MANITOBA FLOODWAY AUTHORITY

RED RIVER FLOODWAY EXPANSION PROJECT

2008 GROUNDWATER MONITORING ACTIVITY REPORT

FINAL REPORT
MARCH 2009

KGS Group Project: 05-1100-01.19.12.06
Reference Number: .9905242 HM50

KGS Group
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March 27, 2009

File No: 05-1100-01.19.12.06

Manitoba Floodway Authority
200 – 155 Carlton Street
Winnipeg, MB
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ATTENTION: Mr. Doug McNeil, P.Eng.
Vice President, Engineering and Construction

RE: Red River Floodway Expansion Project
Groundwater Monitoring Activity Report
Reference Number: .9905242 HM50
Final Report

Dear Mr. McNeil:

Please find enclosed twenty (20) copies of the final 2008 Groundwater Monitoring Activity Report for your use. The report combines requirements for baseline monitoring and annual monitoring in Environmental Licence 2691 (including construction monitoring) for the 2008 period. Because of privacy issues and the volume of data, detailed information is not presented here, but will be made available to the Manitoba Floodway Authority if required.

We appreciate the opportunity to provide on-going services to the Manitoba Floodway Authority on this project.

Sincerely,

J. Bert Smith, P.Eng.
Channel Design Manager

JBS/mfh/mlb
Enclosure

cc: Mr. Doug Peterson, Manager, Environmental Services – MFA
Mr. Dave MacMillan, Project Manager – KGS Group

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1.0 INTRODUCTION AND AQUIFER CHARACTERIZATION

This report is submitted in response to the requirements for annual (construction) monitoring for 2008 in accordance with Clause 27 and Clause 30 of Environmental Licence No. 2691 dated July 8, 2005. Groundwater activities for 2005 and 2006 were summarized in the 2006 Groundwater Monitoring Activity Report, which should be used as a reference to this report. Activities for 2007 are summarized in the 2007 Groundwater Monitoring Activity Report.

Data gathered during the monitoring programs has been analyzed and interpreted to address environmental issues. The interpretations given in this report are preliminary and further study is required to confirm them.

Three monitoring events were conducted in 2008:

- March 2008 – Pre-Spring Runoff (no Floodway Operation)
- April 2008 – Spring runoff (no Floodway Operation – approximate peak April 19, 2008)
- September 2008 – Fall (no Floodway Operation)

The carbonate aquifer found along the Floodway Channel is part of a regional flow system from eastern Manitoba. The confined carbonate bedrock aquifer has natural variations in water quality, with the conductivity ranging from moderate to high (1,000 to 2,000 µS/cm). Locally near the Floodway Inlet, mixing with saline groundwater from southwest Manitoba results in higher conductivity (greater than 3,000 µS/cm) groundwater with increased chloride and sodium. Conductivity is a measure of dissolved solids, such as calcium, magnesium, chloride, sodium and sulphate.

Lower conductivity values are found in the bedrock aquifer where it is influenced by the Birds Hill surficial granular aquifer, from CPR Keewatin Bridge to Church Road. The Birds Hill sand and gravel is a local unconfined aquifer near PTH 59N Bridge. Bedrock beneath and surrounding the Birds Hill deposit has lower groundwater conductivity due to the freshwater recharge through the sand and gravel. Natural variations in groundwater quality with area and with the seasons must be considered when the baseline and ongoing water quality results are evaluated during construction activities and Floodway Operation events. In the vicinity of the Bird's Hill sand and gravel surficial aquifer, recharge from precipitation forms groundwater with lower conductivity (500 µS/cm to 1,000 µS/cm) than other areas of the carbonate aquifer.

