DRAFT

REPORT

Geology and Hydrogeology Existing Condition Report - Preliminary Draft

Walker South Landfill Phase 2 Environmental Assessment

Submitted to:

Walker Environmental Group

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1 INTRODUCTION

This report provides an overview of the existing geology and hydrogeology conditions within the study areas for the South Landfill Phase 2 Environmental Assessment (EA). The Minister of the Environment, Conservation and Parks (Minister) Approved Terms of Reference (ToR) for the EA included a preliminary description of the existing environmental conditions and made a commitment to expand upon this description during the EA.

Walker Environmental Group (Walker) initiated a Comprehensive EA under the Ontario EA Act seeking approval to expand the capacity of its existing South Landfill located at the Walker Resource Management Campus (Campus) in Niagara Falls. The South Landfill is an essential component of Walker's Campus since it began operating in 2009 under Environmental Compliance Approval (ECA) No. 008-78RKAM, as amended, and provides safe, reliable, and affordable disposal capacity for solid, non-hazardous waste from residential and industrial, commercial, and institutional (IC&I) sources to its customer base within the City of Niagara Falls, the Regional Municipality of Niagara, and the Province of Ontario. The South Landfill's total approved disposal capacity is 17.7 million m^3 and is expected to reach maximum capacity by 2029 to 2031.

The proposed Phase 2 of the South Landfill would extend its approved capacity by approximately 18 million m^3 over a 20-year period, ensuring Walker can continue to provide essential residual waste disposal services to its existing customer base. Walker is proposing to locate the additional disposal capacity (Phase 2) to the east of the existing South Landfill within the area currently occupied by Walker's Southeast Quarry. The proposal would maintain the existing landfill service area, as well as the annual volume of solid, non-hazardous waste from the sources currently accepted.

The EA Act requires that proponents describe the environment that may potentially be affected or may reasonably be expected to be affected, directly or indirectly, by the Alternative Methods of Carrying Out the Undertaking (Alternative Methods) proposed as part of an EA. The description of the existing environmental conditions will provide the baseline for the assessment of potential effects for the proposed Undertaking, which will be conducted during the EA. This report focuses on characterizing the existing conditions within the study areas for the South Landfill Phase 2 EA for geology and hydrogeology.

2 STUDY AREAS

From a geology and hydrogeology perspective, the characterization of existing conditions within the following study areas are appropriate to this EA:

- Site Study Area (SSA), including all lands (76.12 ha) owned and operated by Walker that are within the existing approved boundaries of the Southeast Quarry;
- Local Study Area (LSA), including all lands within a one (1) km radius to the east, south, and southwest of the Walker Campus, which includes the SSA, and bounded by the Welland Canal and the Niagara Escarpment to the north and northwest of the Campus; and
- Regional Study Area (RSA), including all lands bounded by the Welland River to the south, the Welland Canal to the west, the Niagara Escarpment and specifically the Lockport and Rochester Formation bedrock subcrops to the north, and the Queenston-Chippewa Hydro Canal to the east.

The current extent of influence from the Campus, including the SSA, on the geology and hydrogeology setting are contained within the LSA. Characterization of the SSA and LSA completed as part of this study provides baseline conditions for evaluating the predicted effects of the proposed South Landfill Phase 2 on groundwater flow and quality. The RSA provides a generalized characterization of geology and hydrogeology conditions beyond the influence of the Campus, but within the active domain of the numerical model used for predictive modelling to support the Alternative Methods evaluation.

The geology and hydrogeology study areas are illustrated on **Figure 2-1**.

3 METHODOLOGY

Available secondary sources of information were collected and reviewed to characterize geologic and hydrogeologic existing conditions within the study areas. The following sources of secondary information were collected and reviewed:

- Annual Compliance Monitoring reports for the Walker South Landfill, East Landfill, West Landfill and Southeast Quarry situated within the Campus.
- Published maps and reports from the Ontario Geological Survey.
- Available site-specific hydrogeology, geology and geotechnical reports from within the Study Areas.
- Niagara Peninsula Conservation Authority (NPCA) published source protection and watershed reports, databases and mapping.
- Provincial Water Quality Monitoring Network (PWQMN) data, where available.
- Ministry of the Environment, Conservation and Parks (MECP) Water Well Record database.
- Environment Canada and local weather station climate data.

A drilling program is being conducted to improve the understanding of the local geology and hydrogeology, particularly to the east of the SSA. The investigation includes:

- Borehole drilling at seven (7) locations to the base of the Irondequoit Formation or the Rochester Formation, depending on location and detailed core logging.
- Hydraulic testing in the open borehole (packer testing) and in the installed monitoring wells.
- Downhole geophysical logging in the deep borehole at four (4) locations closest to the SSA.
- Installation of monitoring well nests in target bedrock zones at each location.

Following installation of the monitoring wells, groundwater elevation and groundwater quality data will be collected to supplement the existing database form the Campus wells.

Results from the drilling program and monitoring will be incorporated into this report to supplement and refine the geology and hydrogeology existing conditions.

4 CHARACTERIZATION OF THE EXISTING ENVIRONMENT

4.1 Physiography and Topography

The Study Areas are situated within the Haldimand Clay Plain physiographic region, extending from the Niagara Escarpment in the north to Lake Erie in the South (Chapman & Putnam, 1984). This physiographic region is characterized by low topographic relief and poorly drained soils. During the last glaciation, the area was inundated by glacial Lake Warren and resulted in the deposition of massive stratified clay and silt over the underlying bedrock. The clay and silt deposits thicken from north to south in the RSA. The SSA is situated just south of the Niagara Escarpment, where the overburden deposits are thinner.

Ground surface within the RSA generally slopes gently southward from the Niagara Escarpment towards the Welland River, with low topographic relief. Topography within the RSA is locally influenced by the Niagara Escarpment to the north, the Welland Canal system to the west, and local drainage courses. Within the LSA, topographic relief is influenced by the various operations on the Walker Campus, and 10 Mile Creek to the southeast and south of the Campus.

4.2 Water Budget

To estimate the water budget, temperature and precipitation data from the Welland-Pelham climatological station (operated by Environment Canada) were used. The 30-year climate normal for the period between 1991 and 2020 is summarized below.

Table 1: Welland-Pelham Climate Station 30-Year Climate Normal (1991 – 2020)

Month	Mean Temperature (°C)	I	E (mm)	Daylight Factor	E Adj. (mm)	Total Precipitation (mm)	WHC (mm)	Surplus (mm)	Deficit (mm)
January	-4.1	0.0	0.0	0.8	0.0	81.6	200.0	81.6	0.0
February	-3.8	0.0	0.0	0.8	0.0	52.8	200.0	52.8	0.0
March	0.7	0.1	2.1	1.0	2.1	70.3	200.0	68.2	0.0
April	7.1	1.7	29.8	1.1	33.4	83.1	200.0	49.7	0.0
May	13.7	4.6	63.3	1.3	80.4	81.0	200.0	0.6	0.0
June	19.0	7.5	92.2	1.3	118.0	85.7	167.7	0.0	0.0
July	21.5	9.0	106.2	1.3	138.1	84.0	113.7	0.0	0.0
August	20.7	8.5	101.7	1.2	122.0	78.7	70.3	0.0	0.0
September	17.0	6.3	81.1	1.0	84.4	96.0	82.0	0.0	0.0
October	10.6	3.1	47.2	1.0	44.8	88.5	125.6	0.0	0.0
November	4.5	0.9	17.7	0.8	14.3	83.7	195.0	0.0	0.0
December	-0.7	0.0	0.0	0.8	0.0	81.6	200.0	76.6	0.0
Totals	**8.9**				**637.5**	**967.0**		**329.5**	**0.0**
			Net Water Surplus			**329.5**	**mm**		

Notes: Calculations based on Thornthwaite Mather method
I – denotes heat index
E – denotes evapotranspiration
WHC – denotes water holding capacity
A value of 200 mm was used for the WHC of the soils (clay loam soil moderately deep-rooted crops)

As shown in the table above, the 30-year climate normal (1991-2020) for total annual precipitation for the LSA is 967.0 mm. Using the Thornthwaite Mather methodology, the estimated annual evapotranspiration is 637.5 mm, yielding an average water surplus of 329.5 mm/year available for surface water runoff and recharge to the groundwater system.

Similar analyses were completed for previous 30-year climate normals after 1961 for comparison. The latest climate normals for mean annual temperature and total precipitation are essentially the same as the 1961 – 1990 climate normals of 8.9°C and 953.1 mm, respectively. It is also noted that mean annual temperature and total precipitation amounts marginally varied for these climate normal time periods with no discernible trend. Periods of abnormal conditions have been observed periodically over these timeframes, which has an effect on groundwater elevations and discharge. For example, a period of notably lower than normal total precipitation was recently observed between August and December 2024.

4.3 Geology

The geology near the Niagara Escarpment and within the RSA is well documented in the technical literature. Within the LSA, boreholes have been drilled within and around the Campus at over 80 different locations to confirm subsurface and geologic conditions. The existing monitoring well locations within the LSA, including those being added as part of the EA investigation, are shown on **Figure 4-1**.

4.3.1 Overburden

The RSA surficial geology is presented on **Figure 4-2**. Within the RSA the overburden largely consists of a relatively thick layer of poorly draining glaciolacustrine clayey silt to silty clay with a discontinuous lower basal till unit overlying the dolostone bedrock. East of the Campus, much of the City of Niagara Falls urban area is underlain by sand and gravel overburden of glaciolacustrine origin. More recent alluvial deposits are present along the local watercourses including the Shriners Creek, Beaverdams Creek and Welland River to the south of the Campus. Areas of modern fill / spoil (i.e., anthropogenic deposits) related to the numerous large-scale historical excavations are present along the modern (and historic) Welland Canal, Queenston-Chippewa Power Canal, Mountain Road Landfill Site to the northeast and Walker Campus operations. The natural overburden thickness generally increases to the south, away from the Escarpment.

Within the LSA, a relatively thin layer of glaciolacustrine clayey silt covers the area and is locally underlain by a glacial silt till. Overburden is absent in the SSA as it has been stripped as part of the current quarry operation. Natural overburden is also absent across most of the Campus as a result of past and current operations. Beyond the Campus area, the overburden thickness within the LSA generally ranges from 2 m to 10 m.

{NOTE: Additional details to be added based on current investigation}

4.3.2 Bedrock

4.3.2.1 Regional Setting

The RSA is underlain by Ordovician and Silurian age shale, sandstone, limestone and dolostone, as shown on **Figure 4-3**. The Niagara Escarpment is the dominant bedrock feature in the area, with many bedrock outcrops along the escarpment brow where the overburden is thinnest. The Paleozoic aged bedrock is the subject of on-going research by the OGS; but for this study, the naming convention follows that of the Paleozoic bedrock Map 2344 (Liberty, Feenstra, & Telford, 1976) as it has been in long-term use at the existing Walker facilities. The naming convention for bedrock stratigraphic units in this report are defined from youngest to oldest in **Table 2**.

Table 2: Bedrock Stratigraphic Units

Group (Age)	**Formation / Member**	**Description**
Salina Formation (Upper Silurian Age)		The Salina Formation consists of argillaceous dolostone and shale and abundant gypsum nodules. This formation subcrops at the very south of the RSA near the Welland River. It is generally not considered a drinking water source due to water quality and quantity issues.
Lockport Group (Middle Silurian age)	**Guelph Formation**	The Guelph Formation is a hard, fresh, brownish-grey, vuggy, medium grained reefal dolostone with saccharoidal texture. The Guelph Formation has a gradational lower contact with the underlying Eramosa member and subcrops in the southern portion of the RSA. It is the primary bedrock aquifer for drinking water where it subcrops south in the RSA. The Guelph Formation is absent in the LSA.
	Lockport Formation -	
	Eramosa Member	The Eramosa member is a hard, fresh, brownish-grey medium grained dolostone with saccharoidal texture and a petroliferous odour when broken. It is thin to medium bedded and often blocky in appearance with occasional shale layers and rare stylolites. The Eramosa member is absent in the LSA and subcrops within the central portion of the RSA. Published values in the literature suggest that the full unit thickness may be up to 10 m; however, thicknesses of 20 m have been observed in some studies. The Eramosa member is the primary bedrock aquifer for drinking water where it subcrops.
	Goat Island Member	The Goat Island member is a hard, fresh, grey to brown, fine-grained dolostone with a weak petroliferous odour when broken and can be up to 8 m thick locally to the south in the RSA. It is medium bedded and has occasional white chert and gypsum nodules. It is much harder than the underlying shales and sandstones and forms the cap rock of the Niagara Escarpment. The Goat Island member is present within the LSA and is the primary bedrock aquifer where it subcrops. The lower contact with the Gasport member is typically gradational.
	Gasport Member	The Gasport member is a hard to medium hard, fresh, grey to dark grey fine to medium grained fossiliferous dolostone with a saccharoidal texture and can locally be up to 14 m thick, although it is normally significantly thinner. The Gasport members is present within the LSA and is not particularly noted as a drinking water source.

Group (Age)	**Formation / Member**	**Description**
Clinton Group (Middle Silurian age)	**DeCew Formation**	The DeCew Formation is a medium hard, dark grey, fine-grained, fresh argillaceous dolostone with occasional shale partings and can locally be up to 4 m thick. This unit is normally not suitable as a drinking water source due to groundwater quality issues.
	Rochester Formation	The Rochester Formation is a dark grey, dolomitic to calcareous shale, which frequently splits along bedding planes and can be up to 14 m thick. On the Niagara Peninsula, the Rochester shale is associated with the presence of naturally occurring hydrogen sulphide gas, and is considered a barrier to groundwater flow. This unit is not suitable as a drinking water source due to the poor quality of the groundwater.
	Irondequoit Formation	The limestone, dolostone and sandstone formations of the lower Clinton Group can collectively be up to 12 m in thickness. These units are generally not used as a drinking water source within the RSA and LSA owing to their depth below the Rochester shale.
	Reynales Formation	
	Thorold Formation	
Cataract Group (Lower Silurian Age)	**Grimsby Formation**	The red and grey sandstone and shale formations that form the Cataract Group can be over 30 m thick in some areas. The Cataract Group is rarely used as a drinking water source due to the depth of formation and typically poor water quality.
	Cabot Head (Power Glen) Formation	
	Whirlpool Formation	
Queenston Formation (Upper Ordovician age)		The red shales of the Queenston Formation are the oldest and thickest bedrock in the RSA and form the base of the Niagara Escarpment. This formation is considered a poor source of drinking water owing to both quantity and quality issues.

Overall, the bedrock surface in the RSA generally dips from the escarpment (approximately 176 masl in the vicinity of the Campus) to the south (approximately 155 masl near the Welland River). The Lockport, DeCew, and Rochester Formations are truncated by the Niagara Escarpment along the north boundary of the RSA and LSA.

4.3.2.2 Local Setting

A conceptual representation of the local setting across the Campus is presented on **Figure 4-4**. It is noted that the figure is not to scale. The SSA is situated within the area currently occupied by Walker's Southeast Quarry. Similarly, the South Landfill and other operations at the Walker Campus are constructed within historic quarries. These quarries excavated the dolostone of the Goat Island and Gasport Members of the Lockport Formation, exposing the DeCew Formation argillaceous dolostone and in some areas the top of the Rochester Formation shale.

The Rochester shale is considered a natural barrier separating groundwater movement between the upper Lockport dolostone unit and the underlying Irondequoit limestone and Reynales dolostone units. Nonetheless, the underlying Irondequoit limestone is included as part of the local setting to assess potential effects on groundwater flow and quality beneath the Rochester shale.

