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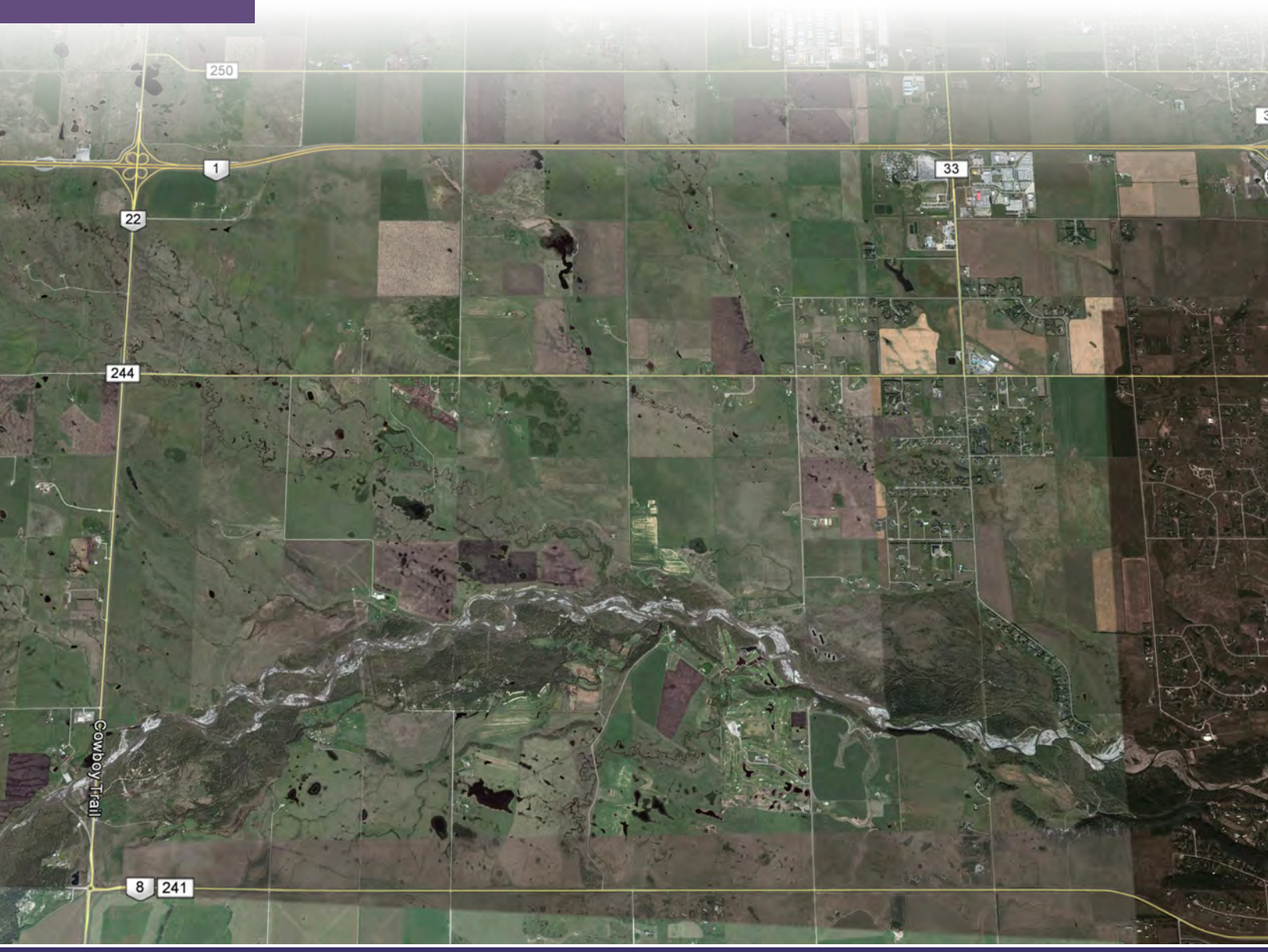

REPORT

Benefit/Cost Analysis of Flood Mitigation Projects for the City of Calgary: Springbank Off-Stream Flood Storage

Prepared for Government of Alberta
ESRD - Resilience and Mitigation
by IBI Group
February 18, 2015

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February 18, 2015

Ms. Heather Ziober
Project Manager, Strategic Integration and Projects
Government of Alberta
Environment and Sustainable Resource Development
205 J.G. O'Donoghue Building
7000 - 113 Street
Edmonton, AB T6H 5T6

Dear Ms. Ziober:

BENEFIT/COST ANALYSIS OF FLOOD MITIGATION PROJECTS FOR THE CITY OF CALGARY: SPRINGBANK OFF-STREAM FLOOD STORAGE

Enclosed please find the draft final report for the aforementioned assignment. The report describes the benefit/cost analysis undertaken for the Springbank Off-Stream Flood Storage Mitigation Project in relation to ameliorating the City of Calgary flood damages. This analysis culminates with a comparison of the benefit/cost ratios for the three major mitigation projects under consideration of which the Springbank Off-Stream Flood Storage Project ranks first.

Should you have any questions or require additional information please do not hesitate to contact the undersigned.

Yours truly,

IBI GROUP

Stephen Shawcross
Director

Augusto Ribeiro, P.Eng.

SS/mp

cc: Cathy Maniego, Government of Alberta, Environment and Sustainable Resource Development
Andrew Wilson, Government of Alberta, Environment and Sustainable Resource Development

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Benefit/Cost Analysis for Flood Mitigation Projects for the City of Calgary: Springbank Off-Stream Flood Storage

Submitted to Government of Alberta
ESRD - Resilience and Mitigation
by IBI Group

February 2015

Study Team Members

IBI Group

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Table of Contents

Executive Summary

Key Metrics

Project Costs

Item	Cost
Project Construction	$159,768,000
Upstream Mitigation	$8,900,000
Land Acquisition	$40,000,000
Total 1:100 Year Protection	**$208,668,000**
Additional Cost for 1:200 Year Protection	$55,000,000
Total 1:200 Year Protection	**$263,668,000**
Annual Operation and Maintenance	$1,800,000

Benefit/Cost Analysis

Indicator	High Damage Scenario		Low Damage Scenario	
	1:100 Year Protection	1:200 Year Protection	1:100 Year Protection	1:200 Year Protection
PV Benefits (average annual damages)	$476,899,000	$639,943,000	$336,847,000	$408,901,000
PV Costs (development & operating total cost)	$255,098,000	$309,607,000	$255,098,000	$309,607,000
Benefit/Cost Ratio	1.87	2.07	1.32	1.32
Net Present Value	$221,801,000	$330,336,000	$81,749,000	$99,294,000
Average Annual Damages	$19,461,291	$26,114,777	$13,746,068	$16,686,439

Benefit/Cost Comparison

Mitigation Project	High Damage Scenario		Low Damage Scenario	
	1:100 Year Protection	1:200 Year Protection	1:100 Year Protection	1:200 Year Protection
SR1	1.87	2.07	1.32	1.32
MC1	1.43	1.65	1.01	1.05
Glenmore	1.21	1.20	0.81	0.83

1 Introduction

1.1 Background

The flood of 2013 was a devastating event for Southern Alberta and the City of Calgary. The flood event had the largest economic impact of any extreme weather event in Canada to date. As part of the response to protect communities from future flood damage, the Province of Alberta commissioned a study through the Flood Mitigation Advisory Panel to provide engineering assessments and practical solutions on possible flood mitigation measures.

In October of 2013, AMEC Environment & Infrastructure (AMEC) was contracted to provide a flood mitigation feasibility study for the Bow River, Elbow River and Oldman River Basins.

A number of mitigation schemes were considered for the Elbow River upstream of the City of Calgary, including an off-stream flood storage project in Springbank.

As part of the subsequent Provincial Flood Damage Assessment Study, IBI Group was commissioned by the Government of Alberta ESRD Operations, Resilience and Mitigation Branch to undertake a benefit/cost analysis of the Springbank Off-Stream Flood Storage project.

1.2 Purpose

The purpose of the benefit/cost analysis is to provide a comparison of project benefits, in terms of damages averted, to project costs including capital and operating costs, to determine if the project under consideration is economically viable.

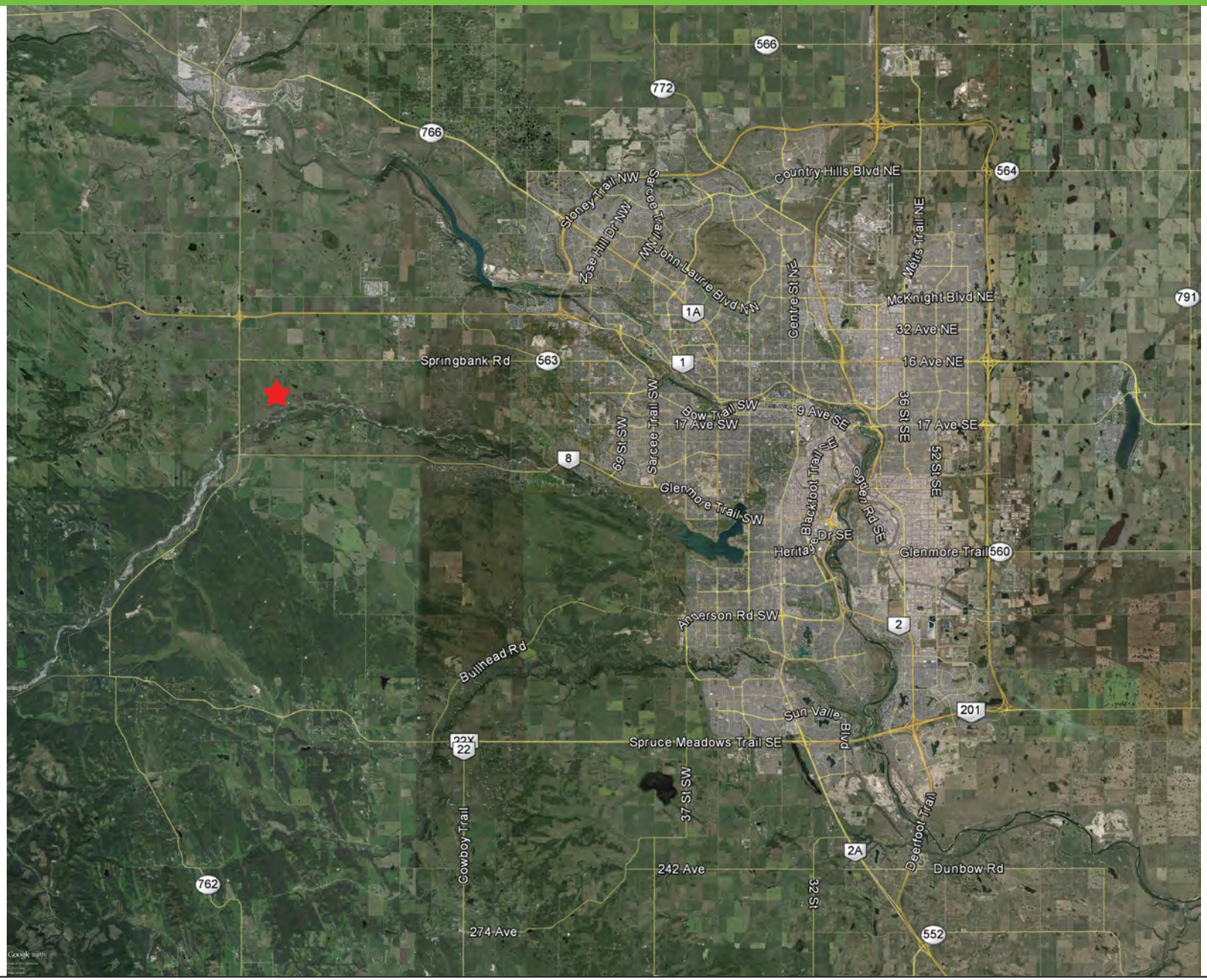
1.3 Scope

For the purposes of this study, benefits are restricted to economic benefits accruing within the study area, which is defined as the flood risk area within the City of Calgary boundaries. The study utilizes current damage estimates based on updated stage-damage curves and the Provincial Rapid Flood Damage Assessment Model. Project costs are based on the estimates prepared as part of the Springbank Off-Stream Storage project submitted to the Southern Alberta Flood Recovery Task Force and dated June 2014.

2 Context

Exhibit 2.1 illustrates the study area, while **Exhibit 2.2** illustrates the location of the off-stream storage project.

Regional Setting



Local Setting

3 Project Description

The project consists of three basic components:

1. a river diversion structure;
2. a diversion channel and reservoir inlet structure; and
3. an off-stream storage dam and reservoir.

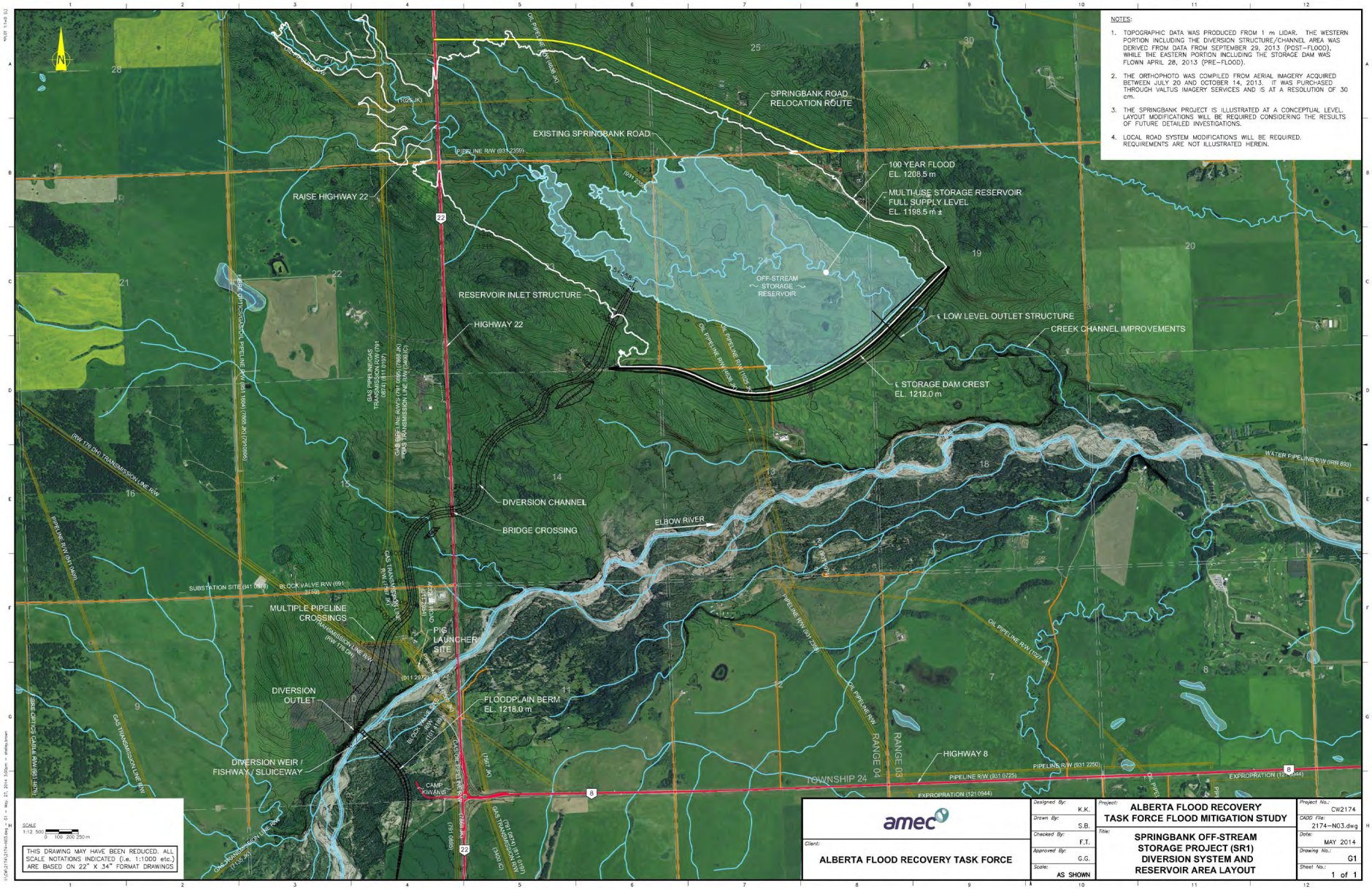
The diversion structure system would consist of a concrete overflow weir section crossing the Elbow River, a gated concrete sluiceway/fishway located adjacent to the left side valley abutment with its invert at the river thalweg level, and a gated diversion outlet structure located in the left valley abutment immediately upstream of the sluiceway. A conceptual design layout for the diversion structure system is provided in **Exhibit 3.1**. Additional structure details are provided in **Exhibit 3.2**, **Exhibit 3.3** and **Exhibit 3.4**.

The proposed diversion channel profile and a typical channel section are illustrated in **Exhibit 3.5**. The diversion channel is designed to convey a peak diversion flow of 300 m^3/s from the Elbow River into the off-stream storage reservoir. The channel is designed with a 24 m bottom width, three horizontal to one vertical side slopes and a 3.6 m water depth.

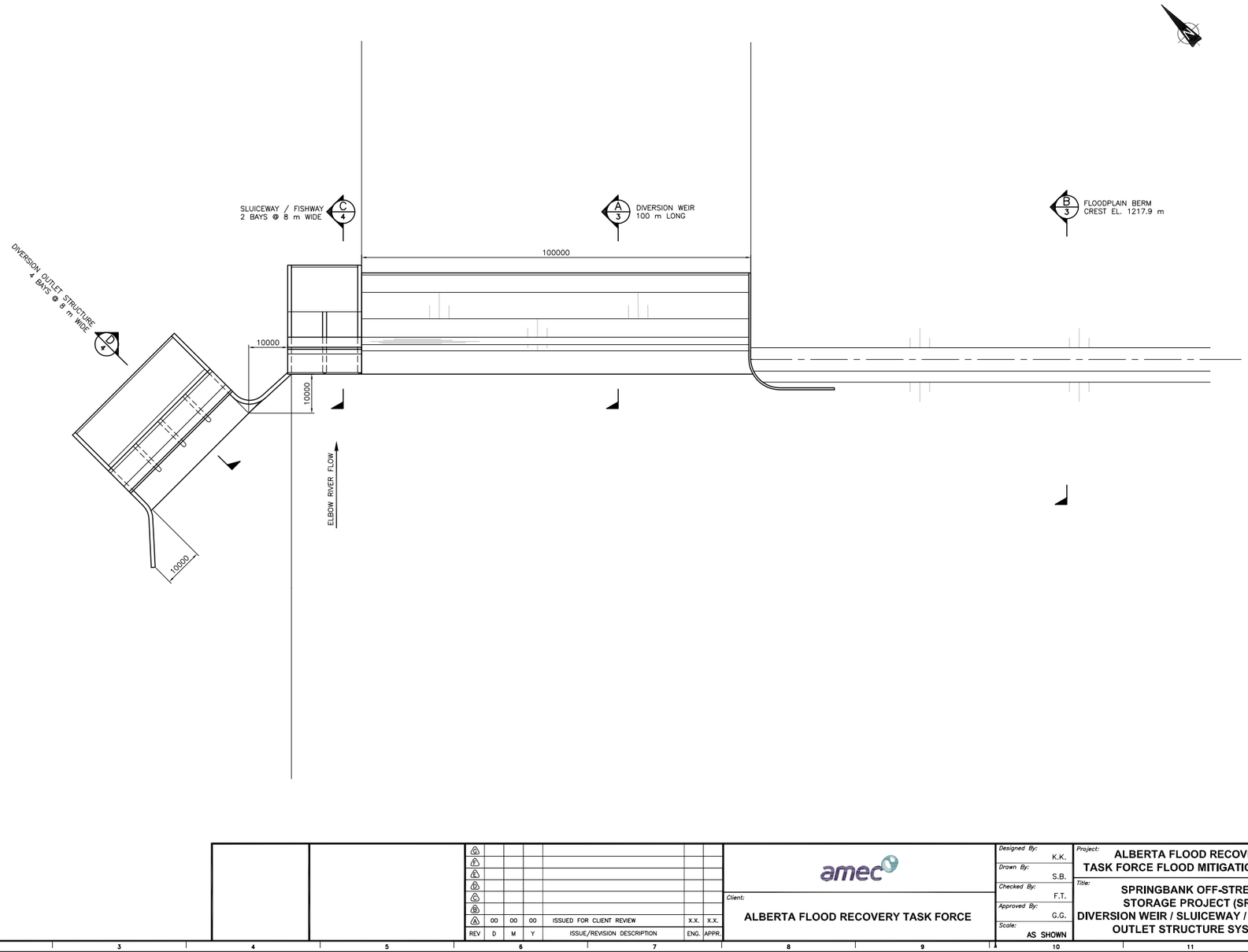
A 3 km long earthfill storage dam, having a maximum height of 24 m, is required to contain the diverted flood water. The conceptual design considers a zoned earthfill dam with a clay core and random earthfill shells as illustrated in **Exhibit 3.6**. Embankment slopes of 3H:1V are provided with 6 m wide berms at strategic levels resulting in average dam slopes of between 3H:1V and 4H:1V. The berms are included to provide stability, and to facilitate access for inspection, maintenance and geotechnical instrument monitoring.

The dam system will include a gated low-level outlet structure. The structure will include a 1.5 m wide by 1.8 m high concrete conduit through the dam, including a gatewell tower located near the dam centreline as illustrated in **Exhibit 3.7**. This structure will be used to release stored water back into the river after the flood has passed. Channel improvements will be required along the creek, connecting this outlet to the Elbow River.

