



CANYONS OUTLINE PLAN AMENDMENT (2026)

PART C-APPENDICES



Table of Contents

1. Land Titles3

2.Phase 1 Environmental Site Assessment36

3.Geotechnical Evaluation111

4.Historical Resources Impact Assessment199

5.Riverbend Habitat Compensation Strategy253

6.Stormwater Pond Report259

7.Overland Drainage Analysis.....317

8.Traffic Impact Assessment375

9.Wetland Evaluation and Wetland Loss Compensation418

10.Open House448

1. Land Titles



LAND TITLE CERTIFICATE

S
LINC SHORT LEGAL TITLE NUMBER
0030 853 980 0414514;1;1 091 032 214

LEGAL DESCRIPTION
PLAN 0414514
BLOCK 1
LOT 1
EXCEPTING THEREOUT ALL MINES AND MINERALS
AREA: 2.53 HECTARES (6.25 ACRES) MORE OR LESS

ESTATE: FEE SIMPLE
ATS REFERENCE: 4;22;8;13;NW

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 041 479 985

REGISTERED OWNER(S)
REGISTRATION DATE(DMY) DOCUMENT TYPE VALUE CONSIDERATION

091 032 214 03/02/2009 TRANSFER OF LAND \$200,000 SEE INSTRUMENT

OWNERS

STEVE DENECKY
OF 84030 RR 211
LETHBRIDGE COUNTY
ALBERTA T1J 5P9
AS TO AN UNDIVIDED 4/9 INTEREST

NICK DENECKY
OF 4005 - 10 STREET WEST
LETHBRIDGE
ALBERTA T1J 4S8
AS TO AN UNDIVIDED 4/9 INTEREST

MARY WESTRUP
OF 651 DUNDAS CRESCENT
CORNWALL
ONTARIO K6H 6L1
AS TO AN UNDIVIDED 1/9 INTEREST

(DATA UPDATED BY: CHANGE OF ADDRESS 191217198)

(DATA UPDATED BY: CHANGE OF ADDRESS 201175804)

ENCUMBRANCES, LIENS & INTERESTS

PAGE 2

091 032 214

REGISTRATION

NUMBER DATE (D/M/Y) PARTICULARS

252LM . 12/04/1972 UTILITY RIGHT OF WAY
GRANTEE - ALTALINK MANAGEMENT LTD.
2611 - 3 AVE SE
CALGARY
ALBERTA T2A7W7
AS TO PORTION OR PLAN:876LK
(DATA UPDATED BY: TRANSFER OF UTILITY RIGHT
OF WAY 021165386)
(DATA UPDATED BY: CHANGE OF ADDRESS 091111938)

751 005 292 21/01/1975 UTILITY RIGHT OF WAY
GRANTEE - CANADIAN WESTERN NATURAL GAS COMPANY
LIMITED.
"PORTION DESCRIBED"

871 226 112 08/12/1987 CAVEAT
RE : AMENDING AGREEMENT
CAVEATOR - ALTALINK MANAGEMENT LTD.
2611 - 3 AVE SE
CALGARY
ALBERTA T2A7W7
(DATA UPDATED BY: TRANSFER OF CAVEAT
021164252)
(DATA UPDATED BY: CHANGE OF ADDRESS 081423216)

041 479 987 20/12/2004 UTILITY RIGHT OF WAY
GRANTEE - THE CITY OF LETHBRIDGE.
AS TO PORTION OR PLAN:0414515

TOTAL INSTRUMENTS: 004

THE REGISTRAR OF TITLES CERTIFIES THIS TO BE AN
ACCURATE REPRODUCTION OF THE CERTIFICATE OF
TITLE REPRESENTED HEREIN THIS 9 DAY OF MARCH,
2026 AT 02:24 P.M.

ORDER NUMBER: 56502834

CUSTOMER FILE NUMBER: P&D-KF



END OF CERTIFICATE

(CONTINUED)

THIS ELECTRONICALLY TRANSMITTED LAND TITLES PRODUCT IS INTENDED FOR THE SOLE USE OF THE ORIGINAL PURCHASER, AND NONE OTHER, SUBJECT TO WHAT IS SET OUT IN THE PARAGRAPH BELOW.

THE ABOVE PROVISIONS DO NOT PROHIBIT THE ORIGINAL PURCHASER FROM INCLUDING THIS UNMODIFIED PRODUCT IN ANY REPORT, OPINION, APPRAISAL OR OTHER ADVICE PREPARED BY THE ORIGINAL PURCHASER AS PART OF THE ORIGINAL PURCHASER APPLYING PROFESSIONAL, CONSULTING OR TECHNICAL EXPERTISE FOR THE BENEFIT OF CLIENT(S) .



LAND TITLE CERTIFICATE

S
LINC SHORT LEGAL TITLE NUMBER
0035 249 143 4;22;8;13;NW 151 048 077

LEGAL DESCRIPTION

MERIDIAN 4 RANGE 22 TOWNSHIP 8
SECTION 13
THE SOUTH HALF OF THE NORTH WEST QUARTER
CONTAINING 32.4 HECTARES (80 ACRES) MORE OR LESS
EXCEPTING THEREOUT:

PLAN	NUMBER	HECTARES (MORE OR LESS)	ACRES
SUBDIVISION	8710224	0.396	0.98
ROAD	0513632	1.546	3.82
SUBDIVISION	0713908	0.434	1.07
SUBDIVISION	1211652	5.628	13.91

EXCEPTING THEREOUT ALL MINES AND MINERALS

ESTATE: FEE SIMPLE

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 121 143 682 +2

REGISTERED OWNER(S)				
REGISTRATION	DATE (DMY)	DOCUMENT TYPE	VALUE	CONSIDERATION
151 048 077	17/02/2015	TRANSFER OF LAND	\$2,520,420	SEE INSTRUMENT

OWNERS

MELCOR DEVELOPMENTS LTD.
OF #900, 10310 JASPER AVENUE, EDMONTON
ALBERTA T5J 1Y8

ENCUMBRANCES, LIENS & INTERESTS

REGISTRATION		
NUMBER	DATE (D/M/Y)	PARTICULARS
252LM	12/04/1972	UTILITY RIGHT OF WAY GRANTEE - ALTALINK MANAGEMENT LTD. 2611 - 3 AVE SE

(CONTINUED)

ENCUMBRANCES, LIENS & INTERESTS

PAGE 2

151 048 077

REGISTRATION

NUMBER DATE (D/M/Y) PARTICULARS

CALGARY

ALBERTA T2A7W7

AS TO PORTION OR PLAN:876LK

(DATA UPDATED BY: TRANSFER OF UTILITY RIGHT
OF WAY 021165386)

(DATA UPDATED BY: CHANGE OF ADDRESS 091111938)

871 226 111 08/12/1987 CAVEAT

RE : AMENDING AGREEMENT

CAVEATOR - ALTALINK MANAGEMENT LTD.

2611 - 3 AVE SE

CALGARY

ALBERTA T2A7W7

(DATA UPDATED BY: TRANSFER OF CAVEAT
021164252)

(DATA UPDATED BY: CHANGE OF ADDRESS 081423216)

071 395 739 08/08/2007 CAVEAT

RE : DEFERRED RESERVE

CAVEATOR - THE CITY OF LETHBRIDGE.

910 - 4TH AVE. SOUTH, LETHBRIDGE

ALBERTA

AGENT - P. GEORGE KUHL.

111 179 312 15/07/2011 CAVEAT

RE : AMENDING AGREEMENT

CAVEATOR - CANADIAN IMPERIAL BANK OF COMMERCE.

COMMERCIAL SALES & SERVICE CENTRE

595 BAY ST SUITE 500

TORONTO

ONTARIO M5G2C2

AGENT - WAYNE R WHITLOCK

TOTAL INSTRUMENTS: 004

THE REGISTRAR OF TITLES CERTIFIES THIS TO BE AN
ACCURATE REPRODUCTION OF THE CERTIFICATE OF
TITLE REPRESENTED HEREIN THIS 9 DAY OF MARCH,
2026 AT 02:24 P.M.

ORDER NUMBER: 56502834

CUSTOMER FILE NUMBER: P&D-KF



END OF CERTIFICATE

(CONTINUED)

THIS ELECTRONICALLY TRANSMITTED LAND TITLES PRODUCT IS INTENDED FOR THE SOLE USE OF THE ORIGINAL PURCHASER, AND NONE OTHER, SUBJECT TO WHAT IS SET OUT IN THE PARAGRAPH BELOW.

THE ABOVE PROVISIONS DO NOT PROHIBIT THE ORIGINAL PURCHASER FROM INCLUDING THIS UNMODIFIED PRODUCT IN ANY REPORT, OPINION, APPRAISAL OR OTHER ADVICE PREPARED BY THE ORIGINAL PURCHASER AS PART OF THE ORIGINAL PURCHASER APPLYING PROFESSIONAL, CONSULTING OR TECHNICAL EXPERTISE FOR THE BENEFIT OF CLIENT(S) .



LAND TITLE CERTIFICATE

S
LINC SHORT LEGAL TITLE NUMBER
0035 249 143 4;22;8;13;NW 151 048 077

LEGAL DESCRIPTION

MERIDIAN 4 RANGE 22 TOWNSHIP 8
SECTION 13
THE SOUTH HALF OF THE NORTH WEST QUARTER
CONTAINING 32.4 HECTARES (80 ACRES) MORE OR LESS
EXCEPTING THEREOUT:

PLAN	NUMBER	HECTARES (MORE OR LESS)	ACRES
SUBDIVISION	8710224	0.396	0.98
ROAD	0513632	1.546	3.82
SUBDIVISION	0713908	0.434	1.07
SUBDIVISION	1211652	5.628	13.91

EXCEPTING THEREOUT ALL MINES AND MINERALS

ESTATE: FEE SIMPLE

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 121 143 682 +2

REGISTERED OWNER(S)				
REGISTRATION	DATE (DMY)	DOCUMENT TYPE	VALUE	CONSIDERATION
151 048 077	17/02/2015	TRANSFER OF LAND	\$2,520,420	SEE INSTRUMENT

OWNERS

MELCOR DEVELOPMENTS LTD.
OF #900, 10310 JASPER AVENUE, EDMONTON
ALBERTA T5J 1Y8

ENCUMBRANCES, LIENS & INTERESTS

REGISTRATION		
NUMBER	DATE (D/M/Y)	PARTICULARS
252LM	12/04/1972	UTILITY RIGHT OF WAY GRANTEE - ALTALINK MANAGEMENT LTD. 2611 - 3 AVE SE

(CONTINUED)

ENCUMBRANCES, LIENS & INTERESTS

PAGE 2

151 048 077

REGISTRATION

NUMBER DATE (D/M/Y) PARTICULARS

CALGARY

ALBERTA T2A7W7

AS TO PORTION OR PLAN:876LK

(DATA UPDATED BY: TRANSFER OF UTILITY RIGHT
OF WAY 021165386)

(DATA UPDATED BY: CHANGE OF ADDRESS 091111938)

871 226 111 08/12/1987 CAVEAT

RE : AMENDING AGREEMENT

CAVEATOR - ALTALINK MANAGEMENT LTD.

2611 - 3 AVE SE

CALGARY

ALBERTA T2A7W7

(DATA UPDATED BY: TRANSFER OF CAVEAT
021164252)

(DATA UPDATED BY: CHANGE OF ADDRESS 081423216)

071 395 739 08/08/2007 CAVEAT

RE : DEFERRED RESERVE

CAVEATOR - THE CITY OF LETHBRIDGE.

910 - 4TH AVE. SOUTH, LETHBRIDGE

ALBERTA

AGENT - P. GEORGE KUHL.

111 179 312 15/07/2011 CAVEAT

RE : AMENDING AGREEMENT

CAVEATOR - CANADIAN IMPERIAL BANK OF COMMERCE.

COMMERCIAL SALES & SERVICE CENTRE

595 BAY ST SUITE 500

TORONTO

ONTARIO M5G2C2

AGENT - WAYNE R WHITLOCK

TOTAL INSTRUMENTS: 004

THE REGISTRAR OF TITLES CERTIFIES THIS TO BE AN
ACCURATE REPRODUCTION OF THE CERTIFICATE OF
TITLE REPRESENTED HEREIN THIS 9 DAY OF MARCH,
2026 AT 02:24 P.M.

ORDER NUMBER: 56502834

CUSTOMER FILE NUMBER: P&D-KF



END OF CERTIFICATE

(CONTINUED)

THIS ELECTRONICALLY TRANSMITTED LAND TITLES PRODUCT IS INTENDED FOR THE SOLE USE OF THE ORIGINAL PURCHASER, AND NONE OTHER, SUBJECT TO WHAT IS SET OUT IN THE PARAGRAPH BELOW.

THE ABOVE PROVISIONS DO NOT PROHIBIT THE ORIGINAL PURCHASER FROM INCLUDING THIS UNMODIFIED PRODUCT IN ANY REPORT, OPINION, APPRAISAL OR OTHER ADVICE PREPARED BY THE ORIGINAL PURCHASER AS PART OF THE ORIGINAL PURCHASER APPLYING PROFESSIONAL, CONSULTING OR TECHNICAL EXPERTISE FOR THE BENEFIT OF CLIENT(S) .



LAND TITLE CERTIFICATE

S
LINC SHORT LEGAL TITLE NUMBER
0037 886 777 4;22;8;14;NE 181 052 918

LEGAL DESCRIPTION

MERIDIAN 4 RANGE 22 TOWNSHIP 8
SECTION 14
QUARTER NORTH EAST
CONTAINING 64.7 HECTARES (160 ACRES) MORE OR LESS
EXCEPTING THEREOUT:

PLAN	NUMBER	HECTARES	(ACRES) MORE OR LESS
SUBDIVISION	0514137	1.555	3.84
SUBDIVISION	0514150	14.040	34.69
SUBDIVISION	0514162	7.583	18.74
SUBDIVISION	0811402	0.103	0.25
SUBDIVISION	0812285	5.545	13.70
SUBDIVISION	0911396	0.280	0.69
ROAD	1010289	1.57	3.88
SUBDIVISION	1010942	4.13	10.21
SUBDIVISION	1012954	4.912	12.1
ROAD	1013789	4.569	11.3
SUBDIVISION	1112039	3.048	7.53
SUBDIVISION	1810565	4.880	12.06
ROAD	1810568	0.827	2.04

EXCEPTING THEREOUT ALL MINES AND MINERALS

ESTATE: FEE SIMPLE

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 181 052 305 +3

REGISTERED OWNER(S)
REGISTRATION DATE(DMY) DOCUMENT TYPE VALUE CONSIDERATION

181 052 918 08/03/2018 ROAD PLAN

OWNERS

THE CITY OF LETHBRIDGE.
OF LETHBRIDGE
ALBERTA

ENCUMBRANCES, LIENS & INTERESTS

PAGE 2

181 052 918

REGISTRATION

NUMBER	DATE (D/M/Y)	PARTICULARS
--------	--------------	-------------

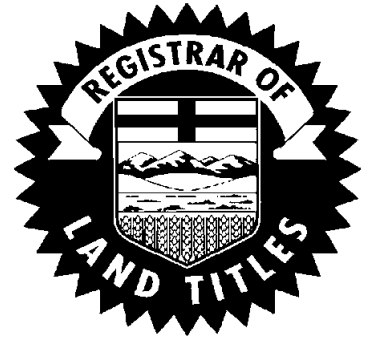
NO REGISTRATIONS

TOTAL INSTRUMENTS: 000

THE REGISTRAR OF TITLES CERTIFIES THIS TO BE AN
ACCURATE REPRODUCTION OF THE CERTIFICATE OF
TITLE REPRESENTED HEREIN THIS 9 DAY OF MARCH,
2026 AT 02:24 P.M.

ORDER NUMBER: 56502834

CUSTOMER FILE NUMBER: P&D-KF



END OF CERTIFICATE

THIS ELECTRONICALLY TRANSMITTED LAND TITLES PRODUCT IS INTENDED
FOR THE SOLE USE OF THE ORIGINAL PURCHASER, AND NONE OTHER,
SUBJECT TO WHAT IS SET OUT IN THE PARAGRAPH BELOW.

THE ABOVE PROVISIONS DO NOT PROHIBIT THE ORIGINAL PURCHASER FROM
INCLUDING THIS UNMODIFIED PRODUCT IN ANY REPORT, OPINION,
APPRAISAL OR OTHER ADVICE PREPARED BY THE ORIGINAL PURCHASER AS
PART OF THE ORIGINAL PURCHASER APPLYING PROFESSIONAL, CONSULTING
OR TECHNICAL EXPERTISE FOR THE BENEFIT OF CLIENT(S).



LAND TITLE CERTIFICATE

S
LINC SHORT LEGAL TITLE NUMBER
0021 626 247 4;22;8;13;SW 181 074 851

LEGAL DESCRIPTION

MERIDIAN 4 RANGE 22 TOWNSHIP 8
SECTION 13
QUARTER SOUTH WEST
CONTAINING 64.7 HECTARES (160 ACRES) MORE OR LESS
EXCEPTING THEREOUT:

PLAN	NUMBER	HECTARES (MORE OR LESS)	ACRES
SUBDIVISION	8710224	47.356	117.02
SUBDIVISION	8711732	0.129	0.319

EXCEPTING THEREOUT ALL MINES AND MINERALS

ESTATE: FEE SIMPLE

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 091 013 989

REGISTERED OWNER(S)				
REGISTRATION	DATE (DMY)	DOCUMENT TYPE	VALUE	CONSIDERATION
181 074 851	13/04/2018	TRANSFER OF LAND	\$2,135,200	\$2,204,000

OWNERS

MELCOR DEVELOPMENTS LTD.
OF #900, 10310 JASPER AVENUE, EDMONTON
ALBERTA T5J 1Y8

ENCUMBRANCES, LIENS & INTERESTS

REGISTRATION		
NUMBER	DATE (D/M/Y)	PARTICULARS
252LM	12/04/1972	UTILITY RIGHT OF WAY GRANTEE - ALTALINK MANAGEMENT LTD. 2611 - 3 AVE SE CALGARY ALBERTA T2A7W7

(CONTINUED)

ENCUMBRANCES, LIENS & INTERESTS

PAGE 2

181 074 851

REGISTRATION

NUMBER DATE (D/M/Y) PARTICULARS

AS TO PORTION OR PLAN:876LK

(DATA UPDATED BY: TRANSFER OF UTILITY RIGHT
OF WAY 021165386)

(DATA UPDATED BY: CHANGE OF ADDRESS 091111938)

871 226 113 08/12/1987 CAVEAT

RE : AMENDING AGREEMENT

CAVEATOR - ALTALINK MANAGEMENT LTD.

2611 - 3 AVE SE

CALGARY

ALBERTA T2A7W7

(DATA UPDATED BY: TRANSFER OF CAVEAT
021164252)

(DATA UPDATED BY: CHANGE OF ADDRESS 081423216)

131 249 306 01/10/2013 CAVEAT

RE : AMENDING AGREEMENT

CAVEATOR - CANADIAN IMPERIAL BANK OF COMMERCE.

C/O COMMERCIAL SALES AND SERVICES CENTRE

595 BAY STREET, SUITE 500

TORONTO

ONTARIO M5G2C2

AGENT - WAYNE R WHITLOCK

TOTAL INSTRUMENTS: 003

THE REGISTRAR OF TITLES CERTIFIES THIS TO BE AN
ACCURATE REPRODUCTION OF THE CERTIFICATE OF
TITLE REPRESENTED HEREIN THIS 9 DAY OF MARCH,
2026 AT 02:24 P.M.

ORDER NUMBER: 56502834

CUSTOMER FILE NUMBER: P&D-KF



END OF CERTIFICATE

THIS ELECTRONICALLY TRANSMITTED LAND TITLES PRODUCT IS INTENDED
FOR THE SOLE USE OF THE ORIGINAL PURCHASER, AND NONE OTHER,
SUBJECT TO WHAT IS SET OUT IN THE PARAGRAPH BELOW.

THE ABOVE PROVISIONS DO NOT PROHIBIT THE ORIGINAL PURCHASER FROM
INCLUDING THIS UNMODIFIED PRODUCT IN ANY REPORT, OPINION,
APPRAISAL OR OTHER ADVICE PREPARED BY THE ORIGINAL PURCHASER AS
PART OF THE ORIGINAL PURCHASER APPLYING PROFESSIONAL, CONSULTING
OR TECHNICAL EXPERTISE FOR THE BENEFIT OF CLIENT(S).



LAND TITLE CERTIFICATE

S

LINC

SHORT LEGAL

TITLE NUMBER

0039 081 229

2210128;1;1

221 272 176

LEGAL DESCRIPTION

PLAN 2210128

BLOCK 1

LOT 1

EXCEPTING THEREOUT ALL MINES AND MINERALS

AREA: 0.734 HECTARES (1.81 ACRES) MORE OR LESS

ESTATE: FEE SIMPLE

ATS REFERENCE: 4;22;8;14;SE

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 221 026 653

REGISTRATION	DATE (DMY)	DOCUMENT TYPE	VALUE	CONSIDERATION
221 272 176	02/12/2022	TRANSFER OF LAND	\$40,000	\$48,769

OWNERS

JOAN OLESKY
OF 138 RIDGEBROOK RD
SHERWOOD PARK
ALBERTA T8A 6M1

ENCUMBRANCES, LIENS & INTERESTS

REGISTRATION NUMBER	DATE (D/M/Y)	PARTICULARS
761 016 900	12/02/1976	UTILITY RIGHT OF WAY GRANTEE - CANADIAN WESTERN NATURAL GAS COMPANY LIMITED.
761 049 092	23/04/1976	UTILITY RIGHT OF WAY GRANTEE - CANADIAN WESTERN NATURAL GAS COMPANY LIMITED.

761 083 127 30/06/1976 UTILITY RIGHT OF WAY

(CONTINUED)

ENCUMBRANCES, LIENS & INTERESTS

PAGE 2

221 272 176

REGISTRATION

NUMBER DATE (D/M/Y) PARTICULARS

GRANTEE - CANADIAN WESTERN NATURAL GAS COMPANY
LIMITED.

TOTAL INSTRUMENTS: 003

PENDING REGISTRATION QUEUE

DRR NUMBER	RECEIVED DATE (D/M/Y)	SUBMITTER	LAND ID
H000JY9	16/01/2026	DUNCAN CRAIG LLP 780-441-4304 CUSTOMER FILE NUMBER: 414-221406 (TP)	
002		TRANSMISSION OF LAND	2210128;1;1

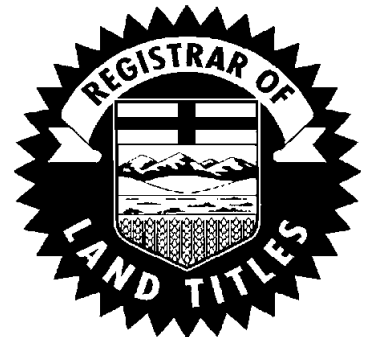
TOTAL PENDING REGISTRATIONS: 001

DISCLAIMER: THE DOCUMENT INFORMATION REFLECTED IN THE PENDING
REGISTRATION QUEUE HAS NOT BEEN VERIFIED BY LAND TITLES AND MAY BE
SUBJECT TO CHANGE UPON REVIEW AND REGISTRATION.

THE REGISTRAR OF TITLES CERTIFIES THIS TO BE AN
ACCURATE REPRODUCTION OF THE CERTIFICATE OF
TITLE REPRESENTED HEREIN THIS 9 DAY OF MARCH,
2026 AT 02:24 P.M.

ORDER NUMBER: 56502834

CUSTOMER FILE NUMBER: P&D-KF



END OF CERTIFICATE

THIS ELECTRONICALLY TRANSMITTED LAND TITLES PRODUCT IS INTENDED
FOR THE SOLE USE OF THE ORIGINAL PURCHASER, AND NONE OTHER,
SUBJECT TO WHAT IS SET OUT IN THE PARAGRAPH BELOW.

THE ABOVE PROVISIONS DO NOT PROHIBIT THE ORIGINAL PURCHASER FROM
INCLUDING THIS UNMODIFIED PRODUCT IN ANY REPORT, OPINION,
APPRAISAL OR OTHER ADVICE PREPARED BY THE ORIGINAL PURCHASER AS
PART OF THE ORIGINAL PURCHASER APPLYING PROFESSIONAL, CONSULTING
OR TECHNICAL EXPERTISE FOR THE BENEFIT OF CLIENT(S).



LAND TITLE CERTIFICATE

S
LINC SHORT LEGAL TITLE NUMBER
0035 377 241 1211652;100;1 121 244 360 +2

LEGAL DESCRIPTION

PLAN 1211652
BLOCK 100
LOT 1
CONTAINING 7.4270 HECTARES (18.35 ACRES) MORE OR LESS
EXCEPTING THEREOUT:

PLAN	NUMBER	HECTARES	(ACRES)	MORE OR LESS
ROAD	1212689	3.350	8.275	
ROAD	1212707	0.884	2.196	

EXCEPTING THEREOUT ALL MINES AND MINERALS

ATS REFERENCE: 4;22;8;13;NW
ESTATE: FEE SIMPLE

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 121 243 653

REGISTERED OWNER(S)
REGISTRATION DATE (DMY) DOCUMENT TYPE VALUE CONSIDERATION

121 244 360 19/09/2012 ROAD PLAN

OWNERS

MELCOR DEVELOPMENTS LTD.
OF #900, 10310 JASPER AVENUE, EDMONTON
ALBERTA T5J 1Y8

ENCUMBRANCES, LIENS & INTERESTS
REGISTRATION
NUMBER DATE (D/M/Y) PARTICULARS

051 056 912 15/02/2005 CAVEAT
RE : DEFERRED RESERVE
CAVEATOR - THE CITY OF LETHBRIDGE.
CITY HALL, 910-4TH AVENUE SOUTH, LETHBRIDGE

(CONTINUED)

ENCUMBRANCES, LIENS & INTERESTS

PAGE 2

121 244 360 +2

REGISTRATION

NUMBER DATE (D/M/Y) PARTICULARS

ALBERTA T1J0P6
AGENT - P GEORGE KUHL
" AFFECTS PART OF THIS TITLE "

061 335 222 17/08/2006 CAVEAT
RE : MORTGAGE
CAVEATOR - CANADIAN IMPERIAL BANK OF COMMERCE.
ATTEN: SECURITY ANALYST
COMMERICAL SALES & SERVICE CENTRE
SUITE 500,595 BAY STREET
TORONTO
ONTARIO M5G2C2
AGENT - WAYNE WHITLOCK
" AFFECTS PART OF THIS TITLE "

071 147 896 27/03/2007 CAVEAT
RE : AGREEMENT CHARGING LAND
CAVEATOR - CANADIAN IMPERIAL BANK OF COMMERCE.
ATTEN: SECURITY ANALYST
COMMERCIAL SALES & SERVICE CENTRE
595 BAY STREET,SUITE 500
TORONTO
ONTARIO M5G2C2
AGENT - TERRY M LIVERMORE
" AFFECTS PART OF THIS TITLE "

071 395 739 08/08/2007 CAVEAT
RE : DEFERRED RESERVE
CAVEATOR - THE CITY OF LETHBRIDGE.
910 - 4TH AVE. SOUTH, LETHBRIDGE
ALBERTA
AGENT - P. GEORGE KUHL.
" AFFECTS PART OF THIS TITLE "

071 551 524 08/11/2007 CAVEAT
RE : AMENDING AGREEMENT
CAVEATOR - CANADIAN IMPERIAL BANK OF COMMERCE.
595 BAY ST,SUITE 500
TORONTO
ONTARIO M5G2C2
AGENT - WAYNE R WHITLOCK
" AFFECTS PART OF THIS TITLE "

101 053 163 23/02/2010 CAVEAT
RE : PURCHASERS INTEREST
CAVEATOR - MELCOR DEVELOPMENTS LTD.
#900, 10310 JASPER AVENUE, EDMONTON
ALBERTA T5J1Y8
AGENT - VICTOR L LIRETTE

(CONTINUED)

ENCUMBRANCES, LIENS & INTERESTS

PAGE 3

REGISTRATION

121 244 360 +2

NUMBER DATE (D/M/Y) PARTICULARS

" AFFECTS PART OF THIS TITLE "

111 179 312 15/07/2011 CAVEAT
RE : AMENDING AGREEMENT
CAVEATOR - CANADIAN IMPERIAL BANK OF COMMERCE.
COMMERCIAL SALES & SERVICE CENTRE
595 BAY ST SUITE 500
TORONTO
ONTARIO M5G2C2
AGENT - WAYNE R WHITLOCK
" AFFECTS PART OF THIS TITLE "

TOTAL INSTRUMENTS: 007

THE REGISTRAR OF TITLES CERTIFIES THIS TO BE AN
ACCURATE REPRODUCTION OF THE CERTIFICATE OF
TITLE REPRESENTED HEREIN THIS 9 DAY OF MARCH,
2026 AT 02:24 P.M.

ORDER NUMBER: 56502834

CUSTOMER FILE NUMBER: P&D-KF



END OF CERTIFICATE

THIS ELECTRONICALLY TRANSMITTED LAND TITLES PRODUCT IS INTENDED
FOR THE SOLE USE OF THE ORIGINAL PURCHASER, AND NONE OTHER,
SUBJECT TO WHAT IS SET OUT IN THE PARAGRAPH BELOW.

THE ABOVE PROVISIONS DO NOT PROHIBIT THE ORIGINAL PURCHASER FROM
INCLUDING THIS UNMODIFIED PRODUCT IN ANY REPORT, OPINION,
APPRAISAL OR OTHER ADVICE PREPARED BY THE ORIGINAL PURCHASER AS
PART OF THE ORIGINAL PURCHASER APPLYING PROFESSIONAL, CONSULTING
OR TECHNICAL EXPERTISE FOR THE BENEFIT OF CLIENT(S) .



LAND TITLE CERTIFICATE

S		
LINC	SHORT LEGAL	TITLE NUMBER
0035 202 506	1211145;1;16	131 059 107 +1

LEGAL DESCRIPTION

DESCRIPTIVE PLAN 1211145
BLOCK 1
LOT 16
EXCEPTING THEREOUT ALL MINES AND MINERALS
AREA: 0.622 HECTARES (1.54 ACRES) MORE OR LESS

ATS REFERENCE: 4;22;8;24;SW
ESTATE: FEE SIMPLE

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 121 100 267

REGISTERED OWNER(S)					
REGISTRATION	DATE (DMY)	DOCUMENT	TYPE	VALUE	CONSIDERATION
131 059 107	12/03/2013	TRANSFER OF LAND			SEE INSTRUMENT

OWNERS

MELCOR DEVELOPMENTS LTD.
OF #900, 10310 JASPER AVENUE, EDMONTON
ALBERTA T5J 1Y8

ENCUMBRANCES, LIENS & INTERESTS

REGISTRATION	DATE (D/M/Y)	PARTICULARS
251LM	12/04/1972	UTILITY RIGHT OF WAY GRANTEE - ALTALINK MANAGEMENT LTD. 2611 - 3 AVE SE CALGARY ALBERTA T2A7W7 AS TO PORTION OR PLAN: 876LK (DATA UPDATED BY: TRANSFER OF UTILITY RIGHT OF WAY 021165386)

(CONTINUED)

ENCUMBRANCES, LIENS & INTERESTS

PAGE 2

131 059 107 +1

REGISTRATION

NUMBER DATE (D/M/Y) PARTICULARS

(DATA UPDATED BY: CHANGE OF ADDRESS 091111938)

141 276 841 14/10/2014 CAVEAT

RE : AMENDING AGREEMENT

CAVEATOR - CANADIAN IMPERIAL BANK OF COMMERCE.

COMMERCIAL SALES AND SERVICE CENTRE

595 BAY ST, SUITE 500

TORONTO

ONTARIO M5G2C2

AGENT - WAYNE R WHITLOCK.

TOTAL INSTRUMENTS: 002

THE REGISTRAR OF TITLES CERTIFIES THIS TO BE AN
ACCURATE REPRODUCTION OF THE CERTIFICATE OF
TITLE REPRESENTED HEREIN THIS 9 DAY OF MARCH,
2026 AT 02:24 P.M.

ORDER NUMBER: 56502834

CUSTOMER FILE NUMBER: P&D-KF



END OF CERTIFICATE

THIS ELECTRONICALLY TRANSMITTED LAND TITLES PRODUCT IS INTENDED
FOR THE SOLE USE OF THE ORIGINAL PURCHASER, AND NONE OTHER,
SUBJECT TO WHAT IS SET OUT IN THE PARAGRAPH BELOW.

THE ABOVE PROVISIONS DO NOT PROHIBIT THE ORIGINAL PURCHASER FROM
INCLUDING THIS UNMODIFIED PRODUCT IN ANY REPORT, OPINION,
APPRAISAL OR OTHER ADVICE PREPARED BY THE ORIGINAL PURCHASER AS
PART OF THE ORIGINAL PURCHASER APPLYING PROFESSIONAL, CONSULTING
OR TECHNICAL EXPERTISE FOR THE BENEFIT OF CLIENT(S).



LAND TITLE CERTIFICATE

S

LINC SHORT LEGAL
0037 027 109 0210062;1;14

TITLE NUMBER
161 011 219 +37

LEGAL DESCRIPTION

PLAN 0210062
BLOCK 1
LOT 14
CONTAINING 17.6350 HECTARES (43.58 ACRES) MORE OR LESS
EXCEPTING THEREOUT:

PLAN	NUMBER	HECTARES (ACRES)	MORE OR LESS
SUBDIVISION	1610143	5.146	12.72

EXCEPTING THEREOUT ALL MINES AND MINERALS

ATS REFERENCE: 4;22;8;24;SE

ESTATE: FEE SIMPLE

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 051 451 794 +1

REGISTRATION	DATE (DMY)	DOCUMENT TYPE	VALUE	CONSIDERATION
--------------	------------	---------------	-------	---------------

161 011 219 13/01/2016 SUBDIVISION PLAN

OWNERS

MELCOR DEVELOPMENTS LTD.
OF #900, 10310 JASPER AVENUE, EDMONTON
ALBERTA T5J 1Y8

ENCUMBRANCES, LIENS & INTERESTS

REGISTRATION	NUMBER	DATE (D/M/Y)	PARTICULARS
--------------	--------	--------------	-------------

251LM	.	12/04/1972	UTILITY RIGHT OF WAY GRANTEE - ALTALINK MANAGEMENT LTD. 2611 - 3 AVE SE CALGARY ALBERTA T2A7W7
-------	---	------------	--

(CONTINUED)

ENCUMBRANCES, LIENS & INTERESTS

PAGE 2

161 011 219 +37

REGISTRATION

NUMBER DATE (D/M/Y) PARTICULARS

AS TO PORTION OR PLAN:876LK
(DATA UPDATED BY: TRANSFER OF UTILITY RIGHT
OF WAY 021165386)
(DATA UPDATED BY: CHANGE OF ADDRESS 091111938)

811 149 951 07/08/1981 UTILITY RIGHT OF WAY
GRANTEE - THE CITY OF LETHBRIDGE.
910 - 4TH AVE. SOUTH, LETHBRIDGE
ALBERTA
(DATA UPDATED BY: TRANSFER OF UTILITY RIGHT
OF WAY 001309776)

911 236 678 21/10/1991 UTILITY RIGHT OF WAY
GRANTEE - THE CITY OF LETHBRIDGE.
AS TO PORTION OR PLAN:9112076

021 011 909 11/01/2002 CAVEAT
RE : DEFERRED RESERVE
CAVEATOR - THE CITY OF LETHBRIDGE.
910 - 4TH AVE. SOUTH, LETHBRIDGE
ALBERTA

031 241 964 21/07/2003 MORTGAGE
MORTGAGEE - CANADIAN IMPERIAL BANK OF COMMERCE.
COMMERCIAL SALES AND SERVICE CENTRE
595 BAY ST, SUITE 500
TORONTO
ONTARIO M5G2C2
ORIGINAL PRINCIPAL AMOUNT: \$5,000,000

031 241 965 21/07/2003 CAVEAT
RE : ASSIGNMENT OF MORTGAGE
CAVEATOR - CANADIAN IMPERIAL BANK OF COMMERCE.
COMMERCIAL SALES AND SERVICE CENTRE
595 BAY ST, SUITE 500
TORONTO
ONTARIO M5G2C2
AGENT - WAYNE R WHITLOCK

051 436 434 18/11/2005 UTILITY RIGHT OF WAY
GRANTEE - LETHBRIDGE NORTHERN IRRIGATION DISTRICT.
334-13TH STREET NORTH, LETHBRIDGE
ALBERTA T1H2R8
SEE INSTRUMENT FOR PLAN NUMBERS

071 147 895 27/03/2007 MORTGAGE
MORTGAGEE - CANADIAN IMPERIAL BANK OF COMMERCE.
COMMERCIAL SALES AND SERVICE CENTRE
595 BAY ST, SUITE 500
TORONTO

(CONTINUED)

REGISTRATION

NUMBER	DATE (D/M/Y)	PARTICULARS
--------	--------------	-------------

ONTARIO M5G2C2

ORIGINAL PRINCIPAL AMOUNT: \$125,000,000

071 233 860	14/05/2007	UTILITY RIGHT OF WAY GRANTEE - THE CITY OF LETHBRIDGE. 910 - 4TH AVE. SOUTH, LETHBRIDGE ALBERTA AS TO PORTION OR PLAN:0712570 AS TO AREA 'A'.
071 551 524	08/11/2007	CAVEAT RE : AMENDING AGREEMENT CAVEATOR - CANADIAN IMPERIAL BANK OF COMMERCE. 595 BAY ST,SUITE 500 TORONTO ONTARIO M5G2C2 AGENT - WAYNE R WHITLOCK
161 011 228	13/01/2016	UTILITY RIGHT OF WAY GRANTEE - THE CITY OF LETHBRIDGE. AS TO PORTION OR PLAN:1610144 ACCESS R/W AREAS 'A' & 'B'

TOTAL INSTRUMENTS: 011

THE REGISTRAR OF TITLES CERTIFIES THIS TO BE AN
ACCURATE REPRODUCTION OF THE CERTIFICATE OF
TITLE REPRESENTED HEREIN THIS 9 DAY OF MARCH,
2026 AT 02:24 P.M.

ORDER NUMBER: 56502834

CUSTOMER FILE NUMBER: P&D-KF



END OF CERTIFICATE

THIS ELECTRONICALLY TRANSMITTED LAND TITLES PRODUCT IS INTENDED
FOR THE SOLE USE OF THE ORIGINAL PURCHASER, AND NONE OTHER,
SUBJECT TO WHAT IS SET OUT IN THE PARAGRAPH BELOW.

THE ABOVE PROVISIONS DO NOT PROHIBIT THE ORIGINAL PURCHASER FROM
INCLUDING THIS UNMODIFIED PRODUCT IN ANY REPORT, OPINION,
APPRAISAL OR OTHER ADVICE PREPARED BY THE ORIGINAL PURCHASER AS
PART OF THE ORIGINAL PURCHASER APPLYING PROFESSIONAL, CONSULTING
OR TECHNICAL EXPERTISE FOR THE BENEFIT OF CLIENT(S).



LAND TITLE CERTIFICATE

S
LINC SHORT LEGAL TITLE NUMBER
0037 905 891 1113731;1;15 181 064 895 +2

LEGAL DESCRIPTION

DESCRIPTIVE PLAN 1113731
BLOCK 1
LOT 15

EXCEPTING THEREOUT;

PLAN	NUMBER	HECTARES	ACRES	MORE OR LESS
SUBDIVISION	1610143	0.819	2.02	
SUBDIVISION	1810690	0.085	0.21	

EXCEPTING THEREOUT ALL MINES AND MINERALS

ATS REFERENCE: 4;22;8;24;SE

ESTATE: FEE SIMPLE

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 161 011 219 +38

REGISTERED OWNER(S)
REGISTRATION DATE (DMY) DOCUMENT TYPE VALUE CONSIDERATION

181 064 895 26/03/2018 SUBDIVISION PLAN

OWNERS

MELCOR DEVELOPMENTS LTD.
OF #900, 10310 JASPER AVENUE, EDMONTON
ALBERTA T5J 1Y8

ENCUMBRANCES, LIENS & INTERESTS

REGISTRATION
NUMBER DATE (D/M/Y) PARTICULARS

251LM . 12/04/1972 UTILITY RIGHT OF WAY
GRANTEE - ALTALINK MANAGEMENT LTD.
2611 - 3 AVE SE
CALGARY
ALBERTA T2A7W7

(CONTINUED)

ENCUMBRANCES, LIENS & INTERESTS

PAGE 2

REGISTRATION

181 064 895 +2

NUMBER DATE (D/M/Y) PARTICULARS

AS TO PORTION OR PLAN:876LK

(DATA UPDATED BY: TRANSFER OF UTILITY RIGHT
OF WAY 021165386)

(DATA UPDATED BY: CHANGE OF ADDRESS 091111938)

051 367 038 30/09/2005 UTILITY RIGHT OF WAY
GRANTEE - LETHBRIDGE NORTHERN IRRIGATION DISTRICT.
334-13TH STREET NORTH, LETHBRIDGE
ALBERTA T1H2R8
SEE INSTRUMENT FOR PLAN NUMBERS

141 276 841 14/10/2014 CAVEAT
RE : AMENDING AGREEMENT
CAVEATOR - CANADIAN IMPERIAL BANK OF COMMERCE.
COMMERCIAL SALES AND SERVICE CENTRE
595 BAY ST, SUITE 500
TORONTO
ONTARIO M5G2C2
AGENT - WAYNE R WHITLOCK.

161 011 222 13/01/2016 CAVEAT
RE : DEFERRED RESERVE
CAVEATOR - THE CITY OF LETHBRIDGE.
910 - 4TH AVE. SOUTH, LETHBRIDGE
ALBERTA
AGENT - MAUREEN GAEHRING.

161 011 226 13/01/2016 UTILITY RIGHT OF WAY
GRANTEE - THE CITY OF LETHBRIDGE.
AS TO PORTION OR PLAN:1610144

161 011 227 13/01/2016 UTILITY RIGHT OF WAY
GRANTEE - THE CITY OF LETHBRIDGE.
AS TO PORTION OR PLAN:1610144
ACCESS R/W AREA 'C'

TOTAL INSTRUMENTS: 006

(CONTINUED)

THE REGISTRAR OF TITLES CERTIFIES THIS TO BE AN
ACCURATE REPRODUCTION OF THE CERTIFICATE OF
TITLE REPRESENTED HEREIN THIS 9 DAY OF MARCH,
2026 AT 02:24 P.M.

ORDER NUMBER: 56502834

CUSTOMER FILE NUMBER: P&D-KF



END OF CERTIFICATE

THIS ELECTRONICALLY TRANSMITTED LAND TITLES PRODUCT IS INTENDED
FOR THE SOLE USE OF THE ORIGINAL PURCHASER, AND NONE OTHER,
SUBJECT TO WHAT IS SET OUT IN THE PARAGRAPH BELOW.

THE ABOVE PROVISIONS DO NOT PROHIBIT THE ORIGINAL PURCHASER FROM
INCLUDING THIS UNMODIFIED PRODUCT IN ANY REPORT, OPINION,
APPRAISAL OR OTHER ADVICE PREPARED BY THE ORIGINAL PURCHASER AS
PART OF THE ORIGINAL PURCHASER APPLYING PROFESSIONAL, CONSULTING
OR TECHNICAL EXPERTISE FOR THE BENEFIT OF CLIENT(S).



LAND TITLE CERTIFICATE

S

LINC SHORT LEGAL
0038 316 063 4;22;8;13;NW

TITLE NUMBER
191 081 676 +28

LEGAL DESCRIPTION

MERIDIAN 4 RANGE 22 TOWNSHIP 8
SECTION 13

THE NORTH HALF OF THE NORTH WEST QUARTER AS SHOWN ON
THE TOWNSHIP PLAN APPROVED AT OTTAWA 15 JUNE 1915
CONTAINING 32.48 HECTARES (80.20 ACRES) MORE OR LESS
EXCEPTING THEREOUT:

PLAN	NUMBER	HECTARES	ACRES	MORE OR LESS
SUBDIVISION	0414514	19.844	49.036	
ROAD	0513632	0.093	0.230	
SUBDIVISION	1211652	1.799	4.444	
ROAD	1212707	0.390	0.963	
SUBDIVISION	1910888	0.030	0.07	

EXCEPTING THEREOUT ALL MINES AND MINERALS

ESTATE: FEE SIMPLE

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 121 244 360 +1

REGISTERED OWNER(S)					
REGISTRATION	DATE (DMY)	DOCUMENT	TYPE	VALUE	CONSIDERATION

191 081 676	30/04/2019	SUBDIVISION PLAN			

OWNERS

MELCOR DEVELOPMENTS LTD.
OF #900, 10310 JASPER AVENUE, EDMONTON
ALBERTA T5J 1Y8

ENCUMBRANCES, LIENS & INTERESTS			
REGISTRATION	NUMBER	DATE (D/M/Y)	PARTICULARS

252LM	.	12/04/1972	UTILITY RIGHT OF WAY

(CONTINUED)

ENCUMBRANCES, LIENS & INTERESTS

PAGE 2

191 081 676 +28

REGISTRATION

NUMBER DATE (D/M/Y) PARTICULARS

GRANTEE - ALTALINK MANAGEMENT LTD.
2611 - 3 AVE SE
CALGARY
ALBERTA T2A7W7
AS TO PORTION OR PLAN:876LK
(DATA UPDATED BY: TRANSFER OF UTILITY RIGHT
OF WAY 021165386)
(DATA UPDATED BY: CHANGE OF ADDRESS 091111938)

751 005 292 21/01/1975 UTILITY RIGHT OF WAY
GRANTEE - CANADIAN WESTERN NATURAL GAS COMPANY
LIMITED.
"PORTION DESCRIBED"

871 226 112 08/12/1987 CAVEAT
RE : AMENDING AGREEMENT
CAVEATOR - ALTALINK MANAGEMENT LTD.
2611 - 3 AVE SE
CALGARY
ALBERTA T2A7W7
(DATA UPDATED BY: TRANSFER OF CAVEAT
021164252)
(DATA UPDATED BY: CHANGE OF ADDRESS 081423216)

051 056 912 15/02/2005 CAVEAT
RE : DEFERRED RESERVE
CAVEATOR - THE CITY OF LETHBRIDGE.
CITY HALL, 910-4TH AVENUE SOUTH, LETHBRIDGE
ALBERTA T1J0P6
AGENT - P GEORGE KUHL

061 335 222 17/08/2006 CAVEAT
RE : MORTGAGE
CAVEATOR - CANADIAN IMPERIAL BANK OF COMMERCE.
ATTEN: SECURITY ANALYST
COMMERICAL SALES & SERVICE CENTRE
SUITE 500,595 BAY STREET
TORONTO
ONTARIO M5G2C2
AGENT - WAYNE WHITLOCK

071 147 896 27/03/2007 CAVEAT
RE : AGREEMENT CHARGING LAND
CAVEATOR - CANADIAN IMPERIAL BANK OF COMMERCE.
ATTEN: SECURITY ANALYST
COMMERCIAL SALES & SERVICE CENTRE
595 BAY STREET,SUITE 500
TORONTO
ONTARIO M5G2C2

(CONTINUED)

ENCUMBRANCES, LIENS & INTERESTS

PAGE 3

REGISTRATION

191 081 676 +28

NUMBER DATE (D/M/Y) PARTICULARS

AGENT - TERRY M LIVERMORE

071 551 524 08/11/2007 CAVEAT

RE : AMENDING AGREEMENT

CAVEATOR - CANADIAN IMPERIAL BANK OF COMMERCE.

595 BAY ST,SUITE 500

TORONTO

ONTARIO M5G2C2

AGENT - WAYNE R WHITLOCK

121 244 362 19/09/2012 EASEMENT

AS TO PORTION OR PLAN:1212708

AS TO AREAS A AND B

TOTAL INSTRUMENTS: 008

THE REGISTRAR OF TITLES CERTIFIES THIS TO BE AN
ACCURATE REPRODUCTION OF THE CERTIFICATE OF
TITLE REPRESENTED HEREIN THIS 9 DAY OF MARCH,
2026 AT 02:24 P.M.

ORDER NUMBER: 56502834

CUSTOMER FILE NUMBER: P&D-KF



END OF CERTIFICATE

THIS ELECTRONICALLY TRANSMITTED LAND TITLES PRODUCT IS INTENDED
FOR THE SOLE USE OF THE ORIGINAL PURCHASER, AND NONE OTHER,
SUBJECT TO WHAT IS SET OUT IN THE PARAGRAPH BELOW.

THE ABOVE PROVISIONS DO NOT PROHIBIT THE ORIGINAL PURCHASER FROM
INCLUDING THIS UNMODIFIED PRODUCT IN ANY REPORT, OPINION,
APPRAISAL OR OTHER ADVICE PREPARED BY THE ORIGINAL PURCHASER AS
PART OF THE ORIGINAL PURCHASER APPLYING PROFESSIONAL, CONSULTING
OR TECHNICAL EXPERTISE FOR THE BENEFIT OF CLIENT(S).



LAND TITLE CERTIFICATE

S

LINC SHORT LEGAL
0038 316 071 4;22;8;13;NE

TITLE NUMBER
191 081 676 +29

LEGAL DESCRIPTION

MERIDIAN 4 RANGE 22 TOWNSHIP 8
SECTION 13
THAT PORTION OF THE NORTH EAST QUARTER
WHICH LIES TO THE NORTH WEST OF THE
BELLY RIVER
CONTAINING 64.3 HECTARES (159 ACRES) MORE OR LESS
EXCEPTING THEREOUT:

PLAN	NUMBER	HECTARES	ACRES
SUBDIVISION	8710224	18.962	46.86
ROAD	9210126	0.840	2.08
SUBDIVISION	9211466	3.039	7.51
SUBDIVISION	0012470	0.170	0.42
SUBDIVISION	1011902	3.968	9.81
SUBDIVISION	1014809	6.703	16.56
SUBDIVISION	1112750	3.381	8.35
ROAD	1212707	1.263	3.12
SUBDIVISION	1312773	4.847	11.98
SUBDIVISION	1910888	2.705	6.68

EXCEPTING THEREOUT ALL MINES AND MINERALS

ESTATE: FEE SIMPLE

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 131 271 284 +37

REGISTERED OWNER(S)
REGISTRATION DATE (DMY) DOCUMENT TYPE VALUE CONSIDERATION

191 081 676 30/04/2019 SUBDIVISION PLAN

OWNERS

MELCOR DEVELOPMENTS LTD.
OF #900, 10310 JASPER AVENUE, EDMONTON
ALBERTA T5J 1Y8

(CONTINUED)

ENCUMBRANCES, LIENS & INTERESTS

PAGE 2

191 081 676 +29

REGISTRATION

NUMBER	DATE (D/M/Y)	PARTICULARS
741 091 031	27/09/1974	IRRIGATION ORDER/NOTICE THIS PROPERTY IS INCLUDED IN THE LETHBRIDGE NORTHERN IRRIGATION DISTRICT
751 005 292	21/01/1975	UTILITY RIGHT OF WAY GRANTEE - CANADIAN WESTERN NATURAL GAS COMPANY LIMITED. "N 20 FEET OF N1/2 OF 13"
061 335 222	17/08/2006	CAVEAT RE : MORTGAGE CAVEATOR - CANADIAN IMPERIAL BANK OF COMMERCE. ATTEN: SECURITY ANALYST COMMERICAL SALES & SERVICE CENTRE SUITE 500,595 BAY STREET TORONTO ONTARIO M5G2C2 AGENT - WAYNE WHITLOCK
071 147 895	27/03/2007	MORTGAGE MORTGAGEE - CANADIAN IMPERIAL BANK OF COMMERCE. COMMERCIAL SALES AND SERVICE CENTRE 595 BAY ST, SUITE 500 TORONTO ONTARIO M5G2C2 ORIGINAL PRINCIPAL AMOUNT: \$125,000,000
071 551 524	08/11/2007	CAVEAT RE : AMENDING AGREEMENT CAVEATOR - CANADIAN IMPERIAL BANK OF COMMERCE. 595 BAY ST,SUITE 500 TORONTO ONTARIO M5G2C2 AGENT - WAYNE R WHITLOCK "ENDORSED BY 071574318 ON 20071123"
101 363 844	15/12/2010	UTILITY RIGHT OF WAY GRANTEE - THE CITY OF LETHBRIDGE. AS TO PORTION OR PLAN:1014810
111 235 141	14/09/2011	CAVEAT RE : DEFERRED RESERVE CAVEATOR - THE CITY OF LETHBRIDGE. CITY HALL 910 4 AVENUE SOUTH LETHBRIDGE ALBERTA AGENT - MAUREEN GAEHRING.
121 244 362	19/09/2012	EASEMENT

(CONTINUED)

ENCUMBRANCES, LIENS & INTERESTS

PAGE 3

191 081 676 +29

REGISTRATION

NUMBER DATE (D/M/Y) PARTICULARS

AS TO PORTION OR PLAN:1212708

AS TO AREAS A AND B

191 081 679 30/04/2019 UTILITY RIGHT OF WAY
GRANTEE - THE CITY OF LETHBRIDGE.
AS TO PORTION OR PLAN:1910889

191 081 680 30/04/2019 UTILITY RIGHT OF WAY
GRANTEE - THE CITY OF LETHBRIDGE.
AS TO PORTION OR PLAN:1910889
ACCESS R/W AREA(S): "A", "B", "C"

TOTAL INSTRUMENTS: 010

THE REGISTRAR OF TITLES CERTIFIES THIS TO BE AN
ACCURATE REPRODUCTION OF THE CERTIFICATE OF
TITLE REPRESENTED HEREIN THIS 9 DAY OF MARCH,
2026 AT 02:24 P.M.

ORDER NUMBER: 56502834

CUSTOMER FILE NUMBER: P&D-KF



END OF CERTIFICATE

THIS ELECTRONICALLY TRANSMITTED LAND TITLES PRODUCT IS INTENDED
FOR THE SOLE USE OF THE ORIGINAL PURCHASER, AND NONE OTHER,
SUBJECT TO WHAT IS SET OUT IN THE PARAGRAPH BELOW.

THE ABOVE PROVISIONS DO NOT PROHIBIT THE ORIGINAL PURCHASER FROM
INCLUDING THIS UNMODIFIED PRODUCT IN ANY REPORT, OPINION,
APPRAISAL OR OTHER ADVICE PREPARED BY THE ORIGINAL PURCHASER AS
PART OF THE ORIGINAL PURCHASER APPLYING PROFESSIONAL, CONSULTING
OR TECHNICAL EXPERTISE FOR THE BENEFIT OF CLIENT(S).

2. Phase 1 Environmental Site Assessment

Melcor Developments Ltd.

PHASE I ENVIRONMENTAL SITE ASSESSMENT

4005 - 10 STREET WEST

4040 - 10 STREET WEST

4805 - 10 STREET WEST

5050 - 10 STREET WEST

5255 - 10 STREET WEST

500 - 40 AVENUE WEST

505 - 40 AVENUE WEST

509 - 40 AVENUE WEST

650 - 40 AVENUE WEST

4 CANYON BOULEVARD WEST

LETHBRIDGE, ALBERTA

L22101051

June 2007

EXECUTIVE SUMMARY**Foreword**

UMA Engineering Ltd. (UMA) on behalf of Melcor Development Ltd. (Melcor) retained EBA Engineering Consultants Ltd. (EBA) to conduct a Phase I Environmental Site Assessment (ESA) of ten properties located in Lethbridge, Alberta. The municipal addresses of these properties include: 4005 – 10 Street West, 4040 – 10 Street West, 4805 – 10 Street West, 5050 – 10 Street West, 5255 – 10 Street West, 500 – 40 Avenue West, 505 – 40 Avenue West, 509 – 40 Avenue West, 650 – 40 Avenue West, 4 Canyon Boulevard West, herein referred to as the subject site.

The objective of the Phase I ESA was to comment on whether any past or present land use, either off site or on site, may have a potential to cause environmental impairment of the subject site. Three previous ESA's were conducted on portions of the site including:

- Phase I ESA, 4 Canyon Boulevard West, 1045 Canyon Boulevard West, 509 – 40 Avenue West and 4005 – 10 Street West, EBA File No. 0404-4400130, July 2002.
- Phase I ESA, 500 – 40 Avenue West, Lethbridge, Alberta, EBA File No. 0404-4400844, May 2005.
- Phase I ESA, 4805 – 10 Street West, Lethbridge, Alberta, EBA File No. 4400976, September 2005.

Phase I ESA information for these properties are consolidated into this report.

EBA understands that the properties are owned by various owners including Denecky Brother Grains Ltd., Melcor Developments Ltd., the City of Lethbridge and various private owners. It is further understood that Melcor requires this environmental assessment for the Riverbend Subdivision application process.

The Phase I ESA was conducted in general accordance with the Canadian Standards Association (CSA) Phase I ESA standard Z768-01 (April 2003 revision).

Findings and Conclusions

There were four on-site sources identified that might have potential to cause environmental impairment to the subject site through historical or current land use.

POTENTIAL ON-SITE SOURCE SUMMARY			
No.	Potential On-site Source	Information Source	EBA Evaluation
1	4805 – 10 Street West, abandoned wellhead.	AbaData, Environmental Law Centre and the EUB records.	Potential impacts to soil and groundwater quality at Section 11-13-008-22 W4M due to petroleum hydrocarbon drilling activities.
2	650 – 40 Avenue West, several AST's.	Site visit.	Potential impacts to soil quality in the area of the AST's due to the storage and/ or handling of petroleum hydrocarbon products in

POTENTIAL ON-SITE SOURCE SUMMARY			
No.	Potential On-site Source	Information Source	EBA Evaluation
			that area. Should the stripping of the site reveal any large stained areas, it is recommended that laboratory analysis be conducted to characterize the soils.
3	650 – 40 Avenue West, several AST's.	Site visit.	Potential impacts to soil quality in the area of the leaking transformer. Should the stripping of the site reveal any large stained areas, it is recommended that laboratory analysis be conducted to characterize the soils.
4	500 – 40 Avenue West, storage of various equipment and machinery.	Site visit.	Potential impacts to the soils within the abandoned farmyard due to the storage of various abandoned equipment and machinery. Should the stripping of the site reveal any large stained areas, it is recommended that laboratory analysis be conducted to characterize the soils.

No off-site source were identified that might have a potential to cause environmental impairment to the subject site due to historical and/or current land use.

The approximate age of the buildings located at 500 – 40 Avenue West could not be determined, however, based on the aerial photo review, they are understood to be more than fifty-years old. The aerial photo review also revealed that the residence located at 650 – 40 Avenue West is approximately thirty-years old. Given the age of these buildings, potentially hazardous material such as ACBM's, PCB's, lead based paints and piping, and UFFI's may be present. Should the buildings be demolished or extensively renovated, confirmation of these materials should be conducted. If detected, the removal and disposal of these materials should be completed in accordance with provincial and federal regulations.

There are four AST's and various other chemicals present at various locations within the farmyard located at 650 – 40 Avenue West as well as various machinery stored at 500 – 40 Avenue West. Evidence of surficial staining was noted throughout these farmyards. Given that these properties may be included in the development of Riverbend subdivision, any surficial impairment within these areas would likely be removed during the site preparation process. Should the site preparation reveal any large stained areas, it is recommended that laboratory analysis be conducted to characterize the soils.



An abandoned cistern is located within the farmyard located at 500 – 40 Avenue West. Should the contents of the cistern contain any substance(s) other than water, laboratory analysis should be completed.

Numerous appliances including refrigerators were identified within the abandoned farmyard located at 500 – 40 Avenue West. It is recommended that the refrigerators be checked for Freon. Should they contain Freon, then this material should be disposed of according to the current regulations.

Through the air photo review it was determined that ephemeral wetlands may have been present on Section 14-13-008-22 W4M and Section 15-13-008-W4M. The wetlands were visible in aerial photographs from 1950, 1970 and 1980. Where future development would infill or drain a wetland, an approval under the Water Act is required.

There is an abandoned gas well that was drilled in 1977 at 4805-10 Street West. This well was drilled, abandoned and reclamation certificate issued in 1977. Additionally there are records of drill stem tests conducted during drilling. It is unknown if there is a drilling sump and what types of additives to the drilling mud were used. It is also not known if there was a drilling flare or other potential sources of contamination on the site. Typical lease dimensions are 100 m by 100 m. It is recommended that additional records from the EUB library be collected and information from the drilling records be compared to the current Alberta Environment drilling waste guidelines/calculations; as well as research other potential sources of impact. Further, it is recommended that additional assessment be conducted to determine if there is a subsurface impact due to the drilling of the gas well.

When developing around the abandoned wellhead, which was likely cut and capped below the surface, there are setback requirements that are set out by the EUB. These setback guidelines should be followed.

TABLE OF CONTENTS

	PAGE
2.3.9 Hydraulic Elevators and Hoists	11
2.3.10 Underground Storage Tanks (UST's) and Vent Pipes	11
2.3.11 Above Ground Storage Tanks (AST's).....	11
2.3.12 General Housekeeping	11
3.0 GEOLOGICAL INFORMATION	11
3.1 Topography.....	11
3.2 Geology	12
3.3 Hydrology and Hydrogeology.....	12
4.0 OFF-SITE OBSERVATIONS	13
5.0 PERSONNEL INTERVIEWS.....	13
6.0 RECORDS REVIEW	13
6.1 Land Title Records.....	13
6.2 Aerial Photographs	17
6.3 Regulatory Inquiries	18
6.3.1 Petroleum Tank Management Association of Alberta (PTMAA).....	18
6.3.2 Alberta Infrastructure and Transportation (AIT).....	18
6.3.3 Abacus Datagraphics (AbaData).....	18
6.3.4 Environmental Law Centre.....	19
6.3.5 Alberta Environment (AENV)	19
6.3.6 Alberta Government Services	20
6.3.7 The Alberta Energy and Utilities Board (EUB)	20
6.3.8 City of Lethbridge.....	20
6.4 Business Directories	20
6.5 Fire Insurance Maps	20
6.6 Other Information Sources.....	20
7.0 DISCUSSION.....	20
7.1 General.....	20
7.2 Potential for Impairment from On-Site Sources.....	21
7.3 Potential for Impairment from Off-Site Sources.....	21
8.0 FURTHER ACTION / RENDERING AN OPINION.....	22
9.0 LIMITATIONS OF LIABILITY	23
10.0 CLOSURE.....	24

TABLE OF CONTENTS

PAGE

FIGURES

Figure 1 Site Location Plan

Figure 2 General Site Plan

APPENDICES

Appendix A Site Photographs

Appendix B Regulatory Inquiries

Appendix C EBA Terms and Conditions

1.0 INTRODUCTION

1.1 GENERAL

UMA Engineering Ltd. (UMA) on behalf of Melcor Developments Ltd. (Melcor) retained EBA Engineering Consultants Ltd. (EBA) to conduct a Phase I Environmental Site Assessment (ESA) of ten properties located in Lethbridge, Alberta. The municipal addresses of these properties include: 4005 – 10 Street West, 4040 – 10 Street West, 4805 – 10 Street West, 5050 – 10 Street West, 5255 – 10 Street West, 500 – 40 Avenue West, 505 – 40 Avenue West, 509 – 40 Avenue West, 650 – 40 Avenue West, 4 Canyon Boulevard West, herein referred to as the subject site.

The objective of the Phase I ESA was to comment on whether any past or present land use, either off site or on site, may have a potential to cause environmental impairment of the subject sites. Three previous ESA's were conducted on portions of the site including:

- Phase I ESA, 4 Canyon Boulevard West, 1045 Canyon Boulevard West, 509 – 40 Avenue West and 4005 – 10 Street West, EBA File No. 0404-4400130, July 2002.
- Phase I ESA, 500 – 40 Avenue West, Lethbridge, Alberta, EBA File No. 0404-4400844, May 2005.
- Phase I ESA, 4805 – 10 Street West, Lethbridge, Alberta, EBA File No. 4400976, September 2005.

Phase I ESA information for these properties are consolidated into this report.

EBA understands that the properties are owned by various owners including Denecky Brother Grains Ltd., Melcor Developments Ltd., the City of Lethbridge and various other private owners. It is further understood that Melcor requires this environmental assessment for the Riverbend Subdivision application process.

The Phase I ESA was conducted in general accordance with the Canadian Standards Association (CSA) Phase I ESA standard Z768-01 (April 2003 revision).

1.2 AUTHORIZATION

Mr. Cory Armfelt of UMA, on behalf of Melcor, provided written authorization to Ms. Mandi Parker on May 24, 2007 to proceed with the present study.

1.3 SCOPE OF WORK

EBA conducted the following scope of work for the Phase I ESA:

- Conducted site visits and personnel interviews to evaluate the extent and manner that present and surrounding activities may impact upon these sites and the environment. Sampling was not included in the Phase I ESA.

- Investigated and collected relevant information pertaining to environmental concerns at the subject site from Petroleum Tank Management Association of Alberta (PTMAA), Alberta Infrastructure and Transportation (AIT); Alberta Energy and Utilities Board (EUB) Coal Mine Atlas; Alberta Environment's (AENV's) Water Well Records Database and Online Approval Viewer; Alberta Government Spatial Information System (SPIN2); Abacus Datagraphics (AbaData) database for Alberta Energy and Utilities Board (EUB) information and the City of Lethbridge Development Services Department.
- Reviewed available historical information for the site and the immediate surrounding areas, including business directories, and land titles.
- Obtained and reviewed historical aerial photographs of the subject site for previous land use and the immediate surrounding areas.
- Prepared a report discussing the history of the subject sites and identified the potential for environmental concerns resulting from past or present land use at the site and in the surrounding area.

1.4 QUALIFICATIONS OF ASSESSORS

Mr. Deryck Masterman, B.Sc., A.Ag., conducted the records review, site inspections and prepared this report. Mr. Masterman is an environmental scientist for EBA's Lethbridge environmental practice and has over three years of experience in the environmental industry.

Ms. Mandi Parker, P.Ag., assisted with the site inspections, conducted the preliminary review and assisted with the interpretation of the findings. Ms. Parker is an environmental scientist with EBA's Lethbridge environmental practice and has over seven years of experience in the environmental industry.

Mr. Sean Buckles, P. Eng., conducted the final review of the report. Mr. Buckles is a project engineer in EBA's environmental practice in Calgary and has over 12 years of experience in the environmental industry.

2.0 SITE DETAILS

This section summarizes EBA's observations made during previous Phase I ESA's as well as a site reconnaissance on May 31, 2007 and includes a brief description of each property. The reconnaissance included a walk of the site and observations of adjacent properties to identify evidence of impairment or potential sources of impairment, which may adversely affect the site.

Figure 1 shows the site location plan and Figure 2 shows the general site plan. Photographs of the property are in Appendix A of this report. A brief description of each property is provided below.

4 Canyon Boulevard West

This property is bound by 40 Avenue West (north), Riverview Parkway (west and south) and Paradise Canyon subdivision (east). The site is vacant and vegetated by native grasses and weeds. A berm is located on the north end of this property.

500 – 40 Avenue West

This property is bound by 40 Avenue West (north), Riverview Parkway, Paradise Canyon subdivision and coulee (east), Popson Park (south), and 4005 and 4805 – 10 Street West (west). There are three abandoned buildings (two farm houses and a storage shed) located on the site (NW corner). A large concrete cistern is located between the houses. Several old automobiles, empty propane tanks, old appliances (refrigerators, deep freezers, stoves, washers, dryers and hot water tanks) and various scrap materials were also located in this area. An irrigation canal passes through this property from the northeast corner of the site and fills a dugout located on the eastern portion of the site to the south of 4 Canyon Boulevard West. A water pump is utilized to extract water from the dugout. Water from the dugout is utilized for irrigation purposes. It is understood that the Lethbridge Northern Irrigation District (LNID) owns the canal and that water is discharged from the dugout into the coulees. The majority of the property is currently utilized as agricultural cropland.

505 – 40 Avenue West

This property is bound by the Chinook Trail right of way (north), 509 – 40 Avenue West (east), 40 Avenue West (south), and 650 – 40 Avenue West (west). A large berm comprised of topsoil material is located primarily on the adjacent northern property. An irrigation canal passes from the north-western portion of the site to the south-eastern portion. There is also a large pile of boulders, and scrap material piled along the northern region of this site. This property is currently vegetated by both native grasses and invasive species (weeds).

509 – 40 Avenue West

This property is bound by coulees (north and east), Paradise Canyon subdivision (east), 40 Avenue North (south) and 500 – 40 Avenue West (west). A Telus utility box, a catchbasin and several geotechnical standpipes were noted on this property. It is understood that the underground utilities are installed on this site for future development. It is vegetated with both native grasses and invasive species.

650 – 40 Avenue West

This property is divided by 40 Avenue West, and is bound by 505 and 500 – 40 Avenue West (east), 4005 – 10 Street West (south and west). The southern portion of the site is occupied by a farm yard and contains a house, workshop, several sheds and eight grain silos. There is a dugout, four above-ground storage tanks (AST's) and various farming machinery situated on this site. Water from the dugout is utilized for irrigation purposes. This site is surrounded by large mature trees and bushes.

4005 – 10 Street West

This property is bound by 7001 University Drive West (west), 650 – 40 Avenue West (north), 500 – 40 Avenue West (east) and 4805 – 10 Street West (south). This site is utilized as agricultural cropland and is currently cropped. There is a low lying area and a large tree in the southern portion of this site along the property line.

4040 – 10 Street West

This property is bound by agricultural cropland (west and south), Sun Ridge Subdivision (north) and 10 Street West (east). This site is utilized as agricultural cropland and is currently cropped.

4805 – 10 Street West

This property is bound by 10 Street West (west), 4005 – 10 Street West (north), 500 – 40 Avenue West (east) and 5255 – 10 Street West (south). This site is utilized as agricultural cropland, however, at the time of the site visit, no crops were growing. A large pile of boulders and old machinery was noted along the eastern site boundary.

5050 – 10 Street West

This property is bound by agricultural cropland (north, west and south) and 10 Street West (east). This site is utilized as agricultural cropland and is currently cropped.

5255 – 10 Street West

This property is bound by 10 Street West (west), 4805 – 10 Street West (north), and river valley to the east and south. This site is utilized as agricultural cropland and is currently cropped.

2.1 LOCATION, SIZE AND OWNERSHIP

The subject sites are located in Lethbridge, Alberta. The subject site locations, size and ownership are summarized in the following table.

SITE LOCATION, SIZE, AND OWNERSHIP			
Municipal Address	Legal Description	Size	Owner(s)
4 Canyon Blvd. W.	Plan 9211466; Block 4	3.0 ha.	Melcor Developments Ltd.
500 – 40 Avenue W.	NE ¼ 13-8-22 W4M	64.3 ha.	Melcor Developments Ltd.
505 – 40 Avenue W.	SE ¼ 24-8-22 W4M and portion of SW ¼ 24-8-22 W4M	64.7 ha.	City of Lethbridge
509 – 40 Avenue W.	Plan 0210062; Block 1; Lot 14	17.6 ha.	Melcor Developments Ltd.
650 – 40 Avenue W.	Plan 0414514; Block 1; Lot 1	2.5 ha.	Denecky Brother Grain Ltd.
4005 – 10 Street W.	NE ¼ 13-8-22 W4M	32.5 ha.	Denecky Brother Grain Ltd.
4805 – 10 Street W.	NE ¼ 13-8-22 W4M	32.4 ha.	Private
5255 – 10 Street W.	SE ¼ 13-8-22 W4M	64.7 ha.	Private
4040 – 10 Street W.	NE ¼ 14-008-22 W4M	undetermined	Private
5050 – 10 Street W.	SE ¼ 14-008-22 W4M	undetermined	Private

2.2 BUILDING DETAILS

The following table summarizes the age, use and basic details of the residences situated on the properties located at 500 – 40 Avenue West and 650 – 40 Avenue West.

BUILDING AGE, USE AND DESCRIPTION			
Building	Date of Construction	Use	Description
500 – 40 Avenue West	Prior to 1950	Residential	Abandoned single storey residences.
650 – 40 Avenue West	Late 1970s	Residential	Single storey, single family residence.

Based on aerial photograph review, the residences located at 500 – 40 Avenue West were constructed prior to 1950. Due to the unsafe condition of these buildings, an inspection of the interiors was not completed and therefore building details are not available.

Based on aerial photograph review, the residences located at 650 – 40 Avenue West was constructed in the late 1970s. An inspection of the interior of building was not completed and therefore building details are not available.

Building construction details, including basic building materials are summarized in the following table:

BUILDING CONSTRUCTION		
Building	Building Component	Type of Construction
500 – 40 Avenue West	Roof	Cedar shingles
	Foundation	Wooden post
	Exterior Walls	Wood siding
650 – 40 Avenue West	Roof	Asphalt shingles
	Foundation	Concrete
	Exterior Walls	Brick

2.2.1 Water Supply

An abandoned concrete cistern was identified at the old farmyard located at 500 – 40 Avenue West. Mr. Denecky indicated during an interview that the cistern had not been utilized since he purchased the property in 1974. It is suspected that the cistern still contains water. No odours were emanating from the cistern at the time of the site reconnaissance. Mr. Denecky further indicated that the cistern had not been pumped out or filled since he purchased the site. There is also an irrigation canal and dugout situated along the eastern portion of this property.

Potable water is provided to the residence located at 650 – 40 Avenue West via a temporary connection to the City of Lethbridge municipal system. A permanent water connection will be made at the time of development. There is also a dugout situated along the southeast corner of this property. It is understood that this was previously used for irrigation and the domestic water supply.

2.2.2 Sewer Systems

It is suspected that the residences located at 500 (abandoned) and 650 (occupied) – 40 Avenue West are connected to a septic tank/field; however, this could not be confirmed as a reliable source could not be reached for comment. Should development of the site occur, the septic field should be decommissioned as per industry standards and if any staining or odours noted, an environmental professional contacted.

2.2.3 Sumps and Drains

Drains are likely located within the residence located at 650 – 40 Avenue West, however, a detailed inspection of residence was not conducted. There were no sumps identified at the time of the site visit.

2.2.4 Asbestos

Construction materials used prior to the late 1970s were known to possibly contain asbestos. Based on the age of the residences at 500 – 40 Avenue West (constructed prior to 1950) and 650 – 40 Avenue West (constructed in the late 1970s), asbestos may be present in ceiling or floor tiles, drywall, and insulation for the walls, boiler, and piping. Asbestos is considered a health hazard if it is friable, airborne, and exposed to humans. Asbestos-containing materials were not observed during the site reconnaissance; however, intrusive investigation and sampling is not within the scope of a Phase I ESA.

2.2.5 Polychlorinated Biphenyls (PCBs)

The federal Environmental Contaminants Act (1976) has restricted the use and controlled the phase out of polychlorinated biphenyls (PCBs) in Canada. Additionally, the storage and disposal of PCBs is regulated. The Act prohibited the use of PCBs in electrical equipment installed after July 1, 1980. PCBs are commonly found in light ballasts, electrical transformers (pole or ground mounted) and various other types of electrical equipment (i.e., rectifiers) dating back to the early 1980s or earlier.

Based on the age of the residences at 500 – 40 Avenue West (constructed prior to 1950) and 650 – 40 Avenue West (constructed in the late 1970s), PCBs may be present in the ballasts for the fluorescent lights or other electrical equipment at the subject sites; however, intrusive investigation and sampling is not within the scope of a Phase I ESA. PCB-containing light ballasts or electrical equipment should be disposed of appropriately at the end of their useful life.

2.2.6 Ozone-Depleting Substances (ODS)

In December 1998, The Government of Canada enacted the *Ozone-Depleting Substances Regulations*, which governs the use, handling and release of ODS. ODS may include, but are not limited to, chlorofluorocarbons (CFCs), halons, carbon tetrachloride and methyl bromide. ODS are usually associated with operations such as fire extinguishing systems, foam manufacturing, fumigant and pesticide application, prescription metered dose inhalers, refrigeration and air-conditioning units, and solvent cleaning and degreasing facilities. ODS are not a health issue for people in the building, but are more a maintenance issue to limit or prevent their release. This is accomplished by regular maintenance by trained personnel.

ODS containing equipment was not identified at the subject site at the time of the site visit, however, it is possible that the residence at 650 – 40 Avenue West may have an air conditioning unit which use potential ODS as a refrigerant. Inspection of residence was not conducted as a part of the site investigation.

2.2.7 Lead and Lead-Based Paint

Lead can be associated with paints, plumbing solder, pipes and other products such as wall shielding in x-ray rooms. Lead-based paint was withdrawn from the market in the late 1970s. If present, lead-based paint is typically concealed beneath multiple layers of paint applied over the years during renovations. Lead-based paint and plumbing equipment are not a direct health risk when concealed (sealed behind layers of non-lead paint) and/or in good condition. Lead-based paint should be considered, however, when planning future renovations/ demolition, when particles could be released and/or ingested in the course of the work.

Based on the age of the residences at 500 – 40 Avenue West (constructed prior to 1950) and 650 – 40 Avenue West (constructed in the late 1970s), there is a potential for lead to be present in the paint and/or plumbing pipes and solder at the subject sites, however, intrusive sampling for lead and lead based paints is not within the scope of a Phase I ESA.

2.2.8 Urea Formaldehyde Foam Insulation (UFFI)

Insulation materials used during the 1970s and 1980s were known to possibly contain UFFI. UFFI was banned in 1980 under the federal *Hazardous Products Act*. Based on the age of the residences at 500 – 40 Avenue West (constructed prior to 1950) and 650 – 40 Avenue West (constructed in the late 1970s), UFFI-containing materials may be present; however, intrusive investigation of wall cavities and sampling is not within the scope of a Phase I ESA.

2.2.9 Radon

Radon gas is a product of the decay series that begins with uranium. Radon is produced directly from radium that is sometimes found in bedrock containing black shale and/or granite. Radon gas and its by-products occur naturally everywhere, in soil, water, and air, but usually in concentrations too low to pose a threat. Radon gas can migrate through the ground and enter buildings through porous concrete or fractures. Radon can also be released by certain building materials including concrete and gyprock. EBA is not aware of radon gas testing for the subject site; however, natural radon concentrations are low in Alberta and radon gas concentrations are usually well below target limits set for Canada. Additionally, there were no anthropogenic sources of radon gas identified.

2.2.10 Methane

Methane gas is a product of anaerobic decomposition of organic material (e.g., buried fill high in organic material). Methane is also associated with natural gas deposits. Methane gas can migrate through the ground and enter buildings through porous concrete or fractures. Based on review of historical aerial photos (refer to Section 6.2), it was determined that ephemeral wetlands may have been present on Section 14-13-008-22 W4M and Section 15-13-008-W4M. The wetlands were visible in aerial photographs from 1950, 1970 and 1980 and could be a potential source of organic rich materials.

2.2.11 Mould

Mould can be found anywhere in a building; however, it is usually associated with enclosed, damp areas. An inspection of the residences located at 500 and 650 – 40 Avenue West was not conducted, therefore comments on potential mould cannot be made. Intrusive observation of wall and ceiling cavities is not included within the scope of this Phase I ESA.

2.2.12 Electromagnetic Fields

Other than the 138 kV transmission line that crosses the site and runs east along 40 Avenue, there were no high-tension transmission lines or electrical sub-stations identified within 100 m of the subject site that could generate significant electromagnetic fields other than the 138 kV transmission line that crosses the site and runs east along 40 Avenue.

2.2.13 Noise and Vibration

There were no major sources of noise or vibration on or adjacent to the subject site during the site visit.

2.2.14 Waste Storage and Recycling Facilities

It is understood that all household solid waste accumulated at 650 – 40 Avenue West is picked up on a weekly basis by the City of Lethbridge for disposal and taken to the Lethbridge Regional Landfill.

2.3 SITE OBSERVATIONS

2.3.1 Surficial Stains

Small areas of hydrocarbon staining ($<1 \text{ m}^2$) were observed at various locations throughout the old farmyard and beneath the water pump at 500 – 40 Avenue West.

Hydrocarbon stains ($<3 \text{ m}^2$) were observed beneath the aboveground storage tanks (ASTs) and various equipment storage locations throughout the farmyard at 650 – 40 Avenue West.

2.3.2 Vegetation

Vegetation at the subject site consisted primarily of agricultural crops (wheat), however, manicured lawn was observed throughout the farm yards at 500 and 650 – 40 Avenue West. With the exceptions of the area around the cistern located at 500 – 40 Avenue West, no evidence of distressed vegetation was observed at the time of the site visit. No crops had been planted at 4805 – 10 Street West at the time of the site reconnaissance.

2.3.3 Ponding of Water

No evidence of ponded water was observed at the subject site at the time of the site visit, however, there are numerous low areas throughout the site where ponding may occur.

Through the air photo review it was determined that ephemeral wetlands may have been present on Section 14-13-008-22 W4M and Section 15-13-008-W4M. The wetlands were visible in aerial photographs from 1950, 1970 and 1980. Where future development would infill or drain a wetland, an approval under the Water Act is required.

Under the Alberta Water Act, a "water body" refers to "any location where water flows or is present, whether or not the flow or the presence of water is continuous, intermittent or occurs only during a flood, and includes but is not limited to wetlands..." (Water Act, revised Statutes of Alberta 2000, Chapter W-3, Section 1). A wetland identified on the property would be considered a "water body" under the Alberta Water Act and should therefore be included in the wetland compensation plan.

Alberta Environment's Provincial Restoration and Compensation Guide (February 2007) defines a wetland as "land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation and various kinds of biological activity which are adapted to a wet environment".

2.3.4 Washouts and Erosion

No washouts or indications of erosion were observed at the subject site at the time of the site visit.

2.3.5 Fill Areas

The land directly north of 505 – 40 Avenue West (future site of Chinook Trail West) has three large topsoil berms. It is understood that the material has been stripped from the subdivision and brought to the location for storage and will be reused within the subdivision. There are no records available through the City of Lethbridge showing that the material has been analyzed for potential impacts.

2.3.6 Oil / Gas Wells and Pipelines

An abandoned gas well (ID: 00/11-13-008-22 W4/0) was identified on the NW ¼ of Section 13, Township 008, Range 22 West of the Fort Meridian which is located in 4805 – 10 Street West. The well, licensed to West-Can Hydrocarbon Fund Ltd. (Licence #: 0061612), was not visible during the site inspection. Drilling was initiated on February 6, 1977, and was abandoned on February 18, 1977. The well was drilled to a depth of 1371.6 m below surface elevation (929.9 m). A Reclamation Certificate was issued on September 1, 1977, No. 16758 by Tri-West Land Consultants of Calgary, Alberta. This is consistent with AbaData (refer to Section 6.3.3), the Environmental Law Centre (refer to Section 6.3.4) and the SPIN2 website (refer to Section 6.3.5).

2.3.7 Chemical Storage

There were several containers (20 litres or less) identified at various locations throughout the property located at 650 – 40 Avenue West. The containers were generally located on the ground and minor staining (< 1 m) was noted at various locations throughout the farmyard. Chemicals being stored included various types of motor oils, degreasers, and



lubricants. Inspection of individual storage sheds and the residence was not conducted as a part of this investigation.

2.3.8 Transformers

A pole mounted transformer was noted at 650 – 40 Avenue West. The transformer appeared to be leaking as staining was noted on the units' exterior. The age and identification of the unit could not be determined. This unit has the potential to contain PCB's. The owner of the transformer, which could not be determined during the course of this investigation, would be responsible for any impacts resulting from any PCB leakage from the unit.

2.3.9 Hydraulic Elevators and Hoists

There were no hydraulic elevators or hoists observed at the subject site at the time of the site visit.

2.3.10 Underground Storage Tanks (UST's) and Vent Pipes

With the exception of an abandoned concrete cistern located at 500 – 40 Avenue West, there were no UST's or vent pipes identified at the subject site during the site visit.

2.3.11 Above Ground Storage Tanks (AST's)

There were four AST's identified on the property located at 650 – 40 Avenue West. The AST's contained diesel and gasoline. The age and exact size of the AST's was not determined. Several large stains (> 1 m in area) were noted beneath the AST's. According to Mr. Denecky, there have not been any major leaks or spills.

2.3.12 General Housekeeping

The overall, general housekeeping of the subject site was typical of many farmyards in southern Alberta.

3.0 GEOLOGICAL INFORMATION

3.1 TOPOGRAPHY

Surface topography can influence the direction of migration of contaminants at the soil surface. The local topography is the topography at the subject site whereas regional topography is the overall expression of the soil surface in a given region. The surface topography is generally hummocky, but slopes slightly (< 2 degrees) towards the Oldman River to the south and east. Regional topography in the area is generally flat, but slopes northeast towards the Oldman River¹.

¹ 1993, "Lethbridge 82H". Canada Centre for Mapping, Natural Resources Canada.

3.2 GEOLOGY

The surficial geology in the area is characterized by moraine till deposits with sporadic lenses of gravel, sand and silt².

The stratigraphy of the Lethbridge area is generally comprised of 65 m to 70 m of surficial deposits overlying bedrock. Bedrock in the Lethbridge area consists of strata from the upper Oldman formation and the lower Bears paw Formation, both of the late Cretaceous age³. The bedrock has a relatively flat surface dipping slightly to the northwest and is locally encountered at about geodetic elevation 843 m. The bedrock strata consist of thin beds of predominantly weak mudstones, siltstones, and sandstones with occasional bentonite and coal seams.

3.3 HYDROLOGY AND HYDROGEOLOGY

Groundwater is of significance as a potential means of contaminant transport. Regional groundwater flow is the overall direction of groundwater flow in a given region. There may be local groundwater flow within a region that is in a different direction from the regional flow and that is controlled by topography and/or subsurface soil conditions.

The nearest surface water body is the Oldman River located approximately 450 m south of the property located at 500 – 40 Avenue West. It is anticipated that shallow groundwater flow would be south and east towards the Oldman River and that regional groundwater flow would be to the south and northeast towards the Oldman River. Perched groundwater tables have also been encountered in many areas of Lethbridge. The depth to these perched tables can vary from approximately 2 m below ground level to considerable depths within gravel, sand and/or silt seams. The flow of these perched tables can also vary in any direction or be still, dependent on the horizontal and vertical dip and the extent of the sand and/or silt seams.

It should be noted that topography, geologic materials, land development and soil disturbances influence localized variances in groundwater movement and pattern. In addition, groundwater levels will fluctuate seasonally and in response to climatic conditions.

² Shetson, I. 1981. Surficial Geology Lethbridge, Alberta. Alberta Research Council, Edmonton, Alberta.

³ O. Tokarsky, 1974, hydrogeology of the Lethbridge and Fernie Area, Alberta, 74-1, Alberta Research Council, Edmonton, Alberta



4.0 OFF-SITE OBSERVATIONS

The following table summarizes the surrounding land use.

SURROUNDING LAND USE				
Observation	North of Site	South of Site	West of Site	East of Site
Land Use	Urban Reserve	Urban Reserve/ Park	Residential	Residential
Business Name(s)	N/A	N/A	N/A	N/A
Address(es)	Chinook Trail	Popson Park	Various addresses within the Sun Ridge subdivision	Various addresses within the Paradise Canyon subdivision

The areas surrounding the site include a mixture of residential and urban reserve/ parkland properties. The site and the surrounding areas have largely been developed over the past few years. Prior to this time the surrounding area was agricultural cropland and rangeland.

5.0 PERSONNEL INTERVIEWS

EBA interviewed Mr. Nick Denecky who has lived on and farmed these properties for over 30 years. The findings of the personnel interviews, which have been incorporated into this report, are in general agreement with the records review conducted for the subject site.

INTERVIEW DETAILS	
Item	Description
Interviewer	Mr. Deryck Masterman and Ms. Mandi Parker
Interviewee	Mr. Nick Denecky
Position	Owner
Company	Denecky Brothers Grains Ltd.

6.0 RECORDS REVIEW

6.1 LAND TITLE RECORDS

A historical and current land title search was initiated for the site back to 1900. The results of the land title search are summarized in the following table.

LAND TITLES SUMMARY: NW ¼ 13-008-22 W4M (4005 AND 4805 – 10 STREET W)

Year(s) of Ownership	Owner(s)	EBA Evaluation
1974 to present	Denecky Brothers Grains Ltd.	Based on land title records, no obvious potential for environmental concerns were identified.
1912 to 1974	Various Private Owners	

LAND TITLES SUMMARY: NE ¼ 13-008-22 W4M (500 – 40 AVENUE W)

Year(s) of Ownership	Owner(s)	EBA Evaluation
2006 to present	Melcor Developments Ltd.	Based on land title records, no obvious potential for environmental concerns were identified.
1993 to 2006	Paradise Canyon Farms Ltd.	
1974 to 1993	Denecky Brothers Grains Ltd.	
1912 to 1974	Various Private Owners	

LAND TITLES SUMMARY: SW ¼ 13-008-22 W4M (5255 – 10 STREET W)

Year(s) of Ownership	Owner(s)	EBA Evaluation
2004 to present	Various Private Owners	Based on land title records, no obvious potential for environmental concerns were identified.
1974 to 2004	Denecky Brothers Grains Ltd.	
1910 to 1974	Various Private Owners	

LAND TITLES SUMMARY: NE ¼ 14-008-22 W4M (4040 – 10 STREET W)

Year(s) of Ownership	Owner(s)	EBA Evaluation
2005 to present	City of Lethbridge	Based on land title records, no obvious potential for environmental concerns were identified.
1900's to 2005	Various Private Owners	

LAND TITLES SUMMARY: SE ¼ 14-008-22 W4M (5050 – 10 STREET W)

Year(s) of Ownership	Owner(s)	EBA Evaluation
1900's to present	Various Private Owners	Based on land title records, no obvious potential for environmental concerns were identified.

LAND TITLES SUMMARY: SW ¼ 19-008-22 W4M (PORTION OF 505 – 40 AVENUE W)

Year(s) of Ownership	Owner(s)	EBA Evaluation
2005 to present	City of Lethbridge	Based on land title records, no obvious potential for environmental concerns were identified.
1998 to 2005	Paradise Canyon Land Corp.	
1989 to 1998	396976 Alberta Ltd.	
1933 to 1989	Various Private Owners	

LAND TITLES SUMMARY: SE ¼ 24-008-22 W4M (505 – 40 AVENUE W)

Year(s) of Ownership	Owner(s)	EBA Evaluation
1989 to present	The City of Lethbridge	Based on land title records, no obvious potential for environmental concerns were identified.
1973 to 1989	Alberta Housing Corporation	
1969 to 1973	The City of Lethbridge	
1949 to 1969	The Director, The Veterans Land Act	
1947 to 1949	Private Ownership	
1933 to 1947	Lethbridge Northern Colonization Manager	
1932 to 1933	Board of Trustees of the Lethbridge Northern Irrigation District	
1892 to 1932	Various Private Owners	

LAND TITLES SUMMARY: PLAN 0210062, BLOCK 1, LOT 14 (509 – 40 AVENUE W)

Year(s) of Ownership	Owner(s)	EBA Evaluation
2005 to present	Melcor Developments Ltd.	Based on land title records, no obvious potential for environmental concerns were identified.
1989 to 2005	The City of Lethbridge	
1973 to 1989	Alberta Housing Corporation	
1969 to 1973	The City of Lethbridge	
1949 to 1969	The Director, The Veterans Land Act	
1947 to 1949	Private Ownership	
1933 to 1947	Lethbridge Northern Colonization Manager	
1932 to 1933	Board of Trustees of the Lethbridge Northern Irrigation District	
1892 to 1932	Various Private Owners	

LAND TITLES SUMMARY: PLAN 9211466, BLOCK 4 (4 CANYON BLVD WEST)

Year(s) of Ownership	Owner(s)	EBA Evaluation
2005 to present	Melcor Developments Ltd.	Based on land title records, no obvious potential for environmental concerns were identified.
2001 to 2005	Paradise Canyon Land Corp.	
1974 to 2001	Denecky Brothers Grains Ltd.	
1912 to 1974	Various Private Owners	

LAND TITLES SUMMARY: PLAN 0414514, BLOCK 1, LOT 1 (650 – 40 AVENUE W)

Year(s) of Ownership	Owner(s)	EBA Evaluation
1974 to present	Denecky Brothers Grains Ltd.	Based on land title records, no obvious potential for environmental concerns were identified.
1912 to 1974	Various Private Owners	

6.2 AERIAL PHOTOGRAPHS

Aerial photographs provide visual evidence of site occupancy, operational activities and general site details. Aerial photographs capture a view of the subject site and the surrounding areas at a given time. EBA reviewed aerial photographs for the subject site (various scales and area from 1950 to 1999).

HISTORICAL AIRPHOTO SUMMARY					
Year	Subject Site	Off Site			
		North	South	West	East
1950	Subject site is comprised primarily of agricultural crop land. There is a farmyard with several unidentified buildings located at 500 – 40 Avenue West. An irrigation canal runs from the NW ¼ 2-24-008-22 W4M to the SW ¼ 9-13-008-22 W4M. A gravel road runs west to east between the S ½ of 24-008-22 W4M and the N ½ of 13-008-22 W4M. Two ephemeral wetlands (Section 14-13-008-22 W4M and Section 15-13-008-W4M) are located on the subject site.	Agricultural crop land.	Coulee followed by the Oldman River.	10 Street West followed by agricultural crop land.	Agricultural cropland.
1961	The previously noted wetlands are dry. A dugout is located east of the irrigation canal on Section 16-13-008-22 W4M. An unidentifiable pile of material(s) is located on Section 11-13-008-22 W4M.	Similar to previous photograph.	Similar to previous photograph.	Similar to previous photograph.	Similar to previous photograph.
1970	Similar to previous photograph.	Similar to previous photograph.	Similar to previous photograph.	Similar to previous photograph.	Similar to previous photograph.
1980	A second farmyard is located west of the previous farmyard. A large dugout is located south of the farmyards. The previously noted dugout has been expanded. There is a bare patch of land and some ponding located within the previous noted ephemeral wetland (Section 14-13-008-22 W4M).	Similar to previous photograph.	Similar to previous photograph.	Similar to previous photograph.	Similar to previous photograph.

February 18, 1977. The well was drilled to a depth of 1371.6 m below surface elevation (929.9 m). A Reclamation Certificate was issued for this well on September 1, 1977 by Tri-West Land Consultants Ltd. of Calgary, Alberta. No records of spills or complaints have been reported.

This well was drilled and abandoned, however, there are records of drill stem tests conducted during drilling. Although a reclamation certificate was issued in 1977, the regulations have changed significantly since that time. It is unknown if there is a drilling sump and what types of additives to the drilling mud were used. It is also not known if there was a drilling flare or other potential sources of adverse impact on the site. Typical lease dimensions are 100 m by 100 m.

When developing around the abandoned wellhead, which was likely cut and capped below the surface, there are setback requirements that are set out by the EUB. Development should be a total of 15 m away from the well center.

Two flowing gas wellheads are located 100 m (well: 00/04-13-008-22 W4/0) south and 400 m (well: 00/01-14-008-22 W4/2) west of the site. No records of spills or complaints have been reported for either of these wells. Given the proximity of these wells from the site, 100 m (well: 00/04-13-008-22 W4/0) and 400 m (well: 00/01-14-008-22 W4/2), and the absence of any reported spills or complaints these wells are not considered to pose a significant risk to the subject site.

The AbaData database was current to April 30, 2007 for high-pressure pipelines and wells, and November 1, 2006 for low-pressure pipelines.

6.3.4 Environmental Law Centre

EBA contacted the Environmental Law Centre requesting information pertaining to the reclamation of the well located on the NW ¼ 13-008-22 W4M. The Environmental Law Centre's response indicated that a reclamation certificate was issued on September 1, 1977, No. 16758. The certificate was completed by Tri-West Land Consultants Ltd. of Calgary, Alberta.

6.3.5 Alberta Environment (AENV)

The AENV Online Approval Viewer allows the public to view approvals, licenses, registrations and permits issued under the Water Act and Enforcement Protection and Enhancement Act. There were no approvals, licenses, registrations and/or permits identified for the subject site.

The AENV Water Well Database identified a record of three well located near the site. The nearest well is located approximately 600 m west of 4805 – 10 Street West. According to the database the well was installed on May 2, 1953 to a depth of 800 feet below surface elevation and is registered to M. McLeod. No information regarding the usage or current status of the well was provided. A copy of the well information is provided in Appendix B.

6.3.6 Alberta Government Services

The Alberta Government Services spatial information system (SPIN2) website was searched to identify any utility rights-of-way. There were no utility right of ways identified for the subject site.

6.3.7 The Alberta Energy and Utilities Board (EUB)

EBA contacted the EUB requesting a copy of the license and survey lease diagram for the abandoned wellhead located on the NW ¼ 13-008-22 W4M. The EUB's response was not received prior to the issuance of this report.

The EUB Coal Mine Atlas was also reviewed to determine if any coal mines exist or ever have existed at the subject site. The information from the EUB Coal Mine Atlas indicated that there were no records of active or abandoned coal mines located within 500 m of the subject site.

6.3.8 City of Lethbridge

The City of Lethbridge Development Services Department did not have any records regarding any potential environmental concerns for the subject site, however, they did provide the municipal addresses for the site.

6.4 BUSINESS DIRECTORIES

EBA reviewed the Henderson Business Directories for the subject site, however, this region of Lethbridge was not covered by the directories.

6.5 FIRE INSURANCE MAPS

EBA reviewed the Canadian Underwriters Association fire insurance map for Lethbridge from 1955 (partially revised 1964), however, the map did not provide coverage for the subject site or the surrounding area.

6.6 OTHER INFORMATION SOURCES

No other information sources were reviewed for the subject site.

7.0 DISCUSSION

7.1 GENERAL

In general terms, there are two distinct types of potential environmental risk to any property. The first type of risk is from potential contamination from on-site land use. This would include potential accidental spills or site practices that may contaminate the property directly. The second type of risk is from contamination caused by adjacent property owners, which might then be transported through the subsurface soils by groundwater, or in overland runoff onto the subject site.

7.2 POTENTIAL FOR IMPAIRMENT FROM ON-SITE SOURCES

There were four on-site sources identified that might have potential to cause environmental impairment to the subject site through historical or current land use.

POTENTIAL ON-SITE SOURCE SUMMARY			
No.	Potential On-site Source	Information Source	EBA Evaluation
1	4805 – 10 Street West, abandoned wellhead.	AbaData, Environmental Law Centre and the EUB records.	Potential impacts to soil and groundwater quality at Section 11-13-008-22 W4M due to petroleum hydrocarbon drilling activities.
2	650 – 40 Avenue West, several AST's.	Site visit.	Potential impacts to soil quality in the area of the AST's due to the storage and/ or handling of petroleum hydrocarbon products in that area. Should the stripping of the site reveal any large stained areas, it is recommended that laboratory analysis be conducted to characterize the soils.
3	650 – 40 Avenue West, several AST's.	Site visit.	Potential impacts to soil quality in the area of the leaking transformer. Should the stripping of the site reveal any large stained areas, it is recommended that laboratory analysis be conducted to characterize the soils.
4	500 – 40 Avenue West, storage of various equipment and machinery.	Site visit.	Potential impacts to the soils within the abandoned farmyard due to the storage of various abandoned equipment and machinery. Should the stripping of the site reveal any large stained areas, it is recommended that laboratory analysis be conducted to characterize the soils.

7.3 POTENTIAL FOR IMPAIRMENT FROM OFF-SITE SOURCES

There were no off-site sources identified that might have a potential to cause environmental impairment to the subject site due to historical and/or current land use.

8.0 FURTHER ACTION / RENDERING AN OPINION

The approximate age of the buildings located at 500 – 40 Avenue West could not be determined, however, based on the aerial photo review, they are understood to be more than fifty-years old. The aerial photo review also revealed that the residence located at 650 – 40 Avenue West is approximately thirty-years old. Given the age of these buildings, potentially hazardous material such as ACBM's, PCB's, lead based paints and piping, and UFFI's may be present. Should the buildings be demolished or extensively renovated, confirmation of these materials should be conducted. If detected, the removal and disposal of these materials should be completed in accordance with provincial and federal regulations.

There are four AST's, a leaking transformer and various other chemicals present throughout the farmyard located at 650 – 40 Avenue West and machinery stored at 500 – 40 Avenue West. Evidence of surficial staining was noted throughout these farmyards. Given that these properties may be included in the development of Riverbend subdivision, any surficial impairment within these areas would likely be removed during the site preparation process. Should the site preparation reveal any large stained areas, it is recommended that laboratory analysis be conducted to characterize the soil.

An abandoned cistern is located within the farmyard located at 500 – 40 Avenue West. Should the contents of the cistern contain any substance(s) other than water, testing should be completed.

Numerous appliances including refrigerators were identified within the abandoned farmyard located at 500 – 40 Avenue West. It is recommended that the refrigerators be checked for Freon. Should they contain Freon then this material should be disposed of according to the current regulations.

Through the air photo review it was determined that ephemeral wetlands may have been present on Section 14-13-008-22 W4M and Section 15-13-008-W4M. The wetlands were visible in aerial photographs from 1950, 1970 and 1980. Where future development would infill or drain a wetland, an approval under the Water Act is required.

There is an abandoned gas well that was drilled in 1977 at 4805 – 10 Street West. This well was drilled, abandoned and reclamation certificate issued in 1977. Additionally there are records of drill stem tests conducted during drilling. It is unknown if there is a drilling sump and what types of additives to the drilling mud were used. It is also not known if there was a drilling flare or other potential sources of contamination on the site. Typical lease dimensions are 100 m by 100 m. It is recommended that additional records from the EUB library be collected and information from the drilling records be compared to the current Alberta Environment drilling waste guidelines/calculations; as well as research other potential sources of impact. Further, it is recommended that additional assessment be conducted to determine if there is a subsurface impact due to the drilling of the gas well.



When developing around the abandoned wellhead, which was likely cut and capped below the surface, there are setback requirements that are set out by the EUB. These setback guidelines should be followed.

9.0 LIMITATIONS OF LIABILITY

Recommendations presented herein are based on a Phase I Environmental Site Assessment as described in Section 1.0. This report has been prepared for the exclusive use of Melcor Developments Ltd. for the specific application described in Section 1.0 of this report. It has been prepared in accordance with generally accepted geo-environmental engineering practices. No other warranty is made, either express or implied. Engineering judgement has been applied in developing the recommendations of this report.

For further limitations, reference should be made to the General Conditions in Appendix C.

10.0 CLOSURE

We trust this report meets your present requirements. Should you have any questions or comments, please contact the undersigned at your convenience.

EBA Engineering Consultants Ltd.



Deryck Masterman, B.Sc., A.Ag.
Environmental Scientist

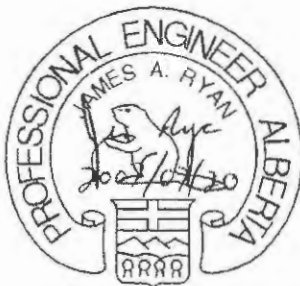


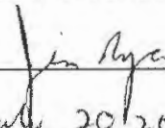
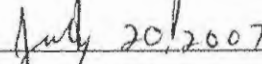
Mandi Parker, P.Ag.
Environmental Scientist

Reviewed by:

Sean Buckles, P. Eng
Project Engineer

/cld



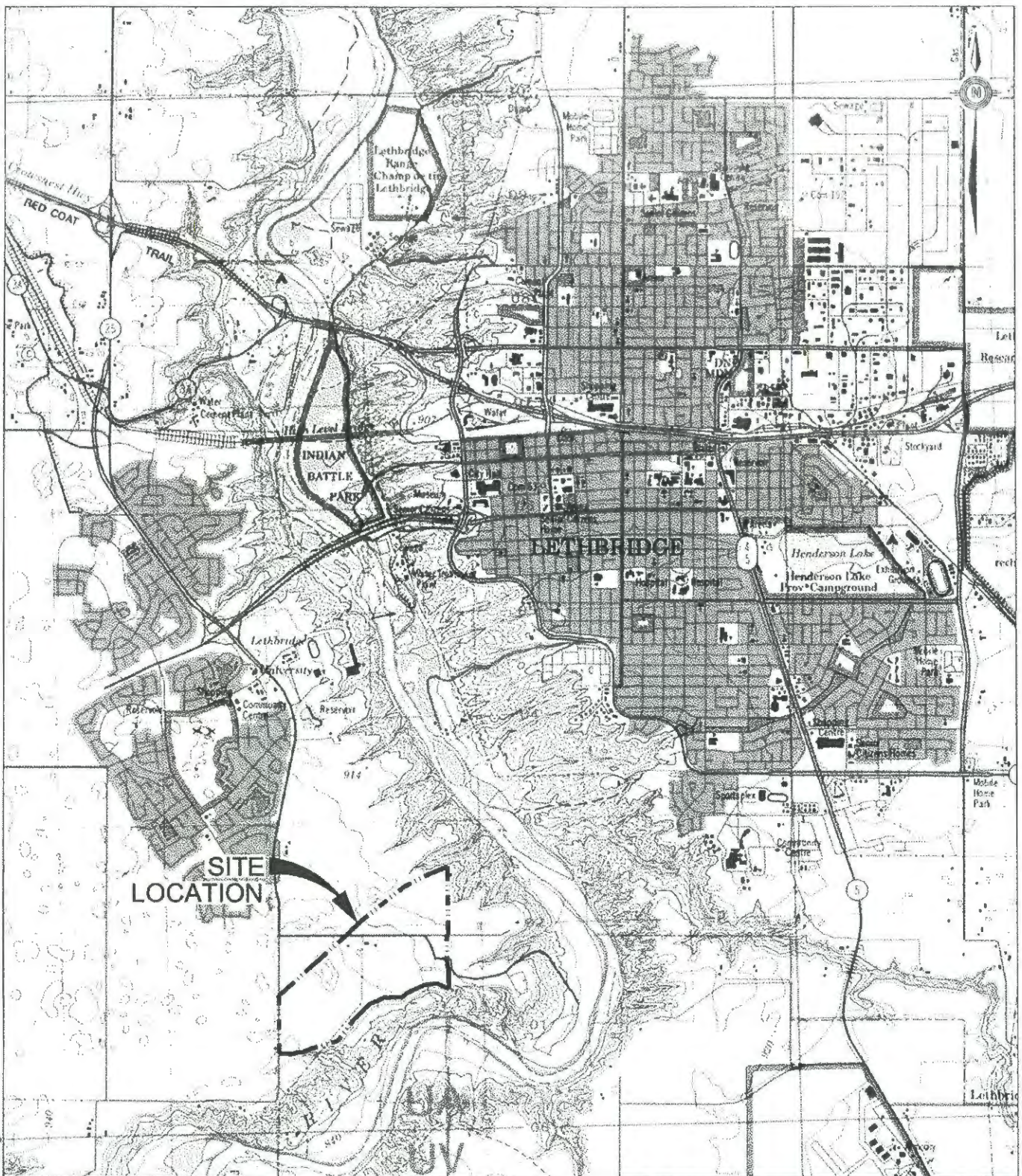
PERMIT TO PRACTICE EBA ENGINEERING CONSULTANTS LTD.	
Signature	
Date	
PERMIT NUMBER: P245 The Association of Professional Engineers, Geologists and Geophysicists of Alberta	





FIGURES





**SITE
LOCATION**

CLIENT

Melcor Developments Ltd.

**PHASE I ENVIRONMENTAL SITE ASSESSMENT
RIVERBEND SUBDIVISION**

SITE LOCATION PLAN



**EBA Engineering
Consultants Ltd.**

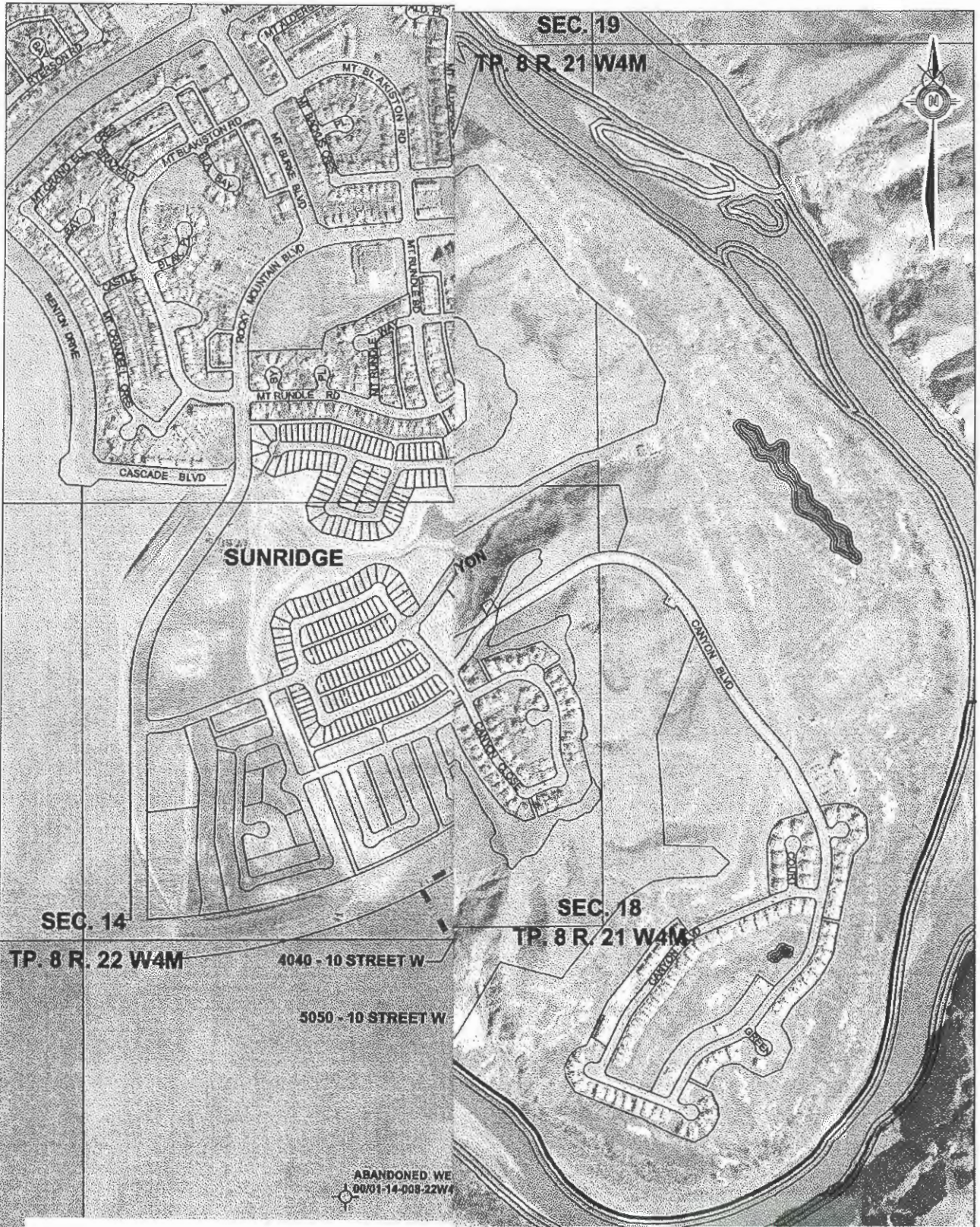


PROJECT NO.
L22101051
OFFICE
EBA-Lethbridge

DWN
LCH
DATE
June 10, 2007

CKD
DM
REV
0

Figure 1



\\sharepoint\U22101051\U22101051 site plan.dwg

ents Ltd.



**PHASE I ENVIRONMENTAL SITE ASSESSMENT
RIVERBEND SUBDIVISION**

SITE PLAN

PROJECT NO.
L22101051

OFFICE
EBA-Lethbridge

DWN
LCH

CRD
DM

REV
0

DATE
July 18, 2007

Figure 2



APPENDIX

APPENDIX A SITE PHOTOGRAPHS

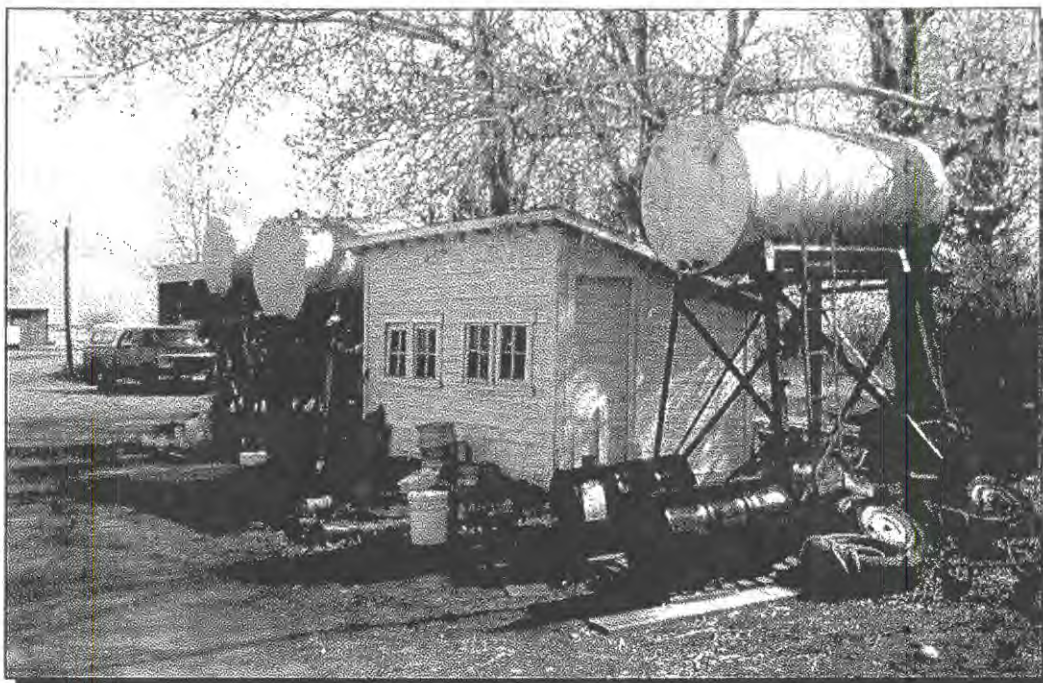


Photo 1
Facing east, looking at storage shed, AST's and oil drums within the farmyard located at 650 - 40 Avenue West.



Photo 2
Facing south, looking at the storage of various solvents, lubricants and used oil filters within the farmyard located at 650 - 40 Avenue West.



Photo 3

Facing southeast, looking at concrete cistern and various waste materials within the abandoned farmyard located at 500 - 40 Avenue West.



Photo 4

Facing east, looking at various used household appliances within the farmyard located at 500 - 40 Avenue West.



Photo 5
Facing south, looking at the dugout located at 650 – 40 Avenue West.

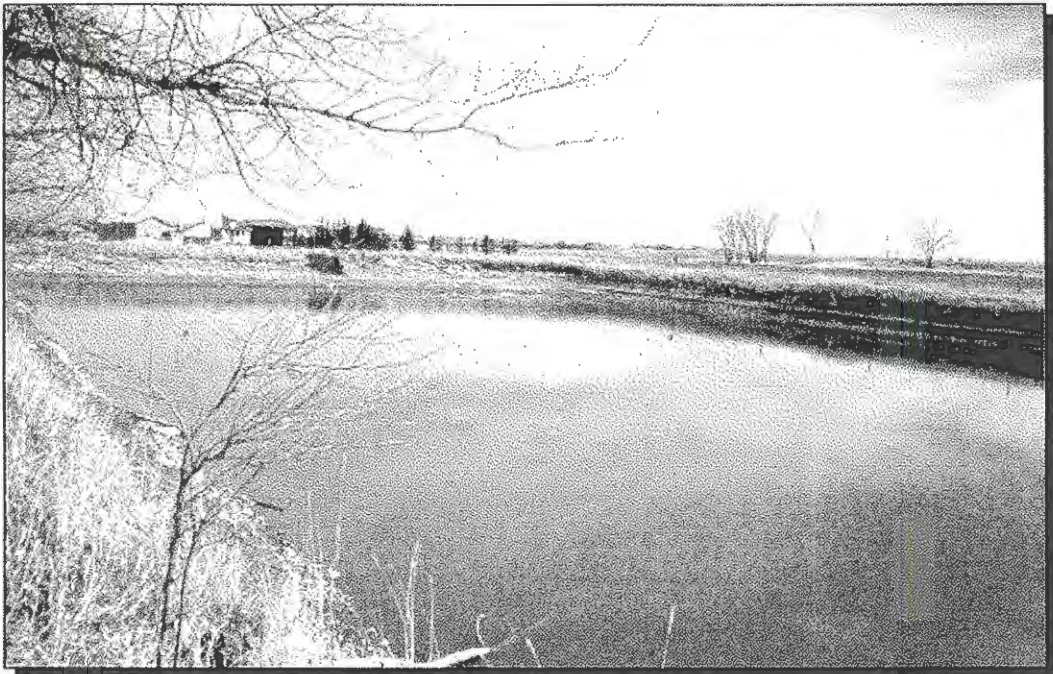


Photo 6
Facing east, looking at the dugout located on the eastern portion of 500 – 40 Avenue West.

