MANITOBA FLOODWAY AUTHORITY

RED RIVER FLOODWAY EXPANSION PROJECT

2007 GROUNDWATER MONITORING ACTIVITY REPORT

FINAL REPORT
MARCH 2008

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TABLE OF CONTENTS

PAGE

1.0 INTRODUCTION AND AQUIFER CHARACTERIZATION

This report is submitted in response to the requirements for annual (construction) monitoring for 2007 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.

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.

Four monitoring events were conducted in 2007:

- March 2007 – Pre-Spring Runoff (no floodway operation)
- April 2007 – Spring floodway operation (which occurred from April 13 to 16, 2007)
- July 2007 – Summer period, when Red River water entered the floodway over the lip of the berm without floodway operation (from June 28 to July 2, 2007).
- September 2007 – 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. An increase in some parameters might occur if the groundwater intruded at that time.

2.0 DOMESTIC WELLS

2.1 INTRODUCTION

Approximately 200 wells were sampled during each of the March, April and September 2007 sampling events. About 45 wells were sampled during the July 2007 sampling event and 48 wells were sampled between June and November 2007 for construction monitoring purposes. 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 2007, wells at 280 residences were sampled at least once. The distribution of these wells is shown on Figure HM39-1. Individual well owners received copies of their laboratory analysis after each sampling event.

The electronic well inventory database was expanded and updated in 2007. 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 as 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 700 locations, with 125 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 contaminants 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. 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.

2.2 BACTERIA

Positive detection of Total Coliform bacteria in domestic wells in 2007 was low and did not correlate with periods of floodway operation or construction activities. In 2007, most of the samples analyzed had no Total Coliform bacteria. In March 2007, 9 of 189 (5%) of samples tested positive for Total Coliform, similar to 2005 and lower than 2006. Detections in April 2007 during floodway operation were 23 of 199 (12%), similar to previous years and similar to September 2007 31 of 213 (15%). Only wells in sensitive areas north of TCH1 Bridge were sampled during July 2007. An increase in Total Coliform was seen in July 2007 11 of 43 samples due to high precipitation.

Most positive detections of Total Coliform bacteria in 2007 have occurred north of the TransCanada Highway Bridge. There was no association between Total Coliform bacteria detection and 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 April 2007 during floodway operation. *E. Coli* was detected during non-operating periods in 2 of 189 of wells in March 2007 and 1 of 213 wells in September 2007. *E. Coli* detection was slightly higher during July 2007 (1 of 43 wells) during the high precipitation period when there was Red River flow in the floodway. 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 2007, 50% to 70% 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. Values greater than 1 mg/L and up to 5 mg/L were found in approximately 2% to 4% of domestic wells. Values from 1 to 5 mg/L were found in 2% of wells only in September 2007. These were located generally

north of Highway 59N Bridge to the Outlet in 2007. None of these well locations had a nitrate + nitrite (as N) value over 10 mg/L. No increase in these broad ranges was seen during spring floodway operation, although there were individual wells that showed slight increases (in the 0.01 to 1 mg/L range) during floodway operation. During July 2007, when there was Red River flow in the floodway, slightly higher nitrate + nitrite (as N) concentrators were observed in the limited sampling conducted.

2.4 PESTICIDES

The pesticides analyzed are used in local agricultural practice and for floodway construction. Pesticides were not detected in the 10 domestic wells sampled in 2007.

2.5 CONDUCTIVITY

If spring floodway surface water intrudes 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 2007 spring floodway operation, no obvious change in conductivity was seen in 82% of the approximate 200 domestic wells sampled. Only 32 wells (16%) showed possible slight to minor decreases in conductivity. The wells selected for sampling were 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 five well sites that were rated as moderate. All domestic wells with conductivity decreases are located from north of PTH15 Bridge to the Floodway Outlet.

