Appendix D
Aquatic Environment

APPENDIX D
AQUATIC ENVIRONMENT

1.1 INTRODUCTION

The receiving water for effluent from the upgraded Neepawa IWWTF will be the Whitemud River, which flows into Lake Manitoba approximately 190 km downstream of the Town of Neepawa. The river receives municipal effluents from various communities along it, the largest of which is the Town of Neepawa. Since approximately 1986, effluent from the hog processing plant has been discharged to the Whitemud River via the Town of Neepawa IWWTF, although these effluents have been routed through Cell #3 of the Neepawa municipal lagoon system since 2001.

This appendix provides a description of existing environmental conditions in the Whitemud River and the analyses undertaken to support assessment of potential impacts of the IWWTF upgrade project. Information has been compiled from existing literature, datasets obtained from the Province of Manitoba and Water Survey of Canada, and field studies conducted in 2007 as part this environmental assessment.

1.2 PHYSICAL ENVIRONMENT

The Whitemud River watershed encompasses a total area of about 7,500 km2 (AAFC-PFRA 2005). Approximately 1,200 km2 of this area lies upstream of Neepawa, primarily consisting of the Boggy Creek, Brookdale Drain, Franklin Creek, and Stony Creek drainage. Downstream of the Town of Neepawa, additional drainage from approximately 6,300 km^2 enters the Whitemud River via Spring, Pine, Squirrel, and Rat Creeks, Big Grass Marsh Drain, and numerous smaller tributaries, before the river flows into Lake Manitoba approximately 15 km north of the community of Westbourne. The majority of this assessment focuses on the general portion of the river between the Towns of Neepawa and Gladstone, at which point the river has an upstream drainage basin area of approximately 2,010 km^2, including the 1,200 km^2 upstream of the Town of Neepawa.

The major impoundments in the watershed are Lake Irwin, which is the water source for the Town of Neepawa, and Park Lake, a small recreational lake formed by a weir on Stony Creek just south of the Town of Neepawa. Prior to construction of the Lake Irwin dam in 1959, the Whitemud River was deemed to have started at the confluence of Stony Creek and Boggy Creek. Often now, literature refers to the origin of the river to be the Lake Irwin dam, although in fact the short 2-km channel from the dam to the intersection with Stony Creek is actually Boggy Creek, although several sections have been re-routed from the original channel as part of the construction of the dam.

Elevation within the watershed ranges from 720 metres above sea level (m.a.s.l.), where Stony Creek has its headwaters in the Riding Mountains, down to 246 m.a.s.l. where the Whitemud River empties into Lake Manitoba. Most of the change in elevation occurs where the Stony

Creek descends from the Riding Mountains, with a more gradual decrease in elevation heading east through the watershed. In the Town of Neepawa, elevation of the river is approximately 356 m.a.s.l.

Agricultural development has altered the upland and riparian vegetation along the majority of the Whitemud River through clearing and soil disturbance associated with crop production, haying, and pasture operations. Although treed buffers between the river and adjacent agricultural lands are present along large portions of the reach downstream of the Town of Neepawa, buffers are thin or absent in some areas, and erosion of the channel and streambanks is evident in many areas (Photo 1). In particular, unrestricted access of cattle to the river has resulted in destabilization of the streambed and banks at numerous locations. Streambank restoration activities are currently administered by a number of agencies, with projects slated for a number of areas including the Whitemud River. Existing riparian conditions in the reach of the river downstream of the Town of Neepawa are presented in Figures 1A & 1B.

1.3 HYDROLOGY

The Whitemud River flows eastward to its junction with Lake Manitoba and forms part of the Nelson River drainage system. Throughout its run, there are several small dams and weirs, the largest being at Lake Irwin with another just downstream of the Town of Gladstone.

Two active Water Survey of Canada (WSC) hydrometric gauging stations are operated on the Whitemud River, located near Westbourne (WSC Gauge 05LL002, near lake Manitoba) and near Keyes (WSC Gauge 05LL005, approximately 75 km downstream of Neepawa). No active gauging system exists on the river near the Neepawa effluent outfalls. Therefore, flows in the reach of the river that receives effluent from the Neepawa municipal lagoons and the IWWTF must be estimated based on operation of the Lake Irwin Dam and historical data measured at WSC Gauges 05LL011 on Boggy Creek (between Lake Irwin and the Town of Neepawa) and 05LL009 on Stony Creek (approximately 7 km west of the Town of Neepawa). These stations operated from July 1960 to May 1994 and March 1959 to July 1993, respectively, only for the March through October period of each year. Flows in the Whitemud River at the Town of Neepawa for March-October, 1961-1992 can be calculated and used to generate statistical flow values using data from these two stations according to the following relationship:

$$Q_{NEEPAWA} = Q_{BOGGY} + \frac{(163+171)}{171} Q_{STONY}$$

where: $Q_{NEEPAWA}$ is the estimated flow in the Whitemud River at Neepawa;

Q_{BOGGY} is the measured flow in Boggy Creek (WSC Gauge 05LL011);

Q_{STONY} is the measured flow in Stony Creek (WSC Gauge 05LL009); and, (163+171)/171 is a correction factor to account for the drainage downstream in Stony Creek and Franklin Creek, which enters Stony Creek downstream of the gauging station. The ratio is based on the drainage areas upstream and downstream of the gauging station in km², estimated by manually tracing watershed boundaries using AutoCAD software and Shape files obtained from the Manitoba Lands Initiative database. The ratio assumes that the runoff hydrographs of Stony and Franklin Creeks are sufficiently similar to allow estimation of flows based on direct correlation with size of drainage basin. The relationship does not account for peak flow attenuation that may be provided by the Park Lake dam on Stony Creek in the Town of Neepawa.

Current operation of the Lake Irwin Dam (on Boggy Creek, just upstream of the Town of Neepawa) is based on a fixed release of 0.2 m³/s (7 cfs). During high water levels, additional flows occur over a fixed spillway, and releases can be increased slightly during dry periods to meet downstream demand (Buermeyer pers. comm. 2007; Laychuk pers. comm. 2008). Although it is believed that 0.2 m³/s represents a consistent base flow in the river, the historical dataset shows that lower flows occurred frequently during the period of record, as summarized in Table 1. Figure 2 shows that, from 1961-1992, flows in the Whitemud River at the Town of Neepawa (including estimated flows from Stony Creek) typically remained at a base flow close to 0.2 m³/s from July through March. However, flows frequently fell just below this base flow and, during summer (July – September inclusive) and late winter, flows were below 0.15 m³/s approximately 10-20% of the time. It is possible that flows since that time have been maintained at the higher base flow to ensure dilution of effluents from the IWWTF, but provincial records do not indicate a change in management strategy for the dam (Laychuk pers. comm. 2008). For the purposes of this assessment, it is assumed that 0.2 m³/s represents both the typical base flow and the minimum flow in the Whitemud River at the Town of Neepawa, but it should be noted that lower flows may occur during dry periods.

Table 1: Percentage of Days, 1961 - 1992 That Estimated Flows In The Whitemud River at Neepawa Were Less Than The Operationl Release of 0.2 m³/sec. From The Lake Irwin Dam

Month	Percent of Days Below 0.2 m³/s	Percent of Days Below 0.15 m³/s	Percent of Days Below 0.1 m³/s
March	19.96	7.26	2.12
April	4.69	0.73	0.00
May	10.18	2.12	0.50
June	22.19	6.04	0.94
July	43.75	20.67	7.46
August	48.49	19.86	9.48
September	45.63	15.83	6.77
October	38.41	18.15	2.12

1.4 WATER QUALITY

As is typical of most streams within agricultural Manitoba, the Whitemud River is susceptible to nutrient inputs from a variety of sources. These include non-point sources (runoff from fields and pastures) and point sources (wastewater discharges from communities).

At least 13 locations in the Whitemud River watershed have been used for water-quality sampling by the Province of Manitoba since 1990. These include five sampling stations on tributaries to the river, several stations that were used specifically for a watershed assessment in 1996-1998, and only two stations (near the river's downstream end at the community of Westbourne and on Boggy Creek below the Lake Irwin Dam) that are still being used for water quality monitoring. A summary of data from five water quality monitoring stations for the 1990-1992 period is provided in Attachment 1.

A water-quality assessment conducted in the summers of 1996 to 1998 showed that nutrient concentrations were particularly elevated in the middle reach of the river (between the Towns of Neepawa and Gladstone) and decreased along the river farther downstream (Hughes 1999), likely due to nutrient inputs at the Town of Neepawa and uptake by plants in the river channel. A trend analysis conducted by Jones and Armstrong (2001) indicated that loads of total phosphorus in the river did not increase over the period of record upstream of the Town of Neepawa, but did show a statistically significant increasing trend near the community of Westbourne, farther downstream. The study identified a trend of increasing total nitrogen loads at both locations (AAFC-PFRA 2005).

Nutrients in the Whitemud River ultimately contribute to nutrient loading to Lake Manitoba and Lake Winnipeg, which has been linked to excessive algal growth in the lakes. Within the river itself, nutrients are temporarily removed from the water column by plants and algae, although downstream transport of attenuated nutrients likely occurs as plants die off seasonally and during scouring flows in spring. Stimulation of plant growth in the river may lead to fluctuations in dissolved oxygen concentrations due to the production of oxygen through photosynthesis during the day and consumption of oxygen through respiration at night. Diel fluctuations in dissolved oxygen have not been assessed in the provincial water monitoring program, as samples are typically collected only during the day. However, a number of data suggest that dissolved oxygen in the river occasionally falls to well below saturation (Attachment 1). Dissolved oxygen concentrations in Manitoba rivers are often lowest in winter, when photosynthesis is minimal and ice cover prevents aeration. There have been some indications that winter flows in the Whitemud River may have the potential for lowered levels (~0.4 ppm) of dissolved oxygen, although no significant data exists to confirm this (Whitemud Conservation District, pers. comm. 2007).

Spatial variation in various water quality parameters can be seen in the attached summary tables. Unfortunately, discontinuation of monitoring at the provincial water quality monitoring stations in the Neepawa area has prevented comparison between stations after approximately 1992. However, trends in total nitrogen and phosphorus concentrations and loads near the upstream end, middle, and downstream end of the reach of the river from the Towns of Neepawa to Gladstone are provided in Figure 3 and Figure 4. For these comparisons, river discharge was determined from the relationship described in the Hydrology section above for the Town of Neepawa, and from data from WSC Gauge 05LL005 near the community of Keyes for the mid-reach and Gladstone areas. Figure 4 suggests that nutrient loads increased toward the downstream end of the reach between the early and late 1990s. These general increases are partly due to higher river flows, but may also reflect transport of nutrients accumulating in the river channel, including those discharged from the Neepawa IWWTF since 1986.