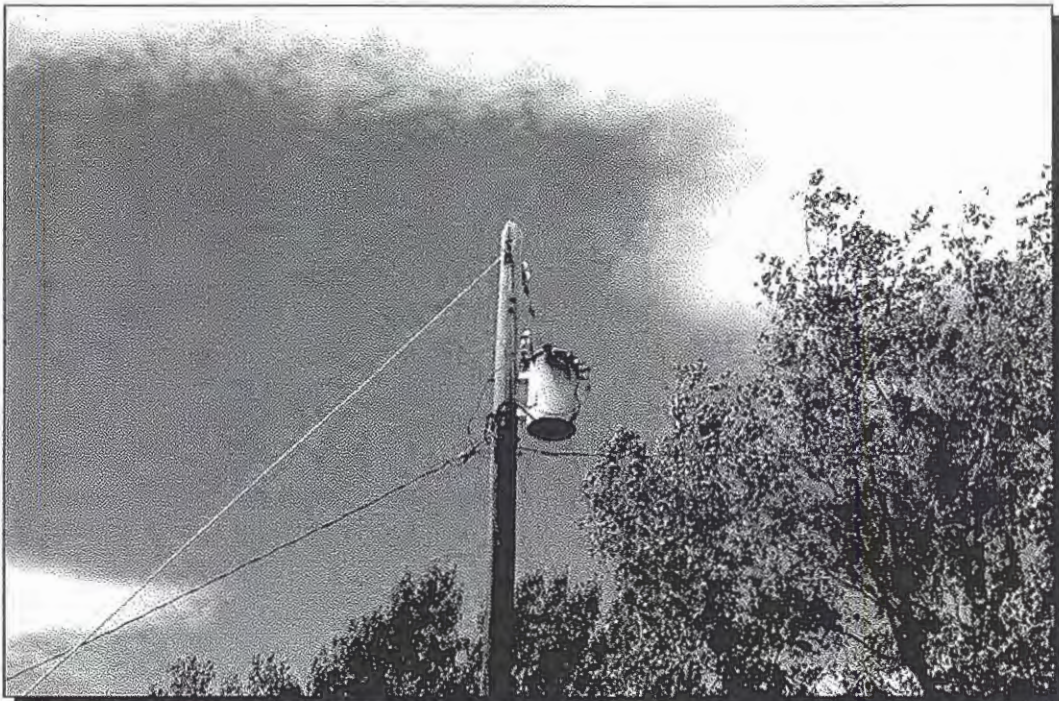


Photo 7

Looking at the staining on the transformer located at 650 – 40 Avenue West.



Photo 8

Looking at the abandoned homes within the farmyard located at 500 – 40 Avenue West.



Photo 9

Facing east, looking across 4005 and 4805 ~ 10 Street West from the southern site boundary.



Photo 10

Facing southeast, looking across the site from the northern site boundary of 505 ~ 40 Avenue West. Note the irrigation canal flowing to the south through the site.

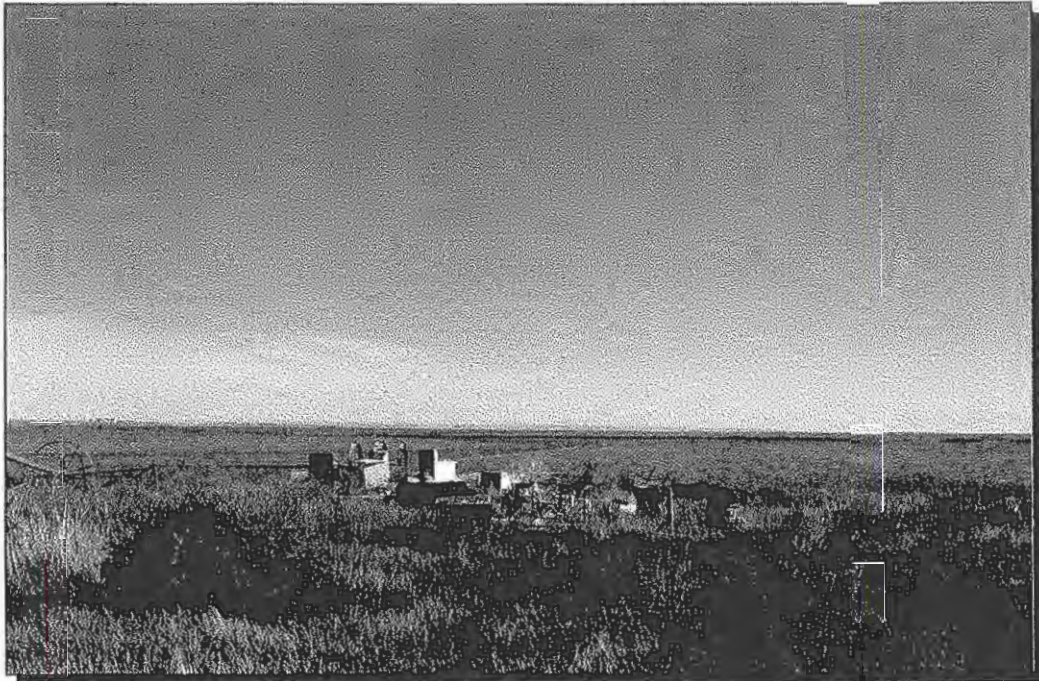


Photo 11

Facing south, looking across the site from the farmyard located 500 – 40 Avenue West.

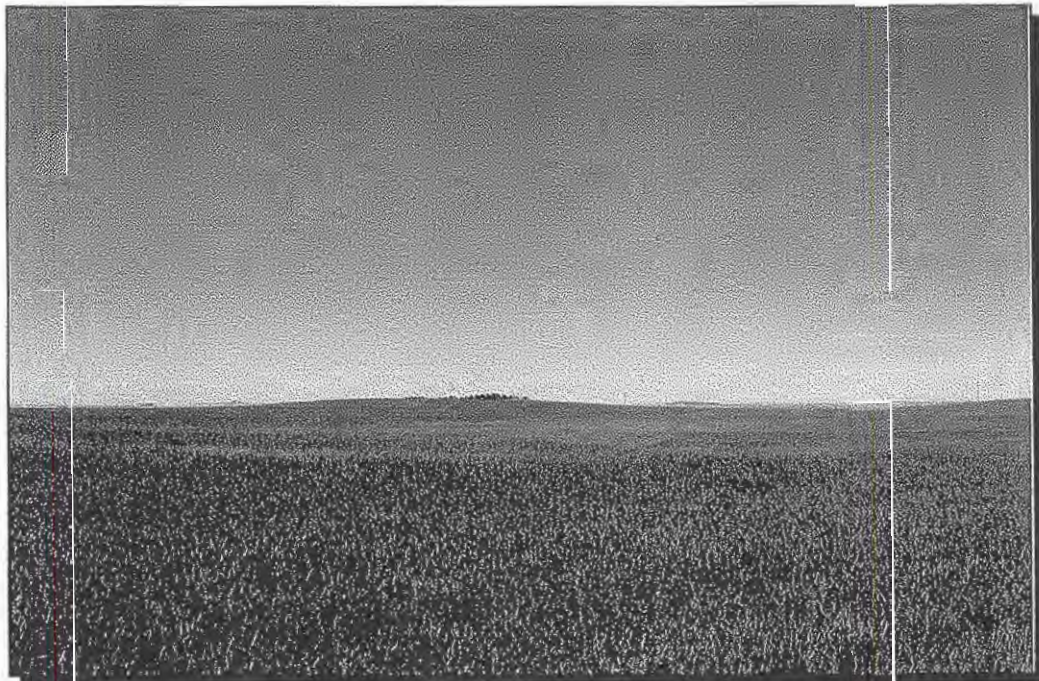


Photo 12

Facing north, looking across the site from the southern boundary of 5255 – 10 Street West.



APPENDIX

APPENDIX B REGULATORY INQUIRIES



ALBERTA REGISTRIES
LAND TITLE CERTIFICATE

S
LINC SHORT LEGAL TITLE NUMBER
0028 907 384 9211466;4 051 451 794

LEGAL DESCRIPTION

PLAN 9211466
BLOCK 4
CONTAINING 3.0390 HECTARES (7.51 ACRES) MORE OR LESS
EXCEPTING THEREOUT:

	HECTARES	(ACRES)	MORE OR LESS
A) PLAN 0111806 SUBDIVISION	0.419	1.04	
EXCEPTING THEREOUT ALL MINES AND MINERALS			

ATS REFERENCE: 4;22;8;13;NE
ESTATE: FEE SIMPLE

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 031 068 581

REGISTERED OWNER(S)				
REGISTRATION	DATE(DMY)	DOCUMENT TYPE	VALUE	CONSIDERATION
051 451 794	29/11/2005	TRANSFER OF LAND		SEE INSTRUMENT

OWNERS

MELCOR DEVELOPMENTS LTD..
OF #900, 10310 JASPER AVENUE, EDMONTON
ALBERTA T5J 1Y8

ENCUMBRANCES, LIENS & INTERESTS

REGISTRATION	DATE (D/M/Y)	PARTICULARS
NUMBER		
921 015 431	22/01/1992	UTILITY RIGHT OF WAY GRANTEE - THE CITY OF LETHBRIDGE.

(CONTINUED)



ALBERTA REGISTRIES
LAND TITLE CERTIFICATE

S

LINC SHORT LEGAL
0028 559 491 4;22;8;13;NE

TITLE NUMBER
061 152 071

LEGAL DESCRIPTION

MERIDIAN 4 RANGE 22 TOWNSHIP 8
SECTION 13
THAT PORTION OF THE NORTH EAST QUARTER
WHICH LIES TO THE NORTH WEST OF THE
BELLY RIVER
CONTAINING 64.3 HECTARES (159 ACRES) MORE OR LESS
EXCEPTING THEREOUT:
PLAN NUMBER HECTARES ACRES
SUBDIVISION 8710224 18.962 46.86
ROAD 9210126 0.840 2.08
SUBDIVISION 9211466 3.039 7.51
SUBDIVISION 0012470 0.170 0.42
EXCEPTING THEREOUT ALL MINES AND MINERALS

ESTATE: FEE SIMPLE

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 001 276 637 +10

REGISTERED OWNER(S)				
REGISTRATION	DATE(DMY)	DOCUMENT TYPE	VALUE	CONSIDERATION
061 152 071	19/04/2006	TRANSFER OF LAND	\$3,370,000	SEE INSTRUMENT

OWNERS

MELCOR DEVELOPMENTS LTD..
OF #900, 10310 JASPER AVENUE, EDMONTON
ALBERTA T5J 1Y8

(CONTINUED)



ALBERTA REGISTRIES
LAND TITLE CERTIFICATE

S
LINC SHORT LEGAL TITLE NUMBER
0030 853 980 0414514;1;1 041 479 985

LEGAL DESCRIPTION
PLAN 0414514
BLOCK 1
LOT 1
EXCEPTING THEREOUT ALL MINES AND MINERALS
AREA: 2.53 HECTARES (6.25 ACRES) MORE OR LESS

ESTATE: FEE SIMPLE
ATS REFERENCE: 4;22;8;13;NW

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 821 025 427 A .

REGISTERED OWNER(S)
REGISTRATION DATE(DMY) DOCUMENT TYPE VALUE CONSIDERATION

041 479 985 20/12/2004 SUBDIVISION PLAN

OWNERS

DENECKY BROTHERS GRAINS LTD.
OF RR8, SITE 21, COMP 16
LETHBRIDGE
ALBERTA T1J 4P4

ENCUMBRANCES, LIENS & INTERESTS

REGISTRATION
NUMBER DATE (D/M/Y) PARTICULARS

252LM 12/04/1972 UTILITY RIGHT OF WAY
GRANTEE - ALTALINK MANAGEMENT LTD..
ATTN: TRANSMISSION LAND DEPT
PO BOX 20, STATION M

(CONTINUED)



ALBERTA REGISTRIES
LAND TITLE CERTIFICATE

S

LINC SHORT LEGAL
0031 373 616 4;22;8;13;NW

TITLE NUMBER
051 414 390

LEGAL DESCRIPTION

MERIDIAN 4 RANGE 22 TOWNSHIP 8
SECTION 13
THE NORTH HALF OF THE NORTH WEST QUARTER AS SHOWN ON
THE TOWNSHIP PLAN APPROVED AT OTTAWA 15 JUNE 1915
CONTAINING 32.48 HECTARES (80.20 ACRES) MORE OR LESS
EXCEPTING THEREOUT:
PLAN NUMBER HECTARES ACRES MORE OR LESS
SUBDIVISION 0414514 19.844 49.036
ROAD 0513632 0.093 0.23
EXCEPTING THEREOUT ALL MINES AND MINERALS

ESTATE: FEE SIMPLE

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 041 479 985 +4

REGISTERED OWNER(S)
REGISTRATION DATE(DMY) DOCUMENT TYPE VALUE CONSIDERATION

051 414 390 03/11/2005 ROAD PLAN

OWNERS

DENECKY BROTHERS GRAINS LTD.
OF RR8, SITE 21, COMP 16
LETHBRIDGE
ALBERTA T1J 4P4

(CONTINUED)



ALBERTA REGISTRIES
LAND TITLE CERTIFICATE

S
LINC SHORT LEGAL TITLE NUMBER
0029 168 697 0210062;1;14 051 451 794 +1

LEGAL DESCRIPTION
PLAN 0210062
BLOCK 1
LOT 14
EXCEPTING THEREOUT ALL MINES AND MINERALS
AREA: 17.635 HECTARES (43.58 ACRES) MORE OR LESS

ESTATE: FEE SIMPLE
ATS REFERENCE: 4;22;8;24;SE

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 031 068 581 +2

REGISTERED OWNER(S)				
REGISTRATION	DATE(DMY)	DOCUMENT TYPE	VALUE	CONSIDERATION
051 451 794	29/11/2005	TRANSFER OF LAND		SEE INSTRUMENT

OWNERS

MELCOR DEVELOPMENTS LTD.,
OF #900, 10310 JASPER AVENUE, EDMONTON
ALBERTA T5J 1Y8

ENCUMBRANCES, LIENS & INTERESTS

REGISTRATION	DATE (D/M/Y)	PARTICULARS
NUMBER		
251LM	12/04/1972	UTILITY RIGHT OF WAY GRANTEE - ALTALINK MANAGEMENT LTD.. ATTN: TRANSMISSION LAND DEPT PO BOX 20, STATION M CALGARY

(CONTINUED)



ALBERTA REGISTRIES
LAND TITLE CERTIFICATE

S
LINC SHORT LEGAL TITLE NUMBER
0031 373 624 4;22;8;13;NW 051 414 390 +1

LEGAL DESCRIPTION

MERIDIAN 4 RANGE 22 TOWNSHIP 8
SECTION 13
THE SOUTH HALF OF THE NORTH WEST QUARTER
CONTAINING 32.4 HECTARES (80 ACRES) MORE OR LESS
EXCEPTING THEREOUT:
PLAN NUMBER HECTARES (MORE OR LESS) ACRES
SUBDIVISION 8710224 0.396 0.98
ROAD 0513632 1.546 3.82
EXCEPTING THEREOUT ALL MINES AND MINERALS

ESTATE: FEE SIMPLE

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 051 050 800

REGISTERED OWNER(S)
REGISTRATION DATE(DMY) DOCUMENT TYPE VALUE CONSIDERATION

051 414 390 03/11/2005 ROAD PLAN

OWNERS

STEVE DENECKY
OF RR 8, SITE 21, COMP 16
LETHBRIDGE
ALBERTA T1J 4P4
AS TO AN UNDIVIDED 4/9 INTEREST

NICK DENECKY
OF 4005 10 ST W
LETHBRIDGE
ALBERTA T1J 4S8
AS TO AN UNDIVIDED 4/9 INTEREST

MARY WESTRUP

(CONTINUED)



ALBERTA REGISTRIES
LAND TITLE CERTIFICATE

S
LINC SHORT LEGAL TITLE NUMBER
0021 626 247 4;22;8;13;SW 051 050 800 +1

LEGAL DESCRIPTION

MERIDIAN 4 RANGE 22 TOWNSHIP 8
SECTION 13
QUARTER SOUTH WEST
CONTAINING 64.7 HECTARES (160 ACRES) MORE OR LESS
EXCEPTING THEREOUT:
PLAN NUMBER HECTARES (MORE OR LESS) ACRES
SUBDIVISION 8710224 47.356 117.02
SUBDIVISION 8711732 0.129 0.319
EXCEPTING THEREOUT ALL MINES AND MINERALS

ESTATE: FEE SIMPLE

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 041 173 095 +1

REGISTERED OWNER(S)				
REGISTRATION	DATE(DMY)	DOCUMENT TYPE	VALUE	CONSIDERATION
051 050 800	09/02/2005	TRANSFER OF LAND		SEE INSTRUMENT

OWNERS

STEVE DENECKY
OF RR 8, SITE 21, COMP 16
LETHBRIDGE
ALBERTA T1J 4P4
AS TO AN UNDIVIDED 4/9 INTEREST

NICK DENECKY
OF 4005 10 ST W
LETHBRIDGE
ALBERTA T1J 4S8
AS TO AN UNDIVIDED 4/9 INTEREST

MARY WESTRUP

(CONTINUED)



ALBERTA REGISTRIES
LAND TITLE CERTIFICATE

S

LINC

0031 436 215

SHORT LEGAL

4;22;8;24;SW

TITLE NUMBER

051 461 590 +103

LEGAL DESCRIPTION

MERIDIAN 4 RANGE 22 TOWNSHIP 8

SECTION 24

QUARTER SOUTH WEST

CONTAINING 64.7 HECTARES (160 ACRES) MORE OR LESS

EXCEPTING THEREOUT:

PLAN	NUMBER	HECTARES	(ACRES)	MORE OR LESS
ROAD	7410377	1.62	4.00	
ROAD	9112075	1.93	4.77	
SUBDIVISION	0010942	4.570	11.3	
SUBDIVISION	0012775	6.114	15.11	
SUBDIVISION	0110136	3.23	7.98	
ROAD	0113064	1.850	4.57	
SUBDIVISION	0211008	2.995	7.40	
SUBDIVISION	0214165	0.966	2.39	
SUBDIVISION	0214169	3.408	8.42	
SUBDIVISION	0410046	5.446	13.46	
SUBDIVISION	0410575	0.508	1.26	
SUBDIVISION	0414423	2.179	5.38	
SUBDIVISION	0514137	1.548	3.83	

EXCEPTING THEREOUT ALL MINES AND MINERALS

ESTATE: FEE SIMPLE

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 041 468 177 +90

REGISTERED OWNER(S)				
REGISTRATION	DATE(DMY)	DOCUMENT TYPE	VALUE	CONSIDERATION

051 461 590 05/12/2005 SUBDIVISION PLAN

OWNERS

THE CITY OF LETHBRIDGE.

OF 910 - 4TH AVENUE SOUTH, LETHBRIDGE,

(CONTINUED)



ALBERTA REGISTRIES
LAND TITLE CERTIFICATE

S
LINC SHORT LEGAL TITLE NUMBER
0030 356 753 4;22;8;24;SE 041 072 310 +28

LEGAL DESCRIPTION

MERIDIAN 4 RANGE 22 TOWNSHIP 8
SECTION 24
QUARTER SOUTH EAST
CONTAINING 64.7 HECTARES (160 ACRES) MORE OR LESS
EXCEPTING THEREOUT:

A) PLAN	NUMBER	HECTARES	(ACRES)	MORE OR LESS
ROAD	7410377	1.57	3.88	
ROAD	9310096	0.248	0.61	
SUBDIVISION	0111806	0.106	0.26	
ROAD	0113064	16.166	39.95	

B) THOSE PORTIONS OF RIVERVIEW PARKWAY WEST ON PLAN 9112075 WHICH
LIE OUTSIDE THE LIMITS OF CHINOOK TRAIL WEST ON PLAN 0113064
CONTAINING 1.95 HECTARES (4.81 ACRES) MORE OR LESS

C) PLAN	NUMBER	HECTARES	ACRES	MORE OR LESS
SUBDIVISION	0210062	17.635	43.58	
SUBDIVISION	0410575	1.741	4.30	

EXCEPTING THEREOUT ALL MINES AND MINERALS

ESTATE: FEE SIMPLE

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 021 011 908 +1

REGISTERED OWNER(S)
REGISTRATION DATE(DMY) DOCUMENT TYPE VALUE CONSIDERATION

041 072 310 23/02/2004 SUBDIVISION PLAN

OWNERS

THE CITY OF LETHBRIDGE.
OF 910-4 ST SOUTH
LETHBRIDGE
ALBERTA T1J 0P6

(CONTINUED)



LAND TITLE CERTIFICATE

S

LINC

0031 442 577

SHORT LEGAL

4;22;8;14;NE

TITLE NUMBER

051 463 980 +125

LEGAL DESCRIPTION

MERIDIAN 4 RANGE 22 TOWNSHIP 8

SECTION 14

QUARTER NORTH EAST

CONTAINING 64.7 HECTARES (160 ACRES) MORE OR LESS

EXCEPTING THEREOUT:

PLAN	NUMBER	HECTARES	(ACRES)	MORE OR LESS
SUBDIVISION	0514137	1.555	3.84	
SUBDIVISION	0514150	14.040	34.69	
SUBDIVISION	0514162	7.583	18.74	

EXCEPTING THEREOUT ALL MINES AND MINERALS

ESTATE: FEE SIMPLE

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 051 462 293 +5

REGISTERED OWNER(S)					
REGISTRATION	DATE(DMY)	DOCUMENT	TYPE	VALUE	CONSIDERATION

051 463 980 06/12/2005 SUBDIVISION PLAN

OWNERS

THE CITY OF LETHBRIDGE.
OF LETHBRIDGE
ALBERTA

ENCUMBRANCES, LIENS & INTERESTS

REGISTRATION		
NUMBER	DATE (D/M/Y)	PARTICULARS

(CONTINUED)



LAND TITLE CERTIFICATE

S
LINC SHORT LEGAL TITLE NUMBER
0022 111 827 4;22;8;14;SE 021 133 592

LEGAL DESCRIPTION

MERIDIAN 4 RANGE 22 TOWNSHIP 8
SECTION 14
QUARTER SOUTH EAST
CONTAINING 64.7 HECTARES (160 ACRES) MORE OR LESS
EXCEPTING THEREOUT:

PLAN	NUMBER	HECTARES	ACRES MORE OR LESS
EXTRA ROADWAY	889HQ	1.056	2.61

EXCEPTING THEREOUT ALL MINES AND MINERALS

ESTATE: FEE SIMPLE

MUNICIPALITY: CITY OF LETHBRIDGE

REFERENCE NUMBER: 011 043 743

REGISTERED OWNER(S)				
REGISTRATION	DATE(DMY)	DOCUMENT TYPE	VALUE	CONSIDERATION
021 133 592	22/04/2002	TRANSFER OF LAND		SEE INSTRUMENT

OWNERS

DIANNE WENSVEEN
OF 3011-6 AVENUE SOUTH
LETHBRIDGE
ALBERTA T1J 1E9
AS TO AN UNDIVIDED 1/2 INTEREST

JOAN OLESKY
OF 49, 22458 TWP. RD. 510
SHERWOOD PARK
ALBERTA T8C 1H1
AS TO AN UNDIVIDED 1/2 INTEREST

(CONTINUED)



**Petroleum Tank Management
Association of Alberta**

Suite 980, 10303 Jasper Avenue
Edmonton, Alberta T5J 3N6
PH: (780)425-8265 or 1-866-222-8265
FAX: (780)425-4722

July 18, 2007

Deryck Masterman
EBA Engineering Consultants Ltd.
442 10 Street N
Lethbridge, AB
T1H 2C7

Dear Deryck Masterman:

As per your request, the PTMAA has checked the registration of active tank sites and inventory of abandoned tank sites and there are no records for the properties with the legal land description:

4040 & 5050 - 10 Street West, Lethbridge
E1/2 14-8-22-W4

Please note that both databases are not complete. The main limitation of these databases is that they only include information reported through registration or a survey of abandoned sites completed in 1992 and should not be considered as a comprehensive inventory of all past or present storage tank sites. The PTMAA cannot guarantee that tanks do not or have not existed at this location. Information in the databases is based on information supplied by the owner and the PTMAA cannot guarantee its accuracy. Information on storage tanks or on past or present contaminant investigations may be filed with the local Fire Department or Alberta Environment.

Yours truly,

A handwritten signature in black ink, appearing to read 'Connie Jacobsen', is written over a horizontal line.

Connie Jacobsen
PTMAA



Petroleum Tank Management Association of Alberta

Suite 980, 10303 Jasper Avenue
Edmonton, Alberta T5J 3N6
PH: (780)425-8265 or 1-866-222-8265
FAX: (780)425-4722

May 29, 2007

Deryck Masterman
EBA Engineering Consultants Ltd.
442 10 Street N
Lethbridge, AB
T1H 2C7

Dear Deryck Masterman:

As per your request, the PTMAA has checked the registration of active tank sites and inventory of abandoned tank sites and there are no records for the properties with the legal land description:

4005 - 10 Str. (NW 13-8-22-W4), Lethbridge
4805 - 10 Str. (NW 13-8-22-W4), Lethbridge
5255 - 10 Str. (SW 13-8-22-W4), Lethbridge
650 - 40 Ave. (Plan 0414514, Block1, Lot1, NW13-8-22-W4 & SW 24-8-22-W4), Lethbridge
4 Canyon Blvd. (Plan 9211466, Block 4 NE 13-8-22-W4), Lethbridge
505 - 40 Ave (SE 24-8-22-W4), Lethbridge
509 - 40 Ave (Plan 0210062, Block 1, Lot 14 SE 24-8-22-W4), Lethbridge

Please note that both databases are not complete. The main limitation of these databases is that they only include information reported through registration or a survey of abandoned sites completed in 1992 and should not be considered as a comprehensive inventory of all past or present storage tank sites. The PTMAA cannot guarantee that tanks do not or have not existed at this location. Information in the databases is based on information supplied by the owner and the PTMAA cannot guarantee its accuracy. Information on storage tanks or on past or present contaminant investigations may be filed with the local Fire Department or Alberta Environment.

Yours truly,

Connie Jacobsen
PTMAA

CREATING AND DELIVERING BETTER SOLUTIONS

www.eba.ca

May 29, 2007

EBA File: L22101051

Alberta Infrastructure and Transportation
Dangerous Goods Control Branch
Traffic Safety Services Division
Main Floor, Twin Atria Building
4999 - 98 Avenue
Edmonton AB T6B 2X3

Via Fax: 780.427.1044

Attention: Duty Officer

Dear Sir/Madam:

Subject Request for Information

EBA Engineering Consultants Ltd. (EBA) has been commissioned to conduct an environmental assessment of eight properties located within the City of Lethbridge, Alberta. The properties are legally described as:

- 4005 - 10 Street West and is located in the NW ¼ 13-008-22 W4M;
- 4805 - 10 Street West and is located in the NW ¼ 13-008-22 W4M;
- 5255 - 10 Street West and is located in the SW ¼ 13-008-22 W4M;
- 650 - 40 Avenue West Lot 1; Block 1; Plan 0414514 and is partially located within the NW ¼ 13-008-22 W4M and the SW ¼ 24-008-22 W4M;
- 500 - 40 Avenue West and is located in the NE ¼ 13-008-22 W4M;
- 4 Canyon Blvd. West; Block 4; Plan 9211466 and is located in the NE ¼ 13-008-22 W4M;
- 505 - 40 Avenue West and is located in the SE ¼ 24-008-22 W4M; and
- 509 - 40 Avenue West; Lot 14; Block 1; Plan 0210062 and is located in the SE ¼ 24-008-22 W4M.

We would be grateful if you would kindly provide any information or concerns that Alberta Environment may have regarding these sites pertaining to current or former underground storage tanks, any spills or release of contaminants and/or any contaminant investigation on or around the subject properties.

NO REPORTED DANGEROUS GOODS
INCIDENTS OCCURRED AT OR NEAR
THE LOCATION(S) SPECIFIED BY YOU.

YOUR REF:

See May 29/07

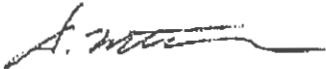
EBA Engineering Consultants Ltd.
p. 403.329.9009 • f. 403.328.8817
442 - 10 Street N • Lethbridge, Alberta T1H 2C7 • CANADA



L22101051
May 29, 2007
2

Thank you for your assistance in this matter.

Yours truly,
EBA Engineering Consultants Ltd.



Deryck Masterman, B.Sc., A.Ag.
Environmental Scientist

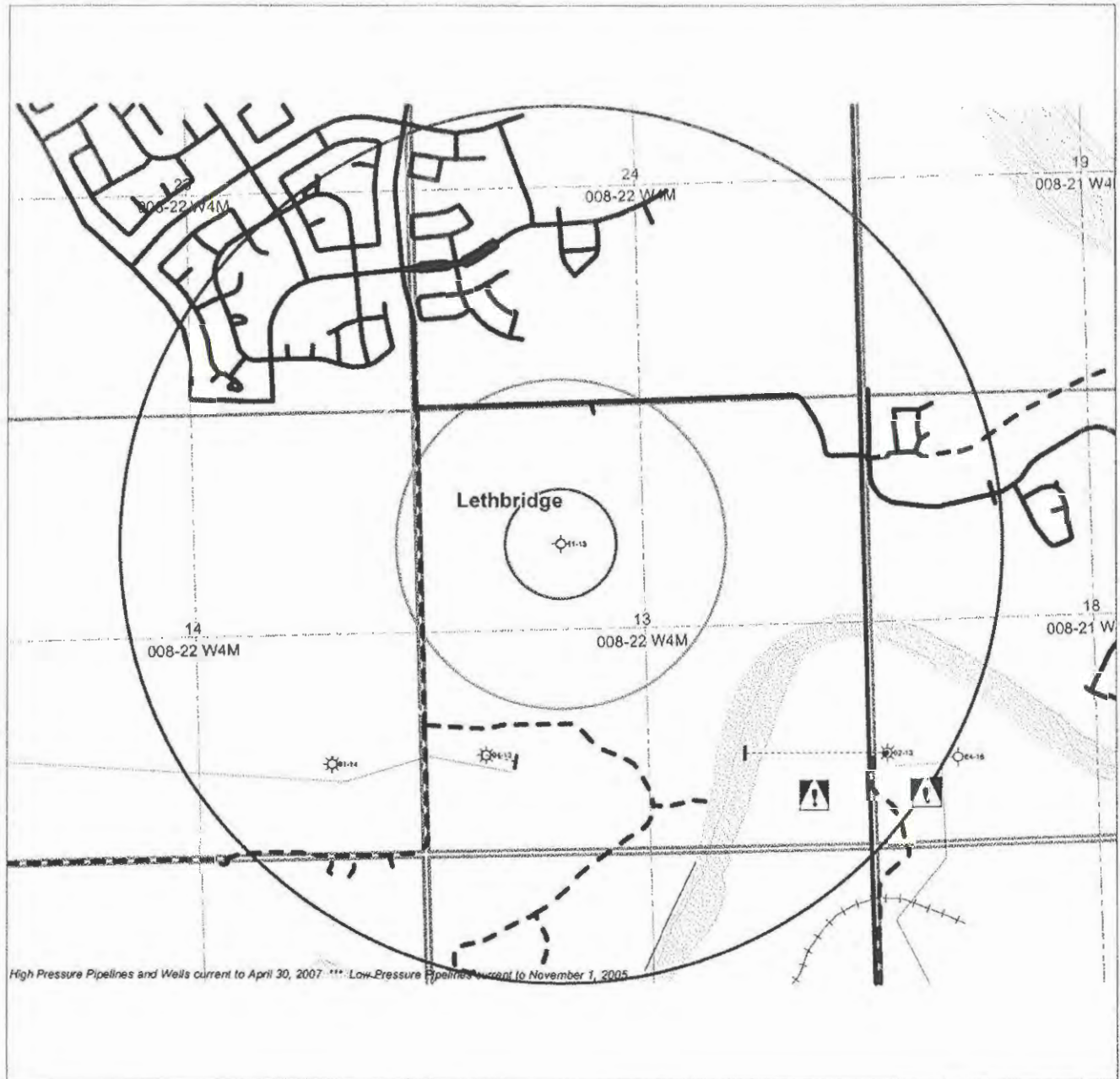
/cld



ATTN:



L22101051: Phase I ESA - Riverbend Subdivision, Lethbridge, AB



- Wellheads**
- ◊ Abandoned Wellhead
 - ⋈ Suspended Gas Wellhead
 - ⊙ Suspended Oil Wellhead
 - ⊙ Flowing Gas Wellhead
 - ⊙ Location Wellhead
 - ⊙ Flowing Oil Wellhead
 - ⊙ Miscellaneous Wellhead
 - ⊙ Water Wellhead
 - ⊙ Well Downhole Location
 - ⊙ Newly Licensed Well
 - ⊙ Newly Spudded Well
- High Pressure Pipelines**
- Gas Pipeline
 - Oil Pipeline
 - Water Pipeline
 - LVP/Hyp Pipeline
 - Foreign Pipeline (Only when a company is specified)
- Low Pressure Pipelines**
- Gas Co-op Pipeline

EUB DATA		ATTACHED FILES		Close Screen	
WELL INFORMATION CURRENT TO APRIL 30, 2007					
EVENT: 0					
WELL ID:		00 / 11-13-008-22 W4 / 0		RecCertified	
LICENCE #:		0061612		LICENCE DATE: DECEMBER 13, 1976	
WELL NAME:		WEST-CAN ET AL LETHBRIDGE 11-13-8-22			
WITHIN:		11-13-008-22 W4		H2S (mol/kmol): NOT AVAILABLE	
LICENCEE:		WEST-CAN HYDROCARBON FUND LTD.			
SPUD DATE:		FEBRUARY 6, 1977		FINAL DRILL DATE: FEBRUARY 14, 1977	
STATUS:		ABD		ABANDONED DATE: FEBRUARY 18, 1977	
SURFACE:		DOWNHOLE:			
OFFSETS:		S 502.9 E 508.1		OFFSETS: S 502.9 E 508.1	
LATITUDE:		49.650166		LATITUDE: 49.650166	
LONGITUDE:		112.862325		LONGITUDE: 112.862325	
GROUND ELEVATION:		929.9 m 3051 '		TOTAL DEPTH: 1371.6 m 4500 '	
WELL TYPE:		NOT AVAILABLE		SUBSTANCE: NOT AVAILABLE	

OPTIONS
[Open Well Plat](#)
[Request Divestco Log](#)
[Create CBM Report](#)
[Add To Custom Well List](#)
[Print Screen](#)

MORE INFO
[Select Info to View](#)

EUB DATA		ATTACHED FILES		Close Screen																																																																															
WELL INFORMATION CURRENT TO APRIL 30, 2007																																																																																			
EVENT: 0																																																																																			
<table border="1"><tr><td>WELL ID:</td><td colspan="5">00 / 04-13-008-22 W4 / 0</td></tr><tr><td>LICENCE #:</td><td>0244815</td><td>LICENCE DATE:</td><td colspan="3">NOVEMBER 22, 2000</td></tr><tr><td>WELL NAME:</td><td colspan="5">BONAVISTA PENNY 4-13-8-22</td></tr><tr><td>WITHIN:</td><td>04-13-008-22 W4</td><td>H2S (mol/kmol):</td><td colspan="3">0 (NO ANALYSIS)</td></tr><tr><td>LICENCEE:</td><td colspan="5">BONAVISTA PETROLEUM LTD.</td></tr><tr><td>SPUD DATE:</td><td>JANUARY 10, 2001</td><td>FINAL DRILL DATE:</td><td colspan="3">JANUARY 14, 2001</td></tr><tr><td>STATUS:</td><td>GAS FLOW</td><td>ABANDONED DATE:</td><td colspan="3"></td></tr><tr><td>SURFACE:</td><td colspan="5">DOWNHOLE:</td></tr><tr><td>OFFSETS:</td><td>N 348.6 E 219.1</td><td>OFFSETS:</td><td colspan="3">N 322.2 E 326.7</td></tr><tr><td>LATITUDE:</td><td>49.643313</td><td>LATITUDE:</td><td colspan="3">49.643066</td></tr><tr><td>LONGITUDE:</td><td>112.866352</td><td>LONGITUDE:</td><td colspan="3">112.864863</td></tr><tr><td>GROUND ELEVATION:</td><td>930.2 m</td><td>3052 '</td><td>TOTAL DEPTH:</td><td>1122 m</td><td>3681 '</td></tr><tr><td>WELL TYPE:</td><td>NOT AVAILABLE</td><td>SUBSTANCE:</td><td colspan="3">NOT AVAILABLE</td></tr></table>						WELL ID:	00 / 04-13-008-22 W4 / 0					LICENCE #:	0244815	LICENCE DATE:	NOVEMBER 22, 2000			WELL NAME:	BONAVISTA PENNY 4-13-8-22					WITHIN:	04-13-008-22 W4	H2S (mol/kmol):	0 (NO ANALYSIS)			LICENCEE:	BONAVISTA PETROLEUM LTD.					SPUD DATE:	JANUARY 10, 2001	FINAL DRILL DATE:	JANUARY 14, 2001			STATUS:	GAS FLOW	ABANDONED DATE:				SURFACE:	DOWNHOLE:					OFFSETS:	N 348.6 E 219.1	OFFSETS:	N 322.2 E 326.7			LATITUDE:	49.643313	LATITUDE:	49.643066			LONGITUDE:	112.866352	LONGITUDE:	112.864863			GROUND ELEVATION:	930.2 m	3052 '	TOTAL DEPTH:	1122 m	3681 '	WELL TYPE:	NOT AVAILABLE	SUBSTANCE:	NOT AVAILABLE		
WELL ID:	00 / 04-13-008-22 W4 / 0																																																																																		
LICENCE #:	0244815	LICENCE DATE:	NOVEMBER 22, 2000																																																																																
WELL NAME:	BONAVISTA PENNY 4-13-8-22																																																																																		
WITHIN:	04-13-008-22 W4	H2S (mol/kmol):	0 (NO ANALYSIS)																																																																																
LICENCEE:	BONAVISTA PETROLEUM LTD.																																																																																		
SPUD DATE:	JANUARY 10, 2001	FINAL DRILL DATE:	JANUARY 14, 2001																																																																																
STATUS:	GAS FLOW	ABANDONED DATE:																																																																																	
SURFACE:	DOWNHOLE:																																																																																		
OFFSETS:	N 348.6 E 219.1	OFFSETS:	N 322.2 E 326.7																																																																																
LATITUDE:	49.643313	LATITUDE:	49.643066																																																																																
LONGITUDE:	112.866352	LONGITUDE:	112.864863																																																																																
GROUND ELEVATION:	930.2 m	3052 '	TOTAL DEPTH:	1122 m	3681 '																																																																														
WELL TYPE:	NOT AVAILABLE	SUBSTANCE:	NOT AVAILABLE																																																																																
OPTIONS Open Well Plat Request Divestco Log Create CBM Report Add To Custom Well List Print Screen MORE INFO Select Info to View																																																																																			

EUB DATA		ATTACHED FILES		Close Screen																																																																															
WELL INFORMATION CURRENT TO APRIL 30, 2007				OPTIONS																																																																															
EVENT: 2				Open Well Plat																																																																															
				Request Divestco Log																																																																															
				Create CBM Report																																																																															
				Add To Custom Well List																																																																															
				Print Screen																																																																															
				MORE INFO																																																																															
				Select Info to View																																																																															
<table border="1"><tr><td>WELL ID:</td><td colspan="5">00 / 01-14-008-22 W4 / 2</td></tr><tr><td>LICENCE #:</td><td>0236003</td><td>LICENCE DATE:</td><td colspan="3">APRIL 6, 2000</td></tr><tr><td>WELL NAME:</td><td colspan="5">BONAVISTA PENNY 1-14-8-22</td></tr><tr><td>WITHIN:</td><td>01-14-008-22 W4</td><td>H2S (mol/kmol):</td><td colspan="3">0 (NO ANALYSIS)</td></tr><tr><td>LICENCEE:</td><td colspan="5">BONAVISTA PETROLEUM LTD.</td></tr><tr><td>SPUD DATE:</td><td>APRIL 12, 2000</td><td>FINAL DRILL DATE:</td><td colspan="3">APRIL 15, 2000</td></tr><tr><td>STATUS:</td><td>GAS FLOW</td><td>ABANDONED DATE:</td><td colspan="3"></td></tr><tr><td>SURFACE:</td><td colspan="5">DOWNHOLE:</td></tr><tr><td>OFFSETS:</td><td>N 325.9 W 326</td><td>OFFSETS:</td><td colspan="3">N 325.9 W 326</td></tr><tr><td>LATITUDE:</td><td>49.643143</td><td>LATITUDE:</td><td colspan="3">49.643143</td></tr><tr><td>LONGITUDE:</td><td>112.874183</td><td>LONGITUDE:</td><td colspan="3">112.874183</td></tr><tr><td>GROUND ELEVATION:</td><td>930.4 m</td><td>3052 '</td><td>TOTAL DEPTH:</td><td>1129 m</td><td>3704 '</td></tr><tr><td>WELL TYPE:</td><td>NOT AVAILABLE</td><td>SUBSTANCE:</td><td colspan="3">NOT AVAILABLE</td></tr></table>						WELL ID:	00 / 01-14-008-22 W4 / 2					LICENCE #:	0236003	LICENCE DATE:	APRIL 6, 2000			WELL NAME:	BONAVISTA PENNY 1-14-8-22					WITHIN:	01-14-008-22 W4	H2S (mol/kmol):	0 (NO ANALYSIS)			LICENCEE:	BONAVISTA PETROLEUM LTD.					SPUD DATE:	APRIL 12, 2000	FINAL DRILL DATE:	APRIL 15, 2000			STATUS:	GAS FLOW	ABANDONED DATE:				SURFACE:	DOWNHOLE:					OFFSETS:	N 325.9 W 326	OFFSETS:	N 325.9 W 326			LATITUDE:	49.643143	LATITUDE:	49.643143			LONGITUDE:	112.874183	LONGITUDE:	112.874183			GROUND ELEVATION:	930.4 m	3052 '	TOTAL DEPTH:	1129 m	3704 '	WELL TYPE:	NOT AVAILABLE	SUBSTANCE:	NOT AVAILABLE		
WELL ID:	00 / 01-14-008-22 W4 / 2																																																																																		
LICENCE #:	0236003	LICENCE DATE:	APRIL 6, 2000																																																																																
WELL NAME:	BONAVISTA PENNY 1-14-8-22																																																																																		
WITHIN:	01-14-008-22 W4	H2S (mol/kmol):	0 (NO ANALYSIS)																																																																																
LICENCEE:	BONAVISTA PETROLEUM LTD.																																																																																		
SPUD DATE:	APRIL 12, 2000	FINAL DRILL DATE:	APRIL 15, 2000																																																																																
STATUS:	GAS FLOW	ABANDONED DATE:																																																																																	
SURFACE:	DOWNHOLE:																																																																																		
OFFSETS:	N 325.9 W 326	OFFSETS:	N 325.9 W 326																																																																																
LATITUDE:	49.643143	LATITUDE:	49.643143																																																																																
LONGITUDE:	112.874183	LONGITUDE:	112.874183																																																																																
GROUND ELEVATION:	930.4 m	3052 '	TOTAL DEPTH:	1129 m	3704 '																																																																														
WELL TYPE:	NOT AVAILABLE	SUBSTANCE:	NOT AVAILABLE																																																																																

ENVIRONMENTAL LAW CENTRE

Suite 800, 10025 - 106 Street, Edmonton, AB T5J 1G4

Phone: (780) 424-5099 Fax: (780) 424-5133

E-Mail: elc@elc.ab.ca Home Page: <http://www.elc.ab.ca>

June 4, 2007

Our File: 013918

Mr. Deryck Masterman
EBA Engineering Consultants Ltd.
442 - 10 Street North
Lethbridge, AB T1H 2C7

RECEIVED

JUN 7 2007

EBA Engineering
Consultants Ltd.

Dear Mr. Masterman:

RE: Search Requested - NW-13-008-22-W4M

In response to your request of June 4, 2007, we have searched the Wellsite Reclamation Historical Search Service database for the following quarter section of land:

W4-22-008-13 NW1/4

and can advise that as of today's date, the reclamation actions listed in the attached report have been issued under the "Alberta Environmental Protection and Enhancement Act" and its predecessor legislation, the "Land Surface Conservation and Reclamation Act", and the "Surface Reclamation Act" since 1963. This search is limited to the following reclamation actions: Reclamation Certificates (applied for, issued and cancelled); Reclamation Orders and Conservation and Reclamation Notices.

Information offered by the Wellsite Reclamation Historical Search Service is limited to wellsites, oil production sites, pipelines, compressor sites and some sand and gravel operations on Alberta private land, Special Areas Board land constituted under the "Special Areas Act" and Metis Settlements established under the "Metis Settlements Act". Not included are coal or oil sands mines or exploration sites.

These search results are based on information provided by Alberta Environment ("AENV"). AENV advises that they try to provide the best information possible. However, AENV advises that it cannot guarantee that the information provided is complete or accurate and that any person relying on these search results does so at their own risk.

Information about Environmental Protection Orders, Emergency Environment Protection Orders and Enforcement Orders issued under the "Alberta Environmental Protection and Enhancement Act" can be obtained by searching the Environmental Enforcement Historical Search Service database through the Environmental Law Centre.

Yours sincerely,



Yankui Lee
Wellsite Reclamation Search Service Coordinator
/id
Encl.

ENVIRONMENTAL LAW CENTRE

Suite 800, 10025 - 106 Street, Edmonton, AB T5J 1G4

Phone: (780) 424-5099 Fax: (780) 424-5133

Home Page: <http://www.elc.ab.ca> E-Mail: elc@elc.ab.ca

WELLSITE HISTORICAL SEARCH SERVICE

Legal Description	Reclamation Certificate Action	Description	Company / Operator	Date Received	Status	Status Date
W4-22-008-13-NW-11	Certificate: 54-16758	WEST CAN ET AL LETHBRIDGE 11-13-8-22 WELL	West-Can Hydrocarbon Fund Ltd.	09-Jun-1977	Issued	09-Sep-1977

Report Run:

June 4, 2007
3:53 PM

Page 1 of 1

Report Issued:

Land Summary Report

Reclamation Certificate Codes:

Certificate: Reclamation Certificate
Appeal: Appeal before the Environmental Board
C/R Notice: Conservation and Reclamation Notice
Order: Reclamation Order

Enforcement: Environmental Protection Order or
Emergency Environmental Protection Order or
Enforcement Order



ENVIRONMENT

Environmental Coordination Services

403/427-6212

Land Conservation and

Telex 097-2906, TWX 810-831-2636

Reclamation Council

11th Floor, Oxbridge Place

9820 - 108 Street

Edmonton, Alberta, Canada

T5K 2J6

County No. 26

Reclamation Certificate No. 16758

This is to certify that the surface of the land held
by West Can Hydrocarbon Fund Ltd.

within NW $\frac{1}{4}$ Sec. 13 Tp. 8 Rge. 22 W. 4th Mer.

In connection with or incidental to West Can et al Lethbridge
11-13-8-22 well, as shown outlined in yellow on the plan
attached hereto, was found to be in a satisfactory condition.

Dated at LETHBRIDGE, Alberta

this 1 day of SEPTEMBER, 1977

Surface Reclamation Council

Tri-West Land Consultants Ltd.
2602, 506 - 6 Street S. W.
CALGARY, Alberta
T2P 1X5

Member

Member

Copy sent by REGISTERED mail to:

Date:

Denecky Brothers Grains Ltd.
c/o Nick Denecky
General Delivery
LETHBRIDGE, Alberta

September 9, 1977

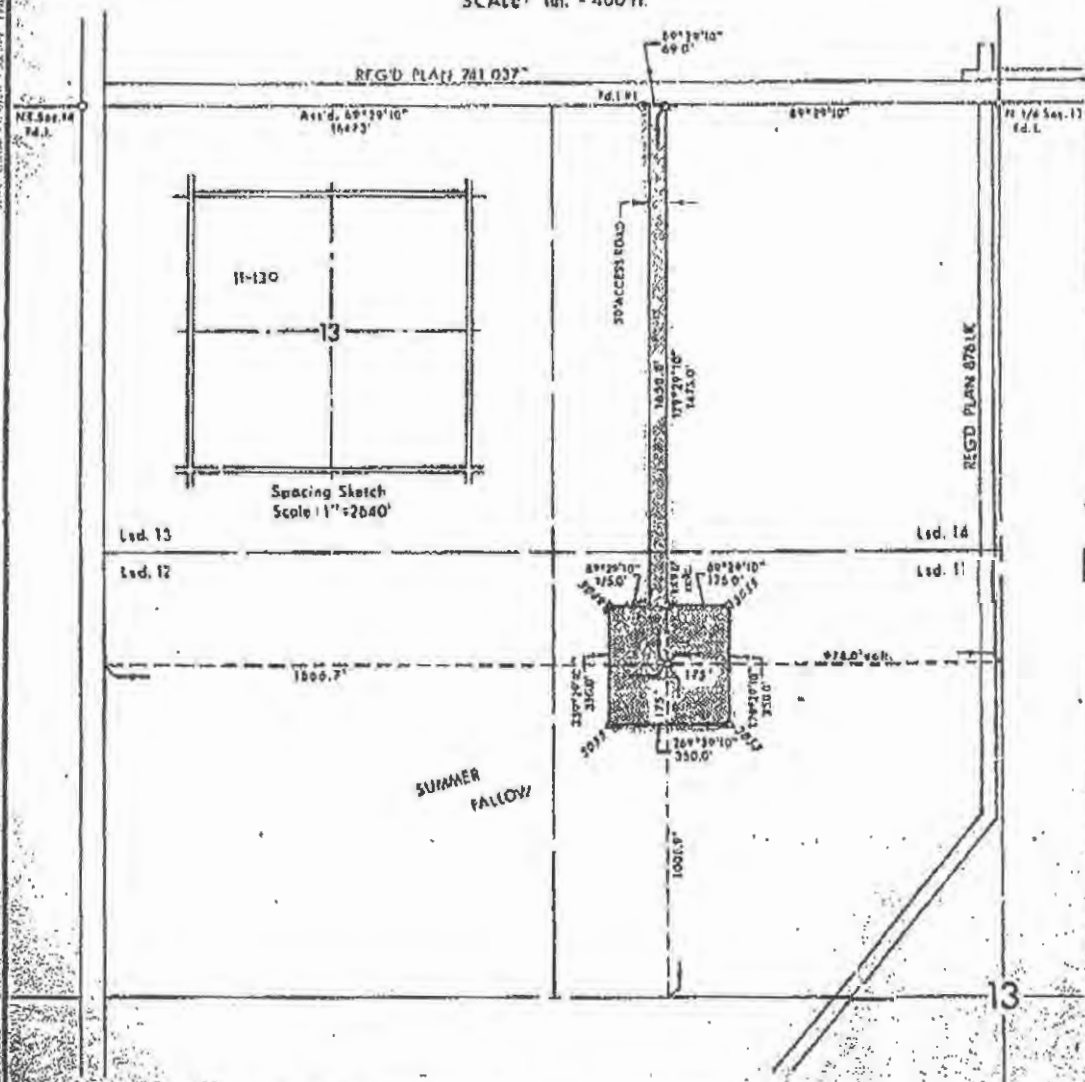
S. Tracy
Secretary

WEST CAN ET AL LETHBRIDGE 11-13-8-22

WELL SITE and ACCESS ROAD

Lsd. 11 Sec. 13 Twp. 8 Rge. 22 W.4M.

SCALE: 1 in. = 400 ft.



I certify that the survey represented by this plan is correct and true to the best of my knowledge and was completed on the 2nd day of Dec. A.D. 1976.

John Klump
 OPERATOR
 WEST CAN HYDROCARBON FUND LTD.



ELEVATION: 3051' Ground
 DATUM: Survey Control Monument 119100

CO-ORDINATES:
 1650.0' feet S of N.
 1000.7' feet E of W.
 By Sect. 13 - 8 - 22 W.4M.

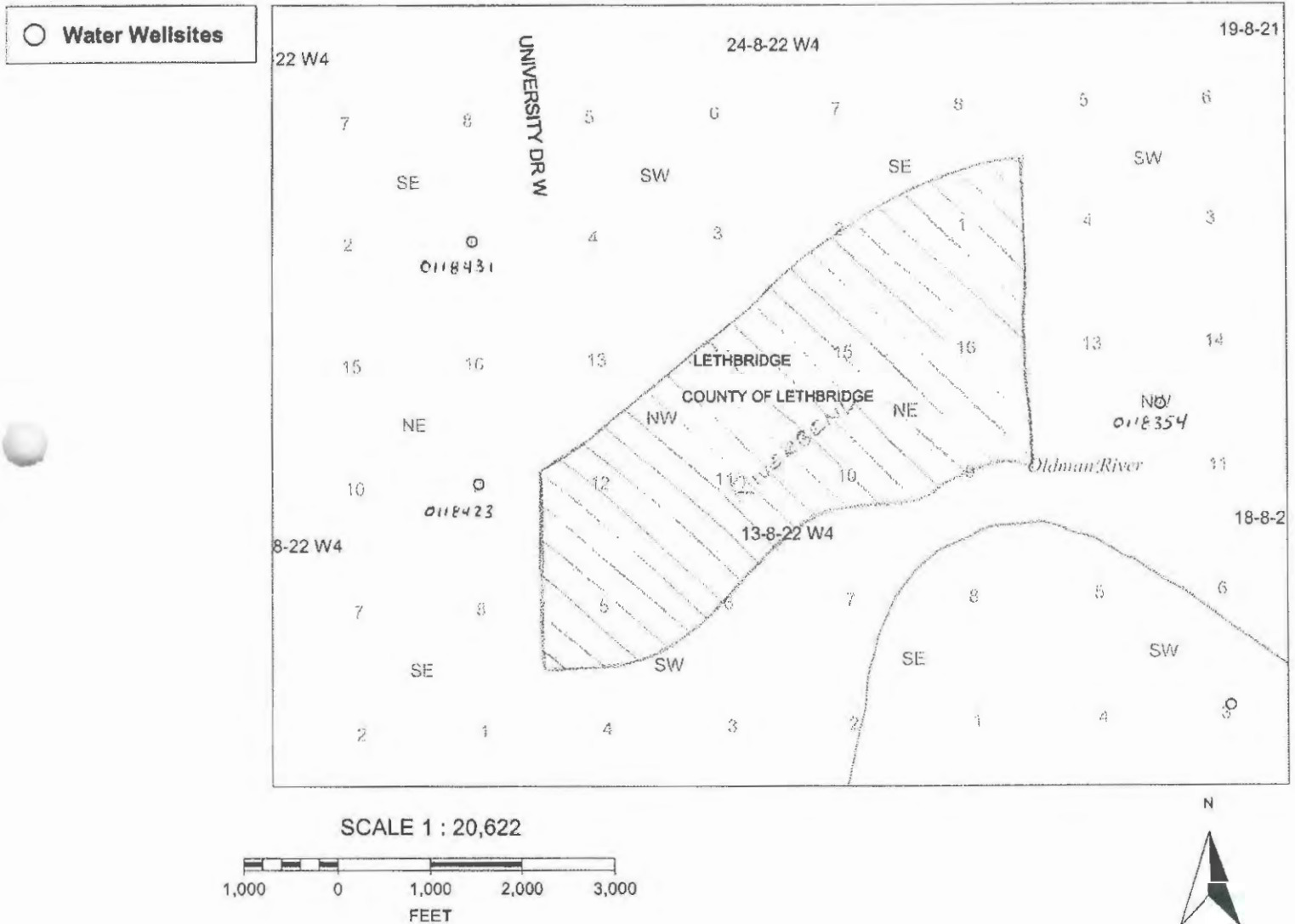
AREAS REQUIRED:
 Well Site - 2.81 acres
 Access Road - 1.52 acres Lsd. 14
 Access Road - 0.17 acres Lsd. 11
 TOTAL - 4.50 acres

LEGEND:

Distances shown are in feet
 Priority related to show that
 Survey Monuments found shown as
 12" iron posts placed shown as

JOB No. 72-020

TELUS Geomatics - Alberta Map





Water Well Drilling Report

The data contained in this report is supplied by the Driller. The province disclaims responsibility for its accuracy.

Well I.D.: 0118354
 Map Verified: Not Verified
 Date Report: 1965/06/08
 Received:
 Measurements: Imperial

1. Contractor & Well Owner Information		2. Well Location	
Company Name: UNKNOWN DRILLER	Drilling Company Approval No.: 99999	1/4 or Sec Twp Rge West of LSD M NW 18 008 21 4	
Mailing Address: UNKNOWN	City or Town: UNKNOWN AB CA	Postal Code:	
Well Owner's Name:	Well Location Identifier:	Location in Quarter 0 FT from Boundary 0 FT from Boundary	
P.O. Box Number:	Mailing Address:	Postal Code:	Lot Block Plan
City:	Province:	Country:	Well Elev: 3042 FT How Obtain: Estimated
3. Drilling Information		6. Well Yield	
Type of Work: Spring Reclaimed Well	Proposed well use: Domestic	Test Date (yyyy/mm/dd):	Start Time:
Date Reclaimed:	Materials Used:	Test Method:	
Method of Drilling: Unknown	Rate: Gallons Oil Present: No	Non pumping FT static level:	
Flowing Well:		Rate of water removal: Gallons/Min	
Gas Present: No		Depth of pump intake: FT	
4. Formation Log		5. Well Completion	
Depth from ground level (feet)	Lithology Description	Date Started (yyyy/mm/dd):	Date Completed (yyyy/mm/dd):
		Well Depth: 0 FT	Borehole Diameter: 0 Inches
		Casing Type:	Liner Type:
		Size OD: 0 Inches	Size OD: 0 Inches
		Wall Thickness: 0 Inches	Wall Thickness: 0 Inches
		Bottom at: 0 FT	Top: 0 FT Bottom: 0 FT
		Perforations from: 0 FT to: 0 FT	Perforations Size: 0 Inches x 0 Inches
		Perforations from: 0 FT to: 0 FT	Perforations Size: 0 Inches x 0 Inches
		Perforations from: 0 FT to: 0 FT	Perforations Size: 0 Inches x 0 Inches
		Perforated by:	
		Seal: from: 0 FT to: 0 FT	
		Seal: from: 0 FT to: 0 FT	
		Seal: from: 0 FT to: 0 FT	
		Screen Type: from: 0 FT to: 0 FT	Screen ID: 0 Inches Slot Size: 0 Inches
		Screen Type: from: 0 FT to: 0 FT	Screen ID: 0 Inches Slot Size: 0 Inches
		Screen Installation Method:	
		Fittings Top: Bottom:	
		Pack: Grain Size: Amount:	
		Geophysical Log Taken:	
		Retained on Files:	
		Additional Test and/or Pump Data	
		Chemistries taken By Driller: No	
		Held: 1 Documents Held: 2	
		Pitless Adapter Type:	
		Drop Pipe Type:	
		Length: Diameter:	
		Comments:	
7. Contractor Certification			
Driller's Name: UNKNOWN DRILLER			
Certification No.:			



Water Well Drilling Report

The data contained in this report is supplied by the Driller. The province disclaims responsibility for its accuracy.

Well I.D.: 0118423
 Map Verified: Field
 Date Report
 Received:
 Measurements: Imperial

1. Contractor & Well Owner Information		2. Well Location	
Company Name: UNKNOWN DRILLER	Drilling Company Approval No.: 99999	1/4 or Sec: Twp Rgs West of LSD 13	
Mailing Address: UNKNOWN	City or Town: UNKNOWN AB CA	Postal Code: 09 14 008 22 4	
Well Owner's Name: MCLEOD, M.	Well Location Identifier:	Location in Quarter 0 FT from Boundary	
P.O. Box Number:	Mailing Address: LETHBRIDGE	Postal Code:	Lot Block Plan
City:	Province:	Country:	Well Elev: 3054 FT
3. Drilling Information		6. Well Yield	
Type of Work: Structure Test Hole	Proposed well use: Industrial	Test Date (yyyy/mm/dd):	Start Time:
Reclaimed Well	Anticipated Water Requirements/day 0 Gallons	Test Method:	
Date Reclaimed:	Materials Used:	Non pumping FT static level:	
Method of Drilling: Drilled	Rate: Gallons Oil Present: No	Rate of water Gallons/Min removal:	
Flowing Well:		Depth of FT pump intake:	
Gas Present: No		Water level at FT end of pumping:	
4. Formation Log		5. Well Completion	
Depth from ground level (feet)	Lithology Description	Date Started (yyyy/mm/dd):	Date Completed (yyyy/mm/dd): 1953/05/02
		Well Depth: 800 FT	Borehole Diameter: 0 Inches
		Casing Type:	Liner Type:
		Size OD: 0 Inches	Size OD: 0 Inches
		Wall Thickness: 0 Inches	Wall Thickness: 0 Inches
		Bottom at: 0 FT	Top: 0 FT Bottom: 0 FT
		Perforations from: 0 FT to: 0 FT	Perforations Size: 0 Inches x 0 Inches
		Perforations from: 0 FT to: 0 FT	Perforations Size: 0 Inches x 0 Inches
		Perforations from: 0 FT to: 0 FT	Perforations Size: 0 Inches x 0 Inches
		Perforated by:	
		Seal: from: 0 FT to: 0 FT	
		Seal: from: 0 FT to: 0 FT	
		Seal: from: 0 FT to: 0 FT	
		Seal: from: 0 FT to: 0 FT	
		Screen Type: from: 0 FT to: 0 FT	Screen ID: 0 Inches Slot Size: 0 Inches
		Screen Type: from: 0 FT to: 0 FT	Screen ID: 0 Inches Slot Size: 0 Inches
		Screen Installation Method:	
		Fittings Top: Bottom:	
		Pack: Grain Size: Amount:	
		Geophysical Log Taken: ELECTRIC	
		Retained on Files: ELECTRIC yes	
		Additional Test and/or Pump Data	
		Chemistries taken By Driller: No	
		Held: 0 Documents Held: 1	
		Pitless Adapter Type:	
		Drop Pipe Type:	
		Length: Diameter:	
		Comments:	
7. Contractor Certification		Total Drawdown: FT	
Driller's Name: UNKNOWN DRILLER		If water removal was less than 2 hr duration, reason why:	
Certification No.:		Recommended pumping rate: Gallons/Min	
		Recommended pump intake: FT	
		Type pump installed	
		Pump type:	
		Pump model:	
		H.P.:	
		Any further pump test information?	



Water Well Drilling Report

The data contained in this report is supplied by the Driller. The province disclaims responsibility for its accuracy.

Well I.D.: 0118431
 Map Verified: Not Verified
 Date Report
 Received:
 Measurements: Imperial

1. Contractor & Well Owner Information

Company Name: UNKNOWN DRILLER Drilling Company Approval No.: 99999
 Mailing Address: UNKNOWN City or Town: UNKNOWN AB CA Postal Code:
 Well Owner's Name: LETHBRIDGE PETRO Well Location Identifier:
 P.O. Box Number: Mailing Address: Postal Code:
 City: Province: Country:

2. Well Location

1/4 or Sec Twp Rge West of
 LSD M
 01 23 008 22 4
 Location in Quarter
 0 FT from Boundary
 0 FT from Boundary
 Lot Block Plan
 Well Elev: 3056 FT How Obtain: Estimated

3. Drilling Information

Type of Work: Structure Test Hole
 Reclaimed Well Proposed well use: Industrial
 Date Reclaimed: Materials Used: Anticipated Water
 Method of Drilling: Drilled Requirements/day
 Flowing Well: Rate: Gallons 0 Gallons
 Gas Present: No Oil Present: No

6. Well Yield

Test Date Start Time:
 (yyyy/mm/dd):
 Test Method:
 Non pumping FT
 static level:
 Rate of water Gallons/Min
 removal:
 Depth of FT
 pump intake:
 Water level at FT
 end of
 pumping:
 Distance from Inches
 top of casing
 to ground
 level:
 Depth To water level (feet)
 Elapsed Time
 Drawdown Minutes:Sec Recovery

4. Formation Log

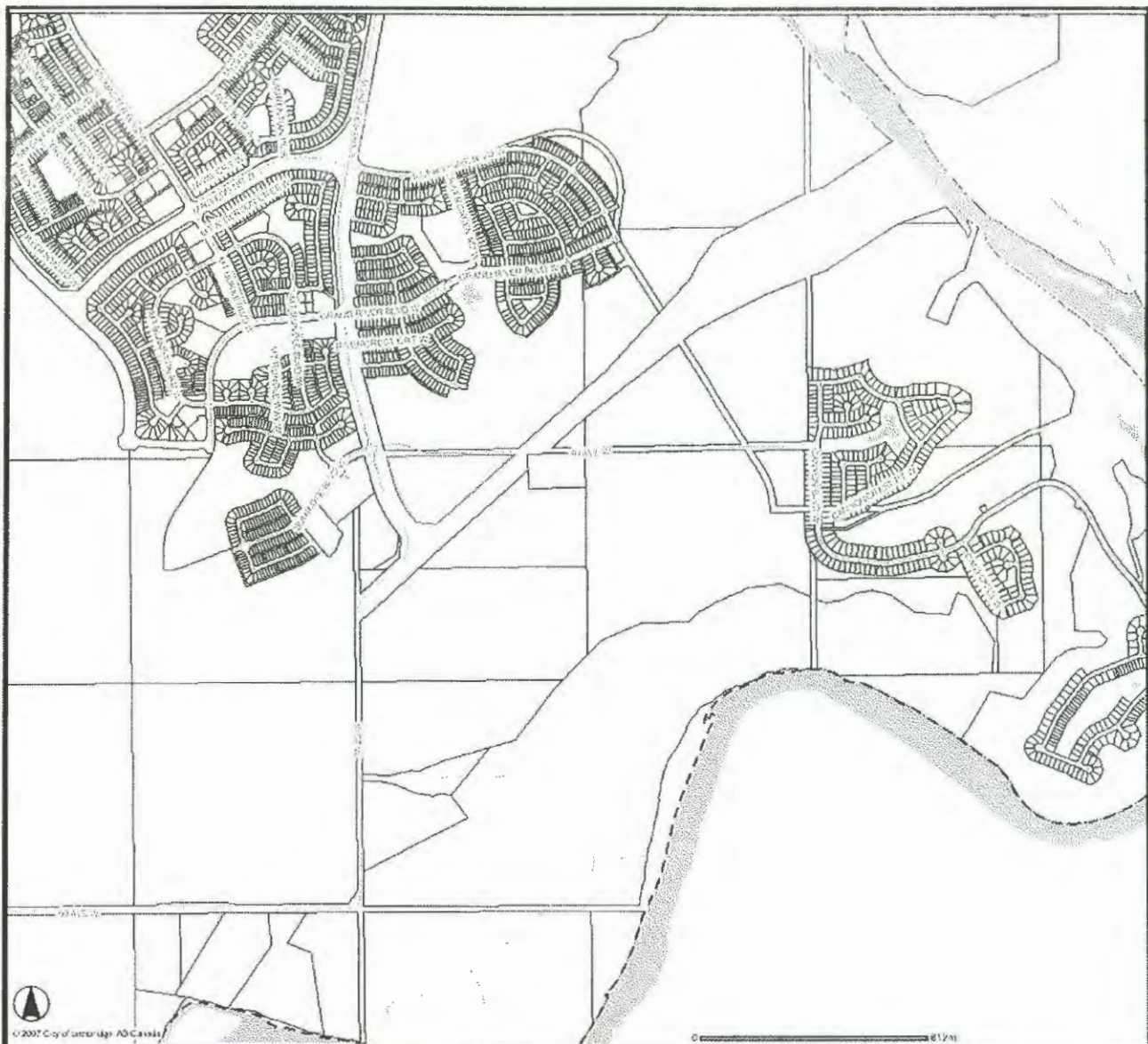
Depth from ground level (feet)	Lithology Description
50	Stoney Clay & Coal
60	Gray Shale
165	Gray Shale & Sandstone
175	Yellow Bentonitic Clay
180	Carbonaceous Shale & Sandstone
205	Gray Sandstone
210	Carbonaceous Shale & Coal
215	Shale & Sandstone
350	Light Gray Sandy Shale

5. Well Completion

Date Started(yyyy/mm/dd): Date Completed (yyyy/mm/dd): 1930/02/26
 Well Depth: 350 FT Borehole Diameter: 0 Inches
 Casing Type: Liner Type:
 Size OD: 0 Inches Size OD: 0 Inches
 Wall Thickness: 0 Inches Wall Thickness: 0 Inches
 Bottom at: 0 FT Top: 0 FT Bottom: 0 FT
 Perforations Perforations Size:
 from: 0 FT to: 0 FT 0 Inches x 0 Inches
 from: 0 FT to: 0 FT 0 Inches x 0 Inches
 from: 0 FT to: 0 FT 0 Inches x 0 Inches
 Perforated by:
 Seal:
 from: 0 FT to: 0 FT
 Seal:
 from: 0 FT to: 0 FT
 Seal:
 from: 0 FT to: 0 FT
 Screen Type: Screen ID: 0 Inches
 from: 0 FT to: 0 FT Slot Size: 0 Inches
 Screen Type: Screen ID: 0 Inches
 from: 0 FT to: 0 FT Slot Size: 0 Inches
 Screen Installation Method:
 Fittings
 Top: Bottom:
 Pack:
 Grain Size: Amount:
 Geophysical Log Taken:
 Retained on Files:
 Additional Test and/or Pump Data
 Chemistries taken By Driller: No
 Held: 0 Documents Held: 1
 Pitless Adapter Type:
 Drop Pipe Type:
 Length: Diameter:
 Comments:

7. Contractor Certification

Driller's Name: UNKNOWN DRILLER
 Certification No.:



CITY OF
Lethbridge

Phase I ESA: Paradise Subdivision, Lethbridge, AB

DISCLAIMER: This map is illustrative only. The City of Lethbridge offers this information in good faith, but makes no warranty or representation, expressed or implied, with regard to the correctness, accuracy and/or reliability of this data.

All rights reserved. No part of this map may be reproduced in any form or by any means without written consent from the City of Lethbridge.

©2007, City of Lethbridge, AB Canada

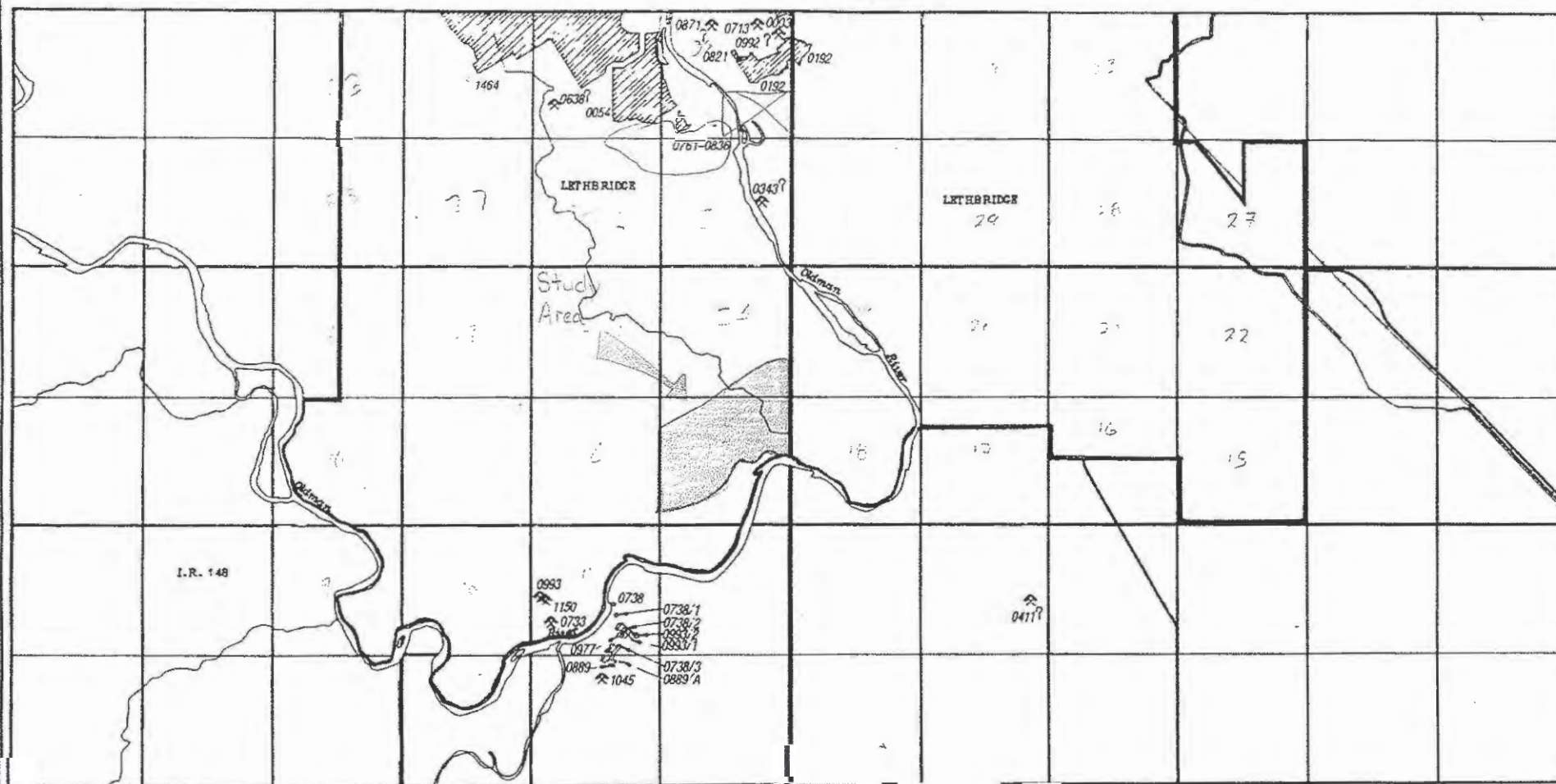
TOWNSHIP 8

RANGE 22

WEST 4 MERIDIAN

TOWNSHIP 8

RANGE 21



COAL MINE LOCATIONS IN ALBERTA

March 1988



- ? Mine location uncertain
- 9999 Mine number
- C99-99 Mine permit number
- or Underground mine
- or Surface mine
- Mine permit boundary (area currently approved for mining)

Map 027



APPENDIX

APPENDIX C EBA TERMS AND CONDITIONS

ENVIRONMENTAL REPORT – GENERAL CONDITIONS

This report incorporates and is subject to these “General Conditions”.

1.0 USE OF REPORT

This report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment.

This report and the assessments and recommendations contained in it are intended for the sole use of EBA's client. EBA does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than EBA's client unless otherwise authorized in writing by EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of EBA. Additional copies of the report, if required, may be obtained upon request.

2.0 LIMITATIONS OF REPORT

This report is based solely on the conditions which existed on site at the time of EBA's investigation. The client, and any other parties using this report with the express written consent of the client and EBA, acknowledge that conditions affecting the environmental assessment of the site can vary with time and that the conclusions and recommendations set out in this report are time sensitive.

The client, and any other party using this report with the express written consent of the client and EBA, also acknowledge that the conclusions and recommendations set out in this report are based on limited observations and testing on the subject site and that conditions may vary across the site which, in turn, could affect the conclusions and recommendations made.

The client acknowledges that EBA is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the client.

2.1 INFORMATION PROVIDED TO EBA BY OTHERS

During the performance of the work and the preparation of this report, EBA may have relied on information provided by persons other than the client. While EBA endeavours to verify the accuracy of such information when instructed to do so by the client, EBA accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

3.0 LIMITATION OF LIABILITY

The client recognizes that property containing contaminants and hazardous wastes creates a high risk of claims brought by third parties arising out of the presence of those materials. In consideration of these risks, and in consideration of EBA providing the services requested, the client agrees that EBA's liability to the client, with respect to any issues relating to contaminants or other hazardous wastes located on the subject site shall be limited as follows:

1. With respect to any claims brought against EBA by the client arising out of the provision or failure to provide services hereunder shall be limited to the amount of fees paid by the client to EBA under this Agreement, whether the action is based on breach of contract or tort;
2. With respect to claims brought by third parties arising out of the presence of contaminants or hazardous wastes on the subject site, the client agrees to indemnify, defend and hold harmless EBA from and against any and all claim or claims, action or actions, demands, damages, penalties, fines, losses, costs and expenses of every nature and kind whatsoever, including solicitor-client costs, arising or alleged to arise either in whole or part out of services provided by EBA, whether the claim be brought against EBA for breach of contract or tort.

4.0 JOB SITE SAFETY

EBA is only responsible for the activities of its employees on the job site and is not responsible for the supervision of any other persons whatsoever. The presence of EBA personnel on site shall not be construed in any way to relieve the client or any other persons on site from their responsibility for job site safety.

5.0 DISCLOSURE OF INFORMATION BY CLIENT

The client agrees to fully cooperate with EBA with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The client acknowledges that in order for EBA to properly provide the service, EBA is relying upon the full disclosure and accuracy of any such information.

6.0 STANDARD OF CARE

Services performed by EBA for this report have been conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Engineering judgement has been applied in developing the conclusions and/or recommendations provided in this report. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of this report.

7.0 EMERGENCY PROCEDURES

The client undertakes to inform EBA of all hazardous conditions, or possible hazardous conditions which are known to it. The client recognizes that the activities of EBA may uncover previously unknown hazardous materials or conditions and that such discovery may result in the necessity to undertake emergency procedures to protect EBA employees, other persons and the environment. These procedures may involve additional costs outside of any budgets previously agreed upon. The client agrees to pay EBA for any expenses incurred as a result of such discoveries and to compensate EBA through payment of additional fees and expenses for time spent by EBA to deal with the consequences of such discoveries.

8.0 NOTIFICATION OF AUTHORITIES

The client acknowledges that in certain instances the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the client agrees that notification to such bodies or persons as required may be done by EBA in its reasonably exercised discretion.

9.0 OWNERSHIP OF INSTRUMENTS OF SERVICE

The client acknowledges that all reports, plans, and data generated by EBA during the performance of the work and other documents prepared by EBA are considered its professional work product and shall remain the copyright property of EBA.

10.0 ALTERNATE REPORT FORMAT

Where EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed EBA's instruments of professional service), the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding. The hard copy versions submitted by EBA shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancies, the hard copy versions shall govern over the electronic versions. Furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed version archived by EBA shall be deemed to be the overall original for the Project.

The Client agrees that both electronic file and hard copy versions of EBA's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except EBA. The Client warrants that EBA's instruments of professional service will be used only and exactly as submitted by EBA.

The Client recognizes and agrees that electronic files submitted by EBA have been prepared and submitted using specific software and hardware systems. EBA makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

3. Geotechnical Evaluation

UMA Engineering Ltd.

**GEOTECHNICAL EVALUATION
RIVER BEND COMMUNITY OUTLINE PLAN
LETHBRIDGE, ALBERTA**

L12101023

September 2007

TABLE OF CONTENTS

	PAGE
1.0 INTRODUCTION.....	1
2.0 PROJECT DETAILS AND SCOPE OF WORK.....	1
3.0 SITE DESCRIPTION.....	3
3.1 Surface Description.....	3
3.2 Historical Aerial Photographic Review	4
4.0 GEOTECHNICAL FIELD AND LABORATORY WORK	5
5.0 SUBSURFACE CONDITIONS	7
5.1 Geology	7
5.2 Mining Activity	7
5.3 Soil Stratigraphy.....	8
5.4 Groundwater Conditions	10
6.0 SLOPE STABILITY EVALUATION.....	12
6.1 General	12
6.2 Present Slope Stability.....	12
6.3 Impact Of Development On Slope Stability	14
6.4 City Bylaw Setback Requirements	15
6.5 Impact Of Slope Instability On The Development (Setback Lines).....	16
7.0 RECOMMENDED DEVELOPMENT GUIDELINES.....	16
8.0 STORMWATER POND DEVELOPMENT	18
8.1 General	18
8.2 Facility Design.....	19
8.3 Pond Construction	21
8.3.1 General Base Preparation	21
8.3.2 Remolded Clay Liner	21
9.0 SUBDIVISION DEVELOPMENT	22
9.1 General	22
9.2 Lot Grading	24
9.3 Street Subgrade Preparation	25
9.4 Excavations and Trench Backfill	25
9.5 Concrete Issues	27
9.5.1 Concrete Type	27

TABLE OF CONTENTS

	PAGE
9.5.2 Concrete Surface Works	27
9.6 Shallow Foundations.....	28
9.7 Bored Cast-In-Place Concrete Piles	29
9.8 Floor Slabs-On-Grade.....	30
9.9 Structural Slabs.....	31
9.10 Basement Construction.....	31
9.10.1 Basement Floor Slabs.....	31
9.10.2 Basement Walls	31
9.11 Foundation Perimeter Drainage Requirements.....	32
9.12 Frost Protection.....	32
9.13 Seismic Design	33
10.0 DESIGN AND CONSTRUCTION GUIDELINES	33
11.0 REVIEW OF DESIGN AND CONSTRUCTION	33
12.0 LIMITATIONS	33
13.0 CLOSURE.....	34

FIGURES

- Figure 1 Site Plan and Borehole Locations
- Figure 2 Cross Sections
- Figure 3 Setback Lines Lenzies and Bedrock
- Figure 4 Recommended Development Setback Line
- Figure 5 Setback Lines Lenzies and Bedrock –Development Setback Line – North Site Area

APPENDICES

- Appendix A Geotechnical Report - General Conditions
- Appendix B Borehole Logs
- Appendix C Recommended General Design and Construction Guidelines

1.0 INTRODUCTION

This report presents the results of a geotechnical evaluation conducted by EBA Engineering Consultants Ltd. (EBA) in support of the proposed River Bend Community Outline Plan, the development of which is to be located in Lethbridge, Alberta.

The scope of work for the geotechnical evaluation was described in a proposal issued to Mr. Cory Armfelt, of UMA Engineering Ltd. (UMA) on February 20, 2007. The scope was subsequently modified in August 2007, in discussions with UMA, to also include the northern end of the site. The objective of this evaluation was to determine the general subsurface conditions in the area of the proposed development and to develop recommendations for the geotechnical aspects of design and construction for the residential subdivision and to provide development setback recommendations, in consideration of the adjacent slopes.

Authorization to proceed with this evaluation was provided by Mr. Armfelt on behalf of Melcor Developments Ltd.

2.0 PROJECT DETAILS AND SCOPE OF WORK

The property to be developed is located within West Lethbridge, Alberta, with the land development limits presented on Figure 1 (a recent orthophoto contour plan provided by UMA). The land area is bounded to the north by the existing Riverstone residential subdivision, University Drive, and the proposed Chinook Trail alignment, to the east by the existing Paradise Canyon residential subdivision and to the west by undeveloped agricultural lands. To the northeast are two tributary coulee valleys draining towards the Oldman River. Along the south property boundary is the north valley wall of the Oldman River Valley.

At the Outline Plan stage, based on discussions with UMA, it is EBA's understanding that the major component of the proposed development includes single family residential housing across most of the property limits. The foundation system for the residences will likely be shallow spread footings and a grade supported lower level floor slab, typical of other residential developments in the area. Other developments that may be considered may include a school, with playground/sports field areas as well as possibly commercial developments. At least one stormwater management facility is understood to be under consideration within the east/southeast area of the property, although the details of such facilities are preliminary at this time.

The proposed street developments will be designed and constructed to the current City of Lethbridge Infrastructure Services Engineering Standards, as deemed appropriate, for each area. A detailed pavement design for the respective street sections has not been requested as part of this evaluation and may be completed at a later date, pending review of any traffic studies completed.

Given the proximity of the adjacent slopes, the scope of work for this evaluation included visual site reconnaissance and geotechnical review of the adjacent slope stability, including slope stability analysis with computer modeling software (Geoslope/Slope/W). Recommendations were developed for development setback limits from the Top of Bank of the slopes. The slope stability evaluation was conducted in accordance with guidelines adopted by City of Lethbridge By-law #5277, 'River Valley Area Redevelopment Plan' (RVARP), adopted on July 26, 2004. As part of the RVARP guidelines, the evaluation considered the recommendations pertaining to safe development setbacks as detailed in the study by AMEC Earth and Environmental Limited (AMEC) entitled, "City of Lethbridge Phase II Development Setback Assessment Oldman River Valley Slopes", issued in November 2002 contained therein.

The agreed work scope for this evaluation also consisted of a review of existing geotechnical data for the property. Existing data in EBA's library include a geotechnical evaluation for a proposed highway bypass/river crossing at the south property boundary, completed by EBA in 2003 (EBA File 4400085), geotechnical evaluations for the adjacent Sunridge residential subdivision and University Drive Upgrades (EBA Files 4400681 and 4400675), a preliminary slope stability assessment for the River Bend residential subdivision completed by EBA in 2006 (EBA File 4401099), as well as a review of historical mine workings (EUB) and historical aerial photographs.

The scope of work also included the installation of fourteen (14) geotechnical boreholes (for the general property development, street developments, and slope stability evaluation). A laboratory program was completed to assist in classifying the subsurface soils and this report provides the following design and construction recommendations.

- Recommendations for development restrictions in consideration of the adjacent slope, specifically including recommended development setback distances.
- Recommendations for general foundation alternatives.
- Recommendations for lot grading, backfill materials and compaction.
- Recommendations for utility line installation, including trench excavation, backfill, and compaction standards.
- Recommendations for general stormwater management facility design considerations.
- Recommendations for subgrade preparation for street pavements.
- Recommendations for dewatering during construction.
- Recommended design and construction provisions for control of groundwater.
- Recommendations for concrete type.

3.0 SITE DESCRIPTION

3.1 SURFACE DESCRIPTION

As shown on Figure 1, the majority of the property was noted to be predominately undeveloped at the time of fieldwork. The exceptions include a farmstead along the north property line (Denecky property), including a relatively small water dugout, as well as a large water dugout in the southeast corner of the property. There is an apparent abandoned canal (Lethbridge Northern Irrigation District (LNID)) leading to the northwest edge of the large dugout. The 40 Avenue right-of-way passes across the north portion of the property, running west to east as well as the old subdivision access road (Riverview Parkway) in the northeast corner of the site. Based on EBA's knowledge of this property's history, including an aerial photograph review from the 1950s to present day, it is understood that the area has been utilized mainly for agricultural purposes (crop cultivation).

The property at the time of fieldwork was surfaced in most areas with stubble crop. The ground surface was noted to be moderately undulating, as indicated on the elevation contours shown on Figure 1. The upper prairie level of the property appears to have a ground surface Geodetic Elevation varying between approximately 917 m (northeast corner) to 936 m (southwest area). Overland drainage appears to be complex, trending generally towards the northeast.

To the south of the site is the north wall of the Oldman River Valley and at the northeast corner, two coulee slopes draining to the northeast. It is these slopes adjacent to the development area that are the focus of this evaluation. Figure 2 depicts profiles of five typical sections of the slopes (A-A', B-B', C-C', D-D', and E-E' shown on Figure 1). Figures 3, 4, and 5 present the slopes in closer scale, including the sections indicated as well as elevation contours.

For this property, the height of the adjacent slopes to the south (shown on Figure 3) appears to vary between approximately 90 m to 100 m. The base elevation, along the edge of the Oldman River appears to be at approximately Elevation 830 m. For the purposes of this evaluation, there are typically two distinct slope sections along the south property area.

Adjacent to the southwest corner of the property (Profile A-A'), this slope is comprised of a coulee draw which extends further inland towards the west. The road access to Popson Park (at the valley base) is located within the base of this coulee draw. At such, this section of slope is flatter overall in relation to the valley wall further to the northeast. The lower portion of this section of slope is deeply buried in colluvium down to the river level. Therefore, for Profile A-A', the upper portion of the slope is given more relevance for this evaluation. The upper portion of this slope appears to average approximately 3 horizontal to 1 vertical down to an elevation of approximately 885 m, becoming flatter than 5H:1V below this elevation, leading down to a gently sloping river terrace area. The river is located several hundred metres to the east of this slope section. The slope faces are smoothly vegetated with grasses and weeds, with no current evidence of active slope instability.

The other south slope section type is illustrated by Profiles B-B' and C-C' and comprises the north valley wall of the Oldman River along this stretch of the Oldman River. The difference between the two sections is that these slopes are being actively eroded by the Oldman River at the toe (particularly for Profile C-C') and appear to be actively failing at this time (creep movement). Tension cracks are noted along the top of bank of these slopes as well as relatively recent back-scarps and apparently recent slide masses on the faces of the slopes.

As witnessed during the site reconnaissance, these sections typically consist of a relatively steep back-scarp adjacent to the upper prairie level, with the slope faces covered with colluvium and a profile in the order of approximately 4H:1V overall within the upper portions of the slopes. The upper portion of Profile C-C' contains evidence of very wet surface conditions, as a result of apparent groundwater seepage out of the slope face. It is considered that the water dugout to the north of this section, as well as overland drainage being directed over the edge of the slope at this location, may be contributing factors to the wet conditions and slope instability at this location.

The lower portions of the slopes, for Profiles B-B' and C-C', appear to have a thick covering of colluvium leading down to river level. The bedrock (at an elevation of approximately 879 m) is covered with colluvium and is not visually evident within these slopes (although the bedrock is evident within the slopes several hundred metres to the east where this colluvium does not exist). The lower portions of the slopes, above river level, appear to be steeper, in the order of 1H:1V. It is apparent that the slope colluvium is being actively eroded by the river along the slope toe adjacent to the eastern area of the property.

Adjacent to the northeast corner of the property (Profiles D-D' and E-E'), are two coulee draws which extend sub-parallel towards the Oldman River to the northeast. Both coulee valleys are deeply incised and although the lower portions are covered in colluvium, the elevation of the bedrock in this area does influence this evaluation. For Profiles D-D' and E-E', the upper portions of the slopes appear to average approximately 4 horizontal to 1 vertical, with some localized steeper sections. The river is located several hundred metres to the east of these slope sections. The slope faces are smoothly vegetated with grasses, weeds, and some shrubs, with very little current evidence of active slope instability. Several small surface slumps were noted within both slope faces, attributed to natural groundwater weeping out of the faces of the slopes.

3.2 HISTORICAL AERIAL PHOTOGRAPHIC REVIEW

As part of the evaluation, EBA reviewed aerial photographs taken of the project area between 1950 and present day (1950, 1956, 1961, 1970, 1980, 1985, 1991, and 2006). Relevant observations from these aerial photographs are presented in this section.

- 1950 to 1961 – The subject property is undeveloped at this time, except for a number of farm buildings on the Denecky property. There appears to be an irrigation canal which runs across the east portion of the property, which apparently discharges over the edge of the valley slope to the east of the location of Profile C-C'. There appears to be

overland drainage directed into a ditch, running north to south which also discharges at this location. There appears to be multiple locations of drainage overflow over the edge of the slope at this location and towards coulee draws further to the east. There appears to be active slope movements in the zone of slope from Profile B-B' to C-C' at this time (and further to the east), with no evidence of recent slope movements along the remainder of the west slopes (Profile A-A'). Popson Park development does not exist at this time, and the west coulee draw appears to be undisturbed until 1961 at which time, there is some evidence of road construction. The slopes along the north area of the property (Sections D-D' and E-E') are virtually unchanged from present day.

- 1970 – Similar to that noted above. The upper slope failures between Profile B-B' and C-C' are clearly evident and appear to be ongoing. There appears to be predominantly a single large soil mass which has experienced a translational slide in this zone, evidenced by a large "graben" depression adjacent to the steep back scarp. The slide mass has over-topped the lower portion of the slope, burying the bedrock face in colluvium. Large tension cracks are noted behind the slope crest in this area. The slopes to the west are undisturbed.
- 1980 to 1985 – Similar to the 1970 photo except that the large dugout in the southeast corner of the property is now evident. The old canal bypasses the dugout to the west as noted above. There appears to be a connection between the canal and the dugout. The Denecky property appears as close to its current condition, including the small dugout. There is an apparent landfill area in the south portion of the subdivision, with a number of abandoned vehicles noted (still there currently and shown on Figure 3). There is a very small dugout to the west (Figure 3). The slopes are as noted above, except that surface water is noted to be ponded within the upper portion of the slope at Profile C-C'. The road down to Popson Park has been developed within the west coulee draw.
- 1991 to Present Day – Approximately represents current conditions, as limited changes to the property are noted. One exception is that Paradise Canyon Subdivision was developed during this period. Another exception is that the canal bypass south and east of the large dugout has been removed. It is uncertain if the canal section had simply been backfilled and/or whether it was possibly redirected towards a major coulee draw to the east, as part of the development of the adjacent subdivision. The subject slopes are assumed to have substantially less water being directed over the crest of the slope at this location due to this canal redirection.

4.0 GEOTECHNICAL FIELD AND LABORATORY WORK

The initial fieldwork for this evaluation was carried out on March 23, April 2, and April 24, 2007. A supplemental program was completed on September 18, 2007. A truck mounted drill rig was contracted from Chilako Drilling Services Ltd. of Coaldale, Alberta. The rig was equipped with 150 mm diameter solid stem continuous flight augers, excepting hollow stem augers used for BH014. EBA's field representatives were Mr. Jackson Meadows and

Mr. John Christensen. The location of buried utilities was first carried out through Alberta First Call.

Fourteen boreholes in total were drilled across the property area. These include relatively deep boreholes (BH001, BH002, BH003) drilled along the slope crest areas to depths of approximately 30.5 m below ground surface. BH014 was added to the program in September 2007 to a depth of 17.3 m below ground surface. The remaining 10 boreholes were drilled across the general subdivision area to depths of 10.6 m (BH004 through BH013). The borehole locations are depicted on Figure 1.

In all of the boreholes, disturbed grab samples were obtained at 600 mm intervals. A solid soil coring technique was utilized for BH014. All soil samples were visually classified in the field and the individual soil strata and the interfaces between them were noted. The borehole logs are presented in Appendix B. An explanation of the terms and symbols used on the borehole logs is also included in Appendix B.

Slotted 25 mm diameter PVC standpipe was installed in all of the boreholes in order to monitor the groundwater level at each location. Auger cuttings were used to backfill around the standpipes and they were sealed at the ground surface with bentonite chips.

The locations of the boreholes were initially selected based on a proposed subdivision concept provided by UMA. The locations and Geodetic Elevations of the existing ground surface at the borehole locations were subsequently determined by detailed surveying by Mike Spencer Geometrics Ltd. The borehole elevations are indicated on the borehole logs.

Classification tests, including natural moisture content, Atterberg Limits, and soluble sulphate content were subsequently performed in the laboratory on samples collected from the boreholes, to aid in the determination of engineering properties. The results of the laboratory tests are presented on the borehole logs in Appendix B.

The geotechnical data presented above was supplemented by two boreholes drilled for a proposed bypass/river crossing in 2003 (EBA File 4400085). This included BH008, drilled within the west coulee draw (to confirm the bedrock elevation), as well as BH009 in the southwest corner of the subdivision (to confirm the elevation of the Lenzie silts deposit). The referenced borehole logs from these studies are also included in Appendix B and noted on Figure 1. The evaluation was further supplemented by a geotechnical evaluation for the adjacent Sunridge residential (City of Lethbridge) subdivision, which included the installation of geotechnical boreholes, as well as constant head hydraulic conductivity testing on soil samples taken from these boreholes (for clay liner recommendation), the results of which are referenced in this report.

5.0 SUBSURFACE CONDITIONS

5.1 GEOLOGY

EBA has reviewed published reports regarding the geological history of the Lethbridge area. A brief summary, in descending order, of the general stratigraphy is presented below.

- Lacustrine Deposit; a fine-grained lacustrine deposit overlies the Buffalo Lake Till, with thickness varying from non-existent to 8 m (less than 2 m for the subject site).
- Buffalo Lake Till; characterized by a lack of cohesion which often leads to slumping of this deposit. A single period of consolidation has resulted in the development of vertical stress cracks, well oxidized, with some limited bedding.
- Lenzie Silts; unit consists of buff, stratified, calcareous silt and silty sand. The deposit includes black or grey varved clays and poorly sorted till-like colluvium with coarse fragments. This is a glacial lake deposit that formed in a peri-glacial (prior to deposition of Buffalo Till) lake environment as continental ice advanced. Overlying the cross-bedded sediments are lake clays deposited in thin, well-bedded laminae forming true rythmites. The clay deposit may have developed as a glacier underwent a minor halt after advancing into the area.
- Labuma Till; columnar, massive till, which is hard as a result of consolidation pressure from overlying ice, deposited during Laurentide glaciation.
- Basal Till; massive till, hard, brown to grey.
- Saskatchewan Sands and Gravels; clean, well-sorted and bedded, rounded to subrounded river gravel deposit with a sandy matrix. It is noted that this layer is not expected as this area was not the site of a pre-glacial river valley.
- Oldman Formation Bedrock; relatively massive, sedimentary deposit in both brackish and freshwater environments (non-marine), light grey to light brownish grey in colour, contains cross bedded silty clay shales, siltstones, calcareous sandstones, ironstones, bentonitic clay and coal layers.

5.2 MINING ACTIVITY

Research was conducted to review the existence of mine workings within the boundary of the subject site. The literature search included documents contained within EBA's in-house library, including publications by ERCB (1988) (now EUB), the Galt Museum (Lethbridge), the Glenbow Museum (Calgary), the Provincial Archives (Edmonton), and various other documents contained in EBA's library regarding the coal mining industry in the Lethbridge area. The literature indicates a number of small surface mine workings along the edge of the river, however, the records do not indicate that the area was extensively under-mined within the subdivision footprint.

5.3 SOIL STRATIGRAPHY

Specific details of the stratigraphy encountered at each borehole location are presented on the borehole logs. In addition, based on the information gathered during this evaluation and from EBA's geotechnical experience in the area, the general soil stratigraphy from prairie level to below the base of the slopes of significance to this evaluation is summarized in this section.

It should be noted that geological conditions are innately variable. Glacial deposits in particular are seldom spatially uniform. At the time of preparation of this report, information on subsurface stratigraphy is available only at discrete borehole locations. In order to develop recommendations from the information, it is necessary to make some assumptions concerning conditions other than that at borehole locations. Adequate monitoring should be provided during construction to check that these assumptions are reasonable.

Upper Stratigraphic Deposits

In general, the majority of the site was open and surfaced with stubble crop at the time of the fieldwork. The topsoil thickness across the property was generally determined to be approximately 100 mm to 150 mm. Underlying the topsoil layer, brown stained inorganic clay (B Horizon) is commonly encountered in this area, typically for a depth of approximately 150 mm. In addition, wind blown topsoil deposits of greater thickness may exist in areas downwind of topographic high areas. One example includes BH003, where this layer extended to a depth of 0.7 m. Variable thickness of topsoil should be expected across the site.

It is important to note that based on the proposed stripping methodology (i.e. equipment usage) the thickness of stripping may vary. The method of stripping should therefore be taken into account when determining stripping volumes. In addition, monitoring by geotechnical personnel to ensure approved subgrade materials are stripped to may reduce the risk of over stripping volumes due to excavation methodology.

Underlying the topsoil, a relatively thin layer of lacustrine clay were encountered at most boreholes, to depths varying between approximately 0.0 m and 2.0 m below the present ground surface (less than 1.5 m thick generally). The clay layer was described as silty, with some sand to sandy, damp to moist, medium plastic, and stiff to very stiff in consistency. The results of Atterberg Limit testing (one test) carried out on a clay soil sample indicated a Plastic Limit of 16 percent and a Liquid Limit of 40 percent, indicative of medium plasticity. Moisture contents within the near clay were variable, between 10 and 18 percent.

Underlying the clay soil layers, glacial clay till (Buffalo Lake Till) was generally encountered, extending to depths of approximately 14 m to 23 m below ground surface at the deepest borehole locations (except that the delineation between the lower layers was less distinct at BH002). This upper clay till layer was described as silty, with some sand to sandy, trace gravel, damp near ground surface, increasing to moist to very moist with depth, medium plastic and stiff to very stiff in consistency. Coal and oxide particles were noted throughout.

Thin wet sand seams and lenses were also noted throughout this layer. Isolated wet layers were noted within the upper clay till zone at some borehole locations.

The results of Atterberg Limit testing (five tests) carried out on clay till soil samples indicated Plastic Limits varying between 12 to 16 percent and Liquid Limits varying between 39 to 48 percent respectively, indicative of medium plasticity. Soil moisture contents within the clay till typically varied between approximately 9 and 20 percent within the upper 6 m of the deposit.

For preliminary design assumptions regarding remolded clay soil liners, the following information is provided. From an evaluation of the adjacent subdivision, the results of a Standard Proctor moisture-density test on the clay till soil indicated a maximum dry density of 1775 kg/m^3 , at an optimum moisture content of 15.3 percent. The clay proctor sample was subsequently compacted to approximately 98 percent of SPD at a moulding moisture content of approximately the optimum moisture content (OMC) for the soil sample and a constant head permeability test was conducted. The measured steady state permeability (K) was $2.28\text{E-}08 \text{ cm/sec}$.

Lower Stratigraphic Deposits

The previous descriptions of the upper soil layers are presented for consideration of the general subdivision development, as well as for preliminary storm pond design and construction. Deeper soil information is available from BH001, BH002, BH003, and BH014 from this evaluation as well as from BH008 and BH009 from a 2003 evaluation completed by EBA, further referenced as well as from EBA's background review (including the AMEC report). The following stratigraphic profile was used in the cross-section models for the slope stability analysis.

- Upper Clay Till (Buffalo Lake Till); silty, some sand to sandy, trace of gravel, medium plastic, brown, moist, coal specs and oxide staining. Surficial layers of medium plastic lacustrine clay (encountered to less than 2 m below existing grade) considered as geologically similar to till materials with respect to the soil parameters used in slope stability analysis (i.e. ϕ , c). The Atterberg Limit tests, conducted on bulk samples from this layer during this evaluation confirmed a medium plastic soil. The upper clay till was encountered to depths below ground surface of 14 m to 24 m (approximate base Elevation of 905 m to 915 m).
- Lacustrine Deposit (Lenzie Silts); typically described as interbedded layers of sand, clay and silt with medium to high plastic clay lenses generally encountered near the top of this deposit. Specifically, at BH001 and BH003 in particular, the Lenzie layer comprised an upper zone with high plastic clay inclusions and layers at depths in the range of approximately 18 m to 24 m below ground surface. The Lenzie layer was also found at BH014 at a depth of 14.6 m. Evidence of medium to high plastic clay layers within this zone were noted at BH002. Based on the field data and review of the literature, the upper boundary of the Lenzie Silts layer is estimated to be within the range of approximately Elevation 900 m to 910 m. Twelve Atterberg Limit tests confirmed a

soil of medium plasticity (typical $LL=30$ to $50\% \pm$, PI 10 to $35\% \pm$), however, some pockets and/or lenses of clay were described as being of high plasticity than that shown by the laboratory tests. The lower portion of Lenzie Silts layer at BH001, BH003, was comprised of sand to depth of approximately 28 m to 29 m below ground surface (elevation of 896 m to 900 m). BH014 was terminated in this sand layer at a depth of 17.3 m. The lower sand portion was described as trace silt to silty, with trace clay, fine to medium grained, with silt and clay inclusions, wet and compact to dense.

- Lower Clay Till (Labuma Till); The lower till unit was encountered within the very base of BH001 and BH003 during this drilling program at depths of approximately 28 m to 29 m below ground surface. As noted at BH002, the upper till appeared to grade into the lower till strata, with an indistinct transition (as the layers appeared similar). The lower unit was described as silty, some sand to sandy, occasional to some gravel, moist to very moist, medium plastic, and stiff to very stiff in consistency.
- Oldman Formation Bedrock; The elevation of the bedrock was confirmed as 879 m at the location of BH008 drilled by EBA within the base of the coulee valley in 2003. The bedrock within the upper zone was comprised of weathered clay shale (claystone), silty, highly weathered, and weak in strength.

It is noted that the elevation of contact with the Lenzie Silts layer, as well as the stratigraphic information below the deepest borehole drilled by EBA for this study compared favourably with the 2002 AMEC study (Section 1.0). The top of the Lenzie Silts layer encountered by EBA is consistent with the elevation ranges indicated in the AMEC report. Furthermore, the AMEC study provided reference to the base of the Labuma Till, the lack of a Saskatchewan Gravels layer, as well as data on the bedrock contact elevation for this area, which generally agrees with EBA's assessment of the local geology noted in this and previous sections of the report.

Stratigraphic cross sections of the soil stratigraphy considered to represent the local conditions are presented on Figure 2 for profiles A-A', B-B', C-C', D-D', and E-E'. The elevations of the geologic layers noted in this section have been included in the slope stability analysis of this evaluation.

A more detailed description of the subsurface stratigraphy encountered on this specific site is provided on the borehole logs included in Appendix B.

5.4 GROUNDWATER CONDITIONS

Seepage and sloughing was generally not encountered within 10 m of ground surface during the borehole drilling program. One exception was at borehole location BH004 where seepage and sloughing was encountered at 2.4 m below ground surface, within wet sand inclusions. The groundwater level was measured within the standpipes on April 11, 2007, excepting (*) BH001 which was measured on May 1, 2007 and BH014, which was measured on September 24, 2007. The following table summarizes the groundwater monitoring data.

Borehole Number	Depth of Standpipe (m)	Ground Elevation of Borehole (m)	Groundwater Monitoring Data April 11, 2007	
			Depth to Groundwater (m)	Elevation of Groundwater (m)
001*	26.0	927.80	25.12	902.68
002	30.5	929.74	13.91	915.83
003	17.5	924.94	12.05	912.89
004	10.6	920.44	1.70	918.74
005	10.6	923.62	2.25	921.27
006	10.6	931.51	Dry	-
007	10.6	934.93	Dry	-
008	10.6	933.77	7.95	925.82
009	10.6	931.04	2.29	928.75
010	10.6	926.18	2.86	923.32
011	10.6	924.65	5.01	919.64
012	10.6	921.44	Dry	-
013	10.6	917.17	Dry	-
014*	17.3	917.50	Dry	-

It should be noted that groundwater levels will fluctuate seasonally and in response to climatic conditions and may be at a different depth when construction commences. Groundwater levels should be monitored periodically prior to development. The intent is to provide an early indication of dewatering requirements during excavation for foundations or utility trenches.

Based on the groundwater data monitored and reported above, there are at least two distinct groundwater regimes evident, an upper regime and a lower regime. The upper regime is evidenced in the shallower boreholes, with localized groundwater perched or trapped within zones of sandy material within the clay till soil, at depths of approximately 2 m to 8 m below ground surface. The wetter areas were noted to be in relative close proximity to the two water dugouts or irrigation canal alignment, which most likely had a major role to play in recharge of the groundwater regime over time. Therefore, significant groundwater problems are not expected for the majority of shallow to moderate excavations expected for this development and relatively minimal dewatering should generally be necessary. The exception of this will be in the areas adjacent to the dugouts, as well as along side the alignment of the canal. A more detailed study is required to assess the requirement for ground improvement due to over optimum moisture content in the surficial soils for development aspects such as roadways, stormwater ponds, and residential foundations/appurtenances. This required detailed study is beyond the scope of work of this evaluation.

The lower groundwater regime, evidenced within the three deepest boreholes, reflects groundwater perched within lower clay till strata as well as within the Lenzie Silts layer overlying relatively low permeable lower cohesive layers. This lower groundwater regime has been considered in the stability analysis completed.

Further comments regarding groundwater issues are provided in subsequent sections.

6.0 SLOPE STABILITY EVALUATION

6.1 GENERAL

EBA's slope stability evaluation for this project comprised an analysis of the present stability of the slopes abutting the south limits of the upland plain of the subject site and the coulee slopes at the northeast corner, an analysis of the impact of development on the stability of the slope and an analysis of the impact of any potential slope instability on the development, i.e. setback requirements. These aspects are detailed in the following sections. The minimum Factor of Safety (FS) used to determine the setback requirements was 1.5. This FS is typically used for developments of this nature and is consistent with the requirements of the City of Lethbridge Bylaw #5277 (RVARP).

The recommendations for stability analyses and appropriate development setback limits, as presented in the AMEC report (referenced in Section 1.0) were also reviewed by EBA and where applicable, incorporated as part of EBA's analyses. The analysis is discussed in the following sections.

6.2 PRESENT SLOPE STABILITY

The present stability of the slopes of this study has been evaluated based on site reconnaissance and analytical techniques using the computer program Slope/W (Morgenstern-Price and Bishop Methods) for circular and block failures.

Visual observations of the slopes in the project area indicate the slopes are currently "meta-stable" within the western areas (west of Profile B-B') and in the northern areas (Profiles D-D' and E-E'), as evidenced by a lack of recent slope instability (air photo review) (i.e. Factor of Safety of 1.0 or slightly higher). For the east slope areas (east of Profile B-B') the slopes are currently experiencing ongoing creeping and slumping (i.e. Factor of Safety of 1.0 or slightly less) in some areas. The mechanism of failure in these areas appear to be continued pinnacle block failures along the head scarp area, with a general creep of the overall failed mass (or sections within the mass) along the failure plane of the instability.

Soil strength parameters assumed by EBA were based on the results of moisture content and Atterberg Limit tests conducted by EBA on soil samples recovered from the development site and from other sites within the boundary of the City of Lethbridge within similar deposits. The historical data also includes triaxial test data obtained by EBA and others for other sites in the Lethbridge area and documented in the AMEC report. Groundwater conditions (pore pressure parameters), reasonably expected from the data

collected in the fieldwork, laboratory program, and from information reviewed from past site studies were then selected by EBA to satisfy the observed conditions.

The soil strength and groundwater parameters selected for the analyses, modelling current conditions, are as follows. It should be noted that these parameters are in general agreement with those assumed in the AMEC stability analyses and have been developed from a collaboration of local geotechnical experience. The order presented is the stratigraphic profile from ground surface to below the base of the slopes being analyzed.

- Material: Upper Clay Till

Unit Weight:	18 kN/m ³
Cohesive Intercept c' :	10 kPa
Friction Angle ϕ' :	27°
Pore Water Pressure Parameter r_u =	0.1

- Materials: Lenzie Silts Deposit (interbedded layers of clay, silt, and sand)

Top layer: Clay (CI-CH)

Unit Weight:	18 kN/m ³
Cohesive Intercept c' :	0 kPa
Friction Angle ϕ'_p (peak):	19°
Pore Water Pressure Parameter r_u =	0.2

Subsequent layers of Silt and Sand

Unit Weight:	21 kN/m ³
Cohesive Intercept c' :	0 kPa
Friction Angle ϕ' :	33°
Pore Water Pressure Parameter r_u =	0.1

- Material: Lower Clay Till

Unit Weight:	20 kN/m ³
Cohesive Intercept c' :	10 kPa
Friction Angle ϕ' :	27°
Pore Water Pressure Parameter r_u =	0.1

- **Materials: Bedrock Surface**

Top bedrock layer: Weathered Clay (CI-CH)

Unit Weight:	21 kN/m ³
Cohesive Intercept c' :	0 kPa
Friction Angle ϕ_p' (peak):	19°
Pore Water Pressure Parameter r_u :	0.2

The current stability of the slopes adjacent to the project site has been evaluated by means of limit equilibrium analyses conducted on five cross-sections of the slope (Sections A-A', B-B', C-C', D-D', and E-E'). It is noted that both moderate failures on the top of the Lenzie Silts layer as well as deep seated failures on the bedrock surface (assumed weakened bedrock surface) have been analyzed. In addition, EBA reviewed the anticipated long-term slope profile due to continued pinnacle block failures at the head scarp and subsequent creep of the soil mass and transport due to river erosion on the downslope side. The slope profiles for the cross-sections were taken from topographic elevation data provided to EBA by UMA (which have been derived from orthophoto mapping from the City of Lethbridge). Figure 1 depicts the location of the five cross-sections and the slope profiles and stratigraphic cross sections are shown on Figure 2.

Slope stability analyses on the cross-sections, using the above parameters, indicate that the existing slopes are "meta-stable". Factors of Safety for shallow slope face failures are slightly less than 1.0 for the east slopes in the area of Section B-B' to C-C' and slightly higher than 1.0 for the west slope areas (A-A') and the north coulee slopes (D-D' and E-E'). With respect to moderate depth instability affecting the slope crests (within the Lenzie Silts layer), the factor of safety varies between 1.0 and 1.2. For deep seated failures on the bedrock surface, the minimum factor of safety affecting the slope crest is approximately 1.5. From this analysis, it is confirmed that a theoretical slope failure on the Lenzie Silts layer appears to be the governing slope failure mechanism for the slopes of this study. It is noted however, that in accordance with the City Bylaw (in part based on the recommendations contained in the AMEC report), the physical mechanism for a deep seated bedrock failure does exist at this location and must be considered for all cases.

6.3 IMPACT OF DEVELOPMENT ON SLOPE STABILITY

The relatively steep river valley slopes in the Lethbridge area rely upon low degrees of soil saturation for stability. Any increase in the level of soil saturation reduces the stability of the slopes.

Development of the site will bring about changes in the factors which contribute to the present stability of the slopes. Evaporation of soil moisture will be reduced by the presence of ground cover such as buildings and roadway structures. Irrigation and possible leakage of water from underground utilities in addition to the water retention within stormwater management facilities will increase the amount of water infiltrating the site subsoils. This

combination of reduced evaporation of subsoil moisture and increased infiltration of water to the subsoils is considered to be the most significant influence of development on the factors that contribute to the present stability of the slopes. Increasing soil moisture content produces a reduction in the total cohesion as the apparent cohesion is reduced or lost and an increase in the pore pressure ratio reduces the effective stress. The result is a corresponding decrease in the factor of safety.

For post-development analyses, the pore pressure parameter r_u was revised to suit anticipated increases in soil moisture and a reduction in the cohesion in the upper till, for moderately deep failure surfaces within the Lenzie Silts layer. The revisions to the parameters developed in Section 6.2 were:

- Cohesion in the upper till layer was revised to 0 kPa for post-development analysis.
- The r_u value in the upper till was revised to 0.20.
- The r_u value in the upper clay layer of the Lenzie Silts was revised to 0.3.

The results of the stability analyses, assuming the development setback line as presented in Section 7.0 (using the minimum Bylaw requirements), using the revised soil and groundwater parameters have confirmed a minimum Factor of Safety of 1.5.

6.4 CITY BYLAW SETBACK REQUIREMENTS

Recommendations presented in the AMEC report (incorporated into the updated City RVARP guidelines) which affect this development are related to slope instabilities sliding along the Lenzie Silts layer. Based on this study, it was determined that in the worst case, slopes above the Lenzie Silts layer will tend to retrogress back to an ultimate, slope of approximately 4H:1V. Therefore, minimum development setback lines should incorporate a line drawn at a slope of 4H:1V from the point where this deposit exits the face of the slope back into the property. The report concludes that the point where this 4H:1V line intercepts the ground surface at upper prairie level should be taken as the development setback line with respect to the Lenzie Silts deposit.

This 4H:1V line has been shown for reference purpose on the sections considered and presented on Figure 2 (in section) and on Figures 3 and 5 (where the line intercepts the prairie level). It is noted that the determination of the 4H:1V line assumes the worst case top of Lenzie Silts deposit elevation of 900 m, determined from this evaluation. In addition, a reasonable assumption of the thickness of colluvium covering the slope face was required, as shown on Figure 2.

Other recommendations in the AMEC report, with respect to bedrock failures, include a 5H:1V line drawn back from where the bedrock is exposed at the valley slope face. As above, with the bedrock elevation of 879 m determined from a previous evaluation as well as the assumption of the thickness of colluvium overlying the slope faces, the 5H:1V line is shown on Figure 2 for each profile section. Where this 5H:1V line intercepts the prairie level is shown on Figure 3 (south slopes) and Figure 5 (north slopes).

With these assumptions, a development setback line, generally in accordance with those noted in the City Bylaw documentation was determined. Section 7.0 presents the results of this analysis.

6.5 IMPACT OF SLOPE INSTABILITY ON THE DEVELOPMENT (SETBACK LINES)

The long-term stability of the slopes adjacent to the project site has been evaluated by means of limit equilibrium analysis conducted on the cross-sections of the slopes noted.

The approach used in the stability analysis was to first establish the existing Factor of Safety against slope instability using the strength parameters indicated in Section 6.2. Successive points set back from the crest of the slopes were then selected and minimum factors of safety were calculated modelling current relatively dry slope conditions. This was followed by additional analysis to determine Factors of Safety when post-development groundwater levels and partially saturated slope conditions, respectively, were assumed (refer Section 6.3).

As noted above, the Development Setback Line presented on Figure 4 was established by using the City of Lethbridge RVARP guidelines in Bylaw #5277 and based on the data and assumptions of this geotechnical evaluation. Based on the stability analysis conducted by EBA, it is confirmed that the development setback line established provides a minimum Factor of Safety of 1.5 against slope failure for the assumed, worst case, post development groundwater condition. The limits of the proposed development setback line established by EBA are described in Section 7.0.

7.0 RECOMMENDED DEVELOPMENT GUIDELINES

Analysis of the present stability of the slopes indicates a factor of safety against slope instability affecting the property at the 'Top of Bank'¹ of between 1.5 (deep seated), 1.2 (moderate seated – Lenzie Silts) and 1.0 (shallow seated). This models the current condition of slopes.

