Grand Forks Floodplain Risk Management and Protection Project

Proposal to Provide Professional Consulting Services

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1.0 Introduction

Urban Systems is pleased to submit the following work plan to undertake a floodplain risk management study for the City of Grand Forks with the aim of assessing flood risks, preparing flood maps, and developing mitigation plans intended to protect the community from flooding. Throughout our work plan, we will refer to this group of major tasks and objectives as a flood hazard study.

Our work plan has been prepared to support applications for grant funding. Furthermore, our work plan presents our understanding of the objectives of a study of this sort, and a set of tasks that will be undertaken in order to achieve the broad aims and directions identified in the following Association of Professional Engineers BC (APEGBC) reference documents:

- *Professional Practice Guidelines – Legislated Flood Assessments in a Changing Climate in BC, June 2012*
- *Flood Mapping in BC, APEBC Professional Practice Guidelines, V1.0, January 2017*

Our work plan focuses on two key areas. The first is a detailed scope of work that we feel is appropriate to achieve the goals and objectives associated with a flood hazard study. The second is a detailed description of our corporate and individual experience and qualifications related to the preparation of flood hazard studies and related work. This is intended to demonstrate the depth and breadth of our skills and experience in the key areas identified in the RFP, such as hydrology, hydraulics, climate, stream channel morphology, community planning, and stakeholder engagement.

In preparing this work plan, we have considered the various components that should ideally be examined in such a study, as well as the cost and value of the depth and breadth of exploration and analysis associated with those components. We believe that our work plan presents a clear picture of the work that we feel is both necessary and sufficient to achieve the City's goals associated with this undertaking.

In order to undertake this work in an efficient and effective way, we have assembled a project team that is well suited to the proposed methodology. We also propose to use our survey team from Calgary to provide field survey services.

2.0 Our Understanding

The City of Grand Forks has been affected by high flood water events in the Kettle and Granby Rivers in recent years. While extreme events of this sort might be seen as rare, they can and sometimes do occur more frequently than expected by the public and community leaders. Extreme events are often referred by their return period, for example, a 100 year event. However, this is normally done in order to help decision-makers more easily imagine the magnitude and severity of an event. It is more appropriate, however, to consider severe events in terms of their probability. A 100 year event, for example, is actually a 1% probability event, and this means that there is a 1% probability that an event of that magnitude and severity will occur in any year.

Snow melt generated runoff events tend to affect larger watersheds – those in the order of thousands of square kilometers. This is significant in the case of Grand Forks, and the Kettle and Granby watersheds, since they are of the size that will be expected to be affected by snowmelt events. In fact, the combined watershed area of the Kettle and Granby Rivers below their confluence in Grand Forks is almost 9,000 km^2. Furthermore, the potential impacts of climate change may adversely affect the historic occurrence of such events. Projections suggest increased precipitation during the winter, with a higher change of rain-on-snow events and earlier snowmelt due to a more rapid onset of warmer spring weather[1].

Rainfall generated extreme runoff events tend to have a greater impact on relatively small watersheds, up to a few hundred square kilometers. Some of the smaller tributaries to the Kettle and Granby Rivers in the vicinity of Grand Forks are more likely to be affected by rainfall events.

Designated floodplain maps for the Kettle and Granby Rivers were created in 1991 by Acres International Ltd. under the Canada-British Columbia Floodplain Mapping Agreement. The study assessed a 52 km length of rivers, which included the Kettle River from its westerly and easterly crossings of the US border, and the Granby River for a length of about 10 km north of Grand Forks.

The analysis used to calculate the design flood flows relied primarily on two flow recording stations; WCS 08NN002 and 08NN012. The first, 08NN002, measures the Granby River at Grand Forks, and includes a period of record beginning in 1914 and running intermittently to the present. The second, 08NN012, measures the Kettle River at Laurier, WA, and includes a period of record beginning in 1930 and running to the present. It is worth noting that station 08NN012 is actually a boundary station, and is operated and maintained by the US Geological Survey (USGS station 12404500), however, the data are readily available.

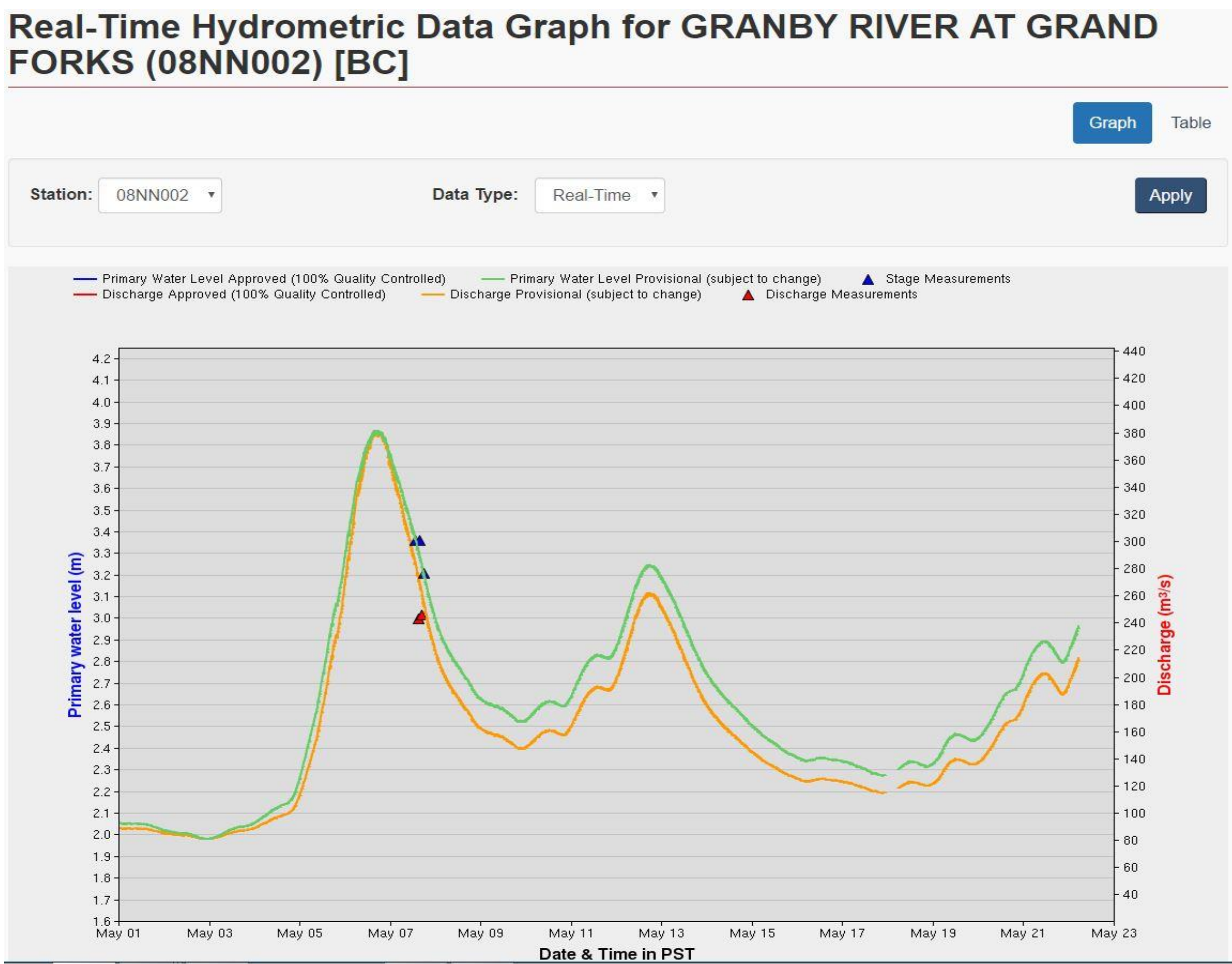
Regardless, because the noted floodplain study was done in 1991, it made use of peak flow data that were available at that time. There are, however, an additional 25 years of data that are now available to update the peak flow estimates, and these may reveal higher design flows than were calculated in 1991.

