Addressed	Estimated Cost	Evaluation Methods and Status	Level of Effort/Interim Milestones	Stony/Paint Subbasins (See Appendix C)
29. Develop water resource and natural feature protection ordinances (includes Natural Features Setback Ordinance, Resource Protection Overlay District, Wetlands Ordinance, Tree/Woodland Preservation Ordinance, Steep Slope Ordinance, Weed Ordinance).	2-A, 2-B, 3-A, 3-B, 3-C, 3-D, 3-E, 3-F, 4-A; 8-A; 8-D	Hydrology, sediment, elevated temperature, nutrients, bacteria, metals, pesticides	Fishery, aquatic life & wildlife, recreation, riparian corridor, preservation of habitats / open space / T&E species	Stormwater runoff, decreased groundwater recharge, streambanks, flow fluctuations, construction site runoff, road runoff	Increased impervious surfaces, removal of vegetation, poor stormwater management practices, improper erosion & sedimentation control	Using existing templates tailor to individual community needs. $2,000 - $12,000per ordinance depending on level of detail.	Municipalities are in various stages of adopting/updating these types of ordinances.	Various levels of effort depending on ordinance and municipality.	All
Design Standards and Maintenance Practices									
15. Develop and implement local Storm Water Master Plans, including stormwater management ordinances and maintenance programs (see also Action 15 under Plans/Policies and Development/Redevelopment Regulations).	2-B, 3-A, 3-B, 3-C, 3-D, 3-E, 3-F, 4-A; 8-A; 8-B; 8-C; 8-D	Hydrology, sediment, elevated temperature, nutrients, bacteria	Fishery, aquatic life & wildlife	Stormwater runoff from developed areas, streambanks, flow fluctuations, construction site runoff, road runoff	Increased impervious surfaces, removal of vegetation, poor storm water management practices, removal of vegetation, improper erosion and sedimentation controls	Using existing templates tailor to individual community needs. $2,000 - $12,000 depending on level of detail.	Completed ordinance / design standards	5 existing/ongoing; 5 planned in 5 years; 2 planned long-term	All
16. Establish detention basin maintenance programs.	2-B, 3-A, 3-B, 3-C, 3-D, 3-E, 3-F, 4-A; 8-D	Hydrology, sediment, elevated temperature, nutrients, bacteria	Fishery, aquatic life & wildlife, recreation	Stormwater runoff, flow fluctuations, construction site runoff, residential fertilizer use	Increased impervious surfaces, removal of vegetation, poor stormwater management practices, removal of vegetation, improper erosion and sedimentation controls, improper or over-application of fertilizers	Incorporate maintenance requirements into ordinance and/or standards; actual maintenance varies; $1,000 - $30,000 depending on needs	Community includes a section within the Stormwater Management Ordinance that requires detention basin maintenance both during construction and after appropriate long-term owners take over responsibility for the basin; creates a final draft through a series of input meetings, and adopts it.	All communities implementing Action 15.	
17. Establish detention basin retrofit and enhancement programs.	2-B, 3-A, 3-B, 3-C, 3-D, 3-E, 3-F, 4-A; 8-D	Hydrology, sediment, elevated temperature, nutrients, bacteria	Fishery, aquatic life & wildlife, recreation	Stormwater runoff, flow fluctuations, construction site runoff, residential fertilizer use	Increased impervious surfaces, removal of vegetation, poorly maintained basins, improper or over-application of fertilizers	Costs variable depending on work involved. $5,000-$100,000 per basin	Number of basins enhanced; pollutants addressed and quantity.	Identify basins in need of retrofitting in developed areas. Identify funding mechanisms.	PC-A; PCB; PC-C; PC-D; PC-E; PC-F; PC-G; PC-H; SC-A; SC-E; SC-J; SC-D