For post-development conditions, the recommended 'Development Setback Line'² is as shown on Figure 4 and Figure 5. Figure 2 presents the cross-section models for Sections A-A', B-B', C-C', D-D', and E-E'. Generally, the development setback distance has been determined by projecting a 4H:1V line back from where the Lenzie Silts layer is exposed at the slope face and/or by projecting a 5H:1V line back from where the bedrock is exposed at the slope face (considering the colluvium) (RVARP Guidelines). The worst case is considered for where both lines intercept the upper prairie level.

¹ Top of Bank: means the line where the general trend of the slope changes from greater than 15 percent to less than 15 percent, as determined by field survey.

² Development Setback Line: established by survey which subsequently is registered on a plan of subdivision which determines the extent of development in relation to the Top of Bank.

It is noted that the bedrock condition appears to be the limiting factor for development setback for this development. However, within the western limits of the project site, along the edge of the south coulee valley, the slope profile orientation compared to the proposed development lands orientation at the Top of Bank do not appear to have the physical conditions present for a deep seated bedrock failure. In addition, the coulee valley is not being actively eroded by the river in this area. Therefore, for the west section of the slope, it is considered that slope failures on the Lenzie Silts layer would be the failure mechanism, and therefore the development setback line recommended coincides with the 4H:1V Lenzie Silts line as shown on Figure 4.

In summary, the recommended development setback lines are presented in Figures 4 and 5, and are based on the various analysis techniques described in the preceding sections. The setback distances have also been transitioned along the perimeter of the slope, based on three dimensional effects. It is recommended that the development setback lines be established by field survey given the setback distances determined by the topographic model derived for this site by EBA. EBA should then be contacted to review and confirm the location of the development setback line prior to any development of the proposed land.

Precautionary measures which should be included in the design of the proposed development (with respect to slope stability issues) are outlined as follows:

- Any fill excavated during development should not be disposed of within the development restriction zone unless directed otherwise after a review by the project geotechnical engineer. The development restriction zone is the area of land between the development setback line and the top of bank.
- Positive grading should be provided to ensure surface drainage from the development is directed as either sheet flow over the crest of the slopes or away from the slopes into the stormwater management facility.
- All utilities and plumbing should be carefully installed and inspected to ensure they are in good working order.
- Normal, prudent design and construction procedures should be followed during development.
- The development recommendations of this geotechnical report should be closely adhered to.

The upper coulee slopes should be treated as a restricted development zone. This involves:

- No excavation on the valley slope without review by a geotechnical engineer.
- No clearing of vegetation.
- No fill to be placed on the crest of the slopes.
- Maintain vegetation cover along the crest and on the slope.

Notwithstanding the setback distances recommended, some sloughing and slope movements may occur. The development may result in a general increase in the degree of saturation of the site subsoils which may cause minor sloughing of the top portion of the slope. The setback distance is not intended to prevent failure of the slope but rather to prevent such failures from directly affecting developed areas of the site.

8.0 STORMWATER POND DEVELOPMENT

8.1 GENERAL

The locations of the stormwater management facilities proposed have not been finalized. It is understood that one option may consider at least one facility to the north of the larger southeast dugout. However, it is noted that the location of any such facility must be outside of the above-noted development setback lines.

Based on EBA's understanding of a typical stormwater management facility design, the majority of the facility would be considered to be a 'dry pond' and would have a base elevation of approximately 2 m to 3 m below final ground surface. It is expected that a small portion of the facility may be a 'wet pond', with a pond invert elevation estimated to be approximately 6 m to 9 m below ground surface. Such a facility may be an excavation below ground surface and above-grade berms are generally not expected to be significant. It is assumed that the 'wet pond' portion of the facility will retain water throughout the year. The facility will provide overland stormwater storage for this area in accordance with municipal regulations.

It is noted by EBA that placement of such a facility in close proximity to the development setback lines recommended will need to have the associated risks of potential impoundment failure, subsequent saturation of the adjacent soils, and impact on development issues including the adjacent slope stability issue given close consideration. For discussion purposes, dry pond components located near the development setback line are less of a concern. However, positioning any wet pond components for such a facility, as far as possible away from the development setback line is recommended. The final location and details of the facility should be reviewed by a geotechnical engineer.

Once the operational water level elevation of the wet pond is designed, it is recommended that the proposed sideslopes for the pond below normal operating level be no steeper than 3 horizontal to 1 vertical. Above the normal water level, the sideslopes are recommended to be no steeper than 5 horizontal to 1 vertical.

In the preparation of the recommendations provided in this report for the geotechnical aspects of design and construction of the facility, EBA reviewed pertinent sections of the "Stormwater Management Guidelines for the Province of Alberta", dated January 1999 and prepared by the Municipal Program Development Branch of Alberta Environmental Protection (known now as Alberta Environment (AENV)). Detailed recommendations for the design and construction of this facility are provided in subsequent sections.

8.2 FACILITY DESIGN

As discussed in the previous sections, the subsurface stratigraphy of the proposed site is considered to consist of a relatively thin lacustrine clay, in turn overlying glacial deposits. Within the stormwater facility footprint, all organic soils must be removed to ensure the pond subgrades bear on the site's clay soils.

For purposes of discussion of the native site soils with regards to containment, the clay till soils will most likely comprise the majority of the clay liner and are found naturally below the proposed pond invert. Literature references (geology) for the clay till (Buffalo Lake Till Sheet) confirm that the till is vertically fractured (due to over consolidation during periods of glaciation). The till is also referenced (as confirmed by the site specific drilling program) to contain sand and/or silt lenses or pockets throughout its matrix. These preferential paths for groundwater seepage may or may not be horizontally continuous and attempts to quantify potential seepage losses are typically unsuccessful. However, the literature does present a range of permeability (k) for this till sheet between $10E-05$ cm/sec and $10E-06$ cm/sec. When compared to the field permeability of a reworked clay liner (refer Section 8.3.2 recommending $k=10E-07$ cm/sec), the difference in potential water loss may be in the order of one to two magnitudes (10 to 100 times less for a remolded clay liner).

It should be recognized that, over time following construction of the wet pond component (3 to 5 years), siltation of the pond floor, swelling of the medium plastic clays, and the development of a groundwater mound will greatly affect these estimated annual water losses. Quantifying this loss to a greater extent than that predicted here would require groundwater modeling which was not included in the current project scope.

In consideration of the above-noted factors, and most particularly, in consideration of maintaining the stability of the adjacent slopes, the utilization of the clay till soils in their native state is not recommended because of the potential loss of containment through the fissured till structure and possible silty or sandy pockets within the native clay till, which may provide preferential seepage paths. For this development, it is recommended that the native, cohesive clay till soils be reworked into a low permeable, compacted clay liner to provide the required containment (for wet ponds). With this option, some loss of containment is still possible (as with any earth retention structure). However, the recommendations presented herein are intended to limit seepage losses to an acceptable level, consistent with current industry standards and furthermore, to reduce the influence of groundwater mounding under the pond on the stability of the adjacent slopes.

Alternate liner types, such as synthetic membranes, are suitable but are not addressed in this evaluation. They may provide additional protection against leakage but are substantially more expensive.

The use of the native clay till materials encountered on this site for construction of a remolded clay liner for the pond is considered feasible, provided certain precautions are undertaken as recommended in the following sections. The results from the field program indicate that at present, perched groundwater levels may be within the proposed wet pond

invert, within relatively thin or small saturated sand/silt seams. The use of native lacustrine clay soils (if required) for construction of remolded clay liners should be limited to areas above the HWL.

It is assumed that above the normal water level, the sideslopes are to be 5 horizontal to 1 vertical (5H:1V). Below the normal water level, the sideslopes are assumed to be at approximately 3H:1V. For this configuration, and assuming the embankment between the normal water level and high water level is constructed with an engineered clay liner (as recommended in this report), the potential for erosion from wave action should be considered. Slope protection consisting of rip-rap designed for potential wave erosion or other means should be given consideration. The use of a filter fabric median between the native soils and rip-rap is also recommended. Design recommendations for this protection is beyond the scope of this report.

For the assessment of clay liner suitability, one laboratory constant head permeability test was conducted on a remolded sample of the native clay soils (during a previous evaluation). The laboratory test was conducted on composite clay till samples retrieved from between 1.5 m to 3.0 m below ground level (to model that excavated from within the pond footprint and proposed for use as a clay liner). The sample was compacted to approximately 98% of SPD at a moulding moisture content of approximately the optimum moisture content (OMC) for the soil sample (17.0%) (Appendix D). The measured steady state permeability (K) was $2.28 \text{ E-}08 \text{ cm/sec}$. Therefore, the design field liner permeability assumed for the remoulded clay till soil is $2.28\text{E-}07 \text{ cm/sec}$. (one order of magnitude larger than the laboratory K value). Prior to final design and construction tendering of the proposed facility, additional permeability testing on site soil samples taken from the proposed excavation of the facility or borrow source should be conducted to verify the site specific permeability coefficient.

Based upon the site soil conditions and the above-noted permeability value, it is recommended that a preliminary thickness for the remolded clay liner be 0.6 m along the base of the wet pond and 1.0 m along the sidewalls up to design operation water elevation (minimum recommended).

A liner thickness of 0.3 m may be given consideration for base liners in other areas of the proposed developed (dry pond), which will only occasionally be below water. This thickness accounts for the potential of desiccation of the upper 0.2 m during the initial periods when the dry pond is empty. It also accounts for potential disturbance during storm events and to facilitate access during periods of maintenance. Thirdly, it is intended as an additional level of protection, to reduce the long term infiltration of groundwater and soil saturation below the dry pond, as a means of maintaining long-term stability of the adjacent slopes.

The following discussions and recommendations pertain to the pond construction, including the construction of a low permeability compacted clay liner.

8.3 POND CONSTRUCTION

8.3.1 General Base Preparation

Following stripping of any organic materials within the development area, the containment basin area should be overexcavated beneath the proposed invert elevation in order to allow sufficient thickness of compacted clay base liner. The clay till soil within the base of the excavation should then be scarified to a minimum depth of 300 mm, moisture conditioned to between -1 percent and +2 percent of optimum moisture content, and recompacted to a minimum of 98 percent of SPD. The prepared subgrade thickness may be taken into account in the design liner thickness.

The basin sidewalls in the cut areas (up to high water level) should also be overexcavated a sufficient amount to allow the construction of a compacted clay liner with the exposed subgrade scarified, moisture conditioned, and compacted as noted above.

Monitoring of excavated soils within the pond footprint is recommended so that unsuitable materials, such as low plastic silts or cohesionless sands, are incorporated only in general landscape areas (above HWL) where low permeability is not a requirement.

The composition and consistencies of the soils encountered on the property are such that conventional hydraulic excavators should be able to remove these materials. Cobbles and boulders may be present within the clay till matrix, albeit infrequently. General recommendations regarding backfill materials and compaction as well as construction excavations are given in Appendix C.

Full time monitoring is recommended by suitably qualified persons, independent of the Contractor. One of the purposes of providing an adequate level of monitoring is to check that recommendations, based on data obtained at discrete borehole locations, are relevant to other areas of the site.

8.3.2 Remolded Clay Liner

The following recommendations for the construction of remolded clay liners are based on compliance with Alberta Environment's publication, "Stormwater Management Guidelines for the Province of Alberta", dated January 1999. This publication does not specifically provide permeability recommendations for wet ponds, however, it does provide a guideline in Figure 6.10, Wet Detention Pond Plan Sections, for "suitable subgrade to prevent infiltration below permanent depth (Max = 1.2 m/Min = 0.6 m).

Recommendations for the pond base and sidewall preparation have been provided in the previous section. The plan dimensions of the excavation should exceed the final "toe to toe" interior basin dimensions to provide an overlap between the pond floor liner and berm or sideslope liner. The subgrade should be relatively level and proof-rolled to provide a good base for compacting the first liner lift to the specified density. Soft pockets that would prevent sufficient compaction of the liner must be overexcavated and replaced with compacted cohesive clay fill materials. In lieu of satisfying the compaction requirements, a

geotextile fabric (such as Armtex 200) may be required on or about the elevation of any encountered soft subgrade, although this is not anticipated for the current site conditions.

Careful site observation and testing will be required to avoid incorporating low or non-plastic materials into the liner. It is recommended that materials with a liquid limit of less than 30 not be incorporated into the liner. However, low plastic clays, silt or sands not meeting liner requirements, may be used in the top areas of the embankments above HWL or outside the liner zones.

Based on the results of the field program, moisture conditioning of the clay liner materials will be required during liner construction. Appropriate methods of moisture conditioning should be reviewed with qualified construction personnel prior to final design of the liner system.

Subsequent to the preparation of the pond floor, the excavated clay soils (liner borrow material) should be moisture conditioned to between -1 percent of the optimum and +2 percent over the optimum moisture content as determined by the Standard Proctor Test. Each lift should then be compacted to a minimum of 98 percent of SPD in lifts of maximum 150 mm compacted thickness to a total placed liner thickness of 0.6 m for the base, as recommended above.

A maximum "clod" size of 100 mm during moisture conditioning (prior to compaction) will produce a relatively uniform moisture content throughout the soil matrix and a relatively homogenous compacted soil structure. The size of the "clods" can be controlled with agricultural equipment such as a disk. As far as practical, the liner should be built up in a uniform fashion over the containment basin area, in order to avoid sections of "butted fill" where seepage paths may develop. Compaction should be carried out utilizing "kneading" type compaction equipment such as vibratory padfoot or sheepsfoot type compactors. Completed liner areas should have the surface smoothed by a vibratory smooth drum roller.

Sideslope liners in "cut" areas should have a minimum thickness (perpendicular to the slope face) of 1.0 m, as noted. The cohesive materials for the sideslope liners should be moisture conditioned and compacted as indicated above for the pond bottom.

If a lift of liner soil is allowed to become dry and desiccated prior to the placement of the next lift, the exposed surface should be scarified, re-moisture conditioned, and recompacted. Prior to pond filling and during maintenance periods when the pond is empty, the pond bottom should be prevented from drying out beyond 0.2 m as accounted for in the design liner thickness.

9.0 SUBDIVISION DEVELOPMENT

9.1 GENERAL

Specific recommendations that apply to this project are provided in the following subsections for shallow footings, basement construction and floor slabs, general site development and lot grading, groundwater issues, trench excavation and backfill, and

concrete type (including commentary on concrete surfacing). Pavement structures for this development should be designed and constructed to the City of Lethbridge Infrastructure Services Engineering Standards and as such, are not presented in this report. However, recommendations for subgrade preparation within the proposed asphalt concrete surfaced roadways are discussed.

Development in close proximity to slopes has been discussed elsewhere in this report and the development restrictions must be considered.

A groundwater study has not been requested as part of this evaluation. It is EBA's understanding that weeping tiles for the residences will most likely include tie-ins to the storm sewer utility or to a surface discharge.

The initial topsoil stripping depth is of particular importance. For such a development, following removal of the surficial organic topsoil, the majority of any underlying B Horizon layer (organic stained, but essentially inorganic clay) can likely remain in place during site stripping and incorporated into the fill mass during general site grading. Full-time monitoring by experienced personnel is recommended in order to avoid over-stripping and to ensure appropriate material mixing and placement.

Subgrade preparation is required in all subdivision development areas, including lot grading, as well as all paved areas to City of Lethbridge Standards as noted in this report. This includes stripping of topsoil and deleterious fill materials, scarification and moisture conditioning and compaction. The native medium plastic clay soils should be acceptable for site grading purposes in all areas. The clay surface appears to be both below and above its optimum moisture content in localized areas and as such, moisture conditioning (wetting, mixing, and drying as necessary) will be required to reduce the swelling potential of this soil and to achieve the compaction standards recommended. Proof-rolling within roadways to detect soft areas is also recommended. The contractor should expect soil moisture variability around the property.

Shallow footings are considered feasible for residential developments in all areas of the subdivision most likely in conjunction with full or partial basements. Further recommendations are provided in Section 9.6. However, because footings will be placed within areas of general engineered fill, full-time quality assurance monitoring by geotechnical personnel is required during fill placement. It is noted that placement of foundations on engineered cohesive fill thicknesses greater than 1 m require special consideration regarding long-term consolidation of the fill and subsequent performance issues with the foundations/floor slabs-on-grade. Following finalization of the final surface grades for the subdivision, this aspect will need to be addressed.

Cast-in-place concrete piles are considered a feasible alternative for other developments under consideration, including schools or commercial buildings. However, for drilled pile foundations, the thin wet sand lenses within the clay till encountered at the borehole locations may necessitate the use of casing to prevent sloughing of the pile bores. This may make this foundation alternative less economic in consideration of a shallow foundation

system. Recommendations for both of these foundation systems are provided in the following subsections.

Slabs-on-grade for this project must consider the precautions recommended. For slabs-on-grade, including the subgrade preparation measures intended to improve slab performance.

All foundation design recommendations presented in this report are based on the assumption that an adequate level of monitoring will be provided during construction and that all construction will be carried out by suitably qualified contractors, experienced in foundation and earthworks construction. An adequate level of monitoring is considered to be:

- for shallow foundations and slabs; inspection of bearing surfaces prior to placement of concrete or mudslab and design review during construction;
- for pile foundations; full time monitoring and design review during construction;
- for earthworks; full-time monitoring and compaction testing.

All such monitoring should be carried out by suitably qualified persons, independent of the contractor. One of the purposes of providing an adequate level of monitoring is to check that recommendations, based on data obtained at discrete borehole locations, are relevant to other areas of the site.

9.2 LOT GRADING

In general terms, the lot grading should be designed and carried out to the current City of Lethbridge Infrastructure Services Engineering Standards. The particulars for this development are discussed as follows.

All lots should be initially graded for drainage at a minimum gradient of 2.0 percent. The existing surficial site soils comprising medium plastic clay and clay till, are suitable for use as 'landscape fill' materials or for use as 'general engineered fill' materials for lot grading, as defined in Appendix C. The moisture content of the site soil materials at surface generally appears to be both above and below the anticipated optimum moisture content for these soils in most areas. It is anticipated therefore, that moisture conditioning consisting of both wetting and drying will be required at the site for proper compaction. Although soil moisture variability should be expected, the earthwork contractor should, however, make his own estimate of the requirements and should consider such factors as weather and construction procedures.

General engineered fill materials for lot grading should be moisture conditioned to within a range of -1 percent of optimum to +2 percent of the optimum moisture content prior to compaction and compacted to a minimum of 98 percent of SPD.

Further recommendations regarding backfill materials and compaction are contained in Appendix C.



9.3 STREET SUBGRADE PREPARATION

Within all asphalt concrete surfaced paved areas, the upper 300 mm of native clay soils or prepared general engineered fill subgrade should be scarified and uniformly moisture conditioned to between minus 1 percent of optimum and 2 percent over optimum moisture content. The subgrade should then be uniformly compacted to a minimum of 98 percent of SPD.

Based on EBA's local experience, the contractor should be made aware that subgrade difficulties often arise at moisture contents of 3 percent over optimum, as noted in the current City of Lethbridge Standards, where siltier soils are encountered. Therefore, in practice, the moisture content within proposed paved areas should be limited to no more than 2 percent over optimum for acceptable subgrade support conditions.

Backfill to raise these areas to subgrade level should be general engineered cohesive fill materials, as defined in the report text or Appendix C, moisture conditioned and compacted as noted previously. The subgrade should be prepared and graded to allow drainage into catchbasins. Proof-rolling of the prepared surface is recommended to identify localized soft areas and for an indication of overall subgrade support characteristics.

It is imperative that positive surface drainage be provided to prevent ponding of water within the roadway structure and subsequent softening and loss of strength of the subgrade materials. Surrounding landscaping should be such that runoff water is prevented from ponding beside paved areas in order to avoid softening and premature failure of the pavement surface.

The soil moisture regime should be considered in achieving the above recommended standards for construction of the subgrades. If localized areas of soft subgrade soils are encountered, provisions may be required to subcut each area and replace with cohesive engineered fill, or alternatively, with granular (pit-run) fill with the use of a geotextile grid or geotextile fabric to strengthen the subgrade support characteristics. Further design information can be provided following initial proof-rolling of the subgrade soils. It should be noted that the use of red shale to stabilize soft areas is no longer recommended in the Lethbridge area.

9.4 EXCAVATIONS AND TRENCH BACKFILL

Excavations should be carried out in accordance with the Alberta Occupational Health and Safety (OH&S) Regulations.

For this project, the depths of excavations are anticipated to be shallow to moderate for such components as service trenches, and tie-ins (< 3.0 m). Excavations which are to be deeper than 1.5 m should have the sides shored and braced or the slopes should be cut back not steeper than 1.0 horizontal to 1.7 vertical for periods up to one month. Where excavations are open for longer than one month, the slopes should be cut back so they are not steeper than 1.0 horizontal to 1.0 vertical.

The maximum allowable sideslopes for utility trenches may not be governed by OH&S regulations, but by construction methodology for ensuring appropriate transition lengths from backfill soils to native soils. As an example, an appropriate transition of 1H:1V is normally recommended to avoid abrupt changes in subgrade stiffness and subsequent consolidation/cracking of the pavement structure. However, areas of multiple trenches, varying trench depth, and position of trenches (parallel or perpendicular to roadway alignments) need to be considered. EBA would be pleased to provide further specific recommendations, once final roadway/utility configurations are known.

It is considered unlikely that significant groundwater seepage will occur where construction is less than 2.5 m below the existing ground surface. Therefore, dewatering of most excavations should not be necessary. For the main utility trenches (deeper than 2.5 m), any seepage encountered, should be directed towards a sump for removal from the excavation.

Temporary surcharge loads, such as spill piles, should not be allowed within a distance from an unsupported excavation face equal to the depth of excavation. Mobile equipment should be kept back at least 2.0 m. All excavations should be checked regularly for signs of sloughing, especially after rainfall periods. Small earth falls from the sideslopes are a potential danger to workmen and must be guarded against.

The moisture content of the clay soils encountered across the site generally varies between below and above the estimated Standard Proctor optimum moisture content for the materials. It is expected that such soils would be satisfactory as trench backfill material, however, may require moisture conditioning prior to reworking. It is anticipated therefore, that moisture conditioning consisting of both wetting and drying or mixing will be required for proper compaction. The earthwork contractor should, however, make his own estimate of the requirements and should consider such factors as weather and construction procedures.

Trenches must be backfilled in such a way as to minimize the potential differential settlement and/or frost heave movements. A minimum density of 98 percent of SPD is recommended for all trench backfill, at a moisture content of between -1 percent and +2 percent of optimum. The compacted thickness of each lift of backfill shall not exceed 150 mm. The upper 1.5 m of service trenches should be cut back at a maximum slope of 1.0 horizontal to 1.0 vertical to avoid an abrupt transition between backfill and in situ soil.

It should be noted that the ultimate performance of the trench backfill is directly related to the uniformity of the backfill compaction. In order to achieve this uniformity, the lift thickness and compaction criteria must be strictly enforced.

For frost protection, pipes buried with less than 2.0 m of soil cover (above top of pipe) should be protected with insulation to avoid frost effects that might cause damage to or breakage of the pipes. Rigid insulation placed under areas subject to vehicular wheel loadings should be provided with a minimum thickness of 600 mm of compacted granular base.

9.5 CONCRETE ISSUES

The water soluble sulphate content of four representative soil samples recovered from the site (determined in a laboratory) varied between 0.1 and 1.3 percent. For this development, based on EBA's experience and CSA A23.1-04, the recommended concrete exposure classification for general usage should be Class S-2 (CSA A23.1-04, Table 3). For this exposure classification, alternatives include the usage of Type HS (Sulphate Resistant) Portland cement, or blends of cement and supplementary cementing materials, conforming to Type MSb and/or Type HSb cements (CSA A3001-03).

Air entrainment of 4 to 6 percent by volume is recommended for all concrete exposed to freezing temperatures, native soils and/or groundwater. This should be increased to 5 to 7 percent for exterior flatwork.

With respect to surface works concrete (i.e., specifically concrete curbs and sidewalks), the recommendations provided in this report for subgrade preparation, including moisture conditioning and compaction, are intended to provide relative uniformity in the subgrade. The intention of uniformity, with respect to material type and moisture content, is to reduce the risk of differential concrete movements due to soil volume changes as a result of fluctuating moisture content. For these types of developments, a gradual increase in moisture content is common, resulting from precipitation, reduced evaporation, and irrigation. However, some differential movement and subsequent cracking of concrete surface works should be anticipated, typical for the Lethbridge area.

On the negative side, if free drainage of the granular layer is not designed, constructed, and maintained, granular materials provide easy access for excess moisture to pond below the concrete, causing swelling of the medium to high plastic subgrade soils and/or consolidation of fill soils. There is also a risk of softening of the adjacent roadway pavement edges.

The risk of differential movement of the subgrade soils and the economic consequence for either option should be given due consideration by the municipal engineer.

9.6 SHALLOW FOUNDATIONS

Shallow foundations, if considered, should be constructed approximately 1.4 m below the final design exterior ground surface (frost protection requirement). At this depth the foundation subgrade soil generally consists of very stiff, damp to moist, medium to high plastic, clay or clay till.

The net allowable static bearing pressure for the design of strip and spread footings for residential construction at this depth may be taken as 75 kPa, on native, undisturbed clay soils, subject to other recommendations in this report. The allowable static bearing pressure is based on correlation between Standard Penetration Test 'N' values. The factor of safety used from ultimate bearing capacity was 3.0. Footing dimensions should be in accordance with the minimum requirements of the Alberta Building Code 1997 (Section 9.15.3 Footings). Bearing certification is recommended to ensure that the footings are placed on competent soils. Full-time quality assurance compaction testing and monitoring is recommended during placement of general engineered fill.

It is recommended to use a smooth edge-trimming bucket or Grade-All for final excavation to the foundation subgrade elevation to minimize disturbance of the founding soils. The foundation concrete should be placed immediately following excavation to ensure the bearing clay soil does not dry out to below the plastic limit.

The anticipated foundation clay soils are expected to be prone to volume changes (both heave and consolidation) with varying moisture content. Therefore, a permanent weeping tile system is also recommended around the outside perimeter of the structure at the foundation elevation to maintain a consistent moisture profile of the founding soils. This will reduce the potential of differential movement (heave or consolidation) of the foundations. Weeping tile drainage is discussed in Subsection 9.11.

Settlement of footings designed and constructed in accordance with the above recommendations should be well within the normally tolerated values of 25 mm total and 20 mm differential.

Recommendations for minimum depth of cover for footings are presented under the heading 'Frost Protection' below. Further recommendations regarding shallow foundations are given in Appendix C.

9.7 BORED CAST-IN-PLACE CONCRETE PILES

Bored cast-in-place concrete piles, founded in native clay till, may be designed to resist axial compressive loads on the basis of the allowable skin friction and end-bearing parameters given below. End-bearing should not be used for small diameter (less than 760 mm base diameter) straight shaft piles because of the difficulties associated with ensuring a clean base. End-bearing may only be considered in the design of underreamed or belled piles if facilities are available during construction for adequate cleaning of the pile base.

Straight shaft bored piles should have a minimum diameter of 400 mm and an overall length of not less than 6.0 m. It is noted that thin saturated sand lenses and pockets were encountered at the borehole locations, interbedded in the clay till deposit. The piling designer and/or contractor should take this into account during pile design consideration. Underreaming to form belled piles may be considered for piles with shaft diameters of 400 mm or greater. The recommended bell depth below the existing ground level should be 6.0 m.

Static design parameters for skin friction and end-bearing are as follows.

Depth Below Final Grade (m)	Allowable Skin Friction (kPa)	Allowable End-bearing (kPa)
0 – 1.5	0	N/A
1.5 – 5.0	20	N/A
Below 5.0	25	250

A minimum ratio of depth of cover versus the base or bell diameter (D/B) of 2.5 has been assumed to determine the above allowable end-bearing pressure. Should less cover be provided, the allowable bearing pressure would have to be reduced. Minimum bell diameters should be twice the shaft diameter.

The pile design for belled piles may consider end-bearing in addition to shaft friction as noted above in order to determine the total pile capacity. However, the shaft friction should be neglected for a distance of one shaft diameter above the top of the bell and within the top 1.5 m portion of the piles.

Casing should be on hand before drilling starts and used if necessary to seal off water and/or prevent sloughing of the hole. In the present site conditions, it is anticipated that casing use may be required at some of the pile locations to seal off groundwater seepage. The piling contractor, however, should make his own estimate of casing requirements, considering such factors as construction procedures and bore diameter.

The bases of all end-bearing piles must be thoroughly cleaned of all loosened material by mechanical methods. Following drilling and cleaning, pile holes should be inspected to ensure that an adequate bearing surface has been prepared at an appropriate depth. Full-time pile monitoring is recommended for this project by qualified geotechnical personnel.

General recommendations for the design and construction of cast-in-place concrete piles are included in Appendix C.

9.8 FLOOR SLABS-ON-GRADE

Construction of floor slabs-on-grade for this project must consider the surficial lacustrine soils noted within the development area as well as the general engineered fill layers placed during site grading. Construction may be considered feasible, provided the following precautions and construction recommendations are followed.

In native soils areas, following removal of topsoil, the subgrade should be scarified to a minimum depth of 300 mm, and moisture conditioned to a range of optimum to 2 percent over optimum moisture content. Within areas of fill, the exposed subgrade should be scarified for a minimum depth of 600 mm, considering the clay fill soils (not containing deleterious materials) and moisture conditioned as noted above. The minimum compaction in each case should be 98 percent of Standard Proctor maximum dry density (SPD). The prepared subgrade should be proof-rolled and any soft or loose pockets detected should be reconditioned as recommended above or over-excavated and replaced with general engineered fill.

As required, all general engineered fill needed to bring the development area to design subgrade elevation should be uniformly moisture conditioned between within 2 percent of optimum moisture content. Recommendations for general engineered fill are provided in Appendix C. The minimum compaction should be 98 percent of SPD. The site soils are generally considered acceptable for use as general engineered fill, provided they are acceptably moisture conditioned.

A levelling course of clean well graded crushed gravel, at least 150 mm in compacted thickness, is recommended directly beneath the slabs-on-grade, unless a thicker course is required for structural purposes. At this time, it is possible that the existing site granular soils could be reused for this purpose, provided they were acceptably clean of fine grained soils. This should be reviewed at the time of development. It is possible that any granular soils, which are contaminated with clay inclusions, may have to be removed from the development areas. The subgrade beneath slabs-on-grade should be protected at all times from moisture or exposure which may cause softening or disturbance of the subgrade soils. This applies during and after the construction period (and before and after replacement of the required general engineered fill). Should the exposed surface become saturated or disturbed it should be reworked to achieve the above standards.

If the subgrade is properly prepared as noted above, floor slab movements should be limited to less than approximately 25 mm. Slabs-on-grade should be separated from bearing members to allow some differential movement. If this range of differential movement is unacceptable, the owner should consider a structurally supported floor.

Recommended procedures for proof-rolling and backfill materials and further recommendations for slabs-on-grade construction are included in Appendix C.

9.9 STRUCTURAL SLABS

A structurally supported floor slab may be used if differential movements from a slab-on-grade system are not tolerable. However, with this type of structurally supported floor slab system, there is a risk of ground movement relative to the slab. This relative movement can lead to problems if piping and other utilities that are connected to the slab are embedded within the ground beneath the slab. Utilities beneath structurally supported ground floor slabs should be protected from differential movement by placing utilities within boxes suspended from the structural slab. In addition, a void form is recommended below the floor slab in order to prevent transfer of uplift pressures due to swelling clay soil.

9.10 BASEMENT CONSTRUCTION

9.10.1 Basement Floor Slabs

Slab-on-grade construction for basements is considered feasible providing certain precautions are undertaken. All excavation should be carried out remotely using a smooth-mouth bucket or Grade-All at final grade in order to minimize disturbance of the base. Basement floor slabs should be supported by a minimum of 150 mm compacted, clean, free-draining granular material.

In areas where floor slabs bear on a clay subgrade, the clay at this site may swell following completion of the floor slabs. Therefore, some movement should be anticipated. Any light columns in the basement designed to support the main floor should be of the adjustable "telepost" type. If partitions are constructed in the basement, provision must be made so that, if the basement floor slab heaves, the partitions do not raise the main floor. A minimum allowance of 25 mm should be left between the top plates of basement partitions and the floor above them to accommodate heaving of the floor slab. This heaving allowance is less applicable for interior columns founded on spread footings.

The slab subgrade should be sloped to provide positive drainage to the edge of the slab (where the native soils are cohesive). A minimum drainage gradient of 0.5 percent is recommended.

Slabs-on-grade should be separated from bearing members to allow some differential movement. If differential movement is unacceptable, a structurally supported floor system or crawlspace may be considered.

General recommendations regarding floor slab construction are presented in Appendix C.

9.10.2 Basement Walls

All basement walls should be designed to resist lateral earth pressures in an "at-rest" condition. This condition assumes a triangular pressure distribution and may be calculated using the following:

$$P_o = K_o (\gamma H + q)$$

where:

P_o	=	lateral earth pressure "at-rest" condition (no wall movement occurs at a given depth)
K_o	=	co-efficient of earth pressure "at-rest" condition (use 0.5 for silt or clay backfill and 0.45 for sand and gravel backfill)
γ	=	bulk unit weight of backfill soil (use 19 or 21 kN/m ³ for clay or granular backfill, respectively)
H	=	depth below final grade (m)
q	=	surcharge pressure at ground level (kPa)

It is assumed that drainage is provided for all basement walls through the installation of weeping tile and hydrostatic pressures will not be a factor in design.

Backfill around concrete basement walls should not commence before the concrete has reached a minimum two-thirds of its 28-day strength and first floor framing are in place or the walls are laterally braced. Only hand operated compaction equipment should be employed within 600 mm of the concrete walls. Caution should be used when compacting backfill to avoid high lateral loads caused by excessive compactive effort. A compaction standard of 95 percent of Standard Proctor maximum dry density (SPD) is recommended. To avoid differential wall pressures, the backfill should be brought up evenly around the walls. A minimum 600 mm thick engineered clay cap should be placed at the ground surface to minimize the infiltration of surface water.

9.11 FOUNDATION PERIMETER DRAINAGE REQUIREMENTS

It is understood that all residential weeping tiles will be tied into the City storm sewer system and/or will have arrangements for surface discharge. An acceptable weeping tile system should consist of a perforated weeping tile, surrounded with a minimum of 150 mm thick blanket of washed rock (maximum size 20 mm), with the drain rock surrounded by non-woven geotextile. The weeping tile should have a minimum 0.5 percent slope leading to a sump to then discharge as noted above.

9.12 FROST PROTECTION

For protection against frost action, perimeter footings in heated structures should be extended to such depths as to provide a minimum soil cover of 1.4 m. Isolated or exterior footings in unheated structures should have a minimum soil cover of 2.1 m unless provided with equivalent insulation.

All piles in unheated areas should have full depth steel reinforcement and should be drilled to a minimum depth of 6 m. Grade beams spanning concrete piles should have a minimum 100 mm void space on the underside of the grade beam and around the pile caps to reduce the risk of interaction with the underlying soil, associated with frost heaving and/or swelling soils.

9.13 SEISMIC DESIGN

A seismic foundation factor of 1.0 is recommended.

10.0 DESIGN AND CONSTRUCTION GUIDELINES

Recommended general design and construction guidelines are provided in Appendix C, under the following headings.

- Shallow Foundations
- Floor Slabs-on-Grade
- Construction Excavations
- Backfill Materials and Compaction
- Bored Cast-In-Place Concrete Piles
- Proof-Rolling

These guidelines are intended to present standards of good practice. Although supplemental to the main text of this report, they should be interpreted as part of the report. Design recommendations presented herein are based on the premise that these guidelines will be followed. The design and construction guidelines are not intended to represent detailed specifications for the works although they may prove useful in the preparation of such specifications. In the event of any discrepancy between the main text of this report and Appendix C, the main text should govern.

11.0 REVIEW OF DESIGN AND CONSTRUCTION

EBA should be given the opportunity to review details of the design and specifications, related to geotechnical aspects of this project, prior to construction.

Bearing surfaces, foundation installation, and deep excavations should be monitored by qualified geotechnical personnel during construction. EBA will provide these services, if requested.

12.0 LIMITATIONS

Recommendations presented herein are based on a geotechnical evaluation of the findings in 14 geotechnical boreholes and a review of existing geotechnical data in EBA's records, including previous reports and historical air photos. The conditions encountered during the fieldwork are considered to be reasonably representative of the site. If, however, conditions other than those reported are noted during subsequent phases of the project, EBA should be notified and given the opportunity to review our current recommendations in light of new findings. Recommendations presented herein may not be valid if an adequate level of monitoring is not provided during construction.

This report has been prepared for the exclusive use of Melcor Developments Ltd., UMA Engineering Ltd., and their agents, for specific application to the development described in Section 2.0 of this report. It has been prepared in accordance with generally accepted soil and foundation engineering practices. No warranty is either express or implied.

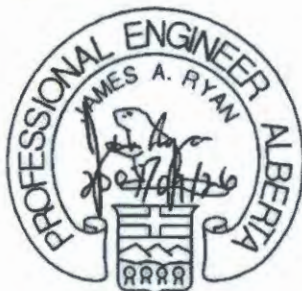
For further limitations, reference should be made to the General Conditions in Appendix A of this report.

13.0 CLOSURE

We trust this report satisfies your present requirements. We would be pleased to provide further information that may be needed during design and to advise on the geotechnical aspects of specifications for inclusion in contract documents. Should you require additional information or monitoring services, please do not hesitate to contact our office.

Respectfully submitted,
EBA Engineering Consultants Ltd.

Prepared by:



J.A. (Jim) Ryan, M.Eng. P.Eng.
Project Director

Reviewed by:



Marc J. Sabourin, P.Eng.
Senior Project Director

/cld

PERMIT TO PRACTICE	
EBA ENGINEERING CONSULTANTS LTD.	
Signature	
Date	
PERMIT NUMBER: P245	
The Association of Professional Engineers, Geologists and Geophysicists of Alberta	



FIGURES



UMA Engineering Ltd.

EBA Engineering Consultants Ltd.

RIVERBEND SUBDIVISION

SITE PLAN AND BOREHOLE LOCATIONS

PROJECT NO. L12101023

DRAWN LCH

CHECKED JAR

DATE September 28, 2007

REV 0

Figure 1

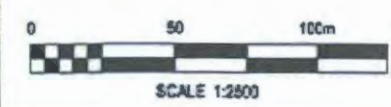
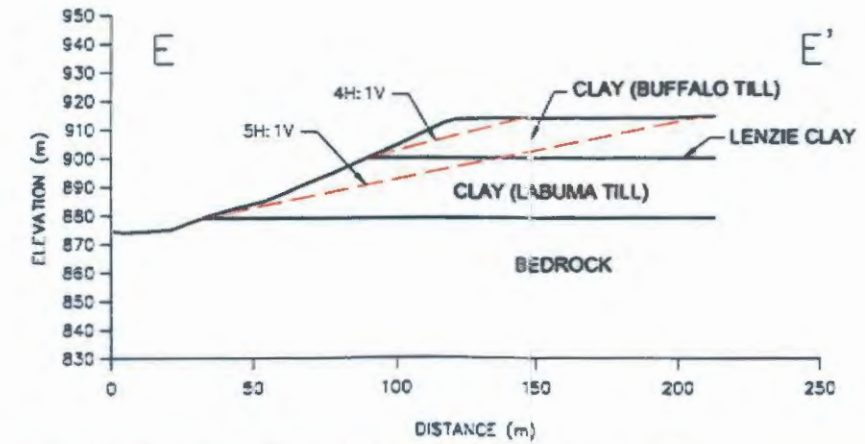
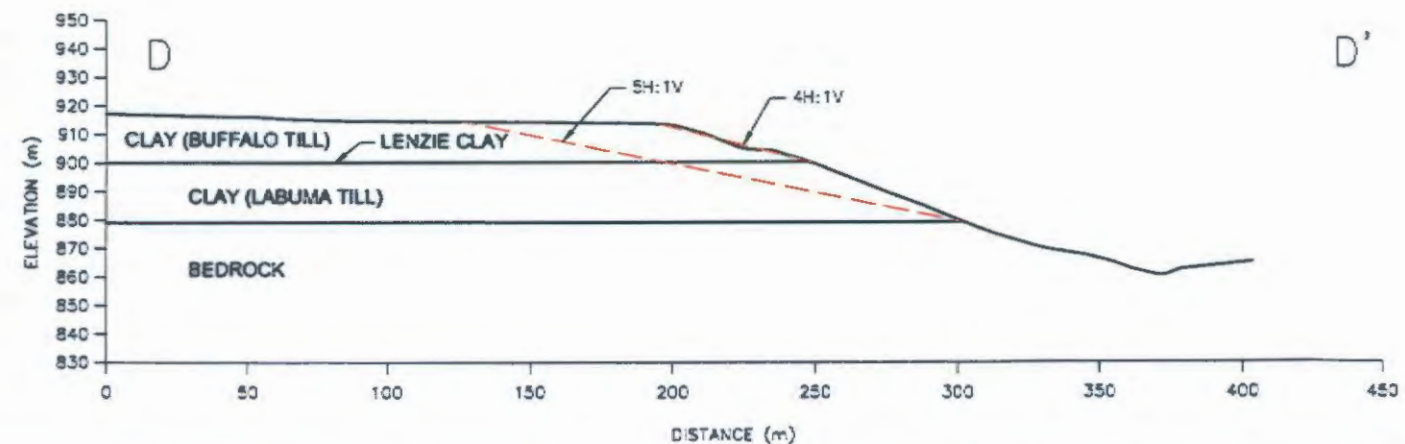
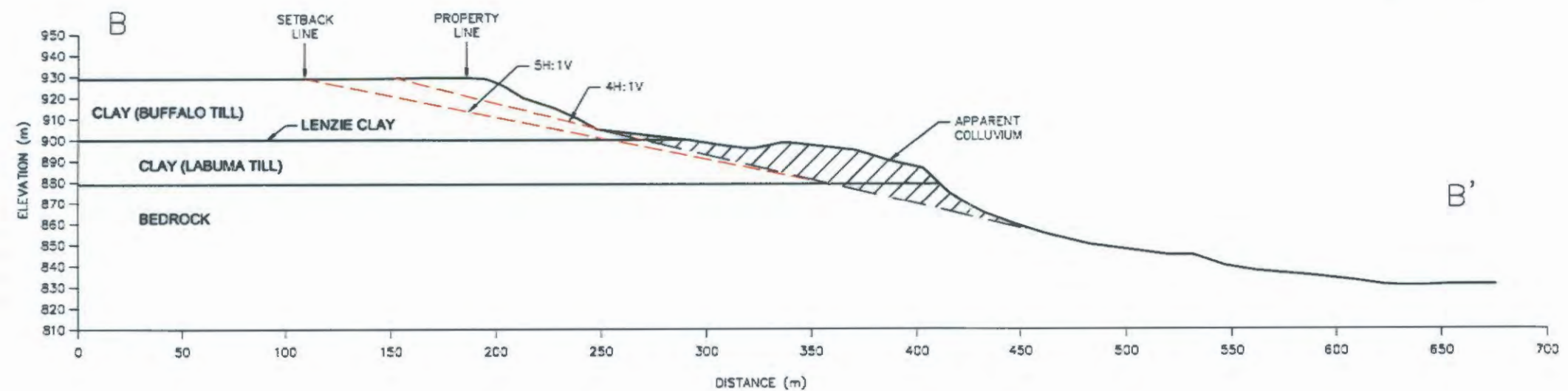
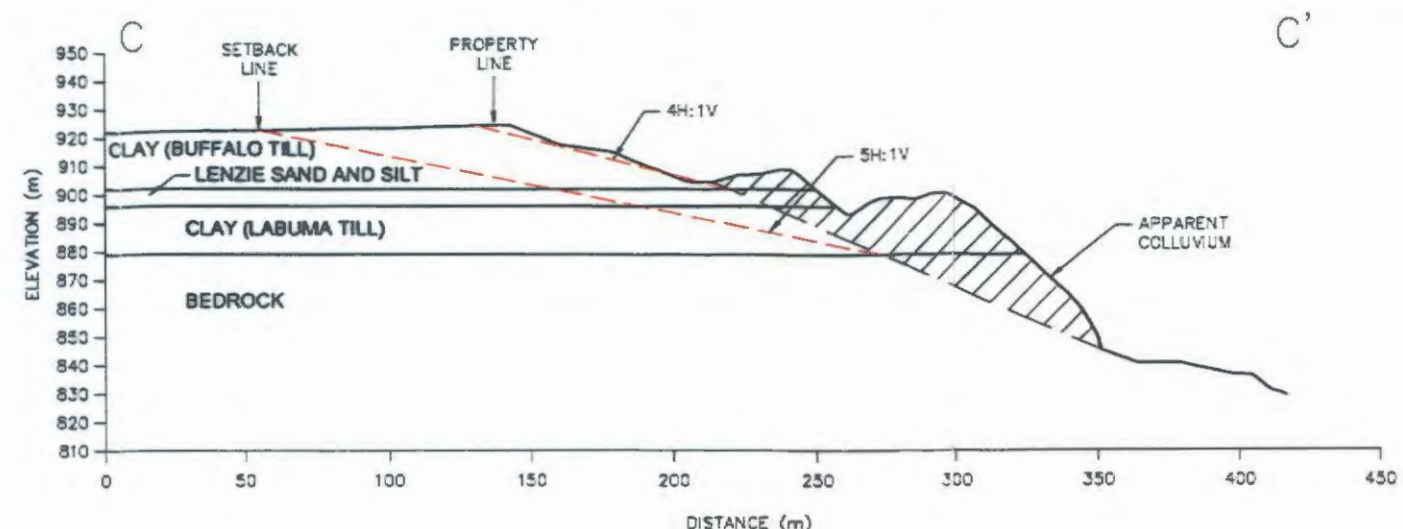
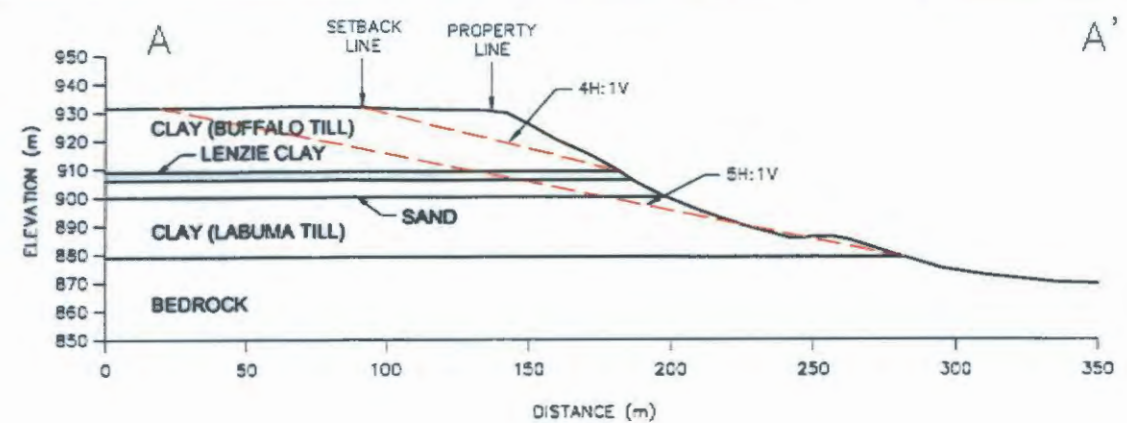
LEGEND

- SITE BOUNDARY
- 2007 BOREHOLE LOCATION
- BOREHOLES FROM 2003 EBA EVALUATION FILE 4400005
- CROSS SECTION LOCATION

0 100 200 300 400 500m

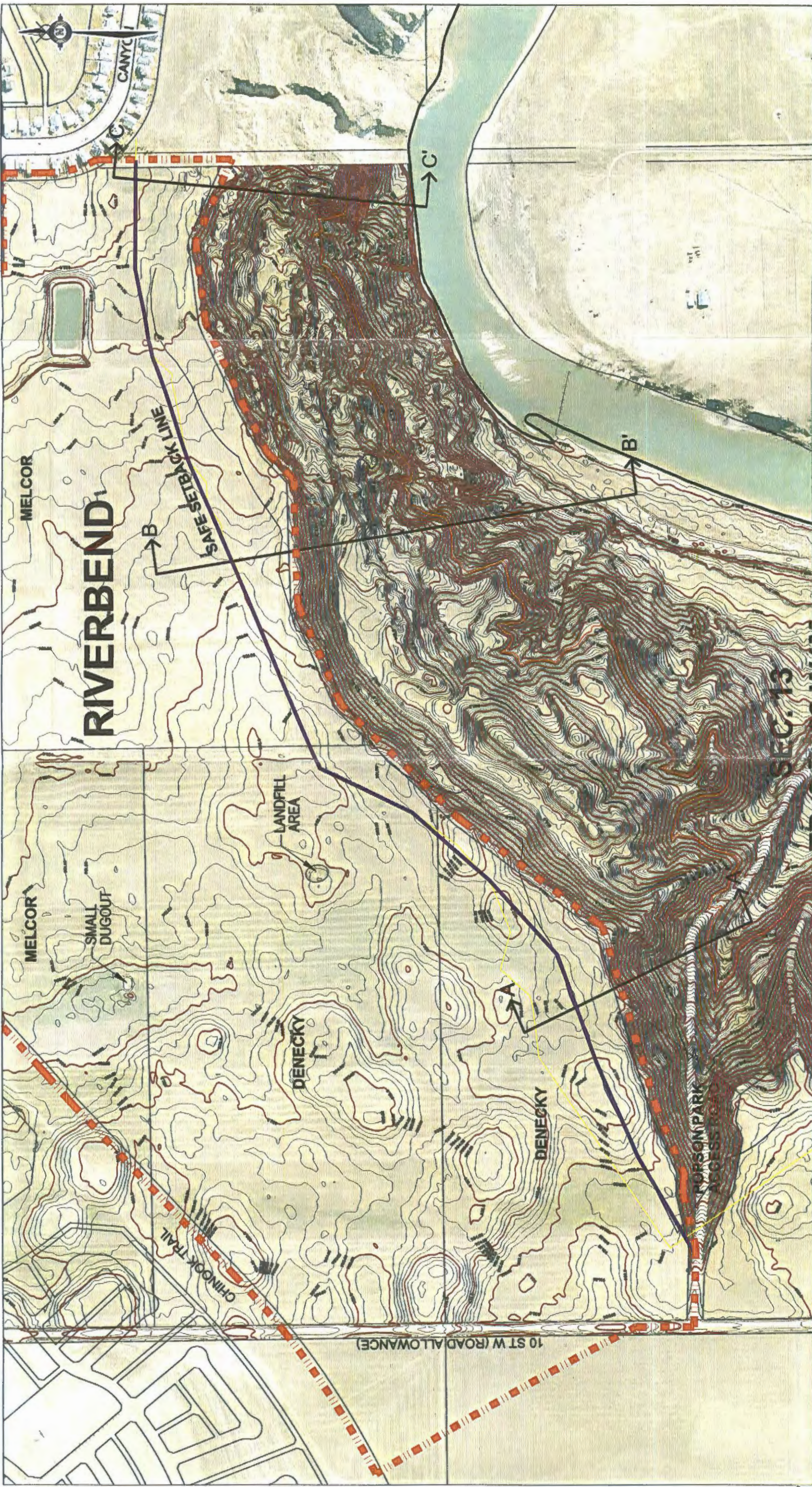
SCALE 1:10 000

Interpretation of 12101023 file plan.dwg



CLIENT		RIVERBEND SUBDIVISION			
UMA Engineering Ltd.		CROSS SECTIONS			
EBA Engineering Consultants Ltd. 	PROJECT NO. L12101023	DWN LCH	QID JAR	REV 0	Figure 2
	OFFICE EBA-Leithridge	DATE September 25, 2007			

\\hpc001\12101023\12101023_solidarea.dwg



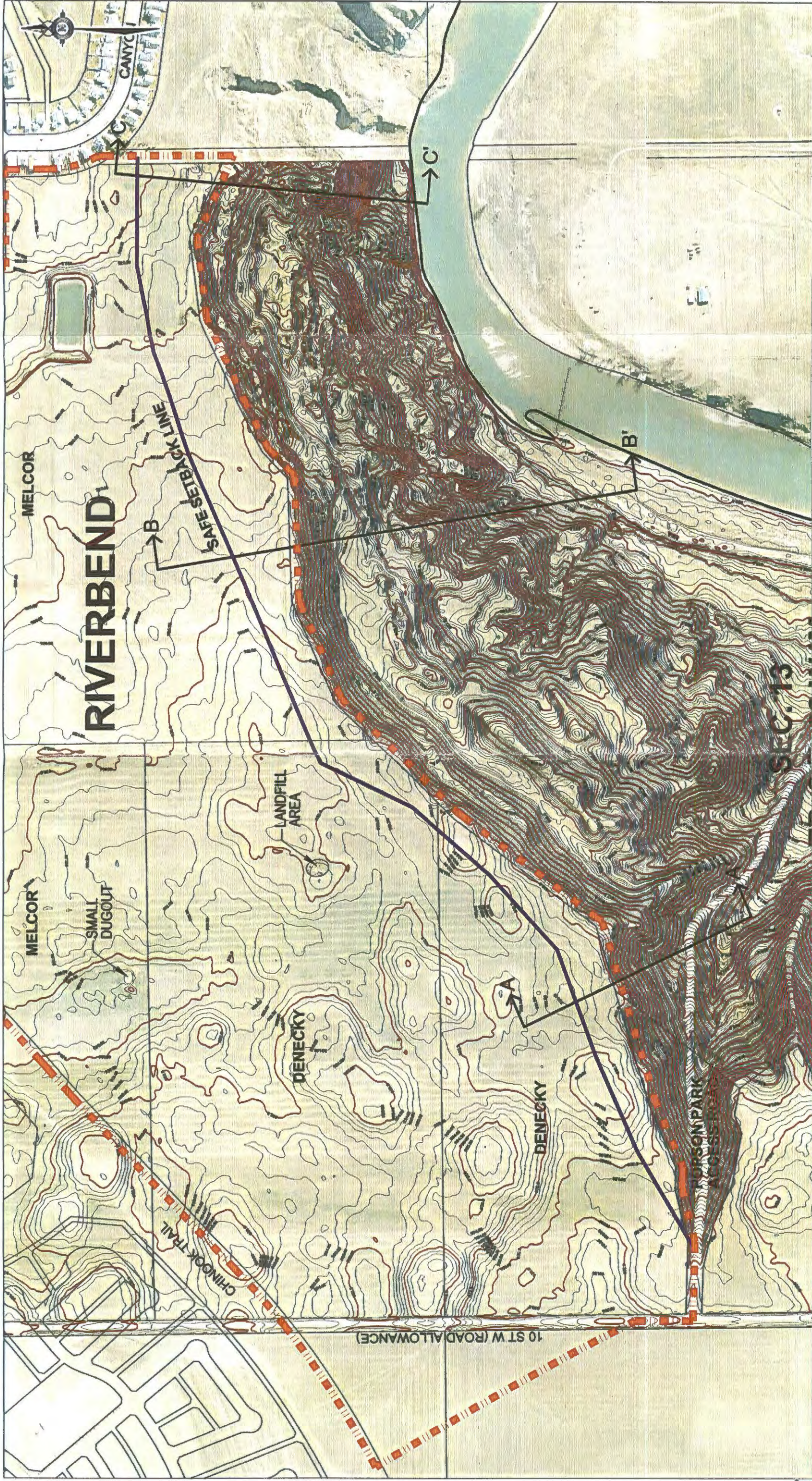
UMA Engineering Ltd.		RIVERBEND SUBDIVISION					
EBA Engineering Consultants Ltd.		SETBACK LINES LENZIES AND BEDROCK					
PROJECT NO.	L12101023	DWG.	LCH	COO	JAR	REV.	0
OFFICE	EBA-LENTIDGE	DATE	July 2, 2007				



EBA Engineering Consultants Ltd.

Figure 3

Figure 3



- LEGEND**
- SITE BOUNDARY
 - SAFE DEVELOPMENT SETBACK LINE
 - CROSS SECTION LOCATION



UMA Engineering Ltd.

RIVERBEND SUBDIVISION

RECOMMENDED SETBACK LINE

PROJECT NO.
L12110023

DATE
July 2, 2007

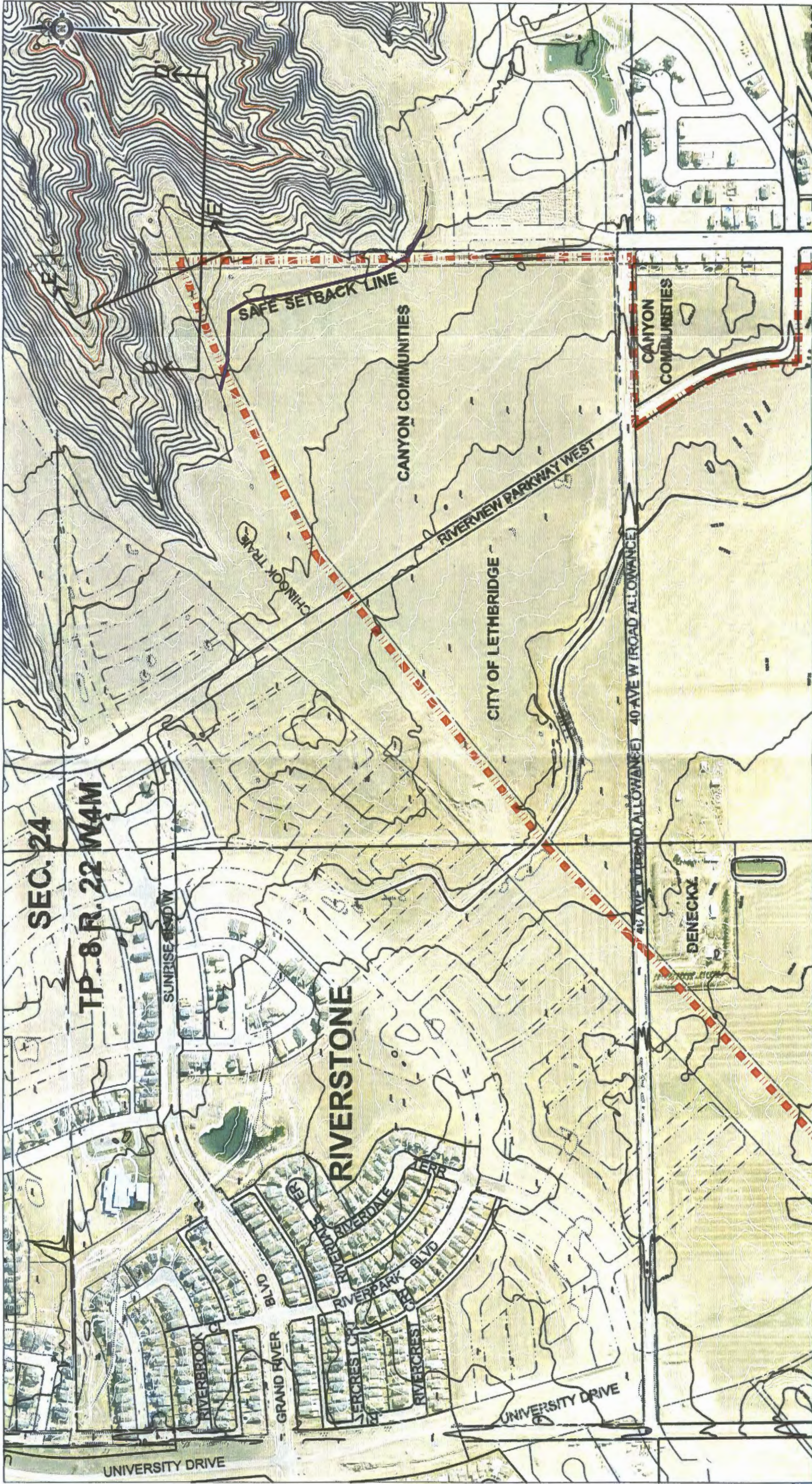
OFFICE
EBA-Leftbridge



EBA Engineering
Consultants Ltd.

Figure 4

Topographic, 12101023, 12101023 site plan.dwg



LEGEND

- SITE BOUNDARY
- LENZIE ELEVATION (900)
- BEDROCK ELEVATION
- SAFE DEVELOPMENT SETBACK LINE
- CROSS SECTION LOCATION

UMA Engineering Ltd.

EBA Engineering Consultants Ltd.

PROJECT NO. L12101023
DATE: September 26, 2007
OFFICE: EBA-Lethbridge

REVIEW: LCH, JAR, REF
DATE: 0

RIVERBEND SUBDIVISION

SETBACK LINES LENZIES AND BEDROCK
RECOMMENDED SETBACK LINE - NORTH SITE AREA

Figure 5



APPENDIX

APPENDIX A GEOTECHNICAL REPORT – GENERAL CONDITIONS

GEOTECHNICAL REPORT – GENERAL CONDITIONS

This report incorporates and is subject to these "General Conditions".

1.0 USE OF REPORT AND OWNERSHIP

This geotechnical report pertains to a specific site, a specific development and a specific scope of work. It is not applicable to any other sites nor should it be relied upon for types of development other than that to which it refers. Any variation from the site or development would necessitate a supplementary geotechnical assessment.

This report and the recommendations contained in it are intended for the sole use of EBA's client. EBA does not accept any responsibility for the accuracy of any of the data, the analyses or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than EBA's client unless otherwise authorized in writing by EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of EBA. Additional copies of the report, if required, may be obtained upon request.

2.0 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. EBA does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

3.0 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

4.0 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. EBA does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

5.0 SURFACE WATER AND GROUNDWATER CONDITIONS

Surface and groundwater conditions mentioned in this report are those observed at the times recorded in the report. These conditions vary with geological detail between observation sites; annual, seasonal and special meteorologic conditions; and with development activity. Interpretation of water conditions from observations and records is judgmental and constitutes an evaluation of circumstances as influenced by geology, meteorology and development activity. Deviations from these observations may occur during the course of development activities.

6.0 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

7.0 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

8.0 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

9.0 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

10.0 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

11.0 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

12.0 SAMPLES

EBA will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the client's expense upon written request, otherwise samples will be discarded.

13.0 STANDARD OF CARE

Services performed by EBA for this report have been conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practising under similar conditions in the jurisdiction in which the services are provided. Engineering judgement has been applied in developing the conclusions and/or recommendations provided in this report. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of this report.

14.0 ENVIRONMENTAL AND REGULATORY ISSUES

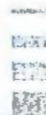
Unless stipulated in the report, EBA has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

15.0 ALTERNATE REPORT FORMAT

Where EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed EBA's instruments of professional service), the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding. The hard copy versions submitted by EBA shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancies, the hard copy versions shall govern over the electronic versions. Furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed version archived by EBA shall be deemed to be the overall original for the Project.

The Client agrees that both electronic file and hard copy versions of EBA's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except EBA. The Client warrants that EBA's instruments of professional service will be used only and exactly as submitted by EBA.

The Client recognizes and agrees that electronic files submitted by EBA have been prepared and submitted using specific software and hardware systems. EBA makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.



APPENDIX

APPENDIX B BOREHOLE LOGS

TERMS USED ON BOREHOLE LOGS

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (major portion retained on 0.075mm sieve): includes (1) clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as inferred from laboratory or in situ tests.

DESCRIPTIVE TERM	RELATIVE DENSITY	N (blows per 0.3m)
Very Loose	0 to 20%	0 to 4
Loose	20 to 40%	4 to 10
Compact	40 to 75%	10 to 30
Dense	75 to 90%	30 to 50
Very Dense	90 to 100%	greater than 50

The number of blows, N, on a 51mm O.D. split spoon sampler of a 63.5kg weight falling 0.76m, required to drive the sampler a distance of 0.3m from 0.15m to 0.45m.

FINE GRAINED SOILS (major portion passing 0.075mm sieve): includes (1) inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as estimated from laboratory or in situ tests.

DESCRIPTIVE TERM	UNCONFINED COMPRESSIVE STRENGTH (kPa)
Very Soft	Less Than 25
Soft	25 to 50
Firm	50 to 100
Stiff	100 to 200
Very Stiff	200 to 400
Hard	Greater Than 400

NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or cracks in the soil.

GENERAL DESCRIPTIVE TERMS

Slickensided	- having inclined planes of weakness that are slick and glossy in appearance.
Fissured	- containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
Laminated	- composed of thin layers of varying colour and texture.
Interbedded	- composed of alternate layers of different soil types.
Calcareous	- containing appreciable quantities of calcium carbonate.
Well Graded	- having wide range in grain sizes and substantial amounts of intermediate particle sizes.
Poorly graded	- predominantly of one grain size, or having a range of sizes with some intermediate size missing.



UNIFIED SOIL CLASSIFICATION †

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES	CLASSIFICATION CRITERIA				
COARSE-GRAINED SOILS More than 50% retained on No. 200 sieve *	GRAVELS 50% or more of coarse fraction retained on No. 4 sieve	CLEAN GRAVELS	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	Classification on basis of percentage of fines GW, GP, SW, SP GM, GC, SC, SM, SC Borderline Classification requiring use of dual symbols	$C_u = D_{60}/D_{10}$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3			
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines		Not meeting both criteria for GW			
		GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits plot below "A" line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols		
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits plot above "A" line and plasticity index greater than 7			
	SANDS More than 50% of coarse fraction passes No. 4 sieve	CLEAN SANDS	SW	Well-graded sands and gravelly sands, little or no fines.		Less than 5% Pass No. 200 sieve More than 12% Pass No. 200 sieve 5% to 12% Pass No. 200 sieve	$C_u = D_{60}/D_{10}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3		
			SP	Poorly graded sands and gravelly sands, little or no fines			Not meeting both criteria for SW		
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures			Atterberg limits plot below "A" line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols	
			SC	Clayey sands, sand-clay mixtures			Atterberg limits plot above "A" line and plasticity index greater than 7		
FINE-GRAINED SOILS 50% or more passes No. 200 sieve *	SILTS AND CLAYS Liquid limit 50% or less	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands						
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays						
		OL	Organic silts and organic silty clays of low plasticity						
	SILTS AND CLAYS Liquid limit greater than 50%	MH	Inorganic silts, micaceous or silty, elastic silts						
		CH	Inorganic clays of high plasticity, fat clays						
		OH	Organic clays of medium to high plasticity						
HIGHLY ORGANIC SOILS				Pt	Peat, muck and other highly organic soils	* Based on the material passing the 3-in. (75-mm) sieve † ASTM Designation D 2487			

PROJECT: RIVER BEND COMMUNITY OUTLINE	LOCATION: N. 5500859, E. 365584.0	BOREHOLE NO: 001
CLIENT: UMA ENGINEERING LTD.	CONTRACTOR: CHILAKO DRILLING SERVICES	PROJECT NO: L12101023
PROJECT ENGINEER: JIM RYAN	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 927.75m
SAMPLE TYPE ☒ DISTURBED ☒ NO RECOVERY ☒ SPT ☐ A-CASING ☐ SHELBY TUBE ☐ CORE		
BACKFILL TYPE ☒ BENTONITE ☒ PEA GRAVEL ☐ SLOUGH ☐ GROUT ☐ DRILL CUTTINGS ☐ SAND		

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT			Elevation (m)
					PLASTIC	M.C. LIQUID	
					20 40 60 80	50 100 150 200	
0	TOPSOIL - clay, silty, sandy, moist, dark brown, roots & root hairs, organics						
1	CLAY - silty, some sand, damp to moist, stiff to very stiff, medium plastic, dark brown, root hairs, white precipitates		B1	19.4			927.0
2	CLAY (TILL) - silty, some sand, trace gravel, damp to moist, stiff to very stiff, medium plastic, coal & oxide specks, white precipitates		B2	8.3			926.0
3	... trace to some sand, medium to high plastic, dark brown with light brown mottling, thin sand lenses from 2.2m to 2.9m		B3	10.6			925.0
4	... some sand to sandy, medium plastic, sand seams to 75mm		B4	19.9			924.0
5			B5	10.4			923.0
6			B6				922.0
7			B7				921.0
8	... some sand, occasional pebbles to 20mm, moist, grey brown, weathered, thin sand lenses		B8	11.7			920.0
9			B9				919.0
10			B10				918.0
11			B11	14.9			917.0
12			B12				916.0
13			B13				915.0
14	... very stiff to hard		B14	13.6			914.0
15			B15				913.0
16			B16				912.0
			B17	14.9			
			B18				
			B19				
			B20	14.5			
			B21				
			B22				
			B23	12.5			
			B24				
			B25				
			B26				



EBA Engineering Consultants Ltd.

LOGGED BY: JM	COMPLETION DEPTH: 30.5m
REVIEWED BY: JAR	COMPLETE: 4/24/2007
DRAWING NO: B1	Page 1 of 2

PROJECT: RIVER BEND COMMUNITY OUTLINE		LOCATION: N. 5500859, E. 365584.0		BOREHOLE NO: 001		
CLIENT: UMA ENGINEERING LTD.		CONTRACTOR: CHILAKO DRILLING SERVICES		PROJECT NO: L12101023		
PROJECT ENGINEER: JIM RYAN		DRILL METHOD: 150mm SOLID STEM AUGER		ELEVATION: 927.75m		
SAMPLE TYPE	☒ DISTURBED	☒ NO RECOVERY	☒ SPT	☒ A-CASING	☒ SHELBY TUBE	☒ CORE
BACKFILL TYPE	☒ BENTONITE	☒ PEA GRAVEL	☒ SLOUGH	☒ GROUT	☒ DRILL CUTTINGS	☒ SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT	PLASTIC M.C. LIQUID			UNCONFINED (kPa)				POCKET PEN. (kPa)				Elevation (m)
					20	40	60	80	50	100	150	200	100	200	300	
16	CLAY (TILL)		B27	13.9												911.0
17			B28													
18			B29	14.4												910.0
19	CLAY - silty, trace to some sand, moist, very stiff, medium to high plastic, brown grey, oxide staining, thin sand lenses, high plastic clay inclusions		B30	14.5												909.0
20			B31	15.4												908.0
21			B32													907.0
22	SAND - silty, trace clay, some gravel with sizes to 20mm, poorly graded, fine to medium grained, damp to moist, compact to dense, light brown		B33	17.6												906.0
23			B34													905.0
24	... trace to some clay		B35	20.9												904.0
25	... wet, medium to coarse grained, grey brown		B36	7.7												903.0
26			B37													902.0
27	... wet clay inclusions, occasional pebbles to 30mm, grey shale fragments		B38	10.1												901.0
28			B39													900.0
29	CLAY - silty, some sand to sandy, occasional gravel to 10mm, very moist to wet, firm to stiff, low to medium plastic, brownish grey		B40	14.7												899.0
30	... occasional high plastic clay inclusions		B41													898.0
31	... moist to very moist, stiff, grey		B42													897.0
32	... damp to moist		B43	18.1												896.0
	End of Borehole @ 30.5m		B44													
	Seepage & Sloughing from 24.0m		B45	15.6												
	Slotted PVC Standpipe Installed to 26.0m		B46													
	Indicated Water Level Measured May 1, 2007		B47	19.5												
			B48													
			B49	17												
			B50													

EBA Engineering Consultants Ltd.	LOGGED BY: JM	COMPLETION DEPTH: 30.5m
	REVIEWED BY: JAR	COMPLETE: 4/24/2007
	DRAWING NO: B1	Page 2 of 2

PROJECT: RIVER BEND COMMUNITY OUTLINE		LOCATION: N. 5501272, E. 366104.1		BOREHOLE NO: 002		
CLIENT: UMA ENGINEERING LTD.		CONTRACTOR: CHILAKO DRILLING SERVICES		PROJECT NO: L12101023		
PROJECT ENGINEER: JIM RYAN		DRILL METHOD: 150mm SOLID STEM AUGER		ELEVATION: 929.74m		
SAMPLE TYPE	☒ DISTURBED	☐ NO RECOVERY	☒ SPT	☐ A-CASING	☐ SHELBY TUBE	☐ CORE
BACKFILL TYPE	☒ BENTONITE	☐ PEA GRAVEL	☐ SLOUGH	☐ GROUT	☐ DRILL CUTTINGS	☐ SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT	PLASTIC M.C. LIQUID			UNCONFINED (kPa)		Elevation (m)
					20	40	60	80	50	
0	TOPSOIL - clay, silty, sandy, moist, dark brown, roots, organics									
	CLAY - silty, some sand to sandy, damp, stiff, medium plastic, light brown		B1	10.3						929.0
1	CLAY (TILL) - silty, some sand to sandy, trace gravel, damp, stiff to very stiff, medium plastic, light brown, coal & oxide specks, white precipitates, occasional high plastic clay inclusions		B2	10.9						928.0
2	... sandy, low to medium plastic, sand lenses with trace free water		B3	11.5						
	... some sand, damp, very stiff, medium plastic		B4	9.1						927.0
3			B5	11.6						926.0
4			B6							925.0
5			B7							924.0
6	... hard, dark brown mottling, weathered		B8	10.8						923.0
	... occasional pebbles to 30mm		B9							922.0
7			B10	12.9						921.0
8			B11							920.0
9			B12							919.0
10			B13	14.2						918.0
11			B14							917.0
12	... moist, stiff to very stiff		B15	16.3						916.0
13			B16							915.0
14			B17	16.8						914.0
15			B18							
16			B19	21.4						
			B20							
			B21							
			B22							
			B23							
			B24							
			B25							
			B26	16						

 EBA Engineering Consultants Ltd.	LOGGED BY: JM	COMPLETION DEPTH: 30.5m
	REVIEWED BY: JAR	COMPLETE: 4/4/2007
	DRAWING NO: 82	Page 1 of 2

PROJECT: RIVER BEND COMMUNITY OUTLINE		LOCATION: N. 5501272, E. 366104.1		BOREHOLE NO: 002	
CLIENT: UMA ENGINEERING LTD.		CONTRACTOR: CHILAKO DRILLING SERVICES		PROJECT NO: L12101023	
PROJECT ENGINEER: JIM RYAN		DRILL METHOD: 150mm SOLID STEM AUGER		ELEVATION: 929.74m	
SAMPLE TYPE	☒ DISTURBED	☒ NO RECOVERY	☒ SPT	☒ A-CASING	☒ SHELBY TUBE
BACKFILL TYPE	☒ BENTONITE	☒ PEA GRAVEL	☒ SLOUGH	☒ GROUT	☒ DRILL CUTTINGS
Depth (m) SOIL DESCRIPTION SAMPLE TYPE SAMPLE NUMBER MOISTURE CONTENT PLASTIC M.C. LIQUID 20 40 60 80 UNCONFINED (kPa) 50 100 150 200 POCKET PEN. (kPa) 100 200 300 400 Elevation (m)					
16		B27			913.0
17	... grey with brown mottling from 17.1m to 17.3m	B28			
18		B29	15.6		912.0
19	... sandy, moist to very moist, stiff, low to medium plastic, light brown with dark brown mottling, sand lenses with free water	B30			
20		B31	17.2		911.0
21	... some sand, very moist to wet, firm to stiff, medium plastic	B32			
22		B33	16		910.0
23		B34	17		909.0
24	... grey, moist, stiff to very stiff	B35			
25		B36	15.4		908.0
26		B37			
27	... occasional high plastic clay inclusions	B38	27.4		907.0
28		B39	19.8		906.0
29		B40			
30	... some sand to sandy, brown	B41	18.9		905.0
31		B42	18.4		904.0
32		B43			
33		B44	14.1		903.0
34		B45			
35		B46			
36	... trace to some gravel	B47			901.0
37		B48	12.9		900.0
38		B49			
39		B50	14.2		899.0
40	End of Borehole @ 30.5m				898.0
No Seepage or Sloughing on Completion Slotted PVC Standpipe Installed to 30.5m Indicated Water Level Measured April 11, 2007					

EBA Engineering Consultants Ltd.

LOGGED BY: JM
 REVIEWED BY: JAR
 DRAWING NO: B2

COMPLETION DEPTH: 30.5m
 COMPLETE: 4/4/2007
 Page 2 of 2

PROJECT: RIVER BEND COMMUNITY OUTLINE		LOCATION: N. 5501377, E. 366420.6		BOREHOLE NO: 003	
CLIENT: UMA ENGINEERING LTD.		CONTRACTOR: CHILAKO DRILLING SERVICES		PROJECT NO: L12101023	
PROJECT ENGINEER: JIM RYAN		DRILL METHOD: 150mm SOLID STEM AUGER		ELEVATION: 924.96m	
SAMPLE TYPE	☒ DISTURBED	☒ NO RECOVERY	☒ SPT	☒ A-CASING	☒ SHELBY TUBE
BACKFILL TYPE	☒ BENTONITE	☒ PEA GRAVEL	☒ SLOUGH	☒ GROUT	☒ DRILL CUTTINGS
Depth (m) SOIL DESCRIPTION SAMPLE TYPE SAMPLE NUMBER MOISTURE CONTENT PLASTIC M.C. LIQUID 20 40 60 80 ◆ UNCONFINED (kPa) ◆ 50 100 150 200 ▲ POCKET PEN. (kPa) ▲ 100 200 300 400 Elevation (m)					
0	TOPSOIL - clay, silty, sandy, moist, dark brown, roots, organics				
1	CLAY - silty, sandy, damp, stiff, low plastic, dark brown, root hairs, trace organics (B horizon)	B1	10.7		924.0
	CLAY - silty, trace to some sand, damp, hard, medium plastic, grey brown, white precipitates	B2	10.4		
2	CLAY (TILL) - silty, some sand to sandy, trace gravel, damp, hard, medium plastic, light brown, coal & oxide specks	B3	14.6		923.0
	... moist, very stiff	B4	15.2		
	... sandy, occasional gravel to 30mm, brown, sand lenses to 20mm with trace free water	B5			922.0
	... very moist, stiff	B6			
4		B7			921.0
		B8	15.8		920.0
5	... some sand, moist, stiff to very stiff, light brown, weathered, occasional high plastic clay inclusions	B9			
6	... sandy, moist to very moist, stiff, sand lenses to 20mm	B10			919.0
7	... some sand, moist, stiff to very stiff, weathered	B11	20.1		918.0
		B12			
8	... mudstone inclusions	B13			917.0
	... very stiff	B14	17.6		916.0
9		B15			
10		B16			915.0
11		B17	16.8		914.0
		B18			
12		B19			913.0
13		B20	15.9		912.0
		B21			
14	SAND - silty, trace clay, poorly graded, fine grained, very moist, compact, light brown	B22			911.0
		B23	19.6		910.0
15		B24			
		B25			909.0
16		B26	22.3		



EBA Engineering Consultants Ltd.

LOGGED BY: JM & JC

REVIEWED BY: JAR

DRAWING NO: B3

COMPLETION DEPTH: 30.5m

COMPLETE: 4/4/2007

Page 1 of 2

PROJECT: RIVER BEND COMMUNITY OUTLINE		LOCATION: N. 5501377, E. 366420.6		BOREHOLE NO: 003	
CLIENT: UMA ENGINEERING LTD.		CONTRACTOR: CHILAKO DRILLING SERVICES		PROJECT NO: L12101023	
PROJECT ENGINEER: JIM RYAN		DRILL METHOD: 150mm SOLID STEM AUGER		ELEVATION: 924.96m	
SAMPLE TYPE	☒ DISTURBED	☒ NO RECOVERY	☒ SPT	☒ A-CASING	☒ SHELBY TUBE
BACKFILL TYPE	☒ BENTONITE	☒ PEA GRAVEL	☒ SLOUGH	☒ GROUT	☒ DRILL CUTTINGS
SOIL DESCRIPTION CLAY (TILL) - silty, very sandy, trace gravel, very moist, firm, low plastic, coal & oxide specks ... some sand, moist, very stiff to hard, medium plastic, brown, weathered ... silty fine sand pockets from 19.3m to 19.5m ... trace to some sand, medium to high plastic from 22.5m to 22.8m SAND - silty, trace clay, poorly graded, fine to medium grained, free water, compact, light brown ... high plastic clay layers to 100mm SILT - sandy, trace clay, free water, soft to firm, low plastic, light brown, sand lenses & pockets SAND - silty, trace clay, poorly graded, fine grained, free water, compact, grey brown CLAY (TILL) - silty, some sand, some gravel to gravelly, moist, stiff to very stiff, medium plastic, grey ... trace gravel End of Borehole @ 30.5m Seepage & Sloughing from 13.6m Slotted PVC Standpipe Installed to 17.5m Indicated Water Level Measured April 11, 2007 SAMPLE TYPE SAMPLE NUMBER MOISTURE CONTENT PLASTIC M.C. LIQUID 20 40 60 80 ◆ UNCONFINED (kPa) ◆ 50 100 150 200 ▲ POCKET PEN. (kPa) ▲ 100 200 300 400					
Depth (m)					Elevation (m)
16					908.0
17					907.0
18					906.0
19					905.0
20					904.0
21					903.0
22					902.0
23					901.0
24					900.0
25					899.0
26					898.0
27					897.0
28					896.0
29					895.0
30					894.0
31					893.0
32					

EBA Engineering Consultants Ltd.

LOGGED BY: JM & JC
 REVIEWED BY: JAR
 DRAWING NO: B3

COMPLETION DEPTH: 30.5m
 COMPLETE: 4/4/2007
 Page 2 of 2

PROJECT: RIVER BEND COMMUNITY OUTLINE		LOCATION: N. 5501573, E. 366636.4		BOREHOLE NO: 004	
CLIENT: UMA ENGINEERING LTD.		CONTRACTOR: CHILAKO DRILLING SERVICES		PROJECT NO: L12101023	
PROJECT ENGINEER: JIM RYAN		DRILL METHOD: 150mm SOLID STEM AUGER		ELEVATION: 920.48m	
SAMPLE TYPE ☒ DISTURBED ☒ NO RECOVERY ☒ SPT		☒ A-CASING ☒ SHELBY TUBE ☒ CORE			
BACKFILL TYPE ☒ BENTONITE ☒ PEA GRAVEL ☒ SLOUGH		☒ GROUT ☒ DRILL CUTTINGS ☒ SAND			

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT	PLASTIC M.C. LIQUID				UNCONFINED (kPa)				Elevation (m)	
					20	40	60	80	50	100	150	200		
0	TOPSOIL - clay, silty, sandy, moist, dark brown, roots, organics													920.0
1	CLAY - silty, trace to some sand, occasional pebbles, moist, very stiff, high plastic, dark brown to black, oxide specks		B1	23.8										919.0
2	CLAY (TILL) - silty, some sand, trace gravel, moist, very stiff, medium plastic, brown, coal & oxide specks, occasional high plastic inclusion		B2											918.0
3	... some sand to sandy, wet, soft to firm, light brown		B3	20.9										917.0
4	... free water		B4											916.0
5	... moist to very moist, stiff, light brown with dark brown mottling, occasional high plastic inclusion		B5	20.2										915.0
6	... very stiff		B6											914.0
7	... weathered		B7	19.7										913.0
8	... grey mottling		B8											912.0
9	... grey with brown mottling		B9	17.4										911.0
10			B10	18										910.0
11			B11	18.4										909.0
12			B12	16.1										908.0
13			B13											907.0
14			B14											906.0
15			B15											905.0
16			B16											
17			B17											
18	End of Borehole @ 10.6m													
19	Seepage or Sloughing from 2.4m													
20	Slotted PVC Standpipe Installed to 10.6m													
21	Indicated Water Level Measured April 11, 2007													

 EBA Engineering Consultants Ltd.	LOGGED BY: JM	COMPLETION DEPTH: 10.6m
	REVIEWED BY: JAR	COMPLETE: 3/23/2007
	DRAWING NO: B4	Page 1 of 1

PROJECT: RIVER BEND COMMUNITY OUTLINE		LOCATION: N. 5501637, E. 366476.3		BOREHOLE NO: 005		
CLIENT: UMA ENGINEERING LTD.		CONTRACTOR: CHILAKO DRILLING SERVICES		PROJECT NO: L12101023		
PROJECT ENGINEER: JIM RYAN		DRILL METHOD: 150mm SOLID STEM AUGER		ELEVATION: 923.66m		
SAMPLE TYPE	☒ DISTURBED	☒ NO RECOVERY	☒ SPT	☒ A-CASING	☒ SHELBY TUBE	☒ CORE
BACKFILL TYPE	☒ BENTONITE	☒ PEA GRAVEL	☒ SLOUGH	☒ GROUT	☒ DRILL CUTTINGS	☒ SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT	PLASTIC M.C. LIQUID			UNCONFINED (kPa)				Elevation (m)	
					20	40	60	80	50	100	150		200
0	TOPSOIL - clay, silty, sandy, moist, dark brown, roots, organics												
0.5	CLAY (TILL) - silty, some sand to sandy, trace gravel, very moist to wet, soft to firm, low plastic, light brown, coal & oxide specks, thin sand lenses		B1	21.6									923.0
1	... 20mm sand lenses with trace free water		B2										922.0
1.5	... some sand, very moist, firm to stiff		B3	21.4									921.0
2			B4										920.0
2.5	... moist, stiff		B5	19.4									919.0
3			B6										918.0
3.5	... stiff to very stiff		B7	18.5									917.0
4			B8										916.0
4.5			B9	18.7									915.0
5			B10										914.0
5.5			B11	17.5									913.0
6			B12										912.0
6.5	... weathered		B13	17.1									911.0
7			B14										910.0
7.5			B15	18.2									909.0
8			B16										908.0
8.5			B17										907.0
10.6	End of Borehole @ 10.6m												
11	No Seepage or Sloughing Slotted PVC Standpipe Installed to 10.6m Indicated Water Level Measured April 11, 2007												

 EBA Engineering Consultants Ltd.	LOGGED BY: JM	COMPLETION DEPTH: 10.6m
	REVIEWED BY: JAR	COMPLETE: 3/23/2007
	DRAWING NO: B5	Page 1 of 1

PROJECT: RIVER BEND COMMUNITY OUTLINE		LOCATION: N. 5501375, E. 365890.4		BOREHOLE NO: 006	
CLIENT: UMA ENGINEERING LTD.		CONTRACTOR: CHILAKO DRILLING SERVICES		PROJECT NO: L12101023	
PROJECT ENGINEER: JIM RYAN		DRILL METHOD: 150mm SOLID STEM AUGER		ELEVATION: 931.5m	
SAMPLE TYPE ☒ DISTURBED ☒ NO RECOVERY ☒ SPT		☒ A-CASING ☒ SHELBY TUBE ☒ CORE			
BACKFILL TYPE ☒ BENTONITE ☒ PEA GRAVEL ☒ SLOUGH		☒ GROUT ☒ DRILL CUTTINGS ☒ SAND			

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT	PLASTIC M.C. LIQUID			UNCONFINED (kPa)				Elevation (m)	
					20	40	60	80	50	100	150		200
0	TOPSOIL - clay, silty, sandy, moist, dark brown, roots, organics CLAY (TILL) - silty, sandy, trace gravel, damp, hard, medium plastic, light brown, coal & oxide specks, sand lenses with white precipitates ... moist, very stiff, brown		B1	8.6									931.0
1			B2										930.0
2	... soluble sulphate content = 0.5% @ 1.8m		B3	17.1									929.0
3			B4										928.0
4			B5	16.7									927.0
5			B6										926.0
6			B7	16.7									925.0
7	... hard, dark brown mottling, weathered		B8										924.0
8	... sandy, low plastic, medium to coarse grained sand lenses from 7.6m to 8.0m ... some sand to sandy, medium plastic, dark brown, weathered		B9	15.9									923.0
9			B10										922.0
10			B11	13.6									921.0
11			B12										920.0
12			B13	12.9									919.0
13			B14										918.0
14			B15	15									917.0
15			B16										916.0
16			B17										

End of Borehole @ 10.6m		LOGGED BY: JM		COMPLETION DEPTH: 10.6m	
No Seepage or Sloughing Slotted PVC Standpipe Installed to 10.6m Water Level Measured Dry April 11, 2007		REVIEWED BY: JAR		COMPLETE: 3/23/2007	
		DRAWING NO: B6		Page 1 of 1	

PROJECT: RIVER BEND COMMUNITY OUTLINE		LOCATION: N. 5501144, E. 36554.2		BOREHOLE NO: 007		
CLIENT: UMA ENGINEERING LTD.		CONTRACTOR: CHILAKO DRILLING SERVICES		PROJECT NO: L12101023		
PROJECT ENGINEER: JIM RYAN		DRILL METHOD: 150mm SOLID STEM AUGER		ELEVATION: 934.89m		
SAMPLE TYPE	☒ DISTURBED	☒ NO RECOVERY	☒ SPT	☒ A-CASING	☒ SHELBY TUBE	☒ CORE
BACKFILL TYPE	☒ BENTONITE	☒ PEA GRAVEL	☒ SLOUGH	☒ GROUT	☒ DRILL CUTTINGS	☒ SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT	PLASTIC M.C. LIQUID			UNCONFINED (kPa)				POCKET PEN. (kPa)				Elevation (m)
					20	40	60	80	50	100	150	200	100	200	300	
0	TOPSOIL - clay, silty, sandy, moist, dark brown, roots, organics															
1	CLAY (TILL) - silty, sandy, moist, stiff to very stiff, medium plastic, light brown with dark brown inclusions, coal and oxide specks, white precipitates		B1	14.1												934.0
2			B2													933.0
3	... trace gravel to 20mm, thin sand lenses		B3	13.8												932.0
4			B4													931.0
5			B5	12.5												930.0
6			B6													929.0
7			B7	15.7												928.0
8	... occasional high plastic inclusion, slightly weathered		B8													927.0
9			B9	19.1												926.0
10			B10													925.0
11	End of Borehole @ 10.6m		B11	22.1												924.0
12	No Seepage or Sloughing Slotted PVC Standpipe Installed to 10.6m Water Level Measured Dry April 11, 2007		B12													923.0
13			B13	18												922.0
14			B14													921.0
15			B15	29.9												920.0
16			B16													919.0
			B17													

 EBA Engineering Consultants Ltd.	LOGGED BY: JM	COMPLETION DEPTH: 10.6m
	REVIEWED BY: JAR	COMPLETE: 4/2/2007
	DRAWING NO: B7	Page 1 of 1

PROJECT: RIVER BEND COMMUNITY OUTLINE		LOCATION: N. 5501260, E. 36518.0		BOREHOLE NO: 008		
CLIENT: UMA ENGINEERING LTD.		CONTRACTOR: CHILAKO DRILLING SERVICES		PROJECT NO: L12101023		
PROJECT ENGINEER: JIM RYAN		DRILL METHOD: 150mm SOLID STEM AUGER		ELEVATION: 933.72m		
SAMPLE TYPE	☒ DISTURBED	☐ NO RECOVERY	☒ SPT	☐ A-CASING	☐ SHELBY TUBE	☐ CORE
BACKFILL TYPE	☒ BENTONITE	☐ PEA GRAVEL	☐ SLOUGH	☐ GROUT	☐ DRILL CUTTINGS	☐ SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT	PLASTIC M.C. LIQUID			UNCONFINED (kPa)				Elevation (m)	
					20	40	60	80	50	100	150		200
0	TOPSOIL - clay, silty, sandy, moist, dark brown, roots & root hairs, organics												
1	CLAY (TILL) - silty, some sand, trace gravel, moist, stiff to very stiff, medium plastic, brown with dark brown mottling, coal & oxide specks, white precipitates		B1	17.2									933.0
2			B2										932.0
3			B3	13.1									931.0
4			B4										930.0
5	... soluble sulphate content = 0.4% @ 3.0m		B5	12.9									929.0
6			B6										928.0
7			B7	15.7									927.0
8			B8										926.0
9			B9	15.7									925.0
10			B10										924.0
11			B11	15.4									923.0
12			B12										922.0
13			B13	16.6									921.0
14			B14										920.0
15			B15	20.5									919.0
16			B16										918.0
17			B17										917.0
18	End of Borehole @ 10.6m												916.0
19	No Seepage or Sloughing												915.0
20	Slotted PVC Standpipe Installed to 10.6m												914.0
21	Indicated Water Level Measured April 11, 2007												913.0

 EBA Engineering Consultants Ltd.	LOGGED BY: JM	COMPLETION DEPTH: 10.6m
	REVIEWED BY: JAR	COMPLETE: 4/2/2007
	DRAWING NO: B8	Page 1 of 1

PROJECT: RIVER BEND COMMUNITY OUTLINE		LOCATION: N. 5501578, E. 365599.5		BOREHOLE NO: 009	
CLIENT: UMA ENGINEERING LTD.		CONTRACTOR: CHILAKO DRILLING SERVICES		PROJECT NO: L12101023	
PROJECT ENGINEER: JIM RYAN		DRILL METHOD: 150mm SOLID STEM AUGER		ELEVATION: 931.03m	
SAMPLE TYPE	☒ DISTURBED	☒ NO RECOVERY	☒ SPT	☒ A-CASING	☒ SHELBY TUBE
BACKFILL TYPE	☒ BENTONITE	☒ PEA GRAVEL	☒ SLOUGH	☒ GROUT	☒ DRILL CUTTINGS
Depth (m) 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 SOIL DESCRIPTION TOPSOIL - clay, silty, sandy, moist, dark brown, roots, organics CLAY (TILL) - silty, sandy, trace gravel, moist, firm to stiff, low to medium plastic, light brown, coal and oxide specks, sand lenses ... some sand, moist, stiff, medium plastic, light brown with dark brown mottling, occasional high plastic inclusion ... some sand to sandy, wet, soft to firm, light brown ... some sand, moist, stiff to very stiff, light brown with dark brown mottling, thin sand lenses ... 300mm sand inclusion, poorly graded, coarse grained, compact, grey ... some sand to sandy, moist to very moist, firm to stiff, light brown with dark brown mottling ... free water ... some sand, moist, stiff to very stiff End of Borehole @ 10.6m No Seepage or Sloughing Slotted PVC Standpipe Installed to 10.6m Indicated Water Level Measured April 11, 2007 SAMPLE TYPE SAMPLE NUMBER B1 B2 B3 B4 B5 B6 B7 B8 B9 B10 B11 B12 B13 B14 B15 B16 B17 MOISTURE CONTENT 20 40 60 80 PLASTIC M.C. LIQUID UNCONFINED (kPa) 50 100 150 200 POCKET PEN. (kPa) 100 200 300 400 Elevation (m) 931.0 930.0 929.0 928.0 927.0 926.0 925.0 924.0 923.0 922.0 921.0 920.0 919.0 918.0 917.0 916.0					
LOGGED BY: JM REVIEWED BY: JAR DRAWING NO: B9 COMPLETION DEPTH: 10.6m COMPLETE: 4/2/2007 Page 1 of 1					

PROJECT: RIVER BEND COMMUNITY OUTLINE		LOCATION: N. 5501810, E. 366108.6		BOREHOLE NO: 010	
CLIENT: UMA ENGINEERING LTD.		CONTRACTOR: CHILAKO DRILLING SERVICES		PROJECT NO: L12101023	
PROJECT ENGINEER: JIM RYAN		DRILL METHOD: 150mm SOLID STEM AUGER		ELEVATION: 926.2m	
SAMPLE TYPE ☒ DISTURBED ☒ NO RECOVERY ☒ SPT ☐ A-CASING ☐ SHELBY TUBE ☐ CORE					
BACKFILL TYPE ☐ BENTONITE ☐ PEA GRAVEL ☐ SLOUGH ☐ GROUT ☐ DRILL CUTTINGS ☐ SAND					

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT	PLASTIC M.C. LIQUID			UNCONFINED (kPa)				Elevation (m)	
					20	40	60	80	50	100	150		200
0	TOPSOIL - clay, silty, sandy, moist, dark brown, roots, organics												926.0
1	CLAY - silty, some sand to sandy, moist, stiff to very stiff, medium plastic, light brown with dark brown inclusions		B1	18.3									925.0
2	CLAY (TILL) - silty, some sand, trace gravel, moist, stiff to very stiff, medium plastic, light brown with dark brown mottling, coal & oxide specks		B2										924.0
3	... trace pebbles to 20mm		B3	18.5									923.0
4	... soluble sulphate content = 0.1% @ 1.8m		B4										922.0
5			B5	19.9									921.0
6			B6										920.0
7	... moist to very moist, firm to stiff		B7	18.3									919.0
8			B8										918.0
9	... moist, very stiff		B9	17.2									917.0
10			B10										916.0
11			B11	18.2									915.0
12			B12										914.0
13			B13	20									913.0
14			B14										912.0
15			B15	19									911.0
16			B16										
17			B17										

End of Borehole @ 10.6m		LOGGED BY: JM		COMPLETION DEPTH: 10.6m	
No Seepage or Sloughing		REVIEWED BY: JAR		COMPLETE: 3/23/2007	
Slotted PVC Standpipe Installed to 10.6m		DRAWING NO: B10		Page 1 of 1	
Indicated Water Level Measured April 11, 2007					

PROJECT: RIVER BEND COMMUNITY OUTLINE		LOCATION: N. 5502036, E. 366192.7		BOREHOLE NO: 011	
CLIENT: UMA ENGINEERING LTD.		CONTRACTOR: CHILAKO DRILLING SERVICES		PROJECT NO: L12101023	
PROJECT ENGINEER: JIM RYAN		DRILL METHOD: 150mm SOLID STEM AUGER		ELEVATION: 924.69m	
SAMPLE TYPE	☒ DISTURBED	☒ NO RECOVERY	☒ SPT	☒ A-CASING	☒ SHELBY TUBE
BACKFILL TYPE	☒ BENTONITE	☒ PEA GRAVEL	☒ SLOUGH	☒ GROUT	☒ DRILL CUTTINGS
					☒ CORE
					☒ SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT	PLASTIC		M.C.	LIQUID		UNCONFINED (kPa)		POCKET PEN. (kPa)	Elevation (m)		
					20	40		60	80	50	100			150	200
									100	200	300			400	
0	TOPSOIL - clay, silty, sandy, moist, dark brown, roots, organics												924.0		
1	CLAY (TILL) - silty, some sand, trace gravel, moist, stiff to very stiff, medium plastic, light brown with dark brown mottling, coal & oxide specks, thin sand lenses		B1	11.9									923.0		
2			B2										922.0		
3			B3	17.3									921.0		
4			B4										920.0		
5			B5	19.1									919.0		
6	... moist to very moist, stiff		B6										918.0		
7	... moist, very stiff		B7	17.8									917.0		
8			B8										916.0		
9			B9	20									915.0		
10			B10										914.0		
11			B11	16.9									913.0		
12			B12										912.0		
13			B13	18.1									911.0		
14			B14										910.0		
15			B15	18.6									909.0		
16			B16												
			B17												

 EBA Engineering Consultants Ltd.		LOGGED BY: JM REVIEWED BY: JAR DRAWING NO: B11	COMPLETION DEPTH: 10.6m COMPLETE: 4/2/2007 Page 1 of 1
---	--	--	--

PROJECT: RIVER BEND COMMUNITY OUTLINE		LOCATION: N. 5502157, E. 366473.8		BOREHOLE NO: 012	
CLIENT: UMA ENGINEERING LTD.		CONTRACTOR: CHILAKO DRILLING SERVICES		PROJECT NO: L12101023	
PROJECT ENGINEER: JIM RYAN		DRILL METHOD: 150mm SOLID STEM AUGER		ELEVATION: 921.5m	
SAMPLE TYPE	☒ DISTURBED	☒ NO RECOVERY	☒ SPT	☒ A-CASING	☒ SHELBY TUBE
BACKFILL TYPE	☒ BENTONITE	☒ PEA GRAVEL	☒ SLOUGH	☒ GROUT	☒ DRILL CUTTINGS
					☒ CORE
					☒ SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT	PLASTIC M.C. LIQUID			UNCONFINED (kPa)				Elevation (m)	
					20	40	60	80	50	100	150		200
0	TOPSOIL - clay, silty, sandy, moist, dark brown, roots, organics												921.0
1	CLAY - silty, some sand to sandy, damp, very stiff, low to medium plastic, light brown, white precipitates		B1	10.4									920.0
2	CLAY (TILL) - silty, some sand, trace gravel, moist, very stiff, medium plastic, brown with dark brown mottling, coal & oxide specks, thin sand lenses		B2										919.0
3			B3	13.7									918.0
4			B4										917.0
5			B5	16.6									916.0
6			B6										915.0
7			B7	21.6									914.0
8			B8										913.0
9			B9	20.6									912.0
10			B10										911.0
11	... occasional high plastic inclusions		B11	18.9									910.0
12			B12										909.0
13			B13	18.2									908.0
14			B14										907.0
15			B15	17.8									906.0
16			B16										
17			B17										
18	End of Borehole @ 10.6m												
19	No Seepage or Sloughing												
20	Slotted PVC Standpipe Installed to 10.6m												
21	Indicated Water Level Measured Dry April 11, 2007												

EBA Engineering Consultants Ltd.		LOGGED BY: JM	COMPLETION DEPTH: 10.6m
		REVIEWED BY: JAR	COMPLETE: 4/2/2007
		DRAWING NO: B12	Page 1 of 1

PROJECT: RIVER BEND COMMUNITY OUTLINE		LOCATION: N. 5502592, E. 386284.6		BOREHOLE NO: 013	
CLIENT: UMA ENGINEERING LTD.		CONTRACTOR: CHILAKO DRILLING SERVICES		PROJECT NO: L12101023	
PROJECT ENGINEER: JIM RYAN		DRILL METHOD: 150mm SOLID STEM AUGER		ELEVATION: 917.24m	
SAMPLE TYPE	☒ DISTURBED	☐ NO RECOVERY	☒ SPT	☐ A-CASING	☐ SHELBY TUBE
BACKFILL TYPE	☐ BENTONITE	☐ PEA GRAVEL	☐ SLOUGH	☐ GROUT	☐ DRILL CUTTINGS
				☐ CORE	☐ SAND

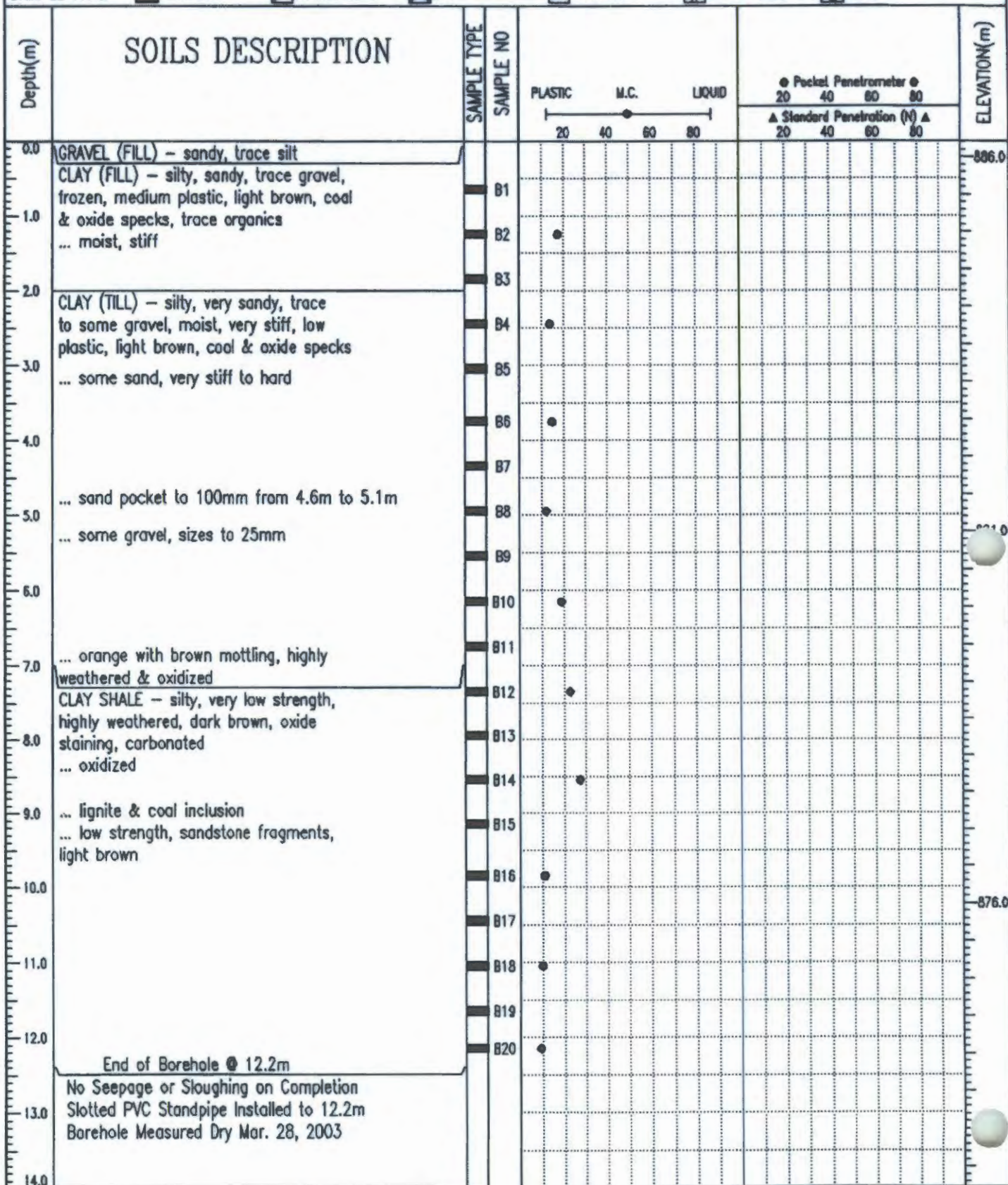
Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT	PLASTIC M.C. LIQUID		UNCONFINED (kPa)		Elevation (m)				
					20	40	60	80		50	100	150	200
0	TOPSOIL - clay, silty, sandy, moist, dark brown, roots, organics								917.0				
1	CLAY - silty, some sand to sandy, damp to moist, very stiff, low to medium plastic, light brown, white precipitates		B1	17.8					916.0				
	... light brown with dark brown mottling		B2						915.0				
2	CLAY (TILL) - silty, some sand, trace gravel, moist, very stiff, medium plastic, brown with dark brown mottling, coal & oxide specks, thin sand lenses		B3	12.8					914.0				
	... soluble sulphate content = 1.3% @ 1.8m		B4						913.0				
	... 150mm sand pocket, poorly graded, coarse grained, compact, grey		B5	17.1					912.0				
	... some sand, trace pebbles to 20mm, brown, coal and oxide specks, thin sand lenses		B6						911.0				
4			B7	18.1					910.0				
5			B8						909.0				
6			B9	16					908.0				
7			B10						907.0				
8	... weathered		B11	16.4					906.0				
			B12						905.0				
9			B13	16.3					904.0				
10			B14						903.0				
11			B15	18.1					902.0				
12			B16										
13			B17										
14	End of Borehole @ 10.6m												
15	No Seepage or Sloughing												
16	Slotted PVC Standpipe Installed to 10.6m												
	Indicated Water Level Measured Dry April 11, 2007												

 EBA Engineering Consultants Ltd.	LOGGED BY: JM	COMPLETION DEPTH: 10.6m
	REVIEWED BY: JAR	COMPLETE: 4/2/2007
	DRAWING NO: B13	Page 1 of 1

PROJECT: RIVER BEND COMMUNITY OUTLINE		LOCATION:		BOREHOLE NO: 014		
CLIENT: UMA ENGINEERING LTD.		CONTRACTOR: CHILAKO DRILLING SERVICES		PROJECT NO: L12101023		
PROJECT ENGINEER: JIM RYAN		DRILL METHOD: CONTINUOUS SAMPLER		ELEVATION: 917.5m		
SAMPLE TYPE	☒ DISTURBED	☒ NO RECOVERY	☒ SPT	☒ A-CASING	☒ SHELBY TUBE	☒ CORE
BACKFILL TYPE	☒ BENTONITE	☒ PEA GRAVEL	☒ SLOUGH	☒ GROUT	☒ DRILL CUTTINGS	☒ SAND

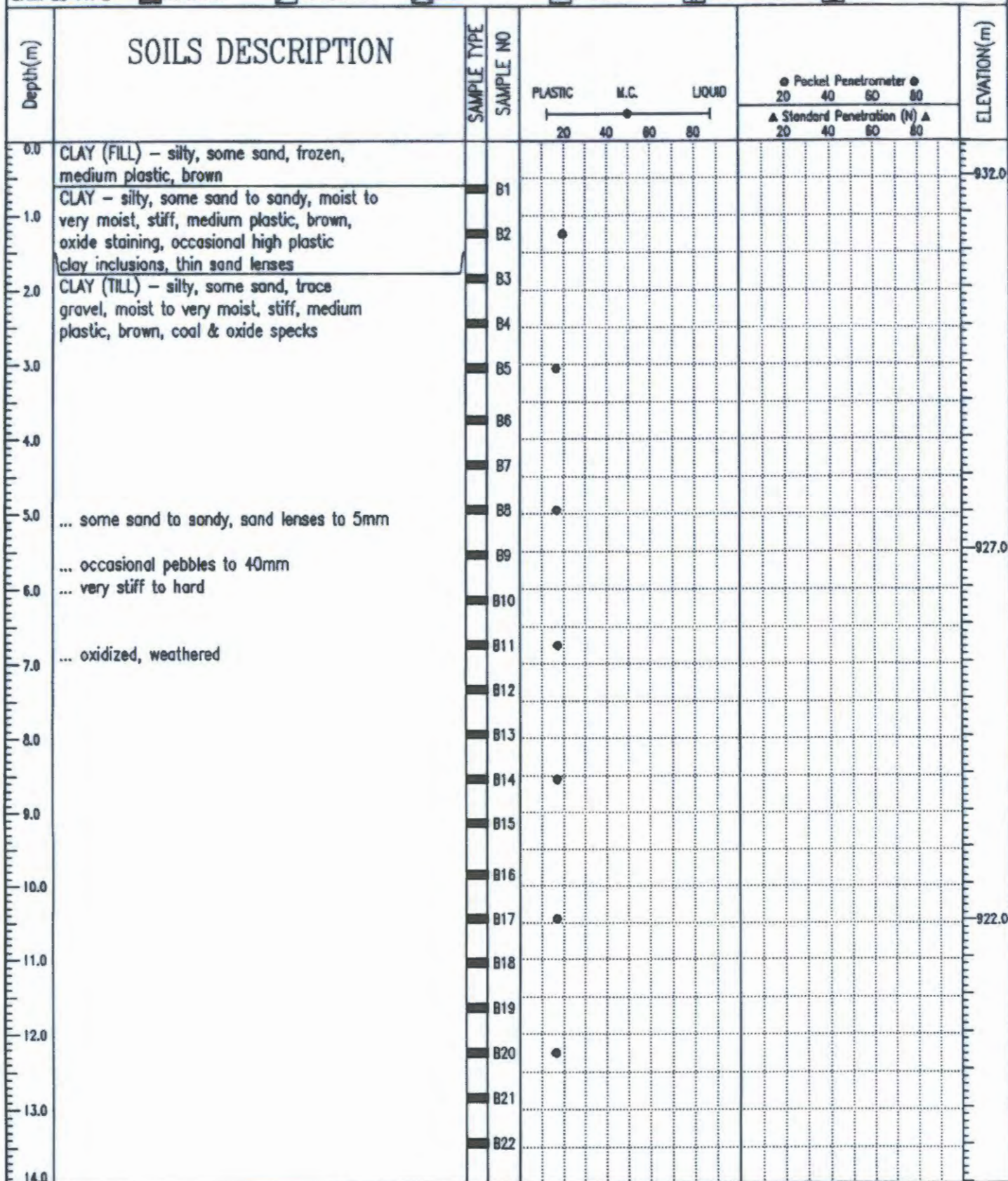
Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	MOISTURE CONTENT	PLASTIC M.C. LIQUID			UNCONFINED (kPa)				Elevation (m)	
					20	40	60	80	POCKET PEN. (kPa)				
									50	100	150		200
0	TOPSOIL - clay, silty, sandy, damp, dark brown, roots, organics												917.0
1	CLAY - silty, sandy, damp, silt, low plastic, light brown		B1	9.3									916.0
2	CLAY (TILL) - silty, sandy, gravelly, damp, hard, medium plastic, light brown, coal & oxide specks, white precipitates		B2	8.4									915.0
3	... some sand, trace gravel, medium plastic		B3	10.9									914.0
4	... damp to moist, brown		B4	12.6									913.0
5	... moist		B5	15.2									912.0
6			B6	14.8									911.0
7	... moister		B7	18.1									910.0
8			B8	17.1									909.0
9			B9	17.5									908.0
10			B10	17.2									907.0
11			B11	18.1									906.0
12			B12	18.4									905.0
13			B13	18									904.0
14	... trace to some sand from 13.4m to 13.7m		B14	17.3									903.0
15	CLAY - silty, trace sand, moist, very silt, medium to high plastic, light brown, thin silt lenses, high plastic clay inclusions & layers		B15	20.1									902.0
16	SAND - trace silt, poorly graded, fine to medium grained, damp, dense, light brown		B16	16									901.0
17			B17	17.9									900.0
18			B18	25.1									899.0
19			B19	22									898.0
20			B20	20									897.0
21			B21	13.7									896.0
22			B22	12.8									895.0
23			B23	13									894.0
24			B24	9.1									893.0
25	End of Borehole @ 17.3m												892.0
26	No Seepage or Sloughing on Completion Slotted PVC Standpipe installed to 17.3m Borehole Measured Dry on September 24, 2007												891.0

PROJECT: LETHBRIDGE TRADE HIGHWAY	LOCATION: S-3, 5501360.0 E-82152.7	BOREHOLE NO: 008
CLIENT: STANTEC CONSULTING LTD.	CONTRACTOR: BECK DRILLING & ENVIRO. SERV.	PROJECT NO: 0404-4400085
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 886.22 m
SAMPLE TYPE ☒ DISTURBED ☒ NO RECOVERY ☒ SPT ☐ A-CASING ☐ SHELBY TUBE ☐ CORE		



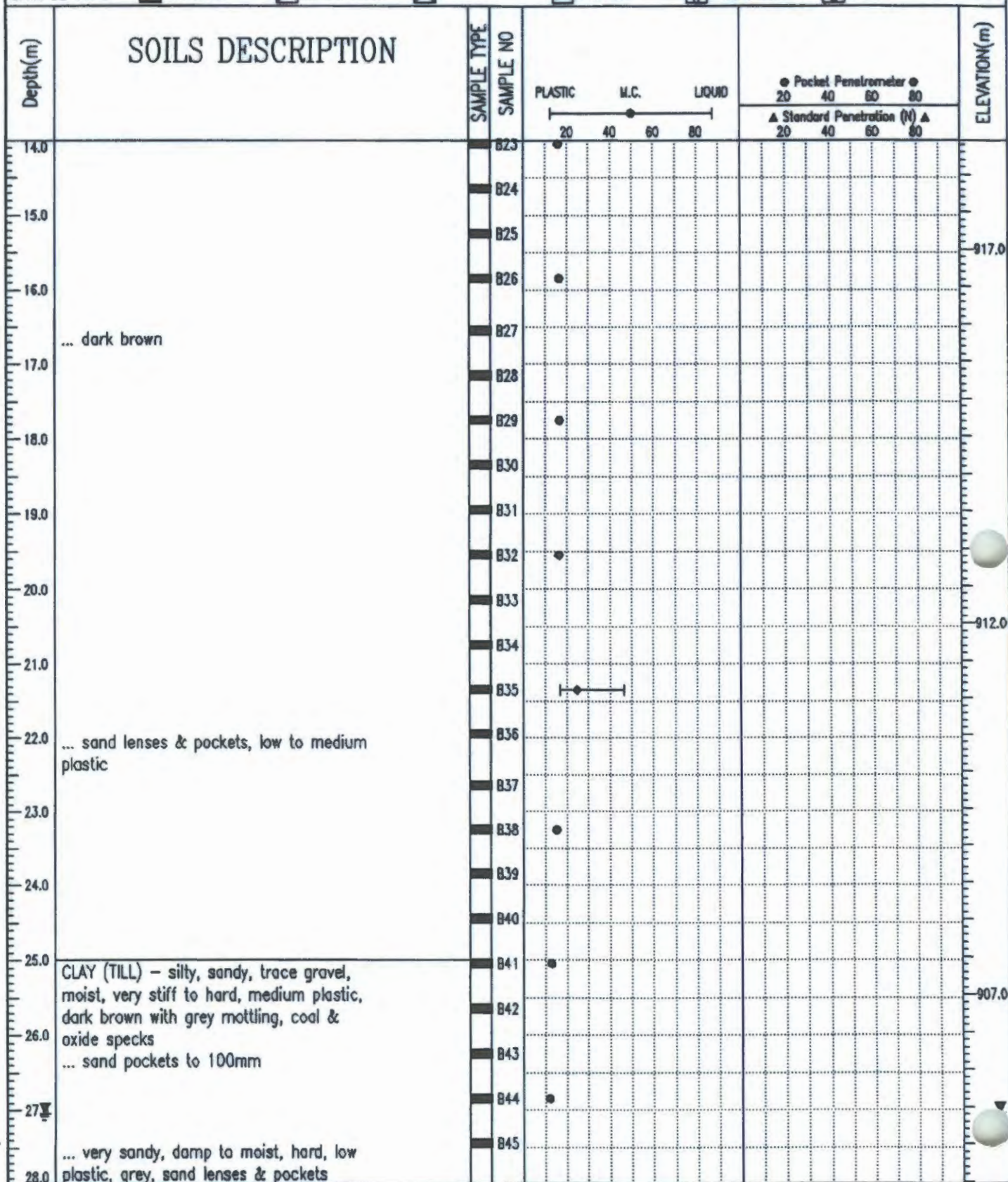
EBA Engineering Consultants Ltd.	LOGGED BY: JHC	COMPLETION DEPTH: 12.2 m
	REVIEWED BY: JAR	COMPLETE: 03/03/20
	Fig. No: B8	Page 1 of 1

PROJECT: LETHBRIDGE TRADE HIGHWAY	LOCATION: S-3, N-5501471.5 E-81633.3	BOREHOLE NO: 009
CLIENT: STANTEC CONSULTING LTD.	CONTRACTOR: BECK DRILLING & ENVIR. SERV.	PROJECT NO: 0404-4400085
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 932.46 m
SAMPLE TYPE ☒ DISTURBED ☒ NO RECOVERY ☒ SPT ☐ A-CASING ☐ SHELBY TUBE ☐ CORE		



EBA Engineering Consultants Ltd.	LOGGED BY: JHC	COMPLETION DEPTH: 35.1 m
	REVIEWED BY: JAR	COMPLETE: 03/03/20
	Fig. No: B9	Page 1 of 3

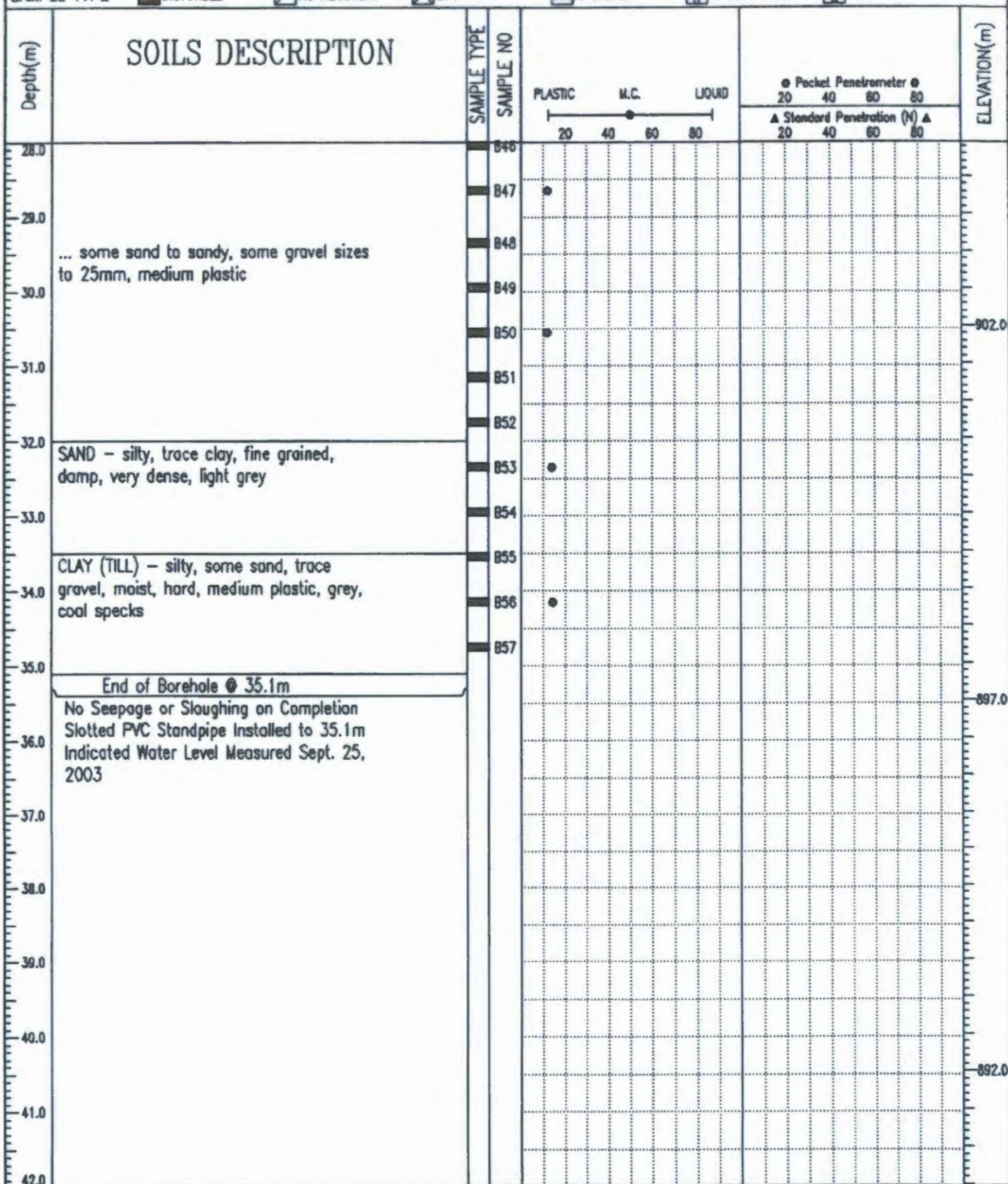
PROJECT: LETHBRIDGE TRADE HIGHWAY	LOCATION: S-3, N-5501471.5 E-81633.3	BOREHOLE NO: 009
CLIENT: STANTEC CONSULTING LTD.	CONTRACTOR: BECK DRILLING & ENVIRI. SERV.	PROJECT NO: 0404-4400085
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 932.46 m
SAMPLE TYPE ☒ DISTURBED ☒ NO RECOVERY ☒ SPT ☒ A-CASING ☐ SHELBY TUBE ☐ CORE		



EBA Engineering Consultants Ltd.