[1] Pacific Climate Impacts Consortium Plan2Adapt

Furthermore, the potential impacts of climate change on peak flow estimates are now much better, although not fully, understood. The potential impacts of future climate should be taken into consideration when developing a flood hazard plan. Guidance for incorporating climate change impacts in flood studies is provided in the APEGBC document *Professional Practice Guidelines – Legislated Flood Assessments in a Changing Climate in BC*.

It is interesting to note that the 1991 study calculated the 200 year return period peak flood flow for the Granby River to be 385 m^3/s. The real time hydrograph for the Granby River flow recording station in Grand Forks, shown in Figure 1, shows that this flow estimate was almost reached earlier this spring on about May 7.

Figure 1 – Granby River Hydrograph for May 2017



There is other information in addition to the 1991 Acres study report that is available and that will serve as a valuable resource in the updating of the existing flood maps. Because Grand Forks is located on the border with the US, there are Flood Insurance Rate Maps (FIRM panels) available from the Federal Emergency Management Agency (FEMA) for the Kettle River immediately south of Grand Forks in the US. These panels show flood hazard levels in terms of water elevation, and will be useful for comparison and calibration purposes. The available FIRM panels are dated May 2006.

Considering these factors, our understanding of the context of this particular study has generated some specific issues that we believe are important and should be addressed in the development of this flood hazard study. These issues include:

- The need to update the hydrologic analysis and peak flow estimates for the Kettle and Granby Rivers in Grand Forks, as well as the hydraulic analysis used to establish flood levels in the two rivers.
- The need to better understand existing flood hazards and risks to existing development, property, and critical infrastructure;
- The need for an assessment of future development plans and land use intensification near river channels to reduce flood hazards and avoid creating new problems, and an assessment of the options available for dealing with existing risks;
- The need to establish a range of suitable, efficient, and cost effective measures for dealing with flood hazards, including potential solutions such as identifying hydraulic improvements at crossings of creek channels (bridges and culverts), erosion protection through bank armoring, flood protection through diking or improving existing dikes, and emergency response strategies related to debris management during flood conditions;
- The need to understand how infrastructure assets may affect flooding potential in the city, particularly the railway and highway bridge crossings.
- The need to develop a long-term capital improvement plan aimed at upgrading the performance of the existing drainage system, where possible and practical, over time; and
- The need to identify non-structural mitigation plans, such as a bylaw aimed at flood hazard protection through municipal regulations.

Our work plan was developed to create a flood hazard plan focused on addressing specific problems within the City, and has been based on the demonstrated performance of best management practices, with the aim of learning and adapting from our real-world experience.

3.0 Our Approach

Our approach to a study of this sort is guided by a few principles based on the insights we have gained from our experience:

1. Flood hazard planning is a means to an end, and not an end itself. Strategies and actions need to add value to staff, to the City of Grand Forks, and to the community. In the approach we take, strategies and actions will be developed with the end in mind, always asking the questions, how will this be used, and how will this make a difference?
2. Make use of what is there. Grand Forks already has many of the building blocks of a flood hazard study. This information, and the connections with stakeholder groups, can be leveraged for improvement and implementation. Using existing knowledge, relationships, and processes is usually more effective and efficient for implementing a study of this type than building new and additional processes from scratch.
3. People are always at the centre. People will implement the flood mitigation plan and adapt to what is learned through the process – or not. While technical expertise is necessary, it is not sufficient. We will continuously strive to make the topic relevant and engaging to staff and stakeholders and consider their input before proposing solutions.

In the case of a flood hazard study, there is a great deal of value in the anecdotal information that can be provided by City staff and members of the community. One of the most effective ways of gathering that information is through public meetings or workshops. The anecdotal information is particularly valuable for confirming the adequacy of the computer model and the results it produces.

With these principles in mind, our approach is to facilitate three important changes that are enhancements over what is the traditional for infrastructure planning:

- Change #1 – A Better Way to Get You Involved
- Change #2 – Thinking Adaptively Upfront
- Change #3 – Recommendations that CAN be implemented

Change #1: A Better Way to Involve Decision Makers

We have found that the traditional approach of "getting your input" often misses the mark, as it is typically synonymous with "reviewing consultants' reports". While we do need you to review reports, what we really need you to do is make decisions. Instead of engaging you only through review processes, we propose to engage you in a much more meaningful way: through workshops where we will facilitate decision-making. Instead of "meeting to talk", we propose "workshops to decide."

We believe this approach is more effective because the technical analyses associated with a flood hazard study are really intended to inform higher-level decisions. These decisions are all about preferences, risk-management, and values – making them requires skilled facilitation.

To develop the flood mitigation plan, we will help you think through decisions like:

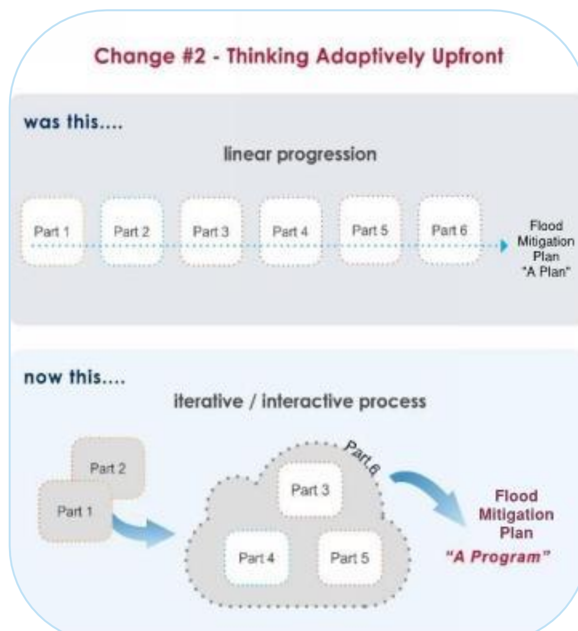
- How are you going to work together to develop and implement this flood mitigation plan?
- What risks to values need to be addressed?
- What does risk-management look like?
- What actions should the City of Grand Forks and regional stakeholders take first?
- What is needed to enable these actions?

All of our work will be geared towards informing these important decisions to advance the flood mitigation plan. This improved approach to engagement will help the City:

- Generate a flood mitigation plan that genuinely speaks to the City's values and capacity.
- Garner support across departments because there is a real decision-making role for staff to play.
- Make efficient use of your time – you will always have clarity on why you are being engaged and what decisions you will be asked to make.

Change #2: Thinking Adaptively Up-front

Programs and plans are typically carried out in a linear fashion. The problem with this is that implementation and adaptive management often feel like they have been tacked onto the end as an afterthought. We want to bring these considerations much further up in the process to significantly increase the likelihood of success for your flood mitigation plan. Ignoring implementation and adaptive management implies that key questions are not being considered when recommendations are being made. In fact, these questions should be asked earlier in the process:



- What does success look like? How can it be measured? How much will measuring success cost?
- What and who has influence on how the flood mitigation plan is implemented? How can we leverage partnerships?
- What capacity needs to be built within the City to achieve desired outcomes?

