

September 5, 2014

File: 0956.0039.01

City of Cranbrook
40 – 10th Avenue South
Cranbrook, BC
V1C 2M8

Attention: Eric Sharpe, Acting Director of Engineering (Project Manager)

RE: ELIZABETH LAKE & RELATED DRAINAGE WORKS

1. Introduction

The following report has been prepared by Urban Systems (Urban) to address flooding issues on Elizabeth Lake and capacity of the related drainage works within the City of Cranbrook (City) to convey runoff from natural catchments outside the city and storm water within the City to Joseph Creek.

2. Scope of Work

The scope of work included an assessment of the flows out of Elizabeth Lake and the capacity of the system downstream to Joseph Creek (Phase 1) and also the capacity of the existing storm drain system that conveys storm runoff plus runoff from the Jim Smith Creek and Hospital Creek catchments to Joseph Creek (Phase 2).

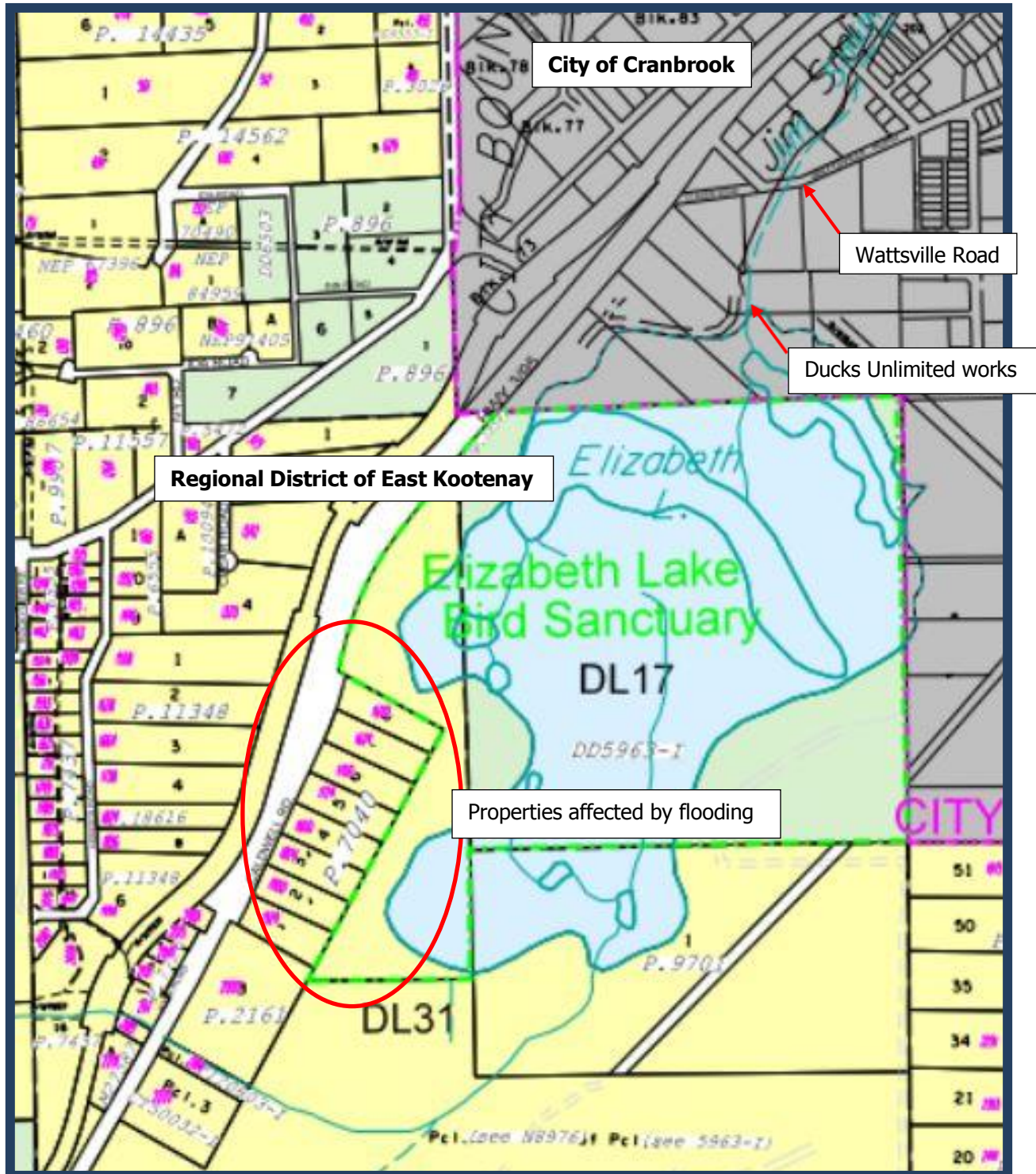
