

Executive Summary

Introduction

In 2013, 1744228 Alberta Ltd. (the Landowner) acquired the former Highland Park Golf Course (HPGC) lands. Maple Projects Inc. and Amble Ventures Ltd. (the Developers) plan to develop the former HPGC lands into a mixed-use, commercial and residential development known as the Highland Park Development (HPD). The City of Calgary (The City) has approved the Land Use and Outline Plan for the proposed development subject to conditions, including but not limited to, the findings of a regional drainage study.

- In 2017, The City commissioned Associated Engineering (AE) to undertake the Confederation Park Regional Drainage Study (The Study) which includes the former HPGC lands.
- On May 31, 2018, AE issued the Draft Final Report for The Study. This report expands on the Draft report with discussions regarding dam safety and new information from AEP.

The Master Drainage Plan (MDP) component of The Study is focused on Confederation Creek, the Lower Confederation Trunk and the Confederation Valley. The analysis will inform The City of regional drainage patterns and the effects of the HPD on the drainage system. Within this study, options have been developed to mitigate regional drainage issues.

This report summarizes the MDP component of The Study.

Study Area

The Confederation Creek Catchment encompasses approximately 2,700 ha in northwest Calgary. It is roughly bounded by Nose Hill Park to the north, Shaganappi Trail NW to the west, 24th Avenue NW to the south, and Edmonton Trail to the east.

Confederation Creek now conveys the combined major and minor system flow from the CP15/16 Outfalls within the Confederation Park Golf Course through Confederation Park to the D33 Inlet. Downstream of the D33 Inlet, minor and major system flows are respectively conveyed to Nose Creek via the Lower Confederation Trunk and the Confederation Valley.

Confederation Creek is interrupted by roadway embankments at 14th Street NW and 10th Street NW. Both embankments have culverts and pedestrian walkways (which function as elevated culverts). During high intensity storm events, the embankments retain water upstream within the Confederation Park Golf Course and Confederation Park.

The Confederation Valley conveys major system flow when the capacity of the Lower Confederation Trunk is exceeded. Major system flow ponds within the Queen's Park Cemetery, the 40th Avenue NW and 4th Street NW intersection, and upstream of the Centre Street N embankment within the former HPGC lands.

Crown Owned Land

In 2017, The City submitted an inquiry to Alberta Environment and Parks (AEP) to gain clarity on the potential for a Public Lands claim along the historic reaches of Confederation Creek. In November of 2017, The City received an email from AEP stating that “*this water feature is indeed Crown owned under Section 3 of the Public Lands Act*”. In October of 2018, The City of Calgary received a letter from AEP indicating a reversal of the Crown claim in the Confederation Creek Catchment.

Highland Park Development

Drainage within the Confederation Creek Catchment will be affected by the proposed HPD. The development includes up to 4 m of fill material to accommodate at-grade intersections of the proposed Highland Drive NW with Centre Street N and 40th Avenue NW. The fill material would remove 97,000 m³ of Confederation Valley’s depression storage west of Centre Street N.

Drainage Modelling

AE built a stormwater model to understand the hydrologic and hydraulic regime of the study area. The modelled results indicate the following drainage issues:

- The size of the existing culverts along Confederation Creek causes the temporary impoundment of stormwater runoff upstream of 14th Street NW and 10th Street NW. Stormwater runoff is also impounded upstream of 30th Avenue NW and Centre Street N.
- Major overland system flow occurs between 30th Avenue NW and the N25 Outfall during high intensity rainfall events. Centre Street N currently impedes overland flow and creates a large depression in the former HPGC lands.
- Flows to Nose Creek will increase if the HPD proceeds as proposed in the Land Use and Outline Plan. This is because 97,000 m³ of existing storage upstream of Centre Street N will be filled in as part of the HPD’s grading requirements causing runoff to overtop Centre Street N more frequently.
- Climate change and densification are predicted to increase the magnitude of the peak flows and runoff volumes during rainfall events. The increased runoff will compound the existing issues.

Preliminary Findings

Overland Flow

There are public safety risks associated with overland flow along the Confederation Valley. These risks will become more severe if development is permitted within the valley as proposed because more people may be exposed to the presence of deep, fast moving water through the valley. The expected overland flow upstream of the HPD would exceed the municipal and provincial safe overland flow criteria without upstream drainage improvements or safe management of overland flow within the HPD. The overland flow criteria serve as an indicator for the potential risk of people being swept away by the force of deep, fast moving water.

