SUPPLEMENTAL GROUNDWATER SUPPLY PROJECT

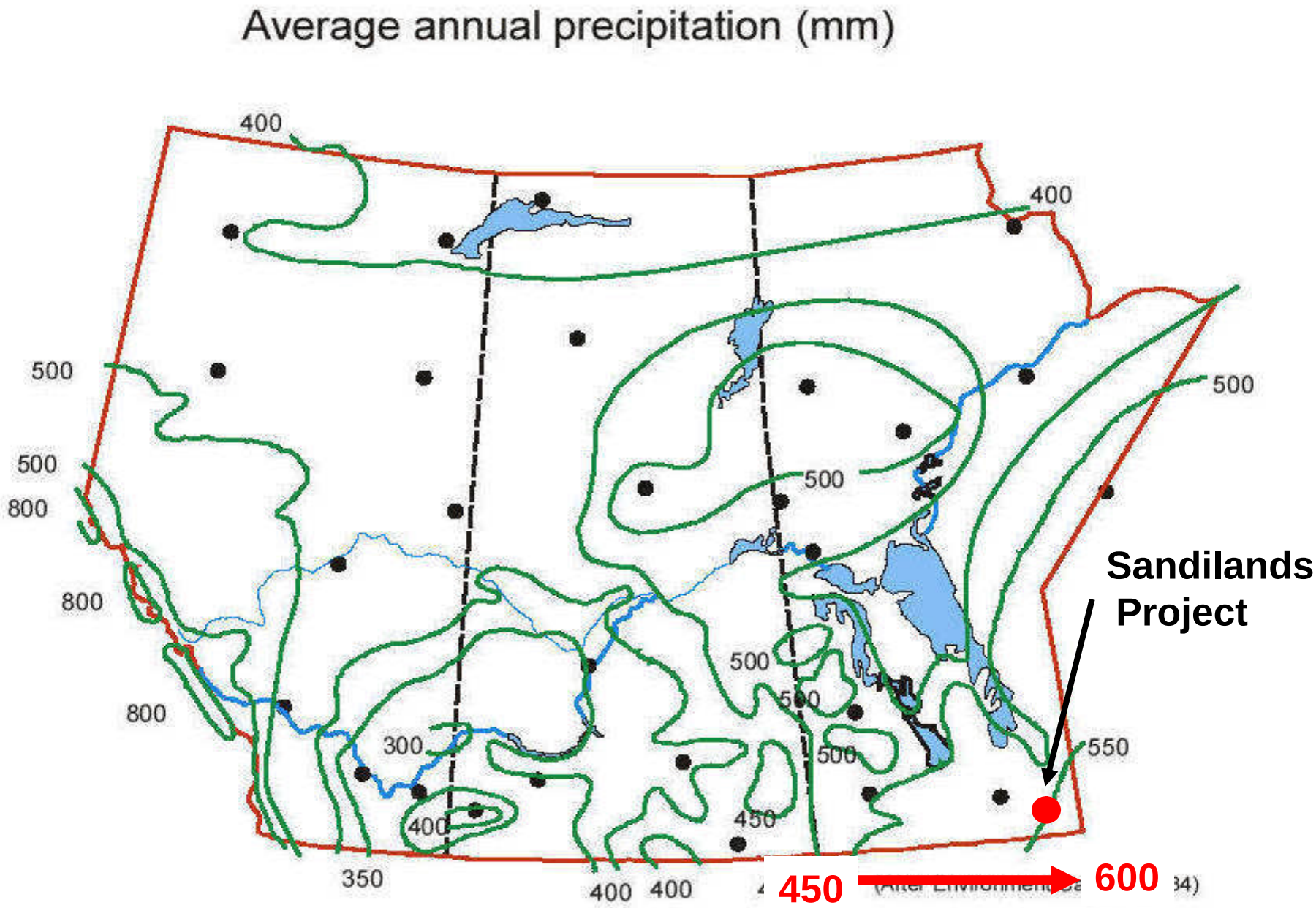
Project Hydrogeology Overview

OUTLINE OF PRESENTATION

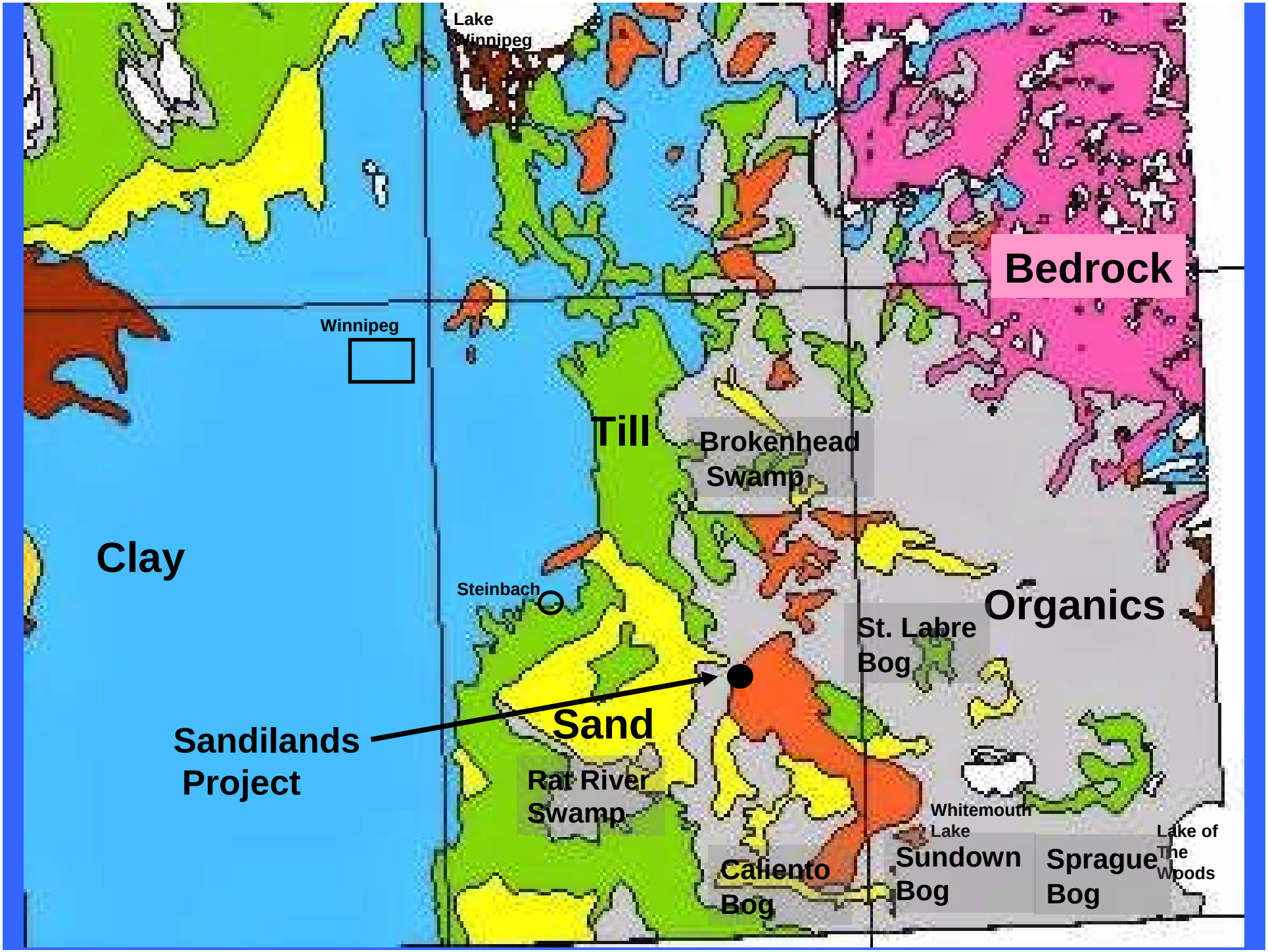
- Site Selection Process Overview
- Site Geology/Hydrogeology
- Field Investigations/Results
- Environmental Effects
- Monitoring Plan
- Contingency Plan

SITE SELECTION PROCESS

- Hydrology of Southern Manitoba
- Regional Geology
- Regional Hydrogeology
- Site Selection



Source: Maathuis et al, 2000, Potential Impact of Climate Change on Prairie Groundwater Supplies


Lake Winnipeg
Bedrock
Winnipeg
Till
Brokenhead Swamp
Clay
Steinbach
Organics
St. Labre Bog
Sandilands Project
Sand
Rat River Swamp
Whitemouth Lake
Lake of The Woods
Caliento Bog
Sundown Bog
Sprague Bog

