3. Chapter 3 - Watershed Inventory: Prioritized Pollutants, Sources and Causes

KAWKAWLIN RIVER INVENTORY

3.1 *Methodology and Findings of the Watershed Inventory*

3.1.1 *Introduction*

In an effort to narrow the area of focus on a large watershed such as the Kawkawlin, an attempt was made to utilize the Watershed Assessment of River Stability and Sediment Supply (WARSSS) procedure developed by Rosgen (2006). WARSSS was developed to quantify the effects of land uses on sediment relations and channel stability and it is intended that large watersheds can be assessed very quickly using this three-phase approach to identify the hill-slope, hydrologic and channel processes responsible for negative impacts to the stream. The Reconnaissance Level Assessment (RLA) is the first phase and focuses primarily on using existing data to identify potential problem areas within the watershed that require more detailed field assessment. Specific to the Kawkawlin River Watershed, it was believed that the RLA would provide the information necessary for prioritizing hydrologic unit classification (HUC) sub-watersheds and guiding the process of identifying critical and priority areas. However, upon further examination of the WARSSS procedure and of the Kawkawlin River Watershed, it became apparent that the RLA would not yield useful results for this plan. As such, a methodology was developed that could quantify each sub-watershed based upon several criteria, several of which are common to WARSSS.

3.1.2 *Methods*

Rosgen (2006) was reviewed and used as a template for the assessment; however, WARSSS was determined to be inappropriate for use in this watershed. Specifically, based upon the RLA criteria, all eight Kawkawlin sub-watersheds would advance to the second phase of the WARSSS assessment, and there is no way to quantify potential differences between sub-watersheds. Furthermore, the Kawkawlin River Watershed is so monotypic across most of its geographic scope in terms of soil types, slope, channel modification and land use that criteria in addition to those listed in WARSSS had to be considered to prioritize the sub-watersheds.

Step 1. Compile and Map Existing Data

- GIS data sources included: Baseflow channels for the Kawkawlin River and tributaries, SSURGO Soils, 1978 Land Use/Land Cover, 1992 Land Use/Land Cover, 1978 Aerial Photography, 2006 Aerial Photography.
- Michigan Department of Environmental Quality biological monitoring results from 1989, 1993, 1995, 2000 and 2005
- Bay, Midland and Gladwin County drain maps and records

Step 2. Review the Landscape History

- Using 1978 and 2001 LULC data and 1978 and 2006 aerial photography, an analysis of land use change was conducted. It was determined that very little change has occurred over the past few decades. Agricultural practices have dominated all areas that have been effectively drained. Much of the areas not being farmed are wetland.

Step 3. Rapid Watershed Review

- An overview of the watershed was conducted over the course of two days. The overview included driving the majority of the roads within the watershed and observing the Kawkawlin River and its tributaries from road crossings, land use and other notable features within the watershed and collecting biological samples at several sites. Results of this overview survey were analyzed and plotted on a GIS, including all road crossings with obvious water quality problems such as excessive algae or plant growth, sediment accumulation, bank erosion or livestock in the stream.

Step 4. Assess Hydrologic Processes

- Based upon analysis of land use data, field observation and historic personal accounts, the hydrology of the watershed has not changed significantly over the past several decades. Additionally, significant change is not expected in the near future.

Step 5. Identify Direct Impacts to Streambanks and Channels

- Nearly every channel within the watershed has been directly impacted to some extent. Most of the streams are maintained as agricultural drains. The Main Branch of the Kawkawlin is in a relatively natural state, but direct impacts are associated with road crossings and armored banks near the outlet. Despite the extensive modifications throughout the watershed, erosion and other evidence of channel "recovery" is not widespread. Overall, the agricultural tributaries are very stable and covered with herbaceous vegetation. Eroded banks are locally prevalent in forested and grazed portions of the upper watershed.

Step 6. Summarize Activities that Potentially Affect Sediment Supply and Channel Stability

- An analysis of Steps 1-5 resulted in a list of considerations for the Kawkawlin River Watershed, including:
    - Livestock in the stream
    - Modified channels for agriculture
    - Dense drainage network
    - Lack of stream buffers
    - Extensive and widespread agricultural land use, including tiled fields and deep tillage practices
    - Limited, but locally significant streambank erosion

Step 7. Development and complete ranking matrix based upon criteria and information determined important during Steps 1-6.

- Criteria used to develop the matrix for each Kawkawlin sub-watershed included:
    - Percentage of agricultural land
    - Percentage of wetland
    - Percentage of channel without vegetative buffer

- Drainage density (feet of stream per acre)
- Obvious problems recorded during Step 3
- Ecological score, including results of biological surveys, amount of quality riparian and upland habitat, wildlife travel corridor, etc.

- Each sub-watershed was given a score between one and eight for each criterion, depending on how it ranked compared to other sub-watersheds. Scores of each criterion were added for each sub-watershed, giving each sub-watershed a total score out of a possible 56 points.

Step 8. Based upon prioritization in Step 7 and observation of obvious problems, areas, sub-watersheds or specific river reaches were selected for further assessment. The prioritization of these sub-watersheds based on the data collected and the prioritization process is stated in the Results section below.

3.1.3 *Results*

Sub-watershed 7 was ranked as the number one priority, followed by sub-watersheds 6, 3, 2, 5, 8, 4 and 1. The highest priority sub-watersheds are located in the most intensively farmed portion of the Kawkawlin Watershed and are impacted by overland sediment transport and nutrient pollution. The lowest ranking sub-watershed, number 1, is located in the northern portion of the Kawkawlin Watershed, which contains much more wetland and forested land. The primary issue of concern in sub-watershed 1 appears to be livestock access and streambank erosion.

3.1.4 *Geomorphic Assessment*

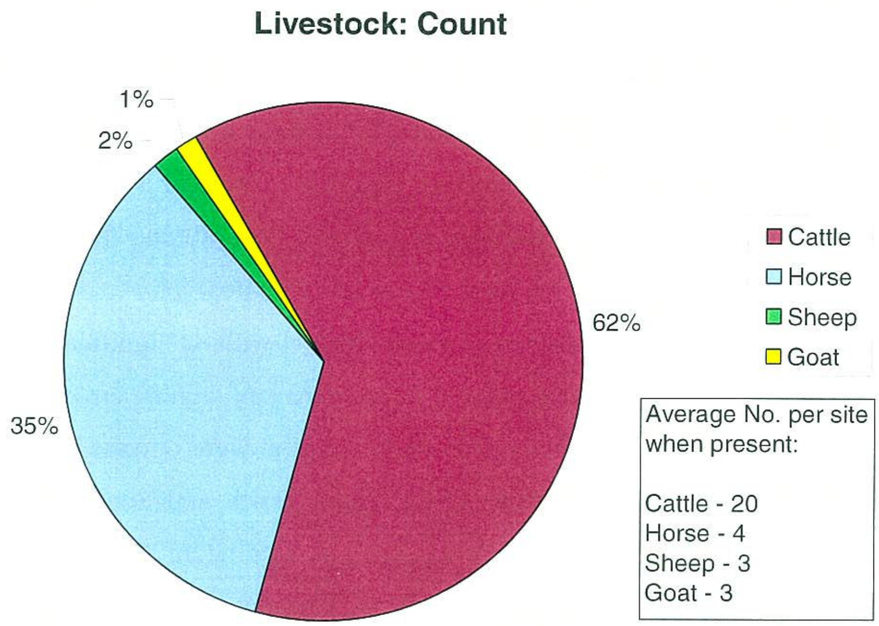
A thorough geomorphic assessment has not been completed at this time. Most of the tributaries and portions of the mainstream have been dredged or maintained over the last several decades. In large part, the tributaries consist of straight, deep, trapezoidal channels capable of containing relatively large storm flows.

Natural sections of the main branches of the Kawkawlin River, as well as the relatively undisturbed tributaries, would be considered to be C or E type channels if using the Rosgen (1996) classification system. These channels are distinguished by their wide floodplains that are inundated during smaller storm events (1 to 5-year). This project also discovered a survey of the Kawkawlin River completed in 1951 by Clifford Spicer that has the centerline and cross sections surveyed for historical reference and future use to verify channel changes. The survey data was analyzed to the best it could be by scanning the plans, setting the plans to a coordinate system and then plotting the centerline of the surveyed river and laying it over the most recent aerial photography to determine channel changes. This data essentially showed a stable channel without significant changes over the past 60 years. To further determine if there were any significant channel changes, aerial photography from the 1938 fly over of this region were obtained and overlaid on the 1998 aerial data of the centerline of the Main, North and South branches of the Kawkawlin, again this showed that there has been no significant channel changes in this 60 year period. See Exhibit 13 in Appendix A. This data is available through Spicer Group at their Saginaw headquarters.

3.2 *Inventories*

3.2.1 *Livestock Inventory*

The entire watershed was assessed for domestic livestock on parcels. The survey was a "windshield" survey with the person not leaving the vehicle or entering onto private property. There were 78 of these surveys completed. In other words, 78 parcels were identified with domestic animals observed on the parcels. Only two sites were observed where domestic animals had access to the river. Manure storage problems where nutrients and pathogens could reach the river were a problem on 9% of the sites encountered. The animals present in the largest number were cattle (62%), followed by horses (35%), sheep (2%) and goats (1%). However, the highest incidence of parcels with domestic animals present was related to horses with 74% of the parcels, followed by cattle on 26% of the parcels. Most of the feeding of these domestic animals was described as range style and were not concentrated feed lots. As far as visible evidence of nutrients reaching the water, this was only evidenced in 1.3% of the surveys.



3.2.2 *Agricultural Inventory*

A windshield survey was performed over the prioritized sub-watersheds, starting with the prioritized sub-watersheds in their order of priorities, those being: 7, then 6, 3, 2 and 5. Sub-watersheds 8, 4 and 1 were not surveyed. Sub-watershed 8 is urban. Sub-watershed 1 is mainly forested and has headwaters of very good quality. Sub-watershed 4 was not prioritized as having significant water quality problems. Therefore, the five other sub-watersheds were concentrated upon. There were 698 surveys completed by staff from Saginaw Bay Resource, Conservation and Development (RC&D) and Spicer Group. Again, staff participating in this survey **did not leave the vehicles and did not enter parcels to determine the extent of erosion in agricultural drains** well out in the middle of large farm parcels.

