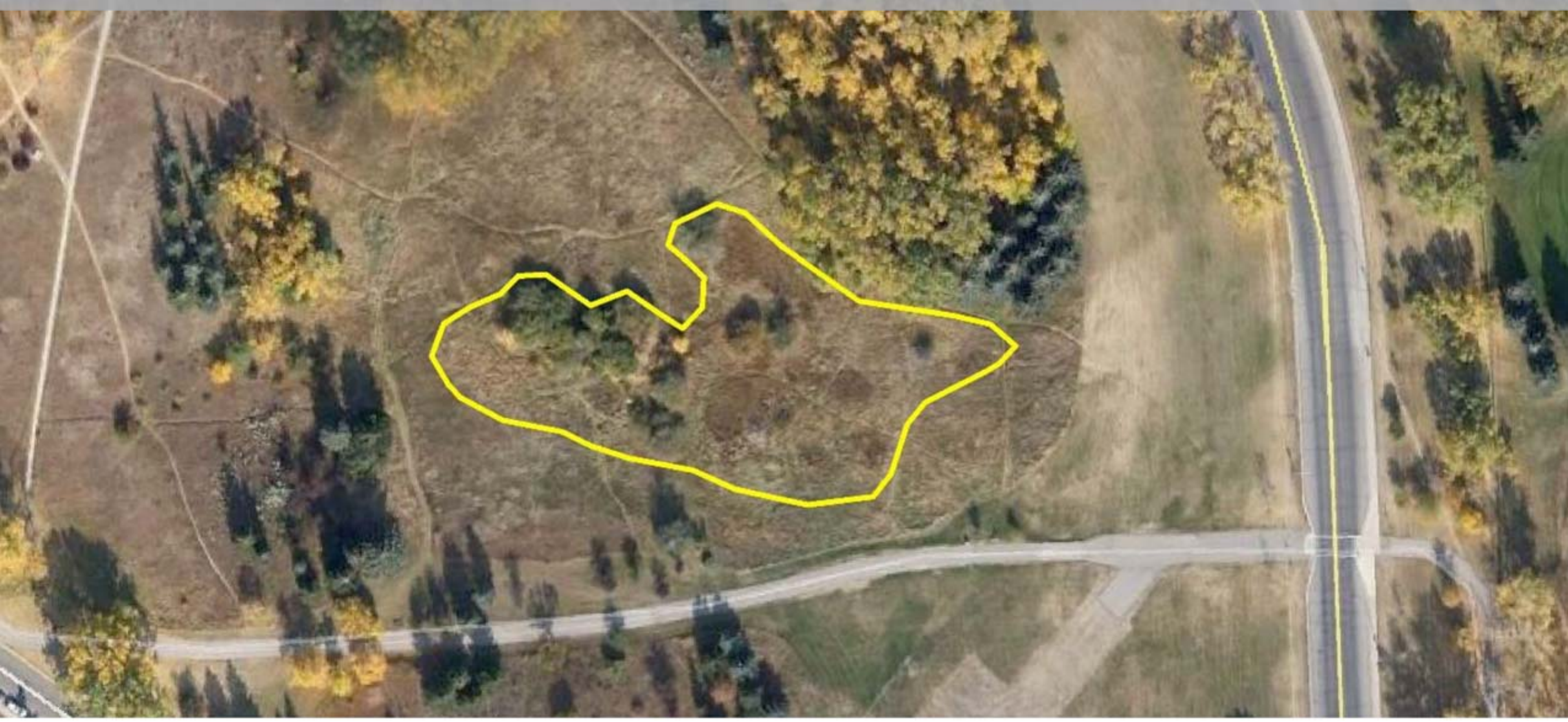
CITY OF CALGARY

canmore park

WETLAND FEASIBILITY STUDY



DRAFT

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1057.0111.00

March 1, 2017

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1.0 INTRODUCTION

1.1 Project Objective

Urban Systems Ltd. (Urban) was retained by the City of Calgary Parks to assess the feasibility of restoring a wetland in Canmore Park, which was significantly impacted by urban development. Urban partnered with Native Plant Solutions (NPS) to conduct the feasibility study with the objective to determine the extent and value of the wetland that exists today, how it can be restored to a higher functioning wetland, and develop and assess options and costs for the restoration of a wetland in Canmore Park. The study considered the impact that such a restoration would have on the existing park that surrounds the wetland and park users, as well as the ways in which the restored wetland can be integrated with the park use to provide an aesthetic amenity and opportunities for interaction and learning.

The initial phase of the investigation identified key factors that affect the feasibility of wetland restoration at the identified site. These are the necessity to re-contour the site so that the restored wetland can produce a hydroperiod and the possibility to augment the drainage area that currently drains through the identified site location to enhance the hydroperiod. The final phase of the investigation includes the assessment of options for restoration that produce an adequately functioning restored wetland.

The site location is shown on **Figure 1.**

1.2 Project Scope

The project scope was developed in discussions with the City of Calgary Parks, and is summarized below:

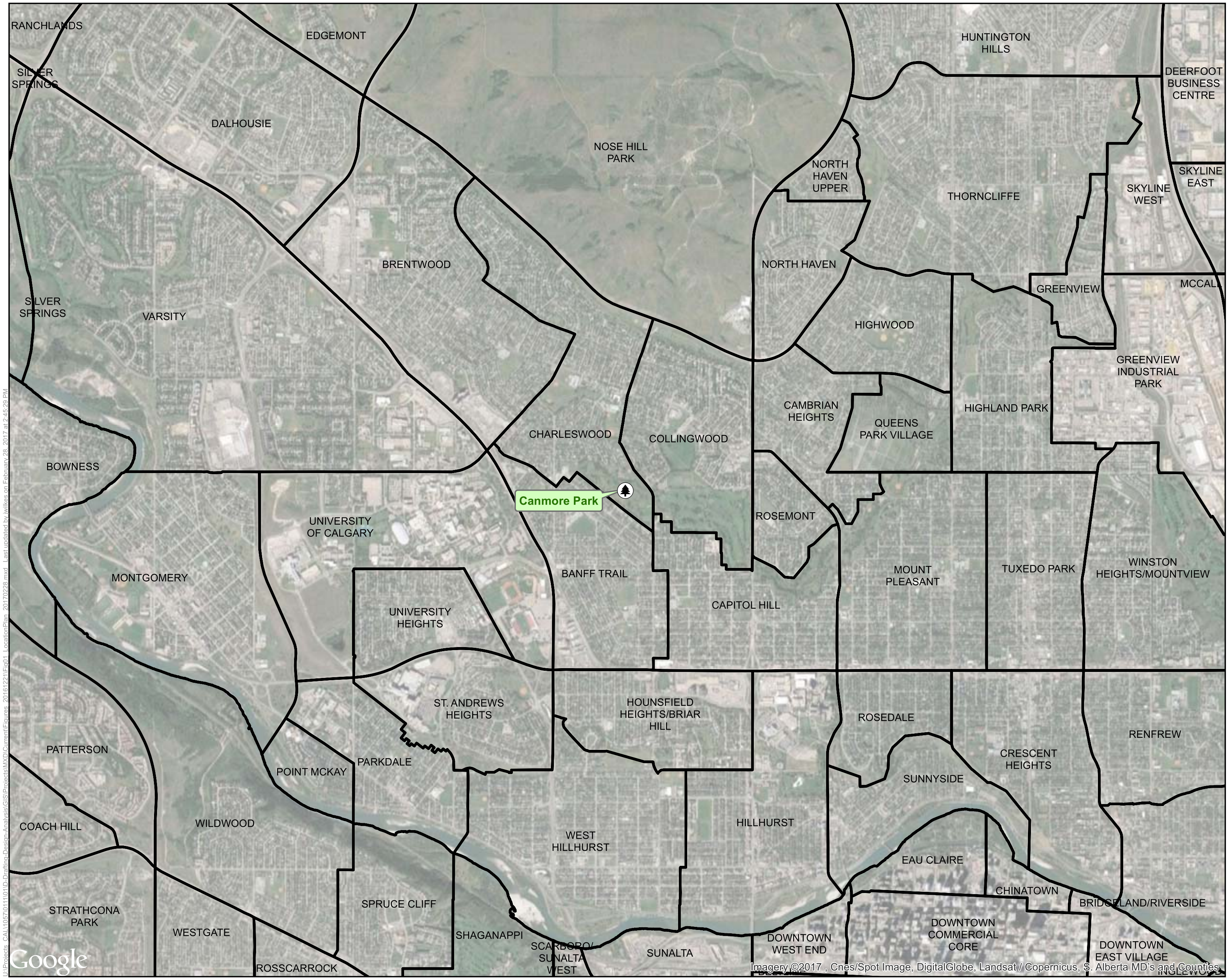
- Research and Document Historic and Existing Conditions - review all available aerial photography for the site, dating back to early 20th century, and identify the changes to the wetland and contributing area as development occurred in NW Calgary. Conduct soil sampling around the subject wetland to determine historic extent of previous wetland and establish current soil conditions, delineate the edge of historic wetland, obtain DTM data and other utility and surface features data from the City of Calgary for the study area, undertake topographical survey of the subject wetland area, classify the wetland, and document findings.
- Establish Desired Outcomes – review current City wetland policy documents and develop rationale for restoration of a wetland at this location.
- Assess Current Conditions – determine existing drainage area boundaries, hydrological characteristics, soil characteristics, conduct hydrological analysis at subject wetland site, identify park facilities and opportunities for integration of wetland with park, and document results.
- Develop and Evaluate Wetland Restoration Options – develop and document options for potential wetland restoration including options to increase wetland catchment area and re-contouring options for the subject wetland site. Present hydrological analysis and related wetland performance metrics. Based on results, indicate the nature of the wetland created through the restoration options in terms of frequency of inundation and likely plant types suited for the resulting wet pond.

- Assess Geotechnical Conditions – undertake desktop geotechnical investigation with the aim of determining whether groundwater flows into or out of the wetland basin or whether the level is relatively static.
- Stakeholder Engagement and Feedback – prepare information and presentation material for stakeholder meetings, discussion and engagement as well as a communication strategy related to stakeholder engagement.
- Prepare Wetland Restoration Feasibility Report.

1.3 Desired Outcomes

The intent of a wetland restoration should be to restore the wetland site to its pre-disturbance condition as best possible, ensuring that the naturally occurring “Class” type is maintained post-restoration. This may entail re-establishing native plant species that are no longer present either due to physical, biological or hydrological disturbances or disruptions. It may also require the re-establishment of the hydrology or hydroperiods originally experienced by the wetland of interest. In order to understand the requirements of the wetland it is imperative that the pre-existing condition of the disturbed site is established through a thorough investigation of the surrounding soils and existing vegetation. This information, coupled with a review of historical photos, and a hydrological modelling exercise based on watershed runoff characteristics, will help to establish what the restoration objectives of the wetland should be.

