

**Clinton Main Subwatershed
of the Clinton River Watershed
Subwatershed Management Plan**

**Prepared by the Clinton Main Subwatershed
Advisory Group:**

**City of Auburn Hills, Avondale Schools, Bloomfield
Township, City of Keego Harbor, City of Lake
Angelus, Oakland County, Oakland University, City
of Orchard Lake Village, Orion Township, City of
Pontiac, City of Rochester, City of Rochester Hills,
Rochester Schools, City of Sylvan Lake, Waterford
Township, West Bloomfield Township**

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Southeast Michigan Council of Governments
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Clinton Main Subwatershed Subwatershed Management Plan

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This Subwatershed Management Plan was updated in July 2010 to incorporate specific EPA Section 319(h) elements. This task was assisted by the Southeast Michigan Council of Governments. Changes to the original plan include the following:

- A matrix of priority projects, subbasins, priority BMPs, and sources/causes/pollutants has been created. (Chapter 5, beginning page 156; Section 5.3 Non-NPDES Phase II Permit Priority Preservation/Restoration Projects and accompanying Tables 5.7a – h, pages 160 – end of Chapter 5) In addition, these tables encompass the 319 elements including critical areas, load reductions, costs, schedule and milestones.
- Requested clarification has been included in Appendix C - Monitoring
- Chapter 4 has been edited to reflect "threats" as opposed to "causes" on page 96.

Chapter 3

Existing Conditions and Characteristics

This chapter provides an overview of existing conditions of the subwatershed and will form the basis for goal setting and identification of structural and non-structural BMPs for implementation across the subwatershed. The information contained in this chapter was developed from a variety of sources including existing studies and field data collection efforts. Information compiled and utilized from existing studies and available information included community land use and planning information, landscape characteristics including wetlands, ecoregions and soil types, water quantity and water quality data as well as an understanding of the existing state of public opinion regarding watershed issues.

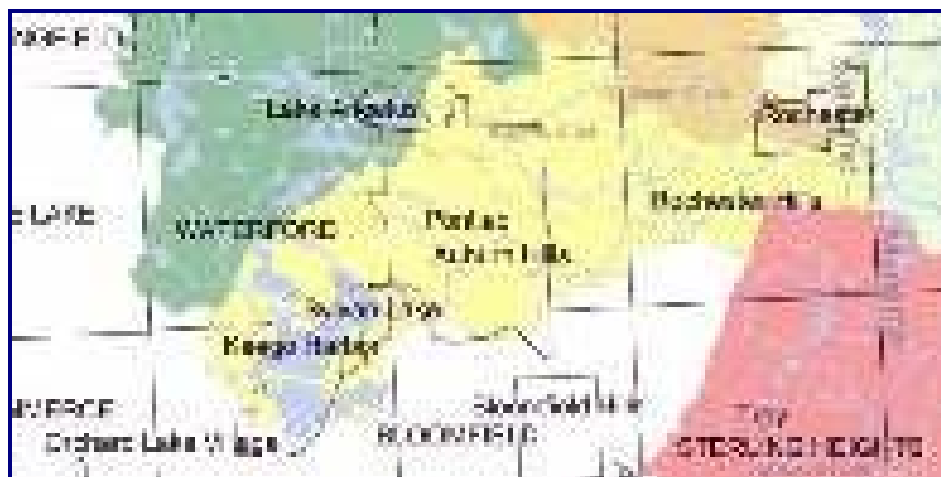
Field data collection efforts included conducting the MDEQ Road Stream Crossing Single Site Watershed Survey, the MDEQ Bank Erosion Hazard Index Survey and the MDEQ Instream Macroinvertebrate Survey at sixteen (16) road crossings throughout the subwatershed. In addition, a computer modeling program was employed to estimate pollutant loading for typical nonpoint source parameters across the subwatershed. This field and modeling data was subsequently compiled into a weighted scoring system to prioritize road crossing areas for further evaluation.

3.1 Land Use and Planning Analysis

This analysis looks at the current land use conditions and other community planning-related topics within the Clinton Main Subwatershed. It identifies trends and potential future water quality issues relative to land use. This section of the plan also evaluates each community's land use plans, programs and ordinances, and provides options to strengthen natural feature and water quality protection.

Growth Trends, Land Use Analysis and Community Profiles

The Clinton Main Subwatershed is over 70 square miles in area and is located within the central portion of Oakland County. A total of 13 communities are located within the subwatershed, of which six have chosen this subwatershed as their primary subwatershed for Phase II purposes. Oakland County and Oakland University are also participating in this subwatershed group as primary participants. Both Keego Harbor and Sylvan Lake are contained entirely within the Clinton Main Subwatershed.



A summary of each of the communities is provided in Table 3.1 on the following page as well as in the descriptions that follow. Note that the Oakland County campus is part of Waterford Township and the City of Pontiac, and that the Oakland University campus is located in Rochester Hills and Auburn Hills.

Table 3.1 Community Area in Subwatershed

Community	Acres in Subwatershed	Percent of Community in Subwatershed
City of Auburn Hills	9,433	20%
Bloomfield Township	366	<1%
City of Keego Harbor	360	<1%
Village of Lake Angelus	35	<1%
Oakland Township	.004	<1%
Orchard Lake Village	1,798	4%
Orion Township	546	1%
City of Pontiac	11,757	25%
City of Rochester	1,168	2%
City of Rochester Hills	9,600	20%
Sylvan Lake Village	516	1%
Waterford Township	8,348	18%
West Bloomfield Township	3,720	8%
Subwatershed Total	47,647	100%
Oakland County Campus	391	100%
Oakland University Campus	1,441	100%

While Oakland University and Oakland County are not technically communities, they both either own or have jurisdiction over considerable land area throughout the subwatershed. A state-supported institution of higher education, Oakland University covers 1,441 acres in the Cities of Rochester Hills and Auburn Hills. All of this acreage is within the Clinton Main watershed, and most is within the Galloway Creek subwatershed. The campus consists of 46 major buildings (3,000,000 total gross square feet), two golf courses, two biological preserves, the cultural/historical centers of Meadow Brook Hall, Meadow Brook Theatre, Meadow Brook Art Gallery, and Meadow Brook Music Festival, and 60 single-family residences.

Growing at 3% annually, the University serves nearly 17,000 students, 2,000 of whom reside on campus. A 2001 Master Plan forecasts “this growth to continue through 2020, focusing mostly on infill of the existing academic core.”

Oakland County’s campus spans the boundary between Waterford Township and the City of Pontiac and is approximately 391 acres in size. The Road Commission and Drain Commission have jurisdiction over 2,600 miles of County roads and more than 500 miles of County drains throughout the County. Oakland County Parks owns 145 acres of land within the subwatershed at Waterford Oaks County Park.

3.1.1 Growth Trends

To understand the land use changes within the Clinton Main Subwatershed, it is helpful to understand the growth trends observed within the southeast Michigan region. The Southeast Michigan Council of Governments (SEMCOG) evaluated the changes that have occurred between the 1990 and 2000 census years. A summary of the findings is as follows:

- ❖ Developed land in the region has increased by 17% (159,300 acres). Thirty-seven percent of the region is now considered developed.
- ❖ The region's population grew by 5% (243,000 people).
- ❖ Between 1990 and 2000 the density of residential development decreased from 2.84 units per acre to 1.26 units per acre, or 55.6%.
- ❖ Average household size has decreased and the average home size has increased.
- ❖ The results of these changes are larger homes on larger pieces of land with fewer occupants.

The trends identified by SEMCOG are indicative of a growing region. SEMCOG projects that similar trends will prevail over the next 30 years. Table 3.2 illustrates the population and housing profiles for each of the 13 communities. Note that this data is for the entire community, not just the area within the Clinton Main Subwatershed.

3.1.2 Subwatershed Community Trends

The growth trends in the Clinton Main Subwatershed are similar to trends in the region. Populations for all but five communities are increasing. Bloomfield Township, Keego Harbor, Lake Angelus, Orchard Lake Village, and Sylvan Lake's populations are stable or are predicted to decrease. One potential reason is because these communities are virtually built out, without significant land area left to develop. The number of people living in each housing unit is decreasing for almost all communities, between 3 – 23%. The City of Rochester is the only exception, where persons per housing unit is predicted to remain stable. In 2000, the average number of people living in each household within subwatershed communities is 2.53, and this number is predicted to fall by 9% to 2.29 by 2030 (SEMCOG 2030 Regional Development Forecast).

Table 3.2 Population and Housing Profiles

	Auburn Hills	Bloomfield Township	Keego Harbor	Lake Angelus	Oakland Township	Orchard Lake Village	Orion Township	Pontiac	Rochester Hills
1990 Population	17,076	42,195	2,932	328	8,226	2,286	21,019	71,136	7,113
2000 Population	19,837	42,585	2,769	326	13,071	2,215	30,748	67,506	10,414
2030 Population	21,013	38,422	2,758	264	26,063	2,216	40,948	75,544	11,111
Households									
1990 Households	6,453	15,734	1,232	122	2,722	696	7,331	24,763	3,414
2000 Households	8,064	16,804	1,223	132	4,341	750	11,048	24,234	4,661
2030 Households	9,753	17,409	1,313	139	9,423	775	16,030	30,204	4,930
2000 Housing Units	8,822	17,455	1,317	146	4,529	805	11,517	26,336	5,039
2000 Household Size	2.25	2.53	2.26	2.47	3.01	2.95	2.77	2.68	2.22
2030 Household Size	1.97	2.21	2.14	1.90	2.77	2.85	2.54	2.44	2.22
2000 Median Household Income	\$51,376	\$103,897	\$46,552	\$144,524	\$102,034	\$121,126	\$73,755	\$31,207	\$65,000
2000 Median Housing Value	\$137,200	\$356,800	\$117,200	\$814,800	\$315,700	\$571,700	\$199,100	\$74,300	\$26,000
Educational Attainment									
No High School	1,521	1,197	294	0	411	98	1,492	12,207	133
High School	3,263	2,979	482	28	1,520	154	4,280	12,775	1,414
Some College	2,696	5,065	417	55	1,794	258	4,767	8,442	1,414
Associates	990	1,406	230	8	647	57	1,797	1,819	502
Bachelor's	2,856	10,277	313	100	2,387	467	4,941	2,842	2,333
Graduate/Professional	1,278	10,204	128	56	1,598	440	2,292	1,212	1,414
Housing Types									
One-Family Detached	3,447	13,711	856	146	4,160	805	9,047	16,237	2,517
One-Family Attached	544	1,573	45	2	8	0	530	1,361	458
Two-Family / Duplex	64	25	20	0	0	0	38	1,210	214
Multi-Unit Apartments	3,912	2,119	311	0	8	0	1,448	6,996	1,717
Mobile Homes	888	31	85	0	353	0	456	517	0
Other	0	0	0	0	0	0	0	15	0
Total	8,822	17,455	1,317	148	4,529	805	11,517	26,336	5,039
2003 Residential									
Single Family	64	46	13	1	260	6	164	272	58
Townhouse / Attached Condos	134	0	0	0	124	0	16	37	0
Two-Family / Duplex	0	0	0	0	44	0	4	0	0

3.1.3 Land Use Analysis

The Clinton Main Subwatershed contains a wide variety of existing land uses from single family to extractive. The 13 land use categories used by Oakland County can be summarized in the following table, and depicted on Map 4 located in Appendix A.

Table 3.3 2000 Existing Land Use Designations

Land Use Category	Total Acres	Percent Total
Single Family	12,915	27%
Road Right-of-Way	6,406	13%
Vacant	5,680	12%
Water	4,759	10%
Industrial	4,385	9%
Recreation / Conservation	3,719	8%
Public / Institutional	3,754	8%
Commercial / Office	2,850	6%
Multiple Family	1,800	4%
Transportation / Utility / Communication	605	1%
Mobile Home Park	501	1%
Railroad Right-of-Way	251	<1%
Extractive	22	<1%
Total	47,647	100%

The top land use in the Clinton Main Subwatershed is single family residential. This accounts for more than 27% of the subwatershed, and points to the importance of citizen action and education in the improvement of water quality. Road right-of-ways account for 13% of the land used within the subwatershed, showing the extent of intense development throughout the urban areas of the subwatershed. Another significant land use is vacant land, accounting for 12% of the subwatershed. This represents an important opportunity to apply contemporary solutions to storm water runoff through reduction, infiltration and filtration in development proposals.

A unique characteristic of this subwatershed is the amount of surface waters, or lakes. They account for 10% of the land area in the subwatershed. Many of the large lakes in the subwatershed were created by impounding streams in the western portion of the subwatershed. Historically, the shorelines of the lakes were developed as summertime retreats, with cottages and recreational amenities. Over time, communities were built up around the lakes, and the cottages were renovated into year-round homes. The impoundments present many challenges for water quality. These include runoff from lawns and roadways, lack of shoreline vegetation, water temperature, sediments built up behind dams, and dams acting as impediments to fish migration, among others.

Nine percent, or more than 4,000 acres of the subwatershed, is used for industrial businesses. The majority of industries fall within Auburn Hills, Pontiac, and Rochester Hills. It is most likely that many of these companies already have storm water permits for direct discharges. However, the large amounts of impervious surfaces associated with these businesses make significant contributions of nonpoint runoff into the Clinton River. Another important land use category includes over 3,700 acres in recreation/conservation. While it is possible that much of this land is used for active recreation (rather than

left in a “natural” state), the infiltration ability of this land use would be greater than more developed land use categories.

3.1.4 Community Profiles

The following are brief profiles of each of the 12 Clinton Main Subwatershed communities, highlighting their existing land uses and growth trends. The communities are listed in alphabetical order.

In addition to each community’s general land use features and trends, reference is also made to the results of the Michigan Natural Features Inventory (MNFI) study, which assesses the quality and extent of the natural areas in Oakland County. Map 5 depicts Vegetative Land Cover and Map 6 shows the MNFI areas.

City of Auburn Hills – Eighty-eight percent of the City, or 9,433 acres, is contained within the Clinton Main Subwatershed. In addition, the City makes up 20% of the subwatershed’s total land area. The predominant land use is industrial (1,857 acres), which is located throughout the community, but primarily along Lapeer Road and I-75. Auburn Hills has the most industrial development (as percent of the community land area) within the subwatershed. The second largest land use type is vacant (1,557 acres), giving the City an opportunity to use new methods of storm water reduction, infiltration, and filtration on new development sites. The rest of the City is occupied by a mix of residential, public, and commercial/office uses.

There are four large areas designated as recreational land as well as wetland ecosystems within Auburn Hills. The Michigan Natural Features Inventory (MNFI) shows seven areas identified as Priority Two preservation areas, and nine areas identified as Priority Three preservation areas throughout the City, many of which are along tributaries. Quite a few of the MNFI sites are located within already designated recreational lands.

The City has experienced a slight increase in population with a commensurate increase in the number of households between 1990 and 2000. This pattern is projected to continue at a similar pace over the next thirty (30) years. As exhibited in almost all of the communities within the subwatershed, the persons per household is projected to decrease between 2000 and 2030. The decrease is in part due to the high number of residential permits, in particular townhouse/ attached condominiums. In 2003 the City issued 202 residential building permits, one of the highest volumes within the subwatershed.

Bloomfield Township – Roughly half a square mile (366 acres) of Bloomfield Township lies within the Clinton Main Subwatershed. Although Bloomfield Township only makes up a small portion of the subwatershed, most of the land is designated as single-family residential and transportation/utility uses. There is also some commercial, public, and vacant township lands within the subwatershed. There are no MNFI sites identified in the subwatershed in this portion of the Township.

Over the past 10 years, the population has remained virtually constant, but is projected to decrease by almost 10% by 2030. The number of persons per household is suspected to decrease, similar to the rest of the subwatershed. For a community this size, the number of building permits in 2003 is relatively low, indicating a built-out character.

City of Keego Harbor – Keego Harbor is the fourth smallest community in population within the subwatershed, and the smallest in land area. One hundred percent of the City’s land area is contained within the subwatershed. Single-family is the highest land use type within the community, followed by

transportation/utility land uses, and then water. The remainder of the community is comprised of commercial, vacant, recreation/conservation, and multi-family uses. There are no MNFI sites identified in this community.

The population has decreased slightly since 1990, but is projected to stay the same for the next 30 years. However, the number of persons per household is projected to go down somewhat, but less than other communities. And as in other built-out communities, only a small number of building permits were issued in 2003.

City of Lake Angelus – Population wise, Lake Angelus is the smallest community within the subwatershed. In addition, only 9% (35 acres) of the City is contained within the subwatershed. The predominant land use within the subwatershed is recreation/conservation (12 acres), with eight acres vacant, and eight acres devoted to transportation/utility uses. The Michigan Natural Features Inventory designates one Priority Three preservation area at the eastern edge of the community.

The City has experienced a slight decline in population with a slight increase in the number of households between 1990 and 2000. This pattern is projected to continue but at a slower pace over the next 30 years. The household size is projected to decrease significantly (23%) between 2000 and 2030 to one of the lowest rates within the subwatershed.

Oakland University – A state-supported institution of high education, Oakland University covers 1,441 acres in the Cities of Rochester Hills and Auburn Hills. All of this acreage is within the watershed, while most is within the Galloway Creek subwatershed. The campus consists of 46 major buildings (3 million total Gross Square Feet), two golf courses, two biological preserves, the cultural/historical centers of Meadow Brook Hall, Meadow Brook Theatre, Meadow Brook Art Gallery, and Meadow Brook Music Festival, and 60 single-family residences.

Growing at 3% annually, the University serves nearly 17,000 students, 2,000 of whom reside on campus. A 2001 master plan forecasts this growth to continue through 2020, focusing mostly on infill of the existing academic core.

Orchard Lake Village – The Village represents another relatively small community within the subwatershed. Sixty-nine percent of the village is contained within the subwatershed, which represents 4% of the subwatershed land total. The land uses within the subwatershed include water as the largest, and single-family residential being the next largest. The other main land uses are recreation/conservation and public land uses, which both cover similar amounts of land area. There are four Priority Three MNFI sites within the Village in the subwatershed boundaries. Three are located south and west of the lake, and one is located on Apple Island in the middle of Orchard Lake.

The population in the Village has not changed significantly since 1990, and is not projected to change in the near future. Similarly, the number of persons per household is also holding steady, only showing a very slight decrease.

Orion Township – Just under 3% (or 546 acres) of Orion Township is located within the subwatershed. These areas are located at the Brown Road and Joslyn Road intersection, and the Brown Road and Lapeer Road intersection. The largest land use is industrial, with almost half of the community's subwatershed area used for this purpose. The remaining land uses include single-family residential, vacant, mobile

home, and transportation/utility uses. There are two MNFI sites identified in this section of Orion Township. A Priority Two site on the east side of Joslyn Road, and a Priority Three site to the west of Joslyn Road.

The population within Orion Township is projected to increase dramatically over the next thirty years with a commensurate increase in the number of households. However, like many of the communities in the subwatershed, the persons per household are projected to decrease over the same time frame. In 2003 the Township witnessed one of the higher growth rates for new residential construction. A total of 184 residential permits were issued that year.

City of Pontiac – The City has, by far, the largest quantity of land contained within the subwatershed. Almost all of the 12,900 acres of the City are located within the subwatershed, and are occupied by a wide variety of land uses. The most prevalent land use is single-family residential, with high-density residential (units less than 8,000 s.f.) being the most common type of residential development. The next largest is land used for transportation/utility/ communication uses, followed closely by vacant, industrial, and public land uses. All other land uses listed for the subwatershed are represented in the City by relatively smaller acreages (less than 1,000 acres). The City has one Priority Two MNFI site, which is located in the far northeast corner of the City. It also has seven Priority Three MNFI sites, scattered across the community.

The City has experienced a decline in population and the number of households between 1990 and 2000. This pattern is projected to change with an upswing projected over the next thirty years. Therefore, the household size is projected to decrease but at a slightly slower rate than that of most other communities within the subwatershed. In 2003 the City issued more residential building permits than almost all other communities within the subwatershed.

City of Rochester – Forty-eight percent of the community is contained within the Clinton Main Subwatershed. The largest land use is single-family residential, representing 33% of the subwatershed in this community. The next largest is vacant lands, followed by road right-of-ways. Other significant land uses within the subwatershed include industrial developments and recreation lands. A large Priority Two MNFI site is located along the Clinton River in the City.

Population in Rochester has grown steadily since 1990, representing a 47% increase over the past 10 years. This increase is predicted to continue, but at a slower rate. The number of people per housing unit is projected to stay the same over the next 30 years, the only community in the subwatershed where this is the case. Building activity in the City is healthy, with 238 building permits being issued in 2003, 45 permits for new construction.

City of Rochester Hills – Rochester Hills has a relatively large land area within the subwatershed, representing 20% of the entire subwatershed. (The subwatershed covers 46% of the community.) The primary land use is single-family residential, accounting for over 3,000 acres. The next largest land use is recreational land, much of which contains the main branch of the Clinton River or its tributaries. Road right-of-ways represent the third largest land use, followed by vacant and public lands. There are three large MNFI areas identified as Priority Two areas, two of which are located along the Clinton River main branch. Five Priority Three MNFI areas have also been identified throughout the community.

The population of the City has continued to rise over the past 10 years, increasing by 11%. SEMCOG predicts that the population will continue to increase over the next 30 years, and persons per household will

decrease. The number of building permits for 2003 was in the top three communities throughout the subwatershed. All building permits were for residential dwellings.

City of Sylvan Lake – In land area, Sylvan Lake is the second smallest community in the subwatershed, and all of its land is located within the subwatershed. Water is the largest land use in Sylvan Lake, representing 38% of the community. Residential development is similar, in that it covers 33% of the community. The next largest land use is road right-of-ways. The remainder of the community is made up of commercial and office uses, public and vacant lands, recreation areas and a small area of industrial development. These land uses are concentrated along Orchard Lake Road, while the residential land uses are concentrated near the lake. There are no MNFI sites identified in the City.

Unlike most other communities, the population of Sylvan Lake Village has decreased over the past 10 years, and is predicted to continue to go down. Persons per household are also predicted to decrease by 13% from 2.09 persons per household to 1.82 persons per household. Two building permits were issued in 2003, which is indicative of a built-out community.

Waterford Township – Waterford Township has 37% of its land area within the subwatershed. The most significant land use is single family residential developments. Thirty-seven percent of the subwatershed is devoted to single-family dwellings. The next most prevalent land use is water, which is the center of many subdivisions. Road right-of-ways and vacant property are also significant land uses. Commercial, office and a small amount of industrial land uses are clustered along the major thoroughfares such as Highland Road and Elizabeth Lake Road. There is also a large amount of public and recreational lands within the subwatershed, including Waterford Oaks County Park along Scott Lake Road. The Michigan Natural Features Inventory has identified the only Priority One MNFI site in the subwatershed, which is located on the very western boundary in Waterford Township. A good deal of this MNFI site is already included in recreation lands. There are also four Priority Two MNFI sites in the Township, as well as six Priority Three sites.

The population within Waterford Township is projected to be nearly constant between 2000 and 2030. The growth rate for the number of households is projected to increase slightly over the same time frame. Therefore, the persons per household should continue to decline. In 2003 the Township granted 176 residential building permits, a rate that is commensurate with several of the other communities within the subwatershed.

West Bloomfield Township – While only 18% of the Township is in this subwatershed, it potentially has a big impact on surface water quality since Cass Lake represents the largest land use (or 41%) of the community's land in the subwatershed. The next largest land use is single-family residential, followed by recreation lands and road right-of-ways. Within the subwatershed boundaries, the Township has very little commercial development, and no industrial development. There are two Priority Two MNFI sites, and four Priority Three sites in West Bloomfield. The Priority Two sites are contiguous with Waterford Township along a stream corridor.

The population in the Township has grown substantially since 1990, increasing by 19%. It is projected to continue growing to 2030, but at a much slower pace. Like other communities, the persons per household are going down, but at a slightly lower rate. Growth is still happening in the Township, which issued 188 building permits (all for single-family developments) in 2003. The number of building permits is similar to other townships within the subwatershed.

3.1.5 Planning Document Analysis

To help determine how well natural resources are currently being preserved and protected throughout the subwatershed, each of the six primary communities, and Oakland County and Oakland University evaluated their current planning documents, programs and practices using a checklist created by Oakland County Planning and Economic Development department, the Drain Commissioner's Office, and SEMCOG. (Note that checklists were not completed for Bloomfield Township, City of Lake Angelus, Orion Township, City of Rochester, Waterford Township or West Bloomfield Township. All of these communities are not "primary" participants in the Clinton Main Subwatershed). The checklist includes the following topics:

- ❖ Storm Water Management
- ❖ Impervious Surface Minimization
- ❖ Erosion and Sedimentation Control
- ❖ Wastewater Planning
- ❖ Open Space, Natural Areas, Native Vegetation and Community Greenways
- ❖ Wetlands and Woodlands Preservation
- ❖ Riparian Lands: Stream Corridors and Floodplains
- ❖ The Development Review Process
- ❖ Groundwater and Wellhead Protection
- ❖ Public Education

Because this is a checklist, the evaluation below cannot be a qualitative evaluation. A "Yes" to the same question across communities may not mean they have the same level of protection. For instance, asking whether or not "the community requires or encourages preservation of a natural drainage pattern to the greatest extent possible" could mean they have a simple statement in their site plan review criteria to this effect, or this statement could be backed up by a series of standards and guidelines for preserving natural drainage patterns. Therefore all "yes's" may not necessarily mean the same thing across communities.

One limitation of this questionnaire is that it is unclear (unless the community offers an explanation in the "Comments" column) whether protection mechanisms are "required" or "encouraged." While communities may be quite successful in convincing developers to create designs that meet the communities' desires for environmental protection, the developer is under no legal obligation to do so unless the idea or concept has been translated into a requirement under site plan review. Planned Unit Developments (PUDs), and other similar planning tools are the exception, as under this mechanism, the community has the discretion to ask for additional items that are not expressly required under the zoning ordinance.

The following summarizes the checklist evaluations, and provides comments on where each community may be able to strengthen their protection of environmental resources.

City of Auburn Hills – Responses to questions about the Master plan show that the City recognizes the importance of wetlands, woodlands, and riparian areas, giving them a policy basis upon which to build their zoning regulations about these topics. Issues where the City could add policy/goal statements include storm water quality and quantity, impervious surfaces, erosion control, and open space preservation. It is important to talk about these issues in the community's Master Plan to create a defensible position for development regulations.

One specific area that could benefit from additional discussion in the City's Master Plan is providing open space on private properties, and how these can be connected to publicly-owned open spaces. Inclusion of the MNFI data into this discussion will also support the City's open space vision. Another important topic for both the Master Plan and zoning ordinance is storm water management options for re-development proposals. The City is nearly built out, and it will most likely receive more re-development proposals in the future than proposals for development on previously undeveloped property. While the storm water quality and quantity standards may remain the same as for new development, solutions to reach these standards may be different for re-development. The City is planning to expand and update its current Master Plan within the next few years. This provides it with an opportunity to evaluate these topics and make decisions about the City's vision on these issues for the future.

Auburn Hills has many ordinances, standards and guidelines that protect natural features during development or re-development. Their planning documents discuss protection of wetlands, woodlands, and riparian buffers from development impacts. They also discuss waterway protection by prohibiting direct discharge, preserving natural drainageways, and providing specific design and performance standards for storm water. The City is almost completely sewerred, and is on Detroit's water system, therefore minimizing the impacts of septic systems and reliance on drinking water wells. While drinking water is not an immediate issue, the City is also encouraging brownfield redevelopment, which ultimately protects groundwater from contamination. It has also been participating in the Rouge River Phase II efforts for the Main 1 and 2 subwatersheds, distributing educational materials to its residents.

One area where ordinances could be expanded consists of requiring BMPs that treat storm water through infiltration into the ground. Such facilities could include drainage swales, or infiltration areas (uplands) planted with deep-rooted plants. Another is requiring visually attractive storm water ponds that emulate natural ponds. Natural ponds with native vegetation improve water quality considerably through biological processes, unlike dry ponds planted in turf grass. Lastly, reducing impervious surfaces is key to helping control storm water quantity. The City currently requires that every development have at least 20% in green space. However, this standard alone could allow substantial imperviousness across the community. There are many new technologies available to create pervious surfaces in addition to green space, such as pervious pavements, bio-retention areas, and green roofs. An ordinance that outlines how reductions in imperviousness could be achieved should be considered.

City of Keego Harbor – While the Master Plan does not address most of the topics outlined in the checklist, many statements in the “comments” column indicate that the City would be willing to or is considering many of these topics for future discussion. The checklist topics may not be addressed because the community is almost completely built out, and does not have many of the natural resources listed in the checklist. The Recreation Master Plan does talk about the importance of open space in City parks, and has inventoried and mapped community greenways/open space, as well as discuss implementation for the greenway/open space plan.

In light of Phase II, it is recommended that the community consider adding background information, policies and goals to the City's Master Plan for the following topics: storm water management quality and quantity, impervious surface minimization for re-development projects, erosion and sedimentation control, riparian (stream and lake side) buffer restoration, and elimination of direct discharge of storm water into the lake.

The City's PUD ordinance addresses several topics in the checklist, including allowing open space/cluster design options and linking open space with adjacent open spaces. The City's site plan review process has

also been successful in achieving the use of native vegetation, providing flexible parking designs, and replacing trees removed during construction. Ordinances, guidelines and standards could be added to include the following topics. Re-development projects should also be considered when looking at adding regulations to address the following concepts:

- ❖ Best Management Practices (BMPs) to improve infiltration of storm water
- ❖ Maintenance agreements for BMPs
- ❖ Design and performance standards for BMPs.
- ❖ Additional details for greenway/open space planning such as preservation priorities (private and public lands), timetable for implementation, long-term management, and relationship with a land conservancy.
- ❖ Natural feature protection (tree and wetland protection; riparian corridor and adjacent uplands), possibly through a natural feature overlay district.
- ❖ Add review criteria designed to protect natural features in the site plan approval process.

Oakland County – Oakland County is made up of several agencies including the Drain Commissioner, Road Commission, Health Department, Planning and Economic Development Department, and Oakland County Parks. Each agency has jurisdiction over different areas included in the checklist. For example, the Drain Commissioner has jurisdiction over storm water management if a community chooses to use the County's Drainage Design Standards, or if the storm water drains to a County drain. The Road Commission has jurisdiction over public roads, and the Health Department has jurisdiction over on-site sewerage disposal systems throughout the County. Oakland County Parks manages Waterford Oaks, the only County Park within the subwatershed. Any development at the County's campus or in the County Park is regulated by ordinances, guidelines and standards adopted by Waterford Township and the City of Pontiac.

Another group of Oakland County divisions also has input about storm water practices. In November, 2003, the Oakland County Stormwater Committee (OCSC) was formed under the direction of the Drain Commissioner's Environmental Unit staff to bring Oakland County into compliance with their Phase II permit. This group is made up of the departments listed above, plus the offices of the Oakland County Executive, Facilities Management, Waste Resource Management Division of the Community and Economic Development Department, Central Services, and the departments of Aviation and Transportation, and Information Technology. The group has been working to define the existing and needed programs that will meet the permit requirements and provides input on the materials submitted to MDEQ for Phase II compliance. It also promotes Best Management Practices (BMP's), open space, and natural area preservation on all County-owned lands.

The Drain Commissioner's Drainage Design Standards cover many of the checklist's points, including preservation of natural drainage patterns, requiring full design specifications in a site plan, using BMPs to improve infiltration of storm water, prohibiting direct discharge of storm water without pretreatment, and BMP maintenance agreements and performance standards. Areas that the Drainage Standards do not address include design standards for storm water BMPs relating to specific "c" factors, and guidelines to make storm water facilities visually attractive with improved functionality. These areas could be considered for addition to the Design Standards. Erosion control permits are also available through the Drain Commissioner, and the permit standards include all topics in the checklist for erosion and sedimentation control.

The Health Department's standards for installation of on-site sewerage disposal systems requires at least a 50' isolation distance between septic systems and water features. The checklist identifies a 100' isolation distance as being preferred. In addition, the Health Department inspects a new septic system when it is installed, or if they have received a complaint about a system. They do not require regular maintenance and inspections of septic systems otherwise.

The checklist items relating to open space and natural area preservation are generally covered by the Parks Department and relate to property already owned by Oakland County Parks. However, the Oakland County Stormwater Committee also promotes preservation of open space and natural features in the course of its work. Through the Parks Natural Areas Program, they have a park master plan that includes goals and policies for natural area preservation, and recognizes the importance of native vegetation. The plan also inventories and maps corridors for an interrelated network of open space, and prioritizes areas for preservation within the park. The Natural Areas Program also integrates MNFI information into its plan, provides for long-term management of the parks, and has a working relationship with local land conservancies. The Natural Areas Program could go further by including watershed information in their plan. Another important step would be to include information about adjacent community or regional greenways, and work with these communities to implement their greenways that connect to County parks.

Lastly, Oakland County Planning and Economic Development Services (OCPEDS) provides communities with information on planning topics and assists them in developing planning tools, including Geographic Information Systems (GIS) data and mapping services. The open space/natural area portion of the checklist indicates that OCPEDS encourages communities to link open spaces with adjacent open spaces when reviewing development plans, and also encourages protection of open spaces in developments through conservation easements or other mechanisms.

Oakland University – While Oakland University is not subject to local zoning regulations, they manage a considerable amount of property within the subwatershed and have developed a Physical Master Plan. The University's Master Plan outlines future projects that the University will undertake to support its academic mission, and provide for managed growth to the year 2020. And like a community master plan, this document includes Oakland University's approach to land development, as well as specific projects. The Plan provides goals and policies for the preservation of natural areas and open space, discusses the local watershed, and recognizes the importance of long-term stewardship of natural areas. They have also prioritized areas for preservation, inventoried these areas, and mapped them. The Plan includes an inventory of wetland and woodland functional values, and encourages woodland and tree protection, as well as provides for a natural feature setback.

One area that the Plan does not discuss is storm water quality and quantity that is generated by the University. A design for sediment forebays adjacent to the lake in the main area of the campus points in the direction the University is willing to go to protect water quality. However, there are many other areas on campus where direction for future improvements could be provided by the Plan. This discussion could also include goals and policies to restore steep banks and reduce erosion within drainageways. Another important topic is reduction of impervious surfaces throughout the campus. Being primarily a commuter school, there is a great deal of surface parking and parking structures. Goals and policies to reduce the impact of these surfaces, through new technology such as pervious pavements, bio-retention areas, or green roofs could be added to the Plan. Improvements in infiltration of storm water could also be considered as a solution to some of the issues mentioned above.

The University is completing a detailed study of storm water issues on its campus, identifying quantity and quality concerns. The report makes recommendations on:

- ❖ Correction of illicit discharges
- ❖ Correction of flooding, erosion and sedimentation
- ❖ Restoration of water features
- ❖ Creation of off-line detention
- ❖ Operation and maintenance practices
- ❖ Changes in development practices

Orchard Lake Village – The Village discusses many of the checklist topics in their Master Plan. Storm water management quality/quantity, the importance of open spaces and native vegetation, open space management, the watershed, wetlands, woodlands, and riparian area protection are all included in the Master Plan. It is important to talk about these issues in the community's Master Plan to create a defensible position for development regulations.

Topics that are not mentioned in the Master Plan include erosion and sedimentation control efforts, minimizing impervious surfaces, and groundwater protection. The community is almost completely built out, and is served by sewer and water systems. This eliminates some risks of groundwater contamination. It is recommended that the Village consider including some information about the importance of minimizing impervious surfaces and ways to minimize them in their Master Plan. Because of the Village's current development status, these regulations would be preparing the community for potential re-development proposals.

Similar to the Master Plan, the ordinance topics are also well covered by the Village. Additional storm water management concepts that could be considered include requiring full storm water design specifications in site plans, encouraging BMPs that improve a site's infiltration, and requiring maintenance agreements for BMPs. While some topics under the impervious surface category are covered in the Village's ordinances, allowing for facilities within parking lots to enhance infiltration, and making the parking requirements more flexible could reduce impervious surfaces within the community. The Village's open space planning includes most topics listed, except for a greenway plan. This may not be necessary, as the community already has a portion of a Regional Greenway within its boundaries. The other sections of the checklist show that the Village provides for the recommended items.

City of Pontiac – The City's Master Plan discusses several important topics on the checklist, including open space, wetland and woodland preservation. The document could be expanded to include the City's approach to storm water quality and quantity, although some storm water planning has been accomplished through Pontiac's involvement in the Rouge River watershed plan, and the Pontiac Creek Watershed Management Plan. The City is currently updating the Pontiac Creek plan, and has an Illicit Discharge Elimination Plan (IDEP) project for this watershed. Other goals that could be added to the Master Plan could include impervious surface minimization, erosion and sedimentation control, watersheds, the use of native vegetation, open space management, wetland and woodland inventories and assessments, riparian (stream and lake side) preservation, and groundwater protection. This last topic may not seem as relevant for the City, as it is served by the Detroit water system. However, groundwater protection is critical to the health of all natural surface water systems within the City, as rivers and lakes can be fed by groundwater. Pontiac currently does not have a greenway plan per se, but it does have a Rail-to-Trail pathway connecting the City to Kensington Metro Park.

Storm water management is covered by the City's ordinances by calling for preservation of natural drainage patterns, discouraging direct discharge to surface waters, and including design standards for specific "c" factors for storm water. These regulations could be strengthened by requiring full details of storm water facilities during site plan review, the use of BMPs that increase infiltration of storm water, maintenance agreements for BMP facilities, storm water performance standards, and design guidelines for making storm water facilities more aesthetically attractive while increasing their functionality. Pontiac is probably the most densely developed community within the subwatershed. For this reason, it is also most likely to be the community with the most impervious surface. A few mechanisms that could be used to reduce imperviousness is the use of infiltration BMPs in parking lots, or allowing setbacks and lot frontages to be reduced to minimize the amount of pavement necessary in new developments. The City should also look at ways that storm water infiltration could be retrofit into urban areas, or included in re-development projects.

Another closely related subject is reducing the amount of storm water. Many communities have had success in disconnecting downspouts to storm water facilities, drastically reducing the amount of runoff that enters the system. Another consideration is that the City currently does not have a wetlands ordinance, nor does it have tools to protect riparian zones (except floodplains). Protection of these two features could be combined to improve the quality of water coming off of properties adjacent to streams and lakes. Concepts such as variable building setbacks or naturally vegetated buffers could be used among other protections. The City could also work with riparian land owners to educate them about water quality, and ways in which they can manage their property to help protect this natural asset.

City of Rochester Hills – The City's Master Plan includes many of the topics in the checklist. The document has goals relating to storm water quality and quantity, erosion and sedimentation control, importance of natural areas and open space preservation, and wetlands and woodlands preservation. They are working to add goals for riparian area protection, and are considering adding a discussion on groundwater protection. Areas that could be considered in the future include minimizing impervious surfaces, and wastewater planning.

Like the Master Plan, the City's ordinances also cover a large number of topics included on the checklist. Recommended additions to the storm water regulations include preservation of natural drainage pathways and existing vegetation on development proposals, and guidelines to create visually attractive and more effective storm water facilities. Another area where improvement could be made includes regulations about minimizing impervious surfaces. Since the City is close to build-out, these regulations would be preparing the City for re-development proposals and potential urbanization along major thoroughfares. Wastewater planning and groundwater protection are other topics that the City may want to consider in their regulations. Currently, the City only has 5% of its properties being serviced by septic systems, and 20% by drinking water wells. However, if the septic systems are old, or are not maintained properly, they could be a significant source of ground and/or surface water contamination. Regular maintenance and inspection of septic systems are very important to their proper functioning, and is an important reason to consider some kind of septic maintenance program.

City of Sylvan Lake– Sylvan Lake addresses a number of checklist items in their Master Plan, including storm water quality and quantity, the importance of natural areas and open space, woodlands, and groundwater. It does not address wetlands, as the City has no wetlands. In addition, wastewater planning is covered in other policies. The City is currently 100% sewerred, and has no septic systems. Topics that could be considered for the Master Plan include minimizing impervious surfaces, erosion and

sedimentation control, and protection and/or restoration of riparian (stream and lake side) areas. This last topic is of particular importance, since the lake and the quality of its water, is paramount to the community. However, it will require a creative approach to implement this concept.

The City is currently working on a relatively new approach to storm water quality. It is drafting a fertilizer ordinance which will regulate the kinds and amounts of fertilizers to be used on lawns. Rather than try and filter the excess nutrients out of storm water before it reaches the lake, the City is working to reduce the amount of fertilizers placed on lawns in the first place. Other ordinances cover storm water management and minimizing impervious surfaces. However, the City could strengthen these rules by adding guidelines, or even public education materials, on how storm water can be directed to infiltration areas, such as rain gardens. The City is built-out, so approaches to storm water need to retrofit into the existing environment, or work in re-development proposals. Another effort underway by the City is identifying, mapping and planning for a network of open spaces within the City. An important idea to consider in this effort is how these open spaces will connect with adjacent open spaces in neighboring communities. Lastly, the City should consider some protection mechanism for woodlands and/or trees within its boundaries.

3.1.6 Planning Summary of the Subwatershed

Overall Results

Based on the community profiles, land use trends, and level of current development, several checklist items came forward as the most important challenges for this subwatershed. Beginning with the planning documents, all subwatershed communities were lacking Watershed Management Plans. Fortunately, the communities represented by this plan (primary and secondary) are all currently involved in one or more watershed planning efforts.

Another main topic that should be considered is impervious surface mitigation and infiltration enhancement. None of the subwatershed communities mention the impact that impervious surfaces have on water quality in their Master Plans, nor have ordinances to control or reduce the amount of impervious surfaces. New goals and policies should be added to Master Plans to address these concerns through site specific techniques such as French drains, disconnecting downspouts, rain gardens and barrels, among others. An impervious surface ordinance should also be added to regulate new development, but more importantly, address redevelopment proposals.

Because this subwatershed has a considerable amount of river/stream front and lakefront property, community efforts should be directed at creating riparian buffers of native vegetation along these shorelines. Goals and policies should be adopted to ensure that public riparian property is protected and, if necessary, revegetated as much as possible to demonstrate the positive benefits of riparian vegetation on water quality. As importantly, Master Plan goals and zoning regulations (through Natural Features Setbacks for example) should be used to protect existing riparian vegetation within each community.

A relatively easy, but important, addition to local plans and codes is encouraging the use of native plants in landscaping. This one element is an important feature of reducing the amount of storm water (through improved infiltration), and providing vegetative buffers to lakes and streams. While communities cannot require the use of native vegetation, they can demonstrate the aesthetic qualities of these plants on municipal properties, and educate property owners about the benefits native plants provide.

Checklist Summary

Checklist responses from the eight communities, the County and University were compiled, and “Yes” and “No” responses tallied. The compiled results are shown in Appendix E Clinton Main Subwatershed Planning Evaluation. Responses such as “Yes/No,” and “Not Yet” were tallied in the “No” column, and responses such as “In Process” or “Soon” were tallied in the “Yes” column. The “Other” column received any additional responses, including “N/A.” Questions that received a count of five or more “Yes” responses were considered areas where the subwatershed had strong planning tools for protecting water quality. Questions that received a count of four or less “Yeses” were considered areas that needed attention. (Note that while the subwatershed may be strong in a particular area, this shouldn’t preclude an individual community from adopting Master Plan or ordinance language in this area to further strengthen their own community’s planning documents.) Also note that not all questions apply to all communities/organizations, which is taken into consideration in the following discussion.

1) Community Snapshot.

Strengths: The majority of communities have plans for the following topics:

- ❖ Natural Areas/Open Space/Greenways
- ❖ Recreation
- ❖ Storm Water Management
- ❖ Wastewater
- ❖ Public Education

The following ordinances, guidelines and standards were also well represented throughout the subwatershed:

- ❖ Storm Water Management
- ❖ Cluster Developments
- ❖ Wetland and Woodland Protection
- ❖ Flexible Parking Requirement Standards
- ❖ Structural Best Management Practice (BMPs) Standards
- ❖ Criteria for Site Plan Review.

Challenges: In general, watershed management plans are not yet part of most community’s planning documents. The other plans shown below may or may not apply to all communities throughout the subwatershed, and may be the reason why few of the subwatershed communities have these types of plans:

- ❖ Watershed Management
- ❖ Wellhead Protection (This is understandable, since almost all communities are on the Detroit Water system through the Detroit Water and Sewerage Department (DWSD))
- ❖ Illicit Discharge Elimination (Also understandable, since most of the communities are starting the Phase II process with this watershed planning effort)

The following ordinances/guidelines/standards are not used a great deal throughout the subwatershed:

- ❖ Impervious Surface/Infiltration
- ❖ Natural Features Setback
- ❖ Resource Protection Overlay District
- ❖ Native Vegetation
- ❖ Flexible Private Road Standards
- ❖ Native Vegetation Practice Standards

2) Storm Water Management.

Strengths: Most communities report that they have done some kind of storm water management planning, although not necessarily as part of their Master Plans. Oakland University has recently adopted a storm water management plan. The policies of most communities call for preservation of existing drainage pathways, require full design details of storm water facilities for site plans, discourage or prohibit direct discharge of storm water to surface water without pretreatment, and have BMP design standards.

Challenges: Some communities do not discuss the community's goals/policies regarding storm water in their Master Plans. In ordinances, most communities do not call for improvements to a sites infiltration potential, nor require maintenance agreements for storm water BMPs. In addition, engineering standards do not include performance standards, nor require that storm water ponds be constructed to increase treatment of pollutants through contouring and use of native plants.

3) Impervious Surface Minimization.

Strengths: This topic is a relatively new concept in planning, and is not typically used in most communities yet. However, it may become more important, and typical, as communities move to higher water quality standards. As of now, most subwatershed communities do have several mechanisms that tend to reduce pervious surfaces. Most communities have minimum required pavement widths to support travel lanes and other roadway uses. The same number provide flexibility in their parking requirements to avoid excessive pavement.

Challenges: Because this is such a new topic, it has not been included in the planning documents of the subwatershed communities. However, it is an approach that could greatly influence the quality of surface waters in the future. First, communities should consider including goals and policies about impervious surfaces in the community's Master Plan. As mentioned above, this will provide the basis for new zoning regulations. One possible technique for communities with most redevelopment proposals is to require some portion of parking facilities be dedicated to increasing infiltration of storm water. For communities that still have undisturbed areas that will be developed, they should incorporate ways to relax side yard setbacks and allow narrower frontages to minimize the amount of roadway necessary to serve a development, among other infiltration techniques.

4) Erosion and Sedimentation Control.

Strengths: All checklist participants have strong soil erosion regulations. This may be the case because they use the County Drain Commissioner's standards. In any event, they all require soil erosion control measures to be in place before construction begins, as well as require maintenance and monitoring of these systems.

Challenges: Few communities include soil erosion and sedimentation control as a topic in their Master Plans. Goals and policies about soil erosion should be included to further minimize the problem of sedimentation in water bodies.

5) Wastewater Planning.

Strengths: Wastewater planning was not well represented in most communities' Master Plans.

Challenges: Most communities within the subwatershed are almost completely sewered and served by the regional waste water treatment authority. The questions asked in the checklist discuss sewered and unsewered areas, and soils capable of handling septic systems. It is somewhat understandable that most answered “no” or “N/A” to these questions. However, discussing the condition, maintenance, and replacement of current sewer facilities should be included in a community’s Master Plan.

6) Natural Areas/Open Space/Native Vegetation and Community Greenways.

Strengths: Most Master and/or Park Plans recognize the importance of natural areas and open space preservation. Many have or are working on inventorying and mapping potential corridors to create an interrelated network of mixed public access and natural area habitats. The plans also recognize that long-term stewardship and management of these areas is important. Development and redevelopment regulations require linking adjacent open spaces together, using conservation easements or other mechanisms to protect privately-held open spaces, and allow open space or cluster design options.

Challenges: Current watershed and native vegetation information and policies need to be added to most Master Plans, particularly in light of Phase II and the background information that should be in place to support storm water regulations. Greenway or open space plans as a way to identify and prioritize protection of natural areas, both private and public, are not being used to a great extent. The MNFI information is also not used in planning documents to identify important natural areas.

7) Wetlands and Woodlands Protection.

Strengths: Most communities call for protection of wetlands and woodlands in their Master Plan documents. In addition, most communities have a woodland/tree ordinance, require replacement of trees that are removed during construction, and have site plan criteria relative to wetlands, woodlands, and landmark trees.

Challenges: While most communities want wetlands and woodlands to be protected, the importance of these natural features within an ecosystem context is not included in most Master Plans. The features themselves are important, but how they interact with the surrounding ecosystems to continue functioning is generally not discussed. Also, most communities do not have a wetland or woodland inventory of their community, nor have they identified the functional values that these natural systems provide. Another area for growth is protection of wetlands below the state’s protection criteria (five acres).

8) Riparian Lands: Stream Corridors and Floodplains.

Strengths: The strengths under this category include participation in water quality monitoring activities, restrictions on clearing within floodplains, and requiring a minimum setback from water features. Most communities include these activities in their planning documents.

Challenges: There is room to further advance the basic riparian protections mentioned above. Most community Master Plans could talk about riparian vegetation protection (including protection of lakeshore vegetation). They could also provide development regulations that protect adjacent steep slopes, or uplands next to streams or lakes, and the existing native vegetation within the riparian buffer. Riparian areas could also be better protected by allowing a flexible setback based on the sensitivity of the natural feature, or implementing an overlay district to protect stream corridors and lakeshore areas.