{NOTE: Additional details to be added to bedrock descriptions below based on current investigation}

Lockport Formation

The Lockport Formation dolostone, consisting of the Goat Island and Gasport Members, is the uppermost bedrock unit in the LSA and has been quarried historically at the Campus. The Goat Island and underlying Gasport Members have a generally similar appearance and composition, and therefore, have not been differentiated in many of the historical geologic borehole logs.

Within the LSA, the Goat Island Member dolostone is grey to brown, fine to medium grained, medium bedded, with occasional white chert and gypsum nodules. The Gasport Member dolostone is grey to dark grey, fine to medium grained, thick to massively bedded, fossiliferous with occasional shale stylolites. The Lockport Formation dolostone in both members is relatively porous due to the presence of natural fractures, vugs (small solution voids), larger cavities, and occasional fossiliferous zones. The upper portion of the Lockport Formation dolostone typically exhibits weathering and a higher degree of fracturing.

Within the LSA, the Lockport Formation dolostone thickness ranges from about 3 m to 15 m, generally becoming thicker toward the south. Studies indicate two main sets of vertical jointing in the bedrock. The primary joint set has a bearing of 14 degrees west of north, while the secondary joint set has a mean bearing of 42 degrees east of north (Gartner Lee Limited, 2006).

DeCew Formation

The underlying DeCew Formation dolostone is a dark grey, massively bedded argillaceous (shaley) dolostone that tends to become increasingly shaley with depth. The shaley content results in the bedrock being easily weathered with lower rock quality. The DeCew Formation thickness is irregular which complicates its identification in drill cores. Across the LSA, the DeCew Formation shaley dolostone ranges from approximately 1 m to 4 m thick.

Most of the DeCew Formation was extracted within the former West and East Quarries, while extraction of the DeCew was limited within the former South and current Southeast Quarries.

Rochester Formation

The Rochester Formation underlies the DeCew Formation and is a dark grey, very fine grained dolomitic to calcareous shale. The bedrock is thin to medium bedded and frequently splits along bedding planes. Occasional interbeds of limestone to dolostone, and calcareous fossiliferous zones occur within the unit. Within the LSA, the Rochester Formation shale bedrock unit ranges from 14 m to 17 m thick.

An observable calcareous and fossiliferous zone, which appears to be laterally extensive across the LSA, is present in the lower portion of the unit. The zone is massive bedded and isolated within the surrounding overlying and underlying shale and is not considered hydraulically significant (Gartner Lee Limited, 2006).

Where the Rochester Formation shale is exposed at the base of the former quarries, the upper portion of the bedrock is inferred to have increased weathering and fracturing due to natural exposure and quarrying activities.

Irondequoit Formation

The Irondequoit Formation consists of light grey to brown grey, medium to coarse grained dolomitic limestone. The unit is medium to thickly bedded. Within the LSA, the Irondequoit Formation ranges from 2 m to 2.5 m thick.

4.3.2.3 Bedrock Hydraulic Conductivity Characteristics

NOTE: To be completed with results from current drilling investigation program

4.4 Hydrogeology

The groundwater setting in the RSA is described in the Niagara Peninsula Source Protection Area Updated Assessment Report (NPCA, 2013) as summarized in the **Table 3**.

Table 3: Regional Study Area Groundwater Setting

Hydrogeologic Unit		Description
Overburden	**Upper Aquitard**	Fine-textured glaciolacustrine clay and silt overburden deposits.
	Contact-Zone Aquifer	Discontinuous basal till layer that underlies the glaciolacustrine clay and silt and overlies the upper weathered bedrock. The contact aquifer is not continuous across the RSA and generally does not occur along the Niagara Escarpment, within the northeastern portion of the LSA near the Campus, or below local watercourse meander valleys and was therefore not a focus of the current study. This aquifer is considered to vary between confined and unconfined depending on the thickness of the overlying aquitard.
Bedrock	**Shallow Bedrock Aquifer**	Shallow bedrock consisting of the Guelph Formation dolostone and the Eramosa member dolostone within the southern portion of the RSA, and the Goat Island member dolostone within the LSA and northern portion of the RSA. This aquifer is continuous across the study area and varies between semi-confined to confined depending on the thickness of the overlying aquitard.
	Deep Bedrock Aquifer	Consists of the Goat Island and Gasport dolostone members of the Lockport Formation. This aquifer is confined and typically has a lower hydraulic conductivity compared to the shallow bedrock aquifer to the south in the RSA. There is interpreted to be no confining layer between the shallow and deep bedrock aquifers.
	Lower Aquitard	DeCew Formation argillaceous dolostone and Rochester Formation shale bedrock units.

Within the LSA, the Goat Island Member associated with the shallow bedrock aquifer is locally thin to occasionally absent; and thus, the shallow and deep bedrock aquifers are considered to function as a single aquifer, referred to as the dolostone bedrock aquifer. Though the Irondequoit Formation limestone is often included as part of the lower aquitard (Novakowski & Lapcevic, 1988), it is also considered to be a semi-pervious aquifer.

In summary, the groundwater setting within the LSA consists of the upper overburden aquitard, the Lockport Formation dolostone bedrock aquifer, the lower aquitard associated with the DeCew and Rochester Formations, and the underlying Irondequoit Formation semi-pervious aquifer.

4.4.1 Existing Anthropogenic Influences

The South Landfill, as well as the East and former West Landfills, were developed within exhausted quarries. Within the former East Quarry, a trench was constructed along the north-south axis of the former quarry floor to provide gravity drainage of water away from the operations to the Old Welland Canal. Upon completion of the Quarry, an engineered perforated collection pipe was installed within the trench, with granular backfill material, to facilitate continued groundwater collection from the original quarry floor below the East Landfill liner. A solid drainage pipe was also installed in the trench to facilitate drainage of surface water from undeveloped areas of the South Landfill floor and from the neighbouring Southeast Quarry sump. The perforated pipe is referred to as the Groundwater Collection System (GWCS), which along with the solid drainage pipe, is collectively referred to as the WEG Drainage System (WDS).

Under baseline (pre-developed) conditions, bedrock groundwater in the vicinity of the Campus flowed generally north towards the Niagara Escarpment. The permitted development at the Campus has altered the potentiometric surfaces for the dolostone bedrock aquifer and shale bedrock aquitard such that surrounding water levels have declined relative to pre-development conditions. The groundwater drawdown cone around the former and current quarries is estimated to extend about 500 m beyond the east / southeast excavation limits, and marginally beyond 500 m to the south of the Campus. The estimated extent of the drawdown in 2024 was inferred to have remained unchanged since 2015, suggesting that conditions may be stable.

Around the perimeter of the East and South Landfills, which are sealed by clay sidewalls and liners, groundwater movement is in a downward direction, along the buried vertical quarry faces, and into the weathered shale floor. The groundwater then mixes with water from the shallow Rochester shale before being collected by the perforated pipe in the GWCS. The groundwater then flows northward through the GWCS pipe to a collection chamber from where it may be discharged to the leachate collection system or used on-site under appropriate conditions based on water quality monitoring results.

The South and East Landfills are designed and constructed to contain and isolate the leachate from the natural environment. Within each landfill cell, an engineered clay liner was continuously constructed to achieve this isolation. An underdrain system was constructed on top of the engineered clay liner, directly below the waste, to collect the leachate. The collected leachate is pumped from the waste cells through a force main to two engineered holding lagoons where the leachate is aerated prior to discharge into the sanitary sewer. Leachate collection reduces potential leachate mounding within each landfill cell, thereby minimizing the potential for the downward migration of leachate through the engineered clay liner. The Closed West Landfill operates on a different design, where pumping from a network of leachate wells is undertaken on an on-going basis to minimize leachate mounding within the waste fill. The leachate from the Closed West Landfill is also directed to the on-Site lagoons.

The design of the South and East Landfills and presence of the GWCS maintains groundwater flow patterns similar to the conditions at the former quarries prior to landfilling, which is a natural sink or drawdown effect in the dolostone bedrock aquifer and shale bedrock aquitard. This creates a continuous inward gradient (i.e., hydraulic trap) surrounding the South and East Landfills and the Southeast Quarry, whereby groundwater within the dolostone aquifer and shale aquitard below the Campus does not flow off-site.

4.4.2 Upper Overburden Aquitard

Within the RSA and LSA, the glaciolacustrine clay and silt overburden deposits act as an aquitard and are not a significant source of potable water owing to its low permeability and poor yields.

The water table in the clayey silt overburden within the LSA is predominantly situated above the potentiometric surface of the underlying Lockport dolostone aquifer and groundwater movement in the overburden is generally downward to the underlying dolostone aquifer. In the areas immediately adjacent to the landfills and quarries, the overburden water table is perched due to the low permeability of the soils relative to the underlying dolostone bedrock. The low permeability of the overburden soils acts as a confining layer to control the downward movement of groundwater recharge from precipitation to the underlying bedrock units.

4.4.3 Lockport Dolostone Bedrock Aquifer

The Goat Island and Gasport Member dolostone of the Lockport Formation are treated as a single bedrock aquifer in the LSA, though the Goat Island Member dolostone is typically more fractured and permeable.

Within the RSA, the potentiometric surface in the dolostone bedrock aquifer appears to be a subtle reflection of bedrock surface topography, as a local potentiometric high is mapped at the north end of the City of Niagara Falls urban area to the east of the Campus beyond the LSA in the Niagara Peninsula Source Protection Area Updated Assessment Report (NPCA, 2013). A smaller localized potentiometric high also occurs southeast of the Campus outside the LSA. Groundwater is inferred to flow radially away from these localized highs toward the Niagara Escarpment to the north, Welland Canal to the west, Welland River to the south, or Queenston-Chippewa Power Canal to the east.

The potentiometric surface within the Lockport dolostone aquifer within the LSA in June 2024 is presented on **Figure 4-5**. Lockport dolostone is present adjacent to the south, east, and north sides of the SSA, but has largely been extracted to the west. **Figure 4-5** shows the inward groundwater flow direction within the dolostone bedrock aquifer around the South Landfill, East Landfill and current Southeast Quarry, which is consistent with the flow regimes observed in previous years. Though potentiometric levels in the dolostone bedrock aquifer monitoring wells fluctuate in response to seasonal and climatic conditions, the groundwater flow directions within the bedrock aquifer remain similar in all seasons.

At the SSA, groundwater discharge occurs along the north, east and south quarry faces. Groundwater discharge and surface water runoff in the SSA drains to the quarry sump, from where it is discharged through the solid drainage pipe to the Old Welland Canal as part of the WDS. Around the perimeter of the South Landfill and East Landfill, which are sealed by clay sidewalls, groundwater movement is in a downward direction, along the buried vertical quarry faces, and into the weathered shale floor. The groundwater then moves beneath the South Landfill and East Landfill clay liners and mixes with water from the shallow Rochester shale before draining to the GWCS.

NOTE: To be completed with results from current drilling investigation / hydraulic testing program and baseline water level monitoring at newly installed wells

- Hydraulic characteristics
- Gradients
- Trends

In summary, within the LSA, groundwater in the Lockport dolostone aquifer flows inward toward the SSA (current Southeast Quarry), South Landfill and East Landfill due to the drawdown effect of the GWCS and quarry. At the SSA, groundwater discharges slowly into the quarry through the north, east and south rock faces and drains to the quarry sump. Around the perimeter of the South Landfill and East Landfill, which are sealed by clay sidewalls, groundwater moves downward along the buried vertical quarry faces and into the weathered shale floor. The groundwater then moves beneath the South Landfill and East Landfill clay liners and mixes with water from the shallow Rochester shale before draining to the GWCS.

4.4.4 Lower Aquitard

The DeCew / Rochester Formations form a lower aquitard that acts as a natural flow barrier separating groundwater flow within the Lockport dolostone bedrock aquifer from flow within the lower Irondequoit limestone unit (Novakowski & Lapcevic, 1988).

Within the RSA outside of the Campus, groundwater movement within the shale lower aquitard is inferred to be primarily vertical, driven by vertical hydraulic gradients; however, minimal groundwater flux occurs due to the low hydraulic conductivity of the shale bedrock.

Within the LSA, and particularly near the Campus, the upper portion of the Rochester shale is inferred to have increased weathering and horizontal jointing along beds due to natural exposure and quarry operations. Groundwater movement in the upper portion of the shale aquitard near the Campus is primarily horizontal due to the bedded nature of the shale, with only minor downward vertical leakage across the relatively low permeability shale beds. Notable downward flow is only expected to occur immediately adjacent to the Niagara Escarpment, where weathering processes are inferred to have caused natural vertical fracturing (Gartner Lee Limited, 2006).

The June 2024 potentiometric surface in the Rochester shale aquitard within the LSA is presented on **Figure 4-6**. The groundwater flow directions in the shale aquitard are consistent throughout the seasons, and similar to historic patterns. **Figure 4-6** shows that horizontal groundwater flow in the shale bedrock within the LSA is radially inward towards the sump within the SSA (Southeast Quarry), South Landfill and the GWCS below the East Landfill liner.

Lower potentiometric heads are observed in the Rochester shale (and DeCew shaley dolostone) relative to the overlying Lockport dolostone at many monitoring locations. The differences in potentiometric heads are attributed to the low hydraulic conductivity of the lower Lockport Formation (Gasport Member), which maintains higher water levels in the Lockport dolostone, along with lateral drainage of the DeCew shaley dolostone and upper Rochester shale to the existing quarry excavations and the Niagara Escarpment. The exposed bedrock faces at these locations allow the deeper groundwater system to drain, lowering the potentiometric heads in those formations.

NOTE: To be completed with results from current drilling investigation / hydraulic testing program and baseline water level monitoring at newly installed wells

- Hydraulic characteristics
- Gradients (vertical)
- trends

In summary, within the LSA, groundwater in the lower aquitard associated with the DeCew and Rochester Formations flows inward toward the SSA (current Southeast Quarry), South Landfill and East Landfill due to the drawdown effect of the GWCS and quarry. At the SSA, groundwater in the lower aquitard moves through the weathered shale floor to the quarry sump from where it is discharged through the solid drainage pipe to the Old Welland Canal as part of the WDS. Around the perimeter of the South Landfill and East Landfill, which are lined by clay, groundwater moves through the weathered shale floor beneath the South Landfill and East Landfill clay liners and drains to the GWCS.

4.4.5 Irondequoit Aquifer

Groundwater pressures in the Irondequoit Formation limestone are measured at a number of locations across the Campus and adjacent to the SSA. The groundwater potentiometric head in the Irondequoit limestone is lower than the overlying Rochester shale piezometric surface; as such, a downward hydraulic gradient exists between these two units. The piezometric surface within the Irondequoit Formation is relatively flat within the LSA, and the flow direction is subject to seasonal variability.

A section of the Old Welland Canal immediately adjacent to the west side of the Campus is drained annually for the winter season (typically from late December through mid-March) by the St. Lawrence Seaway Authority. During this period, groundwater levels at monitoring wells screened within the Irondequoit limestone typically decrease (Gartner Lee Limited, 2006).

Using the available historic water level data for the Irondequoit Formation, the following seasonal trends were identified:

- Prior to drainage of the Canal, west to southwest flow directions are typically observed in December, considered to be naturally occurring as the result of high water surplus (the potential source is recharge through the weathered bedrock along the brow of the escarpment northeast of the Campus).
- During drained conditions, west to southwest flow directions are typically observed from January to early March, interpreted to be the result of induced inward gradients toward the Canal.
- During refilling of the Canal, east to southeast flow directions are typically observed from late March through June, interpreted to be the result of induced outward gradients away from the Canal.
- During periods of low water surplus (September), northwest groundwater flow directions are typically observed, interpreted to be the ambient horizontal hydraulic gradient within the Irondequoit limestone.

