Canadian Consulting Engineering Awards 2018

Northwest Inner City Drainage Study - Sunnyside Review

Resilient and sustainable stormwater management

Calgary, Alberta

Associated Engineering

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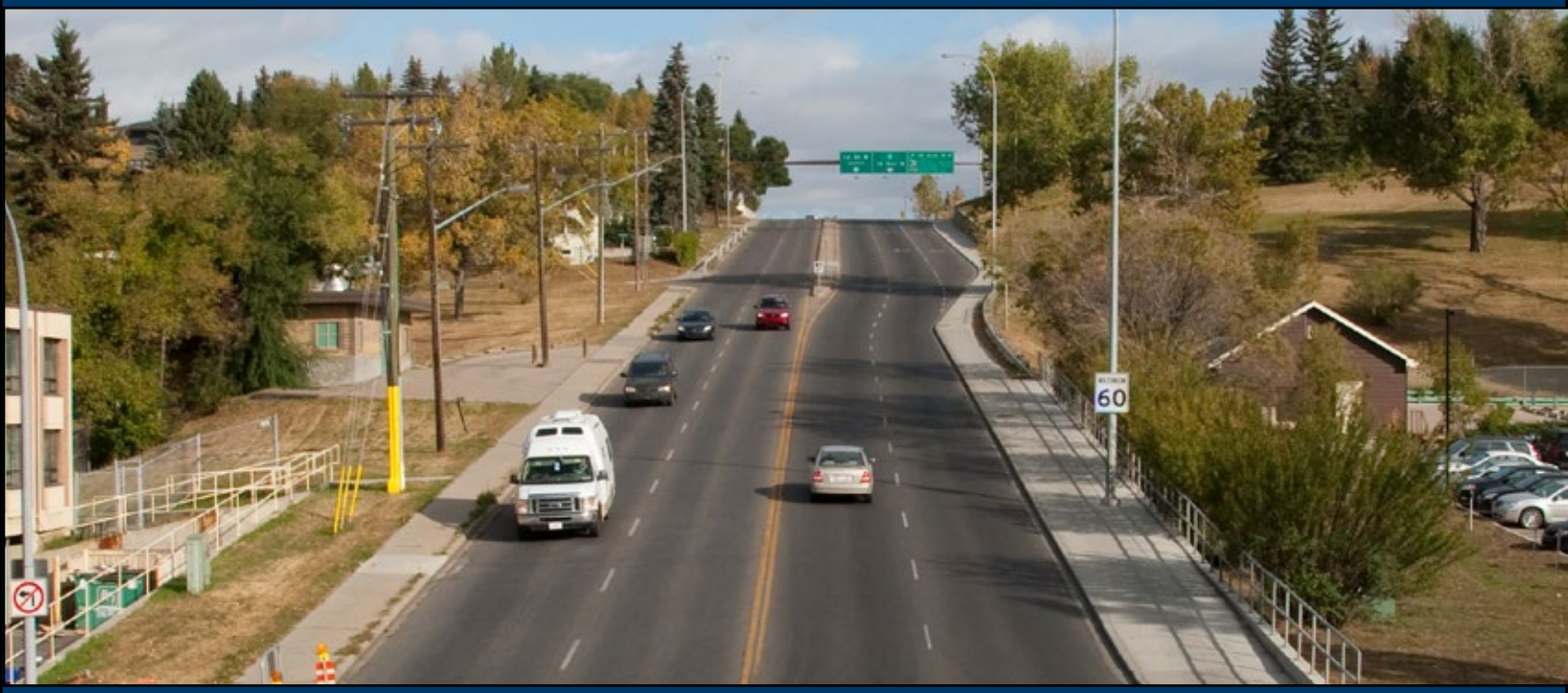


PROJECT SUMMARY

Calgary's Sunnyside community is vulnerable to stormwater and river flooding, and, in 2013, suffered two floods. The City of Calgary engaged Associated Engineering to conduct a drainage study and propose resiliency upgrades. Associated suggested an innovative dual level of service to manage stormwater with high and low rivers, reducing the cost of improvements compared to when using typical design criteria requirements. A first for the City, this sets a precedent for managing stormwater in floodplain communities.

PROJECT TEAM

Prime Consultant: Associated Engineering

Owner/Client: City of Calgary

INTRODUCTION

Located at the bottom of an escarpment near downtown Calgary, the community of Sunnyside has experienced floods due to rainfall and river flooding. Rainfall related flooding can be caused by local rainfall or stormwater that flows to Sunnyside from the upper plateau. The area is also vulnerable to river flooding due to its location in a floodplain below high levels of the adjacent Bow River.

Sunnyside's stormwater outfalls have gates which can be closed to protect the neighbourhood when water levels are predicted to rise in the Bow River. The gate closures prevent river water from entering the community, but makes Sunnyside vulnerable to stormwater flooding as the runoff cannot discharge to the Bow River.

In 2013, Sunnyside experienced significant flooding--twice in two weeks. During the first flood in June, the Bow River overtopped the Sunnyside berms. To protect the community from the high river, the City closed several stormwater outfall gates. Two weeks later, rainfall occurred while the gates were still closed, flooding the community again.