9) Development Review Process.

Strengths: The subwatershed is strong in requiring preapplication meetings before the site plan review process begins. Most communities within the subwatershed also require that all natural features be shown on the site plan. Another positive trend is that most communities require sufficient detail of storm water BMPs to allow a proper review for effectiveness.

Challenges: The subwatershed as a whole could strengthen their protections in this area by having site plan review criteria or standards from which to assess whether or not each development proposal is sufficiently protecting natural resources.

10) Groundwater and Wellhead Protection.

Strengths: This category was not well represented by community planning documents.

Challenges: Most communities answered the questions in this section by providing a “No” or “N/A.” This may be because almost all residents within the subwatershed are serviced by the Detroit water system, and very few people depend on wells. However, groundwater feeds surface water features, such as streams and lakes, all year around. In fact, groundwater is an important source of water for these features during dry spells. Therefore, groundwater is an important resource to consider even if residents aren’t drinking it directly. The subwatershed can address groundwater by improving infiltration of storm water, and by ridding their communities of potential groundwater contaminants. Both of these activities will have a positive effect on stream and lake water quality.

11) Public Education.

Strengths: The subwatershed faired very well in this category. Most communities are already delivering environmental protection and water quality messages to their residents, and coordinate with other organizations (watershed councils, etc.) to distribute this information. Currently, the subwatershed communities have partnered with the Clinton River Watershed Council to provide written communication pieces, presentations, cable messages, and opportunities for resident participation in water quality monitoring and river awareness activities.

Challenges: A few communities that don’t currently educate their residents could begin by fulfilling the Public Education Plan of the Phase II process.

3.1.7 Recreational Opportunities

Recreational land within the Clinton Main Subwatershed comes in many types and uses. They range from school property to private parks and golf courses to state parks. Approximately 15% of the Clinton Main Subwatershed is designated parks and/or institutional.

Recreational land affords opportunities for citizens to enjoy outdoor activities as well as provide desired green space for wildlife habitat. Recreational land along with wetlands, woodlots and other undeveloped spaces provide the linkages throughout the watershed for wildlife to move and live in as well as provide buffers and natural filters for our rivers and creeks.



Trail Signage

Recreational Types

To understand the influence of recreational land within the subwatershed it's important to understand the composition of recreational types. Map 7 Recreational Opportunities and Table 3.4 demonstrate the percentage of recreational land types based on ownership within the subwatershed.

Table 3.4 Ownership of Recreational Land

Property Ownership	Percentage
Oakland County	2%
Educational Facility	43%
Multi-Jurisdictional Trail Land	2%
Local Municipality	38%
State of Michigan (Other than school property)	2%
Private Ownership	12%

The largest recreational type is Educational Facility and includes all public and private schools, along with Oakland University. The next largest is the Local Municipality Ownership with 38% of the holdings. This percentage comparison demonstrates that besides Educational Facilities, the individual communities hold the most recreational land with the state, county and private ownership holding a considerable amount less. The county owns land such as Waterford-Oaks County Park, while private ownership would include homeowner association maintained parks or businesses such as The Palace of Auburn Hills.

Community Recreational Opportunities

After understanding the types of recreational land within the subwatershed it is important to see the dynamic of individual community land holdings. There should be a natural curve between the size of the community and the percent of total recreational land.

Table 3.5 Percent Recreational Land in Each Community

Community	% of Community in Clinton Main Subwatershed	% Recreational Land
Auburn Hills	19%	16%
Keego Harbor	1%	1%
Village of Lake Angelus	1%	1%
Orchard Lake Village	4%	7%
Pontiac	25%	21%
Rochester	2%	3%
Rochester Hills	19%	32%
Sylvan Lake	1%	5%
Waterford	18%	14%
West Bloomfield	8%	5%

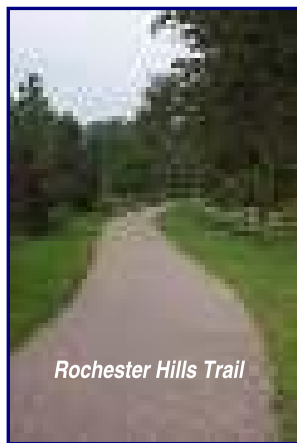
As demonstrated in Table 3.5, the communities with larger Clinton Main subwatershed land area have a larger percentage of the total recreational land. This is a sign of good distribution of recreational land within the subwatershed as a whole. Map 7 shows the distribution of the recreational land throughout the subwatershed. It can be seen that recreational lands are distributed considerably evenly.

Some example parks located within the Clinton Main identified from the Clinton River Watershed Council website (www.crw.org) and described here include the following:

Waterford-Oaks County Park is located in Waterford Township and is the headquarters of the Oakland County Parks and Recreation Commission and Administration for the parks system. This 153-acre park offers multiple recreational opportunities.



Riverside Park is located in Auburn Hills this park features picnic pavilions, a children's play structure, and canoe launch.



Rochester Hills Trail

Bloomer Park is located in Rochester Hills and includes picnicking shelters, a playground, mountain biking, hiking and cross country skiing trails, a toboggan run, horseshoe pits, multi-purpose sports fields, and sand volleyball courts.

Helen V. Allen Park is located in Rochester Hills and offers two softball diamonds and playground equipment.

Orchard Lake Nature Sanctuary is located on Pontiac Trail on the west side of Orchard Lake Village. It is a 50-acre preserve of high quality natural areas with views of both Orchard Lake and



Park Signage

Upper Straits Lake.

Pontiac City Beaudette Park is located in Pontiac and features boat launching, a fishing pier, tennis and horseshoe courts, a lighted softball diamond, picnic sites and a children's playground.

River Woods Park is located in Auburn Hills this park offers facilities for picnicking and canoeing and a pier for fishing.

Marshbank Park is located in West Bloomfield on Cass Lake, the park offers picnicking, a wildlife area, shelters, hiking, scenic views and children's play areas.

Yates Roadside Park is located across from Yates Cider Mill in Rochester Hills and features a scenic turnout, picnic areas, and Clinton River access for fishing and boating.



Educational Signage

Additional recreational opportunities, including boat launch sites, canoeing stretches, cold water and warm water fishing stretches, nature centers, land conservancy holdings, riverfront trails, public swimming beaches, mill sites and public golf courses may be found by visiting www.crw.org.

3.1.8 Sanitary Sewer Service Areas

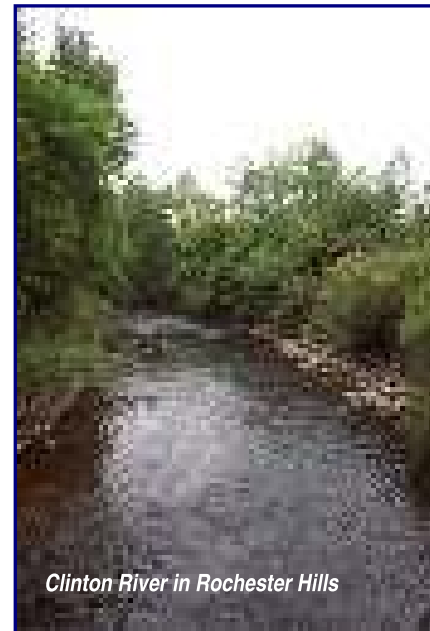
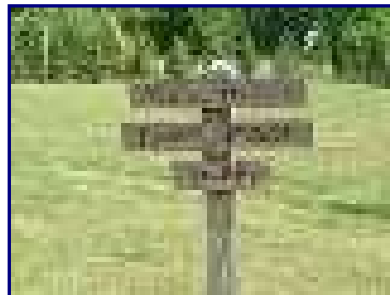
Within the Clinton Main Subwatershed, wastewater is managed either at wastewater treatment plants or within privately owned on-site sewage disposal systems (OSDS) (also referred to as septic systems). Sanitary sewers within each community transport wastewater to wastewater treatment plants as opposed to treating wastewater on privately owned property in OSDS. Thus, the existence of sanitary sewers within local communities provides opportunities to eliminate failing septic systems and potential sources of nonpoint source pollution, including bacteria and nutrients.

Map 8 shows the sanitary sewer service areas within the Clinton Main Subwatershed. This figure demonstrates that the majority of the subwatershed is currently sewered and there is a low percentage of OSDS throughout the subwatershed.

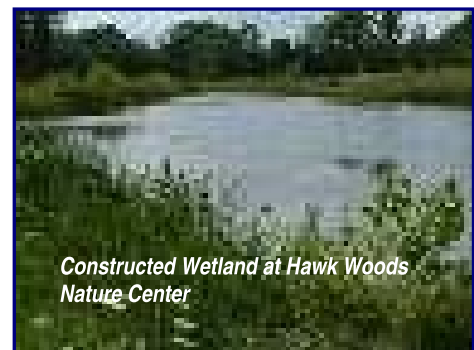
3.1.9 Tours of the Subwatershed

An important component of watershed planning efforts includes gaining insight to high priority restoration or preservation areas from the individual subwatershed representatives. Representatives, including community, county, school district and watershed council staff, have the most thorough knowledge of priority areas in their jurisdictions and this information, combined with the watershed data, translates into defining critical areas within the subwatershed. It is for this reason that individual subwatershed tours were conducted with various municipal staff to further expand knowledge of the subwatershed. Tours included the following subwatershed participants:

- ❖ Auburn Hills;
- ❖ Keego Harbor;
- ❖ Oakland County;
- ❖ Oakland University;
- ❖ Orchard Lake Village;
- ❖ Pontiac;
- ❖ Rochester Hills; and
- ❖ Sylvan Lake.



Clinton River in Rochester Hills



Constructed Wetland at Hawk Woods Nature Center

Auburn Hills

The City of Auburn Hills is located near the center of the Clinton Main subwatershed. The portion of the Clinton Main subwatershed located within the City of Auburn Hills consists mainly of industrial (80%) and residential (20%) land uses.

Eighty-four percent of the City, or 9,040 acres, is contained within the Clinton Main subwatershed. In addition, the City makes up 19% of the subwatershed's total land

area. The predominant land use is industrial (1,860 acres), which is located throughout the community, but primarily along Lapeer Road and I-75. Auburn Hills has the most industrial development (as percent of the community land area) within the subwatershed. Although The City of Auburn Hills has the most industrial development within the subwatershed it does hold 1,101 acres of public and/or private recreational land. Within the subwatershed, Auburn Hills contains 16% of the recreational land.

Several areas of riparian wetland mitigation have been developed with the City of Auburn Hills, helping to increase pollutant uptake and improve overall water quality within the subwatershed (including the constructed wetland located at Hawk Woods Nature Center). In addition, several areas of river corridor have been or are being improved through the implementation of streambank stabilization projects.

Specific issues and areas of concern include the following: areas in need of streambank stabilization, general flashiness of the Clinton Main within the community, erosion problems at roadside storm sewer outfalls, sedimentation within the river, detention basins lacking maintenance and vegetated buffers, and several areas of frequent flooding (within subdivisions near Tienken and Squirrel Roads). Table 3.6 and Map 9 Subwatershed Tour Sites show the sites visited with community representatives and also highlights many of the concerns described previously.

Table 3.6 Auburn Hills Community Tour Sites

Site Number*	Community	Location	Description
AUB01	Auburn Hills	Auburn Road	Streambank erosion
AUB02	Auburn Hills	Auburn Court	Siltation and erosion
AUB03	Auburn Hills	River Woods Park	Streambank enhancement opportunity
AUB04	Auburn Hills	Volkswagen Headquarters	Direct storm water discharge
AUB05	Auburn Hills	Tienken and Squirrel Roads	Wetland mitigation area
AUB06	Auburn Hills	Hawk Woods Nature Center	Wetland mitigation Area
AUB07	Auburn Hills	Riverside Park (Auburn and Squirrel Roads)	Streambank erosion

*Site Number corresponds to locations identified on Map 9

Keego Harbor

Keego Harbor is located in central Oakland County and is referred to as the "Lakes Area." It is situated primarily on the southeast side of Cass Lake. Keego Harbor is located on the southwest side (upstream end) of the Clinton



Main subwatershed and is the fourth smallest community in population within the subwatershed, and the smallest in land area. One hundred percent of the City's land area (360 acres) is contained within the

subwatershed. The highest land use type within the community is single family, followed by transportation/utility land uses, and then water. The remainder of the community is comprised of commercial, vacant, multi-family and 35 acres of recreation/conservation uses.

Specific issues and areas of concern include properly managing direct storm water discharges to Cass Lake along Cass Lake Road. In addition, there are direct storm water connections from impervious areas such as parking lots entering other water features. A pump station along Cass Lake Road (near Cass Lake Manor Apartments) pumps storm water runoff from Cass Lake Road directly to Cass Lake during large storm events. Table 3.7 and Map 9 show the sites visited with community representatives and also highlight many of the concerns described previously.

Table 3.7 Keego Harbor Community Tour Sites

Site Number*	Community	Location	Description
KH01	Keego Harbor	W. side of Cass Lake (Portman Street)	Direct storm water runoff to Cass Lake
KH02	Keego Harbor	W. side of Dollar Lake	Direct storm water drainage to Dollar Lake
KH03	Keego Harbor	Cass Lake Road (near Cass Lake Manor Apartments)	Pump station directs street drainage directly to Cass Lake during large rain events
KH04	Keego Harbor	Cass Lake Road	Dam between Sylvan and Cass Lake

*Site Number corresponds to locations identified on Map 9

Oakland County

Oakland County is the third most affluent county in the United States and the fastest growing county in Michigan. Oakland County houses facilities for nearly 200 Fortune 500 companies, including five world headquarters. More than 400 internationally owned companies also are located within the County. Oakland County's rolling hills, wetlands and woodlands provide beautiful neighborhoods and plenty of year-round recreation. The surrounding community also offers an abundance of entertainment, cultural and other social opportunities.

Priorities for the community include the following:

- ❖ enhanced focus on environmental and water resources stewardship;
- ❖ continued management of storm water on the Waterford Oaks City Park Headquarters and Road Commission properties;
- ❖ development of no-mow and native buffer zones within the County Campus;
- ❖ construction of wetland mitigation areas within the campus for use in future Road Commission projects; and
- ❖ using the recently completed native plant garden on the Campus property as a demonstration and model for construction of future Oakland County native plant gardens and buffers.

Table 3.8 and Map 9 show the sites visited with community representatives and also highlights many of the concerns described previously.

Table 3.8 Oakland County Tour Sites

Site Number*	Community	Location	Description
OAKCNTY01	Oakland County Campus	Waterford Oaks City Park Headquarters	Existing “no-mow” zones
OAKCNTY02	Oakland County Campus	Waterford Oaks City Park Headquarters	Existing “no-mow” zones
OAKCNTY03	Oakland County Campus	Oakland County Road Commission Headquarters	Continued stormwater management
OAKCNTY04	Oakland County Campus	DPW Salt Storage Building	Continued stormwater management
OAKCNTY05	Oakland County Campus	Oakland County Parks Commission	Possible no-mow areas
OAKCNTY06	Oakland County Campus	Oakland County Parks Commission	Possible no-mow areas
OAKCNTY07	Oakland County Campus	County Childcare Facility	Area of localized flooding
OAKCNTY08	Oakland County Campus	Native Plant Demonstration Garden	Continuing Environmental and water resources stewardship

*Site Number corresponds to locations identified on Map 9

Rochester Hills

The City of Rochester Hills is comprised of 32.2 square miles and has a relatively large land area within the subwatershed (8,845 acres), representing 19% of the entire subwatershed. (The subwatershed covers 42% of the community). Rochester Hills is located in the east central portion of Oakland County and is located within the downstream end of the Clinton Main subwatershed. The primary land use is single-family residential, accounting for over 3,000 acres. The next largest land use is recreational land which is approximately 2,146 acres, much of which contains the main branch of the Clinton River or its tributaries. All told Rochester Hills supports 32% of the subwatershed's recreational lands.

The City of Rochester Hills Recreational Opportunities Plan will help manage and reduce impacts to the Clinton River and other natural features located within the City, as well as establish positive uses of these resources. In addition, several areas of riparian wetland mitigation have been constructed within the City of Rochester Hills, helping to increase pollutant uptake and improve overall water quality. A 25' natural features setback has been established along most of the Clinton within



the City. Two (2) egret rookeries have been established and are protected along the river corridor on the west side of the City.

Watershed priorities for the community include the following:

- ❖ high water during rain events at several locations within residential areas;
- ❖ sedimentation within sections of the Clinton Main River;
- ❖ steep slope bank erosion on the upstream end of the community;
- ❖ high number of large, dead ash trees within the subwatershed;
- ❖ encroachment into the 25' natural features setback;
- ❖ use of chemicals, including fertilizers and herbicides adjacent to the river; and
- ❖ restricted flow due to beaver activity within the river corridor and within Galloway Creek.



Table 3.9 and Map 9 show the sites visited with community representatives and also highlights many of the concerns described previously.

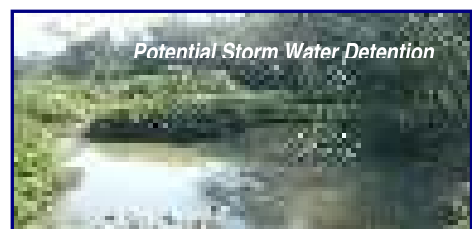
Table 3.9 Rochester Hills Community Tour Sites

Site Number*	Community	Location	Description
ROCH01	Rochester Hills	Butler Ridge Subdivision	High bank erosion areas
ROCH02	Rochester Hills	Butler Ridge Subdivision	Areas of egret rookeries (wildlife conservation)
ROCH03	Rochester Hills	Quail Ridge Subdivision	Areas of encroachment into the 25' natural features setback
ROCH04	Rochester Hills	River Oaks Apartments (Galloway Creek)	Insufficient road freeboard during rain events
ROCH05	Rochester Hills	Confluence Galloway Creek/Clinton Main	Suspected residential herbicide use near river
ROCH06	Rochester Hills	Crooks and Hamlin Roads	Stormwater detention/mitigation areas
ROCH07	Rochester Hills	Crooks and Hamlin Roads	"Old" Hamlin Road bridge and mitigation wetland

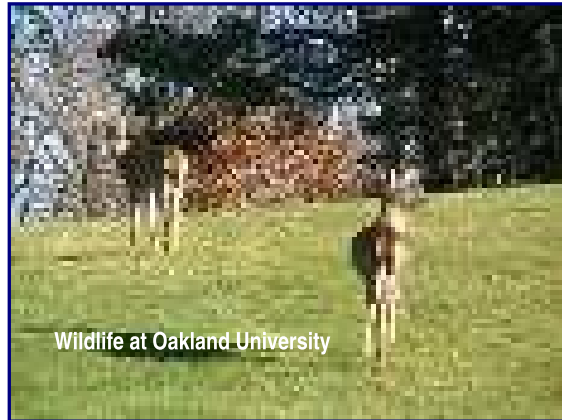
*Site Number corresponds to locations identified on Map 9

Oakland University

Oakland University is a public university located within both Auburn Hills and Rochester Hills and is comprised of approximately 1,441 acres. The land was donated to the state for the purpose of establishing the University. Oakland University is located in the east central portion of Oakland County and lies within the downstream end of the Clinton Main



subwatershed. In 1957, at the time of the University's founding, the surrounding area was very rural. The property was made up of a mix of field areas, woodland, wetland and rolling topography. The property has been a county estate, mansion and farm. By the 1990's the area surrounding the University had developed the suburban character that exists today.



The campus includes university buildings, athletic facilities, two (2) golf courses, nineteen parking lots and on-campus student housing facilities. Oakland University was established in 1959 with only 570 students and continues to grow. Today, more than 16,000 students attend classes at OU each fall, and there are more than 62,000 alumni.

Watershed priorities include the following:

- ❖ implementing actions identified in a recently completed Storm Water Management Study;
- ❖ replacing undersized culverts located on University property;
- ❖ correcting streambank erosion and encouraging stricter management of soil erosion control measures from upstream developing areas;
- ❖ constructing off-line detention areas to minimize flooding of golf course and lower athletic field surfaces (located within the floodplain); and
- ❖ reducing nutrient loading from golf course areas.

Table 3.10 and Map 9 show the sites visited with community representatives and also highlights many of the concerns described previously.

Table 3.10 Oakland University Tour Sites

Site Number*	Community	Location	Description
OAKU01	Oakland University	Galloway Creek near Squirrel	Siltation/Sedimentation and streambank erosion
OAKU02	Oakland University	Pioneer Drive	Wetland swale
OAKU03	Oakland University	Lower athletic field area	Storm sewer outfall to wetlands
OAKU04	Oakland University	Lower athletic field area	Undersized culverts
OAKU05	Oakland University	Near Walton (University Drive)	Undersized culvert
OAKU06	Oakland University	Lower athletic field area	Possible off-line detention area
OAKU07	Oakland University	Golf course	Reduce nutrient loading from golf course areas
OAKU08	Oakland University	Golf course	Area of flooding/beaver activity
OAKU09	Oakland University	Golf course	Erosion and flooding area
OAKU10	Oakland University	Golf course	Galloway at University property boundary

*Site Number corresponds to locations identified on Map 9

City of Orchard Lake Village

The City of Orchard Lake Village represents another relatively small community within the Clinton Main subwatershed and is located among several lakes in Oakland County, Michigan, about 25 miles northwest of Detroit. Sixty-nine percent of the village is contained within the subwatershed, which represents 4% of the subwatershed land total. The City of Orchard Lake Village is approximately 95 percent developed and consists of approximately four (4) square miles (1/2 of which is lake area). This community is located in both the Clinton Main and Rouge Main 1-2 Subwatersheds.



The land uses within the subwatershed include water as the largest (about 43 percent of the City is occupied by lakes and ponds), and single-family residential being the next largest. Approximately 483 acres of the land area within the community are of recreational use. This comprises 7% of the watershed's recreational land. The City surrounds its namesake, Orchard Lake, but also includes a portion of Upper Straits Lake and borders, along its northern limits, the waters of Cass Lake. All residents are connected to the sanitary sewer.

The City of Orchard Lake Village has instituted wetland, tree and environmental protection ordinances in order to protect and preserve the City's natural resources. In addition, the City has started an invasive species removal requirement. The City has also completed improvement projects along Orchard Lake Road, in which biologs were installed in order to help support the road and surrounding lakeshore slopes. More areas of natural preservation have been installed within 35' of the lake or wetlands and a natural rock seawall has been constructed along Old Orchard Trail (southwest side of Orchard Lake).

Improved water quality through the construction of storm water detention at Orchard Lake St. Mary's (on Seminary Street) has been achieved. The impervious areas on the campus formerly drained directly to Orchard Lake. A native wildflower buffer is planned around the storm water detention basin. Catch basin filter inlets have been utilized along Indian Trail (adjacent to Orchard Lake). Drainage improvements, including ditch renovations and pumps along Shady Beach Boulevard (adjacent to Orchard Lake), have been completed that help improve drainage and water quality to Orchard Lake.

Priorities additionally communicated by municipal representatives and City officials include direct storm water drainage to Orchard Lake along Indian Trail (along the east side of Orchard Lake) and along Orchard Lake Road. In addition, there are continued discussions with West Bloomfield Township (WBT) with regard to storm water culvert maintenance and flow capacities (specifically with regard to Pine Lake water levels). High-elevation natural banks along Commerce Road (north side of Orchard Lake) are areas of special concern for



erosion potential. The Orchard Lake Nature Sanctuary provides beautiful recreational opportunities and opportunities for public education activities. Table 3.11 and Map 9 show the sites visited with community representatives and also highlights many of the concerns described previously.

Table 3.11 City of Orchard Lake Village Community Tour Sites

Site Number*	Community	Location	Description
OLV01	Orchard Lake Village	Indian Trail and Orchard Lake Road	Connection of Pine Lake and Orchard Lake
OLV02	Orchard Lake Village	Orchard Lake (N. side)	Control structure for Orchard Lake
OLV03	Orchard Lake Village	Seminary Street (Orchard Lake St. Mary's)	Area of stormwater retention
OLV04	Orchard Lake Village	Shady Beach Boulevard	Drainage/ditch improvement areas
OLV05	Orchard Lake Village	Orchard Lake Nature Sanctuary	Native prairie planting

*Site Number corresponds to locations identified on Map 9

Pontiac

The City has, by far, the largest quantity of land contained within the subwatershed (11,757 acres). Almost all of the 12,900 acres of the City are located within the subwatershed, and are occupied by a wide variety of land uses. The most prevalent land use is single-family residential, with high-density residential being the most common type of residential development. Recreational land use holds 1,415 acres, approximately 21% of the subwatershed share. Priorities of community representatives include the following:

- ❖ locating illicit discharges;
- ❖ minimizing areas of flooding within residential areas;
- ❖ reducing bank erosion and sedimentation;
- ❖ eliminating encroachments along the river corridor; and
- ❖ improving public understanding about available recreational opportunities.

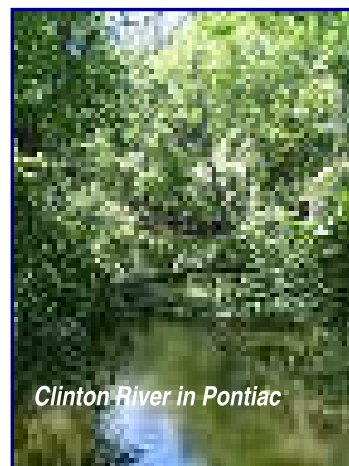


Table 3.12 and Map 9 show the sites visited with community representatives and also highlight many of the concerns described previously.

Table 3.12 City of Pontiac Community Tour Sites

Site Number*	Community	Location	Description
PON01	Pontiac	Featherstone and Northeast Blvd.	Waste water treatment plant
PON02	Pontiac	S. of Auburn Road	High quality stream corridor
PON03	Pontiac	Rails-to-Trails Pathway	High quality stream corridor

Site Number*	Community	Location	Description
		Bridge	
PON04	Pontiac	Skandia Corp. site	High quality wetland area; possible future public access
PON05	Pontiac	Beaudette Dam	Water-level control structure
PON06	Pontiac	Galloway Drain (at Giddings Road)	Area of residential flooding concern
SYL01	Pontiac	Sylvan Lake Estates	Sylvan Lake outlet
SYL02	Pontiac	Telegraph Road (Sylvan Lake Estates)	Potential location of illicit discharge

*Site Number corresponds to locations identified on Map 9

City of Sylvan Lake

The City of Sylvan Lake is located just northeast of Keego Harbor and is bordered by Sylvan Lake to the northwest. The City is located on the southwest side (upstream end) of the Clinton Main subwatershed. In land area, Sylvan Lake is the second smallest community in the subwatershed with all of its 516 acres within the subwatershed.

Water is the largest land use in Sylvan Lake, representing 38% of the community. Residential development is similar, in that it covers 33% of the community. Specific issues and areas of concern communicated by City officials include direct storm water drainage to Sylvan Lake from Orchard Lake Road and the control of fertilizer use within the City.

The City of Sylvan Lake is planning to renovate its community center (located on Pontiac Drive; adjacent to Sylvan Lake) in 2005-2006. The construction will likely incorporate several storm water best management practices within the newly constructed parking areas. An additional City project planned for 2005 includes storm sewer repair/renovation on Garland Avenue adjacent to Sylvan Lake. These improvements will help improve storm water quality by decreasing the amount of floatable debris that reaches the lake from the surrounding City streets. Table 3.13 and Map 9 show the sites visited with community representatives and also highlight many of the concerns described previously.



Sylvan Lake Boat Docks



Sylvan Lake to Clinton River under Telegraph Road

Table 3.13 Sylvan Lake Community Tour Sites

Site Number*	Community	Location	Description
SYL03	Sylvan Lake	Ferndale Street	City-leased dock spaces (street drainage directly to Sylvan Lake)
SYL04	Sylvan Lake	Pontiac Drive	Location of Community Center (proposed storm water BMPs)
SYL05	Sylvan Lake	Lakeview Drive	Location of proposed

<i>Site Number*</i>	<i>Community</i>	<i>Location</i>	<i>Description</i>
			stormsewer improvement

*Site Number corresponds to locations identified on Map 9

3.2 Landscape Characteristics

This analysis looks at the components that make up the landscape characteristics found within the subwatershed, including topography, ecoregions, hydrologic soil groups, flora and fauna, wetlands, woodlands, riparian corridors and channel morphology. These geological and ecological conditions are unique component that helps guide the watershed planning goals, objectives and actions within the subwatershed. It is important to understand how they are affected by activities and development within the subwatershed in order to minimize those impacts. Many of these landscape characteristics are further described in the Clinton Main Riparian Analysis contained in Appendix B.

3.2.1 Topography

Topography in the Clinton Main subwatershed is quite varied. The high elevation located in the headwaters is approximately 1,273 feet while the low elevation in the downstream end is approximately 564 feet. The Clinton River watershed has two distinct topographical regions including the upper portion that has more relief and steeper channels while the lower portion is predominately flat with very low channel slopes. The entire Clinton River is approximately 80 miles with a change in elevation of about 465 feet or an average gradient of 6 feet per mile.

3.2.2 Ecoregions and Soil Characteristics

Glaciers once covered all of Michigan. When a glacier moves down a drainage pathway or a valley, it pushes ahead of itself a large burden of debris, known as glacial till. This debris consists of unstratified mixtures of clay, sand, gravel and boulders. A terminal moraine marks the maximum advance of a glacier, while end moraines mark later stages in the recession of the glacier. As glaciers melted, large quantities of water flowing from the ice deposited various kinds of materials, most of which consisted of glacial outwash. These outwash deposits are characteristically flat and consist of layers of sand and other fine sediments.

The Michigan Department of Natural Resources Fisheries Division DRAFT Clinton River Assessment describes four main ecoregions within the Clinton River Watershed. Ecoregions are classifications of land areas based on climate, physiography, soil and vegetation. Within the Clinton River Watershed, there are four (4) distinct ecoregions of which the Clinton Main subwatershed contains two. The four ecoregions include the Maumee Lake Plan, the Sandusky Lake Plan, the Ann Arbor Moraines and the Jackson Interlobate. The Clinton Main subwatershed is located within both the Ann Arbor Moraines and the Jackson Interlobate. Map 10 Defined Ecoregions shows these two ecoregions within the Clinton Main subwatershed.

The Ann Arbor Moraines encompasses approximately 21% of the entire watershed with an average elevation of 897 feet. This area is primarily located within the western portion of the Middle segment of the Clinton River. Topography consists of primarily low, rounded hills with some more rolling areas near the end moraines. These glacial deposits are approximately 200 feet thick consisting of fine and medium textured material. This area has primarily good drainage with various pockets of poorly drained soils on the lower slopes of the ground moraines. The glacial deposits in this area have a high conductivity thus providing high groundwater input to the river and lakes. Historic vegetation included oak-hickory and swamp forests in areas supporting loam. Galloway Creek is also contained within this defined ecoregion.

The Jackson Interlobate is the most upstream ecoregion and occupies approximately 24% of the watershed. Elevations range from 984 feet to 1276 above mean sea level with an average elevation of 1,018 feet. Glacial deposits are approximately 300 feet thick above bedrock and Albert (1995) described the area as consisting of outwash sands with sandy/gravelly end moraines and ground moraines. The appearance of moraines are like hills surrounded by flat outwash areas. Kettle lakes and ponds were formed from the outwash and end moraines, of which a number are directly connected to the Clinton River. The glacial deposits in this area have a high conductivity thus providing high groundwater input to the river and lakes.

Within Oakland County, soil infiltration characteristics range from well-drained to poorly-drained. The southeastern part of Oakland County soils are generally poorly to moderately well drained and consist of sandy, loamy or clayey materials. In the remaining portions of Oakland County, including the Clinton Main subwatershed, soils are loamy or loamy/sandy and some areas are underlain by gravelly sand.

There are two primary soil texture terms for the surface layer of the major soils in the Clinton Main subwatershed, including the **Urban Land-Marlette-Capac** and the **Urban Land-Spinks-Oshtemo**. Urban Land refers to areas that were fairly developed at the time of the soil survey and include land that is nearly level, but in some places it has gentle slopes. It is covered by impervious surfaces that have obscured the soils so that identification of the soils is not possible.

The soils in these categories are described in three distinct layers, including the *surface layer* that is 8 inches thick, the *subsoil* with a thickness of 24 inches and a *substratum* approximately 60 inches thick. Marlette soils are on plains, ridges and side slopes that are generally level to hilly. They are well-drained with a surface layer of dark grayish brown sandy loam, subsoil consisting of a brown to grayish brown mottled clay loam and a substratum made up of brown, mottled, calcareous loam. Capac soils are located in areas that are nearly level or have gentle rolling slopes. These soils are more poorly-drained than the Marlette group and have a surface layer consisting of dark grayish-brown sandy loam, a subsoil consisting of brown and grayish/brown mottled clay loam, followed by a brown, mottled calcareous loam.

The Spinks and Oshtemo soils are well drained and are located in areas of level terrain. These areas are generally located on broad plains, ridges and along the side slopes of streams, lakes and wetlands. The surface layer of Spinks soils includes dark brown loamy sand, the subsoil consists of pale brown sand and the substratum is made up of brown, loose sand. Oshtemo soils are also well drained with a surface layer of dark brown loamy sand, subsoil of yellowish brown loamy sand and substratum of both reddish-brown and yellowish-brown sandy soil. Other groups of minor extent include poorly drained Granby, Gilford and Houghton soils. These soils are generally located in depressions and waterways.

The soils within the Clinton Main subwatershed were further categorized into hydrologic soil groups, which is a description of their runoff-producing or infiltration characteristics. Topography along with vegetative cover is not considered in the classification of hydrologic soil groupings. Group A soils are well-drained sandy or gravelly materials with a high infiltration rate and low runoff potential. Group D soils, on the other hand, are soils having a very slow infiltration rate and thus a high runoff potential and are generally characterized as having a clay pan or clay later near the surface. High water tables are also characteristic of these types of soils. Soils classified as Group B or C have characteristics intermediate of those soils in Groups A and D. Soils classified in two (2) hydrologic soil groups indicate an upper layer of more permeable material underlain by a less permeable layer.

Map 11 shows the Hydrologic Soil Groups for soils located in the Clinton Main subwatershed. Table 3.14 provides a breakdown of Hydrologic Soil Groups by percentage within the subwatershed.

Table 3.14: Hydrologic Soil Groups

Hydrologic Soil Group	Percentage of Subwatershed
Group A	12%
Group A/D	5%
Group B	43%
Group B/D	6%
Group C	1%
Urban Land	24%
Water	9%

Priorities for subwatershed activities based solely on these types of soil include potential erosion concerns as well as carefully identifying infiltration opportunities. Low permeability soils are located throughout the subwatershed and infiltration best management practices should be limited to Groups A and B soils.

3.2.3 Unique Flora & Fauna

Threatened Species and Species of Special Concern

The protection of threatened and endangered species and species of Special Concern status in Michigan is an important component of protecting natural habitat areas and corridors in the subwatershed. Endangered (E), Threatened (T), and Probably Extirpated (X) plant and animal species of Michigan, are protected under the Endangered Species Act of the State of Michigan (Part 365 of PA 451, 1994 Michigan Natural Resources and Environmental Protection Act).



The Endangered Species Program of the Michigan Department of Natural Resources and the Michigan Natural Features Inventory (MNFI) produced lists of these species. The Michigan Natural Features Inventory



maintains databases of all known occurrences of these types of species (plant and animal), as well as high quality natural communities, occurring within Michigan. These lists are based on known and verified sightings of threatened, endangered, and special concern species and represent the most complete data set available. The current list became effective on March 20, 1999, after extensive review by technical advisors to the Michigan Department of Natural Resources and the citizenry of the state.

The MNFI information is collected by teams of scientists with expertise in botany, zoology, aquatic ecology, and ecology. MNFI has conducted surveys by foot, kayak, canoe, and air, from interior forests and grasslands, Great Lakes shores to remote islands in search of information about Michigan's special plants, animals and plant communities. Information is also gathered by studying museum and herbaria records, communicating with other scientists in the Great Lakes area, and reading published works. It should not be considered a



comprehensive listing of every potential species found within the subwatershed. 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.

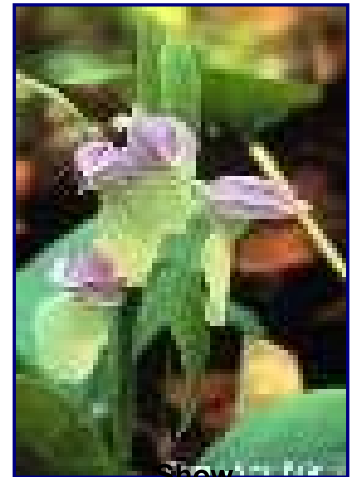
The mission of the MNFI is to actively contribute to decisions that impact the conservation of biological and ecological diversity by collecting, analyzing, and communicating information about rare and declining plants and animals, and the array of natural communities and ecosystems native to Michigan.

Unique flora and fauna thrive in the Clinton Main subwatershed. Red fox, mink and muskrat have been observed along portions of the subwatershed. Great blue herons and other waterfowl, freshwater clams, native fish, and a multitude of native wildflowers populate the stream and riparian corridor. A variety of threatened, endangered, and special concern species, high-quality natural communities, and champion trees have been identified in the Clinton Main subwatershed. Table 3.15 lists Threatened, Endangered and Special Concern Plants and Table 3.16 lists Threatened, Endangered and Special Concern Animals in the Clinton Main Subwatershed. English names in common usage or from published sources have been incorporated, when possible, to facilitate public understanding of and participation in the Endangered Species Program.

Also included in the lists are plant and animal species of Special Concern



(SC). While not afforded legal protection under the Act, many of these species are of concern because of declining or relict populations in the state. Should these species continue to decline, they would be recommended for Threatened or Endangered status. Protection of Special Concern species now, before they reach dangerously low population



levels, would prevent the need to list them in the future by maintaining adequate numbers of self-sustaining populations within Michigan. Some other potentially rare species are listed as Special Concern pending more precise information on their status in the state; when such information becomes available, they could be moved to threatened or endangered status or deleted from the list (MNFI, 2005).

Table 3.15. Threatened, Endangered & Special Concern Plants

Scientific Name	Common Name	State Status
<i>Aralia nudicaulis</i>	Gattinoer's Gerardia	E
<i>Amorpha canescens</i>	Leadplant	SC
<i>Angelica venenosa</i>	Hairy Angelica	SC
<i>Arabis missouriensis var. deamii</i>	Missouri Rock-cress	SC

Scientific Name	Common Name	State Status
<i>Astragalus Canadensis</i>	Canadian Milk-vetch	T
<i>Bouteloua curtipendula</i>	Side-oats Grama Grass	T
<i>Carex lupuliformis</i>	False Hop Sedge	T
<i>Carex richardsonii</i>	Richardson's Sedge	SC
<i>Cirsium hillii</i>	Hill's Thistle	SC
<i>Cyperus acuminatus</i>	Nut-grass	X
<i>Epioblasma triquetra</i>	Snuffbox	E
<i>Galearis spectabilis</i>	Showy Orchis	T
<i>Gentiana puberulenta</i>	Downy Gentian	E
<i>Gentianella quinquefolia</i>	Stiff Gentian	T
<i>Gymnocladus dioicus</i>	Kentucky Coffee-tree	SC
<i>Hieracium paniculatum</i>	Panicled Hawkweed	SC
<i>Hydrastis Canadensis</i>	Goldenseal	T
<i>Linum virginianum</i>	Virginia Flax	T
<i>Scirpus clintonii</i>	Clinton's Bulrush	SC
<i>Trichostema dichotomum</i>	Bastard Pennyroyal	T
<i>Valeriana edulis var. ciliate</i>	Edible Valerian	T

E = State Endangered; T = State Threatened; SC = State Special Concern; T = Probably Extirpated

Table 3.16. Threatened, Endangered & Special Concern Animals

Scientific Name	Common Name	State Status
<i>Acris crepitans blanchardi</i>	Blanchard's Cricket Frog	SC
<i>Buteo lineatus</i>	Red-shouldered Hawk	T
<i>Clemmys guttata</i>	Spotted Turtle	T
<i>Erynnis baptisiae</i>	Wild Indigo Duskywing	SC
<i>Lampsilis fasciola</i>	Wavy-rayed Lampmussel	T
<i>Microtus pinetorum</i>	Woodland Vole	SC
<i>Nicrophorus americanus</i>	American Burying Beetle	E
<i>Notropis anogenus</i>	Pugnose Shiner	SC
<i>Pleurobema coccineum</i>	Round Pigtoe	SC
<i>Sistrurus catenatus catenatus</i>	Eastern Massasauga	SC
<i>Pyrgulopsis letsoni</i>	Gravel Pyrg	SC
<i>Toxolasma lividus</i>	Purple Lilliput	T
<i>Vilosa iris</i>	Rainbow	SC

E = State Endangered; T = State Threatened; SC = State Special Concern

3.2.4 Wetlands, Woodlands & Riparian Corridor

Wetlands

Since pre-settlement, many acres of wetland have been lost in the Clinton Main Subwatershed, either by natural processes or to make way for agriculture and development. Most of the subwatershed's wetlands have been drained and lost due to farming and development since the 1800's. According to state law, only wetland 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 wetland areas.

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.

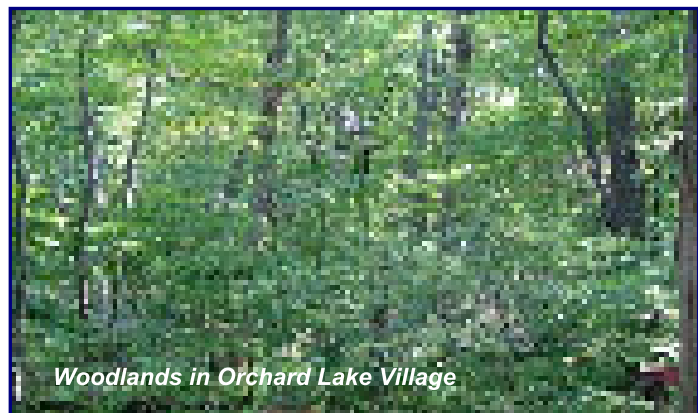
Map 12 is a Potential Wetland Map for the Clinton River Watershed. The GIS data sets used in Clinton Main Watershed Potential Wetland Map were Michigan Resource Inventory System (MIRIS) Land Use/Land Cover data, National Wetland Inventory (NWI) data and Oakland County Planning Department Soil Data. MIRIS Land Use/Land Cover data was acquired through the Michigan Department of Natural Resources online Michigan Geographic Data Library, where it is maintained for public use. 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. Oakland County Soil Data was acquired through Oakland County in cooperation with the Clinton Main subwatershed planning activities.

The Potential Wetland Map was created to depict areas with a moderate to high likelihood of containing wetlands. To synthesize the Clinton Main subwatershed Potential Wetland Map, NWI, MIRIS Land Use/Land Cover and hydric soil themes were superimposed in the ArcView Geographical Information System (GIS) software. The areas where two or more of these themes intersected were identified as potential wetland areas.

The Potential Wetland Map gives an overall generalization of wetland areas within the watershed. Wetland area utilizes approximately 3% of the subwatershed. 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 subwatershed but it demonstrates the likelihood of these natural wetland areas along the river corridor and in the headwaters.

Woodlands

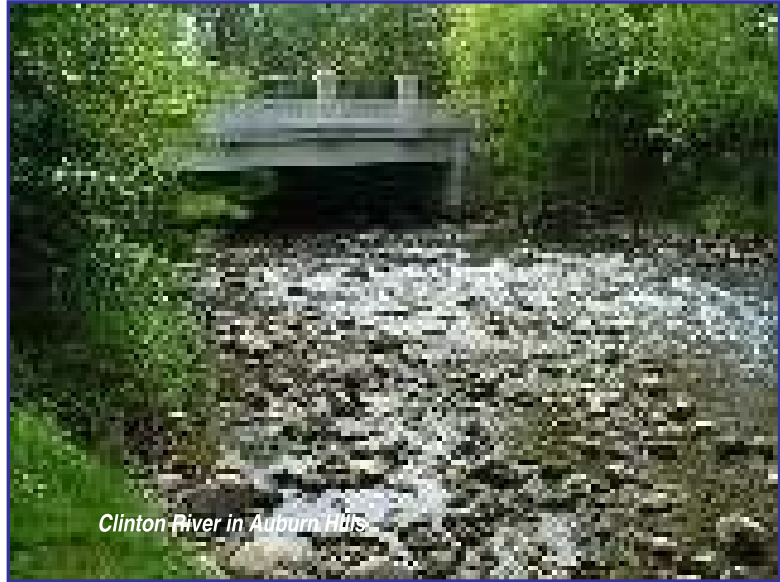
Woodlands, forests and heavily treed areas provide many benefits to water quality, water quantity and wildlife habitat. Wooded areas provide nesting, perching, feeding and cover for birds and mammals. Wooded areas also provide water quality and quantity benefits by cooling and shading storm water, intercepting storm water as it falls with leaf and trunk surface area and leaf litter, and increasing infiltration of storm water with root systems and often more permeable soils.



Wooded areas also benefit humans, providing natural area aesthetics, and passive and active recreation. According to 1995 MIRIS Land Use Data, there are approximately 1,500 acres of woodlands in the Clinton Main subwatershed and make up less than 5% of the subwatershed's land use. For the purpose of comparison, the World Wildlife Fund has recommended that 25% of a watershed should be covered with woodlands in order to support a diversity and abundance of wildlife.

Riparian Corridor

The Clinton Main subwatershed encompasses approximately 60 miles of river and creeks with 22 miles of Clinton Main and the remaining 38 miles consisting of creeks and tributaries. The state of the land area adjacent to the river and creeks is critical to the health of the water that flows through it. A vegetated riparian corridor, or all the land adjacent to the river and creeks, can provide shading and cooling for water; organic debris to feed aquatic organisms; bank stabilization with its root structure; cover, perching and nesting areas for aquatic organisms; and a buffer for pollutants and sediments from surface runoff.



In addition to providing habitat for aquatic organisms, the corridor is used by many birds and mammals. Currently, the riparian corridor in the Clinton Main Subwatershed is in good condition in many areas along the river with woodlands and wetlands lining the banks, but has become mowed lawn in many of the urban areas. Local natural feature setback ordinances in some communities are serving to protect these important systems, yet with pending development, some parts of the corridor are at risk.

A complete detailed Riparian Analysis was conducted by Oakland County Planning and Economic Development Services Environmental Stewardship Group and is included as Appendix B of this plan.

3.2.5 Channel Morphology

The Michigan Department of Natural Resources draft Clinton River Assessment provides a description of morphology throughout the Clinton River Watershed. As discussed in the Introduction, this assessment defined five (5) main river segments, while the Clinton Main Subwatershed is encompassed within two (2) of these segments, including the Upper and Middle segments. See Figure 2.2. The Upper segment includes the western portion of the Clinton Main to just east of I-75. The Middle segment includes the eastern half of the Clinton Main subwatershed.

The Upper segment of the Clinton River runs through glacial outwash sand and gravel, post glacial alluvium, and end moraines of medium textured till. The outwash deposits provided numerous kettle lakes, a number of which are directly connected to the Clinton River. The MDNR Fisheries Division evaluated 233 channel locations using aerial photography and the river width averaged 54 feet with the beginning elevation at 993 feet and ending elevation at 854 feet. With an approximate length of 30 miles, the average gradient was determined to be 4.6 feet per mile, which is considered low and provides only modest potential for sport fisheries habitat. Sinuosity, which provides an indication of the amount of meanders in the river, was calculated to be 1.36. Rivers with no meanders have a Sinuosity Index of 1.0. Rosgen (1994) classified Sinuosity Index as described in Table 3.17.

Table 3.17 Rosgen (1994) Sinuosity Index

Classification	Sinuosity Index
Low	< 1.2
Moderate	1.2 – 1.5
High	> 1.5

The upper half of the Middle segment is located primarily in the Clinton Main subwatershed and consists of glacial outwash sand and gravel between end moraines of medium textured till. Of the 377 channel measurements, the MDNR estimated an average channel width of 56 feet. The elevation at the upper end is about 854 feet above mean sea level and about 617 at the lower end in Utica. With a length of approximately 19 miles, the average gradient was calculated to be 12.4 feet per mile, which is the highest gradient in the entire Clinton River watershed. This area, thus has a high potential for sports fisheries habitat. The sinuosity index was 1.46 and ranked high as compared to other segments. Similar to the Upper segment, the glacial deposits in this area have a high conductivity thus providing high groundwater input to the river and lakes. The high gradient, good potential for groundwater input and opportunities for public access make this segment most opportune for fisheries management.

3.3 Flow Characteristics

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 Clinton River. 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.

3.3.1 Historic Changes in River Flow

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 Clinton Main Subwatershed (see Map 13 USGS Gages). These gages are within the Clinton River in Auburn Hills (gage 04161000) and within the Galloway Creek in Auburn Hills (gage 04161100).