LOGGED BY: JHC	COMPLETION DEPTH: 35.1 m
REVIEWED BY: JAR	COMPLETE: 03/03/20
Fig. No: B9	Page 2 of 3

PROJECT: LETHBRIDGE TRADE HIGHWAY	LOCATION: S-3, N-5501471.5 E-81633.3	BOREHOLE NO: 009
CLIENT: STANTEC CONSULTING LTD.	CONTRACTOR: BECK DRILLING & ENVIR. SERV.	PROJECT NO: 0404-4400085
PROJECT ENGINEER: JAR	DRILL METHOD: 150mm SOLID STEM AUGER	ELEVATION: 932.46 m
SAMPLE TYPE ☒ DISTURBED ☒ NO RECOVERY ☒ SPT ☐ A-CASING ☐ SHELBY TUBE ☐ CORE		



EBA Engineering Consultants Ltd.	LOGGED BY: JHC	COMPLETION DEPTH: 35.1 m
	REVIEWED BY: JAR	COMPLETE: 03/03/20
	Fig. No: B9	Page 3 of 3



APPENDIX

APPENDIX C RECOMMENDED GENERAL DESIGN AND CONSTRUCTION GUIDELINES

SHALLOW FOUNDATIONS

Design and construction of shallow foundations should comply with relevant Building Code requirements.

The term "shallow foundations" includes strip and spread footings, mat slab and raft foundations.

Minimum footing dimensions in plan should be 0.45 m and 0.9 m for strip and square footings, respectively.

No loose, disturbed or sloughed material should be allowed to remain in open foundation excavations. Hand cleaning should be undertaken to prepare an acceptable bearing surface. Recompaction of disturbed or loosened bearing surface may be required.

Foundation excavation and bearing surfaces should be protected from rain, snow, freezing temperatures, drying and the ingress of free water, during and after footing construction.

Footing excavations should be carried down into the designated bearing stratum.

After the bearing surface is approved, a mud slab should be poured to protect the soil and provide a working surface for construction, should immediate foundation construction not be intended.

All constructed foundations should be placed on unfrozen soils, which should be at all times protected from frost penetration.

All foundation excavations and bearing surfaces should be observed by a qualified geotechnical engineer to confirm that the recommendations contained in this report have been followed and that soil conditions are consistent with those assumed in the design.

Where over-excavation has been carried out through a weak or unsuitable stratum to reach into a suitable bearing stratum or where a foundation pad is to be placed above stripped natural ground surface, such over-excavation may be backfilled to subgrade elevation utilizing either structural fill or lean-mix concrete. These materials are defined under the separate heading "Backfill Materials and Compaction."

FLOOR SLABS-ON-GRADE

All soft, loose or organic material should be removed from beneath slab areas. If any local hard spots such as old basement walls are revealed beneath the slab area, these should be over-excavated and removed to not less than 0.9 m below underside of slab level. The exposed soil should be proof-rolled and the final grade restored by general engineered fill placement. If proof-rolling reveals any soft or loose spots, these should be excavated and the desired grade restored by general engineered fill placement. Proof-rolling should be carried out in accordance with the recommendations given elsewhere in this Appendix. The subgrade should be compacted to a depth of not less than 0.3 m to density of not less than 95% Standard Proctor Maximum Dry Density (ASTM Test Method D698).

If for economic reasons, it is considered desirable to leave low quality material in place beneath a slab-on-grade, special ground treatment procedures may be considered. EBA could provide additional advice on this aspect, if required.

A levelling course of structural fill at least 150 mm in compacted thickness is recommended directly beneath all slabs-on-grade. Alternatively, a minimum thickness of 150 mm of pit-run gravel overlain by a minimum thickness of 50 mm of crushed gravel may be used. Very coarse material (larger than 25 mm diameter) should be avoided directly beneath the slabs-on-grade to limit potential stress concentrations within the slab.

General engineered fill, structural fill, pit-run gravel and crushed gravel are defined under the heading "Backfill Materials and Compaction" elsewhere in this Appendix.

The slab should be structurally independent from walls and columns supported on foundations. This is to reduce any structural distress that may occur as a result of differential soil movements. If it is intended to place any internal non-load bearing partition walls directly on a slab-on-grade, such walls should be structurally independent from other elements of the building founded on a conventional foundation system so that some relative vertical movement of the walls can occur freely.

The excavated subgrade beneath slabs-on-grade should be protected at all times from rain, snow, freezing temperatures, excessive drying and the ingress of free water. This applies during and after the construction period.

A minimum slab concrete thickness of 100 mm is recommended. Control joints should be provided in all slabs. Typically for a 125 mm slab thickness, control joints should be placed on a 3 m square grid, should be sawn to a depth of one-quarter the slab thickness and have a width of approximately 3 mm.

Wire mesh reinforcement, 150 mm square grid, should be provided to reduce the possibility of uncontrolled slab cracking. The mesh should be adequately supported and should be located at or above mid-height of the slab with adequate cover.

CONSTRUCTION EXCAVATIONS

Construction should be in accordance with good practice and comply with the requirements of the responsible agencies.

All excavations greater than 1.5 m deep should be sloped or shored for worker protection.

Shallow excavations up to 3 m depth may use temporary side slopes of 1H:1V. A flatter slope of 2H:1V should be used if groundwater is encountered. Localized sloughing can be expected from these slopes.

Deep excavations or trenches may require temporary support if space limitations or economic considerations preclude the use of sloped excavations.

For excavations greater than 3 m depth, temporary support should be designed by a qualified geotechnical engineer. The design and proposed installation and construction procedures should be submitted to EBA for review.

The construction of a temporary support system should be monitored. Detailed records should be taken of installation methods, materials, in-situ conditions and the movement of the system. If anchors are used, they should be load tested. EBA can provide further information on monitoring and testing procedures, if required.

Attention should be paid to structures or buried service lines close to the excavation. For structures, a general guideline is that if a line projected down at 45° from a horizontal, from the base of foundations of adjacent structures, intersects the extent of the proposed excavation, then these structures may require underpinning or special shoring techniques to avoid damaging earth movements. The need for any underpinning or special shoring techniques and the scope of monitoring required can be determined when details of the service ducts and vaults, foundation configuration of existing buildings and final design excavation levels are known.

No surface surcharges should be placed closer to the edge of the excavation than a distance equal to the depth of the excavation, unless the excavation support system has been designed to accommodate such surcharge.

BACKFILL MATERIALS AND COMPACTION

Maximum density, as used in this section, means Standard Proctor Maximum Dry Density (ASTM Test D698) unless specifically noted otherwise. Optimum moisture content is as defined in this text.

"General engineered fill" materials should comprise clean, well-graded granular soils or inorganic, low-plastic cohesive soils. Such material should be placed in compacted lifts not exceeding 200 mm and compacted to not less than 98% of maximum density, at a moisture content at or slightly above optimum.

"Structural fill" materials should comprise clean, well-graded inorganic granular soils. Such fill should be placed in compacted lifts not exceeding 150 mm and compacted to not less than 98% of maximum density, at a moisture content near or slightly above optimum.

"Landscape fill" material may comprise soils without regard to engineering quality. Such soils should be placed in compacted lifts not exceeding 300 mm and compacted to a density of not less than 90% of maximum density.

Backfill adjacent to and above footings, abutment walls, basement walls, grade beams and pile caps or below highway, street or parking lot pavement sections should comprise general engineered fill materials as defined above.

Backfill supporting structural loads should comprise structural fill materials as defined above.

Backfill adjacent to exterior footings, foundation walls, grade beams and pile caps and within 300 mm of final grade should comprise low-plastic cohesive general engineered fill as defined above. Such backfill should provide a relatively impervious surface layer to reduce seepage into the sub-soil.

Backfill should not be placed against a foundation structure until the structure has sufficient strength to withstand the earth pressures resulting from placement and compaction. During compaction, careful observation of the foundation wall for deflection should be carried out continuously. Where deflection is apparent, the compactive effort should be reduced accordingly. In order to reduce potential compaction induced stresses, only hand held compaction equipment should be used in the compaction of fill within 500 mm of retaining walls or basement walls.

Backfill materials should not be placed in a frozen state or placed on a frozen subgrade. All lumps of materials should be broken down during placement.

Where the maximum-sized particles in any backfill material exceed 50% of the lift thickness or minimum dimension of the cross-section to be backfilled, such particles should be removed and placed at the other more suitable locations on site or screened-off prior to delivery to site.

Bonding should be provided between backfill lifts, if the previous lift has become desiccated. For the fine-grained materials, the previous lift should be scarified to 75 mm in depth followed by proper moisture conditioning and recompaction.

Recommendations for the specifications for various backfill types are presented below.

"Pit-run gravel" should conform to the following grading:

Sieve Sizes (Square Openings)	Percent Passing By Weight
200 mm	100 of Total Sample
150 mm	96 - 100 of Total Sample
75 mm	60 - 80 of Total Sample
25 mm	70 - 100 of Material Passing 75 mm Sieve
4.75 mm	25 - 63 of Material Passing 75 mm Sieve
1.18 mm	14 - 41 of Material Passing 75 mm Sieve
0.60 mm	7 - 30 of Material Passing 75 mm Sieve
0.15 mm	3 - 18 of Material Passing 75 mm Sieve
0.075 mm	2 - 9 of Material Passing 75 mm Sieve

Any grading variation from the above should be at the discretion of the Engineer; however, the percent of material passing the 0.075 mm sieve should not exceed 2/3 of the material passing the 0.6 mm sieve. The pit-run gravel should be free of any form of coating and any gravel containing clay, loam or other deleterious materials should be rejected. No oversized material should be tolerated.

"Crushed gravel" should conform to the following grading:

Sieve Sizes (Square Openings)	Percent Passing by Weight (Nominal Gravel Size)		
	100 mm	50 mm	25 mm
100 mm	100	—	—
75 mm	90 - 100	—	—
50 mm	—	100	—
40 mm	60 - 80	90 - 100	—
25 mm	—	—	100
20 mm	40 - 66	50 - 75	95 - 100
10 mm	25 - 54	25 - 52	60 - 80
4.75 mm	15 - 43	15 - 40	40 - 60
2.36 mm	10 - 35	10 - 33	28 - 48
0.60 mm	5 - 23	5 - 23	13 - 29
0.30 mm	—	—	9 - 21
0.15 mm	3 - 12	2 - 14	6 - 15
0.075 mm	2 - 10	1 - 10	4 - 10

Gravel:

100 mm Crushed Gravel: At least 13% by weight of the material retained on the 4.75 mm sieve should have two more fractured faces.

50 mm Crushed Gravel: At least 13% by weight of the material retained on the 4.75 mm sieve should have two more fractured faces.

25 mm Crushed Gravel: At least 50% by weight of the material retained on the 4.75 mm sieve should have two more fractured faces.

Any gravel containing deleterious material should be rejected.

“Coarse gravel” for bedding and drainage should conform to the following grading:

Sieve Sizes (Square Openings)	Percent Passing By Weight (Nominal Gravel Size)	
	50 mm	40 mm
50 mm	100	—
40 mm	90 - 100	100
25 mm	—	95 - 100
20 mm	35 - 70	—
15 mm	—	25 - 60
10 mm	10 - 30	—
4.75 mm	0 - 5	0 - 10
2.36 mm	—	0 - 5

“Coarse sand” for bedding and drainage should conform to the following grading:

Sieve Sizes (Square Openings)	Percent Passing By Weight
10 mm	100
4.75 mm	95 - 100
2.36 mm	80 - 100
1.18 mm	50 - 85
0.60 mm	25 - 60
0.30 mm	10 - 30
0.15 mm	2 - 10

“Lean-mix concrete” should be low strength concrete having a minimum 28-day compressive strength of 3.5 MPa.

BORED CAST-IN-PLACE CONCRETE PILES

Design and construction of piles should comply with relevant Building Code requirements.

Piles should be installed under full-time inspection of geotechnical personnel. Pile design parameters should be reviewed in light of the findings of the initial bored shafts drilled on a site. Further design review may be necessary if conditions observed during site construction do not conform to design assumptions.

Where fill material, lenses or strata of sand, silt or gravel are present within the designed pile depth, these may be incompetent and/or water bearing and may cause sloughing. Casing should be on hand before drilling starts and be used, if necessary, to seal water and/or prevent sloughing of the hole.

If piles are to be under-reamed (belled), the under-reams should be formed entirely in self-supporting soil and entirely within the competent bearing stratum. Where caving occurs at design elevation, it may be necessary to extend the base of the pile bell to a greater depth. Piles may be constructed with bell having outside diameters up to approximately three times the diameters of their shafts. Piles with shaft diameters of less than 760 mm should not be under-reamed due to difficulties associated with ensuring a clean base.

Prior to pouring concrete, bottoms of pile bells or of straight-shaft end-bearing piles should be cleaned of all disturbed material.

Pile excavation should be visually inspected after completion to ensure that disturbed materials and/or water are not present on the base so that recommended allowable bearing and skin friction parameters may apply.

Visual inspection may be accomplished by the inspector descending into the pile shaft [shaft diameter of 760 mm (30 inch) or greater]. A protective cage and other safety equipment required by government regulations should be provided by the contractor to facilitate downhole inspection.

Other procedures to inspect the pile shafts may be used where shaft diameters of less than 760 mm (30 inch) are constructed, such as inspection with a light.

For safety reasons, where hand cleaning and/or "down shaft" inspection by personnel are required, the pile shaft should be cased full-length prior to personnel entering the shaft.

Reinforcing steel should be on hand and should be placed as soon as the bore has been completed and approved.

Longitudinal reinforcing steel is recommended to counteract the possible tensile stresses induced by frost action and should extend to a minimum depth of 3.5 m. A minimum steel of 0.5% of the gross shaft area is recommended.

Where a limited quantity of water is present on the pile base, when permitted or directed by a geotechnical engineer, it should be either removed or absorbed by the addition of dry cement, which should then be thoroughly mixed as an in situ slurry by means of the belling tool, using reverse

rotation of the tool. Where significant quantities of water are present and it is impracticable to exclude water from the pile bore, concrete should be placed by tremie techniques or concrete pump.

A "dry" pile should be poured by "free fall" of concrete only where impact of the concrete against the reinforcing cage, which can cause segregation of the concrete, will not occur. A hopper should be used to direct concrete down the centre of the pile base and to prevent impact of concrete against reinforcing steel.

Concrete used for dry piles should be self-compacting and should have a slump of between 50 mm and 130 mm. Concrete for each pile should be poured in one continuous operation and should be placed immediately after excavation and inspection of piles, to reduce the opportunity for the ingress of free water or deterioration of the exposed soil or rock.

If piles cannot be formed in dry conditions, then the concrete should be placed by tremie tube or concrete pump. Concrete placed by tremie should have a slump of not less than 150 mm. A ball or float should be used in the tremie tube to separate the initial charge of concrete from the water in the pile hole.

The outlet of the tremie tube should be maintained at all times 1.0 m to 2.0 m below the surface of the concrete. The diameter of the tremie tube should be at least 200 mm. The tube should be water-tight and not be made of aluminum. Smaller diameter pipes may be used with a concrete pump. The surface of the concrete should be allowed to rise above the cut-off level of the pile, so that when the temporary casing is withdrawn and the surface level of the concrete adjusts to the new volume, the top of the uncontaminated concrete is at or above the cut-off level. The concrete should be placed in one continuous, smooth operation without any halts or delays. Placing the lower portion of the pile by tremie tube and placing the upper portion of the pile by free fall should not be permitted, to ensure that defects in the pile shaft at the top of the tremie concrete do not occur.

As the surface of the concrete rises in the pile bore, the water in the pile bore will be displaced upwards and out of the top of the pile casing. It may be necessary to pump off this water to a container or temporary ditch drain to prevent the formation of ice or flooding conditions and possibly damage to existing structures.

When concreting piles by tremie techniques, allowance should be made for the removal of contaminated or otherwise defective concrete at the tops of the piles.

The casing should be filled with concrete and then the casing should be withdrawn smoothly and continuously.

Sufficient concrete should be placed to allow for additional volume of the casing and reduction in level of the concrete as the casing is withdrawn. Concrete should not be poured on top of previously poured concrete after the casing is withdrawn.

An accurate record of the volume of concrete placed should be maintained as a check that a continuous pile has been formed.

Concrete should not be placed if its temperature is less than 5°C or exceeds 30°C or if it is more than two hours old.

Where tension, horizontal or bending moment loading on the pile is foreseen, steel reinforcing should be extended and tied into the grade beam or pile cap. The steel should be designed to transfer loads to the required depth in the pile and to resist resultant bending moments and shear forces.

Void formers should be placed beneath all grade beams to reduce the risk of damage due to frost effects or soil moisture changes.

Where the drilling operation might affect the concrete in adjacent pile (i.e., where pile spacing is less than about three diameters), drilling should not be carried out before the previously poured pile concrete has set for at least 24 hours.

Where a group of four or more piles are used, the allowable working load on the piles may need to be modified to allow for group effects.

Piles should be spaced no closer than 2.5 times the pile shaft diameter, measured centre-to-centre. Strict control of pile location and verticality should be exercised to provide accurate locations and spacing of piles. In general, piles should be constructed within a tolerance of 75 mm plan distance in any direction and within a verticality of 1 in 75 mm.

A detailed record should be kept of pile construction including information such as pile number, shaft/base diameter, date and time bored, date and time concreted, elevation of piling platform, depths (from piling platform level) to pile base and to concrete cut-off level, length of casing used, details of reinforcement, brief description of soils encountered in the bore and details of any unusual occurrences during construction.

If a large number of piles are to be installed, it may be possible to optimize the design on the basis of pile load test.

PROOF-ROLLING

Proof-rolling is a method of detecting soft areas in an "as-excavated" subgrade for fill, pavement, floor or foundations or detecting non-uniformity of compacted embankment. The intent is to detect soft areas or areas of low shear strength not otherwise revealed by means of testholes, density testing or visual examination of the site surface and to check that any fill placed or subgrade meets the necessary design strength requirements.

Proof-rolling should be observed by qualified geotechnical personnel.

Proof-rolling is generally accomplished by the use of a heavy (15—60 tonne) rubber-tired roller having four wheels abreast on independent axles with high contact wheel pressures [inflation pressures ranging from 550 kPa (80 psi) up to 1,030 kPa (150 psi)].

A heavily-loaded truck may be used in lieu of the equipment described in the paragraph above. The truck should be loaded to approximately 10 tonnes (22,000 lbs) per axle and a minimum tire pressure of 550 kPa (80 psi).

Ground speed to be maximum of 8 km/hr (133 m/min) (5 mph) (400 ft/min). Recommended speed is 4 km/hr (65 m/min) (2.5 mph) (200 ft/min).

The recommended procedure is two complete coverages with the Proof-rolling equipment in one direction and a second series of two coverages made at right angles to the first series; one "coverage" means that every point of the proof-rolled surface has been subjected to the tire pressure of a loaded wheel. Less rigorous procedures may be acceptable under certain conditions subject to the approval of an engineer.

Any areas of soft, rutted or displaced materials detected should be either recompacted with additional fill or the existing material removed and replaced with general engineered fill or properly moisture conditioned as necessary.

The surface of the grade under the action of the proof-rolling should be observed, noting visible deflection and rebound of the surface or shear failure in the surface of granular soils as ridging between wheel tracks.

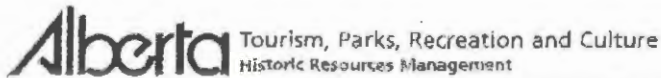
If any part of an area indicates significantly more distress than other parts, the cause should be investigated, by, for example, shallow auger holes.

In the case of granular subgrades, distress will generally consist of either compression due to insufficient compaction or shearing under the tires. In the first case, proof-rolling should be continued until no further compression occurs. In the second case, the tire pressure should be reduced to a point where the subgrade can carry the load without significant deflection and subsequently, gradually increased to its specified pressure as the subgrade increases in shear strength under this compaction.

D

Appendix D

Historical Resources Impact Assessment 2007



Old St. Stephen's College
8820 - 112 Street
Edmonton, Alberta, Canada T6G 2P8
Telephone (780) 431 2300 Fax (780) 427 5598
www.tprc.gov.ab.ca/hrm

November 21, 2007

Project File: 4835-07-050
Permit File: 2007-198

Mr. Corey Armfelt
UMA Engineering Ltd.
514 Stafford Drive North
Lethbridge, Alberta
T1H 2B2

Dear Mr. Armfelt:

**SUBJECT: MELCOR DEVELOPMENTS LTD.
AGENT BEING UMA ENGINEERING LTD.
CITY OF LETHBRIDGE
RIVER BEND COMMUNITY DEVELOPMENT
SECTIONS 13, 14 & 24, TOWNSHIP 8, RANGE 22, W4M
HISTORIC RESOURCES IMPACT ASSESSMENT - FINAL REPORT**

The Historic Resources Management Branch (HRMB) of Alberta Tourism, Parks, Recreation and Culture has received a final report from Melcor Developments Ltd.'s archaeological consultants, Arrow Archaeology Ltd., regarding the results of the Historic Resources Impact Assessment (HRIA) of the **RIVER BEND COMMUNITY DEVELOPMENT**.

HISTORIC RESOURCES IMPACT ASSESSMENT

TERMS OF REFERENCE

The terms of reference for the HRIA were outlined in Schedule "A" of my letter to you dated April 17, 2007. These studies included the conduct of a HRIA in all areas of native prairie and any other areas of moderate to high archaeological potential prior to the initiation of land surface disturbance activities. The historic resources consultant was to pay special attention to previously recorded archaeological site DjPf 128 which has been described as "a large boulder mosaic and associated cairns". This site should be avoided.

MITIGATIVE RESEARCH PERMIT NO. 2007-198

The proposed residential subdivision **RIVER BEND COMMUNITY DEVELOPMENT** is located in west Lethbridge in portions of Sections 13, 14 & 24-8-22-W4M. The majority of the proposed subdivision development area consists of cultivated lands. Additional land disturbances include farmyards, roads, power lines and other urban infrastructure. Minor areas of native prairie are present along the edges of the subdivision adjacent to the Oldman River valley. Under Mitigative Research Permit No. 2007-198, Arrow Archaeology Ltd. examined all native prairie as well as some cultivated lands in the centre of the project area. The field assessment consisted of a foot traverse, an intensive visual inspection of fortuitous exposures and shovel/soil probe testing.

Mr. Corey Armfelt
November 21, 2007
page 2

Project File: 4835-07-050
Permit File: 2007-198

RESULTS

Previously Recorded Historic Resources: Six (6) archaeological sites (DjPf 46, DjPf 88, DjPf 89, DjPf 90, DjPf 127 & DjPf 128)) had been previously recorded in the same sections as the **RIVER BEND COMMUNITY DEVELOPMENT**. DjPf 128 is in the vicinity of the proposed development.

Historic Resources Recorded by Arrow Archaeology Ltd.: No new prehistoric or historic archaeological resources, palaeontological resources nor potential historic sites were encountered during the conduct of the HRIA.

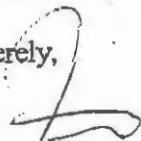
HISTORICAL RESOURCES ACT CLEARANCE/REQUIREMENTS

Melcor Developments Ltd. has *Historical Resources Act* clearance for the proposed **RIVER BEND COMMUNITY DEVELOPMENT** subject to the conditions stated in Schedule B.

Should you require additional information or have any questions concerning the above, please contact George Chalut (Southeast Region, Land Use Planner, Land Use Planning Section, Historic Resources Management Branch, 8820 - 112 Street, Edmonton, Alberta, T6G 2P8); telephone 780-431-2329, fax 780-422-3106 or e-mail gchalut@gov.ab.ca.

On behalf of Alberta Tourism, Parks, Recreation and Culture, I would like to thank officials of Melcor Developments Ltd., UMA Engineering Ltd. and Arrow Archaeology Ltd. for their continued cooperation in our endeavour to conserve Alberta's past.

Sincerely,



David Link
Director

cc: Melcor Developments Ltd.
City of Lethbridge, Planning and Development Department
Annabel Crop Eared Wolf/Dorothy First Rider, Blood Tribe
Cynthia Temoin, Arrow Archaeology Ltd.
Martina Purdon, Historic Resources Management Branch
George Chalut, Historic Resources Management Branch



Tourism, Parks, Recreation and Culture

SCHEDULE B

**HISTORICAL RESOURCES ACT REQUIREMENTS
MELCOR DEVELOPMENTS LTD.
RIVER BEND COMMUNITY DEVELOPMENT**

(PROJECT FILE 4835-07-050)**1. AVOIDANCE OF ARCHAEOLOGICAL SITE DjPf 128 (LSD 1 & 8-24-8-22-W4M)**

Site Description: This is a "Stone Feature" site, consisting of an "agglomeration of cobbles to small boulder sized rocks", located in native prairie on the west side of and overlooking the Oldman River. The site appears to have undergone more than one episode of rock placement and is difficult to interpret. An area of 16m by 22m is fully infilled with rocks. Four (4) stone cairns (three are probable farmer's rock piles) and a possible effigy have been identified. Fifteen (15) shovel tests in the general site area avoiding the stone feature and eighteen (18) soil probes did not yield any additional cultural evidence.

This site is known locally as the "West Lethbridge Turtle Effigy" and has come to have traditional importance to local First Nations.

- Requirements:**
- 1) **Avoidance of this site is required.** The site area shall be surveyed out of the development area. Arrow Archaeology Ltd. indicates that Melcor Developments Ltd. has amended the subdivision plans to avoid DjPf 128.
 - 2) The site area shall be permanently fenced off for avoidance. The best method and manner of fencing shall be determined in consultation with the appropriate First Nations community.

2. FIRST NATIONS CONSULTATION

Alberta Tourism, Parks, Recreation and Culture advises that the appropriate contact for consultation on this project is:

Blood Tribe
Annabel Crop Eared Wolf or
Dorothy First Rider
P.O. Box 60
Standoff A/B, T0L 1Y0
Phone: 403/737-8105
Fax: 403/737-2336

SCHEDULE B**PROJECT FILE: 4835-07-050****PAGE 2****RIVER BEND COMMUNITY DEVELOPMENT****3. FURTHER STUDIES OF DjPf 128**

Any other proposed development in the vicinity of DjPf 128, e.g. development of walking trails or any other improvements to the east of the site on City of Lethbridge lands, shall require a Historic Resources Impact Assessment.

4. REPORTING THE DISCOVERY OF HISTORIC RESOURCES

Please be aware, pursuant to Section 31 of the *Historical Resources Act*, Melcor Developments Inc. and their representatives are required to report the discovery of any additional archaeological resources, palaeontological resources, or historic sites which may be encountered during the conduct of subdivision development activities.

5. FINAL REPORT

Any final Historic Resources Impact Assessment report is to be submitted to Shamim Shivji (Administrative Assistant, Land Use Planning Section, Historic Resources Management Branch, 8820 - 112 Street, Edmonton, Alberta, T6G 2P8).

4. Historical Resources Impact Assessment



**HISTORICAL RESOURCES IMPACT ASSESSMENT
FINAL REPORT**



**RIVER BEND COMMUNITY DEVELOPMENT
LETHBRIDGE,
Prepared for:**

UMA ENGINEERING, LETHBRIDGE

Archaeological Research Permit 2007-198

Cynthia Temoin, Don Boras, Neil Mirau

August, 2007

CREDITS

Permit Holder
Field archaeologists, authors

Cynthia Temoin
Cynthia Temoin
Neil Mirau
Don Boras
Alyssa Hamza
Jim McMurchy
Dave Hastie
Lyle Shanks

Field Assistants

ACKNOWLEDGEMENTS

The authors would like to thank Corey Armfelt of UMA Engineering (agent for Melcor Developments) for retaining Arrow Archaeology Ltd.

Cover Photo: View southwest view along Oldman River and coulee margin from near southeast corner of development area.



2315 – 20 Street Coaldale, Alberta, T1M 1G5
Telephone 403 345 2812
Fax 403 345 2817
Cell 403 330 8376
www.arrowarchaeology.com

MANAGEMENT SUMMARY

This report summarizes the results of a Historical Resources Impact Assessment (HRIA) undertaken by Arrow Archaeology Limited for UMA Engineering of Lethbridge. The HRIA examined a proposed subdivision of approximately 130 ha. on the west side of the City of Lethbridge approximately 4.5 km northeast of the confluence of the Old Man and St. Mary River. The subdivision covers portions of three sections and the legal descriptions and Historical Resource Values (HRV) of the areas within which the subdivision is located are as follows:

LS 5, 11, 12, 13, 14, 15, 16 Section 13 Township 8 Range 22 W4 HRV 5A

LS 6, 9, 10 Section 13 Township 8 Range 22 W4 HRV 5A, P

LS 8, 9 Section 14, Township 8 Range 22 W4 HRV n/a

LS 1, 8 Section 24 Township 8 Range 22 W4 HRV 4A

LS 2, 3 Section 24 Township 8 Range 22 W4 HRA n/a

The subdivision is located between three existing subdivisions (Riverstone to the northwest, Sunridge to the west and Paradise Canyon to the southeast). The Oldman River valley is east of the subdivision and a major coulee, slated for the development of an eventual new crossing of the river valley is located to the north.

The majority of the proposed subdivision area has been disturbed by cultivation and other disturbances such as farmyards, roads, power lines and other urban infrastructure, although there are minor areas of native grassland around the edges of the subdivision. Most of this area was broken for growing cereal grain crops in the early 20th century and some areas of the proposed subdivision are still under active cultivation while other areas have been allowed to return to grassland. Although the subdivision borders the break of slope to the Oldman River valley and therefore is considered to be in an area of significant archaeological potential, long term cultivation has probably destroyed archaeological sites that may have existed in the area. No new sites were recorded as a result of this HRIA and one previously recorded site, DjPf-128 is within the development area. This site is considered significant and as a result UMA Engineering and the developer, Melcor Developments Ltd. have amended

the subdivision plan to avoid directly impacting this site. This site is at the boundary of the subdivision and because it will be near urban development, this HRIA contains recommendations to fence and protect the site from future disturbance.

DjPf-128 was recorded as a possible effigy in 1999 under permit 99-078. The main site feature was mapped in June 2000 by the Alberta Archaeological Society and has become known unofficially as the West Lethbridge Turtle Effigy. Since it was located and recorded in 1999, the site has come to have traditional importance and several Blood and Piikani Tribe members have visited the site.

Although the actual feature was not subject to subsurface testing, several tests were excavated around the feature and tests were placed in cairns that are considered to be part of the site. Small diameter soil cores were taken from within the feature. All failed to locate any buried cultural material. The detailed map completed by the ASA in 2000 precluded the necessity of mapping of the feature during this HRIA. Although the feature appears to be of some antiquity and portions of the outline are relatively well defined, the shape of the feature is equivocal and we cannot confirm that it was intended to be a turtle or other readily identifiable form. It appears likely that at least some of the rocks that are within the outline of the feature and possibly all four of the surrounding cairns are farmer deposited rocks from rock picking activity in the cultivated field adjacent to the site. This matter is discussed in more detail in the text of this report.

Notwithstanding, the uncertain nature and interpretation of this feature, we recommend that it be avoided by the subdivision development and that the feature and site area be protected by fencing or other means that will allow the site to be seen, but not disturbed by development or people using the area. The text of the report contains additional details on our fencing recommendations, but the exact nature and location of the fence have not yet been determined.

Recommendation

We recommend that *Historical Resources Act* clearance be granted for this project. No additional archaeological, historical or palaeontological exploration or mitigation work is recommended or required within the areas to be impacted by the proposed project. We recommend the continued avoidance of DjPf-128 and the construction of suitable temporary and permanent barriers around the site area as it currently defined. The form and type of the permanent site protection should be determined in consultation with Alberta Tourism, Parks, Recreation and Culture and should consider the site's significance.

TABLE OF CONTENTS

Credits	ii
Acknowledgments	ii
Management Summary	iii
Table of Contents	vi
List of Figures	vii
Introduction	1
Background Data	10
Land Use	10
Project Description	10
General Description of Project Area	11
Vegetation	13
Fauna	13
Previous Archaeological Studies	14
Research Strategy and Methodology	14
Results and Site Recommendations	17
Revisited Site: DjPf-128	18
Recommendation Summary and Conclusion	38
References Cited	39
Appendix A – Survey Plans	40
Appendix B – Archaeological Site Inventory Data	43

LIST OF FIGURES

Figure 1	Map of development in relation to Natural Regions of Alberta.	3
Figure 2	General location of River Bend subdivision.	4
Figure 3	River Bend subdivision development survey map.	5
Figure 4	View north to east end of subdivision, DjPf 128 site area	6
Figure 5	View south to Paradise Canyon subdivision	6
Figure 6	View southwest from southeast corner of subdivision	7
Figure 7	View southwest from southern boundary of subdivision	7
Figure 8	View west of slumping river valley slope	8
Figure 9	View east of dumped debris south end of subdivision	8
Figure 10	View northeast of cultivated field in the subdivision area	9
Figure 11	View northeast of south boundary of development	9
Figure 12	Satellite image of area derived from Google Earth	11
Figure 13	DgNg 1 turtle effigy sketch	20
Figure 14	Consort turtle effigy sketch	21
Figure 15	EfOe 10 "turtle effigy" sketch	21
Figure 16	Site map for DjPf 128	28
Figure 17	ASA map of central feature at DjPf 128	29
Figure 18	View north of site area	30
Figure 19	Soil probe sediments	30
Figure 20	View southeast of DjPf 128 site area	31
Figure 21	South portion of central feature	31
Figure 22	North portion of central feature	32
Figure 23	View east of south portion of central feature and river valley	32
Figure 24	View south of central feature	33
Figure 25	View north of central feature	33
Figure 26	ASA map with elements outlined	34
Figure 27	ASA map with tentative feature outline	35
Figure 28	View shed map of general photos of subdivision area	36
Figure 29	View shed map of DjPf 128 site area	37

INTRODUCTION

Personnel from Arrow Archaeology Limited conducted a Historical Resources Impact Assessment (HRIA) under archaeological Research Permit 2007-198 on between June 1 and July 12, 2007. The HRIA was triggered by a referral of the project to Alberta Tourism, Parks, Recreation and Culture (ATPRC) and a Schedule A was issued under project file number 4835-07-050 on April 17, 2007. Cynthia Temoin was permit holder and directed the fieldwork. Arrow archaeologists Don Boras, Neil Mirau carried out field work along with volunteer Jim McMurchy and other field assistants. The DjPf 128 site area was also examined by Blair First Rider of Alberta Tourism, Parks, Recreation and Culture. The HRIA examined a proposed subdivision located ca. 1 km west of the Oldman River in the City of Lethbridge. The development is located between three existing subdivisions of West Lethbridge, Riverstone to the northwest, Sunridge to the west and Paradise Canyon to the southeast. The Oldman River valley is east of the subdivision and a major coulee, slated for an eventual new crossing of the river valley is located to the north. The subdivision covers portions of three sections and the legal descriptions and Historical Resource Values (HRV) of the areas within which the subdivision is located are as follows:

LS 5, 11, 12, 13, 14, 15, 16 Section 13 Township 8 Range 22 W4 HRV 5A
LS 6, 9, 10 Section 13 Township 8 Range 22 W4 HRV 5A, P
LS 8, 9 Section 14, Township 8 Range 22 W4 HRV n/a
LS 1, 8 Section 24 Township 8 Range 22 W4 HRV 4A
LS 2, 3 Section 24 Township 8 Range 22 W4 HRA n/a

The HRIA was completed for:

**Corey Armfelt
UMA Engineering
514 Stafford Drive North
Lethbridge, AB
T1H 2B2**

The HRIA was intended to locate and assess historical resources within and adjacent to the proposed subdivision and provide recommendations for avoidance, mitigation and preservation of any such resources. This final report provides the results of the HRIA, including project description, background data,

applied methodologies, and recommendations regarding historical resource impacts.

The majority of the subdivision area has been cultivated, however, specific attention was paid to areas of native grassland that still exist along coulee margins in LDs 5, 6, 9, 10 and 11 in Sec. 13-8-22 W4M and LD 8 in Sec. 24-8-22 W4M. In addition, DjPf-128, located in LD 1 and 8 of Section 24-8-22 W4M was a significant focus of the survey. The site was surveyed and shovel tested to determine its extent, and staked to facilitate avoidance.

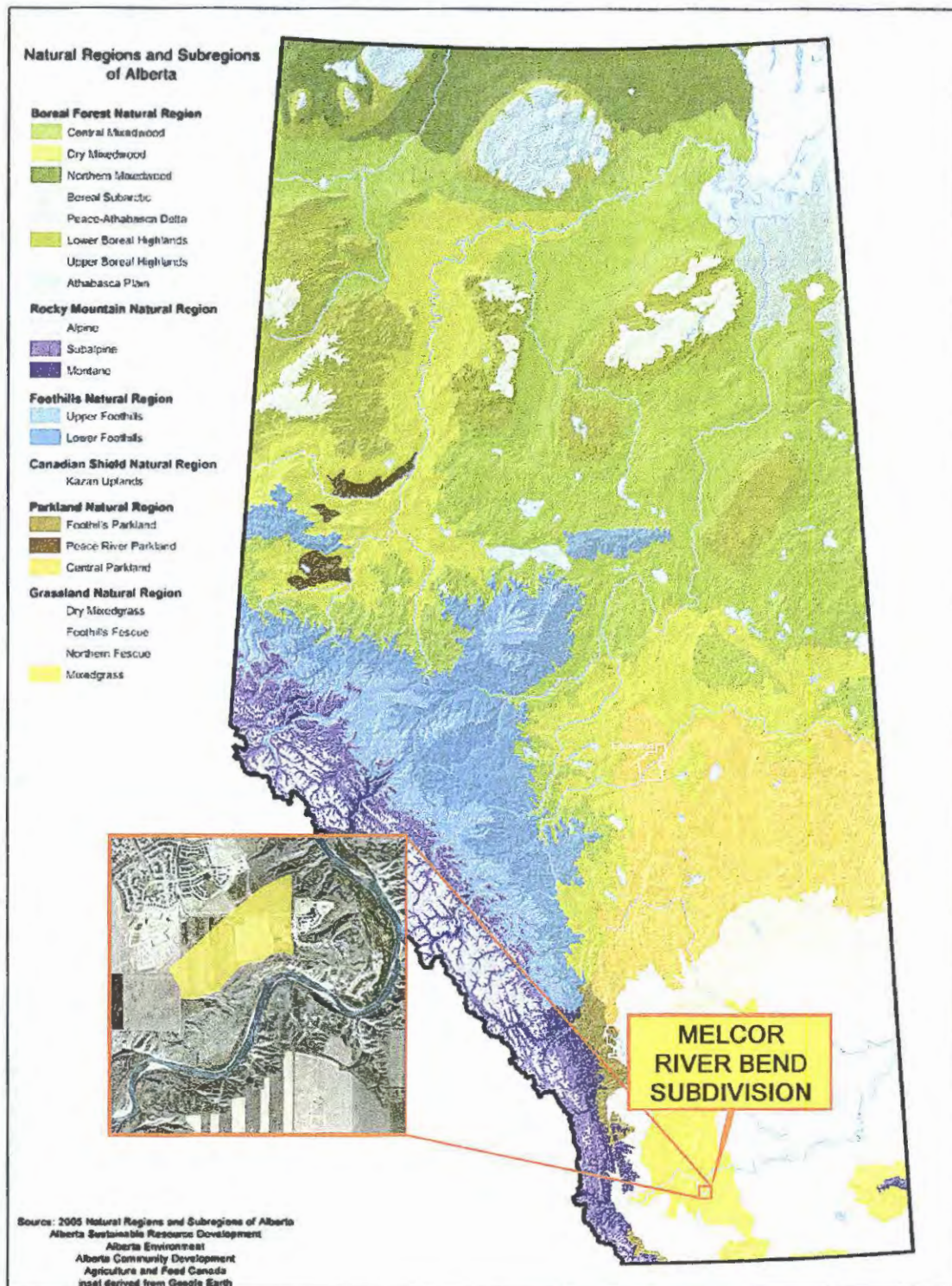


Figure 1. Map of development in relation to Natural Regions of Alberta.

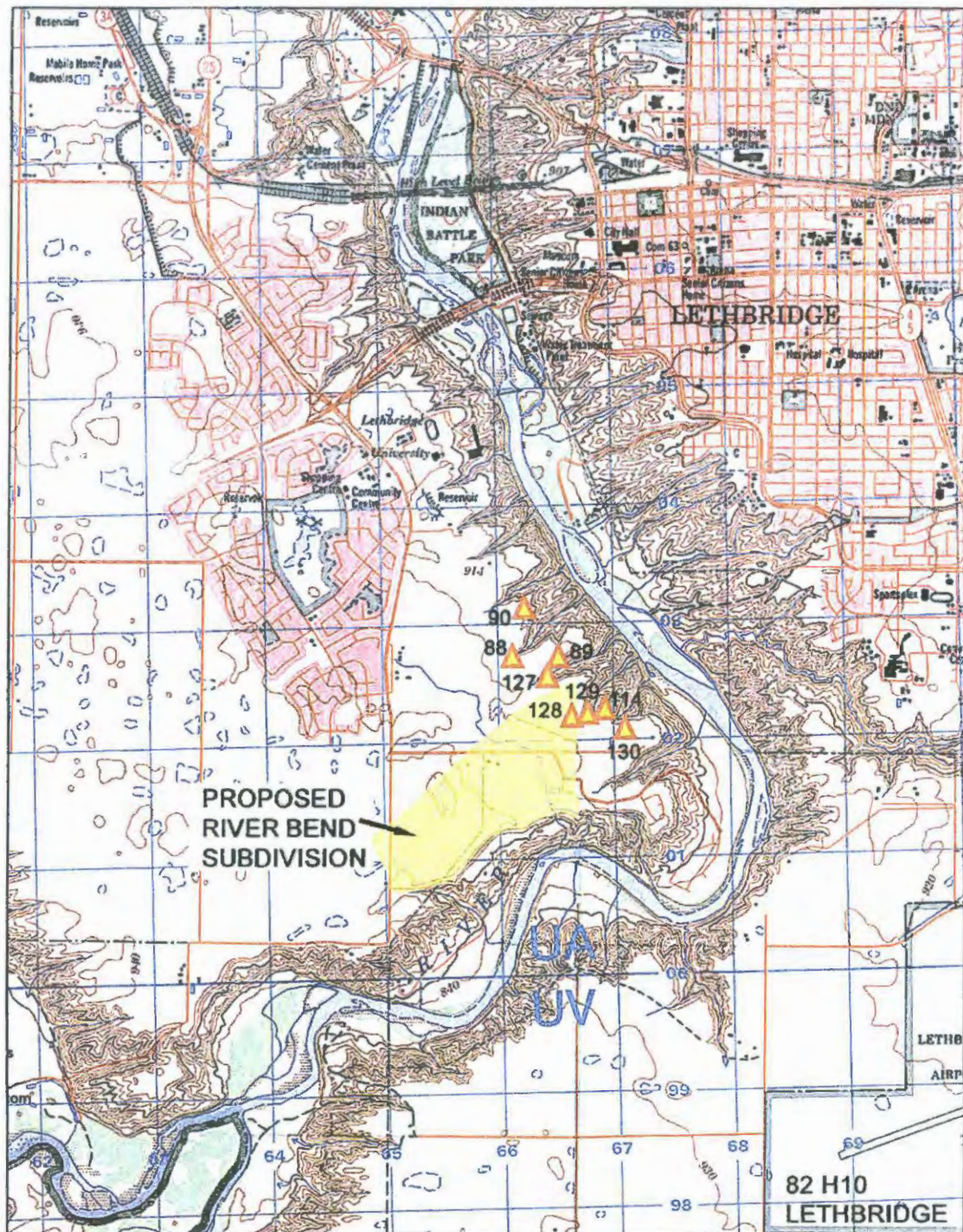


Figure 2. General location of the Melcor River Bend subdivision. The development is in Borden block DjPf. Yellow triangles indicate nearby archaeological sites with their Borden block numbers, including DjPf-128, the only site within the subdivision area.

Figure 3. Melcor River Bend subdivision development survey map. Development area indicated by solid red line. Area of revisited site DjPf-128 also indicated.

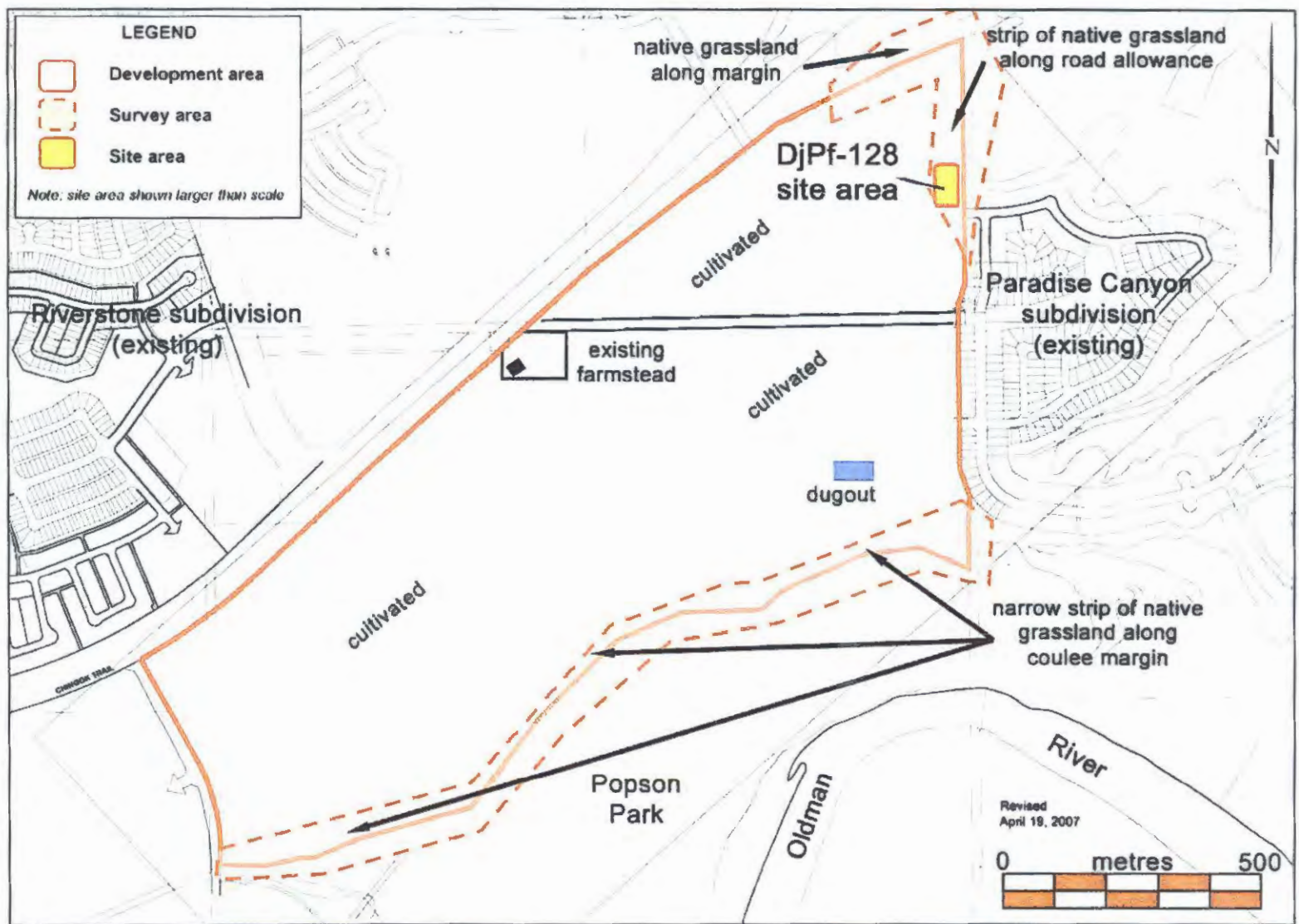




Figure 4. View north toward River Bend development area (on left side of frame) from adjacent subdivision. DjPf 128 is under the power line, left side of photo. See Figure 28 for view shed for this and other photos below.



Figure 5. View south from coulee edge just east of proposed subdivision area. The power transmission line is essentially the eastern boundary of the subdivision.



Figure 6. View southwest along coulee edge from southeast corner of development area. Note massive slumping.



Figure 7. View southwest along southern coulee margin showing slumping. The debris in this area appears to be from illegal dumping.



Figure 8. View west of slumping area encroaching on cultivated field along southern margin of the proposed development.



Figure 9. View east of debris along south coulee margin. This appears to be from an old building from a nearby farm, no significant historical/Euro Canadian historical resources were noted in the subdivision area. At least one former homestead existed in the area, but has been obliterated by cultivation.



Figure 10. View northeast of cultivated rolling prairie in the southwest part of the proposed subdivision.



Figure 11. View northeast from near southern edge of proposed subdivision. Photo taken in mostly native strip between edge of cultivated field to the left and river valley to the right. These strips are the only native prairie in the subdivision, and some are at least partly disturbed.

ENVIRONMENTAL AND CONTEXTUAL DATA

Land Use

The development is located within the City of Lethbridge, in the southern area of West Lethbridge between existing subdivisions. Popson Park, a city owned and operated river valley park and environmental reserve is located in the Oldman River valley south development area. Most of the subdivision is or has been under cereal grain cultivation and most of this land was first broken in the early 20th century. There is an occupied farm in the western portion of the proposed subdivision. A paved access road runs along the road allowance connecting existing subdivisions running between Sections 13 and 24-8-22 W4M. A north-south running power transmission line located along the undeveloped road allowance between Ranges 21 and 22 defines the east boundary of the subdivision. There is an existing dugout in LD 16-13-8-22 W4M. Portions of the southern coulee margin have been used as a recent dumpsite, and the remains of old vehicles, rusted machinery and domestic debris litter some areas of the hillside overlooking the Oldman River Valley (see Figures 7 and 9). Other areas within the proposed subdivision have been impacted by urban development infrastructure including buried gas, water, sewer and telephone lines. Some small areas near the edge of the subdivision are native grassland.

Project Description

The development is a new residential subdivision known as the River Bend Community. The subdivision will include of several hundred residential lots, a school, a commercial area, and a park and necessary streets and infrastructure. The development footprint is a rough NE-SW oriented trapezoid, ca. 1.8 km long by 0.8 km wide, and covers approximately 130 ha. Of this, about 10% (ca. 15 ha) is native grassland, most (ca. 13 ha) along the coulee margins to the north and south, with a thin strip (ca. 20 m wide) along the undeveloped road allowance defining its eastern boundary. These native areas were the areas primarily focussed on during field work for this HRIA.



Figure 12. Subdivision area (indicated by yellow border) on satellite image. Satellite image derived from Google Earth. Most of southern part of subdivision under active cultivation. North part of subdivision has been allowed to return to grass, but was previously cultivated.

General Description of Project Area

The development area is located approximately 1 km west of the Oldman River, which flows from south to north past this area. The Oldman river is one of southern Alberta's major rivers, and the valley that it occupies is deeply incised into the prairie landscape. The modern channel of the river is 80 to 90 m below prairie level in this area and the river valley varies between about 500 and 800 m wide.

Local topography is level to very gently rolling. The surface sediments are derived from glacial, glaciofluvial and glaciolacustrine deposits with some inputs of aeolian deposited fines depending upon slope position. Uncultivated low hills and higher areas in and around West Lethbridge tend to be scoured of silt fines often leaving a pebble to cobble armoured surface. Glacial and glaciofluvial-deposited silts and clays dominate the fine fraction of sediments. Lower areas

can have some sorted fine material over till. In most cases these fines are silty-clays or clays, but silt size particles dominate in most places and at some depths below surface. The regular suite of glacially transported materials including granites, quartzites, limestone among other types dominates lithic material. Oldman Formation bedrock is exposed in the river valley just below the subdivision area and some Cretaceous sandstones are present in the coulees east of the subdivision area, but no bedrock was noted on the prairie surface. On the basis of exposures of bedrock in the river valley, the subdivision area surface is 20 to 40 m above Oldman Formation bedrock.

The river valley is cut through glaciofluvial, glacial moraine deposits and Cretaceous bedrock and is a former glacial drainage (Beaty 1975). The topography and near surface sediments of the surrounding prairie upland are primarily the result of glaciolacustrine, glaciofluvial and glacial ground moraine deposits. The slopes of the Oldman River valley exhibit extensive coulee development and tributary coulees in the area are deeply incised. Although both sides of the river valley in this area have significant coulee development, the coulees on the east side tend to be longer and deeper.

The northeast periphery of the project area is defined by a large, steep sided and deeply incised coulee. There are four distinct eastward extending spurs between smaller, but again steeply sided coulees that overlook the Oldman River valley just beyond the eastern boundary of the development. The development's southern boundary overlooks a more gradual slope down to a wide valley floodplain and Popson Park. This slope has been subject to relatively frequent slope failure and there is evidence of numbers of mass movement events along the slope in this area. (See Figures 6, 7 and 8). Some of these slope failure events appear to be relatively recent and this phenomenon may have destroyed some archaeological sites near the former edges of the slope.

Soils in the area are variable depending upon their topographic position. Most soils are moderately well developed and may be stony, again depending upon slope position. In most cases soils have coarse prismatic or columnar structure,

tend not to be clay illuviated and have strongly carbonate C-horizons. In general this is a zone of Brown Chernozems (Agriculture Canada Expert Committee on Soil Survey 1987).

The elevation of the project area is approximately 920 masl.

Vegetation

The project is within the Xeric Mixed Grassland zone of the subcontinental grassland ecoregion (Ecological Stratification Working Group 1995). Native vegetation in this ecoregion consists primarily of *Bouteloua gracilis* (blue grama), *Stipa comata* (spear grass) and *Stipa spartea* (needle grass), all of which were observed. *Koeleria micrantha*, (Junegrass) *Agropyron smithii* and *A. dasystachyum* (wheatgrasses) are also present in the general area, as well as *Poa sandbergii* (Sandburg bluegrass) and *Bromus* ssp. (Brome grass) (Archaeological Society of Alberta 2000). Other observed vegetation includes *Artemisia* ssp. (sage), *Opuntia polyacantha* (prickly pear cactus) and *mammillaria vivipara* (pincushion cactus). The presence of *Agropyron cristatum* (crested wheatgrass) reflects the introduction of non-native grasses to the area (Kuijt 1972: 97). Woody shrubs are present in the coulees outside of the subdivision area and there are areas of natural riparian gallery forests in the river bottom adjacent to the site area but there are no native trees or shrubs present in the subdivision area. Several non-native species of trees and shrubs have been introduced in the area are present in the surrounding developed areas.

Fauna

The area would have supported grazing bison (*Bison bison*) herds in the past. Other common and culturally important game animals in the immediate area today include whitetail deer (*Odocoileus virginianus*) and mule deer (*Odocoileus hemionus*), pronghorn (*Antilocapra americana*), coyote (*Canis latrans*), red fox (*Vulpes vulpes*), and various rodents, lagomorphs and upland birds. Waterfowl species were observed in the area and would have undoubtedly been present in the past as well.

Previous Archaeological Studies

Prior to conducting fieldwork, archaeological site inventory forms from the Borden Block in which this area is situated were examined. This development is located within Borden Block DjPf and there are 136 recorded sites in this block. Most of these sites are surface sites located on the prairie uplands and are located in the Oldman river valley and on adjacent prairie uplands to the south and west of the subdivision including on Blood Reserve lands located on the western side of the DjPf Borden Block. The recorded sites in this block include precontact campsites, stone features, kill sites, a medicine wheel site, lithic artifact scatters and isolated surface finds and Postcontact Period or historic sites. The medicine wheel is DjPf 23. The site was recorded in 1975 as a tipi ring site and updated by Gerald Conaty in 1984 as part of the Blood Tribe Historic Sites Project. Conaty reported the site as including up to 100 stone circles, 50 cairns, historic graves and lithic material, as well as the Nitapinaw's medicine wheel. The site has not been formally revisited since 1984, but recent air photos indicate some degree of disturbance due to oil or gas drilling in the area. DjPf 2, the Fort Whoop Up site is also in this Borden Block on Blood Reserve Land about 5 km southwest of this subdivision.

There are seven recorded sites along the east-facing slopes of the Oldman River Valley in the adjacent to, but outside of the proposed subdivision, DjPf-88, 89, 90, 114, 127, 129 and 130. DjPf-88 and 89 are stone feature sites originally recorded in 1982 under an HRIA for Lethbridge Urban Parks; DjPf-90 is an historic farmstead recorded during the same survey. All are located between 200 and 750 m north of the development area. DjPf-127 is an historic homestead recorded during the HRIA for the Riverstone Subdivision in 1999 (ASA permit # 99-078) and is located ca. 40 m north of the current project boundary.

DjPf-128 is located just within the eastern boundary of the proposed subdivision and is the only site within the development area. This site was recorded in 1999 by Don Hanna (ASA permit # 99-078) and subsequently mapped by the Lethbridge Archaeological Survey in 2000 (see Figure 12). DjPf-129 and 130 are

recently identified lithic scatters, respectively located ca. 100 m and 400 m east of the development.

It seems likely that additional sites would have been present in the general area in the past, however, sites near the break of slope may have been destroyed by the relatively regular mass movements along some slopes in this area (see Figures 7 and 8). Cultivation in the area as well as related farm and some pre HRIA urban development may have destroyed surface sites such as stone circles in this general area.

DjPf-128 was the only site revisited during this survey. Although no conclusion was reached in regards to its status as an actual "effigy," there is no doubt the feature is some type of cultural construct. This is discussed in more detail below

RESEARCH STRATEGY AND METHODOLOGY

Prior to conducting fieldwork, an archival search was conducted to determine the presence of recorded historical resources in the area and topographic maps were examined to determine the presence of landforms that are considered to have high potential to contain archaeological or other historical resources. Preliminary scouting surveys were conducted to determine the areas with the highest archaeological potential - specifically the coulee margins on the north and south peripheries of the development. These are the only areas of the subdivision area that have not been disturbed by cultivation or related agricultural or urban development. The feature at DjPf-128 was also scrutinized to develop an appropriate sampling strategy procedure.

Site discovery procedures consisted of pedestrian coverage of the native grassland areas along the edges of the development and some cultivated areas in the centre of the area. All native grassland portions were covered at least twice in 5 to 10 m walking transects. A 5 to 10 m wide strip of the adjacent cultivated fields paralleling these margins was also examined to search for fire broken rock, worked lithic material or any other indication of archaeological sites. Rodent burrows, animal trails and other natural and artificial exposures and erosional

surfaces were examined, including slumping areas along the development's southern periphery. Twenty shovel tests were excavated in the native grassland, excluding those excavated in the DjPf 128 site area.

A total of 15 40 x 40 cm shovel tests and 18 soil probes were conducted in and around the DjPf 128 site area. Based on discussions with Wendy Unfreed of ATPRC, the actual feature was not subject to shovel testing, rather we tested around the perimeter. We did, however put small diameter soil probes in the feature, without disturbing the rocks that make up the feature to examine the soil and stratigraphy below the feature. Two of the shovel tests were conducted within the cairns on the north side of the main feature in order to attempt to determine their possible archaeological association with the primary feature at the site. Backdirt was screened through 6 mm mesh. The stones of the feature were also scrutinized for evidence of recent disturbance, such as differential patterns of lichen cover, stone burial depths and any discernible patterns, such as identifiable orientation of rocks relative to one another. The DjPf-128 site area was subsequently staked to facilitate avoidance during construction. Areas both within the development area and to the east of the feature were examined to search for any cultural materials or other archaeological material that might contribute data or information useful to the interpretation of the primary feature of DjPf 128.

The summer season, nature of the local vegetation cover (including previously cultivated terrain and native prairie) and numerous rodent disturbances meant that surface visibility was generally good. The nature of the local geomorphological conditions and natural and artificial exposures indicate that the examination was, in our opinion, sufficient to detect and locate buried historical resources. The field surveys also included a search of the area for palaeontological resources and/or fossiliferous bedrock.

The surveyed and adjacent areas were photographed, as was DjPf-128. Based on our observations and the results of these tests, our opinion is that there is little possibility of deeply buried cultural materials in the proposed development area.

RESULTS AND RECOMMENDATIONS

The majority of the proposed subdivision is in currently or previously cultivated land and there was therefore little potential for undisturbed historical resources in as much as 90% of the subdivision area. As noted the only areas of undisturbed native terrain were narrow strips of land between cultivation and the break of slope to the Oldman River Valley or tributary coulees thereof on portions of the south, east and north boundaries of the proposed development. This land was first broken in the early 20th century and some may have been first cultivated in the late 19th century based on the earliest homesteads in the area (West Lethbridge History Book Society, 1982). Portions of the proposed subdivision have continued to be cultivated following the annexation of the land by the City of Lethbridge, while the northeast part of the subdivision has returned to grassland. This level of disturbance due to cultivation and the subsequent construction of roads and infrastructure meant that the area offered relatively little area where there was potential for undisturbed historical resources.

No previously unrecorded archaeological sites were identified during this study. Significant slumping along the southern boundary of the subdivision has reduced the remaining native grasslands to a narrow strip (ca. 10 m) between the valley slope and cultivated fields; any sites along the margin would have long since collapsed with the original surface.

No palaeontological resources were observed or discovered during the course of this survey.

One previously recorded site, DjPf 128 was revisited during the HRIA. Details of this site are as follows.

Revisited Site

Borden: DjPf-128

Location (NAD 83): 12U 366678E 5502230N

Legal Description: LDs 1 and 8-24-8-22 W4M

Features/Site Type: Stone feature

Description: The site consists of four small cairns and a central surface stone feature of unknown function. It is located on gently rolling native grassland just west of and between the head of two east draining coulees. The eastern boundary of a formerly cultivated field lies 4 to 5 m west of the site. A fence and a graded trail run along the road allowance immediately east of the site. The site lies mostly in an existing power line right of way that runs north south through the area. There is wooden power pole located approximately 12 m southeast of the main site feature.

This central feature, essentially a surface agglomeration of cobble to boulder sized stones, measures ca. 22 m north to south and 16 m east to west. The site was recorded in 1999 as a "large boulder mosaic (Don Hanna, 1999 site form description). Hanna was noncommittal in his assessment of the feature suggesting it could be of historic or First Nations origin based on the contextual data and form of the feature. That is, he suggested it could be historic (i.e. a farmer's rock pile) based on its location along the edge of a cultivated field, near the corner of a quarter section and adjacent to a fence line and road allowance. He also suggested a possible First Nations origin based on the fact that many of the stones making up the feature were deeply sodded in and lichen covered. In 2000 and as described above, the Archaeological Society of Lethbridge mapped the feature in detail and it became known informally as the West Lethbridge Turtle Effigy, based primarily on its oblong shape with a round protuberance on the south side of the feature and a roughly triangular or elongate extension on its north side. The general shape with the round extension being thought of as a head and the triangular/elongate extension viewed as the tail was sufficient to cause some observers to call it a turtle effigy.

While surface stone features referred to as turtle effigies occur on the Northern Plains, they are not common. Brace (2005, p. 61) lists 16 such effigies, including three in Saskatchewan, one (the Consort turtle) in Alberta, and the remainder in Manitoba and the American Plains. DjPf 128 is not included among this number. Other turtle effigies have been recorded in Alberta, but data on these are sparse and conclusions uncertain. One such feature is an alleged turtle effigy recorded in Alberta in association with EfOo-10, the Miner's Medicine Wheel No 1. site near Bindloss, Alberta. This feature could also be interpreted as something other than a turtle. (see Figure 15) Other general data on turtle effigies on the Plains is also open to question. For example, in her popular book on plains archaeology, Bryan (1991) claims that "...ninety percent of all turtles [i.e. turtle effigies] face west". That claim is not borne out by Brace's (2005) illustrated turtle effigies and other data. A quick review of the orientation of the features that are claimed as turtle effigies from illustration in Brace's (2005) book indicates that there is no dominant direction or orientation of these features. The known/claimed turtle effigies are mostly stone outlines, That is, the shape of the turtle is only outlined, without any rock fill in the body of the turtle. The following sketches illustrate three stone outline features that have been interpreted as turtles. These sketches are included herein for illustrative/comparative purposes only and although they are accurate representations of other published sketches, these sketches were not and cannot be used for any systematic or formal analysis. Scales are believed to be accurate, but again should be used with caution. These examples illustrate that some interpretation is required to see these features as representations of turtles. Compare these to the sketch of DjPf 128 below. The features illustrated in the following three figures are all significantly smaller than the feature at DjPf 128.

Of these examples, the DgNg 1 effigy is most convincing as a turtle. Both of the others are located in Alberta, but could seen as something other than turtles. These examples neither support nor negate the interpretation of DjPf 128 as a turtle effigy, but tend to illustrate the point that no more imagination is required to see DjPf 128 as a turtle than either the Consort or EfOo 10 features.

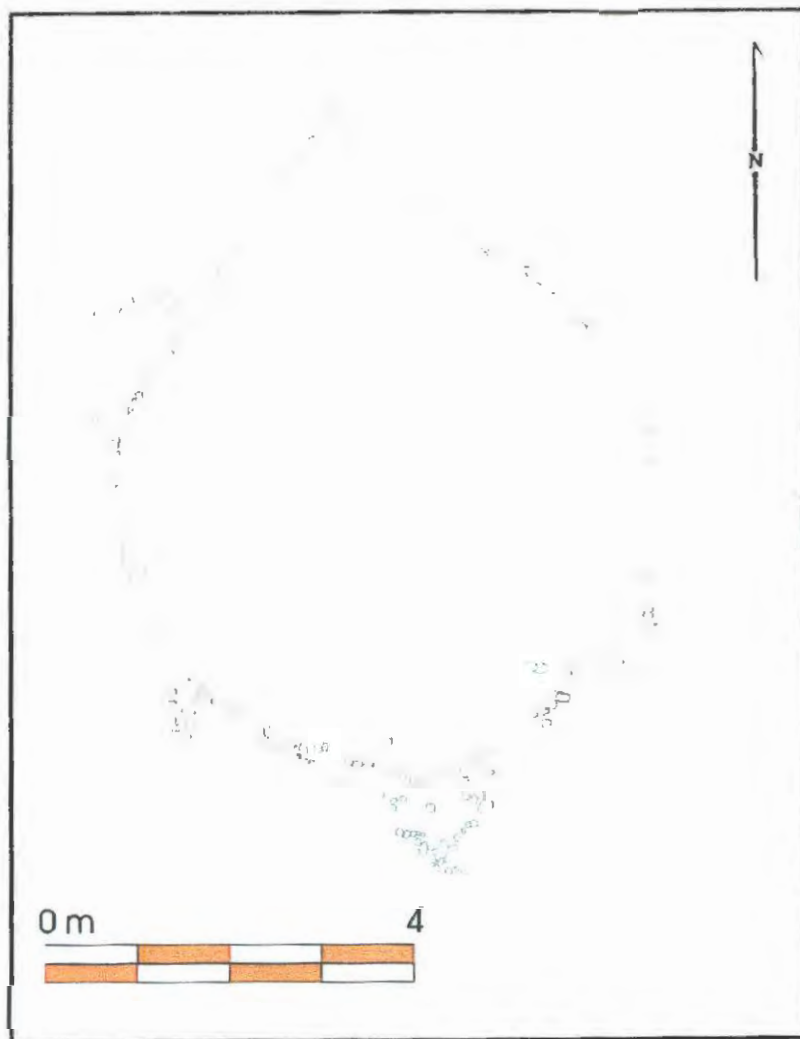


Figure 13. DgNg1, Pat Giles turtle effigy from Saskatchewan, sketch derived from Brace (2005, 54).

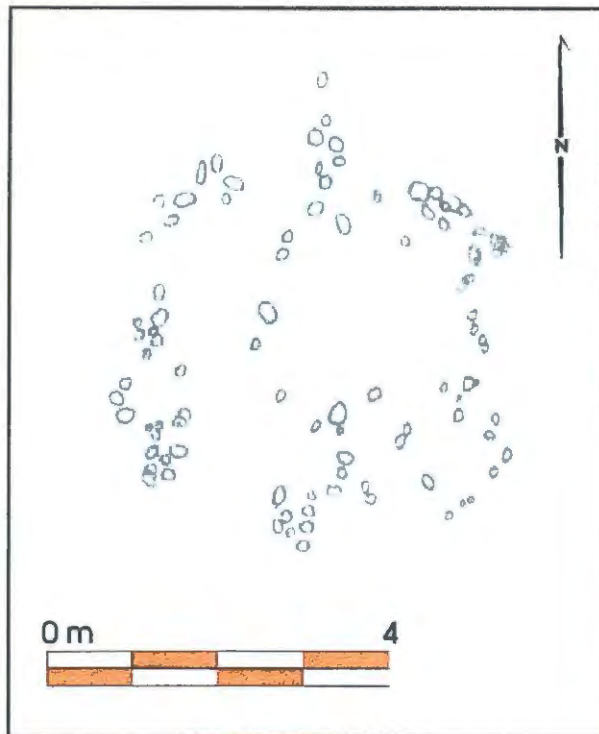


Figure 14. Consort turtle effigy near Consort Alberta. Sketch derived from Brace (2005, 73). The sketch in Brace's volume is illustrated with an interpretative outline of the turtle, not included here. Based on that interpretative outline, the head is facing south. The scale is approximate.

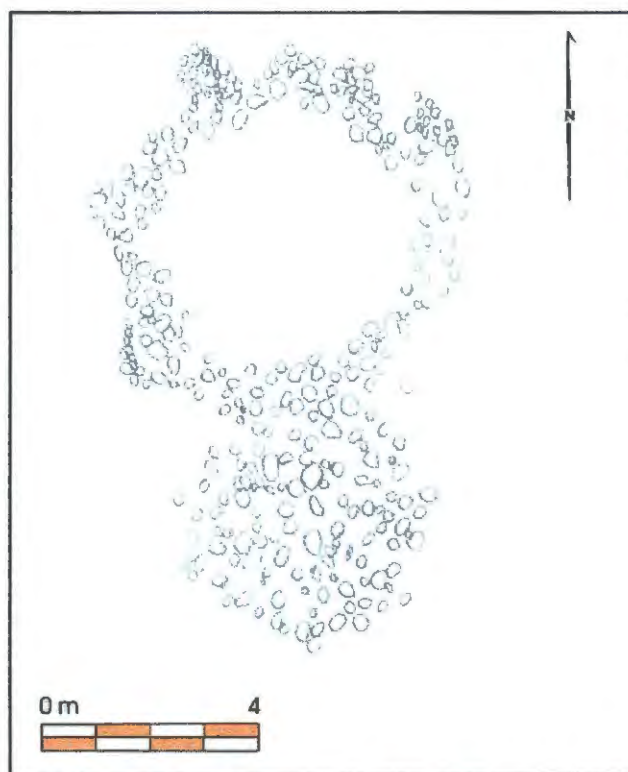


Figure 15. EfOo 10 feature interpreted as a turtle. This sketch based on sketch map at www.usask.ca/education/ideas/tplan/sslp/wheel.

The DjPf 128 feature is fully infilled, forming what amounts to a cobble pavement inside the perimeter of the feature. We estimate that there are over 2000 visible stones that make up the feature and it seems likely based on the appearance of at least a double layer of stones in part of the feature and the likelihood of completely buried stones that are part of the feature, that the total rock count for the central feature at this site is between 2500 and 3000 cobble to small boulder sized stones. Approximately 18 boulder sized rocks are located northern half of the central portion ("body") of the feature. These rocks are not sodded in. Hanna, in the 1999 site form refers to them as an "internal partial arc of large cobbles". These small boulders are an obvious distinct element of the feature although, based on the mapping completed by the ASA in 2000, these small boulders do not form a clear arc. Similarly Hanna refers to an "internal cairn" of large cobbles located in the southern half of the body. Again these are apparent at the feature, but are not readily distinguishable in the ASA map of the feature. In both cases we hesitate to ascribe a label to these groups of rock. They may be groups of rocks that were been added to the feature after it was first made. The rock agglomerations Hanna refers to do not have different patterns of lichen cover or anything else that easily distinguishes them, however they are not sodded in and appear, in our opinion, to have been added to the original feature after it was constructed. Hanna also refers to "at least three linear alignments of large cobbles near the western margin [of the body]". This element of the feature is discernible in the ASA map, but was less visible at the feature at the time of the field work completed for this HRIA due to grass cover. It is our opinion this part of the feature is not so much made up of purposefully placed lines of stone as it is part of the feature where there are generally fewer rocks and some gaps are present between the stones which may give the impression of linearity. Please refer to figure 26 below. Interestingly, if the group of small boulders referred to above was dumped on the feature sometime after the feature was in existence and some equipment such as a stone boat were used to transport those stones to the feature, it is possible that equipment may have disturbed that portion of the feature where the gaps are present. That scenario is, admittedly highly speculative, however again, we do not believe there is any real linearity to the stones on the west margin of the feature.

The eastern margin of the feature is right at a section fence line and on the other side of the fence a well used and once graded access trail is present. The feature is also below an existing power transmission line that would have required at least some heavy equipment to use the area just to east of the feature. Although we cannot confirm this, it is possible that the feature was disturbed by this activity (fence building, trail construction, power line construction) and therefore the extant feature may be less symmetrical than it may have once been.

In addition to the central feature, there are four cairns included in the defined site area, two lie north of the central feature, one is just north of the "body" and just west of the "tail" and one is located in the head of the coulee south of the feature. The two cairns on the north end of the site are most prominent. They are oblong, oriented northwest-southeast and are located at the edge of the break of slope to the south coulee. The features are approximately 1.6 and 1.8 m in length and approximately .75 wide. Both consist of a multi-tiered pile of cobble size rocks. There are similar "cairns" just over the break of slope to the coulee to the north of the subdivision area and these appear to be rock piles cleared by farmers. The cairns near the site are moderately well sodded in, but otherwise look similar to the farmer rock piles. We estimate that each of these features has more than 100 rocks. The third cairn west of the "tail" is a grouping of 10 to 14 small boulder and large cobble size rocks (depending upon what one includes in the count) that is approximately one meter outside the main body of the feature. These rocks appear to be in a single tier and are relatively well sodded in. The rocks are oriented northeast-southwest and the long axis is approximately 1 m while the short axis is about .5 m. The fourth cairn is a small grouping of small boulder and large cobble size rocks located in the head of the coulee south of the main feature. This grouping is irregularly shaped, consists of 12 to 18 rocks. (again depending upon what is included in the grouping) and appears to be a single tier. It is well sodded in and measures about 1 m x 1 m.

As noted above, 15 shovel tests were conducted in the general site area and 18 small diameter soil probes were completed. All shovel tests were negative,

although two tests north of the feature contained one recent glass shard each at between 0 and 10 cm b.s. These shards were from a green bottle(s). No stones or other indication of cultural activity were observed in the soil cores removed from the feature. No shovel tests were completed within the feature. One of the cairns to the north of the feature was tested with two shovel tests, one in the centre of the feature and one at the edge. The test in the middle of the feature revealed 4 tiers of stone, but no indication of any cultural activity was located in this test. This test went to 20 cm below the last layer of rocks and the subsurface was uniform and similar to the sediments in other shovel tests. The tests in this area again suggest to us that these features may be piles of rock deposited during rock clearing in the adjacent field.

The shovel tests in the site area and the soil probes revealed silt and silty clay with some fine sand from the surface to between 10 and 30 cm below the surface. Beneath this were variable layers of clay and gravelly silt to about 80 cm. Tests were terminated at about 80 cm. Soils in the area are Brown Chernozems, but at this site, horizons were somewhat difficult to detect.

We are of the opinion that three of the four previously identified cairns at the site are probably the result of rock clearing activity in the field to the west of this site. This conclusion is based on the presence of very similarly shaped rock piles to the north of this field and on the basis of similar rock piles adjacent to other areas of cultivation. The fourth cairn, noted above as being located just west of the central feature's "tail" may be related to the feature, but does not appear similar to those features we believe are former rock piles.

We cannot, on the basis of our examination and assessment of this site and more specifically the central feature of the site, provide an interpretation or confirm or deny that the feature is or was originally constructed as an animal effigy.

It does appear to us that this agglomeration of cobbles and small boulders represents a palimpsest. That is, some of the stones at the site are the result of

original cultural activity that has been obscured, altered and thus rendered less obvious by subsequent cultural activity. In other words, an original stone feature, most likely constructed by an aboriginal culture either in the Precontact or early Postcontact Period has been impacted and altered by the addition of rocks that may have deposited on the site by rock clearing activity in the cultivated field to the west. This conclusion is based on several lines of evidence. This evidence is essentially as follows: Many of the rocks making up the feature are well sodded in, have extensive lichen cover and form what appears to be a relatively well defined agglomeration of stones. The feature is located on prairie upland adjacent to the break of slope into the Oldman River valley, in a setting where surface stone features are commonly found. The majority of the surrounding area has been cultivated and otherwise disturbed by 20th century activity and so it is possible that other cultural stone features have long since been destroyed, so the lack of other features in the immediate area does not detract from interpretation of this feature as the product of First Nations cultural activity.

The feature is located on a small area of native prairie located between the heads of two coulee features at the edge of a cultivated field on west side and at the break of slope to the Oldman River valley on the east side. As such the feature was located in an area that would have been difficult to break and cultivate with typical early to mid century agricultural equipment. This, perhaps coupled with fact that a large agglomeration of stone at the site may have resulted in the decision to leave the area unbroken when the adjacent field was first broken for cereal grain farming. Near surface sediments in the area due tend to be rocky and rock removal from cultivated fields was a common practice. The small area occupied by the original feature would have been a logical and more or less natural place to deposit rocks removed by rock picking from the field. The presence of large cobbles on top of and more or less in the middle of a rock feature that seems to be composed more of smaller cobbles seems to support this inference. The other rock pile features in the site area and surrounding this field similarly support this inference.

Another issue of possible relevance to this feature and its current condition is the fact that many of the rocks that make up the feature are very deeply sodded in. However, fields to the west of the site have been cultivated for many years and summer fallow was a common practice in the area. The situation of fields being left with exposed sediment combined with the very strong westerly winds in the area result in rapid wind erosion and deposition. It is possible that recent aeolian deposited silts in this site area have buried the rocks more deeply than would be the case if the site was not immediately downwind from fields that over the years have been subject to significant wind effects.

From the outset of this HRIA, the focus was avoidance of this site and although the site area was subject to shovel testing, the central feature was not disturbed. It is possible that additional information could be gleaned from an excavation of the feature, but this would clearly be destructive and may not result in the accumulation of any more useful data.

The site is potentially significant and clearly warrants continued avoidance. We have met on site with the developer and discussed avoidance and protection of this site. Our recommendations as outlined below are based on the above conclusions and the general requirement to avoid and protect sites, as well discussions with Blair First Rider, Ryan Heavyhead and Narcisse Blood. Heavyhead and Blood are Blood Tribe members and are experts in traditional Blackfoot culture and have anthropological and archaeological training.

Recommendation

DjPf-128 is within the proposed development area. To minimize impact and ensure the site's preservation, it will be necessary to isolate the site from the surrounding development. On-site discussions were held to this effect with the developer and UMA engineer Corey Armfelt, after which the site area was staked (with a 4 to 5 m buffer around the site) to facilitate the erection of a temporary fence by the developer so it could be avoided during construction activity in the immediate area. The site should be protected by permanent barrier that would prevent inadvertent damage to the site and prevent the removal of stones that

compose the feature or other purposeful impacts to the site area such as vandalism. It is not our intention herein to provide specifics for protection of this site. Rather, we would prefer to allow the developer with advice and input from Alberta Tourism, Parks, Recreation and Culture and local First Nations to develop protective measures that will preserve the site, but will be sensitive to the site's potential significance and will be aesthetically pleasing. Additional discussions may be necessary to discuss how the site area may be incorporated into a possible walking trail system that may pass to the east of the site. We do not recommend the completion of any additional historical resource assessment at this site with respect to this development. Although, we are not recommending any additional archaeological work with respect to this development, if the City of Lethbridge carries out any improvements on City land to the east of this site (for example, development of walking trails), that work should be preceded by a historical resources impact assessment due to the proximity of this site to potential recreation areas east of this subdivision.

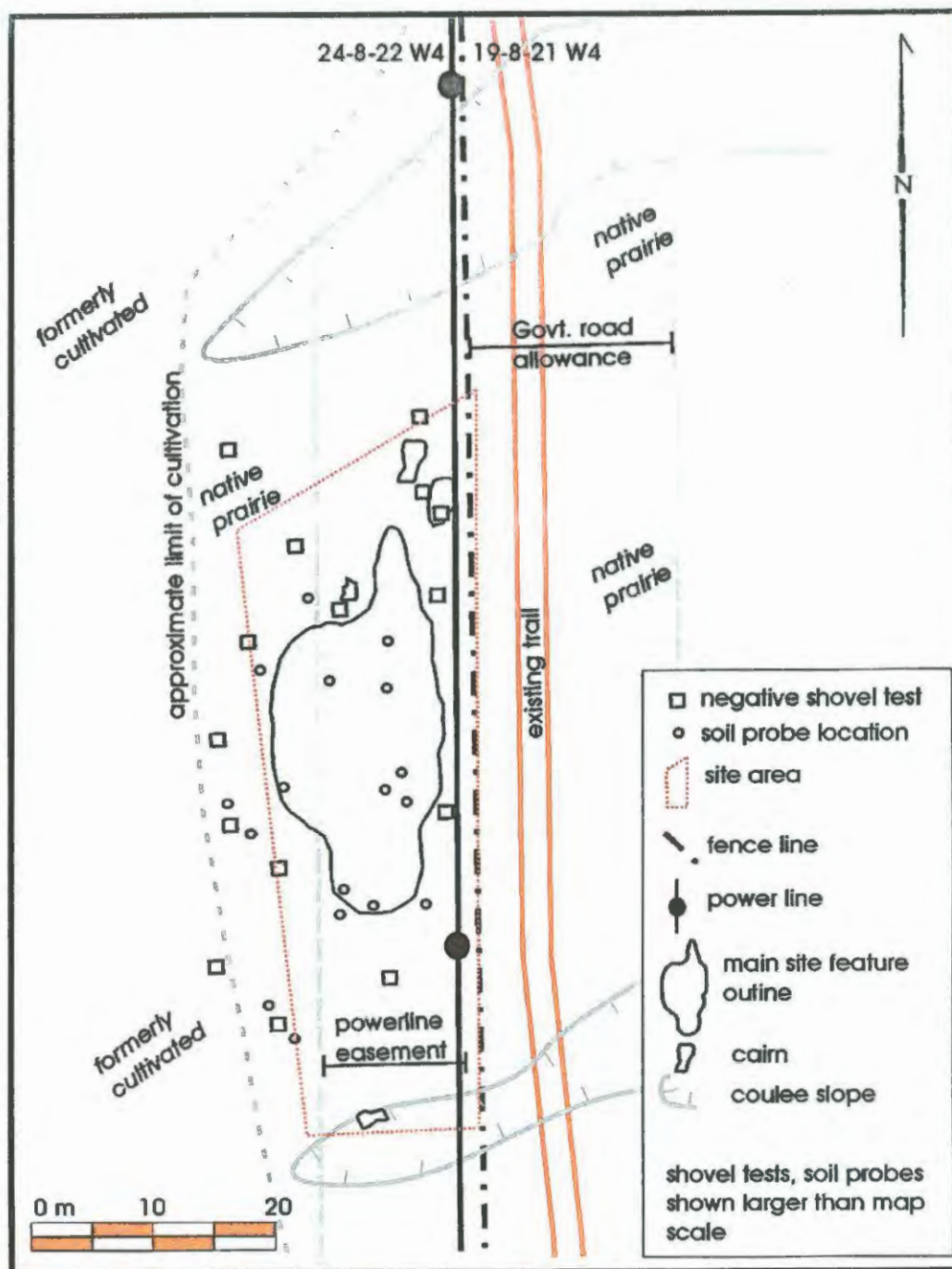


Figure 16. DjPf-128 site map showing test locations.

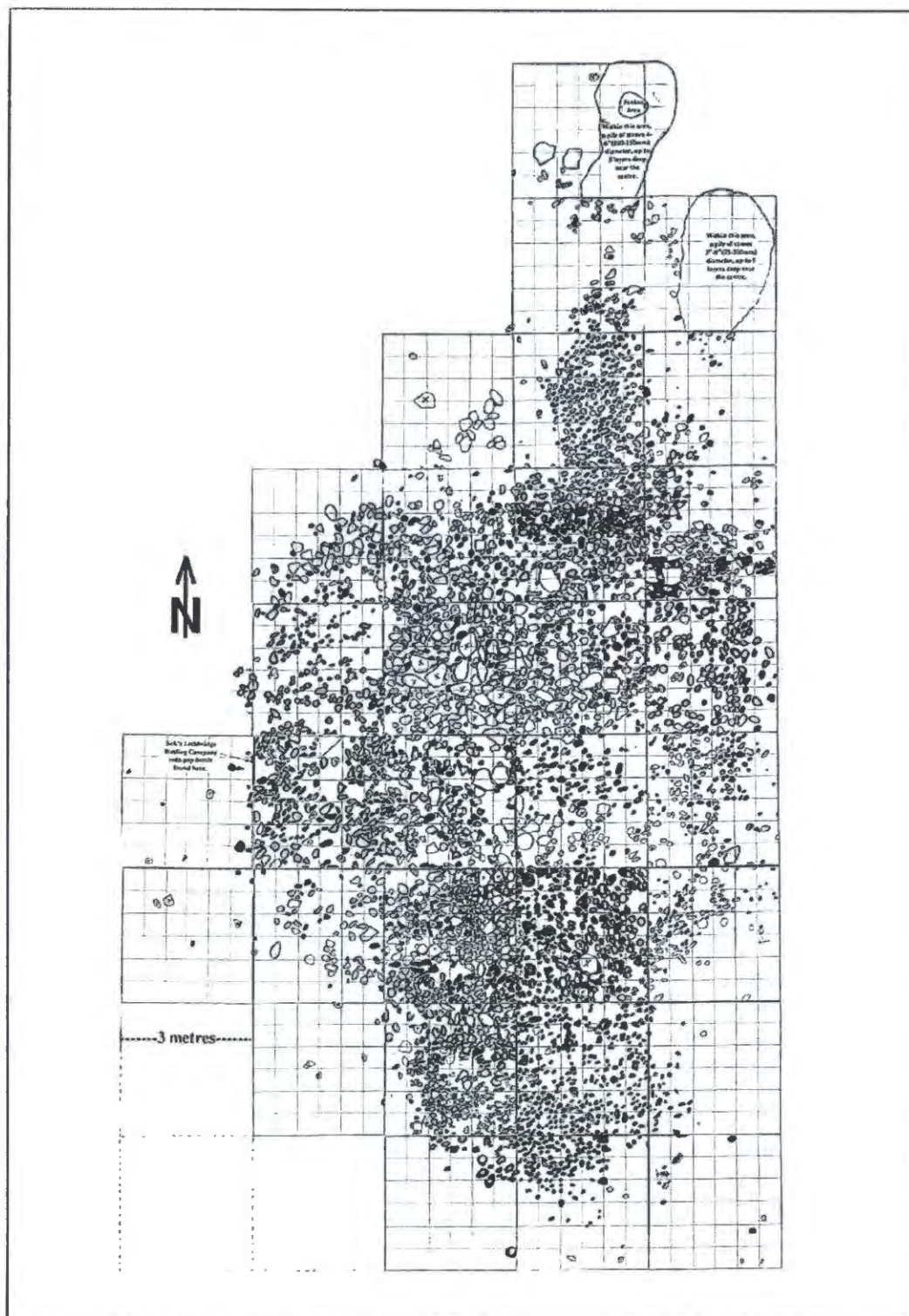


Figure 17. DjPf-128: Map of feature produced by Archaeological Society of Alberta (ASA 2000). Note scale shown on this illustration.



Figure 18. DjPf-128: View north of site area. See Figure 29 for view shed for this and other photos of site area.



Figure 19. DjPf-128: Typical soil probe result showing transition to light coloured clay at ca. 17 cm B.S. Right end of soil sample = surface. No evidence of cultural disturbance or material was located in the small diameter soil probes.



Figure 22. Some of the small boulders located in the northern part of the central portion of the figure. Although these rocks look like they are partially buried in this photo, that is a function of the length of grass. They essentially are sitting on the surface.



Figure 23. View east toward the southern portion of the feature. This photo also illustrates the graded trail just east of the feature (which may have disturbed it) and the coulees and river valley.



Figure 24. View south of the DjPf 128 central feature. The coulee head in the photo just south of the power pole essentially defines the southern boundary of the site. Although most of feature is in this photo, due to grass cover, most rocks are not visible.



Figure 25. View north of the DjPf 128 feature. The coulee head in the photo defines the northern boundary of the site. The same rock is circled in this figure and in Figure 24 above. The trail visible in the background is located in formerly cultivated terrain.

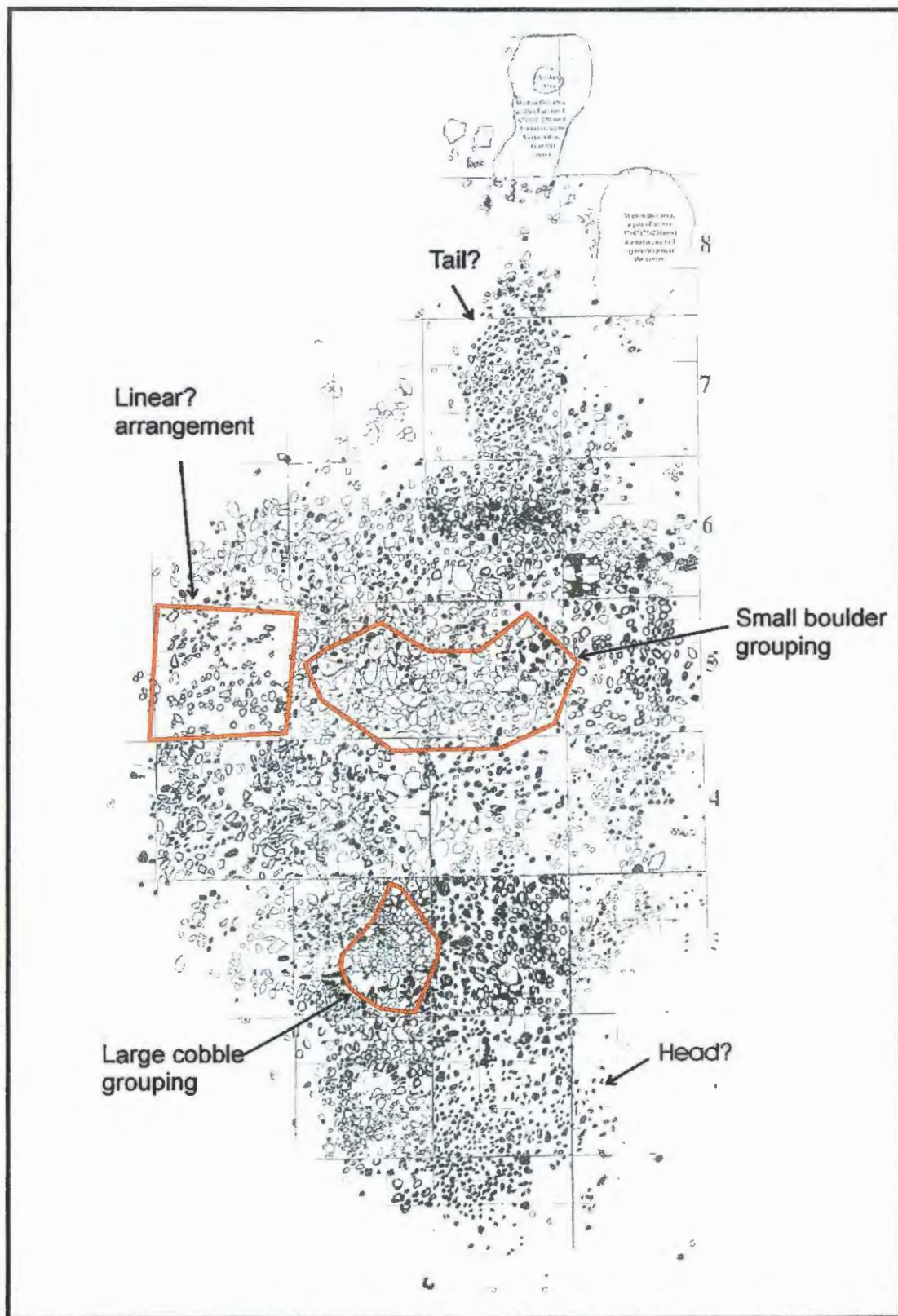


Figure 26. Central site feature showing some of the elements discussed above.

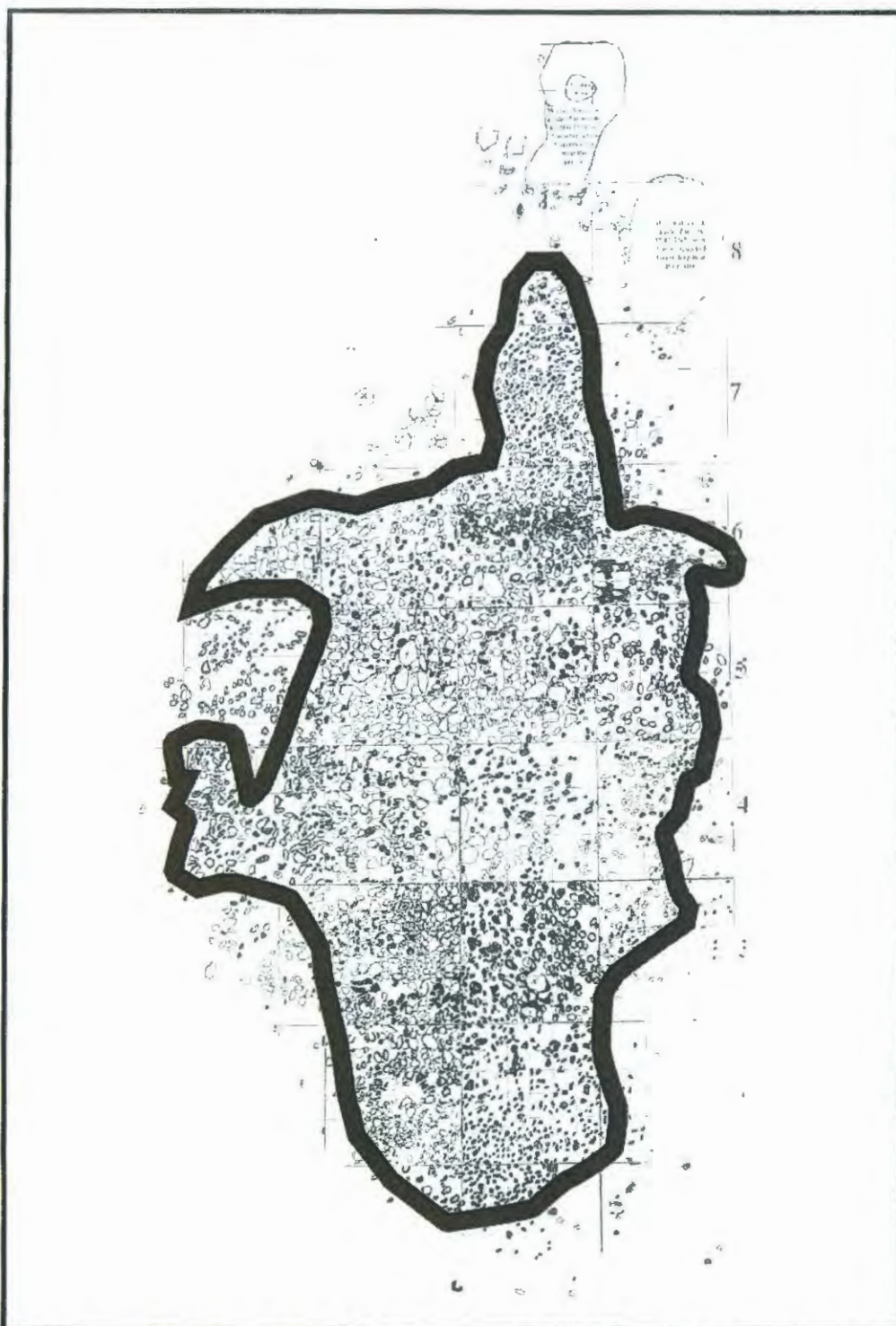


Figure 27. A possible outline of the feature. This illustration is not, in any sense, intended to be a supportable interpretation of the feature, it simply represents a very tentative outline of the feature if one attempts to eliminate possible noise. The outline is highly speculative. Interestingly however, it is possible that extensions of the central portion of the structure (appendages?) on its east side may have been destroyed by fence and road construction. Again this drawing is not intended to illustrate any actual, definitive outline of the original form of the feature.

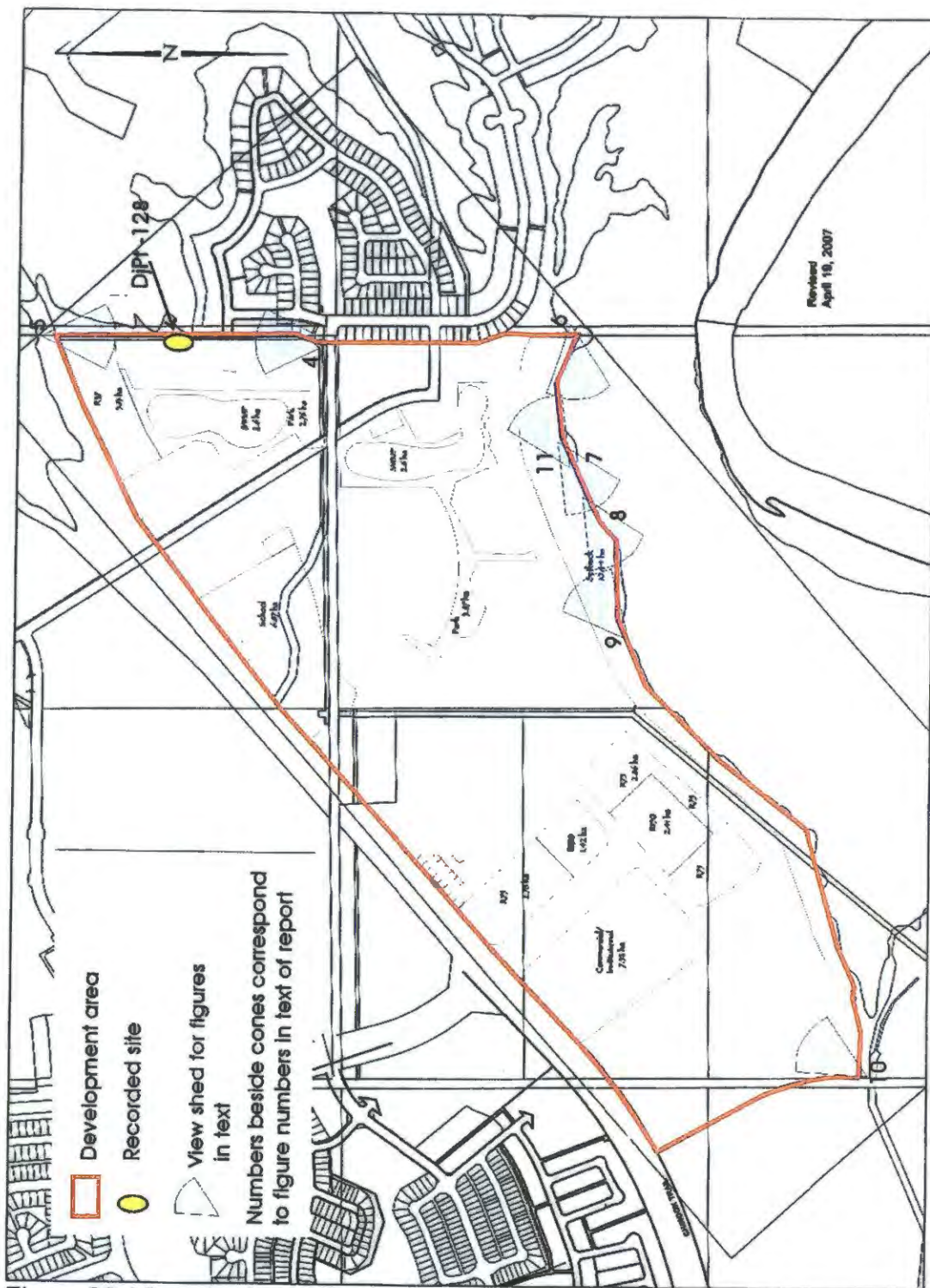


Figure 28. View shed map for photos of general development area. As noted in map, the numbers beside the blue cones represent the figures in the text of this report.

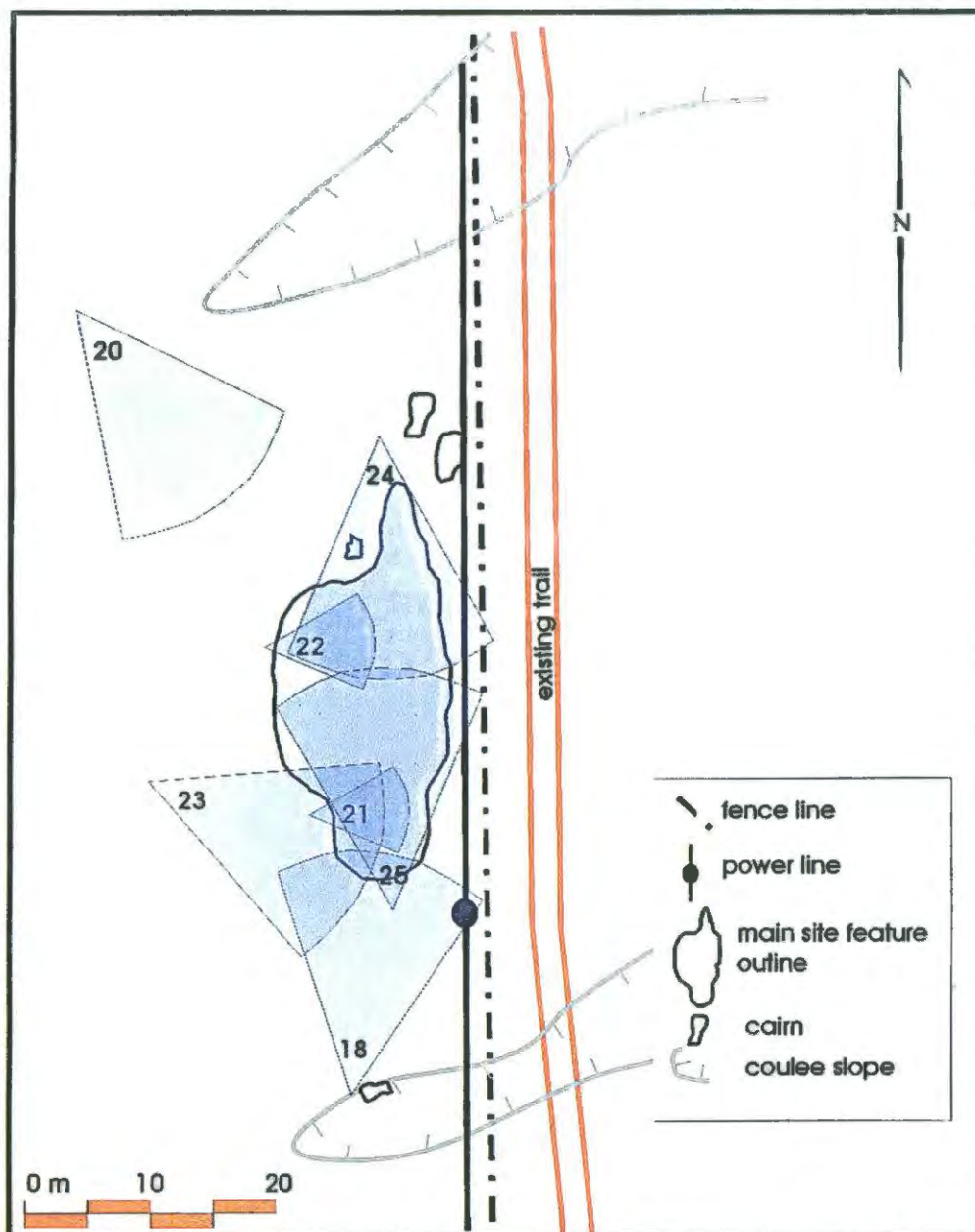


Figure 29. View shed map for photos of site area. Numbers in blue cones correspond to figures in the text of the report.

RECOMMENDATION SUMMARY AND CONCLUSION

We recommend that *Historical Resources Act* clearance be granted for this project. No additional archaeological, historical or palaeontological exploration or mitigation work is recommended or required within the areas to be impacted by the proposed project. We recommend the continued avoidance of DjPf-128 and the construction of suitable temporary and permanent barriers around the site area as it currently defined. The form and type of the permanent site protection should be determined in consultation with Alberta Tourism, Parks, Recreation and Culture and should consider the site's significance.

REFERENCES CITED

Archaeological Society of Alberta

- 2000 *Report of the June 4 & 5, 2000 mapping of the West Lethbridge Turtle Effigy, Borden Number PjDf -128 (sic)*. Archaeological Society of Alberta, Lethbridge Centre, Lethbridge, AB.

Agriculture Canada Expert Committee on Soil Survey

- 1987 *The Canadian System of Soil Classification*, 2nd ed., Research Branch, Agriculture Canada, Ottawa.

Beaty, C B.

- 1975 *The Landscapes of Southern Alberta, A Regional Geomorphology*, The University of Lethbridge Production Services, Lethbridge.

Brace, G. I.

- 2005 *Boulder Monuments of Saskatchewan*. Saskatchewan Archaeological Society, Saskatoon.

Bryan, L.

- 1991 *The Buffalo People*, The University of Alberta Press, Edmonton.

City of Lethbridge

- 2007 <http://www.lethbridge.ca/home/City+Hall/Departments/Parks+-+Pathways+-+Trails/Major+Parks/Popson+Park/Popson+Park+2.htm>

Ecological Stratification Working Group

- 1995 *A National Ecological Framework for Canada*. Agriculture and Agri-Food Canada, Research Branch, Centre for land and Biological Resources Research and Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch, Ottawa.

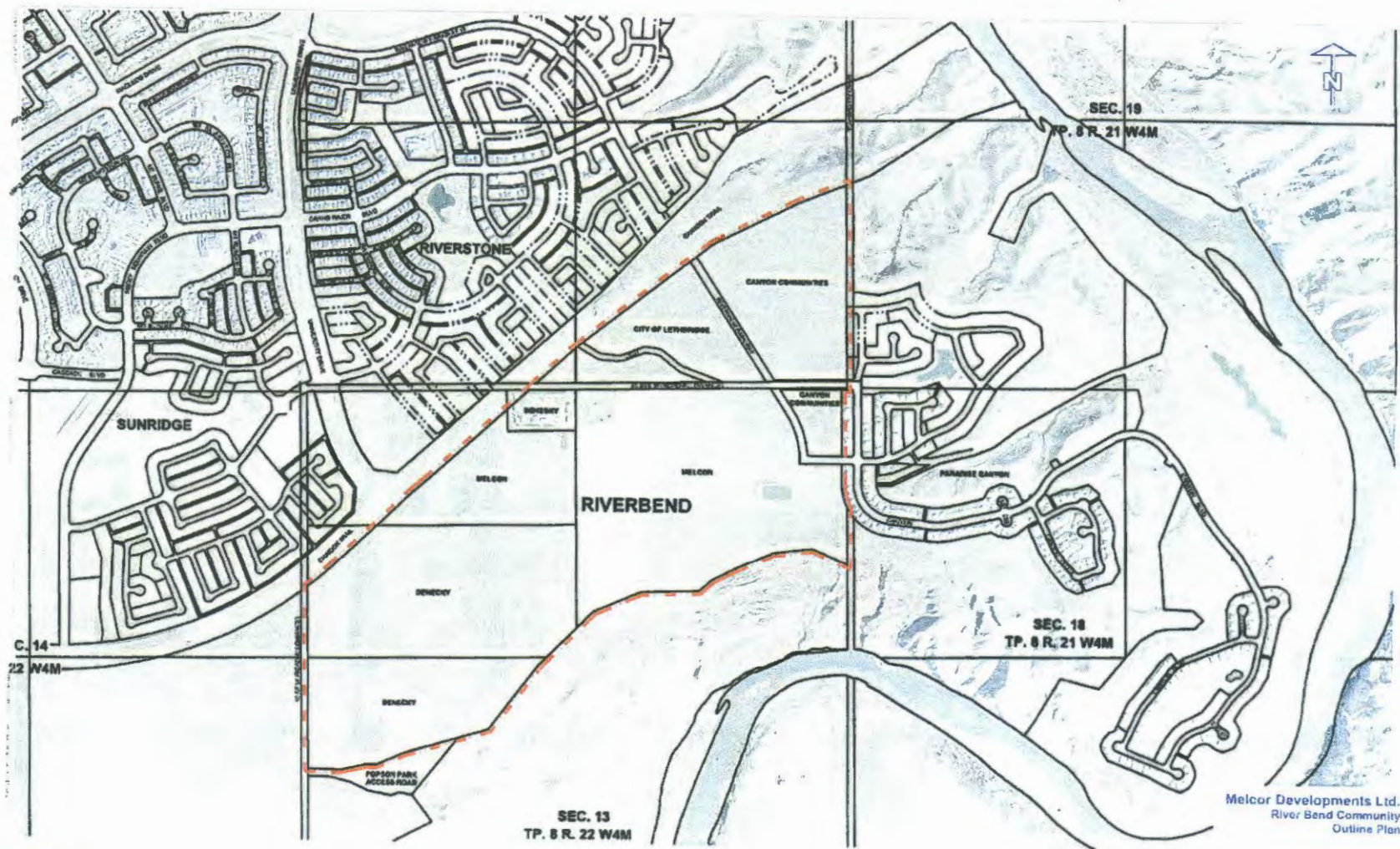
Kuijt, Job

- 1972 *Common Coulee Plants of Southern Alberta*. University of Lethbridge Production Services, Lethbridge.

West Lethbridge History Book Society

- 1982 *The Bend, A History of West Lethbridge*, West Lethbridge History Book Society, Lethbridge.