Following these events, the City retained Associated Engineering to conduct a drainage study of the Sunnyside area to analyze flooding due to rainfall runoff, and propose improvements to mitigate flood risks due to a 1-in-50-year-return-period rainfall, considering a high river level scenario, with stormwater outfall gates being closed.

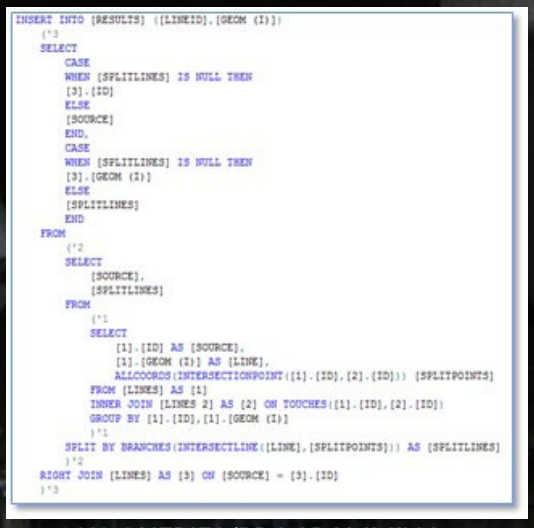
STUDY AREA

INNOVATION

The Associated Engineering team fast-tracked the modelling phase and built a model that allowed quick modifications to scenarios during the analysis. The team took advantage of the hydraulic/hydrologic model of the study area that had been originally developed in 2007 for the Northwest Inner City Drainage Study, expanding the model to include the community of Sunnyside. The team developed an innovative process, programming scripts and queries to automate data extraction from the geographical information system (GIS) and expedite model construction. The programmed scripts decreased the time and cost to build the model by 50%.

The City had not previously developed a stormwater level of service criteria for a community subjected to flooding from both high river levels and stormwater. Associated Engineering reviewed historical occurrences of concurrent high river level and high rainfall events. Using this analysis, the City selected a dual level of service, one when outfall gates are open, and the other when outfall gates are closed. Using this approach, the community is protected from concurrent high river levels and heavy rainfall, at an affordable cost. The City can apply this approach to other floodplain communities.

Associated Engineering proposed upgrades that provide resilience against multiple-flood scenarios to reduce the overall flood risk to the community. These cost-conscious recommendations included pump stations to alleviate stormwater and groundwater flooding, and a pressurized trunk sewer to convey stormwater from the upper plateau directly to the river without pumping.



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        ELSE
        [SPLITLINES]
        END
    FROM
        ('2
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        )'2
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GIS QUERIES/PROGRAMMING

COMPLEXITY

At the outset of the project, Associated Engineering anticipated that requests would regularly arise to examine new scenarios and possibly change some of the initial criteria for the drainage study. Therefore, the adaptability of the drainage model was critical. Associated Engineering examined ways to enable rapid changes to model construction, scenarios, flooding area, and the effects of proposed upgrades. The programmed GIS queries permitted easy modification of the model throughout the analysis. Associated Engineering could quickly and easily alter scenarios for varying rainfall events with stormwater outfall gates open and closed to better understand the flooding impacts for various levels of service. In the analysis phase, this approach saved the City 20-25% of the costs that would have been incurred using a manually constructed model.

Associated Engineering began the analysis phase by following the City's request to propose improvements to mitigate stormwater flooding from a 1-in-50-year event while stormwater outfall gates were closed. However, the team quickly determined that providing flood mitigation to this level of service, a highly unlikely scenario, would require prohibitively expensive improvements to the infrastructure, and would be impractical from a cost/benefit perspective.

Associated Engineering reviewed historical occurrences of concurrent high river level and high rainfall events. The City provided Associated Engineering with historic information from all 41 of their rainfall gauges. Associated Engineering programmed a mechanism to quickly and accurately import, extract and index 54 years of rainfall data at 41 rain gauges and the corresponding 54 years of flow data in the Bow River to compare the historical frequency of high river and high rainfall events. The programming enabled AE to efficiently import and extract data that was inconsistently collected at the various rainfall gauges. Associated Engineering then analyzed the historical rainfall events and corresponding river levels during those events. Analysis showed the majority of the high intensity rainfall events occurred when the Bow River was experiencing less than a 1-in-2-year return period flow. In addition, Over the 54-year period, there were only four combined events which exceeded the 1-in-2-year river levels and the 1-in 2-year rainfall return periods. In summary, the data showed that rainfall and river levels have historically been mutually independent. This analysis allowed Associated Engineering to recommend the dual level of service.

Associated Engineering programmed a mechanism to quickly and accurately import, extract and index 54 years of rainfall data at 41 rain gauges and the corresponding 54 years of flow data in the Bow River to analyze the correlation between historical high river levels and high rainfall events.

