Hydrogeological /

Water Balance Assessment

Proposed Storage Unit

249 Whitfield Crescent, Town of Midland

Prepared for:
Quantum Engineering

Prepared by:
Azimuth Environmental
Consulting, Inc.

Revised January 2019

AEC 18-151

AZIMUTH ENVIRONMENTAL CONSULTING, INC.

Environmental Assessments & Approvals

January 15, 2019 AEC 18-151

Quantum Engineering
97 Copeland Creek Drive
Tiny, ON
L9M 0M2

Attention: Kyle Merritt

Re: **Hydrogeology/ Water Balance Assessment for Proposed Storage Unit Facility (Revised Submission)**
249 Whitfield Crescent, Town of Midland

Dear Mr. Merritt:

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Azimuth Environmental Consulting, Inc. (Azimuth) is pleased to submit our revised Hydrogeological / Water Balance Assessment for a property located at ~~241~~ Whitfield Crescent, Town of Midland (Subject Property) for a proposed storage unit facility. This work is intended to meet Policy LUP-12 of the South Georgian Bay Lake Simcoe Region Source Protection Plan (SPP). The report has updated to address comments provided by the Corporation of the Town of Midland in a letter dated September 2018. This includes changing the assumptions used for the gravel driveway to be impermeable.

This evaluation focuses on the existing soils and surface water regime underlying the Subject Property and the potential for the proposed development to impact the on-site hydrogeological conditions.

Based upon the results of our assessment, it is concluded that the present hydrogeological conditions of the Subject Property will not experience a significant change due to the hard surface being created on the Site. The water balance calculation for the proposed development indicates an increase in the ground water infiltration with the use of low impact development (LIDs) by approximately 242 m^3/year, which represents a potential 20% increase from pre-development conditions.

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The hydrogeological assessment demonstrates the existing water balance can be maintained by incorporating LID thus the development concepts meet Policy LUP 12 of the SPP for the Town of Midland.

If you require further information or have any questions do not hesitate to contact us.

Yours truly,

AZIMUTH ENVIRONMENTAL CONSULTING, INC.

Jackie Coughlin, B.A.Sc., P.Eng
Senior Environmental Engineer/ Partner

Jennifer Thompson, M.Sc., P.Geo.
Hydrogeologist

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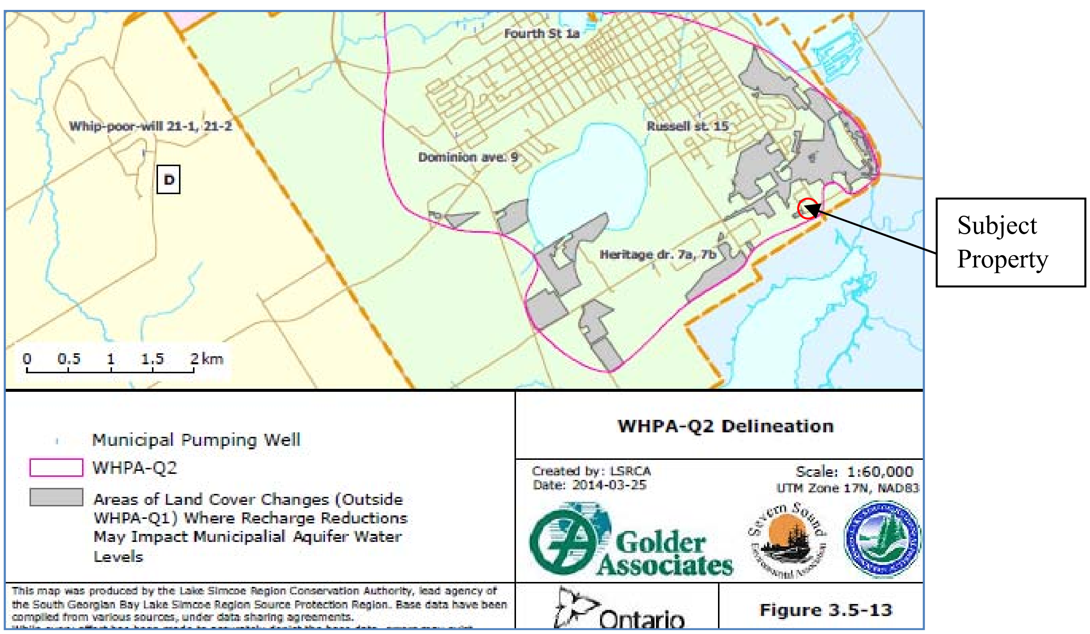
1.0 INTRODUCTION

Azimuth Environmental Consulting (Azimuth) was retained by Quantum Engineering to complete a Hydrogeology / Water Balance Assessment for a proposed industrial development. This work is intended to meet Policy LUP-12 of the South Georgian Bay Lake Simcoe Region Source Protection Plan (2015) which States:

> *"Planning Approval Authorities shall only permit new major development (excluding single detached residential, barns and non-commercial structures that are accessory to an agricultural operation) in a WHPA-Q2 where the activity would be a significant drinking water threat, where it can be demonstrated through the submission of a hydrogeological study that the existing water balance can be maintained through the use of best management practices such as low impact development. Where necessary, implementation and maximization of off-site recharge enhancement within the same WHPA-Q2 to compensate for any predicted loss of recharge from the development. "*

The South Georgian Bay Lake Simcoe Region Source Protection Plan (SPP) (Figure 3.5-13) indicates that the Subject Property is located within the southeast boundary of the WHPA-Q2 (See image below). Therefore, a hygrogeologial study that demonstrates the existing water balance can be maintained through the use of Best Management Practices (BMPs) is required under Policy LUP 12 of the SPP for the Town of Midland.



The following sections provide the background information, our study approach and provide the results of our evaluation and associated recommendations/ conclusions.

2.0 BACKGROUND

The Subject Property is located at 249 Whitfield Crescent, in the Town of Midland, County of Simcoe. The Subject Property is located within the southeastern extent of Midland approximately 350m south of Highway 12.

According to the Site Plan provided by Quantum Engineering (Quantum, 2018), proposed developments concepts include six (6) single storey self storage industrial buildings and a gravel/paved access route via Whitfield Crescent (Figure 2).

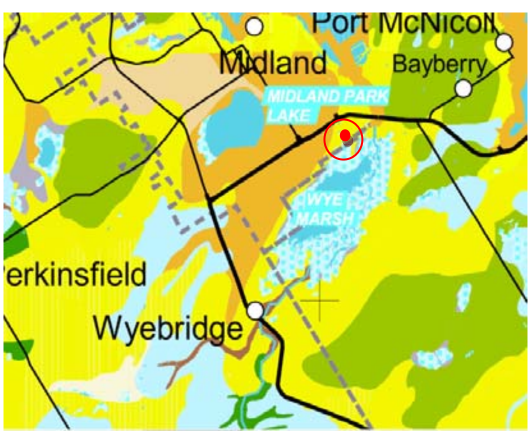
The 0.42 ha property is rectangular in shape and is currently vacant and covered in natural ground vegetation with some forest cover along the west property boundary (Figure 3). The current zoning of the Subject Property and surrounding area is Industrial M1.

The Subject Property is surrounded to the north, east and south by mixed industrial uses and to the west by a wetland. The Wye Marsh Provincially Significant Wetland (PSW) and Mud Lake is located approximately 400 m south and southeast of the Site limits (Figure 5).

3.0 SITE SETTING

3.1 Physiography and Quaternary Geology

The Ontario Geologic Survey (Chapman and Putnam, 1984) describes the area as being part of the Midland area of the Simcoe Uplands Physiographic Region. The Simcoe Uplands comprise a series of broad, rolling till plains separated by steep-sided, flat-floored valleys.



The Quaternary geology of the region (Barnett et al., 1991, South Sheet Map 2556, OGS 1991) (see image to left) is listed as a sandy silt to silt till and glaciolacustrine deposits consisting of sand, sand and gravel and near shore beach deposits.

Burwasser and Boyd (1974) indicate the Subject Property sediments are gravel and sand owing to "ice-contact deposits" creating substratified to stratified gravel and sand.

3.2 Bedrock

The bedrock underlying the area of the Subject Property is of the Middle Ordovician period consisting of limestone and shaley limestone of the Trenton and the Black River formations of the Simcoe County Group of rocks. Bedrock elevations range between 122 metres above sea level (masl) to a high of 190m asl in the region. A review of the local well records within the vicinity of the Subject Property shows bedrock between 14-40 m bgs.

3.3 Topography and Drainage

The local topography of the Subject Property is relatively flat and slopes in a general south to southeasterly direction toward the adjacent wetland to the south. According to the Site Plan (Figure 2), elevations range between 185 masl to 182 m asl (Quantum, 2018).

The soils at the Subject Property are classified as Tioga Sandy Loam (Hoffman & Richards, 1955). This soil is gray, calcareous outwash sand that is stone free to moderately stony. Tioga Sandy Loam is classified within hydrologic soil group “A”. Group A soils have low runoff potential and high infiltration rates even when thoroughly wet.

The Subject Property is located in the Wye River subwatershed, which is part of the Severn Sound watershed. The Severn Sound watershed has been divided into 19 subwatersheds with a total drainage area of 1,380 km^2. The Wye River originates in Tiny Township west of Orr Lake and flows through a wide shallow area just south of Midland forming the Wye Marsh and Mud Lake and eventually discharging into Midland Bay.

The Subject Property is located ~400 northeast of a Mud Lake (Wye Marsh). The elevation drop into this feature is about 10 m (179 m asl). Surface runoff and shallow ground water flow is in a general south to southeasterly direction towards these features, with deeper ground water flow interpreted to flow in an easterly to northeasterly direction towards the Wye River and Midland Bay. The Wye River flows in a northerly direction from Mud Lake for ~1 km before discharging into Midland Bay (Figures 1 and 5).

A review of the well records provided in the Groundwater Information Network (GIN) database as well as the Ministry of the Environment, Conservation and Parks (MECP) online water well database was done to compile supporting hydrogeological data for the Subject Property and adjacent lands. There are approximately sixteen (16) wells within 500 m of the Subject Property; five (5) of which are not used and three (3) of which are reportedly used for livestock wells. Well depths ranged between 11- 35m bgs.

The stratigraphy in the well records is described as layers of silty sand and sand silt mixtures overlying intermittent layers of finer grained materials (clay silt and sand clay) or sand and gravel mixtures. The topographic map which includes well locations is provided on Figure 5 and a summary of the well information is provided in Appendix B.

3.4 Hydrogeology

3.4.1 Water Supply

Another source of information reviewed for this study was the North Simcoe Ground Water Study (NSGWS Appendix D - Town of Midland). The study indicates that the Town of Midland obtains its water supply from ground water via thirteen (13) operational wells within five well fields constructed in both the upper and low overburden aquifer systems (Golder *et al*., 2005).

A review of the NSGWS mapping indicates that a majority of the wells are located in the northwest part of Midland and are remote from the Subject Property. The closest wells to the Subject Property are the Heritage Drive wells (Well 7A and 7B) located ~1.5km to the west and the Russell Street well (Well 15) located ~2km to the north. These wells are installed in the lower aquifer system at elevations between 185 m asl and 189m als (46-65 m bgs). The cross section of the Heritage Wells shows ~20 to 30 m of gravel and sand in the upper aquifer system. A confining layer separates the two aquifer systems but this unit is possibly absent or may pinch out approaching the Wye River to the east. The lower aquifer unit is also ~20m to 30 m thick. Excerpts from the NSGWS are provided in Appendix D of this report.

3.4.2 Capture Zones

Figures 4.16 and 4.17 of the NSGWS provide the 50 day time of travel (ToT) and the 2-25 year time TotT from the Midland Supply wells. The capture zones for the closest wells (Well 7A and 7B) to the Subject Property extend north- northwest toward and beneath Little Lake, approximately 500 away. According to Table 8.1 of the SSGWS, the estimated level of sensitivity for Wells 7A and 7B is Medium. The Subject Property is situated more than 1.5km east of Well 7A and 7B and is not within the 50 day ToT or the 2- 25 year ToT.

The capture zone for Well 15 extends westwards toward Little Lake however Little Lake reportedly does not provided any recharge to this well (Golder *et al*., 2005). According to Table 8.1 of the NSGWS, the estimated level of sensitivity for Well 15 is Low. The Subject Property is situated more than 2.0km north of Well 15 and is not within the 50 day ToT or the 2- 25 year ToT.

The NSGWS indicates that the capture zones at Wells 7A/ 7B and 15 are nearing steady state after 10 years; and that this is an indication that the pumping rates are at near equilibrium with the recharge over the capture zones and that the recharge of these systems occur close to the wells (Golder *et al*., 2005).

3.4.3 WHPA Q2 Area

Based on a review of the South Georgian Bay Lake Simcoe Region SPP mapping (Figure 3.5-13 - WPHA -Q2 Delineation), the Subject Property is located on the southeast boundary of a ground water quantity threat area (see Appendix D). As such, there is a requirement to meet the existing water balance under Policy LUP 12 of the SPP using BMP's. The results of the water balance calculations for the proposed development indicate a small increase in the ground water infiltration by approximately 24 m^3/year (Section 5.0), which represents a 2 % increase from pre-development conditions using BMP's.

3.5 Surface Water

There are two PSW’s with the vicinity of the Subject Property: Little Lake and Wye Marsh / Mud Lake are identified 1.5km west and 400 m south of the Subject Property, respectively (Figure 5). The Wye Marsh is an 800 ha deltaic wetland located near the terminus of the Wye River, approximately 1 km upgradient of Midland / Georgian bay.

A low lying wetland is evident along the rear or west part of the Subject Property and appears to be associated with the Wye Marsh wetland complex to the south.

4.0 SOIL SAMPLING

4.1 Methodology

On May 9, 2016, Azimuth completed a reconnaissance of the Subject Property to confirm the local topography, general soil conditions, depth of the water table and drainage/ flow pathways. This work was completed on behalf of the the previous owner.

As part of the reconnaissance, a Site-specific test pit program was completed to more accurately define the near-surface soils, as well as to assess the presence / absence of a shallow overburden ground water table. Soil samples were collected at each location and initially analyzed in the field to determine soil classifications for each unit found on the Subject Property. These samples were further analyzed in the office to confirm these classifications. The soil description logs can be found in Appendix C.

