Manitoba
Floodway Authority

Red River Floodway Expansion Project
2009 Groundwater Monitoring Activity Report
.9905249 HM60

FINAL REV 0

April 2010

Prepared By

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Principal

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April 26, 2010

File No: 05-1100-01.19.12.06

Manitoba Floodway Authority
200 – 155 Carlton Street
Winnipeg, MB
R3C 3H8

ATTENTION: Ms. Leanne Shewchuk
Manager, Environmental Services

RE: Red River Floodway Expansion Project
Groundwater Monitoring Activity Report
Memo Reference: 9905249 HM60
Final Report – April 2010

Dear Ms. Shewchuk:

Please find enclosed twenty (20) copies of the Final 2009 Groundwater Monitoring Activity Report. The report combines requirements for baseline monitoring and annual monitoring in Environmental Licence 2691 (including construction monitoring) for the 2009 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.
Principal

JBS/mfh/mlb
Enclosure

cc: Mr. Dave MacMillan, Project Manager – KGS Group

X:\projects\2003\03-1100-01\General\(.19) SiteSurv&Invest\(.12) GW Invest\(.06) WaterQ\Reports\HM60\Final\(L. Shewchuk-MFA)_2009GWMonActivityReportHM60_FNLRPT_JBSMFH_Apr2010.doc

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1.0 INTRODUCTION AND AQUIFER CHARACTERIZATION

This report is submitted in response to the requirements for annual (construction) monitoring 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 issued March 2007, which should be used as a reference to this report. Activities for 2007 are summarized in the 2007 Groundwater Monitoring Activity Report issued March 2008 and activities for 2008 are summarized in the 2008 Groundwater Monitoring Activity report issued March 2009.

The Red River began naturally flowing into the Floodway Channel on March 25, 2009. The Floodway gates were operated between April 8 and May 25, 2009 during the spring flood. This flood was the largest flood sampled in this program (2005 to 2009) with a peak flow of 1208 cms on April 18. The next largest flood sampled was in the spring of 2006 (941 cms).

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

Three monitoring events were conducted in 2009:

- March 2009 – Pre-Spring Runoff (no Floodway Operation)
- April 2009 – Floodway Operation – natural flow crested April 23, 2009
- September 2009 – 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). Near the Floodway Inlet, local 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 surficial aquifer 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 by location and with the seasons must be considered when the baseline and ongoing water quality results are evaluated during construction activities and Floodway Operation events. One way to monitor whether there is surface water intrusion is to monitor an indicator parameter such as conductivity. 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 found to be greater than surface water conductivity values measured during spring Floodway Operation. River conductivity values are historically lowest during spring flood events, such as in 2005, 2006, 2007, and 2009. In this situation, conductivity 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. These areas have naturally low conductivity. Floodway Channel surface water conductivity was also higher during the summer precipitation with events in June 2008 than during the spring melt with no Floodway Operation in April 2008. An increase in conductivity might occur in summer if surface water intruded the groundwater at this time.

2.0 DOMESTIC WELLS

2.1 INTRODUCTION

Approximately 200 to 220 wells were sampled in 2009 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 2009, wells at 259 residences were sampled at least once. The distribution of these wells is shown on Figure HM60-1. Individual well owners received copies of their laboratory analysis after each sampling event.

The electronic well inventory database was expanded and updated in 2009. It contains 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 cut-off wall and the Outlet Control Structure. Since 2005, domestic well inventories have been conducted at approximately 747 locations, with 107 other domestic locations identified and georeferenced.

Changes in domestic well water quality consists of increases or decreases in various parameters. An increase could 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. Periods of high rainfall in the summer can also fill the base of the Floodway such as occurred in early July and early August 2009. Summer and fall discharges of potable water from the City of Winnipeg Water Treatment Plant testing also resulted in elevated channel levels in July and August 2009. These events were correlated to 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 2009 was low and did not correlate with the Floodway Operation period in April or construction activities. In 2009, most of the samples analyzed had no Total Coliform bacteria. In March 2009, 15 of 187 (8%) of samples tested positive for Total Coliform, similar to 2008. Detections in April 2009 during Floodway operation were 52 of 220 (24%), higher than during the next largest flood in 2006 (19 of 163, or 12%). Total Coliform was detected in 30 of 212 (14%) samples in September 2009, similar to 2006.

