Red River/Sturgeon Bay Surface Water Resource Appraisal Report

Submitted by

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I. INTRODUCTION

The purpose of this surface water resource appraisal report is to summarize the existing and potential condition of water resources, identify causes of surface water use problems, and to provide preliminary surface water resource objectives and pollutant load reductions needed to meet those objectives for each subwatershed in the *Red River Sturgeon Bay Priority Watershed Project (Figure 1)*.

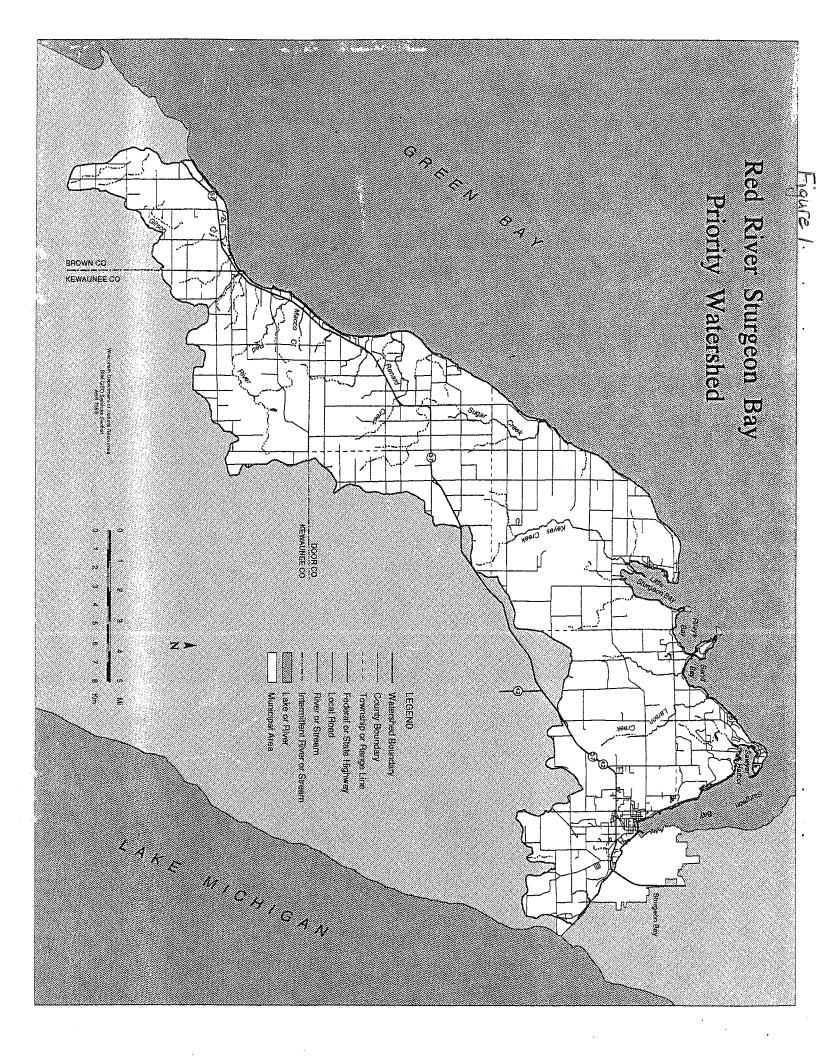
II. SUMMARY OF WATER RESOURCE CONDITIONS

Surface waters included in the Red River/Sturgeon Bay watershed area consist of Little Sturgeon Bay, Rileys Bay, Sand Bay, Sturgeon Bay and several intermittent and perennial tributaries to these bays and to Green Bay. The watershed is 139 square miles in size and located in Door (80%), Kewaunee (10%), and Brown (10%) counties. Land use in the watershed is primarily agricultural with dairy farming being the principal type of agriculture.

Most of the watershed streams are intermittent with extensive seasonal use by several fish species that run up the creeks to spawn. In the southern portion of the watershed, these fish run only as far upstream as the escarpment, but in the northern watershed streams some fish species can travel up into the headwater areas (Lychwick, Pers. Comm.). Generally, for most of the year, these watershed streams only support a warm water or limited forage base fishery. The upper reaches of Keyes Creek is thought to be able to support cold water Class I and II fish communities. Spring ponds in the upper reaches of Gilson Creek are believed to be capable of holding brook trout.

Macroinvertebrate abundance and diversity appears to be limited because of the lack of suitable habitat and the degree of organic pollution in the streams. Aquatic life habitat is degraded in many of the watershed streams from erosion, sedimentation, and dense growth of aquatic plants due to nutrient loading. Generally, the watershed streams do not have the potential to support sport fish or cold water communities because of the streams morphology. However, the streams do have potential to have better habitat which in turn would promote longer residence, and greater diversity and abundance of fish species and macroinvertebrates with the reduction of nonpoint source pollution.

Watershed streams discharge to Sturgeon Bay, Sawyer Harbor, Little Sturgeon Bay, Rileys Bay, and Green Bay. In and around the near shore areas of many of these bays, there is a deposition of soft sediment and a perceived nuisance aquatic plant problem that may limit recreational activities in these waters. In the Sturgeon Bay channel, for instance, commercial and recreational use in recent years has increased and thus, has resulted in more complaints regarding nuisance aquatic plants (Rasman, 1993). Mechanical weed harvesting occurs in



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Sturgeon Bay and herbicides are regularly applied in Little Sturgeon Bay to kill aquatic plants. The reduction of sediment and nutrient loading to the bays would inhibit additional near shore sedimentation and aquatic plant growth.