SOCIAL & ECONOMIC BENEFITS

Throughout the study, Associated Engineering supported City-led open houses, which enabled the public, and, in particular, the community Task Force to give feedback on preferred upgrades. As a result of the high level of stakeholder engagement, the Task Force fully supported the proposed level of service, the proposed upgrades, and the City's prioritization of the proposed infrastructure upgrades.

Associated Engineering's approach of quantifying the risk associated with various levels of service enabled the City to reduce the costs of proposed infrastructure upgrades within the Sunnyside area from over $200 million to $134 million. The dual level of service strategy sets a precedent for floodplain communities in Calgary and establishes a standard that can be utilized for projects in other similar flood-prone communities.

The establishment of two design conditions was immediately beneficial to the community since the proposed upgrades became a higher priority on the City's investment plan due to their high benefit-to-cost ratio. Several of the recommended projects are already in the design and construction phases, including a new stormwater pump station, improvements to an existing stormwater pump station, conveyance upgrades on 14.5 Street NW and a pressurized stormwater trunk conveying flows from the upper plateau to the Bow River. This work has been realized in part with the support of funding from the Provincial and Federal governments.

As an additional benefit, Associated Engineering's proposed infrastructure will not only mitigate rainfall flooding, but will also protect the Sunnyside community from river and groundwater flooding. These improvements will reduce the overall flood risk to the community.

Analysis helped to develop a dual level of service, which manages flood risk while reducing ctost of new stormwater infrastructure

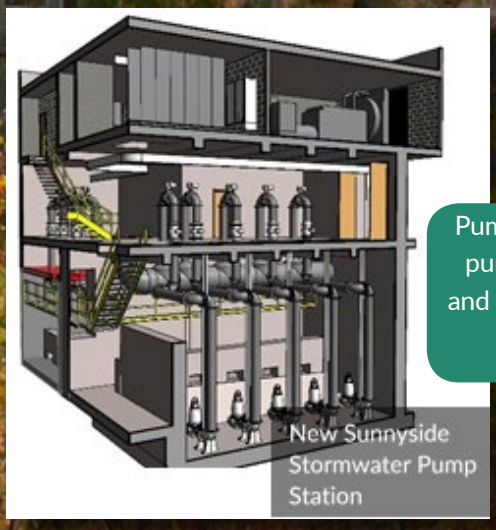
ENVIRONMENTAL BENEFITS

Associated Engineering proposed solutions that satisfy both design conditions for the community of Sunnyside and mitigate flood risk due to alternate causes, such as river or groundwater flooding. These improvements include four pump stations and a pressurized storm trunk directly conveying flow from the upper plateau to the Bow River.

The pump stations are intended to pump the stormwater, but by positioning them in the lowest areas of the community and study area, they also help alleviate river flooding. In addition, Associated Engineering designed the pump stations to allow future connections of groundwater subdrains to mitigate groundwater flooding. This multi-purposing of infrastructure provides The City and community with better value for their investment.

The existing, gravity storm trunk collecting flow from the upper plateau is aligned underneath Sunnyside with manholes in Sunnyside and a gate to the Bow River. When this trunk surcharges, the first location it floods is in Sunnyside. Associated Engineering proposed a pressurized stormwater trunk sewer, to replace the existing gravity trunk. This new trunk will convey flow from the upper plateau directly to the Bow River, using the driving head generated by the elevation change, thus eliminating the need for pumping, and its associated energy consumption. Since the pressurized trunk will not have manholes in Sunnyside, it will not cause flooding in the community, even during a high river level.

The flood mitigation works reduce the risk of future flooding, protecting the community and its environmental assets, including parks and pathways.



New Sunnyside Stormwater Pump Station

Pump stations will serve a dual purpose: pump stormwater to alleviate flooding and connect to groundwater subdrains to mitigate groundwater flooding

MEETING CLIENT'S NEEDS

The Sunnyside drainage study and flood management plan provides an economical and resilient stormwater management solution for the City of Calgary's Sunnyside community.

Associated Engineering's creative application of GIS tools to create queries and use of an established hydraulic/hydrologic model for the study area helped to expedite development of a detailed stormwater model for Calgary's Sunnyside community, providing significant cost savings for the City. When Associated Engineering's analysis showed that stormwater and river levels have historically been independent, the team suggested an innovative approach: adopt a dual level of service for the Sunnyside community.

Using a dual level of service will reduce future flood risks, while lowering the overall cost of new stormwater infrastructure. A first in the City of Calgary, the approaches used for the Sunnyside Community Drainage Improvements Study are a model for other communities seeking to create resilient and sustainable stormwater management solutions.

The recommended flood management projects provided resilience against multiple flooding mechanisms to reduce the overall flood risk to the community. Using the dual level of service and developing multi-purpose solutions gave improvement projects a high benefit-to-cost ratio. As a result, these projects became a high priority in the City's investment plan, and many of the proposed projects are already in the design and construction phase.

The innovation applied throughout this study provides the City with excellent value for their investment and provides the Sunnyside community with resilience to future flooding.

- 33% overall cost reduction in proposed upgrades from $200M+ to $134M
- Half the time and effort required to build the dual drainage model using innovative automated processes
- First dual level of service approach used in Calgary