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Appendix G

Conceptual Snow Storage Facilities and Stormwater Management Servicing Approach Technical Memorandum

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Project name:
Region of Peel Snow Storage Environmental Assessment

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Memo

Subject: Conceptual Snow Storage Facilities and SWM Servicing Approach

1. Introduction

AECOM has been retained by the Regional Municipality of Peel (“The Region”) to complete analysis and conceptual design of short-listed potential snow storage and passive snowmelt sites distributed throughout The Region. The scope of this work includes the completion of necessary studies that would satisfy the Schedule ‘B’ requirements of the Municipal Class Environmental Assessment (MCEA) to establish conceptual designs of validated sites from those identified in the Request for Proposals. These validated sites will provide near and long-term snow storage solutions that are environmentally sound and politically acceptable for the Region. The conceptual snow storage facilities will provide quantity and quality control treatment for design storm events, while also providing appropriate stormwater controls to effectively manage passive snowmelt.

The EA is to consider the following ten sites throughout The Region as part of the assessment for selecting snow storage facility locations:

- Site 1: Highway No. 50 Carpool Lot (Caledon, ON).
- Site 2: Beckett Sproule Reservoir and Pumping Station (Brampton, ON).
- Site 3: West Brampton Reservoir and Pumping Station (Brampton, ON).
- Site 4: Clarkson Wastewater Treatment Plant (Mississauga, ON).
- Site 5: Johnston Sports Park (Caledon, ON).
- Site 6: Tullamore Reservoir and Pumping Station (Caledon, ON).
- Site 7: Future Hanlan West Reservoir Expansion (Mississauga, ON).
- Site 8: 220 Westcreek Boulevard Trunk Sewers and Feedermain (Brampton, ON).
- Site 9: Alloa Reservoir and Pumping Station (Caledon, ON).
- Site 10: 7120 Hurontario Street (Mississauga, ON)

The purpose of this memorandum is to present AECOM's proposed stormwater management approach for the proposed snow storage sites that will provide appropriate quantity and quality control treatment for stormwater management, based on the background review and investigations completed to date at each site.

2. Background

The Region is an upper-tier municipality located in the Greater Toronto Area. Established in 1974, the Region has a geographic management area of 1,225 km^2 and has the highest regional population growth rate in the Greater Toronto Area (GTA). Currently, the Region is home to more than 1.38 million residents living within the lower-tier municipalities of Caledon, Brampton, and Mississauga. With more than 467 km of arterial roadway (1,663 lane-km) under its management authority, the Region is responsible for maintaining world-class transportation infrastructure to facilitate the movement of people and goods while ensuring sustainable economic development across the Region. Adding to this large and complex task is the fact that the Region is tasked with ensuring that their road network remains safe and operational 365 days per year. In the winter months, this requires that the Region clear accumulated snow from bridges and overpasses, intersections with sightline issues, and roadway areas with narrow boulevards/space restrictions, and Regional facilities. To safely dispose of any snow removed from the Region's roadways and facilities, strategically placed and well-designed snow disposal facilities are required to effectively store and manage the passive melting of the snow while mitigating undesirable environmental and operational impacts.

This technical memorandum focuses on the ten subject sites identified in the Request for Proposals as it pertains to conceptual site plans and site servicing with respect to stormwater management (SWM) design and has been updated to include relevant details from the September 7, 2023 Region of Peel stakeholder engagement meeting.

The following four sites have been removed from consideration for future potential snow storage site development. Conceptual site plans and site servicing will not be provided for the following:

- Site 2: Beckett Sproule Reservoir and Pumping Station (Brampton, ON).
    - This site was removed from consideration of snow storage facility development due to conflicting future site development plans.
- Site 4: Clarkson Wastewater Treatment Plant (Mississauga, ON).
    - As a result of the status of a separate site EA, proposed future site build-out, low lane-kilometers of Regional roads in the site's vicinity, and concerns regarding site contamination, this site was removed from further consideration.
- Site 7: Future Hanlan West Reservoir Expansion (Mississauga, ON).
    - This site was removed from consideration due to drainage and site access concerns.
- Site 8: 220 Westcreek Boulevard Trunk Sewers and Feedermain (Brampton, ON).
    - This site was removed from consideration due to concerns which include, but are not limited to, potential site contamination, proximity to highways, and Conservation Authority regulated status.

A memorandum with the subject "Rationale for Eliminated Snow Storage Site Options" was transmitted to the Region on July 27, 2022, which summarized additional details regarding the removal of the above sites from further consideration.

This technical memorandum details the conceptual site plans and SWM design for the remaining properties. A background summary of each of the six short listed sites, in which a conceptual site plan and site servicing will be provided, are summarized in Table 1 below. This table also includes information regarding current site usage at each location.

Table 1: Site Background Information

No.	Site Name	Existing Site Use	Description of the Proposed Location for Development Within the Site Boundaries
1	Highway 50 Carpool Lot	Site 1 is a 24/7 commuter lot for carpooling and for GO Transit Bus Stop Park 'N Ride. Cars can park for free, and there is an on-site passenger pick-up/drop-off location. The bus stop is located south of the site and is serviced by the Bolton GO bus route to and from the Malton GO Station.	The segment of Site 1 currently proposed for snow storage facility implementation is a grassed area with no existing services at the southern edge of the Highway 50 Carpool Lot.
3	West Brampton Reservoir and Pumping Station	Site 3 is a lake-based water transmission facility that is part of the central trunk system, which provides a direct supply to the local water distribution system.	Grassed landscaped area with gravel access road north of the existing reservoir, adjacent to fill berms.
5	Johnston Sports Park	Site 5 is a community recreational outdoor field in the Town of Caledon, owned and operated by the Town. Accessible parking is located near the roadway entrance at King Street.	South-central section of the existing sports complex. Currently planned to serve as facility parking lot "P4".
6	Tullamore Reservoir and Pumping Station	Site 6 is a drinking water transmission facility that is part of the east trunk system which provides a direct supply to the local water distribution network. The Caledon Water Station is a bulk water filling depot, located in the private roadway loop on the north side of the site.	Existing grassed / landscaped area adjacent to Innis Lake Road. Located just south of existing asphalt turning area.
9	Alloa Reservoir and Pumping Station	Site 9 is a lake-based water transmission facility that is part of the west trunk system, which provides a direct supply to the local water distribution system.	East side of the site, in place of existing turnaround area. Adjacent to existing agricultural lands slated for future development.
10	7120 Hurontario Street	Site 10 is a Region of Peel-owned multi-use office complex, with multiple parking lots.	The northwest parking lot is proposed to be redeveloped for dual use; as a snow storage facility in winter and parking in the summer.

A map identifying the location of each of the short-listed sites summarized in Table 1 is presented in Figure 1, below.

Region of Peel

Site Locations - Key Map

Snow Storage Site Analysis and Conceptual Design Project 13-4007
AECOM Project: 60646784

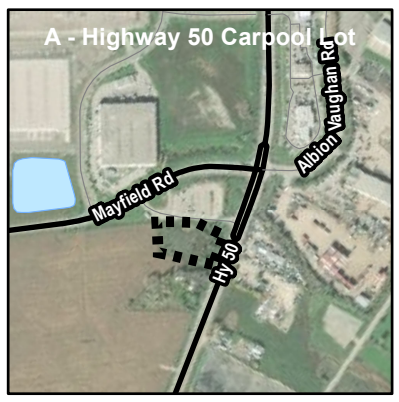
Region of Peel
Working for you

AECOM

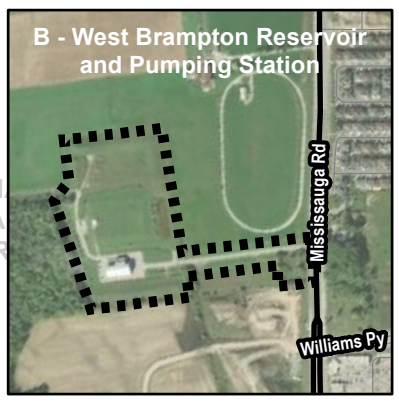
COUNTY OF DUFFERIN
COUNTY OF SIMCOE
COUNTY OF WELLINGTON
REGIONAL MUNICIPALITY OF HALTON
REGION MUNICIPA OF YOR
TOWN OF CALEDON
CITY OF BRAMPTON
CITY OF MISSISSAUGA

Porterfield Rd
Main St
Charleston SR
Forks of the Credit Rd
Bush St
Old Main St
Old Church Rd
Olde Base Line Rd
The Core Rd
Emil Kolb Py
Queen St N
King St E
King St W
Queen St S
King St
Dixie Rd
Airport Rd
Coleraine Dr
Hy 50
Mayfield Rd
Mississauga Rd
Bovaird Dr E
Bovaird Dr W
Kennedy Rd S
Kennedy Rd N
Queen St E
Queen St W
Embleton Rd
Steeles Rd E
Steeles Rd W
Mavis Rd
Finch Rd
Derry Rd E
Derry Rd W
Britannia Rd W
Erin Mills Py
Cawthra Rd
Queensway W
Queensway E
407
410
401
403
QEW

A - Highway 50 Carpool Lot

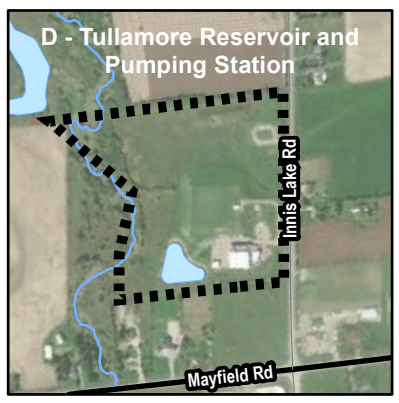


B - West Brampton Reservoir and Pumping Station

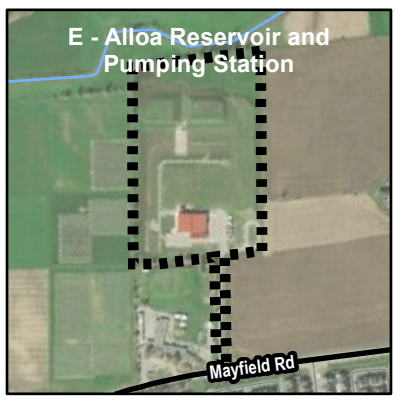


C - Johnston Sports Park

D - Tullamore Reservoir and Pumping Station



E - Alloa Reservoir and Pumping Station



F - 7120 Hurontario St

0 1 2 3 4 5 10 Kilometers

2.1 Natural Heritage

AECOM completed a *Natural Environment Report* as part of a Schedule "B" Municipal Class Environmental Assessment to evaluate snow storage opportunities at selected Region owned properties (1) (2). All sites were assessed based on their existing natural heritage conditions to determine the following potential considerations and constraints:

- Potential effects from existing infrastructure (e.g., fragmentation, edge effects, noise and disturbance of road or train traffic).
    - Level of potential effect on terrestrial and aquatic natural heritage features (e.g., low, medium, or high impact).
    - Level of potential effect on Species at Risk (SAR) and their habitats (e.g., low medium or high impact).
    - Potential for permits/authorizations requirements under the *Endangered Species Act (ESA), Species at Risk Act, Fisheries Act,* and other regulations.

All sites were found to contain natural areas within their study areas, however the specific location of the proposed storage areas are located outside these designated natural areas. The proposed snow storage areas identified across all sites did not fall within any regulated areas of the conservation authorities. Key details from the natural heritage investigation of each study site, as they relate to this report, are provided throughout Section 3.1.

Refer to the natural environment reports prepared by AECOM for further details (1) (2).

2.2 Geotechnical / Hydrogeology

AECOM completed a geotechnical investigation of the shortlisted study sites as part of the background assessment for potential near and long-term snow storage solutions for the Region of Peel (3). The geotechnical field testing and sampling was carried out using American Society for Testing Materials (ASTM) standards which were modified based on site conditions. Standard Penetration Tests (SPTs) were carried out at selected intervals to assess soil compactness and consistency, which is used to assess soil strength and to obtain samples for index (laboratory) testing purposes. SPTs were carried out in general accordance with ASTM D1586. Additional details are outlined in the *Geotechnical Investigation and Pavement Design Report* submitted to the Region on April 13, 2022.

In accordance with the geotechnical investigation, AECOM completed a hydrogeological assessment of the shortlisted study sites with the purpose of summarizing and characterizing the local physical and groundwater setting, and to estimate infiltration and movement of meltwater through the subsurface, as seen in appendix 1 of the geotechnical study (3) (4). Infiltration testing and groundwater monitoring was also completed at the study sites and results are summarized in separate reports (4) (5).

Key details from the geotechnical and hydrogeological investigations, including general soil conditions, groundwater elevations and measured infiltration rates for each study site are provided throughout Section 3.1.

2.2.1 Source Protection

Table 2 below summarizes the policy / source protection areas as they relate to the study sites. These areas were considered throughout the conceptual design phase and should continue to be considered going forward (5).

Table 2: Source Protection Mapping Summary

Site (#)	Conservation Authority Regulation Areas	Wellhead Protection Area (Yes/No)	Intake Protection Zone (Yes/No)	Significant Groundwater Recharge Area (Yes/No)	Highly Vulnerable Aquifer (Yes/No)
1	TRCA	No	No	No – a significant groundwater recharge area is located to the east of the site on Highway 50 (Score 4) [1]	No
3	CVC	No	No	No	Yes (Score 6)
5	TRCA	No	No	Yes (Primarily Score 4 on the proposed site, Score 6 at the north and west sides of site)	Yes (Score 6 at the north and west sides of the site)
6	TRCA	No	No	No	No
9	TRCA CVC	No	No	No	No
10	CVC	No	No	No	No

[1] The score given to a Significant Groundwater Recharge Area and / or Highly Vulnerable Aquifer are indicative of the vulnerability of the source protection area, based on a scale of 1-10 (from low to high vulnerability).

Sites 1, 6, 9 and 10 are not located within highly vulnerable recharge areas while Sites 3 and 5 are, with a vulnerability score of 6. According to the CTC Source Protection Plan, the specific circumstance outlined in the "Tables of Drinking Water Threats" should be reviewed to determine the threat to drinking water. According to the most recent tables from 2018, snow storage is considered a low risk for chloride contamination. Although de-icing salt is of concern at each site, salts within snow collected from roadways is best managed at the source through salt optimization programs. Furthermore, the Transportation Association of Canada cites research that found "…much of the salt that is applied to pavement is not retained in the snow that is removed to snow disposal facilities. This is because chlorides tend to leave stockpiled snow soon after it is plowed. Only a small percentage of the salt that is applied to a road may be reaching the snow disposal facility (6).

2.3 Fluvial Geomorphology

AECOM completed a fluvial geomorphic assessment of the study sites as part of the investigations of the of the sites as potential near and long-term snow storage solutions for the Region (7) (8). The objective of the fluvial geomorphic investigation is to characterize fluvial geomorphological processes and to define management recommendations that will support maintenance of the existing channel processes and limit adverse impacts to surrounding channel morphology. As part of the fluvial assessment, a Rapid Geomorphic Assessment (RGA), an erosion threshold assessment and a meander belt width delineation were completed on Site 5 – Johnston Sports Park, Site 6 – Tullamore Reservoir and Pumping Station, and Site 10 – 7120 Hurontario Street, as these were the only locations where access and collection of quantitative data was permissible. The remaining sites (1 – Highway 50 Carpool Lot, 3 – West Brampton Reservoir, and 9 – Alloa Reservoir) did not have

watercourses within the property boundary, or the watercourses were located on adjacent and inaccessible properties.

The results of the assessments are further discussed in the in body of the Fluvial Geomorphology Reports (7) (8). Based on the results of the fluvial geomorphic assessment, the following recommendations are made:

- The erosion threshold provides targets for the drainage network, thus, any increases in flow to the watercourses due to snow melt should consider the erosion threshold conditions for Site 5 – Johnston Sports Park, Site 6 - Tullamore Reservoir, and Site 10 – 7120 Hurontario Street, since increases in flow have the potential to increase channel instability and lead to morphological adjustment.
- Aggradation of fine sediment was discovered along the bed of the watercourse at Site 5 - Johnston Sports Park and Site 10 – 7120 Hurontario Street and increases in flow may help alleviate this condition.
- Shale bedrock was identified along the bed of the watercourse at Site 6 – Tullamore Reservoir, which may provide resistance to erosional processes. No shale was observed along the banks of the watercourse at Site 6. Additionally, dense riparian vegetation was observed to surround the channel of the receiving watercourse at Site 10 – 7120 Hurontario. It is therefore recommended that care be taken to maintain vegetation cover along and within the receiving watercourses of the identified sites to maintain existing channel stability.
- Due to the location of the watercourses on private property at Site 3 – West Brampton Reservoir, and Site 9 – Alloa Reservoir, and due to the fact than no permission to enter (PTE) was provided, a scoped fluvial geomorphological assessment was completed. A detailed assessment is recommended in the future once permission to enter has been granted.
- The meander belt refers to the lateral extent of floodplain occupation by a meandering watercourse, both now and in the future. Therefore, protecting the meander belt area from encroachment serves the dual purposes of enabling a continuity of natural channel processes, as well as of protecting property and structures from erosion. To prevent, eliminate, or minimize the risks to life and property caused by erosion hazards, it is recommended to maintain the meander belt boundary at all sites.

Detailed assessments will be required at the time of detailed design, based on the selected site locations(s). Refer to the conceptual fluvial geomorphology reports for additional details (7) (8).

2.4 SWM Design Criteria

AECOM established an approved methodology for the design of snow storage facilities within the Region to provide quantity and quality control treatment measures for not only design storm events, but the inclusion of simultaneous passive snowmelt as well. The methodology for which this approach was developed was the Charleston Sideroad Snow Storage Facility, of which the Region was provided an MECP Environmental Compliance Approval (# A-500-4092823881) in August, 2020 (9). Following the approved approach from the Charleston Sideroad project, the current EA has adopted a similar design approach for the subject site locations being considered as part of the assessment of the subject sites, and the following criteria, standards and guidance documents are being considered:

- Ontario Ministry of the Environment *Stormwater Management Planning and Design Manual* (2003).
- Region of Peel *Public Works Stormwater Design Criteria and Procedural Manual* (2019).

- Town of Caledon *Development Standards, Policies & Guidelines* (2009).
- TRCA and CVC Stormwater Management Criteria.

Based on a review of the above documents, the following SWM criteria are required for the subject study areas to meet current regulations, standards, and best management practices:

- Quantity Control: provide on-site attenuation for increased in on-site impervious area for the 2-year through 100-year events including the daily volume of snowmelt from the storage facility based on an inexhaustible volume of snow (10) (11) (12). For Site 10, which is already predominantly impervious but where no current quantity controls exist and site runoff goes to the existing storm sewer, the following guideline was used: the City of Mississauga stormwater criteria states that in all redevelopment cases, the minor system storm sewer capacity governs. The minor system is designed to accommodate the 10-year flows, as such on-site attenuation will be provided to attenuate the 100-year peak flow from the site to the 10-year peak flow including daily volume of snowmelt from the storage facility based on an inexhaustible volume of snow.
- Quality Control: Provide Level 1 ‘enhanced’ treatment (80% long-term TSS removal) for the runoff from the site.
- Control the volume for the Region’s 90th percentile rainfall volume (i.e., 27 mm) to meet both the quality control and erosion and water balance targets via hierarchy of infiltration, filtration, or conventional treatment measures (13).

In addition to the criteria listed above, the following items are required to be considered:

- As snowmelt in the spring months often coincides with rainfall events, the system must be able to treat both the rainfall and simultaneous snowmelt volumes.
- Additionally, as a measure to address runoff concerns during the spring months, the on-site SWM measures will be designed to match the 100-year design storm event to existing conditions while also including storage provisions for the anticipated daily snowmelt volumes.
- The conceptual snow storage facility should be designed in a manner which focuses on minimizing impact on the current Regional operations that take place at each of the shortlisted sites.
- Snow removal operations is likely to take place after a snowfall event, and during daytime and evening hours (7 AM – 11 PM). Noise generated on site after hours should be limited, or the site should be developed away from residents’ homes.

2.5 Opportunities and Constraints

The proposed development of a Snow Storage Facility on any of the subject sites provides several opportunities and constraints:

Constraints:

- Existing on-site infrastructure (or lack thereof). Unlocated infrastructure within any site or nearby may impact the stormwater serviceability of the site (i.e., ditches, sewers, utilities, etc.).
- Maintenance of existing minor/major conveyance from external areas through the sites.
- Provide a simplified, streamlined SWM system to facilitate ease of maintenance by the Region.

- Details regarding outlets for each site have not been assessed in detail. Will be required as part of detailed design; could impact serviceability.
- Capacity of the existing receivers is unknown at the time of this report. A review will be required as part of detailed design.

Existing geotechnical information indicates that some sites have soils present which are not conducive to infiltration and that groundwater levels may be high in some areas. Preliminary *in-situ* hydrogeological studies have been carried out and results for each site are included below.

Opportunities:

- Provide naturalized SWM controls, utilizing the existing soil conditions to provide infiltration through pre-existing roadside ditches and swales on site where possible.
- Minimize the requirement for traditional SWM systems (i.e., dry / wet pond SWM facilities), or utilize pre-existing SWM facilities on site, where applicable, if needed.
- A snow storage facility could serve as a multi-purpose facility, providing for expanded parking in the summer months when snow storage is not required (i.e., Johnston Sports Park, 7120 Hurontario).
- Utilize pre-existing site laneways to access the proposed snow storage facilities, when feasible.

3. Site Development

This technical memorandum provides details related to the conceptual SWM assessment and preliminary design for the following sites:

- Site 1: Highway No. 50 Carpool Lot (Caledon, ON).
- Site 3: West Brampton Reservoir and Pumping Station (Brampton, ON).
- Site 5: Johnston Sports Park (Caledon, ON).
- Site 6: Tullamore Reservoir and Pumping Station (Caledon, ON).
- Site 9: Alloa Reservoir and Pumping Station (Caledon, ON).
- Site 10: 7120 Hurontario Street (Mississauga, ON).

Information regarding existing and proposed site conditions, for the six sites identified, is presented in the following sections.

3.1 Existing Site Conditions

A description of the existing site conditions at each of the pre-identified sites is provided throughout this section. Information relating to existing site conditions includes, but is not limited to:

- General location of each site.
- Location of potential snow storage facility within each site, and description of these lands.
- Existing land use and vegetation cover.
- Nearby watercourses and drains.

- Topography.
- Existing stormwater infrastructure.
- Hydrologic soil type, percolation rates and groundwater conditions.

Maps of the current conditions at each of the sites are provided in Appendix A. It is noted that future snow operations are not anticipated to conflict with existing site uses at any of the sites described below.

3.1.1 Site 1: Highway No. 50 Carpool Lot Existing Conditions

Site 1 (Highway No. 50 Carpool Lot) is located southwest of the Highway No. 50 and Mayfield Road intersection in Brampton, Ontario. Approximately 0.4 ha of land has been identified as a potentially suitable location for the development of a snow storage facility within the property boundaries of Site 1. The subject lands are situated adjacent to the south side of the existing carpool lot and are primarily grass covered. The western half of this site is covered by tall grass, as well as small shrubbery and trees. The eastern half of the site is more densely vegetated due to greater tree coverage.

A nearby intermittent watercourse is present within TRCA Regulation Limits, approximately 150 m southwest of the Highway No. 50 Carpool Lot property. The TRCA Regulation limit also extends to the northeast of the proposed site, along the boulevard of Highway 50. The site drainage direction runs from west to east across the site, changing in elevation by approximately 2 m across a 100m length. A ditch-drainage system runs parallel to Highway 50, towards the Mayfield Road and Highway 50 intersection, where a culvert conveys runoff east under the roadway. The watercourse that is located at the downstream end of this culvert, resides within TRCA Regulation Limits.

Additional information from the geotechnical, hydrogeological, and natural heritage investigation reports regarding existing site conditions, is provided:

- A 5 m layer of silty clay till was encountered beneath the thin topsoil layer in all the site boreholes.
- No groundwater was observed upon the completion of the drilling in all three boreholes; therefore, a monitoring well was not installed during the hydrogeological investigation stage. This does not guarantee that groundwater is not present, as groundwater levels should be expected to fluctuate seasonally and be dependent on precipitation events.
- Based on the infiltration testing and analysis that was completed on site, it was determined that the field saturated vertical hydraulic conductivity of the surficial soils at the two locations of testing ranged between 6.4 x 10^{-7} m/s and 9.6 x 10^{-7} m/s and the percolation rates ranged between 41 and 46 mm/hour.
    - The calculated infiltration rates for Site 1 indicate that the local shallow soils generally are sufficiently permeable to consider multiple Low Impact Development (LID) technologies.
- Sites 1 contained candidate or confirmed Significant Wildlife Habitat (SWH) within the potential snow storage area in addition to Species at Risk (SAR), which may result in additional permits/authorization requirements should snow storage facility development be

pursued. Site 1 was selected as the preferred alternative for development in the Natural Environment Report due to lack of potential effects on SAR and SWH.

3.1.2 Site 3: West Brampton Reservoir and Pumping Station Existing Conditions

Site 3 (West Brampton Reservoir and Pumping Station) is located northwest of the Mississauga Road and Williams Parkway intersection in Brampton, Ontario. The site is accessed via a 350 m laneway off the west side of Mississauga Road. Approximately 1.2 ha of land has been identified as a potentially suitable location for the development of a snow storage facility, within the property boundaries of Site 3. The land identified for potential snow storage development is situated north of the existing reservoir and is surrounded on the north, east, and west by an existing berm / spoil pile. There is an existing drinking water overflow pond located within the boundaries of the proposed snow storage facility. The site is primarily grass covered with a gravel access road running along the west side of the reservoir.

A fill embankment spans the northern and eastern limits of the site to a height of 3-5 m above the surrounding grades. The site drainage direction travels primarily southeast, towards an existing SWM pond that is located within the property limits. The site elevation changes by approximately 5 m (240m to 235m) from the northwest to southeast sides of the site when considering the elevation of the site berm, and by approximately 3 m when disregarding the berm. A 6.5 ha protected woodland area exists to the west of the site, which spans approximately 250 m of the west property line. CVC Regulation limits (Credit River watershed) are present on the lands west of this woodland.

Additional information from the geotechnical, hydrogeological, and natural heritage investigation reports regarding existing site conditions is provided as follows:

- A layer of clayey silt fill was encountered underneath the topsoil in the site boreholes.
- Groundwater monitoring was completed between February 11 to July 7, 2022. Groundwater levels were recorded between 4.26 and 4.5 meters below ground surface (mBGS). It is expected that the groundwater levels within the Site 3 will be subjected to seasonal fluctuations including response to spring freshet and localized precipitation events.
- Based on the infiltration testing and analysis that was completed on site, it was determined that the field saturated vertical hydraulic conductivity of the surficial soils at the three (3) locations of testing ranged between 1.8×10^{-6} m/s and 4.9×10^{-6} m/s and the percolation rates ranged between 54 and 71 mm/hour.
    - The calculated infiltration rates for Site 3 indicate that the local shallow soils generally are sufficiently permeable to consider multiple LID technologies.
- Site 3 contained candidate or confirmed SWH within the potential snow storage area and was identified to provide potential terrestrial SAR habitat for eastern meadowlark (*Sturnella magna*) and bobolink (*Dolichonyx oryzivorus)* which may result in additional permits/authorization requirements should snow storage facility development be pursued.

3.1.3 Site 5: Johnston Sports Park Existing Conditions

Site 5 (Johnston Sports Park) is located northwest of the King Street and Centerville Creek Road intersection in Caledon, Ontario. The site is accessed via a driveway off King Street. Approximately 0.4 ha of land has been identified as a potentially suitable location for the development of a snow storage facility within the existing limits of Site 5, specifically parking lot ‘P4’. The identified land for development is situated on the south-central section of the sports park, which is a primarily flat parking area. The Johnston Sports Park is owned by the Town of Caledon, which has expressed support for

the joint use of any developed snow storage area. The section of land that has been identified for snow storage site development is currently planned to be a parking lot, as per the Town of Caledon/Johnston Sports Park Master Plan and should continue to act as such in the spring/summer months.

TRCA Regulation limits are located nearby the identified section of land, but do not overlap the site. The TRCA Regulation limits are located approximately 200 m outside the northeast corner of the site, as well as 150m from the southeast corner, on the south side of King Street. A SWM facility is located approximately 50m south of the potential snow storage area and is understood to service the sports park.

Additional information from the geotechnical, hydrogeological, fluvial, and natural heritage investigation reports regarding existing site conditions is provided below. The information in these reports related to the Johnston Sports Park is outdated, as the proposed area of land for snow storage facility development within Johnston Sports Park has since been amended. Thus, it is advised these investigations be updated during detailed design to confirm the preliminary findings summarized below.

- A layer of silty clay fill was encountered at the ground surface in all five boreholes. The thickness of this fill layer ranged from 0.7 m to 2.1 m.
- Groundwater monitoring was completed between February 11 to June 30, 2022. Groundwater levels at this location were recorded between 0.11 and 0.32 mBGS. It is expected that the groundwater levels within the Site 5 will be subjected to seasonal fluctuations including response to spring freshet and localized precipitation events.
- Based on the infiltration testing and analysis that was completed on site, it was determined that the field saturated vertical hydraulic conductivity of the surficial soils at the three (3) locations of testing ranged between 1.3 x 10-7 m/s and 6.5 x 10-7 m/s and the percolation rates ranged between 27 and 41 mm/hour.
    - The calculated infiltration rates for Site 5 indicate that the local shallow soils generally are sufficiently permeable to consider multiple LID technologies, however it is noted that elevated groundwater conditions have been observed on site which may limit storage that can be provided from potential LID at this site. Groundwater conditions at the proposed LID locations should be confirmed prior to detailed design since initial groundwater monitoring was completed at the southeastern edge of the Johnston Sporks Park property, approximately 150 m east of proposed lands for development.
- The RGA completed at Site 5 – Johnston Sports Park found that the nearby Lindsay Creek channel is in a “Transitional or Stressed” condition with aggradation and planimetric form adjustment as the main geomorphological processes taking place. In addition, the erosion threshold assessment calculated the critical discharge value required for bed material entrainment was on average 0.15 m3/s. Lastly, the meander belt width was determined using the empirical approach due to historical alterations of the channel and was calculated to be 33.5 m. Based on available topographic information, the section of the site in which snow facility development would likely be sited appears to discharge southwest to an adjacent SWM facility and may not directly contribute to Lindsay Creek.
- Site 5 contained candidate or confirmed SWH within the potential snow storage area. Additionally, aquatic SAR habitat for Redside Dace was identified immediately downstream of the potential snow storage facility area, which may result in additional permits/authorization requirements should snow storage facility development be pursued.

3.1.4 Site 6: Tullamore Reservoir and Pumping Station Existing Conditions

Site 6 (Tullamore Reservoir and Pumping Station) is located along the west side of Innis Lake Road, approximately 200 m northwest of the Mayfield Road / Goreway intersection, in Brampton, Ontario. Approximately 0.4 ha of land has been identified as a potentially suitable location for the development of a snow storage facility, within the boundaries of Site 6. The land identified for development is situated adjacent to the bulk water station at the north end of the site and is primarily flat and grass covered. Trees and shrubs have been planted along the south and east sides of the identified location. A small, wired fence separates the Tullamore Reservoir and Pumping Station property from Innis Lake Road, and the roadside ditch conveyance system accepts drainage from the existing site and the roadway. A conveyance ditch also runs parallel to the western section of the lands that has been identified for potential development within the Tullamore property, which feeds to the ditch along Innis Lake Road.

Nearby Salt Creek runs through a protected wooded area and is situated within the Regulatory jurisdiction of the TRCA. The TRCA Regulation Limits and identified woodland, are located approximately 200 m west of the lands within the Tullamore site which have been identified for potential future development of a snow storage facility. Overland drainage from the western half of the Tullamore property drains toward Salt Creek, however the eastern half of the site appears to drain towards the roadside ditches along Innis Lake Road.

Additional information from the geotechnical, hydrogeological, fluvial, and natural heritage investigation reports regarding existing site conditions, is provided:

- A layer of silty clay fill was discovered at the ground surface in two of the site boreholes. The thickness of this fill layer ranged from 1.2 m to 2.3 m, which may be in the range of depth for LID requirements, should such a SWM servicing strategy be utilized to manage snow melt at this site.
- Groundwater monitoring was completed between March 7 to June 28, 2022. Groundwater levels were recorded between 0.66 and 1.83 mBGS. It is expected that the groundwater levels within the Site 6 will be subjected to seasonal fluctuations including response to spring freshet and localized precipitation events.
- Based on the infiltration testing and analysis that was completed on site, it was determined that the field saturated vertical hydraulic conductivity of the surficial soils at the two (2) locations of testing ranged between 6.4 x 10-7 m/s and 8.9 x 10-7 m/s and the percolation rates ranged between 41 and 45 mm/hour.
    - The calculated infiltration rates for Site 6 indicate that the local shallow soils generally are sufficiently permeable to consider multiple LID technologies, although it is noted that elevated groundwater conditions have been observed on site which may limit storage that can be provided from potential LID at this site. Local groundwater conditions should be considered throughout the site during detailed design.
- The RGA completed at Site 6 – Tullamore Reservoir identified the channel to be in “Regime” with widening and planimetric form adjustment identified as the main geomorphological processes taking place. Minimal evidence of erosion was found within this reach. The erosion threshold identified that the critical discharge value required to entrain or begin to transport bed material is on average 0.13 m3/s. Lastly, the meander belt width was completed using the mapping approach and is 158 m. Based on available topographic information, the site appears to discharge to the west side of Innis Lake Road, where it eventually discharges to a watercourse flowing east along Mayfield Road.

- Aquatic SAR habitat for Redside Dace was identified immediately downstream of the potential snow storage facility area within Site 6, which may result in additional permits/authorization requirements should snow storage facility development be pursued.

3.1.5 Site 9: Alloa Reservoir and Pumping Station Existing Conditions

Site 9 (Alloa Reservoir and Pumping Station) is located approximately 1 km northeast of the Mayfield Road and Mississauga Road intersection in Caledon, Ontario. The site is accessible by means of a 200 m facility laneway which travels north from Mayfield Road. Approximately 0.25 ha of land has been identified as a potentially suitable location for the development of a snow storage facility, within the boundaries of Site 9. The identified land for development is situated on the southeast corner of the site. It is proposed that the turnaround loop at the bulk water station be developed to serve dual purposes –retaining its function as a bulk water fill station, but serving as a snow storage facility as well. The site appears to drain towards on-site roadside ditches that convey runoff south down the access road towards Mayfield Road.

TRCA Regulatory Limits extend through the northern portion of the property (Etobicoke Creek watershed), encompassing approximately 50 m of the northern edge of the site. Additionally, the site is situated within both the TRCA and Credit Valley Conservation (CVC) watershed. A future subdivision development is planned for the lands east of the candidate location identified for possible snow storage facility development.

Additional information from the geotechnical, hydrogeological, and natural heritage investigation reports regarding existing site conditions, is provided:

- A layer of sandy silt fill atop a sandy fill layer was discovered at the ground surface in two of the site boreholes which may support the implementation of LID (i.e., bioswales) that provide acceptable retention storage depth, should such an approach be implemented to provide stormwater management for any proposed snow storage facility.
- Groundwater monitoring was completed between March 7 to June 30, 2022. Groundwater levels were recorded between 3.23 and 5.25 mBGS. It is expected that the groundwater levels within the Site 9 will be subjected to seasonal fluctuations including response to spring freshet and localized precipitation events.
- Based on the infiltration testing and analysis that was completed on site, it was determined that the field saturated vertical hydraulic conductivity of the surficial soils at the two (2) locations of testing ranged between 1.5 x 10-6 m/s and 8.3 x 10-6 m/s and the percolation rates ranged between 51 and 82 mm/hour.
    - The calculated infiltration rates for Site 9 indicate that the local shallow soils generally are sufficiently permeable to consider multiple LID technologies.

No SAR habitat, SWH or natural heritage features for SAR were found within Site 9.

3.1.6 Site 10: 7120 Hurontario Street Existing Conditions

Site 10 (7120 Hurontario Street) is located approximately 400m west of the Hurontario Street and Derry Road intersection in Mississauga, Ontario. The site is accessible by means of multiple entrances (via Derrycrest Drive, Kingsway Drive, and Hurontario Street). Approximately 1.52 ha of land has been identified as a potentially suitable location for development of a snow storage facility, within the borders of Site 10. The identified land for development is situated on the northwest corner of the site over an existing extended parking lot which accommodates the adjacent regional office building. It is proposed that the parking lot be converted to be dual purpose – to serve as a snow melt facility in the winter and to remain an extended parking lot in the offseason for continued parking use. The site appears to drain via existing storm infrastructure along Derrycrest Drive towards a nearby

stormwater management pond (located off of Maritz Drive, 500m southeast of the proposed development site).

Additional information from the geotechnical, hydrogeological, and natural heritage investigation reports regarding existing site conditions, is provided:

- Based on the infiltration testing and analysis that was completed on site, it was determined that the field saturated vertical hydraulic conductivity of the surficial soils at the one (1) location of testing was 1.0 x 10-6 m/s and the percolation rate was 13 mm/hour.
    - The calculated infiltration rates for Site 10 indicate that the local shallow soils generally have a low permeability and may not provide significant infiltration capacity. LID options may need to be limited to quality and peak flow control.
- Groundwater was observed in one of the open boreholes upon the completion of the drilling at Site 10, at depths of 4.57 mBGS. Groundwater monitoring was completed on the east side of the site from July to August 2023. Groundwater levels were recorded between 1.17 to 3.64 mBGS during this time.
- There is no potential for SAR habitat to be found within the proposed snow storage site since it is being proposed over an existing parking lot. SAR habitat may exist in adjacent farmland.

3.2 Proposed Site Conditions and Conceptual Designs

A description of the proposed conditions at each site is provided throughout this section. This includes information relating to the conceptual site plan and proposed site servicing strategy, with respect to conceptual SWM design to provide quantity control volumes for events up to the 100-year storm due to land-use change / increase in impervious area including the estimated volume of daily snowmelt alongside the Region's 90th percentile event for water quality. The quantities have been determined using a modified Rational Method calculation to estimate the post-to-pre-development conditions peak discharge rates and required attenuation volumes; refer to Appendix C for conceptual design calculations.

It is proposed that each site include a monitoring approach that can be customized to a varying degree of detail. Methods of monitoring SWM system performance may include implementing monitoring wells in SWM / LID features, surface water monitoring wells in any bioswales which may be constructed, along with the collection of water quality grab samples from relevant site outlets or features. For example, site outlet water quality can be measured and compared against the Provincial Water Quality Objectives (PWQOs) to confirm that site discharge is not adversely affecting downstream water quality. Such a monitoring approach could also serve to inform the Region regarding maintenance timing/frequencies over the service life of the system.

The proposed conceptual post-development site conditions are described in **Section 3.2.1** to **3.2.6,** below. The conceptual site plans are provided in Appendix A and conceptual site drawings are provided in Appendix B.

3.2.1 Site 1: Highway No. 50 Carpool Lot

The conceptual snow storage facility at Site 1 currently includes the following:

- A 7.5 m wide access laneway which encircles the snow storage pad for efficient snow storage volume and truck traffic flow through the facility.
    - The entrance laneway is located at the southern edge of the existing Highway No. 50 Carpool lot, positioned away from the southwest bus loop.

- A 1,900 m^2 snow storage pad, and a total site paved area of 3,600 m^2 (including access laneway, parking area, and snow storage pad).
- Bioswales along the north and east sides of the facility, to provide retention, attenuation and treatment of drainage conveyed towards the existing Highway 50 roadside SWM infrastructure.
- AECOM was informed on September 7th, 2023, that Highway 50 is scheduled for expansion between 2026 and 2028. After review of the 90% design drawings for the expansion, it appears that the proposed roadside ditch elevation (225.105m) is lower than the elevation of the proposed snow storage facility subdrain outlet (225.107m) and thus the two are understood to be compatible at this time. This is to be confirmed during detailed design.
- Facility parking with block heaters.
- Facility lighting.
- Access gates which can be used to prevent public site access during the winter months.

