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### 1.0 INTRODUCTION

#### 1.1 STUDY OBJECTIVES

Urban Systems was retained by the Village of Ashcroft to prepare a Drainage Study to assess existing drainage conditions in North Ashcroft, assess flooding risks from offsite areas and climate change conditions, recommend drainage improvements for existing built-out areas, and to provide stormwater management guidance to future land development applications.

The study covers the following:

- Background
- Analysis Methodology (hydrology, climate change, hydraulics)
- Mitigation Measures
- Cost Estimates

#### 1.2 ACKNOWLEDGEMENT

Urban Systems is grateful for the assistance and cooperation given by the Village of Ashcroft staff for providing background information, field measurements, comment on model results, and feedback crucial to the development of this report.

#### 1.3 PREVIOUS REPORTS

No previous reports relevant to the Drainage Study carried out here were made available to Urban Systems. It can therefore be deducted this is the first Drainage Study carried out for North Ashcroft.



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### 2.0 BACKGROUND

#### 2.1 DESCRIPTION OF STUDY AREA

The Village of Ashcroft is located 65 km east of Kamloops, upstream along the Thompson River. The Corporation of the Village of Ashcroft encompasses 53 km2, including extensive sparsely inhabited areas to the north-east and south-west. Its first European settlers arrived in 1859 and named the town after their home of Ashcroft Manor in England. The town was later incorporated in 1952, and now boasts a population of 1,558 as of the 2016 census.

The village is bisected by the Thompson River into a northerly section (North Ashcroft) and a southerly section (South Ashcroft). This study is limited to North Ashcroft, which is bounded:

- To the south by the Thompson River
- To the west and north by highway 97C, Elephant Hill Provincial Park, and
- To the east by Bonaparte River (a tributary of the Thompson River)

The drainage direction is from the Elephant Hills located north-west of the study area draining down towards the east and south. Ultimately the flows from the study area drain into the Thompson River .

This Drainage Study considers the entire catchment draining to north Ashcroft, which describes an area of 450 hectares as shown in **Figure 1**, and includes lands in Elephant Hill Provincial Park and the provincial Highway 97C.



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Village of Ashcroft North Ashcroft Drainage Master Plan Study Area

Legend

Study Area



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NAD 1983 CSRS UTM Zone 10N

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FIGURE 1

#### 2.2 MEETINGS WITH VILLAGE OF ASHCROFT

Urban Systems met with the Village of Ashcroft several times to discuss the drainage issues in North Ashcroft. The results of those meetings are summarized here to help orient present and future readers to the drainage problems facing North Ashcroft.

#### 2.2.1 2021-10-17 KICK-OFF MEETING

A project kickoff meeting was held on October 20 of 2021. The notes from this meeting were marked up on a map. Key takeaways included:

- Development of 100-200 homes surrounding the Battel subdivision in the next 5 years will require stormwater management.
- Identification of drainage issues in northern catchments:
  - o No ditches or culverts operate in Battel subdivision, but residents are not interested in building ditches or culverts. They prefer a status quo approach that may lead to their properties flooding.
  - o Flows travel through the agricultural fields.
  - o Occasional issues exist with flows on Western Avenue.
  - o Ponding occurs in ditches north of industrial area.
- Identification of issues with drainage in western catchments along Highway 97C:
  - o High flows and debris/sediment of culvert crossing at Government Street.
  - o High flows and plugging of culvert crossing at Elm Street.
  - o High flows and plugging of culvert crossing north of Highway 97C bridge.

#### 2.2.2 2021-10-21 SITE MEETING

Representatives from the Village of Ashcroft met with Urban Systems to walk through North Ashcroft to get a better sense of the drainage issues. The notes from this meeting were marked up on a map. Key takeaways included:

- Focus on potential offsite flows, including debris and flows from catchments west of Highway 97C.
- Identification of issues with debris in Battel subdivision.
- Recommendation of upgrades required to the drainage path around the Battel subdivision, especially considering future buildout.
- Recommendation to ensure the existing system has capacity for additional flows from improvements to the system.
- Focus on how development will tie into the improvements.



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- Identification of issues with drainage through agricultural land to the north-east of town.
  - o Farmer removed culvert across Harper Mill Road due to flooding in the fields south of the culvert, causing flows to pool and spill across the road instead.
  - o Culvert draining agricultural lands to the south is throttled, and Village of Ashcroft operations staff limit its release during high flows.
- Need to confirm drainage system configurations, as the drainage data is incomplete.

In consequence of this meeting, Urban Systems sent an inspector to Ashcroft to photograph and measure the existing minor system on December 16 of 2021. These measurements and photographs helped confirm the capacity of the existing system.

#### 2.2.3 2022-01-06 VIRTUAL MEETING

Representatives from the Village of Ashcroft met with the Urban Systems stormwater team to discuss model results. The results were recorded in an email. Key takeaways included:

- Ashcroft to pursue Irrigation Reservoir for grant. Flood protection grants will be pursued in the future.
- Flow paths delineated by the model were confirmed, especially spills across Highway 97C at Government Street, Elm Street, and the Highway 97C bridge.
- Confirmation debris and silty sediment were issues for the Battel subdivision.
- Confirmed the development west of the Battel subdivision will be 8 lots fronting onto Government Street. Sizing of the driveway culverts under different scenarios was considered.
- Ashcroft requested Urban Systems quantify the impacts of re-establishing flow paths from Elephant Hills across Highway 97C through the Village of Ashcroft to the Thompson River.
- Clarified improvements will preferably be made all at once rather than incrementally. Sequencing of improvements will therefore not be investigated.
- Urban Systems recommended having emergency overland drainage routes, and looking into drainage right of ways to establish these.
- Village of Ashcroft to confirm pipe sizes where Government Street intersects Cariboo Road.

In consequence of this meeting, Urban Systems devised three scenarios to model the effects of routing flow from the Elephant Hills through the Village of Ashcroft. The Village of Ashcroft operations staff also provided more detailed pipe sizes and materials on January 20, 2022, which are shown in **Appendix B**.

#### 2.3 BACKGROUND INFORMATION

The Village provided stormwater drainage system drawings as well as valuable additional information during our site visits and meetings. Available LiDAR information was used to



delineate catchment areas, identify overland drainage routes, and quantify areas of flooding.

#### 2.4 EXISTING STORMWATER INFRASTRUCTURE

The majority of North Ashcroft relies on overland flows along ditches and roads. Small portions of the village are serviced by a piped (or minor) storm system. The existing minor system is shown in **Figure 4**. A site visit on December 16, 2021 confirmed pipe locations and some sizes. An additional investigation by town staff on January 20, 2022 confirmed more sizes, as shown in **Appendix B** The results of this investigation show that pipe sizes and types in the study area are highly variable. It is recommended that sizes, materials, and invert elevations be fully investigated and described during detailed design.

Flows enter the minor system through catch basins as shown below in **Figures 2 and 3**. Most of these catch basins are not located in areas with deep low areas where water can pond and drain into the catch basin more efficiently. Instead, most catch basins are located on slopes, and so function as flow-by catch basins with relatively low rates of capture.

Figure 2: Typical grated top catch basin



Figure 3: Catch basin on Ranch Road





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## 3.0 ANALYSIS METHODOLOGY

A model was used to quantify flow rates and volumes throughout locations of interest in North Ashcroft, requiring the definition of key hydrologic and hydraulic parameters. The definition of these parameters is described in the sections below.

#### 3.1 HYDROLOGY

Hydrology quantifies how much precipitation reaches the ground and mobilizes as runoff. This study is concerned with how much precipitation is mobilized as runoff during extreme storm events. Extreme storm events are described by their probability of occurrence expressed as a return period. For example, a 1:100 year extreme storm event has a 1% chance of occurring in any given year, and will occur on average once every 100 years.

Extreme storm events are typically developed using recorded precipitation data from weather stations. Since North Ashcroft lacks a weather station with a suitable amount of data to confidently quantify precipitation in extreme storm events, comparison was made to nearby suitable weather stations.

The extreme storm events developed through comparison to nearby suitable weather stations were input into the model to determine peak runoff rates. To verify the peak runoff rates generated from the model, a regional analysis of runoff rates for gaged catchments was carried out to determine the expected peak runoff rates from the ungagged North Ashcroft catchment. These peak runoff rates were then used to calibrate the model inputs until they produced results similar to those expected from the regional analysis.

#### 3.1.1 DEVELOPING EXTRME STORM EVENTS USING NEARBY WEATHER STATIONS

Ashcroft does have a weather station, but it only contains 3 years of data from 2014 to 2017. The short record length makes it unsuitable to calculate the 1:100 year storm, meaning comparison had to be made to nearby weather stations with a sufficiently long record length. Nearby weather stations with more than 10 years of data include Kamloops, Lillooet, and Lytton. Statistics from these stations are presented in **Table 1** below, and locations are shown in **Figure 5**.

Table 1: Statistics for Nearby Weather Stations

Station	Name	Years of data (yr)	1:100 year total rain over 24 hours (mm)
1163842	Kamloops AUT	47	48.74
1114619	Lillooet	27	73.38
1114741	Lytton	21	56.94

Of these stations, Kamloops was selected to develop the 1:100 year storm event in the model. Ashcroft and Kamloops have similar arid landscapes caused by being in the rain



shadow of the Coast Mountain range to the west, and so are assumed to be similar in terms of hydrology as well.

Storm events for the Kamloops station were developed using the IDF\_CC Tool 5.0. This tool provides Intensity-Duration Curves (IDFs) for storm events of various durations (5 minutes to 24 hours long) and various intensities (1:2 year event to 1:100 year event). These IDF curves can then be input into the model to simulate extreme storm events. Current climate storm events were based on recorded rain gage data fit using the Generalized Extreme Value (GEV) distribution, while climate change storm events were based on predictions of what the climate will be like in the year 2100 using an ensemble of climate change models developed by research institutions from around the world.