Springbank Off-Stream Storage Project (SR1) Diversion System and Reservoir Area Layout



Details - Springbank Off-Stream Storage Project (SR1) Diversion Weir / Sluiceway / Fishway / Outlet Structure System



NOTES:

1. ELEVATIONS ARE IN METRES AND DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.

SCALE
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THIS DRAWING MAY HAVE BEEN REDUCED. ALL SCALE NOTATIONS INDICATED (i.e. 1:1000 etc.) ARE BASED ON 22" X 34" FORMAT DRAWINGS

REV	D	M	Y	ISSUE/REVISION DESCRIPTION	ENG.	APPR
A	00	00	00	ISSUED FOR CLIENT REVIEW	X.X.	X.X.

amec

Client: ALBERTA FLOOD RECOVERY TASK FORCE

Designed By: K.K.
Drawn By: S.B.
Checked By: F.T.
Approved By: G.G.
Scale: AS SHOWN

Project: ALBERTA FLOOD RECOVERY TASK FORCE FLOOD MITIGATION STUDY

Title: SPRINGBANK OFF-STREAM STORAGE PROJECT (SR1) DIVERSION WEIR / SLUICEWAY / FISHWAY / OUTLET STRUCTURE SYSTEM

Project No.: CW2174
CADD File: 2174-B08.dwg
Date: MAY 2014
Drawing No.: G2
Sheet No.: 1 of 1

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Details - Springbank Off-Stream Storage Project (SR1) Diversion Structure System Sections (Sheet 1 of 2)

NOTES:

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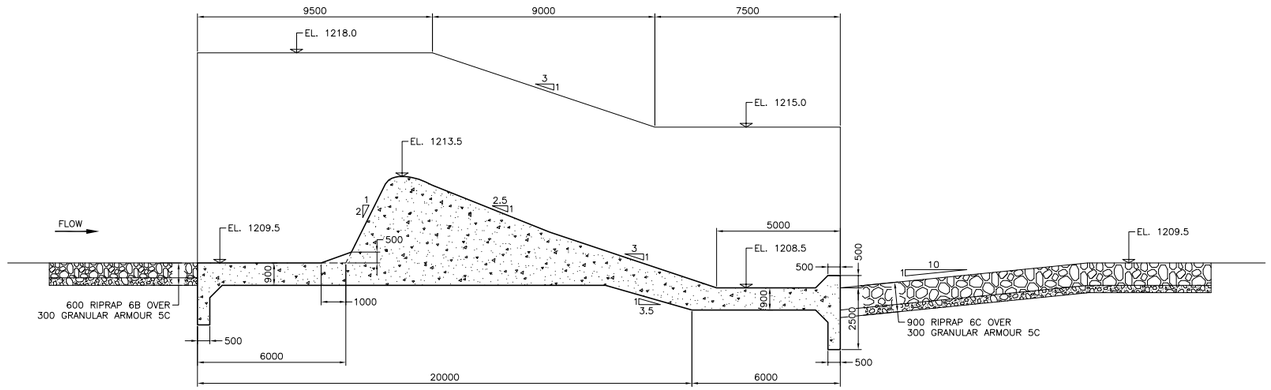
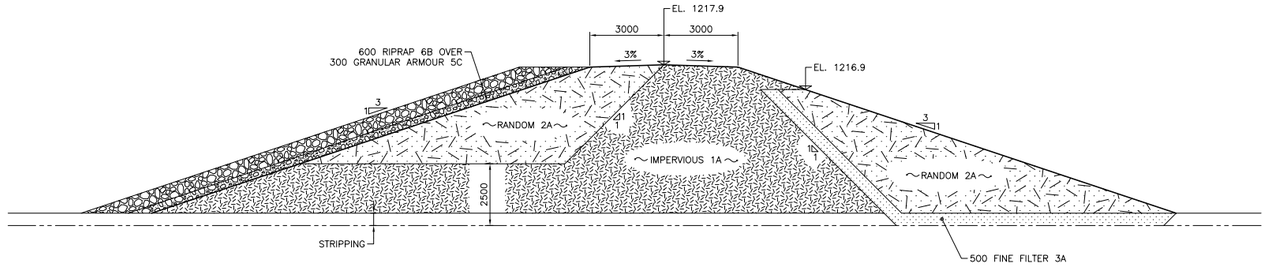


A2 SECTION – DIVERSION WEIR
N.T.S.



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SCALE 1:100 0 1 2m

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Title: SPRINGBANK OFF-STREAM STORAGE PROJECT (SR1) DIVERSION STRUCTURE SYSTEM SECTIONS (SHEET 1 of 2)

Project No.: CW2174
CADD File: 2174–B03.dwg
Date: MAY 2014
Drawing No.: G3
Sheet No.: 1 of 1

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Details - Springbank Off-Stream Storage Project (SR1) Diversion Structure System Sections (Sheet 2 of 2)

NOTES:

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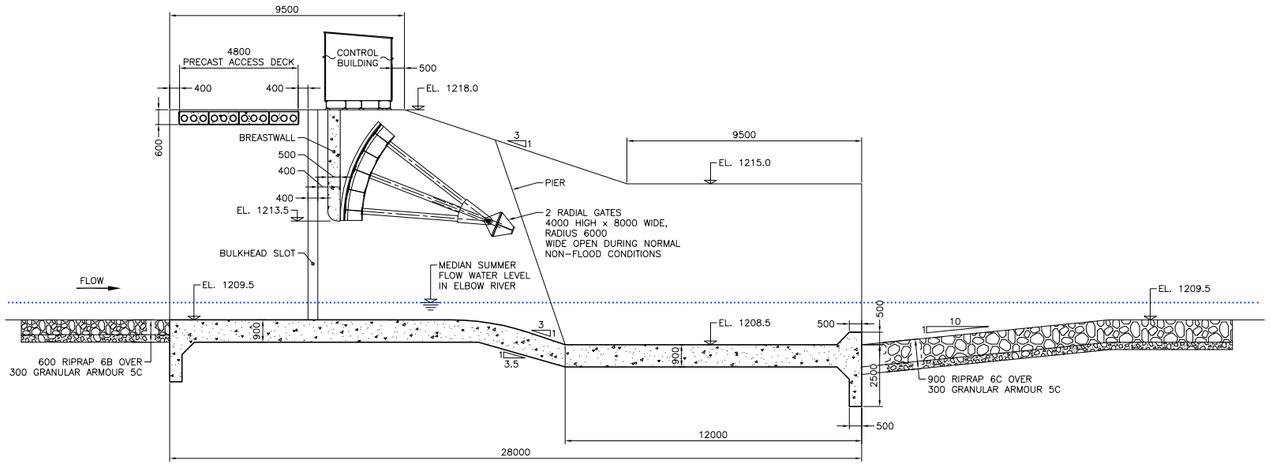

C/2 SECTION – SLUICEWAY / FISHWAY
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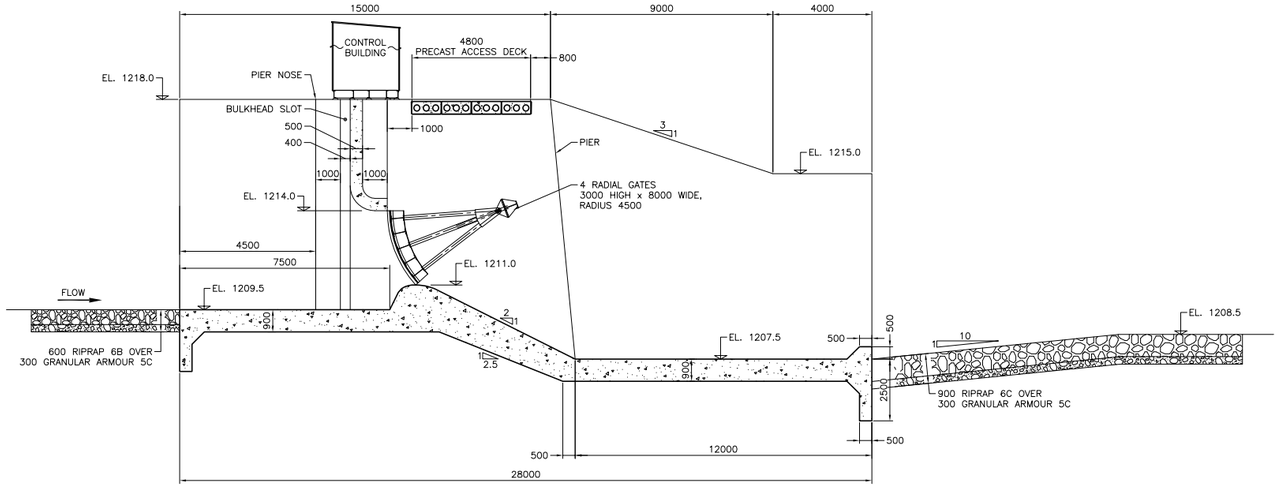

D/2 SECTION – DIVERSION OUTLET STRUCTURE
N.T.S.

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Project: ALBERTA FLOOD RECOVERY TASK FORCE FLOOD MITIGATION STUDY

Title: SPRINGBANK OFF-STREAM STORAGE PROJECT (SR1) DIVERSION STRUCTURE SYSTEM SECTIONS (SHEET 2 of 2)

Project No.:	CW2174
CADD File:	2174-B05.dwg
Date:	MAY 2014
Drawing No.:	G4
Sheet No.:	1 of 1

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Details - Springbank Off-Stream Storage Project (SR1) Diversion Channel

NOTES:

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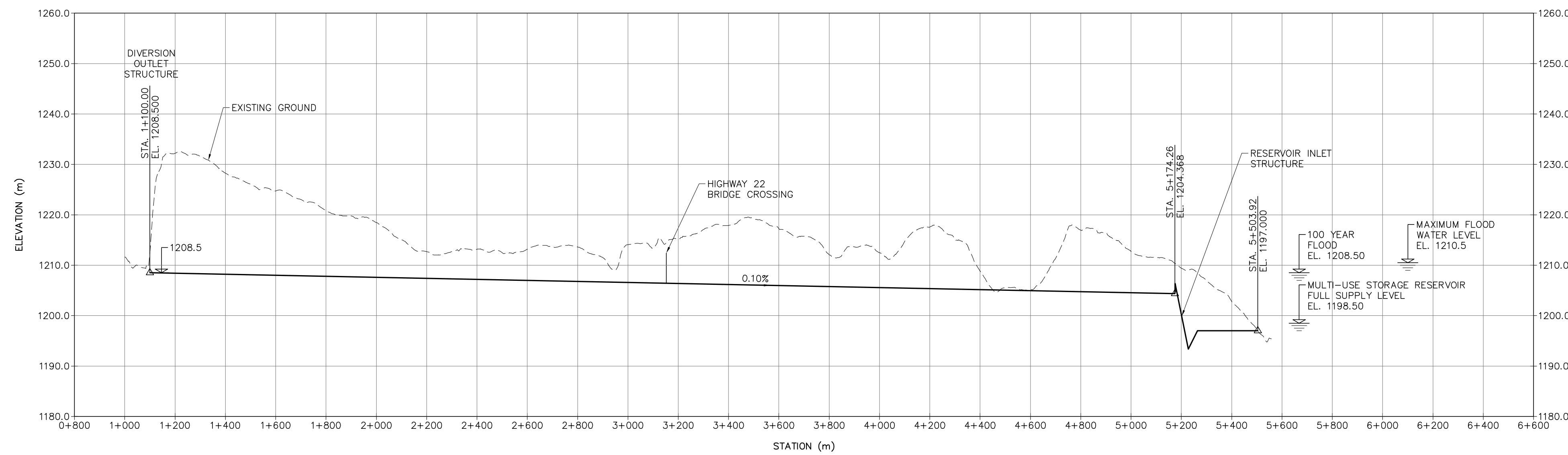

DIVERSION CHANNEL PROFILE
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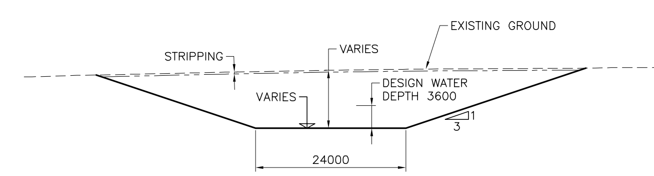
VER. 1:500



DIVERSION CHANNEL TYPICAL CROSS SECTION
SCALE 1:500

SCALES
1:10 000 0 100 200m
1:500 0 5 10m

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B						
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amec

Client: ALBERTA FLOOD RECOVERY TASK FORCE

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Drawn By: S.B.
Checked By: F.T.
Approved By: G.G.
Scale: AS SHOWN

Project: ALBERTA FLOOD RECOVERY TASK FORCE FLOOD MITIGATION STUDY

Title: SPRINGBANK OFF-STREAM STORAGE PROJECT (SR1) DIVERSION CHANNEL

Project No.: CW2174
CADD File: 2174–N03.dwg
Date: MAY 2014
Drawing No.: G5
Sheet No.: 1 of 1

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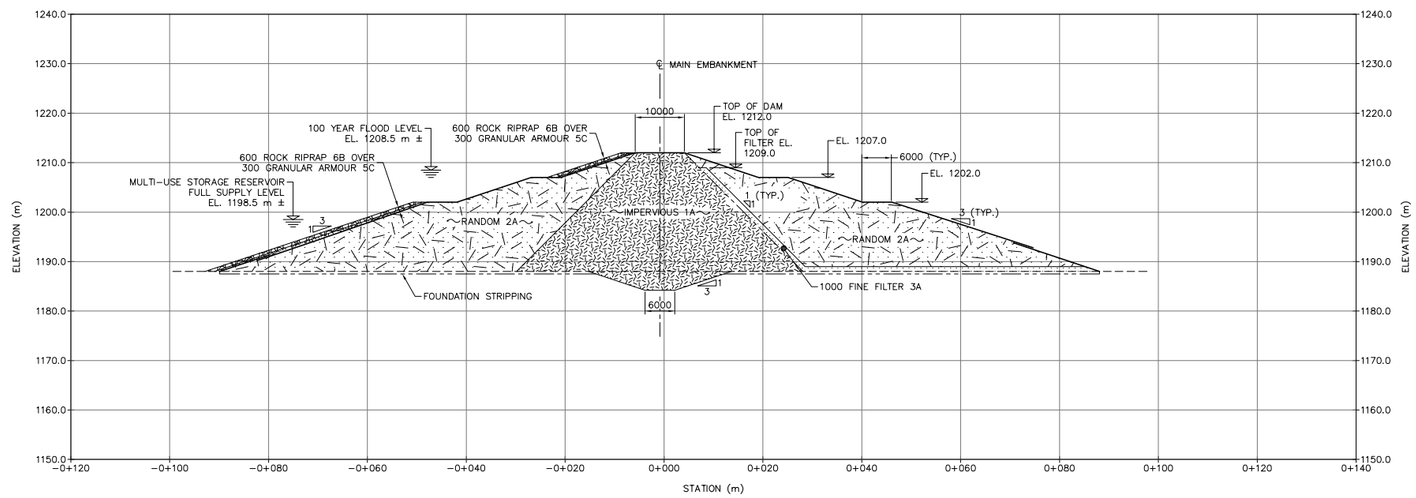
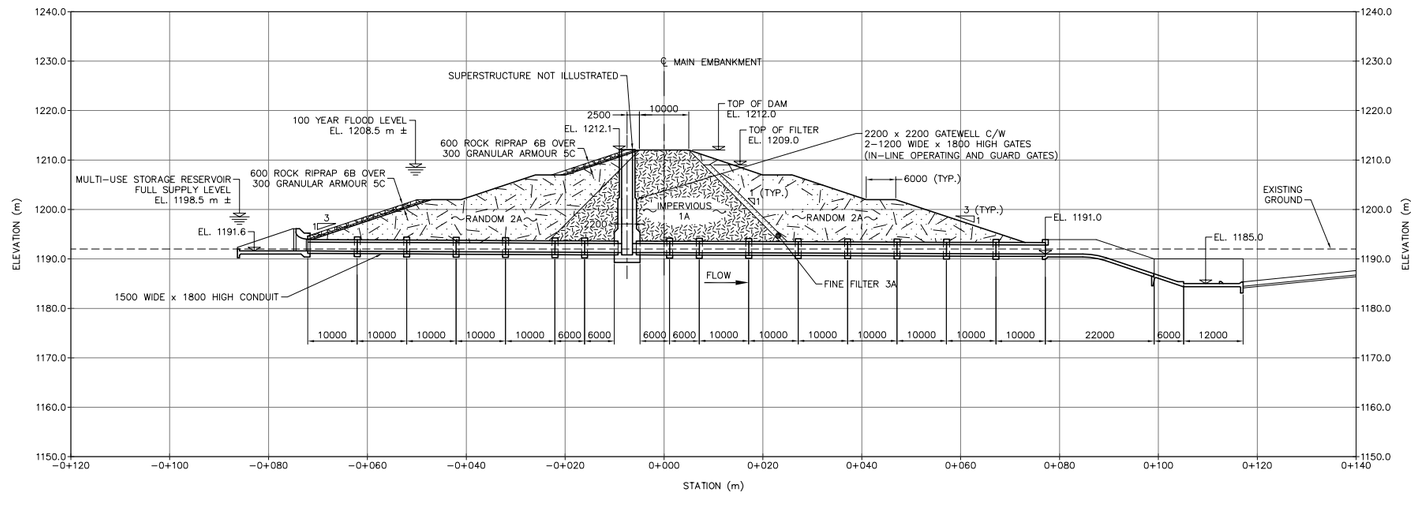
Details - Springbank Off-Stream Storage Project (SR1) Off-Stream Storage Dam & Low Level Outlet



OFF-STREAM STORAGE DAM
SCALE 1:500



LOW LEVEL OUTLET STRUCTURE
SCALE 1:500

NOTES:

1. ELEVATIONS ARE IN METRES AND DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.

SCALE 1:500 0 5 10 m

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Drawn By: S.B.
Checked By: F.T.
Approved By: G.G.
Scale: AS SHOWN

Project: ALBERTA FLOOD RECOVERY TASK FORCE FLOOD MITIGATION STUDY

Title: SPRINGBANK OFF-STREAM STORAGE PROJECT (SR1) OFF-STREAM STORAGE DAM & LOW LEVEL OUTLET

Project No.: CW2174
CADD File: 2174-N03.dwg
Date: MAY 2014
Drawing No.: G6
Sheet No.: 1 of 1

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Details - Springbank Off-Stream Storage Project (SR1) Reservoir Inlet Structure

NOTES:

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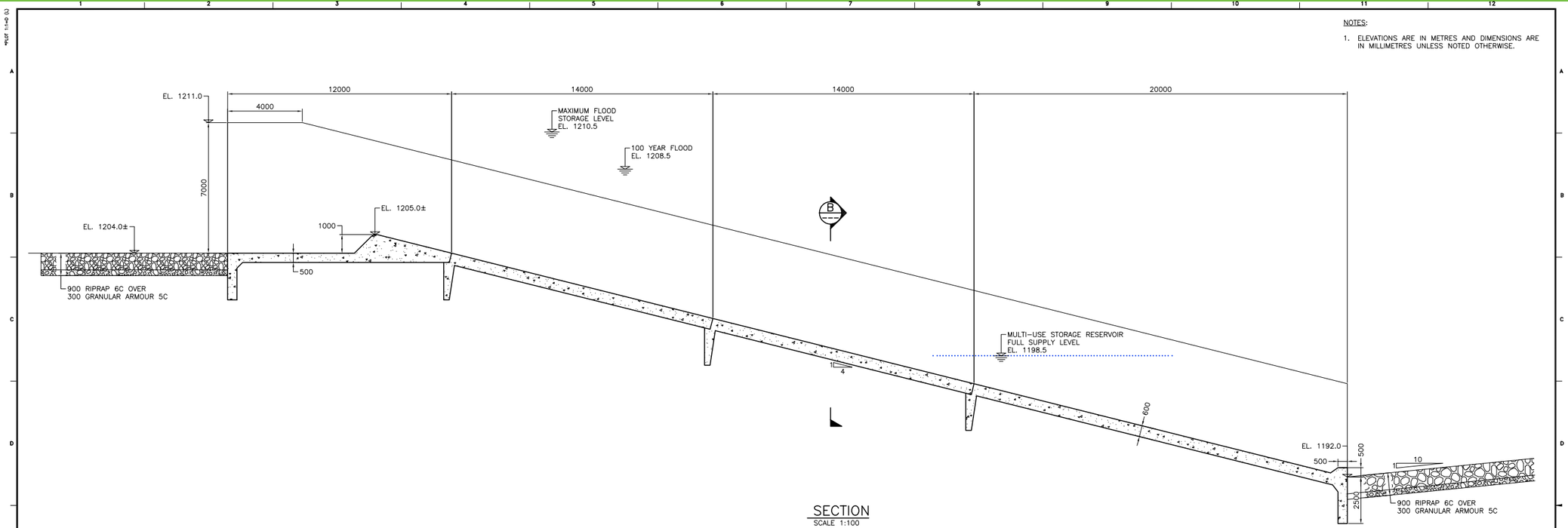

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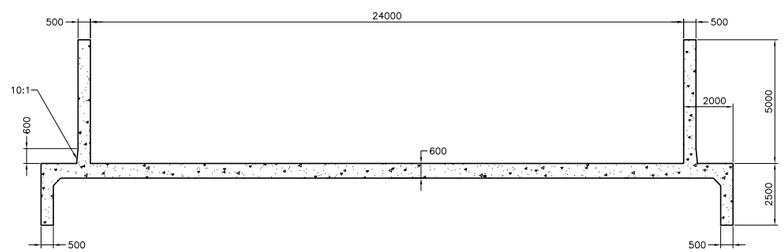
SCALE 1:100



B SECTION
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SCALE 1:100 0 1 2m

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Title: SPRINGBANK OFF-STREAM STORAGE PROJECT (SR1) RESERVOIR INLET STRUCTURE

Project No.: CW2174
CADD File: 2174-B06.dwg
Date: MAY 2014
Drawing No.: G7
Sheet No.: 1 of 1

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4 Cost Estimate

A detailed cost estimate is provided in **Exhibit 4.1A/B**[1]. The project cost is estimated to be $159,768,000. This price does not include the cost of land acquisition. The estimate provided herein is based on 2012 construction price data. Year 2012 prices were used considering that 2013 construction prices are skewed as a result of abnormal activity which resulted from the June 2013 flood event. It is assumed that the construction of SR1 would take place in a more competitive environment for contractors and suppliers, and as such the 2012 prices are considered indicative of realistic project cost. The estimate was produced considering the conceptual designs presented herein. Additional subsurface soils investigations are required to better establish the concept details presented herein. More detailed hydrological assessment and topographic data are required to better establish the size of required works. A contingency allowance of 25% has been included in an effort to account for additional costs which could result from future additional information and the results of more detailed design work. No allowance is included for escalation until the time of construction.