3.2.2 Site 3: West Brampton Reservoir and Pumping Station

The conceptual snow storage facility at Site 3 is currently proposed to include the following:

- A 7.5 m wide access laneway which encircles the snow storage pad for efficient snow storage volume and truck traffic flow through the facility.
    - The facility laneway is proposed to connect to the existing site access road that leads to the north section of the site and loop around the site blowout pond.
- A 3,700 m^2 snow storage pad, and a total site paved area of 6,300 m^2 (includes access laneway, parking area, and snow storage pad).
    - The facility would be built along the edge of the existing fill piles to avoid fill removal/relocation.
    - The existing drinking water overflow pond would remain and be separated by a barrier curb to prevent melt water from entering.
    - Since OCWA operates the water pumping station and is responsible for maintenance of the entire site, access and coordination must be discussed with OCWA during detailed design to ensure that the dual site uses remain congruent.
- Bioswales along the south side of the facility, which will retain, attenuate, treat, and convey drainage away from the site.
    - It is proposed that bioswales servicing the site be connected to the existing site SWM pond, located approximately 100 m from the proposed snow storage facility. Since infiltration rates in the area of the bioswales are good and they would be designed to control post-development to pre-development peak flow rates, it is anticipated that the SWM Pond will likely not require enlargement to provide peak flow for the design event.
    - A 0.4 m to 0.6 m thick layer of sandy/gravel fill is present at the southeast corner of the site, which may support the implementation of a SWM retention feature in this location.
- Facility parking with block heaters.
- Facility lighting

3.2.3 Site 5: Johnston Sports Park

The conceptual snow storage facility at Site 5 would feature the following:

- A 7.5 m wide access laneway utilizing the existing parking lot access.
    - The access road will be connected to the existing park laneways.
- A 1,400 m^2 snow storage pad, and a total site paved area of 3,300 m^2 (includes access laneway, parking area, and snowmelt storage pad).
- Lined bioswales along the south side and south-east corner of the facility will attenuate, treat, and convey drainage towards the existing park SWM facility, 50m south of the proposed site

  Since initial testing shows a high groundwater level in this area, the bioswale may need to be lined. Furthermore, the existing outlet elevation is constrained by the elevation of the culvert leading to the downstream SWM facility, which is approximately 0.5m from the ground surface. To provide the depth necessary for a bioswale, it is proposed that the culvert be lowered by approximately 0.5m.
- The site could act as a multi-purpose facility by serving as additional summer parking for the park grounds when snow storage is not required.
- Facility parking with block heaters.
- Facility lighting.
- Access gates which can be used to prevent public site access during the winter months.

3.2.4 Site 6: Tullamore Reservoir and Pumping Station

The conceptual snow storage facility at Site 6 would feature the following:

- A 7.5 m wide access laneway which encircles the snow storage pad for efficient snow storage volume and truck traffic flow through the facility.
    - The facility laneway is currently proposed to be built adjacent to the existing turnaround loop at the bulk water dispensing station, located on the north side of the site.
- A 2,300 m^2 snow storage pad, and a total site paved area of 3,700 m^2 (includes access laneway, parking area, and snowmelt storage pad).
- Lined biowales along the northeast side of the facility, which would be used to attenuate, treat, and convey drainage to the nearby roadside ditches.
    - Since initial testing shows high groundwater level in this area, the bioswale may need to be lined and would need to tie into the existing outlet, which is approximately 1.0m from the ground surface.
- Facility parking with block heaters.
- Facility lighting.

3.2.5 Site 9: Alloa Reservoir and Pumping Station

The conceptual snow storage facility at Site 9 would feature the following:

- A 7.5 m wide access laneway which encircles the snow storage pad for efficient snow storage volume and truck traffic flow through the facility.

  - This would replace the existing turnaround loop, which is part of the bulk water station, located on the east side of the site.
- A 1,400 m^2 snow storage pad, and a total site paved area of 2,800 m^2 (includes access laneway, parking area, and snowmelt storage pad).
- Bioswales will be installed along the north side of the facility, which will retain, attenuate, treat, and convey drainage to the existing site stormwater infrastructure, and south towards Mayfield Road.
- Facility parking with block heaters.
- Facility lighting.
- Access gates which can be used to prevent public access to the snow storage area during the winter months.

3.2.6 Site 10: 7120 Hurontario

The conceptual snow storage facility at Site 10 would feature the following:

- A 7.5 m wide access laneway which encircles the snow storage pad for efficient snow storage volume and truck traffic flow through the facility.
- An approximately 10,000 m^2 snow storage pad, and a total site paved area of 14,000 m^2 (includes access laneway, parking area, and snowmelt storage pad).
- Bioswales are proposed to be installed along the northeast and southwest side of the facility, which will treat and convey site drainage to the storm sewer network on Derrycrest Drive.
  - Since the infiltration rates at this site are low there will only be partial retention of runoff and bioswales are not anticipated to drain down between events (72hr inter-event time within the Region of Peel), an underdrain at the bottom of the feature is required to convey treated flows to the storm network.
  - The City of Mississauga stormwater criteria states that the minor system should be designed to accommodate the 10-year flows, as such the system is designed to attenuate the 100 year peak flow from the site to the 10 year peak flow.
  - Since the site is very large and highly impervious, the 90^{th} percentile runoff volume + the snow melt volume is larger than the attenuation volume and thus the bioswales are sized to treat the larger of the two event volumes.
- A curb line is proposed along the site's east access laneway to divide the snow melt facility from the existing access laneway off Hurontario Steet, in effort to maintain through-traffic to the other office parking lots year-round.
- Facility parking with block heaters.
- Facility lighting
- Three access gates which can be used to prevent public site access during the winter months.

3.3 Summary of the Proposed Site Conditions Post-Snow Facility Development

Table 3 below summarizes the proposed site conditions and the required measures for SWM systems. It is noted that these values have been assessed based on a conceptual site plan and are subject to change during detailed design following further site assessment.

Table 3: Summary of Proposed Site Conditions with Snow Storage Facility

Parameter	Site 1	Site 3	Site 5	Site 6	Site 9	Site 10
Site Area (m^2) [1]	4,000	11,900	4000	4,000	2,500	15,200
Melt Pad Area (m^2)	1,900	3,700	1,400	2,300	1,400	10,000
Approximate Snow Storage Capacity (m^3) [2]	3,800	7,400	2,800	4,600	2,800	20,000
Total Paved Area (m^2) [3]	3,600	6,300	3,300	3,700	2,800	14,000
Post Developed Approximate Site % Impervious [4]	90	53	83	93	95	92
100-Year Attenuation Volume Required (m^3)	170	275	153	175	68	247
Estimated Snowmelt (m^3)[5]	25	47.5	18	29.5	17.3	128
90th Percentile Runoff Volume (m^3)	92	186	86	94	60	356

[1] The site area is representative of the blue dotted “potential snow storage area” within each site, which can be referenced on each of the existing conditions maps, that are provided in Appendix A.

[2] Assumes a snow storage height of 2m, which can be achieved by end dumping from the snow trucks and shaping the snow pile with a grader with side slopes of 1:2.

[3] The total paved area is inclusive of the paved site melt pad, storage lot, and any newly developed paved laneways that are proposed at each site.

[4] The assumed pre-developed site imperviousness is 0% for all sites (except site 10) – modified Rational Method utilized for attenuation volumes.

[5]Snowmelt that would occur during a 3hr, 100-year storm. Snowmelt (3hr) + 100-year attenuation volume = peak storage capacity required

3.4 Preliminary Evaluation of Suitable Drainage Design Options

Initial screening and evaluation of suitable drainage design options has been completed and is presented in Table 4, below.

Table 4: LID Feasibility Assessment

Criteria / Options	Site 1	Site 3	Site 5	Site 6	Site 9	Site 10
General Soil Type / Founding Soil	Stiff to hard silty clay till	Very stiff to hard silty clay till	Very stiff to hard silty clay till	Very stiff to hard silty clay till	Firm to stiff silty clay fill over stiff to hard silty clay till	Very stiff to hard silty clay till
Shallow Groundwater (Yes/No)	No No GW observed in BHs	No 4.26 - 4.5 mBGS	Yes 0.11 - 0.32 mBGS	Yes 0.66 - 1.83 mBGS	No 3.23 - 5.25 mBGS	No 1.17 - 3.64 mBGS
Mean Hydraulic Conductivity (m/s)	8.0×10^{-7}	3.35×10^{-6}	3.9×10^{-7}	7.65×10^{-7}	4.9×10^{-6}	1.0×10^{-6}
Mean Measured Infiltration Rate (mm/hr)	44	62	34	43	67	13
OGS Unit	No	No	No	No	No	No
Bioswale	Yes	Yes	Yes	Yes	Yes	Yes
Dry-Basin	Yes	Yes	Yes	Yes	Yes	No
Wet Pond	No	No	No	No	No	No
Vault/Chamber	No	No	No	No	No	Yes
Permeable Pavement	No	No	No	No	No	No
Preferred	**Bioswale**	**Bioswale**	**Bioswale**	**Bioswale**	**Bioswale**	**Bioswale**

Due to the lack of storm sewer infrastructure across most sites (except 7120 Hurontario), SWM measures such as OGS units, underground vaults and chambers are not practically possible as they require deeper construction and a deeper outlet than that of a dry-basin, enhanced swale or bioswale to function properly.

A dry basin could be utilized to provide on-site attenuation volumes for some sites as they are effective at providing volume storage to offset peak discharge rates. However, space may be limited and they provide nominal removal of pollutants. A wet pond SWM facility would not be sufficient for the size of area proposed for operation at each site as such features are generally not efficient when servicing areas less than 5 ha (11).

Bioswales are open-channel surface conveyance features that can be designed to provide both filtration and attenuation, with stormwater retention as well (depending on native soil conditions and groundwater considerations). If infiltration is desirable, small check dams could be incorporated within these features to detain surface water and to promote infiltration/filtration through the biomedia. Biofilter check dams can also be used to enhance attenuation and treatment in both lined and unlined

swales. Bioswales include a subsurface storage layer and can thus provide more attenuation and storage than enhanced swales. They can also be lined with an impermeable liner should it be decided that infiltration is not desired due to water quality concerns or if there are high groundwater levels in the area. In such cases an underdrain is required at the base of the system and there would need to be a sufficient outlet from the bottom elevation of the storage layer to drain to.

Preliminary bioswale design details can be found in Figure 3 below and in Appendix B, Plan No. 14-D.

Figure 2. Charleston Sideroad Snow Storage Facility Bioswale

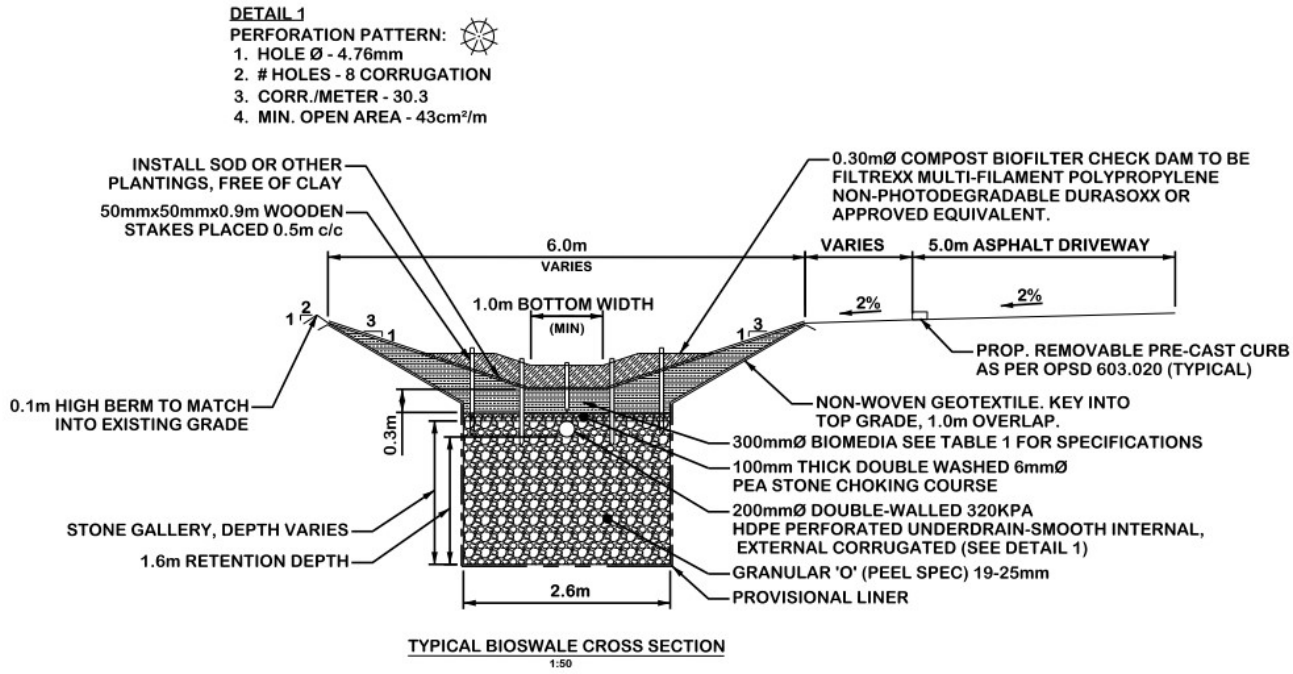


Figure 3. Bioretention Cross Section - General Detail

3.5 Preliminary LID Design Details

For all sites, design infiltration rates were determined and preliminary design calculations were carried out to size the recommended bioswale systems and confirm their suitability. Refer to Appendix B for preliminary design drawings and Appendix C for conceptual calculations for each site. A summary is provided in Table 5 below.

Table 5. Preliminary LID Design Details

Criteria / Options	Site 1	Site 3	Site 5	Site 6	Site 9	Site 10
General Soil Type / Founding Soil	Stiff to hard silty clay till	Very stiff to hard silty clay till	Very stiff to hard silty clay till	Very stiff to hard silty clay till	Firm to stiff silty clay fill over stiff to hard silty clay till	Very stiff to hard silty clay till
Shallow Groundwater (Yes/No)	No	No 4.26 - 4.5 mBGS	Yes 0.11 - 0.32 mBGS	Yes 0.66 - 1.83 mBGS	No 3.23 - 5.25 mBGS	No 1.17 - 3.64 mBGS
Design Infiltration Rate (mm/hr)(1)	18	25	14	17	27	5
Storage Required (greater of 100yr attenuation + snowmelt or 90th percentile runoff volume + snow melt)	195m^3	322m^3	171m^3	205m^3	86m^3	484m^3(2)
Bioswale Length	133m	151m	88m	110m	41m	211m
Bioswale Depth	1.00m	1.30m	1.00m	1.00m	1.20m	1.50m
Bioswale Storage Volume	265m^3	322m^3	176m^3	209m^3	88m^3	503m^3
Drawdown Time (req. < 72hrs)	33hrs	28hrs	Lined	Lined	25hrs	150hrs(3)

(1) Safety factor of 2.5 applied to measured infiltration rate
(2) Only at Site 10 is the 90th percentile runoff volume + snowmelt greater than the 100 year attenuation volume + snowmelt
(3) This bioswale will have an underdrain at the base due to low infiltration rate/long draw down time

Sites 1,3, 9 and 10 do not have shallow groundwater, thus bioswales without a liner are proposed. Sites 5 and 6 have high groundwater and thus a liner is required as well as an underdrain at the base to drain down the system. Since an underdrain is required at the base, the depth of the bioswales are constrained by the outlet elevation. As such, for site 5 it is proposed to lower the culvert downstream of the bioswale by approximately 0.5m to allow a total bioswale depth of 1m. Site 6 has approximately 1m elevation difference between ground level and the outlet and thus the bioswale is designed to be 1m deep.

All the bioswales are designed to capture the greater of either the 100-year attenuation volume + snow melt volume or the 90th percentile runoff volume + snow melt volume. Since Site 10 outlets to the minor system, attenuation of the 100-yr to 10-yr event is required. The site is large and highly impervious; the 90th percentile runoff volume + snow melt volume is greater than the 100yr attenuation volume and thus the bioswales are designed to capture this volume. This is a conservative approach and the size of the bioswales may be able to be reduced based on dynamic modelling or by combining the bioswale with an OGS to achieve the treatment requirements. This should be explored further during detailed design.

3.6 Preliminary Cost Estimate

Preliminary cost estimates for the construction of the proposed sites were developed but will require further refinement during the detailed design as additional site-specific information becomes available and design elements are further elaborated. The cost estimates for each site are provided in Table 6 and Table 7, below.

The estimated costs are based on the previously constructed Charleston Side Road Snow Storage Facility actual construction costs as reported by the Region of Peel and prorated based on the size of asphalt area and the length of the bioswale proposed for each new site. The Charleston Side Road project was used for baseline costing as the overall design of the proposed snow storage sites is similar in surface topology, key servicing elements (gated access, parking, power pedestal, lighting, stormwater management approach), and are situated within the same jurisdictional area.

An assumed engineering fee equivalent to 10% of the parametrically calculated capital cost has been included as an allowance for detailed design and construction administration services. The Bank of Canada Consumer Price Index (CPI) shows an increase of 15% for general goods and services between 2020 and 2023, but since inflationary construction costs are known to have increased at a faster rate than other consumer sectors during this period, a factor of 2 was applied to the CPI, yielding an estimated escalation of 30%.

Table 6. Cost estimates for Site 1, 3 and 5 compared to Charleston Sideroad

				Site 1			Site 3			Site 5		
Charleston Sideroad (2020)	Size		Actual Costs[1]	Size		Cost Estimate	Size		Cost Estimate	Size		Cost Estimate
Site Preparation and Removals	3,380	m^2	$ 217,952.10	3,600	m^2	$ 232,138.33	6,300	m^2	$ 406,242.07	3,300	m^2	$ 212,793.47
Storm System Works	3,380	m^2	$ 26,601.63	3,600	m^2	$ 28,333.09	6,300	m^2	$ 406,242.07	3,300	m^2	$ 212,793.47
Bioswale	125	m	$ 87,414.72	133	m	$ 93,009.27	151	m	$ 9,736.91	88	m	$ 5,674.49
Surface Works	3,380	m^2	$ 501,609.59	3,600	m^2	$ 534,258.74	6,300	m^2	$ 406,242.07	3,300	m^2	$ 212,793.47
Lighting	3,380	m^2	$ 92,132.96	3,600	m^2	$ 98,129.78	6,300	m^2	$ 406,242.07	3,300	m^2	$ 212,793.47
Engineering Fees (10% of construction costs)	10	%				$ 98,586.92			$ 163,470.52			$ 85,684.84
Escalation (CPI [2020-2023] of 30%)	30	%				$ 325,336.84			$ 539,452.72			$ 282,759.96
Total			**$ 925,711.00**			**$ 1,409,792.96**			**$ 2,337,628.44**			**$ 1,225,293.16**

Table 7. Cost estimates for Site 6, 9 and 10 compared to Charleston Sideroad

				Site 6			Site 9			Site 10		
Charleston Sideroad (2020)	Size		Actual Costs[1]	Size		Cost Estimate	Size		Cost Estimate	Size		Cost Estimate
Site Preparation and Removals	3,380	m^2	$ 217,952.10	3,700	m^2	$ 238,586.61	2,800	m^2	$ 180,552.03	14,000	m^2	$ 902,760.16
Storm System Works	3,380	m^2	$ 26,601.63	3,700	m^2	$ 238,586.61	2,800	m^2	$ 180,552.03	14,000	m^2	$ 902,760.16
Bioswale	125	m	$ 87,414.72	110	m	$ 7,093.12	41	m	$ 2,643.80	211	m	$ 13,605.89
Surface Works	3,380	m^2	$ 501,609.59	3,700	m^2	$ 238,586.61	2,800	m^2	$ 180,552.03	14,000	m^2	$ 902,760.16
Lighting	3,380	m^2	$ 92,132.96	3,700	m^2	$ 238,586.61	2,800	m^2	$ 180,552.03	14,000	m^2	$ 902,760.16
Engineering Fees (10% of construction costs)	10	%				$ 96,143.96			$ 72,485.19			$ 362,464.65
Escalation (CPI [2020-2023] of 30%)	30	%				$ 317,275.06			$ 239,201.14			$ 1,196,133.36
Total			**$ 925,711.00**			**$ 1,374,858.59**			**$ 1,036,538.26**			**$ 5,183,244.55**

(1) Based on April 18th, 2022 email from Region of Peel with total amount charged for Charleston SR SS facility construction. Amounts were proportioned into categories based on tender document estimates.

4. Conclusions

AECOM has developed conceptual design and SWM strategies for short-listed potential snow storage sites distributed throughout the Region of Peel. These designs aim to provide near and long-term snow storage solutions that are environmentally sound and politically acceptable for the Region. This memo features high-level requirements for design at each of the short-listed sites.

The following conclusions related to the development of future snow storage facilities on the analyzed sites are provided:

- The six candidate sites are suitable to serve as snow storage facilities, based on a review of currently available background information and ability to provide SWM servicing to each location.
- Subject to detailed design investigations, LID-based servicing approaches are currently understood to be suitable for Site 1, 3, 5, 6, 9, and 10, and may be required to satisfy site grading constraints.
- Servicing designs for each location are to be confirmed following the completion of detailed field studies and analysis.

Attachments:

Appendix A – Existing Conditions and Conceptual Site Plans

Appendix B - Snow Storage Site Conceptual Design Drawings

Appendix C – Conceptual Design Calculations

5. References

1. **AECOM Canada Limited.** *Natural Environment Report: Snow Storage Sites Analysis and Conceptual Design.* Thornhill, ON : AECOM Canada Limited, February 2022.
2. **AECOM.** *Natural Environment Report Addendum– 7120 Hurontario Street Snow Storage Site Analysis.* Mississauga, ON : AECOM Canada Limited, 2023.
3. **AECOM Canada Limited.** *Geotechnical Investigation and Pavement Design Report.* London, ON : AECOM Canada Limited, April 2022.
4. **AECOM.** *Hydrogeological Memorandum - Peel Region Snow Storage, 7120 Hurontario Street, Region of Peel.* Kitchener, ON : AECOM, 2023.
5. **Ontario Ministry of the Environment, Conservation and Parks.** Source Protection Information Atlas. [Online] March 5, 2022. https://www.lioapplications.lrc.gov.on.ca/SourceWaterProtection/index.html?viewer=SourceWaterProtection.SWPViewer&locale=en-CA.
6. *Environmental Study of Richmond Hill Snow Storage Facility, presentation to 1st International Conference in Cold Climates.* **al, K. Exall et.** Waterloo : University of Waterloo, 2009.
7. **AECOM Canada Limited.** *Peel Region Snow Storage Sites Analysis: Fluvial Geomorphology Assessment.* Markham, ON : AECOM Canada Limited, April 2022.
8. **AECOM.** *Peel Region Snow Storage Site Analysis - Additional Site: 7120 Hurontario Street (Fluvial Geomorphic Assessment).* Hamilton, ON : AECOM, 2023.
9. **Ontario Ministry of the Environment, Conservation and Parks.** Access Environment. *www.accessenvironment.ene.gov.on.ca.* [Online] 2010. [Cited: 04 14, 2022.] https://www.lioapplications.lrc.gov.on.ca/Access_Environment/index.html?viewer=Access_Environment.AE&locale=en-US.
10. **Town of Caledon.** *Development Standards, Policies and Guidelines.* Town of Caledon : s.n., 2009.
11. **Ontario Ministry of the Environment.** *Stormwater Management Planning and Design Manual.* 2003.
12. *Road salt application planning tool for winter de-icing operations.* **Trenouth, William R., Gharabaghi , Bahram and Perera, Nandana.** 2015, Journal of Hydrology, pp. 401-410.
13. **Region of Peel.** *Public Works Stormwater Design Criteria and Procedural Manual.* 2019.
14. **Credit Valley Conservation Authority.** *Low Impact Development Stormwater Management Planning and Design Guide.* 2011.

Appendix A

Existing and Conceptual Site Plans

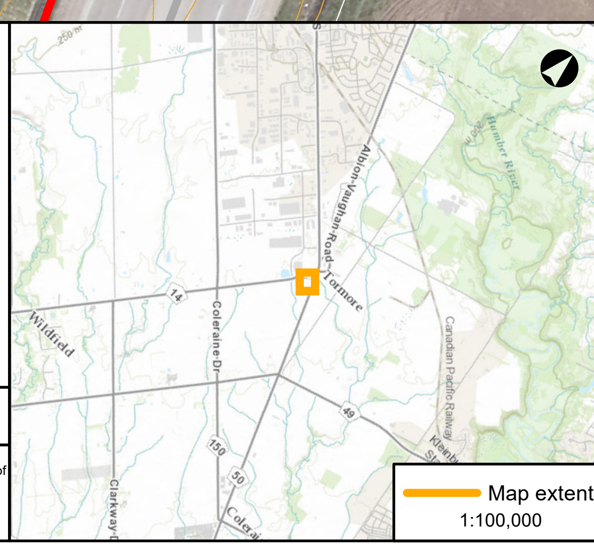
Region of Peel
working with you

AECOM

Snow Storage Site Analysis and Conceptual Design Project 13-4007
AECOM Project: 60646784

Site 1 - Highway No. 50 Car Pool Lot

- Potential Snow Storage Property Boundary
- Potential Snow Storage Area
- Sanitary System (Per GIS; As-Builts; Location Approximate)
- Storm System (Per GIS, As-Builts; Location Approximate)
- Water System (Per GIS, As-Builts; Location Approximate)
- Contours (1 m interval)
- Watercourse
- TRCA Regulation Limits
- Municipal Boundary



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Data Source:
Contains information provided by the Region of Peel, TRCA, City of Mississauga, City of Brampton, and Town of Caledon.
Key base map provided by ESRI.

Region of Peel
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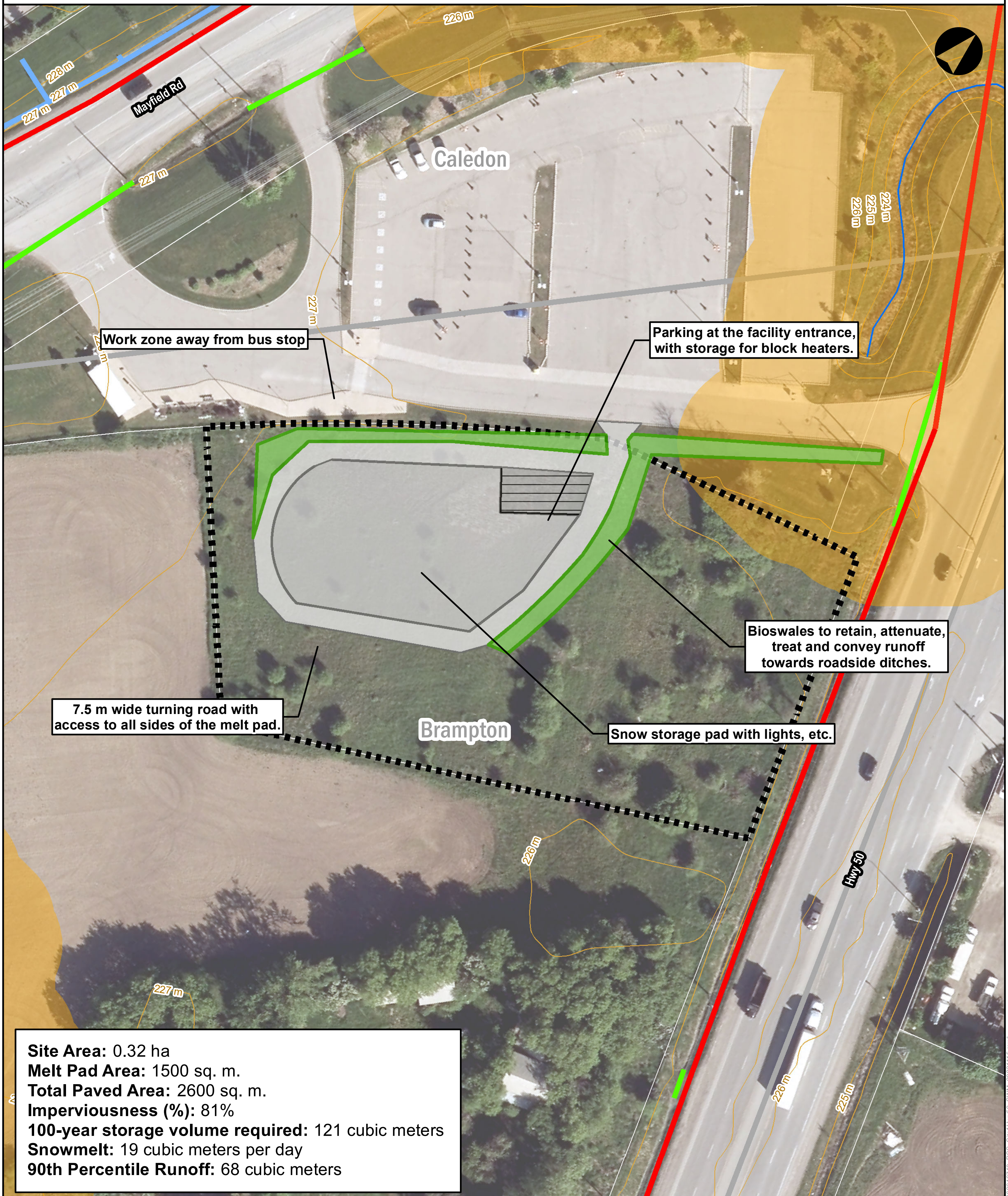
AECOM

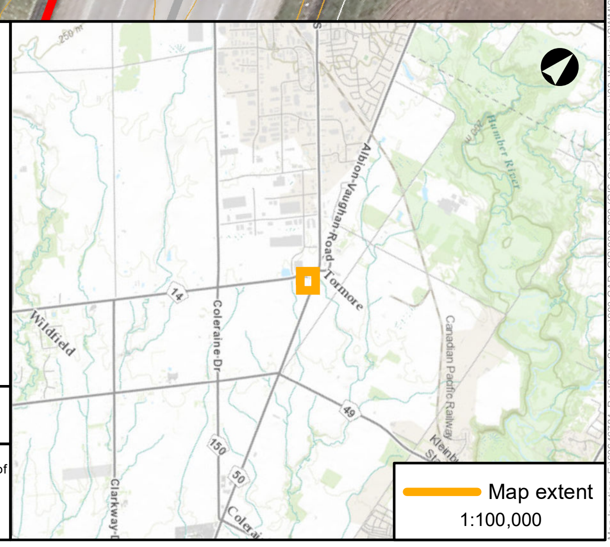
Snow Storage Site Analysis and Conceptual Design Project 13-4007
AECOM Project: 60646784

Site 1 - Highway No. 50 Car Pool Lot



Site Area: 0.32 ha
Melt Pad Area: 1500 sq. m.
Total Paved Area: 2600 sq. m.
Imperviousness (%): 81%
100-year storage volume required: 121 cubic meters
Snowmelt: 19 cubic meters per day
90th Percentile Runoff: 68 cubic meters

Snow Storage Features
- Bioswale
- Access road
- Parking/storage
- Snow pad
- Potential Snow Storage Property Boundary
- Sanitary System (Per GIS; As-Builts; Location Approximate)
- Storm System (Per GIS, As-Builts; Location Approximate)
- Water System (Per GIS, As-Builts; Location Approximate)
- Contours (1 m interval)
- Watercourse
- TRCA Regulation Limits
- Municipal Boundary



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Data Source:
Contains information provided by the Region of Peel, TRCA, City of Mississauga, City of Brampton, and Town of Caledon.
Key base map provided by ESRI.

Region of Peel
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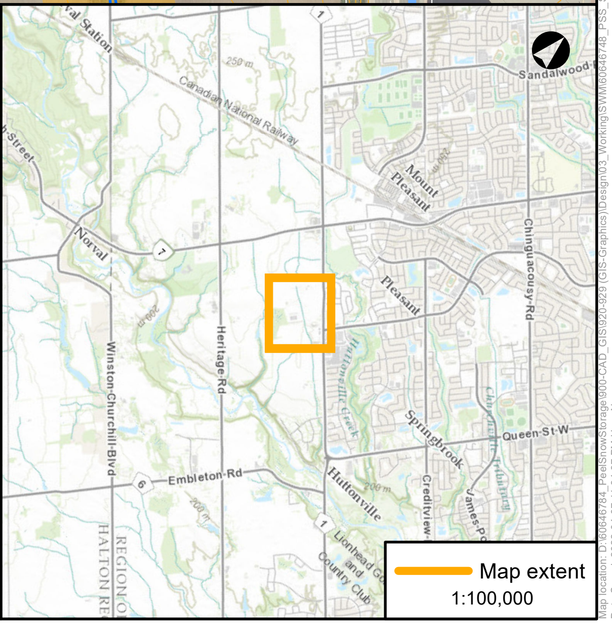
AECOM

Snow Storage Site Analysis and Conceptual Design Project 13-4007
AECOM Project: 60646784

Site 3 - West Brampton Reservoir and Pumping Station

- Potential Snow Storage Property Boundary
- Reservoir
- Potential Snow Storage Area
- Sanitary System (Per GIS, As-Builts; Location Approximate)
- Storm System (Per GIS, As-Builts; Location Approximate)
- Swale/Above-ground feature (Per As-Builts; Location Approximate)
- Water System (Per GIS, As-Builts; Location Approximate)
- SWMF
- Contours (1 m interval)
- Watercourse
- Natural Areas Inventory
- Woodland
- Conservation Authority Regulated Limits
- Municipal Boundary



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Data Source:
Contains information provided by the Region of Peel, City of Mississauga, City of Brampton, and Town of Caledon.
Key base map provided by ESRI.

Region of Peel
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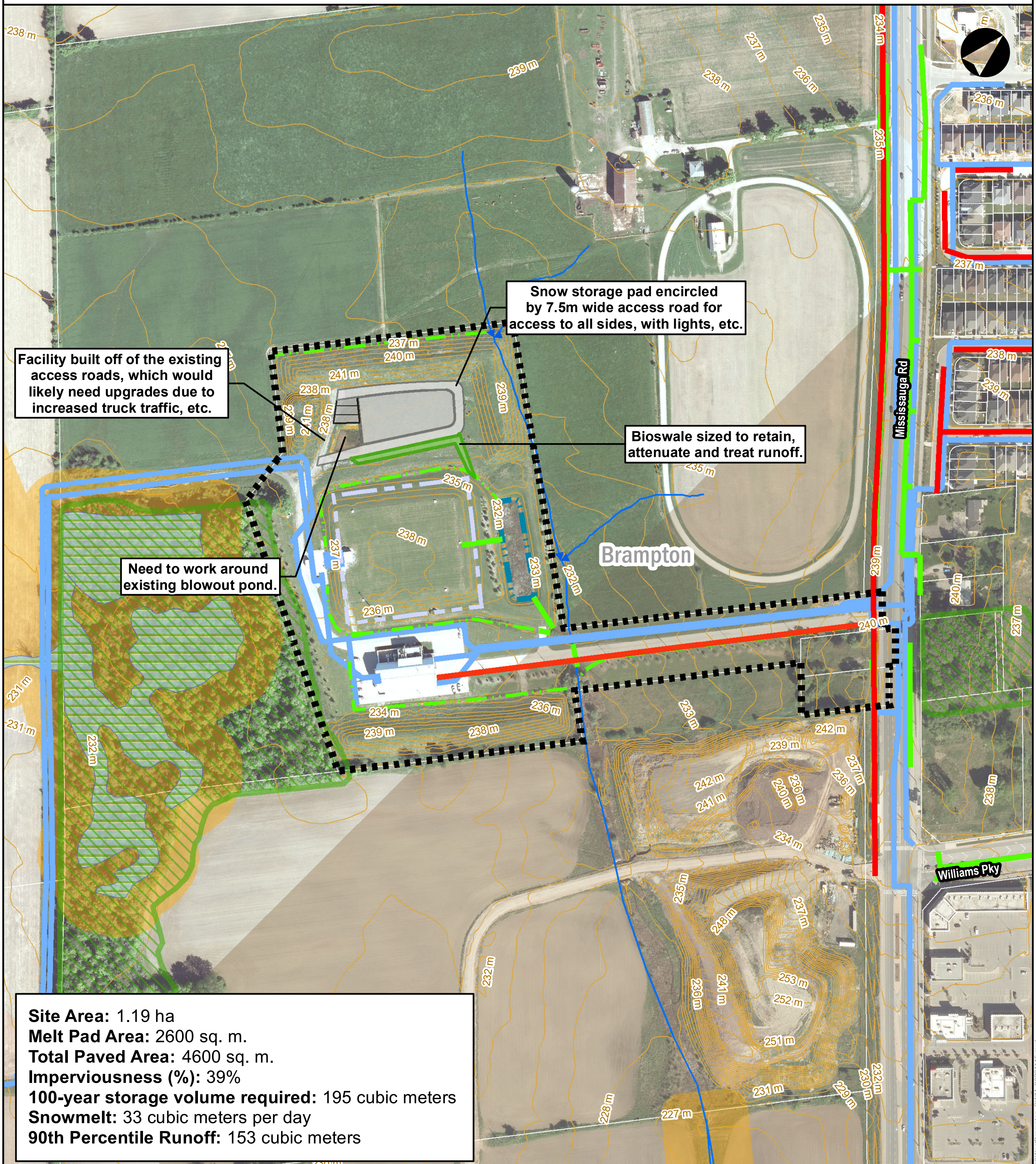
AECOM

Snow Storage Site Analysis and Conceptual Design Project 13-4007
AECOM Project: 60646784

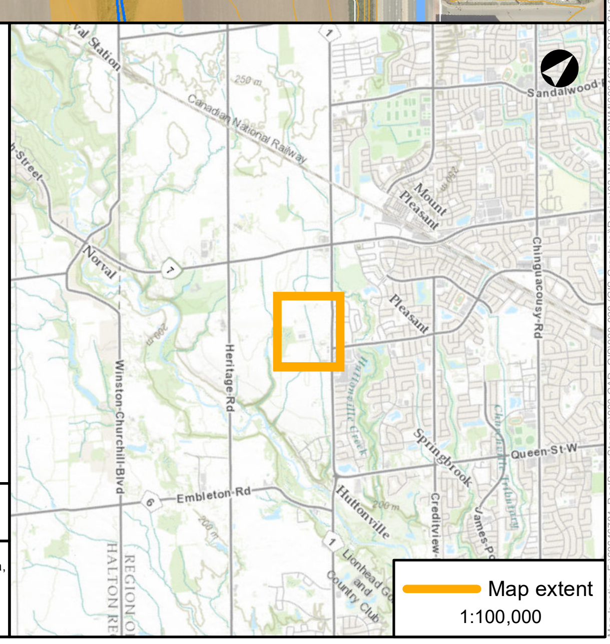
Site 3 - West Brampton Reservoir and Pumping Station



Site Area: 1.19 ha
Melt Pad Area: 2600 sq. m.
Total Paved Area: 4600 sq. m.
Imperviousness (%): 39%
100-year storage volume required: 195 cubic meters
Snowmelt: 33 cubic meters per day
90th Percentile Runoff: 153 cubic meters

Snow Storage Features

- Bioswale
- Access road
- Parking/storage
- Snow pad
- Potential Snow Storage Property Boundary
- Reservoir
- Sanitary System (Per GIS, As-Builts; Location Approximate)
- Storm System (Per GIS, As-Builts; Location Approximate)
- Swale/Above-ground feature (Per As-Builts; Location Approximate)
- Water System (Per GIS, As-Builts; Location Approximate)
- SWMF
- Contours (1 m interval)
- Watercourse
- Natural Areas Inventory
- Woodland
- Conservation Authority Regulated Limits
- Municipal Boundary



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Data Source:
Contains information provided by the Region of Peel, City of Mississauga, City of Brampton, and Town of Caledon.
Key base map provided by ESRI.