4.2 Stratigraphy

During the course of this investigation, a total of eight (8) test pits (TP-1 through TP-8) were excavated using a rubber-tire backhoe to depths between 1.5-1.8 m bgs. Test pits 1 thru 4 were excavated within the central to easterly part (front) of the property and Test pits 5 thru 8 were excavated with the western part (rear) of the property. The test pit locations are provided on Figure 2.

A soil sample was collected at each test pit location at a depth of between 0.5 m and 1.0 m bgs. The shallow overburden soils were observed to consist of silty sand, sand and silt with some gravel and trace of clay. Saturated conditions were observed in test pits No. 6, 7 and 8 between 1.2 and 1.4 m bgs. This is expected given the presence of a wetland along the western property boundary. The test logs are provided in Appendix C.

At the conclusion of our field investigation, four (4) representative surficial soil samples was submitted to Terraprobe for grain size analysis and /or permeability testing ('T' time).

4.2.1 Grain Size Analysis

To provide an estimate of the hydraulic properties of the shallow soils within the general vicinity of the development precinct, the resulting grain size curves were evaluated using the graphical comparison technique of the Unified Soil Classification System.

- Three soil samples (TP-2, 4 and 6) were classified as a S.M. type soil consisting of silty sand with trace silt. Material consisting of silty sand and sand silt mixtures generally have a medium permeability with estimated percolation rates of between 8-25 min/cm (OBC, 1997).
- One soil sample (TP-8) was classified as a ML type soil consisting of Sand and Silt with some clay. Material consisting of fine silts and sand or clayey fine sand have a medium to low permeability with an estimated percolation rate of between 20 - 40 min/cm (OBC, 1997).

Two soil samples (TP-2 and TP-6) were submitted to a laboratory and analyzed for percolation rates (T-Time). The estimated T-time for TP-2 was 20-25 min/cm and the estimated T-Time for TP-6 was 15-20 min/cm. A review of the grain size curves for TP-4 and TP-6 suggest a T-Time of between 20-25 min/cm for TP-4 and 30-35 min/cm for TP-8 (Appendix C). The results suggest and medium permeability across a majority of the property with infiltration rates of between 25-40 mm/hour (Appendix C).

5.0 STORMWATER MANGEMENT BRIEF

The Subject Property is 4,178 m^2 in size and is fairly flat (Figure 2).

In the pre-development scenario (Figure 3), the Site is composed of undeveloped meadow and forest land. The west side of the Site drains as sheet flow primarily to the south and the east part of the Site drains as sheet flow generally to the south and southeast. The entire property eventually drains toward the wetland feature to the south/ southeast of the Site either from the west side (rear) of the property or via the road side ditch along the east side (front) of the property.

In the post-development scenario the Site will be graded so that the north half drains into an infiltration trench to the north, and the south half drains to an infiltration trench to the south. A 1.5m infiltration trench (approximately 118m long) will be positioned along the north and south property boundaries. Runoff from the building rooftops and the gravel/ paved areas will be collected. The infiltration trenches will each discharge any runoff into the existing road side ditch on the west side of Whitfield ~~Court~~. It is our understanding that this road side ditch discharges into a drainage feature ~50 m southeast of the Site, which ultimately outlets to the wetland approximately 130 m south-southeast of the Site. The runoff pathways in the pre- and post-development scenarios are therefore consistent, draining toward the wetland feature to the south-southeast. After all low impact development (LIDs) (i.e., infiltration trenches) are included, the post-development infiltration volume is higher than the post-development scenario (See Section 6.0 for details).

Crescent

Off site runoff from the north adjacent parcel will be collected into the existing drainage ditch that traverses the south side of this parcel (Figure 3). This ditch outlets to the roadside ditch along on the west side of Whitfield ~~Court~~. Off site runoff from the north adjacent parcel will generally flow in a south to south-easterly away from the Subject Property. The Site grading plan will be completed such that surface water drainage will not affect either of these adjacent parcels. Furthermore, the presence of the on-Site infiltration trenches along the north and south boundary and the ditch situated just beyond the north boundary of the Site will also ensure that surface water drainage will not affect either of these adjacent properties.

Crescent

6.0 WATER BALANCE

6.1 Water Balance

In order to determine the potential changes to the natural ground water recharge conditions, a pre- and post-development water balance assessment has been completed using the Thornthwaite and Mather method (1957). This method evaluated evapotranspiration based on precipitation and temperature. Residual soil saturation is a function of topography and soil type. Monthly data are tabulated from daily average temperature and precipitation, and the water budget is a continuous calculation over the period of record. To clarify, the method and approach used by many individuals in examining infiltration resets the annual conditions (moisture deficit, snow storage, etc.) over the winter months because of the general lack of infiltration during the frost period. However, we maintain those records and carry them forward from month to month during the entire period of record.

Values were determined on a monthly basis, compiled from daily Environment Canada meteorological data station located in Midland, Ontario between 1987 and 2006. The calculations are based on the average conditions during this period; the average precipitation was 982 mm, rainfall was 679 mm, evapotranspiration was 492 mm and the surplus was 490 mm. Each parameter falls within a broad range that represents approximately 100% of the lowest values (Appendix E).

As noted, the Site is fairly flat, however there is a slight slope to the south (west side) or southeast (east side). The entire area drains toward the wetland feature to the east and south of the Site. Although the water balance has been completed at the Site scale, the pre- and post-development values can be used to assess potential changes to the receiving feature since the entire Site eventually drains toward the wetland via the road side ditch at the front of the parcel. The proposed development will include LIDs (infiltration trenches) to incorporate additional infiltration in the post-development scenario.

The full water balance tables for pre-development, post-development without mitigation, and post-development with mitigation are included in Appendix E.

6.2 Land Use

6.2.1 Pre-Development Conditions

Using an aerial image the Subject Property was classified according to land use/ vegetation type. Land within the pre-development area can be classified as forest and meadow lands (Table 2).

Table 1: Pre-Development Area Classification

Land Use	Land Area (m^2)
Forest	385
Meadow	3,793
Total	**4,178**

Notes – values are estimated and are rounded for presentation purposes

The pre-development area contains a percent impervious cover of 0%.

6.2.2 Post-Development Conditions

The post-development area classification was determined using the proposed development plan and the following assumptions:

- The driveway/ parking area will be composed of gravel and pavement (2,455m^2);
- The structures are 906 m^2 in total size;
- The green or landscaped area is 479 m^3 in size;
- There will be a 1.5m infiltration trench along the north and south boundaries of the Site;

Table 2: Post-Development Area Classification

Land Use	Land Area (m^2)
Gravel / paved areas	2,455
Buildings	906
Landscaped	479
Infiltration Trenches	338
Total	**4,178**

Notes – values are estimated and are rounded for presentation purposes

The post-development area contains a percent impervious cover of 80%.

6.3 Infiltration Calculation

Infiltration is generated one of two ways: (1) directly from rainfall on pervious surfaces; and (2) indirectly when runoff from impervious surfaces (*i.e.*, rooftops) is diverted into adjacent naturalized areas or LIDs or best management practices (BMPs) such as an infiltration trench.

Infiltration factors for the Site were estimated based on the underlying soil, local topography, and ground cover as per Table 2 of the Ministry of Environment and Energy (MOEE) Hydrogeological Technical Information Requirements for Land Development Applications (1995) and the Ontario Ministry of Transportation Drainage Management Manual (1997). The infiltration factors are summarized in Table 3 below.

Table 3: Summary of Pervious Land Infiltration Factor

Land Use	Infiltration Factor	Assumptions
Forest	0.65	Flat land, medium loam soil, woodland
Meadow	0.60	Flat land, medium loam soil, pasture
Landscaped	0.55	Flat land, medium loam soil, lawn

6.3.1 Pre- Development Infiltration Values

To determine the pre-development direct infiltration amount, the area of each land use was multiplied by the surplus amount (490 mm). The total direct pre-development infiltration for the Subject Property is ~1,238 m^3 (See Table 4 or Appendix E, Table E-1 for details).

6.3.2 Post-development infiltration

Post-development infiltration (without mitigation) was determined by multiplying the annual average surplus amount (490 mm), the area of each land use (Table 2), and the infiltration factor for each land use (Table 3). The post-development infiltration without mitigation is therefore 220 m^3 (Table 4 or Appendix E, Table E-2). There is therefore a reduction of approximately 1,018 m^3 from pre- to post-development without mitigation.

Additional infiltration can be incorporated into the overburden utilizing LIDs (i.e., infiltration trenches). There is approximately 3,361 m^2 of impervious area (storage buildings and gravel/ paved driveway) that can contribute to LIDs at the Site. To determine the amount of precipitation available for infiltration, Azimuth analyzed five years of continuous daily rainfall data between 2013 and 2017. This information was used to determine the percent of annual rainfall that falls within a 10mm daily event (69%). Based on this percentage, there is therefore 0.469 m/m^2 of rainfall available on an annual basis when capturing up to the 10mm rainfall event. After a 20% evaporation factor is applied, this represents approximately 0.375m/m^2 or 1,301 m^3/year when capturing up to the 10mm event across the entire impervious area of the Site. LID design information is included under separate cover.

The total post-development infiltration is therefore 1,480 m^3/year, which exceeds the pre-development infiltration value by approximately 242 m^3 (Table 4 or Appendix E, Table E-3). Based on the above assessment, no significant changes to infiltration at the Site is expected.

6.4 Pre- and Post-development Water Balance Comparison

Using the climate model data, assumptions, and calculations mentioned above, pre and post development infiltration values have been determined.

Post-development ground water infiltration at the Site will decrease by approximately 82% when no mitigation measures are employed. This reduction is based on the creation of impervious surfaces associated with the structures and gravel/ paved areas, and reducing the infiltration coefficient of the land when transitioning from meadow and forest to gravel/ paved areas. The 82% reduction equates to approximately 1,018 m^3 total.

The reduction is minimized when LIDs are incorporated. By capturing up to the 10mm event from the gravel/paved areas and building areas into an LID, an additional 1,260 m^3 can be incorporated to the annual total. The addition of this LID infiltration brings the post-development total to 1,480 m^3 or 120% of the pre-development value (a 20% increase). Based on the above assumptions, no significant change in infiltration between the pre- and post-development scenario is expected.

A summary of the pre and post development water balance is provided in Table 4 and the detailed calculations are provided in Appendix E.

Table 4: Water Balance Summary

Characteristic	Site						
	Pre-Develop	Post-Developm	Change (Pre to Post)		Post-Develop	Change (Pre to Post with	
Inputs (Volume)							
Precipitation (m^3/yr)	4,103	4,103	0	0%	4,103	0	0%
Run-On (m^3/yr)	0	0	0	0%	0	0	-
Other Inputs (m^3/yr)	0	0	0	0%	0	0	-
Total Inputs (m^3/yr)	4,103	4,103	0	0%	4,103	0	0%
Outputs (Volume)							
Precipitation Surplus (m^3/yr)	2,047	3,041	994	49%	3,041	994	49%
Net Surplus (m3/yr)	2,047	3,041	994	49%	3,041	994	49%
Evapotranspiration (m^3/yr)	2,056	1,062	-994	-48%	1,062	-994	-48%
Infiltration (m^3/yr)	1,238	220	-1,018	-82%	220	-1,018	-82%
Rooftop Infiltration (m^3/yr)	0	0	0	0%	0	0	-
LID Infiltration (m^3/yr)	0	0	0	0%	1,260	1,260	-
Total Infiltration (m^3/yr)	***1,238***	***220***	***-1,018***	***-82%***	1,480	***242***	20%
Run-Off Pervious Areas (m^3/yr)	809	180	-629	-78%	180	-629	-78%
Run-Off Impervious Areas (m^3/yr)	0	2,640	2,640	0%	1,381	1,381	-
Total Run-Off (m^3/yr)	809	2,821	2,011	248%	1,561	751	93%
Total Outputs (m^3/yr)	**4,103**	**4,103**	**0**	0%	4,103	0	0%

6.5 Sensitive feature – Wetland

In the pre-development scenario, the Site is composed of undeveloped meadow and forest land. Runoff from the Site is expected to flow via sheet flow to the south and southeast toward the existing offsite wetland feature. The entire Site is therefore considered part of the same catchment area.

In the post-development scenario, the Site will be graded and runoff will be discharged into the existing road side ditch on the south west side of Whitfield ~~Court.~~ Crescent It is our understanding that this road side ditch discharges into the wetland approximately 130 m south east of the Site. The runoff pathways in the pre- and post-development scenarios are therefore consistent, draining toward the wetland feature to the south.

The water balance completed for the Site includes approximately 809 m^3 of runoff in the pre-development scenario. This is the volume of water that will flow into the down gradient wetland over a one year period. In the post-development scenario after LIDs have been accounted for, there is approximately 1,561 m^3 of runoff. This results in an increase of 751 m^3 or 93% of surface water contributions to the wetland. Based on this assessment, the surface water contribution to the wetland feature to the south of the Site should not be reduced by the proposed development.

7.0 SUMMARY AND CONCLUSIONS

Post-development ground water infiltration at the Site will decrease by approximately 82% when no mitigation measures are employed. This reduction is based on the creation of impervious surfaces associated with the structures and gravel/ paved driveway areas. The 82% reduction equates to 1,018 m^3 total.

The reduction is minimized when LIDs are incorporated. By capturing up to the 10mm event from the gravel/ paved driveway and building area into a LID (infiltration trenches), an additional 1,260 m^3 can be incorporated to the annual total. The addition of this LID infiltration brings the post-development total to 1,480 m^3 or 120% of the pre-development value (a 20% increase). Based on the above assumptions, no significant change in infiltration between the pre- and post-development scenario is expected.

The water balance completed for the Site includes approximately 809 m^3 of runoff in the pre-development scenario. This is the volume of water that will flow into the down gradient wetland over a one year period. In the post-development scenario after LIDs have been accounted for, there is approximately 1,561 m^3 of runoff. This results in an increase of 751 m^3 or 93% of surface water contributions to the wetland. Based on this assessment, the surface water contribution to the wetland feature to the south of the Site should not be reduced by the proposed development.

The hydrogeological assessment demonstrates the existing water balance can be maintained by incorporating LID thus the development concepts meet Policy LUP 12 of the SPP for the Town of Midland.