The March 2024 groundwater potentiometric levels measured in the Irondequoit limestone are presented on **Figure 4-7**, along with the west to southwest inferred flow direction. This pattern is consistent with induced gradients toward the Canal during drained conditions. The September 2024 potentiometric surface indicates flow to the northwest, as shown on **Figure 4-8,** which is interpreted to be representative of ambient flow conditions within the Irondequoit formation during dry conditions.

NOTE: To be completed with results from current drilling investigation / hydraulic testing program and baseline water level monitoring at newly installed wells

- Hydraulic characteristics
- Gradients
- Trends

In summary, groundwater in the Irondequoit aquifer in the LSA typically flows west to southwest or west to northwest; but the flow direction is seasonally influenced by the draining and filling of the Welland Canal. The groundwater potentiometric head in the Irondequoit aquifer is lower than the overlying lower aquitard piezometric surface; as such, a downward hydraulic gradient exists between these two units.

4.4.6 GWCS Hydraulic Influence

NOTE: To be completed with results from baseline water level monitoring at newly installed wells

4.4.7 Groundwater Use

There are no municipal well fields in operation within the LSA and RSA, as all of the urban serviced areas are supplied via surface water intake. As such, there are no well-head protection areas (WHPAs) within the LSA. Three MECP Permit-to-Take-Water (PTTW) for groundwater takings exist within the RSA, including water takings for dewatering of the existing Southeast Quarry, operation of groundwater containment system at Niagara Region's Mountain Road Landfill Site east of the LSA, and for irrigation of the Niagara Falls Golf Club within the southern portion of the RSA. It is noted that no PTTWs were found for the dewatering operations along the Welland Canal at the Thorold Stone Road tunnel southwest of the LSA and Townline Road / Main Street Tunnels in Welland southwest of the RSA or dewatering associated with the Queenston-Chippewa Power Canal along the eastern portion of the RSA. It is acknowledged in the Niagara Peninsula Source Protection Area Updated Assessment Report (NPCA, 2013) that these dewatering operations also have an impact on the regional potentiometric surface, although the exact extent of the impact is currently not well documented.

According to the Niagara Region Master Servicing Plan (2016), a significant number of parcels within the LSA are connected to the municipal water supply, particularly along Garner Road east of the SSA. A large proportion of the un-serviced lands are either (i) owned by Walker, (ii) vacant with no associated street address, or (iii) within the hydro corridor right-of-way to the southeast of the SSA or the Niagara Escarpment Parks and Open Spaces System to the west of the SSA.

Addresses of the remaining parcels with the potential for private water well use are shown on **Figure 4-9**. Previous water well surveys have been completed as part of the existing quarry licencing, and a number of residential wells within and adjacent to the LSA are currently included in the annual monitoring program as shown on the figure.

4.4.7.1 MECP Water Well Record Search

A search of the MECP Water Well Record database (data currently available up to June 2023) was undertaken to identify well records located within or adjacent to the LSA. The results of the search are shown on **Figure 4-9** and summarized in **Table D-1, Appendix D**.

A total of 92 water well records plot within the search area. Of these well records, 36 are reported as domestic supply, 11 are reported as livestock / irrigation, 3 are reported as municipal supply (associated with the Thorold Public Works facility west of the East Landfill), 3 are reported as industrial / commercial, 25 are reported as monitoring wells / test holes and 14 have no reported use.

A total of 61 wells are reportedly screened within bedrock, 7 within the overburden and 24 with unknown screen depths. Fresh water was reported in 38 wells, sulphur / mineralized water was reported in 13 wells while the water type at the remaining wells was not specified in the water well record. The recommended pumping rates vary significantly, ranging between 2 Imperial gallons per minute (Igpm) and 17 Igpm, with a median value of 5 Igpm (23 L/min).

4.4.7.2 Water Well Survey

[placeholder for updated water well survey results – to be completed only for addressed parcels noted on Fig 4-9]

In summary, a significant number of parcels within the LSA are connected to the municipal water supply, and a large proportion of the un-serviced lands are either (i) owned by Walker, (ii) vacant with no associated street address, or (iii) within the hydro corridor right-of-way to the southeast of the SSA or the Niagara Escarpment Parks and Open Spaces System to the west of the SSA. A total of 92 MECP water well records plot within the LSA, of which 36 are reported as domestic supply, while the remainder are for use as livestock / irrigation, industrial / commercial, or monitoring wells / test holes.

4.5 Groundwater Quality

4.5.1 Lockport Dolostone Bedrock Aquifer

Groundwater quality within the Lockport dolostone is influenced by the infiltration of precipitation through the overlying overburden, which results in less saline and less mineralized groundwater than in the deeper, more isolated bedrock units. The natural groundwater quality in the Lockport dolostone ranges from potable to non-potable, with increasing mineralization and, therefore, decreasing potability, with increasing depth.

NOTE: To be completed with results from baseline groundwater sampling at newly installed wells

4.5.2 Lower Aquitard

The DeCew and Rochester bedrock units are not suitable as a drinking water source due to the poor quality of the groundwater, and low yields owing to low intrinsic permeabilities in the shale bedrock.

Due to its shale content, groundwater quality in the DeCew dolostone is similar to the quality in the Rochester shale but is less mineralized than the Rochester shale brine. The groundwater in the DeCew dolostone is generally considered to be non-potable due to the presence of naturally elevated concentrations of inorganic compounds.

The Rochester shale was formed in a saline marine depositional environment, which resulted in naturally saline and highly mineralized groundwater within this formation. The groundwater is considered a brine and is more mineralized than modern seawater. The salinity generally increases with both depth within the formation and distance from the Niagara Escarpment. Natural fractures in the shale near the Niagara Escarpment cause mixing with groundwater from overlying units, which decreases the salinity. Trace concentrations of BTEX parameters (benzene, toluene, ethylbenzene and xylenes) have historically been detected in the Rochester shale groundwater at the site, as the Rochester shale is naturally petroliferous (Novakowski & Lapcevic, 1988).

NOTE: To be completed with results from baseline groundwater sampling at newly installed wells

4.5.3 Irondequoit Aquifer

Groundwater in the Irondequoit Formation limestone is not suitable as a drinking water source due to the poor quality of the groundwater. The natural groundwater quality in the Irondequoit aquifer is less mineralized than the quality in the overlying Rochester shale; but is typically considered non-potable owing to its high mineralization. Also, groundwater in this unit is considered to be naturally petroliferous (Novakowski & Lapcevic, 1988).

NOTE: To be completed with results from baseline groundwater sampling at newly installed wells

4.5.4 Groundwater Quality Below the Landfill and within the GWCS

NOTE: To be completed following the baseline groundwater sampling at newly installed wells

5 CONCLUSIONS

The SSA and LSA are situated just south of the Niagara Escarpment in an area characterized by low topographic relief and poorly drained soils. A relatively thin layer of lacustrine clayey silt covers the area and is underlain by a glacial silt till. The overburden thickness generally increases to the south within the LSA and RSA, away from the Escarpment. Beneath the overburden are various bedrock units.

The Lockport Formation dolostone is the uppermost bedrock unit in the Study Areas and has been quarried historically at the Campus. The unit thickness ranges from about 3 m to 15 m and is relatively porous due to the presence of natural fractures, vugs, larger cavities, and occasional fossiliferous zones. The underlying DeCew dolostone is an argillaceous (shaley) dolostone that is up to 4 m thick and tends to become increasingly shaley with depth. The Rochester Formation underlies the DeCew dolostone and consists of thin to medium bedded shale and thin beds of dolomitic shale with occasional isolated thin beds of dolostone. The Rochester shale bedrock ranges from 14 m to 17 m thick. These bedrock units extend regionally to the south but are limited to the north of the Site by the Niagara Escarpment.

The bedrock units below the Rochester Formation, including the Irondequoit Formation limestone, and the deeper bedrock formations of the Clinton and Cataract Groups are not exposed through the historic or current quarry operations at the Campus.

The groundwater setting within the LSA consists of the upper overburden aquitard, the Lockport Formation dolostone bedrock aquifer, the lower aquitard associated with the DeCew and Rochester Formations, and the underlying Irondequoit Formation semi-pervious aquifer. The Rochester shale is considered a natural barrier separating groundwater movement between the upper Lockport dolostone unit and the underlying Irondequoit limestone and Reynales dolostone units.

The design of the South and East Landfills and presence of the GWCS maintains groundwater flow patterns similar to the conditions at the former quarries prior to landfilling, which is a natural sink or drawdown effect in the dolostone bedrock aquifer and shale bedrock aquitard. This creates a continuous inward gradient (i.e., hydraulic trap) surrounding the South and East Landfills and the Southeast Quarry, whereby groundwater within the dolostone aquifer and shale aquitard below the Campus does not flow off-site.

Within the RSA and LSA, the glaciolacustrine clay and silt overburden deposits act as an aquitard and are not a significant source of potable water owing to its low permeability and poor yields.

Within the LSA, groundwater in the Lockport dolostone aquifer and lower aquitard associated with the DeCew and Rochester shale flows inward toward the SSA (current Southeast Quarry), South Landfill and East Landfill due to the drawdown effect of the GWCS and quarry. At the SSA, groundwater discharges slowly into the quarry through the north, east and south rock faces toward the quarry sump. Around the perimeter of the South Landfill and East Landfill, which are sealed by clay sidewalls, groundwater moves downward along the buried vertical quarry faces and into the weathered shale floor. The groundwater then moves beneath the South Landfill and East Landfill clay liners and mixes with the shallow shale groundwater before draining to the GWCS.

Groundwater in the Irondequoit aquifer in the LSA typically flows west to southwest or west to northwest; but the flow direction is seasonally influenced by the draining and filling of the Welland Canal. The groundwater potentiometric head in the Irondequoit aquifer is lower than the overlying lower aquitard piezometric surface; as such, a downward hydraulic gradient exists between these two units.

6 REFERENCES

Chapman, L. J., & Putnam, D. F. (1984). *The Physiography of Southern Ontario.* Ontario Geological Survey, Special Volume 2.

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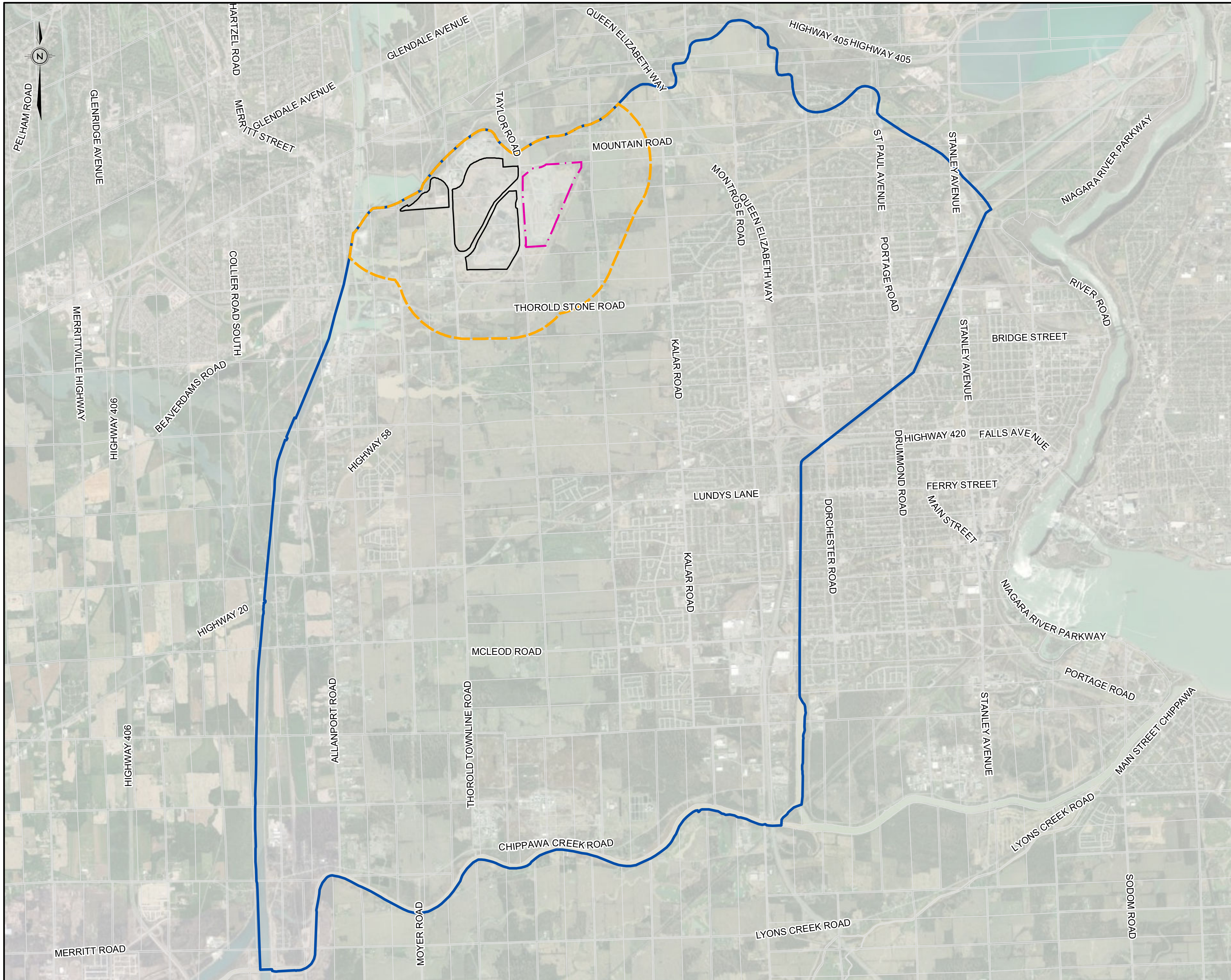
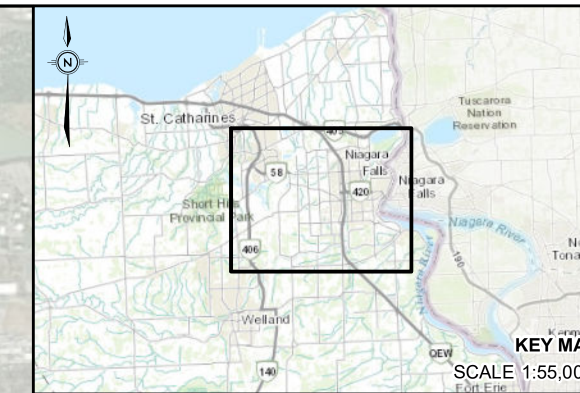
Signature Page

WSP Canada Inc.