Integrating and maintaining a natural wetland in an urban landscape requires ingenuity, cooperation and strategic planning. Two important design considerations for maintaining a healthy wetland will be the timing of water and the volume of water the wetland receives. An additional design consideration is the need for certain wetland types, as is the case for the Canmore wetland, to go dry from time to time. As a result, the restoration objectives must take into consideration the original Class type of the Canmore Park wetland, the water depths required to support the vegetation communities previously present at this site, and a hydroperiod that matches the natural hydroperiod of the site pre-disturbance. The restoration design plan should also ensure that the wetland continues to function as intended with little to no intervention in future years following the restoration.



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Canmore Park

Location Plan

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Coordinate System: NAD 1983 3TM 114

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FIGURE 1

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2.0 EXISTING CONDITIONS INVESTIGATION

2.1 Site Description and Historical Assessment

Urban Systems visited the site on September 10, 2014 and again on October 20, 2014 to conduct the topographic surveys. A field survey of the delineated wetland edge in early September 2014 indicated that the wetland covers an area of 0.36 ha, or 3600 m^2. The results of the survey also indicate that the area slopes from west to east, and does not exhibit a depression where water may have accumulated or pooled in the past. The site visit also identified a shallow surface ditch which runs in an east west direction to the edge of the mowed grass (**Figure 2**) and was identified on the stormwater infrastructure layer provided by the City of Calgary (**Figure 4**). The background information review did not reveal when this ditch was created, and if it is effective at draining the wetland.

Close examination of 21 historical aerial photographs beginning in 1948 and ending in 2013 did not reveal any photos that showed signs of a seasonal wetland in an open water state. This indicates that this wetland is historically covered with seasonal shallow wetland plant communities in almost all years. This is especially evident in 1955 (**Figure 3**), when almost all other wetlands in the area exhibit open water. This demonstrates that the Canmore Park wetland never holds water long enough, and deep enough, to create an open water area. As described in the following section, the hydrological modelling produced results that were consistent with the absence of open water associated with this wetland.

Furthermore, the aerial photo from 1966 shows what appears to be an underdrain system, which is typical of systems designed to drain wet and low lying areas (**Figure 4**). The aerial photo evidence was consistent with the historic context provided by Michelle Reid, a historical resources expert with the City of Calgary, who had advised that the area was modified in the lead up to the Canadian Confederation celebrations in 1967. It is not known if this underdrain system is connected to the underground storm sewer, or if it is still functional. The presence of wetland plant communities in certain locations within the Canmore wetland, but absent in other locations on site could indicate that portions of this underdrain system may still be functional.

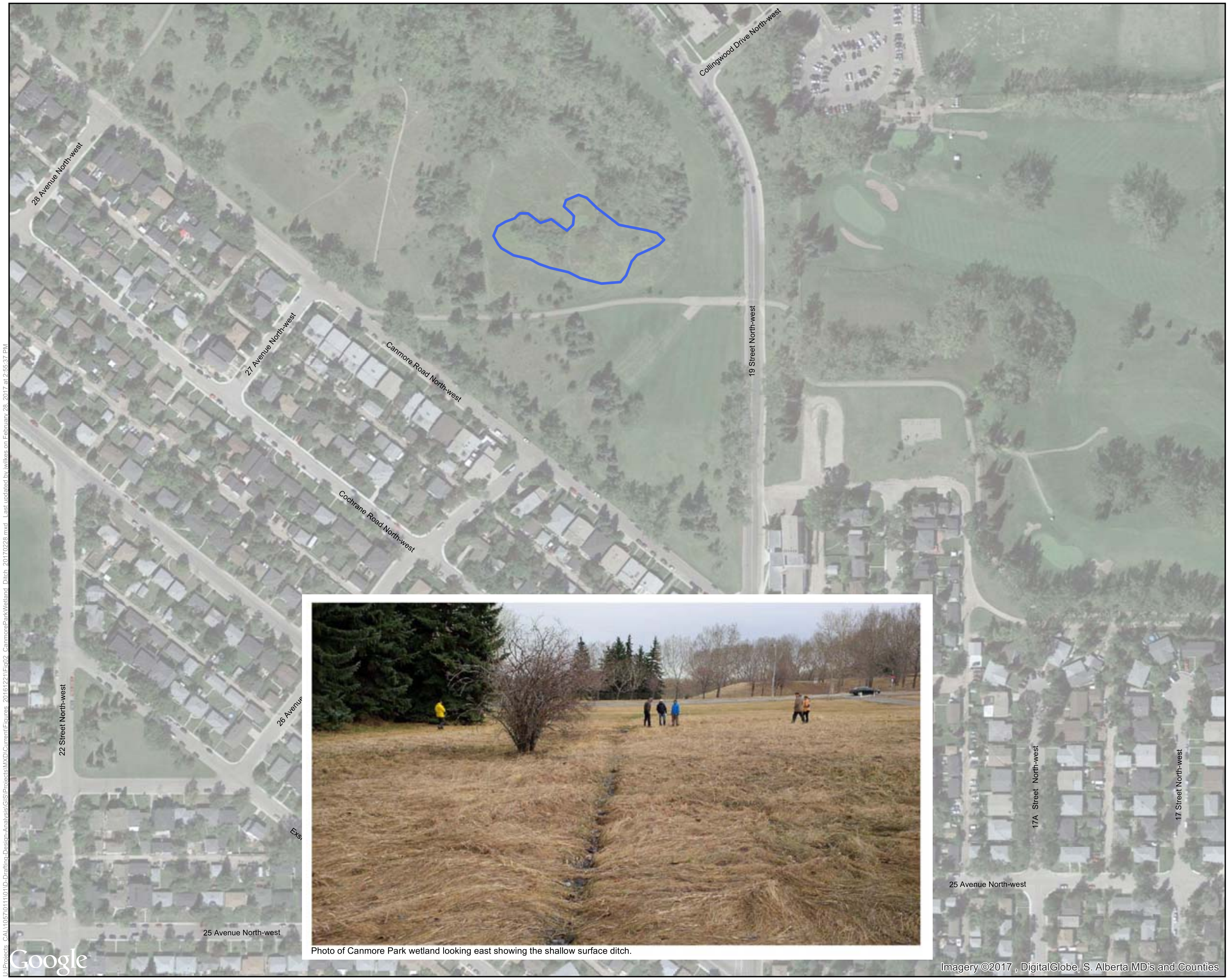

Photo of Canmore Park wetland looking east showing the shallow surface ditch.

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Canmore Park

Wetland and Ditch

Legend

Canmore Park Wetland

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20 10 0 20 40
Metres

Coordinate System: NAD 1983 3TM 114

Scale: 1:2,500

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FIGURE 2

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Historical Aerial Photography (1955)

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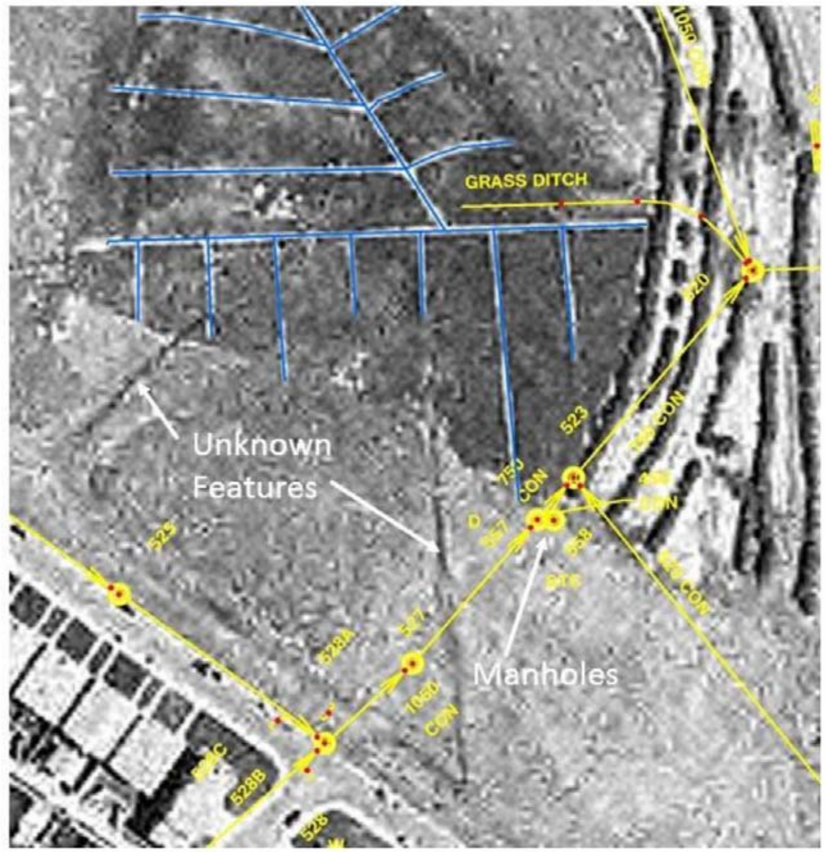
FIGURE 3



Left panel: Aerial photo of Canmore Park in 1966 showing the presence of tile drains in the wetland area. Right panel: a zoomed in view of the drains (highlighted in blue) in relation to stormwater infrastructure (yellow), note unknown features extending to the south and southwest.

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Canmore Park

Historical Aerial Photography (1966) and Stormwater Infrastructure

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FIGURE 4

2.2 Soil Assessment and Wetland Classification

As a first step to determining the feasibility of restoring the Canmore Park wetland, a site visit to conduct physical/biological investigation and description of the wetland was conducted. Native Plant Solutions visited the site on September 8 to 10, 2014, to conduct soil and vegetation surveys. Based on presence or absence of wetland soil characteristics and location of vegetation communities, the edge of the wetland was delineated (**Figure 2**) and represents the edge of the wetland historically. As a result of the field investigation the Canmore wetland is classified as a **Class III** wetland, cover type of 1 (Stewart and Kantrud 1971). Various wetland vegetation communities were identified, including cattails (Typha latifolia), sedges (Carex atherodes), rushes (Juncus arcticus), and willows (Salix lutia, and Salix bebbiana).

In addition to the willows present, additional tree species in the wetland included Manitoba Maple (Acer negundo) and chokecherry (Prunus virginiana). Areas dominated by sedge were also mixed with a variety of other species including Poa spp., Silverweed (Potentilla anserine), Water Smartweed (Polygonum amphibium) and Aster spp.