3. Background

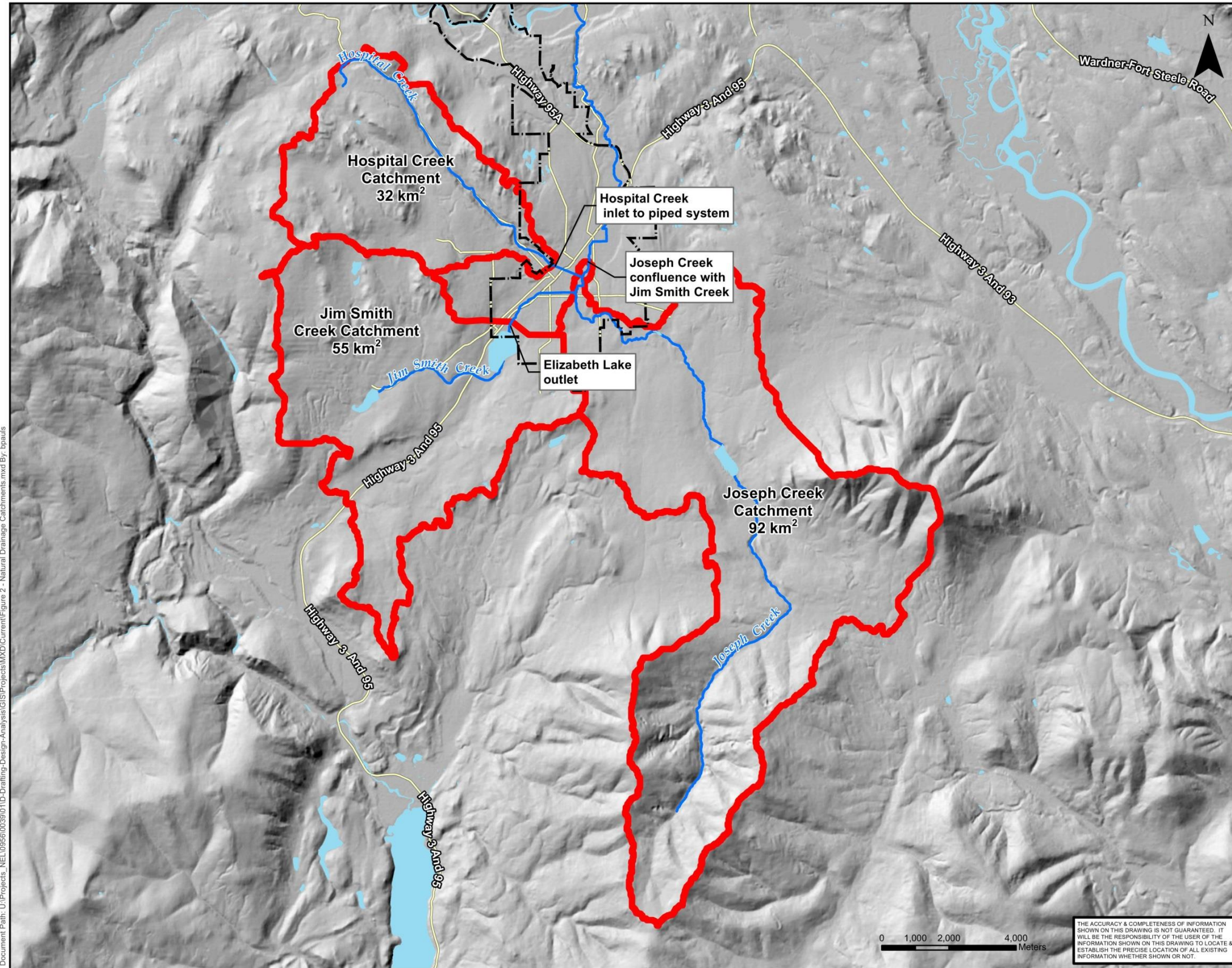
In March 2014 there was an unusual rain-on-snow event that caused widespread flooding throughout the City. There were unusually high inflows into Elizabeth Lake that exceeded the outflow capacity resulting in elevated water levels in the lake and local flooding of several properties within the Regional District of East Kootenay located on the southwest end of the lake (Figure 1). Water levels rose at Wattsville Road that crossed the creek downstream of the outlet (Figure 1). In response to the flooding concerns, the City met with staff from the Regional District, Water Stewardship, Ministry of Transportation and Infrastructure, and Ducks Unlimited. When it was determined that the culverts at Wattsville Road were obstructed the City installed three emergency pumps on April 8th to pump water over the road to reduce water levels in the lake.