APPENDIX A-SUBDIVISION MAPS



Melcor Developments Ltd.
River Bend Community
Outline Plan

Figure 1

UMA



APPENDIX B- ARCHAEOLOGICAL SITE INVENTORY DATA FORM



Alberta Tourism, Parks, Recreation And Culture

Archaeological Survey
Royal Alberta Museum

Borden No. DjPf-128

Permit No. 07-198

ARCHAEOLOGICAL SITE INVENTORY DATA

Return to: Archaeological Inventory and Permit Coordinator Archaeological Survey, 8820-112 Street Edmonton, Alberta, T6G 2P8				Update/Revisit Date: 2007/06/21			
1. Site Name				2. Field Number			
3. Elevation 920 masl		4. NTS 1:50000 Map No. & Name 82H/10 Lethbridge					
5. UTM Grid Zone 12 U		Easting	366678	Northing	5502230		
			366741		5502010		
☒ NAD 83 ☒ NAD 27 GPS ☒ yes ☐ no							
6. Legal Description LSD: 1, 8 Section: 24 Twnshp: 8 Rge: 22 W of 4 M.							
7. Landowner ☐ Government of Canada ☐ Government of Alberta ☐ Municipal Government ☒ Freehold							
Owner: Melcor Developments, Lethbridge							
8. Access (Refer to highway, road number, trail, cardinal directions, landmarks, nearest settlement, distances)							
From the intersection of University Drive and 40 Avenue, go east for 1.6 km. turn north on Canyon Blvd. Park at the north end and walk up the power line right of way for 250 m. The site is just west of a fence line and partially within the power line right of way.							
9. Site Setting (Describe in terms of drainage, slope, aspect, vegetation, landforms)							
The site is on prairie upland on the west side of and overlooking the Oldman River valley. The heads of two significant west to east draining coulees essentially define the site's northern and southern boundaries. Local topography to the west is level and the river valley slope is located immediately to the east of the site. A formally cultivated field (now grass and to become a residential development) borders the west side of the site and the east side of the site is defined by a graded trail. The site itself is native vegetation and is mostly <i>Stipa</i> sp. short grasses. Some woody shrubs are present in coulees immediately to the east. The site is level and does not have a dominant aspect. Surface sediments include glacial lacustrine silts and ground moraine deposits. Surface cobbles are common in the area. Bedrock is exposed in river valley slopes east of the site. Most of the surrounding area has been disturbed by cultivation and urban development.							
10. Site Class		11. Sub Type					
☒ prehistoric ☐ indigenous historic ☐ historic ☐ contemporary ☐ undetermined		☒ surface ☐ subsurface ☐ underwater ☐ stratified ☐ undetermined					
		☒ single component ☐ multi component ☐ undetermined					
12. Site Type							
☐ isolated find ☐ scatter (<10) ☐ scatter (>10) ☐ campsite ☒ stone feature ☐ kill site							
☐ workshop ☐ quarry ☐ rock art ☐ burial ☐ palaeoenvironmental ☐ settlement							
☐ homestead ☐ farm ☐ ranch ☐ dwelling ☐ trading post ☐ police post							
☐ mine ☐ trail ☐ mission ☐ school ☐ urban ☐ ceremonial/religious							
☐ industrial ☐ transportation ☐ other							
13. Features (if possible)							
	stone circle		medicine wheels		pictographs		houses
4	cairns	1	effigy ?		petroglyphs		fences
	stone arc		hearths		depressions		cellars
	stone line		pits		structures		dumps
	drive lanes		mounds		cabins		other (specify)

14. Description (spatial extent, patterning, density, and variety of remains, diagnostics and exotic material, for historic archaeological sites provide details regarding site ownership, origins, function and context)

DjPf-128 has been previously described (Hanna - ASA permit 99-078) and the feature was mapped and described by the Archaeological Society of Alberta (Report of the June 4, 5 Mapping of the West Lethbridge Turtle Effigy, Archaeological Society of Alberta, Lethbridge Centre, 2000). The site's central element is an irregularly shaped agglomeration of cobbles to small boulder sized rocks. The feature has been referred to as a turtle effigy, however, the outline shape of the feature and possibly relatively recent disturbance related to rock clearing from the cultivated field to the west make any categorization or judgment of the original shape of the feature uncertain. Shovel tests and small diameter soil probes conducted under this HRIA did not result in the discovery of any cultural material below surface at the site. One fire broken rock fragment and a possible quartzite core fragment were located in the formerly cultivated field just west of the feature, but no cultural material was collected. When the ASA mapped the feature in 2000, they noted the presence of some recent material such as shotgun shells, glass and metal fragments, but no other cultural material. Four features classed originally as cairns, three north of feature and one south may be former rock piles based on their shape, the degree of sedimentation and the fact that shovel tests in and around them were devoid of any cultural material. (It should also be noted there are similar rock piles along the edge of a large coulee to the north, outside the HRIA impact area and these represent rock piles from clearing of the same cultivated field that lies to the west of this site.) A possible cairn is a small group of rocks located just outside of the somewhat arbitrary outline of the feature and in fact may be part of the feature or more recent disturbance. We have listed it as cairn herein, but are uncertain of the actual function/interpretation of this small group of rocks. Examination of the rocks composing the feature for differential patterns of lichen coverage, patination, burial and orientation suggest there has been some historic disturbance, likely due to the addition of rocks picked from the adjacent cultivated field just to the west, however our analysis of cobbles was rudimentary and should be regarded with caution.

15. Materials observed/collected (frequencies if possible)

Observed / Collected		Observed / Collected		Observed / Collected	
		projectile points		faunal remains	
		lithic tools		human remains	
1	0	lithic debitage		floral remains	
		bone tools		tephra	
		ceramics		soil samples	
1	0	fire broken rock		macrofossils	
		charcoal		wood	

16. Collection remarks (formed tools, raw materials)

n/a

17. Collection repository ☐ Royal Alberta Museum ☐ Archaeological Survey ☐ Private collection ☐ Other

Dispositions File No.

18. Photos/Images ☒ yes ☐ no Repository: Arrow Archaeology Limited

19. Culture ☐ Early Prehistoric ☐ Late Prehistoric ☐ Historic ☐ Other _____
☐ Middle Prehistoric ☐ Fur Trade/Contact ☒ Undetermined

Cultural Affiliation

unknown

20. Calendar date (A. D./B. C.)

21. Radiocarbon ages

22. Estimated Dimensions N-S 50 m NE-SW 20 m Depth 0 cm

23. Means of estimating dimensions ☒ surface inspections ☒ Other 15 No. of shovel tests

☐ erosion exposure 0 No. of backhoe tests

24. Estimated portion intact: Because of the adjacent cultivation, we cannot estimate this with any certainty

25. Disturbance factors (natural, human, current, potential)

Will current development impact site ☒ yes ☐ no ☐ unknown

Type of disturbance:

☐ agriculture ☐ road/highway ☐ coal mine ☐ transmission line ☐ industrial area ☐ other
☐ pipeline ☐ gravel/sand pit ☐ oil sands ☐ reservoir ☐ vandalism
☐ well site ☒ residential ☐ forestry ☐ recreation ☐ erosion

Disturbance factor remarks

The site area will be protected by a fence that is to be erected around the feature and the site area will not be directly impacted by development related to the residential subdivision, however the site will be in a developed urban area, necessitating the erection of a protective barrier. Although, it will not be directly disturbed, the area is subject to urban development and so may be indirectly impacted in terms of site context and setting. See comments below.

26. Researcher/Permit Holder: Cynthia Temoir

Date (Y/M/D) 2007/06/06

27. Observed by: Don Boras, Cynthia Temoir

Date (Y/M/D) 2007/06/11

28. Surface collected by:

Date (Y/M/D)

29. Tested/assessed by: Don Boras, Neil Mirau, Jim McMurchy

Date (Y/M/D) 2007/06/11

30. Form completed by: Don Boras

Date (Y/M/D) 2007/08/20

32. Project Name/Report Title: River Bend Community Residential Subdivision, West Lethbridge

33. Site Significance/Recommendations ☒ no additional investigation required (specify below)

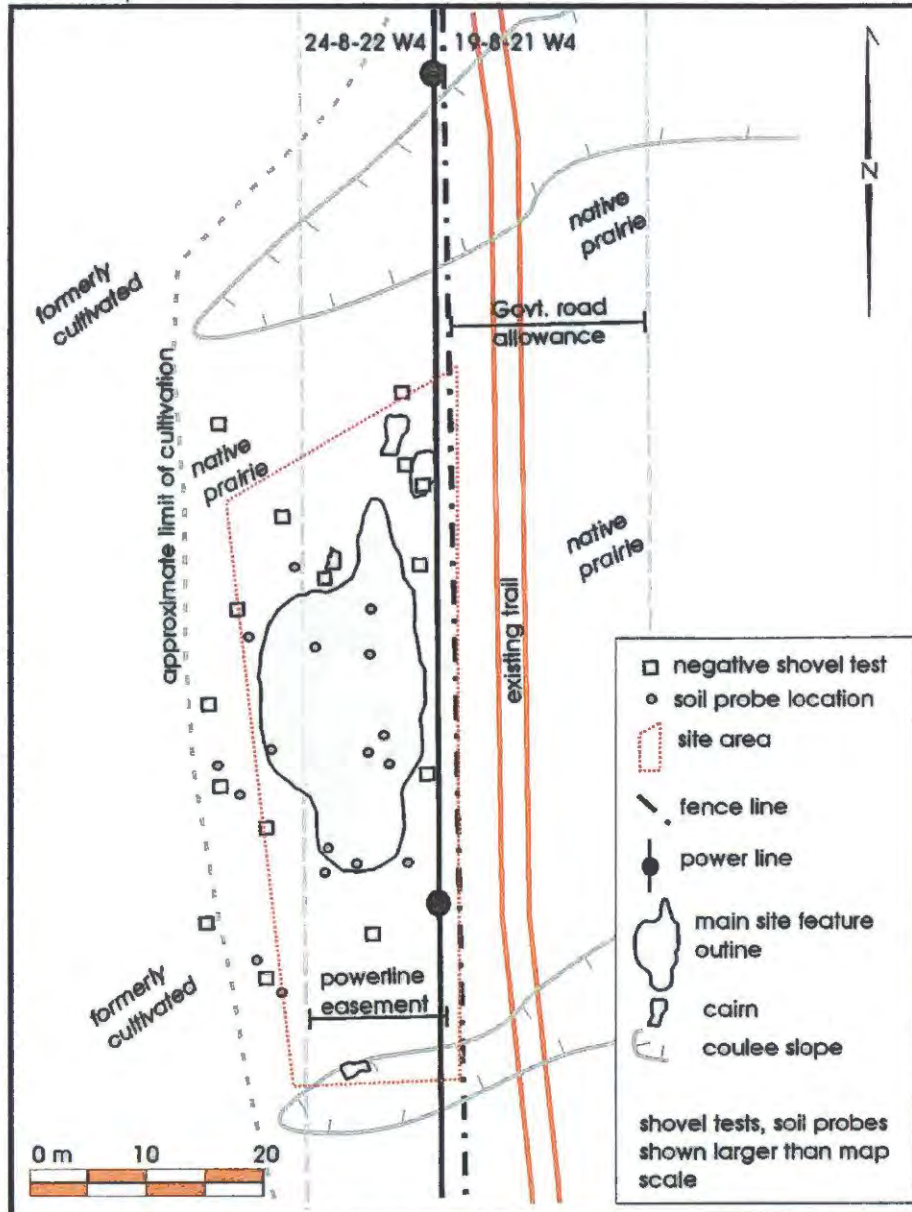
☐ additional investigation required (specify below)

The site area will be avoided by the proposed subdivision and a plan has been proposed to fence off the feature so that it won't be disturbed by development or other impacts after development of the subdivision. We are not recommending any additional work with respect to this proposed project, however see comments below.

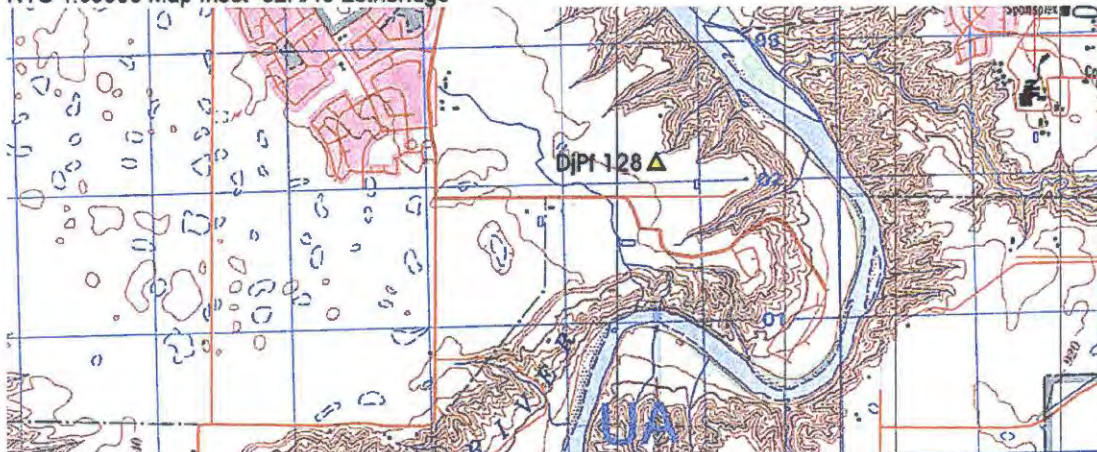
34. Additional remarks

No subsurface materials or any other significant artifacts were found at this site during this HRIA. A significant number of shovel tests were placed around the feature and one of the cairns at the north end of the site was tested. In addition, small diameter soil probes were placed inside the feature to search for any indication of buried material or layers that may have indicated past cultural activity. Although this feature has been called a turtle, the form of feature is equivocal. It appears that the feature is a palimpsest of activity and it may be partially the remains of a feature constructed by a past culture, but it does appear that rocks have been deposited on and near the feature since it was first constructed, obscuring its original form. The feature is at the edge of a cultivated field and this field was subject to rock picking. It is our opinion that a significant percentage of the rocks present at this site are from the cultivated field to the west. We cannot, on the basis of our examination of this site, refer to the feature conclusively as an effigy or infer any other function or classification for this site. The site does appear to have a surface rock feature of some antiquity, however, that is as much as we can state with respect to this site. The features referred to as cairns are almost certainly from rock picking from nearby fields.

35. Site map



NTS 1:50000 Map Inset 82H/10 Lethbridge



5. Riverbend Habitat Compensation Strategy

Prior to development and implementation on the south boundary of the Canyons, it is recommended that the City of Lethbridge, Province of Alberta and Melcor Developments Ltd. review and confirm the Habitat Compensation Strategy.

RiverBend Outline Plan Habitat Compensation Strategy

June 26, 2007

Project Description

The City of Lethbridge enabled residential development of the lands described as the RiverBend Outline Plan area (draft) by adopting the Mountain Heights/RiverStone /RiverBend Area Structure Plan, Bylaw No. 4977 (ASP) in 1999. Within this ASP, direction is given regarding the land uses, transportation, utilities and anticipated sequence of development for the majority of southwest Lethbridge. Recently, Melcor Developments Ltd. has begun the process of initial planning and engineering for the site and in doing so, the existence of a rattlesnake hibernaculum has been brought to the attention of the Developer, not identified in the enabling ASP.

In working with Alberta's Ministry of Sustainable Resources Development and expert stakeholders, UMA Engineering Ltd. on behalf of Melcor Developments Ltd. is proposing to create 11.1 hectares of prairie ecosystem to ensure the continued existence of quality habitat and wildlife species. Melcor is requesting Alberta's Ministry of Sustainable Resources Development consider and accept the mitigation strategy proposed which includes the 11.1 hectares of re-habilitated prairie. (See attached Figure 1, Rattlesnake Den Scope Setback.) The proposed setback would fall along the geotechnical setback line as determined by EBA engineering. Ultimately, this proposal suggests trading 2.87 hectares of what would be a portion of the 200 metre setback area for 11.1 hectares of naturalized habitat.

Mitigation Plan Development

Numerous meetings have been held between Melcor, UMA, Alberta's Sustainable Resource Development, the City of Lethbridge and other expert stakeholders to develop an understanding of each party's interests. This mitigation plan includes elements of ecological enhancement and an education program garnered from the aforementioned stakeholders during the initial meetings.

Mitigation Program Elements

- The entire geotechnical setback area (11.1 ha) will be provided as Environmental Reserve and enhanced as per the **Planting and Construction Works** discussed below to facilitate an increase in wildlife habitat.
- The construction of a fence separating the Environmental Reserve area from the future neighbourhood would be constructed to a level where conveyance of rattlesnakes, into the neighbourhood would be impossible. Further the fence would be wrapped on either end of the development to the crest of the coulee to prevent snake migration into Paradise Canyon and onto the roadway to Popson Park.
- Rattlesnake rookeries as indicated by Figure 2 would be constructed along the length of the environmental reserve area, enhanced with rock piles and shrub trees as key ecological features. These rookeries would be developed at approximately 100m intervals.
- Increased ecological complexity due to the construction of rock and log debris piles for small mammals and reptile lodging/rearing would also occur. Four sites along the length of the coulee area would be developed for this purpose.
- Prominent signage and an education program to inform residents of the benefit and requirement to keep the setback area naturalized will be included at the viewing areas and at key locations along pedestrian corridors of the development. Through the expertise and resources at the Helen Schuler Coulee Centre appropriate signage will be championed between the City of Lethbridge and Alberta's Ministry of Sustainable Resources Development.

Planting and Construction Works

- Native wild flora species reintroduced into the agricultural area would consist of native grass species such as western wheatgrass, northern wheatgrass, blue gramma and sheep fescue
- Shrubs planted will include sage brush and skunk brush depending on availability
- Three or four elevated viewing boardwalks will be constructed extending out into the Environmental Reserve area for the purposes of providing residences with viewing locations and pedestrian destinations. These boardwalks would be elevated and constructed sufficiently enough to prevent snake-human interaction.
- The rookeries would be constructed using weeping tile as the material to create the tunnel/den required to provide habitat for rattlesnakes.
- The emergency access nearest the hibernaculum will be designed to allow for foot access to the hibernaculum site for the purposes of releasing captured snakes from other areas within the City where relocation is required.

Benefits to the Mitigation Plan

- No rookeries currently exist in the cultivated area which is the predominant land use in the setback area. Subsequent to this construction, 16 rookeries would provide shelter and security for small animals and reptiles including rattlesnakes.
- Native flora species would be reintroduced along the length of the environmental reserve area.
- By planting native grass and shrub species to instigate rehabilitation, the City of Lethbridge would not have any maintenance costs for grass cutting, also no trail maintenance or City funded landscaping for an area totaling 11.1 hectares.
- By wrapping the fence around each end of the environmental reserve area, snakes will be directed back to the coulees, away from human conflicts in Paradise Canyon and mortality dangers from crossing the road to Popson Park.
- Foraging and habitat quality is currently poor in the cultivated area, enhancing the ecological value for wildlife will be of significant benefit for all species.
- By having the proposed boardwalks as the focal point for the education program, residents and other users will be able to enjoy the dramatic views of the area provides, while learning the importance of keeping natural areas preserved even when adjacent to the built environment.
- The signage program will focus on educating users on all endemic species and specify the importance of not disturbing or walking/biking through the area due to the existence of the rattlesnake hibernaculum.

Summation

The above strategy was reviewed June 26, 2007 with representatives from Alberta's Sustainable Resources Development, Melcor Development Ltd., expert stakeholders and UMA Engineering Ltd. At this meeting the Habitat Enhancement Compensation Area indicated on the Rattlesnake Den Scope Setback map was accepted as per the mitigation plan discussed above.

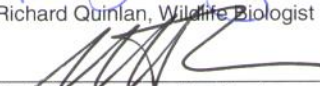
Signatories

Sustainable Resources Development:

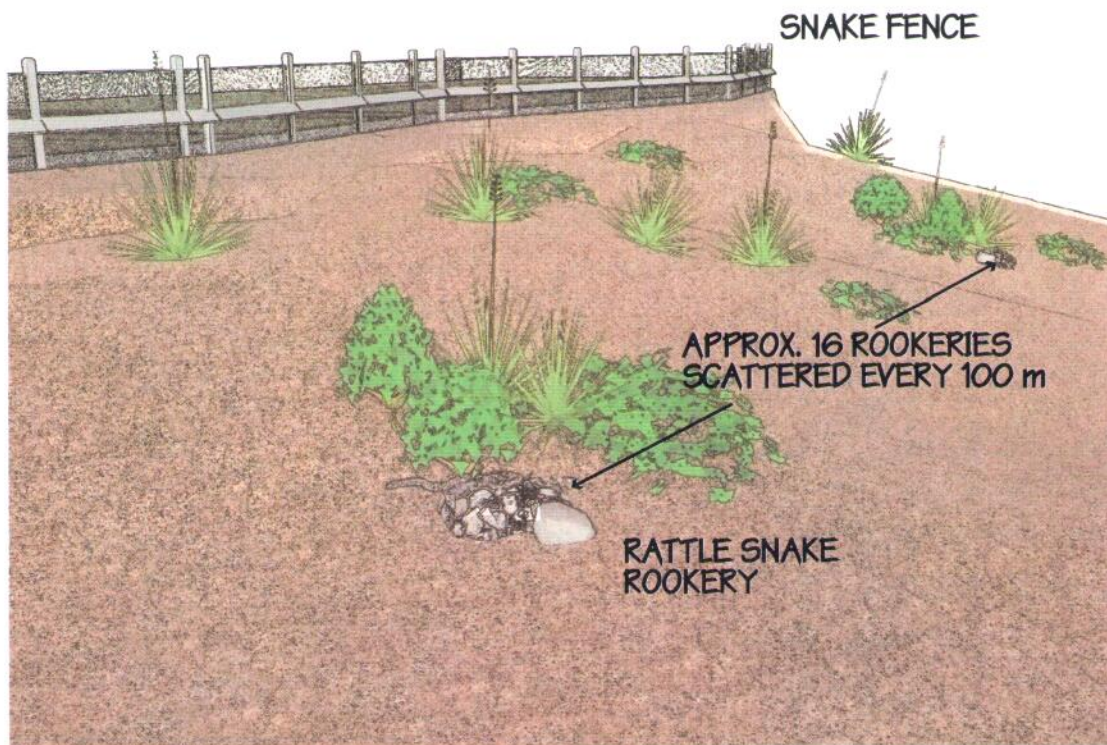

Richard Quinlan, Wildlife Biologist

Date: 28 June/07

Melcor:

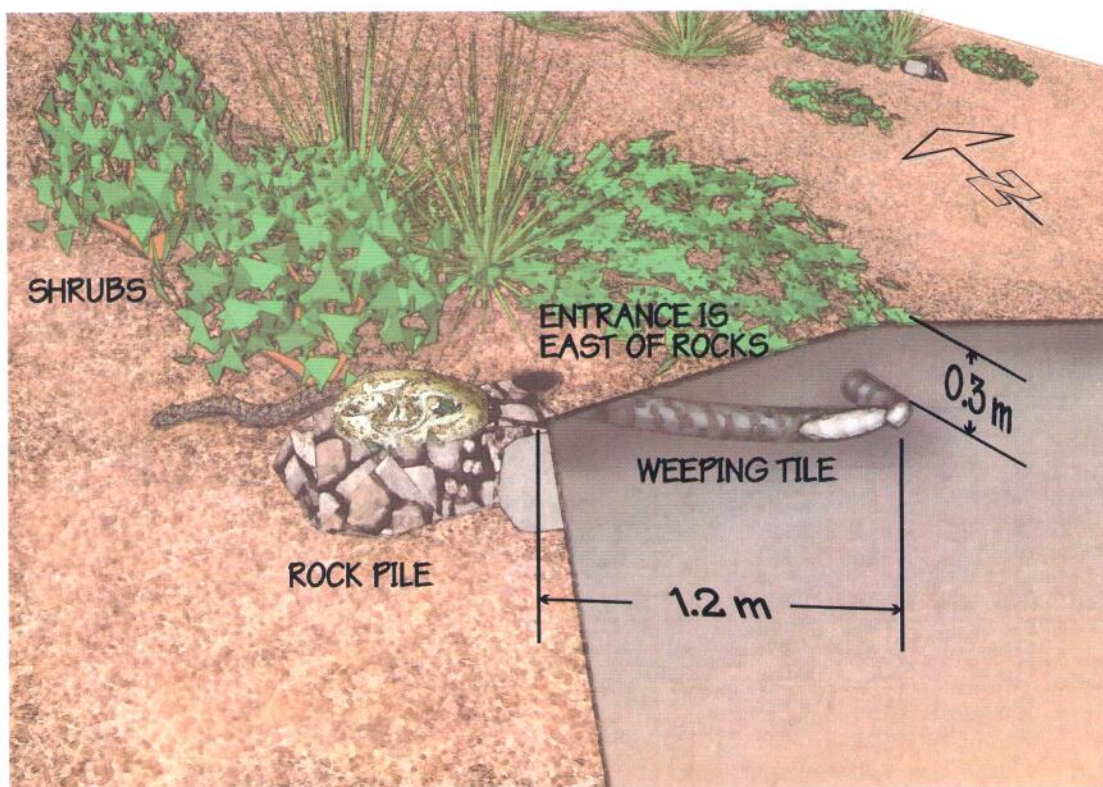

Neil Johnson, Vice President

Date: 28/06/07



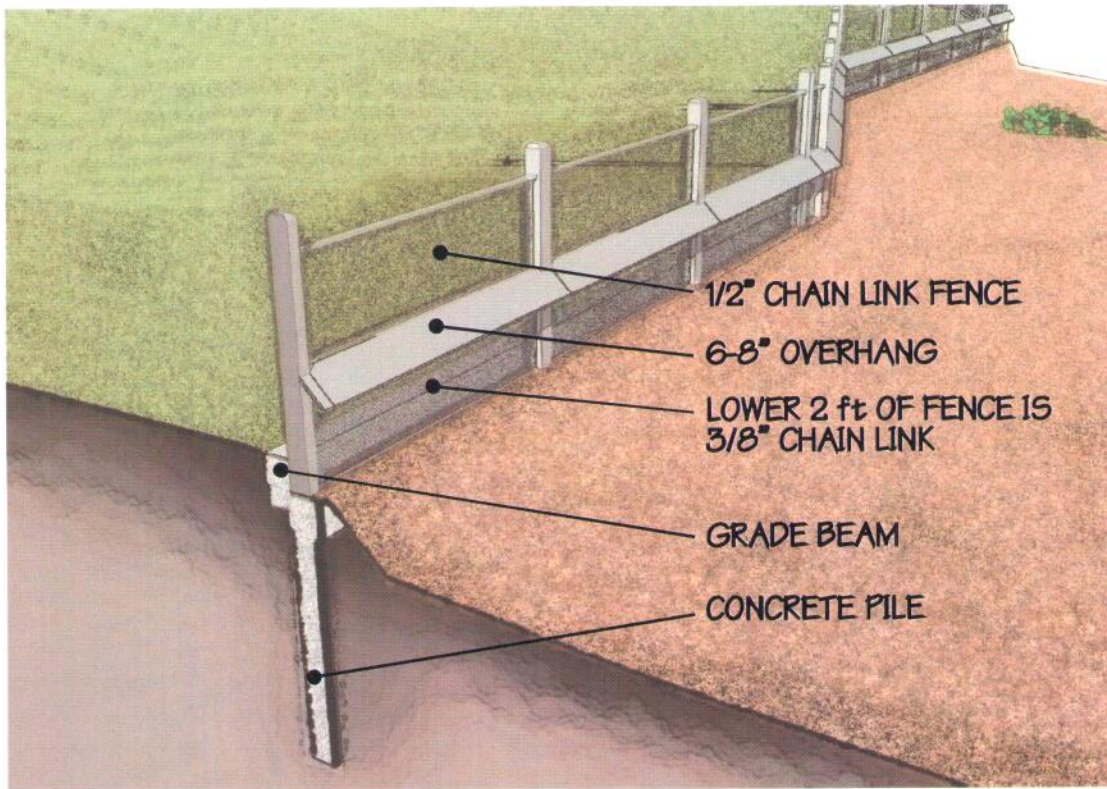
RATTLE SNAKE COLONY

FIGURE 1.0



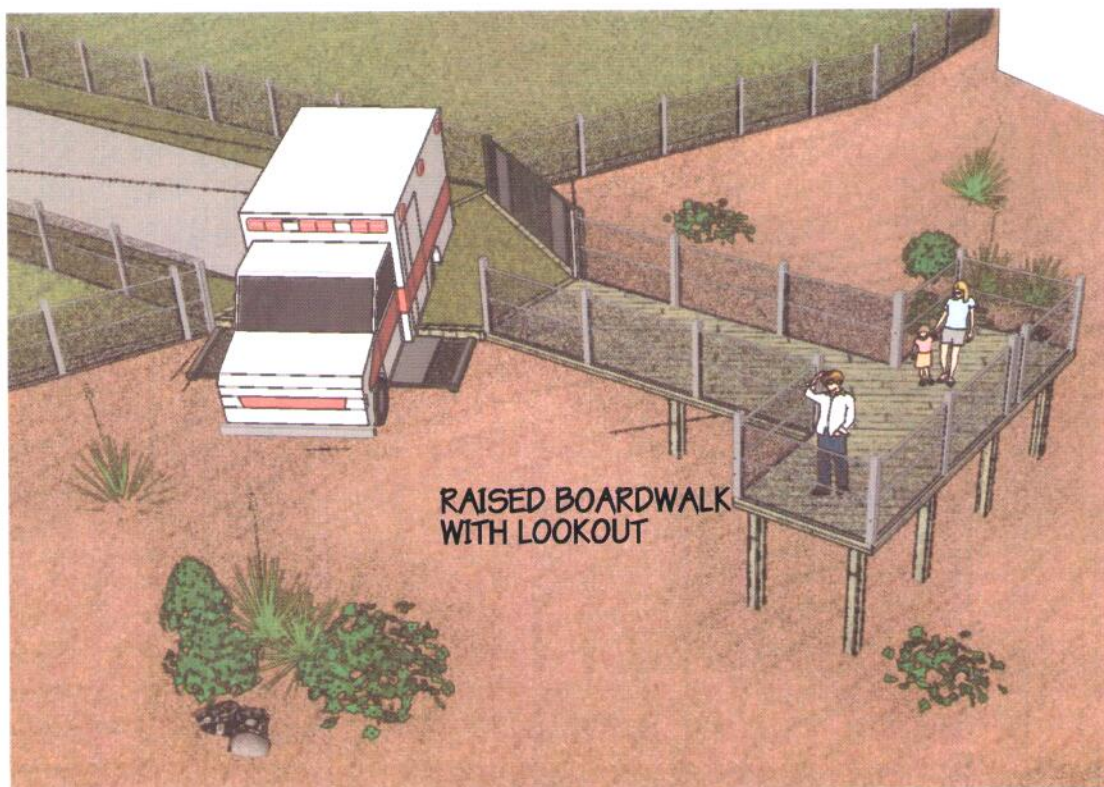
ROOKERY SITE CONCEPT

FIGURE 2.0



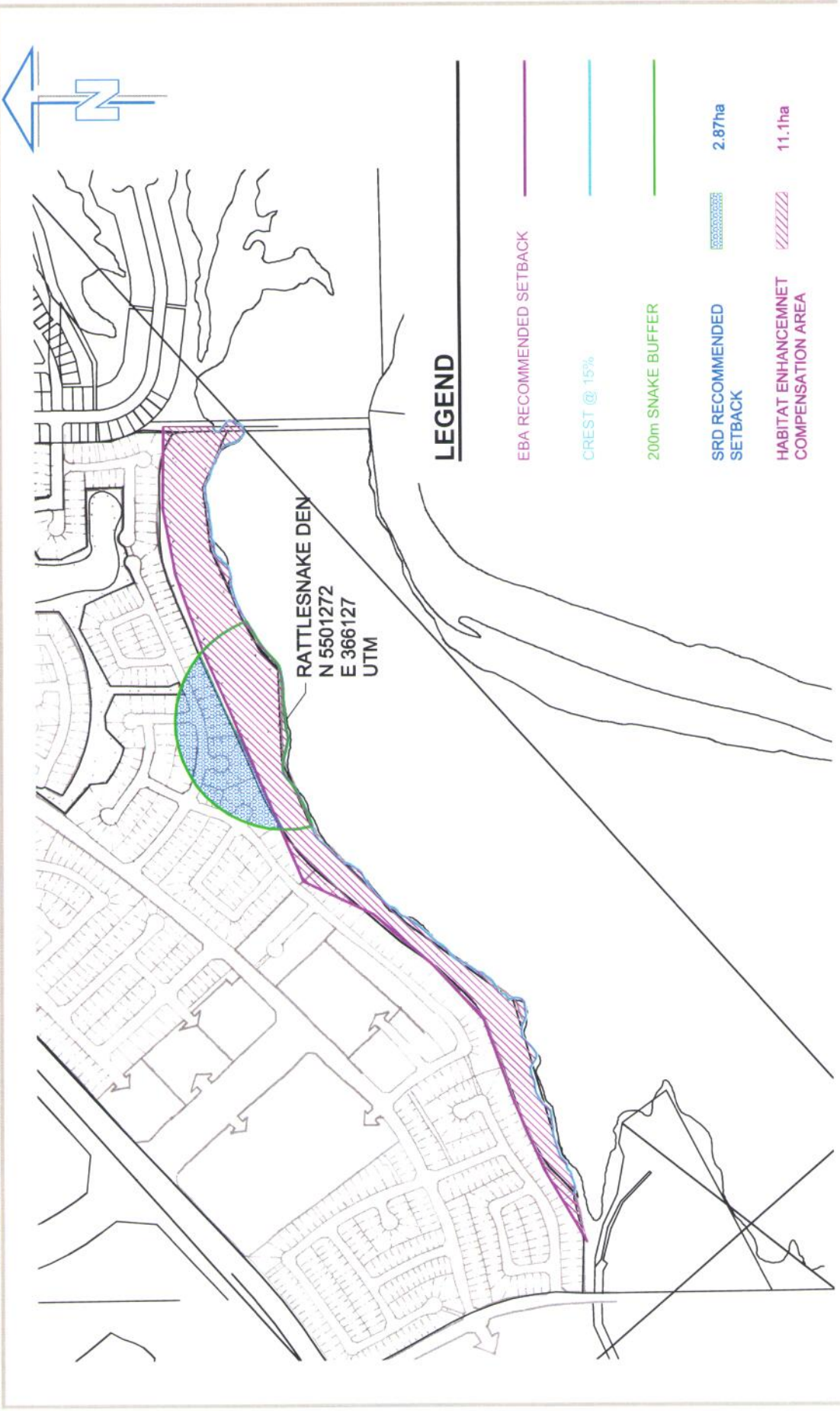
SNAKE FENCE

FIGURE 3.0



EMERGENCY ACCESS

FIGURE 4.0



SITE PLAN



6. Stormwater Pond Report

**Melcor Developments Ltd.
The Canyons - Stormwater Pond Report (Revision C)**

Prepared by:

AECOM Canada Ltd.

2540 Kensington Road NW, Calgary, AB, Canada T2N 3S3
T 403.270.9200 F 403.270.0399 www.aecom.com

Project Number:

1560-245-00

Report Number:

RPT-127-07

Date:

August 11, 2009

Statement of Qualifications and Limitations

The attached Report (the "Report") has been prepared by AECOM Canada Ltd. ("Consultant") for the benefit of the client ("Client") in accordance with the agreement between Consultant and Client, including the scope of work detailed therein (the "Agreement").

The information, data, recommendations and conclusions contained in the Report:

- are subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the "Limitations")
- represent Consultant's professional judgement in light of the Limitations and industry standards for the preparation of similar reports
- may be based on information provided to Consultant which has not been independently verified
- have not been updated since the date of issuance of the Report and their accuracy is limited to the time period and circumstances in which they were collected, processed, made or issued
- must be read as a whole and sections thereof should not be read out of such context
- were prepared for the specific purposes described in the Report and the Agreement
- in the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time

Unless expressly stated to the contrary in the Report or the Agreement, Consultant:

- shall not be responsible for any events or circumstances that may have occurred since the date on which the Report was prepared or for any inaccuracies contained in information that was provided to Consultant
- agrees that the Report represents its professional judgement as described above for the specific purpose described in the Report and the Agreement, but Consultant makes no other representations with respect to the Report or any part thereof
- in the case of subsurface, environmental or geotechnical conditions, is not responsible for variability in such conditions geographically or over time

The Report is to be treated as confidential and may not be used or relied upon by third parties, except:

- as agreed by Consultant and Client
- as required by-law
- for use by governmental reviewing agencies

Any use of this Report is subject to this Statement of Qualifications and Limitations. Any damages arising from improper use of the Report or parts thereof shall be borne by the party making such use.

This Statement of Qualifications and Limitations is attached to and forms part of the Report.

AECOM
2540 Kensington Road NW, Calgary, AB, Canada T2N 3S3
T 403.270.9200 F 403 270 0399 www.aecom.com

August 11, 2009

Project Number: 156J-245-00

Neil Johnson
Melcor Developments Ltd.
1425 33 Street North, 2nd Floor
Lethbridge, AB
T1H 5H2

Dear Neil:

Re: Stormwater Pond Report, The Canyons (Revision C)

Please find enclosed two (2) copies of the Stormwater Pond Report for the Canyons development.
Due to the updated Gate 3 outline plan, we have revised the storm pond report to reflect the changes.

If you have any questions regarding this report, please do not hesitate to contact the undersigned at
(403) 270-9119.

Sincerely,
AECOM Canada Ltd.



Gloria Bei, P.Eng.
Water Management Engineer
gloria.bei@aecom.com
GB:kr

cc: Trevor Loomer, AECOM

Revision Log

Revision #	Revised By	Date	Issue / Revision Description
A	Gloria Bai	October 23, 2007	Issued For Review
B	CE, BA, Bai	June 4, 2008	Issued with Revisions for Submittal
C	Gloria Bai	August 11, 2008	Issued with Revisions for Submittal

Signature Page

Report Prepared By:



Gloria Bei, P.Eng.
Water Management Engineer

Report Reviewed By:

Alan Newcombe, P.Eng.
Project Manager

Table of Contents

Statement of Qualifications and Limitations

Letter of Transmittal

	page
1. Introduction	1
2. Stormwater Management.....	2
2.1 General.....	2
2.2 Site Description.....	2
2.3 Biophysical Impact Assessment.....	2
2.4 Drainage Concept.....	2
2.5 Stormwater Management Design Parameters.....	3
2.5.1 Minor System.....	3
2.5.2 Major System.....	3
2.5.3 Computer Modelling.....	5
2.5.4 Design Storm.....	5
2.5.5 Continuous Simulation Modelling (QHM).....	6
2.6 The Stormwater Pond System.....	6
2.6.1 Introduction.....	6
2.6.2 Computer Model Results.....	8
2.6.2.1 Dry Pond A.....	8
2.6.2.2 Dry Pond B.....	9
2.6.2.3 Wet Pond C.....	9
2.6.2.4 Chinook Wet Ponds E and F.....	9
2.6.3 Modeling of Pond Sediment Removal.....	10
2.6.4 Removal of Floatables.....	11
2.6.5 Pond Design Summary.....	12
2.6.6 Pond Layout.....	18
2.6.7 Proposed Forebay / Ditch Sizing.....	19
2.6.8 Pond Utilization.....	20
2.6.9 Hydstat Statistical Analysis Results.....	23
2.6.10 Groundwater/Geotechnical Considerations.....	25
3. Summary of Conclusions and Recommendations	26
4. References	27

List of Tables

Table 1. Result of 1:5 y-4 hr storm event	3
Table 2. Allowable Velocity and Permissible Depths	4
Table 3. Sediment Removal Efficiency of the Forebay D.....	10

Table 4. Sediment Removal Efficiency of Pond C.....	11
Table 5. Sediment Removal Efficiency of Pond E & F	11
Table 6. Overall Sediment Removal Efficiency of Wet Ponds.....	11
Table 7. Dry Pond A - Design Summary	12
Table 8. Dry Pond B - Design Summary	13
Table 9. Forebay D - Design Summary	14
Table 10. Wet Pond C - Design Summary	15
Table 11. Wet Pond E and F - Design Summary	16
Table 12. Dry Pond A - System Properties.....	17
Table 13. Dry Pond B - System Properties.....	17
Table 14. Forebay D - System Properties	17
Table 15. Wet Pond C - System Properties.....	17
Table 16. Wet Pond E and F - System Properties	18
Table 17. Forebay D - Design Parameters.....	20
Table 18. Summary of Grass Ditch Flow Assessment.....	20
Table 19. Storage Utilization and Water Level Duration Analysis - Pond A.....	21
Table 20. Storage Utilization and Water Level Duration Analysis - Pond B.....	21
Table 21. Storage Utilization and Water Level Duration Analysis - Pond C.....	21
Table 22. Storage Utilization and Water Level Duration Analysis - Forebay D.....	22
Table 23. Storage Utilization and Water Level Duration Analysis - Pond E&F	23
Table 24. Hydstat Statistical Analysis Results - Pond A	23
Table 25. Hydstat Statistical Analysis Results - Pond B	24
Table 26. Hydstat Statistical Analysis Results - Pond C	24
Table 27. Hydstat Statistical Analysis Results - Forebay D	24
Table 28. Hydstat Statistical Analysis Results – Pond E&F	25

Appendices

- A. IDF Curve; 1:5 Year Storm Hyetograph, 4-hour; 1:100 Year Storm Hyetograph, 24-hour; Ponds A, B, C, E & F Rating Curve
- B. Table B-1: Subcatchment Parameters; Figure 11 - SWMHYMO SCHEMATIC; SWMHYMO Input; SWMHYMO Output; 1:5 Year 4 hour SWMHYMO Input; 1:5 Year 4 hour SWMHYMO Output
- C. Table C-1: Subcatchment Parameters; Figure 12 - QHM SCHEMATIC; QHM Input; QHM Output
- D. Hydstat Results
- E. Figure 1 Location Plan; Figure 2 Site Plan; Figure 3 Dry Pond A; Figure 4 Dry Pond B; Figure 5 Wet Pond C & Forebay D; Figure 6 Wet Pond E & Pond F; Figure 7 Pond Properties; Figure 8 Control Structure B, C, E&F; Figure 9 Orifice Details; Figure 10 Details

1. Introduction

This report covers the design of five stormwater management facilities (SWMFs) for the proposed residential subdivision of The Canyons, Lethbridge, Alberta. The facilities conform to Alberta Environment (AENV) guidelines. The south (pond C and its separate forebay D) and west facilities (pond E and F) are designed to manage both water quantity and quality; while the north facilities (pond A and B) are designed only to manage water quantity. The two ponds A and B discharge to an existing wet pond in Paradise Canyon subdivision, which has been designed to provide water quality enhancement for this area.

Figure 1 shows the location plan of the development. **Figure 2** shows the overall site plan and the boundary for the current phase of development.

The site has an area of 128.4 ha and is located within the following legal sections:

- SE ¼-24-8-22-W4M
- NE ¼-13-8-22-W4M
- NW ¼-13-8-22-W4M
- SW ¼-13-8-22-W4M

2. Stormwater Management

2.1 General

Melcor Development Ltd. has retained AECOM Canada Ltd. (AECOM) to conduct a stormwater analysis for the Canyons subdivision to propose SWMFs for the area. This report outlines the methodology used and the results obtained for the stormwater management plan.

2.2 Site Description

The site consists of 128.4 ha and is located in west Lethbridge. The site is bounded by Chinook Trail on the north and is adjacent to Paradise Canyon Phase 6 to the east, as defined in the "Upper Bench Stormwater Management" report which was completed by UMA in June 2003.

The natural contours indicate that the site splits into two portions. Most of the land generally slopes to the north and east toward the Oldman River at a surface gradient from 0.5% to approximately 1.1%. In the most western portion of the site, the topography begins to slope toward the west. The land is considered well drained due to the absence of any significant natural depressions retaining water.

2.3 Biophysical Impact Assessment

A Phase 1 environmental site assessment was conducted by EBA Engineering Consultants Ltd. in June 2007 prior to the Stormwater Management Plan for the Canyons. The report concluded that there are no environmental concerns affecting the site, and no requirement for further environmental investigation.

2.4 Drainage Concept

Urbanization of the existing undeveloped basin will result in an increase of both the rate and the volume of runoff in the watershed. A high percentage of impervious areas (buildings, roads, etc.) increases the volume of runoff and peak flows. Increase in peak flows also requires an introduction of effective drainage conveyance systems, such as underground storm sewers, streets and ditches.

Generally, an urban drainage system may be divided into two components, the minor system and the major system, which are often referred to as the "dual" drainage system.

Further to the "dual" drainage concept within the watershed, it is desirable to limit the allowable discharge rate from the drainage basin to the receiving water body. According to the Alberta Environment (AENV) Stormwater Management Guidelines, 1999, the post-development discharge rate should equal the pre-development rate. Also, Best Management Practice (BMP) should be incorporated in the drainage system to improve the quality of the storm effluent prior to discharging into adjacent streams. The BMP will be to current guidelines and standards at the time of development. The control of the stormwater quantity, as well as quality, is necessary in order to minimize the ecological changes downstream of the urbanized area.

2.5 Stormwater Management Design Parameters

2.5.1 Minor System

The City of Lethbridge uses the 1:5 year, 4-hour storm to design local storm mains and trunk mains. The Outline Plan Area was divided into subcatchments (See **Figure 2**). For each subcatchment, the area and imperviousness was determined. A SWMHYMO model (in Appendix B) was carried out to determine 1:5 year, 4 hour release rate for individual catchment.

Table 1 indicates a summary of model result.

Table 1. Result of 1:5 y-4 hr storm event

SubCatchment	Size (Ha)	Average Slope(%)	Imperviousness	1:5 Y- 4hr Peak Rate (m ³ /s)	Notes
1A	16.14	0.6%	52	1.519	Including hatched part
	0.91	0.8%	55	0.122	Hatched part only
1B	26.49	1.0%	52	2.274	Including hatched part
	0.88	0.6	55	0.118	Hatched part only
	3.2	1.0	65	0.527	Site D
3	6.59	1%	75	1.088	Site A
	4.53	1%	66	0.659	Site B
	5.55	1%	67	1.017	Site C
	15.93	0.6%	51	1.387	Remaining area
2A,2B	33.40	0.7	47	2.255	
4	11.12	0.8%	55	1.116	
5	1.92	2%	40	0.261	
6	0.83	0.6%	50	0.101	
7	1.10	0.6%	50	0.141	
8	0.59	2%	40	0.080	
9	1.02	0.6%	40	0.087	
Total	128.41		53		

2.5.2 Major System

According to the City of Lethbridge guidelines, it is necessary to detain the difference between the post- and pre-development runoff on-site. The design storm used for the major system is the 1:100 year 24-hour event (the hyetograph is shown in Appendix A).

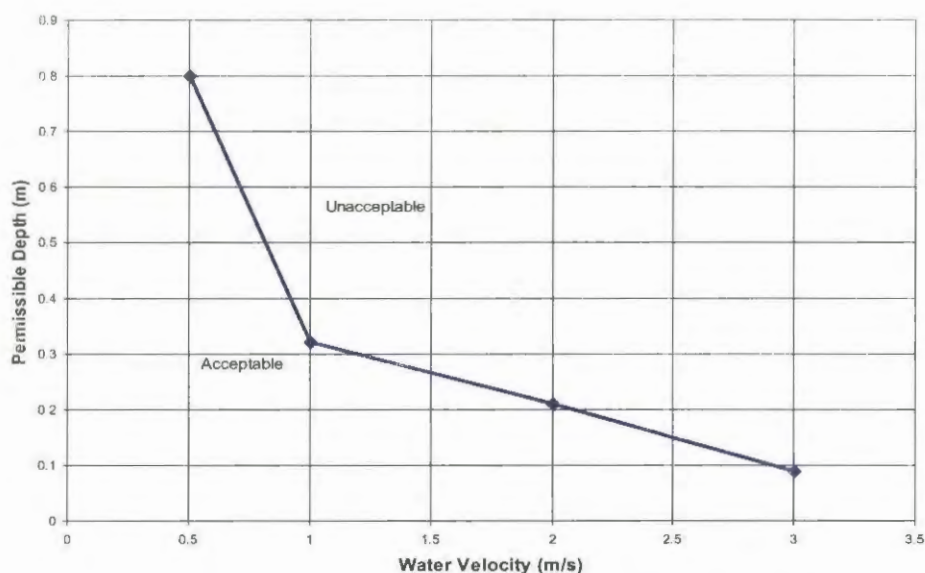
As stated in the Guidelines, the level of analysis and the effort to design facilities to transport major system flows must balance the relatively infrequent occurrence of such events and the seriousness of the damage they cause. Table 2 presents the allowable velocity and permissible depths as per the AENV Guidelines. A graphical representation of velocity and permissible depth is included on the following page.

Table 2. Allowable Velocity and Permissible Depths

Water Velocity (m/s)	Permissible Depth (m)
0.5	0.8
1.0	0.32
2.0	0.21
3.0	0.09

For roadways, the AENV Stormwater Management Guidelines state:

"... flow depths of no more than 0.30 m at the gutter are desirable. Standing water at low points should not exceed 0.50 m or extend to adjacent buildings. For arterial roads, the depths of flow should be less; typical criteria are that two lanes of traffic remain open and that the depth of flow be not greater than 0.05 m where major drainage flows across arterials. No buildings should be allowed in the area flooded by the major event unless they have been specially designed with flood proofing techniques to withstand flood water."



Graphical Representation of Velocity and Permissible Depth

2.5.3 Computer Modelling

The stormwater system must be designed to meet guidelines for both water quality and quantity. There are several computer programs used for this purpose. The SWMHYMO hydrologic/hydraulic computer model was used to analyze the drainage for the catchment area. SWMHYMO was used to simulate runoff from a single storm event. This single event will be either a historical event or a synthetic storm.

In accordance with the above, the 1:5 year and 1:100 year storms were modeled in this study. In accordance with the AENV Guidelines, and based on protection of receiving streams in terms of erosion and sedimentation, the 1:100 year, 24-hour storm was adopted in this study for design of the major system stormwater facilities.

SWMHYMO schematic (**Figure 11**), as well as the input/output results, are included in Appendix B.

2.5.4 Design Storm

A design storm can be either a historical storm, which is considered to be critical for a given area, or a statistically derived synthetic design storm based on an acceptable limit of liability for a given statistical return storm. Synthetic storms are intended to simulate real storms where existing rainfall data is not available. Without historical data, quite often the 1:100 year synthetic storm is used to determine the peak runoff of a major storm event.

The most commonly used synthetic method for developing design storms is the Chicago Method. This method distributes the rainfall indicated by an intensity-duration-frequency (IDF) curve of a selected recurrence frequency (i.e. 1:100 year storm).

The IDF data supplied by Atmospheric Environment Services for Lethbridge, included in Appendix A, was used to generate the Chicago design storm for this study. The 1:5 year, 4 hour and the 1:100 year, 24 hour design storm hyetographs are also included in Appendix A.

2.5.5 Continuous Simulation Modelling (QHM)

A QHM model for the area was also undertaken to confirm the sizing of all the ponds (see Appendix C). The model was run using 35 years of continuous historical rainfall data for the City of Lethbridge. For each year of the analysis, the model provides the maximum storage volume attained in the pond. A frequency analysis of the model results was undertaken using HYDSTAT to provide the 1:100 year storage volume requirements. The following are the distributions available in the HYDSTAT program:

- Normal
- Log-Normal
- Gumbel
- Log-Gumbel
- Pearson III
- Log- Pearson III
- Log-Normal III

2.6 The Stormwater Pond System

2.6.1 Introduction

Due to the discharge restrictions imposed upon the majority of urban development, it is often necessary to store excess stormwater runoff prior to discharge from the site. If the allowable discharge rate is reasonably high, for example around 50 L/s/ha to 70 L/s/ha, then it is possible to store much of the stormwater temporarily in the streets.

However, in areas with lower permissible release rates or areas of high impermeability, extra stormwater storage facilities will be required.

As outlined in the updated Gate 3 submission, five detention ponds are designed within the study area. Most of the runoff generated from the site can be served by these SWMFs. As described in 2.2, in the most western portion of the site, the topography begins to slope toward the west. This area (Area 4) of approximately 11.12 ha will drain to a future SWMF located further west. This SWMF will be constructed with the future development. A temporary dugout located west of site (currently undeveloped) will handle

runoff generated from this area as required. A computer model has been conducted to size the temporary dugout during a 1:100 year 24 hour storm event, and the result from the model indicates that approximate 9,500 m³ active storage is required to remove runoff through evaporation. The model is included in Appendix B.

Two areas will discharge to Coulee directly; a class 2 riprap will be used for bank protection while discharging to the coulee, as necessary:

- Area 8, located in the northeast, is mainly back lots of low density residential with an area of 0.59 ha and will overflow north with a peak rate of 0.17 m³/s during a 1:100 year 24 hour event;
- Area 5, located to the south, is mainly back lots of low density residential with an area of 1.92 ha and will sheet flow towards the south with a peak rate of 0.548 m³/s during a 1:100 year 24 hour event;

The following provides a summary of each SWMF. The ponds are depicted on **Figure 2**. The allowable release rates from individual ponds are determined by the capacity of downstream storm trunks, as described in Revised Gate 3 submission which was approved by City of Lethbridge in July 2009.

Dry Pond A:

- Located at the school site;
- Designed as an internal pond to attenuate the storm runoff generated from Area 1A;
- Water level to be controlled by an outlet control structure at the school site;
- Provides a total of 5,410 m³ of storage at high water level (HWL);
- Discharge water conveyed to dry pond B via storm pipes at a maximum rate of 560 L/s.

Dry Pond B:

- Located at the north park area;
- Receives flow from area 1B and the upstream Dry Pond A;
- Flow from medium-density site D will be restricted to 1:5 year rate prior to discharging to the pond;
- Water level to be controlled by an outlet control structure within the park area;
- Provides a total of 18,976 m³ of storage at HWL;
- Discharges at a maximum rate of 655 L/s from control structure; to the existing pond in Paradise Canyon Subdivision through a proposed 675 mm diameter storm sewer.

Forebay D:

- Located at the south park area;
- Receives flow from Area 2A ;
- A small hatched area of 0.91 ha within Area 1A would be collected in a pipe to Forebay D at 1:5 year 4 hr release rate, overflow is directed to Dry Pond A;
- Normal water level to be controlled by a rock weir;

- Narrow weir opening will be designed to cause short term backflooding during major events (approx. 0.5 m depth);
- No storage volume is provided (sediment removal only);
- Discharges water to Wet Pond C via a lined ditch.

Wet Pond C:

- Located at the south park area;
- Receives flow from Area 2B and upstream Forebay D;
- A small hatched area of 0.88 ha within Area 1B would be collected in a pipe to Pond C at 1:5 year 4 hour release rate; overflow is towards Dry Pond B;
- Provides a total of 40,606 m³ of storage at HWL;
- Normal water level to be controlled by an outlet control structure;
- Runoff from Area 7 will be directed east along roadway and be restricted to 1:5 year -4 hour rate of 95 L/s prior to discharging to the existing minor system, minor system is conveyed to the existing wet pond in Paradise Canyon.
- Discharge from Wet Pond C will be at a maximum rate of 195 L/s to the existing downstream 450 mm pipe with an approximate elevation at 918.07 m, a total flow rate of 290 L/s drains to the existing minor system in Canyons Boulevard.

Wet Ponds E and F:

- Located at the University Drive entrance to the development area ;
- Receives flow from Area 3, which includes three self-contained sites A,B,C;
- Sites A,B,C are designated as one commercial/residential mix-use site and two high/medium density sites;
- Flow from sites A,B,C will be restricted to 1:5 year rate prior to discharging to the pond;
- Two ponds are interconnected by a pipe;
- Provides a total of 30,832 m³ of active storage at HWL;
- Normal water level to be controlled by an outlet control structure.
- Discharge will be at a maximum rate of 500 L/s to the existing downstream storm trunk on University Drive.

2.6.2 Computer Model Results**2.6.2.1 Dry Pond A****SWMHYMO**

Based on the 1:100 year design criteria (Section 2.5.4), SWMHYMO gives the following results:

- Dry Pond – 5,205 m³ of storage at HWL is required.

QHM

Based on the 1:100 year design criteria (Section 2.5.5), QHM and HYDSTAT give the following results:

- Dry Pond – 5,271 m³ of storage at HWL is required.
- The continuous simulation governs over the 1:100 year design storm.

2.6.2.2 Dry Pond B

SWMHYMO

Based on the 1:100 year design criteria (Section 2.5.4), SWMHYMO gives the following results:

- Dry Pond – 17,670 m³ of storage at HWL is required.

QHM

Based on the 1:100 year design criteria (Section 2.5.5), QHM and HYDSTAT give the following results:

- Dry Pond – 12,380 m³ of storage at HWL is required.
- The 1:100 year design storm governs over the continuous simulation storm design.

2.6.2.3 Wet Pond C

SWMHYMO

Based on the 1:100 year design criteria (Section 2.5.4), SWMHYMO gives the following results:

- Wet Pond: 21,010 m³ of active storage at HWL is required.
29,864 m³ of total storage at HWL is required.

QHM

Based on the 1:100 year design criteria (Section 2.5.5), QHM and HYDSTAT give the following results:

- Wet Pond – 27,380 m³ of total storage at HWL is required.
- The 1:100 year design storm governs over the continuous simulation storm design.

2.6.2.4 Chinook Wet Ponds E and F

SWMHYMO

Based on the 1:100 year design criteria (Section 2.5.4), SWMHYMO gives the following results:

- Wet Pond: 17,460 m³ of active storage at HWL is required.
27,097 m³ of total storage at HWL is required.

QHM

Based on the 1:100 year design criteria (Section 2.5.5), QHM and HYDSTAT give the following results:

- Wet Pond – 24,207 m³ of total storage at HWL is required.
- The 1:100 year design storm governs over the continuous simulation storm design.

2.6.3 Modeling of Pond Sediment Removal

The QHM computer model was used to estimate the sediment removal rates from the wet pond. Parameters for sediment build-up rates, wash-off rates and infiltration rates were estimated using the *Strathcona Development Area Sediment Control Analysis-1990* by JN MacKenzie Engineering Ltd., as follows:

Build-up Rate:	0.00055 kg/m ² /day
Equivalent Initial Accumulation:	30 days
Maximum Build-up:	0.20 kg/m ²
Impervious – Washoff Coefficient; Exponent:	6000 per m ³ , 1.2
Pervious – Washoff Coefficient; Exponent:	3000 per m ³ , 1.2

Tables 3 through 6 show the QHM results for the removal efficiency of the proposed south pond system for the 35-year simulation. The model was run using settling velocities interpolated information from the "Stormwater Management Practices Planning and Design Manual (1994)" prepared by the Ontario Ministry of Environment and Energy. An overall sediment removal rate has been provided for an area of 66 ha, of which 32.6 ha is treated by the Chinook Ponds E and F and 33.4 ha is treated by wet pond C and its separate forebay D. The model results indicate sediment removal of 99.7% for particle sizes greater than 75 µm, and a total sediment removal of 98.2%.

Table 3. Sediment Removal Efficiency of the Forebay D

Sediment Fraction	Size (µm)	Size Fractions	Settling Velocity (a) (m/s)	Fraction Removed
1	<5	2.8%	0.0000007	47.6%
2	5-10	1.2%	0.0000025	67.2%
3	10-20	1.2%	0.000008	77.5%
4	20-75	5.8%	0.000025	83.9%
5	>75	89%	0.0005	96.4%
Total		100%		93.7%

Table 4. Sediment Removal Efficiency of Pond C

Sediment Fraction	Size (µm)	Size Fractions	Settling Velocity (a) (m/s)	Fraction Removed
1	<5	2.8%	0.0000007	64.1%
2	5-10	1.2%	0.0000025	75.9%
3	10-20	1.2%	0.000008	85.1%
4	20-75	5.8%	0.000025	93.1%
5	>75	89%	0.0005	99.7%
Total		100%		97.2%

Table 5. Sediment Removal Efficiency of Pond E & F

Sediment Fraction	Size (µm)	Size Fractions	Settling Velocity (a) (m/s)	Fraction Removed
1	<5	2.8%	0.0000007	67.3%
2	5-10	1.2%	0.0000025	81.1%
3	10-20	1.2%	0.000008	87.6%
4	20-75	5.8%	0.000025	92.3%
5	>75	89%	0.0005	99.4%
Total		100%		97.7%

Table 6. Overall Sediment Removal Efficiency of Wet Ponds

Sediment Fraction	Size (µm)	Size Fractions	Settling Velocity (a) (m/s)	Fraction Removed
1	<5	2.8%	0.0000007	70.6%
2	5-10	1.2%	0.0000025	83.2%
3	10-20	1.2%	0.000008	89.7%
4	20-75	5.8%	0.000025	94.3%
5	>75	89%	0.0005	99.7%
Total		100%		98.2%

Note:

Effective settling velocities interpolated from Stormwater Management Practices Planning & Design Manual, Ontario Ministry of Environment and Energy, June 1994.

2.6.4 Removal of Floatables

Removal of hydrocarbons, detergents and solid floatables will occur in the ponds before the runoff is released into the downstream system. This will be cleaned up as part of regular maintenance.

2.6.5 Pond Design Summary

The principle design characteristics of the proposed SWMFs are summarized in Tables 7 to 16. The computer models for the single event and continuous simulation are used to determine the storage for 1:100 year storm events. The calculation of corresponding elevation is based on "interpolation strategy".

Table 7. Dry Pond A - Design Summary

Parameter	Pond
Contributing Area	16.14 ha
Average Imperviousness (%)	52
Maximum water level (HWL)	924.40 m
1:100 year water level (Single Event)	924.36 m
1:100 year water level(Continuous Simulation)	924.37 m
1:5 year water level (Single Event)	923.23 m
1:5 year water level(Continuous Simulation)	926.46 m
Maximum discharge rate (HWL)	0.56 m ³ /s
1:100 year discharge rate (Single Event)	0.55 m ³ /s
1:100 year water level (Continuous Simulation)	0.55 m ³ /s
1:5 year discharge rate (Single Event)	0.38m ³ /s
1:5 year water level (Continuous Simulation)	0.34 m ³ /s
Maximum pond depth (HWL)	1.50 m
1:100 year pond depth (Single Event)	1.46 m
1:100 year pond depth (Continuous Simulation)	1.47 m
1:5 year pond depth (Single Event)	0.73 m
1:5year pond depth (Continuous Simulation)	0.56 m
Maximum Storage at HWL	5,412 m ³
1:100 year pond storage (Single Event)	5,205 m ³
1:100 year pond storage (Continuous Simulation)	1,755 m ³
1:5 year pond storage (Single Event)	5,205 m ³
1:5 year pond storage (Continuous Simulation)	1,131 m ³
Freeboard (FB)	0.60 m

Table 8. Dry Pond B - Design Summary

Parameter	Pond
Contributing Area	29.69 ha *
Average Imperviousness (%)	52
Maximum water level (HWL)	919.40 m
1:100 year water level (Single Event)	919.32 m
1:100 year water level (Continuous Simulation)	918.99 m
1:5 year water level (Single Event)	918.54 m
1:5 year water level (Continuous Simulation)	918.37 m
Maximum discharge rate (HWL)	0.655 m ³ /s
1:100 year discharge rate (Single Event)	0.65m ³ /s
1:100 year water level (Continuous Simulation)	0.63 m ³ /s
1:5 year discharge rate (Single Event)	0.59m ³ /s
1:5 year water level (Continuous Simulation)	0.57 m ³ /s
Maximum pond depth (HWL)	1.50 m
1:100 year pond depth (Single Event)	1.42 m
1:100 year pond depth (Continuous Simulation)	1.09m
1:5 year pond depth (Single Event)	0.64 m
1:5 year pond depth (Continuous Simulation)	0.47m
Maximum Storage at HWL	18,976 m ³
1:100 year pond storage (Single Event)	17,670 m ³
1:100 year pond storage(Continuous Simulation)	12,385 m ³
1:5 year pond storage (Single Event)	5,915 m ³
1:5 year pond storage(Continuous Simulation)	3,608 m ³
Freeboard (FB)	0.6 m

* Areas attributed to upstream facilities are not included.

Table 9. Forebay D - Design Summary

Parameter	Pond
Contributing Area	18.73 ha
Average Imperviousness (%)	51
Maximum water level (HWL)	924.5 m
1:100 year water level (Single Event)	924.47 m
1:100 year water level (Continuous Simulation)	924.28 m
1:5 year water level (Single Event)	924.23 m
1:5 year water level (Continuous Simulation)	924.11 m
Maximum discharge rate (HWL)	4.21 m ³ /s
1:100 year discharge rate (Single Event)	3.84 m ³ /s
1:100 year water level (Continuous Simulation)	1.75 m ³ /s
1:5 year discharge rate (Single Event)	1.29 m ³ /s
1:5 year water level (Continuous Simulation)	0.46 m ³ /s
Maximum pond depth (HWL)	2.50 m
1:100 year pond depth (Single Event)	2.47 m
1:100 year pond depth (Continuous Simulation)	2.28 m
1:5 year pond depth (Single Event)	2.23 m
1:5 year pond depth (Continuous Simulation)	2.11 m
Maximum Active Storage (above PWL)	1,737 m ³
Maximum Total Storage at HWL	4,665 m ³
1:100 year pond storage (Single Event)	4,552m ³
1:100 year pond storage (Continuous Simulation)	3,809 m ³
1:5 year pond storage (Single Event)	3,615m ³
1:5 year pond storage (Continuous Simulation)	3,257 m ³
Freeboard (FB)	0.6 m

Table 10. Wet Pond C - Design Summary

Parameter	Value
Contributing Area	14.67 ha*
Average Imperviousness (%)	39
Maximum water level (HWL)	921.60 m
1:100 year water level (Single Event)	921.02 m
1:100 year water level (Continuous Simulation)	920.89 m
1:5 year water level (Single Event)	920.29 m
1:5 year water level (Continuous Simulation)	920.30 m
Maximum discharge rate (HWL)	0.195 m ³ /s
1:100 year discharge rate (Single Event)	0.16 m ³ /s
1:100 year water level (Continuous Simulation)	0.15 m ³ /s
1:5 year discharge rate (Single Event)	0.11 m ³ /s
1:5 year water level (Continuous Simulation)	0.11 m ³ /s
Maximum pond depth (HWL)	4.0 m
1:100 year pond depth (Single Event)	3.42 m
1:100 year pond depth (Continuous Simulation)	3.29 m
1:5 year pond depth (Single Event)	2.69 m
1:5 year pond depth (Continuous Simulation)	2.70 m
Maximum Active Storage (above PWL)	31,752 m ³
Maximum Total Storage at HWL	40,606 m ³
1:100 year pond total storage (Single Event)	29,864 m ³
1:100 year pond total storage (Continuous Simulation)	27,380 m ³
1:5 year pond total storage (Single Event)	17,982 m ³
1:5 year pond total storage (Continuous Simulation)	18,140 m ³
Freeboard (FB)	0.60 m

* Areas attributed to upstream facilities are not included.

Table 11. Wet Pond E and F - Design Summary

Parameter	Pond
Contributing Area	32.60 ha
Average Imperviousness (%)	61
Maximum water level (HWL)	929.20 m
1:100 year water level (Single Event)	928.89 m
1:100 year water level (Continuous Simulation)	928.65 m
1:5 year water level (Single Event)	927.99 m
1:5 year water level (Continuous Simulation)	927.92 m
Maximum discharge rate (HWL)	0.50 m ³ /s
1:100 year discharge rate (Single Event)	0.45 m ³ /s
1:100 year water level (Continuous Simulation)	0.42 m ³ /s
1:5 year discharge rate (Single Event)	0.29 m ³ /s
1:5 year water level (Continuous Simulation)	0.27 m ³ /s
Maximum pond depth (HWL)	4.0 m
1:100 year pond depth (Single Event)	3.69 m
1:100 year pond depth (Continuous Simulation)	3.45 m
1:5 year pond depth (Single Event)	2.79 m
1:5 year pond depth (Continuous Simulation)	2.72 m
Maximum Active Storage (above PWL)	21,195 m ³
Maximum Total Storage at HWL	30,832 m ³
1:100 year pond total storage (Single Event)	27,097 m ³
1:100 year pond total storage (Continuous Simulation)	24,207 m ³
1:5 year pond total storage (Single Event)	16,905 m ³
1:5 year pond total storage (Continuous Simulation)	16,276 m ³
Freeboard (FB)	0.60 m

Table 12. Dry Pond A - System Properties

Elevation (m)	Depth (m)	Area (m ²)	Volume (m ³)	Discharge (m ³ /s)	Note
922.90	0.0	459	0	0.0	BOTTOM
923.00	0.1	1,220	81	0.13	
923.40	0.5	2,976	894	0.32	
923.90	1.0	4,477	2,745	0.45	
924.40	1.5	6,241	5,412	0.56	HWL
925.00	2.1	7,590	9,555		Freeboard

Table 13. Dry Pond B - System Properties

Elevation (m)	Depth (m)	Area (m ²)	Volume (m ³)	Discharge (m ³ /s)	Note
917.90	0.0	1,194	0	0.000	BOTTOM
918.10	0.2	8,263	840	0.547	
918.40	0.5	12,482	3,930	0.574	
918.90	1.0	15,220	10,844	0.616	
919.40	1.5	17,331	18,976	0.655	HWL
920.00	2.1	17,884	29,540		Freeboard

Table 14. Forebay D - System Properties

Elevation (m)	Depth (m)	Area (m ²)	Volume (m ³)	Discharge (m ³ /s)	Note
922.00	0.00	235	0		BOTTOM
923.00	1.00	1,408	739		
924.00	2.00	2,613	2,928	0.00	PWL
924.20	2.20	3,182	3,507	1.06	
924.50	2.50	4,583	4,665	4.21	HWL
925.10	3.10	7,000	8,115		Freeboard

Table 15. Wet Pond C - System Properties

Elevation (m)	Depth (m)	Area (m ²)	Volume (m ³)	Discharge (m ³ /s)	Note
917.60	0.00	147	0		BOTTOM
918.60	1.00	4,235	1,724		
919.60	2.00	10,490	8,854	0.00	PWL
920.60	3.00	16,113	22,055	0.13	
921.60	4.00	21,100	40,606	0.20	HWL
922.20	4.60	30,000	55,858		Freeboard

Table 16. Wet Pond E and F - System Properties

Elevation (m)	Depth (m)	Area (m ²)	Volume (m ³)	Discharge (m ³ /s)	Note
925.20	0.00	2,522	0		BOTTOM
926.20	1.00	4,575	3,498		
927.20	2.00	7,851	9,637	0	PWL
928.20	3.00	10,563	18,811	0.33	
929.20	4.00	13,542	30,832	0.50	HWL
929.80	4.60	15,604	39,568		Freeboard

2.6.6 Pond Layout

There are two dry ponds and three wet ponds within the study area. Dry ponds A and B have an area of 0.62 ha and 1.73 ha at HWL, respectively. Both dry ponds have a maximum depth of 1.5 m at HWL. **Figure 3** and **Figure 4** show the pond layout of pond A and pond B respectively.

The Wet Pond C comprises a separate forebay D and a main pond, for a total area at permanent water level (PWL) of 1.31 ha. Wet Ponds E and F are interconnected, for a total area at permanent water level (PWL) of 0.79 ha. There are no forebays within the two wet ponds due to space consideration.

The layouts of Pond C and Forebay D, and Ponds E and F are shown on **Figure 5** and **Figure 6** respectively. These ponds are designed to meet all engineering requirements within the constraints imposed by the existing topography and environment.

AENV guidelines recommended that the permanent pool should be sized to store the volume of runoff from a 25 mm storm over the contributing area. Wet Pond C and its Forebay D serve a total 33.4 ha (14.67 ha drain to the main pond directly due to grade limitation). Chinook Ponds E and F have a total contributing area of 32.6 ha. To account for initial loss and coefficient, 1.6mm is selected as initial loss and 0.8 is selected as the coefficient, therefore permanent water runoff from a 25 mm rainfall is 6,265 m³ and 6,103 m³ respectively. The total permanent (passive) volume provided by Wet Pond C (including Forebay D), and Wet Ponds E and F, are 11,782 m³ and 9,637 m³ respectively; therefore the ponds meet this criterion.

All the wet ponds have a maximum depth of 2.00 m at PWL.

Emergency escape routes have been provided for all five ponds. The emergency flow from Dry Pond A will drain toward southeast to a residential road and Chinook Ponds E and F will drain toward Chinook Trail on the north. From Dry Pond B, it will flow east into the existing Paradise Canyon Phase 6. Emergency spill from Pond C will flow out the walkway to the east towards the existing community.

All escape routes have a capacity of about 2.4 m³/s.

All the discharges from ponds, except for pond A, are controlled by the use of inlet control devices (ICDs). Discharges from Ponds B, C and F are controlled by R 187, R 125 and R 203, which restricts flow to a maximum 0.655 m³/s, 0.195 m³/s and 0.50 m³/s at HWL respectively. Discharge from Pond A will be controlled by a 450mm PVC pipe.

Each of the control structures will be a two-chamber structure with a gate valve. The gate valve is used as a bypass for the orifice in the event the orifice plugs, as well as for maintenance purposes. The gate has a non-rising stem that is operated mechanically. Details are shown on **Figure 8** and **Figure 9**. A trash rack will be provided in control structures where the orifice size is less than 200 mm. Details of trash rack are shown on **Figure 8**.

The pond landscaping will incorporate varying edge treatments, wetland plant materials on topsoil terraces and grassy areas around the remainder of the pond edge. All the pond details including access road will be specified during the detailed design stage.

2.6.7 Proposed Forebay / Ditch Sizing

Piped stormwater from Area 2A will enter the forebay through a concrete pipe with the invert located 500 mm above the forebay floor, with rip-rap to prevent scouring of the pond bottom. The majority of heavier sediments will settle out in the forebay, before the flow discharges through a weir at PWL into a ditch to the main pond.

The size and shape of the forebay is largely determined by the physical constraints of the site.

Stormwater Management Guidelines for the Province of Alberta, 1999, provide the following equation for determining the required length of the forebay:

$$Lfb = \left(\frac{rQ_p}{V_s} \right)^{0.5}$$

where

Q_p = peak flow from pond for design quality storm (m³/s)

r = length/width ratio

V_s = settling velocity for desired particle to settle (m/s).

The June 1994 *Stormwater Management Practices Planning and Design Manual* published by the Ontario Ministry of Environment & Energy recommends that the forebay be designed to settle out 150 µm particles, with an 'effective' settling velocity of 0.0003 m/s. (Note that using Stoke's Law, a settling velocity of 0.0003 m/s corresponds to a particle size of 10 µm.)

For the Main Pond, the design quality storm is contained below an elevation of 921.65 m with a peak discharge of 0.195 m³/s. Using the above equation, the required length of the forebay needed to settle out

particles between 40 μm and 150 μm is approximately 37 m. As shown in **Figure 5**, the length of the forebay is approximately 76 m.

A second parameter to check is the dispersion length. The AENV Guidelines provides the following equation for calculating the dispersion length:

$$L_{dis} = \left(\frac{8Q}{dV_f} \right)$$

where

Q = inlet flow rate (m^3/s)

d = depth of permanent pool in the forebay (m)

V_f = desired velocity at the end of the forebay (m/s)

The Ontario manual, referenced above, recommends a desired velocity at the end of the forebay of 0.5 m/s. The inlet pipe into the forebay has a maximum inflow rate of 4.78 m^3/s ; therefore, the required dispersion length of the forebay is 31 m. As shown on **Figure 5**, this requirement is also met.

Table 17 shows the parameters used in the computation. Inlet flow rate is based on peak overflow rate which is generated from the contributing area.

Table 17. Forebay D - Design Parameters

R(length/width)	$Q_p(\text{m}^3/\text{s})$	$V_s(\text{m/s})$	$Q(\text{inlet})(\text{m}^3/\text{s})$	d(m)	$V_f(\text{m/s})$
2	0.195	0.0003	3.90	2.0	0.5

A lined grass ditch shown on **Figure 5** (7 m bottom width at 1% slope) will be considered to tie the forebay to the main pond. A side slope of 7:1 is used for safety consideration within the park area. Riprap protection will also be provided where flow enters the ditch to reduce erosion and scour. A maximum permissible velocity between 0.8 m/s and 1.8 m/s has been maintained in the design. Table 18 is the summary of ditch design.

Table 18. Summary of Grass Ditch Flow Assessment

Facility	1:100 Y Discharge (m^3/s)	Water Velocity (m/s)	Maximum Depth (m)
Ditch	3.24	1.48	0.263

2.6.8 Pond Utilization

The continuous simulation results were used to determine utilization of the active storage volume for the 35-year simulation (1960-1995), as well as the resulting water level in the pond. These results are presented in Tables 19 to 23.

Table 19. Storage Utilization and Water Level Duration Analysis - Pond A

Elevation	Active Storage Used (m ³)	Hours Utilized	% Time
922.9	0	312,000	100
923.0	188	568	0.2
923.1	375	121	0

Table 20. Storage Utilization and Water Level Duration Analysis - Pond B

Elevation	Active Storage Used (m ³)	Hours Utilized	% Time
917.9	0	312,000	100
918.0	441	262	0.1
918.1	943	92	0

Table 21. Storage Utilization and Water Level Duration Analysis - Pond C

Elevation	Active Storage Used (m ³)	Hours Utilized	% Time
917.6	0	312,000	100.0
917.8	397	311,800	100.0
918.1	793	311,700	99.9
918.3	1,189	311,600	99.9
918.5	1,586	311,400	99.8
918.7	2,793	311,100	99.7
919.0	4,433	310,800	99.6
919.2	6,072	310,700	99.6
919.4	7,712	298,100	95.6
919.7	9,776	7,129	2.3
919.9	12,810	918	0.3
920.1	15,850	236	0.1
920.4	18,880	70	0.0

Table 22. Storage Utilization and Water Level Duration Analysis - Forebay D

Elevation	Active Storage Used (m3)	Hours Utilized	% Time
922.0	0	312,000	100.0
922.2	115	186,100	59.7
922.3	229	169,100	54.2
922.5	344	156,900	50.3
922.6	458	146,600	47.0
922.8	573	139,100	44.6
922.9	687	133,200	42.7
923.1	926	122,300	39.2
923.2	1,265	107,300	34.4
923.4	1,604	92,290	29.6
923.6	1,944	74,690	23.9
923.7	2,283	51,660	16.6
923.9	2,622	27,470	8.8
924.0	2,973	356	0.1
924.2	3,421	1.5	0.0

Table 23. Storage Utilization and Water Level Duration Analysis - Pond E&F

Elevation	Active Storage Used (m ³)	Hours Utilized	% Time
925.2	0	312,000	100
925.4	805	305,700	98
925.7	1,609	263,700	84.5
925.9	2,413	227,300	72.9
926.1	3,218	201,800	64.7
926.3	4,418	172,800	55.4
926.6	5,830	146,400	46.9
926.8	7,242	118,200	37.9
927.0	8,654	76,090	24.4
927.3	10,280	3,039	1
927.5	12,390	396	0.1
927.7	14,500	94	0

2.6.9 Hydstat Statistical Analysis Results

A frequency analysis of the model results was undertaken using Hydstat to provide the 1:100 year storage volume requirements. These results are presented in Tables 24 to 28. The models are included in Appendix D.

Table 24. Hydstat Statistical Analysis Results - Pond A

Distribution Type	Total Volume		Least Squares Standard Error
	5 Yr Estimate (m ³)	100 Yr Estimate (m ³)	
NORMAL	1,505	2,625	6.64E+01
LOG-NORMAL	1,197	3,326	4.40E+01
GUMBEL	1,413	3,236	4.62E+01
LOG-GUMBEL	1,100	5,807	2.51E+01
PEARSON-3	1,206	3,842	3.06E+01
LOG-PEARSON-3	1,131	5,271	2.50E+01
LOG-NORMAL-3	1,217	3,151	4.63E+01
Minimum Least-Squares Distribution	LOG-PEARSON-3	LOG-PEARSON-3	

Table 25. Hydstat Statistical Analysis Results - Pond B

Distribution Type	Total Volume		Least Squares Standard Error
	5 Yr Estimate (m ³)	100 Yr Estimate (m ³)	
NORMAL	4,494	8,415	2.35E+02
LOG-NORMAL	3,115	13,762	1.32E+02
GUMBEL	4,173	10,552	1.65E+02
LOG-GUMBEL	2,758	30,938	1.32E+02
PEARSON-3	3,608	12,385	1.06E+02
LOG-PEARSON-3	2,925	24,151	1.07E+02
LOG-NORMAL-3	3,537	9,927	1.67E+02
Minimum Least-Squares Distribution	LOG-PEARSON-3	LOG-PEARSON-3	

Table 26. Hydstat Statistical Analysis Results - Pond C

Distribution Type	Total Volume		Least Squares Standard Error
	5 Yr Estimate (m ³)	100 Yr Estimate (m ³)	
NORMAL	18,566	24,245	1.85E+02
LOG-NORMAL	18,187	25,773	1.37E+02
GUMBEL	18,099	27,342	1.12E+02
LOG-GUMBEL	17,674	31,169	1.16E+02
PEARSON-3	18,140	27,380	1.01E+02
LOG-PEARSON-3	17,965	28,944	1.02E+02
LOG-NORMAL-3	18,053	26,998	1.18E+02
Minimum Least-Squares Distribution	PEARSON-3	PEARSON-3	

Table 27. Hydstat Statistical Analysis Results - Forebay D

Distribution Type	Total Volume		Least Squares Standard Error
	5 Yr Estimate (m ³)	100 Yr Estimate (m ³)	
NORMAL	3,303	3,570	1.34E+01
LOG-NORMAL	3,296	3,575	1.26E+01
GUMBEL	3,281	3,716	9.30E+00
LOG-GUMBEL	3,274	3,738	8.94E+00
PEARSON-3	3,257	3,809	7.61E+00
LOG-PEARSON-3	3,257	3,820	7.62E+00
LOG-NORMAL-3	3,254	3,738	9.07E+00
Minimum Least-Squares Distribution	PEARSON-3	PEARSON-3	

Table 28. Hydstat Statistical Analysis Results – Pond E&F

Distribution Type	Total Volume		Cost (USD/m ³)
	5 Yr Estimate (m ³)	100 Yr Estimate (m ³)	
NORMAL	16,782	21,091	1.74E+02
LOG-NORMAL	16,479	21,731	1.41E+02
GUMBEL	16,428	23,440	1.05E+02
LOG-GUMBEL	16,109	25,269	9.20E+01
PEARSON-3	16,276	24,207	8.34E+01
LOG-PEARSON-3	16,151	25,239	8.47E+01
LOG-NORMAL-3	16,192	23,489	1.08E+02
Minimum Least-Squares Distribution	PEARSON-3	PEARSON-3	

As illustrated above, the storage amounts required for ponds A, B, C, D, and E & F by Hydstat are 5,271 m³, 12,385 m³, 27,380 m³, 3,809 m³ and 24,207 m³ respectively. The maximum pond storage provided for Pond A, Pond B, Pond C, Forebay D and Pond E & F are 5,412m³, 18,976 m³, 40,606 m³, 4,665 m³ and 30,832 m³ respectively. Adequate storage is provided for the all the ponds based on continuous simulation.

The 1:100 year storm model governs the storage required for all the ponds with an exception of pond A as the amount of storage required are larger than the results from the continuous simulation.

2.6.10 Groundwater/Geotechnical Considerations

A geotechnical evaluation for the Canyons outline was completed by EBA Engineering Consultants Ltd. in September, 2007. The report indicates that the soil profile within the pond areas is a thin mantle of topsoil (approximately 0.15 m) overlying about 2.0 m of lacustrine clay. A glacial clay till was encountered extending to depths of approximately 14 m to 23 m. It is recommended that all organic soils be removed to ensure the pond sub-grades bear on the site's clay soils.

Generally, groundwater within pond areas has no significant effect as the monitoring data shows most groundwater tables are well below the pond invert. The exception is within Wet Pond C, where the depth to groundwater is approximate 2.25 m. Therefore, dewatering should be considered during construction.

The ponds cannot allow discharge water into the local groundwater regime or be recharged by the groundwater table. Therefore, a pond liner consisting of a synthetic liner or well compacted clay will be required. The type of liner to be used will be specified in the detailed design phase.

3. Summary of Conclusions and Recommendations

- 1) The criterion used in this study for sizing of the stormwater facilities is the maximum discharge from the study area. Five SWMFs are to be constructed. The south (C) and west SWMFs (E and F) will be designed to control water quantity and water quality. The two north SWMFs (A and B) will be designed to control water quantity only. The 1:100 year maximum allowable discharge rate is 195 L/s from SWMF C to the existing downstream 450mm pipe, 655 L/s from SWMF B to the existing pond in Paradise Canyon Subdivision, and 500 L/s from SWMF F to the existing downstream storm trunk on Chinook Trail.
- 2) The 1:5 year storm was used to determine the minor flows in the study area, and the 1:100 year storm was used to size the major system facilities including stormwater detention facilities. Staged control structures in the ponds are recommended to limit pond outflows to pre-determined levels.
- 3) The SWMFs have been sized based on the most conservative estimate of the 1:100 year return period storage volume computed by the single event analyses and the continuous simulation analyses. The 1:100 year storm model governs the storage required for all the SWMFs except for Dry Pond A which is governed by continuous simulation in the study area.
- 4) The amount of total storage volume requirement during continuous simulation for pond A is 5,271 m³ ; meanwhile the amount of total storage volume requirement during the 1:100 year, 24-hour storm event for ponds B, C, and E & F are 17,670 m³, 29,864 m³ and 27,097 m³ respectively. The amount of total storage provided for pond A, B, C, and E & F are 5,431m³, 18,976 m³, 40,606 m³ and 30,832 m³ respectively.
- 5) In general, streets in developed areas are used to convey the overland (major) stormwater flows. To facilitate this option, the following are recommended:
 - Maximum ponding depth of local traplows should be within the limits recommended by Alberta Environment / City of Lethbridge;
 - Roof-leaders should not be connected to the major system; and
 - Weeping tile drainage will be connected to the storm sewer. It is noted that the City does not allow weeping tile connecting to the sanitary sewer system.
- 6) Stormwater calculations performed in this study were based on an average imperviousness of 53%. For areas such as residential/commercial and high density residential development where impervious areas are high, on-site detention with local restricted outflow to 1:5 Year release rate as per Table 1 to the main.
- 7) During detailed design, proposed drainage courses and facilities should be protected with registered easements. Erosion and sediment control measures should also be implemented during construction to protect natural drainage courses.

4. References

Canyons Gate 3 Revised Outline Plan, *AECOM Canada Ltd.*, 2009

Design Standards, *City of Lethbridge*, 2009

Geotechnical Evaluation Riverbend Community Outline Plan, *EBA Engineering Consultants Ltd.*, 2007

Paradise Canyon Phase 6 construction drawing package, *UMA Engineering Ltd.*, 2005

Paradise Canyon Upper Bench Stormwater Management Plan, *UMA Engineering Ltd.*, 2000

Paradise Canyon Upper Bench Stormwater Management Plan Amendment, *UMA Engineering Ltd.*, 2003

Phase 1 Environmental Site Assessment Report, *EBA Engineering Consultants Ltd.*, 2007

QHM User's Manual, *Centre for Water Resources Studies, Dalhousie University*, 1998

Stormwater Management Guidelines for the Province of Alberta, *Alberta Environment*, 1999

SWMHYMO User's Manual, *J-F Sabourin & Associates*, 1999

Topographic Information, *UMA Engineering Ltd.*, 2007

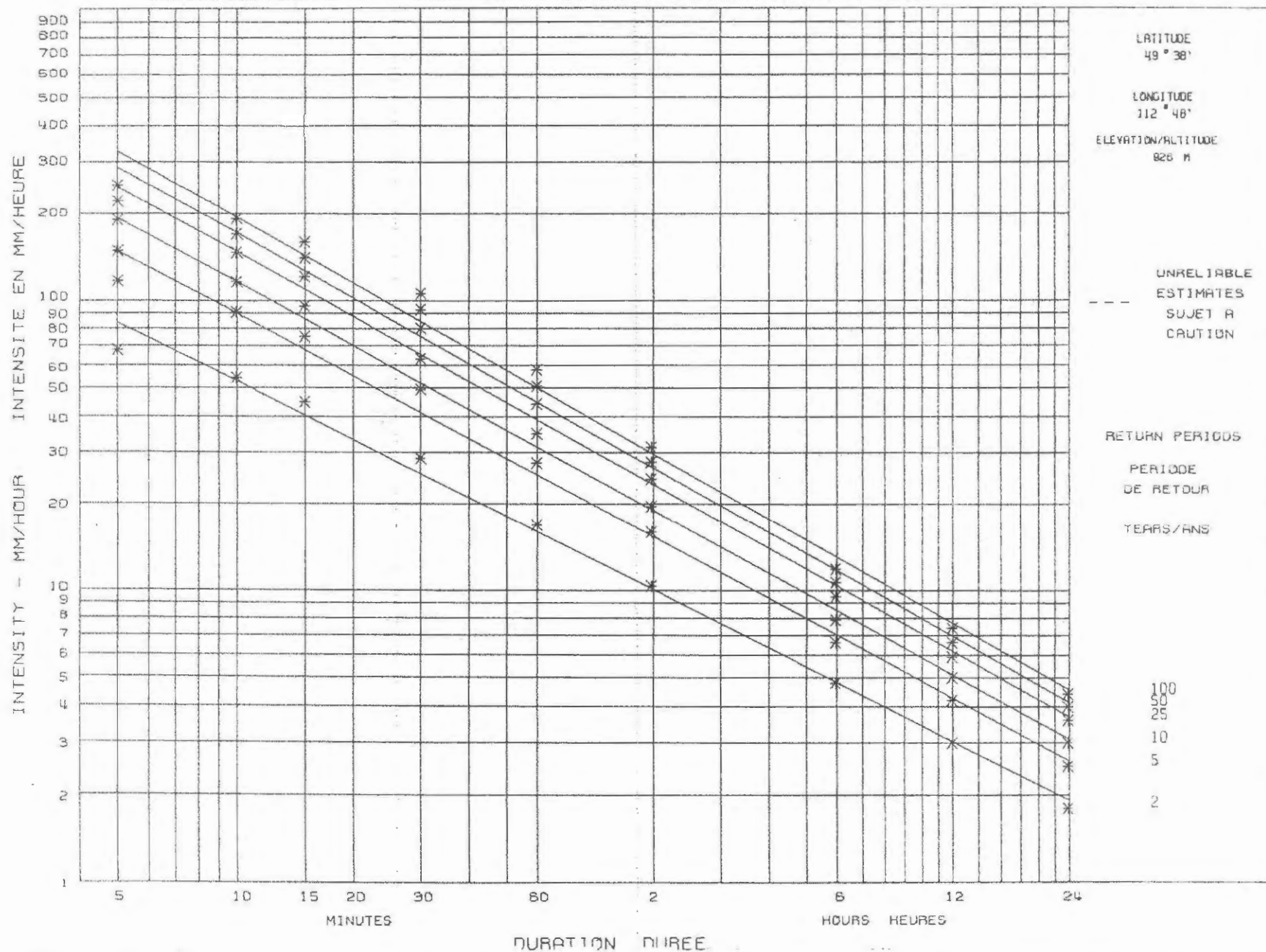
Appendix A

IDF Curve
1:5 Year Storm Hyetograph, 4-hour
1:100 Year Storm Hyetograph, 24-hour
Ponds A, B, C, E & F Rating Curve

SHORT DURATION RAINFALL INTENSITY-DURATION FREQUENCY DATA FOR-
 DONNEES SUR L'INTENSITE, LA DUREE ET LA FREQUENCE DES CHUTES DE PLUIE DE COURTE DUREE A LETHBRIDGE AIRPORT
 GUMBEL-METHOD OF MOMENTS BASED ON RECORDING RAIN GAUGE DATA FOR THE PERIOD-
 METHODE DES MOMENTS BASEES SUR LES DONNEES DU PLUVIOGRAPHES POUR LA PERIODE 1960 - 1990

ALTA

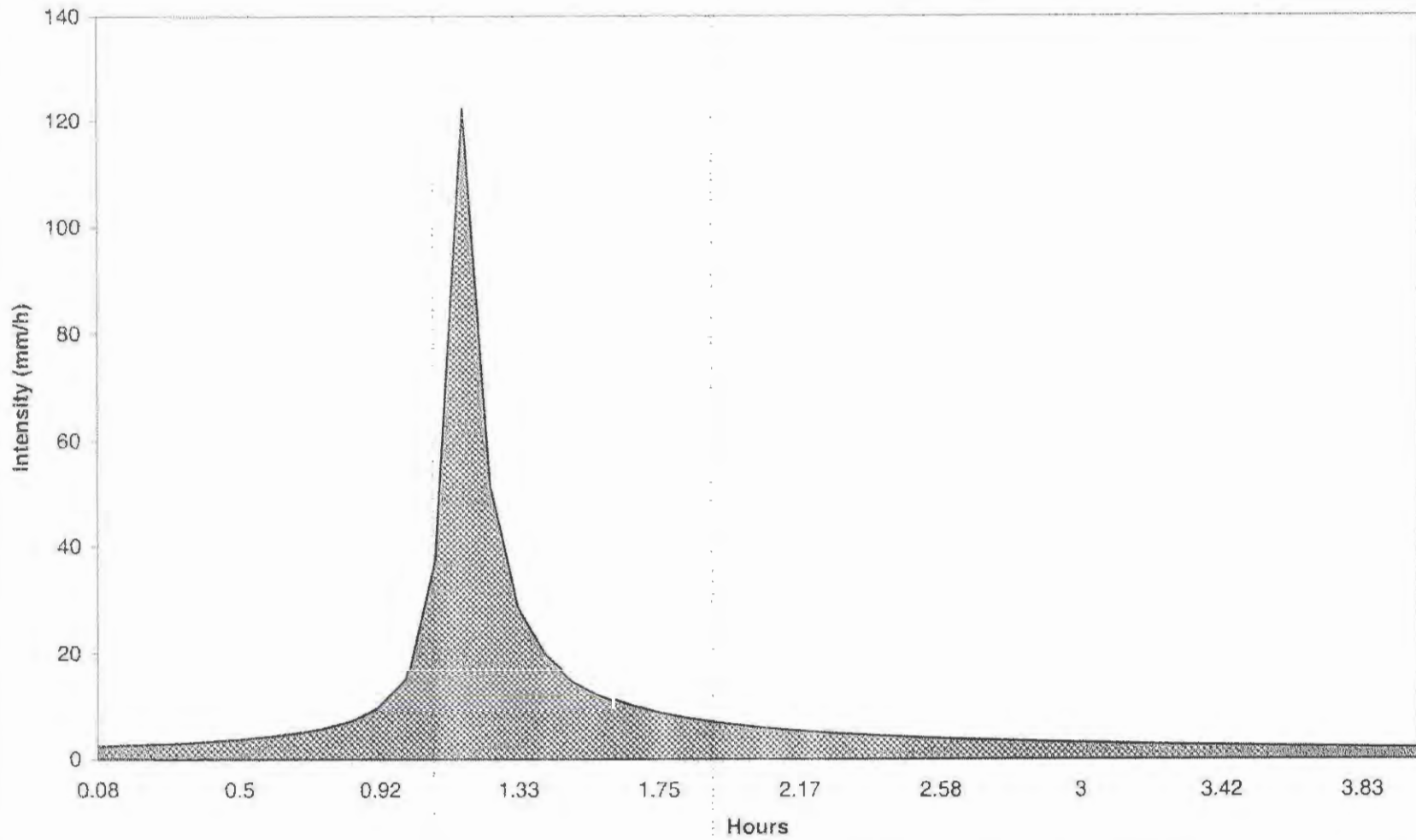
31 YEARS/AN



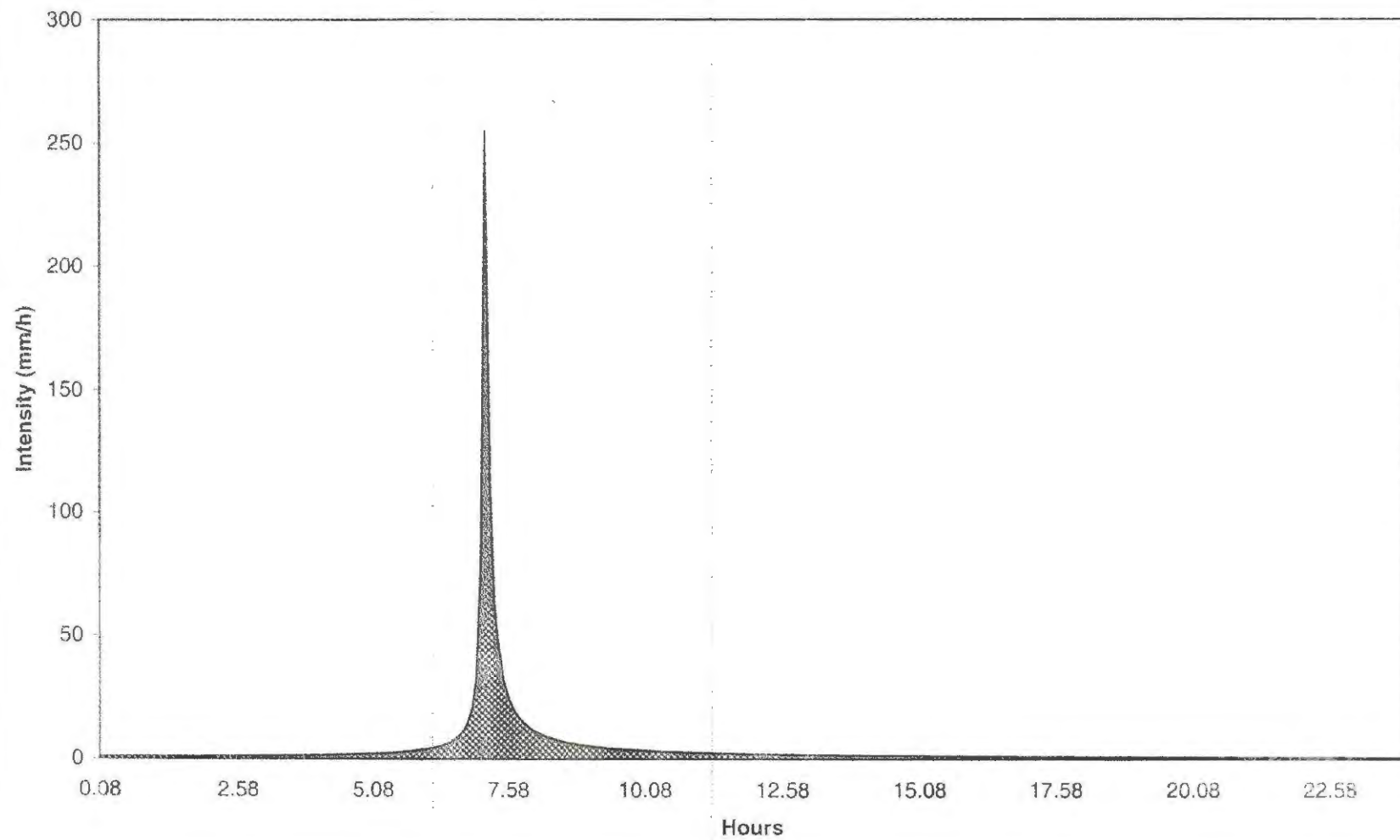
PREPARED BY - PREPARE PAR LE

ATMOSPHERIC ENVIRONMENT SERVICE - ENVIRONNEMENT CANADA
 SERVICE DE L'ENVIRONNEMENT ATMOSPHERIQUE - ENVIRONNEMENT CANADA

Lethbridge 1:5 year,4 hour hyetograph



Lethbridge 1:100 year 24 hour hyetograph



Appendix B

Table B-1: Subcatchment Parameters

Figure 11 - SWMHYMO SCHEMATIC

SWMHYMO Input (on CD)

SWMHYMO Output (on CD)

1:5 Year 4 hour SWMHYMO Input (on CD)

1:5 Year 4 hour SWMHYMO Output (on CD)

Pond A,B,C, E&F Rating Curve

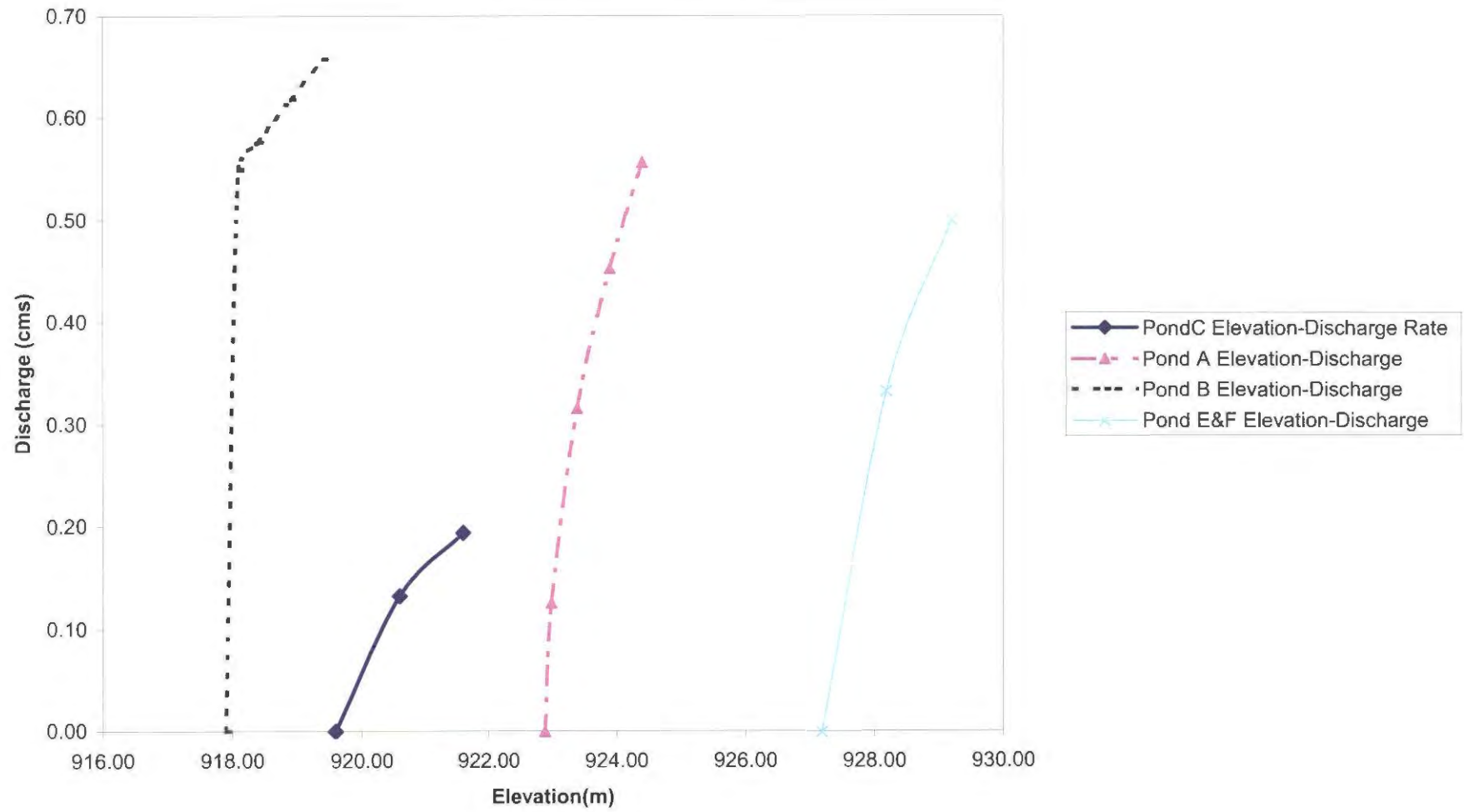


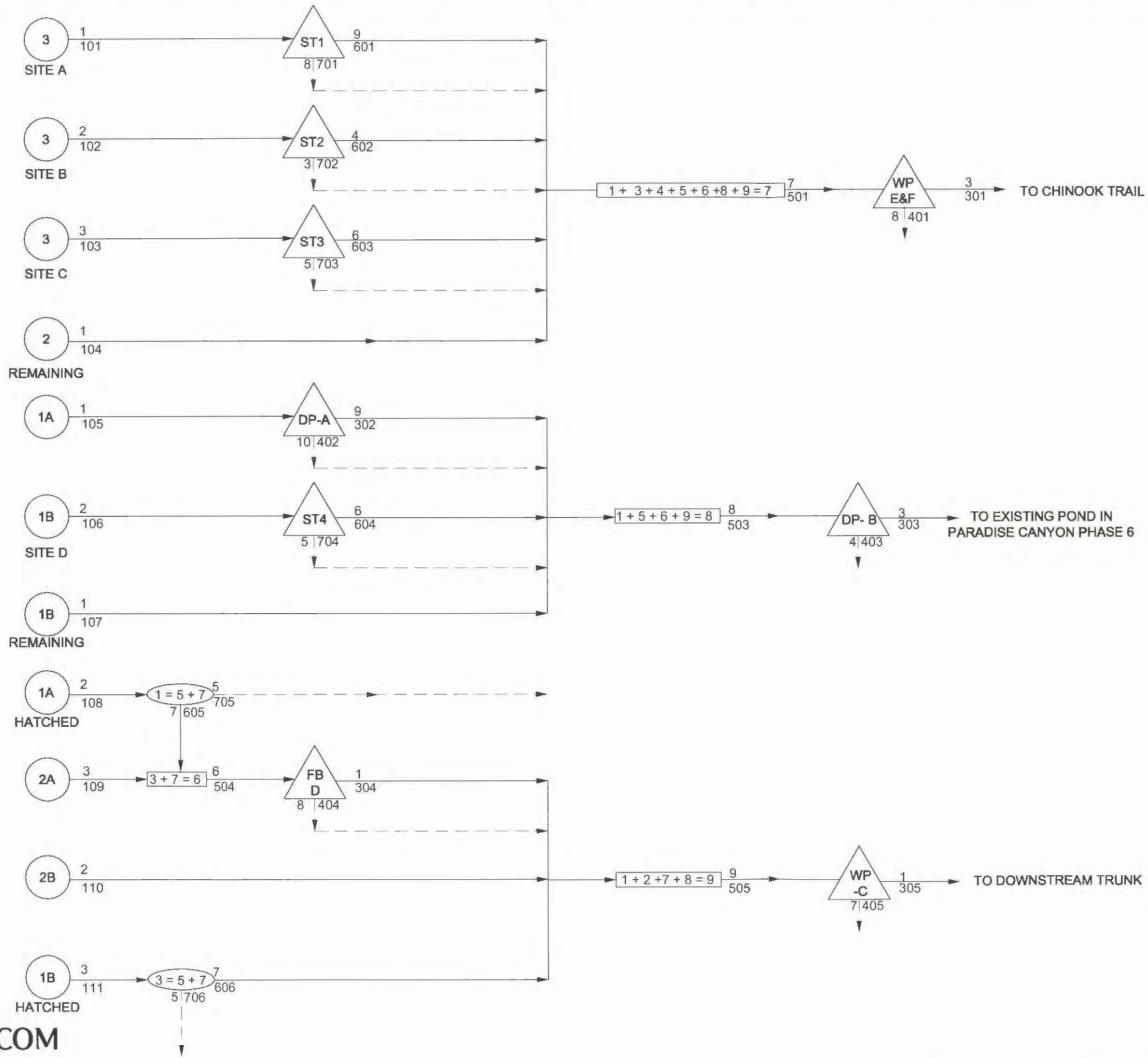
Table B-1: Subcatchment Parameters

Subcatchment Area	SWMHYMO Identification Number	Area (ha)	Size	Imperviousness Percent
3 Site A	101	6.59		75
3 Site B	102	4.53		66
3 Site C	103	5.55		67
3 Remaining	104	15.93		51
1A	105	16.14		52
1B Site D	106	3.2		65
1B Remaining	107	26.49		51
1A Hatched *	108	0.91		55
2A	109	18.73		51
2B	110	14.67		40
1B Hatched *	111	0.88		55
Total		111.83		53
Area drains to future SWMF				
4	112	11.12		55
Areas drain to coulee directly				
5	113	1.92		40
8	114	0.59		40
Areas drain to offsite				
7	115	1.15		50
9	116	1.02		40
6	117	0.78		50

* Hatched Areas are included in 1A, 1B respectively.

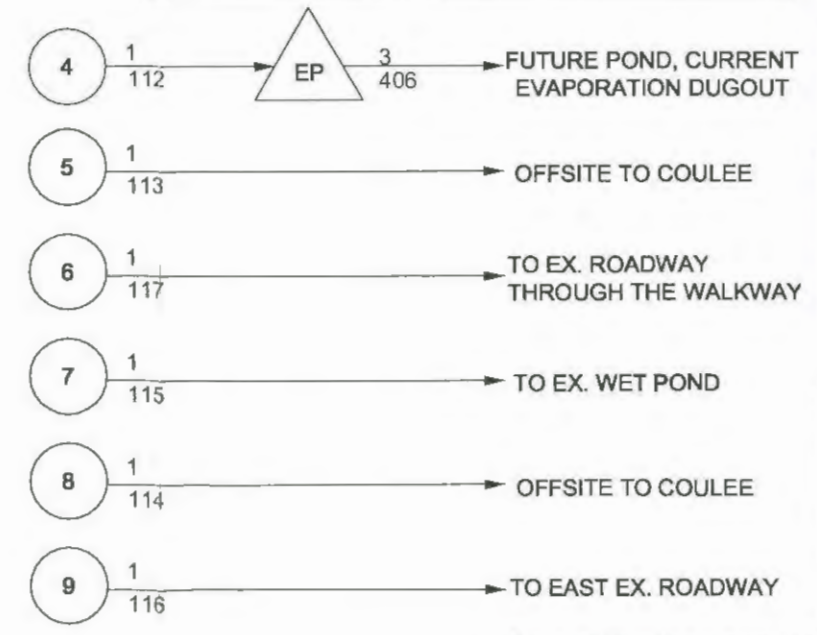
ISS/REV: A
 AECOM FILE NAME: 1560-245-00_03-CWF011_RX.dwg
 PLOT: 11/08/2009 1:33:37 PM
 Saved By: xud
 B SIZE 11" x 17" (279.4mm x 431.8mm)

© 2009 AECOM Canada Ltd. All Rights Reserved. This document is protected by copyright law and may not be used, reproduced or modified in any manner or for any purpose except with the written permission of AECOM Canada Ltd. ("AECOM") or a party to which its copyright has been assigned. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that uses, reproduces, modifies, or relies on this document without AECOM's express written consent.



DEFINITIONS

- 1 SUB CATCHMENT
- 1 + 2 = 8 ADD HYDROGRAPH
- WP WET POND
- DP DRY POND
- FB FOREBAY
- ST1 ON-SITE STORAGE FACILITY
- EP EVAPORATION POND
- SPILLOVER FLOW
- 2 = 4 + 6 SPLIT FLOW



AECOM

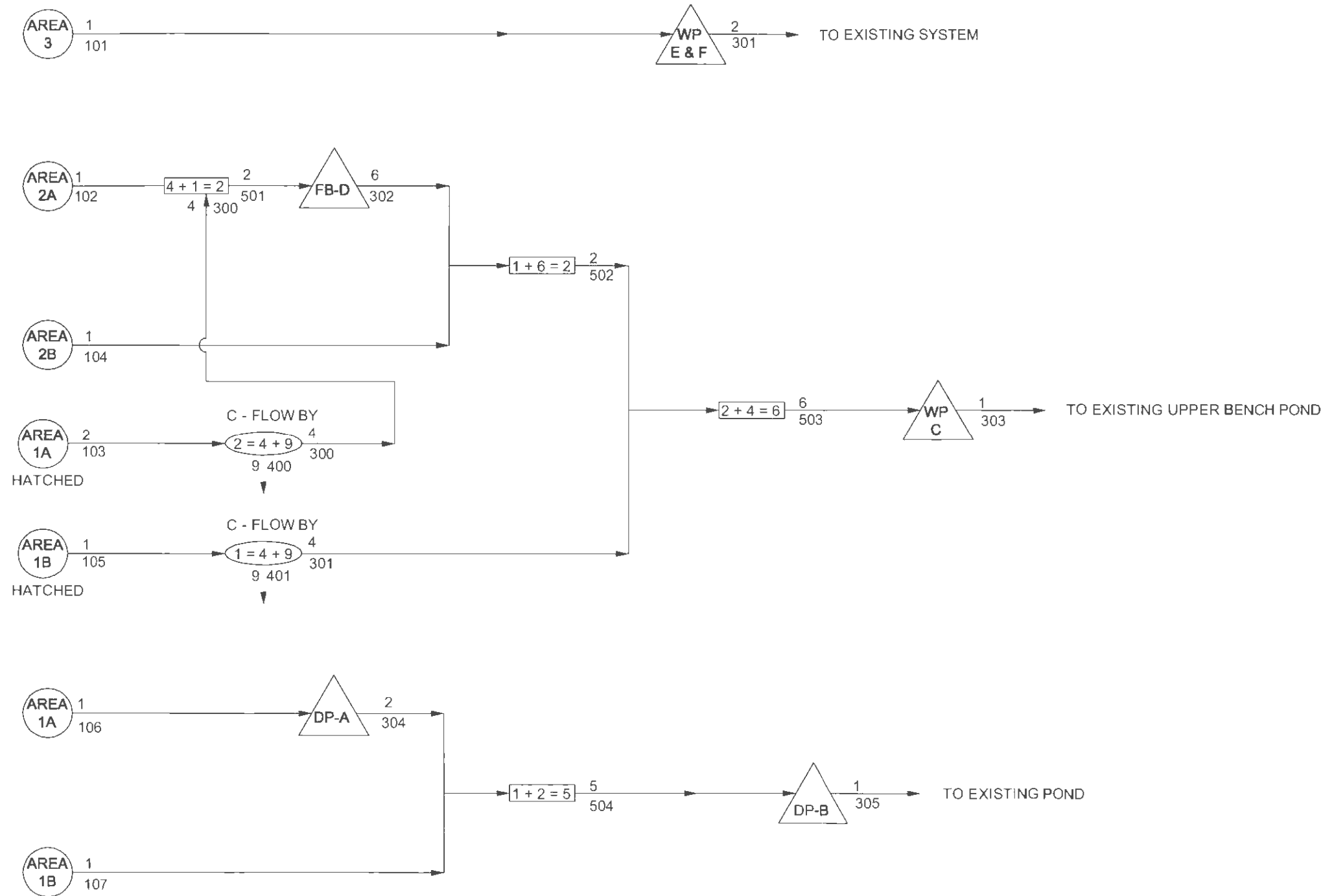
Appendix C

Table C-1: Subcatchment Parameters
Figure 12 - QHM SCHEMATIC
QHM Input (on CD)
QHM Output (on CD)

Table C-1: Subcatchment Parameters

Subcatchment Area	SWMHYMO Identification Number	Area Size (ha)	Imperviousness Percent
3	101	32.60	61
2A	102	18.73	51
1A Hatched*	103	0.91	55
2B	104	14.67	39
1B Hatched*	105	0.88	55
1A	106	16.14	52
1B	107	29.69	52
Total		111.83	53

* Hatched Areas are included in 1A, 1B respectively.



