CHUNG & VANDER DOELEN
ENGINEERING LTD.

GROUNDWATER SUPPLY FEASIBILITY ASSESSMENT

Sarah Properties Ltd.
Waldemar Residential Development

Township of Amaranth, Ontario

SUBMITTED TO:
Sarah Properties Ltd.
2 Prince Edward Road
Woodstock, ON
N4V 1G7

ATTENTION:
Mr. Walter Broos

FILE NO.: / H16033 / June 22 2016

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June 22, 2016
FILE NO.: H16033

Mr. Walter Broos
Sarah Properties Ltd.
2 Prince Edward Road
Woodstock, ON N4V 1G7

Dear Mr. Broos:

RE: **GROUNDWATER SUPPLY FEASIBILITY ASSESSMENT**
Sarah Properties Ltd. Waldemar Residential Development
Township of Amaranth, County of Dufferin

This report presents a hydrogeological assessment of the feasibility for securing additional groundwater supply in Waldemar, Ontario to service Sarah Properties Ltd. proposed 334-lot residential development. It is intended that this report be presented to the Township of Amaranth for its consideration and input to the subsequent steps by Sarah Properties in developing additional source water.

If you have any questions or concerns regarding the report, please contact the undersigned at your convenience.

Yours truly,
CHUNG & VANDER DOELEN ENGINEERING LTD.

S. Anderson.

William (Sandy) Anderson, M.Sc., P.Eng.
Senior Hydrogeologist and Engineer

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1.0 INTRODUCTION

This report presents a feasibility assessment for securing additional groundwater supply to service the Sarah Properties Ltd. (SPL) proposed 334-lot residential development located in Waldemar, Ontario. It is intended that this report be presented to the Township of Amaranth for its consideration and input prior to subsequent steps taken by SPL in developing additional source water supply.

CVD and SPL had general discussions on the matter of groundwater supply in the Waldemar area with R.J. Burnside & Associates Limited (Burnside), the engineering and hydrogeological consultant for the Township of Amaranth (Township). Burnside provided several technical reports as background information on the hydrogeological setting and the existing groundwater supplies in Waldemar and nearby Grand Valley.

The scope of this assessment includes the following:

1. Review of available background information on the hydrogeological setting and existing groundwater use, both municipal and private.
2. Characterization of the general hydrogeological setting.
3. Review the source water capabilities of the existing municipal water system serving Waldemar and assess the requirements for additional source water for the SPL development.
4. Identify the primary technical considerations for securing additional source water capability.
5. Make recommendations for the next steps in securing additional source water supply.

2.0 BACKGROUND INFORMATION

Background information sources used in completing this assessment are listed below.

- Government geological maps and reports on surficial and bedrock geology.
- Water well record database.
- Geotechnical, hydrogeological and functional servicing reports for the SPL development property.
- Well evaluation and GUDI (groundwater under direct influence of surface water) reports for the three existing municipal wells and one former municipal well in Waldemar.
- Water management study for East Luther / Grand Valley.
- Groundwater vulnerability and threats assessment reports for the Waldemar municipal wells.
- Source water protection reports / plans for the Waldemar and Grand Valley water supplies.

Section 7.0 provides a full list of the specific sources and reports. Appendix B provides several relevant figures and maps from the background sources.

The 35.02-hectare SPL development property is located on the west side of Waldemar as shown in Figure 1 (Appendix A). The Township of Amaranth Official Plan Schedule “A-1” (Appendix B, Sept 2010) indicates the SPL property is within the area identified as ‘Community Residential’. Appendix B Figure 2 (Crozier, 2015) shows the Draft Plan of Subdivision for the SPL property, noting the development is an extension from the existing residential subdivision (known as the Acchione Subdivision) along Henry, James, Main and John Streets.

As shown in Figure 1 and OP Schedule A1, Waldemar is bisected by the Grand River into western and eastern portions. At present, there are about 175 residences (+/-) in the Waldemar 'Community Residential' area; roughly 55 to the west and 120 to the east. About 95 residences (+/-) on the east side (Waldemar Heights Subdivision) and 30 residences (+/-) on the west side are serviced by the Waldemar municipal water supply, which serves approximately 342 residents (Burnside, 2010) using three wells (PW1, PW2 and PW3) located in the east side residential area (Figure 1). Remaining residences in the Community Residential area (about 50 +/-) and other residences to the north and south of Waldemar use individual wells (Figure 1). All residences in the area use individual septic systems for sewage waste.

The SPL development would be fully serviced with both municipal water supply and wastewater collection and a wastewater treatment plant that would provide high level treatment prior to effluent discharge to the Grand River. The treatment plant would be located in the southeast corner of the SPL property.