Soils in and around the wetland were examined for characteristics indicating the presence of wetland soils (reactivity and mottling) and to help further verify the hydrological edge of the wetland. Soils in the area have a textural class of sandy clay loam or sandy loam. Twenty-one soil pits were dug and the depths of horizons, presence of mottling, soil colour and reactivity were measured and documented. Six soil samples were sent to the lab to further verify field results. All the soil pits had an upper Ah horizon and a C horizon (with either Cca, or Ck or both), or a Bm horizon. All soils surveyed within the delineated wetland had a Cca horizon present, mottling of the Cca soils, and a moderate to strong reactivity of soil carbonates when tested with dilute hydrochloric acid. These soil attributes also verify the soil characteristics of a **Class III** seasonal wetland habitat.

City of Calgary

Canmore Park

Scenario 1 - Block Grass Ditch

Plan View and Preliminary Results

Legend

- Catchbasin
- Manhole
- Berm (Top Elevation 1088m)
- Grass Ditch
- Storm Pipelines
- Wetland Boundary
- Contours (City of Calgary)
- Drainage Boundary (3.5 ha)
- Maximum Modeled Depth (1088m) Surface Area: 345m²
- Average Modeled Depth (1087.7m) Surface Area: 50m²

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FIGURE 5

2.3 Geotechnical Investigation

McIntosh Lalani Engineering completed a desktop geotechnical investigation in order to determine probable soil and groundwater conditions at the site and to provide general geotechnical information for the wetland restoration. The geotechnical report is enclosed as **Appendix A**. As stated in the report, the available data from nearby areas has recorded water levels from 6.06 to 16.95 meters below grade at the time of borehole drilling. Based on similarities with nearby sites where field geotechnical information was completed, it is reasonable to expect that the stratigraphy of the Canmore Park wetland site should be characterized by fine grained sediments.

A field geotechnical investigation should be completed as part of the preliminary design stage, to confirm soil stratigraphy and presence or absence of shallow groundwater.

3.0 PRELIMINARY HYDROLOGIC ASSESSMENT

3.1 Model Development

Urban Systems conducted the hydrological assessment of the wetland site and developed the wetland hydroperiod, based on the topographical survey and soils information acquired during the site investigation phase and the information provided by the City of Calgary. Based on the existing contours, the delineated catchment area of the wetland is approximately 3.5 ha. It is important to note that, as a result of urban development, the existing catchment is likely significantly smaller than the actual pre-development catchment. The extent of the actual pre-development catchment cannot be ascertained based on the available data.

A continuous simulation model, the Water Balance Spreadsheet for the City of Calgary (WBSCC, Version 1.2), was utilized to assess the hydrological response of the catchment and wetland site. The model has 51 years of built in climate data provided by the City of Calgary, which includes precipitation, temperature, evaporation and evapotranspiration rates. The WBSCC models the water balance seasonally, considers the accumulation of runoff resulting from precipitation events, and tabulates on-site water storage balances with consideration of all natural processes (evaporation, evapotranspiration, and seepage) as defined by the user input. Snow accumulation is accounted for while snowmelt computation is triggered only when temperatures rise above zero degrees Celsius. The model produces daily time step results and runoff volumes. It also accounts for seasonal variations in infiltration rates.

3.2 Model Scenarios

Since the wetland site is on a continuous slope draining west to east, under the existing conditions there is no water ponding in the wetland. In order to create a ponding area or a depression for storage of water, a vertical wall mimicking a berm was modeled along the east catchment boundary near the lowest elevation of the wetland. The potential ponding of water, modeled with the WBSCC, would collect closest to the berm on the downstream end of the sloping wetland site. This is shown on **Figures 5 and 6.** The berm restricts the overland runoff and provides an option to impound water west of the ditch where a manhole is located close to the road.

Two berm heights were modeled for three preliminary model scenarios, described in the following Table.

Table 1 Water Balance Model Scenario Descriptions and Assumptions

	Scenario Description	Catchment Description and Assumptions
Scenario 1	Model iteration is based on potentially blocking a shallow ditch in the area. Berm height of approximately 0.3m is assumed.	See **Figure 5**. Park area catchment is 3.5 ha, and includes some pathways. Low imperviousness. Berm is modeled as vertical wall with top elevation of 1088m.
Scenario 2	Model iteration is based on attenuating maximum volume of storage available for available catchment area. This is the best case scenario at this stage of the feasibility assessment.	See **Figure 6**. Park area catchment is 3.5 ha, and includes some pathways. Low imperviousness. Berm is modeled as vertical wall with top elevation of 1089.5m.
Scenario 3 (Hypothetical)	Model iteration based on optimizing catchment area for an idealized wetland that on average annually fills up to the 1089m contour with open water. This represents an optimal annual average wetland water depth or hydroperiod cycle that could support important habitat features.	Assumed that 16 ha of Canmore Park area can be rerouted to drain overland to the wetland site. Approximately, this includes the entire park area (the existing 3.5 ha catchment, pathways, tennis court, baseball diamond, and a building). Assumed 30% overall imperviousness. An additional catchment area of 0.5 ha of hypothetical post-development urban catchment is assumed to be redirected to drain overland through the park to the wetland site. The hypothetical post-development urban area is assumed to have 60% overall imperviousness.

Scenario 2 represents the largest potential wetland that could be restored and supported by the potentially available drainage area to the wetland site.

3.3 Model Results

Model results for the scenarios described in Section 3.2 are presented in **Table 2**. The model input and output files and hydroperiod graphs are in **Appendix B**.

Table 2 WBSCC Model Results

				Maximum Wetland Results			Average Wetland Results		
	Catchment Area (ha)	Low Point (m)	Top of Berm Elev. (m)	Elev. (m)	Volume (m^3)	Surface Area (m^2)	Elev. (m)	Volume (m^3)	Surface Area (m^2)
Scenario 1	3.5	1087.7	1088.0	1088.0	50	350	1087.7	5	50
Scenario 2	3.5	1087.7	1089.5	1089.0	1990	3660	1088.2	200	830
Scenario 3 (Hypothetical)	16.5	1087.7	1089.5	1089.5	4300	5380	1089.1	2700	4200

As shown on **Figure 5**, Scenario 1 results in a very small average wetland surface area, about 50 m^2, and would be considered negligible. The Scenario 2 (**Figure 6**) results indicated an average wetland area of about 830 m^2 resulting from an average water volume of 200 m^3. Although still relatively small, this is the best case scenario based on the 3.5 ha area which currently drains to the wetland. For Scenario 2, the maximum inundation elevation is potentially 1089.0 m with an approximate surface area of 3660 m^2. However, on average, the footprint of the ponded area would only cover a small portion of the delineated wetland.

For this wetland to be sustained in the long term, more consistent water levels would be desirable over a larger area of the existing delineated wetland soil area. In order to achieve this, it would be necessary to re-grade the upstream catchment area and increase the overall stormwater catchment of the wetland in order to provide a larger volume of runoff to be supplied to the wetland. A hypothetical model (Scenario 3) was run on this premise, and the results indicated that a catchment area of about 16.5 ha, approximately five times larger than the existing catchment, would be required to support a larger open water area that covers a more significant portion of the delineated wetland.

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Scenario 2 - Inundate Full Wetland Extent

Plan View and Preliminary Results

Legend

- Catchbasin
- Manhole
- Berm (Top Elevation 1089.5m)
- Grass Ditch
- Storm Pipelines
- Wetland Boundary
- Contours (City of Calgary)
- Drainage Boundary (3.5 ha)
- Wetland Boundary (1089.5m)
- Maximum Modeled Depth (1089m) Surface Area: 3,660m²
- Average Modeled Depth (1088m) Surface Area: 345m²

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Metres

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Coordinate System: NAD 1983 3TM 114

Scale: 1:1,250

Data Sources:
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FIGURE 6

4.0 WETLAND RESTORATION OPTIONS

4.1 Current Challenges for Wetland Restoration

The preliminary restoration scenarios (described in Section 3) indicate that under the existing conditions, the site cannot support a restored wetland. The challenges are the continuous grade of the site that does not allow ponding of surface runoff, and a small drainage area that cannot adequately sustain a wetland hydroperiod.

The presence of the tile drains further complicates the successful restoration of the wetland within what would have been its historical footprint. It is unknown whether the drains are still functional and to what extent. The tile drains would need to be decommissioned for any amount of water to be maintained and held in the wetland. The decommissioning (locating and removing or plugging) of the drains would be a cost in addition to the cost of regrading and building the berm.

In terms of the Canmore Park wetland restoration, the combination of tile drains with the continuous and relatively steep grades challenges the ability to restore this location using conventional wetland restoration techniques that are used in more typical landscapes. In those situations, as long as a historical drainage network still flows to an impacted site or an alternative water source can be provided, wetland restoration typically only requires a minor intervention (such as a ditch plug) to restore the wetland's hydrology. This approach is fairly straightforward and once the hydrology is restored to the wetland then wetland plants often germinate naturally from the existing wetland seedbank still present in the topsoil.

For the Canmore Park location, this approach is not an option because of the grading and the tile drains, both of which have affected the location and distribution of wetland plants and the soil seedbank across the site over time, in addition to the site's ability to hold back water naturally. With no current ability to hold water back on this site restoration at this site due to those two factors, restoration is not possible in its present state. Therefore, using conventional restoration techniques to encourage the natural re-establishment of wetland vegetation at this site is not possible without addressing the grades, the tile drains and our ability to hold back water.

4.2 Community Engagement

The City of Calgary held a public engagement session on August 8, 2015. The session was attended by 84 residents on neighboring communities. The City's experts were available during the session to discuss the project and provide background information. In addition, an online survey was conducted between August 5 and September 2, 2015. The City received 104 responses to this survey.

The main questions asked during the engagement process were:

- How the community uses Canmore Park, and would wetland restoration impact the park use;
- What is the level of agreement with the plan to restore the wetland; and
- In addition to restoring the biophysical function, what other things should be considered (historic, aesthetic, environmental, etc.)

Overall, there was a large sense of support and enthusiasm within the community for restoring the wetland. Some of the themes that demonstrated support for the project include:

- Natural areas like wetlands are important and support wildlife (plants and animals) which is beneficial. Participants exhibited a general sense of support based on the sentiment that wetlands are important for nature, natural water systems, and biodiversity.
- A wetland will not impact how most people say they use the park. Some are even willing to change how they use the park to support the wetland and some say with a wetland they'd use the park more.
- Wetlands make for beautiful and aesthetically pleasing places to enjoy. Leisure use in the park, particularly around the wetland, would be an added benefit.
- There is an educational importance of wetlands. Many people made suggestions that visitors should have the opportunity to learn (e.g. programs, signage, boardwalks, class visits).
- The preservation of natural areas was a prominent theme. 'Going back to what was naturally there', and preserving nature within urban settings were related themes Many participants offered general support through a variety of comments such as "nice idea", "about time" or "it will be a nicer area".