The surveys bear out the fact that the watershed is generally very flat with little slope. Agricultural practices show that no-till and minimum tillage are used about 50% of the time, with no till around 6%. The crop residue was predominantly corn and bean followed by wheat and sugar beet. These are the main crops grown in the watershed. A predominate amount of farmers were into crop rotation 92% and a small percentage 4% did a cover crop. It was noted there was not much evidence of waste nutrients being applied to fields, only about 0.5% of the surveys, and of that percentage, there were 5 incidences where nutrients/pathogens could reach the drains and the river.

Evidence of erosion was noted 22% of the time, mostly in the form of rills or gullies to agricultural drains or roadside ditches. The sediment would then be subject to deposition in a county drain, tributary or the river. However, if the ditch or private agricultural drain was vegetated, it appears to deposit less sediment at its outlet, supporting the practice of keeping all drainage ditches or manmade surface conveyance systems vegetated to the maximum extent practicable. Erosion was not observed in 62% of the cases, but, again, this must be tempered with the fact that this was a "windshield" survey and the investigators did not leave their vehicles and enter property. Temporary V-ditches were noted in 7.6% of the fields surveyed. The potential cause of streambank/ditch bank erosion was determined to be from the forces of surface flow in 92% of the cases and tile outlets were listed as a source of erosion in 6% of the cases.

Use of vegetated buffer strips was not as high as one would hope; they were reported only about 8% of the time. They had an average width of 25 feet and appeared to be planted and well-established with vegetation over 92% of the time.

Water quality in the portions of county drains visible was commented upon and in 73% of the cases the water was clear and was turbid in 5.6% of the time. The remaining 21.4% the drain was not visible and therefore no answer was applicable. No oily sheens or greenish colored water was noted during this survey.

Wind erosion was also a concern; 35% of the fields had a tree line. There was also a ground cover of vegetation or crop residue to slow down wind erosion, but the potential for wind erosion was felt to be high in 58% of the fields surveyed. See Appendix D for exhibits and data.

3.2.3 *On-Site Treatment Systems Inventory*

The tasks completed in this inventory were the assessment of bacterial contamination and potential causes. Then investigate by data coordination the following information:

- Current on-site disposal systems (OSDS)
- Bacterial testing
- Land use, and
- Other data as developed by other work groups

This data was then integrated into GIS maps to determine areas or parcels that were "at risk" or showing signs of failure and possibly contributing to contamination of the river.

The Bay County Health Department looked for information on 1,068 parcels, not including the 790 parcels that are directly adjacent to the Main Branch of the Kawkawlin River. Of the 1,068 parcels, 191 were not listed as being connected to municipal sewer and no existing OSDS records. 798 were connected to municipal sanitary sewage systems. 177 parcels had OSDS records associated with them; of those records, it was determined the median age of OSDSs was 36 years. There is substantial follow-up information and details that must still be collected by the Bay County Health Department but, the work accomplished during this inventory and the maps created identified critical areas and provided the framework for significant future work to eliminate sources of nutrients and pathogens to the Kawkawlin River. Data collected and the map produced is available in Appendix E as Exhibit 28.

3.2.4 *Wetland Inventory*

The summary finding of the Wetland Inventory shows that sub-watershed 3 has been severely impacted by the loss of wetlands. This sub-watershed retains only 1% of its original wetlands. The pre-settlement wetlands were 31 acres in size and now they only average 5.6 acres in size, so a 99% loss in this area. Sub-watershed 7 has lost 94% of its wetlands and their resultant functions. Only 472 acres remain with an average size of 4 acres compared to a pre-settlement average size of 105 acres. Sub-watershed 8 is a highly urbanized area now and has lost 93% of its wetlands, obviously the size has decreased as in other sub-watersheds. However, there is a parcel in this sub-watershed that is of a rare type of wetland and it is still relatively intact. **It would be beneficial to preserve this parcel of wetland which should be given the highest priority for wetland preservation. It is located in the NE ¼ of the NW ¼ of Section 4 in Bangor Charter Township.** The remaining sub-watersheds should be prioritized as follows, Sub-watershed 6, 5, 4, 2 and 1. Of these, Sub-watersheds 2 and 1 should be slated for wetland preservation efforts, they retain 36% and 72% respectively of their historical wetlands. Table 3.1 summarizes the quantitative aspects of this study.

The MDEQ provided an extensive landscape level study of the wetlands within the Kawkawlin Watershed and ultimately summarized each of the eight sub-watersheds. The wetland boundaries were determined from aerial imagery which was last updated in 2005. The 2005 National Wetland Inventory (NWI) data was used in this analysis to prepare the report on status and trends. Per the MDEQ, this is the best data source currently available. It must be realized that this is aerial data and is subject to interpretation of the conditions present. There may be errors in the interpretation of the data and it may not reflect current conditions on the ground as five years have passed since these aerial photographs were taken.

The MDEQ – Water Resource Division have started a joint project with Ducks Unlimited to update the 1978 NWI using 1998 and 2005 aerial imagery. This project is ongoing and the data set developed will be used for all future Wetland Status and Trends analysis. The staff of the MDEQ have developed a landscape level function and evaluation of the Kawkawlin Watershed based on the data available and have provided their analysis on a CD for use by municipal and township planners/planning commissions, local governing officials, conservancies, environmental groups, organized property owners associations, engineers, regulatory agencies and others to assist with planning and land use efforts in the Kawkawlin Watershed. Appendix B contains the basis of the report. A CD can be requested from the MDEQ with all data and a map reader.

Table 3.1 Sub-Watershed Survey

Sub-Watershed	1	2	3	4	5	6	7	8
Area of pre-settlement wetlands (acres)	16,336	16,944	1,394	5,452	10,091	8,636	6,933	5,669
Area of 2005 wetlands (acres)	11,790	6,225	22.7	1,158	2,087	1,060	472	397
Presettlement avg. size of wetlands (acres)	31	41	63	48	43	62	105	69
2005 Avg size of wetlands (acres)	7.4	5.8	5.6	3.5	3.2	2.44	4	6.5
% of Original wetland remaining	72%	36%	1%	21%	20%	12%	6%	7%
% Loss of wetland resource	28%	64%	99%	79%	80%	88%	94%	93%

3.2.5 *Road/Stream Crossing Survey*

The following summary of the Road/Stream Crossing survey rated physical habitat fair to poor 31% of the time, however physical appearance rated fair to poor approximately 17% of the time. Primary sources for non-point sources (NPS) from this survey for were agriculture 47% of the time, followed by drain management at 7% and residential sites also at 7%. The primary causes of NPS pollutants were land erosion 60% of the time and chemical and nutrient runoff 53%.

The Saginaw Bay RC&D completed a detailed road/stream crossing in 1998 for the Kawkawlin River and other regional streams. This report was very comprehensive and it will be used for determination of future tasks for the watershed in general. A major road crossing was completed on the Main, South and North Branches of the Kawkawlin using information from the Bay County Road Commission and flow rates obtained from the MDEQ. The waterway areas were looked at and the crossings were visited to determine if there was much erosion at these specific sites. The crossings were determined to be adequate and were a source of erosion based on channel geometry and hydraulics at some of those points. However, there was evidence of erosion that may have been caused by winter ice conditions at these points. Appendix H contains Exhibit 26 a three page map of the branches of the Kawkawlin River with priority areas identified and a table with costs for restoration.

3.3 *Ecological Assessment*

Ecological assessments included a survey of aquatic biological communities at six sites; aquatic and riparian habitat assessment and general upland habitat assessments were performed. Assessment of the physical habitat and biological community of the Kawkawlin River and its tributaries was completed to characterize the quality of the watercourses and to provide information necessary for making recommendations for improvements. In addition to collecting physical and biological data, previous studies performed by state agencies and others were reviewed and their findings evaluated.

The aquatic biological community was rated at six sites. The assessment was conducted on November 14, 2008, using protocols set forth in the Great Lakes Environmental Assessment Section, Procedure No. 51 (P51) (MDEQ 1997 and MDEQ 2002). P51 is a rapid assessment technique that is used by the MDEQ to rate streams based upon their physical habitat and aquatic community. It should be noted that these assessments were conducted outside of the recommended seasonal sampling period; so caution must be used when comparing results of this study.

Sites were selected based upon preliminary field observation and review of existing data and previous sampling sites. An effort was made to fill data gaps that had been left by previous studies.

The abundance and diversity of aquatic macroinvertebrates are commonly used as indicators of the overall quality of a stream. As such, assessment of the biological communities within the watershed was completed to characterize the quality of each watercourse and to provide information necessary for making recommendations for improvements.

Dip nets with 1 mm mesh were used to sample aquatic macroinvertebrates. Sampling was conducted in an upstream direction and each station was sampled until no new taxa (taxa is plural for taxon, which refers to a taxonomic category, such as family, genus or species) were found (approximately 20 minutes for each station). All available habitats were sampled, including fast and slow moving water areas, hard and soft substrates, vegetated areas, woody material and undercut banks. Kick sampling was used in most areas, except in slower moving water where dip netting methods were used. Large stones and logs were sampled by handpicking. All organisms collected were identified, counted and recorded.

Relative to macroinvertebrates, P51 uses a set of nine metrics to score the community based upon comparison to an excellent site within the same ecoregion. The P51 Microsoft Excel spreadsheet was used to calculate the following nine metrics for each station to provide a qualitative rating of the macroinvertebrate community:

- Total number of taxa
- Total number of mayfly taxa
- Total number of caddisfly taxa
- Total number of stonefly taxa
- Percent mayfly composition
- Percent caddisfly composition
- Percent stonefly composition
- Percent distribution of dominant taxon
- Percent isopods, snails and leeches
- Percent surface dependant

The process results in a score based upon a scale of -9 to 9; -9 to -5 is rated "poor," -4 to 4 is rated as "acceptable" and anything greater than 4 is rated as "excellent." Generally, flowing waters which harbor a high diversity of macroinvertebrates, specifically different types of mayfly, caddisfly, and stonefly, are of higher quality than those waters that have few taxa. Water bodies with low diversity often have very high numbers of individuals due to their ability to thrive in degraded water with little competition or predation.

