



May 29, 2019

1571145 Ontario Limited
c/o Kirkness Consulting Inc.
1647 Cedar Creek Crescent
London, Ontario
N5X 0C8

**Reference: Geotechnical Design Brief
22447 Komoka Road, Municipality of Middlesex Centre**

This letter provides geotechnical overview on the feasibility of a future residential condominium development occurring at the property located at 22447 Komoka Road, in the hamlet of Komoka. The site is approximately 5.91 ha (14.6 acres) in size, and is bordered to the north by commercial land-uses, to the east by Komoka Road, to the west by a residential development and large pond area, to the south by a residential property and a pond area connected to the lands to the west. The site is occupied in part by a separate large pond which occupies the south end of the site, and relatively flat plateau area which has potential to accommodate future development at the site.

A Key Plan is provided below (refer to Figure 1), for reference.

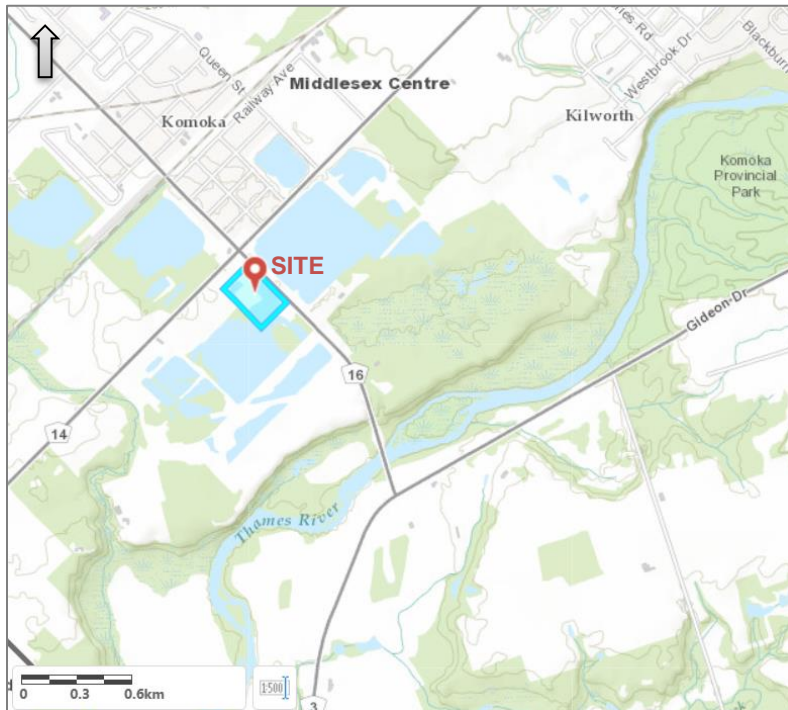


Figure 1: Key Plan

Legal Description: Concession 1
North, Part Lot 4, Geographic
Township of Lobo

Image Source: Middlesex County
online mapping, May 2019
www.maps.middlesex.ca,

LDS visited the site on March 21, 2019 to review the current site conditions. Under current conditions, the developments along the north and northwest sides of the subject property have two stormwater outlets for treated water, which drains to the existing pond onsite. The Municipality also has an untreated stormwater outlet located on the east side of the subject property, which discharges into the existing pond onsite. Drawing 1 (appended) shows existing site features, for reference.

Very little run-off occurs at the site during/following rain events. Much of the site has grass cover, and at-source infiltration into the natural subgrade soils occurs throughout.

LDS participated in a pre-consultation meeting (March 26, 2019) with Municipality of Middlesex Centre staff, Upper Thames River Conservation Authority staff, the landowner/developer and members of the consulting team working on the file. In preparing this Geotechnical Design Brief, LDS has had regard for the geotechnical and hydrogeological items discussed during the pre-consultation meeting and in supplemental email correspondence, and has reviewed the Planning Justification Report prepared by Kirkness Consulting Inc., dated May 2019. A copy of the pre-consultation notes and email correspondence are provided with the aforementioned Planning Justification Report.