8.0 REFERENCES

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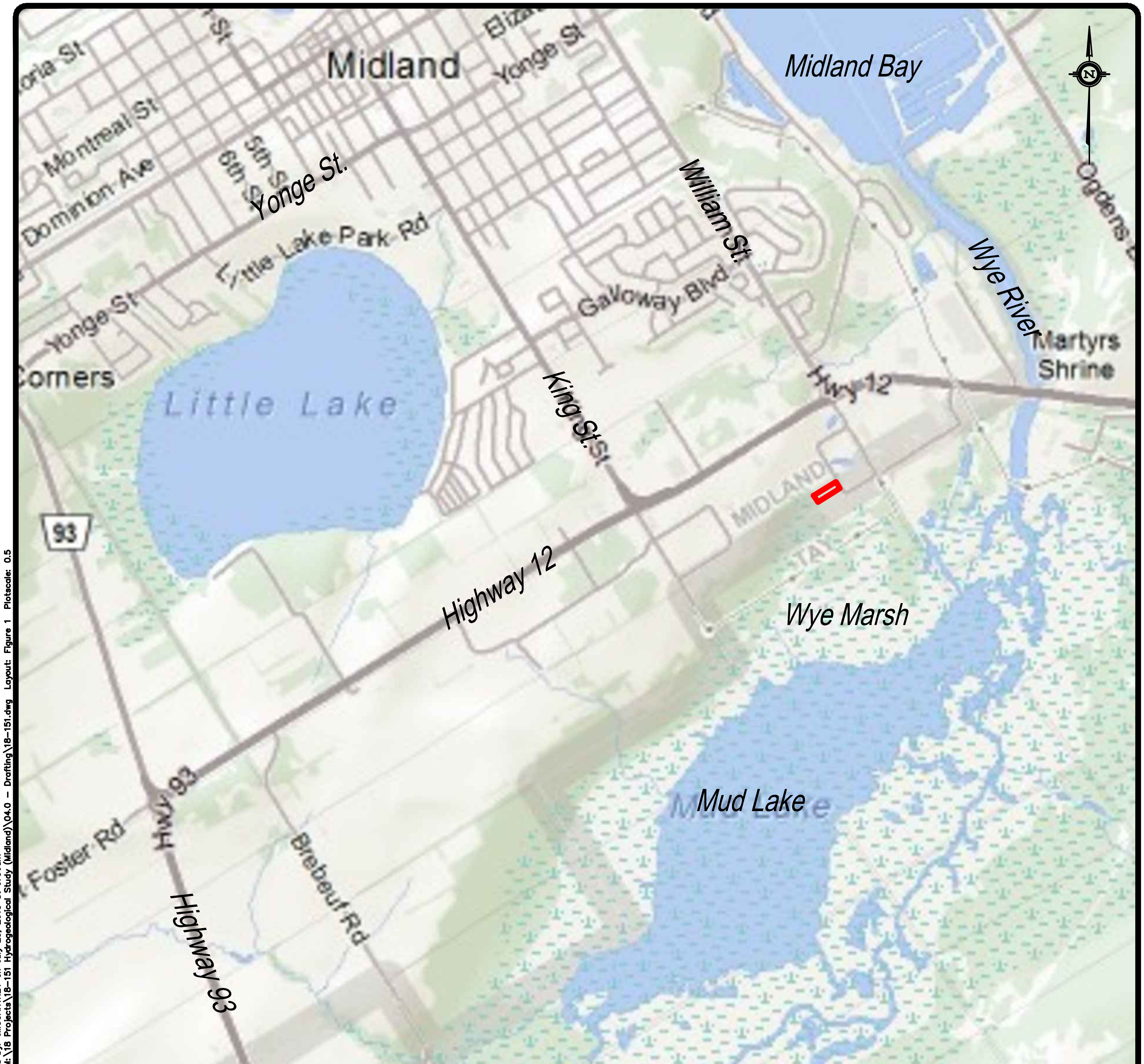
APPENDICES

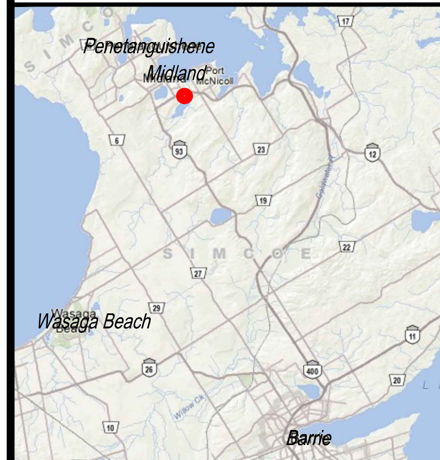
Appendix A: **Figures**
Appendix B: **MECP Well Record Summary**
Appendix C: **Soils Information**
Appendix D: **Hydrogeolgical Study Excerpts**
Appendix E: **Water Budget Calculations (Midland)**

APPENDIX A

Figures



LEGEND:
Approx. Property Boundary



REG MAP

250m 0 750m

HORIZONTAL SCALE 1: 25,000

AZIMUTH ENVIRONMENTAL CONSULTING, INC.

Study Area Location

249 Whitfield Crescent,
Midland, ON

DATE ISSUED: July 2018	Figure No.
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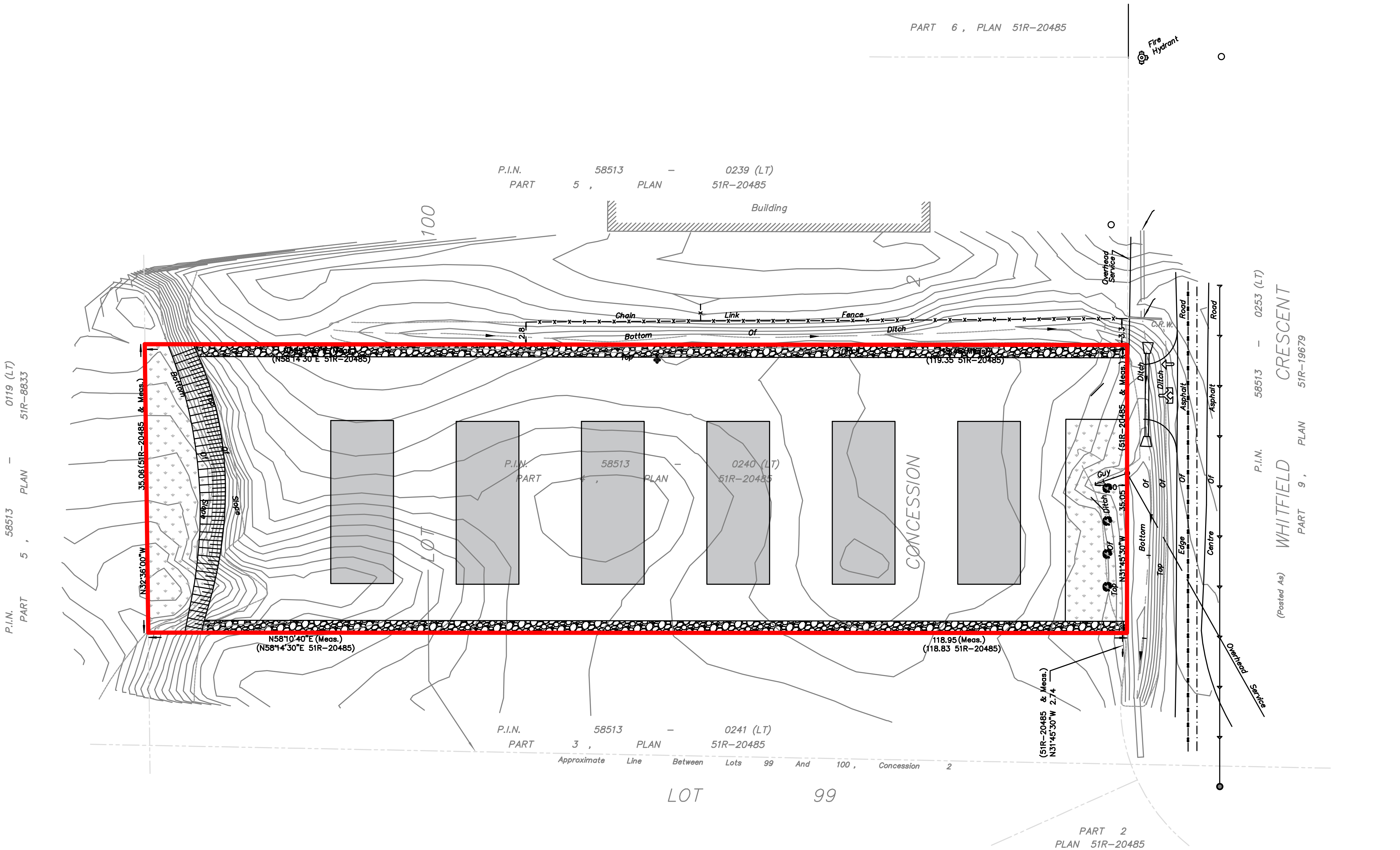
PROJECT NO.: 18-151	
REFERENCE: MNRF	

DAYSTAMP: M:\18 Projects\18-151 Hydrogeological Study (Midland)\04.0 - Drafting\18-151.dwg

Plotted by: JMCCARTNEY on July 25, 2018 at 9:50am Layout: Figure 1 Plotscale: 0.5
File: M:\18 Projects\18-151 Hydrogeological Study (Midland)\04.0 – Drafting\18-151.dwg

LEGEND:

Approx. Property Boundary (0.42ha)



AZIMUTH ENVIRONMENTAL CONSULTING, INC.

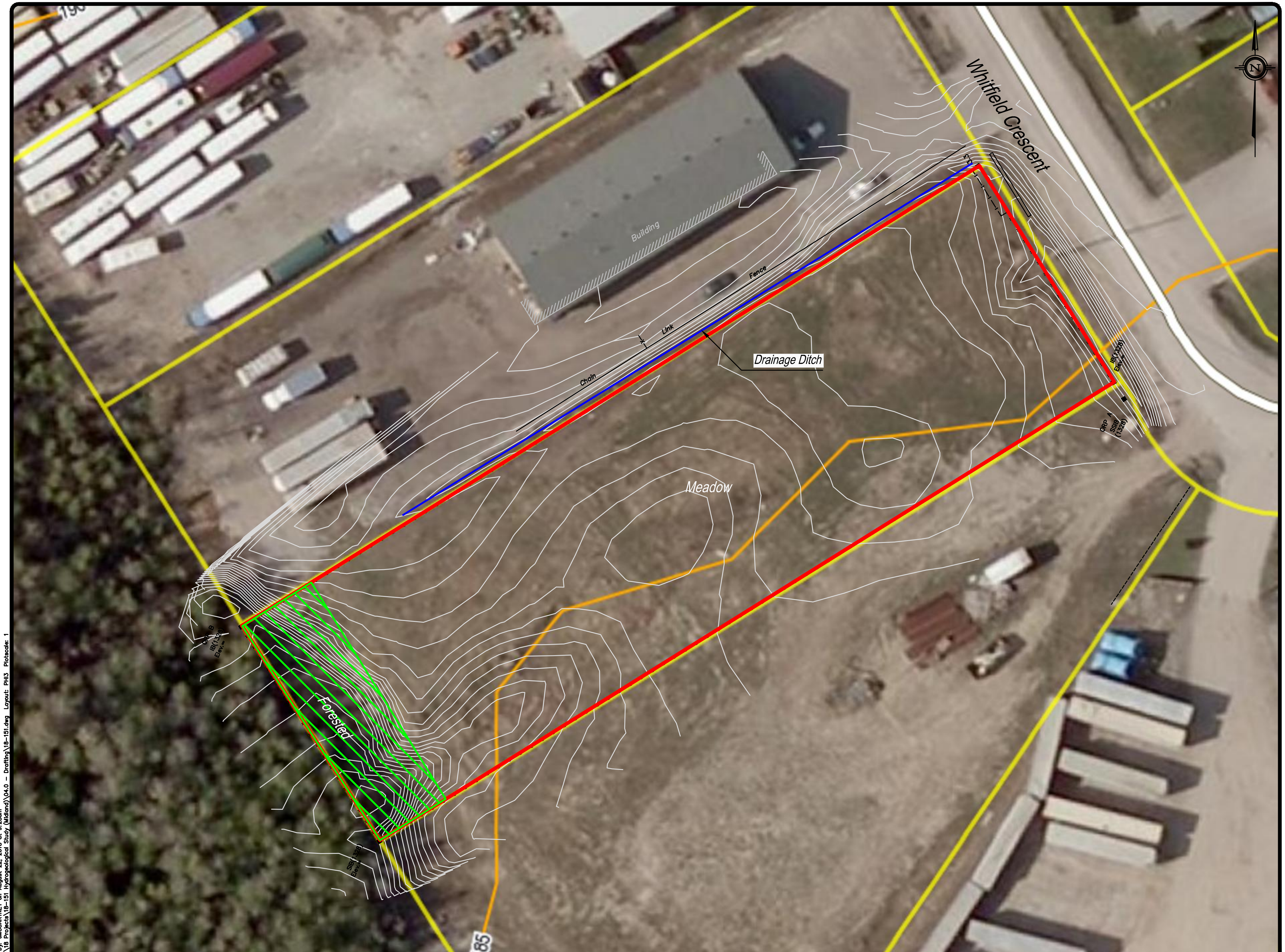
Site Layout

249 Whitfield Crescent,
Midland, ON

DATE ISSUED:	January 2019	Figure No.
CREATED BY:	JLM	2
PROJECT NO.:	18-151	
REFERENCE:	Quantum Engineering	

DAYSTAMP: M:\18 Projects\18-151 Hydrogeological Study (Midland)\04.0 - Drafting\18-151.dwg

Plotted by: JMCCARTNEY on January 7, 2019 at 1:23pm
File: M:\18 Projects\18-151 Hydrogeological Study (Midland)\04.0 - Drafting\18-151.dwg Layout: PH2 Plotscale: 1



LEGEND:

- Approx. Property Boundary (0.42ha)
- 5m OBM Contours
- 0.1m Contours provided by Quantum Engineering (white)
- Forested Areas (385m²)
- Meadow Areas (3793m²)

5m 0 15m

HORIZONTAL SCALE 1:500

AZIMUTH ENVIRONMENTAL CONSULTING, INC.