2.6 RELATIONSHIP AMONG PARAMETERS

Total Coliform presence was not strongly correlated with decreases in conductivity in 2007. Total Coliform was present in only 7 wells of the 37 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 7 of the 37 wells that showed

decreases in conductivity. The increases found in nitrate + nitrite (as N) were very small, with the total concentration ranging from 0.01 mg/L to 0.6 mg/L in all wells except one near the Outlet. Three 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 2007 monitoring well samples were collected primarily within the Floodway Channel Right-of-Way from approximately 38 bedrock wells, 13 till wells adjacent to the floodway, plus 5 sand and gravel wells (Oasis Road area only). Monitoring well locations are shown in Figure HM39-2 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 2007. 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. Elevated nitrate + nitrite (as N) up to 2.8 mg/L was 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.

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 2007.

3.4 CONDUCTIVITY

Of the 37 bedrock wells and 1 sand and gravel well monitored during the spring 2007 flood events, 12 wells (32%) showed possible decreases in conductivity and other parameter concentrations. The decreases were rated as slight (less than 10%) to minor (10% to 25% change) for all but four locations. Four wells with moderate changes (greater than 25%) were found. They are located at the Floodway Inlet (where the Red River is connected to the

carbonate aquifer), at the west side of PTH 59N Bridge in overburden and bedrock wells (where the Floodway Channel is in sand and gravel over bedrock), and at the Floodway Outlet (where the Floodway Low Flow Channel is in till and the Red River is connected to 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

An increase in nitrate + nitrite (as N) was also not strongly correlated with the decreases in conductivity in most of the wells. Increases in nitrate + nitrite (as N) were found in 2 of the 13 wells that showed decreases in conductivity. The increases found in nitrate + nitrite (as N) concentrations were small, with the total concentration ranging from 0.01 mg/L to 1.0 mg/L in the two wells. Bedrock monitoring wells at the outlet (3 wells) and in the sand and gravel on the west side of PTH59 (1 well) had elevated background nitrate + nitrite (as N) concentrations throughout the year, which mask the presumed smaller nitrate + nitrate (as N) changes during the flood events.

The cause of the water quality changes noted above has not been determined and will require additional follow-up study.

3.6 WATER LEVELS

In 2007, water level measurements have been taken during all four 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 2007 floodway operation and summer 2007 floodway use, except at PTH 59N Bridge west side and the Floodway Outlet. Subtle influences on transducers were seen in 2007 at CPR Keewatin Bridge.

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 moderate decrease in conductivity was measured during both the spring and summer 2007 events, consistent with 2005 and 2006. A slight, but definitive temperature decrease was also measured during the spring 2007. Water quality and temperature changes occurred concurrently with water level changes at this location, with little time lag. Water quality returned to groundwater type by the time the Floodway Channel had drained.

Infiltration of floodway surface water and/or Red River water is also seen in April 2007 (prior to cutoff wall construction) at the Floodway Outlet, both at the Outlet Structure (100 m from the low flow channel), and in a monitoring well located 290 m east of the structure on Henderson Highway south of Rockhaven Road. Temperature profiles at both of these wells show slight decreases in temperature correlating with the groundwater elevation rise and fall. A water quality change is also seen in lower parameter concentrations in the laboratory chemical analysis for the Henderson Highway south well and another monitoring well at the Outlet Structure.

4.0 CONSTRUCTION MONITORING

Channel excavation was either complete, or under way in almost all areas of the floodway in 2007. The groundwater monitoring program locations were selected to provide coverage along the channel and in areas of construction for bridges, 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 2007 at the Kildare Flood Pumping Station, Oasis Road Cutoff Wall, the Floodway Outlet, and the CN Redditt Bridge in 2007. Pumping began at the Keewatin Bridge in the last few days of December 2007 and continued to March 20, 2008. 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 each site, groundwater levels returned to normal after pumping programs stopped, with most recovery within hours and full recovery within a week. All wells installed for these programs have either been properly decommissioned by grouting, or have been retained and protected 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.

- ***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. Two water quality complaints were deemed unrelated to pumping.