The comments provided in this document are based on a review of published resources (including geological mapping, topographic mapping, water supply well records), input from the property owner regarding site characteristics, and our familiarity with soil and groundwater conditions in the area. At this time, a site-specific field program of boreholes or test pits has not been completed.

1. Document Review

Review of Geological Mapping

The physiography and distribution of surficial material in the County of Middlesex are primarily the result of glacial activity that took place during the Late Wisconsinan approximately 23 000 to 10 000 years before present. The study area was subjected to oscillating ice margins and multiple ice lobes that have produced a complex suite of tills with distinct properties. The repeated advance and retreat of the ice lobes along with fluctuating lake levels and associated fluvial activity during this time have shaped the landscape.

Select geological mapping and publications were reviewed for the purposes of reviewing regional characteristics for soil conditions in the Komoka area. Findings are summarized below, for reference.

Source Mapping	Summarized Findings
Quaternary Geology mapping for the London area (Ontario Division of Mines, Quaternary Geology Lucan Area, Scale 1:50,000, Preliminary Map P1048, 1975).	The Quaternary Geological survey mapping indicates that the site is located near the border of a glaciofluvial outwash deposits (characterized by sand, gravel, and deltaic deposits for lands within, south and west of the hamlet of Komoka), and Rannoch Till (characterized by silt and clayey silt deposits for lands to the north and east of the hamlet of Komoka).
Physiographic mapping for Southwestern Ontario (Chapman, L.J. and Putnam, D.F. 2007. Physiography of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 228).	The Physiographic mapping identifies that the site is located within the central part of the Physiographic Region known as the Caradoc Sand Plains and London Annex. The mapping indicates that the subgrade soils in the area generally consist of coarse-textured glaciolacustrine deposits. These soils are expected to be predominantly comprised of sand and gravel, with minor silt and clay.

Source Mapping	Summarized Findings
Aggregate Resources Inventory of the County of Middlesex and the City of London, Southern Ontario, Ontario Geological Survey, Aggregate Resources Inventory Paper 78, 2016	Coarse-grained sediments were deposited in the meltwater channels following the present-day valleys of the Thames River and its tributaries. The significant size and thickness of the delta deposits in the Komoka area makes them a significant source of aggregate in the region. Aggregate operations at the site were carried out under license by Johnston Bros. (Bothwell) Limited, and primarily involved dredging activities to extract glaciolucustrine deltaic sands and sand and gravel material, extending below the stabilized groundwater level.
Bedrock Geology of Ontario. Ontario Geological Survey, Miscellaneous Release Data 126, 1:250 000 scale, Revised 2006.	The map reveals that the bedrock in the general area consists of limestone, dolostone and shale from the Hamilton Group. The Hamilton Group (from the middle to lower Devonian period) is characterized by limestones, dolostones, and shale, which can be upwards of 15 m thick, as documented in portions of Middlesex County.

The quality of granular material in the region has resulted in the Komoka area being a primary aggregate resource over the years. This is apparent from the number of open ponds which remain in the region, as a result of aggregate extraction below the stabilized groundwater level, and directly contributes to the conditions observed in the south end of the property.

Review of Water Supply Well Records

A review of local well records available through the Ministry of Environment, Conservation, and Parks (MECP) for this area was carried out to review the water levels recorded in the nearby wells. Drawing 2 (appended) shows the location of the wells (with corresponding Well Registration No.) which are in close proximity to the site.

The majority of the water supply wells in the area are set into shallow unconfined or intermediate overburden aquifers at depths ranging from 4.6 to 19.8 m. Static water levels in these water supply wells are generally reported at depths ranging from 2.5 to 6.1 m. There is no indication that artesian groundwater conditions are present in the area.

A summary of the water supply wells is provided in the following table.

