

Paris – Galt Moraine Hydrogeology

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Guelph Water Services

Paris – Galt Moraine Hydrogeology

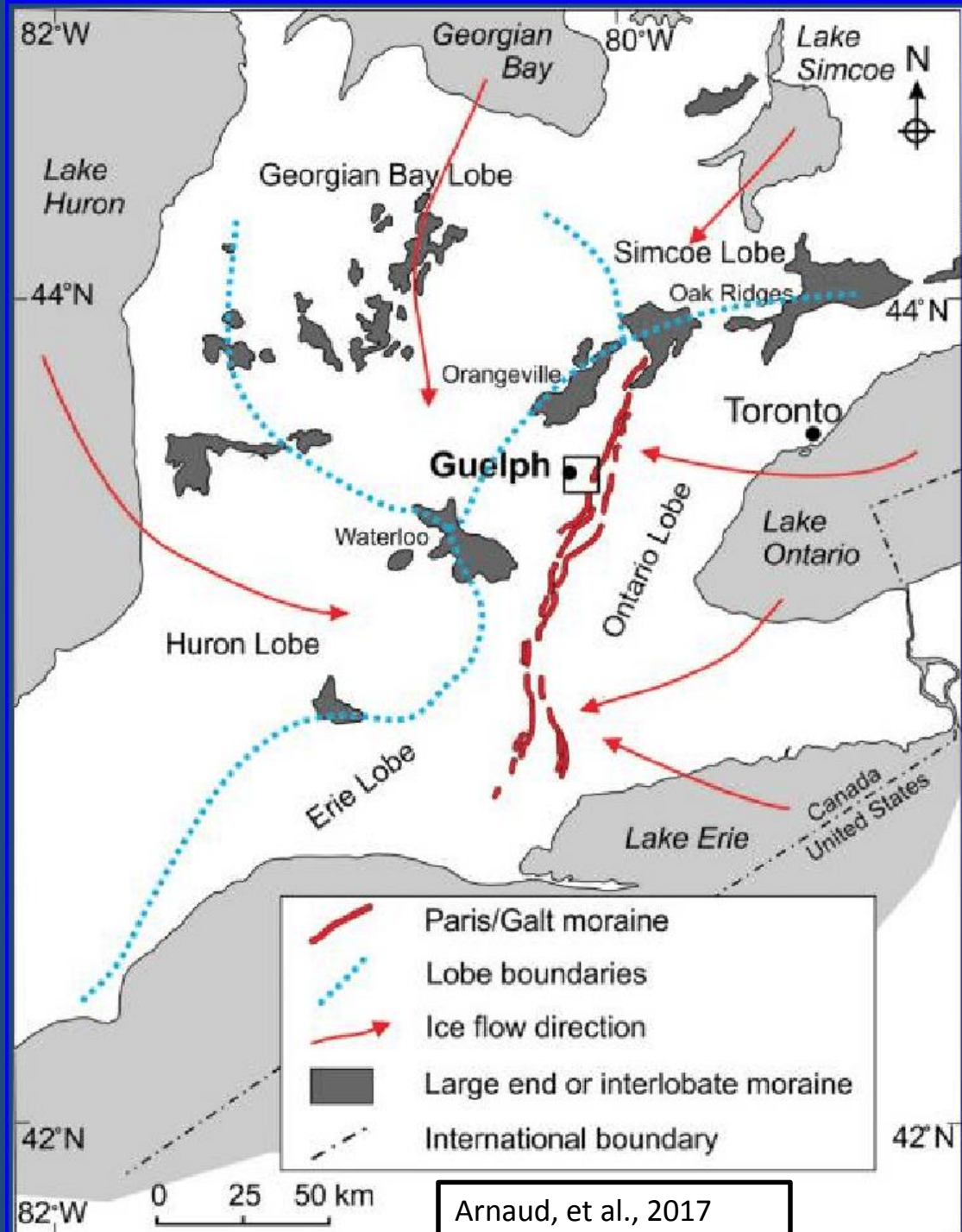
- Three topics:
 - Paris – Galt Moraine – general geology and hydrogeology setting
 - Guelph's Water Supply – where does it come from?
 - Source Protection and the Clair – Maltby Secondary Plan
- High level – not Clair-Maltby specific

Paris – Galt Moraine

- How was it formed
- Where is it found?
- Why is it important?

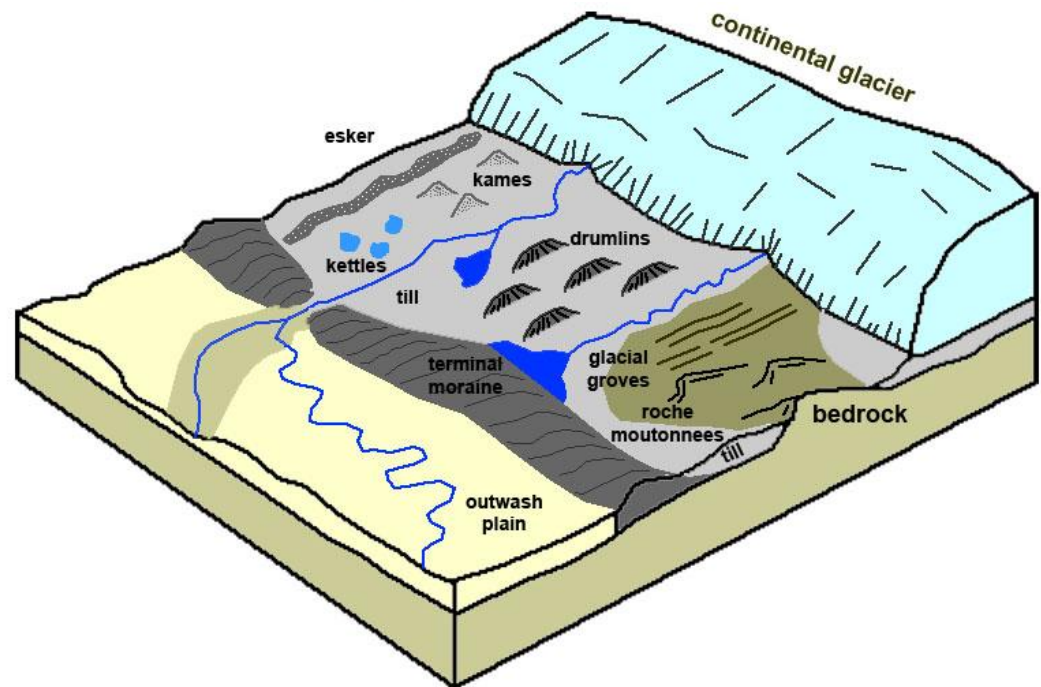
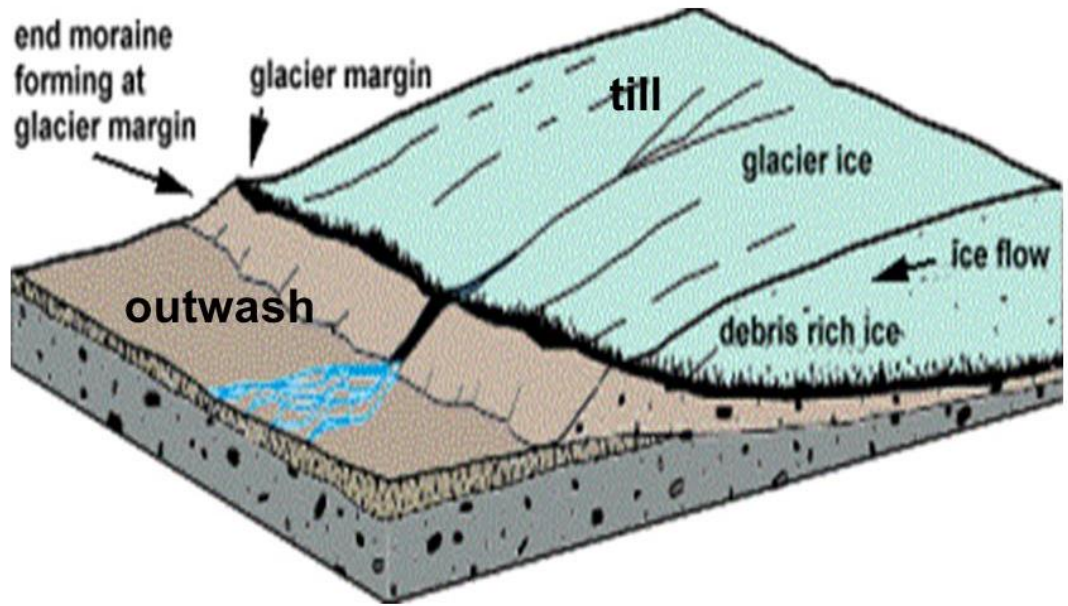
Paris – Galt Moraine

- 130 km long, up to 11 km wide and relief of 30 m
- Formed from continental glaciation - ~12,000 yr ago
- Till or recessional moraine – End or terminal moraine



Moraine Formation

- Continental glaciation
- Formed at the leading edge of the glacier
- Hummocky moraines are “areas of knob-and-kettle topography”
- *Outwash Deposits*