3.0 SETTING

3.1 GENERAL TOPOGRAPHY AND DRAINAGE

Figure 2.1 (Appendix B - Burnside, 2010) shows the Grand River Watershed with the location of Waldemar and Amaranth Township in the northern upstream end of the watershed. The Grand River flows in a southerly direction through the middle of Waldemar at an elevation of about 448 to 446 mASL.

Not surprisingly, topography in the Waldemar area is generally sloped toward the River. On the SPL property, the topographic fall is relatively consistent; from about 476 mASL in the southwest corner, to 460 in the southeast corner, 463 mASL in the north tip, and as low as 456 along the northeast side. There are no permanent water courses on the SPL property. Topography east of the River is somewhat more complicated by a couple of creek valleys, but generally falls westerly toward the River from a similar upland area of about 475 mASL (+/-) near the eastern edge of the residential development area.

3.2 GEOLOGIC SETTING

The geologic setting in the Waldemar area is described by government maps/reports of both the Quaternary-aged surface deposits (Cowen et al., 1973) and the underlying bedrock formations (Liberty et al., 1976), as well as by water well records (MOECC database) and deeper gas well records (Beards, 1967). Burnside has summarized the setting in several reports (e.g., 2001a, 2002, 2003, 2007 and 2010).

3.2.1 Overburden Geology

Overburden thickness varies widely, as shown in Figure 4 (Appendix B - Burnside, 2007) and Figure 2 (Appendix A), and generally as follows:

- 30 to 35 m (100 to 102 feet) in the upland areas extending south and west from the southwest part of the SPL property and eastward from the east-side residential area.
- 15 to 25 m (50 to 80 feet) in the vicinity of the three existing municipal wells (PW1, PW2 and

PW3) and the former Acchione municipal well (ACC).
- Less than 5 m (15 feet) in a 50 to 200 m wide zone adjacent to the Grand River, including several stretches along the River where bedrock is exposed.

The surficial geology across the area is dominated by the silt to clayey silt Tavistock Till, mapped by Cowen et al., 1973 (Deposit 5d, Figure 4, Appendix B - Burnside, 2007). Other notable surficial deposits identified by Cowen et al. include extensive glaciofluvial outwash gravel and sandy gravel deposits within the Grand River valley and in a 1-km wide area extending east of the Grand River through most of the residential area and for several kilometers further east (Deposit 7, Figure 4, Appendix B). Notably, the mapping indicates that virtually the entire SPL property is underlain by the Tavistock Till.

The 2014-2015 subsurface investigation at the SPL property by Terraprobe included ten test pits to 3 m and twenty-three boreholes up to 12 m in depth (locations shown in Figure 2, Appendix B - Crozier, 2015). This investigation has confirmed the widespread presence of clayey silt till across the property. Only along the northeast property edge did a few shallow test pits (TP2 to TP5) indicate presence of the surficial sand/gravel Grand Valley outwash deposit on the property. The only other 'non-till' occurrences at the property were a 3.1 m thick sand and gravel layer at BH1 below the 7.6-m depth (elevation 466.6 mASL) and a 1.9 m thick sand layer at BH7 beneath the 2.7-m depth (elevation 470.1 mASL). In both of the latter occurrences, the granular layers were both over and underlain by silt till.

Borehole data from the Waldemar Heights residential area (Burnside, 2003 and MOECC well records) typically indicates a 3 to 5-m thick surficial sand and gravel layer overlying silt to clayey silt till and occasionally indicates a silt or silt till at surface. This is also consistent with Cowan's mapping.

Water wells records provide some additional information on deeper overburden deposits, although driller's descriptions are not always consistent with standard geological descriptions. Figure 2 (Appendix A) presents the total overburden thickness and the total thickness of materials with 'clay' in the description for selected well records. As shown, there is a predominance of clayey materials in the overburden, particularly at wells located in the upland areas and immediately adjacent to the SPL property.

3.2.2 Bedrock Geology

Bedrock in the area (Figure 5, Appendix B - Terraprobe, 2015) is the Middle Silurian-aged Guelph Formation tan dolostone and the underlying Amabel Formation grey dolostone (Liberty et al, 1976). Regional stratigraphic assessments (Beards, 1967 and Sanford, 1969) suggest these two formations are on the order of 85 to 105 m (280 to 340 feet) thick in the area and are underlain by the Lower Silurian-aged Clinton-Cataract Formations of interbedded shale-dolostone-sandstone.

Two of the deep municipal wells appear to have encountered the full thickness of the Guelph-Amabel dolostone (referred to by drillers as 'limestone'). At PW1, shale was encountered at 88 and 90.5 m (289 and 297 feet) below the bedrock surface and, at PW2, shale was encountered 92 m (301 feet). At Grand Valley municipal well 3 (GV3), 89.9 m (295 feet) of 'limestone' was recorded, apparently without reaching the shale.