As a part of the Clinton River Hydrologic and Geomorphic Analysis of the Clinton River Watershed, detailed flow trend analyses have been conducted deploying the data collected from these USGS gages within the Clinton River watershed, including the following:

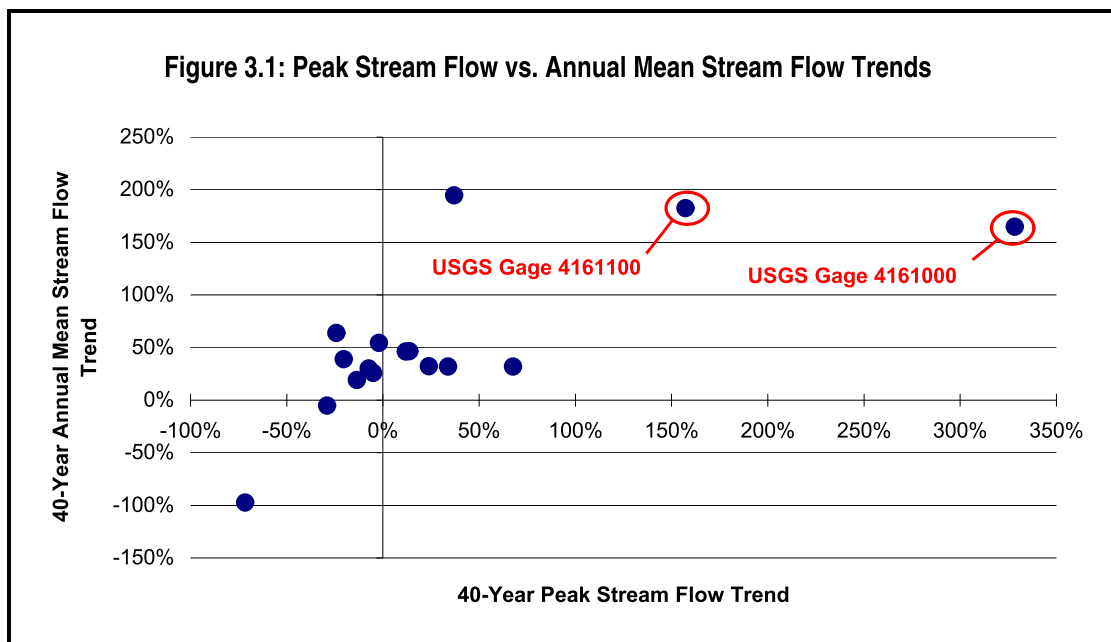
- ❖ Peak Flow Trends – Calculate the trends in the yearly maximum flow for the period of record at the USGS gage;
- ❖ Annual Mean Stream Flow Trends – Calculate the trends in the yearly average flowrate for the period of flow record; and

- ❖ Bankfull Flow Trends – Calculate the trends in the 1.5-year flow (or “channel-forming flow”) over the period of record.

Table 3.18 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 Clinton Main subwatershed are highlighted in grey. Figure 3.1 shows the relationship between the peak stream flows and the annual mean stream flows for these sixteen USGS gages.

Table 3.18: Changes in flows over a 40-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%
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%

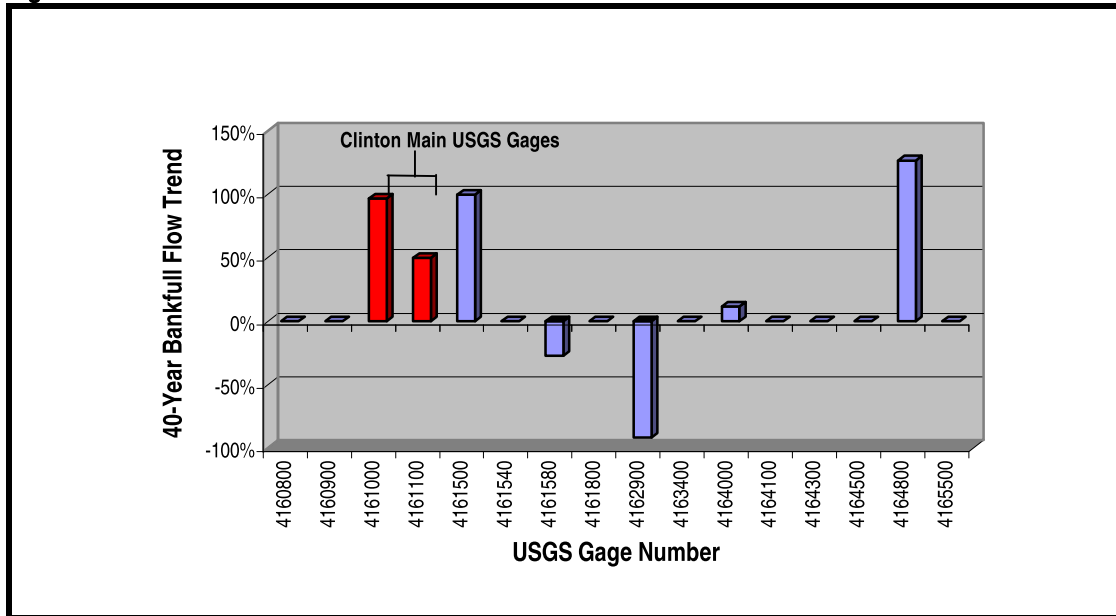


The following conclusions may be drawn from Figure 3.1:

- ❖ Most 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 Clinton Main Subwatershed show the largest increases in both annual mean stream flow and peak stream flow.

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 3.2 for the relative bankfull flow changes within the Clinton River watershed.

Figure 3.2: 40 – Year Bankfull Trends



In many USGS gages within the Clinton River watershed and especially within the Main Subwatershed, this bankfull flow increased from the values early in the record when compared to the bankfull late in the record. See Figures 3.3 through 3.6 for the plots of this analysis for the Clinton Main Subwatershed locations. It is evident that increased imperviousness has had a drastic effect on the bankfull discharge within the Clinton Main subwatershed.

Figure 3.3: Cumulative Volume for Clinton Main USGS Gage 04161000

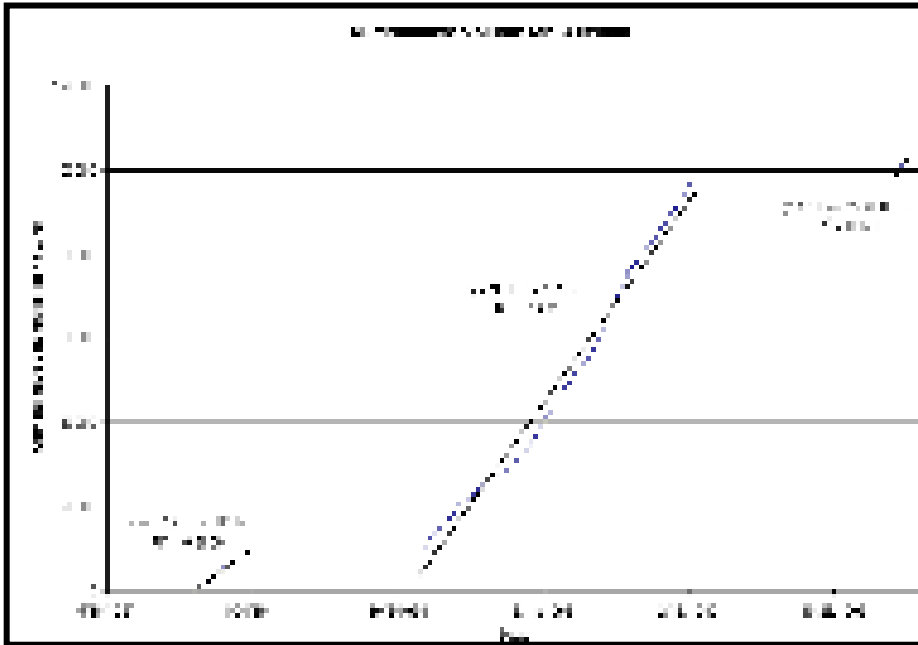


Figure 3.4: Mean Daily Flow for USGS Gage 04161000¹

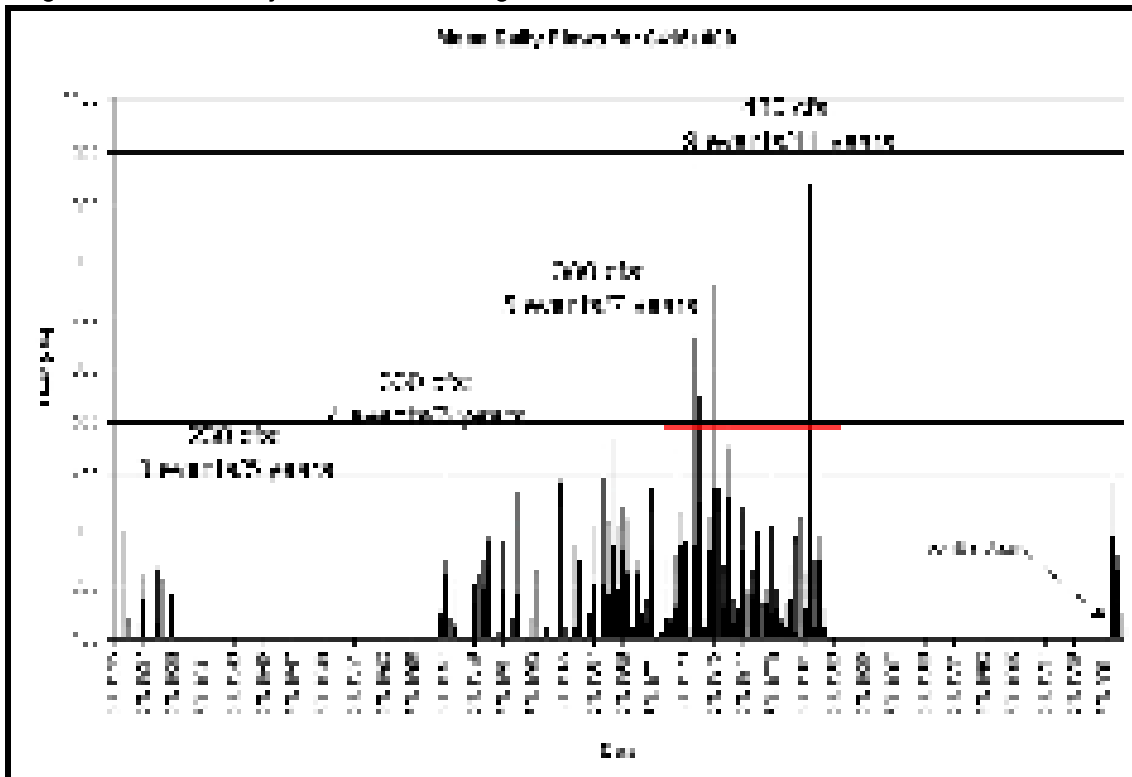


Figure 3.5: Cumulative Volume for Galloway Creek USGS Gage 04161100

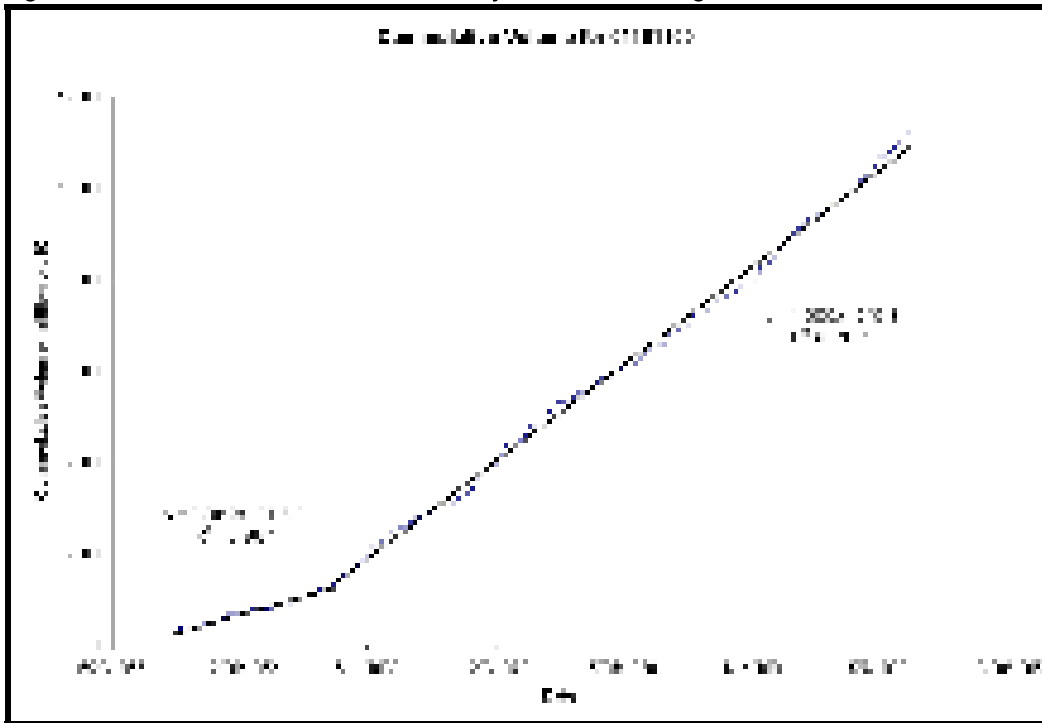
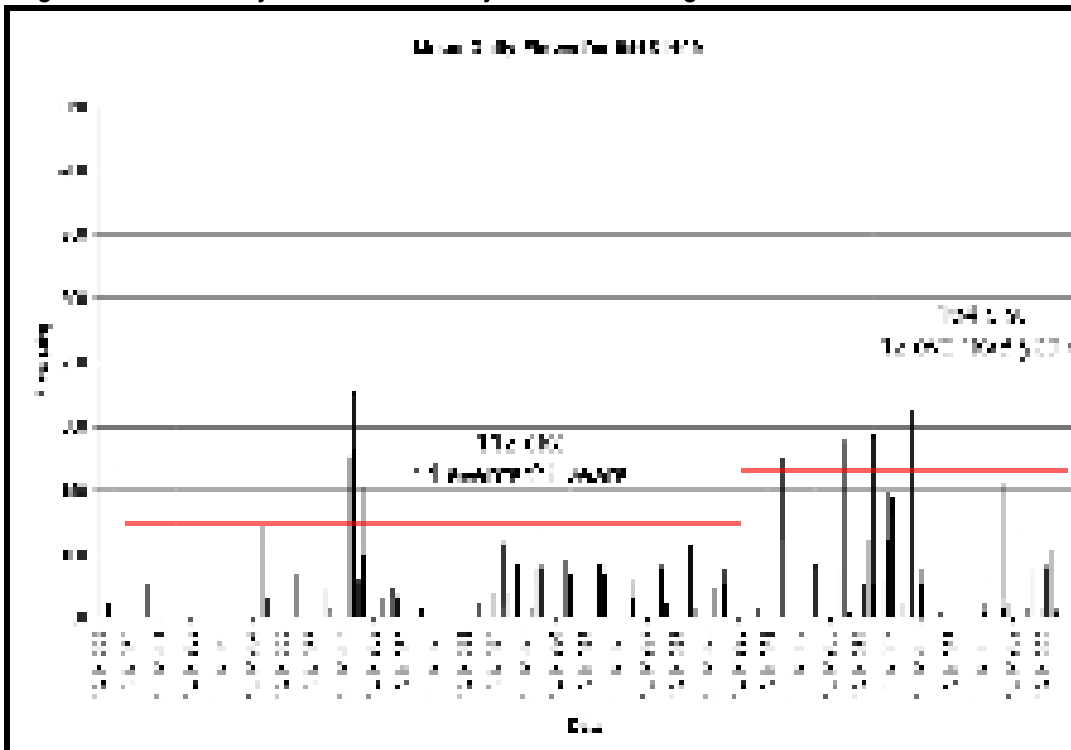


Figure 3.6: Mean Daily Flows for Galloway Creek USGS Gage 04161100



3.3.2 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 Clinton Main subwatershed. These water level control structures are located on most of the lakes within the Clinton Main subwatershed 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 Clinton Main subwatershed.

The Clinton Main subwatershed has six dams and Table 3.19 describes the name, location and legally set elevation for each. Refer to Map 14 Water Level Control Structures for Dam (i.e. Water Level Control Structure) locations within the watershed.

Table 3.19 Control Structure Location and Set Elevation

Lake/Structure Name	City/Township	Summer Level (feet amsl)	Winter Level (feet amsl)
Orchard Lake Dam ID# 2570	City of Orchard Lake Village	930.50	929.50
Watkins Lake Dam ID# 918	Waterford Township	950.00	949.50
Cass Lake (Structure #1) Dam ID# 1664	Waterford Township	929.22	927.87
Cass Lake (Structure #2) Dam ID# 1664	Waterford Township	929.22	927.87
Crystal Lake (Walter Moore Dam) Dam ID# N/A	City of Pontiac	917.50	917.00
Otter and Sylvan Lakes (Price Dam) Dam ID#718	City of Pontiac	928.60	927.25

Strictly from a river restoration perspective, dam removal is a topic of concern, as there are potential long-term benefits; however, there is also documented information regarding ecological impacts of dam removal. Any discussion of these structures should certainly consider all relevant factors including environmental, historical, hydrological, biological and political.

Each of the structures listed in Table 3.19 inspected and maintained by the Oakland County Drain Commission. The following information contains a description of each structure as described in the Oakland County Drain Commission Dam Inspection Reports.

Orchard Lake Dam ID# 2570: (Refer to Figure 3.7)

Description of the structure as per the Oakland County Drain Commissioner Dam Inspection Report is as follows: “The Orchard Lake Level Control System is located on the northern shore of Orchard Lake off of Commerce Road. The control system consists of the following:

1. An 18-inch x 29-inch corrugated metal pipe (CMP) inlet from Orchard Lake.
2. An on-shore 11-foot diameter control structure containing a stop log weir.

3. A pump station
4. A 24-inch diameter reinforced concrete transmission pipe.
5. A 24-inch diameter CMP outlet pipe to Cass Lake. The same pipe acts as the inlet when augmentation pump is on.

The system has two different modes of operation – Overflow to Cass Lake and Pump Augmentation Flow From Cass Lake to Orchard Lake. Each mode is described below.

Overflow to Cass Lake

Water from Orchard Lake drains by gravity through the 18-inch x 29-inch CMP into the control structure manhole. The control structure houses a concrete weir at elevation 929.5 equipped with stop logs that allow the elevation to be adjusted to elevation 930.46. Water flows over the weir and out of the control structure into the pump station wet well the out of the pump station through the 24-inch diameter transmission pipe to Cass Lake. The distance from the pump station to Cass Lake is approximately 620 feet, and there are four manholes along the alignment of the transmission pipe.

Pump Augmentation Flow From Cass Lake to Orchard Lake

Water is pumped from Cass Lake into Orchard Lake as needed if the level of Cass Lake is above legal. There is a rock crib surrounding the Cass Lake inlet/outlet. The pump station consists of a wet well, a 4000 gallon-per-minute axial-flow-type pump, discharging piping, and associated controls. The pump station wet well is connected directly to Cass Lake via the 24-inch transmission pipe, so the water elevation inside the wet well is essentially the same as Cass Lake. The pump discharges into Orchard Lake through a 14-inch steel pipe at an invert elevation of 931.50 feet. A gabion mattress was constructed at the discharge location to protect the lake bed against erosion. The pump is operated by the Oakland County Drain Commissioner's personnel."

Watkins Lake Dam ID# 918:

Description of the structure as per the Oakland County Drain Commissioner Dam Inspection Report is as follows:

"The structure is located on the west shore of the lake on horseshoe canal. It is a concrete structure with a trash rack and a removable aluminum stop log weir. Flow enters the structure and outlets into a 30-inch diameter rcp that is 300 lf long. The reinforced concrete pipe outlets to another concrete structure with a three-sided removable stop log weir. Flow ultimately discharges overland to existing wetlands located within the Drayton Plains Nature Center. The existing force main for the Clinton River augmentation pump is connected to the outlet pipe with a duck bill valve. The pump will be reserved for back-up use."

Cass Lake(Structure #1) Dam ID# 1664: (Refer to Figure 3.7)

Description of the structure as per the Oakland County Drain Commissioner Dam Inspection Report is as follows:

"Cass Lake Control Structure No. 1 is one of two control structures for Cass Lake. It is located on a canal just west of Cass Lake Road between Rosedale and Otter about one mile north of Orchard Lake Road with a portion of the structure lying in Waterford Township and a portion lying in the City of Keego Harbor. The water level of Cass Lake is controlled by the operation of four wooden gates set in a reinforced concrete structure. The gates have manual controls and a bar screen set in concrete upstream of each gate. When the gates are in a closed position the top of each gate is at the summer legal level. The gates are raised as needed with SCADA that electronically monitors the lake level."

Cass Lake(Structure #2) Dam ID# 1664: (Refer to Figure 3.7)

Description of the structure as per the Oakland County Drain Commissioner Dam Inspection Report is as follows:

“Cass Lake Control Structure No. 2 is one of two control structures for Cass Lake. It is located on a canal just east of Cass Lake Road north of Bangor Road about one quarter mile south of Cass-Elizabeth Lake Road in Waterford Township. Control Structure No. 2 has no movable parts and consists of a 20-foot wide by 10-foot long weir box constructed of sheet piling with two, eight-inch diameter outlet pipes through its east or downstream wall. A 22-inch wide concrete cap covers the east wall and angle iron covers the north and south walls of the structure. The top elevation of the structure or weir elevation is 931.0 feet. A 10-foot wide concrete box culvert beneath Cass Lake Road serves as an inlet to the control structure. Water flows from the Dolphine Canal through the box culvert, into the weir box then out of the weir box through the two outlet pipes then back into the canal and into Otter Lake. The function of Control Structure No. 2 compliments Control Structure No. 1, which has gates to regulate the flow from Cass Lake. Control Structure No. 2 holds water in the canal system, provides dry weather flow downstream and provides emergency overflow capacity into the Clinton River.”

Crystal Lake(Walter Moore Dam): (Refer to Figure 3.7)

Description of the structure as per the Oakland County Drain Commissioner Dam Inspection Report is as follows:

“The dam consists of a concrete control structure and steel sheet piling weir. The shorelines of the upstream pond leading to the control structures are protected with steel sheet piling. Flow is regulated through the dam by two methods. The first method is by the operation of two 66” x 66” sluice gates which are enclosed within a concrete structure. The flow through the sluice gates discharges into an 11’ x 10’ enclosed box culvert known as the Pontiac-Clinton River Drain No. 3, which eventually discharges into the Clinton River. The second means of regulating the flow is by the operation of an adjustable overflow weir, which consists of removable stop logs and an adjustable mechanical weir. Flow from the overflow weir discharges into the downstream Oaks Drain open channel (a.k.a. former Clinton River channel) and then into the Pontiac-Clinton River Drain No. 3 enclosure, which eventually flows into the Clinton River. Dry weather flow is conveyed through a sluice gate to the Oaks (County) Park.”

Otter and Sylvan Lakes(Price Dam) Dam ID# 718: (Refer to Figure 3.7)

Description of the structure as per the Oakland County Drain Commissioner Dam Inspection Report is as follows:

“ The dam consists of an earth embankment, protected on the upstream side with steel sheet piling. Flow is conveyed through the dam by opening four sluice gates that are attached to the stream side of the sheet piling. Flow from the gates is conveyed through the embankment by four 4’-0” x 4’-0” concrete box culverts which outlet through a common concrete headwall into an outlet pond. Flow then leaves the outlet pond, through a bridge culvert under Orchard Lake Road, continuing downstream, in the Clinton River, to Crystal Lake. The dam structure is equipped with an emergency overflow spillway and also has a provision to convey dry weather flow through the embankment via a 12” diameter sluice gate.”

3.4 River and Stream Water Quality

Table 3.25: Pollutant Loading Results of PLOAD Model Runs (mg/L)

<i>BASIN</i>	<i>BOD</i>	<i>TSS</i>	<i>TP</i>	<i>DP</i>	<i>TKN</i>	<i>NO23</i>	<i>PB</i>	<i>CU</i>	<i>ZN</i>	<i>CD</i>
<i>Clinton Main</i>	44	158	0.7	0.3	4.2	2.9	0.10	0.065	0.46	0.006
<i>Red Run</i>	63	245	0.9	0.4	5.4	3.7	0.14	0.10	0.73	0.009
<i>North Branch</i>	5	50	0.2	0.1	1.0	1.4	0.01	0.003	0.02	0.000
<i>Clinton Overall</i>	30	112	0.5	0.2	3.0	2.2	0.06	0.04	0.27	0.004

Overall, the delineated basins within the Main Branch of the Clinton River are somewhere between a rural and an urban watershed. However, most of the values of the pollutant loadings more closely resemble the loadings produced from a highly urban basin. Map 18 shows individual parameter results for phosphorus, nitrate and nitrites, biochemical oxygen demand and total suspended solids. The total loading of the Clinton Main subwatershed can also be compared to the total loading from the entire Clinton River watershed. This comparison can show the relative loading generated from the Clinton Main subwatershed. See Table 3.26 and Figure 3.11 for these results.

Table 3.26: Total Pollutant Loading from the Clinton Main Subwatershed

	Entire Clinton River Watershed		Clinton Main	Percent of Total Loading
<i>BOD</i>	13,668,722		2,044,139	15.0%
<i>TSS</i>	50,630,319		7,353,249	14.5%
<i>TP</i>	218,453		31,000	14.2%
<i>DP</i>	103,300		14,848	14.4%
<i>TKN</i>	1,378,958		195,892	14.2%
<i>NO23</i>	1,007,742		136,314	13.5%
<i>PB</i>	28,290		4,478	15.8%
<i>CU</i>	18,374		3,033	16.5%
<i>ZN</i>	123,465		21,314	17.3%
<i>CD</i>	1,740		274	15.8%
<i>Area, Square Miles</i>	760		73	9.6%

All Pollutant Units are in lbs/year

NH₃ is converted to NO₃⁻ and NO₂ by the process of nitrification. When present as organic nitrogen or ammonia, nitrogen exerts an oxygen demand, meaning that oxygen levels are decreasing in the water. Total Kjeldahl Nitrogen (TKN) is a measurement of organic nitrogen plus ammonia nitrogen.

Nitrates and nitrites are commonly measured in river systems. Acceptable levels of nitrate are below 4 mg/L and when the concentration exceeds this level, accelerated plant growth occurs. The EPA ecoregional criteria for total nitrogen in rivers and streams of ecoregion VII is 0.54 mg/L (US EPA 2000). Nitrate less than 90 mg/L has not demonstrated adverse impacts on warm water fish. Nitrite levels less than 5 mg/L have not demonstrated adverse impacts on warm water fish (US EPA 1986). Sources of nitrates come from decomposition of dead plants and animals, fertilizers, animal waste and sewage.

Ammonia (NH₃-N) toxicity is pH and temperature dependent. Chronic and acute toxicity increases as pH decreases and acute toxicity increases as temperature decreases. Freshwater phytoplankton and vascular plants are more tolerant to NH₃-N than invertebrates or fish. At a pH of 8.0 and a temperature of 24 degrees centigrade the chronic criterion for fish protective of early life stages is 1.32 mg nitrogen per liter (mg N/L) (USEPA 1999). It is important to note, however, that the USEPA is currently reevaluating the aquatic life ambient water quality criteria for ammonia (Federal Register: July 8, 2004 (Volume 69, number 130). Further, the State of Michigan Rule 57 final chronic value for the protection of aquatic life for unionized ammonia in warm water is much lower than the EPA value at 0.053 mg/L.

Total Suspended Solids (TSS)

Total suspended solids measure the sediment in the water column. Wet weather loadings are often much higher than dry weather loadings, indicating storm water runoff as the conveyance medium for sediments as opposed to wind or other vehicles. Sediments from streets, stream bank erosion due to high river velocities and lack of vegetation, sediments from agricultural runoff and dust, and construction sedimentation are some of the suspected sources of TSS in the creeks and river.

High TSS in the water column reduces dissolved oxygen concentrations, decreases light penetration for aquatic plants, clogs gills of aquatic organisms and fish, and impairs the aesthetic and recreational uses of the river. TSS may have direct impacts on fish either as fish kills, reduced growth rates or resistance to disease. According to the Neoponset River Basin Survey¹, which used indicators of aesthetic quality to judge TSS concentrations, TSS below 25 mg/l is good, between 25-80 mg/l is fair and above 80 mg/l is poor.

***E. coli* Bacteria**

Elevated numbers of *E. coli* bacteria, a species of fecal coliform, suggest the presence of microorganisms that threaten public health from untreated human and/or animal waste. Dry weather bacteria loading can suggest an illicit sanitary sewer connection to a storm sewer or other constant source, whereas wet weather bacteria loading can suggest that bacteria is being carried by storm water from sources on the landscape such as pet waste, large animal waste, or failing septic systems. Typical standards for bacterial coliforms are as follows:

- 0 total coliforms per 100 milliter (ml) for drinking water;
- 300 *E. coli* per 100 ml (daily geometric mean) or 130 *E. coli*/100 ml (30-day geometric mean for total body contact (swimming));

¹ The Neoponset River Basin study regarding aesthetic quality of water (clarity) is used by the Rouge Program Office as a general guideline for assessing levels of Total Suspended Solids in baseline data reports.

- 1000 E. coli per 100 ml (daily geometric mean) for partial body contact (boating, etc.);
- 200 fecal coliforms per 100 ml (30-day geometric mean) or 400 fecal coliforms/100 ml (discharge) for treated or untreated sewage effluent.

Elevated levels of bacterial coliforms can prevent total body contact recreation, such as swimming, and often preclude partial body contact recreation, such as wading, fishing or boating, in the surface water systems.

Organic Chemicals and Heavy Metals

Organic chemicals and heavy metals (lead, copper, zinc, chromium, cadmium, etc.) are two classes of chemicals that are frequently cited as causing adverse environmental impacts in river ecosystems. The chemicals can disrupt physiology of aquatic organisms and some chemicals have been noted as accumulating in the fatty tissues of fish and other aquatic organisms. Organic chemicals such as polycyclic aromatic hydrocarbons (PAH) are by-products of manufacturing processes and combustion of fossil fuels. A common source of organic chemicals is automobile fluids such as gasoline and lubricating oils. Heavy metals, such as lead, zinc, copper, and mercury are also common by-products of manufacturing, but these contaminants are also common in agricultural and road surface runoff.

Temperature

Water temperature is a critical indicator of and directly affects many physical, biological, and chemical characteristics of a river. Temperature affects the amount of oxygen that can be dissolved in 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 3.20 shows examples of life supported at various temperatures. 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. 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. Temperature also affects the sensitivity of organisms to pollutants, parasites, and disease.

In order to support brown trout, the maximum water temperature should not rise above 20° C, or 68° F, in the summer months. When water temperature rises, dissolved oxygen decreases and fish populations are threatened. Measures should be taken to reduce the impact of impervious surfaces and to increase native stream bank vegetation and shading along the Clinton River and its tributaries. For warm water fisheries, a maximum summer temperature of 29.4° C, 85° F, should be maintained in order to maintain the many warm water fish species.

Table 3.20: Temperature Sensitivity of Aquatic Life

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

(CRWC Stony Creek Subwatershed Management Plan, 2003)

Dissolved Oxygen (DO)

A certain concentration of DO is essential for the survival of fish and aquatic organisms. A stable flow regime with riffles and cool water temperatures lead to increased DO concentrations. 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 – also reported 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. 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 causing poor odors and low food supply for aquatic 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 diffuses very slowly in water and distribution depends on the movement of the aerated water. DO levels naturally fluctuate throughout the day and 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 (CRWC, 2003).

pH

pH is a measure of the hydrogen ion concentration 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 acidic, 7 as neutral and 14 as highly basic. Most organisms have adapted to life in water with a specific pH and may not survive if the pH changes even slightly. 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 (CO₂) 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 and dredging can cause fluctuations in pH levels.

Biochemical Oxygen Demand (BOD)

Aerobic bacteria placed in contact with organic material will use this organic material as a food source. The end products are CO₂ and water. The amount of dissolved oxygen used in this process is the biochemical oxygen demand. It is considered to be a measure of the organic content of the waste. The difference between the DO result and the BOD result is the 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 (mg/L) (US EPA, 2000).

3.4.1 Clinton Main River Water Quality Data Summary

The Clinton River Main Branch is located in Oakland County and flows to Lake St. Clair, near the city of Mt. Clemens. The river consists of many branches that cover 70 square miles of agricultural, urban, suburban, and industrial land. Many parties have collected water quality data in the Clinton River including

Environmental Consulting & Technology, Inc., (ECT), Clinton River Watershed Council (CRWC) volunteers as part of the Global Rivers Environmental Education Network (GREEN) and United States Geological Survey (USGS). This section summarizes data from these sources.

ECT collected water quality data at two locations within the Clinton Main subwatershed as part of the Lake St. Clair Regional Monitoring program conducted for the Macomb County Health Department (MCHD). The two monitoring locations were located at the Clinton River at Auburn Road (CR09) and the Clinton River at M-59 (CR-11) (see Map 15). ECT collected water samples from these locations during dry and wet weather conditions. From September 2004 through October 2005, 16 dry weather events were sampled along with ten wet weather events. Water samples were analyzed for the following parameters: aluminum, biochemical oxygen demand (BOD), chloride, chemical oxygen demand (COD), *E. coli*, hardness, ammonia-N (NH₃), nitrate-N (NO₃), oil & grease (O/G), orthophosphate, total phosphorus (P), total dissolved solids (TDS), total Kjeldahl nitrogen (TKN), total organic carbon (TOC) and total suspended solids (TSS). However, only BOD, chloride, O/G, P, TSS, and *E. coli* are discussed below. These are the constituents that are used as relative indicators for water quality in this system.

The CRWC GREEN volunteers collect data for various water quality parameters, including dissolved oxygen concentrations, BOD, pH, nitrate, phosphate, temperature, turbidity and fecal coliform. They also document recent rain events during their data collection. Data collected by the CRWC GREEN volunteers is generally qualitative in nature. Depending upon the measured concentration, analytical results are classified into one of four categories (excellent, good, fair, and poor) and assigned a numerical ranking (4 through 1). These results are then pooled to calculate an overall qualitative water quality index and classify the water generally in one of the four categories.

Tables 3.21 and 3.22 present the summary data for ECT sample locations CR09 and CR11, respectively. These tables summarize the dry and wet weather monitoring data and compare the values to the average concentration measured at the mouth of the Clinton River (Shoemaker et al., 2002) and “critical values” as defined in Shoemaker et al., (2002). It is important to note that the following text summarizes a limited number of samples and any exceedances of criteria or identified differences may not be statistically significant. In general, there were 16 sets of dry weather data and 10 sets of wet weather data for each site. Four *E. coli* samples were collected during each wet weather event. The geometric mean values for each event were calculated from the individual sample results. These calculated values were used in Tables 3.21 and 3.22.

CR09 (South side of Auburn Road; West of Squirrel Road)

CR09 is located downstream from the City of Pontiac in Auburn Hills at the Auburn Road crossing, west of Squirrel Road. This location is directly across the street and upstream from Riverside Park. This site also corresponds to site #CM03 in these subwatershed planning activities. In general, water quality data at Clinton River at Auburn Road is higher than critical values presented in Shoemaker et al. (2002) for *E. coli*, BOD and total phosphorus. All three of these constituents have the potential to deplete oxygen either directly or indirectly. In addition, measurements collected during the wet-weather monitoring events were significantly higher than the dry weather measurements for *E. coli*, and TSS. This suggests that storm water runoff may be considered a source for these parameters at this location. This is consistent with expectations associated with wet weather monitoring. Four of the 16 dry weather samples for BOD; 12 of the 16 dry weather samples for *E. coli*; and, 16 of the 16 dry weather samples for total phosphorus were above the critical value presented in Shoemaker et al (2002). Further, average concentrations of BOD, chloride and total phosphorus were higher at the Clinton River at Auburn Road location than the mouth of the Clinton River.

In addition, data from the continuous monitoring station installed by the USGS at the Auburn Road crossing were also evaluated for the non-winter months from September 2004 to November 2005. These data indicate that dissolved oxygen concentrations fluctuate seasonally, as expected, and are generally above 6 mg/L. This indicates that dissolved oxygen concentrations are generally adequate at this location.

CR11 (Clinton River at M-59; West of Crescent Lake Road)

CR11 was located on the Clinton River at M-59 west of Crescent Lake Road, upstream of the City of Pontiac and the Clinton Main boundary. Based on the data collected by ECT in 2004 and 2005, water quality appears to be slightly better than that at CR09. The average dry weather measurements were not in excess of the critical values presented in Shoemaker et al (2002). However, all ten *E. coli* measurements collected during wet weather events were higher than the critical values. Of the six parameters, chloride was the only one that did not increase during wet weather conditions. Total phosphorus levels breached the critical values in 3 of the 16 dry weather samples and 2 of the 10 wet weather samples. This is significantly less than those for CR09, and suggests that nutrients may not be elevated at the M-59 location.

As with the data evaluated from the Auburn Road crossing, data from the continuous monitoring station installed by the USGS at the M-59 Road crossing were also evaluated for the non-winter months from September 2004 to November 2005. These data also indicate that the dissolved oxygen concentrations fluctuate seasonally, and are generally above 7 mg/L. This indicates that dissolved oxygen concentrations are generally adequate at this location.

Table 3.21 CR09: Clinton River at Auburn Road

		BOD	Chloride	<i>E. coli</i> ***	O&G	P	TSS
SampleID		(mg/L)	(mg/L)	(cfu/100 mL)	(mg/L)	(mg/L)	(mg/L)
Dry	Maximum	28	300	340	30	0.69	6
	Minimum	< 2	130	20	< 1	0.065	< 1
	Average	5.0	234	130	4.2	0.349	2.0
	Number of non-detect Samples	8	0	0	5	0	10
	Number of exceedences	4		12		16	
	Number of Samples	16	16	16	16	16	16
Wet	Maximum	7	280	71571	8.7	0.67	680
	Minimum	< 2	110	329	< 1	0.096	16
	Average	3	167	4971	2.5	0.321	132
	Number of non-detect Samples	2	0	0	3	0	0
	Number of exceedences	3		9		11	
	Number of Samples	9	11	10	10	11	11
Other	Clinton Mouth (average)**	1.55	63			0.045	
	Critical Value**	4		130		0.05	

* Italics value represents a non-detect. Half the detection limit was used to calculate the average.

** From: Shoemaker et al., 2002

*** Wet weather *E. coli* results reported as the geometric mean values for the 4 samples collected in a single event.

Table 3.22 CR11: Clinton River at M-59

		BOD	Chloride	<i>E. coli</i> ***	O&G	P	TSS
SampleID		(mg/L)	(mg/L)	(cfu/100 mL)	(mg/L)	(mg/L)	(mg/L)
Dry	Maximum	7	190	410	12	0.170	9
	Minimum	< 2	110	< 10	< 1	< 0.01	< 1
	Average	2	144	101	2.6	0.037	3
	Number of non-detect Samples	10	0	1	7.0	3	8
	Number of exceedences	2		9		3	
	Number of Samples	16	16	16	16	16	16
Wet	Maximum	8	150	33888	13	2.2	67
	Minimum	< 2	110	137	< 1	< 0.01	3
	Average	3	129	1171	2.9	0.241	22
	Number of non-detect Samples	5	0	0	7	1	0
	Number of exceedences	2		10		2	
	Number of Samples	9	10	10	9	10	9
Other	Clinton Mouth (average)**	1.55	63			0.045	
	Critical Value**	4		130		0.05	

* Italics value represents a non-detect. Half the detection limit was used to calculate the average.

** From: Shoemaker et al., 2002

*** Wet weather *E. coli* results reported as the geometric mean values for the 4 samples collected in a single event.

3.4.2 Nonpoint Source Pollutant Loading in the Clinton Main Subwatershed

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 Nonpoint 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 nonpoint source pollutant loadings of typical storm water quality parameters for the Clinton Main Subwatershed. The Clinton Main subwatershed was delineated into sixteen (16) sub-basins as identified in Map 16 for purposes of the evaluation. The Total Pollutant Loadings are based upon nonpoint pollution loading factors that vary by land use and the percent imperviousness associated with each land use type. Refer to Map 17. 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. Table 3.23 outlines the Event Mean Concentrations for the pollutants analyzed in the Clinton Main subwatershed.

Table 3.23: Summary of Event Mean Concentrations for the Clinton Main 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

(The Rouge River National Wet Weather Demonstration Project, 1998)

Definition of Terms

BOD: Biochemical Oxygen Demand	NO23: Nitrate + Nitrite
TSS: Total Suspended Solids	Pb: Lead
TP: Total Phosphorus	Cu: Copper
DP: Dissolved Phosphorus	Zn: Zinc
TKN: Total Kjeldahl Nitrogen	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 the Clinton Main subwatershed in the PLOAD model is 32 inches. Table 3.24 provides the corresponding percent impervious value associated with each land use type.

Table 3.24: Percent Impervious Based on Land Use Type

Land Use Type	Percent Impervious
<i>High Density Residential</i>	50
<i>Medium Density Residential</i>	30
<i>Low Density Residential</i>	10
<i>Urban Open</i>	10
<i>Commercial</i>	90
<i>Industrial</i>	80
<i>Highways</i>	90
<i>Forest/Rural Open</i>	0.5
<i>Agricultural</i>	0.5
<i>Water/Wetlands</i>	100

The PLOAD model allows both point source loadings as well as the implementation of BMP . Neither of these inputs was added to the PLOAD model of the Clinton Main Branch Basin due to lack of data available for both of these data inputs.

Results

The Clinton Main subwatershed is urbanized and comprised mainly of single-family residential, low-density residential and industrial land use types. Surface waters and lakes also account for a significant portion of the subwatershed. Map 17 outlines the land use information used in the PLOAD model. Because the subwatershed is significantly urbanized, variability in the storm water runoff pollutant loadings between sub-basins is minimal.

Results of the normalized pollutant loading analysis are shown in Table 3.25: Pollutant Loading Results of PLOAD Model Runs. Map 16 also depicts the delineated sub-basins with the associated annual loading rates. In order to provide a frame of reference for the results, a comparison to both urban and rural subwatersheds has been included . A catchment within the Red Run subwatershed was selected as the nearby urban subwatershed while the North Branch subwatershed was selected as the rural subwatershed.

Table 3.25: Pollutant Loading Results of PLOAD Model Runs

<i>BASIN</i>	<i>BOD</i>	<i>TSS</i>	<i>TP</i>	<i>DP</i>	<i>TKN</i>	<i>NO23</i>	<i>PB</i>	<i>CU</i>	<i>ZN</i>	<i>CD</i>
<i>Clinton Main</i>	44	158	0.7	0.3	4.2	2.9	0.10	0.065	0.46	0.006
<i>Red Run</i>	63	245	0.9	0.4	5.4	3.7	0.14	0.10	0.73	0.009
<i>North Branch</i>	5	50	0.2	0.1	1.0	1.4	0.01	0.003	0.02	0.000
<i>Clinton Overall</i>	30	112	0.5	0.2	3.0	2.2	0.06	0.04	0.27	0.004

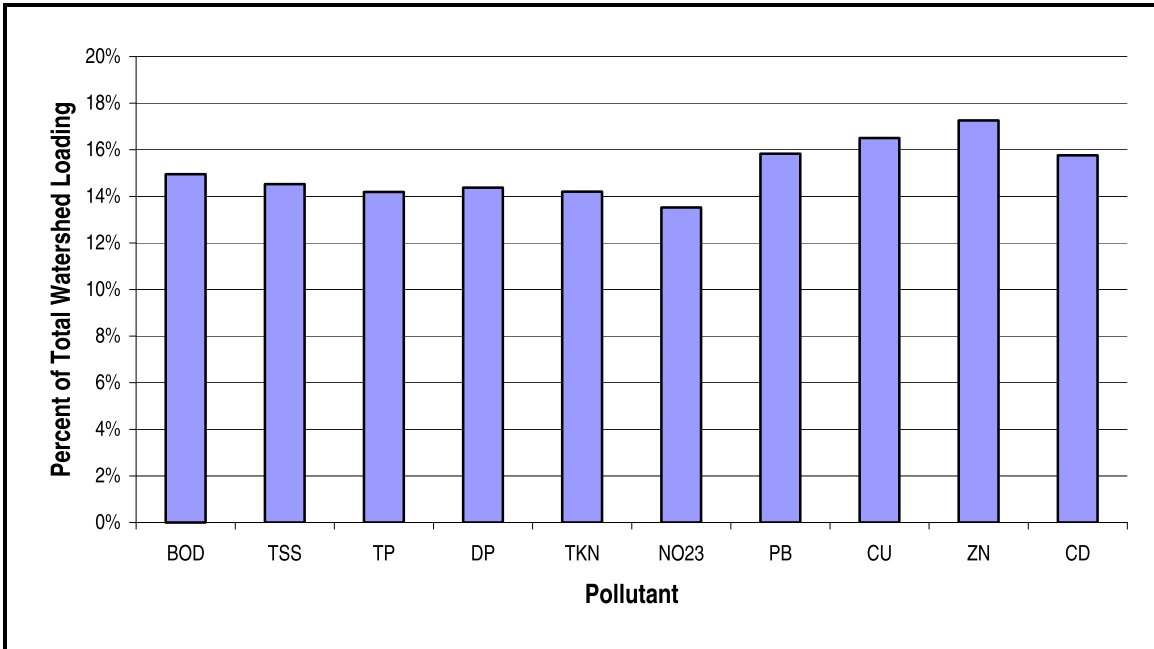
Overall, the delineated basins within the Main Branch of the Clinton River are somewhere between a rural and an urban watershed. However, most of the values of the pollutant loadings more closely resemble the loadings produced from a highly urban basin. Map 18 shows individual parameter results for phosphorus, nitrate and nitrites, biochemical oxygen demand and total suspended solids. The total loading of the Clinton Main subwatershed can also be compared to the total loading from the entire Clinton River watershed. This comparison can show the relative loading generated from the Clinton Main subwatershed. See Table 3.26 and Figure 3.11 for these results.

Table 3.26: Total Pollutant Loading from the Clinton Main Subwatershed

	Entire Clinton River Watershed		Clinton Main	Percent of Total Loading
<i>BOD</i>	13,668,722		2,044,139	15.0%
<i>TSS</i>	50,630,319		7,353,249	14.5%
<i>TP</i>	218,453		31,000	14.2%
<i>DP</i>	103,300		14,848	14.4%
<i>TKN</i>	1,378,958		195,892	14.2%
<i>NO23</i>	1,007,742		136,314	13.5%
<i>PB</i>	28,290		4,478	15.8%
<i>CU</i>	18,374		3,033	16.5%
<i>ZN</i>	123,465		21,314	17.3%
<i>CD</i>	1,740		274	15.8%
<i>Area, Square Miles</i>	760		73	9.6%

All Pollutant Units are in lbs/year

Figure 3.11: Percent of Total Clinton River Watershed Loading from the Clinton Main Subwatershed



Therefore, although the Clinton Main subwatershed comprises roughly 10% of the overall area of the Clinton River watershed, this subwatershed contributes from 13.5% to over 17% of the pollutant loading.

3.4.3 Point Source Discharges

The Michigan Department of Natural Resources Fisheries Division Draft Clinton River Assessment (December 2004) also describes point source pollution within the Clinton River Watershed. The Michigan Department of Environmental Quality has permitted 521 point source (storm sewer outfall discharges) discharges into the Clinton River and its tributaries. These permits have been issued through the National Pollution Discharge Elimination System (NPDES) Clean Water Act program. These permitted discharges emanate from wastewater treatment plants, water treatment facilities, industrial discharges, process water and storm water runoff. These permits also contain limits for various effluent parameters including metals, organics, nutrients, oil and grease, biochemical oxygen demand, temperature, dissolved oxygen and chlorine.

3.4.4 Clinton Main Subwatershed Waters Listed Under the Clean Water Act Section 303(d)

The 1972 Clean Water Act (CWA) Section 303 (d) provides special authority for restoring polluted waters, calling on states to work with interested parties to develop Total Maximum Daily Loads (TMDLs) for polluted waters. A TMDL is essentially a “pollution budget” designed to restore the health of the polluted body of water, specifying the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. It also allocates pollutant loadings among point and non-point sources. If a body of water is “listed” for CWA Section 303 (d) in Michigan, the MDEQ is charged with the task of setting dates to determine the pollution budget for the listed waterbody, as well as setting dates by which the waterbody will meet the designated budget. It is important to recognize TMDL listed waters in the subwatershed so

that the appropriate actions can be considered in this plan to address the various water quality or biological problems in these specified waterbodies.

Recent federal court decisions regarding Total Maximum Daily Loads (TMDLs) and subsequent changes in United States Environmental Protection Agency (USEPA) direction on the listing process have prompted the need for developing TMDLs for impaired waterbodies. In response, the USEPA has developed new rules regarding TMDLs that were implemented in 2002. Until that time, Michigan is proceeding with the TMDL process under the old rules. The MDEQ uses a rotating watershed cycle for surface water quality monitoring and National Pollutant Discharge Elimination System (NPDES) permit reissuance. Each of the 58 major watersheds in the State is scheduled for monitoring and discharge permit reissuance at least once every five years. This approach allows nonpoint source water quality-related issues and all the NPDES permits within a watershed to be addressed at the same time. Monitoring used to enhance permit issuance reviews is conducted in the targeted watersheds two years prior to NPDES permit reissuance. Michigan's Section 303(d) list is compiled by evaluating the most current, available site-specific data using the following decision process:

- ❖ The waterbody is not attaining Water Quality Standards (WQS), and the waterbody will not attain WQS with the application of technology-based controls, Best Available Technologies, or Best Management Practices.
- ❖ The waterbody is presently attaining WQS, but is expected to not meet WQS by April 2004 (Threatened Waterbodies).