Relative to the physical habitat, P51 was used to assess the six biological stations along with 21 general sites within the watershed (Tables 2A & 2B). P51 considers such factors as the amount of woody debris and rock that organisms can hide amongst, the stability of the streambanks, the amount of vegetation growing along the stream margins and the degree of impact to adjacent lands. These "metrics" are scored on an individual basis and then compiled, resulting in a final score of up to 200 points. Sites scoring less than 56 are considered to be "poor," those scoring between 56 and 104 are "marginal," between 105 and 154 points is "good" and sites scoring over 154 are "excellent."

Station 1: Hoppler Creek @ Auburn Road

At the sample site, the drain is linear with evidence of past channelization. Habitat surveys resulted in a score of 113/200, with an adjective rating of good (slightly impaired). The streambanks are extremely stable and well vegetated with herbaceous vegetation, shrubs and some trees. The riparian area is farmed close to the edge of the channel on the left bank, while the riparian area on the right bank contains a home with relatively natural and undisturbed buffer. Overhanging vegetation and small woody debris provide the only epifaunal cover. The dominant substrate is hard sand and the water is uniformly shallow in depth with exception of a pool downstream of the culvert.

The macroinvertebrate community rating was rated as poor (-5). Seventeen taxa were collected, but the sample was heavily dominated by isopods. No mayflies or caddisflies were collected, but four individual stoneflies from the *Capniidae* family were collected. *Capniidae* are known to be intolerant of degraded conditions and were an unexpected find at this station, given the lack of quality habitat and degree of channel impact.

Station 2: South Branch Kawkawlin @ Garfield

Habitat at this station scored 125/200 (good, slightly impaired). Streambanks are very stable and contain dense growth of herbaceous vegetation with scattered trees and shrubs. A narrow, relatively deep low-flow channel exists within the confines of the originally excavated drain banks. The riparian area on the right bank consists of fallow farm field and that on the left bank contains a road with a mowed right-of-way.

High numbers of insects were collected but diversity was very low, with only nine taxa in the sample. The station scored -6, with an adjective rating of poor. Nearly 89% of the sample consisted of amphipods, snails and chironomids. Mayflies, caddisflies and stoneflies were absent from the collection.

Station 3: Herner Drain @ Jefferson Road

This station had the lowest habitat score of the six sites, scoring only 81/200 (marginal, moderately impaired). While it is the most natural of the channels in terms of morphology, it is heavily impacted by livestock grazing. Banks are trampled with locally severe erosion and riparian vegetation is grazed to the ground level on both sides of the stream, with exception of some mature trees. Substrate is poor and epifaunal substrate is noticeably lacking.

The macroinvertebrate score of -6 is indicative of the poor habitat. Only seven taxa were collected and total number of organisms was quite low. Surface dependent notonectids made up about 83% of the sample. Two of the more tolerant families of caddisfly (*Hydropsychidae* and *Phryganeidae*) were present at this location.

Several trout were observed in the Herner Drain upstream of this site in May 2009. Trout are known to be intolerant of degraded water conditions. It is unknown if trout are year-round residents of the drain or if the individuals observed were seeking a seasonal refuge, food source, etc.

Station 4: Watson Drain @ Rhodes Road

Another relatively natural meandering channel, the physical habitat of the Watson Drain scored 129/200 (good, slightly impaired). The riparian area is well vegetated and streambanks are quite stable. A good tree canopy shades the stream. Though the bottom is quite sandy, epifaunal substrate exists in the form of leaf packs, woody debris and overhanging vegetation.

This station received the highest macroinvertebrate score -2 of all those sampled and rates as acceptable. Five families of caddisfly and one family of both stoneflies and mayflies were found, including several that are intolerant of degraded conditions.

Station 5: South Branch Kawkawlin River at Chip Road

The river is wide and deep at this location and probably not suitable for P51 assessment, even during normal flow. However, since this site is representative of a dominant condition of the South Branch in this region, data was collected and the results indicate that habitat is good (slightly impaired) with a score of 123/200. Riparian areas consist of well-vegetated wetland and floodplain, with exception of scattered residences. Streambanks are fairly stable.

The macroinvertebrate community rated a poor (-8). This score may be related to ineffective sampling during the high water level encountered on the sampling date.

Station 6: North Branch Kawkawlin River at Jefferson Road

This river station has the highest quality of habitat (148/200) amongst all of the stations sampled. All individual metrics scored within the good to excellent categories with exception of pool variability and sinuosity.

Despite the high quality habitat, this station received the lowest macroinvertebrate score (-9) of all stations. Only eight taxa were collected and all organisms are tolerant of degraded conditions. It is quite possible that this site, along with the upper reaches of many other tributaries, lack water during dry weather periods. This may be the cause for low macroinvertebrate scores. Water levels in the reach were high during November 2008 assessments and these tributaries should be assessed during low flow periods.

Table 2A. Qualitative macroinvertebrate sampling results for

TAXA	Hoppler @ Auburn STATION 1	S. Kawkawlin @ Garfield STATION 2	Herner @ Jefferson STATION 3	Watson @ Rhodes STATION 4
PLATYHELMINTHES (flatworms)				
Turbellaria	6			
ANNELIDA (segmented worms)				
Oligochaeta (worms)	1	6	1	
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	10	137		
Decapoda (crayfish)			1	
Isopoda (sowbugs)	162	27		
Insecta				
Ephemeroptera (mayflies)				
Baetiscidae				3
Odonata				
Anisoptera (dragonflies)				
Aeshnidae		1		
Zygoptera (damselflies)				
Coenagrionidae	6			
Plecoptera (stoneflies)				
Capniidae	4			3
Hemiptera (true bugs)				
Corixidae				32
Nepidae	1			
Notonectidae			66	
Megaloptera				
Sialidae (alder flies)		1		
Trichoptera (caddisflies)				
Brachycentridae				3
Hydropsychidae			1	1
Leptoceridae				24
Limnephilidae				1
Phryganeidae			2	

TAXA	S. Kawkawlin @ Chip STATION 5	Kawkawlin @ Jefferson STATION 6
ANNELIDA (segmented worms)		
Hirudinea (leeches)		19
Oligochaeta (worms)	1	6
ARTHROPODA		
Crustacea		
Amphipoda (scuds)	18	
Decapoda (crayfish)		
Isopoda (sowbugs)		1
Insecta		
Odonata		
Anisoptera (dragonflies)		
Aeshnidae		
Zygoptera (damselflies)		
Coenagrionidae	1	
Plecoptera (stoneflies)		
Capniidae		
Hemiptera (true bugs)		
Belostomatidae		
Corixidae	18	26
Notonectidae		
Megaloptera		
Sialidae (alder flies)		4
Trichoptera (caddisflies)		
Helicopsychidae		
Coleoptera (beetles)		
Gyrinidae (adults)	1	
Haliplidae (adults)	1	
Haliplidae (larvae)	1	
Diptera (flies)		
Chironomidae	28	42
Culicidae		1

	Station 1	Station 2	Station 3	Station 4
Psychomyiidae				1
Coleoptera (beetles)				
Haliplidae (adults)	14			
Hydrophilidae (total)	2			
Elmidae	2			1
Diptera (flies)				
Chironomidae	8	60	8	5
Culicidae	4			
Simuliidae	9			
Tipulidae	5			
MOLLUSCA				
Gastropoda (snails)				
Lymnaeidae	1	21		22
Physidae	3	65	1	8
Planorbidae	3			2
Pelecypoda (bivalves)				
Sphaeriidae (clams)		1		
TOTAL INDIVIDUALS	241	319	80	106

	Station 5	Station 6
Tipulidae		
MOLLUSCA		
Gastropoda (snails)		
Lymnaeidae	1	2
Physidae	2	
TOTAL INDIVIDUALS	72	101

Table 2B. Macroinvertebrate metric evaluation of

METRIC	STATION 1		STATION 2		STATION 3		STATION 4		STATION 5		STATION 6	
	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	17	0	9	-1	7	-1	13	0	9		8	-1
NUMBER OF MAYFLY TAXA	0	-1	0	-1	0	-1	1	-1	0		0	-1
NUMBER OF CADDISFLY TAXA	0	-1	0	-1	2	0	5	1	0		0	-1
NUMBER OF STONEFLY TAXA	1	1	0	-1	0	-1	1	1	0		0	-1
PERCENT MAYFLY COMP.	0.00	-1	0.00	-1	0.00	-1	2.83	-1	0.00	-1	0.00	-1
PERCENT CADDISFLY COMP.	0.00	-1	0.00	-1	3.75	-1	28.30	0	0.00	-1	0.00	-1
PERCENT DOMINANT TAXON	67.22	-1	42.95	-1	82.50	-1	30.19	0	38.89	-1	41.58	-1
PERCENT ISOPOD, SNAIL, LEECH	70.12	-1	35.42	-1	1.25	1	30.19	-1	4.17	0	21.78	-1
PERCENT SURF. AIR BREATHERS	8.71	0	0.00	1	82.50	-1	30.19	-1	27.78	-1	26.73	-1
TOTAL SCORE		-5		-7		-6		-2		-8		-9
MACROINV. COMMUNITY RATING		POOR		POOR		POOR		ACCEPT.		POOR		POOR

3.3.1 *General Aquatic and Riparian Habitat Assessments*

Rapid assessment of aquatic and riparian habitat was undertaken to generally describe the habitat condition of the stream corridors. These assessments used P51 to document existing habitat in each of the 21 selected tributaries. While many of the tributaries differ in physical condition along their length, areas representing the dominant condition were selected for assessment. Table 3 (4 in this report on the next page) summarizes the results of this assessment.

Nearly all of the channels were determined to be moderately impaired. Results show that many of the lowest scoring tributaries are located in the highest priority sub-watersheds. Also, an overwhelming problem found in nearly all of the channels in the middle and southern portions of the watershed is the lack of riparian buffer, primarily due to the encroachment of agricultural practices. Sediment pollution was also determined to be impacting a majority of the sites throughout the watershed.