3.3 HYDROGEOLOGIC SETTING

The hydrogeologic setting in the Waldemar area has three general components, as follows:

- A shallow water table aquifer in the surficial outwash sand/gravel deposits.
- A low-permeability clayey silt till aquitard.
- A regional aquifer in the Guelph-Amabel dolostone bedrock.

3.3.1 Water Table Aquifer

A shallow water table aquifer exists only where permeable surficial outwash granular deposits exist (e.g., immediately adjacent to the Grand River and eastward from the River through the Waldemar Heights residential area and further south and east from Waldemar Heights).

The Waldemar Heights geotechnical data indicates the water table aquifer beneath this area is no more than about 2 m thick. There may be greater saturated thicknesses in the outwash deposits south and east of Waldemar Heights or in the Grand River valley, however, there is no known data to confirm this.

In areas where the clayey silt till is found at surface (e.g., at the SPL property) no shallow aquifer exists, although the water table itself is found within the till, typically at a relatively shallow depth and seasonally variable.

Burnside (2001a) prepared a regional-scale interpretation of the water table throughout the Township (Figure 6, Appendix B). Although the elevations of the water table contours may not be precise at any particular location (given the regional scale), the pattern of the contours is considered to be a good indicator of the inferred shallow groundwater flow direction. Not surprisingly, in the Waldemar area, the inferred shallow groundwater flow mimics topography (i.e., in an easterly direction in the area west of the Grand River and in a westerly direction in the area east of the River). Across the SPL property, the shallow flow is north-easterly following topography before bending eastward toward the River. This is confirmed with water level data from the Terraprobe investigation (2015b).

3.3.2 Clayey Silt Till Aquitard

Where present, the clayey silt Tavistock Till (possibly combined with other older underlying tills) forms an aquitard, providing hydraulic separation between the water table (aquifer) and the deeper bedrock aquifer.

This aquitard is very substantial beneath the upland areas, owing to both its thickness and its clayey texture. As described in Section 3.2.1 and presented in Figure 2 (Appendix A) the majority of the +30 m of overburden in the southwest part of the SPL property, and extending to the south and west, is clayey aquitard material. Terraprobe (2015b) confirmed, through field testing of eight water table monitoring wells, that the upper portion of the aquitard across the SPL property has very low hydraulic conductivity (or permeability), in the $2x10^{-9}$ to $5x10^{-8}$ m/s range and with a mean of $1x10^{-8}$ m/s. The clayey aquitard beneath the east-side upland area, although not quite as thick near the three municipal wells (15-25 m), is expected to be similarly substantial based on the clayey texture.

Closer to the Grand River, the available well record data (Figure 2, Appendix A) indicate the aquitard conditions are more variable. The data in and south of Waldemar indicate much reduced aquitard thicknesses, typically 5 to 15 m and occasionally as much as 20 m or absent altogether. Further north along the River, the aquitard thickness ranges from 0 to 6 m. In such areas with reduced aquitard thickness there is considerably less protection afforded to the underlying bedrock aquifer.

3.3.3 Bedrock Aquifer

In the Waldemar area the bedrock aquifer is, for the most part, a 'confined' artesian aquifer; meaning that the water in the aquifer is under hydrostatic pressure, such that the 'potentiometric' water levels in the aquifer area rise to an elevation higher than the bedrock surface itself. The pressure and topography are sufficient to create 'flowing artesian' conditions at several wells in the area. This pressure is created by regional recharge to the bedrock aquifer and by the overlying clayey aquitard which 'confines' the aquifer by resisting the upward water pressure created by the regional recharge.

Burnside (2001a) prepared a regional-scale interpretation of the potentiometric surface of the aquifer throughout the Township (Figure 7, Appendix B). A potentiometric surface is similar to a water table contour map, but reflects the groundwater pressure from the deeper level. Although the elevations of the contours may not be precise at any particular location (given the regional scale), the pattern of the contours is considered to be a good indicator of the inferred groundwater flow direction in the bedrock aquifer. Not surprisingly, in the Waldemar area, the deep groundwater flow is toward the Grand River, which is the 'regional' discharge feature for all groundwater. Deep aquifer groundwater flow is, then, similar to flow in the shallow water table zone (i.e., in an easterly direction in the area west of the Grand River and in a westerly direction in the area east of the River).

4.0 GROUNDWATER USE

There is only one overburden well record in the Waldemar area; for a 10-foot deep well drilled in 1962 and located north of the Waldemar Heights subdivision. Notwithstanding this older well, the water table aquifer is generally not considered to be a viable aquifer for water supply due to its insufficient thickness and general lack of wells.