These climate change models work by projecting known changes in climate into the future assuming varying drivers of climate change. In this analysis the RCP 8.5 climate change scenario was chosen, as it represents a "business-as-usual" scenario where industrial growth and pollution continues as usual with little climate change mitigation.

A comparison of IDF curves under the climate change and existing scenarios is presented in Table 2 below.

Table 2: Comparison of Intensity-Duration-Frequency tables for Historical and Future Conditions, in mm/hr of Rainfall

		ŀ	listorical D	ata, GEV Fi	t		
T (years)	2	5	10	20	25	50	100
5 min	38.74	62.22	82.06	105.11	113.37	142.15	176.45
10 min	28.37	44.84	57.6	71.47	76.23	92.1	109.83
15 min	22.36	34.29	43.39	53.15	56.48	67.48	79.63
30 min	13.32	19.82	24.53	29.38	30.99	36.18	41.7
1 h	7.71	11.02	13.47	16.03	16.88	19.67	22.66
2 h	4.84	6.59	7.8	9.01	9.4	10.65	11.93
6 h	2.35	3.02	3.41	3.75	3.85	4.14	4.41
12 h	1.42	1.89	2.19	2.46	2.54	2.78	3.02
24 h	0.81	1.11	1.31	1.52	1.59	1.81	2.03
	Futu	ıre Predictio	n, RCP 8.5,	PCIC Ense	mble, 20 <mark>7</mark> 0	-2100	
5 min	43.64	73.39	98.18	126.94	136.67	175.45	221.6
10 min	32	53.03	69.61	87.45	93.52	115.06	141.31
15 min	25.24	40.53	52.55	65.06	69.49	84.64	103.07
30 min	15.08	23.49	29.85	36.1	38.54	45.79	54.17
1 h	8.72	13.03	16.35	19.62	20.86	24.87	29.68
2 h	5.49	7.79	9.49	11.07	11.72	13.63	15.69
6 h	2.68	3.6	4.17	4.66	4.83	5.25	5.75
12 h	1.62	2.25	2.67	3.05	3.19	3.54	3.95
24 h	0.91	1.31	1.6	1.87	1.99	2.31	2.67



#### 3.1.2 DETERMINING EXPECTED PEAK RUNOFF RATES USING A REGIONAL ANALYSIS

Environment and Climate Change Canada maintains a Data Explorer called HYDAT which displays all Water Survey of Canada monitoring stations across the nation. Stream flow data was used to compare hydrologic conditions in various watersheds and to validate the modelling results of this study.

Following the methodology of the BC River Forecast Centre, every Water Survey of Canada station was processed to develop an Annual Maximum Series of the peak instantaneous flows at each station in each year. The stations were then sorted based on record length. Only stations with at least 25 years of data, or 25% of the record length for a 1:100 year storm, were selected. Then the selected stations were fitted to several statistical distributions, and a distribution with the best fit was chosen. The 1:100 year peak instantaneous flow was then read from this fit, and divided by the catchment area to get a flow rate in L/s/ha. The benefit of converting the peak instantaneous flow to a flow rate per hectare is it makes comparison easier across catchments of different sizes.

Most nearby stations have a much higher catchment size than Ashcroft (study area catchment is 450 ha), making comparison with these stations difficult. The assessed stations are shown in Table 3

Table 3: Hydrometric Station Data

Station	Name	Catchment Area (km2)	1:100 Year Flow Rate (L/s/ha)
08LF084	Anderson Creek Above Diversions	31.9	3.83
08LG055	Bethsaida Creek Above Highland Valley Road	15.5	1.33
08LG066	Chataway Creek Near the Mouth	32.2	2.17
08LF100	Dairy Creek Above Tostin Lake	10.6	0.35

In the absence of actual flow data from Ashcroft or catchments more similar in size, a conservatively high flow rate of 5 L/s/ha was selected for undeveloped catchments in the study area model. 5 L/s/ha is based on rounding up the highest value in **Table 3**, since smaller catchments provide less attenuation from streams and storage areas than large ones, and therefore have higher flow rates. The station locations are shown in **Figure 5** for reference.



#### 3.1.3 CATCHMENT DELINEATION

For the model to work, it must have catchments to receive precipitation from the design storm event generated above. Stormwater catchments are basins bound by ridges that drain to a single point. The model uses these catchments to generate runoff flow rates from each catchment to the point where flow is measured.

Storm catchments and drainage paths for use in the model were delineated using LiDAR data. The LiDAR encompasses all of North Ashcroft and its drainage area. Fine LiDAR was available for the North Ashcroft catchment but not the offsite catchments, so coarse LiDAR was used to delineate catchments and flow paths in Elephant Hills, which were then manually spliced to the catchments and flow paths delineated from the fine LiDAR. The catchments as delineated from LiDAR are shown in **Figure 6** below.

Culverts were not etched into the LiDAR surface during catchment delineation, since in the 1:100 year events the proportion of flow that spills overland will be much greater than the proportion of flow that is conveyed by culverts. However, while culverts cannot convey the same flow as overland drainage paths, they can convey significant volumes of water at lower flows, for which reason they were added to the model after the catchments were delineated.

Further analysis was performed to determine the location and depth of inundation areas in the village. Inundation areas are low-lying depression areas where stormwater will pond until it is able to spill out of the depression. **Figure 7** displays the extent and depth of depression areas when they are full and just about to start spilling over.

#### 3.1.4 OVERLAND DRAINAGE ROUTES

The final inputs needed for the model to work are overland drainage routes. These take the runoff generated from the catchment and convey them outside of the study limits to the Thompson River where they ultimately discharge.

Using the LiDAR provided, overland drainage routes were delineated along the lowest points of valleys in each catchment. These flow drainage routes cause concern where the storm flow exceeds the capacity of culverts and other conveyance structures, which occurs in a few key places, as discussed further in the sections below.



Legend 16.00ha Elephant Hills 10.84ha Elm St 293.42ha 7.02ha 38.57ha 1.49ha Allise 1.52ha 77.21ha 2.76ha NAD 1983 CSRS UTM Zone 10N CNR RW Rd Ashcroft Project #: Authori Status: Revision: Date:



### Village of Ashcroft North Ashcroft Drainage Master Plan Catchments and Flow Paths

- Flow Path

#### Catchment

Farmland

Hill and Escarpment

Urban, Existing

Urban, Proposed

Urban, Future

Urban, Park

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FIGURE 6

Ashcroft \* Village of Ashcroft North Ashcroft Drainage Master Plan **Ponding Areas** Legend Study Area WDT Ponding Depths Swimming Pool Inundation Area Value School Inundation Area 0.01 - 0.1 0.11 - 0.2 0.21 - 0.3 0.31 - 0.4 0.41 - 0.5 Riverside Drive Inundation Area 0.51 - 0.6 0.61 - 0.7 Birch St 0.71 - 0.8 0.81 - 0.9 0.91 - 1 1.01 - 1.1 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 Government Street and Thompson River Cariboo Road CNR RW Rd **Inundation Area** NAD 1983 CSRS UTM Zone 10N Ashcroft Mesa Vista Dr 1093.0056.01 URBAN Project #: Author: Checked: SYSTEMS Status: Review Revision: Date: FIGURE 7 2022/4/14

#### 3.2 STORMWATER MODELLING

#### 3.2.1 COMPUTER MODEL

A PCSWMM stormwater modeling tool was utilized for this study. The model is extensively used to simulate the rainfall/runoff relationships for both new development areas and the existing built form. The model uses the EPA SWMM 5 engine with a GIS-based user interface, and it has powerful modelling capabilities for both overland and stormwater minor piped systems. The PCSWMM model applied in the analysis is:

- PCSWMM Professional 2D, version 7.4.3240
- · Graphical Interface for EPA SWWM version 5.1.015

The hydrologic data discussed in **Section 2** was imported into the PCSWMM model to determine the existing drainage conditions and assess the level of service in the Village of Ashcroft using theoretical design extreme storm events. The design single storm event is the 1:100-year 24-hour Chicago design storm with IDF parameters from **Section 3.1**.

#### 3.2.2 INFILTRATION PARAMETERS

The PCSWMM model used Modified Green-Ampt Infiltration to represent how much and how fast stormwater soaks into the ground. Catchment parameters as based on land use summarized below in **Table 4**. Green-Ampt infiltration parameters are shown in **Table 5**.

Table 4: Model Infiltration Parameters

Land Use	Urban Development	Urban Park	Farm	Hill
Imperviousness (%)	50	25	5	5
Disconnection (%)	40	80	100	100
Manning's n, impervious	0.03	0.03	0.03	0.03
Manning's n, pervious	0.05	0.05	0.05	0.05
Depression storage, impervious (mm)	1.5	1.5	1.5	1.5
Manning's n, pervious (mm)	3.6	3.6	5	5

A map of these areas is provided below in Figure 8.



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Village of Ashcroft North Ashcroft Drainage Master Plan Soil Types

Legend

Study Area Soil Type

Loamy Sand

Sandy Loam

Loam

Silty Loam

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FIGURE 8

#### 3.2.3 SOIL PARAMETERS

In the absence of geotechnical information, soil parameters were assigned based on the Soils of the Ashcroft Area study presented through iMapBC. Soil polygons were imported into PCSWMM and parameters assigned to the three soil types within the study area as follows in **Table 5**. Their locations are shown in **Figure 8**.