The water resources in the Red River/Sturgeon Bay Watershed show extensive nonpoint source pollution problems. The stream beds are often covered with silt and sediment and the high productivity of the streams and bays indicate excessive nutrient input.

Nutrients affect water quality by promoting excessive nuisance plant growth (macrophytes and algae). Excessive aquatic plants may cause severe oxygen fluctuation in the streams and bays. As the plants photosynthesize in the daylight they produce abundant oxygen, but the oxygen is used during plant respiration at night which stresses fish and other aquatic life in these waterbodies. Oxygen is also used during organic matter decomposition in the water column and sediment. Phosphorus is the most significant nutrient which promotes algae and macrophyte growth. Nutrients, pesticides, and pathogens are often attached to sediment and delivered to surface water with sediment runoff.

Water chemistry samples taken during runoff show high levels of contaminants entering the watershed streams. The sources of these pollutants appear to be from streambank and gully erosion, urban runoff, barnyard/feedlot runoff, and upland soil erosion. Streambank erosion appears to be caused by a combination of excessive cattle grazing of streambanks and flooding caused by rapid rain runoff events. Streambank, gully, and upland soil erosion results in sedimentation of pools, filling-in of spawning substrate, reducing suitable habitat for macroinvertebrates in riffle areas, and elimination of streambank cover. Unstable streambanks in both wooded and open areas are prone to sloughing-off and contributing sediment to the stream bed during high water events.

Some of the watershed streams are very flashy and flood easily during rain events or snow melt, but completely dry up or have very low flows during dry weather periods. Excessive flooding in the watershed is primarily due to a combination of high gradient topography and the predominance of intensive agricultural land use. It is likely that high water extremes could be reduced to some extent by changing land management practices that would increase infiltration and reduce peak runoff rates.

Water Resource Objectives

Specific objectives are listed under each subwatershed description; however, overall water resource objectives for the Red River/Sturgeon Bay Priority Watershed are as follows:

- 1. Stabilize flow rates of creeks by implementing land management practices which increase infiltration rates in areas where the ground water contamination potential is low. In areas of high ground water contamination potential, use land management practices which increase the detention of runoff.
- 2. Maintain or develop stream woodland and grassland corridors by developing buffers through the use of stream corridor easements. Corridors also provide wildlife habitat.
- 3. Reduce nutrient and bacteria loading from barnyards and winter spread manure.
- 4. Reduce gully erosion/sedimentation rates by 50%.

III. APPRAISAL METHODS

Following is a brief description of monitoring activities conducted from September 1992 to August 1993 for the surface water resource appraisal. Monitoring procedures are consistent with the quality assurance/quality control "Field Procedures Manual" (WDNR, 1988).

Macroinvertebrate

Aquatic macroinvertebrates were collected in Fall 1992 and Spring 1993 at several locations throughout the watershed and sent to UW-Stevens Point for sorting and identification. Sample results were evaluated using the Hilsenhoff Biotic Index (HBI) which provides a relative measure of organic loading to the streams (Hilsenhoff, 1987).

Habitat Evaluations

Stream habitat conditions were evaluated throughout the watershed in the spring, summer, and fall. A matrix was used to numerically rank physical habitat characteristics that may limit the quantity and quality of aquatic life (Ball, 1982).

Dissolved Oxygen/Temperature

Continuous dissolved oxygen and temperature meters were placed in Renard Creek, Sugar Creek, and Keyes Creek during mid-summer in addition to collecting grab samples in several other streams on several occasions. Wisconsin Administrative Code NR 102 establishes a 5 mg/L dissolved oxygen water quality standard for fish and aquatic life classified streams to maintain favorable aquatic life.

Water Chemistry Samples

Water samples were collected on five occasions to represent runoff from snowmelt and rain events. Stream flow was also collected concurrently with chemistry samples to estimate nutrient loading in pounds per day to the receiving waterbody.

IV. RESULTS AND DISCUSSION

A summary of the major streams in each of the nine subwatersheds in the Red River/Sturgeon Bay Priority Watershed, including monitoring results and observations, problems and/or causes of the degradation of the water resources, and the stream and receiving waterbody potential are presented in Table 1. Water chemistry results are presented in Table 2.

The following subwatershed descriptions provide a summary of current and potential water resource conditions, sources of pollution and other factors causing surface water quality problems, and preliminary surface water resource management objectives.

STRAWBERRY CREEK SUBWATERSHED

Strawberry Creek subwatershed consist of Strawberry Creek, and an Unnamed Tributary (#11, T27N, R26E, S16, NESW), that both drain to Sturgeon Bay.

Strawberry Creek is a perennial warm water forage fish classified stream that supports an annual fall salmon run. The WDNR has an egg taking facility approximately 3/4 miles upstream from the creek mouth. Cold water fish species are common in the lower reaches of Strawberry Creek because of the cold water seiche effect from Lake Michigan. A section of the creek has been ditched which has significantly decreased aquatic life habitat. Dissolved oxygen concentrations remained above 6 mg/l during appraisal monitoring. Habitat evaluations ranked this creek as good aquatic life habitat.

The <u>Unnamed Tributary</u> is a small stream that received a fair aquatic life habitat ranking. Macrophytes in the stream are abundant. This limited forage fish classified stream is intermittent. Silt has covered much of the stream bed. A macroinvertebrate sample in Fall, 1992 received a biotic index value of 7.45 which rates the Unnamed Tributary as fairly poor water quality with significant organic pollution. Nutrient concentrations during a rain event in November, 1992 appears to be relatively low.