SITE SELECTION PROCESS

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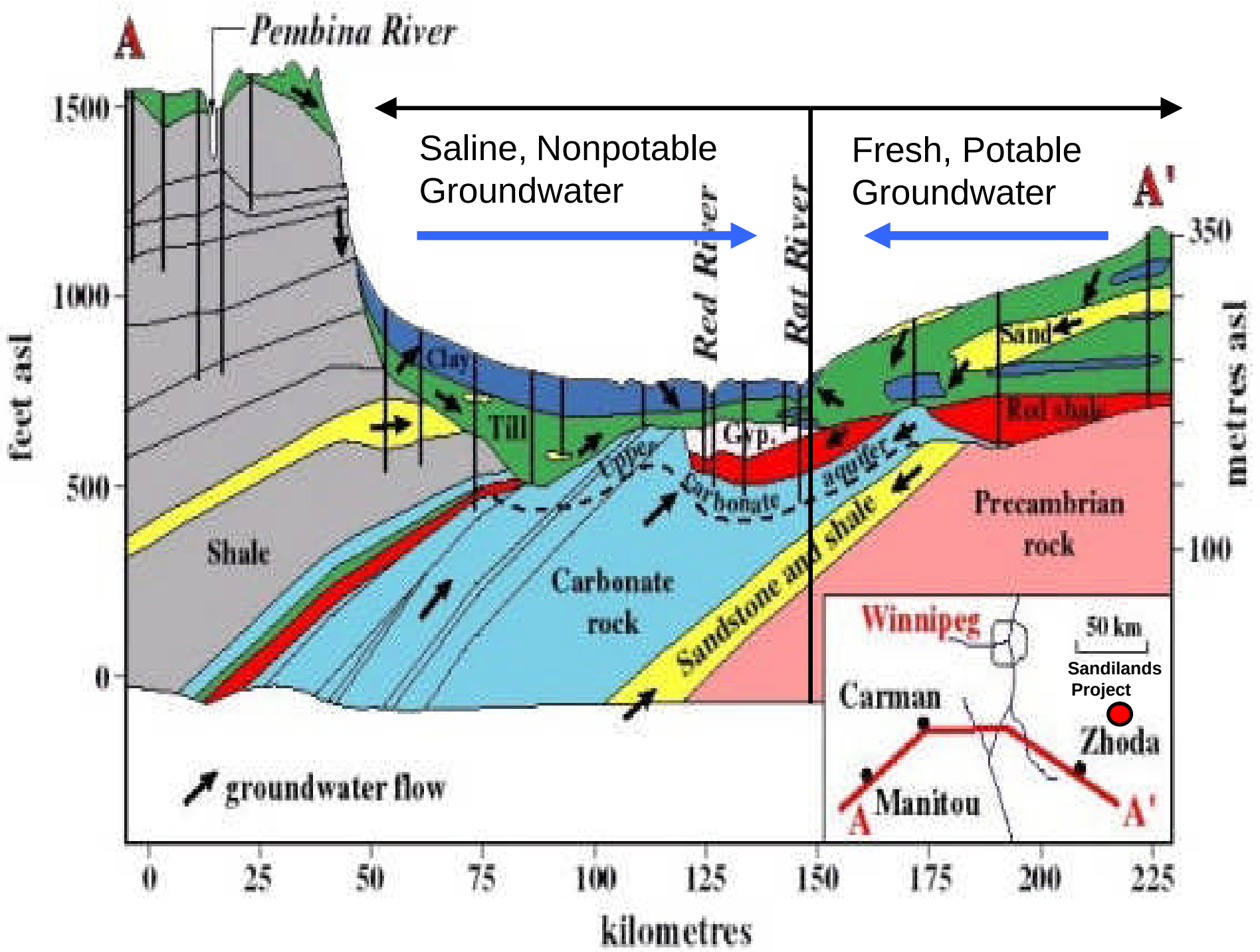
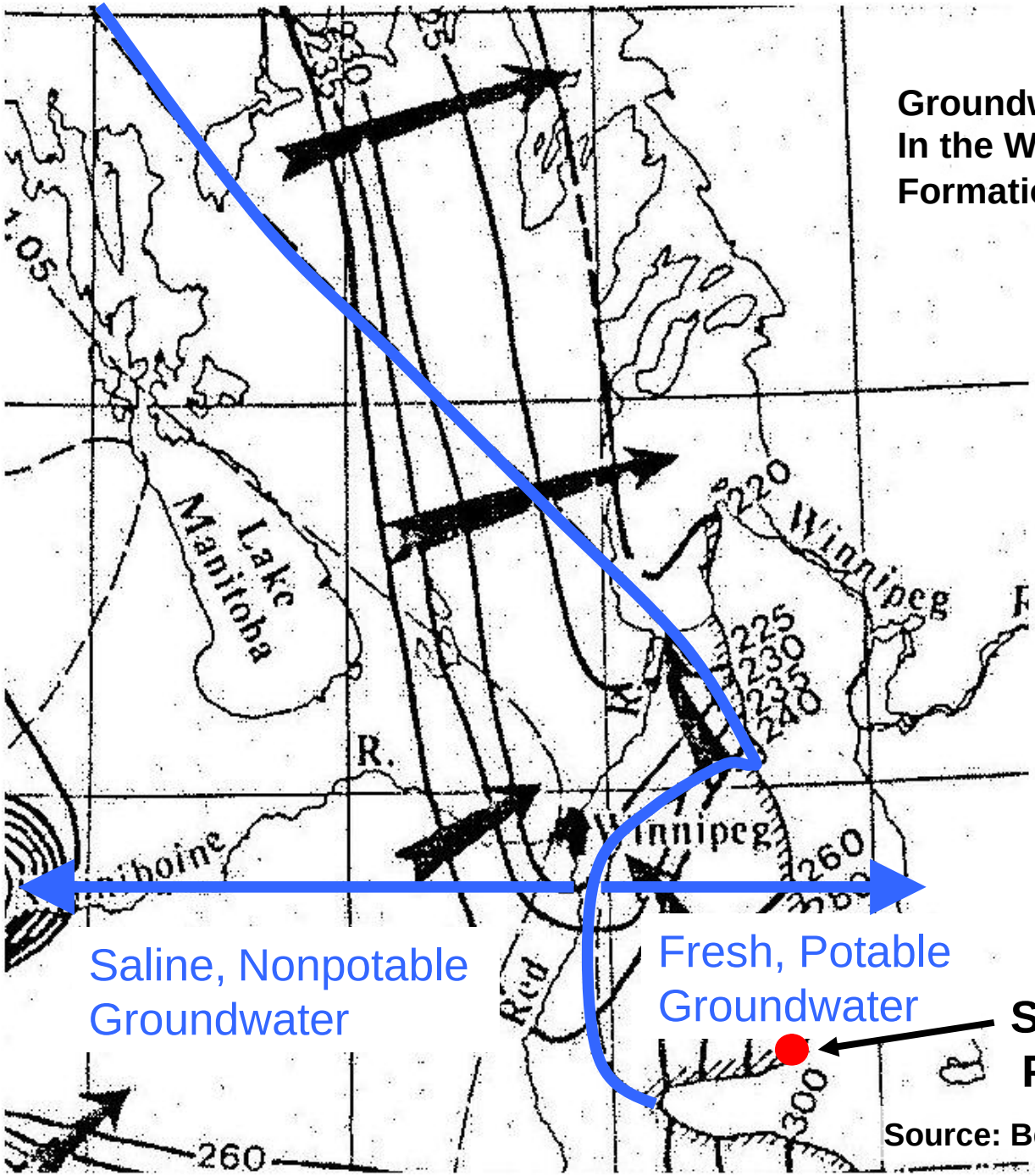
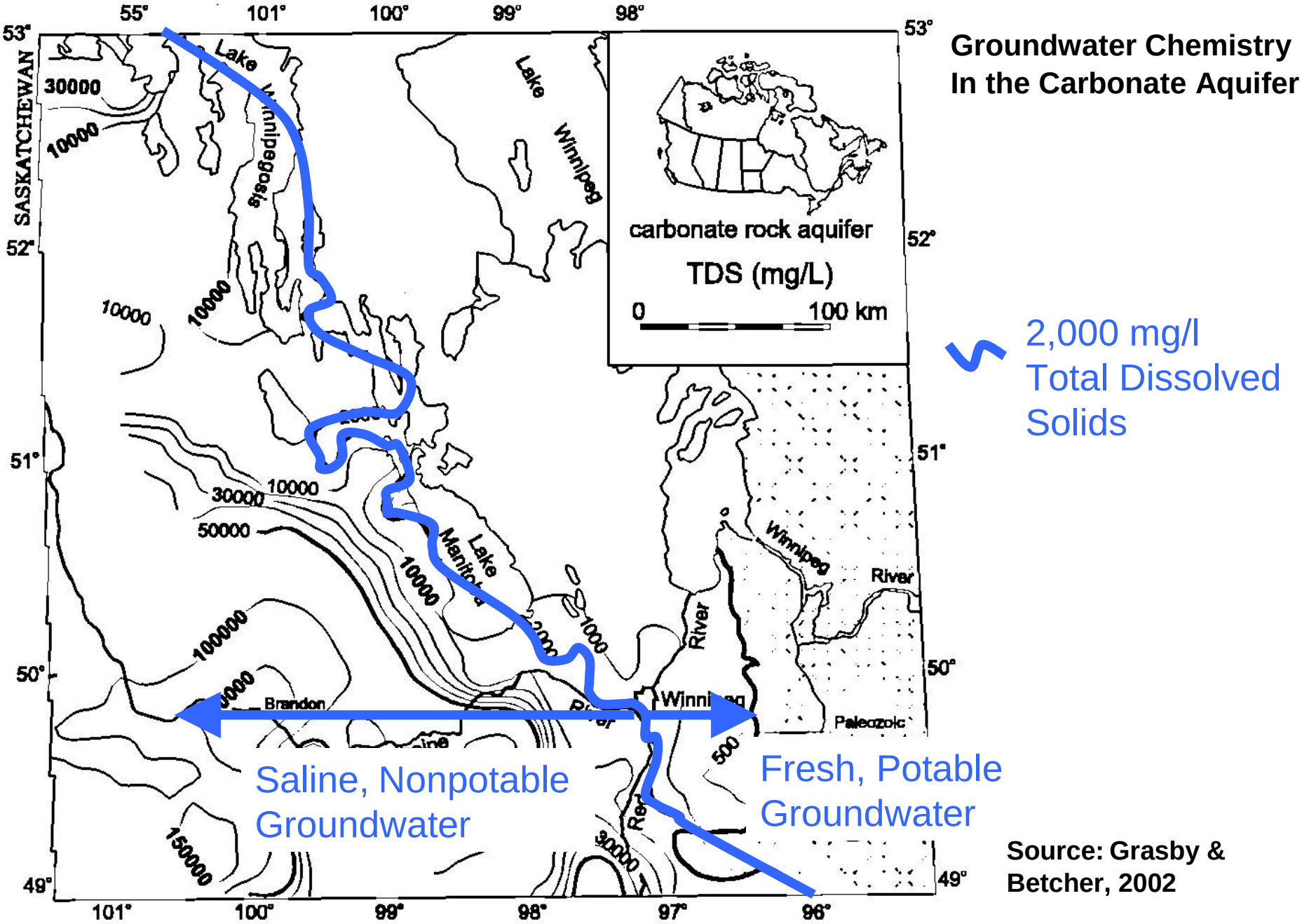

A
Pembina River
A'
Saline, Nonpotable Groundwater
Fresh, Potable Groundwater
Red River
Rat River
1500
1000
500
0
feet asl
350
100
metres asl
Clay
Till
Upper carbonate aquifer
Gyp.
Red shale
Sand
Shale
Carbonate rock
Sandstone and shale
Precambrian rock
groundwater flow
Winnipeg
50 km
Sandilands Project
Carman
Zhoda
Manitou
A
A'
0
25
50
75
100
125
150
175
200
225
kilometres


Groundwater Flow
In the Winnipeg
Formation Sandstones
Lake
Manitoba
Winnipeg
R.
Red
220
225
230
235
240
260
300
Saline, Nonpotable
Groundwater
Fresh, Potable
Groundwater
Sandilands
Project
Source: Betcher, 1986


Groundwater Chemistry
In the Carbonate Aquifer
carbonate rock aquifer
TDS (mg/L)
0
100 km
2,000 mg/l
Total Dissolved
Solids
Saline, Nonpotable
Groundwater
Fresh, Potable
Groundwater
Source: Grasby &
Betcher, 2002
SASKATCHEWAN
Lake Winnipegosis
Lake Winnipeg
Lake Manitoba
Winnipeg River
Brandon
Paleozoic
55°
101°
100°
99°
98°
97°
96°
53°
52°
51°
50°
49°
30000
10000
50000
100000
150000
1000
500