Moraine

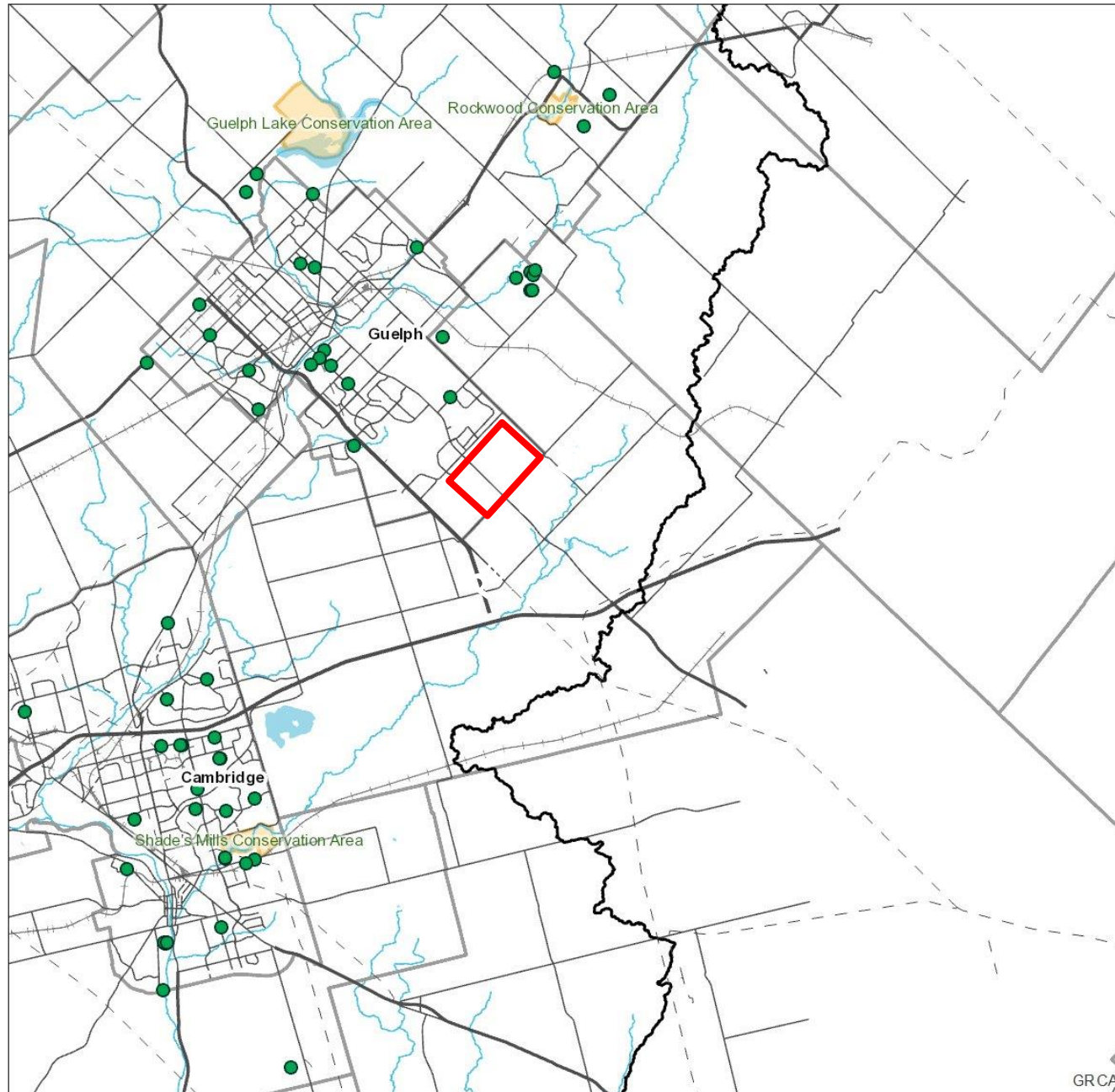
Outwash Plain

Arkell Road and Victoria Rd S. – facing Southeast



Outwash Plain –
Sand and Gravel

Clairfields Dr – facing southeast
(pre-construction)



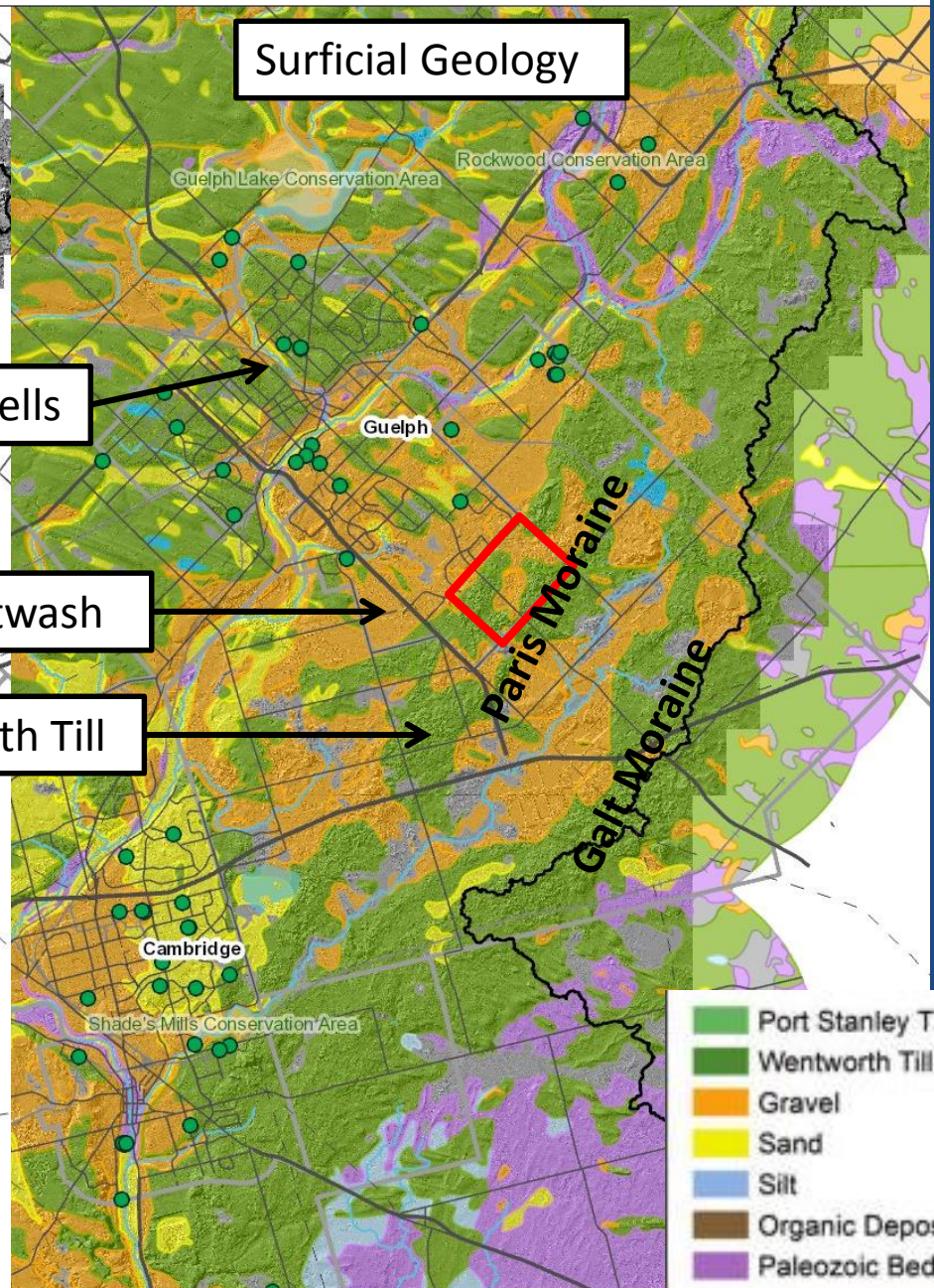
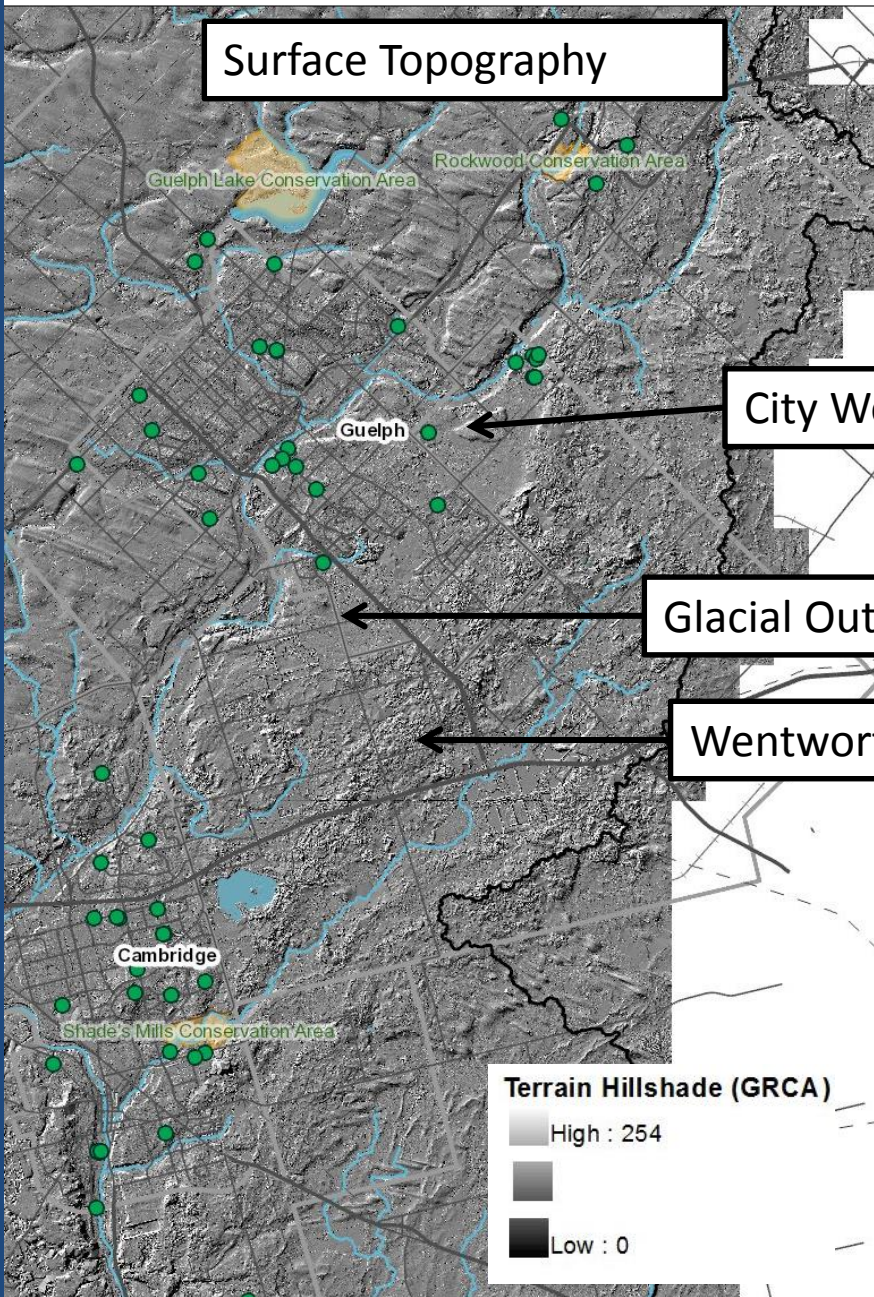
Legend

-  Municipal Well (GRCA)
-  Municipal Boundary (GRCA)
-  Watercourse - Regional (GRCA)
-  Park - Regional (GRCA)
-  Waterbody - Major (GRCA)
-  Great Lakes - Regional (GRCA)