Table 5: Parameters of Soils within Study Area

Soil	Saturated Hydraulic Conductivity (mm/hr)	ctivity Suction Head (mm)	
Loam (L)	3.3	88.9	Loam (L)
Sandy Loam (SL)	10.92	109.98	Sandy Loam (SL)
Loamy Sand (LS)	29.97	60.96	Loamy Sand (LS)

#### 3.2.4 MODEL CALIBRATION

A model was built using the parameters discussed in this section and calibrated to match the flows arrived at in **Section 3.1**. Calibration of the predevelopment catchments was done by adjusting the flow length of the catchments to get runoff rates similar to those predicted by the regional analysis.

The calibrated model was then run under the future climate change extreme storm events and infrastructure sized off the results of those events.

#### 3.2.5 DEVELOPMENT ASSUMPTIONS

The Battel Subdivision drainage improvements were modelled assuming development continues along the upper and lower plateaus exclusive of the undevelopable escarpment. The storm event used was the 1:100 year 24 hour event under future conditions considering predicted climate change for the year 2100. The proposed drainage upgrades, presented in the subsequent sections, have been modelled with the assumption that they will service future developments and the existing Battel Subdivision, with future lands needing to provide minor system upgrades to convey flows to the dry pond or its alternative minor system.

#### 3.2.6 HIGHWAY DRAINAGE SCENARIOS

There are two culverts crossing Highway 97C north of Government Street. It is unclear how much flow they convey across the highway and into the study area due to not being positioned in a low point and to being in poor condition. Due to the existing culvert capture inefficiencies, flows are expected to spill onto Highway 97C on a frequent basis. To deal with this flooding, MOTI may upgrade the culvert crossings. To quantify the impact of upgrading the culvert crossings to re-establish these flow paths through the study area, three



scenarios were considered at the location where Highway 97C intersects Government Street:

- Both culverts across Highway 97C remain unchanged.
- The southern culvert across Highway 97C is upgraded to convey all flows from west of Highway 97 C through the Village of Ashcroft.
- The southern and norther culverts across Highway 97C are both upgraded to convey all flows from west of Highway 97C through the Village of Ashcroft.

The flows from the model under these scenarios are summarized in **Table 6** below, and were used in determining the recommended drainage system improvement sizing:

Table 6: Flows Under Different Improvement Scenarios

Location	North and South culverts upgraded	North culvert upgraded	Both culverts unchanged
	Peak Flow, m3/s	Peak Flow, m3/s	Peak Flow, m3/s
Highway 97 C North Culvert Inlet	1.7		-
Highway 97 C South Culvert Inlet	0.7	2.4	-
Government ST Driveway Culverts	1.0	2.7	0.3
Government ST Ditch Outlet	1.0	2.7	0.3
Battel Subdivision NW Ditch Outlet	3.0	1.3	1.3
Battel Subdivision NE Ditch Outlet	3.7	2.0	2.0
Battel subdivision Minor system to Ashcroft Park	6.7	5.0	5.0
Highway 97C Culvert to Thompson River	1.7	1.7	4.1
Highway 97C Ditch Outlet	0.6	0.6	3.0
Highway 97C crossing culverts	0.6	0.6	3.0

The model suggests upgrading both culverts results in heavy flows to Government Street and the Battel subdivision. Upgrading only the south culvert results in heavy flows travelling along Government Street. Upgrading neither culvert would require upgrades



along the Highway 97C ditch and creating a culvert from that ditch to the Thompson River. The impacts of these heavy flows on the town and the Highway ditch are discussed in **Section 4** of this report.

#### 3.2.7 INUNDATION AREAS

Using the LiDAR provided, a fill pit (low point) analysis was run to see what areas could flood during a storm. A fill pit analysis works by filling up each cell in a LiDAR raster until it spills into the next cell. This provides an approximation of the maximum inundation footprint water will reach before it starts spilling out of the depression or hollow that forms it.

Inundation areas can be broken into two categories:

- Inundation areas driven mainly by flow from upstream catchment overland drainage routes
- Inundation areas driven mainly by flow from the local catchment of the inundation area

Inundation areas driven by flow from overland drainage are most concerning because overland drainage routes typically generate more volume than local catchments, meaning these inundation areas are more likely to be recurring trouble spots. These trouble spots are presented in **Figure 7** and **Table 7** below:

Table 7: Areas Posing Flood Hazards

Reference	Location	Area (m2)	Volume (m3)	Maximum Depth (m)
Swimming Pool	SW of Ashcroft Outdoor Swimming Pool	6,642	1,565	0.58
School	NW of Desert Sands Community School	4,228	842	0.56
Riverside DR	Riverside Drive cul-de-sac	2,830	509	0.72
Government ST & Cariboo RD	Point formed by Tingley ST and Government ST	11,055	3,546	1.06

Of these areas, the area presenting the greatest flood hazard is the Government ST inundation area. This appears to completely inundate one house and several outbuildings and storage yards.



# 4.0 EXISTING SYSTEM ANALYSIS AND MITIGATION MEASURES

Mitigation strategies were developed with the following objectives:

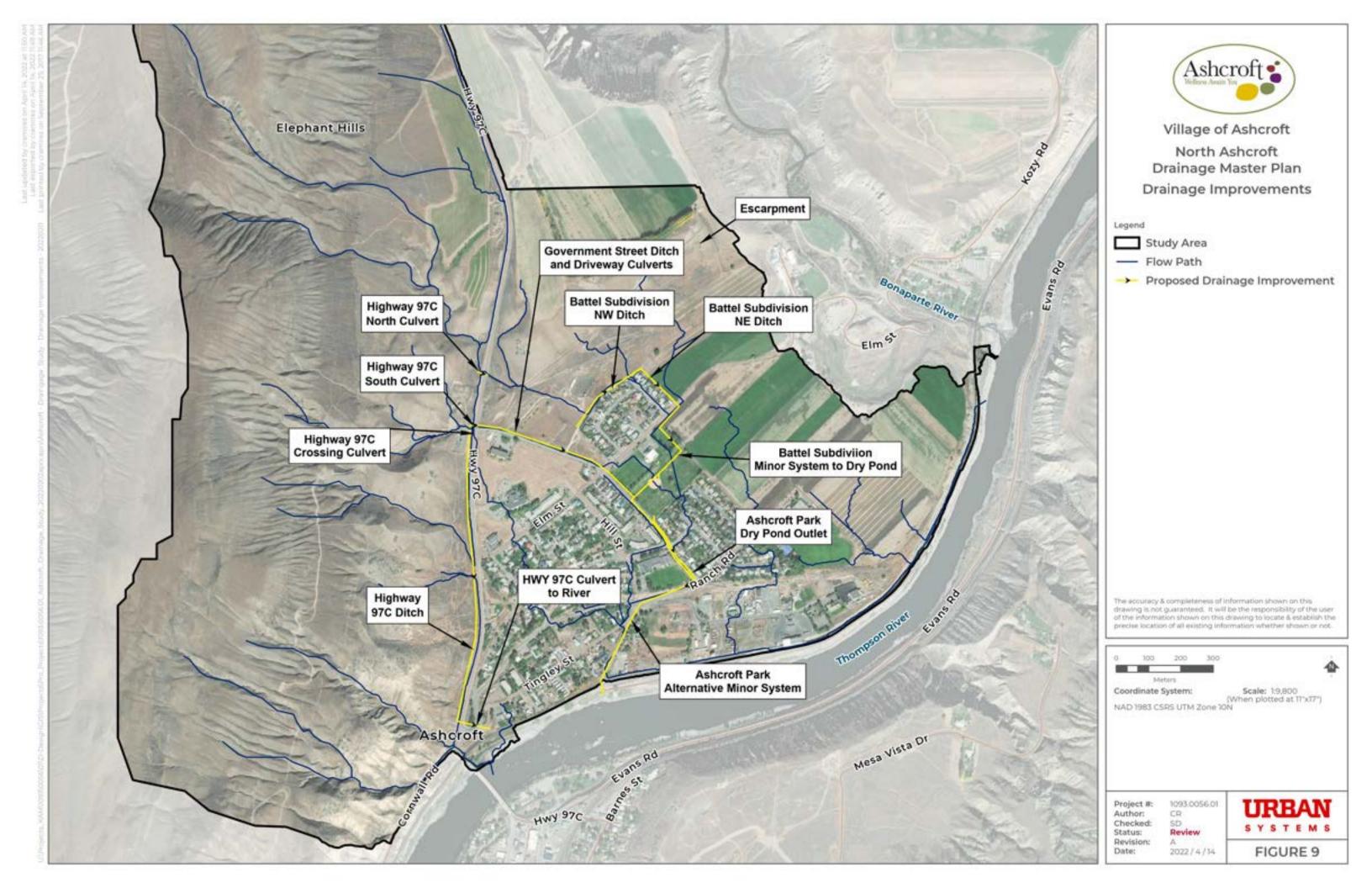
- Improve existing drainage system
- Accommodate future development
- Assess and consider offsite flows on proposed upgrades

The Elephant Hills offsite flows, west of Highway 97C, were considered in the proposed improvement strategies. Due to existing flow conveyance limitations in the Highway culverts, all proposed improvement strategies included scenario variations with and without potential Highway culvert upgrades as explained further in the following sections.