Some participants expressed concerns about restoring the wetland. Very few were wholly opposed, though some were. Some of the themes that demonstrated concern or opposition to the project include:

- Concerns and questions around increased mosquitoes as a result of the wetland. Concerns included the potential for mosquitoes to impact children playing at the spray park
- General concerns regarding the prioritization of tax dollars.
- A small number of participants believed the money could be spent better elsewhere. Some of these comments demonstrated a general distrust of City projects.

Overall, the community was for most part supportive of wetland restoration initiative and how the wetland would be integrated within the existing high-use park. Concerns related to restoration costs and presence of open water were noted, and considered during the development and assessment of restoration options.

Summary of the community engagement process is presented in **Appendix D**.

4.3 Description of Proposed Restoration Options

As described in Section 3.0, three preliminary scenarios were analysed for restoration of Canmore Park wetland. These scenarios were modeled to verify the maximum depth of ponding that could be achieved with the current site drainage boundaries and the berm construction.

Due to the existing site topography, the depth of ponded water would need to reach 1.5m or higher to reach the perimeter of the wetland zone, as delineated based on the presence of wetland plants and soils. This depth of water would not naturally occur in a Class III wetland. In addition, even with a high berm (Scenario 2) and deep ponded water, the resulting restored wetland area would not match the delineated wetland area.

Based on the findings of the preliminary assessment, and in consultation with the City of Calgary, the project team determined that further restorations options should be explored. These additional options include re-contouring of the study area, and finding alternative sources of make-up water for the wetland.

The overall goal of the re-contouring exercise would be to restore a wetland in the area where existing wetland soils were delineated and to promote a maximum normal water level of 0.5m, which is a depth much more reflective of what would naturally occur in a Class III wetland during spring conditions. This also requires the investigation of options to capture more storm water through the wetland study area in order to achieve an acceptable hydroperiod.

The description of potential restoration options and the associated costs are presented below.

Option 1 – Onsite Shallow Berm, no Park or Wetland Re-contouring

This option was reviewed in the initial stages of the feasibility assessment (Scenario 1 in Section 3.2). As indicated on **Figure 5**, it includes blocking the existing ditch and constructing a shallow berm (0.3 m height) to create a ponding area and some storage. This is the scenario that was presented to the community during the City's Open House in August 2015.

The preliminary estimated cost of this option is shown in **Table 3.** While this design has the lowest cost implication, the benefit to the City and the community is also very low. The average wetland surface area would be very small, about 50 m2, with an average volume of only 5 m3.

Table 3: Preliminary Cost Estimate - Option 1

Component	Quantity	Unit	Unit Price	Cost
General Items				
Mobilization	1.0	LS	$ 5,000	$ 5,000.00
Erosion and Sediment Control Measures	1.0	LS	$ 2,000	$ 2,000.00
Geotechnical Investigation	1.0	LS	$ 3,000	$ 3,000.00
Subtotal General				**$ 10,000.00**
Berm				
Stripping of Topsoil	420	m^3	$ 3.00	$ 1,260.00
Bulk Fill (Supply, Trucking, Grading & Compaction)	200	m^3	$ 15.00	$ 3,000.00
Topsoil Replacement	420	m^3	$ 3.00	$ 1,260.00
Drill Seeding of Native Grasses and 3-yr Maintenance	1,400	m^2	$ 4.00	$ 5,600.00
Block Main Underdrain	1.0	LS	$ 2,000.00	$ 2,000.00
Subtotal Berm				**$ 13,120.00**
Subtotal Construction Costs				**$ 23,120.00**
25% Contingency	25%			$ 5,780.00
Subtotal Construction and Contingency Costs				**$ 28,900.00**
15% Engineering	20%			$ 4,335.00
TOTAL PRELIMINARY COST[1]				**$ 33,235.00**

[1] Units per meter developed from experience in transportation and land development projects. Prices and quantities subject to change and detailed design completion.

Option 2 – Storm Pipe Diversion and Wetland Re-contouring

This option includes the diversion of storm flows from the pipe system in the community adjacent to Canmore Park, and the re-contouring of the wetland to better match the footprint delineated during the initial site investigation. The option is shown on **Figure 7**. Flow diversion can ensure that adequate volume of water is available to sustain the wetland hydroperiod, however if this option is chosen, further analysis at the preliminary design stage would be necessary. The analysis would need to include a hydrological assessment of the surrounding community in order to assess the available pipe flows for various design storms at the proposed diversion location.

The preliminary (Class C) cost estimate for Option 2 is presented in **Table 4**. The largest costs incurred in Option 2 are due to re-contouring the wetland area. A cut/fill estimate was calculated using GIS and is indicated in the quantities in **Table 4**. To reduce the construction cost, onsite use of excess dirt is proposed. The exact quantities and placement of excess dirt will need to be determined at the preliminary design stage. It is important to ensure that drainage boundaries are not altered by placing of excess dirt on the site.

The preliminary estimated cost for Option 2 is $680,900. A post-construction cost of $50,000 should also be included and it covers the cost of the restored wetlands' first two years of plant growth, site commissioning, weed control and a management manual for the wetland site.

There are several assumptions made in the preparation of the cost estimate:

- A 300mm pipe was assumed, but it may not be the ultimate size of the pipe required for the proposed Option 2 storm pipe diversion. It is a reasonable estimate at the feasibility stage, but further hydraulic and hydrological analysis is required to confirm.
- The earth balance can be appropriately distributed in the park area and not trucked offsite. As discussed earlier in this section, this will need to be confirmed at the preliminary design stage.
- Separate stock piles are required for the wetland soils, topsoil in other disturbed areas, and other cut/fill soils. This is included in the preliminary cost estimate unit costs.
- An emergency spillway was not designed as part of the feasibility study. At this stage, it was assumed that a matted/vegetated spillway on top of the berm would be adequate for the design. Consultation with Water Resources and confirmation of the capacity of the downstream catch basin system and overland spill route may be required at the preliminary and/or detailed design approval stage.
- Potential tile drains below the wetland restoration site can be plugged during the re-contouring process. An added cost is not proposed at this time as decommission is possible in the earthworks process and cost. Further analysis at the preliminary and/or detailed design stages along with appropriate geotechnical work to confirm the drain locations and functionality may be required.

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Restored Wetland Option 2

Legend

- Catchbasin
- Manhole
- Contours
- Storm Mains
- Grass Ditch
- Berm (Top Elevation 1089m)
- Proposed Storm Diversion
- Wetland Boundary (Proposed)
- Historic Wetland Soils Boundary
- Catchment

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10 5 0 10 20
Metres

Coordinate System: NAD 1983 3TM 114

Scale: 1:2,000

Data Sources:
- Imagery and contours courtesy of the City of Calgary

Project #: 1057.0111.01
Author: JW
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FIGURE 7

Table 4: Preliminary Cost Estimate - Option 2

Component	Quantity	Unit	Unit Price	Cost
General Items				
Mobilization/Demobilization	1.0	LS	$30,000	$30,000
Access	1.0	LS	$10,000	$10,000
Erosion and Sediment Control	1.0	LS	$20,000	$20,000
Care of Water	1.0	LS	$30,000	$30,000
Existing Vegetation Removal	1.0	LS	$20,000	$20,000
Traffic accommodation	1.0	LS	$20,000	$20,000
Subtotal General				**$130,000**
Stormwater Underground				
300mm PVC Pipe (bedding, trench, pipe, backfill & compaction)	35	m	$260.00	$9,100
Manhole Removal	1.0	Unit	$3,000.00	$3,000
New 1-S Manhole (1.2x1.2)	1.0	Unit	$6,600.00	$6,600
Outfall/pipe daylight structure (incl. 5m Riprap channel)	1.0	LS	$10,000.00	$10,000
ICD Plate/Catch Basin Hood	1.0	LS	$800.00	$800
OGS	1.0	LS	$30,000.00	$30,000
Subtotal Stormwater Underground				**$59,500**
Site Re-contouring				
Site Prep	11,900	m^2	$1.00	$11,900
Wetland Soils Removal/Storage	1,080	m^3	$5.00	$5,400
Topsoil Removal/Storage on Site	2,070	m^3	$5.00	$10,350
Cut & Fill	3,650	m^3	$20.00	$73,000
Re-establish wetland and native grass species	6,900	m^2	$12.00	$82,800
Pathway removal/reconstruction	215.0	m^2	$75.00	$16,125
Subtotal Site Re-contouring				**$199,575**
Wetland Restoration				
Wetland soils redepositing	1,080	m^3	$5.00	$5,400
Wetland plants replanting	5,200	m^2	$12.00	$62,400
Subtotal Wetland Restoration				**$67,800**
Berm				
Slope/Surface Preparation with onsite topsoil	900	m^2	$5.00	$4,500
Native Grass seeding	900	m^2	$12.00	$10,800
Impermeable Internal Wall/Liner	150	m^2	$10.00	$1,500
Subtotal Berm				**$16,800**
Subtotal Costs				**$473,675**
25% Contingency	30%			$ 118,418
15% Engineering	15%			$ 88,814
TOTAL PRELIMINARY COST				**$ 680,903**

Option 3 – Park Regrading to Increase the Catchment Area and Wetland Re-contouring

This option includes limited regrading of park area to create a shallow swale north of the wetland that would direct the majority of park drainage to the wetland, and the re-contouring of the wetland to better match the footprint delineated during the initial site investigation. This option is shown on **Figure 8**. Minimal impact to the park function is expected in this re-contoured design, as most of the existing pathways would remain intact. This re-contoured wetland design includes a berm to create a ponding area of 0.5m. As with the previous option, the excess dirt can be used onsite to reduce construction cost.

There are several assumptions in the option assessment and the preparation of the cost estimates:

- The re-contoured shallow swale should be replanted with native grasses and any other wetland buffer zone species to encourage enhancement of the water quality entering the restored wetland open water zone.
- Separate stock piles are required for the wetland soils, topsoil in other disturbed areas, and other cut/fill soils. This is included in the preliminary cost estimate unit costs.
- Special attention to the west buffer zone grading will be required for the preliminary and/or detailed design stage. The preferred side slopes for the approximately 20m wide buffer zone around the restored wetland are 7:1. Currently, the slopes are assumed to be 3:1 on the west side of the wetland site. Benching and/or retaining walls may be required to meet the buffer zone side slopes in this location. Special considerations for plantings in the 3:1 buffer zone on the west side of the restored wetland may be required and need to be included in the preliminary and/or detailed design stage, to avoid higher costs related to retaining walls and other slope protection measures.
- An emergency spillway was not designed at the feasibility stage. It was assumed that a matted/vegetated spillway on top of the berm would be adequate for the design. Consultation with Water Resources and confirmation of the capacity of the downstream catch basin system and overland spill route may be required at the preliminary and/or detailed design approval stage.
- Potential tile drains below the wetland restoration site can be plugged during the re-contouring process. Further analysis at the preliminary and/or detailed design stages along with appropriate geotechnical work to confirm the drain locations and functionality may be required.