Removal of the depression storage could allow overland flows to overtop Centre Street N more frequently. These flows could also damage the future Green Line LRT and inundate the proposed tunnel at McKnight Boulevard NW. Major system flow which overtops Centre Street N could also cause damage within Greenview Park and the community of Greenview.

Dam Safety

The existing embankments along Confederation Creek were not constructed for the purpose of storing water. The embankments were constructed to convey vehicular traffic across the Confederation Valley. Therefore, the existing embankments are not expected to be classified as dams according to provincial regulation.

Despite the roadway embankments not being classified as dams, there is a public safety risk associated with the upstream storage depths and volumes. These risks include slope stability risks and drowning risks. In 2016, Thurber Engineering Ltd. determined that a slope on the upstream face of the 14th Street NW embankment was marginally stable.

Nose Creek

Nose Creek has been modified with the urbanization of Calgary, as have the areas contributing runoff to the creek. The creek has been straightened and now receives more unattenuated and untreated urban runoff than it did previously. As a result, the water quality in Nose Creek has deteriorated, while the bed and banks of the creek have been subjected to excessive scour and erosion.

In 2007, the Nose Creek Watershed Partnership (NCWP) issued the *“Nose Creek Watershed Water Management Plan”*. The plan provides a framework and recommendations for sustainable development within the watershed including rate, volume and quality targets. In 2018, the NCWP updated the *“Nose Creek Watershed Water Management Plan”*. *“The update was necessary to reflect advancements in knowledge, changes in provincial and municipal policies, and to address new challenges in land and water resource management.”* (Nose Creek Watershed Partnership, 2018).

Further increase in the magnitude of the peak flow rate and volume will likely negatively affect Nose Creek and adjacent properties. Based on currently available information, it is unlikely that Nose Creek can accommodate additional flows without major capacity upgrades along the entire creek down to its confluence with the Bow River. The capacity upgrades would not align with the Nose Creek Watershed Management Plan. In addition, due to the anticipated provincial and federal scrutiny, extensive environmental provisions may be required to minimize impacts on fish habitat and riparian areas.

Climate Change and Densification

Research indicates that the climate is changing, which is expected to reflect more extreme weather conditions. *“Climate change will likely result in long-term changes in temperature and precipitation, as well as increased frequency and severity of weather events such as droughts, floods, forest fires, and severe storms.”* (Alberta Government, 2019)

Climate change direction has been set by The Federal and Provincial governments, which Municipalities must adhere to. The City has dedicated a team to facilitating city, citizen, and business actions to mitigate and adapt to the impacts of climate change. This team is taking multiple steps to accomplish this including developing a *Climate Resilience Plan* endorsed by City Council in mid-2018.



The City's *Climate Resilience Plan* includes an "adaptation plan identifying actions to reduce the impacts from the changing climate" (City of Calgary, 2017). Adaptation strategies include building resilience into proposed stormwater infrastructure to manage higher intensity rainfall.

In alignment with The City's approach, The City directed AE to consider the effects of climate change in this Study to determine the impact it will have on existing infrastructure, and to propose improvements to manage the anticipated effects of climate change.

Study Objectives

Upon review of the preliminary findings, The City instructed AE to develop stormwater management options which met the following objectives:

- Reduce the magnitude of overland flooding in Queen's Park Cemetery, at the intersection of 4th Street NW and 40th Avenue NW, and within the former HPGC lands.
- Maximize the amount of developable land within the former HPGC lands.
- Reduce the likelihood of overland flows crossing the future Green Line LRT.
- Reduce the risks associated with dam safety.

The City considers the former HPGC lands as undeveloped land and considers the HPD to be a greenfield development. Considering this and The City's desire to adapt to climate change with resilient infrastructure, The City directed AE to develop options that account for the anticipated effects of climate change for the 1:100-year, 4-hour, storm event. Given the on-going residential and commercial re-development, The City also requested that AE consider an increase in impervious area while developing options.

The City also instructed AE to develop options which maintained the Scenario 1 (1:100-year, existing condition) peak flow rate to Nose Creek recognizing that Nose Creek and the surrounding infrastructure could be negatively affected by receiving additional flow.

Options

AE developed six different options:

- **Option 1A** – No Improvements – Without the HPD.
- **Option 1B** – No Improvements – With the HPD.
- **Option 2** – West Storage and Conveyance to Nose Creek – With the HPD.
- **Option 3** – West Storage and Diversion to the Bow River – With the HPD.
- **Option 4 Ultimate** – West Storage and Centre Street N Storage – Without the HPD.
- **Option 4 Interim** – Existing Risk Mitigation – Without the HPD.