The Guelph and Amabel Formations, together, form a renowned regional bedrock aquifer used for water supply by many communities in the area (e.g., Guelph, Cambridge, Fergus-Elora, Grand Valley and Waldemar) and rural residences and farms.

4.1 AQUIFER GROUNDWATER QUANTITY

The quantities of groundwater available from the bedrock aquifer vary depending on location and depth within the aquifer. Where the water table aquifer or the Grand River directly overlie the bedrock, the capacity of the bedrock aquifer may be higher because of additional direct recharge, although in such instances the vulnerability to the groundwater becoming contaminated is greater.

Figure 2 (Appendix A) provides 'specific capacity' data for selected individual wells around Waldemar and the municipal wells in both Waldemar and Grand Valley. Capacities are simply the well yield divided by the total drawdown at that yield and over a particular pumping duration and are a good relative indicator of aquifer capability. For most private wells, drillers complete a one-hour capacity test (i.e., in gallons per minute per foot of drawdown or gpm/ft). The majority of private wells have one-hour capacities of 0.2 to 0.7 gpm/ft, considered to be more than adequate for individual residential wells, but not typically sufficient for a municipal well. Several of the deeper municipal wells in the area, including Waldemar Wells PW1 and PW3, the former ACC (Acchione) well and Grand Valley Wells GV2 and GV3, have higher capacities, in the 0.9 to 3.8 gpm/ft range. These higher capacities appear to correlate with the greater drilling depths of 76 to 117 m (250 to 385 feet); where the increased capacity appears to be gained by intersecting additional deeper water bearing zones. The 117-m deep Waldemar Well PW2 is the exception for deeper wells, with a more modest 0.3-gpm/ft capacity. Several relatively bedrock private wells located close to the Grand River (Figure 2, Appendix A) also have higher capacities of 1 to 5 gpm/ft; likely higher because of hydraulic connection to the shallow water sources.

The yields from well performance tests and/or the permitted pumping rates of larger production wells is another indicator of available groundwater quantity. Waldemar Wells PW1, PW2 and PW3 were tested and later permitted at rates of, respectively, 341, 273 and 318 L/min (75, 60 and 70 Imperial gpm), although PW1 and PW2 are currently operated at somewhat lower rates of 312 and 235 L/min (68.7 and 51.7 gpm) (DWCo Ltd., 2013). The former Acchione supply well and original 1981 test well were tested at rates of 227 and 273 L/min (50 and 60 Imperial gpm). In Grand Valley, municipal wells GV1 and GV2 area permitted at considerably higher rates of 1590 and 908 L/min (350 and 200 Imperial gpm) and GV1 was initially tested at a rate of 1020 L/min (225 gpm). GV3 was tested and later permitted at 454 L/min (100 Imperial gpm).

4.2 AQUIFER GROUNDWATER QUALITY

The water quality in the Guelph-Amabel aquifer is generally excellent, albeit with elevated hardness, which is common in most Southern Ontario hydrogeological settings.

2001 and 2003 water quality samples from the three existing municipal wells (Burnside, 2002, 2003) indicate very low concentrations of chloride (typically <10 mg/L) and nitrate (typically <1 mg/L), the two most common anthropogenic parameters (i.e., those introduced by man), as well as very low concentrations of iron (<0.1 mg/L), a problematic natural constituent if present at high concentrations. Other than hardness, the only natural constituent present in somewhat elevated concentrations is sulphate; at 150-270 mg/L in PW1 and lower at 75-100 mg/L in PW2 and PW3. The Ontario drinking water objective for sulphate is 500 mg/L, set for aesthetic reasons.

The former Acchione well had slightly elevated iron concentrations (approximately 0.2-0.3 mg/L, 2001) and a documented iron bacteria problem (Burnside, 2002). This well also had somewhat elevated sulphate; at about 300 mg/L in 2001.

In neighbouring Grand Valley, Burnside (2001b) indicates that the bottom 1.8 m of Municipal Well GV3 was grouted to reduce the initially elevated sulphate concentrations (580-610 mg/L) to a more acceptable concentration of about 400 mg/L. It is likely that the elevated sulphate originates from the deeper water bearing zones, which may indeed be part of the Clinton-Cataract formations given the 295-foot drilling depth. CVD has similar experience with elevated sulphate originating from the deeper water bearing zones in the Fergus-Elora area, at the bottom of Guelph-Amabel aquifer.

4.3 BEDROCK AQUIFER VULNERABILITY AND PROTECTION

Considerable effort has been made over the past approximately 15 years by municipalities in Ontario to better understand the source of groundwater that feeds its wells and the related matters of aquifer vulnerability, surface water influence and well head protection.