1.5 AQUATIC COMMUNITIES AND HABITAT

A survey of channel characteristics and morphology of the Whitemud River was undertaken in 2007 within the reach approximately 75 km downstream from the Town of Neepawa. The Whitemud River is a highly meandering river with a sinuosity (ratio of actual channel length/straight line distance) of 2.6. This is indicative of a river that is relatively low in flow velocity (low slope) or whose original channel has not been artificially straightened, but is in a natural condition. Meanders tend to develop over time as a result of deposition areas occurring within the river channel during times of flood. Materials tend to be deposited on the inside convex bend of the river channel, with the largest sized material, generally rocks and cobble, found at the upstream end of the meander. Over time, these deposits can form quite extensive "sand/gravel bars", or deposition areas on the river. Sand/gravel bars were of two types, namely point bars attached to the shore and extending into the channel (Photo 2), and midstream bars with the channel moving down each side of the deposit area. Small pools form on the outside convex bend which can provide significant depth to small rivers.

Over time, the meanders widen the river valley by lateral erosion, and when floods occur, tight meanders are cut off from the main stem of the river leaving oxbow lakes. These phenomena are readily visible in the Whitemud River, and cutoffs and oxbows provide off-channel habitat for those species that utilize ephemerally flooded zones for key life cycle functions (Photo 3).

Downstream of the Town of Neepawa, the majority of the Whitemud River channel is composed of fine substrata (clay, silt and fine sand), reflective of the soils through which the river flows. In numerous areas, fine sediments accumulate as soft deposits in low-velocity areas, but flows along most of the channel keep the bottom substrate at a firm level of compaction. In several locations, short riffles have developed, and provide good habitat for a variety of fish species that use flowing water over gravel/cobble for key life cycle functions such as spawning or feeding (Figure 5). At the time of assessment, water depth in the main channel was variable, ranging from just a few centimeters to over 2 meters in deeper pools. It is expected that the pools provide sufficient depth to provide over-wintering habitat to fish and other aquatic life.

River banks along the Whitemud River tend to be deeply incised, with an average height of at least 2 m above the water level during the summer period. Though floodplains and intermittent wetlands do exist along the river at some locations (Photo 4), during the spring, water levels usually are sufficient to flood oxbow areas and under extreme conditions overtop the banks and cause flooding.

Instream vegetation observed during field investigations in 2007 was patchy but extensive in some areas, dependent on bottom substrate and flow conditions. The main channel did not appear to develop extensive vegetative cover, but slower back eddies and channel margins reached as much as 80% cover from emergent plants.

The Whitemud River provides year-round habitat for a wide variety of fish, including species sought after for recreational fishing (Table 2). The importance of the upper reaches in terms of habitat to fish populations in Lake Manitoba is likely limited by instream barriers to fish passage, including the Gladstone Dam (Figure 6). Sediment loading and water quality deterioration due to anthropogenic effects have the potential to diminish habitat quality in the river, although severe restrictions to the river's habitat value are likely limited to low-flow conditions.

Table 2: Fish Species Believed to Inhabit the Whitemud River

Scientific Name	Common Name
Ameiuris nebulosis	Brown bullhead
Catostomus commersoni	White sucker
Culaea inconstans	Brook stickleback
Esox lucius	Northern pike
Etheostoma exile	Iowa darter
Etheostoma nigrum	Johnny darter
Hybognathus hankinsoni	Brassy minnow
Ichthyomyzon castaneus	Chestnut lamprey
Lota lota	Burbot
Luxilus cornutus	Common shiner
Margariscus margarita	Pearl dace
Moxostoma anisurum	Silver redhorse
Moxostoma macrolepidotum	Shorthead redhorse
Notropis atherinoides	Emerald shiner
Notropis dorsalis	Bigmouth shiner
Notropis heterolepis	Blacknose shiner
Notropis hudsonius	Spottail shiner
Notropis stramineus	Sand shiner
Noturus flavus	Stonecat
Perca flavescens	Yellow perch
Percina maculata	Blackside darter
Percopsis omiscomaycus	Trout-perch
Pimephales promelas	Fathead minnow
Pungitius pungitius	Ninespine stickleback
Rhinichthys atratulus	Blacknose dace
Rhinichthys cataractae	Longnose dace
Semotilus atromaculatus	Creek chub
Sanders vitreus	Walleye

Fish surveys in 2007 indicated the presence of northern pike, fathead minnows, white suckers, and emerald shiners within the channel (Photo 5). Northern pike were observed spawning in several areas of the Whitemud River, including in a small oxbow approximately 2 km downstream from the existing and proposed outfall. Follow up visits showed that the spawning had produced a successful hatch (Photo 6), although by that time water levels had declined to the point that return access to the river was becoming restricted due to dry conditions (Photo 7). No other species were observed spawning in the river, although excellent habitat for both sucker and walleye spawning was abundant.

Benthic invertebrates were sampled in August 2007 at depositional areas above, at, and below the expected location of the Neepawa IWWTF effluent outfall. Whereas the sampling program was not extensive enough to allow detailed analysis and comparison of invertebrate communities, results indicated that no obvious differences in abundance or species diversity existed between sites, which suggests that physicochemical conditions did not vary widely between locations upstream and downstream of the outfall location at the time of sampling. Data from the sampling program is presented in (Attachment 2).

REFERENCES

Agriculture and Agri-Food Canada – Prairie Farm Rehabilitation Administration, Prairies East Region. 2005. Summary of resources and land use issues related to riparian areas in the Whitemud River watershed study area. 70 pp.

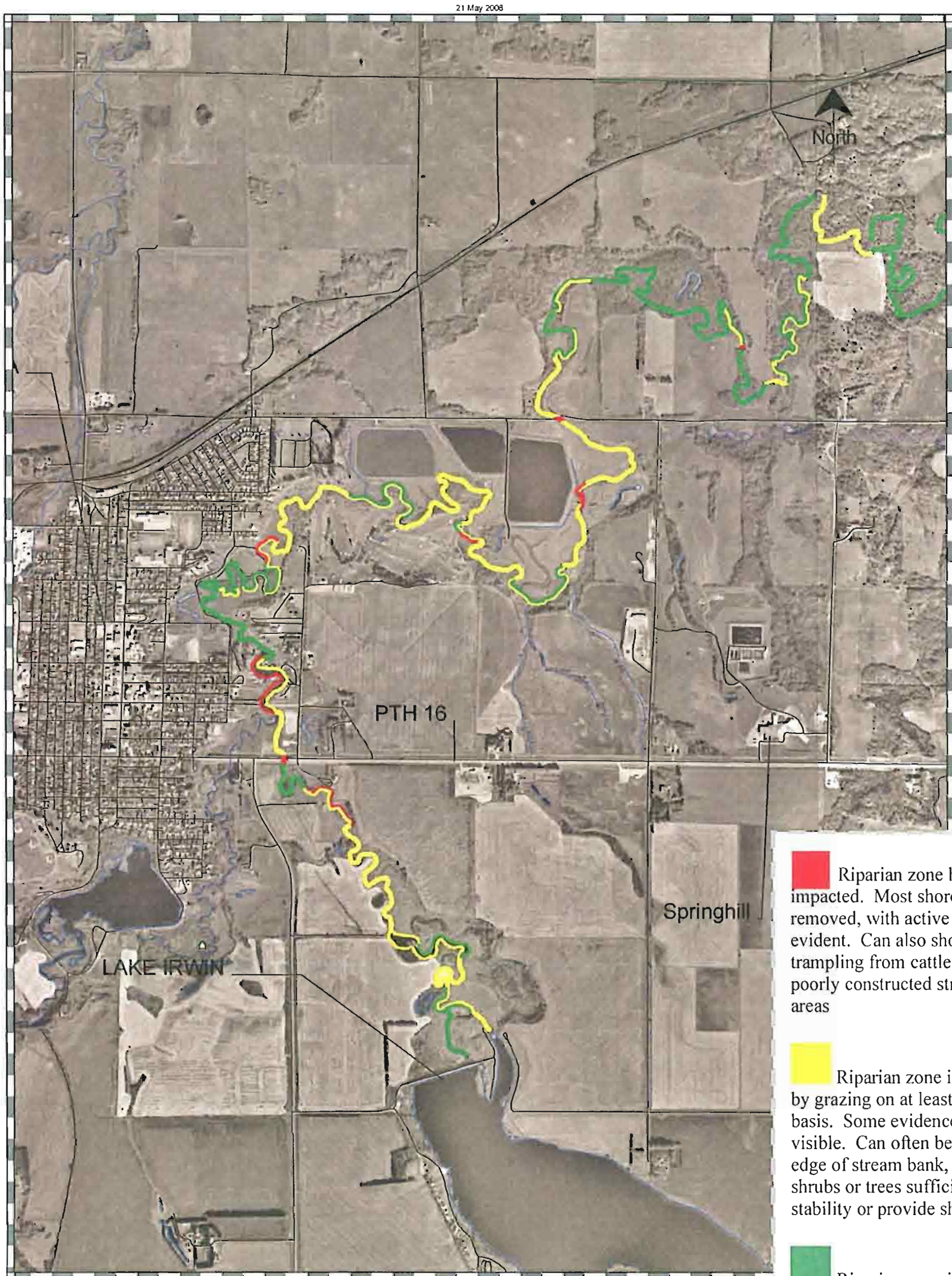
Buermeyer, J. 2007. Regional Engineer, Western Region (now retired), Manitoba Water Stewardship, Neepawa, Manitoba. Email to Alison Weiss, Earth Tech (Canada) Inc., Winnipeg, Manitoba, December 14 2007.

Hughes, C.E. 1999. Water quality assessment of the Whitemud River watershed, 1996 through 1998, Manitoba, Canada. Manitoba Conservation, Water Quality Management Section. Manitoba Environment Report No. 99-06.

Jones, G. and N. Armstrong. 2001. Long-term trends in total nitrogen and total phosphorus concentrations in Manitoba streams. Manitoba Conservation Report No. 2001-07. 154 pp.

Laychuk, D. 2008. Manitoba Water Stewardship. Phone conversation with Jay Toews, Earth Tech (Canada) Inc., Winnipeg, Manitoba, June 3.