Table 4. Habitat evaluation for	STATION 1	STATION 2	STATION 3	STATION 4	STATION 5	STATION 6
HABITAT METRIC						
Substrate and Instream Cover						
Epifaunal Substrate/ Avail Cover	10	12	8	9	10	11
Embeddedness*						
Velocity/Depth Regime*						
Pool Substrate Characterization**	9	14	10	11	10	16
Pool Variability**	7	9	6	6	13	10
Channel Morphology						
Sediment Deposition	8	15	10	11	16	15
Flow Status - Maint. Flow Volume	8	8	5	6	8	7
Flow Status - Flashiness	8	8	5	6	7	8
Channel Alteration	14	8	16	14	13	16
Frequency of Riffles/Bends*						
Channel Sinuosity**	6	3	11	10	8	9
Riparian and Bank Structure						
Bank Stability (L)	8	9	2	7	6	9
Bank Stability (R)	8	9	2	7	9	9
Vegetative Protection (L)	8	7	2	9	6	9
Vegetative Protection (R)	8	7	2	9	8	9
Riparian Veg. Zone Width (L)	2	8	1	9	5	10
Riparian Veg. Zone Width (R)	9	8	1	9	9	10
TOTAL SCORE (200):	113	125	81	123	128	148
HABITAT RATING:	GOOD (SLIGHTLY IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)	MARGINAL (MODERATELY IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)

Note: Individual metrics may better describe conditions directly affecting the biological community while the Habitat Rating describes the general riverine environment at the site(s).

Date:					
Weather:					
Air Temperature:	Deg. F.	Deg. F.	Deg. F.	Deg. F.	Deg. F.
Water Temperature:	Deg. F.	Deg. F.	Deg. F.	Deg. F.	Deg. F.
Ave. Stream Width:	Feet	Feet	Feet	Feet	Feet
Ave. Stream Depth:	Feet	Feet	Feet	Feet	Feet
Surface Velocity:	Ft./Sec.	Ft./Sec.	Ft./Sec.	Ft./Sec.	Ft./Sec.
Estimated Flow:	0 CFS	0 CFS	0 CFS	0 CFS	0 CFS
Stream Modifications:					
Nuisance Plants (Y/N):					
Report Number:					

STORET No.:
Stream Name:
Road Crossing/Location:
County Code:
TRS:

Latitude (dd):
Longitude (dd):
Ecoregion:
Stream Type:

USGS Basin Code:

* Applies only to Riffle/Run stream Surveys
** Applies only to Glide/Pool stream Surveys

COMMENTS:

Habitat score	0	56	105	155
Habitat rating	POOR (SEVERELY	MARGINAL (MODERATELY	GOOD (SLIGHTLY	EXCELLENT (NON-

3.4 *Water Quality Monitoring*

3.4.1 *MDEQ*

The MDEQ has conducted numerous water quality monitoring studies in the Kawkawlin Watershed. The monitoring is detailed in the section of this report devoted to "Studies." These monitoring efforts include biological surveys, pathogen monitoring, nutrient monitoring and fish surveys.

Studies

The following is a summary of a sequence of studies completed by the former MDNR from 1990 to 2007.

Michigan Department of Natural Resources, 1990:

Stations were sampled on the Kawkawlin River at Mackinaw, Eight Mile and Beaver Roads (Appendix F). This study found that, while conditions did improve since their previous assessment in 1987, the quality of the Kawkawlin River remained poor to fair based upon biological communities, water sampling and habitat observations. High levels of turbidity and suspended solids were evident at all sampling locations and nonpoint sources were identified as a major contributor to impairment. Nitrogen, phosphorus, oil and grease, chloride and sulfate were also identified as pollutants.

Michigan Department of Natural Resources, 1994:

The Kawkawlin River was sampled at Eight Mile and Beaver Roads as part of this study. Results were similar to those found in 1990 (Appendix F). Both macroinvertebrates and habitat were rated as fair at both stations. Total phosphorus was elevated and reached levels capable of causing nuisance growth of aquatic plants and algae; these problems were observed in the stream. Phosphorus was believed to originate from intensely farmed portions of the watershed. Low levels of dissolved oxygen were identified as causing fish kills at Beaver Road.

Michigan Department of Natural Resources, 1996:

The South Branch of the Kawkawlin was sampled at Beaver and Mackinaw Roads, Culver Creek was sampled at Wolverine Road and the North Branch of the Kawkawlin was sampled at Chip

Road (Appendix F). The South Branch sites had good fish communities and the presence of juvenile northern pike and walleye suggested that this river was being used by both species for reproduction. Fish communities in the North Branch were sparse, possibly due to low dissolved oxygen levels. Macroinvertebrate communities were rated as fair at all stations except Culver Creek, which was rated as poor. Moderately to severely impaired habitat was determined to be the reason for the low scores at all stations. Contributors to the impaired habitat conditions were identified as livestock access to the stream and lack of vegetated buffer strips. Total phosphorus levels were excessive at all stations, as was the growth of nuisance plants and algae.

Michigan Department of Natural Resources, 2000:

This study included sampling of two stations, one on the North Branch of the Kawkawlin River at Beaver Road and the other at North Union Road on Culver Creek. The actual data was gathered on September 19, 2000 (Appendix F). The macroinvertebrate community was found to be acceptable at Beaver Road and poor at North Union Road. Habitat was rated as fair on both streams. Nonpoint source issues were identified as lack of riparian buffer zones, substantial runoff of sediment and nutrients from agricultural land and highly variable flow regimes. Water chemistry sampling indicated that levels of ammonia and total phosphorus exceeded average values.

Michigan Department of Natural Resources, 2007:

The water chemistry of the Lower Kawkawlin River was sampled at Euclid Road and determined not to exceed Michigan Water Quality Standards (Appendix F). However, at the time of the survey, the river was flowing upstream due to a strong wind off of the Saginaw Bay.

The macroinvertebrate community of the North Branch at Eight Mile Road was determined to be poor (Appendix F). There was a lack of flow and high suspended load noted in the report. At Beaver Road, the macroinvertebrate community was found to be minimally acceptable.

On the South Branch of the Kawkawlin River, very high suspended solids were measured at Wheeler Road and had the highest value of all Saginaw Bay tributaries sampled as part of this 2007 report. The macroinvertebrate community was found to be poor. Habitat was found to be marginal with poor substrate and erosion scars were prevalent. Downstream of the mouth of

Culver Creek, the macroinvertebrate community was found to be acceptable and physical habitat was rated as good. The water was clean when compared with other sites on the Kawkawlin River.

Table 3.2

Year	Location	Total P (mg/L) HT (hold time exceeded)	Kjeldahl N (mg/L)	Suspended Solids (mg/L)
1989	**S.B. Kawkawlin** Mackinaw Rd	0.17	1.95	37
1989	**S.B. Kawkawlin** Eight Mile Rd	0.182	1.78	60
1989	**S.B. Kawkawlin** Beaver Road	0.065	1.02	42
1993	**N.B. Kawkawlin** Eight Mile Rd	0.139	1.26	13
1993	**N.B. Kawkawlin** Beaver Road	0.26	1.39	8
2000	**N.B. Kawkawlin** Beaver Road	0.105 HT	1.22 HT	8
2000	**Culver Ck.** At N. Union Rd	0.078 HT	0.90 HT	<4
2000	**S.B. Kawkawlin** Frasier Road	0.123 HT	1.08 HT	50
2005	**N.B. Kawkawlin** Eight Mile Rd	0.084	0.782	ND
2005	**N.B. Kawkawlin** Beaver Road	0.268	0.954	5
2005	**S.B. Kawkawlin** Wheeler Rd	0.131	1.19	ND
2005	**Kawkawlin River** Euclid Road	0.193	1.06	25

Table 3.3

Year	Location	Macro-Invertebrate Rating	Fish Habitat Rating	Stream Habitat
1989	**S.B. Kawkawlin** Mackinaw Rd	Medium	Fair	Not rated in this study
1989	**S.B. Kawkawlin** Eight Mile Rd	Medium	Fair	Not rated in this study
1989	**S.B. Kawkawlin** Beaver Road	Poor	Low	Not rated in this study
1995	**S.B. Kawkawlin** Mackinaw Rd	Fair (Moderately Impaired)	Good (Slightly Impaired)	Not rated in this study
1995	**S.B. Kawkawlin** Beaver Road	Fair (Moderately Impaired)	Good (Slightly Impaired)	Not rated in this study
1995	**Culver Creek** Wolverine Rd	Poor (Severely Impaired)	Not rated in this study	Not rated in this study
1995	**N.B. Kawkawlin** Chip Road	Fair (Moderately Impaired)	Not rated in this study	Not rated in this study
2000	**N.B. Kawkawlin** Beaver Road	(-2) Acceptable	Not rated in this study	Fair (moderately impaired)
2000	**Culver Ck.** At N. Union Rd	(-7) Poor	Not rated in this study	Poor (severely impaired)
2005	**N.B. Kawkawlin** Eight Mile Rd	(-6) Poor	Not rated in this study	Good (slightly impaired)
2005	**N.B. Kawkawlin** Beaver Road	(-3) Acceptable	Not rated in this study	Good (slightly impaired)
2005	**S.B. Kawkawlin** Wheeler Rd	(-6) Poor	Not rated in this study	Marginal (moderately impaired)
2005	**Kawkawlin River** D/S Culver Ck	(-1) Acceptable	Not rated in this study	Good (slightly impaired)

3.4.2 *Kawkawlin River Watershed Property Owners Association*

This group of active stewards of the Kawkawlin River has performed their own monitoring studies related to water quality on the river. Their reports are available in the section referred to above. This group will be very active in the rehabilitation of the river and there organization should be used as much as it can, for they are a "hands-on" group that wants to be involved. They can be a valuable resource for the river as an involved stakeholder group, political activist group and as a proponent for rehabilitation and recreational use of the river. This group has done sampling and put together testing results from an *E.coli* sampling they have been doing since 1998 and posting on their web site. The following is their website:

http://kawkawlinriver.net/

Studies

Kawkawlin River Volunteer Monitoring Report (1997 – 2001)

The Kawkawlin River Watershed Property Owners Association (KRWPOA) moved forward in 1997 on a 5-year monitoring program to evaluate water quality on the Kawkawlin River. Four monitoring sites were selected and established at the following locations:

- State Park Drive Bridge
- Chip Road Bridge
- Wheeler Road Bridge
- Seven Mile Road Bridge

The following is a quick summary of the results:

Fecal Coliforms – Counts seemed higher and occur more frequently at the Chip Road Bridge and Wheeler Road Bridge. At these stations, the counts were elevated in 31% and 42% of the samples.