FIGURES





LEGEND

- SITE STUDY AREA (SSA)
- PROPOSED LOCAL STUDY AREA (LSA) (1km CAMPUS BUFFER)
- PROPOSED REGIONAL STUDY AREA (RSA)
- WALKER RESOURCE MANAGEMENT CAMPUS (EAST, SOUTH AND WEST LANDFILLS)

PRELIMINARY DRAFT

0 1,100 2,200 m

NAD 1983 UTM Zone 17N

GEOLOGY AND HYDROGEOLOGY STUDY AREAS

GEOLOGY AND HYDROGEOLOGY EXISTING CONDITIONS REPORT
WALKER SOUTH LANDFILL PHASE 2
ENVIRONMENTAL ASSESSMENT
For Walker Environmental Group

DATE: JANUARY 2025	wsp
PROJECT: CA0037248.1905 100	
SCALE: 1 : 55,000	55 KING STREET, SUITE 600 ST. CATHARINES, ON L7R 3H5 T 905-687-1771 | F 905-687-1773 | www.wsp.com
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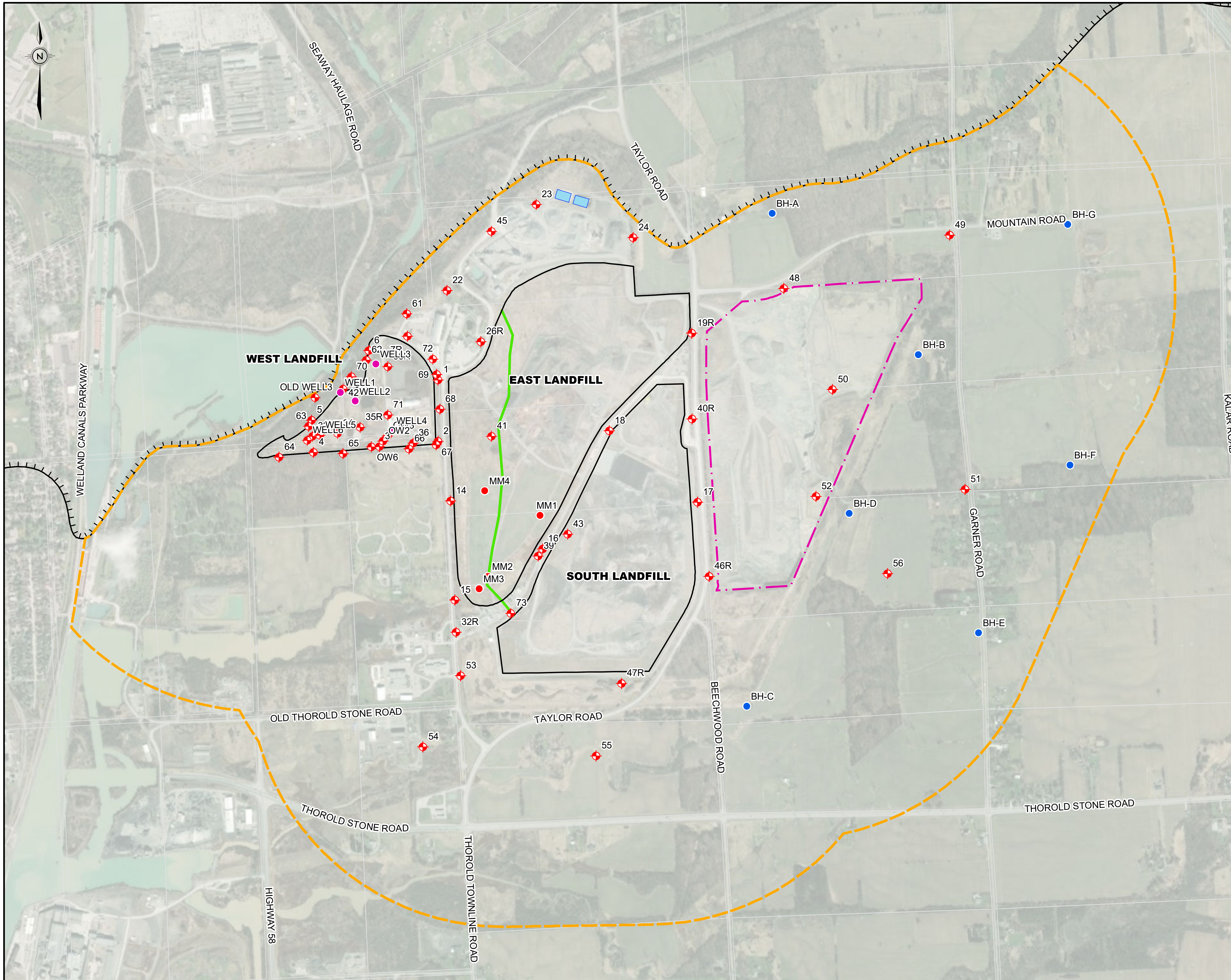

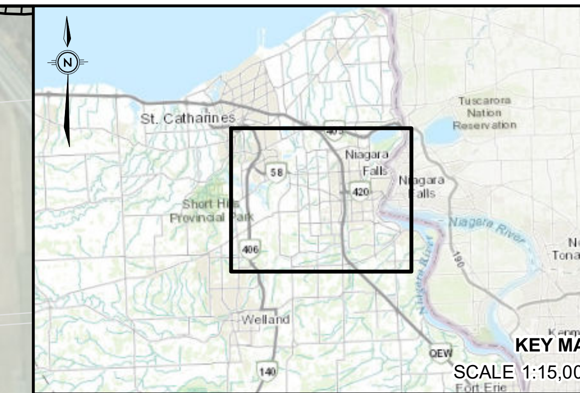

LEGEND

- SITE STUDY AREA (SSA)
- PROPOSED LOCAL STUDY AREA (LSA) (1km CAMPUS BUFFER)
- WALKER RESOURCE MANAGEMENT CAMPUS (EAST, SOUTH AND WEST LANDFILLS)
- APPROXIMATE LOCKPORT SCARP
- GROUNDWATER COLLECTION SYSTEM (GWCS)
- LANDFILL LEACHATE LAGOONS
- MONITORING WELL NEST
- EAST LANDFILL LINER WELL NEST
- WEST LANDFILL LEACHATE PUMPING WELL
- PROPOSED BOREHOLE LOCATIONS

PRELIMINARY DRAFT

0 300 600 m

NAD 1983 UTM Zone 17N

LOCAL STUDY AREA

GEOLOGY AND HYDROGEOLOGY EXISTING CONDITIONS REPORT
WALKER SOUTH LANDFILL PHASE 2 ENVIRONMENTAL ASSESSMENT
For Walker Environmental Group

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PROJECT: CA0037248.1905 100	55 KING STREET, SUITE 600 ST. CATHARINES, ON L7R 3H5 T 905-687-1771 | F 905-687-1773 | www.wsp.com
SCALE: 1 : 15,000	
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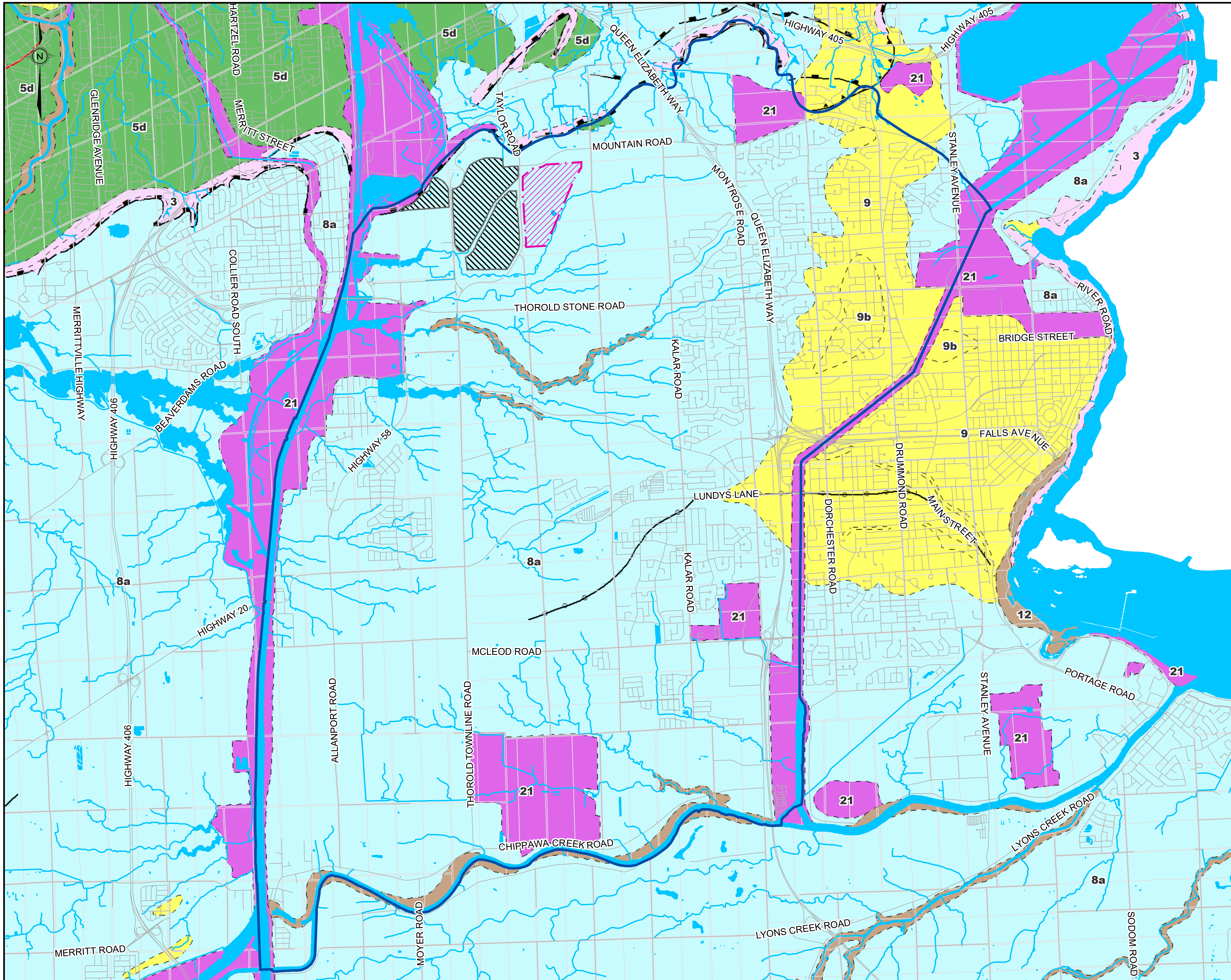

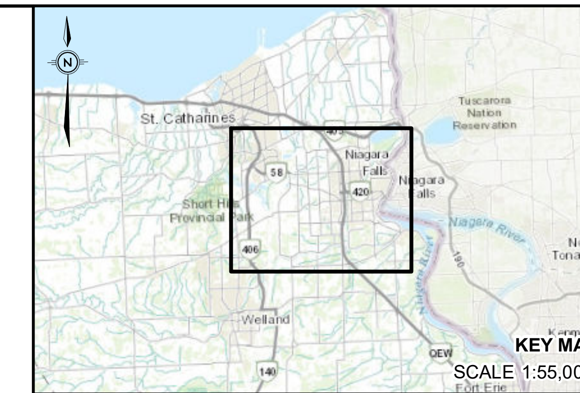

LEGEND

- SITE STUDY AREA (SSA)
- PROPOSED REGIONAL STUDY AREA (RSA)
- WALKER RESOURCE MANAGEMENT CAMPUS (EAST, SOUTH AND WEST LANDFILLS)

SURFICIAL GEOLOGY (OGS, 2003)

- BEDROCK ESCARPMENT
- ICE-CONTACT SLOPE
- MORAINE, MINOR
- SHORE BLUFF OR SCARP
- GEOLOGIC CONTACT; APPROXIMATE /
- 3: PALEOZOIC BEDROCK
- 5d: GLACIOLACUSTRINE-DERIVED SILTY TO CLAYEY TILL
- 8: FINE-TEXTURED GLACIOLACUSTRINE DEPOSITS
- 8a: MASSIVE-WELL LAMINATED
- 9: COARSE-TEXTURED GLACIOLACUSTRINE DEPOSITS
- 9b: LITTORAL-FORESHORE DEPOSITS
- 12: OLDER ALLUVIAL DEPOSITS
- 19: MODERN ALLUVIAL DEPOSITS
- 21: ANTHROPOGENIC DEPOSITS

PRELIMINARY DRAFT

0 1,100 2,200 m

NAD 1983 UTM Zone 17N

SURFICIAL GEOLOGY

GEOLOGY AND HYDROGEOLOGY EXISTING CONDITIONS REPORT
WALKER SOUTH LANDFILL PHASE 2 ENVIRONMENTAL ASSESSMENT
For Walker Environmental Group

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PROJECT: CA0037248.1905 100	
SCALE: 1 : 55,000	55 KING STREET, SUITE 600 ST. CATHARINES, ON L7R 3H5 T 905-687-1771 | F 905-687-1773 | www.wsp.com
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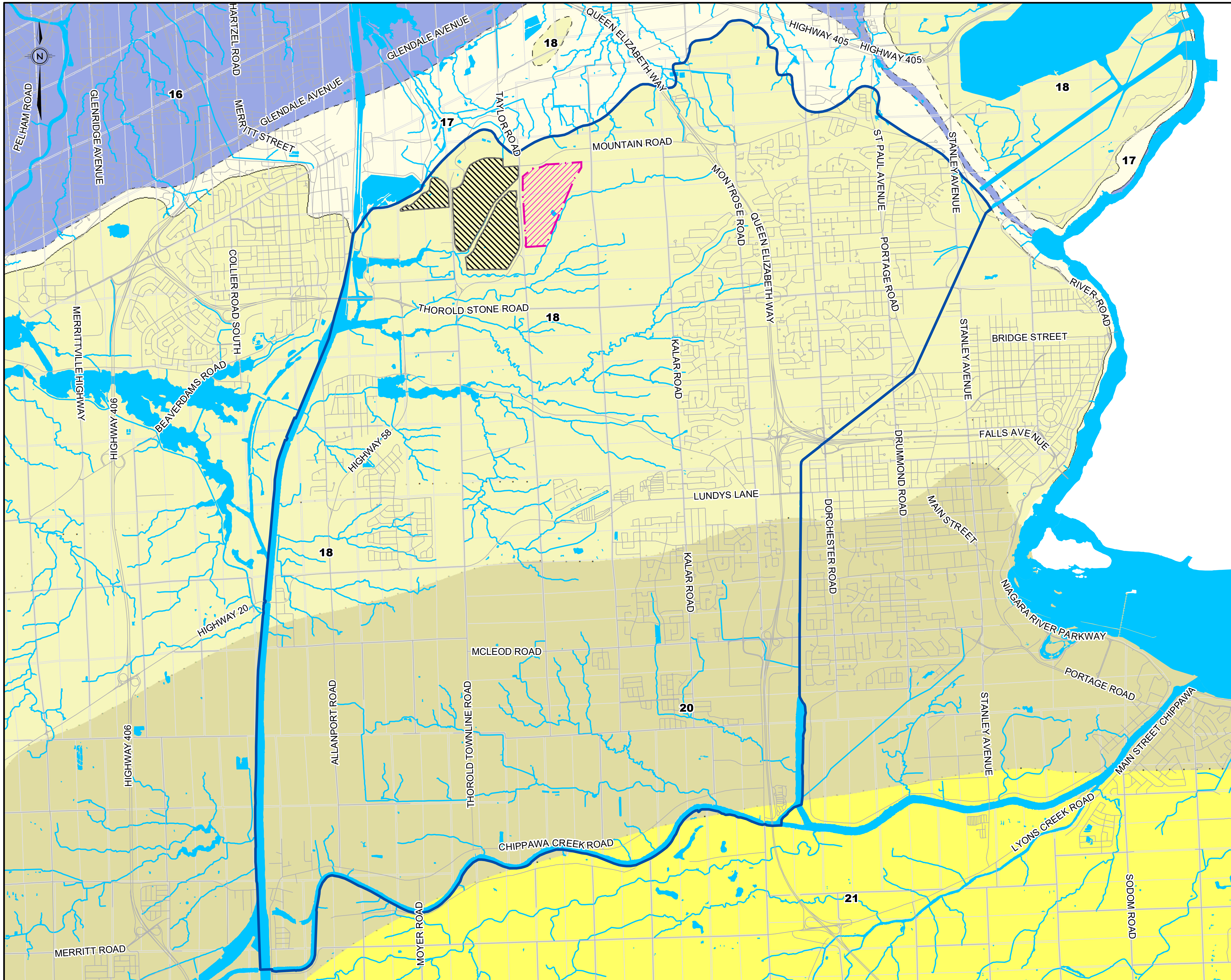