Figure 1A
Riparian Evaluation Of Whitemud River

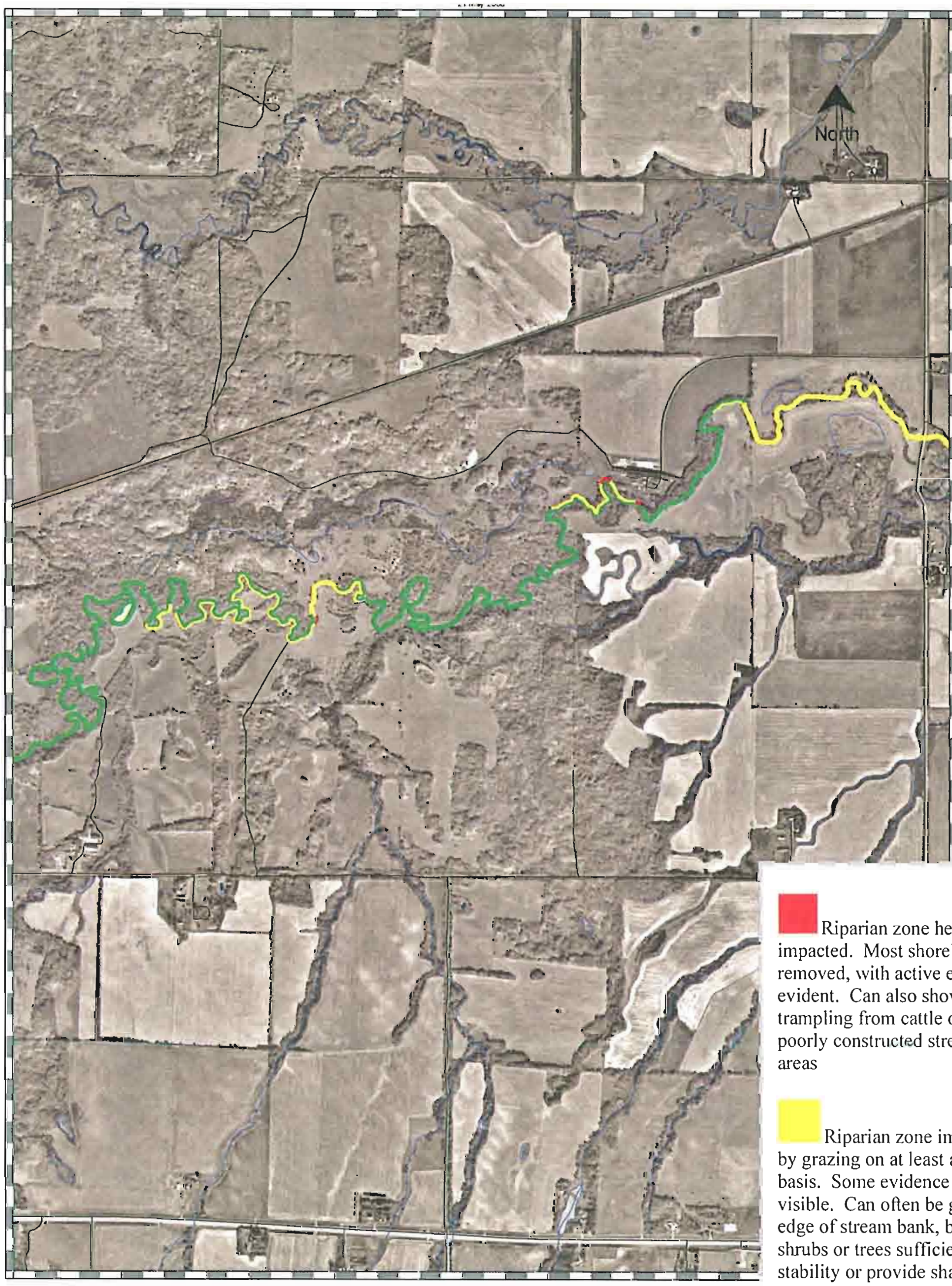


Riparian zone heavily impacted. Most shoreline vegetation removed, with active erosion evident. Can also show heavy trampling from cattle operations, or poorly constructed stream crossing areas

Riparian zone impacted, often by grazing on at least an occasional basis. Some evidence of erosion is visible. Can often be grassed to edge of stream bank, but seldom has shrubs or trees sufficient to add stability or provide shade.

Riparian zone is not impacted. Banks are fairly stable, although natural erosion is expected. Trees and shrubs provide shade to water course

Figure 1B
Riparian Evaluation Of Whitemud River



Riparian zone heavily impacted. Most shoreline vegetation removed, with active erosion evident. Can also show heavy trampling from cattle operations, or poorly constructed stream crossing areas

Riparian zone impacted, often by grazing on at least an occasional basis. Some evidence of erosion is visible. Can often be grassed to edge of stream bank, but seldom has shrubs or trees sufficient to add stability or provide shade.

Riparian zone is not impacted. Banks are fairly stable, although natural erosion is expected. Trees and shrubs provide shade to water course

Figure 2

Flows

Whitemud River @ Neepawa, 1961-1992

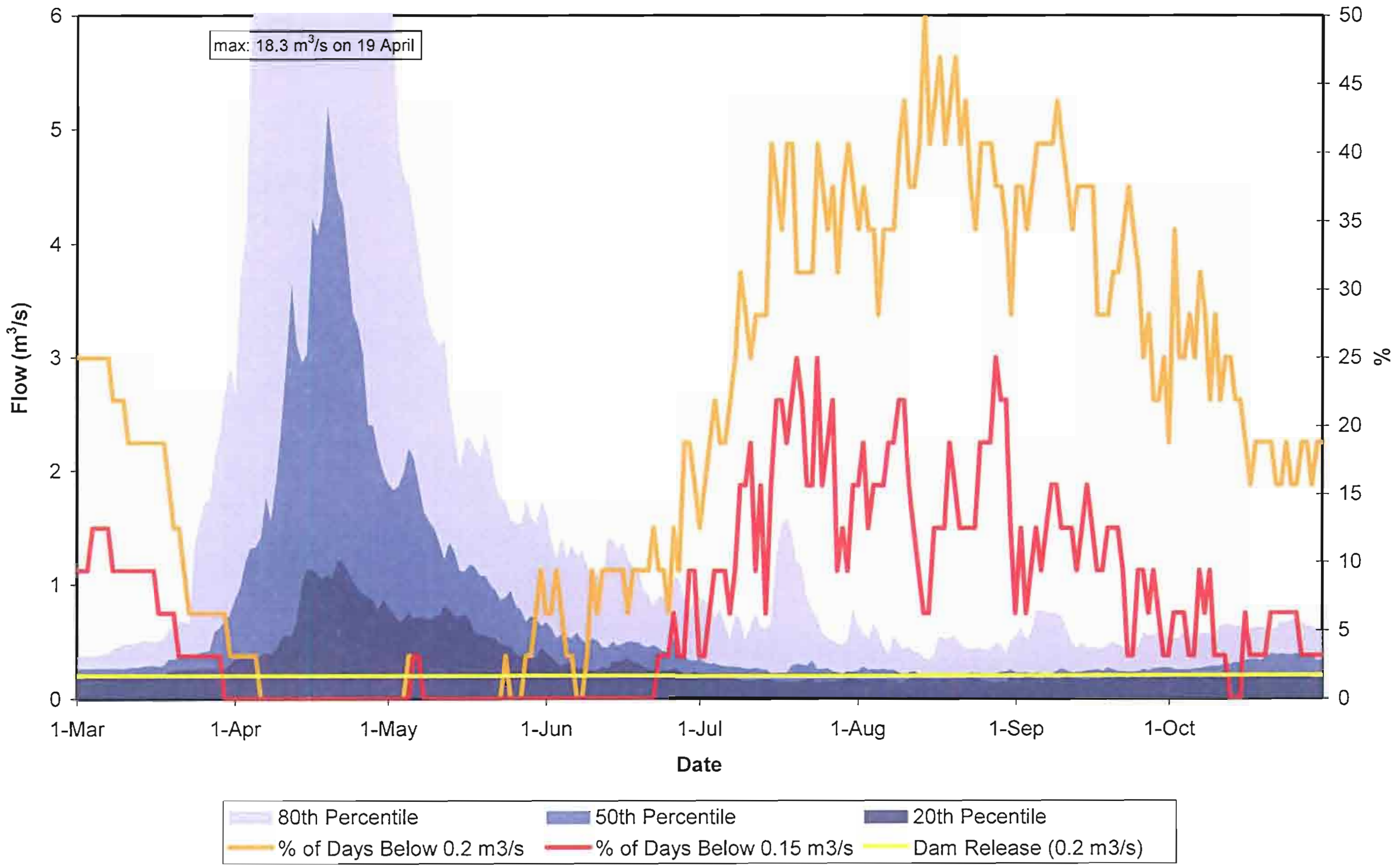
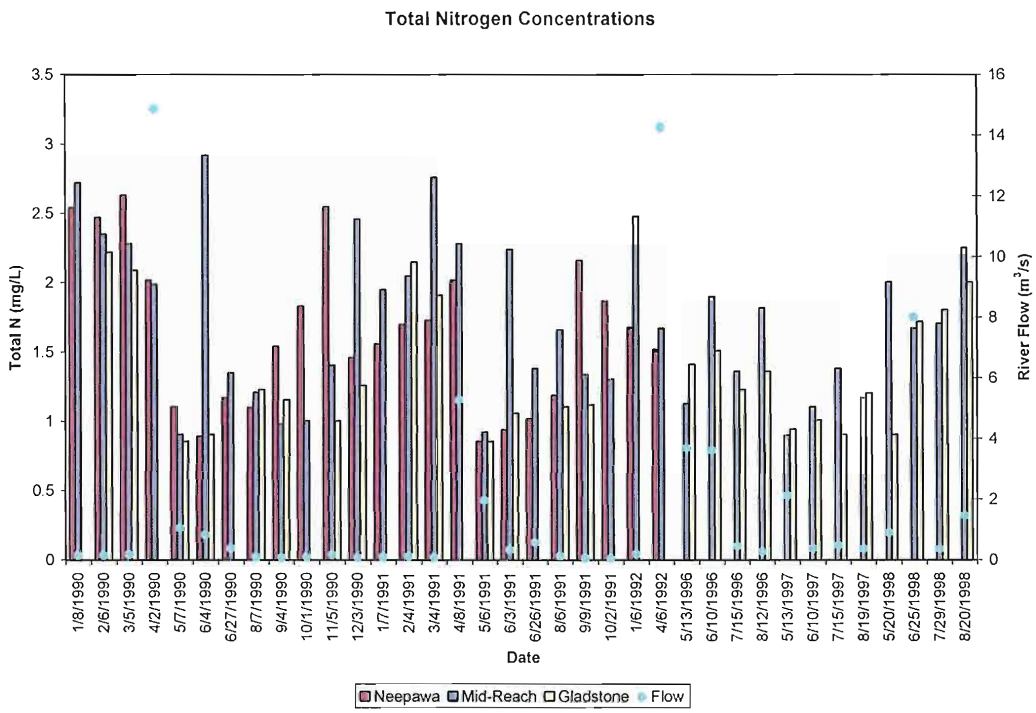