Table 5.4 Stony/Paint Creek Action Matrix

	Goals & Objectives Addressed	Pollutants Addressed	Uses Addressed	Sources Addressed	Causes Addressed	Estimated Cost	Evaluation Methods and Status	Level of Effort/Interim Milestones	Stony/Paint Subbasins (See Appendix C)
18. Develop and implement native vegetation guidelines.	2-A, 2-B, 3-A, 3-B, 3-B, 3-C, 3-D, 4-A	Hydrology, sediment, elevated temperature, nutrients, bacteria	Fishery, aquatic life & wildlife, recreation, riparian corridor, preservation of habitats / open space / T&E species	Stormwater runoff; road-stream crossings, streambanks, construction site runoff, residential fertilizer use, waterfowl	Increased impervious surfaces, removal of vegetation, poor stormwater management practices, improper erosion and sedimentation controls, improper or over-application of fertilizers, lack of buffer	$2,000-$5,000 per community; may be incorporated into landscape or storm water ordinance	Community implements guidelines into storm water BMP review process and other areas as feasible.	2 permittees ongoing; 2 permittees planned within 5 years; 2 permittees long-term	PC-A;PC-E; PC-D; PC-B; PC-F;PC-G; PC-E; PC-E SC-A; SC-D; SC-G; SC-H
19. Establish street sweeping and catch basin cleaning programs.	2-A, 2-B, 3-A, 3-B, 3-C, 3-D, 3-F, 3-G, 4-A; 8-D	Sediment, nutrients, heavy metals	Fishery, aquatic life & wildlife, recreation	Stormwater runoff, road runoff	Increased impervious surfaces, removal of vegetation, poor stormwater management practices, removal of vegetation, improper erosion and sedimentation controls	$50,000 Per year lease; $31/hour operator for 150 days/year; $250 - $1000 per catch basin insert	Miles of streets swept or parking lot areas; # of catch basins cleaned.	7 permittees ongoing; 3 implement long-term	All
20. Identify and eliminate illicit discharges.	3-A, 3-B, 3-B, 3-C, 3-G, 4-A	Elevated temperature, bacteria, nutrients, organic compounds, heavy metals	Fishery, aquatic life & wildlife, recreation	Illicit connections	Improper design / maintenance, historic contamination	Approximately $1,000 per streammile for investigation; correction varies dramatically depending on nature of problem. Communities should coordinate efforts with counties and/or may wish to contract with counties.	Community/county implements IDEPs	Consistent with IDEPS	All
57. Improve soil erosion inspection and enforcement practices.	2-A, 2-B, 3-A, 3-B, 3-C, 3-E, 3-F, 4-A; 8-A; 8-B; 8-C; 8-D	Sediment, elevated temperature, nutrients	Fishery, aquatic life & wildlife, recreation	Construction site runoff, road runoff	Increased impervious surfaces, removal of vegetation, poor stormwater management practices, improper erosion and sedimentation controls, improper or over-application of fertilizers	Increased staffing and enforcement - approximately $50,000 per year.	Community/county expands inspection/enforcement program. Track number of complaints/violations and enforcement actions.	Staff increased	All
58. Work with county road commissions to improve maintenance of unpaved roads.	2-B, 3-A, 3-B, 3-C, 3-D, 3-E, 3-F, 4-A; 8-D	Hydrology, sediment, elevated temperature, nutrients	Fishery, aquatic life & wildlife, recreation	Stormwater runoff, road-stream crossings, streambanks, construction site runoff, road runoff	Increased impervious surfaces, removal of vegetation, poor stormwater management practices, removal of vegetation, improper erosion and sedimentation controls	$10,000-$20,000 to research, conduct meetings and evaluate BMP alternatives. Prepare guidance for implementation by counties and communities as applicable	Road commissions review and revise practices. Coordinate with local communities on road improvements. Sensitive areas are targeted for special consideration.	Counties/communities initially convene in meetings and long-term alternatives are implemented.	Critical Subbasins priority.