The streams in this subwatershed are limited by varying stream flow, macrophyte growth, sedimentation, and channelization. Sturgeon Bay is limited by soft sediment build-up and nuisance macrophyte growth.

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Table 1. Water Resource Conditions

STRAWBERRY CREEK SUBWATERSHED

STREAM NAME	STRAUBERRY CREEK	UNNAMED TRIBUTARY (T27N,R26E,S16,NESW)
EXISTING CONDITION/ OBSERVATIONS	discharges directly to Sturgeon Bay perennial WWFF classification (1) good habitat DNR fish egg taking facility	discharged directly to Sturgeon Bay intermittent fair habitat abundant macrophytes silted
	fall salmon run cold water fish species in lower reaches drains wetlands	significant organic pollution (biotic index) fairly poor water quality (biotic index) low nutrient runoff in events
	flows vary more then years ago	seasonal fish run flows through marsh LFF classification (2)
PROBLEMS &/OR CAUSES IN STREAMS	channelization decreases aquatic life habitat varying stream,flow	dries up abundant macrophytes silted substrate
STREAM POTENTIAL	more habitat aquatic life if not ditched	more aquatic life habitat with continuous flow less macrophyte growth
POTENTIAL OF RECEIVING WATERBODY	less soft sediment and macrophyte growth near-shore in Sturgeon Bay with the reduction of nutrients and sediment	less soft sediment and macrophyte growth nearshore in Sturgeon Bay with the reduction of nutrients and sediments

STURGEON BAY SUBWATERSHED

STREAM NAME	SAMEULSON CREEK
EXISTING CONDITION/OBSERVATIONS	discharges directly to Sturgeon Bay
	intermittent flashy
	fair habitat during flow
	over abundant filamentous algae growth
	urban stream
	seasonal fish run
	LFF classification
PROBLEMS &/OR CAUSES IN STREAMS	intermittent flow - flashy
	abundant filamentous algae growth
	probable urban runoff
STREAM POTENTIAL	more aquatic life habitat with continuous flow
	less algae growth
	less urban runoff
POTENTIAL OF RECEIVING WATERBODY	less soft sediment and macrophyte growth near-shore in Sturgeon Bay with the reduction of nutrients and sediment

(Table 1 continues)	LARSON CREEK SUBWATERSHED	SUBWATERSHED	
STREAM NAME	LARSON CREEK	HAY SUAMP	LOST CREEK
EXISTING CONDITION/OBSERVATIONS	WWFF classification intermittent flow discharges to Sand Bay turbid runoff water high suspended sediment conc. fair habitat drains Cunningham swamp silt in creek bed pasture/feedlot in creek brong through Larson Swamp before bay constant fieth runs	LFF classified stream discharges to Sand Bay drains swamp intermittent flow silt and soft sediment build-up filamentous algae thick fair habitat seasonal fish run	Iff classified stream intermittent flow flows through golf course possible runoff from landfill discharges to Sawyer Harbor seasonal fish run
PROBLEMS &/OR CAUSES IN STREAMS	creek dries up significant sediment runoff significant silt load from swamp pasture and feedlot runoff - nut/sed thick algae growth silt build-up in creek bed	creek dries up significant silt load from swamp thick algae growth	creek dries up possible nutrients from golf course possible sediment from landfill
STREAM POTENTIAL	less silt and sedimentation more aquatic life habitat with continuous flow less nutrients	even with continuous flow, creek potential same as current because of continuous flow swamp	more aquatic life habitat with continuous flow
POTENTIAL OF RECEIVING WATERBODY	same as current - no apparent impacts from NPS	same as current - no apparent impacts from NPS	less soft sediment and macrophyte growth near-shore in Sawyer Harbor with the reduction of nutrients and sediment

KEYES CREEK SUBWATERSHED

STREAM NAME	KEYES CREEK	THREE UNNAMED TRIBUTARIES (KRUEGER, MALVITZ, TWIN HARBOR CREEKS)
EXISTING CONDITION/OBSERVATIONS	perennial stream flows through Gardner swamp discharges to Little Sturgeon Bay discharges to Little Sturgeon Bay WWSF lower reaches (3) trout water upper reaches portions of creek ditched good to fair habitat abundant filamentous algae poor water quality (biotic index) v. sign. organic pollution (biotic index) high bacteria in runoff high sup solids & dis phosphorus Dissolved oxygen violations stream banks pastured seasonal fish run	intermittent drainage ditches discharge to Little Sturgeon Bay filamentous algae thick low dissolved oxygen fair habitat LFF classification seasonal fish run
PROBLEMS &/OR CAUSES IN STREAMS	stream channelized nutrients cause filamentous algae sign. nutrient, sediment, & bacteria runoff plant growth causes DO violations stream banks trampled degraded aguatic life habitat	ditches dry up significant nutrients cause algae growth and DO problems
STREAM POTENTIAL	<pre>improved aquatic life habitat: greater number & diversity of fish/invertebrates less plant growth less sedimentation no DO violations less organic loading</pre>	less plant growth with less nutrients significant DO more aquatic life habitat with continuous flow
POTENTIAL OF RECEIVING WATERBODY	less soft sediment and macrophyte growth in Little Sturgeon Bay with the reduction of nutrients and sediment	less soft sediment and macrophyte growth in Little Sturgeon Bay with the reduction of nutrients and sediment