- ***CN Redditt Bridge –*** No Complaints

Manitoba Floodway Authority also responded to several public complaints in other areas in 2005 to 2007 that were established to be unrelated to floodway operations.

FIGURES

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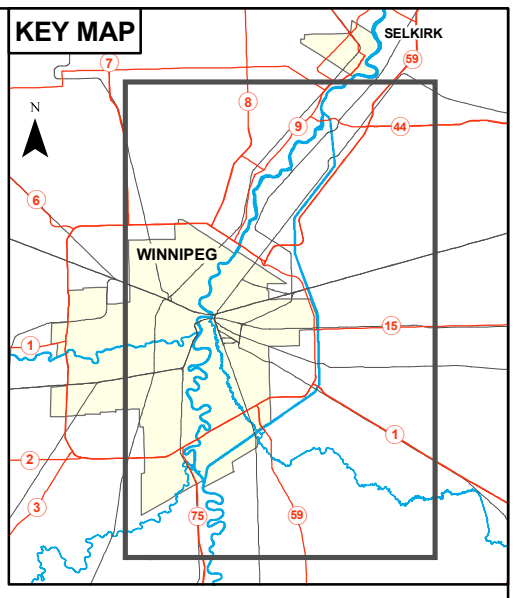
FLOODWAY OUTLET
HWY 44
St. Andrews
RED RIVER
HAY ROAD
CHURCH ROAD
P.R. 407 LUDWIG ROAD
St. Clements
Birds Hill Provincial Park
DUNNING ROAD CROSSING
West St. Paul
East St. Paul
RM of Springfield
HWY 59 NORTH
CPR KEEWATIN BRIDGE
City of Winnipeg
HWY 15
RM of Springfield
HWY 1
HWY 59 SOUTH
RED RIVER
RM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

KEY MAP



- 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 2007
- RM of Springfield
- RM Boundary

1:100,000

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)