Over the course of the 5-year monitoring program there has been an increasing selection for wells in sensitive areas and wells with prior bacteria detection. In 2009, the combination of this factor along with saturated ground conditions, high floodway flows, and precipitation produced the increase in Total Coliform detection.

Most positive detections of Total Coliform bacteria in 2009 occurred north of the TransCanada Highway Bridge. In 2009, four wells south of the TCH 1 Bridge (near the PTH 59S Bridge) had positive detections of Total Coliform. There was a greater detection of Total Coliform bacteria in April 2009. The reasons for this will vary for individual wells. Possible explanations include spring melt conditions or in-well effects Floodway operation may affect select wells. All wells are assumed to be developed in the bedrock aquifer based on drilling records examined in selected areas.

E. Coli bacteria were detected in three wells in March 2009, prior to the Spring melt. *E. Coli* was detected during Floodway operation in only one of 201 of wells in April 2009 and none (0) of 224

wells during September 2009 (non-operation). All homeowners were notified if they had positive bacteria results.

Homeowners participating in the program have received provincial fact sheets on well maintenance and well disinfection. Where bacteria results are positive, homeowners are contacted by phone and directed to the Office of Drinking Water for any further well-related questions.

Further study is required before conclusions can be made about the source of the Total Coliform and *E.Coli* 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 2009, 64% to 70% of nitrate + nitrite (as N) samples were less than detection (0.01 mg/L) and at least 94% of the values were less than 1 mg/L. Values from 1 to 5 mg/L were present in 4 to 6% of wells. Values from 5 to 10 mg/L were found in two wells near the Floodway Outlet, one in March 2009 and one in September 2009 (0.5%). Values over 10 mg/L were found at one well in September (11.9 mg/L) at the Floodway Outlet. This well has a history of high nitrate values. No trends in these broad ranges were seen between pre-melt March conditions and Floodway Operation (April) conditions.

2.4 PESTICIDES

The pesticides analyzed are used in local agricultural practice. No pesticides were used on the channel contracts. Pesticides were not detected in the six domestic wells sampled in 2009.

2.5 CONDUCTIVITY

Conductivity changes are being used as an indicator of surface water influence to detect changes in groundwater quality.

If spring floodway surface water intruded into the aquifer, the mixing would result in a concentration decrease of most chemical 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.

For the 2009 Floodway Operation, no obvious water quality change was seen in 69% (151) of the approximately 220 domestic wells sampled. There were 69 wells (31%) that showed possible slight to moderate decreases in conductivity. The decreases were rated as slight (<10%) to minor (10-25%) for 56 wells and moderate (25-50%) for 13 wells. All of the domestic wells with conductivity decreases are located from north of PTH15 Bridge to the Floodway Outlet. The wells currently selected for the sampling programs are in areas of higher sensitivity with potential for surface water interconnection where changes may be more likely to occur.

Other potential infiltration sources may contribute to these water quality changes, such as current and historic sand and gravel quarries and the Red River near the Floodway Outlet.

2.6 RELATIONSHIP AMONG PARAMETERS

Total Coliform was found in 52 of the 220 wells (24%) during the spring flood in 2009. Total Coliform presence was not strongly correlated with decreases in conductivity in the 2009 spring flood. In 25 wells, Total Coliform was found, but no conductivity changes were observed in 2009. Total Coliform was present in only 27 wells (39%) of the 69 wells that showed decreases in conductivity, while the remaining 42 wells (61%) showing conductivity decreases did not have Total Coliform bacteria. 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 17 of the 69 wells that showed decreases in conductivity. The increases found in nitrate + nitrite (as N) were slight and ranged from 0.02 to 0.09 mg/L in these 17 wells. The total nitrate concentration in these wells was generally less than 0.5 mg/L far below the Canadian Drinking Water Quality Objective for total nitrate. A conductivity decrease associated with both a Total Coliform presence and a nitrate + nitrite (as N) increase was seen in 13 of these 17 wells; one with a moderate (25-50%) conductivity change, 5 with minor (10-25%) conductivity changes and 7 with slight (<10%) conductivity changes. However, some of these wells also had bacteria during

non-flood events. Bacteria were found only during the flood event at 12 of the 27 wells where bacteria were detected. In 6 of these, the timing of the water quality change was observed on several dates corresponding to the filling and draining of the Floodway.