MECP Well ID	Register Date	Depth (m)	Water Found (m)	Static Level (m)	Pump Rate (L/min)	Northing	Easting
Water Supply							
4100870	04/04/1967	5.2	3.0	3.0	19.0	4755123.00	464983.50
4100871	05/04/1967	31.1	31.1	3.0	38.0	4755063.00	464913.50
4100878	07/11/1967	4.6	3.0	3.0	19.0	4754983.00	464673.50
4100880	09/11/1967	4.6	2.4	2.4	15.2	4755183.00	464853.50
4105839	17/04/1972	4.9	3.7	3.7	22.8	4755093.00	464833.50
4107164	21/02/1975	19.5	16.5	4.6	38.0	4755043.00	464513.50
4107338	07/08/1975	16.8	15.2	4.6	30.4	4755023.00	464553.50
4107397	24/09/1975	19.8	16.8	6.1	30.4	4754963.00	464613.50
4107435	10/10/1975	9.4	4.6	4.6	38.0	4755183.00	464833.50
4107742	16/07/1976	9.1	3.7	3.0	30.4	4754933.00	464593.50
4107743	12/05/1976	39.6	4.3	2.4	38.0	4754863.00	464693.50
4107826	15/11/1976	19.5	18.0	4.3	30.4	4754993.00	464563.50
4108139	01/08/1977	10.1	3.7	NR	1900.0	4754303.00	464373.50
4109064	28/08/1979	6.4	3.7	3.7	15.2	4755123.00	464953.50
4109430	15/12/1980	9.1	3.0	2.4	68.4	4754823.00	464733.50
4109675	05/04/1982	11.0	5.5	6.1	38.0	4755023.00	464913.50
4109757	05/10/1982	16.5	15.8	6.7	38.0	4755163.00	464773.50
4110349	09/08/1985	7.9	3.7	3.4	45.6	4755023.00	464793.50
4110661	03/04/1986	9.1	3.0	3.0	76.0	4754903.00	464643.50
4110717	23/01/1986	9.1	6.4	3.0	190.0	4754288.00	464353.50
4110828	13/04/1987	7.0	3.0	3.0	475.0	4754233.00	464408.50
4110872	01/07/1984	15.5	7.3	4.0	26.6	4755018.00	464993.50
4111133	30/10/1987	5.2	4.6	4.6	30.4	4755063.00	464948.50
4111787	12/07/1989	8.5	2.4	2.4	95.0	4754682.00	464486.50
4111886	28/04/1989	8.8	4.3	2.4	95.0	4754900.00	464868.50
4111887	03/01/1989	8.8	3.0	2.7	76.0	4754980.00	464773.50
4114635	30/08/2000	7.9	2.4	2.7	45.6	4754418.00	465124.00
Observation Wells							
7041428	25/01/2007	4.6	2.8	NR	NR	4754840.00	464811.00
7196652	18/09/2012	4.9	3.7	NR	NR	4754730.00	464788.00
7196653	18/09/2012	6.1	3.8	NR	NR	4754767.00	464798.00
7196654	18/09/2012	6.1	3.5	NR	NR	4754756.00	464835.00
7277015	07/11/2016	3.8	NR	NR	NR	4755144.00	465003.00
7290102	24/05/2017	4.6	NR	NR	NR	4754819.00	464839.00
7290103	24/05/2017	4.6	NR	NR	NR	4754819.00	464785.00
7290104	24/05/2017	4.6	NR	NR	NR	4754631.00	464832.00
Abandoned							
4107741	15/07/1976	24.4	NR	NR	NR	4754943.00	464633.50
7117938	10/10/2008	NR	NR	NR	NR	4754593.00	464570.00
7246709	08/07/2015	7.3	NR	5.2	38.0	4755117.00	464789.00

Shallow Groundwater Conditions

The shallow water supply wells noted in the previous section are set into an unconfined aquifer. The shallow nature of this aquifer in the hamlet of Komoka is also apparent from the number of open ponds (resulting from former and active aggregate extraction operations) in the area.

In recent years, earthworks activities (berm construction) by the owner of 22393 Komoka Road on the subject lands have resulted in changes to the natural drainage between the ponds on the subject lands and neighbouring lands, and interruption/partial blockage to the outlet of the neighbouring pond, resulted in water levels increasing within the subject lands. This activity at the site and in proximity to the site demonstrates the reactive nature of the stabilized groundwater level.