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 The source for each data layer is shown in parentheses in the map legend. For a complete listing of sources and citations go to: <https://maps.grandriver.ca/Sources-and-Citations.pdf>

Surface Topography

Surficial Geology



City Wells

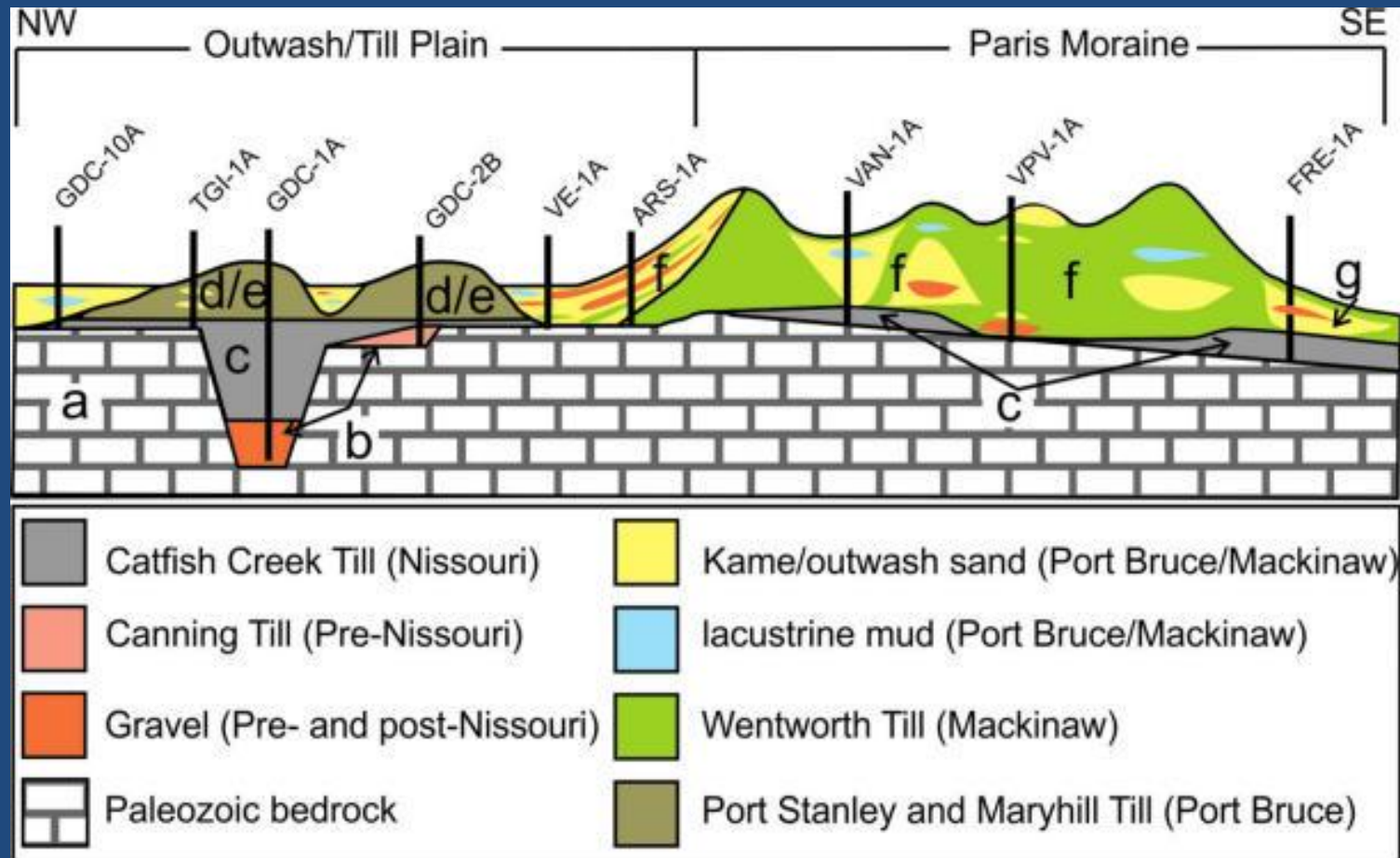
Glacial Outwash

Wentworth Till

Terrain Hillshade (GRCA)
High : 254
Low : 0

- Port Stanley Till
- Wentworth Till
- Gravel
- Sand
- Silt
- Organic Deposits
- Paleozoic Bedrock

Moraine – Geologic Cross Section

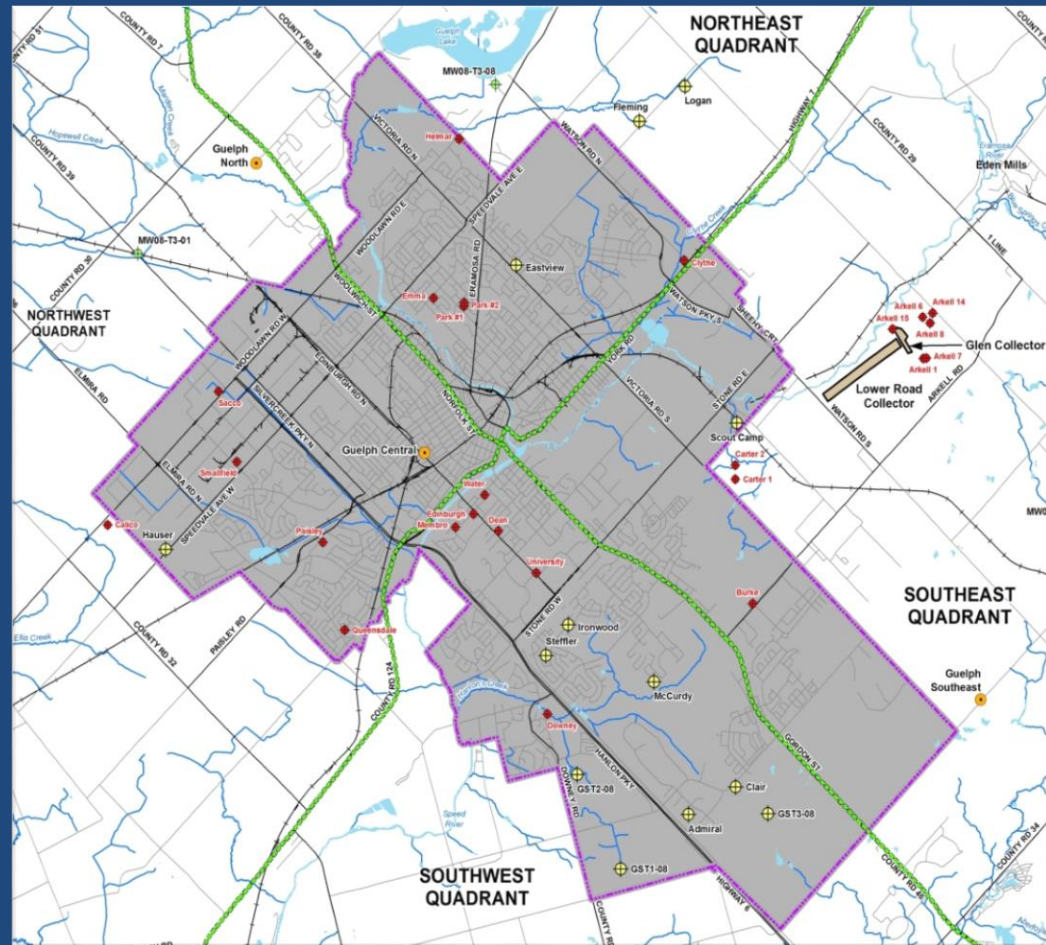


- Wentworth Till – sandy silt to silt matrix
- Port Stanley Till – silt to sandy matrix
- Maryhill Till – silty clay to clay matrix
- Catfish Creek Till – sandy silt to silt matrix

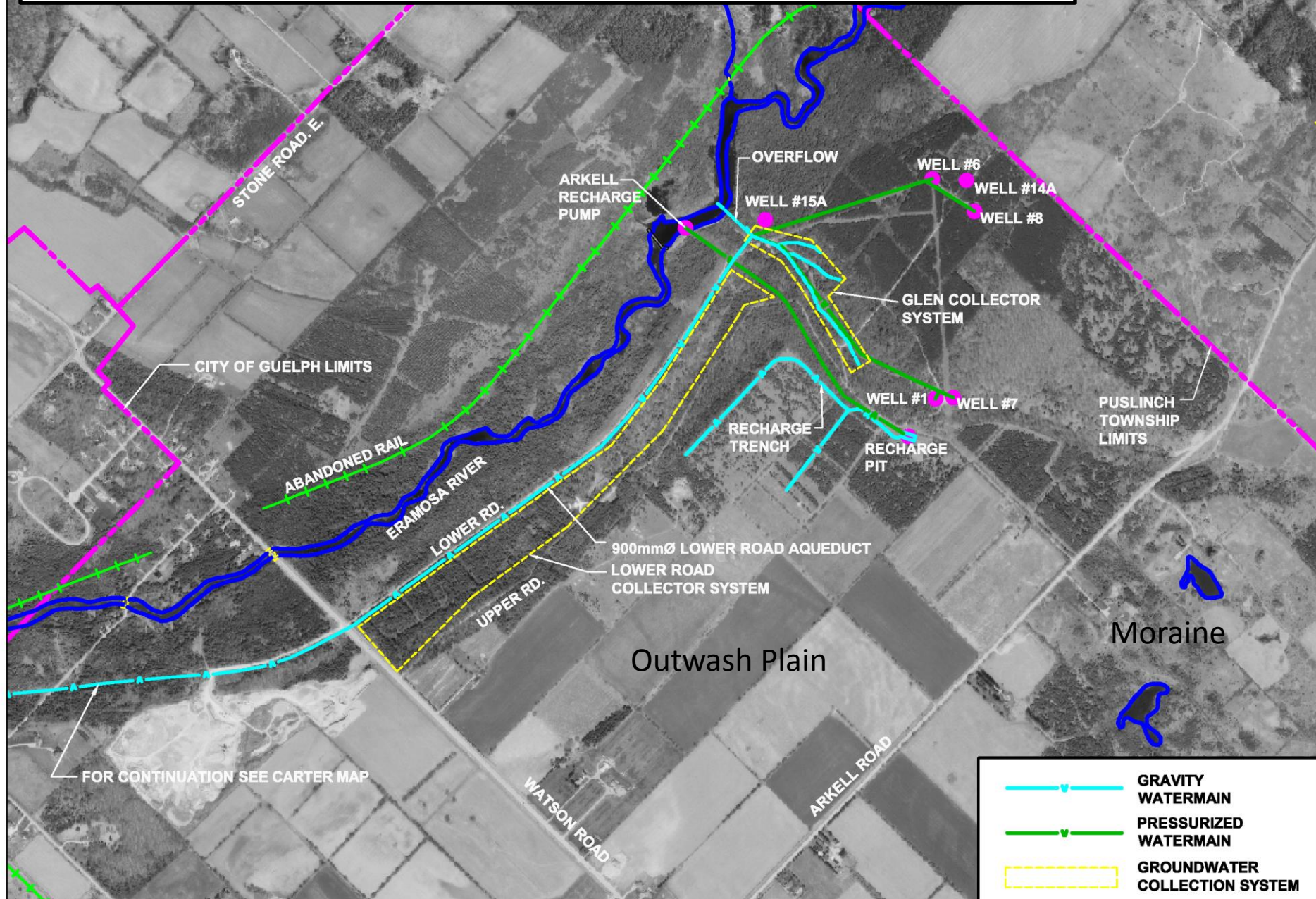
Arnaud, et al., 2017

CITY OF GUELPH - WHERE DO WE GET OUR WATER?