The City contacted Urban Systems following the meeting and requested Urban to assess the Wattsville Road crossing and the drainage system downstream to Joseph Creek, and to provide recommendations that would reduce the risks of future similar problems.

The City has an extensive stormwater system of which there is a portion that conveys runoff from storm drains within the City plus runoff from the Jim Smith Creek and Hospital Creek catchments to Joseph Creek. An overview of the three natural catchments and the City is provided in Figure 2. Historically the stormdrain from Elizabeth Lake to Joseph Creek has safely conveyed the runoff.

Figure 1. Elizabeth Lake





Document Path: U:\Projects\NEL\0956\0939\011D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\Figure 2 - Natural Drainage Catchments.mxd By: bpsulf

MOUNTAINS OF OPPORTUNITY
CRANBROOK

Elizabeth Lake Drainage
Natural Drainage Catchments

Legend

- Primary Watercourses
- Catchment Boundaries
- City of Cranbrook Municipal Boundary

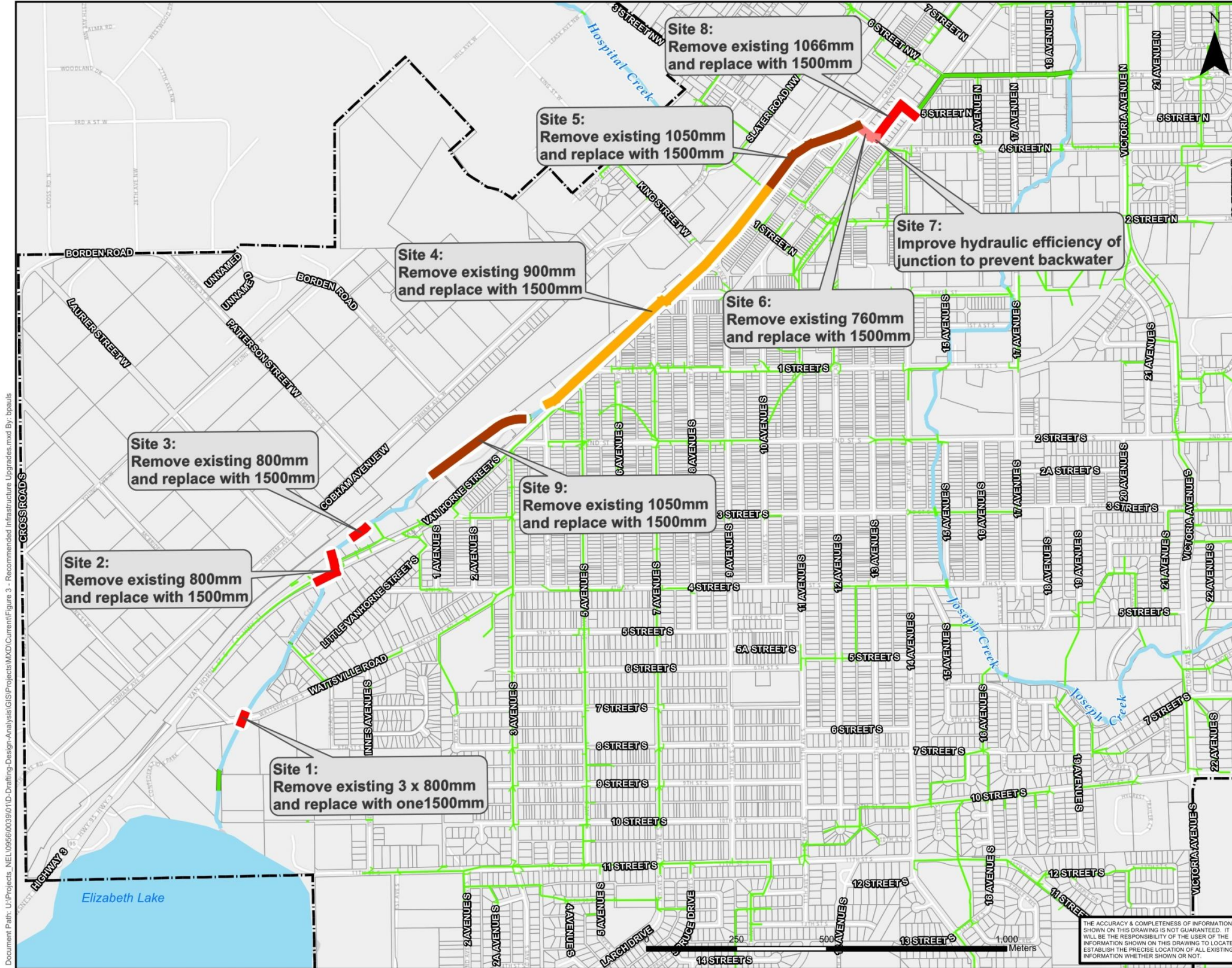
Date
2014.08.15

Project No.
0956.0039.01

Coordinate System
NAD 1983 UTM Zone 11N

URBAN systems **Figure 2**

THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION WHETHER SHOWN OR NOT.



Elizabeth Lake Drainage

Recommended Infrastructure Upgrades

Legend

- Closed Conduit Along Upgrade Route (no upgrade required)
- Cranbrook Storm System
- City of Cranbrook Municipal Boundary

Note: Orange, brown, and red colours are used to differentiate between upgrade sites. Colours chosen are arbitrary and have no other meaning.

Date
2014.08.28

Project No.
0956.0039.01

Coordinate System
NAD 1983 UTM Zone 11N



Figure 3

Document Path: U:\Projects_NEL\0956\0039\01\Drafting-Design-Analyses\GIS\Projects\MKD\Current\Figure 3 - Recommended Infrastructure Upgrades.mxd By: bpauls

THE ACCURACY & COMPLETENESS OF INFORMATION SHOWN ON THIS DRAWING IS NOT GUARANTEED. IT WILL BE THE RESPONSIBILITY OF THE USER OF THE INFORMATION SHOWN ON THIS DRAWING TO LOCATE & ESTABLISH THE PRECISE LOCATION OF ALL EXISTING INFORMATION, WHETHER SHOWN OR NOT.