The preliminary (Class C) cost estimate for the proposed restored wetland plan is summarized in Table 5. In addition to the preliminary estimated cost of $771,000, a post-construction cost of $50,000 needs to be included. This covers the cost of the restored wetland's first two years of plant growth, site commissioning, weed control, and a wetland management manual.

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Canmore Park

Restored Wetland Option 3

Legend

- Catchbasin
- Manhole
- Contours
- Storm Mains
- Grass Ditch
- Berm (Top Elevation 1089m)
- Proposed Storm Diversion
- Wetland Boundary (Proposed)
- Disturbed Area
- Historic Wetland Soils Boundary
- Catchment

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20 10 0 20 40
Metres

N

Coordinate System: NAD 1983 3TM 114

Scale: 1:2,500

Data Sources:
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FIGURE 8

Table 5: Preliminary Cost - Option 3

Component	Quantity	Unit	Unit Price	Cost
General Items				
Mobilization/Demobilization	1.0	LS	$ 30,000	$ 30,000
Access	1.0	LS	$ 10,000	$ 10,000
Erosion and Sediment Control	1.0	LS	$ 20,000	$ 20,000
Care of Water	1.0	LS	$ 30,000	$ 30,000
Existing Vegetation Removal	1.0	LS	$ 50,000	$ 50,000
Traffic accommodation	1.0	LS	$ 20,000	$ 20,000
Subtotal General				**$ 160,000**
Site Re-contouring				
Site Prep	17,300	m^2	$ 1.00	$ 17,300
Wetland Soils Removal/Storage	1,080	m^3	$ 5.00	$ 5,400
Topsoil Removal/Storage on Site	3,630	m^3	$ 5.00	$ 18,150
Cut & Fill (sod - regrading)	4,500	m^3	$ 20.00	$ 90,000
Re-establish wetland and native grass species	12,100	m^2	$ 12.00	$ 145,200
Pathway removal/reconstruction	215.0	m^2	$ 75.00	$ 16,125
Subtotal Site Re-contouring				**$ 292,175**
Wetland Restoration				
Wetland soils redepositing	1,080	m^3	$ 5.00	$ 5,400
Wetland Plants Replanting[2]	5,200	m^2	$ 12.00	$ 62,400
Subtotal Wetland Restoration				**$ 67,800**
Berm				
Slope/Surface Preparation with onsite topsoil	900	m^2	$ 5.00	$ 4,500
Native Grass seeding	900	m^2	$ 12.00	$ 10,800
Impermeable Internal Wall/Liner	150	m^2	$ 10.00	$ 1,500
Subtotal Berm				**$ 16,800**
Subtotal Costs				**$ 536,775**
25% Contingency	30%			$ 134,193
15% Engineering	15%			$ 100,645
TOTAL PRELIMINARY COST				**$ 771,613**

Option 4 – Wetland Re-contouring, no Park Regrading or Alternative Water Supply

This option utilizes the re-contoured wetland proposed in Option 3, without additional park regrading to increase the surface drainage area to the wetland, or alternative water supply option such as storm flow diversion. The only wetland water source is the existing catchment area of 3.5ha. This option is shown on **Figures 9 and 10**. The proposed typical cross section of the re-contoured and restored wetland is shown on **Figure 11**. As with the previous option, minimal impact to the park function is expected and most of the existing pathways would remain intact. The assumptions used in the option assessment and the preparation of cost estimates are the same as in previous options, and are presented here for easy reference:

- Separate stock piles are required for the wetland soils, topsoil in other disturbed areas, and other cut/fill soils. This is included in the preliminary cost estimate unit costs.
- Special attention to the west buffer zone grading will be required for the preliminary and/or detailed design stage. The preferred side slopes for the approximately 20m wide buffer zone around the restored wetland are 7:1. Currently, the slopes are assumed to be 3:1 on the west side of the wetland site. Benching and/or retaining walls may be required to meet the buffer zone side slopes in this location. Special considerations for plantings in the 3:1 buffer zone on the west side of the restored wetland may be required and need to be included in the preliminary and/or detailed design stage, to avoid higher costs related to retaining walls and other slope protection measures.
- An emergency spillway was not designed at the feasibility stage. It was assumed that a matted/vegetated spillway on top of the berm would be adequate for the design. Consultation with Water Resources and confirmation of the capacity of the downstream catch basin system and overland spill route may be required at the preliminary and/or detailed design approval stage.
- Potential tile drains below the wetland restoration site can be plugged during the re-contouring process. Further analysis at the preliminary and/or detailed design stages along with appropriate geotechnical work to confirm the drain locations and functionality may be required.

The preliminary (Class C) cost estimate for the proposed restored wetland plan is summarized in **Table 6**. In addition to the preliminary estimated cost of $595,000, a post-construction cost of $50,000 needs to be included. This covers the cost of the restored wetland's first two years of plant growth, site commissioning, weed control, and a wetland management manual.

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Canmore Park

Restored Wetland Option 4

Legend

- Catchbasin
- Manhole
- Contours
- Storm Mains
- Grass Ditch
- Berm (Top Elevation 1089m)
- Proposed Storm Diversion
- Wetland Boundary (Proposed)
- Disturbed Area
- Historic Wetland Soils Boundary
- Catchment

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20 10 0 20 40
Metres

Coordinate System: NAD 1983 3TM 114

Scale: 1:2,500

Data Sources:
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FIGURE 9

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Canmore Park

Restored Wetland Option 4
Site Plan

Legend

- Contours
- Wetland Boundary - 1,089m (Proposed)
- Historic Wetland Soils Boundary
- Area of Extra Grading Consideration
- Berm 5:1 Slope
- Berm Top
- Disturbed Area

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10 5 0 10 20
Metres

N

Coordinate System: NAD 1983 3TM 114

Scale: 1:1,250

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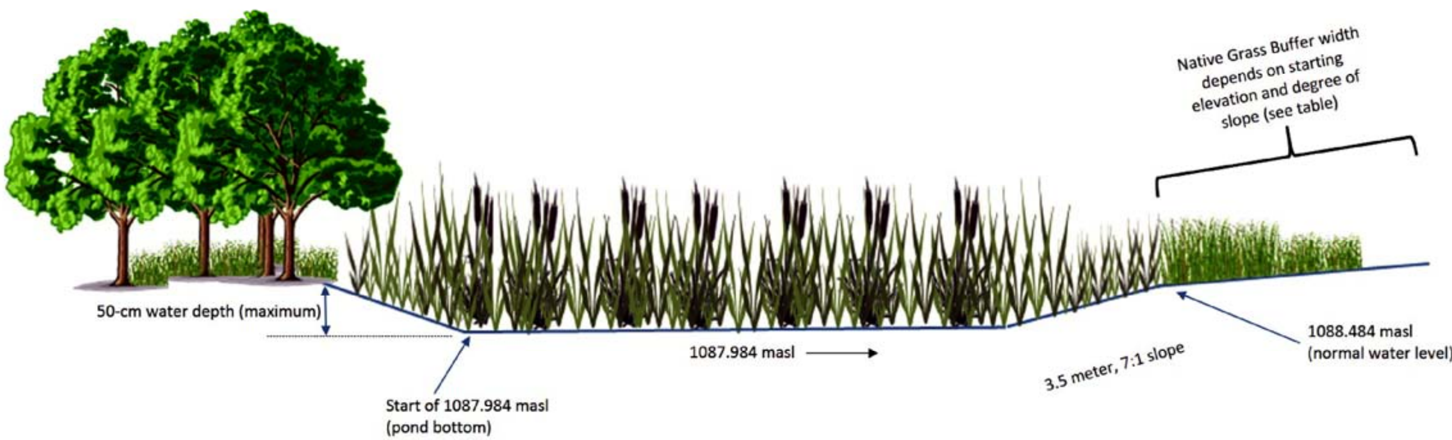
FIGURE 10



Existing Elevation masl	Difference in Elevation to 1088.484 masl Approximate in meters	Buffer Width Required using a 5:1 buffer slope to an elevation of 1088.484 (meters)	Buffer Width Required using a 7:1 buffer slope to an elevation of 1088.484 (meters)
1088.484 (NWL)	0.0	0.0	0.0
1089	0.5	2.5	3.5
1089.5	1.0	5.0	7.0
1090	1.5	7.5	10.5
1090.5	2.0	10.0	14.0
1091	2.5	12.5	17.5

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Canmore Park

Proposed Typical Wetland Cross Section

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FIGURE 11

Table 6: Preliminary Cost - Option 4

Component	Quantity	Unit	Unit Price	Cost
General Items				
Mobilization/Demobilization	1.0	LS	$30,000	$30,000
Access	1.0	LS	$10,000	$10,000
Erosion and Sediment Control	1.0	LS	$20,000	$20,000
Care of Water	1.0	LS	$30,000	$30,000
Existing Vegetation Removal	1.0	LS	$20,000	$20,000
Traffic accommodation	1.0	LS	$20,000	$20,000
Subtotal General				**$130,000**
Site Re-contouring				
Site Prep	11,900	m^2	$1.00	$11,900
Wetland Soils Removal/Storage	1,080	m^3	$5.00	$5,400
Topsoil Removal/Storage on Site	2,070	m^3	$5.00	$10,350
Cut & Fill	3,650	m^3	$20.00	$73,000
Re-establish wetland and native grass species	6,900	m^2	$12.00	$82,800
Pathway removal/reconstruction	215.0	m^2	$75.00	$16,125
Subtotal Site Re-contouring				**$199,575**
Wetland Restoration				
Wetland soils redepositing	1,080	m^3	$5.00	$5,400
Wetland plants replanting	5,200	m^2	$12.00	$62,400
Subtotal Wetland Restoration				**$67,800**
Berm				
Slope/Surface Preparation with onsite topsoil	900	m^2	$5.00	$4,500
Native Grass seeding	900	m^2	$12.00	$10,800
Impermeable Internal Wall/Liner	150	m^2	$10.00	$1,500
Subtotal Berm				**$16,800**
Subtotal Costs				**$414,175**
25% Contingency	30%			$ 103,543
15% Engineering	15%			$ 77,657
TOTAL PRELIMINARY CO[illegible]				**$ 595,375**

4.4 Hydrologic Assessment of Restored Wetland Option

In terms of surface flow hydrologic modeling, Options 1 and 2 have already been assessed as Scenario 1 in Section 3, and have not been further analysed here. Options 3 and 4 include changes in wetland catchment area and modeling assumptions, and have been further assessed with a continuous water balance model, the Water Balance Spreadsheet for the City of Calgary (WBSCC). The model function and capabilities are described in Section 3.