Region of Peel
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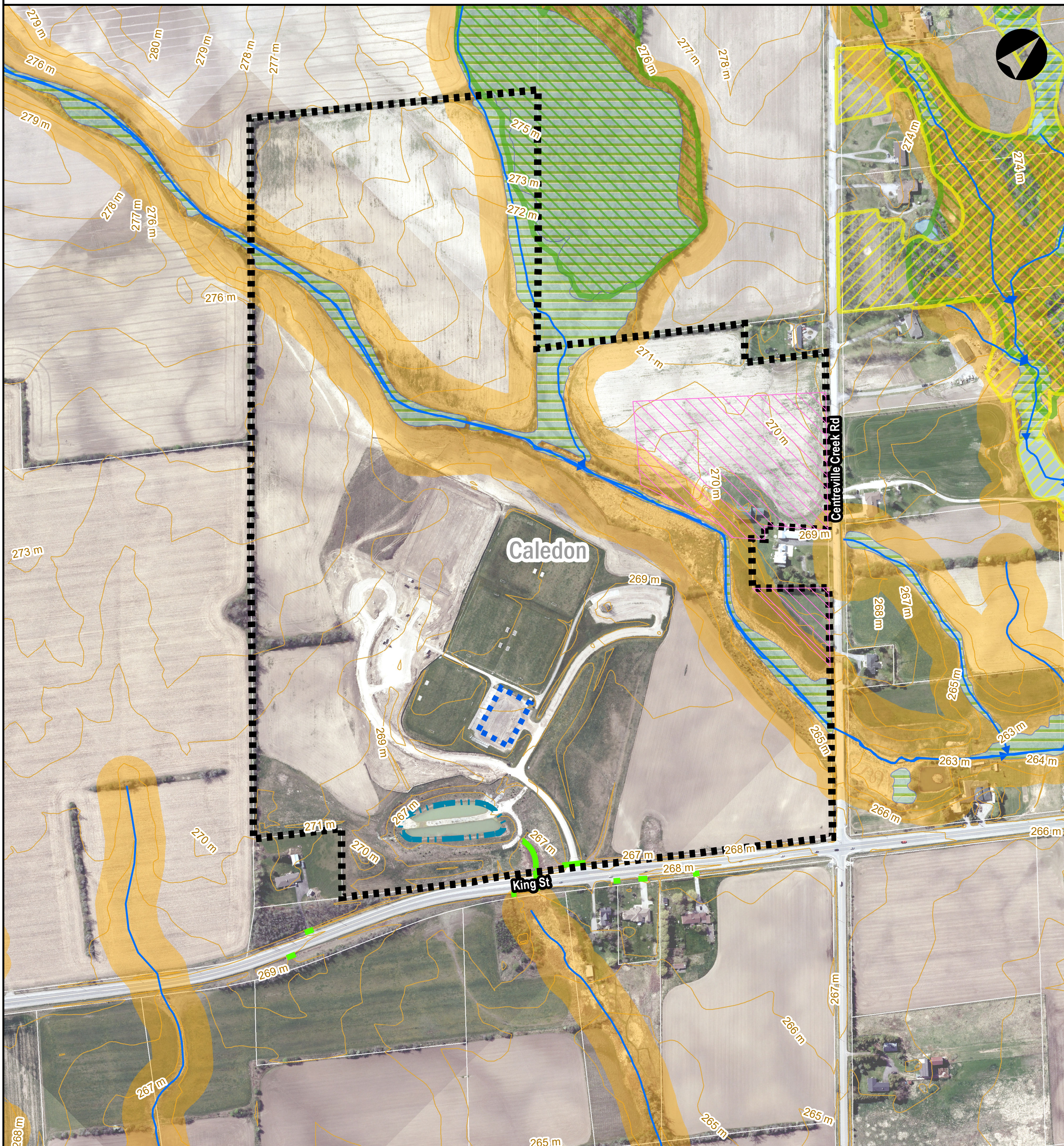
AECOM

Snow Storage Site Analysis and Conceptual Design Project 13-4007
AECOM Project: 60646784

Site 5 - Johnston Sports Park



Potential Snow Storage Property Boundary

Portion of Property Being Sold

Potential Snow Storage Area

Sanitary System (Per GIS, As-Builts; Location Approximate)

Storm System (Per GIS, As-Builts; Location Approximate)

Water System (Per GIS, As-Builts; Location Approximate)

SWMF

Contours (1 m interval)

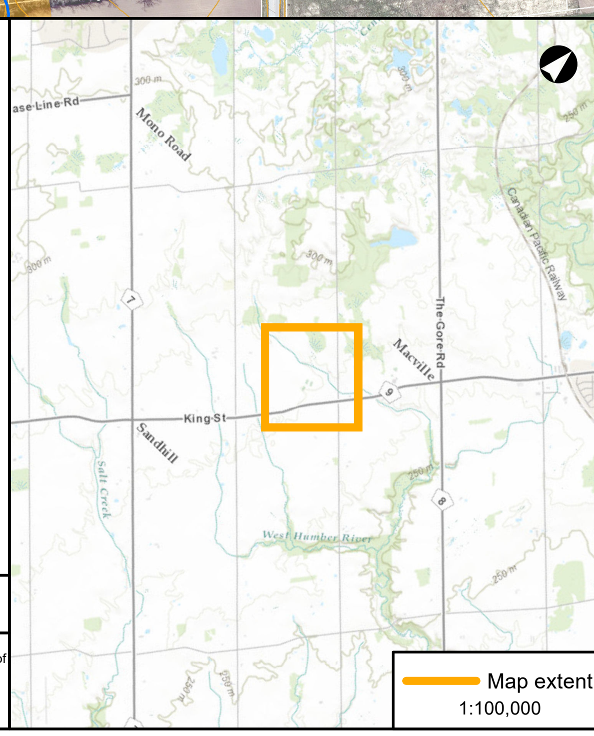
Watercourse

Natural Areas Inventory

Woodland

TRCA Regulation Limits

Municipal Boundary



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Data Source:
Contains information provided by the Region of Peel, TRCA, City of Mississauga, City of Brampton, and Town of Caledon.
Key base map provided by ESRI.

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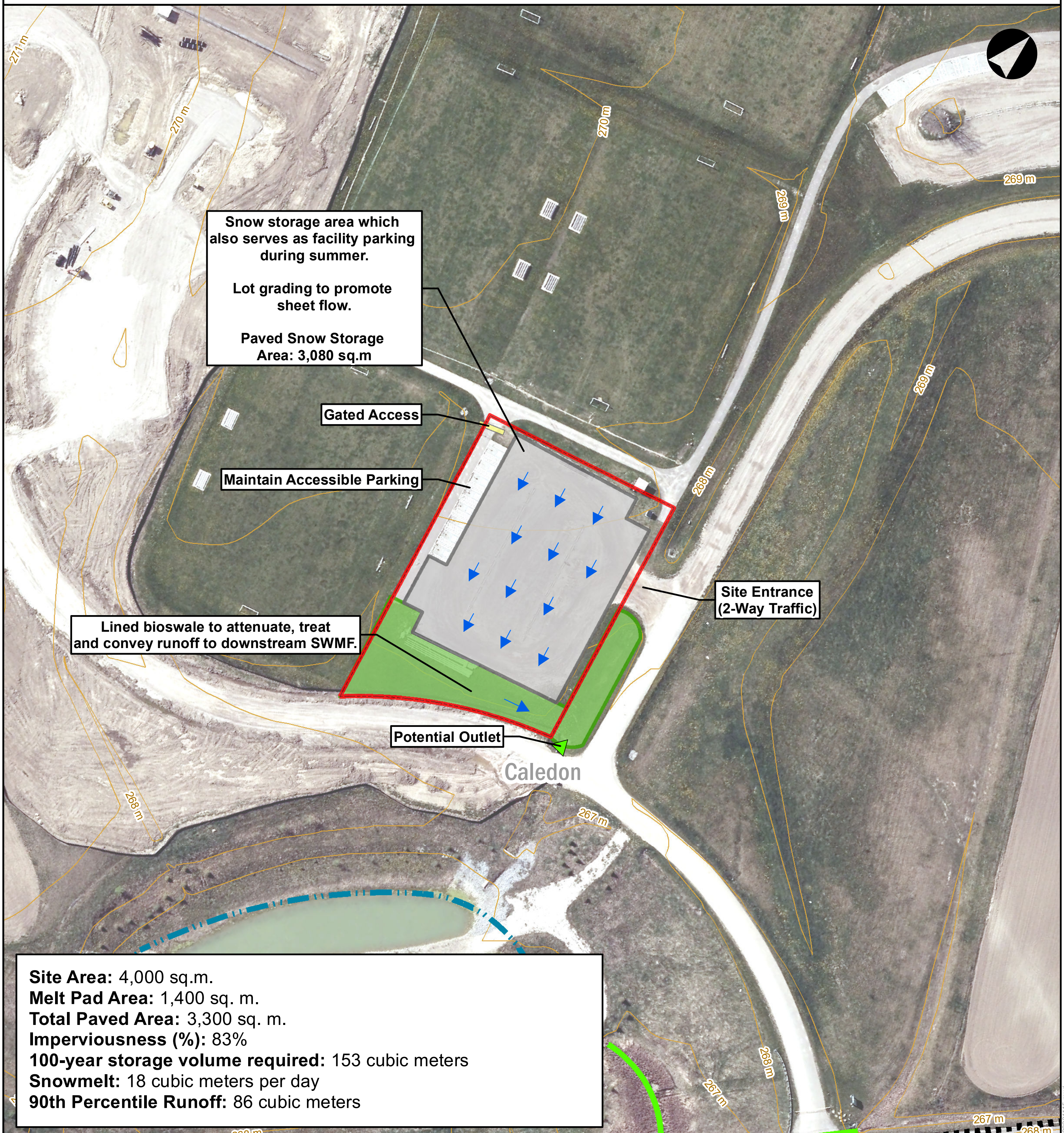
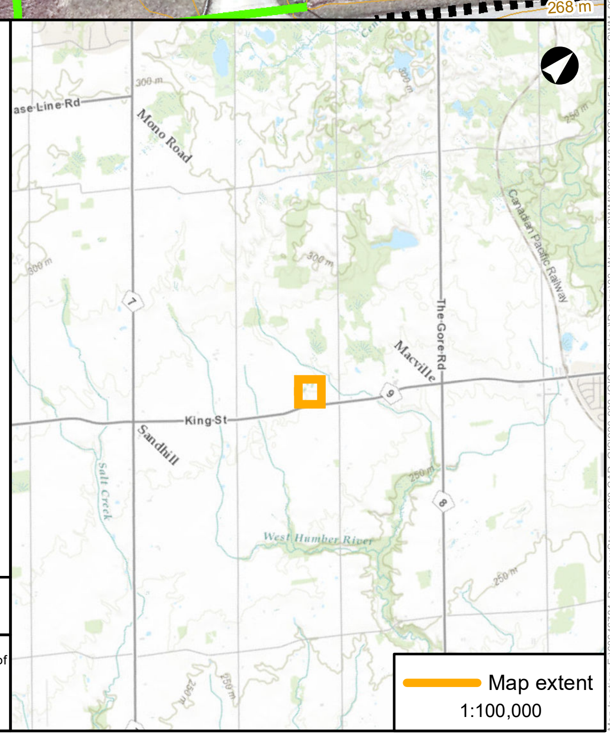
Snow Storage Site Analysis and Conceptual Design Project 13-4007
AECOM Project: 60646784

Site 5 - Johnston Sports Park



Snow Storage Features

- Potential Outlet
- Flow Direction
- Gated Access
- Proposed Treatment
- Snow pad
- Site Area
- Potential Snow Storage Property Boundary
- Portion of Property Being Sold
- Sanitary System (Per GIS, As-Builts; Location Approximate)
- Storm System (Per GIS, As-Builts; Location Approximate)
- Water System (Per GIS, As-Builts; Location Approximate)
- SWMF
- Contours (1 m interval)
- Natural Areas Inventory
- Woodland
- Municipal Boundary



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Data Source:
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Key base map provided by ESRI.

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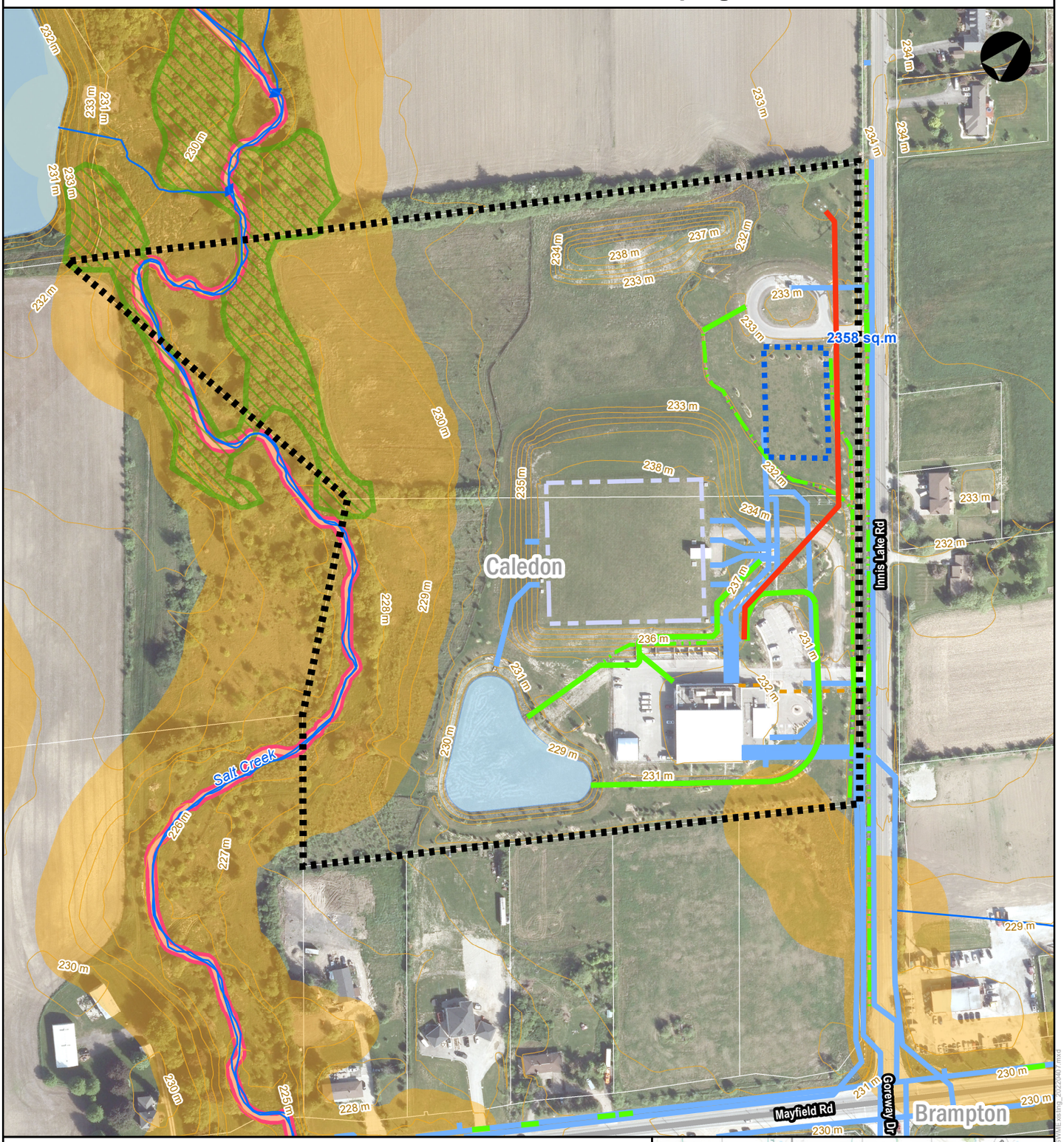
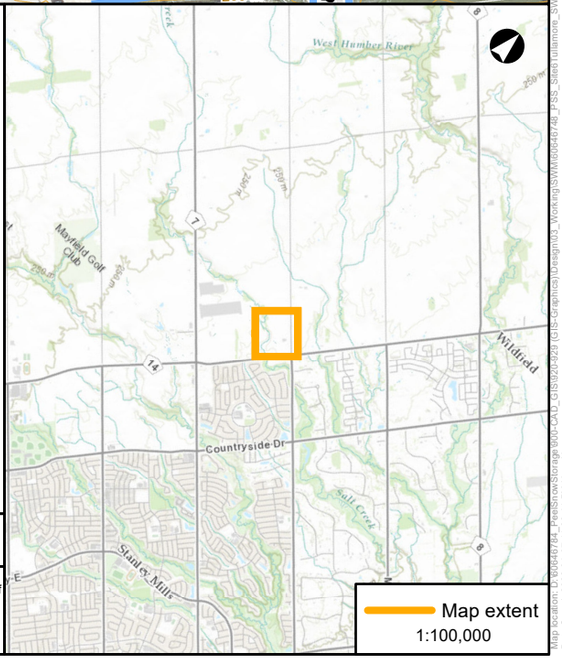
Snow Storage Site Analysis and Conceptual Design Project 13-4007
AECOM Project: 60646784

Site 6 - Tullamore Reservoir and Pumping Station



- Potential Snow Storage Property Boundary
- Reservoir
- Potential Snow Storage Area
- Sanitary System (Per GIS, As-Builts; Location Approximate)
- Storm System (Per GIS, As-Builts; Location Approximate)
- Swale/Above-ground feature (Per As-Builts; Location Approximate)
- Water System (Per GIS, As-Builts; Location Approximate)
- Gas (Per As-Builts, Location
- Contours (1 m interval)
- Watercourse
- Woodland
- TRCA Regulation Limits
- DFO Species at Risk Distribution
- Municipal Boundary



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Key base map provided by ESRI.

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Date Saved: 2022-04-07 11:38:41 PM User Name: anna.waz

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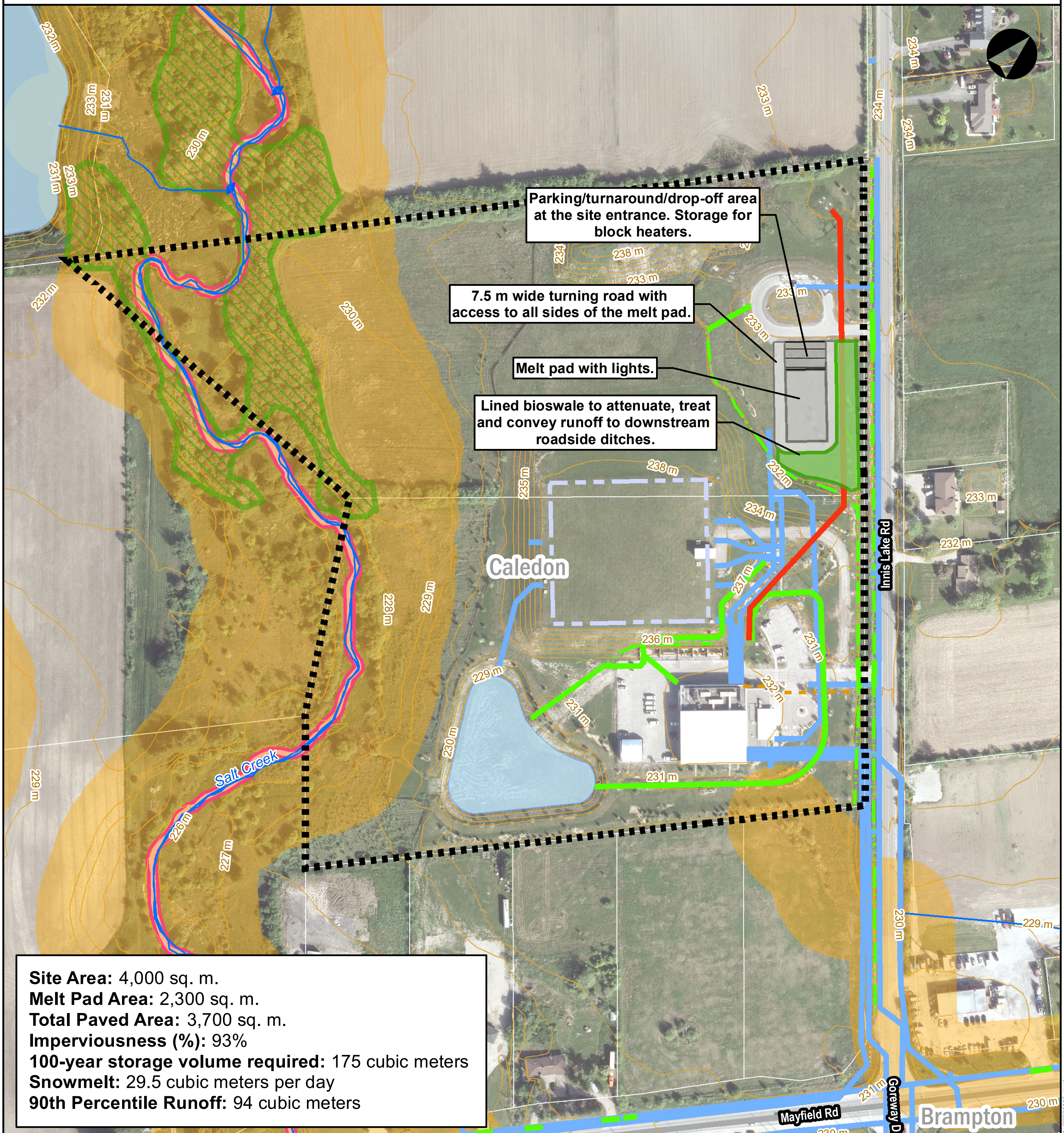
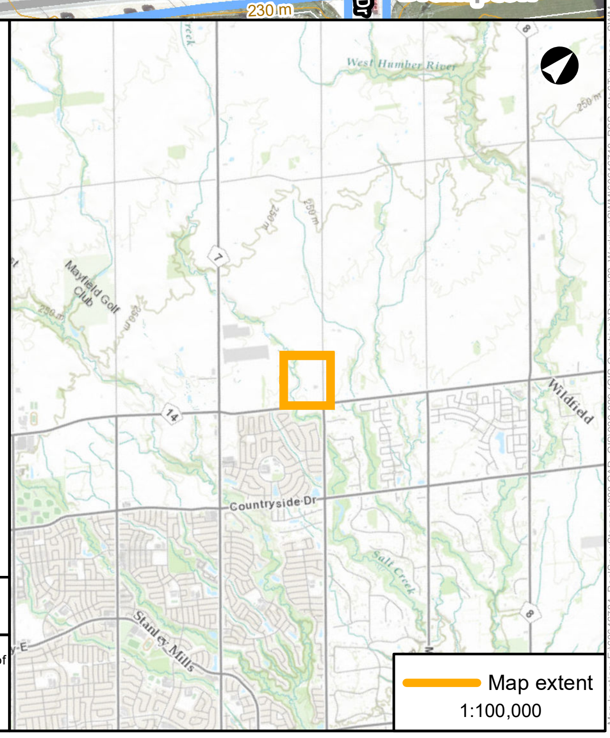
Snow Storage Site Analysis and Conceptual Design Project 13-4007
AECOM Project: 60646784

Site 6 - Tullamore Reservoir and Pumping Station



Snow Storage Features

- Proposed Bioswale
- Access road
- Parking/storage
- Snow pad
- Potential Snow Storage Property Boundary
- Reservoir
- SANITARY_MAIN
- Storm System (Per GIS, As-Builts; Location Approximate)
- Swale/Above-ground feature (Per As-Builts; Location Approximate)
- Water System (Per GIS, As-Builts; Location Approximate)
- Gas (Per As-Builts, Location
- Contours (1 m interval)
- Watercourse
- Woodland
- TRCA Regulation Limits
- DFO Species at Risk Distribution
- Municipal Boundary



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Data Source:
Contains information provided by the Region of Peel, TRCA, City of Mississauga, City of Brampton, and Town of Caledon.
Key base map provided by ESRI.

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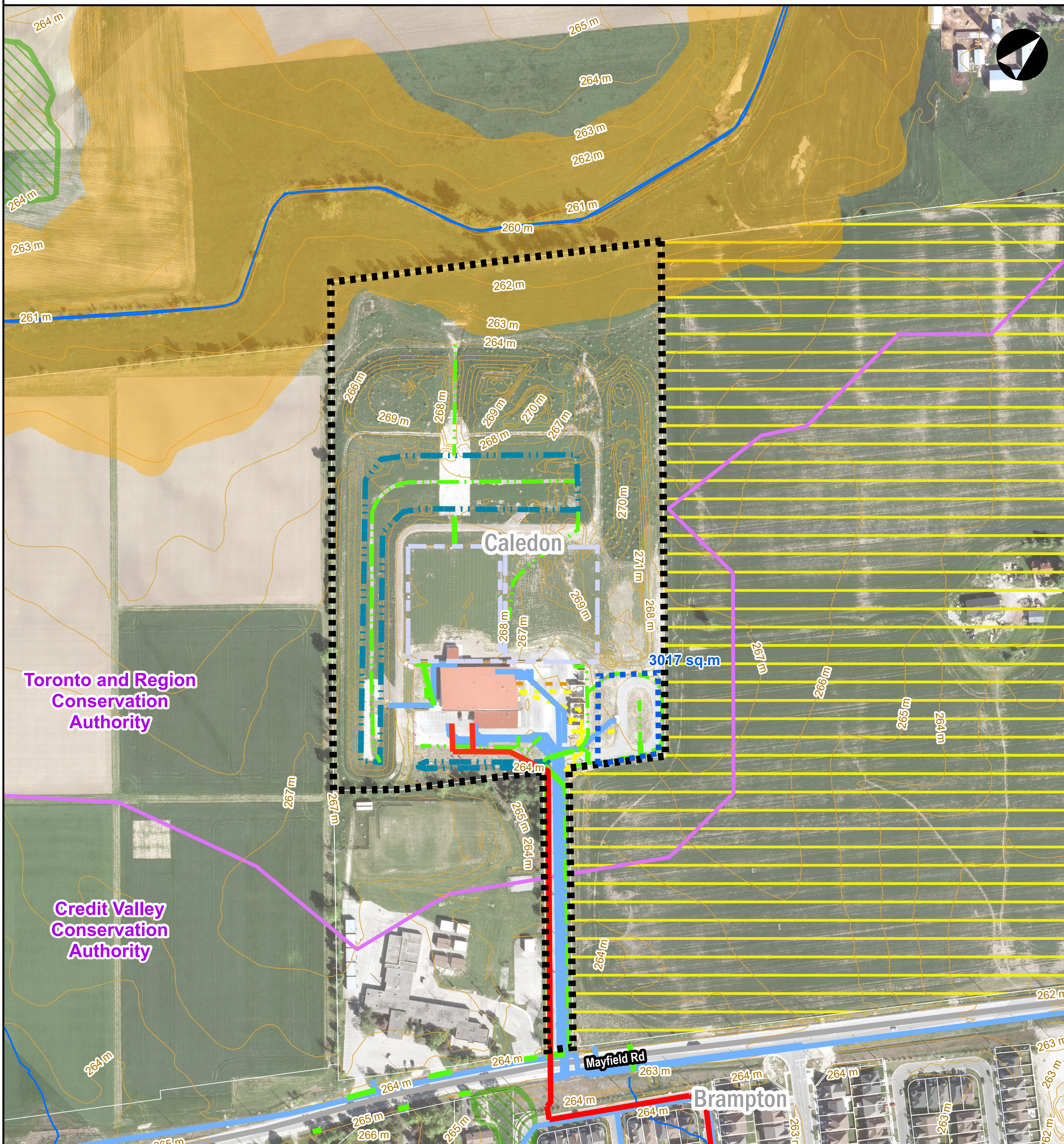
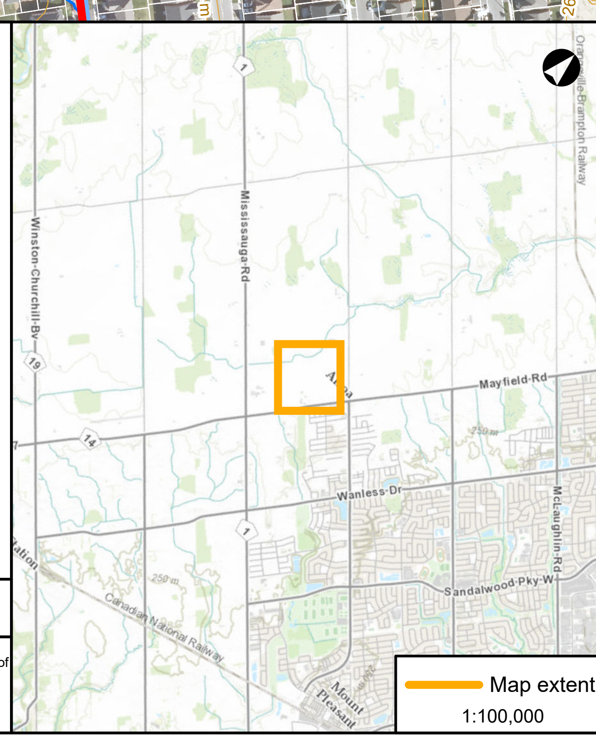
Snow Storage Site Analysis and Conceptual Design Project 13-4007
AECOM Project: 60646784

Site 9 - Alloa Reservoir and Pumping Station



Snow Storage Features

- Proposed Bioswale
- Access road
- Snow pad
- Potential Snow Storage Property Boundary
- Reservoir
- Potential Snow Storage Area
- Sanitary System (Per GIS. As-Builts; Location Approximate)
- Storm System (Per GIS. As-Builts; Location Approximate)
- Swale/Above-ground feature (Per As-Builts; Location Approximate)
- Water System (Per GIS. As-Builts; Location Approximate)
- Gas (Per As-Builts, Location Approximate)
- Hydro (Per As-Builts, Location Approximate)
- SWMF
- Contours (1 m interval)
- Watercourse
- Woodland
- Conservation Authority Regulated Limits
- Conservation Authority Boundary
- Town of Caledon Settlement Area Boundary Expansion
- Municipal Boundary



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Key base map provided by ESRI.

Date Saved: 7/7/2023 3:12 PM User Name: anna.waz

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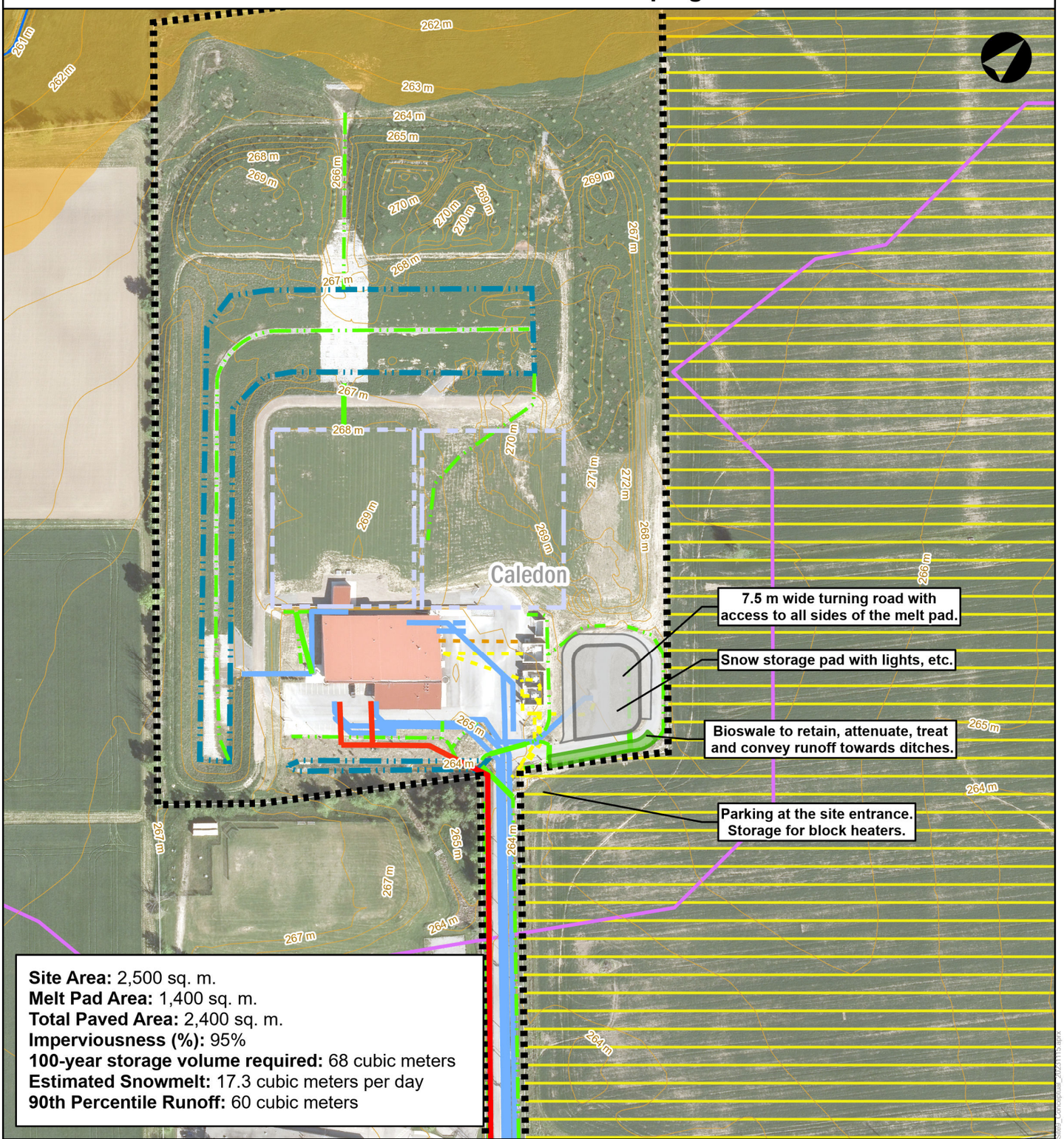
Snow Storage Site Analysis and Conceptual Design Project 13-4007 AECOM Project: 60646784

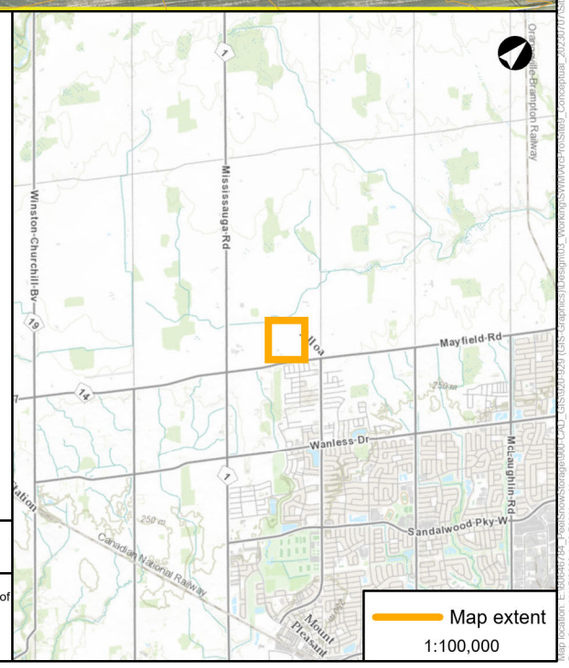
Site 9 - Alloa Reservoir and Pumping Station



Site Area: 2,500 sq. m.
Melt Pad Area: 1,400 sq. m.
Total Paved Area: 2,400 sq. m.
Imperviousness (%): 95%
100-year storage volume required: 68 cubic meters
Estimated Snowmelt: 17.3 cubic meters per day
90th Percentile Runoff: 60 cubic meters

Snow Storage Features

- Proposed Bioswale
- Access road
- Snow pad
- Potential Snow Storage Property Boundary
- Reservoir
- Potential Snow Storage Area
- Sanitary System (Per GIS. As-Builts; Location Approximate)
- Storm System (Per GIS. As-Builts; Location Approximate)
- Swale/Above-ground feature (Per As-Builts; Location Approximate)
- Water System (Per GIS. As-Builts; Location Approximate)
- Gas (Per As-Builts, Location Approximate)
- Hydro (Per As-Builts, Location Approximate)
- SWMF
- Contours (1 m interval)
- Watercourse
- Woodland
- Conservation Authority Regulated Limits
- Conservation Authority Boundary
- Town of Caledon Settlement Area Boundary Expansion
- Municipal Boundary



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Data Source:
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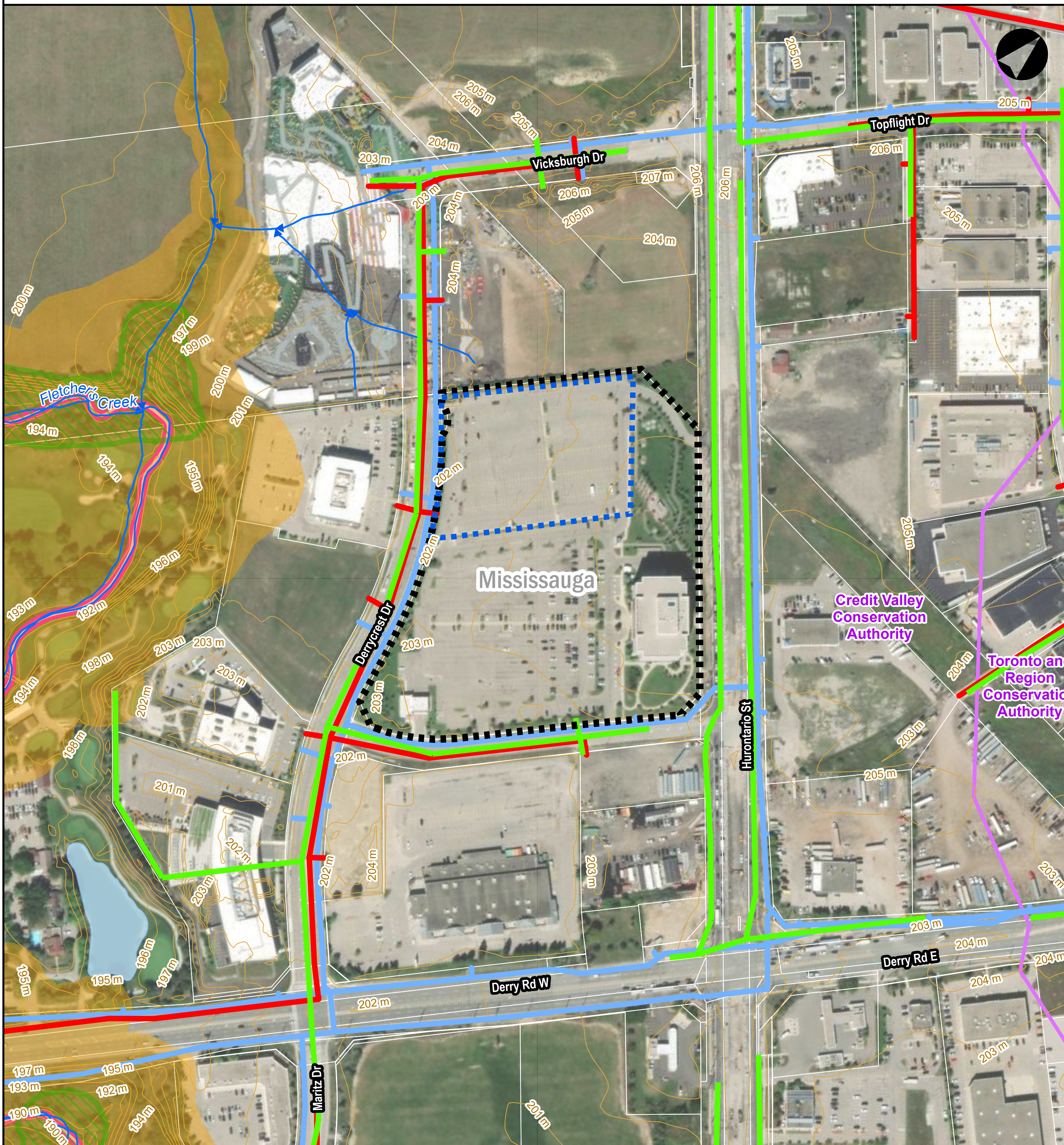
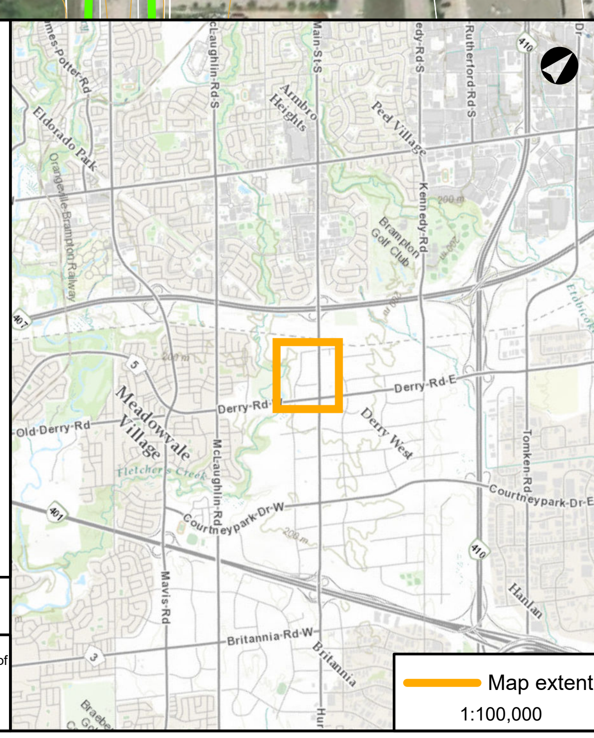
Key base map provided by ESRI.