4. Phase 1 - Assessment of flow design flow capacity at Wattsville Road crossing

The control works constructed by Ducks Unlimited (DU) are reported to have a capacity of 1.7 m³/s at full flow level (920.7 m) and 3.1 m³/s at maximum water level (921.1 m). Based on the drawings of the DU works, when water levels in the lake exceed approximately 920.7 m water would flow around its works. This is a concern since the control works are not able to function as per the design. In order for the works to function as per the design requires raising the embankments on either side of the control works to a level greater than 921.1 m.

The existing culverts under Wattsville Road have a design capacity of approximately 1.4 m³/s with no head over the top of the inlet. The existing culvert under Highway 3 can pass approximately 0.71 m³/s at full capacity with no head over the top of the inlet.

Since the existing culvert at the highway does not have the capacity to pass 3.1 m³/s, and since flows greater than the current culvert capacity can result in flooding within the City upstream of the highway, it may be necessary to include temporary flow control works at Wattsville Road to reduce the risks of flooding within the City upstream of the highway until the capacity of the highway crossing is upgraded. Additional detail for the Wattsville Road crossing are provided in Section 6 of this report.

The capacity of the open channel from the DU structure to Wattsville Road and from Wattsville Road to Highway 3 is not known. Based on recent water releases at Wattsville Road it is apparent that there is a capacity issue between the road and the highway. These are very low gradient sections of channel that have significant vegetation growth that restricts high flows. To improve the flow requires a channel survey that may recommend dredging.