The HPD as referenced in this report refers to the HPD as identified in the current, approved Land Use and Outline Plan.

AE and The City considered several other storage facilities during the development of these options. These storage facilities were comprised of smaller scale storage sites. Some of these suggested alternative storage facilities may be able to be incorporated into the overall option if they are proven to be effective and cost beneficial as detailed design is initiated.

Option 1A – No Improvements – Without the HPD

Option 1A does not include any of the improvement projects and assumes that the former HPGC lands remain as green space.

Option 1B – No Improvements – With the HPD

Option 1B does not include any of the improvement projects proposed; however, in contrast to Option 1A, Option 1B assumes that the HPD will be developed as per the proposed Land Use and Outline Plan. Recognizing that the former HPGC lands are privately owned, Option 1B would limit The City's flexibility to manage stormwater runoff within the Confederation Creek Catchment.

Municipal and provincial overland flow criteria would be exceeded within the HPD without safe management of overland flow within the HPD. These criteria were developed to prevent people from being swept away by the force of deep, fast moving water, and to provide safe access for emergency vehicles during rainfall events.

Option 2 – West Storage and Conveyance to Nose Creek

Option 2 consists of intentional storage upstream of: 14th Street NW, 10th Street NW and 30th Avenue NW; and conveyance improvements that reduce the magnitude of the overland flow in the Confederation Valley. Intentionally storing stormwater upstream of these road embankments would result in them being classified as dams under the Water Act regulation. The storage in the west half of the catchment would attenuate peak flows to reduce the size of downstream conveyance improvements. The conveyance improvements in the east half of the catchment would reduce the magnitude of the overland flow by lowering the hydraulic grade line in the Lower Confederation Trunk. The assumption is that the HPD would be developed as part of Option 2.

Option 2 Summary:

- 310,000 m³ of dam storage upstream of 14th Street NW.
- 295,000 m³ of dam storage upstream of 10th Street NW.
- 80,000 m³ of dam storage upstream of 30th Avenue NW.
- 3,250 m of conveyance upgrades along the Lower Confederation Trunk.
- Centre Street N piped major system.
- 1:100-year peak flows to Nose Creek could increase from 31.8 m³/s for existing conditions to 82.7 m³/s during future conditions.

Option 3 – West Storage and Diversion to the Bow River

Option 3 consists of intentional storage upstream of: 14th Street NW, 10th Street NW and 30th Avenue NW; conveyance improvements, and a flow diversion to the Bow River. Together, these improvement projects reduce the magnitude of the overland flow in the Confederation Valley and prevent an increase in peak flow to Nose Creek. The intentional west catchment storage upstream of 14th Street NW, 10th Street NW and 30th Avenue NW would require classifying the embankments as dams and would attenuate peak flows to reduce the sizes of downstream conveyance improvements. The conveyance improvements in the east half of the catchment would reduce the magnitude of the overland flow by lowering the hydraulic grade line in the Lower Confederation Trunk upstream of the diversion. The Bow River diversion would prevent an increase in the peak flow rate to Nose Creek by directing a significant amount of flow directly to the Bow River. It was assumed that the HPD would be developed as part of Option 3.

Option 3 Summary:

- 310,000 m³ of dam storage upstream of 14th Street NW.
- 295,000 m³ of dam storage upstream of 10th Street NW.
- 80,000 m³ of dam storage upstream of 30th Avenue NW.
- 2,560 m of conveyance upgrades along the Lower Confederation Trunk.
- Centre Street N piped major system.
- The diversion tunnel would be between 4 m and 5 m in diameter and would be at least 4.5 km in length.

Option 4 Ultimate – West Storage and Centre Street N Storage

Option 4 Ultimate consists of intentional storage upstream of: 14th Street NW, 10th Street NW and 30th Avenue NW; conveyance improvements, and intentional storage upstream of Centre Street N within the former HPGC lands (which are privately owned at this time). Together these improvement projects reduce the magnitude of the overland flow in the Confederation Valley and prevent an increase in the peak flow rate to Nose Creek. The intentional storage in the west catchment and upstream of Centre Street N would require classifying the embankments as dams under the Water Act regulation.