A map of the existing drainage problems and proposed drainage improvements is shown in **Figure 9** below and is described in the following sections. These sections are grouped by the following drainage locations:

- Drainage System Upstream of Ashcroft Park Government Street
  - o Highway 97C South Culvert
  - o Government Street Ditch
  - o Government Street Driveway Culverts
- Drainage System Upstream of Ashcroft Park Battel Subdivision
  - o Highway 97C North Culvert
  - o Battel Subdivision NW Ditch
  - o Battel Subdivision NE Ditch
- Ashcroft Park and Downstream Drainage System
  - o Drainage System Downstream of Ashcroft Park Dry Pond Option
    - Dry Pond in Ashcroft Park
    - Minor System from Dry Pond to Existing System
  - o Drainage System Downstream of Ashcroft Park Storm Trunk Option
    - Storm Trunk from Ashcroft Park to Thompson River
- Highway 97C Drainage System
  - o Highway 97 Ditch
  - o Highway 97 Crossing Culverts
  - o Potential Highway 97 Culvert to Thompson River





## 4.1 DRAINAGE SYSTEM UPSTREAM OF ASHCROFT PARK – GOVERNMENT STREET

#### 4.1.1 EXISTING CONDITIONS

Flow-by catch basins on Highway 97C and the small culverts, shown in **Figure 9**, across Highway 97C are not expected to convey significant flows across the highway to the Government Street ditch for events larger than the 1 in 25 year. Images of the existing drainage system infrastructure are shown below in **Figures 10 to 13**.





#### 4.1.2 MITIGATON MEASURES

Flows to Government Street begin in the Elephant Hills on the west side of Highway 97C. Most of these flows collect where the service road opposite of Government Street meets Highway 97C. In the scenario where both Highway culverts are unchanged, these flows will be handled by the Highway 97C ditch. The ditch will need to be improved to handle these flows. In the scenario where one or both culverts are upgraded, these flows will go through the Government Street Ditch. Driveways are proposed across this ditch, for which reason driveway culverts will be needed to convey the flows to Ashcroft Park.

Table 8: Sizes of Government Street Improvements

Location	North and South culverts upgraded	North culvert upgraded	Both culverts unchanged
Government Street Ditch	0.5 m deep, 1 m bottom, 3:1 side slopes, class 25 rip rap	0.7 m deep, 1 m bottom, 3:1 side slopes, class 100 rip rap	0.3 m deep, 1 m bottom, 3:1 side slopes, class 10 rip rap
Government Street Driveway Culverts	Twin 750 mm	Twin 1200 mm	Single 675 mm

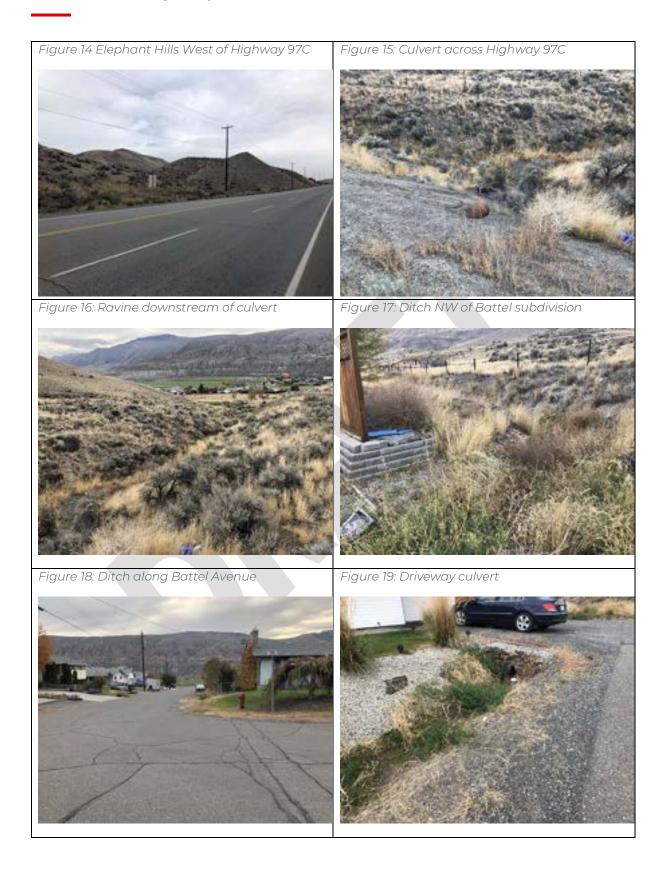
# 4.2 DRAINAGE SYSTEM UPSTREAM OF ASHCROFT PARK – BATTEL SUBDIVISION

#### 4.2.1 EXISTING CONDITIONS

Flows from the escarpment are funnelled into Battel AV where undersized driveway culverts are unable to handle the flows above the 1 in 5 year. LiDAR predicts flows will run along the west side of Battel AV before spilling across Elm ST and running through the agricultural fields.

Images of the existing drainage system are shown below in Figures 14 to 19.





#### 4.2.2 MITIGATION MEASURES

Flows to the Battel Subdivision begin in the Elephant Hills on the west side of Highway 97C. From there a portion of the flows, where the portion varies with the scenario, cross Highway 97C and travel down a ravine and across the rodeo grounds to the Battel subdivision. Future development in the rodeo grounds will need to establish a drainage path for these flows. At the Battel subdivision the flows are collected into a ditch along the NW side of the site. In the proposed condition these flows will enter a ditch along the NE side of the Battel subdivision, where they will be collected into a minor system to Ashcroft Park.

The required sizes of infrastructure under the three scenarios considered are given below:

Table 9: Sizes of Battel Subdivision Improvements

Location	North and South culverts upgraded	North culvert upgraded	Both culverts unchanged
Battel Subdivision NW Ditch	0.9 m deep, 1 m bottom, 3:1 side slopes, class 10 rip rap	0.7 m deep, 1 m bottom, 3:1 side slopes, class 10 rip rap	0.7 m deep, 51 m bottom, 3:1 side slopes, class 10 rip rap
Battel Subdivision NE Ditch	0.8 m deep, 1 m bottom, 3:1 side slopes, class 50 rip rap	0.6 m deep, 1 m bottom, 3:1 side slopes, class 25 rip rap	0.6 m deep, 1 m bottom, 3:1 side slopes, class 25 rip rap
Minor System from Battel Subdivision to Ashcroft Park [1]	1950 mm inlet, 1350 mm main	1650 mm inlet, 1200 mm main	1650 mm inlet, 1200 mm main

<sup>[1]</sup> The inlet will be a headwall structure and connect upstream of a manhole. Downstream of the manhole will be the minor system. This configuration is used because inlets are less efficient than minor systems and therefore have to be oversized.

#### 4.3 ASHCROFT PARK & DOWNSTREAM DRAINAGE SYSTEM

#### 4.3.1 EXISTING CONDITIONS

Ashcroft Park acts as an inundation area. Only flows from Government Street reach Ashcroft Park in the existing condition, flows from the Battel subdivision flow across the agricultural lands to the north-east.

#### 4.3.2 MITIGATION MEASURES

Flows from the proposed Battel Subdivision and Government Street improvements are designed to meet in Ashcroft Park where they will be handled by one of two options: either retrofit part of the Ashcroft Park into a multi-use dry pond to detain these flows and release them slowly to the existing minor system, or a storm trunk large enough to convey the



flows to the Thompson River. It was assumed the new storm trunk option would be installed parallel to the existing storm system. For the dry pond option, the existing system appears to have capacity, meaning the dry pond outlet can tie into the existing minor system. A comparison of the infrastructure needed in these two scenarios is given below:

Table 10: Sizes of Improvements Downstream of Ashcroft Park for Dry Pond System

Location	North and South	North culvert	Both culverts
Location	culverts upgraded	upgraded	unchanged
Dry Pond in Ashcroft Park	200 m long, 100 m	200 m long, 100 m	100 m long, 100 m
Dry Porid III Asticiott Park	wide, 1 m deep	wide, 1 m deep	wide, 1 m deep
Minor System from Dry	375 mm inlet, 300 mm	375 mm inlet, 300	375 mm inlet, 300
Pond to Existing System			mm main
[1]	main	mm main	min Main

<sup>[1]</sup> The inlet will be a headwall structure and connect upstream of a manhole. Downstream of the manhole will be the minor system. This configuration is used because inlets are less efficient than minor systems and therefore have to be oversized.

Table 11: Sizes of Improvements Downstream of Ashcroft Park for Alternative Minor System

Location	North and South culverts upgraded	North culvert upgraded	Both culverts unchanged
Storm Trunk from Ashcroft Park to Thompson River [1]	1950 mm inlet, 1200	1650 mm inlet,	1650 mm inlet,
	mm main	1050 mm main	1050 mm main

<sup>[1]</sup> The inlet will be a headwall structure and connect upstream of a manhole. Downstream of the manhole will be the minor system. This configuration is used because inlets are less efficient than minor systems and therefore have to be oversized.

Both scenarios should be provided with an emergency overland escape route in the event that failure occurs. Failure of a dry pond can occur if the inlet becomes plugged or volume is lost to sedimentation. Failure of a minor system can occur if the inlet becomes plugged, if a pipe collapses, or if capacity is lost to sedimentation. Both systems can fail in extreme storm events more severe than the 1:100 year design event. Any of these mechanisms is likely to occur during the lifetime of the infrastructure so an emergency escape route should be provided.

An ideal location for an emergency escape route would be to skirt the east fringe of existing development. This option would require coordination with the landowner to provide a drainage right of way.



#### 4.4 HIGHWAY 97C DRAINAGE SYSTEM IMPROVEMENTS

#### 4.4.1 EXISTING CONDITIONS

Flows in the ditch along the west side of Highway 97C encounter undersized culverts across the access road in line with Government Street. Flow-by catch basins on Highway 97C and the small culverts across Highway 97C are not expected to convey significant flows across the highway to the Government Street ditch for events larger than the 1 in 25 year. Thus, most flows in extreme events overtop Highway 97C in a southernly direction and either flow in front of the Hospital, or are conveyed along the concrete barriers on the east side of Highway 97C until they spill across the access road to the hospital. From there, they cut through several residential areas before finally collecting at the Government Street and Cariboo Road inundation area.