There is also the matter of the system capacity downstream of the highway. A review of the stormwater master plan that Urban completed in February, 2013¹ indicates that the capacity of the various storm sewer segments between Highway 3 and the discharge to Joseph Creek ranges from 0.44 to 2.4 m³/s. It is important to note that some of this capacity is required to convey flows from Hospital Creek, the outflows from Elizabeth Lake plus the storm drains that service a large portion of the City. The actual impact of these flows on the capacity available to convey flow from Elizabeth Lake depends on the timing of freshet flows from Hospital Creek and Jim Smith Creek, as well as any rainfall event. As indicated previously, the system has historically conveyed runoff to Joseph Creek safely. The standards for storm runoff design is to use a 1 in 10 year rainfall as the basis for the required stormdrain capacity. This is the standard that was used in the 2013 report for the City.

Based on the maximum design flow out of Elizabeth Lake from the DU structure and the downstream drainage system maximum capacity, it is recommended that the capacity of the Wattsville Road crossing should be at least 3.1 m³/s. Since this capacity would exceed the capacity of the existing Highway 3 crossing and also the maximum system capacity downstream, it is further recommended that the improvements at Wattsville Road include temporary control works to reduce the risks of flooding within the City upstream of the highway until that crossing is upgraded, and also from overwhelming the capacity of the City's stormdrain.

¹ City of Cranbrook Stormwater Master Plan – Final Report, Urban Systems, February 2013.

5. Phase 2 - Capacity of the existing stormdrain system that conveys runoff to Joseph Creek

The 2013 Stormwater Master Plan indicates that the existing capacity of the drainage system from Wattsville Road to Joseph Creek has a capacity ranging from 0.44 to 2.4 m³/s. In order for the system to have a capacity of 3.1 m³/s requires the following upgrades at the locations noted on Figure 3:

- 1) Site 1: Wattsville Road - Replace existing 800 mm culverts at Wattsville Road with a single 1500 mm culvert with control works
- 2) Site 2: Highway 3 - The existing culvert across Highway 3 is an 800 mm metal culvert that has a design capacity of approximately 0.7 m³/s. This crossing should be upgraded so that it can safely pass 3.1 m³/s. Since is a provincial highway it is likely that it would be the responsibility of the Ministry of transportation and Infrastructure to address this issue.
- 3) Site 3: Private culvert - Downstream of the highway crossing there is a second 800 mm metal culvert that has been installed in the creek behind a private business. This culvert has the same capacity as at the highway. Assuming that this culvert installation was authorized by Water Stewardship, the agency should be advised of the capacity issue and requested to address this matter.
- 4) Site 4: Van Horne - Replace existing 900 mm culvert with 1500 mm culvert.
- 5) Site 5: Van Horne-Cranbrook St (2 St N – 4 St N) - Replace existing 1050 mm culvert with 1500 mm culvert
- 6) Site 6: 4 St N - Replace existing 760 mm culvert with 1500 mm culvert
- 7) Site 7: Jcn at 4 St N and Lane - The junction of the main stormdrain at the lane between Kootenay Street and Highway 3/95 requires upgrading to improve the hydraulic efficiency to eliminate the existing constriction at high flows
- 8) Site 8: Lane west of Kootenay St between 4 St N and 5 St N - Replace existing 1066 mm culvert with 1500 mm culvert
- 9) Site 9: Behind Prestige - Replace existing 1050 mm culvert with 1500 mm culvert

6. Wattsville Road improvements

It is recommended that the design of the improvements to the crossing capacity at Wattsville Road are based on increasing the capacity of the crossing so that it would not constrict normal outflows from Elizabeth Lake. As indicated in Section 4, this design flow, based on the DU the capacity of the works at the outlet of the lake upstream of Wattsville Road, should be 3.1 m³/s. The capacity at Wattsville Road should be a minimum of 3.1 m³/s that could be achieved with a single 1500 mm round culvert, or two 1200 mm round culverts.

Since a flow of 3.1 m³/s would exceed the current capacity of the culvert at the highway, the private culvert downstream and the existing system capacity of the stormwater mainline, it is recommended that the City include temporary inlet control works at Wattsville Road that allow the City, that in the event the outflows from Elizabeth Lake exceeded the downstream system capacity, to release flows within the system capacity and reduce the impacts of downstream flooding within the City. It is not recommended that the City assume the long-term responsibility and liability associated with controlling the levels in Elizabeth Lake. The ability to control flows at Wattsville Road should be a short-term measure to permit the necessary upgrading of the system downstream as summarized in Section 5 of this report to safely convey a design flow in the 3.1 m³/s range. This flow rate has a return period of approximately 21 years at the outlet of Elizabeth Lake.