Snow Storage Site Analysis and Conceptual Design Project 13-4007
AECOM Project: 60646784

7120 Hurontario St, Mississauga - Existing Conditions



- Potential Snow Storage Property Boundary
- Potential Snow Storage Area
- Sanitary System
- Storm System
- Water System
- Contours (1 m interval)
- Watercourse
- Waterbody
- Woodland
- Conservation Authority Regulated Area
- DFO Species at Risk Distribution
- Conservation Authority Boundary
- Municipal Boundary



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Data Source:
Contains information provided by the Region of Peel, TRCA, City of Mississauga, City of Brampton, and Town of Caledon.
Aerial imagery and key base maps provided by ESRI.

Region of Peel
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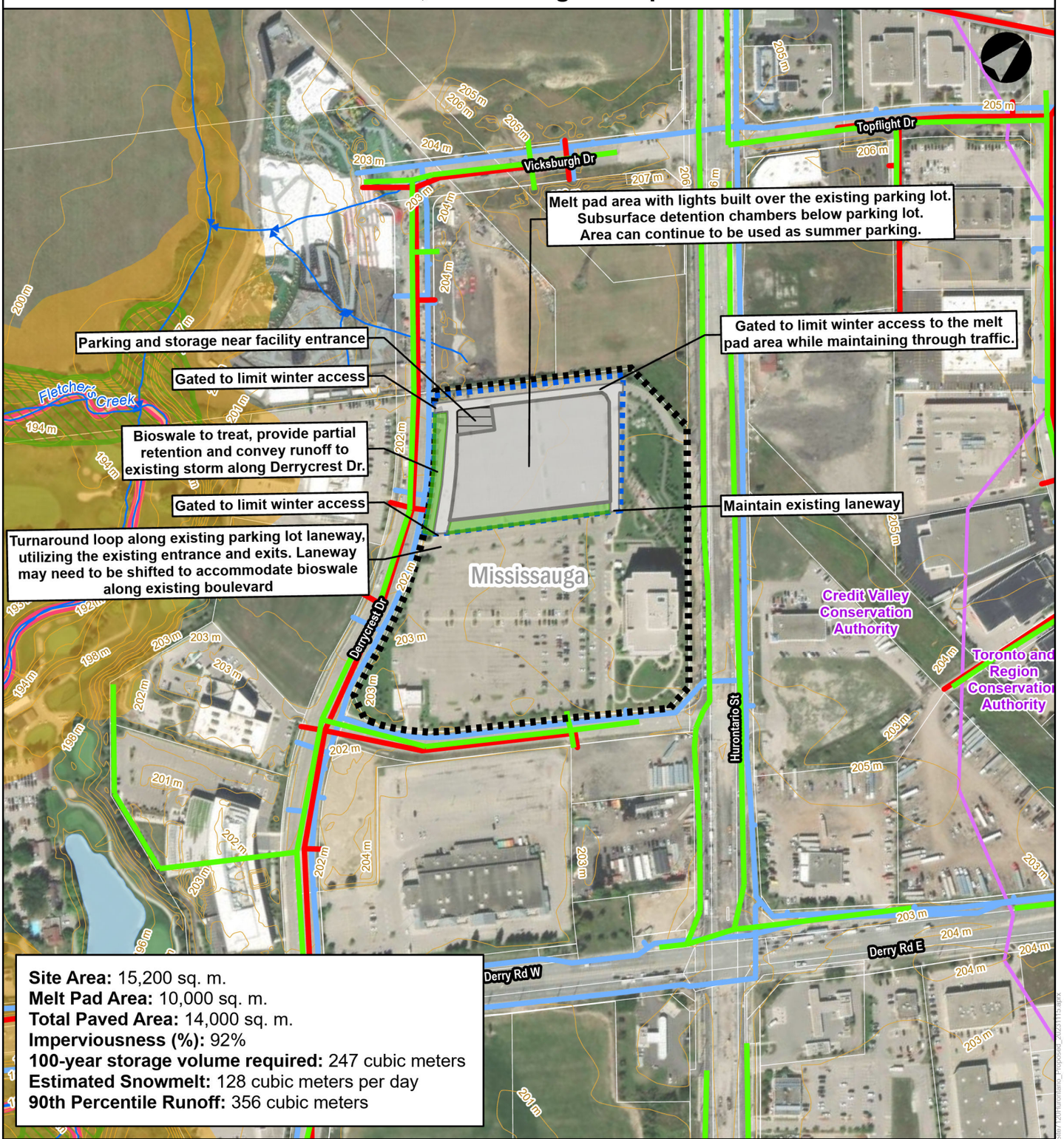
AECOM

Snow Storage Site Analysis and Conceptual Design Project 13-4007
AECOM Project: 60646784

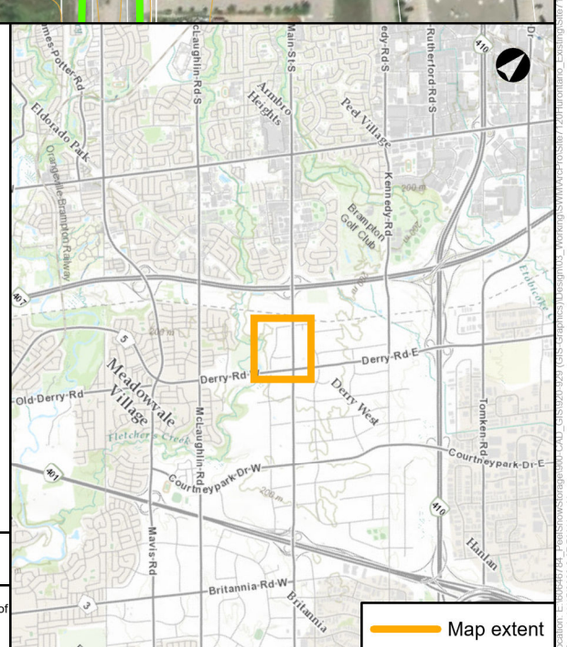
7120 Hurontario St, Mississauga - Proposed Conditions



Site Area: 15,200 sq. m.
Melt Pad Area: 10,000 sq. m.
Total Paved Area: 14,000 sq. m.
Imperviousness (%): 92%
100-year storage volume required: 247 cubic meters
Estimated Snowmelt: 128 cubic meters per day
90th Percentile Runoff: 356 cubic meters

Snow Storage Features

- Proposed Bioswale
- Access road
- Parking/storage
- Snow pad
- Potential Snow Storage Property Boundary
- Potential Snow Storage Area
- Sanitary System
- Storm System
- Water System
- Contours (1 m interval)
- Watercourse
- Waterbody
- Woodland
- Conservation Authority Regulated Area
- DFO Species at Risk Distribution
- Conservation Authority Boundary
- Municipal Boundary

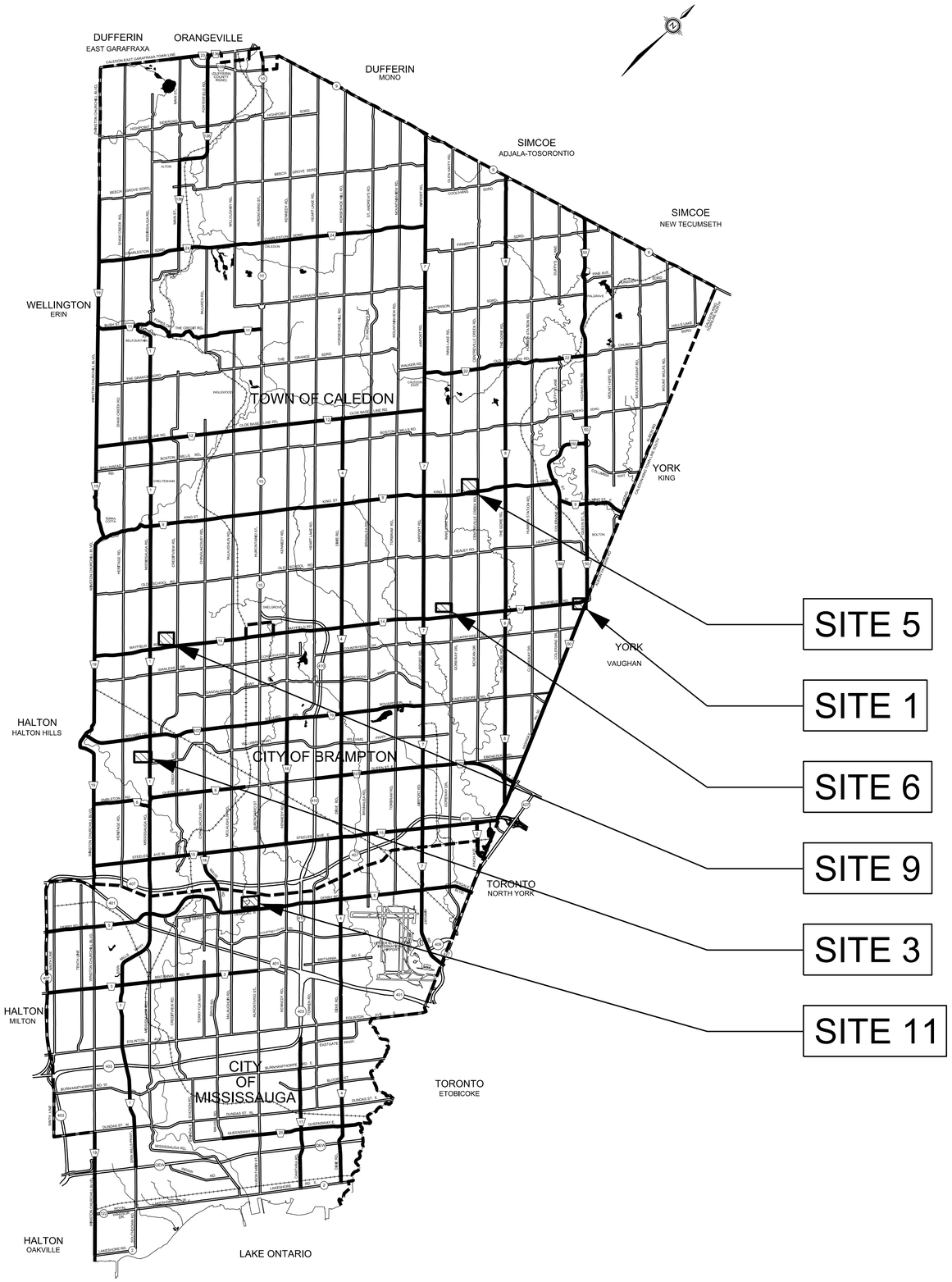


November 2023	Datum: NAD83 UTM17	1:4,000	0 20 40 60 80 100 Meters

Data Source:
Contains information provided by the Region of Peel, TRCA, City of Mississauga, City of Brampton, and Town of Caledon.
Aerial imagery and key base maps provided by ESRI.

Appendix B

Snow Storage Site Conceptual Design Drawings



PROJECT No. 13-4007
SNOW STORAGE SITES

Region of Peel
working with you

Document 13-4007

REVISIONS		
DATE	DETAILS	INIT.
JUNE 22, 2023	ISSUED FOR REVIEW	B.T.
JAN 05, 2024	ISSUED FOR REVIEW	B.T.

SNOW STORAGE SITES

PROJECT NO. 13-4007

DRAWING INDEX

Seal

Seal

AECOM

Region of Peel
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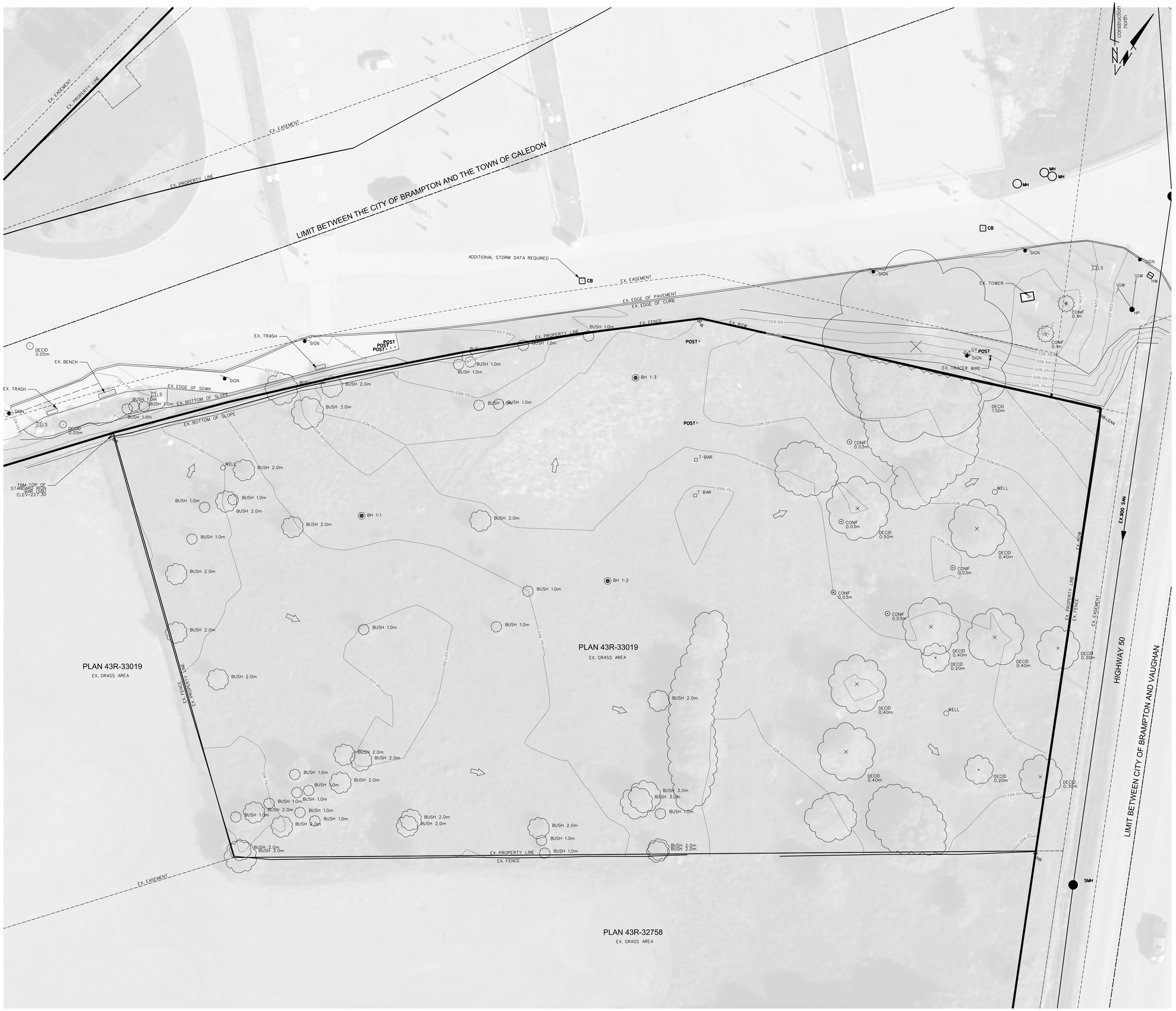
SNOW STORAGE SITES

CAD Area		Area	
Checked by	Z.R	Drawn by	T.M.
Date	MAY 2023	Sheet	1 of 12
Project No.	13-4007		
Plan No.	**1-D**		



REVISIONS		
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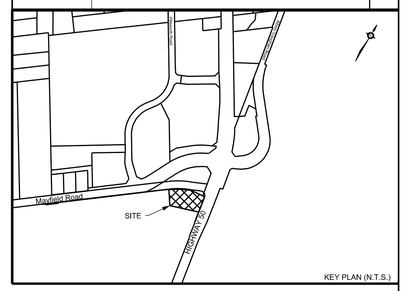
JAN 05, 2024	ISSUED FOR REVIEW	B.T.



LEGEND:

- HP — HYDRO POLE
- EXISTING TREE
- GAS MARKER
- 406.5 — EXISTING CONTOUR
- SS / TS — SIGN
- GUY WIRE
- SIB — PROPERTY BAR
- FLOW ARROWS
- HW — HYDRO WELL
- MH — STORM MANHOLE
- CB — CATCH BASIN
- BH 1-2 — BOREHOLE
- SMH — SANITARY MANHOLE

1:250 0 5 10m

Seal

Seal

AECOM

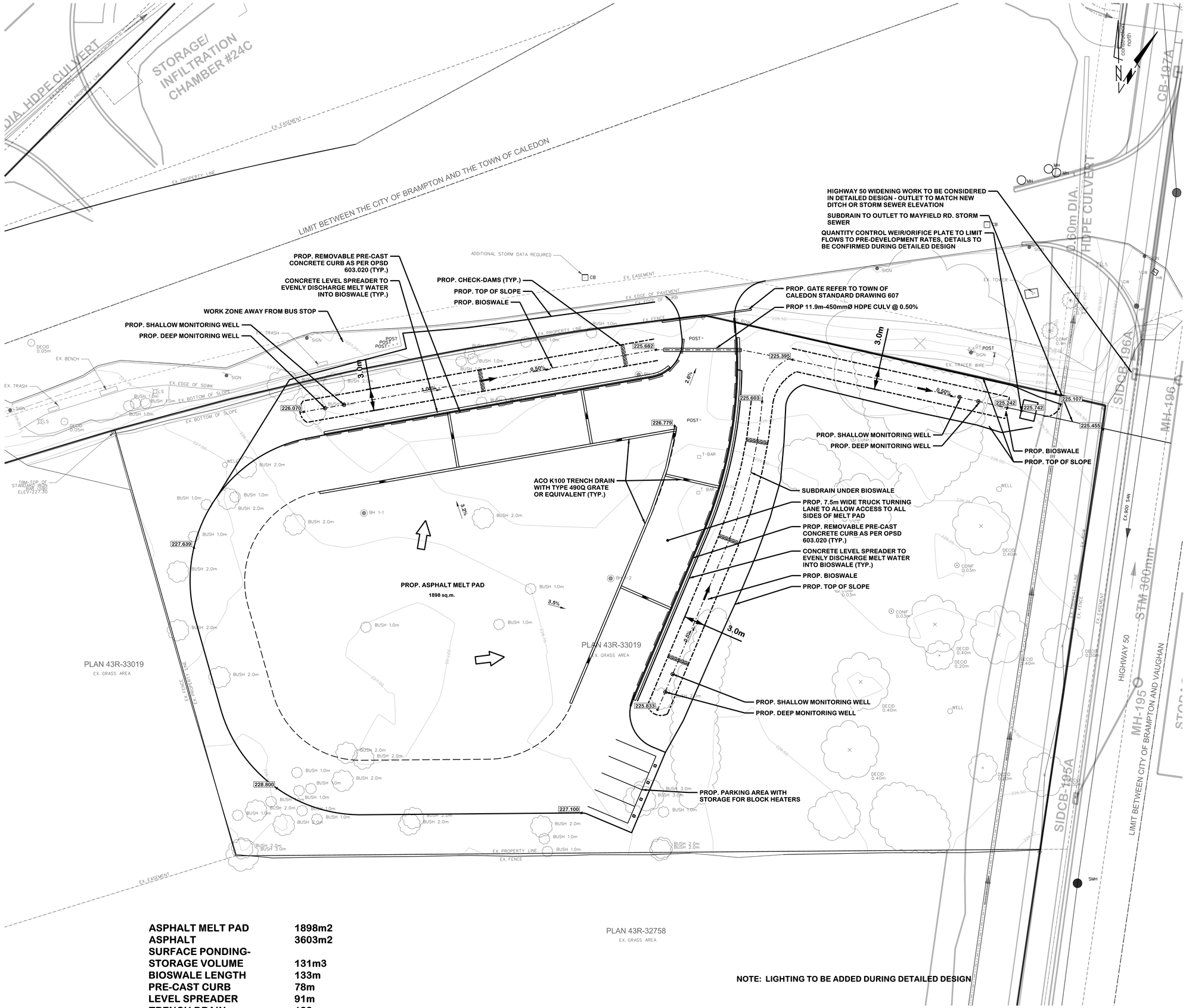
Region of Peel
working with you

SITE 1
SNOW STORAGE

HIGHWAY NO. 50 CARPOOL LOT

EXISTING CONDITIONS

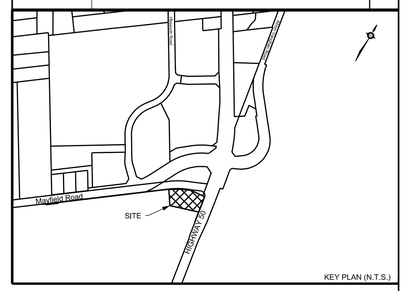
CAD Area		Area	
Checked by Z.R		Drawn by T.M.	Project No. 13-4007
Date FEB 2022		Sheet 2 of 14	Plan No. 2-D



ASPHALT MELT PAD	1898m2
ASPHALT	3603m2
SURFACE PONDING-STORAGE VOLUME	131m3
BIOSWALE LENGTH	133m
PRE-CAST CURB	78m
LEVEL SPREADER	91m
TRENCH DRAIN	122m

REVISIONS

DATE	DETAILS	INIT.
JUNE 22, 2023	ISSUED FOR REVIEW	B.T.
JAN 05, 2024	ISSUED FOR REVIEW	B.T.



LEGEND:

- HP — HYDRO POLE
- EXISTING TREE
- G — GAS MARKER
- 406.5 — EXISTING CONTOUR
- SS / TS — SIGN
- GUY WIRE
- SIB — PROPERTY BAR
- FLOW ARROWS
- HW — HYDRO WELL
- MH — STORM MANHOLE
- CB — CATCH BASIN
- BH 1-2 — BOREHOLE
- SMH — SANITARY MANHOLE

1:250 — 0 5 10m

Seal | Seal

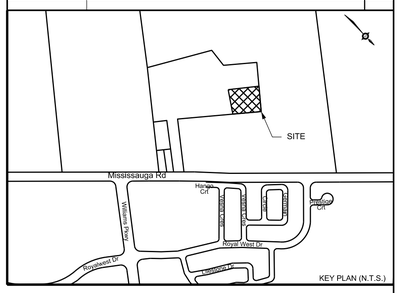
AECOM

Region of Peel
working with you

SITE 1
SNOW STORAGE
HIGHWAY NO. 50 CARPOOL LOT
DESIGN CONCEPT

CAD Area		Area	
Checked by	Z.R	Drawn by	T.M.
Date	MAY 2023	Sheet	3 of 14
Project No.	13-4007		
Plan No.	3-D		

REVISIONS		
DATE	DETAILS	INIT.
JUNE 22, 2023	ISSUED FOR REVIEW	B.T.
JAN 05, 2024	ISSUED FOR REVIEW	B.T.



LEGEND:

- HP — HYDRO POLE
- EXISTING TREE
- GAS MARKER
- 406.5 — EXISTING CONTOUR
- SS / TS — SIGN
- GUY WIRE
- SIB — PROPERTY BAR
- FLOW ARROWS
- HW — HYDRO WELL
- MH — STORM MANHOLE
- CB — CATCH BASIN
- BH 1-2 — BOREHOLE
- SMH — SANITARY MANHOLE

1:300 0 5 10m

Seal

Seal

AECOM

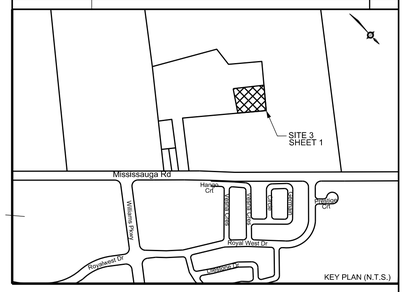
Region of Peel
working with you

SITE 3
POTENTIAL SNOW STORAGE
WEST BRAMPTON RESERVOIR
AND PUMPING STATION

EXISTING CONDITIONS

CAD Area	Area	Project No.	13-4007
Checked by Z.R	Drawn by T.M.	Plan No.	4-D
Date FEB 2022	Sheet 4 of 14		

REVISIONS		
DATE	DETAILS	INIT.
JUNE 22, 2023	ISSUED FOR REVIEW	B.T.
JAN 05, 2024	ISSUED FOR REVIEW	B.T.



EXISTING SWMF

EXISTING SWMF & PROPOSED BIOSWALE AREA ELEVATIONS TO BE ADDED PRIOR TO DESIGN

POTENTIAL OUTLET TO EXISTING SWMF QUANTITY CONTROL WEIR/ORIFICE PLATE TO LIMIT FLOWS TO PRE-DEVELOPMENT RATES, DETAILS TO BE CONFIRMED DURING DETAILED DESIGN

PROP. SHALLOW MONITORING WELL

PROP. DEEP MONITORING WELL

PROP. BIOSWALE

PROP. TOP OF SLOPE

233.990

234.915

234.616

234.690

PROP. CHECK-DAM (TYP.)

PROP. 7.5m WIDE TRUCK TURNING LANE TO ALLOW ACCESS TO ALL SIDES OF MELT PAD

PROP. REMOVABLE PRE-CAST CONCRETE CURB AS PER OPSD 603.020 (TYP.)

CONCRETE LEVEL SPREADER TO EVENLY DISCHARGE MELT WATER INTO BIOSWALE (TYP.)

SHARED DRIVEWAY ENDS HERE TO BE CONFIRMED WITH OCWA

PROP. SHALLOW MONITORING WELL

PROP. DEEP MONITORING WELL

PROP. BIOSWALE

PROP. TOP OF SLOPE

PROP. GATE REFER TO TOWN OF CALEDON STANDARD DRAWING 607

235.290

PROP. BOLLARD (TYP.)

235.738

235.46

ACO K100 TRENCH DRAIN WITH TYPE 490Q GRATE OR EQUIVALENT (TYP.)

PROP. ASPHALT MELT PAD
3714 sq.m.

237.200

EX. OVERFLOW POND TO REMAIN

EX. POND TO BE SEPARATED FROM MELT RUN-OFF WITH BARRIER CURB & PROTECTED WITH BOLLARDS

PROP. PARKING AREA WITH STORAGE FOR BLOCK HEATERS

PROP. 7.5m WIDE TRUCK TURNING LANE TO ALLOW ACCESS TO ALL SIDES OF MELT PAD

236.170

237.629

EX. GRASS AREA

EX. BOTTOM OF BANK

EX. TOP OF BANK

EX. WATER LINE

EX. POND

EX. FENCE

EX. PROPERTY LINE

EX.200 PVC

BH 1-2

BH 3-2

BH 3-1

HOUSE NO. 9752

NOTE: LIGHTING TO BE ADDED DURING DETAILED DESIGN

ASPHALT MELT PAD	3714m2
ASPHALT	6351m2
SURFACE PONDING-STORAGE VOLUME	134m3
BIOSWALE LENGTH	151m
PRE-CAST CURB	72m
LEVEL SPREADER	85m
TRENCH DRAIN	115m

LEGEND:

- HP — HYDRO POLE
- EXISTING TREE
- GAS MARKER
- 406.5 — EXISTING CONTOUR
- SS / TS — SIGN
- GUY WIRE
- SIB — PROPERTY BAR
- FLOW ARROWS
- HW — HYDRO WELL
- MH — STORM MANHOLE
- CB — CATCH BASIN
- BH 1-2 — BOREHOLE
- SMH — SANITARY MANHOLE

1:300 0 5 10m

Seal

Seal

AECOM

Region of Peel
working with you

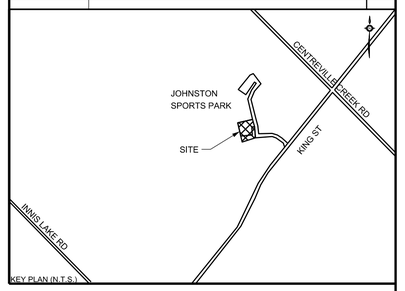
SITE 3
POTENTIAL SNOW STORAGE
WEST BRAMPTON RESERVOIR AND PUMPING STATION

DESIGN CONCEPT

CAD Area	Area	Project No.	13-4007
Checked by Z.R	Drawn by T.M.	Plan No.	5-D
Date MAY 2023	Sheet 5 of 14		

construction north

REVISIONS		
DATE	DETAILS	INIT.
JUNE 22, 2023	ISSUED FOR REVIEW	B.T.
JAN 05, 2024	ISSUED FOR REVIEW	B.T.



EX. BENCH
EX. BENCH
EX. 300mm∘ HDPE
EX. ASPH. WALKWAY
SIGN SIGN SIGN SIGN SIGN SIGN SIGN SIGN
EX. EDGE OF GRAVEL
EX. PRECAST CONC. CURB (TYP)
EX. EDGE OF GRAVEL
EX. EDGE OF GRAVEL
EX. ASPH. WALKWAY
EX. SOCCER NET
EX. GRAVEL PARKING LOT
EX. EDGE OF GRAVEL
EX. PRECAST CONC. CURB (TYP)
EX. BLDG
EX. HYDRO VAULT
EX. BOTTOM OF SLOPE
EX. 300mm∘ HDPE
EX. 300mm∘ HDPE
EX. EDGE OF GRAVEL
EX. EDGE OF GRAVEL
EX. SWALE
TOP OF SLOPE
EX. 300mm HDPE CULVERT
EX. EDGE OF PAVEMENT
EX. CENTRE LINE
EX. EDGE OF PAVEMENT
EX. U/G HYDRO

LEGEND:

- HP — HYDRO POLE
- EXISTING TREE
- G — GAS MARKER
- 406.5 — EXISTING CONTOUR
- SS / TS — SIGN
- GUY WIRE
- SIB — PROPERTY BAR
- FLOW ARROWS
- HW — HYDRO WELL
- MH — STORM MANHOLE
- CB — CATCH BASIN
- BH 1-2 — BOREHOLE
- SMH — SANITARY MANHOLE

1:250 0 5 10m

Seal

Seal

AECOM

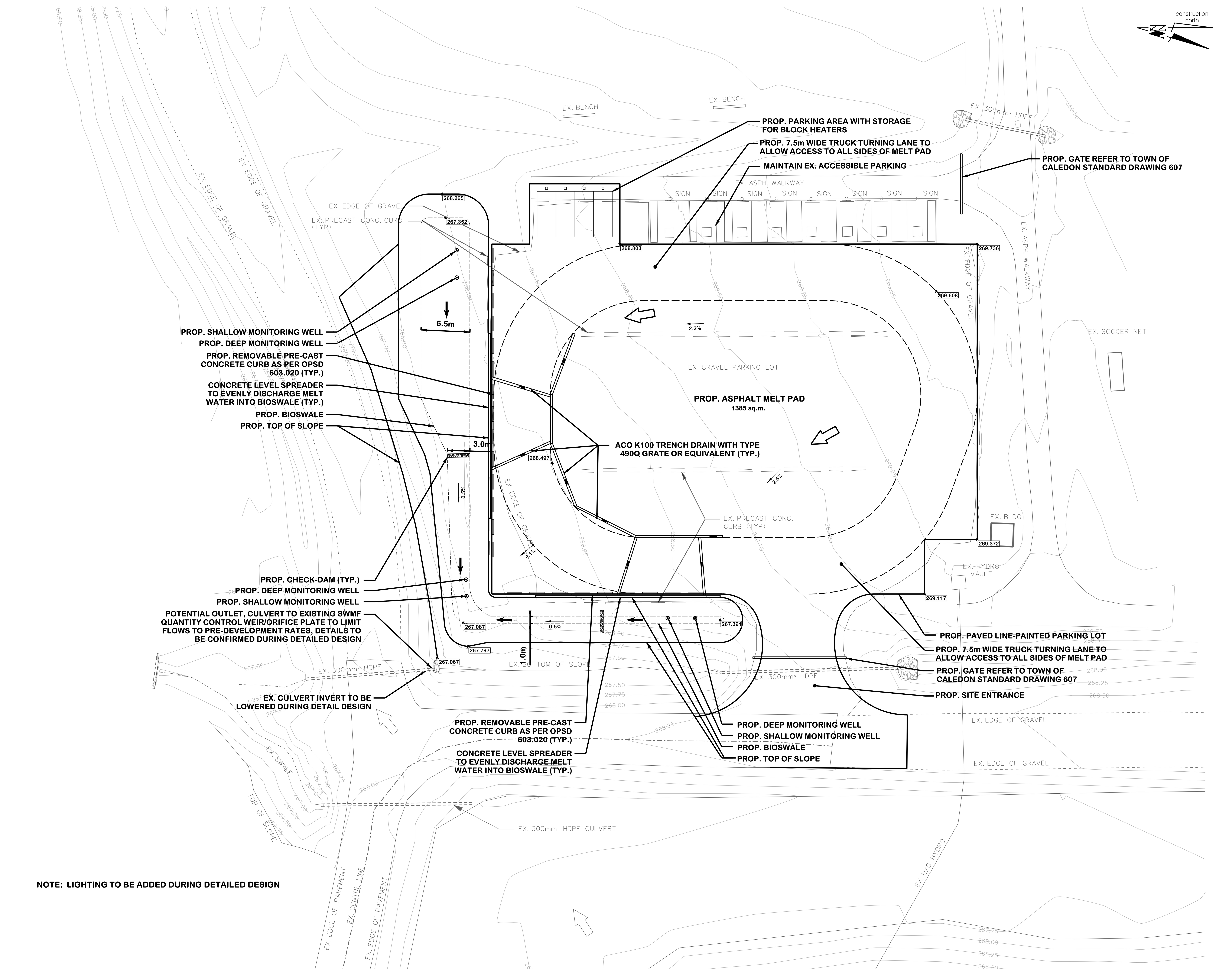
Region of Peel
working with you

SITE 5
POTENTIAL SNOW STORAGE

JOHNSTON SPORTS PARK

EXISTING CONDITIONS

CAD Area	Area	Project No.	13-4007
Checked by Z.R	Drawn by L.McV.	Plan No.	6-D
Date MAY 2023	Sheet 6 of 14		



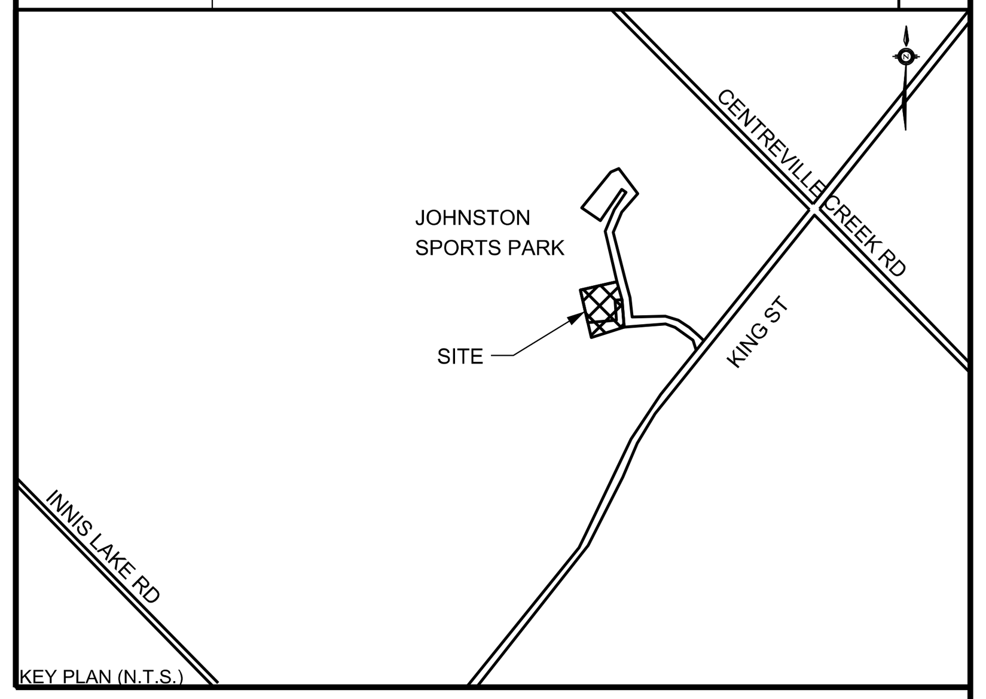
construction north
EX. BENCH
EX. BENCH
EX. 300mm HDPE
PROP. PARKING AREA WITH STORAGE FOR BLOCK HEATERS
PROP. 7.5m WIDE TRUCK TURNING LANE TO ALLOW ACCESS TO ALL SIDES OF MELT PAD
MAINTAIN EX. ACCESSIBLE PARKING
PROP. GATE REFER TO TOWN OF CALEDON STANDARD DRAWING 607
EX. ASPH. WALKWAY
SIGN
EX. EDGE OF GRAVEL
EX. PRECAST CONC. CURB (TYP)
268.265
267.352
268.803
269.736
269.608
EX. SOCCER NET
EX. GRAVEL PARKING LOT
PROP. ASPHALT MELT PAD
1385 sq.m.
2.2%
2.5%
6.5m
3.0m
0.5%
4.1%
268.497
PROP. SHALLOW MONITORING WELL
PROP. DEEP MONITORING WELL
PROP. REMOVABLE PRE-CAST CONCRETE CURB AS PER OPSD 603.020 (TYP.)
CONCRETE LEVEL SPREADER TO EVENLY DISCHARGE MELT WATER INTO BIOSWALE (TYP.)
PROP. BIOSWALE
PROP. TOP OF SLOPE
ACO K100 TRENCH DRAIN WITH TYPE 490Q GRATE OR EQUIVALENT (TYP.)
EX. PRECAST CONC. CURB (TYP)
EX. BLDG
269.372
EX. HYDRO VAULT
269.117
PROP. CHECK-DAM (TYP.)
PROP. DEEP MONITORING WELL
PROP. SHALLOW MONITORING WELL
POTENTIAL OUTLET, CULVERT TO EXISTING SWMF QUANTITY CONTROL WEIR/ORIFICE PLATE TO LIMIT FLOWS TO PRE-DEVELOPMENT RATES, DETAILS TO BE CONFIRMED DURING DETAILED DESIGN
267.087
267.797
267.067
267.391
1.0m
EX. BOTTOM OF SLOPE
EX. 300mm HDPE
PROP. PAVED LINE-PAINTED PARKING LOT
PROP. 7.5m WIDE TRUCK TURNING LANE TO ALLOW ACCESS TO ALL SIDES OF MELT PAD
PROP. GATE REFER TO TOWN OF CALEDON STANDARD DRAWING 607
PROP. SITE ENTRANCE
EX. CULVERT INVERT TO BE LOWERED DURING DETAIL DESIGN
PROP. REMOVABLE PRE-CAST CONCRETE CURB AS PER OPSD 603.020 (TYP.)
CONCRETE LEVEL SPREADER TO EVENLY DISCHARGE MELT WATER INTO BIOSWALE (TYP.)
PROP. DEEP MONITORING WELL
PROP. SHALLOW MONITORING WELL
PROP. BIOSWALE
PROP. TOP OF SLOPE
EX. EDGE OF GRAVEL
EX. EDGE OF GRAVEL
EX. SWALE
TOP OF SLOPE
EX. 300mm HDPE CULVERT
EX. U/G HYDRO
EX. EDGE OF PAVEMENT
EX. CENTRE LINE
EX. EDGE OF PAVEMENT

NOTE: LIGHTING TO BE ADDED DURING DETAILED DESIGN

ASPHALT MELT PAD	1385m2
ASPHALT PARKING LOT	3300m2
SUFACE PONDING-STORAGE VOLUME	84m3
BIOSWALE LENGTH	88m
PRE-CAST CURB	50m
LEVEL SPREADER	49m
TRENCH DRAIN	77m

REVISIONS

DATE	DETAILS	INIT.
JUNE 22, 2023	ISSUED FOR REVIEW	B.T.
JAN 05, 2024	ISSUED FOR REVIEW	B.T.