Phosphorus – Using EPA criteria of 0.1 mg/L, Wheeler Road and Seven Mile Road Bridges were slightly elevated at 0.11 mg/L as a 5-year average and Wheeler Road at a 5-year average of 0.14 mg/L. These results and the affect of the Great Lakes on outlet conditions and the low flow rates of the Kawkawlin has experts thinking of treating this river system more as a lake, using a water quality value of 0.05 mg/L as a target value.

Suspended Solids – The Kawkawlin has been ranked as a moderate priority for suspended solids based on an average of 29 mg/L. The data values for testing at the four stations ranged from 3.4 mg/L (Seven Mile Road) to 33.8 mg/L (Wheeler Road) and confirms previous ranking.

Dissolved Oxygen – The Michigan Water Quality Standard is 4 mg/L. The DO for the Seven Mile Road station was as low as 0.68 mg/L and there were 7 violations of this standard from 1998 to 2001.

It should be noted that the random sampling by Spicer Group also recorded low dissolved oxygen readings in this area in 2009.

3.4.3 *Spicer Group Spot Sampling*

Spicer Group performed spot sampling when in the Kawkawlin Watershed. This sampling was done on an intermittent basis with a HACH QUANTA unit that would test multiple parameters at a site, specifically temperature, specific conductivity, dissolved oxygen, pH, TDS and turbidity. The only poor results encountered during the sampling were on the North Branch of the Kawkawlin River for low dissolved oxygen at the following two locations. At the Mackinaw Road crossing on August 14, 2009, and September 2, 2009, the DO was 0.58 mg/L and 2.75 mg/L, respectively. At the Fraser Road crossing of the North Branch on the same dates, the following DO was recorded at 2.13 mg/L and 3.36 mg/L respectively.

3.4.4 *Flow Rates*

The following table contains flow rates for selected crossings throughout the Kawkawlin Watershed. The source is the hydrology section of the MDEQ. Flow rates are for the 10%, 4%, 2% and 1% recurrence intervals. Results are in Table 3.4.

Indirect Ground-Water Discharge to the Great Lakes (1998)

In a report by the U.S. Geological Survey (USGS) an estimate was formed of the average groundwater component of stream flow for 195 streams in the United States part of the Great Lakes Basin to range between 25 to 97 percent. The study used USGS gauging stations to measure indirect groundwater discharge with hydrograph separation analysis. This measured the portions of discharge into the Great Lakes Basin from surface runoff and indirect groundwater discharge. The North Branch of the Kawkawlin River, which has records of discharge recorded for 30 years, holds an average groundwater component of stream flow for its 101-square-mile drainage area of 65.8%.

Table 3.4 Peak Flows at Various Locations in the Watershed

Location	Drainage Area (Sq. mi.)	Peak Flows			
		10% cfs	4% cfs	2% cfs	1% cfs
Kawkawlin River at Eight Mile Road, Section 12, T14N, R3E, Williams Township	25.2	1100	1400	1600	1800
North Branch Kawkawlin River at Erickson Road, Section 7, T16N, R3E, Garfield Township	25.9	850	1100	1200	1400
North Branch Kawkawlin River at Townline Road, Section35, T15N, R4E, Kawkawlin Township	105	1610	1900	2080	2340
North Branch Kawkawlin River at Eight Mile Road, Section 13, T14N, R4E, Beaver Township	84.2	1400	1600	1800	2000
Kawkawlin River at Mackinaw Road, Section 16, T14N, R4E, Monitor Township	91.4	1800	2200	2600	2900
Kawkawlin River at Euclid Road, Section 6, T14N, R5E, Bangor Township	220	3720	4600	5180	5870
Kawkawlin River at Townline Road, Section 36, T15N, R3E, Beaver Township	43.9	1400	1700	2000	2300
Kawkawlin River at I-75, Section 3, T14N, R4E, Monitor Township	101	1800	2200	2600	2900
North Branch Kawkawlin River at Garfield Road, Section 3, T15N, R3E, Beaver Township	75.5	1200	1400	1600	1800
Kawkawlin River at Ehlers Road, Section 13, T16N, R2E, Mills Township	22.9	470	600	700	800
North Branch Kawkawlin River at I-75, Section 17, T15N, R4E, Kawkawlin Township	87.7	1400	1700	1800	2100
North Branch Kawkawlin River at Flajole Road, Section 31, T16N, R3E,Garfield Township	67.5	1100	1300	1400	1600

3.5 *Pollutants, Sources and Causes*

3.5.1 *Point Sources*

For the NPDES Permitted point sources on the Kawkawlin River, refer to the end of Chapter 2 and Tables 2.6 and 2.7.

3.5.2 *Nonpoint Source Pollution*

Road Crossings

Road crossings are a source of storm water contaminated with nutrients and pathogens from sediment and road kill and a source of petroleum based products such as oil, gasoline, diesel fuel, coolants and road salt. These crossings are also a source of soil erosion problems due to poorly designed road crossings, failing headwalls, limited maintenance programs and changes in hydrology affecting local hydraulics at the crossing. Crossings are also used in the very rural areas as a disposal or dumping area for household trash and construction/demolition materials.

Changes in Hydrology (Flow)

Excessive peak flows can be a result of changing land uses in a given area. For example, a fallow field may go back into agricultural production with row crops, which will increase runoff potential. Therefore, increased drainage in specific areas can result in increased flows to drains feeding to the Kawkawlin. This flow will be characterized by higher peak flows and, in some cases, sustained peak flows. The higher peak flows will increase the stream power or the ability for flowing water to perform "work." This work is essentially erosion, the ability to carrier a sediment load. This stream power results in the ability for excessive bank erosion, increased bed scouring and re-suspension of sediments previously deposited. Additionally, there can be habitat destruction along the channel. This rogue hydrology can also affect the diversity of aquatic fish and bottom dwellers and decrease the diversity if the situation is not corrected.

Storm Water Runoff and Drainage from Agricultural Lands in the Watershed

As in most watersheds, there are a group of concerned, educated farmers who take their responsibility as stewards of the land very seriously and participate in promoting best management practices. However, there is a section of the rural population that still needs to be educated on agricultural best management practices for their industry or, in some cases, for their "hobby" farms. Examples of domestic livestock in a position to have their wastes runoff into drains, tributaries or the river directly were observed during surveys. Livestock that grazed the floodplain in very close proximity to the river were also observed. There were only a couple of incidents where livestock were impacting waterways by direct access to the watercourse to create problems associated with erosion and stream bed disturbances.

The windshield survey and field work supported the lack of sustainable common agricultural practices. The following situations were observed that contribute to soil erosion and sedimentation in the watershed:

- Use of V-ditches for surface drainage without a BMP in place to prevent sediment movement from the site
- Farming to the edge of the established county drains without regard to drainage patterns
- Care of field tile outlets to prevent bank erosion
- Plowing to direct runoff directly to the county drains
- Unnecessary exposure of soil to the elements without leaving a cover crop or crop residue to prevent erosion or sediment transport

Table 3.5 provides an estimation of sediment and nutrient loadings from the agricultural and watershed survey completed for this report. The High Impact Targeting (HIT) online tool published by the USDA and NRCS was applied to each of the identified sites. A 30 foot wide grass buffer strip was used in the model to treat runoff from agricultural lands. HIT provided estimates for sediment load reduction and BMP cost per ton of sediment removed using this BMP.

Contaminated Sediments

The Kawkawlin River has diverse issues with the sediment load contained in the river. The Main Branch of the Kawkawlin has a sediment load that should be better characterized in the future to determine what should happen in this reach of the River. The sediments are known to have nutrients and also suspected to contain and harbor pathogens such at E.coli. This represents a two-fold problem in the Main Branch of the Kawkawlin. The primary concern is the presence of nutrients that continue to flush into the Saginaw

Bay. The secondary concern is the presence of E.coli in levels that affect recreational activities on the river and the beaches of Saginaw Bay near the Kawkawlin.

The Saginaw Bay has a known problem with eutrophication and is an Area of Concern to be addressed by elimination of impaired beneficial uses. Phosphorus is a limiting factor for aquatic plant growth in the Saginaw Bay and phosphorus drives the growth of algae in the Bay. Elimination of sources of nutrients is a key goal of the Saginaw Bay stakeholders. Also, the main branch of the Kawkawlin River has a periodic problem with duckweed and excessive amounts of other aquatic vegetation choking the channel. This excessive plant growth must be addressed at times with applications of aquatic herbicides to eliminate the plants to improve navigation and aesthetics of the Main Branch of the Kawkawlin River.

Surface water conditions in the Kawkawlin River at times become anoxic. This low DO can result in the release of bound up phosphorus from the sediment load in the riverine system. We need to understand more about this phosphorus cycle and how to eliminate it in order to further address restoration of beneficial uses of the Greater Saginaw Bay.

Phosphorus in freshwater and marine systems exists in either a particulate phase or a dissolved phase. Particulate matter includes living and dead plankton, precipitates of phosphorus, phosphorus adsorbed to particulates, and amorphous phosphorus. The dissolved phase includes inorganic phosphorus (generally in the soluble orthophosphate form), organic phosphorus excreted by organisms, and macromolecular colloidal phosphorus.

The organic and inorganic particulate and soluble forms of phosphorus undergo continuous transformations. The dissolved phosphorus (usually as orthophosphate) is assimilated by phytoplankton and altered to organic phosphorus. The phytoplankton are then ingested by detritivores or zooplankton. Over half of the organic phosphorus taken up by zooplankton is excreted as inorganic P, continuing the cycle; the inorganic P is rapidly assimilated by phytoplankton (Smith, 1990; Holtan et al., 1988).

Lakes and reservoir sediments serve as phosphorus sinks. Phosphorus-containing particles settle to the substrate and are rapidly covered by sediment. Continuous accumulation of sediment will leave some phosphorus too deep within the substrate to be reintroduced to the water column. Thus, some phosphorus is removed permanently from bio-circulation (Smith, 1990; Holtan et al., 1988).