Figure 3

Whitemud Concentrations



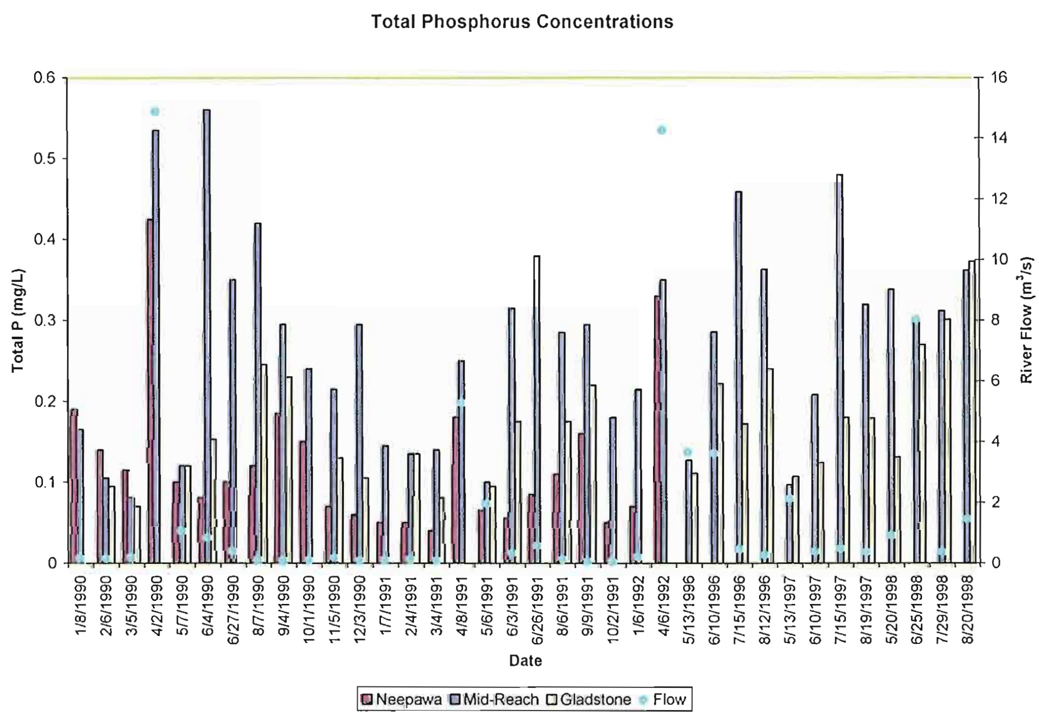
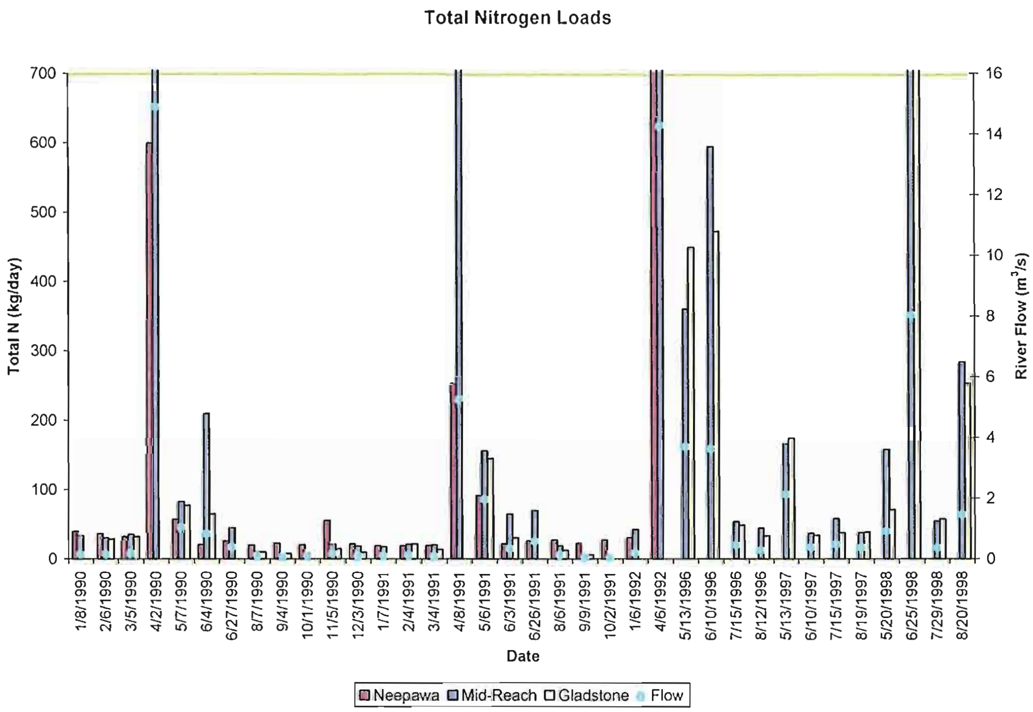