2. Geotechnical Comments

The proposed development at the site is expected to include the construction of two multi-storey (2 to 5 storey) residential buildings, with local roadways and municipal servicing. Underground parking is not planned for the site. Surface car parking is expected to be predominantly located along the north side of the site, closest to the existing commercial lands. A local roadway within the site is expected to access Komoka Road, provide access to site parking, and may connect to the existing site pavements and private roadway on the lands to the north. A Conceptual Site Layout is provided on Drawing 3, and Preliminary Site Plan is provided on Drawing 4 for reference.

The following geotechnical comments are provided from a preliminary standpoint, regarding the various aspects of the proposed development.

Site Preparation

It is understood from the landowner that some fill placement has occurred in the north end of the site, to create the level plateau that exists through that part of the site. The fill placement has not been engineered or certified from a geotechnical perspective; therefore, future geotechnical fieldwork at the site will be required to assess the quality and consistency of the existing fill.

Fill material containing building debris and / or topsoil and organic inclusions is generally not expected to be suitable to support new building foundations, infrastructure or local roadways. Offsite disposal of these soils (if required) will require analytical testing, in accordance with MECP Guidelines and classification requirements for transport and disposal. The testing requirements for disposal will depend on the requirements outlined by the receiver.

Where exposed subgrade soils are approved by the geotechnical consultant, and in areas where grades need to be raised to reach design elevations, it is anticipated that grades will be restored using structural / engineered fill. In accordance with the Ontario Building Code (Section 4.2.4.15), foundations may be set on fill material provided that it can be demonstrated that the fill is capable of safely supporting the building and that detrimental movement of the building will not occur. In this regard, it is recommended that any fill material placed in future building footprints be engineered and verified through an inspection and testing program to verify that suitable materials are used, and to confirm that suitable levels of compaction are achieved.

Engineered fill material should be placed in maximum 300 mm (12 inch) thick lifts and uniformly compacted to 100 percent Standard Proctor Maximum Dry Density (SPMDD). For best compaction results, the fill material should have a moisture content within about 3 percent of optimum, as determined by Standard Proctor testing.

An existing drainage channel (downstream of the stormwater outlets for the lands to the north and northwest of the property) crosses the plateau area and drains stormwater run-off to the onsite pond. As part of the development, it is anticipated that the existing ditch will be rerouted, or diverted through a series of pipes, to

provide clearance for the proposed buildings. The open channel should be properly decommissioned, including removing sediment build-up and restoration to design grades with approved fill material. Geotechnical oversight, including inspection and testing will be required for this work.

Site Excavations and Groundwater Control

All work associated with design and construction relative to excavations must be carried out in accordance with the Occupational Health and Safety Act (OHSA). Based on the documented sand and gravel soils and fill material which is expected to be present in the area, and in accordance with Section 226 of Ontario Regulation 213/91, the soils are generally classified as Type 3 soil above the stabilized groundwater level. Excavations which extend through or terminate in Type 3 soil, temporary excavation side slopes must be cut back at a maximum inclination of 1H:1V from the base of the excavation.

In the event that construction occurs in seasonally wet conditions or when frozen soil conditions are present, care will be required to maintain safe excavation side slopes, and suitable excavation bases. The contractor should use a reasonable effort to direct surface run-off away from open excavations. It should be noted that, if wet seams or zones are encountered, some sloughing may be expected.

Where excavations extend below the stabilized groundwater level, soils are expected to behave as a Type 4 soil, with sloughing occurring and slopes requiring a maximum gradient of 3H:1V or flatter. Excavation support should be anticipated to provide safe and stable excavations for workers. Further, excavation support and cut-off systems may need to be considered to limit water from entering the excavations, and to limit the amount of groundwater pumping required for the construction.

It should be noted that for projects requiring positive groundwater control with a removal rate in excess of 50,000 litres per day, a submission to the Environmental Activity and Sector Registry (EASR) will be required, and a Permit to Take Water (PTTW) will be required for volumes in excess of 400,000 litres per day. The dewatering volumes are subject to seasonal variations in the water table, and will also vary depending on the construction staging. The water-bearing sand soils have a moderate to high soil permeability.