Phosphorus release from the sediment under anoxic riverine conditions in the Main Branch of the Kawkawlin River outlet is an extremely complicated process. It is dependent on physical processes like mixing and diffusion, chemical reactions such as absorption and reduction, as well as biologically mediated processes. To measure this internal phosphorus load would involve elaborate measurements of several physical and chemical parameters. But it can be measured and reported on. The region is fortunate to have Saginaw Valley State University and its staff nearby to assist in this physical assessment of the sediments. It needs to be determined if there is a need to remove the existing contaminated sediments from the Main Branch and other selected areas to further decrease the nutrient loading into Saginaw Bay. One needs to remember that one pound of phosphorus can provide enough nutrients to grow 10,000 lbs of aquatic plants.

E. coli is associated with various diseases like meningitis, sepsis, and gastroenteritis. *E. coli* is released to water bodies (lakes and rivers) through leaking septic systems, feedlot runoff and manure application to fields. It is common belief that water quality in rivers, lakes and streams is at its worst after a large rainfall because of pollutants carried by runoff. Northeastern University in Boston completed a study that discovered elevated concentrations of E.coli in a river after a long period of no rain events. However, research of existing literature did not find a cause – effect relationship with sediment and E.coli. This relationship needs to be researched more to determine if the sediments are harboring and releasing E.coli during runoff events or other times, thereby creating a water quality problem.

Table 3.5 – Sediment and Nutrient Loading in the Kawkawlin River Watershed from the WARSSS

Site Sub-Watershed (X)	HUC 12 Watershed	Length (feet)	Height (feet)	Erosion Rate	Sediment Load (Tons/yr)	P – Load (Lbs/yr)	N – Load (Lbs/yr)	30-ft Grass Buffer Reduction (HIT 2.0)	BMP Cost			Source
									$/Ton Sed.	$/Lb P	$/Lb N	
Watson Drain – Klender to Rhodes (1)	40801020201	3855	4.5	0.1	135.2	148.7	297.5	24%	$122	$111	$55	Streambank erosion, soil erosion
Watson Drain – Upstream of Klender (1)	40801020201	1660	5	0.21	130.7	143.8	287.6	24%	$122	$111	$55	Streambank erosion, soil erosion, runoff
Herner Drain – County Line to Jefferson (1)	40801020201	1300	5.7	0.21	77.8	85.6	171.2	24%	$122	$111	$55	Streambank erosion, soil erosion, runoff
Herner Drain – Upstream of County Line (1)	40801020201	500	5	0.14	17.5	19.3	38.5	24%	$122	$111	$55	Soil erosion, storm water runoff
Herner Drain @ Jefferson (below culvert) (1)	40801020201	200	5	0.4	20.0	22.0	44.0	24%	$122	$111	$55	Soil erosion, storm water runoff, hydrology
Herner Drain – Downstream of Jefferson (1)	40801020201	1000	5	0.21	52.5	57.8	115.5	24%	$122	$111	$55	Streambank erosion, storm water runoff
Torey Drain – Downstream of Anderson (2)	40801020205	800	4	0.25	40.0	44.0	88.0	49%	$110	$100	$50	Streambank erosion, storm water runoff, hydrology
Kawkawlin Ck – Upstream Circle Road (2)	40801020201	50	10	0.4	10.0	11.0	22.0	24%	$122	$111	$55	Streambank erosion, storm water runoff
Kawkawlin Ck – Upstream Circle Road (2)	40801020201	100	4	0.2	4.0	4.4	8.8	24%	$122	$111	$55	Streambank erosion, storm water runoff
Kawkawlin Ck – Downstream of Beaver Road (3)	40801020201	850	7	0.14	41.7	45.8	91.6	24%	$122	$111	$55	Streambank erosion, storm water runoff

Sedimentation rates shown in Table 3.6 were determined through the use of the HIT 2 on-line model. A full set of sediment loading output data for each of the sub-watersheds in the Kawkawlin River Watershed is shown below in Table 3.6. Nutrient Loading rates are consistent with those found in Table 3.6.

Table 3.6 - HIT 2 Model results and associated nutrient load for Kawkawlin River Watershed

Kawk. WMP Sub-watershed	HUC-12 Watershed	Area (sq. mi.)	Sediment Rate (tons/ac/yr)	Sediment (tons/yr)	P-Load (lbs/yr)	N-Load (lbs/yr)
1	40801020201	51.53	0.008	264	290	580
2	40801020205	51.60	0.037	1,222	1,344	2,688
3	40801020205	3.53	0.037	84	92	184
4	40801020202	18.55	0.044	522	575	1149
5	40801020203	32.24	0.037	764	840	1680
6	40801020204	32.94	0.039	822	905	1809
7	40801020206	19.36	0.035	434	477	954
8	40801020206	15.12	0.035	339	373	745
	TOTALS	**225**	**0.031**	**4,450**	**4,890**	**9,790**

Two remaining sources to review in this plan for pollutant loadings and associated costs are located in two tables, both in Appendix H the first references Exhibit 26, the remaining table in Appendix H is based on the April, 2010 low level flight. These tables show the nutrient and sediment loads obtained from the 2010 aerial survey and from the 1998 watershed assessment completed by the Saginaw Bay RC&D. This last study was found to still be accurate and appropriate. For example, the livestock locations have not changed significantly. The aerial survey confirmed the presence of many of the erosion sites that had still not been addressed over the years. The determination of phosphorus and nitrogen loads were calculated in the same manner as performed in the WARSSS study and by the HIT model for the watershed. Essentially, meaning 1.1 lbs of Phosphorus per ton of sediment and 2.2 lbs of Nitrogen per ton of sediment.

In estimating loadings of phosphorus and nitrogen for livestock, research was done on the internet and sources from manure management sites at the University of Minnesota, St Paul, NRCS and the agricultural site for Alberta Canada. With the information obtained estimation of the tons of manure per year for various animals was developed. This information was then put into estimated loads of phosphorus and nitrogen in pounds per year loading. Table 3.6 on the following page provides significant insight into just how much a single cow or horse can contribute into the Kawkawlin River if not properly managed. One horse can produce 9.1 tons of manure per year of that amount there is approximately 29 pounds of phosphorus excreted. When this is coupled with the fact that 1 pound of phosphorus can produce approximately 10,000 pounds of aquatic vegetation we can see that 290,000 pounds (145 tons) of aquatic vegetation can be produced by a single horse. Impressive.

Determination of livestock pollutant loadings were from the following Table 3.7.

Table 3.7 Displays the Average Nutrient Content in lbs/ton, annual manure production and estimated P & N load per year per animal of a variety of Livestock Manures

	Phosphorus (lbs/ton)	Nitrogen (lbs/ton)	Tons of Manure per year/animal	Est. P load per animal / year (lbs)	Est. N load per animal / year (lbs)
Beef	2.4	10	21.9	52.3	219
Dairy	0.9	4.0	14.9	13.4	59.6
Hog	1.1	3.5	0.1	0.11	0.35
Horse	0.6	3.2	9.1	28.9	131.4
Chicken/ 100 birds	12.2	16.0	5.5	67.1	88
Sheep	2.0	7.0		3.1	20.1

Source: US Department of Agriculture 1990 & Manure Nutrient Management, 2008, Alberta, Canada

Construction Activities

Construction results in exposed and compacted soils from heavy equipment increasing the potential for storm water runoff. The removal of the natural vegetated cover on a parcel sharply increases the amount of sediment transported from the site into local waterways. During the survey process, a small number of sites were observed; more control needs to be exercised at construction sites to assure that BMPs are well maintained and properly placed. The program should be looked at to assure there is proper funding for enforcement of existing county programs to prevent sedimentation in local drainage systems and ultimately the river. If necessary, the counties should look at the SESC enforcement ordinance in place in Saginaw County. The county enforcement agency (CEA) has the ability to write a ticket for a civil infraction with a monetary penalty for soil erosion and sediment control problems that are ongoing.

Pollutants / Problems Prioritized from Stakeholders Meeting

The stakeholders meeting in January of 2010 involved obtaining input from those attending on what they felt were the primary pollutants and problems on the Kawkawlin River and in the Kawkawlin Watershed. The following fifteen items were brought up and then ranked by those attending the meeting. The following list is in the order as ranked by the meeting attendees:

1. Pathogens (*E.coli*)
2. Sediments/sedimentation
3. Nutrients
4. Flooding
5. Excessive aquatic plant growth
6. Altered hydrology
7. Channel blockage
8. Low Dissolved Oxygen
9. Herbicides, pesticides
10. Brine, Petroleum products, deicers, metals
11. Pipeline crossings
12. Garbage, other solids
13. Temperature
14. Airborne toxics
15. NPS electric current

3.5.3 *Total Maximum Daily Load (TMDL) for Dissolved Oxygen*

In August of 2007, the Water Bureau of the MDEQ, now Water Resources, released a TMDL for the North Branch of the Kawkawlin River of Bay County. This was done in accordance of Section 303(d) of the federal Clean Water Act and the United States EPA's Water Quality Planning and Management regulations (Title 40 of the Code of Federal Regulations, Part 130) requiring states to develop TMDLs for water bodies that are not meeting Michigan's Water Quality Standards (WQS) pursuant to Part 31, Water Resources Protection, of the Natural

Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA). The TMDL process establishes the allowable loadings of pollutants for a water body based on the relationship between pollution sources and in stream water quality conditions. TMDLs provide states a basis for determining the pollutant reductions necessary from both point and nonpoint sources (NPS) to restore and maintain the quality of the water resources. This TMDL was developed to identify the sources of dissolved oxygen (DO) standard nonattainment in the North Branch of the Kawkawlin River in Kawkawlin and to quantify reductions in these sources necessary for attainment of the standard. The North Branch of the Kawkawlin River is designated as a warmwater stream with a DO standard of 5 mg/L as a minimum. The nonattainment area is described as being on the N. Branch of the Kawkawlin from the confluence of the Kawkawlin River in T14N-R4E, Section 2 defined as the Reach Start to the Reach End 13 miles upstream at Eight Mile Road in T15N-R4E, Section 18. This report goes on to state that the **impaired designated uses** for the N. Branch in this reach are as follows:

- Warmwater fish and other indigenous aquatic live and wildlife uses

The point sources related to this TMDL are listed in the section titled "Pollutant Loadings" in following pages within this chapter. This TMDL is currently not on the list of "Approved" TMDLs for the State. Refer to Appendix G for the Low DO TMDL report.