Figure 4
Whitemud Loads



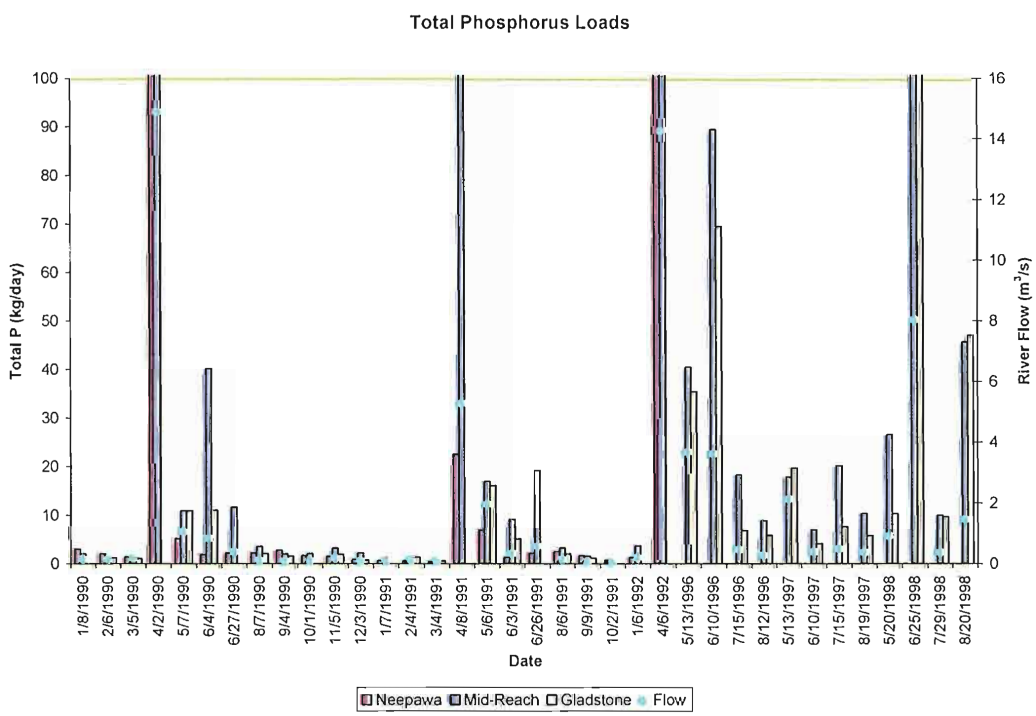


Figure 5

Spawning Locations

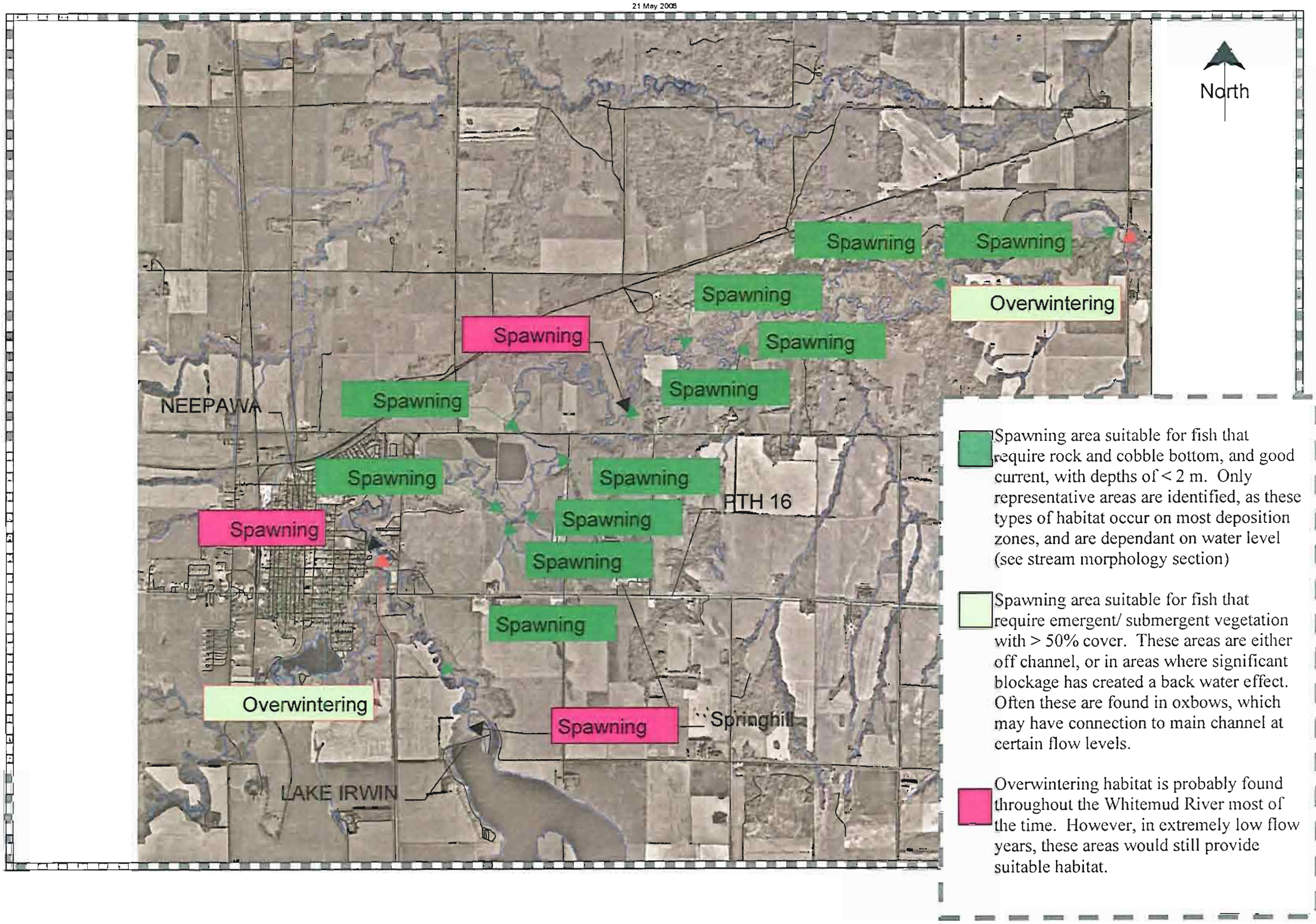


Figure 6

Blockages to Fish Passage

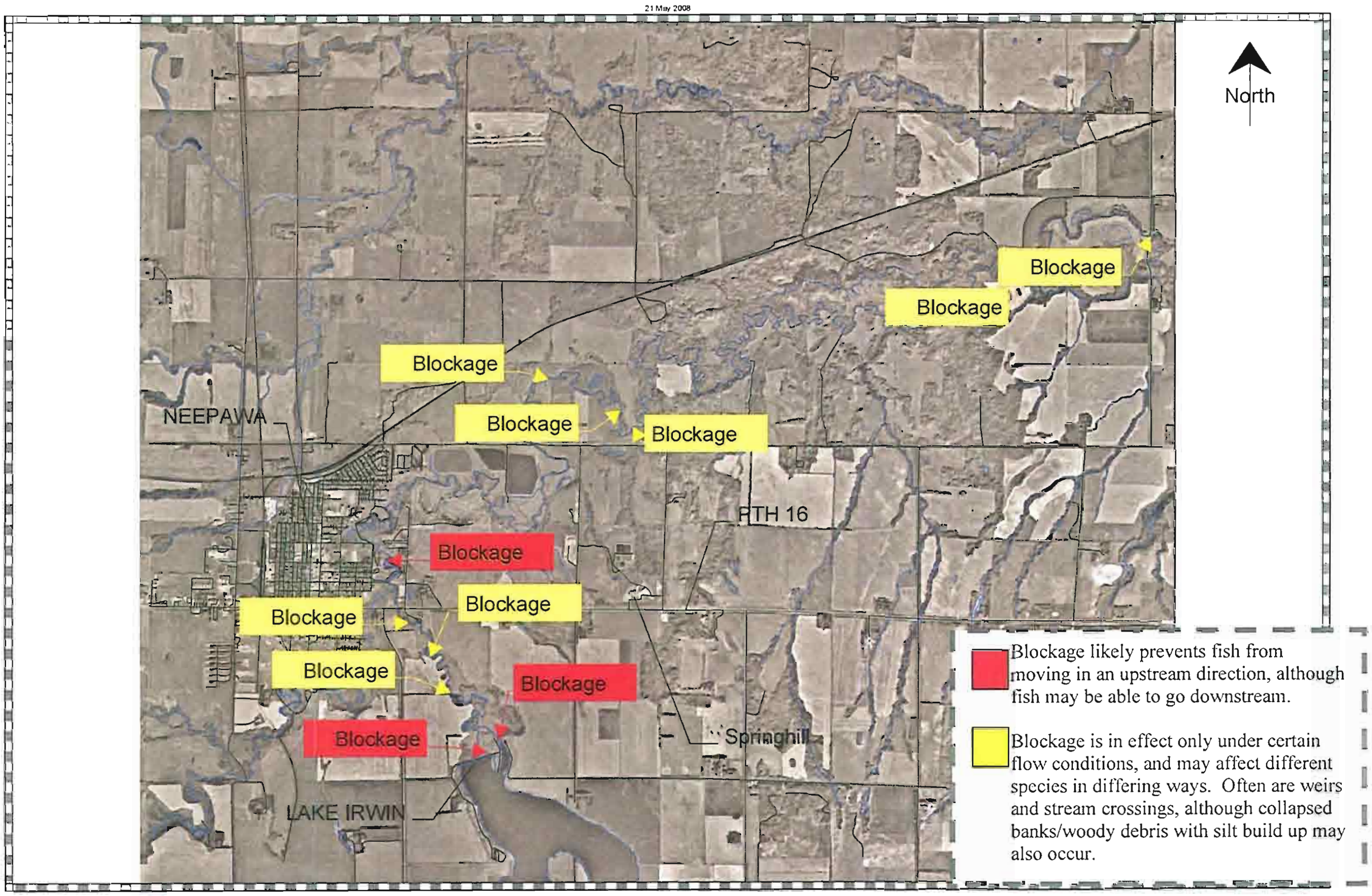


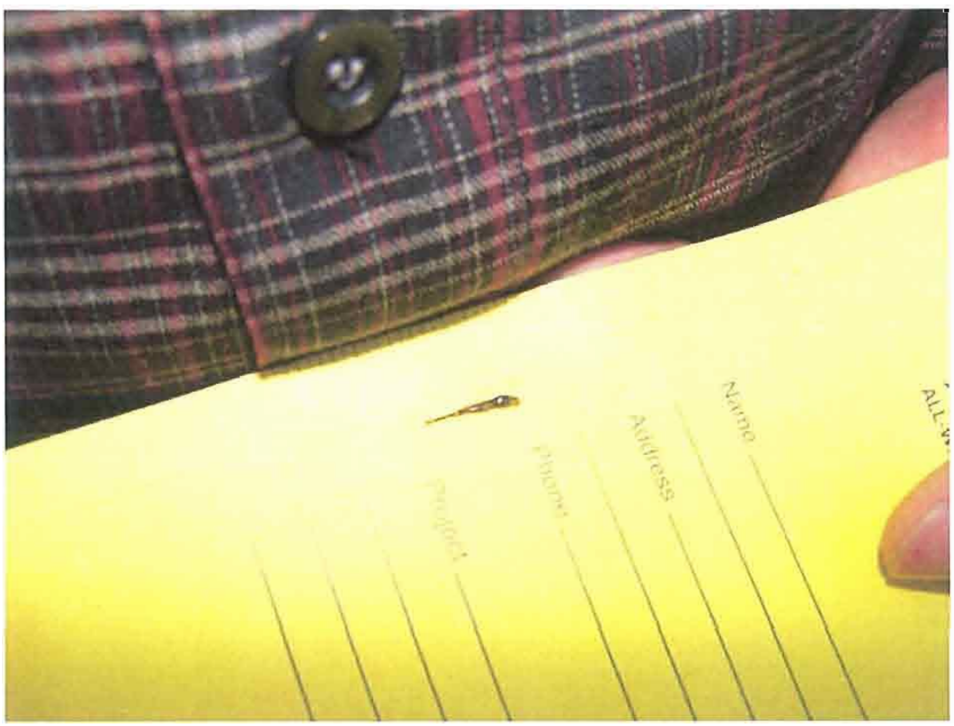
Photo 1: **Cleared riparian vegetation result in stream bank erosion along much of the Whitemud River.**

Photo 2: **Point bar on the inside of a bend on the Whitemud River near Neepewa.**

<u>Photo 3</u>: Off-channel wetland 2 km downstream from IWWTF outfall in early May, 2007.

<u>Photo 4</u>: Outlet of proposed IWWTF traverses this wetland adjacent to the Whitemud River (April 2007).

<u>Photo 5</u>: The shallow water supports several fish species.



<u>Photo 6</u>: Newly hatched northern pike fry captured in off channel habitat of the Whitemud River approximately 2 km downstream of IWWTF outfall, May 2007.

Photo 7: Shallow channel connecting off channel habitat to the Whitemud River, May 2007.

Attachment 1
Provincial Water Quality Data for the Whitemud River, 1990-1992

Attachment 1 - Summary Tables: Turbidity

	MB05LLS011		MB05LLS010		MB05LLS004		MB05LLS003		MB05LLS001	
	WHITEMUD RIVER DOWNSTREAM OF STONY CREEK (NEEPAWA)		WHITEMUD RIVER D/S SPRINGHILL FARMS EFFLUENT OUTFALL		WHITEMUD RIVER AT PTH 16, WEST OF GLADSTONE		WHITEMUD RIVER AT PTH 16 AT GLADSTONE		WHITEMUD RIVER AT PTH 16 AT WESTBOURNE	
Date	TURBIDITY (FIELD)	TURBIDITY	TURBIDITY (FIELD)	TURBIDITY	TURBIDITY (FIELD)	TURBIDITY	TURBIDITY (FIELD)	TURBIDITY	TURBIDITY (FIELD)	TURBIDITY
	Ntu	Ntu	Ntu	Ntu	Ntu	Ntu	Ntu	Ntu	Ntu	Ntu
Jan-08-1990	24	11	23	20	6.4	4.3				
Feb-06-1990	15	4.4	14	5.4	6.6	2	6.6	1.37	3.5	2.9
Mar-05-1990	11	8.1	11	8.1	6.1	4.7	7.8	5.2	3.4	0.98
Apr-02-1990	16	6.3	19	4.3	24	8.9				
May-07-1990	5.9	3.6	5.7	3	4.8	2.5	8.5	6.1	12	3
Jun-04-1990	4	2.6	6.1	3.4	6	3.2	11	5.3	6.3	2.6
Jun-27-1990	3.7	1.46	4.5	3.9	15	7				
Aug-07-1990	8.3	5.7	23	13	24	11	24	11	22	12
Sep-04-1990	13	5.7	19	4.7	11	5.6	18	8.6	13	6.7
Oct-01-1990	27	3.9	39	11	9	2.4				
Nov-05-1990	12	3.2	12	4.3	15	6	10	3.4	3.2	0.67
Dec-03-1990	3.2	1.16	5.6	4.4	7.6	3.5	8.2	2	3.6	0.86
Jan-07-1991	2.5	3.4	6.9	5.6	7.9	5.5				
Feb-04-1991	4.5	6.2	8.3	13	11	6.3	13	5.4	4.9	2.7
Mar-04-1991	4.7	6.4	5.7	5	8.8	6.4	7	5.1	3.5	2.4
Apr-08-1991	8.6	9	11	9.9	24	22				
May-06-1991	6.2	4	6.7	4.8	12	9.2	8.6	5.3	9.5	5.3
Jun-03-1991	3.8	6.1	7.5	8.9	16	16	14	14	14	13
Jun-26-1991	5.4	3.2	7	7.5	19	13				
Aug-06-1991	6.1	4	14	9.2	16	11	12	5.8	16	9.6
Sep-09-1991	14	3.6	15	10	13	7.2	7.7	2.9	14	12
Oct-02-1991	3.4	2.8	6.7	3.5	11	6.4				
Jan-06-1992		2.9		2.3		4.3				
Jan-06-1992	3.1		6		5.7					
Apr-06-1992		10		9.8		37				
Apr-06-1992	11		23		43					
MIN	3	1	5	2	5	2	7	1	3	1
MAX	27	11	39	20	43	37	24	14	22	13
MEDIAN	9.0	4.9	12.5	7.3	13.5	8.6	11.2	5.8	9.2	5.3

Manitoba Water Stewardship, Water Quality Management Section. 2007. Surface Water Quality Data. Government of Manitoba, Winnipeg.