Waterbodies that fall under these definitions are where the State needs to develop and implement either TMDLs or other suitable corrective actions to achieve WQS. The CWA Section 303 (d) list for the Middle One Subwatershed in the year 2004 includes the following waterbodies:

- ❖ Cass Lake located in the vicinity of Keego Harbor and West Bloomfield for PCBs and mercury. The schedule for TMDL development is 2010 & 2011, respectively.
- ❖ Clinton River from Yates Dam upstream to Pontiac WWTP outfall for poor fish communities. The schedule for TMDL development is 2006.
- ❖ Orchard Lake for mercury. The schedule for TMDL development is 2011.
- ❖ Osmun Lake upstream of Terry Lake in Pontiac for FCA-PCBs. The schedule for TMDL development is 2010.
- ❖ Terry Lake in Pontiac for FCA-PCBs. The schedule for TMDL development is 2010.

The complete report can be found on the MDEQ homepage, Surface Water Quality Division, GLEAS section. As the subwatershed communities and agencies develop their Storm Water Pollution Prevention Initiatives (SWPPIs), these waterbodies and their impairments should be given special consideration.

3.4.5 Clinton River Sediment Transport and Bank Erosion Hazard Index US Army Corps of Engineers Clinton River Sediment Transport Modeling Study

The U.S. Army Corps of Engineers (ACOE) developed a series of sediment transport models for the Clinton River Area of Concern. The goal in these and other related studies is to support State and local reductions in sediment loading to navigation channels, and thereby reduce the costs for navigation maintenance and sediment remediation (ACOE 2005).

The ACOE used a set of computational tools to evaluate watershed hydrology, soil erosion, sediment delivery, river channel hydrodynamics and sediment transport to evaluate best management practices (BMPs) within the watershed. Three models were used (Watershed Characterization System [WCS], Soil and Water Assessment Tool [SWAT], and Gridded Surface Subsurface Hydrologic Analysis [GSSHA]). These tools allow a broad understanding of the hydrologic and geomorphic factors in the watershed, which in turn can be used to predict relative effects of changing land use on soil erosion and sediment yield. Each tool is a necessary component of the watershed evaluation, as no individual model can assess the entirety of the system.

This study compared catchment baseline conditions (such as effective precipitation and drainage area) with empirical relationships established in other studies. Using this method, net erosion is estimated on the order of 200 to 600 tons per square kilometer per year (t/km²/yr) and sediment delivery to the outlet of the Clinton River (Lake St. Clair) of around 40,000 – 120,000 tons per year (t/yr) (ACOE 2005).

The Galloway Creek, a tributary to the main branch of the Clinton River, was considered separately in the ACOE investigation. This watershed covers approximately 17 square miles (mi²). It is classified as 44 percent (%) urban/developed, 24% agriculture, 27% forested and 8% water and wetlands. The model calculated that the amount of sediment in urban runoff to this tributary delivered to the channels is on the order of hundreds to several thousand cubic meters of which, approximately 93 percent leaves the system and enters the lower reach of the Clinton Main watershed.

In general, the models determined that land use and land use change are key factors contributing to soil erosion and sediment yield in this watershed. Cultivated and grazed land is the greatest nonpoint source of sediment, while developed land leads to flashy river flow (ACOE 2005). The models determined that sediment yields are not strongly correlated to population or new housing developments. Instead, sediment yield is strongly controlled by the occurrence of peak flows. As a result, increased flashiness due to urban development appears to trigger river channel instability and therefore increased channel erosion (ACOE 2005). This offsets the anticipated reduction in the amount of sediment available for transport once an area undergoes urbanization. The ACOE evaluated several best management practices to determine the effectiveness of various remedial measures. The impact of buffer strips on sediment load was evaluated the most thoroughly. It was determined that buffer width had the most influence on sediment load, rather than the vegetation type within the buffer. Other BMPs that were evaluated included sedimentation basins, wetlands, and construction control measures.

Streambank erosion is a natural process that occurs in every watershed; however excessive erosion has serious consequences for the physical and biological functions of any river system. Eroding streambanks can be a major source of pollutant loading to streams and it is often difficult to quantify streambanks eroding at natural rates as opposed to streambank erosion due to changes in watershed hydrology or sediment loads.

Bank Erosion Hazard Index

The Bank Erosion Hazard Index 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).

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 Clinton Main subwatershed. Results of the field surveys are provided on Table 3.28 and shown on Map 19. 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 of the watercourse are subject to the survey. In both the upstream and downstream directions there are 4 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 Total Score relative to the BEHI Category described in Table 3.27 below describes the potential for bank erosion to occur on one streambank. Four streambanks were assessed at each Survey Site, the right and left bank looking both upstream and downstream. Subsequent to determining the Total Score as shown in Table 3.27, a point system of five (5) points per streambank was assigned in order to further characterize the entire Survey Site.

Table 3.27: Bank Erosion Hazard Index Score

BEHI Category	Total 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	27.827.9-34.0	1
Extreme	34.1-40	0

From these scores, an overall ranking was applied to the survey area. A total of 20 points was possible for each survey site, with 20 points representing the best possible score and minimal erosion potential. Table 3.28 depicts the overall Survey Site score based on this point system.

Table 3.28: Bank Erosion Hazard Index Scoring Results

Survey Site	CM01	CM02	CM03	CM04	CM05	CM06	G01	G02	G03	G04	G05	PC01	PC02	T01	T02	T03
Total Points	14	15	14	13	13	16	14	13	12	16	15	20	12	15	16	16

Map 19 illustrates the ranking for each of the survey sites within the subwatershed. "Poor" sites show signs of extensive erosion conditions. A "Fair" site displays some erosion but has a good foundation that will limit

future erosion. This foundation may consist of vegetation growth on the banks or slight slope angles on the bank. Finally, a “Good” site will have minimal erosion. These sites have a good vegetation buffer and root cover. As the ACOE study demonstrated, increased imperviousness has had an impact on the flashiness in the river, which in turn impacts the direct channel bank erosion.

3.5 Physical Watershed Environment Characteristics

Michigan Department of Environmental Quality Road Stream Crossing

Field surveys were conducted at road stream crossings within the Clinton Main subwatershed in order to gain an overall picture of the physical conditions of the subwatershed. The Michigan Department of Environmental Quality, Surface Water Quality Division, developed the Stream Crossing Watershed Survey Procedure. This procedure is generally used as a screening tool to increase the amount of information available on the water quality of streams and rivers. It provides a standardized assessment with data recording procedures for use by experienced watershed professionals as well as trained volunteers for long-term watershed monitoring programs.

Field surveys within the Clinton Main subwatershed consisted of evaluating various parameters at road stream crossings in the subwatershed. Table 3.29 identifies the community and road crossing location with the corresponding site identification number. Physical conditions were documented on the MDEQ’s Single Site Watershed Survey Data Sheet and compiled into a database for comparison with other watershed data.

Table 3.29 Survey Site Location

Site Number	Road Crossing	Community
CM01	Avon/Dequindre	Rochester Hills
CM02	Livernois south of Avon	Rochester Hills
CM03	Auburn	Auburn Hills
CM04	Martin Luther King	Pontiac
CM05	Orchard Lake Road	Pontiac
CM06	Cooley Lake	Waterford
G01	Butler	Rochester Hills
G02	Pavilion	Oakland University
G03	Squirrel	Auburn Hills
G04	Perry	Pontiac
G05	Giddings	Pontiac
PC01	Sanderson & Norton	Pontiac
PC02	Oakland County	Pontiac
T01	Elizabeth Lake Road	Waterford
T02	Coomer Road	Waterford/W. Bloomfield
T03	Orchard & Pine Lake	Orchard Lake Village

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 H₂O 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 3.4 River Flow Characteristics.

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 3.30 describes the categories and the ranking methodology are described as follows:

Table 3.30 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 3.31 describes the points were assigned as follows:

Table 3.31 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 3.32 describes the points, which were assigned to each characteristic in this category:

Table 3.32 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
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 3.33. 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 3.33: 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 3.34 provides the list of Potential Sources to select from.

Table 3.34 Potential Pollution Source List

POTENTIAL SOURCES	
Crop Related Sources	Land Disposal
Grazing Related Sources	On-site Wastewater Svstems
Intensive Animal Feeding Operations	Silviculture (Forestry NPS)
Highway/Road/Bridge Maintenance and Runoff	Resource Extraction (Mining NPS)
Channelization	Recreational/Tourism Activities
Dredging	<ul style="list-style-type: none"> • Golf Course
Removal of Riparian Vegetation	<ul style="list-style-type: none"> • Marinas/Recr. Boating (water releases)
Bank and Shoreline Erosion/Modification/Destruction	<ul style="list-style-type: none"> • 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

Clinton River Cold Water Conservation Project (CRCCP)

The Clinton River watershed includes three DNR designated trout streams and several more tributaries that are known to harbor trout year-round. A steelhead run is located within the lower main branch of the Clinton River. The Clinton Valley Chapter of Trout Unlimited (TU) has worked on long-term habitat restoration for trout streams in the watershed.

The Clinton River Cold Water Conservation Project consisted of a first phase, which included an evaluation of 25 miles of river and tributary from Squirrel Road downstream to Yates Dam. An assessment of the cold water potential and public access opportunities in lower Galloway Creek and the middle mainstream section of the Clinton River was completed in order to determine potential designation of a trout stream. Stream inventory work consisted of an evaluation of physical conditions including riparian corridor, woody debris and aquatic plants. Stream temperature, morphology and macroinvertebrate surveys were also conducted. Data collected from this study was also incorporated into the physical data collected in the during the road stream crossing.

The maximum number of points possible was 92 with sites ranging from 1 to 40 points. The highest quality sites were G02 and G03 while the lowest quality sites were CM02 and T01 strictly based on this physical characteristic data. These data were further used with the macroinvertebrate survey data, the bank erosion hazard index and the nonpoint source pollutant loading estimates to qualitatively describe initial critical areas within the subwatershed. Further discussion is presented in Section 3.10 Description of Critical Areas.

3.6 Biological Conditions

Macroinvertebrates

Aquatic macroinvertebrate communities (aquatic insects and invertebrate animals) are useful long-term indicators of water quality. Aquatic macroinvertebrates live in or on the bottom of streams, and include species of insects, clams, snails, worms, scuds, sow bugs, and crayfish, among others. Since macroinvertebrates are relatively immobile and short lived, the presence/absence, abundance, and diversity of certain taxonomic groups (taxa or family of macroinvertebrates) can indicate long-term changes in water quality.



Different groups of macroinvertebrates respond differently to changes in water quality and physical habitat characteristics. Generally, a natural, unpolluted stream supports a diversity of macroinvertebrates. Examples of sensitive aquatic insect groups include the stonefly, mayfly, and caddisfly orders. These insect orders are almost always present in healthy stream environments, and usually represent a significant portion of the overall macroinvertebrate numbers. In degraded streams, such “pollution-intolerant” macroinvertebrate groups are less abundant or absent, while more “pollution-tolerant” groups become more abundant. Examples of such pollution-tolerant macroinvertebrate groups include aquatic worms, midges, leeches, and true bugs. Many of the pollution-tolerant aquatic insect groups have the ability to survive low dissolved oxygen conditions by using atmospheric oxygen.

Macroinvertebrate communities have been assessed at twelve main branch sites and nine tributary sites throughout the Clinton River main subwatershed (Map 21). Multiple assessments have been conducted at some sites between 1991 and fall of 2004. Environmental Consulting & Technology, Inc. (ECT) conducted assessments at fourteen sites in November 2004 to provide recent macroinvertebrate community assessment data for the entire Clinton River main subwatershed, including tributaries. All of the assessment data was collected and evaluated using the Michigan Department of Environmental Quality “Stream Crossing Watershed Survey Procedure, April 27, 2000” (Procedure). The Procedure outlines macroinvertebrate sampling methodology and provides a data form for scoring the assessment sites

(Appendix D). The Procedure results in a “Stream Quality Score” (SQS) and ranking. Table 3.36 presents summary statistics for individual main branch sites with three or more data points and all main branch sites combined (includes assessment data collected between 1999 and fall 2004).



Mayfly– Ephemeroptera,
Heptagenidae family



Mayfly adult

Table 3.36: Macroinvertebrate Summary Stream Quality Scores.

Site	Stream Quality Score (SQS)			
	Count	Mean	Min	Max
CM03	9	33	16	45
CM05	3	31	21	39
CM01	3	49	36	59
ALL	24	31	13	59

*Summary statistics of assessment data collected between 1999 and fall 2004

Interestingly, the furthest downstream site, CM01 (23 Mile Road/Yates Park), had the highest SQS, was the only main branch site to receive an Excellent ranking in two out of three assessments, and had the highest mean SQS. The lowest main branch SQS score was 13 and occurred at Auburn Road.

The location and ranking of sites assessed by ECT in November 2004 are shown on Map 22 in Appendix A. Figure 3.12 shows the results of ECT’s November 2004 macroinvertebrate assessments. Although three sites ranked as Good, the scores for those sites (36, 37, 39) only slightly exceeded the lowest possible score for the Good ranking of 34, range 34 to 48. The highest scoring site scored 39 out of a possible 74 points. Generally, as diversity of macroinvertebrates decreases, the SQS and ranking decrease.



Net-spinning caddisfly –
Trichoptera, Hydropsychidae family

The mean number of taxa seemed to be the best predictor of community rank. Figure 3.13 shows that the mean number of taxa was highest for Good sites and lowest for Poor sites. The mean number of common taxa also shows a similar trend. However, the mean number of taxa seemed to be a stronger indicator of macroinvertebrate community health. The low influence of common taxa is probably

suggestive of general low abundance across all sampling stations, and is reinforced by observation during field sampling.

Figure 3.14 shows the contribution of the three pollution tolerance groups to the total SQS. The sensitive group score is an important aspect of higher total SQS scores. The sensitive taxa group accounted for fifty-three percent (53%) of the mean score for the Good sites, but only accounted for thirty-percent (30%) of the mean score for Fair and Poor sites. Furthermore, the mean tolerant taxa group score of Fair and Poor sites was double that of Good sites (24% versus 12%). In addition, the sensitive taxa group was dominant at Good sites, while the moderately sensitive taxa group was dominant at Fair and Poor sites. The primary difference between Good sites and Fair or Poor sites was the number of sensitive taxa. The main difference between Fair and Poor sites was the total number of taxa rather than the community composition.

Typical macroinvertebrates present at the sites included the following:

- ❖ Good: Beetle adults, Caddisfly larvae, Mayfly, Stonefly
- ❖ Fair: Clams, Cranefly, Damselfly, Scuds
- ❖ Poor: Aquatic worms, Midge larvae, Sowbugs, Water snipe flies, Pouch snails



Caddis flies were present, and typically common, at all but three sites (G04, PC02, and T01). Either scuds or sow bugs (crustaceans), sometimes both, were present at all but one site (PC02). One or the other were typically common if present. When both were present, only one was typically common. The most variable taxa were the mayflies, stoneflies, and adult beetles. Other surprising observations include the absence of blackflies at many sites, and low abundance at sites where they were present.

Comparing 2003 and 2004 data, including ECT's fall 2004 data, with data collected prior to 2003 yields some interesting information about macroinvertebrate communities in the Clinton River main subwatershed area (comparisons were not made with tributary data due to the low number of samples available). Due to the low number of assessments in any given year, the assessment data were pooled for the years 1999 through 2001 for comparison to more recent data (2003 and 2004, no 2002 data are available).

This comparison was drawn two ways. First, all of the 2003 and 2004 assessment sites were used to calculate a mean SQS. Second, only the 1999-2001 assessment sites (CM01 and CM03) were used to calculate the mean SQS for 2003 and 2004 (only CM03 was assessed in 2003, yielding two data points). In 2004, twelve different sites were assessed including, CM01 and CM03. Those twelve sites covered the entire Clinton River main branch within the main sub-watershed area, although nine of the twelve are located east of the I-75 corridor. Table 3.37 summarizes the results of macroinvertebrate assessments in the Clinton River main subwatershed area over time.

Table. 3.37: Summary Stream Quality Scores for Clinton Main Sites by Year.

Period	Stream Quality Score (SQS)			
	Count	Mean	Min	Max
99-01 All Sites	5	41	22	59
2003 All Sites	4	35	24	45
2004 All Sites	15	26	13	42

	Stream Quality Score (SQS)			
2003 CM03 Only	2	35	24	45
2004 CM01/CM03 Only	5	35	16	42

Figure 3.15 shows the apparent trend in stream quality score resulting from this comparison between the 1999-2001 period and 2003/2004. The trend using all 2003/2004 assessment sites shows a decrease in the mean SQS from 41 during the 1999-2001 period to 26 in 2004. When only the 1999-2001 period assessment sites are used to calculate the 2004 mean, the difference is less, but still shows a declining trend from 41 to 35. Similar declines can be seen in the maximum and minimum SQS values. The differences in the mean SQS in 2004 for all assessed main branch sites and CM01/CM03 only suggests that spatial variability plays some role in defining the trend. However, even the CM01/CM03 mean for 2004 shows a decline in the mean SQS from the 1991-2001 period. It is worth noting that the differences in the means between the 1991-2001 period and 2004 (including all 2004 sites) is not statistically significant ($t=1.66$, $\alpha=0.5$). However, the t-test used is not very robust due to the low number of samples obtained during the 1991-2001 period ($n=5$). It is plausible that the declining trend may have been significant had the 1999-2001 period assessments been more extensive.

Despite the results presented above, it is difficult to conclude at this time whether the macroinvertebrate community health is changing in the Clinton River main sub-watershed area. Biological populations and communities can fluctuate substantially. It is possible that the 1999-2001 data represent a high point, while the 2004 data represent a low point. Such swings in populations can be caused by various environmental factors, both natural and human-induced. Figure 3.16 illustrates this point very well. Figure 3.16 shows the results of assessments conducted at CM03 between 1999 and fall 2004. This is the only site with a long enough sampling history to make this illustration possible. The CM03 data show substantial variation with no clear trend. Future volunteer monitoring efforts will be important to determining whether macroinvertebrate community health in the Clinton Main subwatershed area is stable, declining, or improving.

The Michigan Department of Natural Resource recently released its Final Draft of the Clinton River Assessment. In the assessment, the MDNR presents the results of watershed-wide sampling in the 1970's and early 1980's (35 sites) and recent, but more limited, sampling. The assessment does not provide about sampling site locations, but does reference a MDNR report (MDNR 1988). The MDNR assessment summarizes macroinvertebrate assessment results in the executive summary:



“The headwaters area and some of the major tributaries, such as Paint Creek and North Branch of the Clinton River have good species diversity, including sensitive species that are indicators of good water quality. However, abundance of sensitive species have declined in recent samples, indicating reduced water quality. But other severely degraded sections, such as downstream of Pontiac, have shown a recovery.”

The results presented in the MDNR assessment are briefly summarized below.

Upper Segment (Middle Lake to I-75)

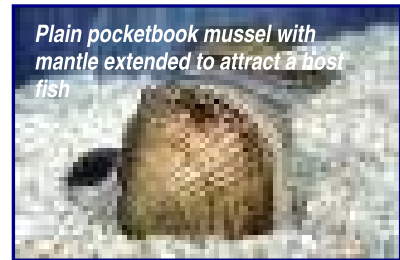
During the 1970's and early 1980's, pollution tolerant species dominated the macroinvertebrate community upstream of Pontiac, although mayflies and caddisflies were present in reduced numbers. Only one site was sampled in 1999. The 1999 sampling found no mayflies or caddisflies.

Middle Segment (I-75 to M-59 at Utica)

Sixteen sites were sampled in the Middle Segment during the 1970's and early 1980's. Macroinvertebrate assessment results during the early 1970's were indicative of heavy industrial pollution and poor waste water treatment, especially downstream of the Pontiac and Rochester waste water treatment plants. Macroinvertebrate communities improved downstream of the WWTPs. Later assessments in 1982 showed that macroinvertebrate communities were improving due to advancing waste water treatment technologies, tighter regulatory controls, and increasing awareness of environmental concerns. More recent assessments in 1994 and 1999 had similar results to the 1982 assessments.

Mussels

Typical macroinvertebrate assessment methods like those described and used herein and by volunteer groups, generally are not designed to assess mussel populations. The macroinvertebrate assessments described above do not provide information about past or current mussel populations. The MDNR assessment (MDNR 2004) provides results from mussel-specific surveys conducted primarily in the late 1970's. The results presented in the MDNR assessment are summarized in the assessment's executive summary:

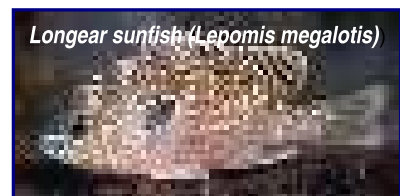


“A comprehensive mussel survey was conducted throughout the watershed in 1977 and 1978. Species richness in the Clinton River was excellent (31 species). A colony of purple lilliput is the only known colony in the state and the largest colony reported anywhere since around 1900 and the upper Clinton also supports what is likely the only population of rayed bean living in Michigan's streams. The North Branch of the Clinton River contains the finest remaining example of a large river mussel community in eastern Michigan, because it has many species that have been extirpated from their range in eastern Michigan. More recent sampling of mussels in the upper Clinton River in the mid-1990s found similar species present as earlier samples, although relative abundance varied.” (MDNR 2004)

An effort should be made to assess the current status of mussel populations in the main sub-watershed area, especially populations of threatened, endangered, and special concern species.

Fisheries

The most comprehensive source of information about the fisheries of the Clinton River main sub-watershed area is the MDNR 2004 Final Draft of the Clinton River Assessment. The assessment thoroughly summarizes past and current fish populations, management practices, and fisheries status in the executive summary:



“There is little information on the Clinton River's original fish community, although fisheries surveys show 100 species of fishes recently occurring in the Clinton River drainage. Most species are native, although 3 species have colonized and 17 species were introduced

(some intentional and others accidental). Four introduced species (coho and kokanee salmon, cutthroat trout, and lake whitefish) are no longer present because their stocking programs have stopped. Nine species have been identified as status unknown because they have not been captured during recent fisheries surveys. Although present fish species richness in the Clinton River watershed remains high, certain species have declined. Watershed development has favored tolerant species with broad habitat requirements. Agricultural and urban development activities have reduced flow stability and increased sediment load in streams throughout the watershed. The abundance of silt-tolerant fish species have increased in the watershed, whereas fishes requiring clean gravel substrate or clean water with aquatic vegetation at some point in their life cycles have declined.” (MDNR 2004)

“Fish sampling was conducted by Fisheries Division at 38 sites throughout the watershed during the summer of 2001 and 2002. Sixty one species of fish were caught, with white suckers, creek chubs, bluegills, green sunfish, largemouth bass, and Johnny darters being the most frequently seen species among sites.” (MDNR 2004)

“Fishery management of the Clinton River ranges from low in the headwaters and upper segment to high in the middle and lower segments and Paint Creek. Past management practices have included fish stocking, habitat improvements, fishing regulations, and chemical reclamation to reduce competitors. A number of species of fish have been stocked at various times and locations throughout the watershed. Current significant sport fisheries include a brown trout fishery on Paint Creek, and a seasonal steelhead and walleye fishery on the lower portion of the Clinton River. There are also ongoing stocking efforts at various lakes within the watershed.” (MDNR 2004)

The MDNR used Michigan’s Procedure 51 protocol to evaluate the well-being of the fish community at sampling sites. Procedure 51 provides a means of scoring and ranking fish communities using a set of ten metrics such as “Total Number of Taxa” and “Number of Darter Taxa.” The results presented in the MDNR assessment are briefly summarized below.

Headwaters Segment (origin in north-central Oakland County to Middle Lake)

One site was surveyed in 2001. Survey results indicated water quality is good. Darter species, a sensitive species, made up 35% of the total number captured. The procedure 51 rating was excellent.

Upper Segment (Middle Lake to I-75)

Two main branch sites were sampled in 2001. Site 2 received an acceptable ranking, while site 3 received an excellent ranking. Several sites throughout Upper Segment were surveyed in the 1970’s and early 1980’s. The 2001 survey results were similar to previous survey results.

Middle Segment (I-75 to M-59 at Utica)

Three sites were sampled in the Middle Segment in 2001 and 2002. One of the sites, site 7, was downstream of the main sub-watershed area. Application of Procedure 51 resulted in site rankings of acceptable for sites 5 and 6. Site 7 received an excellent ranking. The assessment compared recent fisheries survey results in the Middle Segment to results of surveys conducted in 1973:

“Even given these constraints, there have been enough data collected to note clear changes in the fish community in the past three decades. In 1973, twelve stations were sampled along this [Middle] segment.

Catch rates improved from 14.1 fish/100 foot sampled in 1973 to 58.5 fish /100 foot sampled in 2001 and 2002. Not only are more fish present in recent samples, but species richness has also improved. Pollution intolerant species were not found until the late 1980's. These results are not surprising given the history of pollution problems on the Clinton River downstream of Pontiac." (MDNR 2004)

Galloway Creek is the only major tributary of the MDNR's "Middle Segment" that is also within the main sub-watershed area. The MDNR surveyed the fishery of Galloway Creek at one site in 2001. The site was located between Galloway Lake and the confluence with the Clinton River. The fish population was dominated by pollution tolerant species, although a few rainbow trout and brown trout were captured. Results were similar to a survey conducted in 1986 with the exception of trout captured in 2001.

Figure 3.12: Clinton Main Subwatershed Macroinvertebrate Community Ratings

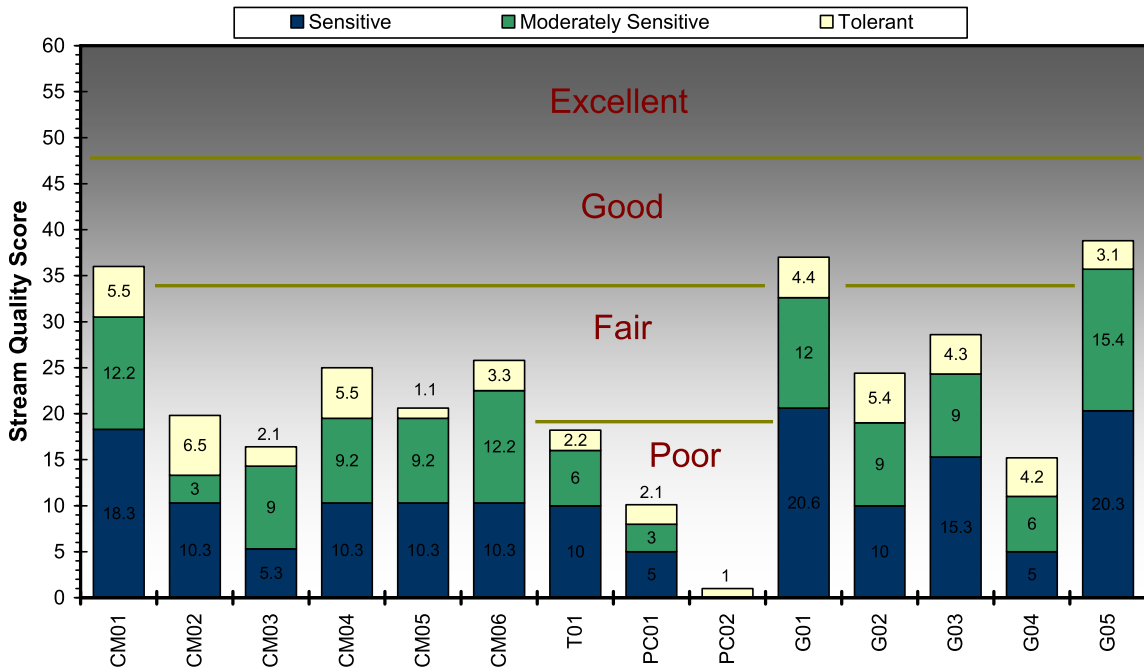


Figure 3.13: Number of Taxa by Rank (Measure of Diversity)

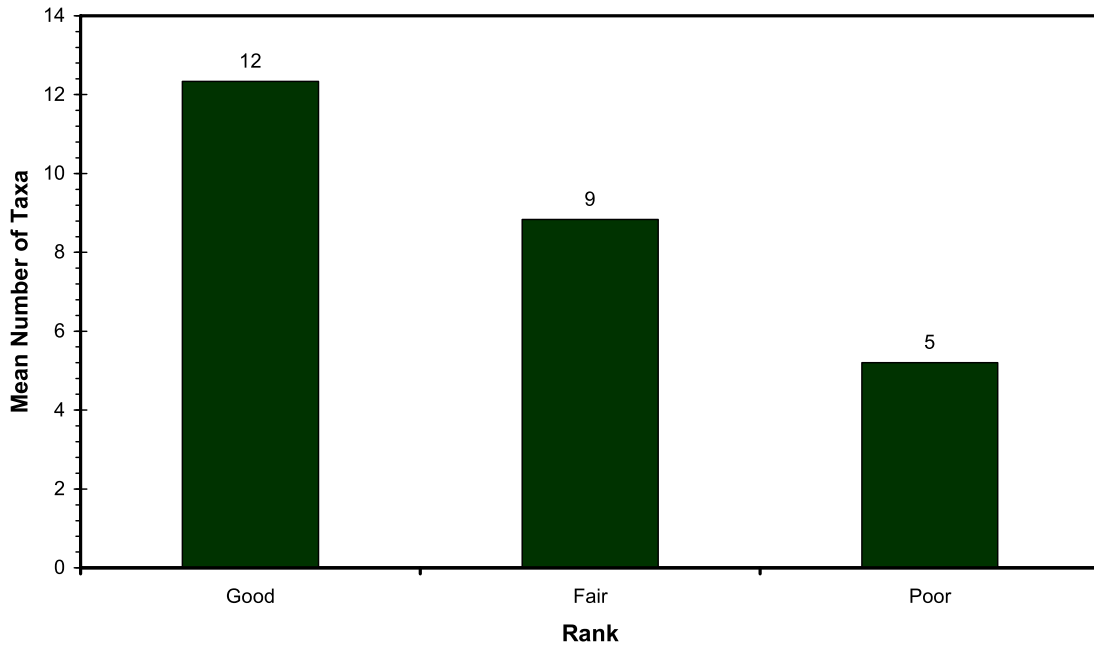


Figure 3.14: Taxa Group Scores by Site Ranking

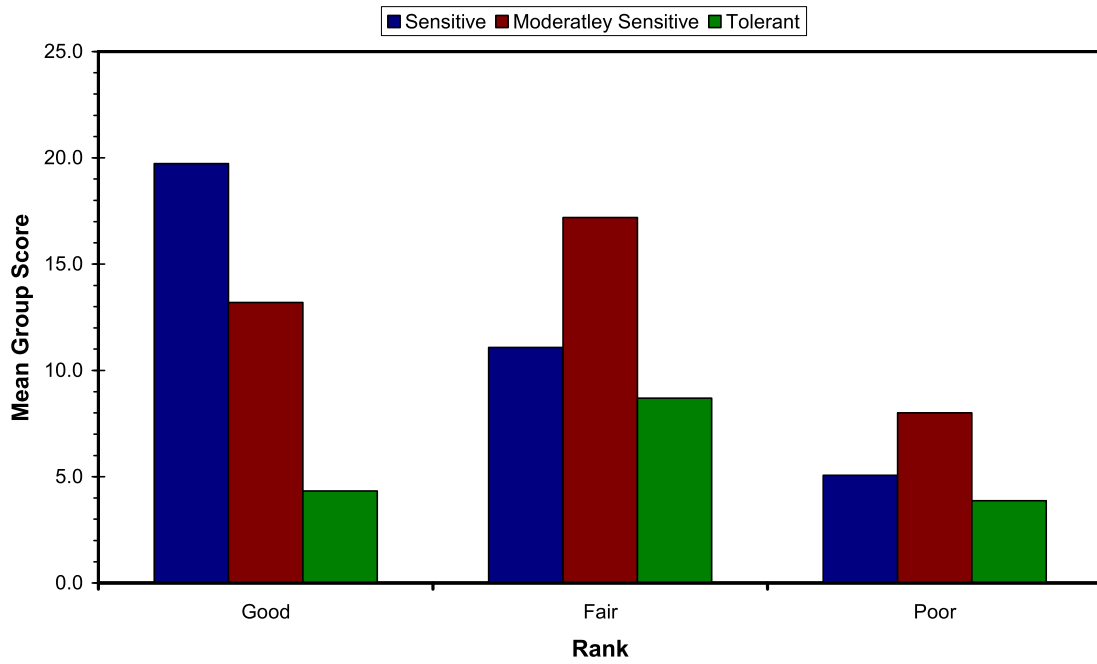


Figure 3.15: Time Trend Plot – Comparison of Stream Quality Scores

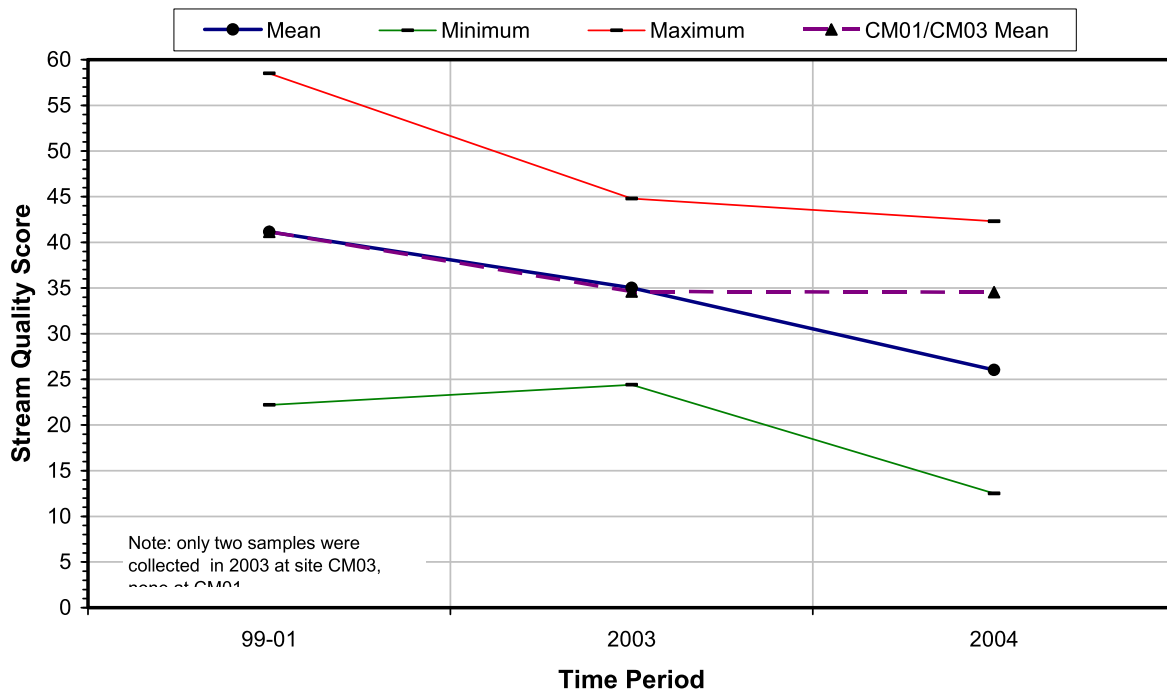
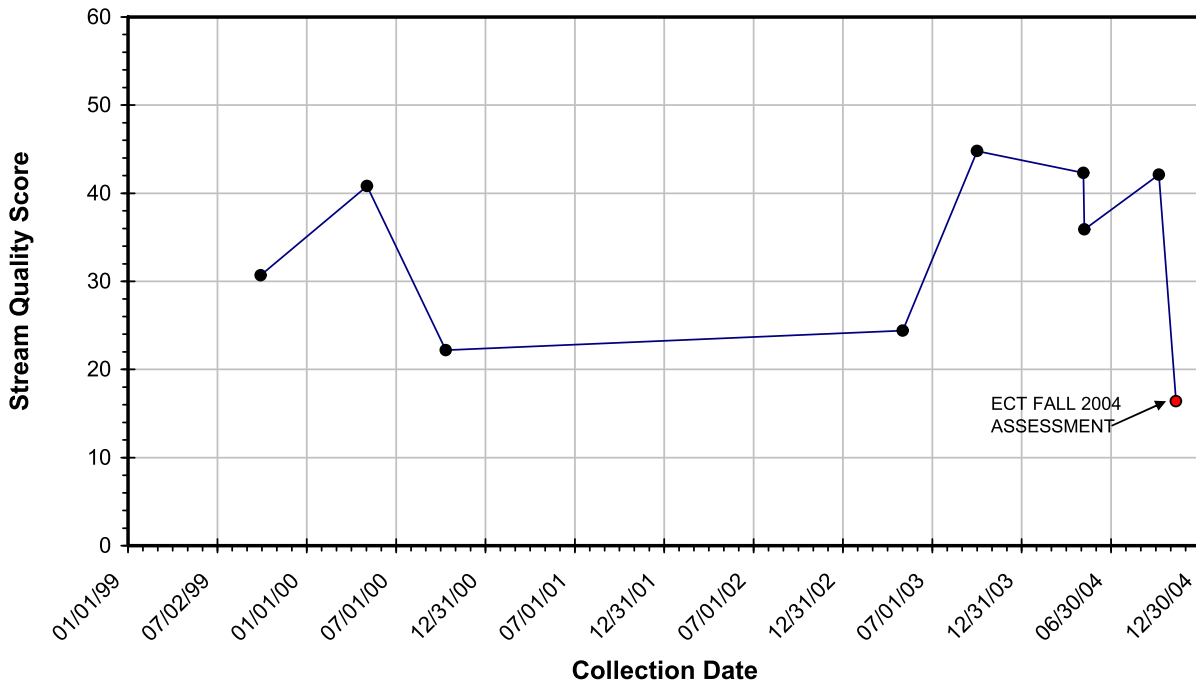


Figure 3.16: CM03 Time Trend – Stream Quality Scores



3.7 Quality of Lakes in the Subwatershed

There are a total of 172 lakes in the Clinton River Watershed that are at least 10 acres in size. The Upper segment of the Clinton River begins at Middle Lake and continues approximately 30 miles to just east of I-75 in Auburn Hills. Both the Upper and Main Clinton River subwatersheds encompass this area. The character of the river is influenced by the lakes that it passes through. Lakes traversed by the Clinton River following Middle Lake in the Upper Clinton subwatershed, include Dollar Lake, Greens Lake, Lotus Lake, Lester Lake, Van Norman Lake, Woodhull Lake, Lake Oakland, Loon Lake, Cass Lake, Otter Lake, Sylvan Lake, Dawsons Mill Pond and Crystal Lake. Of these lakes, Cass Lake, Otter Lake, Sylvan Lake, Dawsons Mill Pond and Crystal Lake are located within the Clinton Main subwatershed.

Within the Clinton Main subwatershed, the Clinton River is a connector between many of the lakes. It enters the west side of Cass Lake, flows to Otter Lake, then thru Sylvan Lake and exits Sylvan Lake at Telegraph Road. It then flows into Dawsons Mill Pond and finally Crystal Lake in Pontiac. All of these lakes have an impact on the flows in the Clinton River.

The overall quality of lakes is dependent on many factors, including water quality, recreational use and development around the shoreline of the lake. Phosphorus is a nutrient that is a major factor influencing the productivity or trophic state of a lake. Trophic state refers to a lake's ability to support plant/animal life. Oligotrophic lakes have little plant/animal life and are generally deep, clear and have little aquatic plant growth. Eutrophic lakes are shallower, turbid and have a high amount of plant and animal life. Mesotrophic lakes are classified in a stage between oligotrophic and eutrophic. Lakes with nuisance algae and weed growth are classified as hypereutrophic. Generally dissolved oxygen concentrations are highest in oligotrophic lakes and these lakes support cold water fish such as trout and whitefish. On the other hand,

eutrophic lakes have lower dissolved oxygen concentrations and support warm water fish such as pike, bass and sunfish.

Various parameters are commonly measured to gage the level of eutrophication in a lake. These parameters include phosphorus concentrations in the water, *chlorophyll a*, transparency, dissolved oxygen, temperature and suspended solids. Temperatures in a lake indicate if the mixing process is occurring. This process occurs as nutrients move from the bottom of the lake into the surface waters and is apparent by the presence of algae blooms. Dissolved oxygen gives an indication of fish populations that may be supported in the lake. The transparency of the water is measured using a Secchi disk and the lower the value the higher the indication of a nutrient rich lake. Chlorophyll a provides an indication of the presence of plants and algae in the lake while phosphorus also is a primary indication of eutrophication.

Phosphorus is a plant nutrient and also a component of commercial products such as detergents and fertilizers. Phosphorus in surface water bodies may contribute to overgrowth of aquatic plants, which in turn can cause low dissolved oxygen levels. Dissolved oxygen is a measurement of the amount of oxygen held in the water and it is critical for survival of fish. Dissolved oxygen levels in the deeper parts of the Lake can be quite low in late summer months (WBTPE 2001). Other parameters, which are routinely measured in lake water, include conductivity, alkalinity and pH. Conductivity is a measurement of the amount of electrical current that can pass through the water. The more ions that are present, the higher the conductivity value. Alkalinity is the capacity of water to neutralize acids. Alkalinity measures components in water such as carbonates and bicarbonates (baking soda is a type of bicarbonate) in the water. The converse of this measurement is acidity (which is a measure of the water's ability to neutralize bases). pH gives an indication of the intensity of the water's acidic or basic character (American Public Health Association [APHA] 1989). Finally, water clarity in lakes is measured by a device known as a secchi disk, which measures the water clarity by depth in feet.

Various water quality and sediment data has been collected throughout a number of the lakes in the Clinton Main subwatershed. Data further described in this section includes water quality data for Orchard Lake, Cass Lake and Pine Lake. Sediment data has been collected in Sylvan Lake and is also summarized in this section. Maps 23 through 28 in Appendix A provided through the Michigan Department of Natural Resources website are survey maps of the following lakes within the Clinton Main subwatershed:

- ❖ Cass Lake; Map 23
- ❖ Crystal Lake; Map 24
- ❖ Elizabeth Lake; Map 25
- ❖ Pine Lake; Map 26
- ❖ Orchard Lake; Map 27 and
- ❖ Sylvan and Otter Lakes Map 28

3.7.1 Cass Lake Water Quality

Cass Lake occupies parts of Bloomfield and Waterford Townships, Orchard Lake Village and Keego Harbor in southeast Michigan. Its main tributary is the Clinton River. According to West Bloomfield Township Planning and Environment Department (WBTPE) (1997) Cass Lake flows to Sylvan Lake. It is approximately 1280 acres in size with a perimeter of 26.1 miles and maximum depth of 120 feet. The shoreline of Cass Lake is mostly developed for residential use, with manicured lawns commonly extending to the water's edge. During initial development, small seasonal summer cottages were constructed on the lakeshore. These summer cottages are being replaced with larger year-round homes. This increases the impervious surface associated with the perimeter of the Lake and may increase direct runoff to the Lake

Chapter 4

Goals and Objectives of the Clinton Main Subwatershed

4.1 Designated and Desired Uses of Waterbodies in the Clinton Main Subwatershed

According to the Michigan Department of Environmental Quality, the primary criterion for water quality is whether the waterbody meets designated uses¹. Designated uses are recognized uses of water established by state and federal water quality programs. In Michigan, the goal is to have all waters of the state meet all designated uses, as listed below that apply to the waterbody. It is important to note that not all of the uses listed below may be attainable, but that as ultimate goals, they provide a positive direction toward which the subwatershed can move. These designated and desired uses for the Clinton Main will be managed by the communities and counties through which it traverses according to the above long-term goals.

Clinton Main Subwatershed Designated Uses:

All surface waters of the state of Michigan are designated for and shall be protected for all of the following uses. Those that currently apply to the Clinton Main Subwatershed (according to discussions and understanding of the representative communities) are in **boldface**:

1. Agriculture (N/A)
2. Industrial water supply (N/A)
3. Public water supply at the point of intake (N/A)
4. **Navigation**
5. **Warm water/cold water fishery**
6. **Other indigenous aquatic life and wildlife**
7. **Partial body contact recreation**
8. **Total body contact recreation between May 1st and October 31st**

The Clinton Main is not known to be used as an industrial, public or agricultural water supply at this time; therefore these uses are not addressed further in this plan.

Clinton Main Subwatershed Desired Uses:

The representative permittees of the Clinton Main Subwatershed also developed the following desired uses for the Clinton Main in addition to the designated uses defined above. Note that these uses apply generally to the natural features of the subwatershed, in addition to the waterways themselves:

- Wildlife habitat enhancement
- Preservation/protection of remaining open spaces/natural areas
- Enhance recreational opportunities (boating, trails, canoeing, fishing)
- Flood control (BMP implementation)

The designated uses 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 4.1). This information is summarized in the table below:

¹ R323.1100 of Part 4, Part 31 of PA 451 of 1994

Table 4.1: Clinton Main Uses, Impairments, and Pollutants / Threats (N/A = currently not applicable; k = known; s = suspected)

Designated or Desired Use	Impaired or Threatened?	Pollutants / Threats
Agriculture	N/A	N/A
Industrial Water Supply	N/A	N/A
Public Water Supply at the Point of Intake	N/A	N/A
Navigation	Impaired in some areas	Hydrology ¹ (k) Debris ² (k) Nutrients (k)
Warm Water/Cold Water Fishery	Impaired in some areas	Sediment (k) Hydrology ¹ (k) Temperature (k) Organic, Industrial & Toxic Compounds (s) Bacteria (k) Salt (s) Low D.O. levels (k) Lack of Aquatic and/or Riparian Habitat (k)
Indigenous Aquatic Life and Wildlife	Impaired in some areas	Sediment (k) Hydrology ¹ (k) Temperature (k) Organic Compounds (s) Bacteria (k) Salt (s) Low D.O. levels (k) Lack of Aquatic and/or Riparian Habitat (k)
Partial Body Contact Recreation	Impaired in some areas	Bacteria (k)
Total Body Contact Recreation (Between May 1 st & October 31 st)	Impaired in some areas	Bacteria (k)
Wildlife Habitat Enhancement	Impaired in some areas	Lack of Aquatic and/or Riparian Habitat (k) Debris ² (k) Loss of natural features (k) Lack of public awareness (k) Limited public awareness (k)
Preservation/Protection of	Impaired in some areas	Loss of natural features (k)

Designated or Desired Use	Impaired or Threatened?	Pollutants / Threats
Remaining Open Spaces/Natural Areas		Lack of public awareness (k)
Enhance Recreational Opportunities (Boating, Trails, Canoeing, Fishing)	Impaired in some areas	Hydrology ¹ (k) Debris ² (k) Bacteria (k) Lack of public awareness (k) Limited public awareness (k)
Flood Control (BMP Implementation)	Impaired in some areas	Sediment (k) Debris ² (k) Hydrology ¹ (k)

¹ Hydrology refers to river flow and includes high flows, low flows and overall flashiness that occur during rain/storm events.

² Debris refers to excessive log jams and trash present in the river.

4.2 Pollutants/Threats, Sources and Causes

Based on the inventory of the critical areas throughout the Clinton Main Subwatershed, a better understanding of the pollutants and threats to water quality in the subwatershed and their sources and causes has been developed. The information listed in the table below summarizes the thirteen (13) pollutants/threats, as determined by the affected permittees that currently have the greatest effect on the subwatershed. The next step was to prioritize them in order to determine which should be addressed first in the subwatershed management plan. Prioritizing the pollutants and threats allows for the greatest pollutant reduction while treating the fewest sources. A clear understanding of the sources and causes of storm water pollution and critical subbasins are also necessary to select the best management practices, or BMPs, that will achieve efficient and effective solutions. Table 4.2 details the nine (9) pollutants and four (4) threatening conditions along with accompanying sources and causes within the subwatershed.