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 2009 monitoring well samples were collected primarily within the Floodway Channel Right-of-Way from approximately 45 bedrock wells, 10 till wells adjacent to the floodway, plus 5 sand and gravel wells (Oasis Road area only). Monitoring wells are not used for water supply and are not domestic wells. During the spring Floodway Operation, 60 monitoring wells were sampled. Monitoring well locations are shown in Figure HM60-2. Conductivity in the monitoring wells generally shows the same distribution along the floodway as for the domestic wells. Bacteria were not sampled in monitoring wells in 2009. 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 2009 were generally very low. About half the values are less than 0.05 mg/L, 40% are between 0.05 and 0.3 mg/l, 3% are between 0.3 and 0.5 mg/l and 9% are greater than 1 mg/L up to 2 mg/L. In 2009 elevated nitrate + nitrite (as N), up to 1.7 mg/L was found during flood events in six bedrock monitoring wells at the Floodway Outlet. All values were below the Canadian Drinking Water Quality Guidelines for nitrate + nitrite (as N), 10 mg/L.

3.3 PESTICIDES

The pesticides analyzed represented products used in the area for agriculture plus those that had been intended for floodway construction use (although pesticides were not ultimately used). There were no pesticides detected in the four monitoring wells sampled in 2009.

3.4 CONDUCTIVITY

Of the 52 wells monitored during Floodway Operation in spring 2009, 23 wells (44%) showed possible decreases in conductivity and other parameter concentrations compared to the pre-flood (March 2009) monitoring. at 19% of the monitoring wells, the decreases were rated as slight (less than 10% change) to minor (10% to 25% change). The decreases were moderate (25 to 50% change) for another 19% of the monitoring wells. Major decreases were seen at 6% of the monitoring wells.

Monitoring wells with moderate and major changes were found as follows:

- One bedrock sand and gravel monitoring well at the west side of PTH 59N Bridge in overburden and bedrock wells (where the Floodway Channel is in sand and gravel over bedrock)
- Six bedrock monitoring wells at the Floodway Outlet where bedrock is close to the channel bottom
- One bedrock monitoring well at the Floodway Inlet Control Structure where there is a direct connection between the Red River and the aquifer
- Two bedrock monitoring wells near CNR Redditt and Kildare in an area where the channel base is in till

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 further away, 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 increased in 6 of the 22 wells where decreases in conductivity occurred. The increases in nitrate ranged from 0.007 to 0.48 mg/L with total nitrate plus nitrite as nitrogen of 0.5 mg/L or less. Nitrate concentration in these wells were below the Canadian Drinking Water Guideline of 10 mg/L nitrate as N.

3.6 WATER LEVELS

In 2009, 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 depressurization programs show the groundwater drawdown and recovery associated with changes in the depressurization programs.

3.7 CONTINUOUS MEASUREMENTS

Transducers were installed at 24 monitoring wells in 2009. Data from the transducers taking continuous conductivity, temperature and elevation measurements at monitoring wells did not identify significant potential surface water intrusion during the Floodway Operation in 2009. Two exceptions to these findings were noted at PTH 59N Bridge west side and at the Floodway Outlet. Minor changes were also seen at Church Road. Temperature measurements using thermistor strings in the bedrock at wells at Ludwick Rd., Church Rd. and CEMR did not show a temperature drop during Floodway Operation.

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 Floodway operation in 2009. This response is consistent with previous years. Water quality and changes occurred concurrently with water level changes at this location, with little time lag. Water quality at the monitoring well changed from a surface water composition to a groundwater composition by the time the Floodway Channel had drained from the spring runoff.