Table 7: Water Balance Model Scenario Descriptions and Assumptions

	Scenario Description	Catchment Description and Assumptions
Option 3	Based on re-contouring the site to increase catchment area to the wetland, and re-contouring the delineated wetland area to promote pooling of water at a maximum depth of 0.5m. Berm height of approximately 0.5m is proposed with 5:1 side slopes and a top width of 3m.	Refer to **Figure 8**. Park catchment area of 12.39 ha that includes some pathways. Low imperviousness (5% assumed). Berm modeled as vertical wall with top elevation of 1088.5m.
Option 4	The proposed re-contoured wetland geometry from Option 3 was utilized with the existing catchment area as the source of surface water for the hydroperiod analysis. Berm height of approximately 0.5m is proposed with 5:1 side slopes and a top width of 3m.	Refer to **Figure 9**. Park catchment area of 3.5ha that includes some pathways. Low imperviousness (5%) assumed. Berm modeled as vertical wall with top elevation of 1088.5m.

Table 8: WBSCC Model Results

				Maximum Wetland Results			Average Wetland Results		
	Catchment Area (ha)	Low Point (m)	Top of Berm Elev. (m)	Elev. (m)	Volume (m^3)	Surface Area (m^2)	Elev. (m)	Volume (m^3)	Surface Area (m^2)
Option 3	12.4	1088.0	1088.5	1088.6	4200	5200	1088.1	1700	4500
Option 4	3.5	1088.0	1088.5	1088.4	1825	5074	1088.0	93	4176

As shown in **Table 8**, Option 3 results in the best case scenario for maintaining a desirable wetland hydroperiod, with an average water volume of 1,700 m^3, and a maximum volume of 4,200 m^3. This option, however, requires significant regrading of the site and has the most impact in terms of costs and park uses. In Option 4, a maximum volume of 1,825 m^3 can be achieved, and the average volume is only 93 m^3 with a footprint of approximately 0.5 ha. In majority of years this option would result in a negligible open water area, however this type of wetland hydroperiod may still adequate for a Class III wetland.

WBSCC input and output files as well as hydroperiod graphs are presented in **Appendix C.**

4.5 Biophysical Assessment of Restored Wetland Options

For naturally occurring prairie wetlands, the timing, frequency, and depth of flooding determines the vegetative communities that exist, the extent of the hydric soil conditions that develop, and the wetland class that ultimately develops. The Canmore Park wetland reveals present-day impacts that have either led to the drying of certain locations within the wetland footprint over time or excess wetting depending on the slope grade or presence of a tile drain. The intent is to restore the site to its original hydroperiod, or most normal condition, as best as possible while accounting for the fact that certain impacts may not be possible to modify or change, such as holding back water without the placement of a berm to the east. The main considerations for restoring the Canmore wetland are:

- How often will the wetland be flooded?
- How deep will it be flooded?
- How long will it be flooded for in any given annual cycle?

Option 3 is designed to support a seasonal wetland that is mainly dependant on spring snowmelt for its annual water supply. Like many Class III wetlands, the productivity of the Canmore Park wetland is determined by a slow and gradual water loss during the summer months of June, July and August through transpiration and evaporation. This results in a drying of the wetland by mid- to late summer in most years. During heavy summer rains the site may fill with water for a short period of time, but the controlled spillover point set at 50-cm above the soil surface will ensure that maximum water levels are set so that the Class III vegetative community will survive even during the wettest precipitation events. Post restoration modelling for the wetland indicates that the average spring water levels for the Canmore wetland will range between 10 cm to 30 cm in most years, water depths that will support the asters, sedges, and *Juncus* species natural to this location.

Option 4 would results in a less desirable wetland hydroperiod, but will still provide some open water in wet conditions, and can support a Class III wetland.

4.6 Opportunities for Wetland and Park Integration

The Canmore Park wetland exists within a highly utilized and visible park area. Numerous natural footpaths, in addition to the paved path system, highlights the value and use of this area by local residents. The ability to incorporate a restored prairie wetland into an already established City park space creates both a recreational and interpretive opportunity for residents and the City of Calgary.

The wetland restoration options, as proposed in this report, have allowed for many of the existing natural footpaths in and around the wetland site to remain intact. A nearby paved pathway with a bench already exists near the proposed restored wetland footprint. The addition of interpretive signs educating City residents on the benefits of prairie wetland habitats and native grasses for improved water quality and for biodiversity is recommended and could be easily incorporated into the existing network of paths. We also recommend a walking path be constructed on top of the proposed north-south berm on the east side of the wetland. This pathway will help to maintain the connection that currently exists between the paved path to the south of the wetland and footpath trails to the north, while providing an elevated perspective of the wetland for the community.

5.0 TRIPLE BOTTOM LINE ASSESSMENT

5.1 Scoring System Template

The City of Calgary uses a Triple Bottom Line (TBL) approach to ensure that sustainable development principles are included in its decision making process. The TBL approach considers economic, environmental, and social impacts when large infrastructure investments are made.

The goals of the TBL policy in regards to protection of water resources and aquatic environment include the following:

- Maintain healthy ecosystems
- Ensure long-term sustainability of our water resources
- Protect the quality and accessibility of our natural areas
- Provide advanced stormwater management, to the greatest extent possible within the City's resources.

The City's TBL Policy Framework document lists a number of guiding questions that are to be considering in options evaluation. For this project, the following relevant guiding questions were identified:

Economic:

- Does this initiative improve Calgary's quality of life?
- Is this initiative an investment in infrastructure that advances Calgary's strategic goals?
- Is infrastructure being designed and managed to optimize its use?
- Will the infrastructure investment benefit the community?
- Will the initiative increase or decrease the City's operational and maintenance costs?

Environmental:

- What are the implications for the quantity and quality of water in Calgary's streams, rivers, wetlands and groundwater?
- Does this initiative affect sustainability of our water resources?
- What are the implications to natural areas, open spaces or urban forest?
- Will the initiative increase or decrease the consumption of resources, such as Land, Water, Energy, Materials/Waste?

Social:

- Have measures to ensure the safety of users been included in this proposal?
- Does this proposal incorporate opportunities for recreational and leisure pursuits?

- What is the impact of the proposal on the neighbors?
- For capital projects, is this proposal physically integrated into the community, ensuring compatibility and physical access?
- Does this project incorporate opportunities for heritage preservation?
- Does this project incorporate opportunities for recreational and leisure pursuits that are appropriate for diverse population?

In discussions with Calgary Parks, a number of relevant criteria and a **subjective** scoring system of the impact of criteria on all three TBL elements were developed to evaluate the project. Relative weightings were attached to each criteria based on **perceived** importance in the final decision.

A template was developed using these criteria and it is shown in **Table 9**. The template indicates the basis for the TBL evaluation for each restoration option.

Table 9: TBL Evaluation - Scoring System

Criteria	TBL Elements		
	Economic	Environmental	Social
Land ownership/ROWs/availability	/10		/5
Construction feasibility	/10	/5	
Disruption of park area during construction	/10		/10
Capital Cost	/15		
Operational and maintenance costs	/10	/10	
Benefits to the community – recreational			/15
Benefits to the community – educational		/15	
Impacts to public safety	/5		/15
Human health risk	/5	/5	/15
Impacts to existing uses	/5	/5	/15
Impact to City's strategic initiatives – Water Resources	/10	/15	/5
Impact to City's strategic initiatives – Parks and Natural Areas	/10	/15	/5
Wetland Health	/10	/15	/5
Wetland Function		/15	/10
Totals	/100	/100	/100

5.2 Option Scoring Results

Each option was rated according to the criteria above and a score was assigned to each appropriate cell. The scoring results summaries for each option are presented in **Tables 10 to 13**.

Table 10: TBL Evaluation - Option 1 - Onsite Shallow Berm, no Park or Wetland Re-contouring

Criteria	TBL Elements		
	Economic	Environmental	Social
Land ownership/ROWs/availability	8/10		4/5
Construction feasibility	8/10	8/5	
Disruption of park area during construction	8/10		8/10
Capital Cost	15/15		
Operational and maintenance costs	8/10	8/10	
Benefits to the community – recreational			1/15
Benefits to the community – educational		3/15	
Impacts to public safety	4/5		12/15
Human health risk	4/5	4/5	12/15
Impacts to existing uses	4/5	4/5	12/15
Impact to City's strategic initiatives – Water Resources	1/10	1/15	1/5
Impact to City's strategic initiatives – Parks and Natural Areas	1/10	1/15	2/5
Wetland Health	1/10	1/15	1/5
Wetland Function		1/15	1/10
Totals	62/100	31/100	54/100

Table 11: TBL Evaluation – Option 2 – Storm Pipe Diversion and Wetland Re-contouring

Criteria	TBL Elements		
	Economic	Environmental	Social
Land ownership/ROWs/availability	5/10		2/5
Construction feasibility	5/10	2/5	
Disruption of park area during construction	3/10		4/10
Capital Cost	5/15		
Operational and maintenance costs	2/10	3/10	
Benefits to the community – recreational			10/15
Benefits to the community – educational		5/15	
Impacts to public safety	3/5		7/15
Human health risk	3/5	2/5	7/15
Impacts to existing uses	3/5	3/5	10/15
Impact to City's strategic initiatives – Water Resources	5/10	7/15	3/5
Impact to City's strategic initiatives – Parks and Natural Areas	6/10	10/15	3/5
Wetland Health	6/10	8/15	4/5
Wetland Function		10/15	6/10
Totals	46/100	50/100	56/100

Table 12: TBL Evaluation – Option 3 – Park Regrading to Increase the Catchment Area and Wetland Re-contouring

Criteria	TBL Elements		
	Economic	Environmental	Social
Land ownership/ROWs/availability	3/10		1/5
Construction feasibility	4/10	2/5	
Disruption of park area during construction	3/10		2/10
Capital Cost	3/15		
Operational and maintenance costs	2/10	3/10	
Benefits to the community – recreational			10/15
Benefits to the community – educational		10/15	
Impacts to public safety	3/5		7/15
Human health risk	3/5	2/5	7/15
Impacts to existing uses	3/5	3/5	7/15
Impact to City's strategic initiatives – Water Resources	5/10	10/15	4/5
Impact to City's strategic initiatives – Parks and Natural Areas	6/10	12/15	4/[illegible]
Wetland Health	6/10	12/15	3/5
Wetland Function		12/15	8/10
Totals	41/100	66/100	53/100