In Waldemar, these matters have been evaluated in detail (Burnside, 2001a, 2002, 2003, 2007 and 2010), particularly in relation to the three municipal wells (PW1, PW2 and PW3) located east of the Grand River and the former Acchione Well that had supplied some homes on the west side of the River. This work determined that the former Acchione Well was potentially influenced by shallow groundwater and/or Grand River water, while the wells on the east side of the River were determined to not obtain 'groundwater under the direct influence' of surface water (or GUDI). The apparent additional water contribution may well be the reason the 1987 Acchione Well and the original 1981 Acchione test well had higher well capacities compared to the existing Waldemar Heights wells (Figure 2, Appendix A). Ultimately, this work resulted in the decommissioning of the Acchione Well and the extension of municipal water from the Waldemar Heights system to the Acchione subdivision (Figure 1, Appendix A).

Figure 9 (Appendix B) presents a portion of Burnside's 2007 township-wide evaluation of bedrock aquifer vulnerability mapping, which is based on a number of hydrogeological factors including overburden texture and thickness. Not surprisingly, the upland areas underlain by clayey aquitard to both the east of the existing municipal wells and across, south and west of the SPL property have the lowest vulnerability rating, meaning these areas are the least susceptible to becoming contaminated from potential surface sources. Conversely, the areas along the Grand River valley have high to moderate vulnerability ratings, owing to the limited thickness of aquitard overlying the bedrock.

Detailed capture zone groundwater modelling was undertaken as part of the 2007 and 2010 assessments and has ultimately led to the delineation of the Waldemar Wellhead Protection Areas in the Grand River Source Water Protection Assessment Report (2012) and Plan (2015). Figure 4.6 (Appendix B) presents the resulting wellhead protection zones, extending eastward from the Waldemar wells and only a short distance westward toward the Grand River. A similar, but less extensive, capture zone / wellhead protection zone extends southwestward from Grand Valley municipal well GV3 (Figure 5.6, Appendix B).

5.0 EXISTING AND FUTURE WALDEMAR WATER SERVICING DEMANDS

5.1 EXISTING DEMANDS

The water usage from the existing Waldemar municipal system are summarized in several sources; Burnside (2010), the Grand River Source Water Protection Plan (2015), and DWCo Ltd. (2013).

Currently, the water demands for the serviced population of 342 are met by Wells PW1 and PW2, while Well PW3 is not currently being used and is considered to be a 'reserve' well (Burnside, 2010).

The MOECC permitted rates for Wells PW1, PW2 and PW3 (341, 273 and 318 L/min, respectively) equate to daily volumes of 491, 393, and 458 m^3/day. Wells PW1 and PW2 had average annual water taking amounts of, respectively, 52.0 and 34.6 m^3/day in 2009, and 60.0 and 54.4 m^3/day in 2012. The increased usage in 2012 occurred mostly in May to July, thus appears to be related to increased outdoor uses (e.g., watering). It is notable, that the higher 2012 average volumes represent only about 12% and 14% of the volumes allowed under the MOECC permits. However, the maximum daily volumes recorded in 2012 were 352 and 234 m^3/day, which represent a much greater proportion of the permitted amounts (72% and 60%).

The 2009 and 2012 total usages (86.6 and 114.4 m^3/day) is equivalent to average per capita usage of 0.25 and 0.33 m^3/day/person for the approximate 342 service population.

The capture zone modelling completed to establish the wellhead protection areas shown in Figure 5.6 (Appendix B) utilized long term average pumping rates of 61, 51 and 61 m^3/day for the three municipal wells (for a total rate of 173 m^3/day). This total exceeds the 2009 and 2012 average water takings by approximately 100% and 50%, respectively, suggesting that the existing wells have some additional capacity to meet increased average demands on the order of at least 60 m^3/day without affecting the wellhead protection plan.

5.2 FUTURE DEMANDS WITH SPL DEVELOPMENT

The theoretical water demand for the 334-lot SPL development was evaluated by Crozier (2015) using the MOECC 2008 Design Manual. The average-day demand was calculated to be about 5.22 L/s (or 451 m^3/day), based on Design Manual assumptions of 3 persons per household and 0.45 m^3/person/day usage. It is notable that this theoretical per capita usage exceeds the actual 2009 and 2012 per capita usage by about 80% and 36%, respectively. So, for the existing Waldemar residents, the 0.45 m^3/day theoretical usage is a very conservative assumption.

The maximum-day demand was calculated by Crozier to be 14.25 L/s (1240 m^3/day), which is based on the Design Manual multiplier of 2.75 times the average day for populations of 500-1000. With the future population of Waldemar being in the 1000-2000 range (i.e., including the 1002 residents in the SPL development), a multiplier of 2.5 is recommended in the Manual. The maximum-day demand with this slightly lower multiplier would be 13.0 L/s (1127 m^3/day).