Infiltration of surface water from the Red River and subsequent Floodway Operation was also seen in April 2009 at the Floodway Outlet, in six monitoring wells located between 200 and 350 m north of the Outlet Structure and cut-off wall, on-site and at Henderson Highway and Rockhaven Road. Conductivity measurements were lower in late March 2009 as the Red River rose quickly and submerged the Outlet Structure weir. These measurements continued to be low in April 2009 during the Floodway Operation. Conductivity measurements increased rapidly

after the peak of the melt, correlating with the groundwater elevation decline. Conductivity returned to typical background quality after the floodway drained.

Two groundwater discharge areas (springs) located in the Floodway Channel were treated with a reverse filter in 2009 and monitored to document water quality changes. The results confirmed that Floodway surface water quality can enter the bedrock locally in these highly connected discharge areas, however, water quality returns to bedrock quality as the floodway drains.

4.0 CONSTRUCTION MONITORING

Channel excavation was complete in all areas of the Floodway by the end of 2009. Construction of the PTH 44 and PTH 15 bridges is continuing into 2010. The groundwater construction 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 of temporary construction depressurization programs was conducted in 2009 at the PTH 44 and PTH15 bridges. These programs were required to minimize groundwater seepage into the excavations required for the bridge piers. Monitoring for these programs included the following activities:

- monitoring well water quality 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. Most of the recovery took place within hours and full recovery took place within a week. Some wells installed for the PTH15 and PTH44 Bridge program have been retained for future use. 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. 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 during the program due to

a collapsed casing, one pump replacement in advance of the program, one pump lowering during the program and one case of temporary turbidity during aquifer recovery.

- ***Outlet Control Structure (2007-2009) –*** One unrelated water quality complaint received during construction. Three complaints received after construction in 2009 unrelated to construction.

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

- ***Oasis Road Cut-off 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 that was done prior to contacting MFA, and needed due to the regional groundwater drawdown.

- ***PTH 15 Bridge (2009) –*** One complaint was received related to prior investigations at a water supply well. Remediation to water supply system was provided.

- ***PTH 44 Bridge (2009) –*** One complaint was received of a well collapse during the pumping program. A new well and hook-up was provided. One complaint of taste in the water during the program was received. Additional water analysis provided.

Manitoba Floodway Authority also responded to public complaints in other areas in 2005 to 2009 that were established to be unrelated to Floodway Operations.

FIGURES

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635000 640000 645000 650000

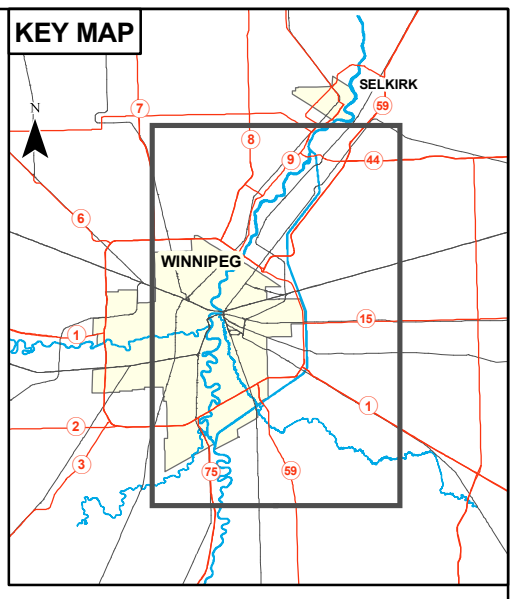
5550000 5540000 5530000 5520000

N W E S

FLOODWAY OUTLET
HWY 44
HAY ROAD
CHURCH ROAD
P.R. 407 LUDWICK ROAD
DUNNING ROAD CROSSING
HWY 59 NORTH
CPR KEEWATIN BRIDGE
HWY 15
HWY 1
HWY 59 SOUTH
FLOODWAY INLET

St. Andrews
St. Clements
West St. Paul
East St. Paul
Birds Hill Provincial Park
RM of Springfield
City of Winnipeg
RM of Ritchot
RM of Tache
RED RIVER