KEY PLAN (N.T.S.)

LEGEND:

- HYDRO POLE
- EXISTING TREE
- GAS MARKER
- EXISTING CONTOUR
- SIGN
- GUY WIRE
- PROPERTY BAR
- FLOW ARROWS
- HYDRO WELL
- STORM MANHOLE
- CATCH BASIN
- BOREHOLE
- SANITARY MANHOLE

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1:250 0 5 10m

Seal

Seal

AECOM

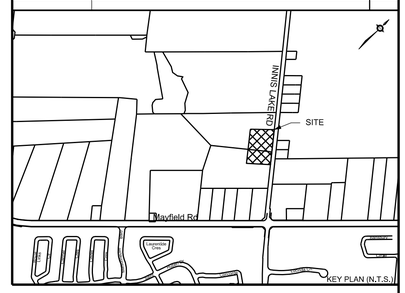
Region of Peel
working with you

SITE 5
POTENTIAL SNOW STORAGE

JOHNSTON SPORTS PARK

DESIGN CONCEPT

CAD Area	Area	Project No.	13-4007
Checked by Z.R	Drawn by T.M.	Plan No.	7-D
Date MAY 2023	Sheet 7 of 14		



REVISIONS		
DATE	DETAILS	INIT.
JUNE 22, 2023	ISSUED FOR REVIEW	B.T.
JAN 05, 2024	ISSUED FOR REVIEW	B.T.

LEGEND:

- HP — HYDRO POLE
- EXISTING TREE
- GAS MARKER
- 406.5 — EXISTING CONTOUR
- SS / TS — SIGN
- GUY WIRE
- SIB — PROPERTY BAR
- FLOW ARROWS
- HW — HYDRO WELL
- MH — STORM MANHOLE
- CB — CATCH BASIN
- BH 1-2 — BOREHOLE
- SMH — SANITARY MANHOLE

1:250 0 5 10m

Seal

Seal

AECOM

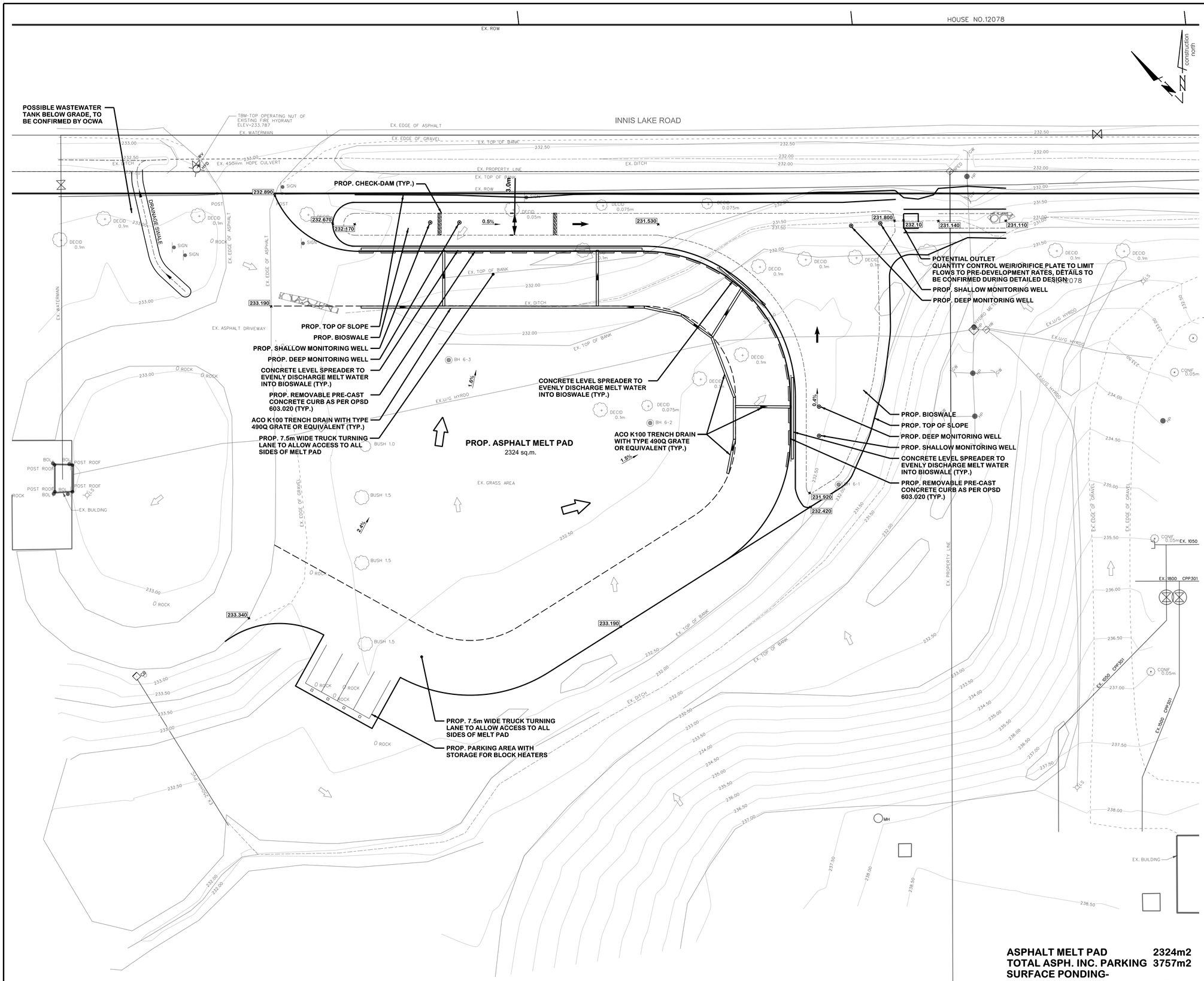
Region of Peel
working with you

SITE 6
POTENTIAL SNOW STORAGE

TULLAMORE RESERVOIR AND PUMPING STATION

EXISTING CONDITIONS

CAD Area		Area	
Checked by Z.R		Drawn by T.M.	Project No. 13-4007
Date FEB 2022		Sheet 8 of 14	Plan No. 8-D



REVISIONS		
DATE	DETAILS	INIT.
JUNE 22, 2023	ISSUED FOR REVIEW	B.T.
JAN 05, 2024	ISSUED FOR REVIEW	B.T.

LEGEND:

- HP — HYDRO POLE
- EXISTING TREE
- GAS MARKER
- 406.5 — EXISTING CONTOUR
- SIGN
- GUY WIRE
- SIB — PROPERTY BAR
- FLOW ARROWS
- HW — HYDRO WELL
- MH — STORM MANHOLE
- CB — CATCH BASIN
- BH 1-2 — BOREHOLE
- SMH — SANITARY MANHOLE

1:250 0 5 10m

ASPHALT MELT PAD	2324m2
TOTAL ASPH. INC. PARKING	3757m2
SURFACE PONDING-STORAGE VOLUME	127m3
BIOSWALE LENGTH	110m
PRE-CAST CURB	54m
LEVEL SPREADER	58m
TRENCH DRAIN	98m

NOTE: LIGHTING TO BE ADDED DURING DETAILED DESIGN

Seal

Seal

AECOM

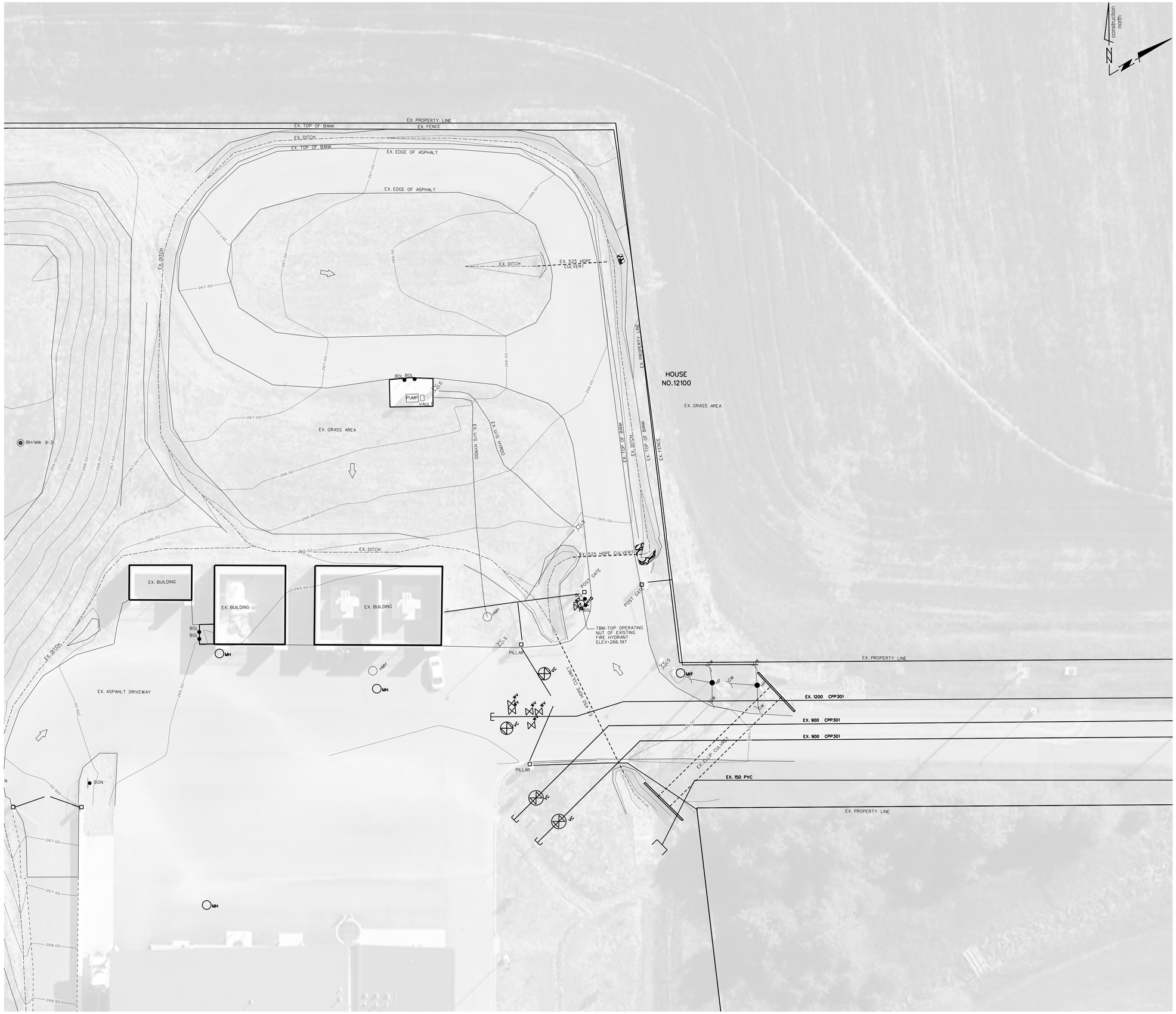
Region of Peel
working with you

SITE 6
POTENTIAL SNOW STORAGE

TULLAMORE RESERVOIR AND PUMPING STATION

DESIGN CONCEPT

CAD Area		Area	
Checked by	Z.R	Drawn by	T.M.
Date	MAY 2023	Sheet	9 of 14
		Project No.	13-4007
		Plan No.	9-D



REVISIONS		
DATE	DETAILS	INIT.
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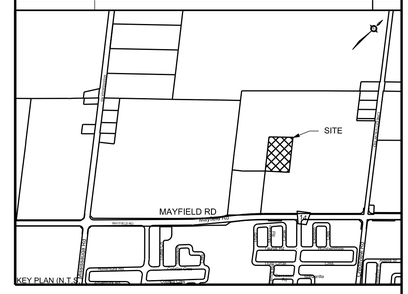


LEGEND:

- HP — HYDRO POLE
- EXISTING TREE
- KG — GAS MARKER
- 406.5 — EXISTING CONTOUR
- SS / TS — SIGN
- GUY WIRE
- SIB — PROPERTY BAR
- FLOW ARROWS
- HW — HYDRO WELL
- MH — STORM MANHOLE
- CB — CATCH BASIN
- BH 1-2 — BOREHOLE
- SMH — SANITARY MANHOLE

1:250 0 5 10m

Seal

Seal

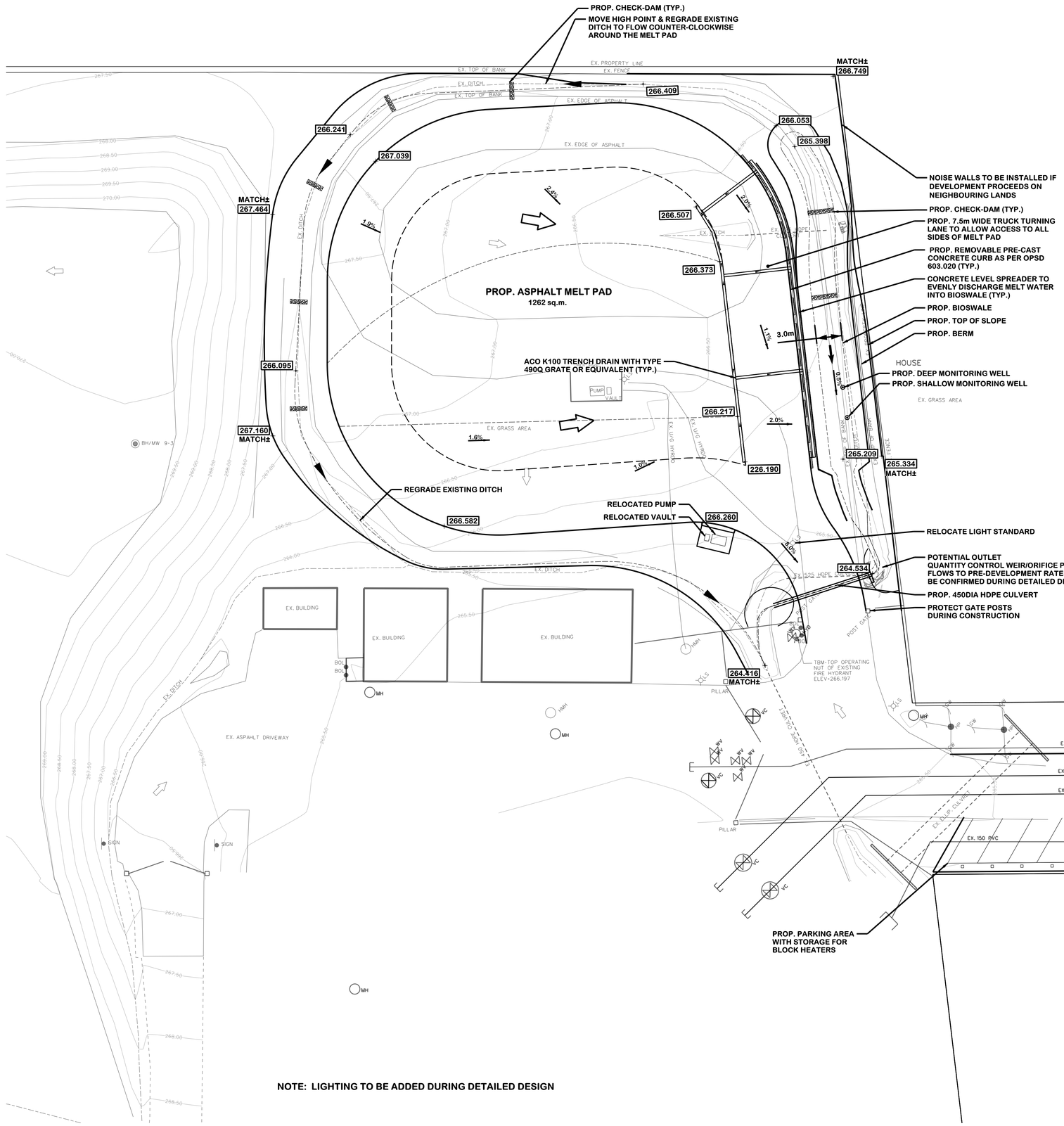
AECOM

Region of Peel
working with you

SITE 9
POTENTIAL SNOW STORAGE
ALLOA RESERVOIR AND PUMPING STATION

EXISTING CONDITIONS

CAD Area		Area	
Checked by	Z.R	Drawn by	T.M.
Date	FEB 2022	Sheet	10 of 14
Project No.			13-4007
Plan No.			10-D

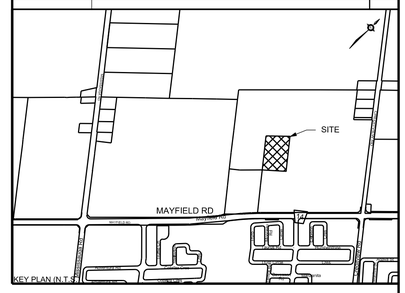


NOTE: LIGHTING TO BE ADDED DURING DETAILED DESIGN

ASPHALT MELT PAD	1262m2
ASPHALT + PARKING	2661m2
SURFACE PONDING-STORAGE VOLUME	43m3
BIOSWALE LENGTH	41m
PRE-CAST CURB	26m
LEVEL SPREADER	36m
TRENCH DRAIN	55m

construction north

REVISIONS		
DATE	DETAILS	INIT.
JUNE 22, 2023	ISSUED FOR REVIEW	B.T.
JAN 05, 2024	ISSUED FOR REVIEW	B.T.



LEGEND:

- HP — HYDRO POLE
- EXISTING TREE
- KG — GAS MARKER
- 406.5 — EXISTING CONTOUR
- SS TS — SIGN
- GUY WIRE
- SIB — PROPERTY BAR
- FLOW ARROWS
- HW — HYDRO WELL
- MH — STORM MANHOLE
- CB — CATCH BASIN
- BH 1-2 — BOREHOLE
- SMH — SANITARY MANHOLE

1:250 0 5 10m

Seal

Seal

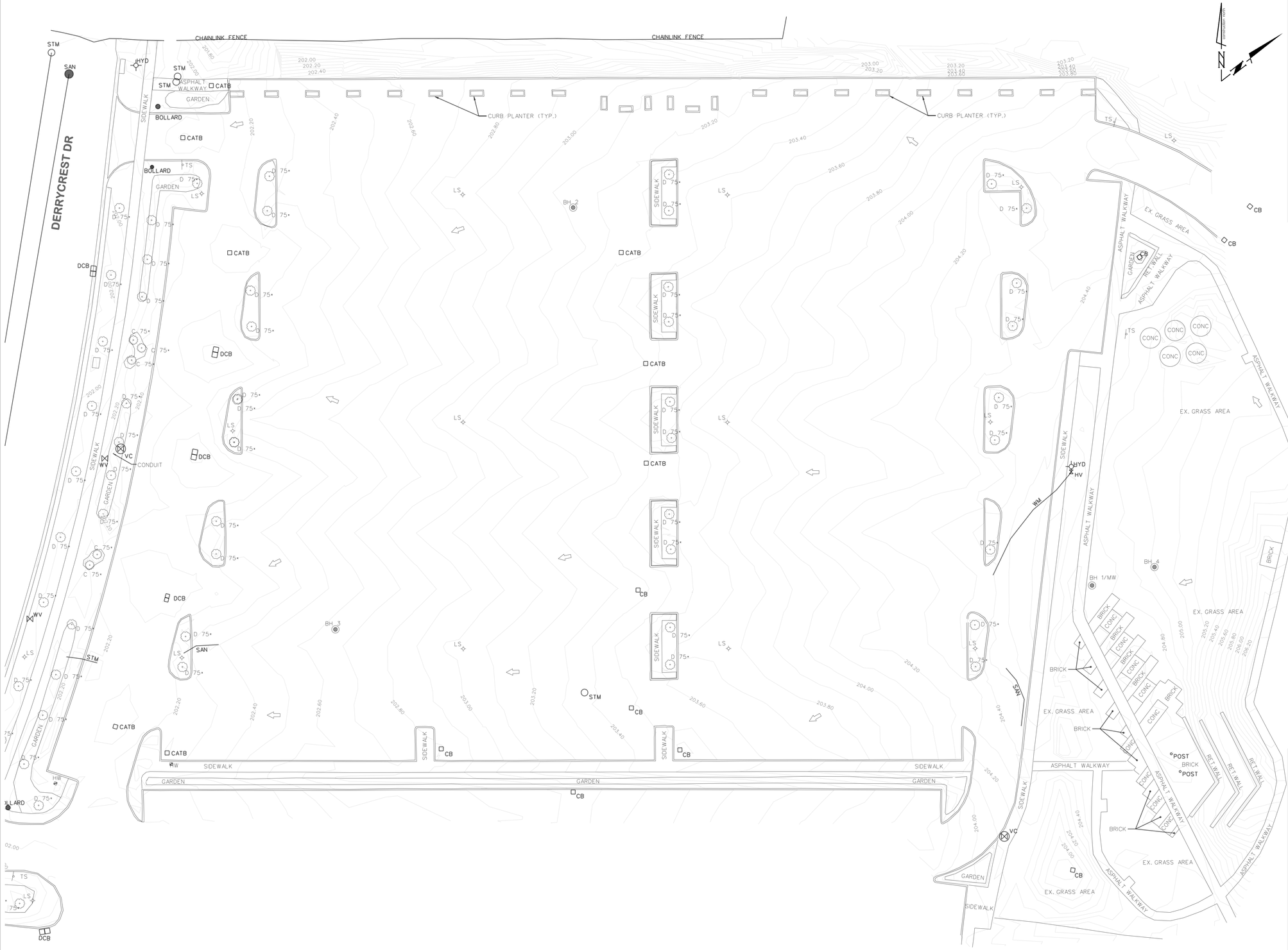
AECOM

Region of Peel
working with you

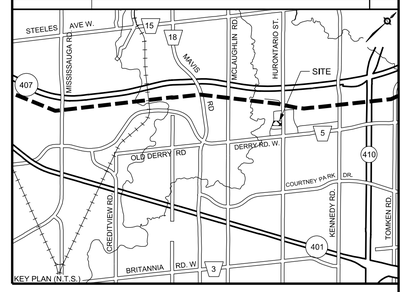
SITE 9
POTENTIAL SNOW STORAGE
ALLOA RESERVOIR AND PUMPING STATION

DESIGN CONCEPT

CAD Area	Area	Project No.	13-4007
Checked by Z.R	Drawn by T.M.	Plan No.	11-D
Date MAY 2023	Sheet 11 of 14		



REVISIONS		
DATE	DETAILS	INIT.
AUG 25, 2023	ISSUED FOR REVIEW	B.T.
JAN 05, 2024	ISSUED FOR REVIEW	B.T.



LEGEND:

- HP — HYDRO POLE
- EXISTING TREE
- G — GAS MARKER
- 406.5 — EXISTING CONTOUR
- TS — SIGN
- GUY WIRE
- SIB — PROPERTY BAR
- FLOW ARROWS
- HW — HYDRO WELL
- MH — STORM MANHOLE
- CB — CATCH BASIN
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1:300 0 5 10m

Seal

Seal

AECOM

Region of Peel
working with you

SITE 10
POTENTIAL SNOW STORAGE
7120 HURONTARIO STREET
REGION OF PEEL PARKING LOT

EXISTING CONDITIONS

CAD Area	Area	Project No.	13-4007
Checked by Z.R	Drawn by L.McV.	Plan No.	12-D
Date OCT 2023	Sheet 12 of 14		

PROP. PARKING AREA WITH STORAGE FOR BLOCK HEATERS

PROP. 7.5m WIDE ASPHALT TURNING ROAD TO ALLOW ACCESS TO ALL SIDES OF MELT PAD

PROP. GATE REFER TO TOWN OF CALEDON STANDARD DRAWING 607

UNDERDRAIN TO OUTLET TO DERRYCREST DR. STORM SEWER

GATED TO LIMIT WINTER ACCESS

PROP. SHALLOW MONITORING WELL

PROP. DEEP MONITORING WELL

ACO K100 TRENCH DRAIN WITH TYPE 490Q GRATE OR EQUIVALENT (TYP.)

CONNECTION DETAILS TO PROVIDED IN DETAILED DESIGN

PROP. ASPHALT MELT PAD
9023 sq.m.

SNOW STORAGE MELT PAD AREA WITH LIGHTS, ETC. THIS WOULD BE BUILT OVER THE THE EXISTING PARKING LOT, AND COULD BE USED AS DUAL PURPOSE SUMMER PARKING.

STREET LIGHTS & TREES TO REMAIN WHERE POSSIBLE DURING CURB RECONSTRUCTION (TYP.)

PROP. REMOVABLE PRE-CAST CONCRETE CURB AS PER OPSD 603.020 (TYP.)

CONCRETE LEVEL SPREADER TO EVENLY DISCHARGE MELT WATER INTO BIOSWALE (TYP.)

PROP. BIOSWALE (SEE TYPICAL BIOSWALE CROSS SECTION ON DETAIL SHEET)

PROP. TOP OF SLOPE

ACO K100 TRENCH DRAIN WITH TYPE 490Q GRATE OR EQUIVALENT (TYP.)

STREET LIGHTS & TREES TO REMAIN WHERE POSSIBLE (TYP.)

ACO K100 TRENCH DRAIN WITH TYPE 490Q GRATE OR EQUIVALENT (TYP.)

OVERFLOW DICB

PROP. DEEP MONITORING WELL

PROP. SHALLOW MONITORING WELL

UNDERDRAIN TO OUTLET TO DERRYCREST DR. STORM SEWER

PROP. DEEP MONITORING WELL

PROP. SHALLOW MONITORING WELL

OVERFLOW DICB

PROP. REMOVABLE PRE-CAST CONCRETE CURB AS PER OPSD 603.020 (TYP.)

CONCRETE LEVEL SPREADER TO EVENLY DISCHARGE MELT WATER INTO BIOSWALE (TYP.)

PROP. BIOSWALE (SEE TYPICAL BIOSWALE CROSS SECTION ON DETAIL SHEET)

PROP. TOP OF SLOPE

PROP. 7.5m WIDE ASPHALT TURNING ROAD TO ALLOW ACCESS TO ALL SIDES OF MELT PAD

SUBDRAIN UNDER BIOSWALE

PROP. CHECK-DAM (TYP.)

PROP. GATE REFER TO TOWN OF CALEDON STANDARD DRAWING 607

SUBDRAIN UNDER BIOSWALE

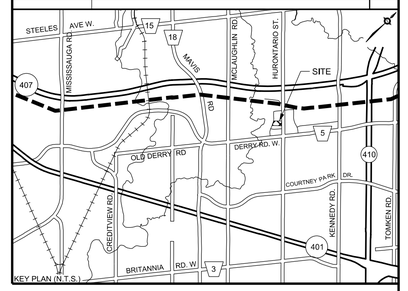
CONNECTION DETAILS TO PROVIDED IN DETAILED DESIGN

MAINTAIN EXISTING LANEWAY

ASPHALT MELT PAD	9023m2
ASPHALT	14126m2
SURFACE PONDING-STORAGE VOLUME	215m3
BIOSWALE LENGTH	211m
PRE-CAST CURB	160m
LEVEL SPREADER	194m
SUBDRAIN LENGTH	247m
TRENCH DRAIN	206m

REVISIONS

DATE	DETAILS	INIT.
AUG 25, 2023	ISSUED FOR REVIEW	B.T.
JAN 05, 2024	ISSUED FOR REVIEW	B.T.



LEGEND:

- HP — HYDRO POLE
- EXISTING TREE
- G — GAS MARKER
- 406.5 — EXISTING CONTOUR
- TS — SIGN
- GUY WIRE
- SIB — PROPERTY BAR
- FLOW ARROWS
- HW — HYDRO WELL
- MH — STORM MANHOLE
- CB — CATCH BASIN
- BH 1-2 — BOREHOLE
- SMH — SANITARY MANHOLE

1:300 0 5 10m

Seal

Seal

AECOM

Region of Peel
working with you

SITE 10
POTENTIAL SNOW STORAGE
7120 HURONTARIO STREET
REGION OF PEEL PARKING LOT

DESIGN CONCEPT

CAD Area	Area	Project No.	13-4007
Checked by Z.R	Drawn by T.M.		
Date OCT 2023	Sheet 13 of 14	Plan No.	13-D

REVISIONS		
DATE	DETAILS	INIT.
JUNE 22, 2023	ISSUED FOR REVIEW	B.T.
JAN 05, 2024	ISSUED FOR REVIEW	B.T.

GENERAL NOTES:

1. ALL WORK SHALL CONFORM TO THE LATEST REVISIONS OF ONTARIO PROVINCIAL STANDARDS FOR ROADS AND PUBLIC WORKS, AND THE REGION OF PEEL, EXCEPT WHERE NOTED.
2. PRIOR TO THE COMMENCEMENT OF CONSTRUCTION, ALL BENCH-MARKS, ELEVATIONS, DIMENSIONS AND GRADES MUST BE CHECKED BY THE CONTRACTOR AND ANY DISCREPANCIES REPORTED TO THE ENGINEER. AT LEAST TWO DIFFERENT BENCHMARKS MUST BE REFERRED TO AT ALL TIMES. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED
3. ALL CONCRETE IS 30MPa IN 28 DAYS WITH 6% +/- 1% AIR ENTRAINMENT UNLESS OTHERWISE STATED.
4. THE CONTRACTOR SHALL NOTIFY THE REGION OF PEEL AND THE ENGINEER AT LEAST 48 HOURS PRIOR TO COMMENCING CONSTRUCTION.
5. THE CONTRACTOR SHALL PROVIDE THE REGION OF PEEL WITH 48 HOURS NOTICE PRIOR TO TESTING OF INSTALLED WORKS.
6. CONTRACTOR TO SUPPORT AND PROTECT EXISTING UTILITIES DURING CONSTRUCTION TO THE SATISFACTION OF THE UTILITY COMPANY.
7. ALL SERVICING CONNECTIONS WITHIN THE EXISTING PAVEMENT AND BOULEVARDS TO BE BACKFILLED WITH GRANULAR 'A' COMPACTED TO A MINIMUM OF 100% SPDD.
8. CONTRACTOR TO RESTORE ANY EXISTING ROAD SURFACE THAT HAS BEEN DAMAGED AS A RESULT OF CONSTRUCTION TRAFFIC TO EXISTING OR BETTER CONDITION.
9. MUD OR DEBRIS THAT HAS BEEN TRACKED ONTO EXTERNAL ROADS TO BE CLEANED AND SWEPT AT THE END OF EACH DAY. ANY DAMAGE DONE TO EXISTING ROADS AND DITCHES ARE TO BE REPAIRED IMMEDIATELY.

PAVEMENT STRUCTURE

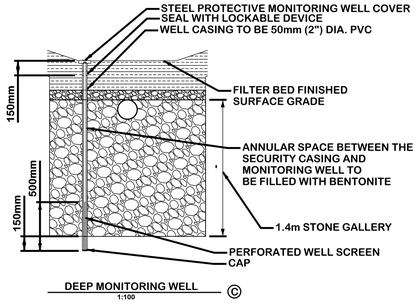
1. CONTRACTOR TO FOLLOW PAVEMENT STRUCTURE.
   - 50mm HL-3
   - 80mm HL-8-HS (I.E HDBC)
   - 130mm GRANULAR 'A'
   - 300mm GRANULAR 'B'
2. GRANULAR 'A' AND 'B' TO BE COMPACTED TO SPDD 100%.

TABLE 1: MEDIA FOR BIOSWALES & PLANTING BED

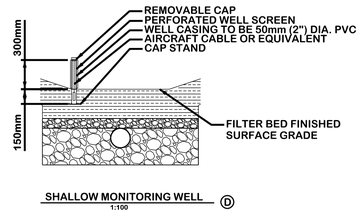
MEDIA	SIZE	% BY WEIGHT
1-SAND	2 to 0.05mm	85-88%
2-FINES	< 0.050mm	8-12%
3-LEAF COMPOST (ORGANIC MATERIAL)	-	3-5%

Notes:
- CEC greater than 10 mg/100g
- PH=5.5-7.5
- K greater that 120mm/hr
- P Index 10-30ppm (Bray Method)

Soil Texture Classification:
No objects greater than 50mm
media obtained from vendor to be tested to confirm design specifications prior to installation. Field engineer to confirm conformance with specification prior to installation.

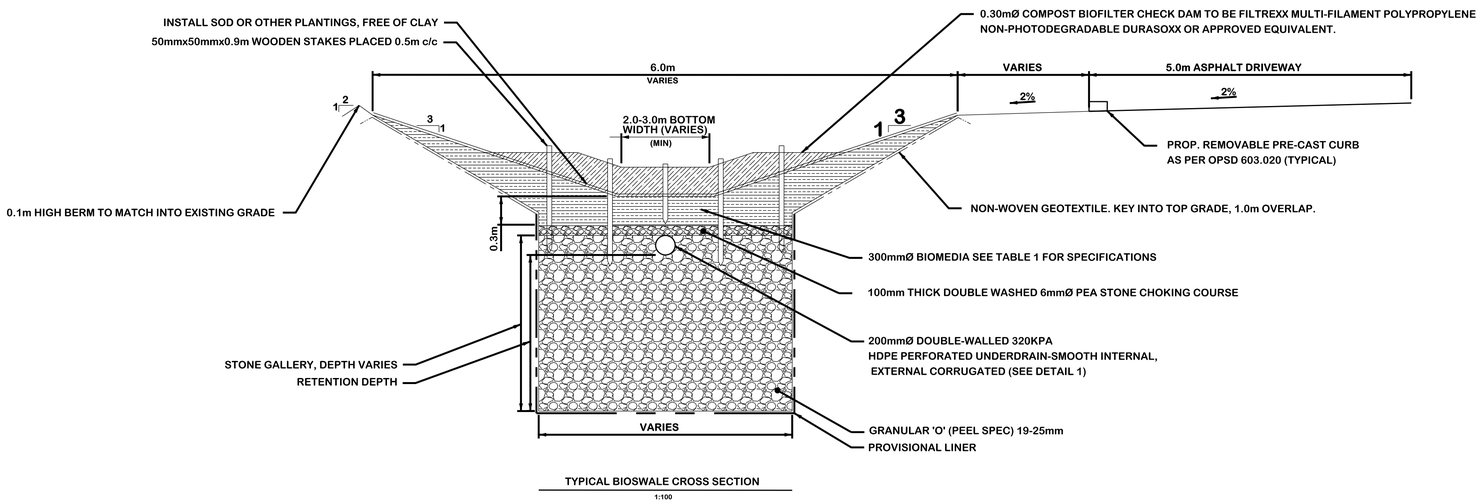


DEEP MONITORING WELL Ⓒ
1:100



SHALLOW MONITORING WELL Ⓓ
1:100

DETAIL 1
PERFORATION PATTERN:
1. HOLE Ø - 4.76mm
2. # HOLES - 8 CORRUGATION
3. CORR./METER - 30.3
4. MIN. OPEN AREA - 43cm²/m



TYPICAL BIOSWALE CROSS SECTION
1:100

10m 0 10 20 30m — HORIZONTAL SCALE
2 3m — VERTICAL SCALE

Seal

Seal

AECOM

Region of Peel
working with you

SNOW STORAGE SITES

GENERAL NOTES AND DETAILS

CAD Area	Area	Project No.	13-4007
Checked by Z.R	Drawn by T.M.	Plan No.	14-D
Date APRIL 2023	Sheet 14 of 14		

Appendix C

Conceptual Design Calculations

Town of Caledon Intensity, Duration, and Frequency Parameters

Town of Caledon			
Event	Parameter		
	A	B	C
2-Year	1,070	0.8759	7.85
5-Year	1,593	0.8789	11
10-Year	2,221	0.9080	12
25-Year	3,158	0.9335	15
50-Year	3,886	0.9495	16
100-Year	4,688	0.9624	17

Town of Caledon										
Event	Rainfall Intensity (mm/hr)									
	5-Minutes	10-Minutes	15-Minutes	30-Minutes	1-Hour	2-Hour	3-Hour	6-Hour	12-Hour	24-Hour
2-Year	114.31	85.72	69.05	44.38	26.62	15.28	10.91	6.05	3.33	1.82
5-Year	139.29	109.68	90.91	60.92	37.60	21.95	15.75	8.79	4.84	2.65
10-Year	169.55	134.16	111.40	74.58	45.72	26.37	18.76	10.29	5.57	2.99
25-Year	192.71	156.47	131.98	90.39	56.11	32.41	23.00	12.49	6.66	3.52
50-Year	215.80	176.19	149.09	102.50	63.63	36.62	25.88	13.94	7.37	3.86
100-Year	239.35	196.54	166.89	115.28	71.69	41.17	29.03	15.54	8.15	4.23

Town of Caledon										
Event	Rainfall Depth (mm)									
	5-Minutes	10-Minutes	15-Minutes	30-Minutes	1-Hour	2-Hour	3-Hour	6-Hour	12-Hour	24-Hour
2-Year	9.53	14.29	17.26	22.19	26.62	30.56	32.72	36.33	39.97	43.76
5-Year	11.61	18.28	22.73	30.46	37.60	43.89	47.26	52.74	58.12	63.63
10-Year	14.13	22.36	27.85	37.29	45.72	52.73	56.29	61.75	66.80	71.73
25-Year	16.06	26.08	33.00	45.20	56.11	64.83	68.99	74.94	79.97	84.55
50-Year	17.98	29.37	37.27	51.25	63.63	73.24	77.65	83.66	88.43	92.53
100-Year	19.95	32.76	41.72	57.64	71.69	82.35	87.08	93.25	97.84	101.55

Notes:

1. Intensity formula: i = a/(t+c)^(b) per Town of Caledon Development Standards (2009).

Modified Rational Method Peak Flow and Attenuation Volume

AECOM

Site 1 - Conceptul Design Calculations

Existing Site Area:	0.40	ha
Existing Impervious Area:	0.00	ha
Existing Pervious Area:	0.40	ha
% Impervious:	0%	
Equivalent Runoff Coefficient:	0.20	
Time of Concentration:	20.00	min
Proposed Site Area:	0.40	ha
Proposed Impervious Area:	0.36	ha
Proposed Pervious Area:	0.04	ha
% Impervious:	90%	
Equivalent Runoff Coefficient:	0.83	
Time of Concentration:	11.00	min

Design Storm	Peak Discharge (m^3/s)		Attenuation Required (m^3)[3]
	Existing	Proposed	
2-Year	0.01	0.08	50
5-Year	0.02	0.10	71
10-Year	0.02	0.12	86
25-Year	0.03	0.16	116
50-Year	0.04	0.20	143
100-Year	0.04	0.23	170

Region of Peel IDF (2019)			
Event	Parameter		
	A	B	C
2-Year	1,070	0.8759	7.85
5-Year	1,593	0.8789	11
10-Year	2,221	0.9080	12
25-Year	3,158	0.9335	15
50-Year	3,886	0.9495	16
100-Year	4,688	0.9624	17

Notes:

1. Minimum filter bed infiltration rate.
2. Intensity formula: i = a/(t+c)^(b) per Region of Peel Public Works Stormwater Design Criteria and Procedure Manual (2019).
3. Attenuation volume required to match existing conditions peak runoff rates.