The intrusion of any surface water into the groundwater is easiest to detect when the chemical contrast between the two is greatest. Most groundwater conductivity values were greater than surface water conductivity measured during spring Floodway Operation, when river conductivity values were lowest. In this situation, most parameters would be expected to decrease if surface water intruded. During summer Floodway Operation in 2005 and floodway use in 2007, river conductivity values were slightly higher than in the spring, and higher than the natural groundwater in some areas near the CPR Keewatin Bridge, PTH 59N Bridge and Church Road. Floodway channel surface water conductivity is also higher in June 2008 than April 2008, with the spring event representing spring melt and the summer event reflecting precipitation with no Floodway Operation. An increase in some parameters might occur in summer if surface water intruded the groundwater at this time.

2.0 DOMESTIC WELLS

2.1 INTRODUCTION

Approximately 200 wells were sampled in 2008 during each of the March, April and September sampling events. A core list of wells is targeted for sampling every year, with additional wells added for construction monitoring as needed. Because homeowners are not always available, or sample tap locations may not be suitable, the list of wells varies slightly among events. In 2008, wells at 227 residences were sampled at least once. The distribution of these wells is shown on Figure HM50-1. Individual well owners received copies of their laboratory analysis after each sampling event.

The electronic well inventory database was expanded and updated in 2008. It contains all homeowner interview information, field sampling results and links to water chemistry results. The inventory is being used with the Floodway GIS database on an on-going basis and has been a resource when investigating public inquiries and during temporary groundwater depressurization activities at construction sites such as bridges, the Aqueduct, Kildare Flood Pumping Station, Oasis Road cutoff wall and the Outlet Control Structure. Since 2005, domestic well inventories have been conducted at approximately 733 locations, with 113 other locations identified and georeferenced.

Changes in domestic well water quality consists of increases or decreases in various parameters. An increase could also be caused by local infiltration or well installation conditions. Increases in parameters would be expected from an influx of surface contaminants such as from septic fields, changes in well water quality due to a change in water elevation in the well, and changes in the bedrock aquifer flow system. These changes could occur without direct infiltration of floodway surface water into the groundwater due to septic fields or other causes. Increases in nitrate + nitrite (as nitrogen) or bacteria may be associated with floodway surface water infiltration, since these parameters are generally higher in floodway water than in the aquifer.

Since the Floodway receives surface water from the Seine River and various Municipal drains and outfalls, the channel can carry a substantial flow, even when the gates are not operated to

allow the Red River to enter. The Spring 2008 spring melt represents the first spring monitoring without Floodway Operations since monitoring for the expansion began in 2003. Periods of high rainfall in the summer can also fill the base of the Floodway. These events result in groundwater elevation changes, and in some cases water quality changes in areas where strong upward groundwater gradients are absent.

2.2 BACTERIA

Positive detection of Total Coliform bacteria in domestic wells in 2008 was low and did not correlate with the spring melt period in April or construction activities. In 2008, most of the samples analyzed had no Total Coliform bacteria. In March 2008, 9 of 169 (5%) of samples tested positive for Total Coliform, similar to 2007. Detections in April 2008 during the spring melt, but with no Floodway Operation were 20 of 178 (11%), similar to previous years with a spring floodway operation. Total Coliform was detected slightly more frequently to September 2008, in 34 of 192 (18%) samples tested.

Most positive detections of Total Coliform bacteria in 2008 have occurred north of the TransCanada Highway Bridge. In 2008 four wells south of the TCH 1 Bridge (near the PTH 59S bridge had positive detections of Total Coliform. There was no association between Total Coliform bacteria detection and the spring melt (with no Floodway Operation). Clusters of wells with positive Total Coliform bacteria can be seen in higher density developments. All wells are assumed to be developed in the bedrock aquifer based on drilling records examined in selected areas.

E. Coli bacteria was not detected in any wells in March 2008 prior to the Spring melt. *E. Coli* was detected during non-operating periods in 1 of 178 of wells in April 2008 and 1 of 192 wells in September 2008. All homeowners were notified if they had positive bacteria results.

Further study is required before conclusions can be made about the source of the bacteria presence.

