

LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS

Question IAAC-35

Table of Contents

ABBREVIATIONS AND ACRONYMS	II
----------------------------------	----

QUESTION IAAC-35	1
------------------------	---

LIST OF TABLES

Table IAAC-35-1	Sources of Primary Productivity Data used in the Existing Environment.....	2
Table IAAC-35-2	Main Sites and Sampling Periods chlorophyll a data collected by for the Regional Water Quality Monitoring Program, 2011-2015.....	4
Table IAAC-35-3	Chlorophyll α Concentrations Measured in the Local Assessment Area Waterbodies During Lake St. Martin Emergency Outlet Channel Monitoring, 2011-2015. Modified from NSC (2016a) ^a	10

LIST OF FIGURES

Figure IAAC-35-1	Water Quality Sampling Sites that were Part of the Regional Water Quality Monitoring Program (RWQMP), 2011-2015 from which chlorophyll a data were extracted.....	5
Figure IAAC-35-2	Locations of Manitoba Water Stewardship Water Quality Monitoring Sites in the Study Area (pre-2011) from which chlorophyll a data were extracted	6
Figure IAAC-35-3	MCWS Water Quality Monitoring Sites in the Fairford and Dauphin Rivers, and Sturgeon Bay from which chlorophyll a data were extracted	7
Figure IAAC-35-4	Chlorophyll α Concentrations in the Fairford River, 2004-2014 (start and end of EOC operation is designated by vertical lines)	15
Figure IAAC-35-5	Chlorophyll α Concentrations at Sampling sites LSM1 and LSM2 in the north basin of Lake St. Martin, 2011-2015 (Operation and Closure Periods for EOC are Delineated by Vertical Lines).....	15
Figure IAAC-35-6	Chlorophyll α Concentrations in the Dauphin River (A) upstream and (B) Downstream of Buffalo Creek, 2011-2015 (Operation and Closure Periods for EOC are Delineated by Vertical Lines).....	16
Figure IAAC-35-7	Chlorophyll α Concentrations in (A) Reach1, Big Buffalo Lake, and (B) Buffalo Creek from 2011-2015 (Operation and Closure Periods for EOC are Delineated by Vertical Lines).....	16
Figure IAAC-35-8	Chlorophyll α Concentrations in Sturgeon Bay, 2011-2015 (Operation and Closure Periods for EOC are Delineated by Vertical Lines).....	17
Figure IAAC-35-9	Benthic Invertebrate Sample Site Locations, by Habitat Type, in Sturgeon Bay, fall 2011 and 2013; Kick Net Sampling Sites are Indicated by the Inclusion of “KN” in the Site Name	19



LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS

Question IAAC-35

Abbreviations and Acronyms

BMI	benthic macroinvertebrates
CAMP	Coordinated Aquatic Monitoring Program
EC	former Environment Canada, now Environment and Climate Change Canada (ECCC)
EIS	environmental impact statement
EOC	emergency outlet channel
IAAC	Impact Assessment Agency of Canada
km	kilometre
LAA	local assessment area
LMOC	Lake Manitoba outlet channel
LSM	Lake St. Martin
LSMOC	Lake St. Martin outlet channel
MWS	former Manitoba Water Stewardship, now Manitoba Conservation and Climate (MCC)
NSC	North South Consultants
RAA	regional assessment area
RWQMP	Regional Water Quality Monitoring Program

Question IAAC-35

QUESTION IAAC-35

EIS Guideline Reference: 7.1.5 Characterization of fish populations

EIS Reference: 7.2.2.1 Methods; 7.2.2.2 Fish and Fish Habitat

Context and Rationale

Section 7.1.5 of the EIS guidelines requires that the proponent provide a description of primary and secondary productivity in affected waterbodies with a characterization of season variability.

Section 7.2.2.2 of the EIS provides some primary and secondary productivity data for some but not all affected waterbodies in the LAA and RAA, and characterization of season variability is missing.

The sources of baseline information for primary and secondary productivity referenced in the text (Section 7.2.2.2) are not described as they are in Section 7.2.2.1 for Fish Inventories, Habitat Use Surveys, and Fish Habitat Assessments.

This information is required to understand the assessment of effects to fish and fish habitat.

Information Requests

- a) Clearly describe the sources of baseline data for primary and secondary productivity, including the methodologies used for data collection.
- b) Provide a description of primary and secondary productivity with a characterization of season variability for LAA waterbodies.

Response IAAC-35

a) and b)

In order to efficiently respond to this request, this response is organized by primary and secondary productivity, with information on sources, methods and results summarized under these two headings.

Primary Productivity

Sources and Methods of Baseline Data Collection

Measurements of chlorophyll α were used as an index to describe primary productivity for waterbodies in the LAA. Identification of phytoplankton taxa was available only for Lake Winnipeg. Aquatic macrophyte maps for Watchorn Bay and Birch Bay are provided in AAE Tech Services (2016). Data sources and methods used in the development of baseline descriptions of primary productivity are identified in Table IAAC-35-1 and included:

LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS

Question IAAC-35

- Water quality data (and associated chlorophyll a data) collected during the Lake St. Martin Emergency Outlet Channel (EOC) monitoring programs. Specifically:
 - o the Regional Water Quality Monitoring Program provided much of the available data;
 - o the program included seasonal water sample collections to describe conditions within the Lake St. Martin region;
 - o sampling locations extended from upstream of the Fairford River Water Control Structure at Lake Manitoba, through the north basin of Lake St. Martin, the Dauphin River and into Sturgeon Bay;
 - o water quality parameters analyzed as part of this program included routine nutrient (including chlorophyll α) and physical parameters, metals (total and dissolved) and major ions, and in situ measurements (water temperature, dissolved oxygen, pH, turbidity and conductivity);
- Water quality data (and associated chlorophyll a data) collected by the Province of Manitoba including the following:
 - o historic baseline conditions in Lake Manitoba to support assessment of the EOC operations (data from 1973 to 2011); and
 - o augmentation of water quality data and analysis in the Fairford River, the Dauphin River and Sturgeon Bay to support assessment of the EOC operations.
- Data from available literature (for Regional Assessment Area waterbodies – see Table IAAC-35-1 for source).

Data sources for Project waterbodies are identified in Table IAAC-35-1.