It is understood that the developer intends for the new buildings to be set at a suitable elevation for building foundations to remain above the stabilized groundwater level. The geotechnical and hydrogeological assessment for the property will determine the stabilized groundwater level, and anticipated seasonal fluctuation. However, anecdotally, it is understood that water levels in the ponds have not varied much more than 0.5 to 0.6 m over the past few years.

Building Foundations

As noted above, subgrade soils in the area of the future buildings will need to be assessed to determine their suitability to support new building foundations. This will be determined through the geotechnical investigation for the site. In the event that the existing fill thickness, composition or consistency is not deemed to be suitable to support new building foundations, and if it is not deemed practical to (partially) excavate, replace or recompact the soils to support new buildings, consideration may be given to supporting future buildings on a deep foundation system set on the underlying natural undisturbed subgrade soils.

The undisturbed natural subgrade soils which are in a compact to dense state in the Komoka area can typically support building foundations with a design net bearing pressure in the range of 200 to 325 kPa, without significant subgrade improvement required. The soil bearing capacity (including serviceability limit state – SLS, and ultimate limit state – ULS) will be verified as part of the geotechnical investigation to support the proposed development.

Engineered fill should consist of suitable, compactable, inorganic soils, which are free of topsoil, organics and miscellaneous debris. Any material proposed for use as engineered fill must be examined and approved by the geotechnical consultant, prior to use onsite.

In the event that construction occurs in seasonally wet conditions, care will be required to maintain safe excavation side slopes, and suitable excavation bases. Site grades should be maintained during area grading activities to promote drainage, to minimize ponding of surface water on the engineered fill mat and to direct surface run-off away from the excavation. Rutting by construction equipment should be kept to a minimum, where possible.

Seismic Design Considerations

Multi-storey building must be designed in accordance with the Ontario Building Code, and site characterization for seismic response will be required from a geotechnical standpoint. Based on the geological mapping and our experience with soil conditions in the general area, the natural, undisturbed subgrade soils, in a compact to dense state are generally expected to be considered to be Site Class C or Site Class D, based on Section 4.1.8.4 and Table 4.1.8.4.A of the Ontario Building Code.

Confirmation of the Seismic Site Classification can be provided when the field program for the Geotechnical Investigation is complete, so that it can be incorporated into the building design, as appropriate

Site Pavements

The development is expected to be accessed via an internal roadway connecting to Komoka Road. It is anticipated that site pavements (including curbs and sidewalls) can be constructed following typical construction practices.

Once the site preparation work is completed, the exposed subgrade soils within the roadways are expected to be comprised of re-compacted soils. The road subgrade should be thoroughly proof-rolled and reviewed by the geotechnical consultant. In the event that loose or soft areas are noted, additional work may be required to sub excavate and replace unstable soils with suitable compactable material. In general terms, subgrade soils supporting site pavements should be compacted to a minimum level of 98 percent SPMDD.

Good drainage provisions will optimize pavement performance. The finished pavement surface should be free of depressions and should be sloped (preferably at a minimum grade of two percent) to provide effective surface drainage.

Recommendations and Next Steps

The Municipality and Conservation Authority have identified the need for a Geotechnical Investigation and Hydrogeological Assessment to support the proposed development. Once planning approvals are secured, it is recommended that scoping of the geotechnical and hydrogeological field program be completed, in consultation with the relevant approval authorities to ensure that the potential issues and concerns related to the proposed development can be adequately assessed and to provide technical guidance to inform the detailed design elements of proposed development.

At a minimum, the Geotechnical Investigation to be completed at the site should include the following elements:

- A summary of soil and groundwater conditions observed in sampled test holes, including detailed borehole logs and stabilized groundwater measurements;
- The results of any laboratory testing used to characterize the soil conditions at the site;
- Geotechnical comments and recommendations for the following:
 - Site Preparation, including subgrade preparation, re-use of onsite soils (if appropriate) and engineered fill placement;
 - Excavations, including excavation support recommendations;
 - Groundwater Control, including typical dewatering operations, and any operations which may be expected to require permitting (EASR or PTTW) from MECP;