2.3 NITRATE+NITRITE (AS NITROGEN)

Most nitrate + nitrite (as N) values throughout the study area are well below the Canadian Drinking Water Quality Guideline (CDWQG) value of 10 mg/L nitrate + nitrite (as N). In March, April and September 2008, 62% to 72% of nitrate + nitrite (as N) samples were less than detection (0.01 mg/L) and 97% of the values were less than 1 mg/L. In March 2008 86% of wells had values form from 0.01 to 1 mg/L, although the reason for this is not clear. Values from 5 to 10 mg/L were found in one well near the outlet in April (1%) and in the same well at values greater than 10 mg/L in September 2008. No changes in these broad ranges were seen during spring melt conditions.

2.4 PESTICIDES

The pesticides analyzed are used in local agricultural practice. Pesticides were not detected in the 10 domestic wells sampled in 2008, except atrazine which was found at a concentration of 0.2 µg/L, slightly over the detection limit of 0.1 µg/L, and below the CCME Drinking Water Interim Maximum Acceptable Concentration of 5 µg/L.

2.5 CONDUCTIVITY

If spring floodway surface water intruded into the aquifer, the mixing would result in a concentration decrease of most groundwater quality parameters (as shown by conductivity) in most areas. The change could be seen most readily in areas of more mineralized groundwater with higher conductivity values. Increases could be seen in some areas of low conductivity baseline groundwater. Conductivity changes have been used as an indicator of surface water influence to evaluate changes in water quality.

For the 2008 spring melt (with no Floodway Operation), no obvious water quality change was seen in 86% of the approximately 178 domestic wells sampled. Only 25 wells (14%) showed possible slight to moderate decreases in conductivity. The wells currently selected for the sampling programs are in areas of higher sensitivity with potential for interconnection where changes may be more likely to occur. The decreases were rated as slight to minor for all but four well sites that were rated as moderate. All but one of the domestic wells with conductivity

decreases are located from north of PTH15 Bridge to the Floodway Outlet. One is located near the Floodway Inlet adjacent to the Red River

2.6 RELATIONSHIP AMONG PARAMETERS

Total Coliform presence was not strongly correlated with decreases in conductivity in 2008. Total Coliform was present in only 5 wells of the 25 wells that showed decreases in conductivity. An increase in nitrate + nitrite (as N) was also not strongly correlated with the decreases in conductivity. Increases in nitrate + nitrite (as N) were found in 3 of the 25 wells that showed decreases in conductivity. The increases found in nitrate + nitrite (as N) ranged from 0.8 to 3.1 mg/L in these wells, which are all located near the Floodway Outlet or Lockport and all had previous elevated nitrate concentrations in the past. None of the wells showed a conductivity decrease associated with both a Total Coliform presence and a nitrate + nitrite (as N) increase.

The cause of the water quality changes noted is under evaluation and will require additional follow-up study.

3.0 MONITORING WELLS

3.1 INTRODUCTION

In 2008 monitoring well samples were collected primarily within the Floodway Channel Right-of-Way from approximately 41 bedrock wells, 10 till wells adjacent to the floodway, plus 7 sand and gravel wells (Oasis Road area only). During the spring melt 31 wells were sampled including 26 bedrock wells and 5 sand and gravel wells. Monitoring well locations are shown in Figure HM50-2 along with additional wells installed at the Outlet Structure and at Oasis Road. Conductivity in the monitoring wells generally shows the same distribution along the floodway as for the domestic wells. Bacteria was not sampled in monitoring wells in 2008. It is not feasible to disinfect the 2-inch standpipes sufficiently to eliminate sediment, which can naturally carry Total Coliform bacteria. Larger diameter provincial wells do not have the sanitary protection needed for reliable bacteria monitoring.