Pre-Development Conditions

249 Whitfield Crescent,
Midland, ON

DATE ISSUED:	July 2018	Figure No.
CREATED BY:	JLM	3
PROJECT NO.:	18-151	
REFERENCE:	First Base Solutions	

DAYSTAMP: M:\18 Projects\18-151 Hydrogeological Study (Midland)\04.0 - Drafting\18-151.dwg

Plotted by: JMCCARTNEY on August 22, 2018 at 9:28am
File: M:\18 Projects\18-151 Hydrogeological Study (Midland)\04.0 – Drafting\18-151.dwg Layout: PH3 Plotcode: 1

LEGEND:

- Approx. Property Boundary (0.42ha)
- 5m OBM Contours
- Test Pit Locations

Surface Areas:
Total Site Area: 4178m²
Total Building Area: 906m²
Total Gravel Area: 2455m²
Total Green Area: 479m²
Total Infiltration Trench Area: 338m²

Estimated Percolation Rates:
TP-2 - 20-25min/cm
TP-4 - 20-25min/cm
TP-6 - 15-20min/cm
TP-8 - 30-35min/cm

5m 0 15m
HORIZONTAL SCALE 1:500

AZIMUTH ENVIRONMENTAL CONSULTING, INC.

Post-Development Conditions

249 Whitfield Crescent,
Midland, ON

DATE ISSUED:	January 2019	Figure No.
CREATED BY:	JLM	4
PROJECT NO.:	18-151	
REFERENCE:	First Base Solutions	

DAYSTAMP: M:\18 Projects\18-151 Hydrogeological Study (Midland)\04.0 - Drafting\18-151.dwg

LEGEND:
- Approx. Property Boundary
- 5m OBM Contours
- GIN Water Well Locations
- Inferred Direction of Ground Water Flow

Note:
Well locations are based on MOECC well records and/ or GIN (2016) mapping.

75m 0 150m

HORIZONTAL SCALE 1: 5,000

AZIMUTH ENVIRONMENTAL CONSULTING, INC.

Area Well Map

249 Whitfield Crescent,
Midland, ON

DATE ISSUED:	July 2018	Figure No.
CREATED BY:	JLM	5
PROJECT NO.:	18-151	
REFERENCE:	First Base Solutions	

DAYSTAMP: M:\18 Projects\18-151 Hydrogeological Study (Midland)\04.0 - Drafting\18-151.dwg

Plotted by: JMCCARTNEY on August 3, 2018 at 11:51am
File: M:\18 Projects\18-151 Hydrogeological Study (Midland)\04.0 – Drafting\18-151.dwg Layout: PHI5 Plotscale: 1

APPENDIX B

MECP Well Record Summary

SUMMARY OF LOCAL WELLS
249 Whitfield Cresent, Midland, ON

Well ID	Elevation (m)	Depth (m)	Water Level (m)	Water Yield (lpm)	Water use	Well purpose	Water status	Top (m)	Bottom (m)	GIN Lithology
4905226	292.61	10.97	6.71	9.09	Livestock	N/A	Water Supply	0.00	0.30	Soil
4905226	292.61	10.97	6.71	9.09	Livestock	N/A	Water Supply	0.30	2.13	Clay Sand
4905226	292.61	10.97	6.71	9.09	Livestock	N/A	Water Supply	2.13	4.57	Sand
4905226	292.61	10.97	6.71	9.09	Livestock	N/A	Water Supply	4.57	6.71	Sand
4905226	292.61	10.97	6.71	9.09	Livestock	N/A	Water Supply	6.71	9.14	Sand
4905226	292.61	10.97	6.71	9.09	Livestock	N/A	Water Supply	9.14	10.97	Clay
4905240	274.32		3.05	4.55	Livestock	N/A	Water Supply	0.00	0.30	Soil Unknown material
4905240	274.32		3.05	4.55	Livestock	N/A	Water Supply	0.30	3.66	Clay Unknown material
4905240	274.32		3.05	4.55	Livestock	N/A	Water Supply	3.66	6.10	Sand Unknown material
4905240	274.32		3.05	4.55	Livestock	N/A	Water Supply	6.10	6.10	Gravel Unknown material
5701896	179.83	15.85	1.83	N/A	Not Used	N/A	Test Hole	0.00	0.30	Soil
5701896	179.83	15.85	1.83	N/A	Not Used	N/A	Test Hole	0.30	4.57	Sand
5701896	179.83	15.85	1.83	N/A	Not Used	N/A	Test Hole	4.57	6.71	Sand Sand
5701896	179.83	15.85	1.83	N/A	Not Used	N/A	Test Hole	6.71	7.92	Clay Silt
5701896	179.83	15.85	1.83	N/A	Not Used	N/A	Test Hole	7.92	13.11	Clay Silt Gravel
5701896	179.83	15.85	1.83	N/A	Not Used	N/A	Test Hole	13.11	14.02	Gravel
5701896	179.83	15.85	1.83	N/A	Not Used	N/A	Test Hole	14.02	15.85	Limestone
5703889	210.31	37.49	25.3	27.28	Domestic	N/A	Water Supply	0.00	0.30	Soil
5703889	210.31	37.49	25.3	27.28	Domestic	N/A	Water Supply	0.30	20.73	Clay Gravel Gravel
5703889	210.31	37.49	25.3	27.28	Domestic	N/A	Water Supply	20.73	31.09	Sand Clay
5703889	210.31	37.49	25.3	27.28	Domestic	N/A	Water Supply	31.09	37.49	Sand Gravel
5703891	210.31	37.8	28.96	45.46	Domestic	N/A	Water Supply	0.00	3.05	Unknown material
5703891	210.31	37.8	28.96	45.46	Domestic	N/A	Water Supply	3.05	11.28	Gravel Gravel
5703891	210.31	37.8	28.96	45.46	Domestic	N/A	Water Supply	11.28	14.94	Gravel
5703891	210.31	37.8	28.96	45.46	Domestic	N/A	Water Supply	14.94	19.51	Sand
5703891	210.31	37.8	28.96	45.46	Domestic	N/A	Water Supply	19.51	26.82	Gravel Gravel
5703891	210.31	37.8	28.96	45.46	Domestic	N/A	Water Supply	26.82	34.14	Diamicton Sand
5703891	210.31	37.8	28.96	45.46	Domestic	N/A	Water Supply	34.14	37.80	Gravel
5703892	208.79	34.14	26.82	45.46	Domestic	N/A	Water Supply	0.00	0.61	Soil
5703892	208.79	34.14	26.82	45.46	Domestic	N/A	Water Supply	0.61	24.38	Clay Sand Gravel
5703892	208.79	34.14	26.82	45.46	Domestic	N/A	Water Supply	24.38	30.48	Sand
5703892	208.79	34.14	26.82	45.46	Domestic	N/A	Water Supply	30.48	34.14	Sand Sand
5703908	208.79	34.14	26.52	68.19	Livestock	N/A	Water Supply	0.00	27.43	Unknown material
5703908	208.79	34.14	26.52	68.19	Livestock	N/A	Water Supply	27.43	34.14	Sand
5703910	211.84	34.75	24.38	27.28	Domestic	N/A	Water Supply	0.00	6.10	Unknown material
5703910	211.84	34.75	24.38	27.28	Domestic	N/A	Water Supply	6.10	27.43	Gravel Clay
5703910	211.84	34.75	24.38	27.28	Domestic	N/A	Water Supply	27.43	34.75	Sand
5703911	210.31	64.92	N/A	N/A	Not Used	N/A	Test Hole	0.00	0.61	Soil
5703911	210.31	64.92	N/A	N/A	Not Used	N/A	Test Hole	0.61	21.34	Clay Gravel Gravel
5703911	210.31	64.92	N/A	N/A	Not Used	N/A	Test Hole	21.34	30.18	Gravel Gravel Sand
5703911	210.31	64.92	N/A	N/A	Not Used	N/A	Test Hole	30.18	30.78	Gravel Sand Silt
5703911	210.31	64.92	N/A	N/A	Not Used	N/A	Test Hole	30.78	34.14	Gravel Sand
5703911	210.31	64.92	N/A	N/A	Not Used	N/A	Test Hole	34.14	35.05	Gravel Gravel
5703911	210.31	64.92	N/A	N/A	Not Used	N/A	Test Hole	35.05	44.20	Clay Gravel Sand
5703911	210.31	64.92	N/A	N/A	Not Used	N/A	Test Hole	44.20	45.11	Sand
5703911	210.31	64.92	N/A	N/A	Not Used	N/A	Test Hole	45.11	48.16	Clay
5703911	210.31	64.92	N/A	N/A	Not Used	N/A	Test Hole	48.16	64.92	Clay Sand Gravel
5705597	205.74	31.7	25.91	36.37	Domestic	N/A	Water Supply	0.00	0.30	Soil
5705597	205.74	31.7	25.91	36.37	Domestic	N/A	Water Supply	0.30	25.91	Clay Gravel
5705597	205.74	31.7	25.91	36.37	Domestic	N/A	Water Supply	25.91	30.48	Sand Clay
5705597	205.74	31.7	25.91	36.37	Domestic	N/A	Water Supply	30.48	31.70	Sand Sand
5707708	182.88	42.37	4.88	N/A	Not Used	N/A	Test Hole	0.00	0.30	Soil
5707708	182.88	42.37	4.88	N/A	Not Used	N/A	Test Hole	0.30	4.27	Sand
5707708	182.88	42.37	4.88	N/A	Not Used	N/A	Test Hole	4.27	9.14	Sand
5707708	182.88	42.37	4.88	N/A	Not Used	N/A	Test Hole	9.14	12.80	Clay
5707708	182.88	42.37	4.88	N/A	Not Used	N/A	Test Hole	12.80	17.37	Sand Silt
5707708	182.88	42.37	4.88	N/A	Not Used	N/A	Test Hole	17.37	18.29	Sand
5707708	182.88	42.37	4.88	N/A	Not Used	N/A	Test Hole	18.29	24.08	Sand Silt Gravel
5707708	182.88	42.37	4.88	N/A	Not Used	N/A	Test Hole	24.08	30.48	Limestone
5707708	182.88	42.37	4.88	N/A	Not Used	N/A	Test Hole	30.48	41.45	Limestone
5707708	182.88	42.37	4.88	N/A	Not Used	N/A	Test Hole	41.45	42.37	Granite
5708920	208.18	32.92	27.13	40.91	Domestic	N/A	Water Supply	0.00	0.30	Soil
5708920	208.18	32.92	27.13	40.91	Domestic	N/A	Water Supply	0.30	25.30	Sand Gravel Gravel
5708920	208.18	32.92	27.13	40.91	Domestic	N/A	Water Supply	25.30	32.92	Sand
5712988	205.74	37.49	24.38	45.46	Domestic	N/A	Water Supply	0.00	0.91	Soil
5712988	205.74	37.49	24.38	45.46	Domestic	N/A	Water Supply	0.91	9.45	Sand Gravel
5712988	205.74	37.49	24.38	45.46	Domestic	N/A	Water Supply	9.45	33.53	Gravel Sand Unknown material
5712988	205.74	37.49	24.38	45.46	Domestic	N/A	Water Supply	33.53	37.49	Gravel Unknown material Unknown material
5715451	210.31	42.06	28.35	22.73	Domestic	N/A	Water Supply	0.00	1.52	Gravel Gravel
5715451	210.31	42.06	28.35	22.73	Domestic	N/A	Water Supply	1.52	3.35	Clay
5715451	210.31	42.06	28.35	22.73	Domestic	N/A	Water Supply	3.35	21.34	Gravel
5715451	210.31	42.06	28.35	22.73	Domestic	N/A	Water Supply	21.34	23.16	Sand
5715451	210.31	42.06	28.35	22.73	Domestic	N/A	Water Supply	23.16	26.82	Gravel Clay Sand
5715451	210.31	42.06	28.35	22.73	Domestic	N/A	Water Supply	26.82	40.54	Sand
5715451	210.31	42.06	28.35	22.73	Domestic	N/A	Water Supply	40.54	42.06	Sand
5738829	N/A		N/A	N/A	Not Used	N/A	Observation Wells	0.00	1.50	Sand Gravel
5738829	N/A		N/A	N/A	Not Used	N/A	Observation Wells	1.50	2.00	Sand Silt
5738829	N/A		N/A	N/A	Not Used	N/A	Observation Wells	2.00	3.00	Sand Gravel Unknown material
5738829	N/A		N/A	N/A	Not Used	N/A	Observation Wells	3.00	7.00	Sand Gravel Silt
7128996	N/A	16.55	N/A	N/A	Not Used	N/A	Observation Wells	0.00	1.20	Sand Gravel Anthropogenic material
7128996	N/A	16.55	N/A	N/A	Not Used	N/A	Observation Wells	1.20	2.90	Sand Silt Soil
7128996	N/A	16.55	N/A	N/A	Not Used	N/A	Observation Wells	2.90	3.25	Silt Unknown material
7128996	N/A	16.55	N/A	N/A	Not Used	N/A	Observation Wells	3.25	3.40	Peat
7128996	N/A	16.55	N/A	N/A	Not Used	N/A	Observation Wells	3.40	8.60	Clay Silt
7128996	N/A	16.55	N/A	N/A	Not Used	N/A	Observation Wells	8.60	16.55	Sand Silt Gravel

Source: GIN, 2016

APPENDIX C

Soils Information

AZIMUTH ENVIRONMENTAL CONSULTING, INC.
Environmental Assessments & Approvals

TEST PIT LOG

Project Name	249 Whitfield Crescent Hydrogeolgical Evaluation	**Project Address**	249 Whitfield Crescent, Midland, ON	**Date**	Monday, May 9, 2016
Test Pit Number	TP-1	**Contractor**	Property Owner	**Elevation**	NA
Equipment	Mini-Excavator	**Test Pit Size**	5.0 x 1.0 x 1.5 (L x W x H)	**Datum**	Ground Surface
Temperature	8 °C	**Weather**	Sunny	**Sample Type**	Soil

Depth		**Soil description**	**Samples**		**Observations**
From (m)	**To (m)**		**No.**	**Depth (mbg)**	
0.0	0.2	**Topsoil**, sandy with some gravel, dark brown; loose; moist.			
0.2	0.5	**Silty Sand**, some Gravel, Cobble & Boulders; brown; mottled; fine to medium grained; loose; moist.			
0.5	1.5	**Silty Sand**, some Gravel, Cobble & Boulders; grey; fine to medium grained; loose; moist.	1	0.5 - 1.0	Soil colour changed from brown to grey @ 0.5 metres below ground.
		Test Pit terminated at 1.5 mbgs			

Comments	Water Conditions in Test Pit
	☐ Wet upon completion ☑ Dry upon completion