7. Estimated costs for recommended improvements

Table 1 summarizes the estimated costs to design and install the recommended improvements at Wattsville Road and also those recommended in Section 5 that would be the responsibility of the City.

Table 1. Estimated costs to address improvements that are the responsibility of the City of Cranbrook

| Location | Description | Est. Cost |
|---|--|-------------|
| Site 1 – Wattsville Road | Replace existing culverts with larger culvert(s) | \$121,100 |
| Site 4 – Van Horne Street | Replace 900 mm culvert with 1500 mm culvert | \$2,945,950 |
| Site 5 – Van Horne-Cranbrook St (2 St N-4 St N) | Replace 1050 mm culvert with 1500 mm culvert | \$864,850 |
| Site 6 – 4St N | Replace 760 mm culvert with 1500 mm culvert | \$308,455 |
| Site 7 – Jcn at 4 St N and lane | Kootenay, improve hydraulic efficiency | \$164,850 |
| Site 8 – Lane west of Kootenay St between 4 St N and 5 St N | Replace 1050 mm culvert with 1500 mm culvert | \$400,750 |
| Site 9 – Behind Prestige | Replace 1050 mm culvert with 1500 mm culvert | \$1,223,600 |

8. Limitations

- 1) The outflows from DU control works used in this report are as stated in documentation provided by DU and have not been independently verified.
- 2) The elevation of the top of the DU control structure is 921.1 m and has been assumed as the maximum level for the lake. The rationale for this elevation was not provided by DU. It is not known if this is the maximum “acceptable” level for the lake or what the residents might consider as the maximum acceptable lake level.
- 3) The recommended sizing for the infrastructure upgrades between Elizabeth Lake and Joseph Creek are based on hydraulic analyses using information originally obtained from the City. These should be reviewed using detailed survey information prior to final design and construction.

9. Cautions

The existing stormwater system that conveys runoff to Joseph Creek from Elizabeth Lake, Hospital Creek and stormdrains within the City has a capacity in the 0.44 to 2.4 m³/s range. Historically this capacity has been adequate. If the system capacity was eventually increased to convey 3.1 m³/s then the system would be able to pass a maximum flow of 3.1 m³/s from Elizabeth Lake provided that other local inflow was minimal.

10. Summary

The culverts under Wattsville Road should be replaced. Two options have been provided. A capacity of 3.1 m³/s that has an estimated return period of approximately 21 years for Elizabeth Lake outflow, would provide a capacity at Wattsville Road that would be unlikely to constrict normal outflows from the lake. This flow capacity would be greater than the current capacity of the system downstream. The first priority should be to improve those sections of the system at site 1 - Wattsville Road, site 4 - Van Horne- , site 6 – 4 St N and site 7 – Junction 4 St N and lane listed in Table 1. Temporary control works at Wattsville Road should be installed to limit downstream flows to reduce the risks of flooding within the City until system improvements were completed. Over the long-term, it is recommended that the capacity of the system be increased to safely convey the maximum discharge capacity of the Ducks Unlimited control structure, i.e. 3.1 m³/s. The estimated flows from Elizabeth Lake used in this report are those values in documents provided by DU. The task to independently verify these values was beyond the scope of this project. A current topographical survey of the entire system within the City from Elizabeth Lake to Joseph Creek is required to confirm open channel capacities, specifically the sections between the DU control structure and the highway, and the locations of all works.

Following a decision on a preferred flow option, and before commencing with detailed design, it is recommended that the proposed flow and design be discussed with Dwain Boyer at the Water Stewardship Division of the Ministry of Forests, Lands and Natural Resource Operations in Nelson. Since the proposed works should be considered as maintenance of existing works, authorization for works in and about a stream should be provided through a “notification” rather than having to submit an application for the Section 9 approval. It is understood that Mr. Boyer is familiar with the issues at this site and he should be able to confirm whether or not a notification is all that is required.

We would be pleased to discuss the details of the options with you at your convenience.

Sincerely,

URBAN SYSTEMS LTD.

Reviewed by:

ORIGINAL SIGNED BY

ORIGINAL SIGNED BY

Don Dobson, P. Eng.
Senior Water Engineer

Anthony Comazzetto, P. Eng.
Project Manager/Principal

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