To increase the flood protection above the 1% AEP, to the 2013 flood of record level would require the dam crest level raised by approximately 2.5m to Elevation 1214.5m and would also require a larger diversion outlet structure and channel. These adjustments would result in additional project cost of approximately $55 million. This amount includes contingency and engineering allowances.

4.1 Land Acquisition

Land requirements were based on the conceptual design footprint including the diversion, storage reservoir to contain a 1:100 year event, and dam, and equated to some ±1,760 acres.[2] Currently, this land is under cultivation or pasture. In terms of planning status, the land is currently designated Ranch and Farm District (RF) according to the Rocky View County Land Use Bylaw. The purpose and intent of this land use designation is to “provide for agricultural activities as the primary land use on a quarter section of land or on a large balance of lands from a previous subdivision” (Rocky View County Land Use Bylaw, 1998).

There are no Area Structure Plans in place for the area and according to the County’s Growth Management Strategy, the area has not been recognized as a location for future growth (see **Appendix A**).

To establish potential land acquisition costs, 2014 MLS sales transactions for raw land and country residential style lots within the Springbank area (see **Exhibit 4.2**) were analyzed along with data from country residential developments including Watermark, Silverhorn and Harmony (see **Appendix B**). In addition, real estate brokers were solicited for opinions on potential land values in the general area.

Typical agricultural land values vary considerably depending upon soil quality, crop potential, etc. and vary from $4,000 to $8,000/acre. Larger transactions of farmland (±120 acres) have ranged between $6,000 and $9,000/acre within the general area. Using the upper bound of say $10,000/acre, would equate to a land acquisition cost of $17.6 million.

Developable land values are considerably higher with larger land assemblies (±120 acres) ranging from between $22,000 and $105,000/acre and averaging $50,000/acre.

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1 AMEC Environmental & Infrastructure, *Southern Alberta Flood Recovery Task Force, Volume 4 – Flood Mitigation Measures, Appendix G – Springbank Off-Stream Storage Project*, May 2014.

2 Actual land requirements will vary based on the detailed design of the facility which is currently underway.

Off-Stream Storage Project (SR1) Cost Estimate (1 of 2)

Item	Unit	Quantity	Unit Price	Extension
General				
Mob./Demobilization	lump sum	lump sum	7,000,000.00	$7,000,000
Care of Water	lump sum	lump sum	3,000,000.00	$3,000,000
Clearing & Timber Salvage	hectares	10	12,000.00	$120,000
Raise Highway 22	lump sum	lump sum	2,000,000	2,000,000
Local Road Modifications	km	15	250,000.00	$3,750,000
Topsoil/Seeding etc.	m^2	1,200,000	1.50	$1,800,000
	Subtotal General			**$17,670,000**
River Diversion Structure System				
Stripping	m^3	5,000	6.00	$30,000
Common Excavation	m^3	20,000	10.00	$200,000
Structure Fill	m^3	10,000	30.00	$300,000
Diversion Weir Concrete	m^3	4,900	1,000.00	$4,900,000
Sluice/Fishway Concrete	m^3	990	1,000.00	$990,000
Outlet Structure Concrete	m^3	1,900	1,000.00	$1,900,000
Precast Decks	lump sum	lump sum	560,000.00	$560,000
Fine Filter	m^3	1,200	90.00	$108,000
Coarse Filter	m^3	1,200	90.00	$108,000
Piping System	lump sum	lump sum	200,000.00	$200,000
Rock Riprap	m^3	6,400	130.00	$832,000
Bedding Gravel	m^3	2,200	70.00	$154,000
Gate/Hoist Systems	each	6	500,000.00	$3,000,000
Controls/Instrumentation	lump sum	lump sum	300,000.00	$300,000
Electrical/Mechanical	lump sum	lump sum	500,000.00	$500,000
Superstructures	each	2	90,000.00	$180,000
	Subtotal Diversion Structure System			**$14,262,000**
Floodplain Berm				
Stripping	m^3	18,000	6.00	$108,000
Impervious Fill	m^3	90,000	1.50	$135,000
Random Fill	m^3	60,000	1.40	$84,000
Fine Filter	m^3	6,000	90.00	$540,000
Rock Riprap	m^3	8,000	130.00	$1,040,000
Bedding Gravel	m^3	4,000	60.00	$240,000
	Subtotal Floodplain Berm			**$2,147,000**

Item	Unit	Quantity	Unit Price	Extension
Diversion Channel & Reservoir Inlet Structure				
Stripping	m^3	180,000	6.00	$1,080,000
Common Excavation	m^3	1,800,000	5.50	$9,900,000
Rock Excavation	m^3	200,000	10.00	$2,000,000
Impervious Fill	m^3	10,000	20.00	$200,000
Inlet Chute Concrete	m^3	2,000	1,200.00	$2,400,000
Fine Filter	m^3	660	90.00	$59,000
Coarse Filter	m^3	1,760	90.00	$158,000
Piping System	lump sum	lump sum	200,000.00	$200,000
Bridge Crossings	each	1	4,000,000.00	$4,000,000
Pipeline Crossings	lump sum	lump sum	4,000,000.00	$4,000,000
Power Line Relocation	lump sum	lump sum	300,000.00	$300,000
	Subtotal Diversion Channel System			**$24,298,000**

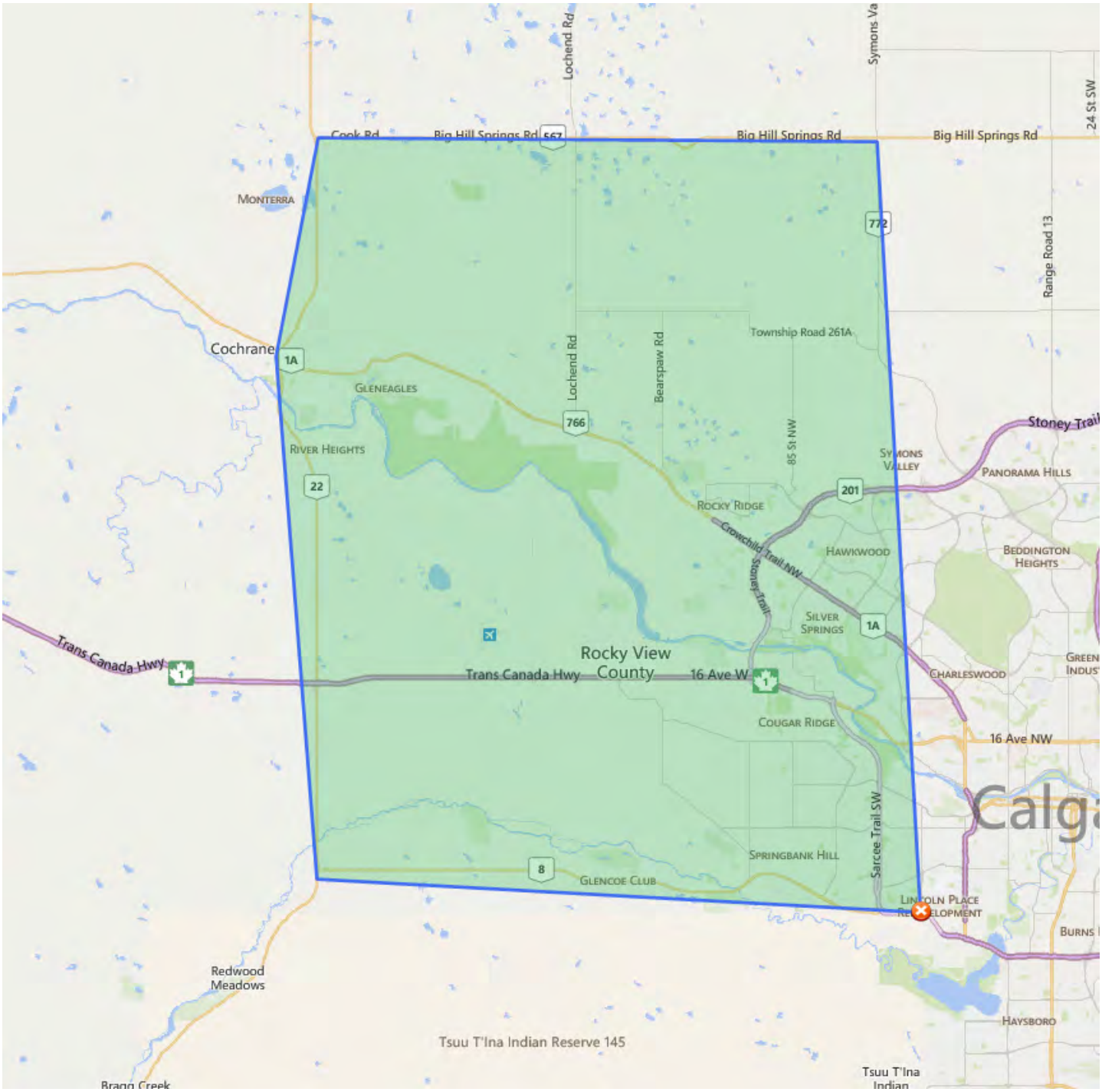
Off-Stream Storage Project (SR1) Cost Estimate (2 of 2)

Off-stream Storage Dam				
Stripping	m^3	180,000	6.00	$1,080,000
Borrow Excavation	m^3	1,700,000	5.00	$8,500,000
Overhaul	m^3km	2,500,000	1.50	$3,750,000
Impervious Fill	m^3	1,600,000	1.50	$2,400,000
Random Fill	m^3	1,200,000	1.40	$1,680,000
Fine Filter	m^3	140,000	60.00	$8,400,000
Coarse Filter	m^3	20,000	60.00	$1,200,000
Rock Riprap	m^3	62,000	130.00	$8,060,000
Bedding Gravel	m^3	31,000	60.00	$1,860,000
Geotechnical Instruments	lump sum	lump sum	400,000.00	$400,000
	Subtotal Off-stream Dam			**$37,330,000**

Dam Outlet Structure and Downstream Channel Improvements				
Structure Excavation	m^3	20,000	20.00	$400,000
Structure Fill	m^3	15,000	30.00	$450,000
Reinforced Concrete	m^3	1,600	1,200.00	$1,920,000
Rock Riprap	m^3	600	130.00	$78,000
Bedding Gravel	m^3	300	70.00	$21,000
Gate/Hoist Systems	each	lump sum	160,000.00	$320,000
Controls/Instrumentation	lump sum	lump sum	100,000.00	$100,000
Electrical/Mechanical	lump sum	lump sum	400,000.00	$400,000
Superstructure	lump sum	lump sum	50,000.00	$50,000
	Subtotal Structure & Channel Improvements			**$3,739,000**

Item	Unit	Quantity	Unit Price	Extension
Springbank Road Relocation				
Grading	km	5	550,000.00	$2,750,000
Base/Pavement	km	5	650,000.00	$3,250,000
Creek Crossings	lump sum	lump sum	1,000,000.00	$1,000,000
	Subtotal Springbank Road Relocation			**$7,000,000**
	SUBTOTAL CONSTRUCTION			**$106,446,000**
	Contingencies (25%)			$26,661,000
	Subtotal Construction and Contingencies			**$133,107,000**
	Engineering/Environmental (20%)			$26,661,000
	TOTAL CONSTRUCTION			**$159,768,000**

Market Area Considered



Individual country residential lots sold within the market area range from $107,000 to $378,000/acre and average $193,000/acre. The latter reflects developed land value with the final sales prices reflecting the cost of raw land, servicing (roads, sanitary, storm and water), sales commissions, marketing, legal and developer profit.

The community of Harmony, located within the market area some 2 to 3 km to the north, is a 1,748 acre master-planned community, featuring a 140 acre lake, golf course, village centre and mixed residential community (see **Appendix C**). Assuming approvals were obtained for a similar type of development on the site in question, with an acquisition price of $50,000/acre, total land acquisition under these assumptions would equate to $88 million; however, given the size of the acquisition it is likely that this value would be discounted to reflect the anticipated absorption over a long timeframe. At a discount rate of 4% and a projected 20 year life expectancy for the development, the acquisition cost would be $40.163 million in 2014$.

If the current land owners choose to develop rather than sell the land to a third party developer, then the value of the ultimate project (depending upon a large number of factors) could be worth considerably more than the land value as stated.

In summary, land acquisition costs range from a low of $17.6 million to a high of $40.1 million, depending upon the precise circumstances surrounding the negotiation and ultimate acquisition. For the purposes of this study the higher value, $40 million, is proposed for use in the benefit/cost analysis.

4.2 Flood Defences at Bragg Creek

The flood mitigation measures study for the Bow, Elbow and Old Man River basins recommended flood defences at Bragg Creek if flood protection infrastructure for the City of Calgary was located downstream of Bragg Creek. Protection of the Hamlet via dykes was proposed with a further recommendation that if a decision was made to proceed with SR1 as the preferred flood storage scheme for the Elbow River, then the detailed design and planning for the dykes of Bragg Creek should be initiated as soon as possible.[3] Costs for the dyke system were estimated at $6.2 million (see **Appendix D**).

5 Flood Damages

5.1 Without Mitigation Alternative

5.1.1 City of Calgary

Flood damage estimates were generated for the City of Calgary employing updated stage-damage curves and the Provincial Rapid Flood Damage Assessment Model. Damage assessments were generated for nine return frequencies including: 1:2 year, 1:5 year, 1:10 year, 1:20 year, 1:50 year, 1:100 year, 1:200 year, 1:500 year and 1:1000 year, which allowed for the computation of average annual damages. Damage estimates were also assessed under two cases: a higher or “worst case” condition and a lower or “anticipated case” condition.

The detailed analysis of City of Calgary flood damages is contained under separate cover; however, summary tables are contained in **Appendix E**. For the 1:100 year flood under the higher damage case, total damages on the Elbow are estimated at $741,005,000. Average annual damages for the Elbow River under the higher case equate to $30,110,965.

[3] AMEC Environmental & Infrastructure, *Southern Alberta Flood Recovery Task Force, Flood Mitigation Measures for the Bow, Elbow and Oldman River Basins, Volume 1 – Summary Recommendations Report – Final,* June 2014.

For the 1:100 year flood under the lower case assumptions, total damages on the Elbow River are estimated at $538,369,000 with average annual damages estimated at $21,728,927.

5.1.2 Other Damages

Flood damage studies, akin to the detailed assessment undertaken for the City of Calgary have not been generated for areas upstream of the Springbank Off-Stream Flood Storage project including Bragg Creek, Redwood Meadows and infrastructure within Rocky View County which would not be protected by the proposed Springbank Off-Stream Flood Storage project. These damages constitute costs over and above those accruing to the City of Calgary and should be taken into consideration as part of the benefit/cost analysis.

A variety of secondary sources were employed to determine damages, including the damage claims submitted under the 2013 Southern Alberta Disaster Recovery Program along with a previous study of Bragg Creek completed for Alberta Environment Planning Division in 1987[4].

In terms of the 2013 Southern Alberta Disaster Recovery Program, the total estimated amount for flood recovery projects between the McLean Creek dam site and the City of Calgary is approximately $5.6 million. This amount is made up of $1.084 million for recovery projects in Rocky View County (including Bragg Creek), $2.657 million for recovery projects in the Townsite of Redwood Meadows, and $1.901 million for recovery projects in the Tsuu T'ina First Nation. Details are contained in **Appendix F**.

5.1.2.1 1987 Bragg Creek Floodplain Management Study

The 1987 Bragg Creek Floodplain Management Study identified 37 residential units and 21 commercial units within the flood hazard area. This has increased to 51 residential units and 29 commercial units, representing an increase of 27% for residential and 28% for commercial. A very cursory assessment of potential damages employing values from the updated stage-damage curves suggests total damages in the order of $12.7 million for the Bragg Creek flood study area for the 1:100 year event.

5.1.2.2 Cost Implications

At this juncture it is not possible to accurately calculate average annual damages for the areas upstream of the Springbank Offstream Flood Storage project. Notwithstanding, in order to account for the other damages, and therefore additional costs that will be incurred by the SR1 project over the MC1 project, an additional $8.9 million in total costs are proposed to be added to the SR1 project.

5.2 With Mitigation Alternative

Implementation of the Springbank Off-Stream Flood Storage project results in a reduction of average annual damages under the four cases as follows:

- 1:100 year level of protection under the higher damage scenario = $19,461,291
- 1:200 year level of protection under the higher damage scenario = $26,114,777
- 1:100 year level of protection under the lower damage scenario = $13,746,068
- 1:200 year level of protection under the lower damage scenario = $16,686,439

[4] *Bragg Creek Floodplain Management Study – Final Report*, J.N. MacKenzie Engineering Ltd. in association with W-E-R Engineering Ltd., IBI Group and Ecos Engineering Services Ltd., January 1987.

6 Benefit/Cost Analysis

6.1 Benefit/Cost Analysis for Flood Mitigation Projects

For flood mitigation projects, economic evaluation requires a comparison between the events predicted to occur if the project is built and those predicted to occur if the project is not built. This is called the "with and without principle". For flood control one cannot directly equate an exchange in the market, however flood control benefits can be estimated by assuming they are equivalent to the flood damage prevented.

For flood mitigation projects the probabilistic approach to benefit/cost estimates is used. To reiterate, within the defined flood risk area, flood damages were estimated with the application of depth-damage curves applied to the various return flood events (probability). The flood damage probability distribution was then plotted and the average annual damage (AAD) estimated for project evaluation purposes.

With the updated average annual damages and cost estimates of the diversion alternative, an economic efficiency evaluation was performed. This evaluation is based upon the net present value (NPV) of respective benefits and costs. The net present value of any project is governed by three variables: the average annual cost or benefit, discount rate, and discount period. To provide a consistent economic evaluation of flood mitigation projects across the Province, a common discount rate of 4% was agreed upon and applied. The discount period is the estimate of the alternative's project life.

The benefit/cost (B/C) ratio of a project is the ratio of net present value of the benefits (average annual damages) over the net present value of the costs. This value is the indicator of economic efficiency. Where the benefits exceed costs, the ratio would be greater than 1.0, and where benefits are less than costs then the ratio would be less than 1.0. An economically-efficient project would have a B/C ratio greater than 1.0. At a B/C ratio of 1.0, the project is at a breakeven point.

6.2 Assumptions/Methodology

The following assumptions were employed in the benefit/cost analysis:

- Costs are based on the estimated capital and operational/maintenance costs presented in Section 4.
- $8.9 million in capital costs was added to the Springbank Off-Stream Flood Storage scenario to account for required mitigation measures upstream.
- Benefits are based on the quantification of flood damages averted as outlined in Section 5.
- The benefit/cost analysis has been carried out using a net present value analysis.
- A 100 year economic analysis.
- Annual operating and maintenance costs of $1.8 million.

6.2.1 MC1 (McLean Creek Flood Storage Project) and SR1 (Springbank Off-Stream Flood Storage Project)

Net benefits for MC1 and SR1 were computed on the basis that the projects will provide protection downstream of Glenmore Dam to the 1:100 and 1:200 year flood events. When these events are exceeded, the damages will start to increase rapidly as the peak discharge passes through the flood hazard area within the City of Calgary. Without additional hydrologic routing, it was assumed that once the design event is exceeded, full damages are incurred. With

additional hydrologic routing it is possible that the benefit/cost ratios of these schemes will improve somewhat.

6.2.2 Glenmore Reservoir Diversion

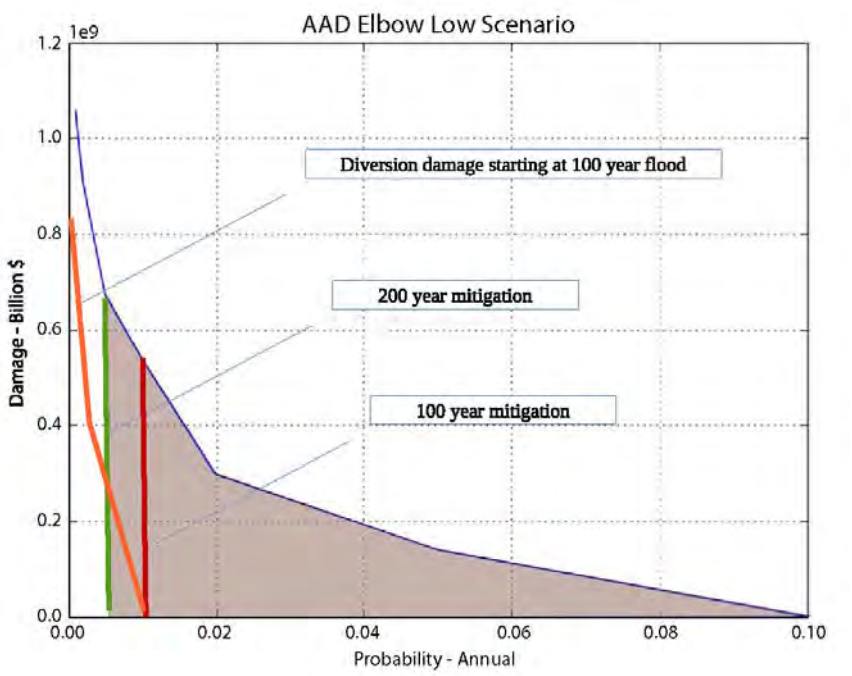
With respect to the Glenmore Reservoir Diversion it was possible to calculate the reduced damages that would be achieved as a result of the 500 and 700 CMS diversion. The incremental flow was passed downstream and damages based on the reduced flood flow were computed to determine the net benefits. Consequently, a higher benefit can be attributed to the diversion scheme based on this higher level of analysis. Notwithstanding the higher overall benefits, the actual benefit/cost ratio as illustrated in the next section is lower than the MC1 and SR1 schemes due to the much higher cost base of the Glenmore Reservoir Diversion.