DEFINITIONS

	SUB CATCHMENT
	ADD HYDROGRAPH
	WET POND
	DRY POND
	FOREBAY
	SPILOVER FLOW
	SPLIT FLOW

Appendix D

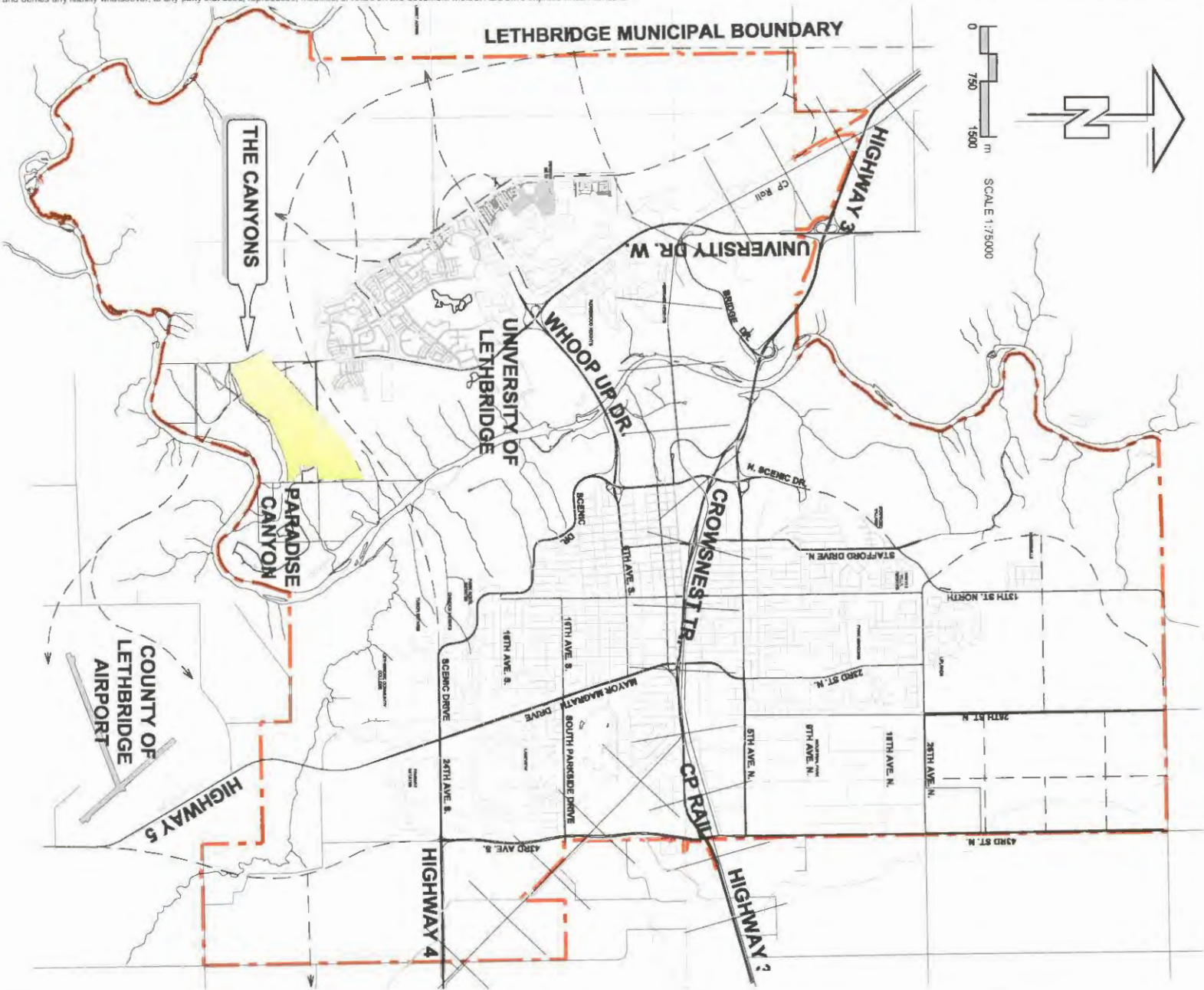
Hydstat Results (on CD)

Appendix E

- Figure 1 Location Plan
- Figure 2 Site Plan
- Figure 3 Dry Pond A
- Figure 4 Dry Pond B
- Figure 5 Wet Pond C & Forebay D
- Figure 6 Wet Pond E & Pond F
- Figure 7 Pond Properties
- Figure 8 Control Structure B, C, E&F
- Figure 9 Orifice Details
- Figure 10 Details

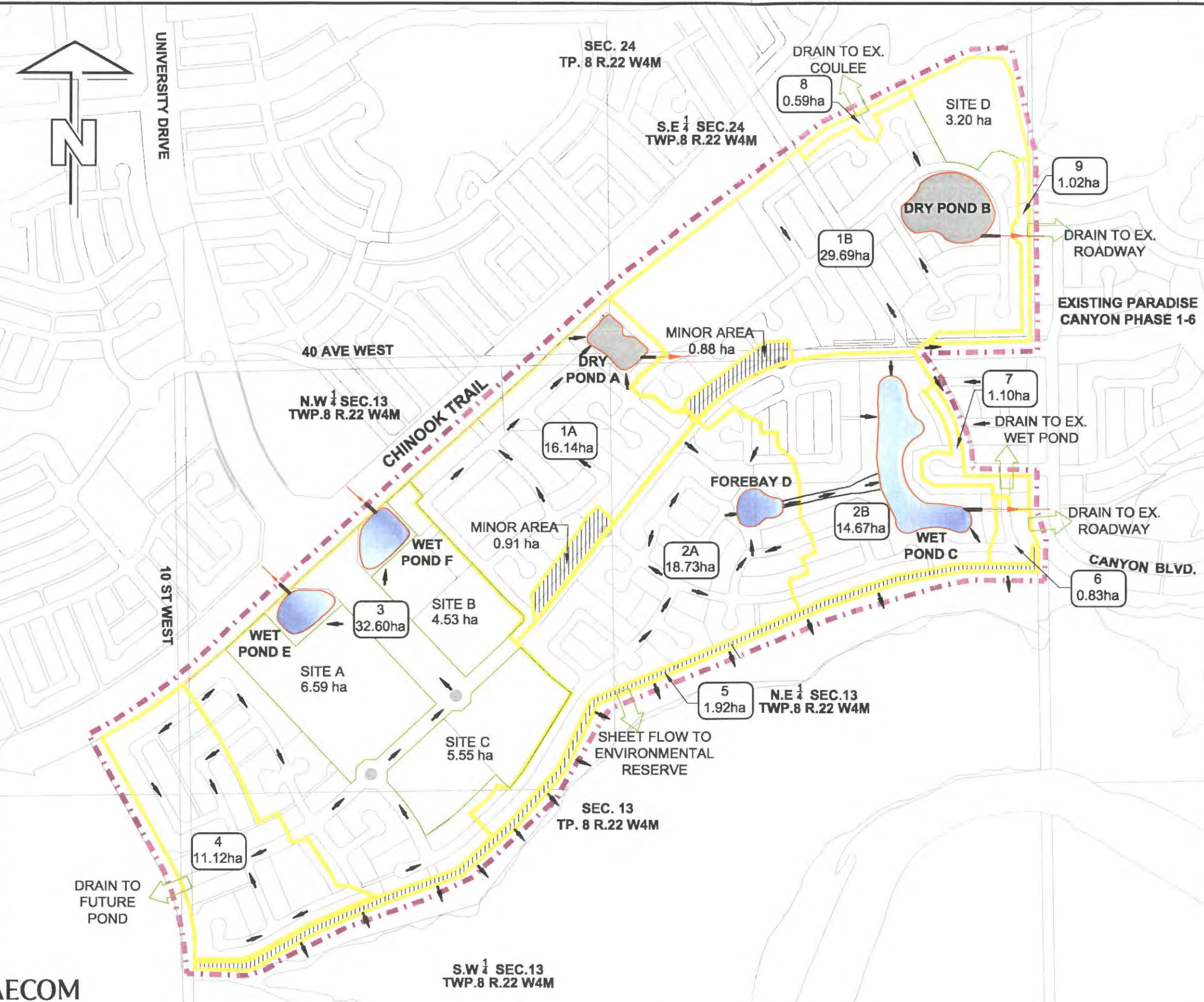
LEGEND

--- CITY BOUNDARY



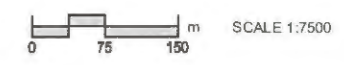
AECOM

Melcor Developments Ltd.
The Canyons
Outline Plan
Stormwater Management Plan
Location Plan
Figure - 1

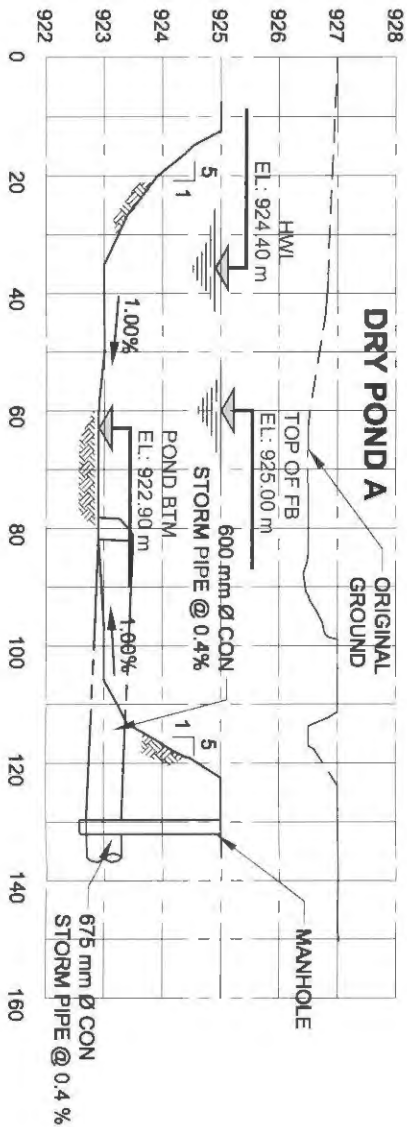


LEGEND

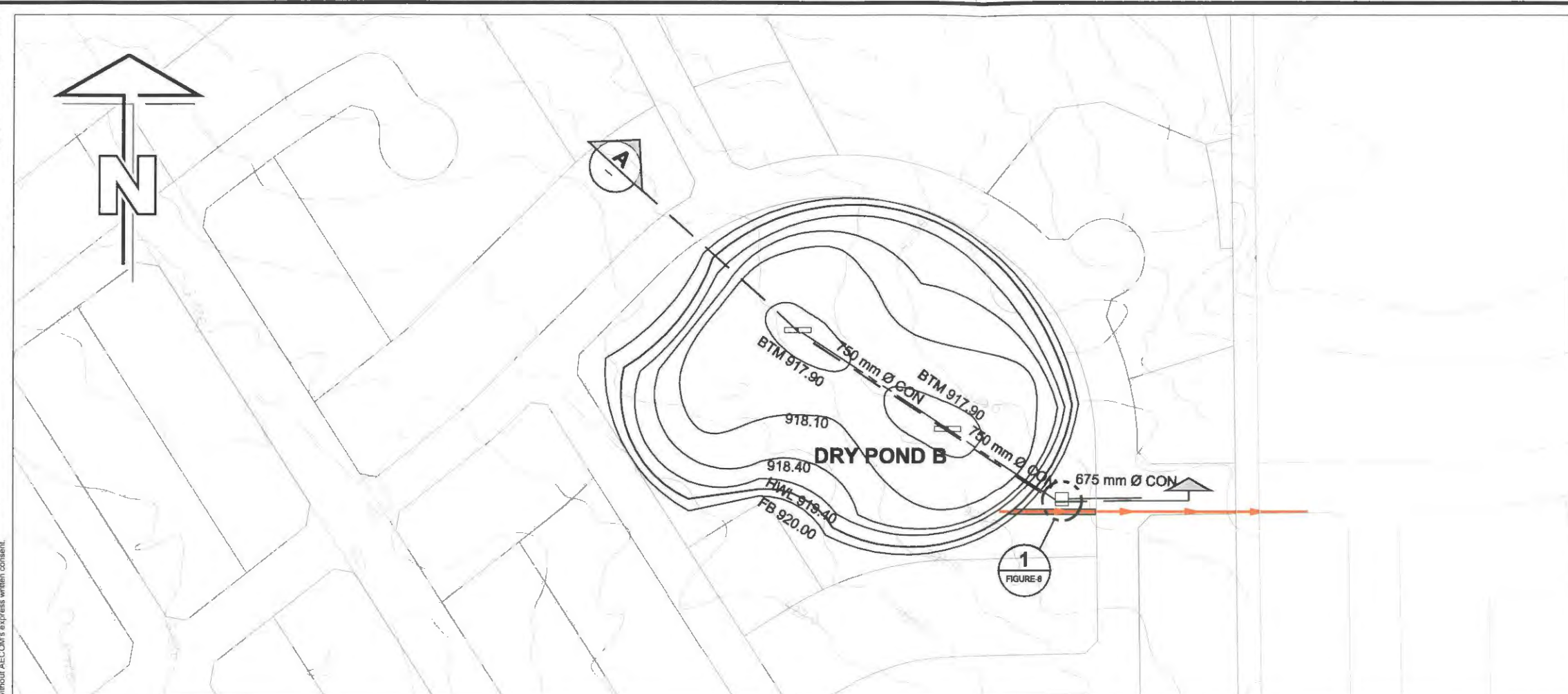
- CONSTRUCTION BOUNDARY
- CATCHMENT AREAS BOUNDARY
- EMERGENCY ESCAPE ROUTE
- CATCHMENT ID
- OVERLAND FLOW DIRECTION
- EMERGENCY ESCAPE ROUTE RIP RAP
- SWMF (DRY POND)
- SWMF (WET POND)
- DRAINAGE EXIT
- MEDIUM/HIGH DENSITY SITE
- 1A DRY POND A CONTRIBUTING AREA
- 2A FORBAY D CONTRIBUTING AREA
- 1B DRY POND B CONTRIBUTING AREA
- 2B WET POND C CONTRIBUTING AREA
- 3 WET POND E & F CONTRIBUTING AREA



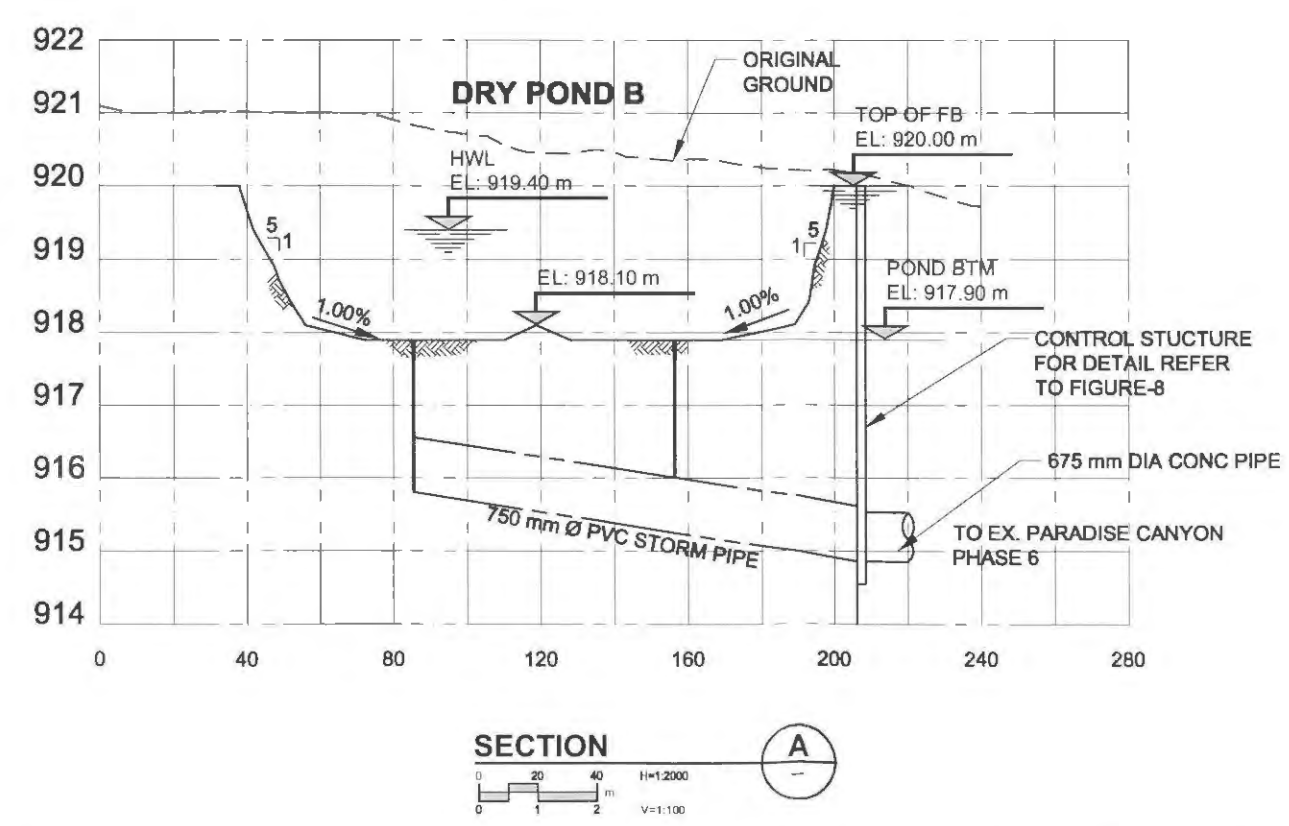
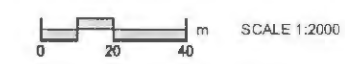
AECOM

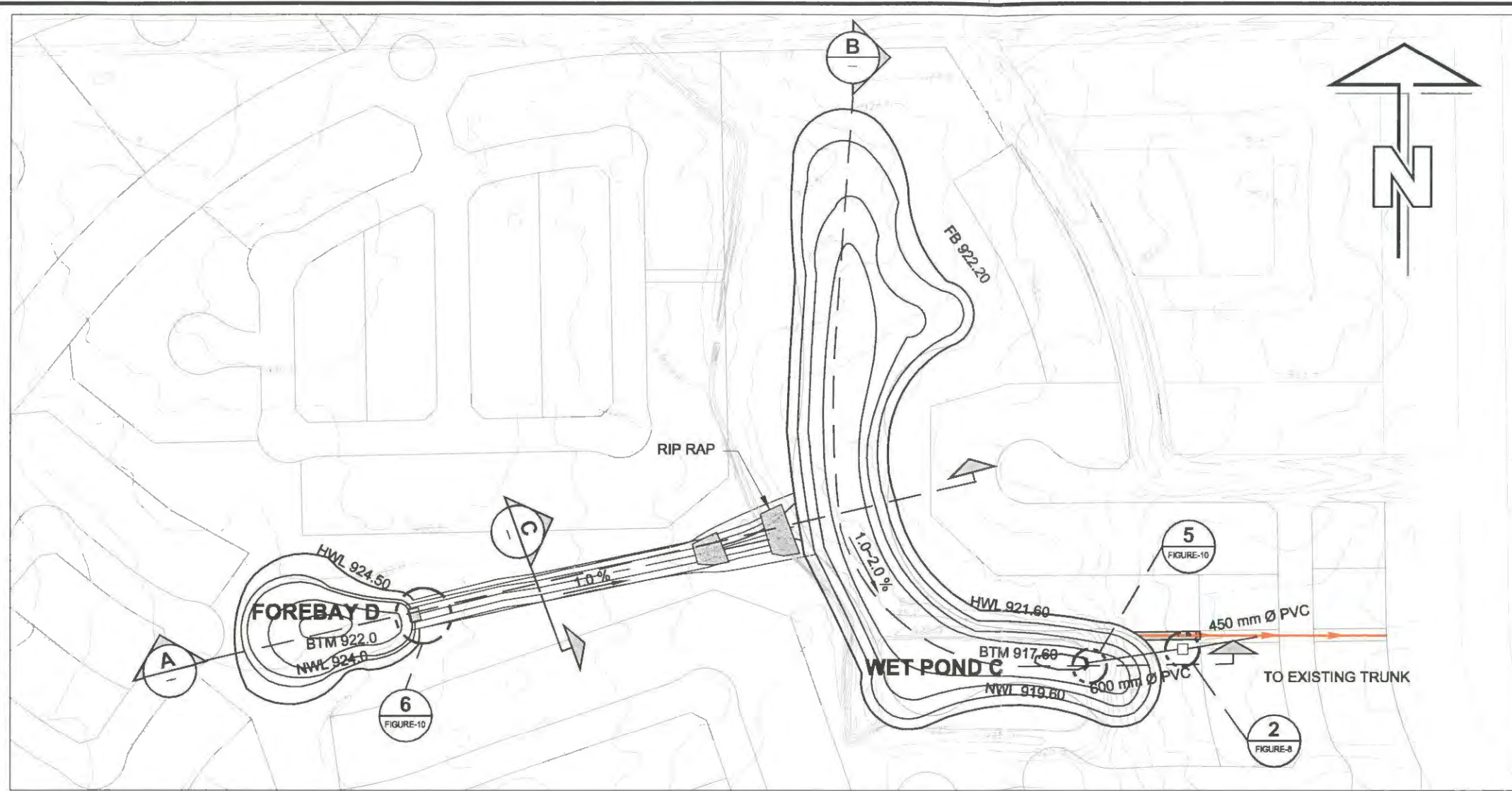


- LEGEND**
- MANHOLE
 - EMERGENCY ESCAPE ROUTE RIPRAP
 - FLARED END PIPE
 - EXISTING CONTOURS
 - EMERGENCY ESCAPE ROUTE
 - PROPOSED STORM PIPE



- LEGEND**
- CONTROL STRUCTURE
 - EXISTING CONTOURS
 - TWIN CATCH BASIN
 - EMERGENCY ESCAPE ROUTE RIPRAP
 - PROPOSED STORM PIPE
 - EMERGENCY ESCAPE ROUTE

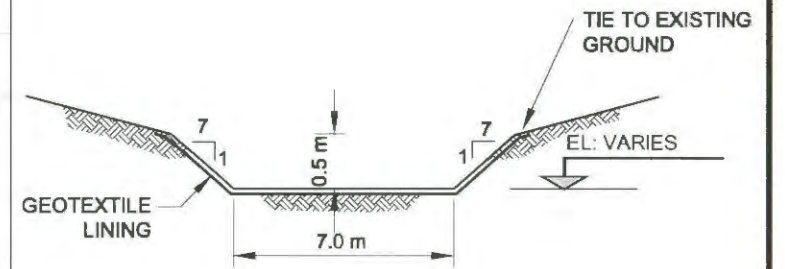




LEGEND

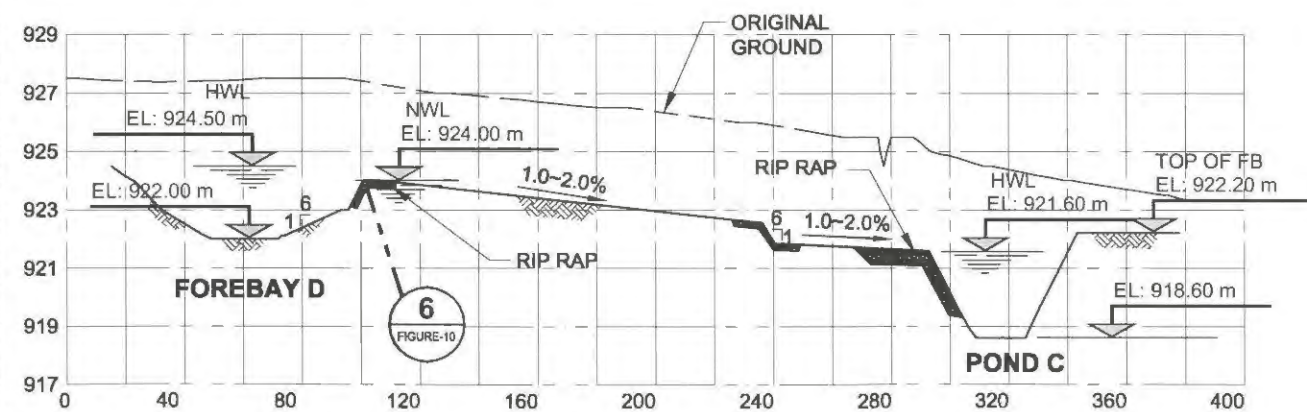
- CONTROL STRUCTURE
- EMERGENCY ESCAPE ROUTE RIPRAP
- FLARED END PIPE
- PROPOSED STORM PIPE
- EMERGENCY ESCAPE ROUTE
- EXISTING CONTOURS

0 25 50 m SCALE 1:2500



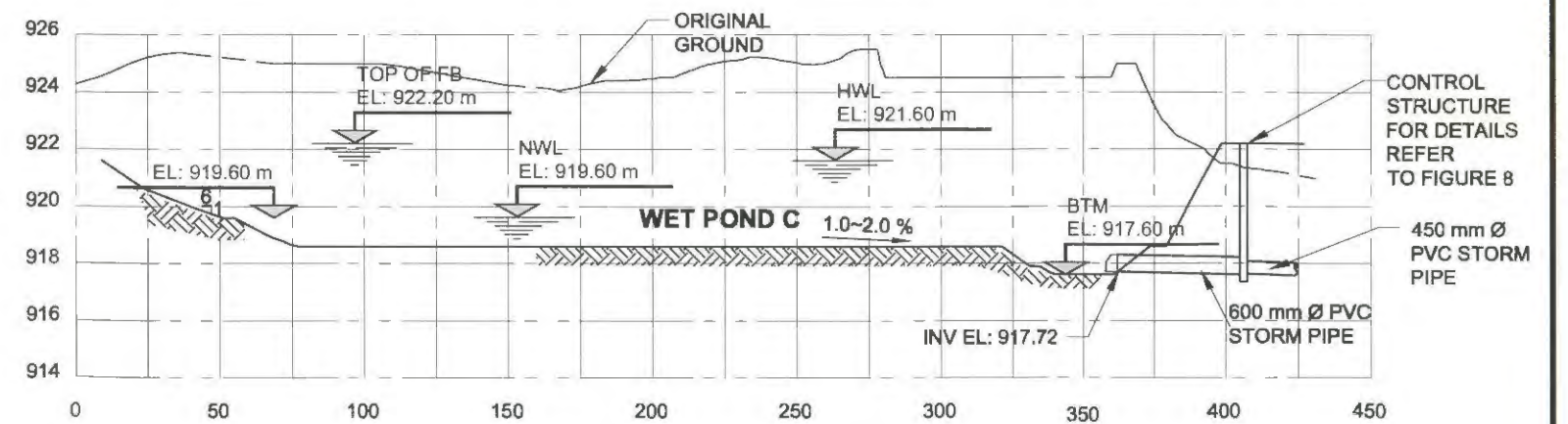
SECTION

SCALE: N.T.S.
 CONVEYANCE DITCH



SECTION

0 25 50 m H=1:2500
 0 5 10 m V=1:250

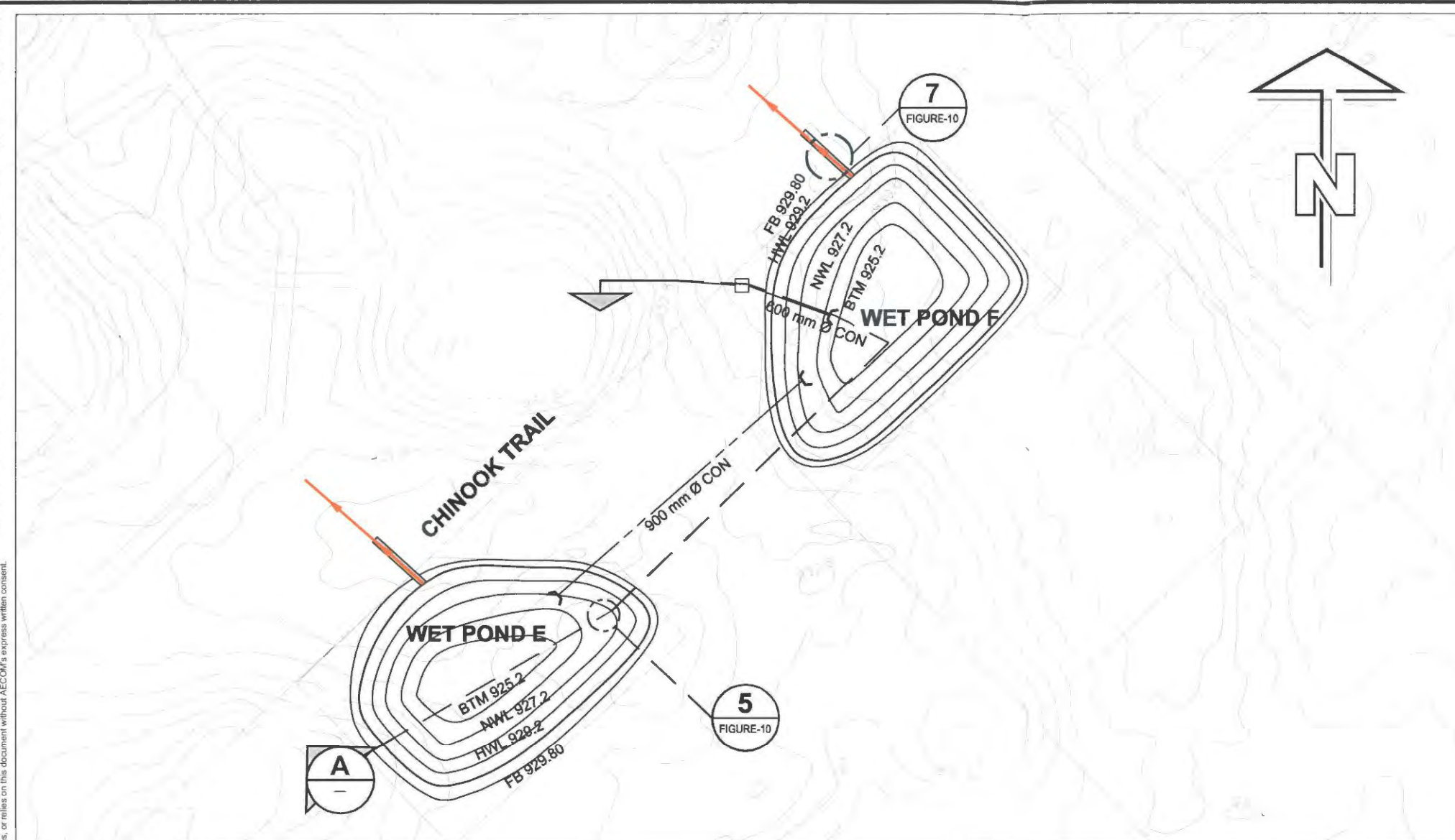


SECTION

0 25 50 m H=1:2500
 0 2.5 5 m V=1:250

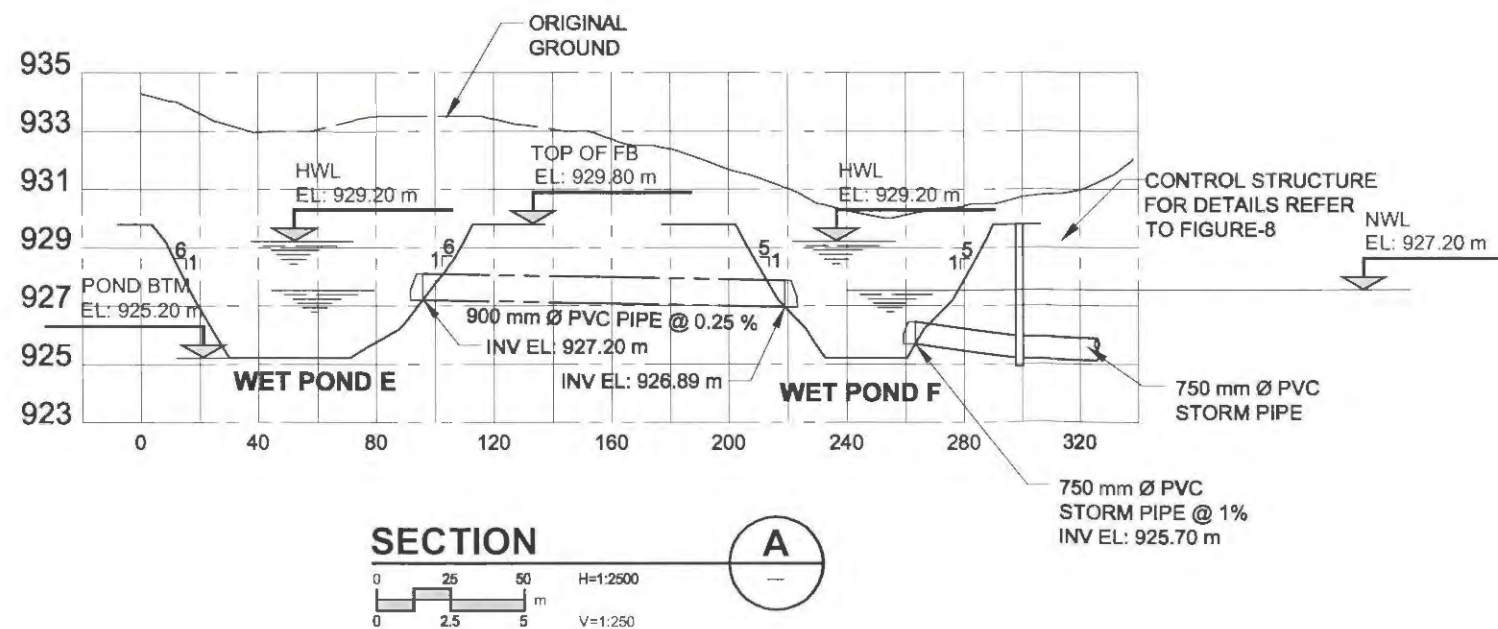
Melcor Developments Ltd.
 The Canyons
 Outline Plan

Stormwater Management Plan
 Wet Pond C & Forebay D
 Figure - 5



LEGEND	
	CONTROL STRUCTURE
	EMERGENCY ESCAPE ROUTE RIPRAP
	FLARED END PIPE
	EXISTING CONTOURS
	EMERGENCY ESCAPE ROUTE
	PROPOSED STORM PIPE

0 20 40 m SCALE 1:2000



Melcor Developments Ltd.
 The Canyons
 Outline Plan

Stormwater Management Plan
 Wet Pond E & F
 Figure - 6

NORTHEAST DRY POND A PROPERTIES

Elevation (m)	Depth (m)	Area (m ²)	Volume (m ³)	Discharge (m ³ /s)	
922.9	0.0	459	0	0.0	BOTTOM
923.0	0.1	1,220	81	0.13	
923.4	0.5	2,976	894	0.32	
923.9	1.0	4,477	2,745	0.45	
924.4	1.5	6,241	5,412	0.56	HWL
925.0	2.1	7,590	9,555		FB

NORTH DRY POND B PROPERTIES

Elevation (m)	Depth (m)	Area (m ²)	Volume (m ³)	Discharge (m ³ /s)	
917.90	0.0	1,194	0	0.00	BOTTOM
918.10	0.2	8,263	840	0.55	
918.40	0.5	12,482	3,930	0.57	
918.90	1.0	15,220	10,844	0.62	
919.40	1.5	17,331	18,976	0.66	HWL
920.00	2.1	17,884	29,540		FB

SOUTH WET POND C PROPERTIES

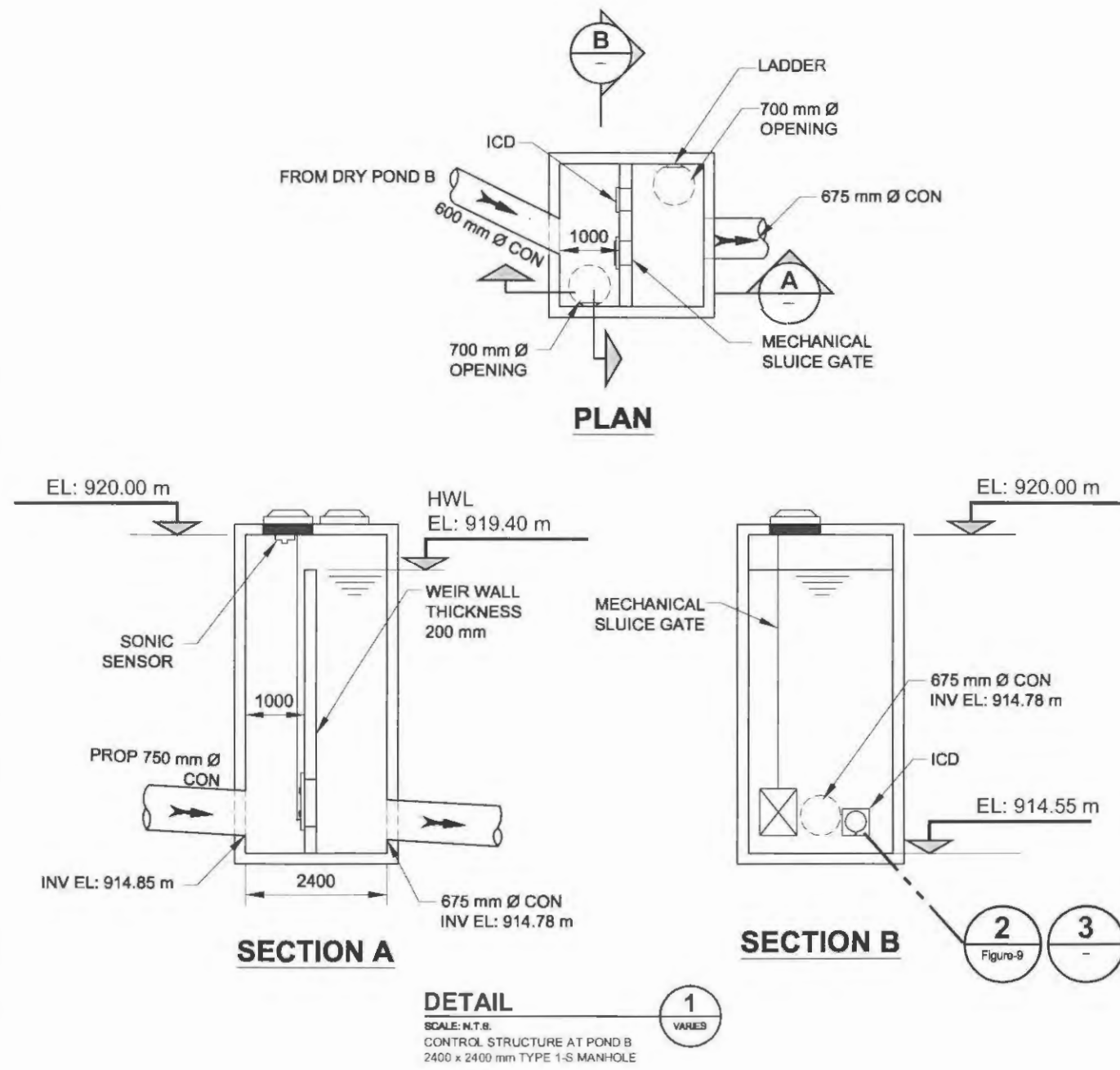
Elevation (m)	Depth (m)	Area (m ²)	Volume (m ³)	Discharge (m ³ /s)	
917.60	0.00	147	0		BOTTOM
918.60	1.00	4,235	1,724		
919.60	2.00	10,490	8,854	0.00	NWL
920.60	3.00	16,113	22,055	0.13	
921.60	4.00	21,100	40,606	0.20	HWL
922.20	4.60	30,000	55,858		FB

SOUTH FOREBAY D PROPERTIES

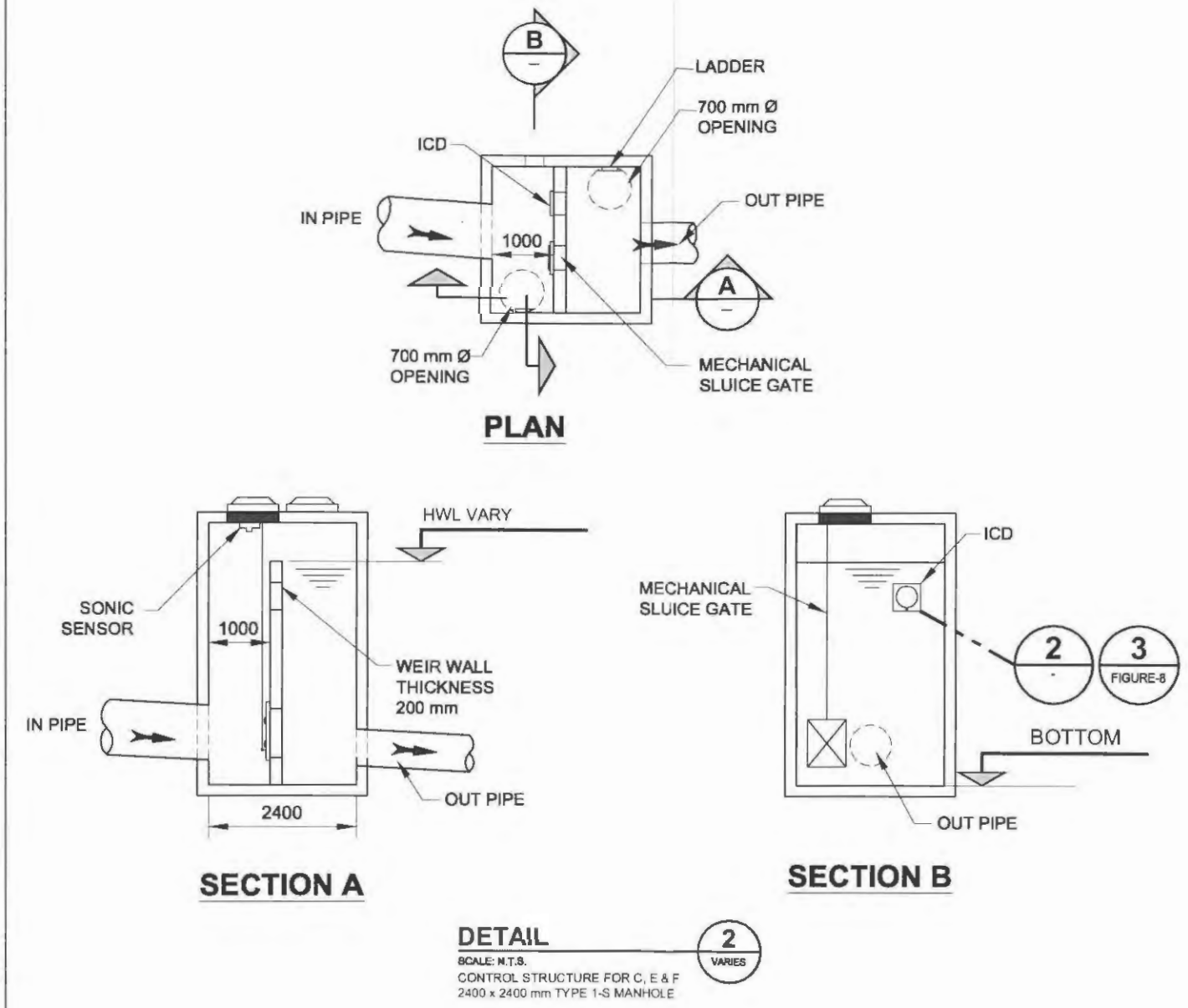
Elevation (m)	Depth (m)	Area (m ²)	Volume (m ³)	Discharge (m ³ /s)	
922.00	0.00	235	0		BOTTOM
923.00	1.00	1,408	739		
924.00	2.00	2,613	2,928	0.00	NWL
924.20	2.20	3,182	3,507	1.06	
924.50	2.50	4,583	4,665	4.21	HWL
925.10	3.10	7,000	8,115		FB

POND E & F PROPERTIES

Elevation (m)	Depth (m)	Area (m ²)	Volume (m ³)	Discharge (m ³ /s)	
925.20	0.00	2,522	0		BOTTOM
926.20	1.00	4,575	3,498		
927.20	2.00	7,851	9,637	0	NWL
928.20	3.00	10,563	18,811	0.33	
929.20	4.00	13,543	30,832	0.50	HWL
929.80	4.60	15,604	39,568		FB

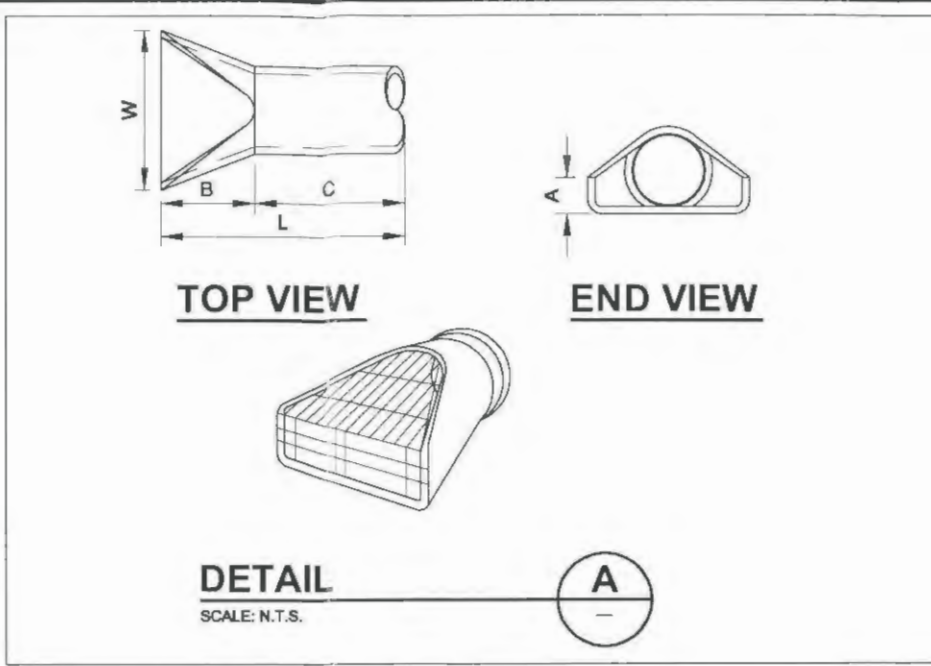
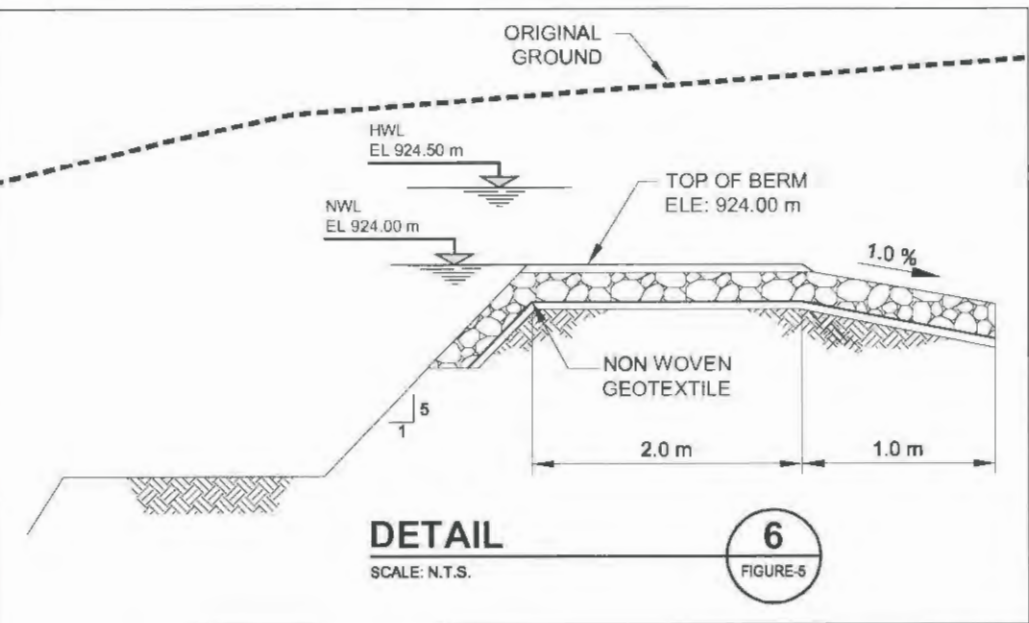
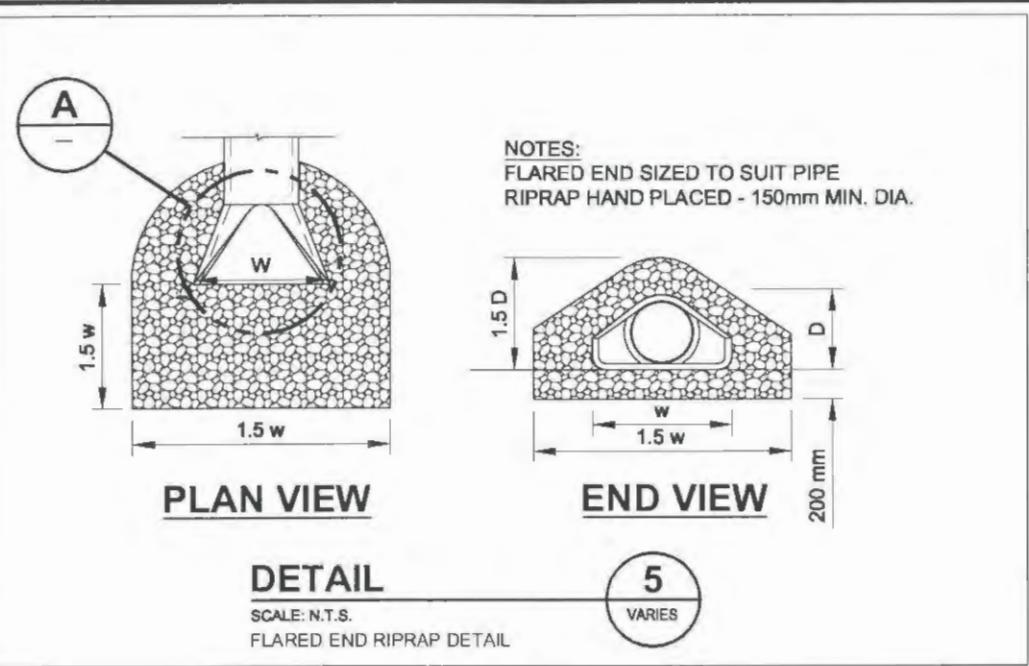


ICD TABLE



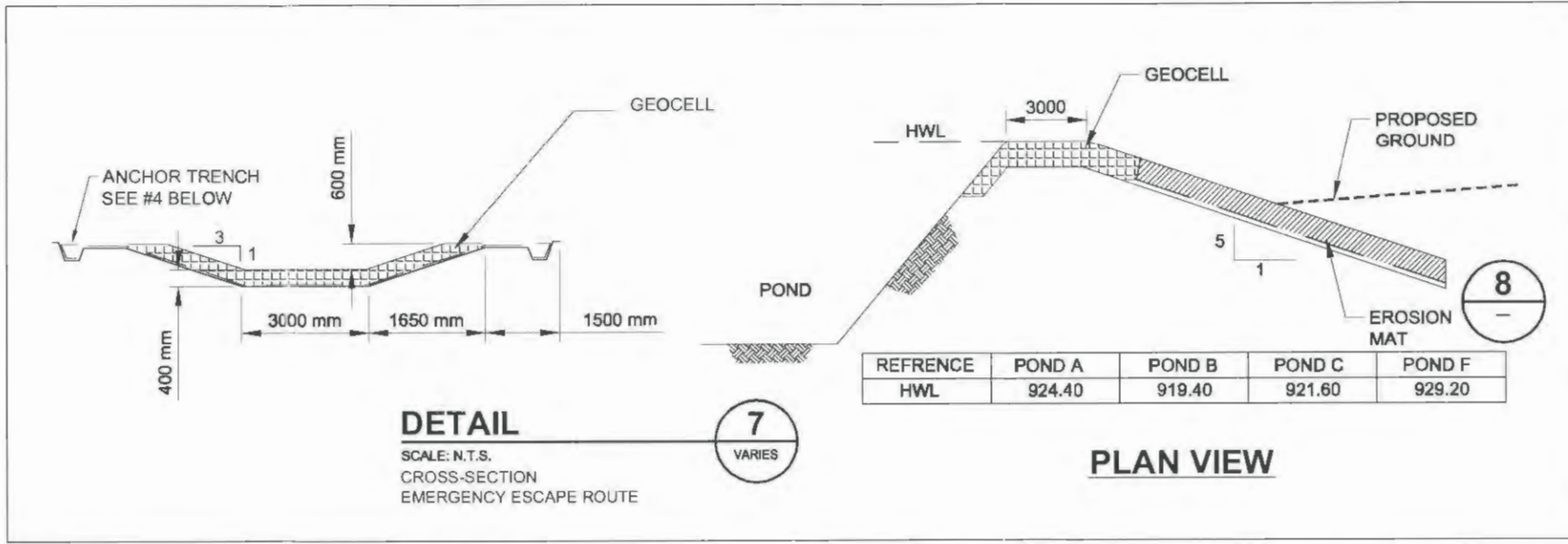
REFERENCE	IN INVERT	OUT INVERT	WEIR HWL	OUT PIPE SIZE	BTM ELEVATION	ORIFICE ELEV
POND E & F	925.20	925.20	929.20	750 mm Ø	924.90	927.20
POND C	917.62	917.62	921.60	450 mm Ø	917.32	919.60

ISS/REV: A
 AECOM FILE NAME: 1560-245-00_03-CWF010_RX.dwg
 PLOT: 11/08/2009 1:33:00 PM
 Saved By: xud
 B SIZE 11" x 17" (279.4mm x 431.8mm)
 © 2009 AECOM Canada Ltd. All Rights Reserved. This document is protected by copyright law and may not be used, reproduced or modified in any manner or for any purpose except with the written permission of AECOM Canada Ltd. ("AECOM") or a party to which its copyright has been assigned. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that uses, reproduces, modifies, or relies on this document without AECOM's express written consent.

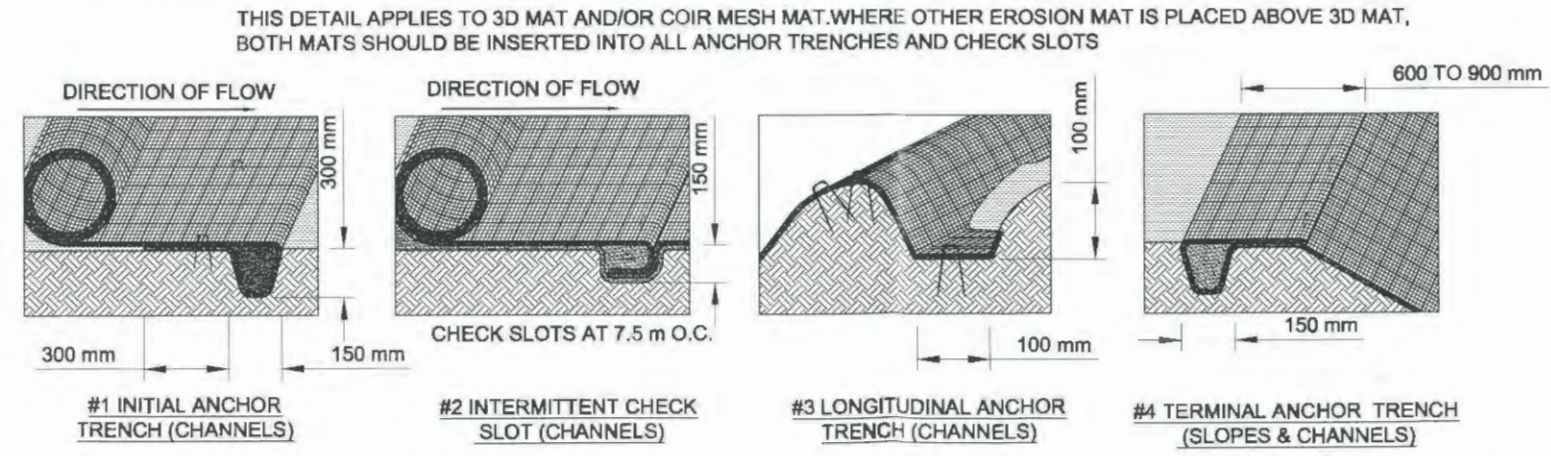


FLARED ENDS	DIMENSIONS (mm)				
NOMINAL DIA. (mm)	A	B	C	L	W
300	188	610	1245	1855	610
*375	TO MATCH DETAILS OF A 450 PIPE				
450	300	670	655	1225	935
525	152	890	965	1855	1067
600	225	1055	725	1780	1200
750	300	1025	525	1850	1500
900	375	570	850	2430	1800
1200	650	1775	875	2450	2100
1350	685	1650	895	2545	2545
1500	760	1525	820	2450	2740
*1950	900	2160	600	2760	1981

*CUSTOM MADE ONSITE FROM 1950 CON PIPE



REFERENCE	POND A	POND B	POND C	POND F
HWL	924.40	919.40	921.60	929.20



7. Overland Drainage Analysis

Melcor Development Ltd.

The Canyons - Overland Drainage Analysis (Revision B)

Prepared by:

AECOM Canada Ltd.

2540 Kensington Road NW, Calgary, AB, Canada T2N 3S3
T 403.270.9200 F 403.270.0399 www.aecom.com

Project Number:

1560-245-00

Report Number:

RPT-076-09

Date:

August 11, 2009

Statement of Qualifications and Limitations

This Statement of Qualifications and Limitations (the "Report") was prepared by AECOM Consulting ("AECOM") on behalf of the client ("Client") in accordance with the agreement between Consultant and Client, including the scope of work ("SOW") therein (the "Agreement").

The information, data, recommendations and conclusions contained in the Report:

- are subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the "Limitations");
- represent Consultant's professional judgement in light of the Limitations and industry standards for the preparation of similar reports;
- may be based on information provided to Consultant which has not been independently verified;
- have not been updated since the date of issuance of the Report and their accuracy is limited to the time period and circumstances in which they were collected, processed, made or issued;
- must be read as a whole and sections thereof should not be read out of such context;
- were prepared for the specific purposes described in the Report and the Agreement;
- in the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time.

Unless expressly stated to the contrary in the Report or the Agreement, Consultant:

- shall not be responsible for any events or circumstances that may have occurred since the date on which the Report was prepared or for any inaccuracies contained in information that was provided to Consultant;
- agrees that the Report represents its professional judgement as described above for the specific purpose described in the Report and the Agreement, but Consultant makes no other representations with respect to the Report or any part thereof;
- in the case of subsurface, environmental or geotechnical conditions, is not responsible for variability in such conditions geographically or over time.

The Report is to be treated as confidential and may not be used or relied upon by third parties, except:

- as agreed by Consultant and Client;
- as required by law;
- for use by governmental reviewing agencies.

Any use of this Report is subject to this Statement of Qualifications and Limitations. Any damages arising from improper use of the Report or parts thereof shall be borne by the party making such use.

This Statement of Qualifications and Limitations is selected to and forms part of the Report.

AECOM

2540 Kensington Road NW, Calgary, AB, Canada T2N 3S3
T 403.270.9200 F 403.270.0399 www.aecom.com

August 11, 2009

Project Number: 1560-245-00

Neil Johnson
Melcor Developments Ltd.
1425 - 33 Street North, 2nd Floor
Lethbridge, AB
T1H 5H2

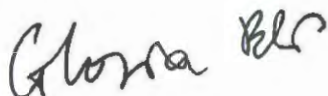
Dear Neil:

Re: Overland Drainage Analysis, The Canyons Revision B

Please find enclosed two (2) copies of the Overland Drainage Analysis for the Canyons. Due to the updated Gate 3 outline plan, we have updated part of the grading plan. The Overland Drainage Analysis presented here is also updated to accommodate all the changes.

If you have any questions regarding this report, please do not hesitate to contact the undersigned at 403-270-9119.

Sincerely,
AECOM Canada Ltd.



Gloria Bei, P.Eng.
Water Management Engineer
gloria.bei@aecom.com

GB:kr

cc: Trevor Loomer, AECOM

Revision Log

Revision #	Revised By	Date	Issue / Revision Description
A	Gloria Bei	July 22, 2008	Issued for Approval
B	Gloria Bei	August 11, 2009	Issued with Revisions for Approval

Signature Page

Report Prepared By:



Gloria Bei, P.Eng.
Water Management Engineer

Report Reviewed By:

Alan Newcombe, P.Eng.
Project Manager

Table of Contents

Statement of Qualifications and Limitations

Letter of Transmittal

	page
1. Introduction	1
1.1 General	1
1.2 Study Area	1
1.3 Study Objective	1
1.4 Design Criteria	1
2. Drainage Characteristics	3
3. Technical Approach	4
3.1 Modelling Approach	4
3.2 Overland Flow Routes	4
3.3 Storm Sewer System	4
3.4 Subcatchment Parameters	5
3.5 Catchbasin Capture Curves	5
3.6 Inlet Control Devices	5
3.7 Surge Analysis	6
3.8 Design Storms	6
3.9 External Areas	6
4. Results of Analysis	7
4.1 Overland Flow	7
4.2 Trap-Low Evaluation	10
4.3 Recommendations	11
4.3.1 Recommended Measures to Protect the Minor System	11
4.3.2 Erosion Control	11
5. Conclusions and Recommendations	13
6. References	14

List of Figures

Figure 4-1. Depth and Velocity of Street Flows for the 4-Hour Duration 1:100 Year Design Storm	10
--	----

List of Tables

Table 3-1. A, B, C Coefficients for use with the Chicago method for Rainfall distribution Hyetographs	6
Table 4-1. Summary of the Canyons Peak Discharge for Critical Segments	7

Table 4-2. Summary of the Canyons Overland Flow Assessment for Critical Segments	9
Table 4-3. Summary of Drop Manholes	12
Table 4-4. Summary of Impact Baffle Structures	12

Appendices

- A. Rainfall Intensity-Duration-Frequency of Lethbridge; Capture Rating Curve for Catchbasins under Flow-by-Condition; Capture Rating Curve for Catchbasins under Ponding Condition; ICD Capture Curves; Impact Baffle Structure
- B. XP-SWMM Model Schematic for West System; XP-SWMM Model Output for West System (on CD); Hydraulic Grade Line during a 1:100 Year, 4-Hour Storm Event; Hydraulic Grade Line during a 1:5 Year, 4-Hour Storm Event
- C. XP-SWMM Model Schematic for Chinook Pond System; XP-SWMM Model Output for Chinook Pond System (on CD); Hydraulic Grade Line During a 1:100 Year, 4 Hour Storm Event; Hydraulic Grade Line During a 1:5 year, 4 Hour Storm Event
- D. XP-SWMM Model Schematic for Dry & Wet Pond System; XP-SWMM Model Output for Dry & Wet Pond System (on CD); Hydraulic Grade Line during a 1:100 year, 4 hour Storm Event; Hydraulic Grade Line during a 1:5 year, 4 hour Storm Event
- E. Figure 1 Location Plan; Figure 2 Site Plan; Drawing CW1001- CW1002 Storm Area Design; Drawing CW1003 – CW1004 Overland Drainage; Drawing CW4001 Details

1. Introduction

1.1 General

Melcor Development Ltd. has retained AECOM Canada Ltd. (AECOM) to conduct a drainage analysis for the Canyons subdivision in Lethbridge. This report outlines the methodology used and the results obtained for the overland drainage assessment and associated storm sewer system analysis.

1.2 Study Area

The site consists of 128.4 ha and is located in west Lethbridge. The site is bounded by Chinook Trail on the north and is adjacent to the Paradise Canyon Phase 6 to the east, as defined in the "Upper Bench Stormwater Management" report which was completed by UMA in June 2003. The site is located within the following legal sections:

- SE ¼-24-8-22-W4M
- NE ¼-13-8-22-W4M
- NW ¼-13-8-22-W4M
- SW ¼-13-8-22-W4M

Figure 1 is the location plan, found in Appendix E.

Figure 2 is the site plan, along with the construction boundary, also in Appendix E.

1.3 Study Objective

The objective of this study is to determine and evaluate the overland flow paths in the development area under severe storm conditions. In addition, this study evaluates the measures required to prevent the storm sewer system from causing flooding under severe storm conditions.

1.4 Design Criteria

Maximum flows, associated depths and velocities are tested against Alberta Environment's (AE) design criteria. These criteria have been adopted by the City of Lethbridge, and have been applied in this report.

During a storm event, lot and street drainage will enter the minor system and into the Stormwater Management Facility (SWMF). The minor system for this site is designed to route the 4-hour, 5-year storm without surcharge. The major system will detain and route the stormwater flows on-site. The major system is designed to accommodate a 4-hour 100-year storm.

The minor system has been designed to ensure the system does not cause flooding during the 4-hour 100-year event. In addition, the following design objectives and criteria, summarized from Stormwater Management Guidelines for the Province of Alberta (Alberta Environment Protection, 1999) have been applied:

- The system should store and efficiently remove the runoff from rainstorms below its design capacity;
- Where system flow is surcharged and weeping tiles are connected to the storm system the surcharge should not exceed basement levels;
- Where there are no weeping tile connections, surcharging is permitted;
- No surcharging to surface is permitted;
- Building grades should be at least 300 mm above the maximum water level of adjacent traplows,
- Flow depths at gutters and traplows should not exceed 300 mm; and,
- Velocities in overland channels should be minimized.

All details of the design conform to the City of Lethbridge Design Standards 2009.

2. Drainage Characteristics

Post-development flows from the proposed development will be conveyed through the proposed storm sewer to five SWMFs. For the detailed pond information please refer to the *"The Canyons Stormwater Pond Report Revision C"* by AECOM Canada Ltd., 2009.

The post-development land use of the development area, as shown in Drawing 02-CW1001 and 02-CW1002, will be residential. In total, the development area conveyed by minor system comprises 123.78ha, with an average imperviousness ratio of about 55%. This ratio has been directly calculated and is similar to City of Lethbridge values for residential developments. The other 2.51 ha back-to-lot area will drain directly to coulees and 2.12 ha will overland to offsite.

Design grades provided indicate that when the area is developed, the overall direction of the overland drainage will be towards their SWMFs respectively. As identified in the design criteria, grading and minor system flows must ensure that overland flow will not cause spillover into other developments.

According to their discharging outlet, the site is divided into 4 systems: Chinook Pond system, Dry Pond system, Wet Pond system and West system. The Dry Pond system comprises of 41.35ha, and drains to Dry Pond A & B. The Wet Pond system comprises of 35.19 ha, conveys to Wet Pond C and its separate Forebay D. The Chinook Pond system contains 32.60 ha, and drains to Chinook pond E & F at the west entrance. The West system has an area of 11.11 ha, which drains to a temporary dugout located offsite. Two areas 226 and 216 on the super collector road will be collected in the minor system that flows to Forebay D and Wet Pond C respectively but north portion of the areas will overland to Dry Pond A and Dry Pond B respectively.

There are four traplows within the West system, six traplows within the Chinook Pond system, 11 traplows within the Wet Pond system and six traplows within the Dry Pond system. Those traplows are shown on Drawings 02-CW1003 and 02-CW1004.

For all of the traplows, the maximum 1:100 year storage depth is less than the permissible maximum 1:100 year depth of ponding of 0.3 m on roadways.

3.4 Subcatchment Parameters

Drainage characteristics of the study area were determined for post-development conditions. These characteristics include catchment size, the imperviousness ratio, slope, depression storage, and SCS curve numbers. To characterize the drainage of subcatchment areas, the following aspects were taken into account in determining the model parameters:

- The imperviousness ratio was calculated for each subcatchment area.
- Depression storage losses of 0.8 mm were used for the impervious and 1.5 mm for the pervious areas, as stated in the City of Lethbridge Guidelines.
- A value of 72 was used for the curve number (CN), as identified in the City of Lethbridge Guidelines.

3.5 Catchbasin Capture Curves

There are two types of catchbasins being used to intercept all overland flows in the Canyons development: K1 and K2. Type K2 is for rolled curb. Type K1 with storm back is for non-rolled curb and gutter. Most residential areas within the Canyons use rolled curb. The only areas that do not would be roads with lots backing onto them and the super collector, type K2 is used where applicable unless a bigger capture rate is preferred at that area. In this case, type K 1 is used for rolled curb and gutter as well.

Two conditions of flow occur with catchbasins: flows along a continuous grade (flow by) and flows under ponding (traplow) conditions.

The capture rating curves for catchbasins under flow-by condition and under ponding condition are used to determine flow captured into pipe system by each catchbasin in the XP-SWMM models. The capture rating curves are based on testing done by Townsend and Moss (1980) and Wilson (1983). Testing results are provided in "City of Calgary Stormwater Management Design Manual 2006". Those rating curves are included in Appendix A.

3.6 Inlet Control Devices

In the City of Lethbridge, the use of ICDs to control inlet capacity is discouraged on all storm systems that are to be dedicated to the City. As a result, ICDs used in the Canyons are in the control structures for the SWMFs.

3.7 Surcharge Analysis

The output of the XP-SWMM model is analyzed to ensure there is no flooding during the 100-year 4-hour storm event. This allows undersized system components to be identified and modified. This is done using an iterative process where flooding is identified, component sizes are modified, and the XP-SWMM model is run again. This process is repeated until the entire system analysis shows the system working efficiently.

Appendix B-D contains the hydraulic grade line analysis from XP-SWMM for a 1:100 year return period event. The analysis shows the storm sewer pipes have enough capacity so that the hydraulic grade line will not rise above the surface.

3.8 Design Storms

The 4-hour 100-year design storm input to the XP-SWMM model is based on a series of synthetic rainfall events developed from long-term City of Lethbridge precipitation data. The design storm used for modeling purposes was generated using the Chicago 4-hour distribution.

Rainfall intensities for the Chicago distribution are derived from an intensity-duration-frequency (IDF) relationship as follows:

$$I = \frac{a}{(b+t)^c}$$

where I is the intensity (mm/hr), t is time in minutes and a, b and c are unit less constants specific to the rainfall data being used.

The a, b & c values used in this report were defined as Table 3.1 below. Use of the term "design storm" hereafter implies a return period of 100 years.

Table 3-1. A, B, C Coefficients for use with the Chicago method for Rainfall distribution Hyetographs

Return Frequency of Rainfall Event (1:Xyear)	A	B	C
1:5	789.6	5.409	0.796
1:100	2067.45	7.067	0.840

3.9 External Areas

With respect to the interaction of the Canyons with external downstream or tributary areas, the Canyons do not receive overland flow from other adjoining areas.

4. Results of Analysis

4.1 Overland Flow

Drawings 02-CW1001 and 02-CW1002 show the delineation of the Canyons catchment area into subcatchments and street segments. The XP-SWMM model was used to assess the overland drainage for the 1:100 year, 4-hour design storm.

Peak discharge rate for a critical segment contains two portions: runoff generated from the catchment and overland flow from its upstream catchment. These two portions are obtained from XP-SWMM model. Table 4.1 shows the accumulative peak rates for the critical segments. Table 4.2 shows the peak discharges, depth of flow, and velocity of flow for critical segments identified on Drawing 02-CW1003 and 02-CW1004.

Table 4-1. Summary of the Canyons Peak Discharge for Critical Segments

Sub-Catchment Reference	Peak Discharge from Sub-Catchment (m ³ /s)	Overland Flow from Upstream Sub-Catchment (m ³ /s)	Accumulative Peak Discharge (m ³ /s)
Chinook Pond System			
332	0.46	0	0.46
330	0.41	0.04	0.45
324	0.39	0	0.39
322	0.29	0.01	0.29
312	0.92	0.23	1.15
West System			
406	0.24	0.25	0.49
404	0.34	0.14	0.48
402	0.47	0	0.47
410	0.49	0	0.49
Dry Pond System			
146	0.15	0.93	1.08
158	0.31	0.07	0.38
148	0.34	0.77	1.11
226	0.42	0.00	1.10

Sub-Catchment Reference	Peak Discharge from Sub-Catchment (m ³ /s)	Overland Flow from Upstream Sub-Catchment (m ³ /s)	Accumulative Peak Discharge (m ³ /s)
142	0.27	0.00	0.27
143	0.10	0.23	0.33
134	0.35	0.00	0.35
132	0.42	0.08	0.50
124	0.44	0.75	1.19
120	0.15	0.72	0.87
106	0.18	0.25	0.43
Wet Pond System			
236	0.26	0	0.26
228	0.23	0.21	0.44
221	0.44	0	0.44
220	0.42	0.43	0.85
202	0.39	0	0.39
214	0.22	0	0.22
208	0.31	0	0.31
600	0.15	0	0.15

Table 4-2. Summary of the Canyons Overland Flow Assessment for Critical Segments

Sub-Catchment Reference	Peak Discharge (m ³ /s)	Maximum Velocity (m/s)	Maximum Depth (m)
Chinook Pond System			
332	0.46	0.69	0.163
330	0.45	0.69	0.163
324	0.39	0.68	0.152
322	0.29	0.63	0.135
312	1.15	0.8	0.227
West System			
406	0.49	0.69	0.167
404	0.48	0.69	0.166
402	0.47	0.69	0.165
410	0.49	0.69	0.167
Dry Pond System			
146	1.08	0.79	0.223
158	0.38	0.68	0.15
148	1.11	0.86	0.22
226	1.10	0.79	0.22
142	0.27	0.27	0.13
143	0.33	0.66	0.14
134	0.35	0.35	0.14
132	0.50	0.79	0.16
124	1.19	1.06	0.20
120	0.87	0.85	0.20
106	0.43	1.03	0.13
Wet Pond System			
236	0.26	0.62	0.13
228	0.44	0.74	0.155
221	0.44	0.68	0.16

Sub-Catchment Reference	Peak Discharge (m ³ /s)	Maximum Velocity (m/s)	Maximum Depth (m)
220	0.85	1.14	0.155
202	0.39	1.1	0.12
214	0.22	0.63	0.12
208	0.31	0.64	0.139
600	0.15	0.64	0.097

*The peak discharge figures are obtained from the XP-SWMM model results in Appendix B-D.

Figure 4.1, which presents the combinations of actual depth of flow and velocity given in **Table 4.2** versus Alberta Environment's Guidelines, shows that flow conditions in all street and gutter segments conform to Alberta Environment's Guidelines.

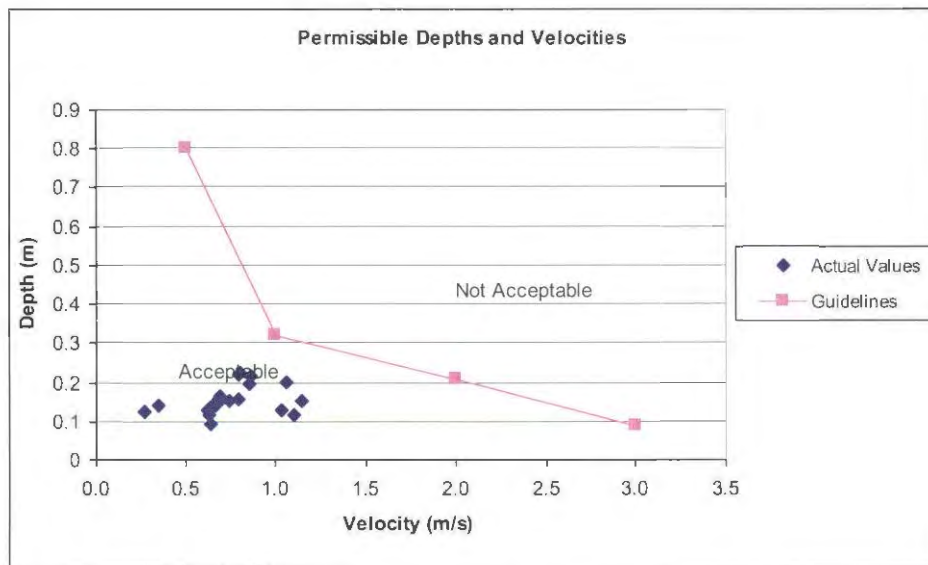


Figure 4-1. Depth and Velocity of Street Flows for the 4-Hour Duration 1:100 Year Design Storm

Appendix B-D contains schematics of the XP-SWMM model and input and output data files for the 4-hour Chicago design storm event.

4.2 Trap-Low Evaluation

The available storage capacity, the maximum storage volume and the associated depth for the 4-hour design storm are tabulated on Drawing 02-CW1003 and 02-CW1004 for the Canyons catchment areas. The maximum 1:100 year trap-low storage and depth of ponding are shown on drawing 02-CW4001 in Appendix E.

Drawing 02-CW1003 and 02-CW1004 show that the maximum depths of ponding for the trap-low in the Canyons catchment areas are less than the permissible maximum 1:100 year depth of 0.30 m on roadways.

4.3 Recommendations

4.3.1 Recommended Measures to Protect the Minor System

To prevent the storm sewer system from overloading under severe storm conditions, proper catchbasins should be strategically located as shown on Drawing 02-CW1001 and 02-CW1002 in Appendix E. The hydraulic grade line (HGL) from the 4-hour duration design storm is also tabulated in Appendix B-D. As a result, the HGLs for a 5 year-4 hour duration storm are below the crown of the pipe, and there is no surcharge to the ground for a 1:100 year-4 hour storm event.

The results of the XP-SWMM analysis show that the minor system does not experience any flooding. Most of overland (major) stormwater flows are collected by catchbasins and conveyed by pipe network into the SWMFs; the excess flow will drain through road gutters to the SWMFs. Q,V,Ds in the most critical segments comply with AENV's guideline during a 1:100 year design event.

Catchbasins, with and without sumps, can collect debris and sediment. The cleaning of accumulated sediments in catchbasins can reduce the amount of pollutants discharged to receiving waters. While catchbasins with sumps are more effective in trapping the larger runoff particles than catchbasins without sumps. To improve sedimentation, all of catchbasins are provided with a 350mm deep sump. Catchbasin cleaning must be carried out frequently.

Sump pumps are used for foundation drainage so no storm sewer back up occurs during major storm events.

Appendix B-D contains the XP-SWMM input and output files for the 1:100 year design storm.

4.3.2 Erosion Control

To minimize erosion and scour, and re-suspension of sediments to the SWMFs, it is desired to limit inlet velocity close to 1.5 m/s where possible. By using drop manholes, some inlet velocities are reduced to meet the criteria. Table 4.3 provides a summary of drop manholes used in the Canyons Development.

Table 4-3. Summary of Drop Manholes

Upstream Manhole Reference	SWMF Reference	Rim of Manhole (m)	Downstream Invert (m)	Drop (m)	Inlet Velocity (m/s)
MH 140	Pond A	926.0	922.60	1.16	2.50
MH 204	Pond C	926.55	919.60	3.63	1.53
MH223	Forebay D	926.50	924.00	0.83	2.03
MH218	Forebay D	928.20	924.00	1.58	3.45
MH200	Pond C	926.26	919.62	1.58	2.81

As outlined in City of Lethbridge Design Standard 2009, the lowest adjacent manhole invert shall be at or above the normal water level elevation. It restricts the application of drop manholes. Alternatively, six impact baffle structures are used to reduce the inlet velocity to 1.5m/s. Table 4.4 provides a summary of impact baffle structures. A concept drawing of impact baffle structure is included in Appendix A.

Table 4-4. Summary of Impact Baffle Structures

Upstream Manhole Reference	SWMF Reference	Inlet Size (mm)	Inlet Flow Rate During a major storm event (m ³ /s)	Inlet Velocity (m/s)
MH140	Pond A	600	0.72	2.50
MH111	Pond B	1200	3.13	2.71
MH218	Forebay D	750	1.55	3.45
MH223	Forebay D	525	0.44	2.03
MH 312	Pond E	1200	2.33	2.68
MH200	Pond C	450	0.45	2.81

5. Conclusions and Recommendations

1. All computed overland flow depths and velocities in the Canyons development comply with Alberta Environment Guidelines, which have been adopted by the City of Lethbridge. In addition, the computed maximum depth of water on the roads is less than 0.30 m and thus complies with the City of Lethbridge's *Design Standards 2008*.
2. The spillover depth is less than 0.30 m for all the road trap-lows in the Canyons development area.
3. The 1:5 year, 4 hour storm was used to determine the minor flows in the study area. The 1:100 year, 4 hour storm results show no surcharging in the minor system.
4. Five SWMFs will need to be constructed so that the runoff can be controlled.
5. Most overland (major) stormwater flows are collected by catchbasins and conveyed by minor system pipe network into the SWMFs; the excess flow will drain through road gutters to the SWMFs. Q,V,Ds in the most critical segments comply with AENV's guideline.
6. Five drop manholes and six impact baffle structures are proposed to reduce the inlet velocity to/below 1.5 m/s to minimize erosion and scour.

6. References

City of Calgary, "*ICD Testing Results (Revised November 1995)*", Sewer Division, 1995

City of Calgary Stormwater Management Design Manual, 2006

Design Standards, *City of Lethbridge*, 2009

Stormwater Pond Report Revision C, *AECOM Canada Ltd.*, 2009

Topographic Information

Appendix A

Rating of Inlet to Gravity Detention Ponds (M. Haktanir, 1992)

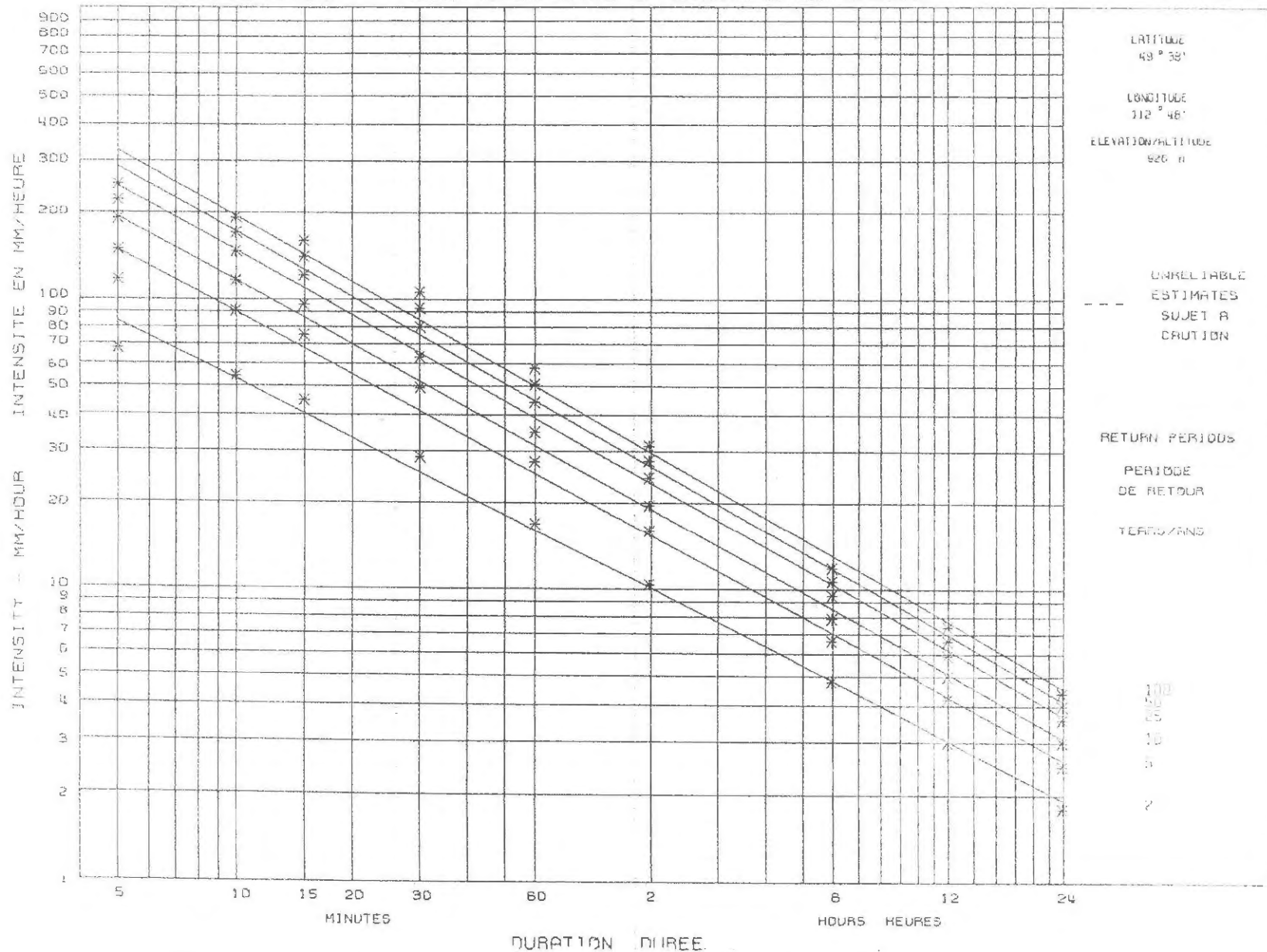
Capture Rating Curve for Catchbasins under Flowing Condition

Capture Rating Curve for Catchbasins under Freezing Condition

ICD Capture Curves

Impact Baffle Structure

SHORT DURATION RAINFALL INTENSITY-DURATION FREQUENCY DATA FOR-
 DONNEES SUR L'INTENSITE, LA DUREE ET LA FREQUENCE DES CHUTES DE PLUIE DE COURTE DUREE A LETHBRIDGE AIRPORT ALTH
 GUMBEL-METHOD OF MOMENTS BASED ON RECORDING RAIN GAUGE DATA FOR THE PERIOD- 1960 - 1990 31 YEARS/AN
 METHODE DES MOMENTS BASEES SUR LES DONNEES DU PLUVIOGRAPHES POUR LA PERIODE



PREPARE BY - PREPARE PAR LE

ATMOSPHERIC ENVIRONMENT SERVICE - ENVIRONNEMENT CANADA
 SERVICE DE L'ENVIRONNEMENT ATMOSPHERIQUE - ENVIRONNEMENT CANADA

Flow-by Conditions

K2 Catchbasin		K3 Catchbasin		C Catchbasin	
Street Flow (L/s)	Capture (L/s)	Street Flow (L/s)	Capture (L/s)	Street Flow (L/s)	Capture (L/s)
0	0	0	0	0	0
5	5	6	6	9	9
10	7.1	10	7.6	15	12.7
25	10.9	25	10.8	25	16.5
50	16	50	15.5	50	23
75	20	75	19.6	75	28.2
100	23.2	100	23.5	100	32.8
200	33.1	200	35.2	200	48
300	38.8	300	42.2	300	61.1
500	46.1	500	51	500	79.3
1000	56	1000	63	1000	104

Source: Stantec Consulting Ltd.

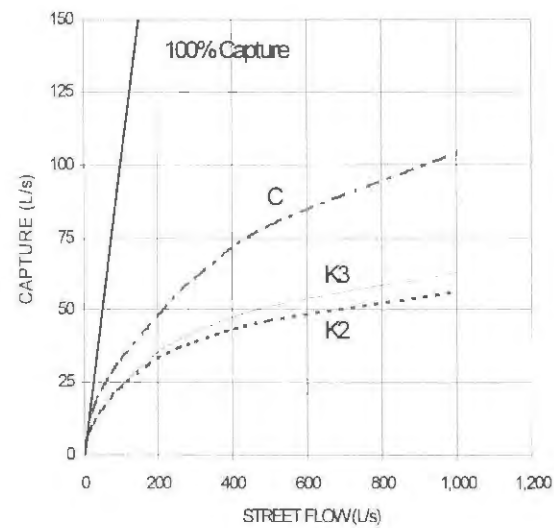
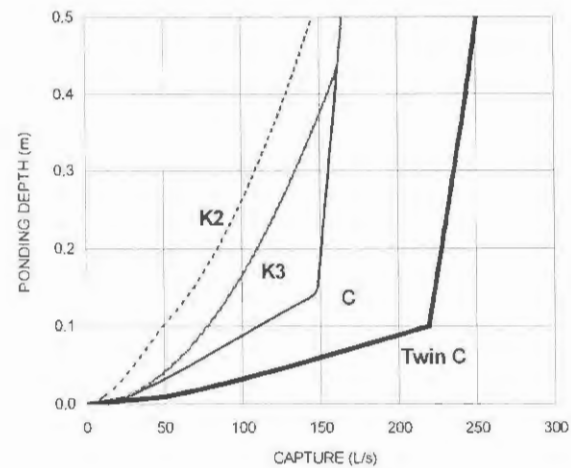


Figure 3.5: Capture Rating Curve for City of Calgary Catchbasins under Flow-by Conditions

Ponding Conditions

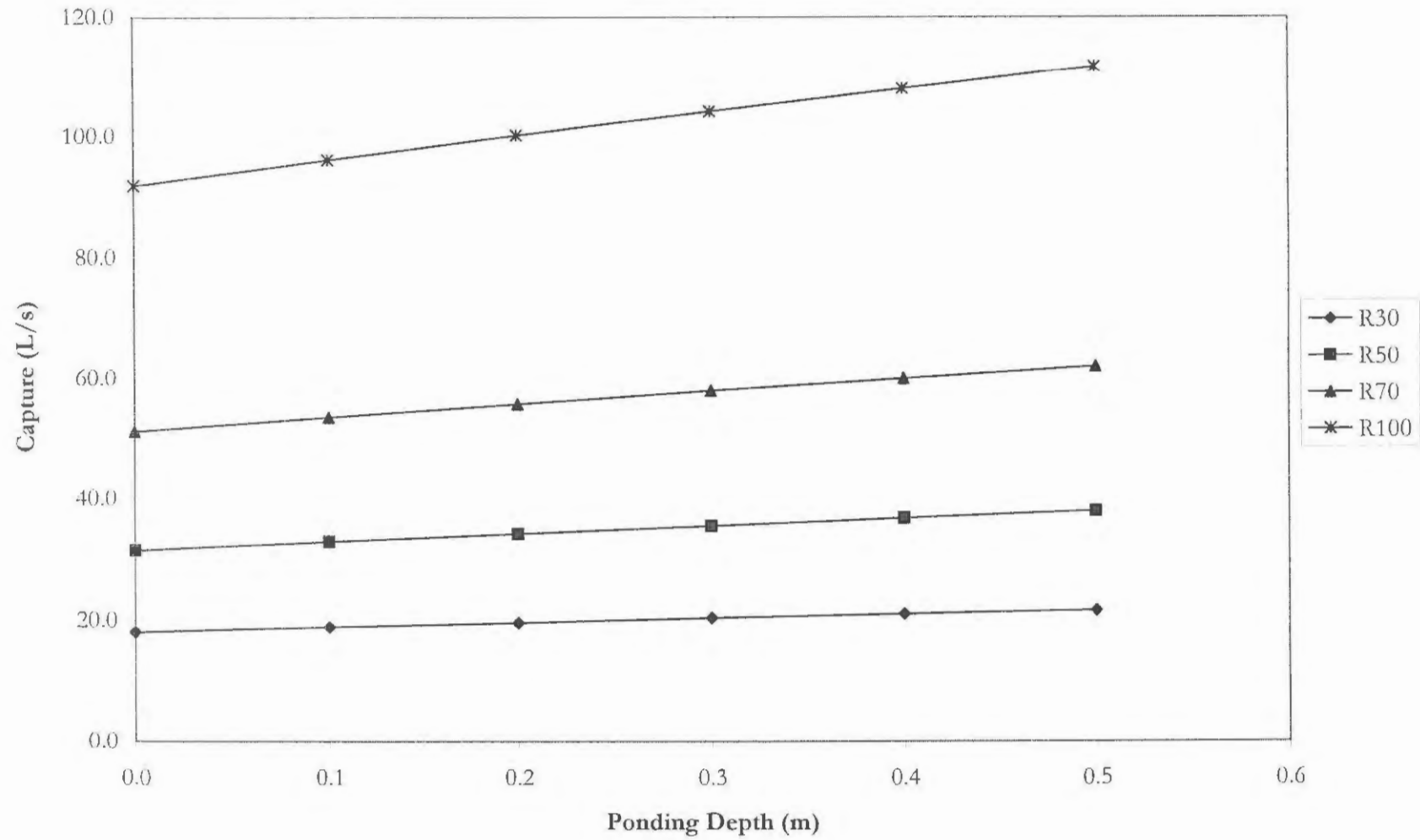
Table 3.12: Capture Rating Data for City of Calgary Catchbasins under Ponding Conditions				
Ponding Depth (m)	Capture Rate (L/s)			
	K2	K3	C	Twin C
0.0	0.0	0.0	0.0	0.0
0.1	48.3	77.5	110.0	219.3
0.2	83.8	109.6	150.7	227.8
0.3	108.3	134.3	155.5	235.9
0.4	128.3	155.1	160.1	243.7
0.5	145.5	164.6	164.6	250.7

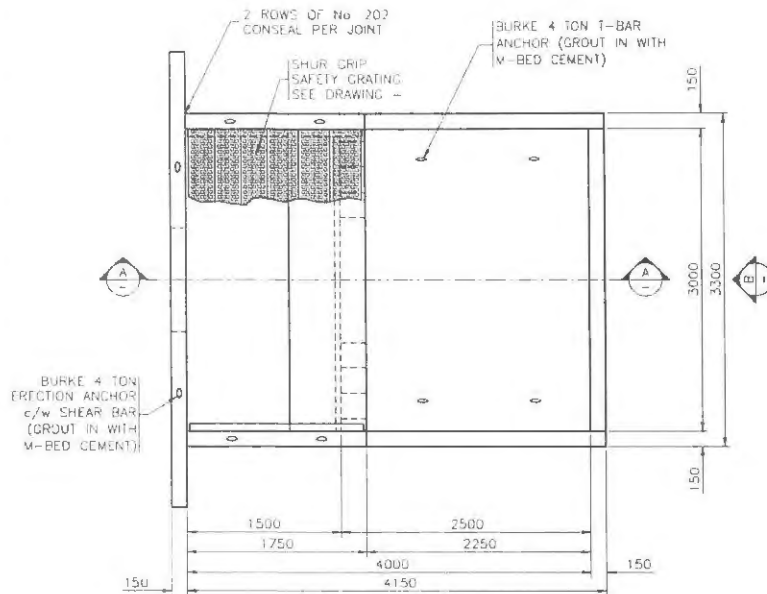
Source: Stantec Consulting Ltd.



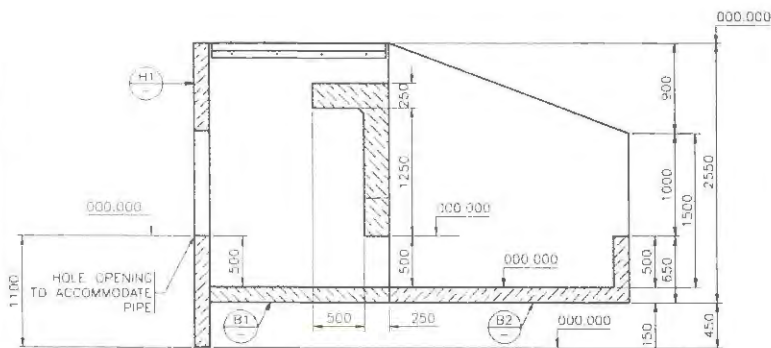
**Figure 3.6: Capture Rating
Curves for City of Calgary
Catchbasins under Ponding
Conditions**

Capture Rating Curves for Standard City of Lethbridge Inlet Control Devices

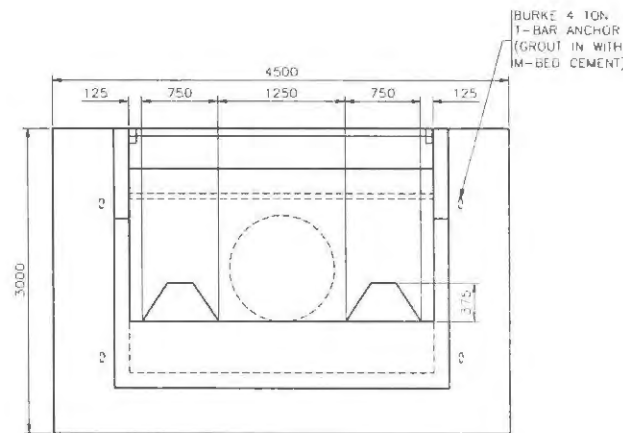




REQUIRED AS SHOWN



SECTION A-A



ELEVATION B

PRECON
precast products

1315 - 33 ST. NORTH, LETHBRIDGE, ALBERTA, CANADA T1M 5P2

ALL SPECIFICATIONS OF PRODUCTS NOT MANUFACTURED BY PRECON PRECAST PRODUCTS ARE BASED ON INFORMATION SUPPLIED BY MANUFACTURER/SUPPLIER. ACTUAL SPECIFICATIONS MUST BE INDEPENDENTLY CONFIRMED. PRECON PRECAST PRODUCTS ACCEPTS NO LIABILITY FOR ERRORS OR OMISSIONS.

GENERAL NOTES:

- CONCRETE - TYPE 33 CEMENT
- 30 MPa AT 28 DAYS
- AIR ENTRAINMENT - 5% TO 8%
- 20mm MAX. AGGREGATE 1-2"
- REINFORCEMENT - 400MPa MINIMUM YIELD STRENGTH
- SEALANT - 25425 CONCRETE JOINT
- ALL DIMENSIONS ARE IN MILLIMETERS, UNLESS OTHERWISE NOTED

TABLE OF WEIGHTS

H1	= 10876 lbs./4938 kg.
B1	= 18557 lbs./8425 kg.
B2	= 14886 lbs./6749 kg.

STANDARD DRAWING

NO. SUBMISSION DATE 1997

DESCRIPTION
IMPACT Baffle STRUCTURE
MODEL JB 3

CONTRACTOR
PRECON PRECAST PRODUCTS

FILE
IMPACT Baffle STRUCTURES

© PRECON MANUFACTURING LTD.

DATE	11/11/01	PROJECT	THURVEYER
DRAWN			
CHECKED BY		DRAWN	11/11/01
SCALE			1 OF 2

Appendix B

XP-SWMM Model Results for West 7th Street
XP-SWMM Model Output for West 7th Street at 104
Hydraulic Grade Line during a 1:100 Year, 4-Hour Storm
Event
Hydraulic Grade Line during a 1:5 Year, 4-Hour Storm
Event

Table B-1 Subcatchment Parameters

Subcatchment Area	XP-SWMM Node	Area Size (ha)	Imperviousness Percent
406	TL-X1	1.30	55
408	CB408	1.57	55
404	TL-X2	1.86	55
400	CB400	0.47	55
402	TL-X3	2.99	48
410	TL-X4	2.92	48
Sub-Total		11.11	

ISS/REV: A

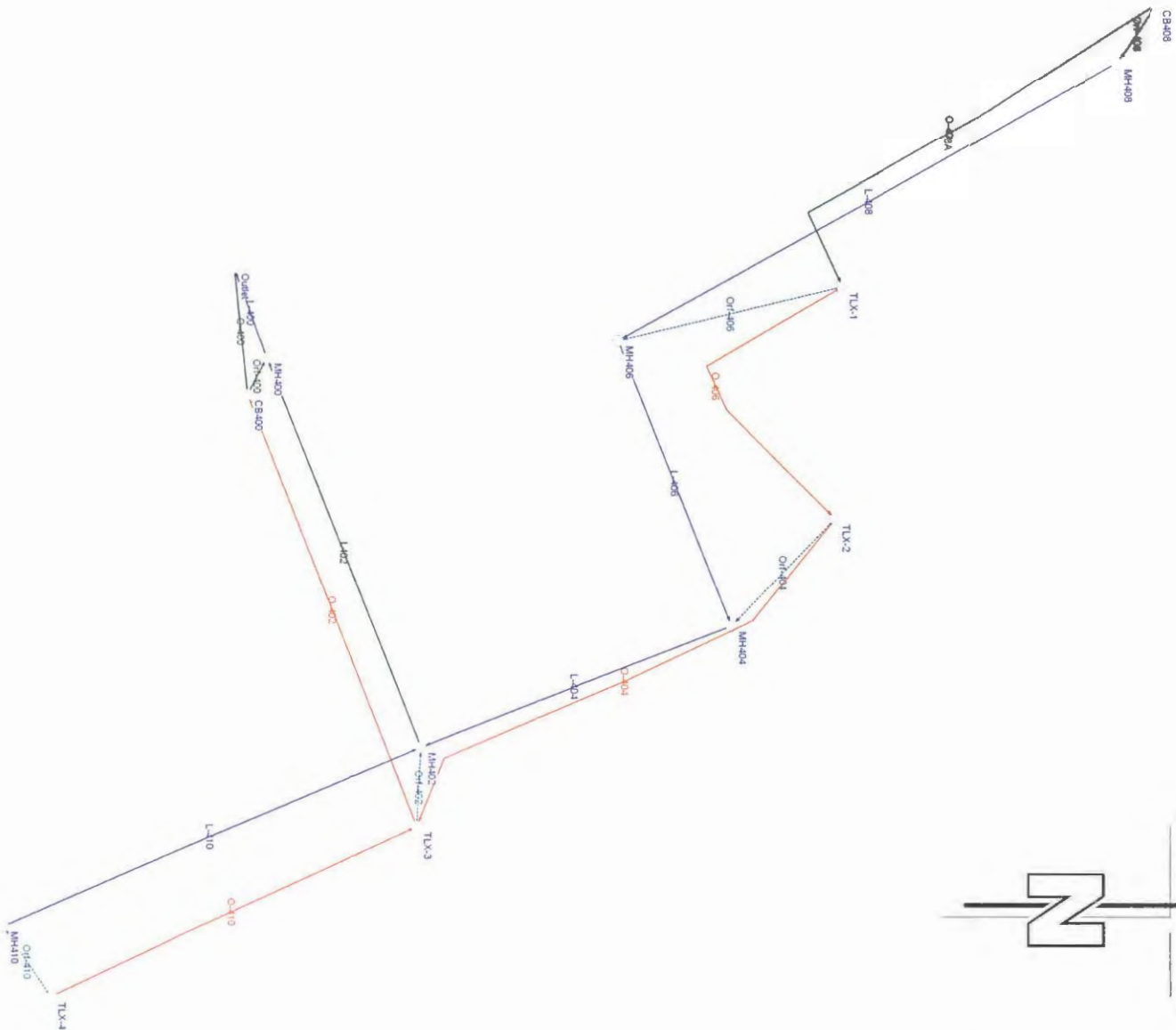
AECOM FILE NAME: 1560-245-00_02-CWF014_RX.dwg

Saved By: xud

PLOT: 11/08/2009 2:42:15 PM

A SIZE 8.5" x 11" (215.9mm x 279.4mm)

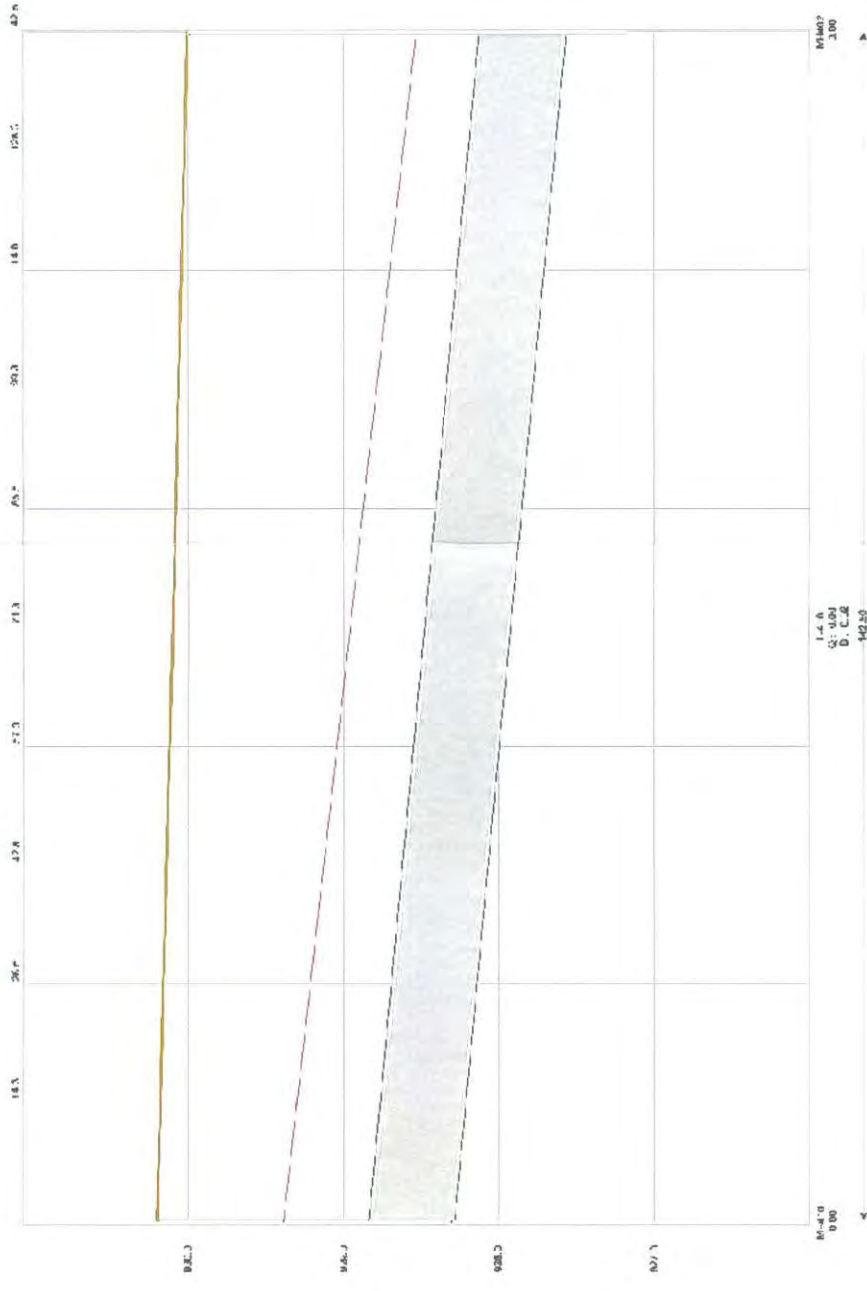
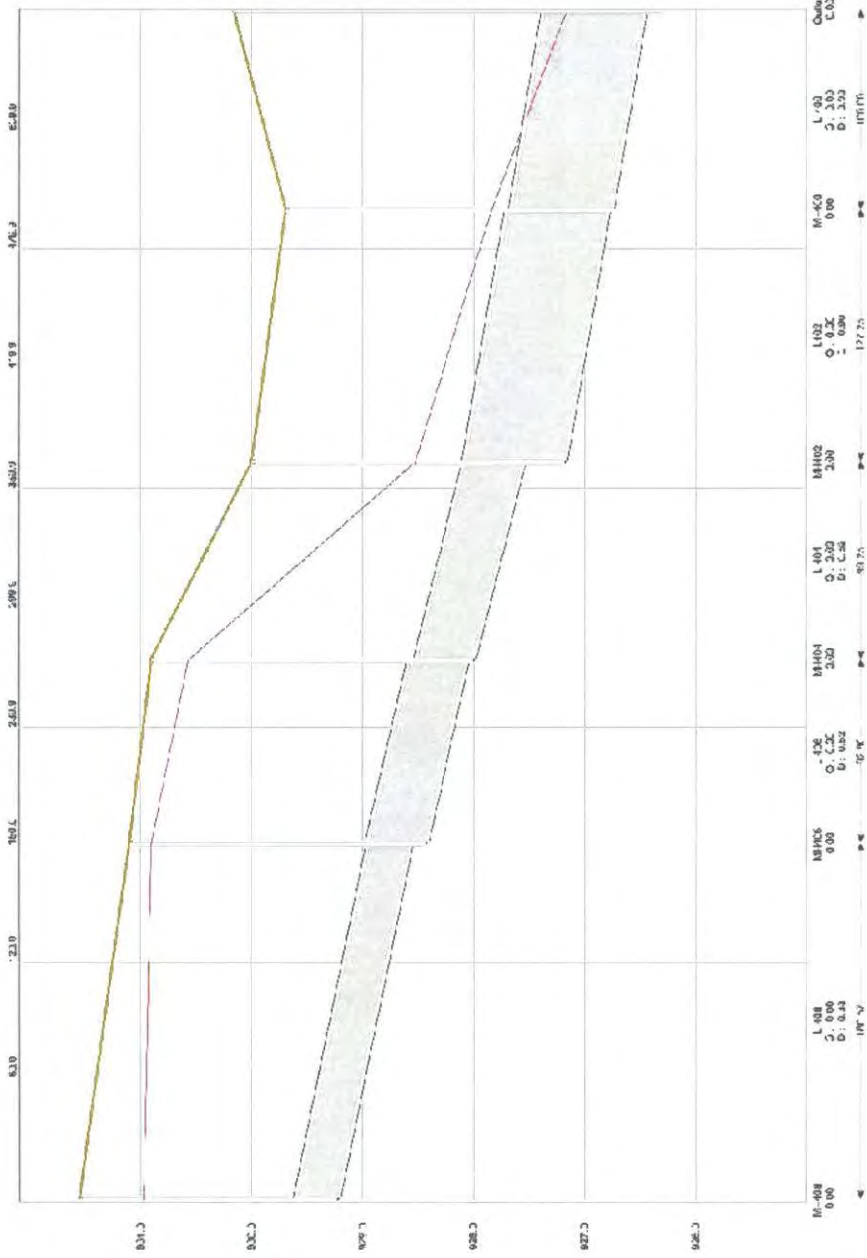
This drawing has been prepared for the use of AECOM's client and may not be used, reproduced or relied upon by third parties, except as agreed by AECOM and its client, as required by law or for use by governmental reviewing agencies. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without AECOM's express written consent. Do not scale this document. All measurements must be obtained from stated dimensions.