- Foundation design, including soil bearing capacity, allowable settlements, frost protection requirements;
- Basement and/or concrete slab on grade construction, including lateral earth pressures, r foundation wall backfill and underfloor fill, modulus of subgrade reaction;
- Foundation drainage and waterproofing/damproofing recommendations;
- Elevator pit/shaft recommendations, including water-proofing and buoyancy recommendations, if required;
- Site servicing installation, including recommendations for pipe bedding, trench backfill and suitability of excavated soils for re-use;
- Seismic design considerations;
- Site Pavements, including recommended pavement component thicknesses and the need for pavement subdrains (if applicable);
- Recommendations for sediment and erosion control measures at the site, to prevent uncontrolled sediment discharge/release into the open pond area; and,
- Recommendations for inspection and testing to provide geotechnical certification of the construction.

As part of the scoping procedure for the Hydrogeological Assessment, an understanding of the stormwater management strategy for the village of Komoka is required. A number of options are currently being considered for the area, however a commitment has not been provided as to when a preferred strategy will be selected or implemented. Based on anecdotal evidence from the landowner, and consistent with the characteristics of allow unconfined aquifers, shallow groundwater conditions can be highly reactive to changes in water levels within the ponds, which can be influenced by a number of factors. If the preferred SWM strategy for the village of Komoka involves increasing flows directed into the existing pond, the stabilized water level at the site may be altered to accommodate the increased flows. Similarly, if downstream outlets for the pond or other downstream features restrict the natural flows which occur, this can also impact the stabilized groundwater level at the site. Similarly, groundwater quality will be influenced by changes in the stormwater being directed to the pond. The scope of the work must be appropriate to characterize the groundwater conditions with regard to the details of the proposed development, to accurately identify constraints (if applicable) and to incorporate suitable recommendations for site specific SWM design and infiltration opportunities.

There is a significant benefit to having as much information as possible available about the preferred stormwater management strategy for the site when scoping the field program for the hydrogeological work at the site. LDS would be pleased to assist in preparing scoping documents for review and consideration by all parties, when planning approvals are secured.

Monitoring wells installed at the site to monitor stabilized groundwater levels must be installed in accordance with the requirements of Ontario Regulation 903. This regulation identifies that only certified and qualified well drilling technicians are permitted to direct the installation of wells, in accordance with the Ontario Water Resources Act. When wells are no longer deemed to be required, they should be decommissioned in accordance with the same regulation. Decommissioning a well which is no longer in use helps to ensure the safety of those in the vicinity of the well, prevents surface water infiltration into an aquifer via the well, prevents the vertical movement of water within a well, conserves aquifer yield and hydraulic head and can potentially remove a physical hazard.


Closing

The format and content of this letter has been guided to address specific client needs. LDS has provided this document to provide a geotechnical overview on the proposed development and to comments on the feasibility of developing the site.