SITE SELECTION PROCESS

- Hydrology of Southern Manitoba
- Regional Geology
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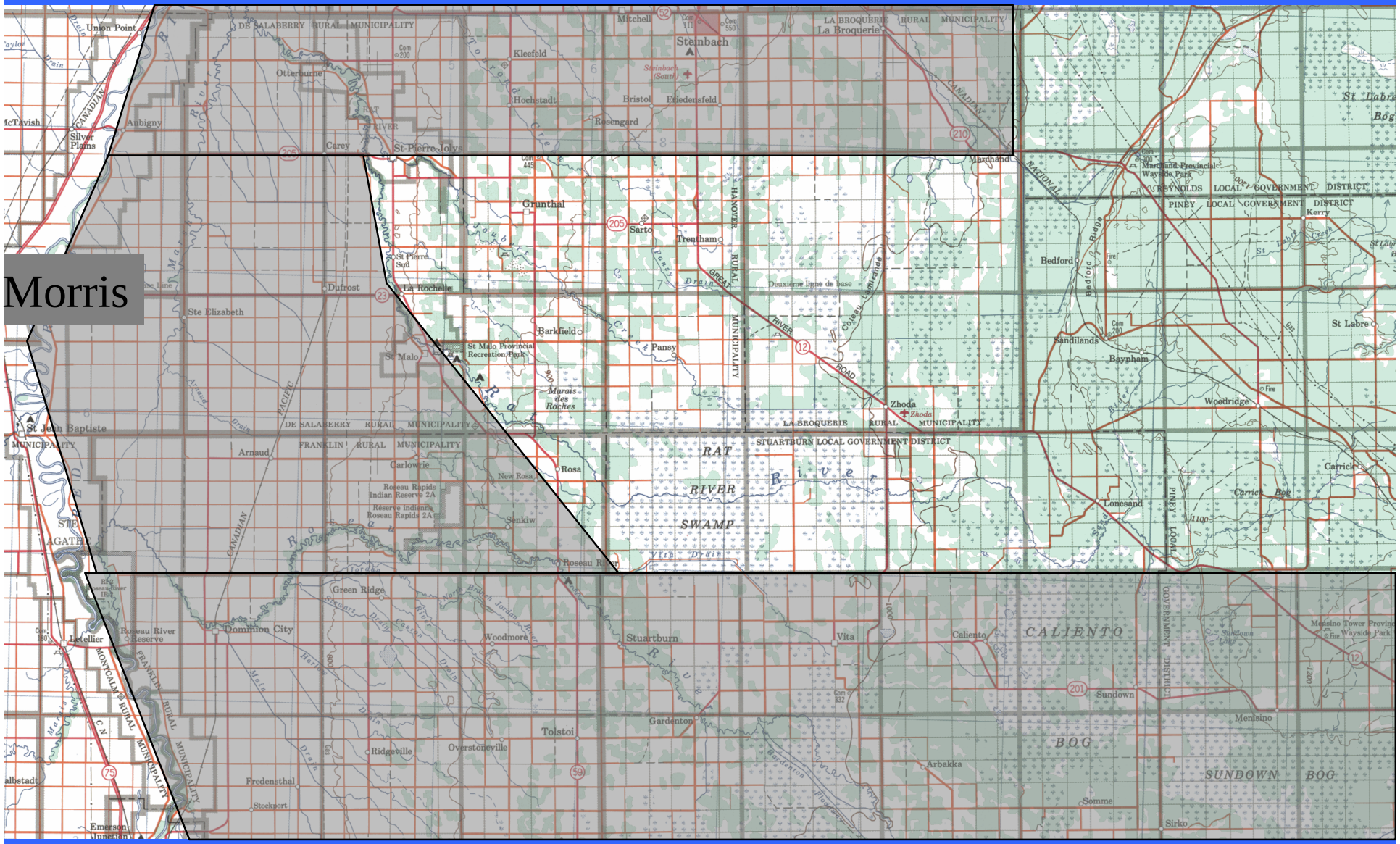
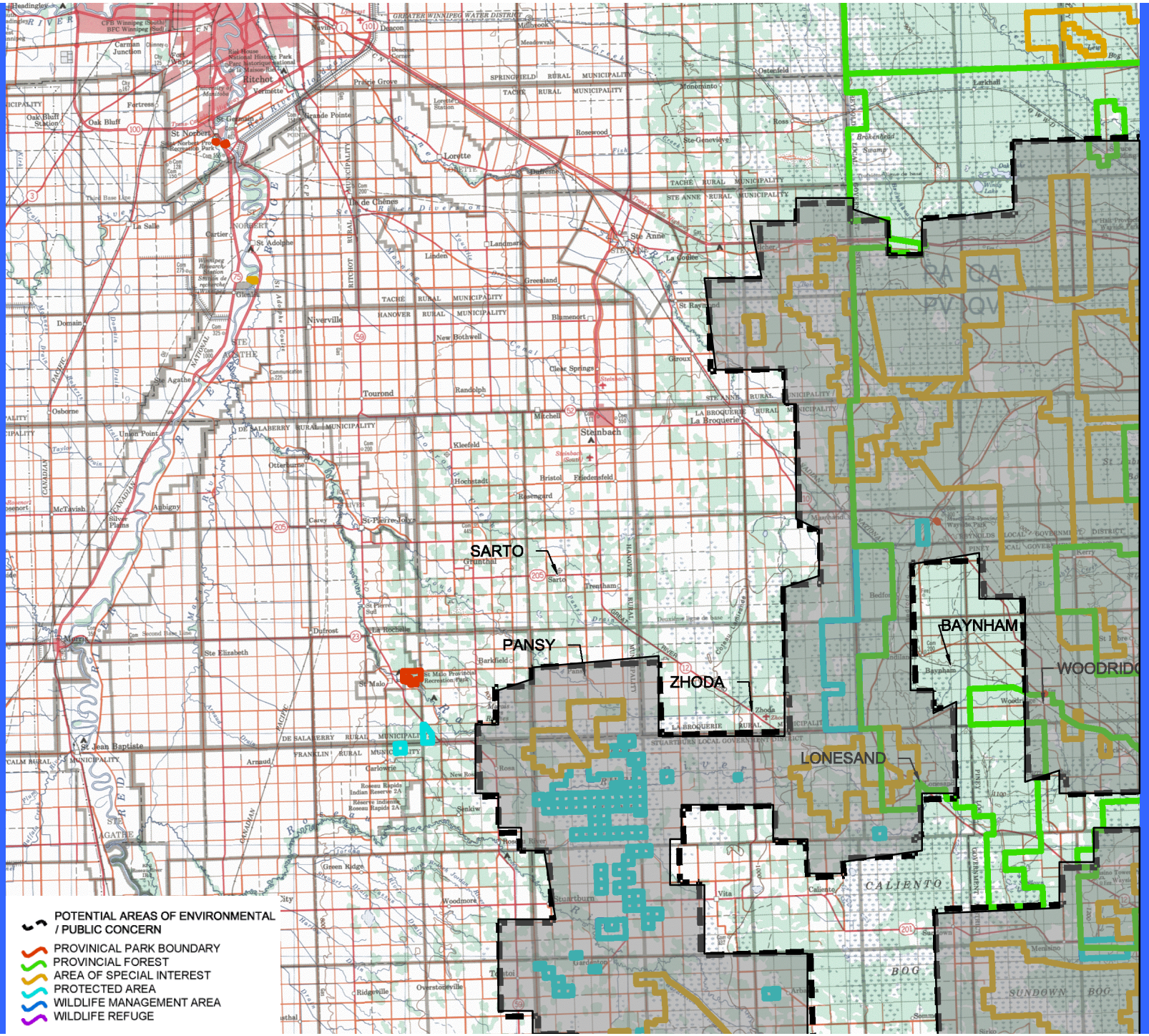
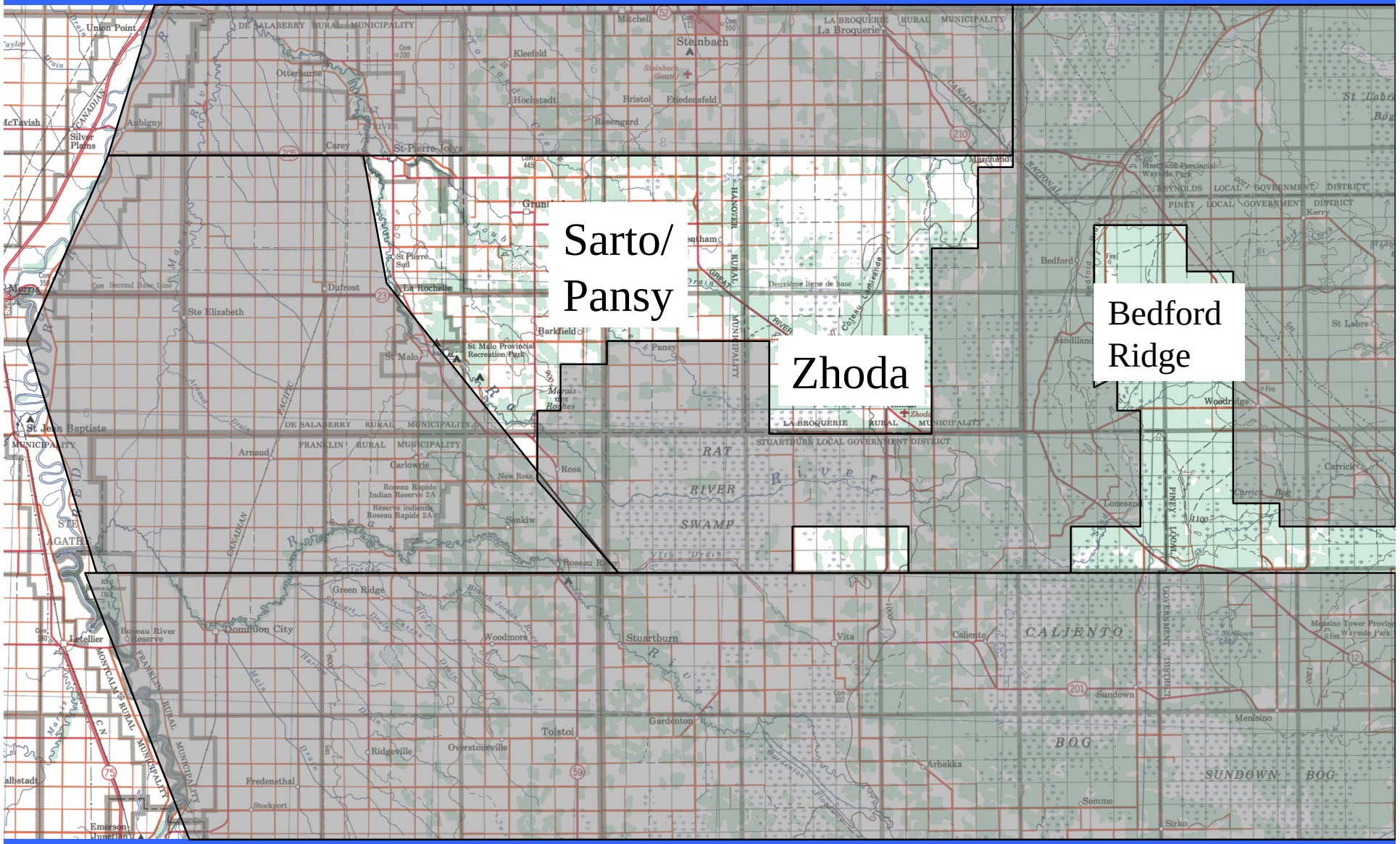