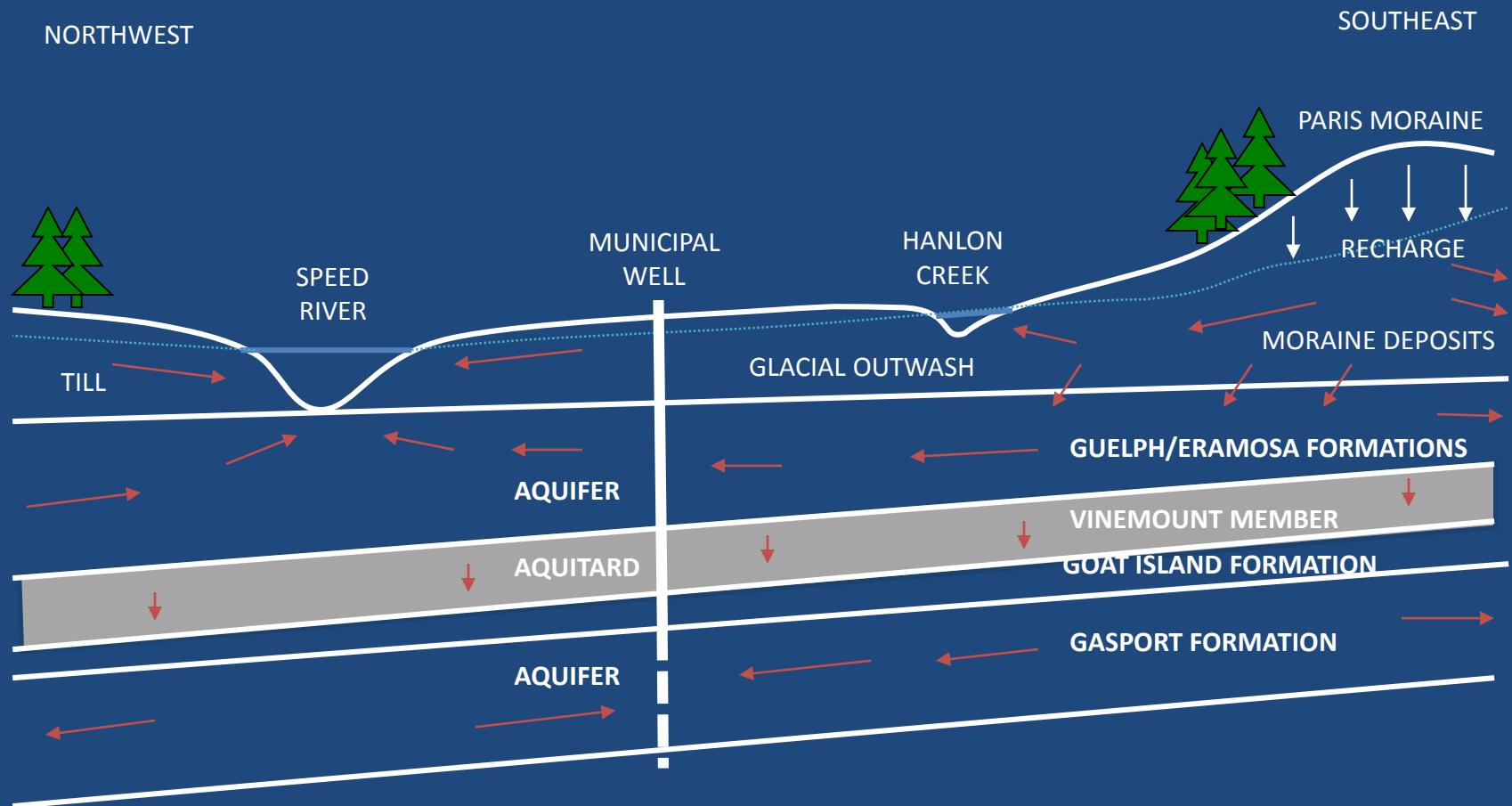
- Have relied on groundwater to meet water demands since 1879;
- Most water supply comes from wells in the Gasport Formation deep bedrock aquifer and the Arkell Spring Grounds collector system;
- Municipal supply system includes 25 production wells:
 - 21 wells are in continuous operation;
 - 4 wells are offline due to water quality concerns.
 - Average day demand – ~46,000 m³/day