Attachment 1 - Summary Tables: Temperature

	MB05LLS011	MB05LLS010	MB05LLS004	MB05LLS003	MB05LLS001
	WHITEMUD RIVER AT DOWNSTREAM OF STONY CREEK (NEEPAWA)	WHITEMUD RIVER AT D/S SPRINGHILL FARMS EFFLUENT OUTFALL	WHITEMUD RIVER AT PTH 16, WEST OF GLADSTONE	WHITEMUD RIVER AT PTH 16 AT GLADSTONE	WHITEMUD RIVER AT PTH 16 AT WESTBOURNE
Date	TEMPERATURE WATER	TEMPERATURE WATER	TEMPERATURE WATER	TEMPERATURE WATER	TEMPERATURE WATER
	deg C	deg C	deg C	deg C	deg C
Jan-08-1990	0	0	0		
Feb-06-1990	0	0	0	0	0
Mar-05-1990	0	0	0	0	0
Apr-02-1990	0.5	0	0		
May-07-1990	11	11	12.5	13	12
Jun-04-1990	15	13	13.5	14	12
Jun-27-1990	23	23.2	23.25		
Aug-07-1990	22.5	22	21	20.5	23
Sep-04-1990	20	19.7	18.8	18	20
Oct-01-1990	10	9.2	9		
Nov-05-1990	2.3	2.3	1.5	1	0.7
Dec-03-1990	0.1	0.2	0	0	0
Jan-07-1991	0	0	0		
Feb-04-1991	0	0	0	0	0
Mar-04-1991	0	0	0	0	0
Apr-08-1991	4	4	0.5		
May-06-1991	5	5	4	4	4
Jun-03-1991	21.5	22	20.2	19.5	21
Jun-26-1991	22.7	23.7	24.5		
Aug-06-1991	19.1	19.1	19	18.9	18.9
Sep-09-1991	17.9	17.3	17.3	16.5	17.8
Oct-02-1991	11	10.8	11.8		
Jan-06-1992	0	0	0		
Apr-06-1992	2.5	3	1		
MIN	0.0	0.0	0.0	0.0	0.0
MAX	23.0	23.7	24.5	20.5	23.0
MEDIAN	8.67	8.56	8.24	8.96	9.24

Manitoba Water Stewardship, Water Quality Management Section. 2007. Surface Water Quality Data. Government of Manitoba, Winnipeg.

Attachment 1 - Summary Tables: Total Phosphorus

	MB05LLS011	MB05LLS010	MB05LLS004	MB05LLS003	MB05LLS001
	WHITEMUD RIVER DOWNSTREAM OF STONY CREEK (NEEPAWA)	WHITEMUD RIVER D/S SPRINGHILL FARMS EFFLUENT OUTFALL	WHITEMUD RIVER AT PTH 16, WEST OF GLADSTONE	WHITEMUD RIVER AT PTH 16 AT GLADSTONE	WHITEMUD RIVER AT PTH 16 AT WESTBOURNE
Date	PHOSPHORUS TOTAL (P)	PHOSPHORUS TOTAL (P)	PHOSPHORUS TOTAL (P)	PHOSPHORUS TOTAL (P)	PHOSPHORUS TOTAL (P)
	mg/L	mg/L	mg/L	mg/L	mg/L
Jan-08-1990	0.19	0.175	0.165		
Feb-06-1990	0.14	0.12	0.105	0.095	0.055
Mar-05-1990	0.115	0.095	0.08	0.07	0.045
Apr-02-1990	0.425	0.42	0.535		
May-07-1990	0.1	0.105	0.12	0.12	0.1
Jun-04-1990	0.08	1.53	0.56	0.153	0.085
Jun-27-1990	0.1	0.185	0.35		
Aug-07-1990	0.12	0.16	0.42	0.245	0.1
Sep-04-1990	0.185	0.685	0.295	0.23	0.08
Oct-01-1990	0.15	0.81	0.24		
Nov-05-1990	0.07	0.67	0.215	0.13	0.045
Dec-03-1990	0.06	0.235	0.295	0.105	0.045
Jan-07-1991	0.05	0.065	0.145		
Feb-04-1991	0.05	0.095	0.135	0.135	0.055
Mar-04-1991	0.04	0.053	0.14	0.08	0.043
Apr-08-1991	0.18	0.19	0.25		
May-06-1991	0.065	0.085	0.1	0.095	0.065
Jun-03-1991	0.055	1.38	0.315	0.175	0.105
Jun-26-1991	0.085	0.33	0.38		
Aug-06-1991	0.11	0.6	0.285	0.175	0.1
Sep-09-1991	0.16	0.97	0.295	0.22	0.1
Oct-02-1991	0.05	0.58	0.18		
Jan-06-1992	0.07	0.305	0.215		
Apr-06-1992	0.33	0.354	0.35		
MIN	0.040	0.053	0.080	0.070	0.043
MAX	0.425	1.530	0.560	0.245	0.105
MEDIAN	0.124	0.425	0.257	0.145	0.073

Manitoba Water Stewardship, Water Quality Management Section. 2007. Surface Water Quality Data. Government of Manitoba, Winnipeg.

Attachment 1 - Summary Tables: pH

	MB05LLS011	MB05LLS010	MB05LLS004	MB05LLS003	MB05LLS001
	WHITEMUD RIVER DOWNSTREAM OF STONY CREEK (NEEPAWA)	WHITEMUD RIVER D/S SPRINGHILL FARMS EFFLUENT OUTFALL	WHITEMUD RIVER AT PTH 16, WEST OF GLADSTONE	WHITEMUD RIVER AT PTH 16 AT GLADSTONE	WHITEMUD RIVER AT PTH 16 AT WESTBOURNE
Date	PH	PH	PH	PH	PH
	pH units	pH units	pH units	pH units	pH units
Jan-08-1990	7.47	7.39	7.41		
Feb-06-1990	7.45	7.39	7.42	7.39	7.25
Mar-05-1990	7.6	7.6	7.46	7.48	7.34
Apr-02-1990	7.81	7.81	7.66		
May-07-1990	8.26	8.25	8.26	8.27	8.12
Jun-04-1990	8.18	8.32	8.25	8.35	8.24
Jun-27-1990	7.74	7.77	7.97		
Aug-07-1990	8.17	8.12	7.96	8.25	8.47
Sep-04-1990	8.48	8.32	7.96	8.34	8.39
Oct-01-1990	8.29	8.01	7.82		
Nov-05-1990	8.23	8.07	8.31	8.09	8.29
Dec-03-1990	7.78		7.69	7.9	7.9
Jan-07-1991	7.58	7.52	7.44		
Feb-04-1991	7.45	7.44	7.42	7.42	7.24
Mar-04-1991	7.53	7.53	7.45	7.4	7.29
Apr-08-1991	8	8.07	8.01		
May-06-1991	8.39	8.41	8.41	8.42	8.35
Jun-03-1991	8.32	7.77	7.97	8.26	8.19
Jun-26-1991	8.12	7.94	8.13		
Aug-06-1991	7.88	7.81	8.2	8.32	8.41
Sep-09-1991	8.05	7.77	8.04	8.21	8.35
Oct-02-1991	7.71	7.89	8.62		
Jan-06-1992	7.47	7.48	7.57		
Apr-06-1992	7.86	7.81	8.05		
MIN	7.45	7.39	7.41	7.39	7.24
MAX	8.48	8.41	8.62	8.42	8.47
MEDIAN	7.91	7.85	7.90	8.01	7.99

Manitoba Water Stewardship, Water Quality Management Section. 2007. Surface Water Quality Data. Government of Manitoba, Winnipeg.

Attachment 1 - Summary Tables: Total Dissolved Solids

	MB05LLS011	MB05LLS010	MB05LLS004	MB05LLS003	MB05LLS001
	WHITEMUD RIVER DOWNSTREAM OF STONY CREEK (NEEPAWA)	WHITEMUD RIVER D/S SPRINGHILL FARMS EFFLUENT OUTFALL	WHITEMUD RIVER AT PTH 16, WEST OF GLADSTONE	WHITEMUD RIVER AT PTH 16 AT GLADSTONE	WHITEMUD RIVER AT PTH 16 AT WESTBOURNE
Date	TOTAL DISSOLVED SOLIDS	TOTAL DISSOLVED SOLIDS	TOTAL DISSOLVED SOLIDS	TOTAL DISSOLVED SOLIDS	TOTAL DISSOLVED SOLIDS
	mg/L	mg/L	mg/L	mg/L	mg/L
Jan-08-1990	430	510	480		
Feb-06-1990	430	440	480	490	610
Mar-05-1990	440	430	440	490	530
Apr-02-1990	210	200	180		
May-07-1990	320	340	360	370	360
Jun-04-1990	280	460	430	420	440
Jun-27-1990	250	270	360		
Aug-07-1990	220	240	280	350	400
Sep-04-1990	220	240	270	330	380
Oct-01-1990	210	240	270		
Nov-05-1990	250	270	380	310	470
Dec-03-1990	300	310	340	430	510
Jan-07-1991	360	370	390		
Feb-04-1991	400	420	450	590	580
Mar-04-1991	400	410	440	480	510
Apr-08-1991	290	300	250		
May-06-1991	310	350	350	350	370
Jun-03-1991	290	420	370	390	410
Jun-26-1991	250	250	360		
Aug-06-1991	190	240	350	380	410
Sep-09-1991	180	220	460	410	430
Oct-02-1991	200	240	260		
Jan-06-1992					
Apr-06-1992					
MIN	180	200	180	310	360
MAX	440	510	480	590	610
MEDIAN	292.3	325.9	361.4	413.6	457.9

Manitoba Water Stewardship, Water Quality Management Section. 2007. Surface Water Quality Data. Government of Manitoba, Winnipeg.