Table 5.4 Stony/Paint Creek Action Matrix

	Goals & Objectives Addressed	Pollutants Addressed	Uses Addressed	Sources Addressed	Causes Addressed	Estimated Cost	Evaluation Methods and Status	Level of Effort/Interim Milestones	Stony/Paint Subbasins (See Appendix C)
59. Prioritize and implement streambank stabilization projects. (See 5.4b for breakdown of specific tasks)	2-A, 2-B, 3-A, 3-B, 3-B, 3-C, 3-D, 3-E, 3-F, 4-A	Hydrology, sediment, elevated temperatures, nutrients	Navigation, fishery, aquatic life & wildlife, recreation, riparian corridor, preservation of habitats / open space / T&E species	Stormwater runoff, streambanks, flow fluctuations, construction site runoff, low flow, residential fertilizer use	Increased impervious surfaces, removal of vegetation, poor stormwater management practices, removal of vegetation, improper erosion and sedimentation controls	Bioengineering costs range from $20 - $120 per lineal foot; road crossings may require structural improvements at higher costs; additional stream surveys at $3,000 per stream mile.	Road crossings ranked thru existing surveys; other areas to survey; document lineal footage of streambank stabilized and address flow reduction upstream.	3 high priority road crossing areas within 5 years.	Road Xing : SC-E; SC-H; PC-A; PC-H; PC-E
50. Identify applicable Generally Accepted Agricultural Management Practices (GAAMPs) and develop a dissemination plan to distribute this information to local farmers.	2-A, 2-B, 3-A, 3-B, 3-C, 6-B; 8-D	Sediment, elevated temperature, nutrients, bacteria, pesticides	Fishery, aquatic life & wildlife, recreation, riparian corridor, preservation of habitats / open space / T&E species	Stormwater runoff, agricultural fertilizer use, livestock in stream, pesticide use	Removal of vegetation, improper erosion and sedimentation controls, improper or over-application of fertilizers / pesticides, lack of buffer	Review practices and develop recommendations. 80-120 hours @ $100-$150/hr (consultant).	GAAMPs are identified and disseminated to farmers; number of farmers reached; monitoring results.	3 communities within 5 years	SC-A; SC-D; SC-G; SC-E; PC-B; PC-D; PC-F; SC-J; SC-O; PC-I; PC-J; PC-K; PC-L; PC-P
24. Encourage golf course management programs that protect water quality.	2-A, 2-B, 3-A, 3-B, 3-B, 3-C, 3-D, 3-E, 3-F, 4-A, 5-A	Hydrology, sediment, elevated temperature, nutrients, bacteria, pesticides	Navigation, fishery, aquatic life & wildlife, recreation, riparian corridor, preservation of habitats / open space / T&E species	Stormwater runoff, flow fluctuations, fertilizer use, waterfowl	Increased impervious surfaces, removal of vegetation, poor stormwater management practices, impoundments, improper or over-application of fertilizers	Varies depending on activity (may include workshops, mailings, site visits).	Golf courses develop and implement management programs.	2 counties/2 communities existing; 1 community within 5-yrs; 3 communities long-term	Subbasins with golf courses
31. Prevent and remove stream obstructions utilizing appropriate management techniques.	2-A, 2-B, 3-A, 3-D, 3-E, 3-F, 4-A	Hydrology, sediment, elevated temperatures, nutrients, bacteria	Navigation, fishery, aquatic life & wildlife, recreation, riparian corridor, preservation of habitats / open space / T&E species	Stormwater runoff, streambanks, flow fluctuations	Increased impervious surfaces, removal of vegetation, poor stormwater management practices	Community staff at $60/hour; equipment costs range from $80 - $150/hour. Some projects may also be completed by volunteers with community oversight.	Project sites are prioritized and projects completed. Measure: number of sites restored, monitoring results.	2 communities planned within 5 years; 1 existing program; 1 long-term program	subbasins in critical areas
30. Identify, prioritize and implement projects to construct, restore, protect and enhance wetlands.	2-A, 2-B, 3-A, 3-B, 3-B, 3-C, 3-D, 3-E, 3-F, 4-A	Hydrology, sediment, elevated temperature, nutrients, bacteria, metals, pesticides	Fishery, aquatic life & wildlife, recreation, riparian corridor, preservation of habitats / open space / T&E species	Stormwater runoff, decreased groundwater recharge, streambanks, flow fluctuations, construction site runoff, road runoff, fertilizer use	Increased impervious surfaces, removal of vegetation, poor stormwater management practices, improper erosion & sedimentation control, improper or over-application of fertilizers	Prioritize based on Stony Creek RAM; conduct RAM in Paint Creek; $50,000	Wetland maps with priority areas; Measure acres of wetlands enhanced/constructed/protected or restored	Paint Creek subshed wide ~ 70 sq. miles to conduct RAM; prepare priority map for both	Critical area subbasins first priority
32. Identify, prioritize & implement projects to restore and enhance instream habitat.	2-A, 2-B, 3-A, 3-E, 3-F, 4-A, 5-A	Hydrology, sediment, elevated temperature	Fishery, aquatic life & wildlife	Stormwater runoff, streambanks, flow fluctuations, construction site runoff, low flow	Increased impervious surfaces, removal of vegetation, poor stormwater management practices, impoundments	Costs may be incorporated into the streambank stabilization activities; vary depending on type and size of project	Sites are identified and prioritized; number of sites/amount of stream habitat restored; monitoring results	Set priorities within 2 years; determine number of projects to implement in 5-yr time frame and construct. Coordinate with streambank priorities	Critical area subbasins first priority

Table 5.4 Stony/Paint Creek Action Matrix

	Goals & Objectives Addressed	Pollutants Addressed	Uses Addressed	Sources Addressed	Causes Addressed	Estimated Cost	Evaluation Methods and Status	Level of Effort/Interim Milestones	Stony/Paint Subbasins (See Appendix C)
36. Develop a Stony/Paint Green Infrastructure Plan.	2-A, 2-B, 3-A, 3-B, 3-C, 3-D, 3-E, 3-F, 4-A, 5-A, 6-A, 7-A; 8-D	Hydrology, sediment, elevated temperature, nutrients, bacteria	All	Stormwater runoff, decreased groundwater recharge, streambanks, flow fluctuations, construction site runoff, low flow, residential fertilizer use	Increased impervious surfaces, removal of vegetation, lack of buffer	Costs associated with staff meetings and map preparation by county.	Plan is prepared	OC coordinating with OC communities in 5-year time frame to prepare plan.	All
38. Develop and implement household hazardous waste collection programs.	3-G	Organic chemicals, heavy metals, pesticides	Fishery, aquatic life & wildlife, recreation	Residential use	Improper disposal	Costs vary depending on whether municipalities are participating in a partnership or establishing their own program.	Community develops and implements the program.	Reference ongoing Public Education Programs	Reference ongoing Public Education Programs
39. Work with local and/or county agencies to research and implement BMP road de-icing techniques.	3-G	Salt	Fishery, aquatic life & wildlife, recreation	Road runoff	Improper or over-application	Requires adjustment of application rates and recalibration of equipment. Calcium chloride $20/land mile extra, CMA $65 / lane mile extra compared with salt.	Community / county reviews and modifies practices.	Majority of subshed representatives to coordinate with county as applicable on identifying BMP techniques.	Critical area subbasins first priority
43. Work with local, regional, and state organizations and agencies to implement fishery restoration projects.	4-A	Hydrology, sediment, nutrients, elevated temperature, salt	Fishery, aquatic life & wildlife, recreation	Stormwater runoff, decreased groundwater recharge, road-stream crossings, road ditches, streambanks, flow fluctuations, construction site runoff, low flow	Increased impervious surfaces, removal of vegetation, poor stormwater management practices, poor road / bridge maintenance, improper erosion and sedimentation controls, impoundments	Costs vary depending on type of project. Labor and materials may be donated.	Number of restoration projects completed.	Communities/counties supporting efforts	Critical areas subbasins priority
EDUCATION AND STEWARDSHIP									
7. Promote and/or participate in existing watershed education and outreach events, such as River Day and Clinton Clean-Up.	2-A	All	All	All	All	Costs vary depending on the type of activity; material donations can often be obtained from local businesses for special events.	Number of events; number of participants; outcome of stewardship project (e.g. quantity of trash collected, miles of stream cleaned).	Reference ongoing Public Education Programs	Reference ongoing Public Education Programs