Arkell Spring Grounds – Water Supply Systems



Guelph Water Supply – Aquifers and Aquitards

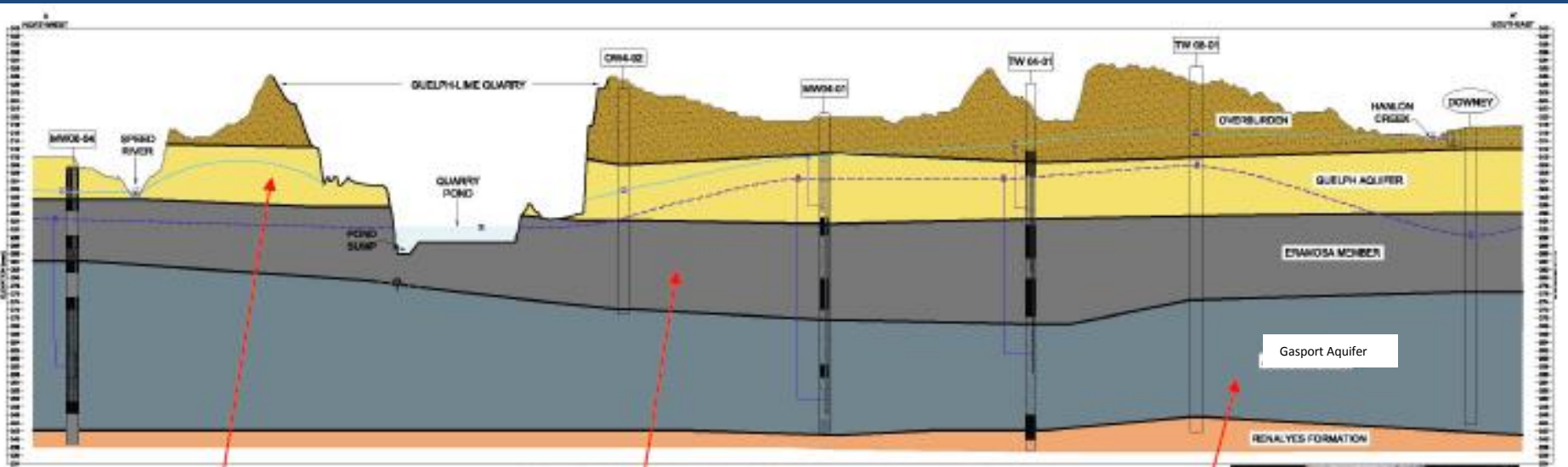


Schematic – Not to Scale

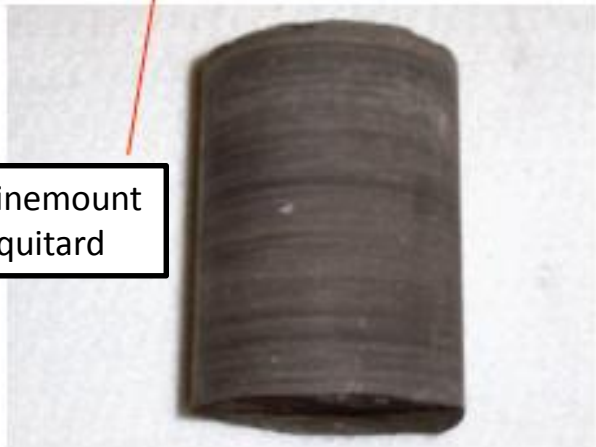
Geologic Cross Section

NW

SE



Guelph Aquifer



Vinemount Aquitard



Gasport Aquifer

Arkeil Spring Grounds - Cross Section

Southwest

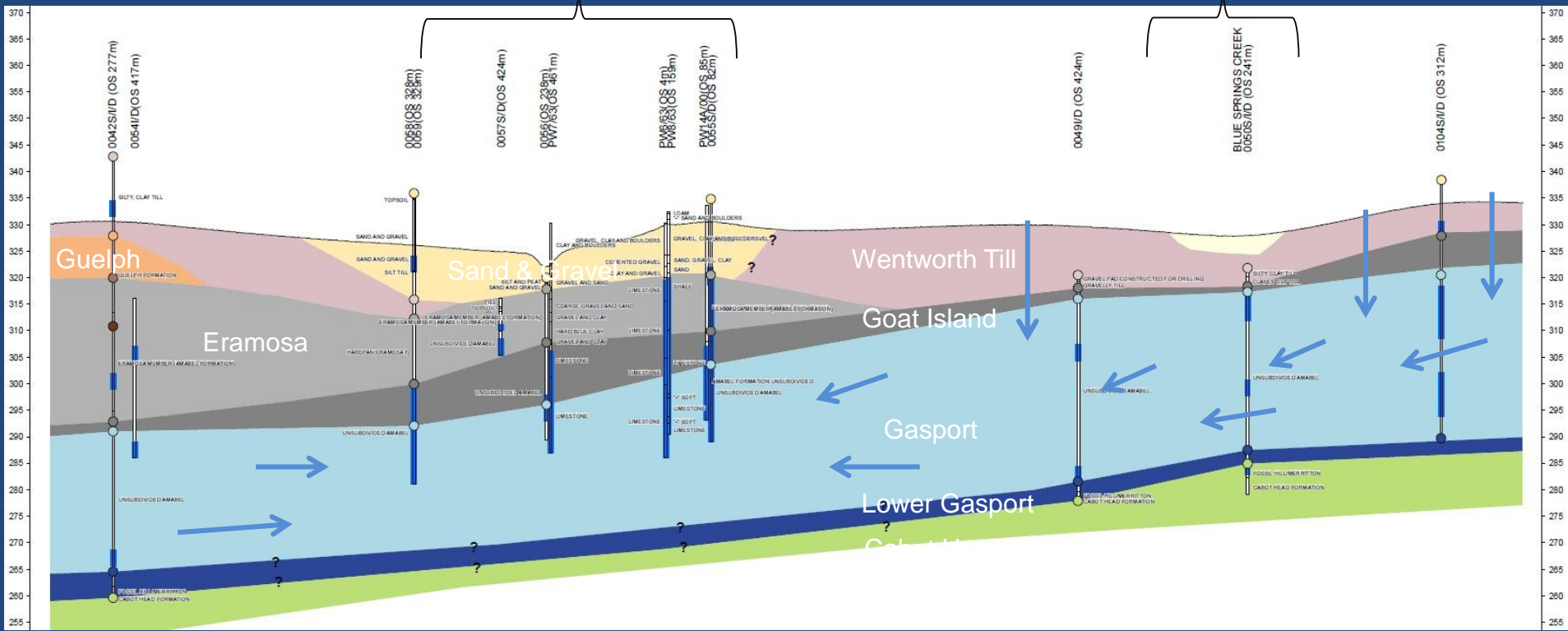
Northeast

A

A'

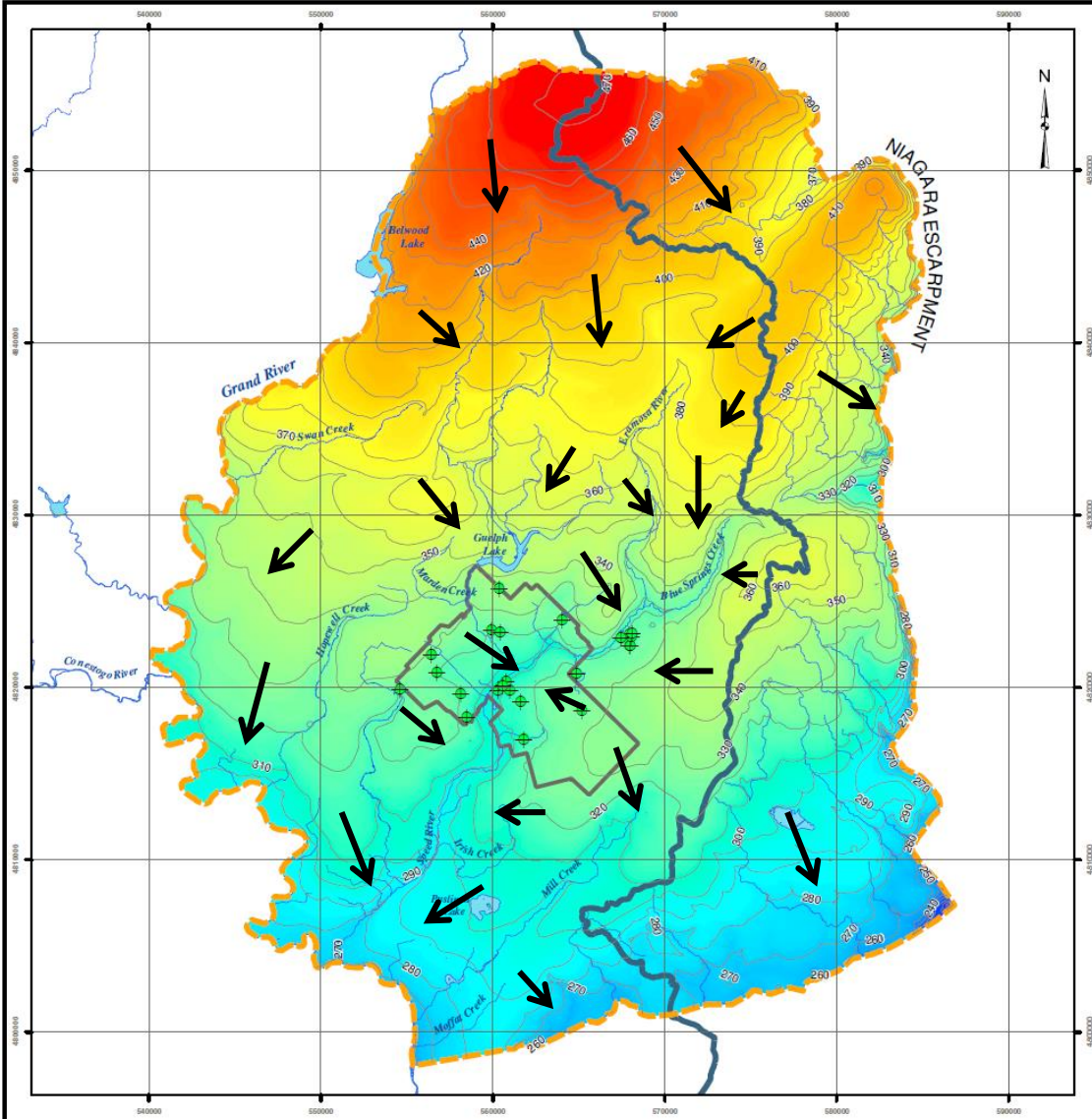
Arkeil Spring Grounds

Blue Springs Creek



Groundwater Flow - Overburden

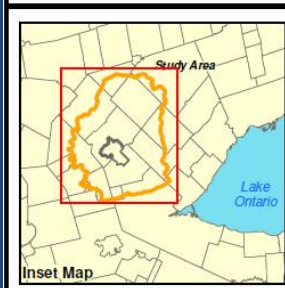
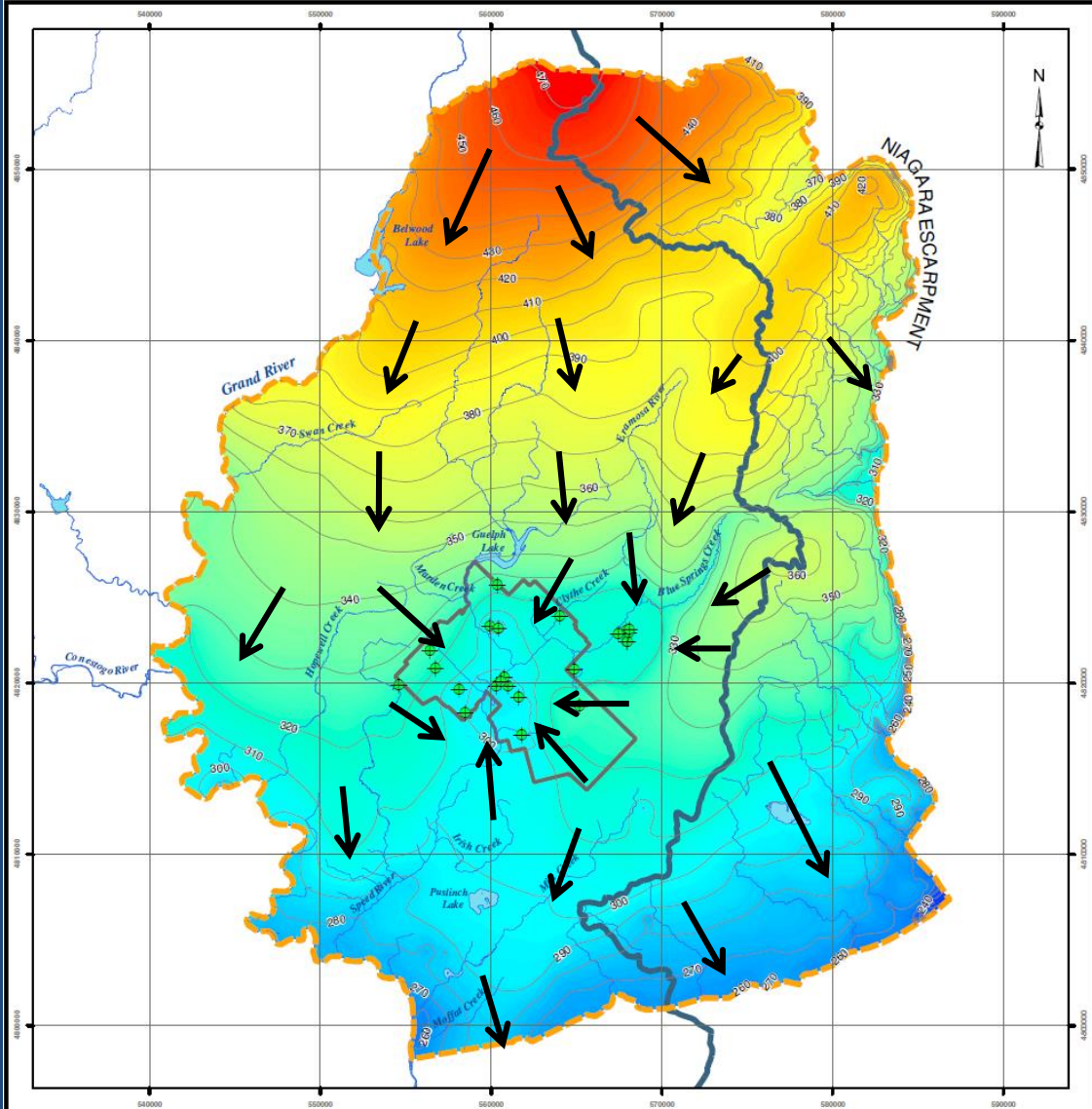
- Mirrors topography
- Flows from high elevation to and discharges into rivers and creeks
- Shallow groundwater supports creeks, wetlands, ecosystems, etc.
- Similar to shallow bedrock