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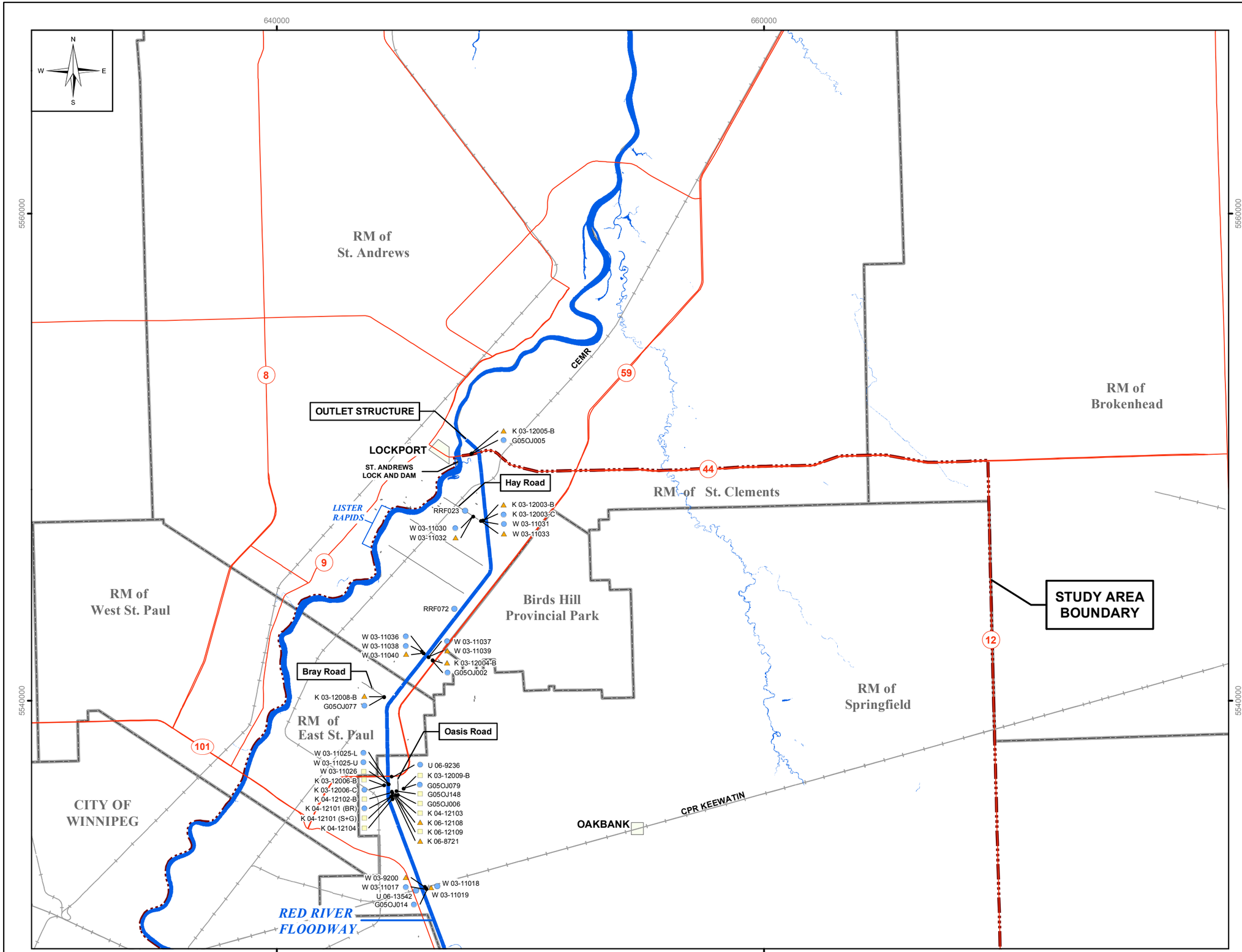
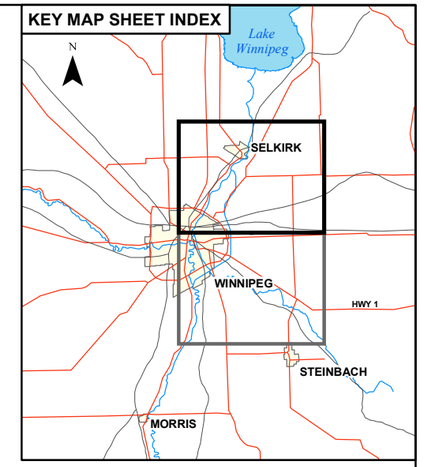
RED RIVER FLOODWAY EXPANSION		
2007 GROUNDWATER MONITORING ACTIVITY REPORT		
DOMESTIC WELL MONITORING LOCATIONS 2007		
MARCH 2008	HM39-1	REV: 0



KEY MAP SHEET INDEX



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

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

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RED RIVER FLOODWAY EXPANSION

2007 GROUNDWATER MONITORING ACTIVITY REPORT

MONITORING PROGRAM
MONITORING WELL LOCATIONS
(NORTH SHEET)