Attachment 1 - Summary Tables: Dissolved Oxygen

	MB05LLS011	MB05LLS010	MB05LLS004	MB05LLS003	MB05LLS001
	WHITEMUD RIVER DOWNSTREAM OF STONY CREEK (NEEPAWA)	WHITEMUD RIVER D/S SPRINGHILL FARMS EFFLUENT OUTFALL	WHITEMUD RIVER AT PTH 16, WEST OF GLADSTONE	WHITEMUD RIVER AT PTH 16 AT GLADSTONE	WHITEMUD RIVER AT PTH 16 AT WESTBOURNE
Date	DISSOLVED OXYGEN	DISSOLVED OXYGEN	DISSOLVED OXYGEN	DISSOLVED OXYGEN	DISSOLVED OXYGEN
	mg/L	mg/L	mg/L	mg/L	mg/L
Jan-08-1990	5.9	5.1	6.3		
Feb-06-1990	4.9	6.7	7.5	13.9	1.9
Mar-05-1990	5.8	7.5	7.1	4.8	2.3
Apr-02-1990	11.2	12	11.1		
May-07-1990	9.7	9.4	8.3	8.7	7.5
Jun-04-1990	9.6	10.6	9.3	8.8	8.2
Jun-27-1990	3.4	3.3	6.5		
Aug-07-1990	7.1	6.6	5.1	6.1	8.1
Sep-04-1990	9.3	9	6	5.7	7.5
Oct-01-1990	7.8	9	7.4		
Nov-05-1990	10.2	10.9	11.8	10.3	12.6
Dec-03-1990	7.8	7.7	8.7	8	9.4
Jan-07-1991	5.4	3.8	4.8		
Feb-04-1991	6.5	6	5.9	5.9	4.7
Mar-04-1991	6.3	7.3	5.4	3.5	3.3
Apr-08-1991	9.8	9.8	11.1		
May-06-1991	11.4	11.9	11.5	11.5	11.7
Jun-03-1991	10	1.8	5.7	6.8	5.7
Jun-26-1991	7.7	7.6	9.2		
Aug-06-1991	5.5	5.9	6.6	7.2	7.6
Sep-09-1991	2.5	5	6.2	5.5	6.5
Oct-02-1991	5.3	9.6	11.2		
Jan-06-1992	7.5	6.4	8.6		
Apr-06-1992	10.7	10.2	10.9		
MIN	2.50	1.80	4.80	3.50	1.90
MAX	11.40	12.00	11.80	13.90	12.60
MEDIAN	7.55	7.63	8.01	7.62	6.93

Manitoba Water Stewardship, Water Quality Management Section. 2007. Surface Water Quality Data. Government of Manitoba, Winnipeg.

Attachment 1 - Summary Tables: Percent Dissolved Oxygen at Actual Temperature and Elevation

	MB05LLS011		MB05LLS010		MB05LLS004		MB05LLS003		MB05LLS001	
	WHITEMUD RIVER DOWNSTREAM OF STONY CREEK (NEEPAWA)		WHITEMUD RIVER D/S SPRINGHILL FARMS EFFLUENT OUTFALL		WHITEMUD RIVER AT PTH 16, WEST OF GLADSTONE		WHITEMUD RIVER AT PTH 16 AT GLADSTONE		WHITEMUD RIVER AT PTH 16 AT WESTBOURNE	
Date	Time	PERCENT DO SATURATION AT ACTUAL TEMPERATURE AND ELEVATION	Time	PERCENT DO SATURATION AT ACTUAL TEMPERATURE AND ELEVATION	Time	PERCENT DO SATURATION AT ACTUAL TEMPERATURE AND ELEVATION	Time	PERCENT DO SATURATION AT ACTUAL TEMPERATURE AND ELEVATION	Time	PERCENT DO SATURATION AT ACTUAL TEMPERATURE AND ELEVATION
		%		%		%		%		%
Jan-08-1990	11:10	44.20	10:20	38.16	8:35	46.99			-	
Feb-06-1990	10:50	36.71	10:20	50.14	9:20	55.94	8:50	103.17	8:10	14.07
Mar-05-1990	11:40	43.45	11:10	56.12	9:55	52.95	9:20	35.63	8:45	17.03
Apr-02-1990	11:55	84.77	11:10	89.80	9:45	82.79	-		-	
May-07-1990	11:35	90.86	10:42	87.94	9:32	79.78	8:58	84.08	8:25	70.87
Jun-04-1990	11:35	97.52	10:55	103.28	9:35	91.23	9:00	86.79	7:55	77.48
Jun-27-1990	10:05	40.63	10:55	39.55	12:40	77.72	-		-	
Aug-07-1990	11:20	83.99	10:40	77.19	9:10	58.26	8:45	68.64	8:00	95.69
Sep-04-1990	12:45	104.57	11:50	100.46	10:25	65.54	9:55	60.97	9:10	83.37
Oct-01-1990	11:40	71.59	10:50	81.18	9:15	66.25	-		-	
Nov-05-1990	11:50	80.07	11:10	85.47	9:45	90.73	9:15	78.02	8:30	94.66
Dec-03-1990	11:25	58.56	10:50	57.85	9:30	64.89	8:50	59.38	8:00	69.62
Jan-07-1991	11:15	40.46	10:25	28.44	9:05	35.80	-		-	
Feb-04-1991	10:25	48.70	10:00	44.90	9:15	44.00	8:40	43.79	8:05	34.81
Mar-04-1991	11:20	47.20	10:50	54.63	9:45	40.27	9:15	25.98	8:30	24.44
Apr-08-1991	11:05	79.63	10:30	79.54	9:00	83.63	-		-	
May-06-1991	11:37	94.53	11:00	98.56	9:45	93.02	9:10	92.58	8:30	93.99
Jun-03-1991	11:25	115.92	10:50	21.05	9:25	64.06	9:05	74.98	8:30	64.66
Jun-26-1991	13:40	91.46	14:40	92.01	16:00	112.83	-		-	
Aug-06-1991	12:08	60.72	11:25	65.06	10:05	72.39	9:30	78.43	8:50	82.61
Sep-09-1991	13:05	26.94	12:30	53.16	11:00	65.70	10:25	57.06	9:35	69.10
Oct-02-1991	12:15	49.64	12:55	89.45	14:30	106.14	-		-	
Jan-06-1992	-	56.19	-	47.89	-	64.14	-		-	
Apr-06-1992	-	84.34	-	81.12	-	82.96	-		-	
MIN		26.94		21.05		35.80		25.98		14.07
MAX		115.92		103.28		112.83		103.17		95.69
MEDIAN		68.03		67.62		70.75		67.82		63.74

Manitoba Water Stewardship, Water Quality Management Section. 2007. Surface Water Quality Data. Government of Manitoba, Winnipeg.

Attachment 1 - Summary Tables: Oxygen Biochemical Demand

	MB05LLS011	MB05LLS010	MB05LLS004	MB05LLS003	MB05LLS001
	WHITEMUD RIVER DOWNSTREAM OF STONY CREEK (NEEPAWA)	WHITEMUD RIVER D/S SPRINGHILL FARMS EFFLUENT OUTFALL	WHITEMUD RIVER AT PTH 16, WEST OF GLADSTONE	WHITEMUD RIVER AT PTH 16 AT GLADSTONE	WHITEMUD RIVER AT PTH 16 AT WESTBOURNE
Date	OXYGEN BIOCHEMICAL DEMAND	OXYGEN BIOCHEMICAL DEMAND	OXYGEN BIOCHEMICAL DEMAND	OXYGEN BIOCHEMICAL DEMAND	OXYGEN BIOCHEMICAL DEMAND
	mg/L	mg/L	mg/L	mg/L	mg/L
Jan-08-1990	1	<1	<1		
Feb-06-1990	1.2	<1	1.3	1.1	<1
Mar-05-1990	1	1.1	1.2	1.5	<1
Apr-02-1990	2.6	3	2.6		
May-07-1990	2.9	2.5	1.7	1.1	1.6
Jun-04-1990	2	3.3	2.2	1	1.1
Jun-27-1990	1.4	1.2	2		
Aug-07-1990	1.9	2.3	1.5	1.8	1.2
Sep-04-1990	5.1	4	<1	1.7	<1
Oct-01-1990	9	11	1.7		
Nov-05-1990	4.5	4.4	4.2	1.6	1.3
Dec-03-1990	2.1	2.4	2.2	2.5	1.4
Jan-07-1991	1.5	1.9	1.5		
Feb-04-1991	1.9	2.3	1.9	1.6	1.3
Mar-04-1991	1.8	2.3	2.4	1.2	1.2
Apr-08-1991	2.6	3.1	2.9		
May-06-1991	4.4	3.9	3.2	3	2.4
Jun-03-1991	1.5	2.9	1.9	<1	1
Jun-26-1991	1.8	3	2.9		
Aug-06-1991	1.5	2.3	2.3	1.6	1.4
Sep-09-1991	5	2.6	1.4	1.2	1.1
Oct-02-1991	2	2.4	4.5		
Jan-06-1992	1.3	1.4	1.5		
Apr-06-1992	3.3	4.2	3.7		
MIN	1	<1	<1	<1	<1
MAX	9.0	11.0	4.5	3.0	2.4
MEDIAN	2.64	2.85	2.15	1.53	1.18

Manitoba Water Stewardship, Water Quality Management Section. 2007. Surface Water Quality Data. Government of Manitoba, Winnipeg.