Table 5.4 Stony/Paint Creek Action Matrix

	Goals & Objectives Addressed	Pollutants Addressed	Uses Addressed	Sources Addressed	Causes Addressed	Estimated Cost	Evaluation Methods and Status	Level of Effort/Interim Milestones	Stony/Paint Subbasins (See Appendix C)
8. Promote and/or participate in the watershed education and outreach activities of local organizations as outlined in community and county Public Education Plans.	2-A	All	All	All	All	Costs vary depending on the type of activity.	Number of events; number of participants; for workshops, pre-/post-surveys can be used to evaluate learning.	Reference ongoing Public Education Programs	Reference ongoing Public Education Programs
9. Promote and participate in the Clinton River Watershed Council's stormwater education program, as outlined in community Public Education Plans.	2-A	All	All	All	All	$10,000-$11,000 per year for entire subwatershed; cost for each community is based on land area and population size. Additional in-kind services to be provided by communities, such as newsletters, cable TV coverage, etc.	Number of events; number of participants; pre-/post-surveys; monitoring results.	Reference ongoing Public Education Programs	Reference ongoing Public Education Programs
10. Develop and/or implement an education strategy targeted at riparian landowners.	2-A	All	All	Stormwater runoff, streambanks, flow fluctuations, residential fertilizer use, failing septic systems, waterfowl	Increased impervious surfaces, removal of vegetation, poor stormwater management practices, improper erosion and sedimentation controls, improper or over-application, lack of buffer, improper construction / maintenance, lack of homeowner education	~3,000 riparian parcels in the Stony Creek subwatershed; costs may include mailings ($500-$1000), workshops, stewardship projects, etc.	Number of activities; number of participants; pre-/post-surveys; monitoring of riparian areas.	Reference ongoing Public Education Programs	Reference ongoing Public Education Programs
11. Promote and/or participate in education opportunities for land use decision-makers offered by the organizations identified in Action 8.	2-B	All	All	All	All	Varies by activity. Costs may be offset by attendance fees.	Number of activities; number of participants; pre-/post-surveys.	Reference ongoing Public Education Programs	Reference ongoing Public Education Programs
21. Educate staff and contractors on "good housekeeping" practices, including proper fleet and service yard maintenance practices and landscaping activities.	2-A, 2-B, 3-A, 3-B, 3-C, 3-G; 8-D	Hydrology, sediment, nutrients, elevated temperature, organic chemicals, heavy metals & pesticides, salt	Fishery, aquatic life & wildlife, recreation, riparian corridor, preservation of habitats / open space / T&E species	Stormwater runoff, fertilizer use, road runoff	Increased impervious surfaces, poor stormwater management practices, removal of vegetation, lack of buffer, improper design / maintenance	Varies by activity; may include workshops, brochures, etc.	Number / type of programs / materials distributed; documentation of changes in practices.	Reference ongoing Public Education Programs	Reference ongoing Public Education Programs