Table 13: TBL Evaluation – Option 4 – Wetland Re-contouring, no Park Regrading or Alternative Water Supply

Criteria	TBL Elements		
	Economic	Environmental	Social
Land ownership/ROWs/availability	5/10		2/5
Construction feasibility	6/10	3/5	
Disruption of park area during construction	5/10		5/10
Capital Cost	7/15		
Operational and maintenance costs	3/10	5/10	
Benefits to the community – recreational			10/15
Benefits to the community – educational		8/15	
Impacts to public safety	3/5		7/15
Human health risk	3/5	2/5	7/15
Impacts to existing uses	3/5	3/5	9/15
Impact to City's strategic initiatives – Water Resources	5/10	9/15	4/5
Impact to City's strategic initiatives – Parks and Natural Areas	6/10	10/15	4/5
Wetland Health	6/10	7/15	3/5
Wetland Function		8/15	5/10
Totals	52/100	55/100	56/100

Table 14: Summary of TBL Evaluation for Restoration Options

Description	TBL Elements			Total Score
	Economic	Environmental	Social	
Option 1	62	31	54	**147**
Option 2	46	50	56	**152**
Option 3	41	66	53	**160**
Option 4	52	55	56	**163**

Based on the above TBL scoring, it is recommended that Option 4 be adopted as the preferred restoration option for Canmore Park wetland. Although this option does not provide an optimal wetland hydroperiod, the wetland re-contouring and runoff from the existing contributing catchment will still result in an adequate wetland function for a Class III wetland, while minimizing the site disturbance and impacts to users.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Based on the presence or absence of wetland soil characteristics and location of wetland communities, the extent of the Canmore Park wetland is delineated as shown on **Figure 2**, and represents the historical edge of the wetland. The wetland is classified as a Class III wetland.

The site presents a number of challenges for successful wetland restoration, including the continuous grade that does not allow any ponding of surface runoff, reduced wetland catchment area that cannot adequately support an optimal wetland hydroperiod, and presence of underdrains that further impacts the ability of wetland to hold water. Using conventional restoration techniques to encourage the natural re-establishment of wetland vegetation at this site is not possible without addressing the grades, the tile drains and our ability to hold back water.

Based on the results of the preliminary hydrologic assessment, it was determined that restoration options should include re-contouring of the site area to promote a more sustainable cross section reflective of a Class III wetland, and finding alternative sources of a make-up water to maintain an appropriate wetland hydroperiod. The site re-contouring exercise would restore a wetland in the area where existing wetland soils were delineated, and would ensure a normal water level of 0.5 m, which is a depth much more reflective of what would naturally occur in a Class III wetland during spring conditions. Four restoration options were developed and assessed.

Option 1 includes the construction a shallow berm of 0.3 m in height, to create a ponding area for surface runoff. While this option has the lowest cost, the restoration benefit is also very low. The average wetland surface area would be only about 50 m^2, with the average volume of water of only 5 m^3. The TBL score for this option is the lowest, at 147 points.

Option 2 includes the diversion of storm flows from nearby storm sewer network to provide make-up water for wetland hydroperiod, and the re-contouring of the wetland to better match the footprint delineated during the initial site investigation. With this option, the restoration benefit is substantial, however the impact to park uses is higher that with other options because of the need to create a flow diversion and potentially a riprapped channel through the park. There is also a higher long term operational and maintenance cost to the City. The TBL score for this option is 152 points.

Option 3 includes limited regrading of park area to direct the majority of park drainage to the wetland, and the re-contouring of the wetland to better match the footprint delineated during the initial site investigation. This option has a minimal impact to the park function and results in the best case scenario for wetland hydroperiod. However, due to significant regrading within the park area, this option also has the highest cost. The TBL score for this option is 160 points.

Option 4 utilizes the re-contoured wetland proposed in Option 3, without additional park regrading to increase the surface drainage area to the wetland, or alternative water supply option such as storm flow diversion. The only wetland water source is the existing catchment area of 3.5ha. As with the previous option, minimal impact to the park function is expected and most of the existing pathways would remain intact. In majority of the years, this option would result is a relatively negligible open water area, but in wet years an adequate hydroperiod can be achieved. This option is still adequate for the restoration of the Canmore Park wetland as Class III. The TBL score for this option is the highest, at 163 points.

Based on the assessment presented here, the recommended restoration option is Option 4. The re-contoured wetland design includes a berm to create a ponding area of 0.5m. The restored wetland would contain a maximum volume of 1825 m^3, with a footprint of approximately 0.5 ha. The recommended cross section is shown in **Figure 11**. The buffer zone would have an approximate slope of 7:1 for an 18m buffer width around the wetland normal water level. The region on the west side of the restored wetland would have approximately 3:1 slope. This grade could be decreased in this region with more regrading on site, however benching or retaining walls may need to be included in the preliminary design to meet safety requirements.

6.2 Recommendations

The following is a summary of recommended action items that should be addressed during future phases of the Canmore Park wetland restoration project:

- The construction cost estimates presented here are preliminary, and based on our experience with land development projects in Calgary region. Exact quantities will be determined during preliminary design phase, and may result in project cost changes.
- Generally, wetland plant seeds are not commercially available, while the native grass species needed to restore the berm area are. The costs for restoring the wetland and upland areas within the Canmore site include the hand collection and preparation of wetland seed prior to the year of restoration and drill seeding the site with wetland seed and upland native grass species within the wetland basin and on the surrounding berms post-construction. Most native plant species seeds are small with very little energy reserves, therefore seed placement using specialized drill seeders is needed so that seed can be placed shallow within the soil, at a depth of ¼ to ½ inch deep depending on the soil type. If seeded too deep, the seed will not be able to penetrate the soil surface. If seeded too shallow, the seed will not have adequate seed to soil contact to germinate and establish a primary root system.
- Final costs may be impacted by the timing of construction and revegetation activities.
- The exact quantities and placement of excess dirt will need to be determined at the preliminary design stage. Careful attention not to impact the catchment boundary due to the spreading of excess dirt is required.
- The re-contouring needed to support the wetland restoration will affect the existing wetland vegetation. Final design plans should work to minimize and protect existing plant communities wherever possible and to identify revegetation strategies for those locations where plants will be

impacted. The minimization of impacts can be accomplished by directing excavation equipment on site while the wetland is being graded.

- Construction plans should include the stockpiling of existing wetland topsoil for reuse within the final wetland footprint.
- The final component of the planting plan strategy should be to reintroduce native wetland and upland species though a seeding and propagule planting plan.
- Broadcast seeding of the wetland basin with wetland seed in the first spring of wetland operation following regrading of the site should be included as part of the restoration plan. A mid-summer propagule planting process in the first summer of wetland operation is currently included in the costs presented here. Propagule planting includes the transfer and replanting of live wetland plants from a suitable donor location into the wetland basin to further ensure the successful revegetation of the site following regrading and flooding. The re-establishment of wetland vegetation at this site should target a minimum of 80% plant coverage by the third spring of operation.
- For upland native grasses planted on the berm and the outer edges of the wetland, an inspection of these areas is recommended after the plant stand has gone through at least one winter of growth. This inspection indicates if further action is required. The target for revegetation of upland native grass species should be set at >6 native grass seedlings per square foot. The suggested actions based on the results of the upland inspection are:

Average Seedlings Per Square Foot	Action/Condition
<1	Reseed
1 – 3	Wait and re-evaluate or reinforce seeding
4 – 5	Successful planting
>6	Very good

7.0 CORPORATE AUTHORIZATION

This report, titled Canmore Park Wetland Feasibility Study, was prepared for The City of Calgary by Urban Systems Ltd. and Native Plant Solutions. The material in this report reflects the best judgement of our team, based on the information available at the time of preparation. Any use that the third party makes of this report, or reliance on or decisions made based on it, is the responsibility of the third party. Urban Systems Ltd. and Native Plant Solutions accept no responsibility for damages, if any, suffered by a third party as a result of decisions made or actions taken based on this report.

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Signature ______________________

Date ______________________

PERMIT NUMBER: P 3836
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

Liliana Bozic, M.Sc., P.Eng.
Senior Water Resources Engineer

NATIVE PLANT SOLUTIONS

Lisette Ross

Appendix A
GEOTECHNICAL INVESTIGATION

March 28th, 2016 ML-7672

City Of Calgary
C/o: Urban Systems
#101 – 2716 Sunridge Way NE
Calgary, AB
T1Y 0A5

Attention: Ms. Liliana Bozic, M.Sc., P.Eng.
Senior Water Resource Engineer

Subject: Geotechnical Desktop Study
Canmore Park Wetland Restoration
Calgary, Alberta

McIntosh•Lalani Engineering Ltd. (M•L) is pleased to present this geotechnical desktop study for the above noted project. The purpose of the study is to review available geotechnical information in order to determine probable soil and groundwater conditions at the site and to provide general geotechnical information for the Canmore park wetland restoration.

1.0 PROJECT DESCRIPTION

It is our understanding that the project may include the design and construction of a berm to establish a water catchment area which will serve to restore a wetland in Canmore Park. The park is located at the intersection of Canmore Road NW and 19th Street NW in Calgary, Alberta.