Table 4.2: Pollutants/Threats, Sources and Causes

Pollutants/Threats	Sources	Causes/Obstacles	Critical Subbasins
1. Hydrology ¹ (k)	1. Storm water runoff	1. Lack of BMPs 2. Removal of vegetation throughout watershed 3. Increased impervious surfaces 4. Improper or poor BMP maintenance	Basin 3 - 5 Basin 11 -15
	2. Decreased groundwater recharge	1. Lack of BMPs 2. Removal of vegetation throughout watershed 3. Increased impervious surfaces 4. Improper or poor BMP maintenance	All
	3. Lake level management practices	1. Legally established lake levels 2. Lack of subwatershed representation by residents outside lake owner associations 3. Lack of awareness by lake owners in understanding downstream impacts	Basin 1 & 2 Basin 16

Pollutants/Threats	Sources	Causes/Obstacles	Critical Subbasins
2. Sediment (k)	1. Storm water runoff	<ol style="list-style-type: none"> 1. Soil erosion 2. Road & impervious surface maintenance practices 3. Removal of vegetation throughout watershed 4. Lack of BMPs 5. Improper or poor BMP maintenance 6. Inadequate enforcement 7. River flashiness 	Basin 3 - 5 Basin 11 -15
	2. Stream bank erosion	<ol style="list-style-type: none"> 1. Soil erosion 2. Removal of vegetation throughout watershed 3. Lack of BMPs 4. Improper or poor BMP maintenance 5. River flashiness 	Basin 4-8 Basin 10 & 11
	3. Construction site runoff	<ol style="list-style-type: none"> 1. Soil erosion 2. Road & impervious surface maintenance practices 3. Removal of vegetation throughout watershed 4. Lack of BMPs 5. Improper or poor BMP maintenance 6. Inadequate enforcement 	All
	4. Road-stream crossings	<ol style="list-style-type: none"> 1. Soil erosion 2. Removal of vegetation throughout watershed 3. Lack of BMPs 4. Improper or poor BMP maintenance 5. River flashiness 	Basin 3 & 4 Basin 14 & 15
3. Nutrients (k)	1. Fertilizer Use	<ol style="list-style-type: none"> 1. Fertilizer application practices 2. Removal of vegetation throughout watershed 3. Lack of BMPs 4. Improper or poor BMP maintenance 5. Grounds maintenance practices 	Basin 1 & 2 Basin 5 - 8 Basin 10 & 11 Basin 16
	2. Illicit discharges	<ol style="list-style-type: none"> 1. Illegal dumping 2. Historic cross connections 3. Sanitary sewer overflows (SSOs) 4. Inadequate enforcement 	All
	3. Storm water runoff	<ol style="list-style-type: none"> 1. Fertilizer application practices 2. Removal of vegetation throughout watershed 3. Lack of BMPs 4. Improper or poor BMP maintenance 5. Grounds maintenance practices 	Basin 3 - 5 Basin 11 -15
	4. Waterfowl & pet waste	<ol style="list-style-type: none"> 1. Residential feeding of waterfowl 2. Pet waste management practices 	Basin 1 & 2 Basin 5 - 8 Basin 10 & 11 Basin 16
	5. Failing septic systems (OSDS)	<ol style="list-style-type: none"> 1. Lack of inspections 2. Lack of maintenance 3. Improper siting for new OSDS 	Basin 1 Bain 5 Basin 1 2-15
4. Bacteria (k)	1. Illicit discharges	<ol style="list-style-type: none"> 1. Illegal dumping 2. Historic cross connections 3. Sanitary sewer overflows (SSOs) 4. Inadequate enforcement 	All
	2. Failing septic systems	<ol style="list-style-type: none"> 1. Lack of inspections 2. Lack of maintenance 3. Improper siting for new OSDS 	Basin 1 Bain 5 Basin 1 2-15

Pollutants/Threats	Sources	Causes/Obstacles	Critical Subbasins
		4. Inadequate enforcement	
	3. Waterfowl & pet waste	1. Residential feeding of waterfowl 2. Pet waste management practices	Basin 1 & 2 Basin 5 - 8 Basin 10 & 11 Basin 16
	4. Storm water runoff	1. Removal of vegetation throughout watershed 2. Lack of BMPs 3. Improper or poor BMP maintenance 4. Economic convenience 5. Waste water treatment plant	Basin 3 - 5 Basin 11 -15
5. Temperatures (k)	1. Storm water runoff	1. Increased impervious surfaces 2. Removal of vegetation throughout watershed 3. Lake level management practices 4. Lack of BMPs 5. Improper or poor BMP maintenance	Basin 3 - 5 Basin 11 -15
	2. Low flow conditions	1. Legally established lake levels 2. Lake level management practices	Basin 1 & 2 Basin 5 - 8 Basin 10 & 11 Basin 16
	3. Reduced vegetation canopy in watershed	1. Increased impervious surfaces 2. Removal of vegetation throughout watershed 3. Lack of BMPs 4. Improper or poor BMP maintenance	All
	4. Decreased groundwater recharge	1. Increased impervious surfaces 2. Removal of vegetation throughout watershed 3. Lake level management practices 4. Lack of BMPs 5. Improper or poor BMP maintenance	All
	5. Impoundment structures	1. Improper or poor BMP maintenance 2. Types of outlet structures in impoundments/BMPs	Basin 1 & 2 Basin 5 - 8 Basin 10 & 11 Basin 16
6. Salt (k)	1. All impervious surface runoff	1. Salt storage practices 2. Equipment maintenance practices 3. Salt application practices 4. Increased impervious surfaces	All
7. Organic, Industrial & Toxic Compounds (s)	1. Sediments/Pesticides	1. Past contamination 2. Disposal practices 3. Grounds maintenance 4. Lack of BMPs 5. Improper or poor BMP maintenance	All
	2. Storm water runoff	1. Lack of BMPs 2. Improper or poor BMP maintenance	Basin 3 - 5 Basin 11 -15
	3. Household hazardous waste	1. Disposal practices 2. Lack of awareness	All
8. Low D.O. Levels (k)	1. Low flow conditions	1. Legally established lake levels 2. Lake level management practices 3. Increased impervious surfaces 4. Removal of vegetation throughout watershed 5. Soil erosion	Basin 1 & 2 Basin 5 - 8 Basin 10 & 11 Basin 16

Pollutants/Threats	Sources	Causes/Obstacles	Critical Subbasins
		6. Grounds maintenance 7. Lack of awareness 8. Fertilizer application practices	
	2. Higher temps	1. Legally established lake levels 2. Lake level management practices 3. Increased impervious surfaces 4. Removal of vegetation throughout watershed	Basin 1 & 2 Basin 5 - 8 Basin 10 & 11 Basin 16
	3. Storm water runoff	1. Increased impervious surfaces 2. Removal of vegetation throughout watershed 3. Lack of BMPs 4. Improper or poor BMP maintenance	Basin 3 - 5 Basin 11 -15
	4. Construction site runoff	1. Soil erosion 2. Road & impervious surface maintenance practices 3. Removal of vegetation throughout watershed 4. Lack of BMPs 5. Improper or poor BMP maintenance 6. Inadequate enforcement	All
	5. Aquatic plant overpopulation	1. Fertilizer application practices	Basin 1 & 2 Basin 5 - 8 Basin 10 & 11 Basin 16
9. Lack of Aquatic and/or Riparian Habitat (k)	1. Low flow conditions	1. Legally established lake levels 2. Lake level management practices	Basin 1 & 2 Basin 5 - 8 Basin 10 & 11 Basin 16
	2. Storm water runoff	1. Increased impervious surfaces 2. Removal of vegetation throughout watershed 3. Lack of BMPs 4. Improper or poor BMP maintenance	Basin 3 - 5 Basin 11 -15
	3. Construction site runoff	1. Soil erosion 2. Road & impervious surface maintenance practices 3. Removal of vegetation throughout watershed 4. Lack of BMPs 5. Improper or poor BMP maintenance 6. Inadequate enforcement	All
10. Debris² (k)	1. Trash	1. Illegal dumping 2. Increased impervious surfaces 3. Lack of awareness	All
	2. Storm water runoff	1. Increased impervious surfaces 2. Removal of vegetation throughout watershed 3. Lack of BMPs 4. Improper or poor BMP maintenance	Basin 3 - 5 Basin 11 -15
	3. Log jams	1. Increased impervious surfaces 2. River flashiness 3. Lack of awareness 4. Lack of woody debris management practices	Basin 4-8 Basin 10 & 11

Pollutants/Threats	Sources	Causes/Obstacles	Critical Subbasins
11. Loss of Natural Features (k)	1. Loss of natural features in new development	1. Inadequate local ordinance or enforcement	All
	2. Lack of natural features ordinance	1. Inadequate local ordinance or enforcement	All
	3. Invasive Species	1. Lack of stewardship 2. Inadequate management 3. Natural system interruption	All
12. Lack of Public Awareness (k)	1. Lack of public education	1. Economical constraints	All
13. Limited Public Access (k)	1. Lack of publicly-owned riparian land	1. Economical constraints 2. Lack of long-term planning to obtain easements/property	All
	2. Lack of conservation easements	1. Economical constraints 2. Lack of long-term planning to obtain easements/property	All
	3. Lack of public education	1. Economical constraints 2. Lack of long-term planning to obtain easements/property	All

With a better understanding of both the pollutants and threats that are currently affecting the Clinton Main Subwatershed and their corresponding sources and causes, the goals and the objectives of the subwatershed management plan have been determined and are outlined in the next section.

4.3 Goals and Objectives

Based upon the identification of designated and desired uses, the pollutant/threat assessment, stream inventory results, and community planning analyses, the representative communities of the Clinton Main established seven (7) goals and associated objectives for the long-term protection of the Clinton Main as a unique natural, recreational, and cultural resource for the communities through which it flows.

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 river. 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.

The designated and desired uses combined with the pollutants, sources and causes for the Clinton Main Subwatershed; provide the basis from which to build long-term goals and objectives for the subwatershed. In the list of goals and objectives below, it is important to realize that the representative permittees are striving not only for the restoration of impairments in the subwatershed, but also for the protection of high quality waters and existing natural features as described in Chapter 3. In addition to defining long-term goals for the restoration and protection of these natural systems through improving ecological parameters, the representative permittees have also incorporated into its goals administrative parameters that will define the long-term institutional framework and sustain the planned restoration and protection efforts over time.

1.B. Develop educational stewardship programs promoting source control to the public.

1.C. Encourage establishment and implementation of innovative BMP programs for effective reduction of pollutants.

Goal 2: Increase public understanding of their role in protecting and enhancing watershed resources.

Objectives: 2.A. Develop and/or promote existing and future public education and outreach programs.

2.B. Promote and encourage participation in educational opportunities for land-use decision makers.

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

Goal 3: Protect and restore Clinton River fisheries.

Objectives: 3.A. Develop and implement a fisheries restoration/enhancement plan.

3.B. Collaborate with and support efforts by regional groups, such as Trout Unlimited (TU) and Michigan Department of Natural Resources (MDNR).

Goal 4: Improve recreational opportunities and access (boating, fishing, trails, canoeing, etc.)

Objectives: 4.A. Develop & implement an opportunities and enhancement plan for passive and active recreation.

Goal 5: Reduce flow variability.

Objectives: 5.A. Address the impact of lake level control structures.

5.B. Develop/enhance ordinances, guidelines and/or standards as appropriate, to reduce storm water peak flows.

5.C. Establish and implement BMPs for effective storm water peak flow reduction from new developments and redevelopments.

5.D. Protect natural areas, such as wetlands and floodplains that naturally function to manage peak flows into the river.

Goal 6: Enhance and protect waterfront areas.

- Objectives:
- 6.A. Develop a riparian corridor management plan.
 - 6.B. Protect and/or establish naturally vegetated buffers for water quality and habitat.
 - 6.C. Promote and encourage participation in educational opportunities for land-use decision makers.
 - 6.D. Improve and protect the aesthetics of the river (odor, trash, color, turbidity, foams, suspended solids, severe log jams, etc.).

Goal 7: Protect and mitigate loss of natural features and open spaces in the watershed.

- Objectives:
- 7.A. Conduct a natural features assessment to determine opportunities for protection/restoration of natural features.
 - 7.B. Develop/enhance ordinances, guidelines and/or standards as appropriate, for managing natural features.
 - 7.C. Participate in local and regional efforts to promote green infrastructure (tree rows, trails, natural beauty roads, utility corridors, waterways, riparian corridors, etc.).

It is the assumption of the representative communities and agencies that if the communities and agencies take action toward the seven goals listed above, that the designated uses appropriate for local creeks and the river, will be under restoration and improved considerably. Taking actions and measuring the progress toward reaching these goals will be characterized by an iterative approach. As described in Appendix C Monitoring and Evaluation for Targets and Load Reductions, the goals and actions will be compared to results of qualitative and quantitative volunteer monitoring, and on a subwatershed and watershed level, to determine reasonable and steady progress toward these goals, related water quality standards, and designated/desired uses over the long-term.

The goals of the subwatershed correlate to the designated and desired uses of the Clinton Main (Table 4.3).

Table 4.3. Correlation of Goals and Designated / Desired Uses of the Clinton Main.

Goals	Designated / Desired Uses											
	A	IW	PW	NV	FI	WL	PR	TR	HE	OS	RE	FC
Reduce sources of pollution.	N/A	N/A	N/A	X	X	X	X	X	X		X	X
Increase public understanding of their role in protecting and enhancing watershed resources.	N/A	N/A	N/A	X	X	X	X	X	X	X	X	X
Protect and restore Clinton River fisheries.	N/A	N/A	N/A		X	X					X	
Improve recreational opportunities and access (boating, fishing, trails, canoeing, etc.).	N/A	N/A	N/A	X	X	X	X	X	X	X	X	
Reduce flow variability.	N/A	N/A	N/A	X	X	X			X		X	X
Enhance and protect waterfront areas.	N/A	N/A	N/A	X	X	X			X	X	X	X
Protect and mitigate loss of natural features and open spaces in the watershed.	N/A	N/A	N/A	X	X	X			X	X	X	X

N/A = Currently Not Applicable

A = Agriculture

IW = Industrial water supply

PW = Public water supply at the point of intake

NV = Navigation

FI = Warmwater / Coldwater fishery

WL = Other indigenous aquatic life and wildlife

PR = Partial body contact recreation

TR = Total body contact recreation (between May 1st & October 31st)

HE = Wildlife habitat enhancement

OS = Preservation/protection of remaining open spaces

RE = Enhance recreational opportunities (boating, trails, canoeing)

FC = Flood Control (BMP implementation)

Chapter 5

Best Management Practices for the Clinton Main Subwatershed

5.1 Selection 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, including the Clinton Main Subwatershed, BMPs focus on both structural and nonstructural BMPs. Nonstructural BMPs include pollution prevention and good housekeeping practices while structural BMPs include many types of construction implementation projects.

Types of BMPs

As described above, 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 5.1) The data presented in Table 5.1 represents the results of nearly numerous monitoring studies from a variety of sources evaluating a diverse range of best management practices, including dry and wet ponds, wetlands, filters, and swales.

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.

Table 5.1 Effectiveness of Storm Water Treatment Practices in Removing Pollutants (Loading Reduction by % Removal Rate).

PRACTICE	TSS	Total P	Total N	Cu	Zn	Pb	BOD₅	O / G¹	Organics	Bact	Criteria for Evaluation
a. Bioretention/Rain Gardens²	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 Strips³	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 Cleaning³	62-97	ND	ND	ND	ND	ND	54-88	ND	ND	ND	# of catch basins cleaned
d. Construction Phasing³	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

PRACTICE	TSS	Total P	Total N	Cu	Zn	Pb	BOD ₅	O / G ¹	Organics	Bact	Criteria for Evaluation
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
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.

PRACTICE	TSS	Total P	Total N	Cu	Zn	Pb	BOD ₅	O / G ¹	Organics	Bact	Criteria for Evaluation
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 ⁴ ; b=If installed at toe of slope ⁵) 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 swept, 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

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 Clayton. 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.

5.2 Clinton Main Best Management Practices

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. The following BMPs/Actions have been identified for implementation within the Clinton Main Subwatershed. Further detail on these actions, including subbasins for implementation, community commitments, costs, goals and objectives addressed, etc. are contained in subsequent tables.

Action 1. Review and Update Ordinances as that Impact Water Resources as Applicable

Increasing development in the subwatershed and the negative impacts of storm water due to land use change is of great concern. Increased impervious surfaces, increase of non-point source pollutants and loss of natural features to slow and filter pollutants, if not controlled, will lead to further degradation of the subwatershed's water resources. To mitigate these impacts, communities have developed and adopted various ordinances that help to control both the quantity and quality of storm water that is permitted to leave a developed site. Examples of such ordinances include storm water management ordinances; natural feature preservation ordinances (wetlands, woodlands, stream corridors); overlay district requirements; buffer requirements; impervious surface ordinances; and site plan review requirements. Many communities in the watershed have either adopted similar ordinances or are considering adopting these types of ordinances. Some communities that are experiencing high growth pressures are especially interested in this approach to protecting high-quality water resources.

Many of these ordinances outline specific requirements for constructing structural best management practices to minimize the flow and water quality impacts associated with new development. Oversight and implementation of storm water standards can be complicated by overlapping jurisdictions and conflicting goals and priorities. Where there are overlapping jurisdictions within individual communities, it is imperative that the municipality and county or state agency work cooperatively to understand the goals and unique issues specific to each.

Action 2. Review and Update Master Plan as Applicable

To provide a legal basis for local ordinances, municipalities need to include their thoughts and desires for the ultimate development of their community into a Comprehensive Land Use Plan or Master Plan. Because managing storm water is a relatively new practice, communities within the Clinton Main should consider amending their Master Plans to include a discussion about how they want storm water to be considered in future development and re-development projects. This discussion can be a few paragraphs, in the existing Master Plan, or it can be a plan on its own, often called a Storm Water Master Plan. This plan addresses development, implementation, and enforcement of controls to protect designated uses in all receiving waters.

Action 3. Preserve Natural Areas

Communities in the subwatershed will continue to encourage private landowners to preserve natural areas that will protect land in its natural state in perpetuity, thereby protecting the water quality in the Clinton Main Subwatershed. One way to achieve this is by developing a plan to identify sensitive lands that are under the greatest threat of development and hold the most value from a natural resource perspective. In addition, publicizing Oakland Land Conservancy efforts will raise awareness of private property owners about the opportunities of establishing conservation easements. This type of land protection with the Conservancy provides a number of benefits to private landowners.

Action 4. Review and Update Storm Water Management Design Standards

As development increases and storm water technology and ideas change, it is beneficial to evaluate current standards. Continuing to improve on and be concurrent with technology will only benefit storm water quality and reduce storm water runoff volumes. Storm water design criteria generally outline standards for best management practices (BMPs). Appropriate BMPs may vary across local jurisdictions; however, the ultimate goal is to establish standards that not only improve storm water quality, but also minimize flow variability.

Action 5. Downspout/Sump Pump Disconnection Programs

In an effort to reduce the amount of storm water that enters the community sewer systems when it rains, the municipalities will continue to evaluate opportunities for downspout/sump pump disconnection programs. Citizens should partner with their communities to continue to improve water quality, protect homes from flooding, and reduce operational cost to the cities and communities.

Action 6. Footing Drain Disconnection Program

In some areas of the watershed, homes have experienced basement backup problems. Many of these have been the result of wastewater backing up from the sanitary sewers through basement floor drains, especially during periods of heavy rainfall. This wastewater presents a potential health risk and can cause damage to the structure and to belongings stored in the basement. In addition, this excess rainwater/groundwater places a strain on the sanitary sewer systems and must be treated at the wastewater treatment plants. Opportunities will be evaluated to establish programs for disconnecting residential and commercial footing drains from the municipal sewage collection and treatment systems.

Action 7. Log Jam Inventory and/or Management

Local municipalities will identify problem log jams acting as restrictors to flow leading to flooding problems. As problems are identified, opportunities will be evaluated for appropriate log jam management. A map is one method identifies locations of log jams throughout the community. This work may be coordinated with streambank stabilization and improvement considerations so that woody and other debris acting as habitat or positively stabilizing slopes will be modified to benefit flow as well as habitat.

Action 8. Streambank Stabilization Program

In areas where upstream flow can be controlled and/or reduced, areas for vegetative and/or structural streambank stabilization should be studied to assist in dissipating flow energy within the channel as well as increasing water quality by controlling erosion and deposition. Aesthetics and wildlife habitat are also improved. Affected communities (or potentially the subwatershed group) in the Clinton Main River watershed, will create a plan/program for identifying lengths of streambank that are in need of stabilization. The program will include methods for prioritization and implementation of vegetative and structural stabilization methods that will also improve riparian terrestrial and aquatic habitat. It is important to note that many of these creeks are located on private property and it may not always be feasible to conduct these types of evaluations if the property owner does not grant permission.

Action 9. Household Hazardous Waste Collection Program

The proper disposal of household hazardous waste is an important component in any water quality protection program. A number of Clinton Main municipalities 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.

Action 10. Habitat Improvement Program

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. Communities will develop a program that includes these appropriate components for habitat improvement.

Action 11. Promote and Encourage Riparian Best Management Practices

In order to reduce nutrient pollution and restore habitat in the Clinton Main subwatershed, the communities will work to promote and encourage, to the extent feasible, the amount of forested or other riparian buffer, conserve existing forests/buffers along all streams and shorelines and increase the use of all riparian buffers and restore riparian forests, targeting efforts where they will be of greatest value to water quality. Construction of riparian buffers can positively affect water quality by decreasing sediment loads from runoff, increasing streambank shading that helps regulate water temperature and adding vegetation that stabilizes the streambanks. Replacing these physical features can help aquatic life by increasing sources of food, shade and shelter. Riparian buffer health is closely linked to healthy streams and watersheds.

Action 12. Storm Water BMP Maintenance and/or Retrofit Programs

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. 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. Local jurisdictions will develop a program to include appropriate components.

Action 13. OSDS Maintenance Program

An on-site sewage disposal system (OSDS) maintenance program can significantly reduce nutrient loading, especially near lakes and impoundments. Many areas around 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 time of sale ordinance is being considered in Oakland County. Most local jurisdictions rely on the County oversight for on-site sewage disposal systems.

Action 14. Natural Areas Restoration/Enhancement Program

Based on previous findings, there are opportunities in the subwatershed for restoration/enhancement of natural areas. Communities will develop a program that priorities restoration and enhancement of natural areas. The program may include one or both of the following two components: (1) Natural Areas

Restoration/Enhancement through new developments and (2) Natural Areas Restoration/Enhancement through stewardship. The first component includes identifying opportunities as site plans are reviewed through the site plan review process while the second component includes promoting and encouraging restoration/enhancement through stewardship and volunteer opportunities. The program will also address invasive species control and management.

Action 15. Implement and/or Improve Inspection/Enforcement of SESC

Within the Clinton Main subwatershed, statewide soil erosion and sedimentation control (SESC) regulations are managed primarily by county agencies. 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 include stabilization measures for construction activities. These ordinances should generally limit the soil exposed during development or redevelopment, limit the rate at which water is transported across the exposed land, and allow for on-site capture of the sediment prior to discharging water from the site.

Action 16. Water Level Control Structure Committee

Interested parties, including local government officials, lake property owners and riparian land owners, will be given an opportunity to participate in a committee to study the issues and evaluate alternatives that address both the impacts and benefits of lake level control structures. Governmental jurisdictions, including state, federal and local jurisdictions along with the Clinton River Watershed Council will form the basis of the committee. The committee will determine the process for evaluating impacts and benefits as well as determine the most appropriate mechanism for public participation. Once the impacts and benefits have been studied, a strategy will be evaluated for implementation.

Action 17. Natural Features Protection Plan/Inventory/Assessments

Protecting existing natural features such as wetlands, woodlands and riparian corridors in the subwatershed is a key goal, especially in less developed areas of the subwatershed. These guidance documents can create opportunities to minimize impacts associated with new developments as well as identify opportunities for preservation and enhancement. A natural features protection plan generally starts out with an inventory and map of the community's existing environmental features, showing where the wetlands, woodlands, meadows, steep slopes, and tree rows are located. The map also shows how these features are interrelated, and how changes to one feature could impact another. The plan provides goals for natural feature preservation, often prioritizing specific natural areas and suggesting methods for their protection. Lastly, goals to create or preserve links between the natural areas for wildlife movement are often included in the plan.

Action 18. Greenway Plan

Greenway and Greenway Infrastructure Plans can serve multiple purposes, including natural features protection, alternative transportation routes, and recreation opportunities. To create such a plan, a map is prepared that identifies connections throughout the watershed utilizing existing 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. Community participation may include attending a visioning session and input to the county as Oakland County is currently working with individual communities to compile an overall Green Infrastructure Plan.

Action 19. Recreation Plan

A number of popular recreation areas are located in the Clinton Main subwatershed. 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 will be included in recreation master plans. The identification of potential recreation parcels should be included in the proposed Clinton Main corridor stewardship efforts. Acquisition efforts and conservation easements can include consideration of recreation potential in addition to natural features protection. Developing and implementing additional public education opportunities can enhance both existing and future recreation areas in the Clinton Main 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 20. Sanitary Sewer Master Plan

The municipalities in the Clinton Main subwatershed that don't already have them should consider developing a comprehensive sewer plan that is 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 or can 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 21. Water Quality Monitoring

Communities will evaluate existing monitoring programs and opportunities for support and collaboration with other watershed communities and agencies that may be conducting similar monitoring programs. Communities will help promote and participate in the current volunteer monitoring that is coordinated through the Clinton River Watershed Council which also forms the basis for the monitoring and evaluation component described in the Appendix.

Action 22. Continue to Implement Actions from Approved PEP Plans

Individual permittees each have approved Public Education Plans. Many communities in the Clinton Main Subwatershed have contracts with the Clinton River Watershed Council for implementation of many PEP components. At the same time, other communities located in both the Rouge Watershed and Clinton Main have PEPs that are not part of the CRWC program. Both types of plans include numerous public education opportunities of which individual actions address many of the goals and objectives contained in the subwatershed management plan. In addition, SEMCOG is also an active partner of numerous public education plans through the Southeast Michigan Partners for Clean Water. This action encompasses all required PEP activities.

Action 23. Pet Waste/Waterfowl Management

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 turf grass 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 24. Training/Inspection Program for Staff and Contractors

Staff training for various storm water related activities would be conducted on an as-needed basis.

Action 25. Catch Basin Inspection and Maintenance

Research has shown that streets in urban areas are large contributors of phosphorus and sediment to water resources. Permittees will implement a catch basin cleaning/maintenance program.

Action 26. Maintenance of Swales

Vegetated swales can decrease the volume and rate of storm water discharged from roads to the Clinton River. To prolong the useful life of these storm water management BMPs, communities will maintain storm water swales by inspecting for and removing excessive build-up of sediment and other debris. The subwatershed group can coordinate with community organizations, schools, churches, and businesses to collect debris along swales along local, county, and state roads and in community parks and other areas.

Action 27. Fleet Maintenance Activities

Individually, vehicle service and repair shops do not generate a lot of hazardous waste, but collectively they represent a significant source of pollution. For these facilities there are opportunities to save money, conserve resources, reduce emissions, possibly reduce permitting fees, and help meet compliance with environmental rules by making simple changes in shop practices. This can be done by implementing various pollution prevention methods associated with material handling and storage, parts cleaning and degreasing, maintenance and repair activities and shop clean-up.

The goal of improving fleet maintenance activities and practices is to reduce environmental and health impacts of vehicle repair and maintenance operations by introducing cost effective pollution prevention practices, working with the vehicle service and repair industry to implement pollution prevention options and increasing compliance with environmental laws and regulations. These improved fleet maintenance activities may also include providing training and technical assistance to identify the economic and environmental benefits of pollution prevention methods, products and services to the private sector, local government agencies, and vehicle repair and fleet maintenance operations.

Action 28. Street & Parking Lot/Pavement Sweeping

Research has shown that streets in urban areas are large contributors of phosphorus and sediment to water resources. Permittees will evaluate opportunities to implement a street sweeping program and/or catch basin cleaning program to pick up finer sediments and debris that may reach surface waters. Communities in other watersheds are currently conducting studies of street sweeping and catch basin cleaning efforts to determine if more powerful equipment and/or more frequent cleaning schedules have a significant impact on sediment and debris removal. These results may be used by Clinton Main subwatershed communities to determine changes in current practices. Communities with roads under the jurisdiction of the county road commission will work with the commission to enhance maintenance for storm water, especially to control soil erosion and sedimentation from the many dirt roads in the area.

Action 29. Salt Storage & Application

Permittees that have deicing responsibilities will review and implement applicable practices to minimize impacts to water resources. These practices may include proper equipment calibration and evaluation of alternative materials. In addition, current salt storage practices will be evaluated and updated as necessary.

Action 30. Golf Course Management

Encouraging golf courses to develop and implement plans to minimize nutrient loading will help preserve the high quality of the Clinton Main 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 Turf grass Stewardship Program is a good source of information for this purpose and offers a certification program for golf courses.

There are several golf courses within the subwatershed, some of which are public courses. With intensive turf management programs, these areas are suspected as large sources of phosphorus loading. Communities will evaluate current golf course operations from a storm water management perspective. Improvements will explore turf management, watercourse and wetland buffers, as well as detention basin maintenance and buffer vegetation.

Action 31. Grounds and Facilities Maintenance

Communities will promote and encourage proper grounds and facilities maintenance for municipally-owned properties. Activities include developing and implementing plans to minimize nutrient loading through educating staff and contractors on “good housekeeping” practices, including proper fertilizing and lawn care practices.

Chapter 4 described goals and objectives of the subwatershed reflecting the subwatershed data in Chapter 3 and also the prioritized pollutants, sources and causes within the subwatershed. The management alternatives and actions identified in this section have been cross-referenced with the information described in Chapter 4 and which is shown in Table 5.2.

Table 5.2 correlates the recommended management alternatives with goals and objectives in the subwatershed. Each goal and objective have at least one (1) recommended alternative associated with them, in most cases there are multiple actions to meet multiple goals. Pollutants addressed by the action, designated and desired uses along with sources and causes of the pollution are also identified.

Table 5.2 Goals, Objectives, Pollutants, Uses, Sources and Causes addressed by Action

Recommended Management Alternative/Action	Goals & Objectives Addressed	Pollutants Addressed	Uses Addressed (see Key below)	Sources Addressed	Causes Addressed
<p>1. Review and Update Ordinances that Impact Water Resources as Applicable</p>	<p>1A, 2B, 5B, 6C, 7B</p>	<p>hydrology; sediment; nutrients; bacteria; temp; low DO levels; lack of aquatic and/or riparian habitat; loss of natural features; lack of public awareness</p>	<p>NV; FI; WL; PR; TR; HE; OS; RE; FC</p>	<p>storm water runoff; decreased groundwater resources; streambank erosion; construction site runoff; road-stream crossings; fertilizer use; lack of public education</p>	<p>lack of BMPs; increased impervious surfaces; improper or poor BMP maintenance; soil erosion; fertilizer application practices; removal of vegetation; types of outlet structures in impoundments/BMPs</p>
<p>2. Review and Update Master Plans as Applicable</p>	<p>1A, 2B, 5B, 6C, 7B</p>	<p>hydrology; sediment; nutrients; bacteria; temp; low DO levels; lack of aquatic and/or riparian habitat; loss of natural features; lack of public awareness</p>	<p>NV; FI; WL; PR; TR; HE; OS; RE; FC</p>	<p>storm water runoff; decreased groundwater resources; streambank erosion; construction site runoff; road-stream crossings; fertilizer use; lack of public education</p>	<p>lack of BMPs; increased impervious surfaces; improper or poor BMP maintenance; soil erosion; fertilizer application practices; removal of vegetation</p>
<p>3. Preserve Natural Areas</p>	<p>5D, 6A, 6B, 7A</p>	<p>hydrology; sediment; nutrients; bacteria; temp; organic, industrial & toxic compounds; low DO levels; lack of aquatic and/or riparian habitat; debris; loss of natural features; lack of public awareness</p>	<p>FI; WL; PR; TR; HE; OS; RE</p>	<p>storm water runoff; decreased groundwater recharge; stream bank erosion; reduced vegetation canopy in watershed; higher temps; log jams; loss of natural features in new development</p>	<p>removal of vegetation throughout watershed; increased impervious surfaces; soil erosion; river flashiness; lack of awareness; lack of long-term planning to obtain easements/property</p>

Recommended Management Alternative/Action	Goals & Objectives Addressed	Pollutants Addressed	Uses Addressed (see Key below)	Sources Addressed	Causes Addressed
4. Review & Update Storm Water Management Design Standards	1A-1C, 2B, 5B, 5C, 7B	hydrology; sediment; nutrients; bacteria; temp; lack of public awareness	NV; FI; WL; PR; TR; HE; OS; RE; FC	storm water runoff; decreased groundwater recharge; stream bank erosion; construction site runoff; lack of public education	lack of BMPs; increased impervious surfaces; improper or poor BMP maintenance; soil erosion; river flashiness
5. Downspout/Sump Pump Disconnection Programs	5B, 5C	hydrology; temp; low DO levels	FI; WL; PR; TR; HE; FC	storm water runoff; decreased groundwater recharge	increased impervious surfaces; river flashiness
6. Footing Drain Disconnection Program	1A, 5B	hydrology; nutrients; bacteria; organic, industrial & toxic compounds; low DO levels	FI; WL; PR; TR; FC	storm water runoff; decreased groundwater recharge; illicit discharges; sediments/pesticides; household hazardous waste	river flashiness; illegal dumping; disposal practices
7. Log Jam Inventory and/or Management	2A, 2C, 3A, 3B, 4A, 6D	hydrology; debris	NV; FI; WL; HE; OS; RE; FC	storm water runoff; log jams	river flashiness; lack of awareness; lack of woody debris management practices

Recommended Management Alternative/Action	Goals & Objectives Addressed	Pollutants Addressed	Uses Addressed (see Key below)	Sources Addressed	Causes Addressed
8. Streambank Stabilization Program	1C, 2C, 3A, 3B	sediment	NV; FI; WL; PR; TR; HE; RE; FC	storm water runoff; stream bank erosion; construction site runoff	removal of vegetation throughout watershed; increased impervious surfaces; soil erosion; river flashiness; lack of awareness
9. Household Hazardous Waste collection Program	AB, 2A, 2B, 2C, 6D	nutrients; bacteria; organic, industrial & toxic compounds	FI; WL; HE; OS	storm water runoff; fertilizer use; illicit discharges; sediments/pesticides; household hazardous waste	disposal practices; lack of awareness; illegal dumping
10. Habitat Improvement Program	3A, 3B, 6A, 6B, 6D, 7A	hydrology; sediment; temp; low DO levels; lack of aquatic and/or riparian habitat	FI; WL; HE; OS; RE; FC	storm water runoff; decreased groundwater recharge; reduced vegetation canopy in watershed; higher temps	legally established lake levels; lake level management practices; increased impervious surfaces; removal of vegetation throughout watershed; soil erosion
11. Promote and Encourage Riparian Best Management Practices	3A, 3B, 5D, 6A, 6B, 7A	hydrology; sediment; nutrients; bacteria; temp; organic, industrial & toxic compounds; low DO levels; lack of aquatic and/or riparian habitat; debris; loss of natural features; lack of public awareness	NV; FI; WL; PR; TR; HE; OS; RE; FC	storm water runoff; decreased groundwater recharge; stream bank erosion; reduced vegetation canopy in watershed; sediments/pesticides; higher temps; log jams; loss of natural features in new development	Lack of BMPs, removal of vegetation throughout watershed; increased impervious surfaces; improper or poor BMP maintenance; soil erosion; road & impervious surface maintenance practices; river flashiness

Recommended Management Alternative/Action	Goals & Objectives Addressed	Pollutants Addressed	Uses Addressed (see Key below)	Sources Addressed	Causes Addressed
12. Storm Water BMP Maintenance and/or Retrofit Programs	1A, 1B, 1C, 2A, 5B	hydrology; sediment; nutrients; bacteria; temp; low DO levels; debris	NV; FI; WL; PR; TR; HE; OS; RE; FC	storm water runoff; decreased groundwater recharge; stream bank erosion; higher temps; trash; impoundment structures	lack of BMPs; removal of vegetation throughout watershed; increased impervious surfaces; improper or poor BMP maintenance; soil erosion; river flashiness; types of outlet structures in impoundments/BMPs
13. OSDS Maintenance Program	1A, 1B, 6D	nutrients; bacteria; low DO levels	FI; PR; TR	illicit discharges; failing septic systems; aquatic plan overpopulation	lack of inspections; lack of maintenance; improper siting for new OSDS
14. Natural Areas Restoration/ Enhancement Program	5D, 6A, 6B, 7A, 7B, 7C	hydrology; sediment; nutrients; temp; low DO levels; lack of aquatic and/or riparian habitat; loss of natural features	FI; WL; HE; OS; RE	storm water runoff; decreased groundwater recharge; streambank erosion; reduced vegetation canopy in watershed;	increased impervious surfaces; inadequate local ordinance or enforcement; removal of vegetation throughout watershed; lack of BMPs
15. Implement and/or Improve Inspection/ Enforcement of SESC	1A, 1B, 1C	sediment; nutrients	NV; FI; WL; PR; TR; HE; OS; RE; FC	storm water runoff; stream bank erosion; construction site runoff	soil erosion; road & impervious surface maintenance practices; lack of BMPs; improper or poor BMP maintenance; inadequate local ordinance enforcement

Recommended Management Alternative/Action	Goals & Objectives Addressed	Pollutants Addressed	Uses Addressed (see Key below)	Sources Addressed	Causes Addressed
16. Water Level Structure Control Committee	5A	hydrology; temp; low DO levels; lack of aquatic and/or riparian habitat	NV; FI; RE; FC	storm water runoff; lake level management; higher temps; low flow conditions; impoundment structures	legally established lake levels; lake level management practices; lack of subwatershed representation by residents outside lake owner associations; lack of awareness by lake owners in understanding downstream impacts
17. Natural Features Protection Plan/Inventory/ Assessments	5D, 6A, 6B, 7A, 7B, 7C	hydrology; sediment; nutrients; temp; low DO levels; lack of aquatic and/or riparian habitat; loss of natural features	FI; WL; HE; OS; RE	storm water runoff; decreased groundwater recharge; streambank erosion; road-stream crossings; reduced vegetation canopy in watershed; loss of natural features in new development; lack of conservation easements; lack of natural features ordinance	increased impervious surfaces; inadequate local ordinance or enforcement; removal of vegetation throughout watershed; lack of BMPs; lack of long-term planning to obtain easements/property
18. Greenway Plan	7C	hydrology; sediment; nutrients; temp; low DO levels; lack of aquatic and/or riparian habitat; loss of natural features	HE; OS; RE	storm water runoff; decreased groundwater recharge; streambank erosion; road-stream crossings; reduced vegetation canopy in watershed; loss of natural features in new development; lack of conservation easements	lack of awareness

Recommended Management Alternative/Action	Goals & Objectives Addressed	Pollutants Addressed	Uses Addressed (see Key below)	Sources Addressed	Causes Addressed
19. Recreation Plan	4A	lack of aquatic and/or riparian habitat, lack of public awareness; limited public access	NV; HE; OS; RE	lack of public education; lack of publicly-owned riparian land	lack of awareness; economical constraints
20. Sanitary Sewer Master Plan	1A	nutrients; bacteria; low DO levels	FI; PR; TR	illicit discharges; aquatic plant overpopulation; failing septic systems (OSDS)	lack of inspections; lack of maintenance; sanitary sewer overflows (SSOs)
21. Water Quality Monitoring	1A, 1B, 1C, 2C, 3B	sediment; nutrients; bacteria; temperature; low DO levels; lack of aquatic and/or riparian habitat; debris; lack of public awareness	FI; WL; PR; TR	illicit discharges; failing septic systems; aquatic plant overpopulation; lack of public education	improper or poor BMP maintenance; soil erosion; lack of BMPs; past contamination; disposal practices; waste water treatment plant
22. Continue to Implement Actions from Approved PEP Plans	2A, 2B, 2C	sediment; nutrients; bacteria; organic, industrial & toxic compounds; low DO levels; debris; lack of public awareness	FI; WL; PR; TR; HE; OS; RE; FC	lack of public education	lack of awareness
23. Pet Waste/Waterfowl Management	1B, 1C, 2A, 6D	nutrients; bacteria; low DO levels	FI; WL; PR; TR; HE	waterfowl & pet waste	lack of awareness; residential feeding of waterfowl; pet waste management practices
24. Training/Inspection Program for Staff and Contractors	1A, 2A, 2B	sediment; nutrients; bacteria; temperature; salt; organic, industrial & toxic compounds; low DO levels; debris; lack of public awareness	FI; WL; PR; TR; OS; RE; FC	construction site runoff; illicit discharges; sediments/pesticides; lack of BMPs; improper or poor BMP maintenance	lack of awareness

Recommended Management Alternative/Action	Goals & Objectives Addressed	Pollutants Addressed	Uses Addressed (see Key below)	Sources Addressed	Causes Addressed
25. Catch Basin Inspection and Maintenance	1A, 6D	sediment; nutrients; lack of aquatic and/or riparian habitat	FI; WL; PR; TR; OS; RE; FC	storm water runoff; construction site runoff; illicit discharges	soil erosion; road & impervious surface maintenance practices; lack of BMPs; improper or poor BMP maintenance; disposal practices
26. Maintenance of Swales	1A, 5B	hydrology; sediment; nutrients; temperature; low DO levels; debris	FI; WL; PR; TR; OS; RE; FC	storm water runoff; decreased groundwater recharge; sediments pesticides	soil erosion; lack of BMPs; improper or poor BMP maintenance
27. Fleet Maintenance Activities	1A, 1B, 6D	sediment; salt; organic, industrial & toxic compounds; low DO levels	FI; WL; PR; TR; OS; RE; FC	illicit discharges	lack of BMPs; improper or poor BMP maintenance; lack of awareness; equipment maintenance practices
28. Street & Parking Lot/Pavement Sweeping	1A, 6D	sediment; nutrients; lack of aquatic and/or riparian habitat	FI; WL; PR; TR; OS; RE; FC	storm water runoff; illicit discharges; sediments/pesticides	soil erosion; road & impervious surface maintenance practices; lack of BMPs; improper or poor BMP maintenance
29. Salt Storage & Application	1A, 1B	salt	FI; WL; PR; TR; OS; RE; FC	all impervious surface runoff	salt storage practices; equipment maintenance practices; salt application practices; increased impervious surfaces

Recommended Management Alternative/Action	Goals & Objectives Addressed	Pollutants Addressed	Uses Addressed (see Key below)	Sources Addressed	Causes Addressed
30. Golf Course Management	1A, 1B, 1C, 2A	nutrients; low DO levels	FI; WL; PR; TR; OS; RE; FC	storm water runoff; fertilizer use; illicit discharges; sediments/pesticides	fertilizer application practices; lack of BMPs, improper or poor BMP maintenance; grounds maintenance practices
31. Grounds and Facilities Maintenance	1A, 1B, 1C	sediment, nutrients; salt; organic, industrial & toxic compounds; low DO levels; debris	FI; WL; PR; TR; OS; RE; FC	storm water runoff; illicit discharges; sediments/pesticides	grounds maintenance practices; improper or poor BMP maintenance

N/A = Currently Not Applicable

A = Agriculture

IW = Industrial water supply

PW = Public water supply at the point of intake

NV = Navigation

FI = Warmwater / Coldwater fishery

WL = Other indigenous aquatic life and wildlife

PR = Partial body contact recreation

TR = Total body contact recreation (between May 1st & October 31st)

HE = Wildlife habitat enhancement

OS = Preservation/protection of remaining open spaces

RE = Enhance recreational opportunities (boating, trails, canoeing)

FC = Flood Control (BMP implementation)

5.3 Subbasin 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 Rouge River 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, ordinance updates, 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 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.

Table 5.3 identifies the most suitable phase associated with each proposed Clinton Main BMP.

Table 5.3: Best Management Practice Phasing

Best Management Practices/ Actions	PHASE I	PHASE II	PHASE III
1. Review and Update Ordinances that Impact Water Resources as Applicable	X		
2. Review and Update Master Plan as Applicable	X		
3. Preserve Natural Areas	X		
4. Review and Update Storm Water Management Design Standards	X		
5. Downspout/Sump Pump Disconnection Programs		X	
6. Footing Drain Disconnection Program		X	
7. Log Jam Inventory and/or Management	X		
8. Streambank Stabilization Program		X	
9. Household Hazardous Waste Collection Program	X		
10. Habitat Improvement Program		X	
11. Promote and Encourage Riparian Best Management Practices	X		
12. Storm Water BMP Maintenance and/or Retrofit Programs		X	X
13. OSDS Maintenance Program	X		
14. Natural Areas Restoration/Enhancement Program			X
15. Implement and/or Improve Inspection/Enforcement of SESC	X		

Best Management Practices/ Actions	PHASE I	PHASE II	PHASE III
16. Water Level Structure Control Committee		X	
17. Natural Features Protection Plan/Inventory/Assessments	X		
18. Greenway Plan	X		
19. Recreation Plan	X		
20. Sanitary Sewer Master Plan	X		
21. Water Quality Monitoring	X		
22. Continue to implement actions from approved PEP Plans	X		
23. Pet Waste Management	X		
24. Training/Inspection Program for Staff and Contractors	X		
25. Catch Basin Inspection and Maintenance	X		
26. Maintenance of Swales	X		
27. Fleet Maintenance Activities	X		
28. Street and Parking Lot/Pavement Sweeping	X		
29. Salt Storage and Application	X		
30. Golf Course Management	X		
31. Grounds and Facilities Maintenance	X		

These BMPs/Management Alternatives/Actions have been further evaluated for applicability to the various subbasins as well as applicability for implementation by each of the subwatershed representatives. In addition, Table 5.1 represents subset BMPs of a majority of the above actions. In fact, Actions 1, 4, 7, 8, 10, 11, 12, 14, 15, 17 and 18 include, as appropriate, BMPs listed in Table 5.1. Each subwatershed representative will incorporate features from Table 5.1 through implementation of the above management alternatives based on their respective suitability and application. Table 5.4 below identifies Recommended Management Alternatives (BMPs) by Critical Subbasin within the Clinton Main Subwatershed.

Table 5.4 Recommended Management Alternatives/Actions by Subbasin

Clinton Main Subbasin ID (Field Survey Site IDs in Subbasin)	Subwatershed Representatives	Preservation/Restoration Category	Recommended Alternatives/Actions (BMP Phase 1)	Recommended Alternatives/Actions (BMP Phase II)	Recommended Alternatives/Actions (BMP Phase III)
1	Orchard Lake Village; Waterford Township; West Bloomfield Township; Oakland County	Preservation Category 1	1, 2, 3, 4, 9, 11, 13, 15, 17, 18, 19, 20, 22, 24, 25, 26, 28, 31	6, 10, 12, 16	12, 14
2	Keego Harbor; Orchard Lake Village; Sylvan Lake; Waterford Township; West Bloomfield Township; Oakland County	Preservation Category 1	1, 2, 4, 9, 11, 13, 15, 19, 20, 21, 22, 23, 24, 25, 26, 28, 31	12, 16,	12, 14
3	Pontiac; Waterford Township; Oakland County	Restoration Category 3	1, 2, 4, 11, 13, 15, 17, 18, 19, 21, 22, 23, 24, 25, 26, 28, 31	8, 10, 16	14
4	Auburn Hills; Bloomfield Township; Pontiac; Rochester Hills; Oakland County	Restoration Category 3	1, 4, 7, 11, 15, 17, 18, 19, 21, 22, 23, 24, 25, 27, 28, 31	5, 6, 8, 10	14
5	Rochester; Rochester Hills; Oakland County	Preservation/Restoration Category 2	1, 4, 7, 11, 17, 18, 19, 22, 23, 24, 25, 26, 28, 31	8, 10, 12	12, 14
6	Rochester Hills; Oakland County	Preservation Category 1	2, 7, 9, 11, 17, 18, 19, 22, 23, 24, 25, 26, 28, 31	8, 10, 12	12, 14
7	Rochester; Rochester Hills; Oakland County	Preservation Category 1	2, 7, 9, 11, 17, 18, 19, 22, 23, 24, 25, 26, 28, 31	8, 10, 12	12, 14

Table 5.4 (cont) Recommended Management Alternatives/Actions by Subbasin

Clinton Main Subbasin ID (Field Survey Site IDs in Subbasin)	Subwatershed Representatives	Preservation/Restoration Category	Recommended Alternatives/Actions (BMP Phase 1)	Recommended Alternatives/Actions (BMP Phase II)	Recommended Alternatives/Actions (BMP Phase III)
8	Rochester; Rochester Hills; Oakland County	Preservation Category 1	2, 7, 9, 11, 17, 18, 19, 22, 23, 24, 25, 26, 28, 31	8, 10, 12	12, 14
10	Rochester; Rochester Hills; Oakland County	Preservation/Restoration Category 2	2, 7, 9, 11, 17, 18, 19, 22, 23, 24, 25, 26, 28, 31	8, 10, 12	12, 14
11	Auburn Hills; Oakland University; Rochester Hills; Pontiac; Oakland County	Preservation/Restoration Category 2	1, 2, 3, 4, 7, 17, 18, 19, 21, 22, 24, 25, 26, 27, 28, 30, 31	8, 10, 12	12, 14
12	Auburn Hills; Orion Township; Rochester Hills; Pontiac; Oakland County	Preservation Category 1	1, 2, 3, 4, 7, 9, 11, 13, 15, 17, 20, 22, 23, 24, 25, 26, 28, 31	8, 10, 12	12, 14
13	Auburn Hills; Pontiac; Orion Township; Oakland County	Preservation/Restoration Category 2	1, 2, 3, 4, 7, 9, 11, 13, 15, 17, 20, 22, 23, 24, 25, 26, 28, 31	8, 10, 12	12, 14
14	Pontiac; Waterford Township; Oakland County	Restoration Category 3	4, 9, 11, 17, 18, 21, 22, 23, 24, 25, 28, 31	5, 6, 8, 10, 12	12, 14
15	Waterford Township; Oakland County	Restoration Category 3	1, 4, 11, 21, 22, 25, 26, 28	5, 10	14
16	Waterford Township; Sylvan Lake; Oakland County	Preservation Category 1	1, 2, 4, 11, 15, 17, 18, 19, 21, 22, 23, 24, 25, 26, 28, 31	8, 10, 16	14

Based on Tables 5.3 and 5.4, subwatershed, individual representatives evaluated all of the management alternatives and actions and subsequently identified applicable commitments for implementation. Table 5.5 Subwatershed Community Action Matrix outlines these commitments. General timeframes for these commitments are defined as follows:

- ❖ E = Ongoing/Current: This commitment describes an action / management alternative already in process. Specific completion dates are anticipated to be included within the representatives' respective SWPPIs.
- ❖ P = Planned within 5 Years: This commitment describes an action / management alternative that will be completed within 5 years or generally the term of the General Storm Water Permit. Since each representative must determine their own specific resources and timeframes for implementation, it is anticipated, similar to "E" above, that specific completion dates will be identified within the representatives' respective SWPPIs.
- ❖ L = Planned after 5 Years: Although this commitment timeframe does not have a specific end date, it is anticipated that during the course of any WMP update these commitments will be updated and most long-term actions will become planned or ongoing/current actions.
- ❖ CS = County Standards Applied: Due to the fact that there are multiple legal jurisdictions within a specific community's boundaries, this designation applies to those actions in which communities do not have authority.
- ❖ NA = Not Applicable: This defines an action to be not applicable for a specific representative. Reasons for this designation vary; however, those justifications are defined separately during the WMP review process.
- ❖ WL = Wish List: This designation determines items that are important from a watershed planning perspective; however, they will be implemented only if grant funding is available.