Flows downstream of the intersection of Highway 97C and Government Street are conveyed in the ditch until the ditch tapers off into a rocky cliff face near the bridge to South Ashcroft. Here the flows spill into the roadway, and there have been reports of spills going across the bridge.

#### 4.4.2 MITIGATION MEASURES

Flows to Highway 97C originate in the Elephant Hills on the west side of Highway 97C. To mitigate impacts within the study area, a conceptual offsite flow diversion scenario was evaluated. In this scenario, an improved ditch system is proposed to convey the offsite flows south towards the intersection of Highway 97 and Cornwall Road. Flows are conveyed across access roads intersecting the ditch by crossing culverts. At Cornwall Road the flows will be collected into a culvert that conveys them to the Thompson River.

Table 12: Sizes of Improvements to Highway 97C

Location	North and South culverts upgraded	South culvert upgraded	Both culverts unchanged
Highway 97C North Culvert	Single 1200 mm	No Change	No Change
Highway 97C South Culvert	Single 900 mm	Twin 1050 mm	No Change
Highway 97C Ditch	0.4 m deep, 3.4 m wide, class 10 rip rap	0.4 m deep, 3.4 m wide, class 10 rip rap	0.7 m deep, 5.4 m wide, class 100 rip rap
Highway 97C Crossing Culverts	Single 300 mm	Single 300 mm	Triple 900 mm
Highway 97C Culvert to Thompson River [1]	1050 mm inlet, 600 mm main	1050 mm inlet, 600 mm main	1500 mm inlet, 900 mm main



#### Village of Ashcroft

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[1] The inlet will be a headwall structure and connect upstream of a manhole. Downstream of the manhole will be the minor system. This configuration is used because inlets are less efficient than minor systems and therefore have to be oversized.

#### 4.5 RIVERSIDE DRIVE

#### 4.5.1 EXISTING CONDITIONS

Flows that have travelled through the agricultural lands reach the School inundation area, where they overtop Ranch Road and spill through a residential area before collecting in the Riverside Drive inundation area.

#### 4.5.2 MITIGATION MEASURES

Flows in this area are not high enough to cause major concerns, and the mitigation measures suggested above would manage the upstream catchments to prevent flows from reaching this area.

#### **4.6 INDUSTRIAL AREA**

#### 4.6.1 EXISTING CONDITIONS

Flows from the Riverside DR inundation area spill south over the embankment and cut through the industrial area before collecting north of the train tracks. The Village of Ashcroft also identified stagnant water in the ditch here.

#### 4.6.2 MITIGATION MEASURES

The mitigation measures suggested above would reduce flows reaching the industrial park. The stagnant water in ditches is likely nuisance flooding caused by improperly graded local catchments. Work could be undertaken to better grade the ditches in the industrial area to alleviate these problems, but the model results do not indicate that high flows will be an issue for the industrial area.



## **5.0 COST ESTIMATES**

Class C cost estimates for the proposed improvements and mitigation measures are presented in Appendix C. A summary of these cost estimates is given in **Table 13** below for consideration. Proposed cost estimates are presented with and without Highway 97C culvert upgrades, consistent with the improvement scenarios described in the previous sections. The total costs are summarized into two variations, one with the Ashcroft Park Dry Pond and the other with the Storm Trunk Upgrade alternative as described in **Section 4.3**.

Table 13: Summary of Detailed Cost Estimates for Improvements

Improvement	North and South culverts upgraded	South culvert upgraded	Both culverts unchanged
General Project Expenses [1]	310,000	310,000	310,000
Drainage improvements			
Upstream of Ashcroft Park -	1,831,000	1,522,000	1,522,000
Battel Subdivision			
Drainage Improvements			
Upstream of Ashcroft Park -	834,000	1,263,000	459,000
Government Street			
Drainage Improvements			
Ashcroft Park and Downstream	2,772,000	2,772,000	1,637,000
Drainage - Dry Pond Option			
Drainage Improvements	7 (50 000	7.00/.000	7.05/.000
Ashcroft Park and Downstream	3,459,000	3,064,000	3,064,000
Drainage - Storm Trunk Option			
Highway 97C Drainage System	789,000	752,000	1,304,000
Improvements [2]			
Total Day Dond Ontion	F 7 / 7 000	F 067 000	7,020,000
Total - Dry Pond Option	5,747,000	5,867,000	3,928,000
40% Contingency [3]	2,299,000	2,347,000	1,572,000
Subtotal	8,046,000	8,214,000	5,500,000
10% Engineering	805,000	822,000	550,000
Total – Dry Pond Option	8,851,000	9,036,000	6,050,000
Total - Storm Trunk Option	6,434,000	6,159,000	5,355,000
40% Contingency [3]	2,574,000	2,464,000	2,142,000
Subtotal	9,008,000	8,623,000	7,497,000
10% Engineering	901,000	863,000	750,000
Total - Storm Trunk Option	9,909,000	9,486,000	8,247,000



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- [1] General Project Expenses include mobilization/demobilization, construction administration, engagement, and traffic control.
- [2] Highway 97C improvements are expected to be covered by MOTI
- [3] 40% contingency is based on the conceptual level of this estimate, the volatility of materials pricing, uncertainty in the ability to source local materials, and the nature of the work as retrofit.





## 6.0 CONCLUSIONS

This report presents the analysis done to describe how the drainage system in North Ashcroft is currently operating, and what improvements are necessary to equip the drainage system to handle climate change and development up to the 1:100 year level of service. It addresses 450 hectares of land draining through North Ashcroft, including its local catchment as well as contributing lands to the west of Highway 97C.

Under existing conditions most stormwater from the contributing lands to the west of Highway 97C are conveyed in the highway ditch until they spill into Ashcroft at the intersection with the hospital entrance as well as Elm Street. Major inundation areas and their spill pathways were identified to demonstrate areas in risk of inundation.

To mitigate these risks, several improvement concepts were evaluated and presented for consideration. The proposed improvement scenarios were developed to achieve a 1:100 year level of service with climate change and future development considerations. Proposed improvement scenarios were evaluated with and without Highway 97C culvert upgrades to assess the impact of offsite flows from Elephant Hills catchment. Improvements include regrading ditches, adding minor systems, constructing a storm pond, and improving culverts.





## 7.0 References

Village of Ashcroft. 2022. *Historic Ashcroft*. 2021. <a href="https://ashcroftbc.ca/blast-through-the-past-overview-2/">https://ashcroftbc.ca/blast-through-the-past-overview-2/</a> (accessed April 1, 2022)

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## 8.0 CORPORATE AUTHORIZATION

This report, titled *DRAFT North Ashcroft Drainage Study*, is prepared for the Village of Ashcroft. The material in this report reflects the best judgement of Urban Systems Ltd. based on the information available at the time of preparation. Any use that the third party makes of this report, or reliance on or decisions made based on it, is the responsibility of the third party. Urban Systems Ltd. accepts no responsibility for damages, if any, suffered by a third party as a result of decisions made or actions taken based on this report.

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Responsible Engineer:

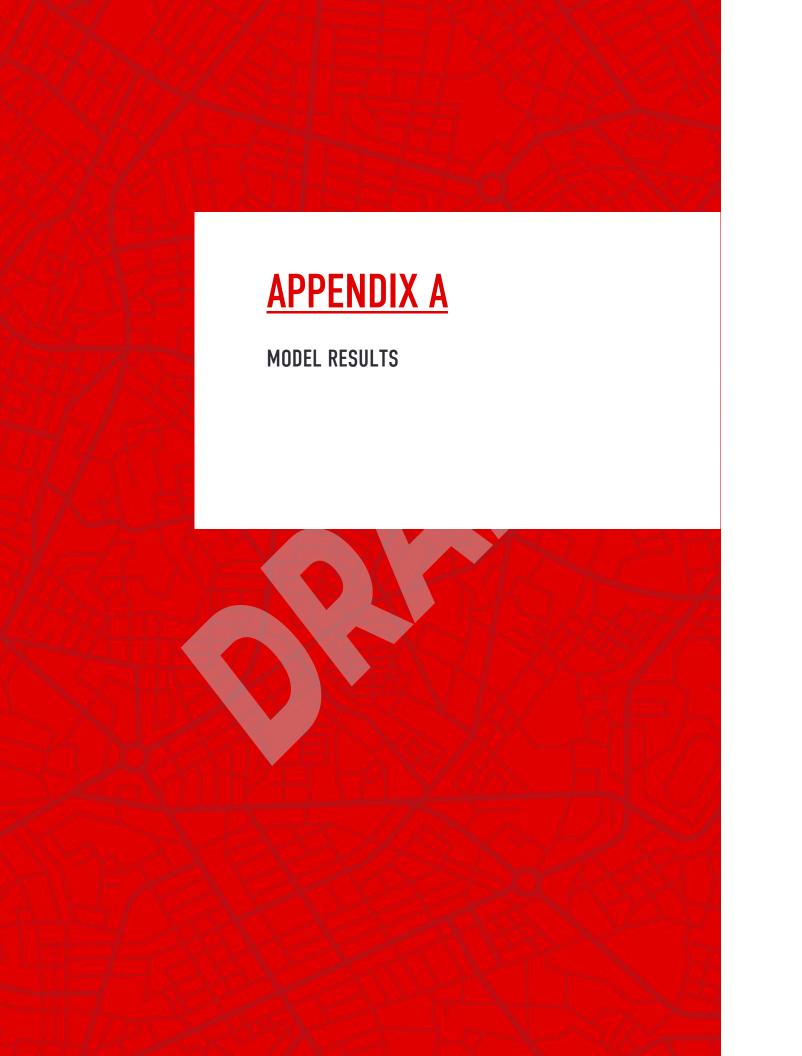
Pablo Lopez, P.Eng.