Table 5.4 Stony/Paint Creek Action Matrix

	Goals & Objectives Addressed	Pollutants Addressed	Uses Addressed	Sources Addressed	Causes Addressed	Estimated Cost	Evaluation Methods and Status	Level of Effort/Interim Milestones	Stony/Paint Subbasins (See Appendix C)
56. Implement soil erosion and sedimentation control education programs.	2-A, 2-B, 3-A, 3-B, 3-E, 3-F; 8-B; 8-C; 8-D	Sediment, elevated temperature, nutrients	Fishery, aquatic life & wildlife, recreation, riparian corridor, preservation of habitats / open space / T&E species	Stormwater runoff, construction site runoff, road runoff	Increased impervious surfaces, removal of vegetation, poor storm water management practices improper erosion and sedimentation controls	Varies by type of education activity. Training - 40-80 hours at $100/hr to prepare and coordinate workshop. Brochure printing - $0.25 - $1 each.	Number of activities; number of individuals reached; quantify of materials distributed.	Reference ongoing Public Education Programs	Reference ongoing Public Education Programs
23. Implement lawn care education programs for residents and businesses.	2-A, 2-B, 3-A,3-B, 3-E, 3-F; 8-D	Elevated temperature, nutrients	Fishery, aquatic life & wildlife, recreation, riparian corridor, preservation of habitats / open space / T&E species	Stormwater runoff, streambanks, residential fertilizer & pesticide use	Increased impervious surfaces, removal of vegetation, poor stormwater management practices, lack of buffer, improper or over-application of fertilizers / pesticides	Varies by type of education activity. Training - 40-80 hours at $100/hr to prepare and coordinate workshop. Brochure printing - $0.25 - $1 each. *Source: Adapted from Middle One Rouge River Subwatershed*	Number of activities; number of individuals reached; quantify of materials distributed; pre-/post-survey results; monitoring results.	Reference ongoing Public Education Programs	Reference ongoing Public Education Programs
26. Implement an animal and pet waste management program.	2-A, 2-B, 3-C, 3-E, 3-F	Sediment, nutrients, bacteria	Fishery, aquatic life & wildlife, recreation, riparian corridor	Stormwater runoff, waterfowl, livestock in stream, pets	Removal of vegetation, improper disposal of pet waste, unrestricted access	Brochure printing: $0.25 - $1 each. Border Collie program - 80-120 hours @ $100-$150/hr to develop. Once in place requires 20-40 hrs/month. Park / common area signage additional.	Number of individuals reached / personal observation; quantity of materials distributed; pre-/ post-survey results; monitoring results.	Reference ongoing Public Education Programs	Reference ongoing Public Education Programs
33. Continue and expand litter and debris cleanup efforts.	2-A, 2-B, 3-B, 3-C, 3-D, 3-E, 3-F, 4-A, 5-A	Nutrients, bacteria, organic chemicals, heavy metals	Fishery, aquatic life & wildlife, recreation	Stormwater runoff	Increased impervious surfaces, removal of vegetation, poor stormwater management practices	Volunteer labor and donated materials and supplies can keep costs to a minimum.	Number of sites / length of stream cleaned; number of participants; quantify of debris removed.	Reference ongoing Public Education Programs	Reference ongoing Public Education Programs
34. Promote and participate in stewardship efforts coordinated by local organizations such as those listed in Action 8.	2-A, 2-B, 3-A, 3-B, 3-C, 3-D, 3-E, 3-F, 4-A, 5-A, 6-A, 6-B, 7-A; 8-D	All	All	All	All	Volunteer labor and donated materials and supplies can keep costs to a minimum.	Number of activities; number of participants	Reference ongoing Public Education Programs	Reference ongoing Public Education Programs
35. Encourage residential stormwater management practices.	2-A, 2-B, 3-A, 3-B, 3-C, 3-D, 3-E, 3-F, 4-A, 5-A, 6-A, 6-B, 7-A; 8-D	Hydrology, sediment, nutrients	Fishery, aquatic life & wildlife, recreation, riparian corridor, preservation of habitats / open space / T&E species	Stormwater runoff	Increased impervious surfaces, removal of vegetation, poor stormwater management practices	Examples include rain barrels ($100-250 each) and raingardens ($250 - $1,000).	Number of residents implementing practices; survey results.	2 counties/6 communities initiating; 3 communities within 5 years	All

Table 5.4 Stony/Paint Creek Action Matrix

	Goals & Objectives Addressed	Pollutants Addressed	Uses Addressed	Sources Addressed	Causes Addressed	Estimated Cost	Evaluation Methods and Status	Level of Effort/Interim Milestones	Stony/Paint Subbasins (See Appendix C)
46. Enhance recreational opportunities by coordinating with local and regional agencies, offering interpretive and educational programs and events.	2-A, 5-A	Hydrology, sediment, nutrients, elevated temperatures	Fishery, aquatic life & wildlife, recreation, riparian corridor, preservation of habitats / open space / T&E species	Stormwater runoff	Increased impervious surfaces, conversion to other land uses	Varies by activity.	Number of activities / participants; type of improvements.	Communities identify opportunities prior to implementation	All
51. Create an information clearinghouse and distribute information on historic sites in the watershed.	7-A		Historic character		Conversion to other land uses	Costs can be minimal if conducted by volunteers. Brochures - $0.25 - $1 each.	Clearinghouse is developed and information distributed. Rochester Hills Museum at Van Hoosen Farms offers extensive	1 county; 4 communities existing programs	Subbasins with historic sites
53. Coordinate with local volunteer organizations to promote preservation and interpretation of historic resources.	7-A		Historic character		Conversion to other land uses	Costs for programming can be minimal if conducted by volunteers. Brochures - $0.25 - $1 each.	Number of activities, number of participants, quantity of materials distributed. Rochester Hills Museum at Van Hoosen Farm and Rochester-Avon Historical Society offer a variety of programs.	1 county; 4 communities existing programs	Subbasins with historic sites