Bringing consideration for implementation and adaptive management early in the study process will:

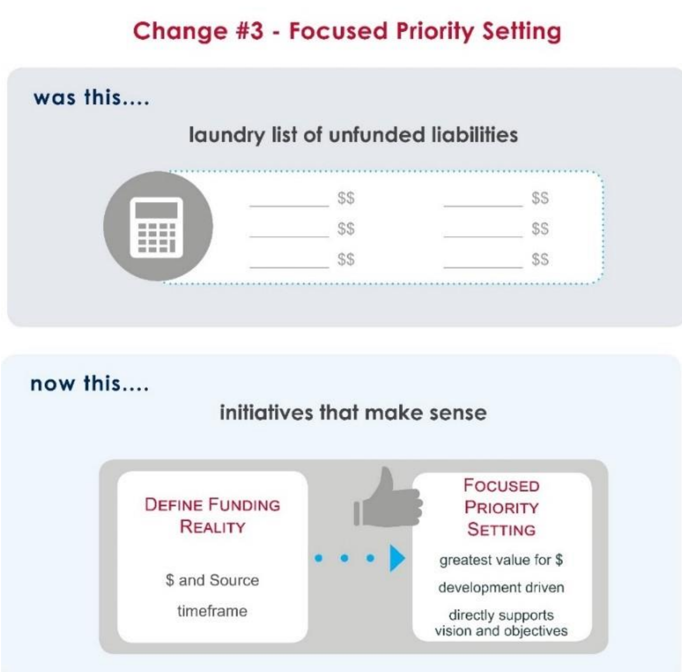
- Yield a more successful flood mitigation plan – a living program as opposed to a document that sits on a shelf;
- Ensure City resources are directed to implementation strategies that will add the most value; and

- Place the City and regional stakeholders in a position to proactively adjust management strategies for the future.

The capital investments proposed need to fit within and complement existing infrastructure (new and proposed) plans and asset management schedules as established within existing short and long-term budgets and capital plans.

Change #3: Recommendations That Can be More Easily Implemented

Programs and plans often generate long lists of recommended actions and projects. This is because it's often felt that *everything* needs to be addressed in order to be successful. However, based on our understanding from similar work in several communities, we often find that resources get spread too thin, recommendations don't get fully implemented, and desired outcomes aren't met. So, we propose to focus our efforts right from the beginning on what matters most to the City, and to develop an action plan through the lens of priorities, available funds, and City capacity.



Focusing on priorities is important for all aspects of the flood mitigation plan: from the information gaps that are identified and filled in the beginning, all the way to the recommendations for actions that are provided in the end. By understanding values and acknowledging and respecting resource constraints, we force ourselves to think much more carefully about where resources are best allocated. This mitigates two key risks: first, to the project process – namely scope creep; and second, to project outcomes – namely recommendations that can't be implemented and become "unfunded liabilities". By developing a more focused list of recommended flood hazard mitigation actions, we offer City staff a clear rationale for each recommendation, which, with public support, can be used to build a strong argument for additional funding to enable implementation of the study results.

4.0 Methodology Framework

Based on our understanding of the issues to be addressed through this study, and the proposed approach to be taken, we have prepared a framework methodology that identifies the tasks that could be undertaken in order to prepare the flood mitigation for the City of Grand Forks and regional stakeholders. We have explicitly described in reasonable detail the level of effort that will be applied to the various tasks, and have used this to establish an associated fee summary to demonstrate that the work can be done for the available budget.

The intent of this section of our work plan is to provide a scope of work that will result in a workable, implementable flood hazard study and flood mitigation plan. However, we recognize that the final scope of work will be established through further discussions with the City based on the funding that is ultimately available to undertake the work, and the work program can be amended to alter the framework in terms of the scope of work, level of effort, schedule, and fees if the City feels that taking this step would result in a project that is better aligned with your specific goals and priorities.

Phase 1 – Data Collection

4.1 Project Start-up

Prior to beginning any work on the project, the first step will be for our key team members to meet with City of Grand Forks' project team to carry out a comprehensive review of the proposed approach to the delivery of the project. This meeting will be used to review and confirm scope of work, provide an opportunity for the City's staff to give feedback on our proposed approaches, and have a team-oriented discussion about the reasons for taking these approaches. We will also use this opportunity to confirm what the City's team will be responsible for, and what Urban Systems' team will be responsible for. We will prepare and distribute meeting notes of this meeting to document the discussion and decisions. At the meeting, we anticipate discussing the following issues or items:

- Introduce project teams, both City's and Urban Systems';
- Establish protocols for information exchange and reporting;
- Verify scope, goals and objectives, budget and schedule;
- Develop a preliminary list of issues, challenges and opportunities that will be addressed in the project;
- Identify areas in community that will be the focus of the flood hazard assessment;
- Develop a preliminary outline of potential alternative strategies;
- Clarify the form and content of deliverables, including the interim submissions, public information packages, and final flood mitigation plan document; and
- Undertake a tour of the community to examine key drainage infrastructure and known flood hazard issues.

4.2 Gather and Review Background Material

The purpose of this task is to research and summarize the existing conditions within the study area based on past studies, development servicing standards, land use plans, the OCP, GIS data, historic air photos, and any other relevant studies. During the preparation of this work plan, we have already undertaken a cursory review of some existing documents to develop an understanding of the quality of information available, and the relevance to the current study. The available information will be used to extract relevant information about the study area. In particular, information about hydrologic and hydraulic conditions, and past and existing drainage problems.

The available reports and documents will also be used to collect information about past recommendations related to drainage system improvements, and to confirm whether the improvements were undertaken, and the effect they had. It may also be relevant to learn that recommended improvements were not undertaken, and to determine the underlying reasons why they weren't carried out.

Geo-spatial data will be gathered for use in the hydrologic and hydraulic modeling of the drainage and stormwater systems in the study area. The City has recently acquired LiDAR (Light Detection And Ranging) data, which will be used to build an accurate digital elevation model. If topographic data is needed outside of the City boundary, partnerships and funding will be sought for acquiring LiDAR or other data in addition to contour mapping for the study area available from Natural Resources Canada maps and Provincial TRIM maps. Channel bathymetry will be collected with field survey data during this study.

4.3 Regional Runoff and Statistical Analysis

Flood assessments are typically done to delineate the area that can be expected to flood once every 200 years, on average. This design event is normally referred to as the 200-year flood. As noted earlier in the work plan, it may be more helpful to think of this as the 0.5% probability event, and remember that it has a 0.5% probability of occurring in any given year.

The hydraulic analysis that will be carried out will be done using data from streamflow record sets maintained by Water Survey Canada and the US Geological Survey. The regional analysis and rainfall data sets will be correlated in order to project a design flow rate that takes into consideration historical flood measurements. The data sets will be analyzed and statistical projections of design events calculated using a range of probability density functions that are appropriate for hydrologic analysis, including:

- Gumbel Extreme Value Type I
- Pearson Type III
- Log Pearson Type III
- Two Parameter Log Normal
- Three Parameter Log Normal