3.2 NITRATE-NITRITE (AS NITROGEN)

Nitrate + nitrite (as N) concentrations in monitoring wells in 2007 were generally very low, below 0.3 mg/L, with a few up to 0.5 mg/L. In 2007 elevated nitrate + nitrite (as N) up to 2.8 mg/L had been found during flood events in three bedrock monitoring wells at the Floodway Outlet, and in one bedrock monitoring well (up to 1.0 mg/L) on the west side of PTH 59N Bridge. The drinking water guideline for nitrate + nitrite (as N) is 10 mg/L. In 2008 elevated nitrate was still found during the spring melt (without Floodway Operation) at the Floodway Outlet K07-8810, but not on the west side of the PTH 59N Bridge.

3.3 PESTICIDES

The pesticides analyzed represented products used in the area for agriculture plus those intended for floodway construction use. There were no pesticides detected in the 9 monitoring wells sampled in 2008.

3.4 CONDUCTIVITY

Of the 31 wells monitored during the spring melt in 2008, 2 wells (6%) showed possible decreases in conductivity and other parameter concentrations. The decreases were rated as minor (10% to 25% change) to moderate (25 to 50%) and are located at the west side of PTH 59N Bridge in overburden and bedrock wells (where the Floodway Channel is in sand and gravel over bedrock). Many of the monitoring wells are located on the shoulder of the Floodway Channel, or in the spoil pile, and would be expected to experience any changes more quickly than domestic wells located beyond the Floodway Right-of-Way. Further study is required to determine the cause of these water quality changes.

3.5 RELATIONSHIP AMONG PARAMETERS

Nitrate values did not increase during the spring melt in the 2 wells where decreases in conductivity occurred.

3.6 WATER LEVELS

In 2008, water level measurements were taken during all three groundwater monitoring periods and during work at sites of temporary construction dewatering. Water level measurements from 10 provincial monitors with chart recorders also were examined. These show water levels within the range of historic data. Those wells close to temporary construction dewatering programs show the groundwater drawdown and recovery associated with the programs.

3.7 TRANSDUCER MEASUREMENTS

Data from the transducers taking continuous conductivity measurements at monitoring wells did not identify potential surface water intrusion events based on conductivity decreases, during the spring melt in 2008, except at PTH 59N Bridge west side and the Floodway Outlet.

Infiltration of floodway surface water into the bedrock aquifer was documented at PTH 59N Bridge west side at a well located within 40 m of the west channel slope within the Floodway Right-of-Way. A short-term minor to moderate decrease in conductivity was measured during

the spring melt in 2008 due to surface water flow to the Floodway (without Floodway Operation). This response is consistent with 2005 through 2007. Water quality and changes occurred concurrently with water level changes at this location, with little time lag. Water quality at the monitoring well returned to groundwater type by the time the Floodway Channel had drained from the spring runoff.

Infiltration of floodway surface water from the spring melt and/or Red River water is also seen in April 2008 at the Floodway Outlet, in a monitoring well located 350 m north of the Outlet Structure and cutoff wall, at Henderson Highway and Rockhaven Road. Conductivity measurements are lower in April during the spring melt and increase rapidly after the peak of the melt, correlating with the groundwater elevation decline.

4.0 CONSTRUCTION MONITORING

Channel excavation was essentially completed, in almost all areas of the floodway in 2008. Work on the Outlet Structure is scheduled for completion in March prior to the spring flood, with some follow-up work anticipated in the summer, 2009. Construction of the PTH 44 and PTH 15 bridges is scheduled for summer/fall 2009. The groundwater monitoring program locations were selected to provide coverage along the channel and in areas of construction for bridges, Oasis Road, the Outlet Structure, and the Kildare Land Drainage Pumping Station. Additional monitoring locations are adjusted or added to increase coverage in certain areas as construction proceeds.

Groundwater monitoring for temporary construction depressurization programs was conducted in 2008 at the Keewatin Bridge and the Floodway Outlet. Monitoring for these programs included monitoring well sampling, continuous water level measurements, domestic well sampling, additional domestic, commercial and industrial well inventories and field water level measurement programs at selected domestic, commercial and industrial wells.