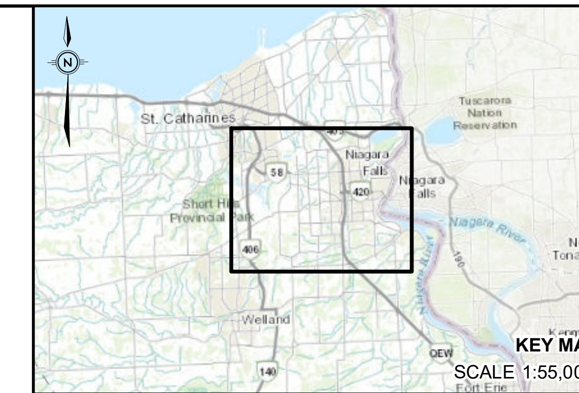

LEGEND

- SITE STUDY AREA (SSA)
- PROPOSED REGIONAL STUDY AREA (RSA)
- WALKER RESOURCE MANAGEMENT CAMPUS (EAST, SOUTH AND WEST LANDFILLS)

PALEOZOIC BEDROCK GEOLOGY (OGS, 2007)

- CONTACT, APPROXIMATE
- CONTACT, INTERPRETED
- CONTACT, OBSERVED

UPPER SILURIAN

- 21: SALINA FORMATION: Argillaceous dolostone, gypsum salt (at depth)
- 20: GUELPH FORMATION: dolostone: sucrosic, fossiliferous, locally biohermal

LOWER SILURIAN

- 18: LOCKPORT FORMATION: dolostone, limestone, argillaceous dolostone; locally cherty; includes bituminous (Eramosa Member)
- 17: CLINTON AND CATARACT GROUPS: shale, sandstone, dolostone, limestone units

UPPER ORDOVICIAN

- 16: QUEENSTON FORMATION: shale, siltstone, minor limestone and sandstone

PRELIMINARY DRAFT

0 1,100 2,200 m

NAD 1983 UTM Zone 17N

PALEOZOIC BEDROCK GEOLOGY

GEOLOGY AND HYDROGEOLOGY EXISTING CONDITIONS REPORT
WALKER SOUTH LANDFILL PHASE 2 ENVIRONMENTAL ASSESSMENT
For Walker Environmental Group

DATE: JANUARY 2025

PROJECT: CA0037248.1905 100

SCALE: 1 : 55,000

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FIGURE No: 4-3

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55 KING STREET, SUITE 600
ST. CATHARINES, ON L7R 3H5
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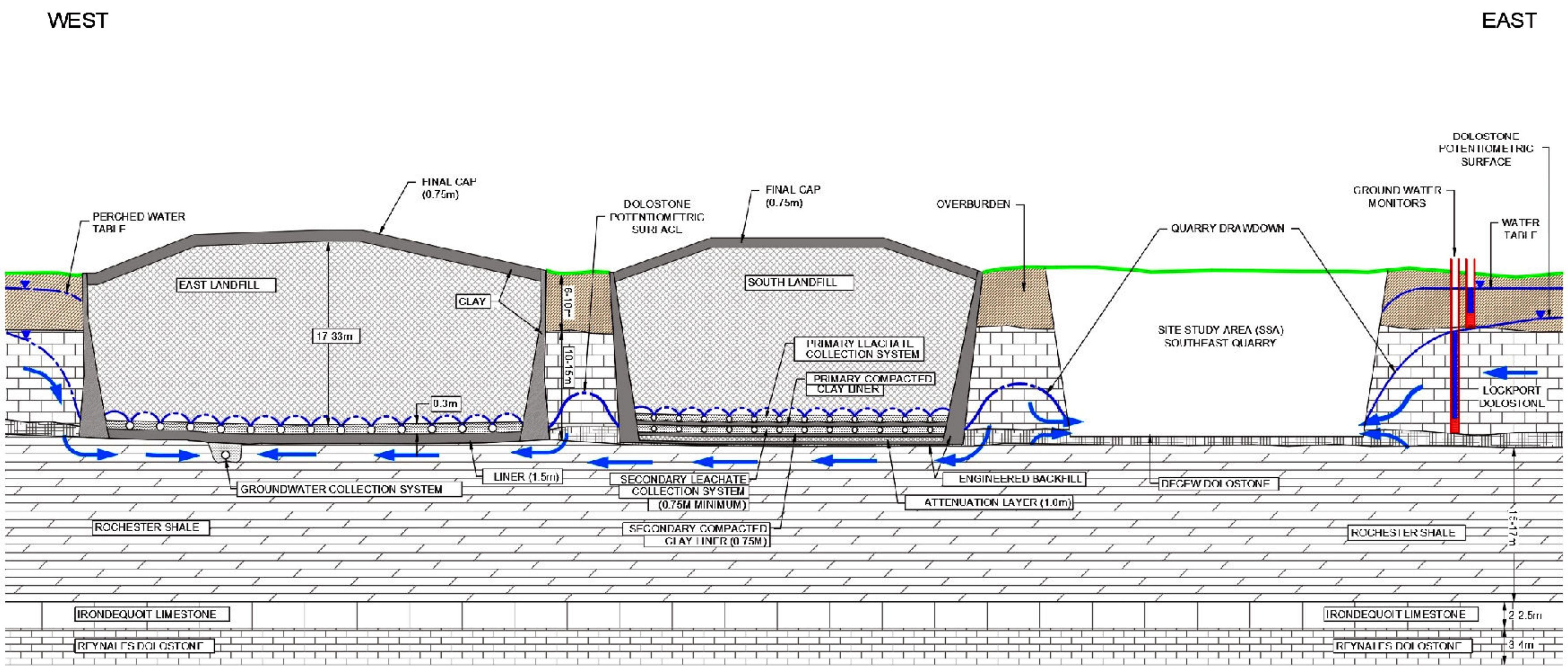

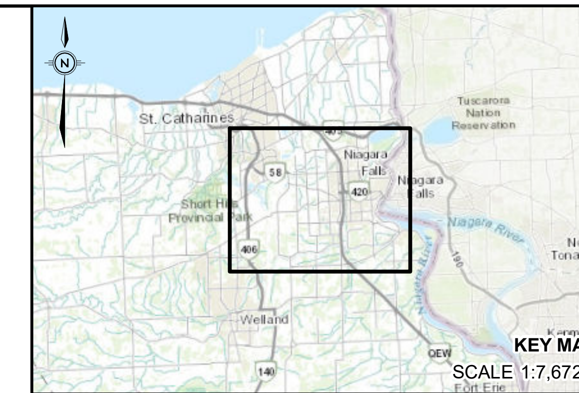

LEGEND

DIRECTION OF GROUNDWATER FLOW

PRELIMINARY DRAFT

SOURCE: 2012 EAST LANDFILL ANNUAL MONITORING REPORT, PREPARED FOR WALKER ENVIRONMENTAL GROUP INC., BY AECOM, APRIL 2013.

NAD 1983 UTM Zone 17N

CONCEPTUAL CROSS SECTION

GEOLOGY AND HYDROGEOLOGY EXISTING CONDITIONS REPORT
WALKER SOUTH LANDFILL PHASE 2
ENVIRONMENTAL ASSESSMENT
For Walker Environmental Group

DATE: JANUARY 2025	wsp
PROJECT: CA0037248.1905 100	
SCALE: NOT TO SCALE	55 KING STREET, SUITE 600 ST. CATHARINES, ON L7R 3H5 T 905-687-1771 | F 905-687-1773 | www.wsp.com
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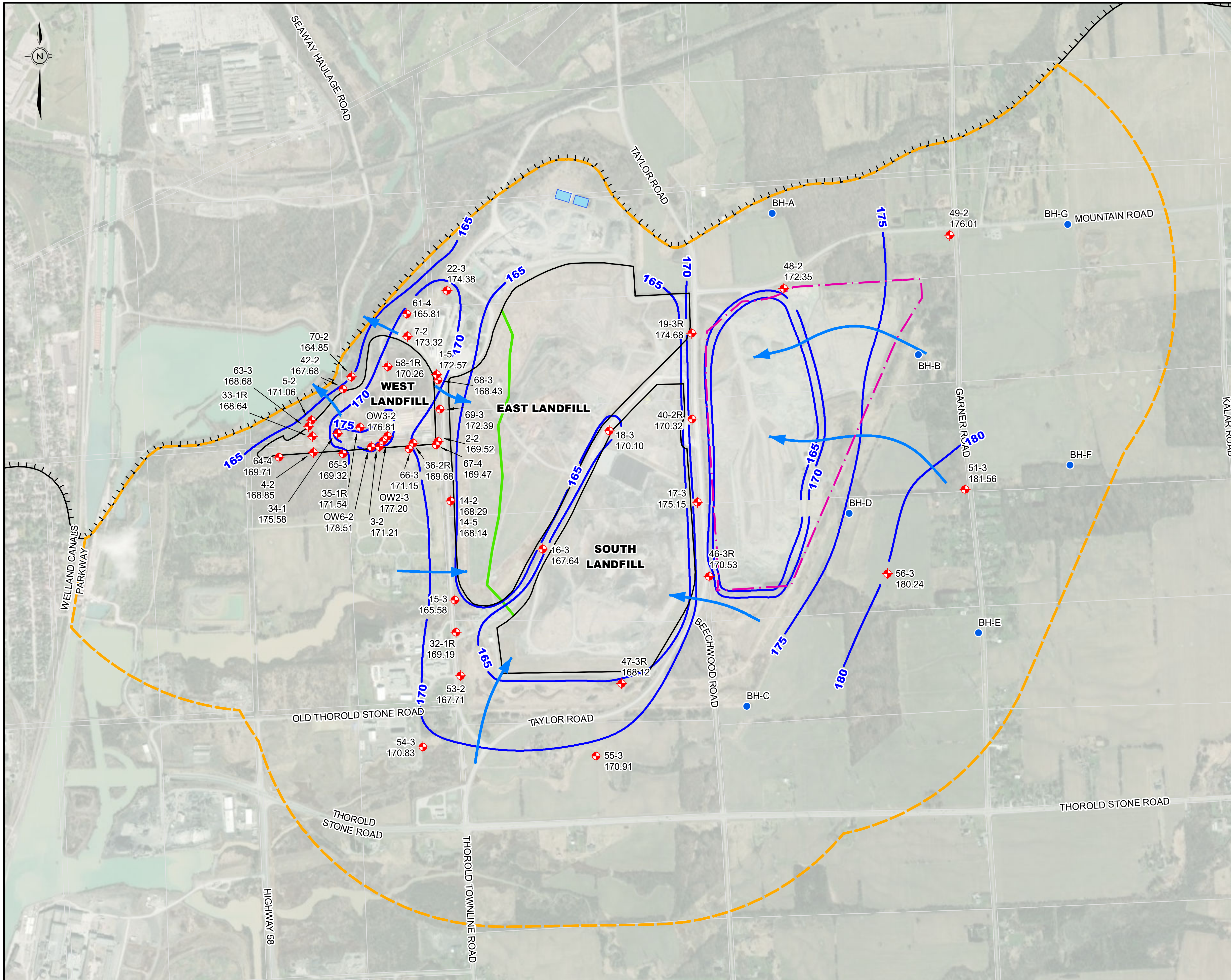

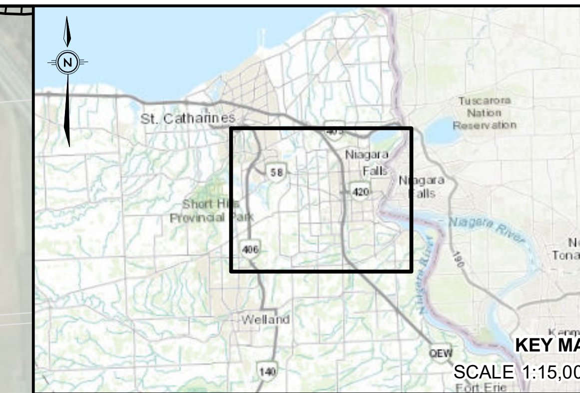

LEGEND

- SITE STUDY AREA (SSA)
- PROPOSED LOCAL STUDY AREA (LSA) (1km CAMPUS BUFFER)
- WALKER RESOURCE MANAGEMENT CAMPUS (EAST, SOUTH AND WEST LANDFILLS)
- APPROXIMATE LOCKPORT SCARP
- GROUNDWATER COLLECTION SYSTEM (GWCS)
- LANDFILL LEACHATE LAGOONS
- MONITORING POINT LOCATION AND DESIGNATION
- PROPOSED BOREHOLE LOCATIONS
- 176.01 POTENTIOMETRIC ELEVATION, JUNE 2024 (masl)
- INFERRED POTENTIOMETRIC CONTOUR (masl)
- INFERRED DIRECTION OF SHALLOW GROUNDWATER FLOW IN LOCKPORT DOLOSTONE

PRELIMINARY DRAFT

0 300 600 m

NAD 1983 UTM Zone 17N

LOCKPORT DOLOSTONE POTENTIOMETRIC SURFACE - JUNE 2024

GEOLOGY AND HYDROGEOLOGY EXISTING CONDITIONS REPORT
WALKER SOUTH LANDFILL PHASE 2 ENVIRONMENTAL ASSESSMENT
For Walker Environmental Group

DATE:	JANUARY 2025
PROJECT:	CA0037248.1905 100
SCALE:	1 : 15,000
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FIGURE No:	4-5

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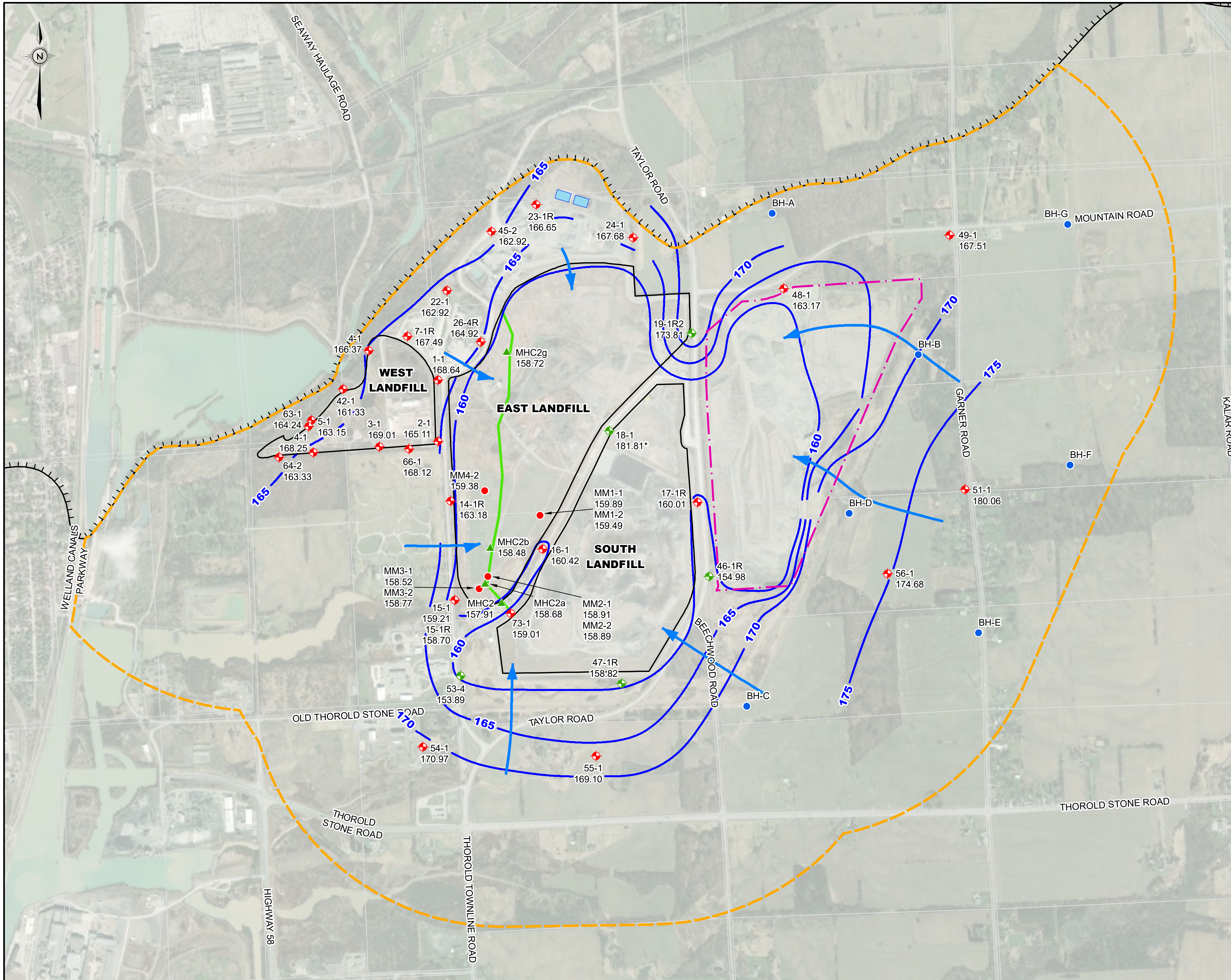
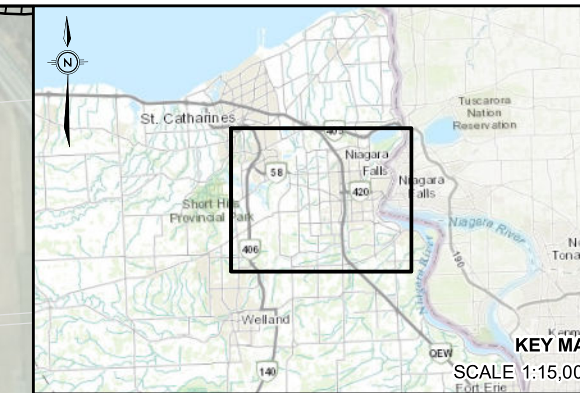
55 KING STREET, SUITE 600
ST. CATHARINES, ON L7R 3H5
T 905-687-1771 | F 905-687-1773 | www.wsp.com