Morris
Union Point
Aubigny
Silver Plains
Carey
St-Pierre-Jolys
Otterburne
Kleefeld
Hochstadt
Steinbach
Bristol
Friedensfeld
Rosengard
Mitchell
La Broquerie
Marchand
Grunthal
Sarto
Trentham
St Pierre Sud
La Rochelle
Dufrost
Ste Elizabeth
St Malo
St Malo Provincial Recreation Park
Barkfield
Pansy
Marais des Roches
Zhoda
St Jean Baptiste
Arnaud
Carlowrie
Rosa
New Rosa
Roseau Rapids Indian Reserve 2A
Réserve indienne Roseau Rapids 2A
Senkiw
Roseau River
Green Ridge
Dominion City
Woodmore
Stuartburn
Vita
Caliento
Letellier
Roseau River Reserve
Tolstoi
Gardenton
Ridgeville
Overstoneville
Fredensthal
Stockport
Emerson Junction
Arbakka
Somme
Sundown
Menisino
Sirko
Bedford
Sandilands
Baynham
Woodridge
Lonesand
Carrick
St Labre
Kerry
Marchand Provincial Wayside Park
REYNOLDS LOCAL GOVERNMENT DISTRICT
PINEY LOCAL GOVERNMENT DISTRICT
DE SALABERRY RURAL MUNICIPALITY
LA BROQUERIE RURAL MUNICIPALITY
FRANKLIN RURAL MUNICIPALITY
STUARTBURN LOCAL GOVERNMENT DISTRICT
MONTCALM RURAL MUNICIPALITY
HANOVER RURAL MUNICIPALITY
GREAT RIVER ROAD
PACIFIC ROAD
RAT RIVER SWAMP
CALIENTO
BOG
SUNDOWN BOG
Rat River
Roseau River
Stuartburn River

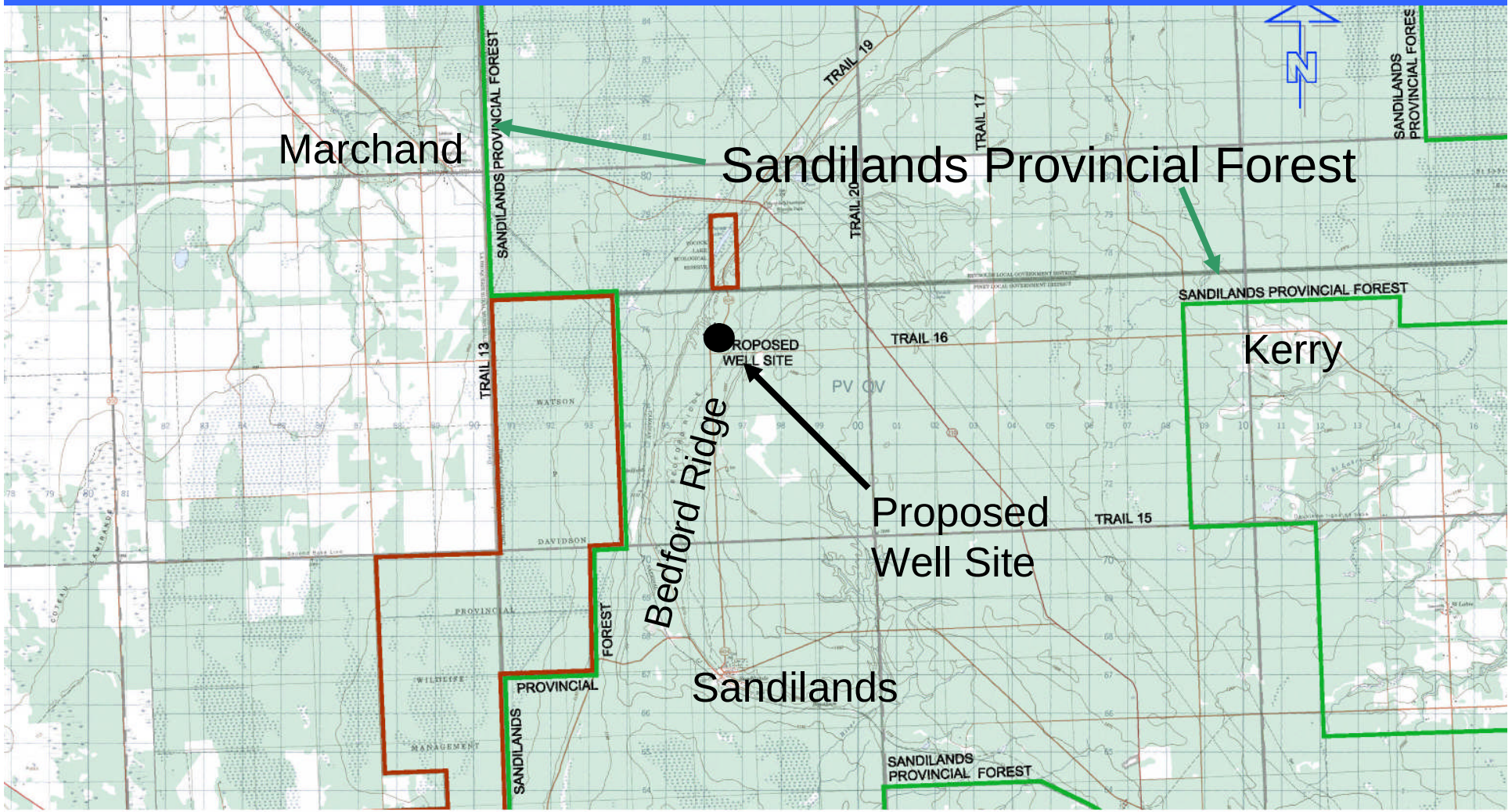

SARTO
PANSY
ZHODA
BAYNHAM
LONESAND
POTENTIAL AREAS OF ENVIRONMENTAL / PUBLIC CONCERN
PROVINICAL PARK BOUNDARY
PROVINCIAL FOREST
AREA OF SPECIAL INTEREST
PROTECTED AREA
WILDLIFE MANAGEMENT AREA
WILDLIFE REFUGE