Attachment 1 - Summary Tables: Nitrogen Dissolved $N0_3$ $N0_2$

	MB05LLS011	MB05LLS010	MB05LLS004	MB05LLS003	MB05LLS001
	WHITEMUD RIVER DOWNSTREAM OF STONY CREEK (NEEPAWA)	WHITEMUD RIVER D/S SPRINGHILL FARMS EFFLUENT OUTFALL	WHITEMUD RIVER AT PTH 16, WEST OF GLADSTONE	WHITEMUD RIVER AT PTH 16 AT GLADSTONE	WHITEMUD RIVER AT PTH 16 AT WESTBOURNE
Date	NITROGEN DISSOLVED NO3 & NO2	NITROGEN DISSOLVED NO3 & NO2	NITROGEN DISSOLVED NO3 & NO2	NITROGEN DISSOLVED NO3 & NO2	NITROGEN DISSOLVED NO3 & NO2
	mg/L	mg/L	mg/L	mg/L	mg/L
Jan-08-1990	0.04	0.15	0.42		
Feb-06-1990	0.02	0.14	0.7	1.02	0.19
Mar-05-1990	0.03	0.21	0.83	1.24	0.38
Apr-02-1990	0.52	0.55	0.49		
May-07-1990	<0.01	<0.01	<0.01	<0.01	0.01
Jun-04-1990	0.04	0.2	0.27	<0.01	0.01
Jun-27-1990	0.12	0.15	0.25		
Aug-07-1990	0.1	<0.01	0.11	0.03	<0.01
Sep-04-1990	0.09	0.6	0.08	<0.01	<0.01
Oct-01-1990	0.13	1.4	<0.01		
Nov-05-1990	1.15	1.42	<0.01	<0.01	<0.01
Dec-03-1990	0.16	0.61	0.76	0.01	0.01
Jan-07-1991	0.16	0.22	0.3		
Feb-04-1991	0.1	0.23	0.4	0.45	0.17
Mar-04-1991	0.18	0.28	0.46	0.61	0.36
Apr-08-1991	0.67	0.78	0.98		
May-06-1991	<0.01	0.01	0.02	<0.01	0.02
Jun-03-1991	0.04	0.14	0.34	0.01	<0.01
Jun-26-1991	0.07	0.22	0.03		
Aug-06-1991	0.09	0.92	0.16	<0.01	<0.01
Sep-09-1991	0.06	1.23	0.04	0.02	<0.01
Oct-02-1991	0.37	2.08	<0.01		
Jan-06-1992	0.23	0.83	1.03		
Apr-06-1992	0.23	0.24	0.38		
MIN	<0.01	<0.01	<0.01	<0.01	<0.01
MAX	1.15	2.08	1.03	1.24	0.38
MEDIAN	0.19	0.53	0.34	0.24	0.08

Manitoba Water Stewardship, Water Quality Management Section. 2007. Surface Water Quality Data. Government of Manitoba, Winnipeg.

Attachment 1 - Summary Tables: Nitrogen Total Kjeldahl

	MB05LLS011	MB05LLS010	MB05LLS004	MB05LLS003	MB05LLS001
	WHITEMUD RIVER DOWNSTREAM OF STONY CREEK (NEEPAWA)	WHITEMUD RIVER D/S SPRINGHILL FARMS EFFLUENT OUTFALL	WHITEMUD RIVER AT PTH 16, WEST OF GLADSTONE	WHITEMUD RIVER AT PTH 16 AT GLADSTONE	WHITEMUD RIVER AT PTH 16 AT WESTBOURNE
Date	NITROGEN TOTAL KJELDAHL (TKN)	NITROGEN TOTAL KJELDAHL (TKN)	NITROGEN TOTAL KJELDAHL (TKN)	NITROGEN TOTAL KJELDAHL (TKN)	NITROGEN TOTAL KJELDAHL (TKN)
	mg/L	mg/L	mg/L	mg/L	mg/L
Jan-08-1990	2.5	2.4	2.3		
Feb-06-1990	2.45	2.4	1.65	1.2	1.75
Mar-05-1990	2.6	2.4	1.45	0.85	0.85
Apr-02-1990	1.5	1.4	1.5		
May-07-1990	1.1	1.15	0.9	0.85	0.85
Jun-04-1990	0.85	5.2	2.65	0.9	0.8
Jun-27-1990	1.05	1.05	1.1		
Aug-07-1990	1	1	1.1	1.2	1
Sep-04-1990	1.45	1.55	0.9	1.15	0.8
Oct-01-1990	1.7	2.2	1		
Nov-05-1990	1.4	1.45	1.4	1	0.6
Dec-03-1990	1.3	1.6	1.7	1.25	0.65
Jan-07-1991	1.4	1.4	1.65		
Feb-04-1991	1.6	1.55	1.65	1.7	1.05
Mar-04-1991	1.55	1.6	2.3	1.3	0.8
Apr-08-1991	1.35	1.35	1.3		
May-06-1991	0.85	0.9	0.9	0.85	0.65
Jun-03-1991	0.9	4.4	1.9	1.05	0.9
Jun-26-1991	0.95	1.75	1.35		
Aug-06-1991	1.1	1.3	1.5	1.1	0.85
Sep-09-1991	2.1	1.75	1.3	1.1	1.1
Oct-02-1991	1.5	1.55	1.3		
Jan-06-1992	1.45	2.05	1.45		
Apr-06-1992	1.29	1.55	1.29		
MIN	0.85	0.90	0.90	0.85	0.60
MAX	2.60	5.20	2.65	1.70	1.75
MEDIAN	1.46	1.87	1.48	1.11	0.90

Manitoba Water Stewardship, Water Quality Management Section. 2007. Surface Water Quality Data. Government of Manitoba, Winnipeg.

Attachment 1 - Summary Tables: Ammonia Soluble

	MB05LLS011	MB05LLS010	MB05LLS004	MB05LLS003	MB05LLS001
	WHITEMUD RIVER DOWNSTREAM OF STONY CREEK (NEEPAWA)	WHITEMUD RIVER D/S SPRINGHILL FARMS EFFLUENT OUTFALL	WHITEMUD RIVER AT PTH 16, WEST OF GLADSTONE	WHITEMUD RIVER AT PTH 16 AT GLADSTONE	WHITEMUD RIVER AT PTH 16 AT WESTBOURNE
Date	AMMONIA SOLUBLE	AMMONIA SOLUBLE	AMMONIA SOLUBLE	AMMONIA SOLUBLE	AMMONIA SOLUBLE
	mg/L	mg/L	mg/L	mg/L	mg/L
Jan-08-1990	1.58	1.58	1.24		
Feb-06-1990	1.85	1.76	1.14	0.57	0.92
Mar-05-1990	1.89	1.72	0.94	0.22	0.42
Apr-02-1990	0.375	0.265	0.245		
May-07-1990	<0.02	<0.02	<0.02	<0.02	0.05
Jun-04-1990	0.07	3.75	1.34	0.03	<0.02
Jun-27-1990	0.24	0.18	0.095		
Aug-07-1990	<0.02	0.02	0.07	0.04	0.02
Sep-04-1990	<0.02	0.02	0.07	0.02	0.02
Oct-01-1990	0.09	0.02	<0.02		
Nov-05-1990	0.195	0.165	<0.02	<0.02	<0.02
Dec-03-1990	0.36	0.485	0.575	0.02	<0.02
Jan-07-1991	0.575	0.595	0.69		
Feb-04-1991	0.685	0.685	0.65	0.655	0.405
Mar-04-1991	0.66	0.65	1.34	0.305	0.265
Apr-08-1991	0.2	0.245	0.2		
May-06-1991	0.02	0.02	0.02	<0.02	<0.02
Jun-03-1991	0.04	3.16	0.575	0.045	0.02
Jun-26-1991	0.08	0.56	<0.02		
Aug-06-1991	0.095	0.14	<0.02	0.03	0.02
Sep-09-1991	0.65	0.225	0.035	0.04	0.03
Oct-02-1991	0.315	0.22	<0.02		
Jan-06-1992	0.605	1.22	0.615		
Apr-06-1992	0.318	0.4	0.287		
MIN	<0.02	<0.02	<0.02	<0.02	<0.02
MAX	1.89	3.75	1.34	0.66	0.92
MEDIAN	0.46	0.75	0.42	0.14	0.16

Manitoba Water Stewardship, Water Quality Management Section. 2007. Surface Water Quality Data. Government of Manitoba, Winnipeg.

Attachment 2
Benthic Invertebrate Sampling Program, 2007

ATTACHMENT 2.0
BENTHIC INVERTEBRATE SAMPLING PROGRAM, 2007

Bottom sediments were collected from the Whitemud River on 24 August 2007, under partly cloudy conditions, wind 6 km/h and daytime temperature 22°C. Locations upstream (Site 1), just below (Site 2) and downstream (Site 3) of the expected Neepawa IWWTF outfall location were selected based on apparent similarity in physical habitats (depth, bottom substrate, water velocities). All sites appeared to be areas of sediment deposition, and depths at the time of sampling were 1.1 m, 1.1 m, and 1.0 m at Sites 1, 2 and 3, respectively. Substrate composition at Sites 1 and 2 was 40% gravel/sand and 60% silt/clay, and at Site 3 was 50% gravel/sand and 50% silt/clay.

Triplicate samples were collected at each site with a 6-inch Ekman dredge and sieved through a 200-μm mesh screen. Fingernail clams (Sphaeridae) were counted and returned to the stream. Other invertebrates were preserved in 8% formaldehyde solution and sent to an analytical laboratory for sorting and identification, with application of QA/QC procedures as set out by the Department of Fisheries and Oceans Canada for Environmental Effects Monitoring. Subsampling was not required due to the small size of samples.

<u>Attachment 2</u>: Invertebrate Figure

				Sample Site 1			Sample Site 2			Sample Site 3		
Common Name	***Class***	**Order**	***Family***	***Rep1***	***Rep2***	***Rep3***	***Rep1***	***Rep2***	***Rep3***	***Rep1***	***Rep2***	***Rep3***
	BIVALVIA											
Freshwater Clam		**Heterodonta**	*Sphaeriidae*	3	4	4	2	6	1	3	9	
	OLIGOCHAETA											
Round Worms		**Haplotaxida**	*Tubificidae*	3	6	3	12	2	17	3	2	
	INSECTA											
Mayflies		**Ephemereoptera**	*Heptageniidae*	6	23	5	3	4	7	12	12	8
			Caenidae	12	7	18	11	6	14		14	22
			Ephemeridae	20	5	12	9	2	12	45	8	19
Dragonflies and Damselflies		**Odonata**	*Gomphidae*	12	7	10	22	8	8	18	20	12
True bugs		**Hemiptera**	*Corixidae*	15	4	4	4	4	11	9	1	2
Caddisflies		**Tricoptera**	*Hydropsychidae*	1			1	2	1	2		3
			Leptoceridae	1	8	3		5	2	2	2	4
Beetles		**Coleoptera**	*Elmidae*	16	18	3		22	11	27	6	19
True flies		**Diptera**	*Chironomidae*	20	23	11	3	15	15	3	3	25
			Simuliidae	23	8	15	22	12	12	16	21	28
			Empididae	5		2		2	6	2	10	3
	Total Taxa per Replicate			**137**	**113**	**90**	**89**	**90**	**117**	**142**	**108**	**145**
	Taxa Richness by Replicate			**15**	**14**	**14**	**12**	**15**	**15**	**15**	**15**	**13**
	Taxa Richness by Site				**340**			**296**			**395**	

<u>Attachment 2</u>: Invertebrate Chart