The long-term planning of these watershed actions recognizes that as these actions are implemented in both the short and long-term, improvements will be observed throughout the Clinton Main subwatershed. Interim goals for these subwatershed-wide improvements are based on implementation and level of effort of these management alternatives and actions by the various responsible entities. Table 5.6 Action Matrix Details identifies the subwatershed cost estimates, resources, level of effort and associated milestones that will be observed throughout the long-term implementation of this subwatershed management plan. This table also outlines the suggested methods of evaluation for the management alternatives.

The Plan, and its long and short-term goals and selected BMPs, is a long-term, iterative process whereby communities and agencies involved with the plan will modify aspects of the documents as they learn more about what works best and what BMPs are most needed to protect and restore the subwatershed. The Clinton Main Subwatershed communities will do bi-annual reviewing of the plan. During review, new data and information will be explored and a decision to revise (or not to revise) the plan will be made.

In addition to these categories of projects, more specifically-defined projects have been identified that are above and beyond NPDES Phase II permit requirements, but are necessary for demonstrated improvements to the Clinton Main river. These specific projects, their respective categories, pollutant and volume reductions, cost-estimates and milestones are outlined following Table 5.6.

**Table 5.5 Subwatershed
Community Action
Matrix**

<p>E = Ongoing /Current</p> <p>Key:</p> <p>P = Planned Within 5 Years</p>	<p>L = Planned After 5 Years</p> <p>WL = Wish List</p>	<p>CS = County Standards Applied</p> <p>NA = Not Applicable</p>
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Action/Management Alternative	Auburn Hills	Avondale Schools	Bloomfield Township	Keego Harbor	City of Lake Angelus	Oakland County	Oakland University	Orchard Lake Village	Orion Township	Pontiac	Rochester	Rochester Hills	Rochester Schools	Sylvan Lake	Waterford Township	West Bloomfield Township
1. Review and Update Ordinances that Impact Water Resources as Applicable	E	NA	E	E	E	E	E	E	P	P	E	E	NA	E	E	E
2. Review and Update Master Plans as Applicable	E	NA	E	E	WL	E	L	NA	L	L	E	E	NA	E	E	E
3. Preserve Natural Areas	E	NA	E	E	E	E	P	P	NA	WL	E	P	NA	E	E	E
4. Review & Update Storm Water Management Design Standards	E	P	E,P	E	NA	E	P	P	P	E	E	E	L	E	E	E
5. Downspout/Sump Pump Disconnection Programs	E	WL	E	E	NA	NA	WL	NA	NA	WL	NA	WL	WL	E	E	E

Action/Management Alternative	Auburn Hills	Avondale Schools	Bloomfield Township	Keego Harbor	City of Lake Angelus	Oakland County	Oakland University	Orchard Lake Village	Orion Township	Pontiac	Rochester	Rochester Hills	Rochester Schools	Sylvan Lake	Waterford Township	West Bloomfield Township
6. Footing Drain Disconnection Program	E	WL	E	E	NA	NA	WL	NA	NA	WL	NA	WL	WL	E	E	E
7. Log Jam Inventory and/or Management	E	NA	NA	NA	NA	WL	WL	NA	NA	WL	WL	E	P	NA	WL	NA
8. Streambank Stabilization Program	NA	NA	NA	NA	NA	WL	E	NA	NA	WL	L	WL	P	NA	WL	NA
9. Household Hazardous Waste Collection Program	E	E	E	NA	E	E	E	E	E	E	E	E	E	E	E	E
10. Habitat Improvement Program	NA	P	NA	NA	NA	WL	E	NA	NA	WL	WL	NA	P	NA	WL	E
11. Promote and Encourage Riparian Best Management Practices	E	L	NA	P	E	E	E	E	NA	E	L	E	L	P	E	E
12. Storm Water BMP Maintenance and/or Retrofit Programs	E	P	NA	CS	NA	WL	P	E	E	E	E	WL	P	E	E	NA
13. OSDS Maintenance Program	CS	CS	CS	CS	E	E	P	CS	CS	CS	CS	CS	CS	CS	CS	E

Action/Management Alternative	Auburn Hills	Avondale Schools	Bloomfield Township	Keego Harbor	City of Lake Angelus	Oakland County	Oakland University	Orchard Lake Village	Orion Township	Pontiac	Rochester	Rochester Hills	Rochester Schools	Sylvan Lake	Waterford Township	West Bloomfield Township
14. Natural Areas Restoration/Enhancement Program	NA	P	E	NA	E	E	P	WL	NA	WL	WL	WL	P	NA	WL	E
15. Implement and/or Improve Inspection/ Enforcement of SESC	CS	CS	CS	CS	E	E	CS	CS	E	E	CS	CS	CS	NA	CS	E
16. Water Level Structure Control Committee	E	NA	NA	P	E	P	WL	P	NA	P	E	WL	WL	E	CS	NA
17. Natural Features Protection Plan/Inventory/ Assessments	NA	WL	E	E	E	E	E	E	WL	WL	WL	E	P	E	WL	E
18. Greenway Plan	NA	NA	NA	E	NA	P	NA	P	P	L	E	E	NA	E	E	NA
19. Recreation Plan	E	NA	NA	E	NA	P	NA	E	L	E	E	E	NA	E	L	NA
20. Sanitary Sewer Master Plan	E	NA	E	CS	NA	CS	P	CS	WL	E	E	E	NA	E	E	E
21. Water Quality Monitoring	E	E	NA	P	E	E	E	P	NA	E	P	E	E	E	E	P

Action/Management Alternative	Auburn Hills	Avondale Schools	Bloomfield Township	Keego Harbor	City of Lake Angelus	Oakland County	Oakland University	Orchard Lake Village	Orion Township	Pontiac	Rochester	Rochester Hills	Rochester Schools	Sylvan Lake	Waterford Township	West Bloomfield Township
22. Continue to Implement Actions from Approved PEP Plans	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
23. Pet Waste/Waterfowl Management	E	E	E	E	E	P	E	E	E	E	E	E	NA	E	E	E
24. Training/Inspection Program for Staff and Contractors	E	E	E	E	E	E	E	E	P	E	E	E	E	E	P	E
25. Catch Basin Inspection and Maintenance	E	E	NA	CS	NA	E	E	E	NA	E	E	E	E	E	E	P
26. Maintenance of Swales	E	E	NA	P	NA	E	E	E	NA	NA	NA	E	E	E	E	NA
27. Fleet Maintenance Activities	E	E	E	P	E	E	E	E	NA	E	P	E	P	E	P	E
28. Street & Parking Lot/Pavement Sweeping	E	E	NA	E	NA	E	E	E	NA	E	E	E	E	E	E	P
29. Salt Storage & Application	E	E	E	P	NA	E	E	E	NA	E	E	E	E	NA	NA	NA

Action/Management Alternative	Auburn Hills	E	E
	Avondale Schools	NA	E
	Bloomfield Township	NA	E
	Keego Harbor	NA	E
	City of Lake Angelus	NA	E
	Oakland County	E	E
	Oakland University	E	E
	Orchard Lake Village	NA	E
	Orion Township	NA	NA
	Pontiac	E	E
	Rochester	NA	E
	Rochester Hills	N/A	E
	Rochester Schools	NA	E
	Sylvan Lake	NA	E
	Waterford Township	WL	P
West Bloomfield Township	NA	E	
30. Golf Course Management			
31. Grounds and Facilities Maintenance			

Table 5.6 Action Matrix Details (Cost, Evaluation, Level of Effort and Interim Milestones)

Watershed Management Alternatives/Actions/Best Management Practices	Estimated Cost and Technical/Financial Assistance*	Methods of Evaluation	Level of Effort (Number below Indicates Percent (%) of Total Representatives)					Overall Subwatershed Interim Milestones
			Ongoing Activity	Completed in < 5 years	Completed in > 5 years	Not Applicable or County Standard	Wish List (Eligible for Grant Funding; Non-Phase II)	
<p>1. Review and Update Ordinances that Impact Water Resources as Applicable</p>	Using existing templates tailor to individual community needs. \$2,000 - \$12,000 per ordinance depending on level of detail. (Subwatershed Representative and Consultant Assistance)	Municipalities are in various stages of adopting/updating these types of ordinances.	69	13		13		82% completion & participation within 5 years
<p>2. Review and Update Master Plans as Applicable</p>	\$5,000-\$20,000 Master Plan (Subwatershed Representative and Consultant Assistance)	Completed Master Plan	56		19	19		56% currently reviewing Master Plans with anticipated completion in next 3 years.

Watershed Management Alternatives/Actions/Best Management Practices	Estimated Cost and Technical/Financial Assistance*	Methods of Evaluation	Level of Effort (Number below Indicates Percent (%) of Total Representatives)					Overall Subwatershed Interim Milestones
			Ongoing Activity	Completed in < 5 years	Completed in > 5 years	Not Applicable or County Standard	Wish List (Eligible for Grant Funding; Non-Phase II)	
3. Preserve Natural Areas	Community staff at \$60/hour or consultant assistance at \$150/hr; Some projects may also be completed by volunteers. (Subwatershed Representative and Consultant Assistance)	Areas are preserved through private efforts, coordination with municipalities and/or Oakland Land Conservancy.	50	19		25		50% currently in process and 69% anticipate completion within 5 years.
4. Review & Update Storm Water Management Design Standards	Using existing templates tailor to individual community needs. \$2,000 - \$12,000 depending on level of detail.	Completed design standards.	63	25	6			63% are currently updating with a total of 88% complete in 5 years.

Watershed Management Alternatives/Actions/Best Management Practices	Estimated Cost and Technical/Financial Assistance*	Methods of Evaluation	Level of Effort (Number below Indicates Percent (%) of Total Representatives)					Overall Subwatershed Interim Milestones
			Ongoing Activity	Completed in < 5 years	Completed in > 5 years	Not Applicable or County Standard	Wish List (Eligible for Grant Funding; Non-Phase II)	
5. Downspout/Sump Pump Disconnection Programs	Using existing templates tailor to individual community needs. \$2,000 - \$12,000 depending on level of program detail. Implementation costs vary widely from \$50 for simple downspout disconnects to \$5,000 for elaborate sump pump disconnect.	Completed program development.	38			25	31	38% have ongoing programs.

Watershed Management Alternatives/Actions/Best Management Practices	Estimated Cost and Technical/Financial Assistance*	Methods of Evaluation	Level of Effort (Number below Indicates Percent (%) of Total Representatives)					Overall Subwatershed Interim Milestones
			Ongoing Activity	Completed in < 5 years	Completed in > 5 years	Not Applicable or County Standard	Wish List (Eligible for Grant Funding; Non-Phase II)	
6. Footing Drain Disconnection Program	Using existing templates tailor program to individual community needs. \$2,000 - \$12,000 depending on level of detail. Implementation costs vary widely.	Completed program development.	38			25	31	38% have ongoing programs.
7. Log Jam Inventory and/or Management	Community staff at \$60/hour; equipment costs range from \$80 - \$150/hour. Some projects may also be completed by volunteers with community oversight. (Subwatershed Representative and Consultant Assistance)	Project sites are prioritized and projects completed. Measure: number of sites restored, monitoring results.	13	6		50	25	19% of representatives will have programs / participation within 5 years.

Watershed Management Alternatives/Actions/Best Management Practices	Estimated Cost and Technical/Financial Assistance*	Methods of Evaluation	Level of Effort (Number below Indicates Percent (%) of Total Representatives)					Overall Subwatershed Interim Milestones
			Ongoing Activity	Completed in < 5 years	Completed in > 5 years	Not Applicable or County Standard	Wish List (Eligible for Grant Funding; Non-Phase II)	
8. Streambank Stabilization Program	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. (Subwatershed Representative; Consultant; CRWC and Volunteers)	Road crossings ranked thru existing surveys; other areas to survey; document lineal footage of streambank stabilized and address flow reduction upstream; lbs of sediment reduced from stabilization.	6	6	6	50	25	19% will have programs within 5 years.
9. Household Hazardous Waste Collection Program	Costs vary depending on whether municipalities are participating in a partnership or establishing their own program. \$5k - \$50k per year. (Subwatershed Representative)	Community develops, implements and/or participates in an existing program.	81			6		88% have ongoing programs.

Watershed Management Alternatives/Actions/Best Management Practices	Estimated Cost and Technical/Financial Assistance*	Methods of Evaluation	Level of Effort (Number below Indicates Percent (%) of Total Representatives)					Overall Subwatershed Interim Milestones
			Ongoing Activity	Completed in < 5 years	Completed in > 5 years	Not Applicable or County Standard	Wish List (Eligible for Grant Funding; Non-Phase II)	
10. Habitat Improvement Program	Costs may be incorporated into the streambank stabilization activities; vary depending on type and size of project. \$40-\$60/hour/representative; \$100-\$150/hour consultant. (Subwatershed Representative; CRWC; Consultant and Volunteers)	Sites are identified and prioritized; number of sites/amount of stream habitat restored; monitoring results	13	13		50	19	26% will have ongoing programs within 5 years.
11. Promote and Encourage Riparian Best Management Practices	Community staff at \$60/hour or consultant assistance at \$150/hr; Some projects may also be completed by volunteers. (Subwatershed Representative and Consultant Assistance)	Riparian BMPs are implemented on private properties.	50	13	13	13		63% will have ongoing practices within 5 years; 50% have ongoing activities.

Watershed Management Alternatives/Actions/Best Management Practices	Estimated Cost and Technical/Financial Assistance*	Methods of Evaluation	Level of Effort (Number below Indicates Percent (%) of Total Representatives)					Overall Subwatershed Interim Milestones
			Ongoing Activity	Completed in < 5 years	Completed in > 5 years	Not Applicable or County Standard	Wish List (Eligible for Grant Funding; Non-Phase II)	
12. Storm Water BMP Maintenance and/or Retrofit Programs	Incorporate maintenance requirements into ordinance and/or standards; actual maintenance varies; \$1,000 - \$50,000 depending on maintenance needs(erosion repair, riprap repair, dredging, buffer construction, native plant enhancement, outlet repair, embankment repair, unclogging of structures) (Subwatershed Representative and Consultant Assistance)	Community includes a section within the Storm Water 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.	44	19	19	13	63% will have ongoing programs within 5 years.	

Watershed Management Alternatives/Actions/Best Management Practices	Estimated Cost and Technical/Financial Assistance*	Methods of Evaluation	Level of Effort (Number below Indicates Percent (%) of Total Representatives)					Overall Subwatershed Interim Milestones
			Ongoing Activity	Completed in < 5 years	Completed in > 5 years	Not Applicable or County Standard	Wish List (Eligible for Grant Funding; Non-Phase II)	
13. OSDS Maintenance Program	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. (Subwatershed Representative and Consultant Assistance)	County jurisdiction and potentially initiates development of the ordinance and adopts.	13	6	75		County primary jurisdiction with 2 additional representatives implementing programs within 5 years.	
14. Natural Areas Restoration/ Enhancement Program	~\$15,000-\$50,000 per community depending on size and whether field surveys are utilized. (Subwatershed Representative and Consultant Assistance)	Plan is prepared and utilized during site planning review processes.	19	19	31	25	38% programs development within 5 years.	

Watershed Management Alternatives/Actions/Best Management Practices	Estimated Cost and Technical/Financial Assistance*	Methods of Evaluation	Level of Effort (Number below Indicates Percent (%) of Total Representatives)					Overall Subwatershed Interim Milestones
			Ongoing Activity	Completed in < 5 years	Completed in > 5 years	Not Applicable or County Standard	Wish List (Eligible for Grant Funding; Non-Phase II)	
15. Implement and/or Improve Inspection/Enforcement of SESC	Increased staffing and enforcement - approximately \$50,000 per year. (Subwatershed Representative)	Community/county expands inspection/enforcement program. Track number of complaints/violations and enforcement actions.	25		69		25% have ongoing programs while most rely on County.	
16. Water Level Structure Control Committee	Community staff at \$60/hour and/or consultants at \$150/hour (Subwatershed Representatives and Consultant Assistance)	Document participation, input and goals developed from committee.	19	25	50	19	39% participation in committee within 5 years.	

Watershed Management Alternatives/Actions/Best Management Practices	Estimated Cost and Technical/Financial Assistance*	Methods of Evaluation	Level of Effort (Number below Indicates Percent (%) of Total Representatives)					Overall Subwatershed Interim Milestones
			Ongoing Activity	Completed in < 5 years	Completed in > 5 years	Not Applicable or County Standard	Wish List (Eligible for Grant Funding; Non-Phase II)	
17. Natural Features Protection Plan/Inventory/ Assessments	~\$15,000-\$50,000 per community depending on size and whether field surveys are utilized. (Subwatershed Representative and Consultant Assistance)	Plan is prepared and utilized during site planning review processes.	44	6		13	31	50% implementation within 5 years.
18. Greenway Plan	Staff time from Oakland County and community participation. \$100/hour with approximately 80 hours/community. (Subwatershed Representatives and Assistance from Counties)	Overall map is created as a guiding document for long-term planning efforts.	25	19		50		44% implementation within 5 years; however, County taking lead so majority of Clinton Main area will have plan within 5 years.

Watershed Management Alternatives/Actions/Best Management Practices	Estimated Cost and Technical/Financial Assistance*	Methods of Evaluation	Level of Effort (Number below Indicates Percent (%) of Total Representatives)					Overall Subwatershed Interim Milestones
			Ongoing Activity	Completed in < 5 years	Completed in > 5 years	Not Applicable or County Standard	Wish List (Eligible for Grant Funding; Non-Phase II)	
19. Recreation Plan	\$5,000-\$20,000 Recreation Plan (Subwatershed Representative and Consultant Assistance)	Completed recreation plan	44	6	13	50		50% plan development within 5 years.
20. Sanitary Sewer Master Plan	\$5,000-\$20,000 Master Plan (Subwatershed Representative and Consultant Assistance)	Completed Master Plan	50	6		31	6	56% plan development within 5 years, most others rely on County.
21. Water Quality Monitoring	Volunteer monitoring \$15,000 annually; long-term water quality sampling program \$200,000; long-term modeling efforts \$150,000. (CRWC Assistance)	Volunteer monitoring ongoing-track progress; long-term dependent on funding availability.	56	25		13		Participation in program increase to 81% within 5 years.

Watershed Management Alternatives/Actions/Best Management Practices	Estimated Cost and Technical/Financial Assistance*	Methods of Evaluation	Level of Effort (Number below Indicates Percent (%) of Total Representatives)					Overall Subwatershed Interim Milestones
			Ongoing Activity	Completed in < 5 years	Completed in > 5 years	Not Applicable or County Standard	Wish List (Eligible for Grant Funding; Non-Phase II)	
<p>22. Continue to Implement Actions from Approved PEP Plans</p>	<p>\$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. (Subwatershed Representative; CRWC and Consultant Assistance)</p>	<p>Number of events; number of participants; pre-/post-surveys; monitoring results.</p>	<p>94</p>					<p>94% ongoing activity as required activity.</p>

Watershed Management Alternatives/Actions/Best Management Practices	Estimated Cost and Technical/Financial Assistance*	Methods of Evaluation	Level of Effort (Number below Indicates Percent (%) of Total Representatives)					Overall Subwatershed Interim Milestones
			Ongoing Activity	Completed in < 5 years	Completed in > 5 years	Not Applicable or County Standard	Wish List (Eligible for Grant Funding; Non-Phase II)	
23. Pet Waste/Waterfowl Management	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. (Subwatershed Representative; CRWC and Consultant Assistance)	Number of individuals reached / personal observation; quantity of materials distributed; pre-/ post-survey results; monitoring results.	81	6		6		81% participation as a required activity; another 6% within 5 years.

Watershed Management Alternatives/Actions/Best Management Practices	Estimated Cost and Technical/Financial Assistance*	Methods of Evaluation	Level of Effort (Number below Indicates Percent (%) of Total Representatives)					Overall Subwatershed Interim Milestones
			Ongoing Activity	Completed in < 5 years	Completed in > 5 years	Not Applicable or County Standard	Wish List (Eligible for Grant Funding; Non-Phase II)	
24. Training/Inspection Program for Staff and Contractors	Varies by activity; may include workshops, brochures, etc. \$40-\$60/hour/representative; \$100-\$150/hour consultant. \$10/hour volunteer. (Subwatershed Representative; CRWC and Consultant Assistance)	Number / type of programs / materials distributed; documentation of changes in practices.	81	13				81% participation currently as required activity; another 13% within 5 years.
25. Catch Basin Inspection and Maintenance	Dependent on number of catch basins; \$30-\$40/hour operator at approximately 1 hour per catch basin; Additional disposal costs if necessary. (Subwatershed Representative)	Miles of streets swept or parking lot areas; # of catch basins cleaned; lbs/tons material captured; or number of truckloads.	63	6		25		63% as ongoing activity as a requirement; another 6% within 5 years.

Watershed Management Alternatives/Actions/Best Management Practices	Estimated Cost and Technical/Financial Assistance*	Methods of Evaluation	Level of Effort (Number below Indicates Percent (%) of Total Representatives)					Overall Subwatershed Interim Milestones
			Ongoing Activity	Completed in < 5 years	Completed in > 5 years	Not Applicable or County Standard	Wish List (Eligible for Grant Funding; Non-Phase II)	
26. Maintenance of Swales	Dependent on area of swales; \$30-\$40/hour operator with 2 operators. (Subwatershed Representative)	Miles of swales cleaned; lbs of material removed.	50	6		38		50% participation ongoing with another 6% in 5 years.
27. Fleet Maintenance Activities	Varies by activity; may include workshops, brochures, etc. \$40-\$60/hour/representative; \$100-\$150/hour consultant. (Subwatershed Representative; CRWC and Consultant Assistance)	Number / type of programs / materials distributed; documentation of changes in practices.	63	25		6		63% ongoing participation as a required activity with another 25% within 5 years.

Watershed Management Alternatives/Actions/Best Management Practices	Estimated Cost and Technical/Financial Assistance*	Methods of Evaluation	Level of Effort (Number below Indicates Percent (%) of Total Representatives)					Overall Subwatershed Interim Milestones
			Ongoing Activity	Completed in < 5 years	Completed in > 5 years	Not Applicable or County Standard	Wish List (Eligible for Grant Funding; Non-Phase II)	
28. Street & Parking Lot/Pavement Sweeping	\$50,000 Per year lease; \$30\$40/hour operator for 150 days/year; Mechanical broom sweeper \$100k; Vacuum Sweeper \$150k - \$250k; \$250 - \$1000 per catch basin insert. (Subwatershed Representative)	Miles of streets swept or parking lot areas; # of catch basins cleaned; lbs/tons material captured; or number of truckloads.	63	6		19		69% ongoing as a required activity with another 6% within 5 years.

Watershed Management Alternatives/Actions/Best Management Practices	Estimated Cost and Technical/Financial Assistance*	Methods of Evaluation	Level of Effort (Number below Indicates Percent (%) of Total Representatives)					Overall Subwatershed Interim Milestones
			Ongoing Activity	Completed in < 5 years	Completed in > 5 years	Not Applicable or County Standard	Wish List (Eligible for Grant Funding; Non-Phase II)	
29. Salt Storage & Application	Requires adjustment of application rates and recalibration of equipment. Calcium chloride \$20/land mile extra, CMA \$65 / lane mile extra compared with salt. \$40-\$60/hour/representative; \$100-\$150/hour consultant. (Subwatershed Representative and Consultant Assistance)	Community / county reviews and modifies practices.	63	6		25		63% as ongoing required activity with another 6% in 5 years.

Watershed Management Alternatives/Actions/Best Management Practices	Estimated Cost and Technical/Financial Assistance*	Methods of Evaluation	Level of Effort (Number below Indicates Percent (%) of Total Representatives)					Overall Subwatershed Interim Milestones
			Ongoing Activity	Completed in < 5 years	Completed in > 5 years	Not Applicable or County Standard	Wish List (Eligible for Grant Funding; Non-Phase II)	
30. Golf Course Management	Varies depending on activity (may include workshops, mailings, site visits). \$40-\$60/hour/representative; \$100-\$150/hour consultant. (Subwatershed Representative and Consultant Assistance)	Golf courses develop and implement management programs.	25			63	6	25% as ongoing activity; most others do not own golf courses.
31. Grounds and Facilities Maintenance	Varies by activity; may include workshops, brochures, etc. \$40-\$60/hour/representative; \$100-\$150/hour consultant. (Subwatershed Representative; CRWC and Consultant Assistance)	Number / type of programs / materials distributed; documentation of changes in practices.	82	6		6		25% as ongoing activity.

5.3 Non-NPDES Phase II Permit Priority Preservation/Restoration Projects

As previously mentioned, there are numerous actions that work towards improving water resources in the Clinton Main subwatershed and the overall Clinton River Watershed. These projects are identified separately in order to qualify for eligibility under the EPA Section 319 grant funding program. While similar categories of information are required for both for Phase II and Non-Phase II activities, these projects are called-out in this section separately so as to clearly identify them as 319 projects. Priorities were established by the Clinton Main Subwatershed Group in December 2009. The prioritized best management practice categories and associated projects for implementation over the short-term (5 – 10 years) are identified as follows:

1. Storm Water Enhancements/Retrofits

- Land Cover Classifications Analysis
- Downspout Disconnect
- Detention Pond Retrofits
- Athletic Field Retrofits
- Porous Pavement
- Regional Detention/Wetland Basins
- Rain Gardens
- Bioswales

2. Stabilization Projects

- Streambank
- Lakeshore
- Outfall
- Easement Acquisition

3. Recreational Enhancements

- Easement Acquisition
- River/Lake Access

4. Habitat Restoration

- Easement Acquisition
- Wetland Restoration/Enhancement
- Invasive Species Management

5. Preservation

- Easement Acquisition

Table 5.7a Clinton Main Proposed Projects Prioritized by Community below identifies the specific BMP projects that have been targeted for implementation over the short-term. The “Priority BMP Category” reflects the priorities listed above, followed by individual prioritization by subwatershed representative.

In order to further evaluate benefits of the proposed projects, a number of approaches were utilized, including the following:

- An estimate of existing storm water runoff volume across the subwatershed was developed that includes both runoff volume during a 2-year, 24-hour event and annual runoff. These estimates are strictly based on the curve number method and an annual rainfall of thirty-two (32)-inches per year and an average runoff coefficient of 0.7. See Table 5.7b. Clinton Main Storm Water Runoff Volume – Existing Conditions.
- Table 5.7c. Clinton Main Annual Storm Water Runoff Volume, Total Phosphorus Loading & Total Phosphorus Loading Reduction Targets shows the annual total phosphorus load estimate along with the estimated phosphorus reduction from the above mentioned projects. These loading estimates were based on the PLOAD analysis described earlier in the watershed plan. The loading reduction estimates were determined from the Center for Watershed Protection spreadsheet tool or the Oakland County Site Evaluation Tool developed as part of the Clinton River project.
- Table 5.7d. Clinton Main Annual Storm Water Runoff Volume, Total Nitrates/Nitrites Loading & Total Nitrates/Nitrites Loading Reduction Targets shows the annual total nitrogen load estimate along with the estimated total nitrogen reduction from the above mentioned projects. The loading reduction estimates were determined from the Center for Watershed Protection spreadsheet tool or the Oakland County Site Evaluation Tool developed as part of the Clinton River project.
- Table 5.7e. Clinton Main Annual Storm Water Runoff Volume, Total Suspended Solids Loading & Total Suspended Solids Loading Reduction Targets shows the annual total suspended solids loading along with the estimated total suspended solids loading reduction from the above mentioned projects. The loading estimates and loading reduction estimates were calculated similarly to the previous pollutants.

Table 5.7f outlines the Pollutants/Threats, Sources and Causes that are addressed by each of these priority projects. Table 5.7g shows the volume and pollutant loading reductions for each project, if applicable. It should be noted that not all projects can specifically estimate direct pollutant loading reduction benefits; however, these projects are still highly valuable in working towards improving water resources. Table 5.7h outlines the individual project costs, schedule, milestones and methods of evaluation. A total estimate of these projects for watershed restoration and preservation is on the order of \$13 million. All of these tables referenced are located at the end of this chapter.

5.4 Available Technical Resources from Partner Organizations

There are many local resources to help further understand and implement the more than 130 different BMPs that can potentially be used to restore urban subwatersheds. Below are a few of the organizations currently working within the Clinton River Watershed:

- Clinton River Watershed Council (www.crowc.org)
- Clinton River Remedial Action Committee (<http://www.epa.gov/glnpo/aoc/clinriv.html>)
- Southeast Michigan Council of Governments (www.semcog.org)
- Michigan Department of Environment (www.michigan.gov/deq)
- Michigan Department of Natural Resources (www.michigan.gov/dnr)
- Oakland County Water Resources Commissioner's Office (www.oakgov.com/drain/)
- Oakland County Planning & Environment (www.oakgov.com/peds/info_pub/planning_and_enviromental_infoandpubs.html)
- United States Environmental Protection Agency – Region 5 (www.epa.gov/region5/)

- ◆ United State Army Corp of Engineers Great Lakes & Ohio River Division (www.lrd.usace.army.mil/)

5.5 Potential Funding Sources

The following are some of the possible funding sources such as grants, loans, and cost share programs, available to stakeholder agencies and non-governmental organizations for watershed management. This list is not exhaustive. Information on these funding sources can be found on the Internet or by contacting the agency.

Agricultural

- ◆ Agriculture in Concert with the Environmental Program (USDA)
- ◆ Watershed Protection and Flood Prevention Program (USDA)
- ◆ Conservation Reserve Program (NRCS)
- ◆ Wetlands Reserve Program (NRCS)
- ◆ Wildlife Habitat Incentive Program (NRCS)
- ◆ Forestry Incentives Program (NRCS)
- ◆ Environmental Quality Incentives Program (NRCS)
- ◆ Farmland Protection Program (USDA)
- ◆ Debt for Nature (Farm Service Agency)
- ◆ SARE Producer Grant Program (USDA)

Storm, waste and drinking water improvements and management

- ◆ MDEQ Clean Water State Revolving Fund Loans
- ◆ MDEQ Drinking Water Revolving Fund Loans
- ◆ Rural Business Enterprise Grants (water, wastewater, storm water) (USDA)
- ◆ Rural Development Water & Wastewater Disposal Program Grants & Loans (USDA)

Habitat restoration and creation

- ◆ Partners for Fish & Wildlife (US Dept Fish & Wildlife)
- ◆ North American Wetland Conservation Act Grant Program (US Dept of Interior)
- ◆ National Fish & Wildlife Foundation (US Dept of Interior)
- ◆ US EPA Five Star Restoration Grant Program
- ◆ Great Lakes Aquatic Habitat Network and Fund
- ◆ Natural Heritage Grant Program (MDNR)
- ◆ Inland Fisheries Grant Program (MDNR)
- ◆ Private Stewardship Grant Program (US Dept of Interior, US Fish & Wildlife, Endangered Species)
- ◆ Aquatic Ecosystems Restoration Grants (US Army Corps of Engineers)
- ◆ Great Lakes Fishery Trust
- ◆ DTE Energy Tree Planting Grants
- ◆ NOAA: Open Rivers Initiative
- ◆ NOAA Community-based Restoration Program - Project Grants

Education

- ◆ US EPA Environmental Education Program
- ◆ US EPA Five Star Restoration Grant Program

Watershed planning and implementation

- ◆ Clean Water Act Section 319 Nonpoint Source Pollution Management Grants (MDEQ)

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General

- ◆ Non-point Source Pollution Management Grant (MDEQ)
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- ◆ The Joyce Foundation
- ◆ Wal-Mart Environmental Grants
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- ◆ Small Watershed Program (NRCS)
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- ◆ Plant Conservation Alliance: NFWF Native Plant Conservation Initiative
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Water quality monitoring

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5. Preservation

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Table 5.7a Clinton Main Proposed Projects Prioritized by Community below identifies the specific BMP projects that have been targeted for implementation over the short-term. The “Priority BMP Category” reflects the priorities listed above, followed by individual prioritization by subwatershed representative.

In order to further evaluate benefits of the proposed projects, a number of approaches were utilized, including the following:

- An estimate of existing storm water runoff volume across the subwatershed was developed that includes both runoff volume during a 2-year, 24-hour event and annual runoff. These estimates are strictly based on the curve number method and an annual rainfall of thirty-two (32)-inches per year and an average runoff coefficient of 0.7. See Table 5.7b. Clinton Main Storm Water Runoff Volume – Existing Conditions.
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- Oakland County Water Resources Commissioner's Office (www.oakgov.com/drain/)
- Oakland County Planning & Environment (www.oakgov.com/peds/info_pub/planning_and_enviromental_infoandpubs.html)
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- ◆ Farmland Protection Program (USDA)
- ◆ Debt for Nature (Farm Service Agency)
- ◆ SARE Producer Grant Program (USDA)

Storm, waste and drinking water improvements and management

- ◆ MDEQ Clean Water State Revolving Fund Loans
- ◆ MDEQ Drinking Water Revolving Fund Loans
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Habitat restoration and creation

- ◆ Partners for Fish & Wildlife (US Dept Fish & Wildlife)
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- ◆ Private Stewardship Grant Program (US Dept of Interior, US Fish & Wildlife, Endangered Species)
- ◆ Aquatic Ecosystems Restoration Grants (US Army Corps of Engineers)
- ◆ Great Lakes Fishery Trust
- ◆ DTE Energy Tree Planting Grants
- ◆ NOAA: Open Rivers Initiative
- ◆ NOAA Community-based Restoration Program - Project Grants

Education

- ◆ US EPA Environmental Education Program
- ◆ US EPA Five Star Restoration Grant Program

Watershed planning and implementation

- ◆ Clean Water Act Section 319 Nonpoint Source Pollution Management Grants (MDEQ)

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General

- ◆ Non-point Source Pollution Management Grant (MDEQ)
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- ◆ Plant Conservation Alliance: NFWF Native Plant Conservation Initiative
- ◆ Paul H. Young Trout Unlimited

Water quality monitoring

- ◆ Clean Water Corps grant program (MDEQ)
- ◆ Great Lakes Aquatic Habitat Network and Fund

Table 5.7a. Clinton Main Proposed Projects Prioritized by Community

Community/County		Project Name	Priority BMP Category	Subbasin Number	Subbasin Type
Entire Subshed		Land Cover Classifications Analysis	1	All	All
City of Auburn Hills	1	Civic Center Parking Lots	1	11	Preservation/Restoration
	2	Hawk Woods Parking Lot	1	12	Preservation
	3	Fire Station No.3 Parking Lots	1	13	Preservation/Restoration
	4	Manitoba Park Parking Lots	1	14	Restoration
	5	Community Dev Center	1	11	Preservation/Restoration
	6	Baseball Field Parking Lot	1	11	Preservation/Restoration
	7	Athletic Field Parking Lot	1	11	Preservation/Restoration
	8	River Woods Parking Lot	1	4	Restoration
City of Keego Harbor	1	City Hall Detention Pond Retrofit	1	2	Preservation
Oakland County	1	Mainland Drain Project-Cons Wet	1	14	Restoration
	2	Mainland Drain Project-Stabilization	2	14	Restoration
	3	Waterford Oaks County Park	3	14	Restoration
	4	PCR#2 Streambank Stabilization	2	4	Restoration
Oakland University	1	East Ravine Tributary Restoration	2	11	Preservation/Restoration
	2	Golf Course Galloway Creek Restoration	2	11	Preservation/Restoration
	3	West Ravine Tributary Restoration	2	11	Preservation/Restoration
	4	Belgian Barn & Pioneer Drive Restoration	2	11	Preservation/Restoration
	5	NW Tributary Enhancement	2	11	Preservation/Restoration
	6	P-11 Biofiltration	1	11	Preservation/Restoration
Orchard Lake Village	1	Orchard Lake Bank Stabilization	2	2	Preservation
City of Pontiac	1	City-Owned Parking Lot Storm Water Pretreatment	1	3, 4, 11, 13, 14	Restoration/Preservation
	2	City-Wide Outfall Stabilization	2	3, 4, 11, 13, 14	Restoration/Preservation
	3	Downspout Disconnection Program	1	3, 4, 11, 13, 14	Restoration/Preservation
City of Rochester	1	Canoe Launch near Diversion St Parking Lot for Clinton River Trail	3	5	Preservation/Restoration
	2	Clinton River Pedestrian Bridge	3	5	Preservation/Restoration
	3	Bank Stabilization near Letica Rd Parking Lot for Clinton River Trail	1	5	Preservation/Restoration
City of Rochester Hills	1	Riverside Put-In/Take-Out	3	5	Preservation/Restoration
	2	Fisherman Access Points	3	5	Preservation/Restoration
	3	Natural Channel Restoration	2	5	Preservation/Restoration
	4	Invasive Species Control	4	5, 11	Preservation/Restoration
	5	City Hall Employee/Visitor Lot	1	5	Preservation/Restoration
	6	Cistern Installation	1	5	Preservation/Restoration
	7	Wetland, floodplain, steep slope and riparian buffer protection through easement acquisition	3	4, 5, 11	Preservation/Restoration
Sylvan Lake	1	Pontiac Drive Cul-de-Sac Retrofit	1&2	2	Preservation

Table 5.7b. Clinton Main Storm Water Runoff Volume - Existing Conditions¹

Land Use Type	Total Area (Acres)	Total Area (Sq.Ft)	Curve Number Existing	Runoff Volume Existing (CF)	Runoff Volume Existing (MG)	Sub-basin ID	% of Total Subwatershed Area	Runoff Volume by Sub-basin (CF)
Single Family	12,915	562,577,400	77	27,596,478	206	1	14%	24,357,889
Road Right-of-Way	6,406	279,045,360	85	22,854,131	171	2	9%	16,077,718
Vacant	5,680	247,420,800	61	2,641,276	20	3	5%	8,658,857
Water	4,759	207,302,040	100	38,869,133	291	4	14%	24,269,493
Industrial	4,385	191,010,600	91	22,042,884	165	5	9%	15,209,897
Recreation / Conservation	3,719	161,999,640	86	14,074,051	105	6	2%	3,827,660
Public / Institutional	3,754	163,524,240	85	13,392,821	100	7	4%	6,302,359
Commercial / Office	2,850	124,146,000	94	16,879,986	126	8	1%	903,023
Multiple Family	1,800	78,408,000	90	8,559,412	64	10	1%	1,676,919
Transportation / Utility / Communication	605	26,353,800	90	2,876,913	22	11	14%	23,574,846
Mobile Home Park	501	21,823,560	90	2,382,370	18	12	6%	10,377,727
Railroad Right-of-Way	251	10,933,560	85	895,471	7	13	6%	9,849,019
Extractive	22	958,320	70	27,284	0	14	10%	17,832,890
Total	47,647	2,075,503,320	71	173,092,208	1,295	16	0.4%	739,853

¹Based on a 2-year, 24-hour rain event.

Table 5.7c. Clinton Main Annual Storm Water Runoff Volume¹, Total Phosphorus Loading² & Total Phosphorus Loading Reduction Targets³

Sub-basin ID	Acreage	% of Total Subwatershed Area	Runoff Volume by Subbasin (Annual Billion Gallons)	Annual Total Phosphorus Loading (lbs)	Total Annual Phosphorus Loading Reduction from Proposed 319
1	6,543	14%	4.08	3,369	
2	4,319	9%	2.69	2,446	34
3	2,326	5%	1.45	1,869	2
4	6,519	14%	4.06	5,478	119
5	4,086	9%	2.55	2,872	96
6	1,028	2%	0.64	450	
7	1,693	4%	1.06	453	
8	243	1%	0.15	38	
10	450	1%	0.28	218	
11	6,333	14%	3.95	4,294	989
12	2,788	6%	1.74	1,064	0.30
13	2,646	6%	1.65	1,794	3
14	4,790	10%	2.99	4,627	376
15	2,534	5%	1.58	1,899	
16	199	0.4%	0.12	100	
TOTAL			29	30,971	1,618

¹Estimate using annual rainfall of 32 inches/year and average subwatershed C-factor

²Using loading from PLOAD estimates and sub-basin acreage

³Using pollutant loading estimates from proposed projects in sub-basin

Table 5.7d. Clinton Main Annual Storm Water Runoff Volume¹, Total Nitrates/Nitrites Loading² & Total Nitrates/Nitrites Loading Reduction Targets³

Sub-basin ID	Acreage	% of Total Subwatershed Area	Runoff Volume by Subbasin (Annual Billion Gallons)	Annual Total Nitrates/Nitrites Loading (lbs)	Total Annual Nitrates/Nitrites Loading Reduction from Proposed 319 Projects (lbs)
1	6,543	14%	4.08	41,993	
2	4,319	9%	2.69	31,134	96
3	2,326	5%	1.45	18,977	7
4	6,519	14%	4.06	55,788	298
5	4,086	9%	2.55	29,902	256
6	1,028	2%	0.64	4,813	
7	1,693	4%	1.06	5,405	
8	243	1%	0.15	544	
10	450	1%	0.28	2,602	
11	6,333	14%	3.95	43,161	2,063
12	2,788	6%	1.74	11,575	2.00
13	2,646	6%	1.65	18,164	11
14	4,790	10%	2.99	46,483	1,360
15	2,534	5%	1.58	19,749	
16	199	0.4%	0.12	1,438	
TOTAL			29	331,727	4,093

¹Estimate using annual rainfall of 32 inches/year and average subwatershed C-factor

²Using loading from PLOAD estimates and sub-basin acreage

³Using pollutant loading estimates from proposed projects in sub-basin

Table 5.7e. Clinton Main Annual Storm Water Runoff Volume¹, Total Suspended Solids Loading² & Total Suspended Solids Loading Reduction Targets³

Sub-basin ID	Acreage	% of Total Subwatershed Area	Runoff Volume by Subbasin (Annual Billion Gallons)	Annual Total Suspended Solids Loading (lbs)	Total Annual Suspended Solids Loading Reduction from Proposed 319 Projects (lbs)
1	6,543	14%	4.08	490,459	
2	4,319	9%	2.69	367,650	51,578
3	2,326	5%	1.45	452,755	326
4	6,519	14%	4.06	1,616,099	215,010
5	4,086	9%	2.55	689,517	603,006
6	1,028	2%	0.64	83,731	
7	1,693	4%	1.06	84,149	
8	243	1%	0.15	12,098	
10	450	1%	0.28	68,042	
11	6,333	14%	3.95	1,075,931	4,978
12	2,788	6%	1.74	301,775	65
13	2,646	6%	1.65	448,441	436
14	4,790	10%	2.99	1,294,413	98,444
15	2,534	5%	1.58	353,156	
16	199	0.4%	0.12	10,419	
TOTAL			29	7,348,634	973,843

¹Estimate using annual rainfall of 32 inches/year and average subwatershed C-factor

²Using loading from PLOAD estimates and sub-basin acreage

³Using pollutant loading estimates from proposed projects in sub-basin

Table 5.7f. Associated Pollutants/Threats, Sources and Causes Addressed by Project

Community/County	Project Name	Pollutants/Threats	Sources	Causes
City of Auburn Hills	1	Civic Center Parking Lots	Storm Water Runoff; Decreased Groundwater Recharge; Streambank Erosion	Lack of BMPs; Increased Impervious Surfaces
	2	Hawk Woods Parking Lot		
	3	Fire Station No.3 Parking Lots		
	4	Manitoba Park Parking Lots		
	5	Community Dev Center		
	6	Baseball Field Parking Lot		
	7	Athletic Field Parking Lot		
	8	River Woods Parking Lot		
City of Keego Harbor	1	City Hall Detention Pond Retrofit	Storm Water Runoff; Decreased Groundwater Recharge;	Increased Impervious Surfaces; Improper or poor BMP Maintenance; Removal of Vegetation throughout watershed;
Oakland County	1	Mainland Drain Project-Cons Wet	Storm Water Runoff; Streambank Erosion;	Lack of BMPs; Removal of Vegetation; Increased Impervious Surfaces; River Flashiness
	2	Mainland Drain Project-Stabilization	Storm Water Runoff; Streambank Erosion	Lack of BMPs; Removal of Vegetation; Increased Impervious Surfaces; River Flashiness
	3	Waterford Oaks County Park	Storm Water Runoff;	Improper or Poor BMP Maintenance; Removal of Vegetation; Road & impervious surface maintenance practices; Lack of BMPs
	4	PCR#2 Streambank Stabilization	Storm Water Runoff; Streambank Erosion	Lack of BMPs; Removal of Vegetation; Increased Impervious Surfaces; River Flashiness
	1	East Ravine Tributary Restoration	Streambank Erosion; Road-Stream Crossings	Removal of Vegetation; Increased Impervious Surfaces; River Flashiness; Lack of BMPs
	2	Golf Course Galloway Creek Restoration	Streambank Erosion; Road-Stream Crossings	Removal of Vegetation; Increased Impervious Surfaces; River Flashiness; Lack of BMPs

Table 5.7f. Associated Pollutants/Threats, Sources and Causes Addressed by Project

Community/County	Project Name	Pollutants/Threats	Sources	Causes
Oakland University	3 West Ravine Tributary Restoration	H; S; N	Storm Water Runoff; Streambank Erosion	Removal of Vegetation; Increased Impervious Surfaces; River Flashiness; Lack of BMPs
	4 Belgian Barn & Pioneer Drive Restoration	H; S; N	Storm Water Runoff; Streambank Erosion; Road-Stream Crossings	Removal of Vegetation; Increased Impervious Surfaces; River Flashiness; Lack of BMPs
	5 NW Tributary Enhancement	H; S; N	Storm Water Runoff; Decreased Groundwater Recharge; Streambank Erosion	Removal of Vegetation; Increased Impervious Surfaces; River Flashiness; Lack of BMPs
	6 P-11 Biofiltration	S; N	Storm Water Runoff	Increased Impervious Surfaces; Lack of BMPs
Orchard Lake Village	1 Orchard Lake Bank Stabilization	S; N	Storm Water Runoff; Bank Erosion	Increased Impervious Surfaces; Road & Impervious Surface Maintenance Practices; Removal of Vegetation
	1 City-Owned Parking Lot Storm Water Pretreatment	S; N	Storm Water Runoff	Increased Impervious Surfaces
	2 City-Wide Outfall Stabilization	S; N	Storm Water Runoff	Increased Impervious Surfaces; Removal of Vegetation; lack of BMPs
City of Pontiac	3 Downspout Disconnection Program	H; S; B	Decreased Groundwater Recharge; Streambank Erosion; Illicit Discharges	Sanitary Sewer Overflows; Increased Impervious Surfaces; Lack of BMPs; Impervious Surface Maintenance Practices
	1 Canoe Launch near Diversion St Parking Lot for Clinton River Trail	P	Storm Water Runoff; Streambank Erosion; Lack of Publicly-Owned Riparian Land; Lack of Conservation Easements; Lack of Public Education	Increase in Impervious Surfaces; Economical Constraints
	2 Clinton River Pedestrian Bridge	P	Storm Water Runoff; Streambank Erosion; Lack of Publicly-Owned Riparian Land; Lack of Conservation Easements; Lack of Public Education	Increase in Impervious Surfaces; Economical Constraints
City of Rochester	3 Bank Stabilization near Leica Rd Parking Lot for Clinton River Trail	S; N	Storm Water Runoff; Streambank Erosion; Lack of Publicly-Owned Riparian Land; Lack of Conservation Easements; Lack of Public Education	Increase in Impervious Surfaces; Removal of Vegetation;

Table 5.7f. Associated Pollutants/Threats, Sources and Causes Addressed by Project

Community/County	Project Name	Pollutants/Threats	Sources	Causes
City of Rochester Hills	1 Riverside Put-In/Take-Out	S; N; P	Storm Water Runoff; Streambank Erosion; Lack of Publicly-Owned Riparian Land; Lack of Conservation Easements; Lack of Public Education	Removal of Vegetation; Increase in Impervious Surfaces; Economical Constraints
	2 Fisherman Access Points	S; N; P	Storm Water Runoff; Streambank Erosion; Lack of Publicly-Owned Riparian Land; Lack of Conservation Easements; Lack of Public Education	Removal of Vegetation; Increase in Impervious Surfaces; Economical Constraints
	3 Natural Channel Restoration	H; S; N	Storm Water Runoff; Streambank Erosion; Lack of Aquatic/Riparian Habitat	Lack of BMPs; Removal of Vegetation; Increased Impervious Surfaces; Improper or Poor BMP Maintenance; Low Flow Conditions
	4 Invasive Species Control	P	Storm Water Runoff; Lack of Public Awareness	Removal of Vegetation; Increase in Impervious Surfaces; Economical Constraints
	5 City Hall Employee/Visitor Lot	H; S; N	Storm Water Runoff;	Increase in Impervious Surfaces; Lack of BMPs
	6 Cistern Installation	H	Storm Water Runoff;	Increase in Impervious Surfaces; Lack of BMPs
	7 Wetland, floodplain, steep slope and riparian buffer protection through easement acquisition	H; S; N	Storm Water Runoff; Streambank Erosion; Lack of Public Awareness; Lack of Publicly-Owned Riparian Land Lack of Conservation Easements	Increase in Impervious Surfaces; Removal of Vegetation; Lack of BMPs; Economical Constraints
Sylvan Lake	1 Pontiac Drive Cul-de-Sac Retrofit	H; S; N	Storm Water Runoff	Lack of BMPs; Increased Impervious Surfaces