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 2009
- 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 05-1100-01.9905249-HM60

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MANITOBA FLOODWAY AUTHORITY

RED RIVER FLOODWAY EXPANSION

2009 GROUNDWATER MONITORING ACTIVITY REPORT

DOMESTIC WELL MONITORING LOCATIONS 2009

APRIL 2010	FIGURE HM60-1	REV: 0

640000 660000 5560000 5540000

N W E S

RM of St. Andrews

RM of West St. Paul

CITY OF WINNIPEG

RM of East St. Paul

RM of Brokenhead

RM of St. Clements

Birds Hill Provincial Park

RM of Springfield

CEMR

CPR KEEWATIN

LISTER RAPIDS

RED RIVER FLOODWAY

OUTLET STRUCTURE

LOCKPORT

ST. ANDREWS LOCK AND DAM

OAKBANK

Hay Road

Bray Road

Oasis Road

STUDY AREA BOUNDARY

8 9 59 44 101 12

K 07-8810
K 09-12319
K 09-12318
K 09-12317
K 07-8809
K 09-12316
K 03-12005-B
G05OJ005

K 08-9262
RRF023 (Decom)
W 03-11030
W 03-11032
K 03-12003-B
K 03-12003-C
W 03-11031
W 03-11033

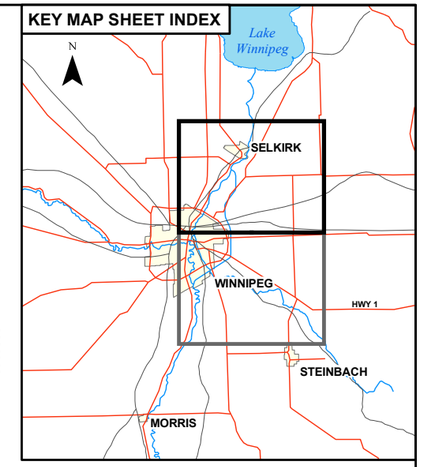
K 09-12012
G05OJ001 (Decom)
K 09-12011
RRF072 (Decom)

W 03-11036
W 03-11038
W 03-11040
W 03-11037
W 03-11039
K 03-12004-B
G05OJ002

K 03-12008-B
G05OJ077

TRUCK TRAINING WELL
W 03-11025-L
W 03-11025-U
W 03-11026
K 03-12006-B
K 03-12006-C
K 04-12102-B
K 04-12101 (BR)
K 04-12101 (S+G)
K 04-12104
U 06-9236
K 03-12009-B
G05OJ079
G05OJ148
G05OJ006
K 04-12103
K 06-12108 (Decom)
K 06-12109
K 06-8721 (Decom)
K 07-12124
K 07-12126
K 07-12136
W 03-11018
W 03-11019
W 03-9200
W 03-11017
U 06-13542
G05OJ014

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

Notes:
1. (Decom) - Decomissioned Well
2. Wells K 09-12316 through K 09-12319 were formerly named K 09-9616 through K 09-9619.

1:150,000 (11" x 17" Plot)

2 0 2 4 6
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

2009 GROUNDWATER MONITORING ACTIVITY REPORT

MONITORING PROGRAM
MONITORING WELL LOCATIONS
(NORTH SHEET)