<p>Inset Map</p>	<p>LEGEND</p> <ul style="list-style-type: none"> Green diamond: Guelph Water Supply Wells Blue line: Rivers / Streams Blue square: Open Water Orange outline: Model Boundary Blue outline: Grand River Watershed Boundary Black outline: City of Guelph Boundary Black line: Potentiometric Surface Contour Interval 10m Color gradient: Potentiometric Surface (m) High: 475, Low: 195 <p>Scale 1:310,000</p> <p>0 2.5 5 10 15 Kilometres</p> <p>REFERENCES: <small>Map Data: City of Guelph, 2009; GPCA, 2008, CVC, 2008, Ministry of Natural Resources, 2008 Produced using information under License with the Grand River Conservation Authority. Copyright © Grand River Conservation Authority, 2010 Produced using information provided by the Ministry of Natural Resources, Copyright © Queen's Printer, 2010 Projection: UTM Zone 17N, NAD 83 Map Version: 3, Map Date: 28-Jul-11; Created By: CC</small></p>	<p>Tier Three Local Area Risk Assessment</p> <p>Produced by Aquaresource Inc. and Golder Associates Ltd.</p> <p>Figure 3-12 Model Predicted Slice 5 (Contact Zone) Potentiometric Surface</p>
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Groundwater Flow – Deep Bedrock

- Subdued reflection of topography
- Flows from the north-northeast to City production wells
- Deep regional groundwater flow system



LEGEND

- Green diamond: Guelph Water Supply Wells
- Blue line: Rivers / Streams
- Blue area: Open Water
- Orange outline: Model Boundary
- Blue outline: Grand River Watershed Boundary
- Black outline: City of Guelph Boundary
- Black line: Potentiometric Surface Contour Interval 10m
- Color gradient: Potentiometric Surface (m)
 - High : 480
 - Low : 210

Scale 1:310,000

0 2.5 5 10 15 Kilometres

REFERENCES:
 Slice 12a - City of Guelph, 2009; GRCA, 2008; CVC, 2008; Ministry of Natural Resources, 2008
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 Map Version: 3, Map Date: 28-Jul-11, Created by: CC

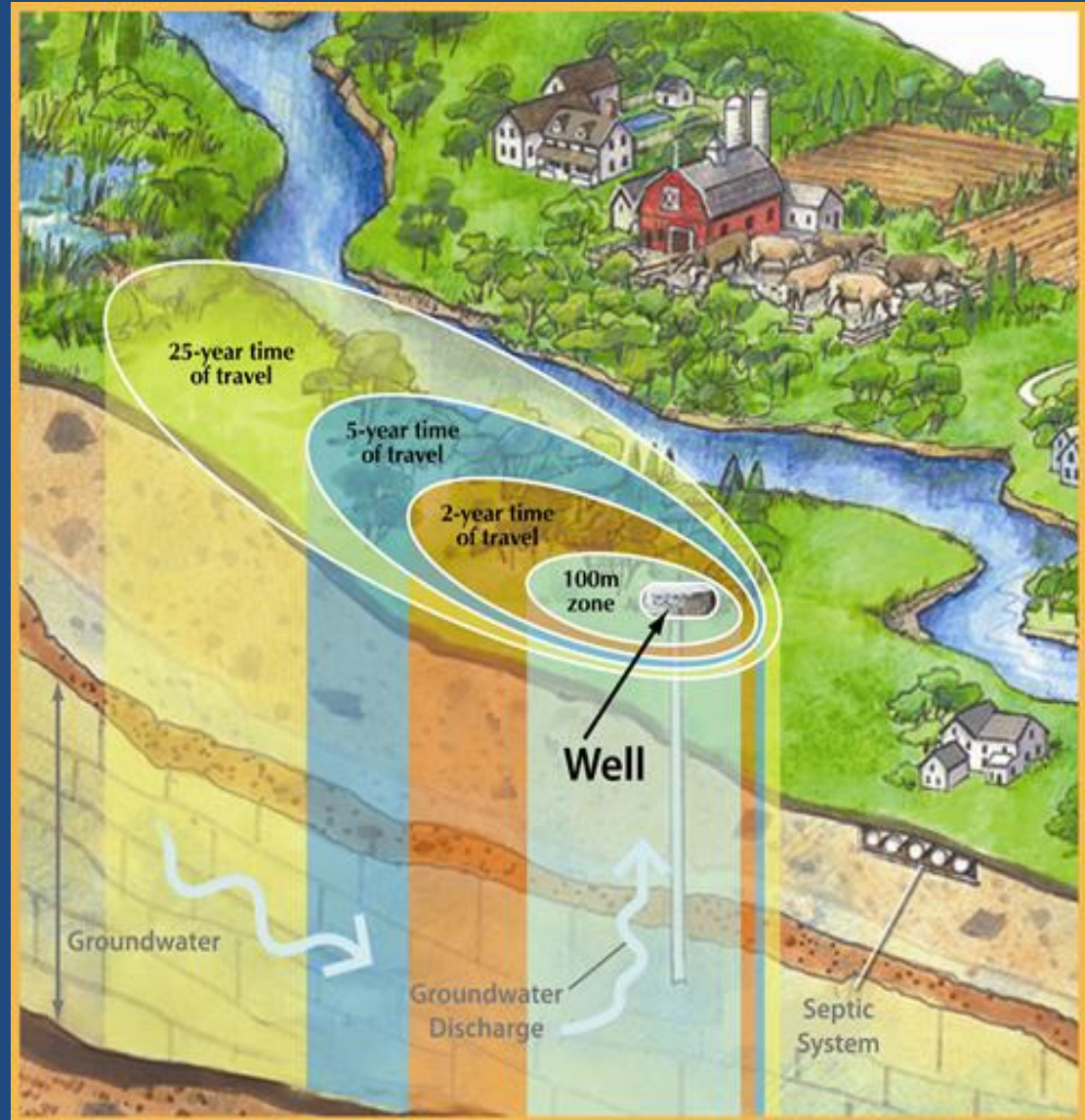
**Tier Three Local Area
Risk Assessment**

Produced by
**Aquasource Inc. and
Golder Associates Ltd.**

Figure 3-14
Model Predicted Slice 12 (Gasport)
Potentiometric Surface

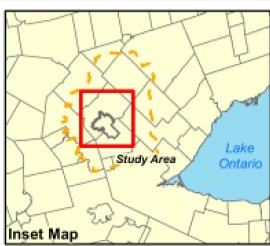
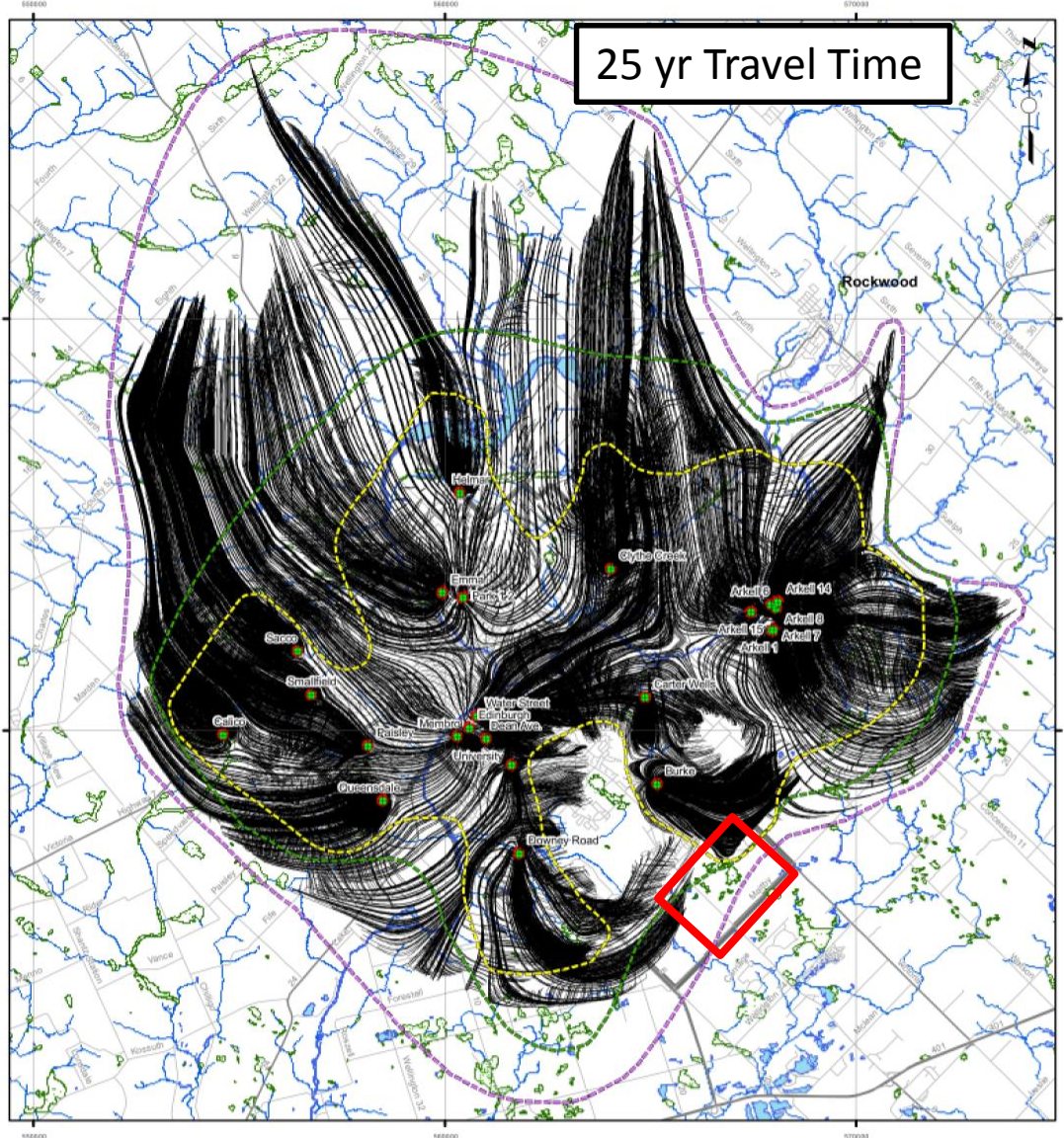
Source Protection Program

- Wellhead Protection Areas delineated for each well
- Based on travel time to the well in the aquifer
- Estimated using a 3-D groundwater flow model



Source Protection - Capture Zones

- Tier 3 Water Budget Model
- Reverse particle tracking
- Future water demand – 2031 (72,535 m³/day)



LEGEND

Water Supply Wells	Wetland	WHPAs
Particle Tracks	Open Water	100m (WHPA-A)
Roads (collector)	City of Guelph Boundary	2yr (WHPA-B)
Expressway / Highway	Rivers / Streams	5yr (WHPA-C)
		25yr (WHPA-D)

Scale 1:130,000
Kilometres

REFERENCES:
Base Data - City of Guelph, 2009; GRCA, 2008, CVC, 2008; Ministry of Natural Resources, 2006
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Projection: UTM Zone 17N, NAD 83
Map Version: 1; Map Date: March, 2012; Created By: osany

City of Guelph Source Water Protection Project

AquaResource
A Division of Matrix Solutions Inc.