Exhibit 6.1 illustrates this principle considering the average annual damage on the Elbow under the low damage scenario. If all flood damage can be eliminated then the average annual damage is equal to the area under the curve from the Y to the X axis. This is the total average annual damage.

If a dyke is constructed to a 100 year flood protection, the area right of the red line is subtracted from the total average annual damage. This is the value of the average annual damage averted. However, when the 100 year flood is exceeded then all the properties are flooded instantaneously (area to the left of the red line). Similarly, for a dyke built to the 200 year level of protection.

Conversely, in the case of the diversion tunnel, the mitigation is the area right of the orange line. In this case, when the diverted flow is exceeded, then the damage occurs gradually (slope of the orange curve) rather than vertically, like the dyke situation.

Exhibit 6.1: Affect of Mitigation on Average Annual Damage



6.3 Discussion of Results

Exhibit 6.2 highlights the key results of the benefit/cost analysis of the Springbank Off-Stream Flood Storage project considering the four cases as discussed.

For the 1:100 year level of protection under the high damage scenario the present value of benefits is $477 million versus $255 million in costs, rendering a positive benefit/cost ratio of 1.87.

At the 1:200 year level of protection, the benefit/cost ratio increases to 2.07, an economically viable project with a very attractive benefit/cost ratio.

For the low damage scenario the 1:100 year present value of benefits is $337 million versus costs of $255 million, rendering a benefit/cost ratio of 1.32.

With the 1:200 year level of protection the benefit/cost ratio remains at 1.32, once again an economically viable project with a positive benefit/cost ratio.

Exhibit 6.2: Benefit/Cost Analysis

Indicator	High Damage Scenario		Low Damage Scenario	
	1:100 Year Protection	1:200 Year Protection	1:100 Year Protection	1:200 Year Protection
PV Benefits (average annual damages)	$476,899,000	$639,943,000	$336,847,000	$408,901,000
PV Costs (development & operating total cost)	$255,098,000	$309,607,000	$255,098,000	$309,607,000
Benefit/Cost Ratio	1.87	2.07	1.32	1.32
Net Present Value	$221,801,000	$330,336,000	$81,749,000	$99,294,000
Average Annual Damages	$19,461,291	$26,114,777	$13,746,068	$16,686,439

6.4 Benefits Beyond the Study Area

Of the three mitigation projects under consideration, only one – the McLean Creek Flood Storage project (MC1) – provides benefits beyond the primary study area, the City of Calgary. An analysis of any potential benefits downstream of the City was outside the scope of this analysis. Needless to say, it is anticipated that benefits downstream of the City would be marginal in any event.

6.5 Triple Bottom Line Considerations

Traditional economic analyses of flood mitigation alternatives have generally assumed a straightforward objective of maximizing the net benefits (total benefits minus total costs) that accrue to a project. Society however, has other goals besides economic efficiency. These goals or objectives are the results of outcomes that society desires and have more recently been described as triple bottom line objectives which include, in addition to economic objectives, considerations of environmental and social impacts. In relation to flood mitigation projects, the following criteria are often considered in the evaluation process:

- Disaster prevention:
  - reduces current losses
  - reduces future losses
  - potential residential loss of life
  - potential non-residential loss of life
- Environmental impact:
  - biophysical impacts
  - social impacts
  - aesthetic impacts
- Implementation:
  - complexity
  - flexibility of integration with other measures
- Incidental benefits:
  - recreation
  - drought mitigation
  - other

This study was concerned solely with economic efficiency and consequently does not include analysis of the aforementioned non-commensurable criteria.

6.6 Summary and Conclusions

Exhibit 6.3 below illustrates the relative ranking of the flood mitigation projects.

Exhibit 6.3: Benefit/Cost Ratio

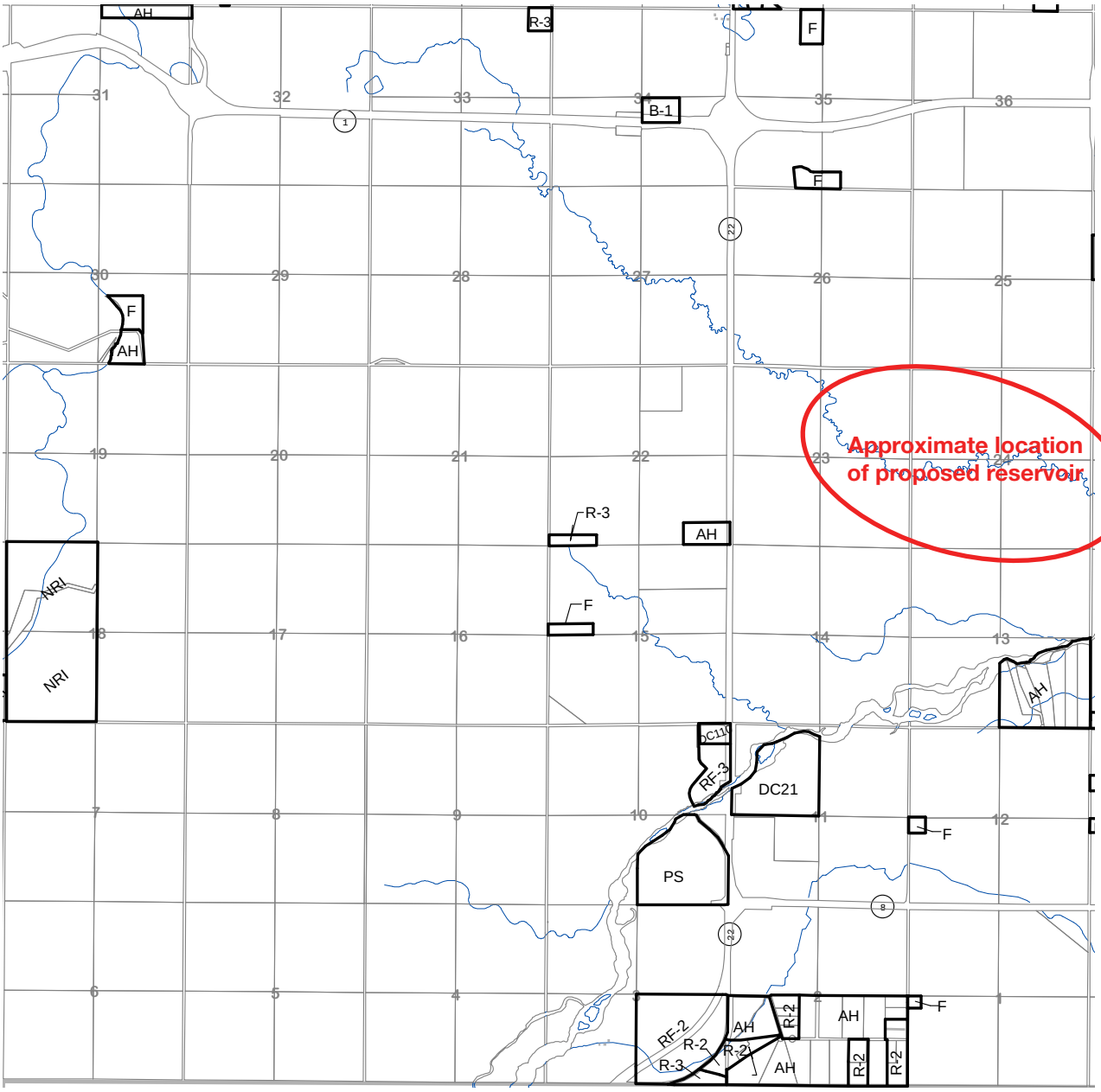
Mitigation Project	High Damage Scenario		Low Damage Scenario	
	1:100 Year Protection	1:200 Year Protection	1:100 Year Protection	1:200 Year Protection
SR1	1.87	2.07	1.32	1.32
MC1	1.43	1.65	1.01	1.05
Glenmore	1.21	1.20	0.81	0.83

The Springbank Off-Stream Flood Storage project achieves a positive benefit/cost ratio under all four scenarios and ranks first ahead of the other two mitigation projects with significantly higher benefit/cost ratios.[5]

[5] Refer to IBI Group Reports: *Benefit/Cost Analysis of Flood Mitigation Projects for the City of Calgary: McLean Creek Flood Storage (February 2015)* and *Benefit/Cost Analysis of Flood Mitigation Projects for the City of Calgary: Glenmore Reservoir Diversion (February 2015).*

Appendix A – Entitlement Status of Lands for Off-Stream Storage Project

Municipal District of Rocky View #44 - Land Use Map No. 48



ALL LANDS ARE DESIGNATED RF UNLESS NOTED OTHERWISE

RANCH AND FARM DISTRICT	RF
SEE EXCEPTIONS LISTED WITH THIS DISTRICT	RF *
RANCH AND FARM TWO DISTRICT	RF-2
RANCH AND FARM THREE DISTRICT	RF-3
AGRICULTURAL HOLDING DISTRICT	AH
FARMSTEAD DISTRICT	F
RESIDENTIAL ONE DISTRICT	R-1
RESIDENTIAL TWO DISTRICT	R-2
RESIDENTIAL THREE DISTRICT	R-3
HIGHWAY BUSINESS DISTRICT	B-1
GENERAL BUSINESS DISTRICT	B-2
LIMITED BUSINESS DISTRICT	B-3
RECREATION BUSINESS DISTRICT	B-4
AGRICULTURAL BUSINESS DISTRICT	B-5
LOCAL BUSINESS DISTRICT	B-6
HIGHWAY FRONTAGE BUSINESS DISTRICT	B-HF
BUSINESS CAMPUS BUSINESS DISTRICT	B-BC
INDUSTRIAL CAMPUS BUSINESS DISTRICT	B-IC

RECREATION DESTINATION BUSINESS DISTRICT	B-RD
LEISURE AND RECREATION BUSINESS DISTRICT	B-LR
AGRICULTURAL SERVICES BUSINESS DISTRICT	B-AS
POINT COMMERCIAL DISTRICT	C-PT
VILLAGE CENTRE COMMERCIAL DISTRICT	C-VC
LOCAL COMMERCIAL DISTRICT	C-LC
REGIONAL COMMERCIAL DISTRICT	C-RC
INDUSTRIAL ACTIVITY DISTRICT	I-IA
STORAGE AND SALES INDUSTRIAL DISTRICT	I-SS
NATURAL RESOURCE INDUSTRIAL DISTRICT	NRI
HAMLET RESIDENTIAL SINGLE FAMILY DISTRICT	HR-1
HAMLET RESIDENTIAL (2) DISTRICT	HR-2
HAMLET COMMERCIAL DISTRICT	HC
HAMLET INDUSTRIAL DISTRICT	HI
PUBLIC SERVICES DISTRICT	PS
AIRPORT DISTRICT	AP
DIRECT CONTROL DISTRICT	DC

N

MUNICIPAL DISTRICT OF ROCKY VIEW #44

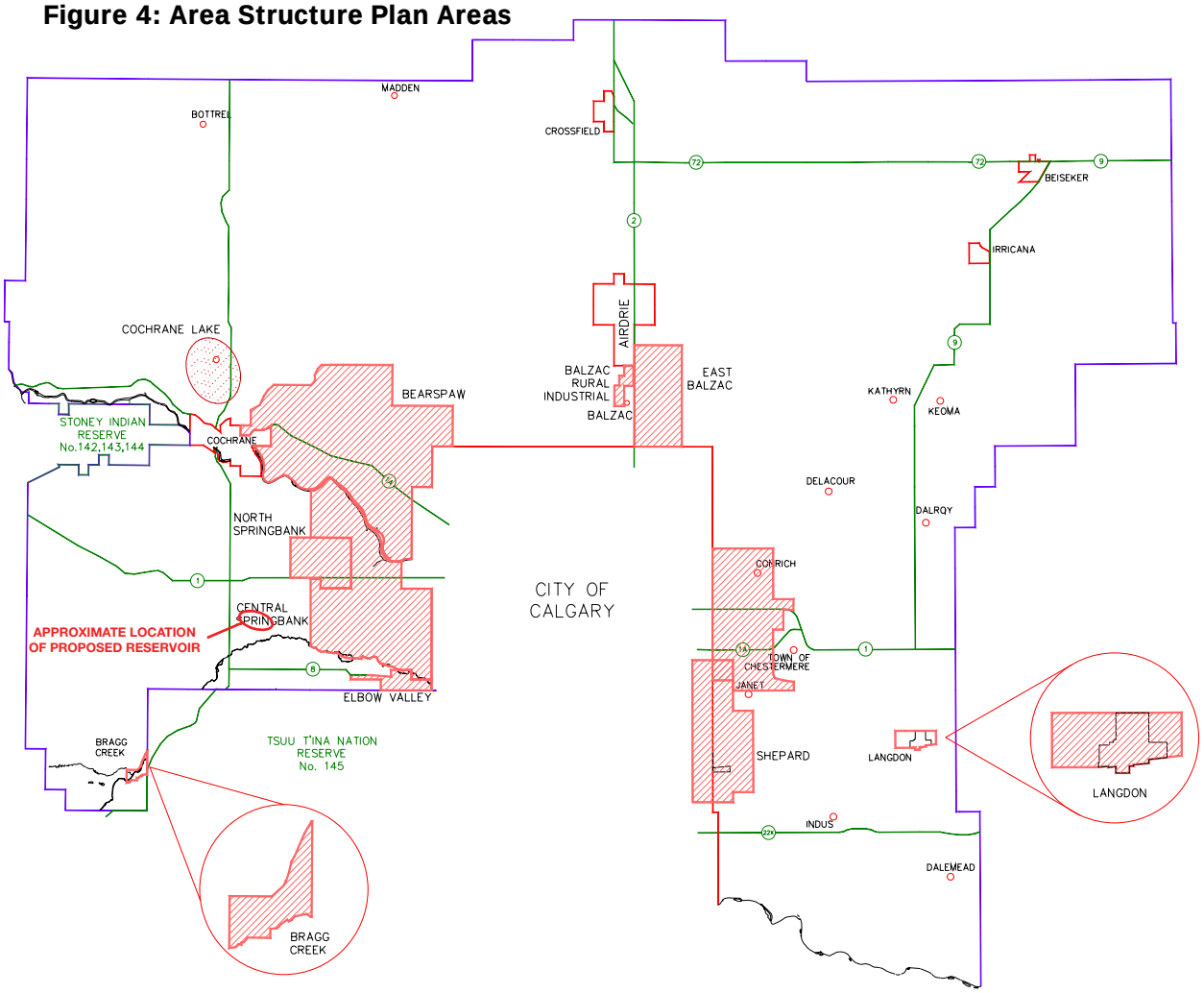
TWP. 24-4-W5M

Part FIVE of the BYLAW No. C-4841-97

LAND USE MAP No. 48

DATE: Mar 02, 2009

Figure 4: Area Structure Plan Areas



MUNICIPAL DISTRICT OF ROCKY VIEW No.44

SUGGESTED AND APPROVED AREA STRUCTURE PLANS

N

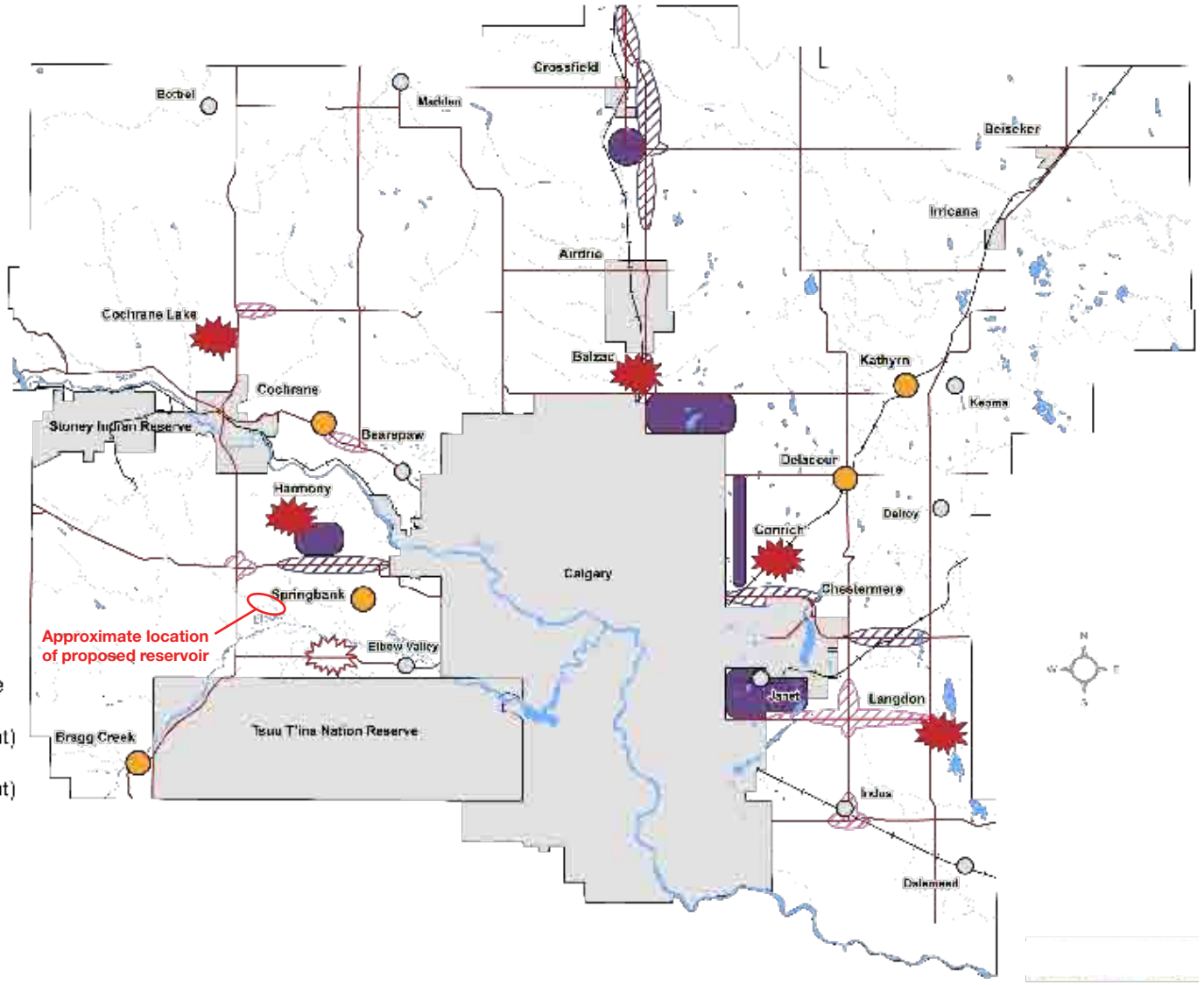
AREA STRUCTURE PLANS
(EXISTING OR BEING PREPARED)

AREAS UNDER DEVELOPMENT PRESSURE

January 2003

Municipal District of Rocky View #44 - Growth Management Strategy Map

this map is conceptual, not to scale and for illustrative purposes only.



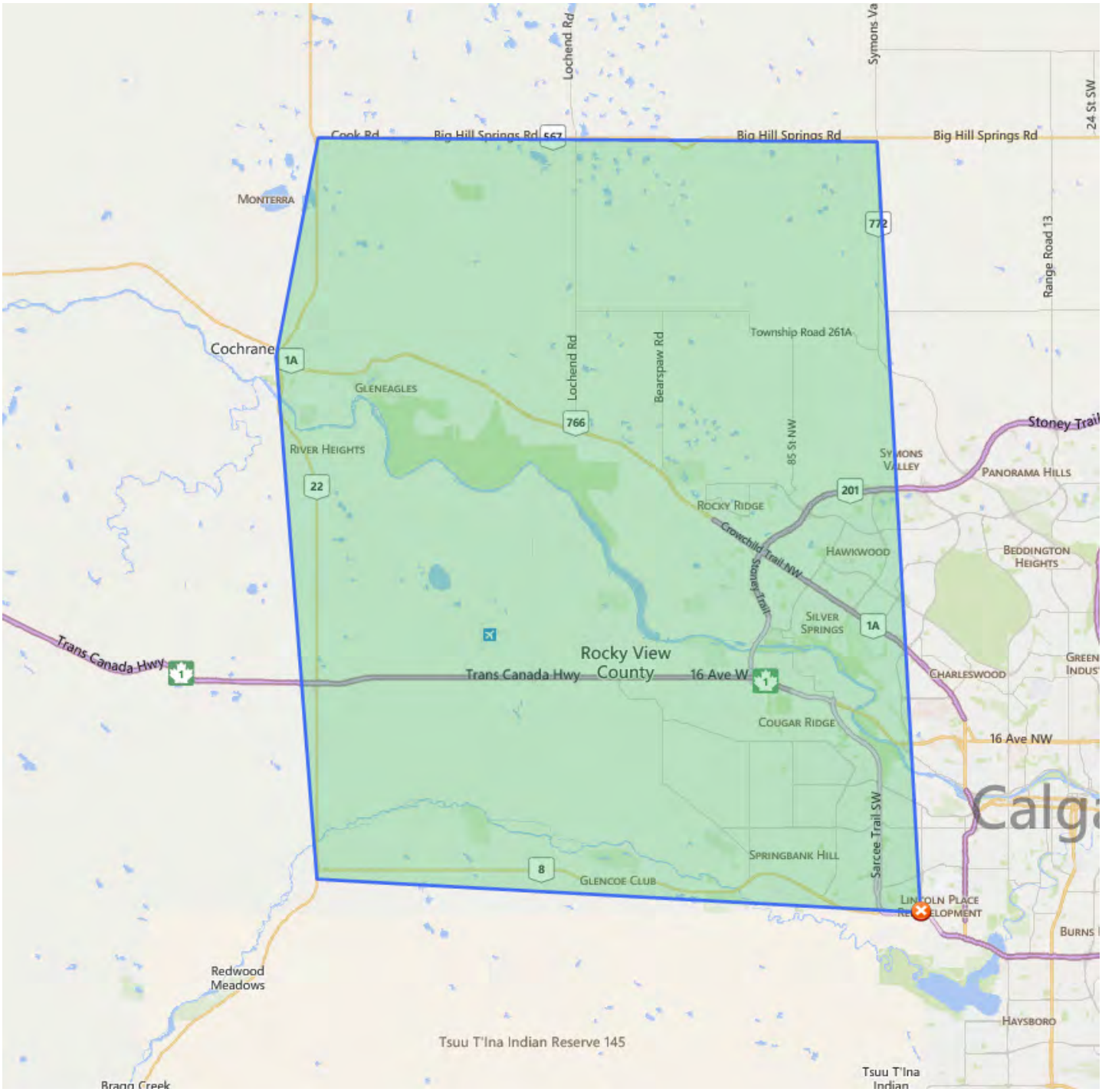
Legend

- Growth Node
- Potential Growth Node
- Community Core
- Existing Community
- Business Node/Regional Employment Centre
- Major Business Corridor (Nodal Development)
- Minor Business Corridor (Nodal Development)

Prepared April 16, 2009.