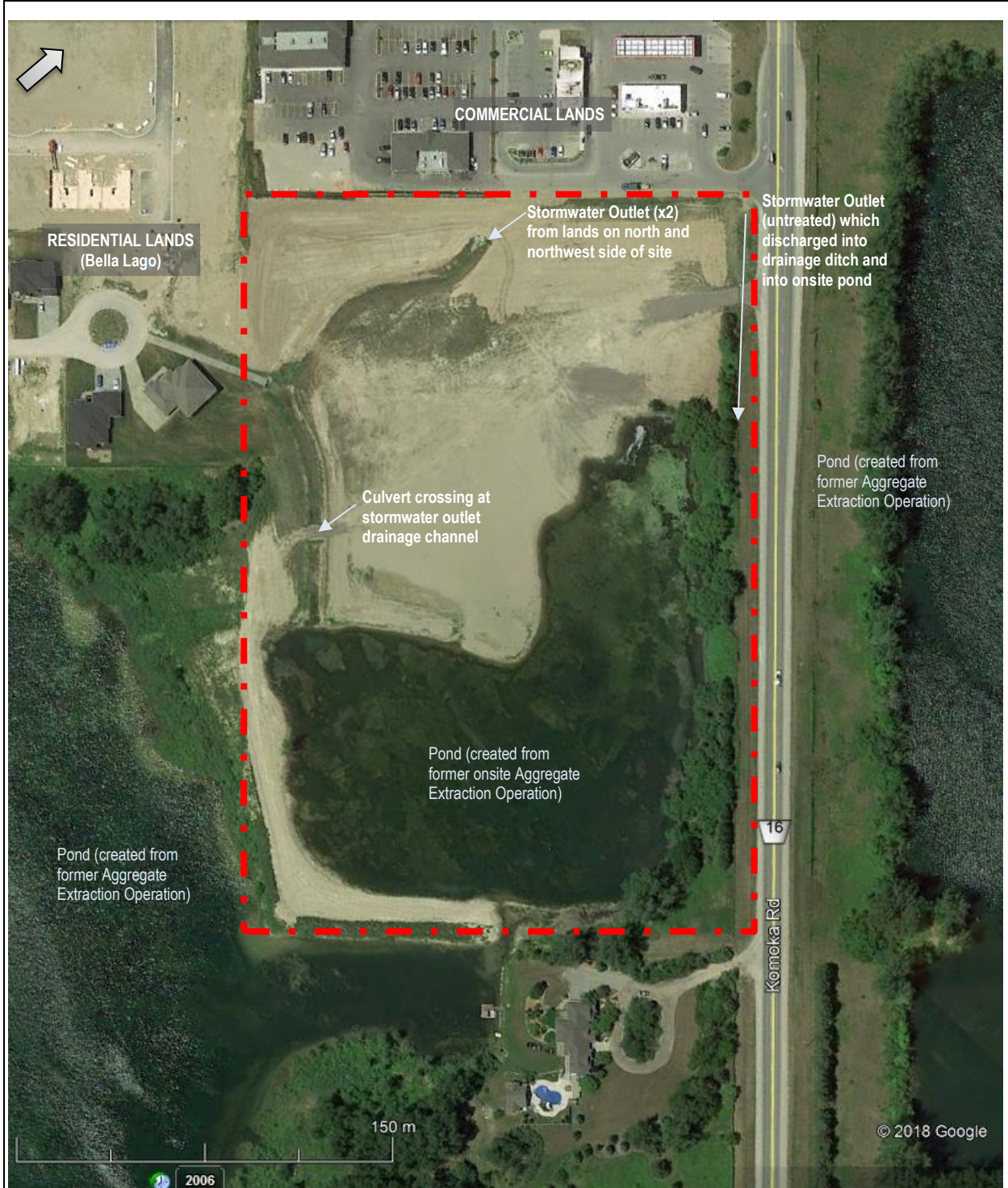
Based on our review of the available published information, and our understanding of the soil and groundwater conditions which are typical for the area and anticipated at the site, it is our opinion that the north part of the site is suitable for future development. The existing pond in the south part of the site provides a beneficial amenity space, and also provides an opportunity to supplement the stormwater design elements of the site.


Respectfully,

LDS CONSULTANTS INC.