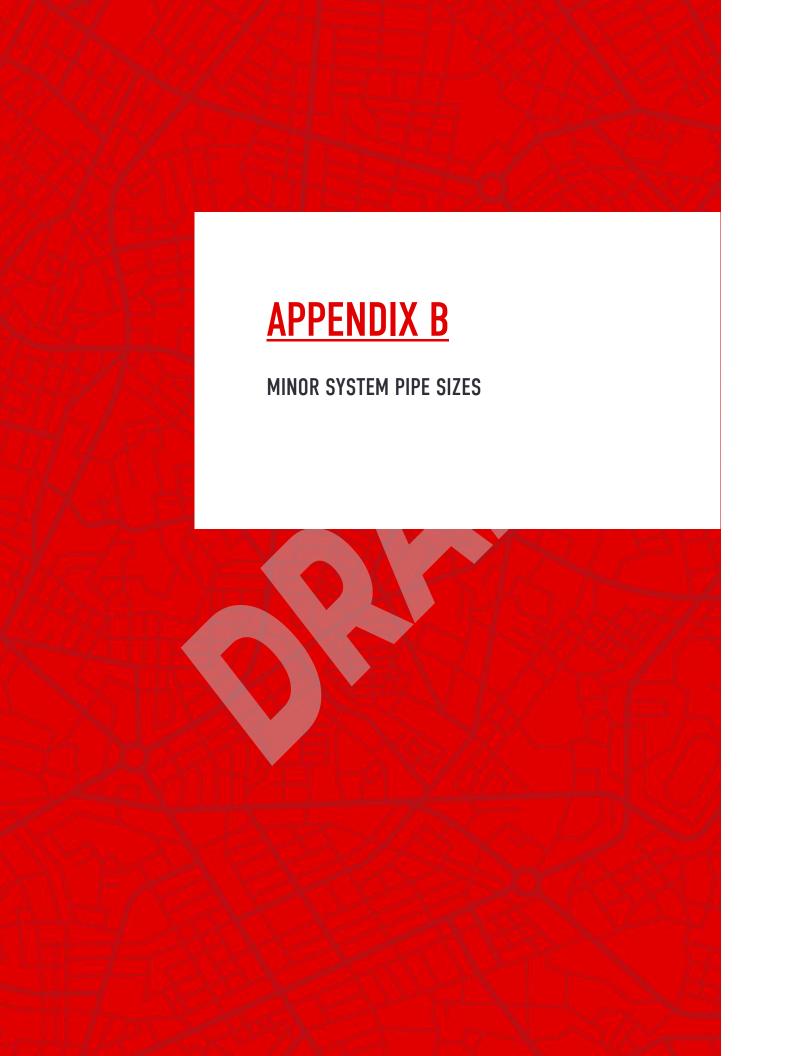


## 9.0 Appendices

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DETAILED COST ESTIMATES	

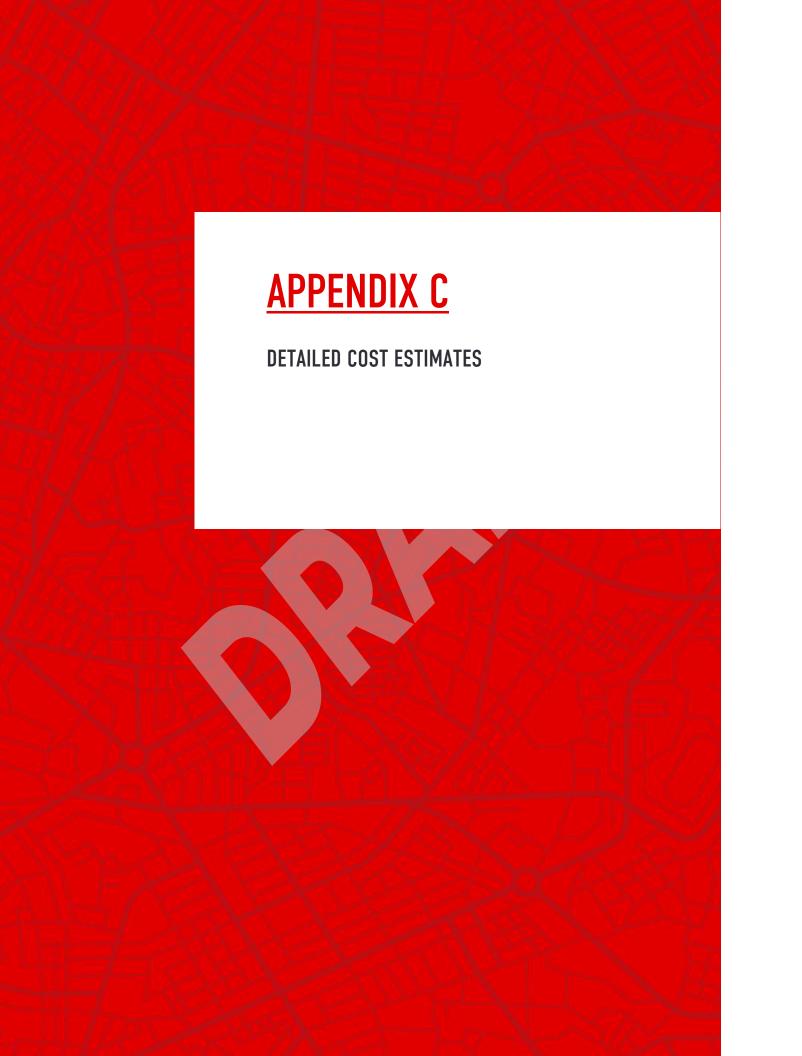






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Item		Unit	Quantity	Uni	it Price \$	Total Amount \$		
-		•			-			
General P	roject Expenses							
	Project Record Documents	l.s.	1	\$	100,000	\$	100,000	
	(O&M manuals, construction administration, record survey, asbuilts		-	<del></del>	100,000	<u> </u>	100,000	
		•						
	Signage and Public notice	l.s.	1	\$	10,000	\$	10,000	
	Mobilization and Demobilization, except HWY 97C	l.s.	1	\$	200,000	\$	200,000	
	Total General Project Expenses					\$	310,000	
Drainage	improvements Upstream of Ashcroft Park - Battel Subdivision							
	Battel Subdivision NW Ditch							
	Excavation and Disposal	c.m.	2000	Ś	35	\$	70,000	
	Rip Rap Class 10, locally sourced	c.m.	600		130	\$	78,000	
	Filter Cloth	s.m.	1700		5	\$	8,500	
	Seeding	s.m.	1700	\$	5	\$	8,500	
	Battel Subdivision NE Ditch							
	Excavation and Disposal	c.m.	1400	Ś	35	\$	49,000	
	Rip Rap Class 50, locally sourced	c.m.	500		175	\$	87,500	
	Filter Cloth	s.m.	900		5	\$	4,500	
	Seeding	s.m.	900	\$	5	\$	4,500	
	Minor System from Battel Subdivision to Dry Pond							
	1350 mm Concrete Main	l.m.	350	Ś	3,000	\$	1,050,000	
	1950 mm Concrete Inlet	ea.	1	\$	70,000	\$	70,000	
	Manholes	ea.	4	\$	25,000	\$	100,000	
	Risers	v.m.	20		2,500	\$	50,000	
	Oil-Grit Separator	ea.		\$	200,000	\$	200,000	
	Concrete outfall	ea.		\$	50,000	\$	50,000	
	Total Drainage improvements Upstream of Ashcroft Park - Battel	Subdivisio	n			\$	1,831,000	
Drainage	Improvements Upstream of Ashcroft Park - Government Street							
	Government Street Ditch							
	Excavation and Disposal	c.m.	2500	Ś	35	\$	87,500	
	Rip Rap Class 25, locally sourced	c.m.	1000		175	\$	175,000	
	Filter Cloth	s.m.	2100		5	\$	10,500	
	Seeding	s.m.	2100		5	\$	10,500	
	Government Street Driveway Culverts							
	750 mm CMP, twin 10 m, 27 lots	l.m.	550	\$	1,000	\$	550,000	
	Total Drainage Improvements Upstream of Ashcroft Park - Govern	nment Str	eet			\$	834,000	

tem			Unit	Quantity	Unit P	rice \$	Total	Amount \$
	•		•	· · · · · · · · · · · · · · · · · · ·				
rainag	e Improvements Do	wnstream of Ashcroft Park						
	Dry Pond Option							
	Build I	Dry Pond						
		Strip Topsoil and dispose off-site	c.m.	6000	\$	35	\$	210,000
		Excavation and Disposal	c.m.	11200	\$	35	\$	392,000
		French Drains	l.m.	800	\$	700	\$	560,000
	Resto	e Play Field						
		Playfield Subbase	s.m.	20000	\$	22	\$	440,000
		Playfield Turf	s.m.	20000	\$	22	\$	440,000
		Irrigation System	ea.	2	\$ 1	100,000	\$	200,000
		Backstop	ea.	1	\$	50,000	\$	50,000
		Bleachers	ea.	1	\$	25,000	\$	25,000
	Minor	System from Dry Pond to Existing System						
		300 mm PVC Main	l.m.	250	\$	600	\$	150,000
		375 mm Concrete Inlet	ea.	1	\$	5,000	\$	5,000
		Flow Control Manhole	ea.	1	\$	15,000	\$	15,000
		Manholes	ea.	3	\$	10,000	\$	30,000
		Risers	v.m.		\$	2,000	\$	30,000
		Tie-in to Existing System	ea.		\$	5,000	\$	5,000
		Remove and replace road	s.m.	2000	\$	110	\$	220,000
	Total Drainage In	nprovements Downstream of Ashcroft Park- D	ry Pond Opt	ion			\$	2,772,000
	Storm Trunk Opt	ion						
	Minor	System Alternative to River						
		1200 mm Concrete Main	l.m.	950	\$	2,500	\$	2,375,000
		1950 mm Concrete Inlet with headwall	ea.			70,000	\$	70,000
		Manholes	ea.	6		15,000	\$	90,000
		Risers	v.m.	25	\$	2,500	\$	62,500
		Concrete outfall	ea.	1		25,000	\$	25,000
		Remove and replace road	s.m.	7600		110	\$	836,000