Appendix B – Springbank Area MLS Sales and Listing Data for 2014

Market Area Considered



Rocky View West Listing

Sta	ML Number	Address	List Price	Sold Price	Community Desc	List Date	Off Market Dat	Total Ac	Days c	Condo Name	Condo Type	Number of Parcels	Cummu	County	List Price / Acre	Sold Price / Acre	Postal Code
A	C3553126	227 CHURCH RANCHES WY NW	$ 719,000.00		Church Ranches	06/02/2013		3.43	650				800	ALBERTA	$ 209,620.99		T3R 1B2
A	C3586217	242258 Windhorse WY	$ 410,000.00		Springbank	19/09/2013		2.05	425				425	ALBERTA	$ 200,000.00		T3Z 0B4
A	C3586227	35 WINDHORSE GR	$ 435,000.00		Springbank	19/09/2013		2.03	425				425	ALBERTA	$ 214,285.71		T3Z 0B4
A	C3599739	Lochend RD NW	$ 8,000,000.00		Bearspaw_Calg	10/02/2014		158.85	281				281	ALBERTA	$ 50,361.98		T3L 2R2
A	C3604034	Highway # 22 North of Cochrane	$ 1,500,000.00		Cochrane Lake	10/03/2014		53.55	253				253	ALBERTA	$ 28,011.20		T4C 1A9
A	C3605546	124 WILLOW CREEK SU	$ 472,500.00		Bearspaw_Calg	21/03/2014		2.02	242				242	ALBERTA	$ 233,910.89		T3R 0K3
A	C3606704	116 GRIZZLY RI	$ 450,000.00		Bearspaw Country Estates	28/03/2014		4.05	235	Z-name Not Listed			235	ALBERTA	$ 111,111.11		T3Z 1H5
A	C3617284	67 CHEYANNE MEADOWS WAY	$ 699,000.00		Church Ranches	23/05/2014		2.34	179				179	ALBERTA	$ 298,717.95		T3R 1B6
A	C3629847	262 Lochend Road	$ 3,969,000.00		None	06/08/2014		157.56	104				104	ALBERTA	$ 25,190.40		T4C 0X0
A	C3631166	251095 WELLAND WY	$ 595,000.00		Bearspaw_Calg	14/08/2014		4.42	96	Z-name Not Listed			277	ALBERTA	$ 134,615.39		T3R 1L3
A	C3631295	41216 Camden Lane	$ 550,000.00		None	12/08/2014		3.95	98				98	ALBERTA	$ 139,240.51		T4C 1B1
A	C3629151	50 BLAZER ESTATES RG	$ 1,100,000.00		Bearspaw_Calg	01/08/2014		8.08	109				109	ALBERTA	$ 136,138.61		T3L 2N7
A	C3641919	116 BEARSPAW MEADOWS	$ 799,999.00		Lynx Ridge	23/10/2014		2.72	26				26	ALBERTA	$ 294,117.28		T3L 2M3
A	C3583465	108 AVENTERRA	$ 359,000.00		Springbank	30/08/2013		2.03	445				445	ALBERTA	$ 176,847.29		T3J 5J4
A	C3640329	31239 TWP RD 252	$ 675,000.00		Springbank	17/10/2014		4	32				32	ALBERTA	$ 168,750.00		T3Z 1E8
A	C3639338	24333 Meadow DR	$ 499,900.00		Bearspaw_Calg	08/10/2014		2	41				41	ALBERTA	$ 249,950.00		T3R 1G3
A	C3621718	10 BEARSPAW VALLEY PLACE	$ 499,900.00		Bearspaw_Calg	16/06/2014		1.96	155				155	ALBERTA	$ 255,051.02		T3G 3G3
A	C3642556	118 WINDHORSE CO	$ 384,900.00		Springbank	03/11/2014		2.05	15				303	ALBERTA	$ 187,756.10		T3Z 0B4
A	C3621729	18 BEARSPAW VALLEY PLACE	$ 499,900.00		Bearspaw_Calg	16/06/2014		1.93	155				155	ALBERTA	$ 259,015.54		T2E 2E2
A	C3575040	242244 WINDHORSE	$ 410,000.00		Springbank	27/06/2013		2.02	509				509	ALBERTA	$ 202,970.30		T3Z 0B4
A	C3637861	6 GLENDALE ESTATES MR	$ 459,000.00		Bearspaw_Calg	29/09/2014		1.98	50				212	ALBERTA	$ 231,818.18		T4C 1A2
A	C3613051	123 BROWN BEAR	$ 399,000.00		Bearspaw Country Estates	02/05/2014		2.08	200				200	ALBERTA	$ 191,826.92		T4C 0B5
A	C3629825	43 Big Hill Springs CV	$ 570,000.00		Bearspaw_Calg	06/08/2014		4.86	104				104	ALBERTA	$ 117,283.95		T4C 1A2
A	C3637529	22 GLENDALE ESTATES MR	$ 389,000.00		Bearspaw_Calg	25/09/2014		2	54	Z-name Not Listed			54	ALBERTA	$ 194,500.00		T3R 1G3
A	C3614265	31060 SWIFT CREEK	$ 494,900.00		Springbank	08/05/2014		2.08	194				194	ALBERTA	$ 237,932.69		T3Z 0B7
A	C3586173	31040 WINDHORSE DR	$ 460,000.00		Springbank	19/09/2013		2.03	425				425	ALBERTA	$ 226,600.99		T3Z 0B4
A	C3586195	12 WINDHORSE BA	$ 460,000.00		Springbank	19/09/2013		2	425				425	ALBERTA	$ 230,000.00		T3Z 0B4
A	C3586198	16 WINDHORSE BA	$ 410,000.00		Springbank	19/09/2013		2	425				425	ALBERTA	$ 205,000.00		T3Z 0B4
A	C3586221	43 WINDHORSE GR	$ 485,000.00		Springbank	19/09/2013		2	425				425	ALBERTA	$ 242,500.00		T3Z 0B4
A	C3586237	242162 WINDHORSE WY	$ 510,000.00		Springbank	19/09/2013		2	425				425	ALBERTA	$ 255,000.00		T3Z 0B4
A	C3586224	39 WINDHORSE GR	$ 485,000.00		Springbank	19/09/2013		2.05	425				425	ALBERTA	$ 236,585.37		T3Z 0B4
A	C3586243	242176 WINDHORSE WY	$ 435,000.00		Springbank	19/09/2013		2.01	425				425	ALBERTA	$ 216,417.91		T3Z 0B4
A	C3586234	242150 WINDHORSE WY	$ 510,000.00		Springbank	19/09/2013		2.02	425				425	ALBERTA	$ 252,475.25		T3Z 0B4
A	C3617248	31156 Township Road 251A	$ 749,800.00		Springbank	23/05/2014		10.63	179	Z-name Not Listed			179	ALBERTA	$ 70,536.22		T3Z 1E6
A	C3602240	21 SWIFT CREEK GR.	$ 588,000.00		Springbank	26/02/2014		2	265				265	ALBERTA	$ 294,000.00		T2Z 0B6
A	C3561891		$ 13,500,000.00		None	05/04/2013		121.37	592				1257	ALBERTA	$ 111,230.12		T3Z 2E4
A	C3633051	37 Westbluff PL	$ 2,450,000.00		Springbank	27/08/2014		10.01	83				83	ALBERTA	$ 244,755.25		T3Z 3P2
A	C3621724	14 BEARSPAW VALLEY PLACE	$ 499,900.00		Bearspaw_Calg	16/06/2014		1.95	155				155	ALBERTA	$ 256,358.97		T2E 2E2
A	C3595058	2 BEARSPAW VALLEY	$ 499,000.00		Bearspaw_Calg	29/12/2013		1.97	324				844	ALBERTA	$ 253,299.49		T3R 1A3
A	C3638507		$ 2,000,000.00		Glendale Meadows	02/10/2014		25.32	47				47	ALBERTA	$ 78,988.94		T4C 2G4
A	C3632325	35195 Springbank RD	$ 8,960,000.00		Springbank	22/08/2014		320	88				436	ALBERTA	$ 28,000.00		T3Z 3H3
A	C3603978	25151 ESCARPMENT RIDGE VW	$ 900,000.00		None	10/03/2014		2.31	253				253	ALBERTA	$ 389,610.39		T3Z 3M7
A	C3618112	Lochend RD	$ 3,080,000.00		Bearspaw_Calg	26/05/2014		138.97	176				176	ALBERTA	$ 22,163.06		T3L 2R2
A	C3593709		$ 3,950,000.00		Springbank	30/11/2013		73.95	353				353	ALBERTA	$ 53,414.47		A0A 0A0
A	C3593826	11 Rolling Range PL	$ 429,000.00		Rolling Range Est	29/11/2013		3.98	354				354	ALBERTA	$ 107,788.95		T4C 1A1
A	C3618530	19 MCKENDRICK PT	$ 684,900.00		Springland Estates	26/05/2014		2.3	176				208	ALBERTA	$ 297,782.61		T3Z 3K1
A	C3639339	24345 Meadow DR	$ 459,000.00		Bearspaw_Calg	08/10/2014		2	41				41	ALBERTA	$ 229,500.00		T3R 1G3
A	C3639342	24349 Meadow DR	$ 449,000.00		Bearspaw_Calg	08/10/2014		2	41				41	ALBERTA	$ 224,500.00		T3R 1G3
A	C3629788	45 BEARSPAW SUMMIT PL	$ 375,000.00		Bearspaw_Calg	06/08/2014		1.98	104				104	ALBERTA	$ 189,393.94		T3A 1G4
A	C3629992	40 Rolling Range DR	$ 3,600,000.00		None	03/08/2014		19.88	107				107	ALBERTA	$ 181,086.52		T4C 2A3
A	C3594983	Bearspaw 160 acres NW of Calgary	$ 1,900,000.00		None	24/12/2013		160	329				601	ALBERTA	$ 11,875.00		T3R 1C4
A	C3629125	251208 RGE RD 32	$ 864,000.00		Springbank	30/07/2014		12.31	111				111	ALBERTA	$ 70,186.84		T3Z 0X0
A	C3586216	31100 WINDHORSE DR	$ 410,000.00		Springbank	19/09/2013		2	425				425	ALBERTA	$ 205,000.00		T3Z 0B4
A	C3586180	4 WINDHORSE BA	$ 435,000.00		Springbank	19/09/2013		2.32	425				425	ALBERTA	$ 187,500.00		T3Z 0B4
A	C3586189	8 WINDHORSE BA	$ 460,000.00		Springbank	19/09/2013		2	425				425	ALBERTA	$ 230,000.00		T3Z 0B4

Rocky View West Listing

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A	C3586233	114 WINDHORSE CO	$ 460,000.00		Springbank	19/09/2013		2	425				425	ALBERTA	$ 230,000.00		T3Z 0B4
A	C3586239	242168 WINDHORSE WY	$ 460,000.00		Springbank	19/09/2013		2.01	425				425	ALBERTA	$ 228,855.72		T3Z 0B4
A	C3633344	30 GLENDALE ESTATES MR	$ 389,000.00		Bearspaw_Calg	28/08/2014		1.98	82				1015	ALBERTA	$ 196,464.65		T3R 1G3
A	C3629801	35 Big Hill Springs CV	$ 540,000.00		Bearspaw_Calg	06/08/2014		4.6	104				104	ALBERTA	$ 117,391.30		T4C 1A4
A	C3640579	24 GRANDVIEW PL	$ 525,000.00		Springbank	19/10/2014		1.98	30				30	ALBERTA	$ 265,151.52		T3Z 0A7
A	C3616382	24 Villosa Ridge PT	$ 389,000.00		None	20/05/2014		2.04	182				182	ALBERTA	$ 190,686.28		T3Z 1H2
A	C3637865	10 GLENDALE ESTATES MR	$ 499,000.00		Bearspaw_Calg	29/09/2014		2	50				1545	ALBERTA	$ 249,500.00		T3R 1G3
A	C3639734	5 MOUNTAIN GLEN	$ 425,000.00		None	12/10/2014		4	37				37	ALBERTA	$ 106,250.00		T4C 0G6
A	C3621144	34080 GLENDALE Road - TWP RD 260	$ 7,559,000.00		None	07/06/2014		134.5	164				164	ALBERTA	$ 56,200.74		T0L 0W0
A	C3627556	243081 Morning Vista WY	$ 405,000.00		None	21/07/2014		1.98	120				120	ALBERTA	$ 204,545.46		T3Z 0B2
X	C3574569	31119 GRANDARCHES DR	$ 735,000.00		Springbank	22/06/2013	15/11/2014	2.04	511				511	ALBERTA	$ 360,294.12		T3Z 0B6
X	C3627952	Glenbow RD	$ 398,500.00		None	24/07/2014	15/11/2014	3.7	114				114	ALBERTA	$ 107,702.70		T4C 2G4
X	C3626603	260084 GLENBOW	$ 1,498,850.00		None	14/07/2014	15/11/2014	22.6	124				124	ALBERTA	$ 66,320.80		T4C 2G4
X	C3545385		$ 555,450.00		Springbank	06/11/2012	06/11/2014	2.91	730	Z-name Not Listed			730	ALBERTA	$ 190,876.29		T3Z 3K1
X	C3634076		$ 499,900.00		None	02/09/2014	05/11/2014	4.3	64				64	ALBERTA	$ 116,255.81		T1T 1T1
X	C3625542	118 WINDHORSE CO	$ 395,000.00		Springbank	08/07/2014	31/10/2014	2.05	115				290	ALBERTA	$ 192,682.93		T3Z 0B4
X	C3587680	251092 WELLAND	$ 585,000.00		Bearspaw_Calg	27/09/2013	31/10/2014	4.25	399				399	ALBERTA	$ 137,647.06		T3R 1L3
S	C3586252	242230 WINDHORSE WY	$ 435,000.00	$ 388,000.00	Springbank	19/09/2013	28/10/2014	2.03	404				404	ALBERTA	$ 214,285.71	$ 191,133.01	T3Z 0B4
S	C3590964	Springbank Heights DR	$ 545,000.00	$ 535,000.00	Springbank	30/10/2013	27/10/2014	4.1	362				359	ALBERTA	$ 132,926.83	$ 130,487.81	T3Z 1C4
T	C3597033	120 GRANDVIEW WY	$ 499,900.00		Springbank	20/01/2014	07/10/2014	2.04	260				260	ALBERTA	$ 245,049.02		T3Z 0A8
X	C3613618	31038 SWIFT CREEK	$ 455,000.00		Springbank	06/05/2014	06/10/2014	2.04	153				153	ALBERTA	$ 223,039.22		T3Z 0B7
X	C3625066	25 SWIFT CREEK GR	$ 479,000.00		Springbank	05/07/2014	05/10/2014	2.01	92				92	ALBERTA	$ 238,308.46		T3Z 0B6
X	C3618522	24190 MEADOW	$ 529,000.00		Bearspaw Acres	29/05/2014	30/09/2014	2.2	124				124	ALBERTA	$ 240,454.55		T3R 1A8
X	C3588538	30032 LOWER SPRINGBANK RD	$ 539,900.00		Springbank	07/10/2013	30/09/2014	2.08	358				358	ALBERTA	$ 259,567.31		T3Z 3K7
X	C3606041	15 CORRAL VIEW	$ 510,000.00		Springbank	24/03/2014	28/09/2014	2.32	188				188	ALBERTA	$ 219,827.59		T3A 2B7
X	C3595970	10 GLENDALE ESTATES MR	$ 499,000.00		Bearspaw_Calg	10/01/2014	26/09/2014	2	259				1495	ALBERTA	$ 249,500.00		T3R 1G3
S	C3625546	242255 WINDHORSE WY	$ 394,900.00	$ 320,000.00	Springbank	08/07/2014	13/09/2014	2.93	67				242	ALBERTA	$ 134,778.16	$ 109,215.02	T3Z 0B4
S	C3586246	242190 WINDHORSE WY	$ 435,000.00	$ 391,500.00	Springbank	19/09/2013	12/09/2014	2	358				358	ALBERTA	$ 217,500.00	$ 195,750.00	T3Z 0B4
S	C3586248	242208 WINDHORSE WY	$ 410,000.00	$ 369,000.00	Springbank	19/09/2013	12/09/2014	2.02	358				358	ALBERTA	$ 202,970.30	$ 182,673.27	T3Z 0B4
S	E3361283	25006 TWP RD 264A	$ 1,500,000.00	$ 1,375,000.00	None	29/01/2014	09/09/2014	151.5	223				222	ALBERTA	$ 9,900.99	$ 9,075.91	T3R 1J6
S	E3361286	25006 TWP RD 264A	$ 1,300,000.00	$ 1,175,000.00	None	29/01/2014	09/09/2014	137.19	223				222	ALBERTA	$ 9,475.91	$ 8,564.76	T3R 1J6
S	E3361284	25006 TWP RD 264A	$ 1,300,000.00	$ 1,175,000.00	None	29/01/2014	09/09/2014	162.99	223				222	ALBERTA	$ 7,975.95	$ 7,209.03	T3R 1J6
S	E3361285	25006 TWP RD 264A	$ 1,300,000.00	$ 1,175,000.00	None	29/01/2014	09/09/2014	172.75	223				222	ALBERTA	$ 7,525.33	$ 6,801.74	T3R 1J6
X	C3623835	Bearspaw RD	$ 1,400,000.00		Bearspaw_Calg	27/06/2014	08/09/2014	20.02	73				73	ALBERTA	$ 69,930.07		T3R 1C4
X	C3623843	Bearspaw RD	$ 2,000,000.00		Bearspaw_Calg	27/06/2014	08/09/2014	20.02	73				73	ALBERTA	$ 99,900.10		T3R 1C4
X	C3598205	224 BROWN BEAR	$ 409,900.00		Bearspaw Country Estates	29/01/2014	31/08/2014	2.01	214	Z-name Not Listed			214	ALBERTA	$ 203,930.35		T4C 0B5
X	C3605262	Symons Valley Road	$ 2,595,000.00		None	15/03/2014	31/08/2014	103	169			1	169	ALBERTA	$ 25,194.18		T4B 2A3
X	C3613691	29 SWIFT CREEK GR	$ 425,000.00		Springbank	06/05/2014	31/08/2014	2	117	Z-name Not Listed			117	ALBERTA	$ 212,500.00		T3Z 0B7
X	C3617357	244230 OLD BANFF COACH	$ 1,288,888.00		Springbank	24/05/2014	30/08/2014	7.05	98				98	ALBERTA	$ 182,820.99		T2H 0K2
X	C3595707	30 GLENDALE ESTATES MR	$ 388,900.00		Bearspaw_Calg	08/01/2014	26/08/2014	1.98	230				934	ALBERTA	$ 196,414.14		T3R 1G3
X	C3616404	35195 Springbank RD	$ 8,960,000.00		Springbank	20/05/2014	20/08/2014	320	92				348	ALBERTA	$ 28,000.00		T3Z 3H3
S	C3621941	32050 KODIAK SPRINGS RD RD	$ 460,000.00	$ 425,000.00	Bearspaw_Calg	16/06/2014	15/08/2014	2.02	60	Z-name Not Listed			60	ALBERTA	$ 227,722.77	$ 210,396.04	T4C 1X2
X	C3602054	12 Cody Range WY	$ 529,900.00		Bearspaw_Calg	26/02/2014	01/08/2014	2.2	156				338	ALBERTA	$ 240,863.64		T3R 1C1
X	C3608525	31120 GRANDARCHES	$ 469,900.00		Springbank	08/04/2014	31/07/2014	2.03	114				114	ALBERTA	$ 231,477.83		T3Z 0C3
X	C3584175	243020 MORNING VISTA WY	$ 399,000.00		Springbank	05/09/2013	31/07/2014	2	329	Z-name Not Listed			329	ALBERTA	$ 199,500.00		T3Z 0B2
X	C3598421	251095 WELLAND WY	$ 639,000.00		Bearspaw_Calg	31/01/2014	31/07/2014	4.42	181	Z-name Not Listed			181	ALBERTA	$ 144,570.14		T3R 1L3
S	C3586219	242211 WINDHORSE WY	$ 410,000.00	$ 390,500.00	Springbank	19/09/2013	25/07/2014	2.04	309				309	ALBERTA	$ 200,980.39	$ 191,421.57	T3Z 0B4
S	C3597208	63 ROLLING ACRES PL	$ 1,050,000.00	$ 1,000,000.00	Bearspaw Acres	19/01/2014	18/07/2014	19.91	180				209	ALBERTA	$ 52,737.32	$ 50,226.02	T3R 1B8
S	C3623094	214 PARTRIDGE BAY	$ 369,900.00	$ 355,000.00	Partridge Heights	23/06/2014	17/07/2014	2	24	Z-name Not Listed			187	ALBERTA	$ 184,950.00	$ 177,500.00	T3Z 2B9
X	C3596752	232 BROWN BEAR PT	$ 399,500.00		Bearspaw_Calg	17/01/2014	17/07/2014	2.01	181				181	ALBERTA	$ 198,756.22		T3R 1G3
S	C3612237	185 SPRINGBANK HEIGHTS	$ 435,000.00	$ 410,000.00	Springbank	29/04/2014	09/07/2014	2.42	71				71	ALBERTA	$ 179,752.07	$ 169,421.49	T3Z 1C4
X	C3584193	243039 MORNING VISTA WY	$ 349,000.00		Springbank	05/09/2013	06/07/2014	1.98	304				304	ALBERTA	$ 176,262.63		T2Z 0B2
S	C3605365	30 WOODLAND GL	$ 398,700.00	$ 390,000.00	Bearspaw_Calg	20/03/2014	02/07/2014	1.98	102			1	102	ALBERTA	$ 201,363.64	$ 196,969.70	T3R 1G4
X	C3595607	118 WINDHORSE CO	$ 425,000.00		Springbank	07/01/2014	02/07/2014	2.05	176				175	ALBERTA	$ 207,317.07		T3Z 0B4
X	C3595610	242255 WINDHORSE WY	$ 399,900.00		Springbank	07/01/2014	02/07/2014	2.93	176				175	ALBERTA	$ 136,484.64		T3Z 0B4