¹Pollutants/Threats (H = Hydrology/Flashiness; S = Sediment; N = Nutrients; B = Bacteria; P = Limited Public Access/Education)

Table 5.7g. Project Volume and Pollutant Load Reductions

Project Name	Sub-basin No.	Other Methods of Improvements	Volume (CF)	TSS (Lb/Yr)	TP (Lb/Yr)	TN (Lb/Yr)
City Hall Detention Pond Retrofit	2	Load Reductions (CWP)	0	1021	6.00	27
Orchard Lake Bank Stabilization	2	Lineal Footage Stabilized	NA	50,000	25	51
Pontiac Drive Cul-de-Sac Retrofit	2	Load and Volume Reductions (CWP)	10,000	557	3	18
River Woods Parking Lot	4	Load Reductions (CWP)	2,790	184	1.00	6
PCR#2 Streambank Stabilization	4	Lineal Footage Stabilized	NA	212,000	106	212
Canoe Launch near Diversion St Parking Lot for Clinton River Trail	5	Project Completion	NA	NA	NA	NA
Clinton River Pedestrian Bridge	5	Project Completion	NA	NA	NA	NA
Bank Stabilization near Letica Rd Parking Lot for Clinton River Trail	5	500 ft -Lineal Footage Stabilized	NA	84	84	170
Riverside Put-In/Take-Out	5	Project Completion	485	57	0	2
Fisherman Access Points	5	1000 ft of streambank managed	NA	NA	NA	NA
Natural Channel Restoration	5	Lineal Footage of Channel Restored	NA	600,000	NA	NA
City Hall Employee/Visitor Lot	5	Load and Volume Reductions (SET)	31,500	365	2	12
Cistern Installation	5	Volume of Storm Water Reduction	4,000,000	NA	NA	NA
Civic Center Parking Lots	11	Load Reductions (CWP)	695	82	0.40	3
Community Dev Center	11	Load Reductions (CWP)	678	80	0.40	3

Table 5.7g. Project Volume and Pollutant Load Reductions

Project Name	Sub-basin No.	Other Methods of Improvements	Volume (CF)	TSS (Lb/Yr)	TP (Lb/Yr)	TN (Lb/Yr)
Baseball Field Parking Lot	11	Load Reductions (CWP)	791	93	0.40	3
Athletic Field Parking Lot	11	Load Reductions (CWP)	1,623	188	0.90	7
West Ravine Tributary Restoration	11	Lineal Footage Stabilized	NA	128	128	256
East Ravine Tributary Restoration	11	Lineal Footage Stabilized	NA	102	102	204
Belgian Barn & Pioneer Drive Restoration	11	2900 Lineal Feet Stabilized	NA	492	492	986
Golf Course Galloway Creek Restoration	11	1000 Lineal Feet Stabilized	NA	170	170	340
NW Tributary Enhancement	11	Lineal Footage Stabilized	NA	80	80	160
P-11 Biofiltration	11	Acres Managed	6400	737	3	21
Hawk Woods Parking Lot	12	Load Reductions (CWP)	549	65	0.30	2
Fire Station No.3 Parking Lots	13	Load Reductions (CWP)	935	110	0.50	4
Manitoba Park Parking Lots	14	Load Reductions (CWP)	320	38	0.20	1
Mainland Drain Project-Cons Wet	14	Load and Volume Reductions (CWP)	4,500,000	60,480	355	1,315
Mainland Drain Project-Stabilization	14	Load and Volume Reductions (CWP)	NA	37,600	19	37
Waterford Oaks County Park	14	Public Education	NA	NA	NA	NA
City-Owned Parking Lot Storm Water Pretreatment	3, 4, 11, 13, 14	Load Reduction	NA	1630	10	36

Table 5.7g. Project Volume and Pollutant Load Reductions

Project Name	Sub-basin No.	Other Methods of Improvements	Volume (CF)	TSS (Lb/Yr)	TP (Lb/Yr)	TN (Lb/Yr)
City-Wide Outfall Stabilization	3, 4, 11, 13, 14	No. Outfalls Stabilized	NA	NA	NA	NA
Downspout Disconnection Program	3, 4, 11, 13, 14	Volume of Storm Water Reduction	48,555	NA	NA	NA
Wetland, floodplain, steep slope and riparian buffer protection through easement acquisition	4, 5, 11	5000 ft (35 acres) property protected (estimates of runoff and loads not entering river)	135,785	7,500	29	217
Invasive Species Control	5, 11	5000 ft of streambank managed	NA	NA	NA	NA
Total Estimated Reductions			8,741,106	973,843	1,618	4,093

Table 5.7h. Project Costs, Schedule, Milestones and Evaluation

Community/County	Project Name	Project Costs	Schedule	Milestones	Evaluation		
All	1 Land Cover Classifications Analysis	\$200,000	2012	Contractor Procurement - Year 2; Project Completion - Year 3	Project Completion Demonstrating Existing Volume and Load Reductions based on Current Land Cover		
	1 Civic Center Parking Lots	\$200,000	2011	Design - Year 1; Construction- Year 2			
	2 Hawk Woods Parking Lot	\$150,000	2011	Design - Year 1; Construction- Year 2			
	3 Fire Station No.3 Parking Lots	\$250,000	2012	Design - Year 2; Construction - Year 3			
	4 Manitoba Park Parking Lots	\$100,000	2012	Design - Year 2; Construction - Year 3			
	5 Community Dev Center	\$180,000	2012	Design - Year 2; Construction - Year 3			
	6 Baseball Field Parking Lot	\$200,000	2013	Design - Year 3; Construction - Year 4			
	7 Athletic Field Parking Lot	\$150,000	2013	Design - Year 3; Construction - Year 4			
City of Auburn Hills	8 River Woods Parking Lot	\$350,000	2014	Design - Year 3; Construction - Year 4	Acres of Impervious Surface Managed; Estimated Volume & Load Reduction		
	1 City Hall Detention Pond Retrofit	200000*	2012	Design - Year 2; Construction - Year 3			
	1 Mainland Drain Project-Cons Wet	\$1,900,000	2012	Design - Year 2; Construction Year 3 & 4			
	2 Mainland Drain Project-Stabilization	\$1,400,000	2012	Design - Year 2; Construction Year 3 & 4			
	3 Waterford Oaks County Park	\$200,000	2012	Design - Year 3; Construction Year 3			
	Oakland County						Acres Managed; Native Vegetation Installed; Reduction in Runoff Rate &/or Volume
City of Keego Harbor					Acres Managed in Wetland; Acres of Habitat Constructed; Reduction in River Flow		

Table 5.7h. Project Costs, Schedule, Milestones and Evaluation

Community/County	Project Name	Project Costs	Schedule	Milestones	Evaluation
	4 PCR#2 Streambank Stabilization	\$450,000	2013	Design - Year 2; Construction Year 4	Lineal Footage of Bank Stabilized
	1 East Ravine Tributary Restoration	\$312,000	2013	Design - Year 2; Construction - Year 3	Lineal Footage of Bank Stabilized
	2 Golf Course Galloway Creek Restoration	TBD	2014	Design - Year 3; Construction - Year 4	Lineal Footage of Bank Stabilized
	3 West Ravine Tributary Restoration	\$333,500	2012	Design - Year 1; Construction - Year 2	Lineal Footage of Bank Stabilized
Oakland University	4 Belgian Barn & Pioneer Drive Restoration	\$904,000	2013	Design - Year 2; Construction - Year 3	Lineal Footage of Bank Stabilized
	5 NW Tributary Enhancement	TBD	2015	Design - Year 4; Construction - Year 5	Lineal Footage of Bank Stabilized
	6 P-11 Biofiltration	\$25,000	2015	Design - Year 4; Construction - Year 5	Acres Managed; Estimated Storm Water Volume Reduction
Orchard Lake Village	1 Orchard Lake Bank Stabilization	\$55,000	2013	Design - Year 2; Construction - Year 3	Project Completion; Lineal Footage of Lakeshore Stabilized
	1 City-Owned Parking Lot Storm Water Pretreatment	\$700,000	2012	Design - Year 2; Construction - Year 3	Acreege of Impervious Surface Managed
	2 City-Wide Outfall Stabilization	\$330,000	2013	Design - Year 2 or 3; Construction - Year 3 or 4	Number of Outfalls Stabilized
City of Pontiac	3 Downspout Disconnection Program	\$1,600,000	2012-2014	Design - Year 3; Construction - Years 3 & 4	Number of Downspouts Disconnected, SF of Roof Area / Impervious Area Disconnected from System
	1 Canoe Launch near Diversion St Parking Lot for Clinton River Trail	\$50,000	2010	Design - Year 1; Construction - Year 1	Project Completion; Estimate of Use by Community

Table 5.7h. Project Costs, Schedule, Milestones and Evaluation

Community/County	Project Name	Project Costs	Schedule	Milestones	Evaluation
City of Rochester	2 Clinton River Pedestrian Bridge	\$400,000	2013	Design - Year 2; Construction - Year 3	Project Completion; Number of Residents Provided Access to River
	3 Bank Stabilization near Leticia Rd Parking Lot for Clinton River Trail	\$500,000	2015	Design - Year 4; Construction - Year 5	Lineal Footage of Bank Stabilized
	1 Riverside Put-In/Take-Out	\$240,000	2012	Design - Year 2; Construction - Year 3	Number of Direct Access Points Constructed
City of Rochester Hills	2 Fisherman Access Points	\$250,000	2012	Design - Year 2; Construction - Year 3	Number of Direct Access Points Constructed
	3 Natural Channel Restoration	\$150,000	2013	Design - Year 3; Construction - Year 4	Lineal Footage of Channel Restored to Natural Regime
	4 Invasive Species Control	\$30,000	2013	Design - Year 3; Construction - Year 4	Acres of Invasive Species Removed
	5 City Hall Employee/Visitor Lot	\$325,000	2014	Design - Year 4; Construction - Year 5	Acres of Impervious Surface Managed; Reduction in Storm Water Runoff Volume
	6 Cistern Installation	\$60,000	2014	Design - Year 4; Construction - Year 5	Acres of Impervious Surface Managed; Reduction in Storm Water Runoff Volume
	7 Wetland, floodplain, steep slope and riparian buffer protection through easement acquisition		2015	Design - Year 5; Construction - Year 6	Acres Preserved
	1 Pontiac Drive Cul-de-Sac Retrofit	\$800,000	2015	Design - Year 3; Construction - Year 4 & 5	Acres of Impervious Road Surface Managed; Estimated Volume Reduction
Total Estimate of Watershed Restoration/Protection		\$12,594,500			

*Schedule (2010 - 2018 with 2010 as Year 1)

Appendix B

Clinton Main Riparian Analysis

Analysis conducted by:
Oakland County Planning & Economic Development Services Environmental Stewardship Group

Introduction: What is a Riparian Ecosystem?

The area of land that exists between low, aquatic areas in a landscape such as rivers, streams, lakes and wetlands, and higher, dry upland areas such as forests, fields, cities and suburbs are known as riparian landscapes. Because these lands travel along the paths of flowing water, they are more aptly called riparian corridors.

Riparian lands are sensitive, critical components of the landscape, providing ecological and cultural value to the communities and landscapes through which they travel. The function of riparian landscapes is governed by their dual roles as transition zones between aquatic and terrestrial environments and as corridors. They often have steep or moderate slopes, sensitive vegetation and soils, provide critical wildlife habitat, and protect the water quality of streams, rivers, lakes and wetlands. When these lands are altered or developed, unique opportunities and challenges arise.

Each riparian corridor provides unique values to local communities which are ecological, cultural, and economic in nature. In landscapes affected by human activity, unique challenges to these values can be addressed through stewardship opportunities tailored to the specific needs of a river corridor. Table B.1 below provides a sampling of typical riparian values and their associated challenges and stewardship opportunities, described in terms of whether they are ecological, cultural, and/or economic in nature.

Table B.1 Riparian Assets, Challenges and Values

Riparian Asset	Potential Challenges	Stewardship Opportunities	Ecological Value	Cultural Value	Economic Value
Generate biodiversity	Habitat destruction and fragmentation, exotic invasive species	Protection and restoration of habitat, exotic management	X		
Provide wildlife corridors	Vegetation destruction and fragmentation	Protection and restoration of land along riparian corridor	X		X
Filter surface runoff pollutants	Direct piping of stormwater to river; inadequate riparian vegetation	Protection and restoration of riparian buffers, innovative stormwater management	X	X	X
Provide recreational opportunities	Lack of public access to river, lack of available land, flooding, poor water quality	Acquisition and development of public access and park land, flood control, water quality improvement		X	X
Provide drinking water	Water quality quantity degradation, alteration of natural hydrologic	Best practices to improve water quality and hydrologic regime			X

Riparian Asset	Potential Challenges	Stewardship Opportunities	Ecological Value	Cultural Value	Economic Value
	regime				
Water supply to wetlands/lakes	Alteration of natural hydrologic regime	Best practices to improve hydrologic regime	X		X
Stormwater detention and treatment	Alteration of natural hydrologic regime	Best practices to improve hydrologic regime	X		X
Provide fisheries/waterfowl habitat	Destruction and fragmentation of natural vegetation, alteration of natural hydrologic regime, invasion by exotic invasive species	Best practices to improve hydrologic regime, protection and restoration of habitat	X	X	X
Provide floral diversity and wildlife habitat	Destruction and fragmentation of natural vegetation, invasion by exotic invasive species	Protection and restoration of habitat, management of exotic invasive species	X	X	X
Protect shoreline and streambank from erosion	Alteration of natural hydrologic regime, hardening of natural shorelines, removal of riparian buffer, development too close to water's edge, filling of riparian wetlands and floodplains	Best practices to improve hydrologic regime, protection and restoration of natural shoreline and riparian buffers,	X		X
Recharge groundwater aquifers	Alteration of natural hydrologic regime	Best practices to improve hydrologic regime, protection of recharge areas	X		X
Provide unique geological resources, topography and scenic vistas	Grading, development too close to water's edge, erosion	Protection of unique areas, interpretation of geological origins of river valley		X	X
Provide historical resources	Destruction or neglect of historic resources	Protection and interpretation of historic resources of river valley		X	X

Riparian Mapping Methodology

In order to facilitate best practices for riparian management, it is useful to map riparian areas. This provides communities with an idea of where riparian resources are located. Some methods of mapping simply delineate riparian vegetation, others map a defined “buffer distance” from water’s edge. These methods are not ideal. Simply mapping riparian vegetation will discount many unvegetated but important riparian areas. Simply applying a buffer distance may discount some riparian areas outside of the buffer while including others within.

Riparian resources are defined by the geomorphology of the landscape. The entire river valley needs consideration. In addition, unique riparian features should be delineated. This type of geomorphologic mapping is possible using a Geographic Information System with high-resolution digital topography and complementary layers including aerial photography.

The following features within the Clinton Main were delineated using a geomorphologic mapping process, as shown in Figure B.1:

Upland features:

The following three features are usually found in association with one another, below headwaters areas but above the lower sections where rivers reach the lake plain. They reflect the action of pro-glacial river systems exerting great force as they incised their river valleys and adjusted for the episodically receding base levels of the glacial lake stages, in a process called base-level adjustment.

- ❖ Valley walls- are steeply sloped lands which enclose the entire river valley. Valley walls are often steeper than may be explained by the size of the modern river, providing evidence of much larger pro-glacial systems that did most of the work carving out the valley.
- ❖ Ravines- are steep-sided tributary channels often found in association with valley walls.
- ❖ Terraces- are abandoned floodplains reflecting a former (higher) river base elevation during a historical lake stage.

Lowland features:

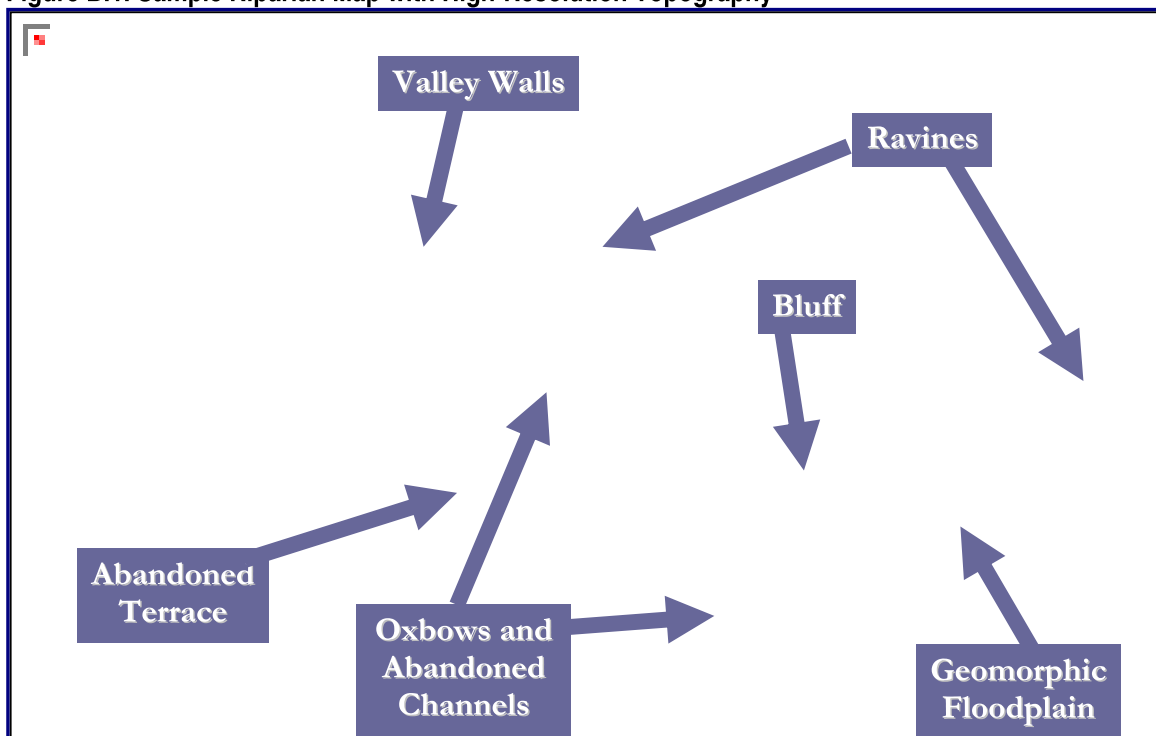
Lowland features are very diverse; some are confined to specific areas within a particular landscape ecosystem types while others may be found in all three.

- ❖ Abandoned channels- are old channels within the floodplain that have been abandoned as the river has migrated and is hydrologically connected to the modern river only minimally or not at all.
- ❖ Oxbows- are old channels that were abandoned as the river migrated that are still hydrologically connected with the modern river and may be inundated during wet seasons or flood events.
- ❖ Confluence areas- are areas where two streams coalesce to flow together as one. They may represent the joining of two small stream systems, or larger subwatershed drainage systems.
- ❖ Deltas- are depositional areas formed as pro-glacial streams or rivers slowed in velocity as they formed confluences with other tributaries or flowed into glacial lakes or estuaries.
- ❖ Lakes Areas- are primarily a feature of the Jackson Interlobate area where lakes were formed in pitted outwash plains and glacial depressions. Kettle lakes, also referred to as “ice-block depressions” were formed as ice-chunks broke away from the receding glaciers and were buried in sand and gravel. Other lakes are formed in old glacial drainages, while still others were formed by beavers.
- ❖ Wetlands Areas- may exist in any of the landscape types. Many types of wetlands may exist depending on local conditions.

In addition to these naturally occurring features, many features occur within riparian corridors that have been significantly altered by human encroachment, development, or management. These features can occur in any of the landscape ecosystems described.

- ❖ Altered riparian areas- are areas in which the topography has been so extensively altered that it is impossible to tell what underlying riparian physical features may exist.
- ❖ Enclosed channels- are channels that have been encased in metal or concrete and diverted through an underground path.
- ❖ Straightened channels- are river channels that have been straightened to accommodate development or facilitate drainage.

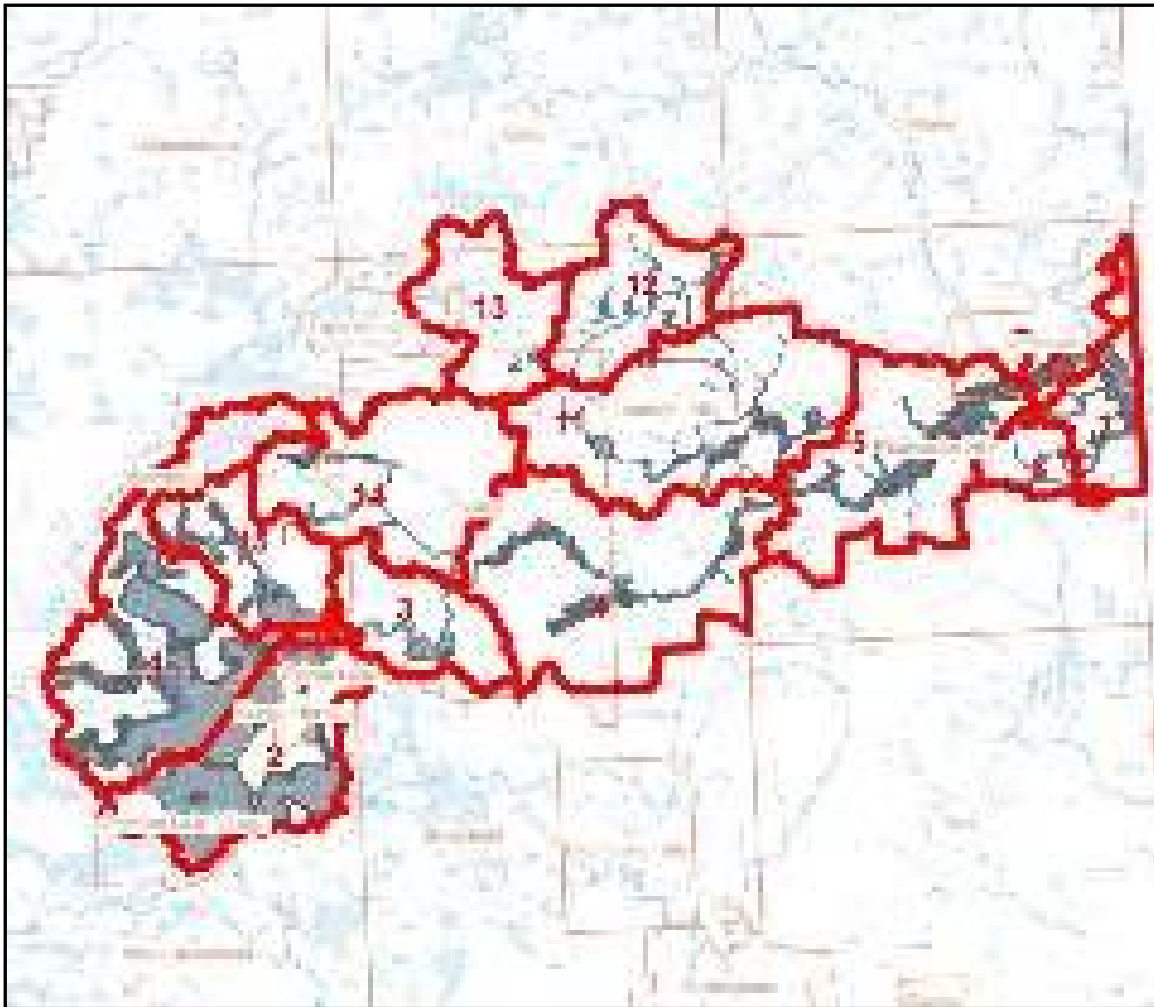
Figure B.1. Sample Riparian Map with High-Resolution Topography



The Clinton Main Riparian Corridor

The Clinton Main Corridor occupies the heart of the Clinton River Watershed, transitioning from a small stream upland lake and wetland- dominated areas through to the confluence of major tributaries (Stony and Paint Creek), emerging as a significantly sized river. The riparian corridor itself is heavily altered in many places, particularly in the smaller tributaries within the watershed. A major stretch of the main branch is enclosed within the City of Pontiac. Figure B.2 highlights the riparian corridor of the Clinton Main subwatershed.

Figure B.2. The Riparian Area of the Clinton Main Subwatershed



Riparian Area and Features

Map 31 illustrates the riparian area and features within the Clinton Main subwatershed. The riparian area is defined by the lakes in the upper part of the subwatershed, the broad outwash channel along the main river corridor, and several steep and narrow tributaries (Pontiac and Galloway Creeks). Natural features of interest include the lakes areas in the upper part of the subwatershed, several oxbows, ravines, and bluffs along the main stem in the lower part of the subwatershed, and a few wetlands areas in Pontiac, Auburn Hills and Rochester Hills. The riparian corridor is heavily altered in many places. A major stretch of the main branch is enclosed within the City of Pontiac. Many stretches have been channelized; most notably a significant stretch of Pontiac Creek along the railroad tracks near the Oakland County Service Center. Large areas within the City of Rochester Hills have been graded and developed, obscuring the original riparian features. Table B.2 summarizes the area of each feature type within each subbasin.

Table B.2. Composition of Riparian Features by Subbasin

Subbasin	Feature Type	Total Area (Acres)
1	Lakes Area	3053.1
2	Lakes Area	2625.6
3	Enclosed Channel	15.7
4	Altered Riparian Area	235.4
	Channelized Section	307.5
	Enclosed Channel	22.4
	Marshy Section	328.7
5	Altered Riparian Area	871.1
	Bluff	32.0
	Channelized Section	136.7
	Oxbow	1.9
	Ravine	39.8
	Terrace	5.1
6	Channelized Section	99.5
7	Altered Riparian Area	338.9
	Channelized Section	197.1
10	Altered Riparian Area	233.8
11	Oxbow	1.6
	Altered Riparian Area	16.0
	Channelized Section	290.9
	Marshy Section	154.8
	Valley Floor	268.0
12	Altered Riparian Area	44.5
	Channelized Section	126.5
	Marshy Section	194.1
13	Channelized Section	6.4
	Marshy Section	49.5
14	Channelized Section	104.7
	Enclosed Channel	33.7
	Lakes Area	211.0
15	Channelized Section	18.4
	Lakes Area	736.4
16	Lakes Area	143.7

Riparian Surface Geologic Landforms

The surficial geology of Oakland County was mapped in 2002 through a partnership initiative between Oakland County Planning & Economic Development Services and the Cranbrook Institute of Science. A combination of data sets including the existing Michigan Surficial Geology data layer and high-resolution digital topography was used to delineate the following landform features and sediment types:

Outwash Plain, Glacial Channel, Recent Alluvium
 End Moraine: Till
 Ground Moraine: Till
 Water-Lain Moraine: Till
 Glacial Lake Plain: Sand, Silt, and Clay

Kame: Stratified Sand, Gravel, and Debris Flow Deposits
 Esker: Stratified Sand and Gravel

In addition, published data was used to map the areas encompassing the elevations of former glacial lake shorelines:

- Lake Maumee Shoreline (790' - 765')
- Lake Arkona Shoreline (710' - 694')
- Lake Whittlesey Shoreline (740' - 735')
- Lake Wayne Shoreline (665' - 660')
- Lake Warren Shoreline (685' - 680')

Map 32 illustrates the geological composition of the corridor. The upper part of the corridor resides in an outwash plain characterized by large lakes. The main branch mainly occupies a large outwash channel that bisects the large end moraines that comprise the river valley. Tributaries following narrow outwash channels also bisect these end and ground moraines as they flow to the river. As the river flows through the City of Rochester, outwash areas broaden as the river arrives at its confluence with Stony and Paint Creeks. Small tributaries in southeast Rochester Hills flow through lake plain topography, crossing old glacial lake ridges. The main corridor descends from the higher ground of the moraine area into the glacial lake plain.

Table B.3 describes the areal geologic composition of the riparian area within each subbasin by percentage. Surficial geology largely controls the permeability of soils. Outwash is the most permeable landform type, followed by end moraine and then ground moraine. Glacial lake plain is generally the least permeable type.

Table B.3. Composition of Riparian Surface Geology and Landforms by Subbasin

Subbasin	% Riparian Area	Geologic Landform Type
1	64	Outwash Plain, Glacial Channel, Recent Alluvium: Stratified Sand and Gravel
	27	Ground Moraine: Till
	8	End Moraine: Till
2	97	Outwash Plain, Glacial Channel, Recent Alluvium: Stratified Sand and Gravel
	3	End Moraine: Till
3	99	Outwash Plain, Glacial Channel, Recent Alluvium: Stratified Sand and Gravel
	1	Ground Moraine: Till
4	69	Outwash Plain, Glacial Channel, Recent Alluvium: Stratified Sand and Gravel
	31	End Moraine: Till
5	32	End Moraine: Till
	2	Ground Moraine: Till
	66	Outwash Plain, Glacial Channel, Recent Alluvium: Stratified Sand and Gravel
6	53	Glacial Lake Plain: Sand, Silt and Clay
	32	Lake Maumee Shoreline (790' - 765')
	15	Lake Whittlesey Shoreline (740' - 735')
7		

51 Outwash Plain, Glacial Channel, Recent Alluvium: Stratified Sand and

Subbasin	% Riparian Area	Geologic Landform Type
		Gravel
	40	Glacial Lake Plain: Sand, Silt and Clay
	5	Lake Maumee Shoreline (790' - 765')
	4	Lake Whittlesey Shoreline (740' - 735')
10	89	Outwash Plain, Glacial Channel, Recent Alluvium: Stratified Sand and Gravel
	7	End Moraine: Till
	2	Glacial Lake Plain: Sand, Silt and Clay
	2	Lake Maumee Shoreline (790' - 765')
11	60	Outwash Plain, Glacial Channel, Recent Alluvium: Stratified Sand and Gravel
	35	End Moraine: Till
	4	Ground Moraine: Till
12	73	Outwash Plain, Glacial Channel, Recent Alluvium: Stratified Sand and Gravel
	20	End Moraine: Till
	3	Ground Moraine: Till
	3	Kame: Stratified Sand, Gravel and Debris Flow Deposits
13	97	Ground Moraine: Till
	3	Outwash Plain, Glacial Channel, Recent Alluvium: Stratified Sand and Gravel
14	53	Ground Moraine: Till
	47	Outwash Plain, Glacial Channel, Recent Alluvium: Stratified Sand and Gravel
15	70	Outwash Plain, Glacial Channel, Recent Alluvium: Stratified Sand and Gravel
	20	End Moraine: Till
	9	Ground Moraine: Till
16	100	Outwash Plain, Glacial Channel, Recent Alluvium: Stratified Sand and Gravel

Riparian Topography

Map 33 illustrates the topographic composition of the corridor. The corridor has a significant gradient, ranging from 1098 and 666 feet in elevation. The upper part of the corridor, dominated by lakes, is relatively high and flat, ranging from between 1098 and 912 feet. The lower part of the subwatershed has a much steeper gradient as the river transitions from the high outwash plains of the headwaters to the lake plain, descending almost 300 feet through auburn Hills, Rochester Hills and the city of Rochester. Table B.4 reports the elevation ranges within the riparian area of each subbasin.

Several viewsheds are significant within the riparian area. Subbasins 10, 11, 12, and 5 contain the greatest elevation ranges and consequently, the greatest viewsheds.

Table B.4. Elevation of Riparian Areas by Subbasin

Subbasin	Minimum Elevation (feet)	Maximum Elevation (feet)	Range of Elevation (feet)
1	925.8	978.0	52.2
2	926.2	978.4	52.3
3	914.2	948.2	34.1
4	811.9	942.2	130.3
5	708.4	864.4	156.1
6	734.1	820.3	86.3
7	666.0	819.1	153.1
10	691.4	807.9	116.5
11	811.9	1003.6	191.7
12	917.1	1098.9	181.9
13	915.4	952.0	36.6
14	912.4	1002.4	90.0
15	926.2	976.6	50.5
16	926.5	952.8	26.4

Riparian Slope

Map 34 and Table B.5 illustrate the slopes in and around the corridor. Because the corridor is a large outwash channel surrounded by moraines and has a significant gradient, there are significant slopes along its length. The greatest slopes can be found in subbasin 10 in the City of Rochester, between the confluences with Paint and Stony Creeks. The lakes-dominated basins (15 and 16) have the lowest slopes. Subbasins 11, 4, and 5, located in the center of the subwatershed, also have significant slopes.

Table B.5. Slope of Riparian Areas by Subbasin

Subbasin	Maximum Percent Slope
1	19
2	16
3	10
4	22
5	29
6	6
7	28
10	39
11	21
12	24
13	6
14	19
15	13
16	9

Riparian Michigan Natural Features Inventory Lands

The Michigan Natural Features Inventory lands are shown in Map 35. The map is the result of an analysis of aerial photos conducted by experienced landscape ecologists with the Michigan Natural Features Inventory for Oakland County. More information about this project and the ranking criteria for natural area priority can be found at the following website:

http://www.oakgov.com/peds/program_service/es_prgm/natural_areas.html.

The majority of MNFI sites contained within the riparian area include priority three Natural Areas. A significant priority one natural area is contained within the riparian areas of subbasins 7 and 10. A small priority one area is contained within the riparian area of subbasin 1. A total of 1802.7 acres exist within the riparian area, with only 22% (393.9 acres) under some form of protection as a public recreation land or other form of committed open space.

Table B.6. MNFI Acreage and Protection Status by Subbasin Riparian Area

Subbasin	Riparian MNFI Protection Status (Acres)		Total MNFI Acres
	NO	YES	
1	291.2	18.1	309.3
2	38.4	0	38.4
3	8.7	18	26.7
4	196.9	33.8	230.7
5	201.7	74.6	276.3
7	156.2	85.1	241.3
10	34.4	79.6	114.0
11	211.8	11.9	223.7
12	105.7	19.4	125.1
13	18.5	0	18.5
14	26.9	34.8	61.7
15	118.3	18.6	136.9
Grand Total	1408.8	393.9	1802.7

Riparian Land Use

Map 36 illustrates the Land Use within each parcel area, derived from Oakland County Parcel data and tax information. Table B.7 summarizes the acres and overall percentages for each land use type corridor-wide, while the appendix summarizes land use for the riparian corridor within each subbasin. Table B.7 removed water from the land use analysis while the appendix includes water. The majority of land use in the corridor is residential (33%). Vacant land accounts for 19% of land and 20% is in a recreation/conservation use.

Table B.7. Land Use in the Clinton Main Riparian Corridor

Land Use	Total	Percent
Commercial/Office	240.53	3%
Industrial	367.43	5%
Mobile Home Park	84.54	1%
Multiple Family	267.66	4%
Public/Institutional	582.61	8%
Railroad ROW	16.96	0%
Recreation/Conservation	1412.86	20%

Land Use	Total	Percent
Road ROW	716.17	10%
S.F. More than one unit per parcel	62.83	1%
Single Family, 1 to 2.5 Acres	341.56	5%
Single Family, 14,000 to 43,559 sq. ft.	648.54	9%
Single Family, 2.5 to 5 acres	175.50	2%
Single Family, 5 to 10 acres	136.75	2%
Single Family, 8,000 to 13,999 sq. ft.	432.33	6%
Single Family, Greater than 10 acres	60.39	1%
Single Family, Less than 8,000 sq. ft.	147.25	2%
Transportation/Utility/Communication	121.90	2%
Vacant	1348.95	19%
Grand Total	7164.77	

Overview of Riparian Historical Channel Migration

The path of a river naturally migrates over time as a river adjusts to the amount of water and sediment in its load. Changes in landscape composition and hydrology (development, impervious surfaces, additional stormwater discharge), as well as changes to the river channel and banks (channelization, bank armoring) can cause additional instability in a river system and speed the migration of the river system. Changes in a river's path can threaten property that has been developed too close to a river (Figure B.3). Examples of channel migration can be seen along the stretch of the Clinton River, particularly in Rochester Hills and the City of Rochester (Figure B.3). The images in Figure B.4 compare a 1963 aerial photo with the stream centerline in 2002.

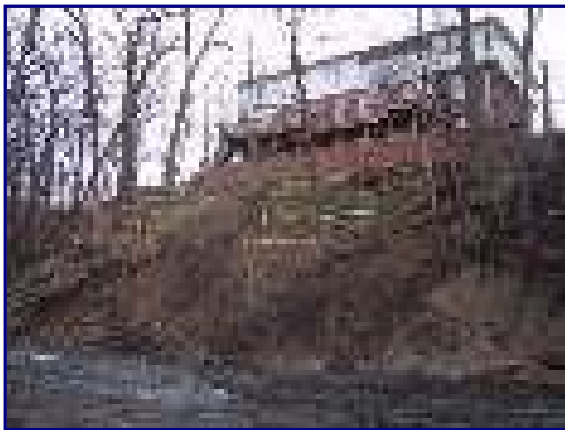
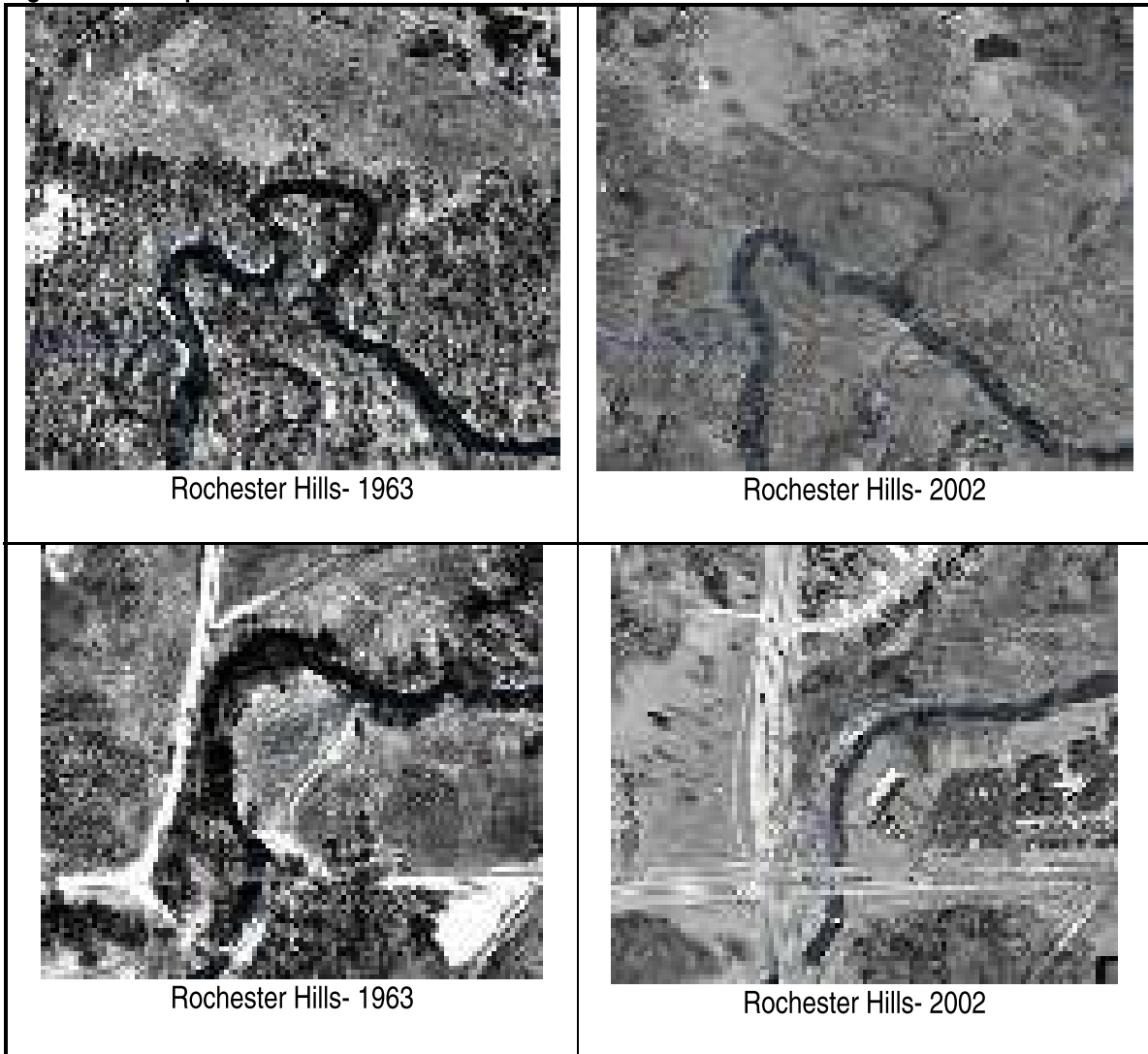


Figure B.3. Erosion due to channel migration is threatening this property in the City of Rochester Hills (photo taken in 2002).



Figure B.4. Comparison of Clinton River meanders between 1963 and 2002




Subbasin Analysis: Riparian Character, Issues & Opportunities

Analyses conducted for subbasins with significant riparian resources. Similar areas geographically connected were considered together. Also see Table B.8 Riparian Land Use Summaries by Subbasin.


Subbasins 1 and 2

<p>Character</p> <p>The riparian area of Subbasins 1 and 2 is entirely a lakes area, is characterized by an outwash plain. The riparian area is dominated by single family residential land uses, as well as recreation/conservation land. The gradient is shallow, with a range of elevation of only 52 feet in subbasins 1 and 2, a maximum slope of 19% in subbasin 1 and 16% in subbasin 2. The riparian area of subbasin 1 contains 309.3 MNFI acres, only 18.1 of which are protected. The riparian area of subbasin 2 contains 38.4 MNFI acres, none of which are protected.</p>	
<p>Issues</p> <ul style="list-style-type: none">❖ Erosion and runoff due to heavy shoreline development❖ Storm water discharge to lakes and wetlands from commercial areas❖ Significant amount of unprotected MNFI area	
<p>Opportunities</p> <ul style="list-style-type: none">❖ Residential shoreline education and management❖ Storm water management in commercial areas❖ Evaluate ways to protect additional MNFI areas	

Subbasin 3

<p>Character</p> <p>The riparian area of Subbasin 3 is varied, including a lake area and an enclosed channel, and is characterized by an outwash plain and ground moraine. The riparian area is 19% recreation/conservation, 10% vacant and 38% water, with significant areas of commercial office and high-density residential. The gradient is very shallow, with a range of elevation of only 34 feet, and maximum slope of 10%. The riparian area contains 26.7 MNFI acres; 18 of which are protected.</p>	
<p>Issues</p> <ul style="list-style-type: none">❖ Multiple land uses require different approaches for BMPs	
<p>Opportunities</p> <ul style="list-style-type: none">❖ Use public recreation land as demonstration for best practices.❖ Daylighting of enclosed channel	

Subbasin 4

<p>Character</p> <p>The riparian area of Subbasin 4 includes a wetlands area, altered riparian area, enclosed channel, and channelized section, and is characterized by an outwash plain and ground moraine. The riparian area is 6% water, 27% vacant, 16% road right of way, and 12% recreation/conservation, with significant areas of commercial/office, industrial, and mobile home park. The gradient is steep, with a range of elevation of 130, and maximum slope of 22%. The riparian area contains 230.7 MNFI acres; only 33.8 of which are protected.</p>	
<p>Issues</p> <ul style="list-style-type: none">❖ Multiple land uses require different approaches for BMP❖ High density of road runoff	
<p>Opportunities</p> <ul style="list-style-type: none">❖ Large MNFI area in a vacant parcel, primarily wetland, could be preserved❖ Utilize BMPs to mitigate impacts of road runoff❖ Daylighting of enclosed channel	

Subbasin 5

Character

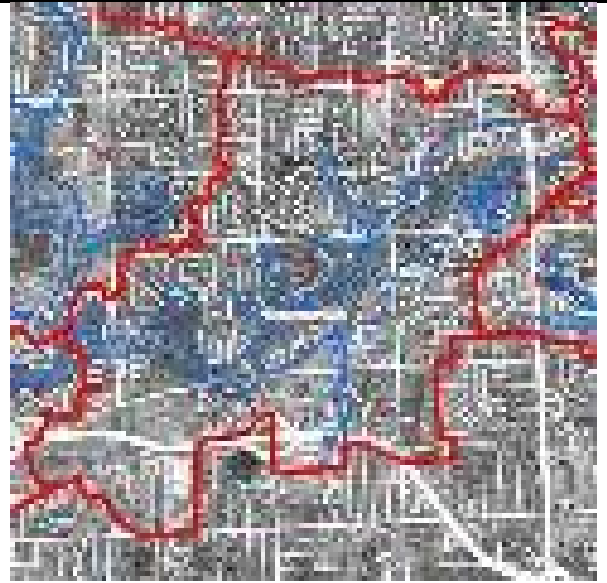
The riparian area of Subbasin 5 is highly varied, including altered riparian areas, bluffs, ravines, terraces, a channelized section and altered riparian area, and is characterized by an outwash plain, end moraine and ground moraine. The riparian area is 13% vacant, 18% recreation and conservation, with significant areas of multiple family, public institutional, and single family residential land uses. The gradient is steep, with a range of elevation of 156, and maximum slope of 29%. The riparian area contains 276 MNFI acres; only 74.6 of which are protected within the public domain.

Issues


- ❖ Multiple intense land uses require different approaches for BMP
- ❖ Varied riparian features sensitive to erosion/sedimentation
- ❖ Steep slopes encourage bank erosion

Opportunities

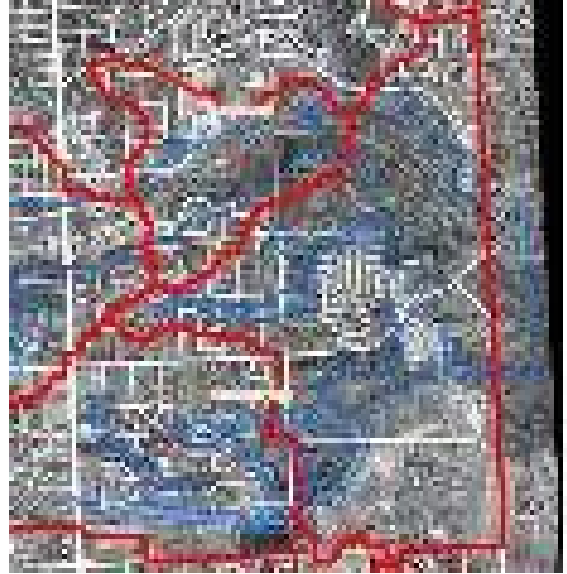
- ❖ Significant amounts of MNFI area worthy of protection
- ❖ Scenic resources including bluffs, terraces, and ravines are worthy of protection
- ❖ Measures to mitigate bank erosion and manage development close to steep slopes




Subbasin 6

<p>Character</p> <p>The riparian area of Subbasin 6 is entirely channelized and characterized by end moraine and glacial lake shoreline. The riparian area is 31% recreation and conservation, and 23% public institutional, with significant single family residential. The gradient is shallow, with a range of elevation of 86 feet, and maximum slope of 6%. The riparian area contains no MNFI area.</p>	
<p>Issues</p> <ul style="list-style-type: none">❖ Riparian area is highly disturbed	
<p>Opportunities</p> <ul style="list-style-type: none">❖ Restoration and buffering of disturbed sections, particularly in recreation & conservation land use areas	

Subbasin 7

<p>Character</p> <p>The riparian area of Subbasin 7 includes a large extent of somewhat altered but largely natural river corridor and channelized sections and is characterized by outwash, lake plain, and glacial lake shoreline. The riparian area is 45% vacant and 18% recreation and conservation, and 23% public institutional, with significant single family residential and a mobile home park. The gradient is relatively steep, with a range of elevation of 153 feet, and maximum slope of 28%. The riparian area contains 241.3 acres of MNFI area, 85.1 of which are protected.</p>	
<p>Issues</p> <ul style="list-style-type: none">❖ Habitat damage in channelized areas❖ Large priority one MNFI natural area in need of permanent protection❖ Steep gradient increases risk of erosion	
<p>Opportunities</p> <ul style="list-style-type: none">❖ Habitat restoration and land protection❖ BMPs for shoreline stabilization❖ Measures to mitigate bank erosion and manage development close to steep slopes	

Subbasin 10

<p>Character</p> <p>The riparian area of Subbasin 10 includes a large extent of somewhat altered but largely natural river corridor characterized by a varied geology including outwash, end moraine, lake plain, and glacial lake shoreline. The riparian area is 16% vacant and 44% recreation and conservation, and 24% industrial. The gradient is relatively steep, with a range of elevation of 116.5 feet, and maximum slope of 39%. The riparian area contains 114 acres of priority one MNFI area, 79.6 of which are protected.</p>	
<p>Issues</p> <ul style="list-style-type: none">❖ Large priority one MNFI natural area in need of permanent protection❖ Steep gradient increases risk of bank erosion❖ Runoff from industrial areas	
<p>Opportunities</p> <ul style="list-style-type: none">❖ Habitat restoration and land protection❖ BMP's for shoreline stabilization and industrial stormwater management❖ Measures to mitigate bank erosion and manage development close to steep slopes	

Subbasin 11 & 12

Character

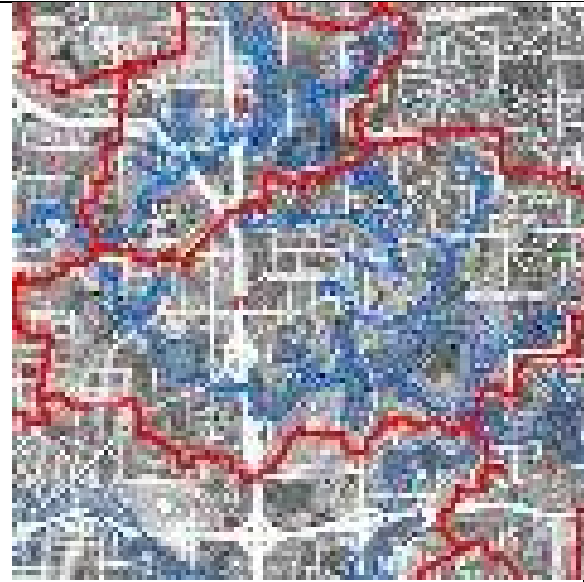
The riparian area of Subbasins 11 and 12 include Galloway Creek and contain an oxbow, altered riparian area, channelized section, wetlands area, and valley floor. It also has a varied geology including outwash, end moraine, and ground moraine. The riparian area of subbasin 11 is 13% vacant and 26% recreation and conservation, 24% public/institutional, and 8% Road Right-of-way. The riparian area of subbasin 12 is 24% vacant and 21% recreation and conservation, and 24% public/institutional, and 7% Road Right-of-way with significant commercial/office and industrial land uses. The gradient is relatively steep, with a range of elevation of 191.7 and 181.7 feet, and maximum slope of 21% and 24%. The riparian area of subbasin 11 contains 223.7 acres of priority one MNFI area, only 11.9 of which are protected, and subbasin 12 contains 125.1 acres, only 19.1 of which are protected.