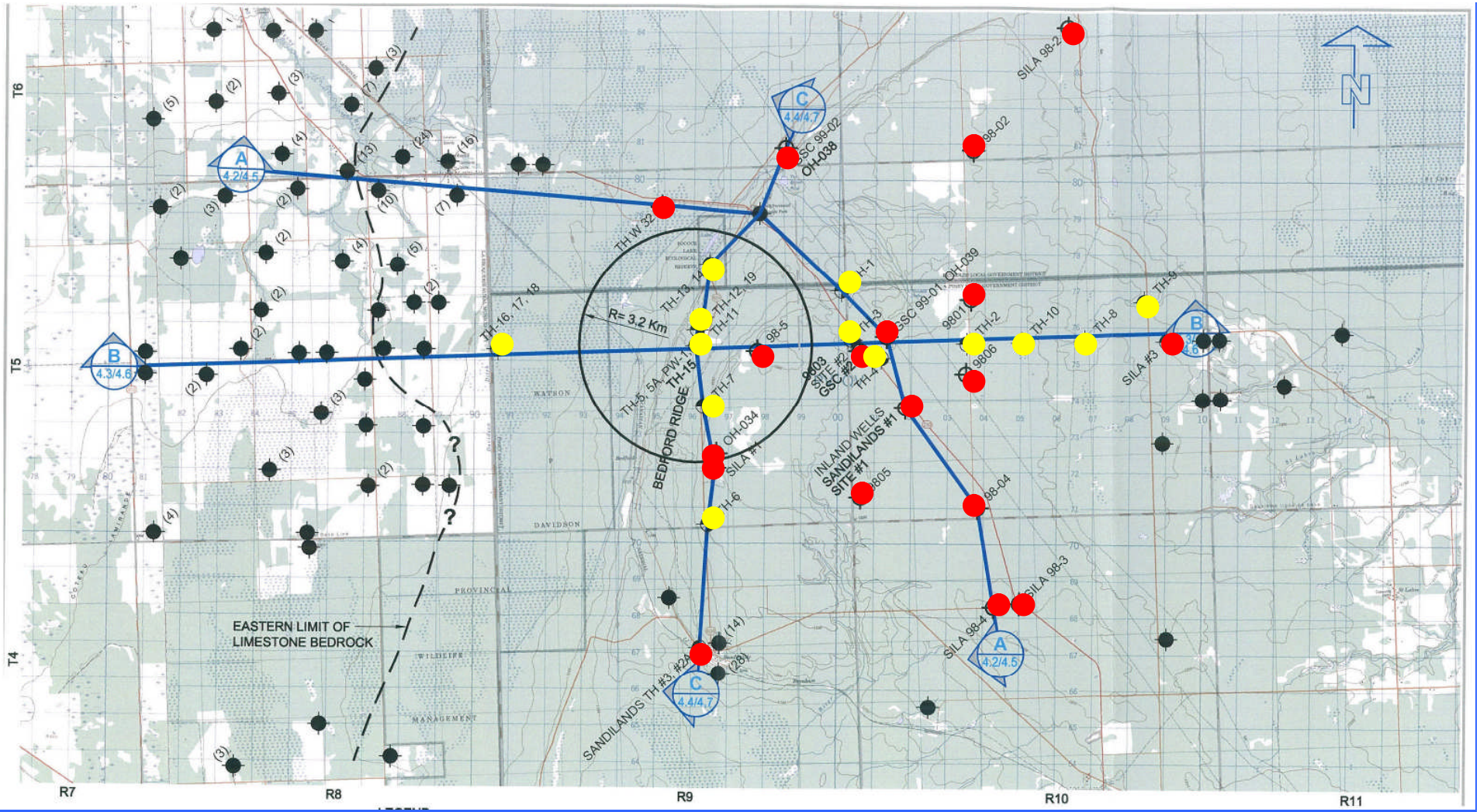

Sarto/
Pansy
Zhoda
Bedford
Ridge

Outline of Presentation

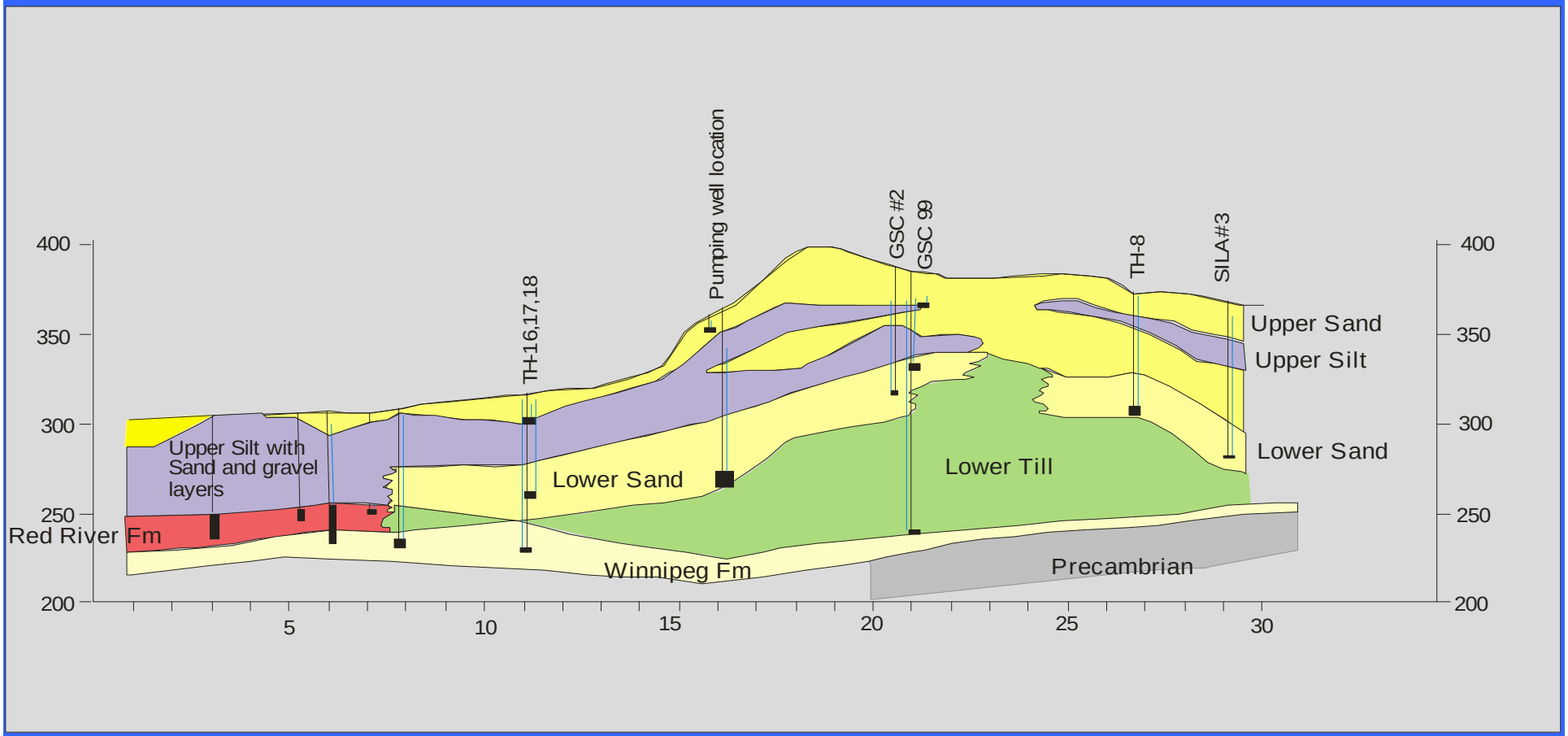
- SITE SELECTION PROCESS
- SITE GEOLOGY/HYDROGEOLOGY
- FIELD INVESTIGATIONS/RESULTS
- ENVIRONMENTAL EFFECTS
- MONITORING PLAN
- CONTINGENCY PLAN

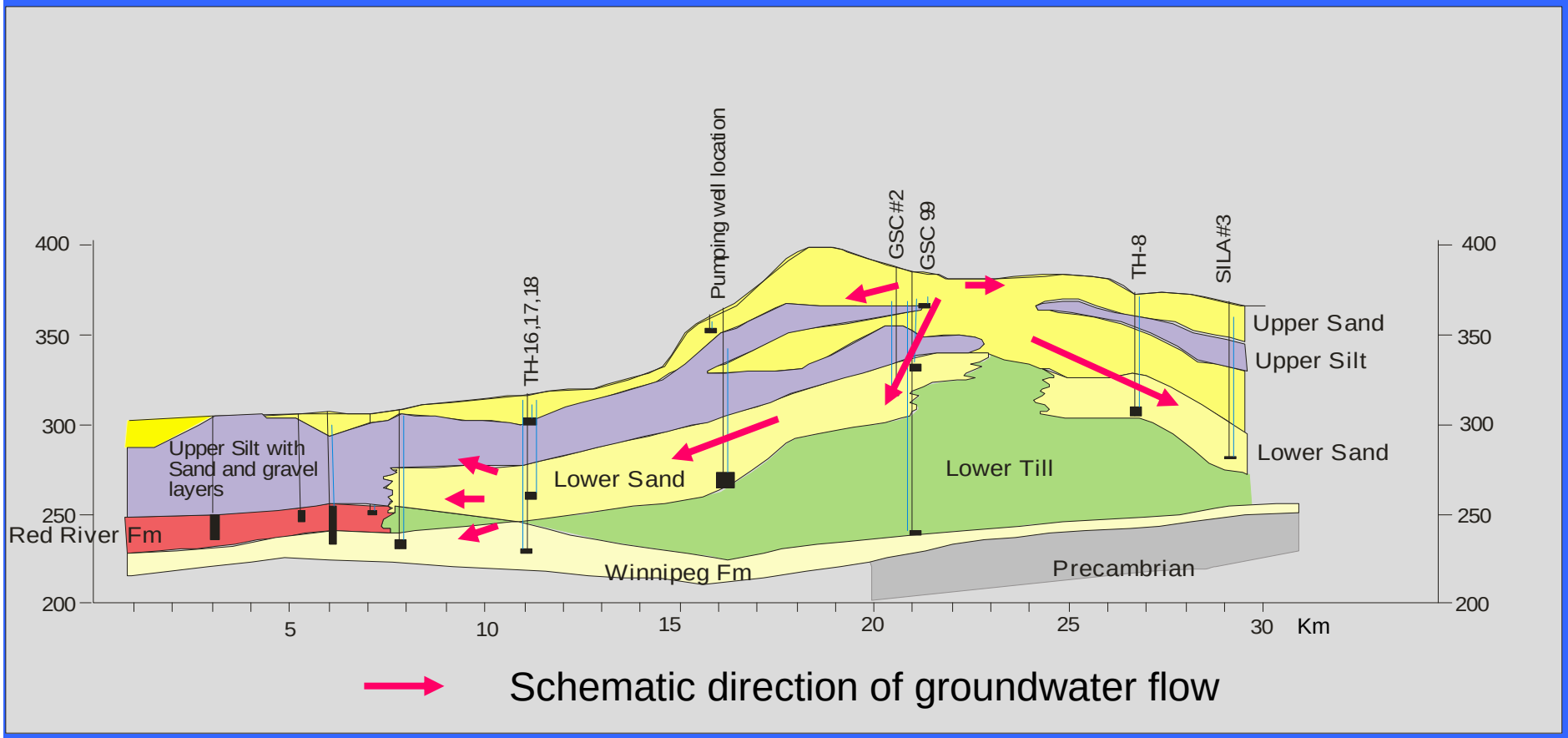
Study Area


Marchand
SANDILANDS PROVINCIAL FOREST
Sandilands Provincial Forest
TRAIL 19
TRAIL 17
TRAIL 20
SANDILANDS PROVINCIAL FOREST
SANDILANDS PROVINCIAL FOREST
Kerry
TRAIL 16
PROPOSED WELL SITE
TRAIL 13
WATSON
Bedford Ridge
Proposed Well Site
TRAIL 15
DAVIDSON
PROVINCIAL FOREST
SANDILANDS PROVINCIAL FOREST
Sandilands
SANDILANDS PROVINCIAL FOREST



- - Existing Domestic Wells
- - Previous Research Wells – Water Stewardship, Geological Survey of Canada, Universities of Manitoba/Ottawa/Carlton
- - Project Test Wells

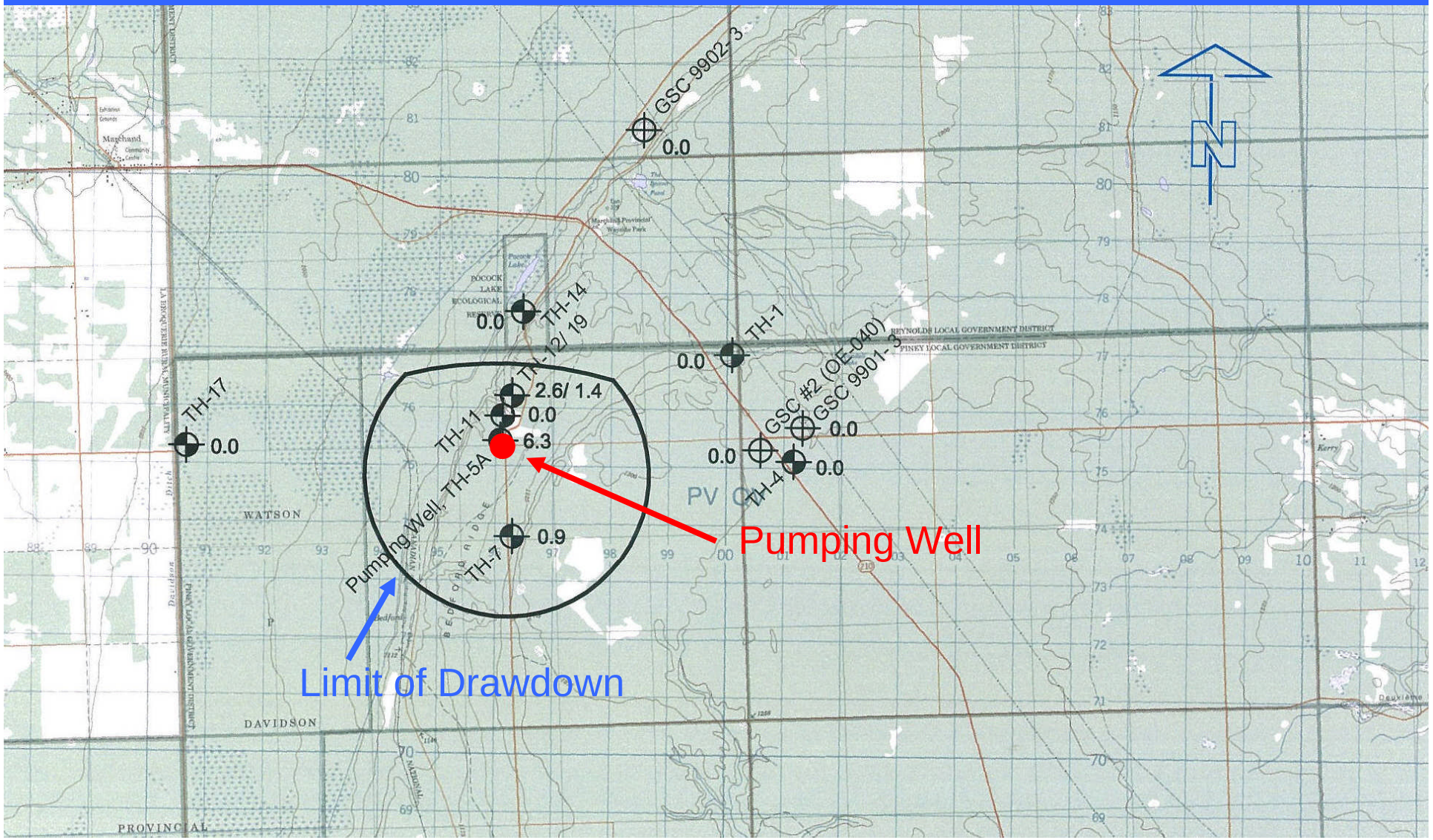

TH-16,17,18
Pumping well location
GSC #2
GSC 99
TH-8
SILA#3
Upper Sand
Upper Silt
Lower Sand
Upper Silt with
Sand and gravel
layers
Lower Sand
Lower Till
Red River Fm
Winnipeg Fm
Precambrian
400
350
300
250
200
5
10
15
20
25
30