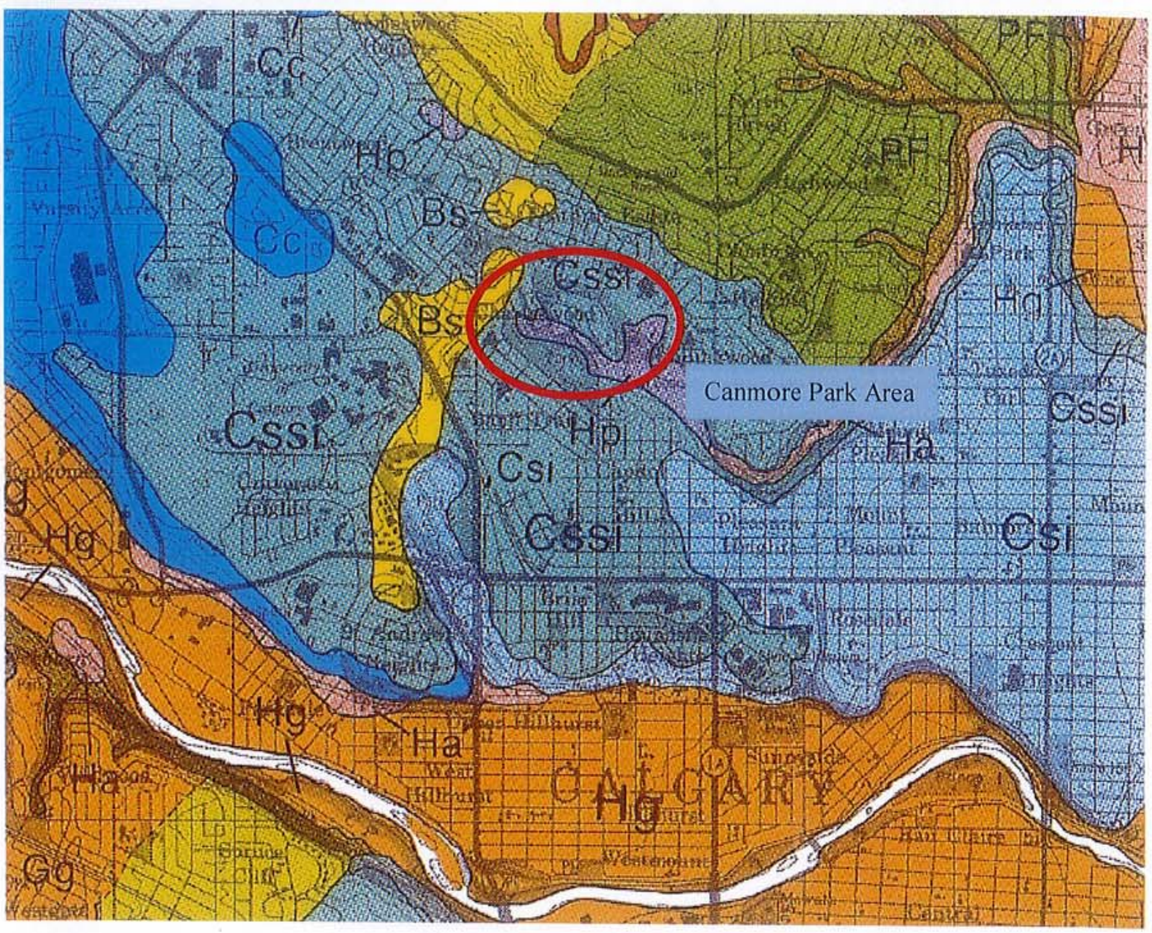
2.0 HISTORICAL INFORMATION

According to the available information, including from Urban Systems 2014 "Canmore Park wetland restoration feasibility study -" (F/N 1057.0111.01, dated October 30th, 2014), the Canmore Park area was did not show signs of the presence of open water based on aerial photos from 1948 onwards. Furthermore, aerial photographs dating from 1966 indicate the construction of a possible drainage system on the wetland site.

2.1 Geological Reference Documents

One important source of geological information for the Calgary area is the Alberta Research Council publication, Bulletin 53 "Surficial Geology of the Calgary Urban Area" by SR Moran, published in 1986. This publication represents the most up to date surficial deposit mapping information available for the Calgary area and is based on a compendium of geological work conducted by the Alberta Research Council from 1974 to 1982. Other older publications were also reviewed but not found to contain any significant information other than what is found in Moran's study.

According to the information contained in this study, the stratigraphy of the Canmore Park site should be characterized by a deposit of sandy lacustrine soils of the Calgary Formation and possibly post glacial pond sediments. The portion of map and legend presented below illustrate the expected surficial soils of the Canmore park area.



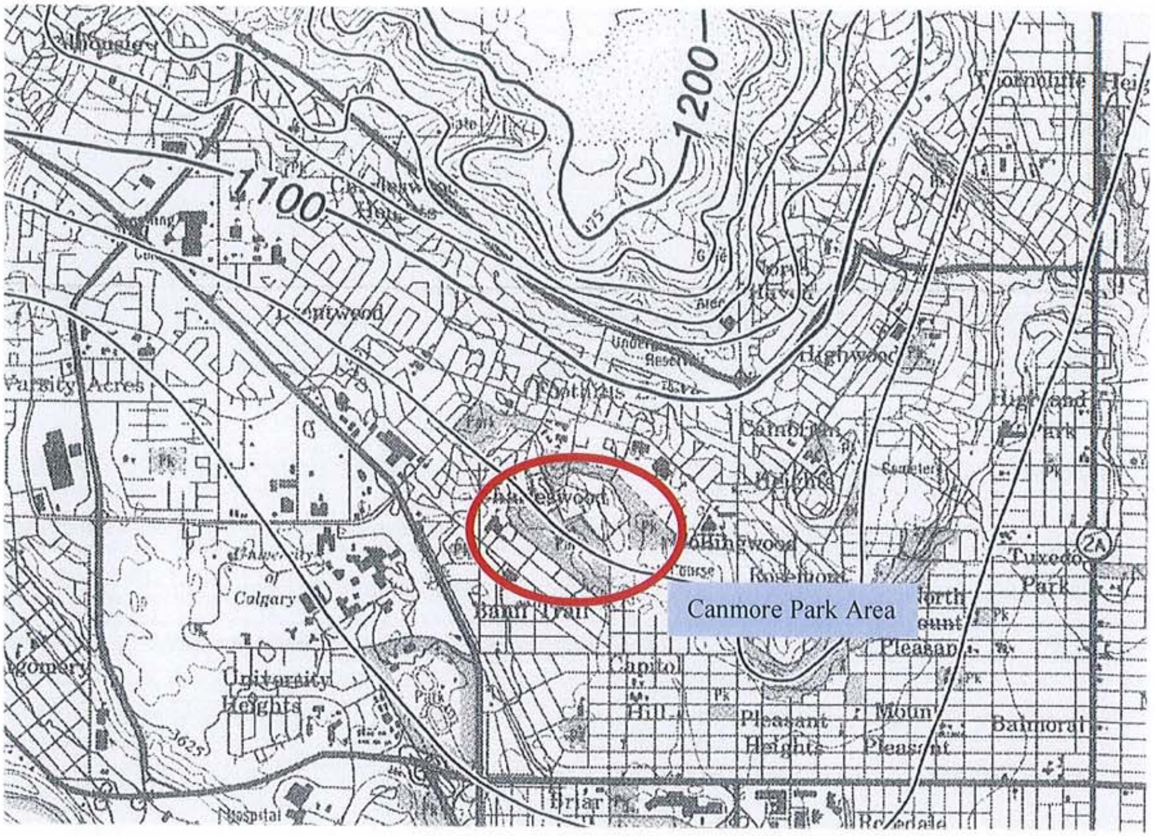
Legend

Quaternary	Till	Clayey Lacustrine	Silty Lacustrine	Sandy Lacustrine	Ice Contact Fluvial Gravel	Fluvial Channel Sand	Fluvial Channel Gravel	Loamy Overbank and Fan Sediment	Pond Sediment	Loess
Post-Glacial Undivided							Hg	Ha	Hp	Hl
Glacial Undivided	Gt				Gl	Gs	Gg			
Calgary Formation		Cc	Csi	Cssi						
Crossfield Formation	Crt		Crsi	Crssi	Crl	Crs				
Balzac Formation	Bt		Bsi		Bl	Bs				
Lochend Formation	Lt	Lc			Ll					
Spy Hill Formation (Upper Unit)	Ut	Uc			Ul	Us				
Spy Hill Formation (Lower Unit)	St	Sc			Sl	Ss				

Taken from: Bulletin 53, "Surficial Geology of the Calgary Urban Area" by SR Moran, Alberta Research Council, 1986

The sandy lacustrine sediments of the Calgary Formation are described as variable proportions of silt, clay and fine sand resulting from all four glaciation periods.

The study also presents information concerning bedrock depth based on collected historical borehole information. Bedrock geodesic elevation for Canmore Park is estimated at approximately 1080 meters. Surface elevation of the Canmore wetland area is approximately 1090 meters.



Taken from: Bulletin 53, "Surficial Geology of the Calgary Urban Area" by SR Moran, Alberta Research Council, 1986

3.0 AREA GEOTECHNICAL INVESTIGATIONS

M•L has completed three geotechnical investigations in the Canmore Park area, including two investigations on the University of Calgary Campus (F/N: ML-5822 and ML-5904, November 2012) and the third for the Banff Trail Holiday Inn hotel (F/N: ML-5500, January 2012) located at the intersection of Banff Trail NW and 23rd Avenue NW. Each of these investigations were completed within approximately 1.5 kilometers from Canmore Park.

For each of these investigations, one or more boreholes were advanced to a maximum depth of 18.3 meters below grade. Bedrock was not identified in any of the boreholes. In each case fine grained soils consisting mainly of varying proportions of sand, silt and smaller proportions of clay were identified to a depth of 18.3 meters.

3.0 GROUNDWATER

For each of the geotechnical investigations presented above, standpipe piezometers were installed in each of the boreholes and water levels measured approximately one week following drilling. The recorded water levels varied from 6.06 to 16.95 meters below grade at the time boreholes were drilled. It is important to note that these investigations were all completed some distance from Canmore Park and as such can only serve as a potential indication of ground water levels. Soil composition variability, terrain topography as well as seasonal climate variations all contribute to the variability of ground water levels within a given area.

A search was also conducted of publically available information through the "Alberta Water Well Information Database" website of Alberta Environment and Parks. Unfortunately, nearby wells identified through the website did not contain pertinent information concerning groundwater levels.

3.0 CONCLUSION

From the information gather, and the similarities between the information gathered from reference material and the geotechnical investigations completed by M•L in the area, we believe it is reasonable to expect that the stratigraphy of the Canmore Wetland site should be characterised by fine grained sediments. Although bedrock was not encountered on the sites at which M•L completed geotechnical investigation, bedrock is known to rise towards Nose Hill and it is therefore not unreasonable to expect bedrock at a depth of approximately 10 meters below surface.

It is important, however to note that there does not seem to be currently available information concerning the construction of a possible drainage system on the wetland site, and that we cannot confirm the depth and extent of any soil disturbance or whether or not any soils were imported on site or removed.

A geotechnical investigation will be required to confirm soil stratigraphy and characteristics as well as groundwater levels on the site. In the case where a geotechnical investigation of the site is requested, it will be M•L's pleasure to prepare a proposal for the investigation in concert with the various stake holders.

6.0 CLOSURE

We trust this study meets with your present requirements. Should you have questions regarding the above, please do not hesitate to contact the undersigned.

Respectfully submitted,
McIntosh•Lalani Engineering Ltd.

Marc A. Gelinas, P.Geo.

Marty Ward, P.Eng.
Senior Project Engineer

Appendix B

WBSCC Input and Output Files – Preliminary Assessment