Table IAAC-35-1 Sources of Primary Productivity Data used in the Existing Environment

Waterbody	Parameter	Source	Data Availability	Sampling Method
Regional Assessment Area				
Lake Manitoba	Chlorophyll α	Page 2011	2005 and 2006	laboratory analysis of surface water samples
Lake Winnipeg	Chlorophyll α	EC/MWS 2011	1999 - 2007	laboratory analysis of surface water samples
	Phytoplankton composition and abundance	EC/MWS 2011	1999 - 2007	-
Local Assessment Area				
Watchorn Bay	Aquatic macrophyte distribution	AAE Tech Services 2016	2016	-
Watchorn Creek	no data	-	-	-
Long Lake and Reed Lake	no data	-	-	-

LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS

Question IAAC-35

Table IAAC-35-1 Sources of Primary Productivity Data used in the Existing Environment

Waterbody	Parameter	Source	Data Availability	Sampling Method
Fairford River	Chlorophyll α	NSC 2016a Province of Manitoba	2011-2015	laboratory analysis of surface water samples
Pineimuta Lake	<i>no data</i>			-
Lake St. Martin	Chlorophyll α	NSC 2016a	2011-2015	laboratory analysis of surface water samples
Birch Bay	Aquatic macrophyte distribution	AAE Tech Services 2016	2016	-
Birch Creek and headwater lakes	no data	-	-	-
Bear Creek	no data	-	-	-
Dauphin River	Chlorophyll α	NSC 2016a Province of Manitoba	2011-2015	laboratory analysis of surface water samples
Big Buffalo Lake and Buffalo Creek	Chlorophyll α	NSC 2016a	2011-2015	laboratory analysis of surface water samples
Sturgeon Bay	Chlorophyll α	NSC 2016a Province of Manitoba	2011-2015	laboratory analysis of surface water samples

The most comprehensive data set for chlorophyll α in Project waterbodies was collected during EOC monitoring programs from 2011 to 2015. Water quality sampling was conducted seasonally over the course of the program at numerous sites extending from the Fairford River downstream to Sturgeon Bay. Sample locations and location-specific sampling dates for the duration of the program are provided in Table IAAC-35-2 and Figure IAAC-35-1.

The Province of Manitoba has monitored water quality at 28 sites in Lake Manitoba, in the Fairford River at Provincial Trunk Highway #6 west of Fairford (MB05LMS001), in the Dauphin River near Anama Bay (MB05LMS003), and in Sturgeon Bay (MB05SES012) over various time periods since 1973 (Manitoba Conservation Water Stewardship 2014). The frequency of sampling has varied over the monitoring period and monitoring in Sturgeon Bay has only been recently initiated (since 2008). The list of water quality parameters measured varies with time and, in some instances, only a limited number of parameters have been measured. Water quality data collected by the Province of Manitoba were used to provide historic baseline conditions in Lake Manitoba to support assessment of the EOC operations and the Project (see Figure IAAC-35-2) and to augment water quality data and analysis in the Fairford River, the Dauphin River and Sturgeon Bay during assessment of the EOC operations (see Figure IAAC-35-3).

LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT
RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS

Question IAAC-35

Table IAAC-35-2 Main Sites and Sampling Periods chlorophyll a data collected by for the Regional Water Quality Monitoring Program, 2011-2015

Waterbody	Site ID	Flood	2011/2012 EOC Operation				2011/2012 EOC Closure							2014/2015 EOC Operation				
		Oct 28-29	Jan 16-19	May 16-21	Jul 16-17	Oct 15-16	Mar 24-27	Jun 10-12	Jul 21-22	Oct 6-7	Apr 7-10	May 28-29	Jun 18-20	Jul 24-25	Aug 26-27	Oct 16-20	Mar 24-27	May 3-4
		2011	2012	2012	2012	2012	2013	2013	2013	2013	2014	2014	2014	2014	2014	2014	2015	2015
Waterhen River	WHR1	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-
Lake Manitoba	NARR1	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-
Fairford River	FR1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
Lake St. Martin	LSM1	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X	-
Dauphin River	DR1.1	X	-	X	X	X	X	X	X	X	X	X	X	X	-	X	X	-
	DR1.3	X	X ¹	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
	DR1	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Buffalo Creek	BC3	X	X	X	X	X	-	X	X	X	-	X	X	X	X	X	X	X
Dauphin River	DR2C	X ²	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Lake Winnipeg	LKW3B	-	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	LKW3	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X	-
	LKW2	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X	-
	LKW1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
	LKW4	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X	-
	LKW5	X	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X	-
	LKW6	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
	LKW7	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-

LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS

Question IAAC-35

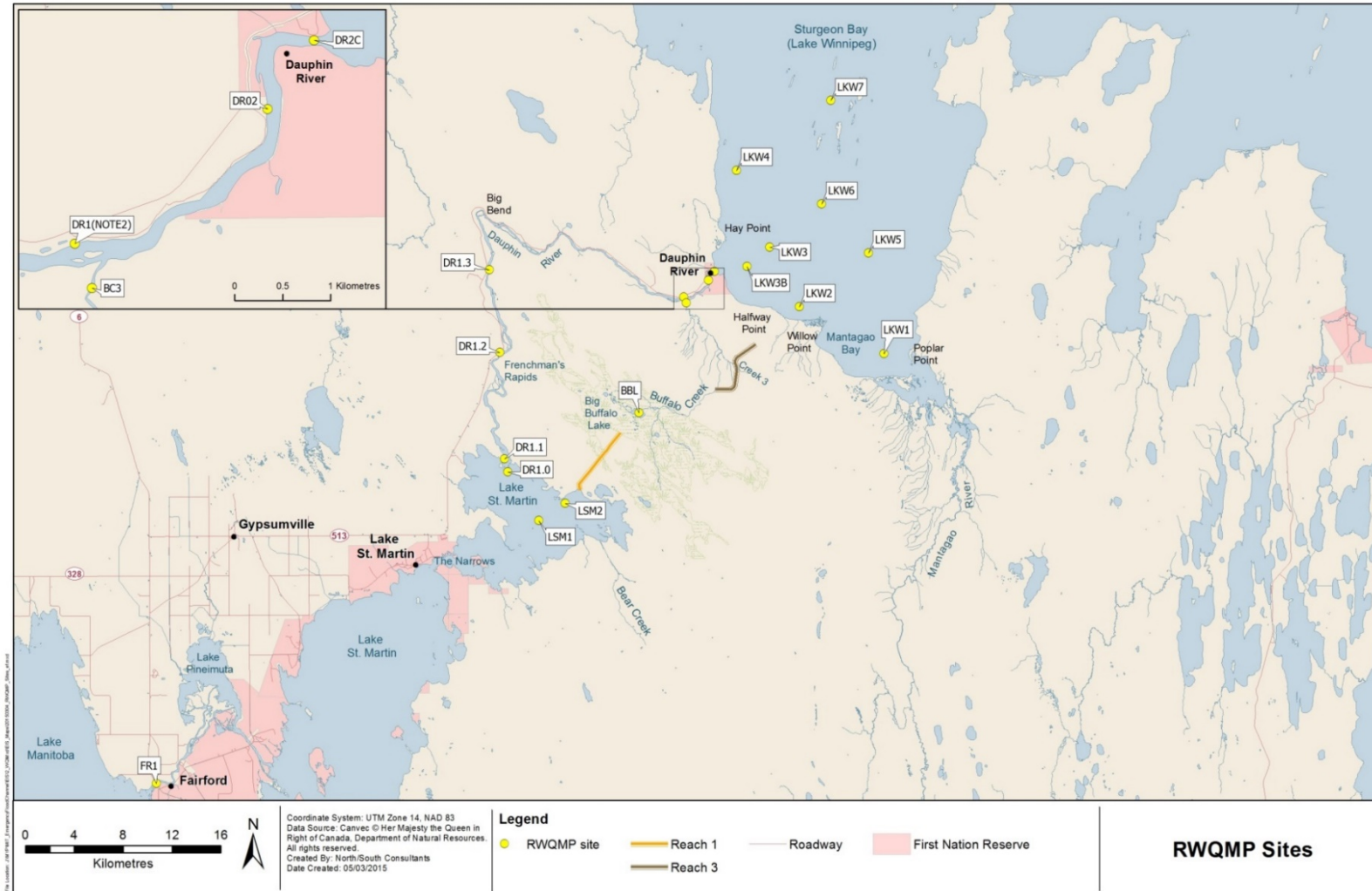


Figure IAAC-35-1 Water Quality Sampling Sites that were Part of the Regional Water Quality Monitoring Program (RWQMP), 2011-2015 from which chlorophyll a data were extracted

LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS

Question IAAC-35

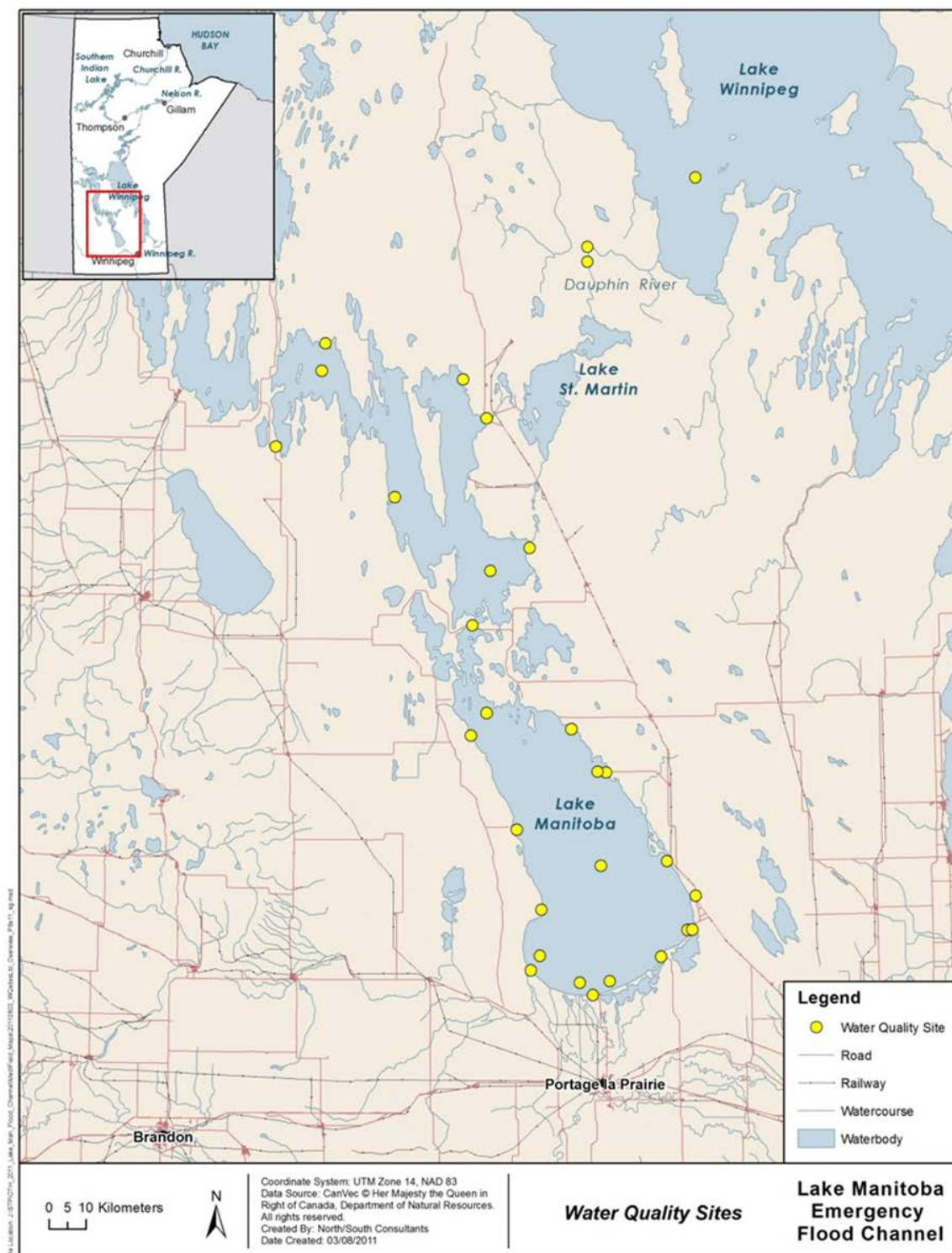


Figure IAAC-35-2 Locations of Manitoba Water Stewardship Water Quality Monitoring Sites in the Study Area (pre-2011) from which chlorophyll *a* data were extracted

LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS

Question IAAC-35

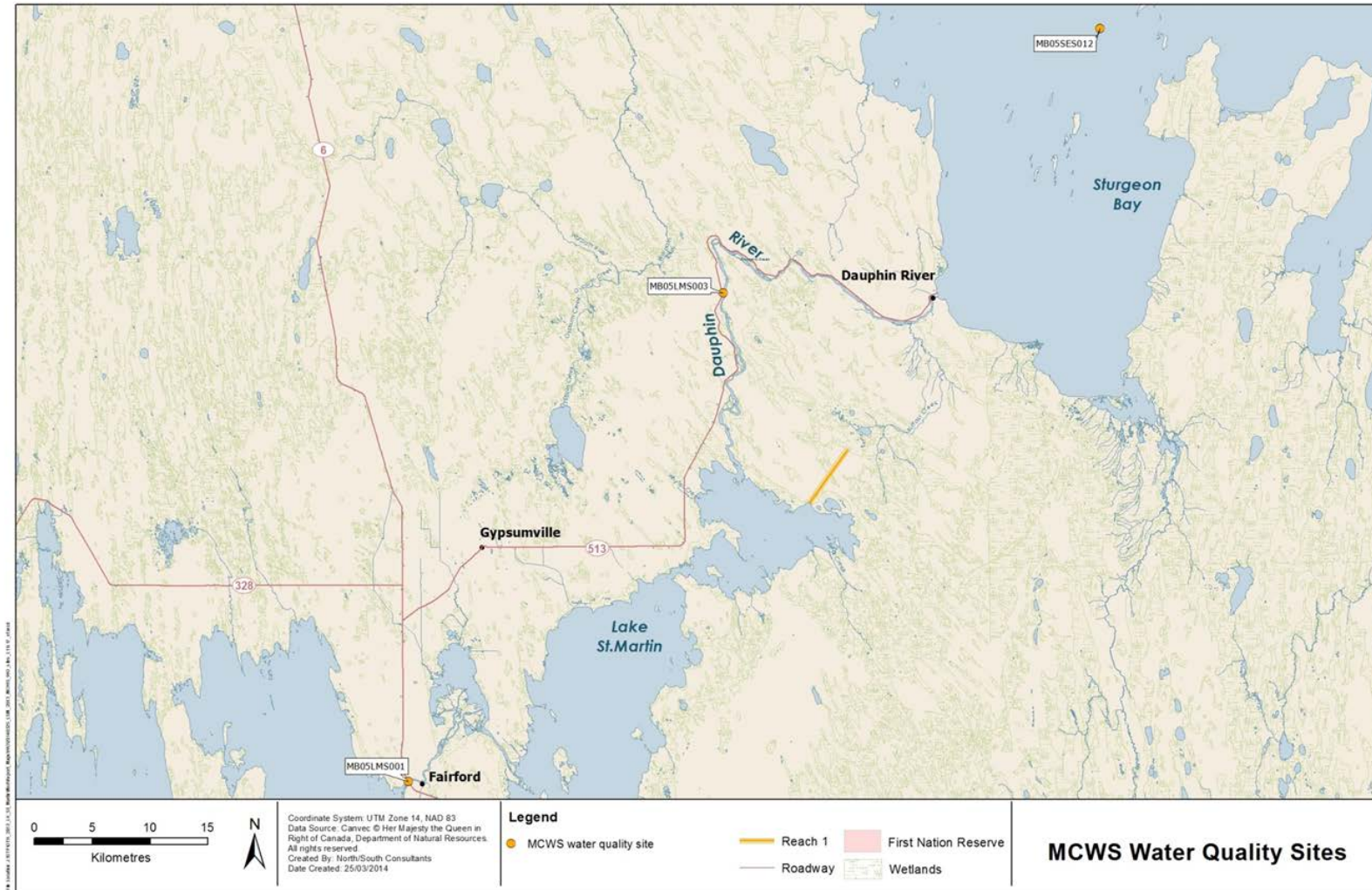


Figure IAAC-35-3 MCWS Water Quality Monitoring Sites in the Fairford and Dauphin Rivers, and Sturgeon Bay from which chlorophyll a data were extracted

LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS

Question IAAC-35

Baseline Descriptions and Seasonal Variability

Measurements of chlorophyll α concentration are not available for the following waterbodies in the Local Assessment Area (LAA) described in the EIS:

- Watchorn Bay
- Watchorn Creek
- Long Lake and Reed Lake
- Pineimuta Lake
- Birch Bay
- Birch Creek and Headwater Creeks
- Bear Creek

The following sections provide baseline descriptions, including seasonal trends, for the following waterbodies:

- Fairford River
- Lake St. Martin
- Buffalo Lake and Buffalo Creek
- Dauphin River
- Sturgeon Bay

These waterbodies capture the downstream effects of the Project on primary productivity. These data are considered sufficient to understand primary productivity in the major waterbodies in the LAA and the potential effects that the Project may have on primary productivity and fish and fish habitat in the LAA.

Fairford River

Prior to 2011, Chlorophyll α concentrations ranged from less than 0.50 $\mu\text{g/L}$ to 19.5 $\mu\text{g/L}$, with a mean of 5.84 $\mu\text{g/L}$. This data indicate that primary productivity in the Fairford River was moderate (as defined by Dodds et al. 1986) (NSC 2016a). Chlorophyll α concentrations remained within this range from 2011 to 2015 (Table IAAC-35-3; Figure IAAC-35-4). In general, chlorophyll α concentrations in the Fairford River are low throughout winter but increase throughout the open water period (Figure IAAC-35-4).

Lake St. Martin

Similar to Lake Manitoba, Lake St. Martin is phosphorus limited and mesotrophic (i.e., intermediate level of productivity) (NSC 2016a). The annual mean open-water chlorophyll α concentrations ranged from 3.5 $\mu\text{g/L}$ to 7.1 $\mu\text{g/L}$ (Table IAAC-35-3). As is typical of Manitoba lakes (CAMP 2017), primary productivity is low in Lake St. Martin during the ice cover season but increases throughout the open water period (Figure IAAC-35-5).

LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS

Question IAAC-35

Dauphin River

Chlorophyll α concentrations measured in the Dauphin River prior to 2011 indicate that primary productivity was moderate (as defined by Dodds et. al. 1998); concentrations ranged from 1.15 to 9.00 $\mu\text{g/L}$ (NSC 2016a). Subsequent chlorophyll α measurements conducted from 2011 to 2015 fell within this range (Table IAAC-35-3). As observed in other Project waterbodies, chlorophyll α concentrations in the Dauphin River tend to be lowest during periods of ice cover but increase throughout the open water season (Figure IAAC-35-6).

Big Buffalo Lake and Buffalo Creek

Chlorophyll α concentrations measured in Buffalo Creek ranged from 0.37 to 5.64 $\mu\text{g/L}$ (NSC 2016a; Table IAAC-35-3; Figure IAAC-35-7), indicating that the creek had moderate primary productivity (as defined by Dodds et. al. 1998). Seasonal trends in chlorophyll α concentrations in Buffalo Creek were less apparent than in other waterbodies in the LAA. However, the limited data from Big Buffalo Lake suggests that chlorophyll α occurs in low concentration during periods of ice cover but increases throughout the open water period (Figure IAAC-35-7).

Sturgeon Bay

Chlorophyll α concentrations measured in Sturgeon Bay prior to 2011 indicated that primary productivity in the bay was moderate (as defined by OECD 1982) with concentrations ranging from 4.9 to 10.7 $\mu\text{g/L}$ (Table IAAC-35-3). Chlorophyll α concentrations remained within this range during sampling between 2011 and 2015 (Table IAAC-35-3; Figure IAAC-35-8). Chlorophyll α concentrations were generally consistent throughout the bay and, similar to other waterbodies in the LAA, concentrations were lowest in the winter and increased throughout the open-water season (Figure IAAC-35-8).

**LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT
RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS**

Question IAAC-35

Table IAAC-35-3 Chlorophyll α Concentrations Measured in the Local Assessment Area Waterbodies During Lake St. Martin Emergency Outlet Channel Monitoring, 2011-2015. Modified from NSC (2016a)^a

Site ID	Period	Chlorophyll α ($\mu\text{g/L}$)						
		Mean	Median	Min	Max	SE	n	%>DL
Fairford River								
FR1	Pre-2011 Flood	5.84	4.49	<0.50	19.5	1.13	16	94
	2011 Flood	8.61	8.02	1.53	14.5	0.823	16	100
	2011/2012 Operation	7.22	6.42	1.07	15.3	1.16	15	100
	2011/2012 Closure	3.41	2.67	0.90	8.29	0.510	17	100
	2014/2015 Operation	5.90	6.20	3.62	7.22	0.413	8	100
	2014/2015 Closure	-	-	-	-	-	0	-
Lake St. Martin								
LSM1	2011 Flood	6.85	6.85	6.85	6.85	-	1	100
	2011/2012 Operation	4.86	4.41	3.48	7.14	0.792	4	100
	2011/2012 Closure	4.10	4.67	0.50	6.86	0.956	7	100
	2014/2015 Operation	4.46	5.89	0.76	6.72	1.864	3	100
	2014/2015 Closure	-	-	-	-	-	0	-
LSM2	2011 Flood	6.98	6.98	6.98	6.98	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-

LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT
RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS

Question IAAC-35

Table IAAC-35-3 Chlorophyll α Concentrations Measured in the Local Assessment Area Waterbodies During Lake St. Martin Emergency Outlet Channel Monitoring, 2011-2015. Modified from NSC (2016a)^a