With the same MOECC assumptions, the overall projected theoretical demands for the existing 342 residents and the 1002 prospective residents at the SPL development (i.e., 1344 total) are calculated to be 7 and 17.5 L/s (604 and 1512 m^3/day) for average and maximum-day demands.

6.0 ASSESSMENT OF ADDITIONAL SOURCE WATER SUPPLY

The ability for a municipal water system to meet the required water demands is generally based on considering: a) the permitted source supply rates, b) the theoretical maximum-day demands, and c) assuming that the highest capacity source supply (or individual well) is not available for use at the time the maximum-day demand is required. This is considered a very conservative approach, especially considered the recent water usage is considerably lower than the theoretical demands. Nevertheless, for Waldemar, with removal of the permitted PW1 source (491 m^3/day), the remaining existing wells PW2 (393 m^3/day), and PW3 (458 m^3/day) have a combined permitted source supply of 851 m^3/day.

In consideration of the 851-m^3/day source water supply from PW2 / PW3 and the future theoretical demand of 1512 m^3/day described in Section 4.2 (i.e., including the existing residences and the SPL residences), it is projected that an additional 661 m^3/day of source water supply would be necessary to service the expanded Waldemar community. This assumes using some of the existing source water 'surplus' and no other population growth or other development additions within the community that would use the surplus.

Based on the typical municipal well yields in the Waldemar area (393-491 m^3/day), it is expected that two additional wells would be necessary to meet the additional 661 m^3/day (equal to 7.7 L/s or 101 Imperial gpm) of source water supply. While it is possible that a single higher-yield well, such as Grand Valley Well GV3 (tested and permitted for 7.6 L/s or 100 gpm) could meet the required demands, such a well would become the highest yielding well in Waldemar and then be eliminated from the source water supply calculation for maximum-day demand. As a result, a minimum of two wells would be required regardless. However, even if typical average yields of 400 m^3/day, two wells would provide some additional surplus water to handle some future growth and/or connection of some additional private residences that are currently on private wells.

6.1 OTHER CONSIDERATIONS FOR ADDITIONAL SOURCE WATER LOCATIONS

There are several other important matters that should be considered when securing additional source water supply for Waldemar. Some of these are hydrogeological in nature, while others relate to engineering or servicing. The following is a list of these key matters.

1) Minimize competition with the existing source water supplies (i.e., Wells PW1, PW2 and PW3).

2) Avoid altering existing source water wellhead protection areas, which are based on a maximum water taking from the existing source water supplies.

3) Avoid potential interference with existing private wells (i.e., maximize separation from as many private wells as possible).

4) Optimize use of the hydrogeological setting and/or other factors to maximize source water protection for the new sources (e.g., select locations with considerable aquitard protection and appropriate distances from land uses with potential contaminant sources, such as a 100-m minimum distance from agricultural sources).

5) Minimize need to alter the existing infrastructure that already meets current requirements (e.g. existing watermain and storage reservoir sizes).

6) Maximize opportunities to improve existing water distribution and supply quality (e.g., remove possible watermain stagnant zones).

7) Optimize use of the existing source water supply 'surplus' to meet the SPL development water requirements, to the extent possible and safely attainable.

8) Maximize the opportunity to secure source water 'redundancy' for Waldemar (i.e., by having separate water source areas, a future problem in one source water area can be addressed with temporary increased use of the other area).

9) Recognize that drilling depth in the bedrock aquifer should be optimized to maximize source water quantity and minimize the possibility of encountering elevated sulphate.

6.2 RECOMMENDED APPROACH FOR ADDITIONAL SOURCE WATER SUPPLY

On the basis of above considerations and the required demands for the proposed SPL development, it is recommended, pursuant to SPL development planning approval, that a test well drilling program be conducted in the southwest portion of the SPL property (see prospective locations in Figure 2, Appendix A). The final drilling locations should be selected after due consideration is given to other matters such as land allocation for other purposes and with appropriate input from the Township and its consultants.

The recommended area would: a) maximize aquitard protection, b) maximize distance from the Grand River and potential surface water influence, c) maximize the distance from most existing private wells, d) provide a totally separate source water area that has little chance for competition with the existing source water area, e) provide source water redundancy in the event of a future problem with one source area, f) limit the potential for modifications to the existing infrastructure, and g) provide opportunity to improve east-west water distribution.

Respectfully submitted,
CHUNG & VANDER DOELEN ENGINEERING LTD.

William (Sandy) Anderson, M.Sc., P.Eng.
Senior Hydrogeologist and Engineer

7.0 REFERENCES

The following documents, maps, or other publications have been used in the preparation of this report.