Pumping well location
GSC #2
GSC 99
TH-8
SILA#3
TH-16,17,18
Upper Sand
Upper Silt
Lower Sand
Upper Silt with Sand and gravel layers
Lower Sand
Lower Till
Red River Fm
Winnipeg Fm
Precambrian
400
350
300
250
200
5
10
15
20
25
30
Km
Schematic direction of groundwater flow

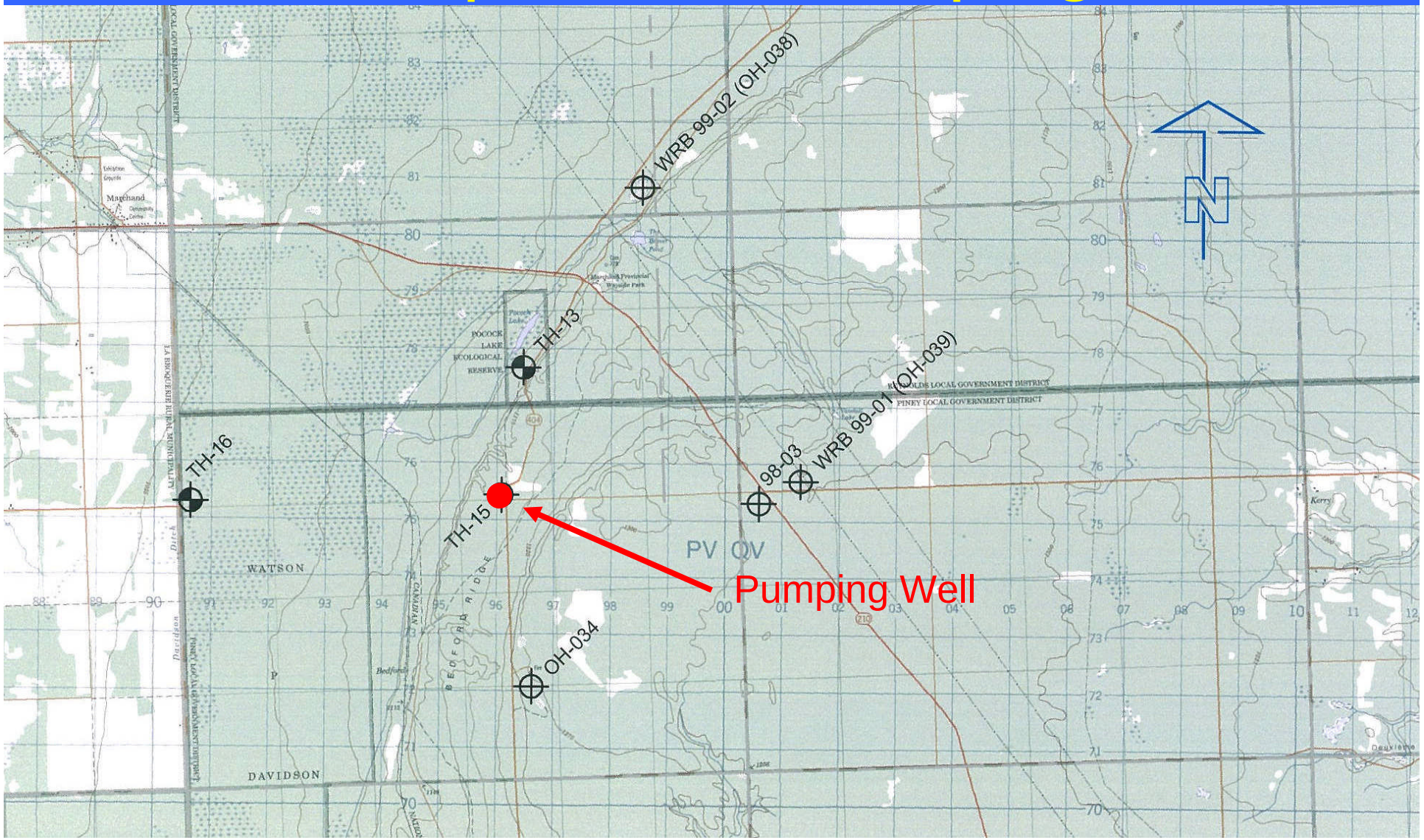
Aquifer Pumping Test

- Purpose of test:
  - Measure the transmissivity and storativity of the aquifer, and
  - Measure the short term dynamic response of the aquifer to pumping.
- Aquifer pumped at 107 litres/sec.
- Aquifer response monitored at 21 monitoring wells.

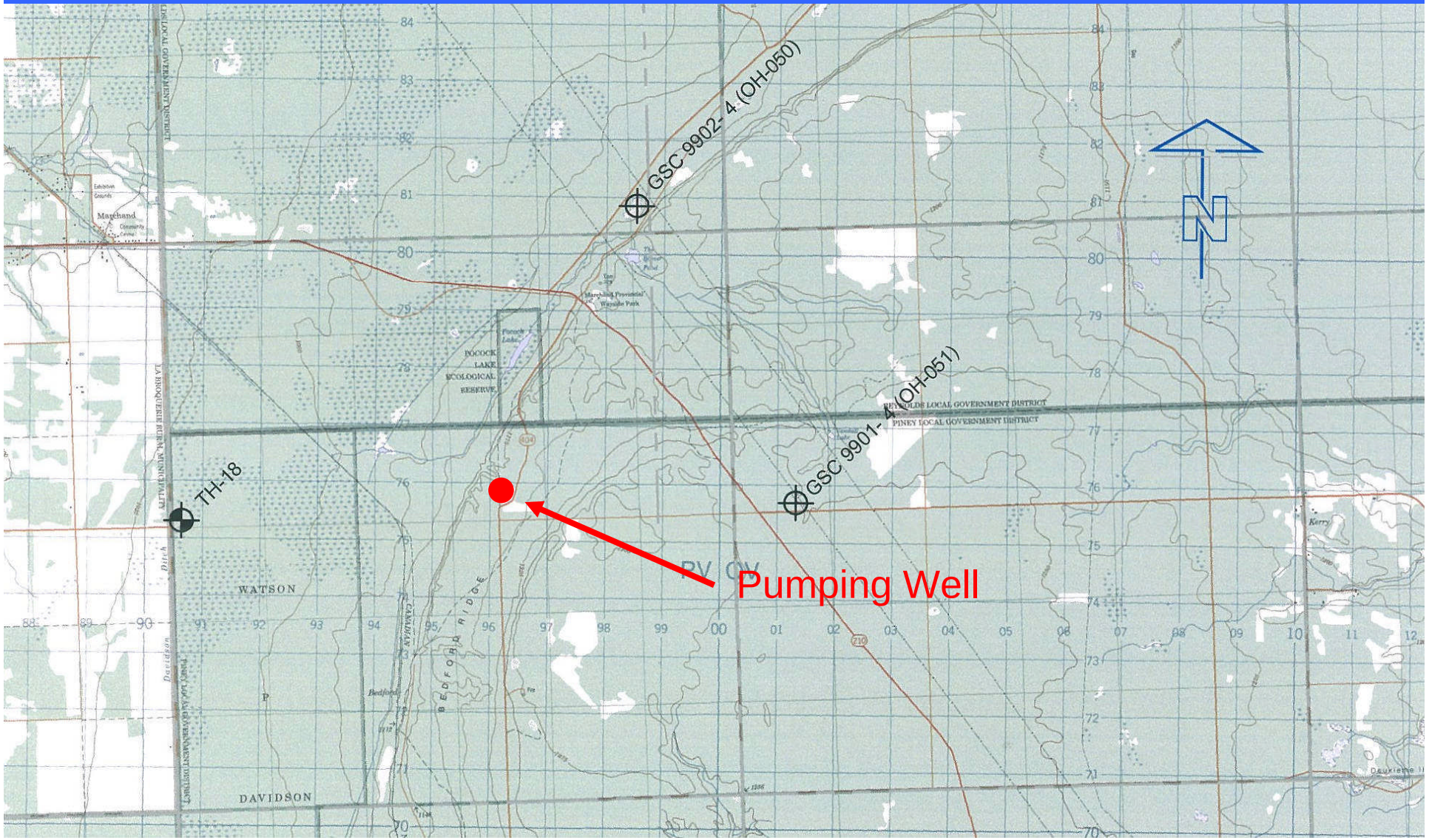
Lower Sand Unit
Response to Pumping



Upper Sand Unit
Response to Pumping



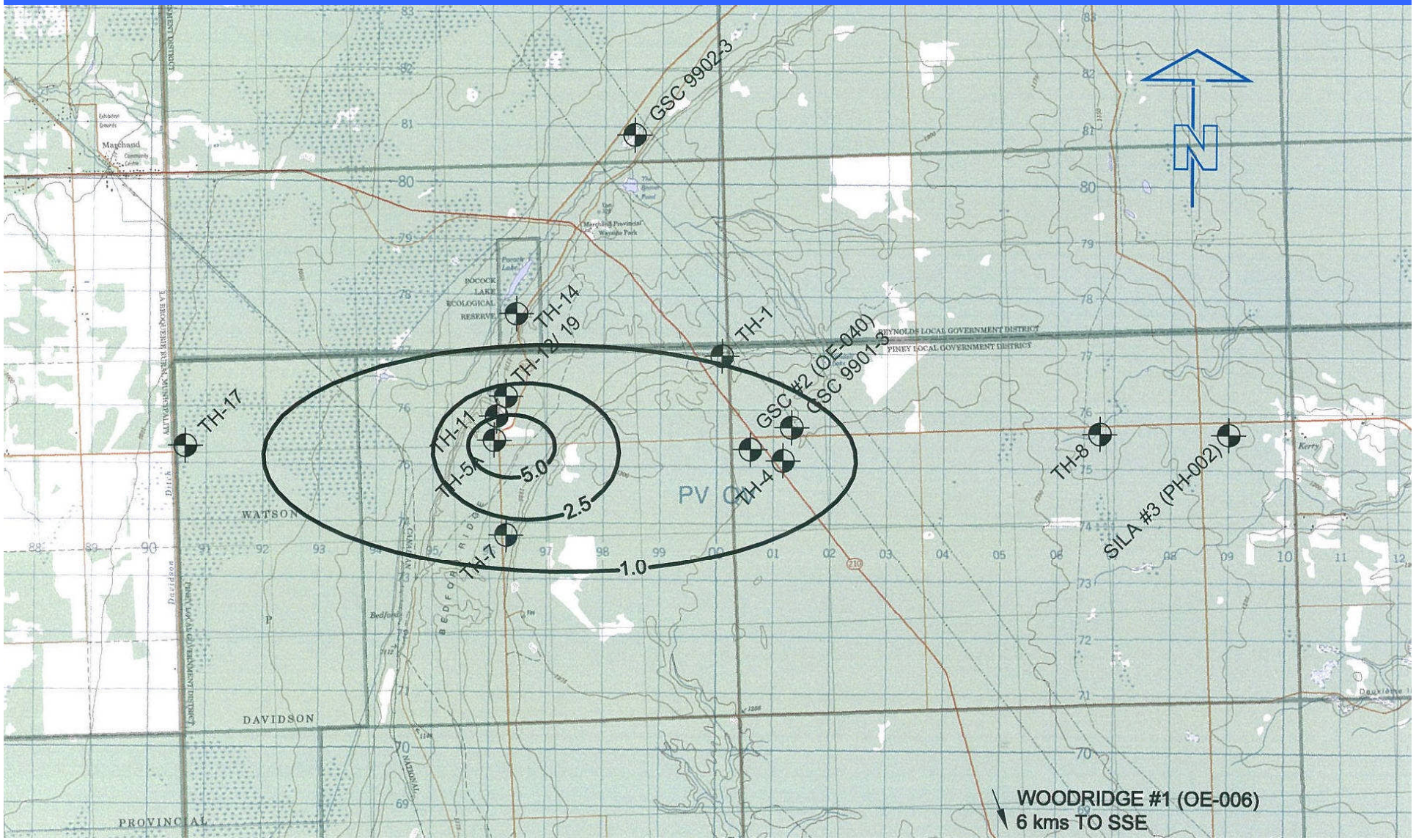
Sandstone Unit Response to Pumping



Pumping Test Results

- Lower Sand Unit is bounded to the north and south.
- A high transmissivity zone is present to the south of the pumping well.
- No response was measured in either the Upper Sand or Sandstone Unit
- Transmissivity = 0.01 m^2/sec
- Storativity = 0.0008