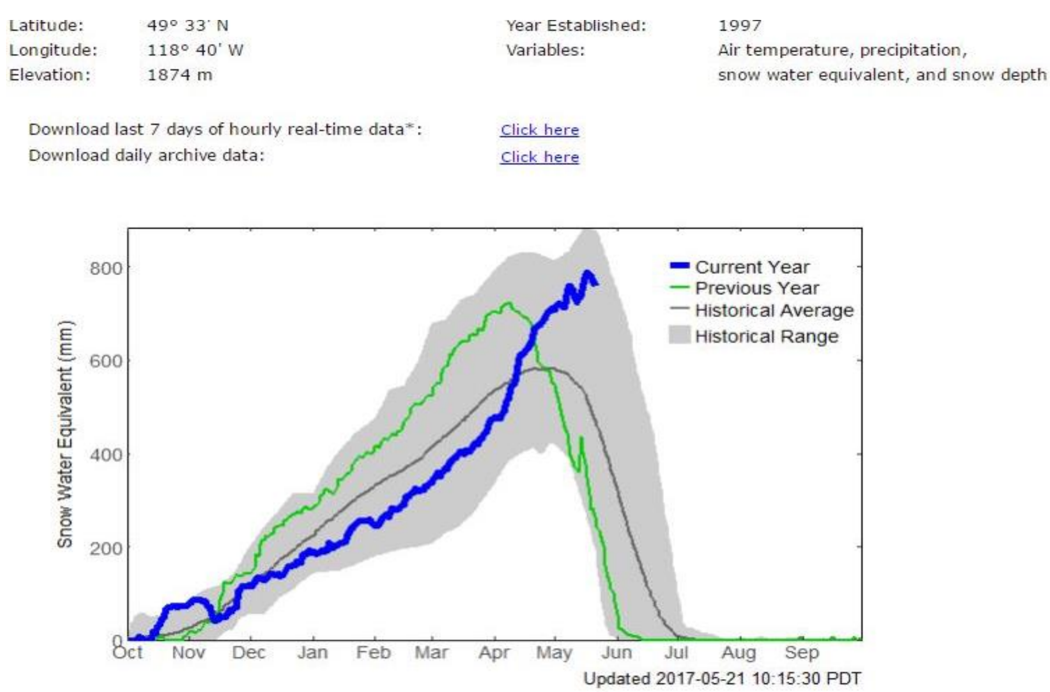
These data sets will be used to create and select a set of flood peak flow probabilities based on historic events, which will be modified in a subsequent task to account for climate change impacts.

4.4 Establish Climatic Data Conditions

Rainfall and snowfall data are one of the key components critical to developing a sound flood hazard study as this information helps to form the basis for hydrologic modeling and assessment. There are no Atmospheric Environment Services (AES) weather recording stations in the vicinity of Grand Forks. The nearest active stations are in Oliver, to the west, and Castlegar to the east. The current Intensity/Duration/Frequency (IDF) curves for these two stations make use of data up to 2005 and 1995 respectively. Both stations are active, however, so data sets up to 2017 are available. These data sets will be obtained, and the outcome of this task will be an updated IDF curve and the selection of a rainfall distribution for the assessment of current conditions, and to be used as a foundation for projected future climate conditions.

Snow pack data are also important to the understanding of peak flood events in watersheds like the Kettle and Granby Rivers. We will make use of historic snow pack data to establish the relationship between total annual precipitation and precipitation falling as snow. There are two nearby automated snow weather stations located in the Kettle River watershed. The Grano Creek station (2E07P) is maintained by the Ministry of Forests, Lands, and Natural Resource Operations. As shown on Figure 2 the current year snow pack is near the maximum recorded values for the period when this report was written. The Sentinel Butte SnoTel station is located due south of Grand Forks in the American Kettle Range.

Figure 2 – Grano Creek Snow Pack Data



In addition to automated snow pack data, manual snow pack data also exist. Stations within the watersheds contributing to runoff of the Kettle and Granby Rivers include stations Carmi (2E02), Bluejoint Mountain (2E06), and Farron (2B02A). These will be used as well as the automated data to establish regional snow pack conditions for the periods of record available.

4.5 Climate Change Adaptation

Consideration of climate change adaptation is now a normal aspect of hydrologic analysis. It takes into consideration the potential future climate conditions that are relevant to hydrology, and the measures that are available to reduce the adverse impacts that might arise. Professional engineers practicing in BC are required by their professional association, APEGBC, to consider the issues surrounding climate change so that informed decisions can be made about adaptation. Professional responsibilities are outlined in the APEGBC position paper *A Changing Climate in British Columbia – Evolving Responsibilities for APEGBC and APEGBC Registrants*.

Ideally, changes to hydrology – specifically peak runoff - would be determined using a hydrologic model with projected climate. Since such modeling work is beyond the scope of this project, we will conduct hydraulic sensitivity analyses based on peak flows projected from available climate change resources.

Since the Granby and Kettle watersheds are snow-dominated, projections with respect to precipitation, temperature, and snow depth prepared by the Pacific Climate Impacts Consortium (PCIC) will be used. PCIC offers this information, generated from the output of an ensemble of Global Circulation Models (GCMs), through two tools – "Plan2Adapt" and the "Regional Analysis Tool". Projections based on GCM runs using Representative Concentration Pathway (RCP) scenario 8.5 or Special Report on Emissions Scenarios (SRES) scenario A2 – both of which reflect little-to-no effort by governments to reduce GHG emissions – will be used since these are the most conservative assumptions.

Peak flows and annual runoff volumes will each be plotted against combinations of annual precipitation, temperature, and snowpack using historical records. Curves will be fitted to these data and corresponding coefficients will be determined. These equations will be applied to the projected climate values to estimate future peak flows and runoff volumes.

We will also develop future IDF curves for the Oliver and Castlegar climate stations using the University of Western Ontario IDF-CC Tool – an on-line tool for developing IDF curves based on the results from an ensemble of GCMs. This information will provide additional context for developing a set of projected peak flow values that take into consideration both historical records and potential climate change impacts.

4.6 Field Survey of River Channels

The calculation of flood levels relies on both hydrologic information as well as physical parameters of the river channels. One of the key physical parameters is the geometry of the channel that conveys the flow. We have reviewed the information that is readily available and found that it is not suitable for the purposes of this study. As such, we have assumed that further survey field work will be required.

We have obtained a price from our Urban Systems survey team to carry out a field survey – to obtain channel cross sections at suitable intervals for the hydraulic modelling of the Kettle and Granby Rivers. We have assumed that the survey will extend from approximately 2.3 km downstream of the confluence of the two rivers, to 7.1 km upstream of the confluence on the Kettle River, and to 2.6 km upstream of the confluence on the Granby River for a total length of approximately 12.0 km. This will be confirmed with the City prior to the start of the project. The survey will also pick up relevant geometric and elevation information for the six crossing structures on these two rivers within the City of Grand Forks.

The survey will generate channel cross section and elevation data that will be used in the analysis of the water surface profile. Our survey team will carry out the work under the following conditions:

- Implementation of an access plan with landowner notice and direct contact prior to accessing sites.
- A combination of Static GNSS techniques, RTK and RTN techniques to be used to establish a precise, reliable Survey Control Network to service the length of the project and for future needs.
- Survey Control Network to be integrated with existing BC Survey Control and/or the Canadian Base Network. The 3TM NAD 83 (CSRS) coordinate system will be used with the CGVD28 Vertical Datum.
- A Least Squares analysis and adjustment of survey control data will be completed before use of this control in data acquisition (survey cross-section) tasks. A 0.05m or better accuracy at the 95% confidence region will be achieved.
- Control Points to be used will include existing survey control markers, statutory iron posts, and newly placed iron bars of sufficient gauge and length for local conditions.
- Conventional survey techniques (RTK and Total Station) will be used for topographic pickup of on-ground features within each cross-section, as well as to collect in-stream information when required.
- All infrastructure crossings will be surveyed and recorded to a high level of detail. These include bridges, roads and culverts. Cross-sections will also be measured immediately on either side of each particular crossing.
- Detailed "geo-referenced" photos will be taken at each infrastructure crossing and at most cross-sections or other key areas along the length of the river. These photographs will be linked to coordinate survey points for easy reference.
- Our well established quality assurance procedures will be used for all survey data collected throughout the project life cycle. These include systematic field procedures, raw data analysis, redundancy checks and statistical analysis.
- Our well established internal filing procedures will also be relied upon to promote ease of access and efficiency. All survey data is recorded and stored within the same system with GIS and engineering data, and is familiar to all people working on the project.