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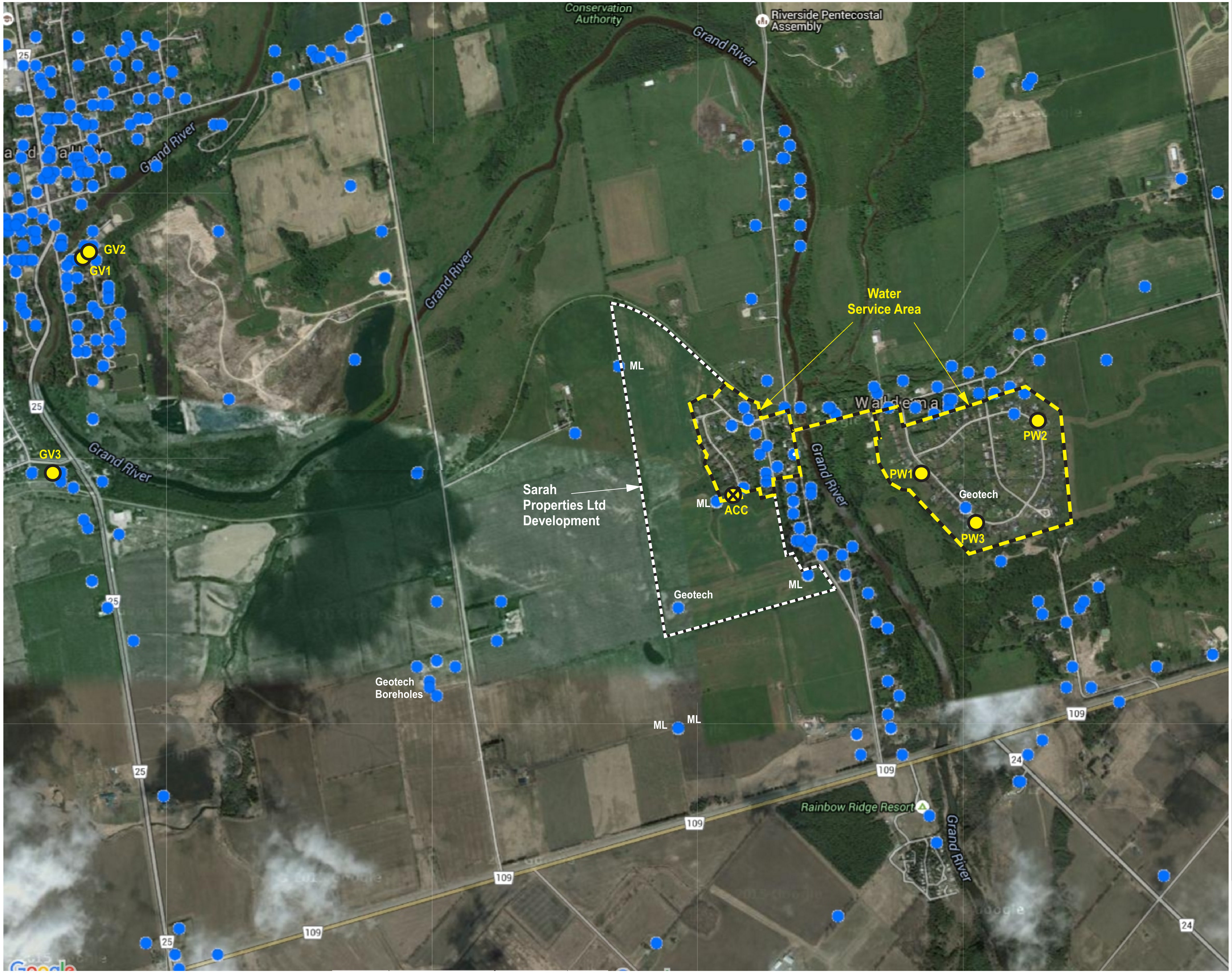
APPENDIX A
Figures 1 and 2



LEGEND

●	MOECC Water Well Record (Feb 8 2016 On-Line Mapping) (Note: Locations May Be Imprecise)
● PW1	Municipal Pumping Well (Correct Locations)
⊗ ACC	Decommissioned Former Acchione Municipal Well
● ML	Mis-Located Well on MOECC Map

N

Source: Google Maps (June 2015) & MOECC Well Record Database (Feb 8 2016)