Total Drainage Improvements Downstream of Ashcroft Park- Storm Trunk Option

\$ 3,459,000

Item		Unit	Quantity	Uni	it Price \$	Total	Amount \$
Liahurau	97C Improvements (MOTI Cost)						
nigiiway	37C Improvements (MOTI Cost)						
	Mobilization and Demobilization	l.s.	1	\$	50,000	\$	50,000
	Traffic Control	l.s.	1	\$	20,000	\$	20,000
	Consultation with 105 Mile Post Indian Reserve No.2	l.s.	1	\$	100,000	\$	100,000
	Highway 97C North Culvert						
	1200 mm CMP	l.m.	30	Ś	2,000	\$	60,000
	Remove and replace road	s.m.	240		110	\$	26,400
	Highway 97C South Culvert						
	900 mm CMP	l.m.	30	Ś	1,500	\$	45,000
	Remove and replace road	s.m.	240		110	\$	26,400
	Highway 97C Ditch						
	Common Excavation	c.m.	3000	\$	35	\$	105,000
	Rip Rap Class 10, locally sourced	c.m.	1000	\$	150	\$	150,000
	Filter Cloth	s.m.	3200		5	\$	16,000
	Seeding	s.m.	3200		5	\$	16,000
	Highway 97C Crossing Culverts						
	No change	l.m.	0	\$	-	\$	
	Highway 97C Culvert to River						
	600 mm Concrete Main	l.m.	110	\$	800	\$	88,000
	1050 mm Concrete Inlet with headwall	ea.		\$	20,000	\$	20,000
	Manholes	ea.		\$	15,000	\$	30,000
	Risers	v.m.		\$	2,000	\$	16,000
	Concrete outfall	ea.		\$	20,000	\$	20,000
	Total Highway 97C Improvements (MOTI Cost)					\$	789,000

Item		Unit	Quantity	Unit Price \$	Total	Amount \$
Summary						
	Total General Project Expenses				\$	310,000
	Total Drainage improvements Upstream of Ashcroft Park - Battel Su	ıbdivision			\$	1,831,000
	Total Drainage Improvements Upstream of Ashcroft Park - Governm	nent Street			\$	834,000
	Total Drainage Improvements Downstream of Ashcroft F	Park- Dry Po	nd Option		\$	2,772,000
	Total Drainage Improvements Downstream of Ashcroft F	Park- Storm	Trunk Optio	on	\$	3,459,000
	Total Highway 97C Improvements (MOTI Cost)				\$	789,000
	Total - Dry Pond Option Cost to Ashcroft				\$	5,747,000
	40% Contingency				\$	2,299,000
	Subtotal				\$	8,046,000
	10% Engineering				\$	805,000
	Total - Dry Pond Option Price to Ashcroft				\$	8,851,000
	Total - Storm Trunk Option Cost to Ashcroft				\$	6,434,000
	40% Contingency				\$	2,574,000
	Subtotal				\$	9,008,000
	10% Engineering				\$	901,000
	Total - Storm Trunk Option Price to Ashcroft				\$	9,909,000

Item		Unit	Quantity	Uni	t Price \$	Tota	I Amount \$	
General P	roject Expenses							
	Project Record Documents	l.s.	1	\$	100,000	\$	100,000	
	(O&M manuals, construction administration, record survey, asbuilts,		<u>.</u>	<u> </u>	100,000	<u>,                                     </u>	100,000	
	Signage and Public notice	l.s.	1	\$	10,000	\$	10,000	
	Mahilization and Domohilization overat LIMV 07C	l.s.		ç	200.000	<u>,</u>	200,000	
	Mobilization and Demobilization, except HWY 97C	1.5.	1.	\$	200,000	\$	200,000	
	Total General Project Expenses					\$	310,000	
Drainage i	improvements Upstream of Ashcroft Park - Battel Subdivision							
	Battel Subdivision NW Ditch							
	Excavation and Disposal	c.m.	1500		35	\$	52,500	
	Rip Rap Class 10, locally sourced	c.m.	500		130	\$	65,000	
	Filter Cloth	s.m.	1400	\$	5	\$	7,000	
	Seeding	s.m.	1400	\$	5	\$	7,000	
	Battel Subdivision NE Ditch							
	Excavation and Disposal	c.m.	1000		35	\$	35,000	
	Rip Rap Class 25, locally sourced	c.m.	350		150	\$	52,500	
	Filter Cloth	s.m.	750		5	\$	3,750	
	Seeding	s.m.	750	\$	5	\$	3,750	
	Minor System from Battel Subdivision to Dry Pond							
	1200 mm Concrete Main	l.m.	350		2,500	\$	875,000	
	1650 mm Concrete Inlet	ea.	1	\$	50,000	\$	50,000	
	Manholes	ea.	4	\$	20,000	\$	80,000	
	Risers	v.m.		\$	2,500	\$	50,000	
	Oil-Grit Separator	ea.		\$	200,000	\$	200,000	
	Concrete outfall	ea.	1.	\$	40,000	\$	40,000	
	Total Drainage improvements Upstream of Ashcroft Park - Battel S	ubdivision				\$	1,522,000	
Drainage	Improvements Upstream of Ashcroft Park - Government Street							
	Government Street Ditch							
	Excavation and Disposal	c.m.	5000		35	\$	175,000	
	Rip Rap Class 100, locally sourced	c.m.	2000	\$	200	\$	400,000	
	Filter Cloth	s.m.	2800	\$	5	\$	14,000	
	Seeding	s.m.	2800	\$	5	\$	14,000	
	Government Street Driveway Culverts							
	1200 mm CMP, twin 10 m, 27 lots	l.m.	550	\$	1,200	\$	660,000	
	Total Drainage Improvements Upstream of Ashcroft Park - Govern	ment Stree	et .			\$	1,263,000	

em		Unit	Quantity	Unit Price \$		Tota	Amount \$
ainage	e Improvements Downstream of Ashcroft Park						
	Dry Pond Option						
	Build Dry Pond						
	Strip Topsoil and dispose off-site	c.m.	6000	\$	35	\$	210,00
	Excavation and Disposal	c.m.	11200	\$	35	\$	392,00
	French Drains	l.m.	800	\$	700	\$	560,00
	Restore Play Field						
	Playfield Subbase	s.m.	20000	\$	22	\$	440,00
	Playfield Turf	s.m.	20000	\$	22	\$	440,0
	Irrigation System	ea.	2	\$	100,000	\$	200,0
	Backstop	ea.	1	\$	50,000	\$	50,0
	Bleachers	ea.	1	\$	25,000	\$	25,0
	Minor System from Dry Pond to Existing System						
	300 mm PVC Main	l.m.	250	\$	600	\$	150,0
	375 mm Concrete Inlet	ea.	1	\$	5,000	\$	5,0
	Flow Control Manhole	ea.	1	\$	15,000	\$	15,0
	Manholes	ea.	3	\$	10,000	\$	30,0
	Risers	v.m.	15	\$	2,000	\$	30,0
	Tie-in to Existing System	ea.	1	\$	5,000	\$	5,0
	Remove and replace road	s.m.	2000	\$	110	\$	220,0
	Total Drainage Improvements Downstream of Ashcroft Park- D	ry Pond Opti	on			\$	2,772,0
	Storm Trunk Option						
	Minor System Alternative to River						
	1050 mm Concrete Main	l.m.	1000	\$	2,000	\$	2,000,0
	1650 mm Concrete Inlet with headwall	ea.	1	\$	50,000	\$	50,0
	Manholes	ea.	6	\$	15,000	\$	90,0
	Risers	v.m.	25	\$	2,500	\$	62,5
	Concrete outfall	ea.		\$	25,000	\$	25,0
	Remove and replace road	s.m.	7600	\$	110	\$	836,0
	Total Drainage Improvements Downstream of Ashcroft Park- St	torm Trunk C	ption			\$	3,064,0

Item		Unit	Quantity U	Init Price \$	Total	Amount \$
Highway	97C Improvements (MOTI Cost)					
nigiiway	7 97C Improvements (WOTI Cost)					
	Mobilization and Demobilization	l.s.	1_\$	50,000	\$	50,000
	Treffic Control	1	4 6	20.000	<b>.</b>	20.000
	Traffic Control	l.s.	1_\$	20,000	\$	20,000
	Consultation with 105 Mile Post Indian Reserve No.2	l.s.	1_\$	100,000	\$	100,000
	Highway 97C North Culvert					
	No Change	l.m.	0_\$		\$	-
	No Change	s.m.	0 \$	-	\$	-
	Highway 97C South Culvert					
	1050 mm CMP	l.m.	60 \$	1,500	\$	90,000
	Remove and replace road	s.m.	240 \$		\$	26,400
	Highway 97C Ditch					
	Excavation and Disposal	c.m.	3000 \$	35	\$	105,000
	Rip Rap Class 10, locally sourced	c.m.	1000 \$	150	\$	150,000
	Filter Cloth	s.m.	3200 \$	5	\$	16,000
	Seeding	s.m.	3200 \$	5	\$	16,000
	Highway 97C Crossing Culverts					
	No change	l.m.	0_\$	_	\$	-
	Highway 97C Culvert to River					
	600 mm Concrete Main	l.m.	110 \$	800	\$	88,000
	1050 mm Concrete Inlet with headwall	ea.	1 \$		\$	20,000
	Manholes	ea.	2 \$		\$	30,000
	Risers	v.m.	10 \$	2,000	\$	20,000
	Concrete outfall	ea.	1 \$	20,000	\$	20,000
	Total Highway 97C Improvements (MOTI Cost)				\$	752,000