JOB No. 15-321
TEST PIT No. TP-1
FIELD STAFF Drew West

Azimuth Environmental Consulting, Inc.
Environmental Assessments & Approvals

TEST PIT LOG

Project Name	249 Whitfield Crescent Hydrogeolgical Evaluation	**Project Address**	249 Whitfield Crescent, Midland, ON	**Date**	Monday, May 9, 2016
Test Pit Number	TP-2	**Contractor**	Property Owner	**Elevation**	NA
Equipment	Mini-Excavator	**Test Pit Size**	5.0 x 1.0 x 1.5 (L x W x H)	**Datum**	Ground Surface
Temperature	8 °C	**Weather**	Sunny	**Sample Type**	Soil

Depth		**Soil description**	**Samples**		**Observations**
From (m)	**To (m)**		**No.**	**Depth (mbg)**	
0.0	0.1	**Topsoil**, sandy with some gravel, dark brown; loose; moist.			
0.1	0.4	**Silty Sand**, some Gravel, Cobble & Boulders, trace Clay; brown; fine to medium grained; compact; moist.			
0.4	1.5	**Silty Sand**, some Gravel, Cobble & Boulders, trace Clay; grey; fine to medium grained; compact; moist	1	0.5 - 1.0	Soil colour changed from brown to grey @ 0.4 metres below ground. T= 20-25 min/cm
		Test Pit terminated at 1.5 mbgs			

Comments	Water Conditions in Test Pit
	☐ Wet upon completion ☑ Dry upon completion

JOB No.	15-321
TEST PIT No.	TP-2
FIELD STAFF	Drew West

AZIMUTH ENVIRONMENTAL CONSULTING, INC.
Environmental Assessments & Approvals

TEST PIT LOG

Project Name	249 Whitfield Crescent Hydrogeolgical Evaluation	**Project Address**	249 Whitfield Crescent, Midland, ON	**Date**	Monday, May 9, 2016
Test Pit Number	TP-3	**Contractor**	Property Owner	**Elevation**	NA
Equipment	Mini-Excavator	**Test Pit Size**	5.0 x 1.0 x 1.5 (L x W x H)	**Datum**	Ground Surface
Temperature	8 °C	**Weather**	Sunny	**Sample Type**	Soil

Depth		**Soil description**	**Samples**		**Observations**
From (m)	**To (m)**		**No.**	**Depth (mbg)**	
0.0	0.1	**Topsoil**, sandy with some gravel, dark brown; loose; moist.			
0.1	1.7	**Silty Sand**, some Gravel, Cobble & Boulders, trace Clay; brown; fine to medium grained; compact; moist.	1	0.5 - 1.0	No colour change in soil observed.
		Test Pit terminated at 1.7 mbgs			

Comments	Water Conditions in Test Pit
	☐ Wet upon completion ☑ Dry upon completion

JOB No. 15-321
TEST PIT No. TP-3
FIELD STAFF Drew West

Azimuth Environmental Consulting, Inc.
Environmental Assessments & Approvals

TEST PIT LOG

Project Name	249 Whitfield Crescent Hydrogeolgical Evaluation	**Project Address**	249 Whitfield Crescent, Midland, ON	**Date**	Monday, May 9, 2016
Test Pit Number	TP-4	**Contractor**	Property Owner	**Elevation**	NA
Equipment	Mini-Excavator	**Test Pit Size**	5.0 x 1.0 x 1.5 (L x W x H)	**Datum**	Ground Surface
Temperature	8 °C	**Weather**	Sunny	**Sample Type**	Soil

Depth		**Soil description**	**Samples**		**Observations**
From (m)	**To (m)**		**No.**	**Depth (mbg)**	
0.0	0.1	**Topsoil**, sandy with some gravel, dark brown; loose; moist.			
0.1	0.7	**Silty Sand**, some Gravel, Cobble & Boulders, trace Clay; brown; fine to medium grained; compact; moist.			
0.7	1.5	**Silty Sand**, some Gravel, Cobble & Boulders, trace Clay; grey; fine to medium grained; compact; moist	1	0.5 - 1.0	Soil colour changed from brown to grey @ 0.7 metres below ground. T=20-25 min/cm
		Test Pit terminated at 1.5 mbgs			

Comments	Water Conditions in Test Pit
	☐ Wet upon completion ☑ Dry upon completion

JOB No.	15-321
TEST PIT No.	TP-4
FIELD STAFF	Drew West

AZIMUTH ENVIRONMENTAL CONSULTING, INC.

Environmental Assessments & Approvals

TEST PIT LOG

Project Name	249 Whitfield Crescent Hydrogeolgical Evaluation	**Project Address**	249 Whitfield Crescent, Midland, ON	**Date**	Monday, May 9, 2016
Test Pit Number	TP-5	**Contractor**	Property Owner	**Elevation**	NA
Equipment	Mini-Excavator	**Test Pit Size**	5.0 x 1.0 x 1.5 (L x W x H)	**Datum**	Ground Surface
Temperature	8 °C	**Weather**	Sunny	**Sample Type**	Soil

Depth		**Soil description**	**Samples**		**Observations**
From (m)	**To (m)**		**No.**	**Depth (mbg)**	
0.0	0.1	**Topsoil**, sandy with some gravel, dark brown; loose; moist.			
0.1	1.5	**Silty Sand**, some Gravel, Cobble & Boulders, trace Clay; brown; fine to medium grained; compact; moist.	1	0.5 - 1.0	No colour change in soil observed.
		Test Pit terminated at 1.5 mbgs			

Comments	Water Conditions in Test Pit
	☐ Wet upon completion ☑ Dry upon completion

JOB No. 15-321

TEST PIT No. TP-5

FIELD STAFF Drew West

AZIMUTH ENVIRONMENTAL CONSULTING, INC.
Environmental Assessments & Approvals

TEST PIT LOG

Project Name	249 Whitfield Crescent Hydrogeolgical Evaluation	**Project Address**	249 Whitfield Crescent, Midland, ON	**Date**	Monday, May 9, 2016
Test Pit Number	TP-6	**Contractor**	Property Owner	**Elevation**	NA
Equipment	Mini-Excavator	**Test Pit Size**	5.0 x 1.0 x 1.5 (L x W x H)	**Datum**	Ground Surface
Temperature	8 °C	**Weather**	Sunny	**Sample Type**	Soil

Depth		**Soil description**	**Samples**		**Observations**
From (m)	**To (m)**		**No.**	**Depth (mbg)**	
0.0	1.4	**Silty Sand**, some Gravel, Cobble & Boulders, trace Clay; brown; fine to medium grained; compact; moist.	1	0.5 - 1.0	Large boulder @ 1.2 metres below ground
1.4	1.6	**Silty Sand**, some Gravel, Cobble & Boulders, trace Clay; grey; fine to medium grained; compact; wet.			Soil colour changed from brown to grey @ 1.4 metres below ground. Ground water seeping into pit @ 1.4 metres below ground and below
					T=15-20min/cm
		Test Pit terminated at 1.6 mbgs			

Comments	Water Conditions in Test Pit
	☑ Wet upon completion ☐ Dry upon completion

JOB No. 15-321
TEST PIT No. TP-6
FIELD STAFF Drew West

Azimuth Environmental Consulting, Inc.
Environmental Assessments & Approvals

TEST PIT LOG

Project Name	249 Whitfield Crescent Hydrogeolgical Evaluation	**Project Address**	249 Whitfield Crescent, Midland, ON	**Date**	Monday, May 9, 2016
Test Pit Number	TP-7	**Contractor**	Property Owner	**Elevation**	NA
Equipment	Mini-Excavator	**Test Pit Size**	5.0 x 1.0 x 1.5 (L x W x H)	**Datum**	Ground Surface
Temperature	8 °C	**Weather**	Sunny	**Sample Type**	Soil

Depth		**Soil description**	**Samples**		**Observations**
From (m)	**To (m)**		**No.**	**Depth (mbg)**	
0.0	1.5	**Sand and Silt**, some Gravel, Cobble & Boulders, trace Clay; brown; compact; moist to wet. Previously disturbed, wood fill material found below 0.5 metres.	1	0.5 - 1.0	Previously disturbed soil, wood material observed 0.5 metres below ground and below. Ground water seeping into pit @ 1.2 metres below ground and below.
		Test Pit terminated at 1.5 mbgs			

Comments	Water Conditions in Test Pit
	☑ Wet upon completion ☐ Dry upon completion

JOB No. 15-321
TEST PIT No. TP-7
FIELD STAFF Drew West

AZIMUTH ENVIRONMENTAL CONSULTING, INC.
Environmental Assessments & Approvals

TEST PIT LOG

Project Name	249 Whitfield Crescent Hydrogeolgical Evaluation	**Project Address**	249 Whitfield Crescent, Midland, ON	**Date**	Monday, May 9, 2016
Test Pit Number	TP-8	**Contractor**	Property Owner	**Elevation**	NA
Equipment	Mini-Excavator	**Test Pit Size**	5.0 x 1.0 x 1.5 (L x W x H)	**Datum**	Ground Surface
Temperature	8 °C	**Weather**	Sunny	**Sample Type**	Soil

Depth		**Soil description**	**Samples**		**Observations**
From (m)	**To (m)**		**No.**	**Depth (mbg)**	
0.0	1.4	**Sand and Silt**, some Gravel, Cobble, Boulders and Clay; brown; compact; moist.	1	0.5 - 1.0	
1.4	1.7	**Sand and Silt**, some Gravel, Cobble & Boulders, trace Clay; grey; compact; wet.			Soil colour changed from brown to grey @ 1.4 metres below ground. Ground water seeping into pit @ 1.4 metres below ground and below
		Test Pit terminated at 1.7 mbgs			T = 35-40

Comments	Water Conditions in Test Pit
	☑ Wet upon completion ☐ Dry upon completion

JOB No.	15-321
TEST PIT No.	TP-8
FIELD STAFF	Drew West

Terraprobe

Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

May 30, 2016 File No. 3-16-0041

Azimuth Environmental
642 Welham Road
Barrie, ON
L4N 9A1

Attention: Ms. Jackie Coughlin

RE: ESTIMATION OF SOIL PERCOLATION RATE
SUBMITTED SOIL SAMPLES
PROJECT NO. 15-321

Dear Ms. Coughlin:

We are pleased to confirm the details of the estimation of soil percolation rate performed on the submitted soil samples for the above referenced project.

Terraprobe has performed a grain size distribution analysis on the four (4) soil samples delivered to our laboratory on May 19, 2016. The locations of delivered samples were identified as being from Project # 15-321, as well, it was requested that only two (2) samples (TP 2 and TP 6) have an Estimated Septic T-Time performed on them.

Grain size distribution curves were plotted for the samples (Lab No. 2425a to 2425d). They are appended on the Sieve and Hydrometer Analysis Test Report forms. Table 1 below represents a summary of the results of the samples tested.

Table 1

Lab No.	Location of sample	Soil Description	Unified Soil Classification	Estimated Soil "T"-Time
2425a	TP#2 - Sample 1	Silty sand, trace clay, trace gravel	SM	20 to 25 min/cm
2425b	TP#4 - Sample 1	Silty sand, some gravel, trace clay	SM	Not estimated as per client
2425c	TP#6 - Sample 1	Silty sand, some gravel, trace clay	SM	15 to 20 min/cm
2425d	TP#8 - Sample 1	Sand & silt, some clay, trace gravel	ML	Not estimated as per client

It should be noted that Terraprobe Inc. did not conduct a field investigation in conjunction with the collection of these samples, or witness the collection of the samples tested. Terraprobe Inc. assumes no responsibility for the application of the above-noted percolation rates ("T"-Time) for use in design of an on-site sewage disposal system. The design of an on-site sewage system must be conducted by a qualified professional with due regard for a number of site-specific conditions in addition to the percolation rates of the soils.

Terraprobe Inc. does not present the estimated percolation rates given in this report as a warranty of performance for the soils tested. Furthermore, the estimate provided is indicative of the sample in a disturbed state only. It must be emphasized that factors such as, but not limited to, consistency, structure, organic content, density and degree of saturation could influence the estimate. The client or third party using this information as a basis for tile field design assumes all risk associated with their evaluation of this report and all other criteria used in the design of any private sewage disposal system.

We trust this information is sufficient for your present purposes. Should you have any questions concerning the content of the information presented, please do not hesitate to contact the undersigned.

Yours truly,

Terraprobe Inc.