0 500 1000 m

Figure 1
2015 Air Photo & Water Servicing Status

Groundwater Supply Feasibility Assessment
Sarah Properties Development, Waldemar

Drawn By: SA	Date: May 27 2016	File No.: H16033

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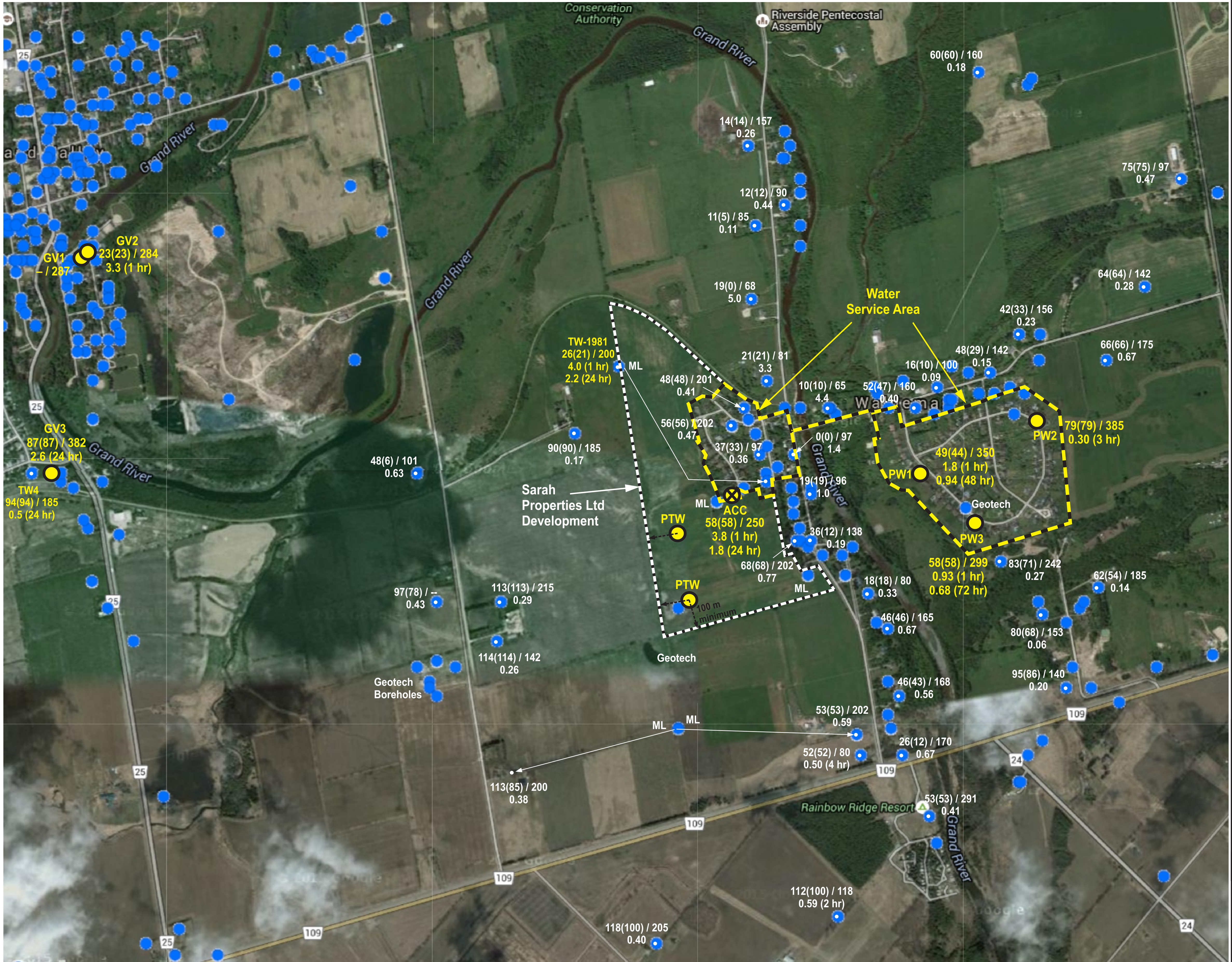

LEGEND

●	MOECC Water Well Record (Feb 8 2016 On-Line Mapping) (Note: Locations May Be Imprecise)
● PW1	Municipal Pumping Well (Correct Locations)
⊗ ACC	Decommissioned Former Acchione Municipal Well
● ML	Mis-Located Well on MOECC Map
● TW-1981	Test Well for Municipality
● PTW	Prospective Test Well Locations for Sarah Proeprties Development
58(58) / 250 3.8 (1 hr)	Overburden (Clayey Material) Thicknesses / Total Well Depth (feet) Well Capacity (gpm/ft) (Test Length) From Well Record or Pumping Test (Note: Test Length 1 hour unless indicated otherwise)

Source: Google Maps (June 2015) & MOECC Well Record Database (Feb 8 2016)

0 500 1000 m

Figure 2
Selected Well Data

Groundwater Supply Feasibility Assessment
Sarah Properties Development, Waldemar

Drawn By: SA	Date: June 17 2016	File No.: H16033

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APPENDIX B
Figures from Background Sources