Site ID	Period	Chlorophyll α ($\mu\text{g/L}$)						
		Mean	Median	Min	Max	SE	n	%>DL
Big Buffalo Lake								
BBL	2011 Flood	-	-	-	-	-	0	-
	2011/2012 Operation	-	-	-	-	-	0	-
	2011/2012 Closure	3.94	2.51	1.34	7.96	2.04	3	100
	2014/2015 Operation	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-
Buffalo Creek								
BC1	2011 Flood	0.51	0.51	0.51	0.51	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-
BC2	2011 Flood	0.37	0.37	0.37	0.37	-	1	100
	2011/2012 Operation	3.89	3.89	3.89	3.89	-	1	100
	2011/2012 Closure	-	-	-	-	-	0	-
	2014/2015 Operation	-	-	-	-	-	0	-
	2014/2015 Closure	-	-	-	-	-	0	-
BC3	2011 Flood	0.52	0.52	0.52	0.52	-	1	100
	2011/2012 Operation	2.33	2.30	1.54	3.20	0.369	4	100
	2011/2012 Closure	3.21	2.79	1.98	5.64	0.650	5	100
	2014/2015 Operation	2.23	2.56	0.61	3.72	0.542	5	100
	2014/2015 Closure	-	-	-	-	-	0	-

LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT
RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS

Question IAAC-35

Table IAAC-35-3 Chlorophyll α Concentrations Measured in the Local Assessment Area Waterbodies During Lake St. Martin Emergency Outlet Channel Monitoring, 2011-2015. Modified from NSC (2016a)^a

Site ID	Period	Chlorophyll α ($\mu\text{g/L}$)						
		Mean	Median	Min	Max	SE	n	%>DL
Dauphin River								
DR-A	2011 Flood	7.93	7.93	7.93	7.93	-	1	100
	2011/2012 Operation	5.03	4.66	3.98	6.44	0.733	3	100
	2011/2012 Closure	4.00	4.52	0.71	7.12	0.885	7	100
	2014/2015 Operation	4.28	5.83	0.62	6.38	1.835	3	100
	2014/2015 Closure	-	-	-	-	-	0	-
DR-B	Pre-2011 Flood	5.52	5.86	1.15	9.00	0.802	12	100
	2011 Flood	4.06	4.06	1.15	6.97	2.91	2	100
	2011/2012 Operation	4.71	4.03	1.91	8.55	0.588	11	100
	2011/2012 Closure	3.23	4.02	0.47	6.44	0.476	17	100
	2014/2015 Operation	4.73	5.35	0.72	5.88	0.518	9	100
	2014/2015 Closure	-	-	-	-	-	0	-
DR-C	2011 Flood	5.83	5.83	5.83	5.83	-	1	100
	2011/2012 Operation	4.22	4.22	4.21	4.22	0.003	3	100
	2011/2012 Closure	3.50	4.11	0.52	5.68	0.797	7	100
	2014/2015 Operation	3.74	4.22	0.80	5.45	0.779	5	100
	2014/2015 Closure	-	-	-	-	-	0	-
DR-D	2011 Flood	5.98	5.98	5.98	5.98	-	1	100
	2011/2012 Operation	-	-	-	-	-	0	-
	2011/2012 Closure	-	-	-	-	-	0	-
	2014/2015 Operation	5.10	5.10	5.10	5.10	-	1	100
	2014/2015 Closure	-	-	-	-	-	0	-

LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT
RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS

Question IAAC-35

Table IAAC-35-3 Chlorophyll α Concentrations Measured in the Local Assessment Area Waterbodies During Lake St. Martin Emergency Outlet Channel Monitoring, 2011-2015. Modified from NSC (2016a)^a

Site ID	Period	Chlorophyll α ($\mu\text{g/L}$)						
		Mean	Median	Min	Max	SE	n	%>DL
DR-E	2011 Flood	5.75	5.75	5.75	5.75	-	1	100
	2011/2012 Operation	4.27	4.23	4.16	4.41	0.074	3	100
	2011/2012 Closure	3.70	4.82	0.56	5.23	0.802	7	100
	2014/2015 Operation	3.89	4.37	0.95	5.45	0.826	5	100
	2014/2015 Closure	-	-	-	-	-	0	-
Sturgeon Bay								
LKW3B	2011 Flood	-	-	-	-	-	0	-
	2011/2012 Operation	5.06	5.27	3.39	6.52	0.910	3	100
	2011/2012 Closure	3.62	4.39	0.59	6.11	0.788	7	100
	2014/2015 Operation	3.56	2.37	1.45	6.78	1.00	5	100
LKW3	2011 Flood	7.04	7.04	7.04	7.04	-	1	100
	2011/2012 Operation	4.11	4.14	2.29	5.88	0.835	4	100
	2011/2012 Closure	3.25	2.86	0.50	6.31	0.818	7	100
	2014/2015 Operation	5.91	5.08	4.23	8.42	1.28	3	100
LKW2	2011 Flood	7.33	7.33	7.33	7.33	-	1	100
	2011/2012 Operation	3.72	3.48	3.20	4.71	0.338	4	100
	2011/2012 Closure	3.05	3.31	0.55	5.88	0.730	7	100
	2014/2015 Operation	4.20	5.04	1.69	5.87	1.278	3	100
LKW1	2011 Flood	14.7	14.7	14.7	14.7	-	1	100
	2011/2012 Operation	3.29	3.39	2.76	3.64	0.205	4	100
	2011/2012 Closure	2.42	2.58	0.13	4.58	0.617	7	100
	2014/2015 Operation	4.94	4.00	3.35	8.41	1.167	4	100

**LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT
RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS**

Question IAAC-35

Table IAAC-35-3 Chlorophyll α Concentrations Measured in the Local Assessment Area Waterbodies During Lake St. Martin Emergency Outlet Channel Monitoring, 2011-2015. Modified from NSC (2016a)^a

Site ID	Period	Chlorophyll α ($\mu\text{g/L}$)						
		Mean	Median	Min	Max	SE	n	%>DL
LKW4	2011 Flood	13.3	13.3	13.3	13.3	-	1	100
	2011/2012 Operation	3.51	3.03	2.73	5.27	0.593	4	100
	2011/2012 Closure	2.97	3.09	0.46	5.95	0.707	7	100
	2014/2015 Operation	4.35	3.17	2.80	7.08	1.37	3	100
LKW5	2011 Flood	11.0	11.0	11.0	11.0	-	1	100
	2011/2012 Operation	3.62	3.75	2.35	4.63	0.472	4	100
	2011/2012 Closure	2.34	2.48	0.40	3.73	0.550	7	100
	2014/2015 Operation	4.09	3.58	1.95	6.75	1.41	3	100
LKW6	2011 Flood	8.62	8.62	8.62	8.62	-	1	100
	2011/2012 Operation	3.30	3.13	1.24	5.68	0.923	4	100
	2011/2012 Closure	1.97	2.59	0.46	2.91	0.386	7	100
	2014/2015 Operation	4.37	3.98	2.11	7.42	1.27	4	100
LKW7	2011 Flood	10.6	10.6	10.6	10.6	-	1	100
	2011/2012 Operation	3.31	3.00	2.25	4.99	0.603	4	100
	2011/2012 Closure	3.88	2.61	0.43	14.5	1.83	7	100
	2014/2015 Operation	4.35	3.30	1.92	8.89	1.56	4	100
MB05SES012	Pre-2011 Flood	4.87	3.44	1.15	10.7	1.68	6	100
	2011 Flood	-	-	-	-	-	0	-
	2011/2012 Operation	5.26	4.28	4.01	7.48	1.11	3	100
	2011/2012 Closure	4.01	4.01	1.72	6.30	2.29	2	100
	2014/2015 Operation	3.25	3.25	2.10	4.39	1.15	2	100

^a Sample sites are identified on Figure IAAC-35-1. Additional data provided by the Province of Manitoba is included. Samples sites for those data area provided on Figure IAAC-35-3.

LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS

Question IAAC-35

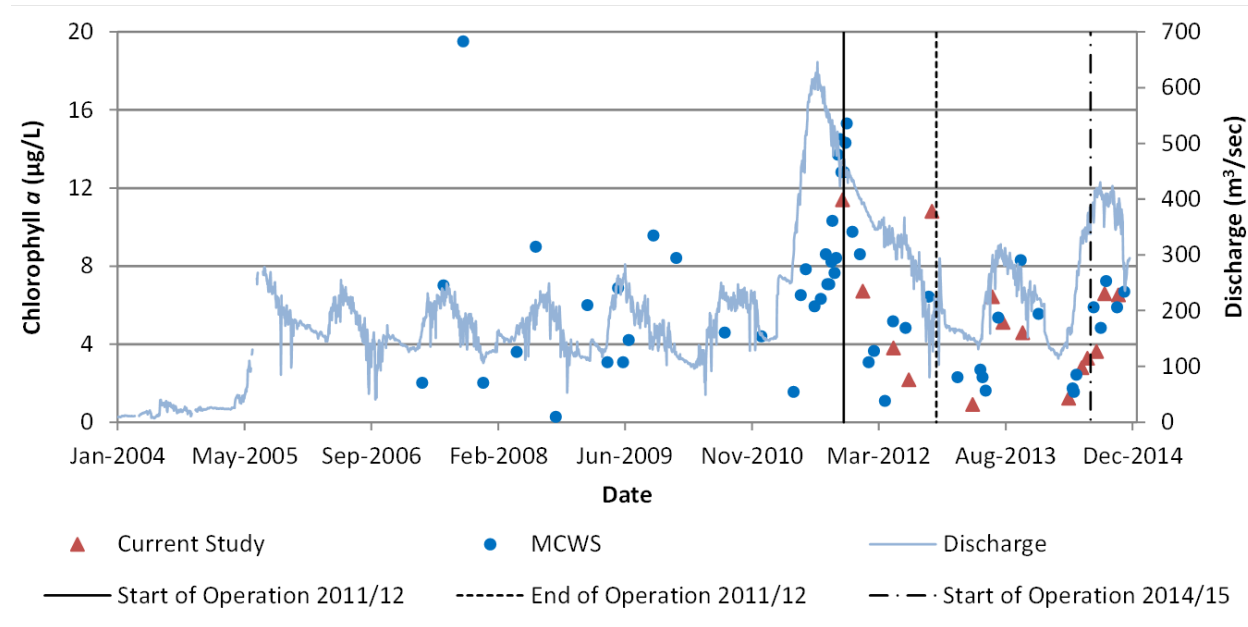


Figure IAAC-35-4 Chlorophyll α Concentrations in the Fairford River, 2004-2014 (start and end of EOC operation is designated by vertical lines)

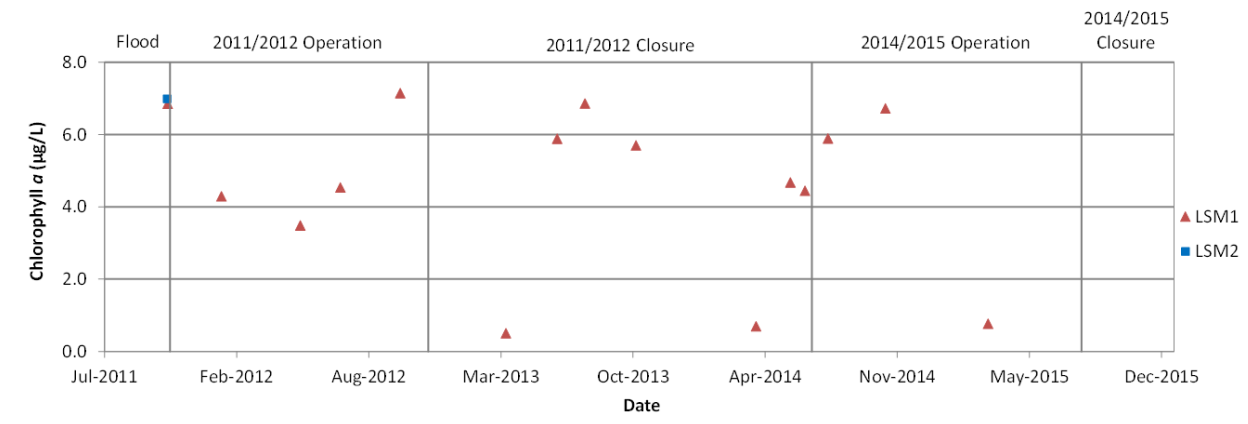


Figure IAAC-35-5 Chlorophyll α Concentrations at Sampling sites LSM1 and LSM2 in the north basin of Lake St. Martin, 2011-2015 (Operation and Closure Periods for EOC are Delineated by Vertical Lines)

LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS

Question IAAC-35

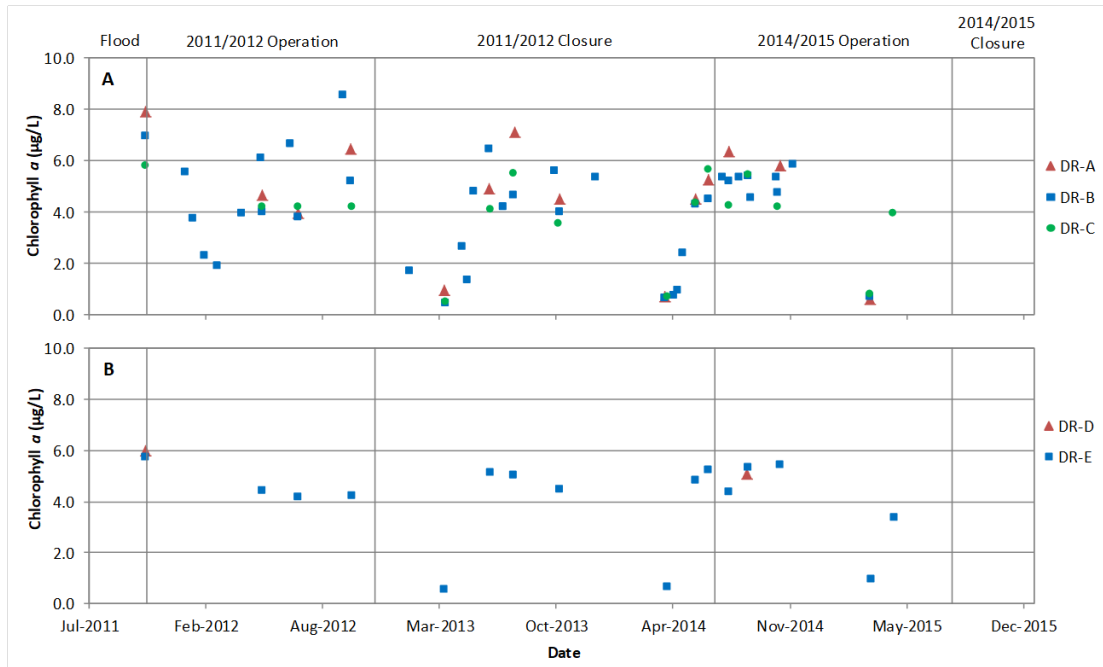


Figure IAAC-35-6 Chlorophyll α Concentrations in the Dauphin River (A) upstream and (B) Downstream of Buffalo Creek, 2011-2015 (Operation and Closure Periods for EOC are Delineated by Vertical Lines)