(Table 1 continued)	UBWATERSHED
CYBEAN NAME	SUGAR CREEK
NDITION/OBSERVATIONS	wwFF classified stream upper reaches intermittent - marsh-like substrate lower reaches perennial - stable rubble substrate good to fair habitat good to fairly poor water quality (biotic index) some to significant organic pollution (biotic index) Dissolved oxygen good significant loading of nutrients, sediment, & bacteria during runoff stream floods turbid during runoff sections ditched feedlot runoff streambank pasturing - erosion seasonal fish run discharges to Green Bay
PROBLEMS &/OR CAUSES IN STREAMS	degraded aquatic life habitat channelized significant nutrient and sediment loading streambank pasturing - erosion stream floods feedlot runoff
STREAM POTENTIAL	improved aquatic life habitat: less sediment covering substrate less nutrient loading less bank erosion from cattle access less flooding of banks more numbers and diversity fish/invertebrate species
POTENTIAL OF RECEIVING WATERBODY	less nutrients and sediment in Green Bay

(Table 1 continued)

RENARD CREEK SUBWATERSHED

STREAM NAME	RENARD CREEK	UNNAMED TRIBUTARY (SILVER CREEK)
EXISTING CONDITION/OBSERVATIONS	upper reaches intermittent lower reaches perennial - WWFF classified fair to poor habitat macrophytes and filementous along thick	intermittent flow flashy filamentous algae thick
	macrophytes and filamentous algae thick very good to poor water quality (biotic index) possible slight to very sign. organic pollution good dissolved oxygen and temperature high nutrient, bacteria, and suspended solids runoff turbid runoff	poor habitat seasonal fish run
	bank erosion from cattle access discharges to Green Bay	
PROBLEMS &/OR CAUSES IN STREAMS	degraded aquatic life habitat sediment erosion from streambank pasturing high nutrient, sediment, and bacteria runoff thick plant growth silted substrate	high nutrient loading tributary dries up banks flood thick algae growth
STREAM POTENTIAL	<pre>improved aquatic life habitat: less nutrient and sediment loading less erosion from cattle less plant growth more numbers and diversity of fish/invertebrates</pre>	more aquatic habitat with continuous flow less algae growth less flooding
POTENTIAL OF RECEIVING WATERBODY	less nutrient and sediments Green Bay	less nutrient and sediment in Green Bay

FABRY CREEK SUBWATERSHED

UNNAMED TRIBUTARY (FABRY CREEK)
intermittent flow
fair habitat stranded minnows in pools
turbid water
dissolved oxygen good
LFF classified
discharges to Green Bay
seasonal fish run
creek dries up
more aquatic life habitat with continuous flow
ess nutrient and sediment in Green Bay
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(Table 1 continued)	RED RIVER SUBWATERSHED	
STREAM NAME	RED RIVER	MACCO CREEK
EXISTING CONDITION/OBSERVATIONS	LFF classification upper reaches fair habitat intermittent flow turbid runoff from clay soils high suspended solids/phosphorus during runoff runs through Duvall swamp seasonal fish run discharges to Green Bay	LFF classified intermittent drainage ditch forem Bay shore line erosion fair habitat discharges to Green Bay seasonal fish run
PROBLEMS &/OR CAUSES IN STREAMS	river dries up in upper reaches high suspended sediments and phosphorus	creek dries up streambank erosion
STREAM POTENTIAL	more aquatic life habitat with continuous flow	more aquatic life habitat with continuous flow
POTENTIAL OF RECEIVING WATERBODY	less sediment/nutrients in Green Bay	less sediment/nutrients in Green Bay

GILSON CREEK SUBWATERSHED

CTDEAN MANE	BADER CREEK	GILSON CREEK
EXISTING CONDITION/OBSERVATIONS	WWFF classified intermittent flow fair to poor habitat seasonal fish rom clay soils stream bank erosion stable substrate discharges to Green Bay	WWFF classified below escarpment fair habitat good to fairly poor water quality (biotic index) some to sign. organic pollution (biotic index) bedrock substrate above escarpment low nutrient loading during runoff high bacteria numbers during runoff drains wetlands intermittent flow moss growth on bedrock discharges to Green Bay discolved oxygen good upstream ponds may hold brook trout sump pump discharge may influence temp. & flow
PROBLEMS &/OR CAUSES IN STREAMS	intermittent flow ' high suspended solids during runoff sediment from stream bank flooding	escarpment prevents fish movement intermittent flow high bacteria counts
STREAM POTENTIAL .	less suspended solids more aquatic life habitat with continuous flow less sediment from bank erosion	lower bacteria counts more aquatic life habitat with continuous flow
POTENTIAL OF RECEIVING WATERBOOY	less sediment loading to Green Bay	less bacteria counts near Green Bay shore
Communities.) IFF - limited forage fish communities; (3) WWSF - warm water sport fish communities	warm water sport fish communities