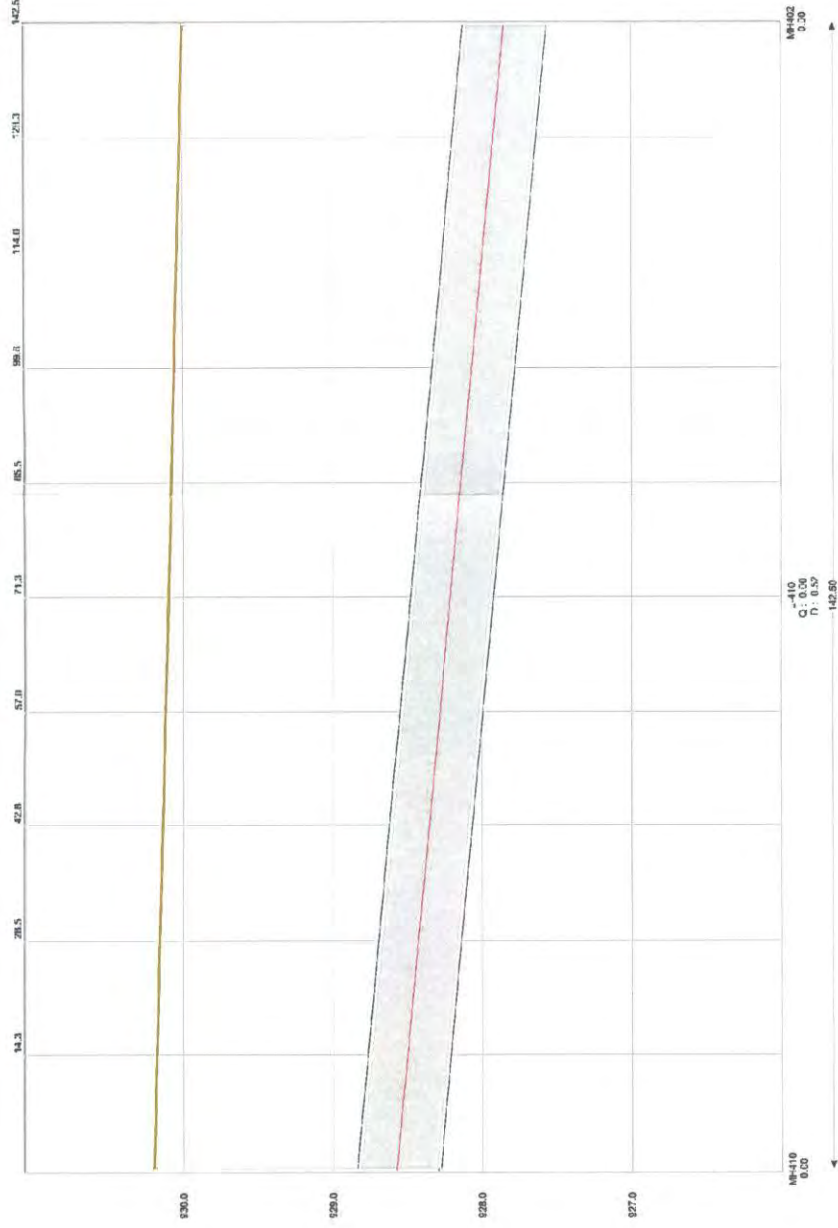
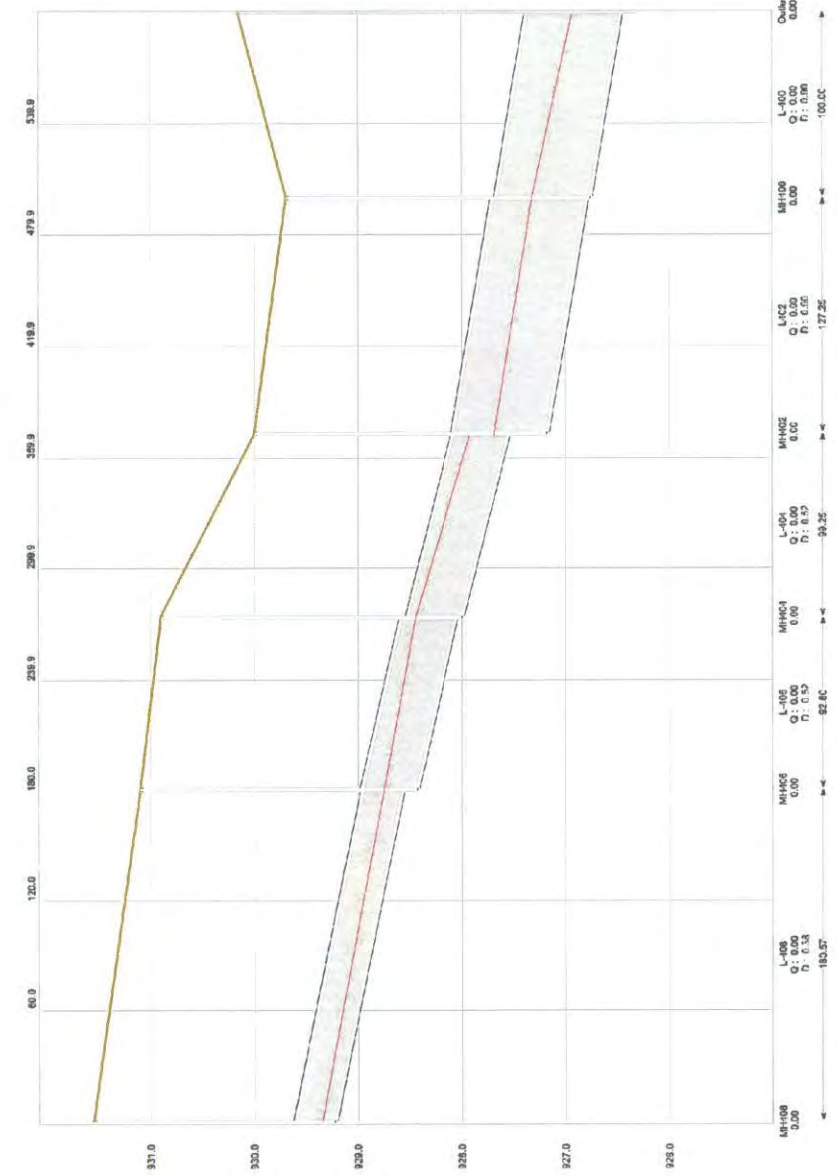


Meicor Developments Ltd.
The Canyons
Outline Plan

AECOM

West System XP Schematic





Melcor Developments Ltd.
The Canyons
Outline Plan

Hydraulic Grade Line - West System 5Y

Appendix C

XP-SWMM Model Hydraulic for Chinook Pond
System

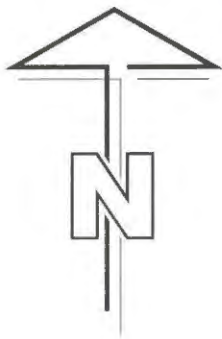
XP-SWMM Model Output for Chinook Pond System
(on CD)

Hydraulic Grade Line During a 1:100 Year, 4 Hour
Storm Event

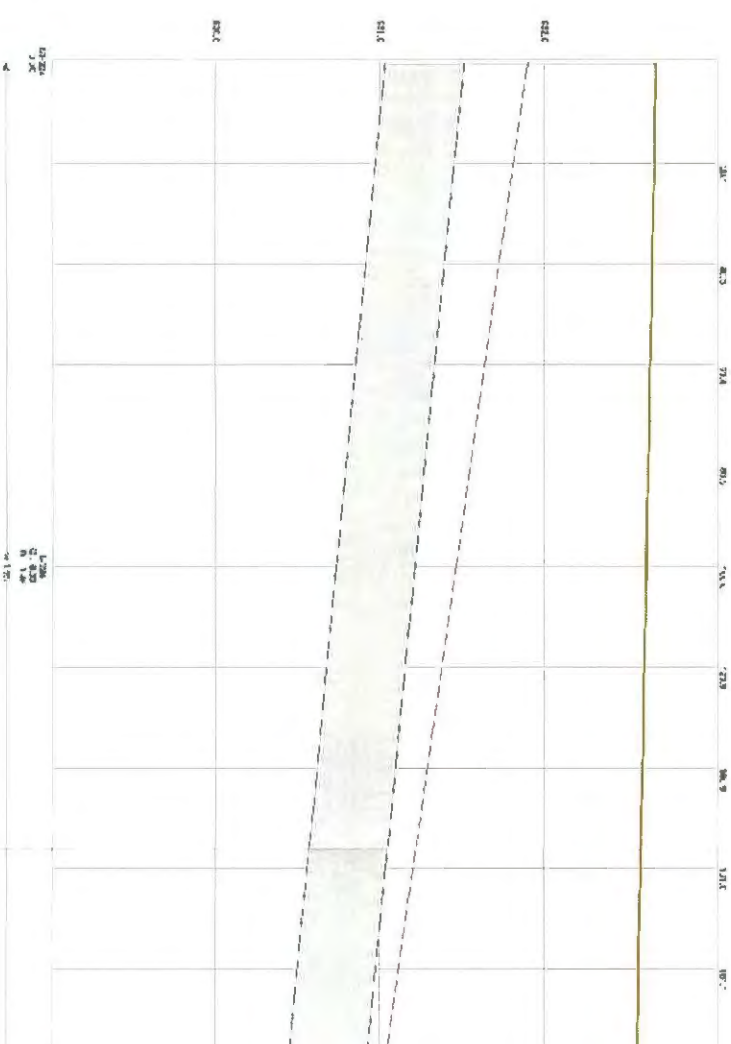
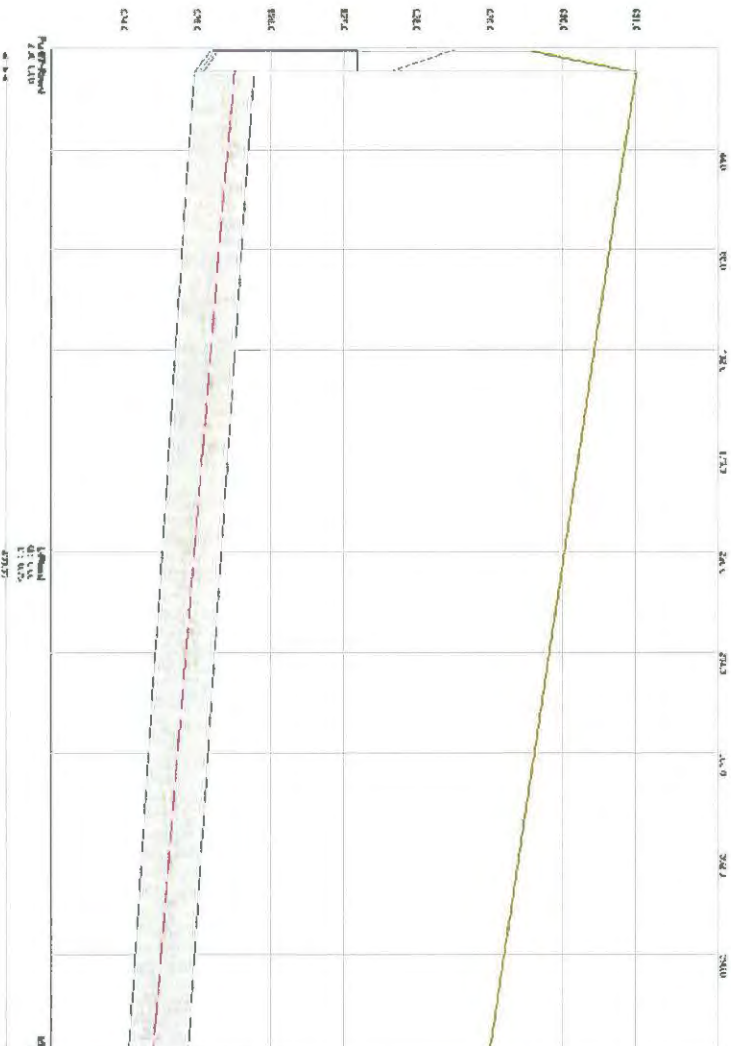
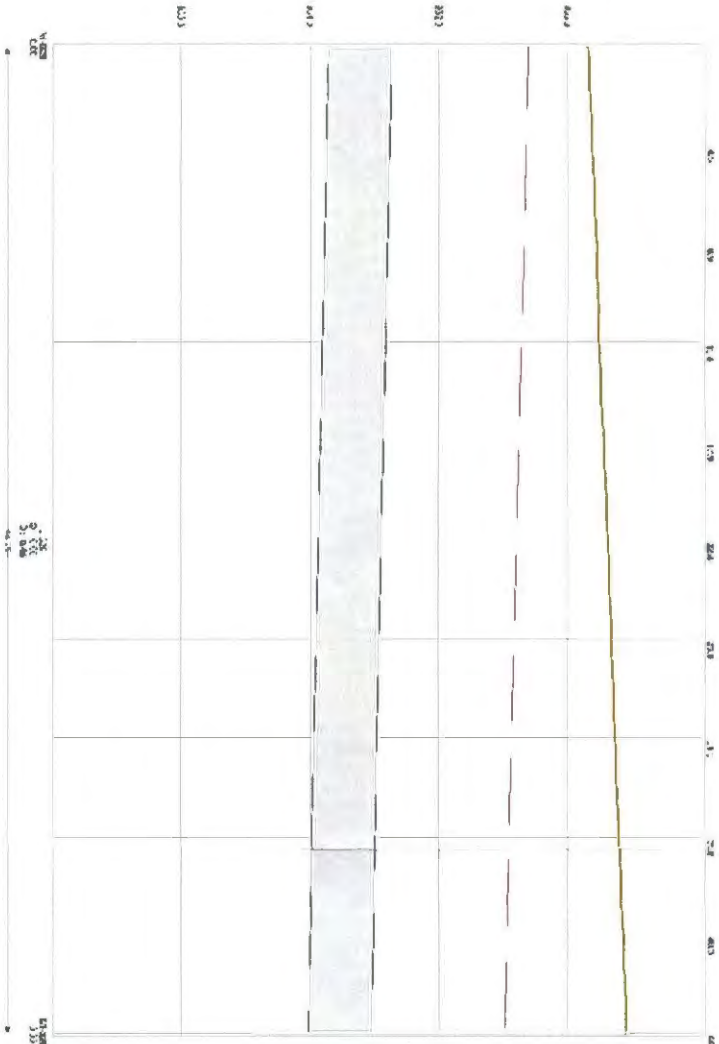
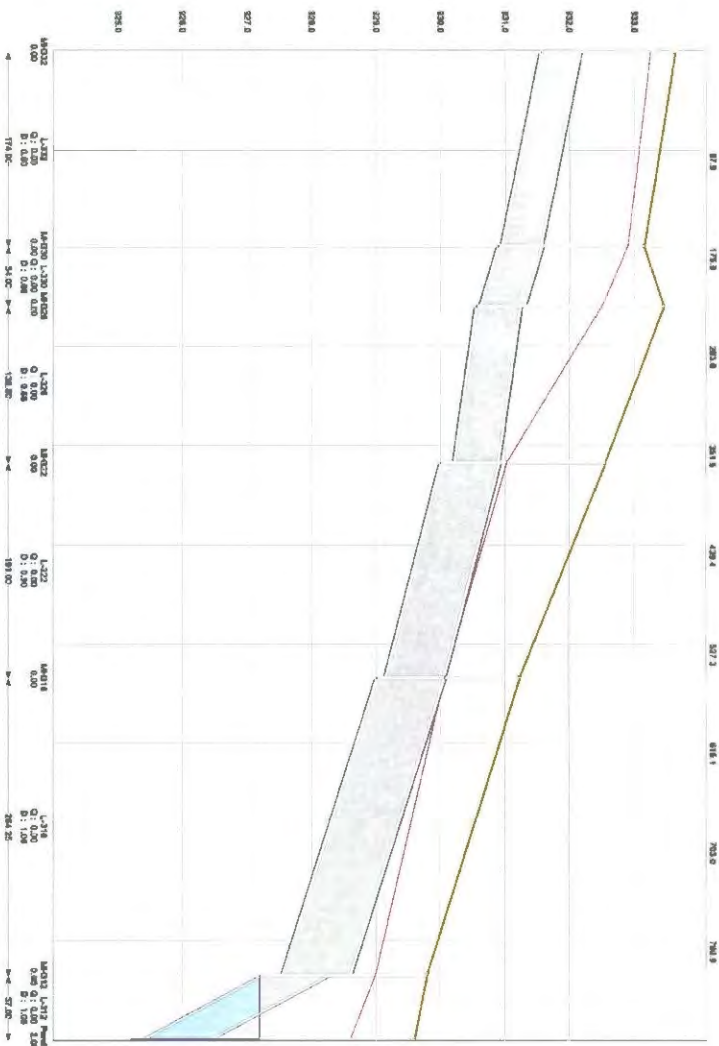
Hydraulic Grade Line During a 1:5 year, 4 Hour
Storm Event

Table C-1 Subcatchment Parameters

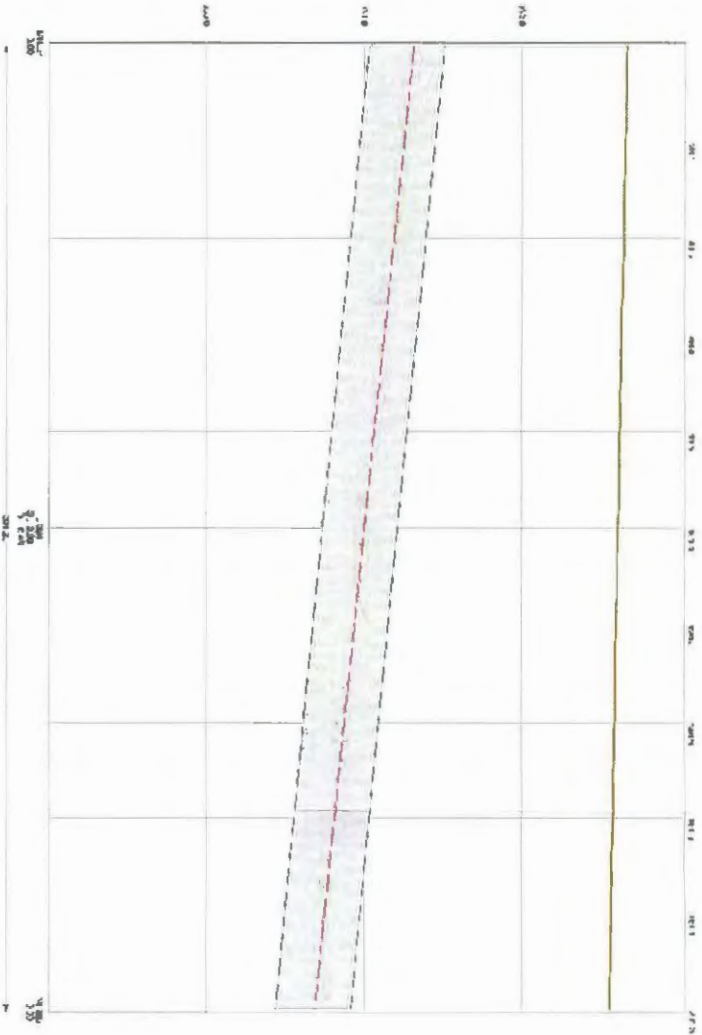
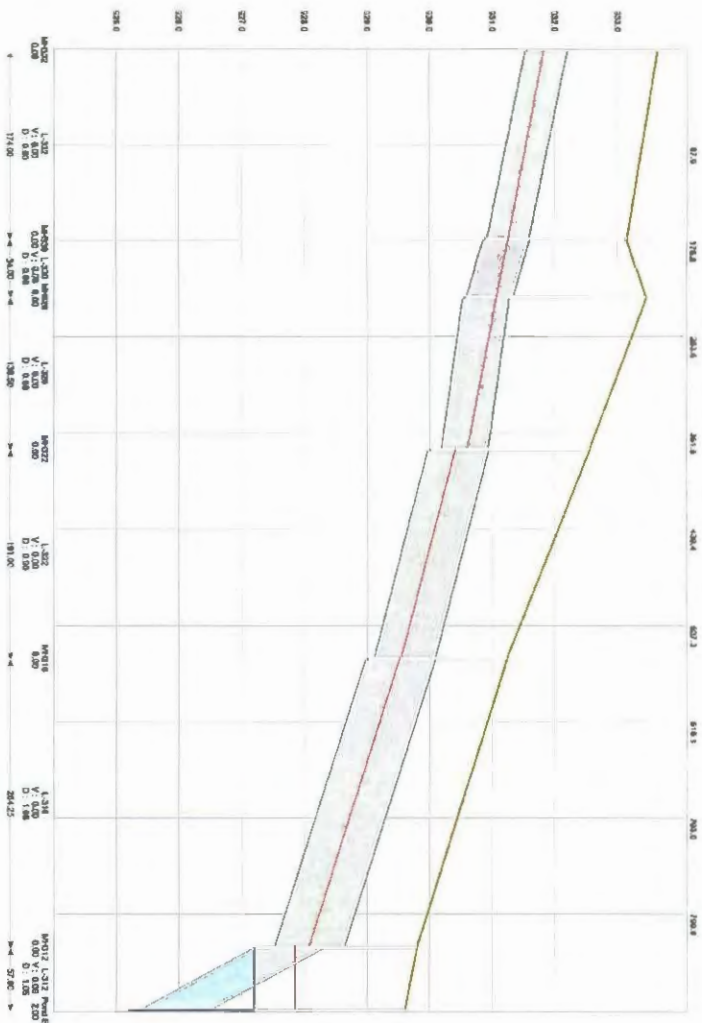
Subcatchment Area	XP-SWMM Node	Area Size (ha)	Imperviousness Percent
332	TL#W2	2.50	55
330	TL#W5	2.23	55
328	TL#W6	1.35	55
326	TL#W5-2,TL#W6-2	0.29	55
324	TL#W3	2.12	55
322	TL#W6	1.55	55
320	TL320	2.60	65
318	TL318	3.13	65
WPE	Pond E	0.91	80
316	CB316	1.07	80
312	TLW-4	2.82	80
314	TL314	6.59	70
306	TL306	0.43	65
308	TL308	0.34	65
302	TL302	1.43	70
310	TL310	2.33	65
WPF	Pond F	0.91	80
Sub-Total		32.60	



Chinook System XP Schematic



© 2009 AECOM Canada Ltd. All Rights Reserved. This document is protected by copyright law and may not be used, reproduced or modified in any manner or for any purpose except with the written permission of AECOM Canada Ltd. ("AECOM") or a party to which its copyright has been assigned. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that uses, reproduces, modifies, or relies on this document without AECOM's express written consent.



Appendix D

XP-SWMM Model Schematic for Dry & Wet Pond System

XP-SWMM Model Output for Dry & Wet Pond System
(on GD)

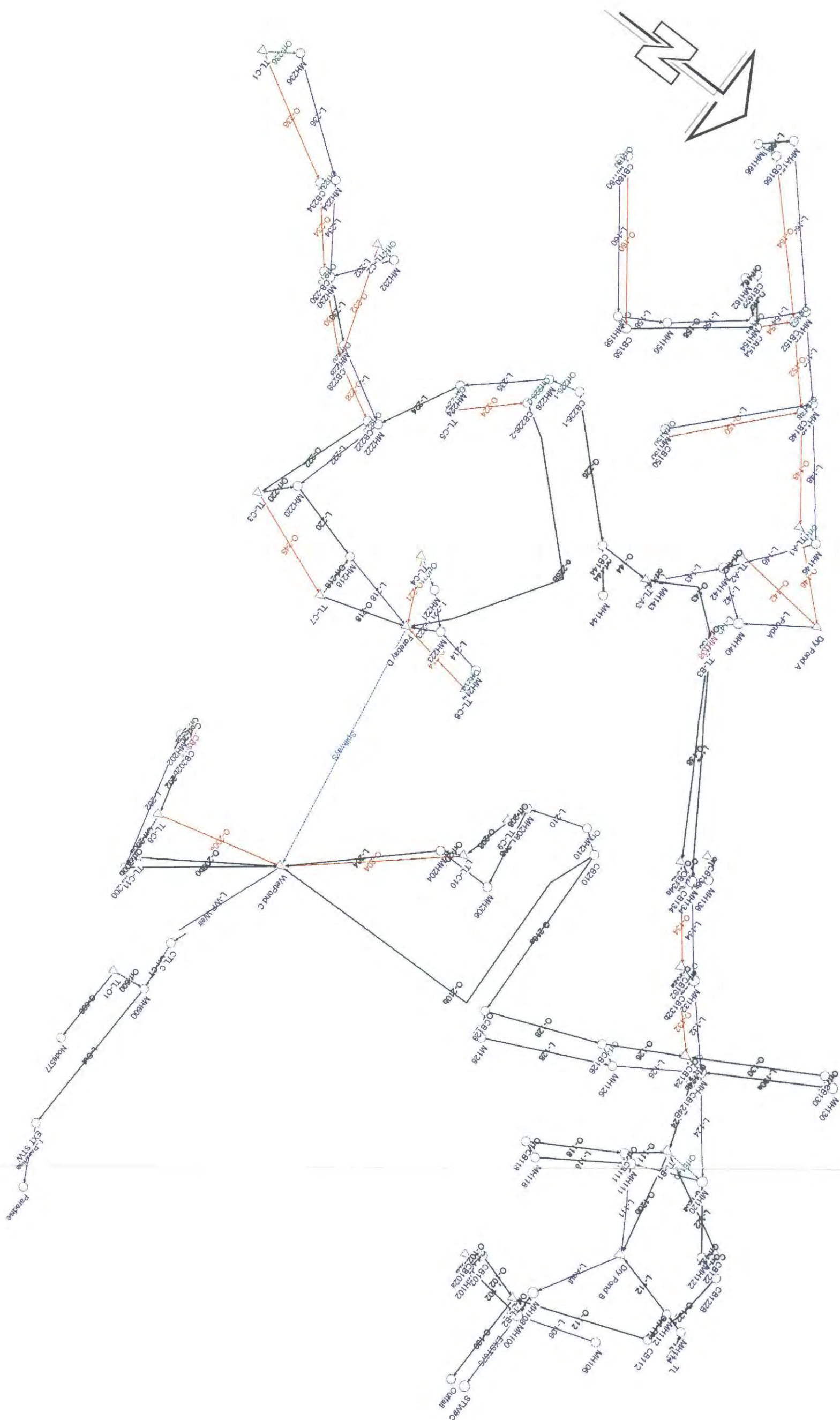
Hydraulic Grade Line during a 1:100 year, 4 hour
Storm Event

Hydraulic Grade Line during a 1:5 year, 4 hour Storm
Event

Table D-1 Subcatchment Parameters

Subcatchment Area	XP-SWMM Node	Area Size (ha)	Imperviousness Percent
Dry Pond System			
166	CB166	0.31	55
160	CB160	0.59	55
158	CB158	1.69	55
156	CB154	0.83	55
162	CB162	1.60	25
152	CB152	1.42	55
150	CB150	0.93	55
148	CB148	1.87	55
146	TL-A1	0.80	55
144	CB144	1.09	55
143	TL-A3	0.52	55
142	TL-A2	1.47	55
DPA	Dry Pond A	2.11	40
138	TL-B3	0.69	55
136	CB136	4.88	50
134	CB134,CB134a	1.87	55
132	CB132,CB132b	2.26	55
128	CB128	1.14	55
126	CB126	0.86	55
130	CB130	1.89	55
124	CB124,CB124b	2.42	55
122	CB122,CB122b	1.36	55
120	TL-B1	0.82	55
118	CB118	1.03	55
111	CB111	0.80	55
114	CB114	3.20	65

Subcatchment Area	XP-SWMM Node	Area Size (ha)	Imperviousness Percent
112	CB112	0.14	55
DPB	Dry Pond B	2.76	7
	Sub- Total	41.35	
Wet Pond System			
236	TL-C1	1.41	55
234	CB234	0.88	55
232	TL-C2	0.93	55
230	CB230	0.81	55
228	CB228	1.25	55
226	CB226	2.30	55
224	TL-C5	1.05	55
222	CB222	0.74	55
220	TL-C3	2.29	55
218	TL-C7	1.18	55
221	TL-C4	2.42	55
214	TL-C6	1.21	55
210	CB210	1.56	55
208	TL-C9	1.69	55
204	TL-C10	1.15	55
WPC	Forebay D, Wet Pond C	11.26	48
202	CB202	2.12	55
200	TL-C8, TL-C11	0.94	55
	Sub- Total	35.19	



This drawing has been prepared for the use of AECOM's client and may not be used, reproduced or relied upon by third parties, except as agreed by AECOM and its client, as required by law or for use by governmental reviewing agencies. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without AECOM's express written consent. Do not scale this document. All measurements must be obtained from stated dimensions.



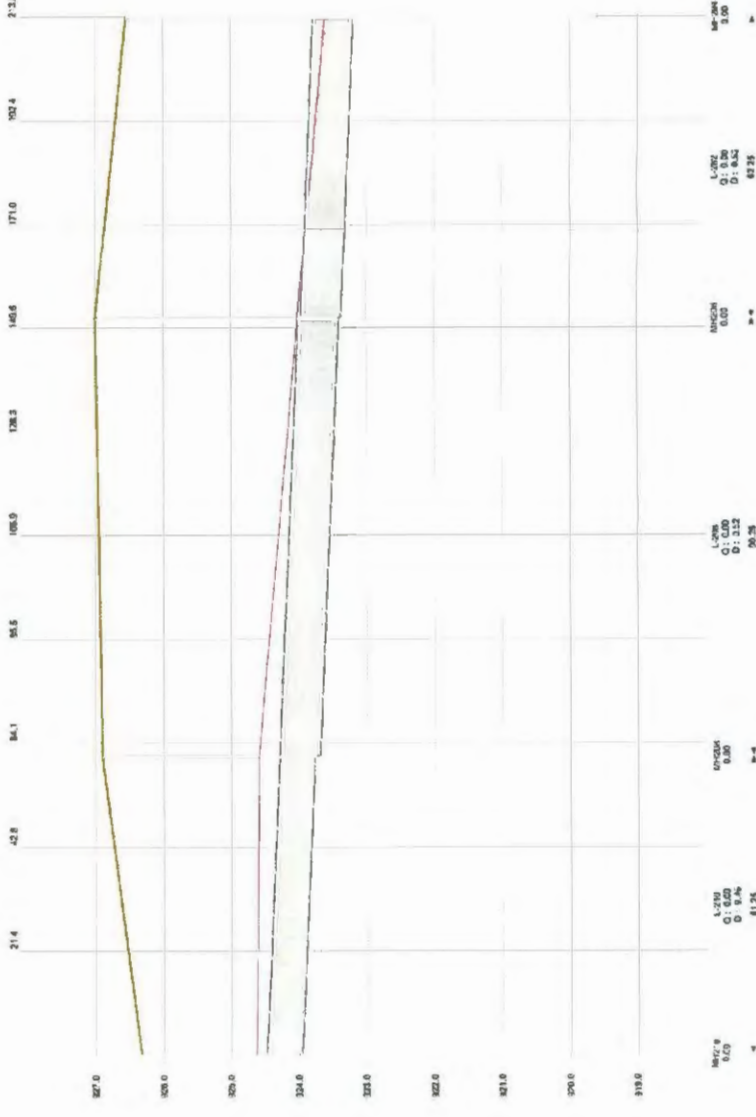
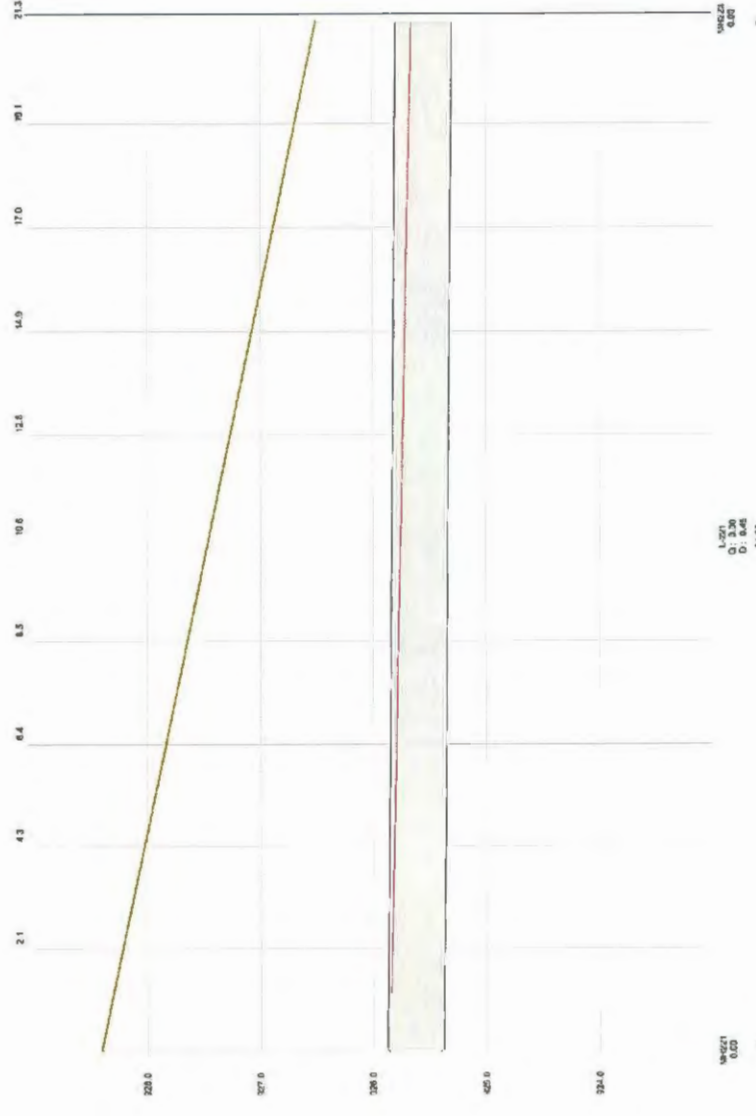
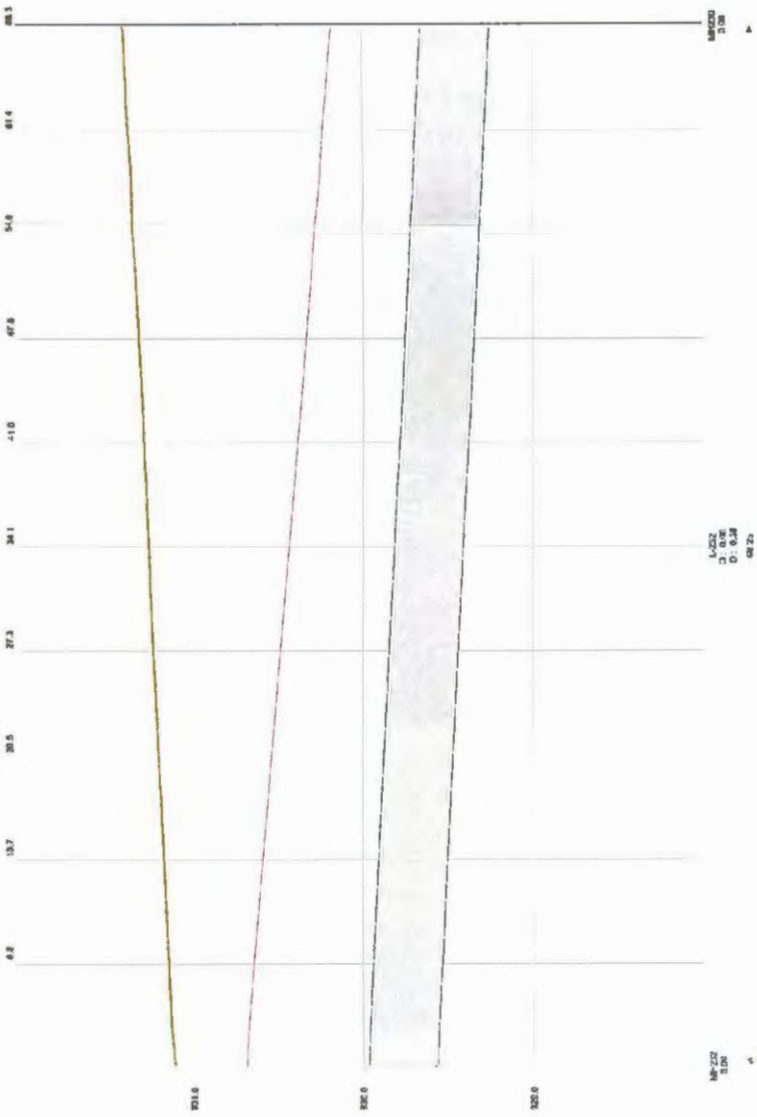
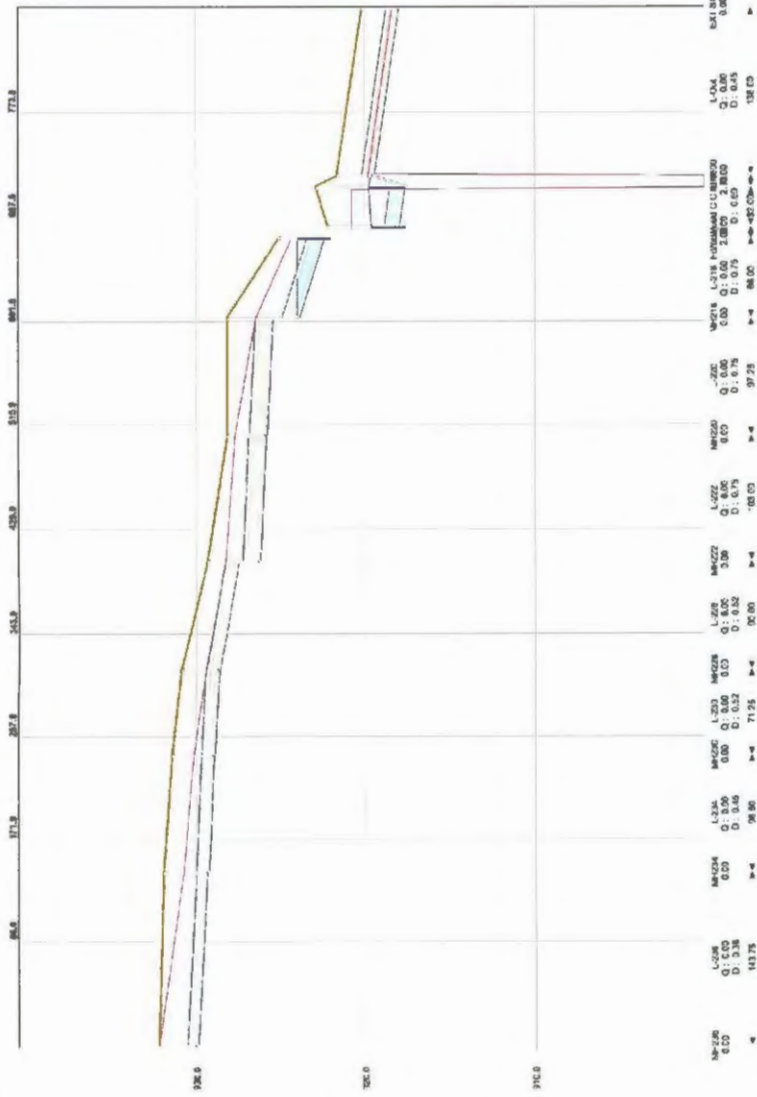
This drawing has been prepared for the use of AECOM's client and may not be used, reproduced or relied upon by third parties, except as agreed by AECOM and its client, as required by law or for use by governmental reviewing agencies. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without AECOM's express written consent. Do not scale this document. All measurements must be obtained from stated dimensions.



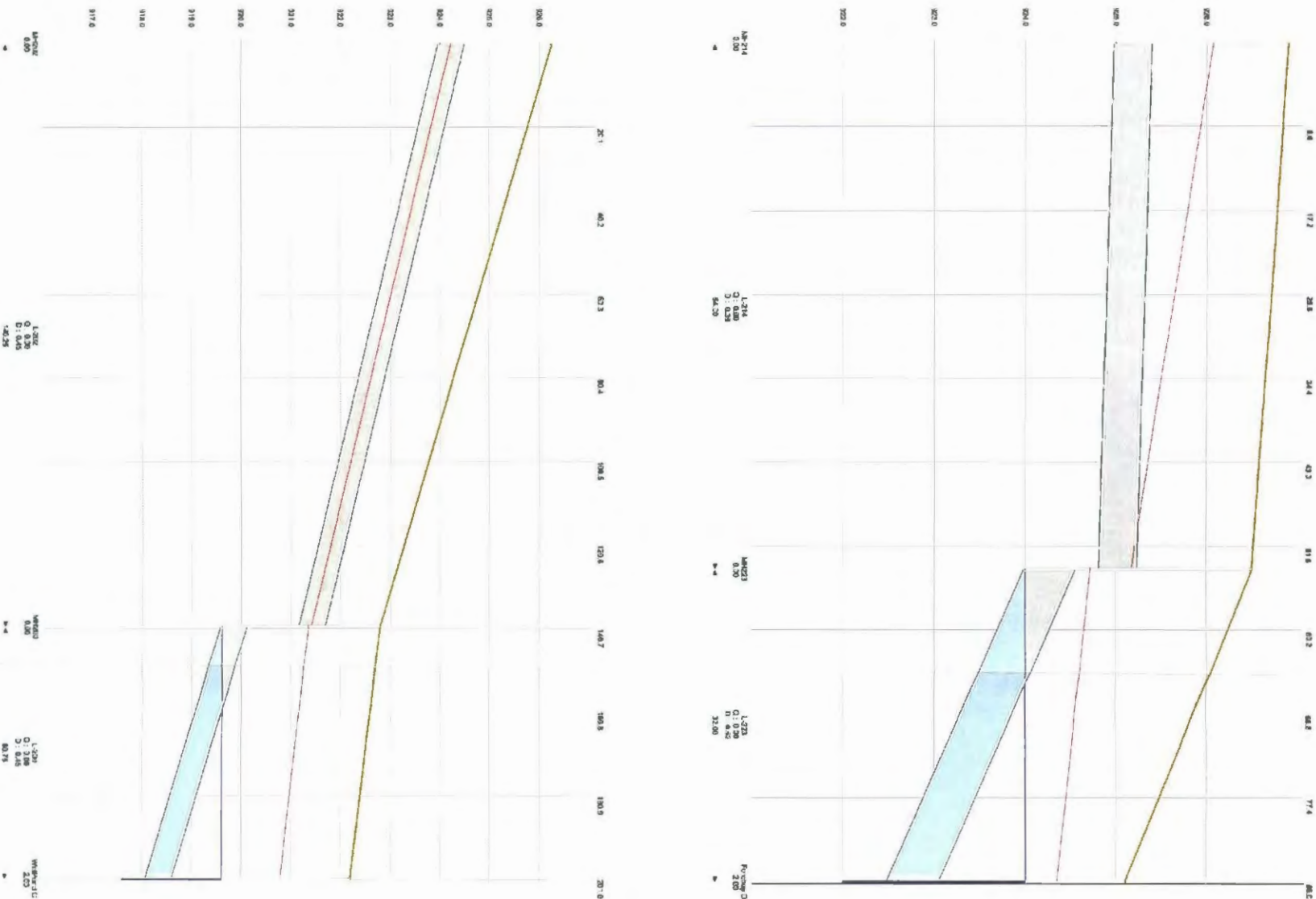
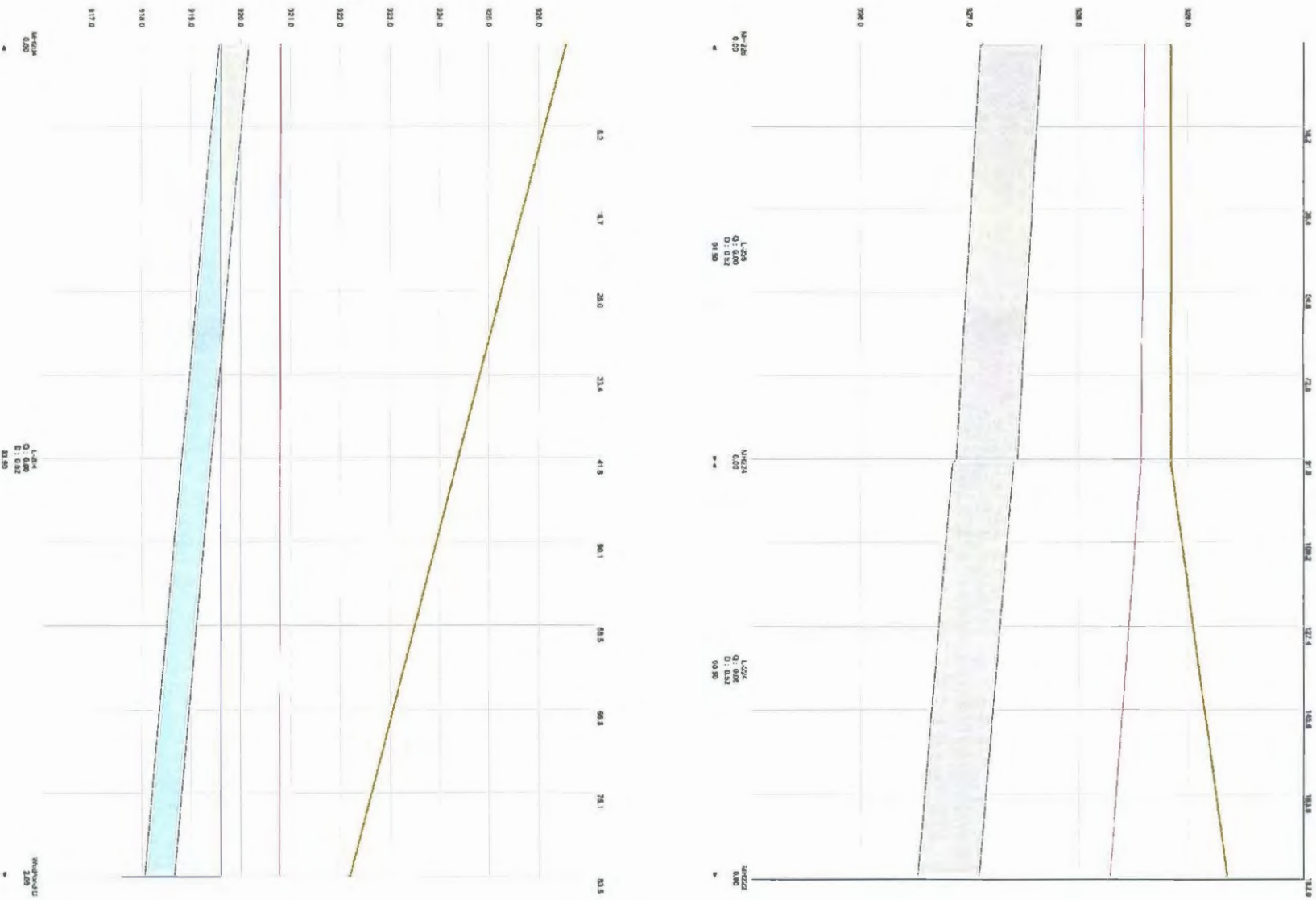
AECOM

Hydraulic Grade Line - East Dry Pond System 100Y - b

Melcor Developments Ltd.
The Canyons
Outline Plan



This drawing has been prepared for the use of AECOM's client and may not be used, reproduced or relied upon by third parties, except as agreed by AECOM and its client, as required by law or for use by governmental reviewing agencies. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without AECOM's express written consent. Do not scale this document. All measurements must be obtained from stated dimensions.

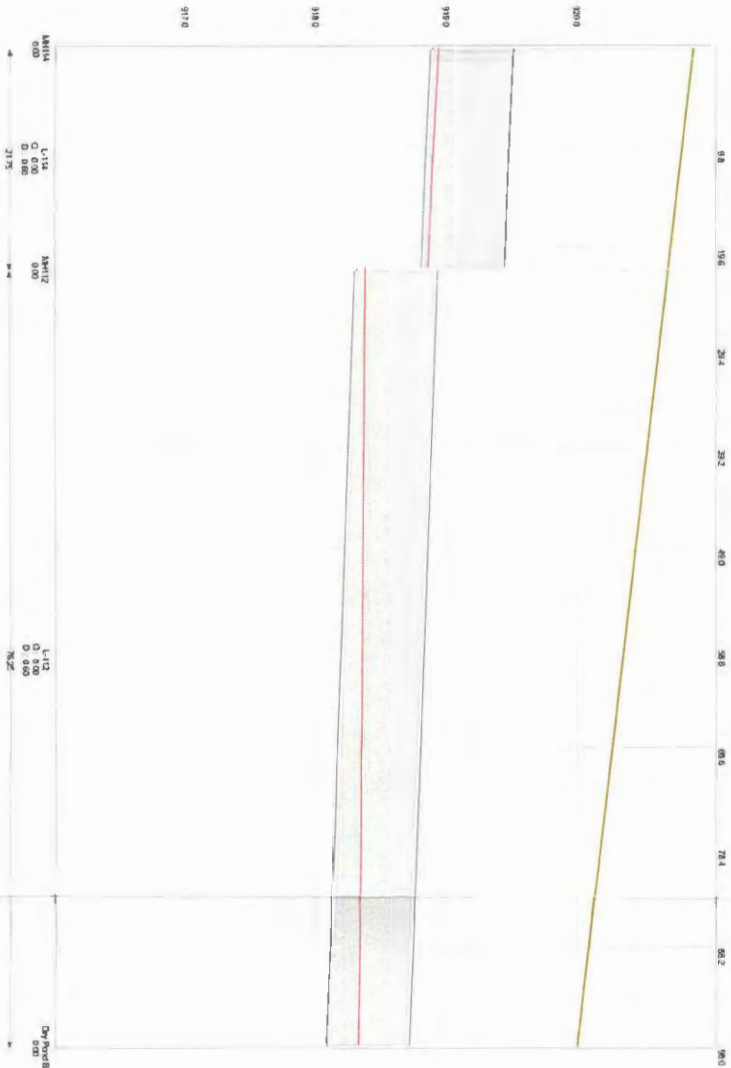
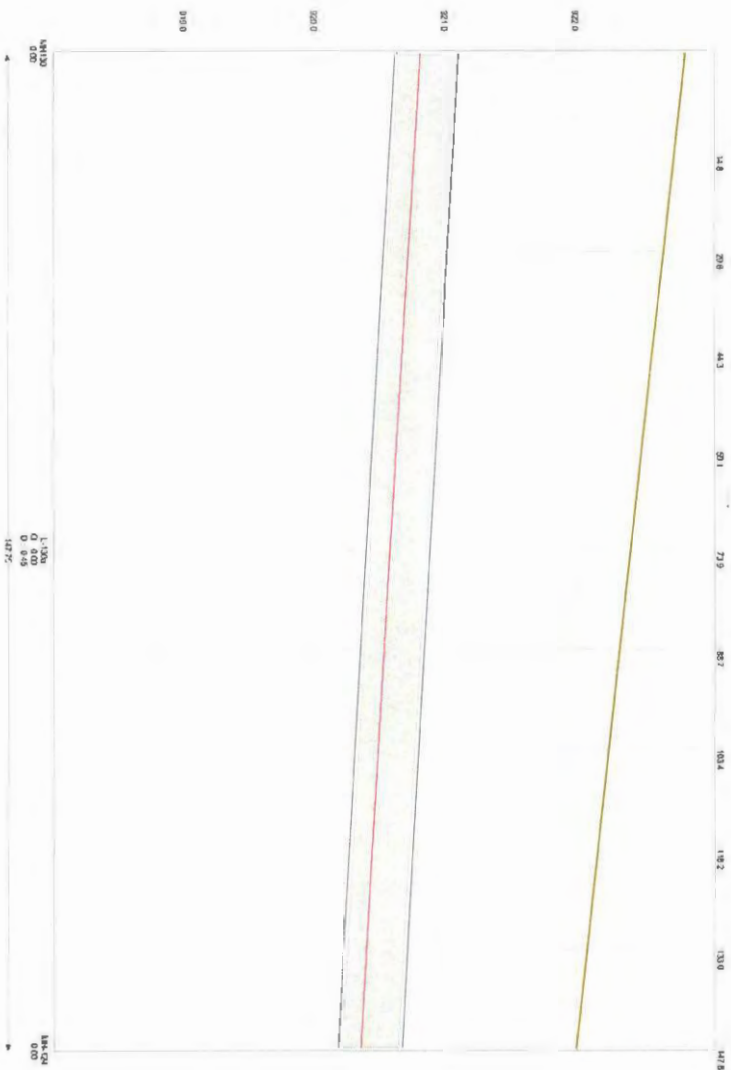
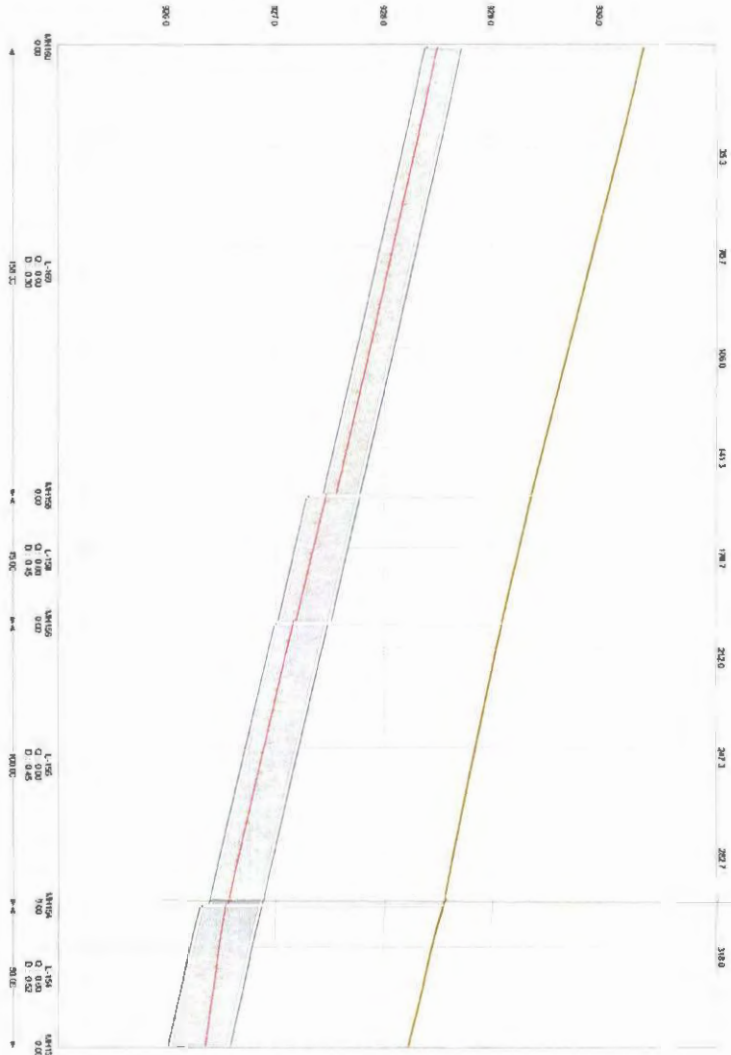
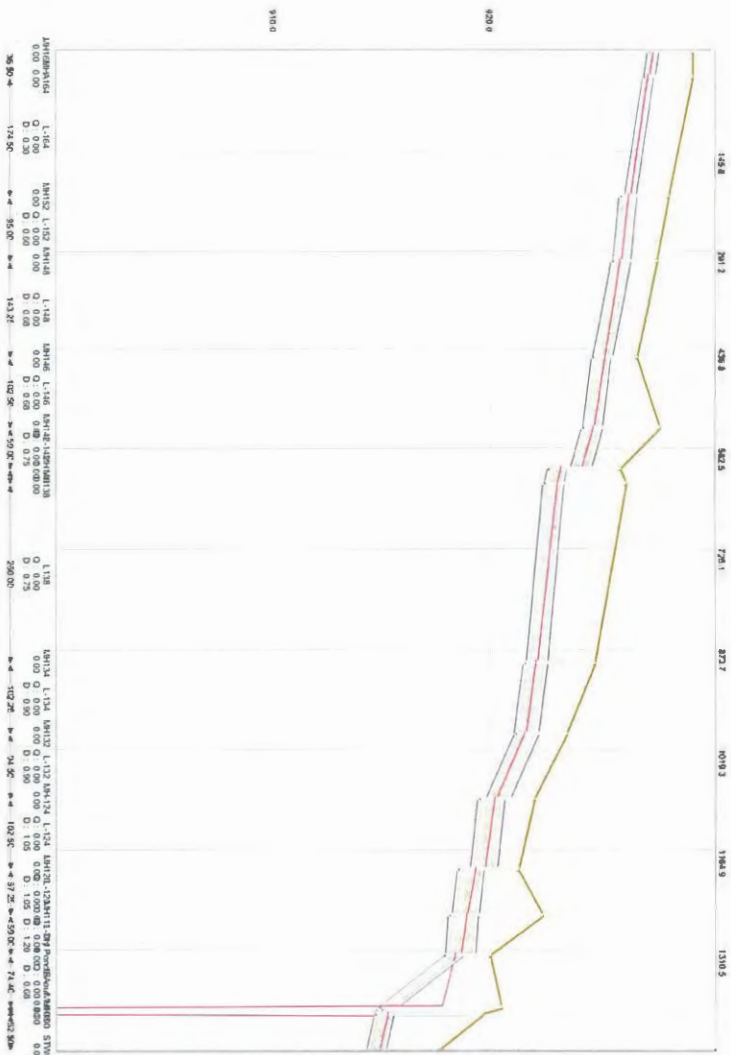


Melcor Developments Ltd.
The Canyons
Outline Plan

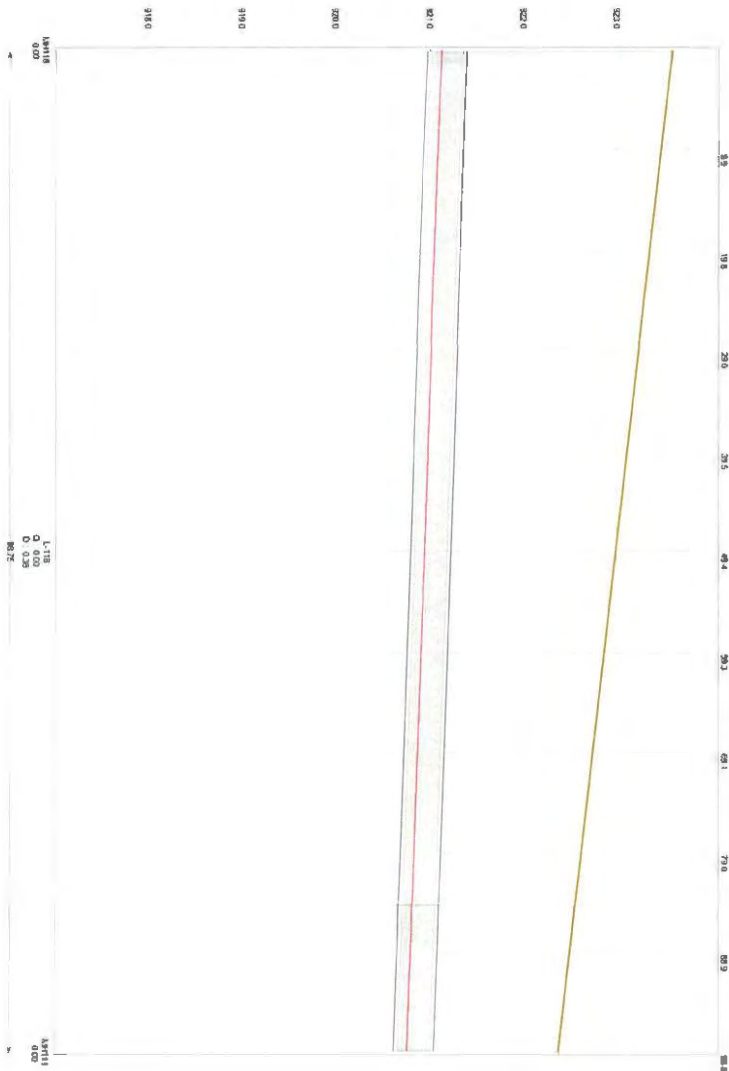
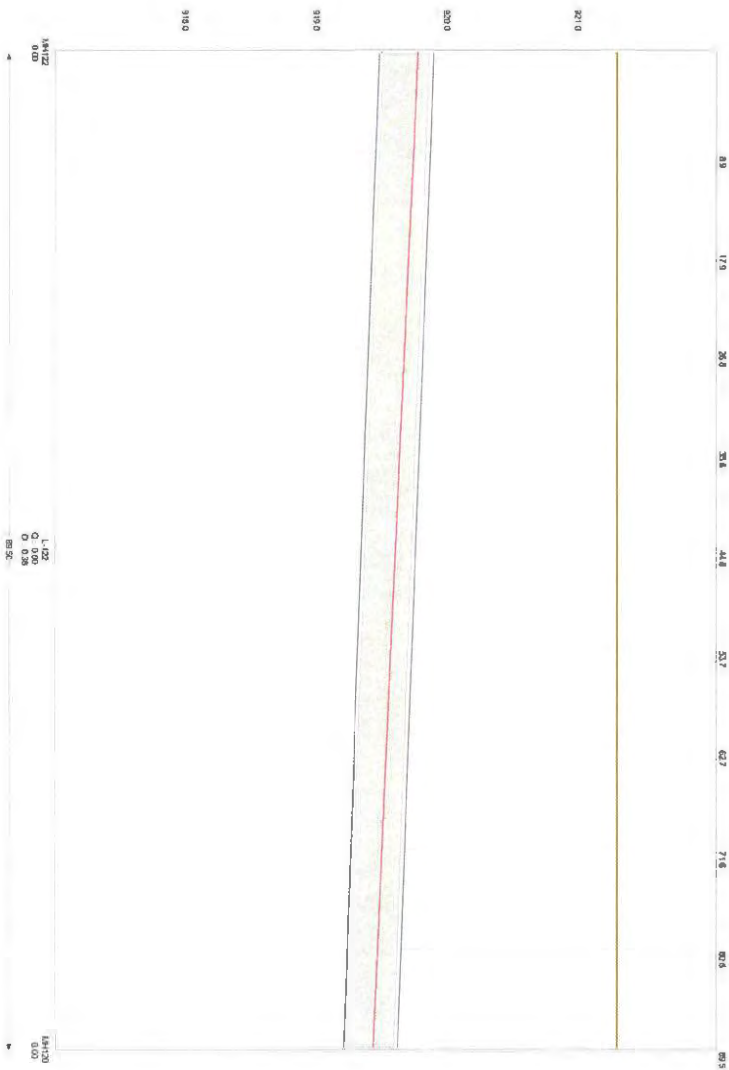
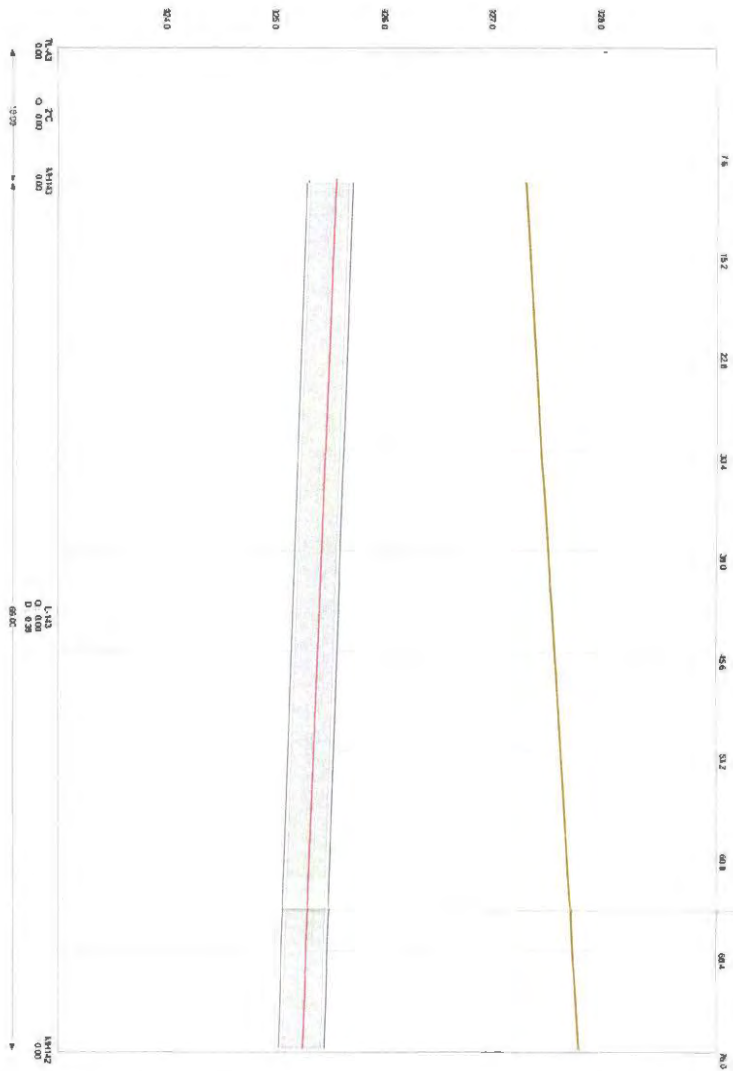
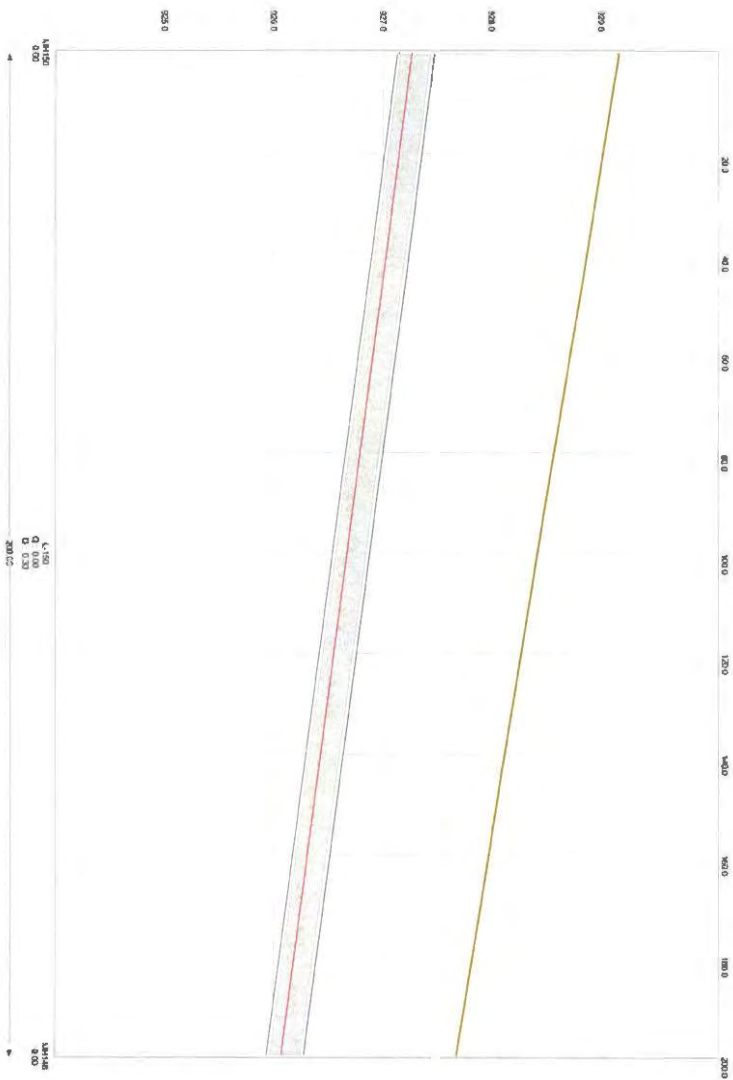
AECOM

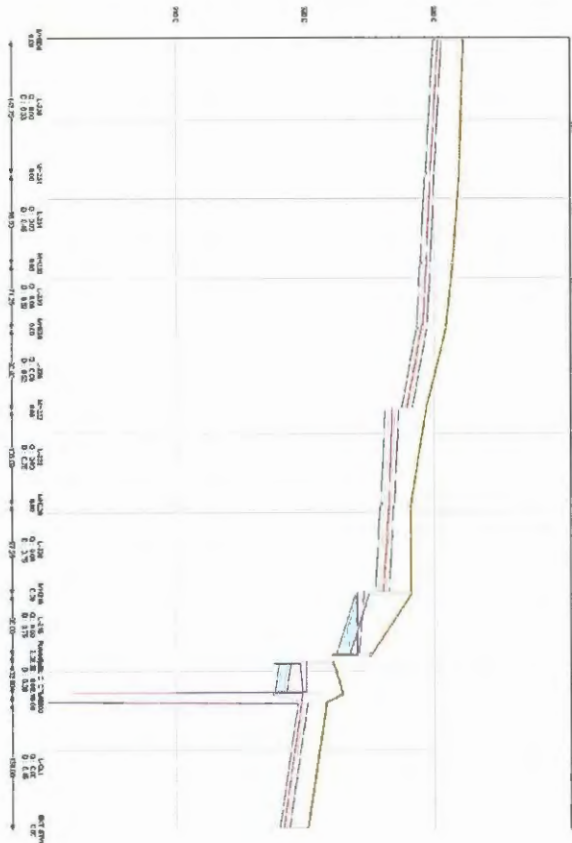
Hydraulic Grade Line - East Wet Pond System 100Y - b

This drawing has been prepared for the use of AECOM's client and may not be used, reproduced or relied upon by third parties, except as agreed by AECOM and its client, as required by law or for use by governmental reviewing agencies. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without AECOM's express written consent. Do not scale this document. All measurements must be obtained from stated dimensions.

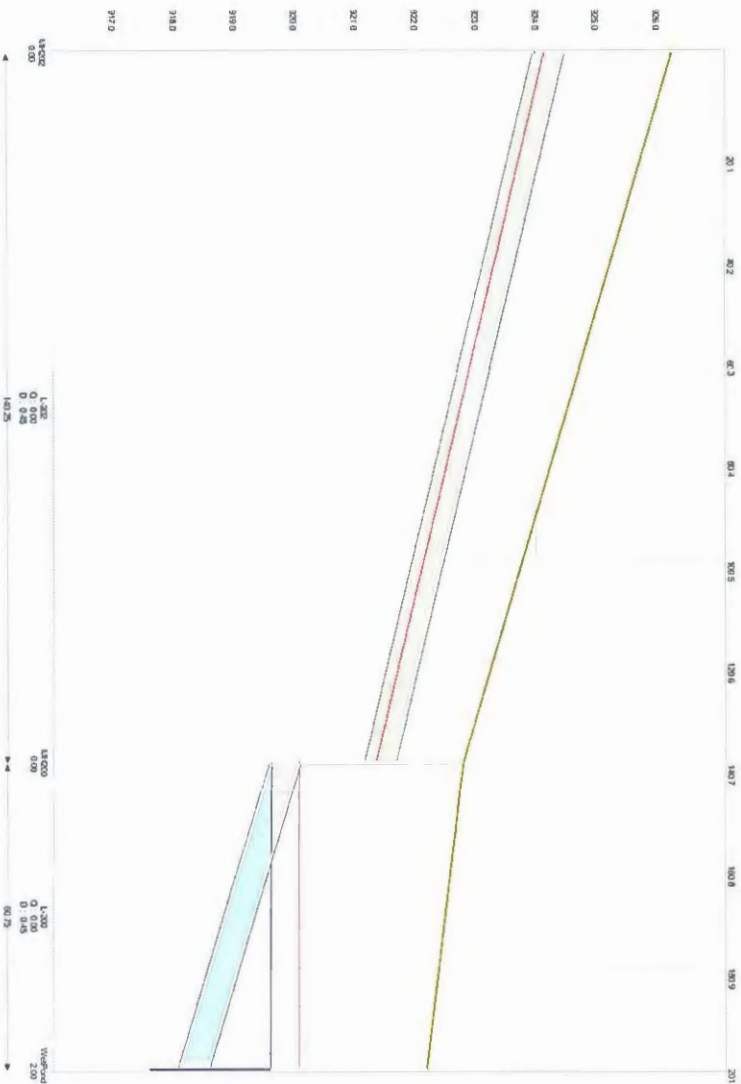
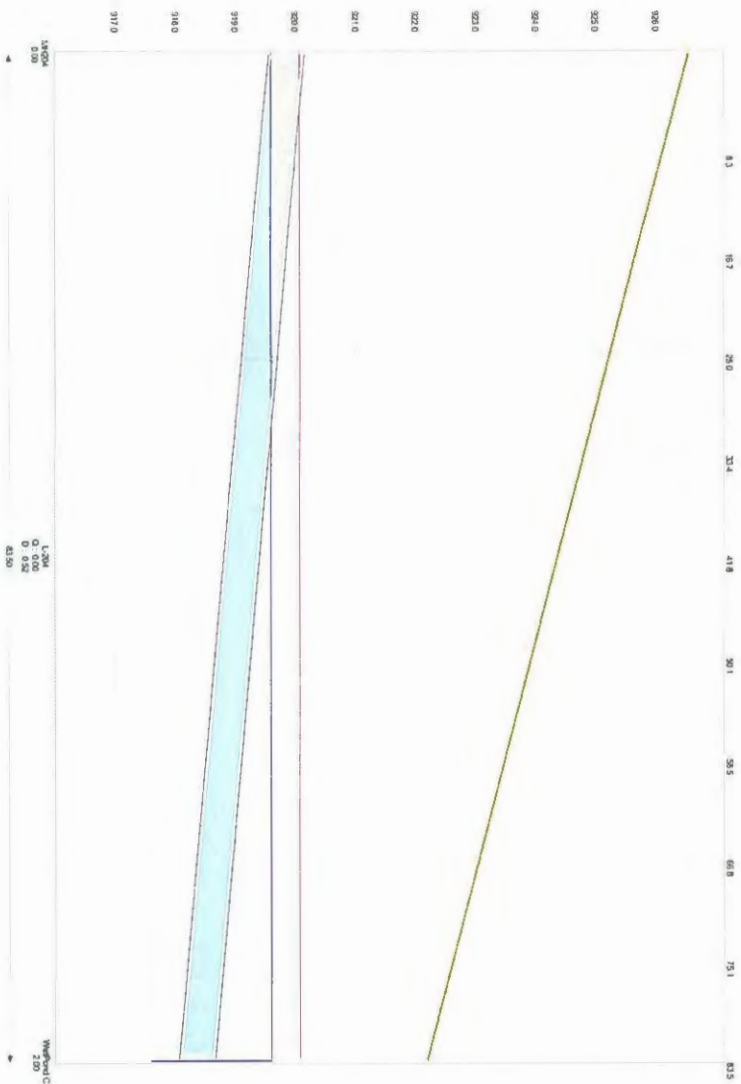
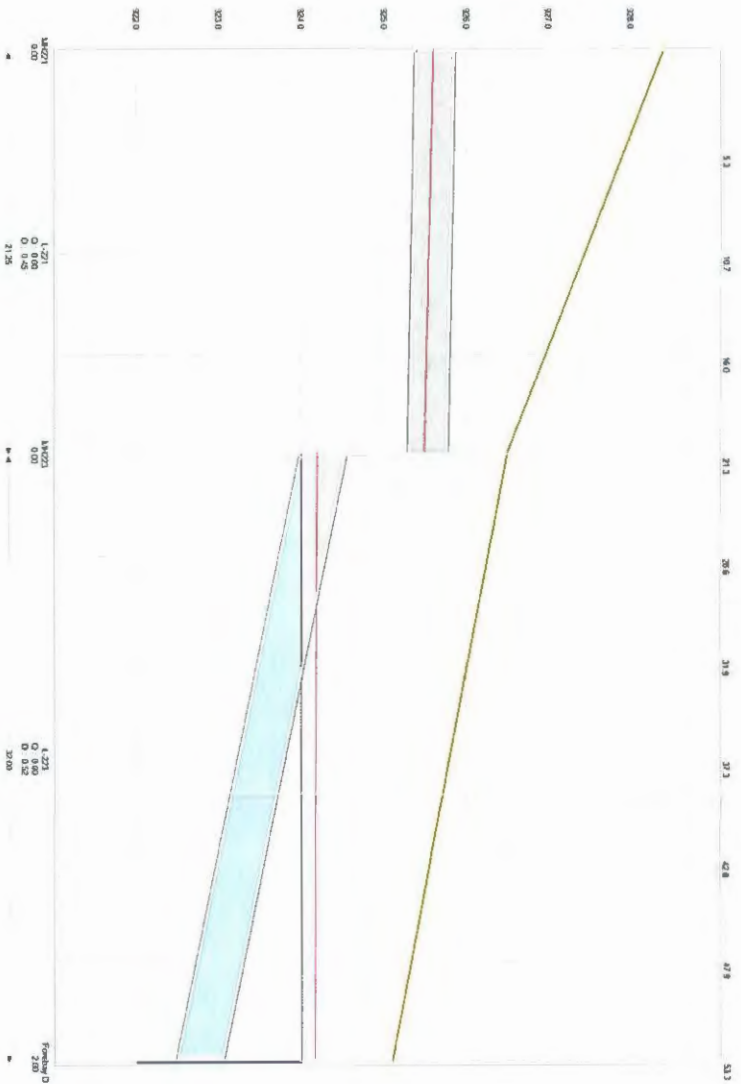
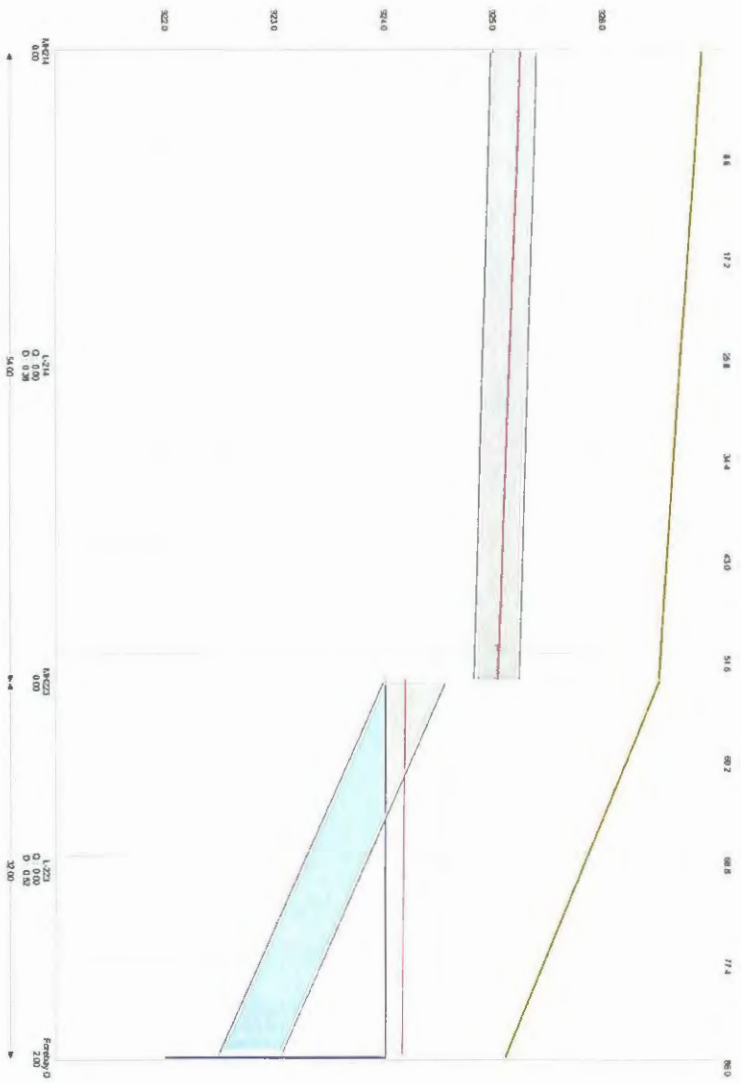


This drawing has been prepared for the use of AECOM's client and may not be used, reproduced or relied upon by third parties, except as agreed by AECOM and its client, as required by law or for use by governmental reviewing agencies. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without AECOM's express written consent. Do not scale this document. All measurements must be obtained from stated dimensions.





This drawing has been prepared for the use of AECOM's client and may not be used, reproduced or relied upon by third parties, except as agreed by AECOM and its client, as required by law or for use by governmental reviewing agencies. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without AECOM's express written consent. Do not scale this document. All measurements must be obtained from stated dimensions.



Melcor Developments Ltd.
The Canyons
Outline Plan

AECOM

Hydraulic Grade Line - East Wet Pond System 5Y - b

Appendix E

Figure 1 Location Map

Figure 2 Site Plan

Drawing CW1001- CW1002 Storm Area Design

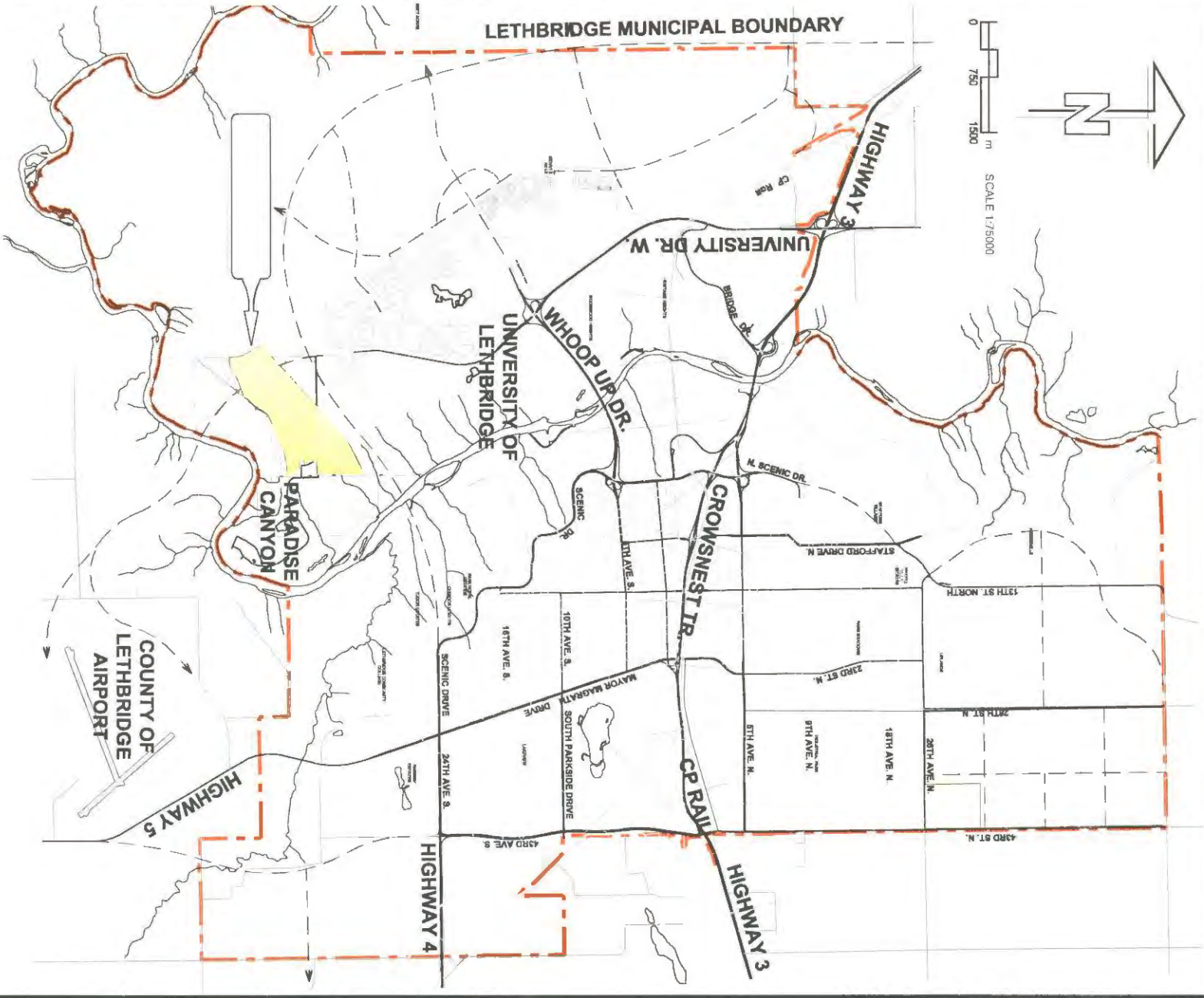
Drawing CW1003 – CW1004 Overland Drainage

Drawing CW4001 Details

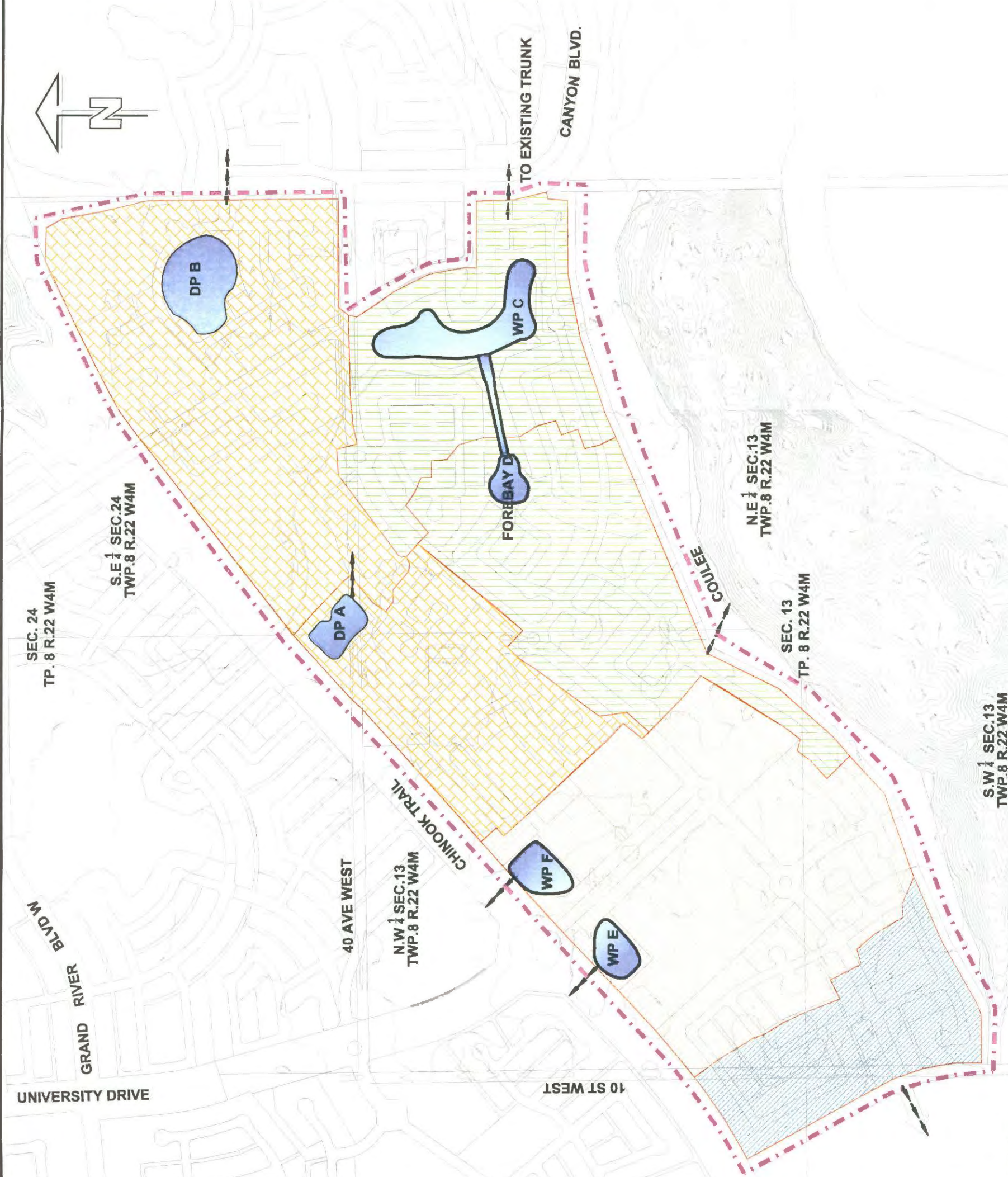
This drawing has been prepared for the use of AECOM's client and may not be used, reproduced or relied upon by third parties, except as agreed by AECOM and its client, as required by law or for use by governmental reviewing agencies. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without AECOM's express written consent. Do not scale this document. All measurements must be obtained from stated dimensions.

LEGEND

--- CITY BOUNDARY



AECOM



LEGEND

- CONSTRUCTION BOUNDARY
- CATCHMENT AREAS BOUNDARY
- DRY POND SYSTEM
- CHINOOK POND SYSTEM
- WETPOND SYSTEM
- WEST SYSTEM
- STORM WATER MANAGEMENT FACILITY
- DP
- WP
- OVERLAND ESCAPE ROUTE





LEGEND

- PROPOSED STORM SEWER
- EXISTING STORM SEWER
- CONSTRUCTION BOUNDARY
- SUBCATCHMENTS BOUNDARY
- ROADWAY SLOPE AND FLOW DIRECTION
- PROPOSED SWMF
- SUBCATCHMENTS AREA NUMBER
- FLOW TO BE STORED ON SITE THEN RELEASED TO THE MINOR SYSTEM
- PROPOSED CATCH-BASIN
- PROPOSED TWIN CATCH-BASIN
- PROPOSED STORM MANHOLE
- CATCH-BASIN TYPE
- PROPOSED CONTROL STRUCTURE
- PROPOSED IMPACT BAFFLE STRUCTURE

SCALE 1:2000

FOR CONTINUATION - REFER TO DWG # 02-CW1002

B	09/08/11	Issued For Approval	KMD	68	48	AN
A	06/07/22	Issued For Approval	N-M	ERC	G-B	JYT
WR	YY/MM/DD	ISSUE/REVISION DESCRIPTION	DRN	CHK	DES	ENG

PROFESSIONAL SEALS



PERMIT TO PRACTICE
AECOM Canada Ltd.
Signature: [Signature]
Date: August 11/09
PERMIT NUMBER: P10450
The Association of Professional Engineers,
Geologists and Geophysicists of Alberta.

This drawing has been prepared for the use of AECOM's client and may not be used, reproduced or relied upon by third parties, except as agreed by AECOM and its client, as required by law or for use by governmental reviewing agencies. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without AECOM's express written consent.

Do not scale this document. All measurements must be obtained from stated dimensions.

AECOM

Melcor Developments Ltd.
The Canyons
Outline Plan
Overland Drainage Analysis
Storm Area Design (1 of 2)

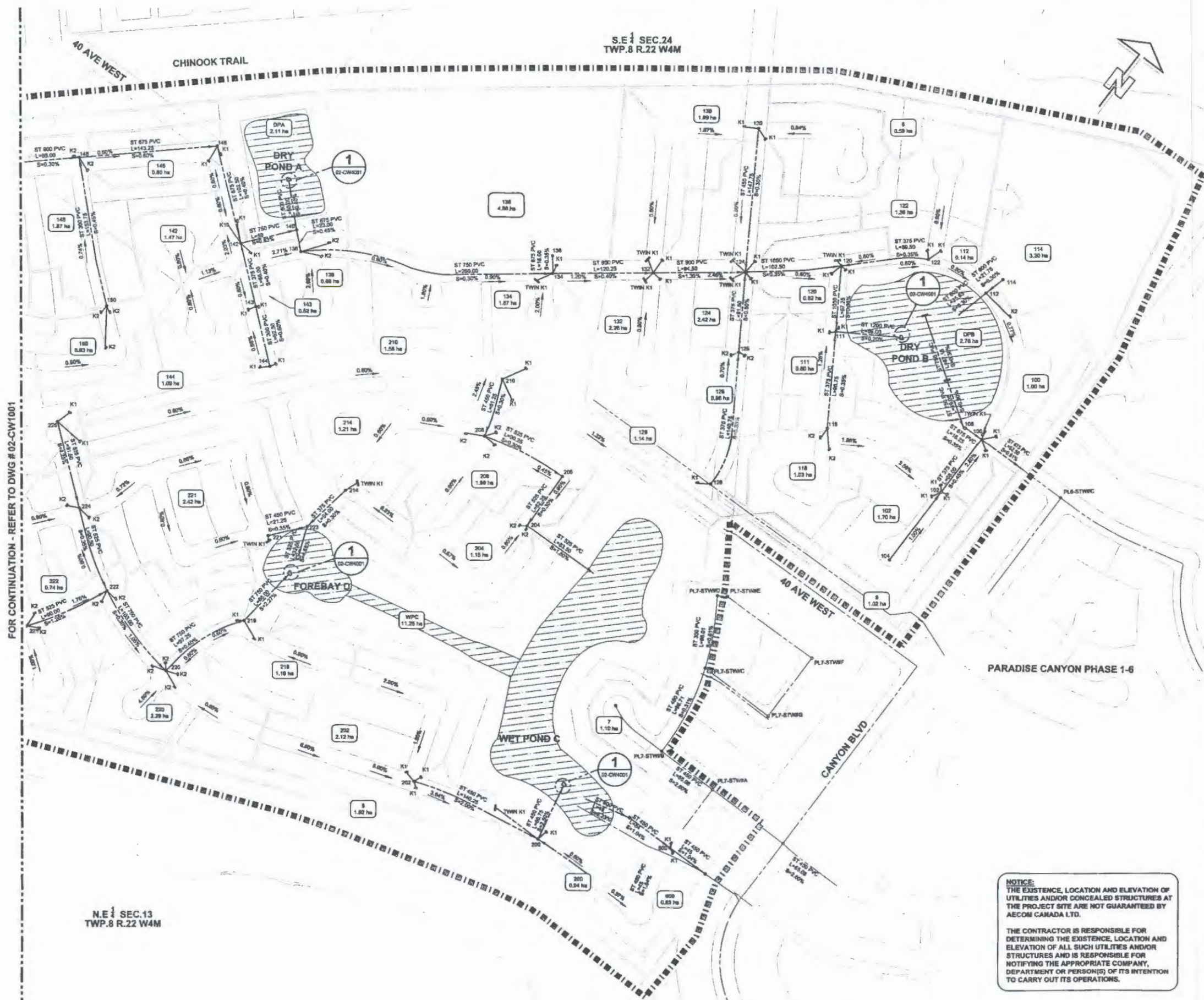
PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
1560-245-00	02-CW1001	B

NOTICE:
THE EXISTENCE, LOCATION AND ELEVATION OF UTILITIES AND/OR CONCEALED STRUCTURES AT THE PROJECT SITE ARE NOT GUARANTEED BY AECOM CANADA LTD.
THE CONTRACTOR IS RESPONSIBLE FOR DETERMINING THE EXISTENCE, LOCATION AND ELEVATION OF ALL SUCH UTILITIES AND/OR STRUCTURES AND IS RESPONSIBLE FOR NOTIFYING THE APPROPRIATE COMPANY, DEPARTMENT OR PERSON(S) OF ITS INTENTION TO CARRY OUT ITS OPERATIONS.

D SIZE 27" x 34" (558.8mm x 863.8mm)

PLOT: 11/08/2009 11:48:14 AM

AECOM FILE NAME: 1560-245-00_02-CW1002_RV.dwg Saved By: stud



LEGEND

- PROPOSED STORM SEWER
- EXISTING STORM SEWER
- CONSTRUCTION BOUNDARY
- SUBCATCHMENTS BOUNDARY
- ROADWAY SLOPE AND FLOW DIRECTION
- PROPOSED SWMF
- SUBCATCHMENTS AREA NUMBER
- FLOW TO BE STORED ON SITE THEN RELEASED TO THE MINOR SYSTEM
- PROPOSED CATCHBASIN
- PROPOSED TWIN CATCHBASIN
- PROPOSED STORM MANHOLE
- CATCHBASIN TYPE
- PROPOSED CONTROL STRUCTURE
- PROPOSED IMPACT Baffle STRUCTURE
- EXISTING STORM MANHOLE

SCALE 1:2000

B	09/06/11	Issued For Approval	XBD	4-B	4-B	4-B
A	08/07/22	Issued For Approval	N-M	ERC	G-B	JYT M-U
YR	YY/MM/DD	ISSUE/REVISION DESCRIPTION	DRN	CHK	DES	ENG
			IDR	APP		

PROFESSIONAL SEALS



PERMIT TO PRACTICE
AECOM Canada Ltd.
Signature: [Signature]
Date: August 4, 2009
PERMIT NUMBER: P10450
The Association of Professional Engineers,
Geologists and Geophysicists of Alberta.

This drawing has been prepared for the use of AECOM's client and may not be used, reproduced or relied upon by third parties, except as agreed by AECOM and its client, as required by law or for use by governmental reviewing agencies. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without AECOM's express written consent.

Do not scale this document. All measurements must be obtained from stated dimensions.

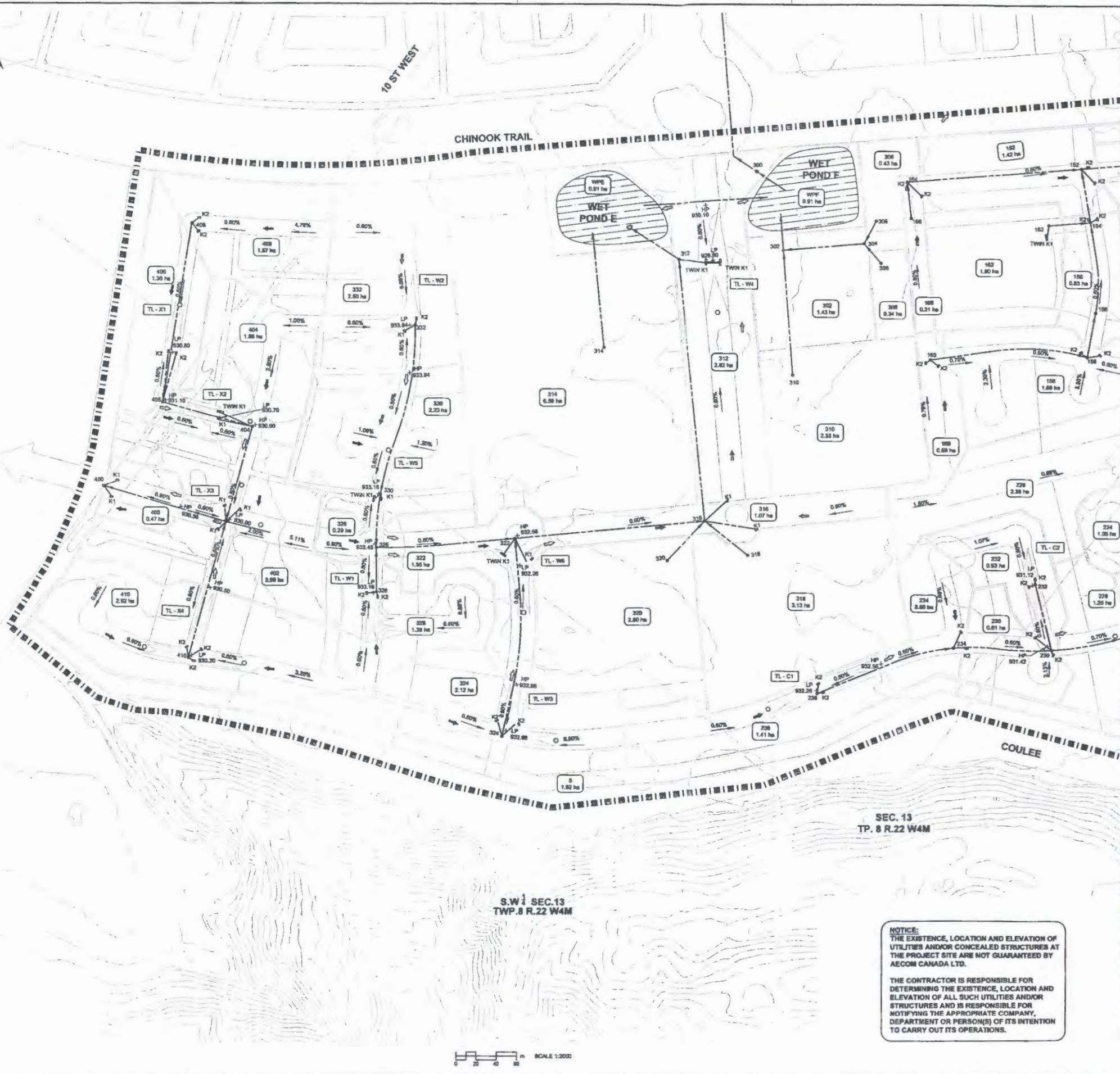
AECOM

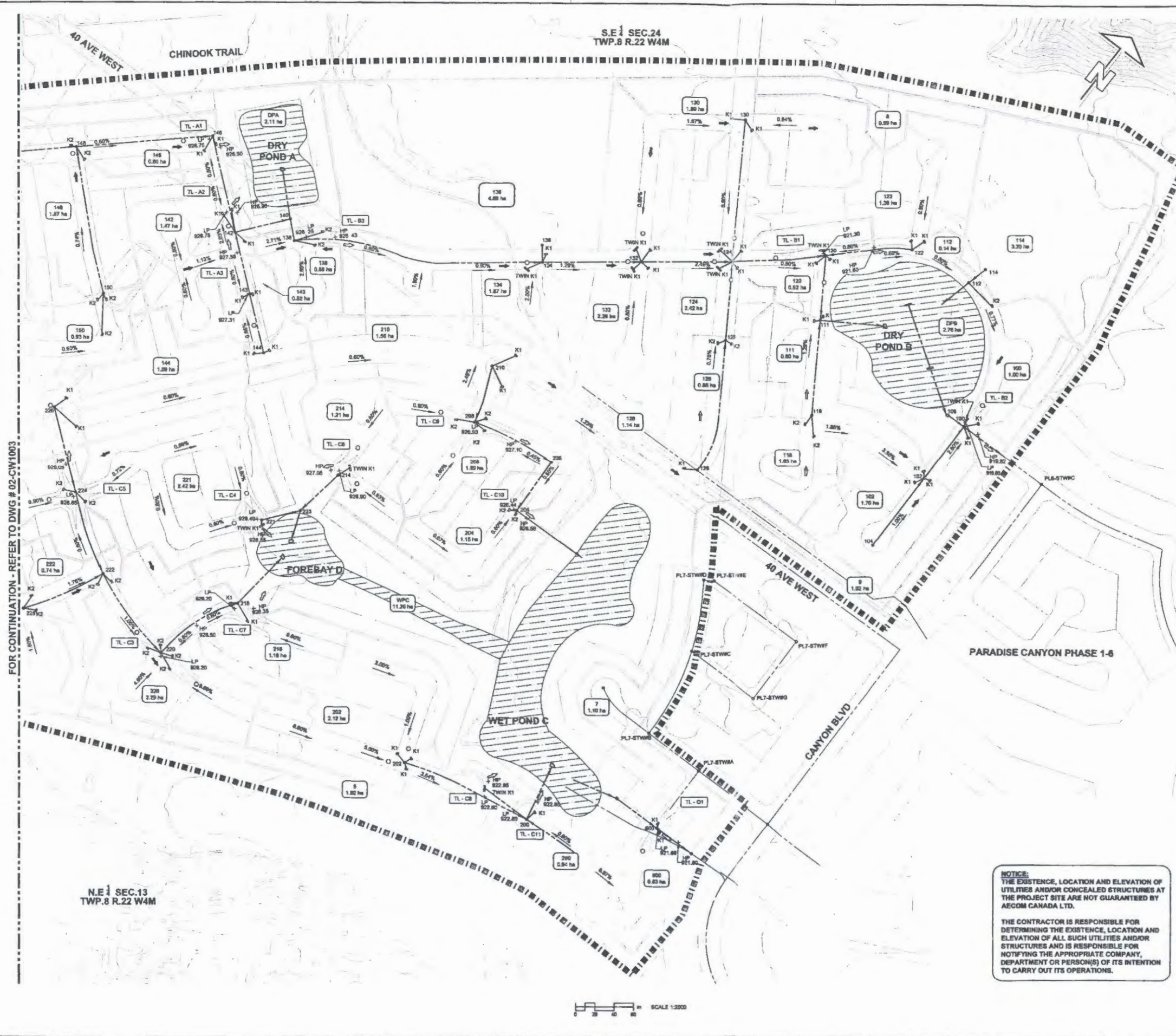
NOTICE:
THE EXISTENCE, LOCATION AND ELEVATION OF UTILITIES AND/OR CONCEALED STRUCTURES AT THE PROJECT SITE ARE NOT GUARANTEED BY AECOM CANADA LTD.

THE CONTRACTOR IS RESPONSIBLE FOR DETERMINING THE EXISTENCE, LOCATION AND ELEVATION OF ALL SUCH UTILITIES AND/OR STRUCTURES AND IS RESPONSIBLE FOR NOTIFYING THE APPROPRIATE COMPANY, DEPARTMENT OR PERSON(S) OF ITS INTENTION TO CARRY OUT ITS OPERATIONS.

Melcor Developments Ltd.
The Canyons
Outline Plan
Overland Drainage Analysis
Storm Area Design (2 of 2)

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
1560-245-00	02-CW1002	B





8. Traffic Impact Assessment



Traffic Impact Assessment

The Canyons Outline Plan Amendment

May 29, 2026

Prepared for:

Melcor Developments

Prepared by:

Stantec Consulting Ltd.
230 – 704 4th Avenue South
Lethbridge AB, T1J 0N8

Sign-off Sheet

This document entitled Traffic Impact Assessment was prepared by Stantec Consulting Ltd. ("Stantec") for the joint accounts of Melcor Developments and the City of Lethbridge. Any reliance on this document by any third party is strictly prohibited. The material in it reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

Prepared by: **Angela Forsyth, P.Eng.**

Reviewed by: **Cheryl Szuch, P.Eng.**

Corporate Authorization

Table of Contents

1.0	INTRODUCTION.....	1
1.1	OBJECTIVES.....	2
1.2	STUDY AREA.....	2
2.0	EXISTING INFRASTRUCTURE	3
2.1	ROAD NETWORK	3
2.2	LAND USE	3
3.0	EXISTING CONDITIONS.....	4
3.1	TRAFFIC VOLUMES	4
4.0	PROPOSED DEVELOPMENT	5
4.1	TRIP GENERATION	7
4.2	TRIP DISTRIBUTION AND ASSIGNMENT	10
5.0	TRANSPORTATION ASSESSMENT	13
5.1	OPERATING CONDITIONS	13
5.2	INTERSECTION ANALYSIS.....	13
5.2.1	Full-Build Operating Conditions.....	14
5.2.2	Full-Build Peak Hour Volumes.....	14
5.2.3	Full-Build Peak Hour Traffic Analysis	17
5.3	ROADWAY AND INTERSECTION CONFIGURATIONS.....	19
5.3.1	Laneing.....	19
5.3.2	Traffic Control	19
5.4	EXISTING UNIVERSITY DRIVE INTERSECTION AND TWINNING	20
5.4.1	University Drive W & Sunridge Blvd W / Riverglen Link W Roundabout	20
5.4.2	University Drive W Twinning.....	21
6.0	RECOMMENDATIONS.....	23

LIST OF TABLES

Table 1: Trip Generation Rate	7
Table 2: Trip Generation by Zone	9
Table 3: Peak Hour Trip Distribution.....	10
Table 4: Level of Service Criteria.....	13
Table 5: Traffic Analysis Results.....	18
Table 6: Traffic Analysis for Adjusted Laneing.....	19
Table 7: MUTCD Warrant Results	20
Table 8: University Drive W Twinning Scenarios	21
Table 9: Horizon Years for University Drive Twinning	22



LIST OF FIGURES

Figure 1: Site Location	1
Figure 2: Existing Intersections	2
Figure 3: Background Traffic Volumes	4
Figure 4: Proposed Plan	6
Figure 5: Trip Generation Zones	8
Figure 6: Estimated AADT	12
Figure 7: AM Peak Hour Turning Movements	15
Figure 8: PM Peak Hour Turning Movements	16

LIST OF APPENDICES

APPENDIX A	Traffic Analysis Output
------------------	-------------------------



TRAFFIC IMPACT ASSESSMENT

Introduction

1.0 INTRODUCTION

In conjunction with The Canyons Outline Plan Amendment, Stantec Consulting Ltd. (Stantec) is undertaking a Traffic Impact Assessment (TIA) for the proposed subdivision configuration, in Lethbridge, Alberta. The subject area is located in west Lethbridge along Canyons Parkway W, south on University Drive W. **Figure 1** illustrates the location of the site within the City of Lethbridge.

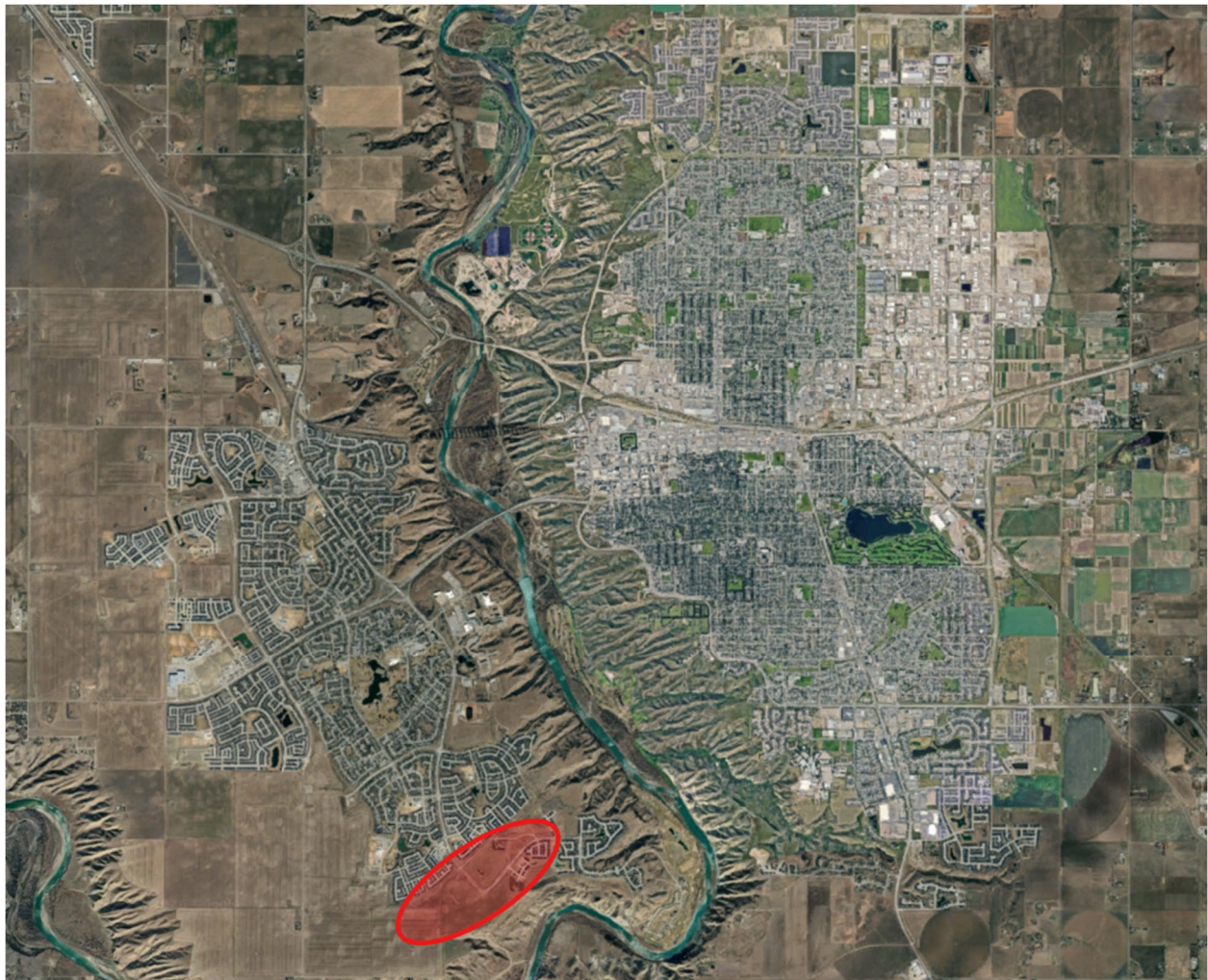


Figure 1: Site Location



TRAFFIC IMPACT ASSESSMENT

Introduction

1.1 OBJECTIVES

The objectives of this TIA are as follows:

- Collect the existing land uses and associated traffic volumes for background information.
- Estimate the magnitude and characteristics of vehicular traffic generated by the proposed development.
- Update and/or recommend roadway classifications as required
- Evaluate the impacts of vehicular traffic generated by the proposed development on key intersections.
- Identify and recommend appropriate traffic operation and/or infrastructure improvements necessary to accommodate the anticipated traffic.

1.2 STUDY AREA

The study area includes the entirety of the repurposed area, including the following existing key intersections:

- Canyon Parkway W & Canyon Ridge Blvd W
- Canyon Parkway W & Canyon Estates Ln W
- Canyon Parkway W & Canyon Meadows Rd W

Additionally, the current 90-degree curve at University Drive W & Canyon Parkway W will be converted into a conventional multilane roundabout, which will serve as the main entrance intersection into the subdivision.

Figure 2 outlines the key intersections within the study. These will continue to be key intersections within the new outline plan.

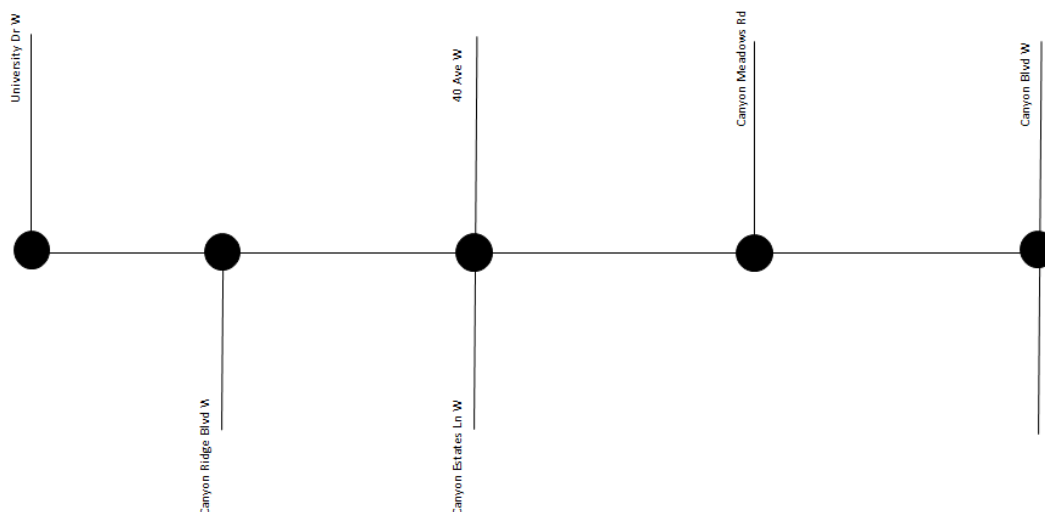


Figure 2: Existing Intersections



2.0 EXISTING INFRASTRUCTURE

2.1 ROAD NETWORK

The existing road network within the area is comprised of a four-lane Super Collector cross section on Canyon Parkway W from University Drive W to Canyon Ridge Blvd W. Extending to the east beyond Canyon Ridge Blvd W, the cross-section changes to a two-lane Super Collector. This cross section extends for the remainder of Canyon Parkway W, where the road terminates at the three-leg intersection with Canyon Blvd W. The posted speed limit is 50 km/h along Canyon Parkway W.

There are three existing intersections along Canyon Parkway W within the study area:

- Canyon Parkway W & Canyon Ridge Blvd W (single-lane roundabout)
- Canyon Parkway W & Canyon Estates Ln W (single-lane roundabout)
- Canyon Parkway W & Canyon Meadows Rd W (two-way stop-controlled intersection)

2.2 LAND USE

There are existing residences and a golf course to the east of the development area. These areas are referred to the upper and lower benches and have been developed for some time. In the immediate area of the amended plan, there are areas that have already been partially developed, such as the Canyon Ridge, Canyon Estates, and Canyon Meadows areas. The remainder of the plan area remains undeveloped.



TRAFFIC IMPACT ASSESSMENT

Existing Conditions

3.0 EXISTING CONDITIONS

3.1 TRAFFIC VOLUMES

Traffic volumes are derived by the ITE TripGen Web-based app using the number of approved residential lots on the upper and lower benches. Similarly, the golf course trips were also generated from the ITE tool. This method will encompass all of the background traffic in the fully developed area. There will be no further future background traffic growth due to the geography and roadway network.

TRIP GENERATION RATES										
Land Use	Units	DAILY			AM			PM		
		Trip Rate	In %	Out %	Trip Rate	In %	Out %	Trip Rate	In %	Out %
Single Family	517	9.09	50%	50%	0.75	27%	73%	0.97	63%	37%
Multi Family	112	6.21	50%	50%	0.47	27%	73%	0.62	60%	40%
Golf Course	18	30.38	50%	50%	2.96	52%	48%	3.68	47%	53%

BACKGROUND TRAFFIC VOLUMES										
Land Use	Units	DAILY			AM			PM		
		Total Trips (vph)	In	Out	Total Trips (vph)	In	Out	Total Trips (vph)	In	Out
Single Family	517	4700	2350	2350	388	105	283	501	316	185
Multi Family	112	696	348	348	53	14	39	69	41	28
Golf Course	18	547	274	274	53	28	25	66	31	35
Sub-total		5943	2972	2972	494	147	347	636	388	248

Figure 3: Background Traffic Volumes



4.0 PROPOSED DEVELOPMENT

The neighbourhood layout has been proposed based on the existing infrastructure in place, as well as existing builds. It is also noted that there is a school site as well as a commercial site within the area plan. The proposed plan is shown in **Figure 4**.

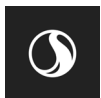




FIGURE 4 | THE CANYONS OUTLINE PLAN AMENDMENT
FIGURE 4: LAND USE CONCEPT

PREPARED FOR: MELCOR DEVELOPMENTS LTD.

U:\116549112\drawings\sheet_files\figures\49112_landuse_1.dwg
 2026/05/07 10:27 AM By: Widen, MHT



116549112
 May 7, 2026

CONCEPT ONLY: THIS DRAWING IS AN ARTISTIC REPRESENTATION OF DESIGNS PREPARED BY STANTEC CONSULTING LTD. IT IS CONCEPTUAL IN NATURE AND SUBJECT TO CHANGE. COPYRIGHT RESERVED.

TRAFFIC IMPACT ASSESSMENT

Proposed Development

4.1 TRIP GENERATION

The trip generation for the site was estimated using the ITE Trip Generation Manual, 12th Edition. **Table 3** summarizes the estimated site traffic rates generated by the proposed site plan.

Land Use	Variable	Daily			AM Peak			PM Peak		
		Trip Rate	% In	% Out	Trip Rate	% In	% Out	Trip Rate	% In	% Out
Single-Family Detached	Units	9.09	50%	50%	0.75	27%	73%	0.97	63%	37%
Multifamily Housing (Low-Rise)	Units	6.21	50%	50%	0.47	27%	73%	0.62	60%	40%
Elementary School	Students	2.27	50%	50%	0.74	54%	46%	0.44	46%	54%
Retail Strip Plaza	1,000 sqft	54.45	50%	50%	5.40	45%	52%	6.24	56%	44%

Table 1: Trip Generation Rate

**derived based on the ITE Trip Generation Handbook and local statistics*

Single and multi family units were derived from the land uses and generally conform to:

- 20 units per hectare for Single Family Detached Housing
- 45 units per hectare (9 ha) and 75 units per hectare (0.7 ha) for Multi-Family Housing
- Elementary school population of 840 students from Lethbridge School District 51
- Retail area estimated based on land available and current trends

Recognizing that school and commercial traffic will somewhat overlap with the residential traffic, a reduction of 30% for the elementary school and 40% for the commercial area were applied. This recognizes that much of the traffic to the school and the retail plaza will be pass-by trips and therefore duplicated in the analysis. These trips are assumed to be entering and exiting the respective site and then continuing on with the original trip. This is consistent for the land use in the area, as much of the school traffic will then continue on out of the development. The retail traffic will likely originate from within the development due to geography and the traffic patterns in the area tending northbound in the AM peak, and southbound in the PM peak. This results in the following trip generation by zone:





FIGURE 5 | THE CANYONS OUTLINE PLAN AMENDMENT

TRIP GENERATION ZONES

PREPARED FOR: MELCOR DEVELOPMENTS LTD.

U:\116549112\drawings\sheet_files\figures\Transportation\49112_Trip Generation Zones_fig_5_20260511.dwg
2026/05/11 12:06 PM By: Miden, Minda



116549112
May 7, 2026

CONCEPT ONLY: THIS DRAWING IS AN ARTISTIC REPRESENTATION OF DESIGNS PREPARED BY STANTEC CONSULTING LTD. IT IS CONCEPTUAL IN NATURE AND SUBJECT TO CHANGE. COPYRIGHT RESERVED.

TRAFFIC IMPACT ASSESSMENT

Proposed Development

Zone	Land Use	Units	Daily			AM			PM		
			Total Trips (vph)	In	Out	Total Trips (vph)	In	Out	Total Trips (vph)	In	Out
1	Single Family	96	873	437	437	72	19	53	93	59	34
	Multi Family	131	814	407	407	62	17	45	81	49	32
2	Single Family	33	300	150	150	25	7	18	32	20	12
3	Single Family	82	745	373	373	62	17	45	80	50	30
4	Single Family	33	300	150	150	25	7	18	32	20	12
5	Single Family	55	500	250	250	41	11	30	53	33	20
6	Single Family	66	600	300	300	50	14	37	64	40	24
7	Single Family	98	891	446	446	74	20	54	95	60	35
8	Single Family	48	436	218	218	36	10	26	47	30	17
9	Single Family	20	182	91	91	15	4	11	19	12	7
10	Single Family	25	227	114	114	19	5	14	24	15	9
11	Single Family	55	500	250	250	41	11	30	53	33	20
12	Single Family	84	764	382	382	63	17	46	81	51	30
	Multi Family	22	137	69	69	10	3	7	14	8	6
13	Single Family	32	291	146	146	24	6	18	31	20	11
	Multi Family	68	422	211	211	32	9	23	42	25	17
	Elem. School	840	1336	668	668	437	236	201	260	120	140
14	Single Family	53	482	241	241	40	11	29	51	32	19
	Multi Family	30	186	93	93	14	4	10	19	11	8
15	Single Family	30	273	137	137	23	6	17	29	18	11
16	Single Family	12	109	55	55	9	2	7	12	8	4
17	Single Family	46	418	209	209	35	9	26	45	28	17
18	Single Family	36	327	164	164	27	7	20	35	22	13
	Multi Family	41	255	128	128	19	5	14	25	15	10
19	Multi Family	58	360	180	180	27	7	20	36	22	14
20	Multi Family	28	174	87	87	13	4	9	17	10	7
	Strip Retail	108	3528	1764	1764	350	168	182	406	227	179
21	Single Family	39	355	178	178	29	8	21	38	24	14
22	Single Family	44	400	200	200	33	9	24	43	27	16
23	Single Family	23	209	105	105	17	5	12	22	14	8
24	Single Family	3	27	14	14	2	1	1	3	2	1
	Multi Family	40	248	124	124	19	5	14	25	15	10
25	Single Family	15	136	68	68	11	3	8	15	9	6
	Multi Family	49	304	152	152	23	6	17	30	18	12
26	Single Family	42	382	191	191	32	9	23	41	26	15
27	Single Family	18	164	82	82	14	4	10	17	11	6
28	Single Family	34	309	155	155	26	7	19	33	21	12
Sub-total			17964	8989	8989	1851	693	1159	2043	1205	838

Table 2: Trip Generation by Zone



TRAFFIC IMPACT ASSESSMENT

Proposed Development

4.2 TRIP DISTRIBUTION AND ASSIGNMENT

The directional distribution patterns for the new primary trips were based on the existing land uses and trip distribution patterns in the area. With the areas to the east fully developed, and the west not yet planned, the primary entrance and exit to the developable area is via University Drive W to the north. This is assumed to be 97% of the generated traffic in each traffic zone. The trip distribution is summarized in **Table 3** and follow the zones outlined in **Figure 5**. Traffic directions are described as towards University Drive W or toward the Oldman River valley to the east.

Zone	Land Use	Units	Daily						AM						PM					
			Total Trips	In		Out		Total Trips	In		Out		Total Trips	In		Out				
				To Univ	To River	To Univ	To River		To Univ	To River	To Univ	To River		To Univ	To River	To Univ	To River			
1	Single Family	96	873	424	13	415	22	72	18	1	50	3	93	57	2	33	1			
	Multi Family	131	814	657	20	643	34	62	16	1	43	2	81	47	1	31	1			
2	Single Family	33	300	146	4	143	7	25	6	0	17	1	32	20	1	11	0			
3	Single Family	82	745	362	11	354	19	62	16	1	43	2	80	49	2	29	1			
4	Single Family	33	300	146	4	143	7	25	6	0	17	1	32	20	1	11	0			
5	Single Family	55	500	243	7	238	12	41	11	1	28	1	53	32	1	19	1			
6	Single Family	66	600	291	9	285	15	50	13	1	35	2	64	39	1	23	1			
7	Single Family	98	891	433	13	424	22	74	19	1	51	3	95	58	2	34	1			
8	Single Family	48	436	211	7	207	11	36	9	0	25	1	47	29	1	17	1			
9	Single Family	20	182	88	3	86	5	15	4	0	10	1	19	12	0	7	0			
10	Single Family	25	227	111	3	108	6	19	5	0	13	1	24	15	0	9	0			
11	Single Family	55	500	243	7	238	12	41	11	1	28	1	53	32	1	19	1			
12	Single Family	84	764	371	11	363	19	63	16	1	44	2	81	49	2	29	1			
	Multi Family	22	137	67	2	66	3	10	3	0	7	0	14	8	0	5	0			
13	Single Family	32	291	142	4	139	7	24	6	0	17	1	31	19	1	11	0			
	Multi Family	68	422	205	6	200	11	32	8	0	22	1	42	24	1	16	1			
	Elem. School	840	1336	695	21	680	36	437	224	12	191	10	260	116	4	136	4			
14	Single Family	53	482	234	7	229	12	40	10	1	28	1	51	31	1	18	1			
	Multi Family	30	186	90	3	88	5	14	4	0	10	1	19	11	0	7	0			
15	Single Family	30	273	133	4	130	7	23	6	0	16	1	29	18	1	10	0			
16	Single Family	12	109	53	2	52	3	9	2	0	6	0	12	7	0	4	0			
17	Single Family	46	418	203	6	199	10	35	9	0	24	1	45	27	1	16	0			
18	Single Family	36	327	159	5	156	8	27	7	0	19	1	35	21	1	13	0			
	Multi Family	41	255	124	4	122	6	19	5	0	13	1	25	15	0	10	0			
19	Multi Family	58	360	175	5	171	9	27	7	0	19	1	36	21	1	14	0			
20	Multi Family	28	174	84	3	83	4	13	3	0	9	0	17	10	0	7	0			
	Strip Retail	108	3528	1711	53	1676	88	350	160	8	173	9	406	221	7	173	5			
21	Single Family	39	355	173	5	169	9	29	7	0	20	1	38	23	1	14	0			
22	Single Family	44	400	194	6	190	10	33	8	0	23	1	43	26	1	15	0			
23	Single Family	23	209	102	3	100	5	17	4	0	12	1	22	13	0	8	0			
24	Single Family	3	27	14	0	13	1	2	1	0	1	0	3	2	0	1	0			
	Multi Family	40	248	120	4	118	6	19	5	0	13	1	25	15	0	10	0			
25	Single Family	15	136	66	2	65	3	11	3	0	8	0	15	9	0	5	0			
	Multi Family	49	304	147	5	144	8	23	6	0	16	1	30	17	1	12	0			
26	Single Family	42	382	185	6	181	10	32	8	0	22	1	41	25	1	15	0			
27	Single Family	18	164	80	2	78	4	14	4	0	10	1	17	10	0	6	0			
28	Single Family	34	309	150	5	147	8	26	7	0	18	1	33	20	1	12	0			
Sub-total			17964	9032	275	8843	464	1851	657	29	1101	57	2043	1168	38	810	20			

Table 3: Peak Hour Trip Distribution

Based on the trip distribution patterns, the AM and PM peak hour traffic generated from the development were then assigned to the subject intersections. The assignment for the generated AM and PM peak hour traffic is illustrated in **Figure 7** and **Figure 8**, respectively.