Estimated Extent of Drawdown



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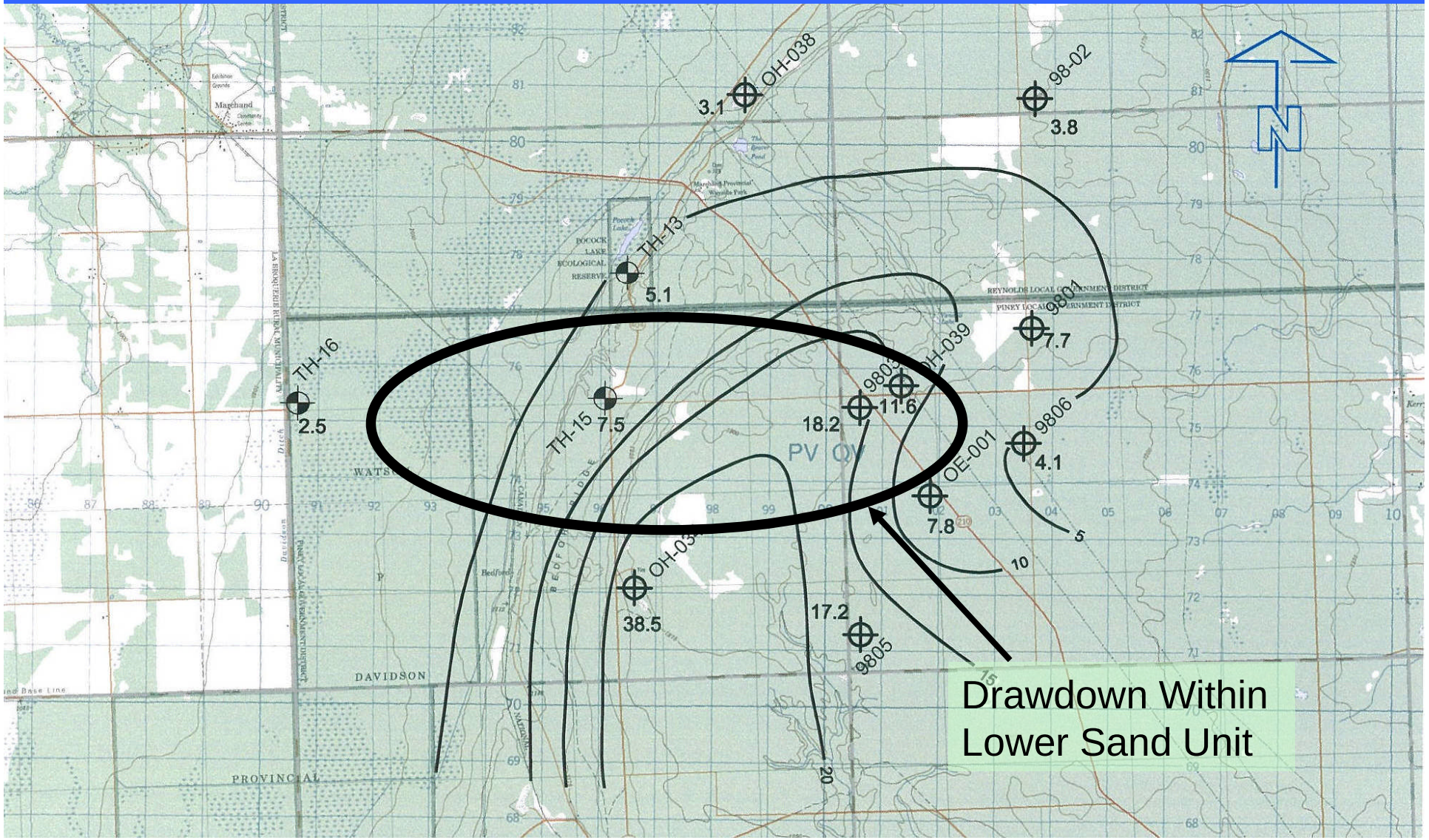
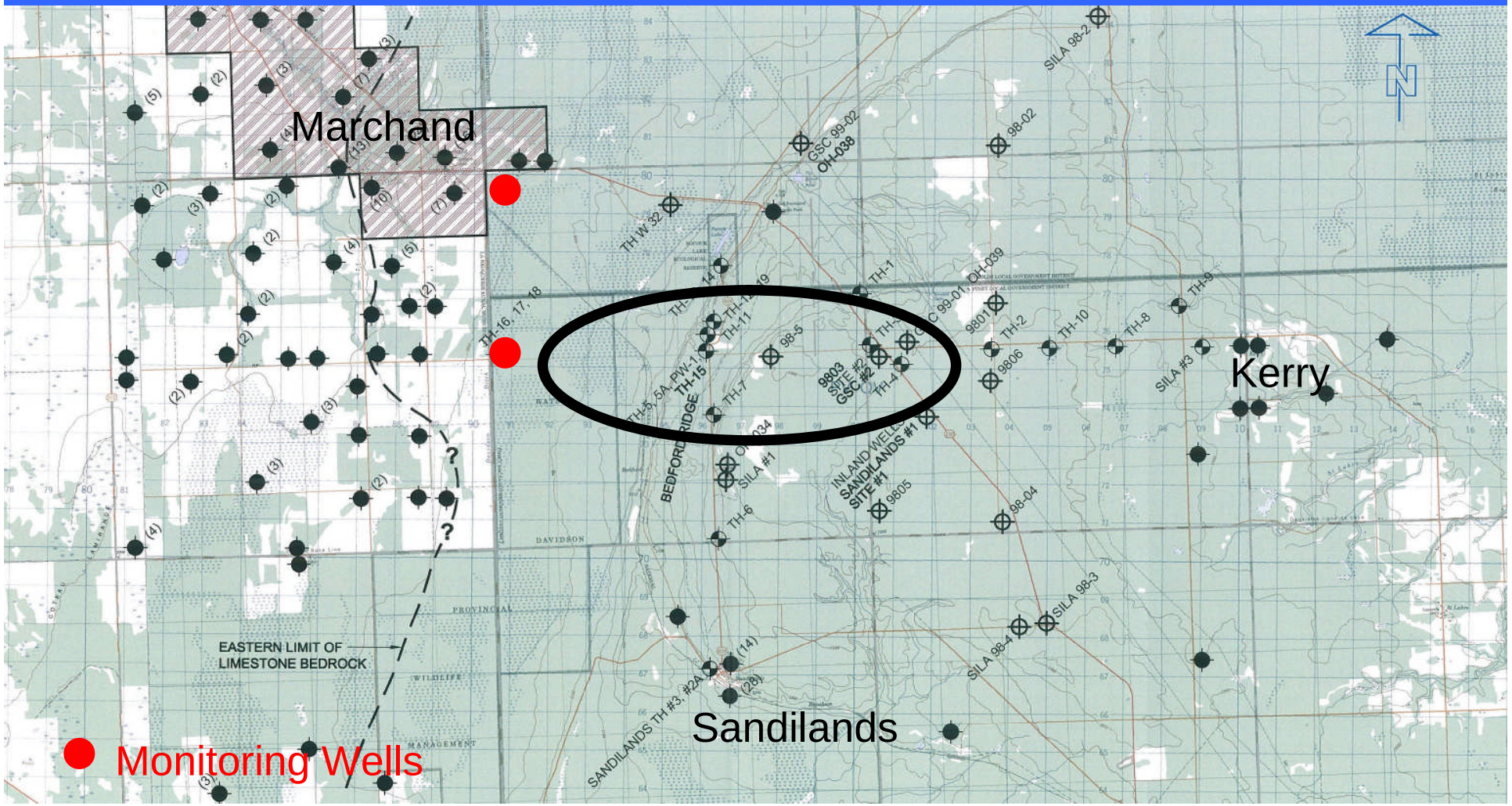
Upper Sand – Depth to Water



Existing Groundwater Users



USGS Circular 1186 -“Sustainability of Ground-Water Resources”

- “Some hydrologists believe that a pre-development water budget for a ground-water system can be used to calculate the amount of water available for consumption. In this case, the development of a ground-water system is considered “safe” if the rate of withdrawal does not exceed the rate of recharge. This concept has been referred to as the **Water Budget Myth** (Bredehoeft and others, 1982)”

Recharge **“Estimate”**

- Overall estimated recharge rate (Thornthwaite Method, Cherry 2000)
  = 71 mm/yr.
- Area of Sandilands Glaciofluvial Complex
  = 1,935,000,000 m^2
- Estimated Annual Recharge
  = 137,000 dam^3/yr (4,300 litres/sec)

Recharge **“Estimate”**

- Estimated Area of Recharge to the Pumping Well = (80,000,000 m^2).
- Estimated Recharge Rate = 174 mm/yr (Cherry 2000 – Recharge to Sandy Soils).
- Annual Recharge Rate
  = 14,000 dam^3/yr (400 litres/sec).