LEGEND

- SITE STUDY AREA (SSA)
- PROPOSED LOCAL STUDY AREA (LSA) (1km CAMPUS BUFFER)
- WALKER RESOURCE MANAGEMENT CAMPUS (EAST, SOUTH AND WEST LANDFILLS)
- APPROXIMATE LOCKPORT SCARP
- GROUNDWATER COLLECTION SYSTEM (GWCS)
- LANDFILL LEACHATE LAGOONS
- MONITORING POINT LOCATION AND DESIGNATION
- SOUTH LANDFILL ECA DESIGNATED SLOW RECOVERY WELLS (sr) - MONITORING WELL MAY BE RECOVERING TO STATIC WATER LEVEL FOLLOWING SAMPLING EVENT
- MANHOLE LOCATION AND DESIGNATION
- GWCS MANHOLE LOCATION AND DESIGNATION
- PROPOSED BOREHOLE LOCATIONS
- 176.01 POTENTIOMETRIC ELEVATION, JUNE 2024 (masl)
- INFERRED POTENTIOMETRIC CONTOUR (masl)
- INFERRED DIRECTION OF HORIZONTAL GROUNDWATER FLOW IN ROCHESTER SHALE

* WATER LEVEL AT 18-1 IS ANOMALOUS DUE TO INFERRED WELL SEAL FAILURE.

PRELIMINARY DRAFT

0 300 600 m

NAD 1983 UTM Zone 17N

ROCHESTER SHALE POTENTIOMETRIC SURFACE - JUNE 2024

GEOLOGY AND HYDROGEOLOGY EXISTING CONDITIONS REPORT
WALKER SOUTH LANDFILL PHASE 2 ENVIRONMENTAL ASSESSMENT
For Walker Environmental Group

DATE: JANUARY 2025	WSP
PROJECT: CA0037248.1905 100	
SCALE: 1 : 15,000	55 KING STREET, SUITE 600 ST. CATHARINES, ON L7R 3H5 T 905-687-1771 | F 905-687-1773 | www.wsp.com
DRAWN BY: JLD	FIGURE No: 4-6

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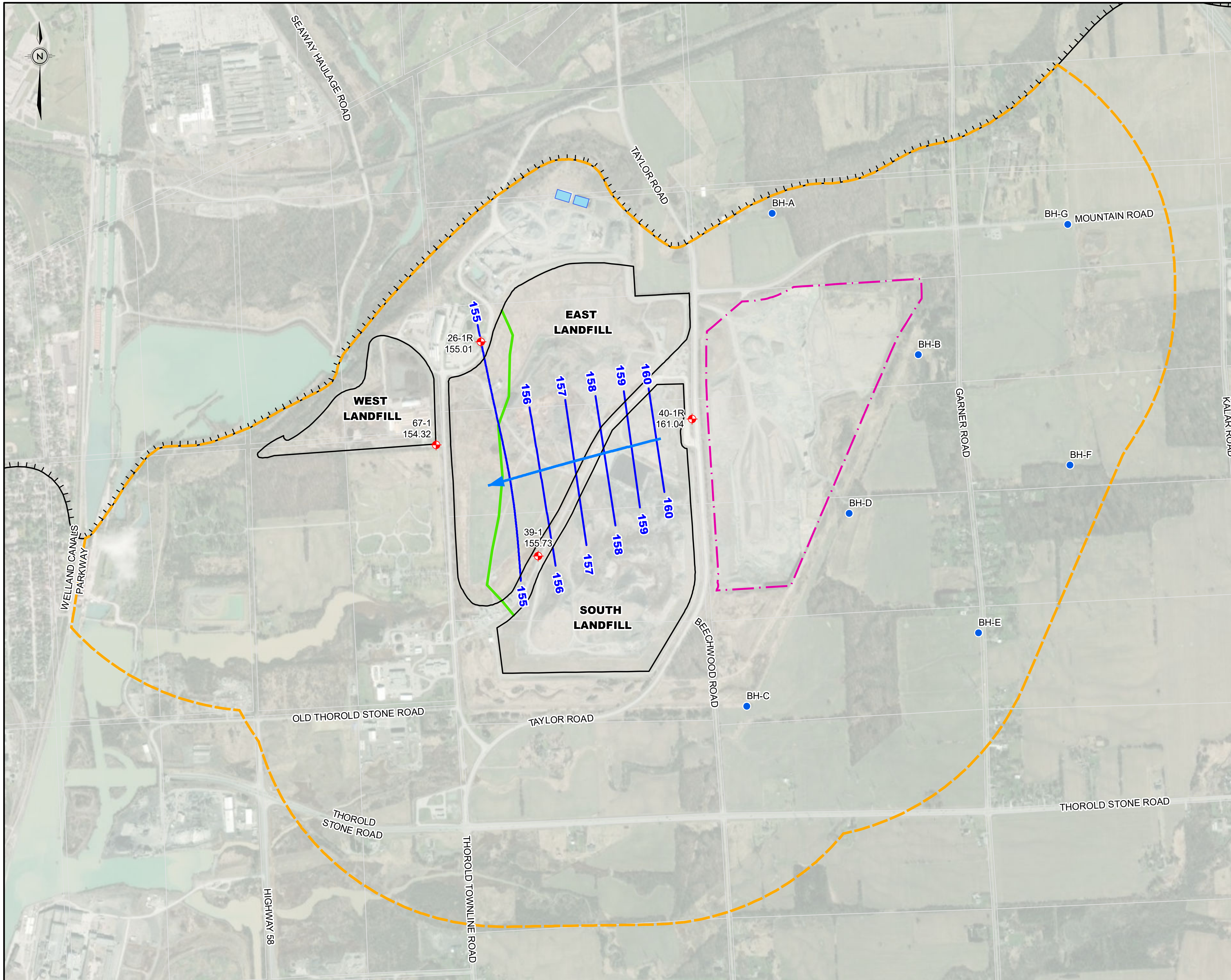

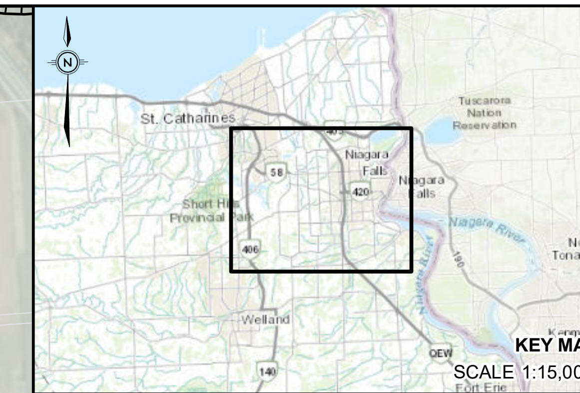

LEGEND

- SITE STUDY AREA (SSA)
- PROPOSED LOCAL STUDY AREA (LSA) (1km CAMPUS BUFFER)
- WALKER RESOURCE MANAGEMENT CAMPUS (EAST, SOUTH AND WEST LANDFILLS)
- APPROXIMATE LOCKPORT SCARP
- GROUNDWATER COLLECTION SYSTEM (GWCS)
- LANDFILL LEACHATE LAGOONS
- MONITORING POINT LOCATION AND DESIGNATION
- PROPOSED BOREHOLE LOCATIONS
- 176.01 POTENTIOMETRIC ELEVATION, MARCH 2024 (masl)
- INFERRED POTENTIOMETRIC CONTOUR (masl)
- INFERRED DIRECTION OF HORIZONTAL GROUNDWATER FLOW IN IRONDEQUOIT LIMESTONE

PRELIMINARY DRAFT

0 300 600 m

NAD 1983 UTM Zone 17N

IRONDEQUOIT LIMESTONE POTENTIOMETRIC SURFACE - MARCH 2024

GEOLOGY AND HYDROGEOLOGY EXISTING CONDITIONS REPORT
WALKER SOUTH LANDFILL PHASE 2 ENVIRONMENTAL ASSESSMENT
For Walker Environmental Group

DATE:	JANUARY 2025
PROJECT:	CA0037248.1905 100
SCALE:	1 : 15,000
DRAWN BY:	JLD
FIGURE No:	4-7

WSP
55 KING STREET, SUITE 600
ST. CATHARINES, ON L7R 3H5
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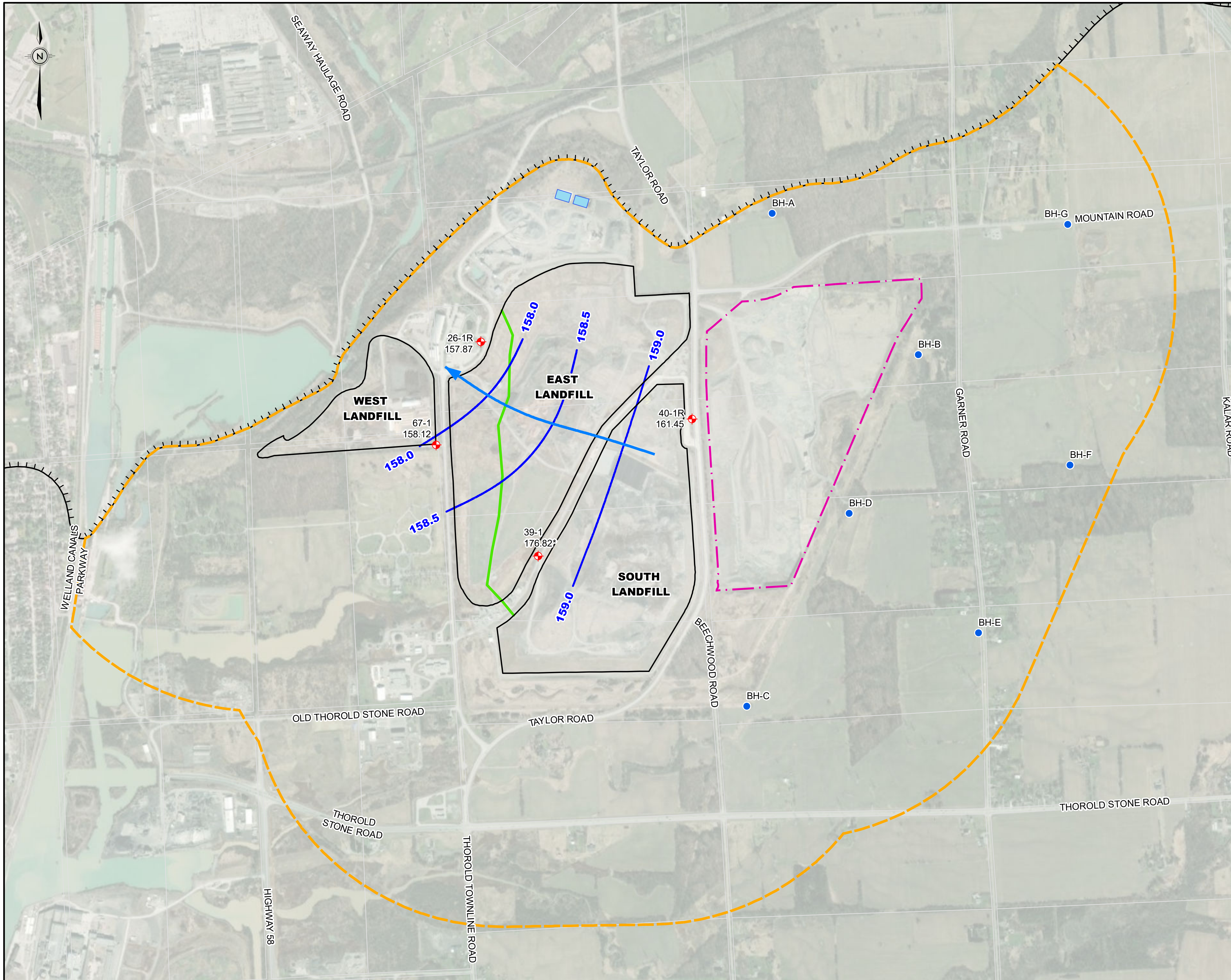

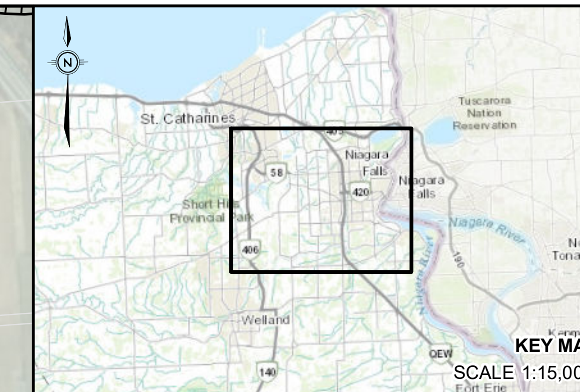

LEGEND

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- LANDFILL LEACHATE LAGOONS
- MONITORING POINT LOCATION AND DESIGNATION
- PROPOSED BOREHOLE LOCATIONS
- 176.01 POTENTIOMETRIC ELEVATION, SEPTEMBER 2024 (masl)
- INFERRED POTENTIOMETRIC CONTOUR (masl)
- INFERRED DIRECTION OF HORIZONTAL GROUNDWAER FLOW IN IRONDEQUOIT LIMESTONE

* WATER LEVEL IN 39-1 INFERRED TO BE ANOMALOUS, CASING FLOODED.