4.7 Develop a Communication and Engagement Plan

Our communication and engagement specialist will develop a Communication and Engagement Strategy (CES) that will serve as the guiding document for community and stakeholder engagement throughout the project. We will provide strategic best practice advice and proven engagement tools and techniques to support the project team in coordinating and delivering engagement activities that will build awareness and facilitate important input to help inform the flood hazard study and create buy-in for eventual solutions.

The CES will assist the team in anticipating and meeting the communication and engagement needs of municipal partners, land owners and the general public throughout the project. The plan will be developed in consultation with the entire project team, and will include the following components:

- Level of engagement – as defined by International Association of Public Participation (IAP2);
- Communication objectives;
- Audience identification and Analysis (including risks and opportunities);
- Key messaging;
- Communication and engagement tools and techniques to be used throughout the process; and
- Success indicators

Not every component of the project will require community and stakeholder involvement. At some stages, there may simply be a need to provide information about the project. At other times, the community and stakeholders will play a significant role in identifying flood hazards and providing input into proposed solutions.

Key audiences are expected to include:

- BC Ministry of Transportation and Infrastructure
- Regional District of Kootenay Boundary
- Local land owners within the flood hazard area
- Interfor
- Developers
- Local NGOs
- Ministry of Forests, Lands and Natural Resource Operations
- Emergency services (RCMP, Fire Department)
- Relevant municipal committees
- Local environmental organizations
- Local recreation clubs
- Community members

Working with our internal writers and graphic design specialists, Urban will produce all communication and advertising materials to support the communication and engagement on this project.

4.8 Project Workshop #1

Following the completion of the preceding tasks, we will meet with the City's Project Team to review the background information and undertake discussions about the viable approaches to dealing with floodplain management issues in the study area. Though we will provide a brief overview of project status and existing conditions within the watershed, the primary focus of this meeting will be to identify opportunities and constraints related to floodplain management in the study area. We specifically wish to identify and overcome the real or perceived barriers in developing and implementing the final plan.

We will also prepare a draft Table of Contents outline for the final flood mitigation plan document and present it at the meeting for review and discussion. We hope to obtain signoff on the outline early in the process, such that the outline can be populated with information, results, and conclusions as the project proceeds. Our aim is to ensure that expectations are clear and agreed upon by all parties from the start with regards to the content of the final document. This course of action will also allow for a quick turnaround between the draft and final plan submissions, as most of the document will have already been reviewed and approved by City's project team as part of the interim submissions.

4.9 Community and Stakeholder Engagement #1

We believe that providing information and engagement opportunities, at the earliest stage of the project, will help to build awareness and support for this work and lead to better solutions that are supported by community members and key stakeholders.

To engage community members, we suggest a "go to the people" approach, whereby we would set up pop-up booths in locations where community members are already gathering. Experience has shown us that scheduling an "open house" event where people must attend at a specific location and time often generates low participation. Setting up booths during community events or in a busy park will allow the project team to connect with many more community members. Advertising these displays in advance will also help to draw more people. Email invitations to special interest groups, such as environmental organizations or recreation clubs, may also help to draw in a wider diversity of perspectives.

In connecting with key stakeholders, we propose face-to-face meetings whereby members of the project team can present background information and solicit input that is specific to stakeholder interests. These meetings are intended to build awareness for the project, encourage land owner support for the study, ensure ease of access to the survey areas and gather relevant input from stakeholders that will inform the study.

We envision holding up to four meetings with various stakeholders. Letters would be sent to each of these groups to provide background information and invite their participation.

Phase 2 – Analysis

4.10 Computer Model Creation

This task is to develop a hydraulic model of the selected segments of river channels within the study area. The work includes incorporation of all pertinent topographic, geometric, geomorphologic and hydrologic data into a single, calibrated, backwater model that accurately represents flood conditions, including hydraulic and energy grade lines, and estimated flow depths and velocities. This task is central to the entire flood hazard study.

Development of the hydraulic model will bring together the cross section and structure survey. Data and model management and documentation will be thorough, using standardized naming conventions to ease future use of the model. We will use HEC-RAS to perform this work.

The HEC-RAS hydraulic model development will require a number of steps:

- Document past flood history, including recent and recorded flood events as well as historic and observed events; information will be gathered from a variety of sources, such as local authorities, Water Survey of Canada, the Provincial Archives, newspaper archives, and local libraries.
- Input geometric data to HEC-RAS from the surveyed cross sections and LiDAR, with sections extending beyond largest floodplain expected to be identified. HEC-GeoRAS or other proprietary software may be used to assist with this task.
- Sufficient downstream sections will be included to provide normal depth results through the entire subject reach.
- Input roughness based on observations obtained in the field.
- Input expansion and contraction coefficients for crossing structures, such as bridges and culverts, based on standard practice for various situations.
- Input geometric data to HEC-RAS for flood control structures, bridges, weirs, and other significant river and flood plain features. Locations of cross sections, placement of ineffective flow areas, and the other parameters for modeling the structures will follow accepted and recommended procedures and guidelines as described in HEC-RAS.
- Input discharge data at appropriately located cross sections for all event frequencies.
- Calibrate to previous flood study undertaken by Acres International Ltd. in 1991.
- Calibrate the model with reference to other historical, surveyed highwater mark data from past floods where this information is available and accurate. If at all possible, and depending on the quality and quantity of historic water level data that is available, the data set will be subdivided into calibration and validation sets, to confirm reliability of the model. In an attempt to yield a single geometric model capable of simulating the entire range of event frequencies, we will exercise professional judgment while calibrating.

Once calibrated, the HEC-RAS model will be used to compute water surface elevations for the selected channel cross-sections. Flood profile plots will be generated on one set of profile drawings. The plots will show all necessary variables to interpret fully the flood profiles.

Sensitivity analyses of the calibrated model will also be conducted by varying boundary conditions, channel roughness values, and overbank roughness values, for the 200-year frequency flood event. Results will be presented in both tabular and graphical form to convey the impact of the various parameter values. Sensitivity analyses using the projected peak flows reflecting climate change will also be completed. These results will be summarized and presented with the base results for comparison and discussion purposes.

The HEC-RAS model creation will be documented so that it can be included in the final study report. In order to properly document this step, it will describe and characterize the entire model creation and calibration process, including a discussion of the historical flooding conditions experienced in the study are and a description of the reliability of the model based on the sensitivity analysis. Other items that will be included in the report include, but are not limited to:

- Methodologies;
- Data sources;
- Procedures;
- Assumptions; and
- Tabular and/or graphical presentation input and output data

4.11 Flood Map Preparation

The purpose of this task is to translate the results of the hydraulic modeling to maps that show the extent and depth of open water flooding projected for the design flood event.

The draft maps will be prepared using the 200-year frequency flood. A scale suitable for tabloid-size paper (11" x 17") will be used; this scale may be used for all flood inundation mapping or only for floods with frequencies less than 200-year. The draft maps will provide all information required to orient the extent of inundation with respect to the built environment (roads; community boundaries; significant infrastructure), using aerial photography background. Neither contours nor hydrography will be shown on the map.

Using the entire set of HEC-RAS results, flood extents will be mapped and overlaid on the base maps. The flooded areas will be shown in with transparent shading and dark solid boundary outline. Flood frequencies and discharge values will be shown on each map. Mapping will be completed using automated GIS tools, manually adjusted where necessary to account for topographic anomalies and to provide smooth transitions between cross-sections.

In addition, we will provide a full discussion of the potential impacts of open water flooding on major infrastructure (roads, bridges, and utility crossings) and developed areas (residential, industrial, and institutional). The discussion will consider the 200-year frequency event as well as other events to provide as complete as a possible a picture of the implications of flooding.