Table 5.4b Stony/Paint Creek Subwatershed Summary of Ongoing and Proposed Actions

Key:

E = Ongoing / current | P = Short-term within 5 years | L = Planned after 5 years | WL = Wish list | CS = County standards applied | NA = Not applicable

Action descriptions contained in Section 5.4

Plans & Policies	Oakland County	Macomb County	Addison Twp.	Auburn Hills	Brandon Twp.	Village of Lake Orion	Oakland Twp.	Orion Twp.	Oxford Twp.	Oxford Village	Shelby Twp.	Rochester Hills	Rochester	Washington Twp.	Rochester Schools	Oxford Schools
1. Identify facilitating body, organizational structure, and decision-making mechanism for the subwatershed group.	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
2. Obtain community commitments of support for operation of and participation in subwatershed group.	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
3. Establish a mechanism for the subwatershed group to research, report on, and pursue financing options.	E	E	E	NA	E	E	E	E	E	E	E	E	E	P	E	E
4. Foster relationships and coordinate efforts with other subwatershed groups.	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
5. Participate in regional planning efforts.	E	E	E	NA	E	E	E	E	E	E	E	E	E	E	E	E
6. Collaborate with the Clinton River Area of Concern Public Advisory Council (PAC) and participate in Remedial Action Plan updates.	E	E	E	NA	E	E	E	E	E	E	E	E	E	E	E	E
14. Develop comprehensive sanitary sewer infrastructure plans.	E	NA	NA	E	WL	E	WL	WL	E	WL	NA	E	WL	P	NA	NA

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15. Develop and implement local Storm Water Master Plans, including stormwater management ordinances and maintenance programs (see also Action 15 under Development / Redevelopment Regulations and Design Standards & Maintenance Practices).	E	P	L	E	WL	P	P	E	E	P	WL	E	P	L	NA	NA
22. Develop and implement a long-term monitoring strategy. (2-part program consisting of using volunteer monitoring and long-term sampling programs).																
22a. Support, promote and/or participate in the Clinton River Watershed Council volunteer monitoring programs, including the Adopt-a-Stream program and Stream Leaders as applicable, as part of a long-term monitoring strategy.	E	E	P	E	WL	P	E	E	E	NA	E	E	P	E	E	E
22b. Support subwatershed and Clinton River Watershed efforts to procure grant funding and projects for a long-term monitoring program.	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
28. Inventory natural features and develop Natural Resource Protection Plans.	WL	WL	WL	NA	WL	WL	E	WL	WL	WL	WL	WL	WL	WL	NA	NA

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36. Develop a Stony/Paint Green Infrastructure Plan	P	E/P	P	NA	WL	E	E/P	E	P	WL	WL	E	P	P	NA	NA
37. Participate in and promote the Southeast Michigan Greenways Network and related county trail and greenway development projects.	E	E/P	E	NA	WL	E	E	E	E	L	NA	E	E	E	E	E
40. Review existing data regarding the presence of PCBs and mercury in Stony Creek Lake, Lake Orion and Lakeville Lake and develop Total Maxium Daily Load plans to restore as required under Clean Water Act Section 303(d).	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
41. Gather and evaluate current and historic fisheries data and establish fisheries restoration targets.	E	NA	NA	NA	WL	E	L	E	E	NA	E	E	E	WL	NA	NA
42. Encourage communities and county agencies to incorporate fisheries restoration measures into local plans, ordinances, and standards.	E	NA	NA	NA	WL	P	L	WL	P	NA	WL	E	P	WL	NA	NA

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44. Inventory existing access points and recreation opportunities to identify gaps and needed improvements.	E	E/P	E	NA	NA	E	E	WL	WL	L	NA	E	E	E	E-working with CRWC	E-working with CRWC
45. Evaluate opportunities to expand recreation access through acquisition and conservation easements and integrate these opportunities into local recreation plans.	E	E/P	E	NA	WL	E	E	WL	WL	L	NA	WL	E	E	NA	NA
45b. Implement opportunities identified thru Action 52.	E	WL	WL	NA	WL	WL	E	WL	WL	WL	NA	WL	WL	WL	NA	NA
47. Identify and prioritize prime farmland for protection.	NA	NA	P	NA	NA	NA	E/P- purchase for park property	NA	E	NA	NA	NA	NA	P	NA	NA
48. Integrate farmland protection priorities into community master plans and ordinances.	NA	NA	L	NA	NA	NA	NA	NA	E	NA	NA	NA	NA	E	NA	NA
49. Support farmland preservation programs.	NA	NA	P	NA	NA	NA	NA	NA	P	NA	NA	NA	NA	E	NA	NA
52. Integrate historic preservation goals into community master plans.	E	E/P- Database of sites	WL	NA	WL	P	E	WL	WL	E	NA	E	WL	WL	NA	NA
52B. Explore opportunities to develop historic preservation ordinances.	NA	NA	WL	NA	WL	P	E	WL	WL	WL	NA	E	WL	WL	NA	NA