Rocky View West Listing

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X	C3560024	# Lot 3 25205 Bearspaw PL	$ 474,900.00		Bearspaw_Calg	26/03/2013	01/07/2014	1.98	462				462	ALBERTA	$ 239,848.49		T3R 1H5
X	C3560021	# Lot 1 25205 BEARSPAW	$ 474,900.00		Bearspaw_Calg	26/03/2013	01/07/2014	1.98	462				462	ALBERTA	$ 239,848.49		T3R 1H5
X	C3607552	43 Big Hill Springs CV	$ 535,000.00		Big Hill Springs Est	02/04/2014	30/06/2014	4.86	89				89	ALBERTA	$ 110,082.31		T4C 1A2
X	C3595854	37 EMERALD BAY DR	$ 950,000.00		Springbank Links	09/01/2014	30/06/2014	2.05	172				172	ALBERTA	$ 463,414.63		T3Z 1E3
S	C3608674	31108 SWIFT CREEK TC	$ 499,800.00	$ 470,000.00	Springbank	09/04/2014	25/06/2014	2.06	77	Z-name Not Listed			77	ALBERTA	$ 242,621.36	$ 228,155.34	T3Z 0B7
S	C3620912	206 GRIZZLY	$ 350,000.00	$ 343,000.00	Bearspaw Country Estates	11/06/2014	24/06/2014	2.01	13				13	ALBERTA	$ 174,129.35	$ 170,646.77	T3L 2M7
S	C3585708		$ 319,900.00	$ 305,000.00	Springbank	16/09/2013	24/06/2014	2.84	281				281	ALBERTA	$ 112,640.85	$ 107,394.37	T3Z 2P8
S	C3595505	34 GLENDALE ESTATES MR	$ 399,000.00	$ 380,000.00	Bearspaw_Calg	06/01/2014	19/06/2014	1.98	164				1403	ALBERTA	$ 201,515.15	$ 191,919.19	T3R 1G3
X	C3608310	24039 Burma RD	$ 895,000.00		Bearspaw_Calg	07/04/2014	13/06/2014	15.81	67	Z-name Not Listed			126	ALBERTA	$ 56,609.74		T3R 1E3
S	C3608128	59 Big Hill Spings CV	$ 460,000.00	$ 460,000.00	Big Hill Springs Est	05/04/2014	11/06/2014	4.01	67				67	ALBERTA	$ 114,713.22	$ 114,713.22	T4C 1A2
X	C3595774	244119 PARTRIDGE	$ 470,000.00		Springbank	08/01/2014	08/06/2014	2	151				151	ALBERTA	$ 235,000.00		T3P 0R3
X	C3582915	244119 PARTRIDGE	$ 549,000.00		Springbank	26/08/2013	08/06/2014	2	286				286	ALBERTA	$ 274,500.00		T2P 0R3
X	C3594825	214 PARTRIDGE BA	$ 389,900.00		Partridge Heights	20/12/2013	01/06/2014	2	163	Z-name Not Listed			163	ALBERTA	$ 194,950.00		T3Z 2B9
X	C3584161	213 MORGANS WY	$ 429,000.00		Springbank	05/09/2013	31/05/2014	2	268	Z-name Not Listed			268	ALBERTA	$ 214,500.00		T3Z 0B9
X	C3568110	24 GRANDVIEW PLACE	$ 550,000.00		Springbank	14/05/2013	31/05/2014	1.98	382				382	ALBERTA	$ 277,777.78		T3Z 0A7
X	C3584203	206 MORNING VISTA VW	$ 479,000.00		Springbank	05/09/2013	31/05/2014	2	268				268	ALBERTA	$ 239,500.00		T3Z 0B2
S	C3605791	242091 RGE RD 32	$ 2,195,000.00	$ 2,195,000.00	Springbank	21/03/2014	27/05/2014	20	67				67	ALBERTA	$ 109,750.00	$ 109,750.00	T1X 0K1
S	C3589267	26 ELBOW RIVER RD	$ 549,000.00	$ 500,000.00	Elbow River Estates	15/10/2013	23/05/2014	4.08	220				435	ALBERTA	$ 134,558.82	$ 122,549.02	T3Z 2V2
S	C3575046	3 WINDHORSE	$ 435,000.00	$ 410,000.00	Springbank	27/06/2013	22/05/2014	2	329				329	ALBERTA	$ 217,500.00	$ 205,000.00	T3Z 0B4
X	C3600987	35195 Springbank Road	$ 8,960,000.00		Springbank	15/02/2014	18/05/2014	320	92				256	ALBERTA	$ 28,000.00		T3Z 3H3
S	C3596619	11 KODIAK SPRINGS CV	$ 435,000.00	$ 435,000.00	Bearspaw Country Estates	14/01/2014	17/05/2014	2	123				123	ALBERTA	$ 217,500.00	$ 217,500.00	T4C 0B5
S	C3613969	HAGGARD ROAD	$ 2,299,000.00	$ 2,100,000.00	Springbank	07/05/2014	16/05/2014	34.35	9				9	ALBERTA	$ 66,928.68	$ 61,135.37	T3Z 3P3
X	C3599346	31099 SWIFT CREEK	$ 749,000.00		Springbank	06/02/2014	14/05/2014	2	97				97	ALBERTA	$ 374,500.00		T3A 0J7
S	C3607356	24166 Old Banff Coach RD SW	$ 930,000.00	$ 825,000.00	NONE	01/04/2014	11/05/2014	6.61	39				39	ALBERTA	$ 140,695.92	$ 124,810.89	T3Z 3N4
S	C3586211	24 WINDHORSE BA	$ 410,000.00	$ 370,000.00	Springbank	19/09/2013	09/05/2014	2.06	232				232	ALBERTA	$ 199,029.13	$ 179,611.65	T3Z 0B4
S	C3581797	5 SWIFT CREEK GR	$ 499,800.00	$ 462,000.00	Springbank	15/08/2013	05/05/2014	2.01	263				263	ALBERTA	$ 248,656.72	$ 229,850.75	T3Z 0B6
S	C3607424		$ 1,500,000.00	$ 1,500,000.00	Bearspaw_Calg	01/04/2014	05/05/2014	73.11	34				34	ALBERTA	$ 20,517.03	$ 20,517.03	T4C 1A7
S	C3610858	116 Swift Creek CV SW	$ 459,900.00	$ 430,000.00	Springbank	22/04/2014	02/05/2014	2.07	10				826	ALBERTA	$ 222,173.91	$ 207,729.47	T3Z 0B6
S	C3603531	76 Eagle Butte Ranch	$ 549,000.00	$ 485,000.00	Springbank	06/03/2014	01/05/2014	2.03	56				126	ALBERTA	$ 270,443.35	$ 238,916.26	T3Z 1K3
S	C3541963	13 Country Meadows PL	$ 435,950.00	$ 430,000.00	Springbank	01/10/2012	30/04/2014	1.98	576				576	ALBERTA	$ 220,176.77	$ 217,171.72	T3Z 0C3
S	C3594713	251100 WELLAND WY	$ 680,000.00	$ 635,000.00	Bearspaw_Calg	18/12/2013	30/04/2014	4.84	133				629	ALBERTA	$ 140,495.87	$ 131,198.35	T3R 1L3
X	C3574240	8 Mountain Glen Close	$ 409,000.00		None	20/06/2013	30/04/2014	2	314				314	ALBERTA	$ 204,500.00		T0L 0W0
X	C3578466	21 Silverhorn VA	$ 625,000.00		None	23/07/2013	30/04/2014	1.98	281				281	ALBERTA	$ 315,656.57		T3R 1C8
X	C3598689	Glenbow RD	$ 399,500.00		None	31/01/2014	30/04/2014	3.7	89				89	ALBERTA	$ 107,972.97		T4C 2G4
S	C3485203	39 MORGANS COURT	$ 475,000.00	$ 488,250.00	Morgans Rise	21/07/2011	29/04/2014	2	1013	Z-name Not Listed			1013	ALBERTA	$ 237,500.00	$ 244,125.00	T3Z 0A5
S	C3593855	251225 Range Road 33	$ 279,900.00	$ 275,000.00	Springbank	02/12/2013	28/04/2014	2.13	147	Z-name Not Listed			147	ALBERTA	$ 131,408.45	$ 129,107.98	T3Z 1K7
X	C3589102		$ 469,000.00		None	09/10/2013	09/04/2014	4.05	182				182	ALBERTA	$ 115,802.47		T4B 2B7
X	C3599079	24039 Burma RD	$ 995,000.00		Bearspaw_Calg	05/02/2014	05/04/2014	15.81	59	Z-name Not Listed			59	ALBERTA	$ 62,934.85		T3R 1E3
S	C3541959	9 Country Meadows PL	$ 430,700.00	$ 422,000.00	Springbank	01/10/2012	26/03/2014	1.98	541				541	ALBERTA	$ 217,525.25	$ 213,131.31	T3Z 0C3
S	C3596982	31159 GRANDARCHES	$ 779,000.00	$ 750,000.00	Springbank	17/01/2014	25/03/2014	1.98	67				67	ALBERTA	$ 393,434.34	$ 378,787.88	T3Z 0A7
X	C3586641	116 Swift Creek CV SW	$ 459,900.00		Springbank	22/09/2013	23/03/2014	2.07	182				816	ALBERTA	$ 222,173.91		T3Z 0B6
S	C3601812	244131 PARTRIDGE	$ 549,000.00	$ 500,000.00	Partridge Heights	25/02/2014	17/03/2014	2.01	20				20	ALBERTA	$ 273,134.33	$ 248,756.22	T2P 0R3
T	C3604801	5 MOUNTAIN GLEN CL	$ 399,500.00		None	14/03/2014	17/03/2014	4	32				32	ALBERTA	$ 99,875.00		T4C 0G6
S	C3586229	31 WINDHORSE GR	$ 410,000.00	$ 380,000.00	Springbank	19/09/2013	13/03/2014	2.1	175				175	ALBERTA	$ 195,238.10	$ 180,952.38	T3Z 0B4
S	C3586253	31071 WINDHORSE DR	$ 435,000.00	$ 393,000.00	Springbank	19/09/2013	05/03/2014	2	167				167	ALBERTA	$ 217,500.00	$ 196,500.00	T3Z 0B4
S	C3598161	251116 WELLAND	$ 589,000.00	$ 579,000.00	None	29/01/2014	05/03/2014	4.5	35				35	ALBERTA	$ 130,888.89	$ 128,666.67	T3R 1L3
S	C3563563		$ 579,900.00	$ 549,900.00	None	17/04/2013	03/03/2014	3.98	320				653	ALBERTA	$ 145,703.52	$ 138,165.83	T3Z 2E3
X	C3561483	49 UPLANDS RIDGE	$ 849,900.00		Uplands	03/04/2013	03/03/2014	2	334	Z-name Not Listed			334	ALBERTA	$ 424,950.00		T3Z 3N5
X	C3576960	24166 Old Banff Coach Road RD	$ 1,200,000.00		None	12/07/2013	01/03/2014	6.61	232				232	ALBERTA	$ 181,543.12		T3Z 3N4
X	C3589835	Eagle Butte Ranch	$ 549,000.00		Eagle Butte Ranches	18/10/2013	28/02/2014	2.03	72				72	ALBERTA	$ 270,443.35		T3Z 1K3
X	C3466512	243238 HORIZON VIEW ROAD	$ 995,000.00		Horizon View Estates	18/03/2011	28/02/2014	5.27	1078	Z-name Not Listed			1078	ALBERTA	$ 188,804.55		T3Z 3M3
X	C3590765	164 GRANDVIEW WAY	$ 625,000.00		Springbank	28/10/2013	28/02/2014	1.99	123				123	ALBERTA	$ 314,070.35		T3Z 0A8
X	C3582467	12 Cody Range WY	$ 519,900.00		Church Ranches	22/08/2013	21/02/2014	2.2	183				183	ALBERTA	$ 236,318.18		T3R 1C1
X	C3581383	45 BEARSPAW SUMMIT PL	$ 390,000.00		Bearspaw_Calg	14/08/2013	14/02/2014	1.98	184				275	ALBERTA	$ 196,969.70		T3A 1G4
X	C3592535	35195 Springbank Road	$ 8,960,000.00		Springbank	15/11/2013	14/02/2014	320	91				168	ALBERTA	$ 28,000.00		T3Z 3H3

Rocky View West Listing

Sta	ML Number	Address	List Price	Sold Price	Community Desc	List Date	Off Market Dat	Total Ac	Days c	Condo Name	Condo Type	Number of Parcels	Cummu	County	List Price / Acre	Sold Price / Acre	Postal Code
X	C3581253		$ 1,000,000.00		Glenbow	12/08/2013	08/02/2014	4.27	180				180	ALBERTA	$ 234,192.04		T4C 0B7
S	C3592943		$ 2,250,000.00	$ 2,000,000.00	Springbank	20/11/2013	07/02/2014	34.32	79				79	ALBERTA	$ 65,559.44	$ 58,275.06	T3Z 3P3
X	C3580848	3 Cheyanne Meadows GA N	$ 588,000.00		Bearspaw Acres	09/08/2013	06/02/2014	1.98	181	No Name			181	ALBERTA	$ 296,969.70		T3R 1B7
X	C3327199	22 Highway, 4 miles north of Cochrane	$ 1,500,000.00		None	13/05/2008	31/01/2014	53.3	2089				2089	ALBERTA	$ 28,142.59		T4C 1A9
S	C3485205	35 MORGANS COURT	$ 425,000.00	$ 441,000.00	Morgans Rise	21/07/2011	20/01/2014	2	914	Z-name Not Listed			914	ALBERTA	$ 212,500.00	$ 220,500.00	T3Z 0A5
S	C3545360	25198 SPRINGBANK RD.	$ 2,185,000.00	$ 1,800,000.00	Springbank	05/11/2012	20/01/2014	20.29	441	Z-name Not Listed			441	ALBERTA	$ 107,688.52	$ 88,713.65	T3Z 3M8
T	C3594630	63 rolling acres PL NW	$ 1,200,000.00		Bearspaw Acres	16/12/2013	16/01/2014	19.91	31			1	31	ALBERTA	$ 60,271.22		T3R 1B8
S	C3587544	31147 GRANDARCHES DR	$ 799,000.00	$ 750,000.00	Springbank	23/09/2013	14/01/2014	1.98	113				113	ALBERTA	$ 403,535.35	$ 378,787.88	T3Z 0A7
S	C3595608	242163 WINDHORSE WY	$ 450,000.00	$ 417,000.00	Springbank	07/01/2014	14/01/2014	2.02	7				7	ALBERTA	$ 222,772.28	$ 206,435.64	T3Z 0B4
S	C3588038	228 Horizon View GL	$ 595,000.00	$ 550,000.00	Springbank	03/10/2013	13/01/2014	1.98	102				102	ALBERTA	$ 300,505.05	$ 277,777.78	T3Z 3M6
X	C3592381	262 Lochend RD	$ 4,410,000.00		None	08/11/2013	10/01/2014	157.56	63				63	ALBERTA	$ 27,989.34		T4C 2A3
X	C3575097	43 GRANDVIEW PL	$ 595,000.00		Springbank	27/06/2013	06/01/2014	2.03	193				193	ALBERTA	$ 293,103.45		T3Z 0A8
X	E3343728	25006 TWP RD 264A	$ 6,200,000.00		None	02/07/2013	06/01/2014	627.89	188			4	188	ALBERTA	$ 9,874.34		T3R 1J6
S	C3591083	ASPEN DRIVE	$ 500,000.00	$ 500,000.00	Aspen park	30/10/2013	05/01/2014	4	67				67	ALBERTA	$ 125,000.00	$ 125,000.00	T3R 1A5

Appendix C – Harmony Mixed-Use Development, Springbank

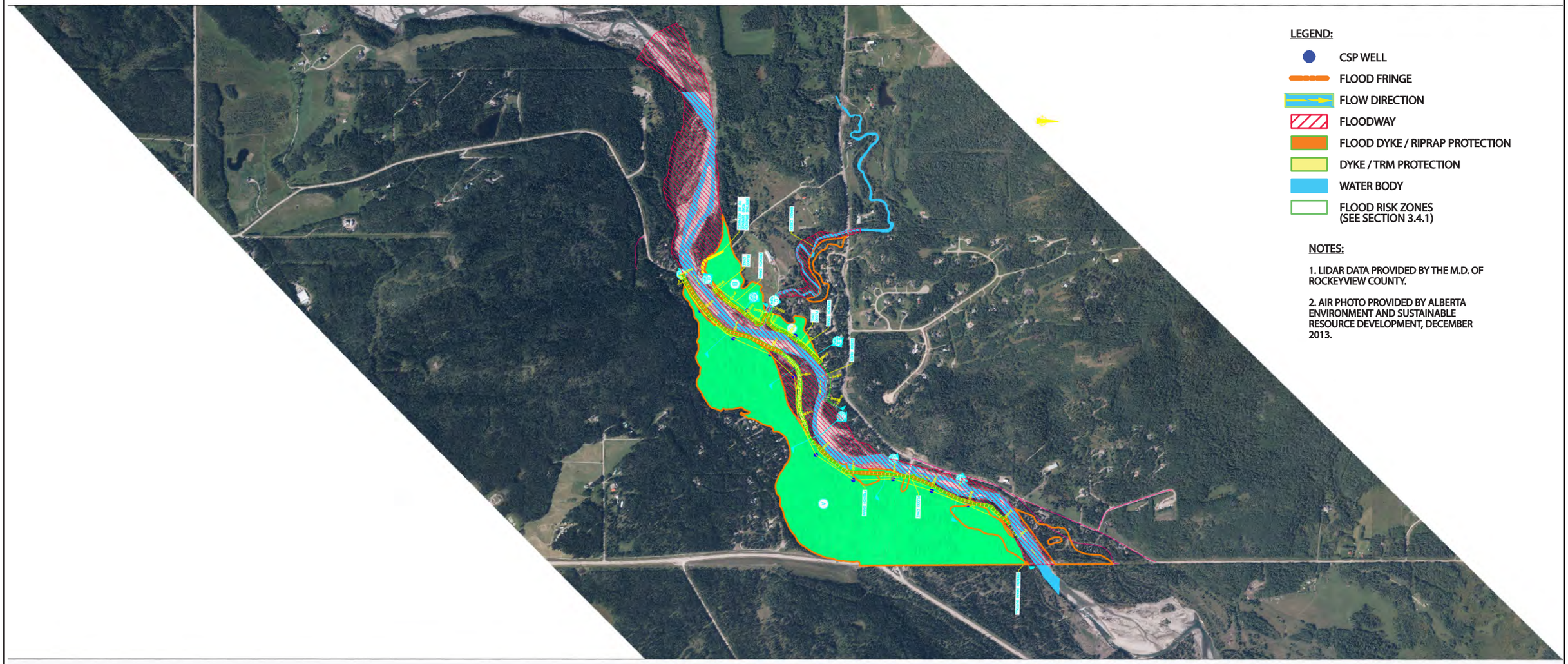
Regional Setting

Local Setting

Conceptual Master Plan - Harmony

Appendix D – Bragg Creek Proposed Dyke System

Bragg Creek Flood Risk Area and Proposed Dyke System



Source:
amec - Southern Alberta Flood Recovery Task Force
Flood Mitigation Measures for the Bow, Elbow and Oldman River Basins
Volume 4 - Flood Mitigation Measures - Final
June 2014

Elbow River at Banff Creek

Source:
amec - Southern Alberta Flood Recovery Task Force
Flood Mitigation Measures for the Bow, Elbow and Oldman River Basins
Volume 4 - Flood Mitigation Measures - Final
June 2014

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Conceptual Cost Estimate - Bragg Creek Flood Defence Dykes & French Drain