MARCH 2008	HM39-2	REV: 0

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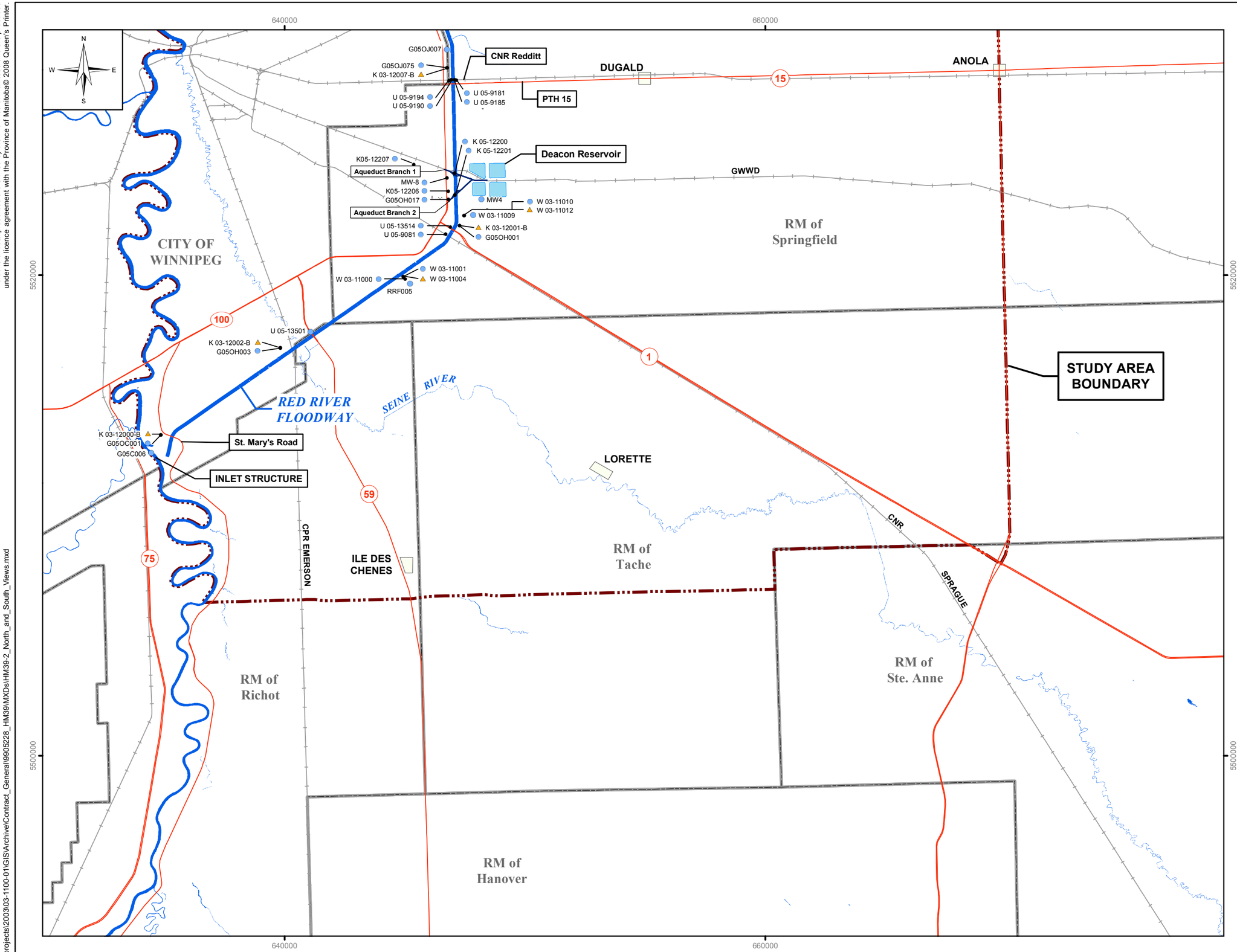

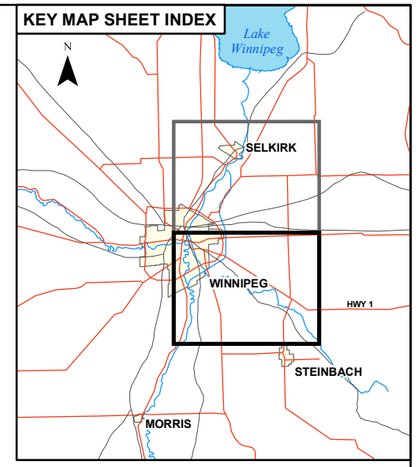

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MANITOBA FLOODWAY AUTHORITY		
RED RIVER FLOODWAY EXPANSION		
2007 GROUNDWATER MONITORING ACTIVITY REPORT		
MONITORING PROGRAM MONITORING WELL LOCATIONS (SOUTH SHEET)		
MARCH 2008	HM39-2	REV: 0

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