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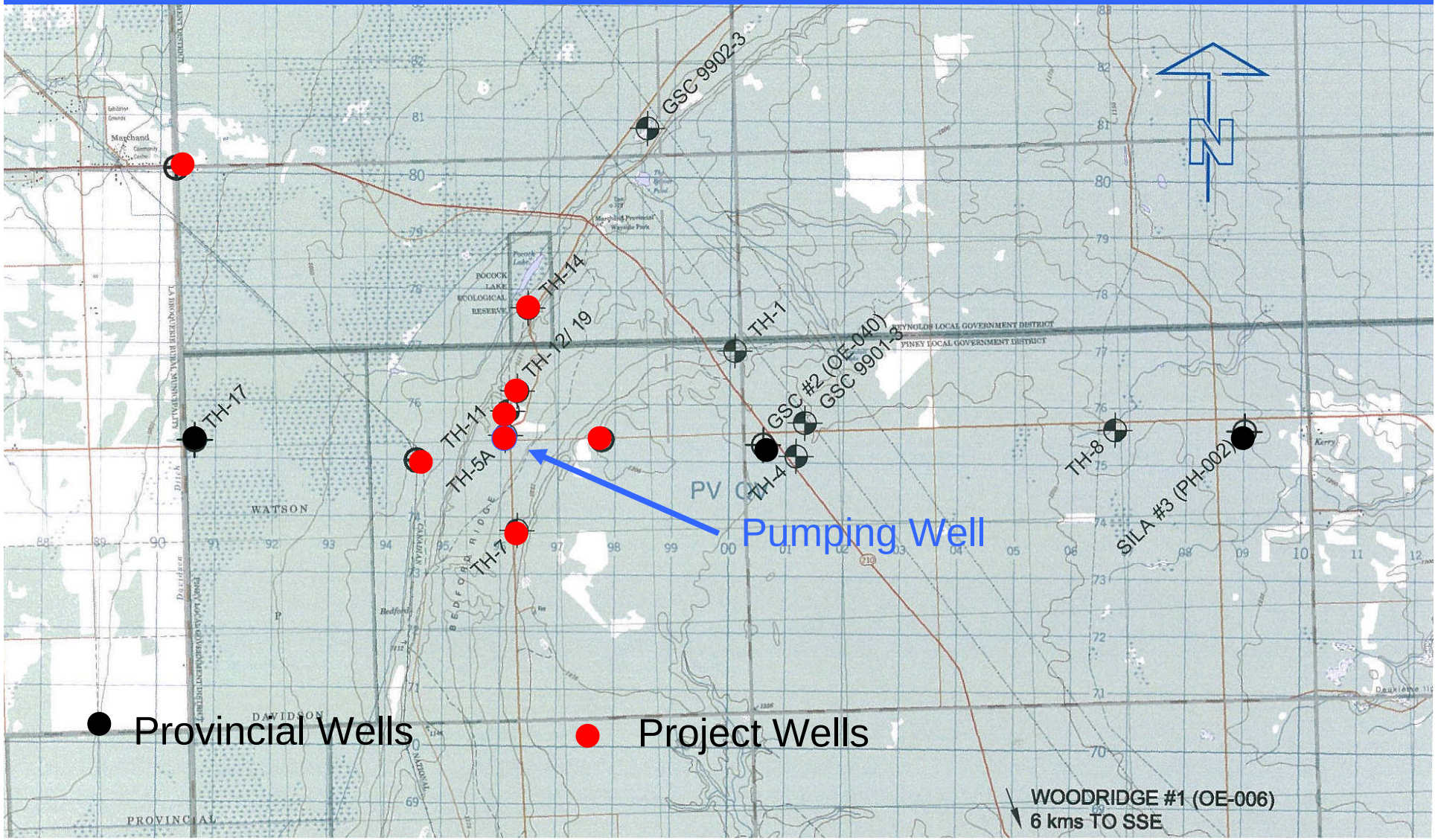
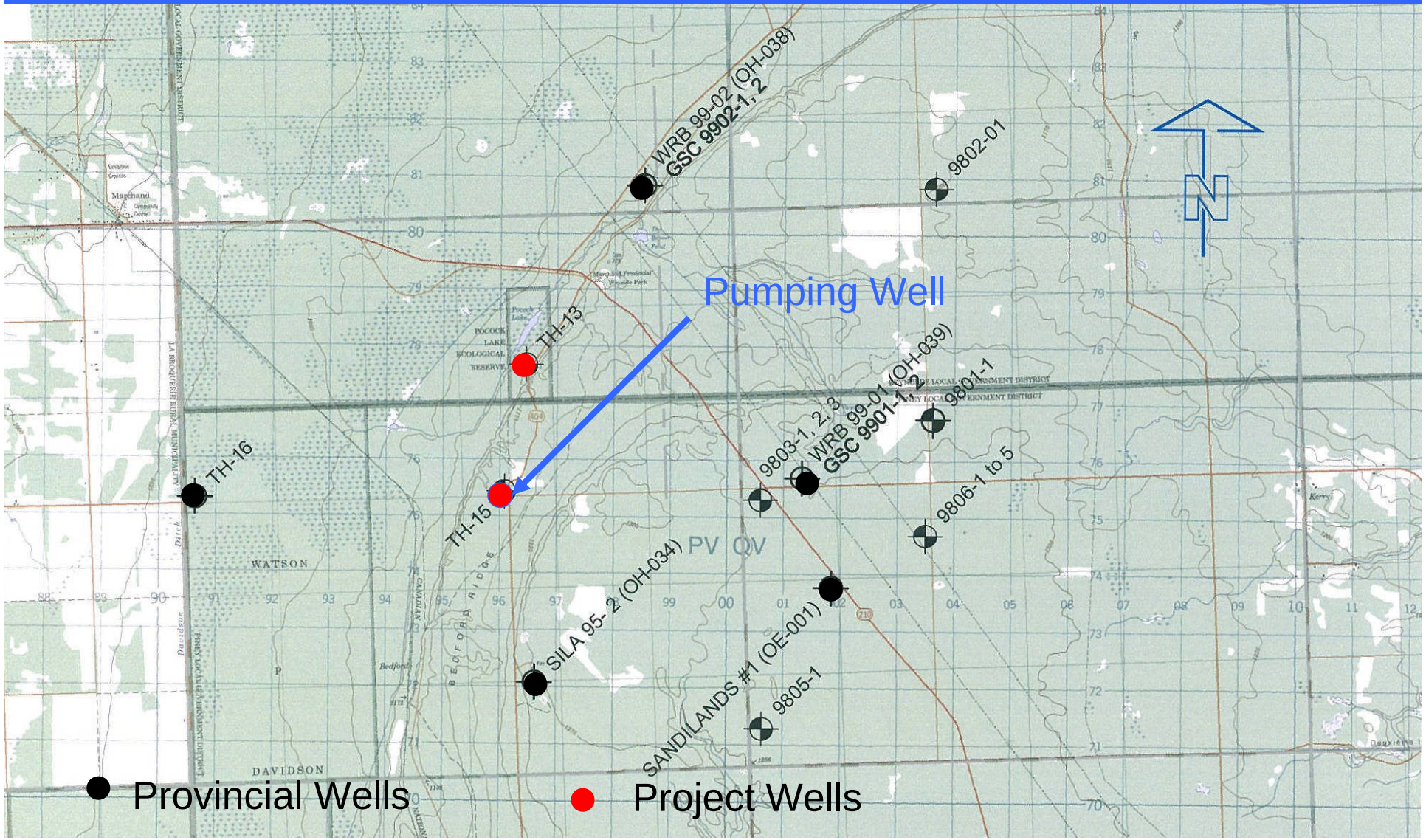
Monitoring Plan

- Groundwater level monitoring will be done both by the province and the proponent.
- All three aquifer units will be monitored.
- Continuous water level recorders will be used.
- Groundwater quality will also be monitored.
- Quarterly and annual reporting.

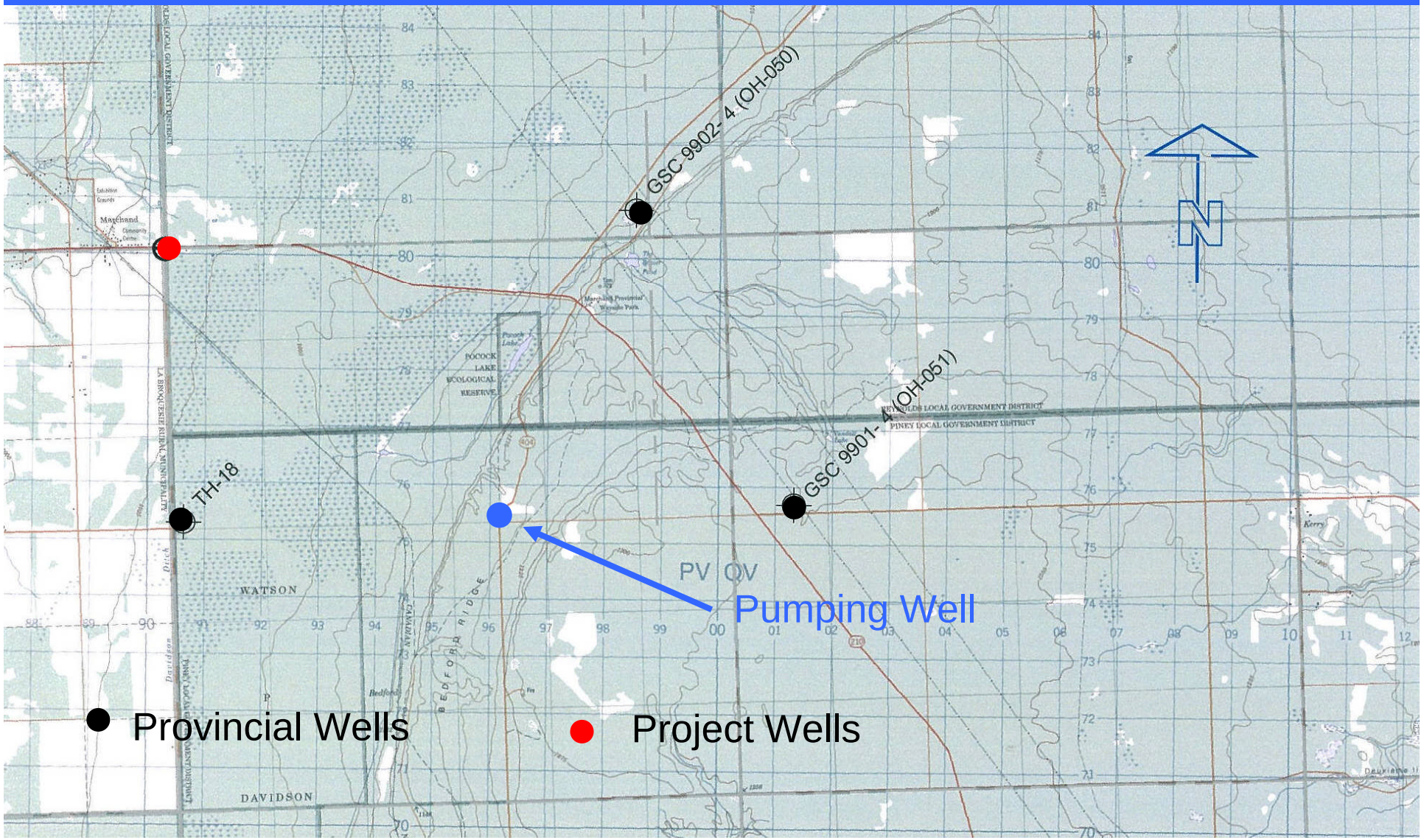
Lower Sand Unit Monitoring Wells



Upper Sand Unit Monitoring Wells



Sandstone Unit Monitoring Wells



Contingency Plan

- Protection of Existing Users
  - Water Rights License will require the Proponent to provide mitigation should any existing users be affected. This could include:
    - Repairing the existing well.
    - Providing a new well/water source.
    - The reduction or cessation of pumping by the Proponent.

Contingency Plan

- Protection of Environment
  - Should the monitoring program identify that the withdrawal is having an adverse effect on the environment or the groundwater resource, the pumping rate will be reduced or ceased and alternate sources of supply developed.