Item No.	Item Description	Unit	Quantity	Unit Price	Extension
	ALLOWANCES				
1	Larger Riprap sizing	Allow.	Allowance		$200,000
	TEMPORARY FACILITIES				
2	Mobilization and Demobilization	L.S.	1	Lump Sum	$50,000
3	Existing and Temporary Roads	L.S.	1	Lump Sum	$10,000
	SITE PREPARATION				
4	Clearing & Grubbing	ha	3	$2,000.00	$6,251
5	Topsoil & Subsoil Stripping	m^3	11315	$5.00	$56,577
6	Care of Water	L.S.	1	Lump Sum	$75,000
	EXCAVATION				
7	Common Excavation	m^3	13820	$6.50	$89,831
	FILL PLACEMENT				
8	Low Permeable Fill	m^3	56263	$10.00	$562,628
9	Common Fill	m^3	9577	$6.00	$57,461
	GRANULAR AND RIPRAP MATERIALS				
10	Granular Drain Rock	tonnes	5456	$35.00	$190,966
11	Riprap Zone 6B	tonnes	14770	$130.00	$1,920,103
12	Riprap Zone 6A	tonnes	202	$110.00	$22,176
13	Gravel Armour	tonnes	9231	$40.00	$369,251
14	Non-Woven Geotextile	m^2	15385	$3.00	$46,156
	SITE CONSTRUCTION				
15	600 Dia. Perforated HDPE Pipe	m	2947	$120.00	$353,606
16	CSP Well Supply and Installation	L.S.	12	$15,000.00	$180,000
	LANDSCAPING				
17	Topsoil & Subsoil Placement	m^2	15390	$1.50	$23,084
18	Turf Reinforcement Mat	m^2	30779	$6.00	$184,674
19	Hydroseeding	m^2	30779	$3.50	$107,727
	SUBTOTAL				**$4,505,490**
	CONTINGENCIES @ 25%				**$1,126,373**
	ENGINEERING @ 12%				**$540,659**
	ESTIMATED TOTAL COST				**$6,173,000**

Source:
amec - Southern Alberta Flood Recovery Task Force
Flood Mitigation Measures for the Bow, Elbow and Oldman River Basins
Volume 4 - Flood Mitigation Measures - Final
June 2014

Appendix E – City of Calgary Flood Damage Estimates

Total Damages, Bow and Elbow Rivers, With Sewer Backup

Categories of damage		Return frequency, in years								
		2*	5*	10**	20	50	100	200	500	1,000
Residential	Direct	$0	$0	$0	$268,753,000	$414,798,000	$686,791,000	$947,786,000	$1,329,201,000	$1,496,364,000
	Indirect 15%	$0	$0	$0	$40,313,000	$62,220,000	$103,019,000	$142,168,000	$199,380,000	$224,455,000
	Total	$0	$0	$0	$309,066,000	$477,018,000	$789,810,000	$1,089,954,000	$1,528,581,000	$1,720,819,000
Commercial	Direct	$0	$0	$0	$15,210,000	$37,446,000	$111,079,000	$271,990,000	$493,824,000	$572,607,000
	Indirect 323%	$0	$0	$0	$49,128,000	$120,951,000	$358,785,000	$878,528,000	$1,595,052,000	$1,849,521,000
	Total	$0	$0	$0	$64,338,000	$158,397,000	$469,864,000	$1,150,518,000	$2,088,876,000	$2,422,128,000
Infrastructure	Direct	$0	$0	$0	$101,508,000	$170,620,000	$299,100,000	$452,626,000	$686,656,000	$780,711,000
	Indirect 20%	$0	$0	$0	$20,302,000	$34,124,000	$59,820,000	$90,525,000	$137,331,000	$156,142,000
	Total	$0	$0	$0	$121,810,000	$204,744,000	$358,920,000	$543,151,000	$823,987,000	$936,853,000
Stampede	Direct	$0	$0	$0	$10,200,000	$42,200,000	$68,900,000	$91,900,000	$166,853,000	$193,472,000
	Indirect 185%	$0	$0	$0	$18,860,000	$78,030,000	$127,400,000	$169,928,000	$308,521,000	$357,741,000
	Total	$0	$0	$0	$29,060,000	$120,230,000	$196,300,000	$261,828,000	$475,374,000	$551,213,000
Total	Direct	$0	$0	$0	$395,671,000	$665,064,000	$1,165,870,000	$1,764,302,000	$2,676,534,000	$3,043,154,000
	Indirect 73%	$0	$0	$0	$128,603,000	$295,325,000	$649,024,000	$1,281,149,000	$2,240,284,000	$2,587,859,000
	Total	$0	$0	$0	$524,274,000	$960,389,000	$1,814,894,000	$3,045,451,000	$4,916,818,000	$5,631,013,000

* No Actual damages occur at these flow levels
** Flood Flow primarily contained within the river

Total Damages, Bow River, With Sewer Backup

Categories of damage		Return frequency, in years								
		2*	5*	10**	20	50	100	200	500	1,000
Residential	Direct	$0	$0	$0	$167,738,000	$247,549,000	$387,075,000	$582,482,000	$891,235,000	$991,311,000
	Indirect 15%	$0	$0	$0	$25,161,000	$37,133,000	$58,062,000	$87,372,000	$133,685,000	$148,697,000
	Total	$0	$0	$0	$192,899,000	$284,682,000	$445,137,000	$669,854,000	$1,024,920,000	$1,140,008,000
Commercial	Direct	$0	$0	$0	$15,128,000	$36,965,000	$100,874,000	$256,774,000	$471,284,000	$539,790,000
	Indirect 323%	$0	$0	$0	$48,863,000	$119,397,000	$325,823,000	$829,380,000	$1,522,248,000	$1,743,522,000
	Total	$0	$0	$0	$63,991,000	$156,362,000	$426,697,000	$1,086,154,000	$1,993,532,000	$2,283,312,000
Infrastructure	Direct	$0	$0	$0	$63,102,000	$98,179,000	$168,379,000	$289,606,000	$470,170,000	$528,344,000
	Indirect 20%	$0	$0	$0	$12,621,000	$19,636,000	$33,676,000	$57,921,000	$94,034,000	$105,669,000
	Total	$0	$0	$0	$75,723,000	$117,815,000	$202,055,000	$347,527,000	$564,204,000	$634,013,000
Stampede	Direct	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Indirect 185%	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Total	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total	Direct	$0	$0	$0	$245,968,000	$382,693,000	$656,328,000	$1,128,862,000	$1,832,689,000	$2,059,445,000
	Indirect 84%	$0	$0	$0	$86,645,000	$176,166,000	$417,561,000	$974,673,000	$1,749,967,000	$1,997,888,000
	Total	$0	$0	$0	$332,613,000	$558,859,000	$1,073,889,000	$2,103,535,000	$3,582,656,000	$4,057,333,000

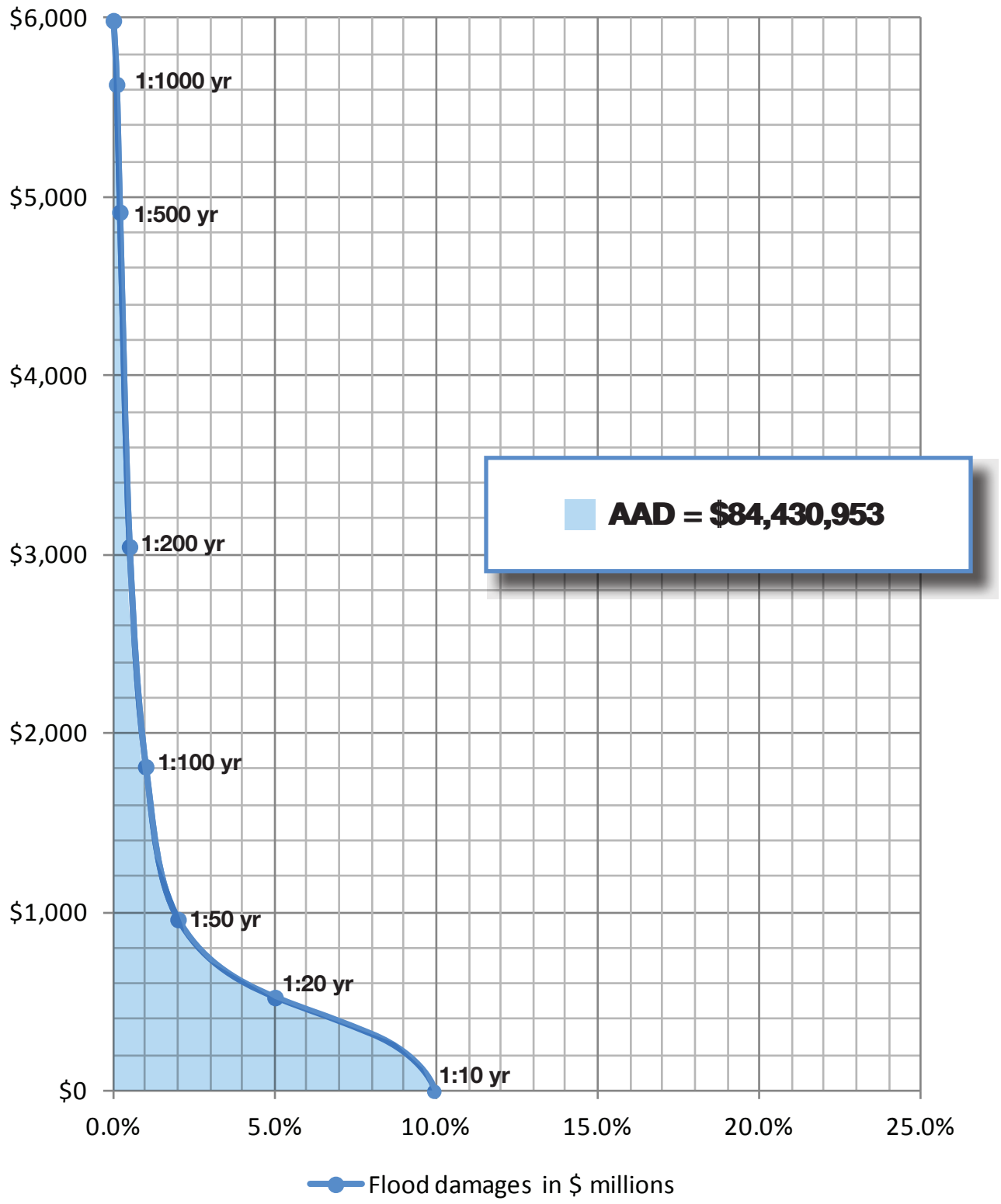
* No Actual damages occur at these flow levels
** Flood Flow primarily contained within the river

Total Damages, Elbow River, With Sewer Backup

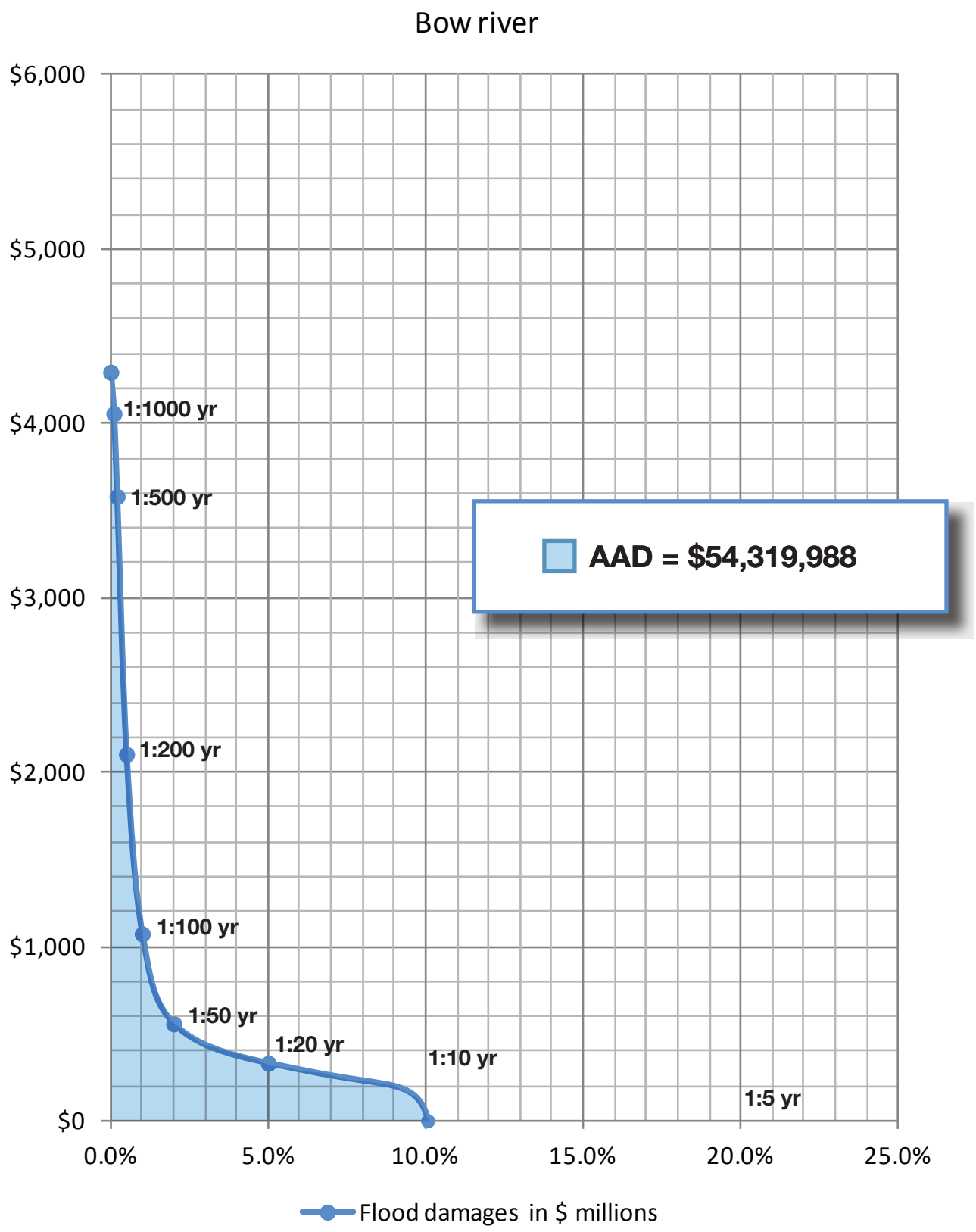
Categories of damage		Return frequency, in years								
		2*	5*	10**	20	50	100	200	500	1,000
Residential	Direct	$0	$0	$0	$101,015,000	$167,249,000	$299,716,000	$365,304,000	$437,966,000	$505,053,000
	Indirect 15%	$0	$0	$0	$15,152,000	$25,087,000	$44,957,000	$54,796,000	$65,695,000	$75,758,000
	Total	$0	$0	$0	$116,167,000	$192,336,000	$344,673,000	$420,100,000	$503,661,000	$580,811,000
Commercial	Direct	$0	$0	$0	$82,000	$481,000	$10,205,000	$15,216,000	$22,540,000	$32,817,000
	Indirect 323%	$0	$0	$0	$265,000	$1,554,000	$32,962,000	$49,148,000	$72,804,000	$105,999,000
	Total	$0	$0	$0	$347,000	$2,035,000	$43,167,000	$64,364,000	$95,344,000	$138,816,000
Infrastructure	Direct	$0	$0	$0	$38,406,000	$72,441,000	$130,721,000	$163,020,000	$216,486,000	$252,367,000
	Indirect 20%	$0	$0	$0	$7,681,000	$14,488,000	$26,144,000	$32,604,000	$43,297,000	$50,473,000
	Total	$0	$0	$0	$46,087,000	$86,929,000	$156,865,000	$195,624,000	$259,783,000	$302,840,000
Stampede	Direct	$0	$0	$0	$10,200,000	$42,200,000	$68,900,000	$91,900,000	$166,853,000	$193,472,000
	Indirect 185%	$0	$0	$0	$18,860,000	$78,030,000	$127,400,000	$169,928,000	$308,521,000	$357,741,000
	Total	$0	$0	$0	$29,060,000	$120,230,000	$196,300,000	$261,828,000	$475,374,000	$551,213,000
Total	Direct	$0	$0	$0	$149,703,000	$282,371,000	$509,542,000	$635,440,000	$843,845,000	$983,709,000
	Indirect 52%	$0	$0	$0	$41,958,000	$119,159,000	$231,463,000	$306,476,000	$490,317,000	$589,971,000
	Total	$0	$0	$0	$191,661,000	$401,530,000	$741,005,000	$941,916,000	$1,334,162,000	$1,573,680,000

* No Actual damages occur at these flow levels
** Flood Flow primarily contained within the river

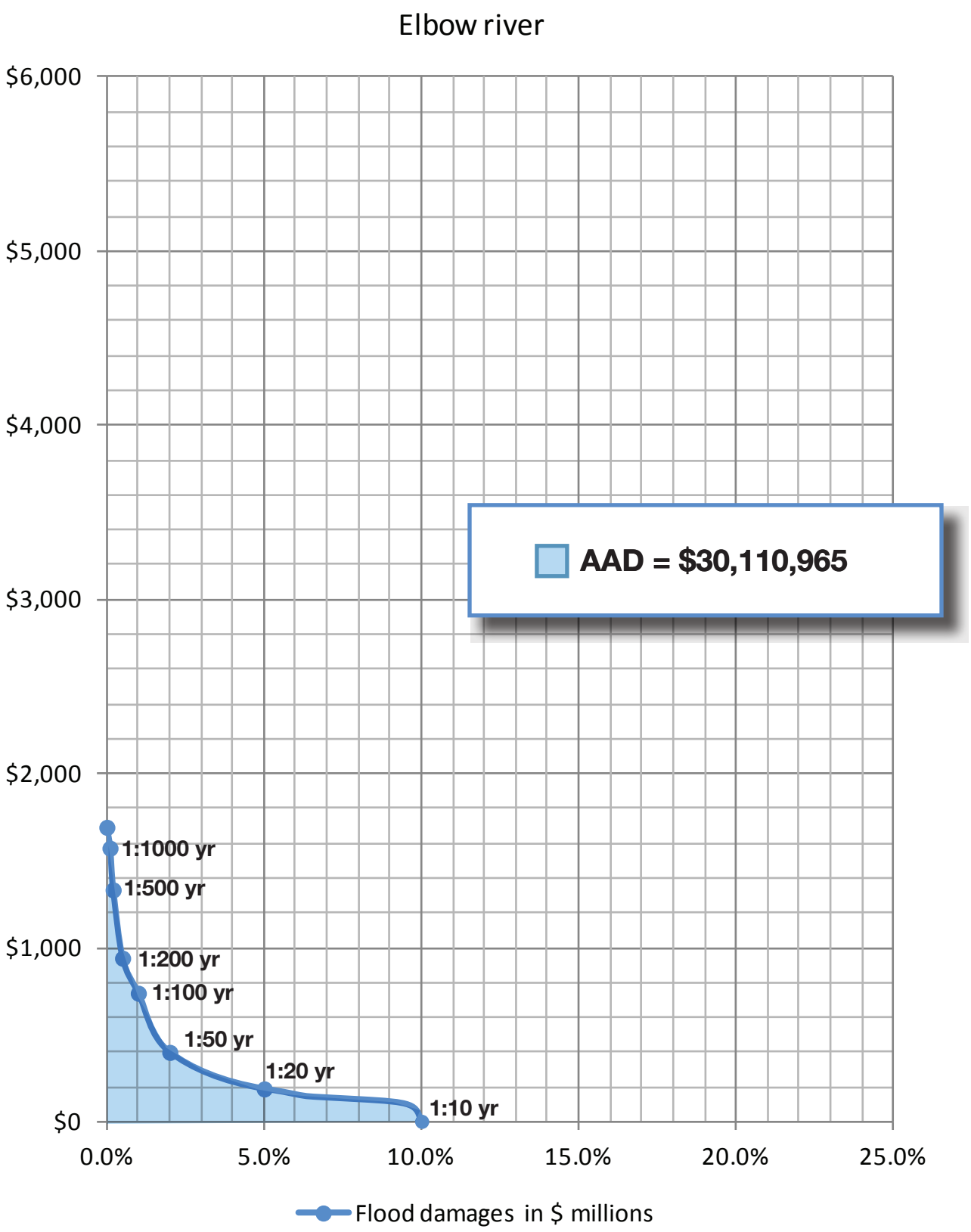
Flood Damages Probability Distribution, Bow and Elbow Rivers



Flood Damages Probability Distribution, Bow River



Flood Damages Probability Distribution, Elbow River



Alternative Damage Scenario - Total Damages, Bow and Elbow Rivers, With Sewer Backup

Categories of damage		Return frequency, in years								
		2*	5*	10**	20	50	100	200	500	1,000
Residential	Direct	$0	$0	$0	$268,753,000	$414,798,000	$686,791,000	$947,786,000	$1,329,201,000	$1,496,364,000
	Indirect 15%	$0	$0	$0	$40,313,000	$62,220,000	$103,019,000	$142,168,000	$199,380,000	$224,455,000
	Total	$0	$0	$0	$309,066,000	$477,018,000	$789,810,000	$1,089,954,000	$1,528,581,000	$1,720,819,000
Commercial	Direct	$0	$0	$0	$15,210,000	$37,446,000	$111,079,000	$271,990,000	$493,824,000	$572,607,000
	Indirect 45%	$0	$0	$0	$0	$16,851,000	$49,986,000	$122,396,000	$222,221,000	$257,673,000
	Total	$0	$0	$0	$15,210,000	$54,297,000	$161,065,000	$394,386,000	$716,045,000	$830,280,000
Infrastructure	Direct	$0	$0	$0	$21,639,000	$90,929,000	$159,400,000	$241,219,000	$365,941,000	$416,066,000
	Indirect 20%	$0	$0	$0	$4,328,000	$18,186,000	$31,880,000	$48,244,000	$73,188,000	$83,213,000
	Total	$0	$0	$0	$25,967,000	$109,115,000	$191,280,000	$289,463,000	$439,129,000	$499,279,000
Stampede	Direct	$0	$0	$0	$10,200,000	$42,200,000	$68,900,000	$91,900,000	$166,853,000	$193,472,000
	Indirect 38%	$0	$0	$0	$3,908,000	$16,170,000	$26,400,000	$35,213,000	$63,932,000	$74,132,000
	Total	$0	$0	$0	$14,108,000	$58,370,000	$95,300,000	$127,113,000	$230,785,000	$267,604,000
Total	Direct	$0	$0	$0	$315,802,000	$585,373,000	$1,026,170,000	$1,552,895,000	$2,355,819,000	$2,678,509,000
	Indirect 22%	$0	$0	$0	$48,549,000	$113,427,000	$211,285,000	$348,021,000	$558,721,000	$639,473,000
	Total	$0	$0	$0	$364,351,000	$698,800,000	$1,237,455,000	$1,900,916,000	$2,914,540,000	$3,317,982,000