B. Jackson

for Jerry Duguid, A. Sc. T.
Laboratory Manager

Brian H. Jackson
Director
Barrie Branch Manager

BHJ/jd
Barrie Office

Terraprobe

SIEVE AND HYDROMETER ANALYSIS TEST REPORT

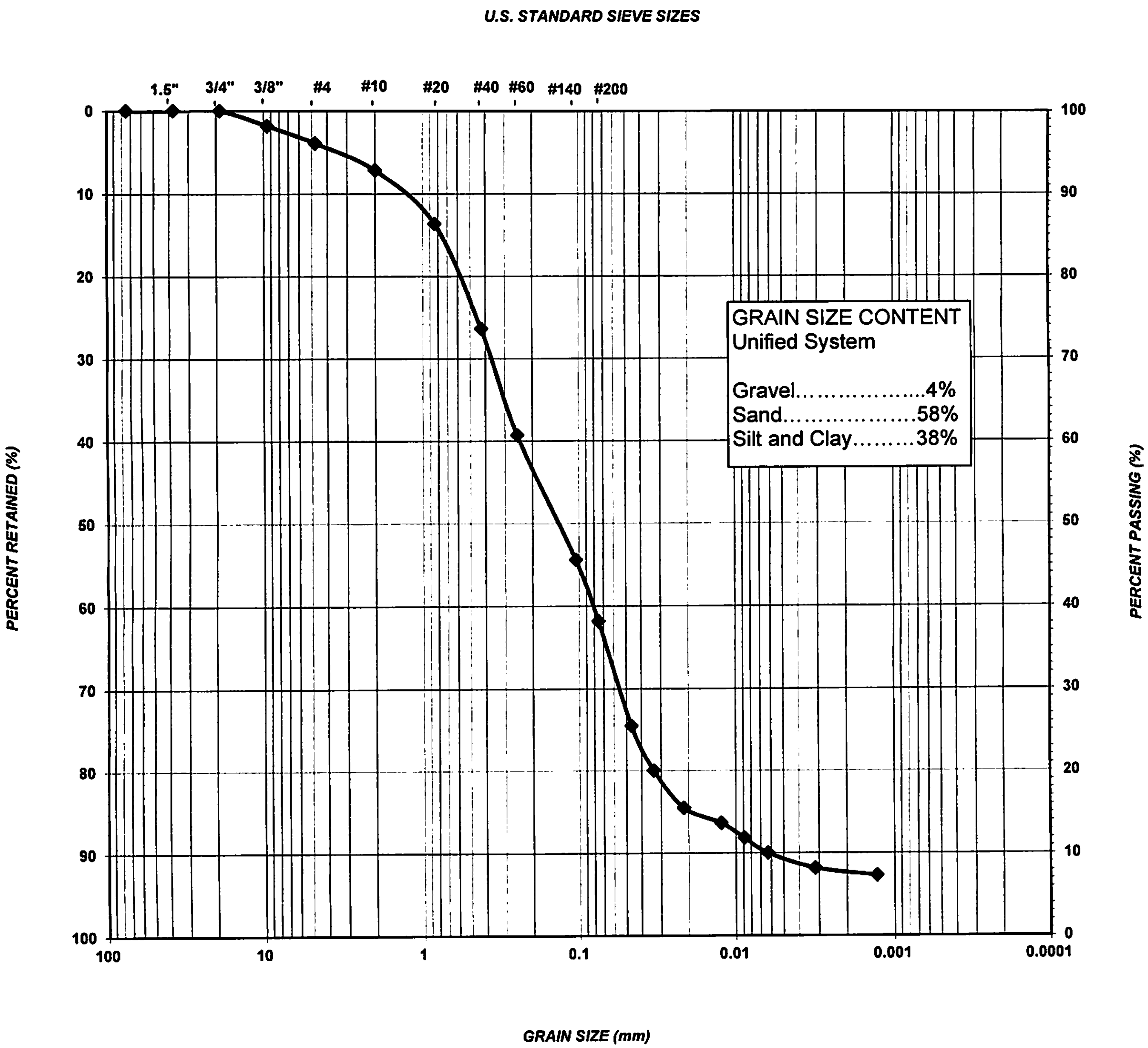
PROJECT: **Laboratory Testing; Septic T-Time**
LOCATION: **Midland, ON**
CLIENT: **Azimuth Environmental**

FILE NO.: **3-16-0041**
LAB NO.: **2425a**
SAMPLE DATE: **May-19-16**
SAMPLED BY: **Client**

TEST PIT NUMBER: **2**
SAMPLE DEPTH: **0.5 to 1.0m**
SAMPLE NUMBER: **1**
SAMPLE LOCATION: **15-321**
SAMPLE DESCRIPTION: **Silty sand, trace clay, trace gravel**

Estimated Septic T-Time: 20 to 25 min/cm

GRAIN SIZE DISTRIBUTION



MIT SYSTEM	GRAVEL	SAND: COARSE	SAND: MEDIUM	SAND: FINE	SILT	CLAY

UNIFIED SYSTEM	GRAVEL: COARSE	GRAVEL: FINE	SAND: COARSE	SAND: MEDIUM	SAND: FINE	SILT AND CLAY

Terraprobe

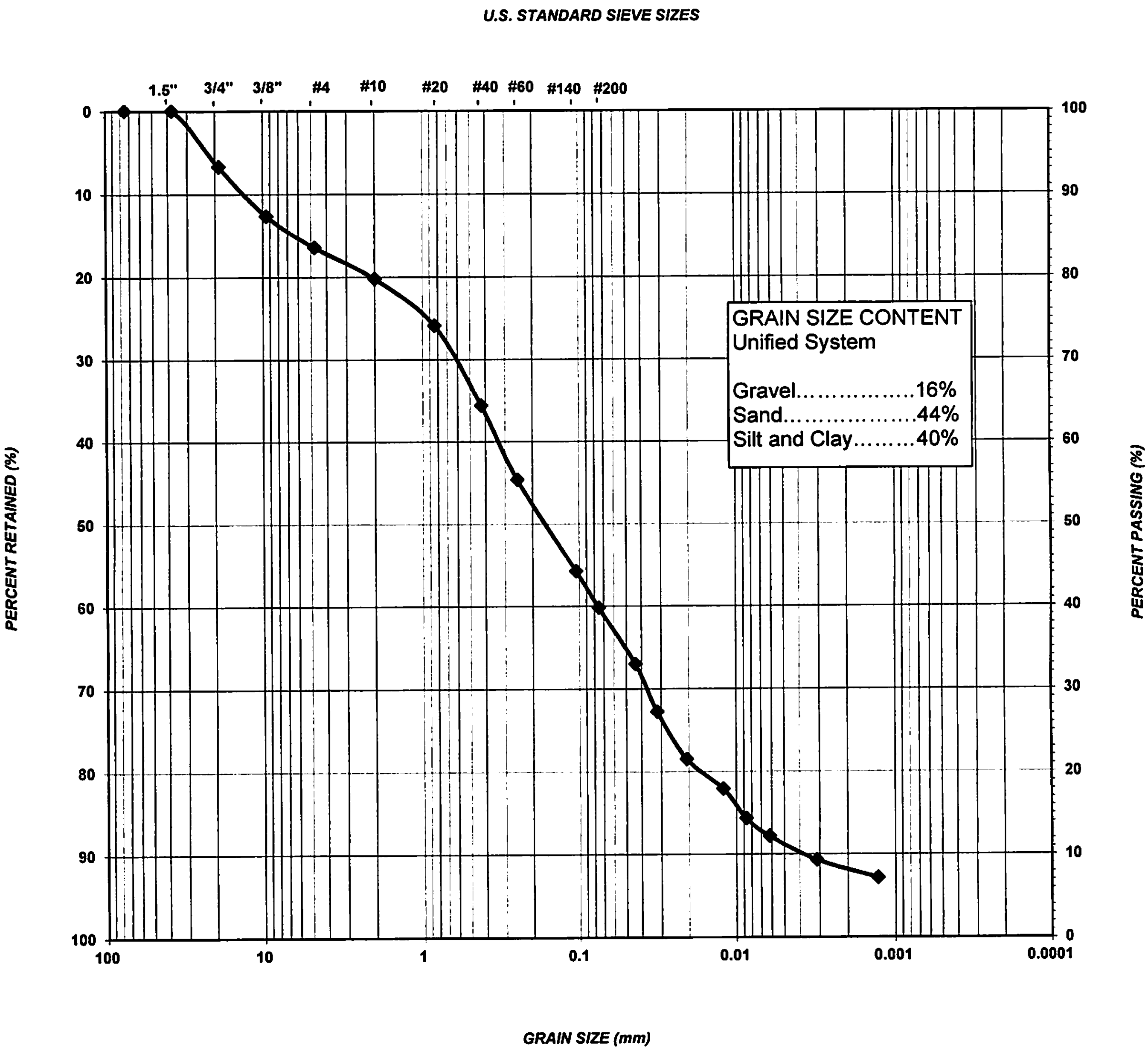
SIEVE AND HYDROMETER ANALYSIS TEST REPORT

PROJECT: **Laboratory Testing; Septic T-Time**
LOCATION: **Midland, ON**
CLIENT: **Azimuth Environmental**

FILE NO.: **3-16-0041**
LAB NO.: **2425b**
SAMPLE DATE: **May-19-16**
SAMPLED BY: **Client**

TEST PIT NUMBER: **4** SAMPLE DEPTH: **0.5 to 1.0m**
SAMPLE NUMBER: **1**
SAMPLE LOCATION: **15-321**
SAMPLE DESCRIPTION: **Silty sand, some gravel, trace clay**

GRAIN SIZE DISTRIBUTION



MIT SYSTEM	GRAVEL	SAND (COARSE / MEDIUM / FINE)	SILT	CLAY

UNIFIED SYSTEM	GRAVEL (COARSE / FINE)	SAND (COARSE / MEDIUM / FINE)	SILT AND CLAY

Terraprobe

SIEVE AND HYDROMETER ANALYSIS TEST REPORT

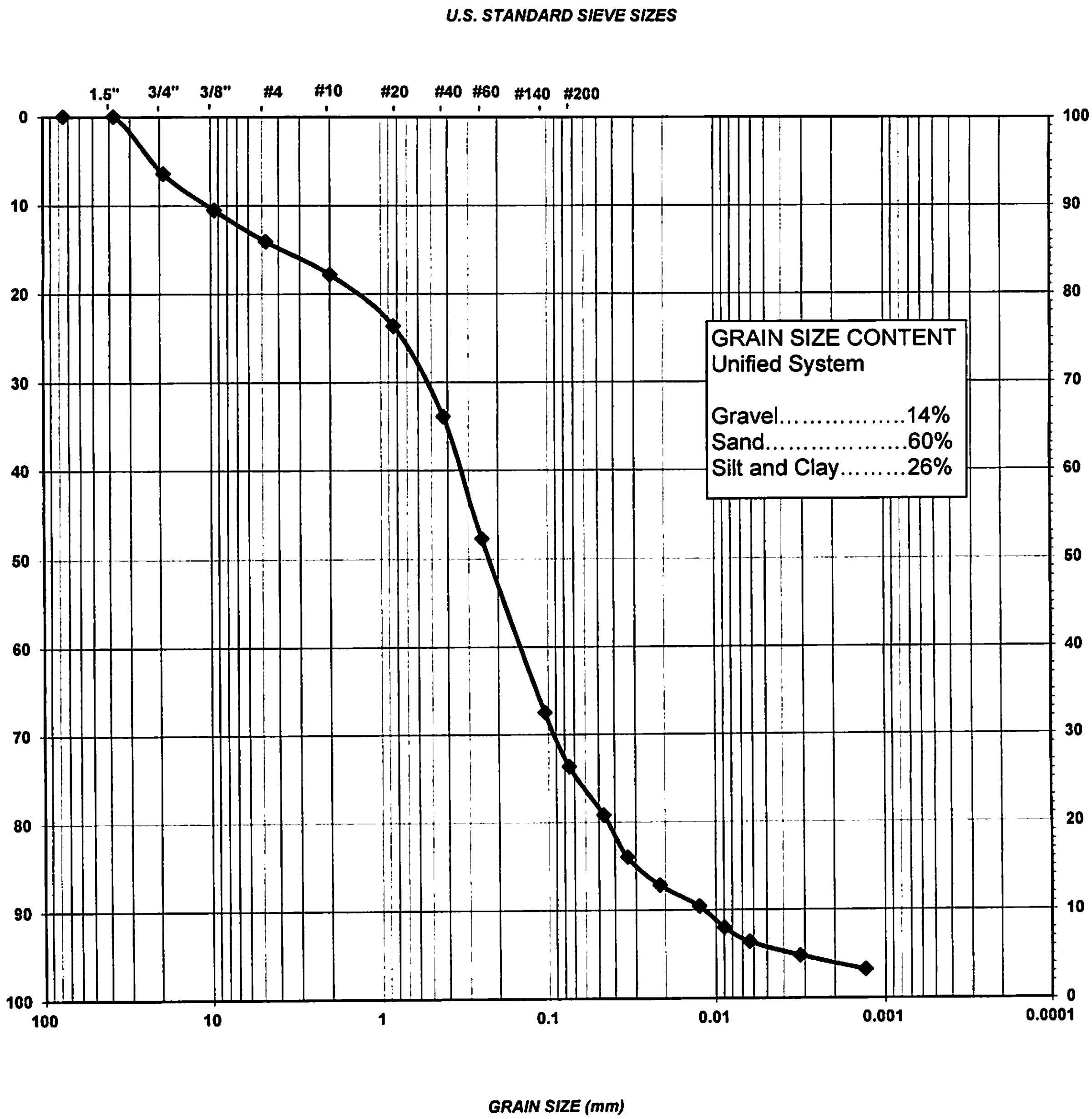
PROJECT: **Laboratory Testing; Septic T-Time**
LOCATION: **Midland, ON**
CLIENT: **Azimuth Environmental**

FILE NO.: **3-16-0041**
LAB NO.: **2425c**
SAMPLE DATE: **May-19-16**
SAMPLED BY: **Client**

TEST PIT NUMBER: **6**
SAMPLE DEPTH: **0.5 to 1.0m**
SAMPLE NUMBER: **1**
SAMPLE LOCATION: **15-321**
SAMPLE DESCRIPTION: **Silty sand, some gravel, trace clay**