4.12 Flood Hazard Assessment

The objective of this task is to develop an inventory of land parcels, buildings, infrastructure, and population that may be at risk of flooding, based on both open water flood inundation and flood hazard maps. The intent of this task is to obtain statistical information to help quantify potential flood vulnerabilities within and around the study reach, and to develop a basic inventory through desktop characterization.

Urban will collect all readily available spatial data relevant to the development of the flood risk inventory. Data includes cadastral and land parcel information, major and minor roads, important institutional buildings (e.g. hospitals, retirement homes, schools, and government buildings), water treatment facilities, and any other major infrastructure. Census data will also be obtained.

- Urban will create an inventory of all non-readily available spatial data. We will create a set of spatial data using land parcel centroids from cadastral information, and major building and infrastructure centroids from detailed provincial and municipal datasets when available.

- In such cases where these datasets are not available, the most recent aerial imagery will be used to delineate major buildings and based on size and other collected local information. Centroids for all major buildings and infrastructure obtained through aerial imagery will be identified post-delineation.
- Spatial data compiled will be inventoried and categorized using basin GIS tools. Classification of spatial data will be performed based on the three major categories: (1) Residential Buildings, (2) Non-Residential Buildings and (3) Major Transportation infrastructure.
- Once the spatial data have been compiled and inventoried, statistics will be prepared for the numbers and/or type of land parcels, infrastructure and population that may be at risk of flooding under different frequency scenarios.
- We will identify the number of land parcels, residential and non-residential buildings, water treatment facilities and other non-residential buildings at risk.
- The number of bridges, as well as the kilometers of roadways and railways at risk will also be identified.
- Estimated population at risk will be identified based on flooded areas and estimated population numbers per land use.
- Statistics will be reported by inundation area as well as floodway and flood fringe zones. Statistics will also be reported by reach, community and local authority to provide more relevant information to individual stakeholders.

All spatial data will be converted to ArcGIS 10.4 geodatabase format, in NAD83 UTM ZONE 11 coordinate system.

4.13 Channel Stability Assessment

The objective of this task is to provide a qualitative evaluation of general channel stability along the study reach by comparing current and historical bank lines, cross-sections, thalweg (river centerline) profiles, and rating curves. It is important to note that this is not meant to be a comprehensive study of bank erosion or channel migration, and that limited quantitative information will be provided.

Preparation of Historical Aerial Photos: We will identify and obtain historical aerial photography that is both available and suitable for analysis.

Channel Bank Delineation: Because of the qualitative nature of the work, banks will be defined to produce GIS files documenting historic and current channel conditions along the study reaches. The results will be presented as a series of air photo mosaics at a scale of approximately 1:5,000 and including imagery and GIS datasets.

Description of Channel Changes Over Time: If the changes in channel conditions over time are of sufficient magnitude, they could affect the results of any floodplain mapping analyses. We will therefore identify areas where significant vertical or lateral channel instability is likely to occur and suggest a methodology for incorporating these effects into the model studies. This might take the form of a freeboard allowance or more elaborate procedures based on site specific hazard and risk analyses.

This part of the study will describe areas of channel instability and will attempt to provide an understanding of why channel change is occurring, how areas of instability are evolving over time or what future conditions are likely to be. We will make recommendations for modifications to the flood hazard mapping based on the results of these findings.

4.14 Flood Mitigation Planning

Working closely with City staff, we will develop a strategy for the City to modernize its efforts for responsible flood hazard management.

1. Facilitate a workshop with Council and staff to develop guiding principles for floodplain management in the community.
2. Review the City's current policies, bylaws, design standards, and development guidelines with respect to floodplain management, and make recommendations to enhance these.
3. Perform background research on floodplain management bylaws then prepare a briefing paper on the use and advantages/disadvantages of adopting such a bylaw. Recommend provisions for inclusion in a potential new Grand Forks floodplain management bylaw.
4. Recommend capital improvements, if any, to minimize loss or damage to currently at-risk public infrastructure.

We will also develop strategies for long-term adaptation to prepare Grand Forks for changing conditions over time and to respond when flooding occurs. To do this, we will:

1. Develop a plan for regular updates of the 0.5% annual probability design flood estimate and recommend a "trigger" for the need to update the river model and flood hazard mapping.
2. Prepare a hazard response action plan, including a proposed implementation plan.
3. Recommend a long-term public awareness and engagement program to address flood and stormwater management in Grand Forks and explain the role residents and businesses can play in implementation, disaster preparedness. We will identify purposes, messages, methods and audiences for the public awareness initiative.

4.15 Cost Estimates

For each of the improvements identified to address existing or future drainage issues, we will prepare Class 'D' cost estimates. This information can be used by the City for setting budgets for its capital improvement program, and could also be incorporated into the planning for development cost charges. Our work, however, does not include the development of DCCs, or the identification of sources of funding to pay for improvements to the proposed stormwater system.

4.16 Project Workshop #2

Prior to preparing the draft plan and summary report, we will meet with the City to review all of the work to date. The plan will clearly set priorities and general time frames for implementation of the various elements of the flood mitigation plan. A key expectation of this meeting is that it will be used to confirm the content of the final report, as first agreed to at Project Meeting #1.

One aspect of the plan that will be incorporated into the final report will be the implementation steps, and this may be of particular interest to those other departments and staffers called upon to carry out aspects of the flood mitigation plan, such as planning and operations. While we believe it will beneficial for representatives from these other departments to participate in this meeting, the decision with respect to who attends rests with the City project leader.

4.17 Community and Stakeholder Engagement #2

A second round of communication and engagement, including pop-up displays and face-to-face stakeholder meetings will be held to build awareness and support for the project, present the findings of the flood hazard study and gather final community and stakeholder input. We propose to follow the same process as Community and Stakeholder Engagement #1 – including pop-up booths where community members meet, and face-to-face meetings to reconnect with the specific stakeholder engaged previously.

Phase 3 – Reporting

4.18 Draft Report Preparation

At this stage, we will prepare the draft report based on the outline and the technical memoranda prepared during the process. It can be expected that the content of the draft report will have been well developed through the interactive process that we have proposed. As a result, we anticipate that there will be very few surprises. Regardless, by being thorough during project meeting #2 prior to starting the draft report it is more likely that the report will include the information most desired by the City and the outcomes that are most likely to lay the foundation for future success in managing the floodplain in the City.

4.19 Project Workshop #3

Project team meeting #3 will be used as an opportunity to thoroughly review the draft Drainage Master Plan report so that the results are understood, its content is clear, and it accurately represents the direction the City of Grand Forks wishes to go with respect to management of stormwater in the community.

4.20 Final Report Preparation

Feedback received on the draft flood hazard document will be reflected in the final document, which will be issued by the target completion date of June, 2018.

We suggest that the City connect with the community and key stakeholders to ensure they receive, or have access to, the final report. Closing the loop with those who have provided input is key to any successful communication and engagement initiative.

4.21 Deliverables

Deliverables will include the following:

- Meeting notes for the start-up meeting and all project meetings;
- Monthly status reports;
- Technical memoranda, as produced;
- Colour, bound hard copies of the final report;
- Digital version of the final report and all drawings in PDF format; and
- Digital version of hydrologic/hydraulic model input files.

5.0 Our Experience

Urban Systems Ltd. (Urban) was founded in 1975 and operates primarily in Western Canada. As you know, we have been working with the City of Grand Forks for over many years and are currently providing our services on a number of different projects and initiatives for the City.