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Development / Redevelopment Regulations																
12. Review land use planning and management practices to promote Low Impact Development (LID).	E	NA	P	NA	E	E	E	E	P	L	NA	WL	WL	WL	NA	NA
13. Reduce directly connected impervious surfaces through the implementation of Low Impact Development Plans.	NA	NA	P	NA	P	E	E	E	P	L	NA	WL	P	WL	E-new construction incorporates BMPs	E-new constructio n incorporate s BMPs
15. Develop and implement local Storm Water Master Plans, including stormwater management ordinances and maintenance programs (see also Action 15 under Plans/Policies and Design Standards & Maintenance Practices).	E	P	L	E	WL	P	P	E	E	P	WL	E	P	L	NA	NA
54. Implement soil erosion and sedimentation control (SESC) ordinances or standards.	E	E	CS	CS	CS	CS	CS	E	CS	CS	CS	CS	CS	CS	NA	NA
55. Develop or modify private road ordinances or standards to incorporate impervious surface reduction techniques.	NA	NA	E	NA	E	NA	WL	E	E	NA	NA	WL	NA	WL	NA	NA
25. Implement local fertilizer ordinances, standards, or guidelines.	WL	WL	WL	NA	WL	P	WL	WL	WL	L	WL	WL	P	WL	P-school properties	P-school properties

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27. Implement on-site sewage disposal system ordinances and/or maintenance programs.	E	E	CS	NA	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	NA	NA
29. Develop water resource and natural feature protection ordinances (includes Natural Features Setback Ordinance, Resource Protection Overlay District, Wetlands Ordinance, Tree/Woodland Preservation Ordinance, Steep Slope Ordinance, Weed Ordinance).																
Natural Features Setback Ordinance	NA	NA	E	E	E	P	E	E	E	L	WL	E	E	WL	NA	NA
Resource Protection Overlay District	NA	NA	E	NA	E	P	E	NA	E	L	WL	E	E	WL	NA	NA
Wetland Ordinance	NA	NA	E	E	E	P	E	E	E	L	WL	E	E	WL	NA	NA
Tree/Woodland Preservation Ordinance	NA	NA	NA	E	E	P	E	E	WL	L	WL	E	E	WL	NA	NA
Steep Slope Ordinance	NA	NA	NA	NA	NA	NA	WL	NA	WL	WL	WL	P	P	WL	NA	NA
Review/Update Weed Ordinance	NA	NA	NA	E	WL	P	NA	NA	WL	WL	WL	P	P	WL	NA	NA
15. Develop and implement local Storm Water Master Plans, including stormwater management ordinances and maintenance programs (see also Action 15 under Plans/Policies and Development/Redevelopment Regulations).	E	P	L	E	WL	P	P	E	E	P	WL	E	P	L	NA	NA

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16. Establish detention basin maintenance programs.	E/P-Require they be maintained	E/P-Require they be maintained	P	E	L	P	P	E	E	WL	WL	E	L	L	E-school district maintains	E-school district maintains
17. Establish detention basin retrofit and enhancement programs.	WL	WL	WL	NA	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
18. Develop and implement native vegetation guidelines.	WL	WL	WL	NA	WL	P	P	E	E	WL	WL	L	L	WL	WL	WL
19. Establish street sweeping and catch basin cleaning programs.	E	E	L	E	NA	E	NA	NA	NA	E	NA	E	E	CS	L-school properties	L-school properties
20. Identify and eliminate illicit discharges.	E	E	E	E	E	P	E	E	E	E	WL	E	P	P	E	E
57. Improve soil erosion inspection and enforcement practices.	E	E	CS	CS	CS	CS	CS	E	CS	CS	CS	CS	CS	CS	CS	CS
58. Work with county road commissions to improve maintenance of unpaved roads.	L	L	L	NA	L	NA	L	L	L	NA	L	L	L	L	NA	NA
59. Prioritize and implement streambank stabilization projects.																

Table 5.4b Stony/Paint Creek Subwatershed Summary of Ongoing and Proposed Actions

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59a. Prioritize streambankstabilization projects at road/stream crossings where surveys were previously completed.	P	P	P	NA	WL	P	P	WL	P	NA	WL	P	WL	WL	WL	WL
59b. Prioritize streambank stabilization projects in areas other than road/stream crossings.	WL	WL	WL	NA	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
59c. Implement streambank stabilization projects.	WL	WL	WL	NA	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
50. Identify applicable Generally Accepted Agricultural Management Practices (GAAMPs) and develop a dissemination plan to distribute this information to local farmers.	NA	NA	P	NA	NA	NA	P	NA	P	NA	NA	NA	NA	WL	NA	NA
24. Encourage golf course management programs that protect water quality.	E	E	E	NA	NA	NA	L	L	P	NA	NA	E	NA	L	NA	NA
31. Prevent and remove stream obstructions utilizing appropriate management techniques.	WL	WL	WL	NA	WL	P	WL	WL	P	NA	WL	E	L	WL	WL	WL
30a. Identify and prioritize projects to construct, restore, protect and enhance wetlands.	WL	WL	WL	NA	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL
30b. Implement projects to construct, restore, protect and enhance wetlands.	WL	WL	WL	NA	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL	WL