At sites requiring construction depressurization of the bedrock aquifer, groundwater levels returned to normal after pumping programs stopped, with most recovery within hours and full recovery within a week. Some pumping from surface sumps is ongoing at the Floodway Outlet. Wells installed for the Keewatin Bridge program have been retained for decommissioning of the temporary bridge and for the floodway groundwater monitoring program. Wells located within the channel have been protected from flooding by waterproof seals.

The Groundwater Action Response Plan has been used effectively during construction. Public complaints during groundwater depressurization projects were minimal, with most being unrelated to operations. A summary of complaints and responses is given below.

- ***PTH 59S Bridge Groundwater Depressurization (2005) –*** One complaint; Unrelated to construction.
- ***Aqueduct Groundwater Depressurization Program (2006) –*** Complaints at four wells near the Aqueduct were resolved including one well replacement due to a collapsed casing, one pump replacement, one pump lowering and one case of temporary turbidity during aquifer recovery.

- ***Outlet Control Structure (2007- on-going) –*** One unrelated water quality complaint.

- ***Kildare Land Drainage System Groundwater Depressurization Program (2007) –*** One water supply complaint unrelated to site operations.

- ***Oasis Road Cutoff Wall Groundwater Depressurization Program (2007) –*** Well remediation was conducted in advance of construction at 6 residences. One water supply complaint due to pumping was handled through monitoring. Four water supply complaints were deemed unrelated to pumping. One of the homeowners was not satisfied with the response and the claim was referred to the Adjudication Panel for resolution. The claim was resolved in favour of the MFA. Two water quality complaints were deemed unrelated to pumping.

- ***CN Redditt Bridge (2007) –*** No Complaints

- ***CPR Keewatin Bridge (2008) –*** Groundwater remediation activities during the program included the following:

    - One business adjacent to the site was contacted by phone during the program to insure no water supply problems were encountered. No problems were encountered.
    - One resident's well was measured on request to determine the pump setting, which was deep enough to handle the projected drawdown. No problems were encountered during the program.
    - A new pump and pump protection was installed at one business to replace a pump burned out due to the regional groundwater drawdown.
    - A pump was lowered at two businesses due to the drop in the regional groundwater levels.
    - A new pump was supplied (at the owners cost) and installed and lowered (MFA cost) due to poor performance of the pump while the regional groundwater elevation was lowered.
    - One business owner was reimbursed for the cost of lowering their pump which was done prior to contacting MFA, and needed due to the regional groundwater drawdown.

Manitoba Floodway Authority also responded to several public complaints in other areas in 2005 to 2008 that were established to be unrelated to Floodway Operations.

FIGURES

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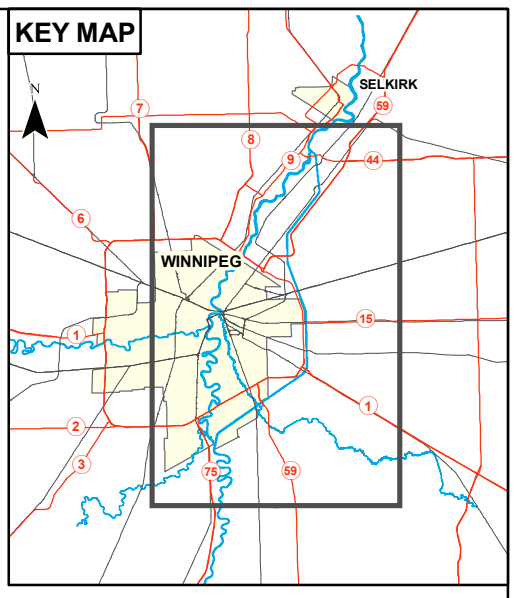
635000 640000 645000 650000