APRIL 2010	FIGURE HM60-2	REV: 0

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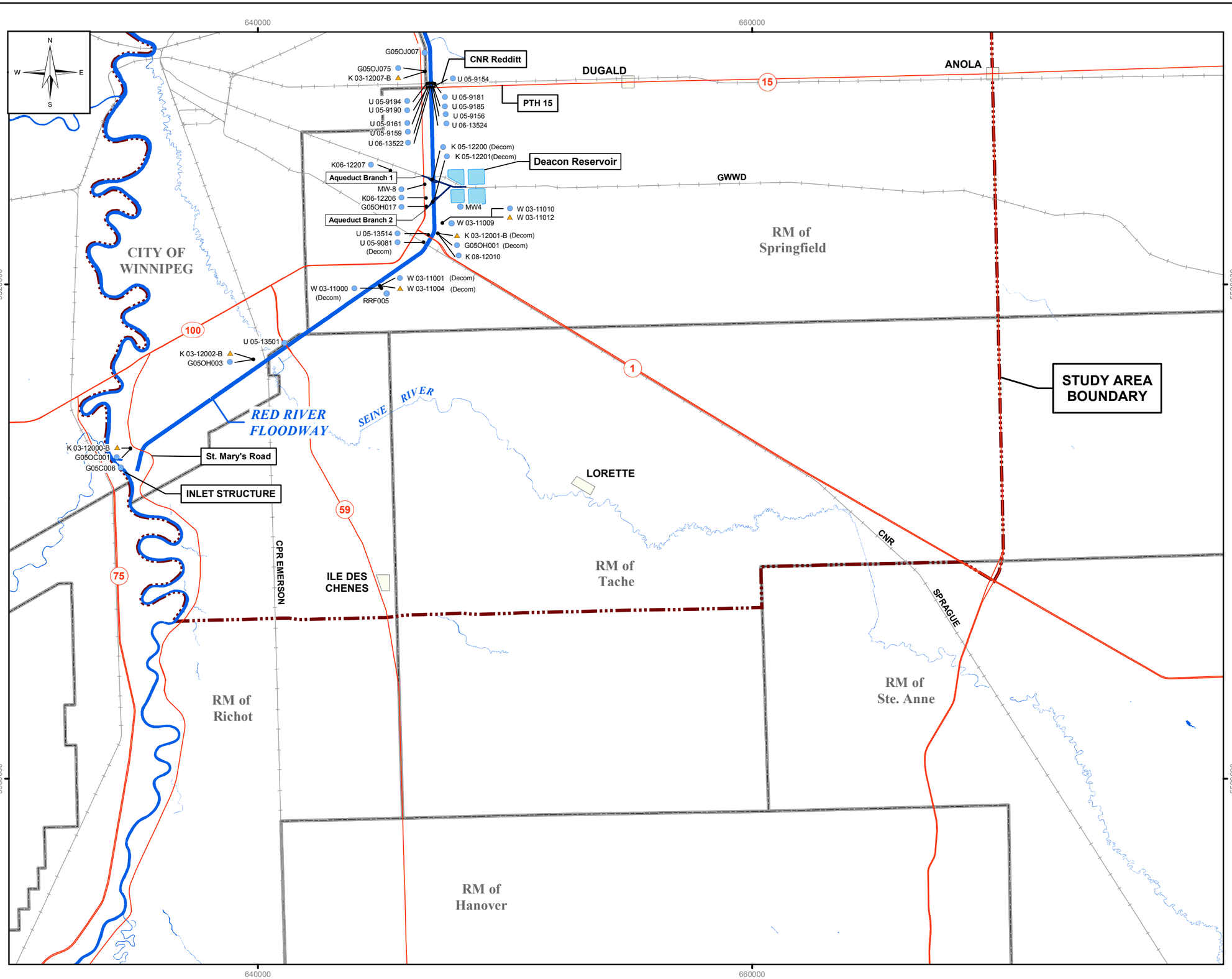

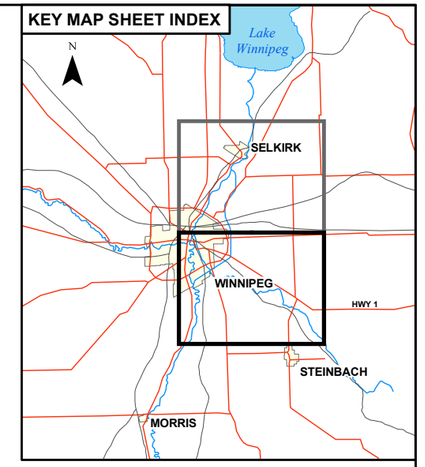

Monitoring Wells
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RED RIVER FLOODWAY EXPANSION

2009 GROUNDWATER MONITORING ACTIVITY REPORT

MONITORING PROGRAM
MONITORING WELL LOCATIONS
(SOUTH SHEET)

APRIL 2010	FIGURE HM60-2	REV: 0

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