2-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.025	8	0.106	32	4	28
10	0.019	11	0.079	47	8	40
15	0.015	14	0.064	58	12	46
20	0.013	16	0.054	65	16	49
25	0.011	17	0.046	69	20	50
30	0.010	18	0.041	74	23	50
35	0.009	19	0.037	78	27	50
40	0.008	19	0.033	79	31	48
45	0.007	19	0.031	84	35	49
50	0.007	21	0.028	84	39	45
55	0.006	20	0.026	86	43	43
60	0.006	22	0.025	90	47	43
65	0.006	23	0.023	90	51	39
70	0.005	21	0.022	92	55	38
75	0.005	23	0.021	95	59	36
80	0.005	24	0.020	96	62	34
85	0.004	20	0.019	97	66	31
90	0.004	22	0.018	97	70	27
95	0.004	23	0.017	97	74	23
100	0.004	24	0.016	96	78	18
105	0.004	25	0.016	101	82	19
110	0.004	26	0.015	99	86	13
115	0.004	28	0.015	104	90	14
120	0.003	22	0.014	101	94	7
125	0.003	23	0.014	105	98	8
130	0.003	23	0.013	101	101	0
135	0.003	24	0.013	105	105	0
140	0.003	25	0.012	101	109	-
145	0.003	26	0.012	104	113	-
150	0.003	27	0.012	108	117	-
155	0.003	28	0.011	102	121	-
160	0.003	29	0.011	106	125	-
165	0.003	30	0.011	109	129	-
170	0.003	31	0.011	112	133	-
175	0.002	21	0.010	105	137	-
180	0.002	22	0.010	108	140	-

5-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.031	9	0.129	39	5	34
10	0.024	14	0.101	61	10	50
15	0.020	18	0.084	76	15	60
20	0.017	20	0.072	86	20	66
25	0.015	23	0.063	95	26	69
30	0.014	25	0.056	101	31	70
35	0.012	25	0.051	107	36	71
40	0.011	26	0.046	110	41	70
45	0.010	27	0.043	116	46	70
50	0.010	30	0.040	120	51	69
55	0.009	30	0.037	122	56	66
60	0.008	29	0.035	126	61	65
65	0.008	31	0.033	129	66	62
70	0.007	29	0.031	130	71	59
75	0.007	32	0.029	131	77	54
80	0.007	34	0.028	134	82	53
85	0.006	31	0.027	138	87	51
90	0.006	32	0.025	135	92	43
95	0.006	34	0.024	137	97	40
100	0.006	36	0.023	138	102	36
105	0.005	32	0.023	145	107	38
110	0.005	33	0.022	145	112	33
115	0.005	35	0.021	145	117	28
120	0.005	36	0.020	144	122	22
125	0.005	38	0.020	150	128	23
130	0.005	39	0.019	148	133	16
135	0.004	32	0.018	146	138	8
140	0.004	34	0.018	151	143	8
145	0.004	35	0.017	148	148	0
150	0.004	36	0.017	153	153	0
155	0.004	37	0.016	149	158	-
160	0.004	38	0.016	154	163	-
165	0.004	40	0.016	158	168	-
170	0.004	41	0.015	153	173	-
175	0.004	42	0.015	158	179	-
180	0.004	43	0.015	162	184	-

10-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.038	11	0.156	47	6	41
10	0.030	18	0.124	74	13	62
15	0.025	23	0.103	93	19	74
20	0.021	25	0.088	106	25	80
25	0.019	29	0.077	116	32	84
30	0.017	31	0.069	124	38	86
35	0.015	32	0.062	130	44	86
40	0.014	34	0.057	137	50	86
45	0.013	35	0.052	140	57	84
50	0.012	36	0.048	144	63	81
55	0.011	36	0.045	149	69	79
60	0.010	36	0.042	151	76	76
65	0.010	39	0.040	156	82	74
70	0.009	38	0.037	155	88	67
75	0.009	41	0.036	162	95	68
80	0.008	38	0.034	163	101	62
85	0.008	41	0.032	163	107	56
90	0.007	38	0.031	167	113	54
95	0.007	40	0.029	165	120	46
100	0.007	42	0.028	168	126	42
105	0.007	44	0.027	170	132	38
110	0.006	40	0.026	172	139	33
115	0.006	41	0.025	173	145	28
120	0.006	43	0.024	173	151	22
125	0.006	45	0.024	180	158	23
130	0.005	39	0.023	179	164	16
135	0.005	41	0.022	178	170	8
140	0.005	42	0.021	176	176	0
145	0.005	44	0.021	183	183	0
150	0.005	45	0.020	180	189	-
155	0.005	47	0.020	186	195	-
160	0.005	48	0.019	182	202	-
165	0.004	40	0.019	188	208	-
170	0.004	41	0.018	184	214	-
175	0.004	42	0.018	189	221	-
180	0.004	43	0.017	184	227	-

25-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.047	14	0.196	59	8	50
10	0.038	23	0.159	95	17	79
15	0.032	29	0.134	121	25	95
20	0.028	34	0.116	139	34	106
25	0.025	38	0.102	153	42	111
30	0.022	40	0.092	166	50	115
35	0.020	42	0.083	174	59	116
40	0.018	43	0.076	182	67	115
45	0.017	46	0.070	189	76	113
50	0.016	48	0.065	195	84	111
55	0.015	50	0.061	201	92	109
60	0.014	50	0.057	205	101	104
65	0.013	51	0.054	211	109	101
70	0.012	50	0.051	214	118	97
75	0.012	54	0.048	216	126	90
80	0.011	53	0.046	221	134	86
85	0.010	51	0.044	224	143	82
90	0.010	54	0.042	227	151	76
95	0.010	57	0.040	228	160	68
100	0.009	54	0.038	228	168	60
105	0.009	57	0.037	233	176	57
110	0.009	59	0.035	231	185	46
115	0.008	55	0.034	235	193	41
120	0.008	58	0.033	238	202	36
125	0.008	60	0.032	240	210	30
130	0.007	55	0.031	242	218	23
135	0.007	57	0.030	243	227	16
140	0.007	59	0.029	244	235	8
145	0.007	61	0.028	244	244	0
150	0.007	63	0.027	243	252	-
155	0.006	56	0.027	251	260	-
160	0.006	58	0.026	250	269	-
165	0.006	59	0.025	248	277	-
170	0.006	61	0.025	255	286	-
175	0.006	63	0.024	252	294	-
180	0.006	65	0.023	248	302	-

50-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.058	17	0.239	72	11	61
10	0.047	28	0.195	117	21	96
15	0.040	36	0.165	149	32	117
20	0.035	42	0.143	172	42	130
25	0.031	47	0.127	191	53	138
30	0.027	49	0.114	205	63	142
35	0.025	53	0.103	216	74	143
40	0.023	55	0.094	226	84	142
45	0.021	57	0.087	235	95	140
50	0.019	57	0.081	243	105	138
55	0.018	59	0.075	248	116	132
60	0.017	61	0.070	252	126	126
65	0.016	62	0.066	257	137	121
70	0.015	63	0.063	265	147	118
75	0.014	63	0.059	266	158	108
80	0.014	67	0.056	269	168	101
85	0.013	66	0.054	275	179	97
90	0.012	65	0.051	275	189	86
95	0.012	68	0.049	279	200	80
100	0.011	66	0.047	282	210	72
105	0.011	69	0.045	284	221	63
110	0.011	73	0.044	290	231	59
115	0.010	69	0.042	290	242	48
120	0.010	72	0.041	295	252	43
125	0.009	68	0.039	293	263	30
130	0.009	70	0.038	296	273	23
135	0.009	73	0.037	300	284	16
140	0.009	76	0.036	302	294	8
145	0.008	70	0.035	305	305	0
150	0.008	72	0.034	306	315	-
155	0.008	74	0.033	307	326	-
160	0.008	77	0.032	307	336	-
165	0.007	69	0.031	307	347	-
170	0.007	71	0.030	306	357	-
175	0.007	74	0.029	305	368	-
180	0.007	76	0.029	313	378	-

100-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.067	20	0.276	83	12	71
10	0.055	33	0.227	136	24	112
15	0.046	41	0.193	174	36	138
20	0.040	48	0.167	200	48	152
25	0.036	54	0.148	222	60	162
30	0.032	58	0.133	239	72	167
35	0.029	61	0.121	254	84	170
40	0.027	65	0.110	264	96	168
45	0.025	68	0.102	275	108	167
50	0.023	69	0.095	285	120	165
55	0.021	69	0.088	290	132	158
60	0.020	72	0.083	299	144	155
65	0.019	74	0.078	304	156	148
70	0.018	76	0.074	311	168	143
75	0.017	77	0.070	315	180	135
80	0.016	77	0.066	317	192	125
85	0.015	77	0.063	321	204	117
90	0.015	81	0.060	324	216	108
95	0.014	80	0.058	331	228	103
100	0.013	78	0.055	330	240	90
105	0.013	82	0.053	334	252	82
110	0.012	79	0.051	337	264	73
115	0.012	83	0.049	338	276	62
120	0.011	79	0.048	346	288	58
125	0.011	83	0.046	345	300	45
130	0.011	86	0.044	343	312	31
135	0.010	81	0.043	348	324	24
140	0.010	84	0.042	353	336	17
145	0.010	87	0.040	348	348	0
150	0.009	81	0.039	351	360	-
155	0.009	84	0.038	353	372	-
160	0.009	86	0.037	355	384	-
165	0.009	89	0.036	356	396	-
170	0.008	82	0.035	357	408	-
175	0.008	84	0.034	357	420	-
180	0.008	86	0.033	356	432	-

Site 1 - Estimation of Snow Melt

Parameter	Jan	Feb	Mar	Apr	Dec	
Average Daily Melt Rate (mm/day) [1]	29.9	21.4	57.9	90.8	40.1	
Average Daily Melt Rate (mm/day/24*3) [1]	6.9	4.8	12.4	12.8	6.7	(Snow melt during 3 hour storm duration)
Average Daily Volume of Melt (m^3/day)	13.4	9.2	24.0	**24.9**	12.9	(Includes only 0.08 ha asphalt snow melting pad)
Average Maximum Daily Rainfall (mm)	13.9	10.8	14.8	18.3	13.8	
Average Maximum Daily Rainfall (m^3)	55.5	43.3	59.3	73.0	55.3	
Regional Specific 90th Percentile Rainfall Volume (mm)	27					
Impervious Runoff (mm)	25					(27 mm subtract 2 mm depression storage)
Impervious Runoff (m^3)	90					
Pervious Runoff (mm)	5.2					(27 mm subtract 5 mm depression storage multiplied by 24%)
Pervious Runoff (m^3)	2.1					
Regional Specific 90th Percentile Rainfall Volume (mm)	23.0					
Regional Specific 90th Percentile Rainfall Volume (m^3)	**92**					
Daily Discharge Volume (mm)	30	28	35	36	30	
Total Discharge Volume (m^3)	105	101	116	117	105	

Melt Coefficient [2]:	3.8	$mm°C^{-1}day^{-1}$
Base Temperature [3]:	0	°C
Snowmelt Pavement Area:	0.19	ha

Notes:

1. Temperature index method for estimating snow melt is based on $M = MC \times (T_{air}-T_{base})$.
2. Melt coefficient values typically vary between 2.8 and 3.8$mm°C^{-1}day^{-1}$.
3. Base temperature is assumed to be 0°C.
4. Average Orangeville, ON, Air Temperature in the Months of January, February, March, April, and December (2005-2015). Orangeville is within 10 km of the Subject Site.

Year	Maximum Daily Temperature (°C)					Maximum Daily Snowmelt Rate (mm/day)					Maximum Daily Rainfall (mm/day)				
	January	February	March	April	December	January	February	March	April	December	January	February	March	April	December
2005	14.5	8.0	16.0	26.5	4.0	55.1	30.4	60.8	100.7	15.2	13.0	16.0	9.8	18.0	14.9
2006	9.0	6.0	18.0	23.5	9.5	34.2	22.8	68.4	89.3	36.1	24.2	24.0	16.0	23.4	11.4
2007	12.0	4.0	19.5	24.0	8.5	45.6	15.2	74.1	91.2	32.3	6.0	0.0	5.0	23.2	23.0
2008	12.5	6.5	11.0	25.5	12.5	47.5	24.7	41.8	96.9	47.5	44.0	21.4	24.4	14.0	22.0
2009	1.0	8.0	14.0	-	9.5	3.8	30.4	53.2	-	36.1	2.4	12.0	19.0	-	17.2
2010	5.0	7.0	17.5	27.0	10.0	19.0	26.6	66.5	102.6	38.0	13.9	0.0	34.0	13.2	4.0
2011	1.5	10.0	12.5	21.0	12.0	5.7	38.0	47.5	79.8	45.6	0.0	16.0	19.0	16.2	12.8
2012	7.5	5.0	26.0	23.0	14.0	28.5	19.0	98.8	87.4	53.2	11.0	2.6	10.0	14.0	9.0
2013	13.0	5.0	13.0	24.5	12.0	49.4	19.0	49.4	93.1	45.6	20.2	3.0	16.8	21.0	12.3
2014	6.0	2.5	10.0	22.0	10.0	22.8	9.5	38.0	83.6	38.0	18.0	24.0	5.0	21.5	11.0
2015	4.5	-4.0	10.0	22.0	14.0	17.1	0.0	38.0	83.6	53.2	0.0	0.0	4.0	18.0	14.4
Minimum	1.0	-4.0	10.0	21.0	4.0	3.8	0.0	38.0	79.8	15.2	0.0	0.0	4.0	13.2	4.0
Average	7.9	5.3	15.2	23.9	10.5	29.9	21.4	57.9	90.8	40.1	13.9	10.8	14.8	18.3	13.8
Maximum	14.5	10.0	26.0	27.0	14.0	55.1	38.0	98.8	102.6	53.2	44.0	24.0	34.0	23.4	23.0

Notes:

1. Based on Orangeville, ON, historic climate data from 2005-2015.
2. No data for April 2009.

Site 1 - LID Design Requirements

Runoff Treatment Depth:	23.0	mm	(Based on runoff from 27 mm of rainfall, greater than maximum average historic rainfall in April)
Rainfall Volume to be Treated:	92	m^3	
Average Daily Snowmelt (8-Hour Duration:	12.8	mm	(Based on Average Daily Snow Melt, April)
Average Daily Snowmelt Volume to be Treated:	25	m^3	
Total Treatment Volume to be Treated:	117	m^3	(Includes 23mm Runoff Depth and 13mm Snow Melt Depth)
100-Year Peak Flow Attenuation:	170	m^3	(Design to LID to 100-year runoff volume, more conservative)
100-Year Peak Flow Attenuation + Snow Melt Volume:	195	m^3	
Measure Infiltration Rate:	44	mm/hr	
Safety Factor:	2.5		
Infiltration Rate:	18	mm/hr	
LID Unit Length:	133	m	(Equivalent length calculated based on provided ponding volume)
Freeboard:	0.2	m	
Ponding Area Width:	3.00	m	
Surface Ponding Depth:	0.3	m	
Side Slope:	3	(x:1)	
Bottom Area:	399	m^2	
Top Area:	474	m^2	
Surface Ponding Volume:	131	m^3	
LID Ratio:	8		(Impervious Area to LID Area)
Filter Media Depth:	0.30	m	
Filter Media Bottom Width:	3.00	m	
Filter Media Surface Area:	480	m^2	
Filter Media Cross-Sectional Area:	0.90	m^2	
Filter Media Length:	160	m	
Total Volume:	144	m^3	(Volume of filter media envelope up to 0.30 m ponding depth)
Filter Media Porosity:	40%		(Volume of the Pore Volume divided by the Total Volume)
Void Ratio:	67%		(Volume of the Pore Volume divided by Solids Volume)
Filter Media Pore Volume:	58	m^3	
Filter Media Volume:	86	m^3	
Filter Bed Infiltration Rate [(2)]:	125	mm/hr	(Minimum filter media design infiltration rate)
Filterbed Drawdown Time:	2.4	hours	
Pea Gravel Choking Layer Depth:	0.10	m	
Pea Gravel Choking Layer Width:	3.00	m	
Pea Gravel Choking Layer Cross-Sectional Area:	0.30	m^2	
Pea Gravel Choking Layer Length:	160	m	
Total Gravel Choking Layer Volume:	48	m^3	
Pea Gravel Choking Layer Porosity:	40%		(Volume of the Pore Volume divided by the Total Volume)
Void Ratio:	67%		(Volume of the Pore Volume divided by Solids Volume)
Pea Gravel Choking Layer Pore Volume:	19	m^3	
Pea Gravel Choking Layer Media Volume:	29	m^3	
Stone Gallery Depth:	0.30	m	
Stone Gallery Width:	3.00	m	
Stone Gallery Cross-Sectional Area:	0.90	m^2	
Stone Gallery Length:	160	m	
Total Stone Gallery Volume:	144	m^3	
Stone Gallery Porosity:	40%		(Volume of the Pore Volume divided by the Total Volume)
Void Ratio:	67%		(Volume of the Pore Volume divided by Solids Volume)
Stone Gallery Pore Volume:	58	m^3	
Stone Gallery Media Volume:	86	m^3	
Native Soil Infiltration Rate:	18	mm/hr	
Drawdown Time:	17	hours	(72 hour maximum drawdown time)
Subdrain Offset:	1.00	m	
Subrain Size:	200	mm	(150 mm orifice cap at outlet)
Subdrain Slope:	1.00%		
Subdrain Length:	160	m	
Total Storage Volume:	**265**	m^3	(pore and ponding volume)
Total Depth	1.00	m	
Infilration Water Storage Depth:	0.58	m	
Draw down time:	33	hr	(pore and ponding)

Modified Rational Method Peak Flow and Attenuation Volume

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Site 3 - Conceptul Design Calculations

Existing Site Area:	1.19	ha
Existing Impervious Area:	0.00	ha
Existing Pervious Area:	1.19	ha
% Impervious:	0%	
Equivalent Runoff Coefficient:	0.20	
Time of Concentration:	20.00	min
Proposed Site Area:	1.19	ha
Proposed Impervious Area:	0.63	ha
Proposed Pervious Area:	0.56	ha
% Impervious:	53%	
Equivalent Runoff Coefficient:	0.57	
Time of Concentration:	11.00	min

Design Storm	Peak Discharge (m^3/s)		Attenuation Required (m^3)[3]
	Existing	Proposed	
2-Year	0.04	0.16	86
5-Year	0.05	0.21	116
10-Year	0.06	0.25	143
25-Year	0.08	0.33	191
50-Year	0.10	0.40	234
100-Year	0.12	0.46	275

Region of Peel IDF (2019)			
Event	Parameter		
	A	B	C
2-Year	1,070	0.8759	7.85
5-Year	1,593	0.8789	11
10-Year	2,221	0.9080	12
25-Year	3,158	0.9335	15
50-Year	3,886	0.9495	16
100-Year	4,688	0.9624	17

Notes:

1. Minimum filter bed infiltration rate.
2. Intensity formula: i = a/(t+c)^(b) per Region of Peel Public Works Stormwater Design Criteria and Procedure Manual (2019).
3. Attenuation volume required to match existing conditions peak runoff rates.

Modified Rational Method Peak Flow and Attenuation Volume

2-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.076	23	0.216	65	11	53
10	0.057	34	0.162	97	23	74
15	0.046	41	0.130	117	34	83
20	0.038	46	0.110	132	46	86
25	0.033	50	0.095	143	57	86
30	0.029	52	0.084	151	68	83
35	0.026	55	0.075	158	80	78
40	0.024	58	0.068	163	91	72
45	0.022	59	0.063	170	103	68
50	0.020	60	0.058	174	114	60
55	0.019	63	0.054	178	125	53
60	0.018	65	0.050	180	137	43
65	0.017	66	0.047	183	148	35
70	0.016	67	0.045	189	160	29
75	0.015	68	0.042	189	171	18
80	0.014	67	0.040	192	182	10
85	0.013	66	0.038	194	194	0
90	0.013	70	0.036	194	205	-
95	0.012	68	0.035	200	217	-
100	0.012	72	0.033	198	228	-
105	0.011	69	0.032	202	239	-
110	0.011	73	0.031	205	251	-
115	0.010	69	0.030	207	262	-
120	0.010	72	0.029	209	274	-
125	0.010	75	0.028	210	285	-
130	0.009	70	0.027	211	296	-
135	0.009	73	0.026	211	308	-
140	0.009	76	0.025	210	319	-
145	0.009	78	0.025	218	331	-
150	0.008	72	0.024	216	342	-
155	0.008	74	0.023	214	353	-
160	0.008	77	0.023	221	365	-
165	0.008	79	0.022	218	376	-
170	0.008	82	0.022	224	388	-
175	0.007	74	0.021	221	399	-
180	0.007	76	0.021	227	410	-

5-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.092	28	0.263	79	16	63
10	0.073	44	0.207	124	31	93
15	0.060	54	0.172	155	47	108
20	0.052	62	0.147	176	62	114
25	0.045	68	0.129	194	78	116
30	0.040	72	0.115	207	94	113
35	0.036	76	0.104	218	109	109
40	0.033	79	0.095	228	125	103
45	0.031	84	0.087	235	140	95
50	0.028	84	0.081	243	156	87
55	0.027	89	0.076	251	172	79
60	0.025	90	0.071	256	187	68
65	0.023	90	0.067	261	203	59
70	0.022	92	0.063	265	218	46
75	0.021	95	0.060	270	234	36
80	0.020	96	0.057	274	250	24
85	0.019	97	0.054	275	265	10
90	0.018	97	0.052	281	281	0
95	0.017	97	0.050	285	296	-
100	0.017	102	0.048	288	312	-
105	0.016	101	0.046	290	328	-
110	0.016	106	0.044	290	343	-
115	0.015	104	0.043	297	359	-
120	0.015	108	0.041	295	374	-
125	0.014	105	0.040	300	390	-
130	0.014	109	0.039	304	406	-
135	0.013	105	0.038	308	421	-
140	0.013	109	0.037	311	437	-
145	0.012	104	0.036	313	452	-
150	0.012	108	0.035	315	468	-
155	0.012	112	0.034	316	484	-
160	0.011	106	0.033	317	499	-
165	0.011	109	0.032	317	515	-
170	0.011	112	0.031	316	530	-
175	0.011	116	0.030	315	546	-
180	0.010	108	0.030	324	562	-

Modified Rational Method Peak Flow and Attenuation Volume

10-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.112	34	0.320	96	19	77
10	0.089	53	0.253	152	38	114
15	0.074	67	0.210	189	57	132
20	0.063	76	0.180	216	76	140
25	0.055	83	0.158	237	95	143
30	0.049	88	0.141	254	113	140
35	0.045	95	0.127	267	132	134
40	0.041	98	0.116	278	151	127
45	0.037	100	0.107	289	170	119
50	0.035	105	0.099	297	189	108
55	0.032	106	0.092	304	208	96
60	0.030	108	0.086	310	227	83
65	0.028	109	0.081	316	246	70
70	0.027	113	0.077	323	265	59
75	0.025	113	0.073	329	284	45
80	0.024	115	0.069	331	302	29
85	0.023	117	0.066	337	321	15
90	0.022	119	0.063	340	340	0
95	0.021	120	0.060	342	359	-
100	0.020	120	0.058	348	378	-
105	0.019	120	0.056	353	397	-
110	0.019	125	0.053	350	416	-
115	0.018	124	0.052	359	435	-
120	0.017	122	0.050	360	454	-
125	0.017	128	0.048	360	473	-
130	0.016	125	0.047	367	491	-
135	0.016	130	0.045	365	510	-
140	0.015	126	0.044	370	529	-
145	0.015	131	0.043	374	548	-
150	0.014	126	0.041	369	567	-
155	0.014	130	0.040	372	586	-
160	0.014	134	0.039	374	605	-
165	0.013	129	0.038	376	624	-
170	0.013	133	0.037	377	643	-
175	0.013	137	0.036	378	662	-
180	0.012	130	0.035	378	680	-

25-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.140	42	0.400	120	25	95
10	0.114	68	0.325	195	50	145
15	0.096	86	0.274	247	75	172
20	0.083	100	0.237	284	100	185
25	0.073	110	0.210	315	125	191
30	0.066	119	0.188	338	149	189
35	0.060	126	0.170	357	174	183
40	0.055	132	0.156	374	199	175
45	0.050	135	0.143	386	224	162
50	0.047	141	0.133	399	249	150
55	0.044	145	0.124	409	274	135
60	0.041	148	0.117	421	299	122
65	0.038	148	0.110	429	324	105
70	0.036	151	0.104	437	349	88
75	0.034	153	0.098	441	374	68
80	0.033	158	0.093	446	398	48
85	0.031	158	0.089	454	423	31
90	0.030	162	0.085	459	448	11
95	0.029	165	0.081	462	473	-
100	0.027	162	0.078	468	498	-
105	0.026	164	0.075	473	523	-
110	0.025	165	0.072	475	548	-
115	0.024	166	0.070	483	573	-
120	0.024	173	0.067	482	598	-
125	0.023	173	0.065	488	623	-
130	0.022	172	0.063	491	647	-
135	0.021	170	0.061	494	672	-
140	0.021	176	0.059	496	697	-
145	0.020	174	0.057	496	722	-
150	0.020	180	0.056	504	747	-
155	0.019	177	0.054	502	772	-
160	0.019	182	0.053	509	797	-
165	0.018	178	0.051	505	822	-
170	0.018	184	0.050	510	847	-
175	0.017	179	0.049	515	872	-
180	0.017	184	0.048	518	896	-

Modified Rational Method Peak Flow and Attenuation Volume

50-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.171	51	0.489	147	31	116
10	0.140	84	0.399	239	62	178
15	0.118	106	0.338	304	93	212
20	0.103	124	0.293	352	124	228
25	0.091	137	0.259	389	155	234
30	0.081	146	0.232	418	185	232
35	0.074	155	0.211	443	216	227
40	0.068	163	0.193	463	247	216
45	0.062	167	0.178	481	278	203
50	0.058	174	0.165	495	309	186
55	0.054	178	0.154	508	340	168
60	0.051	184	0.144	518	371	148
65	0.048	187	0.136	530	402	129
70	0.045	189	0.128	538	433	105
75	0.043	194	0.121	545	464	81
80	0.040	192	0.115	552	494	58
85	0.039	199	0.110	561	525	36
90	0.037	200	0.105	567	556	11
95	0.035	200	0.101	576	587	-
100	0.034	204	0.096	576	618	-
105	0.032	202	0.093	586	649	-
110	0.031	205	0.089	587	680	-
115	0.030	207	0.086	593	711	-
120	0.029	209	0.083	598	742	-
125	0.028	210	0.080	600	773	-
130	0.027	211	0.078	608	803	-
135	0.026	211	0.075	608	834	-
140	0.026	218	0.073	613	865	-
145	0.025	218	0.071	618	896	-
150	0.024	216	0.069	621	927	-
155	0.023	214	0.067	623	958	-
160	0.023	221	0.065	624	989	-
165	0.022	218	0.063	624	1,020	-
170	0.022	224	0.062	632	1,051	-
175	0.021	221	0.060	630	1,082	-
180	0.021	227	0.059	637	1,112	-

Modified Rational Method Peak Flow and Attenuation Volume

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100-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.198	59	0.565	170	36	134
10	0.163	98	0.464	278	72	206
15	0.138	124	0.394	355	108	247
20	0.120	144	0.342	410	144	266
25	0.106	159	0.303	455	180	275
30	0.095	171	0.272	490	216	274
35	0.087	183	0.247	519	252	267
40	0.079	190	0.226	542	288	254
45	0.073	197	0.208	562	324	238
50	0.068	204	0.193	579	360	219
55	0.063	208	0.180	594	396	198
60	0.059	212	0.169	608	432	176
65	0.056	218	0.159	620	468	152
70	0.053	223	0.150	630	504	126
75	0.050	225	0.143	644	540	104
80	0.047	226	0.135	648	576	72
85	0.045	230	0.129	658	612	46
90	0.043	232	0.123	664	648	16
95	0.041	234	0.118	673	684	-
100	0.040	240	0.113	678	720	-
105	0.038	239	0.109	687	756	-
110	0.037	244	0.104	686	792	-
115	0.035	242	0.101	697	828	-
120	0.034	245	0.097	698	864	-
125	0.033	248	0.094	705	900	-
130	0.032	250	0.091	710	936	-
135	0.031	251	0.088	713	972	-
140	0.030	252	0.085	714	1,008	-
145	0.029	252	0.083	722	1,044	-
150	0.028	252	0.080	720	1,080	-
155	0.027	251	0.078	725	1,116	-
160	0.027	259	0.076	730	1,152	-
165	0.026	257	0.074	733	1,188	-
170	0.025	255	0.072	734	1,224	-
175	0.025	263	0.070	735	1,260	-
180	0.024	259	0.068	734	1,296	-

Site 3 - Estimation of Snow Melt

Parameter	Jan	Feb	Mar	Apr	Dec	
Average Daily Melt Rate (mm/day) [1]	29.9	21.4	57.9	90.8	40.1	
Average Daily Melt Rate (mm/8 hours) [1]	6.9	4.8	12.4	12.8	6.7	(Assumes melt occurs during daylight hours)
Average Daily Volume of Melt (m^3/day)	25.5	17.6	45.7	**47.5**	24.6	(Includes only 0.22 ha asphalt snow melting pad)
Average Maximum Daily Rainfall (mm)	13.9	10.8	14.8	18.3	13.8	
Average Maximum Daily Rainfall (m^3)	165.2	128.7	176.3	217.2	164.4	
Regional Specific 90th Percentile Rainfall Volume (mm)	27					
Impervious Runoff (mm)	25					(27 mm subtract 2 mm depression storage)
Impervious Runoff (m^3)	158					
Pervious Runoff (mm)	5.2					(27 mm subtract 5 mm depression storage multiplied by 24%)
Pervious Runoff (m^3)	29.0					
Regional Specific 90th Percentile Rainfall Volume (mm)	15.7					
Regional Specific 90th Percentile Rainfall Volume (m^3)	186					
Daily Discharge Volume (mm)	23	20	28	28	22	
Total Discharge Volume (m^3)	212	204	232	234	211	

Melt Coefficient [2]:	3.8	$mm°C^{-1}day^{-1}$
Base Temperature [3]:	0	°C
Snowmelt Pavement Area:	0.37	ha

Notes:

1. Temperature index method for estimating snow melt is based on $M = MC \times (T_{air}-T_{base})$.
2. Melt coefficient values typically vary between 2.8 and 3.8$mm°C^{-1}day^{-1}$.
3. Base temperature is assumed to be 0°C.
4. Average Orangeville, ON, Air Temperature in the Months of January, February, March, April, and December (2005-2015). Orangeville is within 10 km of the Subject Site.

Year	Maximum Daily Temperature (°C)					Maximum Daily Snowmelt Rate (mm/day)					Maximum Daily Rainfall (mm/day)				
	January	February	March	April	December	January	February	March	April	December	January	February	March	April	December
2005	14.5	8.0	16.0	26.5	4.0	55.1	30.4	60.8	100.7	15.2	13.0	16.0	9.8	18.0	14.9
2006	9.0	6.0	18.0	23.5	9.5	34.2	22.8	68.4	89.3	36.1	24.2	24.0	16.0	23.4	11.4
2007	12.0	4.0	19.5	24.0	8.5	45.6	15.2	74.1	91.2	32.3	6.0	0.0	5.0	23.2	23.0
2008	12.5	6.5	11.0	25.5	12.5	47.5	24.7	41.8	96.9	47.5	44.0	21.4	24.4	14.0	22.0
2009	1.0	8.0	14.0	-	9.5	3.8	30.4	53.2	-	36.1	2.4	12.0	19.0	-	17.2
2010	5.0	7.0	17.5	27.0	10.0	19.0	26.6	66.5	102.6	38.0	13.9	0.0	34.0	13.2	4.0
2011	1.5	10.0	12.5	21.0	12.0	5.7	38.0	47.5	79.8	45.6	0.0	16.0	19.0	16.2	12.8
2012	7.5	5.0	26.0	23.0	14.0	28.5	19.0	98.8	87.4	53.2	11.0	2.6	10.0	14.0	9.0
2013	13.0	5.0	13.0	24.5	12.0	49.4	19.0	49.4	93.1	45.6	20.2	3.0	16.8	21.0	12.3
2014	6.0	2.5	10.0	22.0	10.0	22.8	9.5	38.0	83.6	38.0	18.0	24.0	5.0	21.5	11.0
2015	4.5	-4.0	10.0	22.0	14.0	17.1	0.0	38.0	83.6	53.2	0.0	0.0	4.0	18.0	14.4
Minimum	1.0	-4.0	10.0	21.0	4.0	3.8	0.0	38.0	79.8	15.2	0.0	0.0	4.0	13.2	4.0
Average	7.9	5.3	15.2	23.9	10.5	29.9	21.4	57.9	90.8	40.1	13.9	10.8	14.8	18.3	13.8
Maximum	14.5	10.0	26.0	27.0	14.0	55.1	38.0	98.8	102.6	53.2	44.0	24.0	34.0	23.4	23.0

Notes:

1. Based on Orangeville, ON, historic climate data from 2005-2015.
2. No data for April 2009.

Site 3 - LID Design Requirements

Runoff Treatment Depth:	15.7	mm	(Based on runoff from 27 mm of rainfall, greater than maximum average
Rainfall Volume to be Treated:	186	m^3	historic rainfall in April)
Average Daily Snowmelt (8-Hour Duration:	12.8	mm	(Based on Average Daily Snow Melt, April)
Average Daily Snowmelt Volume to be Treated:	47	m^3	
Total Treatment Volume to be Treated:	234	m^3	(Includes 16mm Runoff Depth and 13mm Snow Melt Depth)
100-Year Peak Flow Attenuation:	275	m^3	(Design to LID to 100-year runoff volume, more conservative)
100-Year Peak Flow Attenuation + Snow Melt Volume:	322	m^3	
Measure Infiltration Rate:	62	mm/hr	
Safety Factor:	2.5		
Infiltration Rate:	25	mm/hr	
LID Unit Length:	151	m	(Equivalent length calculated based on provided ponding volume)
Freeboard:	0.2	m	
Ponding Area Width:	3.00	m	
Surface Ponding Depth:	0.3	m	
Side Slope:	3	(x:1)	
Bottom Area:	453	m^2	
Top Area:	533	m^2	
Surface Ponding Volume:	134	m^3	
LID Ratio:	12		(Impervious Area to LID Area)
Filter Media Depth:	0.30	m	
Filter Media Bottom Width:	3.00	m	
Filter Media Surface Area:	471	m^2	
Filter Media Cross-Sectional Area:	0.90	m^2	
Filter Media Length:	157	m	
Total Volume:	141	m^3	(Volume of filter media envelope up to 0.30 m ponding depth)
Filter Media Porosity:	40%		(Volume of the Pore Volume divided by the Total Volume)
Void Ratio:	67%		(Volume of the Pore Volume divided by Solids Volume)
Filter Media Pore Volume:	57	m^3	
Filter Media Volume:	85	m^3	
Filter Bed Infiltration Rate [(2)]:	125	mm/hr	(Minimum filter media design infiltration rate)
Filterbed Drawdown Time:	2.4	hours	
Pea Gravel Choking Layer Depth:	0.10	m	
Pea Gravel Choking Layer Width:	3.00	m	
Pea Gravel Choking Layer Cross-Sectional Area:	0.30	m^2	
Pea Gravel Choking Layer Length:	157	m	
Total Gravel Choking Layer Volume:	47	m^3	
Pea Gravel Choking Layer Porosity:	40%		(Volume of the Pore Volume divided by the Total Volume)
Void Ratio:	67%		(Volume of the Pore Volume divided by Solids Volume)
Pea Gravel Choking Layer Pore Volume:	19	m^3	
Pea Gravel Choking Layer Media Volume:	28	m^3	
Stone Gallery Depth:	0.60	m	
Stone Gallery Width:	3.00	m	
Stone Gallery Cross-Sectional Area:	1.80	m^2	
Stone Gallery Length:	157	m	
Total Stone Gallery Volume:	283	m^3	
Stone Gallery Porosity:	40%		(Volume of the Pore Volume divided by the Total Volume)
Void Ratio:	67%		(Volume of the Pore Volume divided by Solids Volume)
Stone Gallery Pore Volume:	113	m^3	
Stone Gallery Media Volume:	170	m^3	
Native Soil Infiltration Rate:	25	mm/hr	
Drawdown Time:	24	hours	(72 hour maximum drawdown time)
Subdrain Offset:	1.00	m	
Subrain Size:	200	mm	(150 mm orifice cap at outlet)
Subdrain Slope:	1.00%		
Subdrain Length:	157	m	
Total Storage Volume:	**322**	m^3	(pore and ponding volume)
Total Depth	1.00	m	
Infilration Water Storage Depth:	0.7	m	
Draw down time:	28	hr	(pore and ponding)

Modified Rational Method Peak Flow and Attenuation Volume

AECOM

Site 5 - Conceptul Design Calculations

Existing Site Area:	0.40	ha
Existing Impervious Area:	0.00	ha
Existing Pervious Area:	0.40	ha
% Impervious:	0%	
Equivalent Runoff Coefficient:	0.20	
Time of Concentration:	20.00	min
Proposed Site Area:	0.40	ha
Proposed Impervious Area:	0.33	ha
Proposed Pervious Area:	0.07	ha
% Impervious:	83%	
Equivalent Runoff Coefficient:	0.78	
Time of Concentration:	11.00	min

Design Storm	Peak Discharge (m^3/s)		Attenuation Required (m^3)[3]
	Existing	Proposed	
2-Year	0.01	0.07	45
5-Year	0.02	0.10	65
10-Year	0.02	0.12	78
25-Year	0.03	0.15	105
50-Year	0.04	0.18	128
100-Year	0.04	0.21	153

Region of Peel IDF (2019)			
Event	Parameter		
	A	B	C
2-Year	1,070	0.8759	7.85
5-Year	1,593	0.8789	11
10-Year	2,221	0.9080	12
25-Year	3,158	0.9335	15
50-Year	3,886	0.9495	16
100-Year	4,688	0.9624	17

Notes:

1. Minimum filter bed infiltration rate.
2. Intensity formula: i = a/(t+c)^(b) per Region of Peel Public Works Stormwater Design Criteria and I
3. Attenuation volume required to match existing conditions peak runoff rates.