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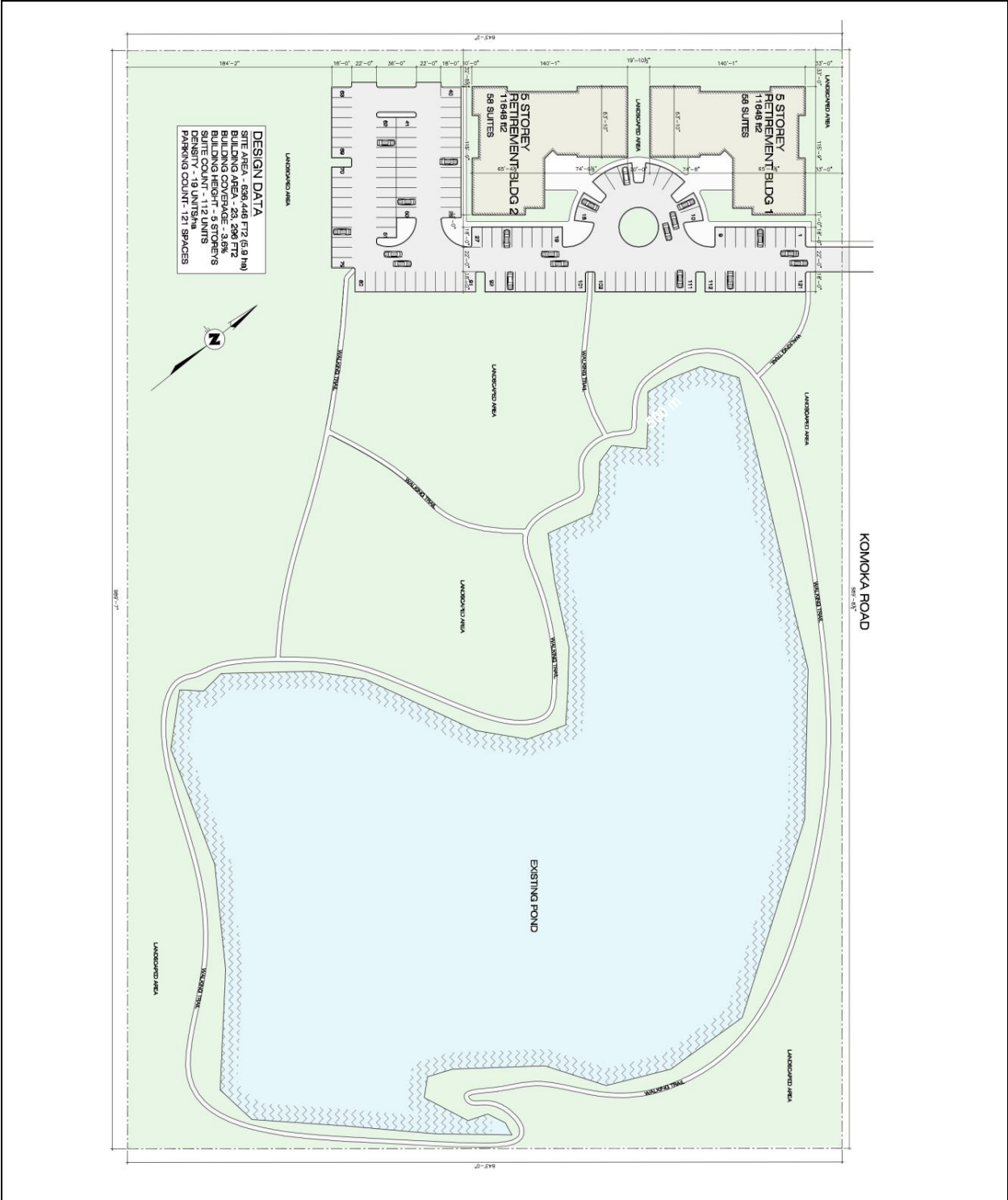



PROJECT NAME Geotechnical Design Brief	PROJECT LOCATION 22447 Komoka Road, Komoka	SCALE As Shown	PROJECT NO. GE-00240
	DRAWING NAME Site Features	DATE May 2019	DRAWING NO. 1




Legend
 ● MECP Well

PROJECT NAME Geotechnical Design Brief	PROJECT LOCATION 22447 Komoka Road, Komoka	SCALE As Shown	PROJECT NO. GE-00240
	DRAWING NAME MECP Well Record Location Plan	DATE May 2019	DRAWING NO. 2



<p>PROJECT NAME Geotechnical Design Brief</p>	<p>PROJECT LOCATION 22447 Komoka Road, Komoka</p>	<p>SCALE As Shown</p>	<p>PROJECT NO. GE-00240</p>
	<p>DRAWING NAME Conceptual Site Layout Plan (prepared by others)</p>	<p>DATE May 2019</p>	<p>DRAWING NO. 3</p>



PROJECT NAME Geotechnical Design Brief	PROJECT LOCATION 22447 Komoka Road, Komoka	SCALE As Shown	PROJECT NO. GE-00240
	DRAWING NAME Preliminary Site Plan (prepared by Zedd Architecture)	DATE May 2019	DRAWING NO. 4