PRELIMINARY DRAFT

0 300 600 m

NAD 1983 UTM Zone 17N

IRONDEQUOIT LIMESTONE POTENTIOMETRIC SURFACE - SEPTEMBER 2024

GEOLOGY AND HYDROGEOLOGY EXISTING CONDITIONS REPORT
WALKER SOUTH LANDFILL PHASE 2 ENVIRONMENTAL ASSESSMENT
For Walker Environmental Group

DATE: JANUARY 2025
PROJECT: CA0037248.1905 100
SCALE: 1 : 15,000
DRAWN BY: JLD

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FIGURE No: 4-8

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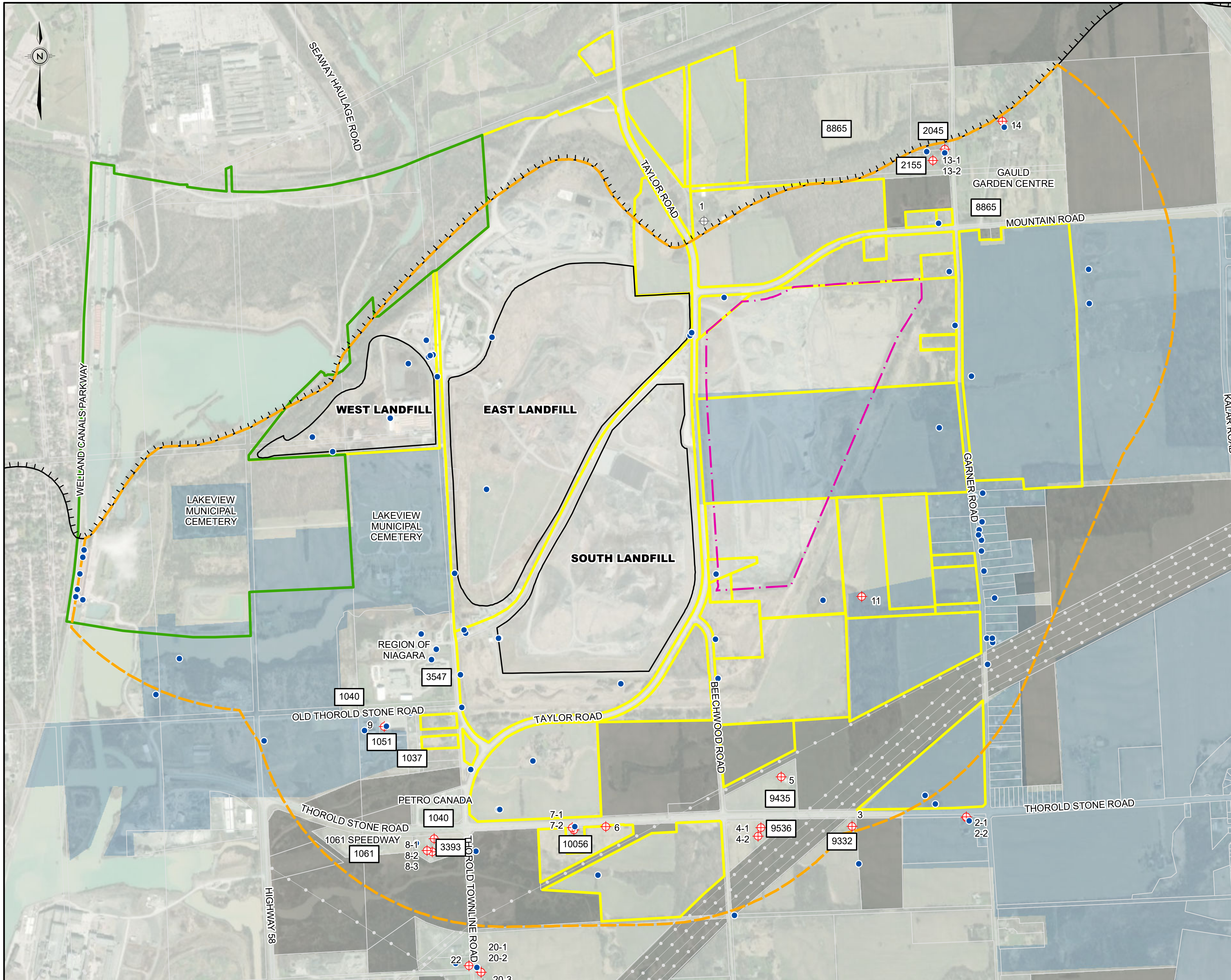

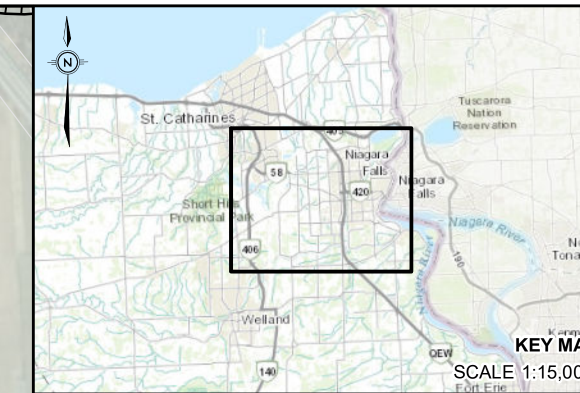

LEGEND

- SITE STUDY AREA (SSA)
- PROPOSED LOCAL STUDY AREA (LSA) (1km CAMPUS BUFFER)
- WALKER RESOURCE MANAGEMENT CAMPUS (EAST, SOUTH AND WEST LANDFILLS)
- APPROXIMATE LOCKPORT SCARP
- HYDRO CORRIDOR
- APPROXIMATE NIAGARA ESCARPMENT PARKS AND OPEN SPACE SYSTEM
- 3547 PARCEL STREET ADDRESS
- WALKER OWNED LANDS
- APPROXIMATE EXISTING WATER SYSTEM (MASTER SERVICING PLAN, NIAGARA REGION, 2016)
- VACANT PARCEL WITH NO ASSOCIATED STREET ADDRESS
- MONITORED RESIDENTIAL WELL LOCATION AND DESIGNATION
- HISTORICALLY MONITORED RESIDENTIAL WELL LOCATION AND DESIGNATION
- MECP WATER WELL RECORD

PRELIMINARY DRAFT

0 300 600 m

NAD 1983 UTM Zone 17N

WATER WELL SURVEY

GEOLOGY AND HYDROGEOLOGY EXISTING CONDITIONS REPORT
WALKER SOUTH LANDFILL PHASE 2 ENVIRONMENTAL ASSESSMENT
For Walker Environmental Group

DATE: JANUARY 2025	WSP
PROJECT: CA0037248.1905 100	55 KING STREET, SUITE 600 ST. CATHARINES, ON L7R 3H5 T 905-687-1771 | F 905-687-1773 | www.wsp.com
SCALE: 1 : 15,000	
DRAWN BY: JLD	FIGURE No: 4-9

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APPENDIX A

Borehole Logs and Rock Core Photos

APPENDIX B

Hydraulic Testing Results

APPENDIX C

Groundwater Elevation Data

APPENDIX D

Water Well Record Search and Survey Results

Table D-1 Water Well Record Search

February 25, 2025
11:11:55 AM

TOWNSHIP CON L	UTM	DATE CN	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
NIAGARA FALLS CITY	17 649042 4775628 W	2005/05 1129	1.97				0091 5	3804251 (Z27858) A026660	BRWN LOAM 0001 BRWN SILT CLAY 0004 BRWN SILT CLAY 0024 GREY 0056 GREY 0067 SHLE 0096
NIAGARA FALLS CITY	17 648475 4774508 W	1971/11 2102	6	FR 0040	14/36/10/2:0	ST DO		6602644 ()	BRWN LOAM 0006 BLUE CLAY 0036 MSND GRVL 0038 ROCK 0044
NIAGARA FALLS CITY	17 650248 4777727 W	1974/08 3608	6	SU 0055 SU 0068	22/65/5/2:0	DO		6602985 ()	BRWN CLAY 0019 GREY LMSN 0070
NIAGARA FALLS CITY	17 650319 4777722 W	1974/12 3608	6	FR 0055	22/60/5/2:0	DO		6603030 ()	BRWN CLAY 0019 GREY LMSN 0063
NIAGARA FALLS CITY	17 648512 4776394 W	2019/12 6607			///:			7351998 (6HI78OQ9) _NO_TAG A	
NIAGARA FALLS CITY	17 650416 4775087 W	2002/05 4795	5 5	FR 0048	8/15/14/2:30	DO		6604658 (240884)	BLCK LOAM PCKD 0001 BRWN CLAY PCKD 0011 BRWN CLAY FGVL PCKD 0019 GREY SHLE LYRD 0020 GREY LMSN LYRD 0051
NIAGARA FALLS CITY	17 649321 4777013 W	2008/06 1129	3.94 1.97			MO		7120942 (Z80401) A067443	LOAM 0000 BRWN FILL SNDY 0002 BRWN CLAY SILT TILL 0022 GRVL 0024 GREY DLMT SHLE 0053 GREY DLMT 0058 GREY SHLE 0091
NIAGARA FALLS CITY	17 649315 4777002 W	2008/09 1129						7120943 (Z85673) A	
NIAGARA FALLS CITY	17 648563 4775806 W	2010/04 7238						7147855 (Z117072) A	
NIAGARA FALLS CITY	17 649321 4777012 W	2015/09 6809	2			MT		7260044 (Z164778) A067443 A	
NIAGARA FALLS CITY 013	17 650555 4777823 W	1972/05 3608	6	FR 0030 FR 0040	20/55/3/3:0	IR DO		6602700 ()	BRWN CLAY STNS 0008 GREY LMSN 0062
NIAGARA FALLS CITY 028	17 650887 4777262 W	1961/02 3409	7 6	FR 0035	18/35/5/2:0	DO		6601269 ()	BRWN CLAY 0028 LMSN 0035
NIAGARA FALLS CITY 029	17 650295 4777443 W	1969/09 3608	6	FR 0055	18/60/6/2:30	DO		6602471 ()	BRWN CLAY 0018 BLUE CLAY 0031 BLUE CLAY GRVL 0033 GREY LMSN 0070
NIAGARA FALLS CITY 029	17 649450 4777151 W	1957/08 3409	6 6	FR 0040	18/43/5/4:0	DO		6601270 ()	CLAY 0018 CLAY STNS 0031 GREY LMSN 0043
NIAGARA FALLS CITY 029	17 650337 4777253 W	1963/12 3608	6 6	FR 0049	25/35/10/1:0	DO		6601271 ()	BLUE CLAY 0036 GREY LMSN 0050
NIAGARA FALLS CITY 032	17 650360 4777041 W	1959/05 3409	6	FR 0030	10/20/5/3:0	DO		6601272 ()	BRWN CLAY 0012 BLUE CLAY 0030 FSND 0031 GRVL 0032

TOWNSHIP CON L	UTM	DATE CN	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
NIAGARA FALLS CITY 033	17 650890 4777127 W	1960/05 3409	7 7	FR 0032	5/20/17/2:0	ST DO		6601274 ()	CLAY 0008 BLUE CLAY 0031 GRVL 0032 LMSN 0033
NIAGARA FALLS CITY 033	17 650425 4776840 W	1956/10 3409	6 6	FR 0019	2/15/25/2:0	DO		6601273 ()	BRWN CLAY 0008 BLUE CLAY 0018 LMSN 0020
NIAGARA FALLS CITY 047	17 650469 4776379 W	1961/05 3409	7 6	FR 0025	6/23/5/2:0	DO		6601281 ()	CLAY 0016 HPAN STNS 0024 LMSN 0025
NIAGARA FALLS CITY 048	17 650298 4776637 W	1957/04 3409	6 4	FR 0020	4/15/8/2:0	DO		6601282 ()	CLAY 0010 BLUE CLAY 0015 CLAY MSND 0020 GRVL 0021 GREY LMSN 0024
NIAGARA FALLS CITY 051	17 649418 4776059 W	1963/07 3608	6 6	FR 0027	12/20/10/1:0	DO		6601283 ()	BRWN CLAY 0025 GREY LMSN 0027
NIAGARA FALLS CITY 051	17 649840 4775957 W	1964/08 3409	6 6	SU 0032	8/28/2/2:0	ST		6601284 ()	BRWN CLAY 0025 LMSN 0032
NIAGARA FALLS CITY 052	17 650465 4776151 W	1959/07 3409	7	FR 0024	9/15/8/2:0	DO		6601292 ()	BRWN CLAY 0024 GRVL 0025 LMSN 0026
NIAGARA FALLS CITY 052	17 650453 4776214 W	1959/06 3409	6	FR 0026	10/23/5/3:0	DO		6601291 ()	BRWN CLAY 0024 CLAY MSND 0025 GRVL 0026 LMSN 0027
NIAGARA FALLS CITY 052	17 650455 4776234 W	1959/03 3409	6	FR 0024	12/23/8/2:0	DO		6601290 ()	BRWN CLAY 0012 BLUE CLAY 0016 BRWN CLAY MSND 0023 GRVL 0024 LMSN 0025
NIAGARA FALLS CITY 052	17 650464 4776194 W	1957/03 3409	6	FR 0020	4/15/8/2:0	DO		6601289 ()	BRWN CLAY 0010 BLUE CLAY 0020 GRVL 0022 LMSN 0023
NIAGARA FALLS CITY 052	17 650474 4776072 W	1956/10 3409	6 6	FR 0028	6/23/5/2:0	DO		6601288 ()	BRWN CLAY 0010 BLUE CLAY 0026 LMSN 0028
NIAGARA FALLS CITY 052	17 650461 4776204 W	1956/10 3409	6 6	SU 0034	6/23/5/2:0	DO		6601287 ()	BRWN CLAY 0010 BLUE CLAY 0020 CLAY MSND 0027 FSND 0028 LMSN 0034
NIAGARA FALLS CITY 052	17 650486 4775807 W	1955/10 3409	6 6	SU 0032	9/33/3/1:0	DO		6601286 ()	BRWN CLAY 0008 BLUE CLAY 0024 LMSN 0034
NIAGARA FALLS CITY 052	17 650438 4776364 W	1953/11 5425	6 6	FR 0026	15/15/6/0:30	DO		6601285 ()	YLLW CLAY 0009 BLUE CLAY 0023 GRVL 0025 LMSN 0028
NIAGARA FALLS CITY 064	17 650508 4775807 W	1958/09 5425	6 6	FR 0029	12/15/10/0:30	DO		6601302 ()	LOAM 0001 BRWN CLAY 0015 BLUE CLAY 0023 SHLE 0024 BRWN LMSN 0031
NIAGARA FALLS CITY 064	17 650509 4775790 W	1955/08 3409	6 6	FR 0032	4/20/8/2:0	DO		6601300 ()	CLAY 0020 MSND STNS 0023 LMSN 0033
NIAGARA FALLS CITY 064	17 650488 4775704 W	1956/06 3609	6	FR 0025	8/8/17/:	DO		6601301 ()	CLAY 0023 GRVL 0025
NIAGARA FALLS CITY 064	17 650516 4775965 W	1954/10 3409	6 6	FR 0029	9/20/20/2:0	DO		6601299 ()	CLAY 0018 BLUE CLAY 0027 GRVL 0029 LMSN 0030
NIAGARA FALLS CITY 065	17 649415 4775803 W	1977/10 2123	7	FR 0035	12//6/2:0	ST DO		6603250 ()	BRWN CLAY 0009 GREY CLAY 0020 CLAY GRVL 0034 ROCK 0035
NIAGARA FALLS CITY 065	17 649425 4775648 W	1971/10 3609	6	FR 0033	12/14/10/1:0	ST DO		6602648 ()	GREY CLAY 0031 HPAN 0032 SHLE 0033