5550000 5540000 5530000 5520000

N W E S

FLOODWAY OUTLET
HWY 44
St. Andrews
RED RIVER
HAY ROAD
CHURCH ROAD
P.R. 407 LUDWIG ROAD
St. Clements
Birds Hill Provincial Park
DUNNING ROAD CROSSING
West St. Paul
East St. Paul
RM of Springfield
HWY 59 NORTH
CPR KEEWATIN BRIDGE
City of Winnipeg
HWY 15
RM of Springfield
HWY 1
HWY 59 SOUTH
RED RIVER
RM of Ritchot
RM of Tache
FLOODWAY INLET

KEY MAP



Legend

- Floodway Right of Way Limits
- Domestic Well Monitoring Area Within
  - 200m of Floodway Right of Way
  - 1km of Bridge Crossings
  - 1km of Detailed Sections
- Additional Monitoring Area Boundary
- Domestic Wells Sampled 2008
- RM Boundary

1:100,000 (11 x 17 Plot)

1 0 1 2 3 4 5

Kilometres

All units are metric and in metres unless otherwise specified.
Universal Transverse Mercator Projection, NAD 1983, Zone 14
Elevations are in metres above sea level (MSL)

MEMO REFERENCE 05-1100-01.9905242-HM50

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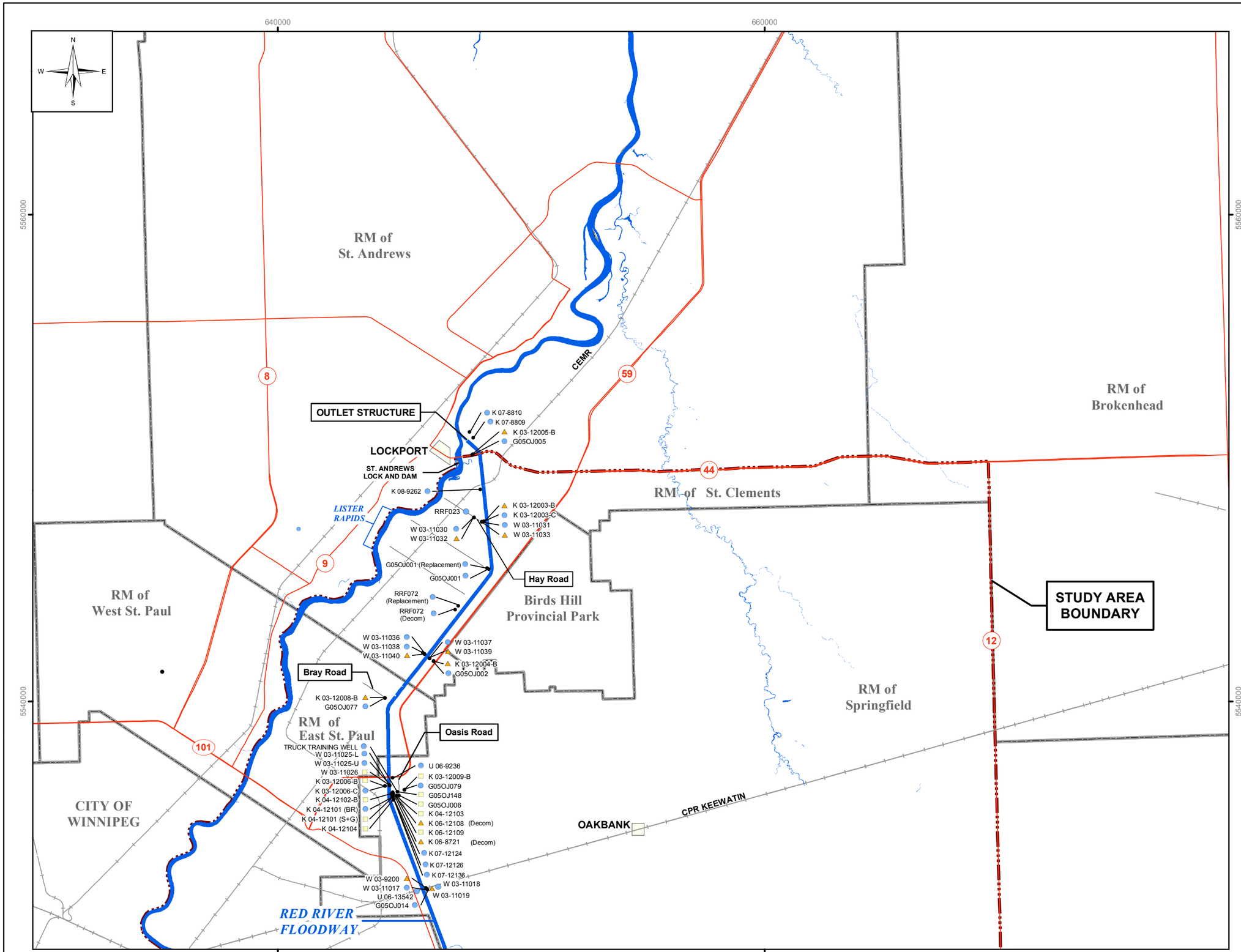
MANITOBA FLOODWAY AUTHORITY