In addition to our previous undertakings in Grand Forks, during the past four decades, we have conducted a large number of water resource engineering projects in both British Columbia and Alberta. These range from high-level analyses (including hydrologic and hydraulic modeling) to floodplain delineation and detailed design and construction of erosion protection works, flood prevention infrastructure, and stormwater outfalls. Some of the flood recovery and hazard assessment work Urban has conducted recently includes:

- Flood Recovery and Erosion Control (FREC) projects along the Sheep River in the Town of Black Diamond, and the Bow River and Jumpingpound Creek in the Town of Cochrane following the 2013 floods in Alberta;
- Design and construction of a revetment for the Whispering Pines Clinton Indian Band, consisting of approximately 600 m of bank armouring along the North Thompson River in British Columbia;
- Engineering works associated with restoring and protecting the Guerin Creek and Springhill Creek channels in the City of Kamloops following extreme weather in July of 2014;
- Assistance in project direction to the BC Ministry of Transportation and Infrastructure following the flooding in Northern BC in 2011. This entailed the coordination of flood projects, handling the recovery of funds for the event, and developing the recovery plans;
- Floodplain delineation of Oldman Creek in Sherwood Park in Strathcona County; and
- Erosion control and bank reconstruction work, as well as outfall construction along the Hangingstone River at Fort McMurray.

The following is a brief description of one of the above noted projects, the Sheep River Flood Recovery and Erosion Control project in Black Diamond. Following the floods of June 2013, the Town of Black Diamond commissioned Urban Systems to undertake the design and construction of a flood protection berm along the Sheep River, downstream of the Highway 22 Bridge. During the flood, the bridge was washed out and many properties in the town were impacted by rising water levels. The following aspects of the project are relevant to the Grand Forks flood hazard study and will form part of our recommended approach:

- Conducted detailed cross-sectional surveys of the Sheep River within the Town of Black Diamond;
- Processed cross-sectional survey information to create a workable surface and obtain geometric information for flood water surface modeling;
- Performed hydrologic analysis and frequency analyses to obtain updated design discharges for modeling;

- Developed a HEC-RAS hydraulic model of the River and calibrated the model based on information obtained from the Turner Valley Flood Risk Mapping Study;
- Conducted sensitivity analyses of modeling parameters; and
- Conducted stakeholder engagement sessions and public consultation meetings with pertinent residents and regulatory agencies.

6.0 Project Team

As noted in the previous section, we have within Urban Systems a wealth of technical experience and expertise in surface water analysis, design and construction, including consultants who have worked on all major aspects of the various drainage issues facing municipalities, such as integrated watershed and stormwater management planning, capital improvement planning, hydrologic and hydraulic modeling, development of design guidelines, implementation of stormwater utilities, design and construction of stormwater peak flow, volume and quality controls, and use of alternative design standards for low impact development. The team that is introduced in this section has proven and extensive experience in the planning, modeling, design and implementation of drainage solutions, and brings our enthusiastic concern for the environment with our keen awareness of the water resource engineering practicalities necessary for long-term sustainability.

Through past project experience in flood protection, erosion control, and other river engineering-related projects, our team members have gained a deep appreciation for what leads to a successful process and a technically sound study. We believe that the following summary highlights some of our key strengths:

We are water resources professionals. Our team members are all experienced water engineers and planners with various specialties within the broad spectrum of river engineering, water management, hydraulic model development and analysis and municipal planning. Our Team is assembled from individuals who bring to the table unique and diverse professional backgrounds and relevant experience. Our expertise goes beyond individual specialists: integration is at our core and is demonstrated by the sum of the parts being far greater than our individual contributions.

We know and understand the local perspective in Grand Forks. As noted, we have had the pleasure of working for the City of Grand Forks for the past 20 year. Over this period, we have become intimately knowledgeable with almost all aspects of the community. We know and understand the previous struggles the City has had with flooding and have been there on the ground to help the City through those times. In addition to the local flooding context, we have undertaken a regional watershed study and watershed protection plan that provided key pieces of information on the behavior of the overall Pine River watershed. Based on all this, we know the characteristics of the Pine River watershed very well and understand the issue behind many of the previous events that Grand Forks has experienced.

We are Municipal Government Consultants. Projects such as flood hazard studies have the potential to greatly impact municipal governments and the decisions they make for future planning and budgeting. Our water resources team has worked with many local/regional/provincial governments to aid in flood prevention, erosion control, and stormwater management. We have helped municipalities with the design and construction of flood prevention and erosion control works, and with long-term planning around their needs for flood mitigation. Through our work, we understand that the complex flood mitigation issues that municipalities face cannot be properly addressed by focusing on engineering alone. Rather, these problems often need to account for engineering, land use, environmental, governance, education, risk-management, and financial considerations. This is the foundation of our service mindset and where Grand Forks and all other stakeholders will realize the important benefits of working with our team.

Our senior technical experts will be active participants, adding value at key junctures in the study process. We know that no one single individual can offer the range and depth of skills demanded by today's market. Our approach is to combine complimentary skills of individual team members, thereby ensuring all aspects of the project are well thought out and well executed.

We are skilled in Geographical Information Systems (GIS). We understand the value of information and how it can be used to support numerous initiatives. By leveraging our highly capable GIS team, we are able to take an integrated approach to how we provide our professional services and support our clients. Whether it's capturing and compiling data, performing advanced spatial analysis, or presenting data as a clear graphic, we help our clients, identified stakeholders, and the general public visualize and understand the information in order to make informed decisions. Our GIS team has the technical proficiency, experience, and expertise that a project of this complexity demands.

We are committed to quality and project control. We are passionate about the work we do and the clients we serve. Providing quality services and products is part of that passion. Quality management systems are core to our business and we ensure that quality forms the basis of our day to day work; quality is not merely an afterthought. We recognize that the quality of our work and services directly impact our performance and professional reputation. At the end of the day, we rise or fall depending on the quality of work we generate. Hence our professional staff is committed to providing service and quality deliverables that will satisfy the City of Grand Forks' expectations.

We are effective communicators. Inviting, corralling, and articulating the thoughts of City staff, the public, and other major stakeholders is a vital component of any community-led project. We believe our technical team, our project manager, and our community planning background create a key edge in our ability to present complex findings to varied audiences.

The key members of our project team are identified on the following project organization chart and their skill set and proposed project contribution is described in the section that follows.

Scott Shepherd, A.Sc.T – Project Manager

Scott is a project leader in our Kelowna office. He has undertaken a number of projects with the City of Grand Forks, and has considerable field experience that will serve him well in the role of project manager for this project. His local presence will allow him to respond in a timely fashion to the work that is underway. Scott knows the City well and is familiar with both local geography and ground conditions, and historic events in the City.

Scott will coordinate the Urban project team and will be responsible for all correspondence with the City and any other stakeholders. Scott's detailed knowledge of the City and his understanding of your infrastructure and concerns will allow our team to provide the best end product for the City and ensure your specific needs are met with this project.

Cameron Gatey, P.Eng. – Senior Water Resources Engineer

Cameron is a senior principal with Urban Systems, and has 30 years of progressive civil engineering experience, and 25 of these have been with Urban Systems. The vast majority of this has been focused on stormwater management in jurisdictions including British Columbia, Alberta, Saskatchewan, Ontario, and even Texas. For this project, he will play the role of senior water resources engineer, and will guide the technical work of the team.

Cameron's experience includes the planning, analysis, design, and construction of stormwater management systems. This broad-based experience related to storm water management systems has involved transportation projects, water pumping systems stormwater, and river engineering. He is knowledgeable with respect to analytical tools, including hydrologic, hydraulic, and statistical modeling processes. He is also a competent design professional, and is knowledgeable about practices and challenges with construction projects, as well as design and construction risks and contract administration issues. Because of his practical experience with the implementation of stormwater management solutions, he is particularly knowledgeable about the challenges of converting overarching policy into on-the-ground solutions.