Keyes	Gilson	Sugar	Renard	Larson	Date: 3/8/93	Gilson	Unnamed Trib, #11	Keyes	Sugar	Renard	Date: 11/2/92	Keyes	Sugar	Renard	Date: 9/16/92	Location	Table 2.
	1 5.4	46.5	1 15.8	6.3		8.2	3.3	9.9	17.3	5.0	12	2.9	1.1	0.3	12	lon Flow	2.
5.5	1.4	5 7.2	8.5	7.2		4.5	1.8	2.6	3 4.6	3.2		1.6	1.5	2.2		mg/1	
	40.8	1,804.6	723.9	244.5		198.9	32.0	138.7	428.9	86.2		25.0	8.9	3.6		BOD _s 1bs/day	
0.339	0.159	0.649+	0.86+	0.227		0.016	0.025	0.033	0.077	0.325		0.031	0.039	0.038		Ammonia mg/l	
	4.63	162.66	73.24	7.71		0.71	0.44	1.76	7.18	8.76		0.48	0.23	0.06		Ammonia lbs/day	
0.585	3.68	0.876	1.78	1.2		1.51	0.481	0.275	1.44	2.72		0.033	0.764	2.92		Nitrate Nitrite-N mg/l	
	107.11	219.56	151.59	40.75		66.74	8.56	14.67	134.28	73.30		0.52	4.53	4.72		Nitrate Nitrite-N lbs/day	
1.7	1.0	2.4	3.3	2.5		1.5	1.1	1.6	2.6	4.0		1.0	0.7	1.0		Tot. Kjel-N mg/l	Red Prior
	29.1	601.5	281.0	84.9		66.1	19.6	85.4	242.0	107.8		15.8	4.0	1.6		Tot. Kjel-N lbs/day	Red River/Sturgeon Bay Priority Watershed Project Water Chemistry
0.26	0.08	0.34	0.47	0.3		0.10	0.02	0.19	0.54	1.11		0.068	0.136	0.083		Total Phos mg/l	turgeon rshed P nemistry
	2.33	85.22	40.03	10.19		4.42	0.36	10.14	50.35	29.91		1.06	0.81	0.13		Total Phos lbs/day	Bay roject
0.135+	0.043	0.17+	0.187+	0.026		0.0004	0.002	0.055	0.20+	0.68+		0.028	0.099	0.011		Diss Phos mg/l	
	1.3	42.6	15.9	0.88		0.02	0.04	2.93	18.65	18.33		0.44	0.59	0.02		Diss Phos lbs/day	·
6	2	17	57+	61+		20	4.0	52+	118+	74+	-	6.0	6.0	6.0		Sus Solids mg/l	
		4260	4454	2071		884	71.2	2774	11,003	1994		93.8	35.6	9.7	-	Sus Solids lbs/day	
												7.8	8.8	9.4		Diss O, mg/l	
												16.5	17.5	16.2		Temp °C	
1600	60	110	1200	100		11,000+	1000	2100	66,000+	33,000+		11,400+	370	480		MFFCC Colonies/ 100 ml	
1800	510	920	2500	1700		1600	2400	30,000+	140,000+	220,000+		6800+		240		Fecal Strep Colonies/ 100 ml	

Table 2 continued	ntinu	pa																	
Location Flow cfs	1	BODs mg/l	BOD ₅ Anxnol lbs/day mg/1	nia	Ammonia Nitrate 1bs/day Nitrite mg/l	×	Nitrate Nitrite-N 1bs/day	Tot. Kjel-N mg/l	Tot. Kjel-N lbs/day	Total Phos mg/l	Total Diss Phos Phos 1bs/day mg/l		Diss Phos 1bs/day	Sus Solids ng/l	Sus Diss Solids O, lbs/day mg/l	Diss O, mg/l	Temp	MFFCC Colonies/ 100 ml	Fecal Strep Colonies/ 100 ml
Date: 6/14/93														·					
Gilson	52.1	1.4	393.2	950.0	15.73	0.507	142.38	1.4	393.1	0.11	30.89	0.066	18.5	10	2808	6.2	19		
Red	31.7	2.3	393.0	0.105	17.94	1.58	269.96	1.9	324.6	0.25	42.72	0.132+	22.67	45+	7176	7.8	21		
Renard	43.5	0.4	937.9	790.0	15.01	1.12	262.60	1.8	422.0	0.45	105.51	0.2+	46.9	108+	25,322	7.2	19		
Sugar	62	3.2	1,069.4 0.053	0.053	17.71	1.37	457.83	1.2	401.0	0.25	83.55	0.113+	37.8	88+	29,407	7.5	19		
Keyes	32.6	1.4	246.0	0.025	4.39	0.149	26.18	1.1	193.3	0.06	10.54	0.018	3.2	12	2108	4.8*	20		
Date: 7/6/93																			
Keyes				0.034		90.0		1.0								5.2	21.2		
Unnamed Trib. #18				0.039		960.0		1.1								9.9	21.8		
Unnamed Trib. #27				0.034		0.04		1.1								4.7*	20.3		

⁺ Significantly elevated concentrations.

* Dissolved oxygen concentration violation.

* Dissolved oxygen concentration violation.

#11 Unnamed Tributary to Sturgeon Bay Canal on Tacoma Beach Ave (TZ7N RZ6E S16 NESW).

#18 Unnamed Tributary (Malvitz Creek) on CTH "C" between Squaw Road and Stevensons Pier Road (TZ7N RZ4E S11 NESW).

#27 Unnamed Tributary (Twin Harbor Creek) on CTH "CC" (TZ7N RZ4E S10 SENW).

Note: All sampled collected during rain or snowmelt runoff.