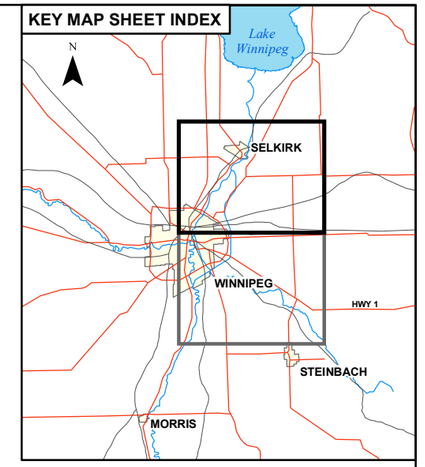
RED RIVER FLOODWAY EXPANSION

2008 GROUNDWATER MONITORING ACTIVITY REPORT

DOMESTIC WELL MONITORING LOCATIONS 2008

MARCH 2009	HM50-1	REV: 0





Monitoring Wells
- Bedrock Well
- Till Well
- Sand and Gravel Well

Topographic Features
- Primary Highways
- Railway
- Major Rivers
- RM Boundaries
- Study Area Boundary

Notes:
1. (Decom) - Decomissioned Well

1:150,000

2 0 2 4 6
Kilometres

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Universal Transverse Mercator Projection, NAD 1983, Zone 14
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MANITOBA FLOODWAY AUTHORITY

RED RIVER FLOODWAY EXPANSION

2008 GROUNDWATER MONITORING ACTIVITY REPORT

MONITORING PROGRAM
MONITORING WELL LOCATIONS
(NORTH SHEET)