Item						Unit	Quantity	Unit Price \$	Total	Amount \$
item						Unit	Quantity	Unit Price \$	Total	Amount \$
Summary										
	Total Genera	al Project E	xpenses						\$	310,000
	Total Draina	ge improv	ements Upstre	am of Ashcroft	Park - Battel Sul	odivision			\$	1,522,000
	Total Draina	ge Improv	ements Upstre	am of Ashcroft	Park - Governm	ent Street			\$	1,263,000
	Т	otal Drain	age Improvem	ents Downstrea	m of Ashcroft P	ark- Dry Po	nd Option		\$	2,772,000
	Т	otal Drain	age Improvem	ents Downstrea	m of Ashcroft P	ark- Storm	Trunk Optic	n	\$	3,064,000
	Total Highwa	ay 97C Imp	provements (M	OTI Cost)					\$	752,000
	Total - Dry P	ond Optio	n Cost to Ashc	roft					\$	5,867,000
	40% Conting	gency							\$	2,347,000
	Subtotal								\$	8,214,000
	10% Enginee	ering							\$	822,000
	Total - Dry P	ond Optio	n Price to Asho	roft					\$	9,036,000
	Total - Storm	n Trunk Op	tion Cost to As	shcroft					\$	6,159,000
	40% Conting	gency							\$	2,464,000
	Subtotal								\$	8,623,000
	10% Enginee	ering							\$	863,000
	Total - Storm	n Trunk Op	tion Price to A	shcroft					\$	9,486,000

Item		Unit	Quantity	Uni	it Price \$	Tota	l Amount \$
		!					
General P	Project Expenses						
	Project Record Documents	l.s.	1	\$	100,000	\$	100,000
	(O&M manuals, construction administration, record survey, asbuilts)				,		<u>, , , , , , , , , , , , , , , , , , , </u>
	Signage and Public notice	l.s.	1	\$	10,000	\$	10,000
	Mobilization and Demobilization, except HWY 97C	l.s.	1	\$	200,000	\$	200,000
	Total General Project Expenses					\$	310,000
Drainage	improvements Upstream of Ashcroft Park - Battel Subdivision						
	Battel Subdivision NW Ditch						
	Excavation and Disposal	c.m.	1500	\$	35	\$	52,500
	Rip Rap Class 10, locally sourced	c.m.	500	\$	130	\$	65,000
	Filter Cloth	s.m.	1400		5	\$	7,000
	Seeding	s.m.	1400	\$	5	\$	7,000
	Battel Subdivision NE Ditch						
	Excavation and Disposal	c.m.	1000		35	\$	35,000
	Rip Rap Class 25, locally sourced	c.m.	350		150	\$	52,500
	Filter Cloth	s.m.	750		5	\$	3,750
	Seeding	s.m.	750	\$	5	\$	3,750
	Minor System from Battel Subdivision to Dry Pond						
	1200 mm Concrete Main	l.m.	350	\$	2,500	\$	875,000
	1650 mm Concrete Inlet with headwall	ea.	1	\$	50,000	\$	50,000
	Manholes	ea.	4	\$	20,000	\$	80,000
	Risers	v.m.	20	\$	2,500	\$	50,000
	Oil-Grit Separator	ea.	1	\$	200,000	\$	200,000
	Concrete outfall	ea.	1	\$	40,000	\$	40,000
	Total Drainage improvements Upstream of Ashcroft Park - Battel S	ubdivisior	1			\$	1,522,000
Drainage	Improvements Upstream of Ashcroft Park - Government Street						
	Government Street Ditch						
	Excavation and Disposal	c.m.	1500	\$	35	\$	52,500
	Rip Rap Class 10, locally sourced	c.m.	600	\$	150	\$	90,000
	Filter Cloth	s.m.	1600	\$	5	\$	8,000
	Seeding	s.m.	1600		5	\$	8,000
	Government Street Driveway Culverts						
	675 mm CMP, single 10 m, 27 lots	l.m.	300	\$	1,000	\$	300,000
	Total Drainage Improvements Upstream of Ashcroft Park - Government	ment Stree	et			\$	459,000

m		Unit	Quantity	Uni	it Price \$	Tota	l Amount \$
inage	e Improvements Downstream of Ashcroft Park						
	Dry Pond Option						
	Build Dry Pond						
	Strip Topsoil and dispose off-site	c.m.	3000	\$	35	\$	105,00
	Excavation and Disposal	c.m.	5200		35	\$	182,00
	French Drains	l.m.	400		700	\$	280,0
	Restore Play Field						
	Playfield Subbase	s.m.	10000	\$	22	\$	220,0
	Playfield Turf	s.m.	10000	\$	22	\$	220,0
	Irrigation System	ea.	1	\$	100,000	\$	100,0
	Backstop	ea.	1	\$	50,000	\$	50,0
	Bleachers	ea.	1	\$	25,000	\$	25,0
	Minor System from Dry Pond to Existing System						
	300 mm PVC Main	l.m.	250	\$	600	\$	150,0
	375 mm Concrete Inlet	ea.	1	\$	5,000	\$	5,0
	Flow Control Manhole	ea.	1	\$	15,000	\$	15,0
	Manholes	ea.	3	\$	10,000	\$	30,0
	Risers	v.m.	15	\$	2,000	\$	30,0
	Tie-in to Existing System	ea.	1	\$	5,000	\$	5,0
	Remove and replace road	s.m.	2000	\$	110	\$	220,0
	Total Drainage Improvements Downstream of Ashcroft Park- D	ry Pond Optio	on			\$	1,637,0
	Storm Trunk Option						
	Minor System Alternative to River						
	1050 mm Concrete Main	l.m.	1000	\$	2,000	\$	2,000,0
	1650 mm Concrete Inlet with headwall	ea.	1	\$	50,000	\$	50,0
	Manholes	ea.	6	\$	15,000	\$	90,0
	Risers	v.m.	25	\$	2,500	\$	62,5
	Concrete outfall	ea.	1	\$	25,000	\$	25,0
	Remove and replace road	s.m.	7600	\$	110	\$	836,0
			- •				

3,064,000

Total Drainage Improvements Downstream of Ashcroft Park- Storm Trunk Option

Item		Unit	Quantity Ur	nit Price \$	Total	Amount \$
Highway	97C Improvements (MOTI Cost)					
ingiiway	576 mprovements (MOTI Cost)					
	Mobilization and Demobilization	l.s.	1 \$	50,000	\$	50,000
	- 60					
	Traffic Control	l.s.	1_\$_	20,000	\$	20,000
	Consultation with 105 Mile Post Indian Reserve No.2	l.s.	1_\$	100,000	\$	100,000
	Highway 97C North Culvert					
	No Change	l.m.	0_\$	-	\$	-
	No Change	s.m.	0 \$	-	\$	-
	Highway 97C South Culvert					
	No Change	l.m.	0 \$	-	\$	-
	No Change	l.m.	0 \$	-	\$	-
	Highway 97C Ditch					
	Excavation and Disposal	c.m.	9000 \$	35	\$	315,000
	Rip Rap Class 100, locally sourced	c.m.	3500 \$	150	\$	525,000
	Filter Cloth	s.m.	4900 \$	5	\$	24,500
	Seeding	s.m.	4900 \$	5	\$	24,500
	Highway 97C Crossing Culverts					
	900 mm CMP	l.m.	10_\$	1,500	\$	15,000
	Highway 97C Culvert to River					
	900 mm Concrete Main	l.m.	110 \$	1,000	\$	110,000
	1500 mm Concrete Inlet with headwall	ea.	1 \$	40,000	\$	40,000
	Manholes	ea.	2 \$	15,000	\$	30,000
	Risers	v.m.	10 \$	2,000	\$	20,000
	Concrete outfall	ea.	1 \$	30,000	\$	30,000
	Total Highway 97C Improvements (MOTI Cost)				\$	1,304,000

Item		Unit	Quantity	Unit Price \$	Total Amount \$	
Summary						
	Total General Project Expenses				\$	310,000
	Total Drainage improvements Upstream of Ashcroft Park - Ba	ttel Subdivision			\$	1,522,000
	Total Drainage Improvements Upstream of Ashcroft Park - Go	vernment Street			\$	459,000
	Total Drainage Improvements Downstream of Ashcroft Park- Dry Pond Option				\$	1,637,000
	Total Drainage Improvements Downstream of Ashcroft Park- Storm Trunk Option				\$	3,064,000
	Total Highway 97C Improvements (MOTI Cost)				\$	1,304,000
	Total - Dry Pond Option Cost to Ashcroft				\$	3,928,000
	40% Contingency				\$	1,572,000
	Subtotal				\$	5,500,000
	10% Engineering				\$	550,000
	Total - Dry Pond Option Price to Ashcroft				\$	6,050,000
	Total - Storm Trunk Option Cost to Ashcroft				\$	5,355,000
	40% Contingency				\$	2,142,000
	Subtotal				\$	7,497,000
	10% Engineering				\$	750,000
	Total - Storm Trunk Option Price to Ashcroft				\$	8,247,000