* No Actual damages occur at these flow levels
** Flood Flow primarily contained within the river

Alternative Damage Scenario - Total Damages, Bow River, With Sewer Backup

Categories of damage		Return frequency, in years								
		2*	5*	10**	20	50	100	200	500	1,000
Residential	Direct	$0	$0	$0	$167,738,000	$247,549,000	$387,075,000	$582,482,000	$891,235,000	$991,311,000
	Indirect 15%	$0	$0	$0	$25,161,000	$37,133,000	$58,062,000	$87,372,000	$133,685,000	$148,697,000
	Total	$0	$0	$0	$192,899,000	$284,682,000	$445,137,000	$669,854,000	$1,024,920,000	$1,140,008,000
Commercial	Direct	$0	$0	$0	$15,128,000	$36,965,000	$100,874,000	$256,774,000	$471,284,000	$539,790,000
	Indirect 45%	$0	$0	$0	$0	$16,635,000	$45,394,000	$115,549,000	$212,078,000	$242,905,000
	Total	$0	$0	$0	$15,128,000	$53,600,000	$146,268,000	$372,323,000	$683,362,000	$782,695,000
Infrastructure	Direct	$0	$0	$0	$13,452,000	$52,323,000	$89,734,000	$154,340,000	$250,569,000	$281,571,000
	Indirect 20%	$0	$0	$0	$2,691,000	$10,465,000	$17,947,000	$30,868,000	$50,114,000	$56,314,000
	Total	$0	$0	$0	$16,143,000	$62,788,000	$107,681,000	$185,208,000	$300,683,000	$337,885,000
Stampede	Direct	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Indirect 38%	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Total	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total	Direct	$0	$0	$0	$196,318,000	$336,837,000	$577,683,000	$993,596,000	$1,613,088,000	$1,812,672,000
	Indirect 23%	$0	$0	$0	$27,852,000	$64,233,000	$121,403,000	$233,789,000	$395,877,000	$447,916,000
	Total	$0	$0	$0	$224,170,000	$401,070,000	$699,086,000	$1,227,385,000	$2,008,965,000	$2,260,588,000

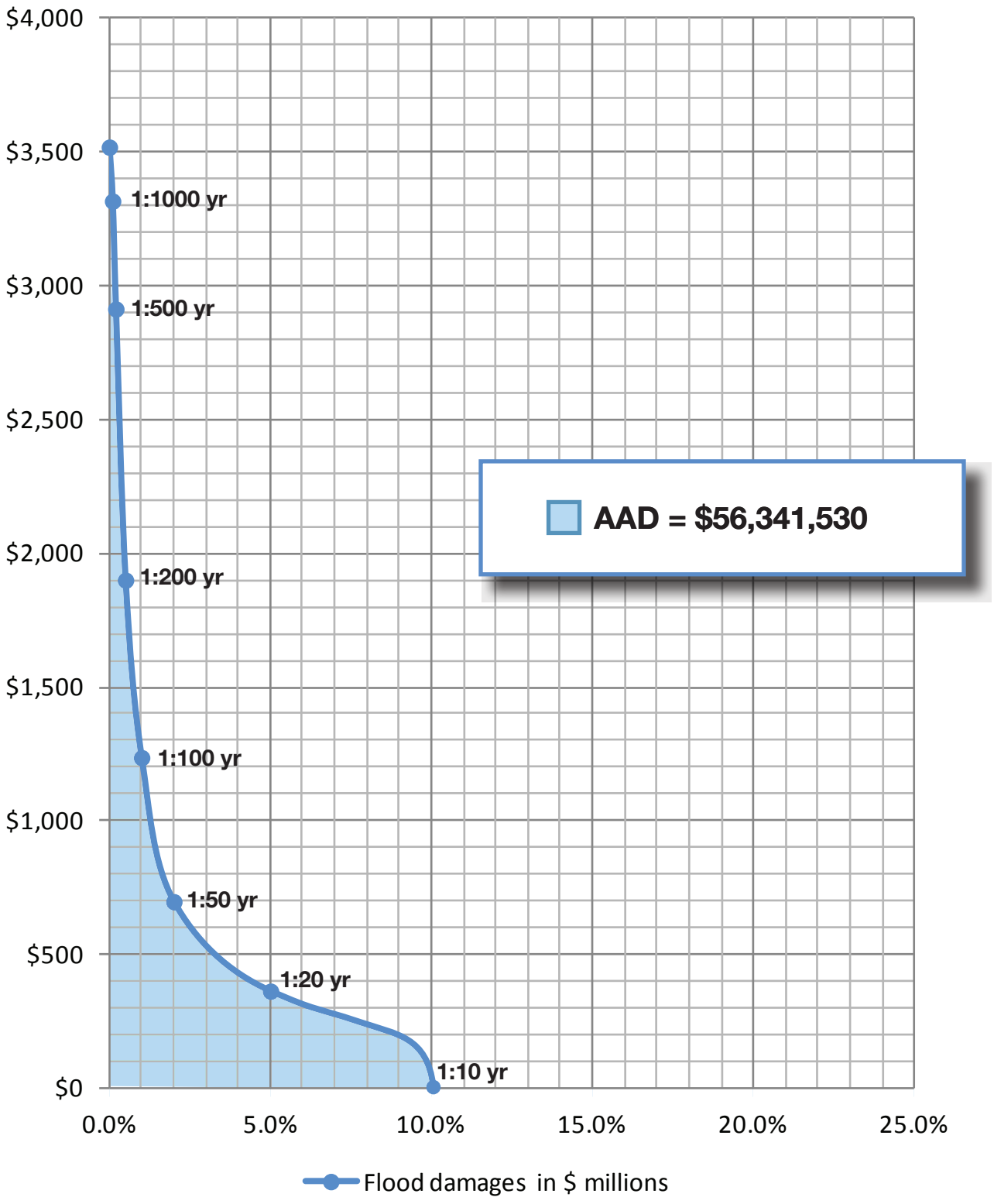
* No Actual damages occur at these flow levels
** Flood Flow primarily contained within the river

Alternative Damage Scenario - Total Damages, Elbow River, With Sewer Backup

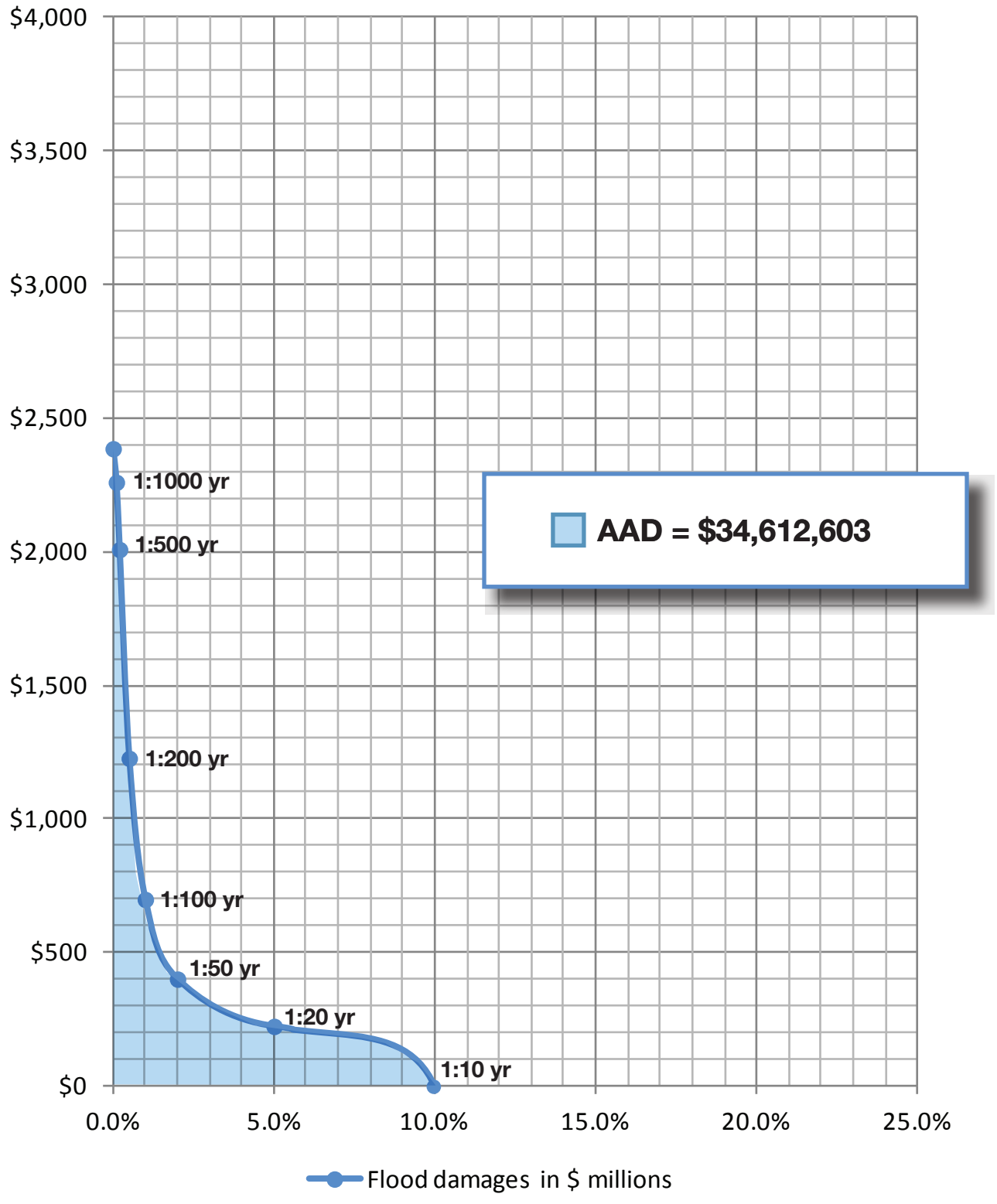
Categories of damage		Return frequency, in years								
		2*	5*	10**	20	50	100	200	500	1,000
Residential	Direct	$0	$0	$0	$101,015,000	$167,249,000	$299,716,000	$365,304,000	$437,966,000	$505,053,000
	Indirect 15%	$0	$0	$0	$15,152,000	$25,087,000	$44,957,000	$54,796,000	$65,695,000	$75,758,000
	Total	$0	$0	$0	$116,167,000	$192,336,000	$344,673,000	$420,100,000	$503,661,000	$580,811,000
Commercial	Direct	$0	$0	$0	$82,000	$481,000	$10,205,000	$15,216,000	$22,540,000	$32,817,000
	Indirect 45%	$0	$0	$0	$0	$216,000	$4,592,000	$6,847,000	$10,143,000	$14,768,000
	Total	$0	$0	$0	$82,000	$697,000	$14,797,000	$22,063,000	$32,683,000	$47,585,000
Infrastructure	Direct	$0	$0	$0	$8,187,000	$38,606,000	$69,666,000	$86,879,000	$115,372,000	$134,495,000
	Indirect 20%	$0	$0	$0	$1,637,000	$7,721,000	$13,933,000	$17,376,000	$23,074,000	$26,899,000
	Total	$0	$0	$0	$9,824,000	$46,327,000	$83,599,000	$104,255,000	$138,446,000	$161,394,000
Stampede	Direct	$0	$0	$0	$10,200,000	$42,200,000	$68,900,000	$91,900,000	$166,853,000	$193,472,000
	Indirect 38%	$0	$0	$0	$3,908,000	$16,170,000	$26,400,000	$35,213,000	$63,932,000	$74,132,000
	Total	$0	$0	$0	$14,108,000	$58,370,000	$95,300,000	$127,113,000	$230,785,000	$267,604,000
Total	Direct	$0	$0	$0	$119,484,000	$248,536,000	$448,487,000	$559,299,000	$742,731,000	$865,837,000
	Indirect 21%	$0	$0	$0	$20,697,000	$49,194,000	$89,882,000	$114,232,000	$162,844,000	$191,557,000
	Total	$0	$0	$0	$140,181,000	$297,730,000	$538,369,000	$673,531,000	$905,575,000	$1,057,394,000

* No Actual damages occur at these flow levels
** Flood Flow primarily contained within the river

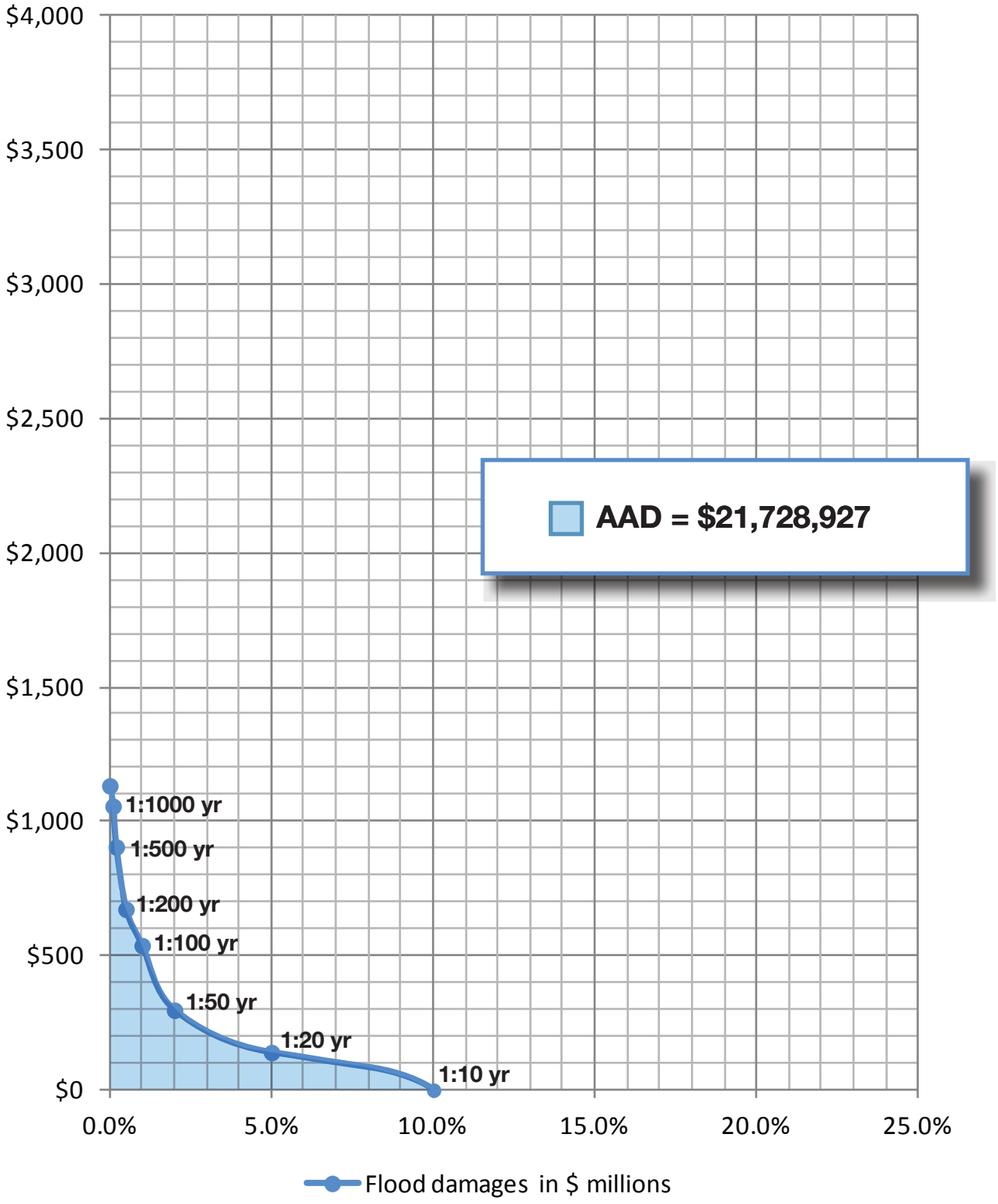
Alternative Damage Scenario - Flood Damages Probability Distribution, Bow and Elbow Rivers



Alternative Damage Scenario - Flood Damages Probability Distribution, Bow River



Alternative Damage Scenario - Flood Damages Probability Distribution, Elbow River



Appendix F – 2013 Southern Alberta Disaster Recovery Program

Rocky View County Ongoing Project Estimates

Project Number	Project Name	Status	Approved Estimate (Y/N)	Latest Estimate Date	Estimate ($)	Comments
1	Emergency Operations	Ongoing	Y	Sept. 19, 2013	450000.00	Approved inspection estimate
2	Hamlet of Bragg Creek water intake	Ongoing	Y	Sept. 19, 2013	110000.00	Approved inspection estimate
3	Hamlet of Bragg Creek road damage	Ongoing	Y	Sept. 19, 2013	20000.00	Approved inspection estimate
4	Balsam Ave Erosion	Ongoing	Y	Sept. 19, 2013	25000.00	Approved inspection estimate
5	Access to Hamlet of Bragg Creek Snowbirds Chalet	Ongoing	Y	Sept. 19, 2013	5000.00	Approved inspection estimate
6	Hamlet of Bragg Creek Community Centre	Ongoing	Y	Sept. 19, 2013	35000.00	Approved inspection estimate
7	Wood debris site	Ongoing	Y	Sept. 19, 2013	25000.00	Approved inspection estimate
8	Wintergreen road	Ongoing	Y	Sept. 19, 2013	10000.00	Approved inspection estimate
9	Slapping Tail Pond	Ongoing	Y	Sept. 19, 2013	75000.00	Approved inspection estimate
12	RR 54, S of TWP road 234	Ongoing	Y	Sept. 19, 2013	10000.00	Approved inspection estimate
14	Bracken Road gate and spillway	Ongoing	Y	Sept. 19, 2013	15000.00	Approved inspection estimate
15	Bracken Road	Ongoing	Y	Sept. 19, 2013	25000.00	Approved inspection estimate
16	Bracken Road S TWP Rd 232, Bragg Creek BF72292	Ongoing	Y	Sept. 19, 2013	29000.00	Approved inspection estimate
18	RR 41, S of Springbank Road, Gross Creek BF74057	Ongoing	Y	Sept. 19, 2013	15000.00	Approved inspection estimate
19	Springbank road W of RR 35, Springbank Creek BF9024	Ongoing	Y	Sept. 19, 2013	20770.00	Approved inspection estimate
33	Bragg Creek Municipal Park	Ongoing	Y	Sept. 19, 2013	20000.00	Approved inspection estimate
34	Springbank Park for All Seasons	Ongoing	N	Dec. 9, 2013	194000.00	Applicant initial estimate only
TOTAL BUDGET ESTIMATES FOR ROCKY VIEW COUNTY ONGOING PROJECTS					$1,083,770.00	

2013 Southern Alberta Disaster Recovery Program - Ongoing Project Estimate Tracking - As of February 4, 2014

Townsite of Redwood Meadows Ongoing Project Estimates

Project Number	Project Name	Status	Approved Estimate (Y/N)	Latest Estimate Date	Estimate ($)	Comments
1	Northern berm breach	Ongoing	Y	Sept. 10, 2013	838000.00	Approved inspection estimate
2	Sleigh Drive berm breach	Ongoing	Y	Sept. 10, 2013	75000.00	Approved inspection estimate
3	Use of existing rip rap for flood protection	Ongoing	Y	Sept. 10, 2013	465000.00	Approved inspection estimate
4	Water treatment plant	Ongoing	Y	Sept. 10, 2013	75000.00	Approved inspection estimate
5	Playground berm breach	Ongoing	Y	Sept. 10, 2013	690000.00	Approved inspection estimate
6	Berm breach, #18 Redwood Meadows Drive	Ongoing	Y	Sept. 10, 2013	444000.00	Approved inspection estimate
7	Sanitary sewer pumping station	Ongoing	Y	Sept. 10, 2013	70000.00	Approved inspection estimate
TOTAL BUDGET ESTIMATES FOR TOWNSITE OF REDWOOD MEADOWS ONGOING PROJECTS					$2,657,000.00	

Tsuu T'ina Ongoing Project Estimates

Project Number	Project Name	Status	Approved Estimate (Y/N)	Latest Estimate Date	Estimate ($)	Comments
1	Emergency Operations	Ongoing	N	Sept. 25, 2013	60384.22	Applicant initial estimate only
2	Infrastructure Damage	Ongoing	N	Sept. 25, 2013	211611.26	Applicant initial estimate only
3	Housing	Ongoing	N	Sept. 25, 2013	29914.77	Applicant initial estimate only
4	Band Works	Ongoing	Y	Nov. 11, 2013	800000.00	Approved inspection estimate
5	Redwood Meadows Golf Course	Ongoing	Y	Nov. 11, 2013	800000.00	Approved inspection estimate
TOTAL BUDGET ESTIMATES FOR TSUU T'INA FIRST NATION ONGOING PROJECTS					$1,901,910.25	

TOTAL ESTIMATE OF ONGOING PROJECTS **$5,642,680.25**