Figure 7.
Basecase Scenario - Particle Tracks (25-Year TOT)

Wellhead Protection Area - Quality

- WHPA defined from Capture Zones:
 - WHPA-A – 100 m
 - WHPA-B – 2 yr Time of Travel
 - WHPA-C – 5 yr
 - WHPA-D – 25 yr
- Small area of WHPA-C in Clair-Maltby – water quality policies apply

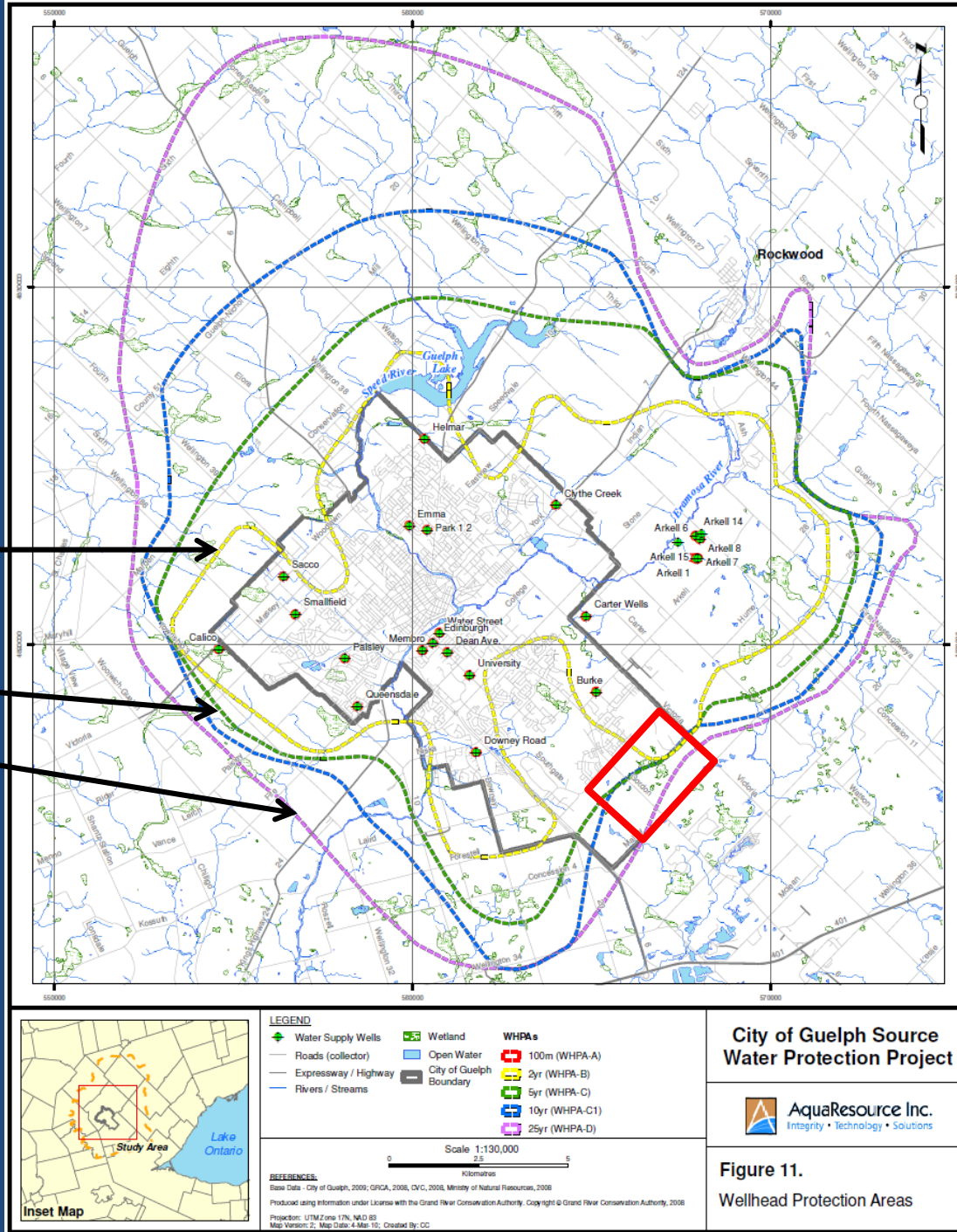
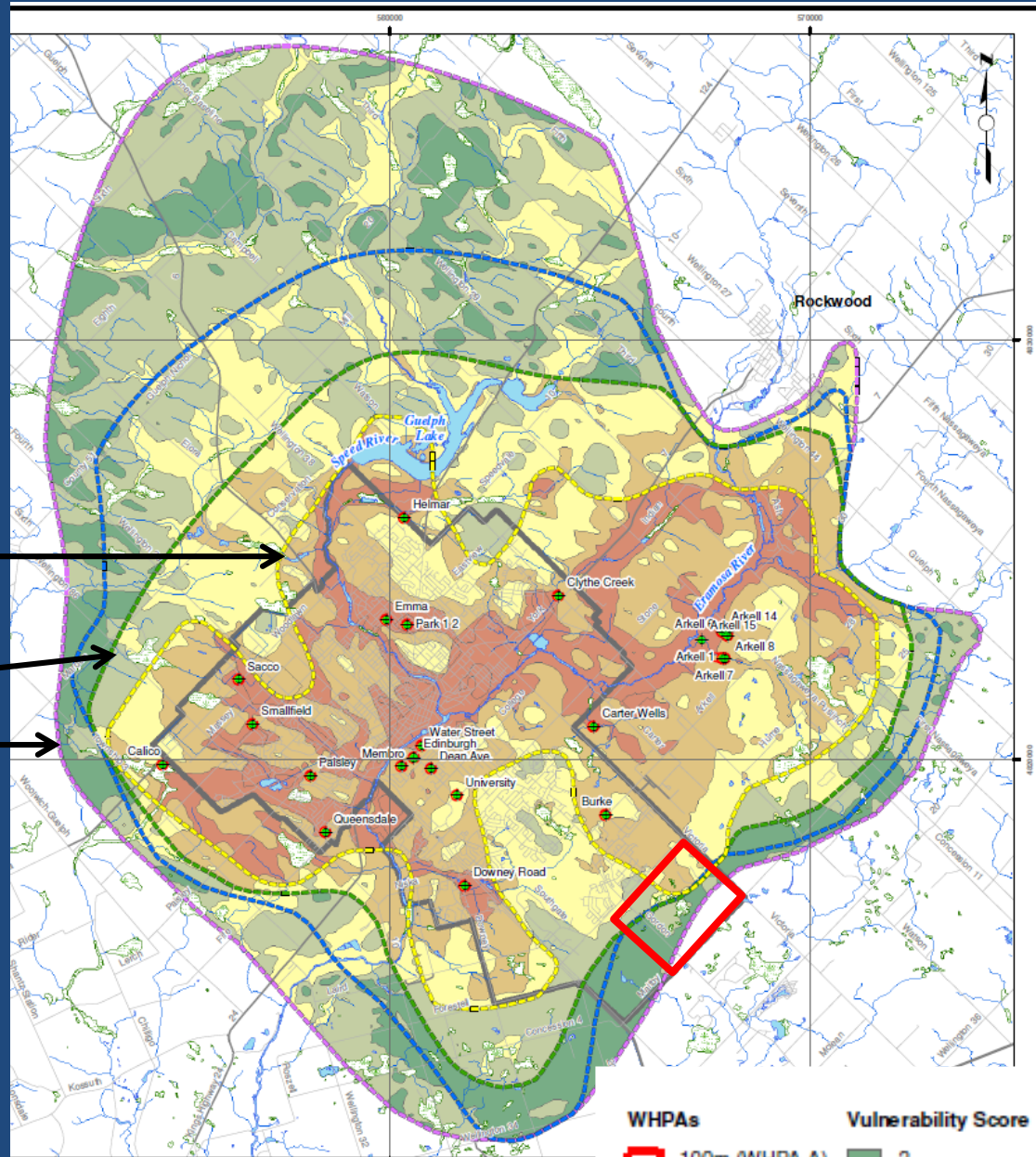


Figure 11.
Wellhead Protection Areas

Wellhead Protection Area - Quality

- WHPA defined from Capture Zones:
 - WHPA-A – 100 m
 - WHPA-B – 2 yr Time of Travel
 - WHPA-C – 5 yr
 - WHPA-D – 25 yr
- Small area of WHPA-C in Clair-Maltby – water quality policies apply
- Low vulnerability



WHPAs	Vulnerability Score
100m (WHPA-A)	2
2yr (WHPA-B)	4
5yr (WHPA-C)	6
10yr (WHPA-C1)	8
25yr (WHPA-D)	10

Wellhead Protection Area - Quantity

- Defined four WHPA-Qs within study area
- Based on combined drawdown of water takings – 2 m contour
- Considered current and future water takings under future land use and drought conditions
- GGET WHPA-Q - **Significant Risk Level**