TOWNSHIP CON L	UTM	DATE CN	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
NIAGARA FALLS CITY 066	17 648415 4775533 W	1972/10 3608	6	FR 0034	18/25/5/2:0	DO		6602725 ()	BRWN CLAY 0015 GREY CLAY 0032 GREY CLAY GRVL 0034
NIAGARA FALLS CITY 067	17 648695 4775323 W	1978/03 5417	6	FR 0031	15/19/25/1:0	DO		6603262 ()	BRWN CLAY 0013 GREY CLAY 0030 GREY LMSN 0032
NIAGARA FALLS CITY 067	17 648450 4775288 W	1953/06 3409	6	SU 0033	6/23/10/2:0	DO		6601303 ()	CLAY 0015 BLUE CLAY 0025 MSND 0032 LMSN 0033
NIAGARA FALLS CITY 068	17 650242 4775187 W	1960/06 5425	6 6	FR 0028	2/13/6/0:30	DO		6601304 ()	LOAM 0001 BRWN CLAY 0017 BLUE CLAY 0027 GRVL 0028 BRWN LMSN 0030
NIAGARA FALLS CITY 069	17 650283 4775153 W	1949/04 3409	6 6	FR 0029	10/20/15/1:0	ST DO		6601305 ()	CLAY 0005 BRWN CLAY 0018 MSND STNS 0025 GRVL 0028 LMSN 0030
NIAGARA FALLS CITY 082	17 649980 4774916 L	2000/05 2123	6	FR 0038 SU 0055	13//20/1:0	DO		6604439 (210921)	BRWN CLAY 0001 GREY CLAY 0029 GREY CLAY GRVL 0033 ROCK LMSN 0063
NIAGARA FALLS CITY 083	17 648861 4775064 W	1967/05 3409	6	FR 0031	12/23/17/2:0	DO		6601326 ()	CLAY 0031 LMSN 0032
NIAGARA FALLS CITY 083	17 648471 4774966 W	1949/08 3409	6 6	MN 0036	22/25/15/1:0	ST		6601325 ()	CLAY 0010 BLUE CLAY 0034 MSND 0035 LMSN 0037
NIAGARA FALLS CITY 083	17 648952 4774872 L	1998/10 2123	6	FR 0055	20//15/1:0	DO		6604319 (192377)	BRWN CLAY 0002 GREY CLAY 0014 GREY CLAY GRVL 0030 ROCK 0060
NIAGARA FALLS CITY 085	17 649491 4774713 W	1956/12 3409	6 6	SU 0043	14/30/8/3:0	DO		6601328 ()	LOAM MSND 0005 BLUE CLAY 0020 CLAY MSND 0033 CLAY MSND STNS 0035 LMSN 0044
NIAGARA FALLS CITY (	17 650467 4776266 W	7179						7168531 (Z127633) A112542	
NIAGARA FALLS CITY (066	17 648560 4775131 W	2010/04 7238						7147854 (Z117073) A	
NIAGARA FALLS CITY (066	17 648560 4775806 W	2010/04 7238						7147856 (Z117071) A	
NIAGARA FALLS CITY (066	17 648565 4775131 W	2010/04 7238						7147857 (Z117085) A	
THOROLD TOWN	17 647905 4776543 W	1960/06 3409	7 6	FR 0039	33/37/3/2:0	DO		6601625 ()	BRWN CLAY 0032 LMSN 0039
THOROLD TOWN	17 648275 4776983 W	1963/04 3409	7 6	SU 0301	91/291/13/2:0	CO		6601626 ()	BRWN CLAY STNS 0034 LMSN 0145 WHIT SNDS 0167 RED SNDS 0201 LMSN 0210 RED SNDS 0241 RED SHLE 0301
THOROLD TOWN	17 648131 4776679 W	2022/06 7282		UT 0036	///:	MO		7426996 (WZKXI3TH) _NO_TAG A	
THOROLD TOWN	17 648302 4776925 W	2007/09 1129	1.97		///:	MO		7100093 (Z67566) A060903	BRWN LOAM FILL 0002 BRWN SILT CLYY 0010 BRWN CLAY SLTY 0018 BRWN CLAY 0028 BRWN GRVL SNDY 0030 GREY SAND GVLY 0032 GREY GRVL 0041 GREY SHLE 0092 GREY LMSN 0100

TOWNSHIP CON L	UTM	DATE CN	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
THOROLD TOWN	17 648133 4776675 W	2022/06 7282		UT 0036	///:	MO		7422646 (I994J74U) _NO_TAG A	
THOROLD TOWN	17 648284 4776917 W	2007/05 1129	1.97		///:	MO		7052656 (Z67540) A055377	BRWN FILL CLAY SILT 0007 BRWN TILL SILT SILT 0040 GREY DLMT 0051 GREY SHLE 0090
THOROLD TOWN	17 648133 4776675 W	2022/06 7282		UT 0036	///:	MO		7426997 (I994J74U) _NO_TAG A	
THOROLD TOWN	17 648134 4776681 W	2022/06 7282		UT 0036	///:	MO		7422644 (LPC4BA63) _NO_TAG A	
THOROLD TOWN	17 648131 4776679 W	2022/06 7282		UT 0036	///:	MO		7422645 (WZKXI3TH) _NO_TAG A	
THOROLD TOWN	17 648284 4776917 W	2007/05 1129			///:	MO		7100086 (Z67558) A	
THOROLD TOWN	17 648410 4775663 W	2008/12 1129	1.97				0098 5	7120522 (Z87494) A073967	BRWN SILT CLYY 0018 BRWN CLAY SLTY SOFT 0030 BRWN CLAY CSND SLTY 0033 GREY DLMT 0068 GREY DLMT 0078 BLCK DLMT SHLE CLAY 0104
THOROLD TOWN	17 648134 4776681 W	2022/06 7282		UT 0036	///:	MO		7426995 (LPC4BA63) _NO_TAG A	
THOROLD TOWN	17 648290 4776922 W	2007/05 1129			///:	MO		7102530 (Z67574) A	
THOROLD TOWN	17 648534 4776994 W	2008/03 1129				MO		7106013 (Z80372) A	
THOROLD TOWN (THOROL	17 646920 4775959 W	2010/12 7238				TH	0087 5	7157907 (Z123642) A109984	GREY ---- 0085 BLCK SHLE ROCK 0092
THOROLD TOWN (THOROL	17 646925 4776155 W	2010/12 7238				TH	0087 5	7157911 (Z123648) A110034	GREY ---- 0085 BLCK SHLE ROCK 0092
THOROLD TOWN (THOROL	17 646892 4775970 W	2010/12 7238	2			TH	0087 5	7157912 (Z123647) A110031	GREY ---- 0085 BLCK SHLE ROCK 0092
THOROLD TOWN (THOROL	17 646920 4775959 W	2010/12 7238	2			TH	0087 5	7157906 (Z123641) A109985	GREY ---- 0085 BLCK SHLE ROCK 0092
THOROLD TOWN (THOROL	17 648355 4775164 W	2015/08 7179	6.25 6.25	UT 0050	20/20/10/:30	IR		7248844 (Z201587) A141372	BRWN LOAM 0008 BRWN CLAY DNSE 0019 GREY CLAY SOFT 0035 GREY ROCK FCRD 0065

TOWNSHIP CON L	UTM	DATE CN	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
THOROLD TOWN (THOROL	17 647301 4775727 W	2018/11 7609						7326551 (C42418) A242648 P	
THOROLD TOWN (THOROL	17 648387 4776063 W	2015/09 6809						7260185 (C31309) A177560 P	
THOROLD TOWN (THOROL	17 648430 4775827 W	2018/09 7320	0.79	UT		TH MO	0033 33	7322943 (Z292692) A252233	BRWN FILL 0007 BRWN CLAY 0039 GREY CLAY 0066
THOROLD TOWN (THOROL	17 646920 4776126 W	2010/12 7238	2			TH	0087 5	7157913 (Z123646) A107525	GREY ---- 0085 BLCK SHLE ROCK 0092
THOROLD TOWN (THOROL	17 646896 4775972 W	2010/12 7238	2			TH	0087 5	7157905 (Z123643) A109983	GREY ---- 0085 BLCK SHLE ROCK 0092
THOROLD TOWN (THOROL	17 646898 4776000 W	2010/12 7238	2			TH	0087 5	7157904 (Z123644) A109982	GREY ---- 0085 BLCK SHLE ROCK 0092
THOROLD TOWN (THOROL	17 646909 4776060 W	2010/12 7238	2			TH	0087 5	7157903 (Z123645) A109981	GREY ---- 0085 BLCK SHLE ROCK 0092
THOROLD TOWN (THOROL	17 648118 4775460 W	2019/09 7179						7342579 (Z298876) A	
THOROLD TOWN (THOROL	17 647825 4776600 W	2007/05 1129			///:	MO		7100095 (Z67557) A	
THOROLD TOWN (THOROL	17 648204 4776890 W	2007/05 1129			///:	MO		7100094 (Z67556) A	
THOROLD TOWN (THOROL	17 648031 4775442 W	2019/11 7179	6.25 6.25	UT 0055 UT 0120	18/67/10/1:0	IN		7349174 (Z326122) A283985	BRWN CLAY DNSE 0033 GREY ROCK FCRD 0125
THOROLD TOWN (THOROL	17 647208 4775585 W	1950/07 3409	6 6	SU 0052	10/23/15/2:0	CO		6601628 ()	CLAY 0010 BLUE CLAY 0048 STNS 0050 LMSN 0052
THOROLD TOWN (THOROL	17 648423 4775839 W	2018/09 7320	0.79	UT		TH MO	0033 33	7322944 (Z292693) A252234	BRWN FILL 0007 BRWN CLAY 0039 GREY CLAY 0066
THOROLD TOWN (THOROL	17 648119 4775462 W	2019/09 7179						7342540 (Z298875) A	
THOROLD TOWN (THOROL 004	17 648318 4776839 W	2018/05 7626						7328170 (C40335) A243073 P	
THOROLD TOWN (THOROL 012	17 648295 4775723 W	1978/10 5417	6	SU 0032	14/26/10/1:0	MN		6603287 ()	BRWN CLAY 0019 GREY CLAY 0031 GREY LMSN 0032

TOWNSHIP CON L	UTM	DATE CN	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
THOROLD TOWN (THOROL 012	17 648415 4775163 W	1978/06 2123		FR 0042	16/25/20/2:0	ST		6603302 ()	BRWN CLAY 0006 BLUE CLAY 0032 STNS 0045
THOROLD TOWN (THOROL 012	17 648315 4775763 W	1980/05 5417	7	SU 0032	14/20/18/1:0	MN		6603388 ()	BRWN CLAY 0018 GREY CLAY 0032 GREY LMSN 0032
THOROLD TOWN (THOROL 012	17 648255 4775823 W	1978/10 5417	6	SU 0027	11/21/8/1:0	MN		6603286 ()	BRWN CLAY 0017 GREY CLAY 0026 GREY LMSN DKCL 0028
THOROLD TOWN (THOROL 025	17 648213 4775512 W	1951/10 4754	6 6	FR 0035	12///:	DO		6601637 ()	CLAY 0020 LMSN 0035
THOROLD TOWN (THOROL 025	17 648391 4774524 W	1964/12 3608	6 6	FR 0035	20/25/10/1:0	ST		6601638 ()	RED CLAY 0032 GREY SHLE 0035
THOROLD TOWN (THOROL 025	17 648235 4774998 L	1989/08 2123	6	FR 0047	26/49/5/1:0	DO		6603911 (42613)	BRWN CLAY LOAM 0002 GREY CLAY 0021 GREY CLAY GRVL 0030 LMSN 0049
THOROLD TOWN (THOROL 026	17 647635 4775401 W	1949/09 3409	6 6	SU 0040	10/42/10/1:0	DO		6601639 ()	CLAY 0020 BLUE CLAY 0035 LMSN 0042

Notes:
UTM: UTM in Zone, Easting, Northing and Datum is NAD83; L: UTM estimated from Centroid of Lot; W: UTM not from Lot Centroid
DATE CNTR: Date Work Completedand Well Contractor Licence Number
CASING DIA: .Casing diameter in inches
WATER: Unit of Depth in Fee. See Table 4 for Meaning of Code

PUMP TEST: Static Water Level in Feet / Water Level After Pumping in Feet / Pump Test Rate in GPM / Pump Test Duration in Hour : Minutes
WELL USE: See Table 3 for Meaning of Code
SCREEN: Screen Depth and Length in feet
WELL: WEL (AUDIT #) Well Tag . A: Abandonment; P: Partial Data Entry Only

1. Core Material and Descriptive terms

Code	Description	Code	Description	Code	Description	Code	Description	Code	Description
BLDR	BOULDERS	FCRD	FRACTURED	IRFM	IRON FORMATION	PORS	POROUS	SOFT	SOFT
BSLT	BASALT	FGRD	FINE-GRAINED	LIMY	LIMY	PRDG	PREVIOUSLY DUG	SPST	SOAPSTONE
CGRD	COARSE-GRAINED	FGVL	FINE GRAVEL	LMSN	LIMESTONE	PRDR	PREV. DRILLED	STKY	STICKY
CGVL	COARSE GRAVEL	FILL	FILL	LOAM	TOPSOIL	QRTZ	QUARTZITE	STNS	STONES
CHRT	CHERT	FLDS	FELDSPAR	LOOS	LOOSE	QSND	QUICKSAND	STNY	STONEY
CLAY	CLAY	FLNT	FLINT	LTCL	LIGHT-COLOURED	QTZ	QUARTZ	THIK	THICK
CLN	CLEAN	FOSS	FOSILIFEROUS	LYRD	LAYERED	ROCK	ROCK	THIN	THIN
CLYY	CLAYEY	FSND	FINE SAND	MARL	MARL	SAND	SAND	TILL	TILL
CMTD	CEMENTED	GNIS	GNEISS	MGRD	MEDIUM-GRAINED	SHLE	SHALE	UNKN	UNKNOWN TYPE
CONG	CONGLOMERATE	GRNT	GRANITE	MGVL	MEDIUM GRAVEL	SHLY	SHALY	VERY	VERY
CRYS	CRYSTALLINE	GRSN	GREENSTONE	MRBL	MARBLE	SHRP	SHARP	WBRG	WATER-BEARING
CSND	COARSE SAND	GRVL	GRAVEL	MSND	MEDIUM SAND	SHST	SCHIST	WDFR	WOOD FRAGMENTS
DKCL	DARK-COLOURED	GRWK	GREYWACKE	MUCK	MUCK	SILT	SILT	WTHD	WEATHERED
DLMT	DOLOMITE	GVLY	GRAVELLY	OBDN	OVERBURDEN	SLTE	SLATE		
DNSE	DENSE	GYPS	GYPSUM	PCKD	PACKED	SLTY	SILTY		
DRTY	DIRTY	HARD	HARD	PEAT	PEAT	SNDS	SANDSTONE		
DRY	DRY	HPAN	HARDPAN	PGVL	PEA GRAVEL	SNDY	SANDYOAPSTONE		

2. Core Color

Code	Description
WHIT	WHITE
GREY	GREY
BLUE	BLUE
GREN	GREEN
YLLW	YELLOW
BRWN	BROWN
RED	RED
BLCK	BLACK
BLGY	BLUE-GREY

3. Well Use

Code	Description	Code	Description
DO	Domestic	OT	Other
ST	Livestock	TH	Test Hole
IR	Irrigation	DE	Dewatering
IN	Industrial	MO	Monitoring
CO	Commercial	MT	Monitoring TestHole
MN	Municipal		
PS	Public		
AC	Cooling And A/C		
NU	Not Used		

4. Water Detail

Code	Description	Code	Description
FR	Fresh	GS	Gas
SA	Salty	IR	Iron
SU	Sulphur		
MN	Mineral		
UK	Unknown		

APPENDIX E

Groundwater Quality Data

APPENDIX F

Limitations

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