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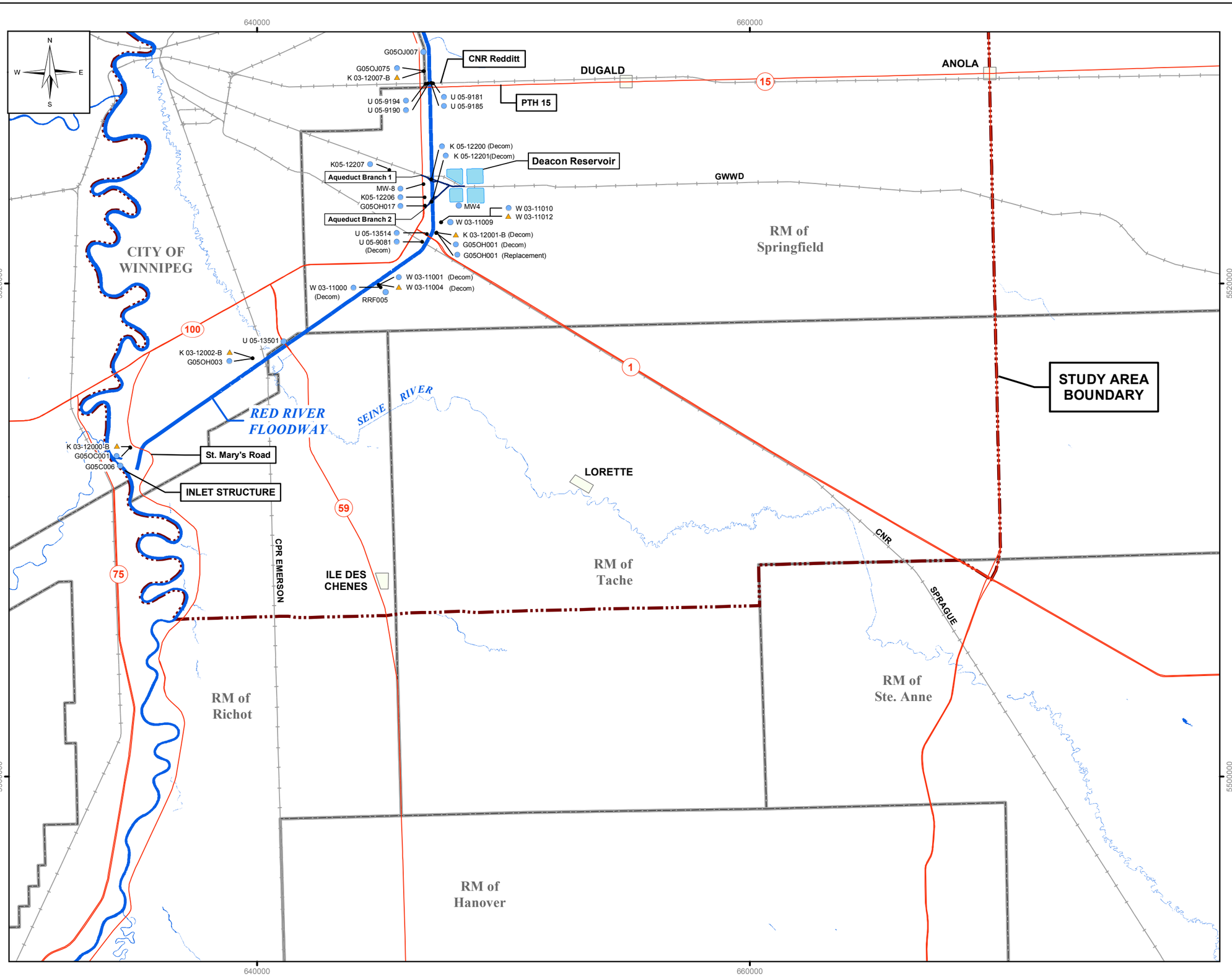
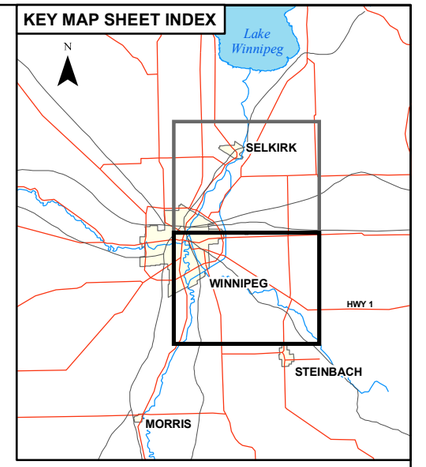


KEY MAP SHEET INDEX



Monitoring Wells
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2008 GROUNDWATER MONITORING ACTIVITY REPORT

MONITORING PROGRAM
MONITORING WELL LOCATIONS
(SOUTH SHEET)

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