Estimated Septic T-Time: 15 to 20 min/cm

GRAIN SIZE DISTRIBUTION



MIT SYSTEM	GRAVEL	SAND (COARSE / MEDIUM / FINE)	SILT	CLAY

UNIFIED SYSTEM	GRAVEL (COARSE / FINE)	SAND (COARSE / MEDIUM / FINE)	SILT AND CLAY

Terraprobe

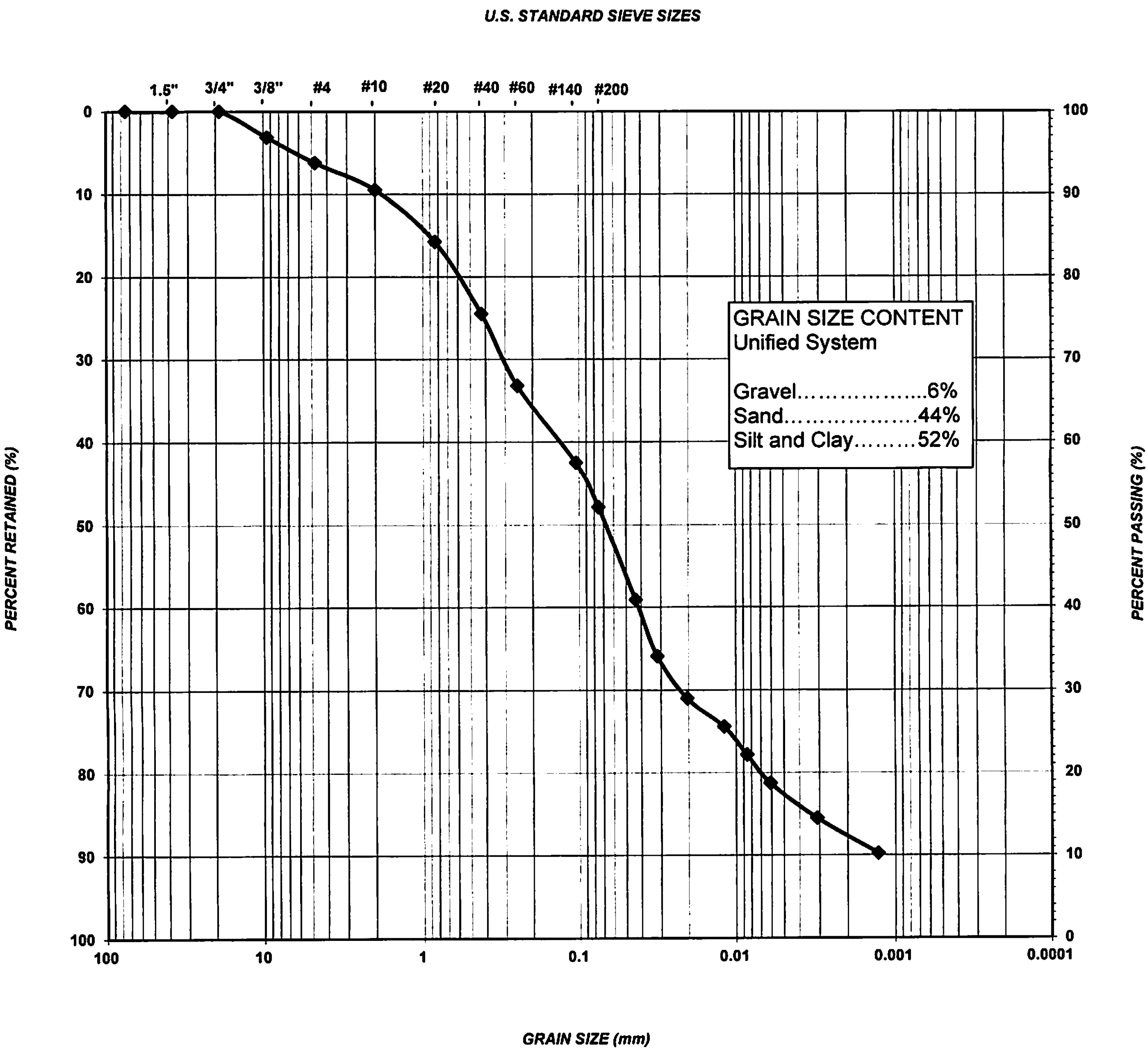
SIEVE AND HYDROMETER ANALYSIS TEST REPORT

PROJECT: **Laboratory Testing; Septic T-Time**
LOCATION: **Midland, ON**
CLIENT: **Azimuth Environmental**

FILE NO.: **3-16-0041**
LAB NO.: **2425d**
SAMPLE DATE: **May-19-16**
SAMPLED BY: **Client**

TEST PIT NUMBER: **8** SAMPLE DEPTH: **0.5 to 1.0m**
SAMPLE NUMBER: **1**
SAMPLE LOCATION: **15-321**
SAMPLE DESCRIPTION: **Sand and silt, some clay, trace gravel**

GRAIN SIZE DISTRIBUTION



<table>
<tr><td rowspan="2">MIT SYSTEM</td><td rowspan="2">GRAVEL</td><td>COARSE</td><td>MEDIUM</td><td>FINE</td><td rowspan="2">SILT</td><td rowspan="2">CLAY</td></tr>
<tr><td colspan="3">SAND</td></tr>
</table>

<table>
<tr><td rowspan="2">UNIFIED SYSTEM</td><td>COARSE</td><td>FINE</td><td>COARSE</td><td>MEDIUM</td><td>FINE</td><td rowspan="2">SILT AND CLAY</td></tr>
<tr><td colspan="2">GRAVEL</td><td colspan="3">SAND</td></tr>
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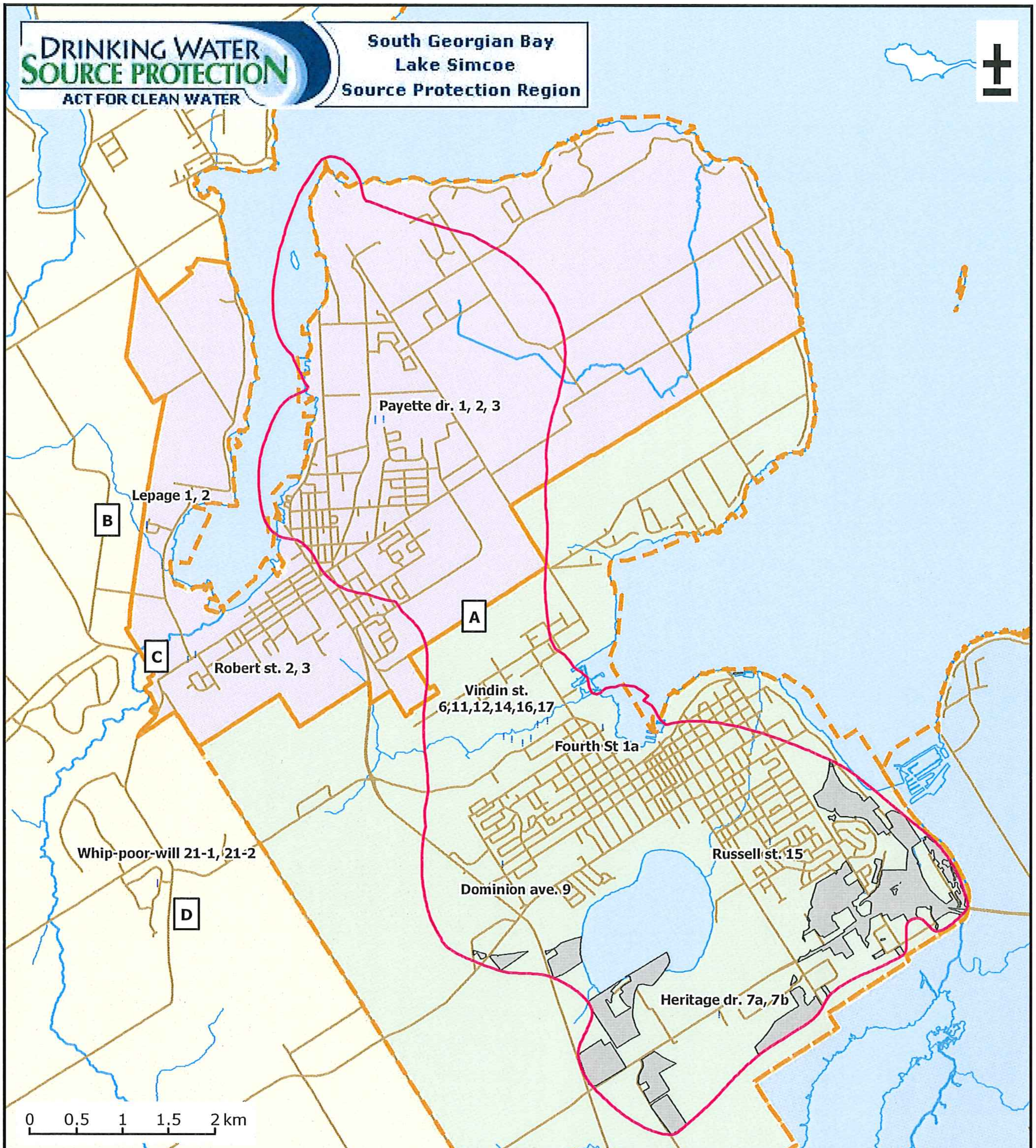
APPENDIX D

Hydrogeolgical Study Excerpts



Municipal Pumping Well

WHPA-Q2

Areas of Land Cover Changes (Outside WHPA-Q1) Where Recharge Reductions May Impact Municipalial Aquifer Water Levels

WHPA-Q2 Delineation

Created by: LSRCA
Date: 2014-03-25

Scale: 1:60,000
UTM Zone 17N, NAD83

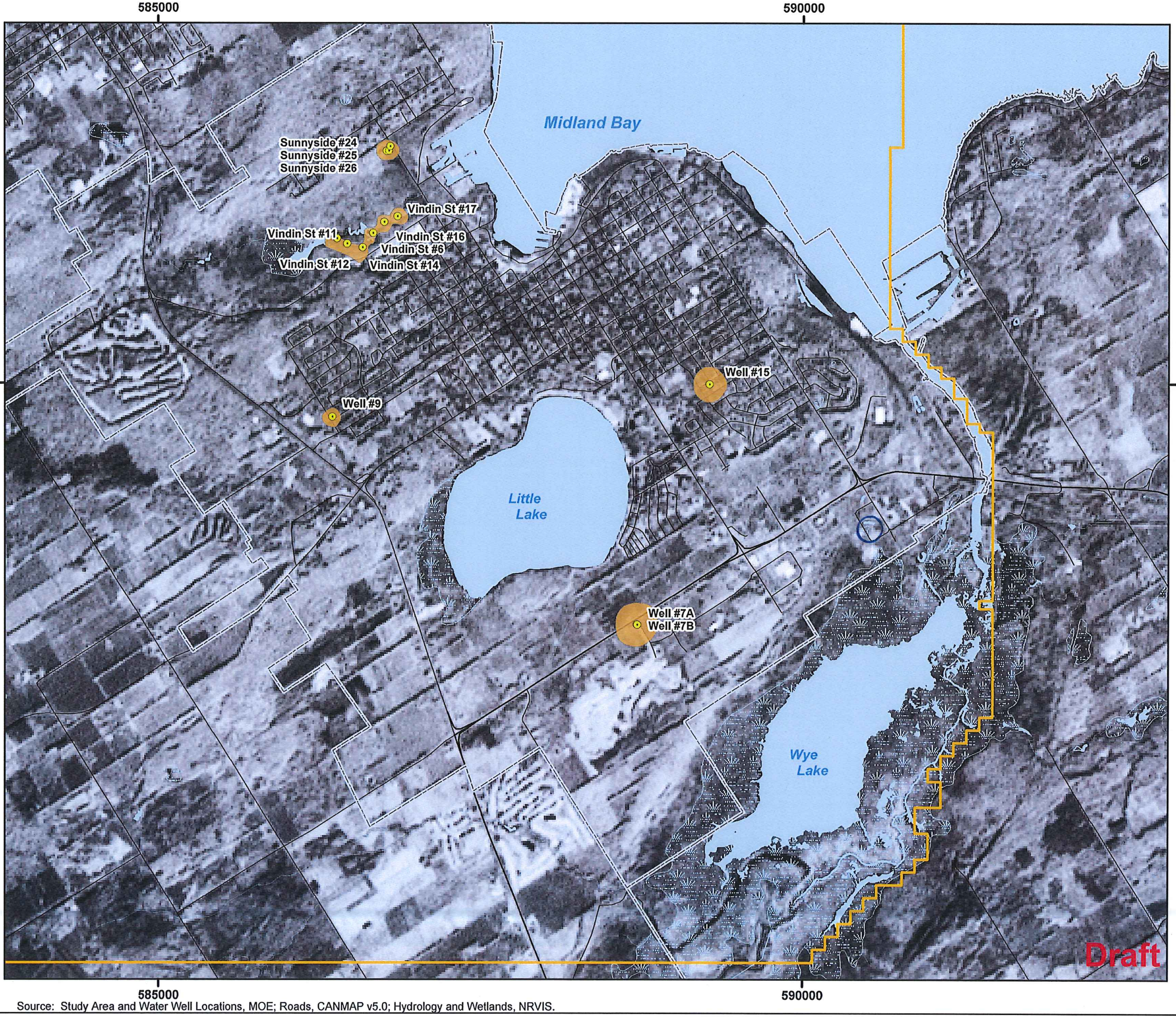
Golder Associates

Severn Sound Environmental Association

This map was produced by the Lake Simcoe Region Conservation Authority, lead agency of the South Georgian Bay Lake Simcoe Region Source Protection Region. Base data have been compiled from various sources, under data sharing agreements.
While every effort has been made to accurately depict the base data, errors may exist.

Ontario

Figure 3.5-13



Source: Study Area and Water Well Locations, MOE; Roads, CANMAP v5.0; Hydrology and Wetlands, NRVIS.

G:\Projects\2002\021-1206_Simcoe\GIS\MXDs_8.2\Midland_Penetang\Figure4.16_Capture Zones - 50day ToT.mxd

Severn Sound Environmental Association

Legend

- Municipal Wells
- Municipal Boundaries
- Roads
- Rivers
- Surface Water
- Wetlands
- 50 day Capture Zones
- Groundwater Model Boundary