Table 3.8 Estimated North Branch Kawkawlin River Conventional Pollutant Loads from Industrial Storm Water and MS4 General NPDES Permitted Point Sources.

Pollutant	Daily Load (lbs/day)	Annual Load (lbs/yr)
Biochemical Oxygen Demand (BOD)	17.9	6,539
TSS	38.1	13,923
Ammonia Nitrogen	1.12	409
Total Phosphorus	0.30	108

Estimates of the NPS annual loads of BOD ($CBOD_5$ + nitrogenous BOD), TSS, Total Phosphorus, and Total Nitrogen to the North Branch of the Kawkawlin River were estimated using the L-THIS application. Estimates of NPS loads to the North Branch of the Kawkawlin River appear in Table 3.8. These loads impact all North Branch Kawkawlin River tributaries and are based on non-site-specific data, and represent a best approximation using software default even mean concentration and curve number values. These estimates do not include point source loads from the industrial storm water permitted facility and MS4's contained in Table 3.8.

Table 3.9: Estimated Daily and Annual NPS Conventional Pollutant Loads.

Pollutant	Daily Load (lbs/day)	Annual Load (lbs/yr)
Biochemical Oxygen Demand (BOD)	123	44,700
TSS	3,230	1,180,000
Ammonia Nitrogen	135	49,400
Total Phosphorus	39.3	14,300

In accordance with the USEPA guidelines, urban runoff from storm water conveyances from Bay City, Kawkawlin Township, and Monitor Township (MS4s) will be considered in the waste load allocation portion of this TMDL as will Industrial storm water permitted facilities.

There is an additional "approved" TMDL for the Kawkawlin for FCA-PCBs completed in 2002 for the Kawkawlin River. It extends from the mouth of the river to the confluence with the North Branch, a reach length of 5 miles. In August 1988 10 Carp and 9 Northern Pike were collected and analyzed for PCBs in their edible portions. The results were 3.62 mg/kg for the carp and 0.61 mg/kg for the northern pike, a copy of the TMDL is in Appendix G.

3.6 *Designated and Desired Uses, Met, Impaired or Threatened*

Agriculture

The designated use of agriculture is considered to be met on the Kawkawlin River for the most part. However, the hydrology of the river does create flooding issues for bordering agricultural lands. At times, some areas just north of the confluence of the North and South Branches experience excessive flooding and "wet" periods of time which delay the farmers' ability to enter their fields to pursue their industry. Additionally, there are areas where the channel of the River has narrowed and affects farmers in one area by creating a situation where flooding is an annual event.

Industrial Water Supply

The use of the Kawkawlin as a source of water for industrial enterprises is not a designated use in this watershed. No industrial facilities draw water from the River or its branches.

Public Water Supply at the Point of Intake

The Kawkawlin River is not a source of water for public use or as a point of intake for water for public use. However, there is a municipal water intake located to the south for the residents of Bay City and surrounding communities that purchase their municipal water from this treatment plant. The actual point of intake is the Saginaw Bay, but the Kawkawlin contributes a sediment load to the greater bay that could have an effect on this water supply if the Kawkawlin River water quality and sediment load is not addressed.

Navigation

The designated use of navigation is impaired in the watershed. In the Main Branch, the impediment is excessive aquatic plant growth with its subsequent issues. There is a significant amount of trash and floatables that must be addressed every year in an annual cleanup effort by property owners along the river. In the upper reaches of the North and South Branches, bank erosion undermines trees along the bank causing them to fall into the river creating hazards to navigation by canoes, kayaks and similar light watercraft. This woody debris can, at times, exacerbate sedimentation and erosion in the channel especially if the tree falls across the entire width of the channel. On the Main Branch, there are areas of sedimentation creating problems for power boats trying to safely navigate the river corridor. With the current low water levels of the Great Lakes or the seasonal low flow levels in the River these sediment bars severely hinder recreational use of the Kawkawlin. When the Saginaw Bay is at a low water level, there are issues with navigation at the mouth of the Kawkawlin River as well. Overall, there are large amounts of sediment that are affecting the capacity of the river channel and the channel is in need of dredging, and in some areas widening, to assure better hydraulics of the channel. The South and North Branches have limited public access sites to the River while the upper branches may not necessarily be suitable for motor boats to access. More access points for recreational watercraft such as canoes and kayaks would be beneficial. A green path for recreational boaters has been recommended. More public access sites and facilities are needed. Another hazard to navigation is the old pipe crossings from the oil fields in the lower portion of the watershed. It is understood these pipes are no longer being used and should be removed to lessen a navigation hazard but also a safety hazard and potential pollution source.

Warmwater Fishery

The warmwater fishery for the North Branch of the Kawkawlin has been addressed by a report issued by the MDEQ in 2007 as being impaired. This was primarily because of a dissolved oxygen issue in the river. When looking at the South Branch, there is also an issue of sedimentation that is creating problems for fish and the fishery of the South Branch. During the summer, the dissolved oxygen in both branches gets very low. The backwater effect of Saginaw Bay on the River also impedes the flow regime and creates a "stagnant" water situation that is not conducive to a good warmwater fishery. However, there is a walleye rearing pond on the Kawkawlin and this fish species is making a comeback in the River. There have been reported fish kills on the river related to low oxygen levels. Additionally, the problems with sedimentation are eliminating a healthy substrate for macroinvertebrates that are an important food source for the warmwater fish species that stakeholders in the watershed wish to promote.

Other Indigenous aquatic and wildlife

The native wildlife and aquatic life is impaired in the Kawkawlin Watershed. Along the South Branch, the greatest impairment is the loss of habitat. But the most obvious impairment is wetland loss and fragmentation. Nutrients and pesticides are also impairing aquatic life and wildlife by killing off fish and associated food sources, promoting algae growth that can decimate oxygen levels in the water.

Total and Partial Body Contact Recreation between May 1 and October 31

Total and partial body contact recreation is impaired in the Kawkawlin Watershed. In the Main Branch in particular, it is threatened by pathogens (*E.coli*) in the water column and in the sediments that can pose a threat to individuals who come into contact with the water when levels of pathogens are high. During 2009, there were no beach closings or advisories. However, the following Table 3.10 indicates closures from 2005 to 2008, noting there were historical closures before those years. This information is from the MDEQ web site for the Kawkawlin River Boat Launch at the mouth of the river.

Table 3.10: Contamination Advisories at Kawkawlin Boat Launch

Year	Dates	# Days Closed	Reason	Source
2008	8/20 to 9/24	35	High Bacteria levels	Unknown
2008	6/24 to 7/22	28	High Bacteria levels	Unknown
2007	8/23 to 8/29	6	High Bacteria levels	Unknown
2007	6/7 to 6/12	5	High Bacteria levels	Unknown
2006	8/29 to 8/31	2	High Bacteria levels	Unknown
2006	6/20 to 7/26	36	High Bacteria levels	Unknown
2005	6/29 to 8/2	34	High Bacteria levels	Unknown
2005	6/17 to 6/22	5	High Bacteria levels	Unknown
2005	6/10 to 6/13	3	High Bacteria levels	Unknown

At a quarterly meeting, the stakeholders group determined their priorities. After discussions regarding the health of the watershed in various formats over the years, the following Table 3.11 was developed to reflect the priority of designated uses for the Kawkawlin River.

Table 3.11: Prioritization of Designated Uses in the Watershed

Priority Level	Designated Use	Designated Use Status	Water Quality Standard to determine impairment	Suspected or Known Pollutant
1	Total and Partial body contact recreation	Impaired	Impaired per *E.coli* Standards Surface Waters and Surface Water Discharges: *Partial Body Contact: 1,000 *E.coli* per 100 mL of water at any time *Total Body Contact: 130 *E.coli* per 100 mL of water as a 30 day average and 300 *E.coli* per 100 mL of water at any time	*E.coli,* nutrients, sediment, pesticides, chemicals (brine, petroleum, etc).
2	Indigenous aquatic life and other wildlife	Impaired	Impaired per P-51 Standards Scores of 5 or more = Excellent Scores of -5 or lower = Poor Score of 0 is neutral with no tendency to Excellent or Poor	Loss of habitat both terrestrial and aquatic, sediment, nutrients, low dissolved oxygen, pesticides
3	Warmwater fishery	Impaired	Impaired per DO & P-51 standards >5 mg/L DO for surface waters designated for warmwater fishery and aquatic life	Sediment, nutrients, low dissolved oxygen (N. & S. Branch), loss of habitat (S. Branch) water depth, loss of aquatic habitat
4	Navigation	Impaired	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, suspended solids, and deposits. This kind of rule, which does not establish a numeric level, is known as a "narrative." See Table 8.2 for additional WQS	Sediment, water depth, trash, woody debris, pipe crossings, limited access sites, water depth
5	Agriculture	Meets		N/A
6	Public water supply	Not a use in this watershed		N/A
7	Industrial water supply	Not a use in this watershed		N/A

Table 3.12 lists all information found on the impairments to the Kawkawlin River from the most recent draft of the 303(d) (Oct., 2010) list from the MDEQ website. Also, a map of these areas is in the map labeled Exhibit 14, found in Appendix A.