Thomas Simkins, P.Eng. – Project Engineer

Thomas is a talented municipal engineer who has been with Urban since 2006. He started his career as a Civil Engineering Technologist where he developed his skills as a practical and effective designer, field inspector, and contract administrator. Thomas later went on to graduate from UBCO Engineering with distinction.

Thomas will conduct many of the day-to-day tasks required to bring this project to successful completion. This will include gathering data, coordinating information flow between team members, completing calculations and analyses, preparing cost estimates, preparing technical sections for the final report.

Brendan Pauls, GISP – GIS and Hydraulic Modeller

Brendan has been working as a GIS Specialist with Urban Systems for more than 8 years. In this time, he has established himself as an expert in data management, organization, and presentation. He is passionate about performing quality analysis and using spatial data to inform decisions and provide clarity. He is especially experienced in preparing data for hydrologic and hydraulic modeling, and has prepared several HEC-RAS models for projects within BC.

Brendan will prepare the base mapping and work with the survey team to integrate the LiDAR and field survey data into a single digital surface. This will allow easier extraction of cross sections for the hydraulic model, post modeling presentation of the results, and flood mapping preparation. Brendan will also prepare and run the models, working closely with Cameron

Pam Robertson, BA, CTDP, ABC

Pam Robertson is a professional communicator, stakeholder engagement specialist, and certified trainer. For the past 25 years, she has provided professional counsel and expertise to a diversity of clients including provincial and municipal governments, private and non-profit organizations, and First Nation communities. She is skilled in strategy development as well as implementation using numerous communication and engagement methods. Since joining Urban Systems 10 years ago, Pam has worked closely with clients and Urban's technical experts to lead communication and engagement initiatives on a variety of high profile, and sometimes sensitive, community topics. Some relevant past projects in which Pam led communication and engagement initiatives include:

- City of Calgary, Stormwater Level of Service Benchmarking Study
- Regional Municipality of Wood Buffalo Rural Water and Sewer Servicing
- City of Kamloops, Master Stormwater Management Plan
- City of Fernie, Liquid Waste Management Plan
- Town of Lumby, Liquid Waste Management Plan
- Tsawwassen First Nations Rainwater Management Plan

Pam holds a BA in Communications from Simon Fraser University and is an Accredited Business Communicator (ABC) through the International Association of Business Communicators (IABC). She is certified by the International Association of Public Participation (IAP2) and is also a Certified Training and Development Professional (CTDP) with the Canadian Institute for Performance and Learning. As a certified facilitator of Franklin Covey's 7 Habits of Highly Effective People program, Pam is well equipped to lead community dialogues that lead to win-win results.

7.0 Project Management

Urban Systems recognizes that an important aspect of any successful project is the soundness of the way in which it is managed. Fortunately we have at our disposal many systems and tools that are very effective in streamlining project management processes, which ultimately help in completing a project in an efficient and effective manner.

Scott Shepherd, A.Sc.T, our Principal in Charge and Project Manager, will be responsible for primary liaison with the City, and will report directly to, and work very closely with, the City's Project Manager. Scott will also be responsible to provide direction to the Project Team, and to ensure that all team members fully understand the project objectives, scope, schedule and budget, and are in tune to the multi-disciplined nature of this assignment including:

- Project planning and implementation;
- Intervention and problem solving;
- Adherence to project scope and objectives; and
- Quality and completion of services.

We will also apply a budget control system for this project. Fundamental to this system is a comprehensive work plan which clearly defines specific project tasks and key deliverables.

The assignment of appropriate and sufficient resources will be a key component of our project management approach. Our team will confidently commit the necessary resources to lead, manage, and deliver all phases of this assignment. Our resource management strategy will include regular reviews of schedule and progress to anticipate the need to adjust project resources. Our assembled team for this assignment has significant depth for each project role and technical discipline.

Monthly project update reports will be submitted to the City outlining the following:

- Work completed in the previous month;
- Work anticipated in the coming month;
- Decisions and data pending from the City;
- Decisions pending from other sources, if applicable; and
- Changes, if any, to the scope of work, budget, and schedule.

Our approach to project management also includes a number of project team meetings at specific stages of the project. In addition to these predetermined meetings, however, we intend to communicate with the City's project team on an as-needed basis throughout the project. Invariably, issues arise that are easily solved through discussion, and we make it our practice to initiate proactive communication as required throughout the project life.

8.0 Project Schedule

We have prepared a preliminary schedule showing the duration of critical path tasks and based on the assumption that the work will begin in June. The schedule is intended to show the amount of time required to undertake such a study. We recognize that the schedule will be modified to reflect the final scope of work when it has been established. The schedule includes the following durations, which results in a total project duration of about 21 weeks, or four months:

Item	Duration
Appointment of Consultant	August 1, 2017
Project Start-up	1 week
Gather and Review Background Material, Establish Climate Conditions/Climate Change, Regional Analysis, Communications Plan	3 weeks
Field Survey	3 weeks
Project Workshop #1 and Stakeholder Engagement	2 weeks
Computer Modelling, Flood Map Preparation, Flood Hazard Assessment, Channel Stability Analysis	6 weeks
Flood Mitigation Planning Meeting	1 week
Cost Estimates	1 week
Draft Report Preparation	3 weeks
Report Review Workshop	2 weeks
Final Report Preparation	2 weeks
Total Duration	Approximately 24 weeks

A more detailed project schedule, identifying each project task, would be prepared when the final scope of work for the project is agreed to by the City of Grand Forks.

9.0 Fees

We have fully costed the work outlined in our work plan, and prepared a detailed breakdown for the work. A summary of the costs associated with each of the tasks is provided in the following table. The summary does not include any taxes as may be applicable throughout the project.

Fee Summary

Description	Amount
Project Start-up	$5,700
Gather and Review Background Material	$5,600
Regional Runoff and Statistical Analysis	$6,300
Establish Climatic Conditions	$3,200
Climate Change Adaptation	$5,300
Field Surveys of Creek Channels	$51,600
Develop Communication and Engagement Strategy	$10,300
Project Workshop #1	$7,300
Community and Stakeholder Engagement #1	$26,300
Computer Model Creation	$26,300
Flood Map Preparation	$11,000
Flood Hazard Assessment	$7,400
Channel Stability Assessment	$12,400
Flood Mitigation Planning	$9,500
Cost Estimates	$4,500
Project Workshop #2	$4,600
Community and Stakeholder Engagement #2	$26,300
Draft Report Preparation	$14,400
Project Workshop #3	$5,700
Final Report Preparation	$3,700
Total Fees	**$225,700**

Our fee estimate includes allowances for all disbursements except for those costs that may be incurred through stakeholder engagement – i.e. room rentals, refreshments, etc. Specific amounts have been included for travel costs, while a flat rate of 8% of professional fees has been included for all other disbursements. The intent of the flat rate is to eliminate the need to track disbursements, but the rate reflects an accurate estimate of anticipated project disbursements based on our past project experiences. Our fee also includes disbursements for a mark-up of 5% on sub-consultant invoices in order to cover the administrative costs of processing invoices, as well as the potential professional liability that accrues to Urban Systems by engaging sub-consultants through our business.

We have prepared our work plan and fees to provide the most valuable tasks sought by the City in the RFP, and to bring to them an appropriate level of effort in order to achieve the desired objectives. Our experience with other flood hazard studies has shown that this is an appropriate level of effort. It is our view that the long-term improvements that result from planning level studies such as this study need to be well thought out and properly funded. The infrastructure investments that will result from this work can be expected to be orders of magnitude greater than the study itself, and proper funding levels will help to ensure that sound decisions are made early in the process of creating a healthy and sustainable community. Nonetheless, we remain ready to discuss with you ways in which you may modify the scope of work, and hence the fee, to better align with the City's budget and the desired scope of work and project deliverables.