North Simcoe Groundwater Study
Capture Zones - 50 day ToT - Midland

Figure 4.16

N

Scale 1:30,000

0.5 0.25 0 0.5 1

Kilometres

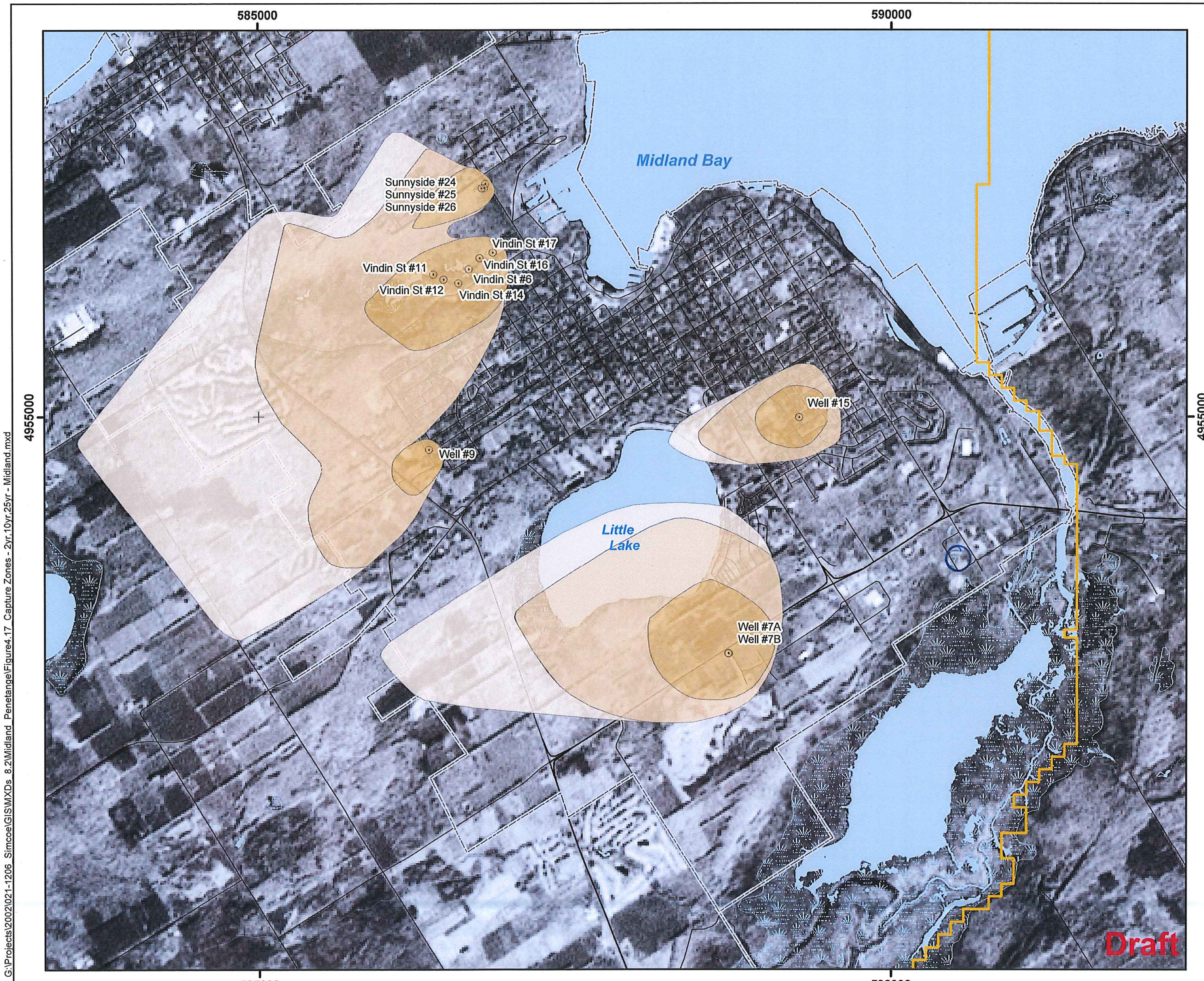
Projection: UTM 17 NAD83

Date: July, 2003
Project: 021-1206

Drawn: CC
Chkd: SD

DIXON HYDROGEOLOGY

Golder Associates



Source: Study Area and Water Well Locations, MOE; Roads, CANMAP v5.0; Hydrology and Wetlands, NRVIS.

G:\Projects\2002\021-1206 Simcoe\GIS\MXDs 8.2\Midland Penetange\Figure4.17 Capture Zones - 2yr,10yr,25yr - Midland.mxd

Severn Sound Environmental Association

Legend

- Municipal Wells
- Municipal Boundaries
- Roads
- Rivers
- Surface Water
- Wetlands
- 2 year Capture Zones
- 10 year Capture Zones
- 25 year Capture Zones
- Groundwater Model Boundary

North Simcoe Groundwater Study
Capture Zones - 2 year, 10 year, 25 year - Midland

Figure 4.17

N

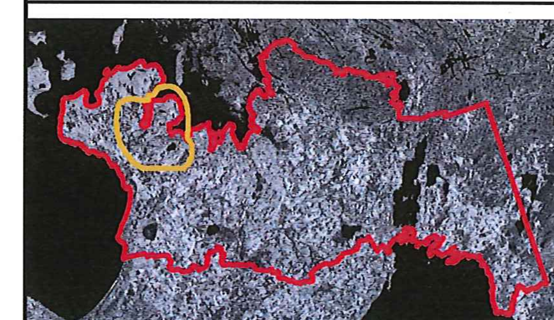
Scale 1:30,000

0.5 0.25 0 0.5 1

Kilometres

Projection: UTM 17 NAD83

Date: July, 2003 Drawn: CC
Project: 021-1206 Chkd: SD



DIXON HYDROGEOLOGY

Golder Associates

APPENDIX E

Water Budget Calculations (Midland)

Water Balance Summary Table E-1 - Pre-Development

249 Whitfield Cr Self Storage Development

Catchment Designation	Site		Total
	Forest	Meadow	
Area (m^2)	385	3,793	4,178
Pervious Area (m^2)	385	3,793	4,178
Impervious Area (m^2)	0	0	0
Infiltration Factors			
Topography Infiltration Factor	0.3	0.3	
Soil Infiltration Factor	0.2	0.2	
Land Cover Infiltration Factor	0.15	0.1	
Infiltration Factor	0.65	0.6	
Run-Off Coefficient	0.35	0.4	
Run-Off From Impervious Surfaces	0.8	0.8	
Inputs (Per Unit Area)			
Precipitation (mm/yr)	982	982	982
Rainfall (mm/yr)	679	679	679
Run-On (mm/yr)	0	0	0
Other Inputs (mm/yr)	0	0	0
Total Inputs (mm/yr)	**982**	**982**	**982**
Outputs (Per Unit Area)			
Precipitation Surplus (mm/yr)	490	490	490
Net Surplus (mm/yr)	490	490	490
Evapotranspiration (mm/yr)	492	492	492
Infiltration (mm/yr)	319	294	296
Rooftop Infiltration (mm/yr)	0	0	0
Total Infiltration (mm/yr)	319	294	296
Run-Off Pervious Areas (mm/yr)	172	196	194
Run-Off Impervious Areas (mm/yr)	0	0	0
Total Run-Off (mm/yr)	172	196	194
Total Outputs (mm/yr)	**982**	**982**	**982**
Difference (Inputs - Outputs)	**0**	**0**	**0**
Inputs (Volumes)			
Precipitation (m^3/yr)	378	3,725	4,103
Run-On (m^3/yr)	0	0	0
Other Inputs (m^3/yr)	0	0	0
Total Inputs (m^3/yr)	**378**	**3,725**	**4,103**
Outputs (Volumes)			
Precipitation Surplus (m^3/yr)	189	1,859	2,047
Net Surplus (m^3/yr)	189	1,859	2,047
Evapotranspiration (m^3/yr)	189	1,866	2,056
Infiltration (m^3/yr)	123	1,115	1,238
Rooftop Infiltration (m^3/yr)	0	0	0
Total Infiltration (m^3/yr)	***123***	***1,115***	***1,238***
Run-Off Pervious Areas (m^3/yr)	66	743	809
Run-Off Impervious Areas (m^3/yr)	0	0	0
Total Run-Off (m^3/yr)	66	743	809
Total Outputs (m^3/yr)	378	3,725	4,103
Difference (Inputs - Outputs)	**0**	**0**	**0**

Water Balance Summary Table E-2 - Post-Development (no mitigation)

249 Whitfield Cr Self Storage Development

Catchment Designation	Storage Buildings	Landscaped	Infiltration Trench	Gravel	Total
Area (m^2)	906	479	338	2,455	4,178
Pervious Area (m^2)	0	479	338	0	817
Impervious Area (m^2)	906	0	0	2,455	3,361
Infiltration Factors					
Topography Infiltration Factor	-	0.3	0.3	-	
Soil Infiltration Factor	-	0.2	0.2	-	
Land Cover Infiltration Factor	-	0.05	0.05	-	
Infiltration Factor	0	0.55	0.55	0	
Run-Off Coefficient	1	0.45	0.45	1	
Run-Off From Impervious Surfaces	0.8	0.8	0.8	0.8	
Inputs (Per Unit Area)					
Precipitation (mm/yr)	982	982	982	982	982
Rainfall (mm/yr)	679	679	679	679	679
Run-On (mm/yr)	0	0	0	0	0
Other Inputs (mm/yr)	0	0	0	0	0
Total Inputs (mm/yr)	**982**	**982**	**982**	**982**	**982**
Outputs (Per Unit Area)					
Precipitation Surplus (mm/yr)	786	490	490	786	728
Net Surplus (mm/yr)	786	490	490	786	728
Evapotranspiration (mm/yr)	196	492	492	196	254
Infiltration (mm/yr)	0	270	270	0	53
Rooftop Infiltration (mm/yr)	0	0	0	0	0
Total Infiltration (mm/yr)	0	270	270	0	53
Run-Off Pervious Areas (mm/yr)	0	221	221	0	43
Run-Off Impervious Areas (mm/yr)	786	0	0	786	632
Total Run-Off (mm/yr)	786	221	221	786	675
Total Outputs (mm/yr)	**982**	**982**	**982**	**982**	**982**
Difference (Inputs - Outputs)	**0**	**0**	**0**	**0**	**0**
Inputs (Volumes)					
Precipitation (m^3/yr)	890	470	332	2,411	4,103
Run-On (m^3/yr)	0	0	0	0	0
Other Inputs (m^3/yr)	0	0	0	0	0
Total Inputs (m^3/yr)	**890**	**470**	**332**	**2,411**	**4,103**
Outputs (Volumes)					
Precipitation Surplus (m^3/yr)	712	235	166	1,929	3,041
Net Surplus (m^3/yr)	712	235	166	1,929	3,041
Evapotranspiration (m^3/yr)	178	236	166	482	1,062
Infiltration (m^3/yr)	0	129	91	0	220
Rooftop Infiltration (m^3/yr)	0	0	0	0	0
Total Infiltration (m^3/yr)	***0***	***129***	***91***	***0***	***220***
Run-Off Pervious Areas (m^3/yr)	0	106	75	0	180
Run-Off Impervious Areas (m^3/yr)	712	0	0	1,929	2,640
Total Run-Off (m^3/yr)	712	106	75	1,929	2,821
Total Outputs (m^3/yr)	890	470	332	2,411	4,103
Difference (Inputs - Outputs)	**0**	**0**	**0**	**0**	**0**

Water Balance Summary Table E-3 - Post-Development (with mitigation)
249 Whitfield Cr Self Storage Development

Catchment Designation	Storage Buildings	Landscaped	Infiltration Trench	Gravel	Total
Area (m^2)	906	479	338	2,455	4,178
Pervious Area (m^2)	0	479	338	0	817
Impervious Area (m^2)	906	0	0	2,455	3,361
Infiltration Factors					
Topography Infiltration Factor	-	0.3	0.3	-	
Soil Infiltration Factor	-	0.2	0.2	-	
Land Cover Infiltration Factor	-	0.05	0.05	-	
Infiltration Factor	0	0.55	0.55	0	
Run-Off Coefficient	1	0.45	0.45	1	
Run-Off From Impervious Surfaces	0.8	0.8	0.8	0.8	
Inputs (Per Unit Area)					
Precipitation (mm/yr)	982	982	982	982	982
Rainfall (mm/yr)	679	679	679	679	679
Run-On (mm/yr)	0	0	0	0	0
Other Inputs (mm/yr)	0	0	0	0	0
Total Inputs (mm/yr)	**982**	**982**	**982**	**982**	**982**
Outputs (Per Unit Area)					
Precipitation Surplus (mm/yr)	786	490	490	786	728
Net Surplus (mm/yr)	786	490	490	786	728
Evapotranspiration (mm/yr)	196	492	492	196	254
Infiltration (mm/yr)	0	270	270	0	53
Rooftop Infiltration (mm/yr)	0	0	0	0	0
LID Infiltration (mm/yr)	375	0	0	375	302
Total Infiltration (mm/yr)	375	270	270	375	354
Run-Off Pervious Areas (mm/yr)	0	221	221	0	43
Run-Off Impervious Areas (mm/yr)	411	0	0	411	330
Total Run-Off (mm/yr)	411	221	221	411	374
Total Outputs (mm/yr)	**982**	**982**	**982**	**982**	**982**
Difference (Inputs - Outputs)	**0**	**0**	**0**	**0**	**0**
Inputs (Volumes)					
Precipitation (m^3/yr)	890	470	332	2,411	4,103
Run-On (m^3/yr)	0	0	0	0	0
Other Inputs (m^3/yr)	0	0	0	0	0
Total Inputs (m^3/yr)	**890**	**470**	**332**	**2,411**	**4,103**
Outputs (Volumes)					
Precipitation Surplus (m^3/yr)	712	235	166	1,929	3,041
Net Surplus (m^3/yr)	712	235	166	1,929	3,041
Evapotranspiration (m^3/yr)	178	236	166	482	1,062
Infiltration (m^3/yr)	0	129	91	0	220
Rooftop Infiltration (m^3/yr)	0	0	0	0	0
LID Infiltration (m^3/yr)	340	0	0	920	1,260
Total Infiltration (m^3/yr)	***340***	***129***	***91***	***920***	***1,480***
Run-Off Pervious Areas (m^3/yr)	0	106	75	0	180
Run-Off Impervious Areas (m^3/yr)	372	0	0	1,008	1,381
Total Run-Off (m^3/yr)	372	106	75	1,008	1,561
Total Outputs (m^3/yr)	890	470	332	2,411	4,103
Difference (Inputs - Outputs)	**0**	**0**	**0**	**0**	**0**

Overall Water Balance Summary Table

249 Whitfield Cr Self Storage Development

Characteristic	Site						
	Pre-Develop	Post-Developm	Change (Pre to Post)		Post-Develop	Change (Pre to Post with	
Inputs (Volume)							
Precipitation (m^3/yr)	4,103	4,103	0	0%	4,103	0	0%
Run-On (m^3/yr)	0	0	0	0%	0	0	-
Other Inputs (m^3/yr)	0	0	0	0%	0	0	-
Total Inputs (m^3/yr)	4,103	4,103	0	0%	4,103	0	0%
Outputs (Volume)							
Precipitation Surplus (m^3/yr)	2,047	3,041	994	49%	3,041	994	49%
Net Surplus (m3/yr)	2,047	3,041	994	49%	3,041	994	49%
Evapotranspiration (m^3/yr)	2,056	1,062	-994	-48%	1,062	-994	-48%
Infiltration (m^3/yr)	1,238	220	-1,018	-82%	220	-1,018	-82%
Rooftop Infiltration (m^3/yr)	0	0	0	0%	0	0	-
LID Infiltration (m^3/yr)	0	0	0	0%	1,260	1,260	-
Total Infiltration (m^3/yr)	***1,238***	***220***	***-1,018***	***-82%***	1,480	***242***	20%
Run-Off Pervious Areas (m^3/yr)	809	180	-629	-78%	180	-629	-78%
Run-Off Impervious Areas (m^3/yr)	0	2,640	2,640	0%	1,381	1,381	-
Total Run-Off (m^3/yr)	809	2,821	2,011	248%	1,561	751	93%
Total Outputs (m^3/yr)	**4,103**	**4,103**	**0**	0%	4,103	0	0%