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32. Identify and prioritize projects to restore and enhance instream habitat.																
32a. Convene discussions between the subwatershed group to identify potential projects involving instream habitat.	P	P	P	NA	P	P	P	P	P	NA	WL	P	P	WL	P	P
32b. Implement projects to restore and enhance instream habitat.	WL	WL	WL	NA	WL	WL	WL	WL	WL	NA	WL	WL	WL	WL	WL	WL
36. Develop a Stony/Paint Green Infrastructure Plan.	P	P	P	NA	WL	E	P	E	E	P	WL	E	L	P	NA	NA
38. Develop and implement household hazardous waste collection programs.	E	E	E	E	E	*ORION TWP	E	E	E	E	E	E	E	L	NA	NA
39. Work with local and/or county agencies to research and implement BMP road de-icing techniques.	L	L	L	E	WL	L	L	L	L	L	L	L	E	L	NA	NA
43. Work with local, regional, and state organizations and agencies to implement fishery restoration projects.	E	NA	E	NA	NA	WL	P	WL	E	NA	WL	E	P	WL	NA	NA

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EDUCATION AND STEWARDSHIP																
7. Promote and/or participate in existing watershed education and outreach events, such as River Day and Clinton Clean-Up.	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
8. Promote and/or participate in the watershed education and outreach activities of local organizations as outlined in community and county Public Education Plans.	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
9. Promote and participate in the Clinton River Watershed Council's stormwater education program, as outlined in community Public Education Plans.	E	E	E	NA	E	E	E	E	E	E	E	E	E	E	NA	NA
10. Develop and/or implement an education strategy targeted at riparian landowners.	L	L	E	NA	E	P	E	L (via CRWC)	P	WL	L	P	L	WL	NA	NA
11. Promote and/or participate in education opportunities for land use decision-makers offered by the organizations identified in Action 8.	E	NA	E	E	E	E	E	E	E	WL	L	E	E	L	NA	NA

Table 5.4b Stony/Paint Creek Subwatershed Summary of Ongoing and Proposed Actions

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21. Educate staff and contractors on "good housekeeping" practices, including proper fleet and service yard maintenance practices and landscaping activities.	E	E	E	E	E	P	E	P	P	L	NA	E	P	P	E	E
56. Implement soil erosion and sedimentation control education programs.	E	E	CS	CS	CS	CS	CS	P	CS	CS	CS	CS	CS	CS	CS	CS
23. Implement lawn care education programs for residents and businesses.	E	E	E	E	E	P	E	E (via written materials)	E	E	E	E	P	L	NA	NA
26. Implement an animal and pet waste management program.	E	E	E	E	L	P	E	E (via written materials)	E	L	NA	E	P	WL	NA	NA
33. Continue and expand litter and debris cleanup efforts.	E	E	E	NA	E	P	E	WL	E	E	E	E	E	WL	E	E
34. Promote and participate in stewardship efforts coordinated by local organizations such as those listed in Action 8.	E	E	E	E	E	P	E	E	E	E	E	E	P	E	E	E
35. Encourage residential stormwater management practices.	E	E	E	E	P	P	E	E	P	E	L	E	WL	L	NA	NA

Table 5.4b Stony/Paint Creek Subwatershed Summary of Ongoing and Proposed Actions

Key:

E = Ongoing / current | P = Short-term within 5 years | L = Planned after 5 years | WL = Wish list | CS = County standards applied | NA = Not applicable

Action descriptions contained in Section 5.4

Plans & Policies	Oakland County	Macomb County	Addison Twp.	Auburn Hills	Brandon Twp.	Village of Lake Orion	Oakland Twp.	Orion Twp.	Oxford Twp.	Oxford Village	Shelby Twp.	Rochester Hills	Rochester	Washington Twp.	Rochester Schools	Oxford Schools
46. Enhance recreational opportunities by coordinating with local and regional agencies, offering interpretive and educational programs and events.	E/P	E/P	WL	NA	P	WL	E	WL	P	WL	NA	E	E	L	L	L
46b. Enhance recreational opportunities by developing signage and other needed improvements	WL	WL	WL	NA	WL	WL	WL	WL	WL	WL	NA	WL	WL	WL	WL	WL
51. Create an information clearinghouse and distribute information on historic sites in the watershed.	E	NA	P	NA	NA	E	E	WL	WL	E	NA	NA	E	WL	NA	NA
53. Coordinate with local volunteer organizations to promote preservation and interpretation of historic resources.	E	NA	P	NA	NA	E	E	WL	WL	WL	NA	NA	E	WL	NA	NA