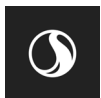


TRAFFIC IMPACT ASSESSMENT

Proposed Development

Adding the development volumes to the background volumes give the full-build traffic volumes distributed over the roadway network. The resulting estimated AADT for collector roads is shown in **Figure 6**.

Figure 6 also identifies specific higher-priority intersections identified for potential accessibility and traffic calming measures. These intersections highlighted in grey circles should be evaluated and may need further refinement at detailed design stage, which may include curb extensions, additional wheelchair ramps, tactile warning pads, raised crosswalks, rectangular rapid flashing beacons, or other measures.



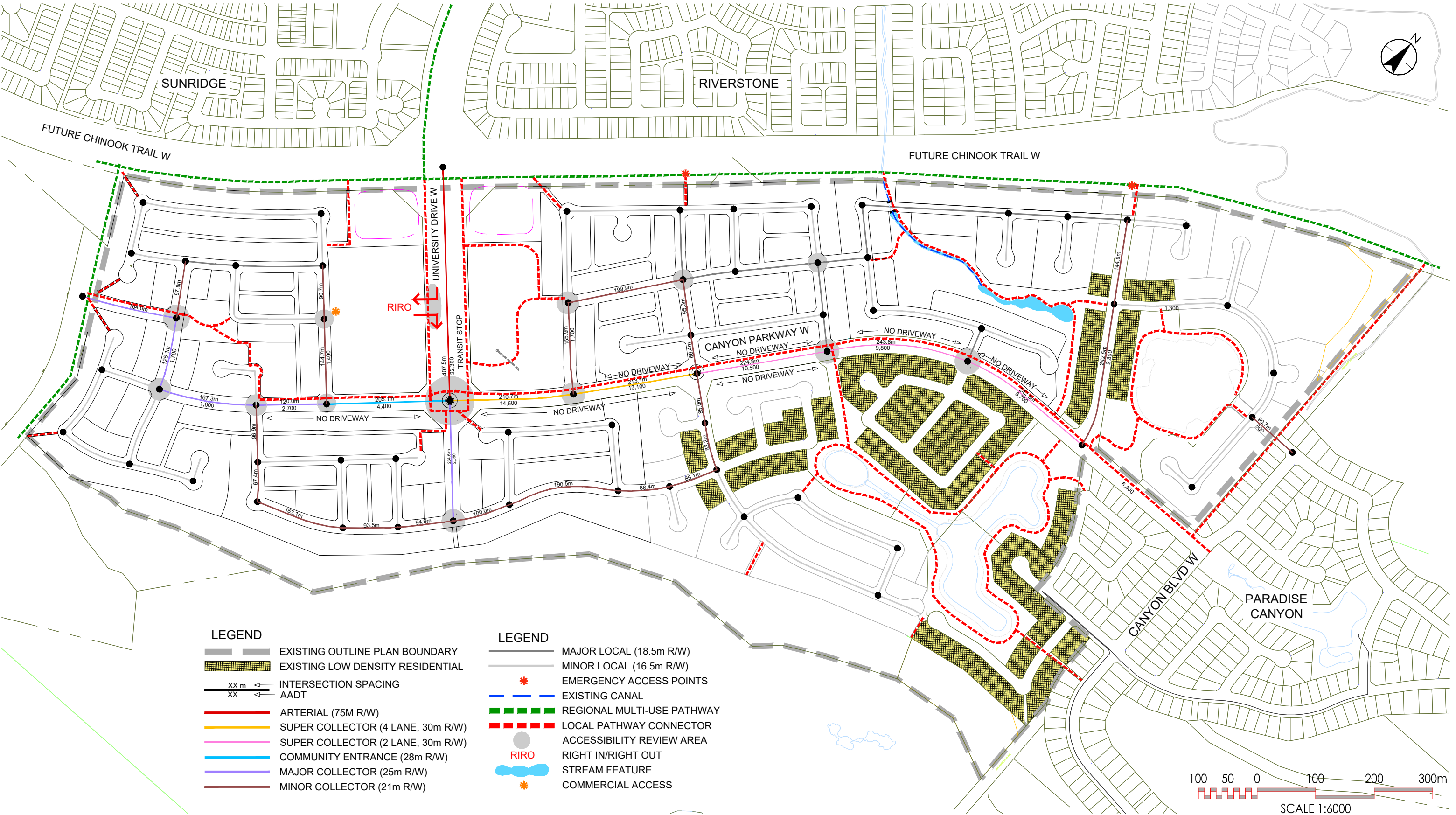


FIGURE 6 | THE CANYONS OUTLINE PLAN AMENDMENT
ESTIMATED AADT

PREPARED FOR: MELCOR DEVELOPMENTS LTD.

U:\116549112\drawings\sheet_files\figures\49112_transportation_Network_Fig 8.0.dwg
2026/05/26 2:14 PM By: Widen, Mira



116549112
May 26, 2026

CONCEPT ONLY: THIS DRAWING IS AN ARTISTIC REPRESENTATION OF DESIGNS PREPARED BY STANTEC CONSULTING LTD. IT IS CONCEPTUAL IN NATURE AND SUBJECT TO CHANGE. COPYRIGHT RESERVED.

5.0 TRANSPORTATION ASSESSMENT

5.1 OPERATING CONDITIONS

Intersection analysis was completed using the Synchro 12 software package, supporting the Highway Capacity Manual. The methodology considers the intersection geometry, traffic volumes, posted speed limit, and intersection control for unsignalized intersections. For signalized intersections and roundabouts, the intersection geometry, traffic volumes, posted speed limit, traffic signal phasing/timing plan and pedestrian volumes are all considered. The level-of-service criteria is tabulated below in **Table 1** for both unsignalized and signalized intersections.

Level of Service	Average Control Delay (seconds per vehicle)		Comment
	Signalized Intersection	Unsignalized Intersection	
A	10.0 or less	10.0 or less	Very good operation
B	10.1 to 20.0	10.1 to 15.0	Good operation
C	20.1 to 35.0	15.1 to 25.0	Acceptable operation
D	35.1 to 55.0	25.1 to 35.0	Congestion
E	55.1 to 80.0	35.1 to 50.0	Significant congestion
F	More than 80.0	More than 50.0	Unacceptable operation

Table 4: Level of Service Criteria

The volume-to-capacity (v/c) ratio was also considered in the analysis. The v/c ratio represents the percentage of capacity the traffic volumes are consuming. If the v/c ratio is above 1.0, then the movement or intersection has exceeded capacity.

5.2 INTERSECTION ANALYSIS

The major intersections in the proposed site plan were analyzed for traffic operations. In consultation with the City of Lethbridge, beginning with the intersection of University Drive W and Canyon Parkway W, intersections were then analyzed laterally until traffic signals or a 4-way stop were no longer required. As traffic volumes decrease from the University Drive access to the development, intersection efficiency will naturally increase.



TRAFFIC IMPACT ASSESSMENT

Transportation Assessment

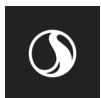
5.2.1 Full-Build Operating Conditions

The post-development full-build operating conditions for the aforementioned intersections in the study area were reviewed based on the following:

- Existing laneing along Canyon Parkway W
- University Drive 4-lane arterial cross-section
- Addition of a roundabout at University Drive W and Canyon Parkway W
- Existing configurations for those intersections already built.
- Single lane approaches in all other locations

5.2.2 Full-Build Peak Hour Volumes

Development peak hour traffic was distributed in accordance with the volumes and distribution identified for AADT in Section 3 of this document. This results in the following traffic volumes for the University Drive W area as shown in **Figure 7** and **Figure 8**.



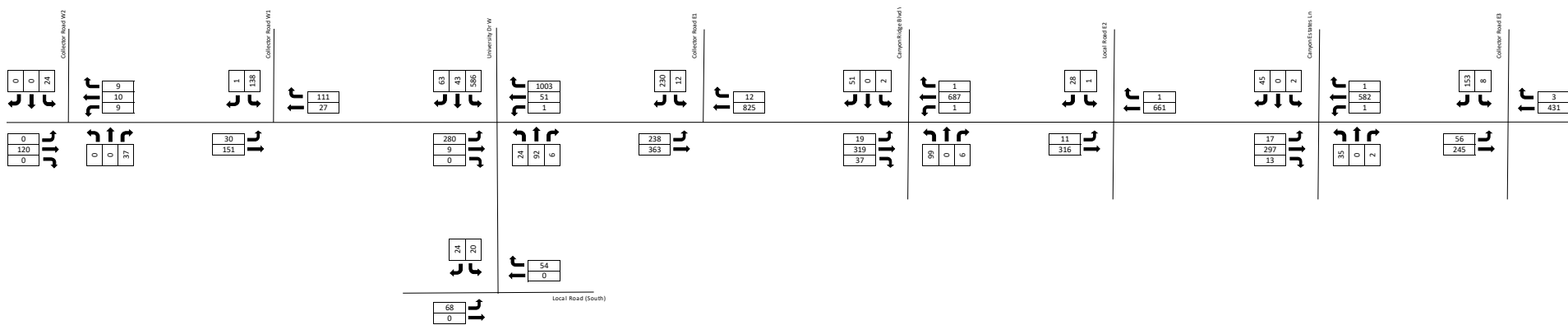


Figure 7: AM Peak Hour Turning Movements

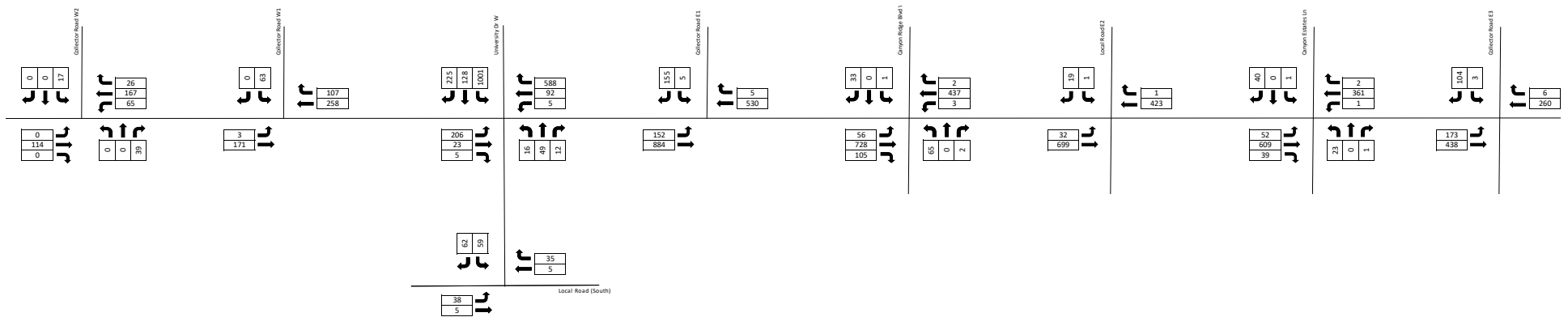


Figure 8: PM Peak Hour Turning Movements

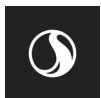
TRAFFIC IMPACT ASSESSMENT

Transportation Assessment

5.2.3 Full-Build Peak Hour Traffic Analysis

Development peak hour traffic was added to the background traffic already distributed on the network.

Peak hour traffic was analyzed in Synchro Studio 12 for signalized and stop controlled intersections, while Rodel Interactive software was used to analyze roundabouts. The resulting analysis is outlined in **Table 5**.



TRAFFIC IMPACT ASSESSMENT

Transportation Assessment

	Intersection Control	Scenario	Measure	Eastbound			Westbound			Northbound			Southbound			Level of Service
Intersection				Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	
Canyon Pkwy W & University Dr W	Roundabout	AM Peak	Volumes (vph)	280	9	5	5	51	1003	24	92	6	586	43	63	A
			Level of Service	B			A			A			A			
			V/C Ratio by Movement	0.51			0.7			0.24			0.38			
			95th Percentile Queue (m)	19.6			50.5			6.1			5.0			
		PM Peak	Volumes (vph)	5	92	340	206	23	5	16	49	12	613	128	225	A
			Level of Service	C			A			B			A			
			V/C Ratio by Movement	0.52			0.4			0.19			0.72			
			95th Percentile Queue (m)	26.3			14.3			4.8			70.9			
Canyon Pkwy W & Collector Rd (West)	Two-Way Stop Control	AM Peak	Volumes (vph)		27	111	30	151					138		5	A
			Level of Service	A			A						B			
			V/C Ratio by Movement	0.02			0.09						0.27			
			95th Percentile Queue (m)	0.6			0						8.1			
		PM Peak	Volumes (vph)		5	171	258	75					63		5	A
			Level of Service	A			A						B			
			V/C Ratio by Movement	0.01			0.22						0.15			
			95th Percentile Queue (m)	0.1			0						4.1			
Canyon Pkwy W & Collector Rd (East)	Two-Way Stop Control	AM Peak	Volumes (vph)	238	363			825	12				12		230	A
			Level of Service	A			A						E			
			V/C Ratio by Movement	0.38			0.37			0.19			0.75			
			95th Percentile Queue (m)	13.3			0			0			45.6			
		PM Peak	Volumes (vph)	152	1036			530	5				5		155	A
			Level of Service	A			A			A			B			
			V/C Ratio by Movement	0.18			0.46			0.24			0.32			
			95th Percentile Queue (m)	4.9			4.9			0			10.6			
University Dr W & Local Rd (South)	Two-Way Stop Control	AM Peak	Volumes (vph)	68	5			5	54				20		24	A
			Level of Service	A			A						A			
			V/C Ratio by Movement	0.09			0.07						0.06			
			95th Percentile Queue (m)	0			0						0			
		PM Peak	Volumes (vph)	38	5			5	35				59		62	A
			Level of Service	A			A						A			
			V/C Ratio by Movement	0.06			0.05						0.16			
			95th Percentile Queue (m)	0			0						0			

Table 5: Traffic Analysis Results



TRAFFIC IMPACT ASSESSMENT

Transportation Assessment

This analysis indicates that each of the subject intersections appear to operate acceptably with the proposed configurations. Each intersection operates at LOS A overall, with no individual movement below LOS E and no individual v/c ratio above 0.75. 95th percentile queues all appear manageable, with the largest queue being on southbound University Drive in the PM peak hour; which is estimated at 70.9 metres, or 12 vehicles.

The intersection immediately east of the University Drive W roundabout (Collector E1), accessing the school, is estimated to operate as LOS E in the AM peak hour in the southbound direction. Although this is LOS E, the v/c ratio is 0.75 and queues are manageable at 45 metres. In an effort to improve operations at this intersection, a southbound left turn lane was added and the scenario was analyzed once again. The southbound right movement was increased to LOS C, but the left turn in the newly created lane is LOS F, however the v/c ratio is 0.27 and the 95th percentile queue is estimated to be only 7 metres, or one vehicle.

Intersection	Intersection Control	Scenario	Measure	Eastbound			Westbound			Northbound			Southbound			Level of Service
				Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	
Canyon Pkwy W & Collector Rd (E1)	Two-Way Stop Control	AM Peak	Volumes (vph)	238	363			825	12				12		230	A
			Level of Service	B	B			A	A				F		C	
			V/C Ratio by Movement	0.38	0.12			0.37	0.19				0.27		0.49	
			95th Percentile Queue (m)	13.3	0			0	0				7.0		20.1	
	PM Peak		Volumes (vph)	152	1036			530	5				5		155	A
			Level of Service	A	A			A	A				E		B	
			V/C Ratio by Movement	0.18	0.35			0.24	0.12				0.07		0.25	
			95th Percentile Queue (m)	0	0			0	0				1.7		7.7	

Table 6: Traffic Analysis for Adjusted Laneing

There is a tangible possibility that the 12 vehicles in the AM peak hour will travel to the existing adjacent intersection to the east, where traffic volumes will be a bit lower and on a loop from the school site.

5.3 ROADWAY AND INTERSECTION CONFIGURATIONS

5.3.1 Laneing

Two-lane roadways are adequate where new infrastructure will be built. It does not appear that any upgrading to additional 4-lane cross sections is warranted.

It is recommended that each intersection operates with a single approach lane, with the exception of the existing left turn lanes and the two roundabouts already built: Canyon Parkway W & Canyon Ridge Blvd W and Canyon Parkway W & Canyon Estates Lane W. Stop conditions on the minor approaches appear to be adequate at all locations where roundabouts are not currently constructed.

5.3.2 Traffic Control

An all-way stop warrant analysis was conducted in accordance with the Transportation Association of Canada (TAC) Manual of Uniform Traffic Control Devices (MUTCD) for Canada. The following are indications that an all-way stop may be warranted:

- Where the traffic volumes on the intersecting roads are approximately equal, and the combined pedestrian and vehicular volumes on the minor road average 200 per hour for an eight hour period;



TRAFFIC IMPACT ASSESSMENT

Transportation Assessment

- b) Where the average delay to the minor road vehicular traffic entering the intersection exceeds 30 seconds per vehicle during the peak hour;
- c) Where traffic signals are not warranted, and a collision problem exists, as indicated by five or more reported collisions per year of a type which may be prevented by an All Way Stop sign installation;
- d) As an interim measure prior to the installation of traffic signals; or
- e) As in interim measure, for a period of approximately one month prior to switching the stop control from one road to an intersecting road, and the subsequent removal of existing Stop signs on the first road.

A summary of the evaluation is shown in **Table 7**.

Intersection	A	B	C	D	E
Canyon Pkwy & Collector W2	no	no	n/a	no	no
Canyon Pkwy & Collector W1	no	no	n/a	no	no
Canyon Pkwy & Collector E1	no	*yes	n/a	no	no
Canyon Pkwy & Canyon Ridge Blvd	no	no	no	no	no
Canyon Pkwy & Local E2	no	no	n/a	no	no
Canyon Pkwy & Canyon Estates Ln	no	no	no	no	no
Canyon Pkwy & Collector E3	no	no	n/a	no	no

Table 7: MUTCD Warrant Results

Although Collector E1 experiences an estimated delay of 49 seconds in the left turn lane, the rest of the movements are below 30 seconds. The addition of an all-way stop here would be detrimental to the flow of Canyon Parkway W.

5.4 EXISTING UNIVERSITY DRIVE INTERSECTION AND TWINNING

In an effort to evaluate existing infrastructure to the north of the development, two items were reviewed for capacity and upgrading.

5.4.1 University Drive W & Sunridge Blvd W / Riverglen Link W Roundabout

This intersection is located approximately 800 metres to the north of Canyon Parkway W on University Drive W. The existing roundabout is currently built to the anticipated full build condition, however this study aimed to confirm that the roundabout operations are not anticipated to deteriorate to unacceptable conditions upon full build-out of the



TRAFFIC IMPACT ASSESSMENT

Transportation Assessment

development. The traffic turning movements were observed and tabulated on Tuesday April 14, 2026. These turning movements were then used as the background condition for the roundabout analysis. Previously calculated development volumes were then added to the intersection as southbound throughs and northbound throughs.

Once the anticipated full-build traffic volumes were applied to the intersection, an analysis was undertaken to evaluate intersection operations. From the analysis, it appears that the roundabout will accommodate the anticipated traffic volumes; all movements are LOS A, with v/c ratios below 0.75 and 95th percentile queues anticipated to be 68 metres in the southbound lanes in the PM peak hour. Analysis results can be viewed in **Table 5**.

5.4.2 University Drive W Twinning

In conjunction with this development, the need for twinning University Drive W between Sunridge Blvd W and Canyon Parkway W was evaluated. It was found that the existing peak hour flow is approximately 700 vehicles per hour, leaving an unused capacity of 1,050 vph before twinning is warranted. Using this available capacity and the trip generation rates from Section 4.1, and understanding that the school site, is likely to be developed in the short-term, the following three scenarios would warrant twinning:

Scenario	Description	Single Family Units	School Site	Retail Site
1	Single Family Units and School Site	800	Fully Developed	n/a
2	Single Family Units, School Site and Retail Site	600	Fully Developed	Half Developed
3	Single Family Units, School Site and Retail Site	400	Fully Developed	Fully Developed

Table 8: University Drive W Twinning Scenarios

It is noted that for each single-family unit, 1.5 multi-family units may be substituted, given the trip generation rates from Section 4.1.

Recent historical development rates in The Canyons has been approximately 10 units per year over the last 13 years; with roughly 130 lots developed since 2012. Given the likelihood of the school site coming online, this rate may increase somewhat as potential homeowners seek to build near a new school. In the event that the growth rate doubles to 20 builds per year, the anticipated horizon for University Drive W twinning is shown in **Table 9**.



TRAFFIC IMPACT ASSESSMENT

Transportation Assessment

Scenario	Lots Developed per Year	Horizon Year for Twinning
1	20	2066
2	20	2056
3	20	2046

Table 9: Horizon Years for University Drive Twinning



6.0 RECOMMENDATIONS

It is recommended that the proposed roadway classifications be maintained and that no additional turning lanes are constructed. Existing infrastructure appears to be adequate to accommodate the estimated projected traffic volumes.

It is recommended that the intersection of Canyon Parkway W & Collector Road (East) be constructed and signed as a stop condition on the collector road. Once the school is built, it is recommended to periodically revisit the intersection operating conditions. Pedestrian facilities and landscaping in the immediate vicinity of this intersection should be designed such that the addition of potential traffic signals in the future would not be hindered or cause new infrastructure to be removed. Although the analysis indicates that this intersection will operate acceptably without signals, it is prudent to keep a viable traffic signal option open.

Intersections should be visited individually for the potential addition of traffic calming or safety enhancing design or devices. This should be done at the detailed design stage for each phase as outlined within this TIA.



APPENDIX A

Traffic Analysis Output



Operational Data

Main Geometry (m)

Approach and Entry Geometry

Leg	Leg Names	Approach Bearing (deg)	Grade Separation G	Half Width V	Approach Lanes n	Entry Width E	Entry Lanes n	Flare Length L'	Entry Radius R	Entry Angle Phi
1	University Dr W	0	0	7.00	2	8.00	2	50.00	20.00	30.00
2	Canyon Pkwy W	90	0	3.50	1	4.00	1	50.00	20.00	30.00
3	Local Road	180	0	3.50	1	4.00	1	50.00	20.00	30.00
4	Canyon Pkwy W	270	0	7.00	2	8.00	2	50.00	20.00	30.00

Circulating and Exit Geometry

Leg	Leg Names	Inscribed Diameter D	Circulating Width C	Circulating Lanes nc	Exit Width Ex	Exit Lanes nex	Exit Half Width Vx	Exit Half Width Lanes nvx
1	University Dr W	55.00	5.00	1	8.00	2	7.00	2
2	Canyon Pkwy W	55.00	10.00	2	4.00	1	3.50	1
3	Local Road	55.00	10.00	2	4.00	1	3.50	1
4	Canyon Pkwy W	55.00	5.00	1	8.00	2	7.00	2

Capacity Modifiers and Capacity Calibration (veh/hr)

Leg	Leg Names	Entry Capacity		Entry Calibration		Approach Road			Exit Road		
		Capacity + or -	XWalk Factor	Intercept + or -	Slope Factor	V (m)	Default Capacity	Calib Capacity	V (m)	Default Capacity	Calib Capacity
1	University Dr W	0	1.000	0	1.000	6.00	3430	0	7.00	3430	0
2	Canyon Pkwy W	0	1.000	0	1.000	6.00	1715	0	3.50	1715	0
3	Local Road	0	1.000	0	1.000	6.00	1715	0	3.50	1715	0
4	Canyon Pkwy W	0	1.000	0	1.000	7.00	3430	0	7.00	3430	0

Operational Results

2046 AM Peak - 60 minutes

Flows and Capacity

Leg	Leg Names	Bypass Type	Flows (veh/hr)				Capacity (veh/hr)			
			Arrival Flow		Opposing Flow		Exit Flow		Average VCR	
			Entry	Bypass	Entry	Bypass	Entry	Bypass	Entry	Bypass
1	University Dr W	None	692		80		1374		1808	0.3826
2	Canyon Pkwy W	None	294		634		138		581	0.5060
3	Local Road	None	122		875		53		499	0.2444
4	Canyon Pkwy W	None	1059		396		601		1511	0.7007

Delays, Queues and Level of Service

Leg	Leg Names	Bypass Type	Average Delay (sec)			95% Queue (veh)		Level of Service		
			Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Leg
1	University Dr W	None	3.53		3.53	2.13		A		A
2	Canyon Pkwy W	None	11.72		11.72	3.27		B		B
3	Local Road	None	9.07		9.07	1.02		A		A
4	Canyon Pkwy W	None	7.90		7.90	8.42		A		A

Operational Data

Main Geometry (m)

Approach and Entry Geometry

Leg	Leg Names	Approach Bearing (deg)	Grade Separation G	Half Width V	Approach Lanes n	Entry Width E	Entry Lanes n	Flare Length L'	Entry Radius R	Entry Angle Phi
1	University Dr W	0	0	7.00	2	8.00	2	50.00	20.00	30.00
2	Canyon Pkwy W	90	0	3.50	1	4.00	1	50.00	20.00	30.00
3	Local Road	180	0	3.50	1	4.00	1	50.00	20.00	30.00
4	Canyon Pkwy W	270	0	7.00	2	8.00	2	50.00	20.00	30.00

Circulating and Exit Geometry

Leg	Leg Names	Inscribed Diameter D	Circulating Width C	Circulating Lanes nc	Exit Width Ex	Exit Lanes nex	Exit Half Width Vx	Exit Half Width Lanes nvx
1	University Dr W	55.00	5.00	1	8.00	2	7.00	2
2	Canyon Pkwy W	55.00	10.00	2	4.00	1	3.50	1
3	Local Road	55.00	10.00	2	4.00	1	3.50	1
4	Canyon Pkwy W	55.00	5.00	1	8.00	2	7.00	2

Capacity Modifiers and Capacity Calibration (veh/hr)

Leg	Leg Names	Entry Capacity		Entry Calibration		Approach Road			Exit Road		
		Capacity + or -	XWalk Factor	Intercept + or -	Slope Factor	V (m)	Default Capacity	Calib Capacity	V (m)	Default Capacity	Calib Capacity
1	University Dr W	0	1.000	0	1.000	6.00	3430	0	7.00	3430	0
2	Canyon Pkwy W	0	1.000	0	1.000	6.00	1715	0	3.50	1715	0
3	Local Road	0	1.000	0	1.000	6.00	1715	0	3.50	1715	0
4	Canyon Pkwy W	0	1.000	0	1.000	7.00	3430	0	7.00	3430	0

Operational Results

2046 PM Peak - 60 minutes

Flows and Capacity

Leg	Leg Names	Bypass Type	Flows (veh/hr)					Capacity (veh/hr)			
			Arrival Flow		Opposing Flow		Exit Flow	Capacity		Average VCR	
			Entry	Bypass	Entry	Bypass		Entry	Bypass	Entry	Bypass
1	University Dr W	None	1354		113		843	1887		0.7177	
2	Canyon Pkwy W	None	234		1134		333	447		0.5232	
3	Local Road	None	77		1230		138	414		0.1861	
4	Canyon Pkwy W	None	685		271		1036	1734		0.3951	

Delays, Queues and Level of Service

Leg	Leg Names	Bypass Type	Average Delay (sec)			95% Queue (veh)		Level of Service		
			Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Leg
1	University Dr W	None	9.19		9.19	11.81		A		A
2	Canyon Pkwy W	None	17.74		17.74	4.39		C		C
3	Local Road	None	10.73		10.73	0.80		B		B
4	Canyon Pkwy W	None	3.91		3.91	2.39		A		A

Canyons Outline Plan
17: Canyon Parkway W & Collector Road (West)

AM Peak Hour

						
Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations						
Traffic Volume (veh/h)	138	5	30	151	111	27
Future Volume (Veh/h)	138	5	30	151	111	27
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	157	6	34	172	126	31
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	382	142	157			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	382	142	157			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	74	99	98			
cM capacity (veh/h)	606	906	1423			
Direction, Lane #	SE 1	NE 1	SW 1			
Volume Total	163	206	157			
Volume Left	157	34	0			
Volume Right	6	0	31			
cSH	613	1423	1700			
Volume to Capacity	0.27	0.02	0.09			
Queue Length 95th (m)	8.1	0.6	0.0			
Control Delay (s/veh)	13.0	1.4	0.0			
Lane LOS	B	A				
Approach Delay (s/veh)	13.0	1.4	0.0			
Approach LOS	B					
Intersection Summary						
Average Delay			4.6			
Intersection Capacity Utilization		37.2%		ICU Level of Service		A
Analysis Period (min)			15			

Canyons Outline Plan
17: Canyon Parkway W & Collector Rd (West)

PM Peak Hour

						
Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations						
Traffic Volume (veh/h)	63	5	5	171	258	75
Future Volume (Veh/h)	63	5	5	171	258	75
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	72	6	6	194	293	85
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	542	336	378			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	542	336	378			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	86	99	99			
cM capacity (veh/h)	499	706	1180			
Direction, Lane #	SE 1	NE 1	SW 1			
Volume Total	78	200	378			
Volume Left	72	6	0			
Volume Right	6	0	85			
cSH	511	1180	1700			
Volume to Capacity	0.15	0.01	0.22			
Queue Length 95th (m)	4.1	0.1	0.0			
Control Delay (s/veh)	13.3	0.3	0.0			
Lane LOS	B	A				
Approach Delay (s/veh)	13.3	0.3	0.0			
Approach LOS	B					
Intersection Summary						
Average Delay			1.7			
Intersection Capacity Utilization		30.5%		ICU Level of Service		A
Analysis Period (min)			15			

Canyons Outline Plan
8: Canyon Parkway W & Collector Road (East)

AM Peak Hour

						
Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations						
Traffic Volume (veh/h)	12	230	238	363	825	12
Future Volume (Veh/h)	12	230	238	363	825	12
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	14	261	270	413	938	14
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	1692	476	952			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1692	476	952			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	73	51	62			
cM capacity (veh/h)	52	535	717			
Direction, Lane #	SE 1	NE 1	NE 2	NE 3	SW 1	SW 2
Volume Total	275	270	207	207	625	327
Volume Left	14	270	0	0	0	0
Volume Right	261	0	0	0	0	14
cSH	364	717	1700	1700	1700	1700
Volume to Capacity	0.75	0.38	0.12	0.12	0.37	0.19
Queue Length 95th (m)	45.6	13.3	0.0	0.0	0.0	0.0
Control Delay (s/veh)	39.7	13.0	0.0	0.0	0.0	0.0
Lane LOS	E	B				
Approach Delay (s/veh)	39.7	5.1			0.0	
Approach LOS	E					
Intersection Summary						
Average Delay			7.6			
Intersection Capacity Utilization			65.7%		ICU Level of Service	C
Analysis Period (min)			15			

Canyons Outline Plan
8: Canyon Parkway W & Collector Rd (East)

PM Peak Hour

						
Movement	SEL	SER	NEL	NET	SWT	SWR
Lane Configurations						
Traffic Volume (veh/h)	5	155	152	1036	530	5
Future Volume (Veh/h)	5	155	152	1036	530	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	6	176	173	1177	602	6
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	1540	304	608			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1540	304	608			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	93	75	82			
cM capacity (veh/h)	87	692	966			
Direction, Lane #	SE 1	NE 1	NE 2	SW 1	SW 2	
Volume Total	182	565	785	401	207	
Volume Left	6	173	0	0	0	
Volume Right	176	0	0	0	6	
cSH	563	966	1700	1700	1700	
Volume to Capacity	0.32	0.18	0.46	0.24	0.12	
Queue Length 95th (m)	10.6	4.9	0.0	0.0	0.0	
Control Delay (s/veh)	14.4	4.5	0.0	0.0	0.0	
Lane LOS	B	A				
Approach Delay (s/veh)	14.4	1.9		0.0		
Approach LOS	B					
Intersection Summary						
Average Delay			2.4			
Intersection Capacity Utilization			72.7%	ICU Level of Service		C
Analysis Period (min)			15			

Canyons Outline Plan
8: Canyon Parkway W & Collector Road (East)

AM Peak Hour

							
Movement	SEL	SER	NEL	NET	SWT	SWR	
Lane Configurations							
Traffic Volume (veh/h)	12	230	238	363	825	12	
Future Volume (Veh/h)	12	230	238	363	825	12	
Sign Control	Stop			Free	Free		
Grade	0%			0%	0%		
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	
Hourly flow rate (vph)	14	261	270	413	938	14	
Pedestrians							
Lane Width (m)							
Walking Speed (m/s)							
Percent Blockage							
Right turn flare (veh)							
Median type				None	None		
Median storage veh							
Upstream signal (m)							
pX, platoon unblocked							
vC, conflicting volume	1692	476	952				
vC1, stage 1 conf vol							
vC2, stage 2 conf vol							
vCu, unblocked vol	1692	476	952				
tC, single (s)	6.8	6.9	4.1				
tC, 2 stage (s)							
tF (s)	3.5	3.3	2.2				
p0 queue free %	73	51	62				
cM capacity (veh/h)	52	535	717				
Direction, Lane #	SE 1	SE 2	NE 1	NE 2	NE 3	SW 1	SW 2
Volume Total	14	261	270	207	207	625	327
Volume Left	14	0	270	0	0	0	0
Volume Right	0	261	0	0	0	0	14
cSH	52	535	717	1700	1700	1700	1700
Volume to Capacity	0.27	0.49	0.38	0.12	0.12	0.37	0.19
Queue Length 95th (m)	7.0	20.1	13.3	0.0	0.0	0.0	0.0
Control Delay (s/veh)	97.0	18.0	13.0	0.0	0.0	0.0	0.0
Lane LOS	F	C	B				
Approach Delay (s/veh)	22.0		5.1			0.0	
Approach LOS	C						
Intersection Summary							
Average Delay			5.0				
Intersection Capacity Utilization			52.8%		ICU Level of Service		A
Analysis Period (min)			15				

Canyons Outline Plan
8: Canyon Parkway W & Collector Rd (East)

PM Peak Hour

							
Movement	SEL	SER	NEL	NET	SWT	SWR	
Lane Configurations							
Traffic Volume (veh/h)	5	155	152	1036	530	5	
Future Volume (Veh/h)	5	155	152	1036	530	5	
Sign Control	Stop			Free	Free		
Grade	0%			0%	0%		
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	
Hourly flow rate (vph)	6	176	173	1177	602	6	
Pedestrians							
Lane Width (m)							
Walking Speed (m/s)							
Percent Blockage							
Right turn flare (veh)							
Median type				None	None		
Median storage veh							
Upstream signal (m)							
pX, platoon unblocked							
vC, conflicting volume	1540	304	608				
vC1, stage 1 conf vol							
vC2, stage 2 conf vol							
vCu, unblocked vol	1540	304	608				
tC, single (s)	6.8	6.9	4.1				
tC, 2 stage (s)							
tF (s)	3.5	3.3	2.2				
p0 queue free %	93	75	82				
cM capacity (veh/h)	87	692	966				
Direction, Lane #	SE 1	SE 2	NE 1	NE 2	NE 3	SW 1	SW 2
Volume Total	6	176	173	589	589	401	207
Volume Left	6	0	173	0	0	0	0
Volume Right	0	176	0	0	0	0	6
cSH	87	692	966	1700	1700	1700	1700
Volume to Capacity	0.07	0.25	0.18	0.35	0.35	0.24	0.12
Queue Length 95th (m)	1.7	7.7	4.9	0.0	0.0	0.0	0.0
Control Delay (s/veh)	49.3	12.0	9.5	0.0	0.0	0.0	0.0
Lane LOS	E	B	A				
Approach Delay (s/veh)	13.2		1.2			0.0	
Approach LOS	B						
Intersection Summary							
Average Delay			1.9				
Intersection Capacity Utilization			41.1%		ICU Level of Service		A
Analysis Period (min)			15				

Operational Data

Main Geometry (m)

Approach and Entry Geometry

Leg	Leg Names	Approach Bearing (deg)	Grade Separation G	Half Width V	Approach Lanes n	Entry Width E	Entry Lanes n	Flare Length L'	Entry Radius R	Entry Angle Phi
1	University Dr W	0	0	7.00	2	8.50	2	50.00	20.00	30.00
2	Sunridge Blvd W	90	0	4.50	1	5.80	1	50.00	20.00	30.00
3	University Dr W	180	0	7.00	2	8.00	2	50.00	20.00	30.00
4	Riverglen Lk W	270	0	4.50	1	5.80	1	50.00	20.00	30.00

Circulating and Exit Geometry

Leg	Leg Names	Inscribed Diameter D	Circulating Width C	Circulating Lanes nc	Exit Width Ex	Exit Lanes nex	Exit Half Width Vx	Exit Half Width Lanes nvx
1	University Dr W	50.00	6.00	1	9.00	2	7.00	2
2	Sunridge Blvd W	50.00	9.00	2	6.80	1	4.50	1
3	University Dr W	50.00	6.00	1	9.00	2	7.00	2
4	Riverglen Lk W	50.00	9.00	2	6.00	1	4.50	1

Operational Results

2046 AM Peak - 15 minutes

Flows and Capacity

Leg	Leg Names	Bypass Type	Flows (veh/hr)					Capacity (veh/hr)			
			Arrival Flow		Opposing Flow		Exit Flow	Capacity		Average VCR	
			Entry	Bypass	Entry	Bypass		Entry	Bypass	Entry	Bypass
1	University Dr W	None		866		74	1871		2225		0.3892
2	Sunridge Blvd W	None		404		799	141		878		0.4598
3	University Dr W	None		1430		449	754		1743		0.8205
4	Riverglen Lk W	None		167		1779	98		516		0.3236

Delays, Queues and Level of Service

Leg	Leg Names	Bypass Type	Average Delay (sec)			95% Queue (veh)		Level of Service		
			Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Leg
1	University Dr W	None		2.69	2.69		1.72		A	A
2	Sunridge Blvd W	None		6.62	6.62		1.99		A	A
3	University Dr W	None		8.11	8.11		8.37		A	A
4	Riverglen Lk W	None		9.04	9.04		1.15		A	A

Operational Data

Main Geometry (m)

Approach and Entry Geometry

Leg	Leg Names	Approach Bearing (deg)	Grade Separation G	Half Width V	Approach Lanes n	Entry Width E	Entry Lanes n	Flare Length L'	Entry Radius R	Entry Angle Phi
1	University Dr W	0	0	7.00	2	8.50	2	50.00	20.00	30.00
2	Sunridge Blvd W	90	0	4.50	1	5.80	1	50.00	20.00	30.00
3	University Dr W	180	0	7.00	2	8.00	2	50.00	20.00	30.00
4	Riverglen Lk W	270	0	4.50	1	5.80	1	50.00	20.00	30.00

Circulating and Exit Geometry

Leg	Leg Names	Inscribed Diameter D	Circulating Width C	Circulating Lanes nc	Exit Width Ex	Exit Lanes nex	Exit Half Width Vx	Exit Half Width Lanes nvx
1	University Dr W	50.00	6.00	1	9.00	2	7.00	2
2	Sunridge Blvd W	50.00	9.00	2	6.80	1	4.50	1
3	University Dr W	50.00	6.00	1	9.00	2	7.00	2
4	Riverglen Lk W	50.00	9.00	2	6.00	1	4.50	1

Operational Results

2046 PM Peak - 15 minutes

Flows and Capacity

Leg	Leg Names	Bypass Type	Flows (veh/hr)					Capacity (veh/hr)			
			Arrival Flow		Opposing Flow		Exit Flow	Capacity		Average VCR	
			Entry	Bypass	Entry	Bypass		Entry	Bypass	Entry	Bypass
1	University Dr W	None		1870		55	948		2245		0.8330
2	Sunridge Blvd W	None		224		1575	348		591		0.3796
3	University Dr W	None		716		335	1464		1854		0.3862
4	Riverglen Lk W	None		124		879	171		848		0.1462

Delays, Queues and Level of Service

Leg	Leg Names	Bypass Type	Average Delay (sec)			95% Queue (veh)		Level of Service		
			Entry	Bypass	Leg	Entry	Bypass	Entry	Bypass	Leg
1	University Dr W	None		7.99	7.99		10.48		A	A
2	Sunridge Blvd W	None		8.56	8.56		1.45		A	A
3	University Dr W	None		2.92	2.92		1.55		A	A
4	Riverglen Lk W	None		4.56	4.56		0.42		A	A

9. Wetland Evaluation and Wetland Loss Compensation



Ducks Unlimited Canada
Conserving Canada's Wetlands

Active by nature.

June 3, 2011

Melcor Developments Ltd.
Second Floor, 1425-33rd Street North
Lethbridge, AB
T1H 5H2

Attention: Neil Johnson

Re: Wetland Loss Compensation – The Canyons Subdivision

AENV #: 00289505

Ducks Unlimited Canada confirms that Melcor Developments Ltd. has fulfilled its requirements for wetland compensation on NE 13-08-22-W4m for wetland loss as outlined in our proposal dated March 28, 2011.

Sincerely,

Craig Bishop

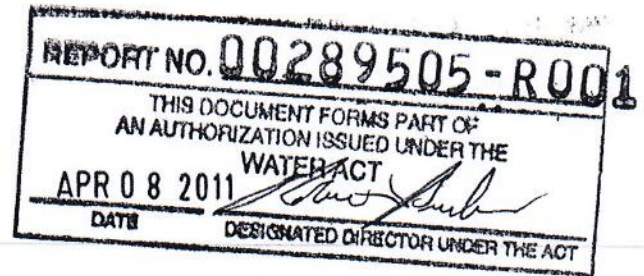
Mitigation Services Coordinator
Ducks Unlimited Canada

**Cc: Mathyk, Stephen - Alberta Environment
Tagoe, Albert – Associated Engineering**



Ducks Unlimited Canada
Conserving Canada's Wetlands

Active by nature.



March 28, 2011

Melcor Developments Ltd.
Second Floor, 1425-33rd Street North
Lethbridge, AB
T1H 5H2

Attention: Neil Johnson

Re: Wetland Loss Compensation – The Canyons Subdivision

Ducks Unlimited Canada (DUC) supports the protection of wetlands as the foundation to fulfilling the goals of the North American Waterfowl Management Plan (NAWMP), specifically the Alberta component. In cases where avoidance or minimization of the wetland impacts cannot be achieved, DUC through its proactive wetland restoration efforts supports the mitigation process by providing restoration of drained wetlands as a compensation option resulting in no net loss of wetlands.

DUC is currently engaged in implementing restoration activities for wetland loss compensation options based upon program area implementation. The wetlands to be restored will fall into the Milk River Ridge initiative and will replace the wetland loss from the proposed development with similar wetland classes within the same major watershed basin. This landscape has been identified as an important wetland restoration area, which will support the recovery of waterfowl, wildlife and biodiversity within the southern region of Alberta.

Following restoration of these drained wetlands, each individual project will be managed consistent with the Alberta NAWMP objectives. These projects and the wetlands associated with them vary in size and class. The restoration of wetlands in this initiative will provide adequate compensation for the wetland loss created by the proposed development.

The proposed development according to the wetland impact assessment supplied by Associated Engineering states that there would be a direct loss of 1.33 hectares of wetland habitat. With the replacement ratio of 3:1, 3.99 hectares of restored wetland habitat will be required. The cost of restoring these wetlands in the Milk River Ridge initiative being \$7,500/ha, this equates to \$29,925.00 as total compensation.

DUC requires written acceptance from Melcor Developments Ltd. in the space provided below. Please return a signed copy of the proposal to the address outlined below. Once approved by Alberta Environment (AENV), please remit payment to DUC by a certified cheque or Bank draft to the address as indicated on the invoice.

Upon receipt, DUC will provide a confirmation notice for Melcor Developments Ltd. and AENV's files. This proposal and the fees charged will be available for acceptance for 90 days from the date of issue. Payment must be received within 30 days after approval has been issued from AENV. If these terms are not met, DUC will not be obligated to complete the agreement.

Please feel free to call Craig Bishop at (403) 668-0974 if you have any questions or concerns regarding this proposal.

Yours Truly,


Barry Bishop

Head of Wetland Restoration - Alberta

Ducks Unlimited Canada

Cc: Tagoe, Albert -- Associated Engineering

Enclosures

I, Neil Johnson, on behalf of Melcor Developments Ltd., do acknowledge and agree to accept the Wetland Loss Compensation proposal and its terms as prepared by Ducks Unlimited Canada.


Signature of Neil Johnson for Melcor Developments Ltd.

Ducks Unlimited Canada -- Wetland Loss Compensation Proposal

Impacted Wetland Site Information

Clients Name: Melcor Developments Ltd.
Development Name: **The Canyons Subdivision**
Impact Location: NE 13-08-22-W4m
Impact Area: 1.33 ha.
Classification System: Stewart & Kantrud
Impacted Classes: Class V
Impacted Watershed: Oldman River

Restoration Compensation

NAWMP Initiative: Milk River Ridge
Restoration Watershed: Oldman River
Replacement Ratio: 3:1
Replacement Area: 3.99 ha.
Compensation Rate: \$7,500/ha.
Total Compensation: ~~\$29,225.00~~
Prepared for: Melcor Developments Ltd.
Prepared by: Craig Bishop
Ducks Unlimited Canada
Date: March 28, 2011

**APPROVAL
PROVINCE OF ALBERTA
WATER ACT, R.S.A. 2000, c. W-3, as amended**

APPROVAL NO.: 00289505-00-00

FILE NO.: 00289505

WATERBODY: Unammed Wetlands

ACTIVITY LOCATION: NE-13-008-22-W4

EFFECTIVE DATE: April 8, 2011

EXPIRY DATE: April 8, 2016

APPROVAL HOLDER: Melcor Developments Ltd.

Pursuant to the Water Act, R.S.A. 2000, c. W-3, as amended, an Approval is issued to the Approval Holder for the following activity:

constructing works in a water body;

removing or disturbing ground, vegetation or other material in a water body; and

altering the flow, direction of flow or level of water.

subject to the attached terms and conditions.

Designated Director under the Act:



Robert Burland

APR 08 2011

Date Signed: _____

DEFINITIONS

- 1.0 All definitions from the Act and the Regulations apply except where expressly defined in this Approval.
- 1.1 In all parts of this Approval:
- (a) "Act" means the Water Act, RSA 2000, c. W-3, as amended;
 - (b) "Director" means an employee of the Government of Alberta designated as a Director under the Act;
 - (c) "Regulations" means the regulations, as amended, enacted under the authority of the Act.

GENERAL

- 2.0 The Approval Holder shall immediately report to the Director by telephone, any contravention of the terms and conditions of this Approval at (780) 422-4505.
- 2.1 The terms and conditions of this Approval are severable. If any term or condition of this Approval is held invalid, the application of such term or condition to other circumstances and the remainder of this Approval shall not be affected thereby.
- 2.2 The Approval Holder shall retain a copy of:
- (a) this Approval; and
 - (b) the plan(s)/report(s) referred to in Section 3.1
- at the site of the activity at all times while conducting the activity.

PARTICULARS

- 3.0 This Approval is appurtenant the undertakings associated with the loss of wetlands at the existing wetland locations in the Canyon's Subdivision Development located in NE-13-008-22-W4 as shown on Plan No. 00289505-P001.
- 3.1 The Approval Holder shall undertake the activity in accordance with the following plan(s)/report(s):

TITLE	AENV NUMBER
Wetland Loss Compensation – The Canyons Subdivision (Ducks Unlimited Canada, Letter Dated March 28, 2011).	00289505-R001



Melcor Developments Ltd., The Canyons, Outline Plan, Development Concept, Figure 6.	00289505-P001
--	---------------

- 3.2 The Approval Holder shall not undertake the activity in any manner or use any material that causes or may cause an adverse effect on the aquatic environment, human health or public safety.

SILTATION AND EROSION CONTROL

- 4.0 The Approval Holder shall minimize:

- (a) siltation; and
- (b) erosion

of the water body as a result of the activity.

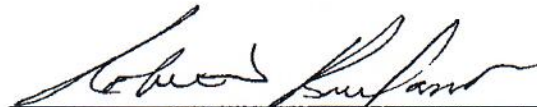
WETLAND COMPENSATION

- 5.0 The Approval Holder shall provide compensation for the loss of wetlands as stipulated in Report No. 00289505-R001 such that the Approval Holder shall pay financial compensation in the amount of \$29, 925.00 to Ducks Unlimited Canada.
- 5.1 On or before August 8, 2011, the Approval Holder shall provide to the Director written confirmation from Ducks Unlimited Canada, that the compensation stipulated in Report No. 00289505-R001 has been received.

CERTIFICATE OF COMPLETION

- 5.2 A Certificate of Completion is not required for this activity.

Date Signed: APR 08 2011


Designated Director under the Act
Robert Burland

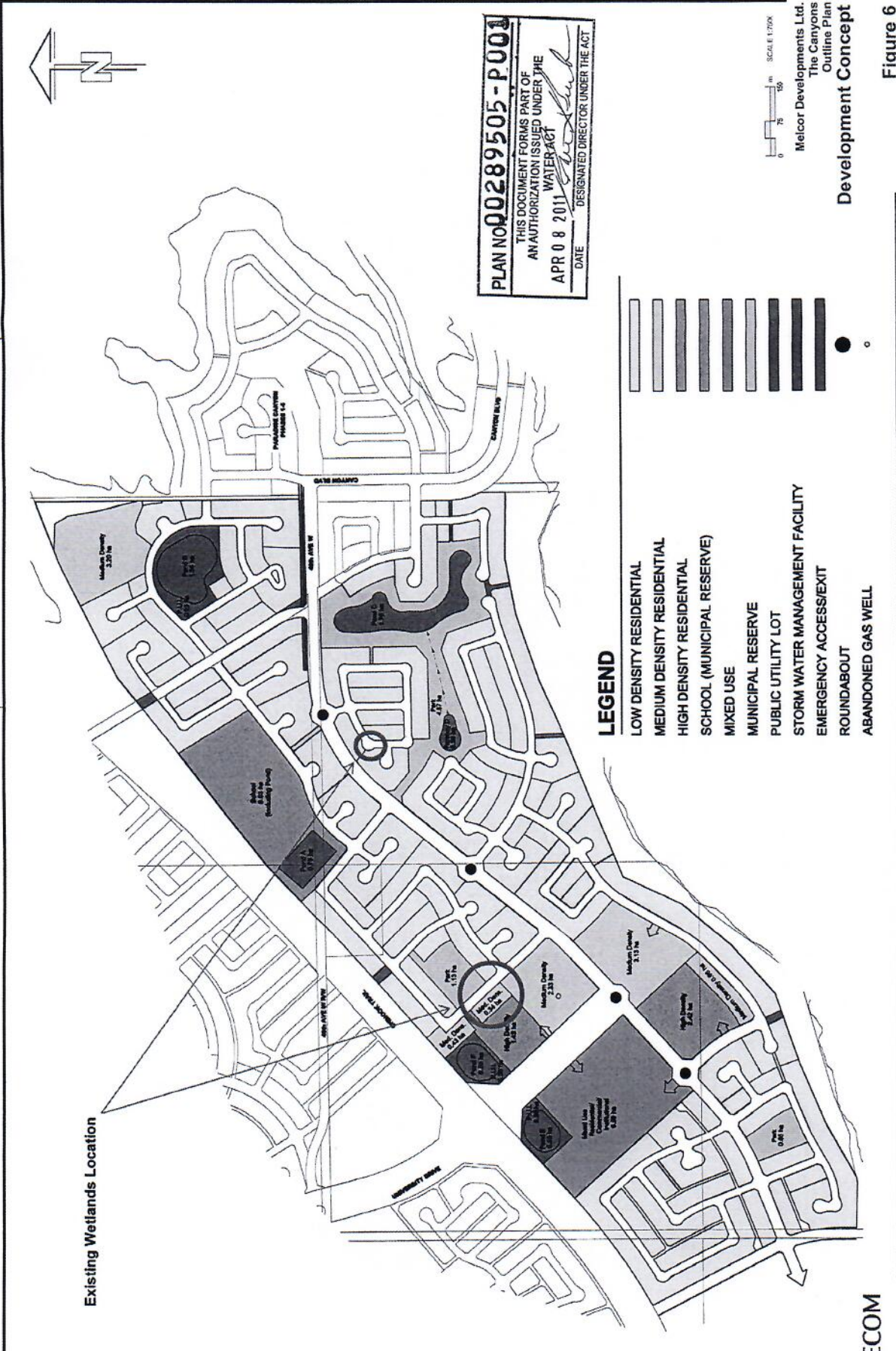


Figure 6

March 23, 2011

EBA File: L12101879.001

Melcor Developments Ltd.
2 Floor, 1425 – 33 Street North
Lethbridge AB T1H 5H2

Attention: Mr. Neil Johnson

Dear Mr. Johnson:

**Subject: Revised Wetland Classification and Delineation Assessment
The Canyons Subdivision, NE ¼ Section 13-008-22 W4M
Lethbridge, Alberta**

1.0 INTRODUCTION

As per your request, EBA Engineering Consultants Ltd. (EBA) has completed a wetland classification and delineation assessment, including a background review and field assessment, for The Canyons Subdivision development within the NE¼ Section 13-008-22 W4M, within the City of Lethbridge, Alberta. This report provides a description of the study area, a summary of the background research results, a description of field methods, the results of the field survey, and recommendations and conclusions for the proposed development.

The objective of the wetland classification and delineation assessment was to identify and classify all wetlands located within the study area according to the Stewart and Kantrud (1971) "Classification of Natural Ponds and Lakes within the Glaciated Prairie Region", and to delineate the wetlands to determine the total area of wetland that will be impacted by the proposed development.

Preparation of the Alberta Water Act application and consultation with Ducks Unlimited for compensation purposes were outside of this scope of work.

2.0 PROJECT DESCRIPTION

EBA identified two wetlands during preparation of The Canyons development outline plan in a Phase I Environmental Site Assessment (2007) and conducted a wetland classification and delineation assessment on these two wetlands. The Canyons Subdivision include; SE 24-8-22-W4M, SW 24-8-22-W4M, NE 13-8-22-W4M, North ½ of NW 13-8-22-W4M, South ½ of NW13-8-22-W4M, and SW 13-8-22-W4M. The Canyons Subdivision

development will consist of a residential development and will be in line with the surrounding land use.

The construction activities will include stripping, grading, and building within the study area (Figure 1), which will result in the loss of natural site features such as wetlands. The surrounding parcels of land to the east, north, and west have already been stripped, graded, and developed for residential land use.

3.0 HISTORICAL AERIAL PHOTOGRAPH REVIEW

Aerial photographs from 1950, 1961, 1970, 1979, 1990, 1999, and 2007 were reviewed to determine the historical ecological context for the subject site (Figures 1). The subject site appeared to be used for agricultural purposes throughout the period depicted in the aerial photographs. No substantial changes to the subject lands were observed through review of the historical aerial photographs. Surrounding land use has changed in the last few years as the surrounding land has been cleared and developed. Wetland 1 and Wetland 2 (Figure 1) appear throughout the aerial photos and change in size from year to year. Residential development to the north, east, and west of the study area has occurred since 2007.

4.0 ASSESSMENT METHODOLOGY

4.1 FIELD ASSESSMENT

A two-person crew conducted a wetland classification and delineation field survey of the study area on November 2, 2010. The survey consisted of classifying the wetlands on site using the Stewart and Kantrud wetland classification system (Stewart and Kantrud 1971). Wetlands were delineated in the field using a Trimble global positioning system (GPS) instrument and defined based upon the abundance of wetland and upland vegetation species and the distinction of these plant communities. The field crew took several photographs of the subject site and representative photographs are provided in the photographs section of this report.

The wetlands were then digitally mapped and assigned a classification using the Stewart and Kantrud wetland classification system. This classification system is widely used in southern Alberta and has been adopted by Alberta Environment (AENV) as the standard guideline for wetland delineation for compensation purposes. This system is also used by Ducks Unlimited for determining the suitable classification for wetland compensation.

Wetland classification is based on the distinct vegetational zone occurring within the central or deeper portion of the wetland and occupying 5% or more of the total wetland area being classified. There are seven wetland classes determined by Stewart and Kantrud (1971), which are as follows:

- Class I Ephemeral – Wetlands have surface water present in the spring only. These wetlands generally have low prairie vegetation species present such as Kentucky bluegrass (*Poa pratensis*), quackgrass (*Agropyron repens*), and goldenrod (*Solidago canadensis*).
- Class II Temporary – Wetlands have surface water present in the spring, for weeks in the summer, and after heavy rainfall events. These wetlands generally consist of fine low grasses, emergent rushes and sedges, weedy species such as foxtail barley (*Hordeum jubatum*), and docks.
- Class III Seasonal – Wetlands that have surface water present in the spring and summer, but are usually dry in the fall and winter. The vegetation consists of intermediate height grasses and glass-like species.
- Class IV Semi-permanent – Wetlands that have surface water in the spring and summer and frequently in the fall and winter. This wetland class consists of deep marsh vegetation and floating plants, as well as emergent vegetation such as Hybrid cattail (*Typha latifolia*) and Bulrushes (*Schoenoplectus lacustris*).
- Class V Permanent Ponds and Lakes – The permanent open water zone dominates the deepest part of the wetland area. Peripheral deep marsh, shallow marsh, wet meadow, and low prairie zones are often present, and isolated marginal pockets of fen occasionally occur.
- Class VI Alkali Ponds and Lakes – The intermittent alkali zone dominates the deepest part of the wetland area. A deep marsh zone is normally absent except occasionally for isolated patches near marginal seepage areas. A few isolated pockets of fen zone are normally present along the margins.
- Class VII Fen (Alkaline bog) Ponds – The fen zone dominates the deepest part of the wetland area. Peripheral wet-meadow and low prairie zones are often present.

4.2 HISTORICAL AERIAL PHOTOGRAPH ANALYSIS

Due to the wet conditions of the site in the year of the field assessment, EBA reviewed historical air photos and calculated the historical size of the wetlands onsite to determine an average size for each wetland for compensation purposes. Historical air photos from 1950, 1961, 1970, 1979, 1990, and 1999 were analyzed and the wetland boundaries were traced to determine size for each year. These are included in Figure 2. The size of each wetland for each year was calculated using Geographic Information Systems (GIS) software, and then compared to the other years. EBA calculated a historical average size for the wetlands and compared this to the field assessment wetland sizes.

5.0 WETLAND ASSESSMENT RESULTS AND DISCUSSION

During the Phase I Environmental Site Assessment conducted on the site in 2007 (noted in Figure 3), two wetlands were identified in the findings of the assessment. These two wetlands that were identified are also presented on Figure 1, and are the subject for this project. The majority of the subject site has been used for crop production. The wetlands were classified as a Class II Temporary wetland and a Class V Permanent Pond wetland.

5.1 WETLAND 1

Wetland 1 was delineated on November 2, 2010 to have an area of 0.48 ha, and was located within the east portion of the study area, to the south of 40 Avenue West. The average historical size of the wetland was 0.86 ha. Wetland 1 was classified as a Class II Temporary wetland that was dominated by bare soil with some remnant wetland vegetation species and a small portion of open water. The wetland vegetation consisted of pondweed (*Potamogeton natans*) and western dock (*Rumex aquaticus*). Due to the position of the wetland within an agricultural field, the outer portion of the wetland had been cropped through during our site visit (Photo 1 and Photo 3).

Through historical air photo review, it appears that Wetland 1 has been cropped through and has been impacted by the surrounding agricultural activities. During the field assessment, it was evident that the wetland had been cropped through around the border of the wetland and that crop species were present within the wetland, with few occurrences of typical wetland vegetation present.

No wildlife species were observed on or around Wetland 1 during the site assessment, though there were tracks from Canada geese (*Branta Canadensis*) found throughout the wetland.

5.2 WETLAND 2

Wetland 2 was delineated on November 2, 2010 to have an area of 2.00 ha, and a historical average size of 1.22 ha. The wetland was located within an agricultural field to the west of Wetland 1 and to the south of 40 Avenue West (Figure 1). Wetland 2 was classified as a Class V Permanent Pond wetland due to the presence of defined banks and presence of open water given the late fall timing of the site assessment. A large mound of soil was present within the centre of the wetland where a dugout has been created to provide drainage of the surrounding area. During the site assessment, the open water component of the wetland covered the area of the dugout.

The wetland vegetation consisted of hairy pepperwort (*Marsilea vestita*), barnyard grass (*Echinochloa crusgalli*), marsh cudweed (*Gnaphalium palustre* Nutt.), western dock, Canada thistle (*Cirsium arvense*), and common cattail (*Typha latifolia*). Canada thistle is listed as a noxious weed. The majority of the wetland vegetation was found along the banks of the

wetland, while no aquatic or emergent vegetation was observed. One Balsam poplar (*Populus balsamifera*) was observed within the centre portion of the wetland adjacent to the mound of soil.

During the site assessment, approximately 100 Canada geese were observed on and surrounding Wetland 2. Two mallards (*Anas platyrhynchos*) and two Franklin's gulls (*Larus pipixcan*) were also observed near the centre of the open water component of the wetland.

Due to the higher than average precipitation that the Lethbridge region received in 2010 (November 2010 field assessment), Wetland 2 had surface water present to a greater extent than would be expected for November (AENV, 2011). Through historical air photo review, it appears that Wetland 2 varied in size and general location throughout the timeframe that was analyzed and has been greatly impacted by the surrounding agricultural land use. In the 1961 air photo Wetland 2 is not visible and it appears that it has been cropped through. In the 1991 air photo a dugout is visible within the centre of the wetland and the open water component is only 0.17 ha in size. EBA reviewed the historical air photos to determine an average wetland size of 1.33 ha for compensation purposes.

6.0 HISTORICAL AVERAGE AND TOTAL WETLAND AREA

The total wetland area during the field assessment was determined using a Trimble GPS unit and walking around the outer edge of each wetland. The area for each size of each wetland was then calculated using GIS software.

The historical average size of the wetlands was determined by reviewing six historical air photos and outlining the extent of each wetland for each air photo, and calculating the size for each year reviewed (in ha). The sizes for each year were added together with the delineated size from the field assessment to determine a historical average.

The total area of the wetlands is presented in Table 1.

TABLE 1: WETLAND AREA SUMMARY			
Class	Area (ha) (from field assessment)	Historical Average Wetland Size	Total Average Size
II	0.48	0.86	0.80
V	2.00	1.22	1.33
Total	2.48 ha	2.08 ha	2.13 ha

7.0 RECOMMENDATIONS

The Provincial Wetland Restoration/Compensation Guide (November 2005) states that "A minimum replacement ratio of 3:1 is commonly used" and indicates that "...a ratio of

3:1 means three hectares of equivalent wetland must be restored for each hectare of natural wetland impacted or lost". The typical wetland compensation as determined by Ducks Unlimited is \$7,500 per hectare (for the Lethbridge Region) at a 3:1 ratio (Mr. Craig Bishop, Ducks Unlimited, personal communication 2010). While the 3:1 minimum replacement ratio is commonly used for the loss of natural wetlands, wetlands that have been directly impacted through agricultural land use and are no longer functioning as natural wetlands may be considered as being exempt for wetland compensation.

TABLE 2: ESTIMATED WATERBODY AREAS WITHIN THE SE¼ SECTION 10-026-029 W4M AND PROPOSED COMPENSATION

Wetland Class	Waterbody Type	Average Area (ha)	Proposed Compensation (area) (3:1)	Proposed Compensation
II	Temporary	0.80	0	\$0
V	Permanent Pond	1.33	3.99	\$29,925
Total		2.13 ha	3.99 ha	\$29,925

EBA proposes that compensation for the loss of the Class II temporary wetland may not be required due to the impacts to the wetland from the surrounding agricultural land use and lack of typical Class II wetland vegetation. With respect to the Class V Permanent wetland, EBA proposes compensation at a 3:1 ratio for the following reasons:

- The provincial guidelines for wetland restoration and compensation outline a ratio of 3:1 being the accepted standard for wetland compensation where the loss of naturally occurring wetlands will be offset by the creation of or restoration to larger established wetlands.
- Wetland 1 and Wetland 2 did not appear to provide any regionally environmentally significant habitat to wildlife or plant species with respect to unique habitat features, location of the wetlands within the watershed, or with respect to the abundance or diversity of wildlife or plant species found. The proposed wetland area restoration or financial compensation areas will provide important habitat and play a key role in enhancing more ecologically sensitive riparian and aquatic ecosystems as dictated by Ducks Unlimited.

EBA recommends avoiding construction activities in and around the wetlands during the migratory bird timing window (March to August).

EBA proposes a 3:1 restoration or financial compensation for this project for the Class V wetland, consisting of either 3.99 ha of Class V wetlands, or a total financial compensation of \$29,925 to be allotted to a wetland restoration agency (Ducks Unlimited).

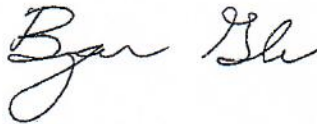
8.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Melcor Developments Ltd. and their agents. EBA does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Melcor Developments Ltd., or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in EBA's Services Agreement and in the Geo-environmental Report – General Conditions provided in Appendix A of this report.

9.0 CLOSURE

We trust the contents of this report meet your present requirements. Please contact Mr. Shawn Martin or Mr. Bryan Gale at our Calgary office if you have any questions, comments, or concerns.

Respectfully submitted,
EBA Engineering Consultants Ltd.



Bryan Gale, B.E.S., EPt
Environmental Scientist
Environment Practice
Direct Line: 403.203.3305 x230
bgale@eba.ca

/rcm



Shawn Martin, B.Sc., P.Biol., R.P.Bio., EP
Project Director, Natural Sciences
Environment Practice
Direct Line: 403.723.6948
shmartin@eba.ca

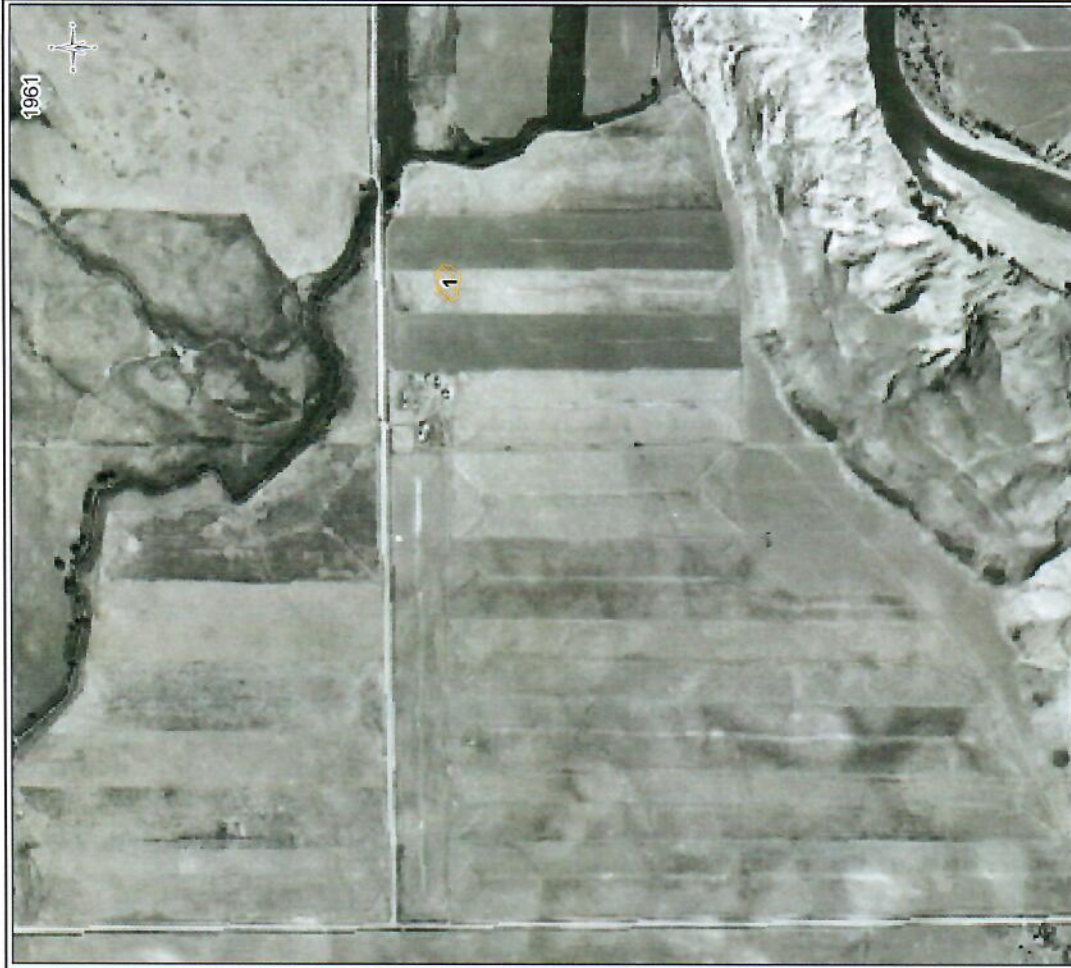
REFERENCES

- Alberta Environment, Alberta NAWMP Partnership. November 2005. Provincial Wetland Restoration/Compensation Guide. Alberta Environment Information Centre. Edmonton.
- Alberta Environment, Precipitation % Normal Map. 2011.
<http://www.environment.alberta.ca/forecasting/data/precipmaps/nov2010/watyearnorm.pdf> (Accessed on February 3, 2011)
- Ducks Unlimited. November 10, 2010. Mr. Craig Bishop, Personal Communication.
- EBA Engineering Consultants Ltd., June 2007, Phase I Environmental Site Assessment Phase I Environmental Site Assessment, 4005 – 10 Street West, 4040 – 10 Street West, 4805 – 10 Street West, 5050 – 10 Street West, 5255 – 10 street West, 500 – 40 Avenue West, 505 – 40 Avenue West, 509 – 40 Avenue West, 650 – 40 Avenue West, 4 Canyon Boulevard West Lethbridge, Alberta. EBA File No. L22101051
- Stewart, R.E., and Kantrud, H.A. 1971. Classification of Natural Ponds and Lakes in the Glaciated Prairie Region. Washington D.C. Northern Prairie Wildlife Research Center – Division of Wildlife Research, United States Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife.



FIGURES





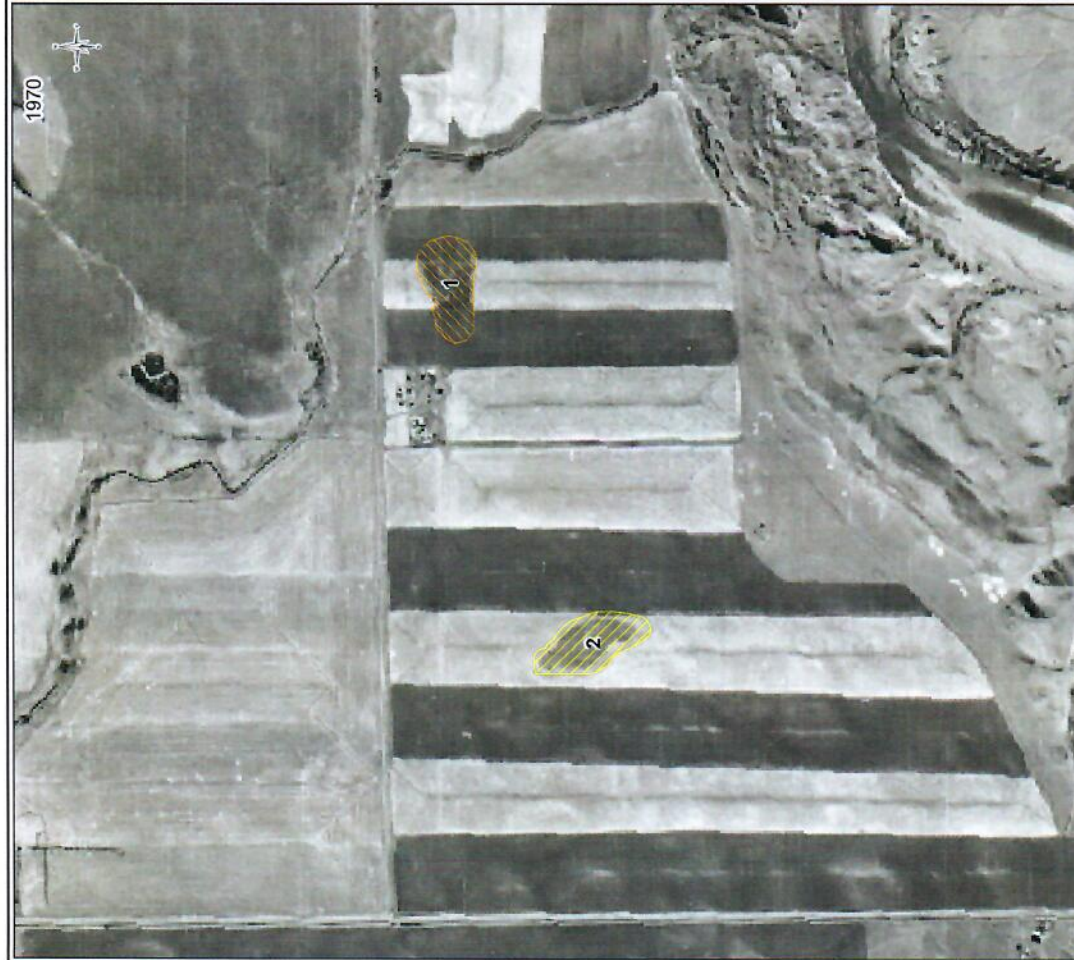
Legend

-  Class 2 Wetland
-  Class 5 Wetland

AERIAL PHOTOGRAPH REVIEW

Historic Aerial Photograph Review										EBA Engineering Consultants Ltd.		Figure 2	
13-008-22 W4M										EBA		Page 1/3	
50 25 0 50 Metres										Scale 1:8,000		DATE	
PROJECT NO. L1201879_Montage_1cd.mxd										DATE 14/03/2011		REV 0	
PROJECT NO. L1201879										DATE		REV	
UTM ZONE 12										DATE		REV	
BM BG										DATE		REV	
EBA-RV										DATE		REV	
February 2 2011										DATE		REV	

NOTES
Image source: Alberta Sustainable Resource Development (1950, 1961, 1970, 1975, 1991 and 1999)



Legend

-  Class 2 Wetland
-  Class 5 Wetland

AERIAL PHOTOGRAPH REVIEW

13-008-22 W4M

Historic Aerial Photograph Review

FILE NO.	PROJECT NO.	DATE	SCALE	DATE	DATE
L12101879_Montage_2013.mxd	UTM ZONE 12	14/03/13	1:5,000	REV	13-008-22 W4M
L12101879	DATE	DATE	DATE	DATE	DATE
BM	BM	BM	BM	BM	BM
BM	BM	BM	BM	BM	BM

NOTES
Image source: Alberta Sustainable Resources Development
(1950, 1961, 1970, 1979, 1991 and 1999)



1991



1999

Legend

-  Class 2 Wetland
-  Class 5 Wetland

AERIAL PHOTOGRAPH REVIEW

13-008-22 W4M

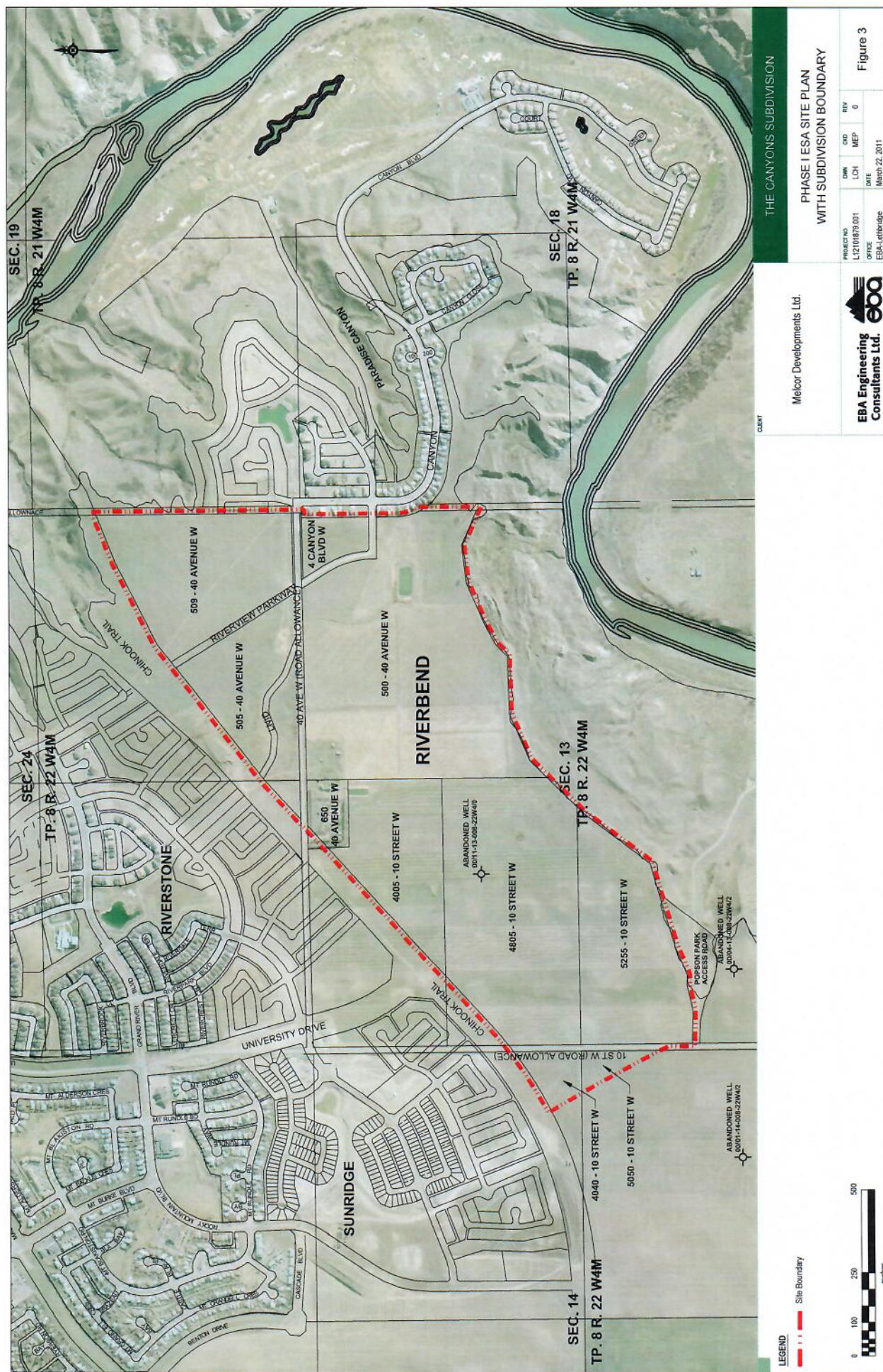
Historic Aerial Photograph Review

FILE NO.	112101079	PROJECT NO.	112101079
DATE	14/03/03	DATE	14/03/03
BY	BM	BY	BM
CHKD	BG	CHKD	BG
OFFICE	EEA-RV	OFFICE	EEA-RV
SCALE	1:8,000	SCALE	1:8,000
DATE	February 2, 2011	DATE	February 2, 2011

EEA Engineering Consultants Ltd.

Figure 2
Page 3/3

NOTES
Image source: Alberta Sustainable Resource Development (1950, 1961, 1970, 1979, 1991 and 1999)





PHOTOGRAPHS



Photo 1
Looking southwest across Wetland 1



Photo 2
Pondweed and Canada goose prints observed on the east boundary of Wetland 1



Photo 3

Looking north from the south boundary of Wetland 1, across a small open water component



Photo 4

Looking south from the north boundary of Wetland 2



Photo 5

Looking east from the west boundary of Wetland 2, towards a soil mound and Balsam-poplar tree in the centre of the Wetland



Photo 6

Looking north from the south boundary of Wetland 2



Photo 7

Looking at cattails and barnyard grass found in the north corner of Wetland 2



Photo 8

Looking north from the east bank of Wetland 2, showing the transition between open water, banks, and crop field



APPENDIX

APPENDIX A GEO-ENVIRONMENTAL REPORT – GENERAL CONDITIONS

GEO-ENVIRONMENTAL REPORT – GENERAL CONDITIONS

This report incorporates and is subject to these “General Conditions”.

1.0 USE OF REPORT AND OWNERSHIP

This report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment.

This report and the assessments and recommendations contained in it are intended for the sole use of EBA's client. EBA does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than EBA's Client unless otherwise authorized in writing by EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of EBA. Additional copies of the report, if required, may be obtained upon request.

2.0 ALTERNATE REPORT FORMAT

Where EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed EBA's instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of EBA's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except EBA. The Client warrants that EBA's instruments of professional service will be used only and exactly as submitted by EBA.

Electronic files submitted by EBA have been prepared and submitted using specific software and hardware systems. EBA makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

3.0 NOTIFICATION OF AUTHORITIES

In certain instances, the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the client agrees that notification to such bodies or persons as required may be done by EBA in its reasonably exercised discretion.

4.0 INFORMATION PROVIDED TO EBA BY OTHERS

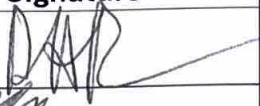
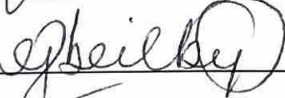
During the performance of the work and the preparation of the report, EBA may rely on information provided by persons other than the Client. While EBA endeavours to verify the accuracy of such information when instructed to do so by the Client, EBA accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

10. Open House

Canyons Outline Plan Amendment

Open House: February 25, 2026

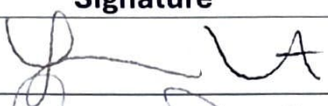
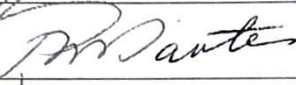
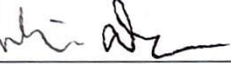
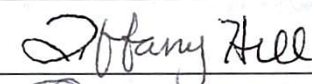
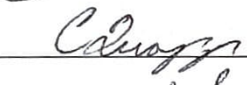
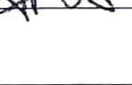
Sign-In Sheet

Name	Signature	Address
Roy Remus		306 CEPW
Shari Remus		306 CEPW.
Megan Thompson		84 Canyon Blvd W
Kenneth Thompson		84 Canyon Blvd W
Audrey Regner	Audrey Regner	23 Canyon Estates Lane
Richard Regner	Ril Regner	23 Canyon Estates Lane
Ron Freng	R. Freng	408 Canyon Ridge Circle
Ali Freng	Ali Freng	"
Karen Forsyth	K. Forsyth	275 Canyon Estates Way
Marg Schlaht	Marg Schlaht	198 Canyon Estates Way
Ron SCHLAHT	Ron Schlaht	198 CANYON ESTATES WAY WEST
Nick Beruby	N. Beruby	10th St. 4005 West
Elena Zurelauta		19 Rivergrove Lane W
Cam Denecky	Cam Denecky	4005 10 St. West
Emily Beilby		347 Canyon Meadows Rd W.
Taymaz Goharian		617 canyon ridge Ct W
Jessie Ellis		9 Canyon Blvd
Geoff & Diane Page	Geoff & Diane Page	223 CANYON ESTATES WAY W

Canyons Outline Plan Amendment

Open House: February 25, 2026

Sign-In Sheet

Name	Signature	Address
LISA NAST		331 CANYON MEADOWS RD W.
Jenae Dunlop		941 Canyonview Pl W
Shawn ^{Harrison} Darlene		319 Canyon Meadows Rd W.
Karla Gwyn		800 Canyonview Close
Jimm DEVERIES		800 CANYONVIEW CLOSE W.
Raige Sauter		Canyonview Landing.
Bill/Kristin/Klaire McKAY		1064 CANYON BLVD W
Jodie Dunbar		255 Canyon Estate Way West
Tiffany Hill		183 Sixmile Ridge South.
Eno Ayemala		115 Canyon Estates W.
Christine Quapp		635 Canyonview Landing
Marie France ^{Beaud}		626 Canyon View Landing W
Charlene ^{Thorlacius}		350 Canyon Meadows Rd → outline plan needs to be changed!
Bruce McKillop		263 Canyon Boulevard West
ADINA SANDERSON		1072 Canyon Blvd W.
Scott Bowch		420 Canyon Ridge Cir W
Ryan + Shanna Peto		306 Canyon Meadows Rd.

CANYONS OPEN HOUSE COMMENT SHEET (February 25, 2026)

- still 1 road in or out
- School by busy road with multi residences planned - possible bottleneck with no other route available

CANYONS OPEN HOUSE COMMENT SHEET (February 25, 2026)

- We have continued concern about the powerlines still above ground behind Canyon Blvd. W.
- We were promised they would be put underground 10 years ago 2016 and a green space would replace lines
- Concerned about the one way in one way out - emergency exits won't be enough. - Real Fire concerns in this community - please improve infrastructure first.

CANYONS OPEN HOUSE COMMENT SHEET (February 25, 2026)

any options to look at pathways + sidewalk connections that are incomplete (gaps) to connect existing developed area to the school.

CANYONS OPEN HOUSE COMMENT SHEET (February 25, 2026)

Cool excited for the school! Thanks :)

CANYONS OPEN HOUSE COMMENT SHEET (February 25, 2026)

I AM WORRIED ABOUT ACCESS OUT OF THE AREA
IN CASE OF A FIRE, I ROAD OUT AND WE NEED
EMERGENCY ACCESS OUT!

CANYONS OPEN HOUSE COMMENT SHEET (February 25, 2026)

Concerned re # medium density units
& impact on traffic & property
values especially the east most (NE)
plot on the corner side.

CANYONS OPEN HOUSE COMMENT SHEET (February 25, 2026)

Think about adding commercial development where business is on main floor and owner lives above, like in Copperwood.

Plus maybe a community pub? please?
would be nice to have something within walking distance of many in the community!



CANYONS OPEN HOUSE COMMENT SHEET (February 25, 2026)

This outline plan "2026" is unacceptable for 2 reasons:

- ① The current transportation infrastructure to and within The Canyons (Canyon Estates, Canyon meadows, Canyon, Paradise Canyon) is not good enough/big enough to handle the residents let alone the huge increase in traffic that a school brings. As well, the location of the school will cause a traffic congestion nightmare at the only corner/road that all residents of the Canyons "must" use to enter and exit the Canyons.
- ② The canal that was to

run from Riverstone to Canyon meadows Road - creating park + water view to all lots surrounding (which we paid extra for) has been "erased" in this new plan! There was no reason to take away our canal view. It must be returned or else there will be many angry homeowners who will be considering their legal options. We bought ~~an~~ reliance of promises made by Melcor.

Most importantly - without extra roads entering + exiting the canyons, you have created a safety + emergency liability.

CANYONS OPEN HOUSE COMMENT SHEET (February 25, 2026)

Megan Thompson
megancethompson@gmail.com

Concerns:

★ Emergency access. There is a single entry & exit into these neighbourhoods. Given the population increase (residents), staff at commercial area & school, staff at golf course, and golfers and the traffic that is generated from this will pose a major safety concern in the event of an emergency. In a major emergency the proposed access points will be insufficient to handle the demand of everything I mentioned above. If an emergency is at the proposed school, there will also be an increase of traffic from concerned parents/family members.

There are more appropriate sites to build a school within Lethbridge that will ensure safety for the school and community.

↳ Flip over

Given the single entry/exit, the lack of efficient emergency redundancy, established older/retired mobility limited demographic, and absence of infrastructure need, this location is fundamentally unsuitable for a school, or anything of this nature that poses this kind of increase in population/traffic.

If Chinook Trail existed before these proposed changes, this may change emergency access concerns.

CANYONS OPEN HOUSE COMMENT SHEET (February 25, 2026)

Concern #2

Increased Traffic

Where are the traffic impact assessments, when were they completed, and by whom? What are peak vehicle projections and stacking lengths in/out of the community? Will parking areas for the school, commercial district, and medium density residential units accommodate the new level of traffic? Will buses have specific routes?

Concern #3

A school was already ~~proposed~~ ^{removed} in 2009 Canyons Outline Plan. What changed? Where is the current proposed plan?

L3 Flie over ②

Concern #4

The addition of Medium Density Residential at the point will directly impact property values negatively. Residents chose these communities based on the luxury feel, limited - no medium density existing units, and quiet location ideal for retirement as it was not near immediate services/busy roadways. The main feature of this community is the Paradise Canyon Golf resort, which also contributes to the luxury feel of the community. Adding medium density units will detract from the reason residents chose to live here in the first place.

CANYONS OPEN HOUSE COMMENT SHEET (February 25, 2026)

Concern #5

- Is there a formal request from a school / division / board, or is this a land-use placeholder want?

There are already a large number of schools within the West Side of Lethbridge. Also, Lethbridge is not a large area from any side to the other, therefore it does not take much time to travel to any of the existing schools.

From: [CHARLENE THORLACIUS](#)
To: [Perry Neufeld](#); brad_smdi@outlook.com
Cc: charthor@shaw.ca; rzucco@shaw.ca; [BILL PONECH](#); [Bill Ponech](#)
Subject: New 2026 proposed outline plan for the Canyons - complaint
Date: February 25, 2026 8:53:37 PM

February 25, 2026

Hello Perry,

Thankyou for taking the time to talk to us about your proposed new outline plan for the Canyons. Thankyou for staying calm despite having to deal with many angry people - including me.

As stated, and for the written record, my husband and I (and many others who were too afraid to speak out) have TWO significant concerns regarding your new plan:

1. There has always been a storm water management plan from Riverstone through the Canyons. The plan has always seen a wet canal/creek running visibly from Riverstone and visibly through the Canyons (the empty land just east of Denecky's farm) to the back of the houses along Canyon Meadows Road.

When I was considering purchasing my house at 350 Canyon Meadows Road, both myself and my realtor (Bill Ponech) contacted you about what would be developed behind my house. You sent us the outline plan showing a wet canal/creek visibly running all the way from Riverstone to the back of my house. It also showed some grassy areas along the sides of the canal and a walkway for people to walk along the canal and enjoy the water and wildlife. Based upon your assurances that this would be my view, I bought the lot (paid extra as it was a "view" lot). I am aware that you had the same discussion with others on my street who asked for your assurances as well (before they bought). The view of a running canal/creek was the selling point for all of us.

In your new (2026) plan drawing, the amount of green space behind my house has remained the same, BUT, for no rational or explainable reason, you have decided that the creek/canal will be covered over and that it will run "hidden" underground. There, instead, will only be grass and a walkway behind our houses. THIS IS ENTIRELY UNACCEPTABLE! The people of Canyon Meadows politely but firmly demand that the "visible" creek/canal be returned to the outline plan and that the area be developed with a visible creek/canal running through the greenspace as depicted in all drawings from 2009 - December 2025.

In all of the write ups by Melcor and the City, including in the outline plan, the Canyons has been promised to be, and advertised as, a higher end subdivision specifically with abundant green spaces, water, wildlife and pathways. We expect you and the City to honour your promises. Please provide a revised 2026 outline plan that restores the creek/canal behind my house and please publish that revised plan for the public to view. (A number of us heard you state to me, at the open house, that you would return the canal/creek to the Plan...Thankyou... I await these revisions).

2. The location of the school proposal is UNACCEPTABLE. There is currently NO traffic infrastructure in place, nor proposed, that would allow a school (and all of its parking lots, fields, etc) to be built in the Canyons "east" of university drive. University Drive, past Riverstone, is a ONE lane road. Canyon Parkway is a ONE lane road. The corner where you want to put the school is the ONLY entrance and exit from the Canyons. As it sits currently, ALL of the residents of: Paradise Canyon (and its golf course patrons), Canyon Point, Canyon Estates, and Canyon Meadows use this ONE (one lane) road to get to and from our houses. There is already enough congestion on that road. There are no other roads to use.

Lets look at reality: The school will employ hundreds of employees who will now be driving on our one road (all congregating at the corner we need to get through to leave the Canyons). Then we need to add in all of the children and their parents who will be coming and going on that ONE road to get to and from school at least twice a day (with congestion forming at that specific corner). Then you add the buses that will be coming into and out of our ONE road, at that very corner, to drop off and pick up children twice a day.

There will be congestion and backlogs at the only corner of our ONE street - impeding our entrance and exit to ALL of the homes in the extended Canyons subdivision. This is not just a huge inconvenience - IT IS A SAFETY LIABILITY. The City's response was " don't worry - one day there will be 2 small dirt roads that will exit on to Chinook Trail". THIS IS UNACCEPTABLE! There is no plan to develop Chinook Trail. I will likely be dead before there is a third road to the south side. There will be no other exits out of our subdivision - ever - except at the very corner that the School will be overtaking/impeding/blocking/congesting!

It was argued that it is most convenient for Melcor/the City to place a school along University Drive. With respect, Your convenience does not trump our lives/ our convenience/ our safety. If Melcor/the City want to put a School on University Drive, Melcor owns plenty of undeveloped property on the west side of University Drive that currently does not affect "any" people and can be developed with ample PROPER roads/exits for not only a school, but also any commercial development. Accordingly, we the people of the large Canyons subdivision politely but firmly demand you re-locate the School to the "west" side of University Drive.

Please revise the 2026 online plan to reflect this important change, and please publish a new 2026 outline plan reflective of this change (as well as the one mentioned above in point number 1).

As an aside: It is unfortunate that Melcor/City chose to hold the open house in the winter when many of the Canyon residents have gone south for the winter. I am quite positive if they knew about this new proposal they would be objecting quite loudly.

thank you,
Charlene Thorlacius

From: [Megan Thompson](#)
Subject: Canyons Open House Follow Up Questions
Date: February 27, 2026 12:51:55 PM
Attachments: [image.png](#)

Dear Melcor Developments Ltd., City of Lethbridge Planning & Development, and Lethbridge School Division,

I am a resident of Paradise Canyon and recently attended the public open house regarding the proposed amendments and future development plans within The Canyons area.

In order to better understand the proposed amendments and to provide informed feedback to other community members, I am respectfully requesting clarification and access to supporting information related to the following items.

The Canyons Outline Plan Amendments & Demographics

The original Outline Plan was approved in November 2009. In December 2017, an amendment was approved to remove a school site and introduce a Mixed Use Residential/Commercial block, citing “changing community demographics” as the rationale.

On Page 9, Section 1.3 of The Canyons Outline Plan it is stated that:

“The ASP provides for a community core in southwest Lethbridge, which includes four unique neighbourhoods, two significant school sites and a commercial area.”

1. Given the existence of St. Patrick Fine Arts Elementary School (Riverstone) and Senator Joyce Fairbairn Middle School (Mountain Heights/Sunridge), how was the requirement for “two significant school sites” within the referenced ASP determined to be unmet?
2. Only nine years after the approval to remove a school, an amendment is now being sought to reintroduce a school.
 - a. What updated demographic data or enrollment projections support this reversal?
 - b. Where can this information be reviewed?
3. If community demographics have changed or are projected to change to this extent, will updated assessments be completed, including but not limited to:
 - a. Traffic Impact Studies (TIS)
 - b. Emergency Access and Fire Protection Assessments
 - c. Stormwater Management Assessments
 - d. Sound Attenuation Studies
 - e. Water Distribution and Sanitary Collection capacity reviews
 - f. Additionally, has a School Siting and Safety Assessment been completed to confirm that the proposed location is the safest available

option?

4. Why is an elementary school being proposed as opposed to a middle school or high school?

Emergency Access / Fire Protection

The Canyons, and Paradise Canyon currently rely on a single access route in and out, including in the event of an emergency.

The Canyons Outline Plan's Emergency Services Access Points and Fire Protection information assumptions appear to rely on *Chinook Trail West*, which:

- Does not currently exist,
- Is not under construction, and
- Does not appear to be included in an approved and funded capital plan.

Despite being a conceptually envisioned roadway for over 40 years now, Chinook Trail West remains non-operational.

As such, any Emergency Modeling and Fire Protection planning that relies upon Chinook Trail West being operational, appears to rely on infrastructure that is neither in existence nor committed.

Given the proposed increase in density and the addition of a large elementary school, emergency services planning should be evaluated based on:

- The current build road network, or
- Infrastructure that is fully approved, funded and scheduled for construction.

Accordingly, clarification is requested regarding:

1. Whether Chinook Trail West is formally approved, funded, and scheduled for construction.
2. Whether a formal review and endorsement from Lethbridge Fire & EMS exists regarding emergency access/emergency modeling, and fire flow assumptions for The Canyons and whether such analysis assumed Chinook Trail West to be operational.
3. How emergency response times and access redundancy are calculated if Chinook Trail West is not available.

The complex terrain of The Canyons – including significant grades, high wind exposure, limited access points, extended emergency response routes, and phased development sequencing – has the potential to increase risk in the event of a fire or other emergency events and warrants careful consideration in access and response planning.

Transportation & Traffic

Two Traffic Impact Studies (TIS) are referenced within The Canyons Outline Plan; however, the two Appendices E and H, regarding the specific TIS could not be located.

1. When were the TIS listed in Appendix E and H conducted?
2. Could copies of Appendix E and Appendix H be provided?
3. Given the proposed school site and commercial district, will new Traffic Impact Studies be conducted to assess:
 - a. AM and PM peak hour traffic,
 - b. School drop-off and pick-up scenarios, and
 - c. Increased pedestrian and bus activity?
4. Section 5.3 in The Canyons Outline Plans regarding *“Forecast Traffic Volumes”* references that *“overall daily traffic volumes are comparable to the original 2009 TIS. As such, all the forecast traffic volumes on the roadway links are within the City of Lethbridge Standards for each respective roadway classification”*
 - a. Has the original 2009 TIS been recalibrated within the last 5 years, and
 - b. If not, why is a 2009 baseline considered reliable for public safety and access decisions?
5. The Canyons Outline Plan also references lane and laneless dwellings. Will roadway widths and parking provisions be sufficient to:
 - a. Accommodate resident and visitor vehicles, and
 - b. Function safely during winter parking bans when on-street parking is restricted?

Environmental & Wildlife Considerations

Section 2.1 of The Canyons Outline Plan regarding *“Existing Features”* notes the presence of a prairie rattlesnake hibernacula and consultation with Alberta Sustainable Resource Development regarding mitigation.

While Section 2.2 references an Environmental Site Assessment (ESA), Appendix B (Phase I ESA) appears limited to contamination and environmental liability and does not assess wildlife presence or impacts to species at risk.

Given the site’s location within a native prairie, coulee and river valley-adjacent landscapes known to support multiple federally and provincially listed species – including, but not limited to:

- a. Burrowing Owl,
 - b. Piping Plover,
 - c. Ferruginous Hawk,
 - d. Loggerhead Shrike,
 - e. Long-billed Curlew,
 - f. Northern Leopard Frog, and
 - g. Prairie Rattlesnake
1. Was a Wildlife Impact Assessment, Species-at-Risk Assessment, or Environmental/Biophysical Impact Assessment completed, and if so, where can

it be reviewed?

Irrigation Canal & Stormwater Sustainability

The existing Canyons Outline Plan Section 2.1 and Section 8 references an Irrigation Canal/Irrigation water which is intended to supplement water levels in the wet pond, supporting naturalized stormwater features and ecological enhancements.

The proposed Outline Plan map appears to omit this irrigation canal, showing only pathways and park/recreation areas.

1. Was the irrigation canal omitted intentionally or in error?
2. If intentionally removed or covered, what hydrological mechanism replaces it to sustain naturalized storm ponds?
3. How does the revised design meet stated ecological enhancement objectives without a reliable water source?
4. Will a Biophysical Impact Assessment, updated Stormwater Management Report, and Wetland/Aquatic Habitat Evaluation be completed if the irrigation canal is removed?
5. How will potential nuisance conditions (e.g., stagnant water, algae growth, mosquito breeding) and habitat failure be mitigated should it be removed?

Thank you for your time and consideration. I look forward to your responses and to reviewing the supporting materials related to these proposed amendments.

Sincerely,



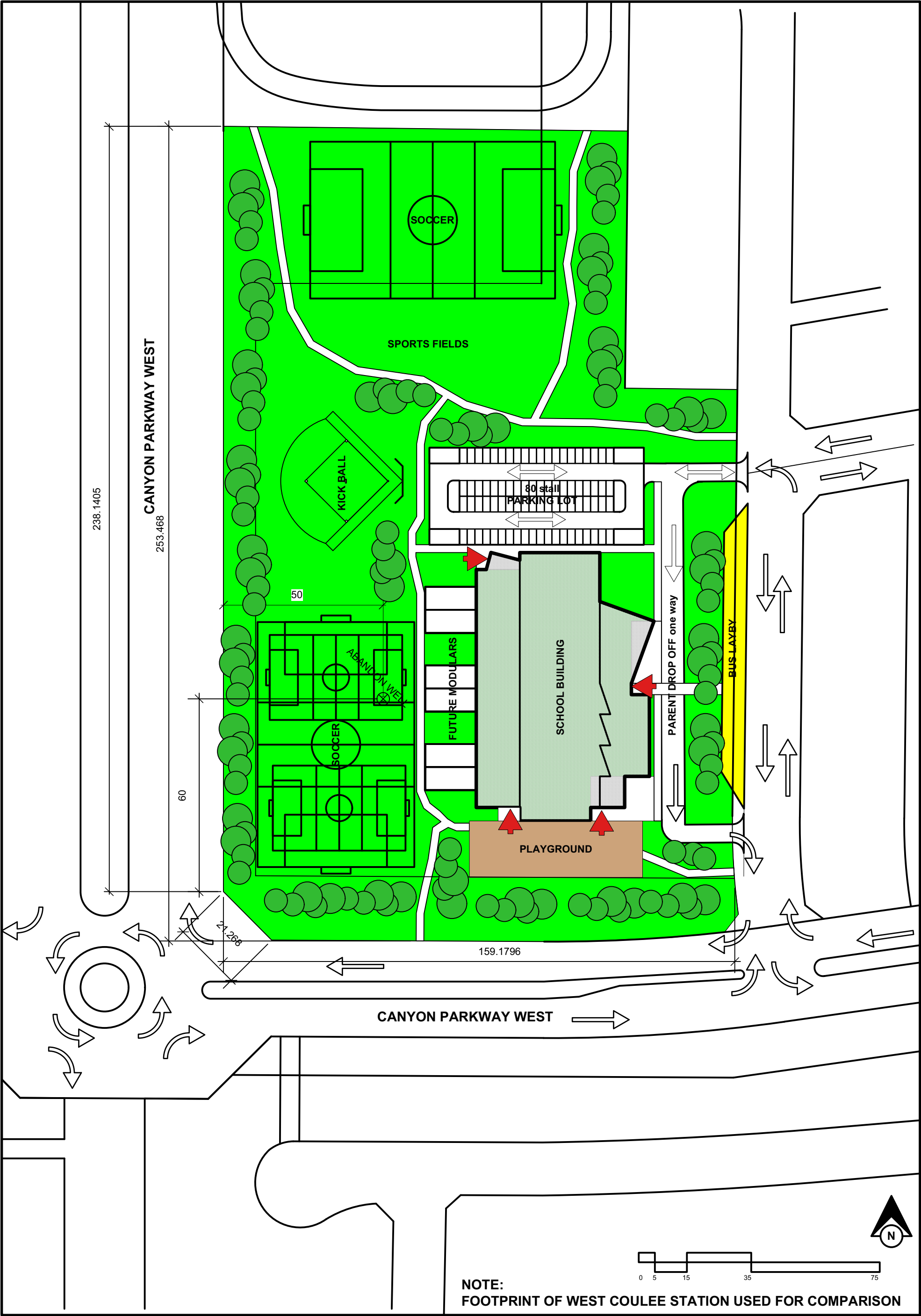
Megan Thompson, CD
Paradise Canyon Resident

--



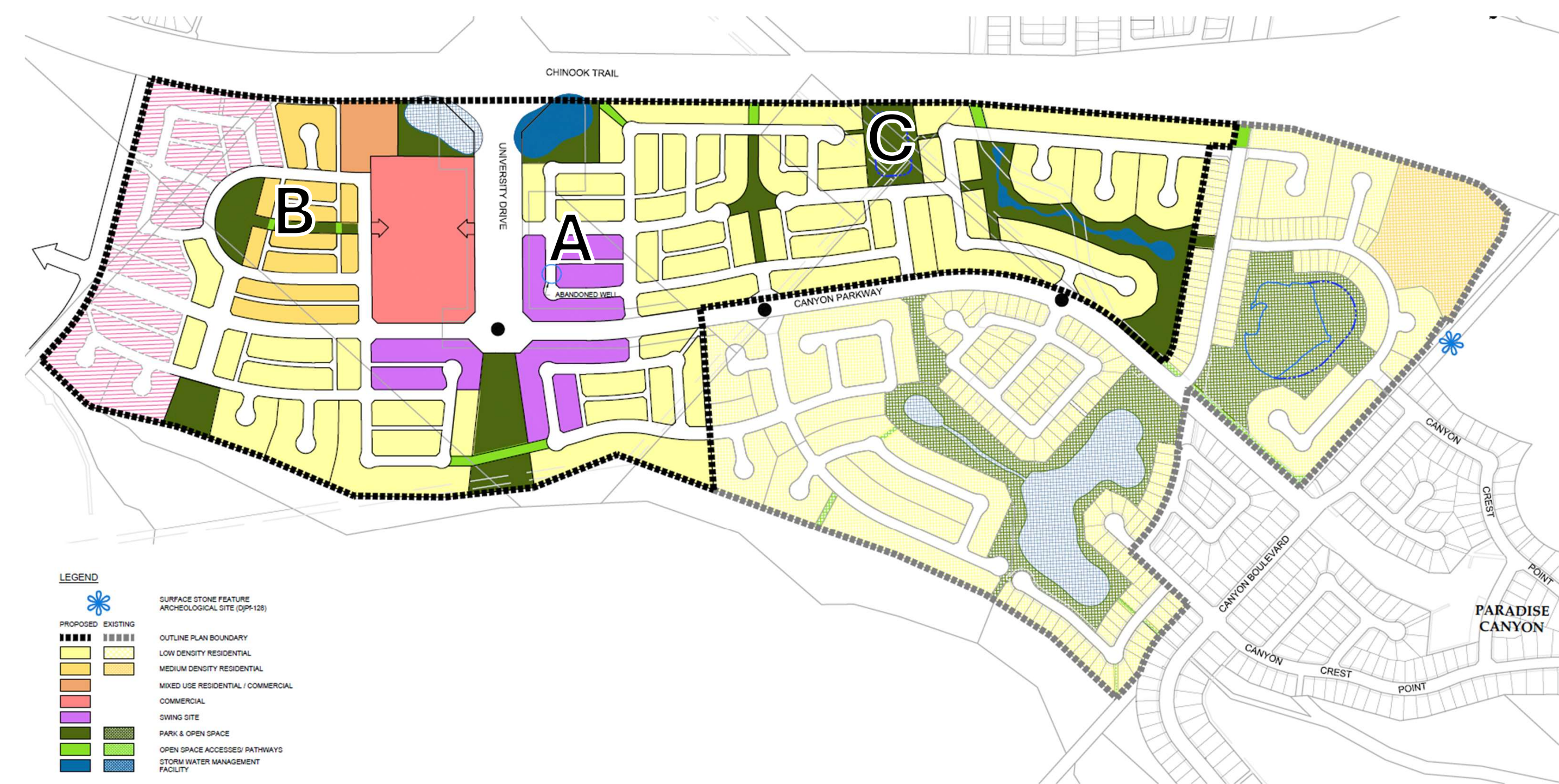
Megan Thompson, CD

email: megancethompson@gmail.com

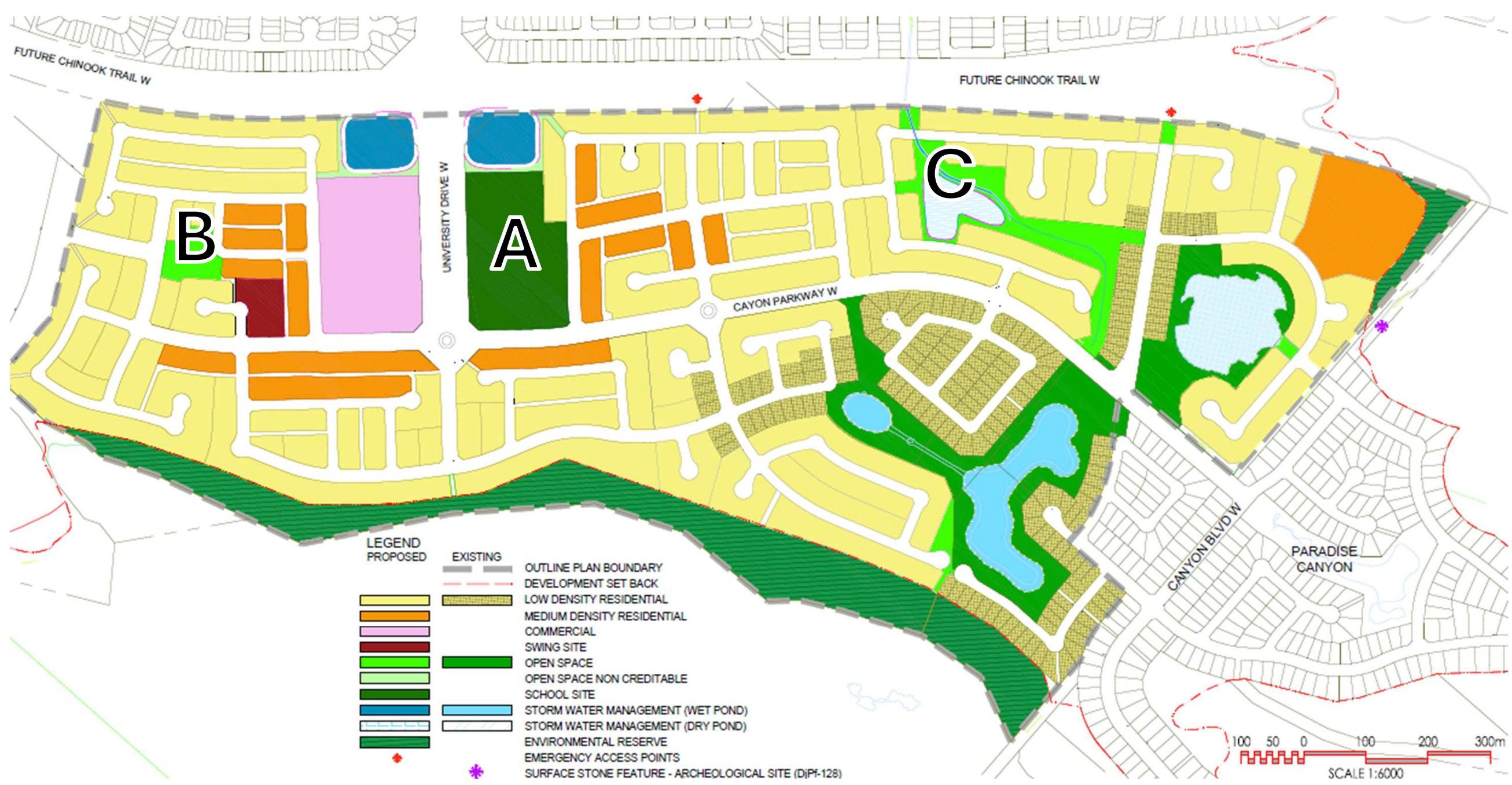


Canyons Land Use Concept

2017 Land Use Concept



2026 Land Use Concept



Community Plan Changes

- A** Addition of 9-acre School Site
- B** Reconfiguration of western plan area
- C** Relocation of stormwater pond to Linear Green Space

2026 Plan Statistics

Developable Area (320 Acres)

Population (4,800)

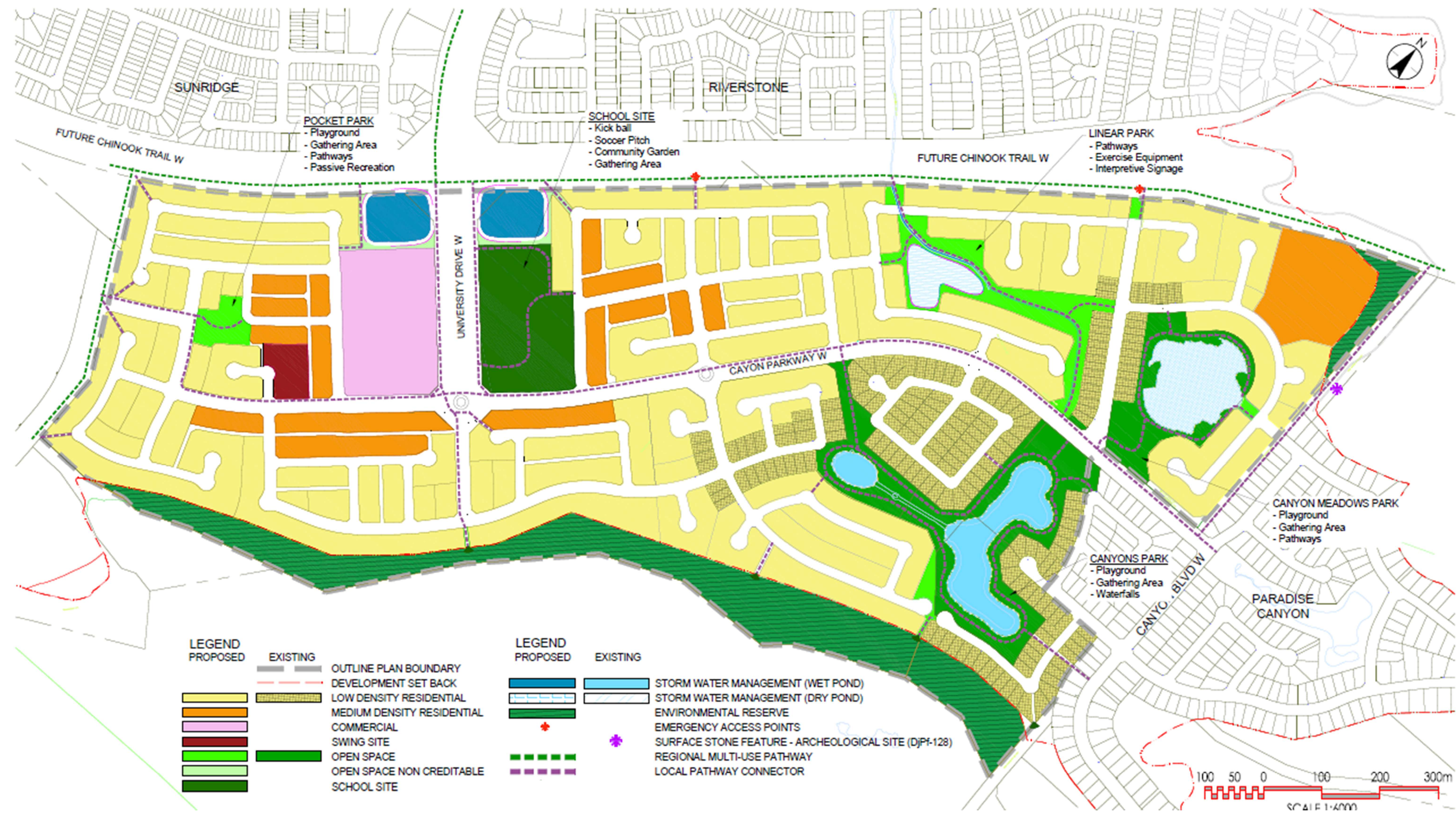
Single Detached Residences (1,180)

Multi-Family Units (560)

Commercial Parcel (9.9 acres)

Park Space (30 acres)

Canyons Open Space



Open Space Statistics

5 Programmed Park Spaces (30 acres)

Naturalized Areas (28 acres)