Water Resources Objectives

The following water resource management objectives are recommended for the Strawberry Creek subwatershed:

- A. Maintain and improve water quality and aquatic life in the streams by improving overall habitat conditions by:
 - * reducing sedimentation rates by a high level
 - * reducing nutrient/phosphorus loading by a high level to reduce macrophyte growth
 - * enhancing existing or degraded wetlands which act as filtering areas, protect the stream channel, and help maintain stream base flow.
- B. Decrease soft sediment build-up and nuisance macrophyte growth in Sturgeon Bay waters by reducing sediment and nutrient loading from streams, direct drainage, and urban runoff.
- C. Reduce nutrients, suspended solids, and toxic compounds in urban stormwater runoff to the waters of Sturgeon Bay.

STURGEON BAY SUBWATERSHED

<u>Sameulson Creek</u> is the only major tributary in the Sturgeon Bay subwatershed. Sameulson Creek is a flashy intermittent limited forage fish classified tributary that flows mostly through an urban area before discharging to Sturgeon Bay. This stream received a fair aquatic life habitat rating. The rocky bottom substrate is completely covered with filamentous algae and periphyton.

The tributaries in this subwatershed are limited by minimal stream flow, dense algae growth, and probable heavy urban stormwater runoff. Sturgeon Bay is limited by soft sediment build-up and nuisance macrophyte growth.

Water Resources Objectives

The following water resource management objectives are recommended for the Sturgeon Bay subwatershed:

- A. Maintain and improve water quality and aquatic life in the streams by improving overall habitat conditions by:
 - * reducing sedimentation rates by a high level
 - * reducing nutrient/phosphorus loading by a high level to reduce macrophyte growth
 - * enhancing existing or degraded wetlands which act as filtering areas, protect the stream channel, and help maintain stream base flow.
- B. Decrease soft sediment build-up and nuisance macrophyte growth in Sturgeon Bay waters by reducing sediment and nutrient loading from streams, direct drainage, and urban runoff.
- C. Reduce toxic compounds in urban stormwater runoff to the waters of Sturgeon Bay.
- D. Develop an aquatic plant management plan for waters of Sturgeon Bay to identify sensitive areas for aquatic life and high value plants.

LARSON CREEK SUBWATERSHED

Larson Creek and May swamp are intermittent streams that drain to Sand Bay. Lost Creek drains to Sawyer Harbor.

<u>Larson Creek</u> receives a considerable amount of sediment indicated by the turbid water during rain events and the high concentration of suspended sediments on March 3, 1993 during snow melt. This stream is classified as a warm water forage fishery. Aquatic life habitat was ranked as fair. Larson Creek originates in Cunningham swamp and flows through pastures, feedlots, and Larson Swamp before discharging to Sand bay. Silt covers much of the creek bed.

May Swamp Creek is a three mile long limited forage fish classified creek that flows through a cedar swamp. Aquatic life habitat was ranked as fair. Filamentous algae is abundant on the hard substrate and silt and soft sediment cover most of the creek bed. At 17.5 °C, dissolved oxygen was 7.3 mg/l. Fish use the creek for spring spawning runs.

<u>Lost Creek</u> is also an intermittent limited forage fish classified stream. A local golf course may be contributing nutrients to this creek during runoff events.

Surface runoff from a landfill near here may possibly be contributing a significant amount of sediment to Sawyer Harbor.

The creeks in this subwatershed are limited by minimal stream flow, dense algae growth, sedimentation from stream bank erosion caused by cattle access and possibly erosion from the landfill, nutrients from barnyard/feedlot runoff and the possibly the golf course, and silt load from wetland drainage. Sawyer Harbor is limited by soft sediment build-up and nuisance macrophyte growth.

Water Resources Objectives

The following water resource management objectives are recommended for the Larson Creek subwatershed:

- A. Maintain and improve water quality and aquatic life in the streams and Sawyer Harbor by improving overall habitat conditions by:
 - * reducing sedimentation rates by a high level
 - * reducing nutrient/phosphorus loading by a high level to reduce macrophyte growth
 - * enhancing existing or degraded wetlands which act as a filtering area, protect the stream channel, and help maintain stream base flow
 - reducing streambank erosion.
- B. Decrease soft sediment build-up and nuisance macrophyte growth in Sawyer Harbor waters by reducing sediment and nutrient loading from streams and direct drainage.
- C. Reduce nutrient loading from golf course.

KEYES CREEK SUBWATERSHED

Keyes Creek subwatershed consist of Keyes Creek and three Unnamed (however, locally known as Krueger, Malvitz, and Twin Harbor creeks) Tributaries to Little Sturgeon Bay.

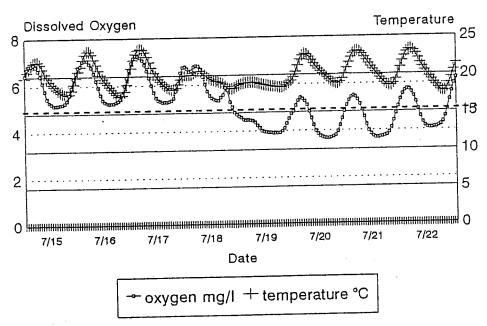
Keyes Creek is a seven mile long perennial stream which originates in springs, flows through the Gardner Swamp Wildlife Area before discharging into Little Sturgeon Bay. The lower reaches support a warm water sport fishery and forage fishery, while the upper reaches are a Class I and II trout stream. The stream was stocked with brook trout from 1956-1970, but a fish survey in

1976 found only forage fish. Portions of this creek have been ditched or are pastured. Aquatic life habitat evaluations ranged from good to fair. Filamentous algae is abundant on the rocky substrate near Pickerel Road. Macroinvertebrate samples at Pickerel Road received biotic index values of 7.53 and 7.60 which rates Keyes Creek as poor water quality with very significant organic pollution. Runoff samples collected on three occasions showed very high levels of bacteria present in this stream. Also, on one occasion, suspended solids concentrations were as high as 52 mg/l and dissolved phosphorus was at 1.135 mg/l.