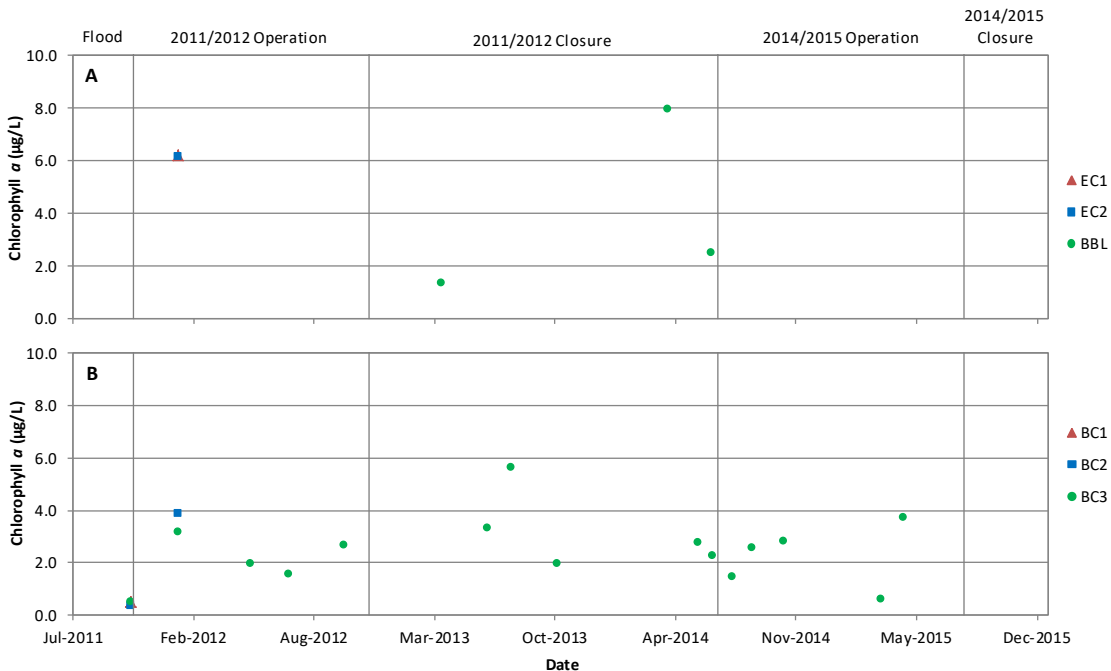


Figure IAAC-35-7 Chlorophyll α Concentrations in (A) Reach1, Big Buffalo Lake, and (B) Buffalo Creek from 2011-2015 (Operation and Closure Periods for EOC are Delineated by Vertical Lines)



LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS

Question IAAC-35

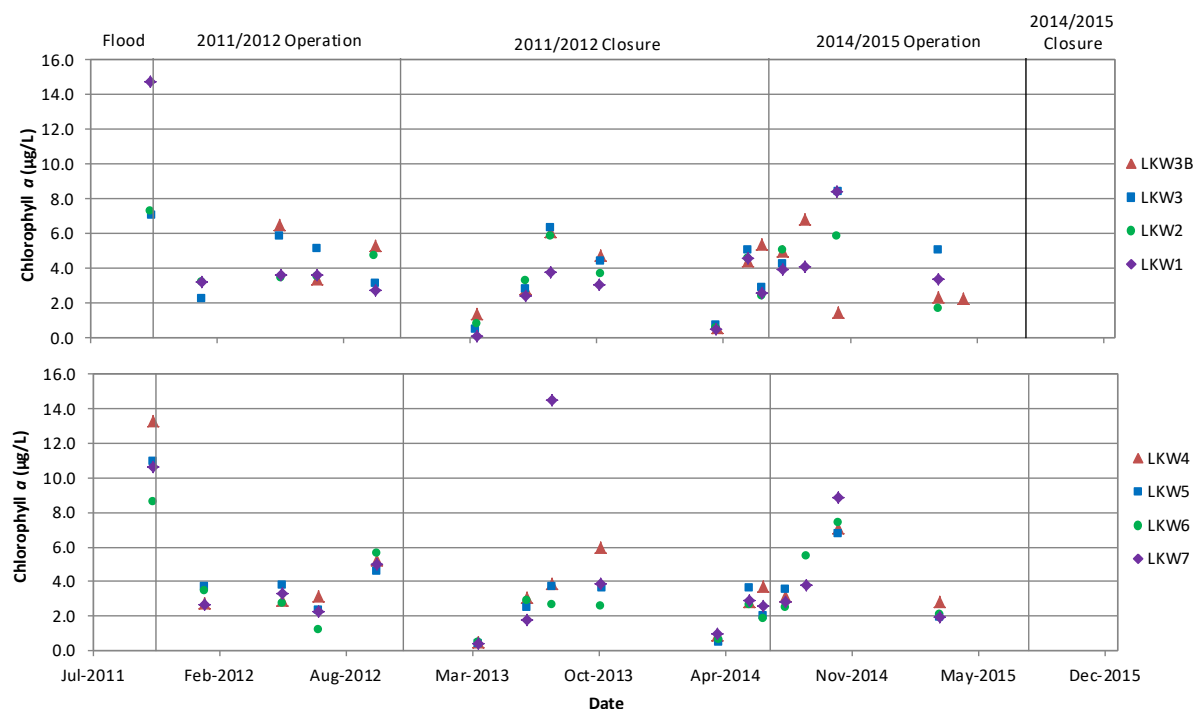


Figure IAAC-35-8 Chlorophyll α Concentrations in Sturgeon Bay, 2011-2015 (Operation and Closure Periods for EOC are Delineated by Vertical Lines)

Secondary Productivity

Sources and Methods of Baseline Data Collection

The composition and abundance of benthic macroinvertebrates were used as indicators of secondary productivity in waterbodies within the LAA. Benthic invertebrate data used to support the Project EIS were provided by several sources, including data collected as part of EOC monitoring programs (2011-2015), baseline data collections conducted to support the Project (fall 2015 – fall 2018) and from available literature.

Benthic invertebrate data were collected from Sturgeon Bay as part of EOC monitoring in fall 2011 and fall 2013 (NSC 2016b) as follows:

- Samples were collected from several sites along transects oriented perpendicular to the shoreline and extending 3-4 km offshore (Figure IAAC-35-9).
- Samples from 2011 were comprised of a single benthic grab collected opportunistically during substrate sampling. In contrast, benthic invertebrate samples collected in 2013 were comprised of three benthic grabs which were pooled to comprise a single sample.
- Benthic invertebrate samples were also collected from nearshore areas (water depth < 1.0 m) with a 500 μm mesh kick net in 2013. In both years, invertebrate data were analyzed by habitat type.

LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS

Question IAAC-35

Benthic invertebrate data collected as part of Project baseline included:

- Baseline invertebrate collections at four lake sites during fall 2015 and at alternate route options for the LMOC in spring 2016. Benthic invertebrates were collected from nearshore habitats using a 500 µm mesh kick net and were focussed at potential channel inlets and outlets. Sampling effort included collection of 10 kick net samples per location. Invertebrate data were pooled by sampling location to provide a general description of the benthic invertebrate community at each location. Results are presented in AAE Tech Services (2016). Sampling sites included:
 - o Lake Manitoba at Fairford;
 - o Lake Manitoba at Watchorn Bay;
 - o Lake St. Martin at Harrison Bay; and
 - o Lake St. Martin at Birch Bay.
- Baseline invertebrate collections in fall 2018 in close proximity to the inlet of the LSMOC in Lake St. Martin, the outlet of the LSMOC in Sturgeon Bay and an additional reference area in Sturgeon Bay. Sampling was comprised of five replicate benthic grab samples at each location. Each benthic sample was comprised of five pooled grabs. Results are provided in NSC (2019b).

Seasonal Variability

Baseline descriptions of benthic invertebrate communities for waterbodies in the LAA provided in the EIS are derived from fall sampling events which, in most cases, include only a single year of sampling. The only exception is for Sturgeon Bay, where fall samples were collected during 2011, 2013, and 2018. It is not possible to provide an assessment of seasonal variability in benthic communities with the data that are currently available. Seasonal variability of benthic macroinvertebrates (BMI) is rarely informative for assessing project effects as it is highly variable. This is due to the difficulty identifying small instars early in the season, and due to the variability between taxa in reproductive seasons, growth rates, and emergence. Fall is the time of year when BMI communities are most stable and when the larvae are largest and most easily identifiable. For these reasons the assessment focused on benthic communities during fall.

LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS

Question IAAC-35

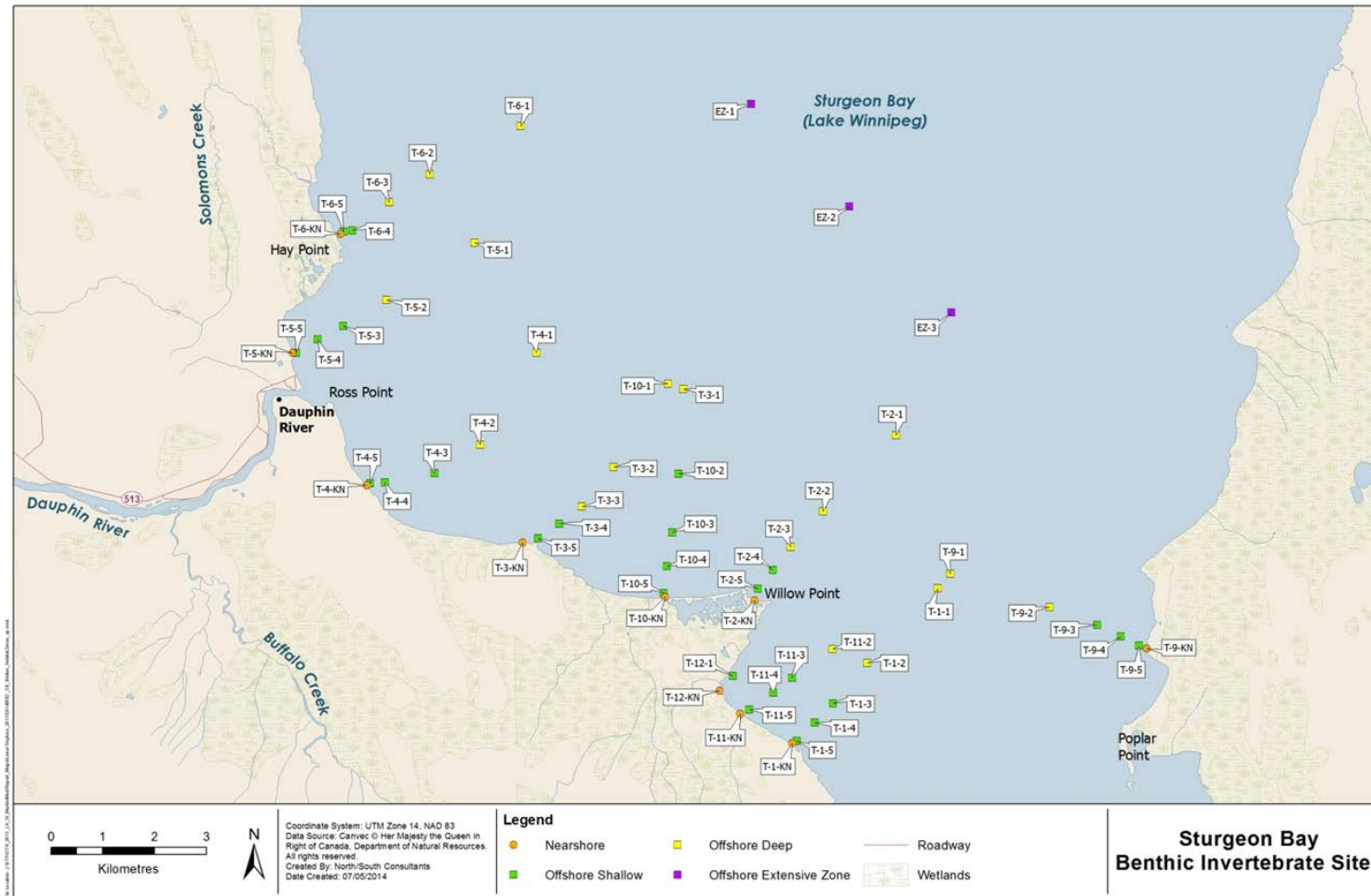


Figure IAAC-35-9 Benthic Invertebrate Sample Site Locations, by Habitat Type, in Sturgeon Bay, fall 2011 and 2013; Kick Net Sampling Sites are Indicated by the Inclusion of “KN” in the Site Name

LAKE MANITOBA AND LAKE ST. MARTIN OUTLET CHANNELS PROJECT RESPONSE TO IAAC TECHNICAL INFORMATION REQUESTS

Question IAAC-35

References

AAE Tech Services Inc. 2016. Fisheries and Aquatic Habitat Baseline Assessment. Lake Manitoba Outlet Channel Route Options. Manitoba Infrastructure, Winnipeg, MB.

Dodds, W.K., E.R. Jones, and E.B. Welch. 1998. Suggested classification of stream trophic state: distributions of temperate stream types by chlorophyll, total nitrogen and phosphorous. *Wat. Res.* 32: 1455-1462.

North/South Consultants Inc. 2016a. Volume 3: Water Quality. Lake St. Martin Emergency Outlet Channel Assessment of Effects and Development of Offsetting. Manitoba Infrastructure and Transportation. Winnipeg, MB.

North/South Consultants Inc. 2016b. Volume 4: Aquatic Habitat. Lake St. Martin Emergency Outlet Channel Assessment of Effects and Development of Offsetting. Manitoba Infrastructure and Transportation. Winnipeg, MB.

North/South Consultants Inc. 2019b. Lake Manitoba and Lake St. Martin Outlet Channel Project: Benthic Invertebrate Investigations 2018. Manitoba Infrastructure, Winnipeg, MB.

Organization for Economic Cooperation and Development (OECD). 1982. Eutrophication of waters: monitoring, assessment and control. Final Report. OECD cooperative programme of monitoring of inland waters. (eutrophication control). Environment Directorate, OECD, Paris, France. 154 p.