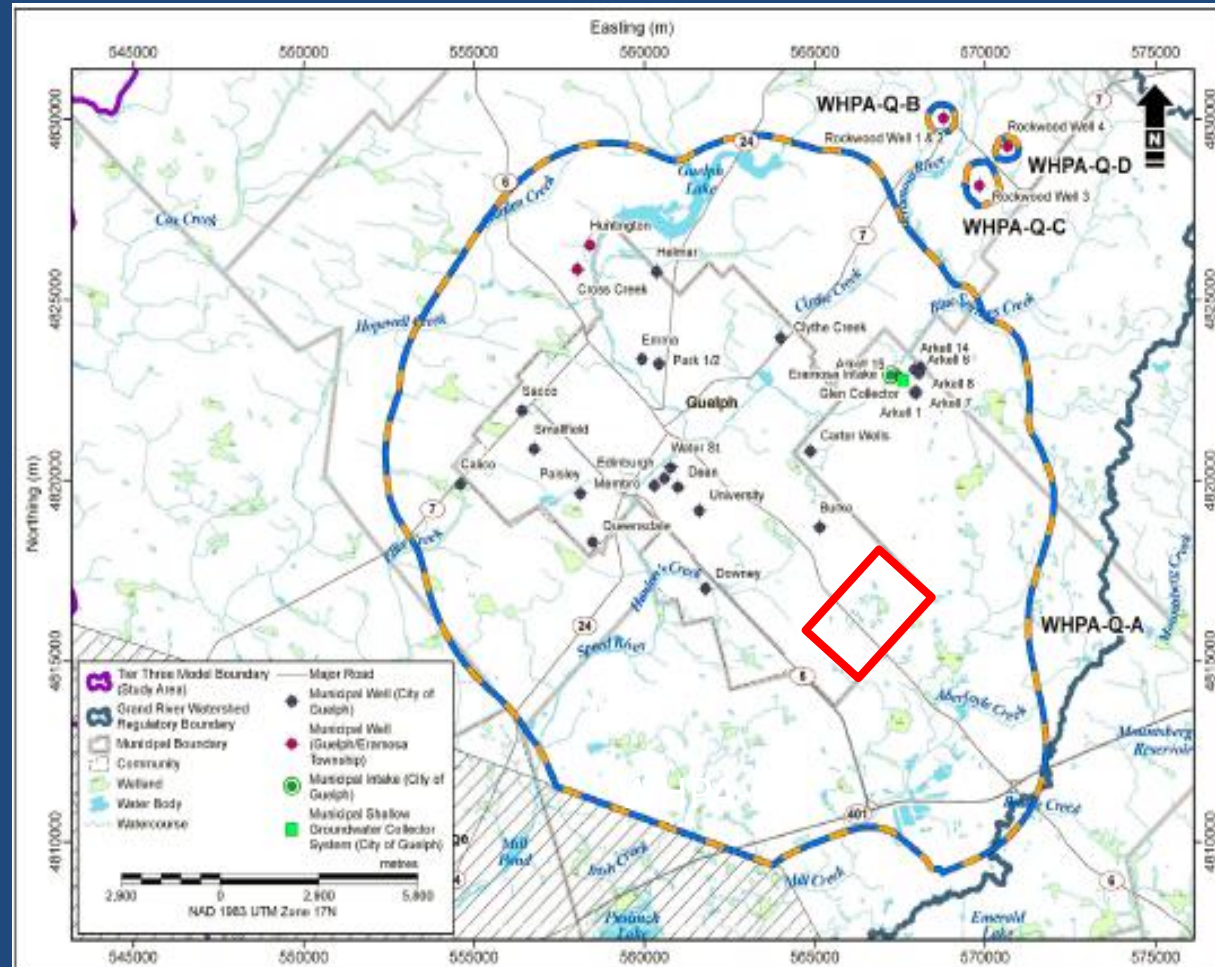


FIGURE 2 WHPA-Qs Delineated in Tier Three Assessment (Matrix 2017)

WHPA-Q Drawdown

- Contour
Intervals:

- 0.5 to 1 m

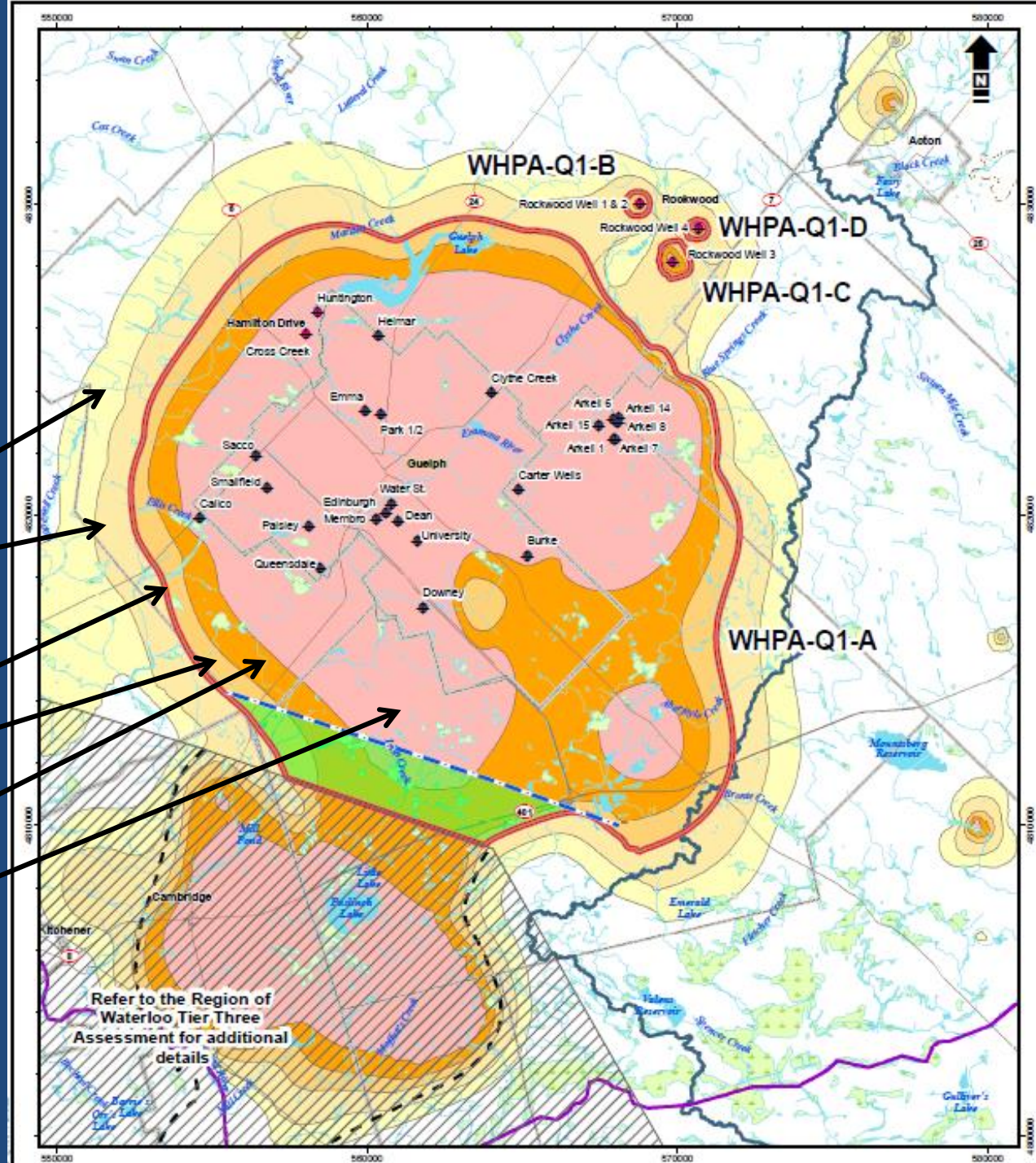
- 1 to 2 m

- 2 m contour

- 2 to 3 m

- 3 to 5 m

- > 5 m



Risk Ranking

- Municipal wells ranked highest
- Queensdale, Arkell Wells and Dolime Quarry – ranked 1, 2 and 3
- All recharge reduction areas ranked low – 15th out of 24 threats
- Water quantity policies under development

Water Quantity Threat	Greatest % Impact	Rank	Well under Greatest % Impact
Municipal Well Takings	91%	-	Queensdale
Queensdale well	72%	1	Queensdale
Arkell System (Arkell 1, Arkell 6, Arkell 7, Arkell 8, Arkell 14, Arkell 15 wells and artificial recharge and collector system)	53%	2	Arkell 8
Clythe Creek well	32%	4	Clythe Creek
Calico well	24%	5	Calico
Sacco well	22%	6	Sacco
Helmar well	19%	7	Helmar
Smallfield well	19%	8	Smallfield
Carter wells	17%	9	Carter Wells
Water St. well	17%	10	Water St.
Burke well	15%	11	Burke
Membro well	13%	12	Membro
Downey well	12%	13	Downey
University well	7%	16	University
Dean well	4%	17	Dean
Paisley well	2%	18	Paisley
Future Municipal Takings: Hamilton Drive (GET)	<1%	22	-
All Permitted, Non-Municipal Takings	51%	-	Dean
5080-8TAKK2 (River Valley Developments)	50%	3	Membro
All other Permitted, Non-Municipal Takings Inside WHPA-Q except Dewatering, Commercial, and Industrial Permits (32 permits as of 2008)	10%	14	Emma
1245-AB8RMW (Gay Lea Foods)	2%	19	Emma
1381-95ATPY (Nestle Waters)	1%	20	Burke
5448-9FLM5E (Holody Electro Plating)	< 1%	23	-
5736-8QSS7B (Flochem)	<1%	24	-
All Recharge Reduction Areas (due to future land use)	9%	15	Burke
All Non-Permitted Takings (WWIS-Domestic)	1%	21	Helmar

Recharge Reduction - Policy Approaches

Policy Approach Themes	Policy Approach
Water Conservation and Efficiency	<ul style="list-style-type: none">• Incentive programs for water conservation and efficiency
Recharge Maintenance	<ul style="list-style-type: none">• Guidelines for groundwater recharge maintenance• Groundwater recharge maintenance where appropriate• Environmental Compliance Approval (ECA) review for stormwater management facilities with LID systems
Growth and Development	<ul style="list-style-type: none">• Update of subwatershed studies
Coordination	<ul style="list-style-type: none">• Water Resource Technical Working Group
Education and Outreach	<ul style="list-style-type: none">• Education and outreach initiatives• Web-based resources as part of EnviroGuide platform
Monitoring	<ul style="list-style-type: none">• Long-term monitoring program of shallow groundwater and surface water systems
Prioritization	<ul style="list-style-type: none">• Prioritization of ECA review and inspection for stormwater management facilities with LID systems

Recharge Reduction Policies

- Source Protection Policies developed with City Water, Planning and Engineering Services
- Consistent with good land use planning in Clair-Maltby
- Maintain high quality recharge to support baseflow in creeks – salt mitigation to prevent quality degradation
- Maintaining baseflow will help sustain municipal water supply
- Proposed monitoring programs to help manage groundwater and surface water resources
- Source Protection Plan, once approved by MECP, is an obligation of the City to implement

Summary

- Paris-Galt Moraine is a major geological feature that supports groundwater recharge areas – hydrological function is important
- Guelph's water supply is derived from deep bedrock wells - not much water originates from the Paris Moraine
- Source Protection Quality Policies – C-M not a water quality issue except salt
- Source Protection Quantity Policies - Recharge reduction policies developed with Planning and Engineering to protect C-M infiltration function and protect, restore and replenish surface and groundwater resources