Dissolved oxygen monitoring documented water quality standards violations in the summer of 1993 on several occasions (Figure 2). Dissolved oxygen dropped as low as 3.7 mg/l with regular diurnal oxygen and temperature swings.

Figure 2.

Keyes Creek
Dissolved Oxygen and Temperature
July 14 to 22, 1993



-- Line indicates 5 mg/l state standard oxygen level

The three <u>Unnamed Tributaries</u> (T27N, R24E, SEC11, NESW 'Malvitz Creek'; SEC10, SWNE 'Twin Harbor Creek'; SEC11, NENE 'Krueger Creek') to Little Sturgeon Bay are intermittent limited forage fish classified drainage ditches. Aquatic life habitat was ranked as fair. Filamentous algae is abundant on the rocky substrate; however, silt and sediment is not a problem in these creek beds. A dissolved oxygen reading of 4.7 mg/l on July 6, 1993 was below the state standard of 5 mg/l.

The tributaries in this subwatershed are limited by sedimentation, minimal stream flow, nutrients which cause dense algae and plant growth, erosion from streambank pasturing, lack of quality instream aquatic life habitat due to stream channelization, and low dissolved oxygen levels caused by excessive plant growth. Little Sturgeon Bay is limited by soft sediment build-up and nuisance macrophyte growth.

Water Resources Objectives

The following water resource management objectives are recommended for the Keyes Creek subwatershed:

- A. Maintain and improve water quality and aquatic life in the streams and Little Sturgeon Bay by improving overall habitat conditions by:
 - * reducing sedimentation by a high level
 - * reducing nutrient/phosphorus loading by a high level to reduce macrophyte growth
 - * enhancing existing or degraded wetland which act as filtering area, protect the stream channel, and help maintain stream base flow
 - * reducing streambank erosion.
- B. Decrease soft sediment build-up and nuisance macrophyte growth in Little Sturgeon Bay waters by reducing sediment and nutrient loading from streams and direct drainage.

SUGAR CREEK SUBWATERSHED

Sugar Creek is the only major tributary in this subwatershed. It is a nine mile long warm water forage fishery classified stream that drains to Green Bay. The upper reaches of Sugar Creek flow intermittently and are rather marsh like, whereas, the lower reaches flows continuously and have more of a stable rubble substrate. Habitat evaluations ranged from good to fair aquatic life habitat. Macroinvertebrate samples at Sugar Creek County Park received biotic index values of 6.26 and 6.74 which rates this portion of Sugar Creek as fair and fairly poor water quality with fairly significant to significant organic pollution. At Lovers Lane, macroinvertebrates received values of 5.42 and 6.12 which rates this portion of Sugar Creek as good and fair water quality with some to fairly significant organic pollution.

Dissolved oxygen monitoring for a seventeen day period in the summer of 1993 and several grab samples did not reveal any dissolved oxygen violations in this creek even during significant runoff events. Sugar creek receives a considerable amount of nutrients, sediment and bacteria indicated by water samples collected on three different occasions. Suspended solids were high on two occasions, dissolved phosphorus on three occasions, and bacteria on one occasion during runoff. Sugar Creek is subject to flooding and becomes very turbid and muddy during runoff events. Sections of the creek have been ditched, are pastured, or have feedlots next to the creek.

The creeks in this subwatershed are limited by nutrient loading from feedlot runoff, sediment erosion from streambank pasturing, and lack of quality instream habitat due to channelization, sedimentation, and flooding.

Water Resources Objectives

The following water resource management objectives are recommended for the Sugar Creek subwatershed:

- A. Maintain and improve water quality and aquatic life in the streams and the stream mouth by improving overall habitat conditions by:
 - * reducing sedimentation by a high level
 - * reducing nutrient/phosphorus loading by a high level to reduce macrophyte growth
 - * enhancing existing or degraded wetland which act as filtering area, protect the stream channel, and help maintain stream base flow
 - * reducing streambank erosion.

RENARD CREEK SUBWATERSHED

Renard Creek subwatershed consist of Renard Creek and an Unnamed Tributary - locally known as Silver Creek (T26N, R23E, SEC16, NENE) that both drain directly to Green Bay.

The lower reaches of Renard Creek is classified as a warm water forage fishery. The upper reaches are intermittent and flood easily. Habitat evaluations ranked this stream as fair to poor aquatic life habitat. Macrophytes and filamentous algae are extremely dense in some locations. Macroinvertebrate samples at Pleasant Ridge Road received biotic index values of 6.66 and 4.35 which rates this portion of Renard Creek as fairly poor to very good water quality with significant to possible slight organic pollution. At Shoemaker Road, macroinvertebrates received values of 7.50 and 7.56 which rates this portion of Renard Creek as fairly poor to poor water quality with significant to very significant organic pollution. Two weeks of continuous dissolved oxygen and temperature monitoring and several grab samples did not document any oxygen or temperature violations in Renard Creek; however, huge drifting mats of filamentous algae blanketed the monitoring equipment and thus, may have given false data. Chemistry samples taken during three different runoff periods show high concentrations of dissolved phosphorus, bacteria, and suspended solids. Also the turbid, muddy waters during these events indicate high sediment loads. Cattle access has contributed to excessive streambank erosion on this creek.