The storage in the west half of the catchment would attenuate peak flows to reduce the size of downstream conveyance improvements. The conveyance improvements in the east half of the catchment would reduce the magnitude of overland flow by lowering the hydraulic grade line in the Lower Confederation Trunk upstream of the former HPGC lands. The storage upstream of Centre Street N would prevent an increase in the peak flow rate to Nose Creek by attenuating flows. Based on collaboration with the developer's consultant it was determined that intentionally storing stormwater upstream of Centre Street N would substantially reduce the development potential of the parcel. As such, for Option 4, the assumption is that the HPD would not be developed as indicated in the proposed Land Use and Outline Plan, but Option 4 does not preclude all development on these lands.

Option 4 Ultimate Summary:

- 310,000 m³ of dam storage upstream of 14th Street NW.
- 295,000 m³ of dam storage upstream of 10th Street NW.
- 80,000 m³ of dam storage upstream of 30th Avenue NW.
- 2,350 m of conveyance upgrades along the Lower Confederation Trunk.
- 180,000 m³ of storage upstream of Centre Street N within the former HPGC lands.

The HPGC lands and parcel east of Centre Street N are privately owned. A significant portion of the HPGC lands would be required for Option 4 Ultimate. If necessary, the required land extents would be delineated in a future study.

Option 4 Interim – Existing Risk Mitigation

Option 4 Interim consists of small-scale improvement projects to mitigate some of the existing risk within the Confederation Creek Catchment assuming that the HPGC lands remain as greenspace until a new Land Use and Outline Plan is proposed by the landowner.

Option 4 Interim would allow The City to mitigate some of the existing risk while studies and data collection are undertaken to inform and optimize the final configuration of Option 4 Ultimate.

Option 4 Interim Summary:

- Ponding level monitoring upstream of 14th Street NW, 10th Street NW, 30th Avenue NW and Centre Street N.
- Periodic geotechnical inspection of 14th Street NW, 10th Street NW, 30th Avenue NW and Centre Street N.
- Geotechnical Improvements at 14th Street NW.
- Major system conveyance through Greenview Park.
- All interim improvements noted above are within public property.

Option Evaluation

Table E-1 below identifies which objectives are met within each option.

**Table E-1
Objective Summary**

Objectives	Option 1A	Option 1B	Option 2	Option 3	Option 4 Ultimate	Option 4 Interim
Reduce the magnitude of overland flooding in Queen’s Park Cemetery, at the intersection of 4 th Street NW and 40 th Avenue NW, and within the former HPGC lands.	No	No	Yes	Yes	Yes	No
Maximize the amount of developable land within the former HPGC lands.	None	Full	Moderate	Moderate	Minimal	None
Reduce the likelihood of overland flows crossing the future Green Line LRT.	No	No	Yes	Yes	Yes	No
Maintain Current Peak Flow Rate to Nose Creek.	No	No	No	Yes	Yes	No
Address Impacts of Climate Change and Densification.	No	No	Yes	Yes	Yes	No
Reduce the risks associated with dam safety.	Yes	Yes	No	No	No	Yes

Cost Estimates

Class 5 cost estimates are presented within **Table E-2**. Class 5 cost estimates have an expected variance of -50 % to +100 % according to The City's "*Estimation and Contingency Standard*" (City of Calgary, 2012).

Table E-2
Class 5 Cost Estimates

Option	Estimated Cost*	Inclusions	Exclusions
Option 2	\$110,000,000 <u>Cost Estimate Range</u> \$55,000,000– \$220,000,000	<ul style="list-style-type: none"> Engineering Fees Lower Confederation Trunk Capacity Increases Dam Safety Retrofits at 14th Street NW, 10th Street NW and 30th Avenue NW 	<ul style="list-style-type: none"> Contingency Centre Street N Piped Major System Crossing Substantial Nose Creek Improvements to Receive Increased Flows
Option 3	\$370,000,000 <u>Cost Estimate Range</u> \$185,000,000– \$740,000,000	<ul style="list-style-type: none"> Engineering Fees Lower Confederation Trunk Capacity Increases Dam Safety Retrofits at 14th Street NW, 10th Street NW and 30th Avenue NW Bow River Diversion Tunnel 	<ul style="list-style-type: none"> Contingency Centre Street N Piped Major System Crossing
Option 4 Ultimate	\$130,000,000** <u>Cost Estimate Range</u> \$65,000,000– \$260,000,000	<ul style="list-style-type: none"> Engineering Fees Lower Confederation Trunk Capacity Increases Dam Safety Retrofits at 14th Street NW, 10th Street NW and 30th Avenue NW Dam Safety Retrofits at Centre Street N HPGC Lands Channel and Storage Facility 	<ul style="list-style-type: none"> Contingency Land Acquisition
Option 4 Interim	\$10,000,000** <u>Cost Estimate Range</u> \$5,000,000– \$20,000,000	<ul style="list-style-type: none"> Engineering Fees Monitoring & Inspection of Roadway Embankments Local Stabilization of 14th Street NW Greenview Park Conveyance Channel 	<ul style="list-style-type: none"> Contingency