2-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.025	8	0.099	30	4	26
10	0.019	11	0.074	44	8	37
15	0.015	14	0.060	54	12	42
20	0.013	16	0.050	60	16	44
25	0.011	17	0.043	65	20	45
30	0.010	18	0.038	68	23	45
35	0.009	19	0.034	71	27	44
40	0.008	19	0.031	74	31	43
45	0.007	19	0.029	78	35	43
50	0.007	21	0.026	78	39	39
55	0.006	20	0.025	83	43	40
60	0.006	22	0.023	83	47	36
65	0.006	23	0.022	86	51	35
70	0.005	21	0.020	84	55	29
75	0.005	23	0.019	86	59	27
80	0.005	24	0.018	86	62	24
85	0.004	20	0.017	87	66	20
90	0.004	22	0.017	92	70	22
95	0.004	23	0.016	91	74	17
100	0.004	24	0.015	90	78	12
105	0.004	25	0.015	95	82	13
110	0.004	26	0.014	92	86	7
115	0.004	28	0.014	97	90	7
120	0.003	22	0.013	94	94	0
125	0.003	23	0.013	98	98	0
130	0.003	23	0.012	94	101	-
135	0.003	24	0.012	97	105	-
140	0.003	25	0.012	101	109	-
145	0.003	26	0.011	96	113	-
150	0.003	27	0.011	99	117	-
155	0.003	28	0.011	102	121	-
160	0.003	29	0.010	96	125	-
165	0.003	30	0.010	99	129	-
170	0.003	31	0.010	102	133	-
175	0.002	21	0.010	105	137	-
180	0.002	22	0.009	97	140	-

Procedure M

5-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.031	9	0.120	36	5	31
10	0.024	14	0.095	57	10	47
15	0.020	18	0.079	71	15	56
20	0.017	20	0.067	80	20	60
25	0.015	23	0.059	89	26	63
30	0.014	25	0.053	95	31	65
35	0.012	25	0.048	101	36	65
40	0.011	26	0.043	103	41	62
45	0.010	27	0.040	108	46	62
50	0.010	30	0.037	111	51	60
55	0.009	30	0.035	116	56	59
60	0.008	29	0.033	119	61	58
65	0.008	31	0.031	121	66	55
70	0.007	29	0.029	122	71	50
75	0.007	32	0.027	122	77	45
80	0.007	34	0.026	125	82	43
85	0.006	31	0.025	128	87	41
90	0.006	32	0.024	130	92	38
95	0.006	34	0.023	131	97	34
100	0.006	36	0.022	132	102	30
105	0.005	32	0.021	132	107	25
110	0.005	33	0.020	132	112	20
115	0.005	35	0.020	138	117	21
120	0.005	36	0.019	137	122	14
125	0.005	38	0.018	135	128	8
130	0.005	39	0.018	140	133	8
135	0.004	32	0.017	138	138	0
140	0.004	34	0.017	143	143	0
145	0.004	35	0.016	139	148	-
150	0.004	36	0.016	144	153	-
155	0.004	37	0.015	140	158	-
160	0.004	38	0.015	144	163	-
165	0.004	40	0.015	149	168	-
170	0.004	41	0.014	143	173	-
175	0.004	42	0.014	147	179	-
180	0.004	43	0.014	151	184	-

10-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.038	11	0.147	44	6	38
10	0.030	18	0.116	70	13	57
15	0.025	23	0.096	86	19	68
20	0.021	25	0.083	100	25	74
25	0.019	29	0.072	108	32	77
30	0.017	31	0.064	115	38	77
35	0.015	32	0.058	122	44	78
40	0.014	34	0.053	127	50	77
45	0.013	35	0.049	132	57	76
50	0.012	36	0.045	135	63	72
55	0.011	36	0.042	139	69	69
60	0.010	36	0.040	144	76	68
65	0.010	39	0.037	144	82	62
70	0.009	38	0.035	147	88	59
75	0.009	41	0.033	149	95	54
80	0.008	38	0.032	154	101	53
85	0.008	41	0.030	153	107	46
90	0.007	38	0.029	157	113	43
95	0.007	40	0.028	160	120	40
100	0.007	42	0.026	156	126	30
105	0.007	44	0.025	158	132	25
110	0.006	40	0.024	158	139	20
115	0.006	41	0.024	166	145	21
120	0.006	43	0.023	166	151	14
125	0.006	45	0.022	165	158	8
130	0.005	39	0.021	164	164	0
135	0.005	41	0.021	170	170	0
140	0.005	42	0.020	168	176	-
145	0.005	44	0.019	165	183	-
150	0.005	45	0.019	171	189	-
155	0.005	47	0.018	167	195	-
160	0.005	48	0.018	173	202	-
165	0.004	40	0.017	168	208	-
170	0.004	41	0.017	173	214	-
175	0.004	42	0.017	179	221	-
180	0.004	43	0.016	173	227	-

25-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.047	14	0.183	55	8	47
10	0.038	23	0.149	89	17	73
15	0.032	29	0.126	113	25	88
20	0.028	34	0.109	131	34	97
25	0.025	38	0.096	144	42	102
30	0.022	40	0.086	155	50	104
35	0.020	42	0.078	164	59	105
40	0.018	43	0.071	170	67	103
45	0.017	46	0.066	178	76	103
50	0.016	48	0.061	183	84	99
55	0.015	50	0.057	188	92	96
60	0.014	50	0.053	191	101	90
65	0.013	51	0.050	195	109	86
70	0.012	50	0.047	197	118	80
75	0.012	54	0.045	203	126	77
80	0.011	53	0.043	206	134	72
85	0.010	51	0.041	209	143	66
90	0.010	54	0.039	211	151	59
95	0.010	57	0.037	211	160	51
100	0.009	54	0.036	216	168	48
105	0.009	57	0.034	214	176	38
110	0.009	59	0.033	218	185	33
115	0.008	55	0.032	221	193	28
120	0.008	58	0.031	223	202	22
125	0.008	60	0.030	225	210	15
130	0.007	55	0.029	226	218	8
135	0.007	57	0.028	227	227	0
140	0.007	59	0.027	227	235	-
145	0.007	61	0.026	226	244	-
150	0.007	63	0.026	234	252	-
155	0.006	56	0.025	233	260	-
160	0.006	58	0.024	230	269	-
165	0.006	59	0.024	238	277	-
170	0.006	61	0.023	235	286	-
175	0.006	63	0.022	231	294	-
180	0.006	65	0.022	238	302	-

50-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.058	17	0.224	67	11	57
10	0.047	28	0.183	110	21	89
15	0.040	36	0.155	140	32	108
20	0.035	42	0.134	161	42	119
25	0.031	47	0.119	179	53	126
30	0.027	49	0.106	191	63	128
35	0.025	53	0.096	202	74	128
40	0.023	55	0.088	211	84	127
45	0.021	57	0.081	219	95	124
50	0.019	57	0.075	225	105	120
55	0.018	59	0.070	231	116	116
60	0.017	61	0.066	238	126	112
65	0.016	62	0.062	242	137	105
70	0.015	63	0.059	248	147	101
75	0.014	63	0.056	252	158	95
80	0.014	67	0.053	254	168	86
85	0.013	66	0.050	255	179	77
90	0.012	65	0.048	259	189	70
95	0.012	68	0.046	262	200	63
100	0.011	66	0.044	264	210	54
105	0.011	69	0.042	265	221	44
110	0.011	73	0.041	271	231	40
115	0.010	69	0.039	269	242	28
120	0.010	72	0.038	274	252	22
125	0.009	68	0.037	278	263	15
130	0.009	70	0.036	281	273	8
135	0.009	73	0.034	275	284	-
140	0.009	76	0.033	277	294	-
145	0.008	70	0.032	278	305	-
150	0.008	72	0.031	279	315	-
155	0.008	74	0.031	288	326	-
160	0.008	77	0.030	288	336	-
165	0.007	69	0.029	287	347	-
170	0.007	71	0.028	286	357	-
175	0.007	74	0.028	294	368	-
180	0.007	76	0.027	292	378	-

100-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.067	20	0.259	78	12	66
10	0.055	33	0.212	127	24	103
15	0.046	41	0.180	162	36	126
20	0.040	48	0.157	188	48	140
25	0.036	54	0.139	209	60	149
30	0.032	58	0.125	225	72	153
35	0.029	61	0.113	237	84	153
40	0.027	65	0.103	247	96	151
45	0.025	68	0.095	257	108	149
50	0.023	69	0.089	267	120	147
55	0.021	69	0.083	274	132	142
60	0.020	72	0.077	277	144	133
65	0.019	74	0.073	285	156	129
70	0.018	76	0.069	290	168	122
75	0.017	77	0.065	293	180	113
80	0.016	77	0.062	298	192	106
85	0.015	77	0.059	301	204	97
90	0.015	81	0.056	302	216	86
95	0.014	80	0.054	308	228	80
100	0.013	78	0.052	312	240	72
105	0.013	82	0.050	315	252	63
110	0.012	79	0.048	317	264	53
115	0.012	83	0.046	317	276	41
120	0.011	79	0.044	317	288	29
125	0.011	83	0.043	323	300	23
130	0.011	86	0.042	328	312	16
135	0.010	81	0.040	324	324	0
140	0.010	84	0.039	328	336	-
145	0.010	87	0.038	331	348	-
150	0.009	81	0.037	333	360	-
155	0.009	84	0.036	335	372	-
160	0.009	86	0.035	336	384	-
165	0.009	89	0.034	337	396	-
170	0.008	82	0.033	337	408	-
175	0.008	84	0.032	336	420	-
180	0.008	86	0.031	335	432	-

Site 5 - Estimation of Snow Melt

Parameter	Jan	Feb	Mar	Apr	Dec	
Average Daily Melt Rate (mm/day) [1]	29.9	21.4	57.9	90.8	40.1	
Average Daily Melt Rate (mm/8 hours) [1]	6.9	4.8	12.4	12.8	6.7	(Assumes melt occurs during daylight hours)
Average Daily Volume of Melt (m^3/day)	9.6	6.7	17.3	**18.0**	9.3	(Includes only 0.31 ha asphalt snow melting pad)
Average Maximum Daily Rainfall (mm)	13.9	10.8	14.8	18.3	13.8	
Average Maximum Daily Rainfall (m^3)	55.5	43.3	59.3	73.0	55.3	
Regional Specific 90th Percentile Rainfall Volume (mm)	27					
Impervious Runoff (mm)	25					(27 mm subtract 2 mm depression storage)
Impervious Runoff (m^3)	83					
Pervious Runoff (mm)	5.2					(27 mm subtract 5 mm depression storage multiplied by 24%)
Pervious Runoff (m^3)	3.6					
Regional Specific 90th Percentile Rainfall Volume (mm)	21.5					
Regional Specific 90th Percentile Rainfall Volume (m^3)	86					
Daily Discharge Volume (mm)	28	26	34	34	28	
Total Discharge Volume (m^3)	96	93	103	104	95	

Melt Coefficient [2]:	3.8	$mm°C^{-1}day^{-1}$
Base Temperature [3]:	0	°C
Snowmelt Pavement Area:	0.14	ha

Notes:

1. Temperature index method for estimating snow melt is based on $M = MC \times (T_{air}-T_{base})$.
2. Melt coefficient values typically vary between 2.8 and 3.8$mm°C^{-1}day^{-1}$.
3. Base temperature is assumed to be 0°C.
4. Average Orangeville, ON, Air Temperature in the Months of January, February, March, April, and December (2005-2015). Orangeville is within 10 km of the Subject Site.

Year	Maximum Daily Temperature (°C)					Maximum Daily Snowmelt Rate (mm/day)					Maximum Daily Rainfall (mm/day)				
	January	February	March	April	December	January	February	March	April	December	January	February	March	April	December
2005	14.5	8.0	16.0	26.5	4.0	55.1	30.4	60.8	100.7	15.2	13.0	16.0	9.8	18.0	14.9
2006	9.0	6.0	18.0	23.5	9.5	34.2	22.8	68.4	89.3	36.1	24.2	24.0	16.0	23.4	11.4
2007	12.0	4.0	19.5	24.0	8.5	45.6	15.2	74.1	91.2	32.3	6.0	0.0	5.0	23.2	23.0
2008	12.5	6.5	11.0	25.5	12.5	47.5	24.7	41.8	96.9	47.5	44.0	21.4	24.4	14.0	22.0
2009	1.0	8.0	14.0	-	9.5	3.8	30.4	53.2	-	36.1	2.4	12.0	19.0	-	17.2
2010	5.0	7.0	17.5	27.0	10.0	19.0	26.6	66.5	102.6	38.0	13.9	0.0	34.0	13.2	4.0
2011	1.5	10.0	12.5	21.0	12.0	5.7	38.0	47.5	79.8	45.6	0.0	16.0	19.0	16.2	12.8
2012	7.5	5.0	26.0	23.0	14.0	28.5	19.0	98.8	87.4	53.2	11.0	2.6	10.0	14.0	9.0
2013	13.0	5.0	13.0	24.5	12.0	49.4	19.0	49.4	93.1	45.6	20.2	3.0	16.8	21.0	12.3
2014	6.0	2.5	10.0	22.0	10.0	22.8	9.5	38.0	83.6	38.0	18.0	24.0	5.0	21.5	11.0
2015	4.5	-4.0	10.0	22.0	14.0	17.1	0.0	38.0	83.6	53.2	0.0	0.0	4.0	18.0	14.4
Minimum	1.0	-4.0	10.0	21.0	4.0	3.8	0.0	38.0	79.8	15.2	0.0	0.0	4.0	13.2	4.0
Average	7.9	5.3	15.2	23.9	10.5	29.9	21.4	57.9	90.8	40.1	13.9	10.8	14.8	18.3	13.8
Maximum	14.5	10.0	26.0	27.0	14.0	55.1	38.0	98.8	102.6	53.2	44.0	24.0	34.0	23.4	23.0

Notes:

1. Based on Orangeville, ON, historic climate data from 2005-2015.
2. No data for April 2009.

Site 5 - LID Design Requirements

	Runoff Treatment Depth:	21.5	mm	(Based on runoff from 27 mm of rainfall, greater than maximum average
	Rainfall Volume to be Treated:	86	m^3	historic rainfall in April)
	Average Daily Snowmelt (8-Hour Duration:	12.8	mm	
	Average Daily Snowmelt Volume to be Treated:	18	m^3	(Based on Average Daily Snow Melt, April)
	Total Treatment Volume to be Treated:	104	m^3	(Includes 22mm Runoff Depth and 13mm Snow Melt Depth)
	100-Year Peak Flow Attenuation:	153	m^3	(Design to LID to 100-year runoff volume, more conservative)
	100-Year Peak Flow Attenuation + Snow Melt Volume:	171	m^3	
	Measure Infiltration Rate:	34	mm/hr	
	Safety Factor:	2.5		
	Infiltration Rate:	14	mm/hr	
	LID Unit Length:	54	m	(Equivalent length calculated based on provided ponding volume)
	Freeboard:	0.2	m	
	Ponding Area Width:	5.00	m	
	Surface Ponding Depth:	0.3	m	
	Side Slope:	3	(x:1)	
	Bottom Area:	270	m^2	
	Top Area:	332	m^2	
	Surface Ponding Volume:	70	m^3	
	LID Ratio:	10		(Impervious Area to LID Area)
	Filter Media Depth:	0.30	m	
	Filter Media Bottom Width:	5.00	m	
	Filter Media Surface Area:	270	m^2	
	Filter Media Cross-Sectional Area:	1.50	m^2	
	Filter Media Length:	54	m	
	Total Volume:	81	m^3	(Volume of filter media envelope up to 0.30 m ponding depth)
	Filter Media Porosity:	40%		(Volume of the Pore Volume divided by the Total Volume)
	Void Ratio:	67%		(Volume of the Pore Volume divided by Solids Volume)
	Filter Media Pore Volume:	32	m^3	
	Filter Media Volume:	49	m^3	
	Filter Bed Infiltration Rate [2]:	125	mm/hr	(Minimum filter media design infiltration rate)
	Filterbed Drawdown Time:	2.4	hours	
S				
e	Pea Gravel Choking Layer Depth:	0.10	m	
c	Pea Gravel Choking Layer Width:	5.00	m	
t	Pea Gravel Choking Layer Cross-Sectional Area:	0.50	m^2	
i	Pea Gravel Choking Layer Length:	54	m	
o	Total Gravel Choking Layer Volume:	27	m^3	
n	Pea Gravel Choking Layer Porosity:	40%		(Volume of the Pore Volume divided by the Total Volume)
	Void Ratio:	67%		(Volume of the Pore Volume divided by Solids Volume)
1	Pea Gravel Choking Layer Pore Volume:	11	m^3	
	Pea Gravel Choking Layer Media Volume:	16	m^3	
	Stone Gallery Depth:	0.30	m	
	Stone Gallery Width:	5.00	m	
	Stone Gallery Cross-Sectional Area:	1.50	m^2	
	Stone Gallery Length:	54	m	
	Total Stone Gallery Volume:	81	m^3	
	Stone Gallery Porosity:	40%		(Volume of the Pore Volume divided by the Total Volume)
	Void Ratio:	67%		(Volume of the Pore Volume divided by Solids Volume)
	Stone Gallery Pore Volume:	32	m^3	
	Stone Gallery Media Volume:	49	m^3	
	Native Soil Infiltration Rate:	14	mm/hr	
	Drawdown Time:	22	hours	(72 hour maximum drawdown time)
	Subdrain Offset:	1.00	m	
	Subrain Size:	200	mm	(150 mm orifice cap at outlet)
	Subdrain Slope:	1.00%		
	Subdrain Length:	64	m	
	Total Storage Volume:	**151**	m^3	(pore and ponding volume)
	Total Depth	1.00	m	
	Infiltration Water Storage Depth:	0.58	m	
	Draw down time:	43	hr	(Not applicable as the swale will be lined)
	LID Unit Length:	35	m	(Equivalent length calculated based on provided ponding volume)
	Freeboard:	0.2	m	
	Ponding Area Width:	1.00	m	
	Surface Ponding Depth:	0.3	m	
	Side Slope:	3	(x:1)	
	Bottom Area:	35	m^2	
	Top Area:	60	m^2	
	Surface Ponding Volume:	14	m^3	
	LID Ratio:	0		(Impervious Area to LID Area)
	Filter Media Depth:	0.30	m	
	Filter Media Bottom Width:	1.00	m	
	Filter Media Surface Area:	35	m^2	
	Filter Media Cross-Sectional Area:	0.30	m^2	
	Filter Media Length:	35	m	
	Total Volume:	11	m^3	(Volume of filter media envelope up to 0.30 m ponding depth)
	Filter Media Porosity:	40%		(Volume of the Pore Volume divided by the Total Volume)
	Void Ratio:	67%		(Volume of the Pore Volume divided by Solids Volume)
	Filter Media Pore Volume:	4	m^3	
	Filter Media Volume:	6	m^3	
	Filter Bed Infiltration Rate [2]:	125	mm/hr	(Minimum filter media design infiltration rate)
	Filterbed Drawdown Time:	2.4	hours	
S				
e	Pea Gravel Choking Layer Depth:	0.10	m	
c	Pea Gravel Choking Layer Width:	1.00	m	
t	Pea Gravel Choking Layer Cross-Sectional Area:	0.10	m^2	
i	Pea Gravel Choking Layer Length:	35	m	
o	Total Gravel Choking Layer Volume:	4	m^3	
n	Pea Gravel Choking Layer Porosity:	40%		(Volume of the Pore Volume divided by the Total Volume)
	Void Ratio:	67%		(Volume of the Pore Volume divided by Solids Volume)
2	Pea Gravel Choking Layer Pore Volume:	1	m^3	
	Pea Gravel Choking Layer Media Volume:	2	m^3	
	Stone Gallery Depth:	0.30	m	
	Stone Gallery Width:	1.00	m	
	Stone Gallery Cross-Sectional Area:	0.30	m^2	
	Stone Gallery Length:	35	m	
	Total Stone Gallery Volume:	11	m^3	
	Stone Gallery Porosity:	40%		(Volume of the Pore Volume divided by the Total Volume)
	Void Ratio:	67%		(Volume of the Pore Volume divided by Solids Volume)
	Stone Gallery Pore Volume:	4	m^3	
	Stone Gallery Media Volume:	6	m^3	
	Native Soil Infiltration Rate:	1	mm/hr	
	Drawdown Time:	517	hours	(72 hour maximum drawdown time)
	Subdrain Offset:	1.00	m	
	Subrain Size:	200	mm	(150 mm orifice cap at outlet)
	Subdrain Slope:	1.00%		
	Subdrain Length:	64	m	
	Total Storage Volume:	**25**	m^3	(pore and ponding volume)
	Total Depth	1.00	m	
	Infiltration Water Storage Depth:	0.58	m	
	Draw down time:	1000	hr	(Not applicable as the swale will be lined)
	Total Storage	**176**		

Modified Rational Method Peak Flow and Attenuation Volume

AECOM

Site 6 - Conceptul Design Calculations

Existing Site Area:	0.40	ha
Existing Impervious Area:	0.00	ha
Existing Pervious Area:	0.40	ha
% Impervious:	0%	
Equivalent Runoff Coefficient:	0.20	
Time of Concentration:	20.00	min
Proposed Site Area:	0.40	ha
Proposed Impervious Area:	0.37	ha
Proposed Pervious Area:	0.03	ha
% Impervious:	93%	
Equivalent Runoff Coefficient:	0.85	
Time of Concentration:	11.00	min

Design Storm	Peak Discharge (m^3/s)		Attenuation Required (m^3)[3]
	Existing	Proposed	
2-Year	0.01	0.08	53
5-Year	0.02	0.10	74
10-Year	0.02	0.13	89
25-Year	0.03	0.16	120
50-Year	0.04	0.20	147
100-Year	0.04	0.23	175

Region of Peel IDF (2019)			
Event	Parameter		
	A	B	C
2-Year	1,070	0.8759	7.85
5-Year	1,593	0.8789	11
10-Year	2,221	0.9080	12
25-Year	3,158	0.9335	15
50-Year	3,886	0.9495	16
100-Year	4,688	0.9624	17

Notes:

1. Minimum filter bed infiltration rate.
2. Intensity formula: i = a/(t+c)^(b) per Region of Peel Public Works Stormwater Design Criteria and I
3. Attenuation volume required to match existing conditions peak runoff rates.

2-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.025	8	0.108	32	4	29
10	0.019	11	0.081	49	8	41
15	0.015	14	0.065	59	12	47
20	0.013	16	0.055	66	16	50
25	0.011	17	0.047	71	20	51
30	0.010	18	0.042	76	23	52
35	0.009	19	0.038	80	27	53
40	0.008	19	0.034	82	31	50
45	0.007	19	0.031	84	35	49
50	0.007	21	0.029	87	39	48
55	0.006	20	0.027	89	43	46
60	0.006	22	0.025	90	47	43
65	0.006	23	0.024	94	51	43
70	0.005	21	0.022	92	55	38
75	0.005	23	0.021	95	59	36
80	0.005	24	0.020	96	62	34
85	0.004	20	0.019	97	66	31
90	0.004	22	0.018	97	70	27
95	0.004	23	0.017	97	74	23
100	0.004	24	0.017	102	78	24
105	0.004	25	0.016	101	82	19
110	0.004	26	0.015	99	86	13
115	0.004	28	0.015	104	90	14
120	0.003	22	0.014	101	94	7
125	0.003	23	0.014	105	98	8
130	0.003	23	0.013	101	101	0
135	0.003	24	0.013	105	105	0
140	0.003	25	0.013	109	109	0
145	0.003	26	0.012	104	113	-
150	0.003	27	0.012	108	117	-
155	0.003	28	0.012	112	121	-
160	0.003	29	0.011	106	125	-
165	0.003	30	0.011	109	129	-
170	0.003	31	0.011	112	133	-
175	0.002	21	0.011	116	137	-
180	0.002	22	0.010	108	140	-

Procedure M

5-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.031	9	0.131	39	5	34
10	0.024	14	0.103	62	10	52
15	0.020	18	0.086	77	15	62
20	0.017	20	0.073	88	20	67
25	0.015	23	0.064	96	26	71
30	0.014	25	0.057	103	31	72
35	0.012	25	0.052	109	36	74
40	0.011	26	0.047	113	41	72
45	0.010	27	0.044	119	46	73
50	0.010	30	0.040	120	51	69
55	0.009	30	0.038	125	56	69
60	0.008	29	0.035	126	61	65
65	0.008	31	0.033	129	66	62
70	0.007	29	0.032	134	71	63
75	0.007	32	0.030	135	77	59
80	0.007	34	0.028	134	82	53
85	0.006	31	0.027	138	87	51
90	0.006	32	0.026	140	92	49
95	0.006	34	0.025	143	97	46
100	0.006	36	0.024	144	102	42
105	0.005	32	0.023	145	107	38
110	0.005	33	0.022	145	112	33
115	0.005	35	0.021	145	117	28
120	0.005	36	0.021	151	122	29
125	0.005	38	0.020	150	128	23
130	0.005	39	0.019	148	133	16
135	0.004	32	0.019	154	138	16
140	0.004	34	0.018	151	143	8
145	0.004	35	0.018	157	148	9
150	0.004	36	0.017	153	153	0
155	0.004	37	0.017	158	158	0
160	0.004	38	0.016	154	163	-
165	0.004	40	0.016	158	168	-
170	0.004	41	0.016	163	173	-
175	0.004	42	0.015	158	179	-
180	0.004	43	0.015	162	184	-

10-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.038	11	0.160	48	6	42
10	0.030	18	0.126	76	13	63
15	0.025	23	0.105	95	19	76
20	0.021	25	0.090	108	25	83
25	0.019	29	0.079	119	32	87
30	0.017	31	0.070	126	38	88
35	0.015	32	0.063	132	44	88
40	0.014	34	0.058	139	50	89
45	0.013	35	0.053	143	57	86
50	0.012	36	0.049	147	63	84
55	0.011	36	0.046	152	69	83
60	0.010	36	0.043	155	76	79
65	0.010	39	0.041	160	82	78
70	0.009	38	0.038	160	88	71
75	0.009	41	0.036	162	95	68
80	0.008	38	0.034	163	101	62
85	0.008	41	0.033	168	107	61
90	0.007	38	0.031	167	113	54
95	0.007	40	0.030	171	120	51
100	0.007	42	0.029	174	126	48
105	0.007	44	0.028	176	132	44
110	0.006	40	0.027	178	139	40
115	0.006	41	0.026	179	145	35
120	0.006	43	0.025	180	151	29
125	0.006	45	0.024	180	158	23
130	0.005	39	0.023	179	164	16
135	0.005	41	0.023	186	170	16
140	0.005	42	0.022	185	176	8
145	0.005	44	0.021	183	183	0
150	0.005	45	0.021	189	189	0
155	0.005	47	0.020	186	195	-
160	0.005	48	0.020	192	202	-
165	0.004	40	0.019	188	208	-
170	0.004	41	0.019	194	214	-
175	0.004	42	0.018	189	221	-
180	0.004	43	0.018	194	227	-

25-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.047	14	0.200	60	8	52
10	0.038	23	0.162	97	17	80
15	0.032	29	0.137	123	25	98
20	0.028	34	0.118	142	34	108
25	0.025	38	0.105	158	42	116
30	0.022	40	0.094	169	50	119
35	0.020	42	0.085	179	59	120
40	0.018	43	0.078	187	67	120
45	0.017	46	0.072	194	76	119
50	0.016	48	0.066	198	84	114
55	0.015	50	0.062	205	92	112
60	0.014	50	0.058	209	101	108
65	0.013	51	0.055	215	109	105
70	0.012	50	0.052	218	118	101
75	0.012	54	0.049	221	126	95
80	0.011	53	0.047	226	134	91
85	0.010	51	0.044	224	143	82
90	0.010	54	0.042	227	151	76
95	0.010	57	0.041	234	160	74
100	0.009	54	0.039	234	168	66
105	0.009	57	0.038	239	176	63
110	0.009	59	0.036	238	185	53
115	0.008	55	0.035	242	193	48
120	0.008	58	0.034	245	202	43
125	0.008	60	0.032	240	210	30
130	0.007	55	0.031	242	218	23
135	0.007	57	0.030	243	227	16
140	0.007	59	0.030	252	235	17
145	0.007	61	0.029	252	244	9
150	0.007	63	0.028	252	252	0
155	0.006	56	0.027	251	260	-
160	0.006	58	0.026	250	269	-
165	0.006	59	0.026	257	277	-
170	0.006	61	0.025	255	286	-
175	0.006	63	0.024	252	294	-
180	0.006	65	0.024	259	302	-

50-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.058	17	0.244	73	11	63
10	0.047	28	0.199	119	21	98
15	0.040	36	0.169	152	32	121
20	0.035	42	0.146	175	42	133
25	0.031	47	0.129	194	53	141
30	0.027	49	0.116	209	63	146
35	0.025	53	0.105	221	74	147
40	0.023	55	0.096	230	84	146
45	0.021	57	0.089	240	95	146
50	0.019	57	0.082	246	105	141
55	0.018	59	0.077	254	116	139
60	0.017	61	0.072	259	126	133
65	0.016	62	0.068	265	137	129
70	0.015	63	0.064	269	147	122
75	0.014	63	0.061	275	158	117
80	0.014	67	0.058	278	168	110
85	0.013	66	0.055	281	179	102
90	0.012	65	0.052	281	189	92
95	0.012	68	0.050	285	200	86
100	0.011	66	0.048	288	210	78
105	0.011	69	0.046	290	221	69
110	0.011	73	0.045	297	231	66
115	0.010	69	0.043	297	242	55
120	0.010	72	0.041	295	252	43
125	0.009	68	0.040	300	263	38
130	0.009	70	0.039	304	273	31
135	0.009	73	0.037	300	284	16
140	0.009	76	0.036	302	294	8
145	0.008	70	0.035	305	305	0
150	0.008	72	0.034	306	315	-
155	0.008	74	0.033	307	326	-
160	0.008	77	0.032	307	336	-
165	0.007	69	0.032	317	347	-
170	0.007	71	0.031	316	357	-
175	0.007	74	0.030	315	368	-
180	0.007	76	0.029	313	378	-

100-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.067	20	0.282	85	12	73
10	0.055	33	0.232	139	24	115
15	0.046	41	0.197	177	36	141
20	0.040	48	0.171	205	48	157
25	0.036	54	0.151	227	60	167
30	0.032	58	0.136	245	72	173
35	0.029	61	0.123	258	84	174
40	0.027	65	0.113	271	96	175
45	0.025	68	0.104	281	108	173
50	0.023	69	0.097	291	120	171
55	0.021	69	0.090	297	132	165
60	0.020	72	0.084	302	144	158
65	0.019	74	0.079	308	156	152
70	0.018	76	0.075	315	168	147
75	0.017	77	0.071	320	180	140
80	0.016	77	0.068	326	192	134
85	0.015	77	0.064	326	204	122
90	0.015	81	0.062	335	216	119
95	0.014	80	0.059	336	228	108
100	0.013	78	0.056	336	240	96
105	0.013	82	0.054	340	252	88
110	0.012	79	0.052	343	264	79
115	0.012	83	0.050	345	276	69
120	0.011	79	0.049	353	288	65
125	0.011	83	0.047	353	300	53
130	0.011	86	0.045	351	312	39
135	0.010	81	0.044	356	324	32
140	0.010	84	0.043	361	336	25
145	0.010	87	0.041	357	348	9
150	0.009	81	0.040	360	360	0
155	0.009	84	0.039	363	372	-
160	0.009	86	0.038	365	384	-
165	0.009	89	0.037	366	396	-
170	0.008	82	0.036	367	408	-
175	0.008	84	0.035	368	420	-
180	0.008	86	0.034	367	432	-

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Site 6 - Estimation of Snow Melt

Parameter	Jan	Feb	Mar	Apr	Dec	
Average Daily Melt Rate (mm/day) [1]	29.9	21.4	57.9	90.8	40.1	
Average Daily Melt Rate (mm/8 hours) [1]	6.9	4.8	12.4	12.8	6.7	(Assumes melt occurs during daylight hours)
Average Daily Volume of Melt (m^3/day)	15.8	10.9	28.4	29.5	15.3	(Includes only 0.1 ha asphalt snow melting pad)
Average Maximum Daily Rainfall (mm)	13.9	10.8	14.8	18.3	13.8	
Average Maximum Daily Rainfall (m^3)	55.5	43.3	59.3	73.0	55.3	
Regional Specific 90th Percentile Rainfall Volume (mm)	27					
Impervious Runoff (mm)	25					(27 mm subtract 2 mm depression storage)
Impervious Runoff (m^3)	93					
Pervious Runoff (mm)	5.2					(27 mm subtract 5 mm depression storage multiplied by 24%)
Pervious Runoff (m^3)	1.6					
Regional Specific 90th Percentile Rainfall Volume (mm)	23.5					
Regional Specific 90th Percentile Rainfall Volume (m^3)	94					
Daily Discharge Volume (mm)	30	28	36	36	30	
Total Discharge Volume (m^3)	110	105	122	124	109	

Melt Coefficient [2]:	3.8	$mm°C^{-1}day^{-1}$
Base Temperature [3]:	0	°C
Snowmelt Pavement Area:	0.23	ha

Notes:

1. Temperature index method for estimating snow melt is based on $M = MC \times (T_{air}-T_{base})$.
2. Melt coefficient values typically vary between 2.8 and 3.8$mm°C^{-1}day^{-1}$.
3. Base temperature is assumed to be 0°C.
4. Average Orangeville, ON, Air Temperature in the Months of January, February, March, April, and December (2005-2015). Orangeville is within 10 km of the Subject Site.

Year	Maximum Daily Temperature (°C)					Maximum Daily Snowmelt Rate (mm/day)					Maximum Daily Rainfall (mm/day)				
	January	February	March	April	December	January	February	March	April	December	January	February	March	April	December
2005	14.5	8.0	16.0	26.5	4.0	55.1	30.4	60.8	100.7	15.2	13.0	16.0	9.8	18.0	14.9
2006	9.0	6.0	18.0	23.5	9.5	34.2	22.8	68.4	89.3	36.1	24.2	24.0	16.0	23.4	11.4
2007	12.0	4.0	19.5	24.0	8.5	45.6	15.2	74.1	91.2	32.3	6.0	0.0	5.0	23.2	23.0
2008	12.5	6.5	11.0	25.5	12.5	47.5	24.7	41.8	96.9	47.5	44.0	21.4	24.4	14.0	22.0
2009	1.0	8.0	14.0	-	9.5	3.8	30.4	53.2	-	36.1	2.4	12.0	19.0	-	17.2
2010	5.0	7.0	17.5	27.0	10.0	19.0	26.6	66.5	102.6	38.0	13.9	0.0	34.0	13.2	4.0
2011	1.5	10.0	12.5	21.0	12.0	5.7	38.0	47.5	79.8	45.6	0.0	16.0	19.0	16.2	12.8
2012	7.5	5.0	26.0	23.0	14.0	28.5	19.0	98.8	87.4	53.2	11.0	2.6	10.0	14.0	9.0
2013	13.0	5.0	13.0	24.5	12.0	49.4	19.0	49.4	93.1	45.6	20.2	3.0	16.8	21.0	12.3
2014	6.0	2.5	10.0	22.0	10.0	22.8	9.5	38.0	83.6	38.0	18.0	24.0	5.0	21.5	11.0
2015	4.5	-4.0	10.0	22.0	14.0	17.1	0.0	38.0	83.6	53.2	0.0	0.0	4.0	18.0	14.4
Minimum	1.0	-4.0	10.0	21.0	4.0	3.8	0.0	38.0	79.8	15.2	0.0	0.0	4.0	13.2	4.0
Average	7.9	5.3	15.2	23.9	10.5	29.9	21.4	57.9	90.8	40.1	13.9	10.8	14.8	18.3	13.8
Maximum	14.5	10.0	26.0	27.0	14.0	55.1	38.0	98.8	102.6	53.2	44.0	24.0	34.0	23.4	23.0

Notes:

1. Based on Orangeville, ON, historic climate data from 2005-2015.
2. No data for April 2009.

Site 6 - LID Design Requirements

Runoff Treatment Depth:	23.5	mm	(Based on runoff from 27 mm of rainfall, greater than maximum average
Rainfall Volume to be Treated:	94	m^3	historic rainfall in April)
Average Daily Snowmelt (8-Hour Duration:	12.8	mm	(Based on Average Daily Snow Melt, April)
Average Daily Snowmelt Volume to be Treated:	29	m^3	
Total Treatment Volume to be Treated:	124	m^3	(Includes 24mm Runoff Depth and 13mm Snow Melt Depth)
100-Year Peak Flow Attenuation:	175	m^3	(Design to LID to 100-year runoff volume, more conservative)
100-Year Peak Flow Attenuation + Snow Melt Volume:	205	m^3	
Measure Infiltration Rate:	43	mm/hr	
Safety Factor:	2.5		
Infiltration Rate:	17	mm/hr	

	LID Unit Length:	45	m	(Equivalent length calculated based on provided ponding volume)
	Freeboard:	0.2	m	
	Ponding Area Width:	3.00	m	
	Surface Ponding Depth:	0.3	m	
	Side Slope:	3	(x:1)	
	Bottom Area:	135	m^2	
	Top Area:	180	m^2	
	Surface Ponding Volume:	47	m^3	
	LID Ratio:	21		(Impervious Area to LID Area)
	Filter Media Depth:	0.30	m	
	Filter Media Bottom Width:	3.00	m	
	Filter Media Surface Area:	135	m^2	
	Filter Media Cross-Sectional Area:	0.90	m^2	
	Filter Media Length:	45	m	
	Total Volume:	41	m^3	(Volume of filter media envelope up to 0.30 m ponding depth)
	Filter Media Porosity:	40%		(Volume of the Pore Volume divided by the Total Volume)
	Void Ratio:	67%		(Volume of the Pore Volume divided by Solids Volume)
	Filter Media Pore Volume:	16	m^3	
	Filter Media Volume:	24	m^3	
	Filter Bed Infiltration Rate [2]:	125	mm/hr	(Minimum filter media design infiltration rate)
	Filterbed Drawdown Time:	2.4	hours	
	Pea Gravel Choking Layer Depth:	0.10	m	
Section 1	Pea Gravel Choking Layer Width:	3.00	m	
	Pea Gravel Choking Layer Cross-Sectional Area:	0.30	m^2	
	Pea Gravel Choking Layer Length:	45	m	
	Total Gravel Choking Layer Volume:	14	m^3	
	Pea Gravel Choking Layer Porosity:	40%		(Volume of the Pore Volume divided by the Total Volume)
	Void Ratio:	67%		(Volume of the Pore Volume divided by Solids Volume)
	Pea Gravel Choking Layer Pore Volume:	5	m^3	
	Pea Gravel Choking Layer Media Volume:	8	m^3	
	Stone Gallery Depth:	0.30	m	
	Stone Gallery Width:	3.00	m	
	Stone Gallery Cross-Sectional Area:	0.90	m^2	
	Stone Gallery Length:	45	m	
	Total Stone Gallery Volume:	41	m^3	
	Stone Gallery Porosity:	40%		(Volume of the Pore Volume divided by the Total Volume)
	Void Ratio:	67%		(Volume of the Pore Volume divided by Solids Volume)
	Stone Gallery Pore Volume:	16	m^3	
	Stone Gallery Media Volume:	24	m^3	
	Native Soil Infiltration Rate:	17	mm/hr	
	Drawdown Time:	17	hours	(72 hour maximum drawdown time)
	Total Section 1 Storage Volume:	**85**	m^3	(pore and ponding volume)
	Total Depth	1.00	m	
	Infilration Water Storage Depth:	0.58	m	
	Draw down time:	34	hr	(pore and ponding) (Note the swale will be lined)

	LID Unit Length:	40	m	(Equivalent length calculated based on provided ponding volume)
	Freeboard:	0.15	m	
	Ponding Area Width:	5.00	m	*Based on an approximate average bottom width of proposed retention cell/dry basin
	Surface Ponding Depth:	0.3	m	
	Side Slope:	3	(x:1)	
	Bottom Area:	200	m^2	
	Top Area:	254	m^2	
	Surface Ponding Volume:	68	m^3	
	LID Ratio:	15		(Impervious Area to LID Area)
	Filter Media Depth:	0.30	m	
	Filter Media Bottom Width:	5.00	m	(Average)
	Filter Media Surface Area:	200	m^2	
	Filter Media Cross-Sectional Area:	1.50	m^2	
	Filter Media Length:	40	m	
	Total Volume:	60	m^3	(Volume of filter media envelope up to 0.30 m ponding depth)
	Filter Media Porosity:	40%		(Volume of the Pore Volume divided by the Total Volume)
	Void Ratio:	67%		(Volume of the Pore Volume divided by Solids Volume)
	Filter Media Pore Volume:	24	m^3	
	Filter Media Volume:	36	m^3	
	Filter Bed Infiltration Rate [2]:	125	mm/hr	(Minimum filter media design infiltration rate)
	Filterbed Drawdown Time:	2.4	hours	
	Pea Gravel Choking Layer Depth:	0.10	m	
Section 2	Pea Gravel Choking Layer Width:	5.00	m	(Average)
	Pea Gravel Choking Layer Cross-Sectional Area:	0.50	m^2	
	Pea Gravel Choking Layer Length:	40	m	
	Total Gravel Choking Layer Volume:	20	m^3	
	Pea Gravel Choking Layer Porosity:	40%		(Volume of the Pore Volume divided by the Total Volume)
	Void Ratio:	67%		(Volume of the Pore Volume divided by Solids Volume)
	Pea Gravel Choking Layer Pore Volume:	8	m^3	
	Pea Gravel Choking Layer Media Volume:	12	m^3	
	Stone Gallery Depth:	0.30	m	
	Stone Gallery Width:	5.00	m	(Average)
	Stone Gallery Cross-Sectional Area:	1.50	m^2	
	Stone Gallery Length:	40	m	
	Total Stone Gallery Volume:	60	m^3	
	Stone Gallery Porosity:	40%		(Volume of the Pore Volume divided by the Total Volume)
	Void Ratio:	67%		(Volume of the Pore Volume divided by Solids Volume)
	Stone Gallery Pore Volume:	24	m^3	
	Stone Gallery Media Volume:	36	m^3	
	Native Soil Infiltration Rate:	17	mm/hr	
	Drawdown Time:	17	hours	(72 hour maximum drawdown time)
	Total Section 2 Storage Volume:	**124**	m^3	(pore and ponding volume)
	Total Depth	1.00	m	
	Infilration Water Storage Depth:	0.58	m	
	Draw down time:	34	hr	(Not applicable as the swale will be lined)
	Subdrain Offset:	1.00	m	
	Subrain Size:	200	mm	(150 mm orifice cap at outlet)
	Subdrain Slope:	1.00%		
	Subdrain Length:	100	m	
	Total Storage Volume:	209	m^3	(pore and ponding volume)

Modified Rational Method Peak Flow and Attenuation Volume

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Site 9 - Conceptul Design Calculations

Existing Site Area:	0.25	ha
Existing Impervious Area:	0.08	ha
Existing Pervious Area:	0.18	ha
% Impervious:	30%	
Equivalent Runoff Coefficient:	0.41	
Time of Concentration:	20.00	min
Proposed Site Area:	0.25	ha
Proposed Impervious Area:	0.24	ha
Proposed Pervious Area:	0.01	ha
% Impervious:	95%	
Equivalent Runoff Coefficient:	0.86	
Time of Concentration:	11.00	min

Design Storm	Peak Discharge (m^3/s)		Attenuation Required (m^3)[3]
	Existing	Proposed	
2-Year	0.02	0.05	22
5-Year	0.02	0.07	30
10-Year	0.03	0.08	36
25-Year	0.04	0.10	48
50-Year	0.04	0.13	59
100-Year	0.05	0.15	68

Region of Peel IDF (2019)			
Event	Parameter		
	A	B	C
2-Year	1,070	0.8759	7.85
5-Year	1,593	0.8789	11
10-Year	2,221	0.9080	12
25-Year	3,158	0.9335	15
50-Year	3,886	0.9495	16
100-Year	4,688	0.9624	17

Notes:

1. Minimum filter bed infiltration rate.
2. Intensity formula: i = a/(t+c)^(b) per Region of Peel Public Works Stormwater Design Criteria and I
3. Attenuation volume required to match existing conditions peak runoff rates.