The <u>Unnamed Tributary</u> (Silver Creek) is a flashy intermittent stream. Filamentous algae covers the sparse rocky substrate. Aquatic life habitat was ranked as poor.

The tributaries in this subwatershed are limited by sediment erosion from streambank pasturing, minimal stream flow, lack of quality instream aquatic life habitat, high nutrient, bacteria, and sediment loading, excessive macrophyte and algae growth, flooding, and sedimentation.

Water Resources Objectives

The following water resource management objectives are recommended for the Renard Creek subwatershed:

- A. Maintain and improve water quality and aquatic life in the streams and stream mouth by improving overall habitat conditions by:
 - * reducing sedimentation by a high level
 - * reducing nutrient/phosphorus loading by a high level to reduce macrophyte growth
 - * enhancing existing or degraded wetland which act as filtering area, protect the stream channel, and help maintain stream base flow
 - * reducing streambank erosion.

FABRY CREEK SUBWATERSHED

The most significant stream in the Fabry Creek subwatershed is an <u>Unnamed Tributary</u> (T26N R23E, SEC28, NWNW - locally known as Fabry Creek) that drains to Green Bay. This is a small, high gradient limited forage fish classified intermittent tributary. A habitat evaluation ranked this stream as fair. Pools in the stream contained hundreds of stranded minnows. The water was turbid but dissolved oxygen was 7.0 mg/l. Sediment has accumulated in the lower reaches of Fabry Creek.

The tributaries in this subwatershed are limited by minimal stream flows and soft sediment build-up near the creek mouth.

Water Resources Objectives

The following water resource management objectives are recommended for the Fabry Creek subwatershed:

- A. Maintain and improve water quality and aquatic life in the streams and stream mouth by improving overall habitat conditions by:
 - * reducing sedimentation by a high level
 - * reducing nutrient/phosphorus loading by a high level to reduce macrophyte growth
 - * enhancing existing or degraded wetland which act as filtering area, protect the stream channel, and help maintain stream base flow.

RED RIVER SUBWATERSHED

Red River subwatershed consists of Red River and Macco Creeks.

Red River is classified as a limited forage fishery that discharges to Green Bay. Since the Red River is intermittent, it precludes the development of a fishery during most of the year. In the lower reaches, spring smelting and sucker spearing are common. Aquatic life habitat evaluations ranked this stream as fair. The stream bed is mostly rock and rubble and other stable substrate with very little silt and sediment deposition. Red River flows through Duvall Swamp. The clay soils in this area make the water very turbid with high suspended solids concentrations during runoff events. Dissolved phosphorus was also high during runoff. Dissolved oxygen concentrations appear adequate.

<u>Macco Creek</u> is a high gradient limited forage fish classified intermittent drainage ditch to Green Bay. A habitat evaluation ranked this stream as fair aquatic life habitat. Bank erosion is significant along this creek.

The tributaries in this subwatershed are limited by minimal stream flow, high suspended sediment and phosphorus during runoff events, and streambank erosion.

Water Resources Objectives

The following water resource management objectives are recommended for the Red River subwatershed:

- A. Maintain and improve water quality and aquatic life in the streams and stream mouth by improving overall habitat conditions by:
 - * reducing sedimentation by a high level
 - * reducing nutrient/phosphorus loading by a high level to reduce macrophyte growth
 - * enhancing existing or degraded wetland which act as filtering area and/or protect the stream channel
 - * reduce streambank erosion.

GILSON CREEK SUBWATERSHED

Gilson Creek subwatershed consist of Bader and Gilson Creek. Both creeks are intermittent tributaries which drain directly to Green Bay.

Bader Creek is classified as a warm water forage fishery in its lower reaches. Spring spawning runs of white suckers and smelt use the stream. Aquatic life habitat evaluations ranked the stream as fair to poor. The stream bed is mostly rubble and other stable habitat. During runoff events, the clay soils easily become suspended and cause turbid water. Stream bank erosion is common at some locations. Dissolved oxygen levels appear to be adequate.

The lower 0.25 miles of Gilson Creek below the escarpment is classified as a warm water forage fishery. Spring ponds in the upper reaches may support brook trout. The creek flows through a wetland area. Habitat evaluations ranked the stream as fair aquatic life habitat. Macroinvertebrate samples at Shore Acres received biotic index values of 6.86 and 4.57 which rates Gilson Creek as fairly poor to good water quality with significant to some organic pollution. Immediately above the escarpment, the stream substrate is bedrock which becomes completely covered with Byrophyta - a leafy moss. Nutrient loadings during rain events appear to be relatively low, however bacteria levels on one occasion was high. Dissolved oxygen and temperature levels also appear to be adequate. Future development in the area may influence water temperature and flows if not carefully planned.

The creeks in this subwatershed are limited by streambank erosion caused by flooding, high sediment solids and bacteria during runoff events, and minimal stream flows, and fish movement inhibited by the escarpment.

Water Resources Objectives

The following water resource management objectives are recommended for the Gilson Creek subwatershed:

- A. Maintain and improve water quality and aquatic life in the streams and stream mouth by improving overall habitat conditions by:
 - * reducing sedimentation by a high level
 - * reducing nutrient/phosphorus loading by a high level to reduce macrophyte growth
 - * enhancing existing or degraded wetland which act as filtering area, protect the stream channel, and help maintain stream base flow
 - * reduce streambank erosion.

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