*The Class 5 cost estimates are presented as a value and a range. The value presented does not include contingency. The range presented is -50 % to +100 % of the cost estimate and is based on the expected variance of the Class 5 cost estimates. The range has been rounded up to the nearest \$1,000,000.

** The costs of Option 4 Interim are not included in Option 4 Ultimate.

The cost estimates also exclude the following items:

- Future Studies
- Permits
- Approvals
- Environmental Requirements and Compensation
- Operation and Maintenance Costs
- Taxes.



Summary

In 2017, AE was commissioned to undertake the Confederation Park Regional Drainage Study to inform The City of regional drainage patterns within the Confederation Creek Catchment.

The Confederation Creek Catchment is affected by regional drainage issues which stem from existing development. AE's drainage modelling suggests that: runoff is impounded within the Confederation Valley upstream of roadway embankments; major overland system flow occurs within the Confederation Valley; flows to Nose Creek will increase with increased re-development in the catchment area; and climate change and densification will compound these issues.

These drainage issues create risks within the Confederation Creek Catchment. These risks include:

- Public safety risks associated with deep fast-moving water;
- Dam safety risks associated with water retention in the Confederation Valley;
- Risk of property damage due to flooding; and
- Environmental risks associated with erosion damage to Nose Creek.

If future development and climate change are not planned for and managed, these drainage risks could be further compounded. In an attempt to mitigate these risks, AE and The City developed five regional options. It should be noted that the proposed HPD was a key consideration for each option due to its impacts on regional drainage and potential stormwater management strategies.

Option 1A and Option 1B (No Improvements – Without/With the HPD) would result in unacceptable levels of risk. These risks would be associated with dam safety, high flows through the proposed HPD and Nose Creek's lack of ability to receive additional flow. The City is not investigating Option 1A or 1B any further.

Option 2 (West Storage and Conveyance to Nose Creek) would increase peak flow rates to Nose Creek beyond those in existing conditions. Given Nose Creek's lack of ability to receive the additional flow required to accommodate Option 2, The City is not investigating Option 2 any further.

Option 3 (West Storage and Diversion to the Bow River) would result in the removal of 97,000 m³ of stormwater attenuation in the catchment to accommodate the HPD. The estimated cost of managing this removal of storage is prohibitively expensive (\$370,000,000). The City also anticipates that a feasibility study to assess the viability of the Bow River Diversion Tunnel could take between 1 and 2 years to complete. Therefore, The City is not investigating Option 3 any further.

Option 4 Ultimate (West Storage and Centre Street N Storage) would achieve most of The City's objectives; however, the HPGC lands and parcel east of Centre Street N are privately owned. As such, for Option 4, the assumption is that the HPD would not be developed as indicated in the proposed Land Use and Outline Plan, but Option 4 does not preclude all development on these lands.

Option 4 Interim (Existing Risk Mitigation) would allow The City to mitigate some of the existing risk while further studies and data collection are undertaken to inform and optimize the final configuration of Option 4 Ultimate.

Conclusions

AE recommends that The City take a two-stage approach to stormwater management in the Confederation Creek Catchment (Option 4 Interim & Option 4 Ultimate).

- Option 4 Interim (Stage 1) would allow The City to mitigate some of the existing risks while:
 - The City addresses the need for land within the HPGC lands for Option 4 Ultimate.
 - The City undertakes a regional study of Nose Creek.
 - The City further assesses the potential effects of climate change on rainfall.
 - The City undertakes geotechnical inspection of the roadway embankments.
 - The City considers optimization of Option 4 Ultimate
- Option 4 Ultimate (Stage 2) would allow The City to meet its ultimate objectives.

The City's next steps include:

- Finalizing the reporting for the Community Drainage Improvement component of this Study.
- Continued discussion with the landowner on a revised plan for the HPGC lands to accommodate Option 4 Ultimate.
- A regional study of Nose Creek which confirms the creek's existing hydraulics and identifies the potential for regional improvements which may enable optimization of Option 4.