Issues

- ❖ Significant areas of unprotected MNFI area within riparian corridor
- ❖ Steep gradient increases risk for shoreline
- ❖ Road runoff

Opportunities

- ❖ Land protection
- ❖ BMP's for shoreline stabilization and industrial stormwater management
- ❖ Mitigation of road runoff



Subbasin 14

<p>Character</p> <p>The riparian area of Subbasin 14 includes a small lake area, extensive channelized section and enclosed channel and is characterized by outwash and ground moraine. The riparian area is 18% vacant, 18% recreation and conservation, and 26% public/institutional. The gradient is relatively moderate, with a range of elevation of 90 feet, and maximum slope of 19%. The riparian area contains 61.7 acres of MNFI area, 34.8 of which are protected.</p>	
<p>Issues</p> <ul style="list-style-type: none"> ❖ Habitat degradation in channelized areas ❖ Runoff from public institutional areas 	
<p>Opportunities</p> <ul style="list-style-type: none"> ❖ Buffering and habitat restoration in channelized areas ❖ Stormwater BMP's in public institutional areas 	

Subbasin 15

<p>Character</p> <p>The riparian area of Subbasin 15 includes a lake area and small channelized and is characterized by outwash, end moraine and ground moraine. The riparian area is 12% vacant, 5% recreation and conservation, and primarily in single-family residential land use. The gradient is relatively shallow, with a range of elevation of 50.5 feet, and maximum slope of 13%. The riparian area contains 136.9 acres of MNFI area, 18.6 of which are protected.</p>	
<p>Issues</p> <ul style="list-style-type: none"> ❖ Residential runoff 	
<p>Opportunities</p> <ul style="list-style-type: none"> ❖ Education of residents on use of residential BMP's 	

Table B.8. Riparian Land Use Summaries by Subbasin

Subbasin	Land Use	Total Acres	% Riparian Area
Subbasin 1	Commercial/Office	14.70	0%
	Multiple Family	36.83	1%
	Public/Institutional	25.91	1%
	Recreation/Conservation	316.04	10%
	Road ROW	201.91	7%
	S.F. More than one unit per parcel	19.10	1%

Subbasin	Land Use	Total Acres	% Riparian Area
	Single Family, 1 to 2.5 Acres	78.66	3%
	Single Family, 14,000 to 43,559 sq. ft.	243.20	8%
	Single Family, 2.5 to 5 acres	49.03	2%
	Single Family, 5 to 10 acres	58.88	2%
	Single Family, 8,000 to 13,999 sq. ft.	235.68	8%
	Single Family, Greater than 10 acres	22.88	1%
	Single Family, Less than 8,000 sq. ft.	71.18	2%
	Transportation/Utility/Communication	0.71	0%
	Vacant	252.38	8%
	Water	1411.89	46%
	(blank)	14.07	0%
Subbasin 1 Total		3053.05	
Subbasin 2	Commercial/Office	1.34	0%
	Industrial	4.51	0%
	Mobile Home Park	2.05	0%
	Multiple Family	21.06	1%
	Public/Institutional	11.16	0%
	Recreation/Conservation	104.82	4%
	Road ROW	91.62	3%
	S.F. More than one unit per parcel	8.36	0%
	Single Family, 1 to 2.5 Acres	108.22	4%
	Single Family, 14,000 to 43,559 sq. ft.	166.18	6%
	Single Family, 2.5 to 5 acres	17.11	1%
	Single Family, 5 to 10 acres	7.24	0%
	Single Family, 8,000 to 13,999 sq. ft.	74.00	3%
	Single Family, Less than 8,000 sq. ft.	26.25	1%
	Transportation/Utility/Communication	4.02	0%
	Vacant	48.06	2%
	Water	1922.23	73%
	(blank)	7.50	0%
Subbasin 2 Total		2625.71	
Subbasin 3	Commercial/Office	10.82	5%
	Industrial	2.69	1%
	Mobile Home Park	2.21	1%
	Multiple Family	4.55	2%
	Public/Institutional	8.00	4%
	Railroad ROW	1.05	1%
	Recreation/Conservation	40.56	19%
	Road ROW	16.87	8%
	Single Family, 1 to 2.5 Acres	1.59	1%
	Single Family, 14,000 to 43,559 sq. ft.	2.98	1%
	Single Family, 8,000 to 13,999 sq. ft.	4.61	2%
	Single Family, Less than 8,000 sq. ft.	6.00	3%

Subbasin	Land Use	Total Acres	% Riparian Area
	Transportation/Utility/Communication	3.78	2%
	Vacant	21.93	10%
	Water	80.45	38%
	(blank)	0.88	0%
Subbasin 3 Total		208.99	
Subbasin 4	Commercial/Office	55.86	6%
	Industrial	77.30	9%
	Mobile Home Park	49.85	6%
	Multiple Family	13.36	1%
	Public/Institutional	20.74	2%
	Railroad ROW	1.24	0%
	Recreation/Conservation	111.41	12%
	Road ROW	139.51	16%
	Single Family, 1 to 2.5 Acres	6.02	1%
	Single Family, 14,000 to 43,559 sq. ft.	19.82	2%
	Single Family, 5 to 10 acres	7.10	1%
	Single Family, 8,000 to 13,999 sq. ft.	8.98	1%
	Single Family, Less than 8,000 sq. ft.	11.02	1%
	Transportation/Utility/Communication	82.25	9%
	Vacant	237.44	27%
	Water	50.73	6%
	(blank)	1.32	0%
Subbasin 4 Total		893.94	
Subbasin 5	Commercial/Office	24.88	2%
	Industrial	113.61	10%
	Multiple Family	115.06	11%
	Public/Institutional	113.71	10%
	Recreation/Conservation	199.38	18%
	Road ROW	80.04	7%
	S.F. More than one unit per parcel	1.79	0%
	Single Family, 1 to 2.5 Acres	71.02	7%
	Single Family, 14,000 to 43,559 sq. ft.	63.94	6%
	Single Family, 2.5 to 5 acres	24.41	2%
	Single Family, 5 to 10 acres	25.56	2%
	Single Family, 8,000 to 13,999 sq. ft.	39.86	4%
	Single Family, Less than 8,000 sq. ft.	19.33	2%
	Transportation/Utility/Communication	3.87	0%
	Vacant	137.38	13%
	Water	48.63	4%
	(blank)	1.37	0%
Subbasin 5 Total		1083.84	
Subbasin 6	Commercial/Office	5.38	5%

Subbasin	Land Use	Total Acres	% Riparian Area
	Public/Institutional	22.48	23%
	Recreation/Conservation	30.87	31%
	Road ROW	5.61	6%
	Single Family, 1 to 2.5 Acres	0.76	1%
	Single Family, 14,000 to 43,559 sq. ft.	3.34	3%
	Single Family, 2.5 to 5 acres	0.72	1%
	Single Family, 8,000 to 13,999 sq. ft.	12.38	12%
	Single Family, Greater than 10 acres	5.41	5%
	Single Family, Less than 8,000 sq. ft.	0.36	0%
	Transportation/Utility/Communication	7.74	8%
	Vacant	2.26	2%
	Water	2.22	2%
Subbasin 6 Total		99.50	
Subbasin 7	Commercial/Office	5.11	1%
	Industrial	3.09	1%
	Mobile Home Park	18.66	3%
	Recreation/Conservation	95.57	18%
	Road ROW	21.60	4%
	Single Family, 1 to 2.5 Acres	23.81	4%
	Single Family, 14,000 to 43,559 sq. ft.	20.84	4%
	Single Family, 2.5 to 5 acres	25.01	5%
	Single Family, 5 to 10 acres	7.21	1%
	Single Family, 8,000 to 13,999 sq. ft.	4.65	1%
	Single Family, Greater than 10 acres	31.21	6%
	Single Family, Less than 8,000 sq. ft.	0.01	0%
	Transportation/Utility/Communication	0.47	0%
	Vacant	241.96	45%
	Water	36.55	7%
Subbasin 7 Total		535.74	
Subbasin 10	Industrial	57.13	24%
	Multiple Family	6.44	3%
	Public/Institutional	0.87	0%
	Recreation/Conservation	102.92	44%
	Road ROW	6.21	3%
	Single Family, 1 to 2.5 Acres	1.19	1%
	Single Family, 14,000 to 43,559 sq. ft.	1.35	1%
	Single Family, 2.5 to 5 acres	4.47	2%
	Single Family, 8,000 to 13,999 sq. ft.	1.69	1%
	Single Family, Less than 8,000 sq. ft.	0.89	0%
	Transportation/Utility/Communication	0.10	0%
	Vacant	37.15	16%
	Water	13.42	6%
Subbasin 10		233.82	

Subbasin	Land Use	Total Acres	% Riparian Area
Total			
Subbasin 11	Commercial/Office	10.12	1%
	Industrial	77.39	9%
	Mobile Home Park	9.68	1%
	Multiple Family	40.44	5%
	Public/Institutional	200.48	24%
	Recreation/Conservation	219.78	26%
	Road ROW	36.73	4%
	S.F. More than one unit per parcel	5.36	1%
	Single Family, 1 to 2.5 Acres	11.08	1%
	Single Family, 14,000 to 43,559 sq. ft.	23.56	3%
	Single Family, 2.5 to 5 acres	8.14	1%
	Single Family, 5 to 10 acres	1.86	0%
	Single Family, 8,000 to 13,999 sq. ft.	8.71	1%
	Transportation/Utility/Communication	0.09	0%
	Vacant	110.34	13%
	Water	80.26	10%
	(blank)	0.14	0%
Subbasin 11 Total		844.17	
Subbasin 12	Commercial/Office	24.57	7%
	Industrial	24.71	7%
	Public/Institutional	32.91	9%
	Recreation/Conservation	76.83	21%
	Road ROW	29.15	8%
	S.F. More than one unit per parcel	24.60	7%
	Single Family, 1 to 2.5 Acres	5.06	1%
	Single Family, 14,000 to 43,559 sq. ft.	5.47	1%
	Single Family, 2.5 to 5 acres	21.80	6%
	Single Family, 5 to 10 acres	9.65	3%
	Single Family, 8,000 to 13,999 sq. ft.	5.34	1%
	Single Family, Greater than 10 acres	0.89	0%
	Single Family, Less than 8,000 sq. ft.	0.29	0%
	Vacant	88.78	24%
	Water	15.09	4%
	(blank)	0.09	0%
Subbasin 12 Total		365.22	
Subbasin 13	Recreation/Conservation	8.92	16%
	Road ROW	4.18	7%
	Single Family, 1 to 2.5 Acres	8.76	16%
	Single Family, 14,000 to 43,559 sq. ft.	5.28	9%
	Single Family, 2.5 to 5 acres	4.60	8%
	Single Family, 5 to 10 acres	1.94	3%
	Single Family, 8,000 to 13,999 sq. ft.	1.35	2%

Subbasin	Land Use	Total Acres	% Riparian Area
	Single Family, Less than 8,000 sq. ft.	0.22	0%
	Transportation/Utility/Communication	1.00	2%
	Vacant	13.07	23%
	Water	6.39	11%
	(blank)	0.27	0%
Subbasin 13 Total		55.98	
Subbasin 14	Commercial/Office	23.84	7%
	Industrial	3.80	1%
	Multiple Family	6.83	2%
	Public/Institutional	92.00	26%
	Railroad ROW	14.67	4%
	Recreation/Conservation	65.86	18%
	Road ROW	31.05	9%
	Single Family, 14,000 to 43,559 sq. ft.	0.38	0%
	Single Family, 2.5 to 5 acres	0.21	0%
	Single Family, 8,000 to 13,999 sq. ft.	1.77	0%
	Single Family, Less than 8,000 sq. ft.	3.25	1%
	Transportation/Utility/Communication	14.16	4%
	Vacant	64.60	18%
	Water	37.25	10%
	(blank)	0.29	0%
Subbasin 14 Total		359.97	
Subbasin 15	Commercial/Office	63.84	8%
	Industrial	3.20	0%
	Mobile Home Park	0.01	0%
	Multiple Family	23.09	3%
	Public/Institutional	54.35	7%
	Recreation/Conservation	39.46	5%
	Road ROW	46.68	6%
	S.F. More than one unit per parcel	3.62	0%
	Single Family, 1 to 2.5 Acres	25.39	3%
	Single Family, 14,000 to 43,559 sq. ft.	86.31	11%
	Single Family, 2.5 to 5 acres	20.00	3%
	Single Family, 5 to 10 acres	17.31	2%
	Single Family, 8,000 to 13,999 sq. ft.	27.06	4%
	Single Family, Less than 8,000 sq. ft.	6.28	1%
	Transportation/Utility/Communication	3.72	0%
	Vacant	91.48	12%
	Water	243.03	32%
Subbasin 15 Total		754.83	
Subbasin 16	Commercial/Office	0.08	0%
	Mobile Home Park	2.09	1%

Subbasin	Land Use	Total Acres	% Riparian Area
	Recreation/Conservation	0.44	0%
	Road ROW	5.02	3%
	Single Family, 14,000 to 43,559 sq. ft.	5.88	4%
	Single Family, 8,000 to 13,999 sq. ft.	6.27	4%
	Single Family, Less than 8,000 sq. ft.	2.16	1%
	Vacant	2.13	1%
	Water	123.37	84%
	(blank)	0.14	0%
Subbasin 16 Total		147.57	
Grand Total		11262.34	

Appendix C

Monitoring and Evaluation for Targets and Load Reductions

Introduction

The Clinton Main 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 Clinton Main 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 Clinton Main 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 the Clinton Main River and its tributaries. This baseline data and incorporation of these procedures and sites into the well-established Clinton River Watershed Council volunteer monitoring programs and State of Michigan Monitoring Strategy will serve as the basis for long-term monitoring. Currently the Clinton River Watershed Council monitors six (6) sites within the Clinton-Main (Figure attached) and the State of Michigan completes monitoring within the Clinton River Watershed during the second year of their strategic monitoring 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. The ultimate goal is to have enough volunteers to conduct similar monitoring at all sites used in the development of this plan.

Qualitative Program Evaluation Techniques: Tier 1

Qualitative Program Evaluation Techniques

As seen in the Action Matrix, there are and will be many programs and projects implemented to improve water quality, water quantity and habitat in the Clinton Main 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 of the methods that are proposed will provide an 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 C.1: Clinton Main 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.

Evaluation Methods	Types of programs/projects	What is Measured	Pros and Cons	Implementation
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.
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. Determine appropriate storm water parameters for monitoring and determine optimum procedures for documenting 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.

Evaluation Methods	Types of programs/projects	What is Measured	Pros and Cons	Implementation
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 Clinton Main and Stony/Paint 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.crowc.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.

The field survey data collected for this subwatershed plan by ECT, Inc. and which is described in Chapter 3 encompasses a number of Adopt-a-Stream program sites. This data will be used as a baseline set of data for monitoring and evaluation of progress. Data from the following surveys assisted in prioritizing critical areas within the subwatershed:

- ❖ 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 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 and Load Reductions

When measuring parameters to assess whether or not a goal is being achieved, it is useful to establish targets and associated load reductions 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 and restoration 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 for coldwater streams. The Administrative Rules state:

“for waters of the state designated for use for warm water 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.”

Dissolved Oxygen Sampling Results from Lake St. Clair Regional Monitoring Program

As described in Chapter 3, data from the continuous monitoring station installed by the USGS at the Auburn Road crossing were also evaluated for the non-winter months from September 2004 to November 2005. These data indicate that dissolved oxygen concentrations fluctuate seasonally, as expected, and are generally above 6 mg/L.

As with the data evaluated from the Auburn Road crossing, data from the continuous monitoring station installed by the USGS at the M-59 Road crossing were also evaluated for the non-winter months from September 2004 to November 2005. These data also indicate that the dissolved oxygen concentrations fluctuate seasonally, and are generally above 7 mg/L.

Based on this data, **targets are to maintain current conditions of dissolved oxygen concentrations within the Clinton Main Subwatershed.**

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.

Bacterial data at the two water quality sampling locations described in Chapter 3 indicated that average dry weather E. coli sampling results were within the 130 E. coli per 100 milliliters standard; however, wet weather results showed significantly higher levels of E. coli. **Targets are to maintain existing dry weather conditions.**

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.”

As described in Chapter 3, Shoemaker et. al. determined a critical concentration for phosphorus at 0.05 mg/L. Both dry weather and wet weather sampling results indicate much higher concentrations. In addition, the PLOAD model also demonstrated that the Clinton Main subwatershed has higher than the overall Clinton River Watershed average phosphorus loading. **Targets and loading reductions for phosphorus are shown on Map 30 which will achieve a lower overall phosphorus concentration.**

Nitrogen (N) in the form of nitrates and nitrites are commonly measured in river systems. Acceptable levels of nitrate are below 4 mg/L and when the concentration exceeds this level, accelerated plant growth occurs. The EPA ecoregional criteria for total nitrogen in rivers and streams of ecoregion VII is 0.54 mg/L

(US EPA 2000). Nitrate less than 90 mg/L has not demonstrated adverse impacts on warm water fish. Nitrite levels less than 5 mg/L have not demonstrated adverse impacts on warm water fish (US EPA 1986). Sources of nitrates come from decomposition of dead plants and animals, fertilizers, animal waste and sewage. **Map 30 shows targeted load totals for nitrates and nitrites in the Clinton Main Subwatershed.**

Embeddedness is an alternative measurement to Total Suspended Solids that can be used to determine sediment load. Embeddedness measures the degree to which larger particles are covered with finer particles or to the extent of how much of the stream bottom is covered with fine silts and what percentage of the bottom is covered with soft muck, indicating deposition of fine silts. There is not a numerical standard set by the State, however, **the target for this measurement is to maintain the current ratings and improve ratings where possible.** The baseline data, included in field surveys described in Chapter 3, are rated from “poor” to “excellent”.



Schematic representation of embeddedness.

Another measurement that can be used to determine sediment load is Total suspended solids (TSS) for surface waters does not have a numerical standard set by the state. Waters of the state shall not have any of the following unnatural physical properties in quantities which are or may become injurious to any designated use: turbidity, color, oil films, floating solids, foam, settleable solids and deposits (Rule 50 Michigan Water Quality Standards (Part 4 of Act 451). 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. In addition, TSS targeted loading totals are shown on Map 30.**

Flow Rates (cfs) for surface waters do not have a numerical standard set by the state. Although this section 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 Clinton Main flow rates have showed an increasing trend for peak flows, annual mean flowrate and bankfull flows. At the same time, flow rates are also significantly impacted by water level control structures during different times

of the year. As described in Chapter 3, bankfull flows have a significant impact on bank erosion, channel formation and ultimately water quality, habitat and wildlife. Reductions in these flow impacts will be observed thru implementation of BMP retrofits, reductions in impervious surfaces and construction of BMPs for new and redevelopment areas. **Targets are to maintain the current flow rates and reduce to the maximum extent possible any increase in flow.** At the same time, management of the lake level control structures continues to play a significant role in impacting flow and it is through these combined efforts that flow rates will be more effectively managed.

Biochemical Oxygen Demand (BOD) represents the amount of dissolved oxygen consumed by aerobic bacteria placed in contact with organic material in the water. End products of the organic decomposition are CO₂ and water. The amount of dissolved oxygen used in this process is the biochemical oxygen demand. It is considered to be a measure of the organic content of the waste. The difference between the DO result and the BOD result is the 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 (mg/L) (US EPA, 2000).

BOD concentrations from the water quality sampling results show both higher and lower concentrations than the critical value of 4 mg/L identified from Shoemaker et. al. **Targets in the long-term are to maintain and ultimately reduce these concentrations. In addition, targeted loading totals for BOD are shown on Map 30.**

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 Clinton Main 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 warm water streams. The state standards recommend that temperatures for coldwater fisheries not exceed temperatures greater than the monthly maximum temperatures listed in the table below. **Based on this table targets for the subwatershed is to maintain at least warm water stream recommended temperatures.**

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

Aesthetics and recreation potential: 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.

Aesthetics: 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. **Targets for aesthetic include favorable responses during public surveys, and reduced suspended solids and debris within the river.**

Recreation potential: 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 Greenway Plan as described in Action 18 and here as follows:

Greenway 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 Clinton Main Subwatershed. Community participation may include attending a visioning session and input to the county.

The target 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.

Appendix D

Public Participation and Involvement

Public Participation Activities

As an important component of the development of the Clinton Main Subwatershed Management Plan, the Clinton River Subwatershed Group initiated and participated in a number of public participation and educational stewardship efforts to engage the public in watershed planning activities. The Clinton Main Public Participation Process included the following activities as methods with which to involve the public through the watershed planning activities:

- Activity 1. Website
- Activity 2. Newsletter
- Activity 3. Focus Group
- Activity 4. Annual Events
- Activity 5. Cable Television and/or Cable Bulletin Board
- Activity 6. Media/Press Releases
- Activity 7. Presentation to Specific Groups
- Activity 8. Public Survey
- Activity 9. Email Distribution List
- Activity 10. Public Comment Period for WMP

Summary of Subwatershed Activities

Activity 1. Website: The Clinton River Watershed Council (CRWC) has a very active ongoing website (www.crwc.org) on which ongoing watershed and subwatershed events are posted. The website was further tailored to include specific information about ongoing watershed planning activities for each of the seven Clinton River subwatersheds. Furthermore, the Clinton Main Subwatershed Management Plan is included on the website for review and comment. Comments outside of the subwatershed advisory group have not been received, but will be included in this section in the event that comments are received during the public comment period, Activity 10. In addition, other subwatershed representatives have provided links from their individual websites to the CRWC website.

Activity 2. Newsletter: The Clinton River Watershed Council has developed and mailed at least two (2) newsletters each year from 2004 through 2006 that describe ongoing watershed planning activities within the Clinton River Watershed, as well as pertinent opportunities for learning more about public education and participation efforts through local workshops and annual events.

Activity 3. Focus Group: Focus group meetings were conducted on an individual basis with each of the subwatershed representatives and permittee staff. These focus group meetings were intended to engage other community staff and departments into the watershed planning process and identify further areas of concern that were representative within their individual areas of expertise. These “community tours” involved numerous staff and field visits to sites of particular interest, either from a protection and/or restoration standpoint.

Activity 4. Annual Events: The Clinton River Watershed Council with support from the local communities and counties has organized and hosted both River Day and Clinton Clean-Up annually. River Day is held

in June and the Clinton Clean-Up is hosted in September. Both events bring about numerous residents at the different sites throughout the subwatershed. In 2005, a Clinton River Clean-Up Survey was utilized at a number of the sites within the Clinton Main Subwatershed. The survey was intended to help prioritize goals and objectives for the Clinton Main Subwatershed. The following table highlights the goals most often selected in the survey by the twelve (12) recipients:

Clinton River Clean-Up 2005 Survey Results

DRAFT Goal Language	Percent of Respondents Selecting as an Important Goal
1. Reduce Sources of Pollution	67%
2. Increase public understanding of their role in protecting and enhancing watershed resources.	58%
3. Protect and restore Clinton River fisheries	75%
4. Improve recreational access and opportunities.	58%
5. Reduce flow variability.	50%
6. Enhance and protect water-front areas.	58%
7. Protect and mitigate loss of natural features and open spaces in the watershed.	83%

In addition to identifying which goals are important to the subwatershed, 100% of the respondents believed that the goals were representative for the subwatershed. Other items for consideration in the plan that were suggested by the respondents included the following:

- ❖ Sustainability, slope restoration, native plantings;
- ❖ Historical aspects; and
- ❖ How to actually tabulate the information in a uniform and consistent manor.

A survey identifying areas of concern was also utilized during River Day 2005; however, no surveys were returned.

Activity 5. Cable Television and/or Cable Bulletin Board: Various cable television, PSAs and bulletin board announcements were coordinated through the CRWC Public Education Program. These activities were reported through the individual PEP reports.

Activity 6. Media/Press Releases: The Clinton River Watershed Council has distributed numerous press releases and has received coverage for various events during the watershed planning phase. A list of watershed-wide press releases and subsequent media coverage articles may be viewed at www.crw.org/pressroom/mediarchives/mediarchives.html.

Activity 7. Presentation to Specific Groups: The Clinton River Watershed Council has contracted with most representatives throughout the watershed to implement most components of the Public Education Plan. This PEP includes workshops that discuss specific information about watersheds and watershed planning activities. At least six (6) storm water presentations were conducted throughout the watershed focusing on various aspects of storm water. Results and evaluations of these workshops have been included and reported in annual PEP reporting. In addition, volunteer stream monitoring activities have also incorporated similar survey sites as those evaluated through this planning process which has given residents opportunities to further engage and understand about subwatershed awareness.

In addition to these ongoing presentations and volunteer monitoring activities, the Clinton Main Subwatershed also organized and hosted the “Clinton Main Subwatershed Open House”. This was held on July 13, 2005 and hosted by Oakland University. Approximately 70 people visited the event. The Open House was set up to encourage residents to visit different areas of the room that had displays/handouts on various topics pertinent to watershed planning. Categories of discussion/booth topics included Recreational Opportunities, Land Use Planning, Existing Watershed Conditions and Stewardship/Volunteer Opportunities. Displays were provided by Oakland County, Friends of the Clinton River Trail, DNR Fisheries, Sheriff’s Department Marina Division, Southeast Michigan Council of Governments, Oakland County Planning and Economic Development, Oakland County Drain Commissioner’s Office, Trout Unlimited and the Clinton River Watershed Council.

A survey was also utilized to help focus watershed planning efforts. This survey resulted in a general ranking of priorities which is described as follows:

Ranking of Priorities by Visitors to the Clinton Main Open House

Rank	Area of Concern
1	River and Lake Quality
2	Protection of Waterfront
3	Educating the Public about Actions to Protect Water Quality
4	Future Development and Redevelopment
5	Recreational Opportunities
6	Clinton River Flow
7	Visual Appeal of Lakes and Streams

In addition to completing the survey, many visitors provided individual comments regarding the open house and Clinton Main Subwatershed. These comments are summarized as follows:

What Planning and Land Use Issues Concern You?

1. It is difficult to get the development community to accept and embrace innovative stormwater techniques...including municipal planning commissions, councils/boards

2. Concerned about how the road (county "MAIN TYPE") are keeping up with development. How is the Road Commission handling increased stormwater directed to road ditches
3. Too much development
4. Need more open space
5. Invite High School science classes to open house (when planning for next open house)
6. Lack of stormwater management for road systems
7. Open space and natural areas need to be calculated for their economic values and designed in to land use planning and development
8. Too much impervious surface runoff, not enough infiltration
9. The Drain Office is keeping all the water in the lakes and the river gets too dry in the summer
10. Insufficient stormwater retention in the system
11. How can we restore/incentives for ground water recharge? This subwatershed is blessed with highly porous geology.
12. How can we improve public education of water quality and stormwater BMP's in the key public: golf courses, builders/developers, homeowners
13. How can we educate Oakland County's lake owners that their lake is really a wide spot in the Clinton River to see it from a watershed view?

Stewardship Opportunities / Concerns

1. Native prairie restoration on private property
2. Concerned about protecting steep slopes in Rochester Hills
3. Log jams / river flow issues in Rochester Hills
4. Identify natural features in each municipality and create stewardship partnerships to care for / protect them (like Adopt-A-Highway)
5. Galloway Creek, Galloway Lake, Clinton River corridors, below Bloomer Park, Riverside to Riverwoods park corridor in Auburn Hills, Crystal Lake, Clinton River corridor in Waterford, Stony Creek corridor
6. Log jams near Auburn / Opdyke in Auburn Hills
7. What happens to the frogs?

Community Tour Desired Watershed Issues to Address

1. Encroachment into Riparian Corridor areas
2. Lack of detention
3. Soil erosion/sedimentation
4. Log jams/woody debris management
5. Bank erosion
6. Maintaining riparian corridor
7. BMP implementation and maintenance
8. Invasive species control along riparian areas (lakes and streams)
9. Need more environmental protection ordinances
10. Water levels in River drop in the summer
11. Coordination between county and communities
12. Redevelopment BMPs
13. River flashiness and flooding
14. Increase recreational opportunities and public education
15. Road maintenance and salt application

Activity 8. Public Survey: The Southeast Michigan Council of Governments and the Southeast Michigan Partners for Clean Water conducted a water quality survey during the summer of 2004. The purposes of the survey were to provide a benchmark to gauge the effectiveness of regional and local public outreach campaigns, leverage resources, and provide the opportunity to compare results from different areas of the SEMCOG region.

A four-page survey and cover letter were mailed to a stratified random sample of 10,800 households in the SEMCOG planning area, which includes the City of Detroit along with Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw, and Wayne counties. Another 1200 households outside the SEMCOG area were selected for a total sample of 12,000 households. Approximately 10 days after the surveys were mailed, residents who received the survey were contacted by phone. Those who indicated that they had not returned the survey were given the option of completing it by phone.

Of the 10,800 households in the SEMCOG planning area that received a survey, 1,824 households returned the survey by mail and 1,896 completed the survey by phone for a total of 3,720 completed surveys. An additional 411 surveys were completed outside the SEMCOG area with residents of the City of Flint and Jackson County. The sample was stratified to obtain at least 200 completed surveys from the 7-county SEMCOG area and each of nineteen subareas (see figure A). This was done to ensure that the results from each subarea would be statistically representative of all households within the subarea. The results for each watershed have a precision of at least $\pm 6.9\%$ at the 95% level of confidence.

The overall results for the SEMCOG region have a precision of at least $\pm 2\%$ at the 95% level of confidence. Since the population of the subareas is not equal, the final survey results were weighted based on the relative population of each subarea. This was done to ensure that overall results were representative of the entire SEMCOG region. Results for the Clinton Main Subwatershed are included in Chapter 3.

Activity 9. Email Distribution List: The Clinton River Watershed Council established an email listserve that currently has at least 900 members. The listserve has been an invaluable resource with which to provide notices on meetings, events and workshops across the entire Clinton River Watershed. It is anticipated that a notice will be emailed to advertise that the Clinton Main Subwatershed Management Plan is available for public comment.

Activity 10. Public Comment Period: The Clinton Main State of the Subwatershed Report has been available for public comment since March 2005. No significant comments have been received. The public comment period for this watershed management plan is anticipated to occur during the month of September 2006. During this timeframe, comments will be received, evaluated and the plan will be updated, if necessary based on these comments.

Appendix E
Clinton Main Subwatershed Planning Evaluation

Compiled Results

November, 2004

										Totals			
										Yes	No	Other	
1. Snapshot													
Has your community adopted any of the following types of resource protection measures?													
Plans:													
Natural Areas/Open Space /Greenways	Yes	Yes	No	Yes	No	Yes	Yes	No	No /Yes for parks	Yes	6	2	-
Recreation	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No /Yes for parks	No	6	2	
Watershed Management	Yes	No	Yes	Yes	Partially	Yes	Yes	No	No	No	4	3	1
Stormwater Management	Yes	Yes	Yes	Yes	Partially	Yes	Yes	No	Yes	No	5	2	1
Wastewater (Septic/Sewer) Infrastructure	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	-	-
Wellhead Protection	No	No	No	No	No	No	No	Yes	No	No	1	7	-
Public Education	Yes	No	Yes	Yes	Partially	Yes	Yes	No	Yes	Yes	5	2	1
Illicit Discharge Elimination	Yes	No	No	No	Partially	Yes	Yes	No	Yes	No	3	4	1
Other:		No											
Ordinances/Guidelines/Standards:													
Storm Water Management	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	No	5	3	-
Impervious Surface/Infiltration	Yes	No	Yes	Yes	No	Yes	Yes	Yes	N/A*	No	4	3	1
Natural Features Setback	Yes	No	Yes	Yes	No	Yes	No	No	N/A*	Yes	4	3	1
Resource Protection Overlay District	Yes	No	Yes	No	No	No	No	No	N/A*	No	1	6	1
Cluster Development	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	N/A*	N/A	5	1	2
Wetland Protection	Yes	No	Yes	Yes	No	Yes	Yes	No	N/A* /Yes for parks	Yes	5	3	-
Woodlands Protection	Yes	No	Yes	Yes	Yes	Yes	Yes	No	N/A* /Yes for parks	Yes	6	1	-
Native Vegetation	No	Yes	Yes	Yes	No	No	No	No	N/A* /Yes for parks	No	3	5	-
Flexible Parking Requirement Standards	Yes	Yes	No	No	Yes	Yes	Yes	Yes	N/A*	No	5	2	1
Flexible Private Road Standards	No	No	Yes	Yes	No	No	No	No	N/A*	No	1	6	1
Structural Best Management Practice Standards for Stormwater	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	No	5	3	-
Native Vegetation Practice Standards	No	No	Yes	Yes	No	No	No	No	N/A* /Yes for parks	No	2	6	-
Criteria for Site Plan Review	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	7	1	-
Other Standards								Fertilizer Ordinance					

Appendix E		Clinton Main Subwatershed Planning Evaluation										Totals		
Compiled Results		Auburn Hills	Keego Harbor	Orchard Lake Village	Pontiac	Rochester Hills	Sylvan Lake	Oakland County	Oakland University					
2. Storm Water Management		Plans and Policies:										Yes	No	Other
1. Does your Master Plan identify storm water management quality and/or quantity as an important community goal or policy relating to the protection of health, safety and welfare of your community's residents?		No	No	Yes	No	Yes	Yes	Yes	No	Yes	Yes	4	4	-
Development / Redevelopment Regulations and Standards:														
1. Does your community <u>require or encourage</u> the following :														
a.	preservation of natural drainage pathways and existing vegetation to the greatest extent possible?	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	7	1	-
b.	full detail of specific storm water design specifications in the site plan?	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	Yes	5	3	-
c.	the use of BMP's to improve a site's infiltration potential (such as naturally vegetated open space or vegetated swales)?	No	No	No	No	Yes	No	Yes	No	Yes	Yes	2	6	-
d.	discouragement or prohibition of direct discharge of storm water into wetlands, streams or other surface waters without pre-treatment?	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	6	2	-
e.	maintenance agreements for all storm water management systems or other BMP ?	No	No	No	No	Yes	Yes	Yes	No	Yes	Yes	3	5	-
2. Does your community <u>provide</u> the following?														
a.	specific design standards for stormwater BMP's relating to the specific "c" factors of areas to be developed?	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	No	5	3	-
b.	performance standards for stormwater management (e.g. requiring maintenance of pre-development runoff rates or volumes, pollutant removal standards, etc.)?	Yes	Yes/No	Yes	No	No	Yes	Yes	Yes	Yes	No	4	4	-
c.	guidelines to make drainage systems and retention ponds visually attractive while enhancing functionality? (for example, avoiding traditional turf grass, using native species and contoured ponds)	No	No	Yes	No	No	Yes	Yes	No	Yes	No	2	6	-

Appendix E
Clinton Main Subwatershed Planning Evaluation
Compiled Results

	Auburn Hills	Keego Harbor	Orchard Lake Village	Pontiac	Rochester Hills	Sylvan Lake	Oakland County	Oakland University	Totals		
									Yes	No	Other
3. Impervious Surface Minimization											
Plans and Policies:											
1. Does the Master Plan identify impervious surface minimization in new construction and redevelopment as an important community goal or policy relating to the protection of health, safety and welfare of your community's residents?	No	No	No	No	No	No	N/A*	No	-	7	1
Development / Redevelopment Regulations and Standards:											
1. Does your community <u>require</u> or <u>encourage</u> the following :											
a. some portion of a parking facilities be dedicated to enhancing infiltration (such as planting trees / vegetation within the parking lot paving, allowing pervious spill over areas, using porous pavement, and using islands as detention areas)?	Yes	No	No	No	No	No	N/A*	No	1	6	1
b. streets to have the minimum required pavement width (specify minimum) needed to support travel lanes, emergency, maintenance and service vehicles?	Yes	No	Yes	Yes	No	Yes	N/A*	No	4	3	1
2. Does your community <u>provide</u> the following?											
a. flexibility in the parking ordinance (such as shared parking) to reduce the number of spaces constructed if warranted by the proposed development?	Yes	Yes	No	Yes	No	Yes	N/A*	No	4	3	1
c. relaxation of side yard setbacks and narrower frontages to reduce total road length, driveway length, and overall site imperviousness?	Yes	Yes	Yes	No	No	No	N/A*	N/A	3	3	2

Appendix E
Clinton Main Subwatershed Planning Evaluation
Compiled Results

	Auburn Hills	Keego Harbor	Orchard Lake Village	Pontiac	Rochester Hills	Sylvan Lake	Oakland County	Oakland University	Totals			
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Other	
4. Erosion and Sedimentation Control												
Plans and Policies:												
1. Is erosion and sedimentation control identified in the Master Plan as an important mechanism to protect the health, safety and welfare of residents through protection of water and soil resources?	No	No	No	No	Yes	No	Yes	No	2	6	-	
Development / Redevelopment Regulations and Standards:												
1. Does your community <i>require or encourage</i> the following :												
a. soil erosion control measures to be in place before construction begins?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	-	-	
b. maintenance and monitoring of soil erosion and sedimentation controls ?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8	-	-	
5. Wastewater Planning												
Plans and Policies:												
1. Does the Master Plan (or other plan) address wastewater planning and relate adequate wastewater treatment to the protection of the health, safety and welfare of residents?	Yes	No	100% Sewered	Yes	No	Yes	N/A*	No	3	3	2	
2. If yes, does the Master Plan (or other plan) include the following:												
a. Mapping and discussion of current and planned sewered and unsewered areas?	Yes	N/A	N/A	Yes		Yes	N/A*		3	-	5	
b. Mapping and discussion of soils and their capabilities for handling septic systems?	No	N/A	N/A	No		No	N/A*		-	3	5	
c. Guidelines on how maps and discussion relating to wastewater infrastructure and soil capability are to be used in land use, zoning and site plan decisions?	Yes	N/A	N/A	No		Yes	N/A*		2	1	5	
Development / Redevelopment Regulations and Standards:												
1. Does your community <i>require or encourage</i> the following :												
a. a minimum isolation distance for septic system location of at least 100 feet from a lake, wetland, stream, or other water feature?	Yes?	N/A	N/A	Yes	Unknown	N/A	N/A*	N/A	2	-	6	
b. prohibition on connecting downspouts to the storm water system?	Yes	No	N/A	No	Yes	Yes	N/A*	?	3	2	3	
c. regular maintenance and inspection of septic facilities?	Yes	N/A	N/A	No	No	N/A	N/A*	Yes	2	2	4	

Appendix E		Clinton Main Subwatershed Planning Evaluation										Totals			
Compiled Results		Auburn Hills	Keego Harbor	Orchard Lake Village	Pontiac	Rochester Hills	Sylvan Lake	Oakland County	Oakland University						
6. Open Space, Natural Areas, Native Vegetation and Community Greenways															
Plans and Policies:															
1. Does the Master Plan include goals and policies which recognize the importance of natural areas and open space preservation?	No	Yes & No	Yes	Yes	Yes	Yes	Yes	N/A* /Yes for parks	Yes	6	2	-			
2. Does the Master Plan identify the watershed(s) in which the community is located?	No	No	Yes	Yes	No	In Process	No	N/A*	Yes	3	4	1			
3. Does the Master Plan include goals and policies which recognize the importance of native vegetation?	No	No	Yes	Yes	No	In Process	No	N/A* /Yes for parks	No	3	5	1			
4. Has your community adopted a plan which does the following:															
a. Inventories and maps potential corridors in your community to create an interrelated network of open space??	Yes	Yes	No	No	Yes	In Process	No	N/A* /Yes for parks	Yes	6	2	-			
b. Coordinates community greenways/open space with adjacent community, County or regional greenway plans?	Yes	Yes & No	No	No	Yes	Yes	No	N/A*	No	3	4	1			
c. Prioritizes areas for preservation?	Yes	No	No	No	No	Yes	No	N/A* /Yes for parks	Yes	4	4	-			
d. Includes a mix of public access and natural area habitat?	Yes	No	Yes	Yes	No	Yes	No	N/A* /Yes for parks	Yes	5	3	-			
e. Identifies tools and timetable for implementation?	Yes	No	No	No	No	No	No	N/A*	No	1	6	1			
f. Proposes location-specific recommendations of tools and techniques?	Yes	No	No	No	No	In Process	No	N/A*	No	2	5	1			
g. Identifies roles and responsibilities for implementation?	Yes	Yes & No	No	No	No	No	No	N/A*	No	1	6	1			
h. Proposes a mechanism to track the success of the plan?	Yes	No	No	No	No	No	No	N/A*	No	1	6	1			
5. Has your community incorporated the Oakland County MNFI Potential Natural Areas GIS Coverage (or an equivalent inventory) into the Master Plan ?	No	No	No	No	No	In Process	No	N/A* /Yes for parks	No	2	6	-			
6. Do plans, policies, or regulations recognize the importance of long-term stewardship and management of preserved open space and natural areas?	Yes	No	Yes	Yes	No	Yes	No	N/A* /Yes for parks	Yes	5	3	-			
7. Does your community have a working relationship with a local land conservancy?	Yes	No	Yes	Yes	No	Yes	Yes	N/A* /Yes for parks	No	5	3	-			
Development / Redevelopment Regulations and Standards:															
1. Does your community <u>require</u> or <u>encourage</u> the following :															
a. linking of open space with adjacent open spaces in site planning?	Yes	Yes	Yes	Yes	Yes	Yes	No	N/A* /Yes for OCPEDS	No	6	2	-			
b. protection of the open space in new developments through a conservation easement or other similar mechanism?	Yes	Yes	Yes	Yes	Yes	Yes	No	N/A* /Yes for OCPEDS	No	6	2	-			

Appendix E Clinton Main Subwatershed Planning Evaluation											
Compiled Results											
	Auburn Hills	Keego Harbor	Orchard Lake Village	Pontiac	Rochester Hills	Sylvan Lake	Oakland County	Oakland University	Totals		
	Yes	No	Yes	No	Yes	No	N/A*	No	Yes		
2. Does your community provide the following?									Yes	No	Other
a. flexible site design criteria available for developers that use open space or cluster design options?	Yes	Yes	Yes	Yes	Yes	Yes	N/A*	No	6	1	1
b. a natural features or greenways plan map to guide the placement of open space in site planning of new developments?	Yes	No	No	No	Yes	No	N/A*	Yes	3	4	1
7. Wetlands & Woodlands Preservation											
Plans and Policies:											
1. Does the Master Plan recognize the importance of wetlands and woodlands and the functions they play in protecting residents' health, safety and welfare from problems such as flooding and poor water quality?	Yes	No	Yes	Yes	Yes	Yes/No	N/A*	N/A	4	2	2
2. Does the Master Plan call for the protection of wetlands and woodlands within an ecosystem context (protecting adjacent uplands, waterways, and vegetated buffers as well)?	Yes	No	Yes	Yes	Yes	Yes	N/A*	No	5	2	1
3. Has your community compiled and mapped a wetland and woodland inventory?	Yes	No	Yes	No	In Process	No	N/A*	No	3	4	1
4. Has your community identified the functional values of wetlands and woodlands?	Yes	No	Yes	No	Yes	No	N/A*	Yes	4	3	1
Development / Redevelopment Regulations and Standards:											
1. Does your community require or encourage the following :											
a. protection of wetlands below state protection criteria (less than five acres in size)?	Yes	No	Yes	No	Yes	No	N/A*	No	3	4	1
b. protection of local woodlands or trees?	Yes	No	Yes	Yes	Yes	No	Yes	Yes	6	2	-
c. replacement of trees that are removed during construction?	Yes	Yes	Yes	Yes	Yes	Yes	N/A*	No	6	1	1
d. the inclusion of woodlands, wetlands, and landmark trees on site plans											
2. Does your community provide the following?											
a. Site plan review criteria relative to woodlands, wetlands, and landmark trees?	Yes	No	Yes	Yes	Yes	Yes	Yes	No	6	2	-

Appendix E
Clinton Main Subwatershed Planning Evaluation
Compiled Results

	Auburn Hills	Keego Harbor	Orchard Lake Village	Pontiac	Rochester Hills	Sylvan Lake	Oakland County	Oakland University	Totals
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8. Riparian Lands: Stream Corridors and Floodplains

Plans and Policies:

	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Other
1. Does the Master Plan state that protection of riparian areas (including stream corridors and floodplains) is important in promoting the health, safety and welfare of residents through flood control, water quality and riparian corridor preservation?	Yes	No	Yes	No	Soon	No	N/A*	No	3	4	1
2. Does the community participate in any watershed/water quality monitoring activities?	Yes	No	Yes	Yes	Yes	No	Yes	No	5	3	-

Development / Redevelopment Regulations and Standards:

	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Other
1. Does your community require or encourage the following :											
a. restriction of clearing and/or construction within floodplains?	Yes	No	Yes	No	Yes	No	N/A*	No	6	1	1
b. protection of adjacent sensitive upland riparian features, such as steep slopes?	Yes	No	Yes	No	Yes	No	N/A*	No	4	3	1
c. a minimum building envelope setback from designated water features (Specify setback)?	Yes	No	Yes	No	Yes, 25'	No	N/A*	No	5	2	1
d. a naturally vegetated buffer along riparian corridors?	Yes	No	Yes	No	No	No	N/A*	No	2	5	1

2. Does your community **provide** the following:

	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Other
a. flexibility in standards to allow your community to determine stream setback width based on the sensitivity of the natural features?	Yes	No	Yes	No	No	No	N/A*	No	2	5	1
b. an overlay district designed to protect riparian areas?	Yes	No	No	No	Soon	No	N/A*	No	2	5	1

9. The Development Review Process

Development / Redevelopment Regulations and Standards:

	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Other
1. Does your community require or encourage the following :											
a. a "pre-application" meeting or site analysis before engineered drawings are submitted?	Yes	No	Yes	No	Yes	No	Yes	No	7	-	1
b. mapping of all natural features on site plan proposals, such as surface water, floodplains, wetlands, woodlands, steep slopes, and natural drainage patterns?	Yes	No	Yes	No	Yes	No	N/A*	No	6	1	1
c. Sufficient detail of stormwater Best Management Practices (BMP's) on site plan proposals so that they can be reviewed for effectiveness during the site plan review process?	Yes	No	Yes	No	Yes	No	Yes	No	6	2	-

2. Does your community **provide** the following:

	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Other
a. Site plan review criteria/standards, including information requirements and performance standards, designed to protect natural features and resources.	Yes	No	Yes	No	Yes	No	N/A*	No	3	4	1

Appendix E

Clinton Main Subwatershed Planning Evaluation

Compiled Results

	Totals							
	Auburn Hills	Keego Harbor	Orchard Lake Village	Pontiac	Rochester Hills	Sylvan Lake	Oakland County	Oakland University
10. Groundwater and Wellhead Protection (Optional for Applicable Communities)								
Plans and Policies:								
1. Does the Master Plan recognize the importance of groundwater as a natural resource important to the health, safety and welfare of its residents?	No	No	No	No	Not Yet	Yes	N/A*	No
2. Is the importance of groundwater recharge to maintaining the integrity of aquatic resources such as streams and wetlands described in the master plan?	No	No	No	No	No	No	N/A*	No
3. If your community has municipal well fields, have you established a Wellhead Protection Program approved by the State?	N/A	N/A	N/A	N/A	N/A	Yes	N/A*	N/A
4. If not, has your community done the following:								
a. Identified the groundwater recharge area that contributes to your community's groundwater supply?	No	N/A	N/A	N/A	N/A	N/A	N/A*	N/A
b. Identified sources of contamination within these groundwater recharge areas?	Yes	N/A	N/A	N/A	N/A	N/A	N/A*	N/A
c. Developed methods to cooperatively manage the groundwater recharge area and minimize any threats to the groundwater supply?	Yes	N/A	N/A	N/A	N/A	N/A	N/A*	N/A
11. Public Education								
Plans and Policies:								
1. Does your community deliver public education services to residents regarding environmental protection (please provide examples)?	Yes	No	Yes	Yes	Yes	No	N/A* / Yes for OCPEDS	No
2. Does your community coordinate public education efforts with other organizations, such as watershed, county, or regional agencies?	Yes	No	Yes	Yes	Yes	No	Yes	No
N/A* = Oakland County relies on standards from Waterford Township or the City of Pontiac, if any.								