Table 3.12: From Draft 303(d) list

HUC 14	Name of waterbody	Designated Use	Use Support	Cause	Pollutant
040801020201-01	Kawkawlin Creek & NB Kawkawlin River	Other indigenous aquatic life and wildlife	Not Supporting	Other anthropogenic substrate alterations	Not listed in report
040801020201-01	Kawkawlin Creek & NB Kawkawlin River	Other indigenous aquatic life and wildlife	Not Supporting	Other flow regime alterations	Not listed in report
040801020202-01	Waldo Drain	Other indigenous aquatic life and wildlife	Not Supporting	Other anthropogenic substrate alterations	Not listed in report
040801020202-01	Waldo Drain	Other indigenous aquatic life and wildlife	Not Supporting	Other flow regime alterations	Not listed in report
040801020205-01	Crump Drain, Kawalski Drain, Monison Drain, NB Kawkawlin River & Renner Drain	Other indigenous aquatic life and wildlife	Not Supporting	Other anthropogenic substrate alterations	Not listed in report
040801020205-01	Crump Drain, Kawalski Drain, Monison Drain, NB Kawkawlin River & Renner Drain	Other indigenous aquatic life and wildlife	Not Supporting	Other flow regime alterations	Not listed in report
040801020205-02	Bedell Drain, NB Kawkawlin River	Warmwater fishery	Not supporting	Oxygen, Dissolved	Yes, TMDL completed 9-1-2007
040801020205-02	Bedell Drain, NB Kawkawlin River	Other indigenous aquatic life and wildlife	Not Supporting	Other anthropogenic substrate alterations	Not listed in report
040801020205-02	Bedell Drain, NB Kawkawlin River	Other indigenous aquatic life and wildlife	Not Supporting	Other flow regime alterations	Not listed in report

3.6.1 *Desired Uses in the Kawkawlin River Watershed*

Members of the stakeholders group discussed desired uses for the watershed as improving warmwater fisheries and conditions (habitat) for the river system. They wished to improve and protect habitat and conditions for aquatic life and wildlife along the river. This group of concerned stakeholders also wished to protect the quality natural features of the river corridor and preserve the rural character (farmland and open spaces) of the watershed. The development of a sustainable plan for the watershed and implementation of BMPs along with providing environmental education opportunities were among the goals for the overall watershed. The Saginaw Bay area has been the focus of many efforts to improve water quality. Reducing the amount of pollutants entering the Great Lakes from a tributary such as the Kawkawlin River also meets the goals of the Great Lakes Restoration Initiative as presented in 2009. The development of this plan and the future work on the Kawkawlin River has and will involve the residents, business owners, local officials and decision-makers in a hands-on effort to improve and protect their environment and local water resources. The Saginaw Bay is a recreational area, providing opportunities for swimming, biking destinations, camping, boating, fishing and hunting. The residents support these uses and desire the watershed to maintain its environmental integrity in order to continue these uses. The preservation and enhancement of opportunities for human use of the watershed with minimal adverse impact was a definite goal for the stakeholders. They love their watershed and invest their time and energy in it. They want to learn how to better care for it and implement projects in the river that will have a beneficial long term affect on the quality of the river and its habitats. The Kawkawlin River Watershed is within the eligibility sphere for Michigan's Conservation Reserve Enhancement Program. Participation in this program has provided funding to enhance wildlife habitats and encourages wildlife diversity. Also, there has been voluntary participation in use of vegetated buffers along county drains and similar surface drainage systems by area farmers. They are concerned with the outcome of this overall plan and want more of their colleagues to become involved with prevention of sedimentation. The expected benefits of the continued improvements within the watershed will be a cleaner Kawkawlin River and Saginaw Bay. With improved water quality will begin improvements in the wildlife community, recreational opportunities for the public and business opportunities, with a reduction in health risk and expenditure of scarce funds for remediation of polluted regional resources.

3.7 *Critical Areas*

The critical area is defined as "That part of the watershed that is contributing a majority of the pollutants and is having the most significant impacts on the waterbody." In the case of the Kawkawlin and most other river systems, it is the source of the greatest amounts of NPS pollutants to the river. By prioritizing the 8 sub-watersheds, this plan will define the boundaries for the implementation of BMPs to address issues in the sub-watersheds which will have an effect on the overall watershed.

Identification of Critical Areas

Several different methods could be used for identification of critical areas; these were discussed in various committees that have been established. All committees looked at data gathered and looked at prioritizing the sub-watersheds based on the aspect in which they were specializing. For example, the Corridor Subcommittee was involved in land use issues, and would prioritize based on those criteria. The Water Course Subcommittee would look at water quality issues as presented in data and make decisions based on their focused view of the watershed, as would the Nutrient/Pathogen Subcommittee. This plan ranks the priorities by sub-watersheds, see map Exhibit 1, in Appendix A.

The highest priority sub-watersheds are located in the most intensively farmed portion of the Kawkawlin Watershed and are impacted by overland sediment and nutrient pollution. The lowest ranking sub-watershed, number 1, is located in the northern portion of the Kawkawlin Watershed, which contains much more wetland and forest. The primary issue of concern in Sub-watershed 1 appears to be livestock access and streambank erosion because of lighter soils. However, Sub-watershed 1 ranks highest for preservation of wetlands and land use.

The highest priority watershed is Sub-watershed 7, also known as Culver Creek. This area is predominately agricultural for land use. It historically had a large pre-settlement wetland area of 6,933 acres but has lost almost 94% of those wetlands. The upper reaches of the Culver Creek hold an extensive amount of sediment to the point of choking off field tile outlets. Agricultural fields in this region are primarily surface drained now, which exacerbates the sedimentation issues. This sediment loading is a nutrient, pathogen source and an oxygen demanding source attributing to the low dissolved oxygen levels discharging into the Kawkawlin River. There is also a moderate number of roadside culverts and crossings that are eroding and contributing to the sediment deposition. The cleaning out of the Culver Creek to remove nutrient loads and reinstate the function of the field tiles would be extremely beneficial. This would also alleviate some of the surface drainage sediments and decrease those sediment loads.

Specific problem areas and topics have been identified as outlined below. Maps and location data are provided in Appendix D after each exhibit.

Road/Stream Crossings

High Priority sites identified in sub-watersheds 8, 3, 2, 6, 4 and 7 and in Garfield Township sub-watersheds: Culver Creek (7), Bangor and Monitor Townships (3, 7). In sub-watersheds 3 and 7, the primary crossings of concern are former petroleum pipelines. Pictures of these pipe crossings are located in Appendix J. There needs to be an effort to have these removed to better navigate the River and prevent petroleum from leaking into the River.

Medium Priority sites were identified in 5 other sub-watersheds: Betzoid Drain (South Branch), Keck Drain, refer to the survey information for the remaining. A table has been developed from the Watershed Assessment of the Lower Western Coastal Basin of Saginaw Bay which included the Kawkawlin River. These sites are listed on three maps labeled Exhibit 26, one for each branch, and are available in Appendix H with a table that includes costs and priorities.

Livestock Access and Potential Runoff

High Priority – access site identified in Sub-watersheds 1 and 2

Medium Priority – Sub-watersheds 7 and 4

Low Priority – remaining sub-watersheds

Rill and Gully Erosion

High Priority – Sub-watersheds 7, 6, 5 and 2 estimated from inventory and percentage of agricultural land use

Medium Priority – Sub-watersheds 4 and 3

Low Priority – Sub-watersheds 1 and 8

Streambank / Drain Bank Erosion

High Priority – Sites of streambank erosion and problems were identified in Sub-watersheds 7 and 6 and are considered a high priority for action.

Medium Priority – Sub-watersheds 5, 2, 4 and 3

Low Priority – Sub-watersheds 1 and 8

Tile Outlets

High Priority – sites identified in Sub-watershed 8, primarily in Bangor Charter Township. This area has completed and NPDES Illicit Discharge Elimination Plan. However, it needs to be monitored over the next few years to assure it is not causing a problem during event storms.

Medium Priority - sites in Sub-watersheds 2, 3, 5, 6, and 7. The present documentation of identified locations are a result of a windshield survey. Additional field inspection may be needed to further quantify and prioritize these sites. Tile outlets should be addressed under routine drain maintenance.

Low Priority - sites in Sub-watersheds 1 and 4.

Storm Water Runoff

High Priority – sites were identified in sub-watersheds with municipal storm sewer system outfalls in Bangor and Monitor Townships. They are: Mill Pond Drain and branches, Bangor Twp Relief Drain, Drouillard Drain, Frank Jean Drain, Burgeson and the Jean Aplin Drain.

On-Site Treatment (Septic) System Maintenance

High Priority in this context is defined as a high number of septic systems per square mile, the prioritized sub-watershed is as follows: Sub-watershed 8, where the mean age of the systems is 36 years per records found.

Medium Priority – Sub-watershed 3 is also a priority in the few residential areas in proximity to the North Branch.

Low Priority sub-watersheds include the remaining sub-watersheds. It is assumed that systems in these areas are greater than 25 years old. The BCHD will need to gather information to further expand its database for the entire Kawkawlin Watershed.

Manure Management

High Priority sites were identified in sub-watersheds 7 and 2.

Medium Priority sites were identified in sub-watersheds 1, 6 and 4.

Low Priority sites were identified in the remaining sub-watersheds.

Wetland Restoration

A portion of the Kawkawlin Watershed was determined to be a critical area for wetland restoration due to the high amount of wetlands already lost. The historical pre-settlement times (pre-European), there was over 71,968 acres of wetlands functioning in the watershed. As of 2005 data, only 23,264 acres of wetland remain and with that loss there is a substantial functional aspect of the wetlands that has been lost. In a priority restoration objective, the following sub-watersheds are a **high priority**: Sub-watershed 7 (Culver Creek), Sub-watershed 2 (North Branch) and Sub-watershed 5 (Betzoid Drainage District). A **medium priority** has been established for the upper portion of Sub-watershed 2 and lower portion of Sub-watershed 1 (Kawkawlin Creek). These two areas should be protected and have restoration goals set. Recommendations to continue to assess the watershed are discussed in further chapters. See the maps in Appendix B for locations of high and medium potential areas that should be concentrated upon for future restoration. Areas that should be concentrated on are identified as also being PA 116 lands, as those lands have owners that appear to be concerned with preservation of their lands. These property owners may be more approachable for utilization of their lands for restoration aspects.

Wetland Preservation

Portions of the watershed were also identified as being critical for preservation of the wetlands that exist in those sub-watersheds. The first area of concern is in Sub-watershed 8 in Bangor Township. There is a rare type of wetland under litigation and enforcement. The owner may be approached by the right mix of stakeholders to place a permanent conservation easement on this parcel and potentially end the years of litigation with the state. This parcel can be identified by contacting the Bay County Drain Office for further information.

The remaining critical area for preservation is sub-watershed 1 in the far northern reach of the watershed with lands located mainly in Midland and Gladwin Counties. There is already a significant amount of CARL Lands in this sub-watershed. Mills Township, Gladwin County is represented in this sub-watershed and has completed an ordinance review. The townships in Midland and Bay should also go through an ordinance review to help with preservation of this critical area for the health of the watershed.

Also, Appendix B contains the MDEQ reports on wetlands in the watershed.