2-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.033	10	0.069	21	5	16
10	0.024	14	0.051	31	10	20
15	0.020	18	0.041	37	15	22
20	0.017	20	0.035	42	20	22
25	0.014	21	0.030	45	26	20
30	0.013	23	0.027	49	31	18
35	0.011	23	0.024	50	36	15
40	0.010	24	0.022	53	41	12
45	0.009	24	0.020	54	46	8
50	0.009	27	0.018	54	51	3
55	0.008	26	0.017	56	56	0
60	0.008	29	0.016	58	61	-
65	0.007	27	0.015	59	66	-
70	0.007	29	0.014	59	71	-
75	0.006	27	0.013	59	77	-
80	0.006	29	0.013	62	82	-
85	0.006	31	0.012	61	87	-
90	0.006	32	0.012	65	92	-
95	0.005	29	0.011	63	97	-
100	0.005	30	0.011	66	102	-
105	0.005	32	0.010	63	107	-
110	0.005	33	0.010	66	112	-
115	0.005	35	0.010	69	117	-
120	0.004	29	0.009	65	122	-
125	0.004	30	0.009	68	128	-
130	0.004	31	0.009	70	133	-
135	0.004	32	0.008	65	138	-
140	0.004	34	0.008	67	143	-
145	0.004	35	0.008	70	148	-
150	0.004	36	0.008	72	153	-
155	0.004	37	0.007	65	158	-
160	0.003	29	0.007	67	163	-
165	0.003	30	0.007	69	168	-
170	0.003	31	0.007	71	173	-
175	0.003	32	0.007	74	179	-
180	0.003	32	0.007	76	184	-

Procedure M

5-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.040	12	0.084	25	7	19
10	0.031	19	0.066	40	13	26
15	0.026	23	0.055	50	20	30
20	0.022	26	0.047	56	26	30
25	0.019	29	0.041	62	33	29
30	0.017	31	0.037	67	40	27
35	0.016	34	0.033	69	46	23
40	0.014	34	0.030	72	53	19
45	0.013	35	0.028	76	59	16
50	0.012	36	0.026	78	66	12
55	0.011	36	0.024	79	73	7
60	0.011	40	0.023	83	79	4
65	0.010	39	0.021	82	86	-
70	0.010	42	0.020	84	92	-
75	0.009	41	0.019	86	99	-
80	0.009	43	0.018	86	106	-
85	0.008	41	0.017	87	112	-
90	0.008	43	0.017	92	119	-
95	0.008	46	0.016	91	125	-
100	0.007	42	0.015	90	132	-
105	0.007	44	0.015	95	139	-
110	0.007	46	0.014	92	145	-
115	0.006	41	0.014	97	152	-
120	0.006	43	0.013	94	158	-
125	0.006	45	0.013	98	165	-
130	0.006	47	0.012	94	172	-
135	0.006	49	0.012	97	178	-
140	0.006	50	0.012	101	185	-
145	0.005	44	0.011	96	191	-
150	0.005	45	0.011	99	198	-
155	0.005	47	0.011	102	205	-
160	0.005	48	0.010	96	211	-
165	0.005	50	0.010	99	218	-
170	0.005	51	0.010	102	224	-
175	0.005	53	0.010	105	231	-
180	0.004	43	0.009	97	238	-

10-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.048	14	0.102	31	8	23
10	0.038	23	0.081	49	16	32
15	0.032	29	0.067	60	24	36
20	0.027	32	0.057	68	32	36
25	0.024	36	0.050	75	41	35
30	0.021	38	0.045	81	49	32
35	0.019	40	0.040	84	57	27
40	0.018	43	0.037	89	65	24
45	0.016	43	0.034	92	73	19
50	0.015	45	0.031	93	81	12
55	0.014	46	0.029	96	89	7
60	0.013	47	0.027	97	97	0
65	0.012	47	0.026	101	105	-
70	0.012	50	0.024	101	113	-
75	0.011	50	0.023	104	122	-
80	0.010	48	0.022	106	130	-
85	0.010	51	0.021	107	138	-
90	0.009	49	0.020	108	146	-
95	0.009	51	0.019	108	154	-
100	0.009	54	0.018	108	162	-
105	0.008	50	0.018	113	170	-
110	0.008	53	0.017	112	178	-
115	0.008	55	0.016	110	186	-
120	0.008	58	0.016	115	194	-
125	0.007	53	0.015	113	203	-
130	0.007	55	0.015	117	211	-
135	0.007	57	0.014	113	219	-
140	0.007	59	0.014	118	227	-
145	0.006	52	0.014	122	235	-
150	0.006	54	0.013	117	243	-
155	0.006	56	0.013	121	251	-
160	0.006	58	0.012	115	259	-
165	0.006	59	0.012	119	267	-
170	0.006	61	0.012	122	275	-
175	0.005	53	0.012	126	284	-
180	0.005	54	0.011	119	292	-

25-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.060	18	0.127	38	11	27
10	0.049	29	0.103	62	22	40
15	0.041	37	0.087	78	32	46
20	0.036	43	0.076	91	43	48
25	0.032	48	0.067	101	54	47
30	0.028	50	0.060	108	65	43
35	0.026	55	0.054	113	76	38
40	0.023	55	0.050	120	86	34
45	0.022	59	0.046	124	97	27
50	0.020	60	0.042	126	108	18
55	0.019	63	0.040	132	119	13
60	0.018	65	0.037	133	130	4
65	0.017	66	0.035	137	140	-
70	0.016	67	0.033	139	151	-
75	0.015	68	0.031	140	162	-
80	0.014	67	0.030	144	173	-
85	0.013	66	0.028	143	184	-
90	0.013	70	0.027	146	194	-
95	0.012	68	0.026	148	205	-
100	0.012	72	0.025	150	216	-
105	0.011	69	0.024	151	227	-
110	0.011	73	0.023	152	238	-
115	0.011	76	0.022	152	248	-
120	0.010	72	0.021	151	259	-
125	0.010	75	0.021	158	270	-
130	0.010	78	0.020	156	281	-
135	0.009	73	0.019	154	292	-
140	0.009	76	0.019	160	302	-
145	0.009	78	0.018	157	313	-
150	0.008	72	0.018	162	324	-
155	0.008	74	0.017	158	335	-
160	0.008	77	0.017	163	346	-
165	0.008	79	0.016	158	356	-
170	0.008	82	0.016	163	367	-
175	0.007	74	0.016	168	378	-
180	0.007	76	0.015	162	389	-

50-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.074	22	0.156	47	13	34
10	0.060	36	0.127	76	26	50
15	0.051	46	0.107	96	40	57
20	0.044	53	0.093	112	53	59
25	0.039	59	0.082	123	66	57
30	0.035	63	0.074	133	79	54
35	0.032	67	0.067	141	92	48
40	0.029	70	0.061	146	106	41
45	0.027	73	0.057	154	119	35
50	0.025	75	0.052	156	132	24
55	0.023	76	0.049	162	145	17
60	0.022	79	0.046	166	158	7
65	0.020	78	0.043	168	172	-
70	0.019	80	0.041	172	185	-
75	0.018	81	0.039	176	198	-
80	0.017	82	0.037	178	211	-
85	0.017	87	0.035	179	224	-
90	0.016	86	0.033	178	238	-
95	0.015	86	0.032	182	251	-
100	0.015	90	0.031	186	264	-
105	0.014	88	0.029	183	277	-
110	0.013	86	0.028	185	290	-
115	0.013	90	0.027	186	304	-
120	0.013	94	0.026	187	317	-
125	0.012	90	0.026	195	330	-
130	0.012	94	0.025	195	343	-
135	0.011	89	0.024	194	356	-
140	0.011	92	0.023	193	370	-
145	0.011	96	0.022	191	383	-
150	0.010	90	0.022	198	396	-
155	0.010	93	0.021	195	409	-
160	0.010	96	0.021	202	422	-
165	0.010	99	0.020	198	436	-
170	0.009	92	0.020	204	449	-
175	0.009	95	0.019	200	462	-
180	0.009	97	0.019	205	475	-

100-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.085	26	0.180	54	16	38
10	0.070	42	0.148	89	31	58
15	0.059	53	0.125	113	47	66
20	0.052	62	0.109	131	62	68
25	0.046	69	0.096	144	78	66
30	0.041	74	0.087	157	94	63
35	0.037	78	0.079	166	109	57
40	0.034	82	0.072	173	125	48
45	0.031	84	0.066	178	140	38
50	0.029	87	0.062	186	156	30
55	0.027	89	0.057	188	172	17
60	0.026	94	0.054	194	187	7
65	0.024	94	0.051	199	203	-
70	0.023	97	0.048	202	218	-
75	0.022	99	0.045	203	234	-
80	0.020	96	0.043	206	250	-
85	0.019	97	0.041	209	265	-
90	0.019	103	0.039	211	281	-
95	0.018	103	0.038	217	296	-
100	0.017	102	0.036	216	312	-
105	0.016	101	0.035	221	328	-
110	0.016	106	0.033	218	343	-
115	0.015	104	0.032	221	359	-
120	0.015	108	0.031	223	374	-
125	0.014	105	0.030	225	390	-
130	0.014	109	0.029	226	406	-
135	0.013	105	0.028	227	421	-
140	0.013	109	0.027	227	437	-
145	0.012	104	0.026	226	452	-
150	0.012	108	0.026	234	468	-
155	0.012	112	0.025	233	484	-
160	0.011	106	0.024	230	499	-
165	0.011	109	0.024	238	515	-
170	0.011	112	0.023	235	530	-
175	0.011	116	0.022	231	546	-
180	0.010	108	0.022	238	562	-

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Site 9 - Estimation of Snow Melt

Parameter	Jan	Feb	Mar	Apr	Dec	
Average Daily Melt Rate (mm/day) [1]	29.9	21.4	57.9	90.8	40.1	
Average Daily Melt Rate (mm/8 hours) [1]	6.9	4.8	12.4	12.8	6.7	(Assumes melt occurs during daylight hours)
Average Daily Volume of Melt (m^3/day)	9.3	6.4	16.7	17.3	9.0	(Includes only 0.09 ha asphalt snow melting pad)
Average Maximum Daily Rainfall (mm)	13.9	10.8	14.8	18.3	13.8	
Average Maximum Daily Rainfall (m^3)	34.7	27.0	37.0	45.6	34.5	
Regional Specific 90th Percentile Rainfall Volume (mm)	27					
Impervious Runoff (mm)	25					(27 mm subtract 2 mm depression storage)
Impervious Runoff (m^3)	59					
Pervious Runoff (mm)	5.2					(27 mm subtract 5 mm depression storage multiplied by 24%)
Pervious Runoff (m^3)	0.7					
Regional Specific 90th Percentile Rainfall Volume (mm)	24.0					
Regional Specific 90th Percentile Rainfall Volume (m^3)	60					
Daily Discharge Volume (mm)	31	29	36	37	31	
Total Discharge Volume (m^3)	69	66	77	77	69	

Melt Coefficient [2]:	3.8	$mm°C^{-1}day^{-1}$
Base Temperature [3]:	0	°C
Snowmelt Pavement Area:	0.14	ha

Notes:

1. Temperature index method for estimating snow melt is based on $M = MC \times (T_{air}-T_{base})$.
2. Melt coefficient values typically vary between 2.8 and 3.8$mm°C^{-1}day^{-1}$.
3. Base temperature is assumed to be 0°C.
4. Average Orangeville, ON, Air Temperature in the Months of January, February, March, April, and December (2005-2015). Orangeville is within 10 km of the Subject Site.

Year	Maximum Daily Temperature (°C)					Maximum Daily Snowmelt Rate (mm/day)					Maximum Daily Rainfall (mm/day)				
	January	February	March	April	December	January	February	March	April	December	January	February	March	April	December
2005	14.5	8.0	16.0	26.5	4.0	55.1	30.4	60.8	100.7	15.2	13.0	16.0	9.8	18.0	14.9
2006	9.0	6.0	18.0	23.5	9.5	34.2	22.8	68.4	89.3	36.1	24.2	24.0	16.0	23.4	11.4
2007	12.0	4.0	19.5	24.0	8.5	45.6	15.2	74.1	91.2	32.3	6.0	0.0	5.0	23.2	23.0
2008	12.5	6.5	11.0	25.5	12.5	47.5	24.7	41.8	96.9	47.5	44.0	21.4	24.4	14.0	22.0
2009	1.0	8.0	14.0	-	9.5	3.8	30.4	53.2	-	36.1	2.4	12.0	19.0	-	17.2
2010	5.0	7.0	17.5	27.0	10.0	19.0	26.6	66.5	102.6	38.0	13.9	0.0	34.0	13.2	4.0
2011	1.5	10.0	12.5	21.0	12.0	5.7	38.0	47.5	79.8	45.6	0.0	16.0	19.0	16.2	12.8
2012	7.5	5.0	26.0	23.0	14.0	28.5	19.0	98.8	87.4	53.2	11.0	2.6	10.0	14.0	9.0
2013	13.0	5.0	13.0	24.5	12.0	49.4	19.0	49.4	93.1	45.6	20.2	3.0	16.8	21.0	12.3
2014	6.0	2.5	10.0	22.0	10.0	22.8	9.5	38.0	83.6	38.0	18.0	24.0	5.0	21.5	11.0
2015	4.5	-4.0	10.0	22.0	14.0	17.1	0.0	38.0	83.6	53.2	0.0	0.0	4.0	18.0	14.4
Minimum	1.0	-4.0	10.0	21.0	4.0	3.8	0.0	38.0	79.8	15.2	0.0	0.0	4.0	13.2	4.0
Average	7.9	5.3	15.2	23.9	10.5	29.9	21.4	57.9	90.8	40.1	13.9	10.8	14.8	18.3	13.8
Maximum	14.5	10.0	26.0	27.0	14.0	55.1	38.0	98.8	102.6	53.2	44.0	24.0	34.0	23.4	23.0

Notes:

1. Based on Orangeville, ON, historic climate data from 2005-2015.
2. No data for April 2009.

Site 9 - LID Design Requirements

Runoff Treatment Depth:	24.0	mm	(Based on runoff from 27 mm of rainfall, greater than maximum average historic rainfall in April)
Rainfall Volume to be Treated:	60	m^3	
Average Daily Snowmelt (8-Hour Duration:	12.8	mm	(Based on Average Daily Snow Melt, April)
Average Daily Snowmelt Volume to be Treated:	17	m^3	
Total Treatment Volume to be Treated:	77	m^3	(Includes 24mm Runoff Depth and 13mm Snow Melt Depth)
100-Year Peak Flow Attenuation:	68	m^3	(Design to LID to 100-year runoff volume, more conservative)
100-Year Peak Flow Attenuation + Snow Melt Volume:	86	m^3	
Measure Infiltration Rate:	67	mm/hr	
Safety Factor:	2.5		
Infiltration Rate:	27	mm/hr	
LID Unit Length:	41	m	(Equivalent length calculated based on provided ponding volume)
Freeboard:	0.2	m	
Ponding Area Width:	3.00	m	
Surface Ponding Depth:	0.3	m	
Side Slope:	3	(x:1)	
Bottom Area:	123	m^2	
Top Area:	166	m^2	
Surface Ponding Volume:	43	m^3	
LID Ratio:	14		(Impervious Area to LID Area)
Filter Media Depth:	0.30	m	
Filter Media Bottom Width:	3.00	m	
Filter Media Surface Area:	123	m^2	
Filter Media Cross-Sectional Area:	0.90	m^2	
Filter Media Length:	41	m	
Total Volume:	37	m^3	(Volume of filter media envelope up to 0.30 m ponding depth)
Filter Media Porosity:	40%		(Volume of the Pore Volume divided by the Total Volume)
Void Ratio:	67%		(Volume of the Pore Volume divided by Solids Volume)
Filter Media Pore Volume:	15	m^3	
Filter Media Volume:	22	m^3	
Filter Bed Infiltration Rate [(2)]:	125	mm/hr	(Minimum filter media design infiltration rate)
Filterbed Drawdown Time:	2.4	hours	
Pea Gravel Choking Layer Depth:	0.10	m	
Pea Gravel Choking Layer Width:	3.00	m	
Pea Gravel Choking Layer Cross-Sectional Area:	0.30	m^2	
Pea Gravel Choking Layer Length:	41	m	
Total Gravel Choking Layer Volume:	12	m^3	
Pea Gravel Choking Layer Porosity:	40%		(Volume of the Pore Volume divided by the Total Volume)
Void Ratio:	67%		(Volume of the Pore Volume divided by Solids Volume)
Pea Gravel Choking Layer Pore Volume:	5	m^3	
Pea Gravel Choking Layer Media Volume:	7	m^3	
Stone Gallery Depth:	0.50	m	
Stone Gallery Width:	3.00	m	
Stone Gallery Cross-Sectional Area:	1.50	m^2	
Stone Gallery Length:	41	m	
Total Stone Gallery Volume:	62	m^3	
Stone Gallery Porosity:	40%		(Volume of the Pore Volume divided by the Total Volume)
Void Ratio:	67%		(Volume of the Pore Volume divided by Solids Volume)
Stone Gallery Pore Volume:	25	m^3	
Stone Gallery Media Volume:	37	m^3	
Native Soil Infiltration Rate:	27	mm/hr	
Drawdown Time:	19	hours	(72 hour maximum drawdown time)
Subdrain Offset:	1.00	m	
Subrain Size:	200	mm	(150 mm orifice cap at outlet)
Subdrain Slope:	1.00%		
Subdrain Length:	213	m	
Total Storage Volume:	**88**	m^3	(pore and ponding volume)
Total Depth	1.20	m	
Infilration Water Storage Depth:	0.66	m	
Draw down time:	25	hr	

Modified Rational Method Peak Flow and Attenuation Volume

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Site 10 - Conceptul Design Calculations

Existing Site Area:	1.52	ha
Existing Impervious Area:	1.42	ha
Existing Pervious Area:	0.10	ha
% Impervious:	93%	
Equivalent Runoff Coefficient:	0.85	
Time of Concentration:	11.00	min
Proposed Site Area:	1.52	ha
Proposed Impervious Area:	1.40	ha
Proposed Pervious Area:	0.12	ha
% Impervious:	92%	
Equivalent Runoff Coefficient:	0.84	
Time of Concentration:	11.00	min

Design Storm	Peak Discharge (m^3/s)		Attenuation Required (m^3)[3]
	Existing	Proposed	
2-Year	0.30	0.31	34
5-Year	0.38	0.39	35
10-Year	0.47	0.48	42
25-Year	0.60	0.61	89
50-Year	0.74	0.76	174
100-Year	0.86	0.88	247

Region of Peel IDF (2019)			
Event	Parameter		
	A	B	C
2-Year	1,070	0.8759	7.85
5-Year	1,593	0.8789	11
10-Year	2,221	0.9080	12
25-Year	3,158	0.9335	15
50-Year	3,886	0.9495	16
100-Year	4,688	0.9624	17

Notes:

1. Minimum filter bed infiltration rate.
2. Intensity formula: i = a/(t+c)^(b) per Region of Peel Public Works Stormwater Design Criteria and I
3. Attenuation volume required to match existing conditions peak runoff rates.

2-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.412	124	0.408	122	89	34
10	0.309	185	0.306	184	177	7
15	0.249	224	0.246	221	266	-
20	0.209	251	0.207	248	354	-
25	0.181	272	0.179	269	443	-
30	0.160	288	0.158	284	531	-
35	0.144	302	0.142	298	620	-
40	0.130	312	0.129	310	708	-
45	0.120	324	0.118	319	797	-
50	0.110	330	0.109	327	885	-
55	0.103	340	0.102	337	974	-
60	0.096	346	0.095	342	1,062	-
65	0.090	351	0.089	347	1,151	-
70	0.085	357	0.084	353	1,239	-
75	0.081	365	0.080	360	1,328	-
80	0.077	370	0.076	365	1,416	-
85	0.073	372	0.072	367	1,505	-
90	0.070	378	0.069	373	1,593	-
95	0.067	382	0.066	376	1,682	-
100	0.064	384	0.063	378	1,770	-
105	0.062	391	0.061	384	1,859	-
110	0.059	389	0.059	389	1,947	-
115	0.057	393	0.056	386	2,036	-
120	0.055	396	0.055	396	2,124	-
125	0.053	398	0.053	398	2,213	-
130	0.052	406	0.051	398	2,301	-
135	0.050	405	0.049	397	2,390	-
140	0.049	412	0.048	403	2,478	-
145	0.047	409	0.047	409	2,567	-
150	0.046	414	0.045	405	2,655	-
155	0.045	419	0.044	409	2,744	-
160	0.043	413	0.043	413	2,832	-
165	0.042	416	0.042	416	2,921	-
170	0.041	418	0.041	418	3,009	-
175	0.040	420	0.040	420	3,098	-
180	0.039	421	0.039	421	3,186	-

Procedure M

5-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.503	151	0.497	149	114	35
10	0.396	238	0.391	235	228	7
15	0.328	295	0.324	292	342	-
20	0.281	337	0.278	334	456	-
25	0.246	369	0.244	366	570	-
30	0.220	396	0.217	391	684	-
35	0.199	418	0.197	414	798	-
40	0.181	434	0.179	430	912	-
45	0.167	451	0.165	446	1,026	-
50	0.155	465	0.153	459	1,140	-
55	0.145	479	0.143	472	1,254	-
60	0.136	490	0.134	482	1,368	-
65	0.128	499	0.126	491	1,482	-
70	0.121	508	0.120	504	1,596	-
75	0.115	518	0.113	509	1,710	-
80	0.109	523	0.108	518	1,824	-
85	0.104	530	0.103	525	1,938	-
90	0.100	540	0.098	529	2,052	-
95	0.095	542	0.094	536	2,166	-
100	0.092	552	0.091	546	2,280	-
105	0.088	554	0.087	548	2,394	-
110	0.085	561	0.084	554	2,508	-
115	0.082	566	0.081	559	2,622	-
120	0.079	569	0.078	562	2,736	-
125	0.077	578	0.076	570	2,850	-
130	0.074	577	0.073	569	2,964	-
135	0.072	583	0.071	575	3,078	-
140	0.070	588	0.069	580	3,192	-
145	0.068	592	0.067	583	3,306	-
150	0.066	594	0.065	585	3,420	-
155	0.064	595	0.064	595	3,534	-
160	0.063	605	0.062	595	3,648	-
165	0.061	604	0.060	594	3,762	-
170	0.060	612	0.059	602	3,876	-
175	0.058	609	0.058	609	3,990	-
180	0.057	616	0.056	605	4,104	-

10-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.612	184	0.605	182	140	42
10	0.484	290	0.479	287	279	8
15	0.402	362	0.398	358	419	-
20	0.345	414	0.341	409	558	-
25	0.302	453	0.299	449	698	-
30	0.269	484	0.266	479	837	-
35	0.243	510	0.240	504	977	-
40	0.222	533	0.219	526	1,116	-
45	0.204	551	0.202	545	1,256	-
50	0.189	567	0.187	561	1,395	-
55	0.176	581	0.174	574	1,535	-
60	0.165	594	0.163	587	1,674	-
65	0.155	605	0.154	601	1,814	-
70	0.147	617	0.145	609	1,953	-
75	0.139	626	0.137	617	2,093	-
80	0.132	634	0.131	629	2,232	-
85	0.126	643	0.125	638	2,372	-
90	0.120	648	0.119	643	2,511	-
95	0.115	656	0.114	650	2,651	-
100	0.110	660	0.109	654	2,790	-
105	0.106	668	0.105	662	2,930	-
110	0.102	673	0.101	667	3,069	-
115	0.099	683	0.097	669	3,209	-
120	0.095	684	0.094	677	3,348	-
125	0.092	690	0.091	683	3,488	-
130	0.089	694	0.088	686	3,627	-
135	0.086	697	0.085	689	3,767	-
140	0.084	706	0.083	697	3,906	-
145	0.081	705	0.080	696	4,046	-
150	0.079	711	0.078	702	4,185	-
155	0.077	716	0.076	707	4,325	-
160	0.075	720	0.074	710	4,464	-
165	0.073	723	0.072	713	4,604	-
170	0.071	724	0.070	714	4,743	-
175	0.069	725	0.069	725	4,883	-
180	0.068	734	0.067	724	5,022	-

25-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.765	230	0.757	227	180	88
10	0.621	373	0.614	368	359	89
15	0.524	472	0.518	466	539	-
20	0.454	545	0.449	539	719	-
25	0.400	600	0.396	594	899	-
30	0.359	646	0.355	639	1,078	-
35	0.325	683	0.322	676	1,258	-
40	0.298	715	0.294	706	1,438	-
45	0.274	740	0.271	732	1,617	-
50	0.255	765	0.252	756	1,797	-
55	0.238	785	0.235	776	1,977	-
60	0.223	803	0.220	792	2,156	-
65	0.210	819	0.207	807	2,336	-
70	0.198	832	0.196	823	2,516	-
75	0.188	846	0.186	837	2,696	-
80	0.179	859	0.177	850	2,875	-
85	0.170	867	0.168	857	3,055	-
90	0.163	880	0.161	869	3,235	-
95	0.156	889	0.154	878	3,414	-
100	0.149	894	0.148	888	3,594	-
105	0.144	907	0.142	895	3,774	-
110	0.138	911	0.137	904	3,953	-
115	0.133	918	0.132	911	4,133	-
120	0.129	929	0.127	914	4,313	-
125	0.124	930	0.123	923	4,493	-
130	0.120	936	0.119	928	4,672	-
135	0.117	948	0.115	932	4,852	-
140	0.113	949	0.112	941	5,032	-
145	0.110	957	0.109	948	5,211	-
150	0.107	963	0.106	954	5,391	-
155	0.104	967	0.103	958	5,571	-
160	0.101	970	0.100	960	5,750	-
165	0.098	970	0.097	960	5,930	-
170	0.096	979	0.095	969	6,110	-
175	0.094	987	0.093	977	6,290	-
180	0.091	983	0.090	972	6,469	-

50-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	0.934	280	0.924	277	221	138
10	0.763	458	0.755	453	442	174
15	0.646	581	0.639	575	662	-
20	0.560	672	0.554	665	883	-
25	0.495	743	0.490	735	1,104	-
30	0.444	799	0.439	790	1,325	-
35	0.402	844	0.398	836	1,546	-
40	0.368	883	0.364	874	1,766	-
45	0.339	915	0.336	907	1,987	-
50	0.315	945	0.312	936	2,208	-
55	0.294	970	0.291	960	2,429	-
60	0.276	994	0.273	983	2,650	-
65	0.259	1,010	0.257	1,002	2,870	-
70	0.245	1,029	0.242	1,016	3,091	-
75	0.232	1,044	0.230	1,035	3,312	-
80	0.221	1,061	0.218	1,046	3,533	-
85	0.210	1,071	0.208	1,061	3,754	-
90	0.201	1,085	0.199	1,075	3,974	-
95	0.192	1,094	0.190	1,083	4,195	-
100	0.184	1,104	0.182	1,092	4,416	-
105	0.177	1,115	0.175	1,103	4,637	-
110	0.170	1,122	0.169	1,115	4,858	-
115	0.164	1,132	0.163	1,125	5,078	-
120	0.159	1,145	0.157	1,130	5,299	-
125	0.153	1,148	0.152	1,140	5,520	-
130	0.148	1,154	0.147	1,147	5,741	-
135	0.144	1,166	0.142	1,150	5,962	-
140	0.139	1,168	0.138	1,159	6,182	-
145	0.135	1,175	0.134	1,166	6,403	-
150	0.131	1,179	0.130	1,170	6,624	-
155	0.128	1,190	0.126	1,172	6,845	-
160	0.124	1,190	0.123	1,181	7,066	-
165	0.121	1,198	0.120	1,188	7,286	-
170	0.118	1,204	0.117	1,193	7,507	-
175	0.115	1,208	0.114	1,197	7,728	-
180	0.112	1,210	0.111	1,199	7,949	-

100-Year						
Storm	Existing		Proposed		Release	Storage Volume
Duration	Runoff Rate	Runoff Volume	Runoff Rate	Runoff Volume	Volume	Required
(min)	(m^3/s)	(m^3)	(m^3/s)	(m^3)	(m^3)	(m^3)
5	1.080	324	1.068	320	257	181
10	0.886	532	0.877	526	514	247
15	0.753	678	0.745	671	770	-
20	0.655	786	0.648	778	1,027	-
25	0.579	869	0.573	860	1,284	-
30	0.520	936	0.514	925	1,541	-
35	0.472	991	0.467	981	1,798	-
40	0.432	1,037	0.427	1,025	2,054	-
45	0.398	1,075	0.394	1,064	2,311	-
50	0.370	1,110	0.366	1,098	2,568	-
55	0.345	1,139	0.341	1,125	2,825	-
60	0.323	1,163	0.320	1,152	3,082	-
65	0.304	1,186	0.301	1,174	3,338	-
70	0.287	1,205	0.284	1,193	3,595	-
75	0.272	1,224	0.269	1,211	3,852	-
80	0.259	1,243	0.256	1,229	4,109	-
85	0.247	1,260	0.244	1,244	4,366	-
90	0.236	1,274	0.233	1,258	4,622	-
95	0.225	1,283	0.223	1,271	4,879	-
100	0.216	1,296	0.214	1,284	5,136	-
105	0.208	1,310	0.205	1,292	5,393	-
110	0.200	1,320	0.198	1,307	5,650	-
115	0.192	1,325	0.190	1,311	5,906	-
120	0.186	1,339	0.184	1,325	6,163	-
125	0.179	1,343	0.177	1,328	6,420	-
130	0.174	1,357	0.172	1,342	6,677	-
135	0.168	1,361	0.166	1,345	6,934	-
140	0.163	1,369	0.161	1,352	7,190	-
145	0.158	1,375	0.156	1,357	7,447	-
150	0.153	1,377	0.152	1,368	7,704	-
155	0.149	1,386	0.148	1,376	7,961	-
160	0.145	1,392	0.144	1,382	8,218	-
165	0.141	1,396	0.140	1,386	8,474	-
170	0.138	1,408	0.136	1,387	8,731	-
175	0.134	1,407	0.133	1,397	8,988	-
180	0.131	1,415	0.130	1,404	9,245	-

Site 10 - Estimation of Snow Melt

Parameter	Jan	Feb	Mar	Apr	Dec	
Average Daily Melt Rate (mm/day) [1]	29.9	21.4	57.9	90.8	40.1	
Average Daily Melt Rate (mm/8 hours) [1]	6.9	4.8	12.4	12.8	6.7	(Assumes melt occurs during daylight hours)
Average Daily Volume of Melt (m^3/day)	68.9	47.5	123.5	128.3	66.5	(Includes only 0.22 ha asphalt snow melting pad)
Average Maximum Daily Rainfall (mm)	13.9	10.8	14.8	18.3	13.8	
Average Maximum Daily Rainfall (m^3)	211.0	164.4	225.2	277.4	210.0	
Regional Specific 90th Percentile Rainfall Volume (mm)	27					
Impervious Runoff (mm)	25					(27 mm subtract 2 mm depression storage)
Impervious Runoff (m^3)	350					
Pervious Runoff (mm)	5.2					(27 mm subtract 5 mm depression storage multiplied by 24%)
Pervious Runoff (m^3)	6.2					
Regional Specific 90th Percentile Rainfall Volume (mm)	23.4					
Regional Specific 90th Percentile Rainfall Volume (m^3)	356					
Daily Discharge Volume (mm)	30	28	36	36	30	
Total Discharge Volume (m^3)	425	404	480	484	423	

Melt Coefficient [2]: 3.8 $mm°C^{-1}day^{-1}$

Base Temperature [3]: 0 °C

Snowmelt Pavement Area: 1.00 ha *as of sept 5, 2023

Notes:

1. Temperature index method for estimating snow melt is based on $M = MC \times (T_{air}-T_{base})$.
2. Melt coefficient values typically vary between 2.8 and 3.8$mm°C^{-1}day^{-1}$.
3. Base temperature is assumed to be 0°C.
4. Average Orangeville, ON, Air Temperature in the Months of January, February, March, April, and December (2005-2015). Orangeville is within 10 km of the Subject Site.

Year	Maximum Daily Temperature (°C)					Maximum Daily Snowmelt Rate (mm/day)					Maximum Daily Rainfall (mm/day)				
	January	February	March	April	December	January	February	March	April	December	January	February	March	April	December
2005	14.5	8.0	16.0	26.5	4.0	55.1	30.4	60.8	100.7	15.2	13.0	16.0	9.8	18.0	14.9
2006	9.0	6.0	18.0	23.5	9.5	34.2	22.8	68.4	89.3	36.1	24.2	24.0	16.0	23.4	11.4
2007	12.0	4.0	19.5	24.0	8.5	45.6	15.2	74.1	91.2	32.3	6.0	0.0	5.0	23.2	23.0
2008	12.5	6.5	11.0	25.5	12.5	47.5	24.7	41.8	96.9	47.5	44.0	21.4	24.4	14.0	22.0
2009	1.0	8.0	14.0	-	9.5	3.8	30.4	53.2	-	36.1	2.4	12.0	19.0	-	17.2
2010	5.0	7.0	17.5	27.0	10.0	19.0	26.6	66.5	102.6	38.0	13.9	0.0	34.0	13.2	4.0
2011	1.5	10.0	12.5	21.0	12.0	5.7	38.0	47.5	79.8	45.6	0.0	16.0	19.0	16.2	12.8
2012	7.5	5.0	26.0	23.0	14.0	28.5	19.0	98.8	87.4	53.2	11.0	2.6	10.0	14.0	9.0
2013	13.0	5.0	13.0	24.5	12.0	49.4	19.0	49.4	93.1	45.6	20.2	3.0	16.8	21.0	12.3
2014	6.0	2.5	10.0	22.0	10.0	22.8	9.5	38.0	83.6	38.0	18.0	24.0	5.0	21.5	11.0
2015	4.5	-4.0	10.0	22.0	14.0	17.1	0.0	38.0	83.6	53.2	0.0	0.0	4.0	18.0	14.4
Minimum	1.0	-4.0	10.0	21.0	4.0	3.8	0.0	38.0	79.8	15.2	0.0	0.0	4.0	13.2	4.0
Average	7.9	5.3	15.2	23.9	10.5	29.9	21.4	57.9	90.8	40.1	13.9	10.8	14.8	18.3	13.8
Maximum	14.5	10.0	26.0	27.0	14.0	55.1	38.0	98.8	102.6	53.2	44.0	24.0	34.0	23.4	23.0

Notes:

1. Based on Orangeville, ON, historic climate data from 2005-2015.
2. No data for April 2009.

Site 10 - LID Design Requirements

Runoff Treatment Depth:	23.4	mm	(Based on runoff from 27 mm of rainfall, greater than maximum average
Rainfall Volume to be Treated:	356	m^3	historic rainfall in April)
Average Daily Snowmelt (8-Hour Duration:	12.8	mm	(Based on Average Daily Snow Melt, April)
Average Daily Snowmelt Volume to be Treated:	128	m^3	
Total Treatment Volume to be Treated:	484	m^3	Snow melt only as existing condition runoff went to minor system
100-Year Peak Flow Attenuation:	247	m^3	(Design to LID to 100-year runoff volume, more conservative)
100-Year Peak Flow Attenuation + Snow Melt Volume:	375	m^3	
Measure Infiltration Rate:	13	mm/hr	
Safety Factor:	2.5		
Infiltration Rate:	5	mm/hr	
LID Unit Length:	209	m	(Equivalent length calculated based on provided ponding volume)
Freeboard:	0.2	m	
Ponding Area Width:	3.00	m	
Surface Ponding Depth:	0.3	m	
Side Slope:	3	(x:1)	
Bottom Area:	627	m^2	
Top Area:	720	m^2	
Surface Ponding Volume:	202	m^3	
LID Ratio:	19		(Impervious Area to LID Area)
Filter Media Depth:	0.30	m	
Filter Media Bottom Width:	3.00	m	
Filter Media Surface Area:	627	m^2	
Filter Media Cross-Sectional Area:	0.90	m^2	
Filter Media Length:	209	m	
Total Volume:	188	m^3	(Volume of filter media envelope up to 0.30 m ponding depth)
Filter Media Porosity:	40%		(Volume of the Pore Volume divided by the Total Volume)
Void Ratio:	67%		(Volume of the Pore Volume divided by Solids Volume)
Filter Media Pore Volume:	75	m^3	
Filter Media Volume:	113	m^3	
Filter Bed Infiltration Rate [(2)]:	125	mm/hr	(Minimum filter media design infiltration rate)
Filterbed Drawdown Time:	2.4	hours	
Pea Gravel Choking Layer Depth:	0.10	m	
Pea Gravel Choking Layer Width:	3.00	m	
Pea Gravel Choking Layer Cross-Sectional Area:	0.30	m^2	
Pea Gravel Choking Layer Length:	209	m	
Total Gravel Choking Layer Volume:	63	m^3	
Pea Gravel Choking Layer Porosity:	40%		(Volume of the Pore Volume divided by the Total Volume)
Void Ratio:	67%		(Volume of the Pore Volume divided by Solids Volume)
Pea Gravel Choking Layer Pore Volume:	25	m^3	
Pea Gravel Choking Layer Media Volume:	38	m^3	
Stone Gallery Depth:	0.80	m	
Stone Gallery Width:	3.00	m	
Stone Gallery Cross-Sectional Area:	2.40	m^2	
Stone Gallery Length:	209	m	
Total Stone Gallery Volume:	502	m^3	
Stone Gallery Porosity:	40%		(Volume of the Pore Volume divided by the Total Volume)
Void Ratio:	67%		(Volume of the Pore Volume divided by Solids Volume)
Stone Gallery Pore Volume:	201	m^3	
Stone Gallery Media Volume:	301	m^3	
Native Soil Infiltration Rate:	5	mm/hr	
Drawdown Time:	154	hours	(72 hour maximum drawdown time)
Subdrain Offset:	1.00	m	
Subrain Size:	200	mm	(150 mm orifice cap at outlet)
Subdrain Slope:	1.00%		
Subdrain Length:	157	m	
Total Storage Volume:	**503**	m^3	(pore and ponding volume)
Total Depth	1.50	m	
Infilration Water Storage Depth:	0.78	m	
Draw down time:	150	hr	(underdrain required)